

SN3090

By

TREAD CORPORATION

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Unibody



Heavy ANFO 1



Heavy ANFO 2



Quad with rear hosereel 1



Quad with rear hosereel 2

 ***Warning Sign (used throughout this manual)***

Safety

Around the world in our industry safety is of the utmost importance. To meet this objective we have done a comprehensive study of the regulations that apply and have incorporated our interpretation of these regulations into the design. These safety features include interlocks on boom discharge outlets, controls systems that will not allow operation to start without being reset. These are only a few.

Stability

The blasting industry experiences some of the roughest terrains in the world. We are the second on the job behind the drill many times. By extensive use of Finite Element Analysis, we have produced a unique design allowing more material to be hauled in a shorter body with a lower center of gravity than a conventional design.

Light Weight

A vehicle's empty weight is its greatest enemy. Whether traveling across the highway or in off road service every pound of capacity lost to body weight is a pound of product that cannot be hauled. The new UniBody with the same capacities as conventional designs weighs about 20% less. This amounts to 2000 to 3000 pounds of additional payload that can be transported across the highway legally. In an off road application this means that more payload can be hauled with less effort and lower ground contact pressures.

Maximum Flexibility

The most difficult decisions in selecting a bulk truck is making sure that we do not over spend or under buy. This is an age-old problem. The first form of flexibility comes in the form of capacity. This is addressed in a unique way. The new UniBody has convertible bins to allow the customer maximum flexibility to haul all ANFO, a 30% emulsion blend, a 50% emulsion blend or pure emulsion. The unique part is that through conversion of the bins and the truck design, the UniBody will be able to haul almost the same amount of each product. The bin conversion can be completed in about four hours with normal mechanics tools. While this is not meant to be changeable on a load-by-load basis, users will have the ability to meet customer's changing needs.

The next form of flexibility comes in the ability to change capability. The new UniBody can be upgraded from an ANFO truck to a heavy ANFO truck to a QUAD. These steps can be taken at the user's discretion and all of the existing parts can be incorporated in the upgrade. These upgrades are bolted on and can be done by the user with normal maintenance people.

The fenders of the unit incorporate a unique design allowing change panels to be replaced with added functional capability. For instance a panel can be removed and an emulsion metering pump module can be simply bolted in place. The balance of the meters, piping and hydraulic system also are bolt on items.

Easy to Maintain

The new UniBody is designed with maintenance in mind. All shaft seal and bearings require no attention. No attention means no lubrication, no adjustment, and a long life. The remaining lubrication points are all brought down to the fender level, allowing for

easy access. The rotate mechanism is a integral motor and gearbox unit that carries the full load of the boom's weight and rotation. This device is modified for use in the harsh ANFO environment. Use of hydraulic tubing is maximized to increase cooling and reduce chafing and wear problems related to hydraulic hoses. Hydraulic components are covered where possible to keep them safe from the elements. The unit is manufactured with the minimum number of bolted connections. These are only a few of the features allowing for more boreholes time and less down time.

High Value

The new UniBody is designed to give the owner/user outstanding value. This comes in three forms.

The UniBody capabilities can be expanded, as your business requires, making it a universal asset to your growing business.
The UniBody allows the maximum amount of payload as a byproduct of light body weight.
The average bulk body last 20 years and wears out three chassis. This being said, the paybacks are limitless over the life of the unit.

These points will also add to the resale value of the unit.

Clean Appearance

The UniBody is the first bulk truck designed from the ground up with countless number of hours of input from customers, and our field service people. Tread's state of the art design tools have been coupled with our state of the art manufacturing facility. This combination of design and build capability allows us the luxury of incorporating all of the utilitarian features that the customer needs into a unit with a highly appealing appearance. What you see is what you are and the new UniBody line gives you the ability to impress any user.

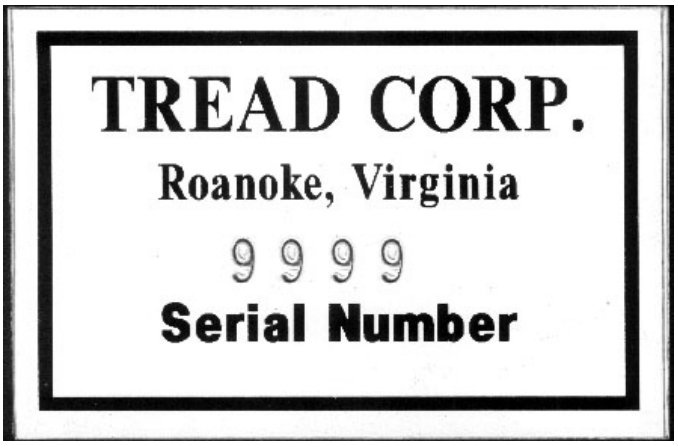
Model Identification

The Tread Corporation UniBody model number is used to define the Body Size, Body Style, Body Material, DOT Specification, Auger Size, Auger Style, Auger Material, Reel Size, Reel Style, Reel Material, Gassing Components and Control System.

BODY				-	AUGERS			-	REEL			-	GAS	-	CONTROL
BODY SIZE	BODY STYLE	BODY MAT'L	DOT SPEC		AUGER SIZE	AUGER STYLE	AUGER MAT'L		REEL SIZE	REEL STYLE	REEL MAT'L		QTY		TYPE
1608 2607 2614 3216 3716 4216 4219	M = Minipumper R = Repump A = Anfo U = Unibody	C = Carbon S = Stainless	01 = NON 06 = 406 12 = 412	-	0 = None 8 = 8-10-8 1 = 10-10-10	0 = None F = Front R = Rear S = Side	0 C S	-	0 = None 1 = 1.5 inch 2 = 2 inch 3 = 3 inch 4 = 2@1.5"	0 = None F = Front R = Rear	0 C S	-	0=0 1=1 2=2		P=proBlast D=DCC+ I=iBlast S=SCS A=ACS
2607	M	S	06	-	0	0	0	-	4	R	S	-		-	
2607	M	S	12	-	0	0	0	-	4	R	S	-		-	
2614	R	S	06	-	0	0	0	-	2	R	S	-		-	
3216	R	S	06	-	0	0	0		2	R	C	-		-	
3216	R	S	12	-	0	0	0		2	R	S	-		-	
3216	A	C	01	-	8	R	C	-	0	0		-		-	
3216	A	S	01	-	8	F	S	-	0		0	-		-	
3216	U	C	01	-	8	R	C	-	2	R	C	-		-	
3216	U	S	06	-	8	F	S	-	2	R	S	-		-	
3216	U	S	12	-	8	S	S	-	2	R	S	-		-	
4216	R	S	12		0	0	0		3	F	S	-		-	
4216	A	C	01	-	1, 8	R	S		0	0	0	-		-	
4216	A	S	01	-	1, 8	F	S		0	0	0	-		-	
4216	U	C	01	-	1, 8	R	C	-	2	F	C	-		-	
4216	U	S	06 (1)	-	1, 8	F	S	-	2	F	S	-		-	
4216	U	S	12	-	1, 8	S	S	-	3	F	S	-		-	
4219	A	C	01	-	1	R	C		0	0	0	-		-	
4219	A	S	01	-		F	S		0	0	0	-		-	
4219	U	C	01	-	1	R	C	-	2	F	C	-		-	
4219	U	S	06 (1)	-	1	F	S	-	2	F	S	-		-	
4219	U	S	12	-	1	S	S	-	3	F	S	-		-	

(1) DOT 406 SPEC TANKS IN 42 SQFT PROFILE HAVE A DE-RATED CAPACITY FOR HIGHWAY USE.

Serial Numbers



All Tread Corporation UniBody bodies are numbered serially. It is important that you know your serial number when calling Tread Corporation with questions regarding your UniBody. The serial number may be found on the body at the ladder location. This is done to give us a reference number that is unique to each specific body. This allows us to help you with trouble- shooting your unit in the field. When you call in for parts or help with your unit, it is very important to have this number in hand. If your tag has been lost or has become unreadable, we can help you find this information through a search of the truck files. Your company should have this data on file as it was on the original invoice. We cannot stress the importance of having this number available when calling for help. Your company unit number is not kept on file in our records as the unit may have changed hands a few times since it was originally built, and this would make keeping up with this information almost impossible.

The Treadbed serial number tag is mounted near the ladder. This is done to give you a reference as to where to look for the tag. The tag is white and about 2”x3”. This tag carries a four-digit number that is unique to your unit.

Hatch covers



Hopper bodies are equipped with hatch covers that are used as closure for the AN/ANFO compartments. The hatches are on slides allowing them to be opened under the bin. These hatches are designed to keep rain and other foreign material out of the product. Their other purpose is to keep product from blowing out of the unit during travel. These covers should be open only during filling and when dislodging hung product.



WARNING: Your hopper is a confined space and should ONLY be entered following all rules that apply from your company as well as OSHA and MSHA.



Many of your companies have BATF preloading variance that allows you to load your unit the night before the shot. When this is done, the variance has rules that must be followed. Each company has specific rules and we will not attempt to cover them now, however, almost all of them require the locking of the AN hopper and emulsion tank.



Hatch cover daily inspection and maintenance:

Make sure that the hatch cover is free of foreign material and the unit slides freely on the guides.

Inspect the locking device to make sure that it works freely and accepts the lock properly.

If the hatches have become bent or do not fit properly, they should be repaired or replaced at once.

When the vehicle is moved over the highway or between the bench and the pattern, the hatches should be secured properly.

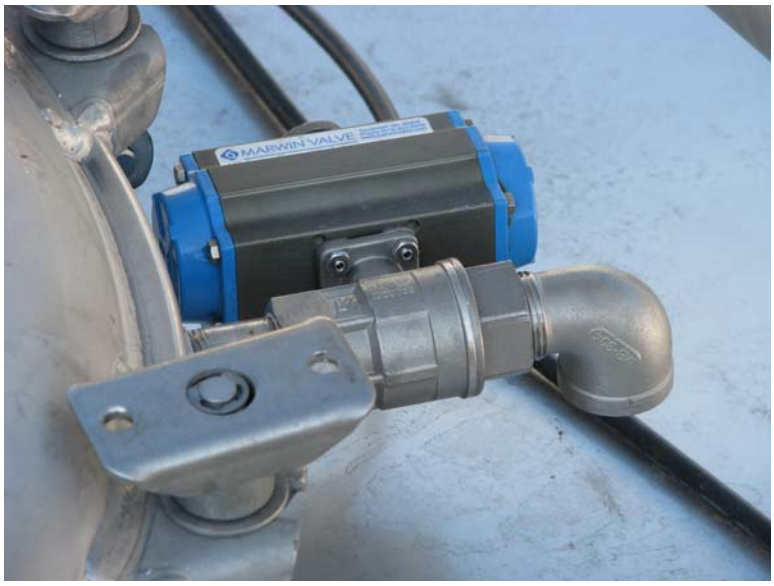
Emulsion Tanks

Emulsion tanks are built to perform three major tasks:

1- Transport emulsion safely on the job site and across the highway.
2- Prevent a spill in the event of an accident.
3- Provide the maximum scavenge for the pump. This is achieved through design. All sides slope toward the pump at the steepest angles possible. This leaves the minimum amount of product left in the tank when it is empty.









Daily inspection and maintenance:

Manhole should be opened and a visual inspection should be made of the tank interior for foreign material.
The tank-open valve should be actuated to make sure that the vent is operating properly.
If the vent is not coming to the full open position, check for lack of air pressure or clogged or disconnected airlines in the system.
Check to make sure that the breathing vent is not clogged.
Inspect tank for any dents or any other form of deformation.
Check cab information to be sure all proper documentation is in place.
Make sure all valves and vents are operating properly.

DOT certification applies to tanks that are built to the US DOT regulations. In these cases, this would apply to MC 306, MC 406, and MC 412 tanks. These tanks are certified when they are built and this certification must be renewed on a periodic basis.

They must pass a external visual and leakage test annually. A registered inspector must conduct these tests.

The transport of bulk explosives is forbidden by the DOT and, therefore, is done under exemptions. The exemption must be marked on the tank. Every company operates under different exemptions and the inspection criteria are spelled out in the specific exemption.

> *IT IS THE RESPONSIBILITY OF THE UNIT'S OWNER TO ENSURE THE INSPECTION CRITERIA MEETS THE PARTICULAR CRITERIA OF HIS EXEMPTION.*

As stated previously: If these documents have been lost or become unreadable they should be replaced as soon as possible.
Your site manager should be notified of any loss of documents as soon as possible.

Flex Mount System



Tread Corporation has developed a new body mounting system for bulk trucks called ***Flex Mount***. The new mounting system supports the body along its entire length on UHMW polyethylene mounting sills and uses a spring-loaded tie-down system that allows for body movement due to chassis flex. The spring-loaded attachment brackets permit vertical movement of the body which reduces stresses at the attachment points that might otherwise damage the chassis or the body. The continuous mounting sill transfers uniformly distributed loads to the truck frame for reduced flexural stresses, while the UHMW material protects the top surface of the frame flange from damage.

Daily inspection and maintenance:

1 - Check chassis bracket bolts for tightness.
2 - Check flex mount springs for any sign of cracking or breakage.
3 - Check flex mount bolts for properly adjusted spring height of 1.5 inches.

Preventative Maintenance

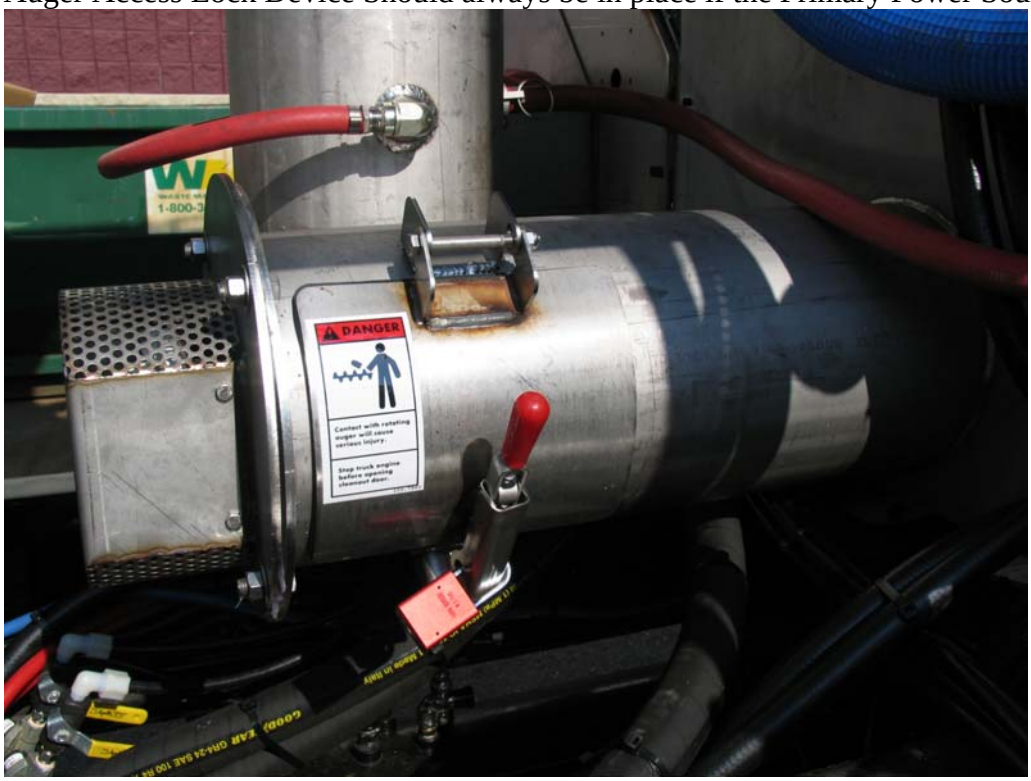
Introduction

This manual covers preventative maintenance procedures recommended by Tread Corporation for the safe and efficient operation of Tread bulk trucks. Several different styles and general arrangements of trucks have been manufactured throughout the years. In order to be as concise as possible, this comprehensive manual was created. In doing so, there may be sections that will not apply to your specific truck. However, if you need additional information, don't hesitate to contact your Tread Corporation representative. Don't forget, preventative maintenance sheets are located at the conclusion of the manual.

Ensure that you practice safe work habits while performing your regular maintenance program. This includes all lockout and tag out procedures.

MSHA / OHSA Requirements
Lock out / tag out always applies when doing maintenance.
No welding or spark producing work can be preformed around any part of the delivery equipment until it has been washed down and all oxidizer material removed.
Before welding or spark producing work can performed to hollow shafts, the shaft shall be thoroughly cleaned inside and out and vented with a ½" diameter opening.

Auger Access Lock Device Should always be in place if the Primary Power Source is NOT LOCKED OUT



Your auger inspection doors should be unlocked and opened ONLY in compliance with the stated tag out/lock out procedure following all rules that apply from your company as well as OSHA and MSHA.

Auger Access Lock Device

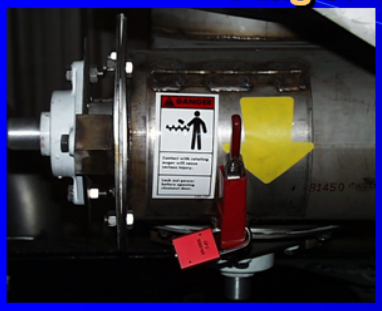


Auger Warning- Remember Multiple People can Lock out a Piece of equipment

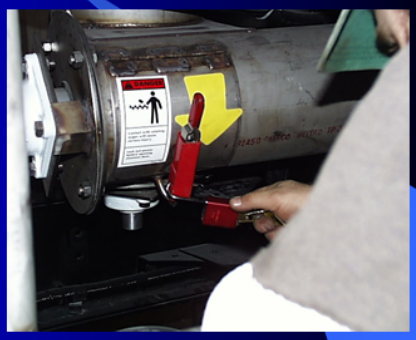




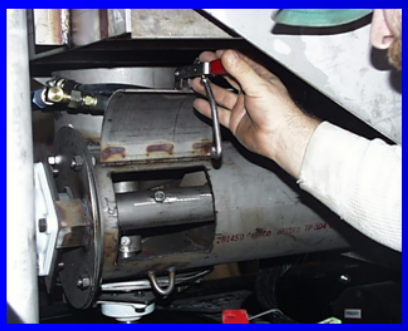
Auger Inspection Doors



- Locked during normal operation.



- Located at auger intersections.



- Unlocked only for maintenance of auger system – After Lock Out / Tag Out

General Information

Grease and oil specifications
Grease all bearings with high grade, anti-friction grease of medium to medium-soft consistency. The grease must be free of acid, alkali, or any filler, which could act as a lapping agent.
Fill all gearboxes with SAE 80W-85W – 140 gear lube.

Lubrication
Emulsions pump shafts.
Gear reducer on the boom swing drive.
Gear reducer located on the hose reel boom.
Hose reel boom pulley axle bearings.
Hose reel bearings.
Main pump drive shaft.
Main pump slip joint.
Brush Nickel never seize compound over any exposed moving part every two weeks.
Valve-body handle linkages.

Keeping Your Equipment Clean
Due to the corrosive nature of commercial explosives it is to your benefit to periodically wash your truck to ensure that the expected lifetime for the unit is reached. ***It's very important that the auger system be kept free of any and all loose material when the truck is stored overnight or for extended periods of time.***

Fasteners
All fasteners are stainless steel to prevent servicing problems. It is imperative that all fasteners that are lost or damaged be replaced with matching stainless steel hardware.

AN Body

Both ladders and walkways should be cleaned on a daily basis to ensure that no items or materials could be present that could cause a slip, trip, or fall.
Daily inspect all welded and bolted joints to assure a safe situation.
Make sure that the hatch covers are free of foreign material and the units slide freely on the guides.
Inspect the hatch-locking device to make sure that the rod moves freely and accepts the lock properly.
If the hatches have become bent or do not fit properly, they should be repaired or replaced at once.
Replace any locks that are missing or damaged.
Check general condition of the body for deformation or leaks.
Inspect all lights for function.

Emulsion Tank

Both ladders and walkways should be cleaned on a regular basis to ensure that no items or materials could be present that could cause a slip, trip, or fall.
Inspect all welded and bolted joints to assure a safe situation.
Inspect tank for dents or other physical deformation.
Insure all appropriate tank information is located in cab of truck.
Manhole should be opened and a visual inspection should be made of the tank interior for foreign material prior to loading.

- The "tank open" air valve should be actuated to ensure that the vent is operating properly. The vent should not leak air. If it is, then it should be repaired or replaced at once.
- Check to make sure the breathing vent is not clogged
- Operate the main tank valve to make sure that it is opening and closing fully

Inspect the suction piping between the pump and valve to check for leaks. There are rubber couplings in the suction piping that form the seal at the pipe intersections. If these units show cracks or other deterioration they should be replaced at once.
Inspect the main valve bolts and operating linkage to assure that all parts are intact and properly functioning.
Inspect the airlines for leaks and chafing.

Mounting System

Flex Mount System
Check chassis bracket bolts for tightness
Check flex-mount springs for any signs of cracking or breakage.
Check flex-mount bolts for properly adjusted spring height of 1.5 inches.

Rear Bumper

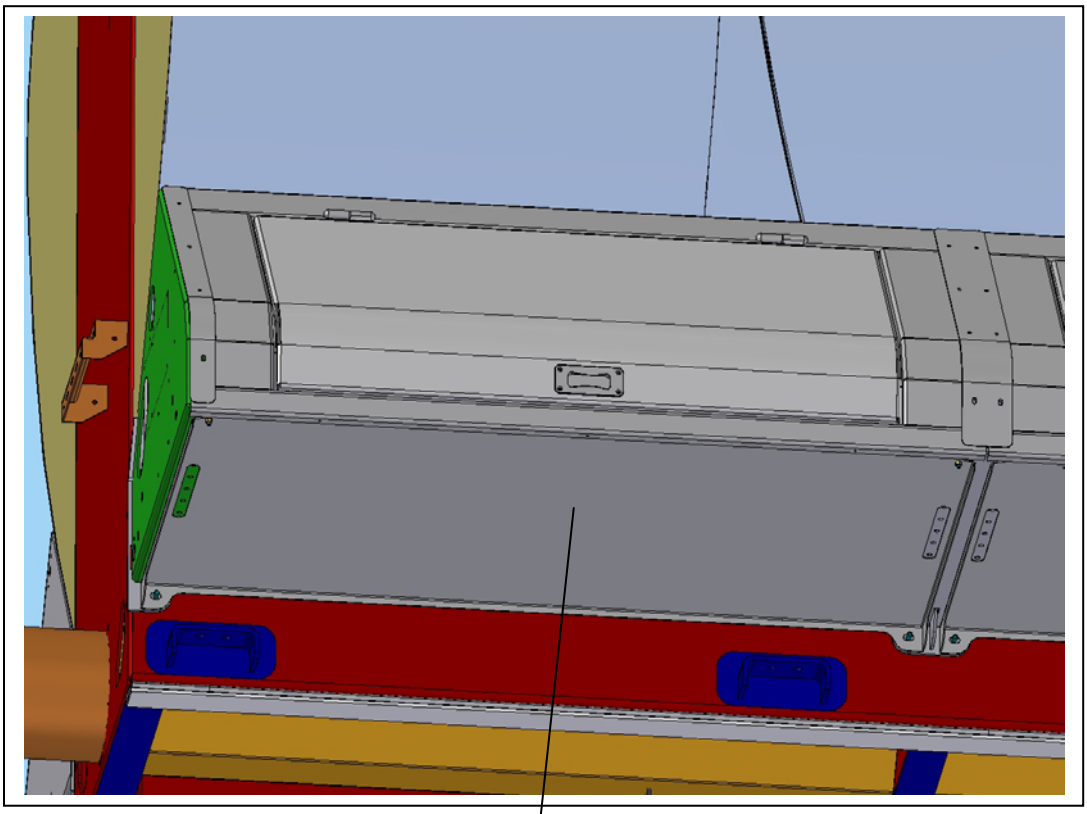
Inspect for any damage to the bumper that would lessen its ability to withstand a rear end collision.
Inspect the under-run unit for any damage that would impair its designed function.
All lights should be in place and in working order.

PTO and Main Hydraulic Pump

Check mounting bolts
Check airlines for leaks.
Check application cable for proper fitting and function.
Check drive shaft and lubricate u-joints.
Check and lubricate drive shaft slip joint.
Inspect pump for leaks and poor hose condition.

Compartment Dust Pan Removal

Each UniBody compartment has a removable dust pan. It may be very advantageous during maintenance to first remove a pan for better access. These pans are the only shield against debris entering the compartment from the bottom. If they are removed it is critical they be reinstalled. This will help protect components and keep the compartment clean.



Removable dustpan on underside of compartment.

Hydraulic System

Check condition of all hoses and replace any that are chafed, cracked, or show signs of internal failure.
Check system for leaks.
Ensure tank is full of quality oil matched to the ambient temperature ranges of your area. Our most common oil is VG-68 (SAE 20) oil. Colder conditions may require VG-32 (SAE 5) whereas warmer climates may need a VG-100 (SAE 30).
Filter should be changed at least once a month or engine service intervals, whichever comes first.
Ensure filters are installed correct
Oil should be changed at least every two years.
If oil appears to be white change oil immediately

 ***WARM HYDRAULIC OIL CAN CAUSE SERIOUS INJURIES***

Air System

Check filter for foreign material or water, clean if necessary
Ensure lubricator bowl is full of high-grade oil such as air tool oil and adjusted properly. The lubricator should introduce a few drops of oil into the system upon operation of any air valve. Consult your manual for more information and instructions for adjusting the lubricator.
Check for leaks in the console as well as the entire air system.
Spray all valve knobs and stems with a lubricant while repeatedly operating valve to ensure smooth operation and prevent seizing of valves.
Check all detent valves for proper operation. If they fail to work, replace them at once.

 ***DO NOT REMOVE AIR PIPES UNDER PRESSURE***

Valves

Ensure all valve function properly prior to loading.
Ensure all knobs are in place and functioning properly.
Lubricate spool ends on all selector valves weekly to prevent seizing.
Coat valve spool handles with never seize weekly

Bed Auger

Check drive motor for leaks, paying special attention to the shaft seal.
With the truck empty and locked out, inspect augers for missing or loose drive bolts.
Make sure there is no foreign material in the auger intersection area.

Ensure Lock and Tag out Procedure is followed prior of inspection of augers



Vertical Auger and Housing

Checks drive motor for hydraulic leaks, paying special attention to the shaft seal.
Make sure that all inspection doors are closed and secured before starting operation.
Replace any locks that are missing or damaged.
With the auger empty and locked out, inspect augers for missing or loose drive bolts. Make sure there is no foreign material in the auger intersection area.

ALWAYS LOCK AND TAG AUGERS PRIOR OF INSPECTION

Boom Auger and Housing

Checks drive motor for hydraulic leaks, paying special attention to the shaft seal.
Ensure cylinder clevis pins are in place.
Inspect for leaks around cylinder fittings and rod seal.

With the auger empty and locked out**,** visually inspect that auger through bolts are in place and secure. In order to inspect the bolts, lower the boom to the ground and after ***de-powering truck, locking it out, and supporting boom*** look into discharge end of boom to inspect through bolts.

 ***ALWAYS LOCK AND TAG AUGERS PRIOR OF INSPECTION***

Emulsion Pump(s) and Pressure Piping

Grease all pump bearings
Check drive motor for hydraulic leaks, paying special attention to the shaft seal.
Check for leaks at the product inlet or outlet of the pump.
Ensure all pump mounts are tight and not cracked or broken.
Check all piping for leaks and if found, repair immediately.

Check that all bolts attaching piping to pump are in place and properly tightened.
Ensure that at least one replacement burst disc and two gaskets are located in the cab of the truck.

Fuel Oiling System

Clean pump strainer.
Check the drive coupling, spider, shaft and motor to ensure that all are tight and in good working order
Check drive motor for leaks, paying special attention to the shaft seal.
Check the pump and piping for leaks.
Check tank and cap for leaks.
Periodically check injectors to ensure that they are free of foreign material.
Periodically check pump backlash (9/16 in.) and relief valve settings (100 psi).

Surge Hopper

Clean any residual product from the clear view window.
Keep all lockout devices in working order and in place.
The locking mechanism on the clean out door must be adjusted in order to seal the clean out door.
View the inlet and outlet of the surge hopper each week for product build-up.
Check the fasteners that attach the surge hopper to the product pump.
Ensure the probe is properly attached to the surge hopper.
Check to make sure that the lid of the probe is tight and provides a good seal to the probe body.
Test the level periodically to ensure that the probe is set and operating properly. If your unit needs adjustment consult the manual provided with the truck or call your Tread Corporation representative.

Hose Reel and Boom

Ensure gearbox is full of the rated gear lubricant.
Check swing motor and extension cylinder for leaks.
Check torque tamer bolts for tightness
Check torque tamer retaining bolt for tightness.
Inspect flex ring for cracks as well as retaining bolts for tightness.

Check clutch adjustment and adjust if necessary.
Check pulley wheel axle bolts for tightness.

Water System

Clean water strainer daily.
Check system for water leaks.
Inspect pump drive and couplings for tightness and absence of hydraulic leaks.
Ensure proper functioning of all ball valves.
Check oil level in water pump. Replace with oil specified by the pump manufacturer.
Check adjustment of regulator (200 psi) and adjust if necessary.
Disassemble clean and inspect water ring for appropriate operation.
(Use appropriate tool for disassembly)
Ensure water tank bolts are tight.
Check function of pressure gauge.

Gassing System

Clean strainer.
Check oil level in pump. Replace with oil specified by the pump manufacturer.
Check for hydraulic leaks on pump drive motor and fittings.
Inspect pump for product leaks.
Check sight gauge for leaks.
Ensure all ball valves are in safe operating order.
Check hoses for cracks, leaks, and chafing.
Check pressure gauge function.
(Use approved method for testing gauge function)
Check tank and pump mounting bolts.
Check injector piping for leaks.
Check adjustment of pressure regulator (175 psi) and adjust if necessary.



DEPENDING ON GASSING FORMULA IT CAN CAUSE INJURIES. WEAR PROTECTIVE GEAR

Electrical System

The electrical system of Tread bulk trucks is only as good as the maintenance performed on them. Weekly checks must be done to ensure a reliable system. On replacing fuses, solenoids, electrical connections and relays make sure that it is the correct rating for the application
Junction boxes:
Check electrical control junction boxes door seal replace if necessary
Check door seal lubricant.
Ensure door hitches is secure and in place.
Check conduit for cracks and shaving.
Ensure gable glands are tight and secure.
Check locking mechanisms on junction boxes.

Check terminal rails inside junction boxes
Check loose connections on terminals.
Check for corrosion on terminal connections.
Ensure that equipment inside junction boxes is always secure.
Clean inside junction boxes with brush.
Check mounting system.

Do not wash or spray inside junction boxes with water. Use only approved electrical cleaning agents.

Wiring harness

Check all wiring harnesses under Cab of vehicle for damaged.
Check routing of wiring harness and correct if necessary.
Check harness for signs of sharp bends correct if necessary.
Check securing mechanisms for wiring harnesses.



ALL REPLACEMENT EQUIPMENT MUST BE THE CORRECT RATING FOR THE APPLICATION.

Daily Inspection Sheet

Lock Out Tag Out - Your Family is Counting on You!

Company	
Unit Number	
Tread Serial Number	
Date	
Operator	

TREAD CORPORATION
1764 Granby St. Roanoke, VA 24012
1-(540)-556-1082

Lubrication		**Inspection**		**Inspection (cont.)**	
Main Pump U-joints		Mounting System		Rear Bumper	
Main Pump Slip Joint		Body Structure		Auger Inspection Doors	
Hose Reel Bearings		Ladder & Walkways		Bed Auger Bolts	
Hose Reel Pulley Axles		Handrails		Vertical Auger Bolts	
		Hatch Covers		Vertical Auger Housing	
		Emulsion Tank Structure		Boom Auger and Housing	
		Tank Manhole and vents		Air System (filter and lubricator)	
		Emergency Tank Valve		Fuel Oil System (strainer)	
		Emulsion Pump and Piping		Gassing System (filter)	
		Hydraulic Oil		Water System (filter)	
		Hydraulic Hoses, Piping and Leaks		Surge Hopper	
		Valve Condition and Operation		Hose Reel	
		Lights		Product Pump and Pressure Piping	
				Electrical System	

Comments:	

Unibody Maintenance Schedule

Item	Daily	Weekly	Monthly
Body Structure	X		
Grease Main Pump Slip Joint	X		
Grease Main Pump U-joints	X		
Ladder & Walkways	X		
Mounting System	X		
Apply Never Seize to Valve Spools		X	
Grease Hose Reel Bearings		X	
Grease Hose Reel Pulley Axles		X	
Grease Split Clamp Ring		X	
Lubricate Flow Valves		X	
Lubricate Gate Rack and Pinion		X	
Lubricate Hose Reel Chain		X	
Lubricate Selector Valves		X	
Lubricate Swing Chain		X	
Lubricate Top Drive Chain		X	
Electrical System			X
Lubricate Hose Boom Gear Reducer			X

Item	Daily	Weekly	Monthly
Air System (filter and lubricator)	X		
Auger Inspection Doors	X		
Bed Auger Bolts	X		
Boom Auger and Housing	X		
Emergency Tank Valve	X		
Emulsion Pump and Piping	X		
Emulsion Tank Structure	X		
Fuel Oil System (strainer*)	X	X*	
Gassing System (filter)	X		
Handrails	X		
Hatch Covers	X		
Hose Reel	X		
Hydraulic Hoses, Piping and Leaks	X		
Hydraulic Oil	X		
Lights	X		
Product Pump and Pressure Piping	X		
Rear Bumper	X		
Surge Hopper	X		
Tank Manhole and vents	X		
Valve Condition and Operation	X		
Vertical Auger Bolts	X		
Vertical Auger Housing	X		
Water System (filter)	X		
Calibrate System			X
Change Hydraulic Filters			X
Torque Mounting Bolts			X

TRUCK PRE-START INSPECTION

COMPANY:---------- WEEK NUMBER:----------
TRUCK SN NUMBER:---------- DATE:----------
UNIT NUMBER: ---------- OPERATOR NAME: ----------

	CROSS WITH x WHEN OUT OF ORDER							REMARKS (specify defects in remarks column)
	M	T	W	T	F	S	S	
PRE-START:								
Seatbelts								
Stop Blocks								
Strobe lights								
Reverse Alarm								
Radiator & hose,water leaks or level								
Fan belt (s)								
Engine oil leaks & level								
Diesel tank leaks & level								
Brake and clutch oil level								
Tires: tread, damaged,pressure								
Wheel-nuts: tightness								
Fire extinguisher seal & pressure								
Body damaged								
Air compressor oil leaks								
Rearview mirrors								
Road safety triangles								
Spare wheel,jack,wheel spanner								
START ENGINE:								
Horn,reverse alarm, wipers & gauges								
Pull away 1st gear brake test								
Permits, placards								
License and other documents								
POST TRIP CHECK : (report all faults)								
Check lights,gauges and indicators								
Check tires & body damaged								
Check water & oil leaks								

Ladder & Walkway

The function of the ladders and walkway is to give the operator a safe and easy way to ascend to the top of the unit and perform the necessary tasks that must be undertaken on a routine basis.

The ladder assembly starts close to the ground and gives three points of contact from the ground to the top of the vehicle.

The walkway runs the full length of the body and gives the operator a working surface to load the vehicle, as well as perform any necessary maintenance that is required.

Walkways are equipped with a 6-inch toe board for added safety and compliance to MSHA and OSHA.

Ladder and walkway daily inspection and maintenance:

Ladder and walkways should be cleaned on a regular basis to allow for an uncluttered workspace.

All welded joints should be inspected on a regular basis to assure a safe situation. Any damaged area should be repaired in as timely a fashion as possible.



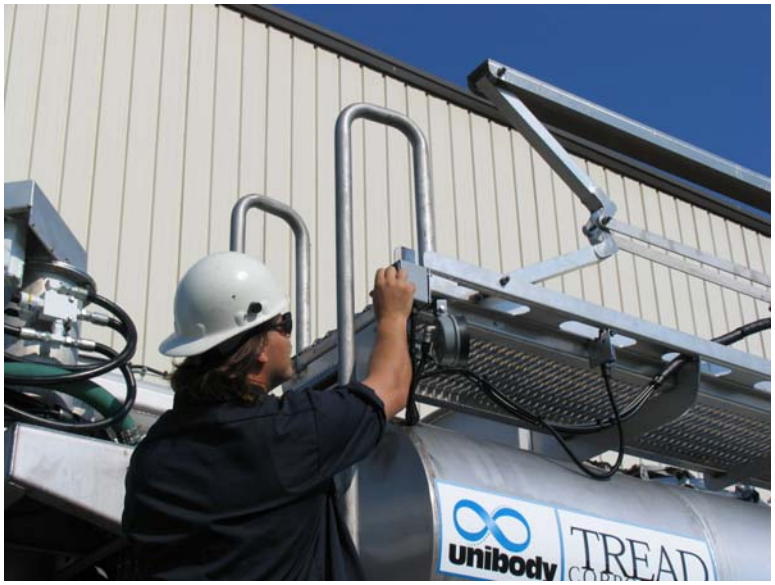
*Handrails are in the down position in these photographs

Ladder and Walkway Safety

Safety First – Always Maintain Three Points of Contact
Keep Walkways Free of Foreign Material
Check for Damaged or Unsafe Conditions
Always Be Alert
Always Following OSHA and MSHA Regulations
Always Follow Your Companies Regulations and Guidelines.



Three points of contact 1



Raise handrails 1


unibody
TREAD
1942
3139
1942


unibody
TREAD
1942
3139
1942
1942

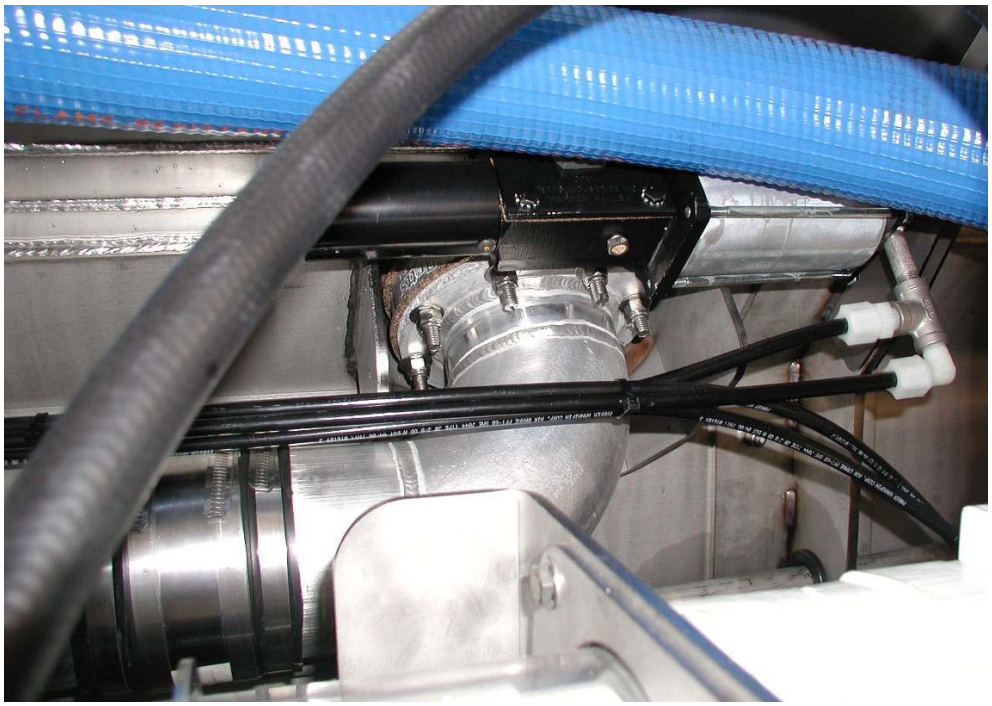
Tank Conversion

Anyone entering the product tanks must comply with OSHA and MSHA safety regulations for confined space entry.

Converting a tank from emulsion to prill

Review pictures for the piping and valve assembly layout.





Clean the tank to be converted thoroughly of emulsion. Loosen the T-handle bolt(s) that secure the inside tank lids. Remove the lid and rubber gasket. After the tank is cleaned, it may be helpful to temporary place the lid back in place while working inside the tank. SEE PHOTO 1-a

Momentarily run the emulsion pump to empty all emulsion left in the outlet valve and inlet piping through the pump. Make sure the air valve pushbutton is pulled out for the tank that is **not** to be converted.

Add a spacer (hex nut works fine) behind the air valve pushbutton knob for the tank **to be converted**. This will prevent accidentally pushing the button in and damaging the outlet valve butterfly plate against the inside cover plate.

spacer



Loosen the band clamps around the rubber boot coupling. Slide the boot clear of outlet valve elbow piping. SEE Photo 1b

Loosen and remove the 7 elastic lock nuts that secure the outlet valve assembly to the tank. One short bolt will not have a lock nut. It will be necessary to secure the hex head bolts from the inside of the tank while the nuts are being removed from the outside.

Lower the elbow piping and outlet valve from the assembly bolts.

Remove the 8 bolts that secure the suction inlet pipe from the inside of the tank. These bolts are threaded into the ring plate located between the outside of the tank and the outlet valve. Remove the suction inlet pipe.



Clean all gasket surface areas. Inspect all gaskets and replace as necessary.

Locate the blank cover plate and gasket over the inlet suction hole inside the tank. Place a stainless steel washer and a nylon washer in that order on each bolt. Insert each bolt through the cover plate and gasket inside the tank and into the gasket and threaded ring plate on the outside. Place the short bolt in the 6 o'clock position of the circular pattern. This will locate the hole without the locknut under the piping elbow outside of the tank.



Place the gaskets, outlet valve and pump inlet piping on the bolt studs. Use new elastic locknuts to secure the outside tank assembly. SEE Photo 1b

Slide the rubber boot coupling over the piping joint and secure the band clamps.

Clear all loose items from inside the tank. Remove the inside lid if it was temporarily put back in place during the conversion process.

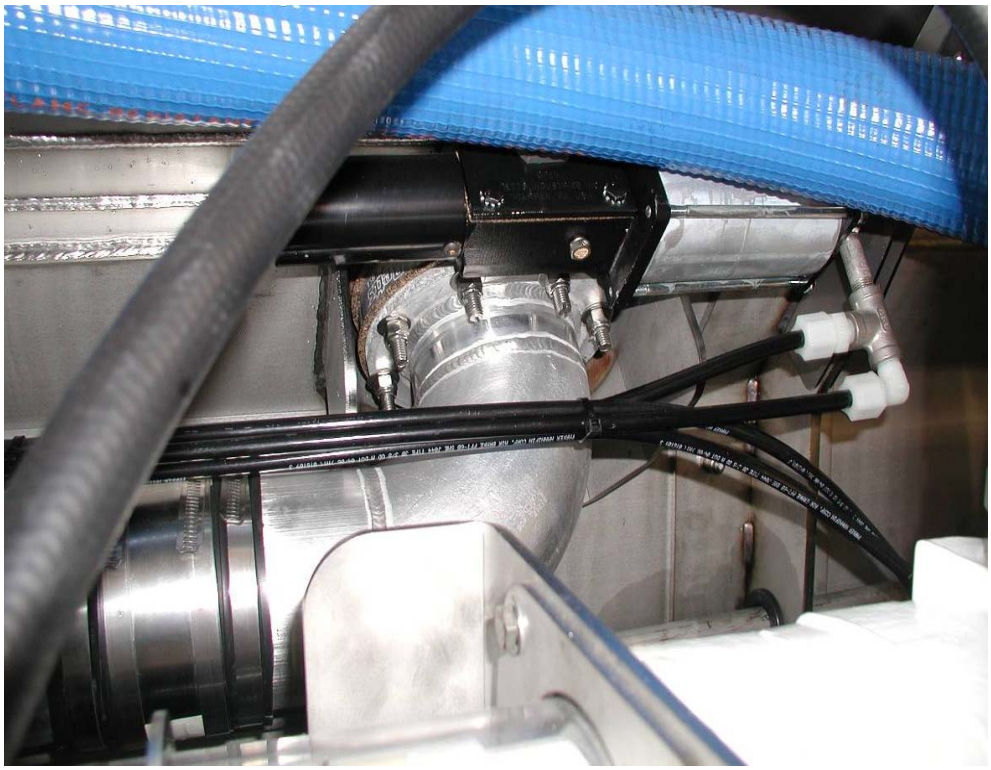
Change the metal product ID tag on the manhole lid latch from EMULSION to ANFO.



Converting a tank from prill to emulsion

Review pictures for the piping and valve assembly layout.

a. 

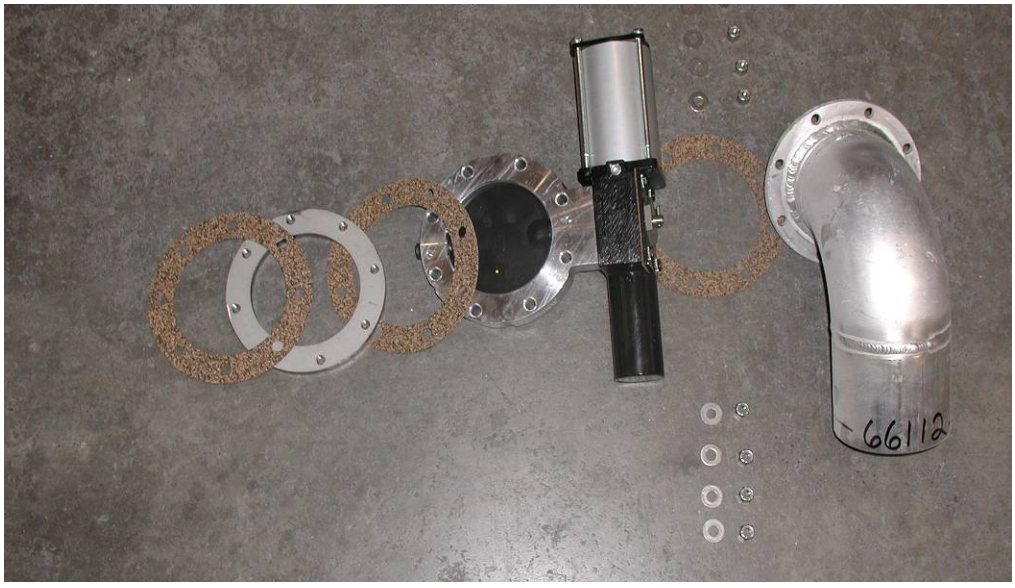
b. 

Empty the tank to be converted to emulsion. Thoroughly clean the opening gasket surface area inside the tank before installing the lid. Clean and inspect the gasket and gasket grove in the lid for any damage or debris. If the lid is separated from the gasket, apply a small amount of silicone sealant in the lid groove to hold the gasket in place. *If the lid gasket is a 5/8" square flat gasket, replace it with a 3/4" gumdrop shape gasket. Contact Tread Corporation for the gasket part number that applies specifically to this tank configuration.*

Slide the lid bolt(s) with securing nut(s) into the slotted retainer plate. Hand tighten the nut. Guide the tank lid hole over each bolt until the lid gasket is flush with the mating flange. Place the nylon washer over the bolt. Start the T-handle nut(s) that secure the inside tank lids and tighten them by hand.

Loosen the band clamps around the rubber boot coupling. Slide the boot clear of outlet valve elbow piping.

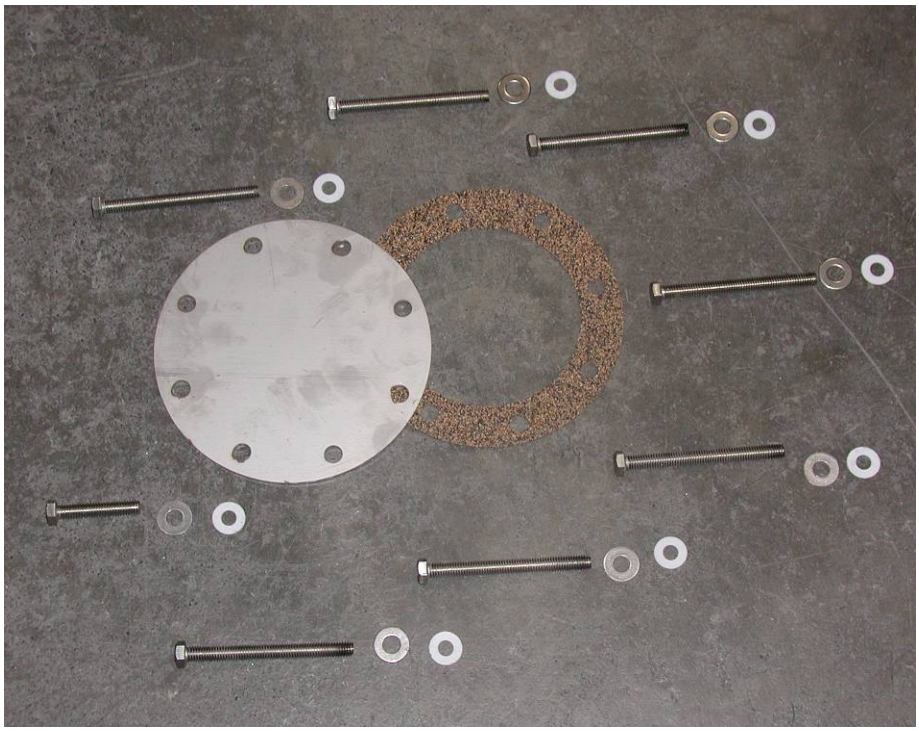
Loosen and remove the 7 elastic lock nuts that secure the outlet valve assembly to the tank. One short bolt will not have a lock nut. It will be necessary to secure the hex head bolts from the inside of the tank while the nuts are being removed from the outside.



Lower the elbow piping and outlet valve from the assembly bolts.

Remove the 8 bolts that secure the inlet cover plate from the inside of the tank. These bolts are threaded into the ring plate located between the outside of the tank and the outlet valve. Remove the inlet cover plate.

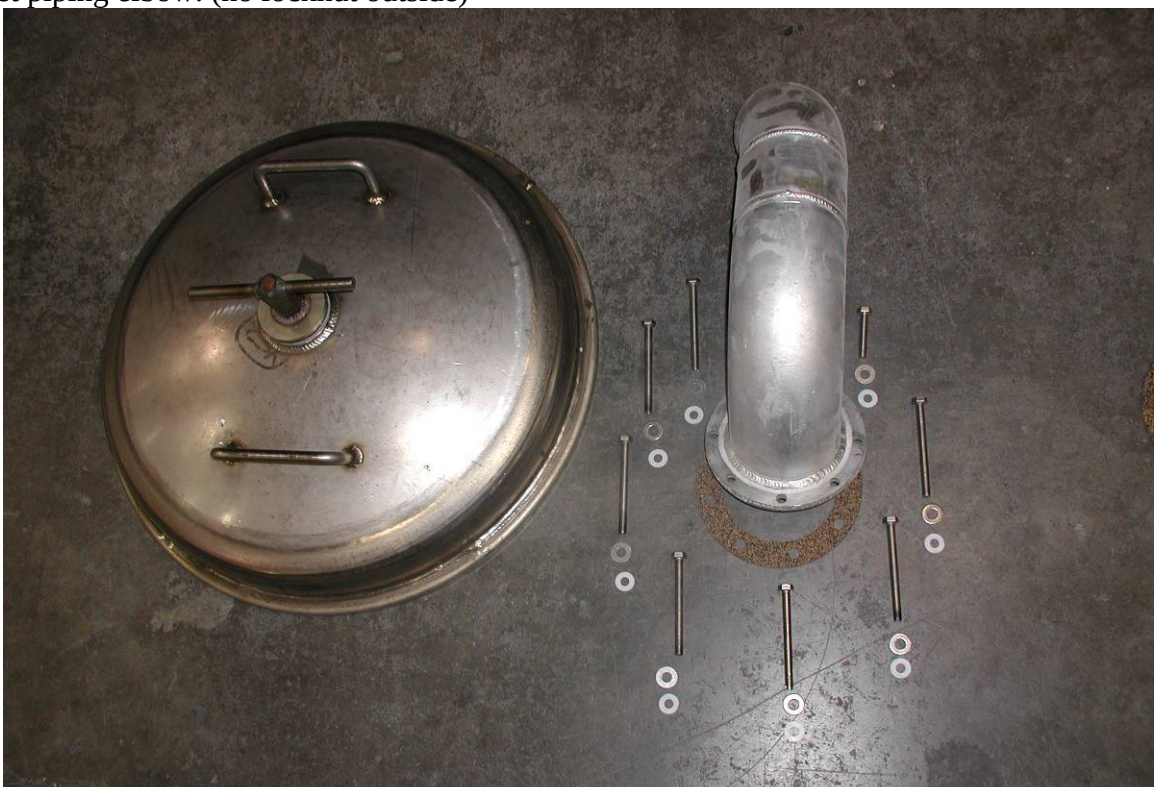




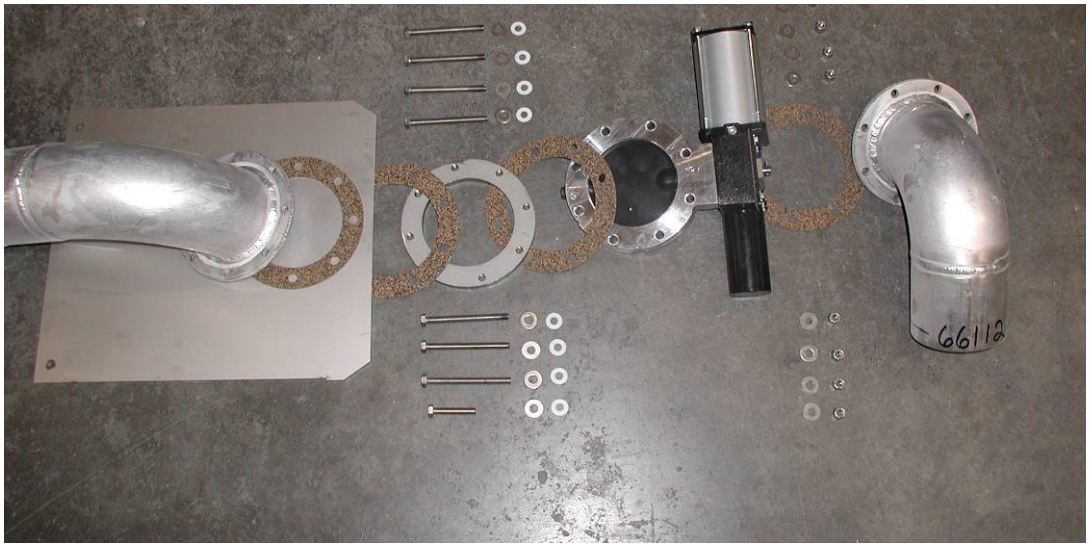
Clean all gasket surface areas. Inspect all gaskets and replace as necessary.

Locate the inlet suction piping and gasket over the inlet suction hole inside the tank. Place a stainless steel washer and a nylon washer in that order on each bolt. Insert each bolt through the inlet piping flange and

gasket inside the tank and into the gasket and threaded ring plate on the outside. Place the short bolt under the inlet piping elbow. (no locknut outside)



Place the gaskets, outlet valve and pump inlet piping on the bolt studs.
Use new elastic locknuts to secure the outside tank assembly.
See the following picture for the complete assembly layout.



Slide the rubber boot coupling over the piping joint and secure the band clamps.

Finish tightening the T-handle nut(s). Tighten the nut(s) until the rubber gasket has some compression and the bolt has enough resistance not to loosen due to vibration. If there are more than one nut, tighten each nut 1/2 turn alternately until each nut has approximately the same resistance.

Earlier Unibody models do not have reinforcement bars welded across the auger cover plate. Excessive torque may bend 2 and 3 bolt covers upward and loosen the seal.

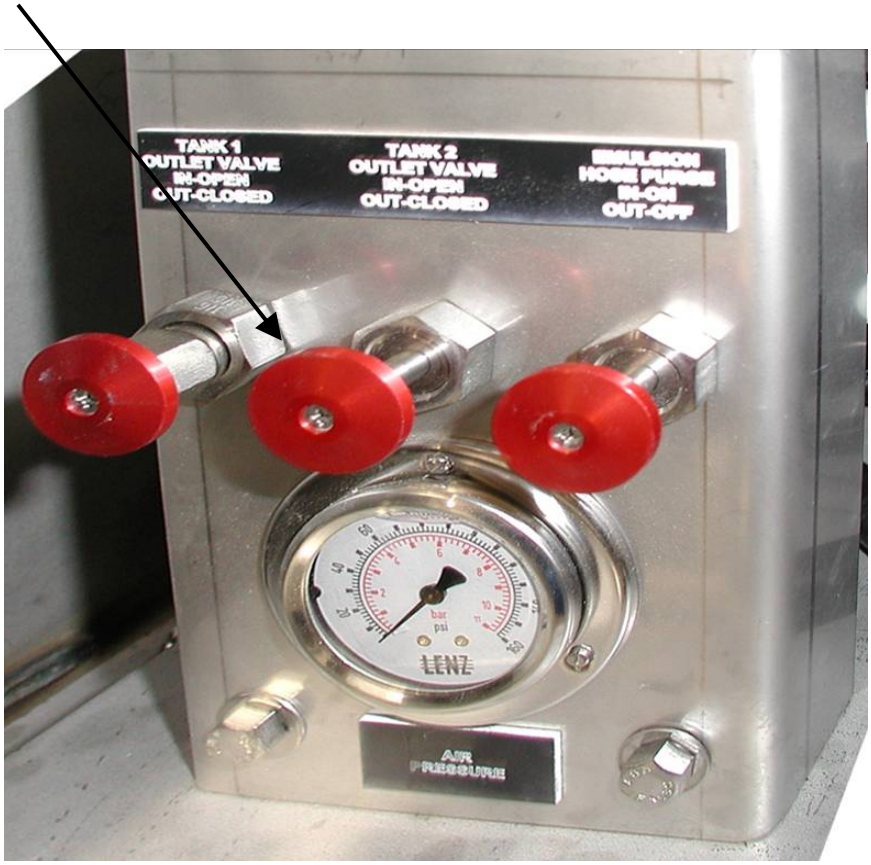
Clear all loose items from inside the tank.

Before loading the tank with emulsion, test the tank seals. Fill the tank with enough water to cover the top of the lid and the inlet piping. Mark the water level and check it after 1 hour.

Change the metal product ID tag on the manhole lid latch from ANFO to EMULSION.

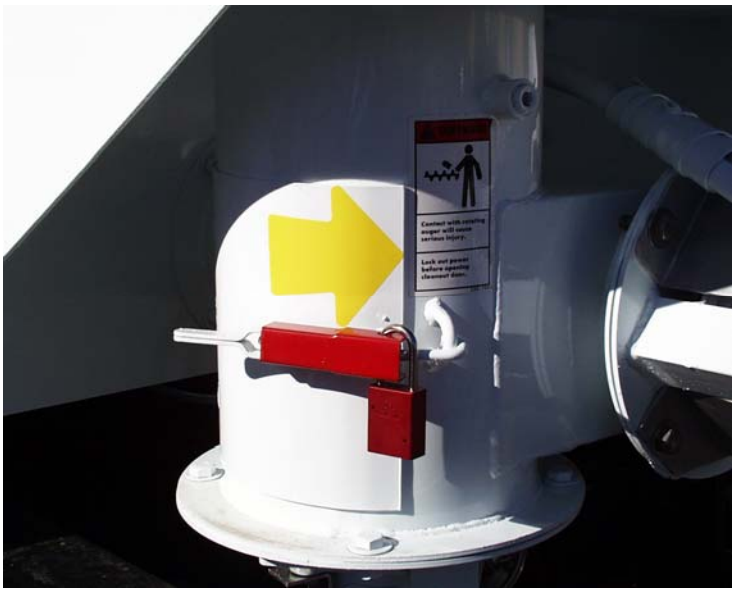


Remove the spacer behind the air valve pushbutton knob for the tank that was converted.



Augers

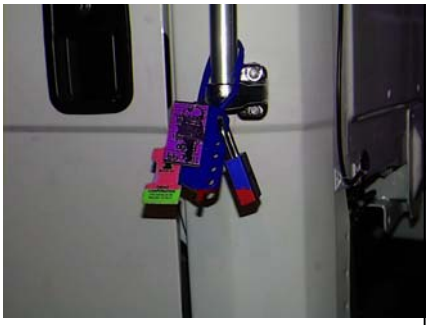
UniBody augers are accessible through inspection doors that are locked during normal operation. These doors are strategically located at auger intersections to allow the cleaning and disassembly and reassembly of augers. These doors should only be unlocked for maintenance of the auger system or freeing jammed material from the augers.



Your auger inspection doors should be unlocked and opened ONLY in compliance with the stated tag out/lock out procedure following all rules that apply from your company as well as OSHA and MSHA.

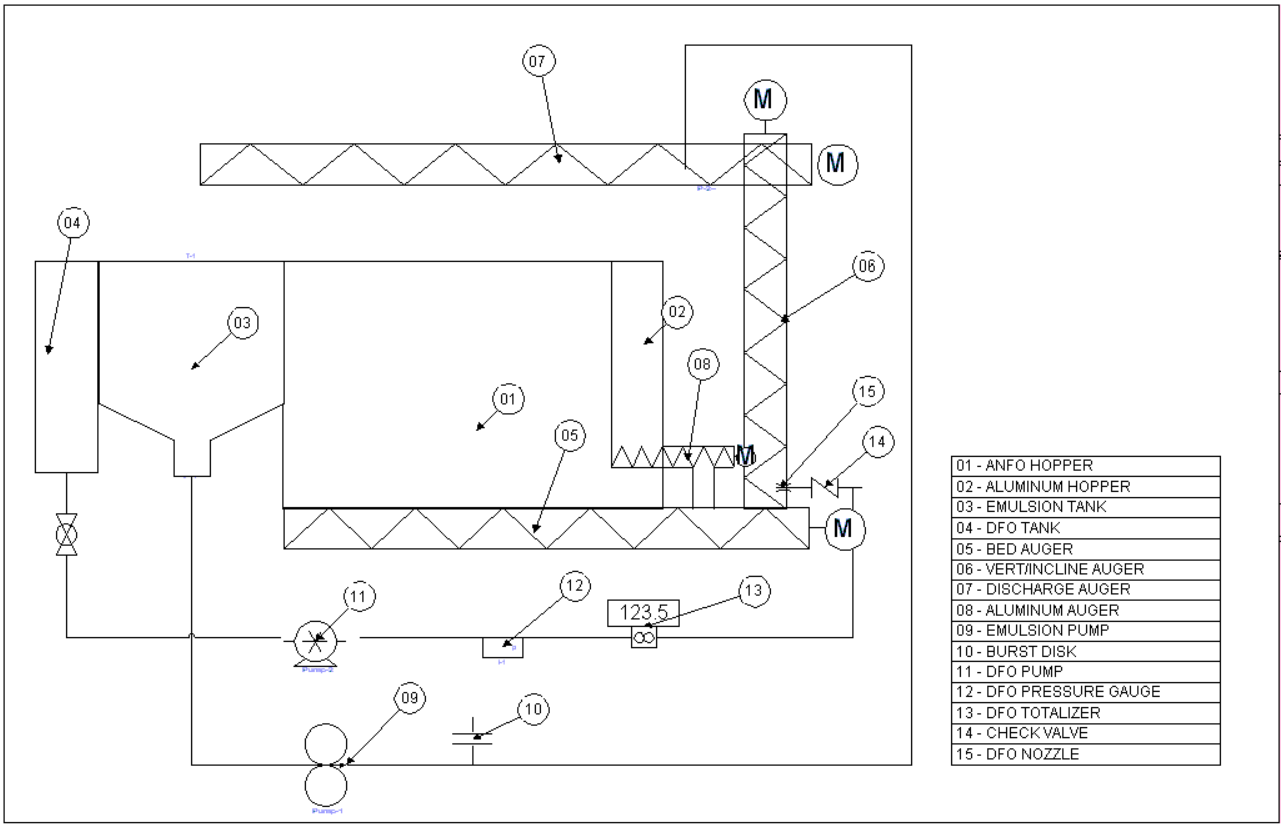
During these operations, the engine of the truck should be off and the ignition keys locked out.

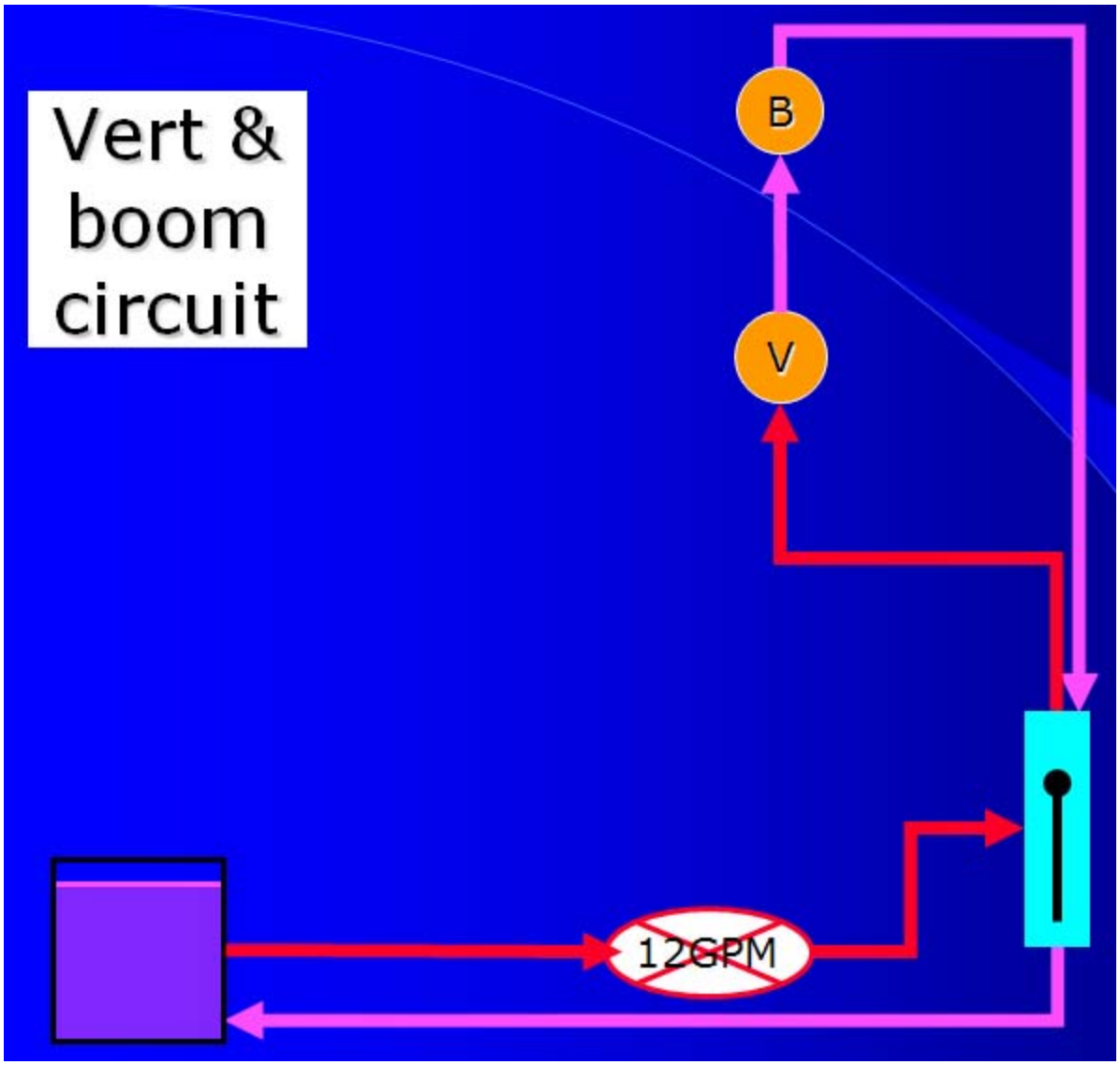




Auger inspection door daily inspection and maintenance:

1 - Make sure that all doors are closed and secured before starting operation.
2 - Replace any locks that are missing or damaged.
3 - **With the truck empty and engine locked out**, inspect augers for missing drive bolts. Make sure there is no foreign material in the auger intersection area.

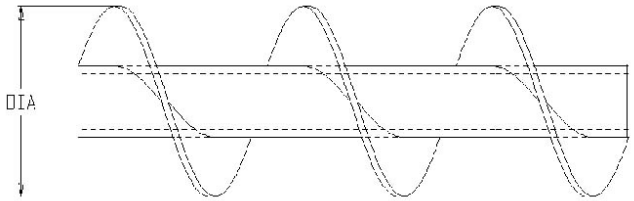



Vert &
boom
circuit
B
V
12GPM

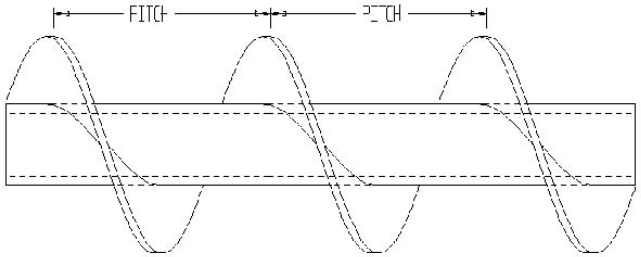
Auger Basics

Archimedes invented screw conveyor in 240 B.C.
It can be used for lifting water.
It consists of a conveyor screw rotating in a stationary trough.
It is a constant volume device.
Is used for accurate metering of materials.
It must be calibrated for material being conveyed.
Screw efficiency will change with age (usually better).

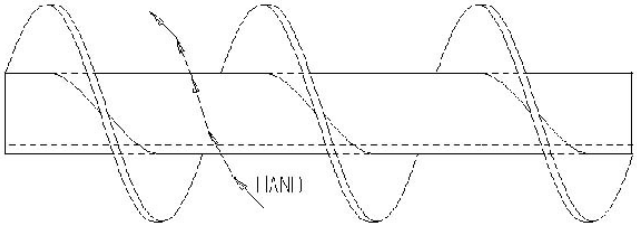
Diameter is the outside diameter of the flighting. It usually 1 inch less than housing diameter (7 inch diameter auger in an 8 inch housing).



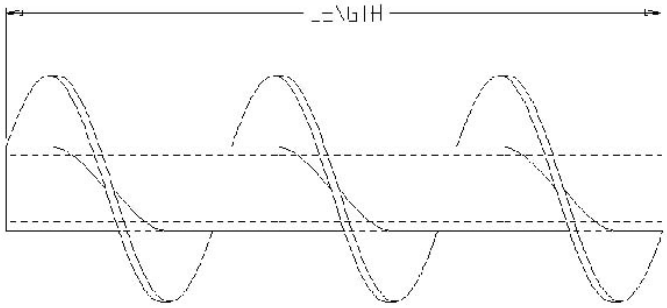
Pitch is the distance between flights and is specified as a fraction of the diameter. Normally full, 2/3, ½.
7 inch full pitch has 7 inches between flights.
9 inch 2/3 pitch has 6 inches between flights.



Hand is the rotation direction relative to the material movement
Right hand - auger turns to the right (clockwise)
Left hand - auger turn to the left (counter clockwise)



Length is the total length of the auger
Usually the housing length less 2 inches



Auger percent fill

The auger can not convey material within a housing if it is loaded at 100%.
If you are going to add material (emulsion, aluminum) there must be somewhere for it to go.

Design techniques are used to keep the augers properly filled with material. This is referred to as PERCENT OF FILL.

The manner in which the augers convey material can adversely affect product quality

Augers that are overloaded can crush/grind the ANFO lowering its density

Augers that have reduced capacity from product buildup (less void space) can affect quality

Augers that are worn (reduced diameter) or damaged (bent flight) can affect quality.

Augers that are worn (reduced diameter) or damaged (bent flight) will affect the material delivery rate.

Augers that are overloaded are prone to jamming.

Reducing the percent of fill in the bed auger is accomplished by
1. Change in pitch at transition from hopper body to bed auger housing. (2/3 to full or 1/2 to 2/3)
2. Larger bed auger housing. 10 inch housing with a 7 inch auger (side boom trucks)

Reducing the percent of fill in auger to auger transitions is accomplished by
1. Change in relative speed of augers (faster motor or higher output pump section)
2. Change in relative size of auger (8 to 10)

Delivery rates

7 inch 1/2 pitch ~ 3.0 lbs/rev
7 inch 2/3 pitch ~ 4.5 lbs/rev
7 inch full pitch ~ 6.0 lbs/rev

Delivery rates will change over time. Augers that are worn smooth from use will have better delivery rates. Augers must be calibrated when new. Should follow-up in one month and then annually thereafter.

Safety

Moving parts of mixing system designed to prevent heat buildup.
Bearings are >1 in. from the product container.
Auger drive shaft has a bushing for easier removal.

Clogged or jammed augers are a fact of auger systems
Must be dealt with in a safe manner
Never stick your hands in the auger
Know where everyone else is and what they are doing

Guards in place
Keep hands/clothing away from rotating parts
Before clearing the auger follow lockout/tagout procedures
remove primary power (PTO disengaged, engine off, keys in pocket)

Lockout/tagout always applies when doing maintenance
No welding or open flames shall be used on or around any part of the delivery equipment unless it has been completely washed down and all oxidizer material removed.
Before welding or making repairs to hollow shafts, the shaft shall be thoroughly cleaned inside and out and vented with a one-half-inch diameter opening.

GuardMaster

Prevents the discharge auger from running without the discharge cone in place



Guardmaster switch 1



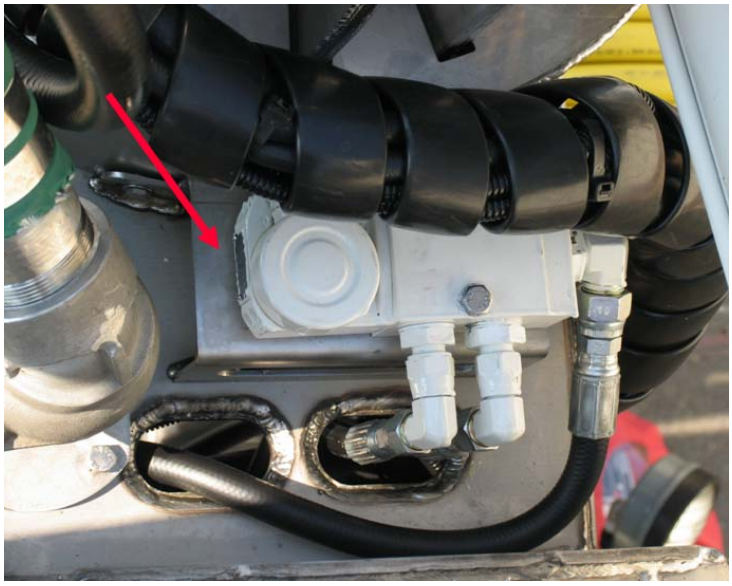
Safety pin inserted 1



Discharge cone installed 1

SwingMaster

A Safety System
Lessen the Chance of Injury
Prevent the Discharge Auger from Swinging Over Walkway
Hydraulically or
Electrically
The Top of a Bulk Truck is an Elevated Walkway
This Feature is to Keep The Boom From
Swinging over the walkway
Keeping you Safer

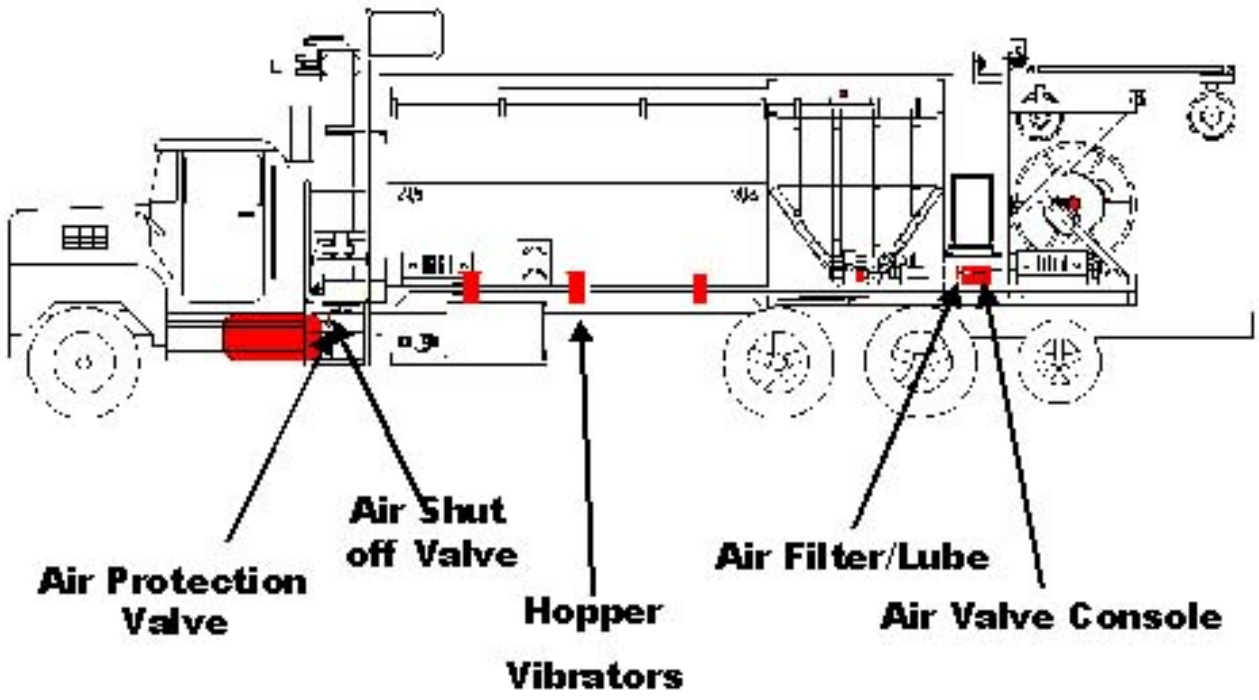


Air Controls

An Important Safety Note

Compressed air is very dangerous. Never remove an air-operated component without first shutting off the air supply first. This is done by moving the handle of the shut off ball valve perpendicular to the valve body. This isolates the UniBody Air system. To inspect or replace the air filter element, the filter bowl must first be removed. The bowl is removed by unscrewing it from the body. Once the bowl is loose, pull it straight off the cartridge. The filter element also screws off. Pull down while turning. The filter element fits very tight. Once the element is free, study its condition. Discoloration indicates that the pores of the element are dirty. The element can be cleaned in a mild detergent solution. Very dirty elements should be replaced. The large particles that are collected in the filter bowl can be drained without removing the filter bowl. The valve screw on the bottom of the bowl turns clockwise to open. Allow the fluid to drain out. Close the valve back before returning it to operation. Drain the filter bowl before the liquid reaches the lower baffle inside the filter bowl.

Component Location



UniBody trucks vary in individual configuration so component locations will vary from truck to truck.

Operation

Open the air shut off valve, located near the air tank. The valve is in the open position when the handle of the valve is in line with the body of the valve

Press and hold the air valve on the air control console marked vibrators. There is a valve for each AN hopper compartment. Release the valve, and it will spring return to the neutral position.
Close the air shut off valve after using the hopper vibrators.

Air Control Console

Opens emulsion tank valve and vent.
Closes DOT (7AR15) valve.
Applies air to blow down port on emulsion pump pressure piping.
Use caution when clearing emulsion hose. Burst disk can break.

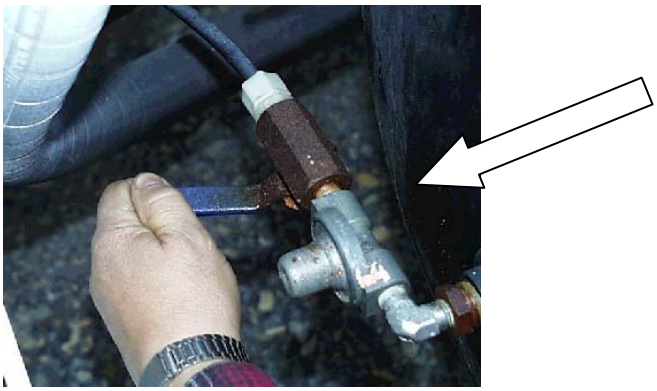


The air control console is mounted on top of the hydraulic controls. The Air Valve console is the mounting location for the individual air valves. These valves each have a knob to actuate the function on the truck. The console also contains an air pressure gauge to measure the incoming air pressure from the truck. Individual Air valves are used to actuate certain truck functions. The Air Valve has a body with a “spool” connected to a red knob. The spool moves through the valve body closing and opening passageways for the air supply. This way the air can be directed to the right side of the air actuator used on the vehicle. There are basic types of air valves used on the trucks. “Spring Return” types are used for momentary air supply (while the handle is depressed). The spool will return to the original position after pressure to the handle is removed. “Detent” types are for air functions that need to remain open or closed for longer periods of time. The valve spool will remain in position. The Air Valve can be disassembled for inspection and cleaning should it begin to stick or leak. This procedure can be done without the valve removed from its stack or individually. Unscrew jam nut and pull knob and spool out of the body. Look closely at the o-ring. Dirt or a cut O-ring may cause the air to escape by. Clean dirt from the o-ring and lubricate the o-ring again with grease. Replace a cut o-ring. Reassemble valve.



Air control console 2

Air Protection Valve



The air protection valve is located near the truck cab and is just adjacent to the air reservoir. Its purpose is to protect the truck chassis's air system. Should the UniBody body develop an air leak, it will not draw down air pressure below 70 psi. Maintaining air pressure is important for proper brake operation. The Air protection Valve requires little maintenance. The operator should periodically check for and visual damage to the unit and its plumbing. Check for air leaks on each side of the valve.

Air Filter and Lubricator



The Air filter and lubricator is located adjacent to the air valve console. The location of the air valve console varies.

The Air filter removes dirt particles from the incoming air stream. These irt particles could damage the air-operated components. Therefore it is important to keep the air filter cartridge clean. The Lubricator adds special oil into the air stream after it has been filtered. This oil will lubricate the moving parts of all air-operated parts. Specifically, the Air Filter has two-stage filtration. The larger dirt particles are caught in the filter bowl. These collect in the filter bowl. The smaller particles are caught in the filter element. To maintain

peak filter efficiency, keep the filter element clean. A dirty air filter will reduce air pressure. If the filter element has a light coating of dirt, clean or replace it.

VIBCO

PNEUMATIC PISTON TYPE

Uniquely designed FLANGE-MOUNTED vibrators develop greater output energy per cubic foot of air consumed at all pressures than any previous or competitive models.

CONSTRUCTION & OPERATION: Series 50 vibrators are constructed of fatigue-resistant steel alloys which are heat treated to guarantee long service under high stress conditions. The flat base plate provides an efficient means of transmitting the shock energy to the system which is developed by the reciprocating piston. The repetitive hammer action of the vibrator on the apparatus to which it is attached is controllable by regulating the applied air pressure.

Series 50 vibrators are available in the High Impact (Standard), High Amplitude (L), Silent Operating (S), and High Temperature (H) models, all of which can be equipped with Dustproofers. Models are available in the following bore sizes: 1", 1-1/4", 1-1/2", 2", 3", and 4". Other models are: Model 10, 20, 30, 40, 42, 43, 44--all following these service instructions.

HIGH IMPACT VIBRATORS: This standard model provides much higher impact than competitive and end-mounting vibrators and yet it is lighter in weight. Through the use of a new shock isolation assembly design, bolt fatigue problems are eliminated in these flange-mounted vibrators. Close tolerance construction results in reduced air consumption and increased efficiency.

HIGH AMPLITUDE (L) VIBRATORS: Certain applications require a low impact but a high reciprocating momentum action. These requirements can be satisfied through the use of high amplitude models. This type of action is usually necessary for the movement of dry materials of low density and high surface area.

"SILENT" OPERATING (S) VIBRATORS: This model is utilized in areas where noise is objectionable and may affect production. Its high thrust action permits operation at low air pressures. When used in place of an impacting model, the next larger size should be employed.

HIGH TEMPERATURE (H) VIBRATORS: This model is available upon special request for use on high temperature applications up to 600°F. It is also designed to function under conditions of marginal lubrication.

IMPORTANT CONSIDERATIONS FOR LONG OPERATING LIFE.

1. Always blow out the airline before attaching it to the vibrator.
   - A. UNCLEAN AIR will diminish the life considerably and clog the 3-4/1000 clearance between cylinder and piston.
   - B. UNCLEAN AIR will increase the wear of the piston which will increase the air consumption and diminish vibrator efficiency.
   - C. WATER IN THE LINE will diminish the protection of the oily air necessary to make the unit operate properly.

D. WATER, DIRT & AIR LINE RUST at air pressures over 80 PSI will create a smear similar to grinding compound and will wear down the cylinder and piston very fast.

2. Piston vibrators must be lubricated. Use SAE-10, or lighter.

   A. NO OIL in the air will wear down the piston and cylinder walls very quickly, even perhaps in less than 8 hours.

   B. IN VERY COLD OPERATION, mix antifreeze or kerosene with the oil.

   C. INJECT a small quantity of kerosene directly into the vibrator ocassionally to clean out accumulated sludge.

3. Make sure air pressure is not higher than 80 PSI.

   A. AIR PRESSURE in excess of 80 PSI will increase the velocity of the piston, diminishing the protective oil film and increasing the unit wear.

PISTON REPAIRS

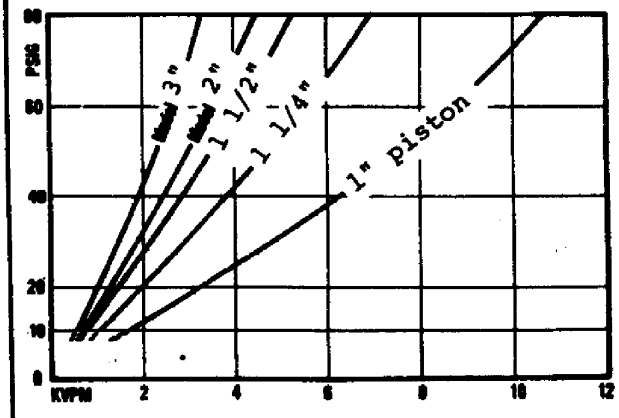
Field repairs of piston vibrators are limited to replacing bolts, nuts, washers, and rubber shocks. Any other repairs should be done at the factory. Once the piston and cylinder have worn down, the cylinder can be rebored and the piston replaced with an oversized one.

A. BOLT BREAKAGE is caused by:

   (1) Air pressure in excess of 80 PSI.
   (2) Loose mounting bolts.
   (3) Excessive movement of vibrator on hopper or bin caused by:
      (a) Too flexible hopper or bin that cannot absorb vibration created.
      (b) Operation on empty hopper.
   (4) Dried up rubber buffers. Buffers are used to absorb shock energy and prolong bolt life. Through aging the buffers will take a "set" and deteriorate. It is advisable to replace all buffers and bolts at this time.

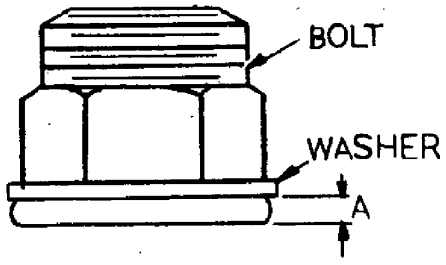
B. REPLACE BUFFERS following these instructions. The bolts are not torqued but tightened to compress the buffers to dimension "A" below:

Vibrator Frequency vs. Applied Air Pressure



The above data is for standard models only. Technical data concerning amplitude, frequency, force and air consumption for High Amplitude (L) Vibrators is available

MODEL	DIMENSION "A"
50-1"	3/16
50-1-1/4"	7/32
50-1-1/2"	9/32
50-2"	1/4
50-2L"	1/4
50-3"	5/16
50-3L"	5/16
50-4"	3/4



VIBCO INC.

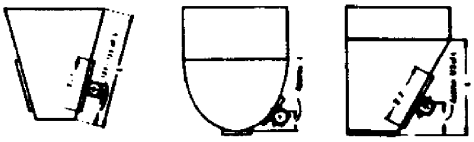
MOUNTING AND SERVICE INSTRUCITONS FOR PNEUMATIC, TURBINE & BALL & ROTARY VIBRATORS

A. MOUNTING

1. PLACEMENT

a) for coarse materials, mount vibrator 1/3 up the bin side from the discharge.

b) for fine materials 1/4 up



2. MOUNTING CHANNEL

Never place the vibrator directly on the skin of the bin. It is either mounted to a plate or a channel iron, welded to the bin. The plate should be 1/3 to 1/4" thick and extend 3 - 4" outside the vibrator, for the smaller vibrators with impacts up to 100 lbs. For vibrators up to 500 lbs. force, use a 3/8 to 1/2" thick plate and 6 - 8" larger than the vibrator. For vibrators with a force over 500 lbs., use a 1/2' - 5/8" thick plate 8 - 12" larger than the vibrator. The preferable mounting is to use a 3 or 4" channel iron, which will not only help to stiffen up the structure to be vibrated but also spread the vibration over a larger surface, increasing the overall efficiency and diminishing the possibilities of fatigue cracks in the bin material. THE LENGTH OF THE CHANNEL IRON is determined by the thickness of the bin plate. for 3/16" - 3/8" plate, the channel iron should be 1 - 2' long under 3/16", 1-1/2 - 3' long, over 3/8" it need only be 8 - 12" The above for vibrators with a force up to 500 lbs. For vibrators with forces from 500 - 1000 lbs., add 1 - 1-1/2' to the channel iron.

3. WELDING MOUNTING PLATE TO CHANNEL IRON

Weld the mounting plate to the middle of the channel iron. If bin plate is 3/16" or less, weld the mounting plate to the back of the channel iron, if bin plate is over 3/16" weld mounting bracket to the legs of the channel iron. Make sure bracket does not warp. If it did straighten it out or replace it.

4. DIFFERENT SUGGESTIONS FOR MOUNTING CHANNEL

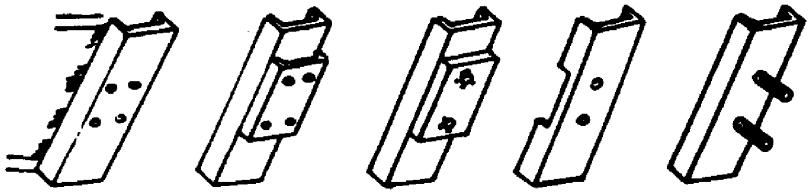
NOTE Always stop welds 1" from ends, to prevent a heat concentration and bin cracks, skip weld channel weld 2 - 3" skip 1 - 2".

a) 3 or 4" channel with holes or nuts welded on back side

b) Add mounting plate and tap 2 holes

c) Notch the channel for access to mounting bolts

d) Weld studs to back of channel



5. WELDING CHANNEL IRON TO BIN

Where possible the mounting plate on the channel iron should be placed 1/3 to 1/4 of the distance L. on the bin. Tack weld channel iron in place, then weld intermittent welds 3 - 6" long with 3" between them. NOTE: STOP WELDS AT LEAST 1" FROM THE ENDS OF THE CHANNEL IRON – DO NOT WELD THE ENDS. The heat concentration when welding the ends could cause crystallization of the metal and the start of fatigue cracks.

6. INSTALLATION OF VIBRATOR

THE VIBCO vibrator is now put in place. Make sure it is secured tightly. Retighten the bolts after the first 10 - 15 minutes of running, then check them periodically for tightness. NOTE: A loose vibrator can cause damage to the bin and itself. It is also advisable to install a safety chain or wire in case the vibrator works itself loose.

7. TO OBTAIN MAXIMUM PERFORMANCE

It is not necessary to operate the vibrators at their maximum capability to obtain maximum performance, as well as you do not drive your car at maximum speed because it has that capability. Air regulators, timers, etc. should be used to tune the vibration for optimum performance and to save operating dollars and the equipment for longer life.

8. CONTINUOUS VERSUS INTERMITTENT OPERATION

For bulk material handling applications the vibrator should be used to reduce the material friction not as a feeder.

Once the friction of the particles have been reduced, gravity flow occurs and the vibrator has performed the function it should then be shut off for several reasons.

a) ECONOMY. Power is a cost of production and is increasing every year.

Most vibrators run up to 60 - 80% of the time longer than they should. They run for the full time the bin is being activated. If the vibrator has performed its function, why leave it on? A great amount of energy is wasted.

Rotary vibrators produce enough force that short bursts of vibration are usually more effective than operating continuously. Experience has shown that for most applications short bursts of only 10 to 30 seconds for each 1 to 5 minutes of discharge are more effective and efficient.

b) LIFE OF THE UNIT. The life of the vibrator will be extended to the same degree that the power is conserved.

c) GUARANTEE SUCCESS OF THE APPLICATION. The vibrator can only furnish material to the discharge area. If more material is furnished than conveyed, the remaining material will pack in the bin.

We suggest the vibrators only run when the gates or doors are open on the bin, or when material flow is desired.

9. AIR LINE TO VIBRATOR

The hose to the vibrator should have the same or larger hose ID as the inlet ID (pipe size) of the vibrator, so that the pressure loss from the compressor to the vibrator is minimized.,

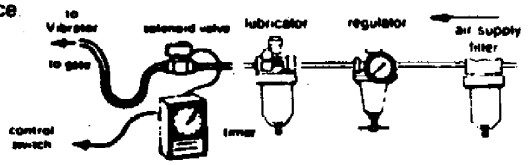
10. FLOW VALVE

A simple Flow Control Valve is recommended to allow "tuning" the vibrator to the desired force necessary for solving your material flow problem. The flow volume determines the force and frequency of the vibrator. By throttling the flow, you can "find" the desired material discharge rate and avoid the natural frequency of the bin or hopper. You should watch for and avoid speeds (frequency) at which the bin wall and vibrator shake violently. A simple increase or decrease of the speed will (assuming the amount is rigid) usually cause them to smooth out and run with a minimum of movement.

11. QUICK OPENING VALVES

These are recommended between the air regulator and the vibrator so that the air enters the vibrator with full starting force even at low regulator valve settings. The only requirement is that you install the air regulator at some distance from the quick-opening valve so that the air pressure between the two valves will build up enough to yield the necessary starting force.

Solenoid (quick opening) valves are recommended for automatic operations. Automatic Timed Cycling is diagrammed below with the timer usually directly connected to the bin or hopper gate switch. When the gate is opened, the timed cycling system is activated.



12. AIR LUBRICATOR

Lubrication is only to be used for Rotary and ball vibrators, not for turbines (they have prelubricated bearings). Adjust lubricator to 5 drops of oil per minute.

13. AIR FILTER

Use an air cleaner in the line. Clean air will prolong the life of any pneumatic vibrator. Dirty or moist air will harm the unit and impair it from operating at maximum efficiency and lowest energy consumption.

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WILKERSON

84-013-000 REV 1 08/02

INSTALLATION AND MAINTENANCE SHEET

Lubricator Model L18 and L28

⚠ WARNING ⚠

EXCEPT as otherwise specified by the manufacturer, this product is specifically designed for compressed air service, and use with any other fluid (liquid or gas) is a misapplication. For example, use with or injection of certain hazardous liquids or gases in the system (such as alcohol or liquid petroleum gas) could be harmful to the unit or result in a combustible condition or hazardous external leakage. Manufacturer's warranties are void in the event of misapplication, and manufacturer assumes no responsibility for any resulting loss. Before using with fluids other than compressed air, or for nonindustrial applications, or for life support systems consult manufacturer for written approval.

ATTENTION: Make sure bowl is fully inserted into body, and then fully turned to lock bowl in place before applying air pressure to unit. When bowl is properly installed, the alignment markings on the bowl/bowlguard assembly and the marks on the body will line up, indicating proper assembly. Failure to do so may cause air pressure to blow bowl off of unit, resulting in serious personal injury or death.

INSTALLATION

1. Refer to WARNING prior to installation.
2. Install as close to the point of use as possible.
3. Unit must be installed with the flow in the direction of the flow arrow on the body cover and with bowl down.
4. Avoid using reducing bushings, couplings, etc., whenever possible to install this product. These devices restrict air flow and can affect performance.

NOTE: CONTAMINATES REMOVED FROM THE COMPRESSED AIR SYSTEM MUST BE DISPOSED OF IN ACCORDANCE WITH LOCAL, STATE AND FEDERAL STANDARDS.

OPERATION

1. **NOTE: Maximum inlet pressure and temperatures are as follows:**
   a. **Plastic bowl/bowl guard assembly: 150 psig (10,3 bar) 125°F (51,7°C)**
   b. **Metal bowl with Sight Gauge: 250 psig (17,2 bar) 150°F (65,6°C)**
2. Use only clean, light machine oil, preferably SAE 10 or lighter. DO NOT USE PHOSPHATE ESTER OR DIESTER BASED FLUIDS IN LUBRICATORS
3. This lubricator may be filled under pressure by opening the top fill port slowly, allowing the pressure in the bowl to slowly vent to atmosphere. After the pressure has bled off, the fill plug may be removed completely and oil poured into the fill port. When the fill plug is removed, a small amount of air will be venting from the fill port. This is to serve as an audible signal denoting that the unit is in fact under pressure. If faster filling is desired, slowly remove the fill plug to vent the bowl pressure to atmosphere. Then remove the bowl/bowl guard assembly by pushing up on the bowl and turning clockwise. Fill the bowl, reposition the bowl O-ring seal on the bowl and reinstall the bowl. To reinstall the bowl, insert the bowl into the body, push up and turn counterclockwise until you feel the locating stops engage. Pull down on the bowl and turn clockwise to insure the bowl has been properly installed and locked. Now reinstall the fill plug. The unit is ready for use.
4. To adjust and set oil delivery rate, the unit must be pressurized and air must be flowing through the unit. Turn the transparent SIGHT DOME, located on the top of the unit counterclockwise to initiate oil delivery. The rate of oil delivery depends on air flow rate. If flow increases or decreases, the oil delivery rate will increase or decrease proportionately. Turning the SIGHT DOME clockwise to limit stop will stop all oil delivery.

MAINTENANCE

THIS UNIT MAY BE SERVICED WITHOUT REMOVING THE UNIT FROM THE COMPRESSED AIR LINE.

1. To clean the bowl, slowly open and remove the fill plug located on the top of the lubricator to vent bowl pressure to atmosphere. Push up on bowl assembly and turn clockwise to remove. Use a clean, dry cloth to wipe inside of bowl. Inspect the filter located in the bottom of the siphon tube assembly. Clean or replace the siphon tube assembly as required. To reinstall the bowl, insure that the bowl seal O-ring is properly installed on the bowl, insert the bowl into the body and push-up and turn counterclockwise until the locating stops engage. Pull down on the bowl and turn clockwise to insure the bowl has been properly installed and locked.
2. Before returning unit to service, insure that all seals have been reinstalled or replaced and bowl is locked in position with drain properly secured.

DRAINS

Manual Drain **GRP-96-685**

ACCESSORIES

Joiner set **GPA-96-601**
T-Bracket **GPA-96-602**
T-Bracket with Joiner set **GPA-96-603**
C-Bracket (18 Series) **GPA-96-604**
C-Bracket (28 Series) **GPA-96-605**
Force Fill Adapter **LRP-96-704**

FRENCH

FICHE D'INSTALLATION ET D'ENTRETIEN

Lubrificateurs modèles L18 et L28

⚠ AVERTISSEMENT ⚠

SAUF indication contraire du fabricant, le présent produit est spécifiquement conçu pour fonctionner à l'air comprimé et son utilisation avec tout autre fluide (liquide ou gazeux) constitue un usage abusif. Par exemple, l'utilisation du produit avec certains liquides ou gaz dangereux (tels que l'alcool ou le gaz de pétrole liquéfié) ou l'injection de tels liquides ou gaz dans le système risque d'endommager le dispositif ou de produire des conditions favorables à la combustion ou des fuites dangereuses à l'extérieur. Les garanties accordées par le fabricant sont nulles en cas d'usage abusif et le fabricant se dégage de toute responsabilité concernant toute perte susceptible d'en résulter. Avant d'utiliser le produit avec des fluides autres que air comprimé, ou pour les applications non-industrielles, ou pour les systèmes d'entretien de la vie, demander l'autorisation écrite du fabricant.

ATTENTION : S'assurer que le bol est bien inséré dans le corps et tourné à fond pour le verrouiller avant de mettre le système sous pression. Quand le bol est bien positionné, les repères portés sur l'ensemble de bol/protège-bol et sur le corps sont alignés. Une mise en place défectueuse peut provoquer une éjection du bol sous la pression de l'air, ce qui risque de causer des blessures graves ou la mort.

INSTALLATION

1. Lire L'AVERTISSEMENT ci-haut avant l'installation.
2. Installer le dispositif aussi près du point d'utilisation que possible.
3. Ce dispositif doit être monté de manière à ce que le débit soit orienté dans la direction de la flèche placée sur l'enveloppe du corps, le bol étant vers le bas.
4. Éviter dans toute la mesure du possible d'utiliser des bagues, raccords ou autres dispositifs de réduction pour installer ce produit. Ils diminuent le débit d'air et risquent d'affecter le fonctionnement.

NOTE : LES CONTAMINANTS ÔTÉS DU SYSTÈME À AIR COMPRIMÉ DOIVENT ÊTRE MIS AU REBUT CONFORMÉMENT AUX NORMES LOCALES, PROVINCIALES ET FÉDÉRALES.

FONCTIONNEMENT

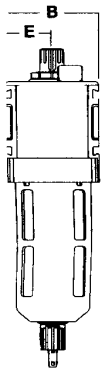
1. **NOTE : Pression d'entrée et température maximales :**
   a. **Bol/protège-bol en plastique : 150 psig (10,3 bar) 51,7 °C (125 °F)**
   b. **Bol en métal avec jauge visuelle : 250 psig (10,3 bar) 65,6 °C (150 °F)**
2. N'utiliser que de l'huile pour machines légère propre, de préférence de viscosité SAE 10 ou plus légère. NE PAS UTILISER DE FLUIDES À BASE D'ESTEROU DE DIESTERPHOSPHORINE DANS LES LUBRIFICATEURS.
3. On peut remplir ce lubrificateur sous pression en ouvrant lentement l'orifice de remplissage supérieur et en laissant la pression du bol s'équilibrer lentement avec la pression atmosphérique. On peut alors dévisser complètement le bouchon de remplissage et verser de l'huile dans l'orifice de remplissage. Lorsque l'on ôte le bouchon de remplissage, il s'échappe un peu d'air par l'orifice : cela constitue un signal sonore qui indique que le dispositif est bien sous pression. Si l'on souhaite remplir le dispositif plus rapidement, ouvrir lentement l'orifice de remplissage et laisser la pression du bol s'équilibrer avec la pression atmosphérique. Puis, démonter l'ensemble de bol/protège-bol en poussant le bol vers le haut et en tournant dans le sens horaire. Remplir le bol; repositionner le joint torique du bol sur le bol et remonter le bol. Pour remonter le bol, introduire le bol dans le corps, pousser vers le haut et tourner dans le sens antihoraire jusqu'à ce que l'on sente que les butées de positionnement s'engagent. Tirer vers le bas sur le bol et le tourner dans le sens horaire pour s'assurer qu'il a été bien positionné et verrouillé. Remettre alors le bouchon de remplissage. Le dispositif est prêt à être utilisé.
4. Pour régler le débit de distribution d'huile, le dispositif doit être sous pression et l'air doit passer. Tourner le DÔME DE REGARD transparent placé en haut du dispositif dans le sens antihoraire pour faire commencer la distribution d'huile. Le débit de l'huile dépend du débit de l'air. Si celui-ci augmente ou diminue, le débit de l'huile diminue en proportion. Tourner le DÔME DE REGARD dans le sens horaire jusqu'à la butée d'arrêt arrête la distribution d'huile.

ENTRETIEN

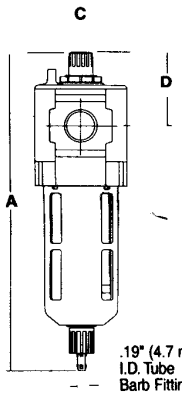
L'ENTRETIEN DE CE DISPOSITIF PEUT S'EFFECTUER SANS LE DÉMONTER DE LA CONDUITE D'AIR COMPRIMÉ.

1. Pour nettoyer le bol, ouvrir lentement le bouchon de remplissage placé en haut du lubrificateur pour laisser la pression du bol s'équilibrer lentement avec la pression atmosphérique. Pousser l'ensemble de bol vers le haut et tourner dans le sens horaire pour le démonter. Avec un chiffon propre et sec, essuyer l'intérieur du bol. Examiner le filtre placé en bas de l'ensemble de siphon. Nettoyer ou remplacer l'ensemble de siphon selon les besoins. Pour remonter le bol, s'assurer que le joint torique du bol est bien positionné sur le bol, introduire le bol dans le corps, pousser vers le haut et tourner dans le sens antihoraire jusqu'à ce que les butées de positionnement s'engagent. Tirer vers le bas sur le bol et le tourner dans le sens horaire pour s'assurer qu'il a été bien positionné et verrouillé.
2. Avant de remettre le dispositif en service, vérifier que tous les joints ont bien été remis en place ou remplacés et que le bol est verrouillé en position avec le bouchon de vidange bien serré.

84-013-000 REV 1 08/02



FRONT VIEW
VUE DE FACE
VISTA DELANTERA



.19" (4.7 mm) I.D. Tube Barb Fitting

Raccord cannelé de 4,7 mm (0,19") dia. int.

Accesorio dentado de tubo con un diámetro interior de 0.19" (4.7 mm)

SIDE VIEW
VUE DE CÔTÉ
VISTA LATERAL

Models Modèles Modelos	Dimensions INCHES millimeters A	B	Dimensions POUCES millimètres C	D	Dimensiones PULGADAS milímetros E
L18	**8.25** 212	**2.36** 60	**2.36** 60	**2.0** 51	**1.0** 26
L28	**9.36** 238	**2.9** 73	**2.9** 73	**2.0** 51	**1.44** 37

REPAIR KITS AND REPLACEMENT PARTS
TROUSSES DE RÉPARATION ET PIÈCES DE RECHANGE
JUEGOS DE REPARACION Y REPUESTOS

L18	LRP-96-677	LRP-96-678	LRP-96-679	LRP-96-680	LRP-96-701	GRP-96-636
L28	LRP-96-681	LRP-96-678	LRP-96-679	LRP-96-680	LRP-96-702	GRP-96-644
	Siphon Tube Assembly Kit	By-Pass Assembly Kit	Plastic bowl/ Fill Plug and O-Ring	Metal bowl/ Tamper Resistant Cap	bowl guard with Manual Drain	Sight gauge with Manual Drain
	Trousse d'ensemble de tube de siphon	Trousse d'ensemble de dérivation	Bouchon de remplissage et joint torique	Capuchon inviolable	Bol/protège-bol en plastique à vidange manuelle	Bol en métal à jauge visuelle à vidange manuelle
	Juego de ensamble del tubo del sifón	Juego de ensamble del tubo de desvío	Tapón y junta tórica	Tapa a prueba de manipulaciones indebidas	Taza de plástico/ protector de la taza con drenaje manual	Taza de metal/ indicador visual de nivel con drenaje manual

WILKERSON

84-012-000 Rev 1 04/02

ENGLISH

INSTALLATION AND MAINTENANCE SHEET

Safety Lockout Valve
Models V18 and V28

⚠ WARNING ⚠

EXCEPT as otherwise specified by the manufacturer, this product is specifically designed for compressed air service, and use with any other **fluid (liquid or gas) is a misapplication. For example, use with or injection of** certain hazardous liquids or gases in the system (such as alcohol or liquid petroleum gas) could be harmful to the unit or result in a combustible condition or hazardous external leakage. Manufacturer's warranties are void in the event of misapplication, and manufacturer assumes no responsibility for any resulting loss. Before using with fluids other than compressed air, or for nonindustrial applications, or for life support systems consult manufacturer for written approval.

ATTENTION: Make sure bowl is fully inserted into body, and then fully turned to lock bowl in place before applying air pressure to unit. When bowl is properly installed, the alignment markings on the bowl/bowiguard assembly and the marks on the body will line up, indicating proper assembly. Failure to do so may cause air pressure to blow bowl off of unit, resulting in serious personal injury or death.

INSTALLATION

1. Refer to WARNING prior to installation.
2. Install as close to the point of use as possible.
3. Unit must be installed with the flow in the direction of the flow arrow on top of the body.
4. Avoid using reducing bushings, couplings, etc., whenever possible to install this product. These devices restrict air flow and can affect performance.
5. Maximum inlet pressure and temperatures are as follows:
   150 psig (10,3 bar)
   150°F (65,5°C)
6. Unit can be locked in the closed position using a standard padlock.

MAINTENANCE

THE UNIT MUST BE REMOVED FROM THE COMPRESSED AIR LINE.

1. Remove retaining screws, and separate body halves.
2. Remove shut off blade.
3. Remove O-rings from body halves.
4. Lightly lubricate O-rings and place in grooves on body halves.
5. Align shut off blade on pivot pin located on outlet body half as shown.
6. Place body halves together and tighten screws to approximately 20 in/lbs.

ACCESSORIES

Plastic Slide and O-rings:
V18 ..... **VRP-96-925**
V28 ..... **VRP-96-926**

FRENCH

FICHE D'INSTALLATION ET D'ENTRETIEN

Vannes d'isolement de sécurité modèles V18 et V28

⚠ AVERTISSEMENT ⚠

SAUF indication contraire du fabricant, le présent produit est spécifiquement conçu pour fonctionner à l'air comprimé et son utilisation avec tout autre fluide (liquide ou gazeux) constitue un **usage abusif.** Par exemple, l'utilisation du produit **avec certains liquides ou gaz dangereux** (tels que l'alcool ou le gaz de pétrole **liquéfié**) **ou l'injection de tels liquides** ou gaz dans le système risque d'endommager **le dispositif** ou de produire des conditions favorables à la combustion ou des fuites dangereuses à l'extérieur. Les garanties accordées par le fabricant sont nulles en cas d'usage abusif et le fabricant se dégage de toute responsabilité concernant toute perte susceptible d'en résulter. Avant d'utiliser le produit avec des fluides autres que air comprimé, ou pour les applications non-industrielles, ou pour les systèmes d'entretien de la vie, demander l'autorisation écrite du fabricant.

ATTENTION : S'assurer que le bol est bien inséré dans le corps et tourné à fond pour le verrouiller avant de mettre le système sous pression. Quand le bol est bien positionné, les repères portés sur l'ensemble de bol/protège-bol et sur le corps sont alignés. Une mise en place défectueuse peut provoquer une éjection du bol sous la pression de l'air, ce qui risque de causer des blessures graves ou la mort.

INSTALLATION

1. Lire L'AVERTISSEMENT ci-haut avant l'installation.
2. Installer le dispositif aussi près du point d'utilisation que possible.
3. Ce dispositif doit être monté de manière à ce que le débit soit orienté dans la direction de la flèche placée sur le haut du corps.
4. Éviter dans toute la mesure du possible d'utiliser des bagues, raccords ou autres dispositifs de réduction pour installer ce produit. Ils diminuent le débit d'air et risquent d'affecter le fonctionnement.
5. Pression d'entrée et température maximales :
   150 psig (10,3 bar)
   65,5°C (150°F)
6. On peut verrouiller le dispositif en position fermée au moyen d'un cadenas standard.

ENTRETIEN

CE DISPOSITIF DOIT ÊTRE DÉMONTÉ DE LA CONDUITE D'AIR COMPRIMÉ POUR L'ENTRETIEN.

1. Dévisser les vis de fixation et séparer les deux demi-corps.
2. Démonter le battant.
3. Démonter les joints toriques des deux moitiés du corps.
4. Lubrifier légèrement les joints toriques avec du ou un produit équivalent et les replacer dans leur logement.
5. Aligner le battant sur l'axe **situé sur le demi-corps de** sortie comme illustré.
6. Remettre les deux demi-corps ensemble et serrer les vis à environ 20 po/lb.

ACCESSOIRES

Glissière en plastique et joints toriques :
V18 ..... **VRP-96-925**
V28 ..... **VRP-96-926**

SPANISH

HOJA DE INSTALACION Y MANTENIMIENTO

Valvula de cieree de seguridad modelo V18 y V28

⚠ ADVERTENCIA ⚠

SALVO que el fabricante especifique lo contrario, este producto está diseñado específicamente para el uso con aire comprimido, y su uso con cualquier otro fluido (líquido o gas) es una aplicación indebida. Por ejemplo, el uso o la inyección de ciertos líquidos o gases peligrosos en el sistema (tales como el alcohol o el gas de petróleo líquido) podría ser nocivo para la unidad o resultar en una condición de combustión o una fuga externa peligrosa. Las garantías del fabricante no tendrán validez en el caso de aplicación indebida y éste no asume ninguna responsabilidad por cualquier pérdida resultante. Antes de usar con otros fluidos que no sean el aire comprimido, o para aplicaciones no industriales, o para sistemas de mantenimiento de vida, consulte al fabricante para obtener su aprobación por escrito.

ATENCION: Asegúrese de que la taza esté totalmente insertada en el cuerpo y luego completamente girada para fijarla en posición antes de aplicar presión neumática a la unidad. Cuando la taza esté debidamente instalada, las marcas de alineación en la taza y el ensamble del protector de la taza y las marcas en el cuerpo coincidirán, lo cual indica que el ensamble es correcto. De no hacerse así, la presión del aire podrá causar que la taza se desprenda con fuerza de la unidad, lo cual resultará en graves lesiones personales o la muerte.

INSTALACION

1. Remítase a la ADVERTENCIA antes de proceder a la instalación.
2. Efectúe la instalación lo más cerca posible del punto de uso.
3. La unidad se debe instalar con el flujo en dirección de la flecha de flujo en la parte superior del cuerpo.
4. Evite utilizar casquillos reductores, acopladores reductores, etc., siempre que sea posible al instalar este producto. Estos dispositivos restringen el flujo de aire y pueden afectar el rendimiento.
5. La presión de entrada y temperaturas máximas son las siguientes:
   150 psig (10,3 barias)
   150°F (65,5°C)
6. La unidad puede fijarse en la posición de cerrado utilizando un candado estándar.

MANTENIMIENTO

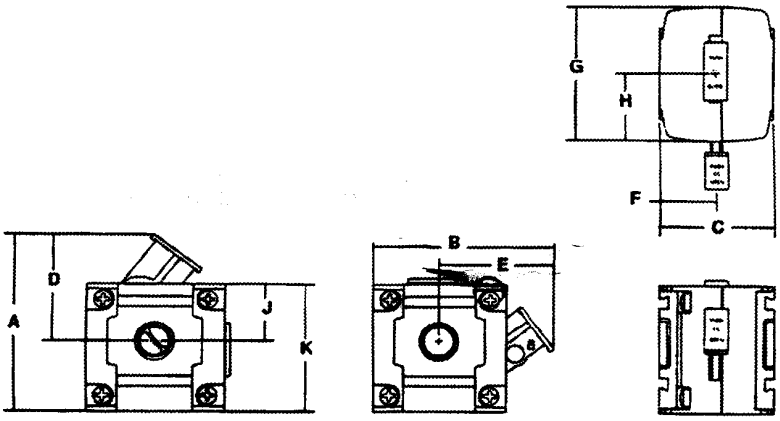
SE DEBE RETIRAR LA UNIDAD DEL CONDUCTO DE AIRE COMPRIMIDO.

1. Retire los tornillos de sujeción y separe las mitades del cuerpo.
2. Retire la hoja de cierre.
3. Retire las juntas tóricas de las mitades del cuerpo.
4. Lubrique ligeramente las juntas tóricas con o equivalente y colóquelas en las ranuras de las mitades del cuerpo.
5. Alinee la hoja de cierre en el pasador-pivote ubicado en la mitad del cuerpo de salida como se muestra en la figura.
6. Una las mitades del cuerpo y ajuste los tornillos a aproximadamente 20 pulg/lb.

ACCESORIOS

Accesorios plásticos deslizantes y juntas tóricas:
V18 ..... **VRP-96-925**
V28 ..... **VRP-96-926**

84-012-000 Rev 1 04/02
Printed in U.S.A.



Models ~~Modèles~~ Modelos	A	B	C	D	E	F	G	H	J	K
	Dimensions **INCHES** millimeters				**Dimensions** **POUCES** millimètres		**Dimensiones** **PULGADAS** milímetros			
V18	**3.16** 80	**3.19** 80	**1.93** 49	**1.19** 49	**2.02** 51	**.97** 24.5	**2.36** 60	**1.18** 30	**1.03** 26	**2.28** 58
V28	**3.23** 82	**3.41** 86	**2.28** 58	**1.98** 50	**2.13** 54	**1.14** 28	**2.58** 65	**1.29** 33	**1.03** 26	**2.28** 58

WILKERSON

84-009-000 Rev 1 08/02 Printed in U.S.A.

ENGLISH

INSTALLATION AND MAINTENANCE SHEET
Filter Model F18 and F28

⚠ WARNING ⚠

EXCEPT as otherwise specified by the manufacturer, this product is specifically designed for compressed air service, and use with any other fluid (liquid or gas) is a misapplication. For example, use with or injection of certain hazardous liquids or gases in the system (such as alcohol or liquid petroleum gas) could be harmful to the unit or result in a combustible condition or hazardous external leakage. Manufacturer's warranties are void in the event of misapplication, and manufacturer assumes no responsibility for any resulting loss. Before using with fluids other than compressed air, or for nonindustrial applications, or for life support systems consult manufacturer for written approval.

ATTENTION: Make sure bowl is fully inserted into body, and then fully turned to lock bowl in place before applying air pressure to unit. When bowl is properly installed, the alignment markings on the bowl/bowlguard assembly and the marks on the body will line up, indicating proper assembly. Failure to do so may cause air pressure to blow bowl off of unit, resulting in serious personal injury or death.

INSTALLATION

1. Refer to **WARNING** prior to installation.
2. Install as close to the point of use as possible.
3. Unit must be installed with the flow in the direction of the flow arrow on the body cover and with bowl down.
4. Avoid using reducing bushings, couplings, etc., whenever possible to install this product. These devices restrict air flow and can affect performance.
5. Do not install this product in any application where the pressure drop across the unit will exceed 20 psig (1,4 bar).
6. Maximum inlet pressure and temperatures are as follows:
   a. Plastic bowl/bowl guard assembly:
      150 psig (10,3 bar)
      125°F (51,7°C)
   b. Metal bowl with Sight Gauge:
      250 psig (17,2 bar)
      150°F (65,5°C)
7. To install a drain line, use the following procedure:
   a. On units with the MANUAL DRAIN, attach flexible tubing having an I.D. of 3/16" (4.8 mm) to drain stem.
   b. On units with AUTOMATIC FLOAT DRAIN, install using a 1/8 NPT fitting and flexible tubing.

NOTE: CONTAMINANTS REMOVED FROM THE COMPRESSED AIR SYSTEM MUST BE DISPOSED OF IN ACCORDANCE WITH LOCAL, STATE AND FEDERAL STANDARDS.

MAINTENANCE

⚠ DEPRESSURIZE SYSTEM BEFORE ATTEMPTING SERVICE!

THIS UNIT MAY BE SERVICED WITHOUT REMOVING THE UNIT FROM THE COMPRESSED AIR LINE. UNIT SHOULD BE SERVICED AT LEAST EVERY SIX MONTHS.

1. Filter element replacement:
   a. **DEPRESSURIZE UNIT.**
   b. Remove bowl/bowl guard assembly by pushing up on bowl assembly and turning counter-clockwise, viewed from below. Clean inside of bowl using a clean, dry cloth. Inspect plastic bowl for damage and replace if necessary.
   c. Remove filter element by turning retainer counter-clockwise.
   d. Remove filter element and discard.
   e. Install a new filter and reassemble in reverse order.
2. Liquid level in the bowl must be kept below the level indicator line as marked. It is a recommended practice to drain a unit equipped with the manual drain at least once during an eight (8) hour period. To do so, rotate the drain knob counter-clockwise one or two turns* (viewed from below).
3. To clean the AUTOMATIC FLOAT DRAIN, remove the drain nut and drain. DO NOT DISASSEMBLE THIS DRAIN! Clean the unit in warm soapy water and blow dry with a compressed air blow gun. **DO NOT CLEAN IN SOLVENTS!**
4. **Before returning unit to service, insure that all seals have been reinstalled or replaced and bowl is locked into position with drain properly secured.**
5. If the unit has the optional Differential Pressure Indicator, RED indicates that the filter element needs to be replaced (Refer to Step 1). If the indicator no longer functions, it must be replaced.

***NOTE: IN THE EVENT THE DRAIN KNOB IS OVER-ROTATED, IT MAY BECOME DISENGAGED FROM THE DRAIN STEM. IN SUCH A CASE, PULL DOWN ON BOTH THE KNOB AND THE STEM WHILE ROTATING CLOCKWISE TO RE-ENGAGE.**

DRAINS

Manual Drain	**GRP-96-685**
Automatic Mechanical Drain (Nitrile)-1/8 NPT	**GRP-95-973**
Low Flow Drain (Nitrile)-1/8 NPT	**GRP-95-400**
Automatic Drain (Fluorocarbon)-1/8 NPT	**GRP-95-981**
Low Flow Drain (Fluorocarbon)-1/8 NPT	**GRP-96-500**
Automatic Mechanical Drain (Nitrile)-1/8 BSP	**GRP-96-200**
Low Flow Drain (Nitrile)-1/8 BSP	**GRP-96-600**
Automatic Drain (Fluorocarbon)-1/8 BSP	**GRP-96-300**
Low Flow Drain (Fluorocarbon)-1/8 BSP	**GRP-96-700**

ACCESSORIES

Joiner set	**GPA-96-601**
T-Bracket	**GPA-96-602**
T-Bracket with Joiner set	**GPA-96-603**
C-Bracket (18 Series)	**GPA-96-604**
C-Bracket (28 Series)	**GPA-96-605**
Differential Pressure Indicator	**DP8-01-000**

FRENCH

FICHE D'INSTALLATION ET D'ENTRETIEN
Filtre modèles F18 et F28

⚠ AVERTISSEMENT ⚠

SAUF indication contraire du fabricant, le présent produit est spécifiquement conçu pour fonctionner à l'air comprimé et son utilisation avec tout autre fluide (liquide ou gazeux) constitue un usage abusif. Par exemple, l'utilisation du produit avec certains liquides ou gaz dangereux (tels que l'alcool ou le gaz de pétrole liquéfié) ou l'injection de tels liquides ou gaz dans le système risque d'endommager le dispositif ou de produire des conditions favorables à la combustion ou des fuites dangereuses à l'extérieur. Les garanties accordées par le fabricant sont nulles en cas d'usage abusif et le fabricant se dégage de toute responsabilité concernant toute perte susceptible d'en résulter. Avant d'utiliser le produit avec des fluides autres que air comprimé, ou pour les applications non-industrielles, ou pour les systèmes d'entretien de la vie, demander l'autorisation écrite du fabricant.

ATTENTION : S'assurer que le bol est bien inséré dans le corps et tourné à fond pour le verrouiller avant de mettre le système sous pression. Quand le bol est bien positionné, les repères portés sur l'ensemble de bol/protège-bol et sur le corps sont alignés. Une mise en place défectueuse peut provoquer une éjection du bol sous la pression de l'air, ce qui risque de causer des blessures graves ou la mort.

INSTALLATION

1. Lire **L'AVERTISSEMENT** ci-haut avant l'installation.
2. Installer le dispositif aussi près du point d'utilisation que possible.
3. Ce dispositif doit être monté de manière à ce que le débit soit orienté dans la direction de la flèche placée sur l'enveloppe du corps, le bol étant vers le bas.
4. Éviter dans toute la mesure du possible d'utiliser des bagues, raccords ou autres dispositifs de réduction pour installer ce produit. Ils diminuent le débit d'air et risquent d'affecter le fonctionnement.
5. Ne pas installer ce dispositif sur les systèmes où la différence de pression entre l'entrée et la sortie du dispositif est appelée à dépasser 20 psig (1,4 bar).
6. Pression d'entrée et température maximales :
   a. Bol/protège-bol en plastique :
      150 psig (10,3 bar)
      51,7 °C (125 °F)
   b. Bol en métal avec jauge visuelle :
      250 psig (17,2 bar)
      65,5°C (150°F)
7. Pour mettre en place une conduite de vidange, procéder comme suit :
   a. Sur les modèles à VIDANGE MANUELLE, raccorder un tuyau flexible de 4,8 mm (3/16") de diamètre intérieur au raccord de vidange.
   b. Sur les modèles à VIDANGE AUTOMATIQUE À FLOTTEUR, utiliser un raccord NPT et un tuyau flexible de 1/8".

NOTE: LES CONTAMINANTS ÔTÉS DU SYSTÈME À AIR COMPRIMÉ DOIVENT ETRE MIS AU REBUT CONFORMÉMENT AUX RÈGLEMENTS LOCAUX, PROVINCIAUX ET FÉDÉRAUX.

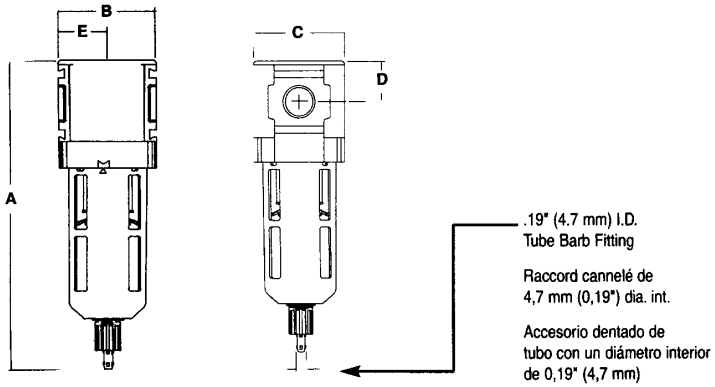
ENTRETIEN

⚠ METTRE LE SYSTÈME HORS PRESSION AVANT D'INTERVENIR!

L'ENTRETIEN DE CE DISPOSITIF PEUT S'EFFECTUER SANS LE DÉMONTER DE LA CONDUITE D'AIR COMPRIMÉ. EFFECTUER L'ENTRETIEN AU MOINS TOUS LES SIX MOIS.

1. Remplacement de l'élément filtrant :
   a. **METTRE LE DISPOSITIF HORS PRESSION.**
   b. Ôter l'ensemble de bol/protège-bol en pesant dessus et en tournant l'ensemble dans le sens horaire, vu de dessous. Nettoyer l'intérieur du bol avec un chiffon sec et propre. Examiner le bol pour s'assurer qu'il n'est pas endommagé et le remplacer si nécessaire.
   c. Démonter l'élément filtrant en tournant le dispositif de retenue dans le sens antihoraire.
   d. Ôter l'élément filtrant et le mettre au rebut.
   e. Installer un nouvel élément filtrant et remonter le tout en procédant en sens inverse pour le remontage. Voir les valeurs du couple de serrage dans le tableau au verso.
2. Le niveau de liquide dans le bol doit être maintenu en-dessous du repère. Il est recommandé de vidanger les régulateurs à vidange manuelle au moins une fois toutes les huit (8) heures. Pour cela, tourner le bouton de vidange d'un ou deux tours dans le sens antihoraire (vu de dessous).*
3. Pour nettoyer le dispositif de vidange automatique à flotteur, dévisser l'écrou de vidange et le dispositif de vidange. NE PAS DÉMONTER CE DISPOSITIF. Le nettoyer dans de l'eau savonneuse chaude et le sécher au pistolet à air comprimé. **NE PAS SE SERVIR DE SOLVANTS!**
4. **Avant de remettre le dispositif en service, vérifier que tous les joints ont bien été remis en place ou remplacés et que le bol est verrouillé en position avec le bouchon/écrou de vidange bien serré.**
5. Si le dispositif est équipé de l'indicateur de pression différentielle en option, cet indicateur devient ROUGE pour signaler qu'il faut remplacer l'élément filtrant. (Se reporter alors à l'étape 1.) Si l'indicateur de pression différentielle ne fonctionne plus, il doit être remplacé.

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FRONT VIEW
VUE DE FACE
VISTA DELANTERA

SIDE VIEW
VUE DE CÔTÉ
VISTA LATERAL

DIMENSIONS
INCHES
(millimeters)

DIMENSIONS
POUCES
(millimètres)

DIMENSIONES
PULGADAS
(milímetros)

Models / Modèles / Modelos	Torque Specifications: Retainer / Couples de serrage: Disp. de retenue / Especificaciones de torsión: Retén	Deflector / Déflecteur / Deflector	A	B	C	D	E
F18	9-11 in. - lbs. (1,0-1,2 N-m)	19-21 in. - lbs. (2,1-2,4 N-m)	7.4 (188)	2.26 (60)	2.26 (60)	1.0 (26)	1.2 (30)
F28	9-11 in. - lbs. (1,0-1,2 N-m)	19-21 in. - lbs. (2,1-2,4 N-m)	8.4 (213)	2.9 (73)	2.9 (73)	1.0 (26)	1.44 (37)

REPAIR KITS AND REPLACEMENT PARTS
TROUSSES DE RÉPARATION ET PIÈCES DE RECHANGE
JUEGOS DE REPARACION Y REPUESTOS

Note: Standard seal material is Nitrile.
Note : Les joints standard sont en nitrile.
Nota: El material sellador estándar es Nitrilo.

F18	FRP-96-639	FRP-96-641	GRP-96-640	GRP-96-634	GRP-96-635	GRP-96-638	GRP-96-636	GRP-96-637
F28	FRP-96-653	FRP-96-283[1]	GRP-96-654	GRP-96-642	GRP-96-643	GRP-96-652	GRP-96-644	GRP-96-645
	Element 5 micron	Element Retainer and Deflector Kit with Bowl O-ring	Bowl O-ring	Plastic bowl/ bowl guard with Manual Drain/Bowl O-ring	Plastic bowl/ bowl guard with Automatic Drain/Bowl O-ring	Plastic bowl/ bowl guard no drain with Bowl O-ring	Metal bowl/ Sight gauge with Manual Drain/Bowl O-ring	Metal bowl/ Sight gauge with Automatic Drain/Bowl O-ring
	Élément de 5 microns	Trousse de disp. de retenue d'élément et déflecteur avec joint torique de bol	Joint torique de bol	Bol en plastique/ protège-bol à vidange manuelle Joint torique de bol	Bol en plastique/ protège-bol à vidange automatique Joint torique de bol	Bol en plastique/ protège-bol sans vidange Joint torique de bol	Bol en métal à jauge visuelle à vidange manuelle Joint torique de bol	Bol en métal à jauge visuelle à vidange automatique Joint torique de bol
	Elemento de 5 micrones	Retén del elemento y juego deflector con junta tórica de la taza	Junta tórica de la taza Nitrilo	Taza de plástico/ Protector de la taza con drenaje manualmanuelle Junta tórica de la taza	Taza de plástico/ Protector de la taza con drenaje automático Junta tórica de la taza	Taza de plástico/ Protector de la taza sin drenaje Junta tórica de la taza	Taza de metal/ Indicador visual de nivel con drenaje manual Junta tórica de la taza	Taza de metal/ Indicador visual de nivel con drenaje automático Junta tórica de la taza

[1] Replaces FRP-96-655
[1] Remplace FRP-96-655
[1] Reemplaza FRP-96-655

PT Coupling



PART A-ADAPTER

ADAPTER x FEMALE NPT THREAD

Made in U.S.A.



PT Coupling Company has a state of the art engineering department to custom design fittings to fit your application.

Size	Aluminum		Brass		Stainless Steel	
	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	1000101	E05A	1200101	E05A	1400101	E05A
3/4 x 1/2"	1000105	1/2A	1200105	1/2A	1400105	1/2A
3/4"	1000107	3/4A	1200107	3/4A	1400107	3/4A
1"	1000110	10A	1200110	10A	1400110	10A
1 1/4"	1000112	12A	1200112	12A	1400112	12A
1 1/2"	1000115	15A	1200115	15A	1400115	15A
2"	1000120	20A	1200120	20A	1400120	20A
2 1/2"	1000125	25A	1200125	25A	1400125	25A
3"	1000130	30A	1200130	30A	1400130	30A
4"	1000140	40A	1200140	40A	1400140	40A
5"	1000150	50A	1200150	50A	1400150	50A
6"	1000160	60A	1200160	60A	1400160	60A
8"	1000180	80A	1200180	80A	1400180	80A
10"	1000190	100A	1200190	100A	1400190	100A
12"	1000192	120A	1200192	120A	☎	120A

Size	Ductile Iron		Hard Coat Alum		Carbon Steel	
	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	1800101	E05A	2000101	E05A	2400101	E05A
3/4 x 1/2"	1800105	1/2A	2000105	1/2A	2400105	1/2A
3/4"	1800107	3/4A	2000107	3/4A	2400107	3/4A
1"	1800110	10A	2000110	10A	2400110	10A
1 1/4"	1800112	12A	2000112	12A	2400112	12A
1 1/2"	1800115	15A	2000115	15A	2400115	15A
2"	1800120	20A	2000120	20A	2400120	20A
2 1/2"	1800125	25A	2000125	25A	2400125	25A
3"	1800130	30A	2000130	30A	2400130	30A
4"	1800140	40A	2000140	40A	2400140	40A
5"	1800150	50A	2000150	50A	2400150	50A
6"	1800160	60A	2000160	60A	2400160	60A
8"	1800180	80A	2000180	80A	☎	80A
10"	1800190	100A	2000190	100A	☎	100A
12"	1800192	120A	☎	120A	☎	120A

Size	Polypropylene		Food Grade Poly		Nylon	
	Item #	Part #	Item #	Part #	item #	Part #
1/2"	NA	NA	NA	NA	NA	NA
3/4 x 1/2"	NA	NA	NA	NA	NA	NA
3/4"	2700107	3/4A	2770107	3/4A	2900107	3/4A
1"	2700110	10A	2770110	10A	2900110	10A
1 1/4"	2700112	12A	2770112	12A	2900112	12A
1 1/2"	2700115	15A	2770115	15A	2900115	15A
2"	2700120	20A	2770120	20A	2900120	20A
2 1/2"	NA	NA	NA	NA	NA	NA
3"	2700130	30A	2770130	30A	2900130	30A
4"	2700140	40A	2770140	40A	NA	NA
5"	NA	NA	NA	NA	NA	NA
6"	NA	NA	NA	NA	NA	NA
8"	NA	NA	NA	NA	NA	NA
10"	NA	NA	NA	NA	NA	NA
12"	NA	NA	NA	NA	NA	NA

PART B-COUPLER

COUPLER X MALE NPT THREAD

Made in U.S.A.



PT maintains inventories at its 14 branch warehouse locations.

All bodies are 316 Stainless Steel and all components are 300 series Stainless Steel

Call for special quote on complete cam arm assembly in 316 Stainless Steel.

Size	Aluminum w/HBS		Aluminum w/HB		Brass w/HB		Brass w/HBS	
	Item #	Part #	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	1000201	E05B	1070201	E05B	1200201	E05B	1290201	E05B
3/4 x 1/2"	1000205	1/2B	1070205	1/2B	1200205	1/2B	1290205	1/2B
3/4"	1000207	3/4B	1070207	3/4B	1200207	3/4B	1290207	3/4B
1"	1000210	10B	1070210	10B	1200210	10B	1290210	10B
1 1/4"	1000212	12B	1070212	12B	1200212	12B	1290212	12B
1 1/2"	1000215	15B	1070215	15B	1200215	15B	1290215	15B
2"	1000220	20B	1070220	20B	1200220	20B	1290220	20B
2 1/2"	1000225	25B	1070225	25B	1200225	25B	1290225	25B
3"	1000230	30B	1070230	30B	1200230	30B	1290230	30B
4"	1000240	40B	1070240	40B	1200240	40B	1290240	40B
5"	1000250	50B	1070250	50B	1200250	50B	1290250	50B
6"	*1000260	60B	1070260	60B	1200260	60B	☎	60B
8"	NA	80B	1000280	80B	1200280	80B	☎	80B
10"	NA	100B	1000290	100B	1200290	100B	☎	100B
12"	NA	120B	1000292	120B	☎	120B	☎	120B

**Note: Standard Cam is HS*

Size	Stainless Steel		Ductile Iron		Hard Coat Alum		Carbon Steel	
	Item #	Part #	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	1400201	E05B	1800201	E05B	2000201	E05B	2400201	E05B
3/4 x 1/2"	1400205	1/2B	1800205	1/2B	2000205	1/2B	2400205	1/2B
3/4"	1400207	3/4B	1800207	3/4B	2000207	3/4B	2400207	3/4B
1"	1400210	10B	1800210	10B	2000210	10B	2400210	10B
1 1/4"	1400212	12B	1800212	12B	2000212	12B	2400212	12B
1 1/2"	1400215	15B	1800215	15B	2000215	15B	2400215	15B
2"	1400220	20B	1800220	20B	2000220	20B	2400220	20B
2 1/2"	1400225	25B	1800225	25B	2000225	25B	2400225	25B
3"	1400230	30B	1800230	30B	2000230	30B	2400230	30B
4"	1400240	40B	1800240	40B	2000240	40B	2400240	40B
5"	1400250	50B	1800250	50B	2000250	50B	☎	50B
6"	*1400260	60B	1800260	60B	*2000260	60B	☎	60B
8"	*1400280	80B	1800280	80B	2000280	80B	☎	80B
10"	☎	100B	☎	100B	☎	100B	☎	100B
12"	☎	120B	☎	120B	☎	120B	☎	120B

**Note: Standard Cam is HS*

Size	Polypropylene		Food Grade Poly		Nylon	
	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	NA	NA	NA	NA	NA	NA
3/4 x 1/2"	NA	NA	NA	NA	NA	NA
3/4"	2700207	3/4B	2770207	3/4B	2900207	3/4B
1"	2700210	10B	2770210	10B	2900210	10B
1 1/4"	2700212	12B	2770212	12B	NA	NA
1 1/2"	2700215	15B	2770215	15B	2900215	15B
2"	2700220	20B	2770220	20B	2900220	20B
2 1/2"	NA	NA	NA	NA	NA	NA
3"	2700230	30B	2770230	30B	2900230	30B
4"	NA	NA	NA	NA	NA	NA
5"	NA	NA	NA	NA	NA	NA
6"	NA	NA	NA	NA	NA	NA
8"	NA	NA	NA	NA	NA	NA
10"	NA	NA	NA	NA	NA	NA
12"	NA	NA	NA	NA	NA	NA

*8, 10, and 12 inch couplers are 4 cam designs with the *STA-LOK® positive locking feature.*

PART C-COUPLER

COUPLER X HOSE SHANK

Made in U.S.A.



PT hose shanks are the most versatile for attaching to hose. The specially designed multi-barbed shank allows for attachment via original Punch-Lok center punch clamps (see page 110 for more details), or by an interlocked ProGrip C-50 ferrule (see page 95 for more details).

All bodies are 316 Stainless Steel and all components are 300 series Stainless Steel

Call for special quote on complete cam arm assembly in 316 Stainless Steel.

Size	Aluminum w/HBS		Aluminum w/HB		Brass w/HB		Brass w/HBS	
	Item #	Part #	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	1000301	E05C	1070301	E05C	1200301	E05C	1290301	E05C
3/4 x 1/2"	1000305	1/2C	1070305	1/2C	1200305	1/2C	1290305	1/2C
3/4"	1000307	3/4C	1070307	3/4C	1200307	3/4C	1290307	3/4C
1"	1000310	10C	1070310	10C	1200310	10C	1290310	10C
1 1/4"	1000312	12C	1070312	12C	1200312	12C	1290312	12C
1 1/2"	1000315	**15C	1070315	**15C	1200315	15C	1290315	15C
2"	1000320	**20C	1070320	**20C	1200320	20C	1290320	20C
2 1/2"	1000325	**25C	1070325	**25C	1200325	25C	1290325	25C
3"	1000330	**30C	1070330	**30C	1200330	30C	1290330	30C
4"	1000340	**40C	1070340	**40C	1200340	40C	1290340	40C
5"	1000350	**50C	1070350	**50C	1200350	50C	1290350	50C
6"	*1000360	**60C	1070360	**60C	1200360	60C	☎	60C
8"	NA	80C	1000380	80C	1200380	80C	☎	80C
10"	NA	100C	1000390	100C	1200390	100C	☎	100C
12"	NA	**120C	1000392	120C	☎	120C	☎	120C

**Note: Standard Cam is HS*

Size	Stainless Steel		Ductile Iron		Hard Coat Alum		Carbon Steel	
	Item #	Part #	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	1400301	E05C	1800301	E05C	2000301	E05C	☎	E05C
3/4 x 1/2"	☎	1/2C	☎	1/2C	2000305	1/2C	☎	1/2C
3/4"	1400307	3/4C	1800307	3/4C	2000307	3/4C	2400307	3/4C
1"	1400310	10C	1800310	10C	2000310	10C	2400310	10C
1 1/4"	1400312	12C	1800312	12C	2000312	12C	2400312	12C
1 1/2"	1400315	15C	1800315	15C	2000315	15C	2400315	15C
2"	1400320	20C	1800320	20C	2000320	20C	2400320	20C
2 1/2"	1400325	2 5C	1800325	25C	2000325	2 5C	2400325	25C
3"	1400330	30C	1800330	30C	2000330	**30C	2400330	30C
4"	1400340	40C	1800340	40C	2000340	**40C	2400340	40C
5"	1400350	50C	1800350	50C	2000350	50C	☎	50C
6"	*1400360	60C	1800360	60C	2000360	**60C	2400360	60C
8"	*1400380	80C	1800380	80C	2000380	80C	☎	80C
10"	*1400390	100C	☎	100C	☎	100C	☎	100C
12"	*1400392	120C	☎	120C	☎	120C	☎	120C

**Note: Standard Cam is HS*

Size	Polypropylene		Food Grade Poly		Nylon	
	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	NA	NA	NA	NA	NA	NA
3/4 x 1/2"	NA	NA	NA	NA	NA	NA
3/4"	2700307	3/4C	2770307	3/4C	2900307	3/4C
1"	2700310	10C	2770310	10C	2900310	10C
1 1/4"	2700312	12C	2770312	12C	NA	NA
1 1/2"	2700315	15C	2770315	15C	2900315	15C
2"	2700320	20C	2770320	20C	2900320	20C
2 1/2"	NA	NA	NA	NA	NA	NA
3"	2700330	30C	2770330	30C	2900330	30C
4"	2700340	40C	2770340	40C	2900340	40C
5"	NA	NA	NA	NA	NA	NA
6"	NA	NA	NA	NA	NA	NA
8"	NA	NA	NA	NA	NA	NA
10"	NA	NA	NA	NA	NA	NA
12"	NA	NA	NA	NA	NA	NA

*** Available w/undersized shank add US to item #.*

*8, 10, 12 inch couplers are 4 cam designs with the *STA-LOK® positive locking feature*

PART D-COUPLER

COUPLER X FEMALE NPT THREAD

Made in U.S.A.



PT maintains inventories at its 14 branch warehouse locations.

All bodies are 316 Stainless Steel and all components are 300 series Stainless Steel

Call for special quote on complete cam arm assembly in 316 Stainless Steel.

Size	Aluminum w/HBS		Aluminum w/HB		Brass w/HB		Brass w/HBS	
	Item #	Part #	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	1000401	E05D	1070401	E05D	1200401	E05D	1290401	E05D
3/4 x 1/2"	1000405	1/2D	1070405	1/2D	1200405	1/2D	1290405	1/2D
3/4"	1000407	3/4D	1070407	3/4D	1200407	3/4D	1290407	3/4D
1"	1000410	10D	1070410	10D	1200410	10D	1290410	10D
1 1/4"	1000412	12D	1070412	12D	1200412	12D	1290412	12D
1 1/2"	1000415	15D	1070415	15D	1200415	15D	1290415	15D
2"	1000420	20D	1070420	20D	1200420	20D	1290420	20D
2 1/2"	1000425	25D	1070425	25D	1200425	25D	1290425	25D
3"	1000430	30D	1070430	30D	1200430	30D	1290430	30D
4"	1000440	40D	1070440	40D	1200440	40D	1290440	40D
5"	1000450	50D	1070450	50D	1200450	50D	1290450	50D
6"	*1000460	60D	1070460	60D	1200460	60D	☎	60D
8"	NA	80D	1000480	80D	1200480	80D	☎	80D
10"	NA	100D	1000490	100D	1200490	100D	☎	100D
12"	NA	120D	1000492	120D	☎	120D	☎	120D

**Note: Standard Cam is HS*

Size	Stainless Steel		Ductile Iron		Hard Coat Alum		Carbon Steel	
	Item #	Part #	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	1400401	E05D	1800401	E05D	2000401	E05D	2400401	E05D
3/4 x 1/2"	1400405	1/2D	1800405	1/2D	2000405	1/2D	☎	1/2D
3/4"	1400407	3/4D	1800407	3/4D	2000407	3/4D	2400407	3/4D
1"	1400410	10D	1800410	10D	2000410	10D	2400410	10D
1 1/4"	1400412	12D	1800412	12D	2000412	12D	2400412	12D
1 1/2"	1400415	15D	1800415	15D	2000415	15D	2400415	15D
2"	1400420	20D	1800420	20D	2000420	20D	2400420	20D
2 1/2"	1400425	25D	1800425	25D	2000425	25D	2400425	25D
3"	1400430	30D	1800430	30D	2000430	30D	2400430	30D
4"	1400440	40D	1800440	40D	2000440	40D	2400440	40D
5"	1400450	50D	1800450	50D	2000450	50D	2400450	50D
6"	*1400460	60D	1800460	60D	*2000460	60D	☎	60D
8"	*1400480	80D	1800480	80D	2000480	80D	2400480	80D
10"	*1400490	100D	1800490	100D	2000490	100D	2400490	100D
12"	☎	120D	☎	120D	☎	120D	☎	120D

**Note: Standard Cam is HS*

Size	Polypropylene		Food Grade Poly		Nylon	
	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	NA	NA	NA	NA	NA	NA
3/4 x 1/2"	NA	NA	NA	NA	NA	NA
3/4"	2700407	3/4D	2770407	3/4D	2900407	3/4D
1"	2700410	10D	2770410	10D	2900410	10D
1 1/4"	2700412	12D	2770412	12D	NA	NA
1 1/2"	2700415	15D	2770415	15D	2900415	15D
2"	2700420	20D	2770420	20D	2900420	20D
2 1/2"	NA	NA	NA	NA	NA	NA
3"	2700430	30D	2770430	30D	2900430	30D
4"	NA	NA	NA	NA	NA	NA
5"	NA	NA	NA	NA	NA	NA
6"	NA	NA	NA	NA	NA	NA
8"	NA	NA	NA	NA	NA	NA
10"	NA	NA	NA	NA	NA	NA
12"	NA	NA	NA	NA	NA	NA

8, 10, 12 inch couplers are 4 cam designs with the "STA-LOK® positive locking feature

PART E-ADAPTER

ADAPTER X HOSE SHANK

Made in U.S.A.



For best results use Punch-Lok® center punch hose clamps with PT Coupling's machined hose shanks

Size	Aluminum		Brass		Stainless Steel	
	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	1000501	E05E	1200501	E05E	1400501	E05E
3/4x1/2"	☎	1/2E	1200505	1/2E	1400505	1/2E
3/4"	1000507	3/4E	1200507	3/4E	1400507	3/4E
1"	1000510	10E	1200510	10E	1400510	10E
1 1/4"	1000512	12E	1200512	12E	1400512	12E
1 1/2"	1000515	**15E	1200515	15E	1400515	15E
2"	1000520	**20E	1200520	20E	1400520	20E
2 1/2"	1000525	**25E	1200525	25E	1400525	25E
3"	1000530	**30E	1200530	30E	1400530	30E
4"	1000540	**40E	1200540	40E	1400540	40E
5"	1000550	**50E	1200550	50E	1400550	50E
6"	1000560	**60E	1200560	60E	1400560	60E
8"	1000580	80E	1200580	80E	1400580	80E
10"	1000590	100E	☎	100E	☎	100E
12"	1000592	120E	☎	120E	☎	120E

Size	Ductile Iron		Hard Coat Alum		Carbon Steel	
	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	1800501	E05E	2000501	E05E	2400501	E05E
3/4x1/2"	☎	1/2E	☎	1/2E	☎	1/2E
3/4"	1800507	3/4E	2000507	3/4E	2400507	3/4E
1"	1800510	10E	2000510	10E	2400510	10E
1 1/4"	1800512	12E	2000512	12E	2400512	12E
1 1/2"	1800515	15E	2000515	15E	2400515	15E
2"	1800520	20E	2000520	20E	2400520	20E
2 1/2"	1800525	25E	2000525	25E	2400525	25E
3"	1800530	30E	2000530	**30E	2400530	30E
4"	1800540	40E	2000540	**40E	2400540	40E
5"	1800550	50E	2000550	50E	☎	50E
6"	1800560	60E	2000560	**60E	2400560	60E
8"	1800580	80E	2000580	80E	☎	80E
10"	☎	100E	☎	100E	☎	100E
12"	☎	120E	☎	120E	☎	120E

Size	Polypropylene		Food Grade Poly		Nylon	
	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	NA	NA	NA	NA	NA	NA
3/4x1/2"	NA	NA	NA	NA	NA	NA
3/4"	2700507	3/4E	2770507	3/4E	2900507	3/4E
1"	2700510	10E	2770510	10E	2900510	10E
1 1/4"	2700512	12E	2770512	12E	☎	12E
1 1/2"	2700515	15E	2770515	15E	2900515	15E
2"	2700520	20E	2770520	20E	2900520	20E
2 1/2"	NA	NA	NA	NA	NA	NA
3"	2700530	30E	2770530	30E	2900530	30E
4"	2700540	40E	NA	NA	NA	NA
5"	NA	NA	NA	NA	NA	NA
6"	NA	NA	NA	NA	NA	NA
8"	NA	NA	NA	NA	NA	NA
10"	NA	NA	NA	NA	NA	NA
12"	NA	NA	NA	NA	NA	NA

*** Available w/undersized shank add US to item #.*

PART F-ADAPTER

ADAPTER X MALE NPT THREAD

Made in U.S.A.



PT maintains inventories at its 14 branch warehouse locations.

Size	Aluminum		Brass		Stainless Steel	
	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	1000601	E05F	1200601	E05F	1400601	E05F
3/4 x 1/2"	1000605	1/2F	1200605	1/2F	1400605	1/2F
3/4"	1000607	3/4F	1200607	3/4F	1400607	3/4F
1"	1000610	10F	1200610	10F	1400610	10F
1 1/4"	1000612	12F	1200612	12F	1400612	12F
1 1/2"	1000615	15F	1200615	15F	1400615	15F
2"	1000620	20F	1200620	20F	1400620	20F
2 1/2"	1000625	25F	1200625	25F	1400625	25F
3"	1000630	30F	1200630	30F	1400630	30F
4"	1000640	40F	1200640	40F	1400640	40F
5"	1000650	50F	1200650	50F	1400650	50F
6"	1000660	60F	1200660	60F	1400660	60F
8"	1000680	80F	1200680	80F	1400680	80F
10"	1000690	100F	1200690	100F	1400690	100F
12"	1000692	120F	☎	120F	☎	120F

Size	Ductile Iron		Hard Coat Alum		Carbon Steel	
	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	1800601	E05F	2000601	E05F	2400601	E05F
3/4 x 1/2"	1800605	1/2F	2000605	1/2F	2400605	1/2F
3/4"	1800607	3/4F	2000607	3/4F	2400607	3/4F
1"	1800610	10F	2000610	10F	2400610	10F
1 1/4"	1800612	12F	2000612	12F	2400612	12F
1 1/2"	1800615	15F	2000615	15F	2400615	15F
2"	1800620	20F	2000620	20F	2400620	20F
2 1/2"	1800625	25F	2000625	25F	2400625	25F
3"	1800630	30F	2000630	30F	2400630	30F
4"	1800640	40F	2000640	40F	2400640	40F
5"	1800650	50F	2000650	50F	☎	50F
6"	1800660	60F	2000660	60F	2400660	60F
8"	1800680	80F	2000680	80F	☎	80F
10"	1800690	100F	☎	100F	☎	100F
12"	☎	120F	☎	120F	☎	120F

Size	Polypropylene		Food Grade Polypropylene		Nylon	
	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	NA	NA	NA	NA	NA	NA
3/4 x 1/2"	NA	NA	NA	NA	NA	NA
3/4"	2700607	3/4F	2770607	3/4F	2900607	3/4F
1"	2700610	10F	2770610	10F	2900610	10F
1 1/4"	2700612	12F	2770612	12F	2900612	12F
1 1/2"	2700615	15F	2770615	15F	2900615	15F
2"	2700620	20F	2770620	20F	2900620	20F
2 1/2"	NA	NA	NA	NA	NA	NA
3"	2700630	30F	2770630	30F	2900630	30F
4"	NA	NA	NA	NA	NA	NA
5"	NA	NA	NA	NA	NA	NA
6"	NA	NA	NA	NA	NA	NA
8"	NA	NA	NA	NA	NA	NA
10"	NA	NA	NA	NA	NA	NA
12"	NA	NA	NA	NA	NA	NA

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PART V-COUPLER

DUST CAP

Made in U.S.A.



All bodies are 316 Stainless Steel and all components are 300 series Stainless Steel

Call for special quote on complete cam arm assembly in 316 Stainless Steel.

PT maintains inventories at its 14 branch warehouse locations.

Size	Aluminum w/HBS		Aluminum w/HB		Brass w/HB		Brass w/HBS	
	Item #	Part #	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	1001101	E05V	1071101	E05V	1201101	E05V	1291101	E05V
3/4"	1001107	3/4V	1071107	3/4V	1201107	3/4V	1291107	3/4V
1"	1001110	10V	1071110	10V	1201110	10V	1291110	10V
1 1/4"	1001112	12V	1071112	12V	1201112	12V	1291112	12V
1 1/2"	1001115	15V	1071115	15V	1201115	15V	1291115	15V
2"	1001120	20V	1071120	20V	1201120	20V	1291120	20V
2 1/2"	1001125	25V	1071125	25V	1201125	25V	1291125	25V
3"	1001130	30V	1071130	30V	1201130	30V	1291130	30V
4"	1001140	40V	1071140	40V	1201140	40V	1291140	40V
5"	1001150	50V	1071150	50V	1201150	50V	☎	50V
6"	*1001160	60V	1071160	60V	1201160	60V	NA	60V
8"	1001180	80V	1071180	80V	1201180	80V	NA	80V
10"	1001190	100V	1071190	100V	1201190	100V	NA	100V
12"	1001192	120V	1071192	120V	☎	120V	NA	120V

**Note: Standard Cam is HS*

Size	Stainless Steel		Ductile Iron		Hard Coat Alum		Carbon Steel	
	Item #	Part #	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	1401101	E05V	1801101	E05V	2001101	E05V	☎	E05V
3/4"	1401107	3/4V	1801107	3/4V	2001107	3/4V	2401107	3/4V
1"	1401110	10V	1801110	10V	2001110	10V	2401110	10V
1 1/4"	1401112	12V	1801112	12V	2001112	12V	☎	12V
1 1/2"	1401115	15V	1801115	15V	2001115	15V	2401115	15V
2"	1401120	20V	1801120	20V	2001120	20V	2401120	20V
2 1/2"	1401125	25V	1801125	25V	2001125	25V	2401125	25V
3"	1401130	30V	1801130	30V	2001130	30V	2401130	30V
4"	1401140	40V	1801140	40V	2001140	40V	2401140	40V
5"	1401150	50V	1801150	50V	2001150	50V	☎	50V
6"	*1401160	60V	1801160	60V	*2001160	60V	2401160	60V
8"	*1401180	80V	1801180	80V	2001180	80V	2401180	80V
10"	*1401190	100V	1801190	100V	☎	100V	☎	100V
12"	*1401192	120V	1801192	120V	☎	120V	☎	120V

**Note: Standard Cam is HS*

Size	Polypropylene		Food Grade Poly		Nylon	
	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	NA	NA	NA	NA	NA	NA
3/4x1/2"	NA	NA	NA	NA	NA	NA
3/4"	2701107	3/4V	2771107	3/4V	2901107	3/4V
1"	2701110	10V	2771110	10V	2901110	10V
1 1/4"	2701112	12V	2771112	12V	NA	NA
1 1/2"	2701115	15V	2771115	15V	2901115	15V
2"	2701120	20V	2771120	20V	2901120	20V
2 1/2"	NA	NA	NA	NA	NA	NA
3"	2701130	30V	2771130	30V	2901130	30V
4"	2701140	40V	2771140	40V	2901140	40V
5"	NA	NA	NA	NA	NA	NA
6"	NA	NA	NA	NA	NA	NA
8"	NA	NA	NA	NA	NA	NA
10"	NA	NA	NA	NA	NA	NA
12"	NA	NA	NA	NA	NA	NA

*8, 10, and 12 inch couplers are 4 cam designs with the *STA-LOK® positive locking feature.*

PART VL-COUPLER

DUST CAP W/LOCKING CAM ARMS

Made in U.S.A.



Size	*Aluminum		*Brass		**Stainless Steel	
	Item #	Part #	Item #	Part #	Item #	Part #
1 1/2"	60800015	15VL	☎	15VL	☎	15VL
2"	60800020	20VL	62800020	20VL	64800020	20VL
2 1/2"	60800025	25VL	62800025	25VL	64800025	25VL
3"	60800030	30VL	62800030	30VL	64800030	30VL
4"	60800040	40VL	62800040	40VL	64800040	40VL
5"	60800050	50VL	62800050	50VL	☎	50VL
6"	60800060	60VL	62800060	60VL	64800060	60VL

Size	*Ductile Iron		*Hard Coat Alum		Polypropylene	
	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	☎	15VL	☎	15VL	☎	*15VL
3/4x1/2"	68800020	20VL	70800020	20VL	67800020	**20VL
3/4"	68800025	25VL	70800025	25VL	NA	NA
1"	68800030	30VL	70800030	30VL	67800030	**30VL
1 1/4"	68800040	40VL	70800040	40VL	67800040	**40VL
1 1/2"	68800050	50VL	☎	50VL	NA	NA
2"	68800060	60VL	70800060	60VL	NA	NA

**Priced with brass cam arms. Dust caps with Brass cam arms are priced without pull rings.*
***Priced with stainless cam arms. Dust caps with stainless steel locking arms are supplied with pull rings.*

PT maintains inventories at its 14 branch warehouse locations.

All bodies are 316 Stainless Steel and all components are 300 series Stainless Steel

Call for special quote on complete cam arm assembly in 316 Stainless Steel.

XL LOCKING CAM ASSEMBLY FOR LOCKING VL COUPLER

INCLUDES 1 CAM, 1 PIN AND 1 RING

Made in U.S.A.

Size	Stainless Steel		Cast Brass	
	Item #	Part #	Item #	Part #
2-2 1/2"	5004020A	20XL	5003520A	20XL
3"	5004030A	30/40XL	5003530A	30XL
4"	5004030A	30/40XL	5003540A	40XL
5"	NA	NA	5003550A	50XL
6"	NA	NA	5003560A	60XL

SECURITY CHAINS

FOR DUST CAPS AND DUST PLUGS

Made in U.S.A.

Length	Stainless Steel Chain W/Hooks or Rings		Brass Chain w/hooks or rings W/Hooks or Rings	
	Item #	Part #	Item #	Part #
6"	5101060A	S56	5100560A	C51
8"	5101080A	S51	NA	NA
12"	5101092A	S52	5100592A	C52

Please specify hooks or rings when ordering. Chains can also be ordered to custom lengths. Please call for pricing and availability. Bulk Chain is also available — Call for pricing.

PART W-ADAPTER

DUST PLUG

Made in U.S.A.



PT maintains inventories at its 14 branch warehouse locations.

Size	Aluminum		Brass		Stainless Steel	
	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	1001201	E05W	1201201	E05W	1401201	E05W
3/4"	1001207	3/4W	1201207	3/4W	1401207	3/4W
1"	1001210	10W	1201210	10W	1401210	10W
1 1/4"	1001212	12W	1201212	12W	1401212	12W
1 1/2"	1001215	15W	1201215	15W	1401215	15W
2"	1001220	20W	1201220	20W	1401220	20W
2 1/2"	1001225	25W	1201225	25W	1401225	25W
3"	1001230	30W	1201230	30W	1401230	30W
4"	1001240	40W	1201240	40W	1401240	40W
5"	1001250	50W	1201250	50W	1401250	50W
6"	1001260	60W	1201260	60W	1401260	60W
8"	1001280	80W	1201280	80W	1401280	80W
10"	1001290	100W	1201290	100W	1401290	100W
12"	1001292	120W	☎	120W	☎	120W

Size	Ductile Iron		Hard Coat Alum		Carbon Steel	
	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	1801201	E05W	2001201	E05W	2401201	E05W
3/4"	1801207	3/4W	2001207	3/4W	2401207	3/4W
1"	1801210	10W	2001210	10W	2401210	10W
1 1/4"	1801212	12W	2001212	12W	☎	12W
1 1/2"	1801215	15W	2001215	15W	2401215	15W
2"	1801220	20W	2001220	20W	2401220	20W
2 1/2"	1801225	25W	2001225	25W	☎	25W
3"	1801230	30W	2001230	30W	2401230	30W
4"	1801240	40W	2001240	40W	2401240	40W
5"	1801250	50W	2001250	50W	☎	50W
6"	1801260	60W	2001260	60W	☎	60W
8"	1801280	80W	2001280	80W	☎	80W
10"	1801290	100W	☎	100W	☎	100W
12"	☎	120W	☎	120W	☎	120W

Size	Polypropylene		Food Grade Poly		Nylon	
	Item #	Part #	Item #	Part #	Item #	Part #
1/2"	NA	NA	NA	NA	NA	NA
3/4"	2701207	3/4W	2771207	3/4W	2901207	3/4W
1"	2701210	10W	2771210	10W	2901210	10W
1 1/4"	2701212	12W	2771212	12W	NA	NA
1 1/2"	2701215	15W	2771215	15W	2901215	15W
2"	2701220	20W	2771220	20W	2901220	20W
2 1/2"	NA	NA	NA	NA	NA	NA
3"	2701230	30W	2771230	30W	2901230	30W
4"	2701240	40W	2771240	40W	NA	NA
5"	NA	NA	NA	NA	NA	NA
6"	NA	NA	NA	NA	NA	NA
8"	NA	NA	NA	NA	NA	NA
10"	NA	NA	NA	NA	NA	NA
12"	NA	NA	NA	NA	NA	NA



AccuPAX® Battery Master Switch

Installation and Specification Manual

HM4660A / HM4660B

911-354-55

HELLA

Installation and Specification Manual

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Release date: October 2006

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Overview

The HM4660A (12 Volt) and HM4660B (24 Volt) Battery Master Switches have been designed to comply with Australian Standards AS 2809.2 and European ADR 2005. HM4660A and HM4660B are 2-Pole Bi-stable electro-mechanical switches with mechanical locking. They also incorporate Printed Circuit Boards (PCB) to monitor and operate several additional functions, many previously unavailable on older style battery isolator switches.

The prime function of the HM4660A and HM4660B is to disconnect and isolate the main battery positive and negative circuits of the vehicle or engine plant to render it safe and/or inoperable. You are offered several options to operate the switch; it may be operated directly at the control panel on the switch face, it can also be operated by means of a control switch located in the drivers' cabin or additional control switches at desired locations around the vehicle.

In **emergency shut down** situation, such as in the event of a roll over the HM4660A/ HM4660B switch will disconnect all power immediately via the emergency shut down switch or via a Roll Over Device.

In **non-emergency shut down** situations, the Battery Master Switch will step through a pre-programmed shut-down, which after a 10 second delay, enables the safe disconnection of on board engine management systems to avoid data corruption. Incorporated in the non-emergency shut down is Alternator field isolation to ensure that the alternator has been shut down prior to the disconnection of the main battery supply. If the alternator is not adequately shut down, damage to the alternator is likely to occur.

Features

- Ex & CE Certified
- Compliant with ADR 2005
- Compliant with AS 2809 (Draft)
- Field isolation for North American vehicles
- D+ shutdown for European vehicles
- Delayed ECM shutdown to prevent re-programming
- Direct plug in iROS™ roll over device - works with all other roll over devices (optional equipment - not supplied)
- Roll over simulation test with status light
- Luminous On/ Off/ Roll Over push button switches
- Robust IP65 rated enclosure
- Stainless Steel mounting bracket (Lucas SSB interchangeable)
- Low battery voltages disconnect
- Lockable cover (optional equipment - not supplied)

Specifications

Switch Compliance

ADR Battery Switch
Type : ATEX 250
CE 0081
Ex II 2 G
EEx ib II C T6
LCIE 05 ATEX 6050 X
EMC 95/54/EC
IP65

Note: It is highly recommended that the installation of the HM4660A or HM4660B is performed by a qualified Automotive Electrician or Electrical Engineer.

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Mechanical

Housing material
Reinforced PBT (black) withstanding extreme environmental conditions

Mounting bracket/ bolts
Stainless steel

Connection studs
Silver plated copper

Size
approx. 160 x 100 x 170mm

Weight
approx. 3.2kg

Environment

Degree of Protection
Minimum IP65 for the housing (ADR Requirement)

Temperature Range
-40° to +85°C

Vibration Resistance
EC 60068-2-6, Test Fc, 5g (50-200Hz)

Ideally the battery switch should be placed in the battery box (also see 'Fitting'). Otherwise the cable connections shall have protection degree IP54.



Fitting

The Battery Master Switch should be fitted in accordance with State or Federal laws relevant to the application it is required to meet. Please refer to the appropriate governing authority for specific fitting requirements.

ADR Regulation 9.2.2.3

9.2.2.3.1

A switch for breaking the electrical circuits shall be placed as close to the battery as practicable. If a single pole switch is used it shall be placed in the supply lead and not in the earth lead.

9.2.2.3.2

A control device (not supplied) to facilitate the disconnecting and reconnecting functions of the switch shall be installed in the driver's cab. It shall be readily accessible to the driver and be distinctively marked. It shall be protected against inadvertent operation by either adding a protective cover, by using a dual movement control device or by other suitable means. Additional control devices may be installed provided they are distinctively marked and protected against inadvertent operation. If the control device(s) are electrically operated, the circuits of the control device(s) are subject to the requirements of 9.2.2.5.

9.2.2.3.3

The switch shall have a casing with protection degree IP65 in accordance with IEC Standard 529.

9.2.2.3.4

The cable connections on the switch shall have protection degree IP54. However, this does not apply if these connections are contained in a housing which may be the battery box. In this case it is sufficient to insulate the connections against short circuits, for example with a rubber cap.

9.2.2.4

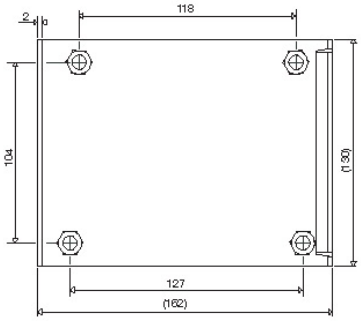
The battery terminals shall be electrically insulated or covered by the insulating battery box cover. If the batteries are not located under the engine bonnet, they shall be fitted in a vented box.

6

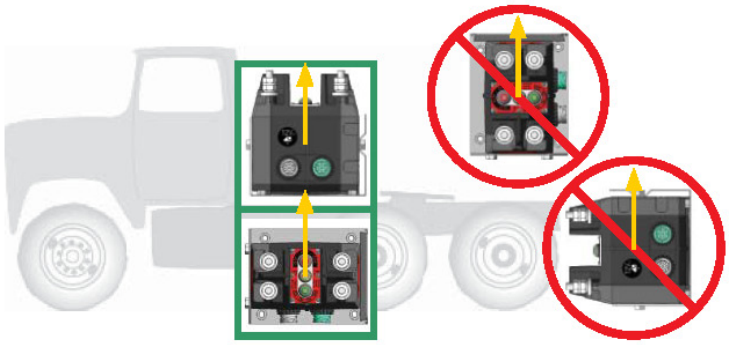
Mounting Positions

The mounting bracket offers the same interface as the Lucas 196A (SSB). Use 4 x M8 bolts for fixation. The welded nuts are part of the bracket.

- Maximum Tightening torque: 14 N.m
- It is strongly recommended to add locking nuts or thread locking adhesive to secure fastening (not supplied).
- 2 mounting axis allowed (refer illustration below).



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Electrical

The Battery Master Switch is used for the disconnection of both positive and negative terminals of the battery (compliant with ADR 2005 regulation).

The positive circuit disconnects first.

Main terminals
4 x M10 studs. Use ring terminals for the cable connections positive caps.

Tightening torque
14 Nm.

Respect carefully the polarities marked on the Battery Switch housing:

+BAT = Red Terminal
(positive terminal of the battery)

-BAT = Blue or Black Terminal
(negative terminal of the battery)

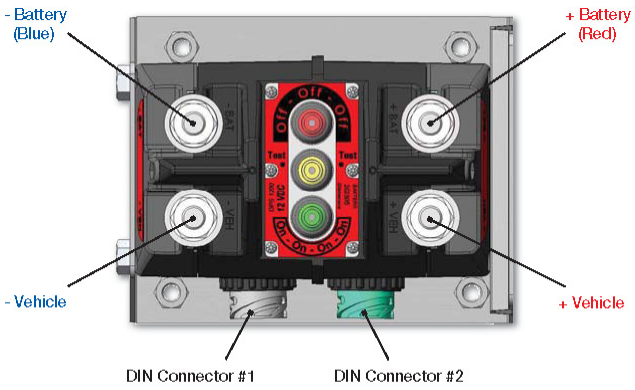
External connections to Battery Master Switch via 2 DIN connectors (refer illustration).

WARNING:

Damage may occur if connected incorrectly.

Do not conduct welding to a vehicle while HM4660A/ HM4660B Battery Master Switch is fitted and connected to it.

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Switch Rating

	HM4660A	HM4660B
Operating Voltage **(Note 1)**	9 to 15 Volts	18 to 30 Volts
Current Rating	300A continuous	300A continuous
Max Current 5 Sec	2500A	2500A
Max Current 30 Sec	600A	600A
Field Isolation Circuit	10A max	10A max
Optional Low Voltage Monitoring **(Note 1)**	< 11.4V ± 0.3V (60sec delay)	< 22.5V ± 0.3V (60sec delay)
Low Voltage Disconnect **(Note 1)**	< 9.5V (60sec delay)	< 18V (60sec delay)
External Trigger	10mA	10mA
Roll Over	1A	1A
Current Draw OFF mode	150mA (red LED Illumination)	150mA (red LED Illumination)
Auxiliary relay # 1 **(Note 2)**	10A	10A
Auxiliary relay # 2 for ECM Delay **(Note 3)**	0.5A	0.3A

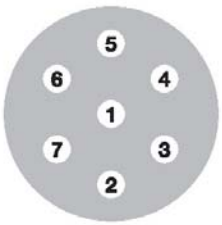
Note 1 See information on 'Battery Voltage Monitoring', page 19.

Note 2 This circuit (change-over relay #1) switches immediately after the control switch is operated, then the main circuits open after > 30 millisecond delay.

Note 3 This circuit switches OFF after a 10 second delay when the main circuits are open. **In case of emergency (o nly via Roll Over Device) all auxiliary and main circuits are disconnected immediately without delay.** While in the ON position the green push button of the control panel will remain illuminated.

Connector #1 (Grey or Black)

Connector #1 (Grey or Black)
for Control Circuit and Auxiliary Circuit

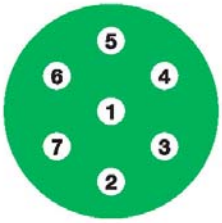


Pin #	Description	
Pin 1	**12 Volt** Negative (-Bat) Supply Output.	**24 Volt** Negative (-Bat) Controlled Output*. 300mA Max. External Fuse recommended.
Pin 2	**12 Volt** Postive (+Bat) Controlled Output*. 500mA Max. External Fuse recommended.	**24 Volt** Positive (+Bat) Supply Output.
Pin 3	Battery Master Switch "OFF" trigger. Used in conjunction with Pin 7/ Connector 1 to turn the Battery Master Switch **OFF** via remote push button switch.	
Pin 4	Battery Master Switch "ON" trigger. Used in conjunction with Pin 7/ Connector 1 to turn the Battery Master Switch **ON** via remote push button switch.	
Pin 5	Field Isolation Circuit (accommodates European & American type field isolation). 10Amps Max. **European Type Isolation:** Pin is connected to the D+ on the alternator. When the Battery Master Switch is switched OFF this pin is switched to ground. **American Type Isolation:** Used in conjunction with Pin 6 / Connector 1 to cut field current. *Note: Caution is required when connecting this Pin for the American type field isolation. If connected around the wrong way it can cause the alternator to keep charging in a Full Field Situation.*	
Pin 6	Field Isolation Circuit. 10Amps Max. Used in conjunction with Pin 5 / Connector 1 for the American style field isolation.	
Pin 7	Battery Master Switch Common B+ supply. Used in conjunction with Pins 3 & 4 / Connector 1 to turn the Battery Master Switch **ON & OFF**. *Note: This pin cannot be used to supply power for anything else.*	

* This output is deactivated 10 seconds **after** the main circuits opening.

Connector #2 (Green or Blue)

Connector #2 (Green or Blue)
for Control Circuit and Auxiliary Circuit



Pin #	Description
Pin 1	Constant Battery Negative output. 1Amp.
Pin 2	Battery Master Switch Emergency "OFF" trigger. This is a negative OFF only trigger and when used will override the time delay on Pin 2 / Connector 1.
Pin 3	Switched Battery Positive output. 1Amp. This pin is switched ON and OFF the same as the main contacts.
Pin 4	Warning light test switch. When grounded it will illuminate the LED warning light marked "TEST" in the panel on the Battery Master Switch.
Pin 5	Positive output from test switch. This is a positive switched output from the TEST switch on the Battery Master Switch.
Pin 6	Test switch warning light output. This is a direct connection to Pin 4 / Connector 2 and is used to operate an external warning light.
Pin 7	Voltage Monitoring Inhibition. Connect to + Positive Ignition supply (also refer to 'Voltage Monitoring', page 19).

Installation

The following instructions provide for the most basic installation and operation of the Battery Master Switch (it is not required to have all functions operational to operate the Hella Battery Master Switch).

Battery Cable Installation

This installation will allow the Battery Master switch to function in the simplest form. The Master switch will be able to turn the connections to the vehicles batteries ON and OFF .

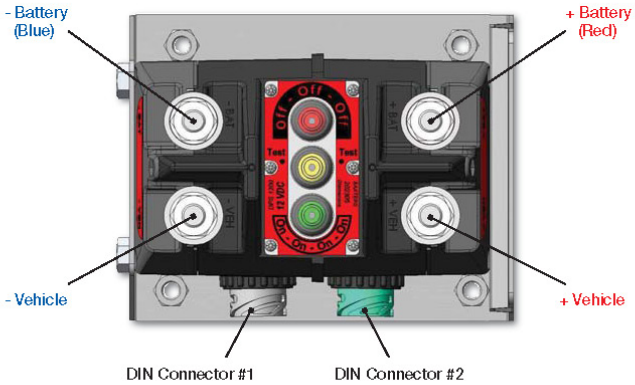
Connect battery cables as per markings on the Battery Master Switch:

Positive battery cable from vehicle connects to +VEH
Negative battery cable from vehicle connects to -VEH

Positive battery cable from batteries connects to +BAT
Negative battery cable from batteries connects to -BAT

The two DIN Connectors supplied in the installation kit must be installed into connector 1 & 2 on the Master switch. Each connector must be fitted with blanking seals (supplied) to ensure the IP Rating (weatherproofing) of the switch is not compromised. Failure to do so could allow water to ingress the Battery Master Switch, which will void the warranty.

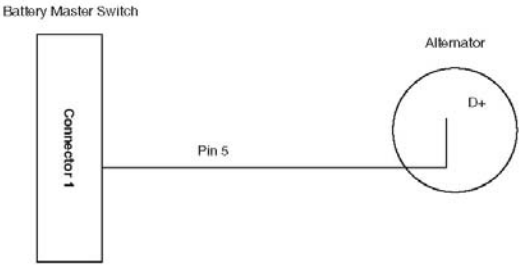
Note: If the Battery Master Switch is to be turned off while the engine is running, it is required to further install a circuit for Alternator Field Isolation. Isolating or de-energising the field system of the alternator avoids voltage peaks for open load when disconnecting the batteries.



Alternator Field Isolation

European Style Field Isolation

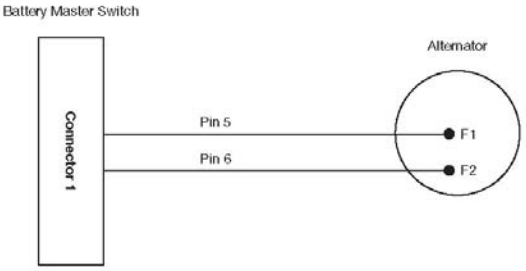
European style Field Isolation requires only one wire connection. Pin 5 of connector 1 is required to be connected to D+ on the Alternator. This covers most of the European alternators but caution is required for later model alternators.



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American Style Field Isolation

American Style Field Isolation requires the field circuit to be opened circuited and a connection from these two circuits to return back to the Battery Master Switch.



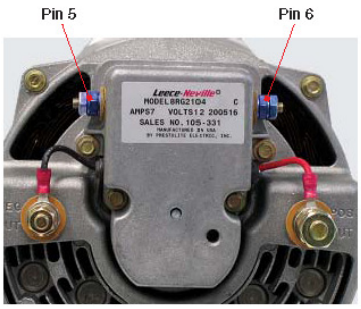
American Delco Remy 33/34 SI & Prestolite Regulator 105-331

When connecting the HM4660A or HM4660B Battery Master Switch, field isolation must be connected to the alternator in the correct manner. The alternator field terminals are to be wired as indicated when connecting field isolation via Connector 1/ Pin 5 and 6.

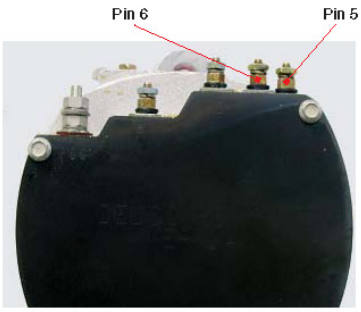
Note: Caution is required when connecting the two wires. Incorrect connection to the alternator can cause the alternator to charge full field or cause damage to the regulator when the Battery Master Switch is turned OFF while the engine is running.

	Negative Field Isolation	Positive Field Isolation
Regulator Side of Field Circuit	PIN 5	PIN 6
Field Side of Field Circuit	PIN 6	PIN 5

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Prestolite Regulator; 105-331



Delco 33/34SI (Field Isolation not standard)

Late Bosch Alternators

Cut ignition supply to Alternator Regulator Terminal 3 and reconnect as per diagram.

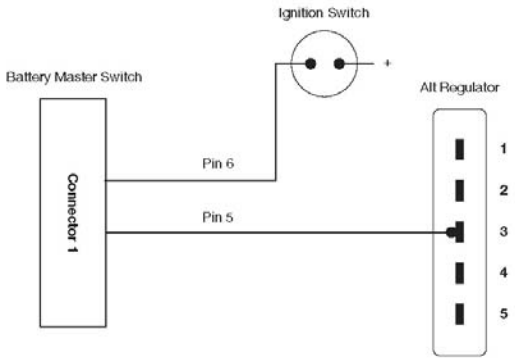
Pin 1 W: AC Output re tacho

Pin 2 L: Warning Light

Pin 3 15: Ignition

Pin 4 S: Battery Sense

Pin 5 DFM: Digital Field Monitor (output to ECM)



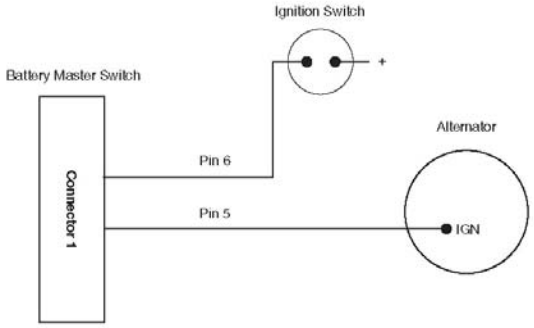
15

Late Type Alternators

Some of the later type alternators have an ignition supply to the alternator, including some European and Japanese alternators.

It is required to open circuit the ignition supply to the alternator and ground the IGN terminal on the alternator. Correct polarity is required here to ensure the ignition supply from the vehicle is not grounded inside the Battery Master Switch when it is turned OFF while the vehicle is running.

Note: All efforts are taken to provide accurate information, however it is advised the method is checked before final connection to avoid problems as the manufacturer may have altered the way the IGN supply to the alternator functions.

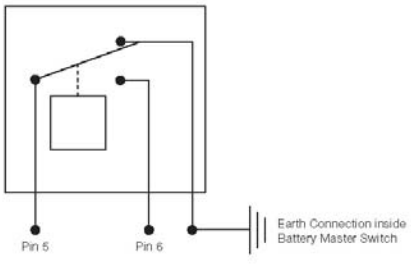


16

Alternator Field Isolation Relay

Field isolation connections are made by connecting the alternator field connections to Pin 5 or Pin 5 and Pin 6 on Connector 1.

This is a schematic of the field isolation relay which is integrated into the circuit board inside the Battery Master Switch (shown with relay in rest/ off mode).



Fitment of Optional Remote Mount Switches

External Switching - Connector 1

Pin 3 - External OFF Activation

Pin 4 - External ON Activation

Pin 7 - External Switching Supply

A variety of wiring and switching options are suitable to control the Battery Master Switch. Additional switches in different locations can be connected in parallel. It is recommended that only additional OFF switches are added due to the complexity of keeping switches synchronized.

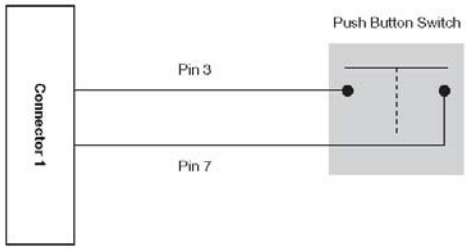
The External switch can be used to turn the master switch OFF only.

The OFF signal from any of the switches will override the ON signal. If the Battery Master Switch is turned OFF, the switch cannot be turned ON if any external switch is in the ON position.

17

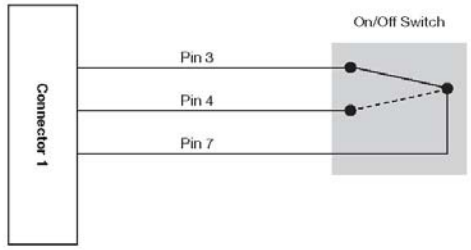
Momentary Switch OFF only

Battery Master Switch



ON / OFF Control Switch

Battery Master Switch

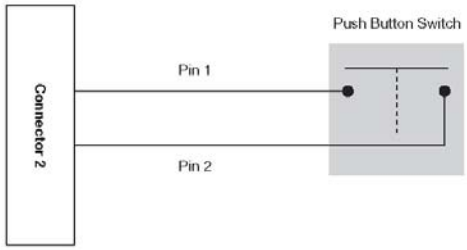


External Switching - Connector 2

The Battery Master Switch can also be turned OFF via pin 2/ connector 2. This is an emergency negative shutdown that will override the 10-second delay on the Engine ECM output. This pin is commonly used for a roll over device but can be used for an immediate emergency shutdown of the Battery Master Switch.

Emergency Shut Down

Battery Master Switch



18

Low Voltage Monitoring

Voltage Monitoring Circuit

Activate Battery Voltage Monitoring

Once installation is completed and batteries are connected, press red and green buttons simultaneously for at least 5 seconds. Deactivation is by removing battery positive supply.

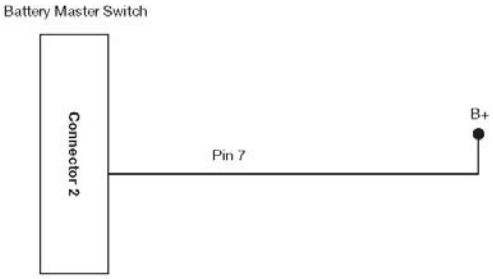
When activated the Hella Battery Master Switch automatically switches OFF if the battery voltage is less than 11.4 Volts ± 0.3V (12V version) or 22.5 Volts ± 0.3V (24V version) for 1 minute continuously. This prevents the battery from complete discharge during extended periods with electrical loads on and engine not running.

A. **Permanently de-activated LVM**
To permanently deactivate the Low Voltage Monitoring Connector 2/ Pin 7 is connected to + Battery positive supply of the vehicle.

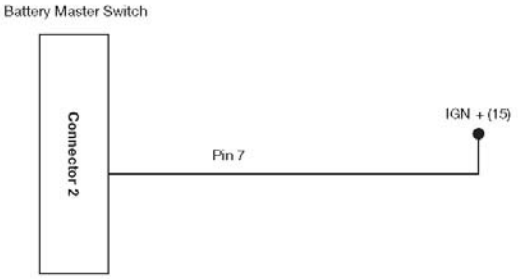
B. **De-activate LVM during start and ignition ON**
To deactivate the Low Voltage Monitoring during start and ignition ON, Connector 2/ Pin 7 is connected to + Positive ignition supply of the vehicle.

Note: The Hella Battery Master Switch has a second voltage threshold of 9.5 Volts (12V) and 18 Volts (24V) which cannot be overridden and will always be activated. The switch will automatically open after 60 seconds on continuous detection of a voltage below the threshold of 9.5 Volts (12V version) or 18 Volts (24V version). This ensures compliance with AS 2809 (Draft).

A. Disable Voltage Monitoring



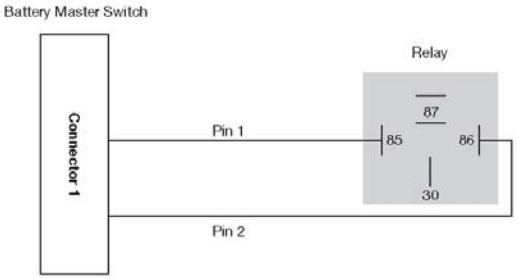
B. Disable Voltage Monitoring - Vehicle Operational



ECM Delay Control

The purpose of the ECM delay control is to supply power to the ECM for 10 seconds after the Battery Master Switch has turned OFF. Some engine computers become scrambled if power is removed while the engine is still running. This can often result in the need for a service technician to reset the engine ECM.

The Battery Master Switch has a positive and negative output to control up to 2 relays, one relay for the positive and one for the negative supply to the engine ECM. The Battery Master Switch cannot directly power the ECM; it has a current limit of 0.5A.



Control Panel

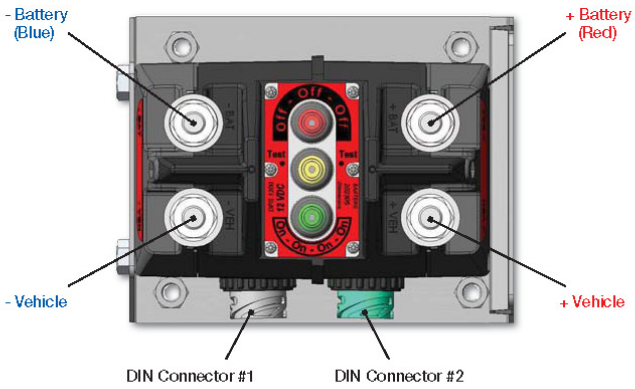
Control Panel Features

1 x Illuminated push-button ON switch – Green*
1 x Illuminated push-button OFF switch – Red*
1 x Illuminated push-button TEST switch for "fROS" module test - Yellow

Each button is equipped with a clear silicon cap.

*Other remote push–buttons can be used outside (e.g. cab, chassis).

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DIN Connector

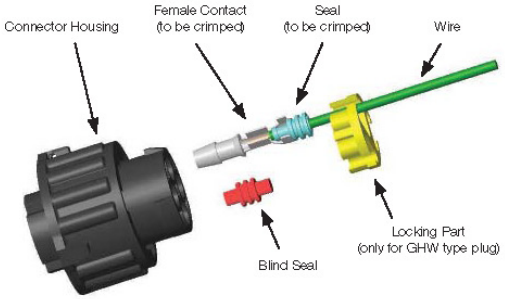
Fitting Instructions

When connecting conductors into DIN connectors, carefully observe correct installation of terminal and cable seals as illustrated below.

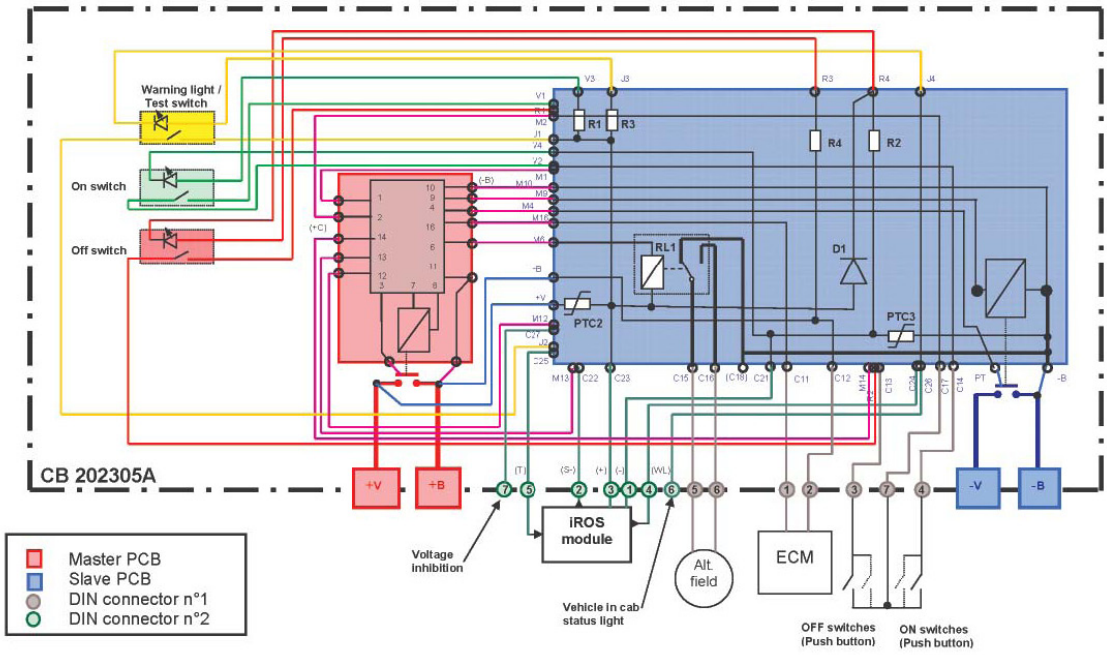
The electrical installation kit (Part No. HM4660KTA) supplied with each Battery Master Switch includes:

2 x DIN style connector assembly 1 x Grey or Black, 1 x Green or Blue
20 x Female (receptacle) contact terminals
20 x Blue wire seals
2 x Terminal retainer locking tabs (supplied only for GHW connector)
12 x Blanking seals
4 x Battery cable protective boots & flat washers

22



Electrical Diagram



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General Information

Handy Tips to Observe

1. Ensure Batteries are fully charged.
2. Ensure correct operation of starter motor.
3. Always ensure adequate cable size is used when installing a Battery Master Switch.
4. Always leave this installation and specification manual with the vehicle.
5. When a Hella Master switch has been switched OFF via a remotely mounted switch, it is required that all other switches be similarly switched OFF before the Master Switch will be capable of turning ON.

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Optional Equipment

iROS Roll-over Protection

Part No. HM4660ROD

The multi-voltage iROS roll-over protection device is available from Hella and can be mounted directly on the HM4660A / HM4660B bracket.

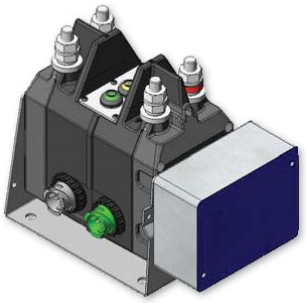
WARNING:

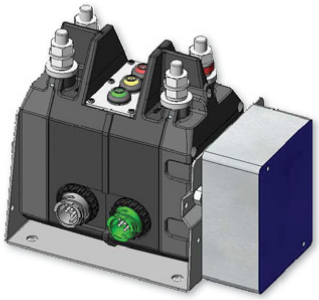
This unit (like all electronics) is ESD (Static) sensitive. When working on exposed conductors (wires) always wear ESD wrist/ grounding straps and always work on ESD bench mat. It must be securely fastened.

Pin#	Wiring Designation iROS	Connector 2
Pin 1	Blue	iROS Module - Negative Supply
Pin 2	Green	iROS Module - Emergency Shutdown Negative Pulse
Pin 3	Brown	iROS Module - Positive Supply
Pin 4	Black	iROS Module - Warning Light Output
Pin 5	Yellow	iROS Module - Test Signal
Pin 6	White	Not used, spare for future product development
Pin 7	See 'Low Voltage Monitoring', page 19.	

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2 Mounting Possibilities





Emergency Stop Control Switch

A remote control device to facilitate the disconnecting and reconnecting functions of the battery switch shall be installed in the drivers cab. Other remote push–buttons may be installed outside, in parallel (e.g. chassis). The control switches shall be protected against inadvertent operations (e.g. cover).

Part No.	Description
HM4660SWA	Latching Push On / Twist Off Switch - Double Pole, IP65
HM4660SWB	Latching Push On / Twist Off Switch - Double Pole with Guard, IP65
HM4660SWC	Momentary Push Button Switch - Single Pole, IP65
HM4660SWD	Momentary Push Button Switch - Single Pole with Guard, IP65

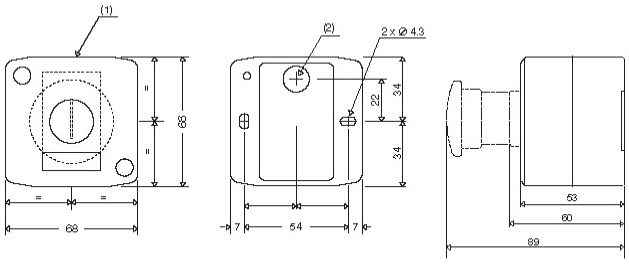
26



HM4660SWA/ HM4660SWC



HM4660SWB/ HM4660SWD



Spare Parts & Accessories

Part No.	Description
HM4660SWE	Rotary On / Off Switch, 4 pin, with Lid (use connector kit HM4660KTD)
HM4660SWF	Push Button Switch, 2 pin (use connector kit HM4660KTD)
HM4660LOC	Lockable Cover, Stainless Steel
HM4660KTB	7 Pin Din Connector with 5M Harness
HM4660KTC	7 Pin Din Connector with 700mm Harness



HM4660LOC





HM4660KTB / HM4660KTC



HM4660SWE

Replacing Lucas Master Switch

Description	Lucas Master Switch	HM4660A / HM4660B	
Battery Positive	Pin 7	Bat +	
Battery Negative	Pin 9	Bat -	
Vehicle Positive	Pin 8	Veh +	
Vehicle Negative	Pin 10	Veh -	
Field Isolation	Pin 1	Connector 1 / Pin 5	
	Pin 3	Connector 1 / Pin 6	
External Shutdown		Positive Trigger	Negative Trigger
	Pin 2	Connector 1 Pin 7	Connector 2 Pin 1
	Pin 4	Connector 1 Pin 3	Connector 2 Pin 2
Vehicle Positive Output	Pin 12	Connector 1 / Pin 2 (Note 1)	
Battery Negative Output	Pin 11	Connector 1 / Pin 1	
Auxiliary Contacts	Pin 5	N/A (Note 2)	
	Pin 6	N/A (Note 2)	

Note 1 This is a positive vehicle output, the same as the Lucas SSB Master Switch except that it is current limited to 1Amp. It also has a 10 second delay when the master switch is turned off via the external shutdown on connector 1 or on the master switch itself.

Note 2 There is not an internal set of contacts to directly replace these contacts. This is easily overcome by adding an external relay. This can be controlled by using either Pins 1 & 2 on connector 1 or using Pins 1 & 3 on connector 2.

Note 3 Using the positive shutdown trigger allows for the 10 second delay on Pins 1 & 2 on connector 1. If using the negative trigger there will be no delay.

Statement of Warranty

Hella Mining products are covered by a one-year warranty which covers faults in material or workmanship only and provided that the product is used for its intended purpose.

Note: Excluded from this warranty are all globes and lamps. Warranty is void if manufacturers and/ or Hella labels are removed or tampered with. Also excluded from this warranty are parts subject to normal wear and tear.

Support

Should you require any assistance with this product or any other Hella Mining products, please contact Hella Customer Service on **1800 061 729** or email custservice@ha.hella.com.

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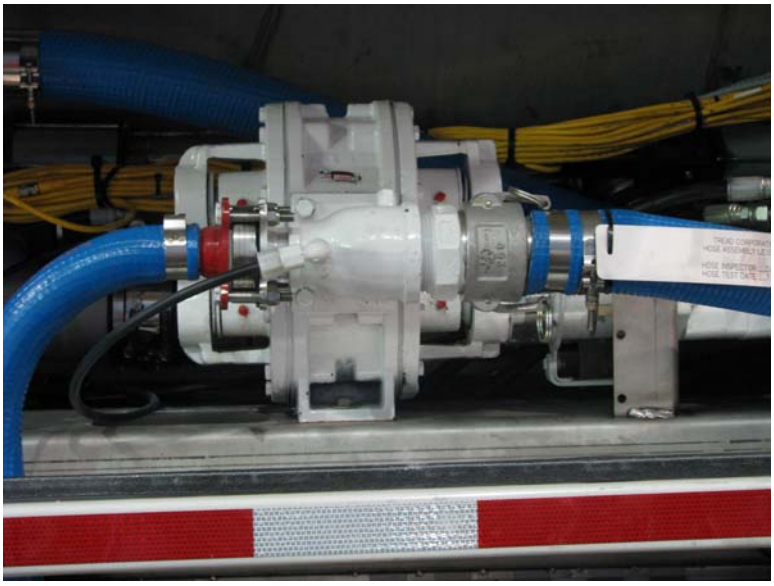
www.hella.com.au

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Mentone. Vic. 3194 Australia.

911-354-55 (Vers.2)

Emulsion Pump







An explosive pump is a potential bomb, since any thermal event may easily transition to detonation because of the high internal pressure and strong confinement. Even a low order event can cause a pump to fragment, with severe shrapnel projection. Additionally, considerable amounts of energy are being input at the pump, much of which is dissipated as heat in the explosive. If, for some reason, flow is restricted or blocked, the heat is not carried away and builds up inside the pump.

Suction Piping

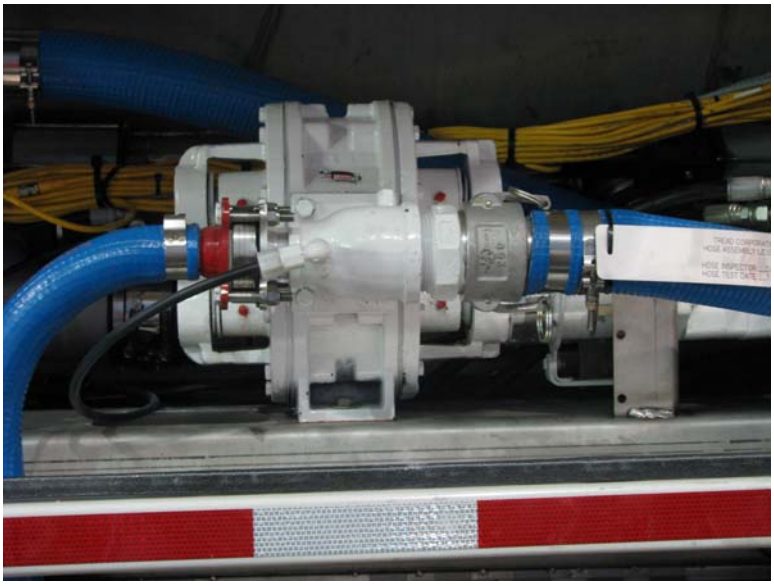
Fluid path from tank to pump consists of an air actuated valve, alum pipe and a plumbquick adapter for vibration isolation.





Pump and Motor

The pump is usually a gear pump.
It has a Lovejoy coupling for misalignment.
Fits all Char-Lynn 2000 series motors.
Pump runs in proportion to bed auger over the full operating range.





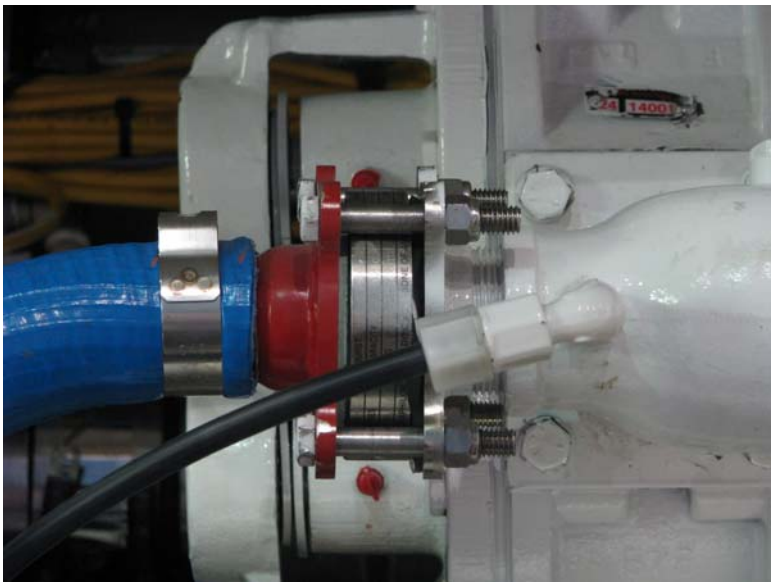
Pressure Piping

2.5 or 3” inch coupling for emulsion hose.
100 or 200 psi burst disc assembly.
Emulsion blow down port.



Burst Disc

The burst disc is installed as a part of the pump safety system to provide over pressure protection for the product pump. The burst disc is independent of the other devices.



The burst disc provides pressure relief for the pumping system.



It is a one time relief valve valve. When the pumping pressure exceeds the disc

rating, the disc ruptures, venting the product.

There are two standard pressure ranges 200 & 300 psi rated discs.

Safety

It is important that:
1) Only Approved Discs be used.
2) The disc must have the proper pressure rating for the pump.
3) The disc must be installed properly including:
a) The direction of installation must be correct. The disc is marked with the direction of venting.
b) The disc must be properly gasketed. The gaskets provide for any curvature of the holder.
c) The bolts must be properly torqued. Overtorquing the bolts may cause pre-mature failure.

Troubleshooting

Before replacing burst disc:

Determine the cause of the failure

If the failure occurred prematurely, before the rated disc pressure:
1) Determine if it is the pressure rating is correct.
2) Were the bolts properly torqued.
3) Are the gaskets in place. Both sides should be gasketed.

If the disc does not rupture:
1) Determine if the pressure rating is correct.
2) Is the direction of the disc correct.
    1) Check the inlet to the disc for blockages.

    Graphite burst disc is designed and manufactured to break at design pressure.

Provides fail safe pressure relief.
100 or 200 psi for gear pumps



You must not substitute the burst disc. Replace with same type disc.
Be certain of pressure rating and flow direction when replacing.
Bolts must be tightened evenly to avoid breaking disc.
Must be kept clean.
Emulsion salt changes effect burst pressure of disc.
You should clean burst disk assembly every 6 months.

Injection Port



2.5 inch standard port size.
2.5 inch standard hose size.
Allows emulsion stream to blend with ANFO stream.

Safety

Do not allow the emulsion pump to run dry. Excessive heat buildup can occur.

Before removing the emulsion hose, make certain that any pressure in the hose has been reduced. You can run the pump in reverse to obtain a zero pressure.

Air Controls

Opens emulsion tank valve and vent.
Closes DOT (7AR15) valve.
Applies air to blow down port on emulsion pump pressure piping.
Use caution when clearing emulsion hose. Burst disk can break.



An Important Safety Note.

Compressed air is very dangerous. Never remove an air-operated component without first shutting off the air supply first. This is done by moving the handle of the shut off ball valve perpendicular to the valve body. This isolates the UniBody Air system. To inspect or replace the air filter element, the filter bowl must first be removed. The bowl is removed by unscrewing it from the body. Once the bowl is loose, pull it straight off the cartridge. The filter element also screws off. Pull down while turning. The filter element fits very tight. Once the element is free, study its condition. Discoloration indicates that the pores of the element are dirty. The element can be cleaned in a mild detergent solution. Very dirty elements should be replaced. The large particles that are collected in the filter bowl can be drained without removing the filter bowl. The valve screw on the bottom of the bowl turns clockwise to open. Allow the fluid to drain out. Close the valve back before returning it to operation. Drain the filter bowl before the liquid reaches the lower baffle inside the filter bowl.

DOT Interlock Valve



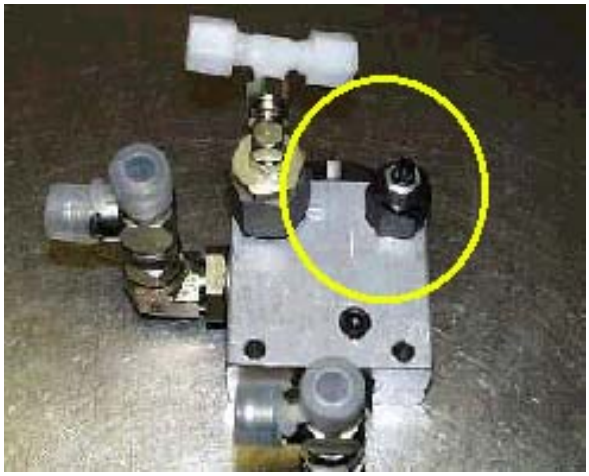
Provides an interlock between the emulsion pump and tank valve.
Air operated relief valve.
Closes when air is supplied to tank valve.
Will relieve at the valve relief setting.

Relief setting should be max available (set scew in).

If your pump does not run forward but runs in reverse..

1. Check for air pressure at air cartridge.
   Air pressure must be > 90 psi for air to operate.





2. Is the relief valve set at maximum?
   Loosen locknut.
   Turn screw all the way in.
   Tighten locknut.

3. Is air escaping from small hole in air cartridge?
   Broken o-ring seal causes air to discharge from small hole.



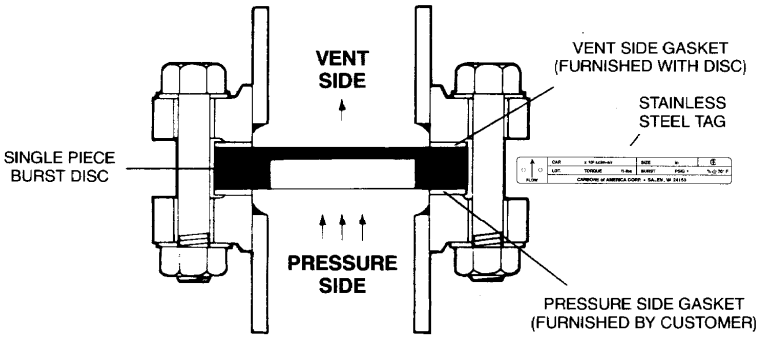


4. Disassemble air cartridge, clean, reassemble
   Poppet can become stuck due to dirt. Wipe clean. Remove burrs with emery paper.

Burst Disc

SINGLE PIECE DISC INSTRUCTIONS
(SERIES 3)

TYPICAL INSTALLATION



IMPORTANT NOTES:

1. All Graphilor® single piece burst discs have a stainless steel label, as shown below, affixed to the outer circumference.

FLOW	CAP.	x 10^3 scfm-air		SIZE	in.	CE
	LOT.	TORQUE	ft-lbs	BURST	PSIG ±	% @ 70° F
	CARBONE of AMERICA CORP. • SALEM, VA 24153					

   Make sure the disc information agrees with the intended application.

2. Discs are designed to fit within the bolt circle of 150# or 300# ANSI flanges. Make sure disc is properly centered between flanges during installation.

3. It is important to install the disc in the correct flow direction. This is noted by an arrow on the label.

4. Flange faces should be parallel to each other in order to eliminate excessive bolting forces when installing disc.

5. The vent side gasket is furnished with the disc because the gasket material and inside diameter are critical to the burst disc accuracy.

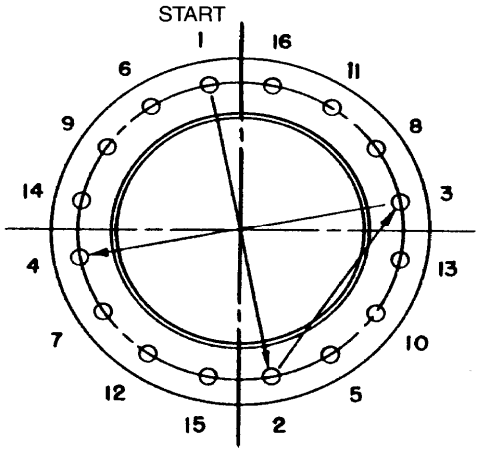
6. The process (or pressure) side gasket, furnished by customer, must be compatible with the process fluid and therefore the preferred type is a standard 150# ANSI TFE envelope gasket with a soft ⅛" thick filler. Do not us a gasket having a metal insert.

7. Burst pressure shown on label has been established at ambient temperature. Elevated temperatures may cause a reduction in the actual burst pressure of the disc.

INSTALLATION INSTRUCTIONS

RECOMMENDED BOLT TIGHTENING PROCEDURE

Tighten flange bolts using a diagonal pattern gradually increasing the torque to the value indicated on the disc label or the chart shown to the right. Torque values are based upon ANSI standards for size and number of bolts and the use of clean, lubricated nut and bolt threads. The gasket used for these torque loadings has a 4400 "Y" value or minimum design seating stress.

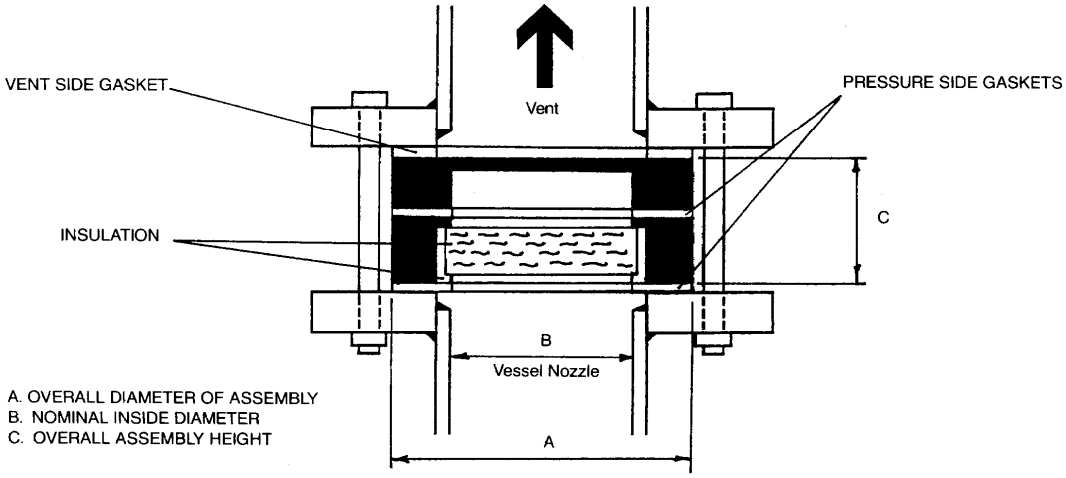


DISC SIZE (INCHES)	TORQUE (FT./LBS.)
For 150# ANSI Flanges	
1	10
1.5	15
2	25
2.5	30
3	30
4	35
6	45
8	65
10	55
12	70
14	100
16	80
18	100
20	80
24	120
For 300# ANSI Flanges	
1	20
1.5	40
2	20
3	40
4	60
6	60
8	100

Improper installation can cause discs to break outside of specified burst pressure. Potential causes are:

- Misaligned flanges
- Excessive or uneven bolt torque
- Improper centering of disc
- Incorrect vent side gasket material or dimensions
- Discs with cracks or surface imperfections due to mishandling

HIGH TEMPERATURE ASSEMBLY FOR SERIES 3 DISC



HIGH TEMPERATURES:
For applications where disc exposure is in excess of 300°F the use of an insulating spacer is recommended. Special high temperature resins and spacers are available for operating temperatures from 300°F to 700°F.

MONOLITHIC DISC HIGH TEMPERATURE ASSEMBLY FOR 150 # ANSI FLANGES			
NOMINAL PIPE SIZE	DIMENSIONS IN INCHES		
	A	B	C
1	2½	1	2¼
1½	3¼	1½	2¼
2	4	2	2¼
3	5¼	3	2½
4	6¾	4	2½
6	8⅝	6	2¾
8	10⅞	8	3
10	13¼	10	3⅜
12	16	12	4⅛
14	17⅜	13¼	4⅞
16	20⅛	15¼	5⅛
18	21½	17¼	5⅞
20	23¾	19¼	6⅛
24	28⅛	23¼	6⅝

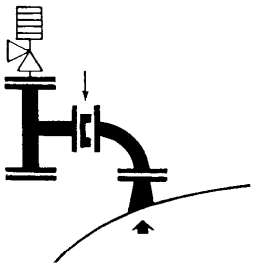
PRECAUTION & WARRANTY

GROUPE
CARBONE LORRAINE

PRECAUTION

Upon rupture, fragments of the graphite burst disc are propelled into vent line; toxic or flammable materials may be vented; blow-down may be at very high velocity; discharge from the vent opening can be hazardous. Safety provisions should be undertaken to prevent possible damage to plant equipment and injury to operating personnel.

Graphite particles generated by ruptured discs can be trapped by utilization of screens and or diversion traps as shown below. See disc installation instructions which accompany all disc shipments or contact Carbone's Engineering Department for further details.

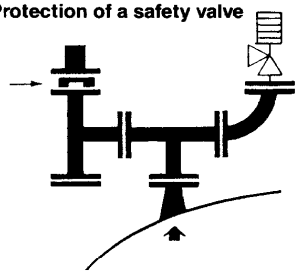


In series

The effective burst pressure of the disc should be more than the opening pressure set for the valve.

The safety valve would operate after the bursting of the safety disc.

Protection of a safety valve

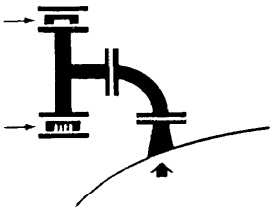


In parallel

The effective burst pressure of the disc should be higher than the opening pressure of the valve.

The safety disc operates only when the safety valve fails.

Protection against overpressure and negative pressure



The upper disc insures the protection against over-pressure.

The lower disc insures the protection against negative pressure.

WARRANTY

Carbone of America Corp. warrants its products to be free of any defects in material or workmanship for a period of 12 months from date of installation or 18 months from shipment, whichever comes first.

However, Carbone of America Corp. shall have no liability whatsoever for units which fail due to mechanical damage, misuse or abuse. Except for this warranty, Carbone of America Corp. makes no warranty, expressed or implied, and expressly excludes any warranty of application or fitness for a particular service. Carbone's maximum liability hereunder shall be limited to the repair or replacement of any defective product, if appropriate. Carbone of America Corp. shall, under no circumstances, be liable for any incidental, consequential, or other damages, including but not limited to, loss of business or profits, based on any alleged negligence, breach of warranty, strict liability or other theory, arising out of the use or handling of these products.

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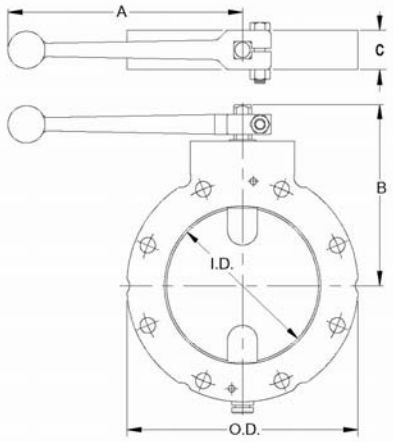
Wet-R-Dri Valve

TTMA STYLE

LIGHTWEIGHT

COMPACT

VERSATILE



Size	Detent Model Assembly No.	Wt.	Standard Material Body	Standard Material Disc	Max. Working Pressure	Temperature Range
2"	WD201 AL B	2.4	Aluminum	Buna-N	75 PSI	See Chart Below
	WD201 GI B	4.6	Grey Iron			
3"	WD301 AL B	3.6	Aluminum	Buna-N	75 PSI	
	WD301 GI B	6.9	Grey Iron			
4"	WD401 AL V	4.5	Aluminum	Viton	75 PSI	
	WD401 GI V	8.3	Grey Iron			
5"	WD501 AL V	7.9	Aluminum	Viton	50 PSI	
6"	WD601 AL U	11.8	Aluminum	Urethane	50 PSI	
8"	WD801 AL U	17.3	Aluminum	Urethane	50 PSI	

NOTE: Standard drilling fits TTMA recommended standards.
Valves are available with the following options: Stainless steel liners and shafts, grease fittings installed in the drive and bearing shafts, and "E" Coating of aluminum valves (recommended for aluminum valves used in water service).
For repair kit, see Section 20, Page 5B.

Dimensions

Size	A	B	C	I.D.	O.D.	B.C.	Holes
2"	$6^{3}/_{4}$	$4^{1}/_{4}$	$1^{1}/_{8}$	$2^{1}/_{4}$	$3^{3}/_{4}$	$3^{3}/_{4}$	$6\text{-}^{7}/_{16}$
3"	$6^{3}/_{4}$	$4^{5}/_{8}$	$1^{1}/_{8}$	$3^{3}/_{8}$	$5^{3}/_{8}$	$4^{7}/_{8}$	$8\text{-}^{7}/_{16}$
4"	$6^{3}/_{4}$	$5^{1}/_{8}$	$1^{1}/_{8}$	$4^{3}/_{8}$	$6^{5}/_{8}$	$5^{7}/_{8}$	$8\text{-}^{7}/_{16}$
5"	$6^{3}/_{4}$	$6^{3}/_{8}$	$2^{1}/_{8}$	$5^{7}/_{16}$	$7^{5}/_{8}$	7	$12\text{-}^{7}/_{16}$
6"	12	7	$2^{1}/_{8}$	$6^{1}/_{8}$	$8^{3}/_{8}$	$8^{1}/_{8}$	$12\text{-}^{7}/_{16}$
8"	12	8	$2^{1}/_{2}$	8	$10^{7}/_{8}$	$10^{1}/_{8}$	$16\text{-}^{7}/_{16}$

Suffix for Disc Material

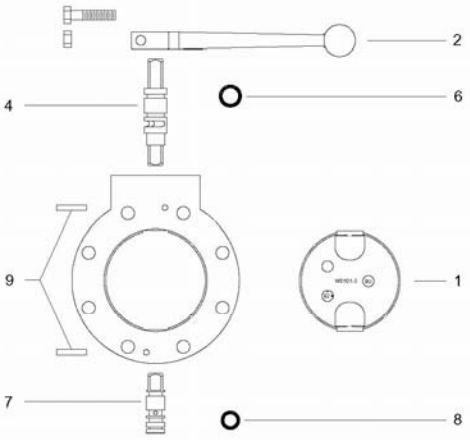
Buna-N Black	Buna-N White	Viton	Urethane Black	Urethane White	EPDM
B	WB	V	U	WU	E
-40°F	-40°F	-0°F	-40°F	-40°F	-50°F
+200°F	+200°F	+400°F	+200°F	+200°F	+300°F

NOTE: Temperature ranges based on published information and may vary due to actual operating conditions.

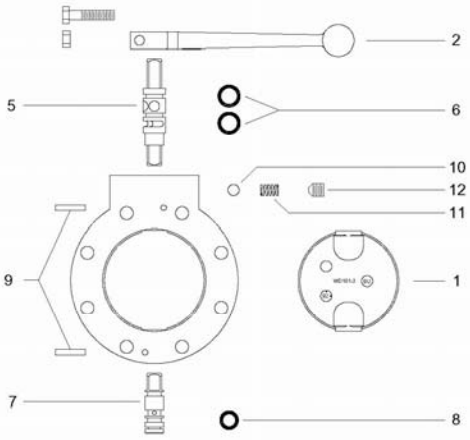
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PARTS LIST

Wet-R-Dri VALVE



STANDARD MODEL



DETENT MODEL

No.	Description	Material	2" Size	3" Size	4" Size	5" Size	6" Size	8" Size
			Part No.	Part No.	Part No.	Part No.	Part No.	Part No.
1	Disc	Buna-N	WD101-2 BN	WD101-3 BN	WD101-4 BN	WD101-5 BN	WD101-6 BN	WD101-8 BN
		Viton	WD101-2 VT	WD101-3 VT	WD101-4 VT	WD101-5 VT	WD101-6 VT	WD101-8 VT
		Urethane	WD101-2 PY	WD101-3 PY	WD101-4 PY	WD101-5 PY	WD101-6 PY	WD101-8 PY
		EPDM	WD101-2 EP	WD101-3 EP	WD101-4 EP	WD101-5 EP	WD101-6 EP	WD101-8 EP
2	Handle	Mall. "E" Coated	25884EY	25884EY	25884EY	25884EY	25933AL	25933AL
	Cap Screw	Steel Zinc Plt.	9Q5813	9Q5813	9Q5813	9Q5813	9Q5898	9Q5898
	Hex. Nut	Steel Zinc Plt.	9Q5808	9Q5808	9Q5808	9Q5808	9Q5808	9Q5808
4	Drive Shaft	Steel	27053MS	27050MS	27050MS	27051MS	16229MS	16229MS002
5	Drive Shaft	Steel	27053MS001	27050MS001	27050MS001	27051MS001	16229MS	16229MS002
6	O-Ring	To Match Disc Mat'l.	17889**	17889**	17889**	17889**	18831**	18831**
7	Bearing Shaft	Steel	16006MS	15913MS	15913MS	15913MS	16230MS	16230MS002
8	O-Ring	To Match Disc Mat'l.	17781**	18141**	18141**	18141**	18831**	18831**
9	Driv-Lok-Pin	Steel Zinc Plt.	9Q4893	9Q4893	9Q4893	9Q4925	9Q4926	9Q4938
10	Detent Ball	440 Stnls	9Z4856	9Z4856	9Z4856	9Z4856	9Z4856	9Z4856
11	Detent Spring	304 Stnls	15229SL	15229SL	15229SL	15229SL	15229SL	15229SL
12	Ret. Screw	304 Stnls	9Q5838	9Q5838	9Q5838	9Q5838	9Q5838	9Q5838

** O-Ring material suffix to match Disc suffix (i.e.-17889VT)

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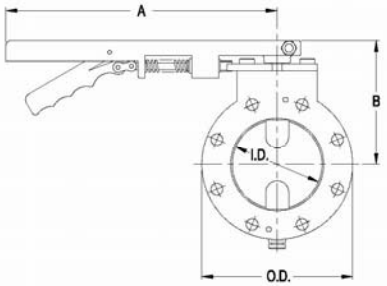
Wet-R-Dri VALVE

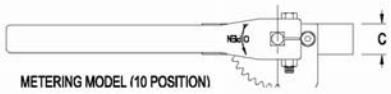
TTMA STYLE

LIGHTWEIGHT

COMPACT

VERSATILE





The Betts Wet-R-Dri Valve is designed for handling liquid, gaseous or dry products, and is available in a variety of sizes and models. This space saving valve is lightweight, easily maintained, and has a positive stop in the open and closed position.
The Locking model has a 2 notch indexing plate which locks disc in the open or closed positions.
The Metering model has a 10 notch indexing plate which allows disc to be positioned in 10 various positions.

Size	Metering Model Assembly No.	Wt.	Standard Material		Max. Working Pressure	Temperature Range
			Body	Disc		
2"	WD204 AL B	3.1	Aluminum	Buna-N	75 PSI	See Chart Below
	WD204 GI B	5.3	Grey Iron			
3"	WD304 AL B	4.3	Aluminum	Buna-N	75 PSI	
	WD304 GI B	7.6	Grey Iron			
4"	WD404 AL V	5.2	Aluminum	Viton	75 PSI	
	WD404 GI V	9.0	Grey Iron			
5"	WD504 AL V	8.6	Aluminum	Viton	50 PSI	
6"	WD604 AL U	12.2	Aluminum	Urethane	50 PSI	
8"	WD804 AL U	17.7	Aluminum	Urethane	50 PSI	

NOTES: Standard drilling fits TTMA recommended standards.
Valves are available with the following options: Stainless steel liners and shafts, grease fittings installed in the drive and bearing shafts, and "E" Coating of aluminum valves (recommended for aluminum valves used in water service).
For repair kit, see Section 20, Page 5B.

Dimensions

Size	A	B	C	I.D.	O.D.	B.C.	Holes
2"	$10^{1}/_{8}$	$4^{1}/_{4}$	$1^{1}/_{8}$	$2^{1}/_{4}$	$3^{3}/_{4}$	$3^{3}/_{4}$	$6\text{-}^{7}/_{16}$
3"	$10^{1}/_{8}$	$4^{5}/_{8}$	$1^{1}/_{8}$	$3^{3}/_{8}$	$5^{5}/_{8}$	$4^{7}/_{8}$	$8\text{-}^{7}/_{16}$
4"	$10^{1}/_{8}$	$5^{1}/_{8}$	$1^{1}/_{8}$	$4^{3}/_{8}$	$6^{5}/_{8}$	$5^{7}/_{8}$	$8\text{-}^{7}/_{16}$
5"	$10^{1}/_{8}$	$6^{3}/_{8}$	$2^{1}/_{8}$	$5^{7}/_{16}$	$7^{5}/_{8}$	7	$12\text{-}^{7}/_{16}$
6"	12	7	$2^{1}/_{8}$	$6^{1}/_{8}$	$8^{5}/_{8}$	$8^{1}/_{8}$	$12\text{-}^{7}/_{16}$
8"	12	8	$2^{1}/_{2}$	8	$10^{7}/_{8}$	$10^{1}/_{8}$	$16\text{-}^{7}/_{16}$

Suffix for Disc Material

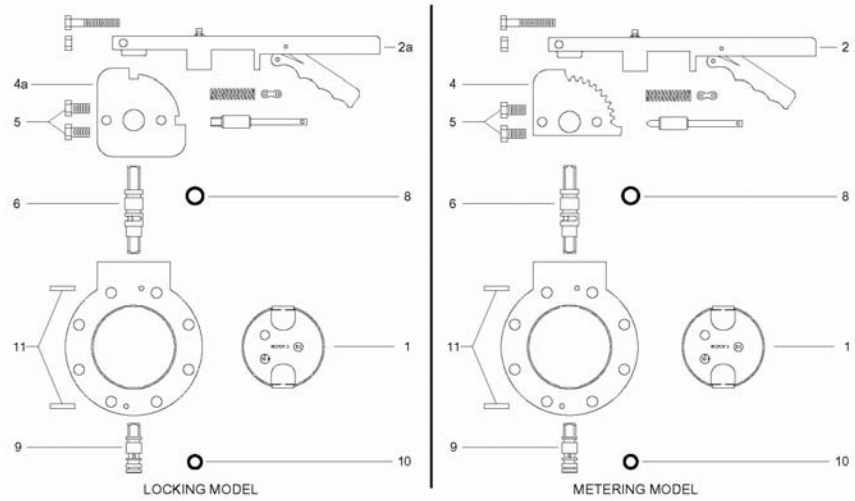
Buna-N		Viton	Urethane		EPDM
Black	White		Black	White	
B	WB	V	U	WU	E
-40°F	-40°F	-0°F	-40°F	-40°F	-50°F
+200°F	+200°F	+400°F	+200°F	+200°F	+300°F

NOTE: Temperature ranges based on published information and may vary due to actual operating conditions.

Betts

PARTS LIST

Wet-R-Dri VALVE



No.	Description	Material	2" Size	3" Size	4" Size	5" Size	6" Size	8" Size
			Part No.	Part No.	Part No.	Part No.	Part No.	Part No.
1	Disc	Buna-N	WD101-2 BN	WD101-3 BN	WD101-4 BN	WD101-5 BN	WD101-6 BN	WD101-8 BN
		Viton	WD101-2 VT	WD101-3 VT	WD101-4 VT	WD101-5 VT	WD101-6 VT	WD101-8 VT
		Urethane	WD101-2 PY	WD101-3 PY	WD101-4 PY	WD101-5 PY	WD101-6 PY	WD101-8 PY
		EPDM	WD101-2 EP	WD101-3 EP	WD101-4 EP	WD101-5 EP	WD101-6 EP	WD101-8 EP
2	Handle Assy.	Alum. "E" Coated	26284AL	26284AL	26284AL	26284AL	26287AL	26287AL
2a	Handle Assy.	Alum. "E" Coated	26075AL	26075AL	26075AL	26075AL	26077AL	26077AL
	Handle/Grip	Alum. "E" Coated	25815ALEY	25815ALEY	25815ALEY	25815ALEY	25802ALEY	25802ALEY
	Spring	302 Stnls	16365SL	16365SL	16365SL	16365SL	16365SL	16365SL
	Plunger-Metering	Steel	16969MS	16969MS	16969MS	16969MS	17020MS	17020MS
	Plunger-Locking	Steel	16385MS	16385MS	16385MS	16385MS	16400MS	16400MS
	Chain Link	Steel	9Z4915	9Z4915	9Z4915	9Z4915	9Z4915	9Z4915
	Cap Screw	Alum. Or Steel	9Q5897	9Q5897	9Q5897	9Q5897	9Q5898	9Q5898
	Hex. Nut	Steel Zinc Plt.	9Q5808	9Q5808	9Q5808	9Q5808	9Q5808	9Q5808
4	Indexing Plate	Steel "E" Coated	17012EY	17012EY	17012EY	17012EY	17016EY	17016EY
4a	Indexing Plate	Steel "E" Coated	16358EY	16358EY	16358EY	16358EY	16668EY	16668EY
5	Cap Screw	Stainless	9Q5884	9Q5884	9Q5884	9Q5884	9Q5884	9Q5884
6	Drive Shaft	Steel	27053MS	27050MS	27050MS	27051MS	16229MS	16229MS002
8	O-Ring	To Match Disc Mat'l.	17889**	17889**	17889**	17889**	18831**	18831**
9	Bearing Shaft	Steel	16006MS	15913MS	15913MS	15913MS	16230MS	16230MS
10	O-Ring	To Match Disc Mat'l.	17781**	18141**	18141**	18141**	18831**	18831**
11	Driv-Lok-Pin	Steel Zinc Plt.	9Q4893	9Q4893	9Q4893	9Q4925	9Q4926	9Q4938

** O-Ring material suffix to match Disc suffix (i.e.-17889VT)

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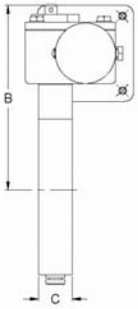
Wet-R-Dri VALVE

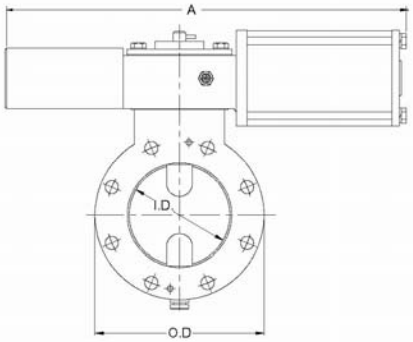
TTMA STYLE

LIGHTWEIGHT

COMPACT

VERSATILE





The Betts Wet-R-Dri Valve is designed for handling liquid, gaseous or dry products, and is available in a variety of sizes and models. This space saving valve is lightweight, easily maintained, and has a positive stop in the open and closed position. The air operated valve is opened and closed by air. The air-spring operated valve can be sold as either an air to open, spring return valve or as an air to close spring to open valve. Please specify.

Size	Wt.	Air-Spring Model Assembly No.	Wt.	Standard Material		Max. Working Pressure	Temperature Range
				Body	Disc		
2"	5.9	WD219 AL B	6.4	Aluminum	Buna-N	75 PSI	See Chart Below
	8.1	WD219 GI B	8.6	Grey Iron			
3"	7.1	WD319 AL B	7.6	Aluminum	Buna-N	75 PSI	
	10.4	WD319 GI B	10.9	Grey Iron			
4"	8.0	WD419 AL V	8.5	Aluminum	Viton	75 PSI	
	11.8	WD419 GI V	12.3	Grey Iron			
5"	11.4	WD519 AL V	11.9	Aluminum	Viton	50 PSI	
6"	15.3	WD619 AL U	15.8	Aluminum	Urethane	50 PSI	
8"	20.8	WD819 AL U	21.3	Aluminum	Urethane	50 PSI	

NOTES: Standard drilling fits TTMA recommended standards.
Valves are available with the following options: Stainless steel liners and shafts, and "E" Coating of aluminum valves (recommended for aluminum valves used in water service).
For repair kit, see Section 20, Page 5B.

Dimensions

Size	A	B	C	I.D.	O.D.	B.C.	Holes
2"	$13\frac{5}{16}$	$5\frac{13}{16}$	$1\frac{1}{8}$	$2\frac{1}{4}$	$3\frac{3}{4}$	$3\frac{3}{4}$	$6\text{-}\frac{7}{16}$
3"	$13\frac{5}{16}$	$6\frac{5}{32}$	$1\frac{1}{8}$	$3\frac{3}{8}$	$5\frac{5}{8}$	$4\frac{7}{8}$	$8\text{-}\frac{7}{16}$
4"	$13\frac{5}{16}$	$6\frac{11}{16}$	$1\frac{1}{8}$	$4\frac{3}{8}$	$6\frac{5}{8}$	$5\frac{7}{8}$	$8\text{-}\frac{7}{16}$
5"	$13\frac{5}{16}$	$7\frac{7}{8}$	$2\frac{1}{8}$	$5\frac{7}{16}$	$7\frac{5}{8}$	7	$12\text{-}\frac{7}{16}$
6"	$13\frac{5}{16}$	$8\frac{7}{16}$	$2\frac{1}{8}$	$6\frac{1}{8}$	$8\frac{5}{8}$	$8\frac{1}{8}$	$12\text{-}\frac{7}{16}$
8"	$13\frac{5}{16}$	$9\frac{3}{8}$	$2\frac{1}{2}$	8	$10\frac{7}{8}$	$10\frac{1}{8}$	$16\text{-}\frac{7}{16}$

Suffix for Disc Material

Buna-N		Viton	Urethane		EPDM
Black	White		Black	White	
B	WB	V	U	WU	E
-40°F	-40°F	-0°F	-40°F	-40°F	-50°F
+200°F	+200°F	+400°F	+200°F	+200°F	+300°F

NOTE: Temperature ranges based on published information and may vary due to actual operating conditions.

PARTS LIST

Wet-R-Dri VALVE

ACTUATOR ONLY PART NOS.
2" Thru 5" Spring Return Act. Part No. 46495AL
2" Thru 5" Double Acting Act. Part No. 46504AL
6" & 8" Spring Return Act. Part No. 46496AL
6" & 8" Double Acting Act. Part No. 46519AL

INDICATOR PIN ASSEMBLY PART NO.
2" Thru 5" Part No. 19531AL
6" & 8" Part No. 19532AL

No.	Description	Req'd.	Size	Material	Part No.
1	Mtg. End Plate	1	2"Thru 8"	Aluminum	19243ALEY
2	O-Ring	2	2"Thru 8"	Buna-N	17666BN
3	Piston Seal	As Req'd.	2"Thru 8"	Buna-N	17669BN
†4	Piston	1	2"Thru 8"	Aluminum	19437AL
††4a	Piston	1	2"Thru 8"	Aluminum	19285AL
†5	Spring	1	2"Thru 8"	316 Stnls.	19413SS
6	Cylinder	1	2"Thru 8"	Aluminum	19240AL
7	Stop Tube	1	2"Thru 8"	Aluminum	19241AL
8	Housing	1	2"Thru 5"	Aluminum	35390ALEY
		1	6"& 8"	Aluminum	35400ALEY
9	Clevis	1	2"Thru 5"	17-4 Stnls.	19237SL
		1	6"& 8"	17-4 Stnls.	19238SL
10	Button Head S.C.S.	2	2"Thru 8"	Steel	9Q5940
11	Hex Jam Nut	2	2"Thru 8"	Steel Zinc Plt.	9Q5910
12	O-Ring	1	2"Thru 8"	Buna-N	17781BN
13	Shaft	1	2"Thru 8"	304 Stnls.	19239SL
14	O-Ring	1	2"Thru 8"	Buna-N	19350BN
15	Washer	1	2"Thru 8"	Aluminum	19268AL
16	End Cap	1	2"Thru 8"	Aluminum	19244ALEY
17	1/4 Lockwasher	4	2"Thru 8"	Steel	9Q5845
18	Hex. Hd. Bolt	4	2"Thru 8"	Steel Zinc Plt.	9Q5938
19	Retaining Ring	2	2"Thru 8"	Steel Plated	9Q4932
20	Bearing	2	2"Thru 8"	Bronze	9Z4870
21	Clevis Pin	1	2"Thru 8"	Steel Plated	9Q4729
22	Cover Plate	1	2"Thru 8"	Aluminum	19490ALEY
23	Hex. Hd. Bolt	4	2"Thru 8"	Steel Zinc Plt.	9Q5849
23a	1/4 Star Washer	4	2"Thru 8"	Steel Zinc Plt.	9Q5923
24	Gasket	1	2"Thru 8"	Cork-Neoprene	19269CN
26	O-Ring	1	2"Thru 8"	Buna-N	18066BN
††27	Socket Hd. Screw	1	2"Thru 8"	Steel	9Q5798
†28	1/8 Pipe Plug	1	2"Thru 8"	Steel	9V4915
A1	Plug	1	2"Thru 8"	Aluminum	19489AL
A2	O-Ring	1	2"Thru 8"	Buna-N	19357BN
A3	O-Ring	1	2"Thru 8"	Buna-N	19505BN

No.	Description	Req'd.	Size	Material	Part No.
A4	Indicator Pin	1	2"Thru 5"	316 Stnls.	19528SS
			6"& 8"	316 Stnls.	19529SS
A5	Spirol Pin	1	2"Thru 8"	304 Stnls.	9Q8601
A6	1/2 Star Washer	1	2"Thru 8"	410 Stnls.	9Q5916
A7	Breather	1	2"Thru 8"	Brass	9Z4895
31	Cap Screw	2	2"Thru 8"	Steel	9Q5856
32	Gasket	1	2",3"& 4"	Cork-Neoprene	18308CN
			5",6"& 8"	Cork-Neoprene	19351CN
33	O-Ring	1	2"Thru 5"	Buna-N	17889**
			6"	Buna-N	18831**
		2	8"	Buna-N	18831**
34	Drive Shaft	1	2"	Steel	27053MS
			3"& 4"	Steel	27050MS
			5"	Steel	27051MS001
			6"	Steel	16229MS
			8"	Steel	16229MS002
35	Disc	1	2"	* Specify Material See Section 20 Page 4C	WD101-2*
			3"		WD101-3*
			4"		WD101-4*
			5"		WD101-5*
			6"		WD101-6*
			8"		WD101-8*
36	O-Ring	1	2"	Buna-N	17781**
			3"Thru 5"	Buna-N	18141**
			6"& 8"	Buna-N	18831**
36a	O-Ring	1	8"	Buna-N	18831**
37	Bearing Shaft	1	2"	Steel	16006MS
			3"Thru 5"	Steel	15913MS
			6"	Steel	16230MS
			8"	Steel	16230MS002
38	Driv-Lok Pin	2	2"Thru 5"	Steel Zinc Plt.	9Q4893
			6"	Steel Zinc Plt.	9Q4926
			8"	Steel Zinc Plt.	9Q4938
39	Grease Fitting	1	8"	Steel	9Z3058

** O-Ring material suffix to match Disc suffix (i.e.-17889VT)

† PART REQ'D ON SPRING RETURN MODELS ONLY
†† PART REQ'D ON DOUBLE ACTING MODELS ONLY

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PARTS LIST

Wet-R-Dri VALVE Repair Kit

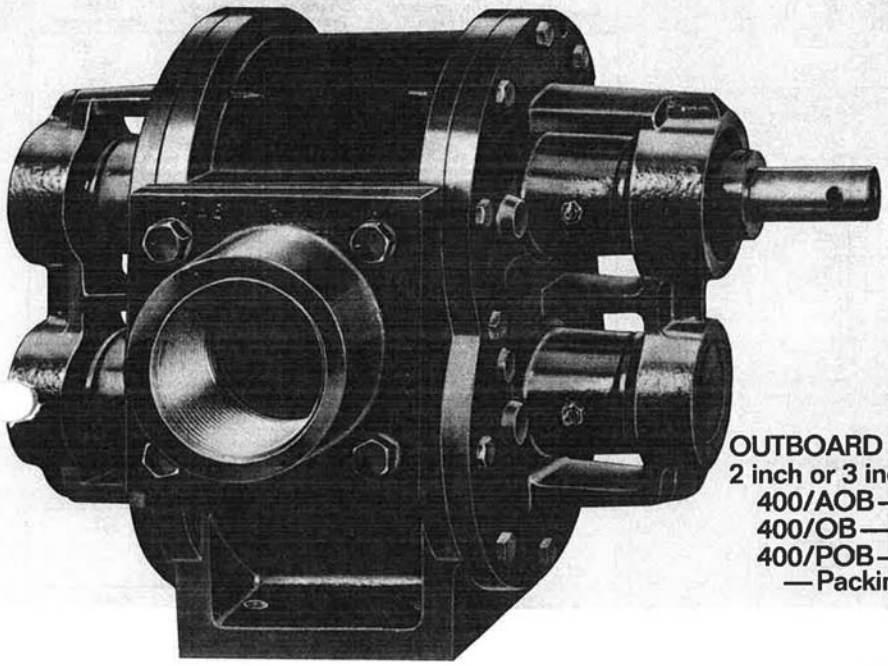
For WD Valve Size	Repair Kit Part No.	
2"	WD18402BN	Suffix: BN Buna-N Disc PY Urethane Disc VT Viton Disc EP EPDM Disc REPAIR KITS CONSIST OF: 1 Disc 2 Drive Shaft O-Rings 1 Bearing Shaft O-Ring 2 Drive Lock Pins 2 Flange Gaskets 1 Sec. 20, Page 1A & B
	WD18402VT	
3"	WD18403BN	
	WD18403VT	
4"	WD18404VT	
5"	WD18405VT	
6"	WD18406PY	
	WD18406VT	
8"	WD18408PY	
	WD18408VT	
All Detent	WD18400SL	Detent Repair Kit (For all sizes detent models) CONSISTS OF: 1 Detent Ball WD109SL 1 Detent Spring WD110SL 1 Retaining Screw WD111SL

For Detent model valves a Detent Repair Kit is required in addition to the appropriate size valve repair kit.

Bowie Pump Series 400

SERIES 400 ROTARY PUMPS

BOWIE®



OUTBOARD BALL BEARING
2 inch or 3 inch
400/AOB—Aluminum Bronze
400/OB—Cast Iron—Lip Seal
400/POB—Cast Iron
—Packing Type

CONSTRUCTION FEATURES

RUGGED HOUSING:
Series 400/AOB
- Aluminum Bronze for Corrosive and Heavy-Duty Applications

Series 400/OB & 400/POB
- Cast Iron for General and Heavy-Duty Applications

GEARS or IMPELLERS:
Series 400/AOB, 400/OB, 400/PB
- Buna-N/Nitrile for most Hydrocarbons, Oils, Greases, Hydraulic Fluids, Water, Some Chemicals & Solvents
- Polyurethane for Moderate Chemicals, Light Oils, Fats, Greases, and many Hydrocarbons
- Ductile Iron, for certain chemicals and solvents, High Temperature Oils and Greases.

BEARINGS:
Series 400/AOB, 400/OB, 400/POB
- Roller Bearings for Durability and Long Life

SEALS & PACKING:
Series 400/AOB & 400/OB
- Metal Covered Lip Seal of Buna-N/Nitrel Compound suitable for sealing abrasive slurries away from bearings. Temperature Limit 275°F

Series 400/POB
- Graphite Rubber Packing Rings
- Teflon Packing
- Graphite Packing

All suitable for low-pressure, general-purpose applications

SHAFTS:
Series 400/AOB, 400/OB, 400/POB
- Fatigue Proof for General-Purpose, Heavy-Duty applications
- Stainless Steel for Corrosive Resistance and Durability

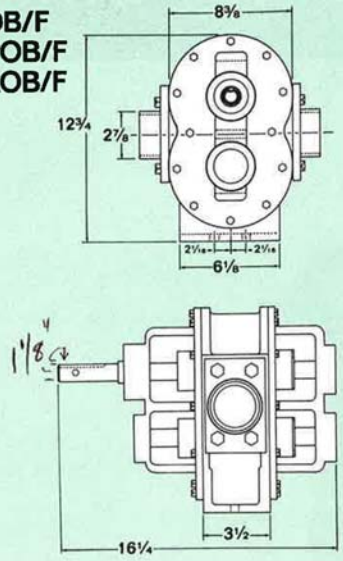
MATERIALS OF CONSTRUCTION

Standard Fitted	Flanged Ports	Housing	Gears	Bearings	Seals	Shafting
Series 400/AOB	2" or 3"	Aluminum Brz	Buna-N	Roller	Lip Type	Stainless Steel
Series 400/OB	2" or 3"	Cast Iron	Buna-N	Roller	Lip Type	Fatigue Proof
Series 400/POB	2" or 3"	Cast Iron	Buna-N	Roller	Rubber Pkg	Fatigue Proof

APPLICATION DATA

Bowie Rotary Pump Series 400 is used for pumping many liquids with varied viscosity, including water, dirty fluids, asphalt emulsions with sand additives. The Aluminum Bronze type is especially suitable for pumping fertilizers, salt water and various corrosive materials. The Bowie Pump is compact and built for trouble-free operation and will perform under a wide range of temperature conditions.

2400/OB/F
2400/POB/F
2400/AOB/F

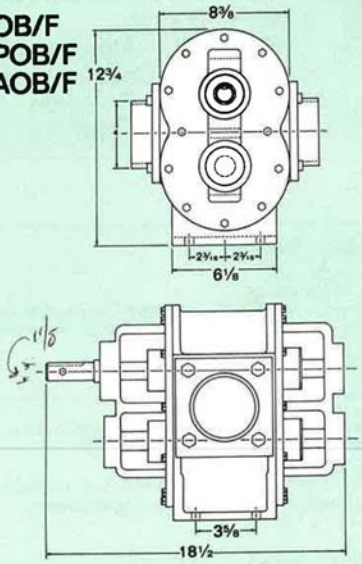


SERIES 400 SIZE: 2 INCH

BOWIE PUMP RATINGS FOR 2″ PUMP SIZES FLUID KEROSENE

Pump RPM	Temperature of Fluid °F	Discharge Pressure	Capacity GPM	Brake Horsepower
190	147	6	68.5	.83
190	147	10	67.0	1.0
190	147	30	60.0	1.9
190	147	50	55.8	2.7
190	146	70	53.0	3.6
190	146	100	50.0	4.7
280	146	10	99.0	1.8
280	146	30	95.0	3.1
280	146	50	89.0	4.3
280	146	70	86.0	5.6
280	146	100	83.0	7.5
420	146	20	147.0	4.3
420	146	40	144.0	3.9
420	147	60	139.0	8.4
420	147	80	136.0	10.3
420	147	100	133.0	12.2

3400/OB/F
3400/POB/F
3400/AOB/F



SERIES 400 SIZE: 3 INCH

BOWIE PUMP RATINGS FOR 3″ PUMP SIZES FLUID KEROSENE

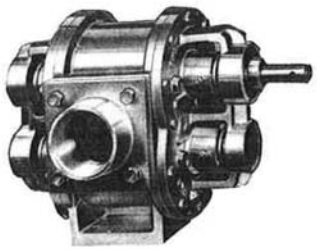
Pump RPM	Discharge Pressure	Capacity GPM	Brake Horsepower
190	6	101	1.1
190	10	99	1.3
190	30	89	2.5
190	50	83	3.6
190	70	78	4.8
190	100	74	6.3
280	10	147	2.4
280	30	141	4.1
280	50	132	5.7
280	70	127	7.5
280	100	123	9.9
400	10	233	5.2
400	20	218	5.7
400	40	213	8.6
400	60	206	11.2
400	80	201	13.7
400	100	197	16.2

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"400" Series

OUTBOARD BALL BEARING

WITH PACKING GLAND



PARTS LIST

2-INCH OUTBOARD PACKING GLAND BALL BEARING PUMP

PART NUMBER	DESCRIPTION		PART NUMBER	DESCRIPTION
2400/POB	Outboard Bowie Pump		2400/POBSS	Outboard Bowie Pump w/S.Steel Shafts
2400/POB/F	Outboard Bowie Pump w/ Adptr. Flngs		2400/POBSS/F	Outboard Bowie Pump w/S. Steel Shafts and Adapter Flanges

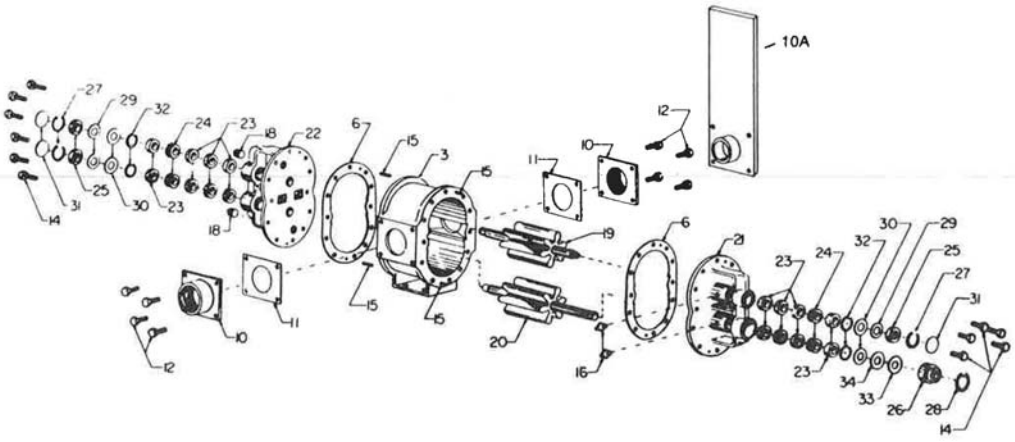
Available options: extended drive shaft

PARTS

REF NO	PART NUMBER	DESCRIPTION	NO REG
3	2403	Center Case	1
6	406	Pump Gasket	8
10	2410	Adapter Flange	2
10A	2410A	Mounting Flange	1
11	2411	Adapter Flange Gasket	2
12	2412	Adapter Flange Bolt	8
14	414	End Plate Bolt	24
15	415	Taper Pin	4
16	416	Grease fitting	4
18	418	Drain Plug	2
19	2419	Hy Car Gear w/Reg Idler Shaft	1
19	2419SS	Hy Car Gear w/S. Steel Idler Shaft	1
19	2419A	Reg. Idler Shaft	1
19	2419SSA	Stainless Steel Idler Shaft	1
19	2419K	Gear Key	2
19	2419G	2" Gear Only	2
20	2420	Hy Car Gear w/Reg Drive Shaft	1
20	2420SS	Hy Car Gear w/S. Steel Drive Shaft	1

REF NO	PART NUMBER	DESCRIPTION	NO REG
20	2420A	Reg Drive Shaft	1
20	2420SSA	Stainless Steel Drive Shaft	1
21	421P	Outboard Front Plate	1
22	422P	Outboard Back Plate	1
23	423G	OutboardPacking (Standard)	12
23	423R	Outboard Packing (Rubber)	12
23	423T	Outboard Packing (Teflon)	12
24	424P	Outboard Packing Nut	4
25	425	Outboard Small Bearing	3
26	426	Outboard Main Drive Bearing	1
27	427	Outboard 2" Bearing Lock Ring	3
28	428	Outboard 3" Drive Bearing Lock Rg	1
29	429	Red Rubber Washer	3
30	430	Black Rubber Slinger Washer	4
31	431	Expansion Plug	3
33	433	Shield Washer for Main Dr. Bearing	1
34	434	Steel Washer for Main Drive Bearing	1

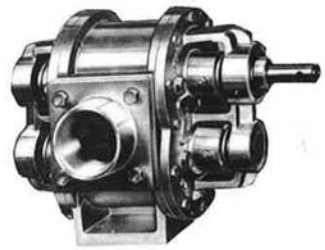
Note:Four digit part numbers beginning with #2 denotes parts for 2" Pump only
Four digit part numbers beginning with #3 denotes parts for 3" Pump only
Three digit part numbers represent parts that are interchangeable between the two & three " 400 series pumps.



"400" Series

OUTBOARD BALL BEARING

WITH PACKING GLAND



PARTS LIST

3-INCH OUTBOARD PACKING GLAND BALL BEARING PUMP

PART NUMBER	DESCRIPTION		PART NUMBER	DESCRIPTION
3400/POB	Outboard Bowie Pump		3400/POBSS	Outboard Bowie Pump w/S.Steel Shafts
3400/POB/F	Outboard Bowie Pump w/ Adptr. Flngs		3400/POBSS/F	Outboard Bowie Pump w/S. Steel Shafts and Adapter Flanges

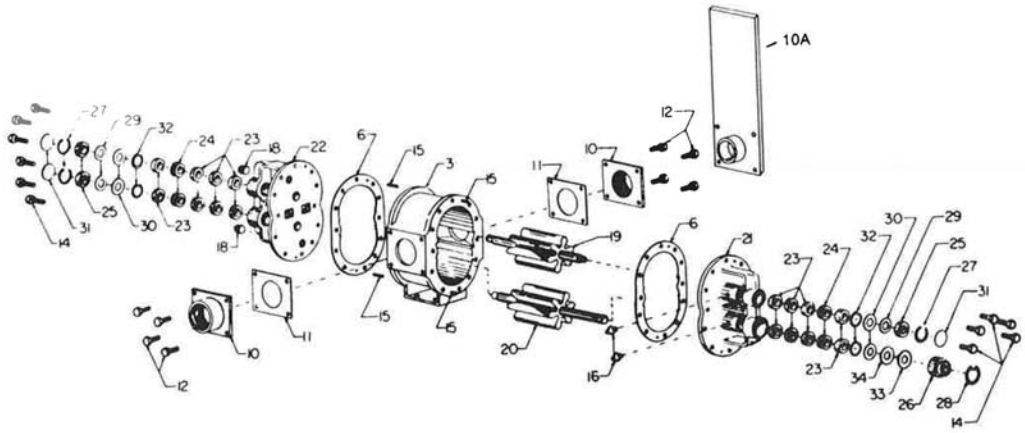
Available options: extended drive shaft

PARTS

REF NO	PART NUMBER	DESCRIPTION	NO REG
3	3403	Center Case	1
6	406	Pump Gasket	8
10	3410	Adapter Flange	2
10A	3410A	Mounting Flange	1
11	3411	Adapter Flange Gasket	2
12	3412	Adapter Flange Bolt	8
14	414	End Plate Bolt	24
15	415	Taper Pin	4
16	416	Grease fitting	4
18	418	Drain Plug	2
19	3419	Hy Car Gear w/Reg Idler Shaft	1
19	3419SS	Hy Car Gear w/S. Steel Idler Shaft	1
19	3419A	Reg. Idler Shaft	1
19	3419SSA	Stainless Steel Idler Shaft	1
19	419K	Gear Key	2
19	3419B	3" Gear Only	2
20	3420	Hy Car Gear w/Reg Drive Shaft	1
20	3420SS	Hy Car Gear w/S. Steel Drive Shaft	1

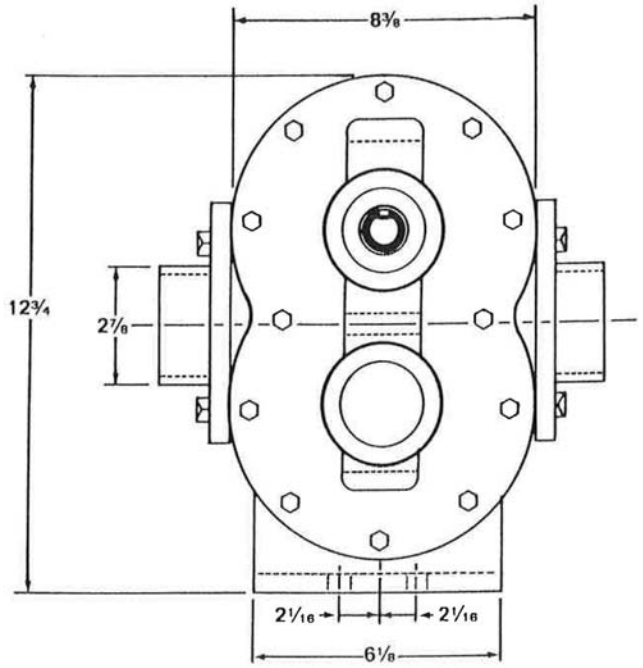
REF NO	PART NUMBER	DESCRIPTION	NO REG
20	3420A	Reg Drive Shaft	1
20	3420SSA	Stainless Steel Drive Shaft	1
21	421P	Outboard Front Plate	1
22	422P	Outboard Back Plate	1
23	423G	OutboardPacking (Standard)	12
23	423R	Outboard Packing (Rubber)	12
23	423T	Outboard Packing (Teflon)	12 16
24	424P	Outboard Packing Nut	4
25	425	Outboard Small Bearing	3
26	426	Outboard Main Drive Bearing	1
27	427	Outboard 2" Bearing Lock Ring	3
28	428	Outboard 3" Drive Bearing Lock Rg	1
29	429	Red Rubber Washer	3
30	430	Black Rubber Slinger Washer	4
31	431	Expansion Plug	3
33	433	Shield Washer for Main Dr. Bearing	1
34	434	Steel Washer for Main Drive Bearing	1

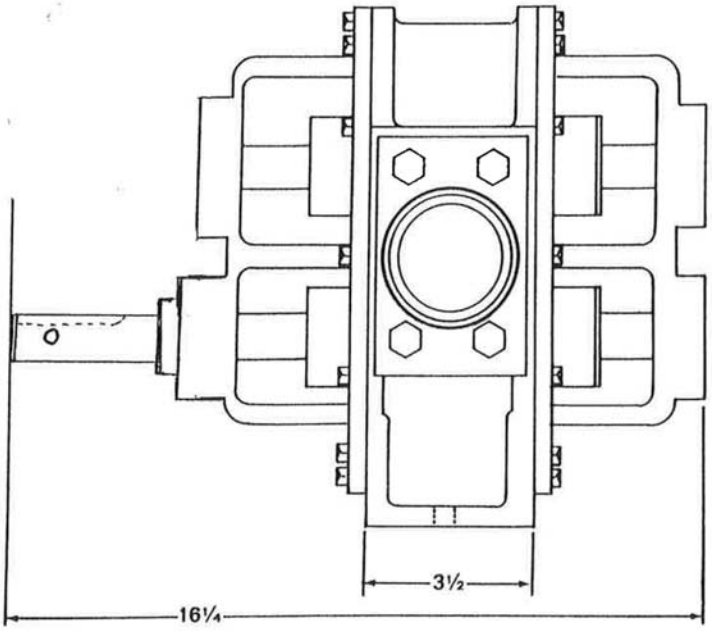
Note:Four digit part numbers beginning with #2 denotes parts for 2" Pump only
Four digit part numbers beginning with #3 denotes parts for 3" Pump only
Three digit part numbers represent parts that are interchangeable between the two & three " 400 series pumps.



DRIVE ON BOTTOM

2400/OB/F
2400/POB/F
2400/AOB/F





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BOWIE PUMPS

INSTALLATION — OPERATION — MAINTENANCE

PUMPING PRINCIPLE:

The meshing of the gears cause a slight depression, with the resulting unmeshing of the gears causing a vacuum drawing the fluid being pumped into the space between the teeth of the gear. The liquid is carried between the teeth and the case to the opposite side of the pump. The fluid is also forced into the discharge line by the meshing of the gears. Bowie Pumps are positive displacement pumps. The pumping gears are of equal size and are the only two moving parts in the pump, which promotes longer life.

PUMP CAPACITY:

The Series 300, 400 and 500 — 2" and 3" Bowie Pumps are designed and recommended to be operated not to exceed 400 RPM and not in excess of 100 psi of pressure. At this speed the 2" Bowie Pump will deliver approximately 140 GPM at no discharge pressure and the 3" will deliver approximately 238 GPM. The Series 8100 — 9100, 1¼" - 1½" are designed and recommended to be operated not to exceed 780 RPM. At this speed either size will deliver approximately 48 GPM and not in excess of 100 psi of pressure. The Bowie Pump is a rotary pump, and the delivery rate will vary some with the differential pressure and the viscosity of the liquid. The Bowie Pumps operate either clockwise or counterclockwise with equal efficiency. No alterations are necessary relative to connections, but it must be remembered that when reversing rotation, the flow of liquid is also reversed in that suction line becomes discharge line and vice versa. The suction line must always be at least the same size of the suction port.

INSTALLATION:

Bowie Pumps are ideally adapted to truck mount power take-off drive. The most popular method of tank truck installation is "Direct Drive" with two U-joints being utilized (one on each end of the drive shaft). A sleeve joint is recommended at the pump to compensate for any play caused by road conditions. The alignment is of utmost importance in mounting pumps on tank trucks. Misalignment will cause excessive wear on U-joints, and many breakdowns due to U-joint failure. The alignment should be held to not less than 3 degrees and not more than 15 degrees line connection if possible and never should be allowed a deviation in excess of 20 degrees variation between the two joints. It is pointed out that even though an alignment in excess of 20 degrees does not exist this WILL NOT CAUSE PUMP FAILURE.

Chain and V-belt drives are the most popular and economical method for installing the Bowie Pump on drive equipment other than tank trucks. It is recommended to use a pillow block bearing on all series of Bowie Pumps when using V-Belt or chain drives, due to the side pull and weight on the drive shaft.

IT IS VERY IMPORTANT THAT A STRAINER OR SCREEN BE INSTALLED ON THE SUCTION LINE TO PREVENT FOREIGN MATTER FROM ENTERING THE PUMP, CAUSING COSTLY BREAKDOWNS. THIS STRAINER OR SCREEN SHOULD BE LARGE ENOUGH AS TO NOT OBSTRUCT SUCTION.

LUBRICATION:

Bowie Pumps require lubrication only where grease fittings are provided. All bearing and bushing type pumps require a good grade of gun grease to insure longer life of the pumps. No lubrication is required on bushing or bearing type pumps if oil is pumped exclusively. This is the only exception. Periodic lubrication is of utmost importance in the care of the Bowie Pumps. This point cannot be over emphasized, and depending on use, this greasing should be done every four (4) hours of continuous operation.

ADJUSTMENT FOR CLEARANCE: All Series BOWIE PUMPS

Should it be necessary to adjust the pumps due to excessive clearance from normal wear of the impellers between the front and back plate housing, remove the backplate and remove one, two or three, etc., pump gaskets as may be required to take up the slack. Replace back plate, being extremely careful that the remaining gaskets do not crimp or wrinkle, and tighten bolts diametrically opposed to each other, pulling each bolt up evenly.

MAINTENANCE ON STANDARD BOWIE PUMPS: Series 300 and 8100 - 9100

The standard or stock sleeve bearing Bowie Pump is furnished with a high grade, braided type of asbestos packing, lubricated with graphite and impregnated with lubricant. No further lubrication is needed for normal operation of this packing. When tightening the packing nut do not compress the packing too greatly and cause excessive binding on the shaft. Another type of packing used is the graphited rubber packing ring. This type is preferred by many, however; great care must be taken when installing this ring to insure that the packing nut is not too tight causing binding on the shaft. This type packing tends to bind easier than the asbestos packing, due to friction on shaft and packing causing heat which swells the rubber. When installing bronze or teflon bushings in the standard Bowie Pump, care must be taken not to "scar" the bushings. It is preferable to press the bushings in place rather than tap or hammer them.

When purchasing replacement gears for Bowie Pumps, the gears are sold with shafts installed. Shafts may be purchased separately, however. Often when shafts are pressed into the gears the shafts will bend and cause pump malfunction, however; this is checked at the factory. If this is done by someone other than the factory, care must be taken to insure that the shafts are perfectly straight after pressing into the gears.

MAINTENANCE OF BALL BEARING PUMPS: Series 400/OB/POB and 500/IB

On each plate of the ball bearing Bowie Pumps are two (2) $^{3}/_{8}$" threaded bolt holes which aid in the pulling of the plates when disassembling for maintenance. Merely insert a $^{3}/_{8}$" USS (approximately 2" in length) bolt and turn into threaded holes, this operation should be done in a manner where both bolts pull the plates evenly to eliminate binding on the bearings and shafts.

When replacing shafts in plates extreme care must be taken on the bearing type pumps to insure that the seals are not damaged. A good method to insure against this is to grease these seals thoroughly so that the shaft may slip in without binding and turning the lips of the seal backwards.

When replacing bearings in the Bowie Pump, caution must be exercised to not damage the bearing by hammering, prying, etc.

TROUBLESHOOTING A PUMPING SYSTEM

Once a pump is properly selected and installed in a system, operation should be trouble-free. However, in existing systems or as pump and system conditions change, problems may develop. Following are some troubleshooting hints to help identify and solve problems.

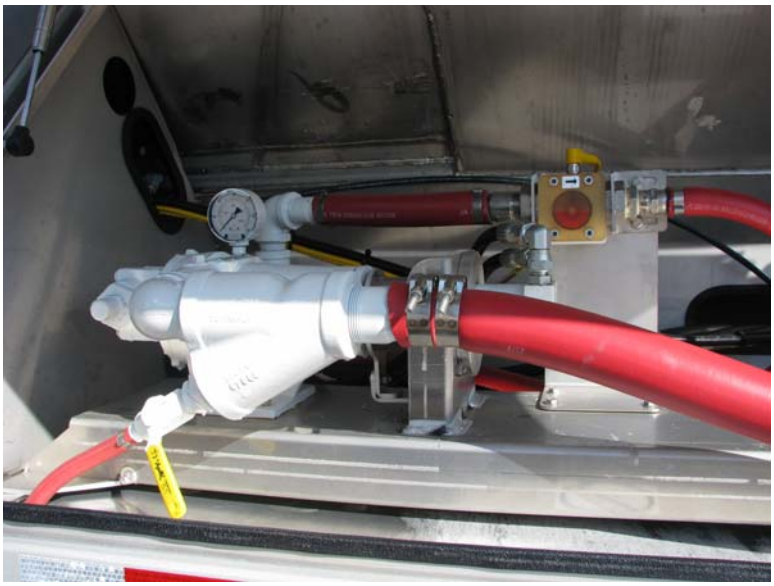
PROBLEM	PROBABLE CAUSES	SOLUTIONS
no flow, pump not turning	Keys sheared or missing	Replace
	Pump shaft keys, or gears sheared	Inspect, replace parts
No flow, pump turning	Wrong direction of rotation	Reverse
No flow, pump not priming	Valve closed in inlet line	Open valve
	Inlet line clogged or restricted	Clear line, clean filters, etc.
	Air leaks due to bad seals or pipe connections	Replace seals; check lines for leakage (can be done by air pressure or by filling with liquid and pressurizing with air)
	Pump speed too slow	Speed up pump. Filling inlet lines with fluid may allow initial start-up. Foot valve may solve start-up problems permanently.
	Liquid drains or siphons from system during off period	Use foot valve or check valves.
No flow, pump not priming	Extra clearance gears worn pump	Increase pump speed, use foot valve to improve priming. Remove back plate gasket.
No flow	Relief valve not properly adjusted, or held off seat by foreign material (flow is being recirculated to inlet)	Adjust or clear valve
Insufficient flow	Speed too low to obtain desired flow	Check flow-speed chart
	..... Air leak due to bad seals or pipe connections	Replace seals, check inlet fittings.
Fluid vaporization ("starved" pump inlet)	Strainers, foot balves, inlet fittings or lines clogged	Clear lines. If problem continues, inlet system system may require change
	Inlet line size too small, inlet line length too long. Too many fittings or valves. Foot valves, strainers too small.	Increase inlet line size, reduce length, minimize direction and size changes, reduce number of fittings.
	NIPA too low	Raise liquid level in source tank
	NIPA too low	Increase by raising or pressurizing source tank
	NIPA too low NIPA NIPR	Select larger pump size with smaller NIPR
	Fluid viscosity greater than expected.	Reduce pump speed and accept lower flow or change system to reduce line losses.
	Fluid temperature higher than expected (vapor pressure higher)	Reduce temperature, reduce speed and accept lower flow or change system to increase NIPA
Insufficient flow, fluid being bypassed somewhere	Relief valve not adjusted or jammed	Adjust or clear
	Flow diverted in branch line, open valve, etc.	Check system and controls

TROUBLESHOOTING A PUMPING SYSTEM

PROBLEM	PROBABLE CAUSES	SOLUTIONS
Insufficient flow, high slip	Hot (HC) or extra clearance gears on cold fluid, and/or low viscosity fluid	Replace with standard clearance gears
	Worn pump	Increase pump speed (within limits). Replace gears, re-condition pump
	High pressure	Reduce pressure by system changes
Noisy operation	.CAVITATION	
	High fluid viscosity, High vapor pressure fluids, High temperature	Slow down pump, reduce temperature, change system
	.AIR OR GAS IN FLUID	
	Leaks in pump or piping	Correct leaks
	Dissolve gas or naturally aerated products	Minimize discharge pressure. Also see "Cavitation" above
	MECHANICAL NOISES GEAR TO BODY CONTACT	
	Improper assembly	Check clearance with Pump Gasket
	.ROTOR TO BODY CONTACT	
	Distortion of pump due to improper piping installation	Reassemble pump or re-install piping to assure free running.
	Pressure higher than rated	Reduce pressure if possible.
	Worn bearing or bushings	Rebuild with new bearings, or bushings, lubricate regularly
Noisy Operation	Worn gears	Rebuild with new gears, lubricate regularly
	.Rotor to rotor contact	
	.Relief valve chattering	Re-adjust, repair or replace
Pump requires excessive power (over-heats, stalls, high current draw, breaker trip)	.Higher viscous losses than expected	If within pump rating, increase drive size
	.Higher pressure than expected	REduce pump speed, increase line sizes
	.Fluid characteristics	
	. . . . . Fluid colder than expected	Heat fluid, insulate or heat trace lines. Use pump with more running clearances
	Fluid sets up in line and pump during shut down	Insulate or heat trace line. Install "soft start" drive. Install recirculating bypass system. Flush with other fluid.
	Fluid builds up on pump surfaces (examples: latex, chocolate, fondants)	Use pump with more running clearance
"Short" pump service life	High corrosion rate	Upgrade material of pump
	Pumping abrasives	Larger pumps at slower speeds can help
	Speeds and pressures higher than rated	Reduce speeds and pressurs by changes in system
	Worn bearings and gears due to lack of lubrication	Set up and follow regular lubrication schedule
	Misalignment of drive and piping. Excessive overhung load or misaligned couplings.	Check alignment and loads.

Fuel Pump

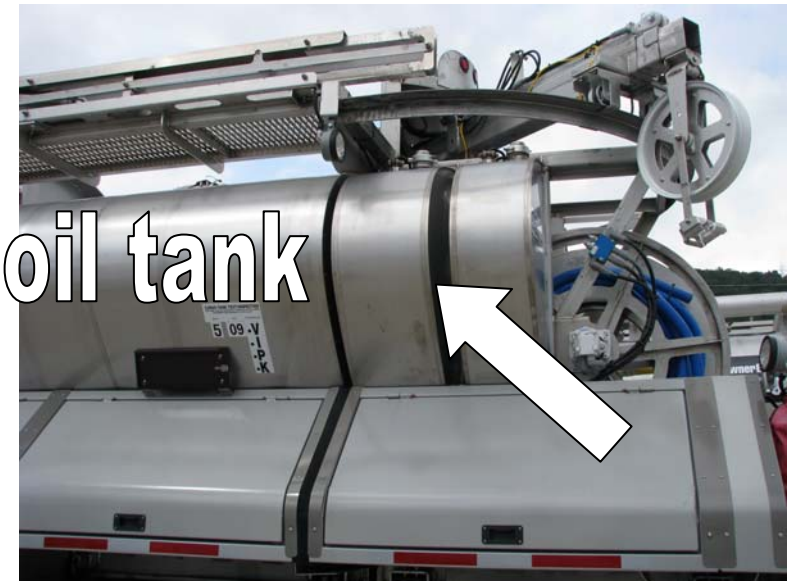




There are three control points in the ANFO oiling system

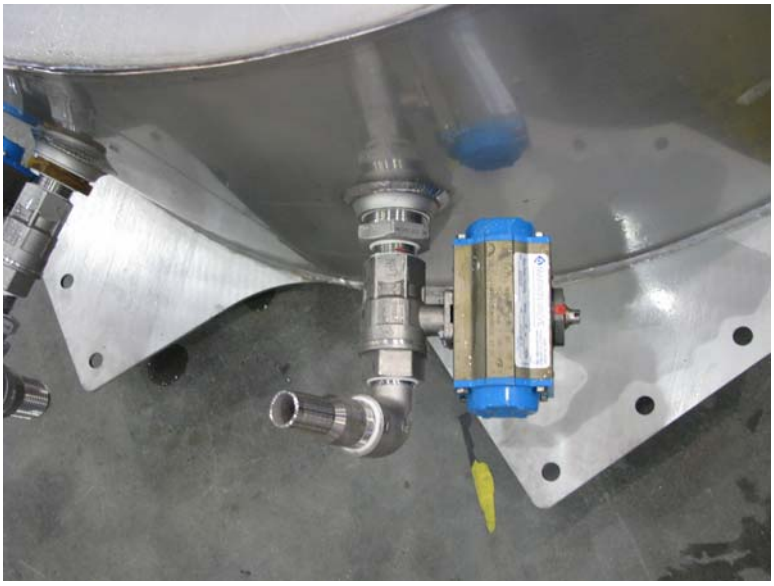
1. Ball valves on the oil tank.
2. Fuel oil select valve.
3. Adjustable proportional flow control.

The ball valves are located at the bottom of the fuel oil tank. The ball valves MUST be open any time the oiling system is activated. The open position is when the handle of the ball valve is “in-line” with the valve. The closed position is when the handle of the ball valve is perpendicular to the valve. Also, make certain that there is oil in the fuel oil tank before operating the oiling system. Replace the fuel oil tank sight gauge if you cannot clearly see the oil level. Running the oil pump for even brief periods with no oil may result in pump damage.





Fill cap and optional upfill cutoff switch



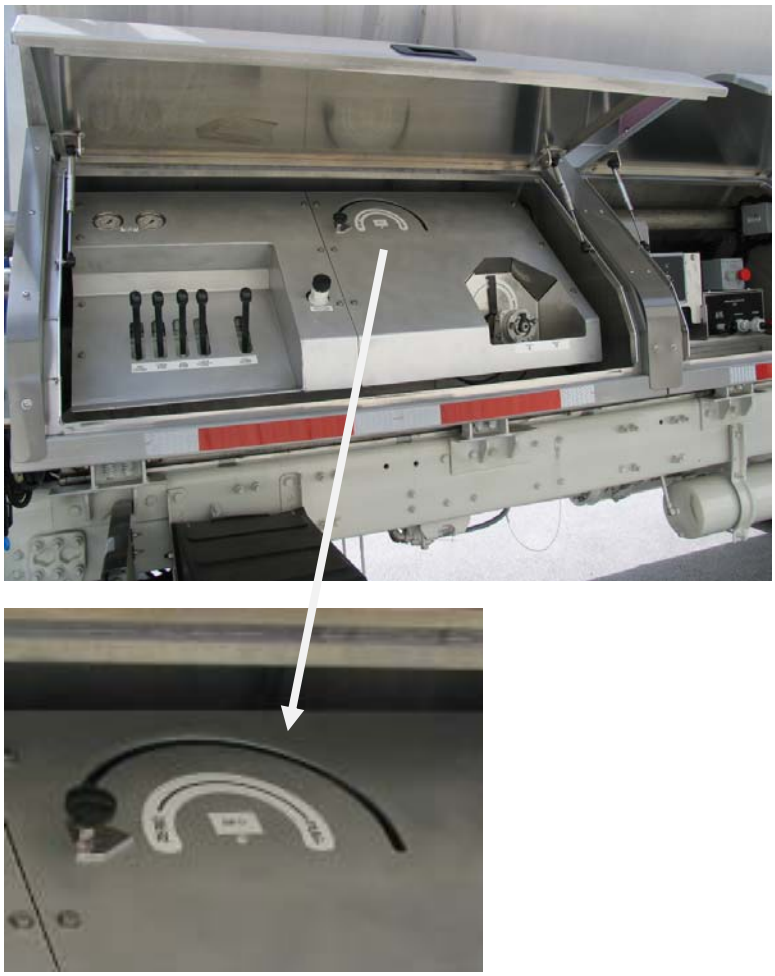
Ball valve on bottom of fuel tank 1

Fuel oil select valve

The fuel oil select valve is located near hydraulic control console on a manual selection system. The fuel oil select valve is to allow for product delivery without the addition of fuel oil. If you do not desire oil, put the valve labeled “FUEL OIL” in the “IN_OFF” position.

The fuel oil selection will operate in various ways depending upon the customer specified control systems.

Adjustable proportional flow control



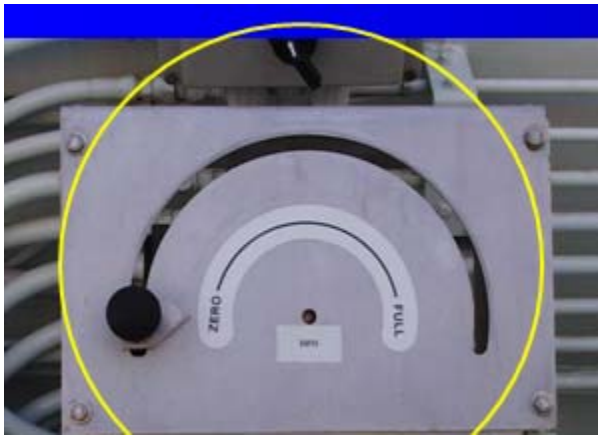
The adjustable proportional flow control is located on the fender in close proximity to the hydraulic controls. The adjustable proportional flow control is provided to insure flexibility of the oiling system. This valve actually adjusts the amount of oil going to the ammonium nitrate. The adjustable proportional flow control operates in an arch from left to right. The handle can be locked in place by turning the flow control knob in the clockwise direction. Full left allows little or no DFO into the AN stream and full right allows 10 to 12% DFO into the AN stream.

The AP flow divider splits the flow into two adjustable portions.

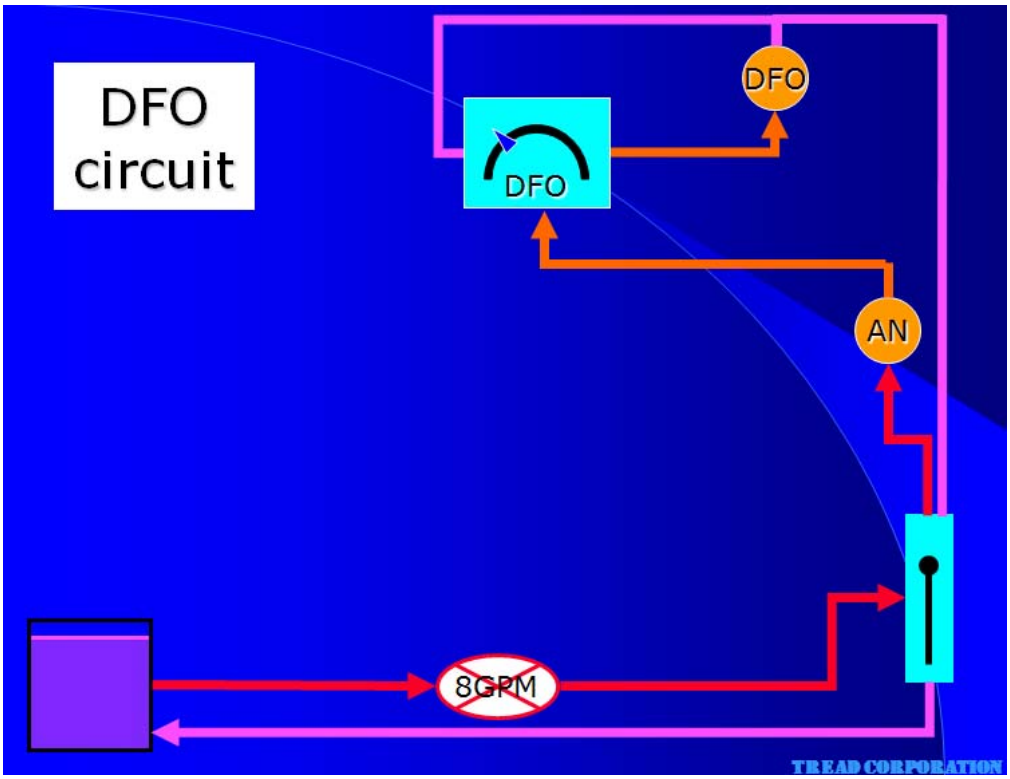
The set portions (percentage) remain constant when input flow changes.

The adjustable proportional flow control is used to calibrate the oiling system and to "trim" the system for specific conditions. It should be checked frequently to make sure that it slides freely. When sliding the adjustment, make certain the locking knob is in the unlocked position and that it is returned to the locked position when adjustment is completed.

Under cold conditions it is possible for the diesel fuel oil to gel, which may appear to be a malfunctioning oiling system or miscalibration of the system. Under these conditions it is recommended that the fuel oil distributor be consulted concerning different fuel blends or additives.



- Controls fuel pct from 0% - 20% of AN.
- Must be calibrated before first use
- Annual calibration thereafter



Oil Injectors



The oil injectors are normally located in the bottom auger housing just below the connection with the vertical auger housing . The fittings should be unscrewed and the orifices checked for wear on an annual basis or when calibration of the system becomes difficult. The injectors should also be inspected for seepage of oil when the oiling system is off. An undue amount of seepage indicates that the check valve may have dirt on the valve seat that interferes with proper seating of the valve. Otherwise, the valve may be worn and in need of replacement. Be sure to install the 30 psi check valve with the flow direction toward the oil injectors. The check valve will prevent gravity feed from the tank.

- Spray nozzle for diesel fuel
- Worn orifice will change calibration
- Should be replaced when rebuilding system (new pump)
- 30 psi check valve to stop gravity feed from tank
- check valve will leak if dirt gets on valve seat

Oil Strainer



The strainer is located on the oil pump assembly. The strainer should be cleaned out as often as necessary to insure an uninterrupted flow of oil to the oil injectors.

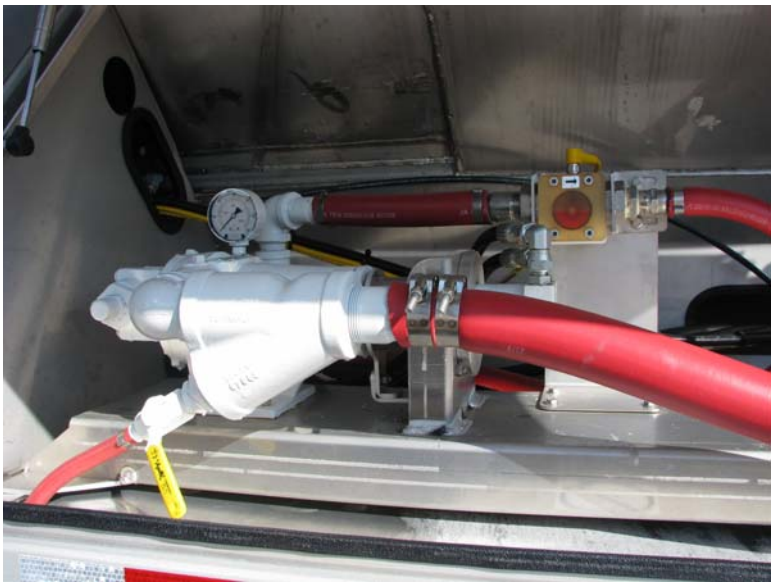
Fuel Oil Totalizer

- Indicates total gallons (liters) used since last reset
- Also indicates total gallons (liters) used since install
- Meter is manufactured for the fluid being metered.
- Use with scale weights to determine % fuel on ANFO trucks



Pump and Motor

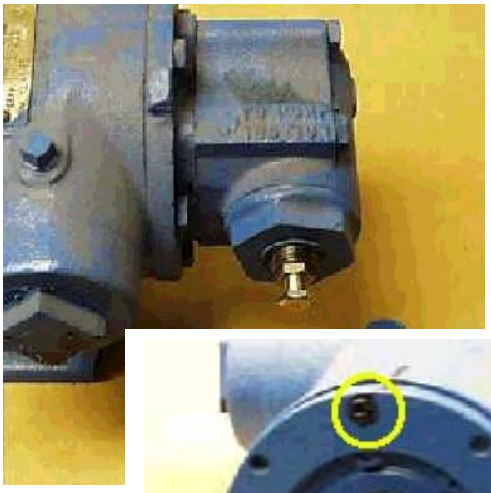
The Viking gear pump has an internal relief valve. The pump runs in proportion to the bed auger over the full operating range. The pump discharges approximately .017 gallons per minute, although pump wear will change this calibration. The pump is supplied with a thrust bearing, which allows for adjustment to compensate for pump wear.







Pressure relief setting



1. Remove the valve cap covering the adjustment screw, and loosen the locknut.
2. Back off the adjusting screw by turning it CCW until it is almost all the way out.
3. Remove the discharge line and plug it.
4. Run the pump and observe the pressure gauge reading.
5. Turn the adjusting screw CW to increase the pressure to 100 psi.
6. Tighten the locknut and install the valve cap.
7.

Thrust ring adjustment

Loosen the set screws in the face of the thrust bearing assembly using a 7/16 inch allen wrench.



While turning the rotor shaft, rotate the thrust bearing assembly until a noticeable drag occurs. This is zero clearance. Mark this position with the pump housing.



Rotate the thrust bearing assembly CCW 9/16 of an inch, as measured on the outside of the pump housing. Tighten the setscrews to secure the thrust bearing assembly in this position.



VIKING PUMP

TECHNICAL SERVICE MANUAL

HEAVY-DUTY PUMPS
SERIES 4195 AND 495
SIZES GG - AL

SECTION	TSM 144
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INTRODUCTION

The illustrations used in this manual are for identification purposes only and cannot be used for ordering parts. Obtain a parts list from the factory or a Viking® representative. Always give complete name of part, part number and material with model number and serial number of pump when ordering repair parts. The unmounted pump or pump unit model number and serial number are on the nameplate.

In the Viking model number system, basic size letters are combined with series number (4195 and 495) are used to indicate either an unmounted pump or mounted pump unit.

UNMOUNTED PUMP	UNITS
Foot Mounted	Units are designated by the unmounted pump model numbers followed by a letter(s) indicating drive style. D = Direct Drive
GG4195	
HJ4195	
HL4195	
AS4195	
AK4195	
AL4195	
Flange Mounted	M = Horizontal Direct Drive
GG495	
HJ495	
HL495	
AS495	
AK495	
AL495	

This manual deals only with Series 4195 and 495 Heavy Duty Pumps. Refer to Figures 1 through 14 for general configuration and nomenclature used in this manual. Pump specifications and recommendations are listed in Catalog Section 144, Series 4195 and 495 Heavy Duty Pumps.



FIGURE 1
GG, HJ and HL4195 SERIES
Foot Type Unmounted Pump with Tapped Ports



FIGURE 2
AS, AK and AL4195 SERIES
Foot Type Unmounted Pump with Tapped Ports



FIGURE 3
GG, HJ and HL495 SERIES
Unmounted Pump with Tapped Ports



FIGURE 4
AS, AK and AL495 SERIES
Unmounted Pump with Tapped Ports

SAFETY INFORMATION AND INSTRUCTIONS

IMPROPER INSTALLATION, OPERATION OR MAINTENANCE OF PUMP MAY CAUSE SERIOUS INJURY OR DEATH AND/OR RESULT IN DAMAGE TO PUMP AND/OR OTHER EQUIPMENT. VIKING'S WARRANTY DOES NOT COVER FAILURE DUE TO IMPROPER INSTALLATION, OPERATION OR MAINTENANCE.

THIS INFORMATION MUST BE FULLY READ BEFORE BEGINNING INSTALLATION, OPERATION OR MAINTENANCE OF PUMP AND MUST BE KEPT WITH PUMP. PUMP MUST BE INSTALLED, OPERATED AND MAINTAINED ONLY BY SUITABLY TRAINED AND QUALIFIED PERSONS.

THE FOLLOWING SAFETY INSTRUCTIONS MUST BE FOLLOWED AND ADHERED TO AT ALL TIMES.

Symbol Legend :

⚠ **Danger -** Failure to follow the indicated instruction may result in serious injury or death.

WARNING **Warning -** In addition to possible serious injury or death, failure to follow the indicated instruction may cause damage to pump and/or other equipment.

⚠ **BEFORE** opening any liquid chamber (pumping chamber, reservoir, relief valve adjusting cap fitting, etc.) be sure that :

- Any pressure in the chamber has been completely vented through the suction or discharge lines or other appropriate openings or connections.
- The pump drive system means (motor, turbine, engine, etc.) has been "locked out" or otherwise been made non-operational so that it cannot be started while work is being done on the pump.
- You know what material the pump has been handling, have obtained a material safety data sheet (MSDS) for the material, and understand and follow all precautions appropriate for the safe handling of the material.

⚠ **BEFORE** operating the pump, be sure all drive guards are in place.

⚠ **DO NOT** operate pump if the suction or discharge piping is not connected.

⚠ **DO NOT** place fingers into the pumping chamber or its connection ports or into any part of the drive train if there is **any possibility** of the pump shafts being rotated.

⚠ **WARNING** **DO NOT** exceed the pumps rated pressure, speed, and temperature, or change the system/duty parameters from those the pump was originally supplied, without confirming its suitability for the new service.

⚠ **WARNING** **BEFORE** operating the pump, be sure that:

- It is clean and free from debris
- all valves in the suction and discharge pipelines are fully opened.
- All piping connected to the pump is fully supported and correctly aligned with the pump.
- Pump rotation is correct for the desired direction of flow.

WARNING **INSTALL** pressure gauges/sensors next to the pump suction and discharge connections to monitor pressures.

⚠ **WARNING** **USE** extreme caution when lifting the pump. Suitable lifting devices should be used when appropriate. Lifting eyes installed on the pump must be used **only** to lift the pump, **not** the pump with drive and/or base plate. If the pump is mounted on a base plate, the base plate must be used for all lifting purposes. If slings are used for lifting, they must be safely and securely attached. For weight of the pump alone (which does not include the drive and/or base plate) refer to the Viking Pump product catalog.

⚠ **DO NOT** attempt to dismantle a pressure relief valve that has not had the spring pressure relieved or is mounted on a pump that is operating.

⚠ **AVOID** contact with hot areas of the pump and/or drive. Certain operating conditions, temperature control devices (jackets, heat-tracing, etc.), improper installation, improper operation, and improper maintenance can all cause high temperatures on the pump and/or drive.

⚠ **WARNING** **THE PUMP** must be provided with pressure protection. This may be provided through a relief valve mounted directly on the pump, an in-line pressure relief valve, a torque limiting device, or a rupture disk. If pump rotation may be reversed during operation, pressure protection must be provided on ***both*** sides of pump. Relief valve adjusting screw caps must always point towards suction side of the pump. If pump rotation is reversed, position of the relief valve must be changed. Pressure relief valves cannot be used to control pump flow or regulate discharge pressure. For additional information, refer to Viking Pump's Technical Service Manual TSM 000 and Engineering Service Bulletin ESB-31.

⚠ **WARNING** **THE PUMP** must be installed in a matter that allows safe access for routine maintenance and for inspection during operation to check for leakage and monitor pump operation.

SPECIAL INFORMATION

DANGER !

Before opening any Viking pump liquid chamber (pumping chamber, reservoir, relief valve adjusting cap fitting, etc.) Be sure:

1. **That any pressure in the chamber has been completely vented through the suction or discharge lines or other appropriate openings or connections.**
2. **That the driving means (motor, turbine, engine, etc.) has been "locked out" or made non-operational so that it cannot be started while work is being done on pump.**
3. **That you know what liquid the pump has been handling and the precautions necessary to safely handle the liquid. Obtain a material safety data sheet (MSDS) for the liquid to be sure these precautions are understood.**

Failure to follow above listed precautionary measures may result in serious injury or death.

ROTATION: Viking pumps operate equally well in a clockwise or counterclockwise rotation. Shaft rotation determines which port is suction and which is discharge. Suction Port is where pumping elements (gear teeth) come out of mesh.

PRESSURE RELIEF VALVES:

1. Viking pumps are positive displacement pumps and must be provided with some sort of pressure protection. This may be a relief valve mounted directly on the pump, an inline pressure relief valve, a torque limiting device or a rupture disk.
2. There are relief valve options available on those pump models designed to accept a relief valve. Options may include a return to tank relief valve. Pumps equipped with a jacketed head plate are generally not available with a relief valve.
3. If pump rotation is reversed during operation, pressure protection must be provided on both sides of the pump.
4. The relief valve adjusting screw cap must always point towards the suction side of the pump. If pump rotation is reversed, remove the pressure relief valve and turn end for end. Refer to **Figure 5**.
5. Pressure relief valves should not be used to control flow or regulate discharge pressure.

For additional information on pressure relief valves, refer to **Technical Service Manual TSM 000 and Engineering Service Bulletin ESB-31**.

SPECIAL MECHANICAL SEALS:

This bulletin illustrates the mechanical seal which is standard in the catalog pump. A Seal Installation Drawing will be furnished with a pump fitted with a non-standard mechanical seal. Consult this Seal Installation Drawing before disassembling pump.

Modifications are required to install PTFE mechanical seals in these pumps. Contact the factory for specific information.

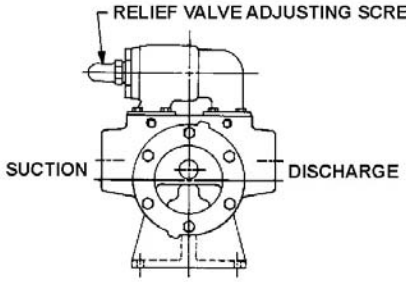


FIGURE 5

MAINTENANCE

Series 4195 and 495 pumps are designed for long, trouble-free service life under a wide variety of application conditions with a minimum of maintenance. The points listed below will help provide long service life.

CLEANING PUMP: Keep the pump as clean as possible. This will facilitate inspection, adjustment and repair work and help prevent overlooking a dirt covered grease fitting.

STORAGE: If the pump is to be stored, or not used for six months or more, the pump must be drained and a light coat of non-detergent SAE 30 weight oil must be applied to all internal pump parts. Lubricate the fittings and apply grease to the pump shaft extension. Viking suggests rotating pump shaft by hand one complete revolution every 30 days to circulate the oil.

SUGGESTED REPAIR TOOLS: The following tools must be available to properly repair Series 4195 and 495 pumps. These tools are in addition to standard mechanics' tools such as open end wrenches, pliers, screw drivers, etc. Most of the items can be obtained from an industrial supply house.

1. Soft Headed hammer
2. Allen wrenches (set screws & special mechanical seals)
3. Snap Ring Pliers
   INTERNAL – Viking Part No. 2-810-047-999
   GG-HJ-HL 4195-495
   EXTERNAL – Viking Part No. 2-810-029-375
   GG-HJ-HL 4195-495
4. Mechanical Seal Installation Sleeve
   2-751-001-730 for 0.75 inch seal; GG 4195-495
   2-751-004-730 for 1.25 inch seal; AS-AL 4195-495
5. Bearing Locknut Spanner Wrench – 2-810-043-375
6. Spanner Wrench, adjustable pin type for use on bearing housing end cap. – 2-810-008-375
7. Brass bar
8. Arbor press
9. Standard 5/16" 12 point socket

DISASSEMBLY

DANGER !

Before opening any Viking pump liquid chamber (pumping chamber, reservoir, relief valve adjusting cap fitting, etc.) Be sure:

1. **That any pressure in the chamber has been completely vented through the suction or discharge lines or other appropriate openings or connections.**
2. **That the driving means (motor, turbine, engine, etc.) has been "locked out" or made non-operational so that it cannot be started while work is being done on pump.**
3. **That you know what liquid the pump has been handling and the precautions necessary to safely handle the liquid. Obtain a material safety data sheet (MSDS) for the liquid to be sure these precautions are understood.**

Failure to follow above listed precautionary measures may result in serious injury or death.

1. Refer to **Figures 7 & 8**, page 5 for model to be disassembled and name of parts. Models 4195 & 495 are disassembled and assembled in the same manner. The difference between these models is the casings.
2. Mark the head and casing before disassembly to insure proper reassembly.
3. **NOTE:** The four valve capscrews, valve and gasket must be removed from the GG4195-495 model before the six head capscrews are removed.

   Remove the head capscrews.
4. Tilt the top of the head back when removing to prevent the idler from falling off the idler pin.
5. Remove the idler and bushing assembly. If the idler bushing needs replacing, see **"Installation of Carbon Graphite Bushings,"** page 8.
6. Insert a brass bar or piece of hardwood in the port opening and between the rotor teeth to keep the shaft from turning. Turn the locknut counterclockwise and remove locknut. See **Figure 9 or 10**, page 6.
7. Loosen the two setscrews in the face of the bearing housing and turn the thrust bearing assembly counterclockwise and remove from casing. See **Figure 9 or 10**, page 6.
8. **GG, HJ, HL:** Remove the snap ring from the shaft. See **Figure 9**, page 6.

   AS, AK, AL: Remove the bearing spacer from the shaft. See **Figure 10**, page 6.
9. Remove the brass bar or piece of hardwood from the port opening.

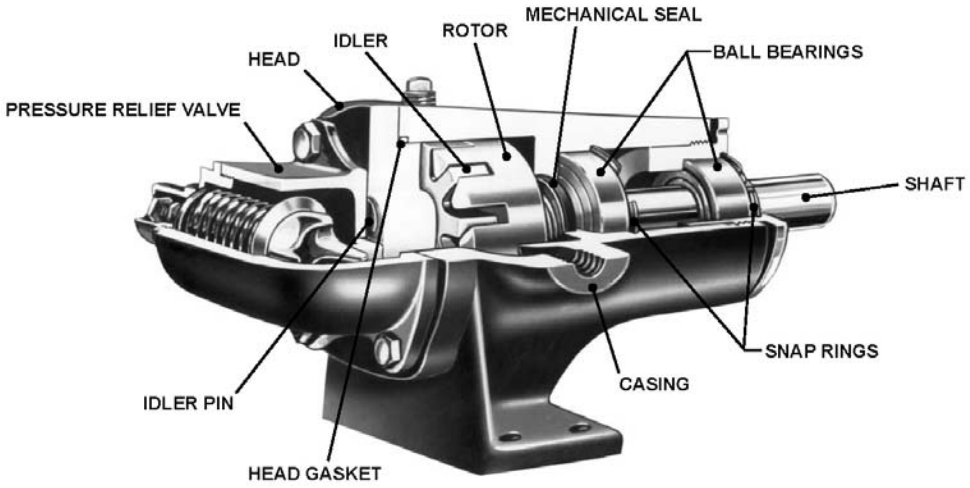
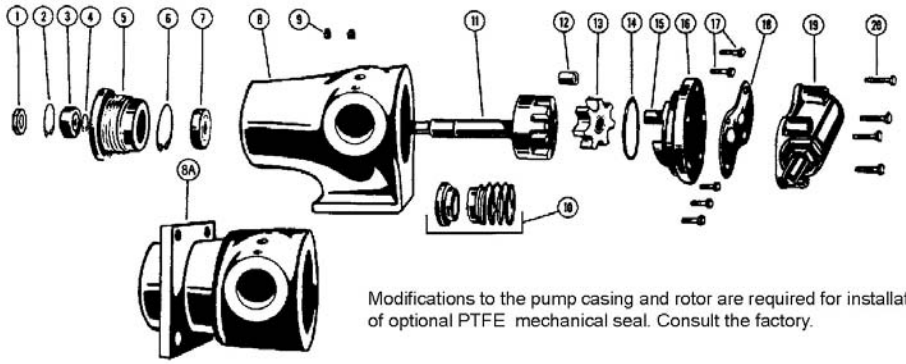


FIGURE 6
CUTAWAY FOR MODELS GG, HJ AND HL4195

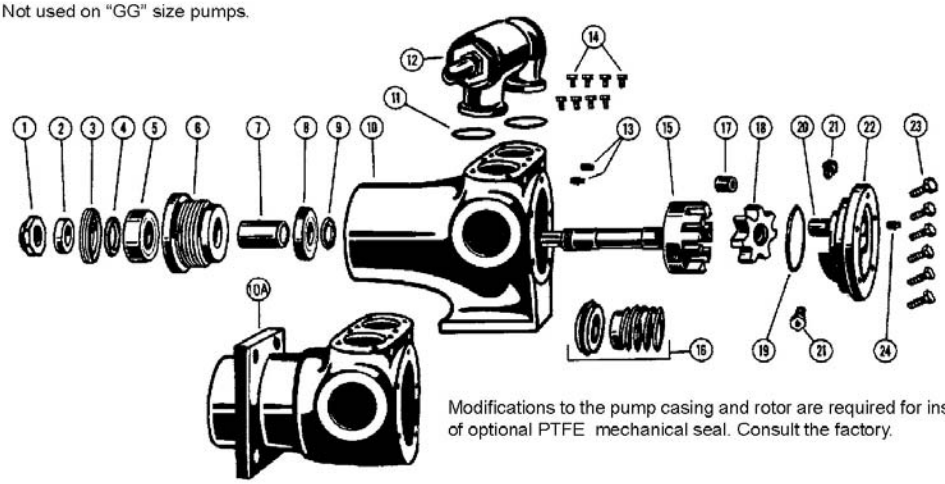


Modifications to the pump casing and rotor are required for installation of optional PTFE mechanical seal. Consult the factory.

FIGURE 7 - EXPLODED VIEW FOR MODELS GG, HJ AND HL 4195 AND 495

ITEM	NAME OF PART	ITEM	NAME OF PART	ITEM	NAME OF PART
1	Locknut	8	Casing (4195)	14	Head O-Ring
2	Snap Ring (Outer)	8A	Casing (495)	15	Idler Pin
3	Ball Bearing (Outer)	9	Pipe Plug	16	Head and Idler Pin Assembly
4	Snap Ring for Shaft *	10	Mechanical Seal	17	Capscrew for Head
5	Bearing Housing	11	Rotor and Shaft Assembly	18	Gasket for Relief Valve
6	Snap Ring (Inner)	12	Idler Bushing	19	Relief Valve
7	Ball Bearing (Inner)	13	Idler and Bushing Assembly	20	Capscrew for Valve

* Not used on "GG" size pumps.



Modifications to the pump casing and rotor are required for installation of optional PTFE mechanical seal. Consult the factory.

FIGURE 8 - EXPLODED VIEW FOR MODELS AS, AK AND AL 4195 AND 495

ITEM	NAME OF PART	ITEM	NAME OF PART	ITEM	NAME OF PART
1	Locknut	9	Bearing Retainer Washer	16	Mechanical Seal
2	Bearing Spacer Collar	10	Casing (4195)	17	Idler Bushing
3	End Cap for Bearing Housing	10A	Casing (495)	18	Idler and Bushing Assembly
4	Lip Seal for Bearing Housing	11	O-Rings for Relief Valve	19	Head O-Ring
5	Ball Bearing (Outer)	12	Relief Valve	20	Idler Pin
6	Bearing Housing	13	Pipe Plug	21	Check Valve
7	Bearing Spacer	14	Capscrew for Valve	22	Head and Idler Pin Assembly
8	Ball Bearing (Inner)	15	Rotor and Shaft Assembly	23	Capscrew for Head

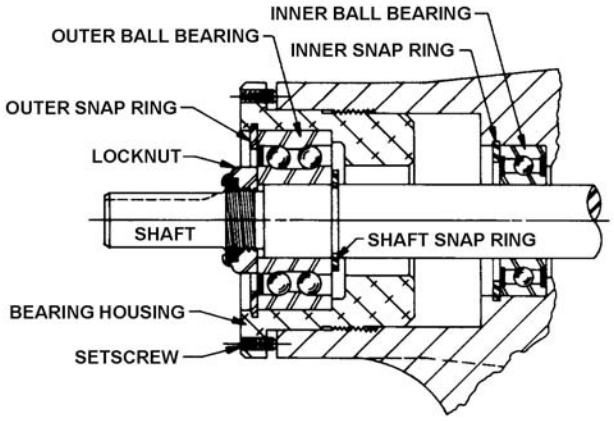


FIGURE 9 - THRUST BEARING ASSEMBLY GG, HJ AND HL SIZES

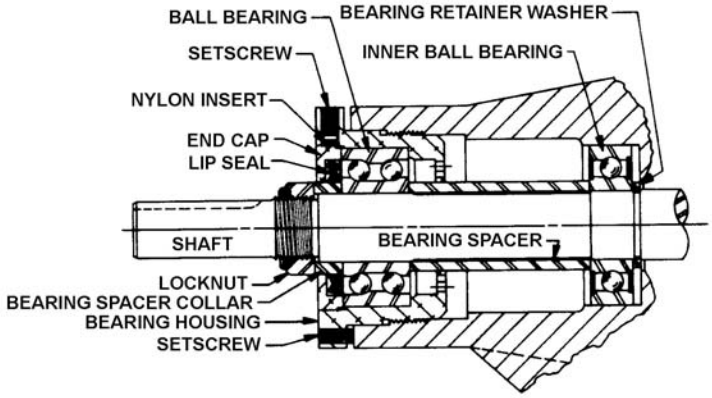


FIGURE 10 - THRUST BEARING ASSEMBLY AS, AK AND AL SIZES

10. The rotor and shaft can now be removed by tapping on the end of the shaft with a lead hammer or, if using a regular hammer, use a piece of hardwood between the shaft and hammer. The rotary member of the seal will come out with the rotor and shaft.

11. **AS, AK, AL:** Remove the bearing retainer washer. The washer may have stayed with the rotor and shaft when removed or is against the ball bearing. See **Figure 10.**

12. Remove the mechanical seal rotary member and spring from the rotor and shaft assembly.

13. **GG, HJ, HL:** Remove the inner snap ring and single row ball bearing from the casing.

AS, AK, AL: Remove the single row ball bearing from the casing.

14. Remove the seal seat or stationary part of the seal from the casing.

15. Disassemble the thrust bearing assembly.

GG, HJ, HL: Remove the outer snap ring from the bearing housing and remove the ball bearing. See **Figure 9.**

AS, AK, AL: Loosen the two setscrews in the flange outside diameter. Rotate the end cap and lip seal counterclockwise and remove. Remove the ball bearing. See **Figure 10.**

The casing should be examined for wear, particularly in the area between the ports. All parts should be checked for wear before the pump is put together.

When making major repairs, such as replacing a rotor and shaft; it is advisable to also install a new mechanical seal, head and idler pin, idler and bushing. See **"Installation of Carbon Graphite Bushings,"** page 8.

Clean all parts thoroughly and examine for wear or damage. Check the lip seals, ball bearings, bushing and idler pin and replace if necessary. Check all other parts for nicks, burrs, excessive wear and replace if necessary.

Wash the bearings in clean solvent. Blow out the bearings with compressed air. Do not allow the bearings to spin; turn them slowly by hand. Spinning the bearings will damage the race and balls. Make sure the bearings are clean, then lubricate with non-detergent SAE 30 weight oil and check for roughness. Roughness can be determined by turning the outer race by hand. Replace the bearings if they have roughness.

Be sure the shaft is free from nicks, burrs and foreign particles that might damage the mechanical seal. Scratches on the shaft in seal area will provide leakage paths under the mechanical seal. Use a fine emery cloth to remove scratches or sharp edges.

ASSEMBLY

Standard Mechanical Seal
(Synthetic Rubber Bellows Type)

READ CAREFULLY BEFORE REASSEMBLING PUMP

The seal used in this pump is simple to install and good performance will result if care is taken during installation. The principle of a mechanical seal is contact between the rotary and stationary members. These parts are lapped to a high finish and their sealing effectiveness depends on complete contact.

Prior to installing the rotary portion of the mechanical seal, prepare and organize the rotor shaft, head and idler assemblies and appropriate gaskets for quick assembly.

Once the rotary portion of the mechanical seal is installed on the rotor shaft, it is necessary to assemble the parts as quickly as possible to insure the seal does not stick to the shaft in the wrong axial position. The seat will stick to the shaft after several minutes setting time.

Never touch the sealing faces with anything except clean hands or clean cloth. Minute particles can scratch the seal faces and cause leakage.

1. Coat the idler pin with non-detergent SAE 30 weight oil and place idler and bushing on idler pin in the head. If replacing a carbon graphite bushing, refer to **"Installation of Carbon Graphite Bushings,"** page 8.
2. Clean the rotor hub and casing seal housing bore. Make sure both are free from dirt and grit. Coat the outer diameter of seal seat and inner diameter of seal housing bore with non-detergent SAE 30 weight oil.
3. Start the seal seat in the seal housing bore. If force is necessary protect the seal face with a clean cardboard disc and gently tap it in place with a piece of wood. Be sure the seal seat is completely seated in the bore.
4. Place a tapered installation sleeve on the shaft, refer to **Figure 11.** The sleeve is furnished with GG, AS, AK and AL replacement mechanical seals. Coat the rotor shaft, tapered installation sleeve and inner diameter of the mechanical seal rotary member with a generous amount of non-detergent SAE 30 weight oil. Petrolatum may be used but grease is not recommended.
5. Place the seal spring on the shaft against the rotor hub. Refer to **Figure 12.**

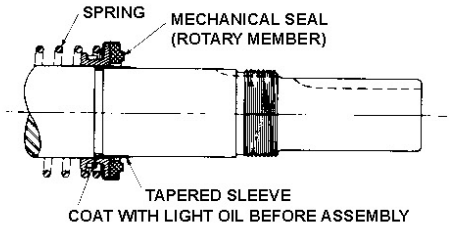


FIGURE 11

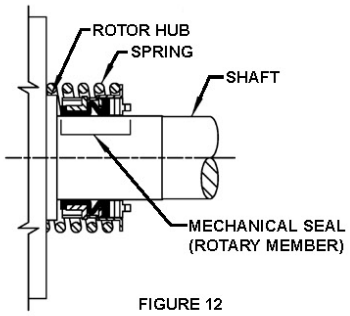


FIGURE 12

6. Slide the rotary member, lapped contact surface facing away from the spring, over installation sleeve on shaft until just contacting the spring. Do not compress the spring. Remove the installation sleeve.
7. Coat the rotor shaft with non-detergent SAE 30 weight oil. Install the rotor and shaft into the casing, slowly pushing until the ends of the rotor teeth are just below the face of the casing. Take care not to damage the seal seat.
8. Leave the rotor in this position. Withdrawal of the rotor and shaft may displace the carbon seal rotating face and result in damage to the seal.
9. Place the O-ring or gasket on the head and install the head and idler assembly on pump. The pump head and casing were marked before disassembly to insure proper reassembly. If not, be sure the idler pin, which is offset in the pump head, is positioned up and equal distance between port connections to allow for proper flow of liquid through the pump.
10. Tighten the head capscrews evenly.
11. If the pump was equipped with a relief valve and was removed during disassembly, install on the head with new O-Rings or gaskets. The relief valve adjusting screw cap must always point towards the suction port. Refer to **Figure 5,** page 3. For relief valve repair or adjustments, see **"Pressure Relief Valve Instructions,"** Page 9.
12. In 2005, the use of single seal bearings were phased out. Pumps now use "Sealed for Life" bearings that have seals on both sides. The new bearings can be installed either side first and do not need to be packed with grease. For older models with single seal bearings, pack the inner ball bearing with multi-purpose grease, NLGI #2.

GG, HJ, HL: Drive the bearing into the bore. Tap the inner race with a brass bar and lead hammer to position bearing. Install the inner snap ring.

AS, AK, AL: Install the bearing retainer washer over the shaft before installing the ball bearing. Install the ball bearing in the casing with sealed side towards head end of the pump. Drive the bearing into the bore. Tap the inner race with a brass bar and lead hammer to position the bearing.

13. **GG, HJ, HL:** Install the shaft snap ring in groove in the shaft. See **Figure 9**, page 6.

    AS, AK, AL: Install the bearing spacer over the shaft and against the single row ball bearing. See **Figure 10**, page 6.

14. Pack the lubrication chamber between the inner ball bearing and double row ball bearing in the thrust bearing assembly approximately one-half full of multi-purpose grease, NLGI #2. The thrust bearing assembly will take the remaining space. See **Figure 9 and 10**, page 6.

15. Pack the double row ball bearing with multi-purpose grease, NLGI #2.

    GG, HJ, HL: Install the ball bearing into the bearing housing with shield side toward the coupling end of the shaft. See **Figure 9**, page 6. Install the snap ring into bearing housing to retain ball bearing. This snap ring has a tapered edge to fit tapered groove in bearing housing. The tapered edge is located away from the ball bearing.

    AS, AK, AL: Install the ball bearing into the bearing housing. Install the lip seal in the bearing housing end cap. The lip should face towards the end of the shaft. Put the bearing spacer collar in the lip seal and install in the bearing housing and tighten the set screws securely. See **Figure 10**, page 6.

16. Insert a brass bar or piece of hardwood through the port opening between the rotor teeth to keep the shaft from turning.

17. Start the thrust bearing assembly into casing. Turn by hand until tight. This forces the rotor against the head. Replace and tighten the locknut or shaft.

18. Remove the brass bar or hardwood from port opening.

19. Adjust pump end clearance, refer to **"Thrust Bearing Adjustment"**.

DANGER !

Before starting pump, be sure all drive equipment guards are in place.

Failure to properly mount guards may result in serious injury or death.

THRUST BEARING ADJUSTMENT

See **Figures 9 and 10.**

Loosen the two screws in the face of the thrust bearing assembly.

If the shaft cannot be rotated freely, turn the thrust bearing assembly counterclockwise until the shaft can be turned easily.

To set end clearance:

1. While turning the rotor shaft, rotate the thrust bearing assembly clockwise until a noticeable drag occurs. This is zero end clearance.
2. Mark the position of the bearing housing with respect to the casing.
3. Rotate the thrust bearing assembly counterclockwise the distance listed below as measured on outside of bearing housing.
4. After the adjustment is made, tighten the two setscrews in the face of the bearing housing assembly to secure the position.

   For viscosities above 2500 SSU, add additional end clearance (0.004" for GG, HJ and HL size pumps and 0.005" for AS, AK and AL size pumps).

PUMP SIZE	DISTANCE IN INCHES ON O.D. OF BEARING HOUSING	STANDARD END CLEARANCE
GG	0.44" (7/16")	.003
HJ , HL	0.56" (9/16")	.003
AS , AK , AL	0.5" (1/2")	.003

INSTALLATION OF CARBON GRAPHITE BUSHINGS

When installing the carbon graphite bushings, extreme care must be taken to prevent breaking. Carbon graphite is a brittle material and is easily cracked. If cracked, the bushing will quickly disintegrate. Using a lubricant and adding a chamfer on the bushing and the mating part will help in installation. The additional precautions listed below must be followed for proper installation:

1. A press must be used for installation.
2. Be certain the bushing is started straight.
3. Do not stop pressing the operation until the bushing is in the proper position, as starting and stopping may result in a cracked bushing.
4. Check the bushing for cracks after installation.

PRESSURE RELIEF VALVE INSTRUCTIONS

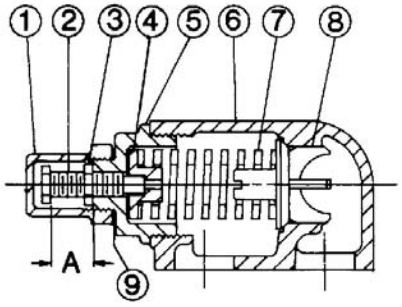


FIGURE 13
VALVE - GG, HJ and HL SIZES

VALVE - LIST OF PARTS			
1.	Valve Cap	6.	Valve Body
2.	Adjusting Screw	7.	Valve Spring
3.	Lock Nut	8.	Poppet
4.	Spring Guide	9.	Cap Gasket
5.	Bonnet		

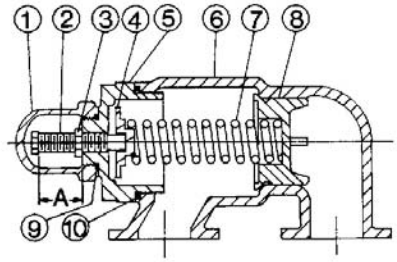


FIGURE 14
VALVE - AS, AK and AL SIZES

VALVE - LIST OF PARTS			
1.	Valve Cap	6.	Valve Body
2.	Adjusting Screw	7.	Valve Spring
3.	Lock Nut	8.	Poppet
4.	Spring Guide	9.	Cap Gasket
5.	Bonnet	10.	Bonnet O-Ring

DISASSEMBLY

DANGER !

Before opening any Viking pump liquid chamber (pumping chamber, reservoir, relief valve adjusting cap fitting, etc.) Be sure:

1. **That any pressure in the chamber has been completely vented through the suction or discharge lines or other appropriate openings or connections.**
2. **That the driving means (motor, turbine, engine, etc.) has been "locked out" or made non-operational so that it cannot be started while work is being done on pump.**
3. **That you know what liquid the pump has been handling and the precautions necessary to safely handle the liquid. Obtain a material safety data sheet (MSDS) for the liquid to be sure these precautions are understood.**

Failure to follow above listed precautionary measures may result in serious injury or death.

Mark the valve and head before disassembly to ensure proper reassembly.

1. Remove the valve cap.
2. Measure and record the length of extension of the adjusting screw. Refer to **"A"** on **Figures 13 and 14**.
3. Loosen the locknut and back out the adjusting screw until spring pressure is released.
4. Remove the bonnet, spring guide, spring and poppet from the valve body. Clean and inspect all parts for wear or damage and replace as necessary.

ASSEMBLY

Reverse the procedures outlined under **"Disassembly."** If the valve is removed for repairs, be sure to replace in the same position. The relief valve adjusting screw cap must always point towards suction side of the pump. If the pump rotation is reversed, remove the relief valve and turn end for end. Refer to **Figure 5**, page 3.

DANGER !

Before starting pump, be sure all drive equipment guards are in place.

Failure to properly mount guards may result in serious injury or death.

PRESSURE ADJUSTMENT

If a new spring is installed or if the pressure setting of the pressure relief valve is to be changed from that which the factory has set, the following instructions must be carefully followed.

1. Carefully remove the valve cap which covers the adjusting screw.

   Loosen the locknut which locks the adjusting screw so the pressure setting will not change during operation of the pump.
2. Install a pressure gauge in the discharge line for actual adjustment operation.
3. Turn the adjusting screw in to increase the pressure and out to decrease the pressure.
4. With discharge line closed at a point beyond pressure gauge, the gauge will show the maximum pressure the valve will allow while the pump is in operation.

IMPORTANT

When ordering parts for the pressure relief valve, always give the model number and serial number of the pump as it appears on the nameplate and the name of the part wanted. When ordering springs, be sure to give the pressure setting desired.

VIKING PUMP — IDEX CORPORATION

WARRANTY

Viking warrants all products manufactured by it to be free from defects in workmanship or material for a period of one (1) year from date of startup, provided that in no event shall this warranty extend more than eighteen (18) months from the date of shipment from Viking. If, during said warranty period, any products sold by Viking prove to be defective in workmanship or material under normal use and service, and if such products are returned to Viking's factory at Cedar Falls, Iowa, transportation charges prepaid, and if the products are found by Viking to be defective in workmanship or material, they will be replaced or repaired free of charge, FOB. Cedar Falls, Iowa.

Viking assumes no liability for consequential damages of any kind and the purchaser by acceptance of delivery assumes all liability for the consequences of the use or misuse of Viking products by the purchaser, his employees or others. Viking will assume no field expense for service or parts unless authorized by it in advance.

Equipment and accessories purchased by Viking from outside sources which are incorporated into any Viking product are warranted only to the extent of and by the original manufacturer's warranty or guarantee, if any.

THIS IS VIKING'S SOLE WARRANTY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, WHICH ARE HEREBY EXCLUDED, INCLUDING IN PARTICULAR ALL WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. No officer or employee of IDEX Corporation or Viking Pump, Inc. is authorized to alter this warranty.

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Fill-Rite Liquid Flow Meter

The Most Trusted name in Pumps & Meters FILL-RITE.

Series 800C Meter



Model 807C Pump Shown

Description of Included Models

Model Number	Description
806C	Basic Meter with Strainer & Fittings with 1" Inlet & Outlet
807C	Basic Meter with 3/4" Inlet & Outlet
807C-1	Basic Meter with 1" Inlet & Outlet
KIT 807CMK	Basic 807C Meter with Pipe Fittings to Add Meter to Models 112, 122, FR152, FR162, 1210B, FR610 and FR700

Safety Listings

Approval Mark	Organization Description	File Number	Guide Number
c UL us	**Underwriters Laboratories Inc**., a nationally recognized independent organization for testing of products to ensure public safety. Recognized and accepted in USA,Canada and other countries	MH8290	PLRZ

Available Options

Option	Description
L	Liter Registration in Place of Standard Gallon Measure
N	Nickel Plating on Fluid Handling Components
Q	Basic Meter with EPDM Seals
T	Teflon Coating on Fluid Handling Components

Accessories

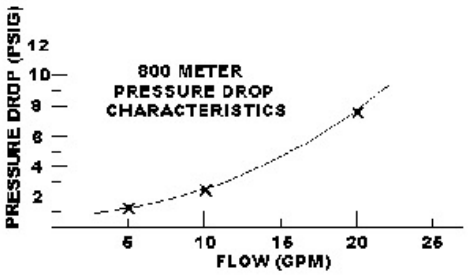
Part Number	Description
TH18T	Strainer Kit for Mounting Series 800C Meter on an Overhead Tank
TH18T	Teflon Coated Strainer Kit for Mounting Series 800C Meter on an Overhead Tank

Performance

Recommended Flow Range	5 to 20 GPM (19 to 76 LPM)
Rated Accuracy	±1%
Maximum Pressure	50 PSIG
Meter Digit Indication	Up to 99.9 Gallons or 999.9 Liters (Resettable)
Totalizer Digit Indication	Up to 99,999.9 Gallons or Liters (Non-Resettable)

Pressure Drop Curve

A. This curve represents the expected pressure loss through the **Model 800 Meter** as a function of flow. Any pump used in the system must supply not only the pressure required to move the fluid, but also that required to overcome the pressure drop through the meter.



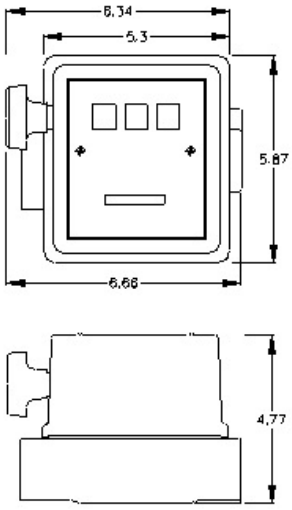
Fluid Compatibility

The 800C series meters are compatible with the following fluids:
Diesel Fuel, Gasoline, Kerosene, Mineral Spirits, Heptane and Hexane.
The 800C Series meters are NOT compatible with the following fluids:
Bleach, Hydrochloric Acid, Ink, Motor Oil and Salt Water.

If in doubt about the compatibility of a specific fluid, contact the supplier of the fluid to check for any adverse reactions to the following wetted materials.

PPS	**300S Stainless Steel 400S Stainless Steel** All
Aluminum	806C, 806CL, 806CI, 807C, 807CL, 807CI, 807C-1, 807CL-1, 807CI-1
Aluminum, Nickel Plated	807CN , 807CN-1, 807CNL
Aluminum, Teflon Coated	806CT, 806CTL, 807CT, 807CT-1, 807CTL-1
Viton	806C, 806CT, 806CL, 806CTL, 806CI, 807C, 807CN, 807CT, 807CL, 807C-1, 807CN-1, 807CT-1, 807CL-1, 807CNL-1, 807CTL-1, 807CI-1
Buna N	806C, 806CL, 806CI, 807C, 807CL, 807C-1, 807CL-1, 807CI-1
EPDM	806CQ, 807CQ
Cast Iron	806C, 806CT, 806CL, 806CLT, 806CI

Dimensions



Repair

To insure the ultimate performance, pumps must be set up according to the "INSTALLATION" section of the Owner's Manual packed with the pump and available below in the **eLibrary**..

Meters requiring repair should be taken to an authorized repair shop for service. Meters MUST be thoroughly triple-rinsed before being taken in, or shipped, for repair.

Maintenance

Meters are designed to operate maintenance free. Certain liquids can dry out while in the meter housing, preventing the meter from operating properly when next used. If this happens, the meter should be thoroughly cleaned by running a flushing fluid through the meter in the normal direction of fluid flow, without disassembly. If fluid cannot be "forced" through the meter with 50 PSIG fluid pressure and thus freed, the meter must be disassembled and thoroughly cleaned. Refer to the instructions in the ASSEMBLY/DISASSEMBLY section of the Parts and Technical Service Guide that was packed with your meter or is available below in the **eLibrary.**

Frequently Asked Questions

1.When I went to use my meter for the first time this year it was stuck. What can I do?

Although your meter is designed to require little or no maintenance, the residual material left when a fluid dries in the meter can jam the close tolerance disc within the chamber. See the procedure recommended for cleaning the meter above and in the Guide packed with the meter. Generally a thorough cleaning will restore the meter to full operation.

2. Can I use this meter to sell kerosene from my tank?

This meter mechanism is capable of high accuracy, typically 0.5%, if operated under steady flow rate and calibrated at that rate. This capability however does not meet the requirements of the Weights and Measures Departments in most states and they therefore will not approve this meter for use for the resale of liquids like kerosene.

See the Troubleshooting Guide in your Owner's Manual packed with your unit or the copy available in the eLibrary.

3. What do you mean by a "positive displacement meter?

A positive displacement meter allows a VERY specific volume of fluid to move through the meter with every rotation of the mechanism. Conversely if the mechanism of a positive displacement meter is held, there should be no flow through the meter. That VERY specific volume is determined by the designed size of the meter chamber and allows the rotating meter shaft to be tied to a counter which indicates the count of rotations as the volume of fluid passing through the meter. By varying the gear ratio tying the chamber to the counter, the same chamber can be used for different units of measure, like gallons and liters.

4. How can I be sure my meter is operating properly?

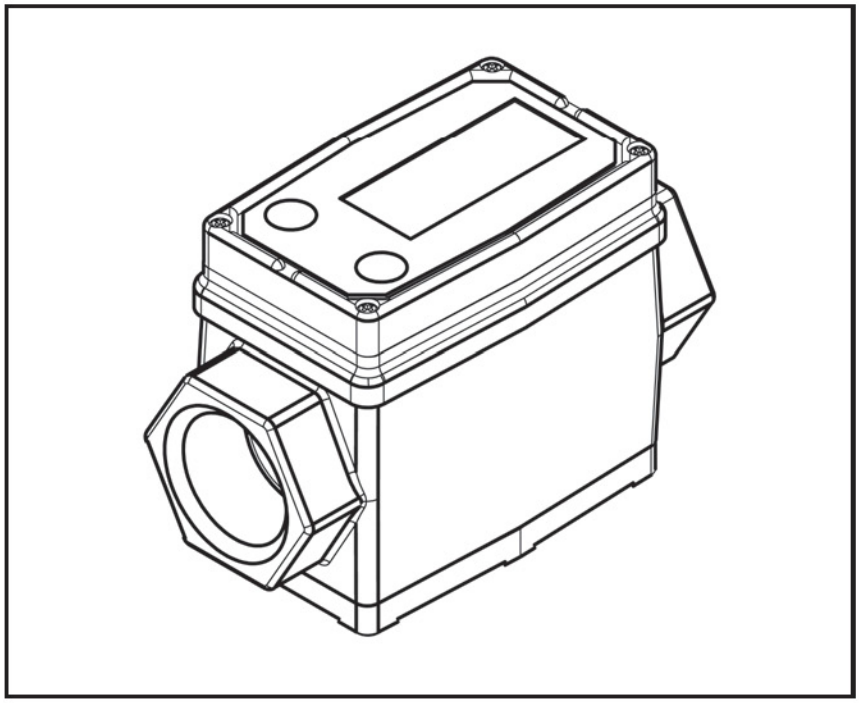
After zeroing the meter, fill a container of known volume and compare the indicated volume to the measured volume. As simple as this method seems it is used universally as the absolute calibration means by all requiring accurate meter indication. A container used for this type calibration is described as a "proving can" and the use of a proving can. In the case of the 800 meter, a five gallon proving can or larger is recommended and generally can be obtained from the dealer where your meter was purchased.

5. What limits the flow capacity of this meter?

The forced flow of fluid through the meter results in a pressure differential measured across the meter, and the higher the flow through the meter, the higher that pressure drop across the meter. While the increase in pressure drop is close to linear with the increase of flow over a considerable range, that linearity is lost at the upper flow levels because of the physical size of the chamber and the ports into and out of the chamber. The upper limit where that linearity is lost is normally taken as the upper flow limit of allowed operation. In the case of the 800C that flow level is 20 GPM.

Flow Sensor GPI Remote Electronics

Industrial Grade
09 COMPUTER ELECTRONICS
Owner's Manual



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04/10 Rev. E 920709-05

To the owner . .

Congratulations on receiving your GPI Industrial Grade Computer Electronics. We are pleased to provide you with a product designed to give you maximum reliability and efficiency.

Our business is the design, manufacture, and marketing of liquid handling, agricultural, and recreational products. We succeed because we provide customers with innovative, reliable, safe, timely, and competitively-priced products. We pride ourselves in conducting our business with integrity and professionalism.

We are proud to provide you with a quality product and the support you need to obtain years of safe, dependable service.



President
Great Plains Industries, Inc.

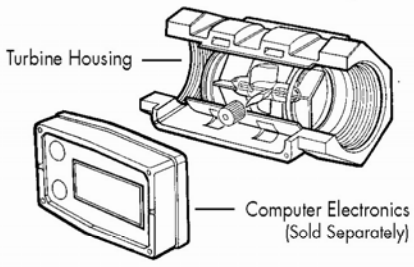
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GENERAL INFORMATION

This manual will assist you in operating and maintaining the Computer Electronics of the GPI Industrial Grade Meters. (See Figure 1) Calibration details are given in this manual. Information on turbine housings and accessory modules are contained in other manuals. Please reference those as necessary.

Figure 1



Before Getting Started

Take the time to fully acquaint yourself with all information about the components of your GPI Electronic Digital Meter. If you need assistance, contact the distributor from whom you purchased your computer.

This symbol is used throughout the manual to call your attention to safety messages.

⚠ WARNING **Warnings** alert you to the potential for personal injury.

⚠ CAUTION **Cautions** call your attention to practices or procedures which may damage your equipment.

Notes give information that can improve efficiency of operations.

It is your responsibility to make sure that all operators have access to adequate instructions about safe operating and maintenance procedures.

Safety Instructions

For your safety, review the major warnings and cautions below before operating your equipment.

1. This equipment is approved to handle only fluids which are compatible with all wetted materials.

2. When measuring flammable liquids, observe precautions against fire or explosion.
3. When handling hazardous liquids, always follow the liquid manufacturer's safety precautions.
4. When working in hazardous environments, always exercise appropriate safety precautions.
5. For best results, always verify accuracy before use.

Product Description

These computer electronics are designed specifically for use on GPI Industrial Grade Turbine Housings. They are also designed to work with several accessory output modules.

The CMOS, microprocessor-based electronics have extremely low power requirements and data retention capabilities in both RAM and ROM. Information is clearly displayed on a large 6-digit LCD readout with two-point floating decimal for totals from .01 to 999,999. All operations are easily accessed with the two buttons on the front panel.

Liquid flows through the turbine housing causing an internal rotor to spin. As the rotor spins, an electrical signal is generated in the pickup coil. This pulse data is translated from the turbine into calibrated flow units shown on the computer's readout.

Upon receipt, examine your equipment for visible damage. The computer is a precision measuring instrument and should be handled as such. If any items appear damaged or missing, contact your distributor.

Make sure your computer model meets your specific needs. Refer to the Specifications Section to confirm required features. The model number of your computer is displayed on the lower front side of the computer and also underneath a battery.

INSTALLATION

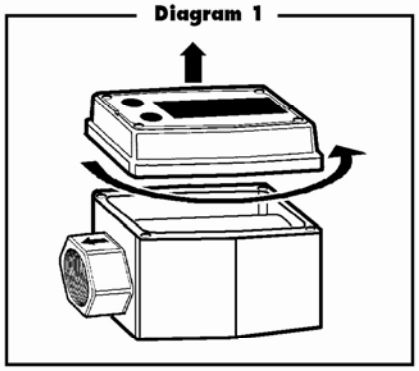
If you ordered your computer electronics with a turbine housing, it is installed at the factory.

If you ordered your computer separately from your turbine, simply mount the computer on the turbine with the four screws at the corners of the faceplate. Make sure the seal is fully seated before tightening the screws.

If you ordered the computer with turbine and an accessory module, please review and thoroughly understand all installation instructions before proceeding.

All GPI turbines are designed to measure flow in only one direction. The direction is indicated by the arrow cast-molded in the turbine outlet. If the computer display is upside down, remove the four screws, turn the display 180° and reinstall the screws. See Diagram 1.

Diagram 1



Avoid electronically "noisy" environments. Install at least 6 inches (15.2 cm) away from motors, relays, or transformers.

Our computer electronics are Factory Mutual Approved, C-UL Classified and carry a Class 1, Division 1 Approval for hazardous environments. In addition, GPI meters have NEMA Type 4 enclosures.

To ensure accurate measurement, remove all air from the system before use.

It is strongly recommended that accuracy be verified prior to use. To do this, remove all air from the system, measure an exact known volume into an accurate container, and verify the volume against the readout or recording equipment. If necessary, use a correction factor to figure final volume. For best results, accuracy should be verified periodically as part of a routine maintenance schedule.

OPERATION

Computer Display

All operations are reflected in the LCD readout. The large center digits indicate amounts, where smaller words or "icons" located above and below indicate specific information regarding totals, flow, calibration and units of measure.

Activate the Meter

Computer is on continuously and always ready to perform. The computer is powered by field replaceable batteries. When display becomes dim, faded or the low battery message appears (see below), the batteries need to be replaced. Reference the Maintenance Section for details.



Batch and Cumulative Totals

The computer maintains two totals. The Cumulative Total provides continuous measurement and cannot be manually reset. The Batch Total can be reset to measure flow during a single use. The Cumulative Total is labeled with TOTAL 1, Batch Total is labeled TOTAL 2 BATCH.

When the Cumulative Total reaches a display reading of 999,999 the computer will highlight an X10 icon. This indicates to the operator that a zero must be added to the 6 digits shown. When the next rollover occurs, the computer will highlight an X100 icon. This indicates to the operator that two zeroes must be added to the 6 digits shown.

Press the DISPLAY button briefly to switch between the TOTAL 1, TOTAL 2 BATCH and FLOWRATE. Press DISPLAY briefly to display the TOTAL 2 BATCH. Hold the DISPLAY button for 3 seconds to reset the Batch Total to zero.

When fluid is flowing through the meter, a small propeller icon is highlighted.

NOTE: Totalization counts total units without differentiating between gallons, litres or field calibrated units.

Flowrate Feature (some models)

To use this feature, press and release DISPLAY until FLOWRATE icon appears. The factory set time base will be highlighted to the right of FLOWRATE (M = minutes, H = hours, D = days). When FLOWRATE is invoked, the display will be indicating rate of flow.

Factory and Field Calibration

All calibration information is visible to the user as icons on the top line of the display, above the numeric digits.

All units are configured with a "factory" calibration. Both gallons and litres are available ("GL" or "LT" will be displayed). While holding the CALIBRATE button, briefly press DISPLAY to toggle between gallons and litres. This factory calibration (indicated with FAC) is permanently programmed into the computer and is not user adjustable.

NOTE: Your computer may have other units of measure programmed into it. If so, holding the CALIBRATE button and momentarily pressing the DISPLAY button will toggle through all factory set units. Other possible units are: IGL (imperial gallon), QT (quart), CF (cubic feet), CM (cubic meter), BL (42 gal. barrel), CC (cubic centimeter) or OZ (ounce).

Switching between different units will not corrupt the Total's contents. For example, in GL mode, the computer totalizes 10.00 gallons, if the user switches to LT mode, the display will read 37.85 litres (the same volume, different unit).

The "field" calibration may be set by the user, and can be changed or modified at any time using the calibration procedure described in the Calibration Section. Totals or flowrate derived from the field calibration are invoked when the FAC icon is no longer visible on the top line of the display.

CALIBRATION

Verify Accuracy Before Beginning Field Calibration

For the most accurate results, dispense at a flowrate which best simulates your actual operating conditions. Avoid "dribbling" more fluid or repeatedly starting and stopping the flow. This can result in less accurate calibrations.

Make sure you meet the meter's minimum flowrate requirements:

1/2 inch meter	1 GPM (3.8 LPM)
3/4 inch meter	2 GPM (7.6 LPM)
1 inch meter	5 GPM (18.9 LPM)
1-1/2 inch meter	10 GPM (37.9 LPM)
2 inch meter	20 GPM (75.7 LPM)

The use of a uniformly dependable, accurate calibration container is recommended for the most accurate results. For best results, the meter should be installed and purged of air before field calibration.

Due to high flowrate on the 2 inch meter, it is strongly recommended that Field Calibration be completed with a combination of volume and weight determined with fine resolution scales.

Field Calibration Necessity

Field Calibration and Factory Calibration are defined in the Operation Section. Factory calibration settings are programmed into each computer during manufacturing, using stoddard test solvent at 70° F (21° C) for low flow and 1-inch meters and water at 70° F (21° C) for 2-inch meters. Settings are correct for light liquids such as water, gasoline or diesel. Readings using the Factory Calibration (FAC) may not be accurate in some situations, for example, "heavy" liquids such as motor oil, under extreme temperature conditions, non-standard plumbing configurations or with fluids other than mentioned above.

For improved accuracy under such conditions, the computer allows for "field" calibration, that is, user entry of custom calibration parameters. A "single point" calibration may yield acceptable accuracy when used in a non-standard application.

Field Calibration Procedures (Correction Factor Method)

1. To calibrate, press and hold the CALIBRATE and DISPLAY buttons for about 3 seconds until you see FLdCAL. Release both buttons and you will see CF - 00.0. You are now in the field calibration mode and values from -99.9% to +99.9% can be entered.
2. The +/– position appears either as an "underscore" character for plus, or as a "hyphen" character for minus. The DISPLAY button selects the position and the CALIBRATE button toggles this character.
3. The DISPLAY button can then be pushed to select the numeric positions. Press the CALIBRATE button to scroll from 0 to 9. Enter the percentage of change you want the display to correct. When satisfied with the value, press both CALIBRATE and DISPLAY buttons simultaneously. CALEnd will be displayed and unit will go back to normal operation, less the FAC (factory calibration) icon.
4. All enabled units-of-measure remain visible and selectable – the entered correction will be applied to all enabled units.
5. To return to factory calibration (FAC), press and hold both CALIBRATE and DISPLAY buttons for about 3 seconds until FAcCAL is displayed. Then release buttons. Unit should return to normal operation and FAC icon is visible.

USER CONFIGURATION

The "09" series GPI display has been programmed with many new features, most of which can be enabled by the end user by way of a configuration process. By disabling "unnecessary" features, day-to-day flowmeter operation can be greatly simplified, making the unit easier to use. There are several features that GPI disables by default when shipping standard meters. (For example, K-Factor Entry Field Calibration, described below.) For more advanced users, it may be desirable to enable ALL possible features. User configurable features include:

- Totalizers/Modes Enabled (Cumulative Total, Batch 2 Total, Flowrate Mode)
- Flowrate Timebase (Units per Minutes, Hours and Days)

- Factory Calibration Curve Units Enabled (Gallons, Imperial Gallons, Litres, Quarts, Ounces, Cubic Feet, Cubic Centimeters, Cubic Meters or Barrels (42 gal.)
- Dispense/Display or K-Factor Entry Calibration

Changing Configuration Settings

Access to the configuration process is restricted for security until a "password" is entered. Contact your distributor or GPI to get the password and instructions to unlock and reset configuration settings. This information is also available on the GPI Web site. Configurations are entered and stored as six-digit "codes" where each digit represents a setting for one of the configuration options. New configuration settings are stored in the computer's long-term memory and will not be lost either in OFF mode or during battery change.

K-Factor Entry Field Calibration

Presently all GPI computers are programmed with three different field calibration methods, only one of which is active, the "correction/factor" calibration procedure described above. It is possible to activate "K-Factor entry" or "dispense/display" field calibration by changing configuration settings. Contact your distributor or GPI to get the correct password, configuration code, and instructions for this calibration method. This information is also available on the GPI Web site.

MAINTENANCE

The computer electronics is powered by lithium batteries. Removing the batteries before storing the meter will extend battery life. If the meter's readout should become dim, blank or the low battery message appears (see below), the batteries should be replaced. Replacement batteries can be ordered from your distributor or the factory. See details in the Parts Section.



When batteries are disconnected or fail, the Batch and Cumulative Totals will maintain the value they had. Factory and Field Calibration Curves are retained in the meter's computer when power is lost.

It is strongly recommended that battery check and terminal cleaning be a part of a routine maintenance schedule. Battery terminals should be cleaned annually. Batteries can be replaced without removing the meter from the piping system.

Replace Batteries

1. Remove the corner screws from the meter face and lift the computer electronics from the turbine.
2. Remove the batteries.
3. Check the battery terminals and remove any corrosion.
4. Install the new batteries and make sure the positive posts are positioned correctly. When the batteries are installed correctly, the computer powers on automatically and the readout displays information.
5. Make sure the seal is fully seated before placing the computer electronics on the turbine. Tighten the four screws.
6. Do not clean exterior of computer assembly with Isopropyl Alcohol.

TROUBLESHOOTING

Symptom	Probable Cause	Corrective Action
Meter is not accurate	1. Field Calibration not performed properly	Field calibrate again or select Factory Calibration.
	2. Factory Calibration not suitable for liquid being measured	Perform a Field Calibration according to Calibration Section.
	3. Meter operated below minimum flowrate	Increase flowrate.
	4. Meter partially clogged with dried liquid	Remove meter. Clean carefully. Make sure rotor spins freely.
	5. Turbine bearings partially clogged with dried liquid	Remove meter. Clean carefully. Make sure rotor spins freely.
	6. Sealant material wrapped around rotor	Remove meter. Make sure rotor spins freely.
	7. Installed too close to fittings	Install correctly.
	8. Installed too close to motors or electrically "noisy" environment	Install correctly.
Readout faded or blank	1. Batteries weak, dead, or not connected	Remove computer, check and replace batteries if necessary.
	2. Computer defective	Contact the factory.
Normal flowrate but meter does not count	1. Field Calibration not performed correctly	Field Calibrate again or select Factory Calibration.
	2. Rotor stuck or damaged	Remove meter. Make sure rotor spins freely.
	3. Sealant material wrapped around rotor	Remove meter. Make sure rotor spins freely.
	4. Computer defective	Contact the factory.
Reduced flowrate and meter does not count	1. Meter clogged with dried liquids	Remove meter. Clean carefully. Make sure rotor spins freely.
	2. Below minimum flowrate	Increase flow.
Cannot get meter into field calibration	1. Wrong button sequence	Proceed with calibration according to the Calibration Section.
	2. Computer circuit board defective	Replace computer. Contact the factory.
	3. Button defective	Replace computer. Contact the factory.

SPECIFICATIONS

Standard Features Include:

- 2 Totalizing Registers
- 1 Factory Calibration Curve
- 1 Field Calibration Curve
- Rate of Flow Feature
- Flowrate Time Base in Minutes

Input Pulse Rate:

Minimum Pulse In:	DC
Minimum Coil Input:	10 Hz
Maximum Raw:	1,000 Hz

K-Factor:

Minimum:	.01 pulses/unit
Maximum:	> 999,999 pulses/ unit

Field Calibration Correction:

Minimum:	-99.9%
Maximum:	+99.9%

Readout Totals:

Minimum Display:	0.01
Maximum Display:	999,999 (x100)

Temperatures:

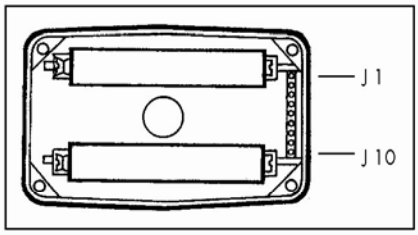
Operational:	+0° to +140° F (-18° to +60° C)
Storage:	-40° to +158° F (-40° to +70° C)

If wider operating temperature ranges are desired, reference information on GPI Remote Kits.

Power:

Internal Power Supply:	2 Lithium Batteries at 3 volts each
Battery Life:	5 years
Optional External Power Module:	7-30 VDC

Computer Electronics Terminal Connections



J-1 **Reset**
Programming interfaces. Not accessible to user.

J-2 **Pulse Signal Output**
This supplies a high-level amplified open collector signal. Output will withstand a maximum open-circuit voltage of 60 volts DC and a maximum closed-circuit of 100 mA.

J-4 **Pulse Signal Input**
Requires a sine or square wave with open-circuit voltage of 3-30 volts P-P, a maximum rise/fall rate of 0.01 V/μ second and a maximum frequency of 750 Hz.

J-5 **Power Input**
When used with Ground (J1-6), this has reverse polarity protection, but no on-board voltage regulation. Supplied voltage may be 5 volts to 10 volts DC.

J-6 **Ground**

J-7, 8, 9, 10 Programming interfaces. Not accessible to user.

NOTE: Safety approvals are void if any external connections are made to computer electronics.

PARTS

The factory, when provided with model number and serial number, can replace your entire Computer Electronics Assembly.

Order replacement kits, parts, and accessories with the part numbers given here.

Part No.	Description
113520-1	Battery Replacement Kit
901002-52	O-Ring
116000-1	Large (5 gal.) Calibration Container

SERVICE

For warranty consideration, parts, or other service information, please contact your local distributor. If you need further assistance, call the GPI Customer Service Department in Wichita, Kansas, during normal business hours.

1-888-996-3837

To obtain prompt, efficient service, always be prepared with the following information:

1. The model number of your computer electronics.
2. The serial number or manufacturing date code of your computer electronics.
3. Specific information about part numbers and descriptions.

For warranty work always be prepared with your original sales slip or other evidence of purchase date.

Returning Parts

Please contact the factory before returning any parts. It may be possible to diagnose the trouble and identify needed parts in a telephone call. GPI can also inform you of any special handling requirements you will need to follow covering the transportation and handling of equipment which has been used to transfer hazardous or flammable liquids.

⚠ CAUTION

Do not return computer electronics or meters without specific authority from the GPI Customer Service Department. Due to strict regulations governing transportation, handling, and disposal of hazardous or flammable liquids, GPI will not accept computer electronics or meters for rework unless they are completely free of liquid residue.

⚠ CAUTION

Meters not flushed before shipment can be refused and returned to the sender.

WEEE DIRECTIVE



The Waste Electrical and Electronic Equipment (WEEE) directive (2002/96/EC) was approved by the European Parliament and the Council of the European Union in 2003. This symbol indicates that this product contains electrical and electronic equipment that may include batteries, printed circuit boards, liquid crystal displays or other components that may be subject to local disposal regulations at your location. Please understand those regulations and dispose of this product in a responsible manner.

Copy the information located on the Turbine housing.
This information will be required by Customer Service.

Model No: _____

Serial No: _____

MFD: _____

Distributor Name: _____

Distributor Phone Number: _____

Declaration of Conformity

Manufacturer's Name:	Great Plains Industries, Inc.
Manufacturer's Address:	5252 East 36th Street North Wichita, KS USA 67220-3205

Declares, that the product:

Product Name:	Electronic Digital Meter
Model Numbers:	03***** A1********** A2********** G2*********

Model numbers include all combinations of an alpha-numeric series as illustrated above.

Conform to the following Standards:

EMC:	EN 50081-1 (Reference EN 55022) EN 50082-1
Energy - Limited Apparatus:	EN 50021
I.P. Code:	BS EN 60529

Supplementary Information:

"The products comply with the requirements of the EMC Directive 89/336/EEC and the ATEX Directive 94/9/EC (ANNEX VIII)."

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

Signature:	
Full Name:	Mr. Grant Nutter
Position:	President Great Plains Industries, Inc.
Place:	Wichita, KS USA May 2003

Limited Warranty Policy

Great Plains Industries, Inc. 5252 E. 36th Street North, Wichita, KS USA 67220-3205, hereby provides a limited warranty against defects in material and workmanship on all products manufactured by Great Plains Industries, Inc. This product includes a 1 year warranty. Manufacturer's sole obligation under the foregoing warranties will be limited to either, at Manufacturer's option, replacing or repairing defective Goods (subject to limitations hereinafter provided) or refunding the purchase price for such Goods theretofore paid by the Buyer, and Buyer's exclusive remedy for breach of any such warranties will be enforcement of such obligations of Manufacturer. The warranty shall extend to the purchaser of this product and to any person to whom such product is transferred during the warranty period.

The warranty period shall begin on the date of manufacture or on the date of purchase with an original sales receipt. This warranty shall not apply if:

A. the product has been altered or modified outside the warrantor's duly appointed representative;
B. the product has been subjected to neglect, misuse, abuse or damage or has been installed or operated other than in accordance with the manufacturer's operating instructions.

To make a claim against this warranty, contact the GPI Customer Service Department at 316-686-7361 or 888-996-3837. Or by mail at:

Great Plains Industries, Inc.
5252 E. 36th St. North
Wichita, KS, USA 67220-3205

The company shall, notify the customer to either send the product, transportation prepaid, to the company at its office in Wichita, Kansas, or to a duly authorized service center. The company shall perform all obligations imposed on it by the terms of this warranty within 60 days of receipt of the defective product.

GREAT PLAINS INDUSTRIES, INC., EXCLUDES LIABILITY UNDER THIS WARRANTY FOR DIRECT, INDIRECT, INCIDENTAL AND CONSEQUENTIAL DAMAGES INCURRED IN THE USE OR LOSS OF USE OF THE PRODUCT WARRANTED HEREUNDER.

The company herewith expressly disclaims any warranty of merchantability or fitness for any particular purpose other than for which it was designed.

This warranty gives you specific rights and you may also have other rights which vary from U.S. state to U.S. state.

Note: In compliance with MAGNUSON MOSS CONSUMER WARRANTY ACT – Part 702 (governs the resale availability of the warranty terms).

FM APPROVED

Factory Mutual Approved
Intrinsically Safe for Class I, II, III, Division 1, All Groups.

CLASSIFIED c UL CE NEMA 4

5252 East 36th Street North
Wichita, KS USA 67220-3205
TEL: 316-686-7361
FAX: 316-686-6746

GREAT PLAINS INDUSTRIES, INC.
"A Great Plains Ventures Subsidiary"
www.gpimeters.net
1-888-996-3837

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04/10 Rev. E 920709-05

Hose reel Assembly



Some of the features of our hose reel include an adjustable retraction rate. This is convenient for retracting the hose at the same rate that you are filling the bore hole. By using the depth meter, you know exactly where you are in the bore hole. The meter is scalable for use with various units of measure. Pressure piping from the product pump to the hose reel is generally 2 or 3”, and the discharge hose generally ranges from 1” to 2.5”.

Hose Reel Components

Fluid path of the material being delivered, the mechanical drive components of the hose reel, the boom extend cylinder and the hydraulic controls for the hose reel.

Fluid Path

The pressure hose runs from the pressure pump to the swivel fitting, which allows the hose reel to turn while product is being conveyed. The axle of the hose reel drum is a pipe, allowing the material to flow to the hose. The hose reel hose (or down the hole hose) goes into the bore hole.

The function of the hose reel fluid path is to convey material from the product pump to the bore hole. The important thing to remember regarding the hose reel fluid path is to always maintain a smooth transition for each coupling point.

For fluid path safety, make sure that everyone is clear of the truck when operating the hydraulic controls. This is true for all the components we will discuss. It is imperative to know where everyone is relative to the equipment being operated.

To be safe always check on top of the truck, all around the truck, and pay particular attention to any moving parts like pumps, motors, booms, hoses, hydraulic cylinders, etc. We cannot over emphasize safety.



Always Remember all clear before operating

There are some items in the hose reel fluid path components that will need some maintenance. Use good judgment when inspecting the condition of parts and components. In the hose reel fluid path you should check the hose reel hose for leaks or chaffing. Cracking may occur and ultraviolet rays from the sun will also deteriorate the hoses. Check all the clamps, which hold the hoses in place. Make sure they are tight and in good repair. Look for any leaks or signs of previous leaks. Pay close attention to the swivel fitting. The swivel fitting works with ball bearings and packing. As the packing wears, a leakage may occur. There are rebuild or re-packing kits available for the hose reel swivels. You will also need to apply grease to the hose reel swivel. It has a grease or zerk fitting located on the side of the swivel.

Fluid Path Daily Inspection and Maintenance

- **Hose reel hose for leaks or chaffing**
- **Hose clamps tight**





TREAD CORPORATION

Fluid Path Troubleshooting

- Check hose connection.
- Check inner lining of hose
- Check for damaged hose
- If you have a blockage, follow the unclogging procedure.





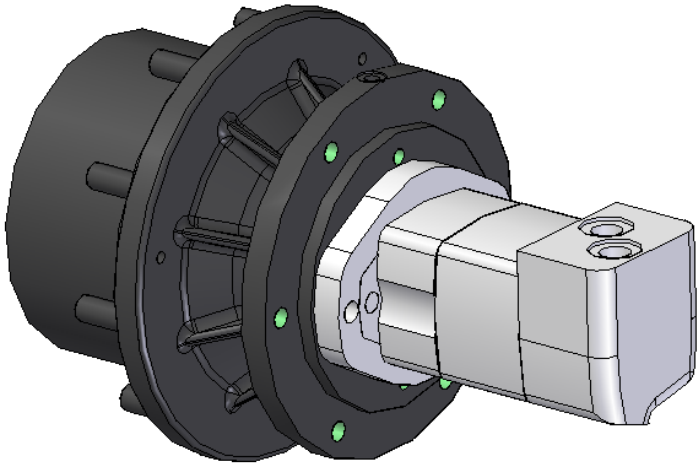


TREAD CORPORATION

Drive Components



The hydraulic motor, torque hub, hose reel drum and the pillow block bearings make up the drive components. The functions of the drive components are to rotate the hose reel drum. It is hydraulically driven and goes in one of two directions, either up or down. The speed of the rotation of the drum is metered, to allow for precise retrieval of the hose from the bore hole. Make sure the reel is clear, as well as the hose reel hose path. Always make sure your work area is clear and safe before operating any equipment.

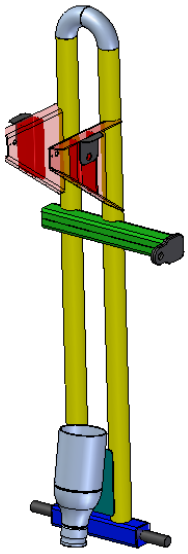


Maintenance of the drive components should include:
Check the drive component conditions. Check for any leaks in the hydraulic motor, hoses, and fittings.

If the hose reel drum will not go up or down, you might want to check the key in the hydraulic motor, to make sure it hasn't been sheared.

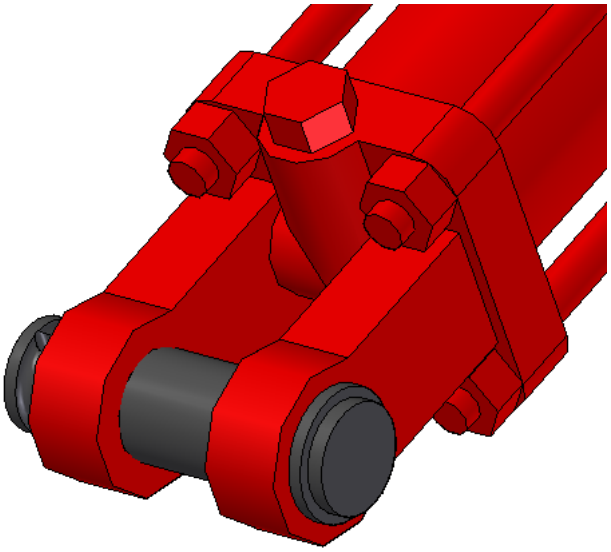
Boom Extend Cylinder





The boom jack cylinder is hydraulically driven, either in or out and the pulley and yolk assembly.

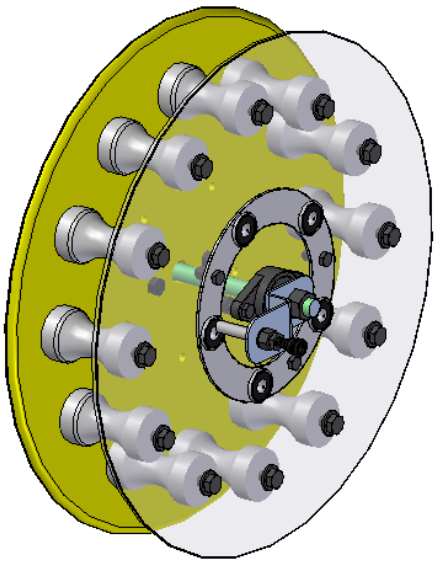






The pulley and yolk assembly is on the front of the boom, and extends with the boom.



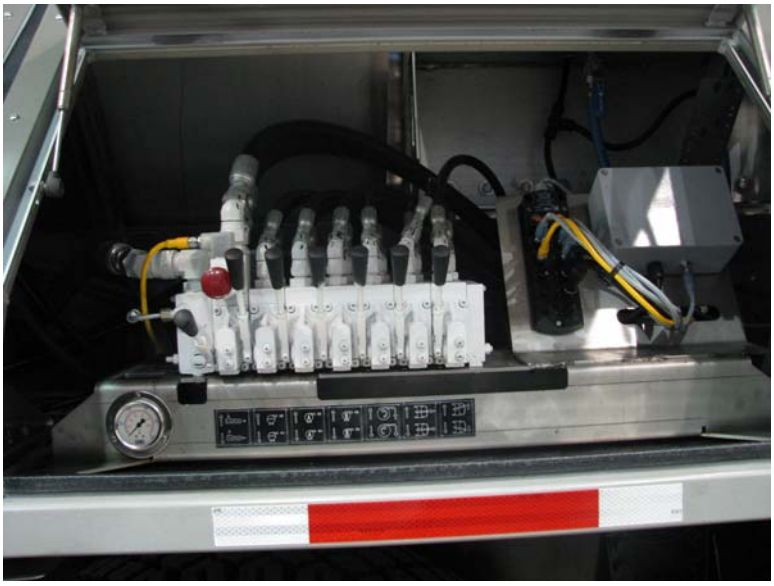


Check for all obstructions. Remember to lock the boom when finished using the hose reel boom.

Inspection and maintenance of the hose reel should include:

Check the boom cylinder for hydraulic leaks. Check the pulley center bolts for tightness. Check the conditions of the clevis pins and the hitch pins that hold the clevis pins in place.

Hose reel Hydraulic Control Components:



Hydraulic hoses, hydraulic tubing, directional control valves, relief valves, motors and cylinders are all part of the hose reel hydraulics. The hydraulic controls operate the product pump, which pumps the material through the fluid path. It also operates the hose reel components like, the drum up and down, the speed of the drum, the boom left and right, and the boom in and out.

Operation of the components is dependant on the controls system specified by the customer. To operate the components manually you either push the control handle in or out for the desired function. On the hydraulic controls, you have two way valves. They can be detented, which means they will stay in that position or they can be spring returned, which means they will spring to the neutral position.

To adjust the speed of the hose reel up and down at the metered rate, you rotate the handle on the flow control. The flow control is used to control or meter the flow on hydraulic fluid, thus determining the speed. Clockwise will close the flow, or decrease the flow, and counterclockwise will open, or increase the flow.

Hydraulic control safety includes the same practices we discussed earlier. Make sure all is clear before operating hydraulic controls. Check on top and all around the truck. Make sure all components can move freely and unobstructed. Always monitor your hydraulic pressure. If it exceeds 3000 psi, there is a problem with the pressures being too high. You need to stop and troubleshoot the hydraulic system.

Inspection of the hydraulic controls should include:
Checking the hydraulic oil level and condition. The proper level is half way up the sight gauge. Check all hoses and fittings for leaks and wear. Check the valves for any leaks. Lubricate the valve handles. Troubleshooting the hydraulic controls should include making sure the PTO is properly engaged. If the PTO is engaged, make sure the

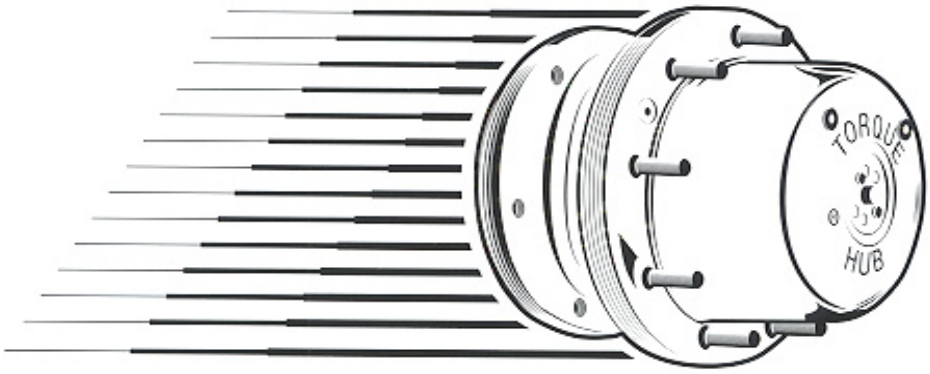
hydraulic valve handles either depress or pull the spool on the valve section. Make sure the flow valves are turning when the handle is rotated.

Fairfield Reel Planetary Torque-Hub

Ratings and Performance Guide

FAIRFIELD

GEARED FOR EXCELLENCE



TORQUE-HUB®

PLANETARY FINAL DRIVES

About this Guide...

This guide to Fairfield Torque-Hub® Drive ratings and technical issues has been created to help you in selecting the proper Fairfield product for your application, as well as address the frequent questions that arise pertaining to available product options, features, and service issues. Our standard Torque-Hub® drives are available with maximum output torque ratings from 12,000 in-lbs up to 4,000,000 in-lbs, with ratios from 3:1 to more than 1,100:1.

The Fairfield approach to drive system applications center around the belief that thorough "front-end" application engineering practices, field testing and in-depth communication with our customers and their designers, will always provide the best drive system. Particular attention must be given to gear and bearing life. We also feel that it is extremely important that our customers know how we obtain our product ratings. Hopefully, the information in this guide will provide you with a better understanding of how we rate and apply our products to *fully* meet your drive needs.

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NOTE: This catalog was complete and correct at the time of printing for the specific Torque-Hub products designated at the time of its printing. However, Fairfield Manufacturing Co., Inc. reserves the right to update and improve its products at any time. All specifications are therefore subject to change without notice.

Torque-Hub® Product Lubrication Specification

General Properties

The lubricant used in all Torque-Hub® drives should be a petroleum based, non-detergent gear fluid containing antioxidation, antifoaming and extreme pressure additives. The lubricant should have a minimum viscosity index of 95 cst and maintain a minimum viscosity of 40 cst under normal operating temperature conditions.

The following table lists the recommended viscosities for various ambient operating temperatures. These recommendations are based on a temperature rise of 50 to 100° F at normal operating conditions.

Maintenance

Oil quantities for each series of Torque-Hub® drives are indicated in the appropriate series literature. An initial oil change should be made after the first 50 hours of operation.

Subsequent oil changes should be made at 1000 hour intervals or annually, whichever occurs first.

Oil temperature should be no higher than 160° to 180° for continuous operation, and no higher than 200° F for intermittent operation. For special applications, high horsepower, high speeds or wide temperature changes, please consult Fairfield Manufacturing.

Oil Fill Level

When the Torque-Hub® unit is mounted horizontally, the gearbox should be filled half-full of oil. Please consult the appropriate series literature for approximate fill volumes. Vertically mounted Torque-Hub® units may require special lubrication procedures. Please contact Fairfield Manufacturing for vertically mounted applications.

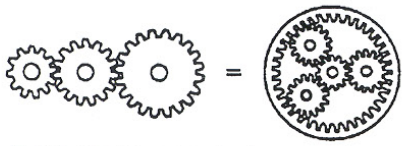
	Differential Planetaries		Simple Planetaries	
Ambient Temperature	ISO Index	AGMA Lubricant Number	ISO Index	AGMA Lubricant Number
-40° to -5° F(1)	VG100	3EP	VG100	3EP
-5° to 40° F	VG150	4EP	VG100	3EP
40° to 105° F	VG220/VG320	5EP/6EP	VG150/VG220	4EP/5EP
105° to 150° F(2)	VG460	7EP	VG320	6EP

Footnotes

1. For operation in this ambient temperature range a synthetic oil or multi-grade oil is recommended with a pour point of 10° F lower than the minimum ambient temperature.
2. For operation in this ambient temperature range a synthetic oil is recommended for proper lubricant life at elevated temperatures.

Gear Basics

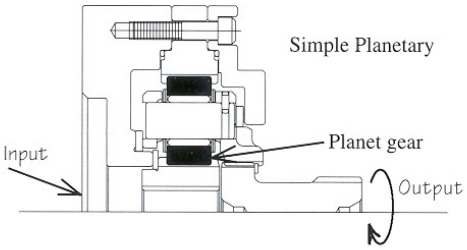
Gears come in many sizes and shapes. Their teeth may be straight or curved and run parallel or inclined to the axis of rotation. They are connected together in many different ways, usually within a housing, to transmit motion and torque. Even with all the different combinations possible, they all have common actions. If one gear rotates, it will move any gear meshed with it in the opposite direction. A difference in speed between two gears produces a change in the amount of torque transmitted.

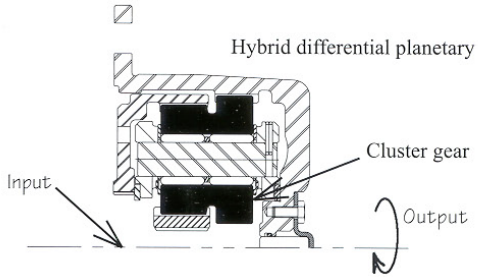


In-line gear set versus planetary gear set

The simplest spur gear set consists of two gears meshed together in the same plane (an in-line gear set). If both gears are the same size, they will rotate at the same speed and torque, but in opposite directions. When running gears in increasing sizes, the input torque is multiplied, reducing the speed. The output torque is proportionate to the combined ratios of all the gears in the gear set multiplied by the input torque. Torque-Hub® products use these basic principles in both the simple planetary and hybrid differential models.

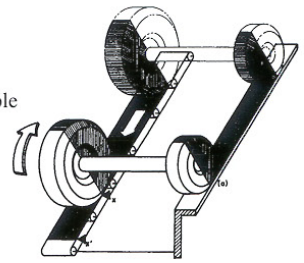
The **Simple Planetary Gear Set** is defined as a sun (input) gear, planet gears, positioned by a carrier, and a ring gear. Compared to an in-line gear set, a planetary gear set provides torque multiplication in a smaller, more compact mounting package. However, the maximum ratio attainable from a single, simple planetary stage is 7.5:1. By stacking, or coupling, more than one simple planetary gear set together inside one final drive, higher reduction ratios are achieved.





Fairfield's **Hybrid Differential Planetary Gear Set** consists of a sun (input) gear, three cluster (planet) gears and two internal (ring) gears. The dotted line in the diagram above shows how torque flows through the input gear driving the cluster gears. The cluster gears, then, react off a fixed ring gear, causing output torque to flow to a second ring gear. The unique feature of our hybrid differential planetary is the clustered planet gear. Each clustered planet gear consists of two gears with different diameters clustered together on the same shaft. This allows higher ratios in a shorter package when compared to simple planetary gear sets. The example below illustrates the mechanics of differential gear sets.

Cluster gear example



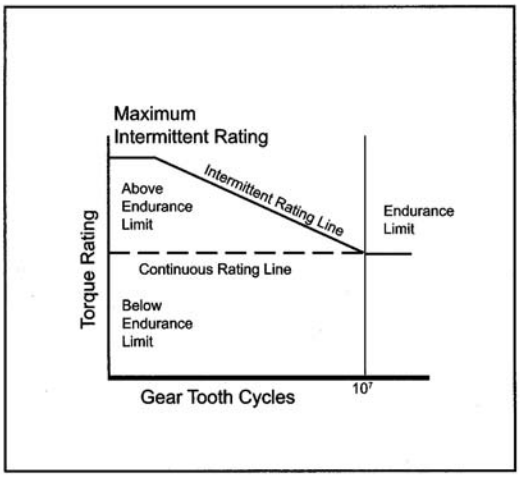
In this example, two wheels of different diameters are connected. They represent the cluster gear. The smaller wheel is on a fixed track, while the larger wheel is on a movable track. The movable track represents the ring gear which drives the output member (hub). The fixed track represents the internal gear, which is the reaction member. After half a revolution, the movable track slides back a distance equal to one-half the difference in the circumferences of the two wheels. Differential gear sets differ from simple planetaries because the ratio is acheived in a differential gear set by the difference in circumference between the large gear and the small gear on the planetary cluster.

Definition of ratings

Continuous Rating - The continuous rating of a Torque-Hub® product is based upon the endurance limit of the gear material and heat treatment selected for the gears. By definition, the endurance limit means that Torque-Hub® products operated at or below the continuous torque output rating should not experience gear tooth breakage. Torque-Hub® product life will then be determined by bearing and seal wear, structural stresses or thermodynamic considerations.

Intermittent Rating - Operation of the Torque-Hub® product above the continuous rating will result in gear tooth bending stresses above the endurance limit. Therefore, gear tooth breakage will occur in a finite number of cycles. Please reference the Sn curve, shown below, for a visual explanation.

Sn curve



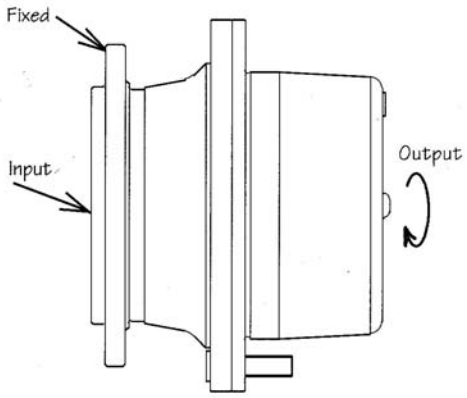
The maximum intermittent torque ratings listed for Torque-Hub® products represent structural limits for safe operation. Gear stresses at this level are still below the yield point for the material. Spindle shafts, hubs, and bolted connections have been designed to operate at their endurance value at the maximum intermittent torque rating.

Peak Rating - The peak rating for a Torque-Hub® product is the maximum, one-time torsional load the Torque-Hub® unit can be subjected to without failure. However, this rating should be considered as a worst case or shock load only, and should not be considered as a part of the normal duty cycle.

Horsepower Capacity - High horsepower applications are defined as applications requiring continuous high speed and high torque. The horsepower capacity of each Torque-Hub® drive is based on thermodynamic capacity of the unit and the heat dissipation characteristics of its installation. The location of a Torque-Hub® drive in your installation greatly effects the steady state temperature value of that unit. For example, if a Torque-Hub® drive is located inside a drum or other closed cavity, then the resulting internal temperature will be higher than a Torque-Hub® unit located on an open wheel because of the lack of air flowing over the unit.
In general, mobile applications experience a wide range of horsepower levels throughout a normal duty cycle. This is true of non-drawbar type vehicles such as spray tractors, combines, lift trucks, etc. Average horsepower throughout the duty cycle for these types of machines is usually acceptable if the unit is properly sized for torque and speed.

In contrast, drawbar type vehicles and industrial type applications often see long periods of continuous duty. This can result in higher continuous horsepower levels than normally experienced in mobile applications. In this case, the horsepower requirement by itself may dictate the size of the Torque-Hub® unit, rather than the torque output requirement. Forced cooling may be necessary to meet the thermal dissipation requirements of the gearbox in severe applications. Please contact a Fairfield representative for horsepower guidelines and suggestions when applying Torque-Hub® drives in high horsepower applications.

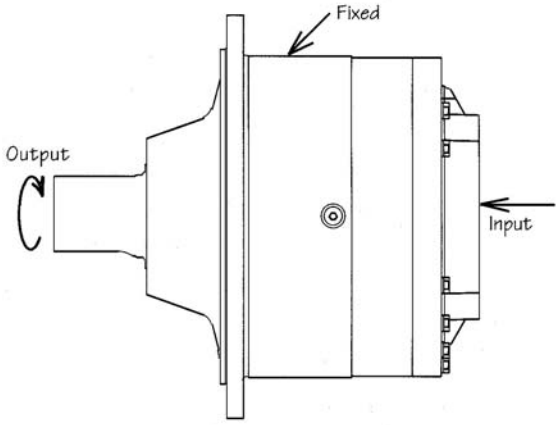
Product Configurations and Applications



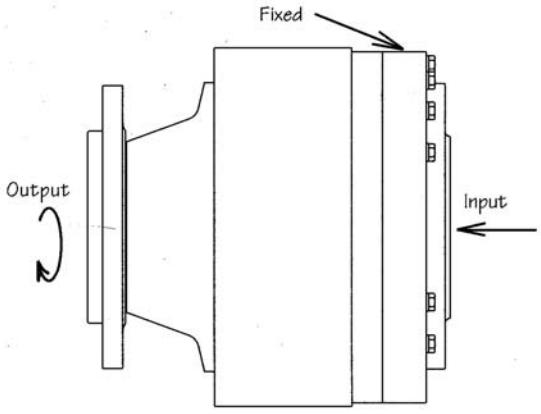
Wheel Drive Output

Torque-Hub® Wheel Drives are proven performers in many types of off-road, mobile vehicles and equipment. In these applications, wheel drives are often used to propel pneumatic tires, tracks or rollers. They have also found a variety of uses in other industries such as on-road equipment, where Torque-Hub® units are applied in street sweepers and buses. In industrial and marine applications, wheel drives are used to power winches and hoists.

Torque-Hub® Shaft Output Drives can be applied to industrial applications such as conveyors, mixers, and augers. Shaft output Torque-Hub® units also meet power requirements for mobile equipment such as swing drives on access platforms, cranes, elevators and logging equipment. Our largest Torque-Hub® unit, the S200A shaft output, has a continuous rating of more than two million inch- pounds. It is used to raise and lower the legs of marine jack-up boats.



Shaft Output



Spindle Output

For applications requiring flange mounts, **Torque-Hub® Spindle Output Drives** offer design flexibilty to meet your size restrictions. Spindle output units are used to power small lift trucks, mowers and scissor lifts. Any vehicle with small diameter drive wheels is a perfect candidate for spindle output Torque-Hub® unit.

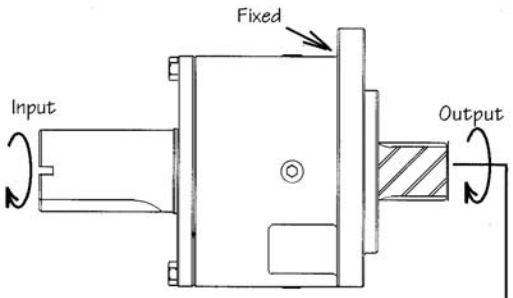
Product Information Chart

Series	Outputs Available	Ratios Available (x:1)	Planetary Type	Continuous Torque Rating (in-lbs x 1,000)	Intermittent Torque Rating (in-lbs x 1,000)	Max. Speed (x 1,000 rpm)
06	whd	3-222	Simple	6	12	5
07	whd,sho,spo	4,12	Simple	7.5	15	5
1	sho	3-6	Simple	15	30	5
1	whd,sho,spo	18-68	Differential	15	30	4
MW1	whd	15-68	Differential	15	30	4
2	whd,sho,spo	13-49	Differential	25	50	4
MW3	whd	10-110	Simple	30	60	5
3	whd,sho,spo	18-54	Differential	37.5	75	4
4	whd	12-37	Simple	40	80	5.5
6	sho	4-6	Simple	60	120	3
6	whd, sho, spo	13-42	Simple	60	120	5
7	whd,sho,spo	26-94	Differential	75	150	3
9T	whd	35	Simple-2 Speed	90	250	3.75
10	whd,sho,spo	43-123	Differential	125	250	2
11	whd	46,57	Compound	110	220	4
12	whd,sho,spo	20-40	Simple	125	250	4
12T	whd	20,29,40	Simple-2 Speed	125	250	3.75
16	whd,sho,spo	20-40	Simple	160	320	4
16T	whd	20,29,40	Simple-2 Speed	160	320	3.75
20	whd,sho,spo	26-115	Differential	250	500	2
25	whd,sho,spo	19-25	Simple	200	400	3
50	whd,sho,spo	18-40	Simple	500	1,000	3
90	whd,spo	25	Simple	1,200	2,000	2
200	sho	1176	Hybrid	2,000	c/f	2
T2A	sho	3.46-4.09	Simple	6	c/f	4
G07	sho	3.6	Simple	6	c/f	4
IA15	sho	1	Input Adapter	15	c/f	3.6
RA7	sho	1	Straight Bevel	3.7	c/f	3.4
RA708	sho	1.53	Straight Bevel	1.2	c/f	3.4
RA10	sho	2.78	Straight Bevel	3.7	c/f	3.4

Series	Outputs Available	Ratios Available (x:1)	Planetary Type	Continuous Torque Rating (Nm x 1000)	Intermittent Torque Rating (Nm x 1000)	Max. Speed (x1000 rpm)
CW12	whd	18-51	Simple	6	12	units with
CW18	whd	26-51	Simple	9	18	brake - 5
CT18	whd	63-136	Simple	9	18	
CT26	whd	51-202	Simple	13	26	units without
CT35	whd	63-136	Simple	17.5	35	brake - 6
CT45	whd	63-136	Simple	22.5	45	

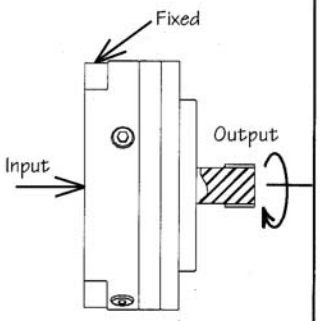
Key
whd = wheel hub drive
sho = shaft output
spo = spindle output
c/f = contact Fairfield

Input Adapters



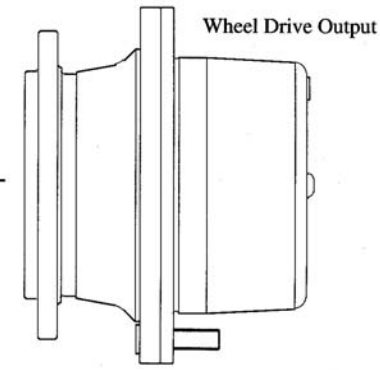
Inline Adapter

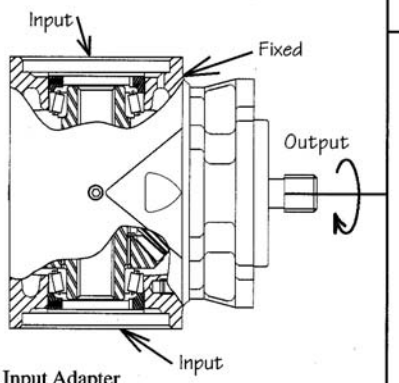
The **Inline Adapter** series is the simplest of the input adapters. The straight keyed input shaft makes it possible for virtually any rotating member, such as PTO shaft inputs or pulleys, to drive the Torque-Hub®. Its large common shaft is supported in a rugged housing by two heavy duty bearings. This allows for large multiple row belts and larger centerline offsets than most comercially available overhung load adapters.



G07

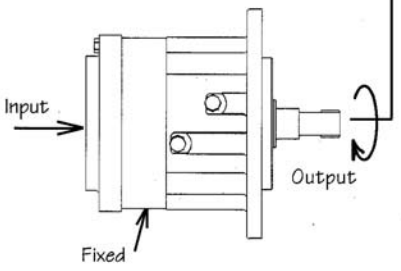
The **G07** "gearhead" increases the input torque by 3.6 and reduces the output speed by the same ratio. This makes it possible to increase the reduction of an existing machine or add reduction for a new design, while still using a standard Torque-Hub®. Its oil is shared with the primary Torque-Hub® model, but may be accessed from the G07 housing.





Right-Angle Input Adapter

The **Right-Angle** series makes it possible to drive a Torque-Hub® from 90° to its centerline. This keeps the overall length shorter than an inline drive. The dual inputs on either side of the housing make it possible to use multiple drives or add a brake. Ports are available for speed sensors. The RA oil may be shared with the primary Torque-Hub® or sealed from it.



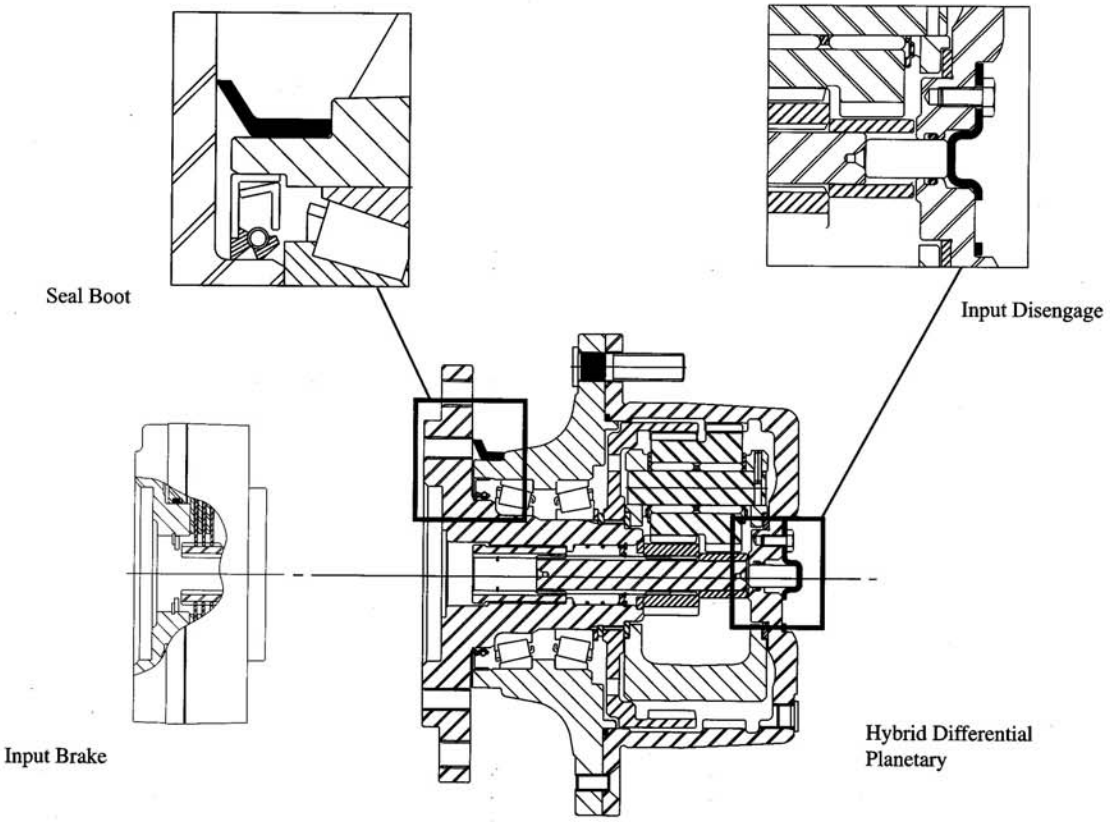
T2A

The **Two Speed** (T2A) series can make any Torque-Hub® a two speed transmission. The ratio range is 1:1 and 3.56 or 4.09:1. The T2A is shifted by hydraulic or pneumatic pressure. Ratio changes are acheived by a patented Fairfield shifter which is unique because it can shift while moving but not under load. This is a very economical way to create a two speed axle.

Options

The **Seal Boot** is a supplementary seal that helps protect the main oil seal from dirt and debris encountered in the operating environment, thus extending the life of your equipment. The seal is lubricated by injecting grease through a Zerk fitting (not provided) on the motor mount

The **Input Disengage** feature is standard on most Torque-Hub® wheel drives. When the disengagement cap is removed and reversed, the Torque-Hub® gear package is disconnected from the motor so that the machine may be towed. Towing speeds, however, cannot exceed the maximum speed rating for the unit (Please reference product information chart for maximum speed information).



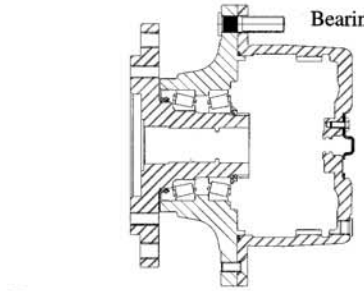
Input Brakes are available for almost every Torque-Hub® product. They come in two basic styles, a bolt-on extra like the "pancake" brake, shown above, or as a fully integrated brake like the CT/CW series. These brakes are to be used as parking brakes only. Dynamic braking is not allowed under normal operating conditions. Please consult our applications engineering personnel for further information.

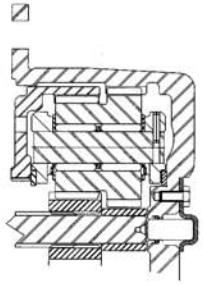
Dynamic (service) brakes can be applied to Torque-Hub® products in the form of some wet types of pancake brakes, disc/caliper brakes and by conventional drum brakes on certain Torque-Hub® models. Ask your Fairfield representative for ideas and information about adding dynamic braking to your Torque-Hub® application.

Kits

A **Bearing Support Kit** usually contains all the non-drive parts of a Torque-Hub® unit. They are very useful where load support is needed, but no drive is required. They contain standard Torque-Hub® parts which are manufactured in large quantities. This makes our bearing support kit more economical than custom-made parts.

Where space or design limitations preclude the use of a Torque-Hub® unit, a **Gear Kit** allows the designer to retain the torque and ratio capabilities of the Torque-Hub® product while meeting other design criteria. The standard gear kit contains a ring gear, carrier package, input gear, input coupling and shaft, and a cover. Many combinations exist to meet your specific torque and speed requirements.


Bearing Support Kit


Gear Kit

Torque-Hub® Mobile Application Warranty Policy

Fairfield Manufacturing Company, Inc., warrants all products manufactured to be free from defects in material and workmanship, for a period of (12) months from the date of product is put into service, or (18) months from date of shipment from our factory, whichever comes first.

Fairfield Manufacturing Company, Inc., may elect to repair or replace, at its discretion, any product that it deems defective, based on inspection and examination of the returned goods.

This warranty is in lieu of all other warranties, either implied or expressed, and all other obligations or liabilities, including damages resulting directly or indirectly due to said defects. Fairfield Manufacturing Company, Inc., neither assumes nor authorizes any person or company to assume liability on the company's behalf, in connection with the sale of our products.

This warranty does not cover any labor charges for replacement of parts, adjustments, repairs, or any other work done in connection with the use of Fairfield products.

This warranty does not apply to any product which has been repaired or altered by a source other than Fairfield Manufacturing Company, Inc., in such a way, that in our judgement, affects the products stability or proper operational characteristics. In addition, this warranty does not apply to products, found by Fairfield, to be have been subjected to misuse, negligence, or accidental damages. In addition, this warranty does not apply to the application of products manufactured by Fairfield Manufacturing Co., Inc.

TORQUE-HUB®

Ratings and Performance Guide

Date: _____

FAIRFIELD
GEARED FOR EXCELLENCE
U.S. 52 South
P.O. Box 7940
Lafayette, IN 47903-7940
Telephone: **(765) 474-3474**
automated: (765) 474-3128
FAX: **(765) 474-2153** or
FAX: (765) 477-7342

Company _____
Address _____
_____
_____
Telephone _____
Fax _____
Contacts(s) _____

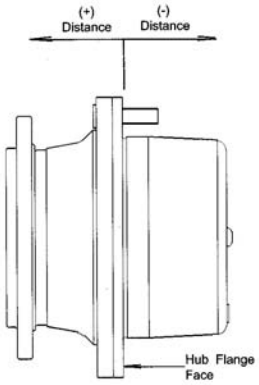
TORQUE-HUB®
Wheel Drive
Application
Worksheet
FAX TO: APPLICATION
ENGINEERING

Form F100

Machine Data

Type of Vehicle _____
Torque Hub Function _____
Indicate Brake Requirement (Type, Make/Model) _____
Brake Torque Requirement _____ **(in-lbs)** **Release Pressure** _____ **(psi)**

Engine Horsepower _____ **@** _____ **RPM**
Gross Vehicle Weight (lbs) _____ **(empty)** _____ **(loaded)**
Number of Wheels _____
Number of Driven Wheels _____
Weight Distribution **Front** _____ **Rear** _____ **(lbs)**
Loaded Rolling Radius **Front** _____ **Rear** _____ **(inches)**
Number of Hydraulic Pumps & Disp. _____ **(in³/rev)**
Hydraulic Pump Speed _____ **(rpm)**
Hydraulic Motor Displacement (Min/Max.) _____ **(in³/rev)**
Charge Pressure _____ **(psi)**
Continuous Operating Pressure _____ **(psi)**
Maximum Relief Valve Setting _____ **(psi)**
Distance from Hub Flange to Tire Center Line _____ **(inches)**
Ratio _____



Performance Data

Maximum Output Torque Required _____ **(in-lbs)**
Maximum Tractive Effort Required _____ **(rpm)**
Maximum Gradeability _____ **(%)**
Max/Min Vehicle Speed _____ **(mph)**
Draw Bar Pull _____ **(lbf)**
Estimated Machine Use per Year _____ **(hours)**
Desired Design Life _____ **(hours)**
Estimated Annual Production _____ **(units)**

Typical Operating Conditions

Condition #	Output Torque (in-lbs)	Radial Load (lbs)	Output Speed (rpm)	% of Cycle
1				
2				
3				
4				
5				
6				

Form F100

Please Attach any Drawings, Sketches, Comments, etc.
For other Application Worksheets, Please Contact Fairfield Manufacturing

Revised 6/98

FAIRFIELD
GEARED FOR EXCELLENCE

11

Hose Concord Yellow Jacket

Boston Concord Yellow Jack Hose
Check up to five results to perform an action.



larger image

- Oil and heat resistant tube is ideal for compressor, Bull line and manifold service.
- High tensile steel wire reinforcement handles high pressure and the crushing, pulling and kinking found on the toughest applications.
- The bright yellow cover is continuously branded and resists cutting, abrasion, oil and weathering.
- Stocked in 50 foot lengths.

Results 1 - 9 of 9 1

Item Name	Application	Tube	Cover	Reinforcement	Color	Nominal I.D.	Nominal I.D.	Nominal O.D.	Nominal O.D.	Braids	Length	Max. Working Pressure	Approx. Weight	Weight - Remark
Boston Concord Yellow Jack Hose	Used for high pressure air service in heavy construction, funneling, mining and other applications where abuse kills ordinary hose.	Oil and heat resistant tube	Bright yellow cover is continuously branded and resists cutting, abrasion, oil, and weathering.	High tensile steel wire reinforcement handles high pressure and the crushing, pulling and kinking found on the toughest applications.	Yellow	1/2 Inch	12.700 mm	15/16 Inch	23.813 mm	1 wire	50 ft.	1500 psi	40 lbs.	per 100 ft.
Boston Concord Yellow Jack Hose	Used for high pressure air service in heavy construction, funneling, mining and other applications where abuse kills ordinary hose.	Oil and heat resistant tube	Bright yellow cover is continuously branded and resists cutting, abrasion, oil, and weathering.	High tensile steel wire reinforcement handles high pressure and the crushing, pulling and kinking found on the toughest applications.	Yellow	3/4 Inch	19.050 mm	1 7/32 Inch	30.956 mm	1 wire	50 ft.	1200 psi	67 lbs.	per 100 ft.
Boston Concord Yellow Jack Hose	Used for high pressure air service in heavy construction, funneling, mining and other applications where abuse kills ordinary hose.	Oil and heat resistant tube	Bright yellow cover is continuously branded and resists cutting, abrasion, oil, and weathering.	High tensile steel wire reinforcement handles high pressure and the crushing, pulling and kinking found on the toughest applications.	Yellow	1 Inch	25.400 mm	1 1/2 Inch	38.100 mm	1 wire	50 ft.	1000 psi	85 lbs.	per 100 ft.
Boston Concord Yellow Jack Hose	Used for high pressure air service in heavy construction, funneling, mining and	Oil and heat resistant tube	Bright yellow cover is continuously branded and resists cutting, abrasion,	High tensile steel wire reinforcement handles high pressure and the crushing, pulling and kinking found on	Yellow	1-1/4 Inch	31.750 mm	1 13/16 Inch	46.038 mm	1 wire	50 ft.	650 psi	114 lbs.	per 100 ft.

	other applications where abuse kills ordinary hose.		oil, and weathering.	the toughest applications.										
Boston Concord Yellow Jack Hose	Used for high pressure air service in heavy construction, funneling, mining and other applications where abuse kills ordinary hose.	Oil and heat resistant tube	Bright yellow cover is continuously branded and resists cutting, abrasion, oil, and weathering.	High tensile steel wire reinforcement handles high pressure and the crushing, pulling and kinking found on the toughest applications.	Yellow	1-1/2 Inch	38.100 mm	2 1/32 Inch	54.769 mm	2 wire	50 ft.	500 psi	146 lbs.	per 100 ft.
Boston Concord Yellow Jack Hose	Used for high pressure air service in heavy construction, funneling, mining and other applications where abuse kills ordinary hose.	Oil and heat resistant tube	Bright yellow cover is continuously branded and resists cutting, abrasion, oil, and weathering.	High tensile steel wire reinforcement handles high pressure and the crushing, pulling and kinking found on the toughest applications.	Yellow	2 Inch	50.800 mm	2 23/32 Inch	69.056 mm	2 wire	50 ft.	500 psi	210 lbs.	per 100 ft.
Boston Concord Yellow Jack Hose	Used for high pressure air service in heavy construction, funneling, mining and other applications where abuse kills ordinary hose.	Oil and heat resistant tube	Bright yellow cover is continuously branded and resists cutting, abrasion, oil, and weathering.	High tensile steel wire reinforcement handles high pressure and the crushing, pulling and kinking found on the toughest applications.	Yellow	2-1/2 Inch	63.500 mm	3 7/32 Inch	81.756 mm	2 wire	50 ft.	400 psi	250 lbs.	per 100 ft.
Boston Concord Yellow Jack Hose	Used for high pressure air service in heavy construction, funneling, mining and other applications where abuse kills ordinary hose.	Oil and heat resistant tube	Bright yellow cover is continuously branded and resists cutting, abrasion, oil, and weathering.	High tensile steel wire reinforcement handles high pressure and the crushing, pulling and kinking found on the toughest applications.	Yellow	3 Inch	76.200 mm	3 25/32 Inch	96.044 mm	2 wire	50 ft.	400 psi	317 lbs.	per 100 ft.
Boston Concord Yellow Jack Hose	Used for high pressure air service in heavy construction, funneling, mining and other applications where abuse kills ordinary hose.	Oil and heat resistant tube	Bright yellow cover is continuously branded and resists cutting, abrasion, oil, and weathering.	High tensile steel wire reinforcement handles high pressure and the crushing, pulling and kinking found on the toughest applications.	Yellow	4 Inch	101.600 mm	5-1/8 Inch	130.175 mm	4 wire	50 ft.	400 psi	606 lbs.	per 100 ft.

Print Back

Hose Royalflex

EATON | Boston

Royalflex

Lightweight, Kink-resistant hardwall hose for suction and discharge service for petroleum products.

Like no other, Royalflex hose from Boston is a breed of it's own. This hose is different because it has no separate tube or cover, they are homogeneous. What this means is, along with it's extremely abrasion resistant Thermoplastic Vinyl Nitrile materials, this hose has no layers that could separate. In addition, this hose has more turns of helical wire per inch compared to traditional transfer hose, making it more crush and kink-resistant. With stocked lengths of 50', 60', 100', and 120', Boston has the right length to meet your needs and upon request can make it longer to meet your application needs.

Whether it be an Ag, Construction, Mining, Waste Hauling/ Treatment or Petroleum/Petrochemical application, Royalflex is made to meet the challenge!



Features

- Thermoplastic vinyl nitrile (H1196), Nitrile (H1193) homogeneous tube and cover
- More turns of helical wire per inch
- Higher working pressure
- Lightweight
- Long lengths
- Retains flexibility and vacuum characteristics from -20° to 180°F (-29° to 82°C)





Advantages

- Separation problems are virtually eliminated
- More crush and kink-resistant
- Up to 300 PSI applications depending on size
- Economical; eliminates couplings
- Handles a wide range of applications



BOSTON®

1193

Boston Royalflex
Heavy Duty Petroleum



PRODUCT NAME	NOMINAL I.D. (IN.)	(MM)	NOMINAL O.D. (IN.)	(MM)	APPROX WEIGHT W/O FITTINGS (LB/FT)	(KG/M)	MAXIMUM WORKING PRESS. (PSI)	(BAR)	MINIMUM BEND RADIUS (IN.)	(MM)	MTO MIN. ORDER QTY.	STANDARD LENGTH (FT)
H119324	1-1/2	38.1	2	50.8	.80	1.191	300	20.68	6	152	1,000	50
H119324-60												60
H119324-100												100
H119324-120												120
H119332	2	50.8	2-1/2	63.5	1.10	1.652	300	20.68	8	203	1,000	50
H119332-60												60
H119332-100												100
H119332-120												120
H119340	2-1/2	63.5	3	76.2	1.34	1.994	300	20.68	10	254	1,000	50
H119340-60												60
H119340-100												100
H119340-120												120
H119348	3	76.2	3-1/2	88.9	2.00	2.992	250	17.24	12	305	1,000	50
H119348-60												60
H119348-100												100
H119348-120												120
H119364	4	102.0	4-1/2	114.3	2.72	4.084	200	13.79	16	406	1,000	50
H119364-60												60
H119364-100												100
H119364-120												120

1196

Boston Royalflex
Suction and Discharge



PRODUCT NUMBER	NOMINAL I.D. (IN.)	(MM)	NOMINAL O.D. (IN.)	(MM)	APPROX. WEIGHT (LBS./FT.)	MAXIMUM WORKING PRESS. (PSI)	MINIMUM BEND RADIUS (IN.)	(MM)	STANDARD REELS (FT)
H119624	1-1/2	38.1	2	50.8	.81	300	6	152	50
H119624-60									60
H119624-100									100
H119624-120									120
H119632	2	50.8	2-1/2	63.5	1.09	300	8	203	50
H119632-60									60
H119632-100									100
H119632-120									120
H119640	2-1/2	63.5	3	76.2	1.32	300	10	254	50
H119640-60									60
H119640-100									100
H119640-120									120
H119648	3	76.2	3-1/2	88.9	1.94	250	12	305	50
H119648-60									60
H119648-100									100
H119648-120									120
H119664	4	102.0	4-1/2	115.9	2.72	200	16	406	50
H119664-60									60
H119664-100									100
H119664-120									120

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BOSTON®

EATON | Boston

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September 2004

Hydraulics





WARNING *** the surface of the hydraulic components can become very hot. The hydraulic oil tank has a "hot surface".

The objective of this section is to provide you with a working knowledge of our STANDARD bulk truck hydraulic system. By STANDARD, we mean the traditional gear pump hydraulic systems found on the majority of Tread bulk trucks.

Note - You may have a pressure compensated hydraulic pump powering your particular system.

In order to understand the hydraulic system, we will discuss the function of the individual components that make up the system. Operation of a particular truck will depend on the control system specified by the customer.

As we discuss each of the hydraulic system components, our focus will include the following points:

1. The operation of all controls

2. Safety considerations

3. Daily inspection and maintenance requirements

On-the-bench troubleshooting and repair

Two of the most frequently used words in the vocabulary of hydraulics are the terms PRESSURE and FLOW. It helps to understand just what these terms mean.

1. Pressure is a measure of the force that the hydraulic oil pushes with. Pressure is defined as force of hydraulic fluid per unit area and is usually measured in pounds per square inch, or PSI. This means the force in pounds that pushes on a one square inch area.

2. Flow is a measure of the volume of hydraulic fluid passing a point in a given amount of time.

Flow is defined as volume per unit time and is typically measured in gallons per minute, or GPM.

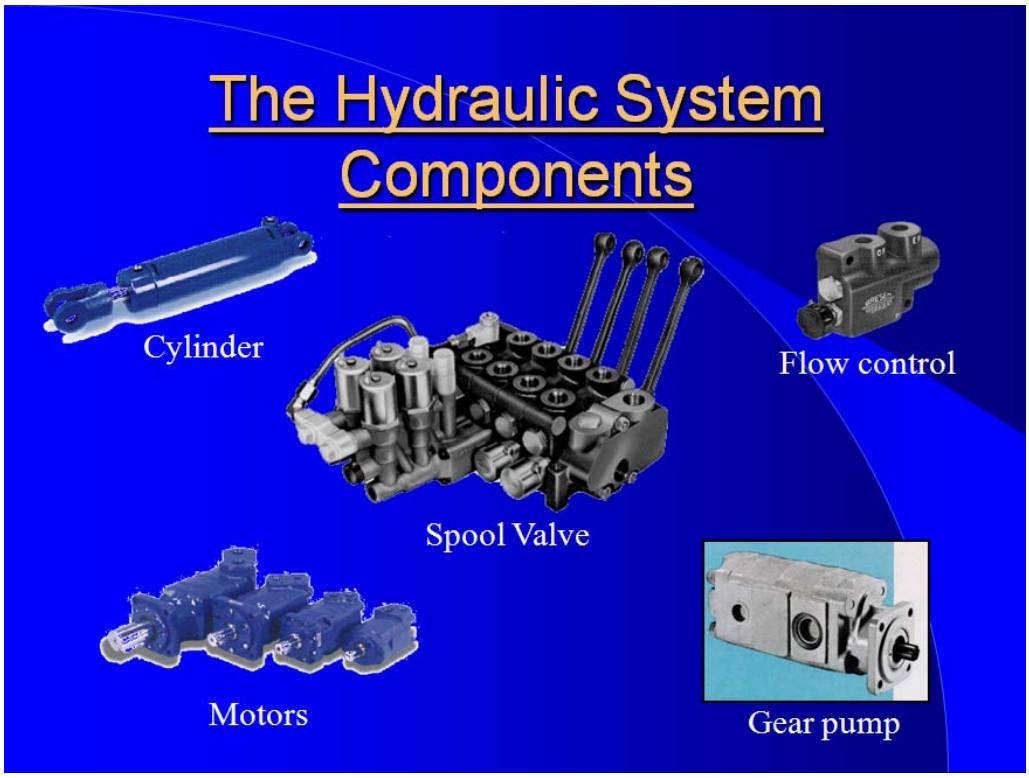
It is pressure that produces force, while it is flow that produces movement.

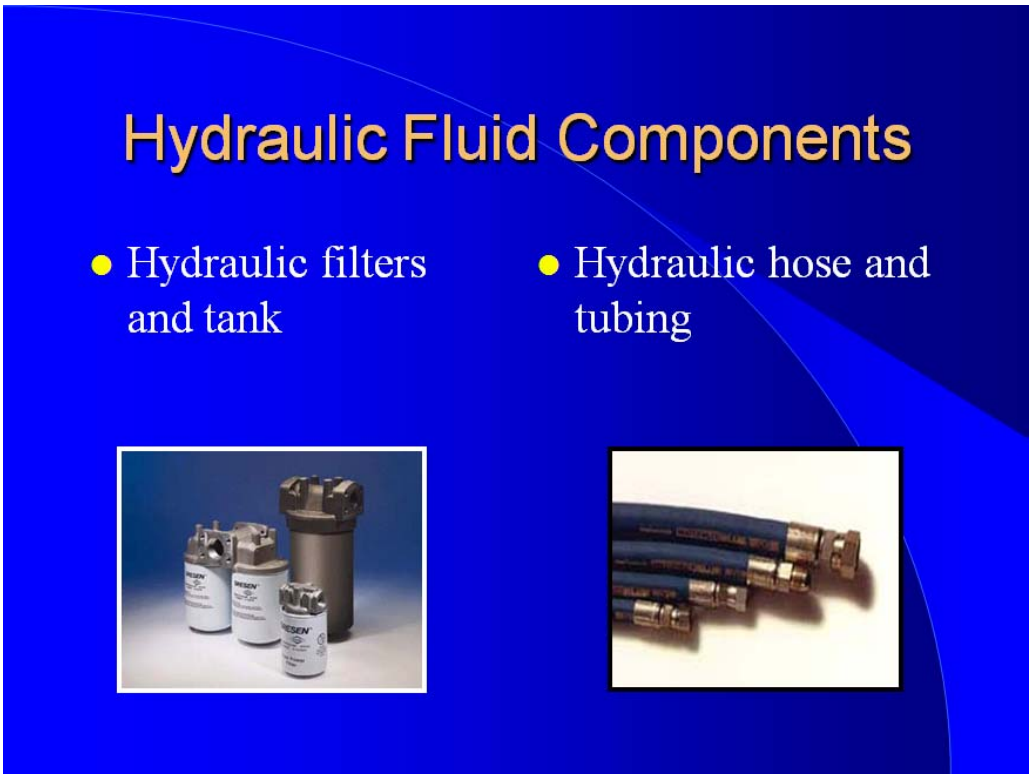
One of the first indications of an improperly functioning system will be the pressure reading of the console pressure gauges. For a normally operating system delivering material at the design rate (1000 lbs/min for overhead boom trucks and 1500 lbs/min for side boom trucks), the pressure reading should be about 1500 PSI for the bottom auger and 1700 PSI for the vertical or incline augers. Under the no-load condition (i.e. no material being conveyed but the augers engaged), the pressure readings should be about 1/2 of that when conveying material.

Flow information can only be determined with a flow meter installed in the hydraulic line. Standard Unibodies have a two-section pump that delivers 12 GPM and 8 GPM at approximately 1000 engine RPM.

The only way to adequately test a hydraulic system is from information about both the flow and pressure. Therefore, in order to obtain the data for a proper evaluation of the hydraulic system, it is necessary that a flow meter/pressure gauge test kit be used. The flow meter should be of the in-line variety and should read from about 1 GPM to 15 GPM. The pressure gauge should read 0 to 4000 PSI.

Hydraulic Fluid Components

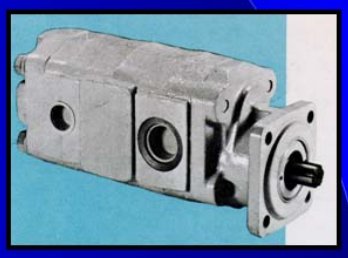




Hydraulic Pump and Power Source

- Power Take-off
- Hydraulic pump





Hydraulic Control Valves

- Flow control valves
- Directional control valves







Our review of the hydraulic system will begin with the components that produce and convey power.

1. The power take-off draws power from the engine.

2. The hydraulic pump converts engine power into hydraulic fluid pressure and flow.

3. The hydraulic tubing conveys hydraulic fluid through the system.

The hydraulic reservoir and filters store and condition the hydraulic fluid.

In order to understand how to operate the hydraulic system, we will need to pay particular attention to the components that control the hydraulic fluid.

1. Pressure control valves are used to limit the pressure of hydraulic fluid.

2. Flow control valves are used to control the flow of hydraulic fluid.

Directional control valves are used to start, stop, and control the direction of fluid flow.

Reservoir and Filters



Make certain that the replacement filter is equivalent to the original equipment. On all return line filters, the filter element is 30-micron size. These filters are found on the main hydraulic return lines at the hydraulic fluid reservoir.

Components

Tank of 40 to 60 gallon capacities, with suction strainer.
Return line filter.
Suction line valves.
Filler and breather cap.
Level and temperature gauge.

Function and Operation

Filters the oil.
Helps cool the oil.
Allows air bubbles to escape from the oil.
Supplies oil to make up for leaks.

Safety

Tank surfaces may be hot.

Inspection

Check fluid level daily.
Check fill cap secure daily.
Check valves open daily.

Maintenance

Replace filter when engine is serviced.
Replace fluid every two years.

Troubleshooting and Repair

Hydraulic oil temperature exceeds 150 °F.
Look for a problem in the hydraulic system.
Stop operation until repaired.

Hydraulic fluid

Hydraulic fluids serve three main functions:

1. Fluid under pressure provides the linear force to push, pull or rotate mechanical components. It is often referred to as the “working fluid”.

2. It lubricates the components of the hydraulic system, especially the bearings in pumps and motors.

3. It acts as a sealant by helping to prevent dirt from reaching mechanical components.

 CAUTION: HYDRAULIC OIL CAN REACH TEMPERATURES OF 180°F IN LESS THAN 30 MINUTES OF OPERATION. AT THIS TEMPERATURE, CONTACT WITH THE SKIN WILL EASILY CAUSE SECOND DEGREE BURNS. EXERCISE CAUTION WHEN WORKING AROUND HOT HYDRAULIC FLUID.

Hydraulic Fluid Selection

The efficiency of the system, the cost of maintenance and the service life of the components depend upon the selection of the proper hydraulic fluid. Hydraulic fluids are formulated to protect the hydraulic system against rust, wear, oxidation and foam.

Industrial grade anti-wear hydraulic oil is installed in the hydraulic reservoir at the factory. This oil is formulated to protect the hydraulic system against rust, wear, oxidation and foam. The hydraulic oil level should be checked daily at the pre-shift inspection and should be visible through the sight glass on the hydraulic reservoir.

Oil operating temperature is the main factor in determining the weight, or Viscosity Grade, of oil to use. The following chart shows ISO-VG to use for different oil temperatures. SAE grades are listed for reference.

Oil Temperature Range, °F	ISO VG	SAE Grade
35° - 120°	32	5
55° - 140°	46	10
75° - 160°	68	20
95° - 180°	100	30

Our standard hydraulic oil is VG-68 which is acceptable for the majority of conditions and oil temperatures experienced after normal system warm-up. For operation in extreme cold, it may be desirable to drain the reservoir and refill with the thinner VG-32 oil. However, it will likely be necessary to change back to VG-68 for summertime operation.

Although not recommended, multi-grade automotive engine oils can be used in the hydraulic system if hydraulic oil is not available. SAE 10W/40, API classification SE or SG, may be used with the expectation of more frequent filter changes. Also, multi-grade oils will tend to loose viscosity with use and will need to be changed more frequently.

Hose &Tubing



Conveys hydraulic oil through the system.
Contains hydraulic fluid under pressure.
Helps cool the oil.

Safety

 WARNING! Hot hydraulic oil at 3000 PSI can cause serious injury.
DO NOT OPERATE with visible defects.
DO NOT OPERATE with loose fittings.

Inspection and Maintenance

Check for visible defects.
Check for tight fittings.

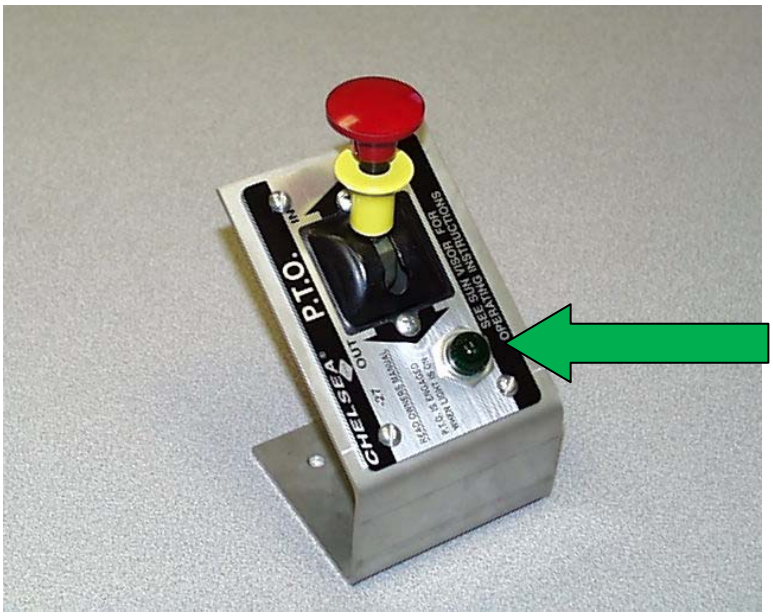
 CAUTION: A DOUBLE WIRE BRAID HOSE SHOULD NEVER BE USED FOR A VACUUM (SUCTION) LINE. IN A VACUUM, THE INNER LINER OF A DOUBLE BRAID HOSE MAY PULL AWAY FROM THE OUTER LINER AND COLLAPSE. THIS WILL CLOG THE INLET TO THE PUMP AND CAUSE SEVERE DAMAGE. USE ONLY HOSE THAT IS DESIGNED FOR SUCTION LINE APPLICATIONS.

Power Take Off (P.T.O.)



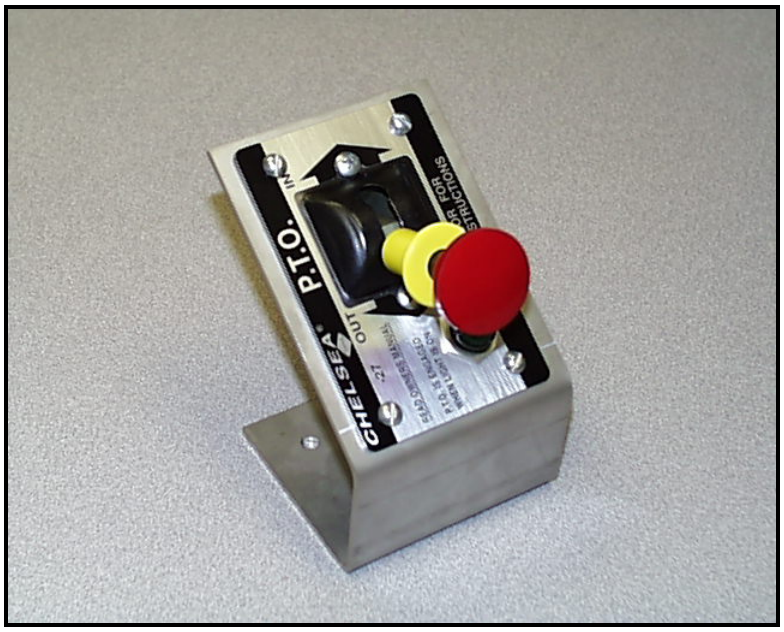
- λ Bolts directly to the truck transmission.
- λ Pump can be direct mounted or driveshaft driven.
- λ Provides engine power to the hydraulic pump.
- λ Can be engaged and disengaged from transmission.

P.T.O. Engagement



- Bring truck to a full stop.
- Depress clutch.
- Pause a moment.
- Lift and shift P.T.O. lever.
- Observe green light.
- Release clutch smoothly.

P.T.O. Disengagement



- Depress clutch.
  - P.T.O. gears are held in under load.
- Lift and shift P.T.O. operator.
- Observe green light off
- Release the clutch.

P.T.O. Safety

- Avoid over speeding P.T.O.
  - Disengage P.T.O. before leaving bench
- Stay clear of rotating driveshaft
  - Follow lockout, tag-out procedures for maintenance
  -

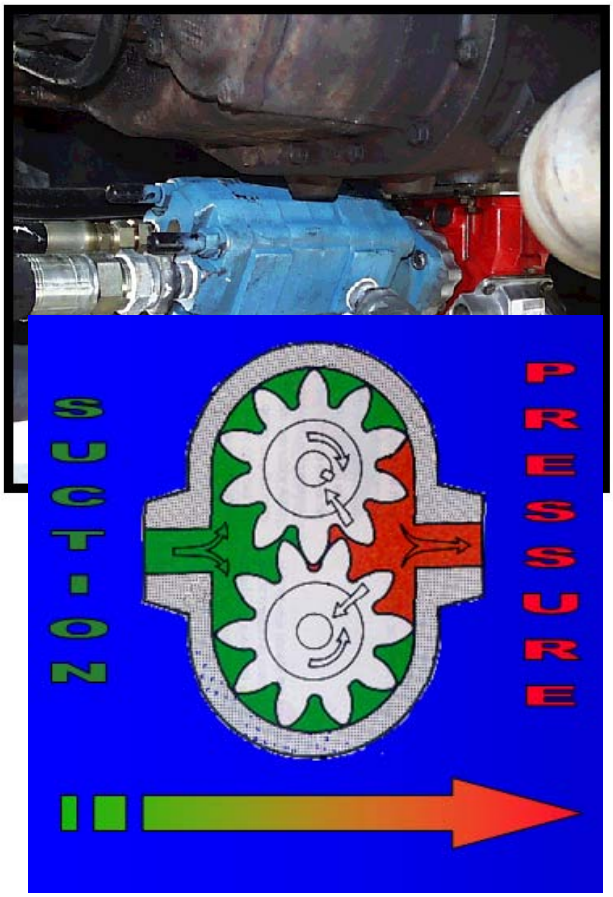
P.T.O. Inspection and Maintenance

- Check P.T.O. mounting flange bolts
- Check air line and fittings

P.T.O. Troubleshooting and Repair

- The P.T.O. does not engage.
  - Check air pressure for 80 psi minimum
  - Check for frozen air line . . . blow out line
- The P.T.O. is making unusual noise
  - Check the transmission oil level
  - Check mounting of the PTO, pump, and drive shaft…tighten any loose bolts

Pump



The hydraulic pump draws fluid from the reservoir. It pushes fluid through the system. Oil pumped under pressure provides power to hydraulic motors. Gears draw oil from suction port and push it out pressure port. The same quantity of oil is moved on every revolution. The pump pressure rises to meet any resistance to flow.
Note - You may have a pressure compensated hydraulic pump powering your particular system.

Operation

Engage the P.T.O. to run pump.
Run the pump at idle to warm the oil.
Set engine throttle for 1100 RPM.
Disengage PTO before leaving the bench.

Safety

Avoid over speeding the hydraulic pump.
Do not operate the pump with an inadequate oil supply.
Do not operate the pump deadheaded (maximum pressure) for extended periods.

Inspection and Maintenance

Check mounting bolts for tightness.
Check fittings for tightness.
Check hoses for wear.

Troubleshooting

The first place to start troubleshooting a hydraulic system is at the pump. A combination flow meter and pressure gauge test kit should be installed between the pump pressure port and the valve assembly. This will enable you to adequately evaluate the condition of the pump when in operation.

With the engine set for a constant engine speed of 1000 RPM and no-load on the pump (none of the spools on the valve are actuated), the pump should be delivering 12 GPM and 8 GPM.

Load Testing the 12 GPM Pump Or the 8 GPM Pump Section

1. Actuate the boom raise circuit until the boom cylinder reaches maximum extension. This provides a restriction and imposes a load on the pump. At this point the pressure gauge should indicate approximately 3000 PSI. (If the gauge does not show 3000 PSI, see the section on relief valve evaluation before proceeding.)

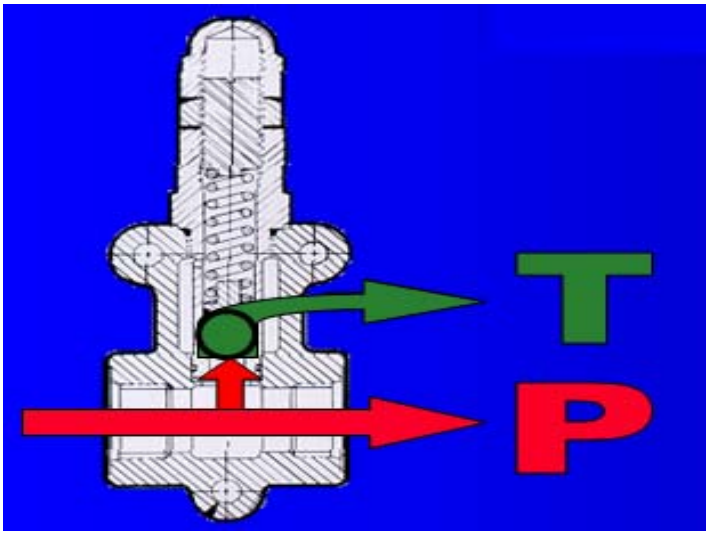
2. As the pump is loaded, the flow rate will fall slightly due to internal leakage in the pump. If, during this load test, the pump flow rate falls below 10 GPM for the 12 GPM section or 6.5 GPM for the 8 GPM section, the pump should be replaced. Increase the engine speed to achieve the flow rate observed under the no-load condition (i.e. 12 GPM and 8 GPM). The engine should now be running approximately 1200 RPM.

Hydraulic Relief Valve



Hydraulic Relief Valve Function

- Relief valve is normally closed
- It is connected between pressure and tank
- Pressure acts against a spring
- At set pressure valve diverts oil to tank



Main System Relief Valve

- The **Main System Relief** valve limits system pressure.
- The **Main System Relief** is located in spool valve inlet section.
- The **Main System Relief** pressure is 3,000 PSI.

Work Port Relief Valve

- A **Work Port Relief** valve is used to limit the pressure at one work port.
- A **Work Port Relief** is located in a spool valve work section.
- **Work Port Relief** pressures may be 600 PSI or 1200 PSI.

Hydraulic Relief Valve Safety

- Oil forced through a relief valve generates **HEAT**
- Heat can seriously damage hydraulic components
- DO NOT OPEATE with Main System Relief valve open continuously

Hydraulic Relief Valve Troubleshooting and Repair

- Hydraulic pump fails to build pressure
  - Hydraulic pump may be worn out
  - Main System Relief valve may be faulty
  - Main System Relief valve O-ring leaking
- Replace Main System Relief cartridge before replacing hydraulic pump

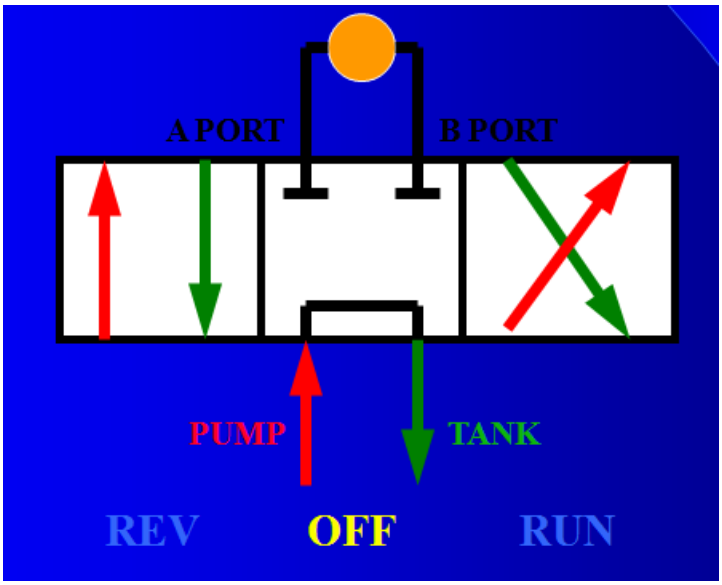
Hydraulic Spool Valve



- λ A spool valve control the direction of flow.
- λ A sectional spool valve combines several spool section into one assembly.

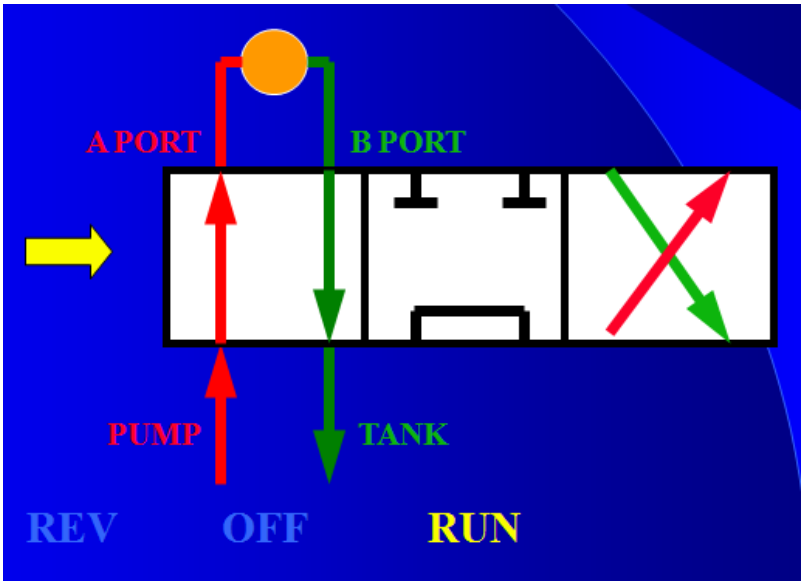
Hydraulic Spool Valve Function

- λ 3-Position spool valve provides RUN-OFF-REV

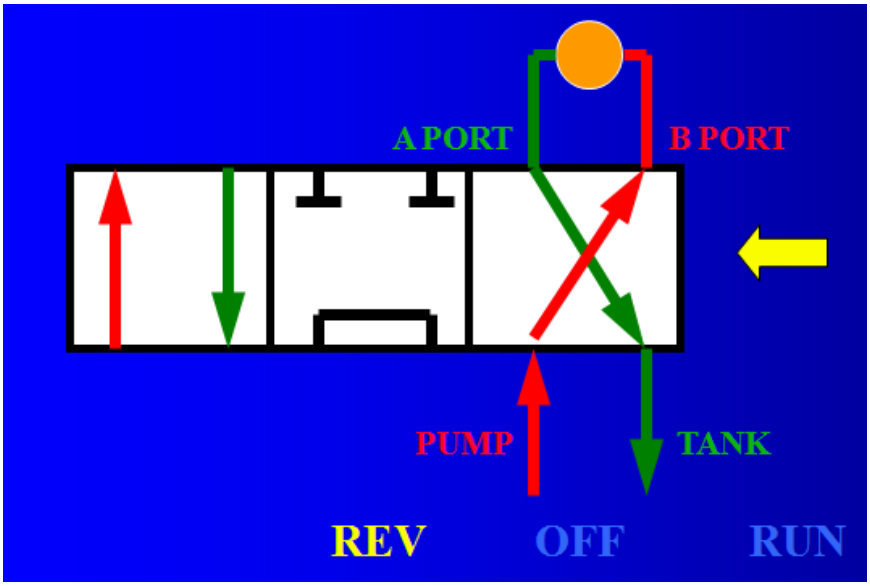


Hydraulic Spool Valve Operation

- Push the spool in for RUN



- Pull the spool out for REVERSE

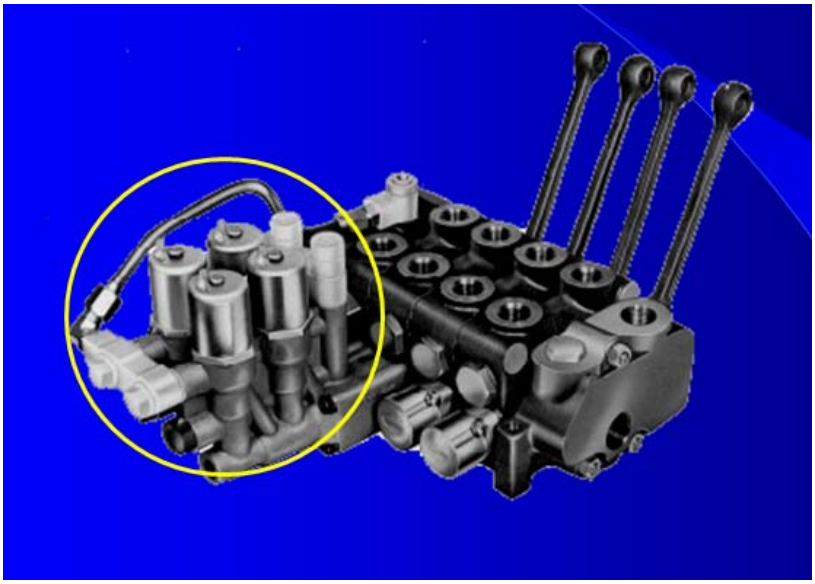


Hydraulic Spool Valve Safety

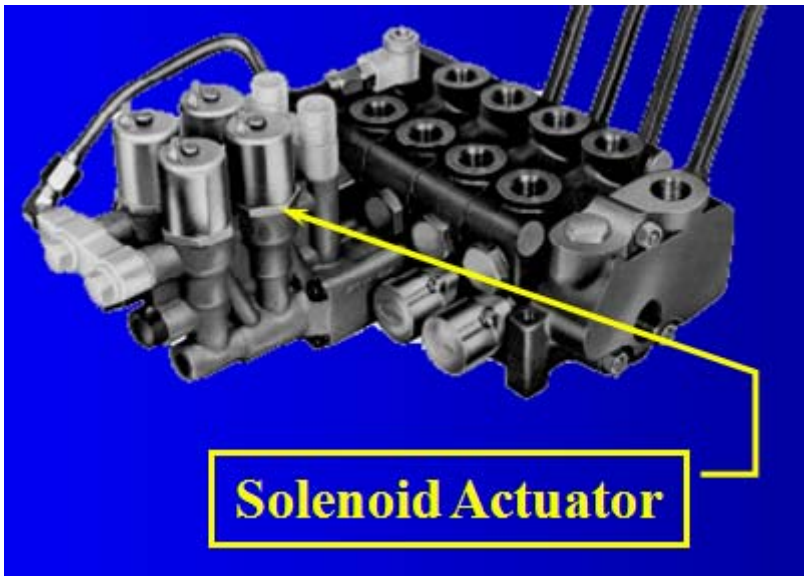
- Clear hazard zone before engaging valve
- Observe expected result after engaging valve

- Valve spool does not move freely
  - Clean debris from around handle linkage
  - Spray exposed valve spool with WD-40
  - Clean rust and crud from valve spool
  - Operate valve spool repeatedly to loosen

Solenoid Actuator

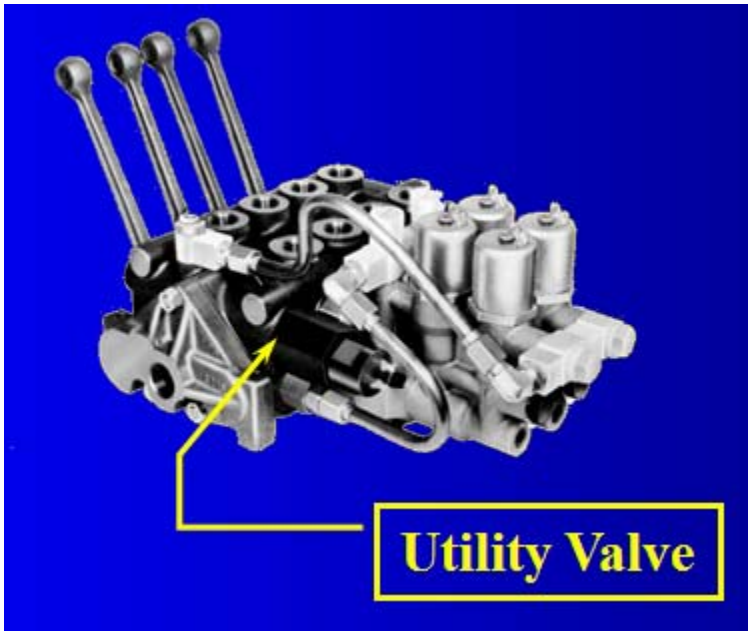


- A solenoid actuator can be attached to a work spool.
- Solenoids direct pilot oil to shift the spool in either the IN or OUT direction.



Utility Valve

- 300 PSI pilot pressure is supplied by the utility valve



Solenoid Actuator Inspection and Maintenance

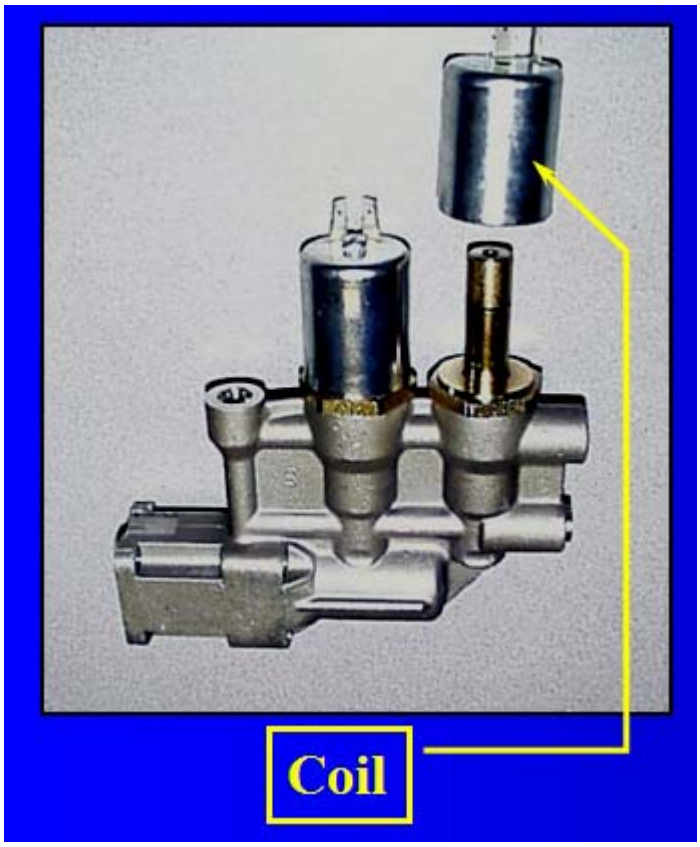
- θ Check for proper spool action
- θ Check for debris around handle linkage
- θ Check for security of solenoid cable boot

Solenoid Actuator Troubleshooting and Repair

- If handle does not move when the switch is actuated
  - Check for 300 PSI pilot pressure.
  - Check for voltage at the coil.
  - Remove and replace solenoid spool.
  - Operate the valve manually

Remove the Solenoid Coil

- Remove pan head screw
- Lift off solenoid coil



- λ Loosen the hexagonal core
- λ Unscrew and remove the core

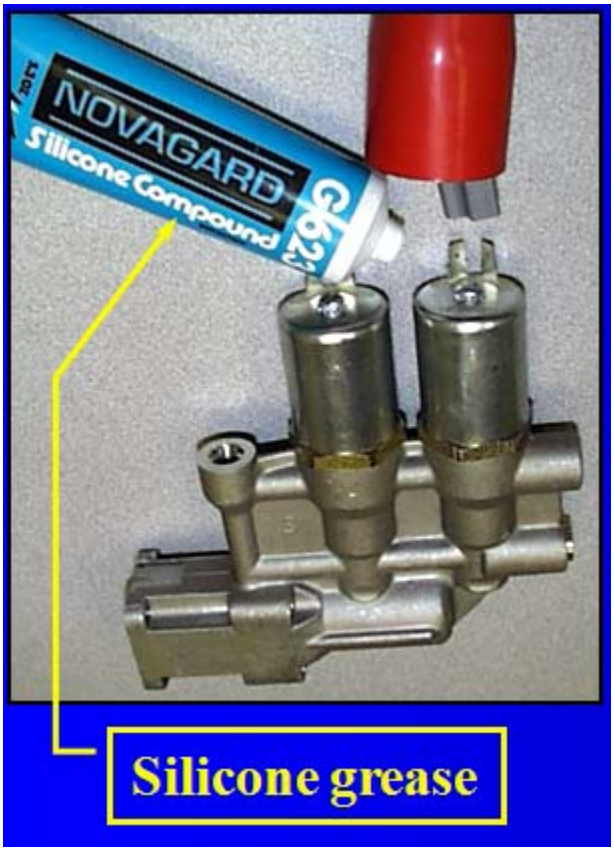


- λ Carefully slide the spool out of the body
- λ Clean the spool with fuel oil and replace
- λ Slide spool in and out to check for free movement



Reassemble and Seal With Silicone

- Reassemble in the reverse order
- Waterproof connector and boot with silicone *dielectric compound*
- **DO NOT USE SILICONE SEALER**



Motor



The hydraulic motor converts flow into rotary motion. Reverses rotation with reverse of flow. Used to drive augers and pumps. Two port design, A and B. It is used to drive augers and pumps. Hydraulic fluid causes motor shaft to rotate. Output speed is a function of flow. Output torque is a function of pressure.

Operation

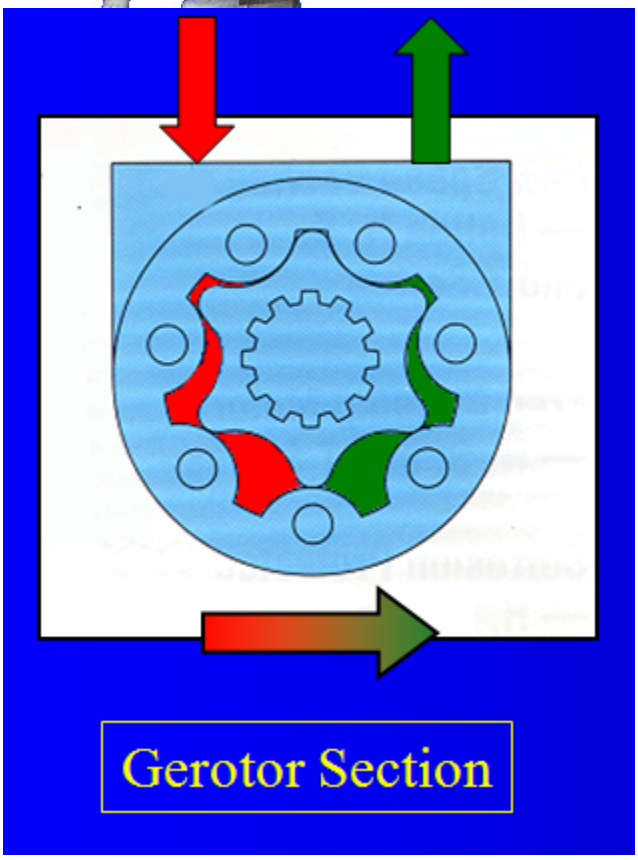
Push spool valve handle to RUN motor.
Center spool valve handle for OFF.
Pull spool valve handle to REVERSE.

Adjust hydraulic flow to change speed

Safety



DANGER! Contact with rotating machinery will cause serious injury.
DO NOT OPERATE if personnel exposed.
Observe lockout, tag-out procedures.



Inspection and Maintenance

Check for tight mounting bolts.
Check for tight hydraulic fittings.
Check for leaking shaft seal.

Troubleshooting

If the hydraulic motor does not turn, or turns slowly when the valve is actuated, there may be a problem with the motor. It is imperative that the hydraulic pump and relief valves be checked BEFORE the motor, if any useful information is to be gained from this test. The following procedure may be used when testing for a leaking auger drive motor.

1. Remove the line from the return side of the motor and either cap the line or place the flow meter test kit in-line. Foul the auger by putting a piece of wood through the clean-out doors. Actuate the motor valve and observe the leakage rate of oil through the motor. The rate should be approximately one pint in 15 to 20 seconds (3/8 to 1/2 GPM). If the motor is defective, the leakage rate will be more on the order of one gallon in 15 to 20 seconds (3 to 4 GPM).

Cylinder



The cylinder moves a load to a position. It also holds a load in position. It is used for boom positioning.

Function

Flow in one port extends piston.

Flow in opposite port retracts piston.

Operation

Pull spool valve handle to extend cylinder.
Push spool valve handle to retrace cylinder.

Safety

 WARNING! A failed cylinder can drop a load and cause serious injury.
DO NOT OPERATE a damaged cylinder.
DO NOT OPERATE with loose or damaged hose or fittings.
Inspection and Maintenance

Check for visible damage.

Check for secure clevis pins.
Check for tight hydraulic fittings.
Check for leaking rod seals.

Troubleshooting

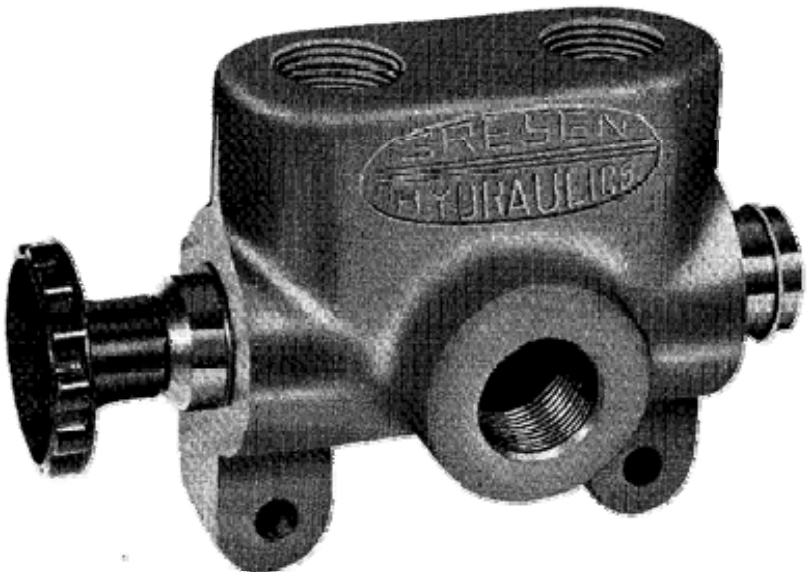
The hydraulic cylinder on the UNIBODY is the simplest component to test. If the boom will not rise when the valve is actuated and you have hydraulic pressure, the piston seal has failed and requires replacement.

If the boom raises very slowly or will only rise when the engine speed is increased, the Boom Fitting orifice may be clogged or the seal is leaking. The seal may be checked by installing the flow meter on the exit port of the cylinder. After the cylinder is fully raised, continue to keep the valve engaged. If flow is noted from the exit port of the cylinder, the seal has failed.

If the cylinder seal is replaced, the cylinder bore will need to be honed. If any scratches are evident inside the cylinder, the unit should be replaced.

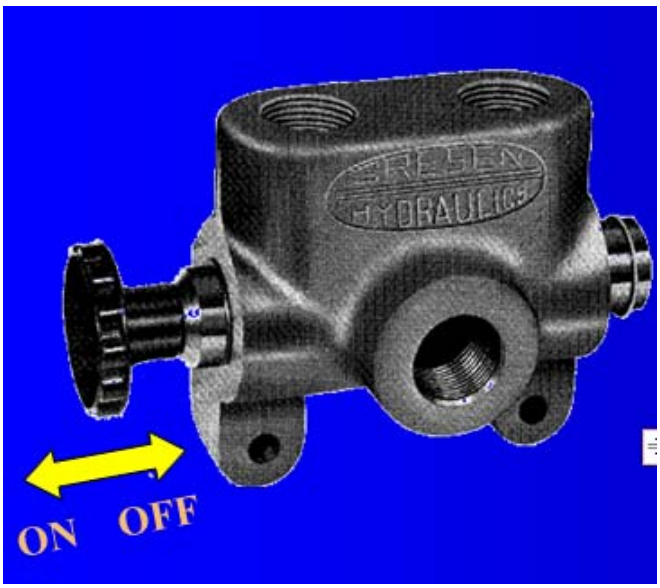
The fitting in the Boom Cylinder has an orifice installed to slow down the boom travel for safety reasons. Check this orifice for blockage and clean if necessary.

The Selector Valve



Selector Valve Function and Operation

- λ Push-Pull two position valve
- λ Usually set up for
- λ Push Off - Pull On
- λ Not made to be switched under pressure



Selector Valve Inspection and Maintenance

- Check for easy movement in and out
- Regular operation helps avoid freeze-up

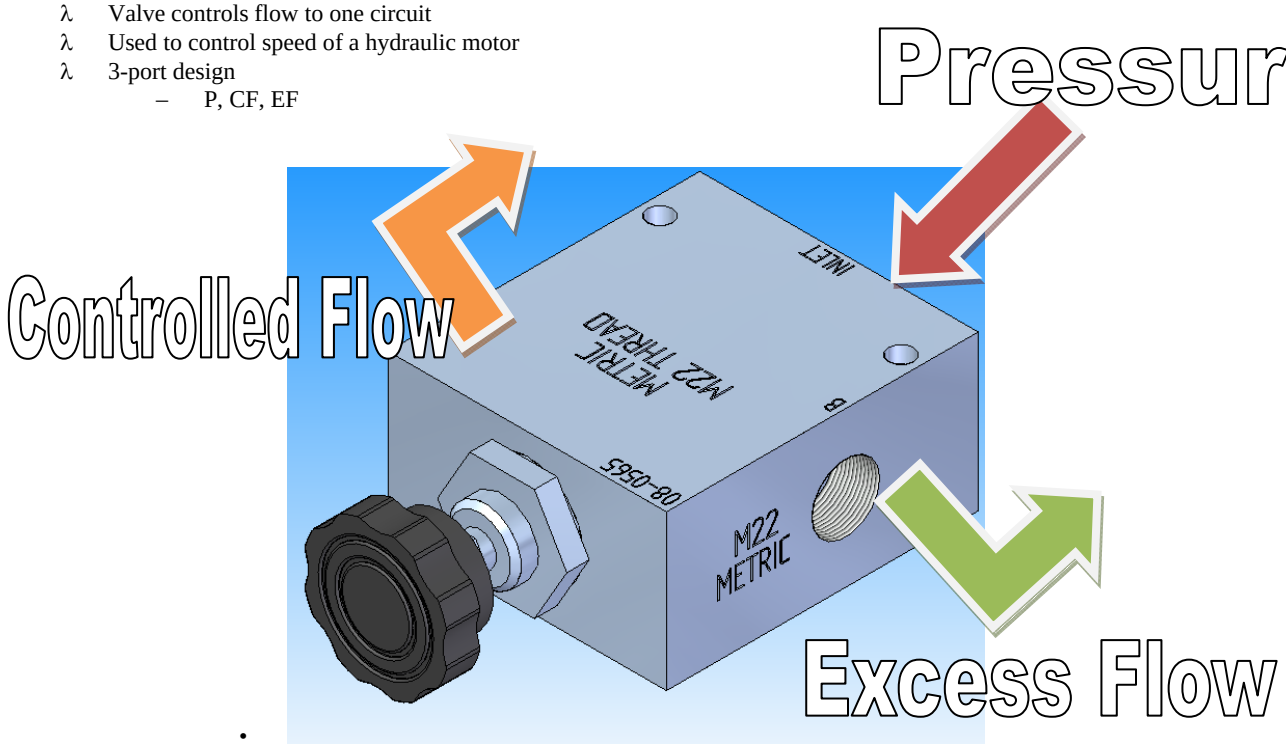
Selector Valve Troubleshooting and Repair

- Selector knob will not move in or out
  - Spray both ends of valve spool with WD-40
  - Clean rust and crud from valve spool ends
  - Work valve in and out until free

Flow Control Valve



- λ Valve controls flow to one circuit
- λ Used to control speed of a hydraulic motor
- λ 3-port design
  - – P, CF, EF



Product pump delivery rate

- Water pump rate
- Hose reel speed
- Blend auger rate



Flow control valve Inspection and Maintenance

- θ Check for easy adjustment through full range
- θ Regular adjustment through full range will help avoid freeze-up

Flow Control valve Troubleshooting and Repair

- λ Adjustment knob will not turn freely
  - Spray valve stem with WD-40
  - Clean valve stem of rust and crud
  - Turn knob back and forth until free

Adjustable Proportional (AP) Flow Divider

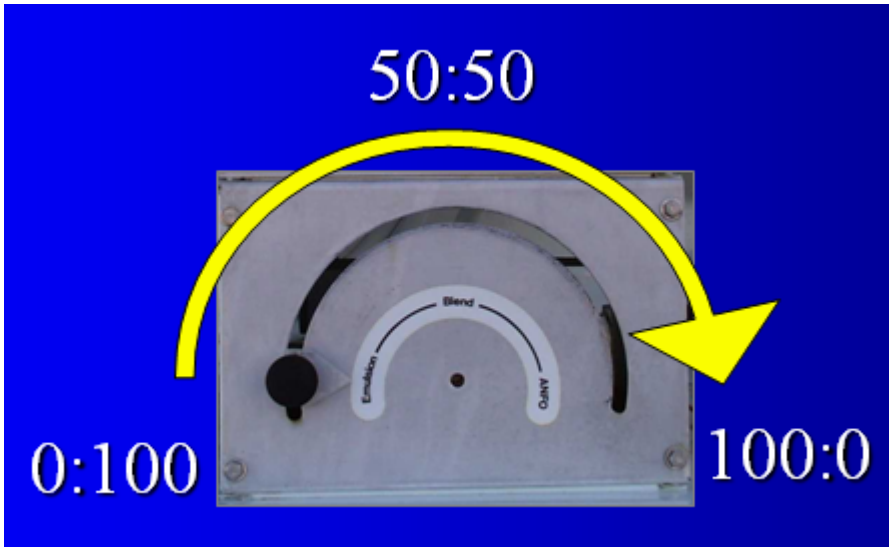


- λ AP flow divider controls flow in two parallel circuits
- λ Divides oil flow into two adjustable portions
- λ Used to control the percentage of ingredients
- λ 3-port design
  - **P, C1, C2**



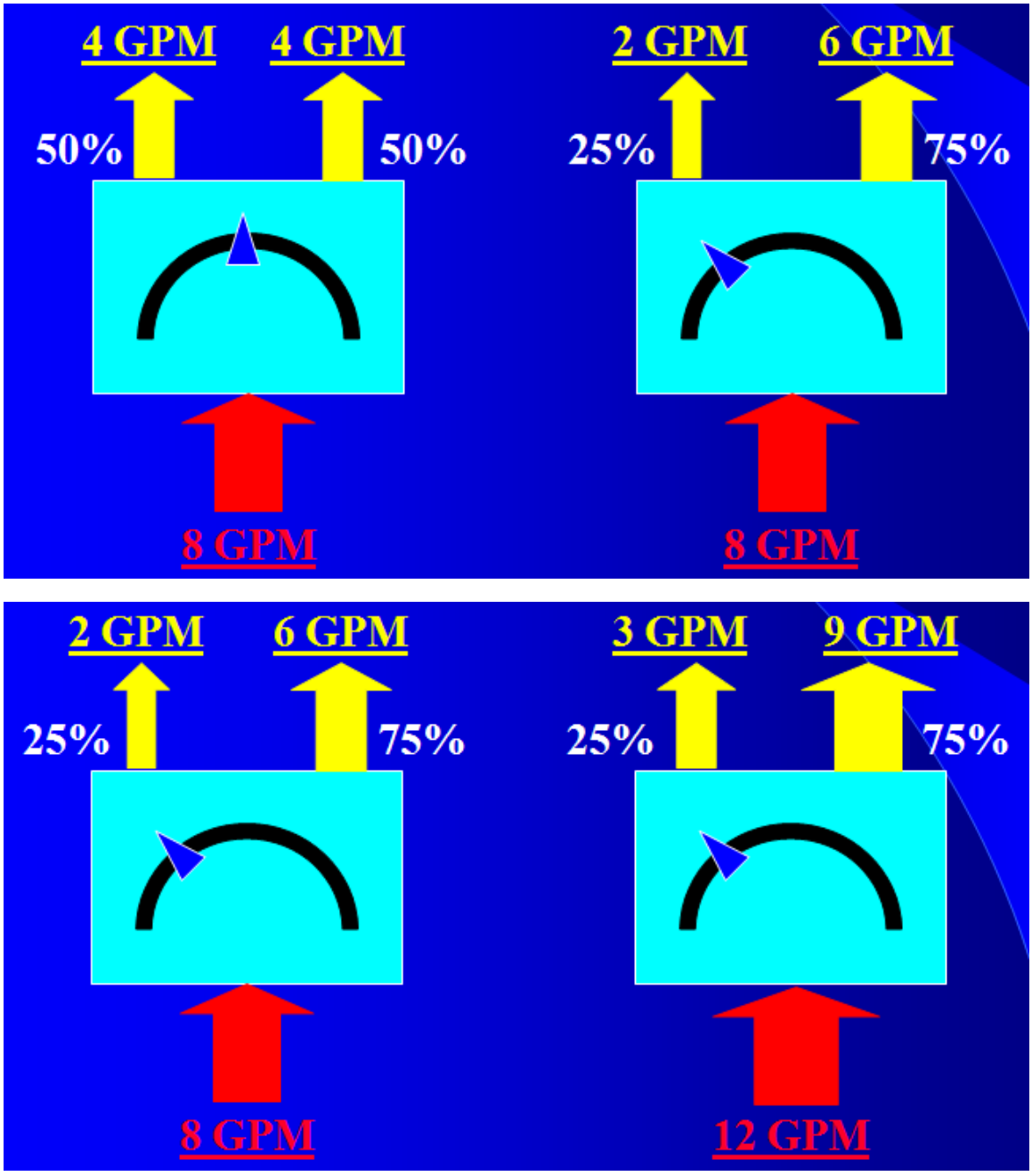
AP Flow Divider Operation

- λ Loosen knob and slide pointer as required
- λ Adjusts any ratio from 0:100 to 100:0
- λ Lock knob at desired position


50:50
0:100
100:0
Blend
Emulsion
Auto

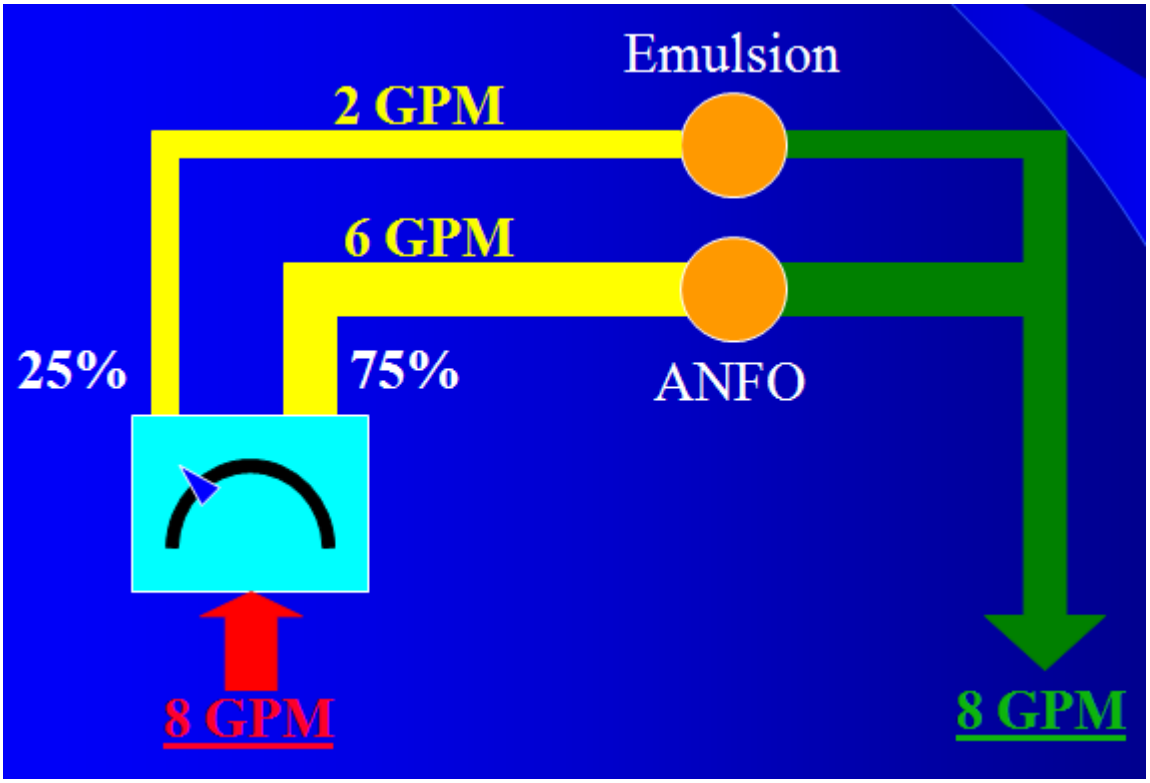
AP Flow Divider Function

- The AP Flow Divider splits input flow into two adjustable portions



AP Flow Divider Circuit

- λ AP Flow as Blend Control



AP Flow Divider Inspection and Maintenance

- θ Check for easy movement throughout full range
- θ Check for proper function of pointer and knob
- θ Check for debris around handle linkage

Auxiliary Hydraulics

The auxiliary hydraulics circuit takes oil being supplied to the vertical and boom augers and directs it to the quick disconnect fittings.



To activate the circuit, push the start button located on the controls.

Troubleshooting Guide

NOTE; OIL OPERATING TEMPERATURE MUST BE ACHIEVED IN ORDER FOR THE SYSTEM TO FUNCTION PROPERLY.

Problem	Possible Cause	What To Do
1. Boom will not raise.	A. Power take-off is not engaged. B. Hydraulic oil level low. C. Inadequate hydraulic pressure. D. Hydraulic cylinder.	A. Check PTO shifter B. Fill to sight glass level. C. See relief valve test procedure. D. See cylinder test procedure.
2. Boom drifts down.	A. Cylinder damaged.	A. See cylinder test procedure.
3. Boom will not swing.	A. Power take-off is not engaged. B. Hydraulic oil level low. C. Hydraulic pressure below 450 PSI. D. Drive sprocket key sheared. E. Chain jumping.	A. Check PTO shifter. B. Fill to sight glass level. C. See boom swing circuit test procedure. D. Replace key. E. Adjust chain tension.
4. Augers will not run.	A. Power take-off is not engaged. B. Hydraulic oil level low. C. Inadequate hydraulic pressure. D. Inadequate hydraulic	A. Check PTO shifter. B. Fill to sight glass level. C. See relief valve test procedure. D. Test pump.
5. Bottom auger will not run. Vertical and overhead augers run.	A. Bottom auger valve not actuated. B. Hydraulic oil level low. C. Hydraulic pressure below 600 PSI. D. Foreign material lodged in auger. E. Bottom auger motor by-passing oil. F. A.P. Flow Control defective.	A. Push in handle. B. Fill to sight glass level. C. See relief valve test procedure. D. Reverse augers for 10 seconds then attempt forward. E. See motor test procedure. F. See A.P. Flow Control test procedure.
6. Vertical auger will not run when overhead auger runs.	A. Vertical auger motor by-passing oil.	A. See motor test procedure.
7. Overhead auger will not run when vertical auger runs.	A. Vertical auger motor by-passing oil.	A. See motor test procedure.

Problem	Possible Cause	What To Do
8. Bottom auger runs slow.	A. Hydraulic oil level low. B. Hydraulic pressure below 1500 PSI. C. Hydraulic pressure above 3000 PSI. D. Jammed material. E. Bottom auger motor by-passing oil.	A. Fill to sight glass level. B. 1. Increase engine speed and check gear selection. 2. See relief valve test procedure. C. Decrease engine speed to achieve 1950 PSI or less. D. Reverse augers for 5 secs. Close all gates and run augers for 1 minute. Open gates. E. Run truck with PTO

		engaged.
9. All augers run slow.	A. Hydraulic oil level low. B. Hydraulic pressure below 1500 PSI. C. Hydraulic pressure above 3000 PSI. D. Jammed material. E. System cold.	A. Fill to sight glass level. B. 1. Increase engine speed and check gear selection. 2. See relief valve test procedure. C. Decrease engine speed to achieve 1950 PSI or less. D. Reverse augers for 5 secs. Close all gates and run augers for 1 minute. Open gates. E. Run truck with PTO engaged.
10. Auger motors run. No material delivered.	A. Gates closed. B. Discharge hose has too much angle. C. Keys or bolts sheared on drive assembly.	A. Open gate. B. Let hose hang down. C. Repair or replace.
11. System runs hot.	A. Hydraulic level low. B. Relief valve set low. C. Suction or return line obstructed. D. Motors bypassing oil or valve spool leaking.	A.. Fill to sight glass level. B. See relief valve test procedure. C. Inspect and replace as necessary. D. See detailed test procedure.
12. Hydraulic gates do not operate.	A. Power take-off is not engaged. B. Hydraulic oil level low. C. Work port relief valve setting too low.	A. Check PTO shifter. B. Fill to sight glass level. C. See relief valve test procedure.
13. Oiling system does not inject oil.	A. Adjustable proportional flow control is in wrong position or bypass is in wrong position. B. Ball valves closed. C. Oil tank empty. D. Adjustable orifice is improperly adjusted. E. Strainer clogged. F. Injectors clogged.	A. Adjust valve. B. Open ball valves. C. Fill tank. D. See oiling system calibration procedure. E. Clean. F. Clean or replace.



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- Lubricant in Transmission/Inspect Installation
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WARRANTY

SAFETY INFORMATION

These instructions are for your safety and the safety of the end user. Read them carefully until you understand them.

GENERAL SAFETY INFORMATION

To prevent injury to yourself and / or damage to the equipment:

- Read carefully all owners' manuals, service manuals, and / or other instructions.
- Always follow proper procedures, and use proper tools and safety equipment.
- Be sure to receive proper training.
- Never work alone while under a vehicle or while repairing or maintaining equipment.
- Always use proper components in applications for which they are approved.
- Be sure to assemble components properly.
- Never use worn-out or damaged components.
- Always block any raised or moving device that may injure a person working on or under a vehicle.
- Never operate the controls of the Power Take-Off or other driven equipment from any position that could result in getting caught in the moving machinery.

PROPER MATCHING OF P.T.O.

WARNING: A power take-off must be properly matched to the vehicle transmission and to the auxiliary equipment being powered. An improperly matched power take-off could cause severe damage to the vehicle transmission, the auxiliary driveshaft, and / or to the auxiliary equipment being powered. **Damaged components or equipment could malfunction causing serious personal injury to the vehicle operator or to others nearby.**

To avoid personal injury and / or equipment damage:

- Always refer to Chelsea catalogs, literature, and owner's manuals and follow Chelsea recommendations when selecting, installing, repairing, or operating a power take-off.
- Never attempt to use a power take-off not specifically recommended by Chelsea for the vehicle transmission.
- Always match the power take-off's specified output capabilities to the requirements of the equipment to be powered.
- Never use a power take-off whose range of speed could exceed the maximum safe speed of the equipment to be powered.

This symbol warns of possible personal injury.

SAFETY INFORMATION (CONT.)

COLD WEATHER OPERATION OF POWER SHIFT P.T.O.'s

WARNING: During extreme cold weather operation [32°F (0°C) and lower], a disengaged Power Shift Power Take-Off can momentarily transmit high torque that will cause unexpected output shaft rotation. This is caused by the high viscosity of the transmission oil when it is extremely cold. As slippage occurs between the Power Take-Off clutch plates, the oil will rapidly heat up and the viscous drag will quickly decrease.

The power take-off output shaft rotation could cause unexpected movement of the driven equipment resulting in serious personal injury, death, or equipment damage.

To avoid personal injury or equipment damage:

- Driven equipment must have separate controls.
- The driven equipment must be left in the disengaged position when not in operation.
- Do not operate the driven equipment until the vehicle is allowed to warm up.

ROTATING AUXILIARY DRIVESHAFTS

WARNING: 

- Rotating auxiliary driveshafts are dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.
- Do not go under the vehicle when the engine is running.
- Do not work on or near an exposed shaft when the engine is running.
- Shut off the engine before working on the power take-off or driven equipment.
- Exposed rotating driveshafts must be guarded.

GUARDING AUXILIARY DRIVESHAFTS

WARNING: We strongly recommend that a power take-off and a directly mounted pump be used to eliminate the auxiliary driveshaft whenever possible. If an auxiliary driveshaft is used and remains exposed after installation, it is the responsibility of the vehicle designer and P.T.O. installer to install a guard.

This symbol warns of possible personal injury.

SAFETY INFORMATION (CONT.)

USING SET SCREWS

WARNING: Auxiliary driveshafts may be installed with either recessed or protruding set screws. If you choose a square head set screw, you should be aware that it will protrude above the hub of the yoke and may be a point where clothes, skin, hair, hands, etc. could be snagged. A socket head set screw, which may not protrude above the hub of the yoke, does not permit the same amount of torquing as does a square head set screw. Also, a square head set screw, if used with a lock wire, will prevent loosening of the screw caused by vibration. Regardless of the choice made with respect to a set screw, an exposed rotating auxiliary driveshaft must be guarded.

IMPORTANT: SAFETY INFORMATION AND OWNER'S MANUAL

Chelsea power take-offs are packaged with safety information decals, instructions, and an owner's manual. These items are located in the envelope with the P.T.O. mounting gaskets. Also, safety information and installation instructions are packaged with some individual parts and kits. **Be sure to read the owner's manual before installing or operating the P.T.O.** Always install the safety information decals according to the instructions provided. Place the owner's manual in the vehicle glove compartment.

WARNING: OPERATING THE P.T.O. WITH THE VEHICLE IN MOTION

Some power take-offs may be operated when the vehicle is in motion. To do so, the P.T.O. must have been properly selected to operate at highway speeds and correctly matched to the vehicle transmission and the requirements of the driven equipment.

If in doubt about the P.T.O.'s specifications and capabilities, avoid operating the P.T.O. when the vehicle is in motion. Improper application and/or operation can cause serious personal injury or premature failure of the vehicle, the driven equipment, and/or the P.T.O.

Always remember to disengage the P.T.O. when the driven equipment is not in operation.

PUMP INSTALLATION PRECAUTIONS

Use a bracket to support the pump to the transmission if:

- The pump weighs 40 pounds or more.
- The combined length of the P.T.O. and pump is 18 inches or more from the P.T.O. centerline to the end of the pump.

Also remember to pack the female pilot of the P.T.O. pump flange with grease before installing the pump on the P.T.O.

This symbol warns of possible personal injury.

P.T.O. RATINGS

Basic P.T.O. Models			Horsepower At		Intermittent	Weight
New Model No.	Old Model No.	SAE Aperture	500 rpm	1000 rpm	Torque Rating *	Approximate Pounds
100	A1, 2, 3N	6-Bolt	11.9	23.5	125 lbs. ft.	10 lbs.
220L & P	A22C & D	6-Bolt	19	38	200 lbs. ft.	30 lbs.
220- E & C	A22L & LL	6-Bolt	23.5	47	250 lbs. ft.	30 lbs.
260	26	6-Bolt	23.5	47	250 lbs. ft.	28 lbs.
321 Hel.	320	6-Bolt	13.2	26.5	140 lbs. ft.	39 lbs.
322 Spur.	S320	6-Bolt	13.2	26.5	140 lbs. ft.	39 lbs.
340	34L	6-Bolt	19	38	200 lbs. ft.	32 lbs.
350	S35, 36, & 37	6-Bolt	13.2	26.5	140 lbs. ft.	37 lbs.
381	S380	6-Bolt	13.2	26.5	140 lbs. ft.	23 lbs.
410__U	41D	6-Bolt	11.9	23.5	125 lbs. ft.	26 lbs.
410__W	41K	6-Bolt	10	20	110 lbs. ft.	26 lbs.
410__X	41X	6-Bolt	8	16	85 lbs. ft.	26 lbs.
420—S		6-Bolt	19	38	200 lbs. ft.	26 lbs.
420—Q	42	6-Bolt	21.4	42.8	225 lbs. ft.	26 lbs.
	430D	6-Bolt	17	32	180 lbs. ft.	30 lbs.
431__U		6-Bolt	18.6	37.1	195 lbs. ft.	30 lbs.
	430K	6-Bolt	15	30	160 lbs. ft.	30 lbs.
431__W		6-Bolt	16.7	33.3	175 lbs. ft.	30 lbs.
450	S45, 46 & 47	6-Bolt	13.2	26.5	140 lbs. ft.	37 lbs.
445-Q		6-Bolt	19	38	225 lbs. ft.	30 lbs.
445-S		6-Bolt	21.4	42.8	200 lbs. ft.	30 lbs.
445-U		6-Bolt	18.6	37.1	195 lbs. ft.	30 lbs.
445-W		6-Bolt	16.7	33.3	175 lbs. ft.	30 lbs.
700	A2625	Gear Box	11.9	23.5	125 lbs. ft.	39 lbs.
710	A2627	Gear Box				
Single Speed Shaft			10	20	110 lbs. ft.	
Two Speed & Input Shaft			11.9	23.5	125 lbs. ft.	39 lbs.
720	2615	Gear Box	13.2	26.5	140 lbs. ft.	49 lbs.
730	2536	Gear Box	13.2	26.5	140 lbs. ft.	49 lbs.
740	2538	Gear Box	13.2	26.5	140 lbs. ft.	49 lbs.
800	810	8-Bolt	33	66	350 lbs. ft.	38 lbs.
812	811	8-Bolt	38	76	400 lbs. ft.	50 lbs.
822	821	8-Bolt	47	94	500 lbs. ft.	76 lbs.
832	831	8-Bolt	28.5	57	300 lbs. ft.	76 lbs.
852	851	8-Bolt	47	94	500 lbs. ft.	88 lbs.
862	861	8-Bolt	47	94	500 lbs. ft.	96 lbs.
901	4600	Split Shaft P.T.O.			4300 lbs. ft.	185 lbs.
911	4700	Split Shaft P.T.O.			4500 lbs. ft.	126 lbs.
931	5551	Split Shaft P.T.O.			250 lbs. ft.	102 lbs.
Front Mounted						
2230U		Gear Box	21.4	42.8	225 lbs. ft.	88 lbs.
2381	2740	Gear Box	13.2	26.5	140 lbs. ft.	69 lbs.
2420*S		Gear Box	19	38	200 lbs. ft.	69 lbs.
2420*Q	2642	Gear Box	21.4	42.8	225 lbs. ft.	69 lbs.

This chart provides a guide to the many different models of P.T.O.'s which may be used in a given application.

From this group, a model can be selected to meet the exact horsepower, speed and rotation requirements of the accessory to be driven.

* At 1200 R.P.M. Output, a minimum of 100 Hours of Total P.T.O. Life is available. For a continuous Duty Rating use 70% of the Intermittent Rating.

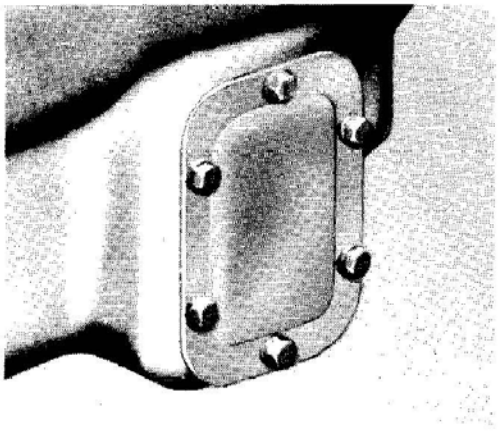
APPLICATION QUESTIONS

Here are some of the questions that are relevant to the Proper Selection of a Transmission Mounted Power Take-Off

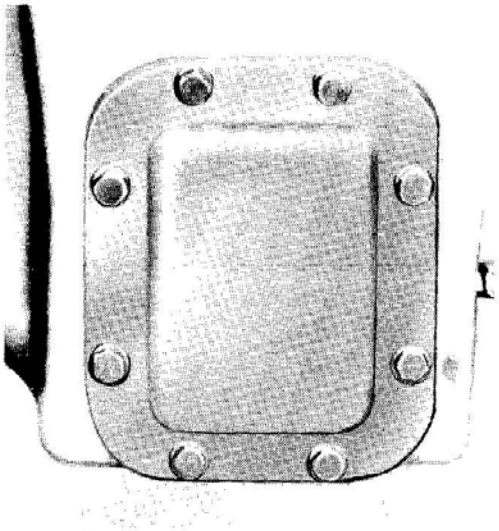
1. What is the make and model of your transmission?
2. Which P.T.O. opening will be used?
3. What accessory is to be driven?
4. How much horsepower is required to drive the accessory?
5. What is the required rotation of the P.T.O.?
6. What is required P.T.O. output shaft speed as a percent of engine speed?
7. What is the required method of shifting the P.T.O., cable, lever of air?

Once all of the answers to these questions have been determined, a transmission mounted P.T.O. can be selected to meet the horsepower, speed and rotation that you require.

Having made the selection of a P.T.O., you are ready to start the installation.

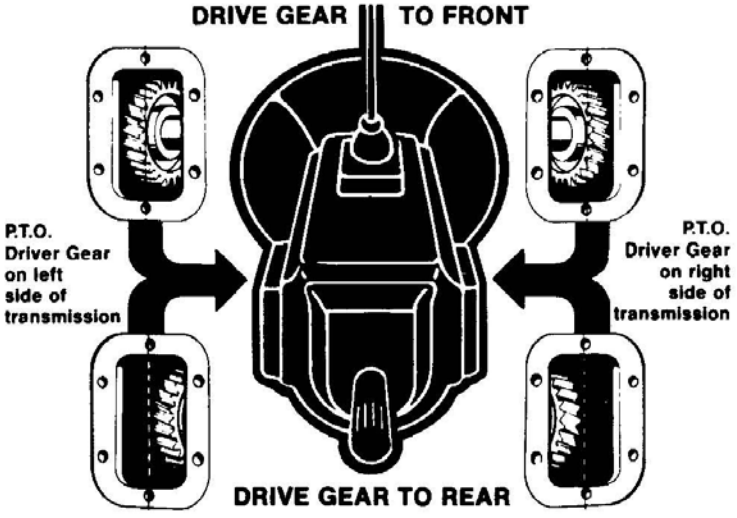


SAE 6 Bolt



SAE 8 Bolt
Standard SAE Power Take-Off Apertures

P.T.O. Drive Gear Location
The standard location for the P.T.O. drive gear in the transmission is ½" to the front or ½"to the rear of vertical center line.



MOUNTING P.T.O. TO TRANSMISSION
For 6 or 8 Bolt Applications

1. Drain the oil from the transmission and remove the P.T.O. aperture cover plate. (See Fig. 1.)
2. Discard the cover plate and cover plate gasket then clean the aperture pad using a putty knife or wire brush. (See Fig. 2.)

   NOTE: Stuff a rag in the aperture opening to prevent dirt from entering the transmission while you are cleaning it.
3. Using your hand, rock the P.T.O. driver gear in the transmission (see Fig. 3) and the driven gear in the P.T.O. assembly (see Fig. 4). Rocking the gears provides two important factors.
   (a) It shows you the amount of backlash that has been designed into each unit.
   (b) It is helpful in establishing the proper backlash when installing the P.T.O.
4. Install the proper studs (furnished with P.T.O.) in the P.T.O. aperture pad using a stud driver. Studs may have either interference fit threads (plain) or preapplied locking/sealing compound. (See Fig. 5 for installation method).
5. Where holes are tapped through the transmission case, use studs with preapplied locking/sealing compound Permatex or equivalent to prevent leaks.

   NOTE: Avoid contact of Permatex with automatic transmission fluid in automatics. Always check to be sure that the studs do not interfere with transmission gears.



Fig. 1

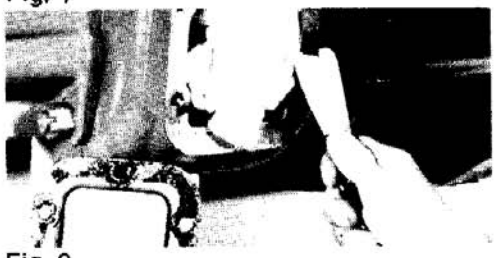

Fig. 2



Fig. 3



Fig. 4


Fig. 5

MOUNTING P.T.O. TO TRANSMISSION (continued)

6. Tighten studs securely and torque to 17-19 lbs. ft. (2.35-2.63 kg meters) for 6 bolt and 19-21 lbs. ft. (2.63-2.90 kg meters) for 8 bolt. Caution - overtightening of studs may damage stud and/or transmission threads. (See Fig. 6)
7. Place the correct number of gaskets over studs. (See Fig. 7.) Do not use Permatex between gaskets because you may want to add or subtract gaskets to obtain proper backlash.
   - When mounting a P.T.O. use gaskets between all mounting surfaces.
   - Do not stack more than **3** gaskets together.
   - Usually one thick gasket .020 (.50mm) will be required.
   - Remember the lubricant in the transmission also lubricates the P.T.O. Therefore, at least one gasket must always be used on either side of filler blocks, adapter assemblies or adapter plates. More gaskets may be required when establishing proper backlash.
8. Secure P.T.O. to the transmission.
   - Copper gaskets are used as a guard against leaks under cap screw head. (See Fig. 8.)

   NOTE: If holes in the P.T.O. aperture are not drilled through, discard the copper gaskets and replace them with lock washers.

   The 220 Series must always have a copper washer under its one cap screw head that goes through inside of housing.
9. Fasten the P.T.O. to the transmission torquing 6 bolt to 30-35 lbs. ft. (4.14-4.84 kg meters) and 8 bolt to 45-50 lbs. ft. (6.22-6.91 kg meters.) (See Fig. 9.)

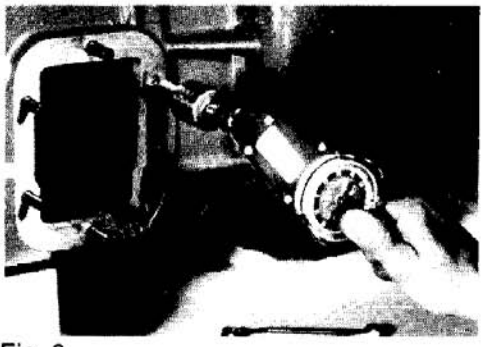


Fig. 6



Fig. 7

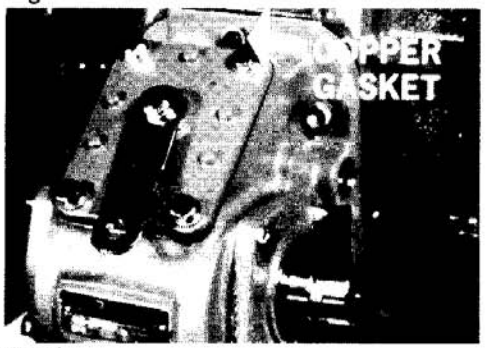


Fig. 8

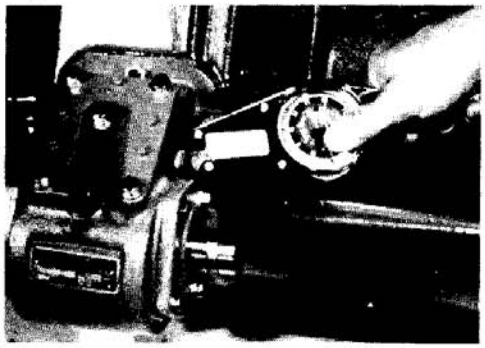


Fig. 9

CHECKING BACKLASH

To check for proper backlash on P.T.O.'s with shift cover

1. Remove the P.T.O. shift housing and/or inspection plate.
2. Mount the dial indicator so that it registers movement of the input gear (driven gear) of the P.T.O. (See Fig. 10.)

NOTE: See Figure 11 for proper location of dial indicator contact point. (Two common type dial indicators shown.)

3. Hold the P.T.O. driver gear in transmission with a screwdriver or bar and rock the P.T.O. input gear (driven gear) back and forth with your hand. Note the total movement on the dial indicator.
4. Establish backlash at .006"-.012" (.15mm-.30mm) by adding or subtracting gaskets.

General rule—A Chelsea .010" gasket will change backlash approx. .006". A .020" gasket changes backlash approx. .012".

5. Replace the shift housing and/or inspection plate and retorque (4) four capscrews to 16-20 lbs. ft. (2.21-2.76 kg meters).

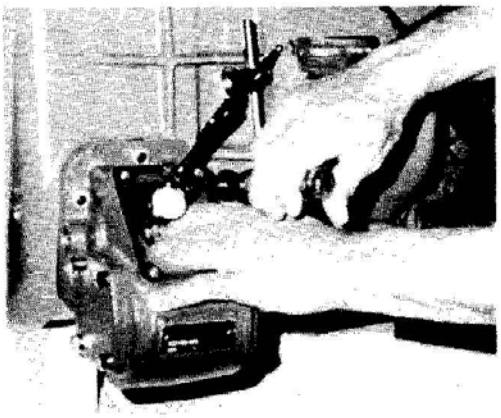


Fig. 10

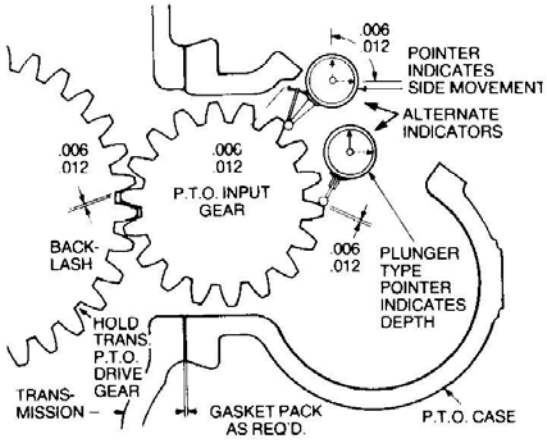


Fig. 11

NOTE: *When using a 220, 260 or 270 Series P.T.O. with the New AJ gear designation on an Allison Automatic transmission with a six bolt opening, a special gasket (35-P-41) is supplied. When installed with the P.T.O. this gasket reduces the need for backlash adjustment.*

2 GEAR—8—BOLTS—822, 832 & 862

An inspection hole is provided in the P.T.O. housing for feeling the mounted backlash.

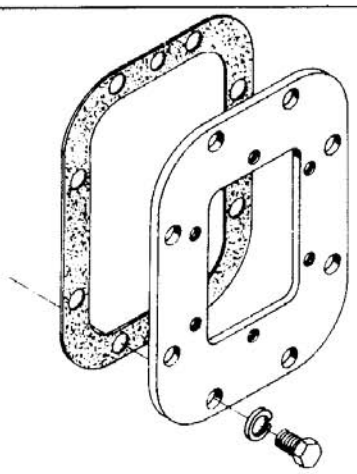
Rock the P.T.O. Input Gear with your hand and correlate this backlash to the unmounted backlash found in Step 3 on page 7. Use Gaskets to get backlash feel as close to unmounted condition as possible.



ADAPTER PLATES

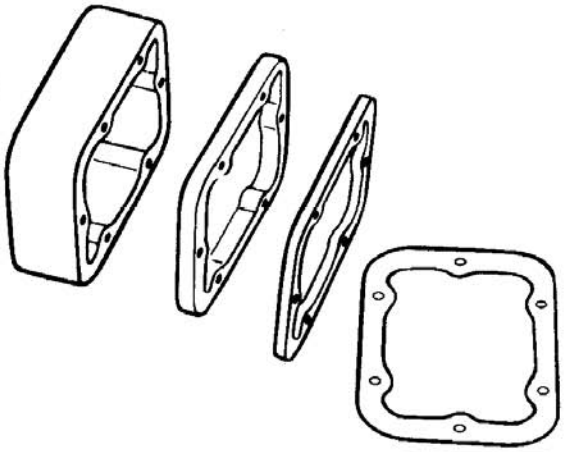
Adapter plates are used to permit mounting a 6 bolt P.T.O. on a transmission that has an 8 bolt aperture.

NOTE: A wire locking stud kit is recommended when mounting a 6 Bolt P.T.O. to an adapter plate on a bottom opening.



FILLER BLOCKS

Filler blocks may be required where it is necessary to use a spacer to mount the power take-off to a particular transmission.



P.T.O. APPLICATION AND ADAPTER ASSEMBLY

Figure 13 illustrates typical adapter assembly configurations. Some P.T.O. applications require adapter assemblies because it is impossible to reach the P.T.O. driver gear in the transmission without this assembly.

An adapter assembly will change the rotation of the P.T.O. and this may be necessary for driving pumps or other accessory equipment. Obstructions, such as a bulge in the transmission, exhaust pipes or motor mounts can sometimes be compensated for through the use of an adapter.

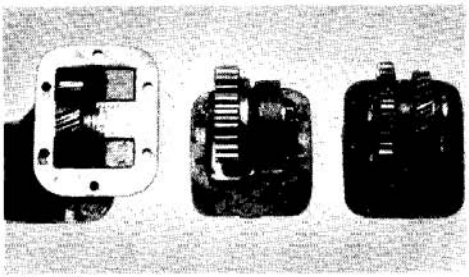


Fig. 13

MOUNTING ADAPTER ASSEMBLY

How to mount an adapter assembly to the transmission and P.T.O.

1. Use same procedure for mounting the adapter and checking backlash as was used when mounting the P.T.O. to transmission. (See Fig. 14.)
2. After checking for proper backlash remove the adapter, gaskets and filler block (if required) from the transmission. Keep the gaskets and filler block as a "package." (See Fig. 15.)
3. Bench mount the adapter to the P.T.O. using appropriate length studs. (See Fig. 16.)
4. Proper backlash will determine the number of gaskets to be used between the adapter and the P.T.O. (See Fig. 17.)
5. Remount the adapter assembly, all gaskets and the P.T.O. to the transmission in their respective sequence. (See Fig. 18.)
6. Secure all nuts and cap screws to proper torque.

Now . . . run the P.T.O. momentarily and check for noise!

CAUTION: The transmission and P.T.O. have no lubrication at this time so running time should be as short as possible.

- If the P.T.O. whines it may be mounted too tight, too little backlash. This indicates that gaskets should be added.
- If the P.T.O. clatters it may be mounted too loose, too much backlash. This indicates that gaskets should be removed.

General Rule: A Chelsea .010 (.25mm) gasket will change backlash approximately .006 (.15mm) and a .020 (.50mm) gasket changes backlash approximately .012 (.30mm).

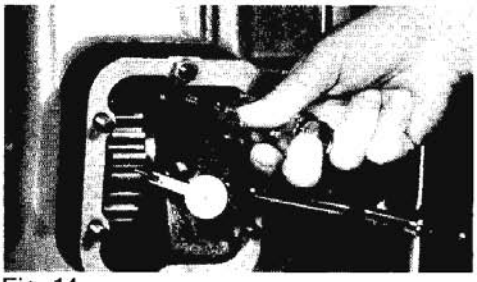


Fig. 14

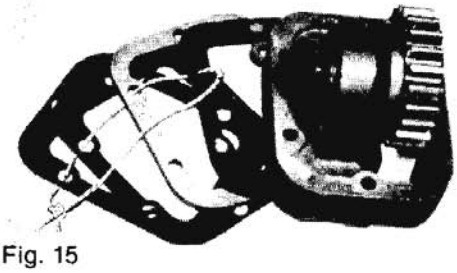


Fig. 15

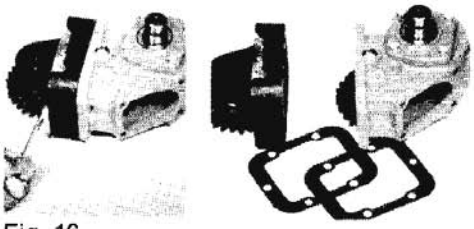


Fig. 16

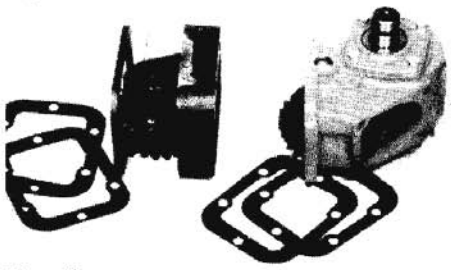


Fig. 18



Figure 19 illustrates a typical input gear (driven gear) in a P.T.O. that was mounted too deep—insufficient backlash. Extreme heat turned the gear blue and resulted in gear and bearing failure.

LUBRICANT IN TRANSMISSION/INSPECT INSTALLATION

1. Remove the filler plug from the transmission and add recommended transmission lubricant to the level prescribed by the transmission or truck manufacturer. (See Fig. 20.)

   NOTE: If the P.T.O. is mounted below oil level, additional lubricant will be required.

2. Run the P.T.O. for 5-10 minutes and check for oil leaks and noise.
3. Should a quiet P.T.O. become noisy after the universal joint connection is made, check the P.T.O. driveline components for an out of phase condition, excessive or unequal joint angles or possibly worn parts in the driven accessory.
4. Re-torque all mounting bolts, nuts, cap screws and set up inspection routine of the P.T.O. driveline components and the driven auxiliary equipment.

   NOTE: Anticipate slight increase in P.T.O. noise level as oil thins out at operating temperatures.



Fig. 20

P.T.O. Installation Tips For Automatic Transmissions

The procedure for installing a P.T.O. on an automatic is basically the same as for a mechanical transmission. Power take-offs for automatic transmissions are assembled with a special drilled input shaft which allows the input gear to be pressure lubricated during operation. (see page 21).

After installing a P.T.O. on an automatic transmission, connect pressure lubrication hose to the P.T.O. and the transmission per installation instructions shown on page 22 of this booklet.

WARNING: Adapter assemblies are never used on an automatic transmission because they do not have pressure lubricated design features.

WARNING: Use only wire control with P.T.O. made for wire cable control. If lever is desired, order P.T.O. for lever control. The internal shifting mechanism for wire is not designed for heavy forces usually encountered with lever control linkage.

CONTINUITY CHECK
378969 and 379110 INDICATOR SWITCHES

In order to insure that the switch is functioning properly, the following procedure can be used with the unit on a bench, or installed.

▲ 1. Use a continuity checker, battery type, either meter or light. Attach one (1) probe to the screw on the 378969 or 379110 Indicator Switch.

2. With the other probe, make contact with the shifter cover or housing (see Figs. #1 & 2).

3. Actuate shifting device and the meter or light* should be actuated when P.T.O. gear is engaged (see Figs. #3 & 4).

4. Shift unit out of gear and the meter or light* should return to normal as shown (see Figs. #1 and 2).

This test procedure can be used to check Chelsea wire, lever, and air shifter covers, although an air source would be necessary for the latter.

*If a meter is not available the light in the 328751X can be used (see Figs. #2 & 4). A six volt battery is all that is necessary for a power source.

▲ **Make sure 378969 and 379110 Indicator Switches, in the P.T.O. shifter or housing, are torqued to 10-15 lbs. ft. (1.38-2.07 kg meters).**

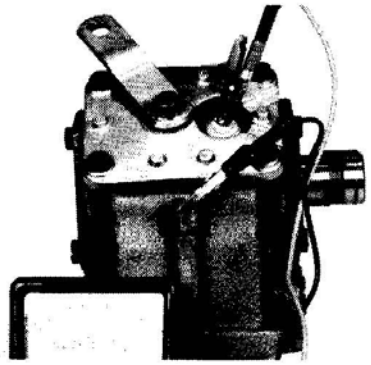


Fig. 1

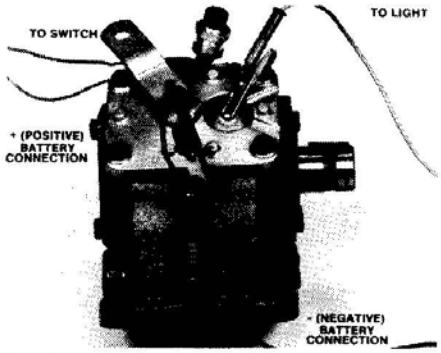


Fig. 2

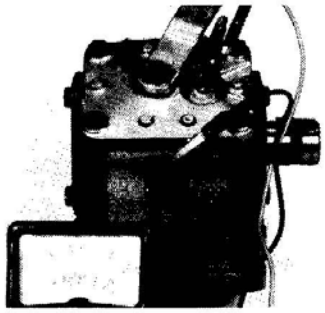


Fig. 3

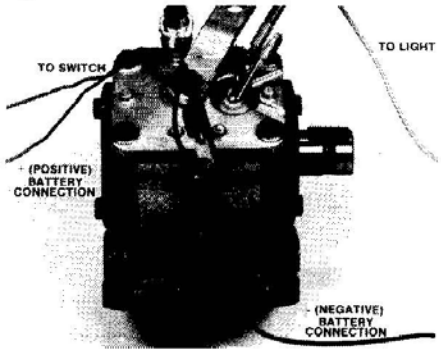


Fig. 4

WIRE SHIFT P.T.O.'s*
Cable Control Installation Instructions

1. Find a suitable area on the dash to install the cable control and the control plate-indicator light.

   NOTE: The location of the cable control and the control plate should be as close to each other as possible and easily accessible by the driver or operator, but should not be an obstacle to driver movement nor interfere with other controls, instruments, or equipment.

2. Drill a ½" (.5") diameter hole for the control cable.

3. Install the control cable on the dash using the hex nuts supplied with the cable. The knob can then be screwed into place. The length of cable can then run through the firewall and back to the P.T.O. — making sure it is kept away from the exhaust, moving parts, etc. (Fig. #1, 2)

   NOTE: Do not kink the cable. In order for the cable to operate properly, there can be no bends smaller than 6 inch radius. Total bends in the cable should not exceed 360° (example - four 90° bends in cable).

4. Using the template found on page 30 drill the necessary holes for the control plate-indicator light (Fig. #3 & 4).

* All six bolt wire shifts with the exception of the reversibles, dual shift units, and some gear boxes.

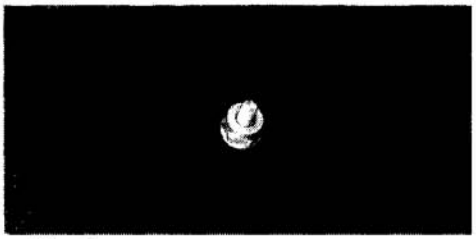


Fig. 1

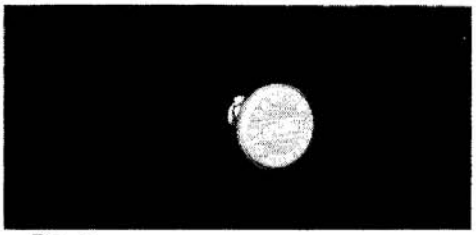


Fig. 2

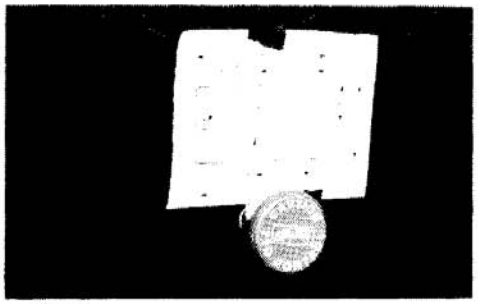


Fig. 3



Fig. 4



Fig. 5

WIRE SHIFT P.T.O.'s (continued)

5. Install the control plate - indicator light on the dash using the hardware supplied in the 328751X parts bag. (Fig. #5)

6. Determine from which direction the cable must come in order for the unit to be disengaged when the knob is all the way in.

   NOTE: The shifter must always be installed in the following manner:

   ▲CABLE IN: P.T.O. DISENGAGED (Fig. #6)
   CABLE OUT: P.T.O. ENGAGED (Fig. #7)

7. Install the wire control bracket found in either the 328380X or 328380-1X wire control parts bag. (Fig. #8)

8. Line the cable up with the wire control bracket and shifter lever (disengaged position) on the P.T.O. cover assembly (Fig. #9)

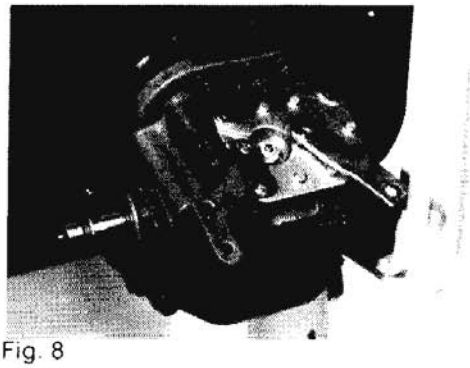
   NOTE: It may be necessary to change the position of the shifter lever on the P.T.O. To do this, remove the shifter cover from the unit. This will prevent the possible loss of the poppet and/or spring into the transmission if the shifter post assembly should be pushed through the cover when reinstalling the lever.

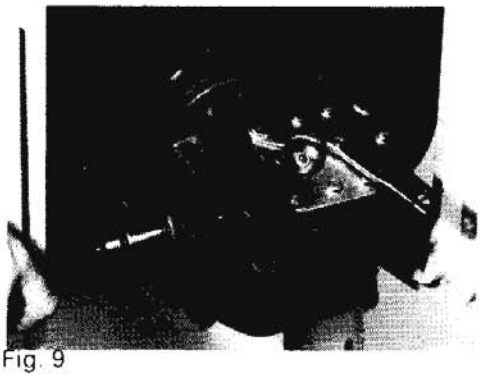


Fig. 6 ▲



Fig. 7


Fig. 8


Fig. 9

▲ The wire shift cable should be installed so that when the cable (knob) is pushed all the way in, the PTO has also moved the full travel of the PTO shifter, to the disengaged mode.

9. Shift the P.T.O. to the engaged position to see how much of the cable casing must be cut to allow the lever enough travel to shift in and out completely. The casing need only go just beyond the bracket, whereas, the wire must be long enough to go through the swivel pin in the shifter lever. (Fig. #10)

   NOTE: In some instances the cable control may not be long enough. Chelsea has available four longer lengths than the standard ten-foot cable. These come in five foot increments (i.e., 328346-15X = 15-foot cable).

10. When the length of the casing has been determined, pull the wire back through until the case can be cut without cutting the wire. Use a hacksaw or heavy pair of sidecutters to cut the casing. (Fig. #11)

    NOTE: The cable can be held by a bench vise as long as the jaws are not tightened to the point where the case mushrooms. If a vise is not accessible, a pair of vise grips will do the job.

11. Push the wire back through and install the cable using the hardware from the previously mentioned wire control parts bag (Step #7), (Fig. #12). See exploded drawing.



Fig. 10



Fig. 11

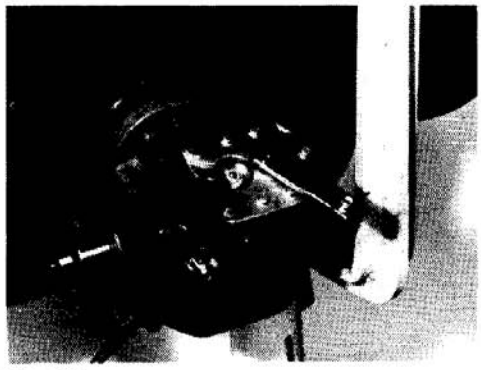


Fig. 12

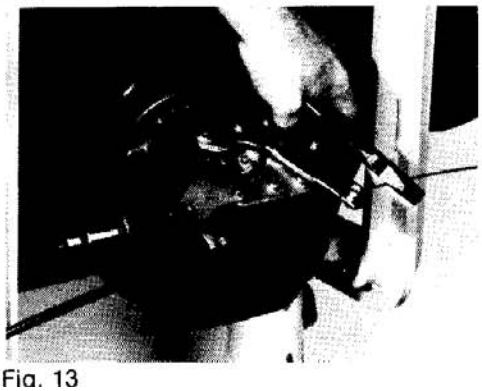


Fig. 13

WIRE SHIFT P.T.O.'s (continued)

12. Cut the excess wire after the cable casing and wire have been installed and tightened. (Fig. #13)
13. Shift the P.T.O. to insure enough casing has been removed to allow full gear engagement.
14. Install the wiring for the indicator light using the schematic from page 30 ■ (Fig. #14).

    NOTE: Check both the cable and indicator light wires to be certain that they are not near the exhaust system or any moving parts. Carefully fasten to stationary parts of the vehicle if necessary.
15. Shift the P.T.O. The following should be adhered to:
    CABLE IN: P.T.O. DISENGAGED: LIGHT OUT (Fig. #14 & 15)
    CABLE OUT: P.T.O. ENGAGED: LIGHT ON (Fig. #16 & 17)

    NOTE: The P.T.O. should be checked for continuity as per the instructions in this manual.

    NOTE: Cable must be rigidly mounted-possibly to the transmission within 12-24" of the PTO.

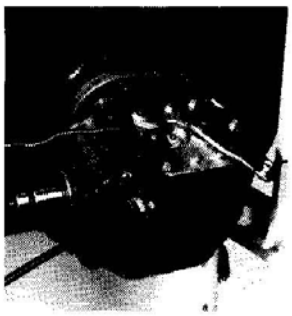


Fig. 14



Fig. 15



Fig. 16

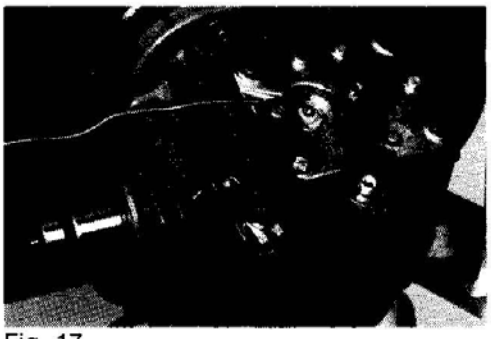


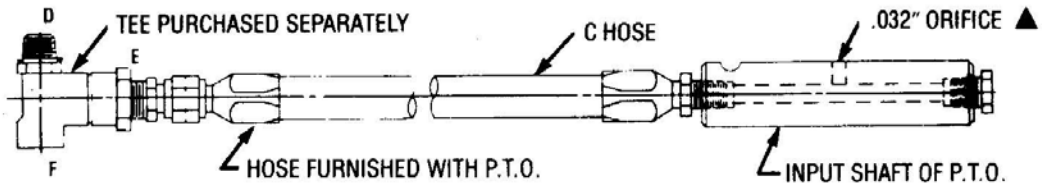
Fig. 17

WIRE SHIFT INSTALLATION INSTRUCTIONS
(Reversibles, dual shift units, and some gear boxes)

1. Use step #1 - #5 from previous instructions.
2. In step #6 the cable can come from either direction since the P.T.O. will always be engaged when all the way in or out.
3. Follow step #7 and #8.
4. In step #9 shift the P.T.O. from forward to reverse or vice versa to determine the amount of travel needed and the length of casing to be cut.
5. Follow step #10 - #14.
6. Step #15 will show the following:

   CABLE IN: P.T.O.
   ENGAGED: LIGHT ON
   CABLE OUT (1st position):
   P.T.O. DISENGAGED:
   LIGHT OUT
   CABLE OUT (2nd position):
   P.T.O. ENGAGED: LIGHT ON

AUTOMATIC TRANSMISSIONS
Pressure Lube Hose Connection



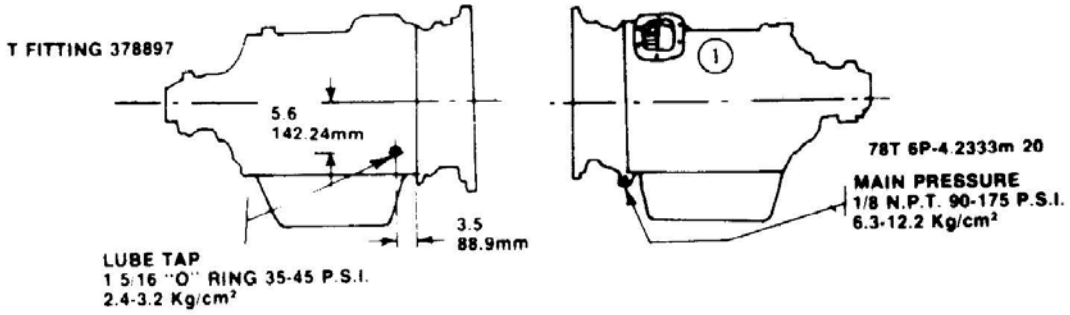
TEE FITTING	378840	378880	378970	378897
D	.750-16 U.N.F. 2A	.875-14 U.N.F. 2A	1.062-12 U.N.F. 2A	1.312-12 U.N. 2A
E	.250-18 N.P.T.F.	.250-18 N.P.T.F.	.250-18 N.P.T.F.	.250-18 N.P.T.F.
F	.750-16 U.N.F. 2B	.875-14 U.N.F. 2B	1.062-12 U.N.F. 2B	1.312-12 U.N. 2B

The specific "T" Fitting for each Automatic Transmission is called out at the bottom of each transmission's application sheet. If a "T" fitting is not called out, then a standard pipe tee will adapt.

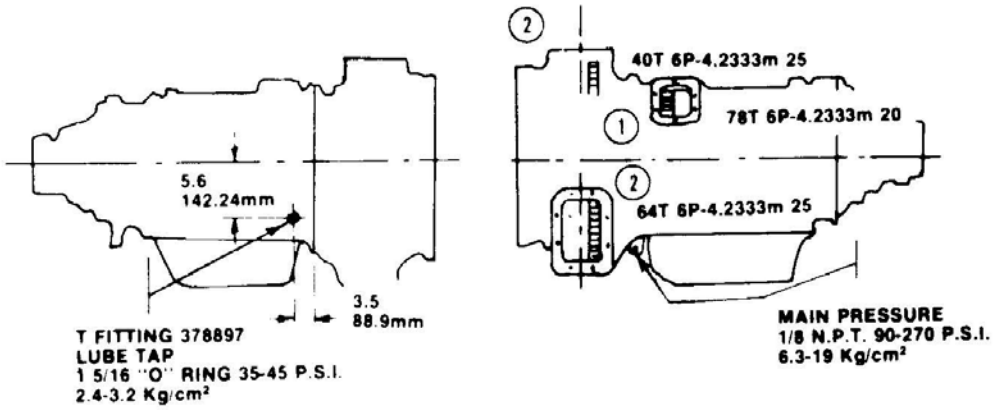
▲**NOTE:** *The .032" orifice is built into all pressure lubed idler shafts. No additional orifices are required when using these pressure lubed shafts.*

P.T.O. OPENINGS
For Automatic Transmissions Allison Models

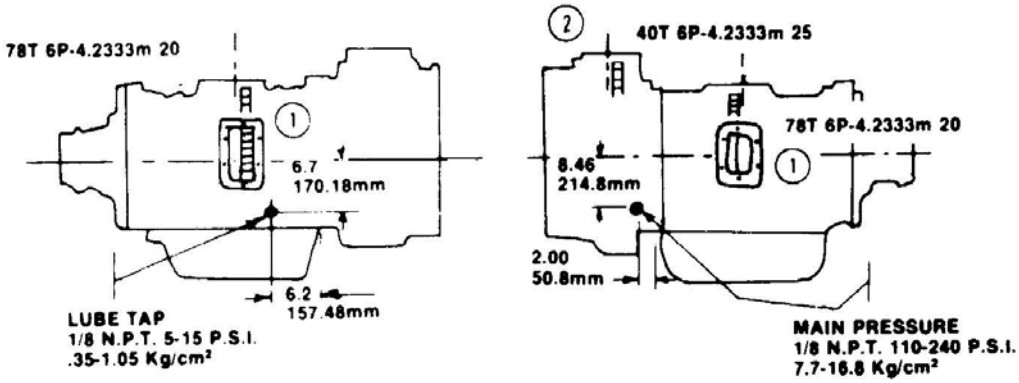
HT-740
HT-750D



CLT-750

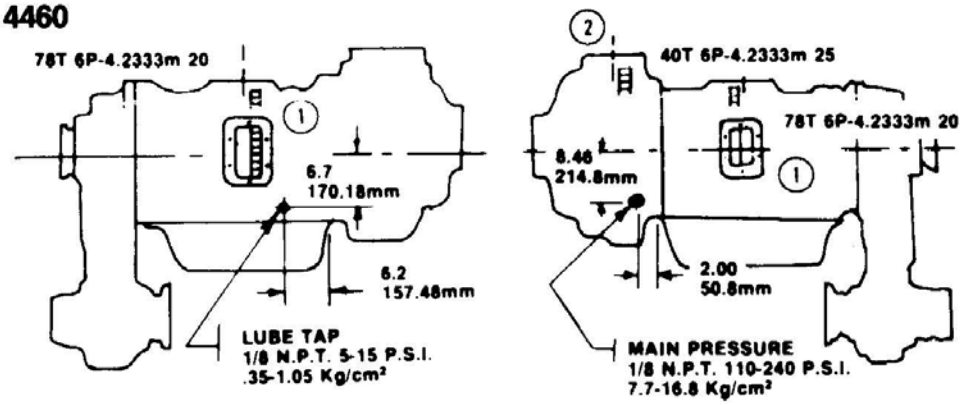


HT-70

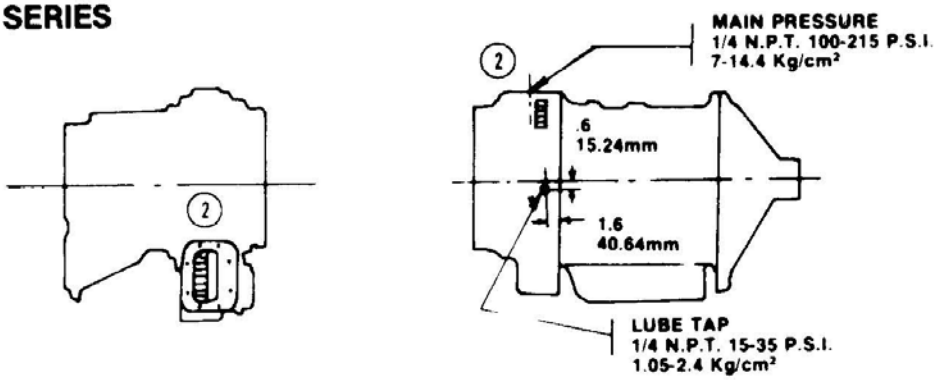


P.T.O. OPENINGS (Continued)

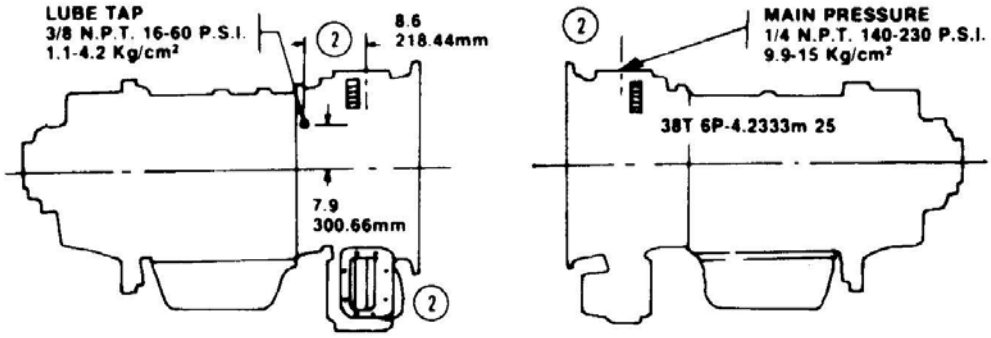
4460



5000 SERIES



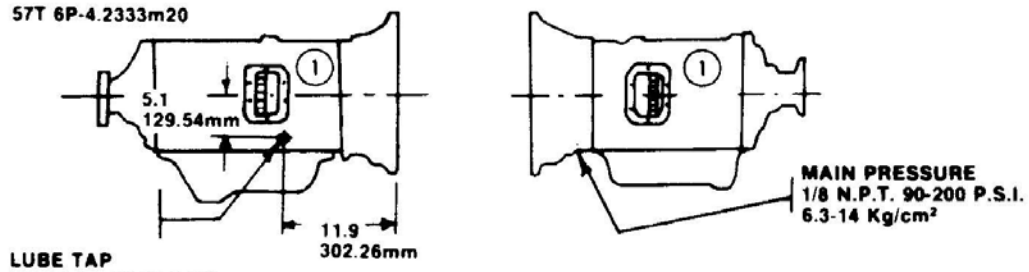
8000 SERIES



1. *Converter driven P.T.O. Drive Gear*
2. *Engine driven P.T.O. Drive Gear*

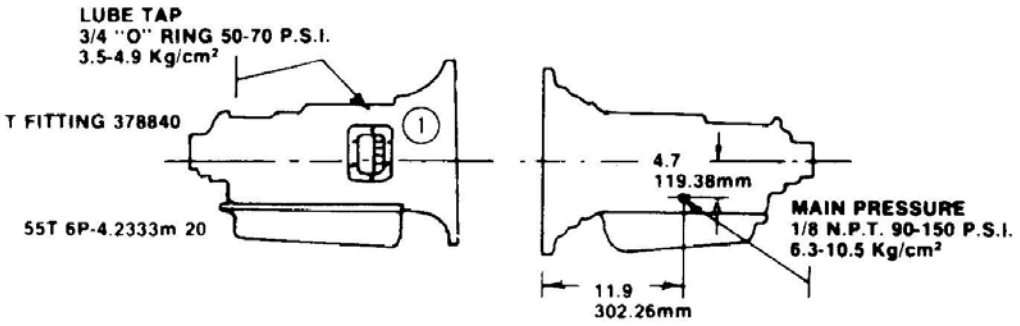
P.T.O. OPENINGS (continued)

MT-30-42
6 SPEED
3341-3441

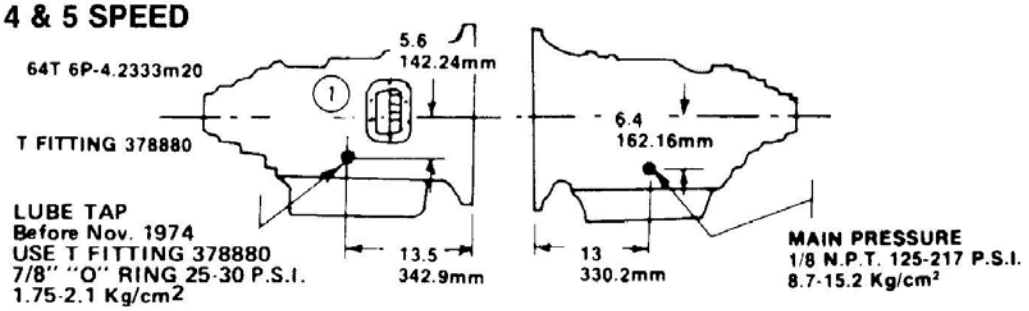


LUBE TAP
3/4 N.P.T. 12-20 P.S.I.
.82-1.4 Kg/cm²

AT-540
4 SPEED



MT-640
MT-650
4 & 5 SPEED



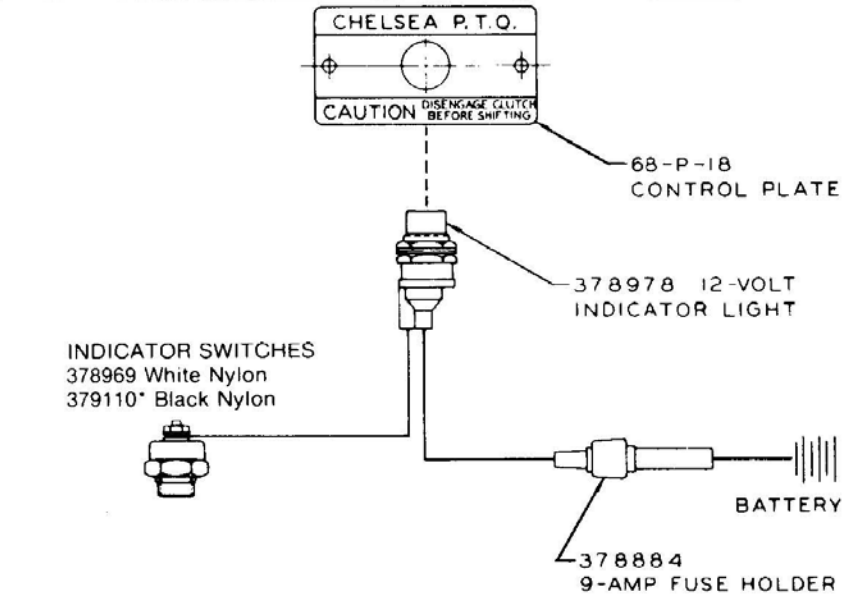
LUBE TAP
Before Nov. 1974
USE T FITTING 378880
7/8" "O" RING 25-30 P.S.I.
1.75-2.1 Kg/cm2

After Nov. 1974
USE T FITTING 378970
1-1/16" "O" RING 25-30 P.S.I.
1.75-2.1 Kg/cm2

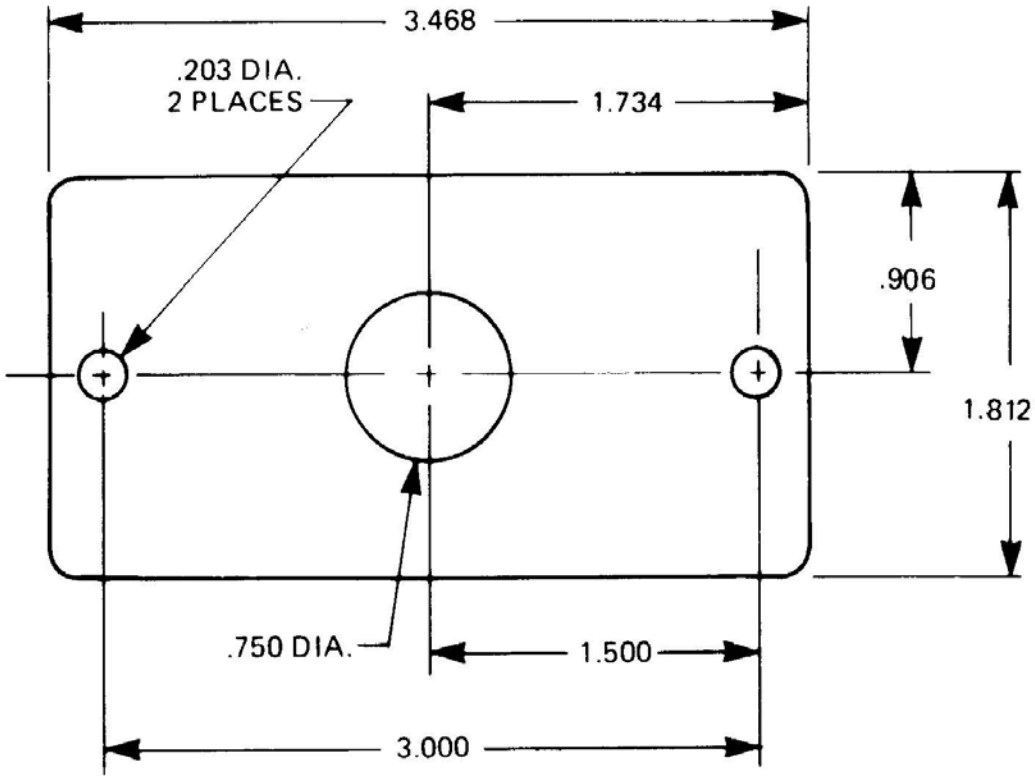
1. Converter driven P.T.O. Drive Gear

INDICATOR LIGHT INSTALLATION/ DASH DRILLING TEMPLATE

For Indicator Light Installation of 220, 260, 812, 100, 321, 322, 340, 350*, 381, 410, 420, 431, 445* and 450* Series Wire and Lever Control



*Special Indicator Switch for these models.



P.T.O. SHIFTING PROCEDURE & PRECAUTIONS

CAUTION

This vehicle is equipped with a POWER TAKE-OFF
Shut Engine Off Before Working On POWER TAKE-OFF Or Getting Below Vehicle.
Consult Operating Instructions Before Using. (See Sun Visor)

POWER TAKE-OFF OPERATION —VEHICLE STATIONARY

I. Mechanical Transmission

1. A power take-off is, and should be, operated as an integral part of the main transmission.
2. Before shifting the power take-off into or out of gear disengage the clutch and wait for transmission or P.T.O. gears to stop rotating.

II. Automatic Transmission with Manual Shift P.T.O.'s (Includes Air Shift)

On automatic transmissions, the gears in the transmission turn when the transmission is in neutral, therefore, gear clashing will occur if the power take-off is shifted into gear at this time.

A. With Converter Driven Gear:

1. Shift transmission lever into any of the drive positions (This will stop transmission gear from turning.)
2. Shift power take-off into gear.
3. Shift transmission into neutral. (This will start transmission gears turning).

B. With Engine Driven Gear:

1. Shift P.T.O. into gear before starting engine.

This procedure should eliminate gear clash.

III. Automatic Transmission with Power Shift P.T.O.'s

Engage P.T.O. with engine at idle speed.

Power Shift P.T.O.'s: Engine must be at idle when P.T.O. is engaged. See transmission manufacturer's instructions for special procedures.

IMPORTANT: Failure to follow proper shifting or operating sequences will result in premature P.T.O. failure with possible damage to other equipment.

WARNING

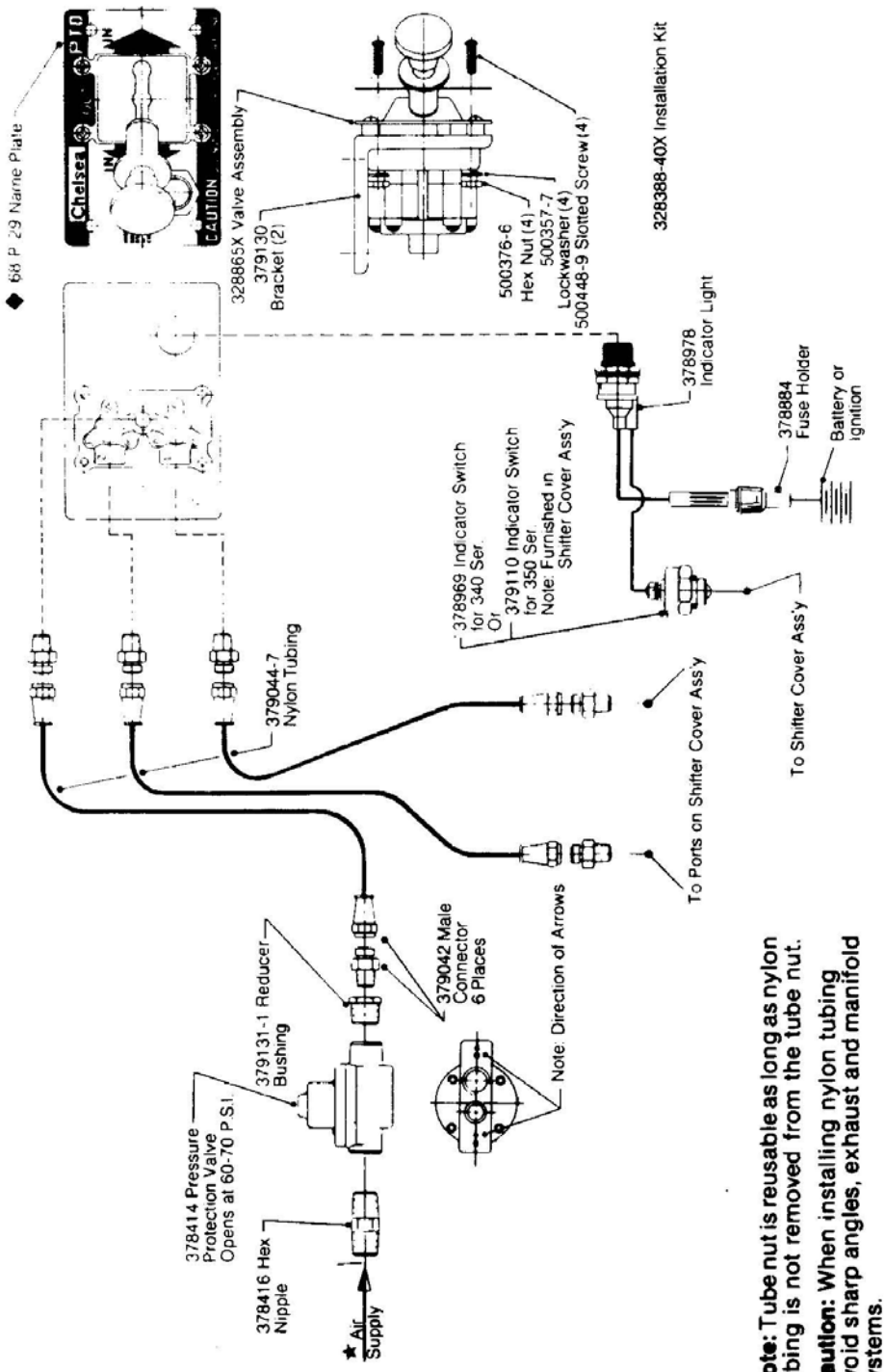
Use only wire control with P.T.O. made for wire cable control. If lever control is desired, order P.T.O. for lever control. The internal shifting mechanism for wire is not designed for heavy forces usually encountered with lever control linkage.

Do not attempt to work on an installed power take off with the engine running.

Make sure to block any moving or raised device that may injure a person working on or under the truck. A lever or its linkage may be accidentally moved causing movement of the device which could cause injury to a person near the device.

AIR SHIFT

Installation Sketch for 340 and 350 Series Using:
New Williams Valve



Note: Tube nut is reusable as long as nylon tubing is not removed from the tube nut.

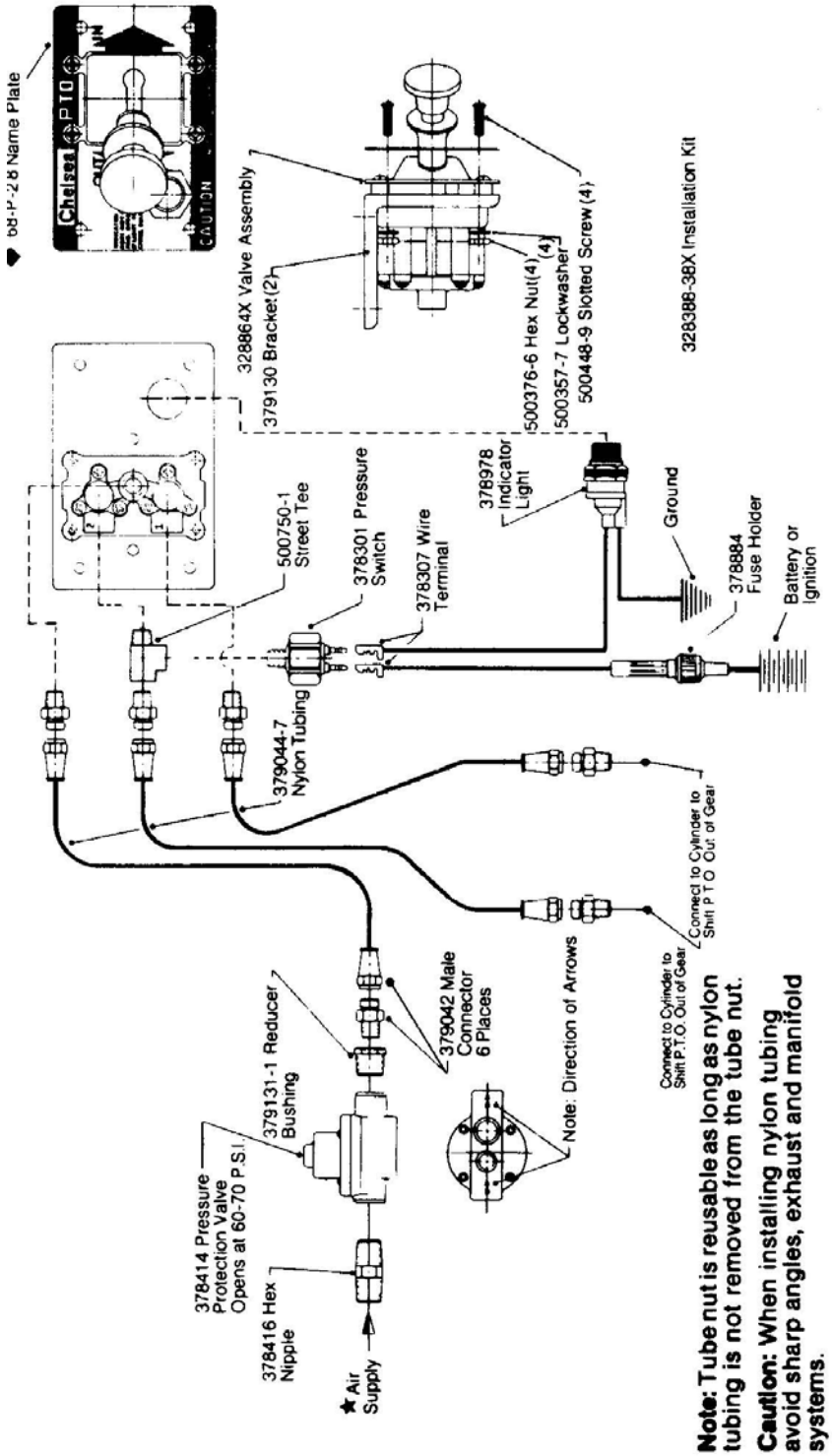
Caution: When installing nylon tubing avoid sharp angles, exhaust and manifold systems.

◆ Template for control plate on page 32.

★ **Warning:** Connect directly to air supply. Do not use tubing between air supply and pressure protection valve.

AIR SHIFT

Installation Sketch for 822, 832, 900, 910, and 920 Series Using:
New Williams Valve



Note: Tube nut is reusable as long as nylon tubing is not removed from the tube nut.

Caution: When installing nylon tubing avoid sharp angles, exhaust and manifold systems.

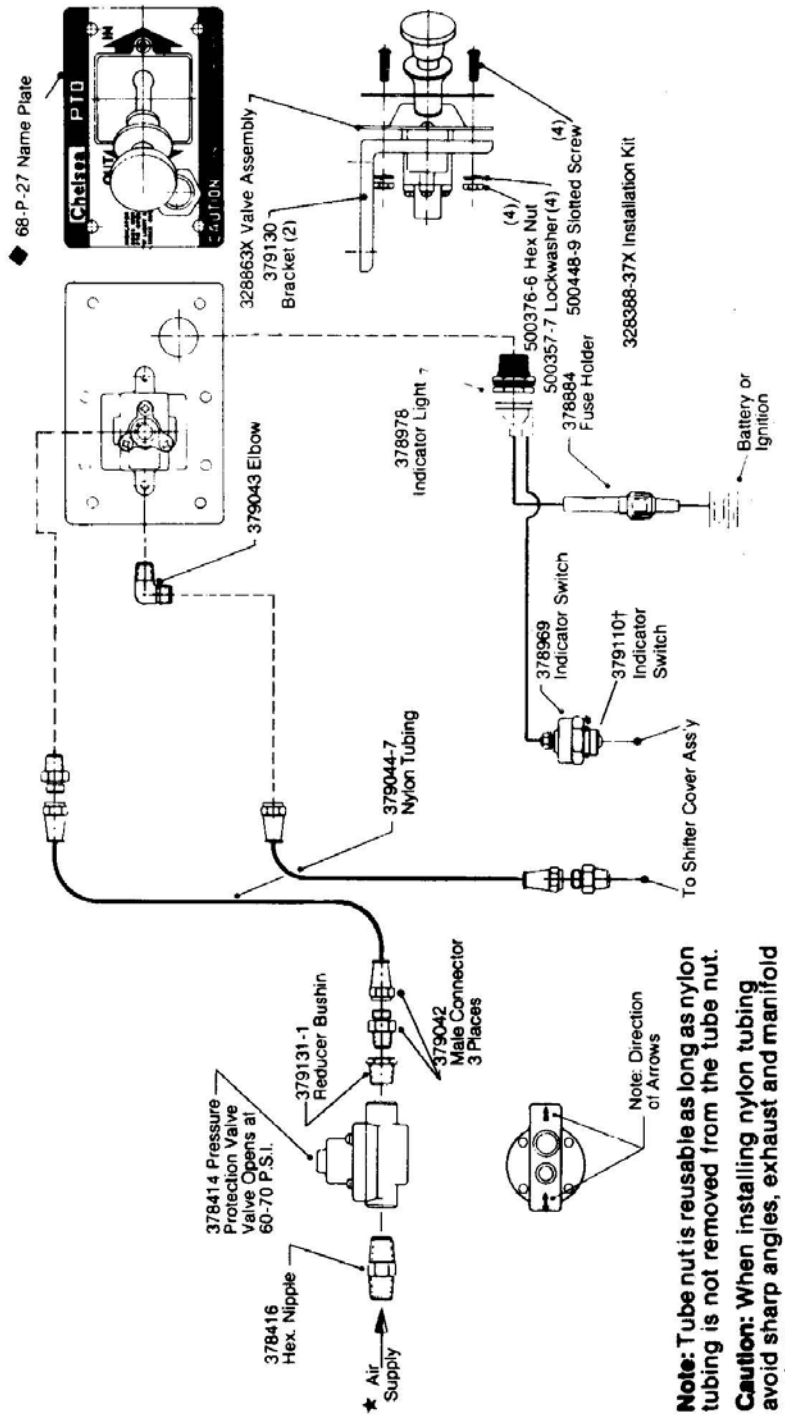
Important: When this installation is used on vehicles with automatic transmissions, the P.T.O. drive gear must be stopped before shifting.

◆ Template for control plate on page 32.

★ **Warning:** Connect directly to air supply. Do not use tubing between air supply and pressure protection valve.

AIR SHIFT

Installation Sketch for 100, 220, 260, 381, 410, 420, 431, 445 and 812 Series
Using: New Williams Valve



Note: Tube nut is reusable as long as nylon tubing is not removed from the tube nut.

Caution: When installing nylon tubing avoid sharp angles, exhaust and manifold systems.

Important: When this installation is used on vehicles with automatic transmissions, the P.T.O. drive gear must be stopped before shifting.

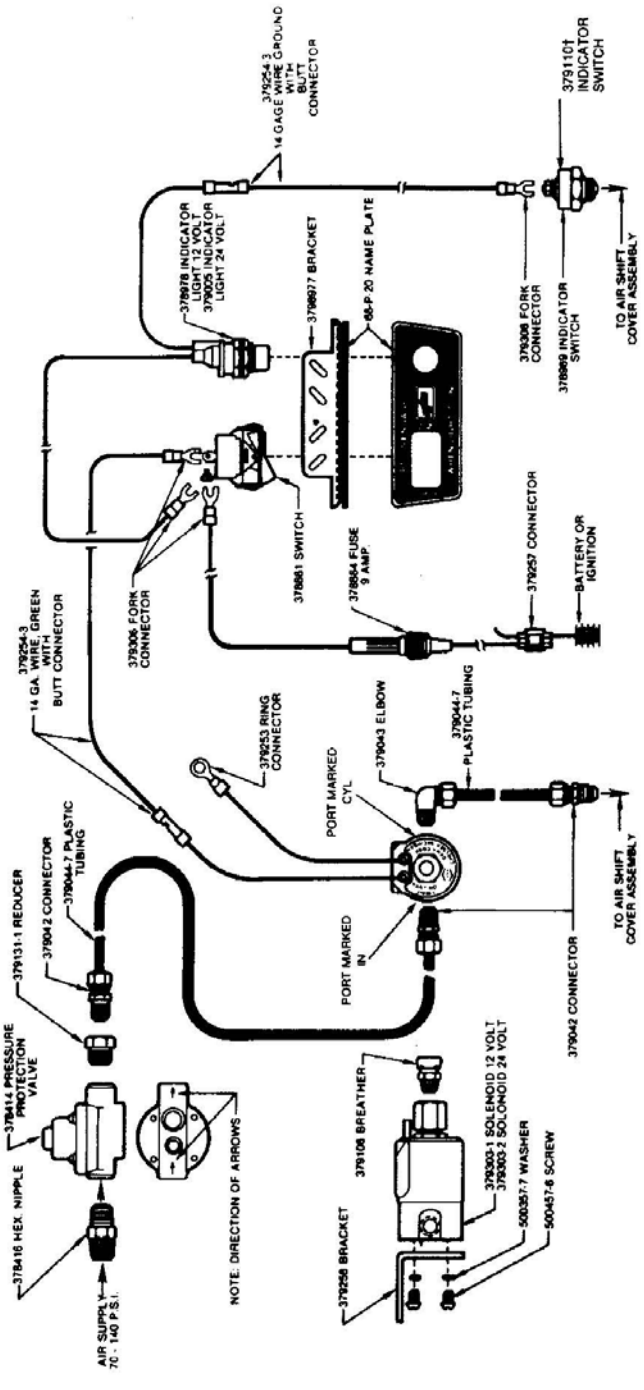
◆ Template for control plate on page 30.

★ **Warning:** Connect directly to air supply. Do not use tubing between air supply and pressure protection valve.

† 379110 Indicator Switch with Black Nylon used on the 445 Series.

ELECTRIC OVER AIR SHIFT

Installation Sketch for 100, 220, 260, 381, 410, 420, 431, 445 and 812 Series



Note: Tube nut is reusable as long as nylon tubing is not removed from the tube nut.

Caution: When installing nylon tubing avoid sharp angles, exhaust and manifold systems.

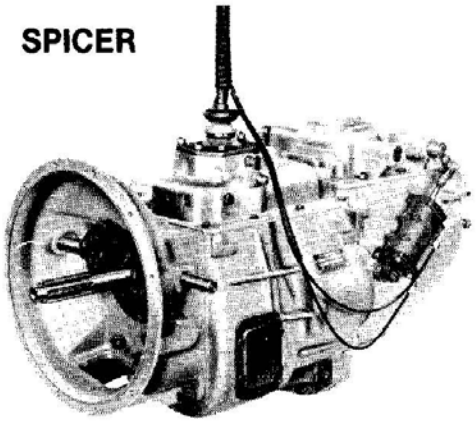
Important: When this installation is used on vehicles with automatic transmissions the P.T.O. drive gear must be stopped before shifting.

***Warning:** Connect directly to air supply. Do not use tubing between air supply and pressure protection valve.

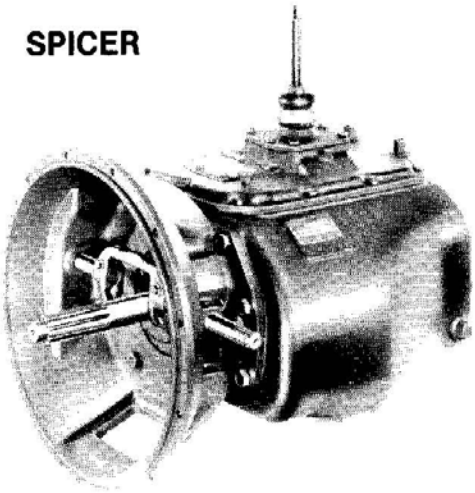
† 379110 Indicator Switch with Black Nylon used on the 445 Series.

TRANSMISSION TAG LOCATIONS

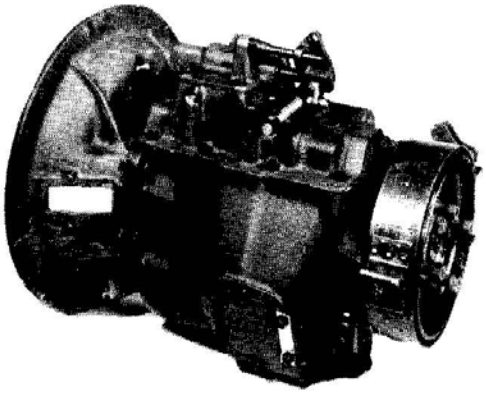
SPICER



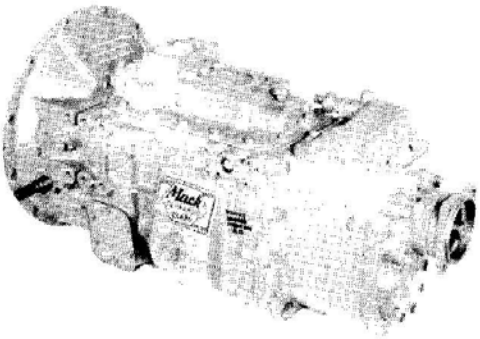
SPICER



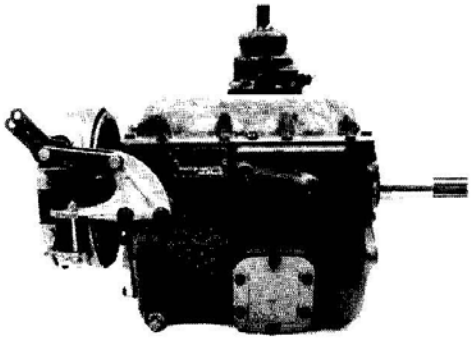
NEW PROCESS



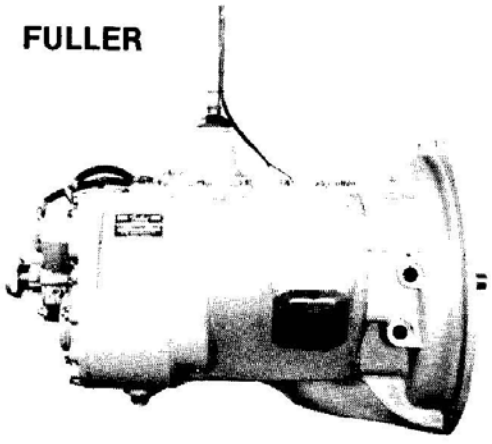
MACK

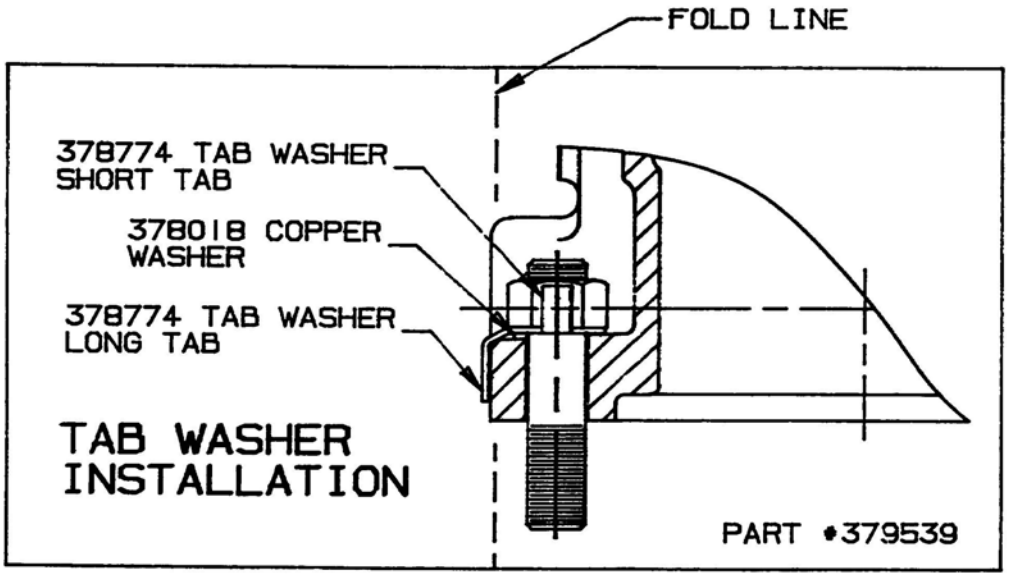


CLARK



FULLER




FOLD LINE
378774 TAB WASHER
SHORT TAB
378018 COPPER
WASHER
378774 TAB WASHER
LONG TAB
TAB WASHER
INSTALLATION
PART #379539

WARNING

ROTATING SHAFTS ARE DANGEROUS

YOU CAN SNAG CLOTHES, SKIN, HAIR, HANDS, ETC
THIS CAN CAUSE SERIOUS INJURY OR DEATH.

- EXPOSED ROTATING SHAFTS MUST BE GUARDED.
- DO NOT WORK ON OR NEAR AN EXPOSED SHAFT WHEN ENGINE IS RUNNING.
- SHUT OFF ENGINE BEFORE WORKING ON POWER TAKE OFF OR DRIVEN EQUIPMENT.



READ P.T.O. OWNERS MANUAL
FOR MORE SAFETY INFORMATION

379276 6/93

WARNING

LOCATE NEAR P.T.O. CONTROL

PLACE THIS PART OF DECAL ON SUN VISOR

379085-1

IMPORTANT

This vehicle is equipped with a POWER TAKE - OFF

-READ OWNERS MANUAL LOCATED IN THE GLOVE BOX.

-SEE SUN VISOR FOR OPERATING INSTRUCTIONS.

CHELSEA®

DANA

6-94

POWER TAKE OFF OPERATION MECHANICALLY SHIFTED P.T.O.'S

I. MANUALLY SHIFTED TRANS.

1) STOP THE VEHICLE, ENGAGE THE VEHICLE BRAKES.
(DO NOT ENGAGE THE PARKING BRAKE AT THIS TIME).
2) DISENGAGE CLUTCH AND SHIFT TRANSMISSION TO NEUTRAL.
WAIT FOR THE TRANSMISSION OR P.T.O. GEARS TO STOP ROTATING.
3) SHIFT THE POWER TAKE OFF.
4) FOR A STATIONARY OPERATION LEAVE THE TRANSMISSION IN NEUTRAL.
APPLY THE PARKING BRAKE, ENGAGE CLUTCH.
5) RELEASE VEHICLE BRAKES.

II. AUTOMATIC TRANSMISSION

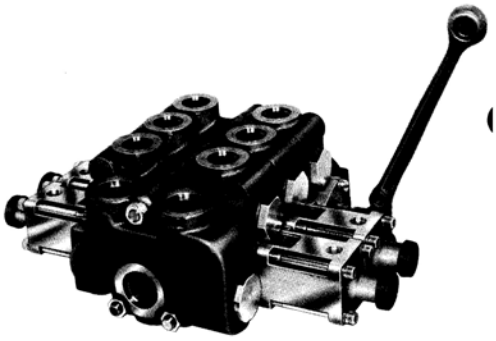
1) STOP THE VEHICLE AND ENGAGE THE VEHICLE BRAKES.
(DO NOT ENGAGE THE PARKING BRAKE AT THIS TIME).
2) SHIFT TRANSMISSION LEVER INTO ANY OF THE DRIVE POSITIONS. (THIS WILL STOP THE TRANSMISSION GEARS FROM TURNING).
3) SHIFT THE POWER TAKE OFF.
4) SHIFT THE TRANSMISSION INTO NEUTRAL. (THIS WILL START THE TRANSMISSION GEARS ROTATING AGAIN).
5) FOR A STATIONARY OPERATION, APPLY THE PARKING BRAKE.
6) RELEASE VEHICLE BRAKES.

6-94

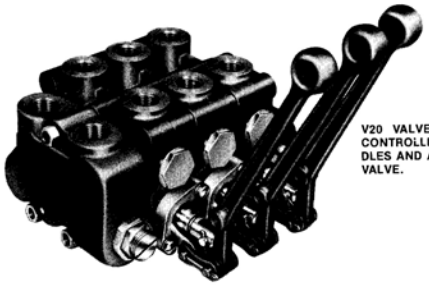
GRESEN®

DANA

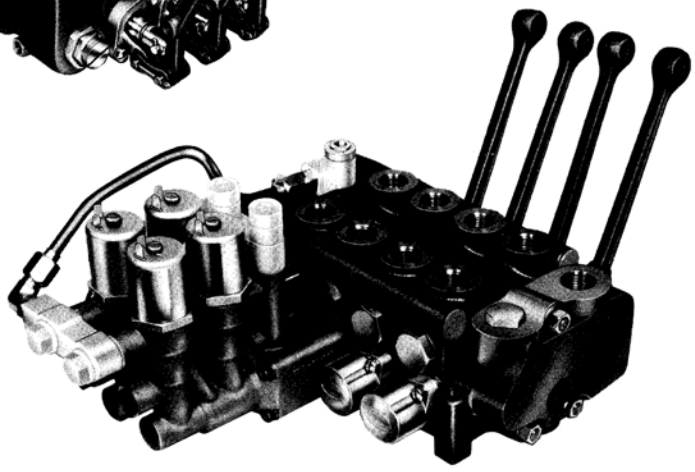
GENERAL INFORMATION



V20 VALVE ASSEMBLY WITH TWO HYDRAULIC REMOTE SPOOL ACTUATORS AND ONE MANUALLY CONTROLLED SECTION.



V20 VALVE ASSEMBLY, MANUALLY CONTROLLED WITH VERTICAL HANDLES AND ADJUSTABLE MAIN RELIEF VALVE.



V20 VALVE ASSEMBLY WITH TWO SOLENOID CONTROLLED SECTIONS AND TWO MANUALLY CONTROLLED SECTIONS.

INTRODUCTION

Directional Control Valves . . . start, stop and direct fluid flow. They control extension and retraction of cylinders, rotation of fluid motors and actuators, and sequence other circuit operations.

Gresen offers two basic types of body designs . . . the Monoblock which has all component parts in one single casting . . . and the Sectional Body design.

Sectional Body Valves . . . consist of one or more complete work sections with end covers. The entire assembly is bolted together to form a complete Sectional Body Directional Control Valve. A variety of work sections, spools, and spool actions, end covers and relief combinations are available to provide the exact type of valve assembly required for any given application whether mobile, industrial or agricultural.

Gresen's Model V20 Directional Control Valve is available for parallel, tandem, combined parallel/tandem and series hydraulic circuit applications, up to 3500 PSI [242 bar] continuous operating pressure. Its new spool design has resulted in lighter spool actuating effort making its finger-tip touch and extra-fine metering characteristics ideal for back hoe, front end loader and personnel lift applications. This sensitivity also gives the design engineer a wider latitude of mechanical linkage possibilities.

Service or conversion is simple since individual sections can be added, removed or replaced in the field. Individual service or field conversion sections, rather than complete valve assemblies, can be stocked thus reducing inventories.

FEATURES

Exact Work Port Control . . . is achieved with smooth, positive metering valve spools. Spools are precisely hone-fitted to a matching work section for excellent spool-hold characteristics giving minimum load "leak down."

Built-In Safety . . . Hydraulic system and equipment protection incorporated at each work port eliminates need for any additional external plumbing. Main relief valves, work port relief valves, anti-cavitation checks and work port restrictors are available for safety, equipment protection and positive control.

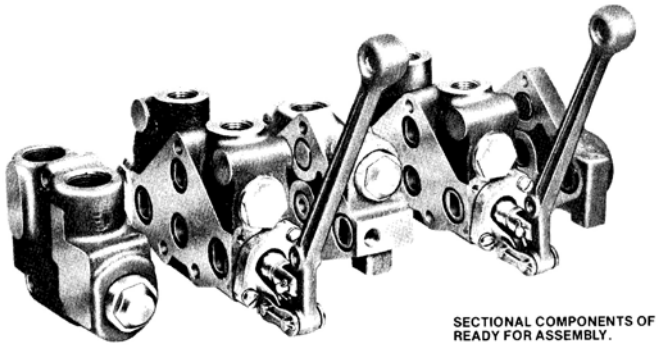
Construction . . . All valve housings are made of ductile cast iron for durability and resistance to shock loads.

Spools are hard, chrome-plated for long life and resistance to corrosion. All spools are select hone-fitted for minimum internal leakage and maximum load-holding ability.

Seal Compatibility . . . All standard Gresen products utilize BUNA-N seals which are compatible with petroleum base, water-in-oil emulsions, and water-glycol fluids. Phosphate ester type fire-resistant fluids will cause BUNA-N seals to swell. This swelling is not normally detrimental to static seals, but will be a problem for dynamic seals such as valve spool seals. Swelling of these seals can result in binding spools. The temperature range of BUNA-N seals is −40°F [−40°C] to +200°F [+93°C] for continuous operation.

VITON seals are recommended for most applications that use phosphate-ester type fluids. VITON seals are also recommended for applications that have a continuous operating temperature of +200°F [+93°C] or more. VITON seals are available for Model V20 valves.

Due to the large number of hydraulic oil manufacturers, and the increasing availability of oil under various brand names, we recommend the customer consult his fluid manufacturer regarding compatibility . . . or test to his own satisfaction.



SECTIONAL COMPONENTS OF A MODEL V20 VALVE READY FOR ASSEMBLY.

GRESEN®

DANA

SELECTING A V20 VALVE

Gresen's V20 Directional Control Valves are offered in six different models and are grouped into two basic systems. . . **open center** and **closed center.** This catalog has grouped these two systems, each into its own section. Full description and specifications for these Valves will be found in their respective sections. To order your V20 Valves, you must first determine which system will be best for your application.

OPEN CENTER SYSTEM • Refer to Page 23

Model V20P Parallel Circuit • **Model V20T** Tandem Circuit • **Model V20PT** Parallel/Tandem Circuit • **Model V20S** Series Circuit

Hydraulic oil is directed from the inlet port, thru the open center core to the outlet port of the Directional Control Valve when all spools are in the neutral position. Shifting the valve spool directs oil flow to the desired work port.

Maximum circuit pressure is limited by the main relief valve, which relieves into the exhaust core.

In a neutral position, open center systems operate at full flow and at low pressure.

ADVANTAGES	DISADVANTAGES
• Requires simpler, fixed displacement pumps	• Limited metering capability
• Lower initial cost	• Lower overall efficiency
• Components more readily available	• Limited simultaneous operation of different functions

CLOSED CENTER SYSTEM • Refer to Page 49

Model V20C Constant Pressure-Parallel Circuit

The Model V20C work section has no open center core. Pump flow is blocked by the valve when the valve spool is in neutral position. Shifting the valve spool directs the oil flow to the desired work port.

A pump that varies the output flow and maintains a predetermined output pressure is required for this type of circuit. Closed center systems typically operate at minimum flow and at high pressure standby when the valve spool is in the neutral position. The only flow required is that which will compensate for internal losses or for other system requirements.

• Delivers only the flow required by the function	• Remains at high pressure when on standby
• Improved metering	• Requires a more complex, variable displacement, pressure compensated pump
• Faster operation	

LOAD SENSING SYSTEM • Refer to Page 49

Model V20LS Load Sensing, flow and pressure compensated, parallel circuit

The Model V20LS load sensing work section is identical to the Model V20C closed center section except that internal porting has been added to allow a signal from the selected work port to be sent to the pump compensator through an external line. A flow and pressure compensated load sensing circuit permits the pump output pressure to drop to a relatively low standby pressure (150 to 250 PSI [10 to 17 bar]) when the valve spool is in the neutral position.

This system varies both pump flow and pressure with work load demand.

• Improved pump life	• More complex pump control required
• Increased overall efficiency	• External pilot line between valve and pump compensator required.
• Increased metering capability	

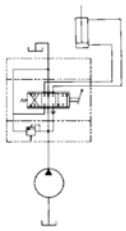
APPLICATION EXAMPLE

Consider an application requiring a maximum flow of 20 GPM [76 litres/min] at a maximum pressure of 2500 PSI [172 bar]. To meet the requirements of the application, the pump must be able to supply maximum flow at maximum pressure when required. However, during most of its operation, it is required to deliver less than its maximum flow at less than its maximum pressure. The way in which the system responds to the reduced-load conditions and the percentage of the total operating time the system will be used under reduced-load conditions should be considered.

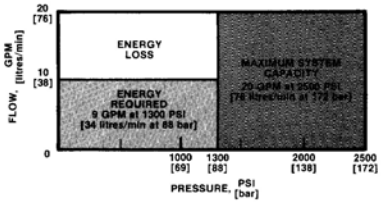
Functions requiring maximum system flow at maximum system pressure will all require approximately the same amount of power, assuming that system components are equivalent in size.

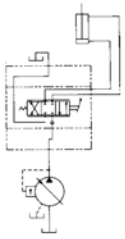
Functions requiring less than maximum flow and pressure best illustrate the advantages of the load sensing system. Consider a function in which a cylinder is to be extended. 1300 PSI [88 bar] is required at a metered flow rate of 9 GPM [34 litres/min].

EFFICIENCY

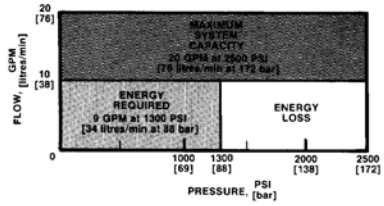


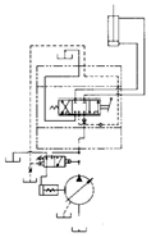
The open center system requires a fixed displacement pump capable of 20 GPM [76 litres/min] and a relief valve set at 2500 PSI [172 bar]. System pressure is determined by load resistance. Therefore, the pump delivers a full 20 GPM [76 litres/min] at 1300 PSI [88 bar] to the control valve. The control valve allows 9 GPM [34 litres/min] to be directed to the cylinder, the remaining 11 GPM [42 litres/min] is directed to the reservoir and its energy lost in the form of heat.



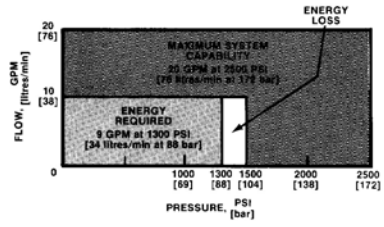


The closed center system requires a variable displacement, pressure compensated pump capable of 20 GPM [76 litres/min] with the compensator set to "destroke" the pump at 2500 PSI [172 bar]. The pump delivers only the required 9 GPM [34 litres/min] to the control valve, but at a pressure of 2500 PSI [172 bar]. Because the cylinder only requires 1300 PSI [88 bar], there is a 1200 PSI [83 bar] pressure drop through the control valve at the 9 GPM [34 litres/min] flow rate. Energy is again lost in the form of heat.





The closed center system with load sensing requires a variable-displacement, pressure compensated pump capable of 20 GPM [76 litres/min] with the compensator set to "destroke" the pump at 200 PSI [14 bar]. As the control valve is shifted to the working position, the pressure within the work port is sensed at the pump compensator. The work port pressure, 1300 PSI [88 bar], is additive to the "destroke" pressure of 200 PSI [14 bar]. Therefore, the pump delivers 9 GPM [34 litres/min] at 1500 PSI [104 bar] to the control valve. There is a 200 PSI [14 bar] pressure drop through the control valve which is lost as heat.

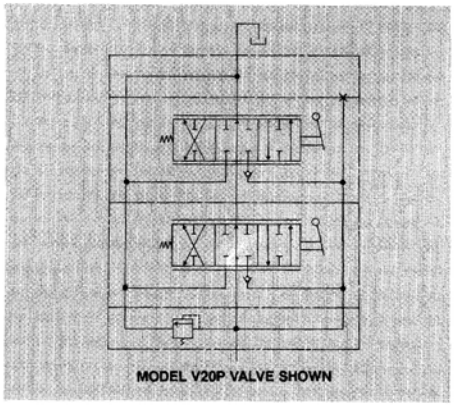


HYDRAULIC CIRCUITS

PARALLEL CIRCUITS

In a parallel circuit valve, two or more spools may be actuated at the same time and the oil will follow the path of least resistance. If a 2-spool valve is used to control two hydraulic cylinders, each with a different load, the cylinder with the lightest load will operate first if both spools are fully actuated at the same time. If the spool controlling the cylinder with the light load is metered (spool not fully actuated), then both cylinders can be operated at the same time.

When a spool is fully actuated, the open center core is blocked and oil is directed into the power core. Oil is then available to the work ports of all sections in the valve assembly.



MODEL V20P VALVE SHOWN

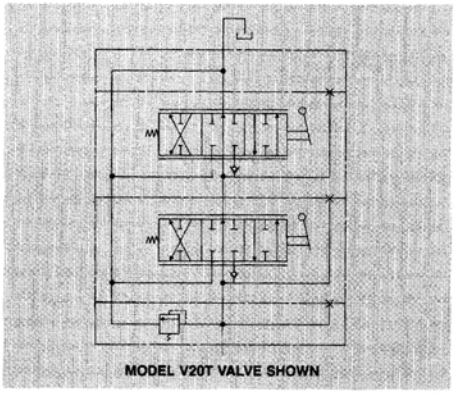
TANDEM CIRCUITS

A valve assembly made up of tandem work sections may be referred to as a priority valve or series parallel valve.

In the neutral position, oil is available to all valve sections through the open center core. When two or more valve spools are fully actuated at the same time, oil will only be available to the work ports of the upstream work section (section closest to the inlet). In a tandem valve, an upstream work section will always has priority over a downstream work section when its spool is fully actuated.

The tandem work section is very similar to the parallel work section with the following exceptions:

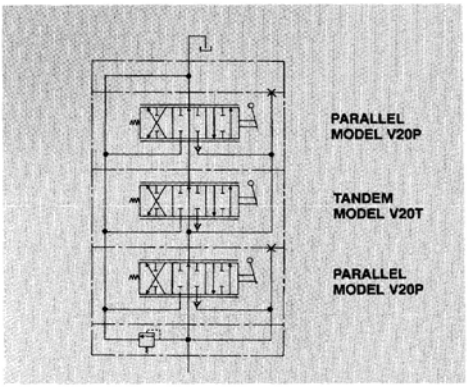
1. A passage within the tandem work section connects the open center core with the power core.
2. The power core is blocked on the upstream side of the tandem work section.



MODEL V20T VALVE SHOWN

COMBINED PARALLEL/TANDEM CIRCUITS

A valve assembly may be made up of any combination of parallel and tandem sections to fit a particular application. In this type of valve assembly, the section upstream from the tandem work section has priority (the tandem section itself does not have priority). The adjacent hydraulic schematic shows a three-work-section valve: the first work section is a parallel valve; the second, a tandem valve; and the third, a parallel valve. Note that in the tandem valve work section the open center core is connected to the power core and the power core from section No. 1 is blocked at the upstream side of the tandem work section. If the spool in section No. 2 is actuated, oil will be available to its work ports. But, if the spool in section No 1 is fully actuated at the same time, all the oil will go to the work ports of section No. 1. No oil will be available to the second or third work sections.

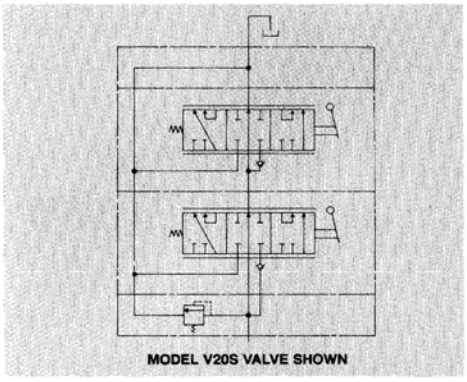


SERIES CIRCUITS

In a series circuit valve, two or more spools may be actuated at the same time. The entire flow of oil is available to each work section in sequence from inlet to outlet port through the open center core. In a 2-spool valve (both spools actuated), oil is directed from the inlet port to a work port of section No. 1. The return oil to work section No. 1 is directed back to the open center core (and not to the tank port as in a parallel valve circuit). The returning oil is then available to section No. 2.

In a series circuit, pressure is additive. That is, the sum of all pressures required by all sections cannot exceed the main relief valve setting or pump pressure capability.

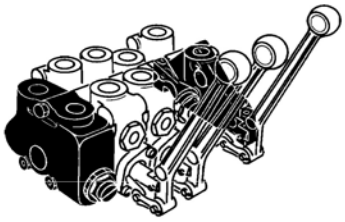
With certain restrictions, Model V20S sections may be intermixed with parallel or tandem work sections in the same valve assembly. Refer to page 38 for V20S stacking sequence restrictions.



MODEL V20S VALVE SHOWN

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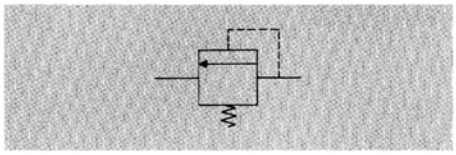
INLET COVERS and OUTLET COVERS

INLET COVERS

Inlet covers are designed to provide a variety of port sizes and locations. This permits valve assemblies to be "customized" using a minimum of external plumbing.

The outlet port may be located in either the inlet (left) cover or the outlet (right) cover. Location must be specified. If the addition of a secondary hydraulic pump is necessary, a mid-inlet conversion section for Model V20P and V20T Valves can be installed between any two work sections, providing an inlet port for the secondary pump (see page 32). Valve inlet covers are machined to accept Model WH or Model RP51 main system relief valve cartridges.

MAIN SYSTEM RELIEF VALVES

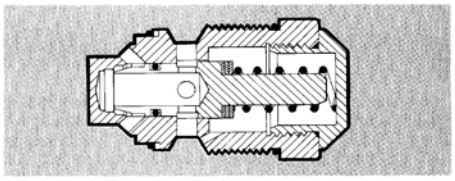


The primary function of a main system relief valve is to prevent excessive system pressures. Normally, this relief valve is installed in the inlet cover.

Relief valves for the V20 Valve Assembly are designed and fabricated in cartridge form to permit easier servicing and allow minimum interchangeability time. They feature quiet operation and are virtually trouble free and highly tolerant of foreign material in the hydraulic system.

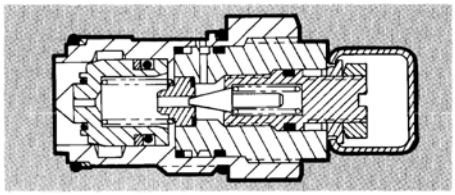
Relief valves are available in adjustable or tamperproof/non-adjustable configurations.

Model WH-Standard



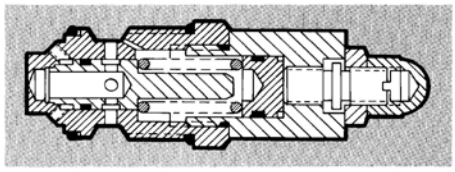
This unit is shim adjustable with shims within the spring range.

Model RP51 Optional



This relief valve cartridge is a pilot-operated type.
- Model RP51A — externally adjustable
- Model RP51N — tamperproof

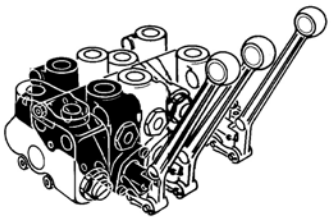
Model WHA-Optional



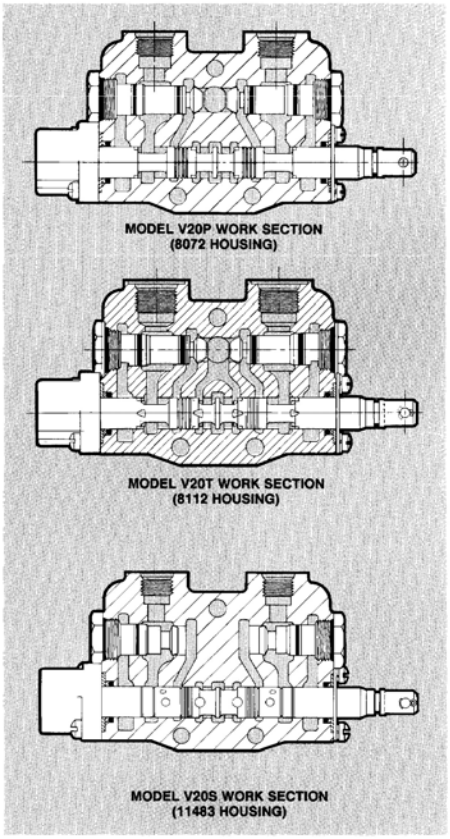
This model is easily adjustable within the spring range.

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WORK SECTIONS



MODEL V20P WORK SECTION
(8072 HOUSING)

MODEL V20T WORK SECTION
(8112 HOUSING)

MODEL V20S WORK SECTION
(11483 HOUSING)

Work sections in Gresen's Sectional Body Directional Control Valves are precisely machined from high tensile cast iron housings.

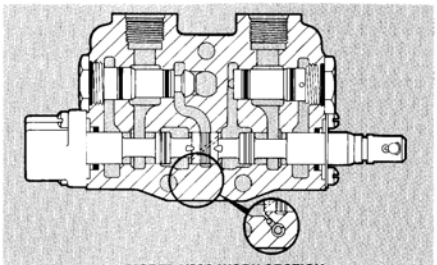
Valve spools may be manually, hydraulically, pneumatically, mechanically or electrically operated. All valve spools are select hone-fitted at the factory for minimum internal leakage and are not field replaceable.

Five types of basic work sections are available:

- Model V20P for open center, parallel circuit applications*
- Model V20T for open center, tandem circuit applications*
- Model V20S for open center, series circuit applications
- Model V20C for closed center, parallel circuit applications
- Model 20LS load sensing, for closed center, parallel circuit applications.

A variety of spools, spool action options and work port options are available for the work sections, depending on the particular application.

*Optional 4-way work sections with reduced open center pressure drop are available for parallel (V20RP) and tandem (V20RT) circuits. These reduced pressure drop sections are interchanged with a standard V20 open center sections and use standard V20 covers. All V20 spools and options are available with these sections. A heavier spool centering spring is required with V20RP and V20RT sections.



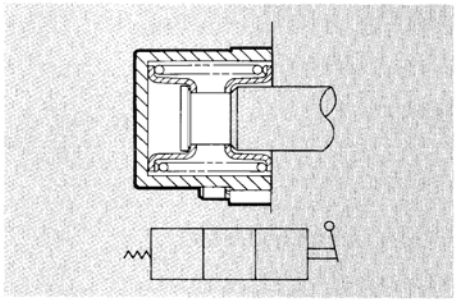
MODEL V20C WORK SECTION
WITH V20LS MODIFICATION
(8364 HOUSING)

SPOOL ACTION OPTIONS

Spring Return to Neutral

(Furnished as standard, unless otherwise specified)

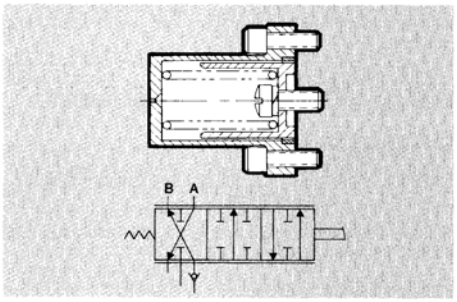
Spool action has three positions with spring return to neutral from "A" and "B" power positions.



Spring Extended Spool

Code Symbol A

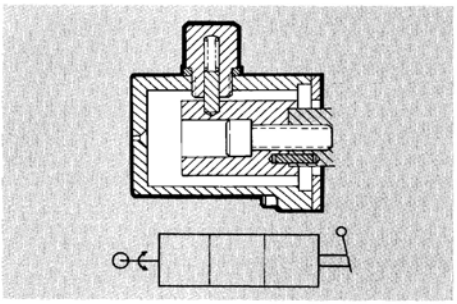
This feature eliminates spring-return to neutral, and spring loads the spool to the "OUT" position only (port "B" power position). Usually used for "Cam-Operation" of spool. Customer must supply cam-follower mechanism. When this option is ordered, a handle assembly is not furnished.



Rotary Spool Actuator

Code Symbol W

With this option, the movement of the spool is controlled by a rotary movement of the handle. Allows for 90° rotation of the spool each direction from center, making 180° total handle rotation with detent position in neutral. There is no spring-centering, therefore the spool will stay in any position placed. Handle assembly option not available with rotary actuator. (Customer must furnish his own handle mechanism.)



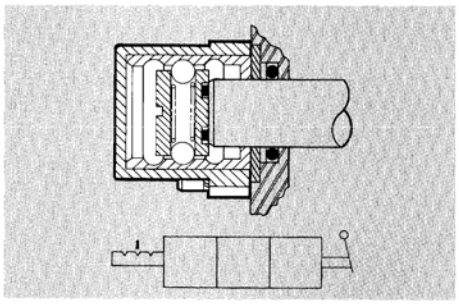
3-Position Detent

Code Symbol D

With this option the valve spool will remain in any of the three detented positions in which it is manually placed. No spring return to neutral.

Detent stop, 1889-001, is available to limit spool travel to two positions—neutral and spool "IN" or neutral and spool "OUT."

NOTE: The detent option is designed to provide operator "FEEL." It is NOT intended for use as a positive spool locking device against excessive external forces or machine vibration.

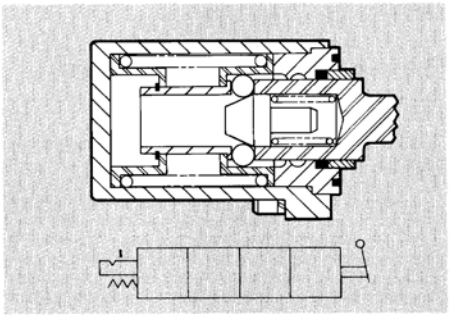


4-Position Float Assembly

Code Symbol K4

This option is spring-centered to neutral from the "A" or "B" work port power position. The fourth position is the detented "Float" position, which allows a cylinder to "Float" or a motor to "Free Wheel."

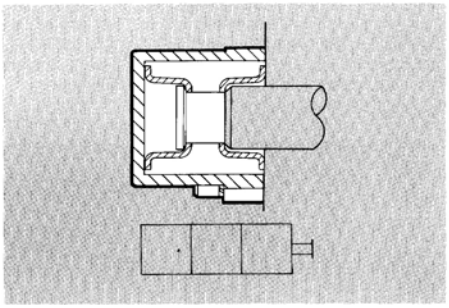
NOTE: Float spool positioners for Series type sections are different from those used in Parallel and Tandem sections.



Manual Actuator

Code Symbol M

The manual spool permits full spool travel without spring centering or detent assemblies.

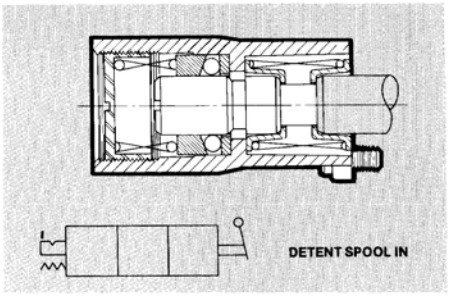


Optional Spool Detent Positions

1-POSITION SPOOL "IN" DETENT WITH SPRING RETURN to NEUTRAL

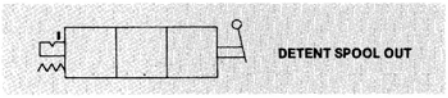
Code Symbol R

Work port "B" remains open to tank in detent position. Allows a single-acting cylinder to "Float."



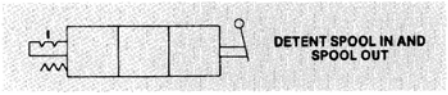
1-POSITION SPOOL "OUT" DETENT WITH SPRING RETURN to NEUTRAL

Code Symbol RO



2-POSITION SPOOL "IN" and "OUT" DETENT WITH SPRING RETURN to NEUTRAL

Code Symbol RIO



Internal Hydraulic Detent Release

Code Symbol KO

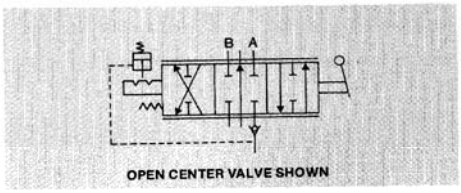
Automatically returns the spool to a neutral position as soon as the work cycle is completed.

The standard 4-way 3-position section has a 2-position detent with the spool spring loaded to the neutral position. The spool is held in either power position by the detent assembly. When pressure in the power circuit reaches a predetermined setting, the detent assembly releases and the centering spring returns the spool to neutral. Pressure detent release is field adjustable. Release pressure must be a minimum of 200 PSI [13,80 bar] below main relief setting.

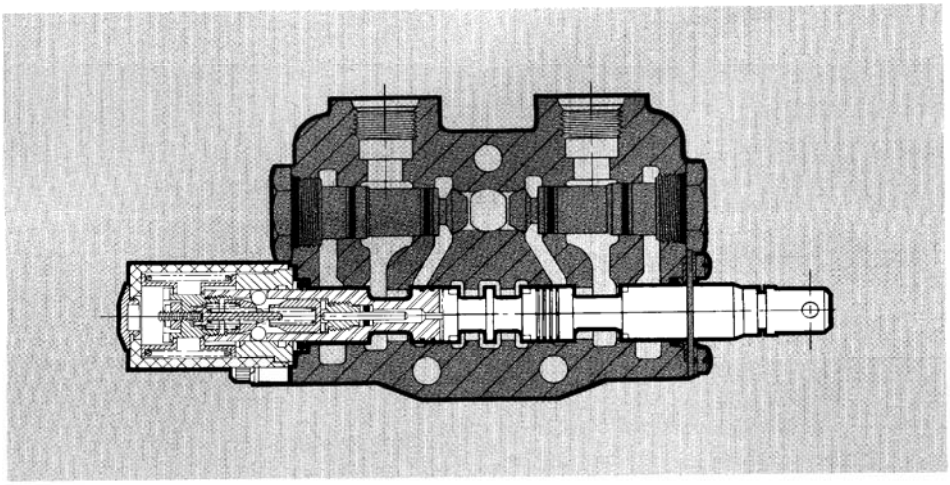
As many valve sections with hydraulic detent release as required may be assembled into one valve assembly. This option is also available for float sections.

SPECIFICATIONS

Operating Range . . . . . 500-3500 PSI [35-242 bar]
Normal Setting Tolerance. . . . . ±100 PSI [±7 bar]
Handles . . . . . "A" or "B" Port End



OPEN CENTER VALVE SHOWN



PRESSURE RELEASE FROM "A" POWER POSITION

Detent release pressure is sensed through the power core of the valve when the spool is in the "A" power position. In a valve assembly containing two or more KO sections, the section having the lowest detent pressure release setting will release its spool first when the spool is in the "A" power position. Each spool will release to neutral from the "A" power position as the pressure increases. The detent having the highest pressure setting will be the last to release to neutral.

PRESSURE RELEASE FROM "B" POWER POSITION

Detent release pressure is sensed only through the open center core of the valve when the spool is in the "B" power position. When an upstream spool is shifted to either power position, the open center core is blocked off preventing any downstream KO sections from sensing pressure in the open center core. Therefore, a downstream KO section will not release to neutral when an upstream spool is shifted to the "A" or "B" power position. A KO spool will only release to neutral from the "B" power position when all upstream sections are in the neutral or float position.

Electro-Magnetic Spool Release

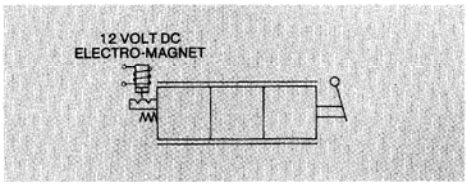
Code Symbol E

This option incorporates two electro-magnets in the bonnet assembly. The magnets may be energized continuously with a 12 volt DC power supply. When the operator manually shifts the spool to either power position, the spool will be held in position by magnetic force. A return spring will center the spool to neutral when the magnet is de-energized, or the spool may be returned to neutral manually.

The male connector on the bonnet contains three pins marked A, B, and C. Both magnets are connected to a common ground (pin C), pin A is connected to the magnet which will hold the spool in the "A" power position (spool "IN"), and pin B is connected to the magnet which will hold the spool in the "B" power position (spool "OUT").

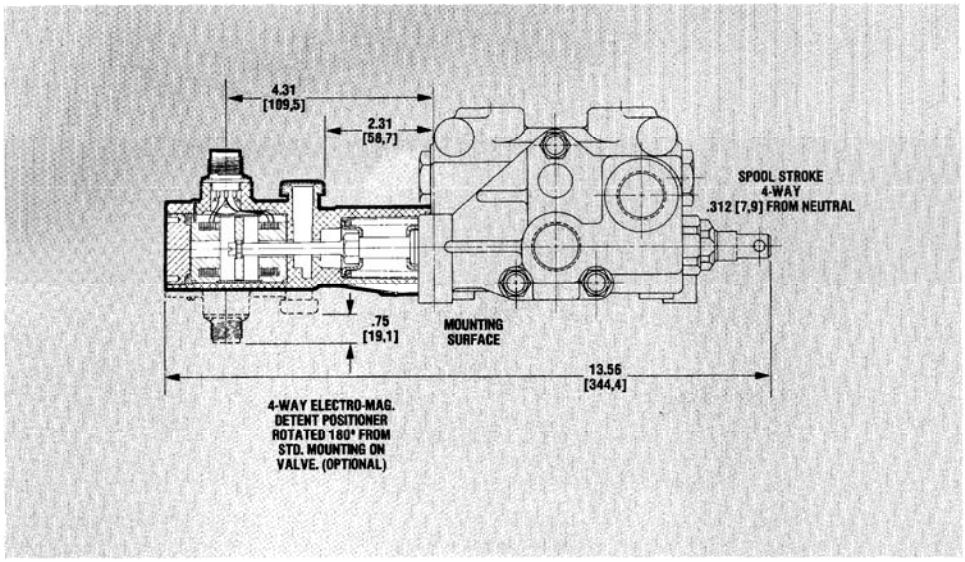
If a one position electric detent is required, only one magnet will be connected to the male connector. Pins A and C will be wired for spool "IN" detent, or pins B and C will be wired for spool "OUT" detent.

The electro-magnetic spool release assembly may be used with an external limit switch (furnished by the customer) to limit the stroke of a cylinder. This results in a more efficient operation, quicker cycle times, and saves time by automatically repositioning the cylinder while the operator is performing other operations. Another advantage is hydraulic system pressure does not build up to main relief valve pressure, which eliminates pressure surges and reduces heat build-up.



SPECIFICATIONS

Spools	Standard 3- or 4-way (not 4-way float)
Supply Voltage	12 volt DC
Male Bonnet Connector	MS 3102A-10SL-3P
Female Connector	MS 3106A-10SL-3S (Furnished by customer)



Hydraulic Remote Spool Actuator

Code Symbol HR, HRO and HRH

Hydraulic Remote Spool Actuators, Option Code HR, provide for remote operation of the Model V20 Directional Control Valve with two or three-position spools.

An external adjustment screw override, Option Code HRO, is available as an option. The screw provides for emergency manual operation in case of pilot pressure failure or permits lowering a load with the pump shut down.

A handle override feature is also available. Option Code HRH. This option allows full manual control at the valve with remote hydraulic control at a remote location. This option is ideal for applications where two control stations are required.

A customer-supplied, remotely located hydraulic controller will provide infinite spool positioning for metering flow to the work ports of the V20 Valve. The only limitation for metering capability is the pressure regulating performance of the hydraulic controller or the Valve.

Although valve work sections with Actuator control are normally assembled at the factory, field assembly on existing valve work sections is possible. Manually-operated valve work sections may be combined with Actuator-operated valve work sections in any arrangement.

For more information, refer to Gresen Catalog No. PC-1103.

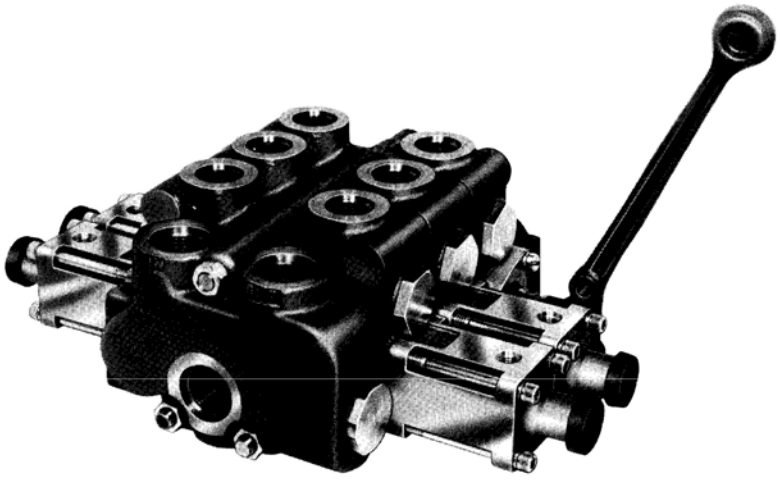
SPECIFICATIONS

DIRECTIONAL CONTROL VALVE

Capacity (nominal) . . . . . 20 GPM [75 litres/min]
Maximum Operating Pressure . . . . . 3500 PSI [242 bar]
Maximum Exhaust Core Pressure . . . . . 500 PSI [34 bar]

SPOOL ACTUATOR

For two, three, or four-position spool functions only
(Four-position for float operation)
Max. Pressure Rating . . . . . 500 PSI [34 bar]
Pilot Pressure to Initiate Spool Movement . . . . . 60 PSI [4 bar]
Pilot Pressure to Compensate for Spring Tension at Full Stroke. . . . . 300 PSI [20 bar]
Pilot Flow . . . . . 2 to 4 GPM [7.5 to 15 litres/min]



Option "HRO" Shown

Solenoid-Controlled Directional Control Valve

Gresen's on-off solenoid-controlled, pilot operated actuators are designed to provide remote operation of Model V20 Hydraulic Directional Control Valves.

Most Gresen Model V20 Sectional Body Directional Control Valves having a 3-position spool will accept a solenoid-controlled actuator. (Exceptions are the float spool and the standard Free Flow spool. A modified Free Flow spool is available for solenoid operation.)

Each Valve section may be solenoid-controlled, manually-controlled or both.

The sectional-body feature offers maximum flexibility and ease of maintenance. Although valve work sections with solenoid control are normally assembled at the factory, field assembly is possible in order to add additional work sections to an existing assembly.

The outlet tank port may be located in the outlet cover or in the left inlet cover of the control valve assembly.

A power beyond option is **not** available in the outlet cover of V20 solenoid operated valve assemblies. The power beyond option is available in the utility section. If a power beyond option is used in the utility section, the pressure build-up valve must be located in the downstream valve assembly.

For more information regarding electrical system requirements, optional accessories, and dimensions, refer to Gresen Catalog No. PC-1104.

SPECIFICATIONS

Pressure Rating. . . . . 3500 PSI [242 bar] max.
(Directional Control Valve)

Capacity (Nominal) . . . . . 20 GPM [75,5 litres/min]

Differential Pilot Pressure to Actuator . . . . . 200-300 PSI [14-21 bar]
(A minimum of 200 PSI [13,8 bar] is required to actuate the valve spool)

Maximum Allowable System Back Pressure. . . . . 300 PSI [21 bar]

Pilot Flow to Actuator . . . . . 2-4 GPM [7,6-15 litres/min]

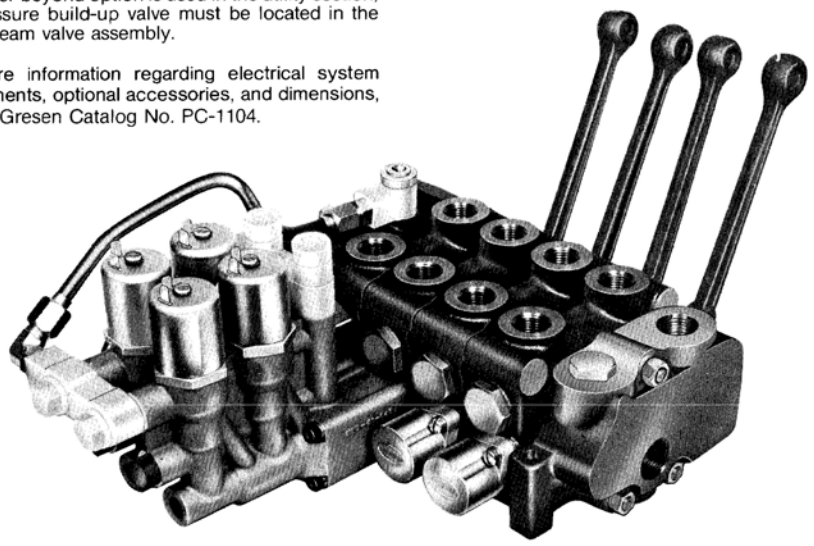
Operating Oil Temp . . . . . 180°F [82°C]
(Maximum)

Filtration Req. (Min.) . . . . . 33 micrometre

Solenoid Power Req. . . . . . 1.7-1.9 amps, 12 VDC
0.6-0.7 amps, 24 VDC

Weight:
Directional Control Valve Work Section with Solenoid-Controlled Actuator . . . . . Approx. 13 lbs. [5,9 kg]
Utility Section . . . . . Approx. 9 lbs. [4.1 kg]

Note: Double-throw switches are required when using internal pilot and must be provided by the customer.



GRESEN®

DANA

SPECIFYING GRESEN SECTIONAL BODY DIRECTIONAL CONTROL VALVES

Sectional Body Valves are custom assembled to meet specific application requirements.

When ordering a work section, valve component or a complete valve assembly, submit the information required in the Table of Options for Complete Valve Assemblies, page 54. Submit all of the information that applies to your application. Add any option information not specifically referred to in this catalog.

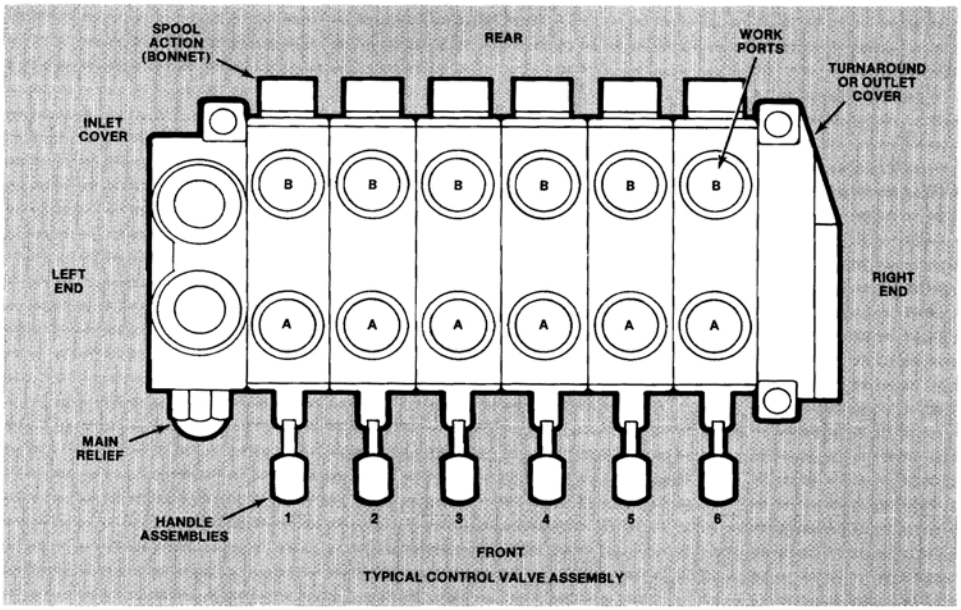
To properly specify the individual work sections, follow this procedure:

Using the diagram below, work ports should be on top with the "A" port nearest you. Inlet cover will be to your left and the outlet cover to your right.

The accompanying sketch of a typical control valve assembly has the handle assemblies in the standard location at the "A" port end of the valve.

Valve assembly specification forms are available to help simplify the ordering of various sections or complete valve assemblies. When ordering V20 Valves, use Form No. 9005. Specification forms have been included at the back of this Catalog. If additional forms are needed, contact any Gresen Distributor, Representative or the Sales Department, Minneapolis.

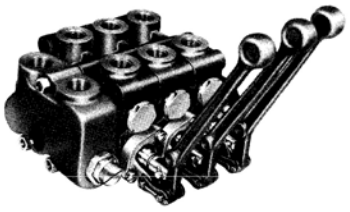
On receipt of the information, an order design number will be assigned to your valve assembly. Then, on future orders, the order design number or your part number need only be specified to identify the correct valve section, or assembly.



TYPICAL CONTROL VALVE ASSEMBLY

OPEN CENTER VALVE ASSEMBLIES

Models V20P, V20T, V20PT and V20S



Models V20P, V20T, and V20S Valve Assemblies utilize the same inlet and outlet covers, and most of the same basic options.

Model V20P, V20T, and V20S sections may be combined into one valve assembly. See page 38 for V20S stacking sequence restrictions.

FEATURES

- **Minimal spool actuating effort—Maximum, 50 pounds [22,6 kg] at the spool**
- **Improved, extra-fine metering**
- **Minimum pressure drops through open center and through work ports**
- **Float section may be installed at any point within the Valve assembly**

SPECIFICATIONS

Pressure Rating:
Continuous Operating ..... 3500 PSI [242 bar] max.
Maximum Exhaust Core Pressure:
With Handle Bracket or Heavy Duty Spool Seal Retainer Installed
Continuous Operating ..... 500 PSI [34,5 bar]
Intermittent Peak ..... 1000 PSI [69,0 bar]
With Standard Spool Seal Retainer Installed ..... 200 PSI [13,8 bar]
Capacity ..... Refer to Pressure Drop Charts. Flow rate is determined by the maximum pressure drop acceptable for the application.
Filtration Required (Min.) ..... 33 micrometre
Weight:
Inlet Cover ..... Approx. 6 lbs. [2,7 kg]
Outlet Cover ..... Approx. 3½ lbs. [1,6 kg]
Work Section, Each ..... Approx. 9 lbs. [4,1 kg]

INLET COVERS

All Model V20 valve inlet covers are machined for the Model WH main relief. If the relief is not required, a no relief (NR) plug will be installed. The following inlet covers are available:

Inlet Cover, No. 8398

No. 8398 inlet cover is available with top, end and bottom inlet ports. It is also available with top and end outlet ports. Top in and top out are the standard port locations for this cover.



NO. 8398 INLET COVER

PORTING OPTIONS AVAILABLE

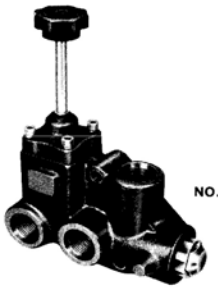
LOCATION	SAE STRAIGHT THREAD PORTS		NPT PIPE PORTS**	BSP PIPE PORTS	GAGE PORTS
	STANDARD	OPTIONAL	OPTIONAL	OPTIONAL	OPTIONAL
No. 8398 LEFT INLET COVER End, Top or Bottom* Inlet Ports. End or Top Outlet Ports.	SAE 12 (1-1/16" - 12 UN)	SAE 10 (7/8" - 14 UNF)	1/2" - 14 3/4" - 14	3/4" BSP	SAE 4 (7/16" - 14 UNF)

*Bottom inlet available only with SAE 10 or 3/4" NPT ports.
**NPT pipe ports are not recommended for pressure ports above 2000 PSI [138 bar].
NOTE: All ports in a casting must be the same type. SAE, BSP and NPT cannot be intermixed. Top inlet and top outlet ports are cored. If not specified, they will be plugged.

Inlet Cover, No. 7736 With Flow Control

A No. 7736 Inlet Cover contains an adjustable flow control assembly which directs the controlled portion of the inlet flow to the work ports and any excess flow into the exhaust core. The adjusted flow is pressure compensated and is the maximum amount of flow available to any work section in the valve assembly.

This inlet cover is machined for the Model WH relief. A no relief (NR) plug may be installed if the main relief valve is not required.



NO. 7736 INLET COVER

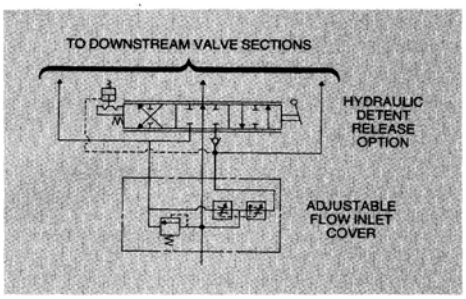
PORTING OPTIONS AVAILABLE

SAE and NPT ports cannot be intermixed in the same casting.

LOCATION	NPT PIPE PORTS		SAE STRAIGHT THREAD PORTS	
	STANDARD	OPTIONAL	STANDARD	OPTIONAL
END INLET	3/4"-14		SAE 12	SAE 10
TOP INLET	3/4"-14		SAE 12	SAE 10
END OUTLET	3/4"-14		SAE 12	

FLOW CONTROL RANGE TO 25 GPM [95 litres/min].

A control knob is furnished as standard. If it is to be omitted, please specify.



Excess Flow Option

This option utilizes the excess flow from the flow control by using the end outlet port as the excess flow port. An outlet port is not available in this cover when this option is specified. A typical application for this option is to direct the excess flow to a combined flow mid-inlet section installed downstream. When the upstream spools are in neutral, all flow is available downstream. When an upstream spool is activated, only excess flow oil is available to the downstream spools. This option also allows the flow from one pump to be split for two separate functions.

To order this option, specify "Plug B end exhaust core".

Main System Relief Valve

The main system relief valve is installed in the inlet cover. A detailed description of the main relief valve, its options and performance will be found on pages 10 and 11.

Relief setting at "crack pressure" or at "full flow" must be specified.

A main relief valve is available in the following configurations:

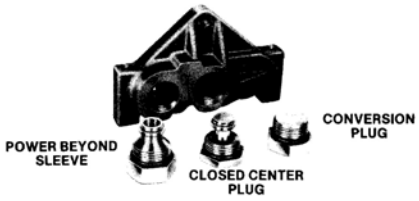
	ORDER CODE
Standard (adjustable with shims)	WH
Tamperproof (adjustable with shims)	WHNJ
Adjustable with screwdriver	WHA
Pilot operated relief	RP51
No Relief Plug (no relief valve installed)	NR

OPTIONS:

- Stainless steel relief springs
- VITON seals to replace standard BUNA-N seals

OUTLET COVERS

A variety of options and combinations of port sizes are offered. These options enable the user to customize valve assemblies while minimizing external plumbing. In addition, four application variations are available:



NO. 6770 OUTLET COVER WITH POWER BEYOND SLEEVE, CLOSED CENTER AND CONVERSION PLUG.

Outlet cover, No. 6770, is available for use with four application variations:

1. Open Center (standard)
2. Closed Center (conversion)
3. Power Beyond
4. Conversion Plug

Application variations are all accomplished by the machining and/or assembly of the outlet cover. Machining and assembly of the inlet cover and center sections do not affect these variations.

Outlet Port Option ...

If the outlet port is to be located in the outlet cover and closed center, power beyond or conversion plug options are specified, then the outlet port will be in the optional location.

Turnaround Cover Option ...

For plumbing convenience, the outlet port may be located in the inlet (left) cover. When it is, the turnaround (right) cover will direct the exhausting oil back to the inlet cover.

Application Variations ...

Application variations are all accomplished by the machining and/or assembly of the outlet cover. Machining and assembly of the inlet cover and center sections do not affect these variations.

OPEN CENTER

(Furnished as standard, unless otherwise specified)

Hydraulic oil is directed from the inlet port, thru the open center core to the outlet port of the Directional Control Valve when all spools are in the neutral position. Shifting the valve spool directs oil flow to the desired work port.

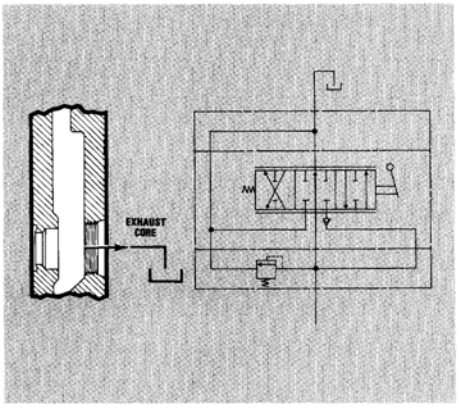
Maximum circuit pressure is limited by the main relief valve, which relieves into the exhaust core.

The standard Gresen valve is an open center control valve. The inlet port is open to the tank port, and both work ports are blocked when the control valve spool is in neutral position, thereby holding the cylinder or hydraulic motor in position.

The outlet port may be located in the right cover . . .

OR

Outlet port may be located in the left cover when a right turnaround cover is used.



Closed Center

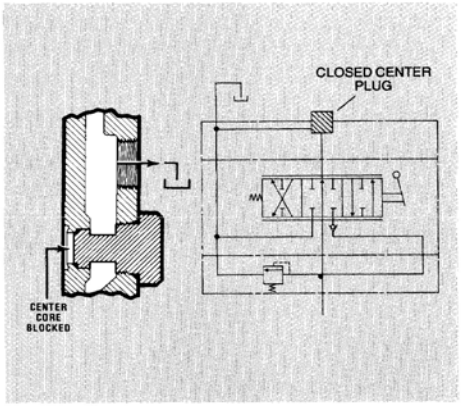
Code Symbol C

To convert an open center valve to a closed center valve.

By installing a special closed center plug in the outlet cover, hydraulic oil flow from the pump is blocked at the outlet port with valve spools in neutral position.

Pressure is normally maintained at the control valve inlet by use of a variable-displacement pump or an accumulator-type circuit with an unloading valve.

In a Gresen closed center control valve, the center passage is blocked and both work ports are also blocked when the control valve spool is in neutral position.



Power Beyond (High Pressure Carryover)

Code Symbol Y

This option allows the installation of another valve downstream from the first valve.

A power beyond sleeve is installed in the outlet cover of the upstream valve which separates the open center core from the exhaust core at the outlet port. This allows hydraulic oil under pressure to be carried thru the upstream valve, thus making it available for a downstream function. A separate tank line is required from each control valve in the circuit.

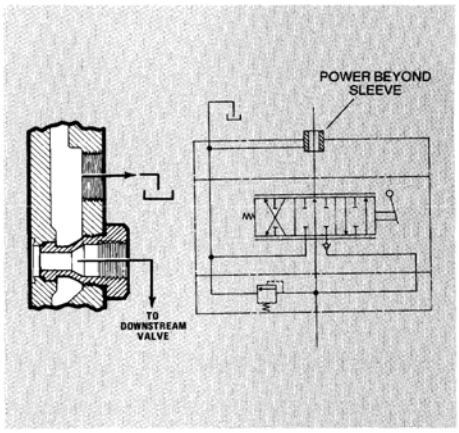
Hydraulic oil is available to the downstream valve only when all spools in the upstream valve are in the neutral position.

If pressure requirements for both valves are the same, only one relief valve is required. It must be installed in the upstream valve.

Each valve in the circuit may have a different relief setting, but the highest setting must be upstream.

The outlet cover can be machined to accept a power beyond sleeve which allows the open center oil to be used by a downstream valve. When a power beyond sleeve is specified, an outlet port is still required. Outlet port can be located in the left inlet cover or in the right outlet cover. The following power beyond sleeve port sizes are available for No. 6770 right outlet cover:

THREAD	1/2" - 14 NPT (Female) SAE 8 (3/4" - 16 UN) (Female) SAE 10 (7/8" - 14 UN) (Female) SAE 16 (1" tube fitting) (Male)



Conversion Plug Assembly

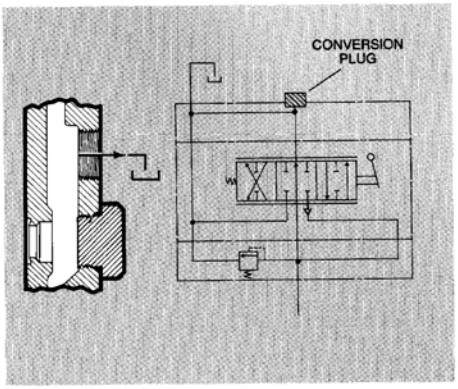
Code Symbol X

If additional hydraulic circuit options are to be added at a later date, or if the control valve is being ordered for stock, a conversion plug assembly should be considered. A conversion plug assembly gives a control valve great versatility and easily converts for different applications, reducing inventory requirements.

A control valve with a conversion plug remains an open center valve. The outlet cover, when machined for this option, will also accept power beyond sleeves and closed center plugs. When the need arises the proper plug or sleeve is inserted to convert the assembly into either a closed center or power beyond

valve. Service kits are available for these optional parts and must be ordered separately.

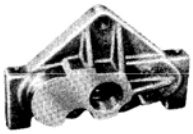
When a conversion plug is installed in the outlet cover the control valve remains an open center valve. When the outlet cover is machined for a conversion plug, it will also accept a power beyond sleeve or a closed center plug. If the need arises, the proper plug or sleeve can be inserted to convert the assembly to either a closed center or power beyond application.



Outlet Port Option



OUTLET COVER FOR MODEL V20P VALVE SHOWING OPTIONAL PORT LOCATION AND POWER BEYOND SLEEVE INSTALLED



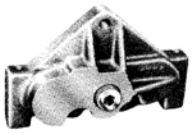
OUTLET COVER FOR MODEL V20P VALVE SHOWING STANDARD PORT LOCATION

If the outlet port is to be located in the outlet (right) cover and closed center, power beyond or conversion plug options are specified, then the outlet port will be in the optional location.

The following outlet port sizes are available for No. 6770 right outlet cover:

	THREAD	
	NPT	SAE
Outlet Ports	1/2" - 14	SAE 10 (7/8" - 14 UN)
	3/4" - 14	SAE 12 (1-1/16" - 12 UN)

Turnaround Cover Option



OUTLET COVER FOR MODEL V20P VALVE SHOWING TURNAROUND

For plumbing convenience, the outlet port may be located in the inlet (left) cover. When it is, the turnaround cover is provided to direct the flow of exhausting oil back to the inlet cover.

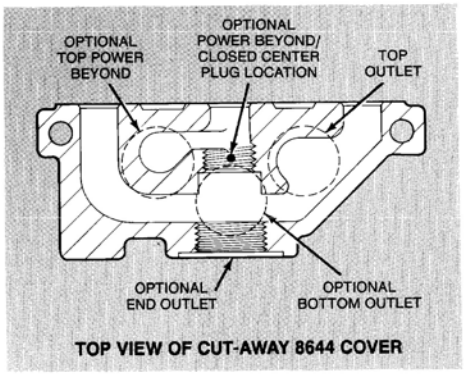
Optional Outlet Cover with Top Outlet and Power Beyond Ports No. 8644



OPTIONAL OUTLET COVER FOR MODEL V20P VALVE SHOWING TOP OUTLET AND POWER BEYOND PORTS.

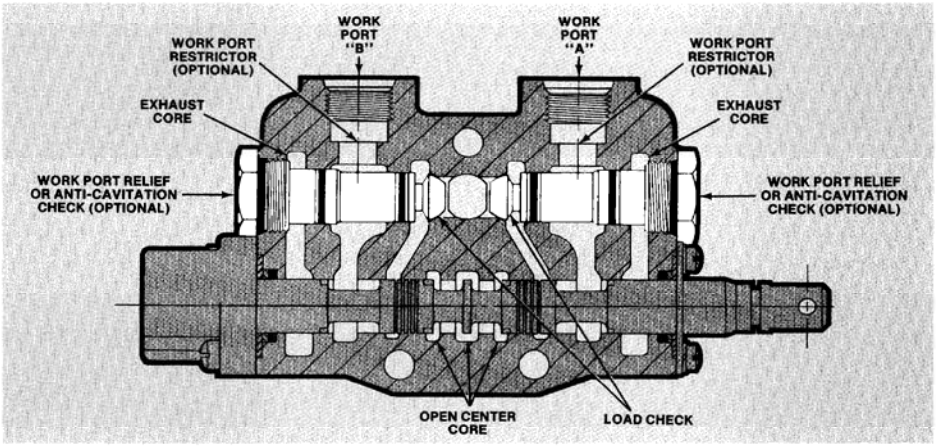
An optional outlet cover, No. 8644, is available. This option offers top porting options rather than end porting only. Port options are:

- Top, End or Bottom Outlet
- Top Power Beyond
- SAE12 or ¾" NPT Ports



TOP VIEW OF CUT-AWAY 8644 COVER

WORK PORT RELIEFS, CHECKS AND RESTRICTORS



In addition to load checks which are standard in the V20 Valves, Gresen offers a wide range of options to control oil flow. From these options you may select the exact accessories to customize your valves to your specific application.

The following are available:

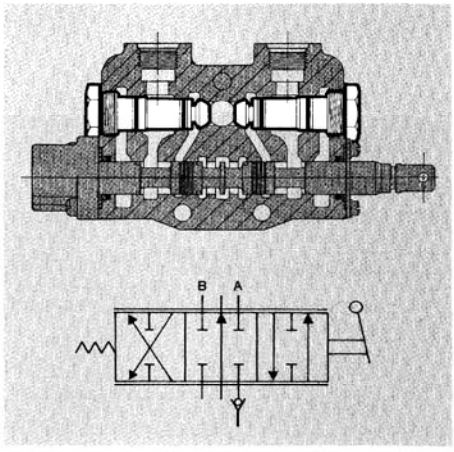
- Work Port Relief Valve
- Anti-Cavitation Check
- Combination Relief and Anti-Cavitation Check
- Pilot-Operated Check Valves
- Work Port Restrictors
  (not available with NPT pipe ports).

Standard Load Check Assembly

A standard load check assembly is provided with every work section except when a free-flow motor spool is installed. Then load checks are not required. The load check blocks against pressurized return flow from a work port back to the inlet port until overcome by pressure build-up from the pump.

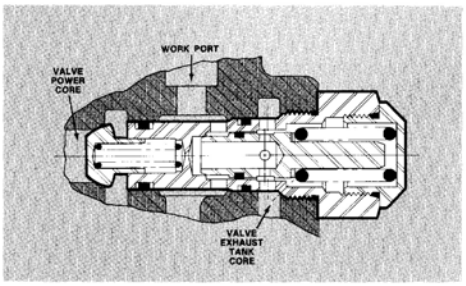
This feature will keep a load from dropping while the control valve spool is being shifted and until the inlet pressure is equal to or slightly greater than the pressure developed by the load. At this time the load check will open and movement of the load can then be controlled by the control valve spool.

NOTE: Load checks for Series type sections are different from those used in Parallel and Tandem sections.



Work Port Relief Valves

MODELS RC and RCS (Series)



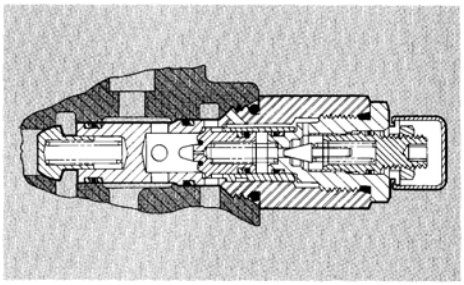
Models RC and RCS work port relief valves are differential poppet type.

Model RP20 recommended for pressures over 3000 PSI [207 bar].

NOTE: If the control valve is equipped with vertical handle, 1802-001, the adjustable relief valve, Model RCA which has an extended profile beyond valve body, will interfere with handle. It should NOT be installed on the valve-handle end.

These relief valves, installed in a work port, will limit the maximum pressure in that work port. They also prevent pressure build up in a work port when the valve spool is in neutral.

MODEL RP20



Model RP20 work port relief valves are pilot-operated type.

- Model RP20A — externally adjustable
- Model RP20N — tamperproof

2-STAGE RELIEF VALVE

A 2-stage relief option is available for Model RC work port relief valve cartridges. This option will provide a second (higher) pressure setting when a pilot pressure (750 PSI minimum) is applied to an SAE 6 pilot port in the cartridge. The "high" pressure setting (3000 PSI maximum) is shim adjustable. The "low" pressure setting (500 PSI c/p minimum) is externally screw adjustable and must be specified as a "crack" pressure (1 GPM flow).

Anti-Cavitation Check

The anti-cavitation check is used in the work section and prevents cylinder or motor cavitation. It allows cavitating work ports to refill from the exhaust core, supplementing pump flow. Anti-cavitation check is non-adjustable but is designed to operate whenever the work port pressure is lower than the exhaust core pressure.

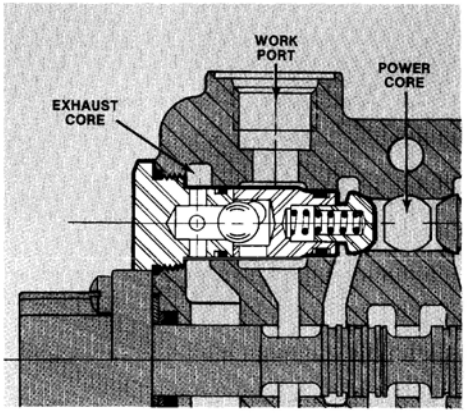
NOTE: Anti-cavitation checks for Series type sections are different from those used in Parallel and Tandem sections.

PERFORMANCE

Will pass 5 GPM [18,93 liters/min] at 8 PSI [,55 bar] Pressure Differential

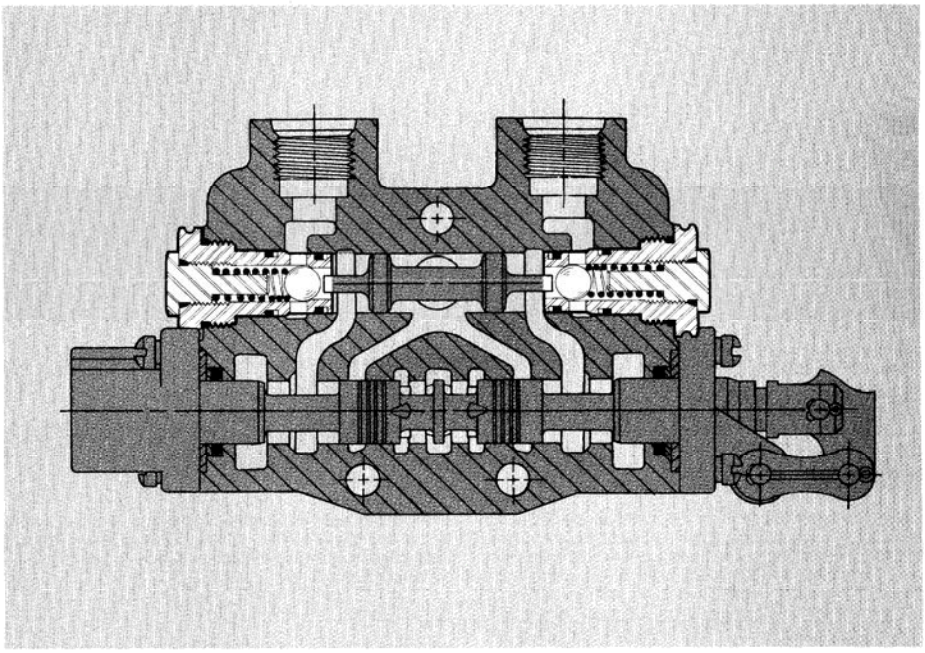
Will pass 10 GPM [37,85 liters/min] at 19.5 PSI [1,35 bar] Pressure Differential

Will pass 15 GPM [56,78 liters/min] at 39 PSI [2,69 bar] Pressure Differential



Pilot-Operated Check Valves

FOR MODEL V20-LO VALVE ONLY

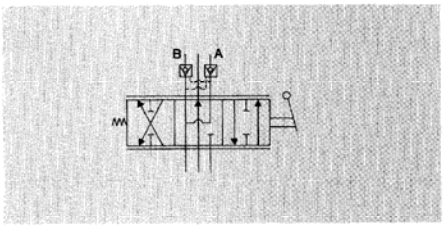


Model V20-LO work sections are designed with double pilot-operated check valves. These pilot operated checks will lock a cylinder or part of a circuit—without leakage—when the control valve spool is in the neutral position. When the spool is shifted to a power position, pressurized oil is directed to one work port. Return oil into the opposite work port is momentarily blocked until pilot pressure unseats the check. Metering characteristics of valve spools are slightly diminished when using these pilot-operated check valves.

These checks are used on applications such as clamps, outriggers, and elevated work platforms where internal fluid leakage could affect the operation of the system. The functions of a 4-Way Section and a pilot-operated check or lock-out in one valve housing are combined in one section.

The spool is a 4-way, 3-position modified free flow spool.

This spool is the same as F4, 4-way, 3-position free flow except the free flow feature is restricted. Free flow prevents any pressure build up between the pump and the pilot operated check when the valve spool is in neutral position.



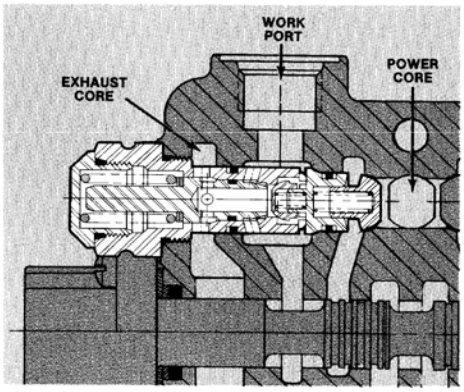
This work section and check valve are combined to perform the functions of a 4-way work section and a pilot-operated check or lockout valve in one single housing.

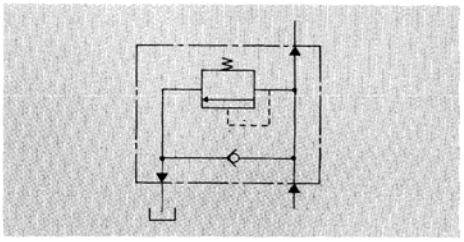
Combination Work Port Relief Valve and Anti-Cavitation Check

MODEL CRA

At times both a relief valve and an anti-cavitation check are required for the same work port. Both of those functions have been incorporated into one assembly.

Pressure range is: 500-3000 PSI [34-207 bar]





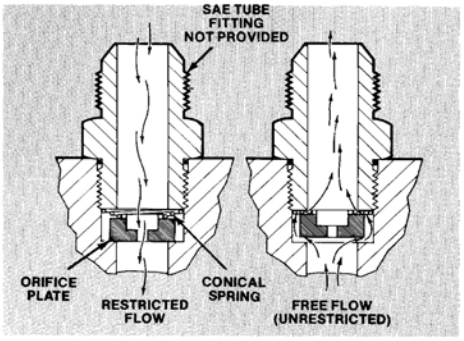
Restrictors

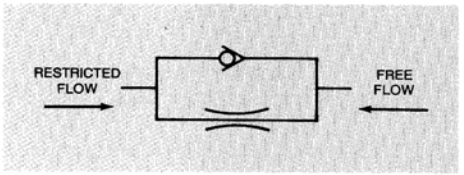
Restrictors may be inserted directly into a SAE work port and will limit oil flow in one direction while allowing free flow in the opposite direction. When restricting flow in the return port, restrictors will:

1. Prevent cylinder or motor cavitation having an inertia load.
2. Provide accurate control of double-acting cylinder by pressurizing both sides of cylinder piston.
3. Restrict oil flow from a hydraulic motor for smoother operation.

When restricting flow in pressure port, restrictors will meter oil flow to provide proper speed of operation.

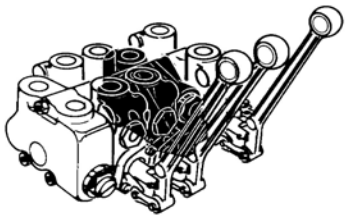
Work port restrictors are available for SAE 8 and SAE 10 work ports. Nominal orifice diameters are available from .015 to .220 inches [.38 to 5.6 mm]. Specify restrictor hole size desired. Specify whether restrictor should be installed to restrict flow out of the valve work port, or restrict flow into the valve work port.





MID-INLET CONVERSION SECTIONS

A mid-inlet conversion section provides an inlet port for a secondary pump downstream in the valve assembly. These sections can be installed between any two work sections thereby providing two different flow paths.



The addition of a mid-inlet section actually combines two separate valve assemblies into one giving them one common tank return line that provides the following advantages:

1. Simplifies installation, reducing plumbing and mounting costs.
2. All valve control handles can be mounted within easy reach.
3. Overall assembly costs are lower than two separate control valves.

Mid-inlet conversion sections are available in the following configurations:

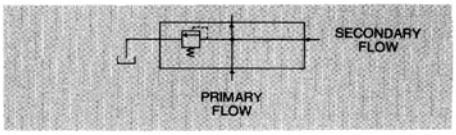
1. Combined Flow Section
2. Split Flow Section
3. Combination 3-Way Work Section and Mid-Inlet Section

Combined Flow Section



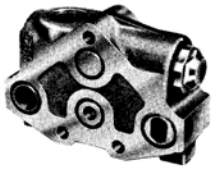
MID-INLET CONVERSION SECTION WITH COMBINED FLOW

When upstream work sections are in the neutral position, the combined flow from both pumps is available to the downstream sections. Combined flow of both pumps cannot exceed the flow capacity of the entire valve.



Split Flow Section

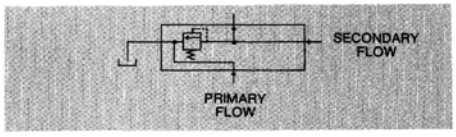
MID-INLET CONVERSION SECTION WITH SPLIT FLOW



Except for a common tank return passage, the split flow section completely separates upstream and downstream work sections. Upstream sections are fed by the primary pump, downstream work sections by the secondary pump.

When ordering a Combined Flow or Split Flow Mid-Inlet Conversion Section be sure to specify:

- Port Size
- Port Location
- Relief Valve Type
- Relief Valve Setting



PORTING OPTIONS AVAILABLE
(Combined Flow and Split Flow Sections)

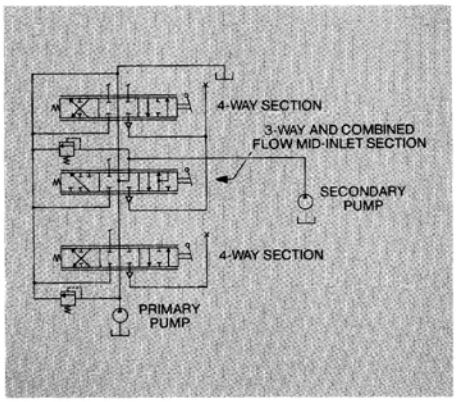
LOCATION	NPT PIPE PORTS		SAE STRAIGHT THREAD PORTS	
	STANDARD	OPTIONAL	STANDARD	OPTIONAL
TOP INLET	1/2"-14	3/4"-14	SAE 10 (7/8"-14 UN)	SAE 12 (1-1/16"-12 UN)
BACK INLET	1/2"-14	3/4"-14	SAE 10 (7/8"-14 UN)	SAE 12 (1-1/16"-12 UN)

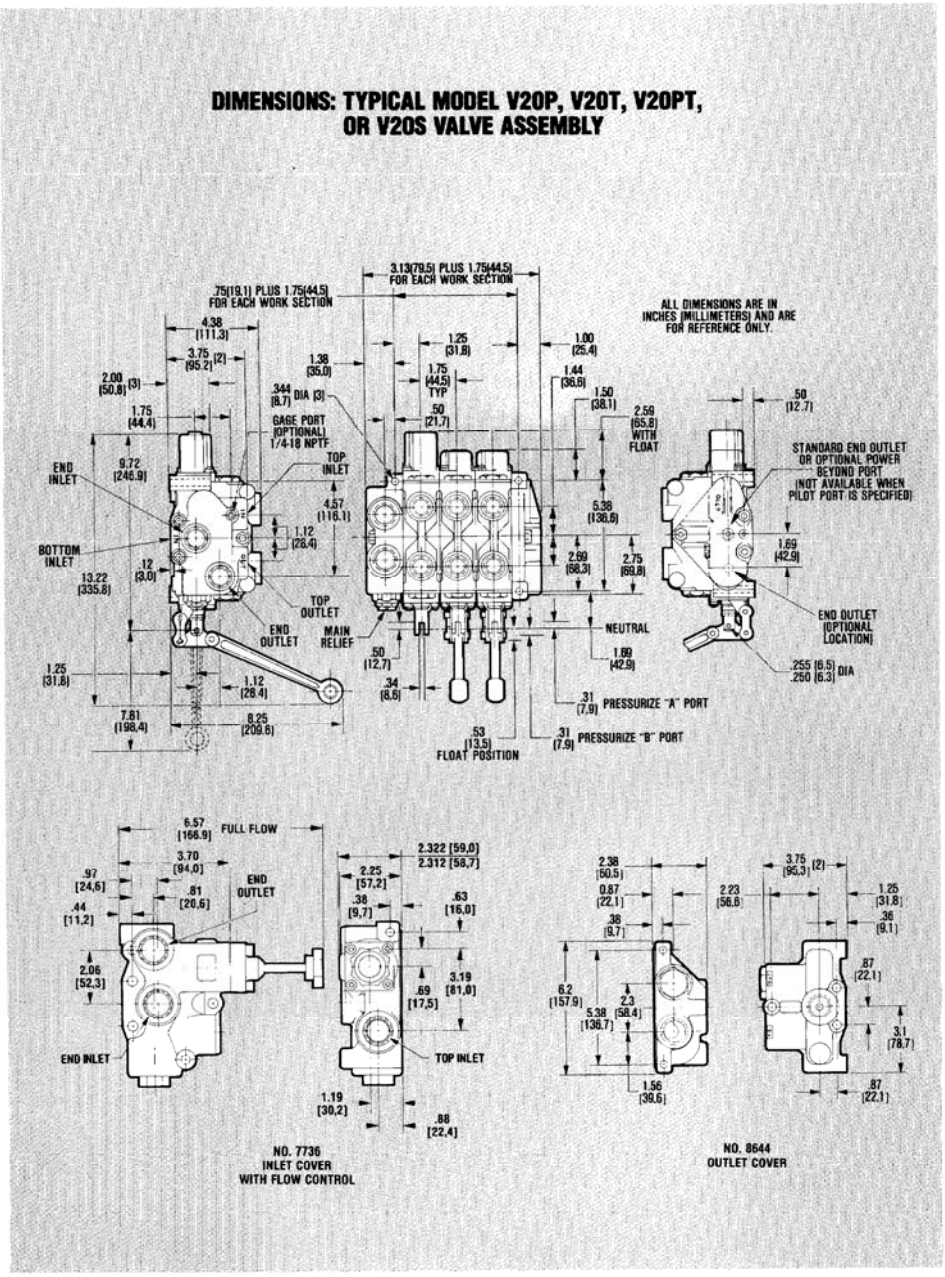
Combination 3-Way Work Section and Mid-Inlet Section

A special 3-way spool is used to convert a tandem work section to a combination 3-way work section and mid-inlet section. Port "A", which is normally plugged in a 3-way work section, is used as the mid-inlet port. A modified work port relief valve installed in port "A" serves as the main relief valve for the secondary pump.

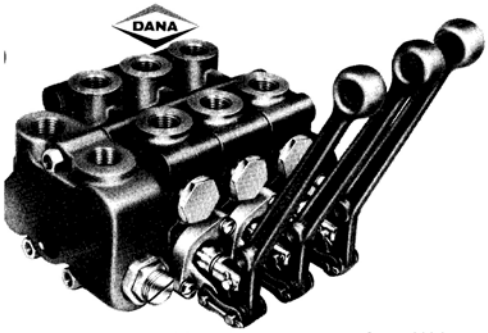
This combination section eliminates the need for separate combined flow mid-inlet section, thus reducing the size and weight of the complete valve assembly. It can be used in any V20 open center application where a 3-way section requires a combined flow. Any number of 3-way or 4-way work sections which require a combined flow can be used downstream from this section.

To order, specify Bill of Material No. 1522-8137. Also, specify port size, relief pressure setting and whether clevis is to be located on the "A" or "B" port end.




DIMENSIONS: TYPICAL MODEL V20P, V20T, V20PT,
OR V20S VALVE ASSEMBLY
ALL DIMENSIONS ARE IN INCHES (MILLIMETERS) AND ARE FOR REFERENCE ONLY.
3.13(79.5) PLUS 1.75(44.5) FOR EACH WORK SECTION
.75(19.1) PLUS 1.75(44.5) FOR EACH WORK SECTION
GAGE PORT (OPTIONAL) 1/4-18 NPTF
TOP INLET
END INLET
BOTTOM INLET
TOP OUTLET
END OUTLET
MAIN RELIEF
NEUTRAL
PRESSURIZE "A" PORT
PRESSURIZE "B" PORT
FLOAT POSITION
STANDARD END OUTLET OR OPTIONAL POWER BEYOND PORT (NOT AVAILABLE WHEN PILOT PORT IS SPECIFIED)
END OUTLET (OPTIONAL LOCATION)
.255 [6.5] .250 [6.3] DIA
FULL FLOW
END OUTLET
END INLET
TOP INLET
NO. 7736
INLET COVER
WITH FLOW CONTROL
NO. 8644
OUTLET COVER

GRESEN®



CLOSED CENTER VALVE ASSEMBLIES

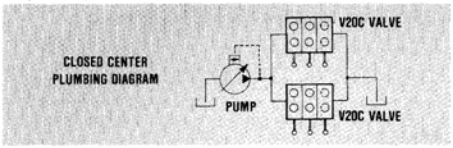
Models V20C and V20LS

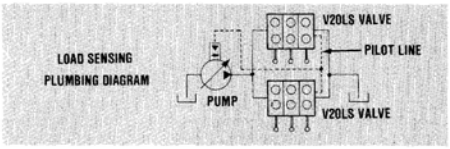
Gresen's Models V20C and V20LS Directional Control Valves are available for parallel, hydraulic circuit applications, up to 3500 PSI [242 bar] continuous operating pressure. New spool designs have resulted in lighter spool actuating effort making their finger-tip touch and extra-fine metering characteristics ideal for back hoe, front end loader and personnel lift applications. This sensitivity also gives the design engineer a wider latitude of mechanical linkage possibilities.

Service or conversion is simple since individual sections can be added, removed or replaced in the field. Individual service or field conversion sections, rather than complete valve assemblies, can be stocked thus reducing inventories.

The Model V20C Directional Control Valve is designed specifically for high standby pressure, closed center systems. The Model V20LS Directional Control Valve is designed specifically for low standby pressure, closed center systems with load sensing.

Normally, an open center valve may be converted to a closed center valve by plugging the open center core in the outlet cover. Under these conditions, the valve's power core is exposed to high pressure at all times. Leakage may then occur past the valve spool and on into the work port area and cause a cylinder to extend while the valve spool is in neutral position. High pressure build-up at the work port in the Models V20C and V20LS is prevented by installing an anti-drift cartridge. Refer to work port options on page 51.





APPLICATIONS

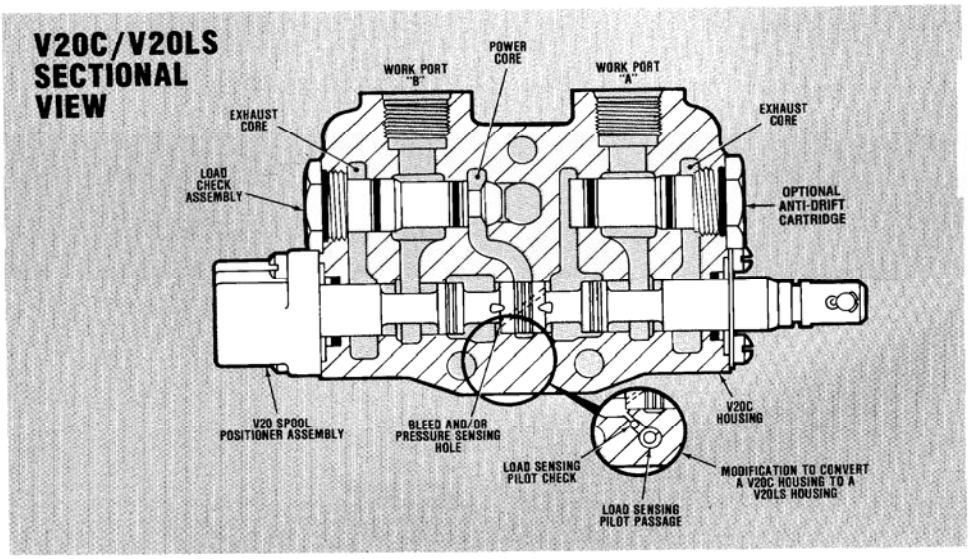
Two or more Directional Control Valve Assemblies may be supplied from a single, variable displacement pump in the hydraulic system by using a "tee" arrangement. The power beyond option normally available with open center valves is not required for Model V20C or V20LS work sections since neither work section has an open center core.

FEATURES

- **Minimal spool actuating effort — Maximum, 50 pounds [23 kg] at the spool**
- **Improved, extra-fine metering**
- **Valve housings made of high tensile cast iron for durability and resistance to shock loads.**
- **Spools are hard, chrome plated for long life and corrosion resistance.**

SPECIFICATIONS

Pressure Rating:
Continuous Operating ..... 3500 PSI [242 bar] max.
Capacity:
Nominal Flow ..... 20 GPM [76 litres/min]
Maximum Flow ..... 30 GPM [114 litres/min]
Maximum Exhaust Core Pressure:
With Handle Bracket or Heavy Duty Spool Seal Retainer Installed
Continuous Operating ..... 500 PSI [34,5 bar]
Intermittent Peak ..... 1000 PSI [69,0 bar]
With Standard Spool Seal Retainer Installed ..... 200 PSI [13,8 bar]
Filtration Required (Min.) ..... 33 micrometre
Weight:
Inlet Cover ..... Approx. 6 lbs. [2,7 kg]
Outlet Cover ..... Approx. 3½ lbs. [1,6 kg]
Work Section, Each ..... Approx. 9 lbs. [4,1 kg]



VALVE METERING

Closed Center Systems

Valve spool metering is improved because the volume of oil is controlled by the metering notches at a constant pressure drop across the spool. The pump displacement will self-adjust to maintain full system pressure thus creating this constant pressure drop across the spool. Controlling flow across spool metering notches is improved when the pressure drop remains constant.

Closed Center Systems with Load Sensing

Valve spool metering is further improved since pump pressure is maintained at the slightly higher standby pressure (150 to 250 PSI [10 to 17 bar]) than is required by the function. This fixed pressure drop remains the same from minimum to maximum load requirements in contrast to the conventional closed center system.

INLET COVER

Part No. 8398-

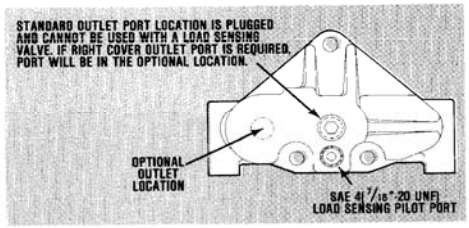
The inlet cover is designed to provide a variety of port sizes and locations. This permits valve assemblies to be "customized" using a minimum of external plumbing. For information regarding main system relief valves, refer to pages 10 and 11.

OUTLET COVER

Part No. 6770-

The outlet cover provides an end outlet port. It also provides for a pilot port in load sensing systems. If the outlet port and the pilot port are both required in the outlet cover, the outlet port will be furnished in the optional location. (Refer to illustration.)

A pilot drain option is available for the load sensing outlet cover. This option is required in a load sensing system when a pilot drain orifice is not provided in the pressure compensated pump. The pilot drain orifice relieves the load sensing pilot pressure in the pump compensator after the control valve spool is returned to neutral. It is necessary to relieve this pressure signal in order for the pump to return to its standby pressure setting.



For plumbing convenience, the outlet port may be located in the inlet (left) cover. When it is, a "turnaround" (right) cover will direct exhausting oil back to the inlet cover.

A power beyond option is not available since there is no open center core in V20C or V20LS work sections.

SPOOL ACTION OPTIONS and HANDLE END OPTIONS

The Models V20C and V20LS work sections are available with the same spool action options and handle end options as offered for the Model V20P except V20LS float option can not be reversed in the housing.

Spool Action Options

Refer to pages 14 through 19.

	CODE SYMBOL
Spring Return to Neutral (Standard)	—
3-Position Detent	D
No. 1889-001 Detent Stop	—
4-Position Float	K4
1-Position, Spool "IN" Detent	R
1-Position, Spool "OUT" Detent	RO
2-Position, Spool "IN" and "OUT" Detent	RIO
Spring Extended Spool	A
Manual	M
Internal Pressure Detent Release	KO
Electro-Mechanical Detent Release	E
Solenoid Control (Request Catalog No. PC-1104)	—
Hydraulic Remote Spool Actuator *	HR
Hydraulic Remote Spool Actuator (Manual Override)* (Request Catalog No. PC-1103)	HRO

* Pilot Pressure For Remote Actuators
300 PSI [21 bar] is required to actuate either Gresen's Solenoid or Hydraulic Remote Actuator Assemblies. This may be accomplished by installing a pressure reducing valve at the pump discharge and plumbing the lower pressure hydraulic fluid to the Remote Actuator Assemblies.

When the system has load sensing, standby pressure must be increased to 300 PSI [21 bar].

Handle and Handle End Options

Refer to pages 20 and 21.

	CODE SYMBOL
Complete Vertical Handle Assembly	CVHA
Complete Horizontal Handle Assembly	CHHA
Die Cast Handle Bracket, No. 1801-001	—
Cast Iron Handle Bracket, No. 7355-001	—
Standard Spool Seal Retainer Assembly, No. K-6033	—
Heavy Duty Spool Seal Retainer Assembly, No. K-6029	—
Spool Wiper, No. 1800-001	—
Spool Boot Assembly, No. K-6056	—
Less Handle Only	LHO
Less Complete Handle Assembly	LCHA

SPOOL VARIATIONS

Refer to page 13.

	CODE SYMBOL
3-Way, 3-Position	3
3-Way, 3-Position, Free Flow	F3
4-Way, 3-Position	4
4-Way, 3-Position, Free Flow	F4
4-Way, 4-Position, Float	K4

WORK PORT OPTIONS

The same work port options which are available for the Model V20P Directional Control Valve are also available for the Models V20C and V20LS in the "B" port location.

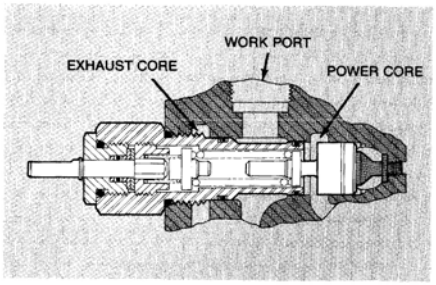
In the "A" port location, an optional anti-drift cartridge is also available. The anti-drift cartridge prevents any build-up of pressure at the work ports when the valve is in neutral position. Any leakage past the spool into the sensing cores is drained back to the tank through the anti-drift cartridge. When the work port is powered, pressure closes the anti-drift cartridge to eliminate any flow loss.

The anti-drift cartridge must be installed in the "A" port location only and one is required for each work section in which pressure build-up at the work port will be detrimental to the application.

The anti-drift cartridge replaces the standard load check plug. It is not available where a work port relief or anti-cavitation check is required in the "A" port location.

OPTION	ORDER CODE	AVAILABLE FOR "A" PORT	AVAILABLE FOR "B" PORT
Work Port Relief	RC,RP20	x	x
Combination Relief and Anti-Cavitation Check	CRA	x	x
Anti-Cavitation Check	AC	x	x
Load Check		—	x
Anti-Drift Cartridge	B	x	—

Pressure Compensated Flow Control



A pressure compensated flow control option is available for Models V20C and V20LS. This option is installed in the load check area of the valve section and is externally adjustable.

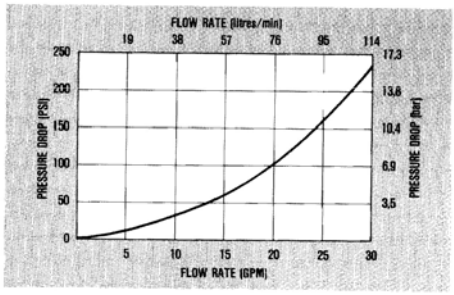
The flow control allows each valve section (both work ports) to operate at a predetermined maximum flow rate independent of pump discharge flow and pressure. Flow ranges of 1 to 5 GPM, 3 to 15 GPM, and 5 to 25 GPM are available.

This flow control option cannot be field installed. Special valve section machining is required.

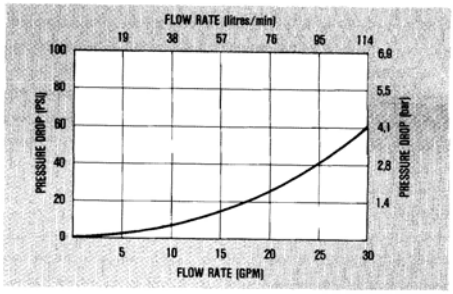
PRESSURE DROP

150 SUS oil at 100° F • Inlet port: SAE 12 • Work port: SAE 10

Inlet To Work Port
Typical pressure drop to any work port in a 4-spool valve



Work Port To Outlet
Typical pressure drop from any work port in a 4-spool valve



CLOSED CENTER VALVE ASSEMBLIES

ORDERING INSTRUCTIONS

To assure delivery of the proper Directional Control Valve, Form 9005 must be completed. Additional ordering information needed for manufacture and assembly of Models V20C and V20LS work sections are:

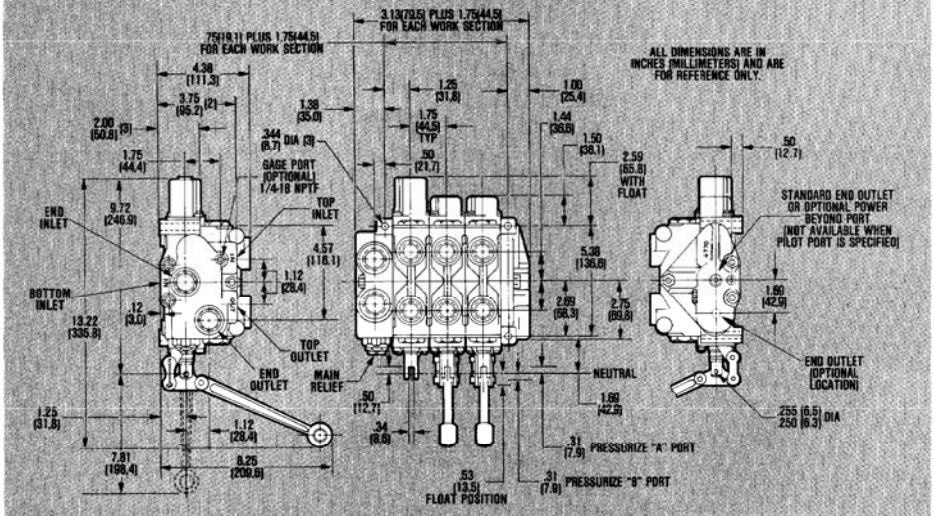
1. To specify a valve with V20C closed center work sections or V20LS load sensing work sections, write in No. 8364 in the "Center Section Housing No." box for each work section required. Do not check the "Closed Center" box in right cover block.
   - Under "Additional Features" write in V20C and check the box in each work section to specify a closed center valve.

   OR

   - Write in V20LS and check the box in each work section to specify a load sensing valve. Also specify Housing No. 6770-LS in right cover block in order to include the SAE 4 pilot port.
2. If an anti-drift cartridge is required, write in under Cylinder Port "A", order symbol Anti-Drift Cartridge and check the box for each work section requiring this option.

NOTE: A V20 closed center valve can also be made from standard V20P, No. 8072, open center section by using a closed center plug in the right cover. To specify this type of closed center valve, write in Housing No. 8072 for center sections and check the closed center box in the right cover. (Anti-drift cartridge cannot be used in this valve.)

DIMENSIONS: Typical V20C and V20LS Assembly



PORTING OPTIONS AVAILABLE

LOCATION	SAE STRAIGHT THREAD PORTS		BSP PIPE PORTS	GAGE PORT	PILOT PORT
	STANDARD	OPTIONAL	OPTIONAL	OPTIONAL	OPTIONAL
No. 8398 LEFT INLET COVER* End, Top or Bottom Inlet. Ports, End or Top Outlet Ports	SAE 12 (1-1/16"—12 UN)	SAE 10 (⅝"—14 UNF)	¾" BSP	SAE 4 (7/16"—20 UNF)	—
WORK SECTION	SAE 10 (⅝"—14 UNF)	SAE 8 (¾"—16 UNF)	½" BSP	—	—
No. 6770 RIGHT OUTLET COVER Standard or Optional End Outlet Ports	SAE 12 (1-1/16"—12 UN)	SAE 10 (⅝"—14 UNF)	¾" BSP	—	SAE 4 (7/16"—20 UNF)

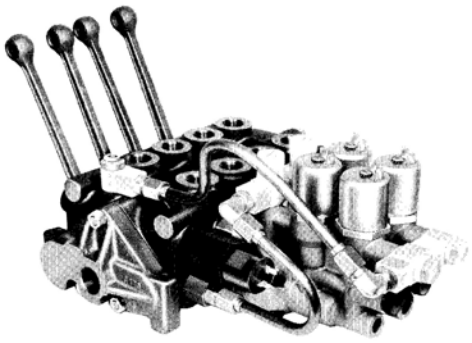
*Top inlet and top outlet ports are cored. If not specified, they will be plugged.

NOTE: All ports in a casting must be the same. SAE and BSP ports cannot be intermixed.

GRESEN®

DANA

Model V20
SOLENOID-CONTROLLED DIRECTIONAL CONTROL VALVE



Gresen's on-off solenoid-controlled, pilot operated actuators are designed to provide remote operation of Model V20 Hydraulic Directional Control Valves.

Most Gresen Model V20 Sectional Body Directional Control Valves, having a 3-position spool will accept a solenoid-controlled actuator. (Exceptions are the float spool and the standard free flow spool. A modified free flow spool is available for solenoid operation.)

Each Valve section may be solenoid-controlled, manually-controlled or both.

Gresen's sectional-body feature offers maximum flexibility and ease of maintenance. Although valve work sections with solenoid control are normally assembled at the factory, field assembly is possible in order to add additional work sections to an exisiting assembly.

The outlet tank port may be located in the outlet cover or in the left inlet cover of the control valve assembly.

SPECIFICATIONS

Pressure Rating ..... 3500 PSI [242 bar] max.
(Directional Control Valve)

Capacity (Nominal) ..... 20 GPM [75,5 litres/min]

Differential Pilot Pressure to Actuator ..... 200-300 PSI [14-21 bar]
(A minimum of 200 PSI [13,8 bar] is required to actuate the valve spool)

Maximum Allowable System Back Pressure ..... 300 PSI [21 bar]

Pilot Flow to Actuator ..... 2-4 GPM [7,6-15 litres/min]

Operating Oil Temp ..... 180°F [82°C]
(Maximum)

Filtration Req. (Min.) ..... 33 micrometre

Solenoid Power Req. ..... 1.7-1.9 amps, 12 VDC
0.6-0.7 amps, 24 VDC

Weight:
Directional Control Valve Work Section with Solenoid-Controlled Actuator ..... Approx. 13 lbs. [5,9 kg]
Utility Section ..... Approx. 9 lbs. [4.1 kg]

Note: Double-throw switches are required when using internal pilot and must be provided by the customer.

FEATURES

- **Electrical or Manual Operation**
- **Either Open Center or Closed Center Hydraulic Circuit Applications**
- **May Be Field Installed**
- **All Gresen Model V20 Features Are Available (Request Catalog No. PC-1106)**
  - **Load check for every work port**
  - **Work port relief valves**
  - **Work port anti-cavitation checks**
  - **Work port restrictors**

DESCRIPTION

Solenoid-Controlled Actuator

The solenoid-controlled actuator assembly contains two, 3-way, normally closed solenoid-operated valves and a pilot-operated piston mounted directly to the control valve spool. When a solenoid is energized, the solenoid valve opens, pilot pressure at 300 PSI [21 bar] above tank line pressure is applied to one side of the piston causing the spool to shift from its neutral position. When both solenoids are de-energized, both sides of the piston are open to exhaust and the spool is spring-returned to neutral.

A needle valve, externally adjustable, meters the exhaust pilot flow to control the spool's rate of travel.

Solenoid coils are molded, impervious to moisture, continuous-duty rated, class H (180°C), and are supplied with two male, spade terminals. Customer must supply two female spade terminals, Packard Part No. 2965470 and one panel connector, Packard Part No. 2965490 or equivalent, for each solenoid.

Utility Section (Casting No. 7820)

A pilot source of 2 to 4 GPM [7,6 to 15 litres/min] at 300 PSI [21 bar] is required to operate each actuator and may be supplied by the customer from a source external to the control valve. Or, the pilot source may be supplied by a utility section which is assembled as an integral part of the control valve.

The utility section incorporates all components required to operate the actuators, eliminating the need to supply any external pilot lines. The entire control valve assembly is self-contained.

The utility section must be installed between the last work section in a directional control valve assembly and the right or outlet cover.

Both open center and closed center applications are available.

The tank port may be located in either the inlet or outlet cover of the control valve assembly.

The following component parts are included with the utility section:

Solenoid-Operated Pressure Build-Up Valve must be wired in parallel with each solenoid-controlled actuator. Because of the low open center pressure drop found in the Model V20 Direction Control Valve, the pressure build-up valve is necessary to increase the oil pressure required to shift the valve spools.

For closed center applications, the pressure build-up valve is not required. However, the system must have a stand-by pressure of 300 PSI [21 bar] available.

Pressure Reducing Valve reduces oil pressure to the solenoid-controlled actuator to 300 PSI [21 bar] at 2 to 4 GPM [7,6 to 15 litres/min].

Uni-Directional Check Valve installed in the soleniod-controlled actuator return or exhaust port to prevent system shock peaks from affecting the actuator.

Hydraulic Systems With A Customer-Supplied External Pilot Source

The utility section is not required if the hydraulic system has a 2 to 4 GPM [7,6 to 15 litres/min], 300 PSI [21 bar] pilot source available. Pilot tubing must be a minimum of 3/8-inch tubing with SAE No. 6 (9/16" — 18) fittings.

The pilot exhaust line should be plumbed directly back to the reservoir. If teed into the control valve return line, a one-way check valve must be installed in the pilot line to prevent shock peaks from affecting the actuators.

Manual Handle Assembly

Handles for manual operation of Gresen Directional Control Valves may be installed on the opposite end of the spool on which the solenoid-controlled actuator is mounted. This gives the operator a choice of either remote electrical control or manual control. Provision for manual operation also offers a standby alternative in case of electrical power failure.

APPLICATION CONSIDERATIONS

Some points to consider when desigining the solenoid valve into a hydraulic system are:

1. The standard free flow spool cannot be used with a solenoid actuator. The spool timing is such that as the spool begins to shift the pump is open to tank dropping pressure below 200 PSI [14 bar] and stopping the spool. A modified free flow spool is provided for solenoid operated valve sections.

2. The 4-way, 4-position float spool cannot be used with a solenoid actuator.

3. The solenoid actuator requires a differential pilot pressure of 200 PSI [14 bar] above the exhaust line back pressure. The pressure reducing valve senses back pressure and will provide a pilot pressure of 200 to 300 PSI [14 to 21 bar] above the back pressure.

   Back pressure should not exceed 300 PSI [21 bar]. This will eliminate the possibility of exceeding 600 PSI [41,4 bar] pilot pressure in the soleniod actuators.

4. For over center or light load applications: if the pressure requirement at the powered work port is less than 200 PSI [14 bar], the pressure at the actuator drops to that same requirement. When that happens, the centering spring begins to move the spool back to neutral. If the solenoid remains actuated, the spool will begin to "hunt".

   Use a restrictor in the work port to maintain pressure requirements above 200 PSI [14 bar] at all times.

5. A power beyond option is **not** available in the outlet cover of V20 solenoid operated valve assemblies. The power beyond option is available in the utility section. If a power beyond option is used in the utility section, the pressure build-up valve must be located in the downstream valve assembly.

ELECTRICAL SYSTEM REQUIREMENTS AND RECOMMENDATIONS

Switches:

The solenoid switch must meet the following requirements:

1. Must be D.C. rated.
2. Electrical rating should be at least 3 AMPS. However, 6 AMPS is suggested.
3. Use a double-pole, double-throw (DPDT) switch for most applications. **Exceptions** are:
   — Closed center
   — Separate pilot source is used (no internal pilot).
   Single-pole, double-throw switches (SPDT) are to be used for the exceptions, because a pressure build-up valve is not required in the circuit for these types of applications.

Types Of Switches:

Literally, dozens of types are available — rocker, rocker with detent, toggle, toggle with detent, push button, etc. It makes no difference which type is used as long as the switch which has been selected meets requirements outlined above.

Wiring:

It is recommended that stranded copper wire be used. The size of wire primarily depends on the length that is required. Keep in mind that the solenoid power requirements must be met. The longer the length, the more current drop there will be.

Generally, 16 gauge wire can be used for lengths up to approximately 80 feet and 14 gauge for lengths up to 100 feet.

Wire classification can be found in an SAE handbook under the heading of "SAE J558, (a Low Tension Cable)".

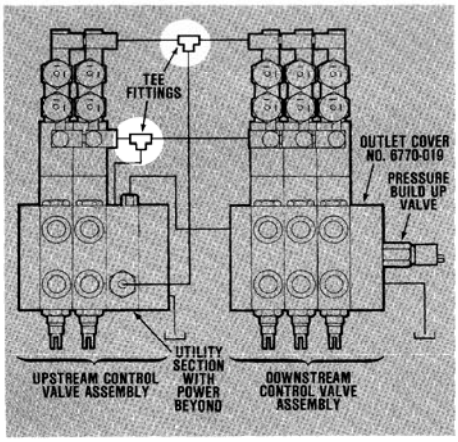
Terminals:

The customer must supply two female spade terminals, Packard Part No. 2965470 and one panel connector, Packard Part No. 2965490 or equivalent for each solenoid.

Note that special tools for crimping terminals are available from most electrical supply houses.

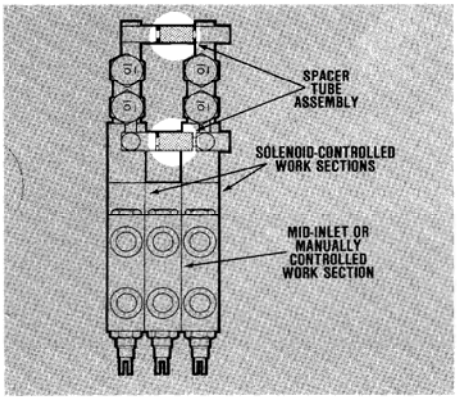
OPTIONAL ACCESSORIES

Optional Tee Fitting (Part No. K-6118) is available to connect an upstream control valve assembly and a downstream control valve assembly to one utility section. A power beyond sleeve must be used in the utility section in the upstream valve assembly and a pressure build-up valve must be used in the outlet cover. Two kits are required.

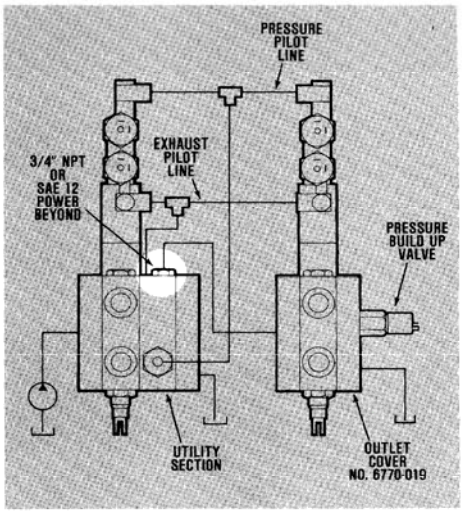


Optional Spacer Tube Assembly (Part No. K-6117). In some applications it is impossible to have adjacent solenoid-controlled work sections, such as valves with mid-inlets. For these applications, two one-section spacer tubes are requried to connect the pilot pressure and exhaust line to the actuators. See diagram for typical application of spacer tubes.

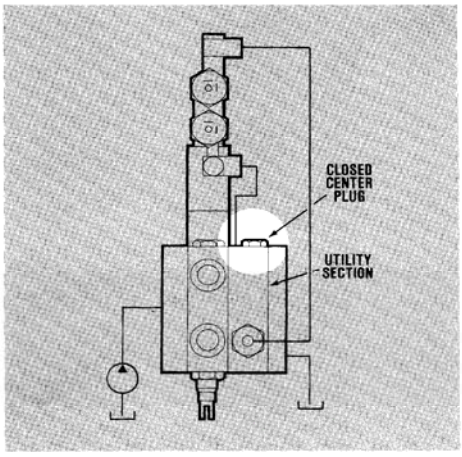
Note: Spacer tubes are designed for a one-section space only. No attempt should be made to stack these tubes in more than a one-section space.



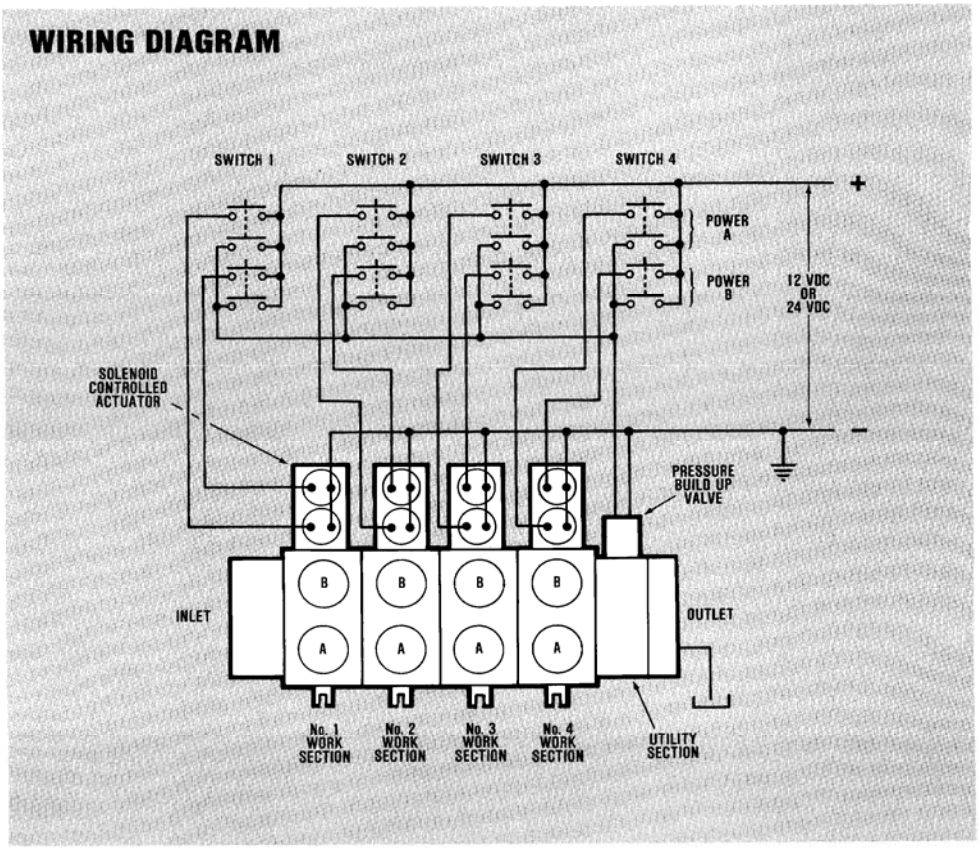
Optional Power Beyond Sleeve is available for use in the utility section in place of the pressure build-up valve. If a power beyond sleeve is used, the pressure build-up valve must be installed in the outlet cover of the downstream valve. Use outlet cover, Part No. 6770-019 in downstream valve. Outlet cover No. 6770-019 has SAE 12 outlet port.



Optional Closed Center Plug is available to replace the pressure build-up valve. System must have standby pressure of 300 PSI [21 bar] available.



WIRING DIAGRAM

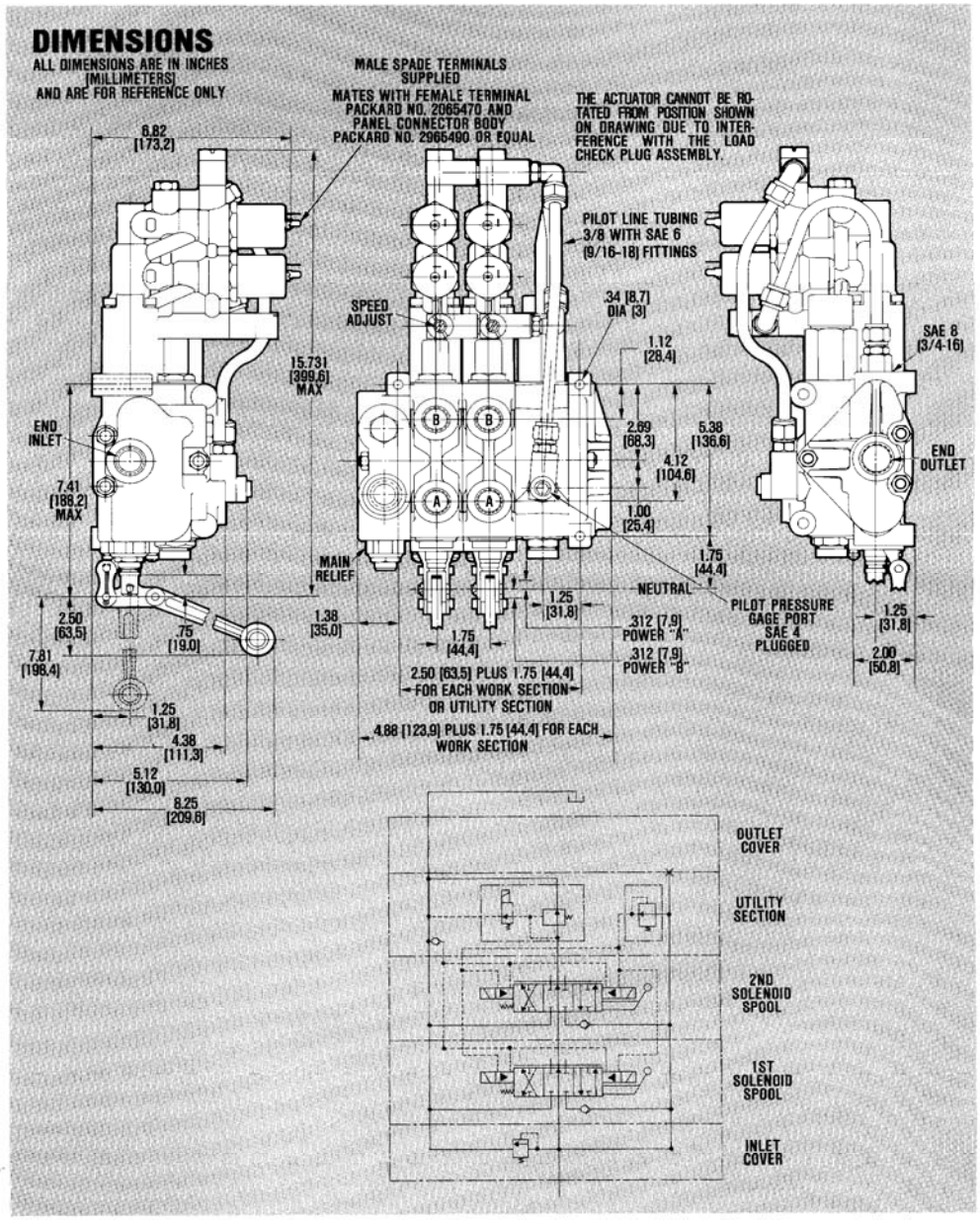


ORDERING INSTRUCTIONS

To assure delivery of the proper directional control valve with the proper options and configuration, Form No. 9005 should be fully completed. Additional ordering information needed for manufacture and assembly of Solenoid-Controlled Directional Valves are:

1. Under "ADDITIONAL FEATURES" write in "soleniod actuator" and check the box for each work section requiring this option. Specify 12 VDC or 24 VDC.

2. If a utility section (Part No. 7820) is not required to be furnished as part of the valve assembly, specify under "REMARKS", utility section not required.

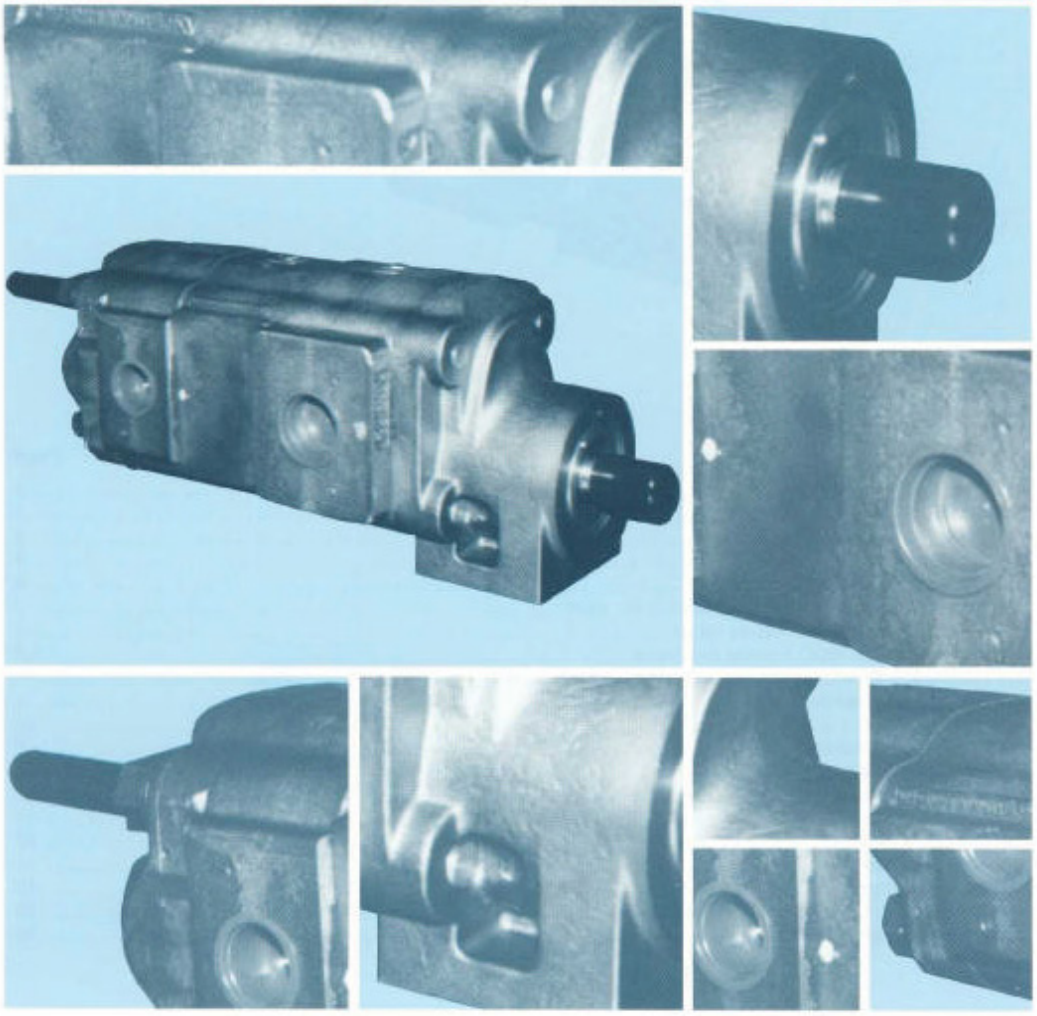


Gresen Manufacturing Company reserves the right to discontinue modify or revise the specifications for the products described herein. All specifications are approximate and may vary depending upon installation.

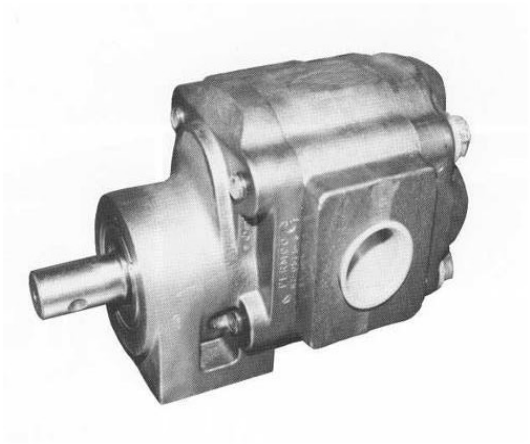
SERIES P2500, P3700
GEAR PUMPS

PERMCO

SERVICE MANUAL



Read this manual carefully before you start to assemble, disassemble, or rebuild your Permco pump: and also before you use Permco's patented diverter plates.



PERMCO PUMP MAINTENANCE...

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If you intend to rebuild a pump that has thrust plates and you wish to replace the thrust plates with Permco diverter plates, inspect the original port end cover, shaft end cover, gear housing and bearing carriers very carefully. To obtain the maxi-mum performance from diverter plates, all of the above components must be in good condition with minimal amount of wear. The following areas of wear are the most critical ... and often overlooked:

1. Shaft end covers, port end covers, and bearing carriers . . . Check bearing bores for out -of-roundness or elliptical shape. If more than 0.003" out-of-round, **do not use.**
2. Gear housings. . .If the wear pattern on the inlet side is in excess of 0.003" depth, **do not use.**
3. Gears . . . Inspect very carefully. If you have scored, scuffed or pitted journals, scratched or scuffed tooth faces, deep nicks on tooth edges, do not use; install new drive and driven gear.
4. Bearings . . . A loose fit between gear hub and bearing I D may not mean a bad bearing. The misalignment it can cause is detrimental to good pump performance. We recommend installing a complete set of new bearings at each rebuild.
5. Seals . . . It is recommended that all seals be replaced on any rebuild job.

Putting Permco diverter plates into a pump and re-using the old worn parts will not necessarily re-store the pump to the high efficiency and perform-ance of a new Permco pump. Merely installing new Permco diverter plates cannot restore the pump to its original performance. Permco's high efficiency, performance, and life expectancy are based on using all new Permco parts.

If you are rebuilding a Permco gear pump, you must not install thrust plates of another make. Tolerances and finishes on Permco parts are held closer than those of other manufacturers of pump parts. For warranty repairs under any circum-stances, you must not substitute other makes of parts in a Permco pump. **USE ONLY GENUINE PERMCO PARTS.**

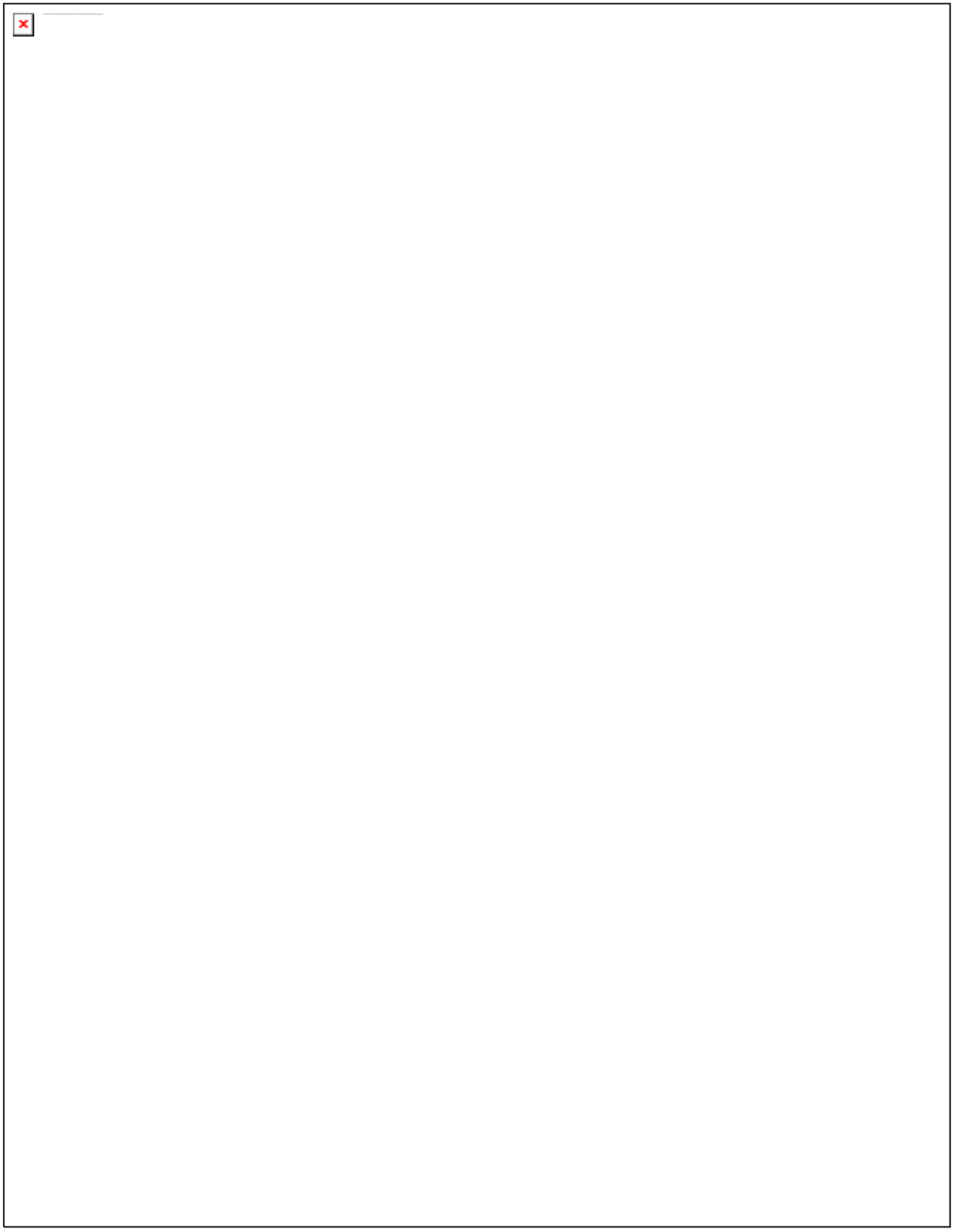
You can successfully use Permco diverter plates to rebuild other makes of pumps to obtain in-creased operating pressures and pump life. How-ever, read the above paragraphs carefully.

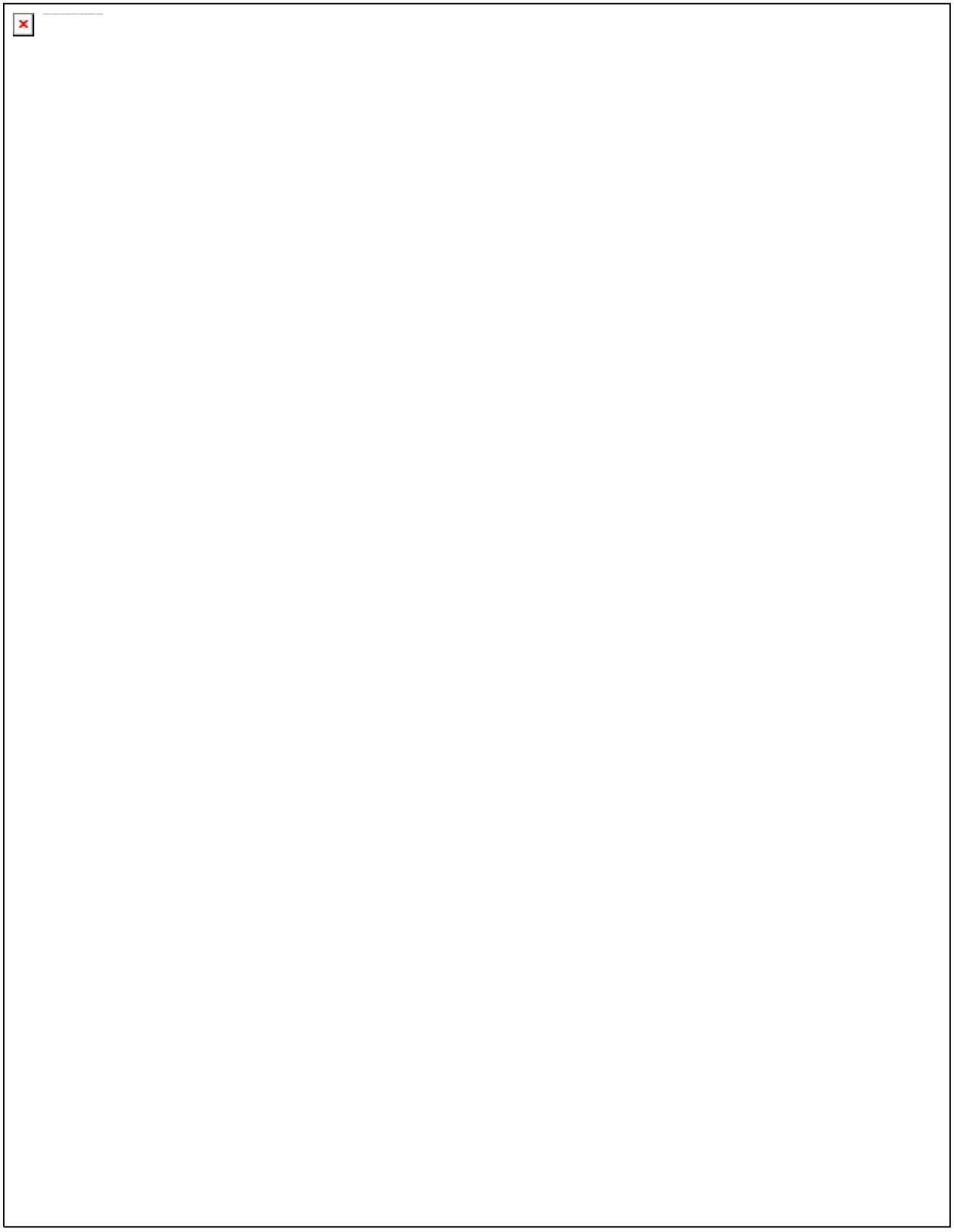
If you have any questions about rebuilding Permco pumps or about using Permco parts to up-grade other makes of pumps, call your local Permco pump and parts distributor.

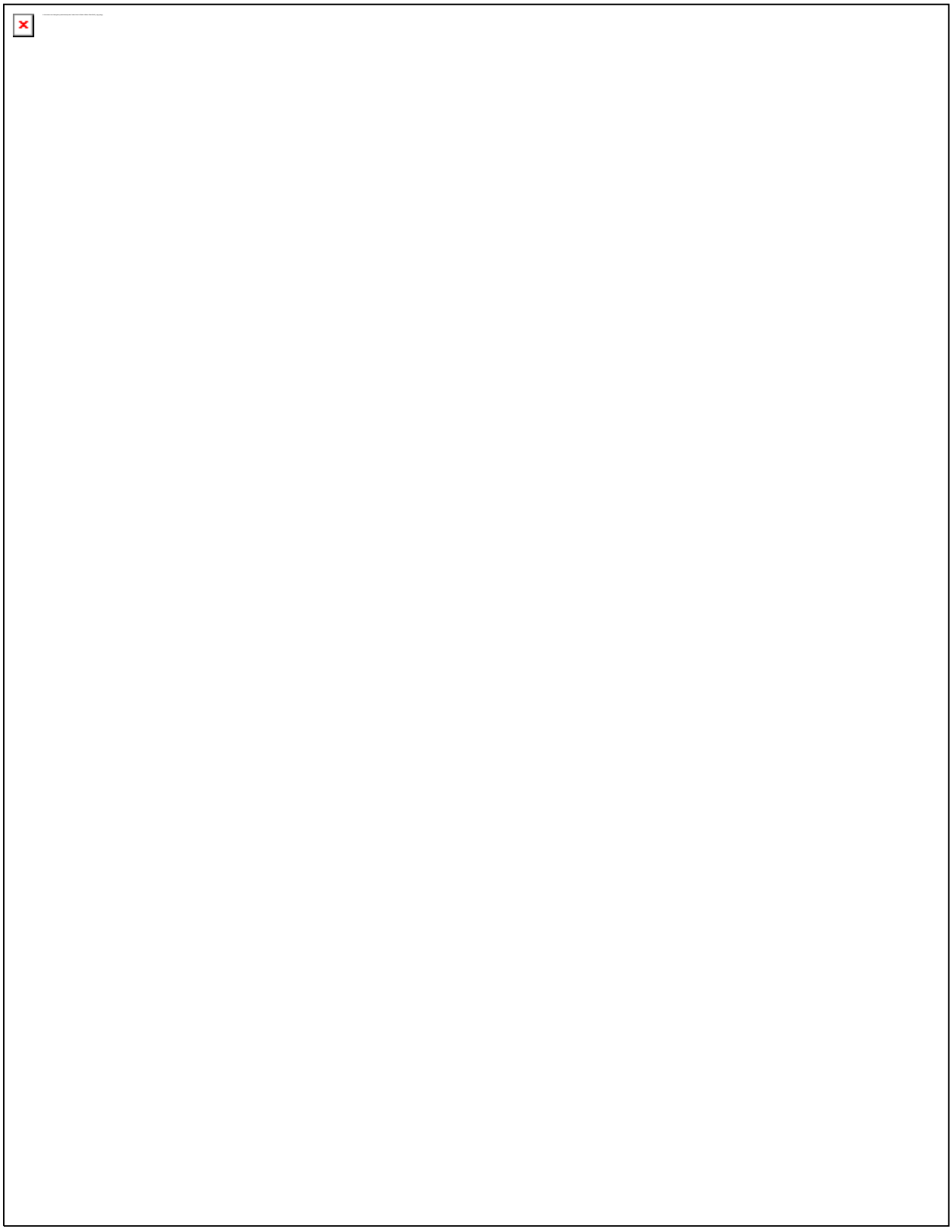
THREE TYPES OF PUMPS

There are three types of Permco pumps, as determined by the configuration of the shaft end covers . . . Type I, Type 11, and Type I II. There are slight differences in disassembly and re-assembly procedures, according to each shaft end cover. Also, Type II and Type III are normally longer from front to back than Type I. Be sure you know which type you are working on.

CLEANLINESS IS HIGHLY IMPORTANT WARNING. Before you start disassembling the pump, clean up your work bench. This will avoid the headaches and danger of getting dirt, metal fragments, and foreign objects into the fine -finished cavities and threads of the pump and com-ponents, and eventually into the entire hydraulic system. In pump maintenance, extreme cleanliness is most important.







PARTS ORDERING NUMBERS

2500 SERIES PUMPS

Item Number On Exploded View	Order This Part Number	Quantity To Order	Item Number On Exploded View	Order This Part Number	Quantity To Order
1	V-0961	1	32	W093-02	1
2	RZ-0558	1	33	ZG-1909	1
3	W62-26-13	1	34	Z-0216-182	1
4 & 13	K-2995-26	1	35	R-0921	4 per section
5 & 6	W015-7	1	36	X-0947	2 per section
7	(Replace original key with identical key).	1		X-0947-TC	2 per section
				X-0947-DS	2 per section
				X-0947-BRD	2 per section
8, 14, 24, 30, 46	See Engineering Catalog		37	TA-2995-244	2 per section
			38	LZ-0577- ** - **	1 per section
9 & 26	** -0575- *	1	39 & 40	JZ-0996L- **	1 set/section
10	S-0280/L-0280-K	2	41	QZ-0592- *	1
11	KZ-0961	1	42	W033-2	4
12	W62-49-3	1	43 & 55	5/8-11 Grade 8	4
15	XZ-0558-1	1	44	W004-19	1
16	W86-100	1	45	ZQ-1909	1
17	W023-206	1	47	FA-0558	1
18	W62-26-15	1	48	XZ-0558-1	1
19	FZ-0961	1	49	SZ-0408- *	1
20	W0921	1	50	ZQ-1909	2
21	K-2995-109	1	51	J*-0576- * - ***	1
22	W051-D9	1	52	SZ-0022	1
25	DA-0558	1	53	3/8-16 Rod	1
27	ZU-1909	1	54	W78-05	1
28	Q-2995-8	1	56	W3-65	4
29	J-2909-19	1	57	GZ-0961	1
31	CA-0558	1	58	K-2995-47	1
32	W093-02	1	59	W62-26-10	1
			60	W62-49-1	1

3700 SERIES PUMPS

Item Number On Exploded View	Order This Part Number	Quantity To Order	Item Number On Exploded View	Order This Part Number	Quantity To Order
1	U-0961 Type I	1	14	W-86-112	1
	IZ-0961 Type III	1	36	W-0947	2 per section
2	QZ-0558 Type I only	1		W-0947-TC	2 per section
3	W62-26-10	1		W-0947-DS	2 per section
4	K-2995-33 Type I	1		W-0947-BRD	2 per section
	K-2995-4 Type III	1	37	TA-2995-249	2 per section
5 & 6	W015-5	1	38	KZ-0577- ** - **	1 per section
7	(Replace original key with identical key).	1	39 & 40	IZ-0996L- **	1 set/section
			41	MZ-0592- *	1
			42	W033-1	8
8 & 46	** -0023	1	43 & 55	1/2-13 Grade 8	8
9	** -0575- *	1	44	W004-19	2
10	S-0280/L-0280-K	2	49	LZ-0408- **	1
11	LZ-0961 Type I	1	50	ZV-1909	1
	IZ-0961 Type III	1	51	*Z-0576- * - ***	1
12	W62-49-1	1	52	RZ-0022	1
33	ZF-1909	1	53	3/8-16 Rod	1
34	Z-0216-177	2	54	W78-05	1
35	Q-0921	4 per section	56	W3-40	8
13	ZA-0558- *	1	47	GA-0558	1

NOTE: * THIS PORTION OF THE PART NUMBER SHOULD BE IDENTICAL TO ORIGINAL PART NUMBER. OBTAIN BY REFERRING TO UNIT CODE NUMBER. CONTACT DISTRIBUTION OR PERMCO SALES DEPT.

DISASSEMBLING TYPE I PUMP:

1. With a sharp metal scribing tool, grease pencil, Magic Marker, or paint, make an indexing mark that runs straight across a surface of the port end cover (41), gear housing (38), and shaft end cover (9). This will enable you to reassemble these parts into the same position when you put the pump back together.

2. With a face spanner wrench, loosen and un-screw the threaded retainer ring (1) on the shaft end of the pump a couple of turns to relieve the preload on the tapered roller bearing (6). **DO NOT REMOVE** the retainer ring (1) entirely.

3. Install the unit in a vise, shaft end down.

4. Remove the cap screws (43) and washers (42) at the rear of the pump that hold the port end cover (41) and the gear housing (38) together. Re-move the port end cover (41) and diverter plate (36), or the thrust plate. The roller bearings (35) will remain intact with the port end cover (41). (In pumps with thrust plates, the pocket seals will come out easily; Permco pumps with diverter plates do not require pocket seals.)

5. Remove the pump drive gear (39), the driven gear (40), and the gear housing (38) from the shaft end cover (9). **BE CAREFUL** to keep the drive gear and driven gear together; you must reassemble them as the original pair later, since they have worked-in together.

DISASSEMBLY:

SHAFT END COVER (9)

1. Set the partially disassembled pump (shaft end cover(9) from which the gear housing was separated in the vise with the pilot up. The drive end of the shaft will be pointing straight up.

2. Now finish unscrewing threaded retainer ring (1), loosened at the start, and remove from shaft (8 or 14).

3. Pull entire drive shaft assembly (2 thru 8) out of shaft end cover (9). Carefully note direction of bearing taper, so bearing can be reassembled correctly.

4. Turn the shaft end cover (9) pilot-down; the end of which the drive shaft assembly (2 thru 8) was removed. Diverter plate (36) will now be accessible.

5. With a knife blade or thin-blade screwdriver, **VERY** gently pry the diverter plate (36) off the bearings of the shaft end cover (9). If working on another make of pump to be refitted with **PERMCO** diverter plates, remove and throw away the pocket seals; **PERMCO** pumps require no pocket seals.

6. With a bearing puller, pull the shaft bearings (35) out of the shaft end cover (9) if you plan to replace the bearings. If you pull the bearings, check bores for out-of-roundness and elliptical shape. If more than 0.003" out-of-round, **DO NOT USE**. If you need to remove only the conical spring (34) and shaft bushing (33), pull **ONLY** the shaft-end **drive** bearing; **do not pull** the shaft-end **driven** bear-ing.

NOTE: Skip Step 7 If the pump drive shaft is 1-1/8" or smaller in diameter; go directly to Step 8. **If** the shaft is larger than 1-1/8" in diameter--

7. Remove snap ring (16) and spacer (15) from gear end of shaft.

8. **If** the drive shaft is 1-1/8" or smaller in diameter, press the tapered bearing (6), the cup (5), seal retainer (2), and lip seal (3) off the **DRIVE** end of the shaft. **If** the shaft is larger than 1-1/8" in diameter, press these four parts off the **GEAR** end of the shaft.

9. Remove and discard the "0" ring from bore in shaft end cover (9). Have an identical new replace-ment "0" ring ready for reassembly. Remove and discard lip seal (3) from seal retainer (2); have re-placement lip seal on hand for reassembly.

GEAR HOUSING

1. Remove square gasket seals (37) from gear housing (38) and discard. Have identical replace-ments on hand for reassembly. **Do Not** re-use "0" rings. Check for depth of wear at this time, using a telescoping gage and a micrometer with the depth tolerance as described on Page 3, Paragraph 2.

PORT END COVER

1. With a knife blade or thin-blade screwdriver, gently pry the diverter plate (36) or thrust plate off the bearings of the port end cover (41).

2. On makes of pumps other than PERMCO, re-move and discard the pocket seals. You do not need pocket seals when installing PERMCO diverter plates; these patented diverter plates do not use pocket seals.

3. Only if you are replacing the two shaft roller bearings (35) with new ones, pull the bearings out of the port end cover (41) with a bearing puller.

TYPE II PUMP:

1. With a sharp metal scribe, grease pencil, magic marker or paint, make an indexing mark that runs straight across a surface of the port end cover (41), gear housing (38), and shaft end cover (26). This will enable you to reassemble these parts into the same position when you put the pump back together.

2. Remove the cap screws (43) and washers (42) from the port end cover (41).

3. Separate the port end cover (41) from the gear housing (38) and the diverter plate (36), or thrust plate from the bearings of the port end cover. The roller bearings (35) will remain intact with the port end cover. (In pumps with thrust plates, the pocket seals will be easily removable; Permco pumps with diverter plates do not require pocket seals.)

4. The drive gear (39) and the driven gear (40) will still be in the gear housing (38). Remove them. **BE CAREFUL** to keep the drive gear (39) and driven gear (40) together; it's recommended that you reassemble them as the original pair later, since they have worked-in together. Now separate the gear housing (38) from the shaft end cover (26).

DISASSEMBLY:

SHAFT END COVER

1. Turn the shaft end cover (26) on end so that the drive end of the shaft (24) is pointing upward. With a pointed tool or thin screwdriver blade, snap out the retaining ring (17) **WARNING USE EYE PROTECTION.**

2. Pull the entire drive shaft assembly out of the shaft end cover (26). If the drive shaft is smaller than 1" diameter, you will have to remove the thrust washer (25) from the base of the bearing bore separately after pulling out the drive shaft assembly. (18 thru 25 for a pump with a 1" diameter drive shaft and smaller; 18-32 for a pump with a drive shaft larger than 1" diameter).

3. Upend the shaft end cover (26) to expose the diverter plate (36) or thrust plate. Gently pry the diverter plate (36) or thrust plate away from the shaft end cover (26), using a knife blade or thin blade screwdriver. On pumps other than Permco's, remove and discard the pocket seals; Permco pumps require no pocket seals.

4. To remove roller bearings (35), pull them out of the shaft end cover (26), using a bearing puller. After bearings have been removed check bores for out-of-roundness and elliptical shape. If more than 0.003" out-of-round **do not use.**

5. (a) For drive shafts 1" in diameter and smaller: Slip the needle bearing assembly (18 thru 20) off the drive end of the shaft (24). The two thrust bearings races (22) and thrust bearing roller (23) can now be slipped off the drive end of the drive shaft (24).

5. (b) For drive shafts larger than 1" in diameter:

(1) Hold the needle bearing assembly (18 thru 23, 31, and 32) forward towards the drive end of the drive shaft (30). Remove snap ring (32) with snap ring pliers.

(2) Slip the snap ring retainer (31), two thrust bearing races (22), thrust bearing roller (23), "0" ring (21), needle bearing (20), bearing and seal retainer (19), and double-lip seal (18) off the gear end of the drive shaft (30).

6. On both diameters of shafts, remove seal (18) and "0" ring (21) from seal and bearing retainer (19). Be sure you have new replacement seal and "0" ring available for replacement.

7. When installing needle bearing (20), press the old bearing out of the seal and bearing retainer (19). Have a new bearing on hand for reassembly.

GEAR HOUSING

Remove square gasket seals (37) from grooves in gear housing (38) and discard. Have replacement seals at hand for re-assembly. Check for depth of wear at this time, using telescoping gage and micrometer with the depth tolerance as described on Page 3, Paragraph 2.

PORT END COVER

1. Gently pry off the diverter plate (36) or thrust plate with a knife blade or thin-blade screwdriver. (On other makes, the pocket seals should be re-moved and discarded —**PERMCO** diverter plates require no pocket seals.)

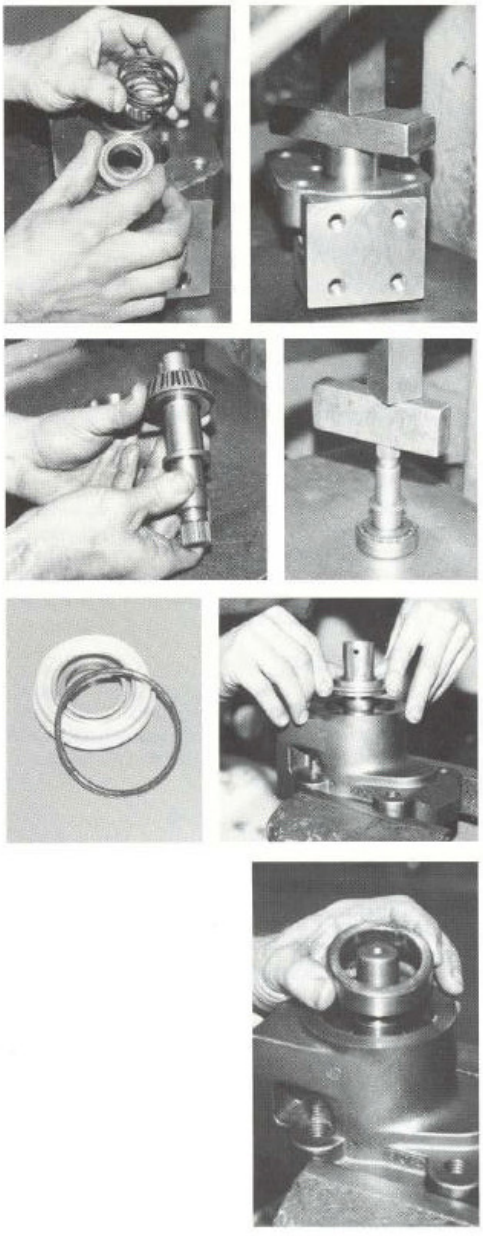
2. To install new roller bearings (35), pull these bearings from the port end cover (41) bearing bores with a bearing puller. After bearings have been removed check bores for out-of-roundness and elliptical shape. If more than 0.003" out-of--round, **do not use**.

END OF DISASSEMBLY OF TYPES I AND II PUMPS

TYPE III PUMP:

For Type III, disassembly is the same as Type I larger than 1-1/8" diameter. However, there are two tapered roller bearings (5 and 6) on shaft (46).

REASSEMBLING TYPE I PUMP:



REASSEMBLING THE TYPE I PUMP

1. Grip shaft end cover (9), gear end up. Place bronze shaft bushing (33) in the bearing bore of the shaft end cover (9) with bushing flange down.

2. Place conical spring (34) against bronze shaft bushing (33) with smaller end of spring over pilot shoulder of bushing.

3. Replace the two roller bearings (35) in the bores of the shaft end cover (9). Take care that the top of the conical spring (34) does not cock and wedge between bearing (35) and bottom of bearing counter-bore.

4. Place shaft end cover in a soft jaw vise. Turn cover end-for-end and clamp with flange end up.

FOR PUMP WITH DRIVE SHAFT SMALLER THAN 1-1/8" DIAMETER

5. Repack tapered roller bearing (6) with good lithium-base high-temperature bearing grease, No. 2 consistency.

6. Carefully press the bearing (6) on the drive shaft (8). Be sure the larger diameter of the bearing (6) is seated against the shoulder of the drive shaft (8).

7. Insert the assembled drive shaft (8) into shaft end cover (9). Be sure shaft bushing (33) is centered in the shaft cover bore (9).

8. Place bearing cup (5) over tapered roller bear-ing (6). Carefully press or tap cup down to seat firmly against bottom of bearing bore.

9. Press lip seal (3) into recess in seal retainer (2) with lip of seal facing up. Put "0" ring into bearing bore on top of bearing cup (5).

10. Install this seal retainer subassembly (1,2,3,4) over drive shaft, being careful to seat it firmly against top side of bearing cup (5).

NOTE: If you are reassembling a unit used as a **MOTOR**, with either diameter shaft, press a motor shaft seal (12) into the seal retainer (11), using proper shaft seal tool.

FOR PUMP WITH DRIVE SHAFT 1-1/8" DIAMETER AND LARGER

5. Carefully press lip seal (3) into seal retainer (2) with lip of seal facing outward.

6. Next, press this seal retainer subassembly (2-3) onto drive shaft (14). Small end of subassem-bly should face outer or drive end of shaft (14).

7. Put "O-ring (4) into groove in seal retainer (2).

8. Repack tapered bearing (6) with good lithium-base high-temperature bearing grease, No. 2 consistency.

9. Carefully press bearing (6) on drive shaft (14). Be sure smaller diameter of bearing (6) is facing towards the seal retainer (2). Place bearing cup (5) over bearing (6).

10. Push the spacer (15) over gear end of shaft (14). Put snap ring (16) in correct groove on shaft (14).

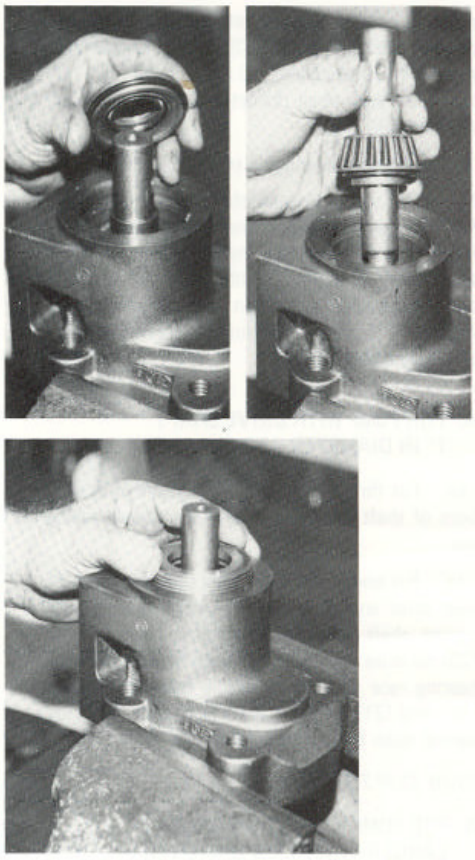
11. Press seal retainer assembly (2, 3, 4), bearing (5, 6), and spacer(15) tightly against snap ring(16).

12. Insert assembled drive shaft (14etc.) in shaft end cover (9).

13. Thread the retainer ring (1) **loosely** into shaft end cover (9), but **DO NOT** tighten retainer ring (1) enough to preload bearing (5, 6); this will be done later.

14. Release shaft end cover (9) from vise, turn cover end-for-end, and clamp with flange end down.

15. If you are reassembling a single-rotation pump, and **if** you removed the plug (10) installed on the high-pressure side of the pump, replace it; leave the low-pressure opening unplugged. If your pump is a double rotation unit, and **if** you re-moved the two check assemblies (10), replace with new valves.



TO COMPLETE THE ASSEMBLY OF A TYPE I PUMP, skip to Page 13: Port End Cover Assembly.

TYPE II PUMP:

REASSEMBLING THE TYPE II PUMP:

SHAFT END COVER

1. With the shaft end cover (26), gear end up, install bronze shaft bushing (33), with flange down.

2. Place conical spring (34) against bronze shaft bushing (33) with smaller end of spring over pilot shoulder of bushing.

3. **If** you removed them, replace the two roller bearings (35) in the bores of the shaft end cover (26). Take care that the top of the conical spring (34) does not cock or wedge between bearings (35) and bottom of bearing counter bore.

4. Place shaft end cover (26) in a soft jaw vise flange end up.

5. With lip of seal (18) facing up, press seal into

recess in bearing- and-seal retainer (19). **If** you removed needle bearing (20) during disassembly, press it into bearing-and-seal retainer (19). Put "0" ring (21) over small diameter of bearing-and-seal retainer (19).

6.For double bearing units, see Page 12.

NOTE: If you are reassembling a unit used as a **MOTOR**, with either diameter shaft (smaller or larger than 1" diameter), install the special motor seal retainer (27) which combines an "0" ring (28) and a back-up ring (29) in the I.D. of the seal retainer (27). (Place "0" ring in retainer first and then install back-up ring).

A. FOR PUMP WITH DRIVE SHAFT 1" IN DIAMETER AND SMALLER

6a. Put thrust washer (25) in bottom of bearing bore of shaft end cover (26), with grooves facing up.

7a. Put one of the two thrust bearing races (22) over drive end of drive shaft (24) so race rests against shaft shoulder. Put thrust bearing roller (23) on drive shaft (24), followed by second thrust bearing race (22). Slide needle bearing (20) and "0" ring (21) on drive shaft (24) with "0" ring against outer thrust bearing race (22).,

(NOW SKIP TO STEP 10)

B. FOR PUMP WITH DRIVE SHAFT LARGER THAN 1" IN DIAMETER

6b. Install the complete seal retainer subassembly (18-21) (Step 5, above) over the drive shaft (30); seal should bear on shoulder of drive end of drive shaft (30).

7b. Put one of the two thrust bearing races (22) on the drive shaft (30) next to the "0" ring (21). Next, slip thrust bearing roller (23) on drive shaft (30). Slide the second thrust bearing race (22) on, follow with snap ring retainer (31).

8b. Push this entire bearing assembly (18-23,31) together on drive shaft (30); hold firmly against shaft shoulder on drive of shaft (30).

9b. Install the snap ring (32) to hold the bearing assembly (18-23,31) in place.

(NOW RESUME ASSEMBLY OF PUMPS WITH EITHER DIAMETER DRIVE SHAFT)

10. Insert complete drive shaft assembly (18-23, or 18-23, 31, 32) into shaft end cover (26).

11. Install retaining ring, either spiralox or snap ring (17) into groove in shaft end cover.

12. Release shaft end cover (26) from vice; turn cover end-for-end; re-clamp with gear end up. At this point, check to be sure plugs or check assem-blies are firmly in place. **NOTE:** Double-rotation pumps require **TWO** check assemblies (10); single rotation pumps **DO NOT** require check assemblies, but **DO** require a plug in the high pressure side of the pump, and **NO** plug in the low-pressure open-ing.

TYPE III PUMP:

REASSEMBLING THE TYPE III PUMP:

1. Put the PERMCO diverter plate (36) in position over the two bearings (35). Counter-bored side of the diverter plate should be placed over the bearings; high-pressure crescent recesses should be on the pump inlet side; gear relief recess should be on the high-pressure side. Double-check this for correct position.

REASSEMBLING THE TYPE III DOUBLE--BEARING SHAFT END COVER.

Where double outboard bearing assemblies are to be installed:

Pack both tapered roller bearings (6) with a No. 2 consistency lithium base high temperature bearing grease. Press the bearings with a spacer (47) between them onto the shaft (46). Be sure that the larger diameter end of the bearing (6) is seated against shaft shoulder. Next, install spacer (48) to insure proper running clearance. Try using the 0.133" thick spacer (48a) and snap ring (16) first. If spacer does not fit, use the 0.128" thick spacer (48b).

Double tapered roller bearing units **do not** have a conical spring (34) behind the bronze shaft bushing.

Double bearing units have a roll pin (44) pressed into the drive bearing bore of the shaft end cover (as shown). Next the bronze bushing (45) is install-ed with the slot placed over the roll pin and this flange portion up.

Before inserting the assembled shaft into the shaft end cover, make sure that the shaft bushing (45) is centered around the shaft. Take care not to nick or damage bronze shaft bushing when inserting the shaft assembly.

Continue assembly procedure.

In the final assembly procedure, the threaded retainer ring (1) should be tightened securely and

staked. **DO NOT BACK OFF RETAINING RING BEFORE STAKING.**

It is not necessary to back off the retainer ring, since the use of the spacer (48) of the proper thickness assures correct running clearance. (With single bearing assemblies, as before, the retaining ring must be backed off 1/2" before staking.)

PORT END COVER ASSEMBLY

1. If you removed the two roller bearings (35) during disassembly, install new bearings in the two bores in the port end cover (41). Fit should be at least a light press fit.

2. Put the diverter plate (36) over the two roller bearings (35). Counter-bored side of the diverter plate should be placed over the bearings with the high pressure crescent recesses on the inlet side and the gear relief recess on the high pressure side of the pump. Double check this.

FINAL ASSEMBLY

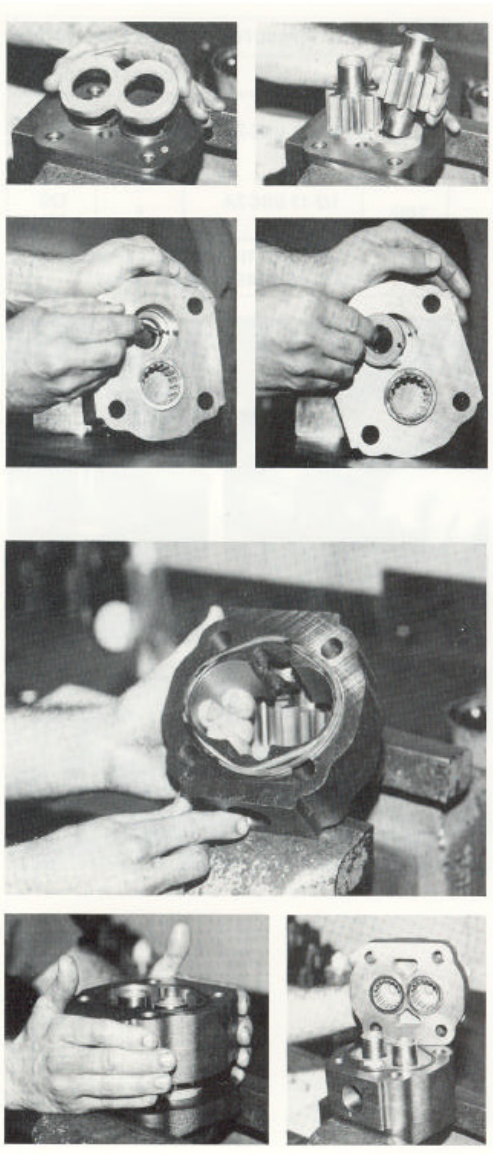
1. Clamp the shaft end cover assembly (26), etc.) in a soft jaw vise, gear end up.

2. Pour a little hydraulic or "STP" oil over face of diverter plate (36) to lubricate gears on startup. Gently stone the sides of each gear (39 and 40) to remove any burrs. Dip whole gear into cleaning solvent to remove dirt and metallic dust particles. Install the drive gear (39) in bore over spline of the shaft. Next install the driven gear (40). Be sure both gears firmly contact plate.

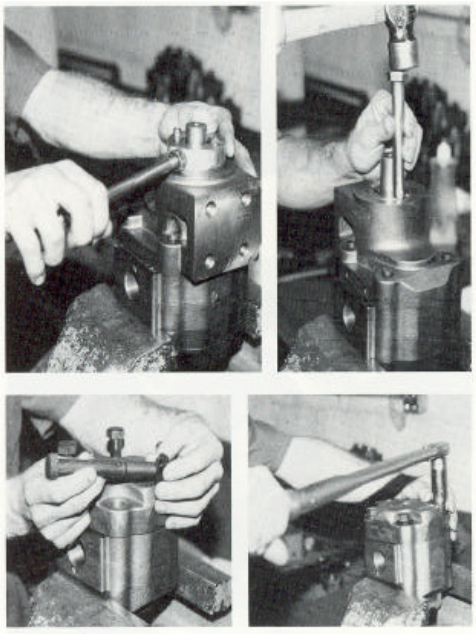
3. Lightly grease square gasket seals (37); carefully install them in the grooves in the two faces of the gear housing (38). Be sure they are properly seated.

4. Carefully place the gear housing subassembly (38 etc.) over the gears, on top of the shaft end cover (26). Making sure that the square gasket (37) is not being pinched or cocked, gently tap the gear housing (38) down on the shaft end cover (26) with a plastic or rawhide mallet. Pour a little hydraulic oil or "STP" over the gears while ro-tating the drive shaft for startup lubrication.

5. Place the Permco diverter plate (36) over the gear hubs - and into the gear housing, face down - counter bores up. The plate should rest slightly below the housing surface. Next, place the port end cover assembly (41) on top of the gear housing guiding the hubs of the gears (39 and 40) into the I.D. of the roller bearings. Gently tap the port end cover (41) down onto the housing with a rubber or rawhide mallet. Be sure the square gasket is not cocked or pinched.



RECOMMENDED TORQUE FOR PUMPS ASS'Y AND MOTORS			
SERIES	SIZE	REQUIRED	TORQUE
2500	5/8-11 UNC-2A THREAD	4	200 Ft.-lbs.
3700	1/2-13 UNC-2A THREAD	8	120 Ft.-lbs.
NOTE: ALL BOLTS OR TIE RODS MUST BE SAE CLASS 8 (TENSILE STRENGTH 150,00 PSI MIN)			



6. Put flat washers (42) on the cap screws (43) and drop them into the port end cover (41) holes. Alternately tighten the cap screws (43) evenly to required torque with a torque wrench. **(See chart)**

7. Test the assembled pump for free rotation by turning the drive shaft. **CAUTION:** Wrap several layers of cloth around the shaft ends before applying the wrench. The shaft should rotate with very little effort, and **NO** hard spots and **NO** rubbing noises.

A. YOUR TYPE II OR TYPE III PUMP IS NOW READY TO GO BACK INTO SERVICE

B. YOUR TYPE I PUMP STILL NEEDS THE FOLLOWING:

8. Release the Type I Pump from the vise; turn it end-for-end so drive shaft (8 and 14) is facing up; re-clamp in vise.

9. Use a face spanner wrench to tighten the retainer ring (1) snugly.

10. Provide required preload on the pump bear-ings and correct running clearance for the pump as follows:

a. With the threaded retainer ring (1) snugged up, scribe a match mark across the face of the retainer ring (1) and the face of the flange of the shaft end cover (9).

b. Using the face spanner wrench, unscrew the retainer ring (1) so that the two ends of the match mark are 1/2" apart, measuring from the outer end of the mark on the outside diameter of the retainer ring (1). This amount of relief will provide the desired 0.005" clearance to produce the required bearing preload and adjustment.

c. After you have checked the distance between the two halves of the match mark to be 1/2", stake the outer edge of the retainer ring (1) into the groove or slot provided in the I.D. of the pilot of the shaft end cover (9). Use a blunt tool and hammer to force the metal of the retainer ring (1) into the pilot groove or slot of the shaft end cover. Check to be sure the ring is firmly locked in place.

C. YOUR TYPE I PUMP IS NOW READY TO GO BACK INTO SERVICE

START-UP INSTRUCTIONS FOR PERMCO PUMPS

FOLLOW THESE INSTRUCTIONS CAREFULLY. If you don't, you can instantly ruin your pump if the relief pressure setting is too high.

1. Before you operate the pump, unscrew the main relief valve adjusting screw on the main hydraulic system. **OR** remove adjusting shims or spacers.
2. Run the pump about five minutes under **ZERO PRESSURE**, with all control valves in neutral position. If the test system has a throttling valve, set it at 100 psi. above user's expected operating pressure.
3. If everything seems to function properly and no unusual noises are heard, back-off the throttling valve to zero. Shut down the system.
4. Adjust the relief valve pressure to the setting your hydrau-lic system requires.

LUBRICATION OF PERMCO PUMPS

1. The hydraulic oil used in the entire circuit provides the lubrication for all parts of the pump. **KEEP THIS OIL CLEAN AND FREE OF DIRT. PERMCO** recommends a 25-micron return filter and a 149-micron (100-mesh screen) suction filter to fully protect the pump and system from excessive wear and damage from dirt.
2. If the pump fails and you think metal particles have gotten in the circuit:

a. Drain **ALL** oil from the whole system,
b. Flush the system with kerosene,
c. Refill the system with fresh oil of correct grade,
(These are correct oils:
Viscosity index at 100°F (37°C): 90 or higher;
Viscosity SUS at 1000 F (37°C): 150 to 300 (32-65 CST);
Aniline point: 165 or higher;
Anti-foam and anti-oxidant additives.)

3. Temperature of oil should never exceed 185°F (85°C.)
4. **NEVER** use low-viscosity naphtha-base oils, aircraft hydraulic fluids, or automotive brake fluids without con-sulting **PERMCO, INC.** or a Permco distributor.

5. For extended operation at temperatures below 20° F (-7° C) always use a low-pour-point oil of top quality.

TROUBLE SHOOTING

PROBLEM	REMEDY
EXCESSIVE NOISE IN PUMP:	
Insufficient Fluid	Replenish fluid to proper level, with proper grade
Fluid is too heavy	Drain system and refill with specified grade of fluid
Oil filter is dirty	Clean or replace filter element
Suction line too small	Install larger suction line
Clogged suction line	Clean line thoroughly
Pump over-speeding	Check pump maximum speed; Slow down pump driver; Or install larger pump
Air vent on fluid reservoir clogged	Clean or replace breather on reservoir
Air bubbles in fluid	Drain system and refill with non-foaming hydraulic fluid
Filter too small	Replace with larger filter
Coupling misalignment	Realign flexible coupling between pump and driver
Air leaks at pump intake on pump shaft packing or inlet pipe	Drip oil over suspected joint; listen for change in sound of pump; tighten joints
Worn or broken pump parts	Replace parts as necessary
FOAMING FLUID:	
Improper fluid	Drain system and refill to correct level with proper grade of anti-foaming fluid
Low fluid level	Top off with proper grade of anti-foaming fluid
Inadequate baffling in tank	Install correct baffling
Air leaking into suction line between reservoir and pump	Tighten all connections
OIL LEVEL IN TANK CONTINUES TO DROP	
Oil level in tank continues to drop	Indicates a broken pipe line or a pipe left out between a bulkhead coupling and the bottom of the tank after cleaning tank. Replace pipe.

PROBLEM	REMEDY
Pump rotating in wrong direction	**IMMEDIATELY STOP PUMP DRIVER** to prevent damaging pump. Then reverse direction of pump rotation
Pump fails to prime itself a. Air leak into suction line b. Oil is too heavy	Tighten up joints. Drain system and replace fluid with proper grade of anti-foaming fluid
c. System not in Neutral	Open valve on pressure side of pump, or install air bleed valve
SYSTEM LACKS ANY PRESSURE WITH PUMP RUNNING:	
Relief valve not set correctly	Use pressure gauge and reset valve to specified pressure
Relief valve leaking	Check relief valve seat for score marks. Reseat by grinding. Or replace.
Broken relief valve spring	Replace spring; reset relief valve
Flow of fluid to tank is unrestricted	Check for control valve in "Neutral" or for open return line
Internal leakage in control valve or power cylinder	Repair or replace leaking valve or cylinder
EXCESSIVE WEAR IN PUMP:	
Abrasive contaminants in fluid	Drain and flush entire system. Install new filter. Fill system with fresh oil of proper grade or filter con-taminated oil through a 10-micron filter before refilling. Operate pump an hour. Drain system again. Install new filter element and fluid.
Fluid too light for pump service	Drain and replace with anti-foaming fluid of proper grade.
Sustained pressure above pump maximum rating	Check and reset relief valve pressure, using pressure gauge.

PROBLEM	REMEDY
Sustained excessive speed at pressure above pump maximum rating	Recheck pump rated speed. Slow down driver to produce this speed.
Drive misalignment; Tight belt; weight of pump supported by its drive shaft	Check pump/driver coupling or belt alignment. Install adequate support for pump.
Entrapped air in hydraulic system	Bleed air from hydraulic system

OVERHEATED FLUID:

Fluid too heavy	Drain system and refill with lighter grade of anti-foaming fluid.
Fluid too light for high temperature pump location	Drain system and refill with heavier weight anti-foaming fluid.
Dirty fluid	Drain and flush system; refill with proper grade of anti-foaming fluid; replace filter element.
Dirt or chip caught between plunger and seat of relief valve	Disassemble relief valve and remove contaminant. Check condition of filter to prevent recurrence.
Incorrect setting on relief valve	Use gauge and adjust relief valve setting to cor-rect pressure
Worn pump permits oil to bypass internally	Repair worn pump parts or replace pump.
Relief valve leaks or not operating	Repair or replace relief valve
Excessive friction caused by pump components over-torqued	Disassemble pump and back off over-torqued component to tightness specified in this maintenance manual
Undersize hoses and valves in system	Replace with proper size hose and valves
Restrictions and excessive bends in lines	Re-plumb system to eliminate restrictions
Inadequate reservoir prevents adequate cooling of fluid	Install larger reservoir or add fluid radiator
Internal leaks not in pump	Locate and repair leaks

PUMP NOT EFFICIENT:

Worn pump parts reduce pump efficiency	Repair or replace pump
Air in system	Bleed air from system; check line connections for air leaks

PROBLEM	REMEDY
Internal leak in control valve or cylinder.	Repair or replace control valve. Replace cylinder packing. Check cylinder walls for scoring and replace if necessary.
Erratic pump performance: a. If pump runs slow on startup, and speeds up after fluid is warm, fluid fluid grade is too heavy.	a. Drain system and refill with lighter grade anti-foaming fluid.
b. If pump slows down after fluid has heated up, fluid is too light	b. Drain system and refill with heavier grade anti-foaming fluid.

MOTOR DOESN'T DEVELOP PROPER TORQUE OR SPEED

(when pump is used as a motor)

Relief valve incorrectly adjusted	Use a pressure gauge and increase relief valve pressure setting to proper level
Relief valve sticking open	Disassemble relief valve and remove dirt from under ball or piston. Check condition of filter to prevent recurrence.
Flow of fluid to tank is unrestricted	Check for control valve in "Neutral" or for open return line.
Insufficient pump pressure or volume	Use pressure and flow gauges to check pump out-put and pressure.
Misalignment of pump/driver	Realign belt drive or coupling, recheck torque requirements of pump for maximum input.

MOTOR SUBJECTED TO OVERPRESSURE.

(when pump is used as hydraulic motor)

If you have used a standard control valve to control a hydraulic motor, serious and catastrophic harm can result. When the standard control valve is returned to "Neutral", to start or stop the motor sudden excessive pressure develops. This pressure can burst seals, fracture drive shafts, burst housings, and rupture hoses.

HOW TO ORDER PARTS

ALWAYS GIVE US THE SERIES NUMBER, please. It instantly tells us what PERMCO Pump or Motor you want parts for. You will find this Series Number on the nameplate.

IF YOU CANNOT SUPPLY THE SERIES NUMBER, Please answer these questions:

1. Is the unit a pump or a hydraulic motor?
2. If a pump, which way does it rotate when you look at it from the shaft end? Clockwise? Or Counter-Clockwise?
3. How many gear housing sections does the unit have?
4. Check "Series Identification Table" below to determine series.

STEPS IN IDENTIFICATION:

1. Shaft end cover:
   Mounting flange: Is it pad mounting or foot mounting? How many bolts, 2, 4, 6, 8? If round flange, measure pilot diameter, center diameter, and bolt-hole diameters.
2. Bearing arrangement:
   With or without outboard bearings? Double outboard bearings? Bearing measurements? Any drains or grease fittings?
3. Drive shaft:
   Diameter of shaft end? Keyed or not? Length of spline? Number of spline teeth O.D.? Total length of shaft?
4. Housing:
   Width of housing? Inside diameter of ports?
5. Port end cover:
   Inside diameter of ports?
6. Bearing carrier:
   Inside diameter of ports? Direction of flow thru internal passage or coring?
7. Gears:
   Gear tooth width? Gear O.D. measured over teeth? If gears are integral, describe drive end of drive gear, as in Paragraph 3 above.

SERIES IDENTIFICATION

SERIES	STUD HOLES No. and Dia.	STUD DIA.	CONTINENTAL (Two-Piece Drive Shaft & Gear Set)	INTEGRAL (One-Piece Drive Shaft & Gear Set)	HOUSING Height	HOUSING WIDTH= GEAR WIDTH, +
1200	10-9/16"	1/2"	X		7"	1/2"
1500	4-9/16"	1/2"	X		5-1/4"	3/4"
2500	4-11/16"	5/8"	X		6"	3/4"
3700	8-9/16"	1/2"	X		7-5/16"	1"
3000 3100 (Doweled)	4-11/16"	5/8"	*	X	5-3/8"	3/4"
5000 5100 (Doweled)	4-11/16"	5/8"	*	X	6"	3/4"
7500 7600 (Doweled)	8-11/16"	5/8"	*	X	7-7/8"	1"

* Continental (Two-Piece Drive Shaft & Gear Set) available on Series 3000, 5000 and 7500 as specials; consult factory.

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OILAIR HYDRAULICS INC.



OAD
Air Oil Cooler

Mobile hydraulic systems

High performance

Compact size

Rugged construction

Balanced oil temperatures - the key to efficiency in hydraulics

Maintaining the correct system temperature is important to ensure optimum performance in a hydraulic system.

In many hydraulic systems, up to 50% of the available horsepower can be lost due to inefficiencies in the system. These inefficiencies include friction, pressure drops and changes/interruption of flow. The end result of these losses is the production of heat.

When the heat generated is greater than the amount that can be naturally dissipated by the system, the fluid temperature will rise until the rate of heat production is equal to the amount of heat dissipated. Unfortunately, in many systems, this point of equilibrium is at a temperature that can damage both the fluid and hydraulic components.

Harmful side effects of excessive temperature include reduction in fluid lubricity, destruction of helpful fluid additives, oxidation of the fluid and "varnishing" of system components. These effects in turn lead to greater energy losses and more heat generation, forming a destructive cycle.

The cooler provides reliable temperature control

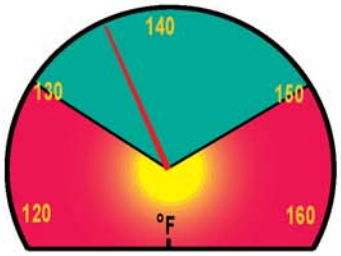
The oil cooler dissipates heat from the system providing reliable temperature control of hydraulic fluids. The correct size of cooler and type of fluid ensure a properly operating system. Inherent advantages include:

- Hydraulic system life extended by 3-5 times.
- Long lasting oil durability.
- Reduced internal potential for leaks.
- Prolonged lubricating qualities.
- Improved hydraulic efficiency.

OilAir offers the best cooler to meet every requirement.

At OilAir we specialize in solving complicated overheating problems in all types of hydraulic systems. Our wide range of cooler sizes and types enables us to offer the cooler that best meet your needs. Our other wide range of standard air oil coolers are grouped in four main series:

OAI	AC motor driven air oil cooler designed for industrial and stationary equipment.
OAO	AC motor driven offline air oil cooler with an integrated circulation pump.
OAH	Hydraulic motor driven air oil cooler designed for mobile equipment.
OAD	DC motor driven air oil cooler designed for mobile equipment.



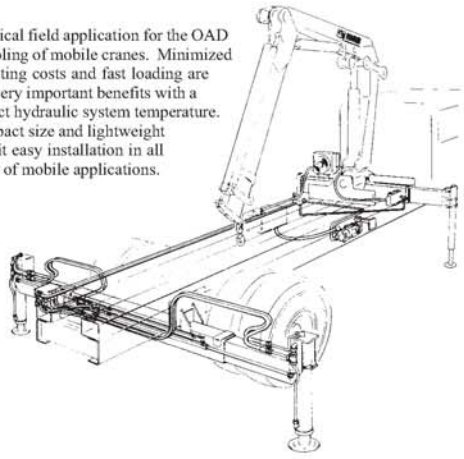
We recommend that the working temperature is held between 130° F and 150° F. (for mobile hydraulic systems). A correctly calculated cooler ensures optimum efficiency.

OAD and OAH cooler specially designed for mobile hydraulic applications

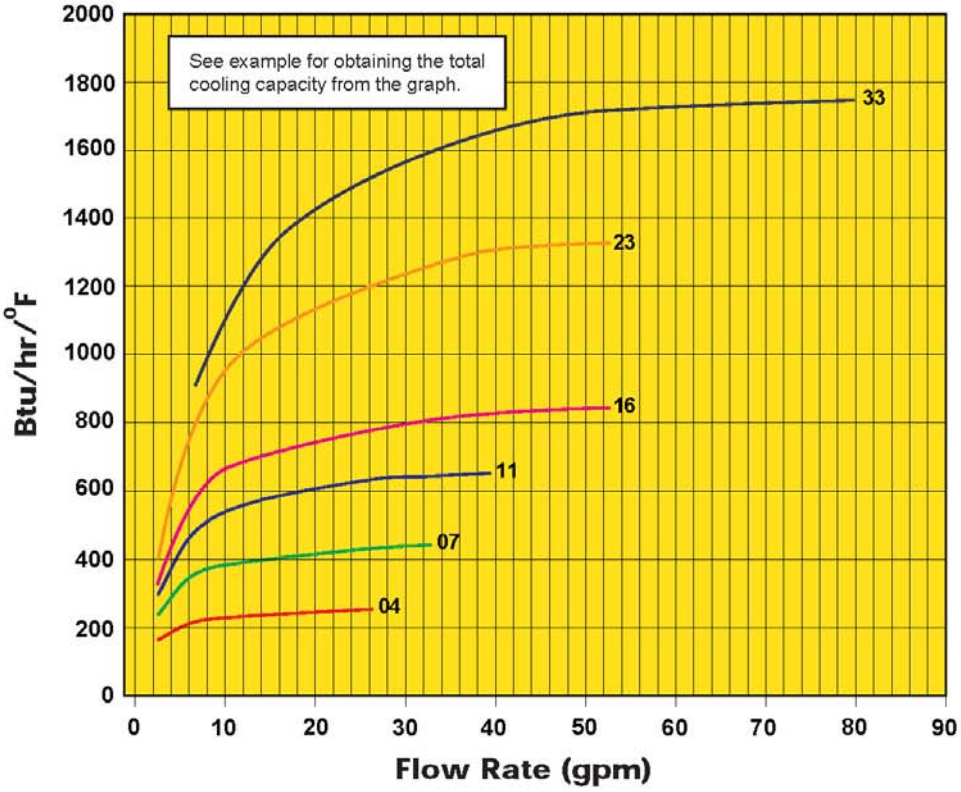
The OilAir OAD cooler (DC-motor driven fan) and OAH cooler (Hydraulic motor driven fan) are designed primarily for mobile applications. Typical applications include:

- Cooling of mobile hydraulics such as cranes, logging equipment and mining equipment.
- Re-cooling of compressors on the air side as well as on the oil side.
- Cooling of Diesel-engine oils.
- Cooling of mobile hydraulics on drill rigs.
- Additional cooling of engine oils and mobile hydraulics under extreme conditions (such as tropical environments).
- Cooling of engine oils on mobile and stationary generating units.

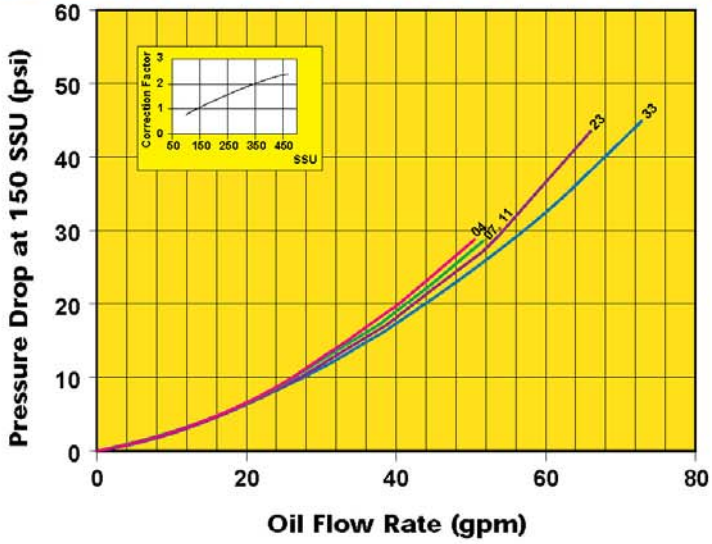
A typical field application for the OAD is cooling of mobile cranes. Minimized operating costs and fast loading are two very important benefits with a correct hydraulic system temperature. Compact size and lightweight permit easy installation in all kinds of mobile applications.



Cooling Capacities



Oil pressure drop curves with correction factors for other viscosities Model BPO



3

Typical characteristics that make the OilAir OAD type of air oil cooler ideal for mobile applications.

- Compact size and lightweight.
- High physical strength and durability.
- Extremely quiet compared to conventional air oil coolers.
- Easy to retrofit on all types of machines.
- Unlimited utilization of all accessory units
- Ease of maintenance (held together by 8 bolts only)

OAD Material

- Core: Aluminum
- Fan Blades: Fiber glass reinforced polypropylene
- Fan Housing: Steel
- Fan Guard: Steel

Surface treatment

- All steel components are electrostatic blast coated with epoxy plastic powder.
- The cooler core has a layer of protective diffused zinc to withstand corrosion before receiving a final coat of electrostatic epoxy plastic powder.
- Consult OilAir Hydraulics Inc. for use in aggressive or corrosive environments.

Technical Specifications for the Cooler core

- Dynamic working pressure: 200 psi.
- Maximum static pressure: 300 psi
- Maximum oil inlet temperature in 250°F. Oil temperature above this will reduce maximum working pressure rating.

Fluid compatible with OAD aluminum cooler core

- Mineral oils
- Oil/water emulsion
- Water glycol
- Phosphate ester

Factors affecting heat dissipation

- Limits of heat dissipation in graph +/- 6%
- Viscosity's above 450 SSU (70 cSt) will cause reduction in heat dissipation. Consult our factory.
- For aggressive environments ambient air may contain dust particles that will increase air fin clogging coefficient.
- Operating coolers at altitudes above 1300 feet will reduce heat dissipation. Consult factory.

	OAD-04	OAD-07,11, 16 23** & 33**
Weight	4.6 lbs	5.39 lbs
RPM	3350 rpm	3060 rpm
Noise Level	70 dB(A)	70 dB(A)
Protection Standard	IP 64	IP 64
Insulation Class	H	H
Ambient Temp.	-22°F to +176°F	-22°F to + 176°F
Life Expectancy	5,000 Hrs.	8,000 - 10,000 Hrs.

** OAD 23 & 33 is twin fan motor

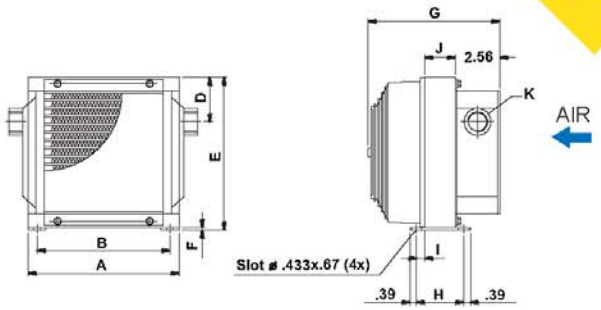
Technical Specifications for Electrical Motors

- Long lasting, high quality motors available in 12V and 24V DC.
- Enclosed for protection
- Please refer table on page 5 for power consumption

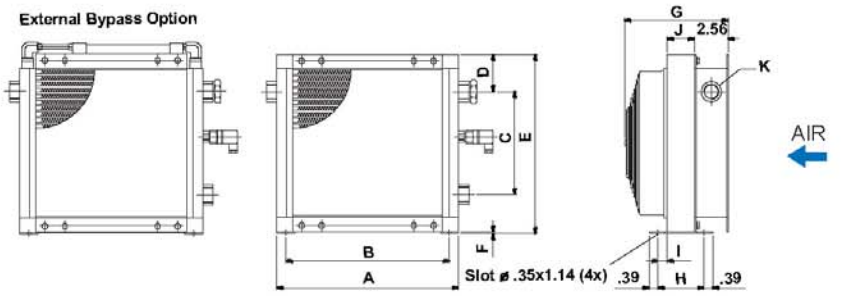
	Dimensions in Inches								
Type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
OAD 04	9.84	8.66	-	2.91	10	0.15	8.58	3	0.55
OAD 07	13.38	11.81	-	3.54	13.54	0.15	8.18	3.54	0.98
OAD 11	15.74	14.17	8.93	3.22	15.6	0.15	8.97	3.97	0.8
OAD 16	17.95	16.37	9	3.14	18.14	0.15	8.97	3.97	1.08
OAD 23*	24.2	14	12	4.68	25	0.78	8.97	11.41	5.11
OAD 33*	24.8	14.6	15.98	3.38	26.7	0.78	10.2	11.41	5.11

** OAIBD 23 is dual fan

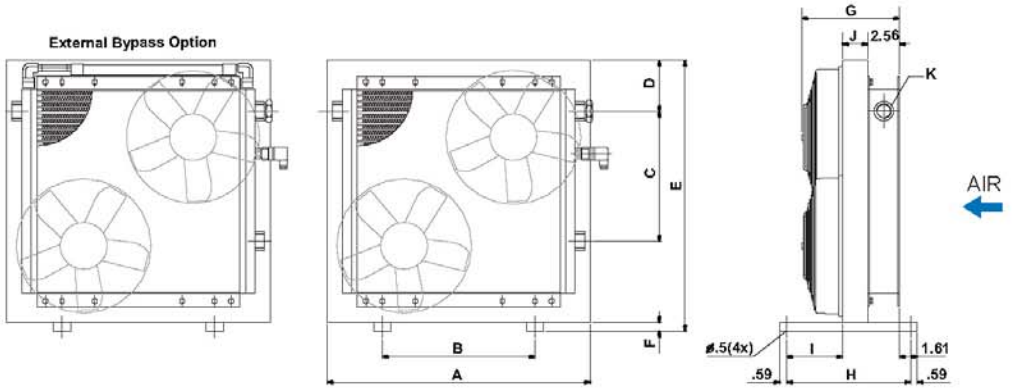
OAD 04



OAD 7, 11&16



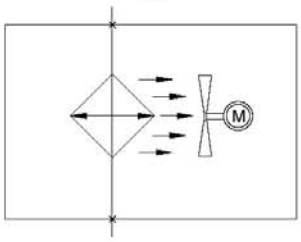
OAD 23 & 33



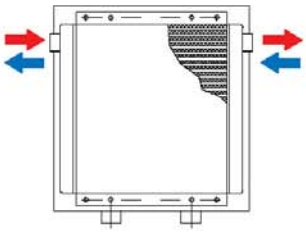
Type	J	K	Air Flow CFM	Max. cons.of current OAD 24V	12V	Fuse OAD 24V	12V	Weight Lbs (Approx)
OAD 04	1.96	1-5/16"-12UN	509	6A	10A	10A	15A	10
OAD 07	1.57	1-5/16"-12UN	806	11A	20A	15A	25A	22
OAD 11	2.36	1-5/16"-12UN	1082	11A	20A	15A	25A	27
OAD 16	2.36	1-5/16"-12UN	1315	11A	20A	15A	25A	33
OAD 23*	2.36	1-5/16"-12UN	2015	2x11A	2x20A	2x15A	2x25A	55
OAD 33*	3.93	1-5/8"-12UN	2892	2x11A	2x20A	2x15A	2x25A	66

Piping diagram for the OAD air oil cooler

No Bypass

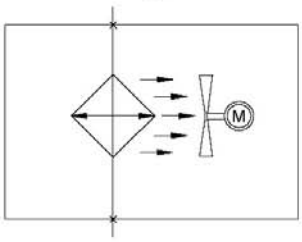


Type OAD 04

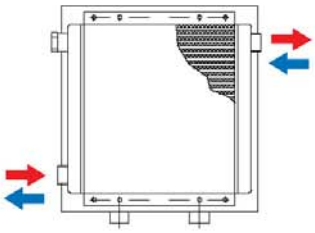


Oil inlet connection may be located either on the right or on the left side of the matrix. The oil outlet connection is always located on the opposite side of the matrix.

No Bypass

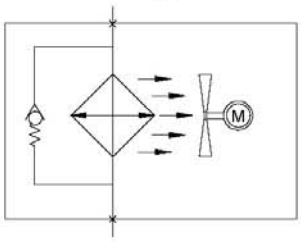


Type OAD 07 - OAD 33

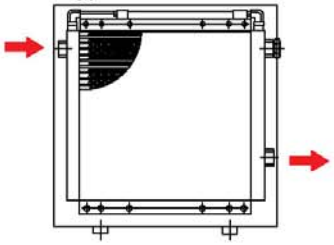


Oil inlet connection may be located either on the right or on the left side of the matrix. The oil outlet connection is always located on the opposite side. There are two connections on the left side, one of these has be plugged.

With Bypass

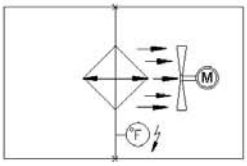


Type OAD 07 - OAD 33

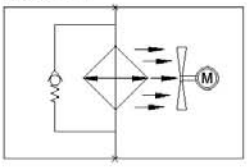


Oil inlet connection is located on the left side of the matrix (on the by-pass valve side). The oil outlet connection is always located on the opposite side. There are two connections on the left side, one of these has to be plugged.

With Thermo Switch Model C & CB



Built in External By-Pass Valve Model BP1



Model Code

OAD 11 - x - x - x

Cooler Size

DC-motor
Voltage 12V or 24V

Thermo-contacts available:
Temp TV 100/120/160/175 °F

C100 = With thermo-contact set at 100°F
CB120 = With relay, fuse, switch box, thermo-contact TV 120°F

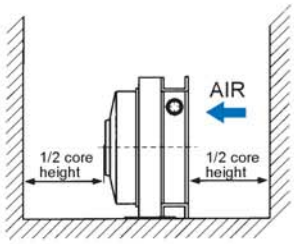
Type of by-pass valve
BP1.2 = With built-in-by-pass valve 20 psi
BP1.5 = With built-in by-pass valve 65 psi

Ordering Example: OAD 11 - 12V - BP1.2 - CB120

Service instructions

Location

Place the cooler so that there is an unrestricted air flow to and from the cooler. The distance from the nearest wall should not be less than half the height of the core.



Cleaning of air fins

The easiest way to clean the air fins is by using compressed air or rinsing with water. Fouling can be dealt with using a degreasing agent and a high pressure washing system. When using a high pressure washing system, point the jet carefully parallel to the air fins.

Cleaning the inside of oil cooling tubes

Connect the cooler to a closed circuit and flush the inside with perchlorethylene. After cleaning, the radiator should be flushed with oil before reconnecting to the hydraulic system.

Noise level

The noise level of the oil cooler may vary within +/-3 dB (A) depending on reflections from surrounding objects, natural frequency and other interference sources etc.

Suspension

The very rigid cooler construction permits both vertical and horizontal mounting. Mounting is facilitated by four mounting holes in each support leg of the cooler. There is a mounting flange in the front of the air oil cooler for wall mounting next to a ventilator shaft or similar structure.

Connection to the system

The air oil cooler is intended to cool the system's return oil. Use hydraulic hoses both to and from the cooler. Avoid hydraulic tubes, unless stress-free joints can be guaranteed. If there is a risk of pressure spikes or flow peaks the cooler should be installed with a bypass valve. If the viscosity of the oil is 450 ssu at cold start, use a full flow pressure or temperature bypass valve external to the cooler.

Useful Technical Information

Recommended Maximum Oil Temperature:

Industrial Hydraulic Systems:	110°F - 130°F
Mobile Hydraulic Systems:	130°F - 150°F
Mobile Hydrostatic Transmission:	160°F - 170°F

Formulas

1 HP	=	746 Watts	=	2545 Btu/hr
1 kW	=	1.34 HP	=	3412 Btu/hr
Temperature conversion °F			=	°C x 1.8 +32

Heat Equivalent of Fluid Power

HP heat	= (PSI x GPM)/1714
BTU/hr heat generation	= 1.5 x PSI x GPM

Heat Radiation from Steel Reservoirs

HP Radiation	=	.001 x T.D. x A
Where A	=	Surface area in Sq. Ft.
TD	=	Temperature difference in °F Between reservoir surface and surrounding air

Examples

Given:	Fluid Type	SAE 10
	Flow Rate	25 GPM
	Desired Oil Temperature (Inlet to Cooler)	130°F
	Ambient Air Temperature	80°F
	Altitude	<3,000 feet
	Heat Dissipation Required	30,000 Btu/hr

Required: Type of air oil cooler

Temperature Difference (ΔT)
(ΔT) = 130°F - 80°F = 50°F
Heat dissipation per °F (P) = 30,000/50
P = 600 Btu/hr/°F

Refer to the cooler capacity chart.

Plot the 600 Btu/hr/°F against the flow of 25 GPM

We recommend Cooler model #OAD 11



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Char Lynn Hydraulic Motor Series 2000, 4000, 6000, & 10,000



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

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

Geroler® Displacement Mechanism

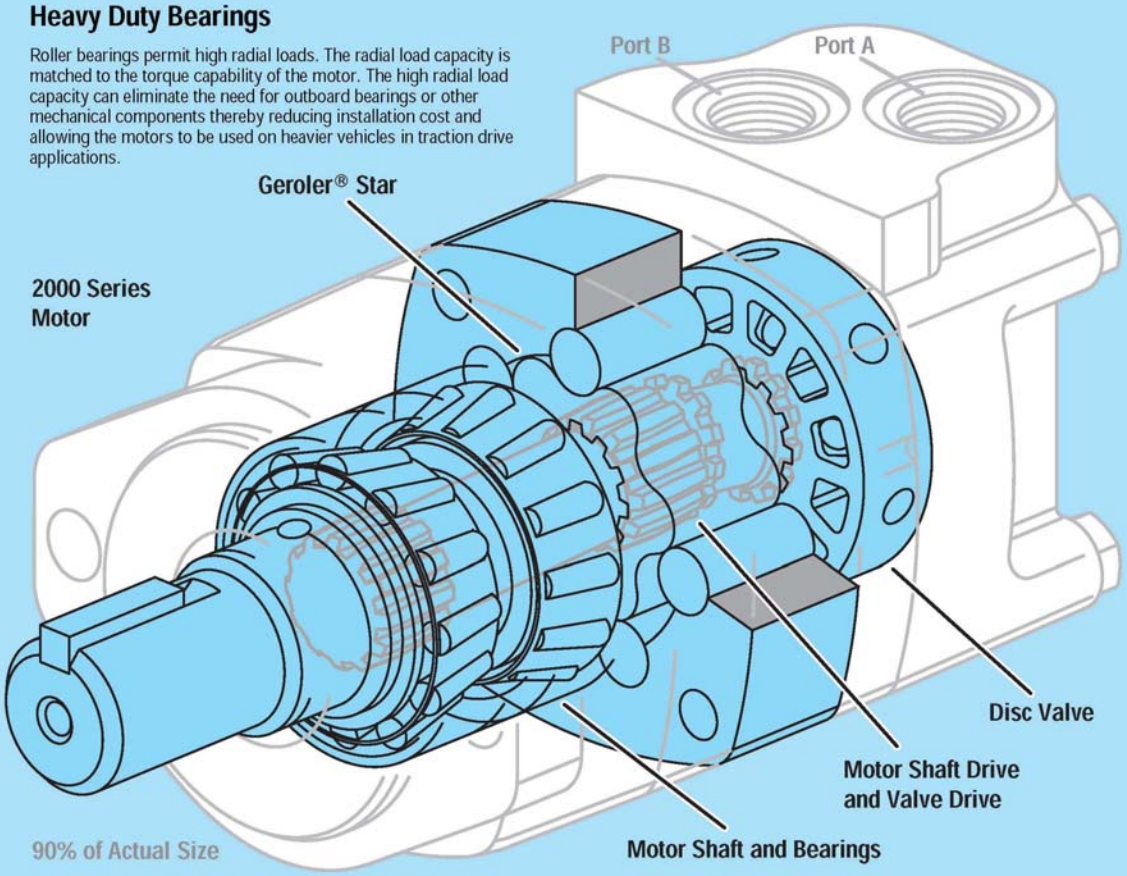
Motors with the Geroler element provide high starting and running torque. The Geroler element minimizes friction and thereby increases efficiency while providing smooth output shaft rotation even at very low speeds. Motor shaft rotation can be instantly reversed by changing direction of input/output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

Disc Valve

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

Heavy Duty Bearings

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



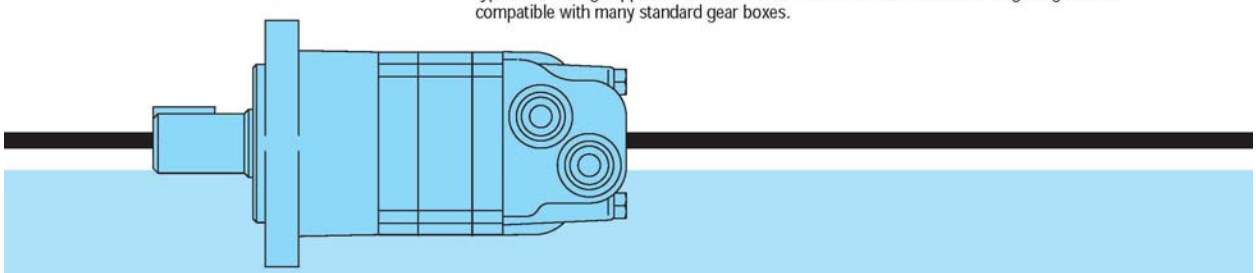
Design Features

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

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

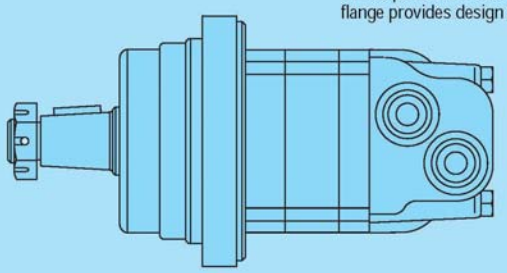
Standard Motor

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



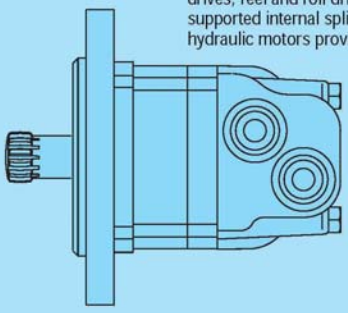
Wheel Motor

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

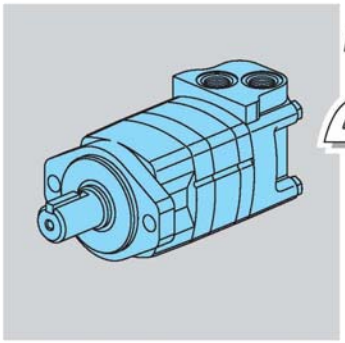


Bearingless Motor

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



2000 Series



2000

2000 Series

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

2000 Series Displacement Size = cubic centimeter per shaft revolution (cm³/r)
= cubic inch per shaft revolution ([in³/r])

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

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

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

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

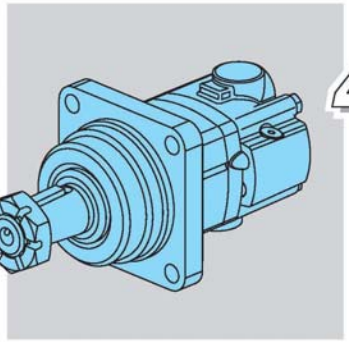
Special Features
- Viton® Shaft Seal
- Viton Seals
- Free Running Geroler
- Speed Sensor
- Two Speed Option
- Hot Oil Shuttle
- Corrosion Protected
- Seal Guard Package

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

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

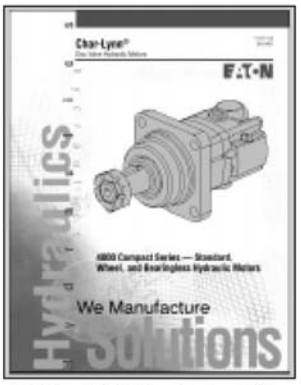
Viton® is a Registered Trade Name of Dupont Corp.

4000 Compact Series



4000 Compact Series

Compact Series



See Catalog 11-01-113 for a Char-Lynn 4000 Compact Series hydraulic motor, this motor has the same pakage size as the 2000 Series with 4000 Series performance.

4000 Compact Series

Geroler® Element..... 6 Displacements
Flow LPM [GPM] ..... 75 [20] Continuous**
115 [30] Intermittent*
Speed ..... Up to 707 RPM
Pressure Bar [PSI] ... 200 [3000] Cont.
300 [4500] Inter.
Torque Nm [lb-in] .... 932 [8250] Cont.
1166 [10320] Inter.

4000 Compact Series Displacement Size = cubic centimeter per shaft revolution (cm^3/r)
= cubic inch per shaft revolution ([in^3/r])

- 160 [9.8]
- 200 [12.3]
- 250 [15.4]
- 325 [19.8]
- 395 [24.0]
- 490 [29.8]

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

Output Shaft
- Bearingless
- 1–1/4 inch Dia. Straight with Straight Key, 3/8-16 Threaded Hole and 47,3 [1.86] Max. Coupling Length
- 1–1/2 inch Dia. Straight with Straight Key, 3/8-16 Threaded Hole and 67,8 [2.67] Max. Coupling Length
- 32 mm Dia. Straight with Straight Key, M 8 x 1,25 -6H Threaded Hole and 56,4 [2.22] Max. Coupling Length
- 40 mm Dia. Straight with Straight Key, M12 x 1,75 -6H Threaded Hole and 79,6 [3.13] Max. Coupling Length
- 1–1/4 inch Dia. Splined 14 T, 3/8-16 Threaded Hole and 38,1 [1.50] Min. Full Spline Length and 53,1 [2.09] Max. Coupling Length
- 1–1/2 inch Dia. Splined 17 T, 31,2 [1.23] Min. Full Spline Length and 51,8 [2.04] Max. Coupling Length
- 1–1/4 inch Dia. Tapered with Straight Key and Nut
- 1–5/8 inch Dia. Tapered with Straight Key and Nut

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

Case Flow
- 7/16-20 UNF 2-B O-ring Port
- G 1/4 (BSP) Straight Thread Port
- Hot Oil Shuttle with 7/16-20 UNF 2-B O-ring Port
- Hot Oil Shuttle with G 1/4 (BSP) Straight Thread Port

Back-Pressure Relief Valve
- Set at 4,5 bar [65 PSI]

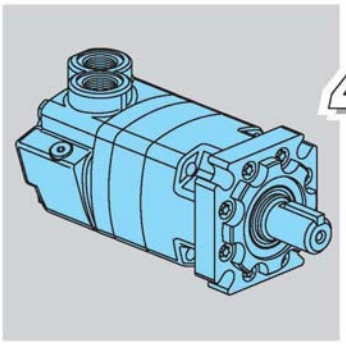
Special Features
- Viton® Seal
- Speed Sensor
- Corrosion Protected
- Seal Guard Package

Viton® is a Registered Trade Name of Dupont Corp.

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

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

4000 Series



4000

4000 Series

Geroler® Element	10 Displacements
Flow LPM [GPM]	95 [25] Continuous**
	150 [40] Intermittent*
Speed	Up to 868 RPM
Pressure Bar [PSI] ...	200 [3000] Cont.
	300 [4500] Inter.
Torque Nm [lb-in]	970 [8600] Cont.
	1180 [10450] Inter.

4000 Series Displacement Size = cubic centimeter per shaft revolution (cm^3/r)
= cubic inch per shaft revolution ([in^3/r])

- 110 [6.7]
- 130 [7.9]
- 160 [9.9]
- 205 [12.5]
- 245 [15.0]
- 280 [17.1]***
- 310 [19.0]
- 395 [24.0]
- 495 [30.0]
- 625 [38.0]

Mounting Flange
- 4 Bolt (Bearingless) 127,0 [5.00] Pilot Dia. and 14,27 [.562] Dia. Mounting Holes 161,9 [6.38] Dia. B.C.
- 4 Bolt (SAE B) (Standard) 101,6 [4.00] Pilot Dia. and 14,7 [.58] Mounting Slots on 127,0 [5.00] Dia. B.C.
- 4 Bolt (Wheel) 139,7 [5.50] Pilot Dia. and 14,3 [.56] Dia. Mounting Holes on 165,1 [6.50] Dia. B.C.
- 4 Bolt (SAE C) (Standard) 127,0 [5.00] Pilot Dia. and 14,3 [.56] Dia. Mounting Holes on 161,9 [6.38] Dia. B.C.

Output Shaft
- Bearingless
- 1-1/4 inch Dia. Straight with Straight Key, 3/8-16 Threaded Hole and 53,1[2.09] Max. Coupling Length
- 1-5/8 inch Dia. Tapered with Straight Key and 1-1/4—18 UNEF Slotted Hex. Nut
- 1-1/4 inch Dia. Splined 14 T with 38,1 [1.50] Min. Full Spline Length and 53,1 [2.09] Max. Coupling Length
- 1-1/2 inch Dia. Splined 17 T with 31,2 [1.23] Min. Full Spline Length
- 40 mm Dia. Straight with Straight Key, M12 x 1,75-6H Threaded Hole

Port Type
- 1-1/16—12 O-ring with 7/16-20 O-ring Case Drain and Check Valve
- G 3/4 (BSP) O-ring with G 1/4 (BSP) O-ring Case Drain and Check Valve
- 3/4 inch 4 Bolt Split Flange with 7/16-20 O-ring Case Drain and Check Valve
- 7/8-14 O-ring with 9/16-18 O-ring Case Drain with Shuttle Valve

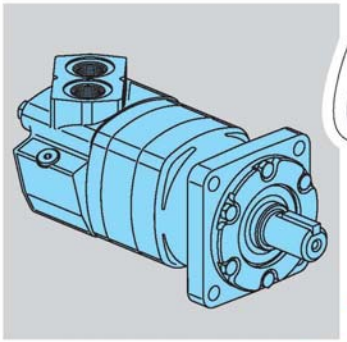
Special Features
- Viton Shaft Seal
- Viton Seals
- Hot Oil Shuttle
- Corrosion Protected

*** For performance and dimension data contact your Eaton Hydraulics representative.

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

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

6000 Series



6000

6000 Series

Geroler® Element ..... 9 Displacements
Flow LPM [GPM] ..... 150 [40] Continuous**
225 [60] Intermittent*
Speed ..... Up to 866 RPM
Pressure Bar [PSI] ... 200 [3000] Cont.
300 [4500] Inter.
Torque Nm [lb-in] .... 1685 [14920] Cont.
1875 [16580] Inter.

6000 Series Displacement Size = cubic centimeter per shaft revolution (cm³/r)
= cubic inch per shaft revolution ([in³/r])

- 195 [11.9]
- 245 [15.0]
- 310 [19.0]
- 390 [23.9]
- 490 [30.0]
- 625 [38.0]
- 740 [45.0]***
- 805 [49.0]***
- 985 [60.0]

Mounting Flange

- 4 Bolt (Bearingless) 127,0 [5.00] Pilot Dia. and 14,3 [.56] Dia. Mounting Holes on 161,9 [6.38] Dia. B.C.
- 4 Bolt (SAE CC)(Standard) 127,0 [5.00] Pilot Dia. and 14,3 [.56] Mounting Holes on 161,9 [6.38] Dia. B.C.
- 4 Bolt (Wheel) 139,7 [5.50] Pilot Dia. and 14,3 [.56] Dia. Mounting Holes on 184,1 [7.25] Dia. B.C.

Output Shaft

- Bearingless
- 1-1/2 inch Dia. Straight with Straight Key, 3/8-16 Threaded Hole and 56,7[2.23] Max. Coupling Length
- 1-3/4 inch Dia. Tapered with Straight Key and 1-1/4—18 UNEF Slotted Hex. Nut
- 1-1/2 inch Dia. Splined 17 T with 40,3 [1.59] Min. Full Spline Length and 3/8-16 Threaded Hole
- 40 mm Dia. Straight with Straight Key, M12 x 1,75-6H Threaded Hole

Port Type

- 1-5/16-12 O-ring with 7/16-20 O-ring Case Drain and Shuttle Valve
- G 1 (BSP) O-ring with G 1/4 (BSP) O-ring Case Drain and Check Valve
- 3/4 inch 4 Bolt Split Flange with 7/16-20 O-ring Case Drain and Check Valve

Special Features

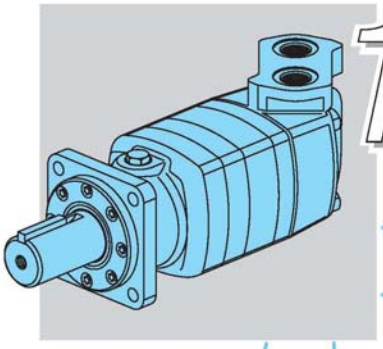
- Viton Shaft Seal
- Viton Seals
- Hot Oil Shuttle
- Corrosion Protected

*** For performance and dimension data contact your Eaton Hydraulics representative.

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

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

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.

Design Flexibility

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

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

Durability

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

Performance Rating

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

Controllable Speeds

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

Dependable Performance

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

Reliability

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

High Efficiencies

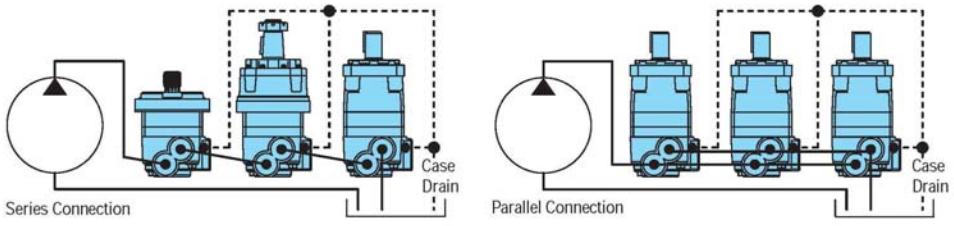
Char-Lynn disc valve motors have high efficiencies providing high output for the pressure and flow supplied. The high mechanical efficiency enables you to obtain a given torque with a smaller displacement motor.

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

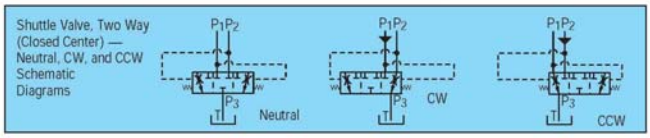
In conclusion, these efficiencies mean less heat buildup in the hydraulic system.

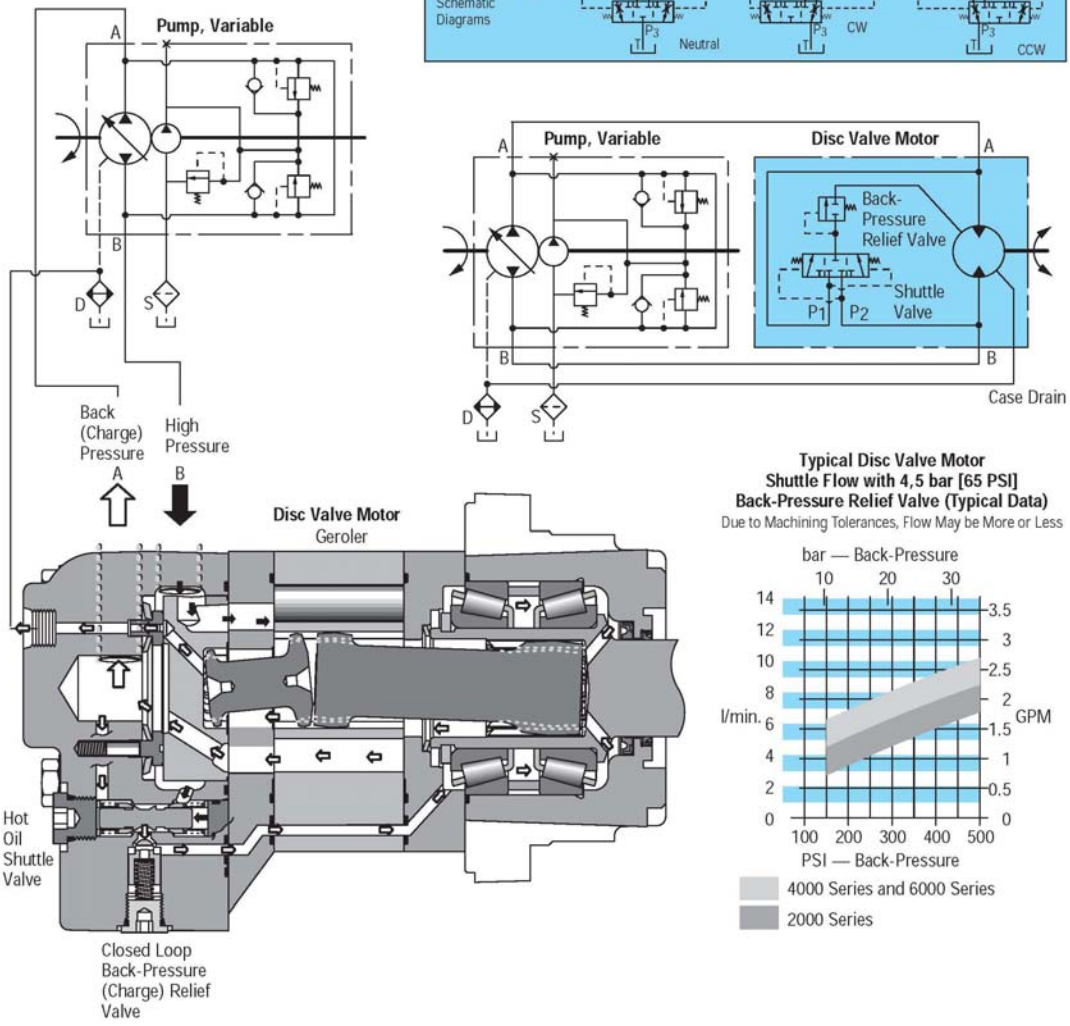
Case Drain and Shuttle Valve Options

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



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





Typical Disc Valve Motor
Shuttle Flow with 4,5 bar [65 PSI]
Back-Pressure Relief Valve (Typical Data)
Due to Machining Tolerances, Flow May be More or Less

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

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

Speed Sensor 2000, 4000 and 6000 Series

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

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

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

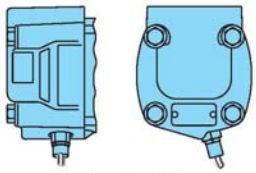
Supply Current: 20 mA max. (Vs) (including internal pull-up resistor)

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

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

2000 Series

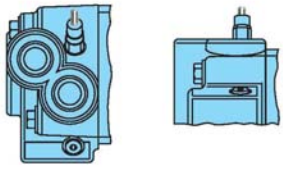
Output
Speed Sensor — digital on/off signal from a Hall Effect switch; 30 pulses/revolution



Output Quadrature Speed Sensor — 60 pulses/revolution

4000 Series

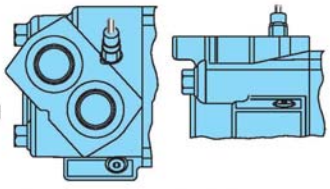
Output
Speed Sensor — digital on/off signal from a Hall Effect switch; 36 pulses/revolution



Output Quadrature Speed Sensor — 72 pulses/revolution

6000 Series

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



Output Quadrature Speed Sensor — 80 pulses/revolution

Quadrature Speed Sensor 2000, 4000 and 6000 Series

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

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

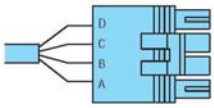
Outputs — Digital signals from NPN transistors (open collector output with internal 10K pull-up resistors).

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

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

Output
Low Voltage: 0.5 Vdc maximum @ 10 mA

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



Weatherpack Tower Connector

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

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

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

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

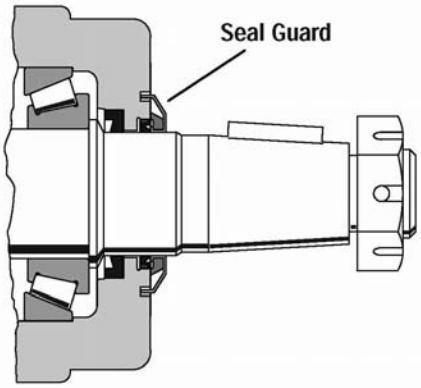
Eaton Corporation
Durant Products
901 South 12th Street
Watertown, WI 57094
1-800-289-3866

Shaft Seal

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

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

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



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

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

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

Internal Check Valves

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

Corrosion Protected Disc Valve Motors

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

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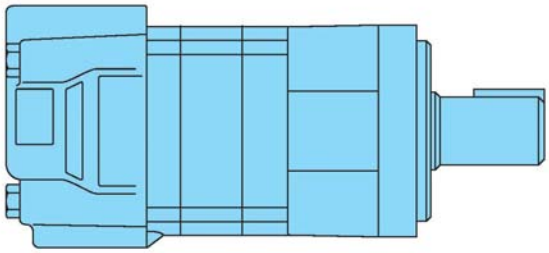
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Specifications
2000 Series



Specification Data—2000 Series

Displ. cm³/r [in³/r]		80 [4.9]	100 [6.2]	130 [8.0]	160 [9.6]	195 [11.9]	245 [14.9]	305 [18.7]	395 [24.0]	490 [29.8]
Max. Speed (RPM) @ ..... Flow	Continuous	799	742	576	477	385	308	246	191	153
	Intermittent	908	924	720	713	577	462	365	287	230
Flow LPM [GPM]	Continuous	75 [20]	75 [20]	75 [20]	75 [20]	75 [20]	75 [20]	75 [20]	75 [20]	75 [20]
	Intermittent	75 [20]	95 [25]	95 [25]	115 [30]	115 [30]	115 [30]	115 [30]	115 [30]	115 [30]
Torque ☆ 1-1/4 Inch or 32 mm Dia. Shaft Nm [lb-in]	Continuous	235 [2065]	295 [2630]	385 [3420]	455 [4040]	540 [4780]	660 [5850]	765 [6750]	775 [6840]	845 [7470]
	Intermittent	345 [3035]	445 [3950]	560 [4970]	570 [5040]	665 [5890]	820 [7250]	885 [7820]	925 [8170]	930 [8225]
Pressure ☆ 1-1/4 Inch or 32 mm Dia. Shaft Δ Bar [Δ PSI]	Continuous	205 [3000]	205 [3000]	205 [3000]	205 [3000]	205 [3000]	205 [3000]	205 [3000]	155 [2250]	120 [1750]
	Intermittent	310 [4500]	310 [4500]	310 [4500]	260 [3750]	260 [3750]	260 [3750]	240 [3500]	190 [2750]	140 [2000]
	Peak	310 [4500]	310 [4500]	310 [4500]	310 [4500]	310 [4500]	310 [4500]	310 [4500]	225 [3250]	170 [2500]
Maximum Case Pressure - without Case Drain * — 140 Bar [2000 PSI]										

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

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

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

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

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

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

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

Intermittent Operation — 10% of every minute.

Peak Operation — 1% of every minute.

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

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

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

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

Performance Data
2000 Series

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

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

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

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

Continuous
Intermittent

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

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

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

Performance Data
2000 Series

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

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

Flow LPM [GPM]	[250] 15	[500] 35	[1000] 70	[1500] 105	[2000] 140	[2500] 170	[3000] 205	[3500] 240	[4000] 275	[4500] 310
[.25] ,95	[170] 20 3									
[.5] 1,9	[190] 20 12	[410] 45 8	[870] 100 2							
[1] 3,8	[230] 25 28	[510] 60 27	[1070] 120 23	[1580] 180 19	[2050] 230 16	[2520] 285 13	[2920] 330 9	[3310] 375 3		
[2] 7.5	[230] 25 56	[510] 60 56	[1080] 120 53	[1600] 180 47	[2090] 235 42	[2580] 290 39	[2930] 330 36	[3320] 375 28	[3640] 410 21	[3990] 450 13
[4] 15	[220] 25 114	[500] 55 113	[1080] 120 111	[1620] 185 104	[2150] 245 97	[2660] 300 95	[3100] 350 92	[3540] 400 85	[3980] 450 77	[4420] 500 70
[6] 23	[220] 25 172	[490] 55 171	[1080] 120 169	[1640] 185 161	[2190] 245 153	[2740] 310 149	[3260] 370 146	[3770] 425 132	[4280] 485 118	[4800] 540 104
[8] 30	[200] 25 230	[480] 55 224	[1080] 120 222	[1650] 185 219	[2220] 250 210	[2780] 315 204	[3310] 375 201	[3840] 435 192	[4360] 495 184	[4890] 550 175
[10] 38	[180] 20 287	[470] 55 286	[1070] 120 282	[1650] 185 276	[2230] 250 269	[2800] 315 261	[3420] 385 255	[3940] 445 243	[4450] 505 231	[4970] 560 219
[12] 45	[160] 20 345	[460] 50 344	[1060] 120 338	[1640] 185 333	[2230] 250 327	[2800] 315 317	[3350] 380 307	[3910] 440 295	[4440] 500 284	[4960] 560 272
[14] 53	[150] 15 403	[440] 50 402	[1030] 115 395	[1620] 185 391	[2220] 250 385	[3000] 340 373	[3350] 380 360	[3910] 440 348	[4440] 500 336	
[16] 61	[130] 15 461	[420] 45 460	[1010] 115 452	[1600] 180 447	[2200] 250 443	[2780] 315 430	[3330] 375 411	[3890] 440 397	[4440] 500 384	
[18] 68	[110] 10 518	[400] 45 517	[990] 110 509	[1580] 180 504	[2160] 245 500	[2750] 310 484	[3300] 375 471	[3860] 435 456	[4410] 500 440	
[20] 76	[90] 10 576	[380] 45 575	[960] 110 568	[1550] 175 560	[2130] 240 551	[2710] 305 539	[3280] 370 524	[3840] 435 508		
[22] 83	[60] 5 634	[350] 40 633	[940] 105 624	[1520] 170 619	[2100] 235 604	[2680] 305 597	[3250] 365 579	[3820] 430 560		
[24] 91	[40] 5 692	[325] 35 691	[920] 105 682	[1490] 170 676	[2070] 235 665	[2650] 300 651	[3220] 365 633	[3780] 425 616		
[25] 95	[20] 1.0 720	[310] 35 719	[900] 100 712	[1480] 165 705	[2050] 230 692	[2630] 295 679	[3200] 360 682	[3700] 420 656		

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

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

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

Continuous
Intermittent

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

Performance Data
2000 Series

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

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

[2120] 240 **562** } Torque [lb-in] N·m **Speed RPM**

Continuous
Intermittent

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

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

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

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

Performance Data 2000 Series

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

Flow LPM [GPM]

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

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

Continuous
Intermittent

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

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

Flow LPM [GPM]

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

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

Performance Data
2000 Series

490 cm³/r [29.8 in³/r]
Δ Pressure Bar [PSI]

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

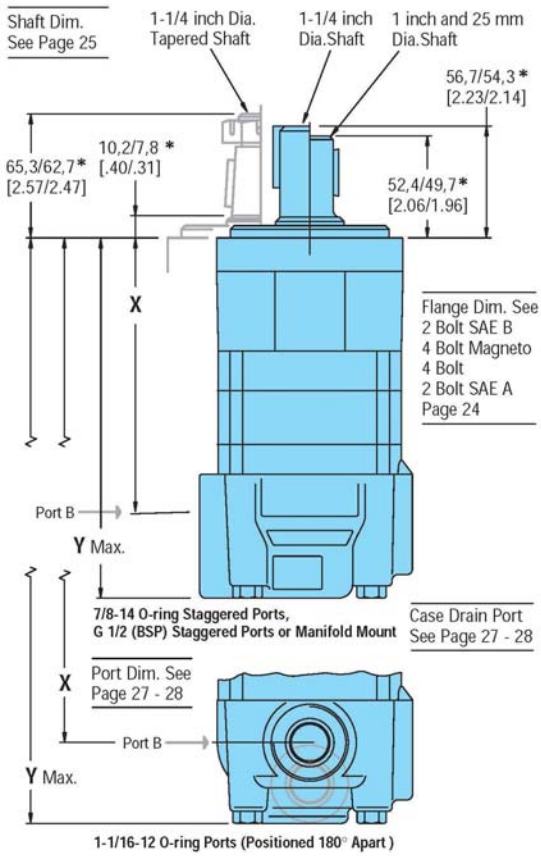
[1130] 125 **230** } Torque [lb-in] Nm / Speed RPM

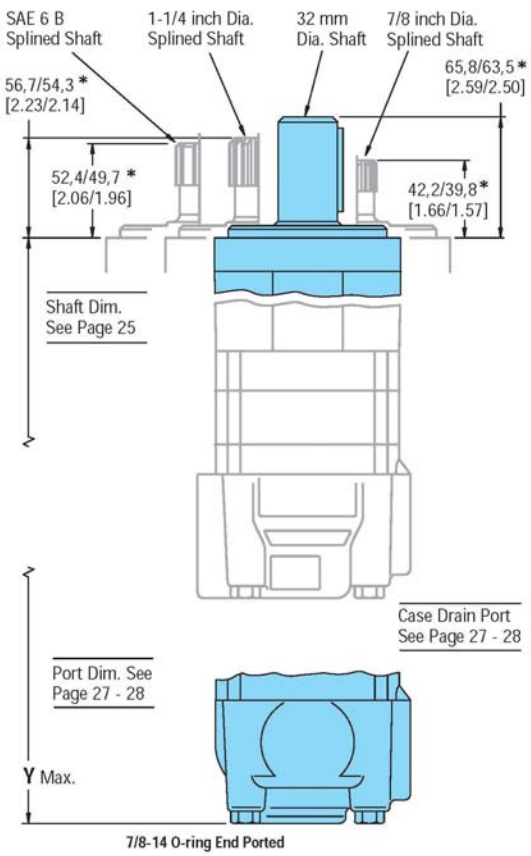
Continuous
Intermittent

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

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

Dimensions — 2000 Series Standard Motor





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

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

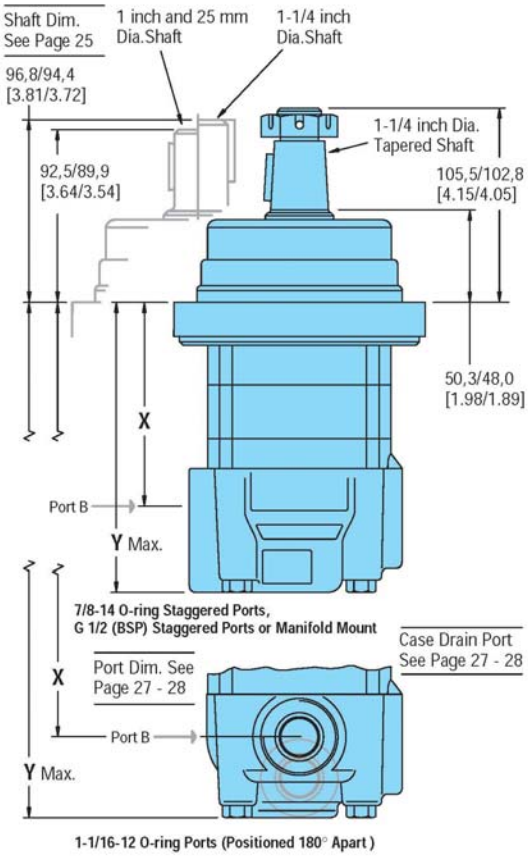
2000 Series Standard Motor with 1-1/16-12 O-ring Ports (Positioned 180° Apart) and use Only Dim. Y for 7/8-14 O-ring End Ported Motors

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

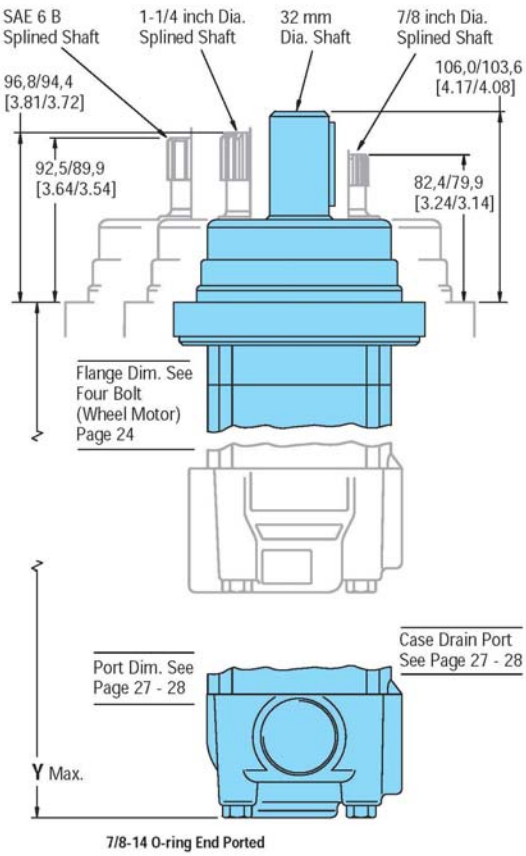
Standard Rotation
Viewed from Shaft End
Port **A** Pressurized — CW
Port **B** Pressurized — CCW

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

Dimensions — 2000 Series Wheel Motor



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



7/8-14 O-ring End Ported

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

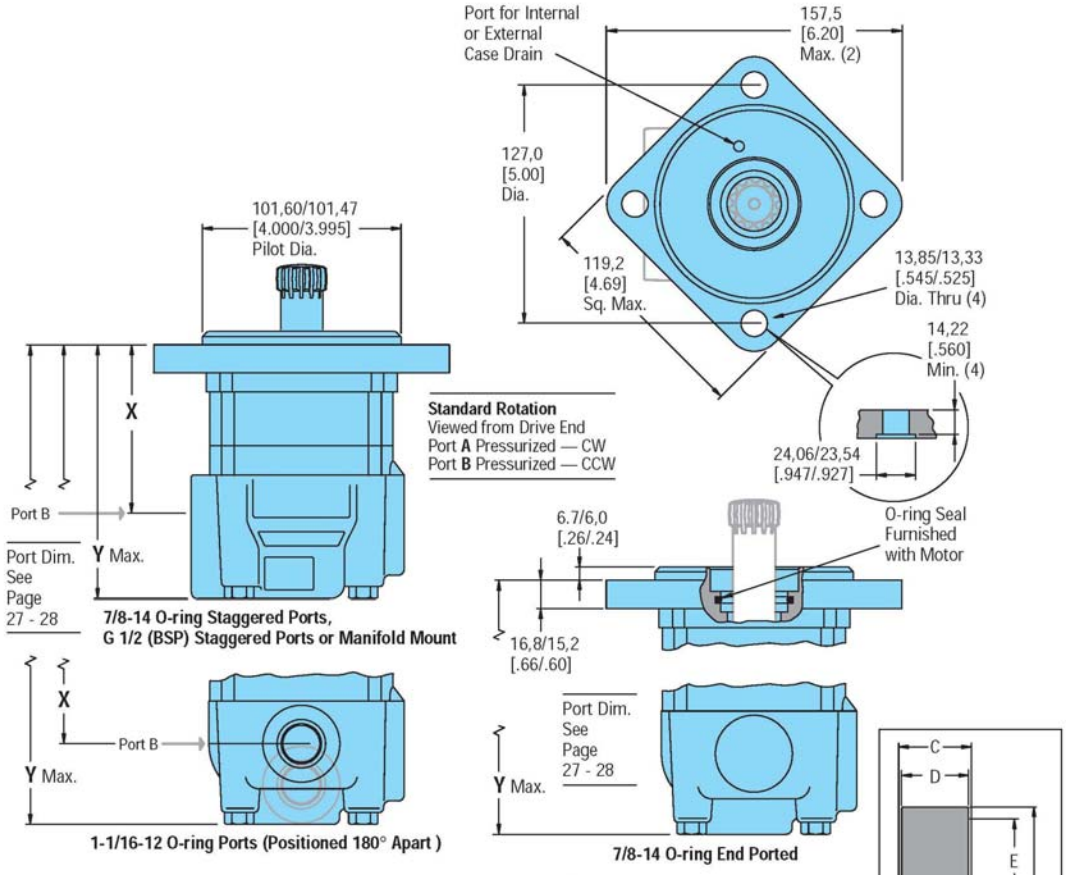
2000 Series Wheel Motor with 7/8-14 O-ring Staggered Ports, G 1/2 (BSP) Staggered Ports or Manifold Mount

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

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

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

Dimensions — 2000 Series Bearingless Motor



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

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

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

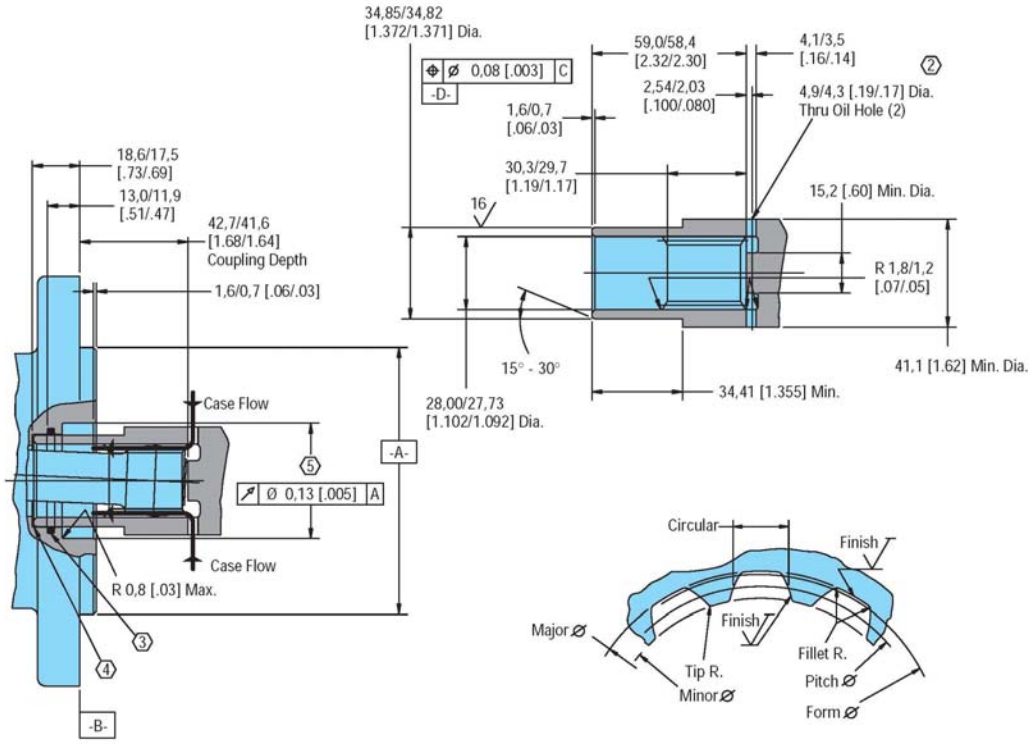
Dim. X	mm	81,3	85,8	92,2	92,2	99,0	107,9	119,4	135,4	152,5
	[inch]	[3.20]	[3.38]	[3.63]	[3.63]	[3.90]	[4.25]	[4.70]	[5.33]	[6.00]
Dim. Y	mm	128,0	132,6	139,0	139,0	145,8	154,7	166,1	182,1	199,3
	[inch]	[5.04]	[5.22]	[5.47]	[5.47]	[5.74]	[6.09]	[6.54]	[7.17]	[7.85]

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

Mating Coupling Blank
Eaton Part No. 13307-003

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

Bearingless Installation — 2000 Series



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

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

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

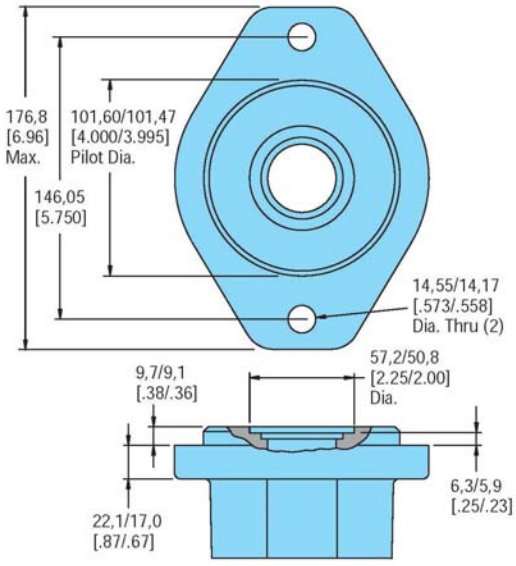
2 Mating part to have critical dimensions as shown. Oil holes must be provided and open for proper oil circulation.

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

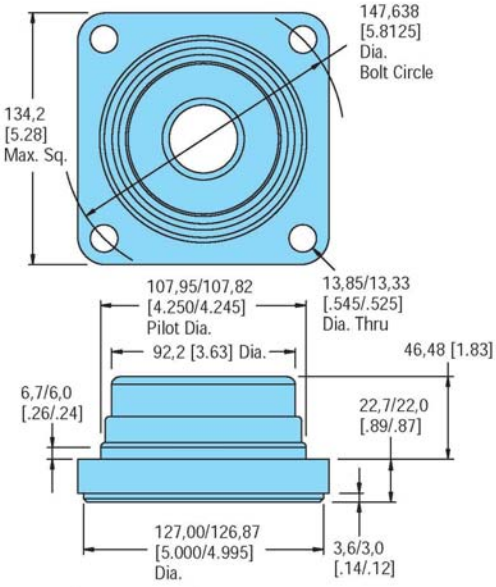
4 Some means of maintaining clearance between shaft and mounting flange must be provided.

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

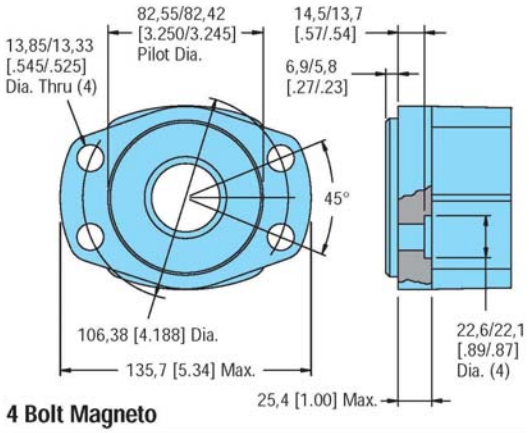
Dimensions — Mounting Options 2000 Series



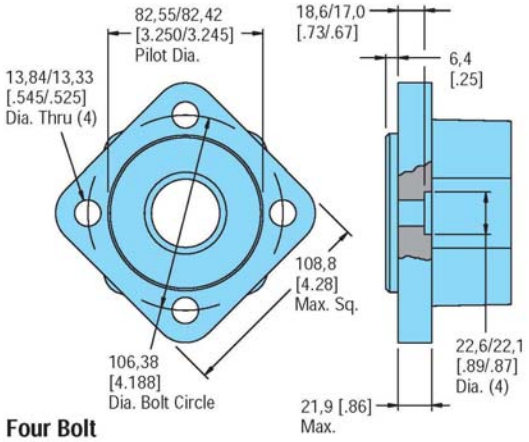
2 Bolt SAE B



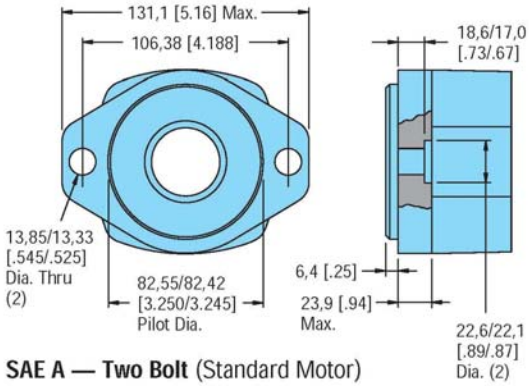
Four Bolt (Wheel Motor)



4 Bolt Magneto

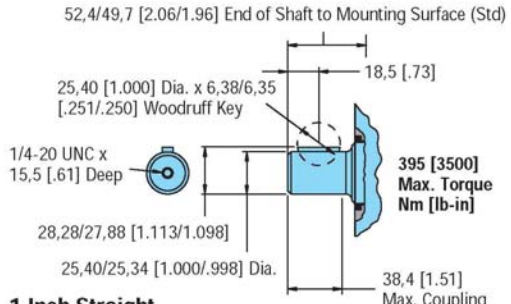


Four Bolt

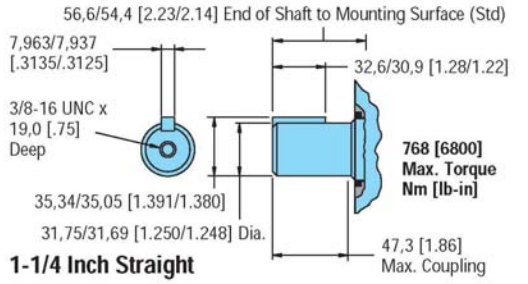


SAE A — Two Bolt (Standard Motor)

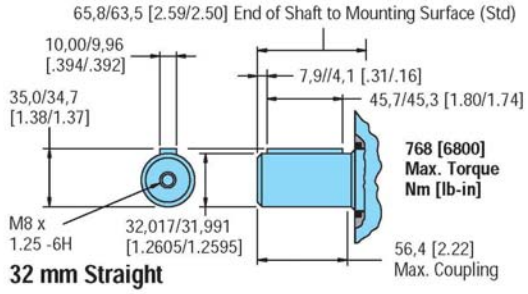
Dimensions — Shafts
2000 Series



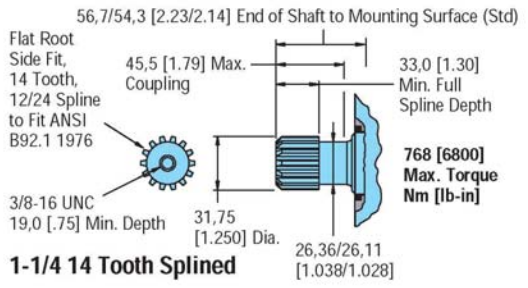
1 Inch Straight



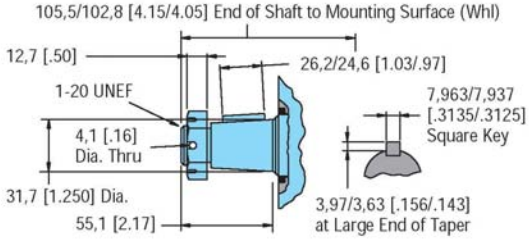
1-1/4 Inch Straight



32 mm Straight



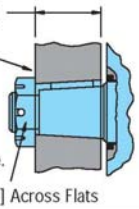
1-1/4 14 Tooth Splined



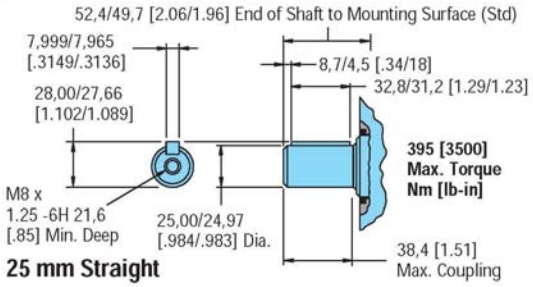
SAE J501 Standard Tapered Shaft
125,00 ± 0,17 Taper per Meter
[1.500 ± .002 Taper per Foot]

768 [6800] Max. Torque Nm [lb-in]

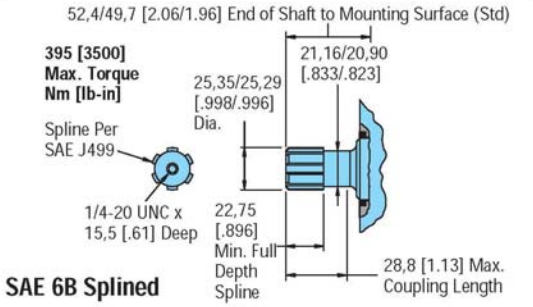
Recommended Torque:
(373 Nm [275 lb-ft] Dry)
(305 Nm [225 lb-ft] Lub)
Plus Torque required to align the slotted nut with the Shaft Crosshole.



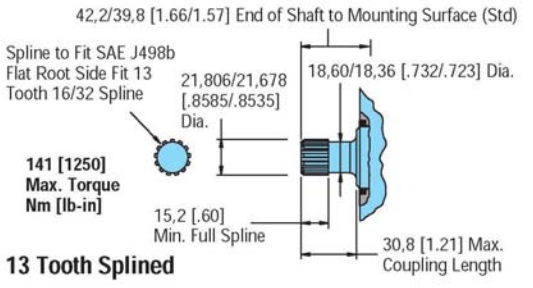
1-1/4 Tapered



25 mm Straight



SAE 6B Splined



13 Tooth Splined

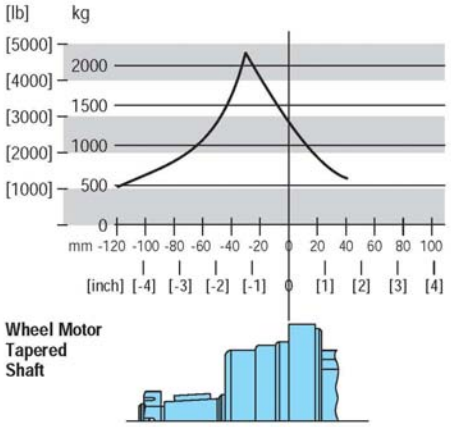
Shaft Side Load Capacity
2000 Series

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

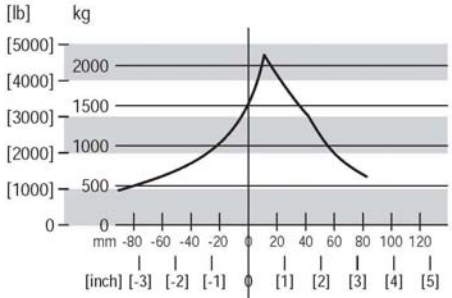
The curve is based on B 10 Bearing life (2000 hours or 12,000,000 shaft revolutions at 100 RPM) at rated output torque. To determine radial load at speeds other than 100 RPM, multiply the load values given on the bearing curve by the factors in the chart below.

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

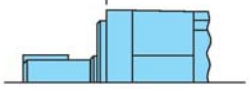
For 3,000,000 Shaft revolutions or 500 hours — Increase these shaft loads 52%.

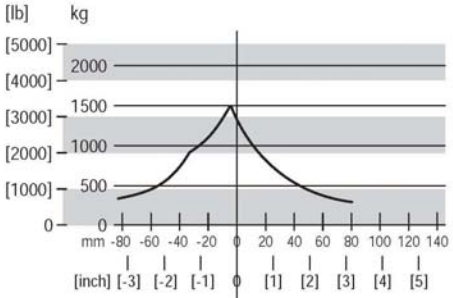


Wheel Motor Tapered Shaft

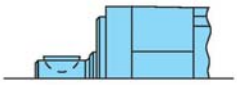


Standard Motor 1-1/4 Inch and 32 mm Straight Shaft





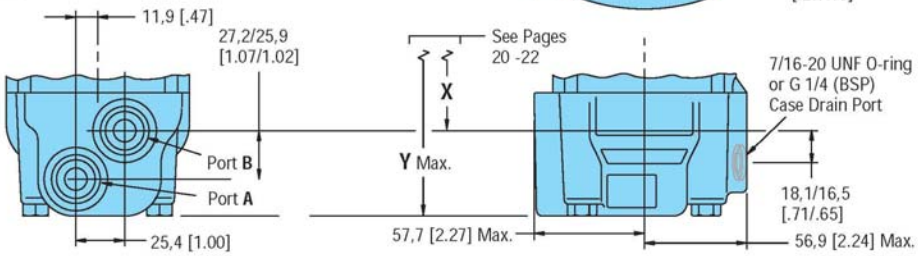
Standard Motor 1 Inch Straight Shaft



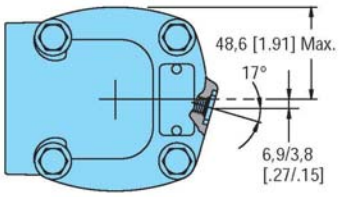
Dimensions — Ports
2000 Series

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

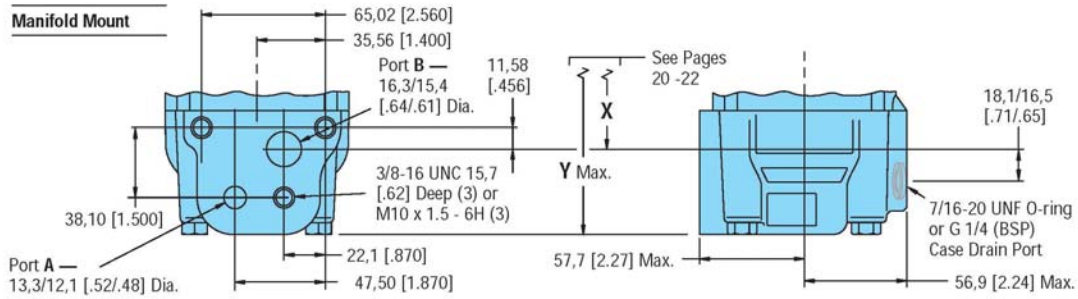
7/8-14 O-ring Ports (2)
or **G 1/2 (BSP) Ports** (2)

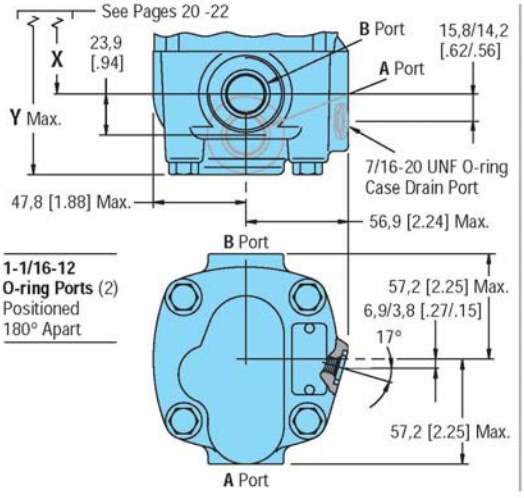


Case Drain Location — Staggered Ports (Including Manifold Mount)



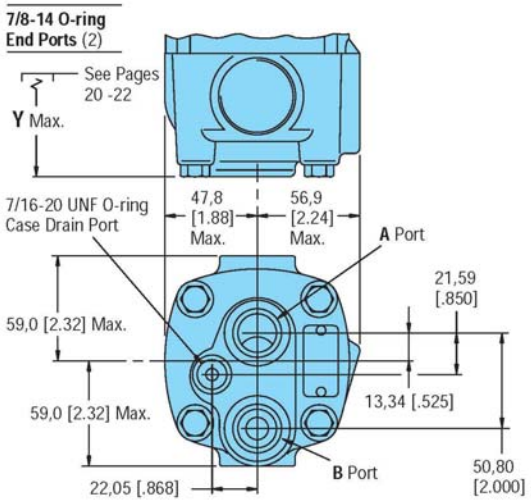
Manifold Mount



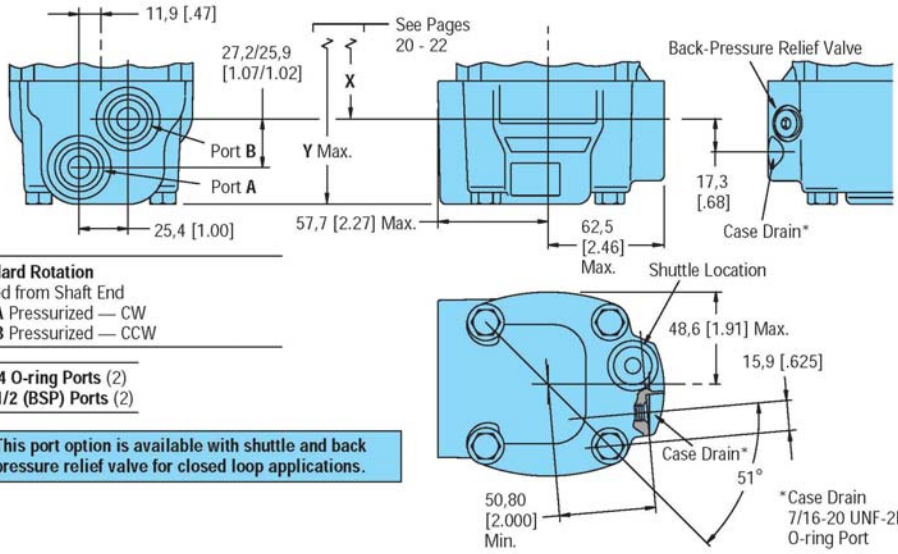


1-1/16-12 O-ring Ports (2)
Positioned
180° Apart

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



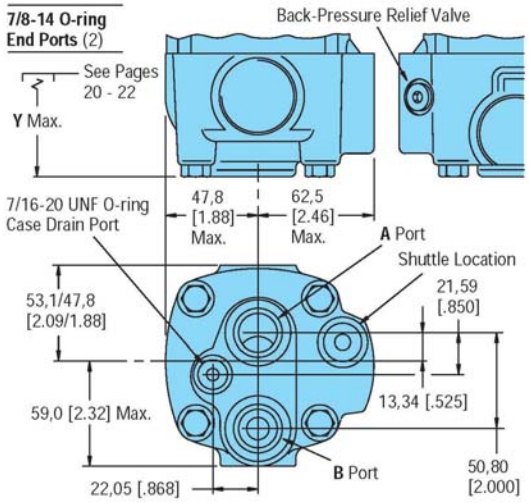
Dimensions — Ports
2000 Series with Shuttle



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

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

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



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

Product Numbers
2000 Series

Product Numbers—2000 Series

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

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

106-1043

Product Numbers—2000 Series Motors with Corrosion Protection

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

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

Model Code for 2000 Series Motors

The following 14-digit coding system has been developed to identify all of the configuration options for the 2000 Series motor Use this model code to specify a motor with the desired features. All 14-digits of the code must be present when ordering. You may want to photocopy the matrix below to ensure that each number is entered in the correct box.

Model Code — 2000 Series Disc Valve Motor

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
M	0	2																					

Position 1 **Product Series**

M.....Motor

Position 2, 3 **2000 Series**

02 .....2000 Series

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

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

Position 6, 7 **Mounting Flange**

AD .....4 Bolt (Bearingless) 101,6 [4.00] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes on 127,0 [5.00] Dia. B.C.
AC .....2 Bolt SAE A (Std.) 82,5 [3.25] Pilot Dia and 13,59 [.535] Dia. Mtg. Holes on 106,4 [4.19] Dia. B.C.
AB .....4 Bolt (Wheel) 108,0 [4.25] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes on 147,6 [5.81] Dia. B.C.
AH .....4 Bolt (Standard) 82,5 [3.25] Pilot Dia. and 14,59 [.535] Dia. Mounting Holes on 106,4 [4.19] Dia. B.C.
AJ .....4 Bolt Magneto (Std.) 82,5 [3.25] Pilot Dia. and 13,59 [.535] Dia. Mtg. Holes on 106,4 [4.19] Dia. B.C.
AF .....2 Bolt SAE B (Std.) 101,6 [4.00] Pilot Dia. and 14,35 [.565] Dia. Mtg. Holes on 146,0 [5.75] Dia. B.C.
AP .....4 Bolt (wheel compatible for HAYES BRAKE) 107,9 [4.25] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes on 147,6 [5.81] Dia. B.C. with Turned Down Housing to 88,9 [3.50] Dia.

Position 8, 9 **Output Shaft**

00 .....Bearingless
01 .....1 inch Dia. Straight with Woodruff Key, 1/4-20 Threaded Hole and 38,4 [1.51] Max. Coupling Length
02 .....1–1/4 inch Dia. Straight with Straight Key, 3/8-16 Threaded Hole and 47,3 [1.86] Max. Coupling Length
23 .....32 mm dia. Straight with Straight Key, M8 x 1,25 -6H Threaded Hole and 56,4 [2.22] Max. Coupling Length
04 .....1-1/4 inch Dia. Splined 14 T, 3/8-16 Threaded Hole and 33,0 [1.30] Min. Full Spline Length and 45,5 [1.79] Max. Coupling Length
03 .....1-1/4 inch Dia. Tapered with Straight Key and Nut
05 .....1 inch SAE 6B Splined 6T, 1/4-20 Threaded Hole and 22,8 [.90] Min. Full Spline Length and 28,8 [1.13] Max. Coupling Length
07 .....7/8 inch Dia. Splined 13T, 15,2 [.60] Min. Full Spline Length and 30,8 [1.21] Max. Coupling Length
24 .....1–1/4 inch Dia. Straight with Straight Key, 3/8-16 Threaded Hole and Corrosion Resistant (seal area to shaft end)
25 .....1–1/4 inch Dia. Tapered with Straight Key and Nut, Corrosion Resistant (under seal area only)
26 .....25 mm Dia. Straight with Straight Key, M8 x 1,25 -6H Threaded Hole and 38,4 [1.51] Max. Coupling Length

Position 10, 11 **Port Type**

AA .....7/8-14 UNF –2B SAE O-ring (Staggered)
AG .....G 1/2 BSP Straight Thread ports (Staggered)
AB .....Manifold Mount with 3/8-16 UNC Mounting Threads (3)
AE .....Manifold Mount with M10 x 1,5 -6H Mounting Threads (3)
AD .....7/8-14 UNF –2B SAE O-ring (End Ports)
AF .....1–1/16 - 12 UN-2B O-ring ports (Positioned 180° Apart)

Position 12, 13 **Case Flow**

(Shuttles available with port code AA or AD only)
01 .....7/16-20 UNF –2B SAE O-ring (Case Drain)
02 .....G 1/4 (BSP) straight thread port (Case Drain)
04 .....Shuttle Valve with 7/16-20 UNF –2B SAE O-ring (Case Drain)
05 .....Shuttle Valve with G 1/4 (BSP) straight thread port (Case Drain)

Position 14 **Low Pressure Relief**

(LPR available with a combination of case flow code 04 or 05 and port code AA or AD only)
0 .....None
A .....Set @ 4,5 bar [65 psi]
B .....Set @ 15,2 bar [220 psi]
C .....Set @ 20,7 bar [300 psi]

Position 15, 16 **Valve Option**

00 .....None

Position 17, 18 **Accessories**

00 .....None
AA .....Seal Guard
AB .....Speed Sensor (Std. With Weatherpack shroud connector)
AH .....Speed Sensor (Std. With M12 connector)
AL .....Quadrature Speed Sensor Version 2 with M12

Position 19, 20 **Special Features (Hardware)**

00 .....None
01 .....Viton Seals
10 .....Viton Shaft Seal

Position 21 **Special Features (Assembly)**

0 .....None
A .....Flange Rotated 90°
B .....Reverse Rotation

Position 22 **Paint/Special Packaging**

0 .....No Paint
A .....Painted Low Gloss Black
B .....Corrosion Protected

Position 23 **Eaton Assigned Code when Applicable**

0 .....Assigned Code

Position 24 **Eaton Assigned Design Code**

0 .....Assigned Design Code

Two Speed Motor — 2000 Series

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

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

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

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

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

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

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

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

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

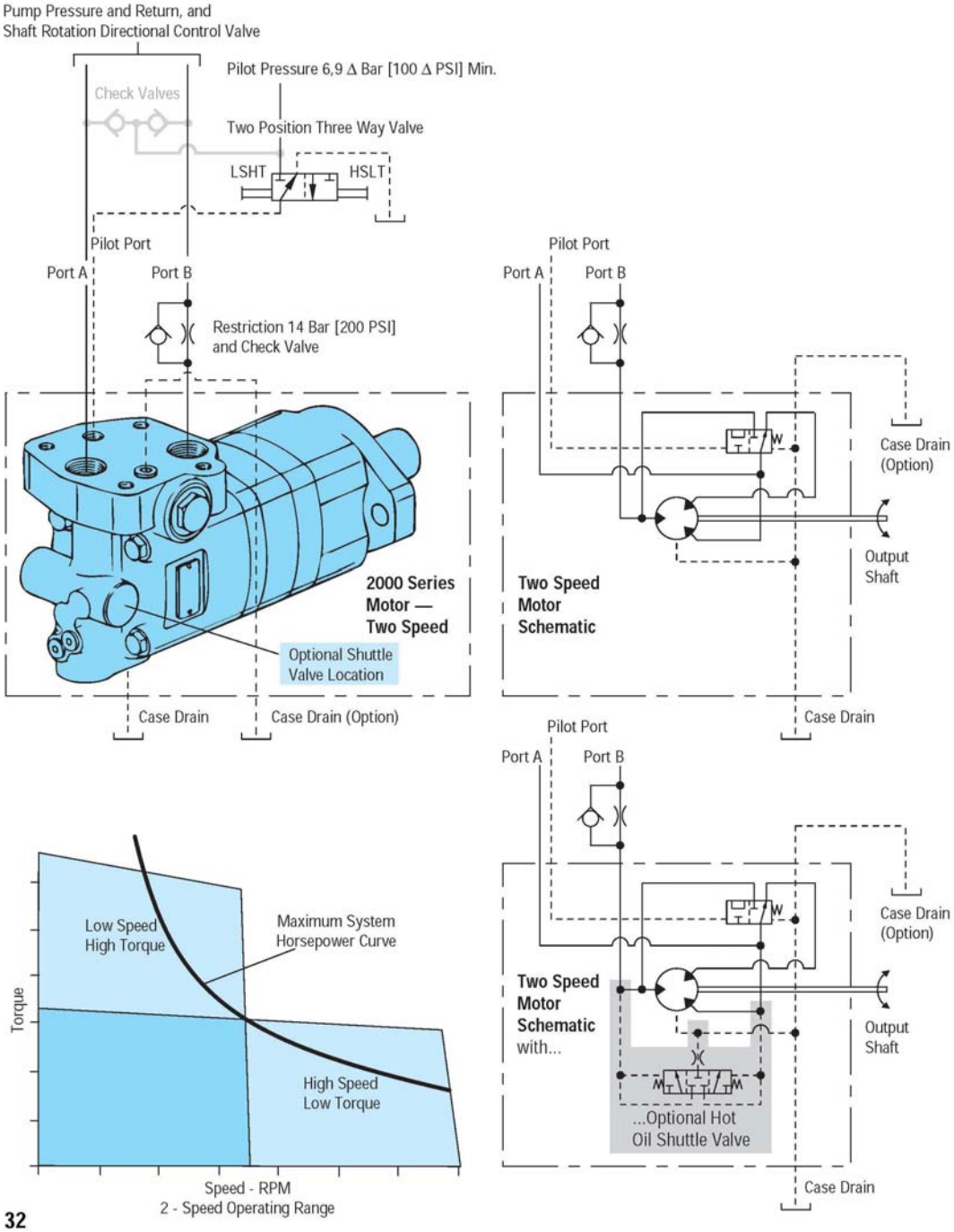
Note: Be certain in closed loop applications that the charge pump when used for back pressure on the B port, has sufficient displacement to maintain charge pressure especially in dynamic braking or overrunning load conditions.

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

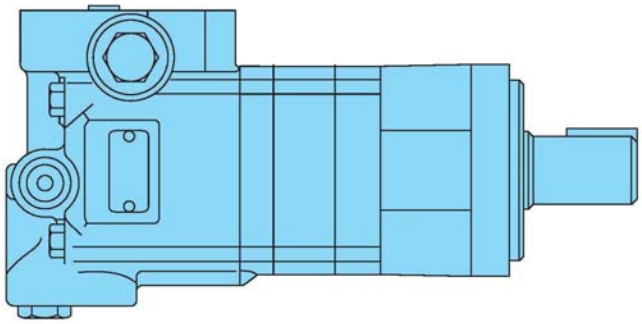
Performance Data Two Speed Motor — 2000 Series

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

Two Speed Motor — 2000 Series



Specifications
Two Speed Motor — 2000 Series



Specification Data—2000 Series Two Speed

Displ. $cm^3/r.$ [in^3/r]	High Speed Mode	40 [2.45]	50 [3.1]	65 [4.0]	80 [4.8]	95 [5.95]	120 [7.45]	155 [9.35]	195 [12.0]	245 [15.0]
	Low Speed Mode	80 [4.9]	100 [6.2]	130 [8.0]	160 [9.6]	195 [11.9]	245 [14.9]	305 [18.7]	395 [24.0]	490 [29.8]
Max. Speed (RPM) @ Continuous Flow	High Speed Mode	1000	1000	990	860	700	560	450	350	230
	Low Speed Mode	500	500	495	430	350	280	225	175	115
Flow LPM [GPM]	High Speed Mode	45 [12]	55 [15]	70 [19]	75 [20]	75 [20]	75 [20]	75 [20]	75 [20]	75 [20]
	Low Speed Mode	45 [12]	55 [15]	70 [19]	75 [20]	75 [20]	75 [20]	75 [20]	75 [20]	75 [20]
Torque Nm [lb-in] ☆ 1-1/4 Inch or 32 mm Dia. Shaft	High Speed Mode Continuous	100 [880]	125 [1115]	165 [1450]	195 [1725]	240 [2150]	300 [2675]	380 [3350]	365 [3225]	448 [3970]
	High Speed Mode Intermittent	145 [1300]	185 [1660]	240 [2150]	240 [2150]	300 [2650]	375 [3330]	440 [3900]	445 [3940]	486 [4300]
Torque Nm [lb-in] ☆ 1-1/4 Inch or 32 mm Dia. Shaft	Low Speed Mode Continuous	235 [2065]	295 [2630]	385 [3420]	455 [4040]	540 [4780]	660 [5850]	760 [6750]	770 [6840]	845 [7470]
	Low Speed Mode Intermittent	345 [3040]	445 [3950]	560 [4970]	570 [5040]	665 [5890]	820 [7250]	885 [7820]	925 [8170]	930 [8225]
Pressure Δ Bar [Δ PSI] ☆ 1-1/4 Inch or 32 mm Dia. Shaft	Continuous	205 [3000]	205 [3000]	205 [3000]	205 [3000]	205 [3000]	205 [3000]	205 [3000]	155 [2250]	120 [1750]
	Intermittent	310 [4500]	310 [4500]	310 [4500]	260 [3750]	260 [3750]	260 [3750]	240 [3500]	190 [2750]	140 [2000]

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

High Speed Mode (Reduced Motor Displacement)

Low Speed Mode **(Full Motor Displacement)**

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

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

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

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

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

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

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

Intermittent Operation — 10% of every minute.

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

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

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

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

Dimensions — Two Speed Standard, Wheel, and Bearingless

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

Two Speed Standard Motor

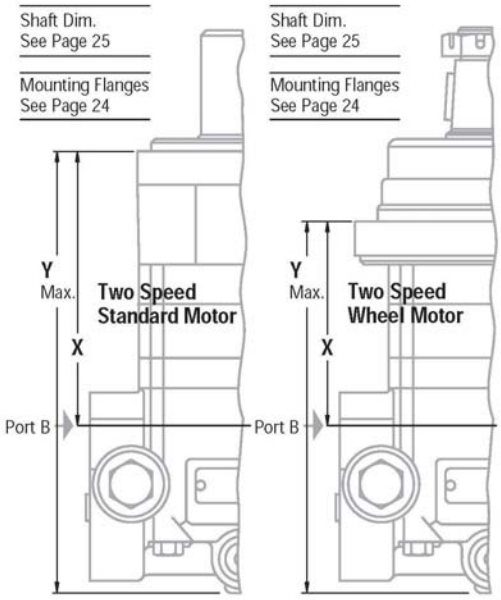
Displ. cm³/r [in³/r]	80 [4.9]	100 [6.2]	130 [8.0]	160 [9.6]	195 [11.9]	245 [14.9]	305 [18.7]	395 [24.0]	490 [29.8]
Dim. **X** mm [inch]	137,4 [5.41]	142,0 [5.59]	148,5 [5.85]	148,5 [5.85]	155,2 [6.11]	164,2 [6.47]	175,7 [6.92]	191,5 [7.54]	209,0 [8.23]
Dim. **Y** mm [inch]	231,6 [9.12]	236,5 [9.31]	242,9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

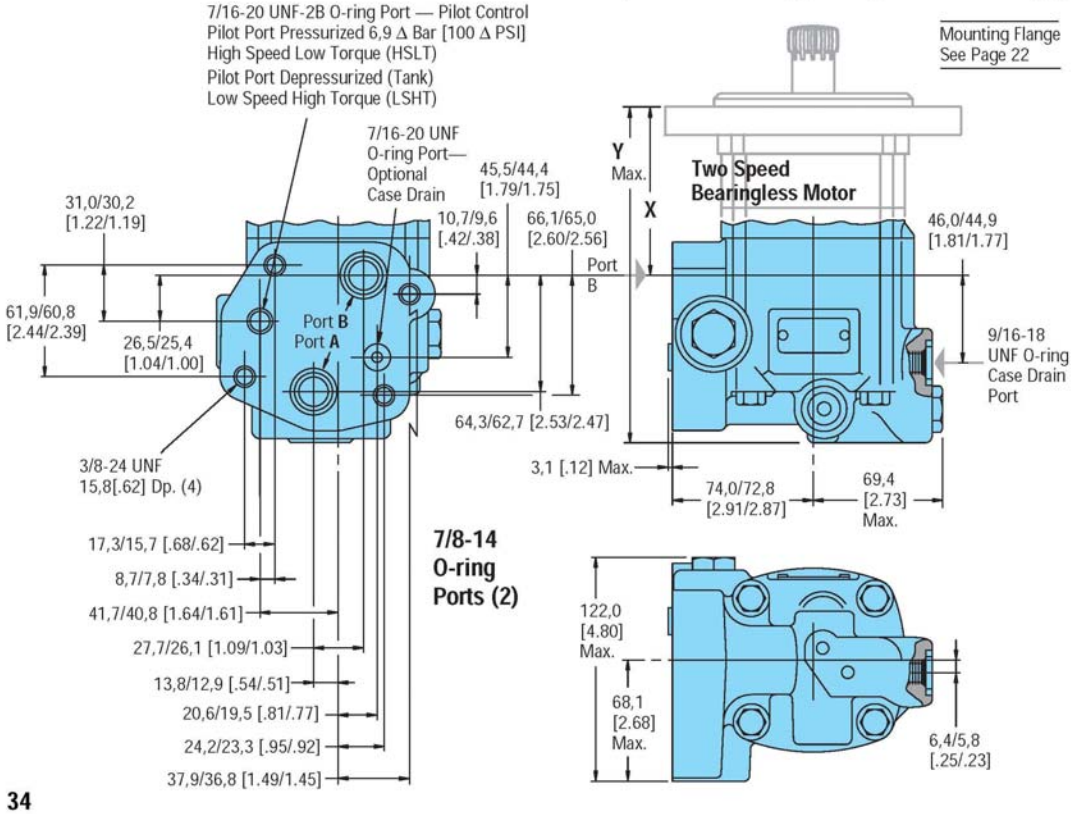
Two Speed Wheel Motor

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

Two Speed Bearingless Motor

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





Product Numbers — Two Speed
2000 Series

Product Numbers—2000 Series Motors — Two Speed

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

			Displ. cm³/r [in³/r] Product Number								
Mounting	Shaft	Ports	80 [4.9]	100 [6.2]	130 [8.0]	160 [9.6]	195 [11.9]	245 [14.9]	305 [18.7]	395 [24.0]	490 [29.8]
2 Bolt SAE A Flange	1 inch Straight	7/8-14 O-ring Staggered	**104**-2001	-2002	-2003	-2004	-2005	-2006	-2007	-2008	—
	1-1/4 Inch Straight	7/8-14 O-ring Staggered	**104**-2009	-2010	-2011	-2012	-2013	-2014	-2015	-2016	—
	1-1/4 Inch 14 T Splined	7/8-14 O-ring Staggered	**104**-2017	-2018	-2019	-2020	-2021	-2022	-2023	-2024	—
Wheel Motor	1-1/4 Inch Tapered	7/8-14 O-ring Staggered	**105**-2001	-2002	-2003	-2004	-2005	-2006	-2007	-2008	—
	1-1/4 Inch 14 T Splined	7/8-14 O-ring Staggered	**105**-2009	-2010	-2011	-2012	-2013	-2014	-2015	-2016	—
Bearingless		7/8-14 O-ring Staggered	**106**-2001	-2002	-2003	-2004	-2005	-2006	-2007	-2008	—

106-2007

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

Hayes M15WM Brake System 2000 Series Wheel Motors

Hayes Industrial Brakes, Inc. supplies its Model M15WM mechanical parking/service brake for use with 2000 Series wheel motors on commercial turf and specialty-vehicle applications. Basic packages available are:

M15WM for 203,2 [8.0] wheels (152,4 [6.0] rotor diameter)
M15WM for 254 [10.0] wheels (209,6 [8.25] rotor diameter)

Features

- **Up to 1450 lb. of clamping force available**
- **Simple single-piece caliper bridge design**
- **Fewer moving parts**
- **Comprehensive braking system design includes:**
  - **Aluminum caliper**
  - **Ductile cast iron bracket**
  - **Ductile cast iron hub/disc**
- **Several shaft sizes and hub mounting hole options available.**

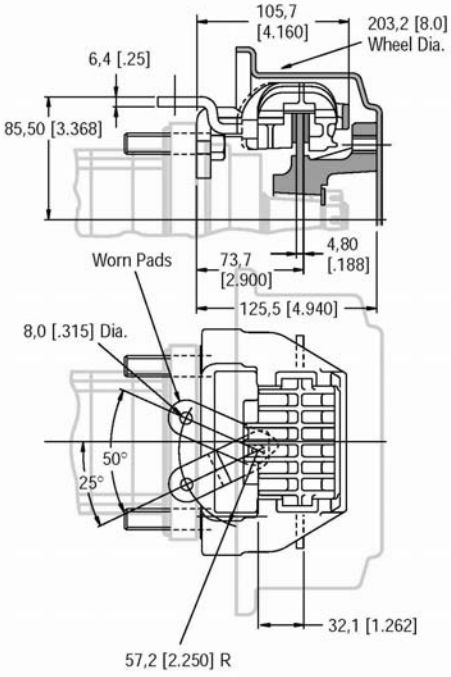
Note: Brake systems must be purchased directly from Hayes Industrial Brake. Eaton does not sell the brake nor does it install on motors. For more information, contact:

Hayes Industrial Brake, Inc.
5800 West Donges Bay Road
Mequon, WI 57092
Phone: (262) 242-4300; Fax: (262) 242-0524

Dimensions — Mounting

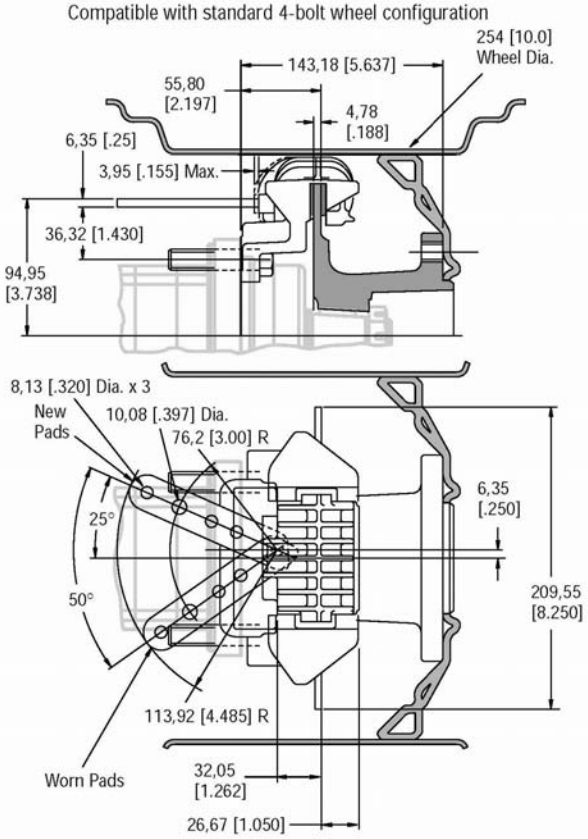
8-Inch Wheel
305 N-m (2700 lb-in) Max. Torque

Requires special 2K mounting code "P".

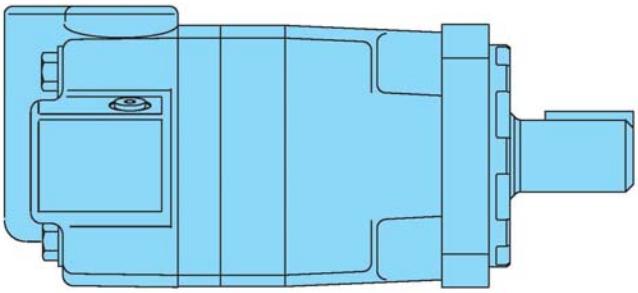


10-Inch Wheel
429,4 N-m (3800 lb-in) Max. Torque

Compatible with standard 4-bolt wheel configuration



Specifications
4000 Series



Specification Data—4000 Series

Displ. cm³/r [in³/r]		110 [6.7]	130 [7.9]	160 [9.9]	205 [12.5]	245 [15.0]	310 [19.0]	395 [24.0]	495 [30.0]	625 [38.0]
Max. Speed (RPM) @ ..... Flow	Continuous	697	722	582	459	383	303	239	191	151
	Intermittent	868	862	693	546	532	422	376	305	241
Flow LPM [GPM]	Continuous	75 [20]	95 [25]	95 [25]	95 [25]	95 [25]	95 [25]	95 [25]	95 [25]	95 [25]
	Intermittent	95 [25]	115 [30]	115 [30]	115 [30]	130 [35]	130 [35]	150 [40]	150 [40]	150 [40]
Torque Nm [lb-in] ☆ 1-5/8 Inch Dia. Tapered Shaft	Continuous	320 [2850]	375 [3330]	485 [4290]	600 [5300]	705 [6240]	850 [7530]	930 [8240]	945 [8375]	970 [8605]
	Intermittent	470 [4160]	560 [4940]	705 [6240]	800 [7100]	845 [7470]	1065 [9420]	1185 [10470]	1170 [10350]	1180 [10450]
Pressure Δ Bar [Δ PSI] ☆ 1-5/8 Inch Dia. Tapered Shaft	Continuous	205 [3000]	205 [3000]	205 [3000]	205 [3000]	205 [3000]	205 [3000]	190 [2750]	140 [2000]	115 [1700]
	Intermittent	310 [4500]	310 [4500]	310 [4500]	310 [4500]	260 [3750]	260 [3750]	240 [3500]	170 [2500]	140 [2000]
	Peak	310 [4500]	310 [4500]	310 [4500]	310 [4500]	310 [4500]	310 [4500]	295 [4250]	230 [3300]	180 [2600]
Maximum Case Pressure - without Case Drain * — 100 Bar [1500 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 38 - 41.

☆ **Maximum torque for 1-1/4 inch shaft** — 770 Nm [6800 lb-in] Continuous and 960 Nm [8500 lb-in] intermittent.

* For back pressure over 105 Bar [1500 PSI] use an external case drain. Install case drain lines so that the motor case remains filled at all times.

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

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

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

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

Intermittent Operation — 10% of every minute.

Peak Operation — 1% of every minute.

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

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

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

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

Performance Data 4000 Series

110 cm³/r [6.7 in³/r]
Δ Pressure Bar [PSI]

Flow LPM [GPM]	[250] 15	[500] 35	[1000] 70	[1500] 105	[2000] 140	[2500] 170	[3000] 205	[3500] 240	[4000] 275	[4500] 310
[.5] 1,9	[150] 15 **14**	[390] 45 **10**	[850] 95 **5**	[1290] 145 **2**						
[1] 3,8	[170] 20 **34**	[440] 50 **33**	[900] 100 **31**	[1380] 155 **28**	[1860] 210 **25**	[2270] 255 **22**	[2680] 305 **18**	[3110] 350 **11**		
[2] 7,5	[180] 20 **68**	[450] 50 **67**	[910] 105 **62**	[1390] 155 **56**	[1860] 210 **50**	[2280] 260 **44**	[2700] 305 **36**	[3120] 355 **28**	[3450] 390 **18**	
[4] 15	[190] 20 **138**	[460] 50 **136**	[940] 105 **123**	[1400] 160 **110**	[1870] 210 **97**	[2310] 260 **84**	[2730] 310 **70**	[3140] 355 **56**	[3560] 400 **42**	[3880] 440 **28**
[6] 23	[200] 25 **207**	[470] 55 **204**	[960] 110 **200**	[1420] 160 **193**	[1880] 210 **184**	[2320] 260 **174**	[2760] 310 **163**	[3200] 360 **150**	[3640] 410 **136**	[3950] 455 **121**
[8] 30	[190] 20 **277**	[460] 50 **274**	[950] 105 **270**	[1420] 160 **262**	[1880] 210 **253**	[2340] 265 **241**	[2790] 315 **228**	[3230] 365 **213**	[3670] 415 **196**	[4010] 455 **179**
[10] 38	[180] 20 **347**	[460] 50 **344**	[950] 105 **340**	[1420] 160 **331**	[1890] 215 **322**	[2350] 265 **308**	[2820] 320 **292**	[3260] 370 **274**	[3700] 420 **255**	[4070] 460 **236**
[12] 45	[160] 20 **417**	[450] 50 **414**	[940] 105 **410**	[1420] 160 **400**	[1880] 210 **390**	[2350] 265 **374**	[2820] 320 **355**	[3260] 370 **335**	[3710] 420 **313**	[4080] 460 **292**
[14] 53	[140] 15 **487**	[440] 50 **484**	[930] 105 **480**	[1420] 160 **469**	[1880] 210 **458**	[2350] 265 **440**	[2830] 320 **419**	[3280] 370 **446**	[3730] 420 **471**	[4110] 465 **348**
[16] 61	[130] 15 **556**	[440] 50 **553**	[920] 105 **549**	[1410] 160 **537**	[1870] 210 **525**	[2350] 265 **505**	[2840] 320 **482**	[3300] 375 **455**	[3750] 425 **428**	[4120] 465 **404**
[18] 68	[100] 10 **626**	[440] 50 **622**	[910] 105 **618**	[1400] 160 **606**	[1870] 210 **593**	[2350] 265 **570**	[2840] 320 **545**	[3300] 375 **516**	[3770] 425 **485**	[4140] 465 **460**
[20] 76	[80] 10 **697**	[430] 50 **694**	[900] 100 **690**	[1370] 155 **677**	[1860] 210 **664**	[2350] 265 **638**	[2850] 320 **611**	[3320] 375 **579**	[3790] 430 **545**	[4160] 470 **518**
[25] 95		[400] 45 **868**	[860] 95 **861**	[1350] 155 **838**	[1850] 210 **816**	[2320] 260 **792**	[2830] 320 **767**	[3300] 375 **729**	[3780] 425 **690**	

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.

[3780] 425 **690** } Torque [lb-in] Nm **Speed RPM**

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

130 cm³/r [7.9 in³/r]
Δ Pressure Bar [PSI]

Flow LPM [GPM]	[250] 15	[500] 35	[1000] 70	[1500] 105	[2000] 140	[2500] 170	[3000] 205	[3500] 240	[4000] 275	[4500] 310
[.5] 1,9	[310] 35 **12**	[510] 60 **9**	[1060] 120 **5**	[1590] 180 **2**						
[1] 3,8	[290] 35 **30**	[530] 60 **28**	[1080] 120 **25**	[1600] 180 **19**	[2110] 240 **14**	[2640] 300 **13**	[3060] 345 **12**	[3450] 390 **4**		
[2] 7,5	[280] 30 **57**	[530] 60 **56**	[1100] 125 **53**	[1620] 185 **47**	[2140] 240 **42**	[2660] 300 **40**	[3180] 360 **38**	[3600] 405 **29**	[4020] 455 **20**	[4080] 460 **12**
[4] 15	[260] 30 **116**	[520] 60 **114**	[1100] 125 **111**	[1650] 185 **105**	[2200] 250 **100**	[2700] 305 **95**	[3210] 365 **90**	[3660] 415 **70**	[4100] 465 **50**	[4560] 515 **37**
[6] 23	[240] 25 **173**	[510] 60 **170**	[1100] 125 **167**	[1650] 185 **161**	[2200] 250 **156**	[2720] 305 **149**	[3240] 365 **142**	[3710] 420 **123**	[4180] 470 **104**	[4660] 525 **91**
[8] 30	[230] 25 **228**	[510] 60 **225**	[1080] 120 **222**	[1640] 185 **216**	[2210] 250 **210**	[2740] 310 **202**	[3270] 370 **194**	[3770] 425 **176**	[4270] 480 **158**	[4750] 535 **145**
[10] 38	[210] 25 **283**	[510] 60 **281**	[1080] 120 **278**	[1640] 185 **272**	[2210] 250 **266**	[2750] 310 **256**	[3300] 375 **246**	[3820] 430 **229**	[4350] 490 **212**	[4840] 545 **189**
[12] 45	[200] 25 **341**	[500] 55 **338**	[1070] 120 **335**	[1640] 185 **329**	[2220] 250 **323**	[2750] 310 **312**	[3300] 375 **300**	[3840] 435 **282**	[4370] 495 **263**	[4870] 550 **237**
[14] 53	[180] 20 **400**	[490] 55 **396**	[1060] 120 **392**	[1640] 185 **386**	[2220] 250 **380**	[2750] 310 **368**	[3310] 375 **355**	[3860] 435 **335**	[4390] 495 **315**	[4890] 550 **286**
[16] 61	[160] 20 **457**	[490] 55 **453**	[1050] 120 **449**	[1630] 185 **443**	[2220] 250 **437**	[2760] 310 **424**	[3310] 375 **410**	[3860] 435 **388**	[4400] 495 **366**	[4920] 555 **335**
[18] 68	[130] 15 **516**	[480] 55 **511**	[1050] 120 **506**	[1630] 185 **500**	[2220] 250 **494**	[2760] 310 **480**	[3320] 375 **465**	[3870] 435 **442**	[4420] 500 **418**	[4940] 560 **384**
[20] 76	[110] 10 **574**	[470] 55 **569**	[1040] 120 **564**	[1620] 185 **559**	[2210] 250 **551**	[2760] 310 **536**	[3330] 375 **520**	[3890] 440 **495**	[4440] 500 **470**	
[22] 83	[70] 10 **633**	[450] 50 **628**	[1020] 115 **624**	[1610] 180 **615**	[2190] 245 **606**	[2750] 310 **590**	[3320] 375 **573**	[3880] 440 **547**	[4440] 500 **520**	
[25] 95	[50] 5 **722**	[430] 50 **718**	[1000] 115 **714**	[1580] 180 **702**	[2160] 245 **690**	[2720] 305 **672**	[3300] 375 **653**	[3860] 435 **625**	[4430] 500 **595**	
[30] 114		[400] 45 **862**	[940] 105 **855**	[1500] 170 **842**	[2080] 235 **827**	[2670] 300 **806**	[3200] 360 **783**	[3740] 425 **749**		

Continuous

Intermittent

160 cm³/r [9.9 in³/r]
Δ Pressure Bar [PSI]

Flow LPM [GPM]	[250] 15	[500] 35	[1000] 70	[1500] 105	[2000] 140	[2500] 170	[3000] 205	[3500] 240	[4000] 275	[4500] 310
[.5] 1,9	[300] 35 **8**	[680] 75 **7**	[1320] 150 **5**	[2050] 230 **3**	[2750] 310 **1**					
[1] 3,8	[320] 35 **23**	[700] 80 **22**	[1350] 155 **20**	[2070] 235 **19**	[2780] 315 **18**	[3300] 375 **16**	[3940] 445 **15**	[4410] 500 **8**	[4950] 560 **2**	
[2] 7,5	[330] 35 **46**	[700] 80 **45**	[1360] 155 **41**	[2080] 235 **40**	[2790] 315 **37**	[3340] 375 **32**	[3970] 450 **29**	[4530] 510 **27**	[5090] 575 **25**	[5590] 630 **13**
[4] 15	[320] 35 **93**	[710] 80 **92**	[1400] 160 **90**	[2100] 240 **88**	[2820] 320 **84**	[3420] 385 **76**	[4020] 455 **73**	[4620] 520 **62**	[5220] 590 **51**	[5730] 645 **35**
[6] 23	[300] 35 **137**	[710] 80 **135**	[1420] 160 **134**	[2140] 240 **131**	[2850] 320 **126**	[3510] 395 **120**	[4180] 470 **114**	[4760] 540 **90**	[5340] 605 **75**	[5870] 665 **57**
[8] 30	[280] 30 **184**	[720] 80 **182**	[1450] 165 **180**	[2180] 245 **176**	[2900] 330 **171**	[3560] 400 **163**	[4230] 480 **154**	[4850] 550 **138**	[5470] 620 **122**	[6010] 680 **100**
[10] 38	[260] 30 **232**	[720] 80 **229**	[1480] 165 **226**	[2220] 250 **221**	[2950] 335 **216**	[3610] 410 **206**	[4290] 485 **194**	[4920] 555 **182**	[5560] 630 **169**	[6160] 695 **142**
[12] 45	[240] 25 **277**	[700] 80 **274**	[1450] 165 **272**	[2190] 245 **266**	[2920] 330 **260**	[3590] 405 **250**	[4280] 485 **238**	[4920] 555 **224**	[5570] 630 **209**	[6180] 700 **182**
[14] 53	[220] 25 **321**	[680] 75 **319**	[1420] 160 **318**	[2160] 245 **311**	[2890] 325 **304**	[3570] 405 **294**	[4270] 480 **282**	[4920] 555 **266**	[5580] 630 **249**	[6200] 700 **222**
[16] 61	[200] 25 **366**	[670] 75 **364**	[1400] 160 **362**	[2130] 240 **356**	[2860] 325 **348**	[3550] 400 **338**	[4260] 480 **326**	[4920] 555 **308**	[5590] 630 **289**	[6220] 705 **262**
[18] 68	[180] 20 **410**	[650] 75 **409**	[1360] 155 **407**	[2100] 235 **401**	[2830] 320 **392**	[3530] 400 **382**	[4250] 480 **370**	[4910] 555 **350**	[5600] 635 **329**	[6240] 705 **302**
[20] 76	[150] 15 **460**	[630] 70 **458**	[1340] 150 **456**	[2070] 235 **448**	[2800] 315 **440**	[3510] 395 **429**	[4240] 480 **417**	[4910] 555 **396**	[5610] 635 **373**	
[22] 83	[120] 15 **509**	[620] 70 **506**	[1330] 150 **502**	[2060] 235 **494**	[2790] 315 **484**	[3500] 395 **473**	[4220] 475 **461**	[4910] 555 **438**	[5600] 635 **413**	
[25] 95	[70] 10 **582**	[600] 70 **578**	[1320] 150 **573**	[2050] 230 **563**	[2780] 315 **552**	[3480] 395 **540**	[4210] 475 **526**	[4900] 555 **501**	[5590] 630 **474**	
[30] 114		[560] 65 **693**	[1280] 145 **687**	[1990] 225 **675**	[2700] 305 **661**	[3430] 390 **647**	[3970] 450 **630**	[4640] 525 **600**		

205 cm³/r [12.5 in³/r]
Δ Pressure Bar [PSI]

Flow LPM [GPM]	[250] 15	[500] 35	[1000] 70	[1500] 105	[2000] 140	[2500] 170	[3000] 205	[3500] 240	[4000] 275	[4500] 310
[.5] 1,9	[400] 45 **8**	[810] 90 **5**	[1500] 170 **1**							
[1] 3,8	[410] 45 **17**	[830] 95 **17**	[1590] 180 **16**	[2220] 250 **15**	[2860] 325 **14**	[3860] 435 **12**	[4560] 515 **11**	[5390] 610 **9**	[5510] 625 **3**	
[2] 7,5	[420] 45 **36**	[850] 95 **35**	[1680] 190 **34**	[2410] 270 **32**	[3140] 355 **29**	[4060] 460 **27**	[4800] 540 **25**	[5420] 610 **22**	[6000] 680 **16**	[6210] 700 **8**
[4] 15	[430] 50 **73**	[870] 100 **73**	[1770] 200 **71**	[2590] 295 **70**	[3410] 385 **68**	[4260] 480 **61**	[5040] 570 **57**	[5730] 645 **45**	[6340] 715 **35**	[6740] 760 **23**
[6] 23	[430] 50 **107**	[880] 100 **106**	[1800] 205 **105**	[2620] 295 **103**	[3530] 400 **101**	[4370] 495 **98**	[5170] 585 **90**	[5900] 665 **81**	[6590] 745 **74**	[7100] 800 **65**
[8] 30	[410] 45 **144**	[870] 100 **143**	[1820] 205 **142**	[2660] 300 **138**	[3560] 400 **136**	[4410] 500 **132**	[5240] 590 **125**	[6020] 680 **116**	[6770] 765 **109**	
[10] 38	[390] 45 **182**	[860] 95 **180**	[1820] 205 **179**	[2700] 305 **174**	[3580] 405 **170**	[4460] 505 **166**	[5300] 600 **160**	[6110] 690 **152**	[6890] 780 **143**	
[12] 45	[350] 40 **217**	[850] 95 **216**	[1810] 205 **215**	[2690] 305 **211**	[3570] 405 **202**	[4440] 500 **200**	[5300] 600 **194**	[6120] 690 **185**		
[14] 53	[330] 35 **256**	[840] 95 **254**	[1790] 200 **252**	[2670] 300 **248**	[3560] 400 **243**	[4430] 500 **237**	[5290] 600 **229**	[6120] 690 **219**		
[16] 61	[290] 35 **291**	[820] 95 **290**	[1770] 200 **289**	[2650] 300 **284**	[3540] 400 **280**	[4410] 500 **272**	[5280] 595 **264**	[6120] 690 **253**		
[18] 68	[270] 30 **329**	[810] 90 **327**	[1750] 200 **325**	[2640] 300 **321**	[3520] 400 **316**	[4400] 495 **308**	[5270] 595 **298**	[6120] 690 **287**		
[20] 76	[230] 25 **366**	[800] 90 **364**	[1730] 195 **362**	[2620] 295 **358**	[3510] 395 **353**	[4380] 495 **345**	[5270] 595 **334**	[6120] 690 **321**		
[22] 83	[190] 20 **402**	[780] 90 **400**	[1690] 190 **398**	[2600] 295 **394**	[3500] 395 **389**	[4370] 495 **380**	[5260] 595 **368**			
[25] 95	[150] 15 **459**	[750] 85 **456**	[1640] 185 **453**	[2560] 290 **448**	[3480] 395 **442**	[4360] 495 **434**	[5240] 590 **421**			
[30] 114		[710] 80 **546**	[1540] 175 **542**	[2510] 285 **537**	[3350] 380 **529**	[4190] 475 **520**	[5030] 570 **504**			

Performance Data
4000 Series

245 cm³/r [15.0 in³/r]
Δ Pressure Bar [PSI]

Flow LPM [GPM]	[250] 15	[500] 35	[750] 50	[1000] 70	[1250] 85	[1500] 105	[1750] 120	[2000] 140	[2250] 155	[2500] 170	[2750] 190	[3000] 205	[3250] 225	[3500] 240	[3750] 260
[.5] 1,9	[460] 50 **5**	[980] 110 **2**													
[1] 3,8	[480] 55 **14**	[990] 110 **14**	[1490] 170 **14**	[1990] 225 **13**	[2480] 280 **13**	[2970] 335 **12**	[3400] 385 **12**	[3830] 435 **11**	[4250] 480 **11**	[4680] 530 **10**	[5020] 565 **4**				
[2] 7,5	[500] 55 **30**	[1000] 115 **30**	[1520] 170 **29**	[2040] 230 **29**	[2540] 285 **28**	[3050] 345 **27**	[3420] 385 **26**	[3930] 445 **24**	[4440] 500 **23**	[4900] 555 **22**	[5320] 600 **20**	[5740] 650 **18**	[6160] 695 **16**	[6640] 750 **14**	[7150] 810 **11**
[4] 15	[510] 60 **61**	[1030] 115 **61**	[1560] 175 **60**	[2080] 235 **60**	[2600] 295 **59**	[3130] 355 **59**	[3630] 410 **58**	[4130] 465 **56**	[4630] 525 **53**	[5120] 580 **49**	[5570] 630 **47**	[6030] 680 **44**	[6480] 730 **42**	[6870] 775 **39**	[7340] 830 **36**
[6] 23	[510] 60 **91**	[1040] 120 **90**	[1570] 175 **90**	[2100] 235 **89**	[2620] 295 **88**	[3160] 355 **88**	[3660] 415 **86**	[4200] 475 **83**	[4710] 530 **80**	[5220] 590 **75**	[5690] 645 **72**	[6150] 695 **70**	[6620] 750 **67**	[7050] 795 **63**	[7430] 840 **59**
[8] 30	[500] 55 **121**	[1020] 115 **121**	[1560] 175 **120**	[2110] 240 **119**	[2630] 295 **118**	[3150] 355 **117**	[3680] 415 **115**	[4210] 475 **113**	[4740] 535 **111**	[5250] 595 **106**	[5720] 645 **103**	[6200] 700 **99**	[6670] 755 **96**	[7090] 800 **91**	[7470] 845 **87**
[10] 38	[470] 55 **152**	[1000] 115 **151**	[1540] 175 **150**	[2100] 235 **148**	[2620] 295 **148**	[3150] 355 **147**	[3690] 415 **145**	[4230] 480 **143**	[4770] 540 **141**	[5290] 600 **137**	[5760] 650 **133**	[6240] 705 **129**	[6710] 760 **125**	[7140] 805 **120**	
[12] 45	[450] 50 **183**	[980] 110 **182**	[1530] 175 **180**	[2080] 235 **179**	[2610] 295 **178**	[3140] 355 **178**	[3680] 415 **176**	[4220] 475 **173**	[4760] 540 **170**	[5280] 595 **166**	[5750] 650 **161**	[6230] 705 **157**	[6700] 755 **152**		
[14] 53	[420] 45 **213**	[960] 110 **212**	[1520] 170 **211**	[2060] 235 **210**	[2600] 295 **209**	[3130] 355 **208**	[3670] 415 **206**	[4200] 475 **203**	[4740] 535 **200**	[5260] 595 **195**	[5740] 650 **190**	[6220] 705 **185**			
[16] 61	[400] 45 **244**	[950] 105 **243**	[1500] 170 **242**	[2040] 230 **241**	[2580] 290 **240**	[3120] 355 **239**	[3660] 415 **236**	[4190] 475 **232**	[4730] 535 **229**	[5250] 595 **225**	[5730] 650 **219**	[6210] 700 **213**			
[18] 68	[380] 45 **275**	[930] 105 **274**	[1480] 165 **273**	[2020] 230 **272**	[2560] 290 **270**	[3110] 350 **269**	[3650] 415 **266**	[4180] 470 **262**	[4710] 530 **259**	[5230] 590 **254**	[5720] 645 **248**	[6200] 700 **241**			
[20] 76	[350] 40 **305**	[910] 105 **305**	[1460] 165 **304**	[2000] 225 **303**	[2550] 290 **302**	[3100] 350 **300**	[3640] 410 **296**	[4170] 470 **292**	[4700] 530 **288**	[5220] 590 **283**	[5710] 645 **276**				
[22] 83	[310] 35 **337**	[870] 100 **336**	[1420] 160 **335**	[1970] 225 **334**	[2500] 280 **332**	[3050] 345 **330**	[3590] 405 **326**	[4140] 465 **323**	[4680] 530 **319**	[5200] 590 **313**	[5680] 640 **306**				
[25] 95	[260] 30 **383**	[820] 95 **382**	[1380] 155 **381**	[1930] 220 **380**	[2460] 280 **378**	[2980] 335 **376**	[3540] 400 **372**	[4090] 460 **369**	[4640] 525 **365**	[5180] 585 **357**					
[30] 114		[680] 75 **457**	[1250] 140 **456**	[1860] 210 **455**	[2390] 270 **453**	[2900] 330 **450**	[3430] 390 **445**	[3960] 445 **442**	[4460] 505 **437**	[4950] 560 **427**					
[35] 132			[1110] 125 **532**	[1740] 195 **531**	[2270] 255 **528**	[2790] 315 **525**	[3340] 375 **519**	[3910] 440 **515**	[4400] 495 **509**						

[1110] Torque [lb-in] / Nm
532 Speed RPM

Continuous
Intermittent

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

310 cm³/r [19.0 in³/r]
Δ Pressure Bar [PSI]

Flow LPM [GPM]	[250] 15	[500] 35	[750] 50	[1000] 70	[1250] 85	[1500] 105	[1750] 120	[2000] 140	[2250] 155	[2500] 170	[2750] 190	[3000] 205	[3250] 225	[3500] 240	[3750] 260
[.5] 1,9	[600] 70 **4**	[1150] 130 **2**													
[1] 3,8	[620] 70 **11**	[1270] 145 **11**	[1920] 215 **11**	[2560] 290 **10**	[3170] 360 **10**	[3780] 425 **10**	[4290] 485 **9**	[4900] 555 **9**	[5490] 620 **9**	[6080] 685 **8**	[6670] 755 **8**	[7270] 820 **7**	[7880] 890 **7**	[8490] 960 **6**	[9080] 1025 **5**
[2] 7,5	[630] 70 **23**	[1280] 145 **23**	[1940] 220 **22**	[2590] 295 **22**	[3230] 365 **21**	[3830] 435 **21**	[4450] 505 **20**	[5070] 575 **20**	[5680] 640 **19**	[6300] 710 **18**	[6910] 780 **18**	[7530] 850 **17**	[8160] 920 **17**	[8790] 995 **16**	[9420] 1065 **15**
[4] 15	[640] 70 **47**	[1290] 145 **47**	[1960] 220 **46**	[2640] 300 **46**	[3290] 370 **45**	[3940] 445 **45**	[4600] 520 **44**	[5240] 590 **44**	[5880] 665 **43**	[6510] 735 **42**	[7150] 810 **42**	[7790] 880 **41**	[8450] 955 **41**	[9100] 1030 **40**	
[6] 23	[650] 75 **71**	[1300] 145 **71**	[1970] 225 **70**	[2660] 300 **70**	[3320] 375 **69**	[4000] 450 **69**	[4680] 530 **68**	[5330] 600 **67**	[5980] 675 **66**	[6630] 750 **64**	[7280] 825 **64**	[7940] 895 **63**			
[8] 30	[640] 70 **96**	[1300] 145 **96**	[1980] 225 **95**	[2670] 300 **95**	[3350] 380 **94**	[4030] 455 **94**	[4710] 530 **93**	[5360] 605 **92**	[6020] 680 **91**	[6670] 755 **89**	[7320] 825 **88**				
[10] 38	[620] 70 **121**	[1280] 145 **120**	[1970] 225 **120**	[2660] 300 **119**	[3340] 375 **119**	[4070] 460 **118**	[4740] 535 **117**	[5390] 610 **116**	[6050] 685 **115**	[6710] 760 **112**	[7370] 835 **109**				
[12] 45	[600] 70 **145**	[1260] 140 **144**	[1940] 220 **144**	[2630] 295 **143**	[3340] 375 **142**	[4040] 455 **142**	[4730] 535 **141**	[5390] 610 **140**	[6060] 685 **139**	[6720] 760 **135**					
[14] 53	[570] 65 **169**	[1240] 140 **169**	[1920] 215 **168**	[2600] 295 **168**	[3310] 375 **167**	[4000] 450 **167**	[4710] 530 **165**	[5380] 610 **164**	[6060] 685 **163**	[6730] 760 **159**					
[16] 61	[540] 60 **193**	[1230] 140 **193**	[1900] 215 **192**	[2580] 290 **192**	[3280] 370 **190**	[3970] 450 **189**	[4700] 530 **188**	[5380] 610 **187**	[6050] 685 **185**						
[18] 68	[490] 55 **217**	[1210] 135 **217**	[1880] 210 **216**	[2550] 290 **216**	[3240] 365 **214**	[3930] 445 **213**	[4680] 530 **211**	[5370] 605 **209**	[6040] 680 **207**						
[20] 76	[450] 50 **242**	[1190] 135 **242**	[1860] 210 **242**	[2520] 285 **241**	[3210] 365 **240**	[3900] 440 **238**	[4670] 530 **236**	[5360] 605 **234**	[6030] 680 **232**						
[22] 83	[420] 45 **267**	[1130] 130 **266**	[1820] 205 **266**	[2520] 285 **265**	[3180] 360 **264**	[3870] 440 **262**	[4640] 525 **260**	[5320] 600 **258**							
[25] 95	[340] 40 **303**	[1050] 120 **303**	[1780] 200 **302**	[2510] 285 **301**	[3160] 355 **300**	[3820] 430 **299**	[4590] 520 **296**	[5280] 595 **293**							
[30] 114		[1010] 115 **363**	[1700] 190 **362**	[2420] 275 **360**	[3100] 350 **359**	[3720] 420 **358**	[4500] 510 **354**	[5140] 580 **351**							
[35] 132			[1580] 180 **422**	[2360] 265 **420**	[2950] 335 **419**	[3540] 400 **418**	[4390] 495 **413**								

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

Performance Data
4000 Series

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

Flow LPM [GPM]	[250] 15	[500] 35	[750] 50	[1000] 70	[1250] 85	[1500] 105	[1750] 120	[2000] 140	[2250] 155	[2500] 170	[2750] 190	[3000] 205	[3250] 225	[3500] 240
[.5] 1,9	[700] 80 **4**	[1340] 150 **2**												
[1] 3,8	[750] 85 **9**	[1430] 160 **9**	[2110] 240 **8**	[2770] 315 **8**	[3460] 390 **8**	[4170] 470 **7**	[4890] 550 **7**	[5610] 635 **7**	[6310] 715 **5**	[7010] 790 **4**	[7700] 870 **2**			
[2] 7,5	[800] 90 **18**	[1500] 170 **18**	[2290] 260 **17**	[3030] 340 **16**	[3850] 435 **16**	[4620] 520 **15**	[5310] 600 **15**	[6000] 680 **14**	[6750] 765 **13**	[7490] 845 **13**	[8240] 930 **12**	[8990] 1015 **11**	[9730] 1100 **10**	[10470] 1185 **8**
[4] 15	[860] 95 **38**	[1630] 185 **38**	[2470] 280 **37**	[3310] 375 **36**	[4120] 465 **36**	[4900] 555 **35**	[5640] 635 **35**	[6390] 720 **34**	[7190] 810 **34**	[7890] 890 **33**	[8780] 990 **32**			
[6] 23	[860] 95 **57**	[1690] 190 **57**	[2540] 285 **56**	[3410] 385 **55**	[4180] 470 **54**	[4980] 565 **53**	[5780] 655 **52**	[6580] 745 **50**	[7400] 835 **49**	[8220] 930 **47**				
[8] 30	[840] 95 **76**	[1680] 190 **76**	[2550] 290 **75**	[3400] 385 **74**	[4260] 480 **73**	[5090] 575 **72**	[5870] 665 **70**	[6650] 750 **68**	[7480] 845 **66**					
[10] 38	[800] 90 **95**	[1680] 190 **95**	[2550] 290 **94**	[3400] 385 **93**	[4260] 480 **92**	[5100] 575 **91**	[5920] 670 **89**	[6730] 760 **86**	[7560] 855 **84**					
[12] 45	[760] 85 **114**	[1660] 190 **114**	[2520] 285 **113**	[3380] 380 **112**	[4270] 480 **111**	[5110] 575 **110**	[5900] 665 **108**	[6690] 755 **105**						
[14] 53	[740] 85 **133**	[1640] 185 **133**	[2490] 280 **132**	[3370] 380 **131**	[4260] 480 **130**	[5100] 575 **129**	[5880] 665 **127**	[6650] 750 **124**						
[16] 61	[710] 80 **153**	[1620] 185 **153**	[2460] 280 **152**	[3350] 380 **151**	[4240] 480 **149**	[5080] 575 **147**	[5840] 660 **145**							
[18] 68	[680] 75 **172**	[1600] 180 **172**	[2430] 275 **171**	[3340] 375 **170**	[4220] 475 **168**	[5060] 570 **166**	[5810] 655 **164**							
[20] 76	[610] 70 **192**	[1580] 180 **191**	[2400] 270 **190**	[3320] 375 **189**	[4210] 475 **187**	[5040] 570 **185**	[5780] 655 **183**							
[22] 83	[570] 65 **211**	[1490] 170 **210**	[2340] 265 **209**	[3220] 365 **208**	[4160] 470 **206**	[5010] 565 **204**	[5740] 650 **201**							
[25] 95	[490] 55 **239**	[1350] 155 **238**	[2250] 255 **237**	[3080] 350 **236**	[4070] 460 **235**	[4960] 560 **233**	[5700] 645 **230**							
[30] 114		[1080] 120 **285**	[1650] 185 **284**	[2270] 255 **282**	[3020] 340 **281**	[3850] 435 **279**								
[35] 132			[1520] 170 **331**	[2120] 240 **330**	[2870] 325 **328**	[3760] 425 **325**								
[40] 151				[2050] 230 **376**	[2790] 315 **374**	[3620] 410 **371**								

[2050] 230 **376** Torque [lb-in] Nm **Speed RPM**

Continuous
Intermittent

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

495 cm³/r [30.0 in³/r]
Δ Pressure Bar [PSI]

Flow LPM [GPM]	[250] 15	[500] 35	[750] 50	[1000] 70	[1250] 85	[1500] 105	[1750] 120	[2000] 140	[2250] 155	[2500] 170
[.5] 1,9	[800] 90 **3**	[1750] 200 **1**								
[1] 3,8	[880] 100 **7**	[1875] 210 **6**	[2875] 325 **6**	[3825] 430 **5**	[4775] 540 **4**	[5720] 645 **3**	[6670] 755 **2**	[7600] 860 **1**		
[2] 7,5	[905] 100 **18**	[1940] 220 **17**	[2975] 335 **17**	[3990] 450 **16**	[5010] 565 **15**	[6010] 680 **12**	[7010] 790 **11**	[8000] 905 **10**	[8980] 1015 **8**	
[4] 15	[935] 105 **30**	[2005] 225 **29**	[3075] 345 **28**	[4160] 470 **27**	[5245] 595 **26**	[6300] 710 **23**	[7355] 830 **21**	[8375] 945 **19**	[9400] 1060 **17**	[10350] 1170 **14**
[6] 23	[920] 105 **45**	[2010] 225 **44**	[3100] 350 **43**	[4185] 475 **42**	[5265] 595 **40**	[6345] 715 **37**	[7420] 840 **35**	[8445] 955 **32**	[9465] 1070 **30**	
[8] 30	[905] 100 **61**	[2015] 230 **60**	[3125] 355 **59**	[4205] 475 **57**	[5290] 600 **55**	[6385] 720 **52**	[7485] 845 **49**	[8510] 960 **46**		
[10] 38	[880] 100 **76**	[1995] 225 **75**	[3095] 350 **74**	[4205] 475 **72**	[5295] 600 **70**	[6390] 720 **66**	[7480] 845 **63**	[8525] 960 **59**		
[12] 45	[860] 95 **91**	[1975] 225 **90**	[3095] 350 **89**	[4200] 475 **87**	[5305] 600 **85**	[6390] 720 **81**	[7475] 845 **77**			
[14] 53	[830] 95 **106**	[1945] 220 **105**	[3055] 345 **104**	[4165] 470 **102**	[5275] 595 **100**	[6360] 720 **96**	[7445] 840 **92**			
[16] 61	[805] 90 **122**	[1910] 215 **120**	[3020] 340 **119**	[4130] 465 **117**	[5245] 595 **115**	[6330] 715 **111**	[7420] 840 **107**			
[18] 68	[740] 85 **137**	[1860] 210 **136**	[2980] 335 **134**	[4105] 465 **132**	[5235] 590 **130**	[6305] 715 **125**	[7380] 835 **121**			
[20] 76	[680] 75 **153**	[1810] 205 **152**	[2940] 330 **150**	[4085] 460 **147**	[5225] 590 **145**	[6285] 710 **140**				
[25] 95	[570] 65 **191**	[1665] 190 **189**	[2800] 315 **187**	[4005] 455 **184**	[5210] 590 **182**	[6135] 695 **177**				
[30] 114		[1520] 170 **228**	[2645] 300 **226**	[3765] 425 **223**	[4885] 550 **220**	[5985] 675 **215**				
[35] 132			[2400] 270 **265**	[3510] 395 **263**						
[40] 151			[2155] 245 **305**	[3260] 370 **303**						

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

Performance Data
4000 Series

625 cm³/r [38.0 in³/r]
Δ Pressure Bar [PSI]

Flow LPM [GPM]	[250] 15	[500] 35	[750] 50	[1000] 70	[1250] 85	[1500] 105	[1600] 100	[1700] 115	[1800] 125	[2000] 140
[.5] 1,9	[1000] 115 **2**									
[1] 3,8	[1080] 120 **5**	[2340] 265 **5**	[3600] 405 **5**	[4850] 550 **4**	[6100] 690 **4**	[7350] 830 **3**	[7820] 885 **3**	[8290] 935 **2**	[8760] 990 **2**	
[2] 7,5	[1085] 125 **14**	[2380] 270 **14**	[3675] 415 **14**	[5010] 565 **13**	[6350] 715 **12**	[7625] 860 **11**	[8115] 915 **10**	[8605] 970 **9**	[9095] 1030 **8**	[10075] 1140 **7**
[4] 15	[1090] 125 **23**	[2420] 275 **23**	[3750] 425 **23**	[5175] 585 **22**	[6600] 745 **21**	[7900] 895 **19**	[8410] 950 **18**	[9000] 1015 **17**	[9590] 1085 **16**	[10450] 1180 **14**
[6] 23	[1095] 125 **35**	[2460] 280 **35**	[3825] 430 **35**	[5220] 590 **34**	[6620] 750 **33**	[7950] 900 **31**	[8430] 950 **30**	[8910] 1005 **29**	[9490] 1070 **28**	
[8] 30	[1100] 125 **48**	[2500] 280 **48**	[3900] 440 **47**	[5270] 595 **46**	[6640] 750 **45**	[7990] 905 **43**	[8460] 955 **43**	[8925] 1010 **42**		
[10] 38	[1130] 130 **60**	[2550] 290 **60**	[3975] 450 **59**	[5320] 600 **58**	[6670] 755 **57**	[8045] 910 **54**	[8595] 970 **53**	[9150] 1035 **52**		
[12] 45	[1160] 130 **72**	[2600] 295 **72**	[4050] 460 **71**	[5375] 605 **70**	[6700] 755 **69**	[8100] 915 **65**	[8660] 980 **64**			
[14] 53	[1105] 125 **84**	[2535] 285 **84**	[3965] 450 **83**	[5325] 600 **82**	[6685] 755 **81**	[8065] 910 **77**	[8620] 975 **76**			
[16] 61	[1050] 120 **96**	[2465] 280 **95**	[3880] 440 **95**	[5275] 595 **94**	[6670] 755 **93**	[8035] 910 **89**	[8580] 970 **88**			
[18] 68	[990] 110 **108**	[2405] 270 **107**	[3825] 430 **107**	[5240] 590 **105**	[6655] 750 **104**	[7345] 830 **100**				
[20] 76	[930] 105 **121**	[2350] 265 **120**	[3770] 425 **120**	[5205] 590 **118**	[6640] 750 **116**					
[25] 95	[750] 85 **151**	[2175] 245 **150**	[3600] 405 **149**	[5000] 565 **147**	[6400] 725 **146**					
[30] 114	[550] 60 **181**	[1975] 225 **180**	[3400] 385 **179**	[4800] 530 **177**	[6200] 700 **176**					
[35] 132			[3125] 355 **210**	[4545] 515 **208**						
[40] 151			[2850] 320 **241**	[4295] 485 **239**						

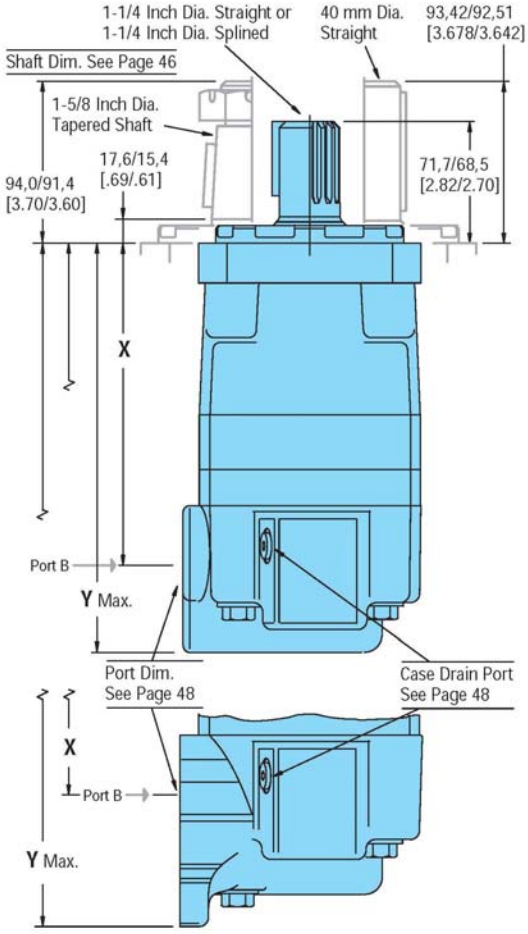
[2850] 320 **241** } Torque [lb-in] Nm **Speed RPM**

Continuous
Intermittent

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

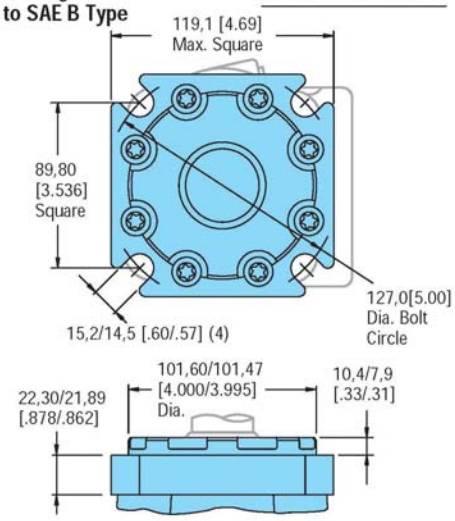
Performance data is typical at 120 SUS. Actual data may vary slightly from unit to unit in production

Dimensions — 4000 Series Standard Motor

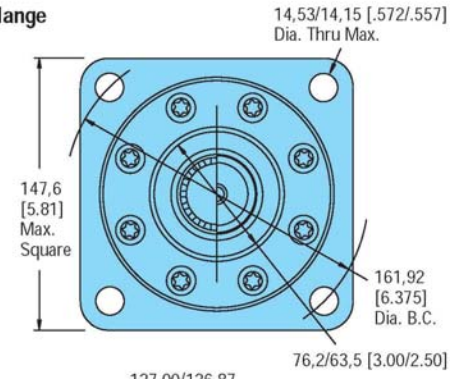


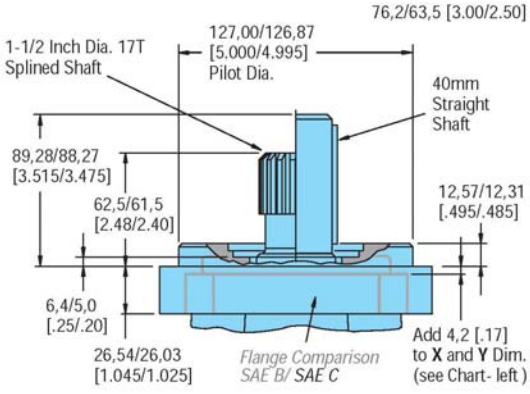
Standard Rotation
Viewed from Shaft End
Port **A** Pressurized — CW
Port **B** Pressurized — CCW

Standard Flange—
Similar to SAE B Type



SAE C Flange





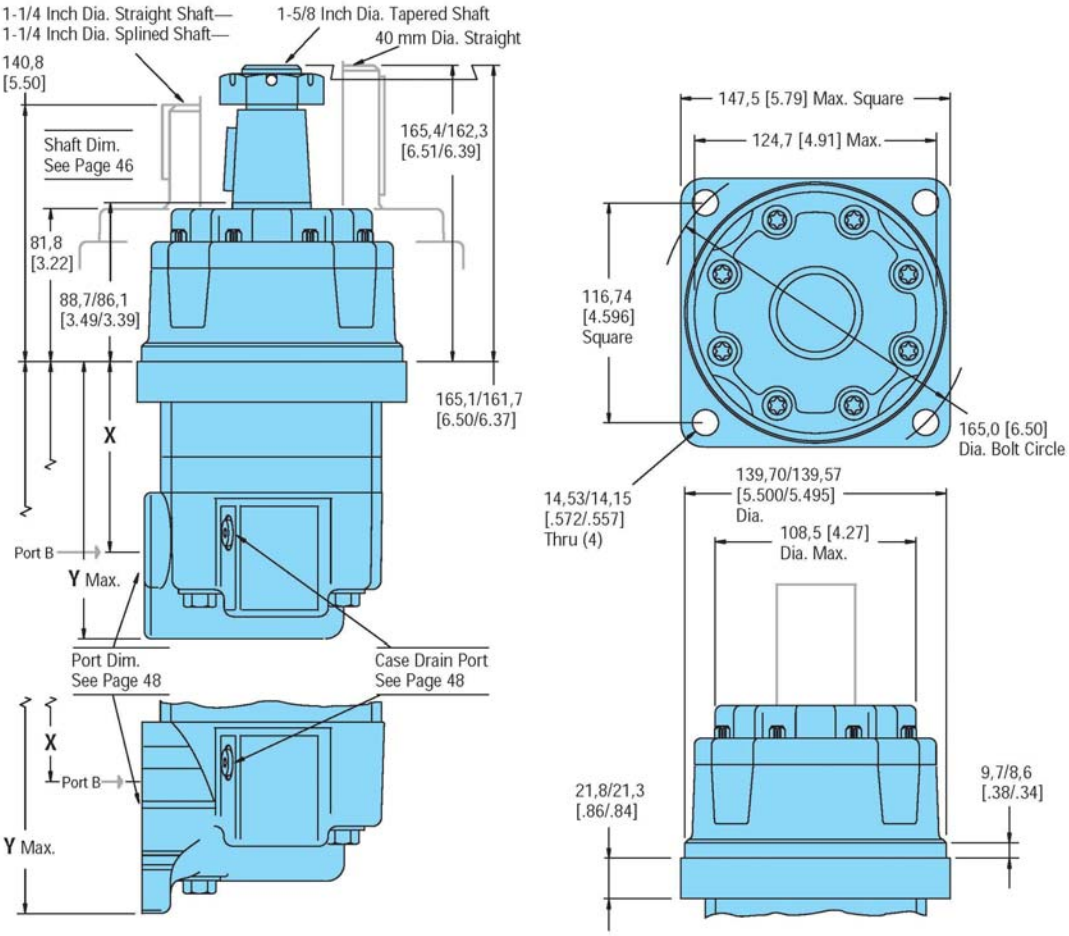
4000 Series Standard Motor with 1-1/16-12 O-ring Ports or G 3/4 (BSP) Ports

Displ.									
cm^3/r	110	130	160	205	245	310	395	495	625
$[in^3/r]$	[6.7]	[7.9]	[9.9]	[12.5]	[15.0]	[19.0]	[24.0]	[30.0]	[38.0]
X Dim.									
mm	158,3	162,3	168,7	177,2	168,7	177,2	187,9	200,7	217,8
[inch]	[6.23]	[6.39]	[6.64]	[6.98]	[6.64]	[6.98]	[7.40]	[7.90]	[8.58]
Y Dim.									
mm	214,4	218,4	224,7	233,2	224,7	233,2	243,9	256,8	273,9
[inch]	[8.44]	[8.60]	[8.85]	[9.18]	[8.85]	[9.18]	[9.60]	[10.11]	[10.78]

4000 Series Standard Motor with 3/4 inch Split Flange Ports

X Dim.									
mm	166,7	170,8	177,0	185,6	177,1	185,6	196,3	209,2	226,2
[inch]	[6.57]	[6.73]	[6.97]	[7.31]	[6.97]	[7.31]	[7.73]	[8.24]	[8.91]
Y Dim.									
mm	246,3	250,4	256,7	265,2	256,7	265,2	275,9	288,8	305,9
[inch]	[9.70]	[9.86]	[10.11]	[10.44]	[10.11]	[10.44]	[10.86]	[11.37]	[12.04]

Dimensions — 4000 Series Wheel Motor



4000 Series Wheel Motor with 1-1/16-12 O-ring Ports or G 3/4 (BSP) Ports

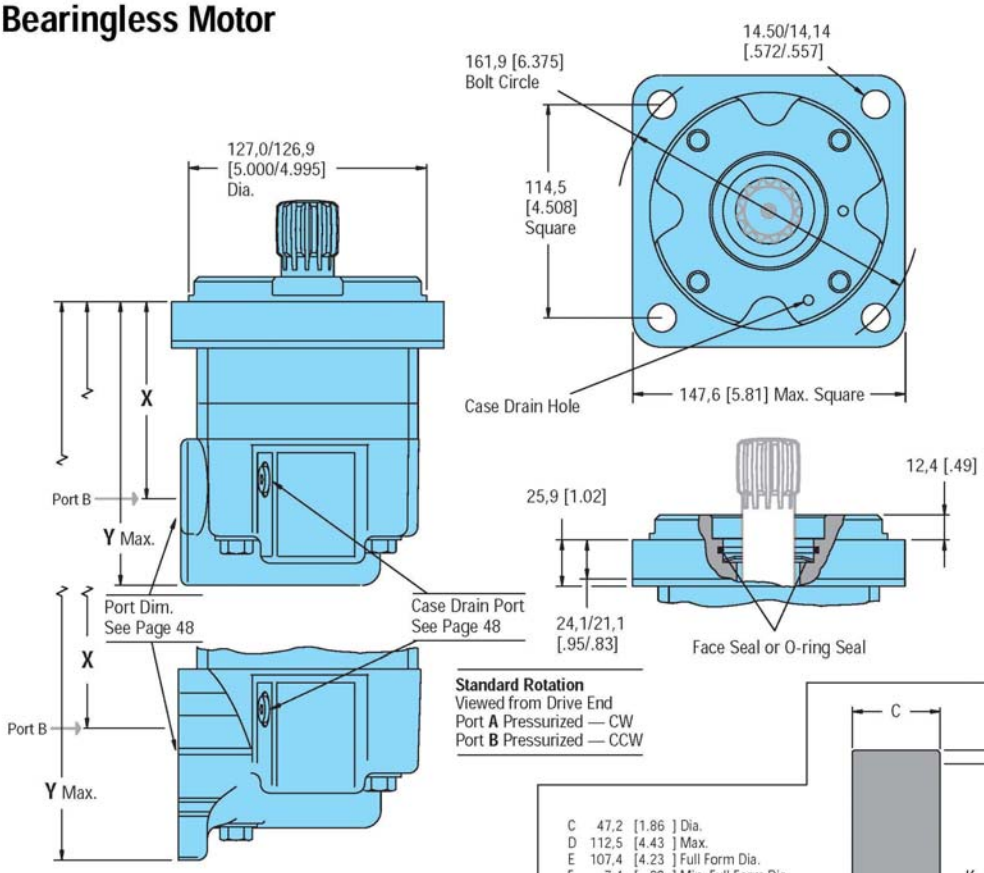
Displ. cm^3/r [in^3/r]	110 [6.7]	130 [7.9]	160 [9.9]	205 [12.5]	245 [15.0]	310 [19.0]	395 [24.0]	495 [30.0]	625 [38.0]
X Dim. mm [inch]	87,4 [3.44]	91,5 [3.60]	97,8 [3.85]	106,3 [4.19]	97,8 [3.85]	106,3 [4.19]	117,0 [4.61]	129,9 [5.12]	146,8 [5.78]
Y Dim. mm [inch]	143,3 [5.64]	147,3 [5.80]	153,6 [6.05]	162,2 [6.38]	153,6 [6.05]	162,2 [6.38]	172,8 [6.80]	185,8 [7.31]	202,8 [7.98]

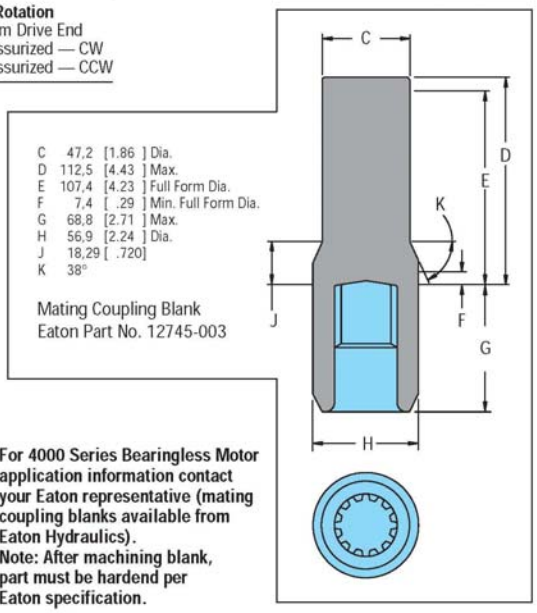
4000 Series Wheel Motor with 3/4 inch Split Flange Ports

X Dim. mm [inch]	95,0 [3.74]	99,1 [3.90]	105,5 [4.16]	114,0 [4.49]	105,5 [4.16]	114,0 [4.49]	124,7 [4.91]	137,6 [5.42]	154,4 [6.08]
Y Dim. mm [inch]	174,5 [6.87]	178,5 [7.03]	184,9 [7.28]	193,4 [7.61]	184,9 [7.28]	193,4 [7.61]	204,1 [8.03]	217,0 [8.54]	234,0 [9.21]

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

Dimensions — 4000 Series Bearingless Motor





4000 Series Bearingless Motor with 1-1/16-12 O-ring Ports or G 3/4 (BSP) Ports

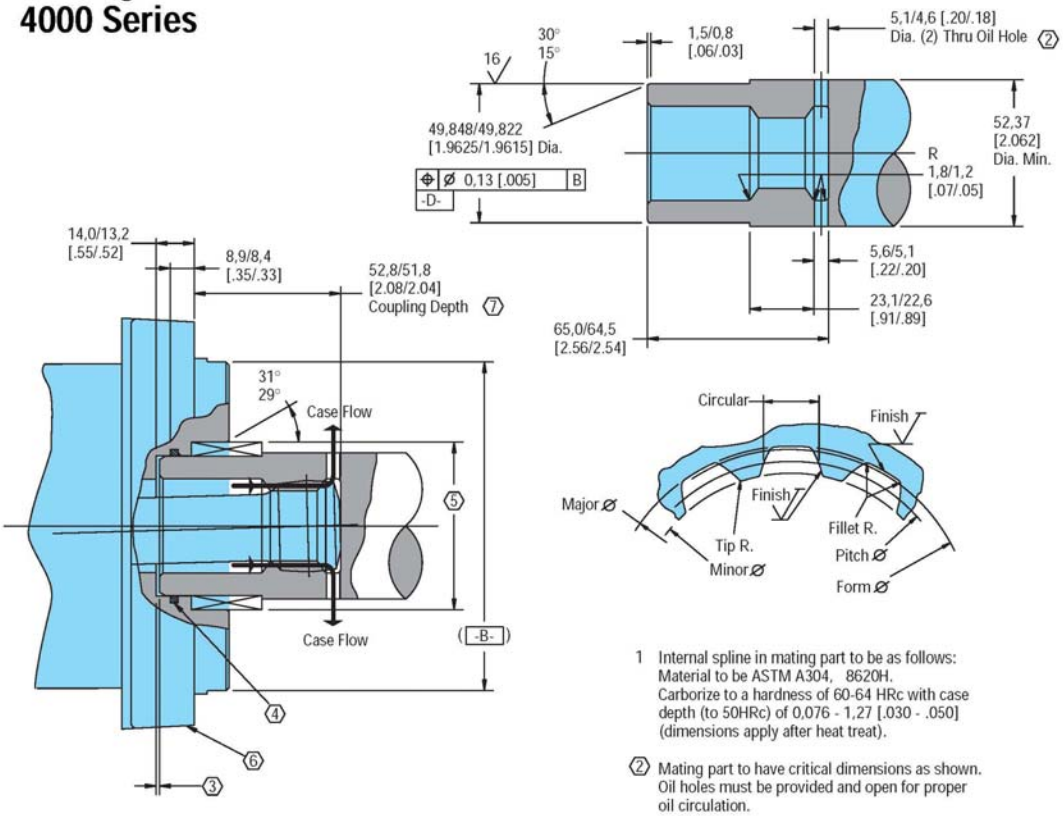
Displ.									
cm^3/r [in^3/r]	110 [6.7]	130 [7.9]	160 [9.9]	205 [12.5]	245 [15.0]	310 [19.0]	395 [24.0]	495 [30.0]	625 [38.0]
X Dim.									
mm	91,0	95,0	101,4	109,9	101,4	109,9	120,6	133,5	150,5
[inch]	[3.58]	[3.74]	[4.00]	[4.33]	[4.00]	[4.33]	[4.75]	[5.26]	[5.93]
Y Dim.									
mm	146,8	150,8	157,1	165,7	157,1	165,7	176,3	189,2	206,3
[inch]	[5.78]	[5.94]	[6.19]	[6.52]	[6.19]	[6.52]	[6.94]	[7.45]	[8.12]

4000 Series Bearingless Motor with 3/4 inch Split Flange Ports

X Dim.									
mm	99,4	103,5	109,7	118,3	109,7	118,3	129,0	141,9	159,0
[inch]	[3.92]	[4.08]	[4.32]	[4.66]	[4.32]	[4.66]	[5.08]	[5.59]	[6.26]
Y Dim.									
mm	178,7	182,8	189,1	197,6	189,1	197,6	208,3	221,2	238,3
[inch]	[7.04]	[7.20]	[7.44]	[7.78]	[7.44]	[7.78]	[8.20]	[8.71]	[9.38]

For 4000 Series Bearingless Motor application information contact your Eaton representative (mating coupling blanks available from Eaton Hydraulics).
Note: After machining blank, part must be hardend per Eaton specification.

Bearingless Installation — 4000 Series



Spline Pitch — 10/20
Pressure Angle — 30°
Number of teeth — 12
Class of Fit — Ref. 5
Type of Fit — Side
Pitch Diameter — Ref. 30,480000 [1.2000000] ◎ 0,20 [.008] H
Base Diameter — Ref. 26,396455 [1.0392305]
Major Diameter — 33,43 [1.316] Max. 33,23 [1.308] Min.
Minor Diameter — 28,40 - 28,58 [1.118 - 1.125]
Form Diameter, Min. — 32,59 [1.283]
Fillet Radius — 0,63 - 0,76 [.025 - .030]
Tip Radius — 0,26 - 0,51 [.010 - .020]
Finish — 1,6 [63]
Involute Profile Variation — +0,000 -0,025 [+.0000 -.0010]
Total Index Variation — 0,038 [.0015]
Lead Variation — 0,013 [.0005]
Circular Space Width:
- Maximum Actual — 5,045 [.1986]
- Minimum Effective — 4,995 [.1951]
- Maximum Effective — Ref. 5,009 [.1972]
- Minimum Actual — Ref. 4,986 [.1963]

Dimension Between Two Pins — Ref. 22,783 - 22,929 [.8970 - .9027]
Pin Diameter — 5,334 [.2100] Pins to Have 3,73 [.147] Wide Flat for Root Clearance

1 Internal spline in mating part to be as follows: Material to be ASTM A304, 8620H. Carborize to a hardness of 60-64 HRc with case depth (to 50HRc) of 0,076 - 1,27 [.030 - .050] (dimensions apply after heat treat).

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

(3) Some means of maintaining clearance between shaft and mounting flange must be provided.

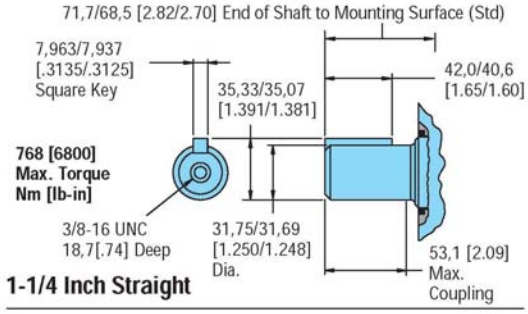
(4) Seal to be furnished with motor for proper oil circulation thru splines.

(5) Counterbore designed to adapt to a standard sleeve bearing 50,010 - 50,040 [1.9689 - 1.9700] ID by 60,050 - 60,080 [2.3642 - 2.3653] (Oilite bronze sleeve bearing).

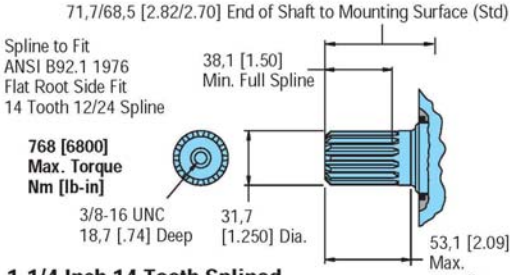
(6) Similar to SAE "C" Four Bolt Flange.

(7) 52,8 [2.08] Max. dimension to be maintained when assembling, shipping and installing unit to insure valve drive engagement with valve (this is required on displacement code number 24 only).

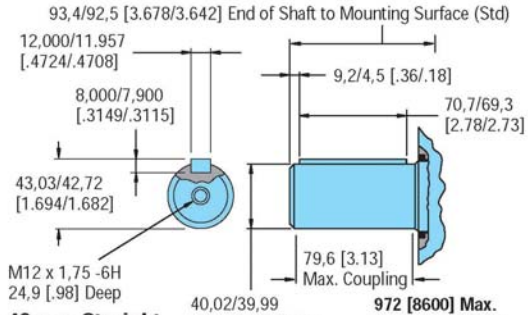
Dimensions — Shafts 4000 Series



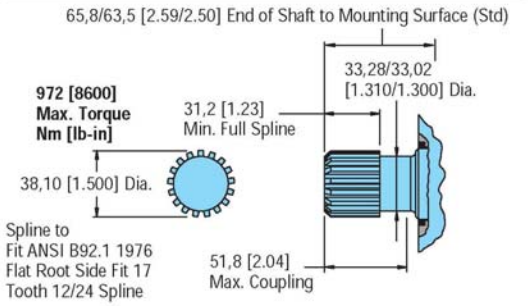
1-1/4 Inch Straight



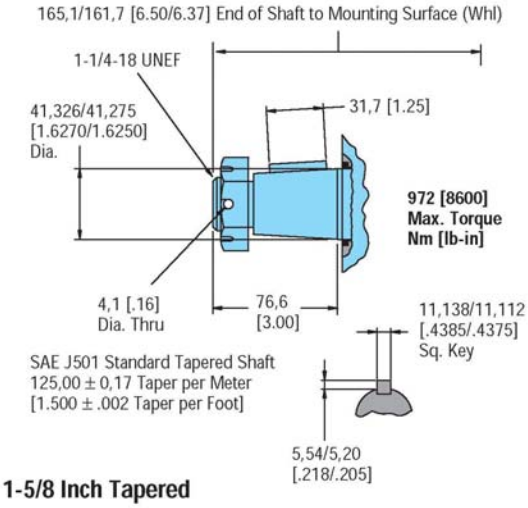
1-1/4 Inch 14 Tooth Splined



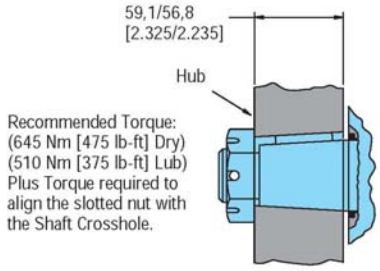
40 mm Straight



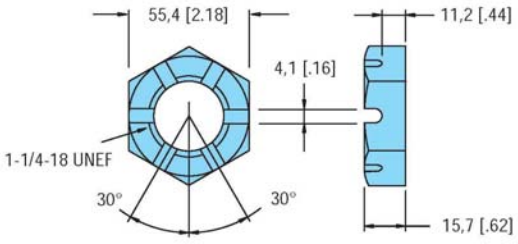
1-1/2 Inch 17 Tooth Splined



1-5/8 Inch Tapered



Tapered Shaft Hub Data



Slotted Hexagon Nut

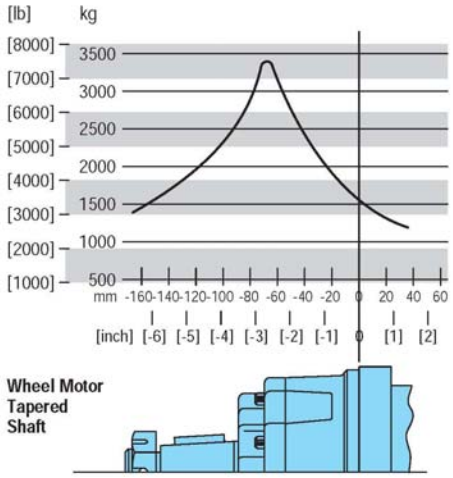
Shaft Side Load Capacity
4000 Series

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

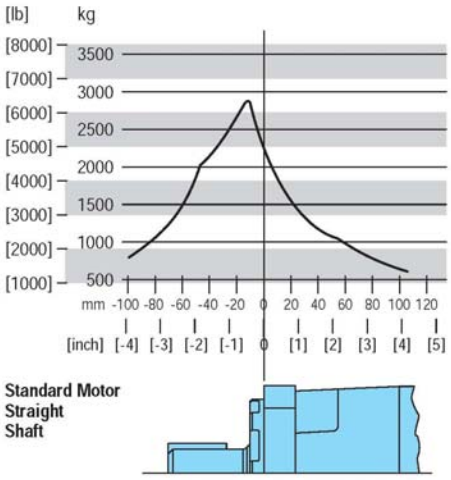
The curve is based on B 10 Bearing life (2000 hours or 12,000,000 shaft revolutions at 100 RPM) at rated output torque. To determine radial load at speeds other than 100 RPM, multiply the load values given on the bearing curve by the factors in the chart below.

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

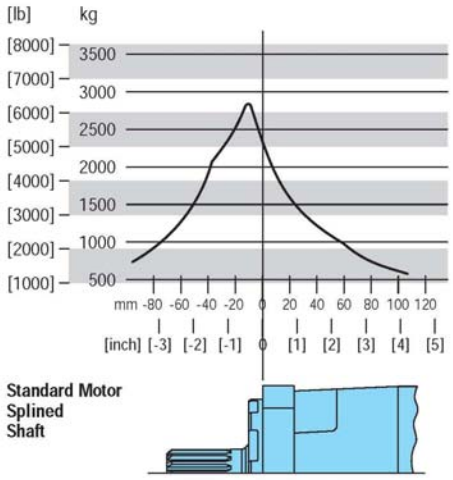
For 3,000,000 Shaft revolutions or 500 hours — Increase these shaft loads 52%.



Wheel Motor Tapered Shaft

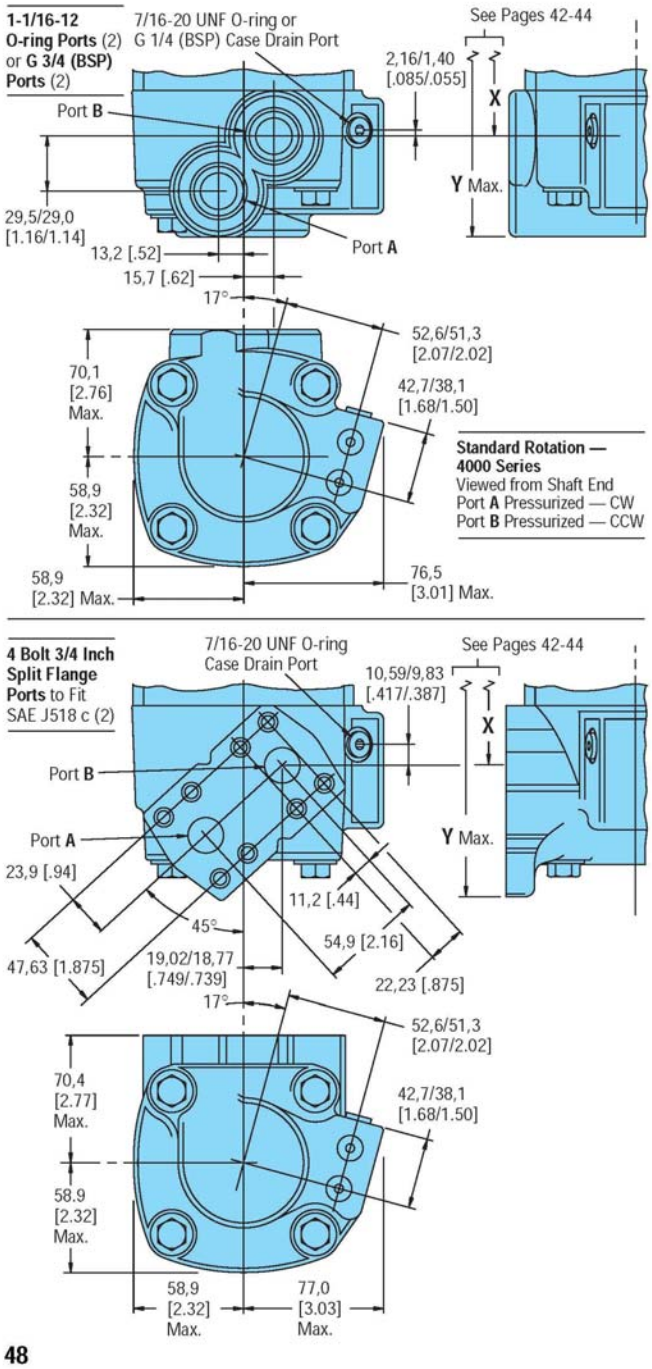


Standard Motor Straight Shaft

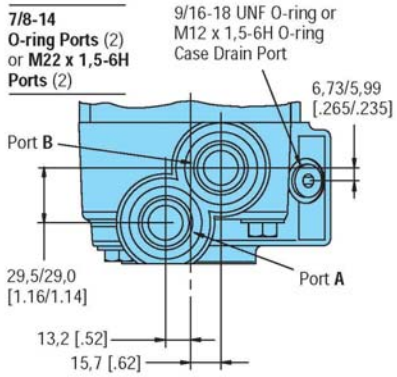


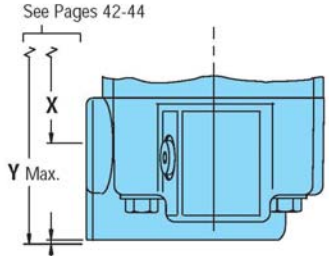
Standard Motor Splined Shaft

Dimensions — Ports 4000 Series

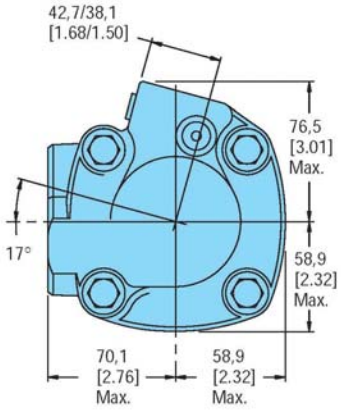


4000 Series with Shuttle Valve





6,9 [.27] Material Removed from this Housing for 7/8-14 O-ring Ports and M22 x 1,5-6H Ports



Product Numbers
4000 Series

Product Numbers—4000 Series Motors

Use digit prefix —**109**-, **110**-, or **111**- plus four digit number from charts for complete product number—Example **111**-1057.
Orders will not be accepted without three digit prefix.

Mounting	Shaft	Ports	Displ. cm³/r [in³/r] Product Number 110 [6.7]	130 [7.9]	160 [9.9]	205 [12.5]	245 [15.0]	310 [19.0]	395 [24.0]	495 [30.0]	625 [38.0]
Standard SAE B-Mount	1-1/4 inch Straight	1-1/16 O-ring	**109**-1100	-1101	-1102	-1103	-1104	-1105	-1106	-1212	-1215
		3/4 inch Split Flange	**109**-1001	-1054	-1002	-1003	-1055	-1056	-1057	—	—
	1-5/8 Inch Tapered	1-1/16 O-ring	**109**-1107	-1108	-1109	-1110	-1111	-1112	-1113	—	—
		3/4 inch Split Flange	**109**-1006	-1058	-1007	-1008	-1059	-1402	-1061	—	—
	1-1/4 Inch 14 T Splined	1-1/16 O-ring	**109**-1114	-1115	-1116	-1117	-1118	-1119	-1120	—	—
		3/4 inch Split Flange	**109**-1011	-1062	-1012	-1013	-1063	-1064	-1065	—	—
Standard SAE C-Mount	40 mm Straight	G 3/4 (BSP)	**109**-1184	-1185	-1227	-1224	-1225	-1189	-1190	—	—
	1-1/2 Inch 17 T Splined	G 3/4 (BSP)	**109**-1191	-1192	-1193	-1194	-1195	-1196	-1197	—	—
Wheel Motor	1-1/4 inch Straight	1-1/16 O-ring	**110**-1074	-1075	-1076	-1077	-1078	-1079	-1080	—	-1122
		3/4 inch Split Flange	**110**-1001	-1040	-1002	-1003	-1041	-1042	-1043	—	—
	40 mm Straight	G 3/4 (BSP)	**110**-1108	-1109	-1110	-1111	-1112	-1113	-1125	—	—
	1-5/8 Inch Tapered	1-1/16 O-ring	**110**-1081	-1082	-1083	-1084	-1085	-1086	-1087	1116	-1117
		3/4 inch Split Flange	**110**-1006	-1044	-1007	-1008	-1045	-1046	-1047	—	—
	1-1/4 Inch 14 T Splined	1-1/16 O-ring	**110**-1088	-1089	-1090	-1091	-1092	-1093	-1094	—	—
		3/4 inch Split Flange	**110**-1011	-1048	-1012	-1013	-1049	-1050	-1051	—	—
Bearingless		1-1/16 O-ring	**111**-1033	-1034	-1035	-1036	-1037	-1038	-1039	-1062	-1063
		3/4 inch Split Flange	**111**-1044	-1015	-1045	-1046	-1016	-1017	-1018	—	—
		G 3/4 (BSP)	**111**-1052	-1053	-1054	-1055	-1056	-1057	-1058	—	—

111-1057

For 4000 Series Motors with a configuration *Not Shown* in the charts above: Use model code number system on page 50 to specify product in detail.

Model Code for 4000 Series Motors

The following 14-digit coding system has been developed to identify all of the configuration options for the 4000 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 — 4000 Series Disc Valve Motors

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

Position 1 **Product Series**

M ..... Motor

Position 2, 3 **4000 Series**

04 ..... 4000 Series

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

07 ..... 110 [6.7]
08 ..... 130 [7.9]
10 ..... 160 [9.9]
12 ..... 205 [12.5]
15 ..... 245 [15.0]
17 ..... 280 [17.1]*
19 ..... 310 [19.0]
24 ..... 395 [24.0]
30 ..... 495 [30.0]
38 ..... 625 [38.0]

*For performance and dimension data contact your Eaton Hydraulics representitive.

Position 6 **Mounting Flange**

A ..... 4 Bolt (Bearingless 127,0 [5.00] Pilot Dia. and 14,27 [.562] Dia. Mounting Holes 161,9 [6.38] Dia. B.C.
B ..... 4 Bolt (SAE B) (Standard) 101,6 [4.00] Pilot Dia. and 14,7 [.58] Mounting Slots on 127,0 [5.00] Dia. B.C.
C ..... 4 Bolt (Wheel) 139,7 [5.50] Pilot Dia. and 14,3 [.56] Dia. Mounting Holes on 165,1 [6.50] Dia. B.C.
F ..... 4 Bolt (SAE C) (Standard) 127,0 [5.00] Pilot Dia. and 14,3 [.56] Dia. Mounting Holes on 161,9 [6.38] Dia. B.C.

Position 7, 8 **Output Shaft**

00 ..... Bearingless
01 ..... 1–1/4 inch Dia. Straight with Straight Key, 3/8-16 Threaded Hole and 53,1 [2.09] Max. Coupling Length
02 ..... 1–5/8 inch Dia. Tapered with Straight Key and 1–1/4 - 18 UNEF Slotted Hex. Nut
03 ..... 1–1/4 inch Dia. Splined 14T with 38,1 [1.50] Min. Full Spline Length and 53,1 [2.09] Max. Coupling Length
13 ..... 1–1/2 inch Dia. Splined 17T with 31,2 [1.23] Min. Full Spline Length
14 ..... 40 mm Dia. Straight with Straight Key, M12 x 1,75 - 6H Threaded Hole

Position 9 **Port Type**

B ..... 1–1/16 - 12 O-ring with 7/16-20 O-ring Case Drain and Check Valve
C ..... G 3/4 (BSP) O-ring with G 1/4 (BSP) O-ring Case Drain and Check Valve
D ..... 3/4 inch 4 Bolt Split Flange with 7/16-20 O-ring Case Drain and Check Valve
A ..... 7/8-14 O-ring with 9/16-18 O-ring Case Drain with Hot Oil Shuttle Valve
H ..... M22 x 1,5-6H (ISO) O-ring with M12 x 1,5-6H O-ring Case Drain with Hot Oil Shuttle Valve

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

00 ..... None
01 ..... Viton Shaft Seal
07 ..... Viton Seals
13 ..... Seal Guard
17 ..... Speed Sensor (Std.)

Position 12 **Paint/Special Packaging**

0 ..... No Paint
A ..... Painted Low Gloss Black
C ..... Corrosion Protected

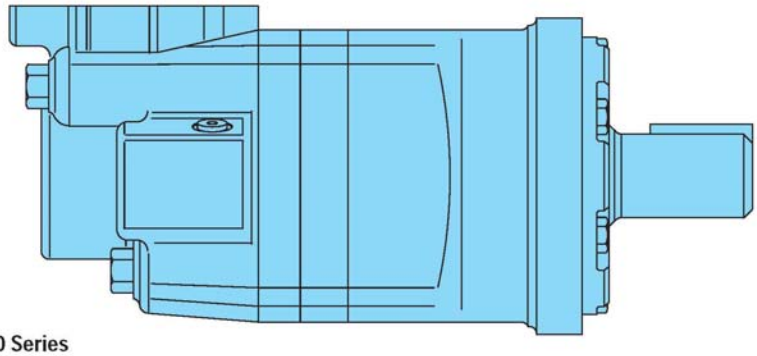
Position 13 **Eaton Assigned Code when Applicable**

0 ..... Assigned Code

Position 14 **Eaton Assigned Design Code**

0 ..... Assigned Design Code

Specifications
6000 Series



Specification Data—6000 Series

Displ. cm³/r [in³/r]			195 [11.9]	245 [15.0]	310 [19.0]	390 [23.9]	490 [30.0]	625 [38.0]	985 [60.0]
Max. Speed (RPM) @ ..... Flow		Continuous	775	615	485	387	307	241	153
		Intermittent	866	834	698	570	454	355	230
Flow LPM [GPM]		Continuous	150 [40]	150 [40]	150 [40]	150 [40]	150 [40]	150 [40]	150 [40]
		Intermittent	170 [45]	210 [55]	225 [60]	225 [60]	225[60]	225 [60]	225 [60]
Torque Nm [lb-in]	☆ 1-3/4 Inch Dia. Tapered Shaft	Continuous	575 [5100]	735 [6510]	930 [8230]	1155 [10230]	1445 [12800]	1480 [13100]	1685 [14920]
		Intermittent	860 [7620]	1100 [9740]	1355 [11990]	1635 [14490]	1885 [16670]	1898 [16800]	1875 [16580]
Pressure Δ Bar [Δ PSI]	☆ 1-3/4 Inch Dia. Tapered Shaft	Continuous	205 [3000]	205 [3000]	205 [3000]	205 [3000]	205 [3000]	170 [2500]	140 [2000]
		Intermittent	310 [4500]	310 [4500]	310 [4500]	310 [4500]	275 [4000]	221 [3200]	140 [2000]
		Peak	310 [4500]	310 [4500]	310 [4500]	310 [4500]	310 [4500]	240 [3500]	170 [2250]
Maximum Case Pressure - without Case Drain * — 70 Bar [1000 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 52-53.

☆ **Maximum torque for 1-1/2 inch shaft** — 1325 Nm [11750 lb-in] Continuous and 1650 Nm [14600 lb-in] intermittent.

* For back pressure over 70 Bar [1000 PSI] use an external case drain. Install case drain lines so that the motor case remains filled at all times.

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

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

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

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

Intermittent Operation — 10% of every minute.

Peak Operation — 1% of every minute.

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

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

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

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

Performance Data 6000 Series

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

Flow LPM [GPM]	[250] 15	[500] 35	[1000] 70	[1500] 105	[2000] 140	[2500] 170	[3000] 205	[3500] 240	[4000] 275	[4500] 310
[.5] 1,9	[280] 30 **9**	[650] 75 **7**	[1450] 165 **5**	[2290] 260 **2**						
[2] 7,5	[290] 35 **38**	[680] 75 **37**	[1500] 170 **35**	[2340] 265 **34**	[3100] 350 **30**	[3880] 440 **26**	[4140] 470 **18**			
[4] 15	[300] 35 **77**	[710] 80 **76**	[1500] 175 **74**	[2390] 270 **72**	[3210] 365 **66**	[4030] 455 **62**	[4600] 520 **46**	[5200] 590 **32**	[5790] 655 **18**	
[8] 30	[310] 35 **154**	[740] 85 **153**	[1590] 180 **148**	[2450] 275 **144**	[3280] 370 **131**	[4120] 465 **119**	[4810] 545 **116**	[5530] 625 **99**	[6250] 705 **83**	[6900] 780 **65**
[12] 45	[320] 35 **232**	[750] 85 **230**	[1610] 180 **225**	[2480] 280 **221**	[3330] 375 **212**	[4190] 475 **203**	[4990] 565 **186**	[5810] 655 **167**	[6630] 750 **148**	[7320] 825 **118**
[16] 61	[300] 35 **309**	[730] 80 **307**	[1600] 180 **303**	[2470] 280 **300**	[3340] 375 **291**	[4210] 475 **283**	[5090] 575 **258**	[5900] 665 **236**	[6710] 760 **214**	[7470] 845 **191**
[20] 76	[270] 30 **387**	[720] 80 **384**	[1590] 180 **379**	[2460] 280 **374**	[3350] 380 **365**	[4240] 480 **356**	[5100] 575 **332**	[5950] 670 **306**	[6800] 770 **280**	[7620] 860 **247**
[24] 91	[240] 25 **465**	[700] 80 **462**	[1570] 175 **456**	[2440] 275 **450**	[3330] 375 **440**	[4220] 475 **429**	[5080] 575 **413**	[5940] 670 **388**	[6810] 770 **363**	
[28] 106	[190] 20 **542**	[660] 75 **539**	[1530] 175 **532**	[2400] 270 **526**	[3300] 375 **514**	[4200] 475 **502**	[5060] 570 **476**	[5940] 670 **449**	[6810] 770 **421**	
[32] 121	[160] 20 **620**	[630] 70 **617**	[1500] 170 **609**	[2370] 270 **602**	[3270] 370 **589**	[4160] 470 **576**	[5040] 570 **542**	[5920] 670 **511**	[6790] 765 **480**	
[36] 136	[120] 15 **697**	[620] 70 **692**	[1480] 165 **683**	[2350] 265 **674**	[3240] 365 **659**	[4130] 465 **645**	[5000] 565 **601**	[5880] 665 **564**	[6760] 765 **527**	
[40] 151	[80] 10 **775**	[610] 70 **770**	[1450] 165 **759**	[2320] 260 **749**	[3210] 365 **733**	[4100] 465 **718**	[4960] 560 **666**	[5840] 660 **624**		
[45] 170		[590] 65 **866**	[1410] 160 **854**	[2280] 260 **843**	[3170] 360 **825**	[4060] 460 **808**	[4920] 555 **749**	[5790] 655 **702**		

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.

[5790] 655 **702** } Torque [lb-in] Nm **Speed RPM**

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

245 cm³/r [15.0 in³/r]
Δ Pressure Bar [PSI]

Flow LPM [GPM]	[250] 15	[500] 35	[1000] 70	[1500] 105	[2000] 140	[2500] 170	[3000] 205	[3500] 240	[4000] 275	[4500] 310
[.5] 1,9	[430] 50 **7**	[860] 95 **4**	[1890] 215 **1**							
[2] 7,5	[440] 50 **30**	[900] 100 **29**	[1940] 220 **26**	[2990] 340 **24**	[3960] 445 **21**	[4920] 555 **17**	[5040] 570 **11**	[5930] 670 **6**		
[4] 15	[460] 50 **61**	[940] 105 **60**	[2000] 225 **56**	[3060] 345 **54**	[4080] 460 **48**	[5090] 575 **42**	[5680] 640 **39**	[6630] 750 **30**	[7570] 855 **12**	[8520] 965 **6**
[8] 30	[470] 55 **122**	[960] 110 **120**	[2060] 235 **116**	[3150] 355 **113**	[4210] 475 **104**	[5260] 595 **95**	[6180] 700 **81**	[7100] 800 **67**	[8020] 905 **53**	[9020] 1020 **37**
[12] 45	[480] 55 **183**	[970] 110 **182**	[2080] 235 **178**	[3180] 360 **174**	[4270] 480 **165**	[5360] 605 **157**	[6390] 720 **141**	[7420] 840 **125**	[8450] 955 **109**	[9510] 1075 **92**
[16] 61	[450] 50 **245**	[960] 110 **244**	[2070] 235 **240**	[3180] 360 **236**	[4290] 485 **228**	[5420] 610 **221**	[6480] 730 **202**	[7490] 845 **184**	[8480] 960 **165**	[9540] 1180 **145**
[20] 76	[420] 45 **307**	[940] 105 **306**	[2050] 230 **301**	[3160] 355 **297**	[4290] 485 **287**	[5440] 615 **277**	[6510] 735 **257**	[7580] 855 **238**	[8660] 980 **218**	[9740] 1100 **197**
[24] 91	[380] 45 **368**	[920] 105 **365**	[2020] 230 **361**	[3120] 355 **358**	[4260] 480 **348**	[5400] 610 **338**	[6490] 735 **316**	[7590] 860 **294**	[8680] 980 **271**	
[28] 106	[330] 35 **430**	[870] 100 **426**	[1980] 225 **421**	[3100] 350 **416**	[4240] 480 **404**	[5380] 610 **376**	[6480] 730 **358**	[7580] 855 **340**	[8670] 980 **322**	
[32] 121	[290] 35 **491**	[800] 90 **489**	[1920] 215 **481**	[3050] 345 **475**	[4170] 470 **461**	[5290] 600 **448**	[6410] 725 **423**	[7520] 850 **398**	[8640] 975 **373**	
[36] 136	[250] 30 **556**	[730] 80 **549**	[1850] 210 **543**	[2980] 335 **537**	[4060] 460 **524**	[5150] 580 **509**	[6300] 710 **482**	[7440] 840 **456**		
[40] 151	[200] 25 **615**	690] 80 **612**	[1790] 200 **606**	[2940] 330 **599**	[4010] 455 **585**	[5130] 580 **570**	[6190] 700 **540**	[7100] 800 **510**		
[45] 170		[570] 65 **688**	[1760] 200 **682**	[2860] 325 **674**	[3960] 445 **658**	[5070] 575 **641**	[6080] 685 **608**	[6690] 755 **574**		
[50] 189			[1720] 195 **758**	[2800] 315 **749**	[3890] 440 **731**	[4920] 555 **712**	[5940] 670 **676**			
[55] 208			[1670] 190 **834**	[2740] 310 **824**	[3820] 430 **804**	[4890] 550 **783**	[5880] 665 **744**			

Continuous
Intermittent

310 cm³/r [19.0 in³/r]
Δ Pressure Bar [PSI]

Flow LPM [GPM]	[250] 15	[500] 35	[1000] 70	[1500] 105	[2000] 140	[2500] 170	[3000] 205	[3500] 240	[4000] 275	[4500] 310
[.5] 1,9	[530] 60 **6**	[1120] 125 **4**	[2440] 275 **1**							
[2] 7,5	[540] 60 **24**	[1150] 130 **23**	[2460] 280 **22**	[3620] 410 **20**	[4780] 540 **17**	[5690] 645 **14**	[6670] 755 **10**	[7780] 880 **4**		
[4] 15	[550] 60 **48**	[1180] 135 **47**	[2560] 290 **45**	[3800] 430 **42**	[5030] 570 **38**	[6050] 685 **32**	[7070] 800 **24**	[8260] 935 **17**	[9070] 1025 **10**	[9530] 1075 **3**
[8] 30	[560] 65 **96**	[1250] 140 **95**	[2650] 300 **91**	[3970] 450 **87**	[5280] 595 **81**	[6480] 730 **73**	[7710] 870 **64**	[8740] 985 **55**	[9770] 1105 **46**	[10990] 1240 **35**
[12] 45	[570] 65 **144**	[1260] 140 **143**	[2690] 305 **140**	[4050] 460 **135**	[5420] 610 **129**	[6730] 760 **121**	[8040] 910 **111**	[9260] 1045 **99**	[10490] 1185 **88**	[11800] 1335 **76**
[16] 61	[540] 60 **193**	[1230] 140 **192**	[2660] 300 **188**	[4060] 460 **184**	[5450] 615 **178**	[6800] 770 **167**	[8150] 920 **156**	[9400] 1060 **141**	[10660] 1205 **126**	[11990] 1355 **109**
[20] 76	[510] 60 **242**	[1200] 135 **241**	[2630] 295 **236**	[4040] 456 **232**	[5450] 615 **226**	[6820] 770 **216**	[8190] 925 **201**	[9520] 1075 **184**	[10840] 1225 **167**	
[24] 91	[480] 55 **290**	[1160] 130 **289**	[260] 295 **282**	[4020] 455 **279**	[5440] 615 **273**	[6840] 775 **260**	[8230] 930 **248**	[9560] 1080 **232**	[10900] 1230 **215**	
[28] 106	[420] 45 **339**	[1130] 130 **336**	[2570] 290 **333**	[3990] 450 **328**	[5420] 610 **320**	[6820] 770 **308**	[8220] 930 **295**	[9520] 1075 **276**	[10840] 1225 **257**	
[32] 121	[360] 40 **388**	[1100] 125 **384**	[2510] 285 **381**	[3920] 445 **375**	[5330] 600 **368**	[6750] 765 **354**	[8170] 920 **341**	[9440] 1065 **320**		
[36] 136	[300] 35 **436**	[1060] 120 **430**	[2440] 275 **421**	[3830] 435 **416**	[5220] 590 **410**	[6660] 750 **396**	[8100] 915 **383**	[9330] 1055 **360**		
[40] 151	[270] 30 **485**	[1020] 115 **478**	[2400] 270 **466**	[3780] 425 **461**	[5150] 580 **456**	[6580] 745 **441**	[8020] 905 **427**	[9220] 1040 **403**		
[50] 189		[982] 110 **597**	[2180] 245 **582**	[3420] 385 **576**	[4660] 525 **570**	[6050] 685 **551**	[7440] 840 **534**			
[60] 227			[1960] 220 **698**	[3250] 365 **691**	[4540] 515 **684**	[5750] 650 **661**	[7080] 800 **641**			

390 cm³/r [23.9 in³/r]
Δ Pressure Bar [PSI]

Flow LPM [GPM]	[250] 15	[500] 35	[1000] 70	[1500] 105	[2000] 140	[2500] 170	[3000] 205	[3500] 240	[4000] 275	[4500] 310
[1] 3,8	[760] 85 **4**	[1570] 175 **2**	[3230] 365 **1**							
[2] 7,5	[780] 90 **19**	[1610] 180 **18**	[3270] 370 **17**	[4910] 555 **16**	[6440] 730 **14**	[7760] 875 **12**	[9080] 1025 **9**	[10590] 1195 **4**		
[4] 15	[800] 90 **38**	[1640] 185 **38**	[3300] 375 **37**	[4970] 560 **35**	[6570] 740 **33**	[8160] 920 **29**	[9570] 1080 **22**	[11270] 1275 **14**	[12120] 1370 **5**	[14490] 1635 **1**
[8] 30	[810] 90 **77**	[1650] 185 **76**	[3370] 380 **74**	[5080] 575 **72**	[6740] 760 **68**	[8430] 950 **65**	[10050] 1135 **55**	[11620] 1315 **45**	[12880] 1455 **33**	[14480] 1635 **21**
[12] 45	[800] 90 **115**	[1620] 185 **115**	[3390] 385 **112**	[5130] 580 **109**	[6810] 770 **105**	[8520] 965 **100**	[10190] 1150 **91**	[11860] 1340 **81**	[13640] 1540 **79**	
[16] 61	[750] 85 **154**	[1600] 180 **154**	[3380] 380 **151**	[5120] 580 **147**	[6820] 770 **143**	[8560] 970 **132**	[10230] 1155 **126**	[11920] 1345 **116**		
[20] 76	[680] 75 **193**	[1580] 180 **193**	[3360] 380 **189**	[5120] 580 **187**	[6840] 775 **182**	[8590] 970 **175**	[10280] 1160 **162**	[11980] 1355 **152**		
[24] 91	[620] 70 **232**	[1520] 170 **230**	[3280] 370 **229**	[5060] 570 **225**	[6780] 765 **220**	[8530] 965 **212**	[10240] 1155 **204**			
[28] 106	[570] 65 **270**	[1460] 165 **268**	[3210] 365 **266**	[5000] 565 **261**	[6730] 760 **256**	[8480] 960 **248**	[10200] 1150 **236**			
[32] 121	[530] 60 **309**	[1420] 160 **306**	[3140] 355 **304**	[4930] 555 **299**	[6640] 750 **292**	[8380] 945 **282**	[10120] 1145 **269**			
[36] 136	[450] 50 **348**	[1370] 155 **346**	[3010] 340 **340**	[4840] 545 **336**	[6500] 730 **329**	[8250] 930 **317**	[10000] 1130 **301**			
[40] 151	[380] 45 **387**	[1320] 150 **386**	[2880] 325 **380**	[4740] 535 **375**	[6460] 730 **368**	[8120] 915 **359**				
[50] 189		[1140] 130 **482**	[2650] 300 **475**	[4540] 515 **469**	[6440] 730 **460**	[8050] 910 **449**				
[60] 227			[2460] 280 **570**	[4430] 500 **562**	[6360] 720 **552**	[7860] 890 **538**				

Performance Data 6000 Series

490 cm³/r [30.0 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	[1010] 115 7	[1200] 235 7	[4260] 480 5	[6140] 695 3					
[2] 7,5	[1020] 115 15	[2110] 240 14	[4270] 480 13	[6280] 710 12	[8350] 945 11	[10420] 1175 8	[12140] 1370 3		
[4] 15	[1030] 115 30	[2100] 235 30	[4280] 485 29	[6410] 725 28	[8500] 960 27	[10590] 1195 25	[12500] 1410 21	[14580] 1645 17	[16670] 1885 12
[8] 30	[1020] 115 60	[2090] 235 60	[4290] 485 59	[6490] 735 57	[8620] 975 54	[10740] 1215 51	[12800] 1445 45	[14930] 1685 38	
[12] 45	[1000] 115 91	[2080] 235 91	[4290] 485 89	[6500] 735 87	[8650] 975 84	[10800] 1220 79	[12890] 1455 71		
[16] 61	[110] 960 122	[2060] 235 122	[4260] 480 121	[6480] 730 118	[8650] 975 114	[10820] 1220 109	[12900] 1460 100		
[20] 76	[900] 100 153	[1980] 225 152	[4180] 470 150	[6420] 725 147	[8620] 975 144	[10820] 1220 139			
[24] 91	[850] 95 184	[1930] 220 184	[4150] 470 181	[6390] 720 180	[8580] 970 176	[10770] 1215 171			
[28] 106	[740] 85 215	[1840] 210 214	[4070] 460 211	[6290] 710 208	[8500] 960 204	[10720] 1210 198			
[32] 121	[690] 80 245	[1710] 195 244	[3970] 450 241	[6190] 700 237	[8420] 950 232	[10660] 1205 226			
[36] 136	[670] 75 276	[1560] 175 275	[3860] 435 272	[6080] 685 265	[8340] 940 260	[10420] 1175 255			
[40] 151	[570] 65 307	[1400] 160 306	[3750] 425 303	[5970] 675 295	[8140] 920 290	[10180] 1150 284			
[50] 189		[1140] 130 382	[3240] 365 379	[5220] 590 369	[7620] 860 362				
[60] 227			[2860] 325 454	[4860] 550 442	[7140] 805 435				

625 cm³/r [38.0 in³/r]
Δ Pressure Bar [PSI]

Flow LPM [GPM]	[250] 15	[500] 35	[1000] 70	[1500] 105	[2000] 140	[2500] 170	[3000] 205	[3200] 221
[1] 3,8	[1060] 120 5	[2205] 250 5	[4515] 510 4	[6690] 755 2				
[2] 7,5	[1090] 125 12	[2300] 260 12	[4720] 535 13	[7025] 795 10	[9360] 1060 6			
[4] 15	[1145] 130 24	[2450] 275 24	[5052] 570 24	[7520] 850 21	[9410] 1065 16	[12700] 1434 13		
[8] 30	[1195] 135 45	[2600] 295 45	[5350] 605 44	[8195] 925 42	[11220] 1270 37	[13100] 1480 35	[15800] 1785 32	[16800] 1898 30
[12] 45	[1200] 135 72	[2600] 295 72	[5390] 610 71	[8145] 920 68	[11770] 1330 64	[13000] 1469 60	[15700] 1774 56	
[16] 61	[1120] 125 94	[2530] 285 94	[5340] 605 92	[8105] 915 89	[11740] 1325 85	[13000] 1469 83		
[20] 76	[1050] 120 120	[2465] 280 119	[5285] 595 117	[8080] 915 115	[11725] 1325 110			
[24] 91	[950] 105 144	[2365] 265 143	[5180] 585 140	[7990] 905 138	[11705] 1320 132			
[28] 106	[855] 95 169	[2255] 255 168	[5080] 575 165	[7915] 895 162	[11640] 1315 156			
[32] 121	[730] 80 193	[2140] 240 192	[4960] 560 188	[7775] 880 185	[11505] 1300 179			
[36] 136	[555] 65 217	[1965] 220 216	[4780] 540 213	[7585] 855 210				
[40] 151	[380] 45 241	[1790] 200 240	[4600] 520 238	[7395] 835 236				
[50] 189			[4180] 470 296	[6985] 790 290				
[60] 227			[3800] 430 353	[6600] 745 345				

[3800] 430 353 } Torque [lb-in] Nm Speed RPM

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.

Continuous
Intermittent

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

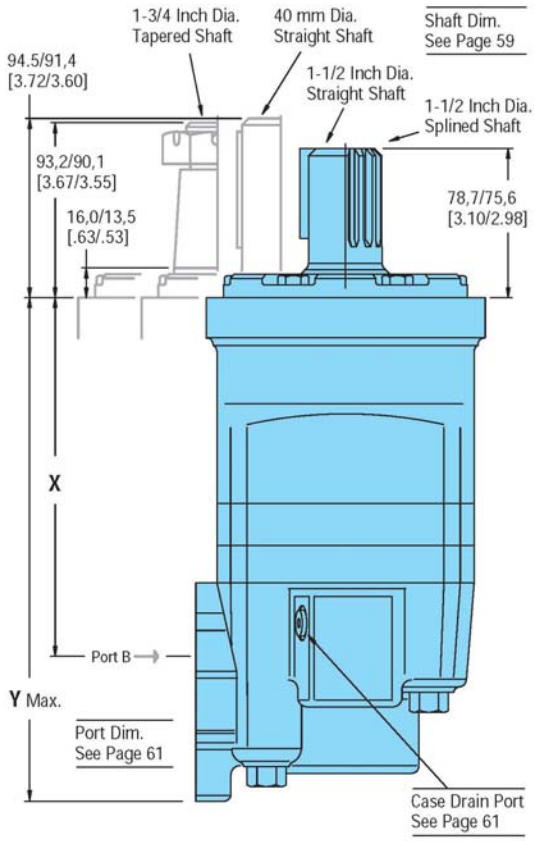
805 cm³/r [49.0 in³/r]
Δ Pressure Bar [PSI]

Flow LPM [GPM]	[250] 15	[500] 35	[750] 50	[1000] 70	[1250] 85	[1500] 105	[1750] 120	[2000] 140	[2250] 155	[2500] 170
[1] 3,8	[1455] 164 4	[3100] 350 4	[4680] 529 2	[6031] 681 2	[7799] 881 1					
[2] 7,5	[1483] 168 9	[3173] 359 9	[5121] 579 9	[6432] 727 8	[8510] 961 7	[9633] 1088 6	[11319] 1279 5	[12127] 1370 5		
[4] 15	[1547] 175 19	[3331] 376 19	[5292] 598 18	[6744] 762 17	[8714] 984 16	[10075] 1138 15	[11352] 1283 14	[12539] 1417 12	[14564] 1645 11	[16377] 1850 10
[8] 30	[1599] 181 35	[3473] 392 35	[5415] 612 34	[7039] 795 33	[8934] 1009 32	[10629] 1201 31	[11842] 1338 29	[14004] 1582 29	[15441] 1745 28	
[12] 45	[1599] 181 56	[3469] 392 56	[5415] 612 55	[7093] 801 53	[9024] 1020 53	[10658] 1204 52	[12283] 1388 50	[13726] 1551 50		
[16] 61	[1543] 174 73	[3395] 384 73	[5357] 605 72	[7032] 794 70	[8983] 1015 69	[10640] 1202 68	[12010] 1357 67			
[20] 76	[1457] 165 93	[3312] 374 92	[5292] 598 91	[6968] 787 89	[8943] 1010 88	[10583] 1196 87	[12146] 1372 86			
[24] 91	[1352] 153 112	[3183] 360 112	[5088] 575 111	[6811] 769 110	[8812] 996 108	[10411] 1176 106				
[28] 106	[1213] 137 131	[3055] 345 131	[5047] 570 131	[6713] 758 129	[8681] 981 128	[10411] 1176 127				
[32] 121	[1075] 121 150	[2907] 328 149	[4884] 552 149	[6546] 740 146	[8395] 949 145	[10060] 1137 144				
[36] 136	[823] 93 168	[2692] 304 168	[4663] 527 168	[6320] 714 167	[8118] 917 165					
[40] 151	[592] 67 187	[2477] 280 186	[4426] 500 186	[6085] 688 185	[7832] 885 184					
[50] 189		[2730] 308 234	[4214] 476 233	[5849] 661 231	[7603] 859 230					
[60] 227			[3806] 430 280	[5459] 617 277	[7407] 837 275					

985 cm³/r [60.0 in³/r]
Δ Pressure Bar [PSI]

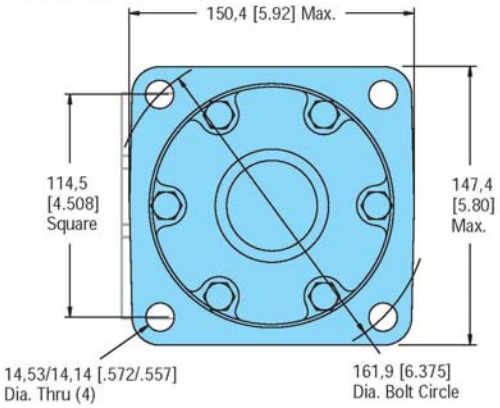
Flow LPM [GPM]	[250] 15	[500] 35	[750] 50	[1000] 70	[1250] 85	[1500] 105	[1750] 120	[2000] 140
[1] 3,8	[1890] 215 3	[4110] 465 3	[5730] 645 2	[7640] 865 2	[9550] 1080 1			
[2] 7,5	[1910] 215 8	[4140] 470 8	[6270] 710 7	[8300] 940 7	[10420] 1175 6	[12500] 1410 5	[13860] 1565 4	[14920] 1685 3
[4] 15	[1980] 225 15	[4290] 485 15	[6480] 775 15	[8540] 965 14	[10670] 1205 14	[12800] 1445 13	[13900] 1570 13	[15850] 1790 12
[8] 30	[2030] 230 30	[4400] 495 30	[6630] 750 30	[8790] 995 29	[10940] 1235 28	[13090] 1480 27	[14500] 1640 26	[16580] 1875 25
[12] 45	[2020] 230 45	[4390] 495 45	[6630] 750 45	[8860] 1000 44	[11050] 1250 43	[13240] 1495 42	[15040] 1700 41	
[16] 61	[2010] 225 61	[4320] 490 61	[6560] 740 61	[8790] 995 60	[11000] 1245 59	[13260] 1500 58		
[20] 76	[1910] 215 77	[4220] 475 77	[6480] 730 76	[8720] 985 76	[10950] 1235 75	[13160] 1485 74		
[24] 91	[1810] 205 92	[4060] 460 92	[6230] 705 92	[8500] 960 91	[10790] 1220 90	[12990] 1470 89		
[28] 106	[1620] 185 107	[3920] 445 107	[6180] 700 107	[8420] 950 106	[10630] 1200 105	[12820] 1450 103		
[32] 121	[1480] 165 123	[3740] 425 123	[5980] 675 122	[8200] 925 121	[10280] 1160 120			
[36] 136	[1140] 130 138	[3490] 395 138	[5710] 645 138	[7930] 895 137	[9940] 1125 135			
[40] 151	[850] 95 153	[3240] 365 153	[5420] 610 152	[7640] 865 151	[9590] 1085 150			
[50] 189		[2960] 325 191	[5160] 585 190	[7350] 830 189	[9310] 1050 188			
[60] 227			[4660] 525 230	[7160] 810 229	[9070] 1025 226			

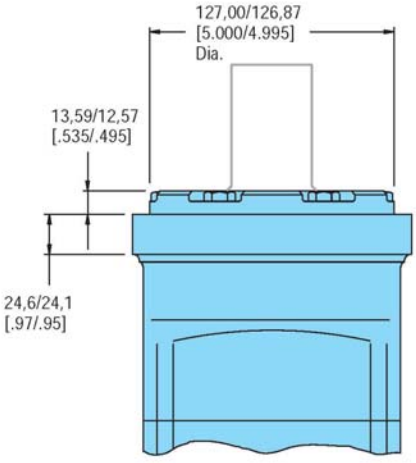
Dimensions — 6000 Series Standard Motor



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

Standard SAE CC Flange

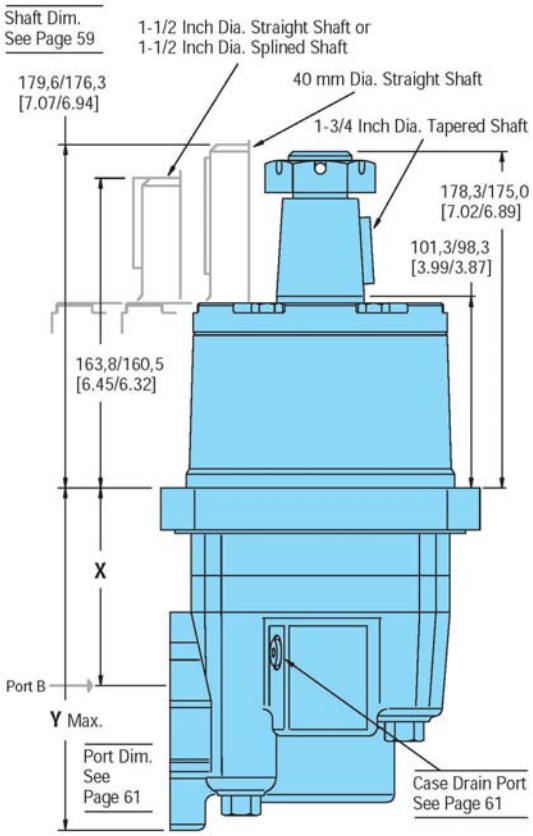




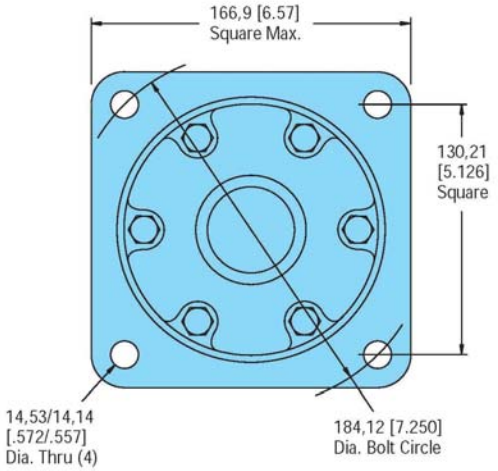
6000 Series Standard Motor with 1-5/16-12 O-ring Ports, G 1 (BSP) Ports, and 3/4 inch Split Flange Ports

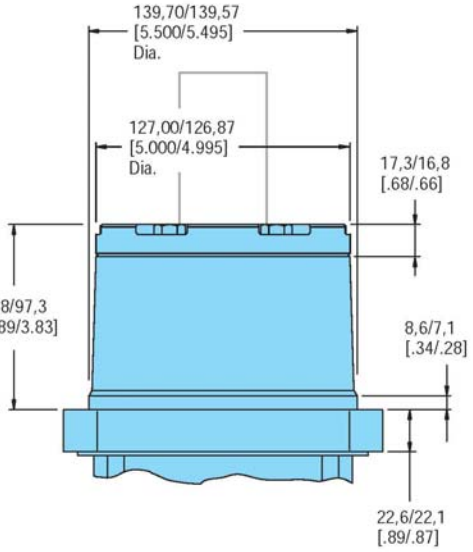
Displ. cm^3/r [in^3/r]	195 [11.9]	245 [15.0]	310 [19.0]	390 [23.9]	490 [30.0]	625 [38.0]	985 [60.0]
X Dim. mm [inch]	187,7 [7.39]	193,3 [7.61]	200,7 [7.90]	209,3 [8.24]	220,5 [8.68]	235,2 [9.26]	274,8 [10.82]
Y Dim. mm [inch]	270,1 [10.63]	275,6 [10.85]	283,0 [11.14]	291,6 [11.48]	302,8 [11.92]	318,5 [12.54]	357,4 [14.07]

Dimensions — 6000 Series Wheel Motor



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

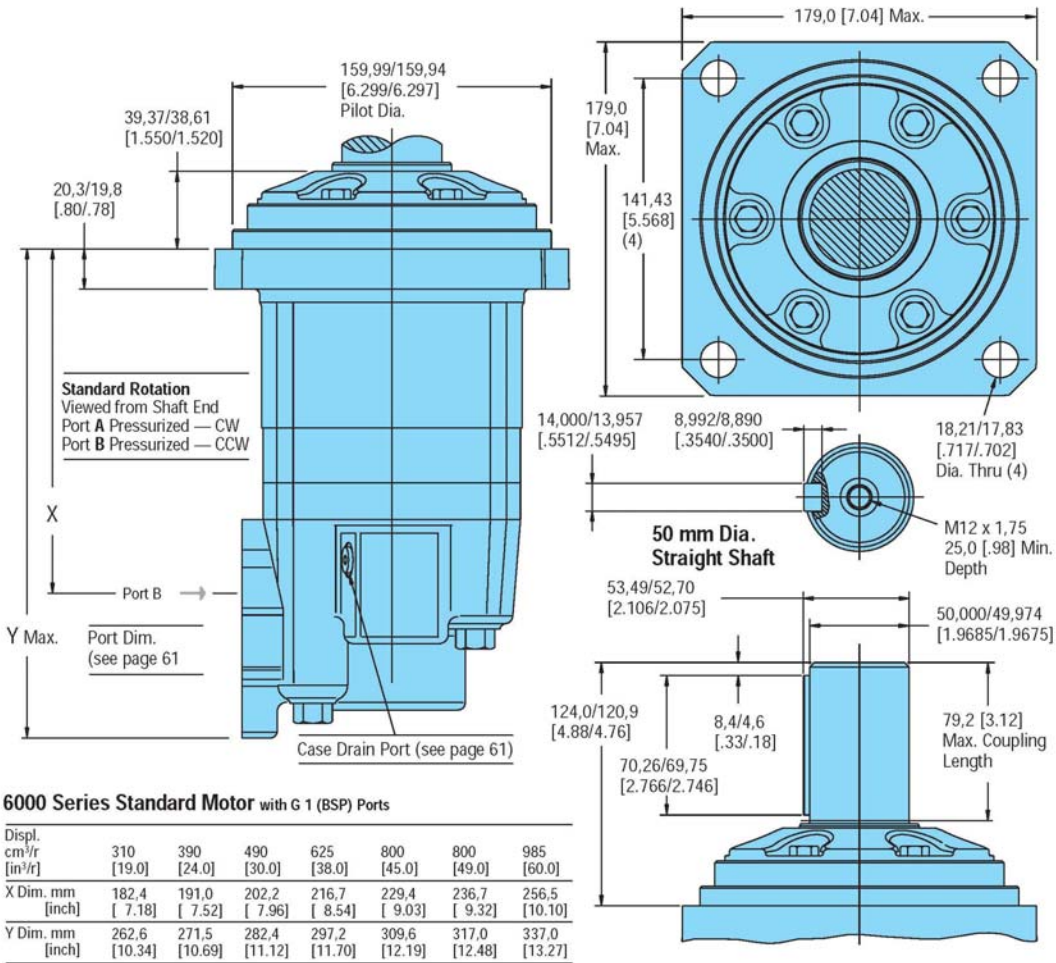




6000 Series Wheel Motor with 1-5/16-12 O-ring Ports, G 1 (BSP) Ports, and 3/4 inch Split Flange Ports

Displ. cm^3/r [in^3/r]	195 [11.9]	245 [15.0]	310 [19.0]	390 [23.9]	490 [30.0]	625 [38.0]	985 [60.0]
X Dim. mm [inch]	102,9 [4.05]	108,4 [4.27]	115,8 [4.56]	124,7 [4.91]	135,6 [5.34]	149,9 [5.90]	190,0 [7.48]
Y Dim. mm [inch]	185,2 [7.29]	190,8 [7.51]	198,2 [7.80]	207,1 [8.15]	218,0 [8.58]	233,0 [9.17]	272,6 [10.73]

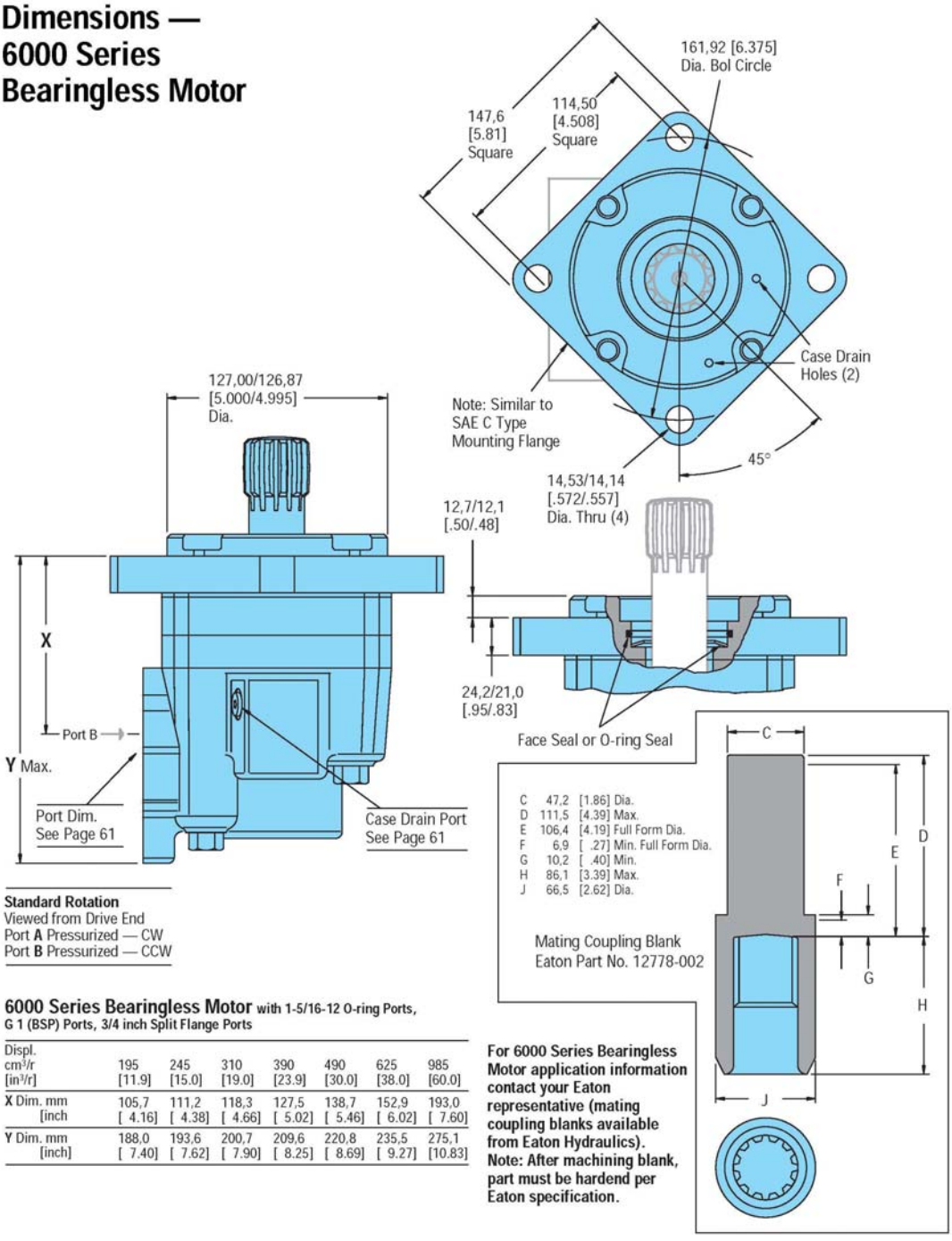
Dimensions — 6000 Series
Global Mount
(Similar to ISO 3019/2)



6000 Series Standard Motor with G 1 (BSP) Ports

Displ. cm^3/r [in^3/r]	310 [19.0]	390 [24.0]	490 [30.0]	625 [38.0]	800 [45.0]	800 [49.0]	985 [60.0]
X Dim. mm [inch]	182,4 [7.18]	191,0 [7.52]	202,2 [7.96]	216,7 [8.54]	229,4 [9.03]	236,7 [9.32]	256,5 [10.10]
Y Dim. mm [inch]	262,6 [10.34]	271,5 [10.69]	282,4 [11.12]	297,2 [11.70]	309,6 [12.19]	317,0 [12.48]	337,0 [13.27]

Dimensions — 6000 Series Bearingless Motor



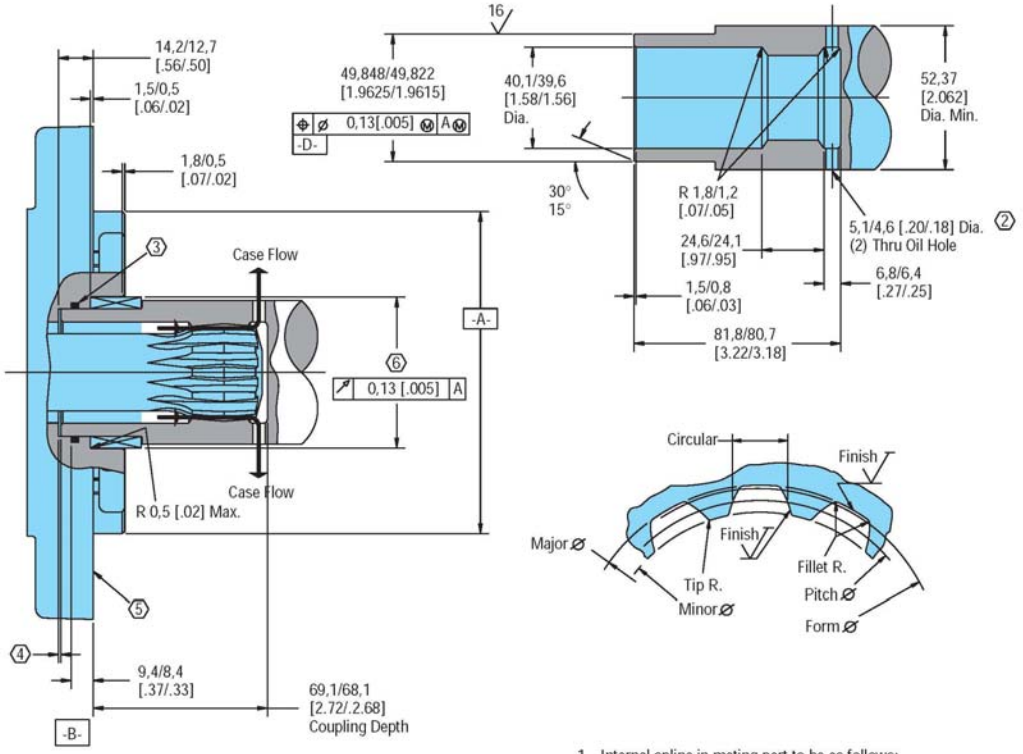
Standard Rotation
Viewed from Drive End
Port **A** Pressurized — CW
Port **B** Pressurized — CCW

6000 Series Bearingless Motor with 1-5/16-12 O-ring Ports, G 1 (BSP) Ports, 3/4 inch Split Flange Ports

Displ. cm³/r [in³/r]	195 [11.9]	245 [15.0]	310 [19.0]	390 [23.9]	490 [30.0]	625 [38.0]	985 [60.0]
X Dim. mm [inch	105,7 [4.16]	111,2 [4.38]	118,3 [4.66]	127,5 [5.02]	138,7 [5.46]	152,9 [6.02]	193,0 [7.60]
Y Dim. mm [inch]	188,0 [7.40]	193,6 [7.62]	200,7 [7.90]	209,6 [8.25]	220,8 [8.69]	235,5 [9.27]	275,1 [10.83]

For 6000 Series Bearingless Motor application information contact your Eaton representative (mating coupling blanks available from Eaton Hydraulics). Note: After machining blank, part must be hardend per Eaton specification.

Bearingless Installation — 6000 Series



Spline Pitch — 8.5/17
Pressure Angle — 30°
Number of teeth — 12
Class of Fit — Ref. 5
Type of Fit — Side
Pitch Diameter — Ref. 35,858823 [1.4117647] ◎ 0,20 [.008] H
Base Diameter — Ref. 31,054652 [1.2226241]
Major Diameter — 39,17 [1.542] Max. 38,97 [1.534] Min.
Minor Diameter — 33,30 - 33,48 [1.311 - 1.318]
Form Diameter, Min. — 38,33 [1.509]
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 -0,025 [+.0000 -.0010]
Total Index Variation — 0,038 [.0015]
Lead Variation — 0,013 [.0005]
Circular Space Width:
- Maximum Actual — 5,898 [.2322]
- Minimum Effective — 5,804 [.2285]
- Maximum Effective — Ref. 5,857 [.2306]
- Minimum Actual — Ref. 5,834 [.2297]

Dimension Between Two Pins — Ref. 26,929 - 27,084 [1.0602 - 1.0663]
Pin Diameter — 6,223 [.2450] Pins to Have 4,0 [.160] Wide Flat for Root Clearance

1 Internal spline in mating part to be as follows: Material to be ASTM A304, 8620H. Carborize to a hardness of 60-64 HRc with case depth (to 50HRc) of 0,076 - 1,02 [.030 - .040] (dimensions apply after heat treat).

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

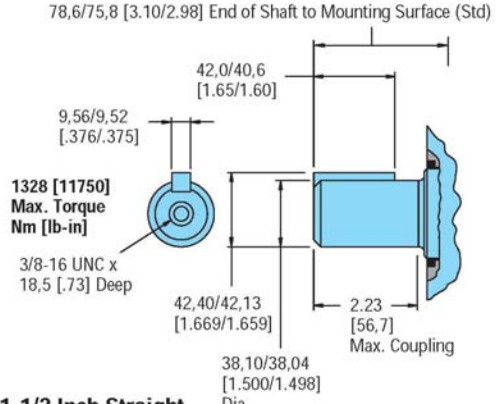
(3) Some means of maintaining clearance between shaft and mounting flange must be provided.

(4) Seal to be furnished with motor for proper oil circulation thru splines.

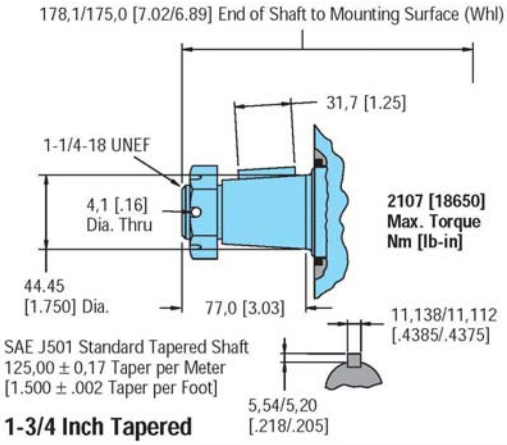
(5) Similar to SAE "C" Four Bolt Flange.

(6) Counterbore designed to adapt to a standard sleeve bearing 50,010 - 50,038 [1.9689 - 1.9700] ID by 60,051 - 60,079 [2.3642 - 2.3653] O.D. (Oilite bronze sleeve bearing).

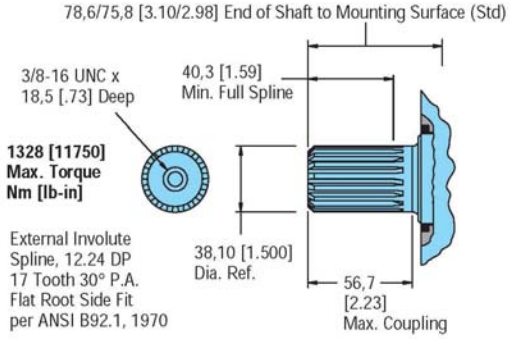
Dimensions — Shafts
6000 Series



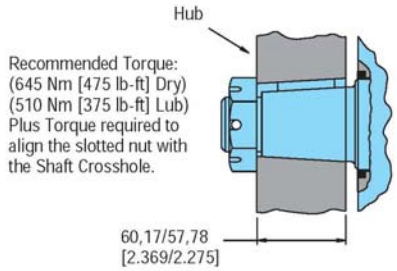
1-1/2 Inch Straight



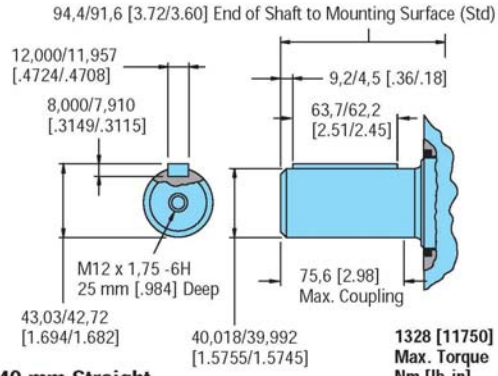
1-3/4 Inch Tapered



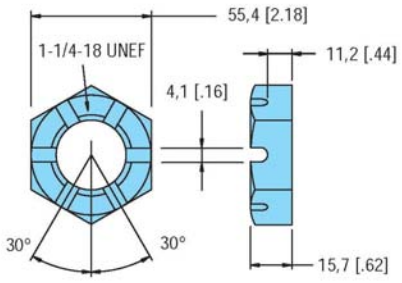
1-1/2 Inch 17 Tooth Splined



Tapered Shaft Hub Data



40 mm Straight



Slotted Hexagon Nut

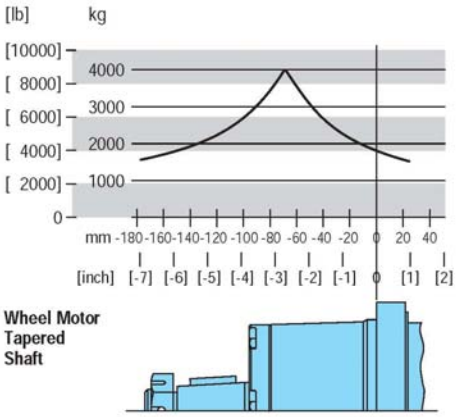
Shaft Side Load Capacity
6000 Series

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

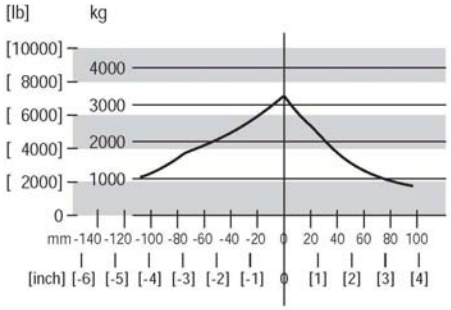
The curve is based on B 10 Bearing life (2000 hours or 12,000,000 shaft revolutions at 100 RPM) at rated output torque. To determine radial load at speeds other than 100 RPM, multiply the load values given on the bearing curve by the factors in the chart below.

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

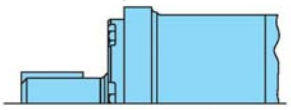
For 3,000,000 Shaft revolutions or 500 hours — Increase these shaft loads 52%.

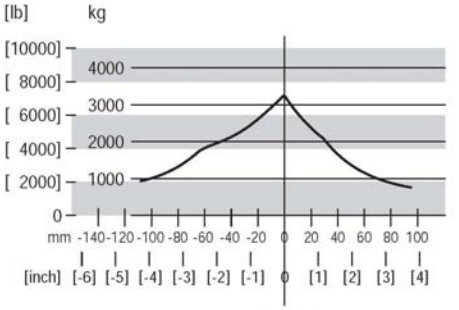


Wheel Motor Tapered Shaft

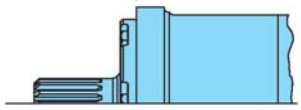


Standard Motor Straight Shaft



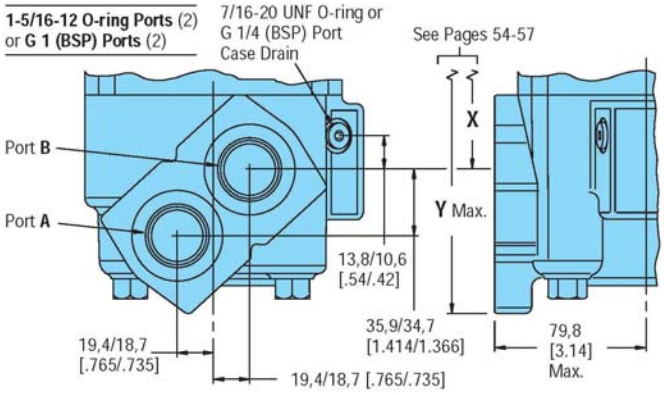


Standard Motor Splined Shaft

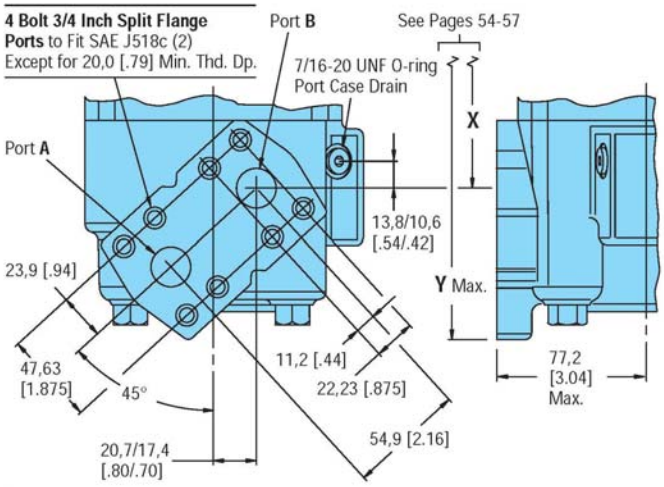


Dimensions — Ports 6000 Series

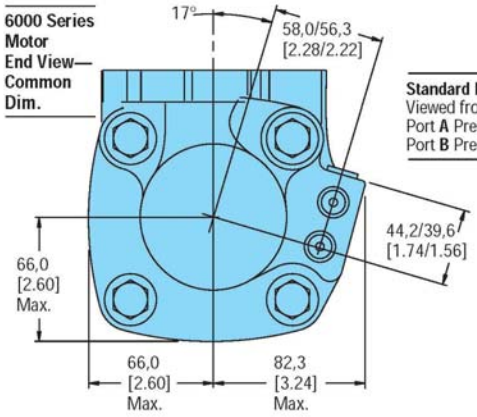
1-5/16-12 O-ring Ports (2) or **G 1 (BSP) Ports** (2)



4 Bolt 3/4 Inch Split Flange Ports to Fit SAE J518c (2) Except for 20,0 [.79] Min. Thd. Dp.



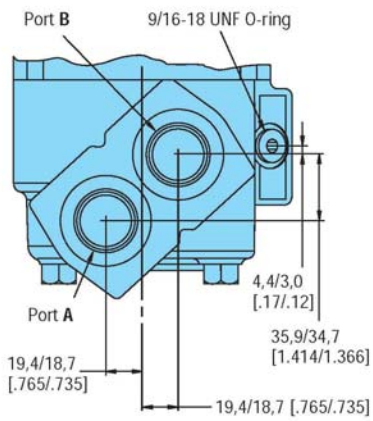
6000 Series Motor End View—Common Dim.

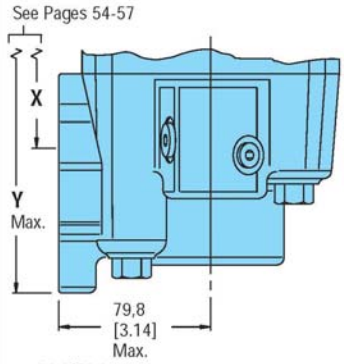


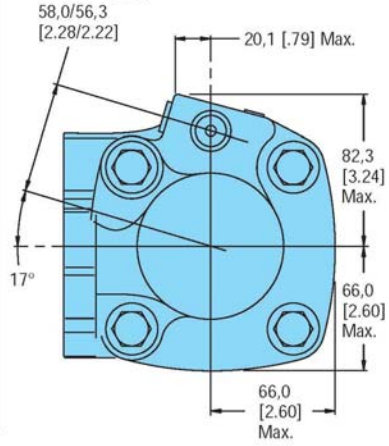
Standard Rotation — 6000 Series
Viewed from Shaft End
Port **A** Pressurized — CW
Port **B** Pressurized — CCW

6000 Series with Shuttle Valve

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







Product Numbers
6000 Series

Product Numbers—6000 Series Motors

Use digit prefix —**112**-, **113**-, or **114**- plus four digit number from charts for complete product number—Example **114**-1047.
Orders will not be accepted without three digit prefix.

			Displacement cm³/r [in³/r] and Product Number						
Mounting	Shaft	Ports	195 [11.9]	245 [15.0]	310 [19.0]	390 [23.9]	490 [30.0]	625 [38.0]	985 [60.0]
Standard	1-1/2 inch Straight	1-5/16 O-ring	**112**-1064	-1065	-1066	-1067	-1068	-1107	-1069
	40 mm Straight	G 1 (BSP)	**112**-1094	-1095	-1096	-1097	-1098	—	-1099
	1-1/2 Inch 17 T Splined	1-5/16 O-ring	**112**-1058	-1059	-1060	-1061	-1062	-1109	-1063
		G 1 (BSP)	**112**-1088	-1089	-1090	-1091	-1092	—	-1093
Wheel Motor	40 mm Straight	G 1 (BSP)	**113**-1082	-1083	-1084	-1085	-1086	-1100	-1087
	1-3/4 Inch Tapered	1-5/16 O-ring	**113**-1070	-1071	-1072	-1073	-1074	-1093	-1075
Bearingless		1-5/16 O-ring	**114**-1031	-1032	-1033	-1034	-1035	-1055	-1036
		G 1 (BSP)	**114**-1043	-1044	-1045	-1046	-1047	—	-1048

114-1047

Product Numbers – 6000 Series

Mounting Type - Standard (Code H), 4 Bolt:
- **160,0 [6.30] Pilot Dia.**
- **18,01 [.709] Dia. Mounting Holes**
- **200,0 [7.87] Dia. Bolt Circle**

Output Shaft - Straight (Code 21)
Ports - G1 (BSP) Staggered G 1/4 Case Drain (Code C)
Paint - Low Gloss Black (Code A)

Use digit prefix —**112-** plus four digit number from charts for complete product number—Example **112**-1215.
Orders will not be accepted without three digit prefix.

112-1215

			Displacement cm³/r [in³/r] and Product Number						
Mounting	Shaft	Ports	310 [19.0]	390 [23.9]	490 [30.0]	625 [38.0]	737 [45.0]	800 [49.0]	985 [60.0]
Standard	50 mm Straight	G 1 (BSP)	112-1217	-1218	-1215	-1216	-1247	-1219	-1220

For 6000 Series Motors with a configuration *Not Shown* in the charts above: Use model code number system on page 63 to specify product in detail.

Model Code for 6000 Series Motors

The following 14-digit coding system has been developed to identify all of the configuration options for the 6000 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 — 6000 Series Disc Valve Motors

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

Position 1 **Product Series**

M ..... Motor

Position 2, 3 **6000 Series**

06 ..... 6000 Series

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

12 ..... 195 [11.9]

15 ..... 245 [15.0]

19 ..... 310 [19.0]

24 ..... 390 [23.9]

30 ..... 490 [30.0]

38 ..... 625 [38.0]

45 ..... 740 [45.0] *

49 ..... 805 [49.0] *

60 ..... 985 [60.0]

* For performance and dimension data contact your Eaton Hydraulics representitive.

Position 6 **Mounting Flange**

A ..... 4 Bolt (Bearingless 127,0 [5.00] Pilot Dia. and 14,3 [.56] Dia. Mounting Holes 161,9 [6.38] Dia. B.C.

B ..... 4 Bolt (SAE CC) (Standard) 127,0 [5.00] Pilot Dia. and 14,3 [.56] Mounting Holes on 161,9 [6.38] Dia. B.C.

C ..... 4 Bolt (Wheel) 139,7 [5.50] Pilot Dia. and 14,3 [.56] Dia. Mounting Holes on 184,1 [7.25] Dia. B.C.

H ..... 4 Bolt (Global) (Standard) 160,0 [6.30] Pilot Dia. and 18,0 [.709] Dia. Mounting Holes on 200,0 [7.87] Dia. Bolt Circle

Position 7, 8 **Output Shaft**

00 ..... Bearingless

01 ..... 1–1/2 inch Dia. Straight with Straight Key, 3/8-16 Threaded Hole and 56,7 [2.23] Max. Coupling Length

02 ..... 1–3/4 inch Dia. Tapered with Straight Key and 1–1/4 - 18 UNEF Slotted Hex. Nut

03 ..... 1–1/2 inch Dia. Splined 17T with 40,3 [1.59] Min. Full Spline Length and 3/8-16 Threaded Hole

10 ..... 40 mm Dia. Straight with Straight Key, M12 x 1,75-6H Threaded Hole

21 ..... 50 mm Dia. Straight with Straight Key, 14W x 9H x 70L, M12 x 1,75-6H Thread in End (Available with Mounting Flange Code H Only)

24 ..... 60 mm Dia. 10:1 Tapered Shaft with M42 x 3-6H Threaded End (Available with Mounting Flange Code H Only)

25 ..... 2 1/8 inch Dia. Splined 16 Tooth, 55,9 mm [2.20] Min. Full Spline Length (Available with Mounting Flange Code H Only)

Position 9 **Port Type**

A ..... 1–5/16 - 12 O-ring with 7/16-20 O-ring Case Drain and Check Valve

B ..... 3/4 inch 4 Bolt Split Flange with 7/16-20 O-ring Case Drain and Check Valve

C ..... G 1 (BSP) O-ring with G 1/4 (BSP) O-ring Case Drain and Check Valve

D ..... 1– 5/16-12 O-ring with (2) 9/16-18 O-ring Case Drain Ports and Hot Oil Shuttle Valve

R ..... 1– 5/16-12 O-ring with (2) 9/16-18 O-ring Ports for External Lubrication Circuit (both case ports must be connected)

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

00 ..... None

10 ..... Viton Shaft Seal

07 ..... Viton Seals

13 ..... Reverse Rotation

14 ..... Seal Guard

21 ..... Speed Sensor (Std.)

Position 12 **Paint/Special Packaging**

0 ..... No Paint

A ..... Painted Low Gloss Black

B ..... Corrosion Protected

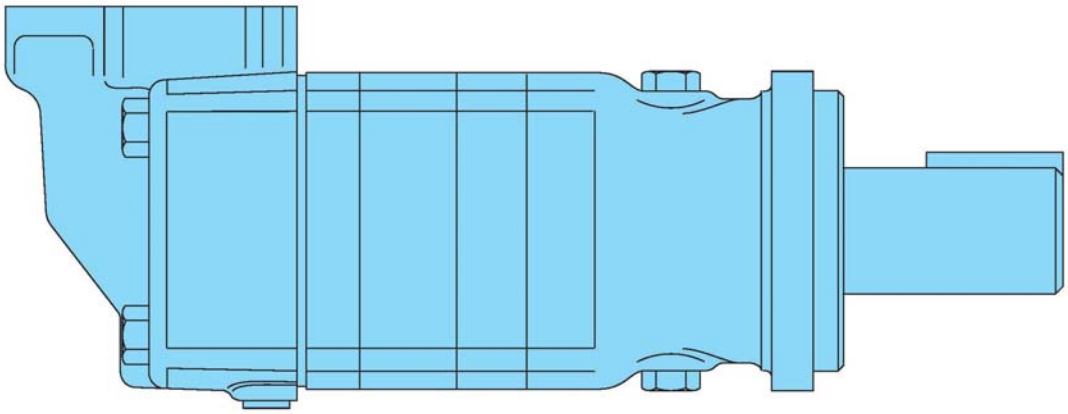
Position 13 **Eaton Assigned Code when Applicable**

0 ..... Assigned Code

Position 14 **Eaton Assigned Design Code**

0 ..... Assigned Design Code

Specifications 10,000 Series



Specification Data—10,000 Series

Displ. cm^3/r [in^3/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**		

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

Continuous
Intermittent

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**		

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]

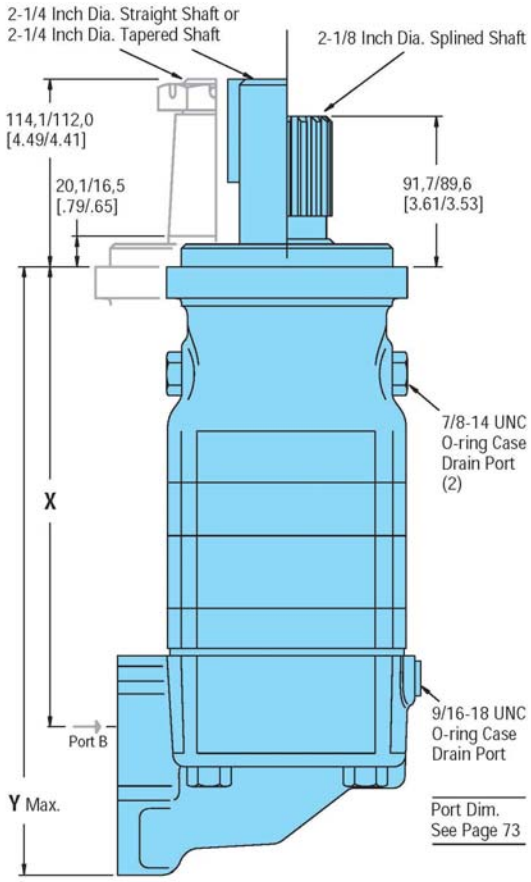
Flow LPM [GPM]	[250] 15	[500] 35	[750] 50	[1000] 70	[1250] 85	[1500] 105	[1750] 120	[2000] 140	[2250] 155	[2500] 170	[2750] 190	[3000] 205	[3250] 225	[3500] 240
[1] 3,8	[2080] 235 **3**	[4260] 480 **2**	[6440] 730 **1**											
[2] 7,5	[2090] 235 **7**	[4270] 480 **6**	[6450] 730 **5**	[8640] 975 **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**								

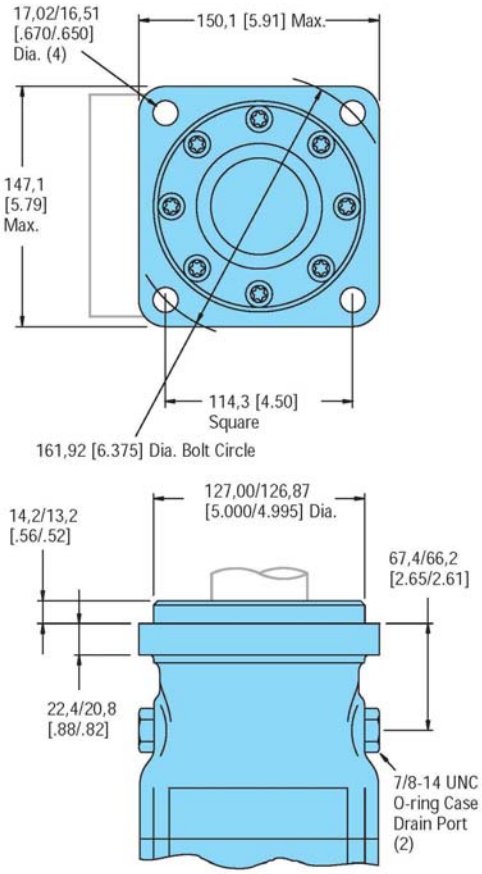
Motors run with high efficiency in all areas designated with a number for torque and speed, however for best motor life select a motor to run with a torque and speed range shown in the light blue area.

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

Dimensions — 10,000 Series Standard Motor

Shaft Dim. See Page 71



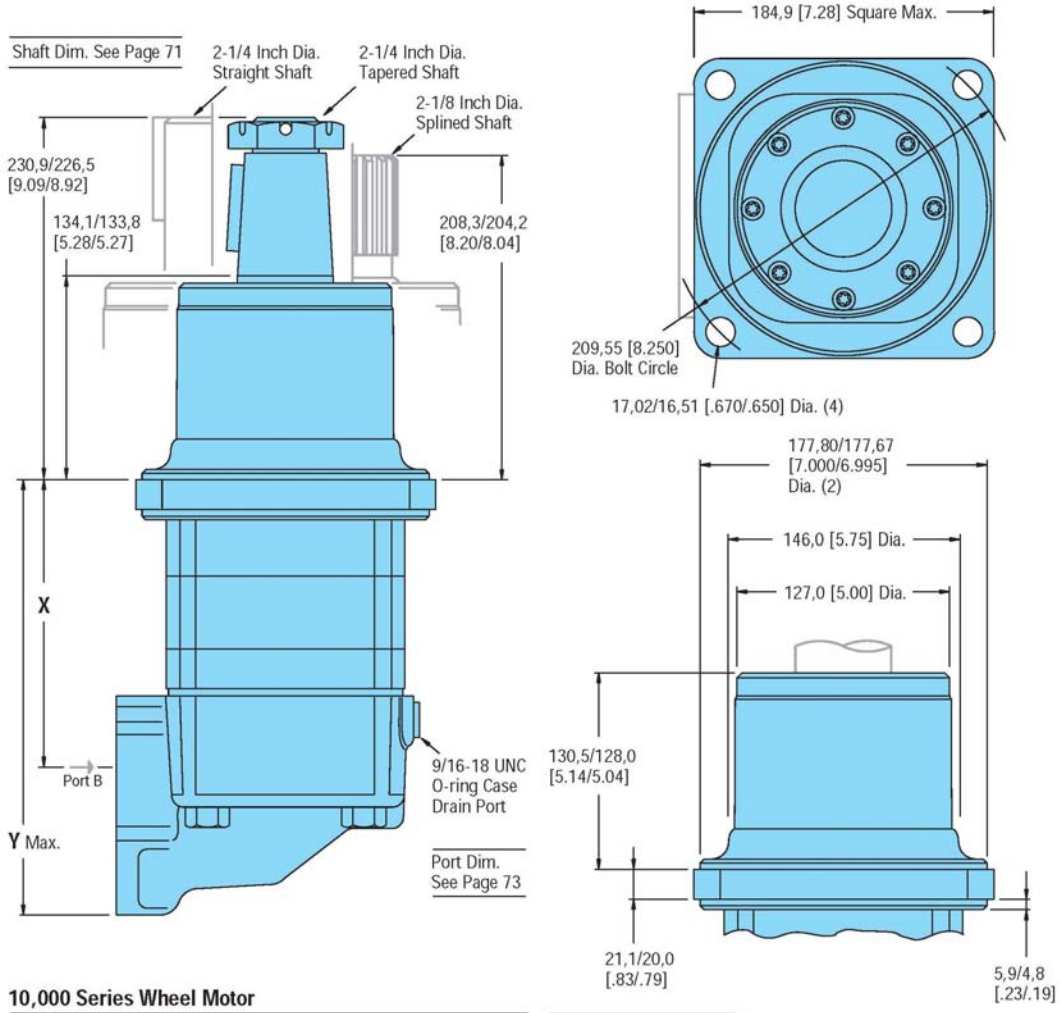


10,000 Series Standard Motor

Displ. cm^3/r [in^3/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

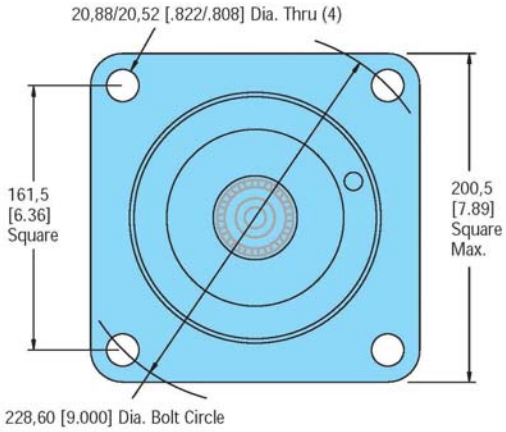


10,000 Series Wheel Motor

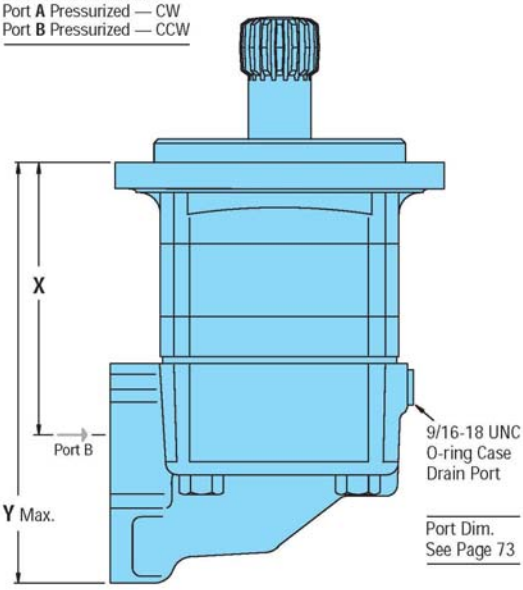
Displ. cm^3/r [in^3/r]	345 [21.0]	480 [29.2]	665 [40.6]	940 [57.4]
X Dim. mm [inch]	166,9 [6.57]	179,6 [7.07]	179,6 [7.07]	197,8 [7.79]
Y Dim. mm [inch]	266,2 [10.48]	278,9 [10.98]	278,9 [10.98]	297,5 [11.71]

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

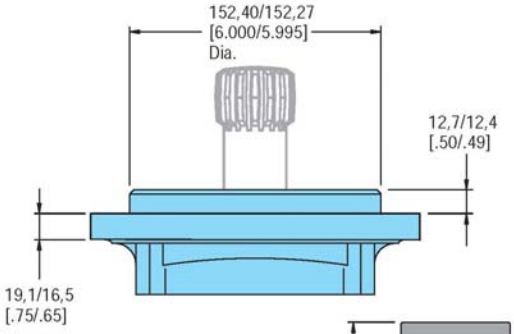
Dimensions — 10,000 Series Bearingless Motor



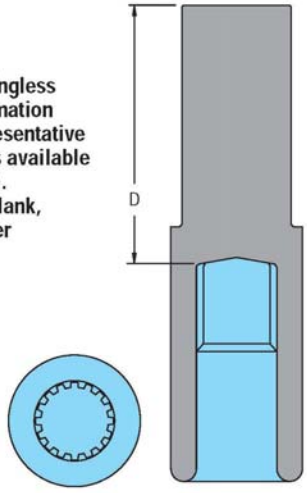
Standard Rotation
Viewed from Drive End
Port **A** Pressurized — CW
Port **B** Pressurized — CCW



Port Dim.
See Page 73



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.

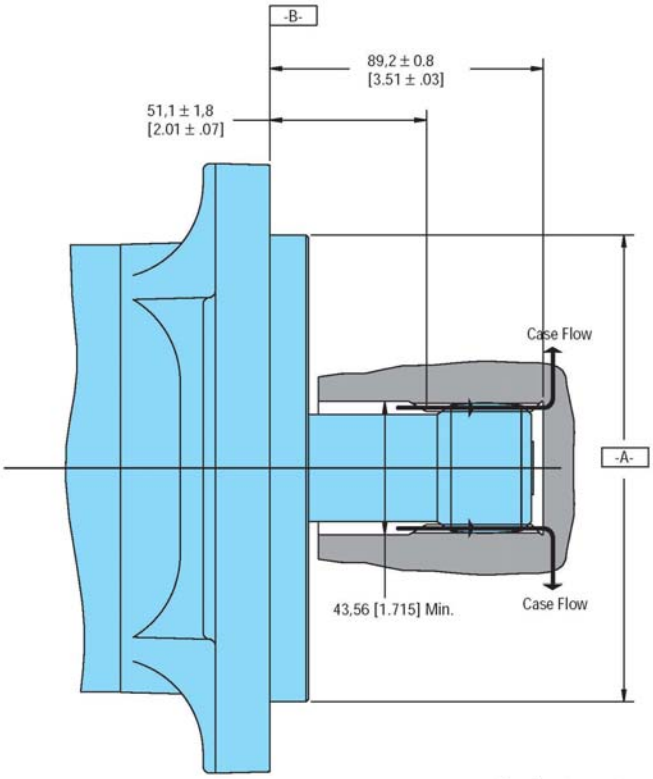


10,000 Series Bearingless Motor

Displ. cm^3/r [in^3/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]

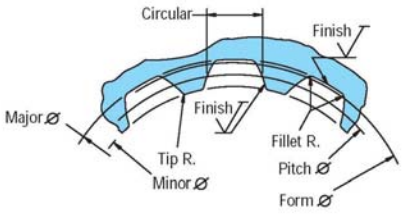
Mating Coupling Blank Eaton Part No.	Dimension D mm [inch]
13280-001	133,6/128,5 [5.26/5.06]
13280-002	156,0/150,9 [6.14/5.94]

Bearingless Installation — 10,000 Series



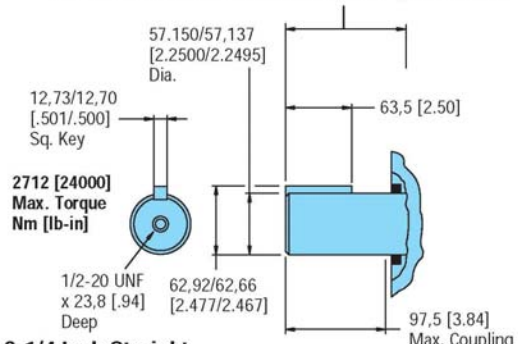
Spline Pitch — 10/20
Pressure Angle — 30°
Number of teeth — 16
Class of Fit — Ref. 5
Type of Fit — Side
Pitch Diameter — Ref. 40,640000 [1.6000000] ⌀ 0,25 [.010] D
Base Diameter — Ref. 35,195272 [1.3856406]
Major Diameter — 43,56 [1.715] Max. 43,18 [1.700] Min.
Minor Diameter — 36,83 - 37,08 [1.450 - 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]

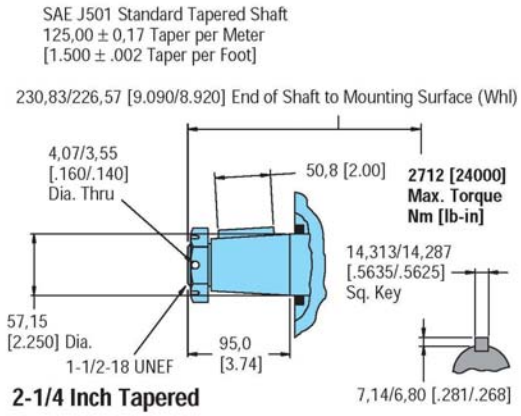


1 Internal spline in mating part to be as follows: Material to be ASTM A304, 8620H. Carborize to a hardness of 58-64 HRc with case depth (to 50HRc) of 0,076 - 1,02 [.030 - .040] (dimensions apply after heat treat).

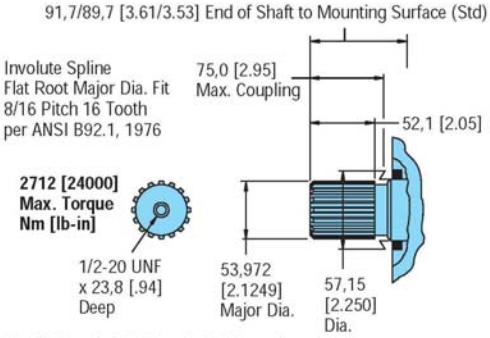
Dimensions — Shafts
10,000 Series



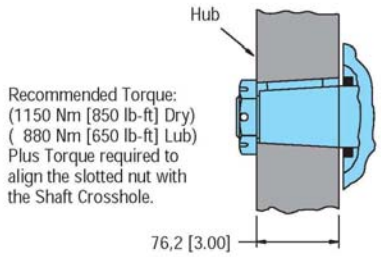
2-1/4 Inch Straight



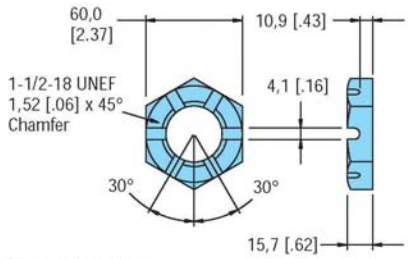
2-1/4 Inch Tapered



2-1/8 Inch 16 Tooth Splined



Tapered Shaft Hub Data



Slotted Hexagon Nut

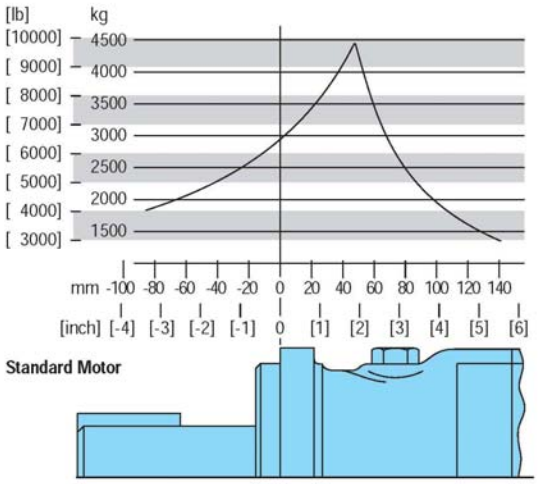
Shaft Side Load Capacity
10,000 Series

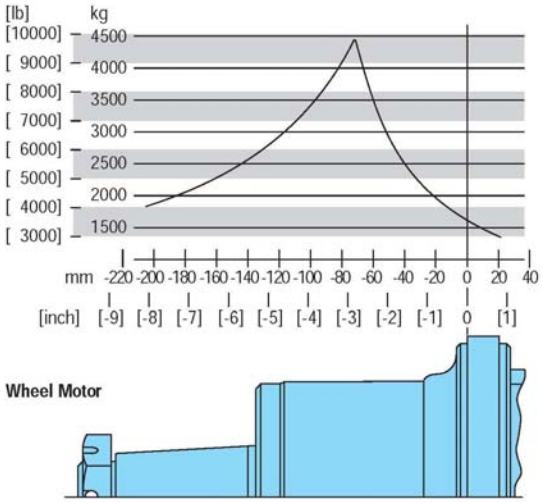
This curve indicates the radial load capacity on the motor shaft(s) at various locations.

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

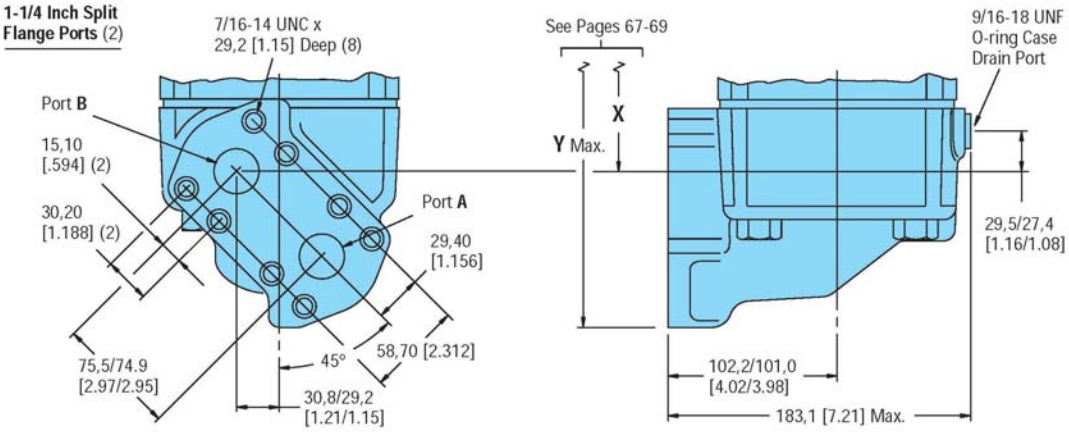
For 3,000,000 Shaft revolutions or 500 hours — Increase these shaft loads 52%.



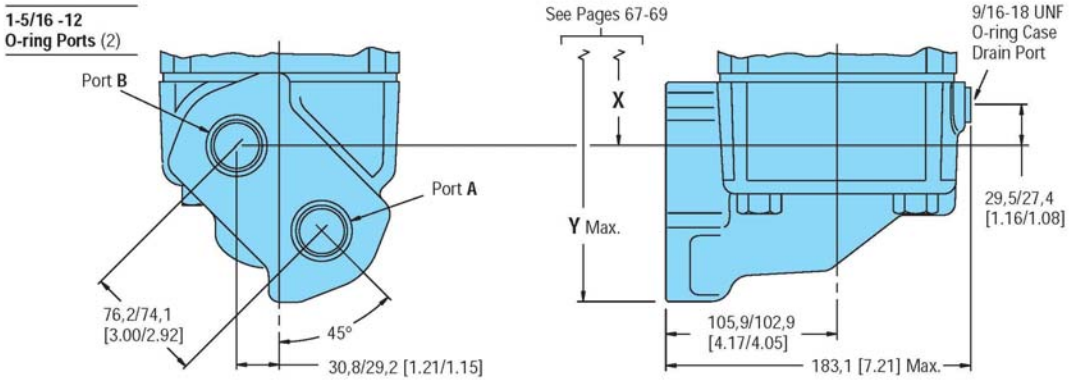


Dimensions —Ports 10,000 Series

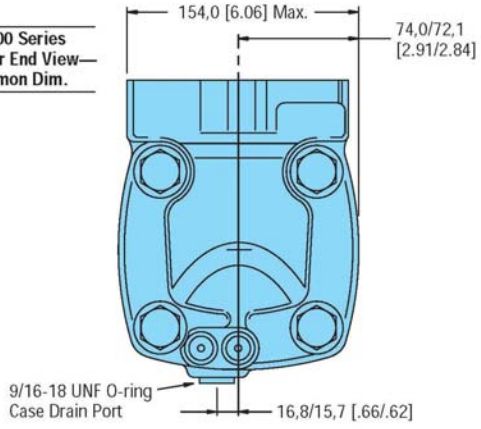
1-1/4 Inch Split Flange Ports (2)



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



10,000 Series Motor End View— Common Dim.



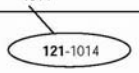
Standard Rotation 10,000 Series
Viewed from Shaft End
Port **A** Pressurized — CW
Port **B** Pressurized — CCW

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.

			Displacement cm^3/r [in^3/r] and Product Number			
Mounting	Shaft	Ports	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



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].

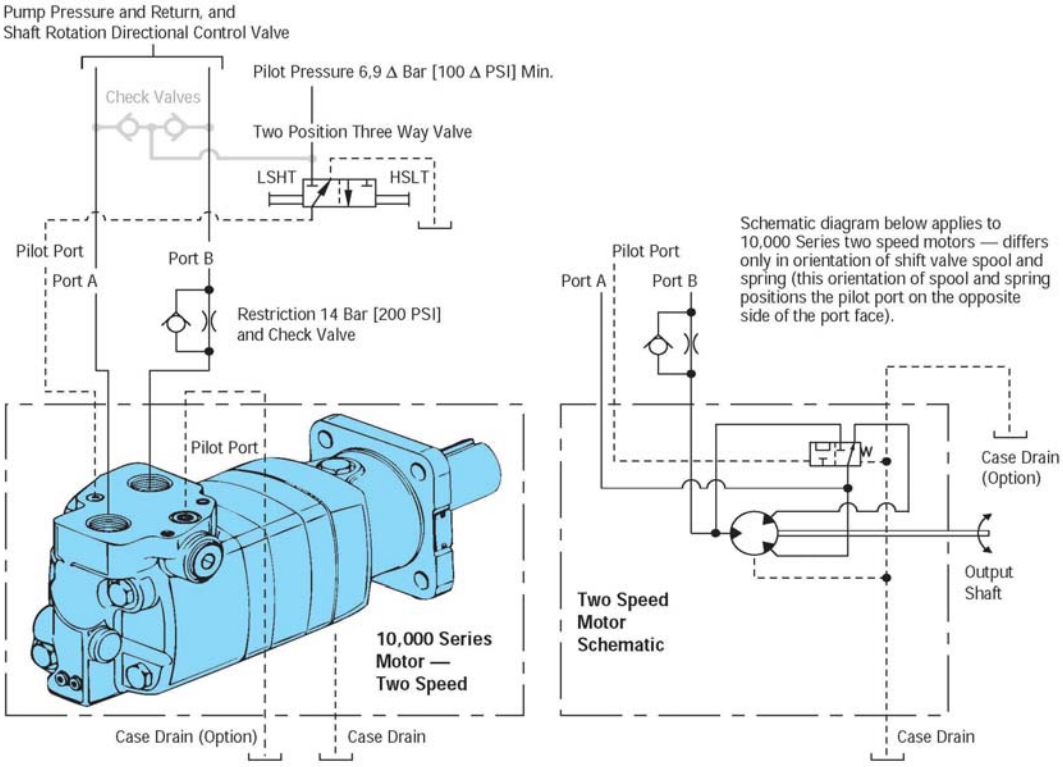
Note: Be certain in closed loop applications that the charge pump when used for back pressure on the B port, has sufficient displacement to maintain charge pressure especially in dynamic braking or overrunning load conditions.

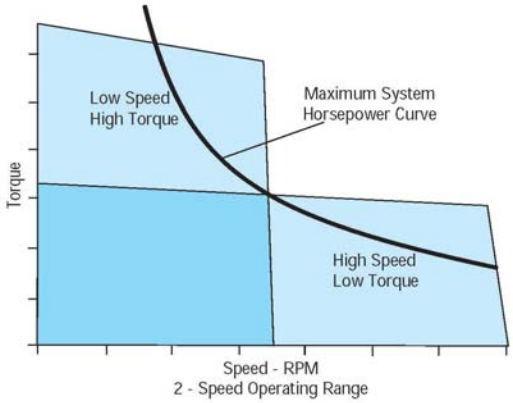
Important! Due to potential problems in maintaining charge pump pressure at port B for uninterrupted back pressure during dynamic braking, Eaton does not recommend the two speed motor where overrunning conditions may exist.

Performance Data Two Speed Motor — 10,000 Series

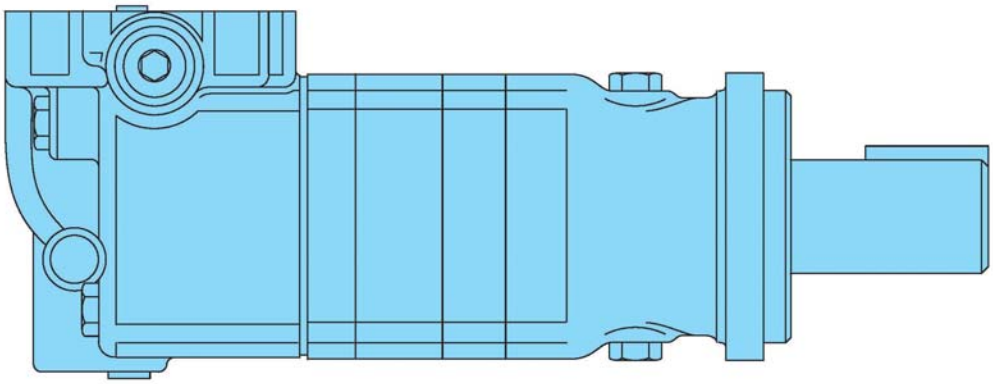
In the high speed mode torque values are approximately one half with twice the speed of the conventional 10,000 Series single speed motors. **In the low speed mode torque and speed values are the same as the conventional**

Two Speed Motor — 10,000 Series





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

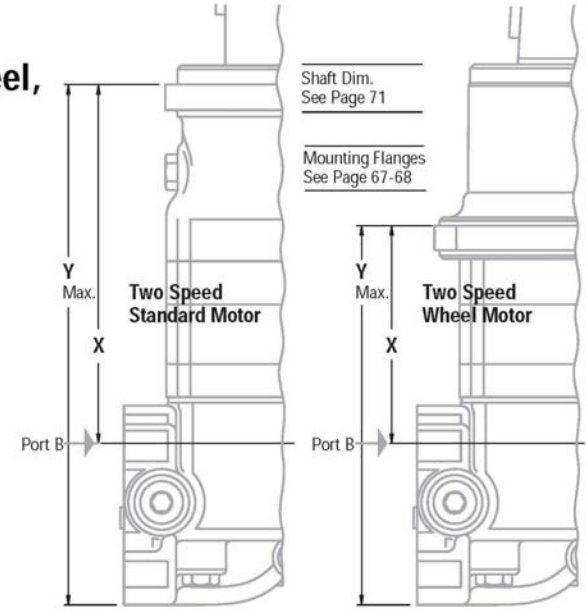
Displ. cm^3/r [in^3/r]	345 [21.0]	480 [29.2]	665 [40.6]	940 [57.4]
X Dim. mm [inch]	270,8 [10.66]	283,5 [11.16]	283,5 [11.16]	301,8 [11.88]
Y Dim. mm [inch]	392,7 [15.46]	405,4 [15.96]	405,4 [15.96]	423,9 [16.69]

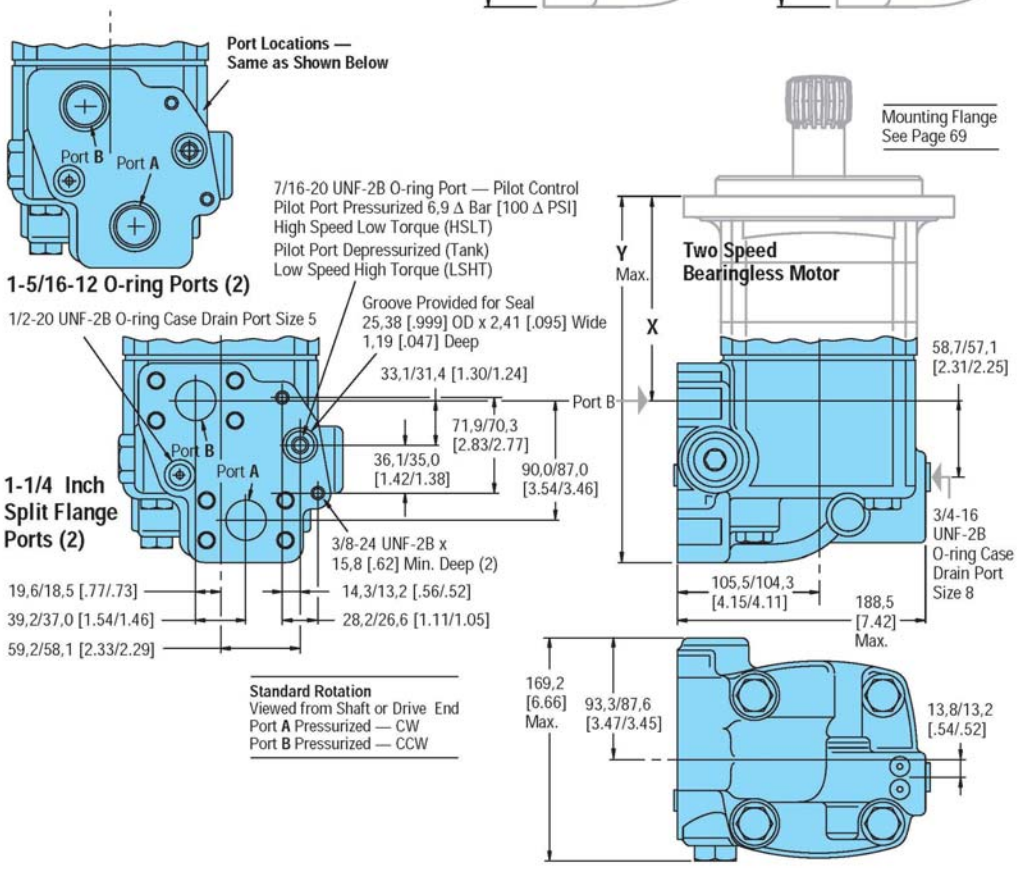
Two Speed Wheel Motor

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]





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. cm³/r [in³/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)

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

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

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

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

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

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

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

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

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

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

Table 2

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

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

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

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

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

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

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

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

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

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

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

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

Step Seven — Calculate Hydraulic Motor Torque (T)

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

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

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.

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

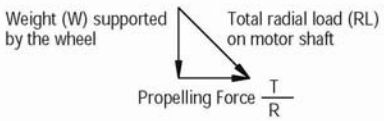
$$TS = \frac{W \times f \times R_l}{G \times Eg} \text{(lb – in / Motor)}$$

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

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

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

Shaft Speed

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

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

Power (into motor)

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

Power (out of motor)

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

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



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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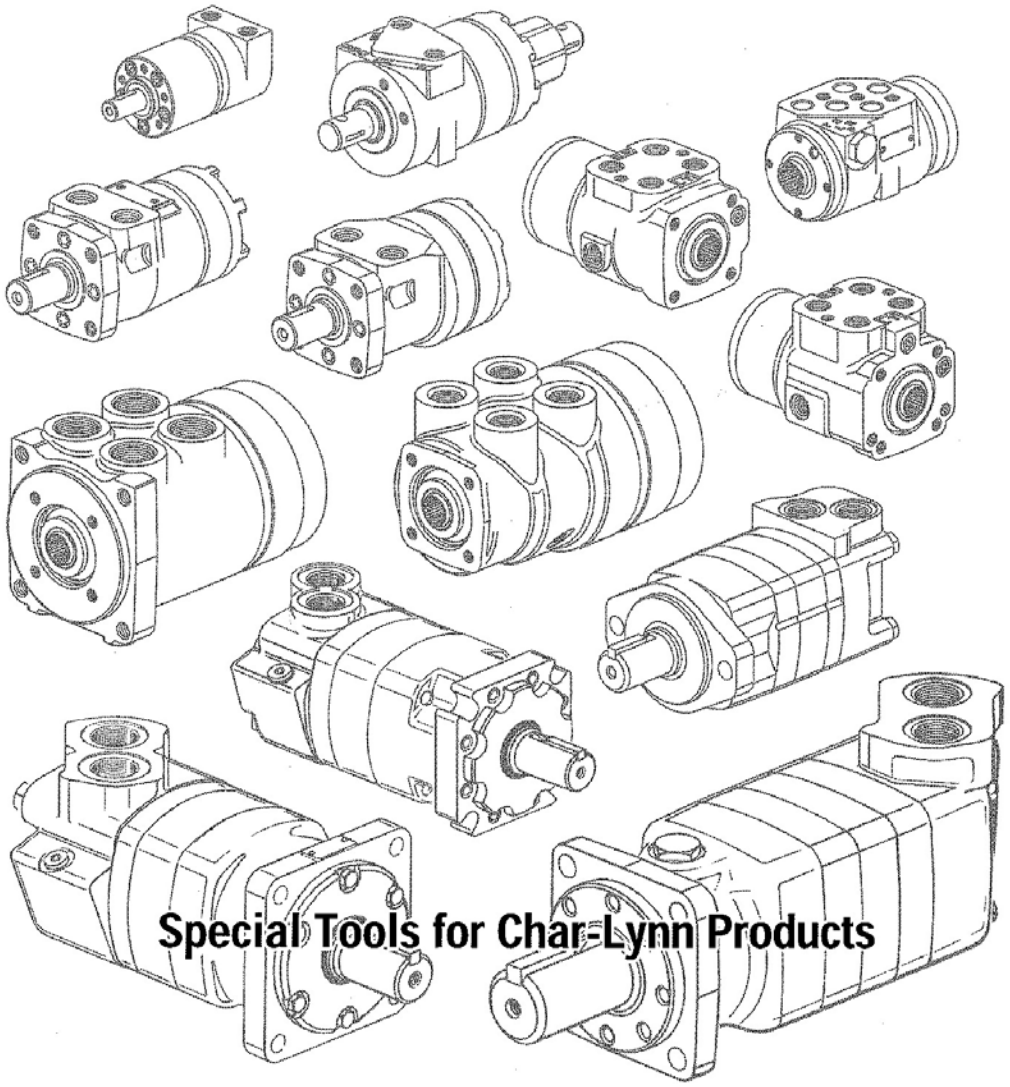
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Char-Lynn®
Product Information

No. 2-805
June, 1996

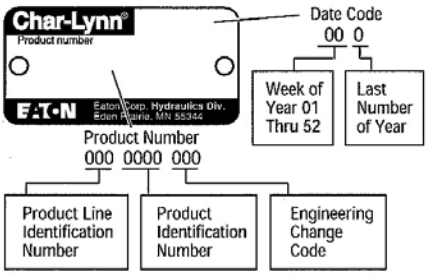
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Special Tools for Char-Lynn Products

Introduction

Eaton Corporation, Hydraulics Division has made available special tools to aid the user in the disassembly and reassembly of Eaton Char-Lynn products. The use of these tools will prevent possible damage to seals and etc. during reassembly of the Char-Lynn products. These special tools are listed first by part number and then by tool description on page 3 of this document. Pages 4, 5, and 6 are to be used to show where each of these special tools may be used by product series and engineering change code. This information may be found on the product information tag located on each and every Char-Lynn product. See Sample tag below.



Special Tools for Char-Lynn Products

Part Number	Special Tool Description
5422-000	5/16 in. -12 Point Socket
600057-000	Spring Installation Tool
600304-000	Shaft Seal Bullet
600336-000	Spring Installation Tool
600421-000	Shaft Face Seal Installation Tool
600463-000	Shaft Seal Bullet
600464-000	Shaft Seal Bullet
600465-000	Shaft Seal Bullet
600466-000	Shaft Seal Bullet
600468-000	Shaft Face Seal Installation Tool
600469-000	Shaft Face Seal Installation Tool
600470-000	Shaft Pressure Seal Installation Tool
600496-000	Shaft Pressure Seal Installation Tool
600523-000	Shaft Pressure Seal Installation Tool
600633-000	Shaft Seal Bullet
600636-000	Bearing Removal Tool
600637-000	Bearing Press Tool
600642-000	Seal Press Tool
64489-000	5/16 in. - 6 Point (E10 Torx Drive) Socket

Special Tools for Char-Lynn Products

Part Number	Special Tool Description
	"A" Series Motors
5422-000	5/16 in. -12 Point Socket Heavy Duty 500 in. lb. [56] Nm. Capacity (001 thru 003) Motors
64489-000	5/16 in. - 6 Point (E10 Torx Drive) Socket (002 and 003) Mtrs.
600470-000	Shaft Pressure Seal Installation Tool (001) Motor
600523-000	Shaft Pressure Seal Installation Tool (002 and 003) Motors
600466-000	Shaft Seal Bullet for 7/8 in. Shaft (001 thru 003) Motors
600304-000	Shaft Seal Bullet for 1 in. Shaft (001 thru 003) Motors
	"H" Series Motors
5422-000	5/16 in. -12 Point Socket Heavy Duty 500 in. lb. [56] Nm. Capacity (007 thru 009) Motors
64489-000	5/16 in. - 6 Point (E10 Torx Drive) Socket (009) Motor
600470-000	Shaft Pressure Seal Installation Tool (007) Motor
600523-000	Shaft Pressure Seal Installation Tool (008 and 009) Motors
600466-000	Shaft Seal Bullet for 7/8 in. Shaft (007 thru 009) Motors
600304-000	Shaft Seal Bullet for 1 in. Shaft (007 thru 009) Motors
	"R" Series Motors
5422-000	5/16 in. -12 Point Socket Heavy Duty 500 in. lb. [56] Nm. Capacity (001) Motor
64489-000	5/16 in. - 6 Point (E10 Torx Drive) Socket (001 and 002) Mtrs.
600523-000	Shaft Pressure Seal Installation Tool (001 and 002) Motors
600466-000	Shaft Seal Bullet for 7/8 in. Shaft (001 and 002) Motors
600304-000	Shaft Seal Bullet for 1 in. Shaft (001 and 002) Motors
	"S" Series Motors
5422-000	5/16 in. -12 Point Socket Heavy Duty 500 in. lb. [56] Nm. Capacity (007 thru 010) Motors
64489-000	5/16 in. - 6 Point (E10 Trox Drive) Socket (010) Motor
600470-000	Shaft Pressure Seal Installation Tool (007 and 008) Motors
600523-000	Shaft Pressure Seal Installation Tool (009 thru 010) Motors
600466-000	Shaft Seal Bullet for 7/8 in. Shaft (007 thru 010) Motors
600304-000	Shaft Seal Bullet for 1 in. Shaft (007 thru 010) Motors

Special Tools for Char-Lynn Products

Part Number	Special Tool Description
	"T" Series Motors
64489-000	5/16 in. - 6 Point (E10 Trox Drive) Socket (001 and 002) Mtrs.
600523-000	Shaft Pressure Seal Installation Tool (001 and 002) Motors
600466-000	Shaft Seal Bullet for 7/8 in. Shaft (001 and 002) Motors
600304-000	Shaft Seal Bullet for 1 in. Shaft (001 and 002) Motors
	"W" Series Motors
600633-000	Shaft Seal Bullet (002) Motor
600636-000	Bearing Removal Tool (002) Motor
600637-000	Bearing Press Tool (002) Motor
600642-000	Seal Press Tool (002) Motor
	2000 Series Motors
600496-000	Shaft Pressure Seal Installation Tool (003 thru 006) Motors
600465-000	Shaft Seal Bullet for 1 in. Shaft (003 thru 006) Motors
	4000 Series Motors
600468-000	Shaft Face Seal Installation Tool (004) Motor
600421-000	Shaft Face Seal Installation Tool (006) Motor
600463-000	Shaft Seal Bullet for 1–1/4 in. Shaft (004) Motor
	6000 Series Motors
600469-000	Shaft Face Seal Installation Tool (005 and 006) Motors
600464-000	Shaft Seal Bullet for 1–1/2 in. Shaft (005 and 006) Motors
	10,000 Series Motors
5422-000	5/16 in. -12 Point Socket Heavy Duty 500 in. lb. [56] Nm. Capacity (002 and 003) Motors
64489-000	5/16 in. - 6 Point (E10 Torx Drive) Socket (003) Motor

Special Tools for Char-Lynn Products

Part Number	Special Tool Description
	Torque Generator
5422-000	5/16 in. -12 Point Heavy Duty Socket 500 in lb. [56 Nm] Capacity (001 and 006) Torque Generators
64489-000	5/16 in. - 6 Point (E 10 Torx Drive) Socket (002) Torque Generator
600057-000	Spring Installation Tool (001, 002, and 006) Torque Generators
	3, 4, 6, and 12 Series SCU
5422-000	5/16 in. -12 Point Heavy Duty Socket 500 in lb. [56 Nm] Capacity (001) SCU
64489-000	5/16 in. - 6 Point (E 10 Torx Drive) Socket (002) SCU
600057-000	Spring Installation Tool (001 and 002) SCU
	110, 230, and 450 Series SCU
5422-000	5/16 in. -12 Point Heavy Duty Socket 500 in lb. [56 Nm] Capacity (001) SCU
64489-000	5/16 in. - 6 Point (E 10 Torx Drive) Socket (002) SCU
600057-000	Spring Installation Tool (001 and 002) SCU
	20 Series SCU
600604-000	Spool/Sleeve Installation Tool (001) SCU
	25, 35, and 40 Series SCU
600336-000	Spring Installation Tool (001 Thru 003) SCU

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Char Lynn Hydraulic Motor H, S, T Series

Char-Lynn®

No. 11-885
April 1999

Hydraulic Motors: http://www.charlynn.com 800-968-0188

EATON



General Purpose Motors
H, S, and T Series

Hydraulics

We Manufacture Solutions

Catalog of General Purpose Spool Valve Hydraulic Motors from One of the World's Leading Manufacturers of Off Highway Mobile Components — Eaton Corporation

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 went into production. This motor had rolls incorporated into the internal ring gear. This element was identified by the name Geroler® and is a registered trade name of Eaton Corporation.

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.

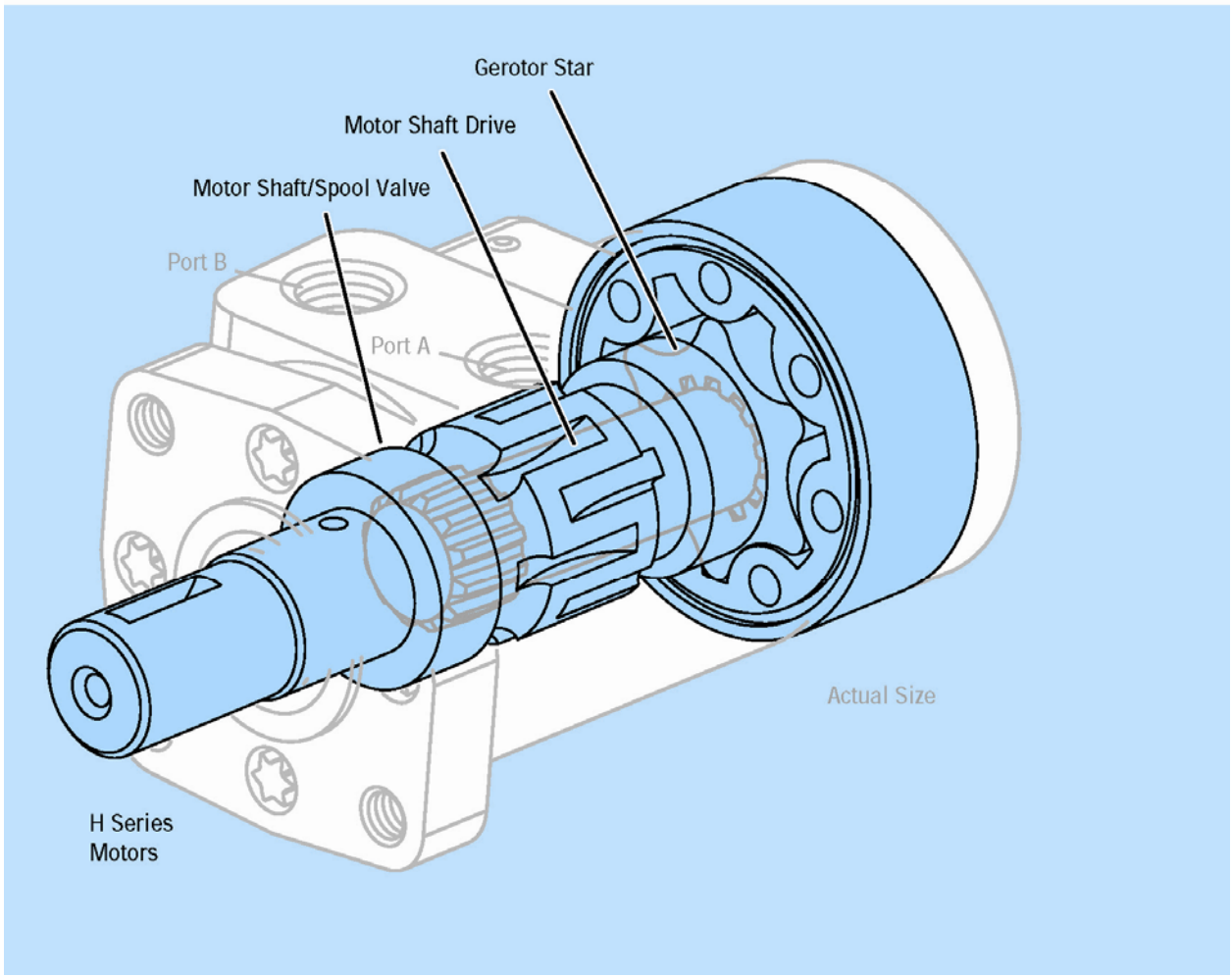
The newest Geroler motor, the "T Series", is included in this catalog. It features the latest innovations in Geroler technology. These innovations include optimized Geroler geometry with lower drive running angle for improved life and improved low speed performance. In addition, the improved housing and smaller diameter end cap results in increased envelope rigidity which improves efficiency under high pressure loads. All of these innovations come together to make the new T Series motor the highest performance motor in its class.

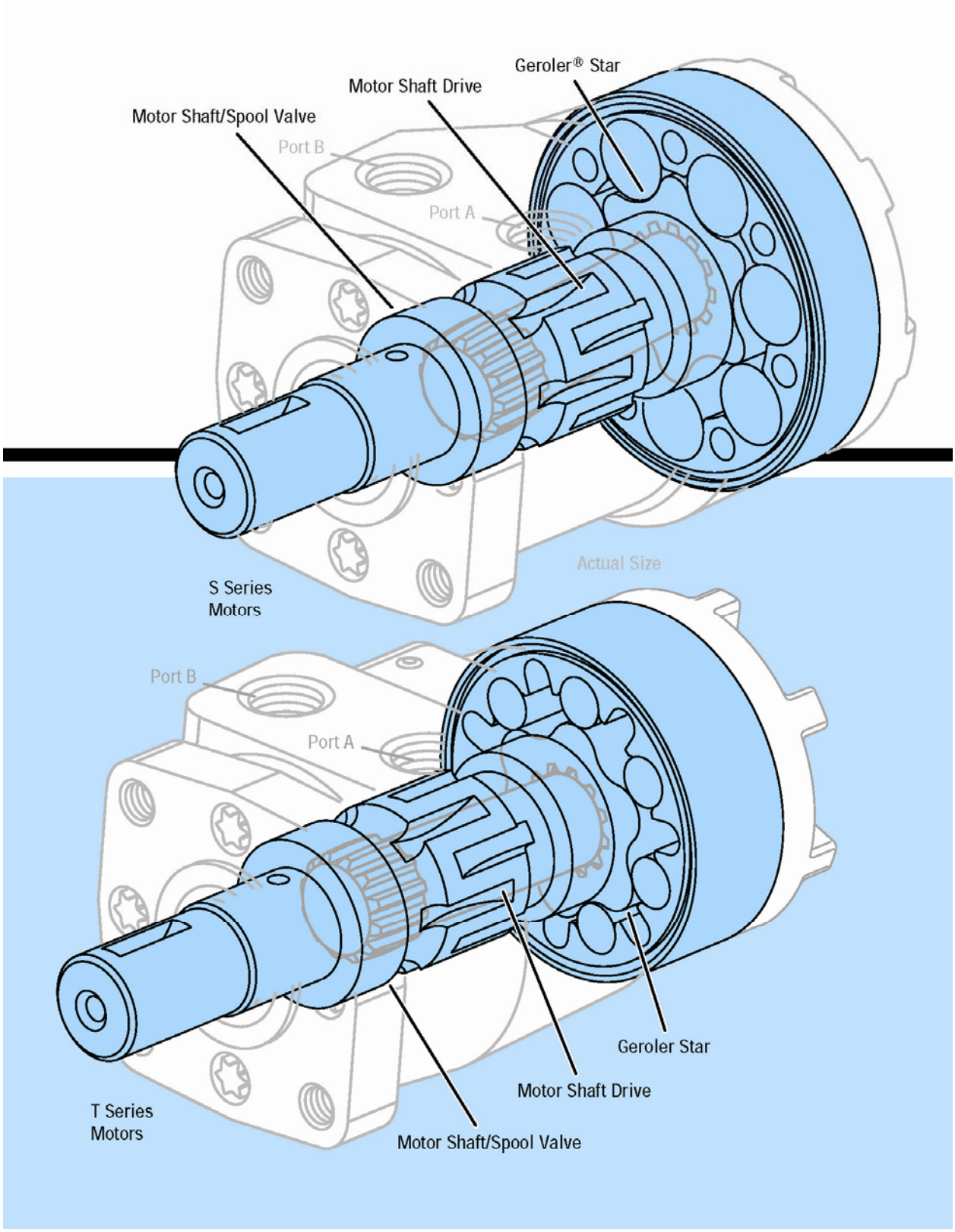
Spool Valve Motors

The function of the spool valve is to distribute pressurized fluid to and from the Geroler or gerotor displacement element. The valve has hydrodynamic bearings, and has infinite life when load ratings are not exceeded.

These motors incorporate the proven orbit motor principle to provide high torque at 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.




Geroler® Star
Motor Shaft Drive
Motor Shaft/Spool Valve
Port B
Port A
Actual Size
S Series
Motors
Port B
Port A
Geroler Star
Motor Shaft Drive
T Series
Motors
Motor Shaft/Spool Valve

H Series



H Series

Gerotor Element	13 Displacements
Flow LPM [GPM]	57 [15] Continuous**
	76 [20] Intermittent*
Speed	Up to 1100 RPM
Pressure Bar [PSI] ...	125 [1800] Cont.
	165 [2400] Inter.
Torque Nm [lb-in]	400 [3600] Cont.
	520 [4600] Inter.

Char-Lynn H Series motors are economical, efficient, small, compact, and powerful, designed for medium duty applications. These motors have the industry proven spool valve design combined with state-of-art gerotors. In addition, a wide variety of mounting flanges, shafts, ports, and a low speed valving option provides design flexibility. Direction of shaft rotation and shaft speed can be controlled easily and smoothly throughout the speed range of the motor, and equipment can be driven direct eliminating costly mechanical components.

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

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

H Series Displacement Size = cubic centimeter per shaft revolution (cm^3/r)
- 37 [2.2] = cubic inch per shaft revolution ([in^3/r])
- 46 [2.8]
- 59 [3.6]
- 74 [4.5]
- 96 [5.9]
- 120 [7.3]
- 146 [8.9]
- 159 [9.7]
- 185 [11.3]
- 231 [14.1]
- 293 [17.9]
- 370 [22.6]
- 739 [45.1]

Mounting Flange
- 2 Bolt (Std.) 82,6 [3.25] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes 106,2 [4.18] Dia. B.C.
- 4 Bolt (Std.) 44,4 [1.75] Pilot Dia. and 3/8-16 Mounting Holes 82,6 [3.25] Dia. B.C.
- 4 Bolt (Std.) 44,4 [1.75] Pilot Dia. and M10 x 1,5 Mounting Holes 82,6 [3.25] Dia. B.C.
- 2 Bolt (Std.) 101,6 [4.00] Pilot Dia. and 14,35 [.565] Dia. Mounting Holes 146,0 [5.75] Dia. B.C. (SAE B)
- 4 Bolt Magneto 82,6 [3.25] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes 106,2 [4.18] Dia. B.C.

Output Shaft
- 1 inch Dia. Straight with Woodruff Key and 1/4-20 Threaded Hole
- 1 inch Dia. SAE 6B Splined with 1/4-20 Threaded Hole
- 1 inch Dia. Straight with 7,9 [.31] Dia. Crosshole 11,2 [.44] from End
- 1 inch Dia. Straight with 10,2 [.40] Dia. Crosshole 15,7 [.62] from End and 1/4-20 Threaded Hole
- 7/8 inch Dia. SAE B 13 T Splined
- 7/8 inch Dia. SAE B Straight with Square Key
- 1 inch Dia. Tapered with Woodruff Key and Nut
- 25mm Dia. Straight with 8mm Key and 8mm x 1,2 Threaded Hole
- 1 inch Dia. Straight with Woodruff Key and 1/4-20 Threaded Hole (Plated for Corrosion Protection)
- 25mm Dia. Straight with 8mm Key and 8mm x 1,2 Threaded Hole (Plated for Corrosion Protection)
- 1 inch Dia. Straight with 10,2 [.40] Dia. Crosshole 15,7 [.62] from End and 1/4-20 Threaded Hole (Plated...)
- 1 inch Dia. Tapered with Woodruff Key and Nut (Plated for Corrosion Protection)

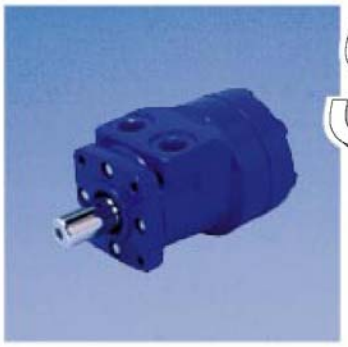
Port Type
- 7/8-14 O-ring
- 1/2-14 NPTF
- Manifold (5/16-18 Mounting Threads)
- Manifold (M8 x 1,25 Mounting Threads)
- G 1/2 (BSP) O-ring
- 3/4-16 End Ported
- G 1/2 (BSP) End Ported

Case Drain
- No Case Drain
- 7/16-20 O-ring Port (End Cap)
- G 1/4 (BSP End Cap)

Special Features Available
- Free Running Gerotor
- Low Speed Valve
- Viton® Shaft Seal
- Reverse Rotation
- Flange Rotated 90°
- Corrosion Protected
- Speed Sensor
- High Pressure Shaft Seal

Viton® is a Registered Trade Name of Dupont Corp.

S Series



S Series

Geroler® Element	10 Displacements
Flow LPM [GPM]	55 [15] Continuous**
	75 [20] Intermittent*
Speed	Up to 1150 RPM
Pressure Bar [PSI] ...	135 [2000] Cont.
	170 [2500] Inter.
Torque Nm [lb-in]	450 [4000] Cont.
	515 [4550] Inter.

Char-Lynn S Series motor with Geroler offers the same advantage of low speed, high torque and compact size as the H Series with gerotor. In the Geroler element precision machined rollers form the displacement chambers. The rollers provide support with rolling contact as the star rotates, minimizing friction, providing high efficiency, especially at start-up and at low speeds.

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

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

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

- 59 [3.6]
- 74 [4.5]
- 97 [5.9]
- 120 [7.3]
- 146 [8.9]
- 159 [9.7]
- 185 [11.3]
- 231 [14.1]
- 293 [17.9]
- 370 [22.6]

Mounting Flange
- 2 Bolt (Std.) 82,6 [3.25] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes 106,2 [4.18] Dia. B.C.
- 4 Bolt (Std.) 44,4 [1.75] Pilot Dia. and 3/8-16 Mounting Holes 82,6 [3.25] Dia. B.C.
- 4 Bolt (Std.) 44,4 [1.75] Pilot Dia. and M10 x 1,5 Mounting Holes 82,6 [3.25] Dia. B.C.
- 2 Bolt (Std.) 101,6 [4.00] Pilot Dia. and 14,35 [.565] Dia. Mounting Holes 146,0 [5.75] Dia. B.C. (SAE B)
- 4 Bolt Magneto 82,6 [3.25] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes 106,2 [4.18] Dia. B.C.

Output Shaft
- 1 inch Dia. Straight with Woodruff Key and 1/4-20 Threaded Hole
- 1 inch Dia. SAE 6B Splined with 1/4-20 Threaded Hole
- 1 inch Dia. Straight with 7,9 [.31] Dia. Crosshole 11,2 [.44] from End
- 1 inch Dia. Straight with 10,2 [.40] Dia. Crosshole 15,7 [.62] from End and 1/4-20 Threaded Hole
- 7/8 inch Dia. SAE B 13 T Splined
- 7/8 inch Dia. SAE B Straight with Square Key
- 1 inch Dia. Tapered with Woodruff Key and Nut
- 25mm Dia. Straight with 8mm Key and 8mm x 1,2 Threaded Hole
- 1 inch Dia. Straight with Woodruff Key and 1/4-20 Threaded Hole (Plated for Corrosion Protection)

Port Type
- 7/8-14 O-ring
- 1/2-14 NPTF
- Manifold (5/16-18 Mounting Threads)
- Manifold (M8 x 1,25 Mounting Threads)
- G 1/2 (BSP) O-ring

Case Drain
- No Case Drain
- 7/16-20 O-ring Port (End Cap)
- G 1/4 (BSP End Cap)

Special Features Available
- Low Speed Valve
- Viton® Shaft Seal
- Reverse Rotation
- Flange Rotated 90°
- Corrosion Protected
- High Pressure Shaft Seal

T Series



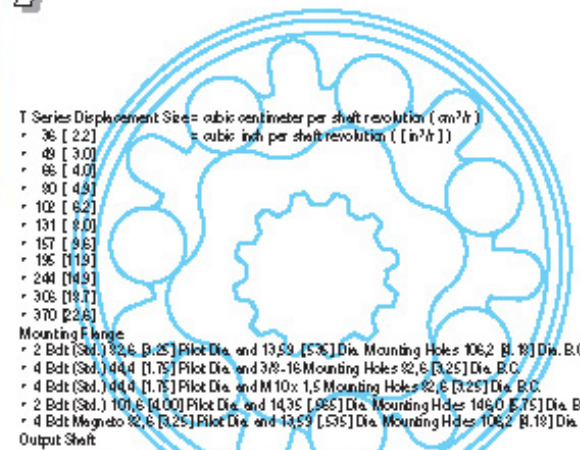
T Series

Geroler® Element	11 Displacements
Flow LPM [GPM]	95 [15] Continuous**
	75 [20] Intermittent*
Speed	Up to 1065 RPM
Pressure Bar [PSI] ...	155 [2250] Cont.
	190 [2750] Inter.
Torque Nm [lb-in]	440 [3905] Cont.
	510 [4515] Inter.

Char-Lynn TSeries motors with the Geroler displacement element, offer the same advantage of low friction, and long life as the S Series in a compact size like the H Series. The TSeries features the simplicity of Eaton's proven spool valve and a compact Geroler element that provides better drive life and smoother performance.

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

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



T Series Displacement Size = cubic centimeter per shaft revolution (cm³/r)
= cubic inch per shaft revolution ([in³/r])
- 36 [2.2]
- 49 [3.0]
- 66 [4.0]
- 80 [4.9]
- 102 [6.2]
- 131 [8.0]
- 157 [9.6]
- 195 [11.9]
- 244 [14.9]
- 308 [18.7]
- 370 [22.6]

Mounting Flange
- 2 Bolt (Std.) 82,6 [3.25] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes 106,2 [4.18] Dia. B.C.
- 4 Bolt (Std.) 44,4 [1.75] Pilot Dia. and 3/8-16 Mounting Holes 82,6 [3.25] Dia. B.C.
- 4 Bolt (Std.) 44,4 [1.75] Pilot Dia. and M10x 1,5 Mounting Holes 82,6 [3.25] Dia. B.C.
- 2 Bolt (Std.) 101,6 [4.00] Pilot Dia. and 14,35 [.565] Dia. Mounting Holes 146,0 [5.75] Dia. B.C. (SAE B)
- 4 Bolt Magneto 82,6 [3.25] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes 106,2 [4.18] Dia. B.C.

Output Shaft
- 1 inch Dia. Straight with Woodruff Key and 1/4-20 Threaded Hole
- 1 inch Dia. SAE BB Splined with 1/4-20 Threaded Hole
- 1 inch Dia. Straight with 7,9 [.31] Dia. Crosshole 11,2 [.44] from End
- 1 inch Dia. Straight with 1Q2 [.40] Dia. Crosshole 15,7 [.62] from End and 1/4-20 Threaded Hole
- 7/8 inch Dia. SAE B 13 T Splined
- 7/8 inch Dia. SAE B Straight with Square Key
- 1 inch Dia. Tapered with Woodruff Key and Nut
- 25mm Dia. Straight with 8mm Key and 8mm x 1,2 Threaded Hole
- 1 inch Dia. Straight with Woodruff Key and 1/4-20 Threaded Hole (Plated for Corrosion Protection)

Port Type
- 7/8-14 O-ring
- 1/2-14 NPTF
- Manifold (5/16-18 Mounting Threads)
- Manifold (M8 x 1,25 Mounting Threads)
- G 1/2 (BSP) O-ring

Case Drain
- No Case Drain
- 7/16-20 O-ring Port (End Cap)
- G 1/4 (BSP End Cap)

Special Features Available
- Low Speed Valve
- Viton® Shaft Seal
- Reverse Rotation
- Flange Rotated 90°
- Corrosion Protected
- Speed Sensor
- High Pressure Shaft Seal

Shaft Seal — H, S, and T Series

The time proven shaft seal design and construction allow the motors to withstand high back pressures without an external case drain. The motors can be connected together in series, or parallel to one another. The H, S, and T Series shaft seal has a patented feature which allows the seal lip to follow shaft deflection and provide better sealing under those conditions. A high pressure shaft seal is available for applications that have intermittent high case pressures above 105 bar [1500 PSI].

Low Speed Valving — Option H, S, and T Series

The low speed valving option provides smooth low speed performace while maintaining high torque. Designed to run continuously at up to 200 RPM at standard rated pressures and reduced flows, providing smooth operation at low speeds. Furthermore, they resist slippage and have more momentary load holding ability than the standard H, and S Series motors. Motors with this valving are not intended for low pressure applications (41 Bar [600 PSI] Minimum).

Free Running Motors — H, S, and T Series

H Series, S Series and T Series motors can be ordered with a special gerotor (H Series), or Geroler (S, and T Series) to permit free running of the output shaft. With this special feature, performance might be affected when extreme conditions exist. Overall efficiency may be reduced slightly.

Corrosion Protected — H, S, and T Series

H Series, S Series, and T Series motors are available with a corrosion resistant coating for use in an hostile environment. This coating protects the motor from salt, water, and various chemicals. It is especially effective in marine, food processing, car wash, fishing, and agricultural applications. Shaft plating helps eliminate seal damage caused by these caustic or acid materials in the shaft sealing area. Corrosion protected motors are available with just the output shaft plated, or protected with an entire motor exterior coating.

Speed Sensor — H, S, and T Series

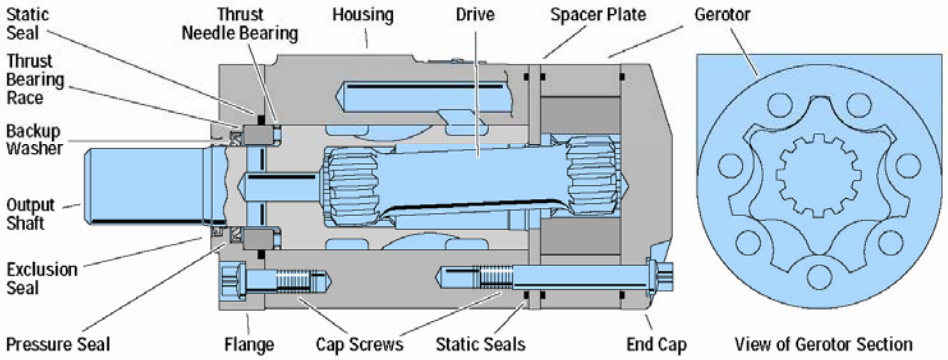
The H, and T Series motors are available with a rugged digital sensor for monitoring motor shaft speed. Compatible with vehicle electrical systems, this feature is ideal for applications where speeds need to be accurately known.

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* Contact your Eaton Representative

Specifications
H Series



Specification Data—H Series

Displ. cm³/r [in³/r]		36 [2.2]	46 [2.8]	59 [3.6]	74 [4.5]	97 [5.9]	120 [7.3]	146 [8.9]	159 [9.7]	185 [11.3]	231 [14.1]	293 [17.9]	370 [22.6]	739 [45.1]
Max. Speed (RPM) @ Continuous Flow		1021	969	953	760	585	469	385	353	304	243	192	152	74
Flow LPM [GPM]	Continuous	38 [10]	45 [12]	57 [15]	57 [15]	57 [15]	57 [15]	57 [15]	57 [15]	57 [15]	57 [15]	57 [15]	57 [15]	57 [15]
	Intermittent	38 [10]	53 [14]	64 [17]	68 [18]	68 [18]	76 [20]	76 [20]	76 [20]	76 [20]	76 [20]	76 [20]	76 [20]	76 [20]
Torque Nm [lb-in]	Continuous	56 [497]	73 [650]	91 [802]	118 [1044]	155 [1368]	192 [1699]	221 [1954]	233 [2059]	265 [2343]	302 [2669]	351 [3110]	407 [3604]	389 [3440]
	Intermittent **	75 [668]	99 [876]	122 [1076]	158 [1401]	207 [1829]	257 [2278]	300 [2653]	319 [2824]	356 [3151]	415 [3671]	466 [4121]	484 [4283]	520 [4600]
Min. Starting Torque Nm[lb-in]	@ Cont. Pressure	46 [410]	59 [520]	76 [670]	95 [840]	124 [1100]	154 [1360]	176 [1560]	186 [1650]	211 [1870]	238 [2110]	282 [2500]	330 [2920]	316 [2800]
	@ Int. Pressure	63 [560]	81 [720]	104 [920]	130 [1150]	171 [1510]	210 [1860]	246 [2180]	262 [2320]	293 [2590]	339 [3000]	388 [3430]	408 [3610]	434 [3840]
Pressure Δ Bar [Δ PSI]	Continuous*	124 [1800]	124 [1800]	124 [1800]	124 [1800]	124 [1800]	124 [1800]	117 [1700]	114 [1650]	110 [1600]	100 [1450]	93 [1350]	86 [1250]	41 [600]
	Intermittent* **	165 [2400]	165 [2400]	165 [2400]	165 [2400]	165 [2400]	165 [2400]	159 [2300]	155 [2250]	148 [2150]	138 [2000]	124 [1800]	103 [1500]	55 [800]
Weight kg [lb]		5,1 [11.2]	5,1 [11.2]	5,2 [11.5]	5,2 [11.5]	5,4 [11.8]	5,5 [12.1]	5,6 [12.4]	5,7 [12.5]	5,8 [12.8]	6,0 [13.3]	6,3 [14.0]	6,7 [14.7]	8,4 [18,6]

Maximum Case Pressure - without Case Drain — 103 Bar [1500 PSI] — See Page 34-35

* Maximum intermittent pressure at motor inlet port of 172 Bar [2500 PSI] without regard to Δ Bar [Δ PSI] and/or back pressure ratings or combination thereof.

** A simultaneous maximum torque and maximum speed NOT recommended.

6B Splined or Tapered shafts are recommended whenever operating above 282 Nm [2500 lb-in] of torque, especially for those applications subject to frequent reversals (see page 30).

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. Minimum oil viscosity (at operating temperature) should be the highest of the following: 100 SUS or $\frac{300 \times \text{Bar}}{\text{RPM}} = \text{SUS}$ $\left[\frac{20 \times \text{PSI}}{\text{RPM}} = \text{SUS}\right]$ (see page 36).

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
H 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.

36 cm³/r [2.2 in³/r]

Δ Pressure Bar [PSI] Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1800] 124	Max. Contin-uous [2400] 165	Max. Inter-mittent
[2] 7,6	[49] 6 **204**	[103] 12 **201**	[162] 18 **198**	[189] 21 **194**	[270] 31 **189**	[325] 37 **184**	[379] 43 **177**	[432] 49 **170**	[489] 55 **162**	[650] 73 **122**	
[4] 15,1	[47] 5 **408**	[106] 12 **407**	[160] 18 **402**	[191] 22 **399**	[274] 31 **394**	[327] 37 **387**	[384] 43 **381**	[439] 50 **373**	[495] 56 **365**	[654] 74 **323**	
[6] 22,7	[44] 5 **613**	[102] 12 **612**	[158] 18 **609**	[186] 21 **604**	[272] 31 **599**	[328] 37 **591**	[383] 43 **586**	[440] 50 **576**	[496] 56 **565**	[661] 75 **523**	
[8] 30,3	[40] 5 **817**	[97] 11 **817**	[153] 17 **814**	[184] 21 **807**	[270] 31 **799**	[326] 37 **793**	[383] 43 **785**	[440] 50 **776**	[497] 56 **762**	[668] 75 **721**	
Max. Contin-uous [10] 37,9	[36] 4 **1021**	[90] 10 **1021**	[148] 17 **1015**	[180] 20 **1008**	[265] 30 **1001**	[322] 36 **991**	[380] 43 **981**	[438] 49 **969**	[495] 56 **959**	[664] 75 **920**	

[90] 10 Torque [lb-in] Nm
1021 Speed RPM

46 cm³/r [2.8 in³/r]

Δ Pressure Bar [PSI] Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1800] 124	Max. Contin-uous [2400] 165	Max. Inter-mittent
[2] 7,6	[64] 7 **161**	[136] 15 **158**	[212] 24 **156**	[284] 32 **153**	[355] 40 **148**	[426] 48 **145**	[497] 56 **139**	[567] 64 **133**	[641] 72 **127**	[852] 96 **95**	
[4] 15,1	[61] 7 **323**	[139] 16 **320**	[209] 24 **316**	[286] 32 **314**	[359] 41 **310**	[429] 48 **304**	[503] 57 **300**	[576] 65 **293**	[649] 73 **287**	[857] 97 **253**	
[6] 22,7	[58] 7 **485**	[134] 15 **481**	[207] 23 **479**	[282] 32 **475**	[356] 40 **471**	[430] 49 **464**	[502] 57 **461**	[577] 65 **453**	[650] 73 **444**	[867] 98 **410**	
[8] 30,3	[52] 6 **648**	[128] 14 **643**	[200] 23 **640**	[276] 31 **635**	[354] 40 **628**	[428] 48 **623**	[502] 57 **617**	[577] 65 **610**	[651] 74 **599**	[876] 99 **566**	
[10] 37,9	[47] 5 **808**	[118] 13 **803**	[194] 22 **798**	[269] 30 **793**	[347] 39 **787**	[423] 48 **779**	[498] 56 **771**	[575] 65 **761**	[649] 73 **753**	[871] 98 **722**	
Max. Contin-uous [12] 45,4	[36] 4 **969**	[109] 12 **964**	[188] 21 **960**	[260] 29 **952**	[340] 38 **946**	[417] 47 **938**	[492] 56 **931**	[567] 64 **922**	[643] 73 **914**	[864] 98 **877**	
Max. Inter-mittent [14] 53,0	[25] 3 **1127**	[98] 11 **1123**	[175] 20 **1115**	[249] 28 **1108**	[327] 37 **1100**	[404] 46 **1093**	[484] 55 **1086**	[559] 63 **1079**	[634] 72 **1068**		

59 cm³/r [3.6 in³/r]

Δ Pressure Bar [PSI] Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1800] 124	Max. Contin-uous [2400] 165	Max. Inter-mittent
[2] 7,6	[79] 9 **127**	[169] 19 **125**	[260] 29 **123**	[305] 34 **121**	[437] 49 **117**	[526] 59 **114**	[616] 70 **109**	[704] 80 **103**	[796] 90 **96**	[1055] 119 **65**	
[4] 15,1	[76] 9 **254**	[168] 19 **254**	[257] 29 **251**	[307] 35 **249**	[441] 50 **246**	[529] 60 **241**	[620] 70 **236**	[710] 80 **230**	[800] 90 **224**	[1065] 120 **193**	
[6] 22,7	[73] 8 **381**	[181] 18 **381**	[252] 28 **380**	[303] 34 **377**	[439] 50 **373**	[529] 60 **368**	[618] 70 **364**	[709] 80 **358**	[802] 91 **349**	[1069] 121 **319**	
[8] 30,3	[64] 7 **508**	[151] 17 **508**	[243] 27 **508**	[294] 33 **504**	[428] 48 **500**	[519] 59 **496**	[609] 69 **491**	[701] 79 **484**	[794] 90 **476**	[1076] 122 **446**	
[10] 37,9	[57] 6 **635**	[141] 16 **635**	[234] 26 **634**	[283] 32 **630**	[419] 47 **626**	[512] 58 **621**	[602] 68 **614**	[693] 78 **608**	[786] 89 **601**	[1071] 121 **571**	
[12] 45,4	[45] 5 **762**	[131] 15 **762**	[227] 26 **762**	[274] 31 **757**	[409] 46 **753**	[505] 57 **747**	[593] 67 **741**	[684] 77 **734**	[778] 88 **728**	[1058] 120 **694**	
[14] 53,0	[33] 4 **889**	[118] 13 **889**	[213] 24 **887**	[266] 30 **882**	[396] 45 **877**	[492] 56 **872**	[583] 66 **866**	[676] 76 **860**	[770] 87 **851**	[1055] 119 **813**	
Max. Contin-uous [15] 56,8	[29] 3 **953**	[111] 13 **953**	[205] 23 **951**	[260] 29 **945**	[389] 44 **940**	[486] 55 **935**	[576] 65 **929**	[670] 76 **921**	[765] 86 **913**	[1055] 119 **872**	
Max. Inter-mittent [20] 75,7	[17] 2 **1090**	[98] 11 **1090**	[192] 22 **1077**	[252] 28 **1071**	[377] 43 **1067**	[475] 54 **1062**	[567] 64 **1055**	[680] 75 **1049**	[757] 86 **1040**		

74 cm³/r [4.5 in³/r]

Δ Pressure Bar [PSI] Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1800] 124	Max. Contin-uous [2400] 165	Max. Inter-mittent
[2] 7,6	[103] 12 **101**	[220] 25 **99**	[339] 38 **98**	[454] 51 **96**	[569] 64 **93**	[685] 77 **90**	[801] 91 **86**	[916] 103 **81**	[1036] 117 **76**	[1373] 155 **51**	
[4] 15,1	[99] 11 **203**	[219] 25 **201**	[335] 38 **199**	[457] 52 **197**	[574] 65 **194**	[689] 78 **191**	[808] 91 **187**	[925] 105 **182**	[1042] 118 **177**	[1386] 157 **153**	
[6] 22,7	[94] 11 **305**	[210] 24 **303**	[328] 37 **301**	[451] 51 **298**	[571] 65 **296**	[689] 78 **292**	[805] 91 **288**	[924] 104 **283**	[1044] 118 **276**	[1392] 157 **252**	
[8] 30,3	[86] 10 **406**	[196] 22 **404**	[319] 36 **402**	[438] 49 **399**	[558] 63 **396**	[676] 76 **393**	[793] 90 **388**	[913] 103 **383**	[1033] 117 **377**	[1401] 158 **352**	
[10] 37,9	[74] 8 **507**	[183] 21 **505**	[310] 35 **502**	[422] 48 **499**	[545] 62 **496**	[667] 75 **492**	[784] 89 **486**	[903] 102 **482**	[1024] 116 **476**	[1394] 158 **452**	
[12] 45,4	[58] 7 **608**	[171] 19 **606**	[295] 33 **603**	[408] 46 **600**	[533] 60 **596**	[657] 74 **591**	[773] 87 **587**	[891] 101 **581**	[1013] 114 **576**	[1377] 156 **549**	
[14] 53,0	[43] 5 **709**	[154] 17 **706**	[277] 31 **702**	[396] 45 **698**	[515] 58 **694**	[640] 72 **691**	[760] 86 **686**	[880] 99 **681**	[1002] 113 **674**	[1374] 155 **643**	
Max. Contin-uous [15] 56,8	[36] 4 **760**	[145] 16 **757**	[268] 30 **753**	[387] 44 **749**	[506] 57 **744**	[632] 71 **740**	[750] 85 **735**	[873] 99 **729**	[998] 113 **723**	[1373] 155 **690**	
Max. Inter-mittent [20] 75,7	[14] 2 **904**	[121] 14 **902**	[233] 26 **898**	[351] 40 **895**	[482] 54 **891**	[609] 69 **887**	[725] 82 **882**	[856] 97 **877**	[981] 111 **869**		

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

Performance Data
H 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.

97 cm³/r [5.9 in³/r]

Flow LPM [GPM]	Δ Pressure Bar [PSI] Continuous [200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1800] 124	Max. Continuous	Max. Intermittent [2400] 165
[2] 7,6	[134] 15 **78**	[292] 33 **76**	[442] 50 **75**	[593] 67 **73**	[746] 84 **71**	[899] 102 **68**	[1054] 119 **65**	[1209] 137 **61**	[1365] 154 **55**	[1806] 204 **33**	
[4] 15,1	[131] 15 **156**	[281] 32 **155**	[436] 49 **153**	[596] 67 **151**	[750] 85 **149**	[903] 102 **147**	[1059] 120 **143**	[1212] 137 **139**	[1367] 154 **134**	[1828] 207 **113**	
[6] 22,7	[126] 14 **234**	[269] 30 **233**	[425] 48 **231**	[588] 66 **230**	[747] 84 **228**	[900] 102 **224**	[1054] 119 **221**	[1206] 136 **217**	[1368] 155 **210**	[1823] 206 **189**	
[8] 30,3	[110] 12 **312**	[246] 28 **311**	[408] 46 **310**	[566] 64 **308**	[718] 81 **305**	[873] 99 **303**	[1023] 116 **300**	[1177] 133 **295**	[1339] 151 **291**	[1829] 207 **269**	
[10] 37,9	[98] 11 **390**	[231] 26 **389**	[392] 44 **387**	[539] 61 **385**	[699] 79 **383**	[859] 97 **380**	[1005] 114 **376**	[1156] 131 **373**	[1318] 149 **368**	[1821] 206 **346**	
[12] 45,4	[77] 9 **469**	[218] 25 **467**	[378] 43 **465**	[522] 59 **463**	[681] 77 **460**	[844] 95 **457**	[990] 112 **453**	[1142] 129 **449**	[1301] 147 **445**	[1792] 202 **421**	
[14] 53,0	[60] 7 **546**	[197] 22 **544**	[358] 40 **542**	[513] 58 **539**	[662] 75 **537**	[828] 94 **535**	[973] 110 **531**	[1131] 128 **526**	[1293] 146 **521**	[1776] 201 **499**	
Max. Continuous [15] 56,8	[52] 6 **585**	[189] 21 **583**	[346] 39 **581**	[495] 56 **578**	[651] 74 **575**	[819] 93 **573**	[963] 109 **569**	[1126] 127 **564**	[1286] 145 **559**	[1778] 201 **536**	
Max. Intermittent [20] 75,7	[25] 3 **701**	[157] 18 **700**	[311] 35 **697**	[455] 51 **694**	[625] 71 **691**	[790] 89 **688**	[941] 106 **684**	[1110] 125 **681**	[1272] 144 **674**		

120 cm³/r [7.3 in³/r]

Flow LPM [GPM]	Δ Pressure Bar [PSI] Continuous [200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1800] 124	Max. Continuous	Max. Intermittent [2400] 165
[2] 7,6	[162] 18 **62**	[357] 40 **61**	[544] 61 **61**	[736] 83 **59**	[927] 105 **58**	[1116] 126 **55**	[1305] 147 **53**	[1498] 169 **49**	[1687] 191 **45**	[2231] 252 **26**	
[4] 15,1	[160] 18 **125**	[348] 39 **124**	[539] 61 **123**	[736] 83 **121**	[930] 105 **120**	[1119] 126 **119**	[1316] 149 **116**	[1506] 170 **114**	[1698] 192 **110**	[2268] 256 **90**	
[6] 22,7	[155] 18 **188**	[338] 38 **187**	[530] 60 **186**	[729] 82 **185**	[923] 104 **183**	[1116] 126 **180**	[1310] 148 **178**	[1500] 169 **175**	[1699] 192 **170**	[2271] 257 **152**	
[8] 30,3	[139] 16 **250**	[319] 36 **250**	[515] 58 **249**	[710] 80 **247**	[901] 102 **245**	[1094] 124 **243**	[1283] 145 **241**	[1476] 167 **237**	[1673] 189 **233**	[2278] 257 **216**	
[10] 37,9	[121] 14 **313**	[303] 34 **312**	[497] 56 **311**	[686] 78 **309**	[883] 100 **308**	[1081] 122 **306**	[1267] 143 **302**	[1460] 165 **300**	[1655] 187 **296**	[2268] 256 **278**	
[12] 45,4	[102] 12 **376**	[288] 33 **374**	[480] 54 **373**	[664] 75 **371**	[862] 97 **370**	[1060] 120 **367**	[1246] 141 **365**	[1440] 163 **361**	[1640] 185 **358**	[2232] 252 **338**	
[14] 53,0	[78] 9 **438**	[263] 30 **437**	[458] 52 **435**	[652] 74 **433**	[841] 95 **431**	[1041] 118 **430**	[1228] 139 **427**	[1420] 160 **423**	[1616] 183 **419**	[2213] 250 **401**	
Max. Continuous [15] 56,8	[67] 8 **469**	[253] 29 **468**	[446] 50 **466**	[632] 71 **464**	[828] 94 **462**	[1030] 116 **460**	[1214] 137 **458**	[1411] 159 **454**	[1608] 182 **450**	[2205] 249 **430**	
Max. Intermittent [20] 75,7	[20] 2 **626**	[202] 23 **624**	[384] 43 **621**	[581] 66 **618**	[778] 88 **617**	[971] 110 **614**	[1169] 132 **611**	[1356] 153 **609**	[1559] 176 **606**		

146 cm³/r [8.9 in³/r]

Flow LPM [GPM]	Δ Pressure Bar [PSI] Continuous [200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1700] 117	Max. Continuous	Max. Intermittent [2300] 159
[2] 7,6	[198] 22 **51**	[435] 49 **50**	[664] 75 **50**	[897] 101 **49**	[1130] 128 **47**	[1361] 154 **45**	[1591] 180 **43**	[1827] 206 **40**	[1942] 219 **39**	[2611] 295 **24**	
[4] 15,1	[196] 22 **103**	[424] 48 **102**	[657] 74 **101**	[898] 101 **99**	[1133] 128 **99**	[1365] 154 **97**	[1604] 181 **95**	[1836] 207 **93**	[1954] 221 **92**	[2648] 299 **78**	
[6] 22,7	[189] 21 **154**	[412] 47 **153**	[646] 73 **152**	[889] 100 **151**	[1125] 127 **150**	[1361] 154 **149**	[1598] 181 **146**	[1829] 207 **143**	[1951] 220 **141**	[2653] 300 **129**	
[8] 30,3	[169] 19 **205**	[389] 44 **205**	[628] 71 **204**	[866] 98 **203**	[1098] 124 **201**	[1333] 151 **200**	[1564] 177 **197**	[1799] 203 **195**	[1919] 217 **193**	[2649] 299 **180**	
[10] 37,9	[148] 17 **267**	[369] 42 **266**	[605] 68 **265**	[836] 94 **263**	[1076] 122 **252**	[1318] 149 **251**	[1544] 174 **248**	[1780] 201 **246**	[1899] 215 **244**	[2789] 315 **231**	
[12] 45,4	[125] 14 **308**	[351] 40 **307**	[586] 66 **306**	[810] 92 **305**	[1051] 119 **303**	[1293] 146 **301**	[1519] 172 **299**	[1756] 198 **296**	[1878] 212 **295**	[2606] 294 **281**	
[14] 53,0	[95] 11 **359**	[321] 36 **358**	[558] 63 **357**	[795] 90 **355**	[1026] 116 **354**	[1290] 146 **352**	[1497] 169 **350**	[1731] 196 **347**	[1851] 209 **346**	[2580] 292 **331**	
Max. Continuous [15] 56,8	[82] 9 **85**	[308] 35 **384**	[544] 61 **383**	[771] 87 **381**	[1010] 114 **379**	[1256] 142 **378**	[1480] 167 **375**	[1720] 194 **373**	[1840] 208 **371**	[2569] 290 **356**	
Max. Intermittent [20] 75,7	[24] 3 **513**	[246] 28 **512**	[468] 53 **509**	[708] 80 **507**	[948] 107 **506**	[1184] 134 **504**	[1425] 161 **501**	[1653] 187 **499**	[1780] 201 **498**		

159 cm³/r [9.7 in³/r]

Flow LPM [GPM]	Δ Pressure Bar [PSI] Continuous [200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1650] 134	Max. Continuous	Max. Intermittent [2250] 155
[2] 7,6	[209] 24 **47**	[465] 53 **46**	[715] 81 **46**	[973] 110 **45**	[1228] 139 **44**	[1478] 167 **42**	[1724] 195 **40**	[1981] 224 **38**	[2046] 231 **37**	[2764] 312 **23**	
[4] 15,1	[210] 24 **94**	[460] 52 **94**	[710] 80 **93**	[971] 110 **91**	[1229] 139 **91**	[1480] 167 **90**	[1745] 197 **89**	[1996] 226 **87**	[2059] 233 **87**	[2813] 318 **76**	
[6] 22,7	[205] 23 **141**	[454] 51 **141**	[704] 80 **140**	[965] 109 **139**	[1216] 137 **138**	[1477] 167 **136**	[1738] 196 **134**	[1991] 225 **132**	[2055] 232 **132**	[2824] 319 **119**	
[8] 30,3	[186] 21 **188**	[440] 50 **188**	[693] 78 **187**	[951] 107 **186**	[1205] 136 **185**	[1461] 165 **183**	[1716] 194 **181**	[1973] 223 **179**	[2038] 230 **178**	[2808] 317 **166**	
[10] 37,9	[164] 19 **236**	[422] 48 **234**	[671] 76 **234**	[930] 105 **232**	[1189] 134 **232**	[1451] 164 **230**	[1702] 192 **228**	[1965] 219 **226**	[2032] 230 **226**	[2789] 315 **213**	
[12] 45,4	[144] 16 **282**	[404] 46 **281**	[652] 74 **281**	[900] 102 **279**	[1163] 131 **279**	[1421] 161 **277**	[1674] 189 **275**	[1937] 219 **273**	[2004] 226 **272**	[2770] 313 **260**	
[14] 53,0	[109] 12 **330**	[374] 42 **329**	[623] 70 **328**	[883] 100 **327**	[1140] 129 **325**	[1396] 158 **323**	[1653] 187 **322**	[1900] 215 **319**	[1963] 222 **319**	[2727] 308 **306**	
Max. Continuous [15] 56,8	[92] 10 **353**	[359] 41 **352**	[612] 69 **351**	[861] 97 **350**	[1123] 127 **348**	[1381] 156 **347**	[1633] 185 **345**	[1886] 213 **343**	[1950] 220 **342**	[2712] 306 **330**	
Max. Intermittent [20] 75,7	[26] 3 **471**	[268] 30 **470**	[510] 58 **467**	[772] 87 **465**	[1034] 117 **464**	[1290] 146 **462**	[1553] 175 **460**	[1802] 204 **458**	[1865] 211 **458**		

[359] 41 **352** } Torque [lb-in] Nm / Speed RPM

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

Performance Data
H 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.

185 cm³/r [11.3 in³/r]
Δ Pressure Bar [PSI] Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	Max. Continuous	Max. Intermittent
[2] 7,6	[257] 29 **40**	[554] 63 **40**	[847] 96 **39**	[1150] 130 **38**	[1447] 163 **37**	[1739] 196 **36**	[2035] 230 **33**	[2320] 262 **29**	[3103] 351 **12**	
[4] 15,1	[254] 29 **91**	[546] 62 **91**	[845] 95 **90**	[1145] 129 **79**	[1448] 164 **79**	[1744] 197 **77**	[2049] 232 **76**	[2343] 265 **74**	[3147] 356 **63**	
[6] 22,7	[246] 28 **121**	[540] 61 **121**	[834] 94 **120**	[1137] 128 **120**	[1434] 162 **119**	[1736] 196 **117**	[2036] 230 **115**	[2337] 264 **112**	[3151] 356 **100**	
[8] 30,3	[224] 25 **162**	[520] 59 **162**	[820] 93 **161**	[1117] 126 **160**	[1414] 160 **159**	[1716] 194 **157**	[2014] 228 **155**	[2315] 262 **152**	[3133] 354 **140**	
[10] 37,9	[202] 23 **202**	[499] 56 **202**	[793] 90 **201**	[1095] 124 **201**	[1394] 158 **200**	[1699] 192 **198**	[1997] 226 **196**	[2299] 260 **193**	[3112] 352 **181**	
[12] 45,4	[176] 20 **243**	[475] 54 **242**	[767] 87 **242**	[1063] 120 **241**	[1368] 155 **240**	[1664] 188 **238**	[1969] 222 **236**	[2268] 256 **234**	[3088] 349 **222**	
[14] 53,0	[140] 16 **283**	[443] 50 **283**	[735] 83 **282**	[1035] 117 **281**	[1340] 151 **280**	[1637] 185 **279**	[1936] 219 **277**	[2227] 252 **274**	[3051] 345 **262**	
Max. Continuous [15] 56,8	[120] 14 **304**	[425] 48 **303**	[719] 81 **302**	[1014] 115 **301**	[1320] 149 **300**	[1618] 183 **299**	[1914] 216 **297**	[2205] 249 **294**	[3023] 342 **283**	
Max. Intermittent [20] 75,7	[27] 3 **405**	[321] 36 **404**	[612] 69 **402**	[911] 103 **401**	[1211] 137 **400**	[1504] 170 **398**	[1795] 203 **397**			

231 cm³/r [14.1 in³/r]
Δ Pressure Bar [PSI] Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1450] 100	Max. Continuous	Max. Intermittent
[2] 7,6	[338] 38 **32**	[707] 80 **32**	[1074] 121 **31**	[1456] 165 **30**	[1827] 206 **30**	[2192] 248 **28**	[2572] 291 **26**	[2657] 300 **25**		
[4] 15,1	[328] 37 **65**	[695] 79 **65**	[1076] 122 **64**	[1447] 163 **63**	[1827] 206 **62**	[2201] 249 **62**	[2577] 291 **60**	[2689] 302 **60**	[3671] 415 **50**	
[6] 22,7	[317] 36 **97**	[687] 78 **97**	[1057] 119 **97**	[1434] 162 **96**	[1811] 205 **95**	[2186] 247 **94**	[2555] 289 **92**	[2650] 299 **91**	[3668] 414 **80**	
[8] 30,3	[289] 33 **130**	[659] 74 **130**	[1038] 117 **130**	[1406] 159 **129**	[1777] 201 **128**	[2160] 244 **127**	[2531] 286 **124**	[2625] 297 **124**	[3644] 412 **112**	
[10] 37,9	[265] 30 **162**	[631] 71 **162**	[1004] 113 **162**	[1381] 156 **162**	[1751] 198 **160**	[2131] 241 **158**	[2510] 284 **156**	[2602] 294 **156**	[3608] 408 **145**	
[12] 45,4	[230] 26 **195**	[599] 68 **195**	[968] 109 **194**	[1345] 152 **194**	[1722] 195 **193**	[2088] 236 **192**	[2480] 280 **189**	[2571] 290 **189**	[3571] 403 **178**	
[14] 53,0	[191] 22 **227**	[563] 64 **227**	[927] 105 **227**	[1299] 147 **226**	[1686] 190 **226**	[2058] 233 **224**	[2428] 274 **222**	[2519] 285 **221**	[3532] 399 **212**	
Max. Continuous [15] 56,8	[167] 19 **243**	[538] 61 **243**	[904] 102 **243**	[1279] 145 **242**	[1681] 188 **242**	[2030] 229 **240**	[2404] 272 **238**	[2493] 282 **238**	[3488] 394 **229**	
Max. Intermittent [20] 75,7	[29] 3 **324**	[411] 46 **324**	[785] 89 **323**	[1152] 130 **322**	[1520] 172 **322**	[1877] 212 **320**	[2222] 251 **319**	[2318] 262 **318**		

293 cm³/r [17.9 in³/r]
Δ Pressure Bar [PSI] Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1350] 93	Max. Continuous	Max. Intermittent
[2] 7,6	[427] 48 **26**	[893] 101 **25**	[1361] 154 **25**	[1829] 207 **24**	[2293] 259 **22**	[2672] 302 **16**	[2977] 336 **13**		
[4] 15,1	[419] 47 **51**	[886] 100 **51**	[1362] 154 **51**	[1833] 207 **50**	[2305] 260 **49**	[2771] 313 **47**	[3110] 351 **44**	[4107] 464 **22**	
[6] 22,7	[402] 45 **77**	[872] 99 **77**	[1342] 152 **76**	[1819] 206 **76**	[2291] 259 **74**	[2757] 312 **71**	[3098] 350 **68**	[4121] 466 **54**	
[8] 30,3	[367] 41 **102**	[838] 95 **102**	[1316] 149 **102**	[1785] 202 **101**	[2252] 254 **100**	[2723] 308 **98**	[3070] 347 **95**	[4086] 462 **84**	
[10] 37,9	[332] 38 **128**	[803] 91 **128**	[1276] 144 **128**	[1749] 198 **127**	[2215] 250 **126**	[2684] 303 **123**	[3034] 343 **120**	[4061] 459 **108**	
[12] 45,4	[289] 33 **153**	[760] 86 **153**	[1230] 139 **153**	[1706] 193 **153**	[2177] 246 **151**	[2634] 298 **149**	[2989] 338 **146**	[4012] 453 **135**	
[14] 53,0	[241] 27 **179**	[712] 80 **179**	[1176] 133 **179**	[1650] 186 **179**	[2126] 240 **177**	[2592] 293 **175**	[2935] 332 **172**	[3963] 448 **161**	
Max. Continuous [15] 56,8	[211] 24 **192**	[683] 77 **192**	[1149] 130 **192**	[1623] 183 **191**	[2096] 237 **190**	[2558] 289 **188**	[2905] 328 **186**	[3914] 442 **174**	
Max. Intermittent [20] 75,7	[43] 5 **256**	[527] 60 **256**	[1001] 113 **255**	[1463] 165 **255**	[1919] 217 **254**	[2375] 268 **252**	[2720] 307 **249**		

370 cm³/r [22.6 in³/r]
Δ Pressure Bar [PSI] Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1250] 86	Max. Continuous	Max. Intermittent
[2] 7,6	[537] 61 **20**	[1121] 127 **20**	[1715] 194 **20**	[2285] 258 **19**	[2862] 323 **16**				
[4] 15,1	[532] 60 **40**	[1123] 127 **40**	[1715] 194 **40**	[2308] 261 **39**	[2893] 327 **38**	[3467] 392 **36**	[3604] 407 **35**	[4274] 483 **27**	
[6] 22,7	[508] 57 **61**	[1100] 124 **61**	[1693] 191 **61**	[2294] 259 **60**	[2884] 326 **58**	[3458] 391 **55**	[3598] 407 **53**	[4283] 484 **47**	
[8] 30,3	[463] 52 **81**	[1060] 120 **81**	[1661] 186 **81**	[2255] 255 **80**	[2840] 321 **79**	[3414] 386 **76**	[3557] 402 **74**	[4254] 481 **69**	
[10] 37,9	[414] 47 **101**	[1017] 115 **101**	[1613] 182 **101**	[2203] 249 **101**	[2788] 315 **99**	[3363] 380 **96**	[3506] 396 **94**	[4212] 476 **88**	
[12] 45,4	[363] 41 **121**	[960] 108 **121**	[1553] 175 **121**	[2152] 243 **121**	[2737] 309 **119**	[3305] 373 **116**	[3446] 389 **115**	[4152] 469 **109**	
[14] 53,0	[303] 34 **142**	[897] 101 **142**	[1484] 168 **142**	[2086] 236 **142**	[2667] 301 **140**	[3246] 367 **137**	[3386] 383 **136**	[4092] 462 **130**	
Max. Continuous [15] 56,8	[266] 30 **152**	[862] 97 **152**	[1452] 164 **152**	[2050] 232 **152**	[2630] 297 **150**	[3206] 362 **148**	[3347] 378 **147**	[4054] 458 **140**	
Max. Intermittent [20] 75,7	[61] 7 **202**	[871] 76 **202**	[1269] 143 **202**	[1847] 209 **202**	[2410] 272 **202**	[2987] 337 **199**	[3119] 352 **198**		

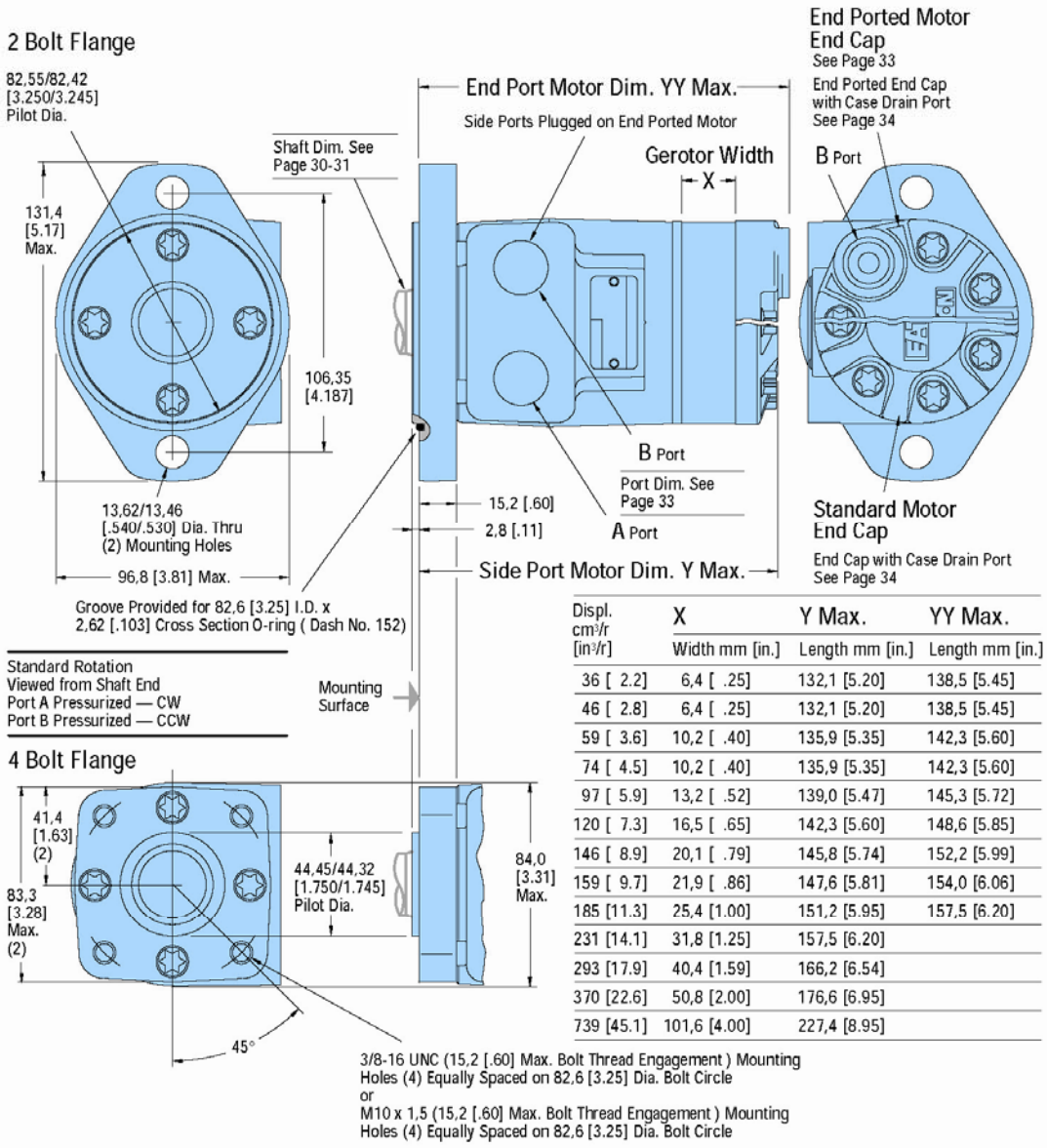
[862] 97 **152** } Torque [lb-in] Nm / Speed RPM

739 cm³/r [45.1 in³/r]
Δ Pressure Bar [PSI] Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	Max. Continuous	Max. Intermittent
[2] 7,6	[1080] 122 **10**	[2250] 254 **10**	[3440] 389 **10**		[4570] 516 **9**
[4] 15,1	[1070] 121 **20**	[2250] 254 **20**	[3440] 389 **19**		[4600] 520 **18**
[6] 22,7	[1020] 115 **30**	[2200] 249 **30**	[3390] 383 **29**		[4590] 519 **27**
[8] 30,3	[945] 107 **40**	[2135] 241 **40**	[3330] 376 **39**		[4515] 510 **37**
[10] 37,9	[840] 95 **50**	[2050] 232 **50**	[3250] 367 **48**		[4430] 501 **46**
[12] 45,4	[740] 84 **60**	[1945] 220 **59**	[3130] 354 **58**		[4320] 488 **55**
[14] 53,0	[630] 71 **69**	[1820] 206 **68**	[3005] 340 **68**		[4195] 474 **66**
Max. Continuous [15] 56,8	[540] 61 **74**	[1735] 196 **74**	[2905] 328 **73**		[4130] 467 **72**
Max. Intermittent [20] 75,7	[143] 16 **99**	[1350] 153 **98**	[2585] 290 **97**		[3705] 419 **96**

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

Dimensions
H Series



Displ. cm³/r [in³/r]	X Width mm [in.]	Y Max. Length mm [in.]	YY Max. Length mm [in.]
36 [2.2]	6,4 [.25]	132,1 [5.20]	138,5 [5.45]
46 [2.8]	6,4 [.25]	132,1 [5.20]	138,5 [5.45]
59 [3.6]	10,2 [.40]	135,9 [5.35]	142,3 [5.60]
74 [4.5]	10,2 [.40]	135,9 [5.35]	142,3 [5.60]
97 [5.9]	13,2 [.52]	139,0 [5.47]	145,3 [5.72]
120 [7.3]	16,5 [.65]	142,3 [5.60]	148,6 [5.85]
146 [8.9]	20,1 [.79]	145,8 [5.74]	152,2 [5.99]
159 [9.7]	21,9 [.86]	147,6 [5.81]	154,0 [6.06]
185 [11.3]	25,4 [1.00]	151,2 [5.95]	157,5 [6.20]
231 [14.1]	31,8 [1.25]	157,5 [6.20]	
293 [17.9]	40,4 [1.59]	166,2 [6.54]	
370 [22.6]	50,8 [2.00]	176,6 [6.95]	
739 [45.1]	101,6 [4.00]	227,4 [8.95]	

Note: Mounting Surface Flatness Requirement is ▱ ,13 mm [.005 inch] Max.

Product Numbers
H Series 101-xxxx

Product Numbers—H Series

Add three digit prefix —101-to four digit number from chart for complete product number—Example 101-1868.
Orders will not be accepted without three digit prefix.

Mounting	Shaft	Ports	Displ. cm³/r [in³/r] Product Number 101-xxxx												
			36 [2.2]	46 [2.8]	59 [3.6]	74 [4.5]	97 [5.9]	120 [7.3]	146 [8.9]	159 [9.7]	185 [11.3]	231 [14.1]	293 [17.9]	370 [22.6]	740 [45.0]
2 Bolt Flange	1 in. Straight w/Woodruff Key	7/8-14 O-ring	101-1700	-1033	-1701	-1034	-1035	-1702	-1703	-1036	-1037	-1038	-1039	-1040	—
		1/2 NPTF	101-1704	-1025	-1705	-1026	-1027	-1706	-1707	-1028	-1029	-1030	-1031	-1032	—
		Manifold*	101-1708	-1041	-1709	-1042	-1043	-1710	-1711	-1044	-1045	-1046	-1047	-1048	—
	1 in. SAE 6B Splined	7/8-14 O-ring	101-1721	-1081	-1722	-1082	-1083	-1723	-1724	-1084	-1085	-1086	-1087	-1088	—
		1/2 NPTF	101-1725	-1073	-1726	-1074	-1075	-1727	-1728	-1076	-1077	-1078	-1079	-1080	—
		Manifold*	101-1729	-1089	-1730	-1090	-1091	-1731	-1732	-1092	-1093	-1094	-1095	-1096	—
	1 in. Straight w/ .31 Dia. Crosshole	7/8-14 O-ring	101-1796	-1797	-1798	-1799	-1800	-1801	-1802	-1803	—	—	—	—	—
		1/2 NPTF	101-1804	-1805	-1806	-1807	-1808	-1870	-1809	-1810	—	—	—	—	—
		Manifold*	101-1811	-1812	-1813	-1814	-1815	-1816	-1817	-1818	—	—	—	—	—
	1 in. Straight w/ .40 Dia. Crosshole	7/8-14 O-ring	101-1819	-1323	-1820	-1324	-1325	-1821	-1822	-1326	—	—	—	—	—
		1/2 NPTF	101-1823	-1319	-1824	-1320	-1825	-1826	-1827	-1828	—	—	—	—	—
		Manifold*	101-1829	-1463	-1830	-1831	-1832	-1833	-1834	-1871	—	—	—	—	—
4 Bolt Flange	1 in. Straight w/Woodruff Key	7/8-14 O-ring	101-1749	-1009	-1750	-1010	-1011	-1751	-1752	-1012	-1013	-1014	-1015	-1016	—
		1/2 NPTF	101-1753	-1001	-1754	-1002	-1003	-1755	-1756	-1004	-1005	-1006	-1007	-1008	—
		Manifold*	101-1757	-1017	-1758	-1018	-1019	-1759	-1760	-1020	-1021	-1022	-1023	-1024	—
	1 in. SAE 6B Splined	7/8-14 O-ring	101-1761	-1057	-1762	-1058	-1059	-1872	-1763	-1060	-1061	-1062	-1063	-1064	—
		1/2 NPTF	101-1764	-1049	-1765	-1050	-1051	-1766	-1767	-1052	-1053	-1054	-1055	-1056	—
		Manifold*	101-1768	-1065	-1769	-1066	-1067	-1770	-1771	-1068	-1069	-1070	-1071	-1072	—
	1 in. Straight w/ .31 Dia. Crosshole	7/8-14 O-ring	101-1835	-1836	-1837	-1838	-1839	-1840	-1841	-1842	—	—	—	—	—
		1/2 NPTF	101-1843	-1497	-1844	-1449	-1352	-1845	-1846	-1847	—	—	—	—	—
		Manifold*	101-1848	-1466	-1849	-1459	-1850	-1851	-1852	-1853	—	—	—	—	—
	1 in. Straight w/ .40 Dia. Crosshole	7/8-14 O-ring	101-1854	-1311	-1855	-1856	-1857	-1858	-1859	-1860	—	—	—	—	—
		1/2 NPTF	101-1861	-1313	-1862	-1312	-1314	-1863	-1864	-1315	—	—	—	—	—
		Manifold*	101-1865	-1305	-1866	-1306	-1307	-1867	-1868	-1869	—	—	—	—	—

101-1868

Product Numbers—H Series Motors with Corrosion Protection

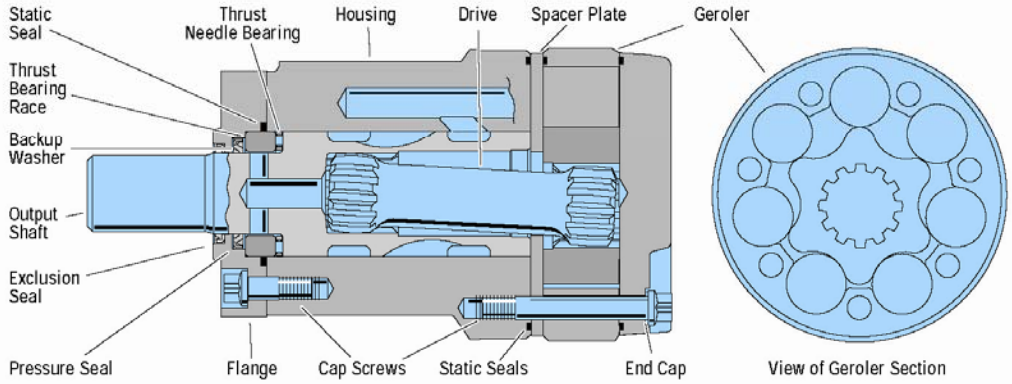
Mounting	Shaft	Ports	Displ. cm³/r [in³/r] Product Number 101-xxxx												
			36 [2.2]	46 [2.8]	59 [3.6]	74 [4.5]	97 [5.9]	120 [7.3]	146 [8.9]	159 [9.7]	185 [11.3]	231 [14.1]	293 [17.9]	370 [22.6]	740 [45.0]
4 Bolt Flange	1 in. Straight w/Woodruff Key	1/2 NPTF	101-2032	-2014	-2093	-2027	-2013	-2094	-2095	-2015	-2028	-2029	-2030	-2031	—
		Manifold*		-2067							-2068	-2069			

*Manifold product numbers shown are for motors with four 5/16-18 port face mounting threads. Manifold, manifold mounting o-rings and bolts are NOT included (for M8 x 1,5 port face mounting threads see note below).

For H Series Motors with a configuration *Not Shown* in the charts above: Use the model code number system on page 37 to specify the product in detail.

For H Series Motors with Low Speed Valving — See Page 28.

Specifications
S Series



Specification Data—S Series

Displ. cm³/r [cu. in³/r]		59 [3.6]	74 [4.5]	97 [5.9]	120 [7.3]	146 [8.9]	159 [9.7]	185 [11.3]	231 [14.1]	293 [17.9]	370 [22.6]
Max. Speed (RPM) @ Continuous Flow		962	762	585	470	385	353	303	243	192	153
Flow LPM [GPM]	Continuous	57 [15]	57 [15]	57 [15]	57 [15]	57 [15]	57 [15]	57 [15]	57 [15]	57 [15]	57 [15]
	Intermittent	68 [18]	76 [20]	76 [20]	76 [20]	76 [20]	76 [20]	76 [20]	76 [20]	76 [20]	76 [20]
Torque Nm [lb-in]	Continuous	107 [943]	139 [1228]	181 [1591]	227 [2010]	263 [2332]	291 [2567]	324 [2870]	369 [3265]	411 [3641]	452 [4004]
	Intermittent **	133 [1174]	173 [1529]	225 [1991]	281 [2490]	323 [2861]	347 [3072]	390 [3450]	438 [3877]	485 [4295]	514 [4548]
Min. Starting Torque Nm[lb-in]	@ Cont. Pressure	90 [800]	113 [1000]	148 [1310]	184 [1630]	212 [1880]	232 [2050]	263 [2330]	302 [2670]	338 [2990]	369 [3270]
	@ Int. Pressure	116 [1030]	146 [1290]	190 [1680]	236 [2090]	271 [2400]	289 [2560]	329 [2910]	374 [3310]	417 [3690]	438 [3880]
Pressure Δ Bar [Δ PSI]	Continuous*	138 [2000]	138 [2000]	138 [2000]	138 [2000]	131 [1900]	131 [1900]	128 [1850]	117 [1700]	103 [1500]	90 [1300]
	Intermittent* **	172 [2500]	172 [2500]	172 [2500]	172 [2500]	162 [2350]	159 [2300]	155 [2250]	141 [2050]	124 [1800]	103 [1500]

Maximum Case Pressure - without Case Drain — 103 Bar [1500 PSI] — See Page 34-35

* Maximum intermittent pressure at motor inlet port of 172 Bar [2500 PSI] without regard to Δ Bar [Δ PSI] and/or back pressure ratings or combination thereof.

** A simultaneous maximum torque and maximum speed NOT recommended.

6B Splined or Tapered shafts are recommended whenever operating above 282 Nm [2500 lb-in] of torque, especially for those applications subject to frequent reversals (see page 30).

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.

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

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

To assure optimum 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
S 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.

59 cm³/r [3.6 in³/r]

Δ Pressure Bar [PSI] Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1800] 124	[2000] 138	Max. Continuous	Max. Intermittent
[2] 7,6	[89] 10 128	[191] 22 127	[289] 33 122	[382] 43 119	[477] 54 114	[571] 65 106	[665] 75 97	[755] 85 84	[834] 94 54			
[4] 15,1	[91] 10 257	[187] 21 254	[283] 32 251	[372] 42 247	[474] 54 241	[572] 65 235	[666] 75 225	[764] 86 214	[849] 96 197	[942] 106 178		
[6] 22,7	[84] 9 385	[176] 20 384	[276] 31 380	[371] 42 376	[469] 53 370	[563] 64 363	[658] 74 355	[753] 85 341	[851] 96 323	[943] 107 300	[1174] 133 187	
[8] 30,3	[75] 8 513	[168] 19 512	[269] 30 509	[364] 41 503	[456] 52 498	[556] 63 491	[657] 74 480	[752] 85 468	[846] 96 450	[939] 106 427	[1174] 133 334	
[10] 37,9	[66] 7 642	[160] 18 640	[258] 29 636	[354] 40 632	[446] 50 626	[544] 61 617	[642] 73 606	[738] 83 594	[834] 94 577	[928] 105 555	[1167] 132 463	
[12] 45,4	[54] 6 770	[147] 17 768	[247] 28 764	[345] 39 758	[441] 50 753	[537] 61 744	[633] 72 733	[728] 82 720	[823] 93 702	[920] 104 678	[1158] 131 585	
[14] 53,0	[39] 4 898	[133] 15 896	[235] 27 891	[327] 37 885	[428] 48 878	[524] 59 871	[618] 70 860	[714] 81 845	[811] 92 827	[907] 102 803	[1145] 129 700	
Max. Continuous [15] 56,8	[29] 3 962	[125] 14 959	[228] 26 955	[321] 36 948	[422] 48 941	[519] 59 933	[613] 69 923	[708] 80 907	[805] 91 889	[901] 102 864	[1138] 129 760	
Max. Intermittent [18] 68,1	[13] 1 1155	[107] 12 1151	[206] 23 1146	[300] 34 1137	[398] 45 1129	[502] 57 1120	[593] 67 1111	[689] 78 1094	[783] 88 1076	[879] 99 1049		

74 cm³/r [4.5 in³/r]

Δ Pressure Bar [PSI] Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1800] 124	[2000] 138	Max. Continuous	Max. Intermittent
[2] 7,6	[116] 13 102	[248] 28 100	[376] 42 97	[498] 56 94	[620] 70 90	[743] 84 84	[865] 98 77	[983] 111 66	[1086] 123 42			
[4] 15,1	[119] 13 203	[244] 28 201	[369] 42 199	[484] 55 196	[618] 70 191	[744] 84 186	[867] 98 178	[995] 112 170	[1105] 125 156	[1227] 139 141		
[6] 22,7	[109] 12 305	[229] 26 304	[359] 41 301	[483] 55 298	[611] 69 293	[733] 83 288	[857] 97 281	[981] 111 270	[1108] 125 256	[1228] 139 238	[1529] 173 148	
[8] 30,3	[97] 11 407	[219] 25 405	[351] 40 403	[474] 54 399	[594] 67 394	[725] 82 389	[856] 97 380	[979] 111 371	[1101] 124 357	[1223] 138 338	[1529] 173 264	
[10] 37,9	[86] 10 508	[209] 24 507	[335] 38 504	[461] 52 501	[580] 66 496	[709] 80 489	[836] 94 480	[961] 109 471	[1086] 123 457	[1209] 137 440	[1520] 172 367	
[12] 45,4	[70] 8 610	[191] 22 608	[322] 36 605	[449] 51 601	[574] 65 596	[699] 79 589	[824] 93 580	[948] 107 570	[1072] 121 556	[1198] 135 537	[1508] 170 464	
[14] 53,0	[51] 6 711	[173] 20 709	[307] 35 706	[425] 48 701	[558] 63 696	[682] 77 690	[805] 91 681	[930] 105 669	[1056] 119 655	[1181] 133 636	[1491] 168 554	
Max. Continuous [15] 56,8	[37] 4 762	[163] 18 760	[296] 33 756	[418] 47 751	[550] 62 745	[676] 76 739	[799] 90 731	[921] 104 718	[1048] 118 704	[1173] 133 685	[1482] 167 602	
Max. Intermittent [20] 75,7	[18] 2 1016	[89] 10 1013	[242] 27 1008	[369] 42 1001	[528] 60 994	[645] 73 986	[762] 86 979	[884] 100 964	[1001] 113 948	[1117] 126 925		

97 cm³/r [5.9 in³/r]

Δ Pressure Bar [PSI] Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1800] 124	[2000] 138	Max. Continuous	Max. Intermittent
[2] 7,6	[152] 17 78	[324] 37 77	[490] 55 74	[649] 73 72	[808] 91 69	[968] 109 64	[1127] 127 59	[1280] 145 51	[1414] 160 33			
[4] 15,1	[155] 18 156	[318] 36 154	[480] 54 153	[630] 71 151	[804] 91 147	[969] 109 143	[1129] 127 137	[1296] 146 130	[1439] 163 120	[1598] 181 109		
[6] 22,7	[142] 16 234	[298] 34 233	[467] 53 231	[629] 71 229	[796] 90 225	[955] 108 221	[1116] 126 216	[1278] 144 207	[1443] 163 196	[1599] 181 183	[1991] 225 114	
[8] 30,3	[126] 14 312	[285] 32 311	[457] 52 310	[618] 70 306	[774] 87 303	[943] 107 298	[1115] 126 292	[1274] 144 285	[1434] 162 274	[1593] 180 260	[1991] 225 203	
[10] 37,9	[112] 13 390	[272] 31 389	[437] 49 387	[600] 68 384	[756] 85 381	[923] 104 375	[1089] 123 369	[1251] 141 361	[1414] 160 351	[1574] 178 338	[1979] 224 282	
[12] 45,4	[92] 10 469	[249] 28 467	[419] 47 465	[584] 66 461	[748] 85 459	[910] 103 453	[1073] 121 446	[1235] 140 439	[1396] 158 427	[1560] 176 412	[1964] 222 356	
[14] 53,0	[66] 7 546	[225] 25 545	[399] 45 542	[554] 63 538	[726] 82 534	[888] 100 530	[1049] 119 523	[1210] 137 514	[1375] 155 503	[1538] 174 488	[1941] 219 425	
Max. Continuous [15] 56,8	[49] 6 585	[213] 24 584	[386] 44 581	[544] 61 577	[716] 81 572	[880] 99 568	[1040] 118 561	[1200] 136 552	[1364] 154 540	[1527] 173 526	[1930] 218 462	
Max. Intermittent [20] 75,7	[24] 3 781	[115] 13 778	[315] 36 774	[481] 54 769	[688] 78 763	[839] 95 757	[993] 112 752	[1151] 130 740	[1303] 147 728	[1455] 164 710		

120 cm³/r [7.3 in³/r]

Δ Pressure Bar [PSI] Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1800] 124	[2000] 138	Max. Continuous	Max. Intermittent
[2] 7,6	[190] 21 63	[403] 46 62	[608] 69 60	[814] 92 58	[1017] 115 56	[1214] 137 52	[1411] 159 47	[1598] 181 41	[1770] 200 31	[1947] 220 27		
[4] 15,1	[192] 22 125	[400] 45 124	[606] 68 122	[803] 91 121	[1014] 115 118	[1221] 138 115	[1422] 161 111	[1627] 184 106	[1815] 205 100	[2008] 227 93		
[6] 22,7	[178] 20 188	[380] 43 187	[591] 67 185	[798] 90 183	[1006] 114 181	[1209] 137 177	[1413] 160 173	[1615] 182 167	[1815] 205 158	[2010] 227 148	[2485] 281 113	
[8] 30,3	[161] 18 250	[366] 41 249	[579] 65 248	[782] 88 246	[982] 111 243	[1193] 135 240	[1403] 159 235	[1605] 181 230	[1804] 204 221	[2003] 226 211	[2490] 281 174	
[10] 37,9	[144] 16 313	[351] 40 312	[556] 63 310	[760] 86 309	[963] 109 305	[1172] 132 302	[1381] 156 297	[1579] 178 292	[1786] 202 283	[1984] 224 274	[2487] 281 235	
[12] 45,4	[124] 14 376	[323] 36 374	[527] 60 372	[739] 83 370	[950] 107 369	[1153] 130 364	[1359] 154 359	[1561] 176 354	[1761] 199 346	[1966] 222 335	[2466] 279 300	
[14] 53,0	[93] 11 438	[296] 33 437	[507] 57 434	[709] 80 432	[920] 104 430	[1123] 127 426	[1328] 150 421	[1532] 173 415	[1738] 196 407	[1940] 219 396	[2446] 276 357	
Max. Continuous [15] 56,8	[72] 8 470	[281] 32 468	[491] 55 466	[696] 79 463	[907] 102 461	[1110] 125 457	[1316] 149 452	[1519] 172 446	[1722] 195 438	[1928] 218 427	[2426] 274 388	
Max. Intermittent [20] 75,7		[179] 20 624	[409] 46 621	[617] 70 618	[851] 96 614	[1047] 118 610	[1249] 141 607	[1448] 164 600	[1644] 186 591	[1837] 208 579		

[281] 32 } Torque [lb-in] Nm
468 Speed RPM

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

Performance Data
S 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.

146 cm³/r [8.9 in³/r]

Δ Pressure Bar [PSI] — Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1800] 124	[1900] 131	Max. Continuous [2350] 162
[2] 7,6	[231] 26 **51**	[491] 55 **50**	[741] 84 **49**	[993] 112 **48**	[1239] 140 **46**	[1480] 167 **42**	[1720] 194 **39**	[1949] 220 **34**	[2159] 244 **25**	[2267] 256 **24**	
[4] 15,1	[234] 26 **103**	[488] 55 **102**	[739] 83 **100**	[979] 111 **99**	[1237] 140 **97**	[1489] 168 **95**	[1734] 196 **91**	[1984] 224 **87**	[2212] 250 **82**	[2331] 263 **79**	
[6] 22,7	[217] 25 **154**	[464] 52 **153**	[721] 81 **152**	[972] 110 **150**	[1227] 139 **148**	[1474] 167 **145**	[1722] 195 **142**	[1969] 222 **137**	[2213] 250 **130**	[2332] 263 **126**	[2859] 323 **105**
[8] 30,3	[196] 22 **205**	[447] 51 **204**	[706] 80 **203**	[954] 108 **201**	[1197] 135 **200**	[1454] 164 **197**	[1711] 193 **193**	[1956] 221 **188**	[2199] 248 **182**	[2321] 262 **177**	[2861] 323 **156**
[10] 37,9	[176] 20 **267**	[428] 48 **266**	[678] 77 **255**	[926] 105 **253**	[1174] 133 **251**	[1429] 161 **247**	[1684] 190 **244**	[1925] 217 **239**	[2178] 246 **232**	[2298] 260 **229**	[2841] 321 **207**
[12] 45,4	[151] 17 **308**	[394] 45 **307**	[643] 73 **305**	[902] 102 **304**	[1159] 131 **302**	[1405] 159 **298**	[1657] 187 **294**	[1903] 215 **290**	[2147] 243 **284**	[2271] 257 **279**	[2828] 320 **258**
[14] 53,0	[113] 13 **360**	[361] 41 **358**	[618] 70 **356**	[864] 98 **355**	[1121] 127 **353**	[1369] 155 **350**	[1619] 183 **346**	[1868] 211 **340**	[2118] 239 **334**	[2241] 253 **330**	[2791] 315 **307**
Max. Continuous [15] 56,8	[88] 10 **385**	[343] 39 **384**	[599] 68 **382**	[848] 96 **380**	[1106] 125 **378**	[1353] 153 **375**	[1605] 181 **371**	[1852] 209 **365**	[2099] 237 **359**	[2224] 251 **355**	[2771] 313 **332**
Max. Intermittent [20] 75,7		[218] 25 **512**	[499] 56 **510**	[752] 85 **507**	[1037] 117 **504**	[1277] 144 **501**	[1523] 172 **498**	[1765] 199 **492**	[2004] 226 **485**	[2121] 240 **480**	

159 cm³/r [9.7 in³/r]

Δ Pressure Bar [PSI] — Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1800] 124	[1900] 131	Max. Continuous [2300] 159
[2] 7,6	[253] 29 **47**	[536] 61 **46**	[805] 91 **45**	[1090] 123 **44**	[1364] 154 **42**	[1623] 183 **39**	[1884] 213 **35**	[2129] 241 **31**	[2365] 267 **26**	[2477] 280 **23**	
[4] 15,1	[254] 29 **94**	[537] 61 **93**	[816] 92 **92**	[1091] 123 **91**	[1365] 154 **89**	[1641] 185 **87**	[1910] 216 **84**	[2180] 246 **81**	[2440] 276 **77**	[2567] 291 **76**	[3042] 343 **65**
[6] 22,7	[238] 27 **141**	[517] 58 **140**	[797] 90 **139**	[1079] 121 **138**	[1356] 153 **136**	[1632] 184 **134**	[1906] 215 **130**	[2177] 245 **126**	[2434] 275 **119**	[2565] 289 **116**	[3059] 345 **100**
[8] 30,3	[217] 24 **188**	[502] 56 **187**	[784] 88 **186**	[1057] 119 **185**	[1328] 150 **183**	[1608] 181 **181**	[1884] 212 **178**	[2155] 243 **174**	[2421] 273 **168**	[2554] 288 **164**	[3072] 347 **147**
[10] 37,9	[198] 22 **236**	[484] 54 **235**	[754] 85 **233**	[1025] 115 **232**	[1307] 147 **230**	[1587] 179 **227**	[1868] 211 **224**	[2126] 240 **221**	[2406] 271 **215**	[2537] 286 **212**	[3055] 345 **194**
[12] 45,4	[177] 20 **283**	[446] 50 **281**	[707] 79 **280**	[998] 112 **278**	[1289] 145 **277**	[1556] 175 **274**	[1837] 207 **271**	[2103] 237 **268**	[2369] 267 **262**	[2505] 283 **259**	[3044] 344 **242**
[14] 53,0	[137] 15 **330**	[415] 46 **328**	[685] 77 **326**	[966] 109 **326**	[1242] 140 **324**	[1514] 171 **322**	[1794] 202 **318**	[2069] 233 **314**	[2341] 264 **309**	[2475] 279 **305**	[3005] 339 **289**
Max. Continuous [15] 56,8	[110] 12 **353**	[395] 44 **352**	[667] 75 **350**	[947] 107 **349**	[1225] 138 **348**	[1493] 168 **345**	[1776] 200 **341**	[2052] 231 **337**	[2317] 261 **333**	[2455] 277 **329**	[2983] 337 **313**
Max. Intermittent [20] 75,7		[284] 32 **469**	[565] 63 **468**	[844] 95 **466**	[1123] 126 **463**	[1394] 157 **462**	[1675] 189 **459**	[1942] 219 **455**	[2211] 249 **450**	[2342] 264 **446**	

185 cm³/r [11.3 in³/r]

Δ Pressure Bar [PSI] — Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1800] 124	[1850] 128	Max. Continuous [2250] 155
[2] 7,6	[296] 33 **40**	[623] 70 **40**	[942] 106 **39**	[1263] 143 **38**	[1577] 178 **36**	[1874] 212 **34**	[2172] 245 **31**	[2450] 277 **27**	[2499] 282 **21**	[2500] 282 **20**	
[4] 15,1	[294] 33 **81**	[619] 70 **80**	[947] 107 **80**	[1265] 143 **79**	[1588] 179 **77**	[1896] 214 **76**	[2200] 249 **73**	[2503] 283 **71**	[2796] 316 **68**	[2868] 324 **67**	[3439] 389 **63**
[6] 22,7	[277] 31 **121**	[602] 68 **121**	[928] 105 **120**	[1255] 142 **119**	[1574] 178 **117**	[1889] 213 **115**	[2196] 248 **112**	[2505] 283 **108**	[2796] 316 **103**	[2870] 324 **101**	[3448] 390 **97**
[8] 30,3	[255] 29 **162**	[582] 66 **161**	[908] 103 **161**	[1229] 139 **160**	[1546] 175 **158**	[1864] 211 **156**	[2180] 246 **153**	[2487] 281 **150**	[2786] 315 **144**	[2861] 323 **142**	[3450] 390 **130**
[10] 37,9	[231] 26 **202**	[560] 63 **202**	[879] 99 **201**	[1195] 135 **200**	[1521] 172 **198**	[1838] 208 **196**	[2160] 244 **193**	[2460] 278 **190**	[2766] 313 **184**	[2841] 321 **183**	[3433] 388 **170**
[12] 45,4	[199] 22 **243**	[522] 59 **242**	[832] 94 **241**	[1163] 131 **240**	[1491] 168 **239**	[1803] 204 **237**	[2127] 240 **234**	[2434] 275 **231**	[2734] 309 **225**	[2810] 317 **224**	[3414] 386 **212**
[14] 53,0	[157] 18 **283**	[485] 55 **283**	[802] 91 **281**	[1124] 127 **281**	[1444] 163 **279**	[1763] 199 **277**	[2080] 235 **274**	[2392] 270 **271**	[2698] 305 **266**	[2774] 313 **264**	[3378] 382 **250**
Max. Continuous [15] 56,8	[132] 15 **303**	[461] 52 **303**	[780] 88 **302**	[1103] 125 **301**	[1422] 161 **299**	[1739] 196 **298**	[2059] 233 **295**	[2372] 268 **291**	[2674] 302 **286**	[2751] 311 **285**	[3374] 381 **271**
Max. Intermittent [20] 75,7		[335] 38 **404**	[662] 75 **403**	[987] 112 **401**	[1307] 148 **399**	[1623] 183 **397**	[1930] 218 **395**	[2227] 252 **392**	[2524] 285 **387**	[2597] 293 **385**	

231 cm³/r [14.1 in³/r]

Δ Pressure Bar [PSI] — Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1700] 117	Max. Continuous [2050] 141	Max. Intermittent
[2] 7,6	[372] 42 **32**	[776] 88 **32**	[1182] 134 **31**	[1567] 177 **30**	[1952] 221 **28**	[2317] 262 **28**	[2682] 303 **22**	[3019] 341 **21**	[2925] 330 **19**		
[4] 15,1	[364] 41 **65**	[764] 86 **65**	[1178] 133 **64**	[1572] 178 **63**	[1979] 224 **62**	[2346] 265 **62**	[2714] 307 **60**	[3078] 348 **58**	[3255] 368 **57**		[3871] 437 **54**
[6] 22,7	[345] 39 **97**	[750] 85 **97**	[1156] 131 **97**	[1564] 177 **96**	[1958] 221 **95**	[2342] 265 **93**	[2710] 306 **91**	[3087] 349 **87**	[3265] 369 **85**		[3875] 438 **74**
[8] 30,3	[320] 36 **130**	[723] 82 **130**	[1128] 127 **129**	[1530] 173 **129**	[1928] 218 **128**	[2315] 262 **126**	[2702] 305 **123**	[3073] 347 **121**	[3254] 368 **118**		[3877] 438 **108**
[10] 37,9	[288] 33 **162**	[693] 78 **162**	[1098] 124 **162**	[1492] 169 **161**	[1896] 214 **160**	[2280] 258 **158**	[2675] 302 **156**	[3050] 345 **152**	[3228] 365 **150**		[3858] 436 **140**
[12] 45,4	[239] 27 **195**	[654] 74 **195**	[1047] 118 **194**	[1453] 164 **193**	[1849] 209 **192**	[2238] 253 **191**	[2637] 298 **188**	[3016] 341 **185**	[3199] 361 **183**		[3825] 432 **174**
[14] 53,0	[194] 22 **227**	[608] 69 **227**	[1004] 113 **227**	[1402] 158 **225**	[1798] 203 **225**	[2199] 248 **223**	[2583] 292 **221**	[2963] 335 **218**	[3147] 356 **216**		[3786] 428 **206**
Max. Continuous [15] 56,8	[189] 21 **243**	[577] 65 **243**	[977] 110 **243**	[1375] 155 **241**	[1768] 200 **241**	[2170] 245 **240**	[2557] 289 **237**	[2936] 332 **234**	[3121] 353 **232**		[3766] 426 **222**
Max. Intermittent [20] 75,7		[424] 48 **324**	[832] 94 **324**	[1236] 140 **322**	[1628] 184 **321**	[2023] 229 **319**	[2381] 269 **318**	[2736] 309 **315**	[2910] 329 **313**		

[977] 110 } Torque [lb-in] Nm
243 } Speed RPM

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

Performance Data
S 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.

293 cm³/r [17.9 in³/r]

Flow LPM [GPM]	Δ Pressure Bar [PSI] Continuous [200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1500] 103	Max. Continuous [1800] 124	Max. Intermittent
[2] 7,6	[471] 53 **26**	[990] 112 **25**	[1502] 170 **25**	[1995] 225 **24**	[2393] 270 **20**	[2837] 321 **17**	[3270] 369 **12**			
[4] 15,1	[465] 53 **51**	[988] 112 **51**	[1502] 170 **50**	[2001] 226 **50**	[2499] 282 **49**	[2967] 335 **49**	[3413] 386 **47**	[3638] 411 **46**	[4295] 485 **42**	
[6] 22,7	[443] 50 **77**	[959] 108 **77**	[1474] 167 **76**	[1985] 224 **76**	[2477] 280 **75**	[2955] 334 **73**	[3415] 386 **69**	[3641] 411 **67**	[4293] 485 **59**	
[8] 30,3	[411] 46 **102**	[927] 105 **102**	[1433] 162 **102**	[1946] 220 **102**	[2439] 276 **101**	[2916] 329 **100**	[3402] 384 **95**	[3624] 409 **93**	[4269] 482 **84**	
[10] 37,9	[372] 42 **128**	[882] 100 **128**	[1393] 157 **128**	[1890] 214 **127**	[2399] 271 **126**	[2872] 324 **125**	[3354] 379 **122**	[3583] 405 **119**	[4251] 480 **112**	
[12] 45,4	[318] 36 **163**	[837] 95 **153**	[1340] 151 **153**	[1844] 208 **153**	[2340] 264 **152**	[2820] 319 **150**	[3308] 374 **147**	[3543] 400 **145**	[4235] 478 **137**	
[14] 53,0	[253] 29 **179**	[773] 87 **179**	[1281] 145 **179**	[1784] 202 **178**	[2275] 257 **178**	[2770] 313 **176**	[3251] 367 **173**	[3482] 393 **171**	[4166] 471 **164**	
Max. Continuous [15] 56,8	[225] 25 **192**	[738] 83 **192**	[1244] 141 **191**	[1748] 197 **191**	[2240] 253 **190**	[2731] 309 **189**	[3218] 364 **185**	[3450] 390 **183**	[4136] 467 **177**	
Max. Intermittent [20] 75,7		[558] 63 **256**	[1077] 122 **255**	[1577] 178 **255**	[2065] 233 **254**	[2546] 288 **253**	[3010] 340 **250**	[3230] 365 **247**		

370 cm³/r [22.6 in³/r]

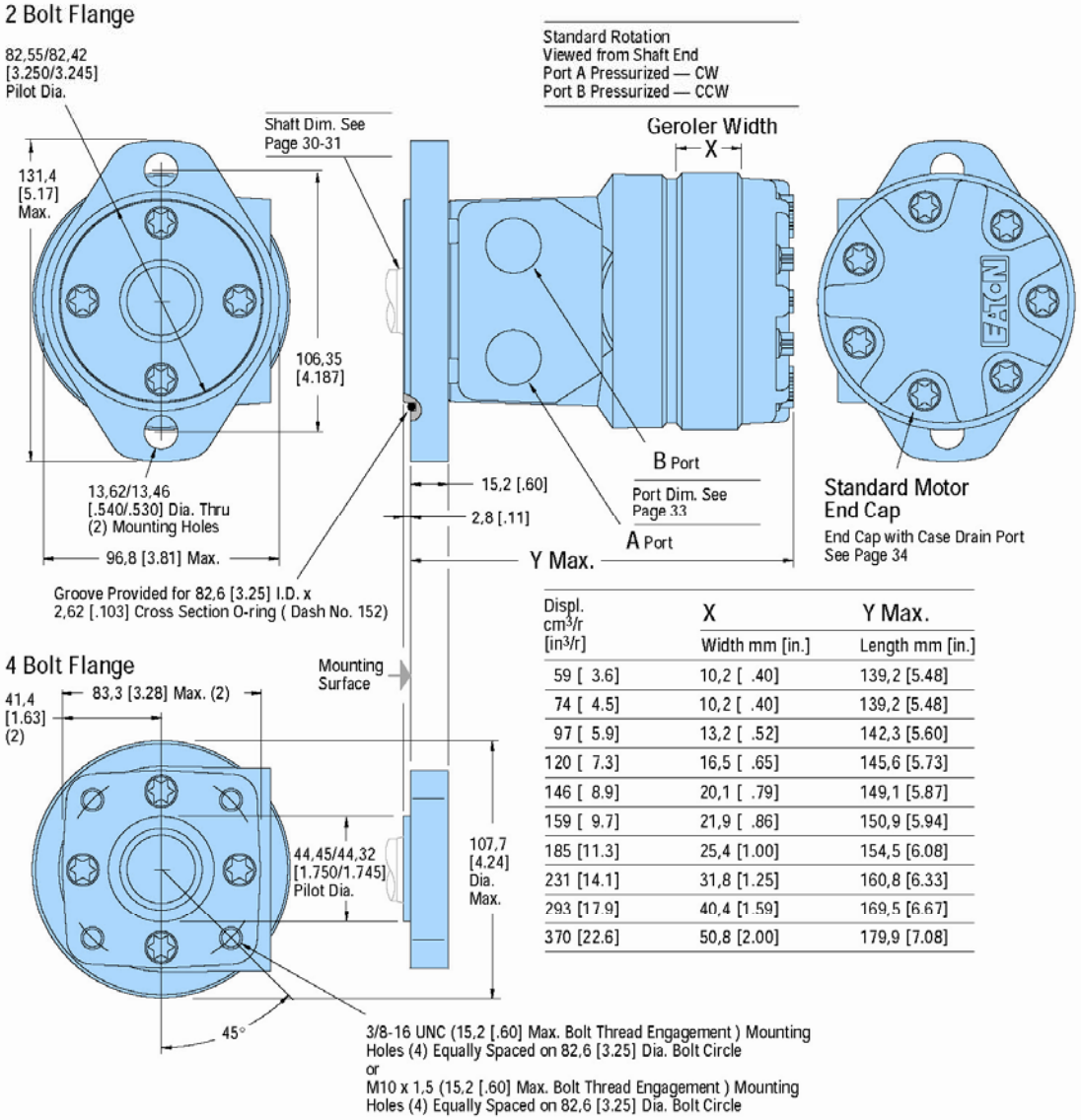
Flow LPM [GPM]	Δ Pressure Bar [PSI] Continuous [200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1300] 90	Max. Continuous [1500] 103	Max. Intermittent
[2] 7,6	[593] 67 **21**	[1256] 142 **20**	[1898] 214 **20**	[2525] 285 **19**	[3082] 348 **14**	[3655] 413 **10**	[3935] 445 **7**		
[4] 15,1	[590] 67 **41**	[1270] 143 **41**	[1905] 215 **40**	[2534] 286 **40**	[3139] 355 **39**	[3734] 422 **39**	[4004] 452 **38**	[4544] 513 **37**	
[6] 22,7	[566] 64 **62**	[1218] 138 **61**	[1869] 211 **61**	[2506] 283 **60**	[3117] 352 **60**	[3708] 419 **57**	[3996] 451 **55**	[4548] 514 **50**	
[8] 30,3	[524] 59 **82**	[1181] 133 **82**	[1810] 205 **81**	[2461] 278 **81**	[3069] 347 **80**	[3652] 413 **79**	[3956] 447 **77**	[4523] 511 **71**	
[10] 37,9	[477] 54 **102**	[1117] 126 **102**	[1757] 199 **101**	[2381] 269 **101**	[3019] 341 **100**	[3596] 406 **99**	[3889] 439 **97**	[4459] 504 **93**	
[12] 45,4	[419] 47 **123**	[1067] 121 **122**	[1705] 193 **122**	[2326] 263 **122**	[2945] 333 **120**	[3533] 399 **119**	[3830] 433 **118**	[4416] 499 **113**	
[14] 53,0	[328] 37 **143**	[976] 110 **143**	[1625] 184 **143**	[2259] 255 **142**	[2862] 323 **141**	[3470] 392 **140**	[3768] 426 **138**	[4348] 491 **133**	
Max. Continuous [15] 56,8	[297] 34 **153**	[939] 106 **153**	[1576] 178 **153**	[2210] 250 **152**	[2824] 319 **151**	[3418] 386 **150**	[3721] 420 **148**	[4309] 487 **144**	
Max. Intermittent [20] 75,7		[729] 82 **203**	[1387] 157 **203**	[2001] 226 **202**	[2604] 294 **202**	[3186] 360 **201**	[3482] 393 **199**		

[939] 106 **153** } Torque [lb-in] Nm Speed RPM

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

Dimensions
S Series

2 Bolt Flange



Displ. cm^3/r [in^3/r]	X	Y Max.
	Width mm [in.]	Length mm [in.]
59 [3.6]	10,2 [.40]	139,2 [5.48]
74 [4.5]	10,2 [.40]	139,2 [5.48]
97 [5.9]	13,2 [.52]	142,3 [5.60]
120 [7.3]	16,5 [.65]	145,6 [5.73]
146 [8.9]	20,1 [.79]	149,1 [5.87]
159 [9.7]	21,9 [.86]	150,9 [5.94]
185 [11.3]	25,4 [1.00]	154,5 [6.08]
231 [14.1]	31,8 [1.25]	160,8 [6.33]
293 [17.9]	40,4 [1.59]	169,5 [6.67]
370 [22.6]	50,8 [2.00]	179,9 [7.08]

Note: Mounting Surface Flatness Requirement is ▱ ,13 mm [.005 inch] Max.

Product Numbers
S Series 103-xxxx

Product Numbers—S Series

Add three digit prefix —103-to four digit number from chart for complete product number—Example 103-1537.
Orders will not be accepted without three digit prefix.

Mounting	Shaft	Ports	Displ. cm³/r [in³/r] Product Number 103-xxxx 59 [3.6]	74 [4.5]	97 [5.9]	120 [7.3]	146 [8.9]	159 [9.7]	185 [11.3]	231 [14.1]	293 [17.9]	370 [22.6]
2 Bolt Flange	1 in. Straight w/Woodruff Key	7/8-14 O-ring	103-1537	-1034	-1035	-1538	-1539	-1036	-1037	-1038	-1039	-1040
		1/2 NPTF	103-1540	-1026	-1027	-1541	-1542	-1028	-1029	-1030	-1031	-1032
		Manifold*	103-1543	-1042	-1043	-1544	-1545	-1044	-1045	-1046	-1047	-1048
	1 in. SAE 6B Splined	7/8-14 O-ring	103-1552	-1082	-1083	-1553	-1554	-1084	-1085	-1086	-1087	-1088
		1/2 NPTF	103-1555	-1074	-1075	-1556	-1557	-1076	-1077	-1078	-1079	-1080
		Manifold*	103-1558	-1090	-1091	-1559	-1560	-1092	-1093	-1094	-1095	-1096
4 Bolt Flange	1 in. Straight w/Woodruff Key	7/8-14 O-ring	103-1570	-1010	-1011	-1571	-1572	-1012	-1013	-1014	-1015	-1016
		1/2 NPTF	103-1573	-1002	-1003	-1574	-1575	-1004	-1005	-1006	-1007	-1008
		Manifold*	103-1576	-1018	-1019	-1577	-1578	-1020	-1021	-1022	-1023	-1024
	1 in. SAE 6B Splined	7/8-14 O-ring	103-1579	-1058	-1059	-1580	-1581	-1060	-1061	-1062	-1063	-1064
		1/2 NPTF	103-1582	-1050	-1051	-1583	-1584	-1052	-1053	-1054	-1055	-1056
		Manifold*	103-1585	-1066	-1067	-1586	-1587	-1068	-1069	-1070	-1071	-1072

*Manifold product numbers shown are for motors with four 5/16-18 port face mounting threads. Manifold, manifold mounting o-rings and bolts are NOT included (for M8 x 1,5 port face mounting threads see note below).

103-1587

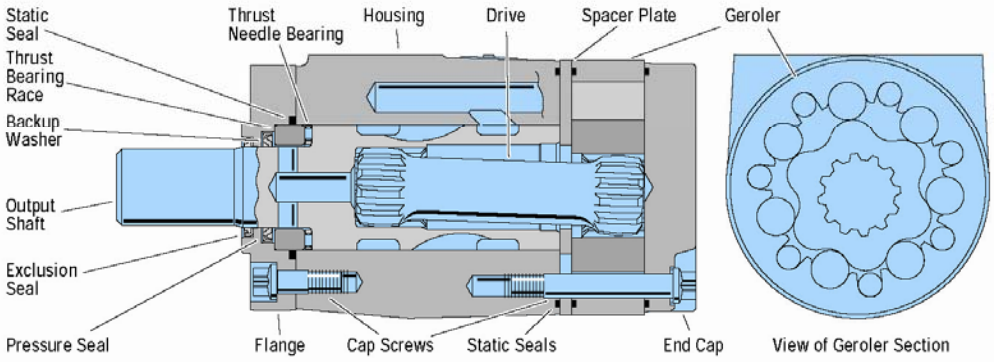
Product Numbers—S Series Motors with Corrosion Protection

Shaft	Mounting	Ports	Displ. cu. cm/rev. [cu. in./rev.] Product Number 103-xxxx 59 [3.6]	74 [4.5]	97 [5.9]	120 [7.3]	146 [8.9]	159 [9.7]	185 [11.3]	231 [14.1]	293 [17.9]	370 [22.6]
1 in. Straight w/Woodruff Key	2 Bolt Flange	7/8-14 O-ring		103-1645						-1649		-1650
	4 Bolt Flange	1/2 NPTF								-1620		-1621

For S Series Motors with a configuration Not Shown in the charts above: Use the model code number system on page 38 to specify the product in detail.

For Product Numbers—S Series Motors with Low Speed Valving — See Page 28.

Specifications
T Series



Specification Data —T Series

Displ. cm³/r [in³/r]		36 [2.2]	49 [3.0]	66 [4.0]	80 [4.9]	102 [6.2]	131 [8.0]	157 [9.6]	195 [11.9]	244 [14.9]	306 [18.7]	370 [22.6]
Max. Speed (RPM) @ Continuous Flow		1021	906	849	694	550	426	355	287	229	183	152
Flow LPM [GPM]	Continuous	38 [10]	45 [12]	57 [15]	57 [15]	57 [15]	57 [15]	57 [15]	57 [15]	57 [15]	57 [15]	57 [15]
	Intermittent	38 [10]	57 [15]	68 [18]	76 [20]	76 [20]	76 [20]	76 [20]	76 [20]	76 [20]	76 [20]	76 [20]
Torque Nm [lb-in]	Continuous	76 [672]	105 [928]	138 [1222]	174 [1541]	219 [1936]	251 [2226]	297 [2628]	359 [3178]	410 [3633]	441 [3905]	430 [3811]
	Intermittent **	93 [824]	118 [1131]	168 [1488]	212 [1872]	264 [2339]	307 [2718]	359 [3178]	437 [3864]	485 [4290]	483 [4275]	486 [4300]
Pressure Δ Bar [Δ PSI]	Continuous*	155 [2250]	155 [2250]	155 [2250]	155 [2250]	155 [2250]	138 [2000]	138 [2000]	138 [2000]	127 [1850]	110 [1600]	90 [1300]
	Intermittent* **	190 [2750]	190 [2750]	190 [2750]	190 [2750]	190 [2750]	172 [2500]	172 [2500]	172 [2500]	155 [2250]	124 [1800]	103 [1500]

Maximum Case Pressure w/o Case Drain — 103 Bar [1500 PSI] see pages 34-35.

* Maximum intermittent pressure at motor inlet port of 190 Bar [2750 PSI] without regard to Δ Bar [Δ PSI] and/or back pressure ratings or combination thereof.

** A simultaneous maximum torque and maximum speed NOT recommended.

6B Splined or Tapered shafts are recommended whenever operating above 282 Nm [2500 lb-in] of torque, especially for those applications subject to frequent reversals (see page 30).

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 36).

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
T 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.

36 cm³/r [2.2 in³/r]
Δ Pressure Bar [PSI]
Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1800] 124	[2000] 138	[2200] 152	[2250] 155	Max. Continuous [2750] 190
[2] 7,6	[50] 6 **209**	[110] 12 **203**	[172] 19 **197**	[233] 26 **191**	[291] 33 **189**	[348] 39 **181**	[401] 45 **167**	[455] 51 **164**	[501] 57 **153**	[546] 62 **139**	[590] 67 **122**	[596] 67 **116**	[635] 72 **64**
[4] 15,1	[50] 6 **415**	[109] 12 **411**	[172] 19 **398**	[233] 26 **388**	[296] 33 **384**	[355] 40 **381**	[414] 47 **368**	[475] 54 **357**	[534] 60 **354**	[584] 66 **323**	[646] 73 **304**	[659] 74 **302**	[786] 89 **283**
[6] 22,7	[43] 5 **617**	[108] 12 **613**	[171] 19 **602**	[233] 26 **595**	[298] 34 **585**	[361] 41 **570**	[420] 47 **563**	[479] 54 **558**	[538] 61 **534**	[595] 67 **520**	[657] 74 **504**	[672] 76 **496**	[824] 93 **425**
[8] 30,3	[39] 4 **821**	[101] 11 **815**	[164] 19 **803**	[226] 26 **797**	[292] 33 **784**	[354] 40 **774**	[415] 47 **758**	[475] 54 **747**	[538] 61 **732**	[592] 67 **707**	[656] 74 **688**	[670] 76 **680**	[819] 92 **607**
Max. Continuous [10] 37,9	[30] 3 **1021**	[93] 11 **1014**	[155] 18 **1002**	[214] 24 **999**	[278] 31 **981**	[342] 39 **965**	[406] 46 **953**	[473] 53 **937**	[532] 60 **921**	[590] 67 **903**	[650] 73 **880**	[668] 75 **873**	[805] 91 **799**

[93] 11 **1014** } Torque [lb-in] Nm / Speed RPM

49 cm³/r [3.0 in³/r]
Δ Pressure Bar [PSI]
Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1800] 124	[2000] 138	[2200] 152	[2250] 155	Max. Continuous [2750] 190
[2] 7,6	[73] 8 **152**	[161] 18 **152**	[245] 28 **148**	[327] 37 **147**	[408] 46 **142**	[486] 55 **141**	[563] 64 **134**	[641] 72 **124**	[710] 80 **115**	[786] 89 **109**	[849] 96 **95**	[866] 98 **92**	[1023] 116 **58**
[4] 15,1	[72] 8 **303**	[160] 18 **298**	[246] 28 **294**	[329] 37 **290**	[416] 47 **276**	[500] 56 **273**	[584] 66 **265**	[668] 75 **261**	[746] 84 **245**	[825] 93 **243**	[901] 102 **235**	[922] 104 **228**	[1123] 127 **152**
[6] 22,7	[58] 7 **461**	[148] 17 **450**	[234] 26 **445**	[326] 37 **438**	[413] 47 **434**	[500] 56 **421**	[583] 66 **419**	[663] 75 **410**	[746] 84 **407**	[827] 93 **389**	[909] 103 **376**	[928] 105 **373**	[1131] 128 **344**
[8] 30,3	[44] 5 **607**	[127] 14 **603**	[216] 24 **600**	[306] 35 **590**	[392] 44 **583**	[480] 54 **576**	[566] 64 **564**	[652] 74 **554**	[734] 83 **545**	[815] 92 **536**	[897] 101 **522**	[917] 104 **520**	[1125] 127 **503**
[10] 37,9	[39] 4 **755**	[128] 14 **750**	[213] 24 **745**	[302] 34 **738**	[391] 44 **732**	[477] 54 **719**	[562] 63 **713**	[647] 73 **702**	[731] 83 **696**	[815] 92 **682**	[897] 101 **663**	[917] 104 **661**	[1121] 127 **638**
Max. Continuous [12] 45,4	[33] 4 **906**	[119] 13 **902**	[203] 23 **895**	[291] 33 **883**	[378] 43 **875**	[464] 52 **862**	[551] 62 **859**	[635] 72 **844**	[719] 81 **835**	[802] 91 **819**	[883] 100 **806**	[900] 102 **804**	[1061] 120 **788**
Max. Intermittent [15] 56,8	[26] 3 **1132**	[86] 10 **1124**	[172] 19 **1113**	[256] 29 **1115**	[342] 39 **1106**	[430] 49 **1106**	[505] 57 **1098**	[591] 67 **1093**	[674] 76 **1079**	[745] 84 **1070**	[830] 94 **1058**	[851] 96 **1056**	

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

Performance Data
T 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.

66 cm³/r [4.0 in³/r]

Flow LPM [GPM]	Δ Pressure Bar [PSI] Continuous [200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1800] 124	[2000] 138	[2200] 152	Max. Continuous [2250] 155	Max. Intermittent [2750] 190
[2] 7,6	[78] 9 **114**	[191] 22 **111**	[303] 34 **110**	[414] 47 **107**	[522] 59 **105**	[625] 71 **101**	[706] 80 **96**	[804] 91 **92**	[898] 101 **87**	[991] 112 **81**	[1081] 122 **73**	[1103] 125 **72**	[1318] 149 **48**
[4] 15,1	[97] 11 **229**	[209] 24 **229**	[325] 37 **217**	[441] 50 **216**	[548] 62 **212**	[657] 74 **205**	[766] 87 **194**	[873] 99 **190**	[972] 110 **186**	[1077] 122 **183**	[1181] 133 **181**	[1205] 136 **178**	[1437] 162 **170**
[6] 22,7	[79] 9 **344**	[192] 22 **343**	[309] 35 **336**	[426] 48 **334**	[534] 60 **321**	[649] 73 **320**	[760] 86 **319**	[874] 99 **315**	[984] 111 **291**	[1090] 123 **288**	[1190] 134 **279**	[1218] 138 **276**	[1488] 168 **270**
[8] 30,3	[75] 8 **456**	[191] 22 **451**	[304] 34 **447**	[419] 47 **442**	[532] 60 **431**	[645] 73 **426**	[759] 86 **419**	[871] 98 **415**	[982] 111 **412**	[1092] 123 **401**	[1197] 135 **391**	[1222] 138 **386**	[1458] 165 **339**
[10] 37,9	[49] 6 **569**	[163] 18 **565**	[283] 32 **560**	[398] 45 **552**	[509] 58 **547**	[623] 70 **541**	[742] 84 **532**	[856] 97 **525**	[971] 110 **512**	[1080] 122 **504**	[1186] 134 **498**	[1209] 137 **496**	[1425] 161 **475**
[12] 45,4	[24] 3 **681**	[156] 18 **678**	[270] 31 **671**	[385] 43 **665**	[502] 57 **658**	[614] 69 **651**	[729] 82 **641**	[845] 95 **635**	[963] 109 **623**	[1067] 121 **612**	[1182] 134 **604**	[1209] 137 **601**	[1472] 166 **571**
[14] 53,0	[19] 2 **793**	[143] 16 **788**	[261] 29 **787**	[370] 42 **778**	[485] 55 **771**	[602] 68 **762**	[718] 81 **753**	[837] 95 **746**	[948] 107 **733**	[1064] 120 **723**	[1175] 133 **715**	[1199] 135 **711**	[1436] 162 **677**
Max. Continuous [15] 56,8	[13] 1 **849**	[120] 14 **844**	[236] 27 **839**	[352] 40 **832**	[471] 53 **826**	[590] 67 **819**	[707] 80 **806**	[823] 93 **800**	[939] 106 **786**	[1052] 119 **779**	[1165] 132 **770**	[1192] 135 **766**	[1462] 165 **725**
Max. Intermittent [18] 68,1		[107] 12 **1006**	[215] 24 **1003**	[326] 37 **998**	[442] 50 **988**	[555] 63 **976**	[669] 76 **975**	[786] 89 **965**	[900] 102 **952**	[1018] 115 **940**	[1123] 127 **924**	[1152] 130 **919**	

80 cm³/r [4.9 in³/r]

Flow LPM [GPM]	Δ Pressure Bar [PSI] Continuous [200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1800] 124	[2000] 138	[2200] 152	Max. Continuous [2250] 155	Max. Intermittent [2750] 190
[2] 7,6	[123] 14 **93**	[265] 30 **90**	[405] 46 **86**	[544] 61 **83**	[680] 77 **80**	[804] 91 **75**	[934] 106 **70**	[1052] 119 **63**	[1181] 133 **57**	[1079] 122 **43**	[937] 106 **24**	[895] 101 **20**	
[4] 15,1	[120] 14 **187**	[264] 30 **185**	[406] 46 **183**	[551] 62 **179**	[689] 78 **175**	[828] 94 **171**	[965] 109 **166**	[1101] 124 **162**	[1237] 140 **156**	[1369] 155 **150**	[1505] 170 **142**	[1537] 174 **140**	[1857] 210 **121**
[6] 22,7	[113] 13 **279**	[255] 29 **275**	[398] 45 **271**	[542] 61 **267**	[682] 77 **265**	[823] 93 **258**	[963] 109 **253**	[1101] 124 **248**	[1239] 140 **240**	[1373] 155 **232**	[1508] 170 **223**	[1541] 174 **221**	[1868] 211 **198**
[8] 30,3	[99] 11 **372**	[243] 27 **367**	[386] 44 **364**	[528] 60 **359**	[669] 76 **354**	[812] 92 **351**	[954] 108 **343**	[1094] 124 **338**	[1233] 139 **333**	[1368] 155 **324**	[1503] 170 **315**	[1537] 174 **313**	[1872] 212 **289**
[10] 37,9	[84] 9 **463**	[228] 26 **460**	[371] 42 **456**	[514] 58 **450**	[655] 74 **446**	[798] 90 **441**	[941] 106 **435**	[1080] 122 **428**	[1219] 138 **420**	[1357] 153 **412**	[1496] 169 **403**	[1530] 173 **399**	[1870] 211 **368**
[12] 45,4	[63] 7 **557**	[209] 24 **552**	[354] 40 **547**	[498] 56 **543**	[638] 72 **537**	[782] 88 **530**	[926] 105 **523**	[1067] 121 **515**	[1208] 136 **509**	[1346] 152 **500**	[1484] 168 **489**	[1520] 172 **487**	[1864] 211 **470**
[14] 53,0	[55] 6 **649**	[185] 21 **646**	[331] 37 **642**	[476] 54 **635**	[620] 70 **630**	[762] 86 **622**	[904] 102 **616**	[1046] 118 **609**	[1188] 134 **599**	[1327] 150 **592**	[1467] 166 **581**	[1502] 170 **578**	[1842] 208 **550**
Max. Continuous [15] 56,8	[51] 6 **694**	[176] 20 **691**	[316] 36 **687**	[463] 52 **680**	[609] 69 **673**	[748] 85 **668**	[891] 101 **660**	[1037] 117 **650**	[1177] 133 **642**	[1316] 149 **634**	[1457] 165 **622**	[1491] 168 **619**	[1844] 208 **598**
Max. Intermittent [20] 75,7		[160] 18 **916**	[305] 34 **910**	[455] 51 **893**	[578] 65 **893**	[737] 83 **875**	[857] 97 **866**	[968] 109 **877**	[1144] 129 **843**	[1277] 144 **833**	[1412] 160 **839**	[1446] 163 **836**	

[176] 20 **691** } Torque [lb-in] Nm / Speed RPM

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

Performance Data
T 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.

102 cm³/r [6.2 in³/r]

Flow LPM [GPM]	Δ Pressure Bar [PSI] Continuous [200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1800] 124	[2000] 138	[2200] 152	Max. Continuous [2250] 155	Max. Intermittent [2750] 190
[2] 7,6	[161] 18 **73**	[341] 39 **71**	[519] 59 **68**	[697] 79 **66**	[871] 98 **63**	[1030] 116 **60**	[1193] 135 **56**	[1349] 152 **51**	[1511] 171 **46**	[1496] 169 **36**	[1441] 163 **23**	[1421] 161 **20**	
[4] 15,1	[157] 18 **149**	[340] 38 **146**	[520] 59 **144**	[702] 79 **141**	[879] 99 **138**	[1056] 119 **135**	[1229] 139 **131**	[1401] 158 **128**	[1567] 177 **124**	[1727] 195 **118**	[1889] 213 **111**	[1925] 217 **109**	[2271] 257 **92**
[6] 22,7	[147] 17 **221**	[329] 37 **217**	[510] 58 **214**	[692] 78 **211**	[871] 98 **208**	[1050] 119 **204**	[1227] 139 **199**	[1401] 158 **195**	[1571] 178 **190**	[1731] 196 **184**	[1895] 214 **176**	[1936] 219 **174**	[2339] 264 **154**
[8] 30,3	[132] 15 **294**	[315] 36 **290**	[497] 56 **287**	[675] 76 **284**	[857] 97 **280**	[1038] 117 **277**	[1216] 137 **271**	[1392] 157 **267**	[1564] 177 **262**	[1725] 195 **255**	[1891] 214 **247**	[1932] 218 **245**	[2326] 263 **220**
[10] 37,9	[109] 12 **367**	[293] 33 **363**	[477] 54 **360**	[657] 74 **355**	[839] 95 **351**	[1018] 115 **347**	[1198] 135 **343**	[1374] 155 **337**	[1542] 174 **332**	[1711] 193 **325**	[1878] 212 **318**	[1918] 217 **315**	[2326] 263 **287**
[12] 45,4	[84] 9 **440**	[271] 31 **436**	[457] 52 **432**	[638] 72 **429**	[818] 92 **424**	[999] 113 **419**	[1179] 133 **414**	[1354] 153 **409**	[1527] 173 **402**	[1697] 192 **395**	[1858] 210 **386**	[1901] 215 **384**	[2323] 262 **364**
[14] 53,0	[59] 7 **513**	[242] 27 **510**	[428] 48 **506**	[611] 69 **501**	[794] 90 **497**	[974] 110 **492**	[1151] 130 **487**	[1328] 150 **482**	[1502] 170 **475**	[1674] 189 **469**	[1841] 208 **458**	[1883] 213 **456**	[2301] 260 **428**
Max. Continuous [15] 56,8	[39] 4 **550**	[227] 26 **545**	[411] 46 **542**	[595] 67 **537**	[780] 88 **532**	[957] 108 **528**	[1136] 128 **522**	[1314] 148 **516**	[1486] 168 **510**	[1658] 187 **502**	[1828] 207 **492**	[1869] 211 **490**	[2285] 258 **463**
Max. Intermittent [20] 75,7		[154] 17 **724**	[328] 37 **718**	[515] 58 **720**	[710] 80 **709**	[874] 99 **707**	[1060] 120 **696**	[1243] 140 **684**	[1405] 159 **683**	[1579] 178 **670**	[1763] 199 **659**	[1803] 204 **660**	

131 cm³/r [8.0 in³/r]

Flow LPM [GPM]	Δ Pressure Bar [PSI] Continuous [200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1800] 124	Max. Continuous [2000] 138	Max. Intermittent [2500] 172
[2] 7,6	[219] 25 **57**	[450] 51 **55**	[682] 77 **53**	[915] 103 **51**	[1144] 129 **49**	[1348] 152 **47**	[1581] 176 **43**	[1771] 200 **40**	[1979] 224 **36**	[2159] 244 **30**	
[4] 15,1	[212] 24 **116**	[449] 51 **113**	[681] 77 **110**	[917] 104 **109**	[1148] 130 **107**	[1376] 155 **105**	[1600] 181 **102**	[1822] 206 **99**	[2025] 229 **96**	[2221] 251 **91**	[2629] 297 **75**
[6] 22,7	[197] 22 **171**	[435] 49 **168**	[669] 76 **166**	[903] 102 **163**	[1139] 129 **160**	[1370] 155 **157**	[1600] 181 **154**	[1818] 205 **150**	[2032] 230 **147**	[2226] 252 **142**	[2718] 307 **125**
[8] 30,3	[181] 20 **227**	[417] 47 **225**	[657] 74 **222**	[886] 100 **219**	[1122] 127 **217**	[1359] 154 **213**	[1589] 180 **209**	[1812] 205 **206**	[2022] 228 **202**	[2215] 250 **196**	[2699] 305 **175**
[10] 37,9	[144] 16 **284**	[389] 44 **281**	[631] 71 **278**	[859] 97 **275**	[1098] 124 **271**	[1330] 150 **267**	[1562] 176 **265**	[1783] 201 **261**	[1993] 225 **258**	[2198] 248 **252**	[2687] 304 **231**
[12] 45,4	[114] 13 **341**	[361] 41 **338**	[605] 68 **334**	[838] 95 **332**	[1075] 121 **328**	[1307] 148 **325**	[1532] 173 **321**	[1755] 198 **318**	[1965] 222 **312**	[2177] 246 **307**	[2671] 302 **286**
[14] 53,0	[82] 9 **397**	[327] 37 **394**	[569] 64 **391**	[803] 91 **387**	[1042] 118 **384**	[1273] 144 **361**	[1498] 169 **378**	[1722] 195 **374**	[1935] 219 **370**	[2147] 243 **365**	[2655] 300 **339**
Max. Continuous [15] 56,8	[66] 7 **426**	[302] 34 **423**	[550] 62 **422**	[785] 89 **415**	[1025] 116 **412**	[1254] 142 **409**	[1480] 167 **405**	[1704] 193 **402**	[1915] 216 **398**	[2119] 239 **392**	[2648] 299 **367**
Max. Intermittent [20] 75,7		[177] 20 **565**	[429] 48 **560**	[678] 77 **556**	[908] 103 **553**	[1143] 129 **549**	[1375] 155 **546**	[1596] 180 **541**	[1811] 205 **536**	[2017] 228 **527**	

[302] 34 **423** } Torque [lb-in] Nm / Speed RPM

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

Performance Data
T 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.

157 cm³/r [9.6 in³/r]

Flow LPM [GPM]	Δ Pressure Bar [PSI] Continuous [200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1800] 124	Max. Continuous [2000] 138	Max. Intermittent [2500] 172
[2] 7,6	[264] 30 **47**	[541] 61 **45**	[819] 93 **44**	[1092] 123 **42**	[1357] 153 **40**	[1605] 181 **37**	[1847] 209 **34**	[2084] 235 **30**	[2311] 261 **25**	[1858] 210 **16**	
[4] 15,1	[259] 29 **96**	[541] 61 **95**	[822] 93 **92**	[1101] 124 **91**	[1373] 155 **90**	[1638] 185 **88**	[1890] 214 **85**	[2145] 242 **82**	[2383] 269 **78**	[2613] 295 **73**	[3063] 346 **60**
[6] 22,7	[241] 27 **142**	[526] 59 **140**	[808] 91 **138**	[1090] 123 **136**	[1368] 155 **134**	[1638] 185 **132**	[1900] 215 **129**	[2150] 243 **125**	[2399] 271 **121**	[2628] 297 **114**	[3169] 358 **99**
[8] 30,3	[219] 25 **189**	[506] 57 **187**	[789] 89 **185**	[1068] 121 **183**	[1348] 152 **181**	[1625] 184 **178**	[1885] 213 **175**	[2140] 242 **172**	[2388] 270 **166**	[2619] 296 **159**	[3178] 359 **140**
[10] 37,9	[180] 20 **237**	[472] 53 **234**	[759] 86 **232**	[1037] 117 **230**	[1319] 149 **227**	[1590] 180 **224**	[1853] 209 **222**	[2111] 239 **218**	[2355] 266 **211**	[2594] 293 **203**	[3170] 358 **183**
[12] 45,4	[141] 16 **284**	436] 49 **282**	[728] 82 **279**	[1010] 114 **277**	[1292] 146 **274**	[1561] 176 **272**	[1821] 206 **269**	[2079] 235 **265**	[2331] 263 **257**	[2573] 291 **248**	[3162] 357 **225**
[14] 53,0	[101] 11 **332**	[397] 45 **329**	[687] 78 **326**	[969] 109 **323**	[1252] 141 **321**	[1519] 172 **319**	[1778] 201 **316**	[2040] 230 **311**	[2295] 259 **305**	[2539] 287 **296**	[3147] 356 **274**
Max. Continuous [15] 56,8	[81] 9 **355**	[367] 41 **353**	[665] 75 **350**	[944] 107 **347**	[1231] 139 **344**	[1497] 169 **342**	[1755] 198 **339**	[2018] 228 **334**	[2273] 257 **327**	[2512] 284 **318**	[3136] 354 **300**
Max. Intermittent [20] 75,7		[221] 25 **472**	[519] 59 **467**	[814] 92 **464**	[1095] 124 **462**	[1368] 155 **459**	[1631] 184 **455**	[1891] 214 **450**	[2149] 243 **443**	[2396] 271 **433**	

195 cm³/r [11.9 in³/r]

Flow LPM [GPM]	Δ Pressure Bar [PSI] Continuous [200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1750] 121	[1800] 125	Max. Continuous [2000] 138	Max. Intermittent [2500] 172
[2] 7,6	[330] 37 **38**	[671] 76 **36**	[1016] 115 **34**	[1345] 152 **33**	[1654] 187 **31**	[1969] 222 **28**	[2242] 253 **25**	[2507] 283 **20**	[2689] 304 **16**	[2748] 310 **14**	[2973] 336 **8**	
[4] 15,1	[328] 37 **77**	[675] 76 **77**	[1026] 116 **75**	[1366] 154 **73**	[1692] 191 **73**	[2010] 227 **71**	[2289] 259 **68**	[2586] 292 **65**	[2799] 316 **62**	[2867] 324 **61**	[3144] 355 **55**	[3797] 429 **40**
[6] 22,7	[306] 35 **115**	[658] 74 **113**	[1011] 114 **111**	[1360] 154 **110**	[1698] 192 **109**	[2021] 228 **107**	[2324] 263 **104**	[2604] 294 **100**	[2829] 320 **97**	[2901] 328 **95**	[3178] 359 **87**	[3831] 433 **68**
[8] 30,3	[272] 31 **153**	[634] 72 **151**	[980] 111 **150**	[1331] 150 **148**	[1675] 189 **146**	[2003] 226 **144**	[2300] 260 **142**	[2592] 293 **139**	[2815] 318 **134**	[2888] 326 **132**	[3174] 359 **123**	[3864] 437 **99**
[10] 37,9	[238] 27 **192**	[596] 67 **189**	[945] 107 **188**	[1296] 146 **186**	[1637] 185 **184**	[1960] 221 **183**	[2255] 255 **181**	[2565] 290 **176**	[2786] 315 **168**	[2857] 323 **166**	[3140] 355 **156**	[3816] 431 **133**
[12] 45,4	[181] 20 **230**	[545] 62 **228**	[908] 103 **226**	[1260] 142 **224**	[1607] 182 **222**	[1924] 217 **221**	[2223] 251 **219**	[2529] 286 **213**	[2759] 312 **207**	[2836] 320 **204**	[3121] 353 **192**	[3807] 430 **160**
[14] 53,0	[154] 17 **268**	[500] 56 **266**	[860] 97 **264**	[1211] 137 **261**	[1556] 176 **259**	[1869] 211 **259**	[2175] 246 **256**	[2483] 281 **251**	[2713] 307 **244**	[2792] 315 **242**	[3080] 348 **229**	[3778] 427 **199**
Max. Continuous [15] 56,8	[140] 16 **297**	[465] 53 **295**	[832] 94 **293**	[1179] 133 **291**	[1525] 172 **279**	[1835] 207 **278**	[2144] 242 **275**	[2459] 278 **269**	[2693] 304 **262**	[2768] 313 **260**	[3061] 346 **247**	[3764] 425 **220**
Max. Intermittent [20] 75,7		[291] 33 **382**	[653] 74 **378**	[1013] 114 **376**	[1366] 154 **373**	[1689] 191 **372**	[1987] 225 **368**	[2298] 260 **363**	[2540] 287 **356**	[2622] 296 **353**	[2928] 331 **342**	

[465] 53 **285** } Torque [lb-in] Nm / Speed RPM

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

Performance Data
T 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.

244 cm³/r [14.9 in³/r]
Δ Pressure Bar [PSI] Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1600] 110	[1650] 114	[1800] 125	Max. Continuous [1850] 127	Max. Intermittent [2250] 155
[2] 7,6	[406] 46 **30**	[833] 94 **29**	[1260] 142 **27**	[1655] 187 **26**	[2038] 230 **24**	[2403] 272 **22**	[2707] 306 **17**	[2597] 293 **12**	[2552] 288 **11**	[2373] 268 **7**	[2299] 260 **6**	
[4] 15,1	[404] 46 **62**	[843] 95 **62**	[1277] 144 **60**	[1695] 192 **59**	[2083] 235 **59**	[2468] 279 **57**	[2820] 319 **55**	[3177] 359 **50**	[3261] 368 **49**	[3509] 396 **46**	[3589] 406 **44**	[4194] 474 **35**
[6] 22,7	[382] 43 **92**	[823] 93 **91**	[1261] 142 **90**	[1687] 191 **89**	[2088] 236 **88**	[2477] 280 **86**	[2843] 321 **82**	[3196] 361 **78**	[3285] 371 **76**	[3547] 401 **72**	[3633] 410 **71**	[4290] 485 **60**
[8] 30,3	[341] 39 **123**	[787] 89 **122**	[1220] 138 **121**	[1651] 187 **120**	[2059] 233 **119**	[2454] 277 **116**	[2820] 319 **113**	[3177] 359 **108**	[3265] 369 **106**	[3530] 399 **101**	[3615] 408 **99**	[4285] 484 **85**
[10] 37,9	[297] 34 **154**	[744] 84 **152**	[1177] 133 **151**	[1611] 182 **150**	[2017] 228 **148**	[2412] 273 **146**	[2774] 313 **143**	[3151] 356 **136**	[3241] 366 **134**	[3504] 396 **127**	[3593] 406 **125**	[4269] 482 **107**
[12] 45,4	[225] 25 **184**	[687] 78 **183**	[1132] 128 **181**	[1553] 175 **180**	[1967] 222 **179**	[2360] 267 **177**	[2734] 309 **173**	[3105] 351 **166**	[3194] 361 **163**	[3466] 392 **156**	[3554] 402 **153**	[4237] 479 **134**
[14] 53,0	[154] 17 **214**	[628] 71 **213**	[1072] 121 **212**	[1498] 169 **211**	[1910] 216 **209**	[2298] 260 **207**	[2674] 302 **202**	[3052] 345 **195**	[3148] 356 **193**	[3419] 386 **185**	[3510] 397 **182**	[4226] 477 **161**
Max. Continuous [15] 56,8	[119] 13 **229**	[586] 66 **228**	[1035] 117 **227**	[1458] 165 **226**	[1872] 212 **224**	[2261] 255 **222**	[2637] 298 **217**	[3022] 341 **209**	[3116] 352 **207**	[3389] 383 **200**	[3488] 394 **197**	[4220] 477 **174**
Max. Intermittent [20] 75,7		[372] 42 **305**	[816] 92 **303**	[1251] 141 **301**	[1663] 188 **300**	[2067] 234 **297**	[2448] 277 **292**	[2832] 320 **284**	[2928] 331 **281**	[3214] 363 **273**	[3312] 374 **270**	

306 cm³/r [18.7 in³/r]
Δ Pressure Bar [PSI] Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1400] 97	[1500] 103	Max. Continuous [1600] 110	Max. Intermittent [1800] 124
[2] 7,6	[499] 56 **24**	[1035] 117 **23**	[1560] 176 **22**	[2034] 230 **21**	[2501] 283 **19**	[2912] 329 **16**	[3239] 366 **11**	[2859] 323 **8**	[2400] 271 **5**	
[4] 15,1	[497] 56 **49**	[1052] 119 **49**	[1590] 180 **48**	[2101] 237 **48**	[2561] 289 **47**	[3023] 342 **47**	[3464] 391 **44**	[3680] 416 **41**	[3886] 439 **38**	[4221] 477 **30**
[6] 22,7	[480] 54 **74**	[1031] 116 **74**	[1578] 178 **72**	[2096] 237 **72**	[2564] 290 **71**	[3023] 342 **69**	[3464] 391 **64**	[3689] 417 **62**	[3905] 441 **60**	[4275] 483 **51**
[8] 30,3	[427] 48 **99**	[975] 110 **98**	[1520] 172 **97**	[2051] 232 **97**	[2525] 285 **96**	[2998] 339 **94**	[3448] 390 **89**	[3667] 414 **86**	[3881] 438 **83**	[4264] 482 **73**
[10] 37,9	[370] 42 **123**	[930] 105 **122**	[1467] 166 **121**	[2001] 226 **120**	[2477] 280 **120**	[2955] 334 **117**	[3406] 385 **112**	[3631] 410 **108**	[3852] 435 **104**	[4264] 482 **92**
[12] 45,4	[281] 32 **147**	[871] 98 **146**	[1410] 159 **145**	[1908] 216 **145**	[2400] 271 **145**	[2887] 326 **142**	[3352] 379 **136**	[3573] 404 **131**	[3790] 428 **127**	[4189] 473 **112**
[14] 53,0	[192] 22 **171**	[791] 89 **171**	[1338] 151 **170**	[1851] 209 **170**	[2338] 264 **169**	[2816] 318 **165**	[3281] 371 **159**	[3511] 397 **154**	[3743] 423 **150**	[4135] 467 **133**
Max. Continuous [15] 56,8	[148] 17 **183**	[738] 83 **183**	[1288] 146 **182**	[1803] 204 **182**	[2287] 258 **181**	[2773] 313 **177**	[3243] 366 **171**	[3475] 393 **165**	[3705] 419 **160**	[4098] 463 **146**
Max. Intermittent [20] 75,7		[476] 54 **243**	[1020] 115 **242**	[1544] 174 **242**	[2010] 227 **241**	[2519] 285 **238**	[3010] 340 **231**	[3243] 366 **226**	[3495] 395 **209**	

[738] 83 **183** } Torque [lb-in] Nm Speed RPM

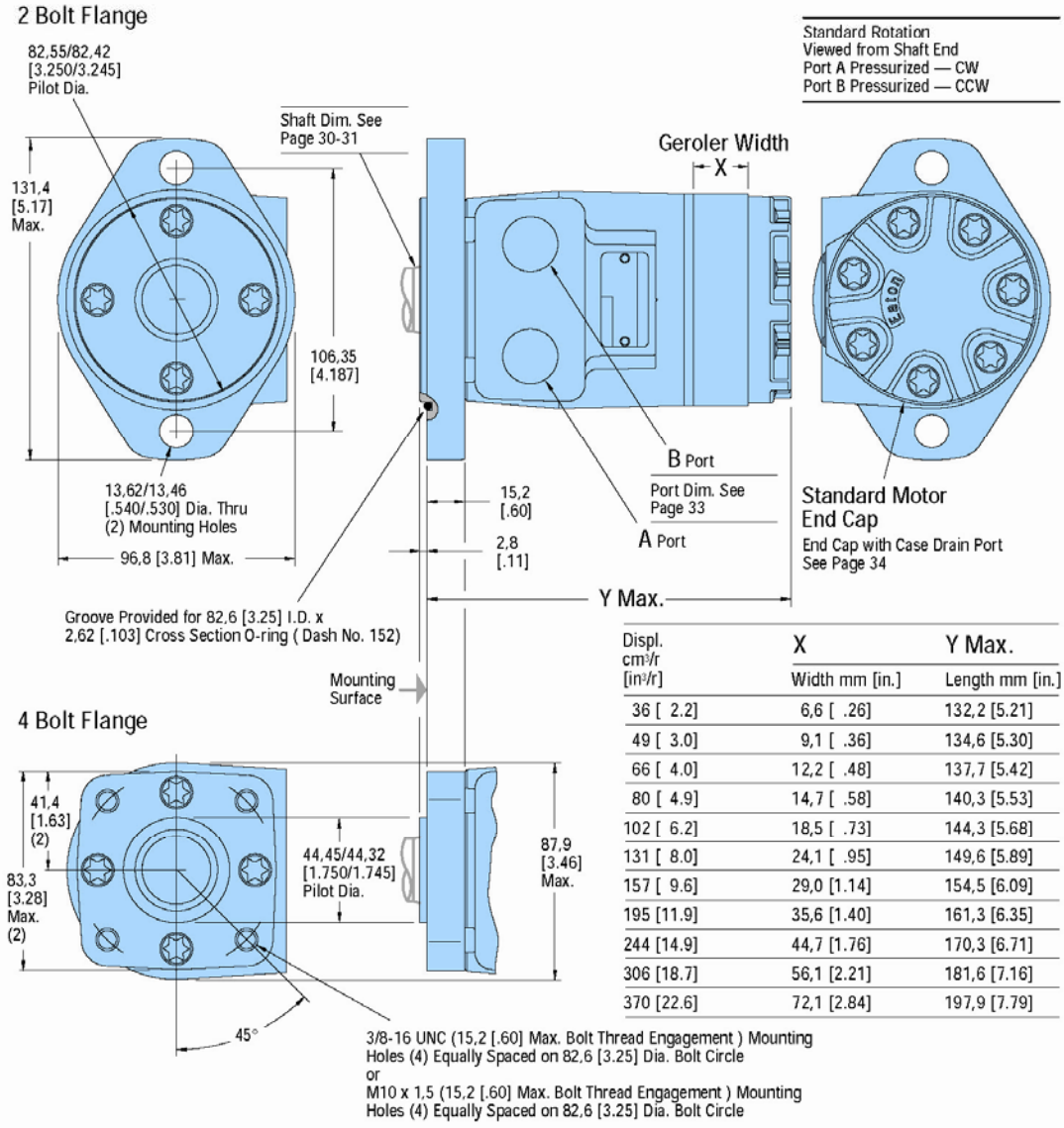
370 cm³/r [22.6 in³/r]
Δ Pressure Bar [PSI] Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[600] 41	[800] 55	[1000] 69	[1200] 83	[1300] 90	Max. Continuous [1500] 103	Max. Intermittent
[2] 7,6	[590] 67 **20**	[1237] 140 **19**	[1858] 210 **18**	[2406] 272 **17**	[2953] 334 **15**	[3388] 383 **12**	[3586] 405 **11**		
[4] 15,1	[588] 66 **41**	[1263] 143 **41**	[1906] 215 **40**	[2506] 283 **40**	[3029] 342 **39**	[3557] 402 **38**	[3811] 431 **37**	[4252] 480 **36**	
[6] 22,7	[580] 66 **61**	[1245] 141 **60**	[1899] 215 **60**	[2506] 283 **59**	[3029] 342 **58**	[3544] 400 **57**	[3788] 428 **56**	[4300] 486 **54**	
[8] 30,3	[514] 58 **82**	[1164] 132 **81**	[1824] 206 **80**	[2452] 277 **79**	[2975] 336 **78**	[3518] 397 **77**	[3783] 427 **77**	[4284] 484 **75**	
[10] 37,9	[444] 50 **102**	[1119] 126 **102**	[1759] 199 **101**	[2391] 270 **101**	[2928] 331 **100**	[3479] 393 **97**	[3750] 424 **96**	[4275] 483 **93**	
[12] 45,4	[337] 38 **122**	[1062] 120 **121**	[1690] 191 **120**	[2256] 255 **119**	[2813] 318 **119**	[3393] 383 **119**	[3685] 416 **116**	[4273] 483 **112**	
[14] 53,0	[231] 26 **142**	[958] 108 **141**	[1608] 182 **140**	[2201] 249 **139**	[2748] 310 **138**	[3319] 375 **137**	[3610] 408 **134**	[4198] 474 **129**	
Max. Continuous [15] 56,8	[178] 20 **152**	[896] 101 **152**	[1543] 174 **151**	[2147] 243 **150**	[2683] 303 **149**	[3272] 370 **147**	[3572] 404 **146**	[4187] 473 **140**	
Max. Intermittent [20] 75,7		[587] 66 **202**	[1228] 139 **201**	[1833] 207 **201**	[2331] 263 **200**	[2948] 333 **198**	[3273] 370 **196**		

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

Dimensions
T Series

Note: Mounting Surface Flatness Requirement is ▱ ,13 mm [.005 inch] Max.



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

Displ. cm³/r [in³/r]	X Width mm [in.]	Y Max. Length mm [in.]
36 [2.2]	6,6 [.26]	132,2 [5.21]
49 [3.0]	9,1 [.36]	134,6 [5.30]
66 [4.0]	12,2 [.48]	137,7 [5.42]
80 [4.9]	14,7 [.58]	140,3 [5.53]
102 [6.2]	18,5 [.73]	144,3 [5.68]
131 [8.0]	24,1 [.95]	149,6 [5.89]
157 [9.6]	29,0 [1.14]	154,5 [6.09]
195 [11.9]	35,6 [1.40]	161,3 [6.35]
244 [14.9]	44,7 [1.76]	170,3 [6.71]
306 [18.7]	56,1 [2.21]	181,6 [7.16]
370 [22.6]	72,1 [2.84]	197,9 [7.79]

Product Numbers
T Series 158-xxxx

Product Numbers—T Series

Add three digit prefix —158-to four digit number from chart for complete product number—Example 158-1068.
Orders will not be accepted without three digit prefix.

Mounting	Shaft	Ports		Displ. cm³/r [in³/r] Product Number 158-xxxx										
				36 [2.2]	49 [3.0]	66 [4.0]	80 [4.9]	102 [6.2]	131 [8.0]	157 [9.6]	195 [11.9]	244 [14.9]	306 [18.7]	370 [22.6]
2 Bolt Flange	1 in. Straight w/Woodruff Key	7/8-14 O-ring	158-	—	—	-1537	-1034	-1035	-1538	-1036	-1037	-1038	-1039	-1040
		1/2 NPTF	158-	—	—	-1540	-1026	-1027	-1541	-1028	-1029	-1030	-1031	-1032
		Manifold*	158-	—	—	-1543	-1042	-1043	-1544	-1044	-1045	-1046	-1047	-1048
	1 in. SAE 6B Splined	7/8-14 O-ring	158-	—	—	-1552	-1082	-1083	-1553	-1084	-1085	-1086	-1087	-1088
		1/2 NPTF	158-	—	—	-1555	-1074	-1075	-1556	-1076	-1077	-1078	-1079	-1080
		Manifold*	158-	—	—	-1558	-1090	-1091	-1559	-1092	-1093	-1094	-1095	-1096
4 Bolt Flange	1 in. Straight w/Woodruff Key	7/8-14 O-ring	158-	—	—	-1570	-1010	-1011	-1571	-1012	-1013	-1014	-1015	-1016
		1/2 NPTF	158-	—	—	-1573	-1002	-1003	-1574	-1004	-1005	-1006	-1007	-1008
		Manifold*	158-	—	—	-1576	-1018	-1019	-1577	-1020	-1021	-1022	-1023	-1024
	1 in. SAE 6B Splined	7/8-14 O-ring	158	—	—	-1579	-1058	-1059	-1580	-1060	-1061	-1062	-1063	-1064
		1/2 NPTF	158-	—	—	-1582	-1050	-1051	-1583	-1052	-1053	-1054	-1055	-1056
		Manifold*	158-	—	—	-1585	-1066	-1067	-1586	-1068	-1069	-1070	-1071	-1072

* Manifold product numbers shown are for motors with four 5/16-18 port face mounting threads. Manifold, manifold mounting o-rings and bolts are NOT included (for M8 x 1,5 port face mounting threads see note below).

158-1068

Product Numbers—T Series Motors with Corrosion Protection

Shaft	Mounting	Ports		Displ. cm³/r [cu. in³/r] Product Number 158-xxxx										
				36 [2.2]	49 [3.0]	66 [4.0]	80 [4.9]	102 [6.2]	131 [8.0]	157 [9.6]	195 [11.9]	244 [14.9]	306 [18.7]	370 [22.6]
1 in. Straight w/Woodruff Key	2 Bolt Flange	7/8-14 O-ring	158-	—	—	—	-1645	—	—	—	—	-1649	—	-1650
	4 Bolt Flange	1/2 NPTF	158-	—	—	—	—	—	—	—	—	-1620	—	-1621

For T Series Motors with a configuration Not Shown in the charts above: Use the model code number system on page 39 to specify the product in detail.

For Product Numbers—T Series Motors with Low Speed Valving — See Page 28.

Specifications H, S Series and T Series with Low Speed Valving — Product Numbers S Series and T Series w/LSV

These motors with the low speed valving option provide very low speed while maintaining high torque. Designed to run continuously at up to 200 RPM at standard rated pressures and reduced flows, providing smooth operation at low speeds. Furthermore, they resist slippage and have more momentary load holding ability than the standard H, and S Series motors. Motors with this valving are not intended for low pressure applications (41 Bar [600 PSI] Minimum). Shaft side / radial load ratings are not affected by this valving.

For H Series Motors with Low Speed Valving — Use the model code number system on page 37 to specify the product in detail.

Product Numbers—S Series Motors with Low Speed Valving

				Displ. cm³/r [in³/r] Product Number 103-xxxx										
Mounting	Shaft	Ports		59 [3.6]	74 [4.5]	97 [5.9]	120 [7.3]	146 [8.9]	159 [9.7]	185 [11.3]	231 [14.1]	293 [17.9]	370 [22.6]
2 Bolt Flange	1 in. Straight w/Woodruff Key	7/8-14 O-ring	103-	—	-1427	-1428	—	—	-1429	-1430	-1431	-1432	-1433
		1/2 NPTF	103-	—	-1419	-1420	—	—	-1421	-1422	-1423	-1424	-1425
		Manifold*	103-	—	—	—	—	—	—	—	—	—	—
	1 in. SAE 6B Splined	7/8-14 O-ring	103-	—	-1525	—	—	-2692	—	—	-1675	—	—
		1/2 NPTF	103-	—	—	-1634	—	—	—	—	—	—	—
		Manifold*	103-	—	-1522	-2678	—	—	—	—	—	—	-1527
4 Bolt Flange	1 in. Straight w/Woodruff Key	7/8-14 O-ring	103-	-1625	-1410	-1411	-1626	-2531	-1412	-1413	-1414	-1415	-1416
		1/2 NPTF	103-	-1644	-1402	-1403	—	—	-1404	-1405	-1406	-1407	-1408

*Manifold product numbers shown are for motors with four 5/16-18 port face mounting threads. Manifold, manifold mounting o-rings and bolts are NOT included (for M8 x 1,5 port face mounting threads see note below).

For S Series Motors with Low Speed Valving Not Shown in the chart above: Use the model code number system on page 38 to specify the product in detail.

Product Numbers—T Series Motors with Low Speed Valving

				Displ. cm³/r [in³/r] Product Number 158-xxxx										
Mounting	Shaft	Ports		36 [2.2]	49 [3.0]	66 [4.0]	80 [4.9]	102 [6.2]	131 [8.0]	157 [9.6]	195 [11.9]	244 [14.9]	306 [18.7]	370 [22.6]
2 Bolt Flange	1 in. Straight w/Woodruff Key	7/8-14 O-ring	158-	—	—	—	-1427	-1428	—	—	-1430	-1431	-1432	-1433
		1/2 NPTF	158-	—	—	—	-1419	-1420	—	—	-1422	-1423	-1424	-1425
		Manifold*	158-	—	—	—	—	—	—	—	—	—	—	—
	1 in. SAE 6B Splined	7/8-14 O-ring	158-	—	—	—	-1525	—	—	—	—	-1675	—	—
		1/2 NPTF	158-	—	—	—	—	-1634	—	—	—	—	—	—
		Manifold*	158-	—	—	—	-1522	-2678	—	—	—	—	—	-1527
4 Bolt Flange	1 in. Straight w/Woodruff Key	7/8-14 O-ring	158-	—	—	-1625	-1410	-1411	-1626	-1412	-1413	-1414	-1415	-1416
		1/2 NPTF	158-	—	—	-1644	-1402	-1403	—	-1404	-1405	-1406	-1407	-1408

*Manifold product numbers shown are for motors with four 5/16-18 port face mounting threads. Manifold, manifold mounting o-rings and bolts are NOT included (for M8 x 1,5 port face mounting threads see note below).

For T Series Motors with Low Speed Valving Not Shown in the chart above: Use the model code number system on page 39 to specify the product in detail.

Shaft Side Load Capacity
H, S, Series and T Series

The hydrodynamic bearing has infinite life when shaft load ratings are not exceeded. Hence, the shaft side load capacity is more than adequate to handle most externally applied loads (such as belts, chains, etc.), providing the motor to shaft size is applied within its torque rating.

Allowable side load chart, shaft load location drawing and load curves (below) are based on the side / radial loads being applied to shaft at locations A, B, and C, to determine the shaft side load capacity at locations other than those shown use the formula (shown below). For more information about shaft side loads on Char-Lynn motors contact your Eaton representative.

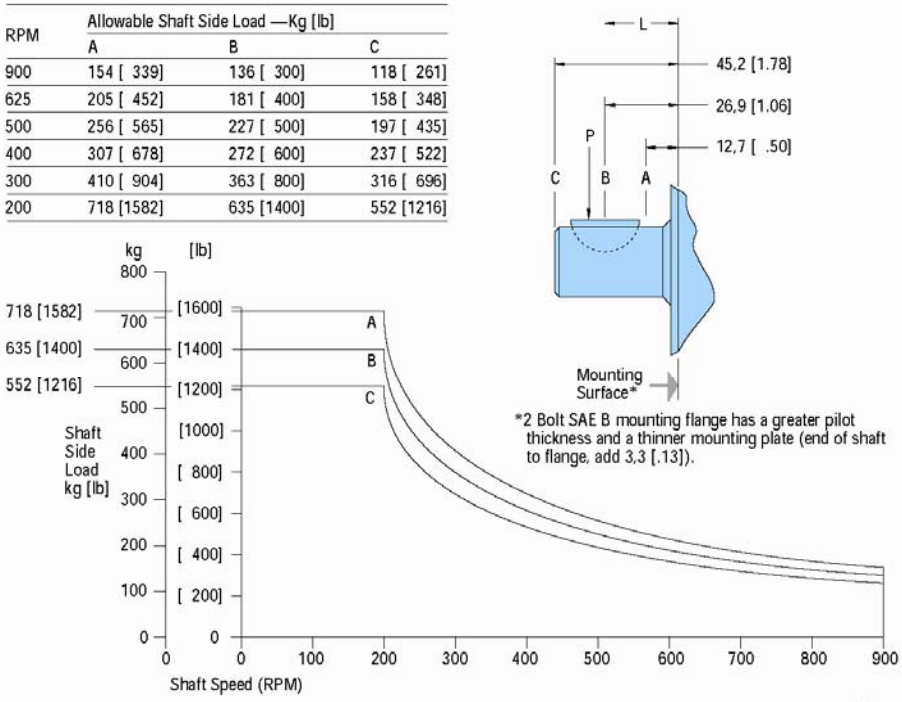
Note: When the speed sensor option is used , the side load ratings are reduced 25%.

$$\text{Sideload P kg} = \frac{900}{N}\left(\frac{16800}{L + 96{,}3}\right) \quad \text{for 200-900 RPM}$$

$$\text{Sideload P [lb]} = \frac{900}{N}\left(\frac{1460}{L + [3.79]}\right) \quad \text{for 200-900 RPM}$$

Where N = Shaft Speed (RPM)
L = Distance from Mounting Surface

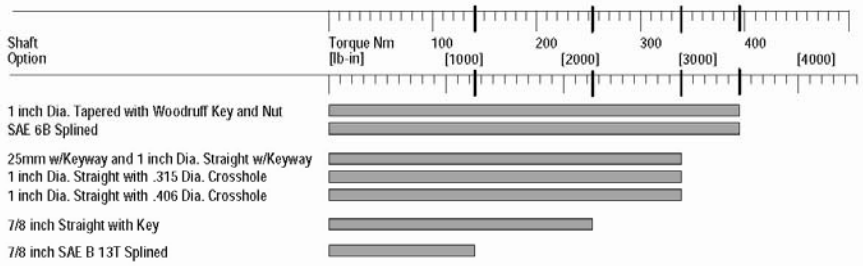
RPM	Allowable Shaft Side Load —Kg [lb]		
	A	B	C
900	154 [339]	136 [300]	118 [261]
625	205 [452]	181 [400]	158 [348]
500	256 [565]	227 [500]	197 [435]
400	307 [678]	272 [600]	237 [522]
300	410 [904]	363 [800]	316 [696]
200	718 [1582]	635 [1400]	552 [1216]

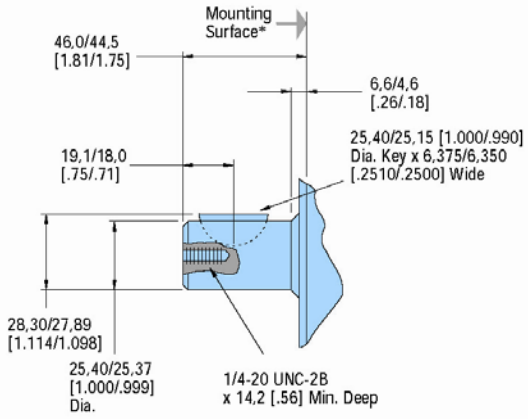


29

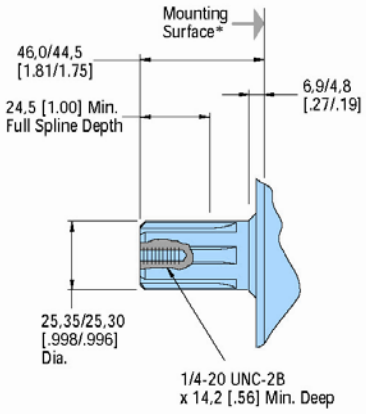
Dimensions — Shafts
H, S, and T Series

Shaft Size /Motor Torque Combination Limit Guide

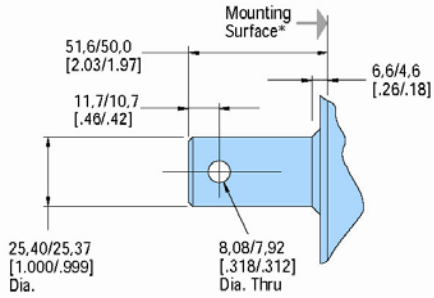




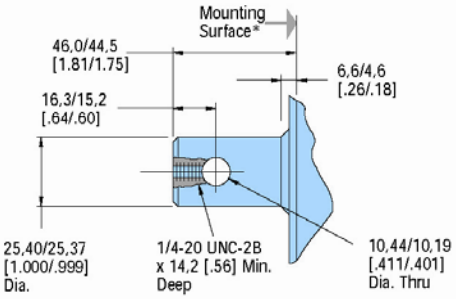
1 in. Dia. Straight with Woodruff Key



SAE 6B Splined Shaft



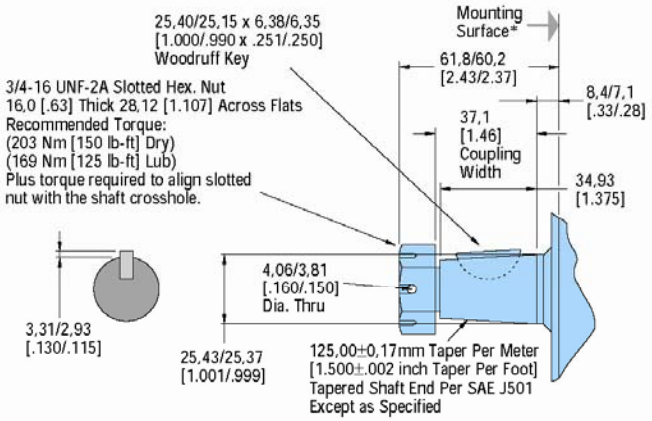
1 in. Dia. Straight Shaft with .315 Dia. Crosshole



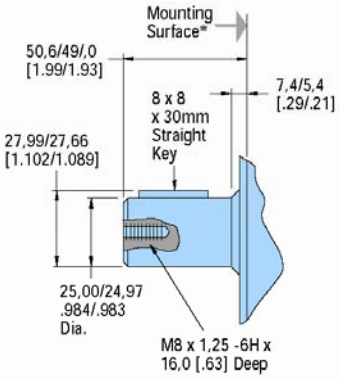
1 in. Dia. Straight Shaft with .406 Dia. Crosshole

*2 Bolt SAE B mounting flange has a greater pilot thickness and a thinner mounting plate (end of shaft to flange, add 3,3 [.13]).

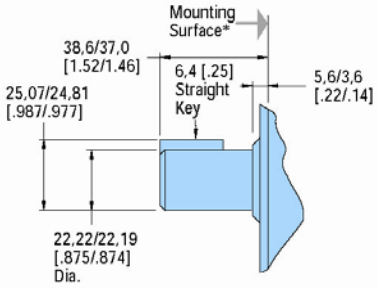
Dimensions — Shafts
H, S and T Series



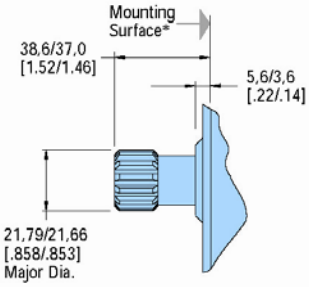
1 in. Dia. Tapered Shaft
with Woodruff Key and Nut



25mm Dia. Straight Shaft
with 8mm Keyway



7/8 in. Dia. Straight
Shaft with Key

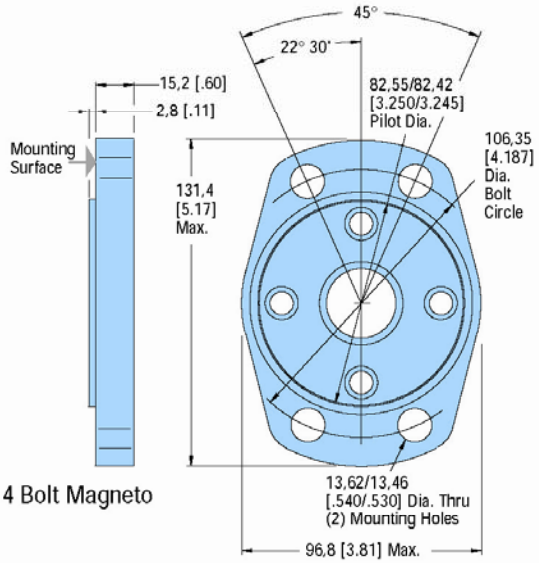


7/8 in. Dia. SAE B Shaft
13 T Splined

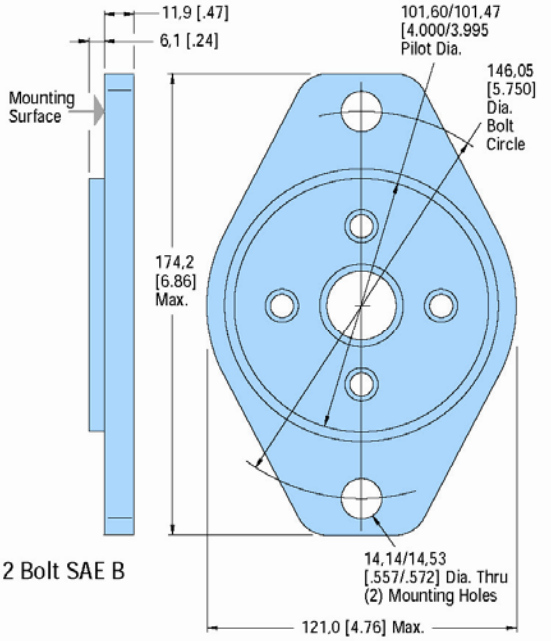
*2 Bolt SAE B mounting flange has a greater pilot thickness and a thinner mounting plate (end of shaft to flange, add 3,3 [.13]).

Dimensions — Mounting Options H, S, and T Series

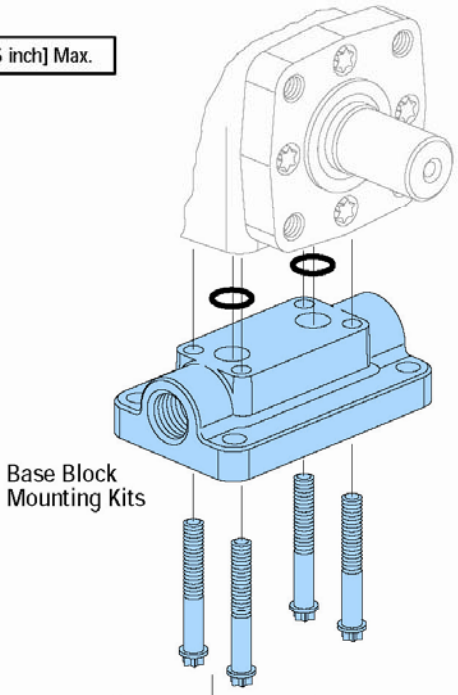
Note: Mounting Surface Flatness Requirement is ▱ ,13 mm [.005 inch] Max.



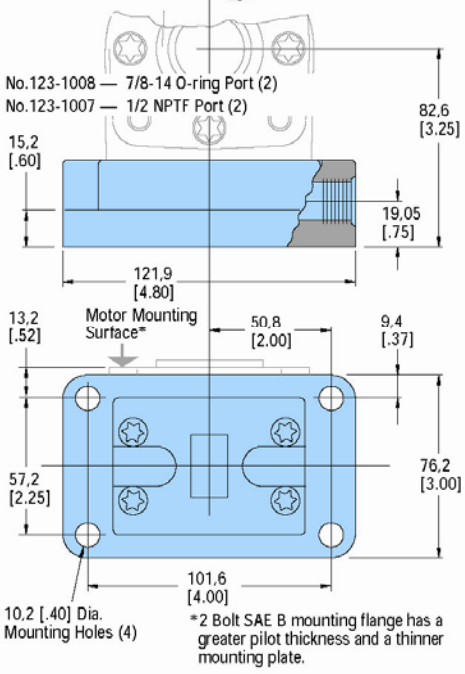
4 Bolt Magneto



2 Bolt SAE B

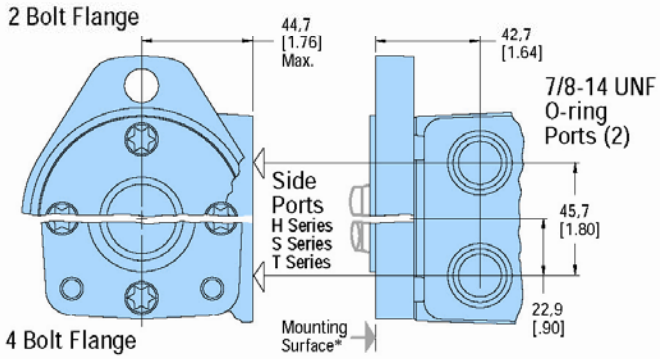


Base Block Mounting Kits

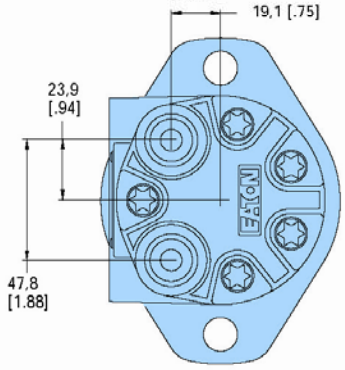


*2 Bolt SAE B mounting flange has a greater pilot thickness and a thinner mounting plate.

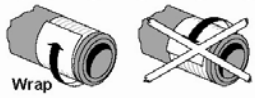
Dimensions — Ports
H, S, and T Series



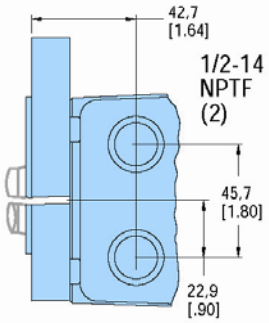
End Ports — H Series
G 1/2 (BSP) (2)
or 3/4-16 O-ring (2)

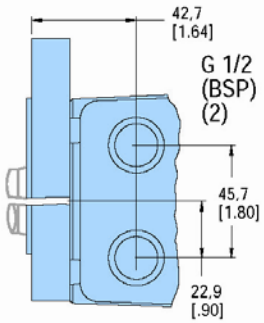


Use of Teflon Tape Sealant/Lubricant (with 1/2 14 NPTF Port Connectors only).
When using fittings with Teflon tape, be careful when taping and tightening. Over tightening or

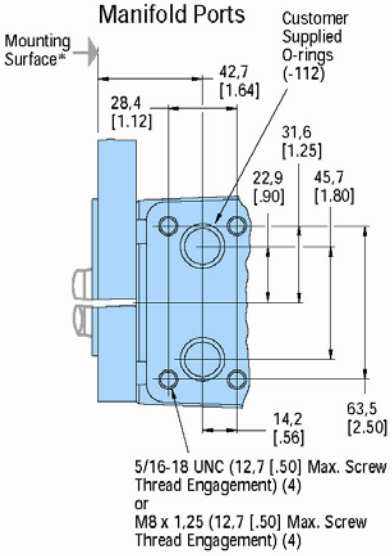


improperly taped fittings can cause damage to housing or leakage.
Use the following procedures:
- Wrap approx. 1 1/2 Turns of 13 mm [1/2 in.] wide Teflon Tape around fitting threads — start tape 2 threads up from end of fitting.
- Tighten threads to a Maximum of 34 Nm [25 lb-ft]. — **Do Not Tighten Further** —
- If fittings leak when tightened to maximum torque, either retape, reseal, or replace fittings.





Manifold Ports



*2 Bolt SAE B mounting flange has a greater pilot thickness and a thinner mounting plate.

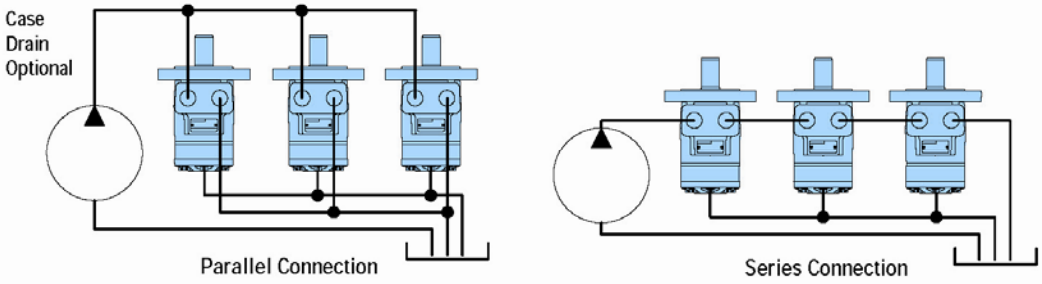
Case Pressure and Case Drain — H, S, and T Series

Series or Parallel Connection

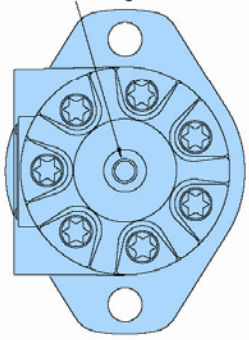
Hydraulic lines bringing pressurized fluid from the pump to the motor and return flow from the motor back to tank can be flexible or ridged. One pump can be sized to supply a single motor or many motors. Furthermore, one pump and multiple motors can be connected in series or in parallel (see each type of connection shown below). When connecting the pump to the motors in series excess internal case pressure is created in the motor, this excess pressure must be ported back to tank. However, when making a parallel connection from the pump to the motors no excess case pressure will be added. Hence, using the case drain ports are not necessary. Meanwhile, take a look at the application and see if this optional case drain port can be connected to your advantage, whether it be a single motor to pump connection, multiple motors connected to pump in parallel, as well as multiple motors connected to pump in series...

...Case Drain Advantage — In addition to providing lower case pressures for motors connected in series, there are advantages for adding an external case drain line to motors with normal case pressures as well. These advantages are: Contamination Control — flushing the motor case. Cooler System — exiting oil draws motor heat away. Extend Motor Seal Life — maintain low case pressure with a preset restriction installed in the case drain line (see page 35).

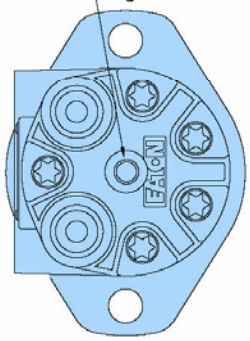
Motors ordered with case drain port will be shipped with steel hex socket plug installed in that end cap drain port.



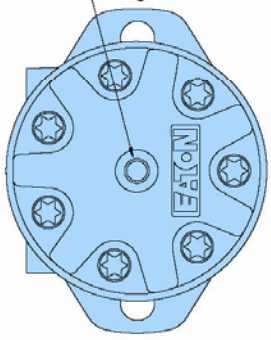
H Series with Case Drain Port — G 1/4 (BSP) or 7/16-20 O-ring



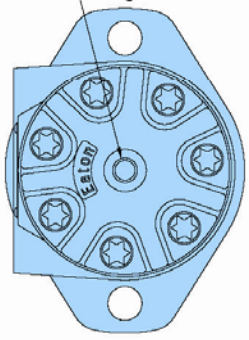
H Series with End Ports and Case Drain Port — G 1/4 (BSP) or 7/16-20 O-ring



S Series with Case Drain Port — G 1/4 (BSP) or 7/16-20 O-ring

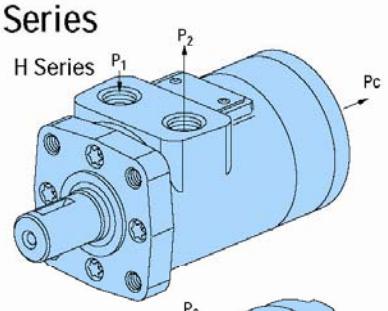


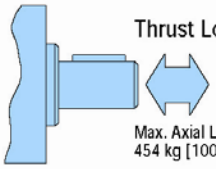
T Series with Case Drain Port — G 1/4 (BSP) or 7/16-20 O-ring



Case Pressure and Case Drain — H, S, and T Series

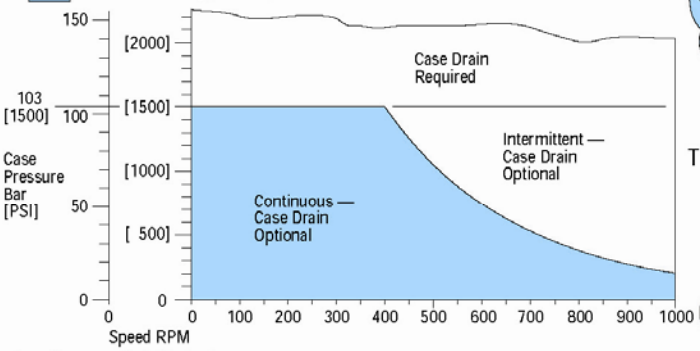
Char-Lynn H Series, S Series and T Series motors are durable and have long life as long as the recommended case pressure is not exceeded. Allowable case pressure is highest at low shaft speeds. Consequently, motor life will be shortened if case pressure exceeds these ratings (acceptability may vary with application). Determine if an external case drain is required from the case pressure seal limition chart below — chart based on case pressure and shaft speed. If a case drain line is needed, connect drain line to assure that the motor will always remain full of fluid. A pressure restriction should be added to the case drain line, during which a motor case pressure of 3,5 Bar [50 PSI] is maintained.



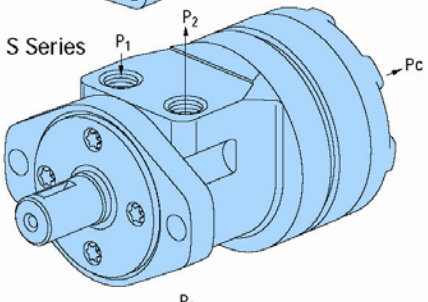


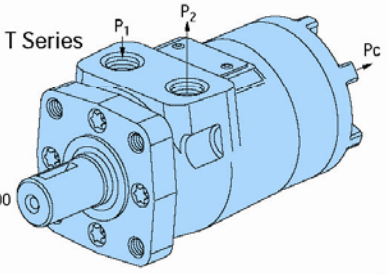
$P_C \simeq .6\Delta P + P_2$

P_C = Case Pressure
P_1 = Inlet Line Pressure
P_2 = Back Pressure
$\Delta P = P_1 - P_2$



Case Pressure Seal Limitation



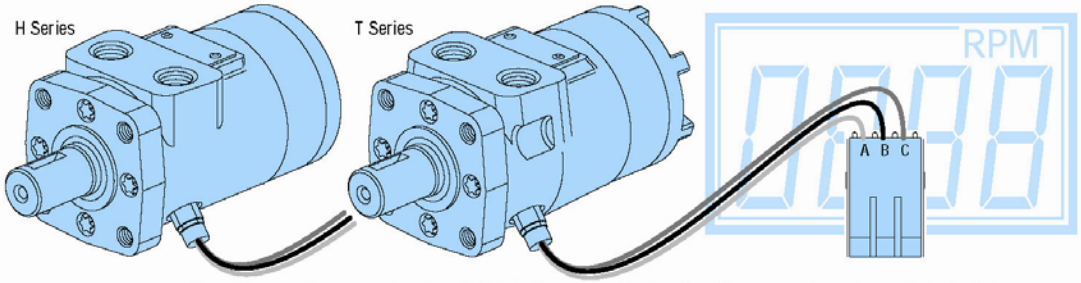


Speed Sensor — H Series and T Series

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

This sensor is fully compatible with mobile vehicle electrical systems and gives a reliable digital on/off signal over a wide speed range and temperature range.

Supply Voltage: 8 to 24 Vdc (compatible with 12V vehicle systems
Supply Current: 20 mA max. (Vs) (including internal pull-up resistor)
Output Voltage: Low < .5 Vdc @ 10 mA; output is open collector with 10kΩ pull-up resistor
Connection — std. 3 prong Weatherpack connector with 18 AWG (american wire gage) cables:
Position A (red) = power supply Position B (wht) = signal output Position C (blk) = common
Output — digital on/off signal from Hall Effect switch; 15 pulses /revolution



Note: The speed sensor option does NOT include read-out display. Possible sources for read-out display include: Eaton Corporation Durant Products 901 South 12 Street Watertown, WI 57094 — Phone 1-800-289-3866.

Fluid Recommendations
H, S, and T Series

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 characteristic to consider when choosing a fluid to be used in a hydraulic system is viscosity. Viscosity choice is always a compromise; the fluid must be thin enough to flow easily but thick enough to seal and maintain a lubricating film between bearing and sealing surfaces. Viscosity requirements, see chart below.

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.

Product Line	Viscosity		ISO Cleanliness Requirements
	Minimum	Best Range	
S Series and T Series	70 SUS 13 cSt	100-200 SUS 20-43 cSt	18/13
H Series	100 SUS 20 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.
- 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.

Model Code for H Series Motors

The following 16-digit coding system has been developed to identify all of the configuration options for the H Series Motor. Use this model code to specify a motor with the desired features. All 16-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 — H Series Spool Valve Motors

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
M	0	H												0	0

Position 1 Product Series

M ..... Motor

Position 2, 3 H Series

0H ..... H Series

Position 4, 5 Displacement cm^3/r [in^3/r]

02 ..... 36 [2.2]*

03 ..... 46 [2.8]

04 ..... 59 [3.6]*

05 ..... 74 [4.5]

06 ..... 97 [5.9]

07 ..... 120 [7.3]

09 ..... 146 [8.9]

10 ..... 159 [9.7]

11 ..... 185 [11.3]

14 ..... 231 [14.1]

18 ..... 293 [17.9]

23 ..... 370 [22.6]

45 ..... 739 [45.1]

Position 6 Mounting Flange

A ..... 2 Bolt (Standard) 82,6 [3.25] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes 106,2 [4.18] Dia. B.C.

B ..... 4 Bolt (Standard) 44,4 [1.75] Pilot Dia. and 3/8-16 Mounting Holes 82,6 [3.25] Dia. B.C.

E ..... 4 Bolt (Standard) 44,4 [1.75] Pilot Dia. and M10 x 1,5 Mounting Holes 82,6 [3.25] Dia. B.C.

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

K ..... 4 Bolt Magneto 82,6 [3.25] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes 106,2 [4.18] Dia. B.C.

Position 7, 8 Output Shaft

01 ..... 1 inch Dia. Straight with Woodruff Key and 1/4-20 Threaded Hole

02 ..... 1 inch Dia. SAE 6B Splined with 1/4-20 Threaded Hole

07 ..... 1 inch Dia. Straight with 7,9 [.31] Dia. Crosshole 11,2 [.44] from End

08 ..... 1 inch Dia. Straight with 10,2 [.40] Dia. Crosshole 15,7 [.62] from End and 1/4-20 Threaded Hole

16 ..... 7/8 inch Dia. SAE B 13T Splined

17 ..... 7/8 inch Dia. SAE B Staight with Square Key

18 ..... 1 inch Dia. Tapered with Woodruff Key and Nut

24 ..... 25mm Dia. Straight with 8mm Key and 8mm x 1,2 Threaded Hole

27 ..... 1 inch Dia. Straight with Woodruff Key and 1/4-20 Threaded Hole (Plated for Corrosion Protection)

29 ..... 25mm Dia. Straight with 8mm x 1.2 Threaded Hole (Plated for Corrosion Protection)

32 ..... 1 inch Dia. Straight with 10,2 [.40] Dia. Crosshole 15,7 [.62] from End and 1/4-20 Threaded Hole (Plated...)

33 ..... 1 inch Dia. Tapered with Woodruff Key and Nut (Plated for Corrosion Protection)

Position 9 Port Type

A ..... 7/8-14 O-ring

B ..... 1/2-14 NPTF

C ..... Manifold (5/16-18 Mounting Threads)

D ..... Manifold (M8 x 1,25 Mounting Threads)

E ..... G 1/2 (BSP)

G ..... 3/4-16 End Ported

K ..... G 1/2 (BSP) End Ported

Position 10 Case Drain

0 ..... No Case Drain

1 ..... 7/16-20 O-ring Port End Cap

2 ..... G 1/4 (BSP) End Cap

Position 11, 12 Special Features (Hardware)

00 ..... None

AA ..... Free Running Gerotor

AB ..... Low Speed Valve

AC ..... Viton Shaft Seal

BW ..... Internal Check Valves

BZ ..... Speed Sensor

AM ..... Free Running Gerotor, Low Speed Valve

DS ..... High Pressure Shaft Seal

Position 13 Special Features (Assembly)

0 ..... None

1 ..... Reverse Rotation

2 ..... Flange Rotated 90°

Position 14 Paint/Special Packaging

0 ..... No Paint

A ..... Painted Low Gloss Black (Standard)

D ..... Corrosion Protected

Position 15 Eaton Assigned Code when Applicable

0 ..... Assigned Code

Position 16 Eaton Assigned Design Code

0 ..... Design Code

*The H Series motors with displacement code "02" or "04" must also specify free running gerotor (option "AA" in positions 11, 12).

Model Code for S Series Motors

The following 16-digit coding system has been developed to identify all of the configuration options for the S Series Motor. Use this model code to specify a motor with the desired features. All 16-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 — S Series Spool Valve Motors

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
M	0	S												0	0

Position 1 Product Series
M ..... Motor
Position 2, 3 S Series
0S ..... S Series
Position 4, 5 Displacement cm^3/r [in^3/r]
04 ..... 59 [3.6]
05 ..... 74 [4.5]
06 ..... 97 [5.9]
07 ..... 120 [7.3]
09 ..... 146 [8.9]
10 ..... 159 [9.7]
11 ..... 185 [11.3]
10 ..... 159 [9.7]
14 ..... 231 [14.1]
18 ..... 293 [17.9]
23 ..... 370 [22.6]
Position 6 Mounting Flange
A ..... 2 Bolt (Standard) 82,6 [3.25] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes 106,2 [4.18] Dia. B.C.
B ..... 4 Bolt (Standard) 44,4 [1.75] Pilot Dia. and 3/8-16 Mounting Holes 82,6 [3.25] Dia. B.C.
E ..... 4 Bolt (Standard) 44,4 [1.75] Pilot Dia. and M10 x 1,5 Mounting Holes 82,6 [3.25] Dia. B.C.
H ..... 2 Bolt (Std.) 101,6 [4.00] Pilot Dia. and 14,35 [.565] Dia. Mounting Holes 146,0 [5.75] Dia. B.C. (SAE B)
K ..... 4 Bolt Magneto 82,6 [3.25] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes 106,2 [4.18] Dia. B.C.
Position 7, 8 Output Shaft
01 ..... 1 inch Dia. Straight with Woodruff Key and 1/4-20 Threaded Hole
02 ..... 1 inch Dia. SAE 6B Splined with 1/4-20 Threaded Hole
07 ..... 1 inch Dia. Straight with 7,9 [.31] Dia. Crosshole 11,2 [.44] from End
08 ..... 1 inch Dia. Straight with 10,2 [.40] Dia. Crosshole 15,7 [.62] from End and 1/4-20 Threaded Hole
16 ..... 7/8 inch Dia. SAE B 13T Splined
17 ..... 7/8 inch Dia. SAE B Straight with Square Key
18 ..... 1 inch Dia. Tapered with Woodruff Key and Nut
24 ..... 25mm Dia. Straight with 8mm Key and 8mm x 1.2 Threaded Hole
27 ..... 1 inch Dia. Straight with Woodruff Key and 1/4-20 threaded Hole (Coated for Corrosion Protection)

Position 9 Port Type
A ..... 7/8-14 O-ring
B ..... 1/2-14 NPTF
C ..... Manifold (5/16-18 Mounting Threads)
D ..... Manifold (M8 x 1,25 Mounting Threads)
E ..... G 1/2 (BSP) End Cap
Position 10 Case Drain
0 ..... No Case Drain
1 ..... 7/16-20 O-ring Port End Cap
2 ..... G 1/4 (BSP) End Cap
Position 11, 12 Special Features (Hardware)
00 ..... None
AB ..... Low Speed Valve
AC ..... Viton Shaft Seal
BZ ..... Speed Sensor
DS ..... High Pressure Shaft Seal
Position 13 Special Features (Assembly)
0 ..... None
1 ..... Reverse Rotation
2 ..... Flange Rotated 90°
Position 14 Paint/Special Packaging
0 ..... No Paint
A ..... Painted Low Gloss Black (Standard)
D ..... Corrosion Protected
Position 15 Eaton Assigned Code when Applicable
0 ..... Assigned Code
Position 16 Eaton Assigned Design Code
0 ..... Design Code

Model Code for T Series Motors

The following 16-digit coding system has been developed to identify all of the configuration options for the T Series Motor. Use this model code to specify a motor with the desired features. All 16-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 — T Series Spool Valve Motors

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
M	0	T												0	0

Position 1 Product Series
M ..... Motor
Position 2, 3 T Series
0T ..... T Series
Position 4, 5 Displacement cm^3/r [in^3/r]
02 ..... 36 [2.2]
03 ..... 49 [3.0]
04 ..... 66 [4.0]
05 ..... 80 [4.9]
06 ..... 102 [6.2]
08 ..... 131 [8.0]
10 ..... 157 [9.6]
12 ..... 195 [11.9]
15 ..... 244 [14.9]
19 ..... 306 [18.7]
23 ..... 370 [22.6]
Position 6 Mounting Flange
A ..... 2 Bolt (Standard) 82,6 [3.25] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes 106,2 [4.18] Dia. B.C.
B ..... 4 Bolt (Standard) 44,4 [1.75] Pilot Dia. and 3/8-16 Mounting Holes 82,6 [3.25] Dia. B.C.
E ..... 4 Bolt (Standard) 44,4 [1.75] Pilot Dia. and M10 x 1,5 Mounting Holes 82,6 [3.25] Dia. B.C.
H ..... 2 Bolt (Std.) 101,6 [4.00] Pilot Dia. and 14,35 [.565] Dia. Mounting Holes 146,0 [5.75] Dia. B.C. (SAE B)
K ..... 4 Bolt Magneto 82,6 [3.25] Pilot Dia. and 13,59 [.535] Dia. Mounting Holes 106,2 [4.18] Dia. B.C.
Position 7, 8 Output Shaft
01 ..... 1 inch Dia. Straight with Woodruff Key and 1/4-20 Threaded Hole
02 ..... 1 inch Dia. SAE 6B Splined with 1/4-20 Threaded Hole
07 ..... 1 inch Dia. Straight with 7,9 [.31] Dia. Crosshole 11,2 [.44] from End
08 ..... 1 inch Dia. Straight with 10,2 [.40] Dia. Crosshole 15,7 [.62] from End and 1/4-20 Threaded Hole
16 ..... 7/8 inch Dia. SAE B 13T Splined
17 ..... 7/8 inch Dia. SAE B Straight with Square Key
18 ..... 1 inch Dia. Tapered with Woodruff Key and Nut
24 ..... 25mm Dia. Straight with 8mm Key and 8mm x 1.2 Threaded Hole
27 ..... 1 inch Dia. Straight with Woodruff Key and 1/4-20 Threaded Hole (Plated for Corrosion Protection)

Position 9 Port Type
A ..... 7/8-14 O-ring
B ..... 1/2-14 NPTF
C ..... Manifold (5/16-18 Mounting Threads)
D ..... Manifold (M8 x 1,25 Mounting Threads)
E ..... G 1/2 (BSP) End Cap
Position 10 Case Drain
0 ..... No Case Drain
1 ..... 7/16-20 O-ring Port End Cap
2 ..... G 1/4 (BSP) End Cap
Position 11, 12 Special Features (Hardware)
00 ..... None
AB ..... Low Speed Valve
AC ..... Viton Shaft Seal
BW ..... Internal Check Valves
BZ ..... Speed Sensor
DS ..... High Pressure Shaft Seal
Position 13 Special Features (Assembly)
0 ..... None
1 ..... Reverse Rotation
2 ..... Flange Rotated 90°
Position 14 Paint/Special Packaging
0 ..... No Paint
A ..... Painted Low Gloss Black (Standard)
D ..... Corrosion Protected
Position 15 Eaton Assigned Code when Applicable
0 ..... Assigned Code
Position 16 Eaton Assigned Design Code
0 ..... Design Code



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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GRAND RAPIDS, MI 49512
Telephone: 800-968-0188
Fax: 616-949-6598
http://www.charlynn.com

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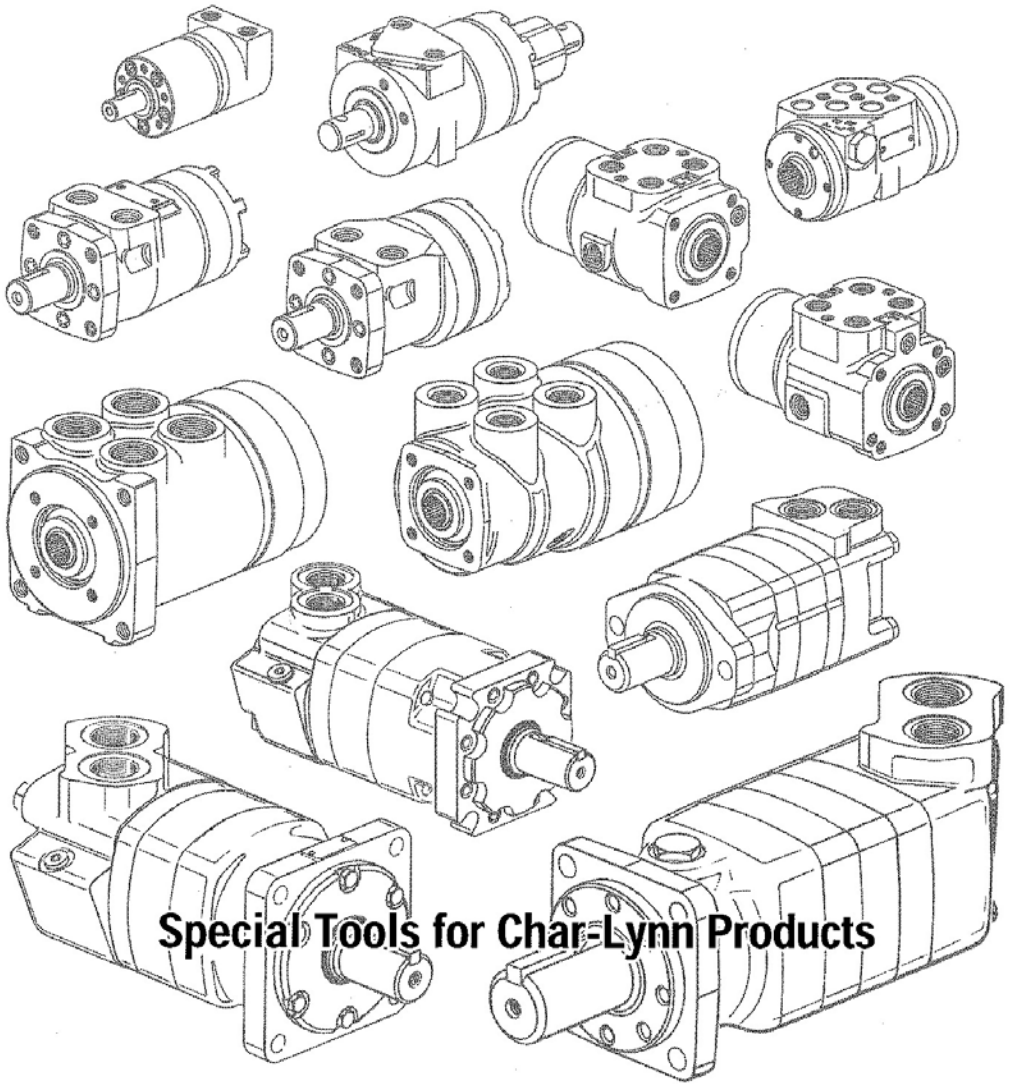
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Char-Lynn®
Product Information

No. 2-805
June, 1996

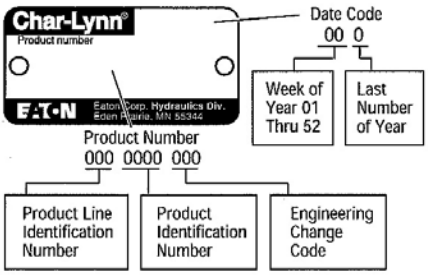
EATON



Special Tools for Char-Lynn Products

Introduction

Eaton Corporation, Hydraulics Division has made available special tools to aid the user in the disassembly and reassembly of Eaton Char-Lynn products. The use of these tools will prevent possible damage to seals and etc. during reassembly of the Char-Lynn products. These special tools are listed first by part number and then by tool description on page 3 of this document. Pages 4, 5, and 6 are to be used to show where each of these special tools may be used by product series and engineering change code. This information may be found on the product information tag located on each and every Char-Lynn product. See Sample tag below.



Special Tools for Char-Lynn Products

Part Number	Special Tool Description
5422-000	5/16 in. -12 Point Socket
600057-000	Spring Installation Tool
600304-000	Shaft Seal Bullet
600336-000	Spring Installation Tool
600421-000	Shaft Face Seal Installation Tool
600463-000	Shaft Seal Bullet
600464-000	Shaft Seal Bullet
600465-000	Shaft Seal Bullet
600466-000	Shaft Seal Bullet
600468-000	Shaft Face Seal Installation Tool
600469-000	Shaft Face Seal Installation Tool
600470-000	Shaft Pressure Seal Installation Tool
600496-000	Shaft Pressure Seal Installation Tool
600523-000	Shaft Pressure Seal Installation Tool
600633-000	Shaft Seal Bullet
600636-000	Bearing Removal Tool
600637-000	Bearing Press Tool
600642-000	Seal Press Tool
64489-000	5/16 in. - 6 Point (E10 Torx Drive) Socket

Special Tools for Char-Lynn Products

Part Number	Special Tool Description
	"A" Series Motors
5422-000	5/16 in. -12 Point Socket Heavy Duty 500 in. lb. [56] Nm. Capacity (001 thru 003) Motors
64489-000	5/16 in. - 6 Point (E10 Torx Drive) Socket (002 and 003) Mtrs.
600470-000	Shaft Pressure Seal Installation Tool (001) Motor
600523-000	Shaft Pressure Seal Installation Tool (002 and 003) Motors
600466-000	Shaft Seal Bullet for 7/8 in. Shaft (001 thru 003) Motors
600304-000	Shaft Seal Bullet for 1 in. Shaft (001 thru 003) Motors
	"H" Series Motors
5422-000	5/16 in. -12 Point Socket Heavy Duty 500 in. lb. [56] Nm. Capacity (007 thru 009) Motors
64489-000	5/16 in. - 6 Point (E10 Torx Drive) Socket (009) Motor
600470-000	Shaft Pressure Seal Installation Tool (007) Motor
600523-000	Shaft Pressure Seal Installation Tool (008 and 009) Motors
600466-000	Shaft Seal Bullet for 7/8 in. Shaft (007 thru 009) Motors
600304-000	Shaft Seal Bullet for 1 in. Shaft (007 thru 009) Motors
	"R" Series Motors
5422-000	5/16 in. -12 Point Socket Heavy Duty 500 in. lb. [56] Nm. Capacity (001) Motor
64489-000	5/16 in. - 6 Point (E10 Torx Drive) Socket (001 and 002) Mtrs.
600523-000	Shaft Pressure Seal Installation Tool (001 and 002) Motors
600466-000	Shaft Seal Bullet for 7/8 in. Shaft (001 and 002) Motors
600304-000	Shaft Seal Bullet for 1 in. Shaft (001 and 002) Motors
	"S" Series Motors
5422-000	5/16 in. -12 Point Socket Heavy Duty 500 in. lb. [56] Nm. Capacity (007 thru 010) Motors
64489-000	5/16 in. - 6 Point (E10 Trox Drive) Socket (010) Motor
600470-000	Shaft Pressure Seal Installation Tool (007 and 008) Motors
600523-000	Shaft Pressure Seal Installation Tool (009 thru 010) Motors
600466-000	Shaft Seal Bullet for 7/8 in. Shaft (007 thru 010) Motors
600304-000	Shaft Seal Bullet for 1 in. Shaft (007 thru 010) Motors

Special Tools for Char-Lynn Products

Part Number	Special Tool Description
	"T" Series Motors
64489-000	5/16 in. - 6 Point (E10 Trox Drive) Socket (001 and 002) Mtrs.
600523-000	Shaft Pressure Seal Installation Tool (001 and 002) Motors
600466-000	Shaft Seal Bullet for 7/8 in. Shaft (001 and 002) Motors
600304-000	Shaft Seal Bullet for 1 in. Shaft (001 and 002) Motors
	"W" Series Motors
600633-000	Shaft Seal Bullet (002) Motor
600636-000	Bearing Removal Tool (002) Motor
600637-000	Bearing Press Tool (002) Motor
600642-000	Seal Press Tool (002) Motor
	2000 Series Motors
600496-000	Shaft Pressure Seal Installation Tool (003 thru 006) Motors
600465-000	Shaft Seal Bullet for 1 in. Shaft (003 thru 006) Motors
	4000 Series Motors
600468-000	Shaft Face Seal Installation Tool (004) Motor
600421-000	Shaft Face Seal Installation Tool (006) Motor
600463-000	Shaft Seal Bullet for 1–1/4 in. Shaft (004) Motor
	6000 Series Motors
600469-000	Shaft Face Seal Installation Tool (005 and 006) Motors
600464-000	Shaft Seal Bullet for 1–1/2 in. Shaft (005 and 006) Motors
	10,000 Series Motors
5422-000	5/16 in. -12 Point Socket Heavy Duty 500 in. lb. [56] Nm. Capacity (002 and 003) Motors
64489-000	5/16 in. - 6 Point (E10 Torx Drive) Socket (003) Motor

Special Tools for Char-Lynn Products

Part Number	Special Tool Description
	Torque Generator
5422-000	5/16 in. -12 Point Heavy Duty Socket 500 in lb. [56 Nm] Capacity (001 and 006) Torque Generators
64489-000	5/16 in. - 6 Point (E 10 Torx Drive) Socket (002) Torque Generator
600057-000	Spring Installation Tool (001, 002, and 006) Torque Generators
	3, 4, 6, and 12 Series SCU
5422-000	5/16 in. -12 Point Heavy Duty Socket 500 in lb. [56 Nm] Capacity (001) SCU
64489-000	5/16 in. - 6 Point (E 10 Torx Drive) Socket (002) SCU
600057-000	Spring Installation Tool (001 and 002) SCU
	110, 230, and 450 Series SCU
5422-000	5/16 in. -12 Point Heavy Duty Socket 500 in lb. [56 Nm] Capacity (001) SCU
64489-000	5/16 in. - 6 Point (E 10 Torx Drive) Socket (002) SCU
600057-000	Spring Installation Tool (001 and 002) SCU
	20 Series SCU
600604-000	Spool/Sleeve Installation Tool (001) SCU
	25, 35, and 40 Series SCU
600336-000	Spring Installation Tool (001 Thru 003) SCU

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EATON

Char Lynn Hydraulic Motor J-2 Series



J-2 Series Features

Integrated Check Valves
Helps extend seal life

Extends seal life, decreasing the fluid pressure acting on the shaft seal and reducing case pressure to return pressure by as much as 60% of full system pressure. Case drain option is recommended for some series applications (see page 13).

Self-Lubricating Bushing

Reduces shaft friction under radial side loads to ensure adequate lubrication and support under all rated conditions.

Lengthened Spool Valve Lands
Higher-efficiency operation

Reduces internal leakage into the motor case resulting in improved efficiencies and increased shaft turns per liter/gallon.

More Rigid Components
Helps reduce internal leakage

Resists deformation and subsequent leaks at higher pressures using more rigid components such as the wear plate.

Shaft Seal
Withstand high back pressures

Time proven shaft seal design and construction allow motors to withstand high back pressures without an external case drain. The motors can be connected together in series, or parallel to one another, see page 12 for more infomation.

Corrosion Protected
Resist corrosion in hosile environments

J-2 Series motors are available with a corrosion resistant coating for use in an hostile environment. Such as salt, water, and various chemicals. It is especially effective in marine, food processing, car wash, fishing, and agricultural applications. Shaft plating helps eliminate seal damage caused by these caustic or acid materials in the shaft sealing area. Corrosion protected motors are available with just the output shaft plated, or protected with an entire motor exterior coating.

Catalog Contents

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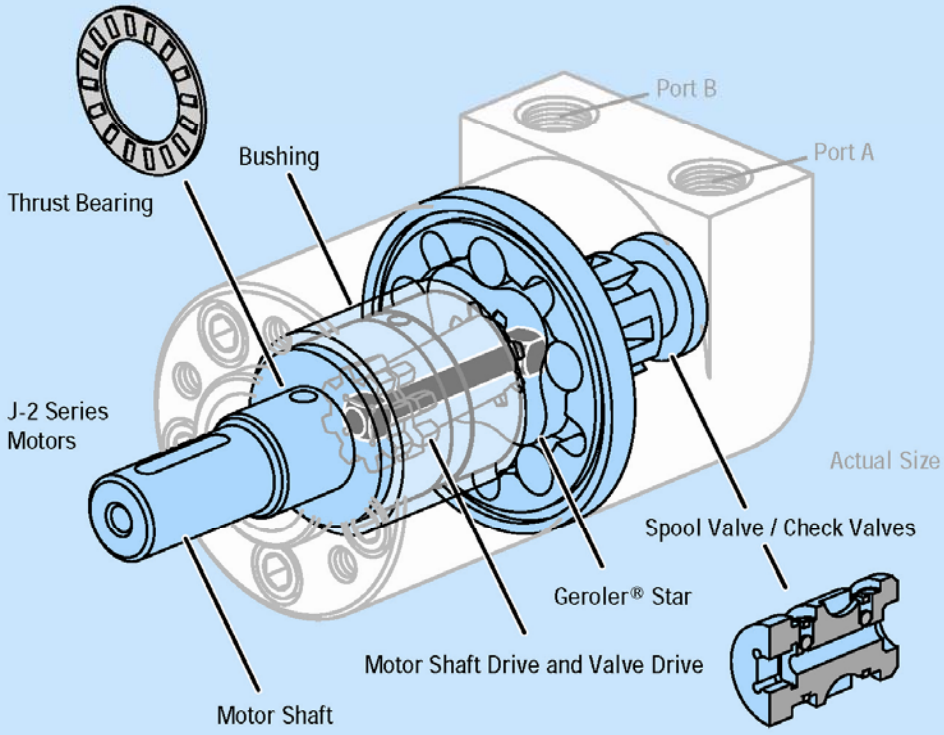
* Contact your Eaton Representative

General Purpose Spool Valve J-2 Series Hydraulic Motors from One of the World's Leading Manufacturers of Off Highway Mobile Components — Eaton Corporation

Char-Lynn J-2 Series motors provide a lot of power from a very small package, indeed, up to 5 kW [6 1/2 HP] of power. These motors are 61 millimeters [2.4 inches] in diameter and 104 to 130 millimeters [4.1 to 5.1 inches] in length.

J-2 Series motors are the smallest of Eaton's line of Char-Lynn motors. These motors have high starting and running torque, and operate with equal torque in either direction.

With this new 4:1 Geroler element, the five rollers provide support with rolling contact as the Geroler four lobe star rotates, minimizing friction and providing high efficiencies especially at start-up and at low speeds.



J-2 Series



J-2 Series

Geroler® Element	5 Displacements
Flow LPM [GPM]	21 [5.5] Continuous**
	25 [6.5] Intermittent*
Speed	Up to 1992 RPM Cont.
	Up to 2458 RPM Inter.
Pressure Bar [PSI] ...	140 [2030] Cont.
	165 [2400] Inter.
Torque Nm [lb-in]	62 [549] Cont.
	84 [743] Inter.

These compact J-2 Series motors have an hydrodynamic output shaft bearing. This hydrodynamic shaft bearing will accept high radial shaft loads, as well as high thrust loads common on sprocket and chain, or pulley and belt drive applications. The new bushing design reduces friction even further.

The J-2 Series motor shaft seal allows a high case pressure of up to 76 Bar [1100 PSI] return line pressure without case drain line. When a case drain line is used a 220 Bar [3190 PSI] peak pressure is allowed in the return line.

These small motors can be mounted in any orientation that would suit the application. The driving device, sprocket, pulley, etc., can be mounted directly onto the motor shaft.

J-2 Series Displacement Size = cubic centimeter per shaft revolution (cm^3/r)
- 8,2 [.50] = cubic inch per shaft revolution ([in^3/r])
- 12,9 [.79]
- 19,8 [1.21]
- 31,6 [1.93]
- 50,0 [3.00]

Mounting Flange
- 5 Bolt: Dia. 31,47 [1.239] x 5,1 [.20] Pilot 1/4-28 UNF - 2B Mounting Holes on 45 [1.77] Dia. Bolt Circle
- 5 Bolt: Dia. 31,47 [1.239] x 5,1 [.20] Pilot M6 x 1 - 6H Mounting Holes on 45 [1.77] Dia. Bolt Circle
- 2 Bolt: Dia. 62,99 [2.480] x 2,0 [.08] Pilot 10,36 [.408] Mounting Holes on 80,0 [3.150] Dia. Bolt Circle
- 2 Bolt: Dia. 62,99 [2.480] x 2,0 [.08] Pilot 9,0 [.354] Mounting Holes on 80,0 [3.150] Dia. Bolt Circle

Output Shaft
- 5/8 inch Dia. Straight with 4,72 [.186] Square Key and 1/4-28 UNF - 2B Threaded Hole
- 16 mm Dia. Straight with 5,00 [.197] Square Key with M6 x 1 - 6H Threaded Hole
- 11/16 inch Dia. Straight with 4,72 [.186] Square Key and 1/4-28 UNF - 2B Threaded Hole
- 18 mm Dia. Straight with 5,92 [.233] Square Key with M6 x 1 - 6H Threaded Hole
- Involute 9T Splined—Metric 16,5 [.650] Dia. (B 17 x 14 DIN 5482) M6 x 1 Threaded Hole
- 5/8 inch Dia. Straight with 4,75 [.187] Dia. Crosshole
- 3/4 inch Tapered with woodruff Key and Nut

Port Type
- 9/16-18 UNF - 2B O-ring End Ported
- G 1/4 (BSP) End Ported
- M14 x 1,5 - 6H O-ring Port, End Ported
- 9/16-18 UNF - 2B O-ring Side Ported
- G 3/8 (BSP) Side Ported
- G 1/4 (BSP) Side Ported
- G 3/8 (BSP) End Ported

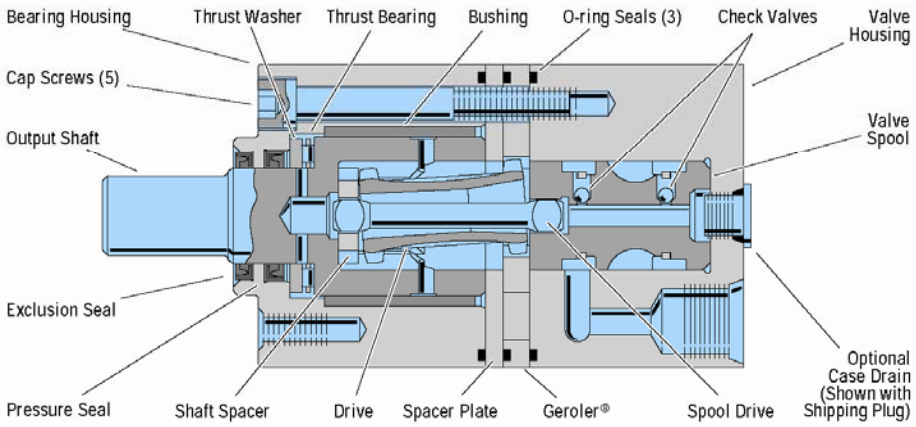
Case Drain
- No Case Drain
- 3/8-24 UNF - 2B O-ring
- G 1/8 (BSP)
- M10 x 1 - 6H O-ring

Special Features Available
- Reverse Rotation
- Painted Low Gloss Black
- Corrosion Protected

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

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

Specifications
J-2 Series



Specification Data—J-2 Series

Displacement cm³/r [in³/r]		8,2 [.50]	12,9 [.79]	19,8 [1.21]	31,6 [1.93]	50,0 [3.00]
Max. Speed (RPM) @ Continuous Flow		1992	1575	1043	650	393
Flow LPM [GPM]	Continuous	17 [4.5]	21 [5.5]	21 [5.5]	21 [5.5]	21 [5.5]
	Intermittent	21 [5.5]	25 [6.5]	25 [6.5]	25 [6.5]	25 [6.5]
Torque Nm [in-lb]	Continuous	16 [141]	25 [225]	38 [333]	50 [446]	62 [549]
	Intermittent	19 [164]	30 [263]	46 [405]	62 [546]	84 [743]
	Peak	22 [193]	36 [321]	48 [425]	83 [733]	86 [765]
Pressure* Δ Bar [Δ PSI]	Continuous	140 [2030]	140 [2030]	140 [2030]	121 [1750]	97 [1400]
	Intermittent	165 [2400]	165 [2400]	165 [2400]	150 [2175]	140 [2030]
	Peak	220 [3190]	220 [3190]	220 [3190]	190 [2756]	150 [2175]
Weight kg [lbs]		2 [4.4]	2,1 [4.6]	2,2 [4.8]	2,3 [5.0]	2,4 [5.4]

* Maximum intermittent pressure at motor inlet port of 220 Bar [3190 PSI] without regard to Δ Bar [Δ PSI] and/or back pressure ratings or combination thereof.

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

See individual shafts for maximum torque recommendation. Splined shafts are recommended for those applications subject to frequent reversals.

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 14).

Recommended Max. System Operating Temp. — -34°C to 82°C [-30°F to 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
J-2 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.

8,2 cm³/r [.50 in³/r]
Δ Pressure Bar [PSI]
Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[500] 34	[600] 41	[700] 48	[800] 55	[1000] 69	[1400] 97	[1500] 103	[2000] 138	Max. Continuous [2030] 140	Max. Intermittent [2400] 165
[1] 3,8	[11] 1 **456**	[25] 3 **444**	[33] 4 **437**	[40] 5 **429**	[47] 5 **422**	[55] 6 **412**	[69] 8 **394**	[96] 11 **347**	[102] 12 **332**	[130] 15 **250**	[132] 15 **239**	[146] 16 **170**
[2] 7,6	[9] 1 **897**	[24] 3 **886**	[31] 4 **877**	[38] 4 **867**	[46] 5 **860**	[53] 6 **847**	[68] 8 **823**	[97] 11 **768**	[105] 12 **749**	[139] 16 **657**	[141] 16 **647**	[163] 18 **557**
[3] 11,4	[6] 1 **1349**	[20] 2 **1331**	[28] 3 **1318**	[35] 4 **1309**	[44] 5 **1296**	[51] 6 **1285**	[65] 7 **1261**	[94] 11 **1198**	[102] 12 **1176**	[137] 15 **1070**	[139] 16 **1060**	[164] 19 **959**
[4.25] 16,0		[16] 2 **1902**	[23] 3 **1885**	[30] 3 **1873**	[36] 4 **1858**	[44] 5 **1846**	[60] 7 **1817**	[90] 10 **1750**	[97] 11 **1721**	[133] 15 **1599**	[135] 15 **1585**	[160] 18 **1475**
Max. Continuous [4.5] 17,0		[16] 2 **1992**	[23] 3 **1979**	[29] 3 **1964**	[36] 4 **1947**	[43] 5 **1929**	[59] 7 **1900**	[89] 10 **1833**	[96] 11 **1808**	[131] 15 **1684**	[134] 15 **1673**	[160] 18 **1553**
Max. Intermittent [5.5] 20,8		[12] 1 **2459**	[18] 2 **2437**	[26] 3 **2420**	[33] 4 **2405**	[40] 5 **2397**	[54] 6 **2353**	[83] 9 **2272**	[92] 10 **2255**	[124] 14 **2134**	[129] 15 **2115**	[154] 17 **1994**

[16] 2 } Torque (lb-in) Nm
1992 } Speed RPM

12,9 cm³/r [0.79 in³/r]
Δ Pressure Bar [PSI]
Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[500] 34	[600] 41	[700] 48	[800] 55	[1000] 69	[1400] 97	[1450] 100	[1500] 103	[2000] 138	Max. Continuous 2030 140	Max. Intermittent [2400] 165
[1] 3,8	[19] 2 **290**	[43] 5 **285**	[54] 6 **281**	[65] 7 **277**	[76] 9 **273**	[88] 10 **268**	[109] 12 **260**	[154] 17 **237**	[159] 18 **234**	[164] 19 **230**	[214] 24 **194**	[217] 25 **189**	[250] 28 **151**
[2] 7,6	[16] 2 **573**	[39] 4 **566**	[51] 6 **561**	[63] 7 **555**	[74] 8 **549**	[86] 10 **544**	[109] 12 **534**	[155] 18 **501**	[160] 18 **496**	[165] 19 **490**	[221] 25 **442**	[225] 25 **437**	[263] 30 **396**
[3] 11,4	[11] 1 **859**	[35] 4 **849**	[47] 5 **843**	[58] 7 **838**	[70] 8 **832**	[82] 9 **825**	[105] 12 **810**	[152] 17 **777**	[157] 18 **771**	[163] 18 **763**	[219] 25 **708**	[223] 25 **701**	[263] 30 **652**
[4] 15,1	[6] 1 **1153**	[30] 3 **1140**	[41] 5 **1135**	[53] 6 **1129**	[64] 7 **1124**	[76] 9 **1117**	[99] 11 **1101**	[146] 16 **1060**	[152] 17 **1051**	[157] 18 **1044**	[214] 24 **982**	[217] 25 **975**	[260] 29 **924**
Max. Continuous [5.5] 20,8		[19] 2 **1575**	[30] 3 **1566**	[42] 5 **1556**	[54] 6 **1547**	[65] 7 **1539**	[89] 10 **1521**	[136] 15 **1473**	[142] 16 **1466**	[148] 17 **1457**	[205] 23 **1396**	[209] 24 **1387**	[251] 28 **1330**
Max. Intermittent [6.5] 24,6		[11] 1 **1859**	[23] 3 **1851**	[35] 4 **1842**	[46] 5 **1831**	[56] 6 **1820**	[81] 9 **1804**	[130] 15 **1755**	[135] 15 **1743**	[140] 16 **1734**	[198] 22 **1670**	[202] 23 **1663**	[243] 27 **1599**

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

Performance Data
J-2 Series

19.8 cm³/r [1.21 in³/r]
Δ Pressure Bar [PSI]
Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[500] 34	[600] 41	[700] 48	[800] 55	[1000] 69	[1400] 97	[1450] 100	[1500] 103	[2000] 138	[2030] 140	Max. Contin-uous	Max. Inter-mittent
[1] 3,8	[32] 4 **189**	[67] 8 **187**	[85] 10 **186**	[102] 12 **185**	[119] 13 **183**	[136] 15 **182**	[170] 19 **179**	[236] 27 **172**	[244] 28 **170**	[253] 29 **169**	[321] 36 **141**	[325] 37 **138**	[2400] 165	[374] 42 **114**
[2] 7,6	[30] 3 **379**	[65] 7 **376**	[83] 9 **373**	[101] 11 **370**	[119] 13 **368**	[136] 15 **366**	[172] 19 **361**	[223] 25 **351**	[248] 28 **349**	[257] 29 **347**	[328] 37 **312**	[333] 37 **309**		[388] 44 **286**
[3] 11,4	[21] 2 **569**	[57] 6 **565**	[75] 8 **563**	[93] 11 **560**	[111] 13 **558**	[128] 14 **556**	[163] 18 **551**	[231] 26 **529**	[240] 27 **526**	[248] 28 **523**	[325] 37 **487**	[330] 37 **484**		[405] 46 **459**
[4] 15,1	[12] 1 **761**	[47] 5 **758**	[65] 7 **754**	[83] 9 **751**	[101] 11 **749**	[119] 13 **746**	[154] 17 **741**	[221] 25 **717**	[230] 26 **711**	[239] 27 **707**	[316] 36 **660**	[320] 36 **656**		[382] 43 **628**
Max. Contin-uous [5.5] 20,8		[31] 4 **1043**	[49] 6 **1040**	[67] 8 **1035**	[84] 9 **1033**	[101] 11 **1028**	[137] 15 **1021**	[202] 23 **997**	[211] 24 **993**	[218] 25 **990**	[295] 33 **938**	[299] 34 **934**		[365] 41 **899**
Max. Inter-mittent [6.5] 24,6		[21] 2 **1226**	[38] 4 **1222**	[56] 6 **1219**	[74] 8 **1216**	[91] 10 **1211**	[126] 14 **1204**	[189] 21 **1179**	[196] 22 **1174**	[206] 23 **1169**	[278] 31 **1121**	[283] 32 **1117**		[347] 39 **1079**

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.

31,6 cm³/r [1.93 in³/r]
Δ Pressure Bar [PSI]
Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[500] 34	[600] 41	[700] 48	[800] 55	[1000] 69	[1400] 97	[1450] 100	[1500] 103	[1750] 121	Max. Contin-uous	Max. Inter-mittent
[1] 3,8	[51] 6 **118**	[106] 12 **116**	[133] 15 **115**	[160] 18 **113**	[187] 21 **112**	[213] 24 **111**	[265] 30 **107**	[362] 41 **91**	[372] 42 **85**	[383] 43 **81**	[439] 50 **70**		
[2] 7,6	[46] 5 **236**	[103] 12 **234**	[132] 15 **232**	[159] 18 **230**	[187] 21 **228**	[214] 24 **225**	[269] 30 **221**	[362] 41 **187**	[374] 42 **179**	[387] 44 **175**	[446] 50 **165**		[546] 62 **145**
[3] 11,4	[36] 4 **355**	[94] 11 **352**	[122] 14 **349**	[149] 17 **347**	[177] 20 **345**	[205] 23 **342**	[259] 29 **336**	[351] 40 **296**	[364] 41 **292**	[377] 43 **287**	[440] 50 **273**		[542] 61 **245**
[4] 15,1	[24] 3 **474**	[79] 9 **472**	[107] 12 **469**	[135] 15 **466**	[162] 18 **462**	[190] 21 **460**	[246] 28 **452**	[337] 38 **404**	[349] 39 **397**	[362] 41 **393**	[425] 48 **373**		[528] 60 **346**
Max. Contin-uous [5.5] 20,8		[55] 6 **650**	[83] 9 **647**	[111] 13 **645**	[139] 16 **640**	[167] 19 **636**	[221] 25 **629**	[307] 35 **584**	[320] 36 **580**	[334] 38 **575**	[400] 45 **550**		[505] 57 **513**
Max. Inter-mittent [6.5] 24,6		[35] 4 **767**	[64] 7 **764**	[93] 11 **760**	[121] 14 **755**	[150] 17 **751**	[204] 23 **742**	[279] 32 **712**	[294] 33 **707**	[308] 35 **701**	[378] 43 **675**		[485] 55 **637**

50.0 cm³/r [3.00 in³/r]
Δ Pressure Bar [PSI]
Continuous

Flow LPM [GPM]	[200] 14	[400] 28	[500] 34	[600] 41	[700] 48	[800] 55	[1000] 69	[1100] 76	[1200] 83	[1300] 90	[1400] 97	Max. Contin-uous	Max. Inter-mittent
[1] 3,8	[82] 9 **75**	[167] 19 **72**	[211] 24 **72**										
[2] 7,6	[70] 8 **149**	[156] 18 **147**	[201] 23 **145**	[243] 28 **144**	[286] 32 **143**	[327] 37 **142**							
[3] 11,4	[53] 6 **221**	[140] 16 **220**	[184] 21 **218**	[227] 26 **217**	[271] 31 **215**	[311] 35 **213**	[396] 45 **209**	[441] 50 **205**	[484] 55 **201**	[521] 59 **200**	[549] 62 **191**		
[4] 15,1	[30] 3 **296**	[120] 14 **292**	[162] 18 **289**	[204] 23 **286**	[250] 28 **284**	[292] 33 **282**	[374] 42 **273**	[419] 47 **270**	[460] 52 **265**	[501] 57 **263**	[541] 61 **259**		[743] 84 **213**
Max. Contin-uous [5.5] 20,8		[81] 9 **393**	[127] 14 **392**	[170] 19 **389**	[214] 24 **387**	[254] 29 **383**	[339] 38 **377**	[379] 43 **372**	[422] 48 **369**	[463] 52 **364**	[506] 57 **359**		[702] 79 **302**
Max. Inter-mittent [6.5] 24,6		[47] 5 **465**	[90] 10 **462**	[133] 15 **460**	[176] 20 **458**	[219] 25 **455**	[307] 35 **448**	[345] 39 **445**	[385] 43 **440**	[429] 48 **435**	[467] 53 **430**		[685] 77 **364**

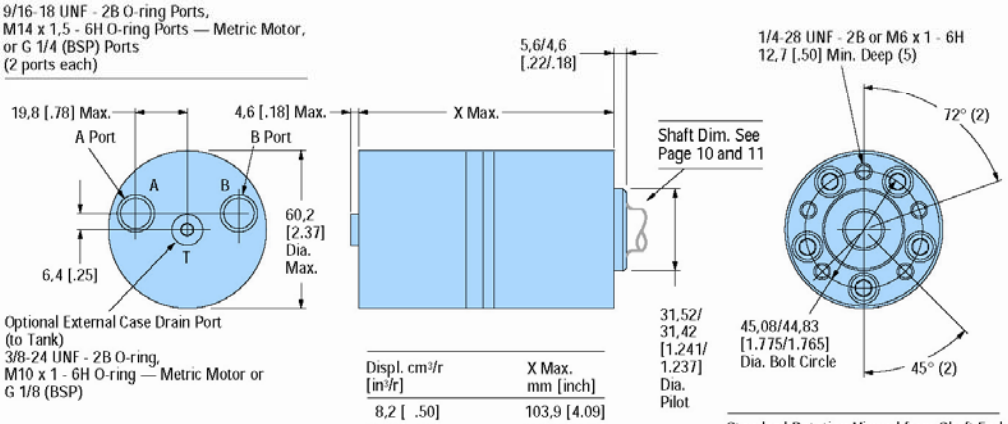
[81] 9 } Torque [lb-in] Nm
393 Speed RPM

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

Dimensions
J-2 Series

End Port Motors

9/16-18 UNF - 2B O-ring Ports,
M14 x 1,5 - 6H O-ring Ports — Metric Motor,
or G 1/4 (BSP) Ports
(2 ports each)

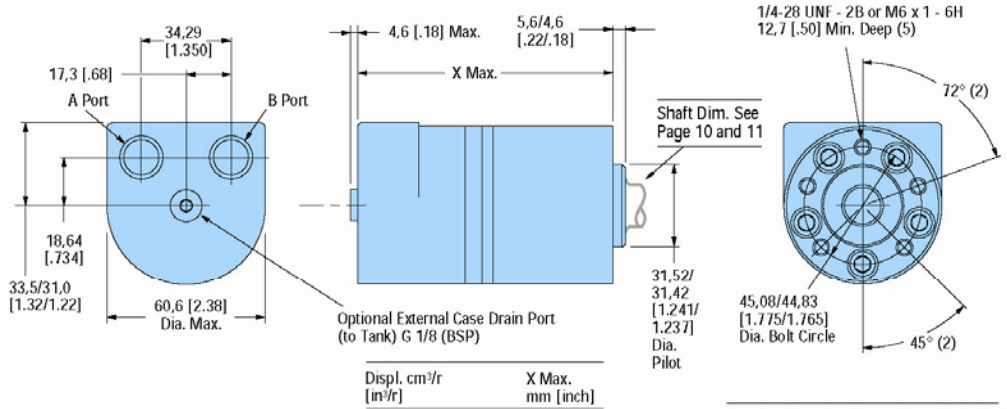


Displ. cm³/r [in³/r]	X Max. mm [inch]
8,2 [.50]	103,9 [4.09]
12,9 [.79]	106,9 [4.21]
19,8 [1.21]	112,5 [4.38]
31,6 [1.93]	118,9 [4.68]
50,0 [3.00]	130,3 [5.13]

Standard Rotation Viewed from Shaft End
Port A Pressurized — Clockwise
Port B Pressurized — Counterclockwise

End Port Motors

G 3/8 (BSP) Ports
(2 ports each)



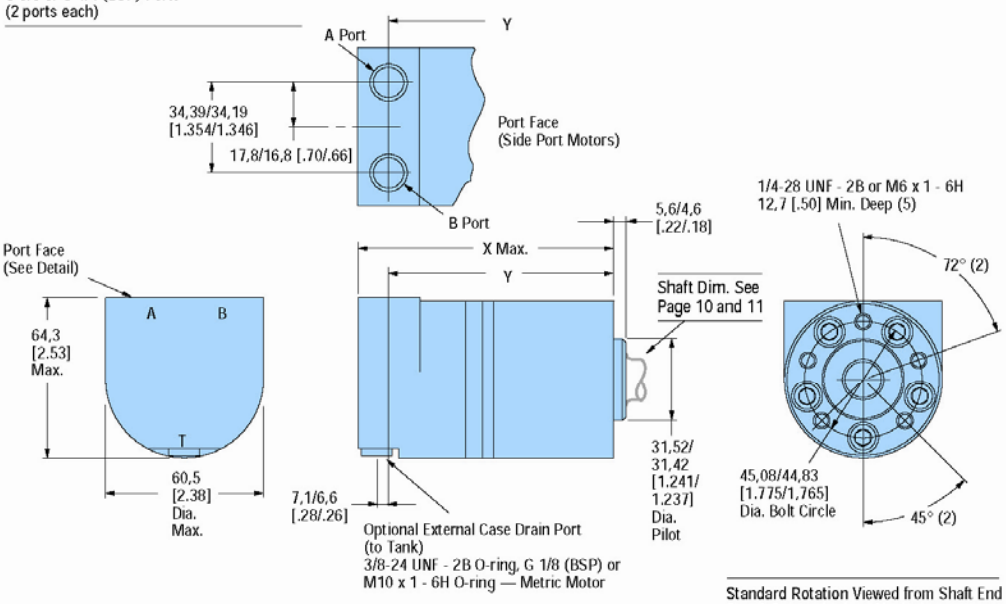
Displ. cm³/r [in³/r]	X Max. mm [inch]
8,2 [.50]	103,9 [4.09]
12,9 [.79]	106,9 [4.21]
19,8 [1.21]	112,5 [4.38]
31,6 [1.93]	118,9 [4.68]
50,0 [3.00]	130,0 [5.12]

Standard Rotation Viewed from Shaft End
Port A Pressurized — Clockwise
Port B Pressurized — Counterclockwise

Dimensions
J-2 Series

Side Port Motors

9/16-18 UNF - 2B O-ring Ports,
M14 x 1,5 -6H O-ring Ports — Metric Motor,
G 3/8 or G 1/4 (BSP) Ports
(2 ports each)

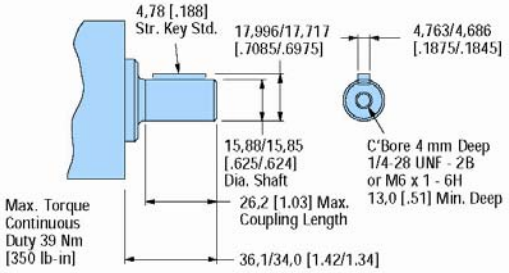


Displ. cm³/r [in³/r]	X Max. mm [inch]	Y mm [inch]
8,2 [.50]	103,9 [4.09]	89,4/ 87,4 [3.52/3.44]
12,9 [.79]	106,9 [4.21]	92,5/ 90,4 [3.64/3.56]
19,8 [1.21]	112,5 [4.38]	96,8/ 94,7 [3.81/3.73]
31,6 [1.93]	118,9 [4.68]	104,4/102,4 [4.11/4.03]
50,0 [3.00]	130,0 [5.12]	115,7/113,9 [4.56/4.48]

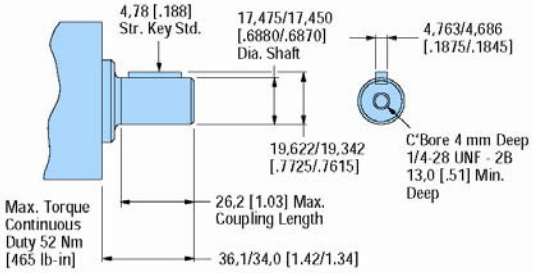
Standard Rotation Viewed from Shaft End
Port A Pressurized — Clockwise
Port B Pressurized — Counterclockwise

Dimensions — Shafts
J-2 Series

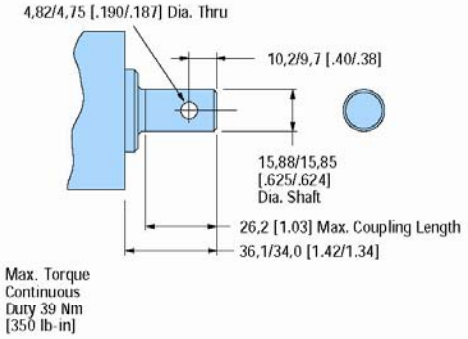
5/8 Inch Straight Keyed



11/16 Inch Straight Keyed

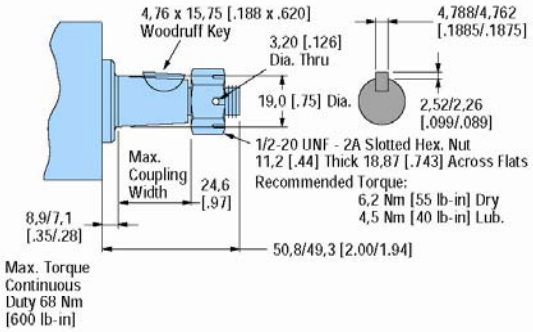


5/8 Inch Straight Keyed w/Crosshole



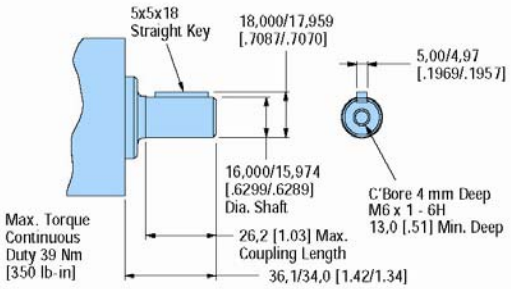
3/4 Inch Tapered

(Tapered Shaft End Per SAE J744
Except as Specified — 1.5 : 12 Ratio)

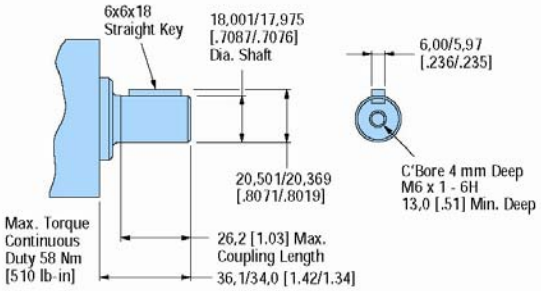


Dimensions — Shafts and Flange Kit
J-2 Series

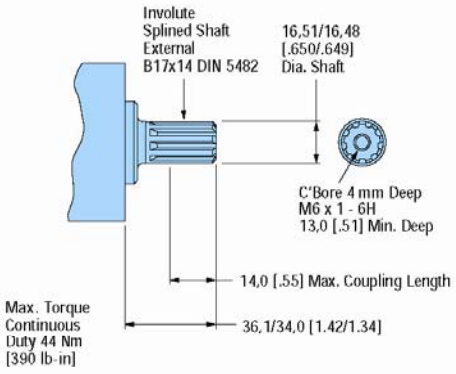
16 mm Straight Keyed



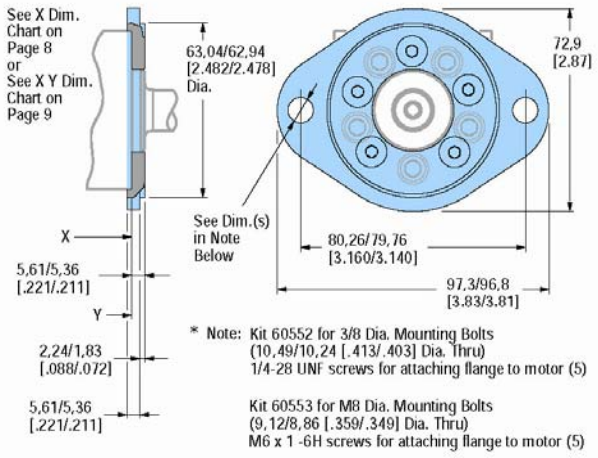
18 mm Straight Keyed



Involute 9T Splined — Metric



2 Bolt Flange Kits (2)*



* Note: Kit 60552 for 3/8 Dia. Mounting Bolts
(10,49/10,24 [.413/.403] Dia. Thru)
1/4-28 UNF screws for attaching flange to motor (5)

Kit 60553 for M8 Dia. Mounting Bolts
(9,12/8,86 [.359/.349] Dia. Thru)
M6 x 1 -6H screws for attaching flange to motor (5)

Product Numbers J-2 Series 129-xxxx

**Add three digit prefix —129-to four digit number from chart for complete product number—Example 129-0382.
Orders will not be accepted without three digit prefix.**

Port Location	Port Size	Mounting Holes (5)	Shaft	Displ. cm³/r [in³/r] / Product Number 129-xxxx 8,2 [.50]	12,9 [.79]	19,8 [1.21]	31,6 [1.93]	50,0 [3.00]
End Port Motors	9/16-18 UNF - 2B O-ring (2)	1/4-28 UNF 2B	5/8 inch Straight	129-0291	-0292	-0293	-0294	-0458
			11/16 inch Straight	129-0295	-0296	-0297	-0298	-0459
			Splined — Metric	129-0299	-0300	-0301	-0302	-0460
			3/4 inch Tapered					129-0480
	M14 x 1,5 - 6H O-ring (2)	M6 x 1 - 6H	16 mm Straight	129-0303	-0304	-0305	-0306	-0461
			18 mm Straight	129-0307	-0308	-0309	-0310	-0462
			Splined — Metric	129-0311	-0312	-0313	-0314	-0463
	G 1/4 (BSP) (2)	M6 x 1 - 6H	16 mm Straight	129-0315	-0316	-0317	-0318	-0464
			18 mm Straight	129-0319	-0320	-0321	-0322	-0465
			Splined — Metric	129-0323	-0324	-0325	-0326	-0466
End Port* Motors	G 3/8 (BSP) (2)	M6 x 1 - 6H	16 mm Straight	129-0327	-0328	-0329	-0330	-0467
			18 mm Straight	129-0331	-0332	-0333	-0334	-0468
			Splined — Metric	129-0335	-0336	-0337	-0338	-0469
Side Port Motors	9/16-18 UNF - 2B O-ring (2)	1/4-28 UNF 2B	5/8 inch Straight	129-0339	-0340	-0341	-0342	-0470
			11/16 inch Straight	129-0343	-0344	-0345	-0346	-0471
			Splined — Metric	129-0347	-0348	-0349	-0350	-0472
			3/4 inch Tapered					129-0481
	M14 x 1,5 - 6H O-ring (2)	M6 x 1 - 6H	16 mm Straight	129-0351	-0352	-0353	-0354	-0473
			18 mm Straight	129-0355	-0356	-0357	-0358	-0474
			Splined — Metric	129-0359	-0360	-0361	-0362	-0475
	G 1/4 (BSP) (2)	M6 x 1 - 6H	16 mm Straight	129-0363	-0364	-0365	-0366	-0476
			18 mm Straight					
			Splined — Metric	129-0367	-0368	-0369	-0370	-0477
	G 3/8 (BSP) (2)	M6 x 1 - 6H	16 mm Straight	129-0371	-0372	-0373	-0374	-0403
			18 mm Straight	129-0375	-0376	-0377	-0378	-0478
			Splined — Metric	129-0379	-0380	-0381	-0382	-0479

Two Bolt Mounting Flange Kit (for 3/8 inch Mounting Bolts) — Kit Number 60552 (includes 5 screws — 1/4-28 UNF - 2B)
Two Bolt Mounting Flange Kit (for M8 Mounting Bolts) — Kit Number 60553 (includes 5 screws — M6 x 1 - 6H)

129-0479

*Note: The Same Casting used for Side Ports is Required for G 3/8 (BSP) End Ports (see Dwg. Page 8 and 9)

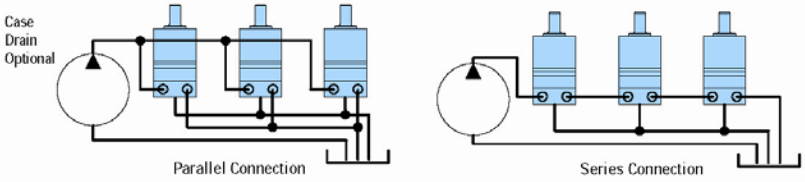
For J-2 Series motors with a configuration *Not Shown* in the chart above: Use the model code number system on page 15 to specify the product in detail.

Series or Parallel Connection

Hydraulic lines bringing pressurized fluid from the pump to the motor and return flow from the motor back to tank can be flexible or ridged. One pump can be sized to supply a single motor or many motors. Furthermore, one pump and multiple motors can be connected in series or in parallel (see each type of connection shown below). When connecting the pump to the motors in series excess internal case pressure is created in the motor, this excess pressure must be ported back to tank. However, when making a parallel connection from the pump to the motors no excess case pressure will be added. Hence, using the case drain ports are not necessary. Meanwhile, take a look at the application and see if this optional case drain port can be connected to your advantage, whether it be a single motor to pump connection, multiple motors connected to pump in parallel, as well as multiple motors connected to pump in series...

...Case Drain Advantage — In addition to providing lower case pressures for motors connected in series, there are advantages for adding an external case drain line to motors with normal case pressures as well. These advantages are: Contamination Control — flushing the motor case. Cooler System — exiting oil draws motor heat away. Extend Motor Seal Life — maintain low case pressure with a preset restriction installed in the case drain line (see page 13).

Motors ordered with case drain port will be shipped with steel hex socket plug installed in that end cap drain port.

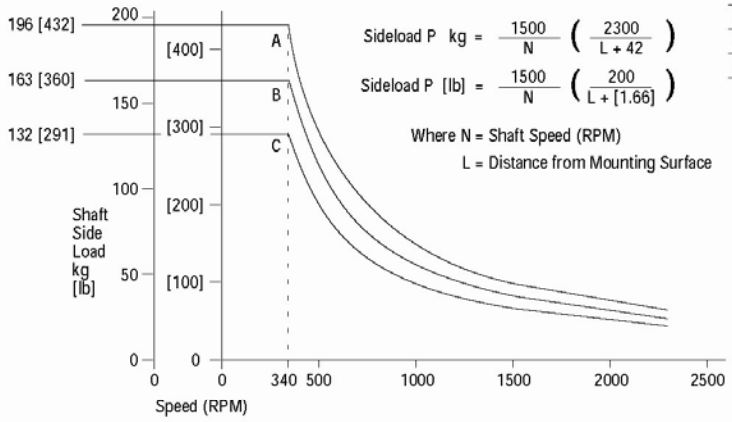


Shaft Side Load Capacity — J-2 Series

The hydrodynamic bearing has infinite life when shaft load ratings are not exceeded. Hence, the shaft side load capacity is more than adequate to handle most externally applied loads (such as belts, chains, etc.), providing the motor to shaft size is applied within its torque rating.

Allowable side load chart, shaft load location drawing (right) and load curves (below) are based on the side or radial loads being applied to shaft at locations A, B, and C, to determine the shaft side load capacity at locations other than those shown use the formula (shown below). For more information about shaft side loads on Char-Lynn motors contact your Eaton representative.

RPM	Allowable Side Load — kg [lb] A	B	C
2300	29 [64]	24 [53]	20 [43]
1500	44 [98]	37 [82]	30 [66]
1250	54 [118]	44 [98]	36 [79]
1000	67 [147]	55 [122]	45 [99]
750	89 [196]	74 [163]	60 [132]
600	111 [245]	93 [204]	75 [165]
500	133 [294]	111 [245]	90 [198]
400	167 [368]	139 [306]	112 [248]
340	196 [432]	163 [360]	132 [291]

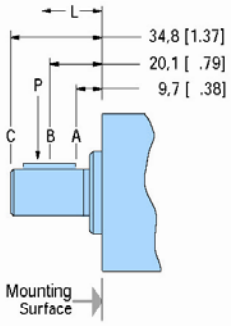


$$\text{Sideload P kg} = \frac{1500}{N}\left(\frac{2300}{L+42}\right)$$

$$\text{Sideload P [lb]} = \frac{1500}{N}\left(\frac{200}{L+[1.66]}\right)$$

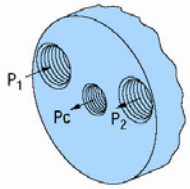
Where N = Shaft Speed (RPM)

L = Distance from Mounting Surface



Case Pressure and Case Drain — J-2 Series

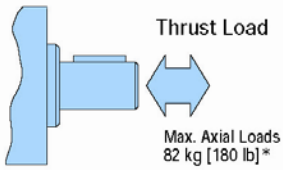
The J-2 Series now offers check valves in the motor as a standard feature. This addition reduces the case pressure in the motor to the return pressure of the system when the case drain is not used. For return pressures higher than the rated pressures (see chart) the external case drain can be connected. If the case drain line is needed, connect drain line to assure that the motor will always remain full of fluid.



Case Drain Advantage — In addition to providing lower case pressures for motors connected in series, there are advantages for adding an external case drain line to motors with normal case pressures as well. These advantages are: Contamination Control — flushing the motor case. Motor Cooler — exiting oil draws motor heat away. Extend Motor Seal Life — maintain low case pressure with a preset restriction installed in the case drain line.

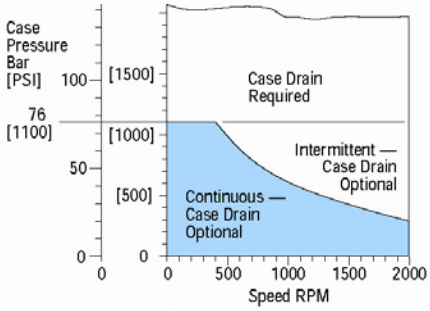
J-2 Series motors can be connected in parallel or in series.
See Text page 12.

* Case pressure will add to the allowable compressive thrust load. Case pressure will push outward on the shaft at 20 kg/7 Bar [44 lb/100 PSI].



Example: A 14 Bar case pressure will cause a load of 40 kg, so the allowable thrust load will be 82 kg plus 40 = 120 kg pushing inward on shaft. Tension load is 82 kg under all case pressure conditions.

[Example:] A 200 PSI case pressure will cause a load of 88 lbs, so the allowable thrust load will be 180 lbs plus 88 = 268 lbs pushing inward on shaft. Tension load is 180 lb under all case pressure conditions.



Case Pressure Seal Limitation

13

Fluid Recommendations
J-2 Series

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 characteristic to consider when choosing a fluid to be used in a hydraulic system is viscosity. Viscosity choice is always a compromise; the fluid must be thin enough to flow easily but thick enough to seal and maintain a lubricating film between bearing and sealing surfaces. Viscosity requirements, see chart below.

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.

Product Line	Viscosity		ISO Cleanliness Requirements
	Minimum	Best Range	
J-2 Series	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.
- 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.

Model Code for J-2 Series Motors

The following 16-digit coding system has been developed to identify all of the configuration options for the J-2 Series Motor. Use this model code to specify a motor with the desired features. All 16-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 — J-2 Series Spool Valve Motors

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
M	0	J								0	0			0	0

Position 1 Product Series

M ..... Motor

Position 2, 3 J-2 Series

0J ..... J-2 Series

Position 4, 5 Displacement cm^3/r [in^3/r]

05 ..... 8,2 [.50]

08 ..... 12,9 [.79]

12 ..... 19,8 [1.21]

19 ..... 31,6 [1.93]

30 ..... 50,0 [3.00]

Position 6 Mounting Flange

A ..... 5 Bolt: Dia. 31,47 [1.239] x 5,1 [.20] Pilot 1/4-28 UNF 2B Mounting Holes on 45 [1.77] Dia. Bolt Circle

B ..... 5 Bolt: Dia. 31,47 [1.239] x 5,1 [.20] Pilot M6 x 1- 6H Mounting Holes on 45 [1.77] Dia. Bolt Circle

C ..... 2 Bolt: Dia. 62,99 [2.480] x 2,0 [.08] Pilot 10,36 [.408] Mounting Holes on 80,0 [3.150] Dia. Bolt Circle

D ..... 2 Bolt: Dia. 62,99 [2.480] x 2,0 [.08] Pilot 9,0 [.354] Mounting Holes on 80,0 [3.150] Dia. Bolt Circle

Position 7, 8 Output Shaft

01 ..... 5/8 inch Dia. Straight with 4,72 [.186] Square Key and 1/4-28 UNF - 2B Threaded Hole

02 ..... 16mm Dia. Straight with 5,00 [.197] Square Key with M6 x 1 - 6H Threaded Hole

04 ..... 11/16 inch Dia. Straight with 4,72 [.186] Square Key and 1/4-28 UNF - 2B Threaded Hole

05 ..... 18mm Dia. Straight with 5,92 [.233] Square Key with M6 x 1 - 6H Threaded Hole

06 ..... Involute Splined 9T—Metric 16,50 [.650] Dia. (B17 x 14 DIN 5482) M6 x 1 - 6H Threaded Hole

07 ..... 5/8 inch Dia. Straight with 4,75 [.187] Dia. Crosshole

08 ..... 3/4 inch Tapered with Woodruff Key and Nut

09 ..... 5/8 inch Dia. Straight w/ 4,72 [.186] Sq. Key w/1/4-28 UNF -2B Threaded Hole (Plated for Corrosion Protection)

14 ..... 16mm Dia. Straight w/ 5,00 [.197] Sq. Key w/M6 x 1 - 6H Threaded Hole (Plated for Corrosion Protection)

Position 9 Port Type

A ..... 9/16-18 UNF - 2B O-ring End Ported

B ..... G 1/4 (BSP) End Ported

C ..... M14 x 1,5 - 6H O-ring Port, End Ported

D ..... 9/16-18 UNF - 2B O-ring Side Ported

E ..... G 3/8 (BSP) Side Ported

F ..... G 1/4 (BSP) Side Ported

H ..... G 3/8 (BSP) End Ported

Position 10 Case Drain

0 ..... No Case Drain

1 ..... 3/8-24 UNF - 2B O-ring

2 ..... G 1/8 (BSP)

3 ..... M10 x 1 - 6H O-ring

Position 11, 12 Special Features (Hardware)

00 ..... None

Position 13 Special Features (Assembly)

0 ..... None

1 ..... Reverse Rotation

Position 14 Paint/Special Packaging

0 ..... No Paint

A ..... Painted Low Gloss Black

B ..... Corrosion Protected (Black)

Position 15 Eaton Assigned Code when Applicable

Position 16 Eaton Assigned Design Code

0 ..... Design Code



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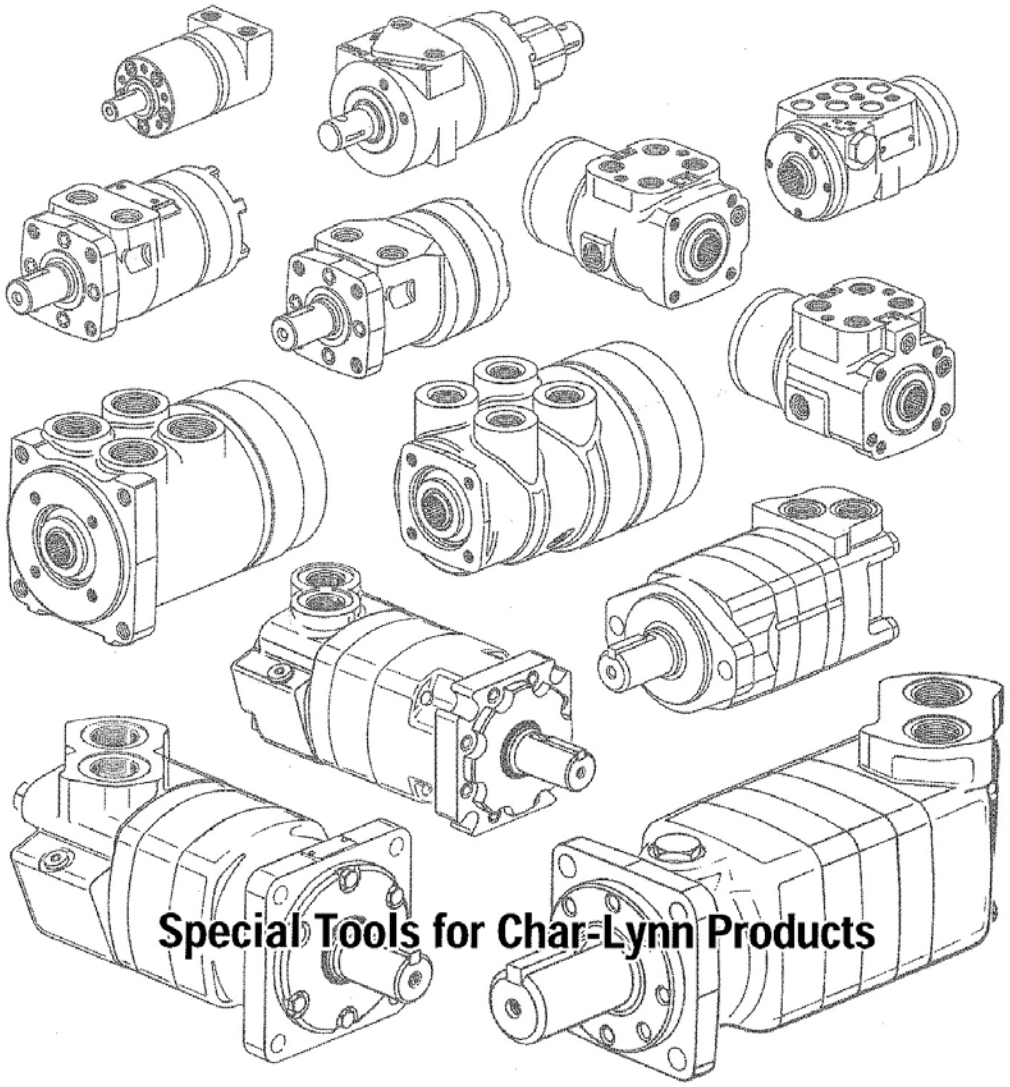
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Char-Lynn®
Product Information

No. 2-805
June, 1996

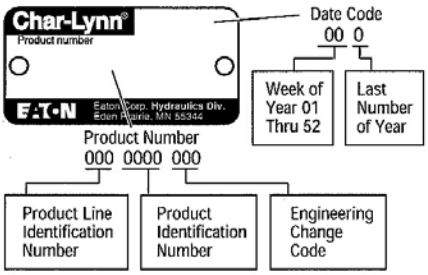
EATON



Special Tools for Char-Lynn Products

Introduction

Eaton Corporation, Hydraulics Division has made available special tools to aid the user in the disassembly and reassembly of Eaton Char-Lynn products. The use of these tools will prevent possible damage to seals and etc. during reassembly of the Char-Lynn products. These special tools are listed first by part number and then by tool description on page 3 of this document. Pages 4, 5, and 6 are to be used to show where each of these special tools may be used by product series and engineering change code. This information may be found on the product information tag located on each and every Char-Lynn product. See Sample tag below.



Special Tools for Char-Lynn Products

Part Number	Special Tool Description
5422-000	5/16 in. -12 Point Socket
600057-000	Spring Installation Tool
600304-000	Shaft Seal Bullet
600336-000	Spring Installation Tool
600421-000	Shaft Face Seal Installation Tool
600463-000	Shaft Seal Bullet
600464-000	Shaft Seal Bullet
600465-000	Shaft Seal Bullet
600466-000	Shaft Seal Bullet
600468-000	Shaft Face Seal Installation Tool
600469-000	Shaft Face Seal Installation Tool
600470-000	Shaft Pressure Seal Installation Tool
600496-000	Shaft Pressure Seal Installation Tool
600523-000	Shaft Pressure Seal Installation Tool
600633-000	Shaft Seal Bullet
600636-000	Bearing Removal Tool
600637-000	Bearing Press Tool
600642-000	Seal Press Tool
64489-000	5/16 in. - 6 Point (E10 Torx Drive) Socket

Special Tools for Char-Lynn Products

Part Number	Special Tool Description
	"A" Series Motors
5422-000	5/16 in. -12 Point Socket Heavy Duty 500 in. lb. [56] Nm. Capacity (001 thru 003) Motors
64489-000	5/16 in. - 6 Point (E10 Torx Drive) Socket (002 and 003) Mtrs.
600470-000	Shaft Pressure Seal Installation Tool (001) Motor
600523-000	Shaft Pressure Seal Installation Tool (002 and 003) Motors
600466-000	Shaft Seal Bullet for 7/8 in. Shaft (001 thru 003) Motors
600304-000	Shaft Seal Bullet for 1 in. Shaft (001 thru 003) Motors
	"H" Series Motors
5422-000	5/16 in. -12 Point Socket Heavy Duty 500 in. lb. [56] Nm. Capacity (007 thru 009) Motors
64489-000	5/16 in. - 6 Point (E10 Torx Drive) Socket (009) Motor
600470-000	Shaft Pressure Seal Installation Tool (007) Motor
600523-000	Shaft Pressure Seal Installation Tool (008 and 009) Motors
600466-000	Shaft Seal Bullet for 7/8 in. Shaft (007 thru 009) Motors
600304-000	Shaft Seal Bullet for 1 in. Shaft (007 thru 009) Motors
	"R" Series Motors
5422-000	5/16 in. -12 Point Socket Heavy Duty 500 in. lb. [56] Nm. Capacity (001) Motor
64489-000	5/16 in. - 6 Point (E10 Torx Drive) Socket (001 and 002) Mtrs.
600523-000	Shaft Pressure Seal Installation Tool (001 and 002) Motors
600466-000	Shaft Seal Bullet for 7/8 in. Shaft (001 and 002) Motors
600304-000	Shaft Seal Bullet for 1 in. Shaft (001 and 002) Motors
	"S" Series Motors
5422-000	5/16 in. -12 Point Socket Heavy Duty 500 in. lb. [56] Nm. Capacity (007 thru 010) Motors
64489-000	5/16 in. - 6 Point (E10 Trox Drive) Socket (010) Motor
600470-000	Shaft Pressure Seal Installation Tool (007 and 008) Motors
600523-000	Shaft Pressure Seal Installation Tool (009 thru 010) Motors
600466-000	Shaft Seal Bullet for 7/8 in. Shaft (007 thru 010) Motors
600304-000	Shaft Seal Bullet for 1 in. Shaft (007 thru 010) Motors

Special Tools for Char-Lynn Products

Part Number	Special Tool Description
	"T" Series Motors
64489-000	5/16 in. - 6 Point (E10 Trox Drive) Socket (001 and 002) Mtrs.
600523-000	Shaft Pressure Seal Installation Tool (001 and 002) Motors
600466-000	Shaft Seal Bullet for 7/8 in. Shaft (001 and 002) Motors
600304-000	Shaft Seal Bullet for 1 in. Shaft (001 and 002) Motors
	"W" Series Motors
600633-000	Shaft Seal Bullet (002) Motor
600636-000	Bearing Removal Tool (002) Motor
600637-000	Bearing Press Tool (002) Motor
600642-000	Seal Press Tool (002) Motor
	2000 Series Motors
600496-000	Shaft Pressure Seal Installation Tool (003 thru 006) Motors
600465-000	Shaft Seal Bullet for 1 in. Shaft (003 thru 006) Motors
	4000 Series Motors
600468-000	Shaft Face Seal Installation Tool (004) Motor
600421-000	Shaft Face Seal Installation Tool (006) Motor
600463-000	Shaft Seal Bullet for 1–1/4 in. Shaft (004) Motor
	6000 Series Motors
600469-000	Shaft Face Seal Installation Tool (005 and 006) Motors
600464-000	Shaft Seal Bullet for 1–1/2 in. Shaft (005 and 006) Motors
	10,000 Series Motors
5422-000	5/16 in. -12 Point Socket Heavy Duty 500 in. lb. [56] Nm. Capacity (002 and 003) Motors
64489-000	5/16 in. - 6 Point (E10 Torx Drive) Socket (003) Motor

Special Tools for Char-Lynn Products

Part Number	Special Tool Description
	Torque Generator
5422-000	5/16 in. -12 Point Heavy Duty Socket 500 in lb. [56 Nm] Capacity (001 and 006) Torque Generators
64489-000	5/16 in. - 6 Point (E 10 Torx Drive) Socket (002) Torque Generator
600057-000	Spring Installation Tool (001, 002, and 006) Torque Generators
	3, 4, 6, and 12 Series SCU
5422-000	5/16 in. -12 Point Heavy Duty Socket 500 in lb. [56 Nm] Capacity (001) SCU
64489-000	5/16 in. - 6 Point (E 10 Torx Drive) Socket (002) SCU
600057-000	Spring Installation Tool (001 and 002) SCU
	110, 230, and 450 Series SCU
5422-000	5/16 in. -12 Point Heavy Duty Socket 500 in lb. [56 Nm] Capacity (001) SCU
64489-000	5/16 in. - 6 Point (E 10 Torx Drive) Socket (002) SCU
600057-000	Spring Installation Tool (001 and 002) SCU
	20 Series SCU
600604-000	Spool/Sleeve Installation Tool (001) SCU
	25, 35, and 40 Series SCU
600336-000	Spring Installation Tool (001 Thru 003) SCU

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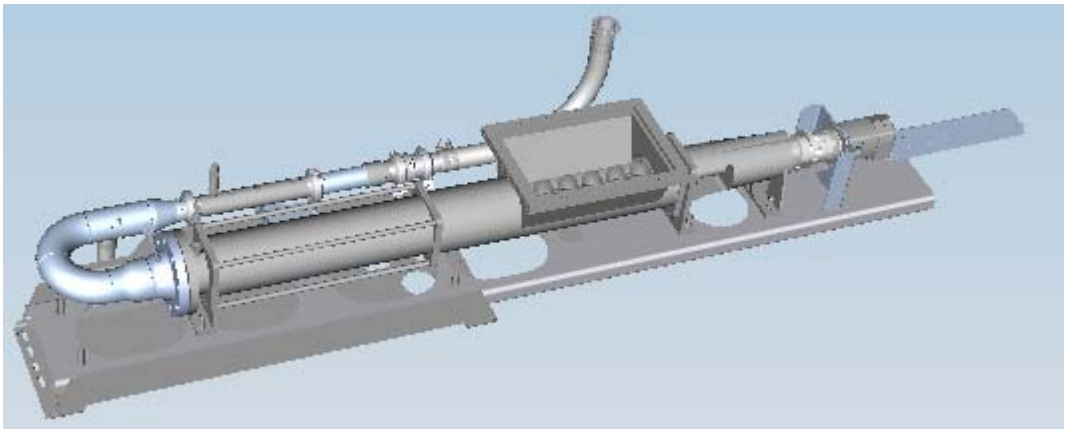
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Form No. 2-805
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Product Pump



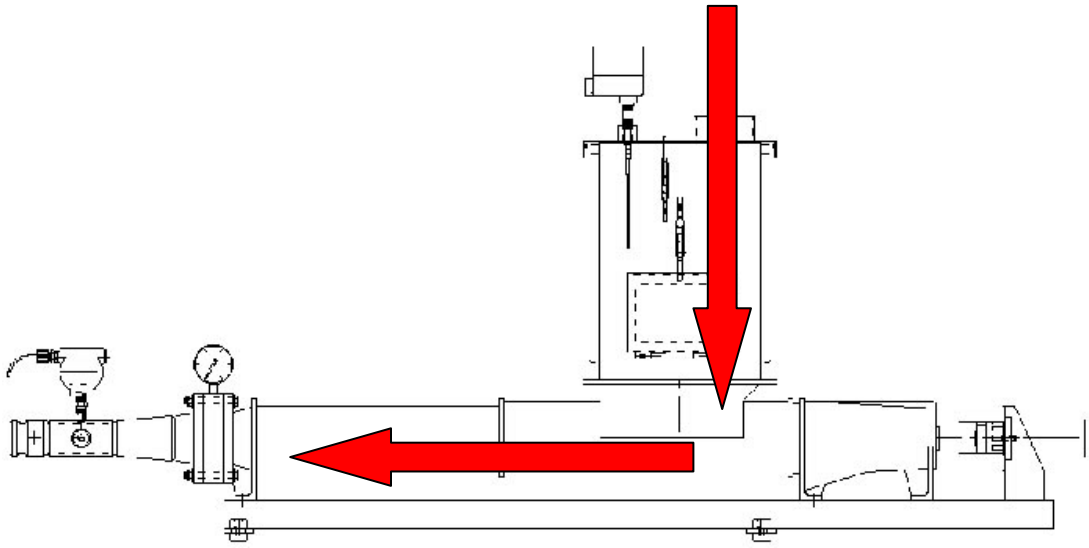


 An explosive pump is a potential bomb, since any thermal event may easily transition to detonation because of the high internal pressure and strong confinement. Even a low order event can cause a pump to fragment, with severe shrapnel projection. Additionally, considerable amounts of energy are being input at the pump, much of which is dissipated as heat in the explosive. If, for some reason, flow is restricted or blocked, the heat is not carried away and builds up inside the pump.

Components include:

Surge Hopper
Level Probe
Product Pump
Pressure Piping
Hydraulic Control
Pump Safety System

An easy way to understand the components and their importance within the system is to view them as they affect the product flow through the system. We will follow the product path as it enters the surge hopper, through the pump and through the pressure piping.



It is important to understand the terminology used in this segment. Two areas that are often confused or misunderstood are the:

Progressive cavity pump (product pump). This pumps the product delivered from the augers into the borehole through the hose reel. This pump should not be confused with the emulsion pump that meters emulsion to be mixed with the ANFO.

Pressure Piping. This in the transition piping that bolts to the discharge end of the product pump for the product exiting to the hose reel.

Surge Hopper

This hopper functions as a short-term storage container. The output rate of the augers and the output rate of the product pump may be somewhat different. The surge hopper provides a holding area that allows for these differences in the augering rate and the pumping rate.

The capacity is approximately 25 US gallons.

Depending on the product, the hopper will hold approximately 250 Lbs. of product. On most units this may be 30-60 seconds of product pumping time.

A clear view window is provided for the operator to monitor the product quality as well as the level of the hopper.

A clean out door is provided on the side opposite the clear view window for gaining easy access to the interior of the hopper.

The surge hopper bolts directly to the product pump. The transition is short to provide a good inlet flow to the pump.

The sides are steeply sloped for easy product flow to the pump and smooth on the interior for easy cleaning.

Maintenance

- Clean the residue product from the clear view window.
- Keep all lock-out devices in working order and in place.
- The locking mechanism on the clean out door must be adjusted in order to seal the clean out door.
- View the inlet and outlet of the surge hopper each week for product build-up.
- Check the fasteners that attach the surge hopper to the product pump.

Safety

- Lock out the hydraulic power supply of the truck before servicing or cleaning the surge hopper.
- Do not open the clean out door or hopper lid without first removing the hydraulic power supply to both the auger system and the pumping system**.**
- Never allow foreign materials to enter the hopper.

Level Control

The level control



maintains the level in the surge hopper. The level control is a Princo Model 3520 and is an adjustable height, single point level probe. With the level control power ON, the level control pauses the auger circuits. If the level control is in the OFF position, the level control does not affect the operation of the standard unit. Keep in mind that the level control only pauses the augers, the CLEAR/OFF/RUN starts and stops the augers.

The level control is used on standard blend & pump units. On this type of unit, the level control starts and pauses the auger circuits directly.

The level control on DCC units with pumping capabilities, the level control provides an input signal to the DCC controller which starts and pauses the auger circuits.

Note: On all systems the level probe controls the electric actuation only of the hydraulic spool valve. The probe has no control over the manual operation of the hydraulic spool valve.

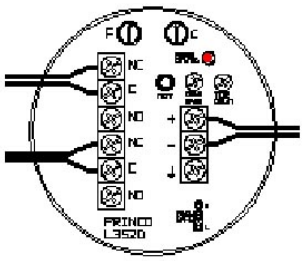
The level probe requires an input power of 12-34 VDC. This power is supplied through the level control enclosure on the rear operator station. In the OFF position, the level control does not affect the operation of the standard unit. With the level probe ON, power is supplied to the level control.

There are two sets of normally closed contacts in the level control. The contacts change state based the sensing probe. As the product level rises to the adjusted set point, the contacts change from normally closed (allowing passage through) to normally open (non passing).

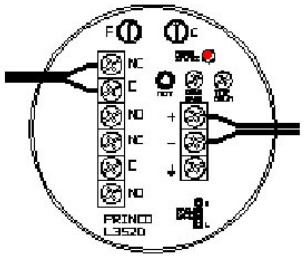
In a standard unit, two sets of contacts are used: the first contact set controls the prill auger and emulsion pump and the second contact set controls the vertical and discharge augers. With the level probe in the ON position and the auger control switch in the RUN position, the auger circuits will both start when the level is low and stop when the level reaches the setpoint

In a DCC unit, only one of the contact sets are used, providing an input signal to the DCC controller.

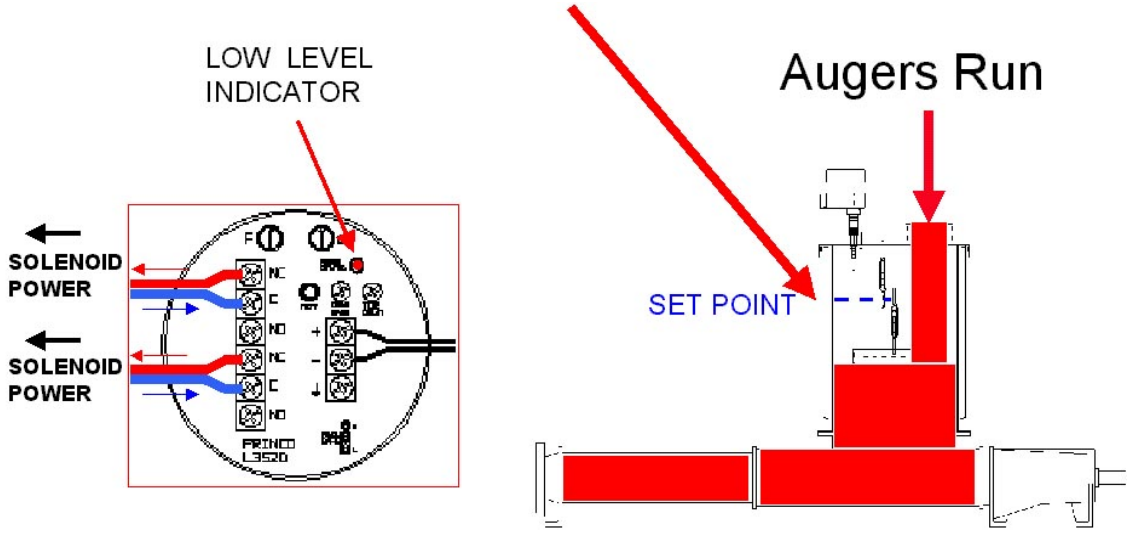
Standard Non DCC unit
2 sets NC contacts
prill auger & emulsion pump
vertical & discharge auger



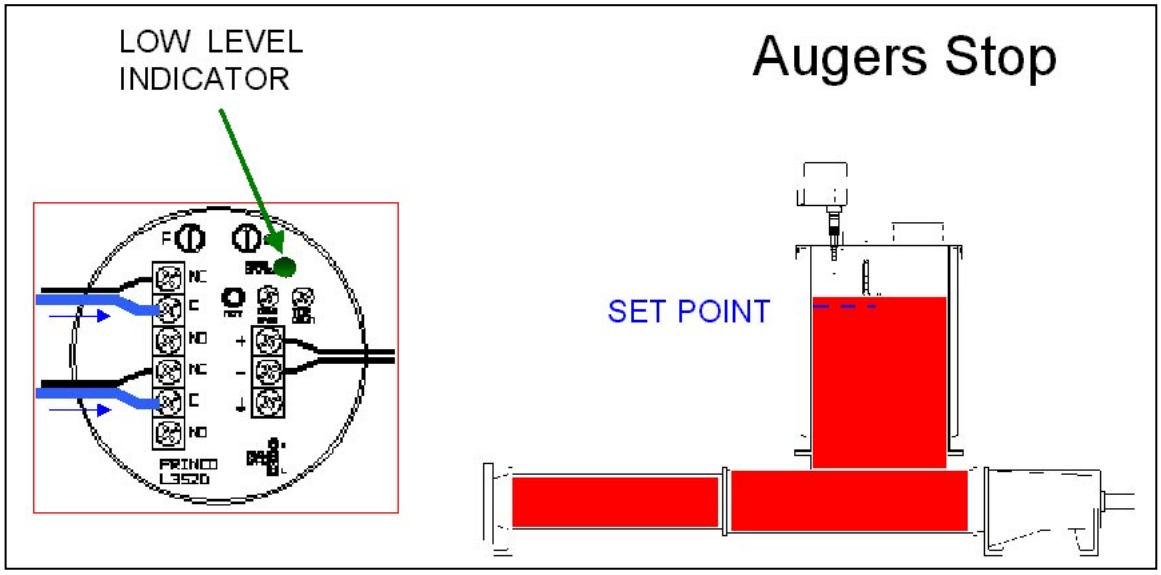
DCC unit
1 set NC contacts
auger circuits



The level control operates as follows:
The setpoint defines the point on the probe where the augers are paused. At the setpoint and above, the augers do not operate. Below the setpoint, the augers are allowed to run.
The probe status indicates the contact state. RED, no material, contacts are closed, allowing power to a solenoid.
In a Non DCC unit, power is supplied to the prill auger / emulsion pump circuit and to the vertical / boom auger circuit.
In a DCC unit, a single signal is supplied to the controller.
As you can see, the level is below the setpoint, solenoid power is input (blue) to the level control, and with closed contacts, passes to the solenoid (red) allowing the augers to run. The augers run and the hopper level raises.
With the level above the setpoint, the probe changes states, the indicator light turns GREEN, indicating presence of material. At this point, the contacts open, and power to the solenoid does not go past the level control. The augers now

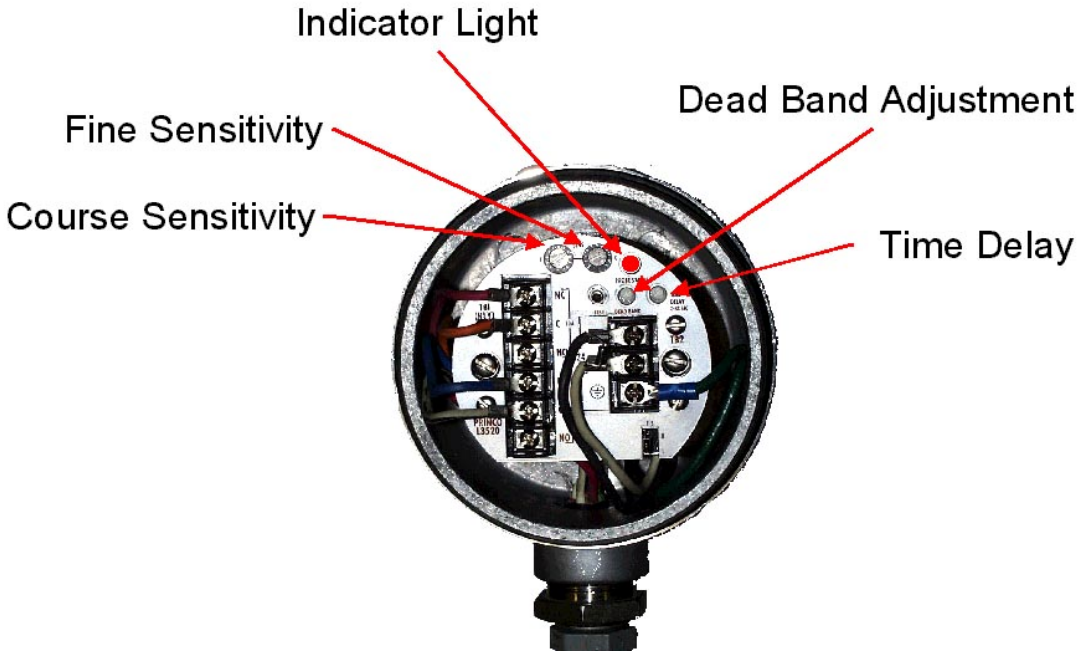


stop.



Adjustments of the level probe should be made with the level control installed in the surge hopper. In order to adjust the level control to the appropriate level, the following adjustments will be utilized.

1) Course sensitivity
2) Fine sensitivity
3) Time delay
4) Dead band adjustment
5) Indicator lights - used to indicate the status of the level control



1) Refer to diagram for Adjustment locations
2) Apply power to the level control
3) Allow the unit to warm-up
4) Preset Course and fine adjustments to mid-point
5) Turn time delay to zero (fully counter clockwise)
6) With material not touching probe: adjust the course sensitivity so that probe status indicator just turns green, do not touch again
7) Adjust fine sensitivity control counter clockwise until the probe status just turns red and back clockwise until the probe just turns green
8) Add product to the desired level of trip point. (approximately half way up)
9) With probe immersed adjust the fine sensitivity such that the probe status light just turns red and stays. Note the position.

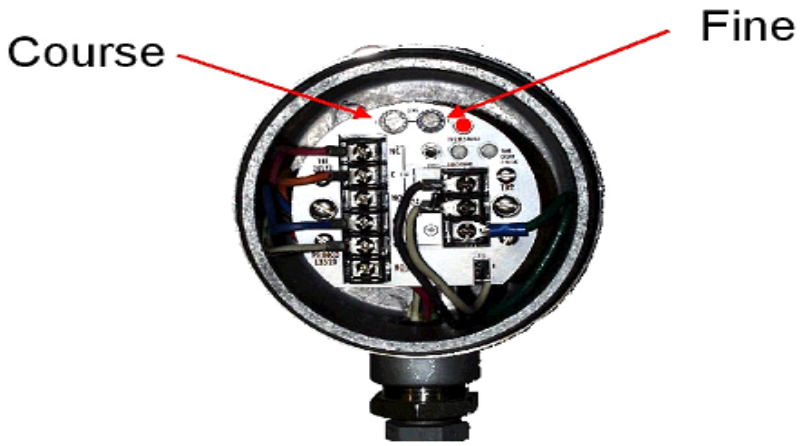
Turn the fine sensitivity control until the screwdriver slot is midway between marks 7 & 9. The probe status indicator should now be green with the hopper level at the same position.

If not repeat the last three steps again.

Note: a green indicator light indicates the presence of material and a red indicator indicates the absence of material.

10) it may be necessary to re-adjust the probe.

- Sensitivity Adjustment



In order to avoid contact chatter (the opening and closing of the contacts multiple times very rapidly), a time delay or a dead band must be adjusted. The chatter would be caused by the hopper level oscillating above and below the set point of the probe very quickly.



The time delay adjustment should be approximately 5 seconds. The factory mode of delay timing is delay off/ delay on. Use the smallest time possible to avoid relay chatter.

The dead band may or may not be adjusted. It is provided to eliminate relay contact chatter. It is not necessary to adjust the dead band if the time delay is adjusted.

The Test push button in the L3502 when pressed will check the operation of the control relay only and any device connected to the relay.

Depressing the Test Button will cause the control rely to change from the non-alarmed state (energized) to the alarmed (de-energized) state . If the hopper level is above the switchpoint and the augers have turned OFF, pressing the TEST BUTTON will allow the augers to run.

- Self test



The fail safe jumper must be in the fail safe low mode. This is a jumper that can be removed with no tools and re-installed if incorrect. Always check when installing a new level probe.

Safety

The level control starts and stops the augers circuits. If the level probe requires maintenance, the maintenance should be performed with the hydraulic power removed. If hydraulic power is present, the augers may start and stop depending on the level of material around the probe.

nce

Clean any product that has built up around the level probe. This build up around the probe may reduce the sensing ability of the probe.

ooting

If the level control does not work; the following are simple troubleshooting techniques that can be used to identify the problem:

1) Is the power switch in the proper position to supply power to the level control? Without power the level probe does not work.

2) Check the level in the hopper. If the level is above the setpoint of the level control, the augers will not run. Empty the hopper, below the probe and the augers should start. If not try adjusting the probe.

3) Clean the probe. Anything more than a thin film of product may affect the sensing ability of the probe.

4) Remove housing cover :

a) check for any loose connections, loose or broken wires or any wires or crimp ends that are corroded

b) check for an indicator light ON. If either the red light or green light is on, this indicates that the probe has power applied.

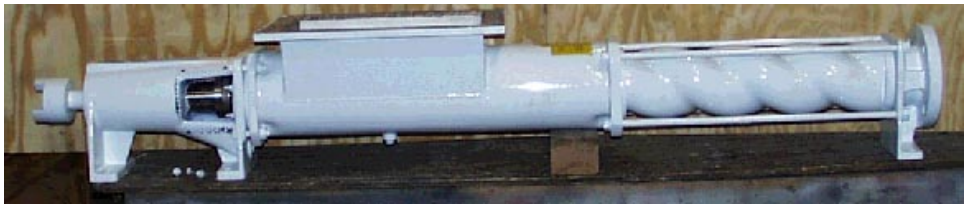
c) if the probe has power from the above check, test the probe with your hand. Observe all safety guidelines when testing. By touching the probe in different locations along the probe depending on the set point, you should be able to make the probe change states, the red light to green. If the probe does not change, replacement may be necessary.

If the probe does change, listen for the contact change in the sensing control. A slight click can be heard if listening carefully.

If all of the above tests yield good results, then further electrical testing is called for and is beyond the scope of this discussion.

Progressive Cavity Pump

The progressive cavity pump is a positive displacement pump.
These pumps are capable of high pumping pressures. In most of the applications during our discussion, the pumps have a pressure capability of either 200 or 300 psi.



A progressive cavity pump provides a smooth non pulsating flow.

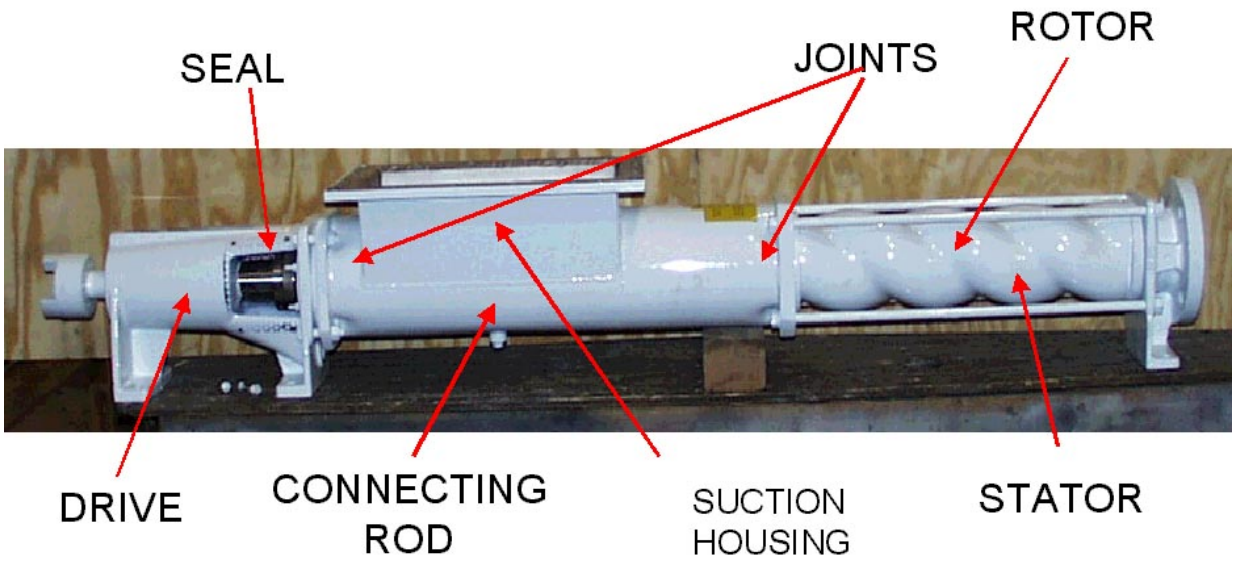
The pumped products may contain solids. The formation of the pumping cavities in the pump allow shear sensitive products as well as blended products (products that contain prilled ammonium nitrate) to be pumped with no change in material characteristics.

Although the design of most progressive cavity pumps is similar, there are also significant differences in the details of the pumps. All of these pumps are available in many different sizes and pressure capabilities. Each pump manufacturer specifies both speed and pressure limitations based on the design of the pump.

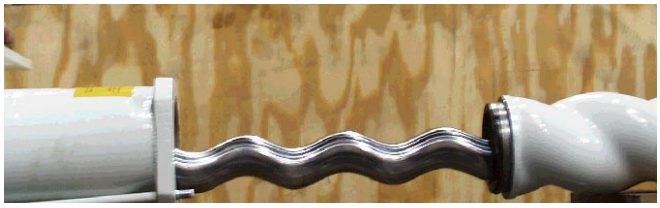
Each explosive manufacturer has conducted hazard and operability studies of the progressive cavity pump and its use in pumping emulsions for their applications. Although the pump characteristics are much the same for all of the pumps, there are differences between them.
It is beyond the scope of this discussion, to do more than compare them in a general way. Each explosive manufacturer has set forth a standard set of pump specifications to which the pumps are purchased, installed, operated, inspected and maintained. Consult your explosives manufacturer for their guidelines.

To form a more complete understanding of the progressive cavity pump it is important to look at the components that comprise the pump:

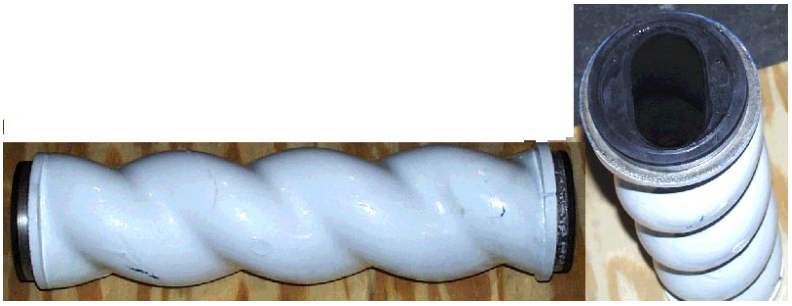
Components



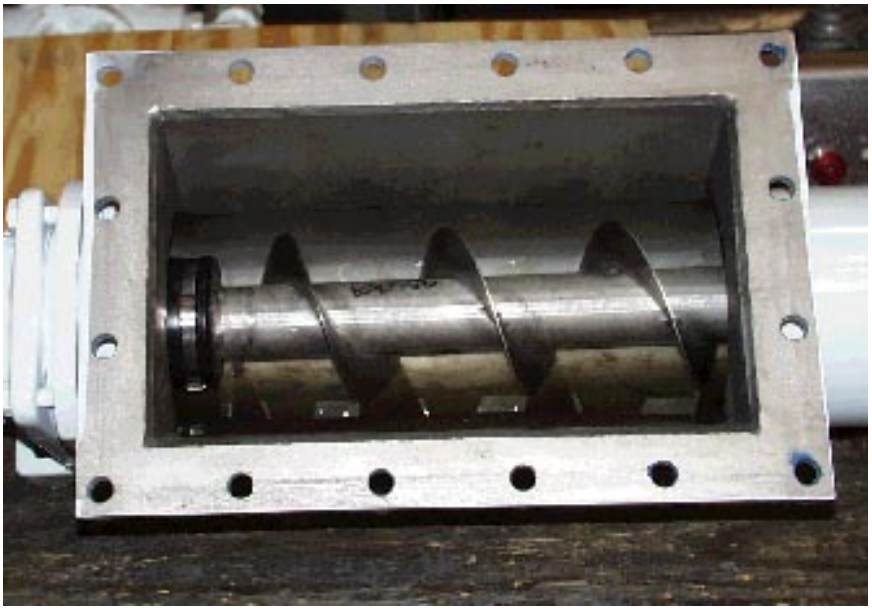
The rotor is shown here. The rotor is part of the rotating group of the pump. As the rotor turns in a circular motion, product is moved from the inlet of the pump to the outlet of the pump. The product flows in a helical direction much like the threads on a screw or an auger.



The stator is the part of a progressive cavity pump that is stationary. It does not rotate. The stator is constructed of a hollow metal tube that has been machined and an elastomer molded to the inside to the tube.
The stator determines the pressure capability of the pump. The pressure output of the pump is dependent on 1) The number of stages (the length of the stator) and 2) the stator configuration. As the stages increase, the stator length will increases and so the maximum pressure capability of the pump increases.
Again the explosive manufacturer has specified the number of stages of the pump stator and the stator configuration for the application.

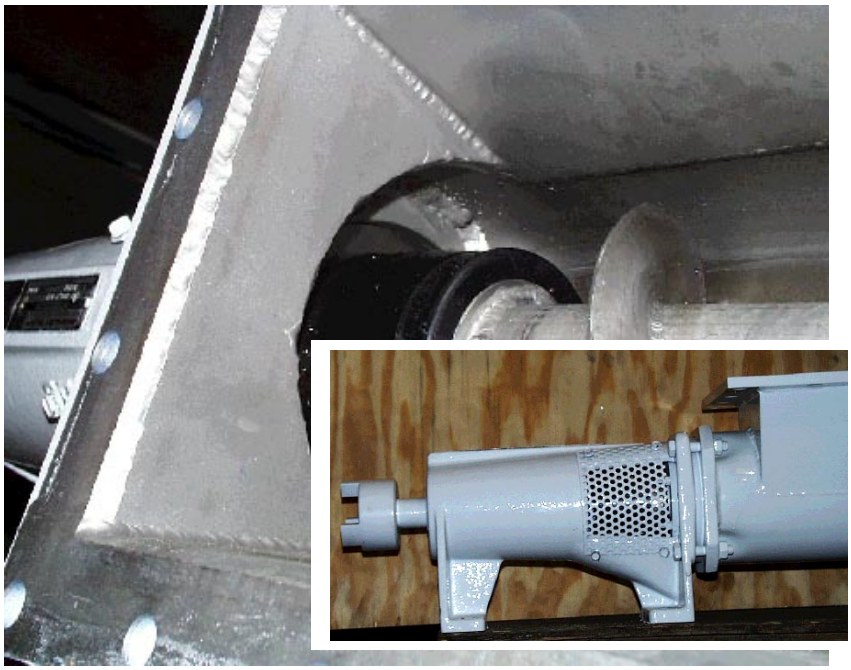


The connecting rod is the link between the hydraulically driven input shaft of the pump and the rotor. The connecting rod transmits the rotational energy provided by the hydraulic motor to the rotor without a loss of power.



Some type of joint is required whenever two shafts are connected. Depending on the type of pump, a joint may have to rotate, of it may simply be a bolted connection.

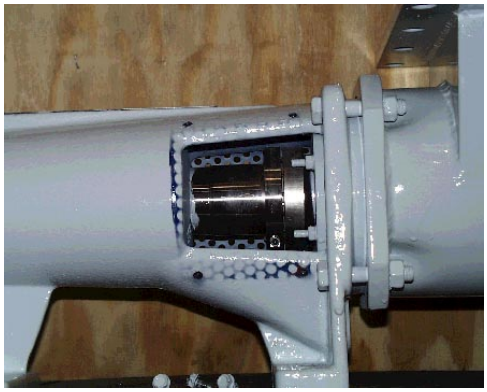
All of these joints rotate in the products being pumped. It is important then, that the joints remained sealed. Any product that is allowed to enter the joint may be subjected to extremely high localized pressures. With these high pressures present, and increases in temperature as a result, the possibility of a detonation does exist.



Pump Components

The drive of the pump is connected by a flexible coupling to the hydraulic drive motor. On the other end, the pump drive shaft is connected to the coupling rod. The purpose of the drive is to allow for the input of power to the pump.

A seal is required where the driveshaft enters the suction housing to prevent air from being drawn into the suction cavity, mixed with the product and being pumped. Air entering the pumping system can cause pulsating or erratic flow while pumping..



Operation

As flow is applied to the hydraulic motor, the pump begins to turn. As with the starting of any device, there is a certain amount of friction that must be overcome in order for rotation to take place.

The rotor now rotates inside the stator with a thin film of product between the surfaces where the two meet. This thin film has two purposes, pump lubrication and the second to help maintain a seal. In order to generate pressure and maintain an output, the rotor stator interface must remain sealed.

A set of definitive guidelines has been set forth by the manufacturer of the progressive cavity pump, the explosive manufacturer, and Tread Corporation, with regard to the proper operating parameters of the equipment. It is important to note, that the guidelines specify conservative operating procedures because of potential safety hazards when pumping explosives. Each pump is chosen based on the requirements of the application; therefore it is important to properly identify the application so the proper pump is used.

The normal operating speed of a progressive cavity pump should be in the range of 100-250 rpm. The pump must operate at speeds above 100 rpm in order for the pump to be efficient. At slower speeds, pump slip is increased. At speeds faster than 250 rpm, pump suction may be inhibited.

The pump requires adequate flow to the inlet of the pump.

Each pump has a defined maximum pressure capability. The stator configuration and the number of stages of the pump determine the maximum pumping pressure.

The pump is also chosen to accommodate the product being pumped.

Safety

The following are general safety recommendations regarding the progressive cavity pump.

As with any rotating equipment, contact with rotating shafts must be avoided. The input shaft of the pump is a rotating device that should be guarded at all times. Do not operate the equipment with the guards removed.

The pump is capable of generating high product pressures. Do not attempt to work on any pump or connected piping that may have stored pressure within it. Always remove any residual pressure by operating the pump in reverse.

The Progressive cavity pump also has specific hazards that must be recognized and guarded against. There have been explosive accidents that are directly linked to a progressive cavity pump. It is because of the potential hazards associated with this type of pump when pumping blasting agents, that the pump safety system was designed and implemented. Because of the importance of the system, it will be discussed in detail latter in this session. For now, we will only briefly mention some of the potential safety hazards.

The pump should never be operated without product. Again the pump relies on the pumping medium for lubrication of the rotor and stator interface. Running the pump dry must be avoided.

The maximum pressure capability of the pump must not be exceeded.

Inspection and Maintenance

A daily inspection should be conducted before operating the pumping unit. Observe all safety procedures when conducting this inspection. As part of the daily inspection, the following should be observed:
The coupling, coupling spyder and drive motor should be tight and in good condition.
There should be no visible product leaks at the inlet or outlet of the pump.
Mounts should be secure and not cracked or broken.
Replace any missing fasteners or tighten any loose ones.

As part of the daily operation, a calibration check may be conducted.

The explosive manufacturers have specifically defined the guidelines for progressive cavity pump maintenance. We will not discuss the specifics of these guidelines except to mention that all pumps must be operated, inspected and maintained and documented according to these recommendations.

Your explosive manufacturer will be able to provide you information regarding the inspection and maintenance of the progressive cavity pump. It is important that all of these recommendations be followed.

Troubleshooting

Check the pump inlet. Any restriction in the inlet may cause the pump to pulsate because of the poor inlet flow. Remove any obstruction.

View the incoming product. Product that is to viscous or dry, may cause erratic pump behavior and may even stall the pump. If the pump will not turn with hydraulic power applied:
1) Run the pump in reverse, if possible, and clean the off-spec product from the inlet.
2) If the pump will not run in reverse, clean as much product as possible from the inlet, add water and continue to jog the pump while removing product until the blockage is eliminated. All safety procedures must be followed during this operation.
Keep in mind that the off spec product must be disposed of properly.

The product coming out of the pump should be the same as the product that entered the pump. Any change in product consistency should be evaluated. A worn pump stator or rotor may cause product degradation, such as a change in density or an increase in viscosity. A calibration check of the pump will determine the stator/rotor wear.

Noises within the pump should be carefully evaluated. Any abnormal noise should be investigated and the pump taken out of service immediately.

Pressure Piping

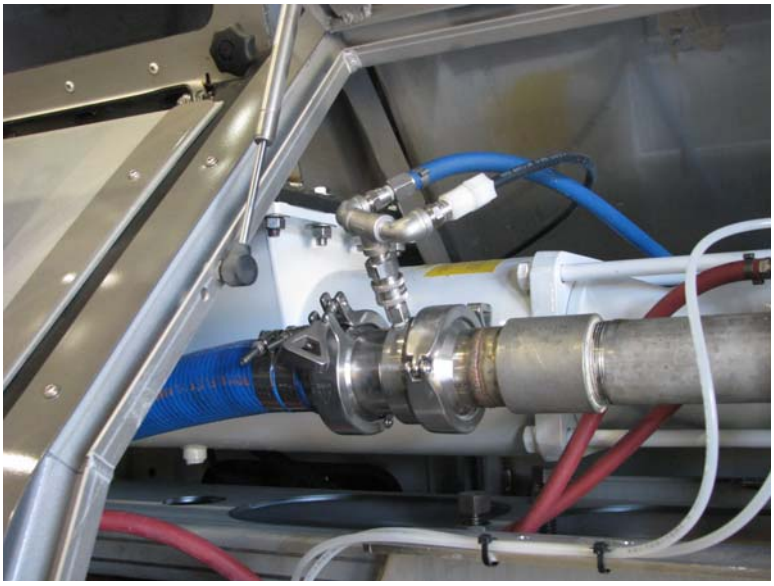


The pressure piping provides a transition from the pump outlet to the the flexible hose that couples to the hose reel.

The transition is a slow gradual decrease in internal diameters while maintaining long sweeps in turns**.**

There is a product pump air blow down located in the pressure piping at the outlet of the pump.

The pressure piping also incorporates many of the components that will be discussed in the pump safety system. The flow switch and burst disc are mounted in the pressure piping as close to the pump outlet as possible.





Safety

The pressure piping may contain pressures to 300 psi on some units. Remove pressure from the system before any service takes place. Never disconnect any pressurized hose or loosen the flange bolts or unscrew any of the installed devices with pressure on the system.

Inspection and Maintenance

Before each use inspect the pressure piping for leaks. An indication of a leak would be residual product on the piping or around any of the threaded connections. Repair any leaks immediately.

The pressure piping is attached to the pump outlet by bolted connections. Keep all fasteners tightened and replace any missing fasteners.

Troubleshooting

Blocked or restricted pressure piping may cause an increase in product pressures. Although an air blow down is provided to clean the pressure piping, depending on the products being pumped, it may be necessary on occasion to remove the pressure piping and clean.

If the piping is not utilized for long periods of time, product may stiffen and dry within the piping. Before use, remove the pressure piping and clean thoroughly.

The product pump is driven and controlled hydraulically. The use of hydraulic power allows simple starting and stopping, precise speed control, and is also a way to limit speed and power input to the pump.

The spool valve controls the direction of fluid applied to the hydraulic drive motor.
In the neutral position, the spool is centered and there is no fluid flow.
Pushing the valve forward, RUN position will operate the pump in the forward direction.
Pulling the valve to the rear, REVERSE position will operate the pump backwards.

Safety

Always remember that the fluid in the hydraulic lines is under high pressure during pumping operation.

The fluid traveling in the hydraulic lines may be hot. Often temperatures in the hydraulic system may achieve 150 degrees.

Before any service to the hydraulic system takes place: Remove any source of hydraulic pressure and of any stored hydraulic pressure that any be present.

Troubleshooting

Product pump does not turn:

1) The spool valve is in the OFF position, Move to forward position.
2) The flow control is in the most SLOW position Increase speed with flow control ccw
3) The Run/Bypass valve is not energized Energize Pump Guard System
4) Pump stalled because of product Hydraulic pressure 3000 psi Remove product from pump

Product Pump turns slowly:
1) The spool must be fully engaged. Move to forward position.
2) The speed control is in a slow position. Increase speed with flow control ccw
3) Relief valve in Bypass/Run valve (Increase relief valve setting discussed in Pump Guard section Torque Limiting)

Pump runs in reverse only:
1) The Run/Bypass valve is not energized Energize Pump Guard System
Hydraulic Pressure is higher than normal
Product is not pumpable. Refer to pump cleaning procedure

Pumping blasting agents with a progressive cavity pump is potentially hazardous. No one should be allowed to operate such a pump without thorough training in understanding and recognizing all potential hazards.

The pump safety system was designed to aid in the prevention of accidents when pumping blasting agents with a progressive cavity pump. It is important to remember that this system does not replace a well-trained operator. The pump safety system should merely be thought of as a back-up safety system for a well-trained operator.

Detonation is a potential disaster that can occur within a progressive cavity product pump with blasting agents. When an detonation does occur, the results may be severe, loss of life and property are not uncommon. Reviews of pumping accidents that have occurred have yielded one conclusion: That they could have been prevented. Some of the reasons that accidents have occurred are:

1) Poor operator training in the operation of the equipment and recognition of the associated hazards.
2) Improper operation of the equipment. These include operating above the pressure capability of the pumps, running pumps without sufficient product and operating with by-passed safety devices.
3) Operating the pumps in ways in which they were never intended or designed to operate.
4) Allowing foreign materials to enter the pumps.
Operating pumps that have not been properly maintained or inspected.

We have seen some of the reasons that accidents have occurred, and from this, it is evident that no safety system could protect an untrained operator from all of the hazards of operating a progressive cavity pump. It is however possible to provide protection against some specifically identified hazards.

Burst Disc



The burst disc is installed as a part of the pump safety system to provide over pressure protection for the product pump. The burst disc is independent of the other devices.

The burst disc provides pressure relief for the pumping system.



It is a one time relief valve valve. When the pumping pressure exceeds the disc rating, the disc ruptures, venting the product.

There are two standard pressure ranges 200 & 300 psi rated discs.

Safety

It is important that:
1) Only Approved Discs be used.
2) The disc must have the proper pressure rating for the pump.
3) The disc must be installed properly including:
   a) The direction of installation must be correct. The disc is marked with the direction of venting.
   b) The disc must be properly gasketed. The gaskets provide for any curvature of the holder.
   c) The bolts must be properly torqued. Overtorquing the bolts may cause pre-mature failure.

Troubleshooting

Before replacing burst disc:

Determine the cause of the failure

If the failure occurred prematurely, before the rated disc pressure:
1) Determine if it is the pressure rating is correct.
2) Were the bolts properly torqued.
3) Are the gaskets in place. Both sides should be gasketed.

If the disc does not rupture:
1) Determine if the pressure rating is correct.
2) Is the direction of the disc correct.
2) Check the inlet to the disc for blockages.

PRINCO™

Instrumentation designed with the user in mind

INSTRUCTION MANUAL

PRINCO MODELS L3610 & L3610R

CONTINUOUS LEVEL TRANSMITTERS

with NULL-KOTE™

PRINCO INSTRUMENTS INC.
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Rev. 1, 9 May 02

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Section One
Description

A. General Description

Princo Models L3610 and L3610R are multi-featured, high technology, RF impedance sensing, continuous level transmitters. Null-Kote™ circuitry permits operation in a wide variety of process materials, regardless of dielectric, conductivity, viscosity or coating characteristics.

The output signal, typically 4 to 20 mA, is directly proportional to the level being measured and can be wire transmitted to a remote meter, controller, recorder, etc. Meter scale calibration may be in percent of level or specific units (i.e. gallons, inches, etc.) related to the application. The L3610 will drive any current sensing device which has an input impedance of 500 ohms or less.

Self-diagnostic circuits give an immediate indication of many application or installation related problems such as bad ground connections, breaches or pinholes in the probe sheath, and moisture in the electronic housing.

The Model L3610 ("integral unit") is packaged in an explosion-proof, weatherproof aluminum housing. Probe connections are made reliably and automatically when the probe is screwed into the electronic housing.

The Model L3610R ("remote unit") allows the electronic controller to be installed in a location removed from the process storage vessel. It consists of a standard L3610 electronic chassis mounted inside a clear-covered, plastic, NEMA 4X housing which is connected to a Model L216 "remote head" via a Model L214 tri-axial cable. Standard cable length is 25 feet. Connection to the probe is made by simply screwing the L216 onto the probe's 1-inch NPT fitting.

Available accessories which enhance the application of the L3610 include Models S954, S960 and S975 indicators. Refer to Section 1.B.4 for descriptions.

Models L3610 and L3610R are covered by Princo's 10-year warranty. Refer to Section 5.B for details.

B. Functional Description

1. RF Impedance Theory

The Princo L3610 works on the concept of monitoring changes in RF impedance between two sensing elements. The two sensing elements are the "active" element of the probe and the "ground reference", which is either a second probe element or a metal tank wall. The two elements are, effectively, the two plates of a capacitor. The electronic unit produces a 100KHz test signal that is applied across the probe elements and is monitored for changes in amplitude and phase angle.

The primary component of the measurement is the capacitive element (with a -90º phase shift, 100% resistive being the 0º reference point). With no process material touching the probe, the dielectric material between the two probe elements is air, which by definition has a dielectric constant of 1.00. As the process level rises, it displaces air as the dielectric. Since the process material has a higher dielectric constant than air, capacitance increases, RF impedance decreases and RF current flow increases, in direct proportion to level change.

The secondary component of the measurement is the resistive component. Buildup of a conductive process material coating on the probe produces increased RF current flow. This coating can be defined electronically as a complex resistive-capacitive network. Due to the resistive component, the phase angle of the measurement shifts away from a pure -90º.

The resistive component of the coating is proportional to the capacitive component of the coating and to the increased current flow produced by the coating. Therefore, by monitoring the magnitude of the phase shift away from the -90° point, the signal processing circuitry of the electronics is able to apply a proportional correction to the RF signal, thus subtracting out the error caused by the coating. The corrected RF signal is ultimately rectified and amplified to produce a proportional DC current output.

Many, if not most, process applications are water-based and, therefore, electrically conductive. If the probe elements were both bare metal, the first contact with the process material would short the capacitive plates producing an exceptionally high current flow. Covering one or both of the probe elements with an insulating material such as Teflon or Kynar solves this problem. Now, with no process material touching the probe, capacitance is determined by the combined dielectrics of air and the probe insulation material in series. As the process rises, it displaces the air and effectively shorts the gap between the two probe elements. Now, capacitance is determined by the dielectric of the Teflon or Kynar insulation alone, producing a directly proportional increase in capacitance and RF current flow as level rises. Process linearity is determined solely by the uniformity of the thickness of the insulation material.

Linearity of non-conductive process measurements depends upon uniform, parallel spacing of the probe elements. Probes used for non-conductive applications normally have at least one element insulated. This is to reduce the magnitude of error that would be caused by a small amount of conductive moisture in the process, such as might result from condensation.

2. *Signal Processing*

The L3610 is factory set on the appropriate RF capacitive measurement range as required for the specific application, based on a capacitance span calculated for the specific application. Normally, the range is not re-set in the field. The RF signal, proportional to level and corrected for coating error, is rectified and filtered into a proportional DC voltage. This signal is processed by a series of DC amplifiers and ultimately converted into a proportional DC current or DC voltage output signal.

Front panel ZERO and SPAN adjustment pots set the span of the DC amplifiers within the pre-set range. The pots are set at the factory relative to calculated zero and span capacitance values for the specific probe and application. They are re-adjusted by the user if need requires.

3. *Basic Features*

- RF Impedance Sensing Technology with Null-Kote™

  The L3610 uses RF impedance technology, proven in tens of thousands of applications. With no moving parts, the measurement depends solely on its modern, electronic circuitry, ensuring years of dependable operation.

- Coating Cancellation

  Null-Kote™ technology allows the cancellation of the build-up on the probe of most process materials. Units are factory set for either Mode A (non-conductive) or Mode B (conductive) process coating cancellation. Coating cancellation is effective within specified limits.

- Superior Temperature Stability

  The L3610 electronics is designed to provide temperature stability superior to that of previous generations of level transmitters. This allows successful, repeatable measurements in many short span, low dielectric applications.

- Self Diagnostic Feature

Provides instantaneous, visual indication of the two most common failure modes - shorted and open probe conditions. The A DIAGNOSTIC LED indicates shorted condition; the B DIAGNOSTIC LED indicates open condition.

- Output Signal

  Standard 4 to 20 mA output with optional 0 to 5Vdc and 0 to 10 Vdc outputs available.

- Remote Mounting

  Optional, Model L3610R, remote mounting configuration is available. This allows mounting of electronic unit in a cabinet, control room, etc., connected to probe by tri-axial cable. Standard cable length is 25 feet; optional lengths available.

- FM Approval

  The L3610 is Factory Mutual Approved as a measurement system when used with various L100 Series Probes as defined in Figure 4-2. The L3610R is not FM approved.

- Conformal Coating

  An insulating coating (conformal coating) is applied to all circuit boards to protect the circuitry against condensation of moisture.

- 10-Year Warranty

  Quality backed by limited 10-year warranty. Refer to Section 5 for details.

4. Accessories

- Model S960 Series Digital Process Indicators

  LED display digital indicator which accepts any input current range between 0 and 50mA. A 6 digit display can be programmed for nearly all engineering units. Programmable digital filtering enhances stability.

  An optional totalizer/ linearizer can be used to totalize or integrate signals up to a maximum display value of 999,999. It features independent scaling and a low signal cut-out to suit a variety of signal integration applications. Additionally, nine slopes and offsets can easily be programmed with this option to linearize transducers and non-linear outputs, such as square law devices. Peak/valley (max/min) reading memory, display hold and a signal re-zeroing (tare) function are also included and they are easily recalled and controlled by either the front panel or remote switch. All readings are retained at power-down.

  Optional dual relays with parallel solid state outputs are fully programmable to operate in a wide variety of modes to suit many control or alarm applications. Refer to Princo Bulletin S-91-2 for specifications.

- Model S975 Digital Loop-Powered Indicator

  Small, easy-to-read, 3½ digit, 4-20mA loop powered LED indicator in NEMA 4X rated housing. Can be scaled in percentage of range, 4 to 20 mA, or for one of many engineering units. Refer to Princo Bulletin L-02-1 for specifications.

- Model S954 Analog Meter

  Typically scaled to read 0 to 100% of range span relative to a 4 to 20 mA input. Suitable for panel mounting or can be mounted in a weatherproof housing. Refer to Princo drawing #A90-S954 CD1 for dimensional details.

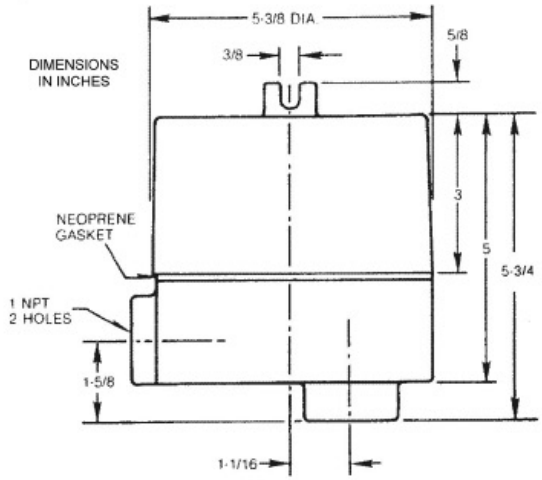


Figure 1-1
L3610 Dimensional Drawing (Integral Unit)

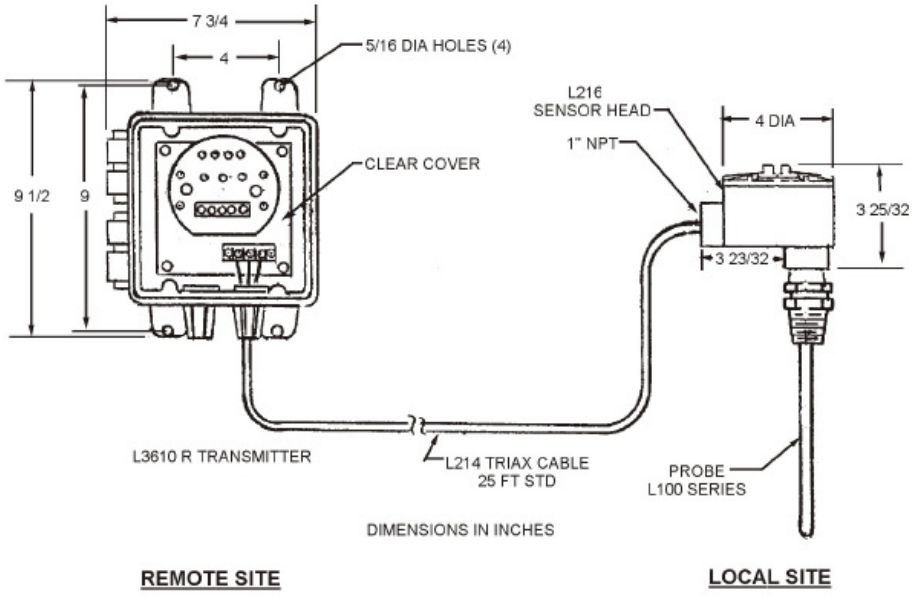


Figure 1-2
L3610R Dimensional Drawing (Remote Unit)

C. L100 Series Probes

1. General Description

Princo offers a wide variety of probes for use with its continuous transmitters and multi-point controllers. Although the measurement technology remains the same, as outlined in the previous section, different probe designs are suited for different applications.

Electrical, chemical and mechanical considerations affect probe selection. Electrically, a ground reference must be present and the probe must be built to provide proper response.

Chemically, the probe must be compatible with the process material. It must be immune to attack and must offer no chance of contaminating the process.

Mechanically, the probe must be able to withstand the pressure and temperature extremes of the application. In addition, turbulence, consistency, viscosity, abrasion and mounting configuration also play a role in probe selection. A flexible probe is required where probe length exceeds 236 inches or where physical restrictions, such as lack of headroom, prevent installation of a rigid probe.

Single element probes (L101, L104 and L109) are often used in situations where a metal tank wall can provide an adequate ground reference (second element). Non-metallic vessels require dual element probes, as do most non-conductive process applications where probe response and/or linearity would be inadequate using the vessel wall as a ground reference.

Dual element probes are made with either parallel (L115, L116, L127, L128) or concentric (L102, L107) elements. Dual concentric probes provide the best response for low dielectric, low consistency, non-conductive processes as well as minimizing the effects of agitation.

Probe sheathing (Teflon, Kynar, or bare) is chosen with regard to chemical compatibility, as well as probe response and ability to withstand abrasion.

All Princo continuous level probes connect to their respective electronic units by means of a 1" NPT threaded hub. The "ground" contact is made by the threads themselves. The "active" contact is made by the spring-loaded pin which projects from the center of the hub NPT fitting. Probes mount to the storage vessel by means of various sizes of flanges, NPT connectors and TRI-CLAMP™ fittings. Refer to Section 2.2 for details.

For detailed listings and specifications for Princo Continuous Level probes, consult Princo Bulletin L-96-4.

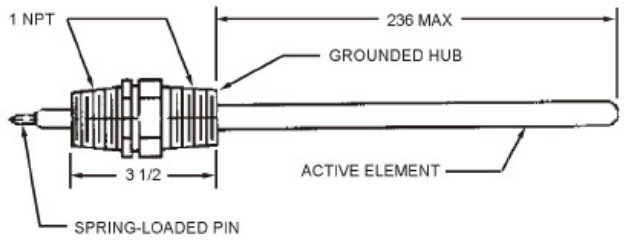


Figure 1-3
Typical 1" NPT Mounted Probe (Model L101)

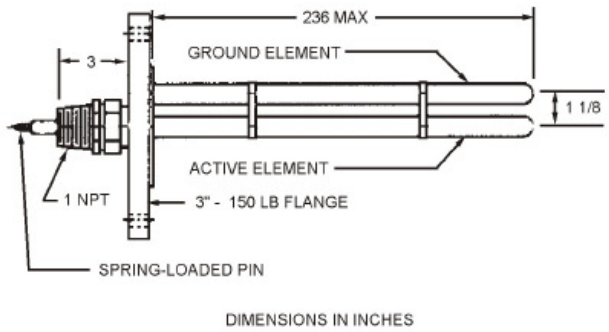


Figure 1-4
Typical 3" Flange Mounted Probe (Model L127)

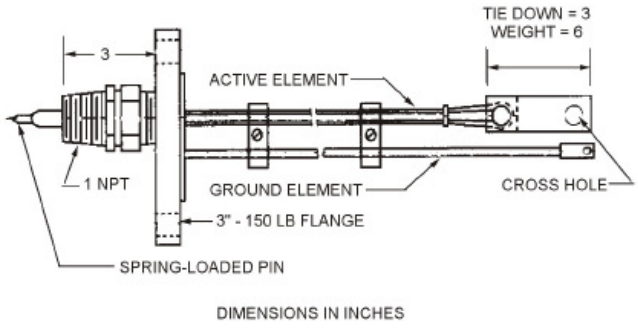


Figure 1-5
Typical Dual Flexible Probe (Model L115)

A. Specifications

1. L3610 AND L3610R CONTINUOUS LEVEL TRANSMITTERS

- TYPE

  Continuous level to current transmitter, high frequency, impedance sensing.

- SPAN RANGE

  From 0.5 to 100 feet typical. Shorter and longer spans available with special probes. Consult Factory.

- OUTPUT SIGNAL

  4 to 20 mAdc into 500 ohms is standard. 0 to 5 Vdc and 0 to 10 Vdc outputs optional.

- REPEATABILITY/ LINEARITY

  0.5% of span over entire range span, process dependent

- AMBIENT TEMPERATURE RANGE

  -30 to 150 °F (-34 to 66 °C)

- TEMPERATURE STABILITY

  Maximum error of 0.25% per 30°F change, or within 1.5% over entire 180°F ambient temperature span.

- PROCESS CONDUCTANCE ALLOWED

  Tolerates process coating conductance up to 5000μS (200 ohms of composite resistance).

- REMOTE MOUTING DISTANCE

  Up to 50 feet (cable connected) for all but the shortest span values.

- POWER REQUIREMENTS

  104 to 126 Vac, 50 to 60Hz, 5 watts; or 207 to 253 Vac, 5 watts; or 21 to 26 Vdc, 5 watts.

- ELECTRONIC HOUSING

  Heavy-duty, cast aluminum.

  Explosion-proof for: Class I, groups C & D; Class II, groups E, F & G.

  Weather proof: NEMA 4.

- FM APPROVAL

  The L3610 is Factory Mutual Approved as a measurement system when used with various L100 Series Probes as defined in Figure 4-2. The L3610R is not FM approved.

2. L100 SERIES PROBES

- TYPE

  Single and dual element continuous, RF impedance level probes.

- DESCRIPTION BY MODEL NUMBER

The below list includes the most commonly used probes. Princo also makes other variations for special applications.

MODEL NO.	ELEMENT CONFIGURATION	TYPE	VESSEL CONNECTION	INSULATION OPTIONS
L101	Single	Rigid	1" NPT	B, KP, KS, TP, TS
L104	Single	Rigid	1", 2", 3" OR 4" TRI-CLAMP™	B, KP, KS, TP, TS
L102	Dual Concentric	Rigid	1½ " NPT	B, KP, KS, TP, TS
L107	Dual Concentric	Rigid	1" NPT	B, KS, TP, TS
L109	Single	Flexible	1" NPT	KW, TW
L113	Dual Parallel	Flexible	1" NPT	KW, TW
L115	Dual Parallel	Flexible	3" Flange	KW, TW
L116	Dual Parallel	Flexible	3" Flange	KW, TW
L127	Dual Parallel	Rigid	3" Flange	B, KP, KS, TP, TS
L128	Dual Parallel	Rigid	3" Flange	KP, KS, TP, TS

B = Bare (No insulation)

KP = Kynar® Pipe (60 mil Kynar over carbon steel)

KS = Kynar Sheath (17 mil Kynar over 316 SS rod)

TP = Teflon® Pipe (60 mil PFA Teflon over 316 SS rod)

TS = Teflon Sheath (17 mil Teflon over 316 SS rod)

KW = Kynar Wire (20 mil Kynar over 316 SS wire rope)

TW = Teflon Wire (12 mil Teflon over copper wire)

- PRESSURE / TEMPERATURE RATINGS

Model Number	Probe Covering	Pressure Rating (PSI) at Temperature Indicated (ºF)						
		-300	-40	100	250	300	400	500
L101, L102, L104, L107, L109, L113	Teflon or Bare	1250	1250	1250	550	450	350	0
	Kynar		1000	1000	250	0		
L115, L116, L127, L128	Teflon or Bare	275[1]	275[1]	275[1]	225[1]	210[1]	180[1]	0
	Kynar		275[1]	275[1]	225[1]	0		

NOTES:

1. Rating of Carbon Steel 150 lb. flange. For higher ratings, consult factory.
2. Temperature Limits: Bare or Teflon covered probes: -300ºF (-184ºC) to 500ºF (260ºC); Kynar covered probes: -40ºF (-40ºC) to 300ºF (149ºC). For temperatures beyond these limits, consult factory.

- SELECTION GUIDE / PHYSICAL DIMENSIONS

Refer to Princo Bulletin L-96-4, Continuous Probe Selection Guide

Section Three
Installation

A. Inspection

The L3610 and L3610R Transmitters are supplied with one of the Princo L100 Series Level Probes. The Transmitter and Probe are shipped in separate packages.

Carefully remove each package's contents and check each item against the packing list. Inspect each item for shipping damage. In particular, check the spring-loaded connection pin, located on the threaded hub end of the Probe (see Figures 1-3, 1-4 and 1-5). This pin provides the necessary electrical connection from the Transmitter bottom printed circuit board, to the active element of the Probe. Make sure this pin is not missing, bent, jammed, or otherwise damaged.

If the Probe is sheathed in Teflon or Kynar, then carefully inspect the condition of the sheathing. Make sure the sheathing forms a smooth continuous coverage over the element. Discontinuities in the sheathing material, which breach through to the metal underneath, will render the Probe useless in most applications. Report any such damage immediately to the factory.

CAUTION !

Care must be exercised when handling probes that incorporate an insulating sheath. Do not allow the sheathed sensing element to come in contact with a rough or sharp surface, as this may cause a breach in the insulating sheath, and render the probe inoperable.

B. Mounting

1. *Headroom*

Proper specification of a Princo Model L100 Series Probe must take into consideration the amount of space available above the storage vessel from which the Probe can be lowered into the vessel. This aspect must be considered prior to probe selection and ordering.

In a situation where headroom limits the use of a rigid type probe, a flexible cable type probe can be used. Refer to Figure 1-1 for electronic housing dimensions. A typical cable probe with a 3-inch flange adds about 3½ inches to the height. Additional headroom is needd to remove the lid and access the top panel controls and terminal blocks.

2. *Mounting Location*

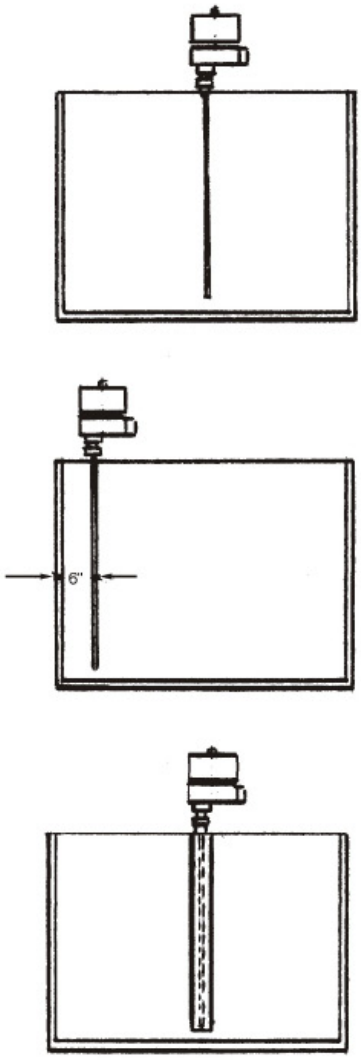
Single element probes use the metal tank wall as a ground reference. If they are used in non-conductive applications, they must be mounted close to the sidewall of the tank (6 to 8 inches recommended) and should maintain an equidistant spacing from the sidewall, as the spacing affects measurement linearity. (Princo generally recommends use of factory-made dual element probes for this reason.) When it is impossible to mount the sensing probe close to the sidewall, at least try to favor an off-center mounting. In conductive applications, single element probes may be mounted anywhere relative to metal tank walls. Refer to Figure 3-1.

Dual element probes have a built-in ground reference and generally can be mounted anywhere relative to tank walls, irregardless of whether the process is conductive or non-conductive.

Be careful not to mount probes any closer than necessary to such devices as baffles, agitators, heaters, etc. This is especially important when the process is non-conductive. When the process is conductive, it is only necessary to have adequate physical clearance, since there should be little or no adverse electrical effects due to proximity of these devices.

Whether the process is conductive or non-conductive, try to mount the probe in an area where the level is stable and representative. Mounting near an input flow or near splashing might

create artificially high level readings. Mounting in a vortex created by a mixer might give an atypically low reading.



SINGLE ELEMENT PROBE, METAL TANK, CONDUCTIVE PROCESS. PROXIMITY TO TANK WALL UNIMPORTANT.

SINGLE ELEMENT PROBE, METAL TANK, NON-CONDUCTIVE PROCESS. DISTANCE FROM TANK WALL AFFECTS RESPONSE. MUST BE PARALLEL TO TANK WALL FOR LINEAR READINGS.

DUAL ELEMENT PROBE (L107), CONDUCTIVE OR NON-CONDUCTIVE PROCESS, METALLIC OR NON-METALLIC TANK. PROXIMITY TO TANK WALL UNIMPORTANT.

Figure 3-1
Probe Mounting Locations

3. *Ground Reference*

Normally, dual element probes (probes with built-in ground references) are used in non-metallic storage vessels. A single element probe may be adapted to the same purpose by supplying a ground reference. The ground reference should be a metal rod, equal in length to the Probe. The reference should be mounted parallel to the length of the Probe, no greater than 6 to 8 inches from it.

The reference must be electrically connected to the Transmitter chassis ground, either directly to the terminal strip ground terminal, or indirectly, by wiring it to the threaded hub of the probe or to the metal housing of the electronic unit. In any case, perform Ground Continuity Check, Section 4.E.6.a to ensure that a good ground connection exists.

If the process is non-conductive, non-parallel spacing between the probe and the ground rod will negatively affect the linearity of the level readings. Also, the probe response will decrease as the distance between the two elements increases.

4. *Flange or NPT Mounting*

Princo L100 Series Probes are normally mounted by means of a flange (typically two or three inch insertion hole diameter) or an NPT type fitting (standard size is one inch).

a) Flange Type. Slip the Probe tip into the storage vessel entry port. Lower the Probe into the vessel, until the probe flange seats and aligns with the corresponding mating surface on the storage vessel. Fasten the flange to the vessel using the appropriate metal fasteners, gaskets, and sealing compounds, as required by the specific installation.

CAUTION!

Single element flange type probes must be fastened to the storage vessel with metal fasteners, such that electrical continuity exists (zero ohms) between probe flange and metal storage vessel. NPT type probes must be fastened to the storage vessel such that electrical continuity (zero ohms) exists between the probe NPT hub and the metal storage vessel. Do not use any kind of thread lubricant on the NPT threads. If lubrication and/or sealing are required, a small amount of Teflon tape can be used. Refer to Section 4.E.6.a for ground continuity testing.

b) NPT Type. Slip the Probe tip into the storage vessel NPT threaded entry port. For probes sheathed with Teflon or Kynar, it is recommended to temporarily line the entry port with cardboard or plastic sheeting to avoid skiving the probe sheathing while guiding the probe through the opening. Lower the Probe into the vessel until the Probe lower hub NPT fitting seats into the vessel NPT receptacle. Tighten the Probe lower hub NPT threads into the storage vessel NPT receptacle using an appropriately sized wrench on the Probe hub hex head fitting

5. *Cable Probe Tie-Down*

Princo flexible cable type probes incorporate either a weight or a tie-down at the probe tip, which is designed to keep the sensing element taunt as it is immersed in the process material. Refer to Figure 1-5.

If the process material is agitated or is turbulent in any way, it may be necessary to fasten the Probe tip to the bottom of the storage vessel. This can be accomplished by using a light cable or nylon rope, looped through the hole in the bottom of the weight or tie-down and, in turn, through a hook fitting in the bottom of the storage tank.

Do not apply excessive downward force to the cable sensing element through the tie-down. It is not necessary and could potentially damage the probe.

Also, note that the weight or tie-down is not an electrically active part of the probe. That is, it stands below the zero level of the measured process material. Standard weight length is six inches. Standard tie-down length is three inches.

Teflon spacers on dual element probes (L113, L115, & L116) are designed to keep the dual cables equidistant. Try to maintain even spacing between them, and avoid crossing of cables by excessive twisting, as this will affect accuracy and linearity.

6. *Electronic Housing Mounting*

The electronic chassis of "integral" units (L3610) is contained within a cast aluminum housing. It is mounted onto the top of the probe by threading the housing's bottom NPT opening onto the probe hub's 1" NPT connector. As with the probe to tank connection, electrical continuity must be maintained through the threaded connection.

NOTE

Do not use any type of thread lubricant on the NPT probe mounting threads or the NPT threads which mount the electronic housing. Application of thread lubricant may cause faulty or improper ground connection. If required, Teflon tape may be used as a thread seal for either threaded connection. If Teflon tape thread sealant is used, the installer should make an electrical continuity check with a hand held ohmmeter. Less than 1 ohm resistance should exist between the storage vessel and the electronic housing. See Section 4.E.6.a.

The spring-loaded pin projecting from the middle of the probe NPT fitting should now be pressing against the underside of the bottom circuit board of the electronic chassis. This may be verified visually through the 1" NPT wiring port on the side of the housing. If the pin is failing to make contact, stretch the spring-loaded pin out further with a pair of pliers. To access the spring-loaded pin, either unthread the housing from the probe hub, or lift the electronic chassis out of the housing after removing the two 8-32 screws which hold it in. Hint: If the spring-loaded pin is properly contacting the circuit board, you will feel the chassis being pushed upward by it as you loosen the two 8-32 screws.

With "remote units" (L3610R), the procedure is basically the same, except that it is the Model L216 Remote Head which is threaded onto the probe NPT fitting. The electronic chassis is contained in a clear-covered, plastic, NEMA 4X housing that is mounted in a location of the customer's choosing and connected by tri-axial cable to the probe via the L216 circuit board.

C. L3610 Electrical Connections (Integral Units)

Remove the lid of the L3610 Transmitter in preparation for connection of signal and power wires. Before drawing wires into the equipment housing, remove the electronic circuit board chassis. This may be done by removing the two 8-32 chassis mounting screws and lifting the chassis off of the mounting posts and out of the housing. Bring the signal/power wires into the Transmitter housing through the 1" NPT wiring port. Leave enough slack in each wire to make connection to the terminal block at the top of the Transmitter.

Replace the electronic chassis in the housing, the flat side of the printed circuit boards facing the wiring port. Slide the chassis onto the mounting posts, keeping the wires toward the housing inner wall, so as not to interfere with the chassis. Replace the two 8-32 mounting screws and tighten firmly to ensure proper chassis electrical ground connection.

Section Three
Installation

WARNING!

For installation which must be explosion-proof, and/or weatherproof, it is the customer's responsibility to install conduit seals which meet applicable safety standards and/or weatherproof requirements.

Connect the power and signal wires to the terminal strip as according to the appropriate wiring diagram: Figure 3-2 for 24 Vdc, 3-wire; Figure 3-3 for 24 Vdc, 4-wire; and figure 3-4 for 115 Vac and 230 Vac. Make certain wires are installed with correct polarity orientation.

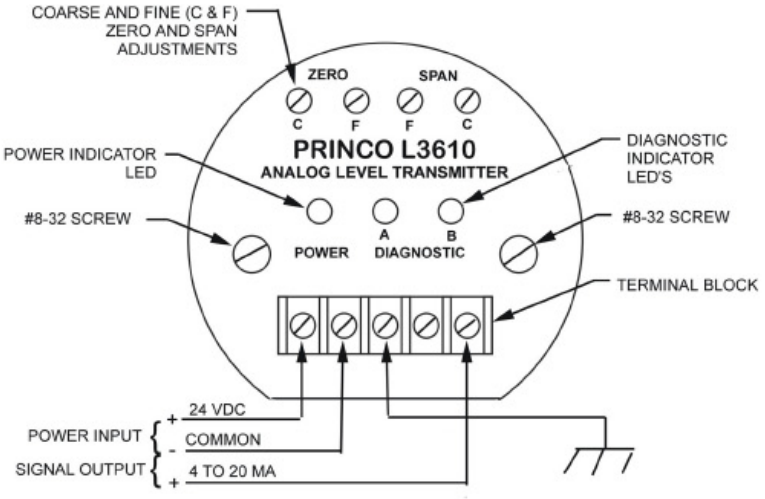


Figure 3-2
L3610 3-Wire Electrical Connections, 24Vdc Input

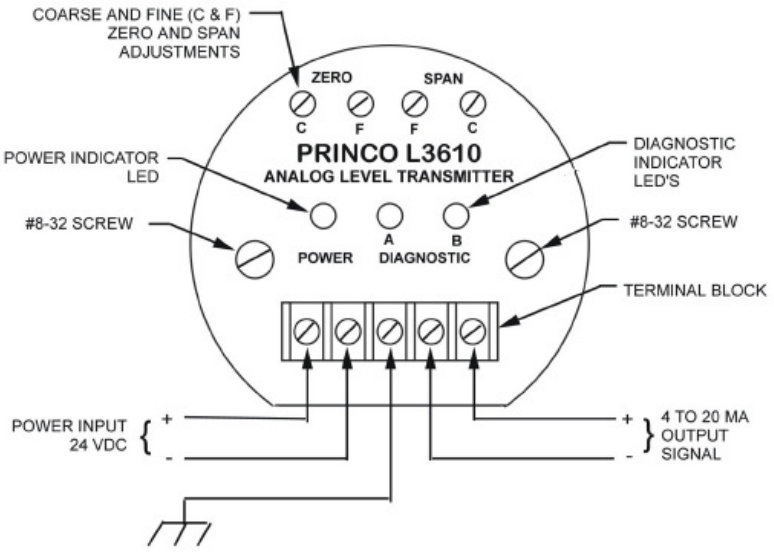


Figure 3-3
L3610 4-Wire Electrical Connections, 24Vdc Input

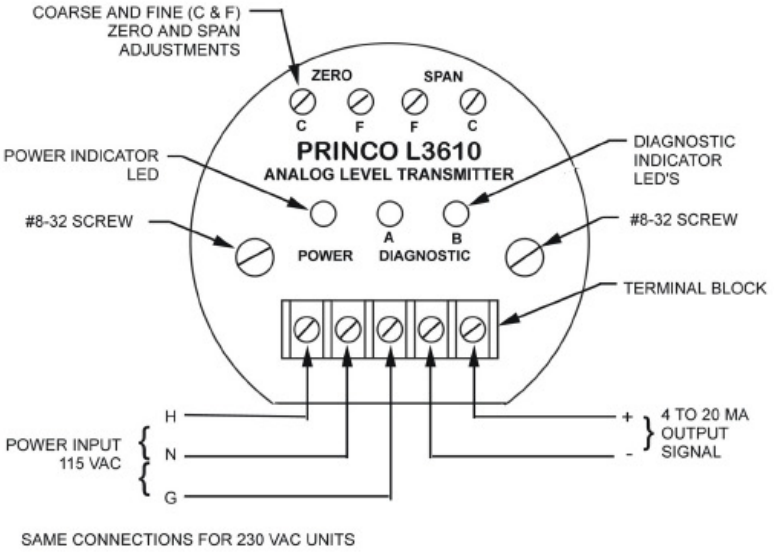


Figure 3-4
L3610 4-Wire Electrical Connections, 115Vac Input

D. L3610R Electrical Connections (Remote Units)

The Model L214 tri-axial cable connects the probe to the L3610R electronic chassis through two three-connection terminal blocks. One is located on the circuit board of the L216 Remote Head. The other is on the electronic chassis mounting plate inside the plastic NEMA 4X housing. Refer to Figure 3-5 for the wiring diagram. Note that the wiring order on both terminal blocks is the same from left to right - Red (guard), Clear (active), and Black (ground). The cable may be drawn through the 1" NPT port on the side of the L216 housing and connected accordingly. Likewise, the other end of the cable can be drawn through one of the two ½ " NPT wiring ports on the control unit housing and connected to its terminal block.

The power and current output wires can be drawn through the other ½ " wiring prt and connected appropriately as per figure 3-5.

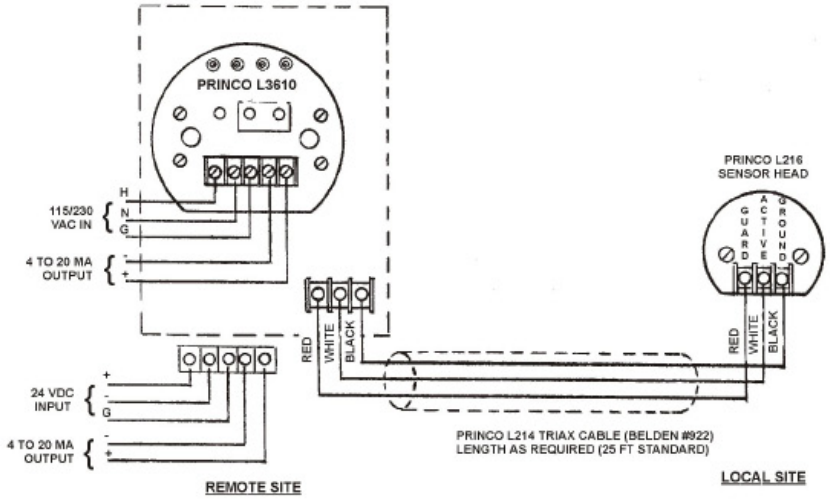


Figure 3-5
L3610R Electrical Connections

E. Installation in Hazardous Areas

The outline which follows points out some of the major requirements of the NEC's (National Electric Code) Section 501, as it relates to typical level control installations.

WARNING!
For applications which MUST BE explosion-proof and/or weatherproof, it is the customer's responsibility to install the required conduit, seals, wiring, etc., which meet national, as well as applicable local and plant safety codes.

For Class 1 locations, rigid metal conduit must be used. At least five full threads of the conduit must be tightly engaged in the enclosure. Conduit seal fittings must also be used. These seal fittings, must be filled with an approved sealing compound and must be installed within 18

inches (or closer) of the enclosure. Conduit seals are also required when the conduit passes from a hazardous area into a non-hazardous area. Water drain seal fittings eliminate or minimize the effect of water that tends to collect in the conduit or enclosure due to condensation.

Approved wire type, such as mineral-insulated wire, is required for use in Division 1 installations. Certain types of metal-clad cable or shielded non-metallic sheathed cable are permitted in Division 2 installations. When multi-conductor cables are used in the conduit, the outer jacket must be cut away in such a manner that allows the sealing compound to surround each insulated wire as well as the jacket.

The preceding information should act as guide to assist the customer/installer in satisfying their responsibility for producing safe installations in hazardous area.

F. Ground Isolation

Ground Isolation refers to the degree of electrical isolation between an instrument's "circuit common" (SIG -) terminal, and "earth ground" (G) terminal. An instrument without ground isolation has a direct electrical connection between its signal minus terminal and chassis ground.

The standard L3610 unit is shipped from the factory without ground isolation. If ground isolation is required, it can be easily provided in the field by cutting open the ground isolation jumper wire (JA1) and connecting a Ground Isolation Capacitor between the G and the SIG - terminals on the terminal block. The jumper wire is located on the top printed circuit board. The Ground Isolation Capacitor is a 0.4 µF, 500 Vdc ceramic capacitor which is available from the factory as Princo part number A60-3610-25. Refer to Figure 4-3.

There are several situations where ground isolation is required:

- The negative signal leg drives a ground referenced input to a Computer (PLC).
- The metal storage vessel resides at an electrical potential that is elevated above "earth ground".

Figure 3-6
L3610 FM Approval Drawing
3-9

Section Four
Adjustments and Operation

A. Factory Pre-calibration

The Princo Model L3610 and L3610R transmitters are supplied pre-calibrated from the Factory. The pre-calibration is established from the application information supplied to Princo Instruments by the customer. Information such as probe type, probe mounting geometry, and process material characteristics is used to calculate a "zero capacitance" and a "span capacitance" for the specific application. These capacitance values are then used to perform a bench top pre-calibration. Note that the 0% (4mA output) and 100% (20mA output) points do not have to coincide with 0 and 100% of probe length, but may, within limitations, be set for points up from the bottom or down from the top of the probe. Consult the factory for specific "zero offset" limitations.

In applications where the transmitter is required to measure electrically conductive process materials, the pre-calibration is generally very accurate, and no further field calibration is required. In applications measuring electrically insulating process materials, it is more likely that "trimming" of the zero and span adjustments will be required.

B. Cancellation of Coating Effects

When a conventional capacitance type level transmitter is required to measure process materials that are electrically conductive and coating in nature, a significant error in the measurement occurs. The L3610 incorporates a feature known as Null-Kote™ which negates the effects of these conductive coatings.

The Null-Kote™ feature is actually a sophisticated electronic measurement system that cancels, or "nulls out" the effect of thick or viscous, electrically conductive, process material coatings that may build up on the sensing probe. The unique action of this measurement system automatically cancels the probe coating as the coating increases or decreases in magnitude.

If the process is coating in nature, then, to obtain the highest degree of accuracy possible, pre-coat the sensing probe with the process liquid prior to installation and field calibration.

If the L3610 equipment is transferred from the original application to an alternate one, and significant measurement error is noted, consult the Factory.

C. Initial Checkout

1. Install the L3610 per the information presented in Section 3 of this manual.
2. Apply power to the unit and allow a 15-minute warm-up time before performing the operational checkout of the equipment.
3. The "A" and "B" LED Diagnostic Indicators, located on the top panel of the L3610 chassis (see Figure 4-1), should be in the OFF (not illuminated) state. Refer to section 4.E for a functional description of these LED indicators.
4. Check the operation of the L3610 by verifying the process variable output as follows:

a) Connect a calibrated 20-milliamp dc ammeter directly to the signal output terminals (SIG + and -). No other devices should be in the signal output loop at this time.

b) Move the process material level to several positions within the storage vessel (preferably as far apart as possible, but within the known calibrated range of the L3610). At each level position, use a dipstick or sight glass to measure and record the actual level from the bottom of the storage vessel. Read and record the corresponding output current for each dipsticked level position. Convert the actual level, from each dipstick reading, into a percentage of the calibrated L3610 span. This number is known as "Percent Level" or "Percent Range".

NOTE
In order to make this calculation, the 4 mA level position, and the 20 mA level position, must be known relative to the storage vessel bottom.

c) Table 4-1 below may be used to determine if the output current is within acceptable accuracy limits. The following equations may also be useful in making comparisons:

Current Output = [(Measured Level - Zero Level) / Span] x 16mA + 4mA

%Level = (Current Output - 4mA) / 16mA x 100%

If the accuracy is unacceptable, then perform the field calibration procedure as per Section 4.D.

Actual Level (from bottom of vessel) (inches)	% Level (% Range)	Transmitter Output Current (Process Variable Output) (milliamps)
Application Specific	0	4.00
"	5	4.80
"	10	5.60
"	15	6.40
"	20	7.20
"	25	8.00
"	30	8.80
"	35	9.60
"	40	10.40
"	45	11.20
"	50	12.00
"	55	12.80
"	60	13.60
"	65	14.40
"	70	15.20
"	75	16.00
"	80	16.80
"	85	17.60
"	90	18.40
"	95	19.20
"	100	20.00

Table 4-1
Percent of Range to Current Conversion Table

D. Calibration Procedure

If it is determined that the pre-calibrated L3610 is not within acceptable accuracy limits, then the unit requires a complete field calibration. Refer to Figure 4-1 for adjustment potentiometers (pots) and indicators locations. Proceed as follows:

1. Pre-set the Coarse (C) SPAN pot to full clockwise rotation. Pre-set the other three pots to half clockwise position (12 o'clock position).

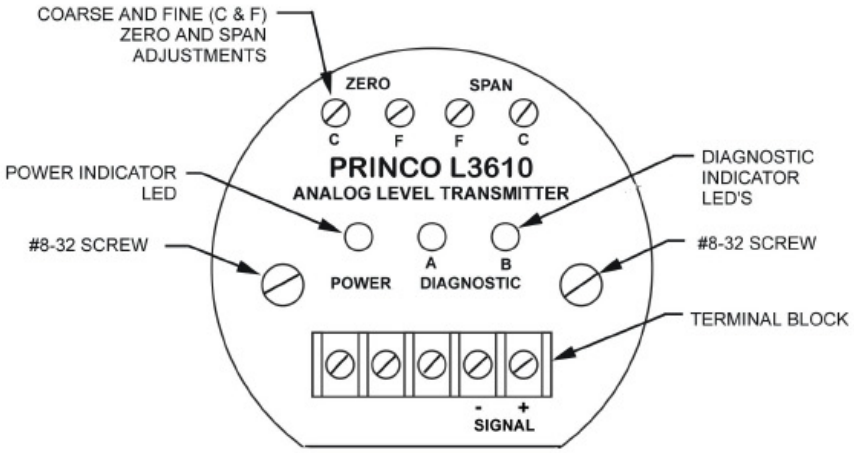


Figure 4-1
L3610 & L3610R Control and Indicator Locations

2. Connect a DC ammeter to the to the + and - SIGNAL terminals on terminal block TB1. Remember that the wires to the control device, i.e. PLC, recorder, controller, etc., have not yet been connected.

NOTE

Optimum calibration accuracy is obtained by pre-coating the probe with the process material **and** then performing the Zero and Span adjustments with the tank level at the actual zero and span points **and** with the probe mounted in its permanent position within the tank. The ALTERNATE METHODS listed in steps 5 and 6 below will compromise the accuracy to a greater or lesser extent, depending upon variables in the specific application. The user must determine whether the accuracy obtained is within acceptable limits.

3. Raise or lower the process material in the storage vessel to the desired 0% of span point (4 mA point). Usually this is the bottom of the storage vessel or the bottom tip of the probe.

4. Adjust the Coarse (C) ZERO pot for approximately 4 milliamps on the meter. Adjust the Fine (F) ZERO pot for exactly 4.00 milliamps.

   ALTERNATE METHOD: If the storage tank is too full and may not be emptied to the level noted above, an **approximate zero adjustment** may be established as follows. It should be noted that this procedure is not acceptable for single element type probes in an electrically non-conducting process material:

   Lift the probe, with housing attached, vertically out of its mounting hole to the point where the process material resides at the desired 0% point (4 mA point) on the probe.

   Again, this is usually the bottom most point, or bottom tip of the probe. Do not touch the probe itself during this procedure - only the housing. Make sure that the electronics housing is connected to the metal storage tank with an inter-connecting wire. This is not required in

tanks where dual type probes are used. Do not allow probe elements to directly contact a metal tank, metal stand pipe, hands, etc. while making the adjustment.

With the probe stabilized in this position, make the ZERO adjustments as noted above. Replace the housing and probe.

5. Raise the process material level to the desired 100% point.
6. Adjust the Coarse (C) SPAN pot for approximately 20 milliamps on the meter. Adjust the Fine (F) SPAN pot for exactly 20.00 milliamps.

   ALTERNATE METHOD: If the storage tank is too empty, and cannot be filled to the level noted above, an **approximate span adjustment** may be established as follows. It should be noted that this procedure is not acceptable for single element type probes in an electrically non-conducting process material:

   Fill the storage tank to a more practical level point. This point should not be below 60% of the desired span. Adjust the (C) & (F) SPAN pots to produce a current on the meter equivalent to this level point (expressed as a percentage of the desired span – see Table 4-1 above). When the tank fills completely, the meter should read close to 20 milliamps, or 100%. Trim adjustment again, if required.

NOTE

The SPAN adjustments **do not interact** with the ZERO adjustments, but the ZERO adjustments **do interact** with the SPAN adjustments. Therefore, once the ZERO has been properly set, the SPAN may be reset without shifting the ZERO point. Resetting the ZERO point, however, will shift the SPAN set point.

7. Adjustments are now complete. Remove current meter from the signal loop, and replace the loop back to the original configuration (see Figure 3-2, 3-3, 3-4 or 3-5). Screw gasketed lid of equipment on electronic housing until it is firmly seated.

E. Diagnostic Indicators and System Troubleshooting

The System Troubleshooting section below includes problems indicated by the condition of the POWER LED or of the "A" and "B" DIAGNOSTIC indicators as well as problems for which the condition of the indicator lights remains normal. "A" and "B" DIAGNOSTIC indicators are in the form of two red LED's on the top panel of the L3610. The POWER LED is an orange LED on the top panel. Also below are procedures for checking ground continuity, for testing a Probe for breached sheathing and for checking Probe response.

1. POWER Indicator not lit or pulsating

- Verify correct power input (115Vac, 230Vac or 24Vdc) is present at POWER terminals of TB1. If correct power is present and condition persists, return electronic chassis to factory for repair or replacement.

2. DIAGNOSTIC "A" Indicator lit ("shorted" probe indication)

- Breach or break, as small as a pinhole, in sensing probe insulating sheath material. Refer to section 4.E.6.b. and 4.E.6.c., Breached Probe Checks. Consult Factory regarding repair.
- Water or foreign liquid collected in probe port of electronic housing. Check wiring port conduit seal and dry housing.
- Conductive film or foreign material bridging probe hub at or near spring loaded connection pin. Clean and check source of problem.

3. DIAGNOSTIC "B" Indicator lit ("open" probe indication)

- Spring-loaded pin which projects from the top of the probe hub is not contacting the bottom of the printed circuit board. Pin may be safely stretched out with a pair of pliers. Replacement pins available from the factory.
- Probe element shifted, etc. Check for physical damage.
- Very loose connection of probe's NPT hub in entry port of electronic housing. Tighten as required. Check ground continuity per Section 4.E.6.a.

4. DIAGNOSTIC "A" and/or "B" Indicators Blinking

- Intermittent connection of probe's spring-loaded pin. Check spring tension. Stretch out pin with a pair of pliers, if necessary.
- Intermittently loose connection of probe's NPT hub in entry port of electronic housing. Tighten as required.

5. DIAGNOSTIC "A" and "B" indicators not lit

a) **Poor Linearity:** Current output goes up and down relative to level change, but accuracy or linearity is unacceptable.

- Perform Section Four D. Calibration Procedure with Probe coated with process material.

b) **Not Enough Adjustment Range:** ZERO and SPAN adjustment pots do not have enough range to produce full 4 to 20 mA output over level span.

- Princo level units are factory set for a specific capacitance range based on customer's Application Data Sheet. If more than one unit was ordered, be sure that the correct unit is being used with the application. Units are normally labeled as to the Probe or process application with which they are to be used. If problem is not resolved, consult the factory.

c) **Current output drifts:** After performing calibration procedure, current output drifts over a period of hours or days.

- Verify that there has not been a change in the conductivity or dielectric constant of the process material. RF impedance technology, by nature, responds to changes in dielectrics. Changes in the nature of the process material may produce different outputs.
- Significant temperature changes may change the dielectric constant of the process material and also of the probe insulation material, Kynar having a much greater change than Teflon. If output drift correlates with temperature change, consult the factory.
- Probe Response Check, Section 4.E.6.d below, may be used to help isolate problem.

d) **Current output erratic**: After performing calibration procedure, current output jumps unpredictably.

- Check ground continuity per Section 4.E.6.a. (Bad grounds may or may not cause the "B" indicator to light.)
- Verify that probe is not exposed to splashing or turbulent conditions within the storage vessel.
- Probe Response Check, Section 4.E.6.d below, may be used to help isolate problem.

e) **No Output Control:** ZERO and SPAN adjustment pots will not control current output.

- A constant output current usually indicates a problem with the electronic chassis. First, break the contact between the electronic chassis and the probe, either by unthreading the housing form the probe or by lifting the electronic chassis from its housing. If moving the ZERO and SPAN pots through their extremes produces no change in output current, return

the electronic chassis to the factory for repair or replacement. If current control has been restored, perform Breached Probe Check, Section 4.E.6.e. or 4.E.6.f. below.

f) **Measuring Device Loads Down Output:** Unit puts out correct current into a handheld ammeter or calibrator, but output is incorrect when measured by a PLC or other measuring device.

- Input impedance of measuring device must not exceed 500 ohms.
- A ground loop may be present due to circuitry within the measuring device. Check circuit diagram of measuring device. Refer to Section 3.G. Ground Isolation for instructions on how to isolate the negative current output from the L3610 chassis ground.

6. Ground Continuity and Probe Checks (Refer to Figure 4-2 below):

a) **Ground Continuity Check:** With unit power off, using an ohmmeter on the lowest range, measuring between any of the following points should yield less than one ohm:

1) Point A (posts) to point B (electronic housing).

2) Point B to point C (probe hub, threads).

3) Point C to point D (except in non-metallic tank).

4) When electronic chassis is installed in housing, the chassis should have continuity to points A, B, & C through the two 8-32 retaining screws which fasten it to posts (A).

b) **Breached Probe Check:** Conductive liquids only with **bare ground reference** contacting process:

1) Remove power and remove the electronic unit from the probe, either by screwing the electronic housing off of the probe, or by removing the two 8-32 screws and lifting the electronic chassis out of the housing.

2) Raise conductive liquid to highest point on probe.

3) Using an ohmmeter on its highest range (20 megohms), connect meter probes to spring-loaded pin (point E) and hub of probe (point C), respectively.

4) An over-range meter indication indicates the probe sheathing is good. A resistance reading (for example, 1.25 megohms) can mean that sheathing is breached, or there is a short in the probe hub, or moisture in the bottom of the housing.

c) **Breached Probe Check:** Conductive liquids only with **insulated ground reference** - L128 & L116 probes, lined tank, etc:

1) Remove power and remove the electronic unit from the probe, either by screwing the electronic housing off of the probe, or by removing the two 8-32 screws and lifting the electronic chassis out of the housing.

2) Raise conductive liquid to highest point on probe.

3) Insert a bare metal wire or rod into the process material, depth of insertion not important.

4) Using an ohmmeter on its highest range (20 megohms), connect meter probes to spring-loaded pin (point E) and the metal wire or rod, respectively.

5) An over-range meter indication indicates the probe sheathing is good. A resistance reading (for example, 1.25 megohms) can mean that sheathing is breached, or there is a short in the probe hub, or moisture in the bottom of the housing.

6) Repeat steps 3 & 4, this time with meter probes between the hub of the probe (point C) and the metal wire or rod.

d) Probe Response Check: If the L3610 output signal readings are erratic or non-linear, and if there is no indication of a poor ground or a breach in the Probe per a, b and c above, the below check can be performed to help isolate the problem.

1) Remove power and remove the electronic unit from the probe, either by screwing the electronic housing off of the probe, or by removing the two 8-32 screws and lifting the electronic chassis out of the housing.

2) Connect a hand-held capacitance meter between points E (spring-loaded pin) and C (probe ground) per Figure 4-2. Capacitance readings should be stable. Changes in capacitance should be linear and directly proportional to changes in level. The approximate capacitance span for a given application may be obtained by consulting the factory.

3) If the readings are not stable and linear, the problem is coming from the probe or is associated with the process material or the tank configuration, piping, etc. If the readings are stable and linear, the problem is in the electronic chassis, wiring, readout device, etc. (Be sure to isolate the electronic chassis from all other devices before assuming that the problem is in the chassis.)

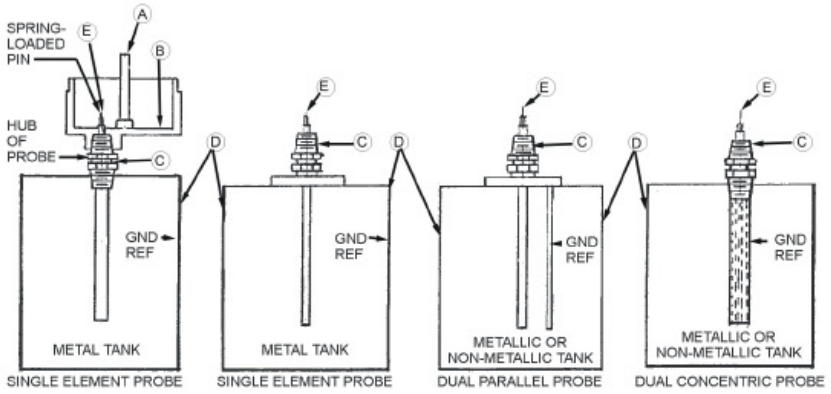


Figure 4-2
Ground Continuity and Probe Checks

F. Field Resetting of Measurement Range, Cancellation and Output Modes

Princo Models L3610 and L3610R are shipped from the factory pre-set on the correct measurement range and correct coating cancellation mode, based on the application data furnished to Princo by the customer at the time of purchase. Occasionally there is need to change these settings in the field. Switching an electronic controller to a probe of a different length or to a process material with a different dielectric constant or conductivity are examples of changes that may require resetting the unit. Consult the factory with the new application data before proceeding with any changes.

Refer to Figure 4-3 for the location of switches and jumpers. A 3-position, rotary range switch is located on the middle circuit board. Range 1 has the highest gain and is therefore used for the lowest capacitance ranges. Gain is successively higher for ranges 2 and 3. Do not reset unless need has been clearly determined.

A and B Mode jumpers, J5 and J6, are located on the "vertical" board. Each jumper connects has 3 connector pins. The jumper connects the center pin to either the A mode or B mode pin per Figure 4-3. A mode is for non-conductive process materials; B mode is for conductive processes.

After resetting the range switch and A and B mode jumpers, it will be necessary to reset the B DIAGNOSTIC light adjustment as follows. With power to the unit and the probe NOT contacting the electronic unit, adjust potentiometer R86 on the top board such that the B DIAGNOSTIC LED just turns on (red). Contact with the probe should now turn the LED off.

The two "output selector switches" determine whether the current output is scaled 4 to 20 mA or 20 to 4 mA relative to 0 to 100% of level span. In most cases the 4 mA point is at the low end of the scale, and the current output rises as level rises. For this use, both switches are in the up (away from the terminal block) position. To reverse the output, move both switches down (toward the terminal block).

After any of the above changes, full re-calibration of the unit is required per Section 4.D.

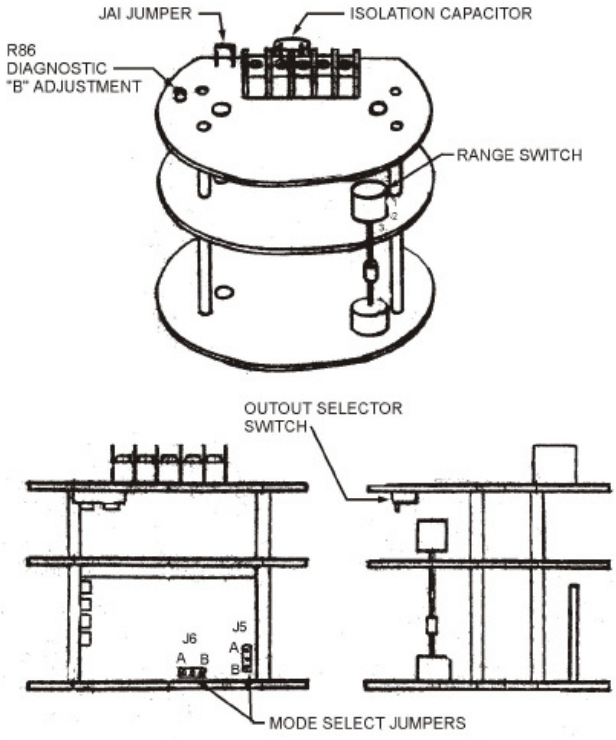


Figure 4-3
Ground Isolation and Switch Locations

Section Five
Equipment Service

A. Getting Help

If your Princo equipment is not functioning properly, and attempts to solve the problem have failed, contact the closest Princo sales representative in your area, or call the factory direct and ask for service assistance. The factory telephone number is 1-800-221-9237.

To assist us in providing an efficient solution to the particular problem, please have the following information available when you call:

1. Instrument Model Number
2. Probe Model Number
3. Purchase Order Number
4. Date of Purchase Order
5. Process Material Being Monitored
6. Detailed Description of the Problem

If your equipment problem cannot be resolved over the phone, then it may be necessary to return the equipment for checkout/repair.

Do not return equipment without first contacting the factory for a Return Material Authorization number (RMA #).

Any equipment which is returned, MUST include the following information in addition to the list above.

7. RMA Number
8. Person to contact at your Company
9. Return (Ship to) Address

Princo level instruments are covered by a 10-year limited warranty. You will not be charged if it is determined that the problem is covered under warranty. Please return your equipment with freight charges prepaid. If repair is covered under warranty, Princo will pay return freight charges.

If telephone assistance or equipment return is not a practical solution to the problem, then it may be necessary for field assistance. Trained field servicemen are available from the factory on a time/expense basis to assist in these instances.

B. Warranty Statement

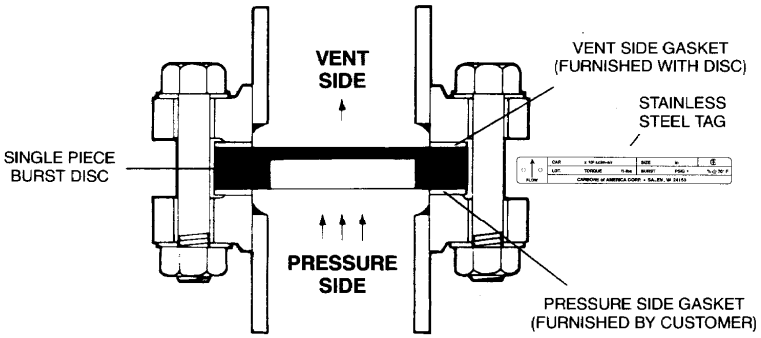
All Princo level control instruments are backed by a 10-year warranty. Princo will repair or replace, at our option, any instrument that fails under normal use for up to 10 years after purchase.

GRAPHILOR®

CARBONE OF AMERICA

SINGLE PIECE DISC INSTRUCTIONS
(SERIES 3)

TYPICAL INSTALLATION



IMPORTANT NOTES:

1. All Graphilor® single piece burst discs have a stainless steel label, as shown below, affixed to the outer circumference.

○ ↑ ○ FLOW	CAP.	x 10^3 scfm-air		SIZE	in.	Ⓒ
	LOT.	TORQUE	ft-lbs	BURST	PSIG ±	% @ 70° F
	CARBONE of AMERICA CORP. • SALEM, VA 24153					

   Make sure the disc information agrees with the intended application.

2. Discs are designed to fit within the bolt circle of 150# or 300# ANSI flanges. Make sure disc is properly centered between flanges during installation.

3. It is important to install the disc in the correct flow direction. This is noted by an arrow on the label.

4. Flange faces should be parallel to each other in order to eliminate excessive bolting forces when installing disc.

5. The vent side gasket is furnished with the disc because the gasket material and inside diameter are critical to the burst disc accuracy.

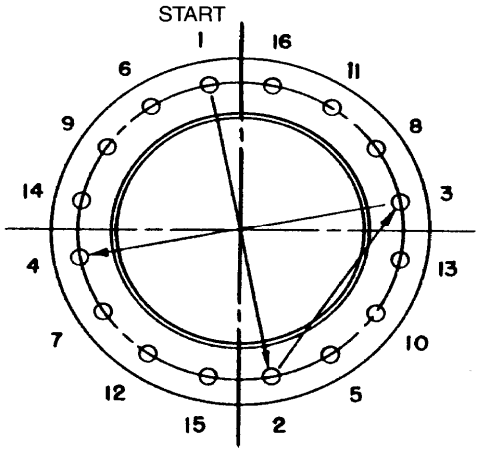
6. The process (or pressure) side gasket, furnished by customer, must be compatible with the process fluid and therefore the preferred type is a standard 150# ANSI TFE envelope gasket with a soft ⅛" thick filler. Do not us a gasket having a metal insert.

7. Burst pressure shown on label has been established at ambient temperature. Elevated temperatures may cause a reduction in the actual burst pressure of the disc.

INSTALLATION INSTRUCTIONS

RECOMMENDED BOLT TIGHTENING PROCEDURE

Tighten flange bolts using a diagonal pattern gradually increasing the torque to the value indicated on the disc label or the chart shown to the right. Torque values are based upon ANSI standards for size and number of bolts and the use of clean, lubricated nut and bolt threads. The gasket used for these torque loadings has a 4400 "Y" value or minimum design seating stress.

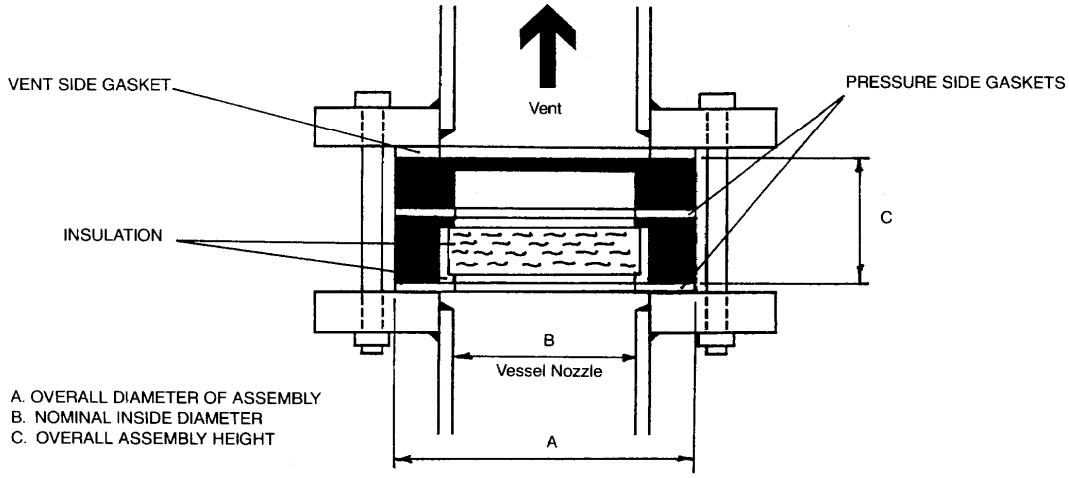


DISC SIZE (INCHES)	TORQUE (FT./LBS.)
For 150# ANSI Flanges	
1	10
1.5	15
2	25
2.5	30
3	30
4	35
6	45
8	65
10	55
12	70
14	100
16	80
18	100
20	80
24	120
For 300# ANSI Flanges	
1	20
1.5	40
2	20
3	40
4	60
6	60
8	100

Improper installation can cause discs to break outside of specified burst pressure. Potential causes are:

- Misaligned flanges
- Excessive or uneven bolt torque
- Improper centering of disc
- Incorrect vent side gasket material or dimensions
- Discs with cracks or surface imperfections due to mishandling

HIGH TEMPERATURE ASSEMBLY FOR SERIES 3 DISC



HIGH TEMPERATURES:
For applications where disc exposure is in excess of 300°F the use of an insulating spacer is recommended. Special high temperature resins and spacers are available for operating temperatures from 300°F to 700°F.

MONOLITHIC DISC HIGH TEMPERATURE ASSEMBLY FOR 150 # ANSI FLANGES			
NOMINAL PIPE SIZE	DIMENSIONS IN INCHES		
	A	B	C
1	2½	1	2¼
1½	3¼	1½	2¼
2	4	2	2¼
3	5¼	3	2½
4	6¾	4	2½
6	8⅝	6	2¾
8	10⅞	8	3
10	13¼	10	3⅜
12	16	12	4⅛
14	17⅜	13¼	4⅞
16	20⅛	15¼	5⅛
18	21½	17¼	5⅞
20	23¾	19¼	6⅛
24	28⅛	23¼	6⅝

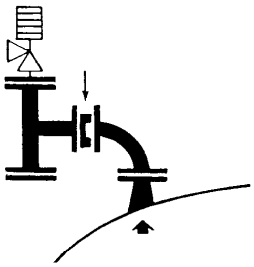
PRECAUTION & WARRANTY

GROUPE
CARBONE LORRAINE

PRECAUTION

Upon rupture, fragments of the graphite burst disc are propelled into vent line; toxic or flammable materials may be vented; blow-down may be at very high velocity; discharge from the vent opening can be hazardous. Safety provisions should be undertaken to prevent possible damage to plant equipment and injury to operating personnel.

Graphite particles generated by ruptured discs can be trapped by utilization of screens and or diversion traps as shown below. See disc installation instructions which accompany all disc shipments or contact Carbone's Engineering Department for further details.

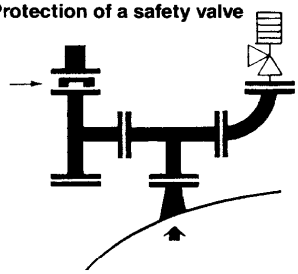


In series

The effective burst pressure of the disc should be more than the opening pressure set for the valve.

The safety valve would operate after the bursting of the safety disc.

Protection of a safety valve

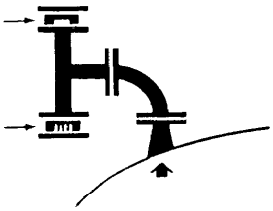


In parallel

The effective burst pressure of the disc should be higher than the opening pressure of the valve.

The safety disc operates only when the safety valve fails.

Protection against overpressure and negative pressure



The upper disc insures the protection against over-pressure.

The lower disc insures the protection against negative pressure.

WARRANTY

Carbone of America Corp. warrants its products to be free of any defects in material or workmanship for a period of 12 months from date of installation or 18 months from shipment, whichever comes first.

However, Carbone of America Corp. shall have no liability whatsoever for units which fail due to mechanical damage, misuse or abuse. Except for this warranty, Carbone of America Corp. makes no warranty, expressed or implied, and expressly excludes any warranty of application or fitness for a particular service. Carbone's maximum liability hereunder shall be limited to the repair or replacement of any defective product, if appropriate. Carbone of America Corp. shall, under no circumstances, be liable for any incidental, consequential, or other damages, including but not limited to, loss of business or profits, based on any alleged negligence, breach of warranty, strict liability or other theory, arising out of the use or handling of these products.

CARBONE OF AMERICA CORP.
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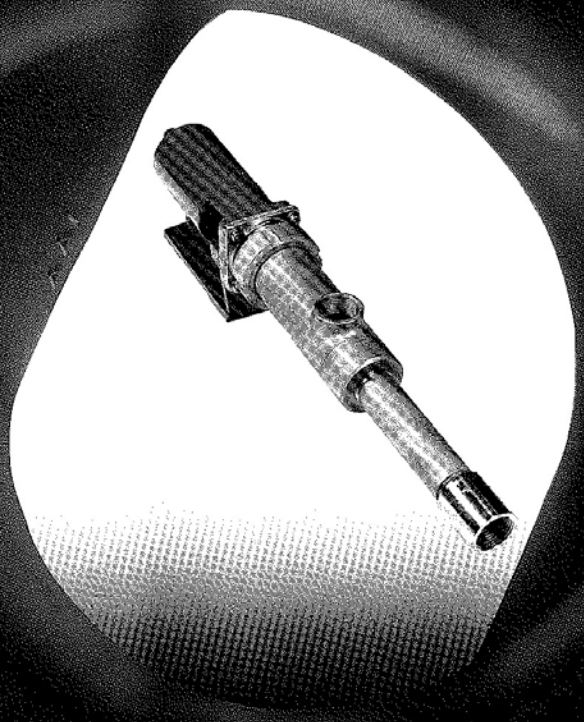
Netzsch Pump

NEMO®
Progressing Cavity Pump
3 NE & 4 NE Series

Applications: NEMO 3 NE and 4 NE Series progressing cavity pumps have the same rugged and versatile design as larger NE pumps. They are ideally suited for metering a wide range of materials, and pumping low volumes of shear sensitive and high viscosity/high solids content materials, sludges, heavy pastes and abrasives.

3 NE and 4 NE pumps deliver between 0 and 10 ltrs./min. depending on speed and have a temperature range of -40° to 160°C. They offer high wear resistance and long service life.

NEMO 3 NE and 4 NE progressing cavity pumps are designed for a wide range of laboratory and industrial applications.



NETZSCH INCORPORATED
NEMO® PUMP DIVISION
119 Pickering Way
Exton, PA 19341-1393
Phone: 610-363-8010
Fax: 610-363-0971

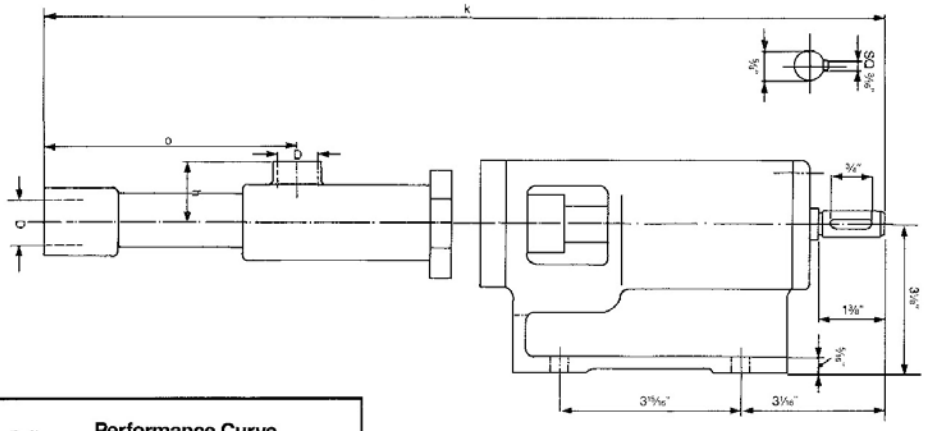
DATA SHEET

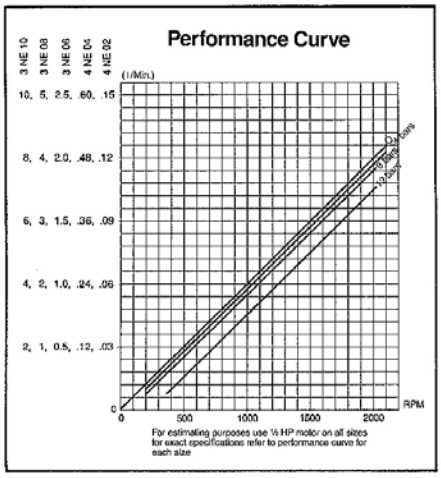
Capacities:
Capacities indicated in the graph are for materials of water-like viscosities. For materials of higher viscosity or those with abrasive characteristics, the pumps should be operated at a slower speed.

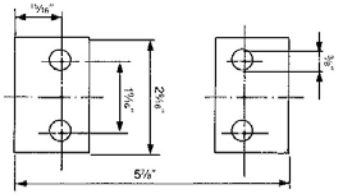
The composite curve shown is intended only as a guide. For exact sizing, horsepower requirements and corresponding RPM, consult your NEMO representative.

Options:
- Bare pump or complete unit
- Choice of rotational direction
- Horizontal or vertical mounting
- Direct connection or Vee-belts and pulleys
- Virtually any choice of drives: induction motors, mechanical variable speed drives, hydraulic drives, DC-SCR drives, inverters and internal combustion engines
- Heating or cooling jackets for the suction housing and stator
- Bypass arrangements
- Portable baseplates
- Packed stuffing box or mechanical seal

Standard Materials of Construction:
- **Suction Housing:**
  #316 stainless steel, Hastelloy
- **Rotating Parts:**
  Mild steel, #316 stainless steel, Hastelloy
- **Rotor:**
  Hardened steel, #316 stainless steel, Hastelloy
- **Stator:**
  More than 7 different materials are available for stators, the most common choice being an elastomer of either a natural or synthetic rubber. NEMO 3 NE and 4 NE Series pumps can be furnished with a wide range of elastomers of various durometer hardnesses, chemical resistances and temperature capabilities. This feature allows a pump to be adapted to your specific application requirements. Consult your NEMO representative for the stator best suited to your application.







PUMP SIZE	k	o	h	D
4 NE 02	15 13/16	3 5/16	1 5/16	NPT 3/8" Internal thread
4 NE 04	17 1/16	4 3/16	1 5/16	NPT 1/2" Internal thread
3 NE 06	17 7/8	5 3/8	1 5/16	NPT 1/2" Internal thread
3 NE 08	20 5/16	7 1/16	1 7/16	NPT 3/4" Internal thread
3 NE 10	22 11/16	8 3/4	1 9/16	NPT 1" Internal thread

Dimensions are subject to change without notice

Bulletin No. 300/52/9/95

NETZSCH INCORPORATED
NEMO® PROGRESSING CAVITY PUMP DIVISION

TYPICAL SPECIFICATIONS FOR NETZSCH NEMO® WASTE TREATMENT PUMPS

Sludge Pumps shall be progressing cavity Moineau principle type.

The pump housing, supports, and packing glands shall be cast iron. The pump shall be provided with braided endless aramid fiber packing, and have fully sealed bearings. Suction and discharge connections shall be ANSI/B16.1 flanges.

The rotor shall be precision machined from tool steel with a chromium content of 11-13.5% hardened to Rockwell C57-60, and then covered with heavy layers of hard chrome plate. The rotor shall be driven by means of a heavy duty sealed drive train. The rotor shall be joined to the drive shaft by means of connecting rod with a crown gear type universal joint at each end. The gear joints shall be factory lubricated and completely sealed from the abrasive fluid being pumped. To optimize seal and gear joint life, the connecting rod shall be of sufficient length to maintain its operating angle within 1°

The drive shaft shall be solid in order to avoid clogging and/or trapping of solids, which could either interrupt the movement of the connecting rod or disturb the seal of the rear gear joint. Maximum shaft deflection under normal operating conditions shall not exceed .002".

The drive shaft shall be mounted in two (2) ball bearings or a set of roller bearings adequate to handle the radial and thrust forces, with a minimum B-10 life of 100,000 hours.

The pump shall be designed to permit the suction port to be rotated in 90° increments. Two (2) inspection ports located 180° apart shall be provided in the suction casting.

The stator shall be formed from Buna-N rubber and affixed to the suction casting by means of four (4) thru-bolts for easy removal and replacement.

The pump and driver shall be mounted on a common fabricated steel baseplate, complete with an OSHA guard.

The pumps shall be NEMO® series NE as manufactured by Netzsch Incorporated, Exton, Pennsylvania.

The pump shall be driven through V-belts and pulleys, or a direct-connected variable speed drive or gear reducer as listed in the pump schedule. If V-belts and pulleys are used, they shall have a means of adjustment and shall not have more than a 4:1 ratio of reduction.

The pump system shall be tested on water at the pump manufacturer's facility. The pump shall be tested as a complete unit, with the drive that is being provided, to assure that the system will perform as specified. Customer or customer's representative may witness the pump test.

119 PICKERING WAY, EXTON, PA 19341-1393 • (610) 363-8010 • FAX (610) 363-0971

NETZSCH INCORPORATED

NEMO® PROGRESSING CAVITY PUMP DIVISION

TYPICAL SPECIFICATIONS FOR NETZSCH NEMO POLYMER PUMPS

Polymer Pumps shall be progressing cavity Moineau principle type.

The pump housing, supports, and packing glands shall be 316 stainless steel. The pump shall be provided with graphite asbestos impregnated packing and with fully sealed bearings. Suction and discharge connections shall be 150 pound raised faced 316 stainless steel flanges.

Flow shall be _____ with a rated discharge pressure of _____ PSI. Polymer material at a viscosity of _____ CPS. Pump speed shall not exceed _____ RPM.

The rotor shall be precision machined from 316 stainless steel. The rotor shall be driven by means of a heavy duty sealed drive train. The rotor shall be joined to the drive shaft by means of connecting rod with pin type universal joints. (Flexible shafts will not be accepted.) To optimize seal and joint life, the connecting rod shall be of sufficient length to maintain its operating angle within 1°.

The drive shaft shall be solid 316 stainless steel chromeplated through the packing area. (Hollow drive shaft that would tend to shear the polymer will not be accepted.)

The drive shaft shall be mounted in two (2) ball bearings adequate to handle the radial and thrust forces for a B-10 life of 100,000 hours.

The pump shall be designed to permit the suction port to be rotated in 90° increments.

The stator shall be formed from a pure Viton compound (or Buna-N depending on the polymer). The stator shall be affixed to the suction casting by means of four (4) thru bolts for easy removal and replacment. (Clamp stators will not be accepted.)

The pump and drive shall be mounted on a common fabricated steel baseplate.

The pumps shall be NEMO as manufactured by Netzsch Incorporated, Lionville, Pennsylvania.

The pump shall be driven through V-belts and pulleys, or direct-connected variable speed drive as listed in the pump schedule. If V-belts and pulleys are used, they shall have a means of adjustment and shall not have more than a 4:1 ratio of reduction.

Recommended Spare - 1 stator 1 set of packing (per pump)

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NETZSCH
Incorporated U.S. Manufacturer of Industrial Equipment 119 Pickering Way Exton, PA 19341-1393 Phone: 610.363.8010 Fax: 610.363.0971

NETZSCH Progressing Cavity

NETZSCH NEMO® PROGRESSING CAVITY PUMPS
Model Designation: NE Series

NE Series: Basic model with flanged connections and solid drive shaft

A. Usage: Industrial and municipal

B. Model Availability:
   1. Model NE .. A
      a. Joint type: pin, single-seal gear, or double-seal gear
      b. One and two stage: drive end rated at 180 psi
      c. Four stage: drive end rated at 350 psi
      d. Low angularity of connecting rod (approx. 1°)
      e. Thru-bolt construction for ease of stator removal
   2. Model NE .. B
      a. Joint type: pin only (exception: sizes 120 through 200)
      b. One stage only
      c. Drive end rated at 90 psi
      d. Low angularity of connecting rod (approx. 1°)
      e. Thru-bolt construction for ease of stator removal

C. Stage Availability:
   1. Single stage: sizes 15 through 200
   2. Two stage: sizes 15 through 150
   3. Four stage: sizes 15 through 120
   4. Other: consult factory

D. Pin Joint Availability:
   1. Model NE .. A sizes 06 through two stage 90
   2. Model NE .. B sizes 20 through 100 (single stage only)

E. Single Seal Gear Joint Availability:
   1. Model NE .. A sizes four stage 30 through two stage 100

F. Double Seal Gear Joint Availability:
   1. Model NE .. A size four stage 30 through four stage 120 and two stage 150
   2. Model NE .. B sizes 120 through 200

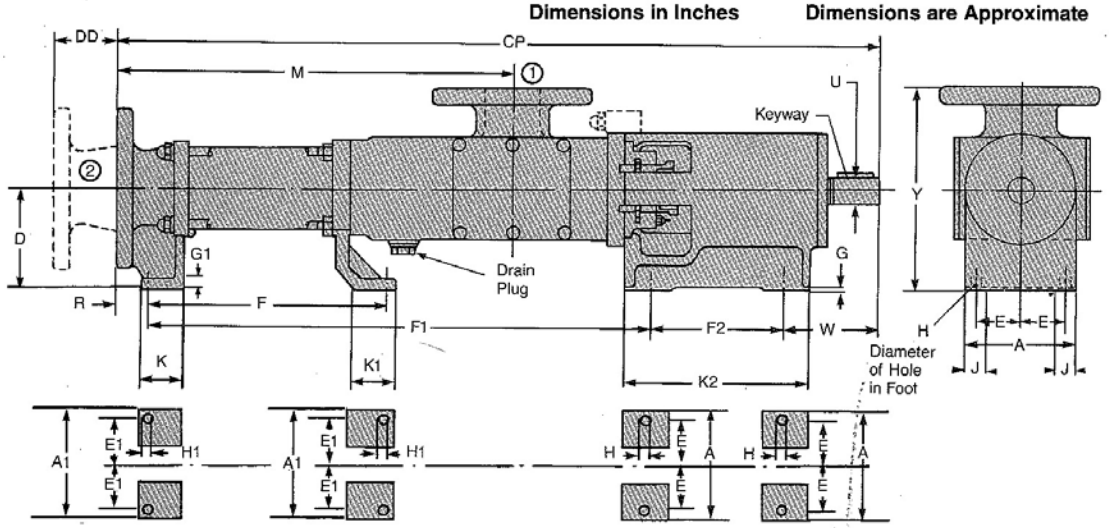
G. Materials of construction:
   1. Stator: over 20 elastomers and rigid materials
   2. Wetted parts: most machinable alloys (linings also available)

H. Reverse Flow Capabilities:
   1. Pin joint: 75 psi (limitation of standard stuffing box)
   2. Single seal gear joint: 25 psi
   3. Double seal gear joint: 50 psi
   4. Consult factory for special applications

300/27/0795

NE...A

Dimensions in Inches **Dimensions are Approximate**



PUMP SIZE	DD	CP	A A1	D	E E1	F	F1	F2	G G1	H H1	J	K	K1	K2	M	R	U	W	Y	DRAIN PLUG	KEYWAY	SUCTION AND DISCHARGE
NE15A	6	20 3/4	2 9/16	3 1/8	3/4	—	13 1/4	3 15/16	5/16	3/8	—	1 1/4	—	5 15/16	10 1/2	1/2	5/8	3 1/16	4 15/16	NPT 1/4	3/16 x 3/32	NPT 3/4 INTERNAL THREAD
2NE15A	9	23 7/8				—	16 7/16								13 11/16							
4NE15A	16	32 5/8				12 1/2	25 3/16						1 1/4	5 7/8	21 5/8				5 1/2			
NE20A	8	24 3/16				—	16 1/2					1 3/16	—	5 15/16	13 1/8	1 1/16			5 7/8			NPT 1 1/4 INTERNAL THREAD
2NE20A	13	28 1/8				—	20 7/16								17 1/16							
4NE20A	22	42 3/16	A 4 5/16 A1 2 9/16	3 9/16	E 1 3/4 E1 1 3/16	15 3/4	33 1/4	4 15/16	G 3/8 G1 5/16	H 7/16 H1 3/8	1 3/16	1 3/16	1 3/16	6 1/2	28 3/4		1 5/16	3 3/8	6 1/8		1/4 x 1/8	
NE30A	10	33 7/8	4 5/16		1 3/4	—	23 3/16		3/8			1 1/16	—		19 1/8	2 1/16			7 15/16	NPT 1/2		2"
2NE30A	17	39 3/4				14	29 7/16						1 9/16		25 1/16							
4NE30A	30	58 1/4	4 15/16	3 15/16	2 1/16	23 9/16	46 7/8	5 1/2	1/2	7/16	1 5/16	2	1 3/4	7 11/16	41 7/8	2	1 1/8	4	9 1/16			2 1/2"
NE40A	14	42 1/2				—	31					1 3/4	—		25 11/16							
2NE40A	22	50 3/8				18 1/8	38 7/8						1 3/4		33 9/16							
4NE40A	39	73 1/16	6 5/16	4 15/16	2 1/16	31 1/2	60 7/16	5 11/16	5/8	9/16	1 3/4	1 7/8	2	8 7/16	54 1/8	2 1/4	1 5/16	5 3/16	10 13/16	NPT 3/4	5/16 x 5/32	3"
NE50A	16	52 11/16				—	39 11/16		9/16			2	—		33 13/16	2 1/8			10 11/16			
2NE50A	27	62 1/8				22	49 1/8						2		43 1/4							
4NE50A	49	85 13/16	6 11/16		2 1/16	38	71 5/8	6 1/8	5/8			2 3/16		8 7/8	65	2 7/8	1 7/16		11 5/8		3/8 x 3/16	4"
NE60A	18	58 11/16				—	45 11/16		9/16			1 11/16	—		38 11/16	1 5/8			11 1/2			
2NE60A	30	70 1/2				26 9/16	57 1/2						1 7/8		50 1/2							
4NE60A	56	108 1/16	7 1/2	5 1/2	3 1/16	47 5/8	90 15/16	8 1/4	5/8	1 1/16	2	2 1/4	2 3/16	11 7/16	81 7/8	2 3/16	1 7/8	6 5/8	13	NPT 3/4	1/2 x 1/4	4"
NE70A	20	67 9/16	6 11/16	4 15/16	2 1/16	—	54 3/8	6 1/8	9/16	9/16	1 3/4	1 11/16	—	8 7/8	47 9/16	1 5/8	1 7/16	5 3/16	11 1/2		3/8 x 3/16	
2NE70A	36	87				43 1/8	74						1 7/8		67							
NE80A	22	77	7 1/2	5 1/2	3 1/16	—	60 1/16	8 1/4	9/16	1 1/16	2	2 3/8	—	11 7/16	52 3/4	2	1 7/8	6 5/8	13 1/8		1/2 x 1/4	6"
2NE80A	39	92 11/16				35 13/16	75 13/16						2 9/16		68 1/2							
4NE80A	74	140 9/16	9 13/16	7 7/8	4 1/16	63 3/4	117 5/16	11 13/16	1 3/16	7/8	2 9/16	3 9/16	3 9/16	14 15/16	110 1/4	3 1/8	2 3/8	8 5/16	16 1/16	NPT 1	3/8 x 1/16	6 ① 125# ② 250#
NE90A	25	81 1/4	7 7/16	5 1/2	3 1/16	—	64 7/16	8 1/4	9/16	1 1/16	2	2 3/8	—	11 7/16	57 1/8	2	1 7/8	6 5/8	13 1/8	NPT 3/4	1/2 x 1/4	6"
2NE90A	45	101				44 1/8	84 1/16						2 9/16		76 3/4							
NE100A	28	96 7/8	9 7/8	7 7/8	4 1/16	—	74 3/16	11 13/16	1 3/16	1 3/16	2 9/16	3 9/16	—	14 15/16	66 1/2	2 9/16	2 3/8	8 5/16	16 1/16	NPT 1	5/8 x 5/16	6"
2NE100A	50	116 9/16				44 1/16	93 7/8						3 9/16		86 9/16							
4NE100A	85	171 5/16	13	9 7/8	5 1/8	85 5/8	143 1/16	13	1	1 5/16	3 5/8	3 15/16	3 15/16	18 1/2	131 1/16	4 13/16	2 7/8	9 13/16	20 1/4	NPT 1	3/4 x 3/8	8 ① 125# ② 250#
NE120A	38	114 3/16				—	88 9/16			1 1/4		—			74 1/2	2 3/4						8"
2NE120A	64	137 13/16				54 1/8	112 3/16								98 1/8							
4NE120A	108	196 3/16				93 9/16	162	15 3/4		1 5/16	—	3 15/16	3 15/16	21 7/16	149 5/8	4 5/16	4 3/4	14 1/16	19 11/16		1 1/4 x 5/8	10 ① 125# ② 250#
NE150A	44	129 3/4				—	97 1/4						—		83 1/4	2 11/16						10"
2NE150A	76	159 5/16				65 15/16	126 3/4						5 1/2		112 3/4							

*Denotes 125# ANSI Flange DD—Disassembly Dimension

Dimensions are subject to change without notice

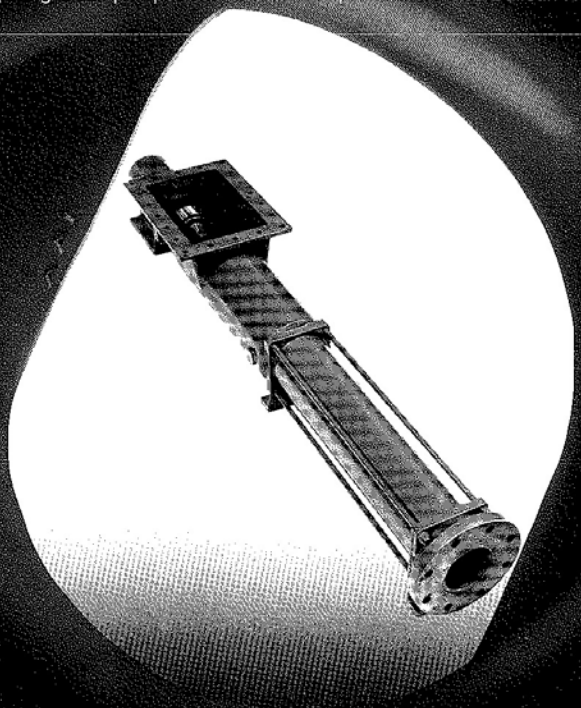
NETZSCH INCORPORATED
NEMO® PUMP DIVISION
119 Pickering Way
Exton, PA 19341-1393
Phone: 610-363-8010
Fax: 610-363-0971

NEMO®
Progressing Cavity Pump
NES Series

Applications: NEMO NES Series progressing cavity pumps are the type of equipment needed when pumping media of heavy solid concentrations, high viscosities or materials that have virtually no flow characteristics. NES and NESP* Series pumps have open throat suction and auger feed to the rotor-stator elements.

Typical materials requiring these pumps are: vacuum filter cake, centrifuge discharge, dry fruit mash, spent grain, wood pulp, tobacco slurries, meat emulsions, calcium carbonate, heavy greases and grout.

*NESP pumps feature a mixing device for materials that do not remain in suspension or a breaking device for materials that tend to bridge in the open-throat. See Bulletin No. 300/48



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DATA SHEET

Capacities:
Capacities indicated in the diagram are for materials of water-like viscosities. For materials of higher viscosity or those with abrasive characteristics, the pump should be operated at a slower speed. Applications with abrasion should not use the full design pressure capability of the pump staging.

The composite curve shown is intended only as a guide. For exact sizing, staging, horsepower requirements and corresponding RPM, consult your NEMO representative. He will provide you with an actual performance curve of the proper pump size needed for your application.

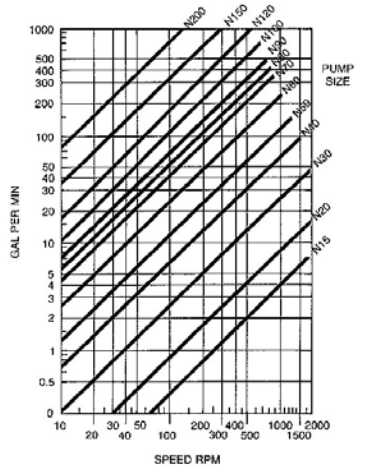
Options:
- Bare pump or complete unit
- Direct connection or Vee-belts and pulleys
- Virtually any choice of drives: induction motors, mechanical variable speed drives, hydraulic drives, DC-SCR drives, inverters and internal combustion engines.
- Heating or cooling jackets for stator
- Bypass arrangements
- Portable baseplates
- Packed stuffing box or mechanical seal

Standard Materials of Construction:

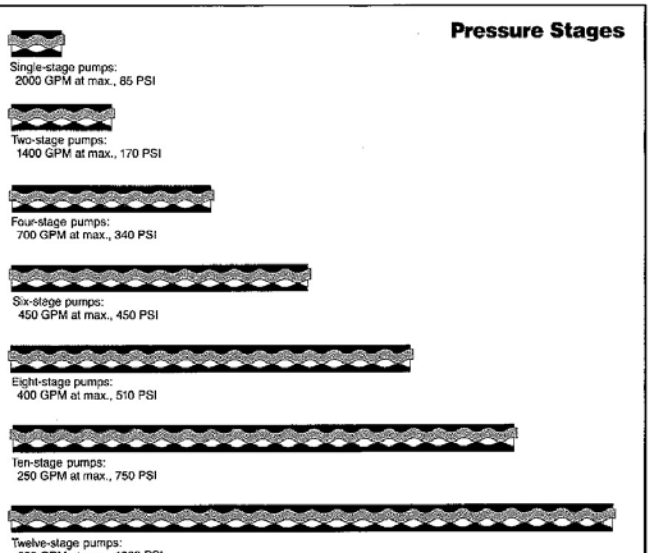
- **Suction Housing:**
  Cast iron
  Cast iron, rubber coated
  #304 Stainless steel
  #316 Stainless steel
  Also available in:
  Monel
  Carpenter 20
  Hastelloy
- **Rotating Parts:**
  Mild steel
  Tool steel
  #304 Stainless steel
  #316 Stainless steel
  Also available in:
  Monel
  Carpenter 20
  Hastelloy
- **Rotor:**
  Mild steel
  Tool steel
  #304 Stainless steel
  #316 Stainless steel
  Also available in:
  Monel
  Carpenter 20
  Hastelloy

  Chrome plating available
  Also available in various plastic materials
- **Stator:**
  More than 20 different materials are available for stators, the most common choice being an elastomer of either a natural or synthetic rubber. NEMO NES Series pumps can be furnished with a wide range of elastomers of various durometer hardnesses, chemical resistances and temperature capabilities. This feature allows a pump to be adapted to your specific application requirements. If an elastomer is not the best choice for a stator material, Netzsch can offer tool steel, stainless steel or a variety of rigid plastics. Consult your NEMO representative for the stator best suited to your application.
- **Joints:**
  Most models available with either pin type universal joints, or our exclusive double sealed gear joint.

Performance Curve



Pressure Stages



Bulletin No. 300/21/12/95

NETZSCH
Incorporated U.S. Manufacturer of Industrial Equipment 119 Pickering Way Exton, PA 19341-1393 Phone: 610.363.8010 Fax: 610.363.0971

NETZSCH Progressing Cavity

NETZSCH NEMO® PROGRESSING CAVITY PUMPS
Model Designation: NES Series

NES Series: Open throat pump with auger feed and solid drive shaft

A. Usage: Industrial and municipal

B. Model Availability:
   1. Model NES .. A
      a. Joint type: pin or double seal gear
      b. Low angularity of connecting rod (approx. 1°)
      c. Thru-bolt construction for ease of stator removal
      d. Auger type connecting rod
      e. Void area for positive element feed
      f. NE series can be field-converted by substitution of connecting rod and suction housing

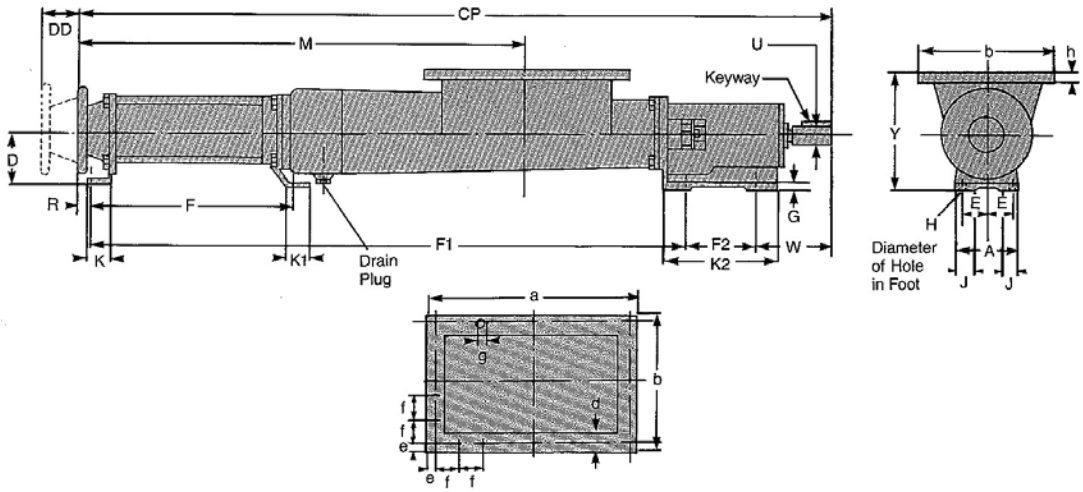
C. Stage Availability:
   1. Single stage: sizes 15 through 200
   2. Two stage: sizes 15 through 150
   3. Four stage: sizes 15 through 120
   4. Six stage: sizes 15 through 100
   5. Eight stage: sizes 15 through 100
   6. Ten stage: sizes 15 through 80
   7. Twelve stage: sizes 15 through 80

D. Materials of Construction:
   1. Stator: over 20 elastomer and rigid materials
   2. Wetted parts: most machinable alloys (linings also available)

300/28/0795

NES...A

Dimensions are Approximate **Dimensions in Inches**



PUMP SIZE	DD	CP	A	D	E	F	F1	F2	G	H	J	K	K1	K2	M	R	U	W	Y	DRAIN PLUG	KEYWAY	DISCHARGE
NES15A	6	20¾	2⁹⁄₁₆	3⅛	¾	—	13¼	3¹⁵⁄₁₆	5⁄₁₆	5⁄₁₆	1	1¼	1⅜	5¹³⁄₁₆	9⁵⁄₁₆	½	⅝	3¹⁄₁₆	7	NPT ¼	³⁄₁₆ x ³⁄₃₂	NPT ¾"*
2NES15A	9	23⅞					16⁷⁄₁₆								12⁷⁄₁₆							
NES20A	8	24¹³⁄₁₆		3¾₆			16½					1³⁄₁₆			10⁹⁄₁₆	1¹⁄₁₆			7½			NPT 1¼"*
2NES20A	13	28⅞				9¾	20⁷⁄₁₆								14⅛							
NES30A	10	33⅞	4¹⁵⁄₁₆		1¾	8¹⁄₁₆	23⁹⁄₁₆	4¹⁵⁄₁₆	⅜	½	1³⁄₁₆	1⁹⁄₁₆	1⁹⁄₁₆	6½	20	2¹⁄₁₆	1⁵⁄₁₆	⅜	7¹⁄₁₆	NPT ½	¼ x ⅛	2"
2NES30A	17	39¾				14	29⁷⁄₁₆								25¹⁵⁄₁₆							
NES40A	14	42½		3¹⁵⁄₁₆	2¹⁄₁₆	10¼	31	5½	⅞		1³⁄₁₆	1¾	1¾	7¹¹⁄₁₆	25⅜	2	1⅛	4	7⅞			2½"
2NES40A	22	50⅜				18⅛	38⅞								33¼							
NES50A	16	52¹¹⁄₁₆	6⁵⁄₁₆	4¹⁵⁄₁₆	2⁷⁄₁₆	12⅝	39¹¹⁄₁₆	5¹¹⁄₁₆	9⁄₁₆	9⁄₁₆	1¾	2	2	8⁷⁄₁₆	31⁵⁄₁₆	2⅛	1⁵⁄₁₆	5³⁄₁₆	9¹³⁄₁₆	NPT ¾	⁵⁄₁₆ x ⁵⁄₃₂	3"
2NES50A	27	62⅛				22¹⁄₁₆	49⅛								40¾							
NES60A	18	58¹¹⁄₁₆	6¹¹⁄₁₆		2¹¹⁄₁₆	14¾	45¹¹⁄₁₆	6⅛				1¹¹⁄₁₆	1¾	8⅞	36¹³⁄₁₆	1⅝	1⁷⁄₁₆		10⁷⁄₁₆		⅜ x ³⁄₁₆	4"
2NES60A	30	70½				26⅝	57½								48⅝							
NES70A	20	67⅝				—	54⅜						—		47⅝							
2NES70A	36	87				43⅛	74						1¾		67							
NES80A	22	77	7⁵⁄₁₆	5½	3¹⁄₁₆	20¹⁄₁₆	60¹⁄₁₆	8¼		1¹⁄₁₆	2	2⅜	2⅜	11⁷⁄₁₆	48¹⁄₁₆	2	1⅞	6⅝	12⁹⁄₁₆		½ x ⅛	6"
2NES80A	39	92¾				35¹³⁄₁₆	75¹³⁄₁₆						—		63¾							
NES90A	25	81¼				—	64⁷⁄₁₆						2½		57⅛							
2NES90A	45	101				44⅛	84¹⁄₁₆								76¾							
NES100A	28	96⅞	9¹³⁄₁₆	7⅛	4¹⁄₁₆	25	74³⁄₁₆	11¹³⁄₁₆	1³⁄₁₆	1⁵⁄₁₆	2⁹⁄₁₆	3⁹⁄₁₆	3⁹⁄₁₆	15	57½	2⁹⁄₁₆	2⅜	8⅝	15¾	NPT 1	⅝ x ⅝	6"
2NES100A	50	116⁹⁄₁₆				44¹¹⁄₁₆	93⅞								77³⁄₁₆							
NES120A	38	114³⁄₁₆	13	9¹³⁄₁₆	5⅛	30½	88⁹⁄₁₆	13	1	1⁵⁄₁₆	3¹¹⁄₁₆	3¹⁵⁄₁₆	3¹⁵⁄₁₆	18½	65	2¾	2⅞	9¹³⁄₁₆	19¹¹⁄₁₆		¾ x ⅜	8"
2NES120A	64	137¹³⁄₁₆				54⅛	112³⁄₁₆								88⁹⁄₁₆							
NES150A	38	129¾		9⅞		36⁷⁄₁₆	97¼	15¾		1⅜	4			21½	77½		4¾	14			1¼ x 1¼	10"
2NES150A	64	160				65¹⁵⁄₁₆	127½								107¹³⁄₁₆							

PUMP SIZE	HOPPER						
	a	b	d	e	f	g	h
NES15A	10	8	1¾	—	—	—	¼
2NES15A							
NES20A	13¾	9	2				5⁄₁₆
2NES20A							
NES30A	10¼	8¹⁄₁₆	1¹¹⁄₁₆	1³⁄₁₆	2³⁄₁₆	7⁄₁₆	9⁄₁₆
2NES30A							
NES40A	11	8¹¹⁄₁₆			2⅜	9⁄₁₆	
2NES40A							

PUMP SIZE	HOPPER						
	a	b	d	e	f	g	h
NES50A	15¾	11	1¾	1³⁄₁₆	2⅜	9⁄₁₆	9⁄₁₆
2NES50A							
NES60A	16¹⁵⁄₁₆	11¹³⁄₁₆			2⁹⁄₁₆		1³⁄₁₆
2NES60A							
NES70A							
2NES70A							
NES80A	22¹⁄₁₆	14⅜	2				
2NES80A							

PUMP SIZE	HOPPER						
	a	b	d	e	f	g	h
NES90A	22¹⁄₁₆	14⅜	2	1³⁄₁₆	2⁹⁄₁₆	9⁄₁₆	1³⁄₁₆
2NES90A							
NES100A	24⅝	16¹⁵⁄₁₆					
2NES100A							
NES120A	29¾	19½	2³⁄₁₆				
2NES120A							
NES150A	30	20	2¼	⅞			
2NES150A							

*Denotes 125# ANSI Flange **Denotes 250# ANSI Flange DD—Disassembly Dimension

Dimensions are subject to change without notice

NETZSCH INCORPORATED
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300/09/4/94

Water Pump Assembly



Water pump assembly 1

Water lubrication is designed to reduce pumping pressures and minimize fluid path blockage. Water can reduce pumping pressures by as much as 80%.
The water required is 1-3% of the weight of the material.



***Be sure to check with your explosives supplier before adding anything to the product*.**

Be sure to check with your explosive supplier before adding anything to the water to insure that the additive will not adversely affect your product.

For cold climates you may need to add Ethyl Glycol (antifreeze) to your water. 50% concentration protects against freeze-ups down to –34%F.

New trucks: you should pump about 5 gallons of ethyl glycol through the pump and the down the hole hose to prime the hose. This should also be done periodically (if you are not mixing it regularly with the water). It makes the hose slippery and will aid in reducing pumping pressure.

Water Lubrication System Components:

Water tank, on/off selector valve, strainer, pump, pressure regulator, flow meter, pressure gauge, check valve and water ring.

Water tank, valve and strainer





Strainer 1

The tank, valve and strainer function to store the water solution and filter it of foreign materials. The open position of the valve is when the handle is in line with the valve body. The closed position is when the handle is perpendicular to the valve.

Be careful not to overfill the water tank.
Always make sure the valve is open before pumping any water.
Remember to close the valve when not in use. This may prevent dumping the tank contents if a hose or fitting should fail.
Avoid contact with ethyl glycol when used.

You should check the tank, valve and strainer for wear and leaks. The strainer should be cleaned out before each use. Make sure and turn the valve off before cleaning the strainer. Pay close attention to the strainer gasket when reinstalling the screen housing. During freezing temperatures, antifreeze should be circulated through the pump to protect it from cracking.

Water pump assembly components

Motor, drive couplings, pump, pump mounting bracket, pump mount, pump shaft guard, coupling guard and pressure regulator.



The pump is hydraulically driven and supplies water to the water ring for lubrication.

Make sure the coupling guard and motor shaft guards are installed before operating the pump.



Be sure to check the oil level in the water pump before each use. Check the drive couplings for wear and alignment. Check the condition of the water hoses and look for any leaks.



If the pump shaft is not rotating, check the key in the motor and the pump, as the key may be sheared.

Water Pressure Relief Adjustment

Check for zero water pressure first!

1. Disconnect the pressure hose from the check valve at the water ring.
2. Plug the hose with a ball valve.
3. Run water pump and close off the ball valve.
4. Read water pressure gauge for current relief setting.
5. Adjust the pressure regulator to a nominal setting of 200 psi. Screw clockwise to increase pressure and counterclockwise to decrease the pressure.



Flow Meter

The water flow meter measures the gallons per minutes that is flowing into the product hose. It operates when the water is flowing. Do not exceed the flow rate of the meter. Check the meter frequently for cracking and leaks. If you are not showing water flow you may have a bad meter or a blockage. We discuss blockage in the hose reel section.

Water Ring

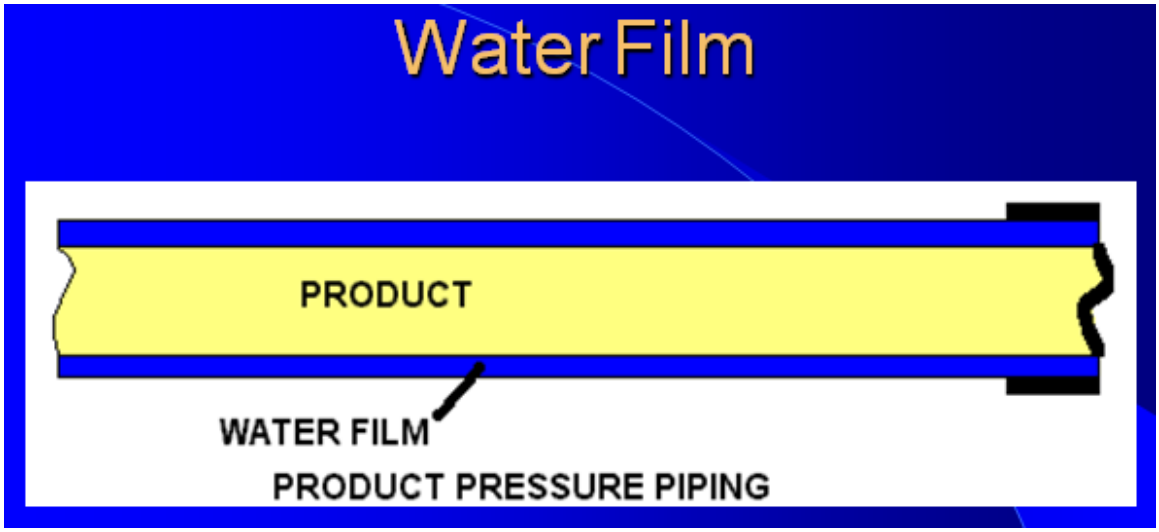


Water ring 1



Water ring 2

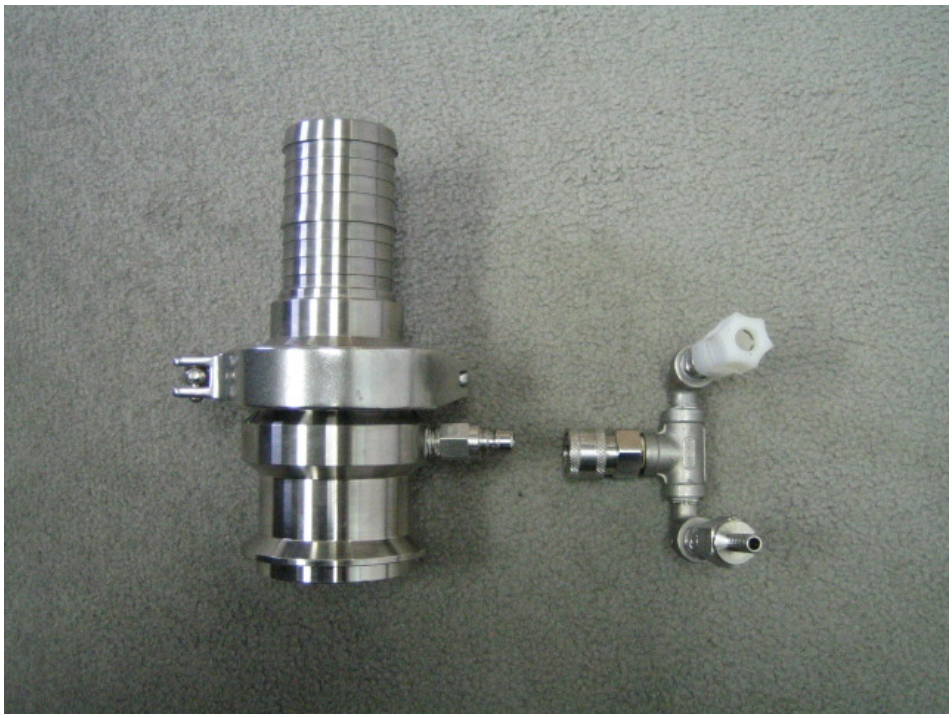
- λ Injects water into hose creating a film between the hose and the product.
- λ Produces an easily sheared film, allowing the product to slide down the water-lined hose.
- λ Hydraulic controls operate the water pump which sends the water to the ring.



Never uncouple the water ring or remove the plug after unclogging until you insure that you do not have any pressure on your product pressure, water pressure and air pressure gauges.You must be safe when attempting to clean the water ring.

Disassemble the water ring

- Remove the Air and water lines form the watering assembly



- λ Pull the sleeve out of the assembly
- λ Take care not to damaged seal







- λ Clean the sleeve area
- λ Clean the groove area inside the assembly





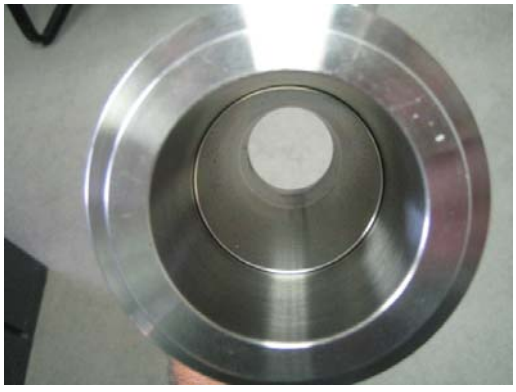
Assemble the water ring

- λ Remember to install the seal
- λ Slide the sleeve into the assembly
- λ Install the I line fittings on both side
- λ Connect air and water lines









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Check Valves



C, CA, CH, CP, and CPA Series

- Working pressures up to 6000 psig (413 bar)
- Adjustable and fixed cracking pressures
- Variety of end connections
- 316 stainless steel and brass materials

Swagelok

Contents

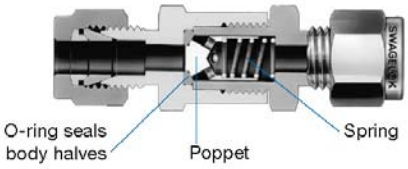
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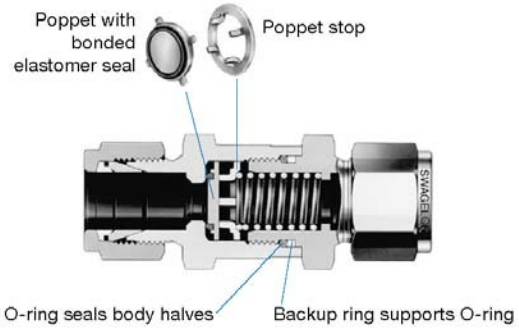
Fixed Cracking Pressures

From 1/3 to 25 psi (0.03 to 1.8 bar)

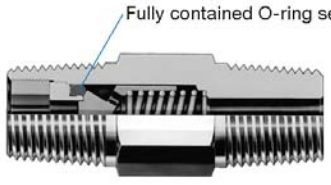
C Series



CH Series



CP Series

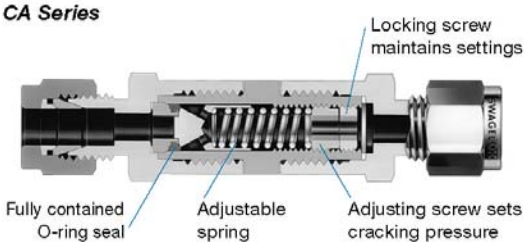


Compact, one-piece body

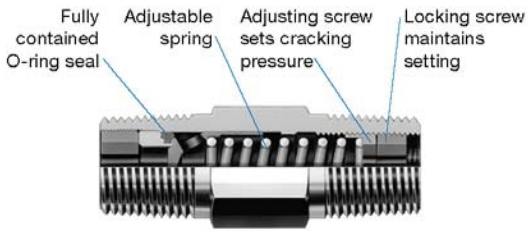
Adjustable Cracking Pressures

From 3 to 600 psi (0.21 to 41.4 bar)

CA Series



CPA Series



Compact, one-piece body

Technical Data

Cracking pressure—the upstream pressure at which the first indication of flow occurs.

Reseal pressure—the pressure at which there is no indication of flow.

⚠ **For valves not actuated for a period of time, initial cracking pressure may be higher than the set cracking pressure.**

Series	Maximum Flow Coefficient (C_V)	Nominal Cracking Pressure psi (bar)	Downstream Pressure at 70°F (20°C) psig (bar)
Fixed Cracking Pressure			
2C	0.10	1/3, 1, 10 and 25 (0.03, 0.07, 0.69, and 1.8)	1000 (68.9)①
4C	0.47		
6C	1.47		200 (13.7)
8C	1.68		
12C, 16C	4.48		
CH4	0.67	1/3, 1, 5, 10 and 25 (0.03, 0.07, 0.35 0.69, and 1.8)	6000 (413)
CH8	1.8		
CH16	4.7		5000 (344)
4CP	0.35	1/3, 1, 10 and 25 (0.03, 0.07, 0.69, and 1.8)	3000 (206)
8CP	1.20		
Adjustable Cracking Pressure			
CA	0.37	3 to 50 (0.21 to 3.5) 50 to 150 (3.5 to 10.4) 150 to 350 (10.4 to 24.2) 350 to 600 (24.2 to 41.4)	3000 (206)
4CPA	0.35		
8CPA	1.20		

① For cracking pressure of 25 psi (1.8 bar), downstream pressure is 3000 psig (206 bar).

Pressure-Temperature Ratings

C (2C, 4C, 6C, and 8C), CA, CP, and CPA Series

Ratings based on fluorocarbon FKM O-rings in 316 stainless steel valves and Buna N O-rings in brass valves.

Material	316 SS	Brass
Temperature, °F (°C)	Working Pressure, psig (bar)①	
–10 (–23) to 100 (37)	3000 (206)	3000 (206)
200 (93)	2575 (177)	2600 (179)
250 (121)	2450 (168)	2405 (165)
300 (148)	2325 (160)	—
375 (190)	2185 (150)	—

① To reduce the possibility of dislodging the O-ring in systems where pressure surges, shock, or pulses occur, for all 2C and 4C series valves and for 6C and 8C series valves with cracking pressures lower than 50 psi (3.5 bar), an optional inlet gasket is available. See page 14 for ordering information. Cracking and reseal pressures may decrease slightly from the ranges listed in this catalog.

Alternatively, CH or CP series valves should be considered.

CH Series

Ratings based on fluorocarbon FKM seals.

Material	316 SS	
Series	CH4, CH8	CH16
Temperature, °F (°C)	Working Pressure, psig (bar)	
–10 (–23) to 100 (37)	6000 (413)	5000 (344)①
200 (93)	5160 (355)	4290 (295)
250 (121)	4910 (338)	4080 (281)
300 (148)	4660 (321)	3875 (266)
400 (204)	4280 (294)	3560 (245)

For more information about pressure ratings of valves with tube fitting end connections, see Swagelok® *Tubing Data*, MS-01-107.

① Pressure ratings may be limited by the end connection See **Dimensions**, page 12.

C Series (12C and 16C)

Ratings based on fluorocarbon FKM O-rings in 316 stainless steel valves and Buna N O-rings in brass valves.

Material	316 SS	Brass
Temperature, °F (°C)	Working Pressure, psig (bar)	
–10 (–23) to 100 (37)	2000 (137)	1500 (103)
200 (93)	1715 (118)	1300 (89.5)
250 (121)	1630 (112)	1200 (82.6)
300 (148)	1545 (106)	—
375 (190)	1450 (99.9)	—

Cracking and Reseal Pressures at 70°F (20°C)

Cracking pressure—the upstream pressure at which the first indication of flow occurs.

Reseal pressure—the pressure at which there is no indication of flow.

⚠ **For valves not actuated for a period of time, initial cracking pressure may be higher than the set cracking pressure.**

C Series

Nominal Cracking Pressure psi (bar)	Cracking Pressure Range psi (bar)	Reseal Pressure psi (bar)
1/3 (0.03)	Up to 3 (0.21)	Up to 6 (0.42) downstream pressure
1 (0.07)	Up to 4 (0.28)	Up to 6 (0.42) downstream pressure
10 (0.69)	7 to 15 (0.49 to 1.1)	3 (0.21) or more upstream pressure
25 (1.8)	20 to 30 (1.4 to 2.1)	17 (1.2) or more upstream pressure

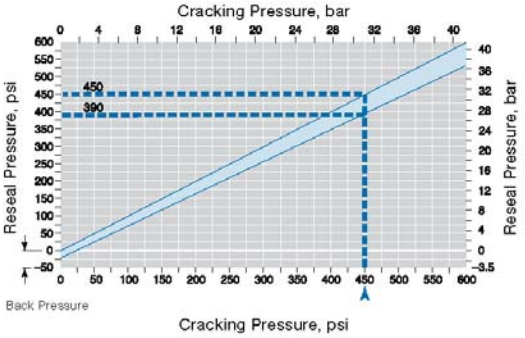
CH Series

Nominal Cracking Pressure psi (bar)	Cracking Pressure Range psi (bar)	Reseal Pressure psi (bar)
1/3 (0.03)	Up to 3 (0.21)	Up to 6 (0.42) back pressure
1 (0.07)	Up to 4 (0.28)	Up to 5 (0.35) back pressure
5 (0.35)	3 to 9 (0.21 to 0.63)	Up to 2 (0.14) back pressure
10 (0.69)	7 to 15 (0.49 to 1.1)	3 (0.21) or more upstream pressure
25 (1.8)	20 to 30 (1.4 to 2.1)	17 (1.2) or more upstream pressure

CP Series

Nominal Cracking Pressure psi (bar)	Cracking Pressure Range psi (bar)	Reseal Pressure psi (bar)
1/3 (0.03)	Up to 3 (0.21)	6 to 20 (0.42 to 1.4) downstream pressure
1 (0.07)	Up to 4 (0.28)	5 to 20 (0.35 to 1.4) downstream pressure
10 (0.69)	7 to 13 (0.49 to 0.90)	3 to 10 (0.21 to 0.69) downstream pressure
25 (1.8)	21 to 29 (1.5 to 2.0)	5 (0.35) or more upstream pressure

CA and CPA Series



Materials of Construction

C and CA Series

Component	Valve Body Materials	
	316 SS	Brass
	Material Grade/ASTM Specification	
1 *Inlet body*	*316 SS/A479*	*Brass 360/B16*
2 *Inlet gasket (CA series)*	*PTFE-coated 316 SS/A240*	
Inlet gasket (standard for 6C and 8C series with ≥ 50 psi [3.5 bar] spring; optional for 2C and 4C series and all other 6C and 8C series)	*PTFE-coated 316 SS/A240*	
Inlet gasket (12C and 16C series)	*PTFE-coated 316 SS/A240*	*PTFE-coated aluminum/B209*
3 *Insert (CA series)*	*316 SS/A479*	*Naval brass 485/ B21*
4 *O-ring*	*Fluorocarbon FKM*	*Buna N*
5 *Poppet*	*316 SS/A479*	*Brass 360/B16*
6 *Spring*	*302 SS/A313*	
7 *Center body (CA series)*	*316 SS/A479*	*Brass 360/B16*
8 *Adjusting screw (CA series)*	*316 SS/A276*	
9 *Locking screw (CA series)*		
10 *Outlet gasket (CA series)*	*PTFE-coated 316 SS/A240*	
11 *Outlet body*	*316 SS/A479*	*Brass 360/B16*
Lubricants	*Silicone-based and molybdenum disulfide-based (C series); PTFE-based and molybdenum disulfide-based (CA series)*	*Silicone-based (C series); PTFE-based (CA series)*

Wetted components listed in *italics*.



12C Series shown



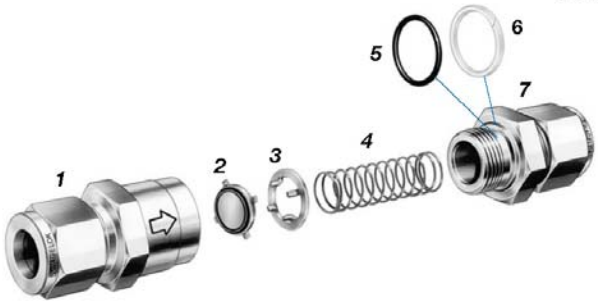
CA Series

CH Series

Component	Material Grade/ ASTM Specification
1 *Inlet body*	*316 SS/A479*
2 *Poppet*	*Fluorocarbon FKM-bonded① 316 SS/A479*
3 *Poppet stop*	*316 SS/A240*
4 *Spring*	*302 SS/A313*
5 *O-ring*	*Fluorocarbon FKM*
6 Backup ring	PTFE/D1710
7 *Outlet body*	*316 SS/A479*
Lubricant	*PTFE-based*

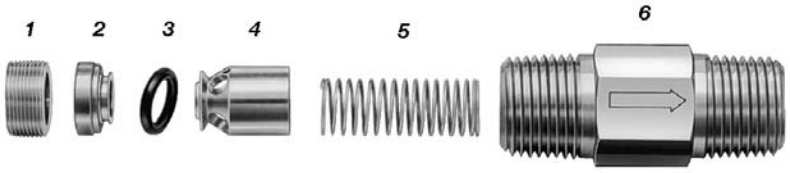
Wetted components listed in *italics*.

① Material Safety Data Sheet for bonding agent available on request.

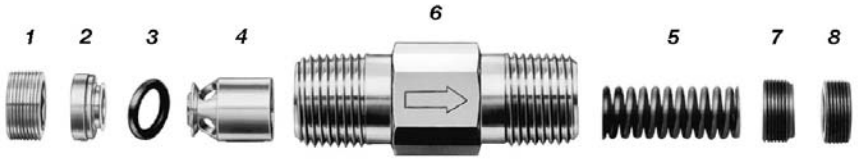


Materials of Construction

CP Series



CPA Series



Component	Valve Body Materials				
		Brass			
	316 SS	4CP	8CP	4CPA	8CPA
	Material Grade/ASTM Specification				
1 Insert lock screw	*316 SS/A276 or A479*	*Brass 485/ B21*	*Brass 360/ B16*	*Brass 485/ B21*	*Brass 360/ B16*
2 Insert	*316 SS/A479*				
3 O-ring	*Fluorocarbon FKM*	*Buna N*			
4 Poppet	*316 SS/A479*	*Brass 360/B16*			
5 Spring	*302 SS/A313*				
6 Body	*316 SS/A479*	*Brass 360/B16*			
7 Adjusting screw (CPA series)	*316 SS/A276*	—		*316 SS/A276*	*Brass 360①/ B16*
8 Locking screw (CPA series)					
Lubricants	*PTFE-based*				

Wetted components listed in *italics*.

① Adjusting screw in valve with 150 or 350 psi (10.4 or 24.2 bar) spring is 316 SS.

Flow Data at 70°F (20°C)

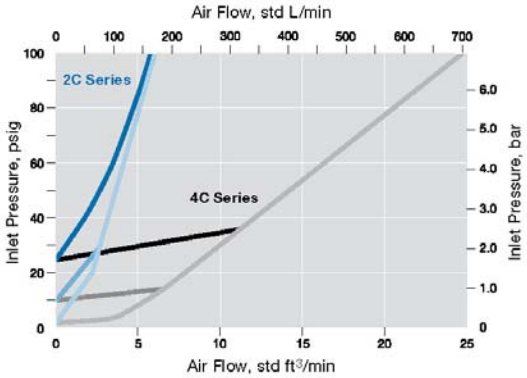
C Series

Nominal Cracking Pressures

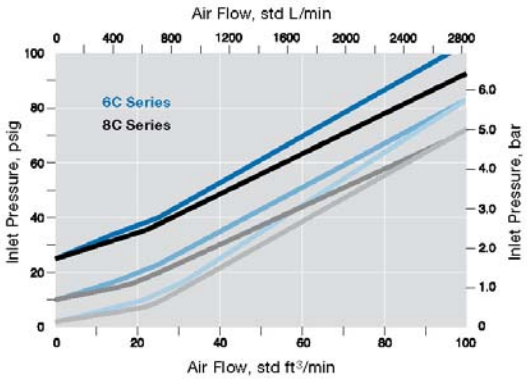
2C, 6C, 16C Series	1 psi (0.07 bar)	10 psi (0.69 bar)	25 psi (1.8 bar)
4C, 8C Series	1 psi (0.07 bar)	10 psi (0.69 bar)	25 psi (1.8 bar)

Air

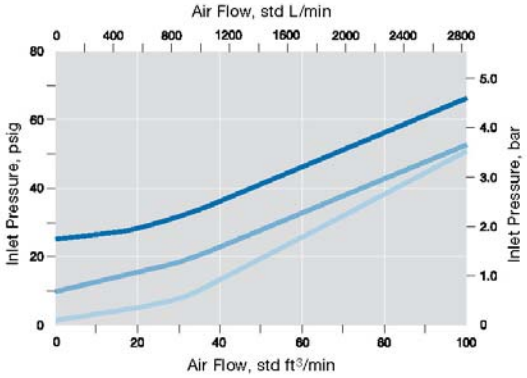
2C, 4C Series



6C, 8C Series

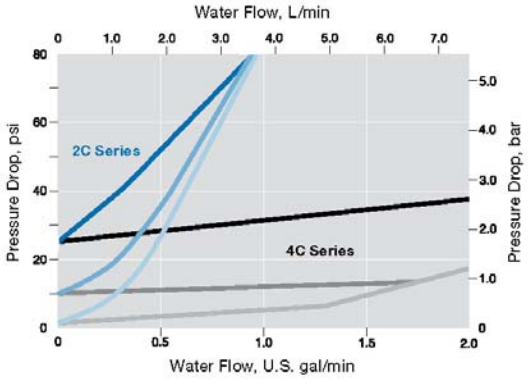


16C Series

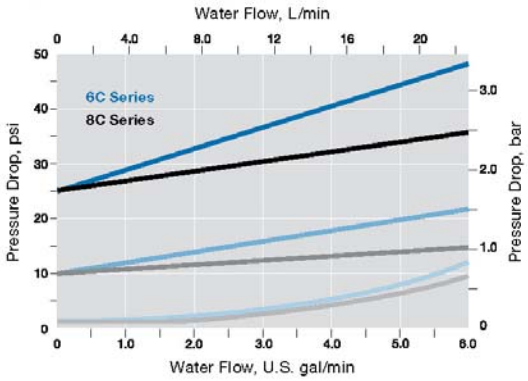


Water

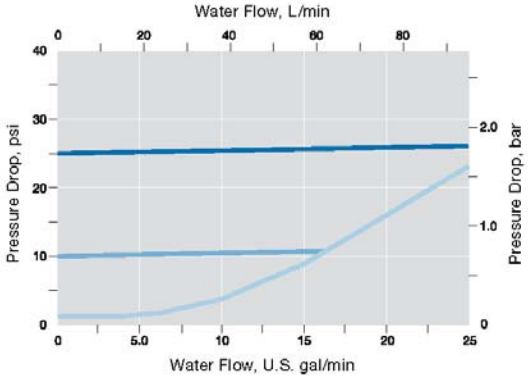
2C, 4C Series



6C, 8C Series



16C Series



Flow Data at 70°F (20°C)

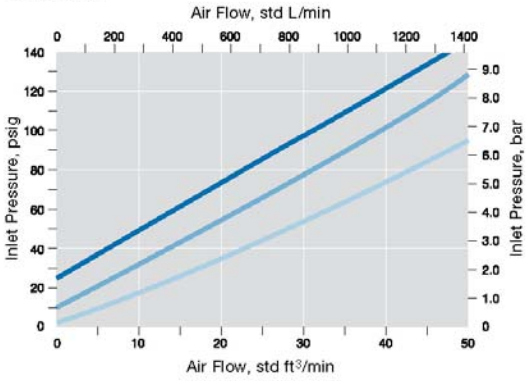
CH Series

Nominal Cracking Pressures

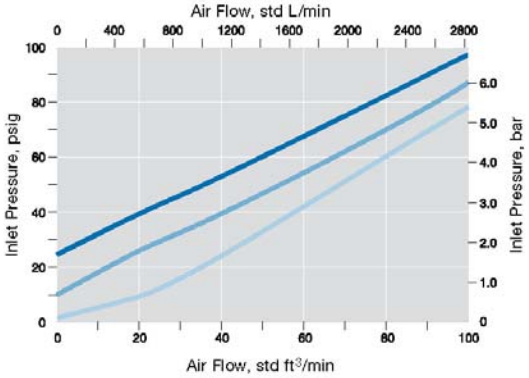
1 psi (0.07 bar) 10 psi (0.69 bar) 25 psi (1.8 bar)

Air

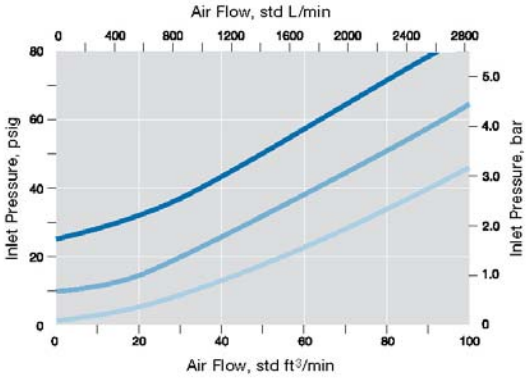
CH4 Series



CH8 Series

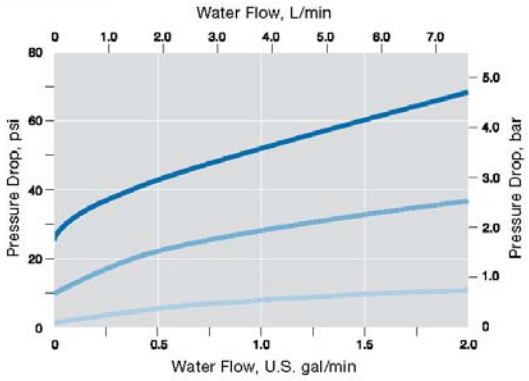


CH16 Series

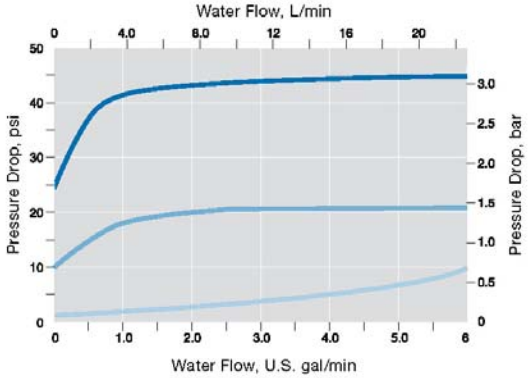


Water

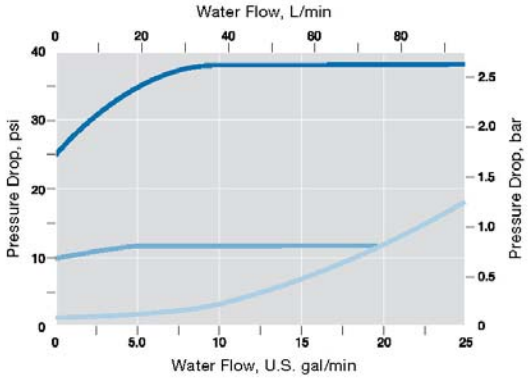
CH4 Series



CH8 Series



CH16 Series



Swagelok

Flow Data at 70°F (20°C)

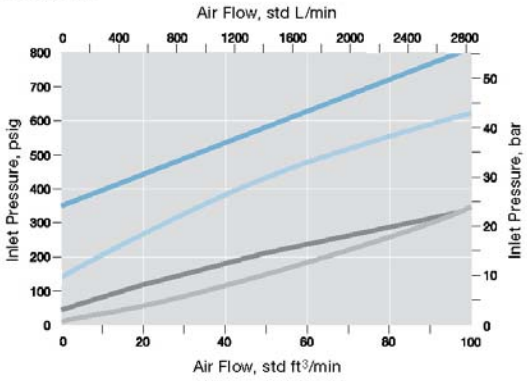
CA and CPA Series

Nominal Cracking Pressures

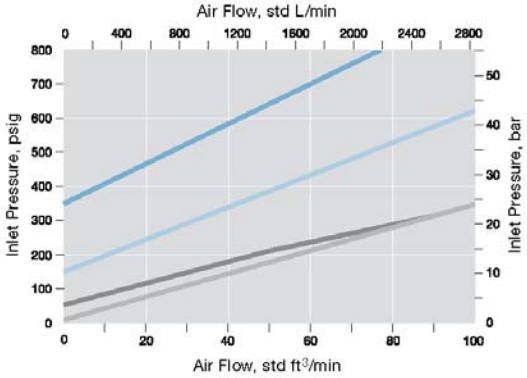
3 psi (0.21 bar) 50 psi (3.5 bar) 150 psi (10.4 bar) 350 psi (24.2 bar)

Air

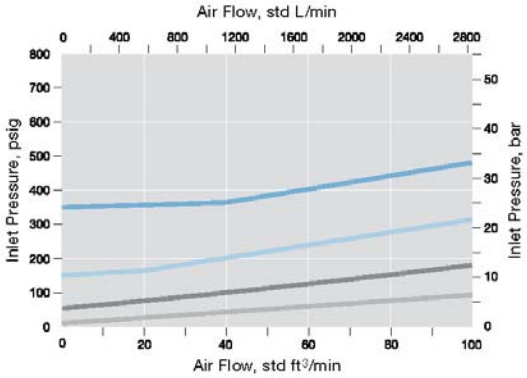
CA Series



4CPA Series

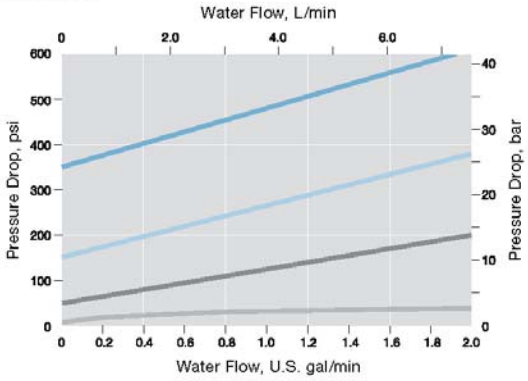


8CPA Series

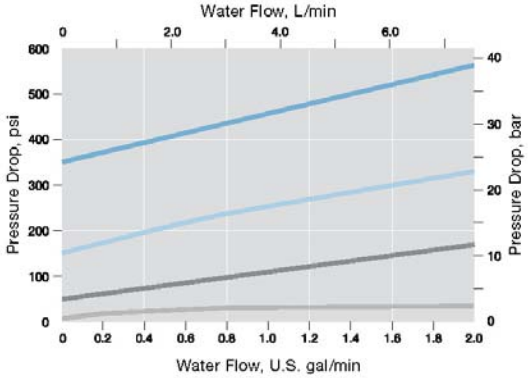


Water

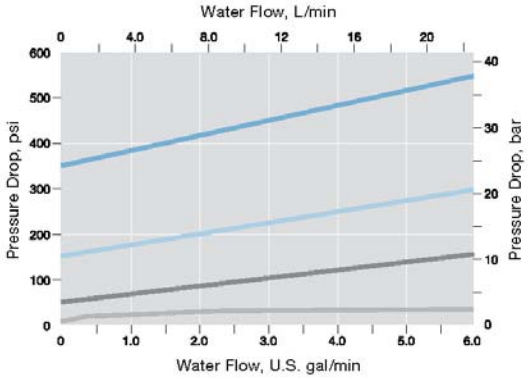
CA Series



4CPA Series

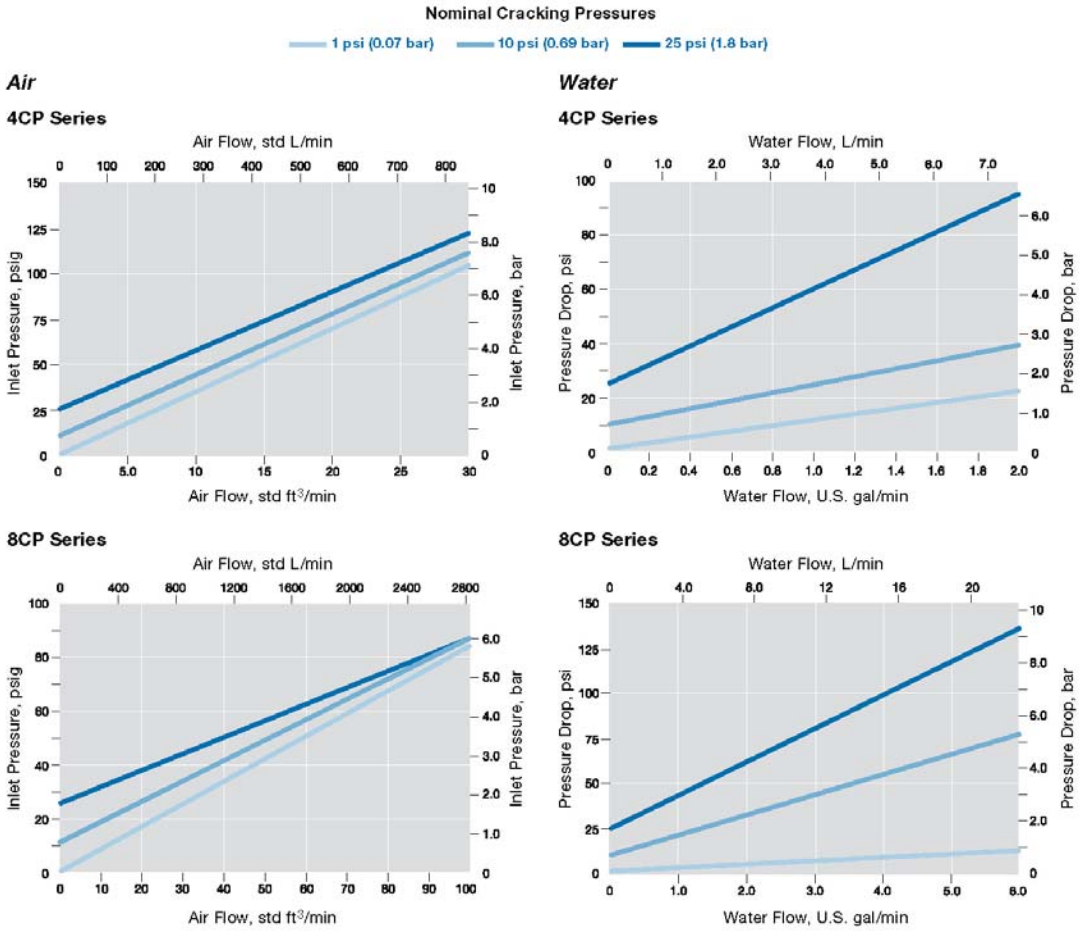


8CPA Series



Flow Data at 70°F (20°C)

CP Series



Testing

Every C, CA, CH, CP, and CPA series check valve is factory tested for crack and reseal performance with a liquid leak detector.

Check valves with fixed cracking pressures, C, CP, and CH series, are cycled six times prior to testing. Every valve is tested to ensure it seals within 5 s at the appropriate reseal pressure.

Check valves with adjustable cracking pressures, CA and CPA series, are tested at two pressure points. Every valve is tested at a low-pressure setting and at a high-pressure setting. All valves must seal within 5 s at the appropriate reseal pressure.

Cleaning and Packaging

Every C, CA, and CH series check valve with VCR® or VCO® end connections is processed in accordance with Swagelok *Special Cleaning and Packaging (SC-11),* MS-06-63, to ensure compliance with product cleanliness requirements as stated in ASTM G93 Level C.

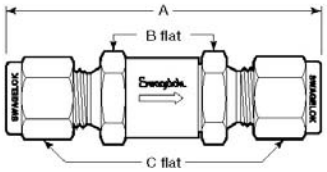
All other C, CA, and CH series check valves, as well as every CP and CPA series check valve, are cleaned in accordance with Swagelok *Standard Cleaning and Packaging (SC-10),* MS-06-62.

Swagelok

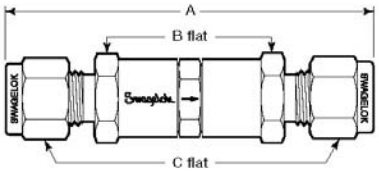
Dimensions

Dimensions, shown with Swagelok tube fitting nuts finger-tight, are for reference only and are subject to change.

C Series



CA Series



End Connections		Basic Ordering Number	Series	Dimensions, in. (mm)		
Inlet/Outlet	Size			A	B	C
Fixed Cracking Pressure, C Series						
Fractional Swagelok tube fittings	1/8 in.	SS-2C-	2C	2.14 (54.3)	5/8	7/16
	1/4 in.	SS-4C-	4C	2.35 (59.7)		9/16
	3/8 in.	SS-6C-	6C	3.17 (80.5)	7/8	11/16
	1/2 in.	SS-8C-	8C	3.42 (86.9)		7/8
	3/4 in.	SS-12C-	12C	4.32 (110)	1 1/4	1 1/8
	1 in.	SS-16C-	16C	4.74 (120)	1 3/8	1 1/2
Metric Swagelok tube fittings	6 mm	SS-6C-MM-	4C	2.36 (59.9)	5/8	(14)
	10 mm	SS-10C-MM-	8C	3.32 (84.3)	7/8	(19)
	12 mm	SS-12C-MM-		3.42 (86.9)		(22)
Female NPT	1/8 in.	SS-2C4-	2C	1.89 (48.0)	5/8	–
	1/4 in.	SS-4C4-	4C	2.15 (54.6)	3/4	
	3/8 in.	SS-6C4-	6C	2.98 (75.7)	7/8	
	1/2 in.	SS-8C4-	8C	3.58 (90.9)	1 1/16	
	3/4 in.	SS-12C4-	12C	4.08 (104)	1 1/4	
	1 in.	SS-16C4-	16C	4.84 (123)	1 5/8	
Male NPT	1/8 in.	SS-2C2-	2C	1.71 (43.4)	5/8	
	1/4 in.	SS-4C2-	4C	2.09 (53.1)		
	3/8 in.	SS-6C2-	6C	2.78 (70.6)	7/8	
	1/2 in.	SS-8C2-	8C	3.16 (80.3)		
	3/4 in.	SS-12C2-	12C	4.08 (104)	1 1/4	
	1 in.	SS-16C2-	16C	4.52 (115)	1 5/8	
Male NPT/ Swagelok tube fitting	1/4 in.	SS-4C1-	4C	2.22 (56.4)	5/8	9/16
Male VCR fittings	1/4 in.	SS-4C-VCR-	4C	2.21 (56.1)	5/8	–
	1/2 in.	SS-8C-VCR-	8C	3.56 (90.4)	15/16	
	3/4 in.	SS-12C-VCR-	12C	4.64 (118)	1 5/8	
	1 in.	SS-16C-VCR-	16C	4.76 (121)		
Adjustable Cracking Pressure, CA Series						
Swagelok tube fittings	1/4 in.	SS-4CA-	CA	3.23 (82.0)	5/8	9/16
	6 mm	SS-6CA-MM-				(14)
	8 mm	SS-8CA-MM-		3.32 (84.3)		(16)
Male NPT/ Swagelok tube fitting	1/4 in.	SS-4CA1-		3.12 (79.2)		9/16
Male VCR fittings	1/4 in.	SS-4CA-VCR-		3.09 (78.5)		–

Ordering Information

Basic ordering numbers specify stainless steel material. To order brass, replace **SS** with **B** in the basic ordering number.

Example: **B**-2C-

C Series

To order, add a cracking pressure designator to the basic ordering number.

Cracking Pressure psi (bar)	Designator
1/3 (0.03)	1/3
1 (0.07)	1
10 (0.69)	10
25 (1.8)	25

Example: SS-2C-**1/3**

CA Series

To order, add a cracking pressure range designator to the basic ordering number.

Cracking Pressure psi (bar)	Designator
3 to 50 (0.21 to 3.5)	3
50 to 150 (3.5 to 10.4)	50
150 to 350 (10.4 to 24.2)	150
350 to 600 (24.2 to 41.4)	350

Example: SS-4CA-**3**

⚠ **Check valves are designed for directional flow control only. Swagelok check valves should never be used as code safety relief devices.**

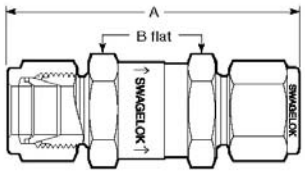
Dimensions

Dimensions, shown with Swagelok tube fitting nuts finger-tight, are for reference only and are subject to change.

End Connections		Pressure Rating at 100°F (37°C) psig (bar)	Basic Ordering Number	Series	Dimensions in. (mm)	
Type	Size				A	B
Fractional Swagelok tube fitting	1/8 in.	6000 (413)	SS-CHS2-	CH4	2.27 (57.7)	11/16
	1/4 in.		SS-CHS4-		2.43 (61.7)	
	3/8 in.		SS-CHS6-	CH8	2.75 (69.9)	1
	1/2 in.		SS-CHS8-		2.96 (75.2)	
	3/4 in.	5000 (344)	SS-CHS12-	CH16	3.52 (89.4)	1 5/8
	1 in.	4700 (323)	SS-CHS16-		3.88 (98.6)	
Metric Swagelok tube fitting	6 mm	6000 (413)	SS-CHS6MM-	CH4	2.43 (61.7)	11/16
	8 mm		SS-CHS8MM-	CH8	2.70 (68.6)	1
	10 mm		SS-CHS10MM-		2.80 (71.1)	
	12 mm		SS-CHS12MM-		2.96 (75.2)	
	22 mm	4900 (337)	SS-CHS22MM-	CH16	3.48 (88.4)	1 5/8
	25 mm	4600 (316)	SS-CHS25MM-		3.88 (98.6)	
Female NPT	1/4 in.	6000 (413)	SS-CHF4-	CH4	2.13 (54.1)	11/16
	3/8 in.	5300 (365)	SS-CHF6-	CH8	2.55 (64.8)	1
	1/2 in.	4900 (337)	SS-CHF8-		3.03 (77.0)	1 1/16
	3/4 in.	4600 (316)	SS-CHF12-	CH16	3.23 (82.0)	1 5/8
	1 in.	4400 (303)	SS-CHF16-		3.83 (97.3)	
Male NPT	1/8 in.	6000 (413)	SS-CHM2-	CH4	1.79 (45.5)	11/16
	1/4 in.		SS-CHM4-		2.17 (55.1)	
	3/8 in.		SS-CHM6-	CH8	2.36 (59.9)	1
	1/2 in.		SS-CHM8-		2.73 (69.3)	
	3/4 in.	5000 (344)	SS-CHM12-	CH16	3.29 (83.6)	1 5/8
	1 in.		SS-CHM16-		3.67 (93.2)	
Female ISO①	1/4 in.	6000 (413)	SS-CHF4RT-	CH4	2.28 (57.9)	11/16
	1/2 in.	5100 (351)	SS-CHF8RT-	CH8	3.29 (83.6)	1 1/16
	3/4 in.	4800 (330)	SS-CHF12RT-	CH16	3.55 (90.2)	1 5/8
	1 in.	4400 (303)	SS-CHF16RT-		3.83 (97.3)	
Male ISO①	1/4 in.	6000 (413)	SS-CHM4RT-	CH4	2.17 (55.1)	11/16
	1/2 in.		SS-CHM8RT-	CH8	2.73 (69.3)	1
	3/4 in.	5000 (344)	SS-CHM12RT-	CH16	3.35 (85.1)	1 5/8
	1 in.		SS-CHM16RT-		3.67 (93.2)	
Female SAE/MS	1/2 in.	4600 (316)	SS-CHF8ST-	CH8	2.74 (69.6)	1
Male SAE/MS	1/2 in.	4600 (316)	SS-CHM8ST-		2.48 (63.0)	
Male VCO fitting	1/4 in.	6000 (413)	SS-CHVCO4-	CH4	1.98 (50.3)	11/16
	1/2 in.		SS-CHVCO8-	CH8	2.35 (59.7)	1
	3/4 in.	5000 (344)	SS-CHVCO12-	CH16	2.90 (73.7)	1 5/8
	1 in.		SS-CHVCO16-			
Male VCR fitting	1/4 in.	6000 (413)	SS-CHVCR4-	CH4	2.28 (57.9)	11/16
	1/2 in.	4300 (296)	SS-CHVCR8-	CH8	2.73 (69.3)	1
	3/4 in.	3700 (254)	SS-CHVCR12-	CH16	3.78 (96.0)	1 5/8

① See specifications ISO 7/1, BS EN 10226-1, DIN 2999, JIS B0203.

CH Series



Ordering Information

To order, add a cracking pressure designator to the basic ordering number.

Cracking Pressure psi (bar)	Designator
1/3 (0.03)	1/3
1 (0.07)	1
5 (0.35)	5
10 (0.69)	10
25 (1.8)	25

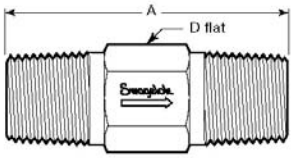
Example: SS-CHS2-**1/3**

⚠ **Check valves are designed for directional flow control only. Swagelok check valves should never be used as code safety relief devices.**

Dimensions

Dimensions, shown with Swagelok tube fitting nuts finger-tight, are for reference only and are subject to change.

CP and CPA Series



End Connections		Basic Ordering Number	Series	Dimensions, in. (mm)	
Inlet/Outlet	Size			A	D
Fixed Cracking Pressure, CP Series					
Female NPT	1/4 in.	SS-4CP4-	4CP	2.41 (61.2)	3/4
	1/2 in.	SS-8CP4-	8CP	3.71 (94.2)	1 1/16
Male NPT	1/4 in.	SS-4CP2-	4CP	1.62 (41.1)	9/16
	1/2 in.	SS-8CP2-	8CP	2.28 (57.9)	7/8
Female/male NPT	1/4 in.	SS-4CP6-	4CP	2.29 (58.2)	3/4
Male/female NPT	1/4 in.	SS-4CP5-		1.75 (44.4)	3/4
	1/2 in.	SS-8CP5-	8CP	2.83 (71.9)	1 1/16
Female ISO①	1/4 in.	SS-4CP4-RT-	4CP	2.54 (64.5)	3/4
Male ISO①	1/4 in.	SS-4CP2-RT-		1.62 (41.1)	9/16
Adjustable Cracking Pressure, CPA Series					
Female NPT	1/4 in.	SS-4CPA4-	4CPA	2.98 (75.7)	3/4
Male NPT	1/4 in.	SS-4CPA2-		1.62 (41.1)	9/16
	1/2 in.	SS-8CPA2-	8CPA	2.56 (65.0)	7/8
Male ISO①	1/4 in.	SS-4CPA2-RT-	4CPA	1.62 (41.1)	9/16
	1/2 in.	SS-8CPA2-RT-	8CPA	2.56 (65.0)	7/8

① See specifications ISO 7/1, BS EN 10226-1, DIN 2999, and JIS B0203.

Ordering Information

Basic ordering numbers specify stainless steel material. To order brass, replace **SS** with **B** in the basic ordering number.

Example: **B**-4CP4-

CP Series

To order, add a cracking pressure designator to the basic ordering number.

Cracking Pressure psi (bar)	Designator
1/3 (0.03)	1/3
1 (0.07)	1
10 (0.69)	10
25 (1.8)	25

Example: B-4CP4-**1/3**

CPA Series

To order, add a cracking pressure range designator to the basic ordering number.

Cracking Pressure psi (bar)	Designator
3 to 50 (0.21 to 3.5)	3
50 to 150 (3.5 to 10.4)	50
150 to 350 (10.4 to 24.2)	150
350 to 600 (24.2 to 41.4)	350

Example: SS-4CPA4-**3**

⚠ **Check valves are designed for directional flow control only. Swagelok check valves should never be used as code safety relief devices.**

Options and Accessories

Seal Materials (All Series)

Fluorocarbon FKM O-rings are standard in 316 stainless steel valves; Buna N O-rings are standard in brass valves. Other elastomer seals (poppet bonding material and O-ring) are available. To order, insert the seal material designator into the valve ordering number.

Seal Material	Designator	Temperature Rating °F (°C)
Buna N	-BU	–10 to 250 (–23 to 121)
Ethylene propylene	-EP	–50 to 300 (–45 to 148)
Fluorocarbon FKM	-VI	–10 to 375 (–23 to 190)①
Neoprene	-NE	–40 to 250 (–40 to 121)

① –10 to 400°F (–23 to 204°C) for CH series.

Example: B-2C-**VI**-1/3

Additional seal materials are available. Contact your authorized Swagelok sales and service representative for details.

Special Alloys (All Series)

Springs of alloy 400 or alloy C-276 are available in some sizes. Valve bodies of alloy 400, carbon steel, aluminum, or other alloys are available in some sizes. Contact your authorized Swagelok representative for more information.

PTFE-Coated Springs (C, CA, CP, and CPA Series)

Springs with PTFE coating are available in some sizes. Contact your authorized Swagelok representative for more information.

Inlet Gaskets (2C, 4C, 6C, and 8C Series)

PTFE-coated 316 stainless steel inlet gaskets are available for 2C, 4C, 6C, and 8C series valves to reduce the possibility of dislodging the O-ring in systems where pressure surges, shock, or pulses occur. Gaskets are standard in 6C and 8C series valves with cracking pressures greater than 50 psi (3.5 bar).

To order an inlet gasket, if it is not standard, insert **-FG** into the valve ordering number.

Example: SS-4C-**FG** -1

Deflector Cap (CP and CPA Series)

A polyethylene deflector cap is available for CP and CPA series valves with male NPT end connections. The deflector cap deflects flow from direct contact with personnel and prevents atmospheric contaminants from entering the valve. The deflector cap screws easily onto the male NPT outlet end of the valve. Maximum rating is 300 psig at 100°F (20.6 bar at 37°C).



To order, insert **-DG** for a green cap or **-DR** for a red cap into the ordering number.

Example: SS-4CPA2-**DR**-3

Sour Gas Valves (CH Series)

CH series valves are available for sour gas service. Materials are selected in accordance with NACE MR0175/ISO 15156.

Technical Data

Pressure Rating at 70°F (20°C)
5000 psig (344 bar)

Temperature Rating
–50 to 300°F (–45 to 148°C)

Nominal Cracking Pressures
1/3, 1, and 5 psi (0.03, 0.07, and 0.35 bar)

End Connections
1/4, 3/8, and 1/2 in. Swagelok tube fittings

Materials of Construction
Body, poppet—alloy 400/B164
Seals—ethylene propylene
Backup ring—PTFE
Spring—alloy X-750/AMS 5699
All other materials and lubricant same as standard product.
See **Materials of Construction,** page 5.

Ordering Information

To order, replace **SS** with **M** and insert **-SG** into the ordering number.

Example: **M**-CHS4-**SG**-1/3

Valves With ECE R110-Type Approval (CH Series)

Stainless steel CH series check valves with Buna C seals are available with ECE R110-type approval for use in alternative fuel service.

- Temperature rating: –40 to 185°F (–40 to 85°C)
- Pressure rating within the range: 3770 psig (260 bar)

To order, add **-11670** to a standard valve ordering number.

Example: SS-CHS8-1/3-**11670**

Special Cleaning and Packaging (SC-11)

Every C, CA, and CH series check valve with VCR or VCO end connections is processed in accordance with Swagelok *Special Cleaning and Packaging (SC-11),* MS-06-63, to ensure compliance with product cleanliness requirements stated in ASTM G93 Level C.

To order special cleaning and packaging for C, CA, and CH series check valves with other end connections, add **-SC11** to the ordering number.

Example: SS-2C-1/3-**SC11**

Oxygen Service Hazards

For more information about hazards and risks of oxygen-enriched systems, see the Swagelok *Oxygen System Safety* technical report, MS-06-13.

Maintenance Kits



C, CP, CA, and CPA Series Seal Kits

Kits contain O-ring and instructions. Select a basic kit ordering number and add an O-ring material designator. Uniform O-ring size and durometer are provided for reference only.

Example: **VI**70-4C-K4

Valve Series	Uniform O-ring Size	Durometer①	Basic Kit Ordering Number
Fixed Cracking Pressures: 1/3, 1, 10, and 25 psi (0.03, 0.07, 0.69, and 1.8 bar)			
2C, 4C, 4CP	009	70②	70-4C-K4
6C, 8C	111		70-8C-K4
8CP	110		70-8CP-K4
12C, 16C	114		70-14C-K4
Adjustable Cracking Pressures: 3 to 150 psi (0.21 to 10.4 bar)			
CA, 4CPA	009	70②	70-4C-K4
8CPA	110		70-8CP-K4
Adjustable Cracking Pressures: 150 to 600 psi (10.4 to 41.4 bar)			
CA, 4CPA	009	90③	90-4C-K4
8CPA	110		90-8CP-K4

① Not applicable to PTFE O-rings. To order PTFE seal kits, omit the durometer number. Example: T-4C-K4

② Fluorocarbon FKM O-rings have a durometer of 75.

③ Silicone O-rings size 009 have a durometer of 80; silicone O-rings size 110 have a durometer of 70.

O-ring Material	Designator
Buna N	BU
Ethylene propylene	EP
Fluorocarbon FKM	VI
Neoprene	NEO

Additional seal materials are available. Contact your authorized Swagelok representative for details.



CH Series Seal Kits

Kits contain bonded poppet, body seal O-ring, PTFE backup ring, and instructions. Select a basic kit ordering number and add a seal material designator.

Example: SS-3K-CH4-**VI**

Valve Series	Valve Body Material	Basic Kit Ordering Number
CH4	316 SS	SS-3K-CH4-
	Alloy 400	M-3K-CH4-
CH8	316 SS	SS-3K-CH8-
	Alloy 400	M-3K-CH8-
CH16	316 SS	SS-3K-CH16-

Seal Material	Designator
Buna N	BN
Ethylene propylene	EP
Fluorocarbon FKM	VI
Neoprene	NE



CA, 8C, and 16C Series Metal Gasket Kits

Kits contain PTFE-coated gasket(s) and instructions. Select a basic kit ordering number and add a gasket material designator.

Example: **SS**-8C-K6

Valve Series	Basic Kit Ordering Number
2C, 4C (1 gasket)①	-4C-K6
6C, 8C (1 gasket)①	-8C-K6
12C, 16C (1 gasket)	-14C-K6
CA (1 inlet gasket, 1 outlet gasket)	-4CA-K6

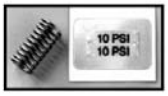
① Gasket is available for 2C, 4C, 6C, and 8C series valves for use in systems where pressure surges, shock, or pulses occur and is required in 6C and 8C series valves with 50 psi (3.5 bar) or higher spring cracking pressure.

Gasket Material	Designator
316 SS	SS
Alloy 400①	M
Aluminum②	A

① Not available for 6C, 8C, and CA series valves.

② Not available for 2C, 4C, 6C, 8C, and CA series valves.

Maintenance Kits



C, CP, CA, and CPA Series Spring Kits

Kits contain spring, two cracking pressure labels, and instructions. Select a basic kit ordering number and add a spring material designator.

Example: **302**-4C-K2-1/3

To order a kit with a PTFE-coated spring, add **T** to the kit ordering number.

Example: 302-4C-K2-1/3**T**

Valve Series	Cracking Pressure psi (bar)	Basic Kit Ordering Number
2C, 4C 4CP	1/3 (0.03)	-4C-K2-1/3
	1 (0.07)	-4C-K2-1
	10 (0.69)	-4C-K2-10
	25 (1.8)	-4C-K2-25
6C, 8C, 8CP	1/3 (0.03)	-8C-K2-1/3
	1 (0.07)	-8C-K2-1
	10 (0.69)	-8C-K2-10
	25 (1.8)	-8C-K2-25
12C, 16C	1/3 (0.03)	-14C-K2-1/3
	1 (0.07)	-14C-K2-1
	10 (0.69)	-14C-K2-10
	25 (1.8)	-14C-K2-25

Valve Series	Cracking Pressure psi (bar)	Basic Kit Ordering Number
CA, 4CPA	3 to 50 (0.21 to 3.5)	-4CA-K2-3
	50 to 150 (3.5 to 10.4)	-4CA-K2-50
	150 to 350 (10.4 to 24.2)	-4CA-K2-150
	350 to 600 (24.2 to 41.4)	-4CA-K2-350
8CPA	3 to 50 (0.21 to 3.5)	-8CA-K2-3
	50 to 150 (3.5 to 10.4)	-8CA-K2-50
	150 to 350 (10.4 to 24.2)	-8CA-K2-150
	350 to 600 (24.2 to 41.4)	-8CA-K2-350

Spring Material	Designator
302 SS	302
Alloy 400①	M

① Not available for CA or CPA series valves.



CH Series Spring Kits

Kits contain spring, two cracking pressure labels, and instructions. Select a basic kit ordering number and add a cracking pressure designator.

Example: 302-13K-CH4-**1/3**

Valve Series	Valve Body Material	Basic Kit Ordering Number
CH4	316 SS	302-13K-CH4-
	Alloy 400	M-13K-CH4-
CH8	316 SS	302-13K-CH8-
	Alloy 400	M-13K-CH8-
CH16	316 SS	302-13K-CH16-

Cracking Pressure psi (bar)	Designator
1/3 (0.03)	1/3
1 (0.07)	1
5 (0.35)	5
10 (0.69)	10
25 (1.8)	25



CP and CPA Series Deflector Cap Kits

Each kit contains five polyethylene deflector caps in red or green.

Male NPT	Kit Ordering Number	
	Red	Green
1/4 in.	P-4CP4-K12-RD	P-4CP4-K12-GR
1/2 in.	P-8CP4-K12-RD	P-8CP4-K12-GR

Safe Product Selection

When selecting a product, the total system design must be considered to ensure safe, trouble-free performance. Function, material compatibility, adequate ratings, proper installation, operation, and maintenance are the responsibilities of the system designer and user.

Caution: Do not mix or interchange parts with those of other manufacturers.

Warranty Information

Swagelok products are backed by The Swagelok Limited Lifetime Warranty. For a copy, visit swagelok.com or contact your authorized Swagelok representative.

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Cat Pump 333, 430, 331, 431, 335, 435



4 Frame Piston Pump

Standard Brass Models **333,430**

Stainless Steel Models **331, 431**

Pulse Pump Models **335,435**

FEATURES

Superior Design

- Triplex Uniflow design provides continuous forward liquid flow for smooth operation.
- Wetted cups and floating pistons are lubricated and cooled by pumped liquid for long cup life.
- Mechanically actuated inlet valves give strong lift and easy prime.
- 304 stainless steel discharge valves for wear resistance.
- Oil bath crankcase assures optimum lubrication.
- 100% wetted seal design allows pumped liquid to cool and lubricate for longer life.

Quality Materials

- Cylinder and sleeve wear surfaces are hard chrome plated 304 stainless steel for maximum durability and abrasion resistance.
- Chrome plated, brass manifolds and optional stainless steel manifolds are strong and corrosion resistant.
- Special high strength TNM connecting rods offer superior bearing quality strength.
- Chrome-moly crankshaft gives unmatched strength and surface hardness.
- Oversized crankshaft bearings with greater loading capacity mean longer bearing life.

Easy Maintenance

- Stepped stainless steel piston rod with chrome-plated, stainless steel sleeve allows easy replacement from front of pump.
- All wet-end wear parts are easily serviced without entering crankcase, requiring less time and effort.
- Wear parts are available in convenient kits.

⚠ WARNING

All systems require both a primary pressure regulating device (i.e., regulator, unloader) and a secondary pressure safety relief device (i.e., pop-off valve, safety valve). Failure to install such relief devices could result in personal injury or damage to the pump or to system components. CAT PUMPS does not assume any liability or responsibility for the operation of a customer's high pressure system.

SPECIFICATIONS

	U.S. Measure	Metric Measure
MODEL 333, 331, 335		
Flow	4.0 GPM	(15 L/M)
Pressure Range	100 to 1200 PSI	(7 to 85 BAR)
RPM	1070 RPM	(1070 RPM)
Bore	0.709"	(18 mm)
MODEL 430, 431, 435		
Flow	5.0 GPM	(19 L/M)
Pressure Range	100 to 1000 PSI	(7 to 70 BAR)
RPM	1040 RPM	(1040 RPM)
Bore	0.787"	(20 mm)
COMMON SPECIFICATIONS		
Stroke	0.768"	(19.5 mm)
Crankcase Capacity	21 oz.	(0.6 L)
Maximum Liquid Temperature	160°	(71°C)
Above 130°F call CAT PUMPS for inlet conditions and elastomer recommendations.		
Inlet Pressure Range	–8.5 to +40 PSI	(–0.6 to +2.8 BAR)
Inlet Ports (1)	1/2" NPTF	(1/2" NPTF)
Auxiliary Port (1)	1/4" NPTF	(1/4" NPTF)
Discharge Ports (2)	3/8" NPTF	(3/8" NPTF)
(1)	1/2" NPTF	(1/2" NPTF)
Pulley Mounting	Either Side	(Either Side)
Shaft Diameter	0.650"	(16.5 mm)
Weight	17.7 lbs.	(8.0 kg)
Dimensions	12.56 x 8.8 x 5.33"	(319 x 223 x 135.5mm)

ELECTRIC HORSEPOWER REQUIREMENTS

MODEL	FLOW		PRESSURE			MOTOR PULLEY SIZE Using 1725 RPM Motor & Std. 8" Pump Pulley O.D.	
			PSI 800	PSI 1000	PSI 1200		
	U.S. GPM	L/M	BAR 55	BAR 70	BAR 85	RPM	Pulley O.D.
333,331,335	4.0	15	2.2	2.7	3.3	1070	5.0
	3.0	11.4	1.6	2.1	2.5	803	3.8
	2.0	7.6	1.1	1.4	1.6	535	2.5
430,431,435	5.0	19	2.7	3.4	N/A	1040	5.1
	4.0	15	2.2	2.7	N/A	832	4.1
	3.0	11.4	1.6	2.1	N/A	624	3.1

DETERMINING THE PUMP R.P.M. $\frac{\text{Rated G.P.M.}}{\text{Rated R.P.M.}} = \frac{\text{"Desired" G.P.M.}}{\text{"Desired" R.P.M.}}$

DETERMINING THE REQUIRED H.P. $\frac{\text{GPM x PSI}}{1460} = \text{Electric Brake H. P. Required}$

DETERMINING MOTOR PULLEY SIZE $\frac{\text{Motor Pulley O.D.}}{\text{Pump R.P.M.}} = \frac{\text{Pump Pulley O.D.}}{\text{Motor R.P.M.}}$

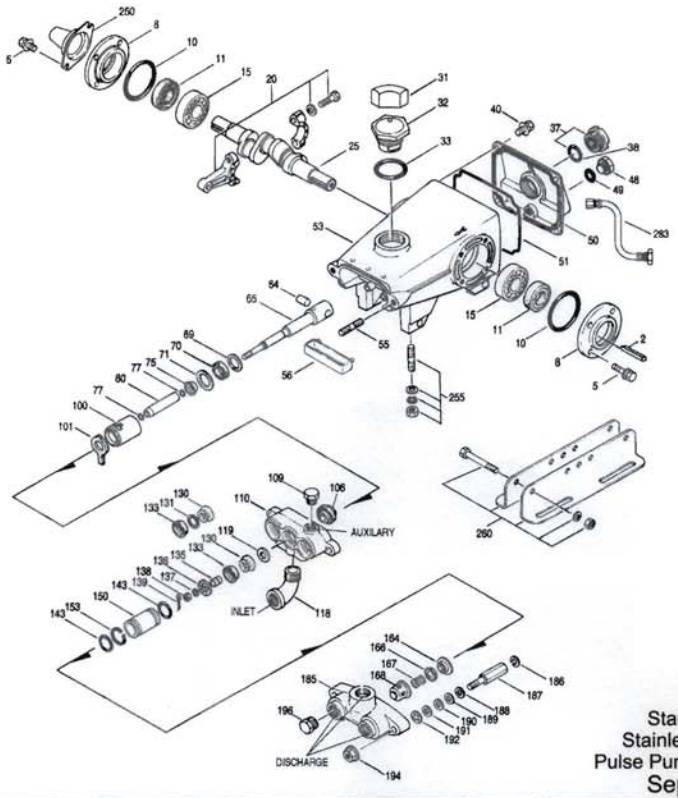
See complete Drive Packages [Incids: Pulleys, Belts, Hubs, Key] Tech Bulletin 003.
Refer to pump **Service Manual** for repair procedure, additional technical information and **pump warranty**.

"Customer confidence is our greatest asset"

PARTS LIST

ITEM	PART NUMBER				DESCRIPTION	QTY
	333 331 335	MATL	430 431 435	MATL		
2	*30047*	*STL*	*30047*	*STL*	*Key (M5x5x24)*	*1*
5	92519	STZP	92519	STZP	Screw, HHC, Sems (M6x16)	8
	125824	*STCP R*	*125824*	*STCP R*	*Screw, HHC, Sems (M6x16)*	*8*
8	27950	AL	27950	AL	Cover, Bearing	2
10	26536	NBR	26536	NBR	O-Ring, Bearing Cover - 70D	2
11	24159	NBR	24159	NBR	Seal, Oil	2
15	14487	STL	14487	STL	Bearing, Ball	2
20	48734	TNM	48734	TNM	Rod, Connecting [3/02]	3
25	43163	FCM	43163	FCM	Crankshaft, Dual End, Tapped (M8x1.25)	1
31	*828710*	*—*	*828710*	*—*	*Protector, Oil Cap w/Foam Gasket*	*1*
32	43211	ABS	43211	ABS	Cap, Oil Filler	1
33	14177	NBR	14177	NBR	O-Ring, Oil Filler Cap - 70D	1
37	92241	—	92241	—	Gauge, Oil Bubble w/Gasket - 80D	1
38	44428	NBR	44428	NBR	Gasket, Flat, Oil Gauge - 80D	1
40	92520	STZP	92520	STZP	Screw, HHC, Sems (M6x20)	4
	126541	*STCP R*	*126541*	*STCP R*	*Screw, HHC, Sems (M6x20)*	*4*
48	25625	STCP	25625	STCP	Plug, Drain (1/4"x19 BSP)	1
49	23170	NBR	23170	NBR	O-Ring, Drain Plug - 70D	1
50	48772	AL	48772	AL	Cover, Rear [10/04]	1
51	48773	NBR	48773	NBR	O-Ring, Rear Cover [10/04]	1
53	48912	AL	48912	AL	Crankcase [10/04]	1
55	126546	STCP R	126546	STCP R	Stud (M8x41.4)	2
56	*27712*	*POP*	*27712*	*POP*	*Pan, Oil (use with Blue-Dot Seals and Wick)*	*1*
64	16948	CM	16948	CM	Pin, Crosshead	3
65	27981	SZZ	27981	SZZ	Rod, Piston, Stepped	3
69	126259	STCP R	126259	STCP R	Washer, Oil Seal	3
70	25301	NBR	25301	NBR	Seal, Oil, Crankcase - 80D	3
71	126189	STCP R	126189	STCP R	Washer, Oil Seal	3
75	25327	S	25327	S	Slinger, Barrier	3
77	25392	NBR	25392	NBR	O-Ring, Sleeve - 70D	6
	28771	*FPM*	*28771*	*FPM*	*O-Ring, Sleeve*	*6*
	28772	*PTFE*	*28772*	*PTFE*	*O-Ring, Sleeve*	*6*
80	25299	SCP	25299	SCP	Sleeve	3
	28460	*S*	*28460*	*S*	*Sleeve*	*3*
100	27710	PVDF	27710	PVDF	Retainer, Seal	3
101	*27711*	*—*	*27711*	*—*	*Wick, Long Tab (use with Blue-Dot Seals and Oil Pan)*	*3*
106	30315	NBR	30315	NBR	Seal, LPS, Prrrrrm-A-Lube - 80D	3
	30325	*FPM*	*30325*	*FPM*	*Seal, LPS, Prrrrrm-A-Lube*	*3*
	25153	*NBR*	*25153*	*NBR*	*Seal, LPS, Blue-Dot (use with Wick and Oil Pan)*	*3*
109	22177	BBCP	22177	BBCP	Plug (1/4" NPT)	1
110	25128	BBCP	25128	BBCP	Manifold, Inlet	1
	25635	*SS*	*25635*	*SS*	*Manifold, Inlet (331, 431)*	*1*
118	22160	BBCP	22160	BBCP	Elbow, Street (1/2" NPTM)	1
119	**28339**	**S**	**27004**	**S**	Valve, Inlet	3
130	**43784**	**S**	**22021**	**S**	Piston	3
131	***43719***	***PTFE***	**—**		Back-up-Ring, Bac-Cup	3
133	***43717***	***FPM***	**43172**	**FPM**	Cup, Piston	3
133	*43826*	***FPM***	**—**		Assy, Bac-Cup (Inclds: 130,131,133) (333 only)	3
133	**28955**	**NBR**	**—**		Cup, Piston, Machined	3
133	*29088*	***SNG***	*29089*	*SNG*	Cup, V-Hot	3
133	***34019***	***TG***	***30145***	***TG***	Cup-Piston, w/O-Ring (1000 PSI Max)	3
135	27983	S	27983	S	Spacer, Piston	3
136	27002	S	27002	S	Retainer, Piston	3
137	27006	S	27006	S	Washer, Conical (M6)	3
138	27000	S	27000	S	Nut, Slotted (M6)	3
139	14158	S	14158	S	Cotterpin (M1.6x10)	3
143	23172	NBR	23172	NBR	O-Ring, Cylinder - 70D	6
	11377	*FPM*	*11377*	*FPM*	*O-Ring, Cylinder - 80D*	*6*
	26961	*PTFE*	*26961*	*PTFE*	*O-Ring, Cylinder*	*6*
150	**25660**	**SCP**	**24285**	**SCP**	Cylinder	3
	29013	***S***	***29044***	***S***	*Cylinder*	*3*
153	**21985**	**PTFE**	**—**		Back-up-Ring, Cylinder	3
164	43434	S	43434	S	Seat, Q.V.	3
	29487	*S*	*29487*	*S*	*Seat, F.V.*	*3*
166	43723	S	43723	S	Valve, Q.V.	3
	22842	*S*	*22842*	*S*	*Valve, F.V.*	*3*
167	43360	S	43360	S	Spring, Q.V.	3
	22031	*S*	*22031*	*S*	*Spring, F.V.*	*3*
168	43442	S	43442	S	Retainer, Spring, Q.V.	3
	22841	*S*	*22841*	*S*	*Retainer, Spring, F.V.*	*3*
185	24459	BBCP	24459	BBCP	Manifold, Discharge	1
	25634	*SS*	*25634*	*SS*	*Manifold, Discharge (331, 431)*	*1*
	6400	*BB*	*6400*	*BB*	*Manifold, Pulse Pump (335, 435)*	*1*
	6300	*BBSS*	*6300*	*BBSS*	*Pump, Pulse (335, 435)*	*1*
186	15845	STZP	15845	STZP	Lockwasher (M8)	2
	126232	*STCP R*	*126232*	*STCP R*	*Lockwasher (M8)*	*2*
187	126564	STCP R	126564	STCP R	Bolt, Cylinder (M8)	2
188	43425	STZP	43425	STZP	Washer, Shim (M13x8x2)	2/4
	126591	*STCP R*	*126591*	*STCP R*	*Washer, Shim (M13x8x2)*	*2/4*
189	126813	STCP R	126813	STCP R	Washer, Shim (M13x8x1))	2/4

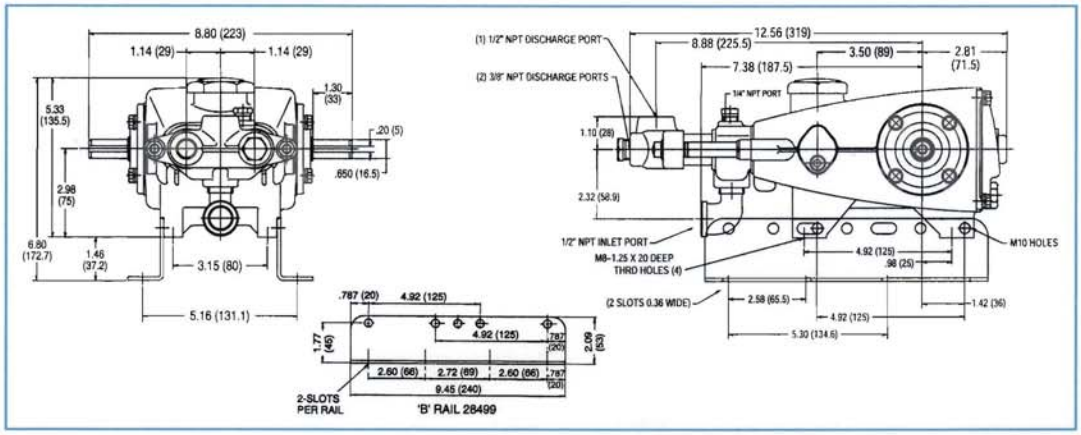
EXPLODED VIEW



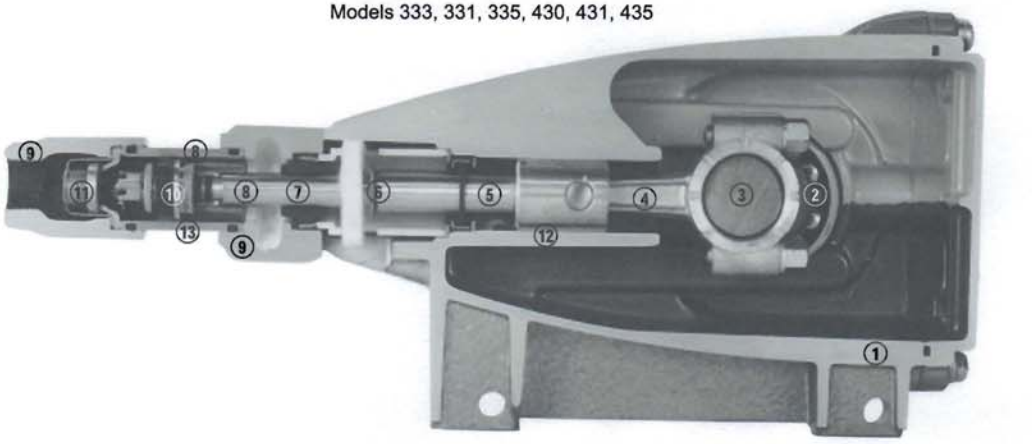
Models
Standard - 333, 430
Stainless Steel - 331, 431
Pulse Pump Manifold - 335, 435
September 2007

	333 331 335	MATL	430 431 435	MATL		
190	126576	STCP R	126576	STCP R	Washer, Shim (M13x8x.5)	2/4
191	43258	STZP	43258	STZP	Washer, Shim (M13x8x.3)	2/4
	126590	*STCP R*	*126590*	*STCP R*	*Washer, Shim (M13x8x.3)*	*2/4*
192	26676	S	26676	S	Lockwasher (M8)	2
194	126201	STCP R	126201	STCP R	Nut, Hex Flange (M8)	2
196	22187	BBCP	22187	BBCP	Plug (3/8" NPT)	1
250	*25130*	*STCP*	*25130*	*STCP*	*Protector, Shaft*	*1*
255	*30243*	*STZP*	*30243*	*STZP*	*Kit, Direct Mount*	*1*
260	*30611*	*STZP*	*30611*	*STZP*	*Assy, Rail Mount*	*1*
265	*30652*	—	*30652*	—	*Assy, Mount (Incids: 30611, 30048, 30047, 25130)*	*1*
270	*30244*	*STL*	*30244*	*STL*	*Assy, Pulley (Incids: 30048, 30047)*	*1*
283	*34334*	—	*34334*	—	*Kit, Oil Drain*	*1*
300	***30239***	***NBR***	—	—	*Kit, Mach Cup (Incids: 133,139,143,153)*	*1*
	—	—	***30023***	***FPM***	*Kit, Cup (Incids: 133,139,143)*	*1*
301	***30841***	***FPM***	—	—	*Kit, Bac-Cup (Incids: 133,139,143,153)*	*1*
302	*30240*	***NBR***	—	—	*Kit, Piston (Incids: 119,133,135-139,143,153)*	*1*
	—	—	***30210***	*NBR*	*Kit, Piston (Incids: 119,130,133,135-139,143)*	*1*
	30842	***NBR***	—	—	*Kit, Bac-Cup Piston (Incids: 119,133,135-139,143,153)*	*1*
304	—	—	***30272***	*NBR*	*Kit, Hot Cup (Incids: 133, 139, 143)*	*1*
305	*30312*	*NBR*	*30312*	*NBR*	*Kit, Sleeve & Prrrrrm-A-Lube Seal (Incids: 75,77,80,106,139)*	*1*
	30230	*NBR*	*30230*	*NBR*	*Kit, Sleeve & Blue-Dot Seal (Incids: 75,77,80,101,106,139)*	*1*
306	*30305*	*NBR*	*30305*	*NBR*	*Kit, Prrrrrm-A-Lube Seal (Incids: 106,139)*	*1*
	30229	*NBR*	*30229*	*NBR*	*Kit, Blue-Dot Seal (Incids: 101,106,139)*	*1*
310	*30686*	*NBR*	*30686*	*NBR*	*Kit, Valve - Q.V. (Incids: 143,164,166,167,168)*	*1*
	30024	*NBR*	*30024*	*NBR*	*Kit, Valve - F.V. (Incids: 143,164,166,167,168)*	*1*
—	*6107*	—	*6107*	—	*Oil, Bottle (21 oz.) ISO 68 Multi-viscosity Hydraulic (Fill to specified crankcase capacity prior to start-up)*	*1*

Bold print part numbers are unique to a particular pump model. *Italics are optional items.*
[ ] Date of latest production change. R Components comply with RoHS Directive.
See Tech Bulletins 002, 016, 017, 020, 024, 025, 026, 030, 034, 036, 037, 038, 043, 074, 077, 083 and 090 for additional information.
MATERIAL CODES (Not Part of Part Number): ABS=ABS Plastic AL=Aluminum BB=Brass BBCP=Brass/Chrome Plated CM=Chrome-Moly FCM=Forged Chrome-moly FPM=Fluorocarbon NBR=Medium Nitrile (Buna-N) POP=Polypropylene PTFE=Pure Polytetrafluoroethylene PVDF=Polyvinylidene Fluoride S=304SS SCP=304SS/Chrome Plated SS=316SS SNG=Special Blend (Buna) STCP=Steel/Chrome Plated STL=Steel STZP=Steel/Zinc Plated SZZ=304SS/Zamak TG=PTFE Graphite Compound (GIT) TNM=Special High Strength



Models 333, 331, 335, 430, 431, 435



1 Die cast aluminum **crankcase** means high strength, lightweight, and excellent tolerance control.

2 Oversized crankshaft **bearings** provide extended bearing life and pump performance.

3 Chrome-moly **crankshaft** provides unmatched strength and surface hardness for long life.

4 Matched oversized TNM **connecting rods** noted for superior tensile strength and bearing quality.

5 The **piston rods** are high tensile strength 304 stainless steel with zamak crossheads.

6 The stainless steel **slinger** provides back-up protection for the crankcase seal, keeping pumped liquids out of the crankcase.

7 The **patented stepped piston rod** with hard chrome-plated stainless steel **sleeve** provides a durable wear surface and easy wet-end servicing.

8 The **cylinder** and **sleeve** wear surfaces are hard chrome-plated 304 stainless steel for longer service life.

9 **Manifolds** are of high tensile strength chrome-plated brass or 316 stainless steel for special corrosion resistance.

10 100% wet **cup/seal** design adds to service life by allowing pumped liquids to cool and lubricate the elastomers on both sides.

11 304 stainless steel **valves, seats, and springs** provide corrosion-resistance, ultimate seating and extended life.

12 **Crossheads** are 360° supported for uncompromising alignment.

13 Mechanically actuated **inlet valves** provide strong lift and easy prime.

Products described hereon are covered by one or more of the following U.S. patents 3558244, 3652188, 3809508, 3920356, 3930756 and 5035580

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PN 993140 Rev C 6725

Pressure Regulator

Standard Models
7001-7033

Stainless Steel Models
7001.100-7033.100



7021-7033 7001-7003 7011-7014

FEATURES

- Lightweight flow-through design for easy installation.
- Unique high velocity design assures consistent pressure for multiple pump or shut-off gun installations.
- All metal wear parts are stainless steel; all elastomers are FPM for durability.
- Adjusting nut allows easy calibrated pressure adjustment.
- Multiple regulators can be installed in parallel to handle larger volumes.
- No external moving parts or springs.

⚠ WARNING

All systems require both a primary pressure regulating device (i.e., regulator, unloader) and a secondary pressure safety relief device (i.e., pop-off valve, safety valve). Failure to install such relief devices could result in personal injury or damage to the pump or to system components. CAT PUMPS does not assume any liability or responsibility for the operation of a customer's high pressure system.

SPECIFICATIONS

		U.S. Measure	Metric Measure
MODELS 7001, 7002, 7003 AND .100			
Flow Range		0.5-5.0 GPM	(1.9-19 L/M)
Pressure Range	(7001)	100-1000 PSI	(7-70 BAR)
	(7002)	500-2000 PSI	(35-140 BAR)
	(7003)	1500-3000 PSI	(105-210 BAR)
Max. Temperature		180°F	(82°C)
Inlet/Outlet Port		3/8" NPTF	(3/8" NPTF)
By-Pass Port		1/2" NPTF	(1/2" NPTF)
Weight		2.25 lbs.	(1.02 kg)
Dimensions		6.25 x 1.5"	(159 x 38 mm)
MODELS 7011, 7012, 7013, 7014 AND .100			
Flow Range		1.0-10.0 GPM	(3.8-38 L/M)
Pressure Range	(7011)	100-1000 PSI	(7-70 BAR)
	(7012)	500-2000 PSI	(35-140 BAR)
	(7013)	1500-3000 PSI	(105-210 BAR)
	(7014)	2000-4000 PSI	(140-275 BAR)
Max. Temperature		180°F	(82°C)
Inlet/Outlet Port		1/2" NPTF	(1/2" NPTF)
By-Pass Port		3/4" NPTF	(3/4" NPTF)
Weight		3.75 lbs.	(1.70 kg)
Dimensions		7.5 x 1.88"	(191 x 48 mm)
MODELS 7021, 7022, 7023, 7024 AND .100			
Flow Range		2.5-25.0 GPM	(9.5-95 L/M)
Pressure Range	(7021)	100-1000 PSI	(7-70 BAR)
	(7022)	500-2000 PSI	(35-140 BAR)
	(7023)	1500-3000 PSI	(105-210 BAR)
	(7024)	2000-4000 PSI	(140-275 BAR)
Max. Temperature		180°F	(82°C)
Inlet/Outlet Port		3/4" NPTF	(3/4" NPTF)
By-Pass Port		1" NPTF	(1" NPTF)
Weight		5.0 lbs.	(2.40 kg)
Dimensions		8.5 x 2.25"	(216 x 57 mm)
MODELS 7031*, 7032, 7033 AND .100			
Flow Range		3.5-35 GPM	(13.2-133 L/M)
Pressure Range	(7031)	250-1000 PSI	(18-70 BAR)
	(7032)	1000-2000 PSI	(70-140 BAR)
	(7033)	1500-3000 PSI	(105-210 BAR)
Max. Temperature		180°F	(82°C)
Inlet/Outlet Port		3/4" NPTF	(3/4" NPTF)
By-Pass Port		1" NPTF	(1" NPTF)
Weight		5.5 lbs.	(2.50 kg)
Dimensions		8.5 x 2.25"	(216 x 57 mm)

* Model 7031 replaces model 7028.

"Customer confidence is our greatest asset"

SELECTION

This pressure regulator is designed for systems with single or multiple pumps, solenoid (gate) valves, nozzles, and standard or "weep" guns.

Note: For multiple pump systems, it is best to use a pressure regulator not a pressure sensitive regulating unloader.

This regulator should meet both the desired system flow (combined nozzle flow rate requirement) and the desired system pressure.

Note: Operation below the minimum flow of the regulator causes the regulator to cycle or chatter. Operation above the maximum flows of the regulator causes premature regulator wear, regulator cycling and prevents attaining desired system pressure.

INSTALLATION

This regulator operates properly when mounted in any direction; however, it is preferred to keep the plumbing to a minimum and the pressure adjusting nut easily accessible. The best mounting location is directly on the pump discharge manifold head. Flexible, high pressure hose (minimum single wire braid) should be at least the size of the regulator ports when plumbing to and from the regulator.

Since this is a flow through design regulator, the inlet and discharge connections are interchangeable and are located on the sides. An arrow on the label indicates liquid flow in either direction. Port size varies with each size of regulator (see specifications). Plumb into one side for inlet flow from pump and plumb opposite side to the discharge line with spray guns, solenoid (gate) valves or nozzles.

The by-pass connection of this regulator is located on the bottom. An arrow on the label indicates the direction of flow. Port size varies with each size of regulator (see specifications). By-pass liquid is directed out this port and can be routed to a reservoir (preferred method), or to a drain or back to the pump inlet.

OPERATION

This pressure regulator maintains established system pressure in the discharge line and at the pump head when the trigger gun is closed or solenoid (gate) valve is closed or the nozzle is clogged, thus by-passing all unrequired flow. Squeezing the trigger gun or opening the solenoid (gate) valve allows for a quick return to established system pressure without delay.

PRESSURE ADJUSTMENT

1. Setting and adjusting the regulator pressure must be done with the system "on".
2. Start the system with regulator backed off to the lowest pressure setting (counterclockwise direction).
3. Squeeze the trigger and read the pressure on the gauge at the pump.

Note: Do not read the pressure at the gun or nozzle.

4. If more pressure is desired, release the trigger, turn brass adjusting nut one quarter turn in clockwise direction.
5. Squeeze the trigger and read the pressure.
6. Repeat this process until desired system pressure is attained.
7. Once the desired system pressure is reached, stop turning the brass adjusting nut.

CAUTION: A minimum by-pass flow of 5% of the regulator rated flow capacity is required for proper regulator performance. If the entire output is directed through the regulator (zero by-pass) the "cushioning" feature of the by-pass liquid is eliminated and the regulator can malfunction or wear prematurely.

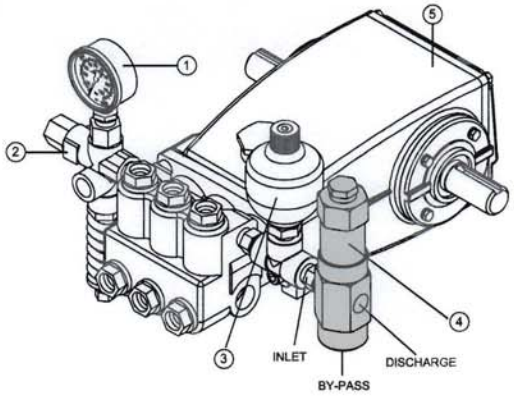
8. If desired system pressure cannot be reached, review TROUBLESHOOTING chart.
9. When servicing existing systems, back off adjusting nut.
10. Follow adjustment procedures as stated above.

Note: Do not adjust regulators pressure setting to compensate for a worn nozzle. Check the nozzle as part of the regular maintenance and replace if worn.

Note: A secondary pressure safety relief device (i.e. pop-off valve, safety valve) should be used along with this pressure regulator. Final adjustment for the relief valve should relieve at 200 psi above the system operating pressure.

TYPICAL REGULATOR INSTALLATION

1 Pressure Gauge
2 Relief Valve
Shown as a secondary safety relief valve
3 Pulsation Dampener
4 Pressure Regulator
5 Triplex Plunger Pump



SERVICING

CAUTION: Before commencing with service, shut off drive (electric motor, gas or diesel engine) and turn off water supply to pump. Relieve all discharge line pressure by triggering gun or opening valve in discharge line.

Disassembly

1. Disconnect by-pass, discharge and inlet plumbing from regulator.
2. Remove regulator from pump.
3. Secure lower body of regulator in a vise with brass adjusting nut facing up.
4. Remove upper body by unthreading from lower body.
5. Grasp top of piston stem and separate from conical piston.
6. Remove piston stem with stack of spring washers, flat washers and anti-rotating washer and place on flat surface.
7. Remove conical piston with reverse pliers by making contact on the inside diameter of conical piston.

CAUTION: Exercise extreme caution to avoid contact and damage to outside diameter and sharp tip of conical piston.

8. Remove piston retainer from lower body of regulator.

CAUTION: Exercise extreme caution to avoid contact and damage to the inside diameter of the piston retainer.

9. Remove conical seat from lower body of regulator.

CAUTION: Exercise extreme caution to avoid contact and damage to outside diameter and the tapered surface of the seat.

Note: With the regulator completely disassembled, inspect lower body sealing areas where the conical seat and piston retainer makes contact for grooves, pitting and wear. If damage is found, replace with new lower body or complete new regulator. If not, proceed with reassembly.

Reassembly

Note: Conical piston and seat should be changed as a matched set when upgrading from the old tapered piston and seat. See Tech Bulletin 097.

Note: Spring washers and flat washers should be changed as a spring set. See Tech Bulletin 102.

1. Place lower regulator body with by-pass port facing down into a vise.
2. Lubricate and install o-ring onto outside diameter of conical seat. Press conical seat down into lower regulator body with small hole facing up.
3. Lubricate and install o-ring onto piston retainer. Press piston retainer with raised surface facing up.
4. Lubricate and install back-up-ring, then o-ring onto outside diameter of conical piston. Press conical piston with sharp point down into piston retainer.
5. Replace piston stem with stack of spring washers and flat washers into hole of conical piston.
6. Place anti-rotating washer on top of spring set. Align tabs on washer with slots on the upper body.

Note: The number of flat washers varies with each spring set. Place the first flat washer between the anti-rotating washer and spring stack. Place second washer (if required) between spring stack and retaining ring. Place all remaining washers with first washer.

7. Thread upper body into lower body.
8. Re-install regulator onto pump.
9. Reconnect by-pass, discharge and inlet plumbing to regulator.
10. Proceed to PRESSURE ADJUSTMENT.

TROUBLESHOOTING

Cycling / Chattering	• Too little flow for valve specifications. • Air in system, poor connections. • Inlet seals in pump worn. • O-ring in gun worn.
System will not build up to pressure	• Nozzle worn. • Improper nozzle size for system specs. • Foreign material trapped in seat.
Pressure drop	• Nozzles worn. • Piston and seat in regulator worn. • Air in system, poor connections. • Insufficient flow to pump. • Filter clogged. Check and clean regularly. • Fatigued or broken spring washers.
Pressure spikes while in by-pass	• Minimum by-pass of 5% not present. • Excessive pressure adjustment made for worn nozzle. REPLACE NOZZLE. Reset system pressure.
Leakage from regulator vent hole or top slots	• O-ring around piston worn. Service with O-ring Kit. • Piston Retainer scored. Service with O-ring kit. • Fatigued or broken spring washers.

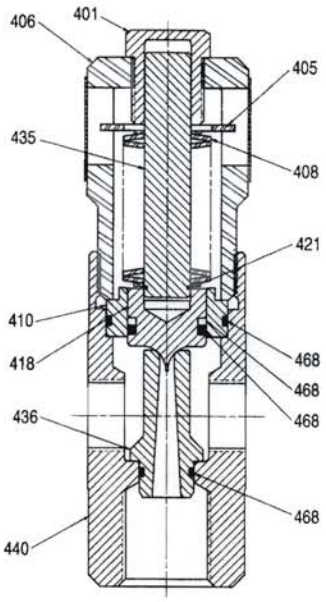
Approximate Pressure Reading at Gauge	Gauge Between Pump/Regulator	Gauge Between Regulator/Gun-Nozz-Valve
System in operation (gun open)	system pressure	system pressure
System in by-pass (gun closed)	200-300 PSI above system pressure	200-300 PSI above system pressure

90 DAY WARRANTY

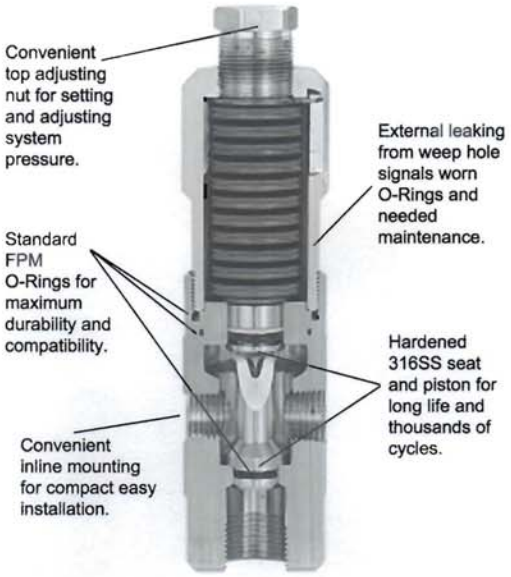
Refer to complete CAT PUMPS Warranty for further information.

EXPLODED VIEW

(Models 7001, 7002, 7003 shown)



CUTAWAY



PARTS LIST

Item	Description	MATL	7001	7002	7003	7011	7012	7013	7014	7021	7022	7023	7024	7031	7032	7033
401	Nut, Adjusting	BB	30758	30758	30758	30759	30759	30759	30759	30760	30760	30760	30760	30760	30760	30760
405	Washer, Anti-Rot	STL	34491	34491	34491	34492	34492	34492	34492	34493	34493	34493	34493	34493	34493	34493
406	Body, Upper		—	—	—	—	—	—	—	—	—	—	—	—	—	—
408	Spring Set	STL	76201	76202	76202	76211	76212	76213	76214	76221	76222	76223	76224	76221	76222	76223
410	Retainer, Piston	SSS	30873	30873	30874	30875	30875	30876	30876	30877	30877	30878	30878	30877	30877	30878
	Retainer, Piston (.100 Option)	*SS*	*33885*	*33885*	*33886*	*31635*	*31635*	*31666*	*31666*	*33877*	*33877*	*31878*	*31878*	*33877*	*33877*	*30878*
418	Piston, Conical	SSB	31733	31733	31734	31738	31738	31739	31739	31743	31743	31744	31744	—	—	—
	Piston, Conical	SSSS	—	—	—	—	—	—	—	—	—	—	—	31749	31749	31750
421	Ring, Retainer	STL	30585	30585	30885	30886	30886	30886	30886	30887	30887	30887	30887	30887	30887	30887
435	Stem, Piston	STL	30588	30588	30888	30889	30889	30889	30889	30892	30892	30892	30892	30892	30892	30892
436	Seat, Conical	SSB	31732	31732	31732	31736	31736	31736	31736	31742	31742	31742	31742	—	—	—
	Seat, Conical	SSSS	—	—	—	—	—	—	—	—	—	—	—	31748	31748	31748
440	Body, Lower	STNP	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Body, Lower (.100 Option)	*SS*	—	—	—	—	—	—	—	—	—	—	—	—	—	—
468	*Kit, O-Ring, Hex Body Style*	*FPM*	*30771*	*30771*	*30775*	*30777*	*30777*	*30781*	*30781*	*30783*	*30783*	*30787*	*30787*	*30783*	*30783*	*30787*
—	*Kit, O-Ring, Round Body Style*	*FPM*	*30770*	*30772*	*30774*	*30776*	*30778*	*30780*	—	*30782*	*30784*	*30786*	—	—	—	—

It is recommended to replace spring washers and flat washers as a set.

Italics are optional items. See Tech Bulletins 022, 044,097 and 102 for additional information.

Material Codes (Not Part of Part Number):

BB=Brass FPM=Fluorocarbon SS=316SS SSB=316SS Condition B SSS=416SS SSSS=440SS STNP=Steel/Nickel Plated STL=Steel

Contact CAT PUMPS for optional NBR or EPDM O-Ring Kits.

Products described hereon are covered by one or more of the following U.S. patents 3558244, 3652188, 3809508, 3920356, 3930756 and 5035580

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PN 993155 Rev D 12725

DF
PADDLE WHEEL FLOW SENSOR

KOBOLD

Flow
Pressure
Level
Temperature
measurement
monitoring
control



- **±2.5% of Full Scale Accuracy**
- **Analog Output**
- **Easy to Install and Maintain**
- **Robust and Reliable**
- **No. Min. Requirements for Straight Inlet and Outlet Pipe**
- **Low Pressure Drop**
- **7 Different Material Combinations Available**

S4

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Visit KOBOLD Online at
www.kobold.com

Model:
DF



DF-...
with female thread

Flow Sensor DF

The main feature of the KOBOLD DF flow sensor is the incorporation of a multipole magnet ring into the paddlewheel. As the paddlewheel rotates, these magnets, hermetically separated from the fluid medium, induce an DC signal in a Hall sensor mounted on the device housing. Since the DC signal frequency is proportional to paddlewheel rotation, an accurate flowrate reading is possible.

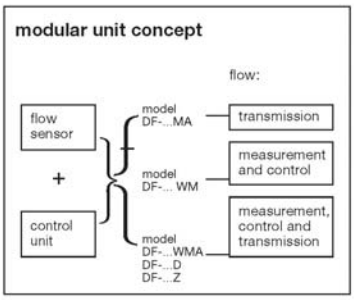
The DF sensor, when coupled with the appropriate KOBOLD electronics unit, can offer the user a number of features useful in the measurement and control of fluid flow. These features include an analog output, adjustable switches, batch controller, or totalizer.

Specifications

Accuracy: ± 2.5% of full scale
Media: water and low viscosity liquids
Orientation: universal
Fittings: 1/8" NPT ... 1 1/2" NPT,
flange ANSI 1/2", 1", 1 1/2"
7 different material combination: trogamid, polysulfone, brass, SS, teflon



DF-...
with flange



Materials combination	Standard I	II/IIB*	III	IV*	High Pressure Design VI*	VII*
Connecting type	Female thread	Female thread	Female thread	Female thread flange	Female thread	Female thread flange
Housing	Trogamid	Polysulfone/PP	Brass Nickel-plated	SS	Brass Nickel-plated	SS
Housing lid	Trogamid	Polysulfone/PP	Polysulfone	Polysulfone	Brass Nickel-plated	SS
Connection	Brass Nickel-plated	SS/PP	Brass Nickel-plated	SS	Brass Nickel-plated	SS
Locking pins	Brass	Brass	Brass	–	–	–
O-rings	Buna-N	Viton	Buna-N	Viton	Buna-N	Viton
Paddle wheel	Delrin	Teflon	Delrin	Teflon	Delrin	Teflon
Axle	SS	SS/Ceramic	SS	SS	SS	SS
Axle Bearing	Teflon	Teflon	Teflon	Teflon	Teflon	Teflon
Orifice	Teflon[2]	Teflon[2]	Teflon[2]	Teflon[2]	Teflon[2]	Teflon[2]
Max. operating pressure PSI	145	145/85	230	230	1450	1450 (with flange 580)
Max. operating temperature (°F)	145	180	180	180	180	180

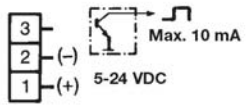
* Fittings not rotatable [1]for Model DF..01 Titanium [2] for Model DF..01 SS

Subject to change without prior notice.

Description

The Kobold DF Flow Sensor is used in applications where flow measurement is desired and flow rate data is to be transmitted as a pulse rate output. the DF Flow Sensor contains a flow transducer which transmits a pulse signal. the output signal is linearly proportional to the flow and is transmitted by a bipolar transistor operating in an open collector configuration (10 mA sinking capability).

Wiring Diagram

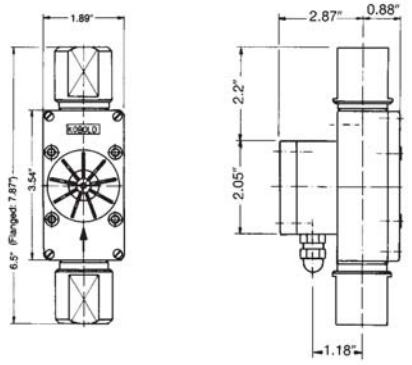


Specifications

Power Supply: + 5 to + 24 VDC
Open Collector: + 5 to + 24 VDC, 10 mA max.
Temperature Range: -10°F to 180°F (145°F DF-01...)
Protection: NEMA 4



Dimensions



S4

Order Numbers

Range water GPM	Stand. conn. NPT	Dia. of Orifice inches	Press. drop max. PSI	DF Flow Sensor Material Combination I DF-01..	II DF-02..	II B DF-00..	III DF-03..	IV DF-04..	VI DF-06..	VII DF-07..	Range Size
0.02– 0.14	1/8"	0.04	10.2								..01
0.05– 0.30	1/4"	0.08	4.2								..02
0.05– 0.60	1/4"	0.08	10.4								..03
0.1 – 0.7	1/4"	0.11	9.6								..04
0.2 – 2.5	3/8"	0.19	12.1								..05
0.4 – 5	1/2"	0.32	2.9								..06
0.5 – 6	3/4"	0.32	4.4								..07
0.5 –12	3/4"	0.49	4.4								..08
1 –25	1 1/4"	0.59	15.9								..09
1.5 –36	1 1/4"	0.73	13.5								..10

Options (add suffix to order number)

Special conn. NPT Suffix "-B"	For flange connection (only material combination IV and VII) Suffix "FL"
1/8"	
3/8"	
3/8"	
3/8"	
1/2"	
3/4"	
1"	
1"	
1 1/2"	
1 1/2"	on request

Note to place an order

1. Select the sensor order no.
2. Select the required suffix

For example: DF-0109B
All Sensors will be delivered with calibration certificate

Subject to change without prior notice.

KOBOLD Model DF Flow Sensor

User Instructions



Kobold Instruments Inc. • 1801 Parkway View Drive • Pittsburgh PA 15205

Phone 1-800-998-1020 • Fax (412) 788-4890 • www.koboldusa.com

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KOBOLD Model DF Flow Sensor
User Instructions

CAUTION: For safety reasons, please read the cautionary information located at the end of the manual, before attempting installation.

1.0 General

The KOBOLD DF flow sensor is intended for use in applications where flow measurement is desired and the flow rate data needs to be transmitted as a pulse rate output. The DF sensor contains a flow transducer which transmits a 0-100 Hz signal. This output frequency is linearly proportional to the flow measured by the instrument and is transmitted by a bipolar transistor operating in an open collector configuration (10 mA sinking capability).

The DF uses a paddle wheel to meter flow. The principle of operation is quite simple; the paddle wheel rotation is calibrated for flow rate. This rotation-flow relationship is linear in theory. In practice, theory is nearly borne out, leading to a very precise measuring device. Any non-linearity is within the stated measurement error of the device.

The paddle wheel approach to flow measurement has the advantage that the instrument may be installed in any orientation; only the flow direction is specified. Further, this measurement technique is relatively insensitive to dirt in the medium (ferritic contaminants, however, must be avoided unless the DF sensor with an inductive, rather than magnetic, pickup has been purchased).

2.0 Specifications

Table 2.1: Material Composition & Operational Limits

Material Combination	I	II/IIB	III	IV *	V *	VI *	VII *
Fittings	**NPT**	**NPT**	**NPT**	**NPT or FLANGE**	**NPT**	**NPT**	**NPT or FLANGE**
Housing	Trogamid®	Polysul-fone/PP	NP-Brass	316 SS	Teflon®	NP-Brass	316 SS
Window	Trogamid®	Polysul-fone/PP	Trogamid®	Polysulfone	Teflon®	NP-Brass	316 SS
Fittings	NP-Brass	316 SS/PP	NP-Brass	316 SS	Teflon®	NP-Brass	316 SS
Locking Pins	Brass	Brass	Brass	-	-	-	-
O-Rings	Buna-N	Viton®	Buna-N	Viton®	-	Buna-N	Viton®
Paddle Wheel	Delrin®	Teflon®	Delrin®	Teflon®	Teflon®	Delrin®	Teflon®
Axle	Brass	SS/ Ceramic	Brass	316 SS	Ceramic	Brass	316 SS
Axle Bearing	Teflon®	Teflon®	Teflon®	Teflon®	GFR-Teflon®	Teflon®	Teflon®
Orifice	Teflon® [2]	Teflon® [2]	Teflon® [2]	Teflon® [2]	Teflon® [3]	Teflon® [2]	Teflon® [2]
STANDARD VERSION						HIGH PRESSURE VERSION	
Maximum Pressure	145 PSIG	145/85 PSIG	230 PSIG	230 PSIG	85 PSIG	1450 PSIG	1450 PSIG or 580 PSIG with flange
Maximum Temperature	145°F	180°F	180°F	180°F	180°F	180°F	180°F

* Fittings not Rotatable

[2] SS on Model DF-XX01

[3] Titanium on Model DF-X501

Abbreviations:

PP - Polypropylene

GFR - Glass Fiber Reinforced

NP - Nickel Plated

FM Rev. 1/12/00

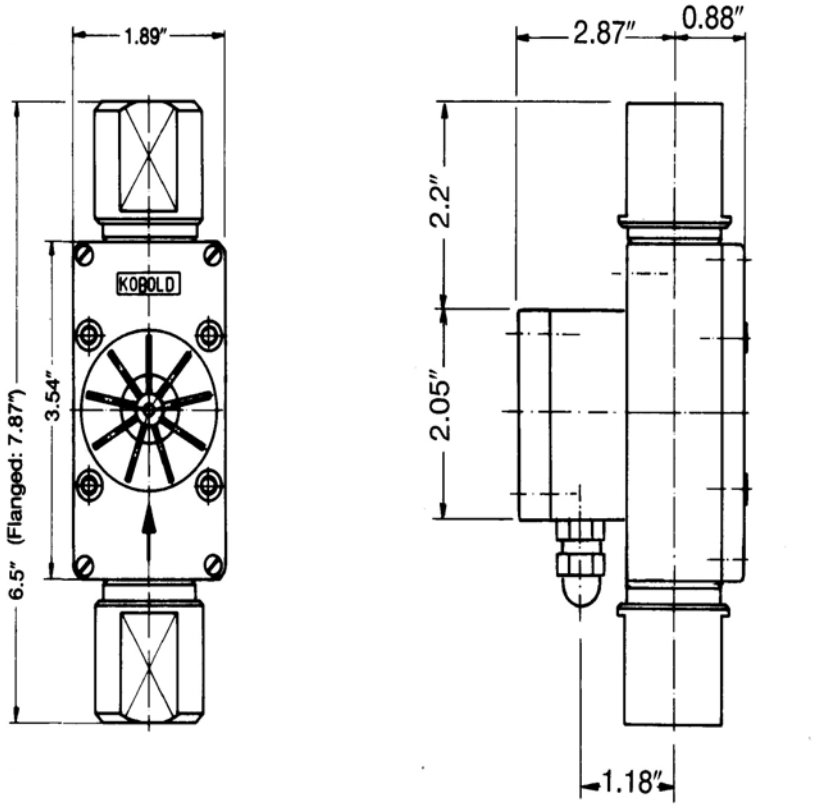
Table 2.2: Electrical Data

Power Supply:	+5 to +24 VDC
Open Collector:	+5 to +24 VDC 10 mA max
Operating Temperature:	-25° C to 80° C -15° F to 180° F
Environmental Protection:	NEMA 4

Table 2.3: Flow Ranges & Fitting Sizes

Sensor Model Number	Range Water GPM	Special Range GPH Suff. "-L"	Standard Fittings NPT	Special Fitting Suff. "-B"	Orifice Diameter Inches	Pressure Drop PSI
DF-XX01	0.02 - 0.14	1 - 7	1/8"	1/4"	0.04	10.2
DF-XX02	0.05 - 0.30	2 - 25	1/4"	3/8"	0.08	4.2
DF-XX03	0.05 - 0.60	3 - 40	1/4"	3/8"	0.08	10.4
DF-XX04	0.1 - 0.7	2.5 - 60	1/4"	3/8"	0.11	9.6
DF-XX05	0.2 - 2.5		3/8"	1/2"	0.11	12.1
DF-XX06	0.4 - 5.0		1/2"	3/4"	0.32	2.9
DF-XX07	0.5 - 6.0		3/4"	1"	0.32	4.4
DF-XX08	0.5 - 12		3/4"	1"	0.49	4.4
DF-XX09	1.0 - 25		1-1/4"	1-1/2"	0.49	15.9
DF-XX10	1.5 - 36		1-1/4"	1-1/2"	0.73	13.5

Diagram 2.4; Sensor Dimensions



3.0 Installation Instructions

CAUTION: For safety reasons, please read the cautionary information located at the end of the manual, before attempting installation.

To install, proceed as follows:

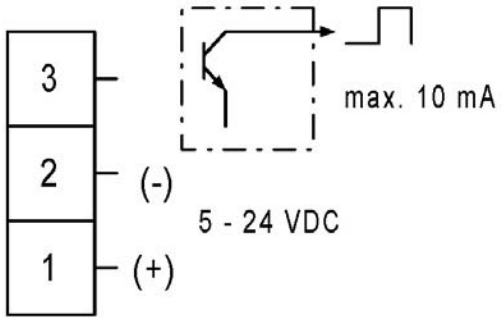
1. Make sure that the actual flow rate in your system lies within the flow range of the instrument. The flow range can be read off the identification tag. Flow rates in excess of 120% of the range maximum will, in continuous use, lead to bearing damage.

2. Ensure that the power supply voltage is in accordance with that specified on the identification tag. Electrical connections are made with a 3-pin terminal block as specified by the wiring diagram (Diagram 3.1).

3. If the sensor is to be used to provide a voltage pulse output, a sourcing output pull-up resistor must be connected between the supply voltage terminal and the open collector output terminal (pins 1 and 3). This resistor should be sized such that the collector to emitter current is nominally 8 mA during the transistor on state. Under no circumstances should the collector to emitter current exceed 10 mA.

Diagram 3.1: Wiring

$$R_{\text{pull-up}} = \frac{V_{\text{supply}}}{.008} \text{ ohms}$$



FM Rev. 1/12/00

If you did not purchase the terminal box, a connector with three wires will be visible. Depending on the color combination of wires your sensor has, attach these as follows:

blue	- (-) Ground		blue	- (+) VDC
yellow	- Open Collector	or	yellow	- Open Collector
red	- (+) VDC		green	- (-) Ground

You are now ready to mechanically connect the unit.

1. The flow direction is indicated by an arrow on the housing. Install the instrument with the arrows aligned with the flow direction in your pipes. Orientation of the unit is unimportant.

2. Connect with appropriately sized fittings. Take care not to place stresses on the housing - use a wrench to hold the instrument fittings static while you tighten the fittings on your pipe.

3. Should there be small amounts of ferrite contaminants in the medium, we recommend the installation of our magnetic filter (type MFR or equivalent).

4. Medium should be introduced to the system slowly to avoid pressure surges which could damage the instrument.

4.0 Operation

1. The device is delivered with a calibration diagram describing its frequency versus flow rate behavior. You must use this to calculate rate of flow in your system. Modification of the sensor (by physically modifying or replacing sensor components) requires recalibration of the unit.

4.1 - Turning the Unit On

The sensor is operational as soon as it is wired into a power supply.

4.2 - Flow Measurement

A frequency counting device must be used to read the sensor output and convert that measurement to rate of flow (frequency is directly proportional to flow). The exact nature of this relationship is graphically presented in the calibration diagram accompanying your unit. The calibration diagram also provides the sensor k-factor which is the number of pulses the sensor generates per gallon of water flow through the sensor.

5.0 Arrival of Damaged Equipment

Your instrument was inspected prior to shipment and found to be defect-free. If damage is visible on the unit, we advise that you carefully inspect the packing in which it was delivered. If damage is visible, notify your local carrier at once, since the carrier is liable for a replacement under these circumstances. If your claim is refused, please contact Kobold Instruments for further advisement.

6.0 Maintenance

The KOBOLD DF sensor requires little maintenance provided the measured medium is kept free of contaminants. In particular, ferritic pollutants can cause problems for this device due to the incorporation of magnets into the paddle wheel (unless you have the DF sensor with inductive pickup). To avoid this, we recommend the installation of a magnetic filter, such as KOBOLD's model MFR or equivalent.

Do NOT tamper with the electronics as this voids your warranty.

7.0 Need help with your DF Flow Sensor?

Call one of our friendly engineers at 412-788-2830.

Caution

PLEASE READ THE FOLLOWING GENERAL FLOW METER/ MONITOR WARNINGS BEFORE ATTEMPTING INSTALLATION OF YOUR NEW DEVICE. FAILURE TO HEED THE INFORMATION HEREIN MAY RESULT IN EQUIPMENT FAILURE AND POSSIBLE SUBSEQUENT PERSONAL INJURY.

- Inspect instrument for damage upon arrival. Cracked, fractured, bent or otherwise damaged instruments must not be put into use, since the device is weakened to an unknown extent. (The operations and installation guide will explain how to make a claim on damaged instruments.)

- Under NO circumstances must the maximum tolerances (temperature and pressure) be exceeded.

- The maximum tolerances of the device have been determined using water, air and/or oil. If using other media, especially corrosive ones, it is critically important that the user determine chemical compatibility with our instruments. A list, detailing material composition of our instruments, is available from KOBOLD Instruments Inc. upon request. KOBOLD Instruments Inc. cannot accept responsibility for failure and consequences resulting from use of media other than water, mineral oil, air, and nitrogen.

- Install the device in a fully supported position within your flow system. This avoids excessive stresses which may damage the instrument. In particular:
    a. Ensure that the plumbing leading to and from the instrument is fully supported and that the instrument does not perform the physical function of a joint.

    b. When calculating stress on the device caused by plumbing, the weight of the medium in the pipes must be considered as well.

    c. Misaligned runs of rigid piping can cause large stresses when connected to the instrument. Do not connect in such a fashion.

- During installation, avoid stresses on the instrument by following guidelines given below:
    a. When connecting fittings, hold the instrument fittings rigid with a correctly sized wrench. Do not install by twisting the instrument into the pipe fittings.

    b. Do NOT install by holding the device housing to provide counter-torque to the pipe fitting.

    c. Use an appropriate amount of teflon tape on male threads of fitting. This reduces the twisting stresses produced by tightening the fittings into each other.

    d. Do not use pliers or wrenches on the housing, as this may damage it.

    e. Do not overtighten, as this may fracture the fittings.

- During operation, there are a number of situations to avoid:
    a. The sudden cessation of fluid flow causes what is typically referred to as "water hammer". Most people are familiar with this phenomenon from their home experience - it is the cause behind the loud clank of water pipes which occurs when faucets are turned off too suddenly. The cause behind this "water hammer" is quite easy to visualize. Water is fairly massive. The amount of water in long runs of pipe is quite substantial. When the faucets are turned off suddenly, especially from a full on condition, the water has considerable momentum and does not want to stop flowing. The situation is similar to stopping a car by running into a wall, rather than by applying brakes. Both are sudden rather than gradual. The damage to the wall can be substantial (not to mention the car).

       The "water hammer" causes surges in fluid pressure which could cause the measurement instrument's pressure limit to be exceeded, resulting in failure and possible personal injury.

    b. Fluid surges, as well as the water hammer, can be particularly damaging to empty flowmeters since there is no back pressure in the device. The damage is caused, once again, by momentary excess pressure. To avoid these surges, fluid lines should remain full (if possible) and water flow should be introduced to the device slowly.

    c. If the instrument is isolated with inlet and outlet valves, the instrument must be completely drained when said valves are both closed. Failure to do so could result in damage to the device caused by thermal expansion of fluid.

    d. Freezing of water in the instrument MUST be avoided since the resultant expansion will damage the instrument and make it unsafe for use.