

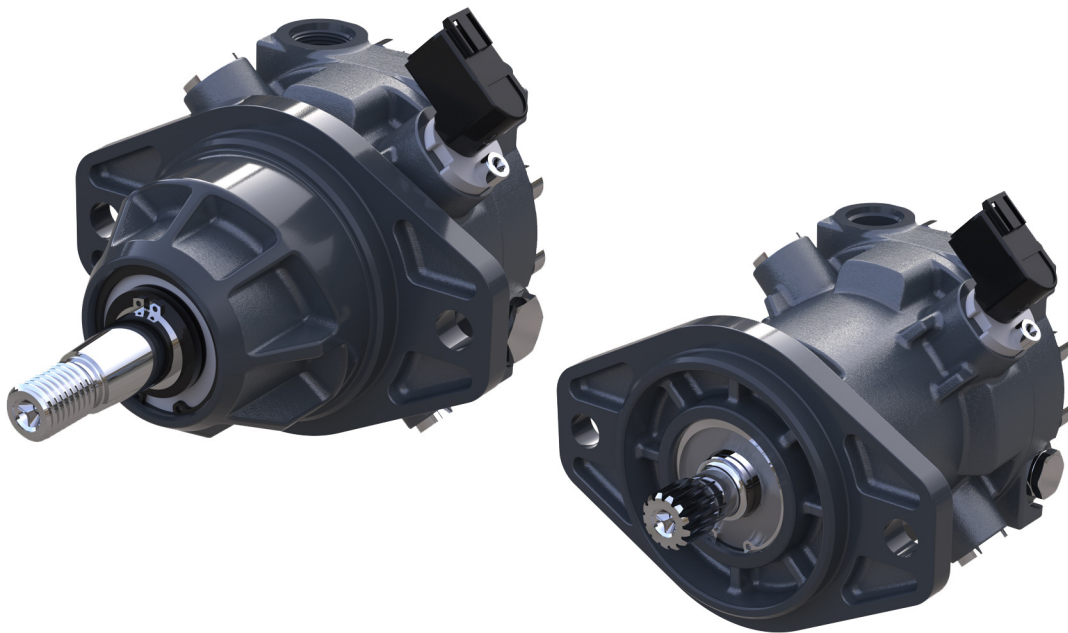
ENGINEERING  
TOMORROW



Service Manual

# Axial Piston Motors

## MP1



**Revision history**

*Table of revisions*

<b>Date</b>	<b>Changed</b>	<b>Rev</b>
October 2023	Added summing pressure in Operating Parameters	0204
April 2023	Various modifications	0203
October 2022	Added size 28/32	0201
November 2020	Updated Part Option for Speed and Temperature Sensor	0104
March 2020	Changed number of the shuttle shifts to 4 bar	0103
December 2019	Changed torque units from N·m [lbf·ft] to N·m [lbf·in]	0102
December 2019	First edition	0101

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## Introduction

### Hydrostatics Servicing Overview

This manual includes information on installation, maintenance, and minor repair of the MP1 motor. It includes a description of the unit and its individual components, troubleshooting information, and minor repair procedures.

Performing minor repairs may require the unit to be removed from the vehicle/machine. Thoroughly clean the unit before beginning maintenance or repair activities. Since dirt and contamination are the greatest enemies of any type of hydraulic equipment, follow cleanliness requirements strictly. This is especially important when changing the system filter and when removing hoses or plumbing.

A worldwide network of Danfoss Global Service Partners is available for major repairs. Danfoss trains and certifies Global Service Partners on a regular basis. You can locate your nearest Global Service Partner using the distributor locator at <http://www.danfoss.com>.

For detailed technical information about the MP1 motor, please see the [relevant technical information document](#).



#### Attention

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Major repairs requiring the removal of a unit's center section, servo sleeves, or front flange voids the warranty unless a Danfoss Authorized Service Center performs them.

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## Safety Precautions

Always consider safety precautions before beginning a service procedure. Protect yourself and others from injury. Take the following general precautions whenever servicing a hydraulic system.

### Unintended machine movement

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Unintended movement of the machine or mechanism may cause injury to the technician or bystanders. Secure the machine or disable/disconnect the mechanism while servicing to protect against unintended movement.

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### Flammable cleaning solvents

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Some cleaning solvents are flammable.  
Do not use cleaning solvents in an area where a source of ignition may be present to avoid possible fire.

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### Fluid Under Pressure

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Escaping hydraulic fluid under pressure can have sufficient force to penetrate your skin causing serious injury and/or infection. This fluid may also be hot enough to cause burns.  
Relieve pressure in the system before removing hoses, fittings, gauges, or components. Never use your hand or any other body part to check for leaks in a pressurized line. Use caution when dealing with hydraulic fluid under pressure. Seek medical attention immediately if you are cut by hydraulic fluid.

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### Personal safety

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Protect yourself from injury whenever servicing a hydraulic system.  
Use proper safety equipment, including safety glasses, at all times.

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### Hazardous material

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Hydraulic fluid contains hazardous material.  
Avoid prolonged contact with hydraulic fluid. Always dispose of used hydraulic fluid according to state, and federal environmental regulations.

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## General Information

### MP1 Motors Overview

The MP1 motor is a fixed displacement axial piston motor intended for closed and open circuit medium power applications. These motors are designed primarily to be combined with other products in closed and open circuit systems to transfer and control hydraulic power.

The MP1 motor consists of four rotating groups (displacements) and three housing (mounting) configurations. An SAE-A two bolt, SAE-B two-bolt and a cartridge style (for space optimized gear box mounting ) configurations.

The motor is ideally configured for installations requiring compact packaging and optimized plumbing such as wheel ends. The standard porting configuration is twin radial (side) O-ring boss main ports.

### MP1 Motor Features

- Four displacements allow the optimum selection of hydraulic motor for the lowest possible installed cost
- SAE-A & B, two bolt, and cartridge style mounting configurations available
- Metric and inch O-ring boss system port interfaces
- Short and compact; fits into existing installation with improved porting
- Proven reliability and performance
- Worldwide sales and service

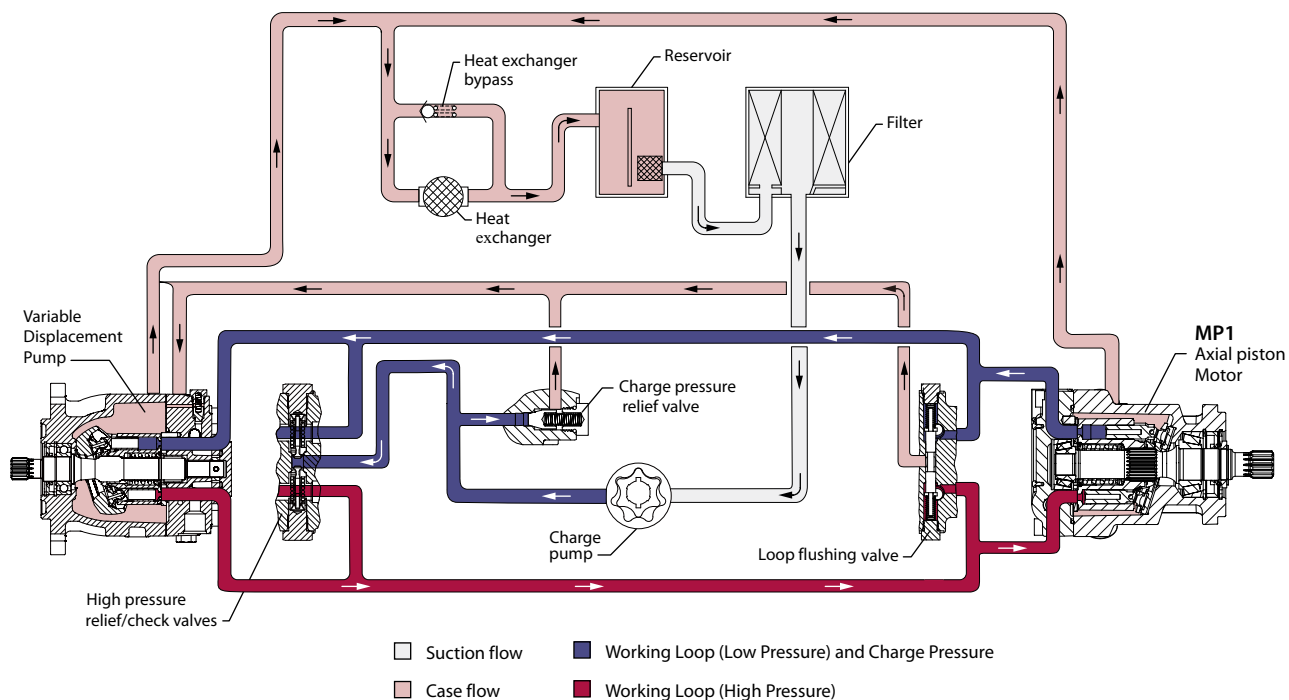
#### Expanded functionality

- Open circuit Fan Drive application
- PLUS+1<sup>®</sup> Compliant speed sensor option
- Integrated Flushing valve option available
- Anti-cavitation valve option available
- Shock valve option available

**General Information**

**System Diagram**

*Pictorial system diagram*



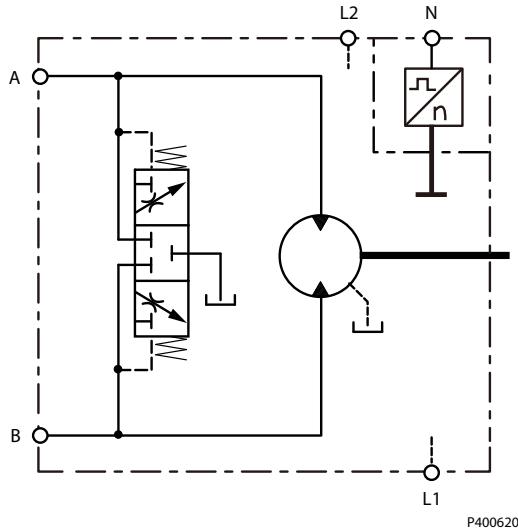
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The system diagram above shows the MP1 motor in a simple closed-loop hydrostatic propel application. The motor is driven by a variable displacement pump. The motor shows an integral loop flushing option that will remove heat and contaminants from the system loop.

**General Information**

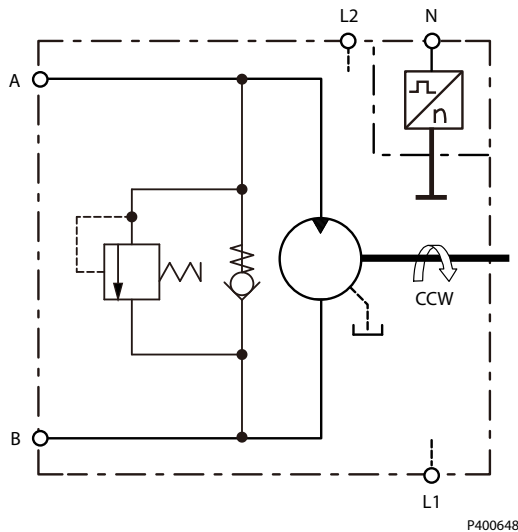
**Schematic Diagram**

*Closed Circuit*



For a close loop system, the system ports (A and B) connect to the high pressure work lines. The motor receives pressurized fluid in its inlet port and discharges de-energized fluid through the outlet port. Either port can act as inlet or outlet; flow is bidirectional. The motor has two case drains (L1 and L2). The motor may include loop flushing. Loop flushing provides additional cooling and filtration capacity.

*Open Circuit*



An open circuit configuration is also possible for the motor and such a system is shown above. A shock valve and an anti-cavitation valve is provided to protect the unit from sudden pressure surges as well as cavitation. The flow path of pressurized fluid is from port A through port B. In this configuration, the direction of rotation of the motor is counter clockwise as seen from shaft side. Similarly, if the anti-cavitation and shock valve is oriented in the reverse position, the direction of rotation will be clockwise. Thus, pressurized fluid flow path is from port B through port A.



## Technical Specifications

### Design Specifications

Features	MP1 Motors
Design	Axial piston motor with fixed displacement design.
Direction of output rotation (as seen from shaft side)	Clockwise or counterclockwise
Recommended installation position	Motor installation position is discretionary, The housing must always be filled with hydraulic fluid. Consult Danfoss for non-conformance to these guidelines.

### Technical Data

Feature	Unit	MP1M20	MP1M24	MP1M28	MP1M32
Model configuration		Fixed displacement motor			
Displacement	cm <sup>3</sup> /rev [in <sup>3</sup> /rev]	20.0 [1.22]	24.0 [1.46]	28.0 [1.71]	31.8 [1.94]
Mass moment of inertia of rotating components	kg·m <sup>2</sup> [slug·ft <sup>2</sup> ]	0.0010 [0.0007]		0.0016 [0.0011]	
Mass (Weight) dry	kg [lb]	5.6 [12]		8.0 [17.6]	
Mounting flange		ISO 3019-1 flange 82-2 (SAE-A), 2 bolt ISO 3019-1 flange 101-2 (SAE-B), 2 bolt Cartridge mounting style		ISO 3019-1 flange 101-2 (SAE-B), 2 bolt Cartridge mounting style	
Output shaft options		Spline 13T 16/32 Spline 15T 16/32 Spline 17T 24/48		Spline 13T 16/32 Spline 15T 16/32	
		Straight keyed 22.2 dia. Tapered 22.2 dia. 1:8			
System port configuration A, B		ISO 11926-1, 7/8-14 (SAE O-ring boss)		ISO 11926-1, 1-1/16-12 (SAE O-ring boss)	
		ISO 6149-1, M22x1.5 (Metric O-ring boss)		ISO 6149-1, M27x2 (Metric O-ring boss)	
		-		ISO 6162-2, Split flange port, DN19 M10x1.5	
Case drain ports L1, L2		ISO 11926-1, 3/4-16 (SAE O-ring boss)			
		ISO 6149-1, M18x1.5 (Metric O-ring boss)			

### Operating Parameters

Parameter		Unit	20/24	28/32
Speed limit	Closed Circuit <sup>1)</sup>	Rated	4200	3900
		Maximum	4700	4400
	Open Circuit	Rated	3400	3100
		Maximum	3800	3500
System pressure	Maximum working pressure <sup>2)</sup>		350 [5000]	350 [5000]
	Maximum pressure		380 [5429]	380 [5429]
	Max summing pressure <sup>3)</sup>		500 [7252]	500 [7252] (28cc) 450 [6527] (32cc)
Case pressure	Rated		2 [29]	2 [29]
	Maximum		6 [87]	6 [87]

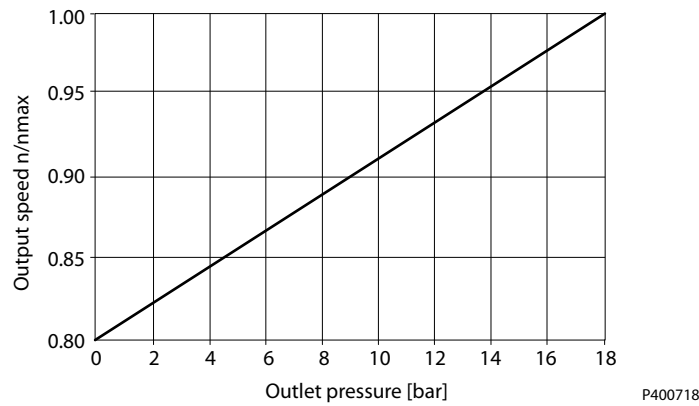
<sup>1)</sup> At the limit speed, system minimum low pressure is 18 bar.

<sup>2)</sup> Applied pressures above maximum working pressure requires Danfoss application approval.

<sup>3)</sup> The sum of the pressures at both system ports (A and B). Application of series circuit with MP1 motors requires Danfoss approval.

### Technical Specifications

Motor speed limit in relation to output (low) pressure



### Fluid Specifications

Features		Units	20/24/28/32
Viscosity	Intermittent <sup>1</sup>	mm <sup>2</sup> /sec. [SUS]	5 [42]
	Minimum		7 [49]
	Recommended range		12 - 80 [66 - 370]
	Maximum (cold start) <sup>2</sup>		1600 [7500]
Temperature range <sup>3</sup>	Minimum (cold start)	°C [°F]	-40 [-40]
	Recommended range		60 - 85 [140 - 185]
	Maximum continuous		104 [220]
	Maximum intermittent		115 [240]
Cleanliness per ISO 4406			22/18/13 (as per ISO 4406)

<sup>1</sup> Intermittent=Short term t < 1 min per incident and not exceeding 2 % of duty cycle based load-life.

<sup>2</sup> Cold start = Short term t < 3 min, p < 50 bar [725 psi], n < 1000 min<sup>-1</sup> (rpm)

<sup>3</sup> At the hottest point, normally case drain port.

## System Design Parameters

### Determination of Nominal Motor Size

The following equations are used to compute the input flow, output torque, output power and speed. Generally, sizing the right motor starts with an evaluation of the machine requirements such as speed and torque. Select a motor that will transmit the required torque, then select a pump that will meet the flow and pressure requirements of the motor.

<i>Unit:</i>	<i>Metric System:</i>	<i>Inch System</i>
<i>Input flow</i>	$Q_e = \frac{V_g \cdot n}{1000 \cdot \eta_v}$ l/min	$Q_e = \frac{V_g \cdot n}{231 \cdot \eta_v}$ [gpm]
<i>Output torque</i>	$M_e = \frac{V_g \cdot \Delta p \cdot \eta_m}{20 \cdot \pi}$ Nm	$M_e = \frac{V_g \cdot \Delta p \cdot \eta_m}{2 \cdot \pi}$ [lbf·in]
<i>Output power</i>	$P_e = \frac{Q_e \cdot \Delta p \cdot \eta_t}{600}$ kW	$P_e = \frac{V_g \cdot n \cdot \Delta p \cdot \eta_t}{396\,000}$ [hp]
<i>Speed</i>	$n = \frac{Q_e \cdot 1000 \cdot \eta_v}{V_g}$ min <sup>-1</sup>	$n = \frac{Q_e \cdot 231 \cdot \eta_v}{V_g}$ (rpm)

### Variables

#### *SI units [US units]*

$Q_e$  = Input flow l/min (US gal/min)

$M_e$  = Output torque N·m (lbf·in)

$p_e$  = Output power kW (hp)

$n$  = Speed min<sup>-1</sup> (rpm)

$V_g$  = Displacement per revolution cm<sup>3</sup>/rev [in<sup>3</sup>/rev]

$p_o$  = Outlet pressure bar [psi]

$p_i$  = Inlet pressure bar [psi]

$\Delta p = p_o - p_i$  (system pressure) bar [psi]

$\eta_v$  = Volumetric efficiency

$\eta_{mh}$  = Mechanical-hydraulic efficiency

$\eta_t$  = Motor total efficiency ( $\eta_v \cdot \eta_{mf}$ )

## Part Options

### Shaft Options

MP1 motors are available with a variety of splined, straight keyed, and tapered shaft ends. Nominal shaft sizes and torque ratings for some available shafts are shown in the accompanying table.

Torque ratings assume no external radial loading. **Continuous torque** ratings for splined shafts are based on spline tooth wear, and assume the mating spline has a minimum hardness of  $R_c 55$  to full spline depth and coupling has good lubrication.

**Maximum torque** ratings are based on shaft torsional strength and assume a maximum of 200,000 load reversals.

*Shaft availability and maximum torque ratings*

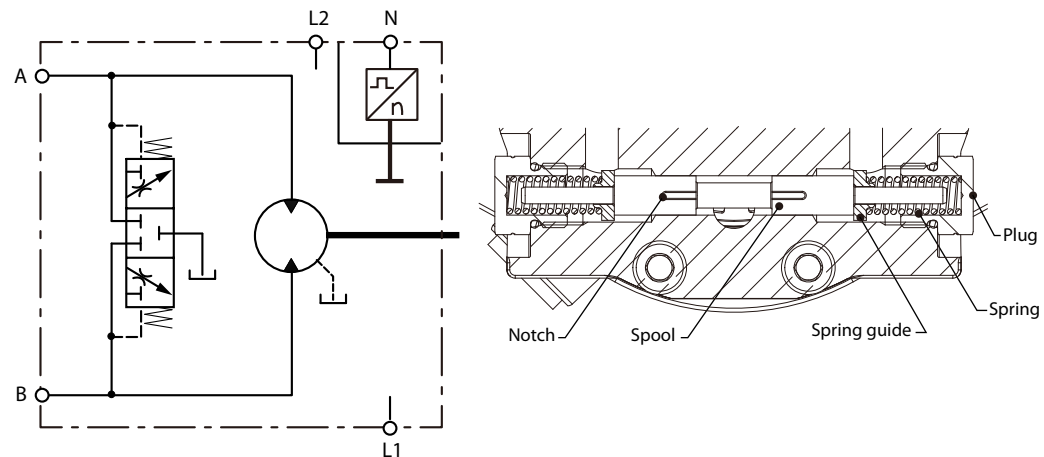
Shaft option	N·m [lbf·in]
Spline, 13 tooth, 16/32 pitch	226 [2000]
Spline, 15 tooth, 16/32 pitch	362 [3200]
Spline, 17 tooth, 24/48 pitch	165 [1460]
Tapered, $\varnothing 22.2$ mm	362 [3200]
Straight keyed, $\varnothing 22.2$ mm	226 [2000]

[Recommended mating splines for MP1 motor splined output shafts should be in accordance with ANSI B92.1. Refer to the shaft option drawings for detailed specifications of each spline.](#)

### Loop Flushing Valve

Closed circuit systems may require loop flushing to meet temperature and cleanliness requirements. MP1 motors are available with an optional integral loop flushing. A loop flushing valve will remove heat and contaminants from the main loop at a rate faster than otherwise possible.

The hydraulic circuit of an MP1 motor with loop flushing option is shown below. The MP1 motor loop flushing design is a simple spring centered shuttle spool with an orifice notch.



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A loop flush shuttle spool is used to separate system A and system B pressures. System delta pressure will cause the shuttle spool to shift, allowing the low side system pressure to flow to the orifice towards the case. The shuttle shifts at approximately 4 bar [57 psi]. The flushing flow is a function of the low loop system pressure and the size of the notch.

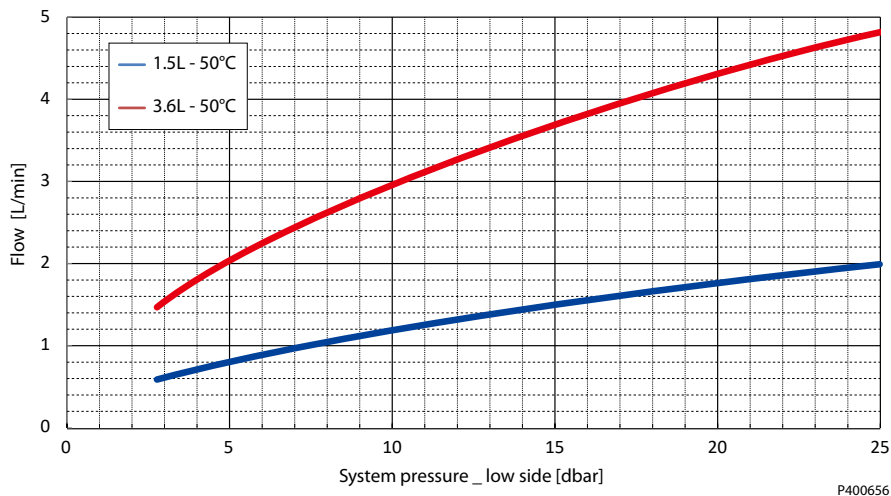
Loop flush flow options of 1.5 & 3.6 l/min [0.4 & 1.0 gal/min] are available for the 20/24cc frame size. Loop flush flow options of 5.2 and 8.0 l/min [1.4 & 2.1 gal/min] are available for the 28/32cc frame size. These options are adequate for most applications.

### Part Options

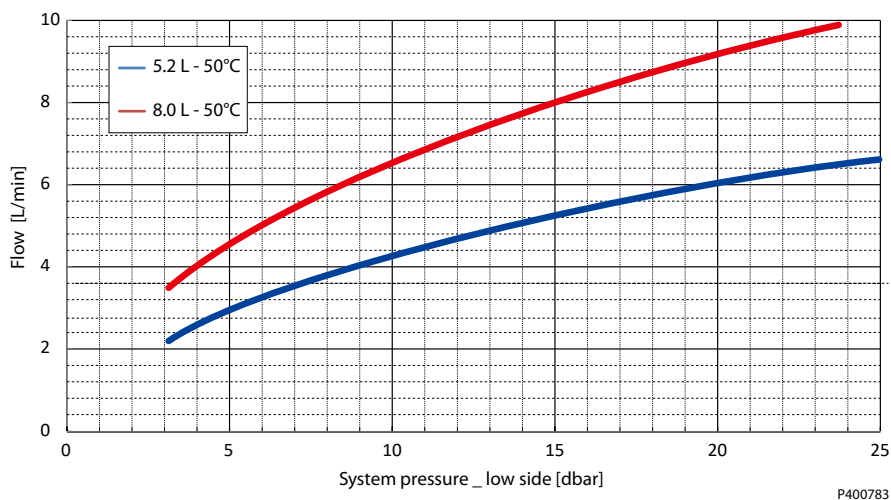
When a MP1 pump is used with an external loop flushing shuttle valve, ensure that the charge setting of the pump matches the setting of the loop flushing shuttle valve. Contact your Danfoss representative for the availability of additional charge relief settings.

#### Loop flush characteristic curves

(Size 20/24) 1.5 L and 3.6 L@15 bar, oil temp=50°C



(Size 28/32) 5.2 L and 8.0 L@15 bar, oil temp=50°C



### Anti-Cavitation and Shock Valve

The MP1M fixed motors are available with an anti-cavitation valve option. The key application for this option is open circuit fan drives.

The anti cavitation valve function as a check valve within the same cavity which is integrated into the endcap. The check valve function provides protection against cavitation that can occur upon introduction of an overrunning load or due to loss of input flow. In such case, the system delta pressure becomes negative and the check valve opens connecting the motor inlet and outlet, effectively short-circuiting the motor. The shock valve function is intended to be used for system overpressure protection events of limited duration only. It is not intended for continuous system pressure limitation.

The shock valve is available with 280 bar [4061 psi] or 345 bar [5004 psi] setting.

**Part Options**

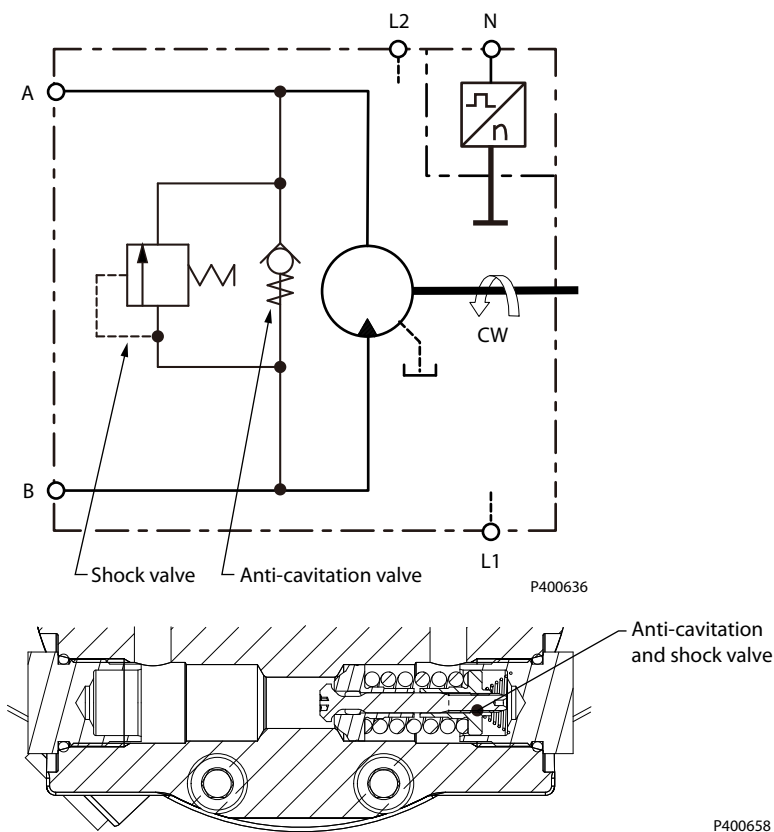
For this option the high pressure port needs to be defined upfront to get the correct motor rotation. Reversing the motor is not possible with this option.

*Flow direction*

Motor shaft rotation (as seen from shaft side)	Port A	Port B	System Port type, Loop Flushing & Anti-cavitation*
Clockwise (CW)	Out	In	MD1/MD2/SD1/SD2
Counterclockwise (CCW)	In	Out	MC1/MC2/SC1/SC2

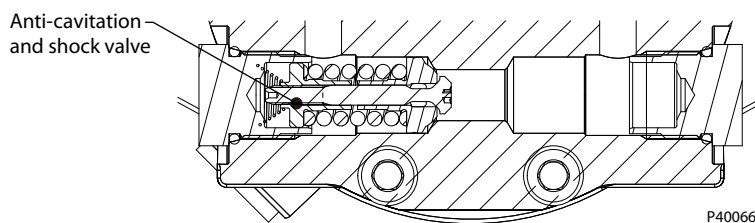
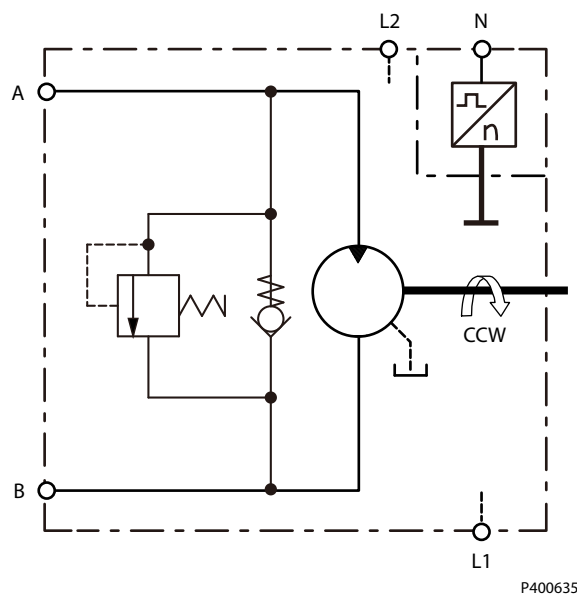
\* See Master Model Code in Technical Information, BC290322888218

*Anti cavitation and shock valve, Port B High Pressure, Clockwise rotation*



**Part Options**

*Anti cavitation and shock valve, Port A High Pressure, Counter Clockwise rotation*



**Speed and Temperature Sensor**

MP1 motors are available with an optional speed and temperature sensor. This hall-effect pulse pick-up is located in the motor housing. The sensor accepts supply voltage and outputs a digital pulse signal in response to the speed of the cylinder block. The output changes its high/low state as the target teeth pass by the sensor's face. The digital (on-off-on-off) pulse train is fed to a controller, which interprets its rate of change as a speed. A logic circuit decodes the two signals to provide an additional direction indication (high or low) depending on direction).

The speed sensor is designed for rugged outdoor, mobile or heavy industrial speed sensing applications. The detection of the speed is contactless and does not need any calibration or adjustments. There are two optional sensors available.

**Available Sensors**

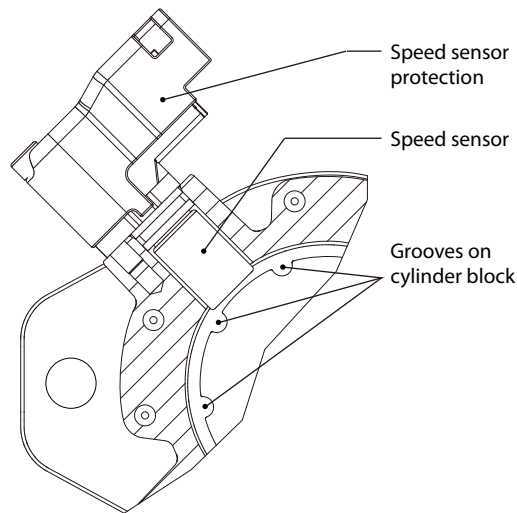
Description	Order number	
	149055	11232698
Supply voltage	4.5 – 8 V	7 – 32 V
Speed signals	Two, 90° Phase shift	Two, 90° Phase shift
Direction signal	One	One
Temperature signal	One	One
PLUS+1 Compliance	Yes	No

## Part Options

### Sensor Position

Sensor position in SAE and Cartridge housing.

SAE & Cartridge housing



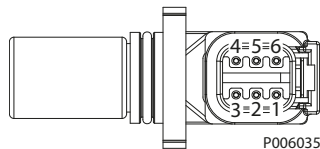
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### Sensor target

Nine arc grooves on cylinder block as target of sensor for detection of direction (CW/CCW) and rotation.

### Speed Sensor 4.5 - 8 V

Speed sensor connector, 6-pin



Pinout:

1. Speed signal 2
2. Direction signal
3. Speed signal 1
4. Supply
5. Ground
6. Temperature

### Technical data

Parameter	Min.	Nom.	Max.	Note
Supply voltage	4.5 V <sub>DC</sub>	5 V <sub>DC</sub>	8 V <sub>DC</sub>	Regulated supply voltage. Reverse polarity protected.
Supply protection	–	–	30 V <sub>DC</sub>	Shuts off above 9 V.
Pulses per revolution	NPN & PNP			
Max. required supply current	–	–	25 mA	At supply voltage
Max. output current	–	–	50 mA	
Operation mode	NPN & PNP			Push-Pull amplifier
Temperature signal	-40°C = 2.318V	–	100°C = 0.675V	



## Part Options

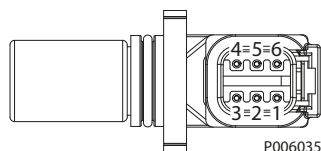
Technical data (continued)

Parameter	Min.	Nom.	Max.	Note
Output low speed signal	5 %	8.5 %	12 %	Ratiometric output voltage Low state > 0 V to provide wire fault detection
Output high speed signal	88 %	91.5 %	95 %	
Detectable frequency range	1 Hz	–	10 000 Hz	
Ordering number	<b>149055</b>			
Color of connector	Black			

### Speed Sensor 7 - 32 V

Speed Sensor 7 – 32 V<sub>DC</sub> technical data and information about connector.

Speed sensor connector, 6-pin



Pinout:

1. Speed signal 2
2. Direction signal
3. Speed signal 1
4. Supply
5. Ground
6. Temperature signal

Technical data

Parameter	Min.	Max.	Note
Supply voltage range	7 V <sub>DC</sub>	32 V <sub>DC</sub>	
Supply protection	–	36 V <sub>DC</sub>	36 V <sub>DC</sub> over voltage protection -36 V <sub>DC</sub> permanent reverse polarity protection
Max. required supply current	–	30 mA	
Max. output current	–	50 mA	
Operation mode	<b>NPN open collector</b>		Internal 2k7 pull-up resistor to supply
Output low signal range	2 %	10 %	Max. output voltage 24 V <sub>DC</sub>
Output high signal range	55 %	85 %	
Detectable frequency range	1 Hz	10 000 Hz	
Speed sensor order number	11232698		
Color of connector	Yellow		

For more information, see *Speed and Temperature Sensor, Technical Information*, **BC152886482203**.

### Output Pulses

The expected number of output pulses per revolution is shown below.

The number of pulses (per rev)	<b>9</b>
--------------------------------	----------

Due to the number of target groove (9) for pulse pick up, the output signal resolution is lower than other products (e.g.71 target teeth for H1B-60) in extra low speed.

For more technical information, please contact your Danfoss representative.

## Operating Parameters

### Overview

This section defines the operating parameters and limitations with regard to output speeds and pressures.

### Speed Ratings

Smooth operation and output torque ripple determine the acceptable low speed operating condition. Generally Danfoss axial piston motors will operate smoothly down to 150 rpm. In some instances, it is possible to operate smoothly at less than 150 rpm, but performance must be verified for the specific application. We do not recommend that any axial piston motor be sized to operate continuously at speeds less than 100 rpm.

**Rated speed** is the highest input speed recommended at full power condition. Operating at or below this speed should yield satisfactory product life.

**Maximum speed** is the highest operating speed permitted. Exceeding maximum speed reduces product life and can cause loss of hydrostatic power and braking capacity. Never exceed the maximum speed limit under any operating conditions.

Operating conditions between Rated speed and Maximum speed should be restricted to less than full power and to limited periods of time. For most drive systems, maximum unit speed occurs during downhill braking or negative power conditions.

#### **Warning**

##### **Unintended vehicle or machine movement hazard**

The loss of hydrostatic drive line power, in any mode of operation (forward, neutral, or reverse) may cause the system to lose hydrostatic braking capacity. You must provide a braking system, redundant to the hydrostatic transmission, sufficient to stop and hold the vehicle or machine in the event of hydrostatic drive power loss.

### System Pressure

**System pressure** is the differential pressure between system ports A and B. It is the dominant operating variable affecting hydraulic unit life. High system pressure, which results from high load, reduces expected life. Hydraulic unit life depends on the speed and normal operating, or weighted average, pressure that can only be determined from a duty cycle analysis.

**Application pressure** is the high pressure relief setting normally defined within the order code of the pump. This is the applied system pressure at which the driveline generates the maximum calculated pull or torque in the application.

**Maximum working pressure** is the highest recommended Application pressure. Maximum working pressure is not intended to be a continuous pressure. Propel systems with Application pressures at, or below, this pressure should yield satisfactory unit life given proper component sizing.

**Maximum pressure** is the highest allowable Application pressure under any circumstance. Application pressures above Maximum Working Pressure will only be considered with duty cycle analysis and factory approval. Pressure spikes are normal and must be considered when reviewing maximum working pressure.

All pressure limits are differential pressures referenced to low loop (charge) pressure. Subtract low loop pressure from gauge readings to compute the differential.

**Minimum low loop pressure** (above case pressure) is the lowest pressure allowed to maintain a safe working condition in the low side of the loop.

## Operating Parameters

### Case Pressure

Under normal operating conditions, **the rated case pressure** must not be exceeded. During cold start, case pressure must be kept below maximum intermittent case pressure. Size drain plumbing accordingly.

 **Caution**

**Possible component damage or leakage.**

Operation with case pressure in excess of stated limits may damage seals, and/or housings, causing external leakage. Performance may also be affected since charge and system pressures are referenced to case pressure.

*Case pressure limits*

<b>Maximum (continuous)</b>	2 bar [29 psi] maximum pressure
<b>Intermittent (cold start)</b>	6 bar [87 psi] maximum pressure

### Temperature

The high temperature limits apply at the hottest point in the transmission, which is normally the motor case drain. The system should generally be run at or below the published **rated temperature**.

The **maximum intermittent temperature** is based on material properties and should never be exceeded.

Cold oil will generally not affect the durability of the transmission components, but it may affect the ability of oil to flow and transmit power.

The **minimum temperature** relates to the physical properties of component materials.

Size heat exchangers too keep the fluid within these limits. Danfoss recommends testing to verify that these temperature limits are not exceeded.

### Viscosity

**Viscosity** For maximum efficiency and bearing life, ensure the fluid viscosity remains in the recommended range.

The **minimum viscosity** should be encountered only during brief occasions of maximum ambient temperature and severe duty cycle operation.

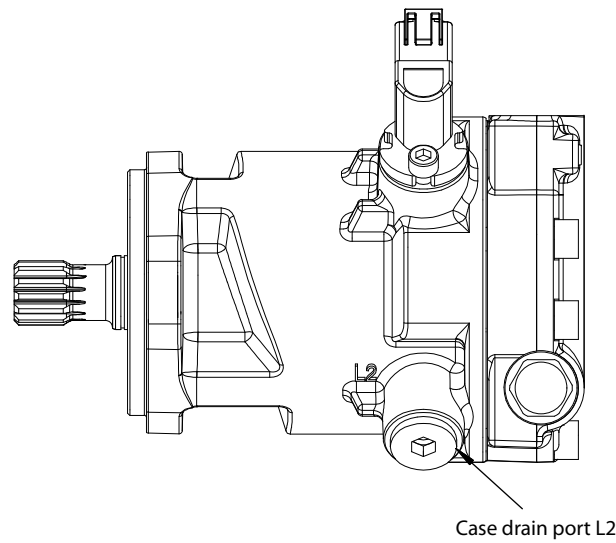
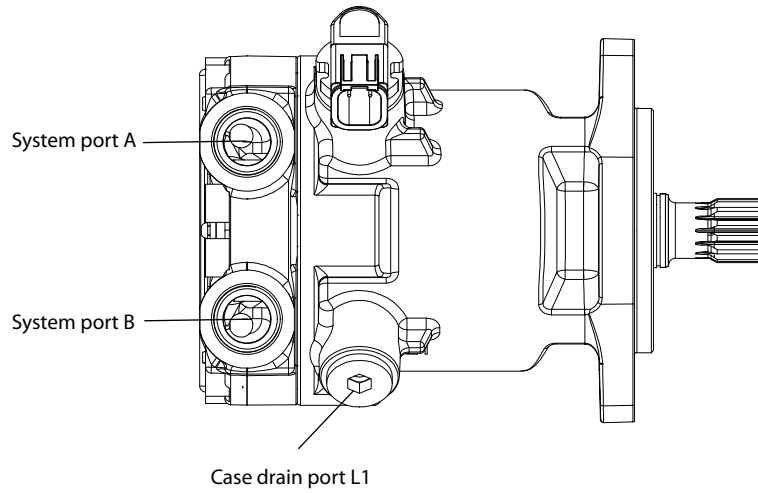
The **maximum viscosity** should be encountered only at cold start.

Ensure fluid temperature and viscosity limits are concurrently satisfied.

**Pressure Measurements**

**MP1M20/24 SAE A Flange Port Locations and Specifications**

*SAE A flange ports*



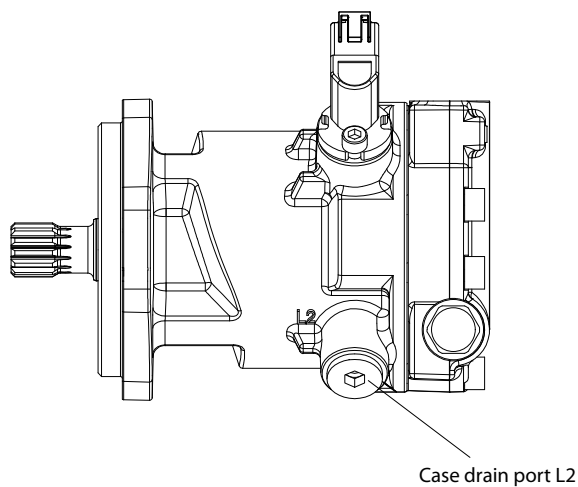
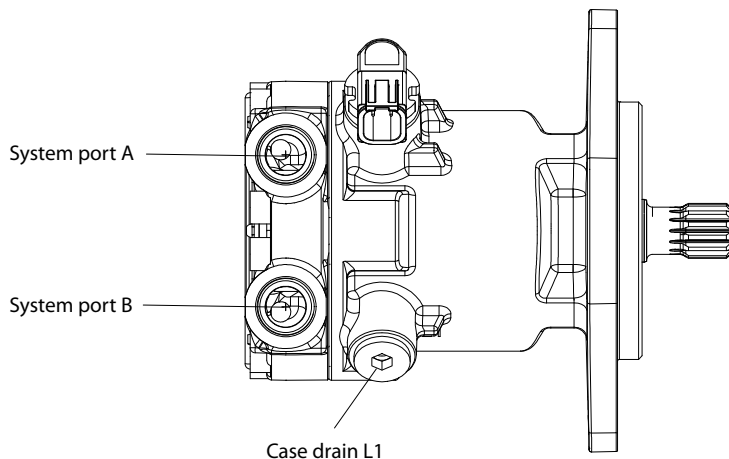
*Port information*

Port	Port size	Pressure obtained	Gauge size, bar [psi]
L1, L2	3/4-16 UNF / M18 x 1.5	Case drain	10 [100]
A	7/8-14 UNF / M22 x 1.5	System pressure	500 [7250]
B	7/8-14 UNF / M22 x 1.5	System pressure	500 [7250]

## Pressure Measurements

### MP1M20/24 SAE B Flange Port Locations and Specifications

*SAE B flange ports*



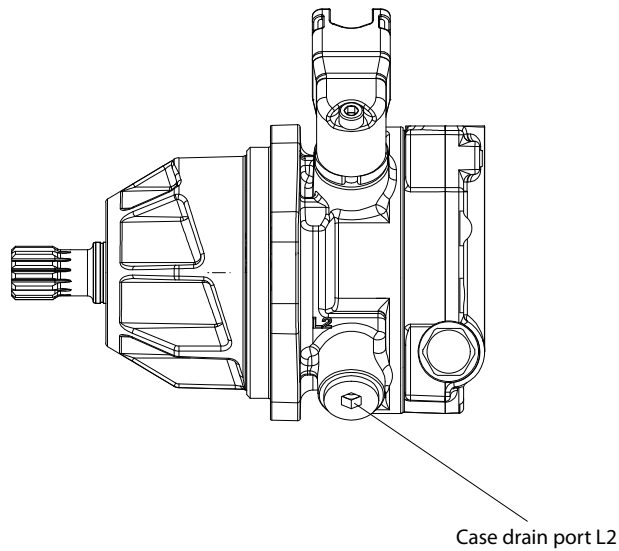
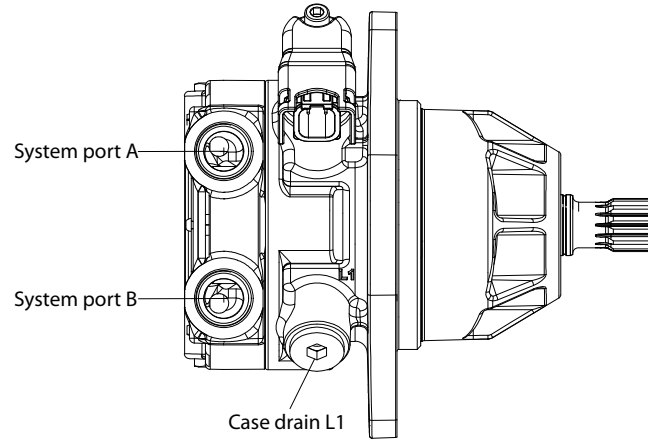
#### *Port information*

Port	Port size	Pressure obtained	Gauge size, bar [psi]
L1, L2	3/4-16 UNF / M18 x 1.5	Case drain	10 [100]
A	7/8-14 UNF / M22 x 1.5	System pressure	500 [7250]
B	7/8-14 UNF / M22 x 1.5	System pressure	500 [7250]

**Pressure Measurements**

**MP1M20/24 Cartridge Flange Port Locations and Specifications**

*Cartridge flange ports*



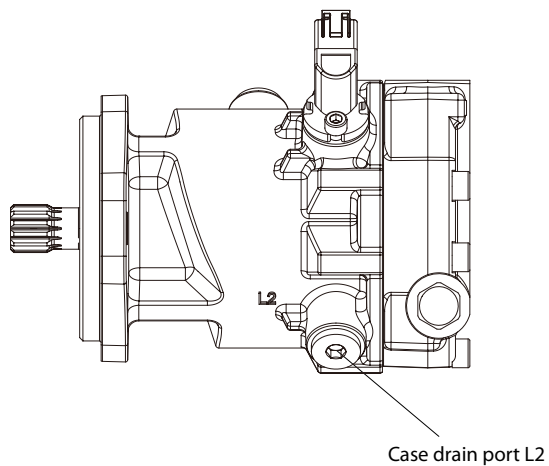
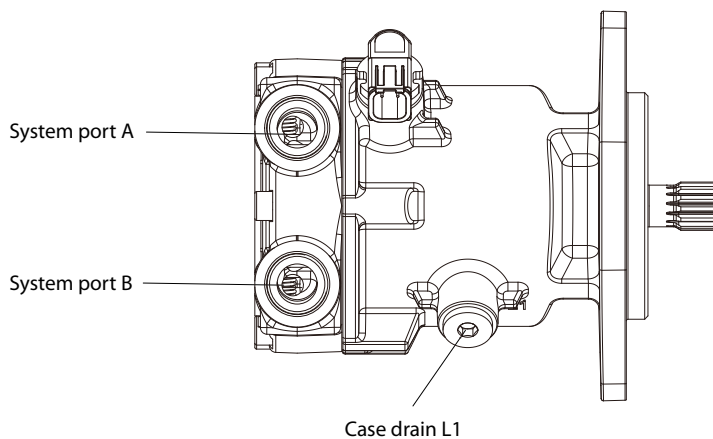
*Port information*

Port	Port size	Pressure obtained	Gauge size, bar [psi]
L1, L2	3/4-16 UNF / M18 x 1.5	Case drain	10 [100]
A	7/8-14 UNF / M22 x 1.5	System pressure	500 [7250]
B	7/8-14 UNF / M22 x 1.5	System pressure	500 [7250]

## Pressure Measurements

### MP1M28/32 SAE B Flange Port Locations and Specifications

*SAE B flange ports*



P400781

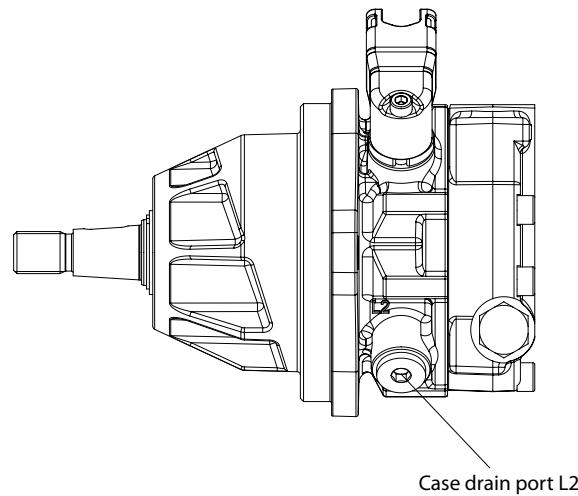
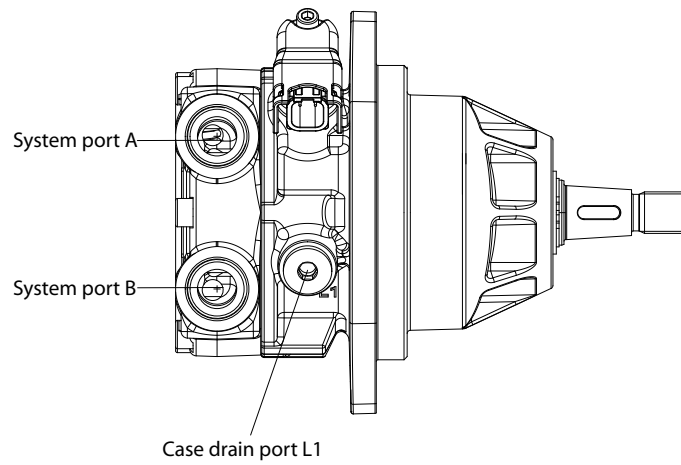
#### *Port information*

Port	Port size	Pressure obtained	Gauge size, bar [psi]
L1, L2	3/4-16 UNF / M18 x 1.5	Case drain	10 [100]
A	1-1/16 -12 UNF / M27x2	System pressure	500 [7250]
B	1-1/16 -12 UNF / M27x2	System pressure	500 [7250]

**Pressure Measurements**

**MP1M28/32 Cartridge Flange Port Locations and Specifications**

*Cartridge flange ports*



P400782

*Port information*

Port	Port size	Pressure obtained	Gauge size, bar [psi]
L1, L2	3/4-16 UNF / M18 x 1.5	Case drain	10 [100]
A	1-1/16 -12 UNF / M27x2	System pressure	500 [7250]
B	1-1/16 -12 UNF / M27x2	System pressure	500 [7250]



## Fluid and Filter Maintenance

### Recommendations of Fluid and Filter Maintenance

To ensure optimal product life, perform regular maintenance of the fluid and filter. Contaminated fluid is the main cause of unit failure. Take care to maintain fluid cleanliness when servicing.

Check the reservoir daily for proper fluid level, the presence of water, and rancid fluid odor. Water in the fluid may be noted by a cloudy or milky appearance or free water in the bottom of the reservoir. Rancid odor indicates the fluid has been exposed to excessive heat. Change the fluid immediately if these conditions occur. Correct the problem immediately.

Inspect vehicle for leaks daily.

Change the fluid and filter per the vehicle / machine manufacturer's recommendations or at these intervals: Change the fluid more frequently if it becomes contaminated with foreign matter (dirt, water, grease, etc.) or if the fluid is subjected to temperature levels greater than the recommended maximum.

#### *Fluid and filter change interval*

Reservoir type	Maximum change interval
Sealed	2000 hours
Breather	500 hours

#### **Caution**

High temperatures and pressures accelerate fluid aging. These conditions will require more frequent fluid changes.

Change filters whenever the fluid is changed or when the filter indicator shows that it is necessary to change the filter. Replace all fluid lost during filter change.

#### **Warning**

Hydraulic fluid contains hazardous material. Avoid contact with hydraulic fluid. Always dispose of used hydraulic fluid according to state, and federal environmental regulations. Never reuse hydraulic fluid.

## Initial Start-Up Procedures

### Start-up Safety Precautions

This service procedure may require disabling the vehicle / machine (raising the wheels off the ground, disconnecting work function). Take the necessary safety precautions to prevent injury to the technician and bystanders.

 **Warning**

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Unintended vehicle/machine movement may occur when using the motor in combination with S45 open circuit pumps with LS, EPC, or FDC controls and the engine is turning.

Due to the design of these controls, a standby pressure will remain in the system even if the normally closed control are fully energized. Lowest standby pressures to the motor, 12-18 bar or above, may be enough to turn the motor and has the potential to cause injury or damage.

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The initial start-up procedure must be completed in order: inspect the unit, fill system components with hydraulic fluid, install charge pressure gauge and calibrate the motor/transmission.

### Inspect the Unit

1. Before installing the motor, inspect the units for possible damage incurred during shipping and handling.
2. Make certain all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean before filling with fluid. Never reuse hydraulic fluid.

### Fill System Components with Hydraulic Fluid

1. Fill the reservoir with recommended hydraulic fluid. Pass this fluid through a 10 micron (nominal, no bypass) filter before it enters the reservoir.
2. Fill the inlet line leading from the reservoir to the pump. Check the inlet line for properly tightened fittings and be certain it is free of restrictions and air leaks.
3. Check inlet line for properly tightened fittings. Make sure the inlet line is free of restrictions and air leaks.
4. Fill the motor and pump housings with clean hydraulic fluid before start up. Fill by pouring filtered oil into the upper case drain port. To ensure the pump and motor stay filled with oil, install case drain lines into the upper most case drain ports.

 **Attention**

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Never start the prime mover unless the motor and pump housings are filled completely with clean hydraulic fluid.

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## Initial Start-Up Procedures

### Install Charge Pressure Gauge

1. For closed loop systems, install a 0-35 bar [0-500 psi] pressure gauge in the charge pressure gauge port of the pump to monitor the charge pressure during start-up.

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[For open circuit systems, use gauges in system ports.](#)

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2. Disconnect any external control input signal or command from the pump control until after initial start-up. This ensures that the pump remains in its neutral position.
3. Jog (slowly rotate) prime mover until charge pressure starts to rise.
4. Start the prime mover and run at the lowest possible speed until charge pressure builds.

#### **Warning**

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Do not start the prime mover unless the pump is in neutral position (swash plate at 0° angle). Take necessary precautions to prevent machine movement in case pump is actuated (in stroke) during initial start-up.

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5. Once charge pressure is established, increase to normal operating speed. Charge pressure should be as indicated in the pump model code. If charge pressure is low, shut down and determine cause.

#### **Caution**

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Low charge pressure may affect ability to control the machine.

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### Calibrate the Motor/Transmission

1. Shut down the prime mover.
2. Connect the external control input signal/command.
3. Reconnect the machine function if disconnected earlier.
4. Start the prime mover, checking to ensure the pump remains in neutral.
5. Check for forward and reverse machine operation, with the prime mover at normal operating speed.

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[Charge pressure may decrease slightly during forward or reverse operation.](#)

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6. Continue to cycle slowly between forward and reverse for at least five minutes.
7. Shut down prime mover.
8. Remove gauges. Replace plugs at the gauge ports.
9. Check reservoir level. Add filtered fluid if needed.

The motor/transmission is now ready for operation.

## Troubleshooting

### Troubleshooting Overview

This section serves as a guide for identifying and resolving undesirable system conditions.

Please observe the safety concerns listed in [Safety Precautions](#) on page 5 and the precautions related to relevant equipment when resolving system issues.

### System Operating Hot

Item	Description	Action
Check oil level in reservoir and oil supply to the pump.	Insufficient amount of hydraulic fluid will not meet the cooling demands of the system.	Fill the reservoir to the proper level.
Inspect the heat exchanger (if equipped).	If the heat exchanger fails or becomes obstructed, it may not meet the cooling demands of the system.	Ensure that heat exchanger is receiving adequate air flow and that the heat exchanger is in good operating condition. Repair or replace as necessary.
Check the system relief valves.	If a system relief valve becomes unseated for an extended period of time or fails for any other reason, the system could become overheated.	Repair or replace any malfunctioning relief valves as applicable and verify that the loads on the machine are not excessive.

### System Noise or Vibration

Item	Description	Action
Check oil level in reservoir and oil supply to the motor.	Insufficient hydraulic fluid could lead to cavitation that would cause system noise.	Fill the reservoir to the proper level and ensure that oil supply to the motor is adequate and the lines are unobstructed.
Check for air in the system.	Air trapped within the system lines or the motor itself could result in cavitation that would cause system noise.	Ensure that all of the system lines and components are purged of air.
Inspect the output shaft couplings.	A loose or incorrect shaft coupling will produce vibrations that could result in system noise.	Ensure that the correct coupling is used and that it fits properly onto the shaft.
Inspect the output shaft alignment.	Misaligned shafts create excessive frictional vibration that could result in system noise.	Ensure that the shafts are properly aligned.
Hydraulic oil viscosity about limits.	Viscosity above acceptable limits will result in cavitation that would lead to system noise.	Replace hydraulic oil with appropriate fluid for operating conditions. Refer to publication 5200L0463 for information on fluid selection.

## Minor Repair

### Shaft Seal and Dust Seal

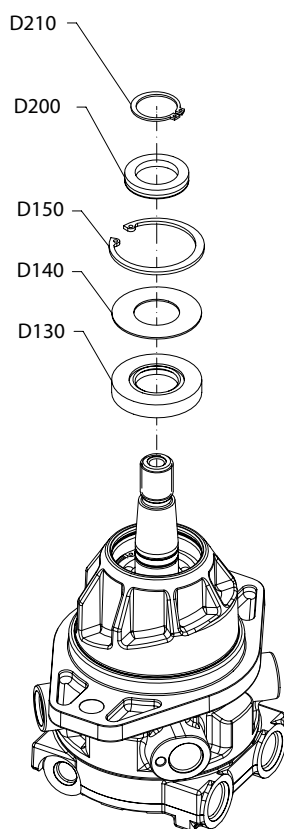
#### MP1M shaft seal and dust seal removal

1. Orient the motor with the shaft pointing upward.
2. If a dust seal is used, use snap ring pliers to remove retaining ring (D210) retaining the dust seal.
3. If a dust seal is used, remove the dust seal (D200).
4. Using snap ring pliers, remove retaining ring (D150) retaining the shaft seal and support washer.
5. Remove support washer (D140).
6. Remove shaft seal (D130) and discard.

**⚠ Caution**

**Do not damage the housing bore, shaft or bearing when removing the shaft and shaft seal.**

Carefully drive a small sheet-metal screw into the shaft seal to facilitate removal. Be careful not to damage the bearing below the seal. Attach a slide hammer or appropriate puller to the screw head and pull to remove the seal.



## Minor Repair

### MP1M Shaft Seal and Dust Seal Assembly

1. Inspect the new seal, the motor housing seal bore, and the sealing area on the shaft for rust, wear, and contamination. Polish the shaft and clean the housing if necessary.
2. Position the motor with the shaft pointing upward.
3. Install the retaining ring (D120) using snap ring pliers.

The retainer ring (D120) is beveled and has a direction requirement; the flat side of the retainer ring must face the bearing.

4. Cover shaft splines with an installation sleeve or packaging tape to protect seal during installation. Lubricate new shaft seal (D130), press into housing until it bottoms out. Press evenly to avoid binding and damaging the seal.

**! Caution**

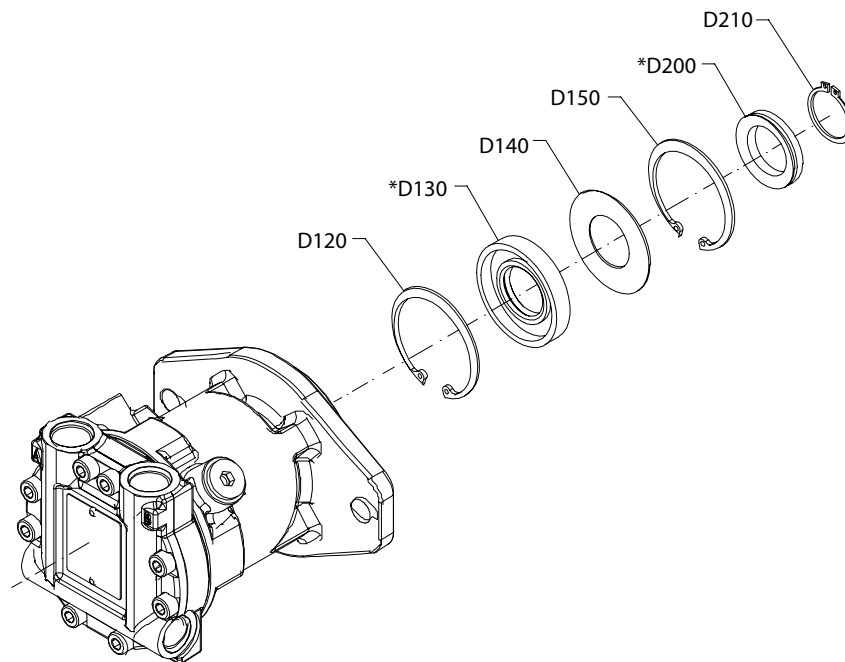
Do not damage the housing bore or shaft when replacing the shaft seal. All components should fit together smoothly.

5. Install support washer (D140).
6. Using snap ring pliers, install the retaining ring (D150) that retains the support washer and shaft seal.

**! Caution**

Do not swap retainer rings D120 and D150.

7. If a dust seal is used, install dust seal (D200).
8. If a dust seal is used, use snap ring pliers to install the retaining ring (D210) to retain the dust seal.

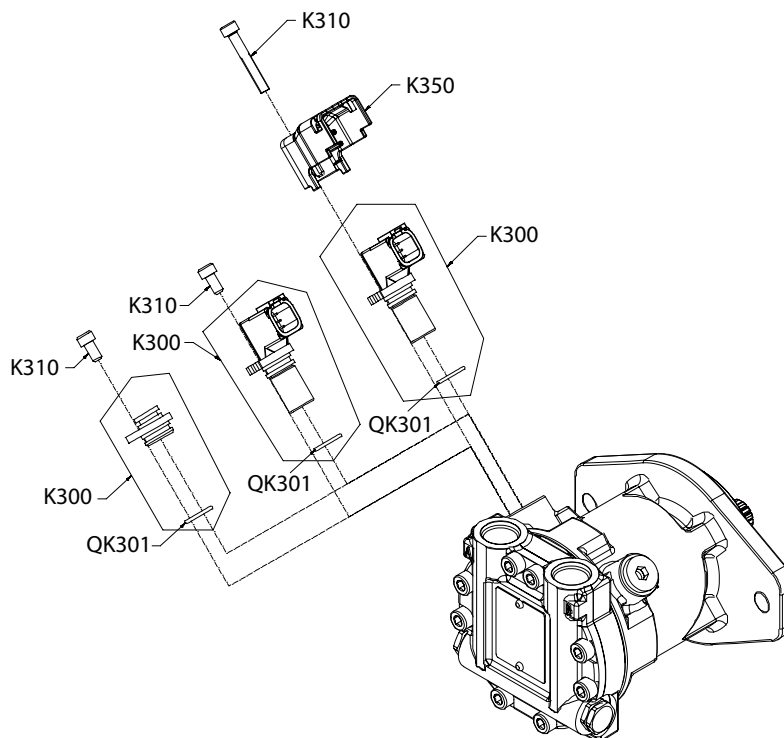


**Minor Repair**

**Speed Sensor**

**MP1M Speed Sensor Removal**

1. Using a 5mm internal hex wrench, remove screw (K310).
2. Remove speed sensor cover (K350), if used.
3. Remove speed sensor (K300).
4. Discard O-ring (QK301).



**MP1M Speed Sensor Assembly**

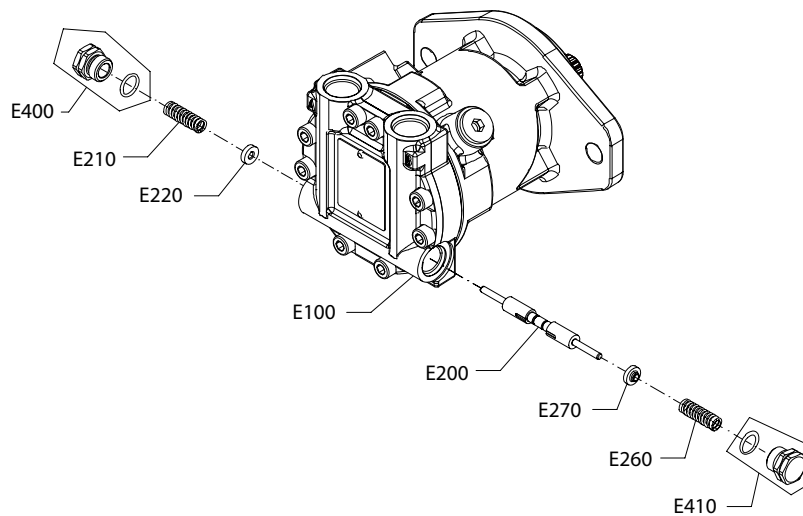
1. Lubricate and install new O-ring (QK301).
2. Install speed sensor (K300).
3. Install speed sensor cover (K350), if used.
4. Install screw (K310) using a 5 mm internal hex wrench with torque to 8 N·m [71 lbf·in].

## Minor Repair

### Loop Flushing Valve

#### MP1M Loop Flushing Valve Removal

1. Using a 19 mm or 3/4 in wrench, remove plugs (E400) and (E410).
2. Remove and discard O-rings (with plugs E400 and E410).
3. Using pliers, remove centering springs (E210 and E260).
4. Remove spring seats (E220 and E270).
5. Remove shift spool (E200).



#### MP1M Inspect the Components

Inspect sealing area for rust, wear, or contamination. Also check springs for wear.

#### MP1M Install the Loop Flushing Valve

1. Install shift spool (E200).
2. Install spring seats (E220 and E270).
3. Carefully install centering springs (E210 and E260).
4. Install new O-rings for plugs (E400 and E410).
5. Using a 19 mm or 3/4 in wrench, torque plugs (E400 and E410) to 35 N·m [310 lbf·in].



## Minor Repair

### Anti-cavitation Valve

#### MP1M Remove the Anti-cavitation Valve (Supply Check Relief Valve)

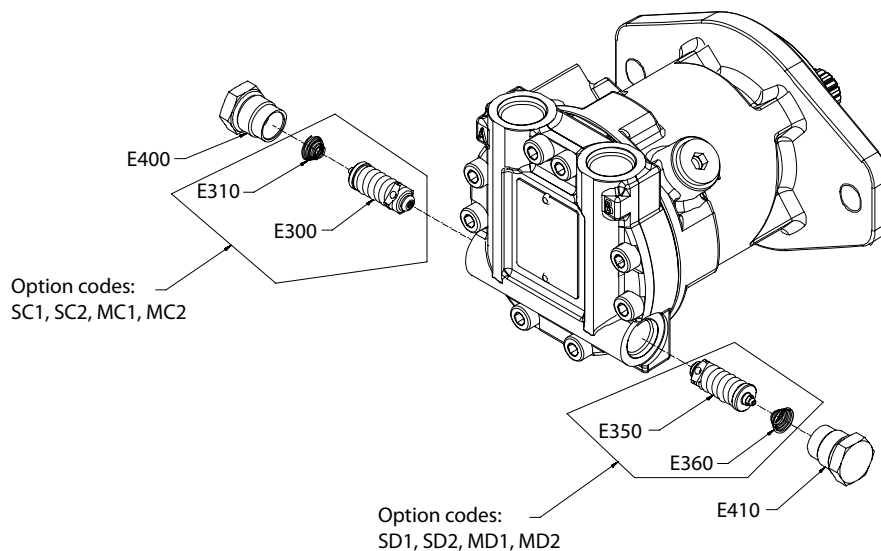
1. Using a 22 mm wrench, remove plugs (E400) and (E410).
2. Remove and discard O-rings (with plugs E400 and E410).
3. Using pliers, carefully remove conical spring (E310). This spring will be on the same side as the supply check relief valve. Please note the direction in which the spring was installed.
4. Carefully remove supply check relief valve assembly (E300). Depending on the configuration selected, this valve may be on the A or B port side. Please note the direction in which this valve was installed.

#### MP1M Inspect the Components

Inspect sealing area for rust, wear, or contamination. Also check springs for wear.

#### MP1M Install the Anti-cavitation Valve

1. Install the plug (either E400 or E410) and a new O-ring on the opposite side of where the anti-cavitation valve will be installed using a 22 mm wrench. Torque to 78 N·m [690 lbf·in].
2. Install the supply check relief valve (E300) on the desired port side. Please note the original direction in which this valve was installed.
3. Carefully install conical spring (E310). Please note the direction in which the spring was installed.
4. Install the plug (either E400 or E410) and a new O-ring on the same side as the supply check relief valve using a 22 mm wrench. Torque to 78 N·m [690 lbf·in].



## Torque Chart

### MP1M Fasteners and Torque

Item	Fastener	Torque
K310	Screw	8 N·m [71 lbf·in]
E400 and E410 (loop flushing)	Plug	35 N·m [310 lbf·in]
E400 and E410 (anti-cavitation)	Plug	78 N·m [690 lbf·in]

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