

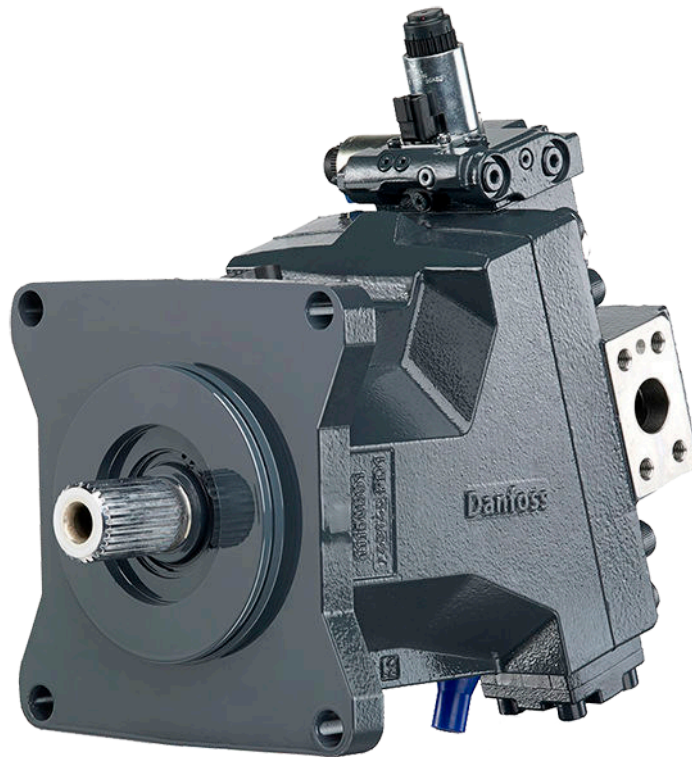
ENGINEERING  
TOMORROW

*Danfoss*

Technical Information

# H1B 060/080/110/160/210/250

## Bent Axis Motors



**Revision history***Table of revisions*

| <b>Date</b>         | <b>Changed</b>  | <b>Rev</b> |
|---------------------|---|------------|
| February 2025       | Updated loop flushing options   | 1302       |
| November 2024       | Added metric information  | 1301       |
| April 2024          | Added AN,AP, 00A options  | 1217       |
| April 2022          | Updated speed sensor information  | 1216       |
| April 2021          | Corrected formatting and content appearance                               | 1215       |
| August 2020         | Added maximum displacement options for 110cc and 210cc                    | 1214       |
| May 2020            | Added DIN 250cc flange, changed document number from BC00000043           | 1213       |
| December 2019       | Updated model code section and corrected speed sensor pinout information. | 1111       |
| July 2019           | Document Title and reference to STS TI.                                   | 1110       |
| May 2019            | Minor update.   | 1109       |
| March 2018          | Model code and ports update.  | 1108       |
| February 2018       | Model code update.  | 1107       |
| December 2017       | PWM data change.  | 1106       |
| November 2017       | Note for speed sensor added.  | 1105       |
| April 2017          | Dimensions table correction.  | 1104       |
| December 2016       | KHKH control correction.  | 1103       |
| August 2016         | DIN, Cartridge flange measures corrections.                               | 1102       |
| July 2016           | Major update. New hydraulic controls added.                               | 1101       |
| May 2008- July 2016 | Various updates, new sizes, Converted to Danfoss, DITA CMS.               | 0101-1001  |

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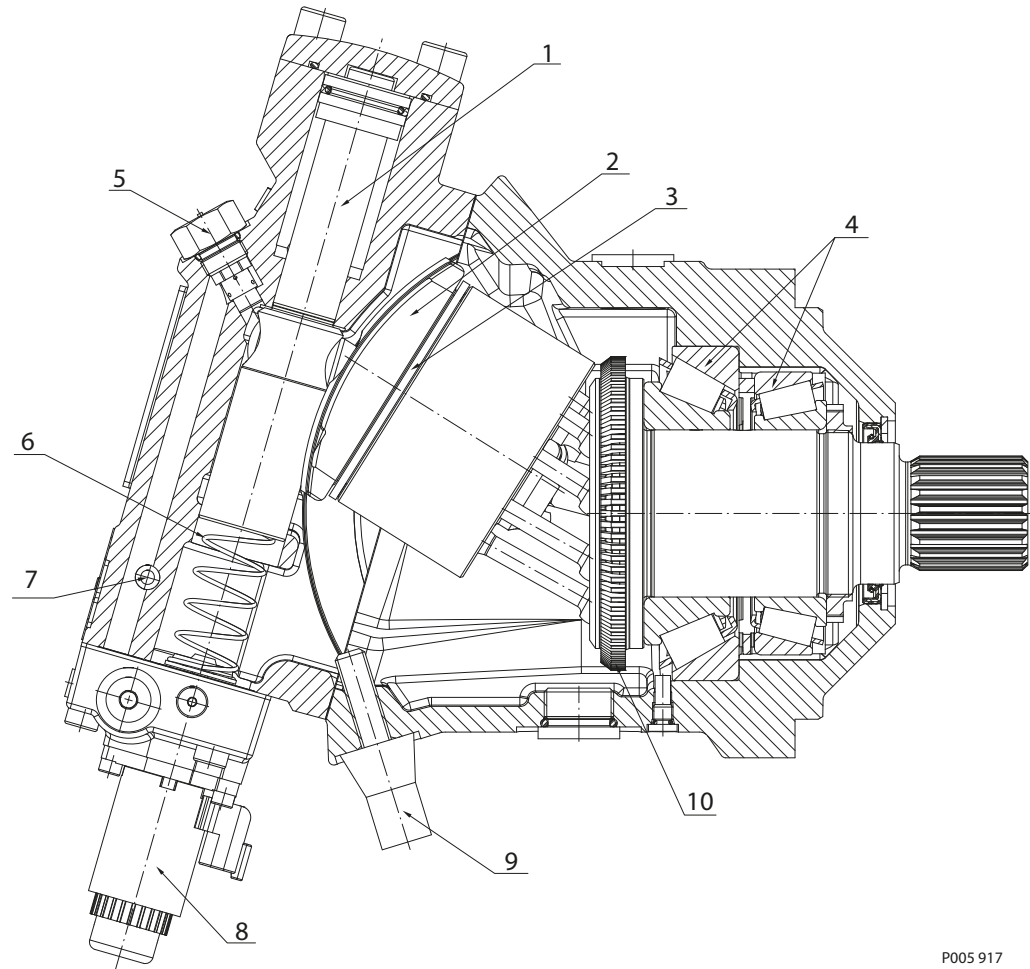
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**General information**

**Design of H1 bent axis motor**

*Cross-section of H1 motor with electric proportional control*

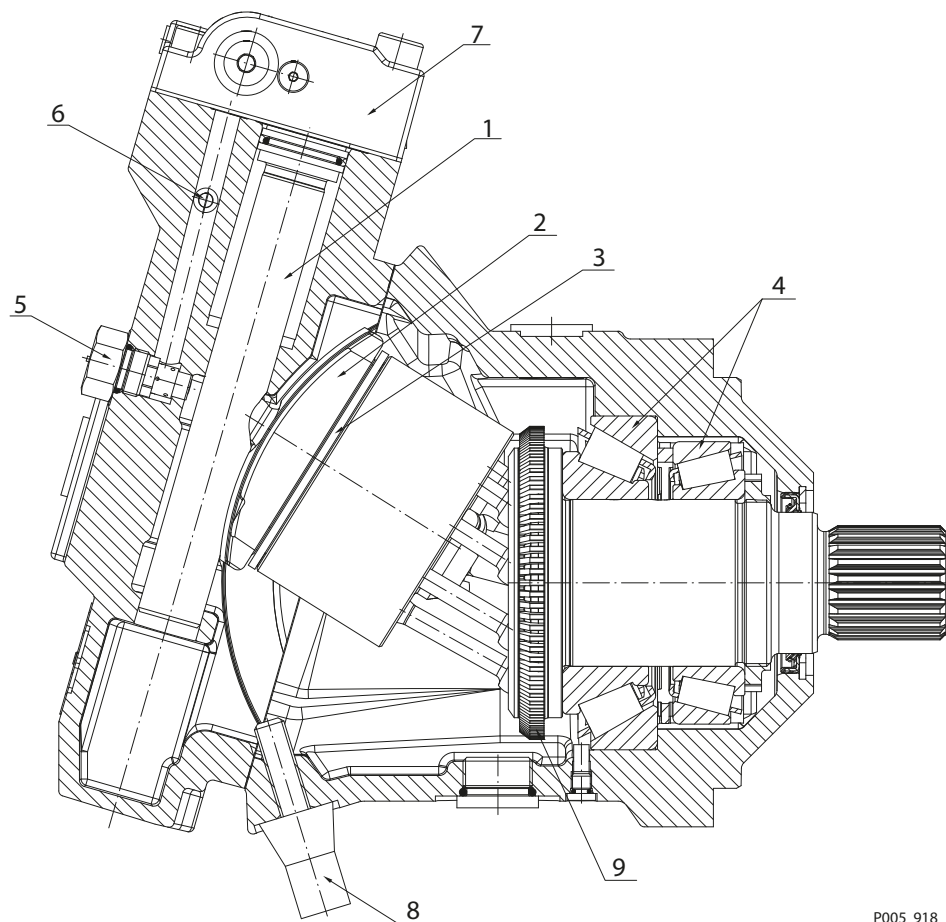


P005 917

- 1. Differential servo piston
- 2. Valve segment
- 3. Bearing plate
- 4. Tapered roller bearing
- 5. Loop flushing relief valve
- 6. Ramp spring
- 7. Loop flushing shuttle spool
- 8. Electric proportional control
- 9. Minimum displacement limiter
- 10. Speed ring (optional)

**General information**

*Cross-section of H1 motor with electric two-position control*



P005 918

- 1.** Differential servo piston
- 2.** Valve segment
- 3.** Bearing plate
- 4.** Tapered roller bearing
- 5.** Loop flushing relief valve
- 6.** Loop flushing shuttle spool
- 7.** Electric two-position control
- 8.** Minimum displacement limiter
- 9.** Speed ring (optional)

## General information

### About the H1 motors

Series H1 variable displacement motors are bent axis design, incorporating spherical pistons.

These motors are designed primarily to be combined with other products in closed circuit systems to transfer and control hydraulic power. Series H1 motors have a large maximum/minimum displacement ratio of 5:1 and high output speed capabilities.

The expanded function of zero degree capability, coupled with a high performance 32 degree maximum angle, creates opportunities to easily improve the machine performance for:

- Wheel assist on the steering axle of high inertia machines (i.e. combines) and could include Anti Slip Control
- Off-highway machines requiring Anti Slip Control (i.e. Ag. sprayer)
- Multi-motor applications requiring optimized work and transport modes (i.e. wheel loader, Ag sprayer) utilizing the zero degree position for maximum transport speed
- Improved machine (i.e. single drum roller) gradeability through precise Anti Slip Control

The Anti Slip Control reduces ground damage, increases traction control and improves machine controllability for the operator.

SAE, Cartridge (not available for 210 cm<sup>3</sup> and 250 cm<sup>3</sup>) and DIN flange with radial or axial high pressure port configurations are available including the loop flushing device.

A complete family of controls and regulators are available to fulfill the requirements of a wide range of applications.

Motors normally start at maximum displacement. This provides maximum starting torque for high acceleration.

All controls utilize internally supplied servo pressure. This may be overridden by a pressure compensator which functions when the motor is operating in motor and pump modes. A defeat option is available to disable the pressure compensator override when the motor is running in pump mode during deceleration/braking.

The pressure compensator option features a low pressure rise to ensure optimal power utilization throughout the entire displacement range of the motor.

Speed sensor options are available to cover all frame sizes and flange styles.

They are capable of sensing the following, all in one package:

- Speed
- Direction (only group "J", option "S")
- Temperature (only group "J", option "S")

The electric controls are specifically designed for the Danfoss family of PLUS+1<sup>®</sup> microcontrollers for easy "Plug and Perform" installation.

### The H1 range of products

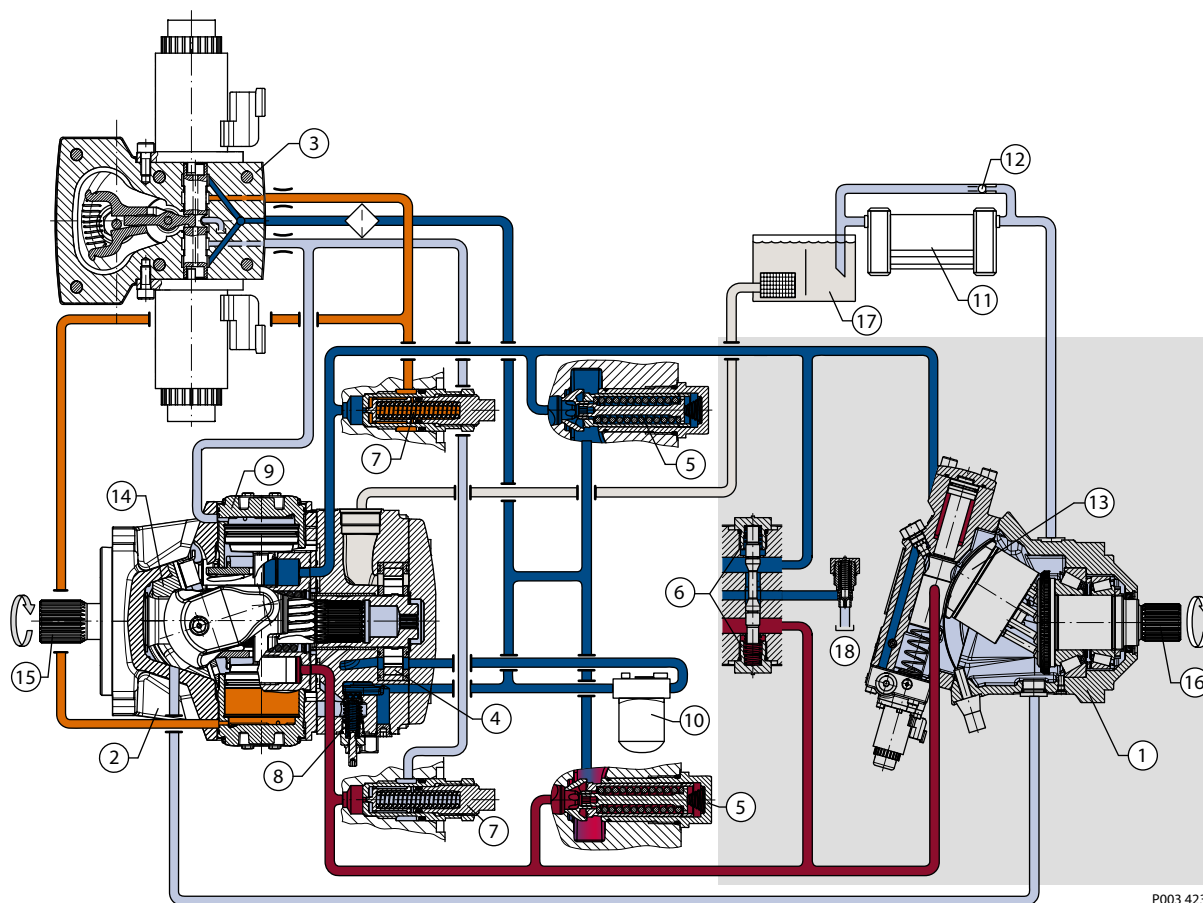
A growing family based on the success of the Series 51 product family:

- Initial release of 060 cm<sup>3</sup>, 080 cm<sup>3</sup>, 110 cm<sup>3</sup>, 160 cm<sup>3</sup>, 210 cm<sup>3</sup> and 250 cm<sup>3</sup> displacement size.
- Development plans include additional displacement sizes.



**General information**

**H1 pictorial diagram**



P003 423

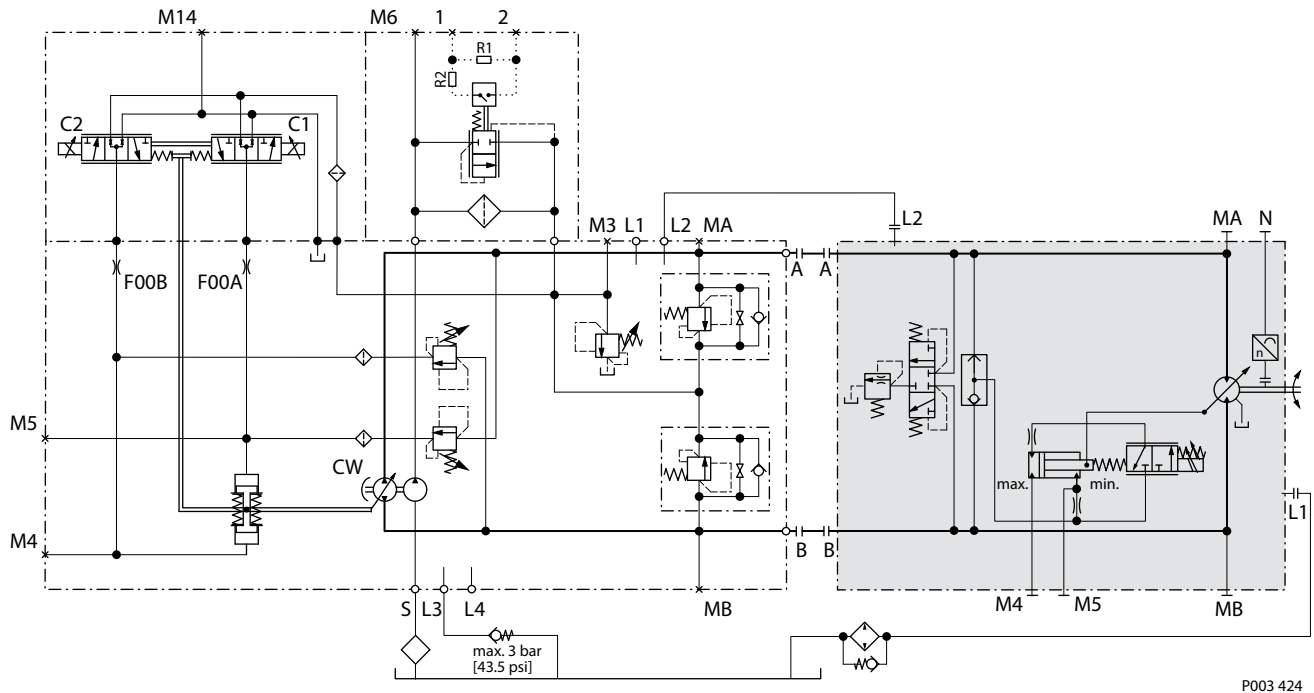
- Working loop A (Low pressure) and charge pressure
- Working loop B (High pressure)
- Servo pressure
- Case drain
- Suction

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li><b>1.</b> Bent Axis Variable Displacement Motor</li> <li><b>2.</b> Axial Piston Variable Displacement Pump</li> <li><b>3.</b> Electric Displacement Control (EDC)</li> <li><b>4.</b> Charge Pump</li> <li><b>5.</b> Charge Check / High Pressure Relief Valve</li> <li><b>6.</b> Loop Flushing Valve</li> <li><b>7.</b> Pressure Limiter Valve</li> <li><b>8.</b> Charge Pressure Relief Valve</li> <li><b>9.</b> Servo Cylinder</li> </ul> | <ul style="list-style-type: none"> <li><b>10.</b> Charge Pressure Filter</li> <li><b>11.</b> Heat Exchanger</li> <li><b>12.</b> Heat Exchanger Bypass Valve</li> <li><b>13.</b> Valve Segment</li> <li><b>14.</b> Pump Swashplate</li> <li><b>15.</b> Input Shaft</li> <li><b>16.</b> Output Shaft</li> <li><b>17.</b> Reservoir</li> <li><b>18.</b> to Motor Case</li> </ul> |
|--|---|

**General information**

**H1 system schematic**

System schematic H1 pump and H1 motor with EDC



P003 424

The schematic above shows the function of a hydrostatic transmission using an H1 axial variable displacement pump with electric proportional displacement control (EDC) and an H1 bent axis variable displacement motor with electric proportional control (L\*) and integrated loop flushing device.

## Technical specifications

### General specifications

#### General specifications

|                                 |   |
|---------------------------------|---|
| <b>Design</b>                   | Piston motor with variable displacement bent axis design  |
| <b>Direction of rotation</b>    | Bi-directional  |
| <b>Pipe connections</b>         | <i>Main pressure ports:</i> ISO split flange boss<br><i>Remaining ports:</i> Metric straight thread O-ring boss |
| <b>Recommended installation</b> | Discretionary, the housing must always be filled with hydraulic fluid   |

### Physical properties

#### Physical properties

| Features  |                       | Unit   | Size               |                    |                    |                    |                    |                    |
|---|-----------------------|--|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
|   |                       |  | 060                | 080                | 110                | 160                | 210                | 250                |
| <b>Displacement</b>   | <b>maximum</b>        | cm <sup>3</sup> [in <sup>3</sup> ]           | 60 [3.66]          | 80 [4.88]          | 110 [6.71]         | 160 [9.76]         | 210 [12.81]        | 250 [15.25]        |
|   | <b>minimum</b>        |  | 12 [0.73]          | 16 [0.98]          | 22 [1.34]          | 32 [1.95]          | 42 [2.56]          | 50 [3.05]          |
| <b>Theoretical flow at max. displ.</b>  | <b>at rated speed</b> | l/min<br>[US gal/min]                        | 216 [57]           | 256 [68]           | 319 [84]           | 416 [110]          | 504 [133]          | 550 [145]          |
|   | <b>at max. speed</b>  |  | 270 [71]           | 328 [87]           | 407 [108]          | 528 [139]          | 630 [166]          | 700 [185]          |
| <b>Theoretical torque at max. displacement</b>  |                       | N•m/bar<br>[lb•in/1000 psi]                  | 0.96 [583]         | 1.27 [777]         | 1.75 [1069]        | 2.55 [1555]        | 3.34 [2038]        | 3.98 [2426]        |
| <b>Theor. corner power at rated speed and max. working pressure (Δp = 450 bar [6527 psi])</b> |                       | kW [hp]                                      | 266 [357]          | 321 [430]          | 396 [531]          | 513 [689]          | 609 [817]          | 684 [917]          |
| <b>Mass moment of inertia of rotating components</b>  |                       | kg•m <sup>2</sup><br>[slug•ft <sup>2</sup> ] | 0.0038<br>[0.0028] | 0.0062<br>[0.0046] | 0.0108<br>[0.0080] | 0.0211<br>[0.0156] | 0.0306<br>[0.0226] | 0.0402<br>[0.0296] |
| <b>Case volume</b>  |                       | l [US gal]                                   | 0.9 [0.24]         | 1.0 [0.26]         | 1.4 [0.37]         | 2.7 [0.71]         | 2.8 [0.74]         | 4.1 [1.08]         |

#### Weight dry (Electric proportional control)

| Configuration    | Size              |                   |                    |                    |                  |                    |
|------------------|-------------------|-------------------|--------------------|--------------------|------------------|--------------------|
|                  | 060               | 080               | 110                | 160                | 210              | 250                |
| <b>SAE</b>       | 29.8 kg [65.7 lb] | 34.8 kg [76.7 lb] | 48.8 kg [107.6 lb] | 61.9 kg [136.5 lb] | 81.0 kg [179 lb] | 87.0 kg [196.2 lb] |
| <b>DIN</b>       | 28.3 kg [62.4 lb] | 34.4 kg [75.8 lb] | 45.0 kg [99.2 lb]  | 59.3 kg [130.7 lb] | 75.0 kg [165 lb] | 79.6 kg [175.5 lb] |
| <b>Cartridge</b> | 26.9 kg [59.3 lb] | 33.0 kg [72.6 lb] | 41.8 kg [92.2 lb]  | 54.7 kg [120.6 lb] | –                | –                  |

#### Mounting flange

| Configuration             | Size                                       |  |   |               |               |               |
|---------------------------|--|--|---|---------------|---------------|---------------|
|                           | 060  | 080  | 110                                     | 160           | 210           | 250           |
| <b>SAE ISO 3019/1</b>     | 127-4 (SAE C) 4-bolt                       |  | 152-4 (SAE-D) 4-bolt                    |               | 165-4 (SAE E) |               |
| <b>DIN ISO 3019/2, B4</b> | 125 HL 4-bolt                              | 140 HL 4-bolt                              | 160 HL 4-bolt                           | 180 HL 4-bolt | 200 HL 4-bolt | 200 HL 4-bolt |
| <b>Cartridge</b>          | Pilot Ø160 mm<br>2-bolt (200 dist.)<br>M16 | Pilot Ø190 mm<br>2-bolt (224 dist.)<br>M20 | Pilot Ø200 mm<br>2-bolt (250 dist.) M20 |               | –             | –             |

## Technical specifications

### Customer ports

| Size                                    |               | 060                                | 080                                | 110                                | 160        | 210                                | 250        |
|---|---------------|------------------------------------|------------------------------------|------------------------------------|------------|------------------------------------|------------|
| <b>Axial and radial<sup>1)</sup></b>    |               | DN19 typ 1                         | DN25 typ 1                         | DN25 typ 1                         | DN32 typ 1 | DN32 typ 1                         | DN32 typ 1 |
| <b>Case drain ports<sup>2)</sup></b>    | <b>Inch</b>   | 0.875 [ $\frac{7}{8}$ ]-14UN-2B    |                                    | 1.0625 [ $1\frac{1}{16}$ ]-12UN-2B |            | 1.313 [ $1\frac{5}{16}$ ]-12UN-2B] |            |
|   | <b>Metric</b> | M22-1.5                            |                                    | M27-2.0                            |            | M33-2.0                            |            |
| <b>Axial gauge ports<sup>2)3)</sup></b> | <b>Inch</b>   | 0.875 [ $\frac{7}{8}$ ]-14UN-2B    | 1.0625 [ $1\frac{1}{16}$ ]-12UN-2B |                                    |            |                                    |            |
|   | <b>Metric</b> | M22-1.5                            | M27-2.0                            |                                    |            |                                    |            |
| <b>Radial gauge port<sup>2)3)</sup></b> | <b>Inch</b>   | 0.5625 [ $\frac{9}{16}$ ]-18UNF-2B |                                    |                                    |            |                                    |            |
|   | <b>Metric</b> | M14-1.5                            |                                    |                                    |            |                                    |            |

<sup>1)</sup> Split flange Boss per ISO6162, 40 MPa series

<sup>2)</sup> O-ring boss

<sup>3)</sup> Countersink may be deeper than specified in the standard.

## Operating Parameters

### Output Speed

| Output Speed | Displacement | Unit                       | Size |      |      |      |      |      |
|--------------|--------------|----------------------------|------|------|------|------|------|------|
|              |              |                            | 060  | 080  | 110  | 160  | 210  | 250  |
| Rated        | Maximum 32°  | min <sup>-1</sup><br>(rpm) | 3600 | 3200 | 2900 | 2600 | 2350 | 2200 |
|              | Minimum 6°   |                            | 5900 | 5300 | 4800 | 4250 | 3850 | 3650 |
|              | Zero 0°      |                            | 6600 | 5950 | 5350 | 4750 | 4300 | 4050 |
| Maximum      | Maximum 32°  |                            | 4500 | 4100 | 3700 | 3300 | 3000 | 2800 |
|              | Minimum 6°   |                            | 7250 | 6600 | 5950 | 5250 | 4800 | 4500 |
|              | Zero 0°      |                            | 7950 | 7200 | 6500 | 5750 | 5250 | 4900 |

### System and Case Pressure, Ambient Temperature

| Parameter                         |                       | All sizes          |
|-----------------------------------|-----------------------|--------------------|
| System pressure                   | Maximum working       | 450 bar [6527 psi] |
|                                   | Maximum               | 480 bar [6962 psi] |
|                                   | Minimum <sup>1)</sup> | <sup>2)</sup>      |
| Case pressure                     | Rated                 | 3 bar [44 psi]     |
|                                   | Maximum               | 5 bar [73 psi]     |
|                                   | Minimum               | 0.3 bar [4 psi]    |
| Ambient temperature <sup>3)</sup> | Maximum               | 70 °C [158 °F]     |
|                                   | Minimum               | -40 °C [-40 °F]    |

<sup>1)</sup> Minimum above case pressure (**open** and **closed** circuit)

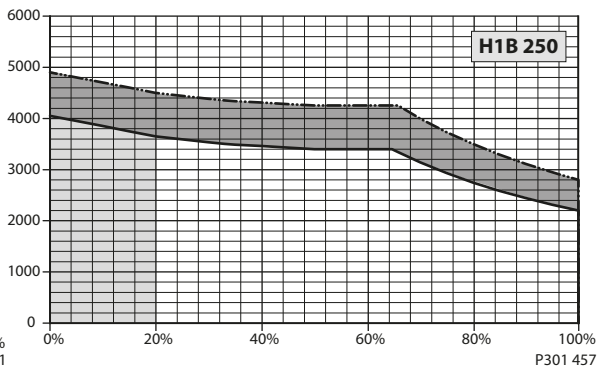
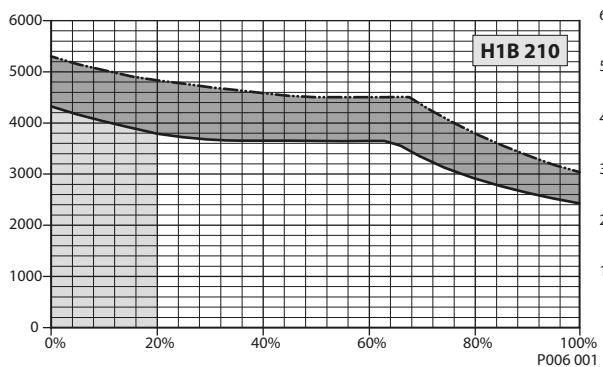
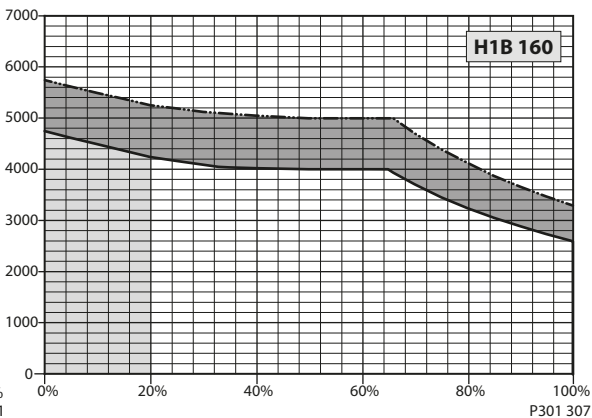
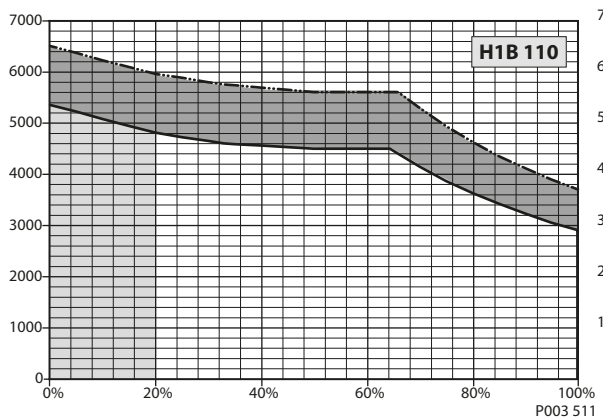
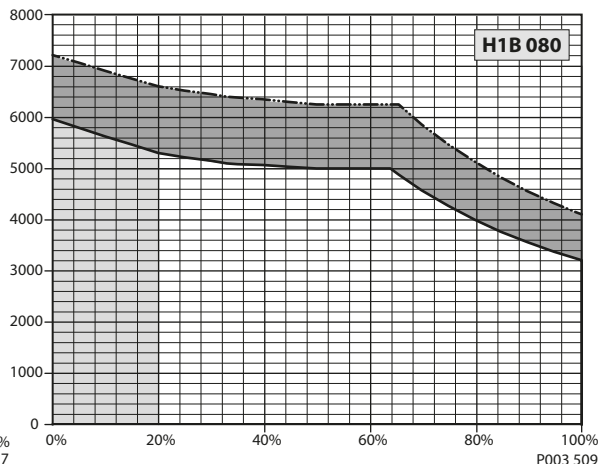
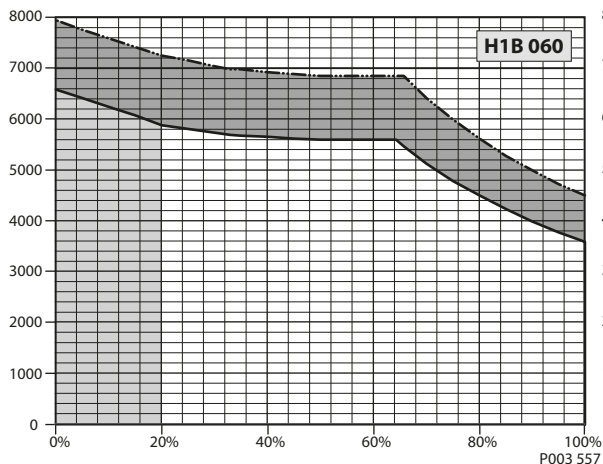
<sup>2)</sup> See the graphs [Required inlet pressure diagrams \(for cylinder block filling\)](#) on page 14.

<sup>3)</sup> Air temperature close to the unit.

## Technical specifications

### H1B speed range diagrams for open and closed circuit

Speed (rpm) versus Displacement (%), Intermittent operation (grey area)



**Warning**

Zero degree capability results in a high risk of overspeed and drops in efficiency if the motor operates between 0–20% displacement.

For **open circuit** applications it is not allowed to operate in the intermittent area.

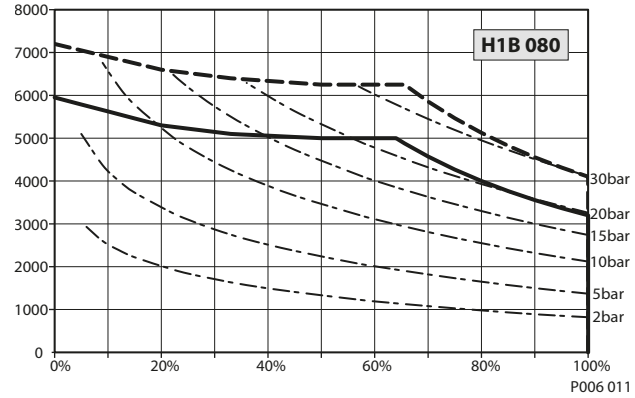
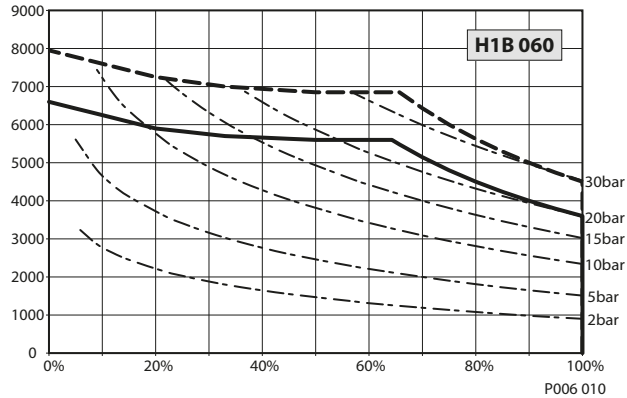
For **closed circuit** applications operating in the intermittent area, please contact your local Danfoss Power Solutions representative.

Contact your Danfoss representative for any operation above Rated speed. In these cases, a special option (AN/AP) is available for 160cc, 210cc and 250cc, for applications with speeds between rated speed and maximum speed for delta pressures over 310 bar. See Model code reference "Special hardware feature" *H1B loop flushing, special hardware options* on page 39

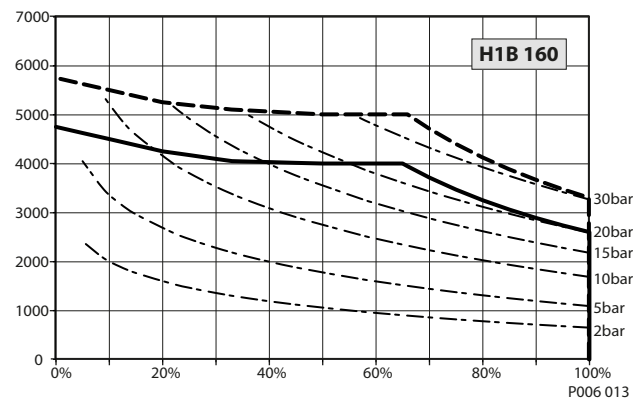
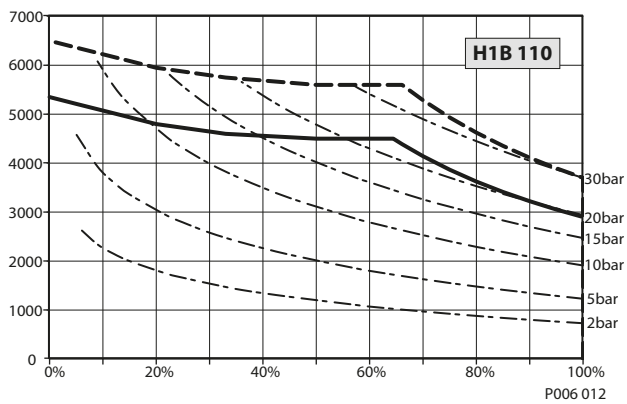
**Technical specifications**

**Required inlet pressure diagrams (for cylinder block filling)**

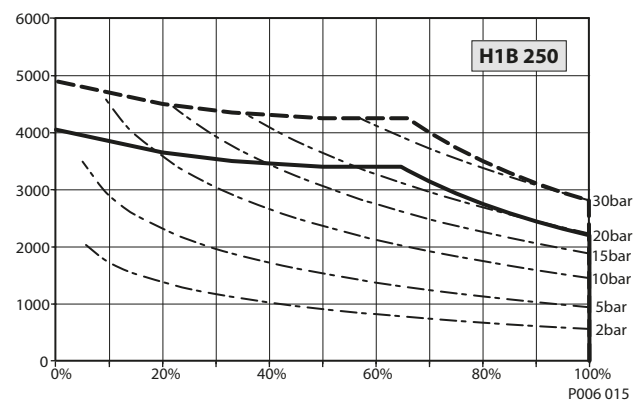
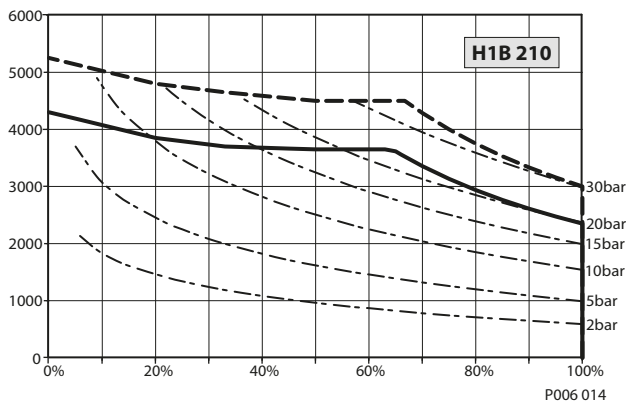
*Speed (rpm) and Pressure (bar) versus Displacement (%)*



*Speed (rpm) and Pressure (bar) versus Displacement (%)*



*Speed (rpm) and Pressure (bar) versus Displacement (%)*



**Bold dashed line:** Maximum speed

**Bold solid line:** Rated speed

This pressure ensures that the cylinder block will be properly filled and that there is no pulling between piston and shaft.

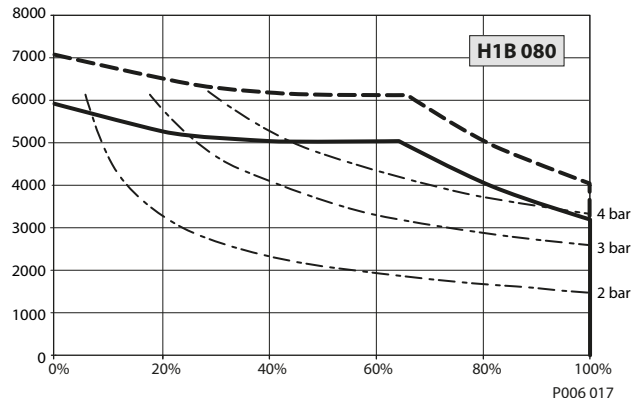
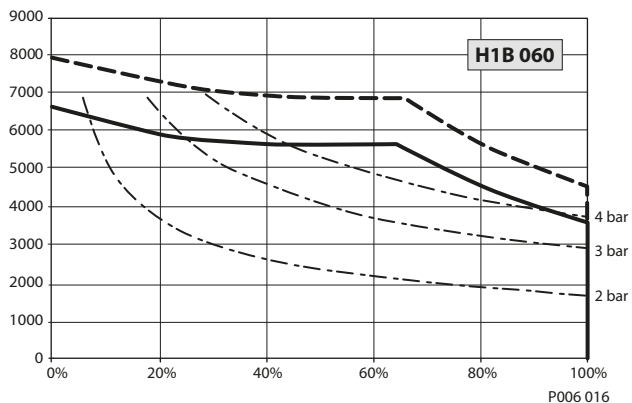
The required pressure is 0 bar at 0 rpm and increases with rpm.

For **open circuit** applications it is not allowed to operate above rated speed. For **closed circuit** applications operating between rated and max. speed, please contact your local Danfoss Power Solutions representative.

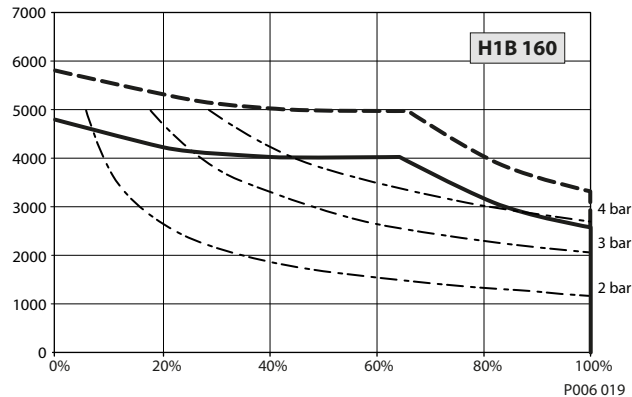
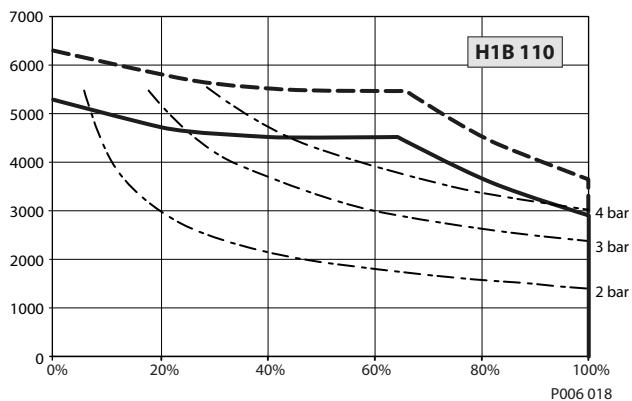
**Technical specifications**

**Required outlet pressure diagrams (minimum for short time usage)**

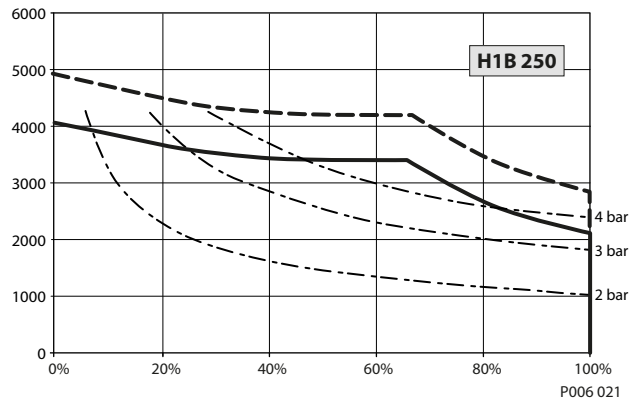
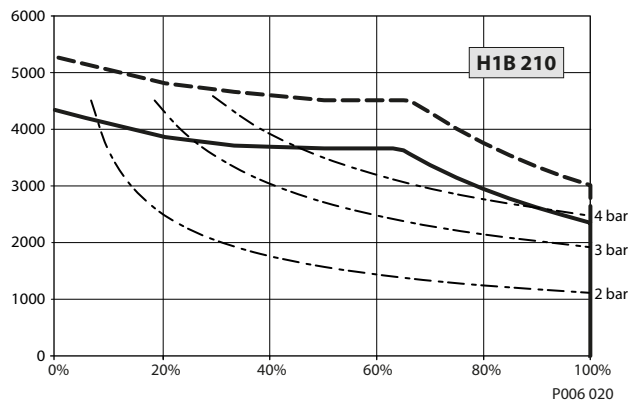
*Speed (rpm) and Pressure (bar) versus Displacement (%)*



*Speed (rpm) and Pressure (bar) versus Displacement (%)*



*Speed (rpm) and Pressure (bar) versus Displacement (%)*



**Bold dashed line:** Maximum speed / **Bold solid line:** Rated speed

The required outlet pressure (above case pressure) makes sure, that there is no pulling between piston and shaft.

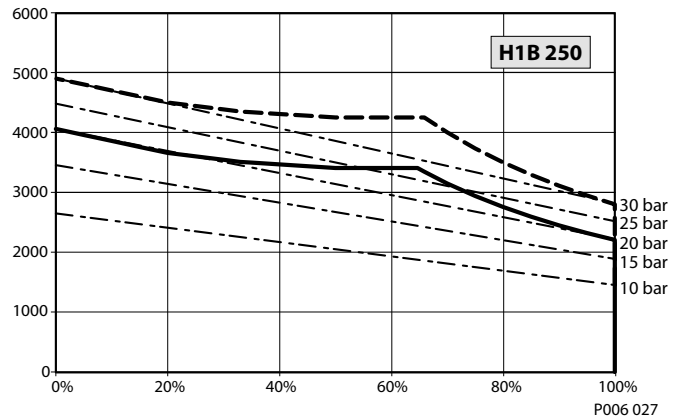
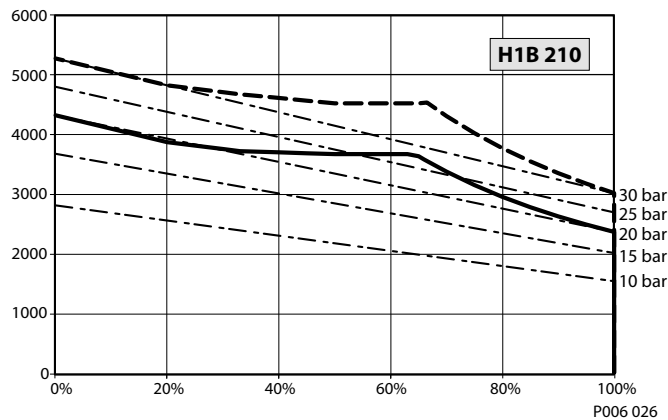
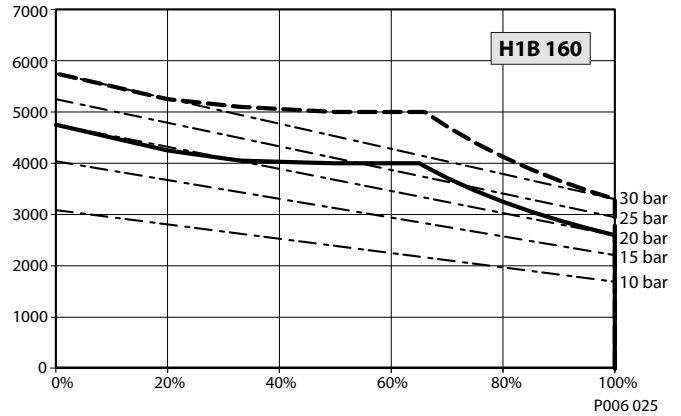
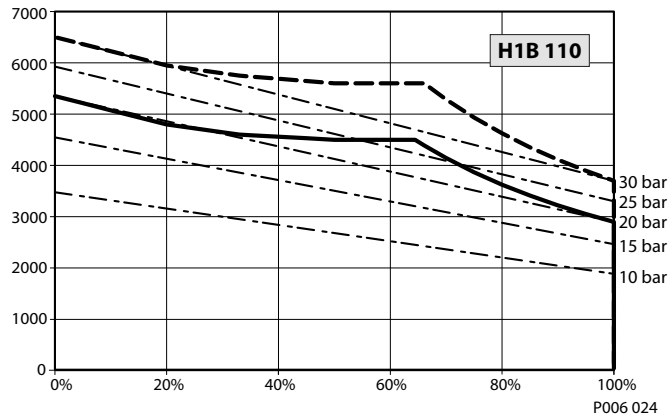
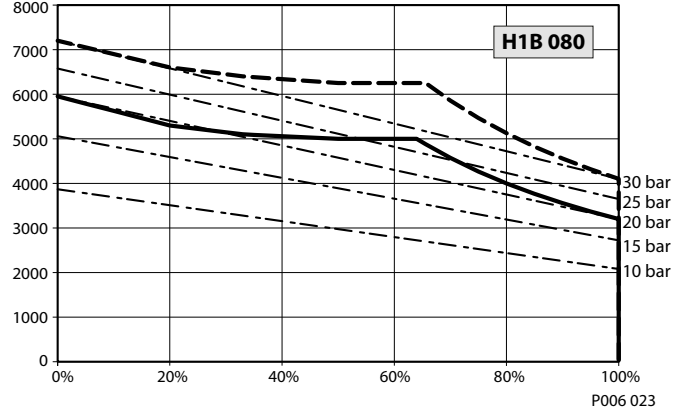
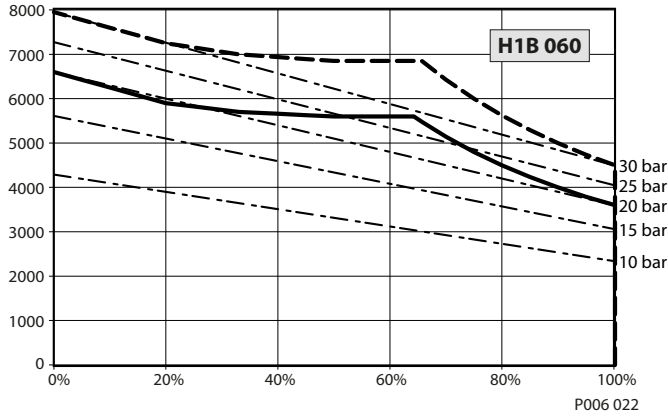
The required pressure is 0 bar at 0 rpm and increases with rpm.

For **open circuit** applications it is not allowed to operate above rated speed. For **closed circuit** applications operating between rated and max. speed, please contact your local Danfoss Power Solutions representative.

**Technical specifications**

**Required low pressure diagrams (minimum for extended usage)**

*Speed (rpm) and Pressure (bar) versus Displacement (%)*



**Bold dashed line:** Maximum speed / **Bold solid line:** Rated speed

These minimum pressures are required for a high duty cycle, defined as 200 hours at 350 bar. Similarly, a duty cycle of 200 hours at 250 bar requires 50% of these pressures.

This low pressure (above case pressure) is required to prevent cavitation, which comes from the pressure change in the cylinder block. There is very high flow velocity in the porting grooves of the valve segment, which causes cavitation.

**For open circuit applications** it is not allowed to operate above rated speed. **For closed circuit applications** operating between rated and max speed, and for specific duty cycle interpretation or analysis, please contact your local Danfoss Power Solutions representative.



## Technical specifications

### Open circuit requirements

H1 Bent Axis Motors may be used in **Open Circuit (OC)** applications.

Since loop flushing is typically not used in OC-applications it is essential to provide sufficient cooling capacity. This can be done by motor case cross flushing.

The flow rate needs to be adjusted to the cooling demand.

The highest case drain outlet port must always be used for the return flow to the cooler or tank.

The motor case, the control system and the working lines connected to Port A and B must be kept full of oil at all times, whether in a dynamic or static condition.

The plumbing must not allow the oil to drain down and be replaced with air in the control or rotating group.

The minimum pressure in the inlet port and the outlet port, measured at gage ports MA and MB, must be equal or higher as shown in the graphs [Required inlet pressure diagrams \(for cylinder block filling\)](#) on page 14.

Danfoss bolt-on counterbalance valves may be used to maintain the minimum pressure requirements. Also the Danfoss Meter-in / Meter-out PVG technology may be used.

Check valves and sufficient charge pressure supply are also possible.

At no time shall the motor be allowed to operate above the rated speed limits. If flow limiter valves are used, they must be selected accordingly. Select Motor controls which use the high loop system pressure to shift the servo piston. This ensures proper function under all conditions.

Valve blocks, such as counter balance valves attached to the inlet and/or outlet ports, must not interfere with any part of the motor. A review of the outline drawings or appropriate 3D models must be completed.

### Fluid specifications

#### Fluid specifications

| Features                          |   | Unit                        | All sizes                                      |
|-----------------------------------|---|-----------------------------|--|
| Viscosity                         | Minimum intermittent                          | mm <sup>2</sup> /s<br>[SUS] | 7 [49]   |
|                                   | Recommended range                             |                             | 12-80 [66-366]                                 |
|                                   | Maximum intermittent                          |                             | 1600 [7416]                                    |
| Temperature range <sup>1)2)</sup> | Minimum                                       | °C<br>[°F]                  | -40 [-40]                                      |
|                                   | Rated   |                             | 104 [220]                                      |
|                                   | Maximum intermittent                          |                             | 115 [240]                                      |
| Cleanliness and Filtration        | Required cleanliness per ISO 4406             | -                           | 22/18/13                                       |
|                                   | Efficiency (charge pressure filtration)       | β-ratio                     | β <sub>15-20</sub> = 75 (β <sub>10</sub> ≥ 10) |
|                                   | Efficiency (suction / return line filtration) |                             | β <sub>35-45</sub> = 75 (β <sub>10</sub> ≥ 2)  |
|                                   | Recommended inlet screen mesh size            | µm                          | 100 – 125                                      |

<sup>1)</sup> At the hottest point, normally case drain port.

<sup>2)</sup> Minimum: cold start, short term t<3 min, p<50 bar, n<1000 rpm.

## Technical specifications

### Determination of nominal motor size

#### Based on SI units

$$Q_e = \frac{V_g \cdot n}{1000 \cdot \eta_v}$$

$$M_e = \frac{V_g \cdot \Delta p \cdot \eta_{mh}}{20 \cdot \pi}$$

$$P_e = \frac{M_e \cdot n}{9550} = \frac{Q_e \cdot \Delta p \cdot \eta_t}{600}$$

$$n = \frac{Q_e \cdot 1000 \cdot \eta_v}{V_g}$$

*Where:*

|                         |  |
|-------------------------|--|
| <b>Q<sub>e</sub></b>    | Input flow (l/min)   |
| <b>M<sub>e</sub></b>    | Output torque (N·m)  |
| <b>P<sub>e</sub></b>    | Output power (kW)  |
| <b>n</b>                | Speed (min <sup>-1</sup> )                                 |
| <b>V<sub>g</sub></b>    | Motor displacement per rev. (cm <sup>3</sup> /rev)         |
| <b>P<sub>high</sub></b> | High pressure (bar)  |
| <b>P<sub>low</sub></b>  | Low pressure (bar)   |
| <b>Δp</b>               | High pressure minus Low pressure (bar)                     |
| <b>η<sub>v</sub></b>    | Motor volumetric efficiency                                |
| <b>η<sub>mh</sub></b>   | Mechanical-hydraulic efficiency                            |
| <b>η<sub>t</sub></b>    | Motor total efficiency (η <sub>v</sub> · η <sub>mh</sub> ) |

#### Based on US units

$$Q_e = \frac{V_g \cdot n}{231 \cdot \eta_v}$$

$$M_e = \frac{V_g \cdot \Delta p \cdot \eta_{mh}}{2 \cdot \pi}$$

$$P_e = \frac{V_g \cdot n \cdot \Delta p \cdot \eta_t}{396\,000}$$

$$n = \frac{Q_e \cdot 231 \cdot \eta_v}{V_g}$$

*Where:*

|                         |  |
|-------------------------|--|
| <b>Q<sub>e</sub></b>    | Input flow [US gal/min]                                    |
| <b>M<sub>e</sub></b>    | Output torque [lb·in]                                      |
| <b>P<sub>e</sub></b>    | Output power [hp]  |
| <b>n</b>                | Speed [rpm]  |
| <b>V<sub>g</sub></b>    | Motor displacement per rev. [in <sup>3</sup> /rev]         |
| <b>P<sub>high</sub></b> | High pressure [psi]  |
| <b>P<sub>low</sub></b>  | Low pressure [psi]   |
| <b>Δp</b>               | High pressure minus Low pressure [psi]                     |
| <b>η<sub>v</sub></b>    | Motor volumetric efficiency                                |
| <b>η<sub>mh</sub></b>   | Mechanical-hydraulic efficiency                            |
| <b>η<sub>t</sub></b>    | Motor total efficiency (η <sub>v</sub> · η <sub>mh</sub> ) |

## Operation

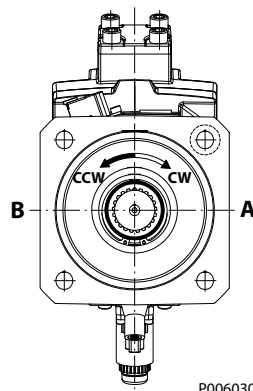
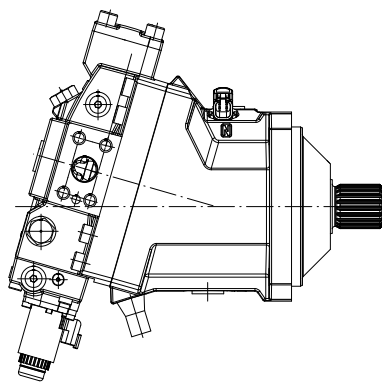
### Shaft rotation direction

Shaft rotation direction is determined with a view from the shaft end.

Rotation direction of the motor will be dependent on the control option used as illustrated below.

In the second number or letter of the control code, 1 means 12 V<sub>DC</sub>, 2 means 24 V<sub>DC</sub>, and H means hydraulic.

*Controls L1, L2, D1, D2, LH, DH*



P006030

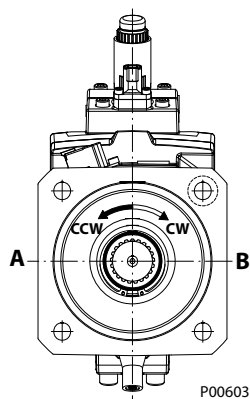
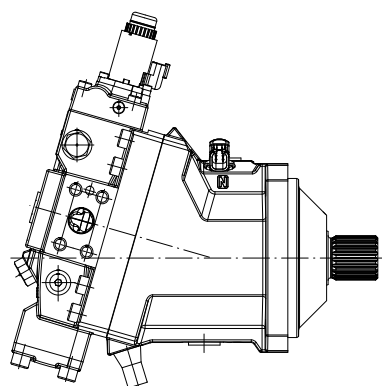
**Flow into port A**

Clockwise

**Flow into port B**

Counterclockwise

*Controls M1, M2, K1, K2, KH, MH*



P006031

**Flow into port A**

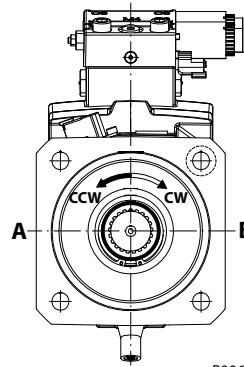
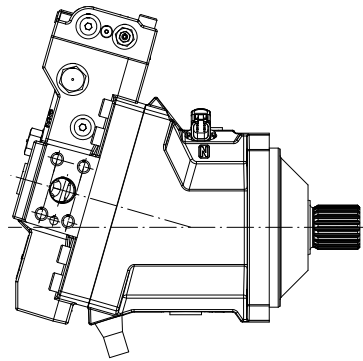
Counterclockwise

**Flow into port B**

Clockwise

**Operation**

*Controls E1, E2, F1, F2, P1, P2, T1, T2, TA, TH, HE, HF*



**Flow into port A**

**Flow into port B**

Counterclockwise

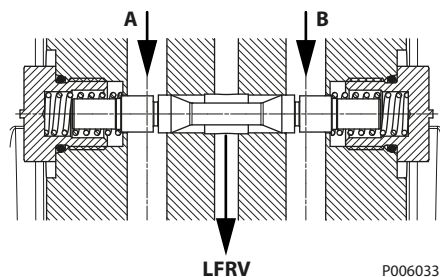
Clockwise

## Operation

### Loop flushing shuttle spool

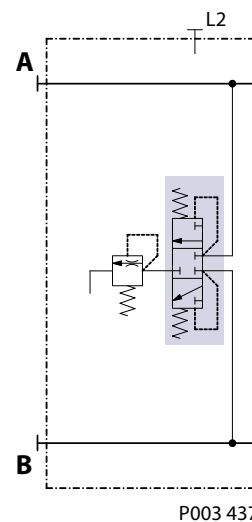
An integral loop flushing shuttle spool is used to separate system A and system B pressures.

System delta pressure will cause the shuttle spool to shift, allowing the low side system pressure to flow to the loop flushing relief valve.



*Legend:*

- A** System loop A
- B** System loop B
- LFRV** to Loop flushing relief valve



### **Warning**

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

Excessive motor loop flushing flow may result in the inability to build required system pressure in some conditions. Maintain correct charge pressure under all conditions of operation to maintain pump control performance in hydrostatic systems.

## Operation

### Loop flushing relief valve

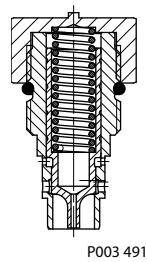
The loop flushing relief valve is incorporated into all H1 motors and uses the loop flushing option in installations that require fluid to be removed from the low pressure side of the system circuit due to cooling requirements.

The loop flushing relief valve is also used to facilitate the removal of contaminants from the loop.

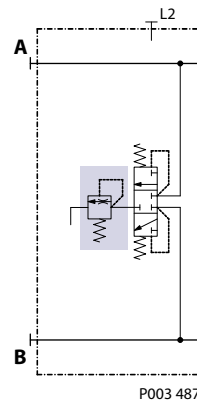
The loop flushing valve is equipped with an orificed charge pressure relief valve designed with a cracking pressure of 16 bar [232 psi].

Valves are available with several orifice sizes to meet the flushing flow requirements of all system operating conditions.

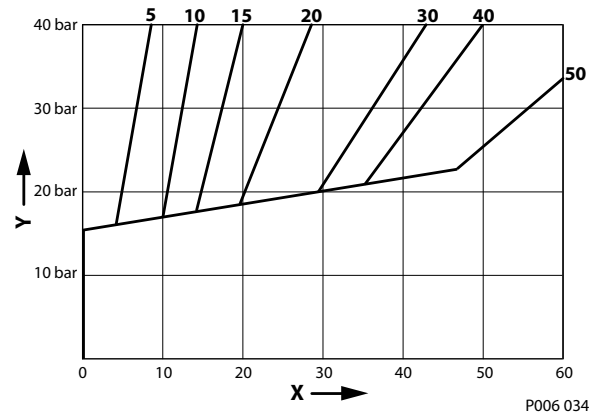
*Loop flushing relief valve (cross section)*



*Loop flushing relief valve schematic*



*Loop flushing relief valve sizes*



- X** Loop flushing flow (l/min)
- Y** Low system pressure minus case pressure (bar)

### Displacement limiter

All Series H1 motors incorporate mechanical displacement limiters.

The minimum displacement of the motor is preset at the factory with a set screw in the motor housing. A tamper-proof cap is provided.

For 0° motors, the minimum displacement screw can be substituted with a plug that uses less space.

## Operation

### Speed sensor

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.

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

### Temperature Range

| Parameter                   | Minimum | Maximum |
|-----------------------------|---------|---------|
| Operation temperature range | -40 °C  | 104 °C  |

115°C intermittent = short term; t < 1min per incident and not exceeding 2 % of duty cycle based load-life.

### Protection Characteristics

| Parameter  | Data   |
|--|--|
| Protection Code (IP class) according IEC 60529 and DIN 40050 | IP 67 (without connector installed)<br>IP 69k (with connector installed) |
| EMC Emission   | EN 61000-6-3   |
| EMC Immunity (EMI)   | 100 V/m incl. 1 kHz AM 80 %; ISO 11452-5 and -2                          |
| ESD  | EN 61000-4-2<br>Air discharge: 15 kV<br>Contact discharge: 8 kV          |
| Vibration  | 30 G (294 m/s <sup>2</sup> )   |
| Shock  | 50 G (490 m/s <sup>2</sup> )   |
| Case maximum pressure  | 5 bar [72.5 psi]   |

### Mating connectors

There are available two types of mating connectors Assembly Bag DEUTSCH DTM06-6S, Black and Grey.

| Ordering number  |  |
|--|--|
| 11033865   | 11033863   |
| Assembly Bag, DEUTSCH DTM06-6S-E004; black, (24-20 AWG) 0.21 -0.52 mm <sup>2</sup> | Assembly Bag, DEUTSCH DTM06-6S, gray, (24-20 AWG) 0.21 -0.52 mm <sup>2</sup> |

### Available Sensors

There are two speed sensors available according to different supply voltage range: 4.5 to 8 V<sub>DC</sub> and 7 to 32 V<sub>DC</sub>.

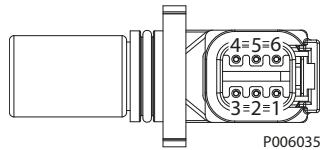
| Description        | Order number         |                      |
|--------------------|----------------------|----------------------|
|                    | 149055               | 11232698             |
| Supply voltage     | 4,5 – 8 V            | 7 – 32 V             |
| Speed signals      | Two, 90° Phase shift | Two, 90° Phase shift |
| Direction signal   | One                  | One                  |
| Temperature signal | One                  | One                  |

For more information, see below.

## Operation

### Speed sensor 4.5 – 8 V

Speed sensor connector, 6-pin



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

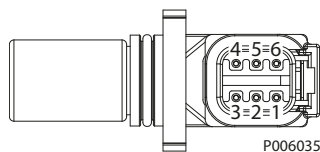
#### Technical data

| 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.<br>Reverse polarity protected.                         |
| Supply protection            | –                    | –                 | 30 V <sub>DC</sub> | Shuts off above 9 V.   |
| Max. required supply current | –                    | –                 | 25 mA              | At supply voltage  |
| Max. output current          | –                    | –                 | 50 mA              |  |
| Operation mode               | <b>NPN &amp; PNP</b> |                   |                    | Push-Pull amplifier  |
| Temperature signal           | -40°C = 2.318V       | –                 | 100°C = 0.675V     |  |
| Output low                   | 5 %                  | 8.5 %             | 12 %               | Ratiometric output voltage<br>Low state > 0 V to provide wire<br>fault detection |
| Output high                  | 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

#### 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<br>-36 V <sub>DC</sub> permanent reverse<br>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<br>supply   |



## Operation

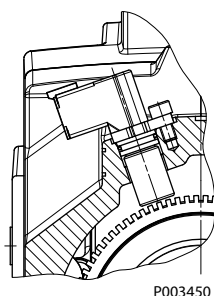
*Technical data (continued)*

| Parameter                         | Min.            | Max.      | Note                                   |
|-----------------------------------|-----------------|-----------|--|
| <b>Output low signal range</b>    | 2 %             | 10 %      | Max. output voltage 24 V <sub>DC</sub> |
| <b>Output high signal range</b>   | 55 %            | 85 %      |  |
| <b>Detectable frequency range</b> | 1 Hz            | 10 000 Hz |  |
| <b>Speed sensor order number</b>  | <b>11232698</b> |           |  |
| <b>Color of connector</b>         | Yellow          |           |  |

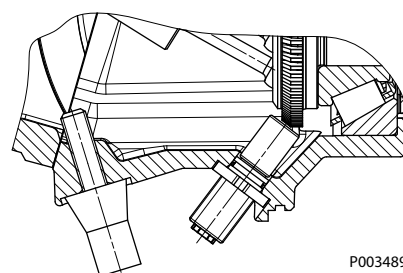
### Sensor position

Sensor position in SAE, DIN and Cartridge housing.

*SAE and DIN housing*



*Cartridge housing*



### Target Ring

Speed (target) rings vary according to the diameter of the cylinder block or shaft on which they are installed. The number of teeth is shown in the table below.

*The number of speed (target) ring teeth*

| H1B and H1F size | 060 | 080 | 110 | 160 | 210 | 250 |
|------------------|-----|-----|-----|-----|-----|-----|
| Teeth            | 71  | 78  | 86  | 95  | 104 | 108 |

Excessive axial shaft loading during installation of motors with speed sensors and cartridge housings must be avoided. High axial shaft loads during installation of motors can lead to a movement of the shaft and damage the speed sensor.

## Operating parameters

### Output speed

**Start and low speed stability.** The motor produces maximum starting torque at maximum displacement. Stable operation can be achieved at 15–34 rpm,  $\pm 5\%$ , depending on system pressure, in applications that require low speed stability. Motor output speed becomes more stable as speed increases.

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

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

Operation between rated and maximum speed is reserved for **intermittent operation** (see [H1B speed range diagrams for open and closed circuit](#) on page 13) not to exceed 10 minutes durations, 2% of duty cycle based load-life, and 310 bar system delta pressure. Speed above rated are anticipated to occur during downhill braking (negative power). Contact factory for any operation above Rated speed when negative power is not involved.

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During hydraulic braking and downhill conditions, the prime mover must be capable of providing sufficient braking torque in order to avoid pump over speed. This is especially important to consider for turbocharged and Tier 4 engines.

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### **Warning**

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

Exceeding maximum speed may cause a loss of hydrostatic drive line power and 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. The braking system must also be sufficient to hold the machine in place when full power is applied.

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## Operating parameters

### System pressure

**System pressure** is the differential pressure between high pressure system ports. 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 or pressure limiter 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. For applications which are above the maximum working pressure, please contact Danfoss

**Minimum pressure** must be maintained under all operating conditions to avoid cavitation.

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

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**Summing pressure** is the sum of both the low and high loop pressures. Summing pressure above 30 bar [435 psi] guarantees reliable use within the rated speed.

**Servo pressure** is the pressure in the servo system and is supplied from the high side of the loop to keep the motor at the required displacement.

### 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**

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**Possible component damage or leakage.**

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

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### External shaft seal pressure

In certain applications, the output shaft seal may be exposed to external pressures. The shaft seal is designed to withstand an external pressure up to 0.25 bar [3.6 psi] above the case pressure. The case pressure limits must also be followed to ensure the shaft seal is not damaged.

## Operating parameters

### 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. Therefore, temperatures should remain 16 °C [30 °F] above the pour point of the hydraulic fluid.

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

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

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

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

## System design parameters

### Filtration system

To prevent premature wear, ensure that only clean fluid enters the hydrostatic transmission circuit. A filter capable of controlling the fluid cleanliness to ISO 4406, class 22/18/13 (SAE J1165) or better, under normal operating conditions, is recommended. These cleanliness levels cannot be applied for hydraulic fluid residing in the component housing/case or any other cavity upon delivery from the factory.

The filter may be located on the pump (integral) or in another location (remote or suction). The integral filter has a filter bypass sensor to signal the machine operator when the filter requires changing. Filtration strategies include suction or pressure filtration. The selection of the filter strategy depends on a number of factors including the contaminant ingress rate, the generation of contaminants in the system, the required fluid cleanliness, and the desired maintenance interval. Filters are selected to meet the above requirements using rating parameters of efficiency and capacity.

Filter efficiency can be measured with a Beta ratio ( $\beta_x$ ). For simple suction-filtered closed circuit transmissions and open circuit transmissions with return line filtration, a filter with a  $\beta$ -ratio within the range of  $\beta_{35-45} = 75$  ( $\beta_{10} \geq 2$ ) or better has been found to be satisfactory. For some open circuit systems, and closed circuits with cylinders being supplied from the same reservoir, a higher filter efficiency is recommended. This also applies to systems with gears or clutches using a common reservoir. For these systems, a charge pressure or return filtration system with a filter  $\beta$ -ratio in the range of  $\beta_{15-20} = 75$  ( $\beta_{10} \geq 10$ ) or better is typically required.

Because each system is unique, only a thorough testing and evaluation program can fully validate the filtration system. For more information, see *Design Guidelines for Hydraulic Fluid Cleanliness, Technical Information BC152886482150*.

[Filter  \$\beta\_x\$ -ratio is a measure of filter efficiency defined by ISO 4572. It is defined as the ratio of the number of particles greater than a given diameter \("x" in microns\) upstream of the filter to the number of these particles downstream of the filter.](#)

*Filtration, cleanliness level and  $\beta_x$ -ratio (recommended minimum)*

|   |   |
|---|---|
| <b>Cleanliness per ISO 4406</b>   | 22/18/13                                      |
| <b>Efficiency <math>\beta_x</math> (charge pressure filtration)</b>         | $\beta_{15-20} = 75$ ( $\beta_{10} \geq 10$ ) |
| <b>Efficiency <math>\beta_x</math> (suction and return line filtration)</b> | $\beta_{35-45} = 75$ ( $\beta_{10} \geq 2$ )  |
| <b>Recommended inlet screen mesh size</b>                                   | 100 – 125 $\mu\text{m}$                       |

### Reservoir

Proper sizing of the hydrostatic system reservoir will allow maximum volume changes during all system operating modes and increase de-aeration of the fluid as it passes through the tank. A suggested minimum total reservoir volume is  $\frac{5}{8}$  of the maximum charge pump flow per minute with a minimum fluid volume equal to  $\frac{1}{2}$  of the maximum charge pump flow per minute. This allows 30 seconds of fluid dwell time for removing entrained air at the maximum return flow. This is usually adequate to allow for a closed reservoir having no breather in most applications.

Locate the reservoir outlet to the charge pump inlet above the bottom of the reservoir to take advantage of gravity separation and prevent large foreign particles from entering the charge inlet line. A 100-125 mesh screen over the reservoir outlet port is recommended. Position the reservoir inlet for the fluid return to discharge below the normal fluid level and toward the interior of the tank. A baffle or baffles, between the inlet and outlet of the reservoir will further increase de-aeration and reduce surging of the fluid.

## System design parameters

### Fluid Selection

Ratings and performance data are based on operating with hydraulic fluids containing oxidation, rust and foam inhibitors. These fluids must possess good thermal and hydrolytic stability to prevent wear, erosion, and corrosion of motor components.

 **Caution**

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Never mix hydraulic fluids of different types.

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### Case Drain

A case drain line must be connected to the case outlets of each motor to return the internal leakage oil to the system reservoir. When filling the case before start up, use the highest case drain outlet to promote complete filling of the case. The case drain fluid is typically the hottest fluid in the system. It is highly recommended to route the case drain flow through a heat exchanger before it is returned to the reservoir.

In some applications, it may be required to provide additional cross-flushing of the motor. If the motor is used mainly in a high speed application, higher cooling requirements may be needed for the rotating kit and tapered roller bearings. Use the lowest case drain port as the inlet port and the highest case drain port as the outlet port. This will ensure that the case is full of oil at all times.

Apply unit case pressure ratings to case drain routing and design.

### Independent braking system

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**Unintended vehicle or machine movement hazard.**

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. The braking system must also be sufficient to hold the machine in place when full power is applied.

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### Bearing loads and life

Bearing life is a function of speed, system pressure, motor angle and any external side or thrust loads. The influence of motor angle includes displacement as well as direction. External side loads are found in some applications such as a helical gear without its own support bearings, installed directly on to the motor shaft. All external side loads will act to reduce the normal bearing life of the motor. Other life factors include oil type and viscosity.

When external side loads are present, the allowable radial shaft loads are a function of the load position relative to the mounting flange, the load orientation relative to the internal loads and the operating pressures of the hydraulic unit. In applications where external shaft loads cannot be avoided, the impact on bearing life can be minimized by proper orientation of the load. Optimal motor orientation is a consideration of the net loading on the shaft from the external load and the motor rotating kit.

Contact Danfoss for a bearing life review if external side loads and thrust loads are present.

### Shaft Torque

Available shafts are capable to transmit the maximum torque capability at maximum working pressure. Lubrication or similar treatment of splined motor shaft is recommended for proper torque transmission.

For more information, see **Lubrication of Splined Shafts, Data Sheet, AI152986482538**.

**Master Model Code**

**H1B size, version, port options**



*H1B frame size*

| Code | Displacement                                 |
|------|--|
| 060  | 60 cm <sup>3</sup> [3.66 in <sup>3</sup> ]   |
| 080  | 80 cm <sup>3</sup> [4.88 in <sup>3</sup> ]   |
| 110  | 110 cm <sup>3</sup> [6.71 in <sup>3</sup> ]  |
| 160  | 160 cm <sup>3</sup> [9.76 in <sup>3</sup> ]  |
| 210  | 210 cm <sup>3</sup> [12.81 in <sup>3</sup> ] |
| 250  | 250 cm <sup>3</sup> [15.25 in <sup>3</sup> ] |

*A – Product version*

|   |               |
|---|---------------|
| A | Revision code |
|---|---------------|

*Z – Port configuration*

|   |  |
|---|--|
| A | Inch, Customer O-ring port sealing according to ISO 11926-1  |
| M | Metric, Customer O-ring port sealing according to ISO 6149-1 |





**Master Model Code**

*B – hydraulic controls*

| Code | Port Config (Z) | Control type           | PCOR | Note   |
|------|-----------------|------------------------|------|--|
| DH   | A               | Hydraulic Proportional | ●    | External pressure control supply<br>Default (w/o control pressure) = Maximum |
| LH   | A               |                        | —    |  |
|      | M               |                        |      |  |
| MH   | A               |                        | —    | External pressure control supply   |
| KH   | A               |                        | ●    | Default (w/o control pressure) = Minimum                                     |
| HE   | A               | Hydraulic 2-position   | —    | External pressure control supply<br>Default (w/o control pressure) = Maximum |
|      | M               |                        |      |  |
| HF   | A               |                        | —    | External pressure control supply   |
| TH   | A               |                        | ●    | Default (w/o control pressure) = Minimum                                     |
| TA   | A               | PCOR                   | ●    | Default (high pressure below PCOR pressure)                                  |
|      | M               |                        |      |  |







**Master Model Code**

*G – Flange and housing (continued)*

| Code | Port Config (Z) | Description  | 060 | 080 | 110 | 160 | 210 | 250 |
|------|-----------------|--|-----|-----|-----|-----|-----|-----|
| CS   | A               | Cartridge flange motor housing, with speed sensor port | ●   | ●   | ●   | ●   | -   | -   |
|      | M               |  | ●   | ●   | ●   | ●   | -   | -   |





**Master Model Code**

**H1B minimum and maximum displacement options**



*N – Minimum displacement*

| Code | Description   | Compatible frame size |
|------|---|-----------------------|
| XXX  | 000 or 012 to 040 cm <sup>3</sup> /rev minimum displacement setting             | 60cc                  |
|      | 000 or 016 to 054 cm <sup>3</sup> /rev minimum displacement setting             | 80cc                  |
|      | 000 or 022 to 074 cm <sup>3</sup> /rev minimum displacement setting             | 110cc                 |
|      | 000 or 032 to 108 cm <sup>3</sup> /rev minimum displacement setting             | 160cc                 |
|      | 000 or 042 to 142 cm <sup>3</sup> /rev minimum displacement setting             | 210cc                 |
|      | 000 or 050 to 169 cm <sup>3</sup> /rev minimum displacement setting             | 250cc                 |
| MBO  | Plug (replaces minimum displacement limiter screw for 0° motors)                | All                   |
| 00A  | 000 cm <sup>3</sup> /rev with adjustment screw for minimum displacement setting | All                   |

*P – Maximum displacement (non adjustable)*

| Code | Displacement           | Use with controls:    | 060                   | 080 | 110 | 160 | 210 | 250 |
|------|------------------------|-----------------------|-----------------------|-----|-----|-----|-----|-----|
| N    | 100 % max.             | L*, M*, K* and D*     | ●                     | ●   | ●   | ●   | ●   | ●   |
| A    | 95 % max.              | L* and D*             | ●                     | ●   | -   | -   | ●   | -   |
| B    | 90 % max.              |                       | -                     | -   | ●   | ●   | -   | ●   |
| C    | 85 % max.              |                       | -                     | ●   | ●   | -   | -   | ●   |
| D    | 80% max.               |                       | -                     | -   | -   | -   | ●   | -   |
| E    | 75 % max.              |                       | ●                     | -   | ●   | -   | -   | ●   |
| Z    | 100 % max.             |                       | E*, F*, H*, T* and P* | ●   | ●   | ●   | ●   | ●   |
| Q    | 95 % max. displacement | ●                     |                       | ●   | ●   | ●   | ●   | ●   |
| R    | 90 % max.              | E*, F*, H*, T* and P* | ●                     | ●   | ●   | ●   | ●   | ●   |
| S    | 85 % max.              |                       | ●                     | ●   | ●   | ●   | ●   | ●   |
| T    | 80 % max.              | E*, F*, H*, T* and P* | ●                     | ●   | ●   | ●   | ●   | ●   |
| U    | 75 % max.              |                       | ●                     | ●   | ●   | ●   | ●   | -   |
| V    | 65 % max.              |                       | ●                     | -   | -   | -   | -   | -   |





## Control operation and description

### Electric controls

Motor displacement can be changed electro hydraulically under load in response to an electrical signal from maximum displacement to minimum displacement and vice versa. Under some circumstances, such as contamination, the control spool could stick and cause the motor to stay at some displacement.

### Electric proportional controls

The electric proportional control consists of a proportional solenoid which acts directly on a two-position, three-way porting spool. When activated, the solenoid pushes on the spool which then ports high pressure to the larger diameter of the servo piston. The servo piston and rotating group move to change the displacement to the point where the pressures on the servo are in balance with the force from the feedback spring.

#### **De-energized = maximum displacement**

With a de-energized to maximum displacement control, the de-energized proportional valve keeps the motor at maximum displacement. When energized, the solenoid pushes on the porting spool which moves to port high system pressure to the larger diameter end of the servo piston. Depending on the current supplied to the proportional valve, the motor will stroke between maximum displacement at zero current and minimum displacement at maximum current.

#### **De-energized = minimum displacement**

With a de-energized to minimum displacement control, the de-energized proportional valve keeps the motor at minimum displacement. When energized, the solenoid pushes on the porting spool which moves to port high system pressure to the larger diameter end of the servo piston. Depending on the current supplied to the proportional valve, the motor will stroke between minimum displacement at zero current and maximum displacement at maximum current.

### Electric two-position controls

The electric two-position control consists of an off/on-solenoid which acts on a two position, three-way porting spool. Servo pressure is internally supplied to the two-position porting spool by an integral system pressure shuttle.

#### **De-energized = maximum displacement**

When the solenoid is de-energized, the motor runs at maximum displacement. When energized, the solenoid applies a force on the spool which ports high pressure to the larger diameter of the servo piston and strokes the motor to minimum displacement. When the solenoid is de-energized, the motor strokes back to maximum displacement.

#### **De-energized = minimum displacement**

When the solenoid is de-energized, the motor runs at minimum displacement. When energized, the solenoid applies a force on the spool which ports the larger diameter of the servo piston to tank, and strokes the motor to maximum displacement. When the solenoid is de-energized, the motor strokes back to minimum displacement.

### Servo supply

The system shuttle check valve supplies the control system with high system pressure. A minimum servo supply pressure (high system pressure) of 20 bar above case pressure is required to shift the motor displacement.

## Control operation and description

### Control options

To enhance the performance of our motors, several options are available to augment the performance of the control system. These control enhancements include:

- Pressure Compensator Over Ride, **PCOR**
- Proportional Pressure Compensator Over Ride, **PPCOR** and
- Brake Pressure Defeat, **BPD**

### PCOR

The de-energized electric control keeps the motor at minimum displacement.

The electric control can be overridden by the PCOR using high loop system pressure. When the system pressure rises above the PCOR setting, the PCOR override will be activated. The motor then increases to maximum displacement.

The motor displacement is regulated automatically between minimum and maximum in response to the high loop pressure. This ensures optimal power throughout the entire displacement range of the motor.

The pressure compensator control can also be overridden with an electric off/on-solenoid option. When the solenoid is energized, the motor strokes to maximum displacement and stays at that position until the solenoid is de-energized.

#### Electric proportional with PCOR

In the de-energized state, the electric proportional control keeps the motor at minimum displacement until system pressure rises above the PCOR setting. When the PCOR activates, it ports high system pressure to the larger end of the servo piston, increasing the motor displacement to maximum.

#### Electric two-position with PCOR

In the de-energized state, the electric two-position control supplies both sides of the servo piston and keeps the motor at minimum displacement as long as the high loop pressure remains below the pressure compensator setting. If the high loop pressure rises above the pressure compensator setting, the porting spool ports the larger diameter of the servo piston to tank. The motor strokes in the direction of maximum displacement.

#### Electric two-position with proportional PCOR

The PPCOR valve consists of an electric proportional solenoid and a two-position, three-way porting spool with an adjustable spring force on the opposite end of the spool. Maximum signal current to the proportional solenoid overrides the pressure compensator and strokes the motor to maximum displacement. The proportional solenoid changes the pressure compensator setting to allow different, on the go, settings.

The solenoid and the high system pressure work against the spring on the end of the two-position, three-way porting spool. With decreased signal current on the proportional solenoid, the reduction of the forces from the proportional solenoid cause an increased pressure compensator setting for the high system pressure and consequently provides a proportional pressure compensator.

During production test, the PPCOR setting is adjusted to 240 bar with the adjusting screw on the control housing in reference to input current of:

- 800 mA for P1 (12 V)
- 400 mA for P2 (24 V)

## Control operation and description

### Hydraulic controls

Motor displacement can be changed hydraulically, under load, from maximum to minimum displacement and vice versa in response to an external hydraulic signal.

### Hydraulic proportional control

The hydraulic proportional control consists of a proportional hydraulic actuator which acts directly on a two-position, three-way porting spool. It uses an external source for control pressure supply. When pressurizing, the hydraulic actuator pushes the spool which then ports high pressure to the larger diameter of the servo piston. The servo piston and rotating group move to change the displacement to the point where the pressures on the servo are in balance with the force from the feedback spring.

#### **De-energized = maximum displacement**

With a de-energized (not pressurized) to maximum displacement control, the de-energized proportional valve keeps the motor at maximum displacement.

When energized, the hydraulic actuator pushes on the porting spool which moves to port high system pressure to the larger diameter end of the servo piston.

Depending on the pressure level supplied to the proportional actuator, the motor will stroke between maximum displacement at start pressure setting and minimum displacement at maximum pressure setting.

#### **De-energized = minimum displacement**

With a de-energized (not pressurized) to minimum displacement control, the de-energized proportional valve keeps the motor at minimum displacement.

When energized, the hydraulic actuator pushes on the porting spool which moves to port high system pressure to the larger diameter end of the servo piston.

Depending on the pressure level supplied to the proportional valve, the motor will stroke between minimum displacement at start pressure setting and maximum displacement at maximum pressure setting.

### Hydraulic two-position control

The hydraulic two-position control uses an external source for control pressure supply (e. g. charge pressure). This control pressure acts on a two position, three-way porting spool. Servo pressure is internally supplied to the two-position porting spool by an integral system shuttle check valve.

#### **Default (without control pressure) = maximum displacement**

With no control pressure applied, the motor operates at maximum displacement.

When control pressure is applied, the spool shifts, porting high system pressure to the large diameter end of the servo piston, shifting the motor to minimum displacement.

When the control pressure is removed, spring forces move the spool, allowing the large diameter end of the servo piston to drain to tank, shifting the motor to maximum displacement.

#### **Default (without control pressure) = minimum displacement**

With no control pressure applied, the motor operates at minimum displacement.

When control pressure is applied, the spool shifts, porting the large diameter end of the servo piston to tank, shifting the motor to maximum displacement.

When the control pressure is removed, spring forces move the spool, porting high pressure to the large diameter end of the servo piston, shifting the motor to minimum displacement.

## Control operation and description

### Hydraulic proportional with PCOR

In the energized (pressurized) state, the hydraulic proportional control keeps the motor at minimum displacement until system pressure rises above the PCOR setting.

When the PCOR activates, it ports high system pressure to the larger end of the servo piston, increasing the motor displacement to maximum.

### Hydraulic two-position with PCOR

In the non-pressurized state, the hydraulic two-position control supplies both sides of the servo piston and keeps the motor at minimum displacement as long as the high loop pressure remains below the pressure compensator setting.

If the high loop pressure rises above the pressure compensator setting, the porting spool ports the larger diameter of the servo piston to tank.

The motor strokes in the direction of maximum displacement.

### Brake Pressure Defeat (BPD)

For propel applications, use the electric or hydraulic BPD option in conjunction with the PCOR option.

#### Electric BPD

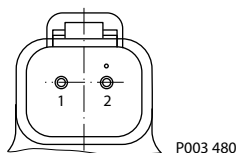
For propel applications, use the electric BPD option in conjunction with the PCOR option. The BPD shuttle valve is located ahead of the pressure compensator control valve.

The BPD consists of an electric off/on solenoid and a two-position, three-way porting spool. The applied logic allows the pressure compensator control to operate normally with high loop system pressure during acceleration and cuts off the supply pressure during deceleration if the motor is running in a pump mode (includes deceleration or overrun). This prevents rapid or uncontrolled deceleration while the machine is slowing down. With the BPD solenoid de-energized, the porting spool is centered by spring force.

The BPD solenoid must be controlled by a direction lever switch or an output signal from a micro-controller.

#### Electric solenoid connector

*DEUTSCH connector, 2-pin*



#### Connector ordering data

| Description                    | Quantity | Ordering data          |
|--------------------------------|----------|------------------------|
| Mating connector               | 1        | DEUTSCH DT06-2S        |
| Wedge lock                     | 1        | DEUTSCH W2S            |
| Socket contact (16 and 18 AWG) | 2        | DEUTSCH 0462-201-16141 |
| Danfoss mating connector kit   | 1        | K29657                 |

## Control operation and description

### Hydraulic BPD

The BPD shuttle valve is located ahead of the pressure compensator control valve. The BPD function consists of an external pressure supply which acts on a two-position, three-way porting spool. The applied logic allows the pressure compensator control to operate normally with high loop system pressure during acceleration and cuts off the supply pressure during deceleration if the motor is running in pump mode. This prevents rapid or uncontrolled deceleration while the machine is slowing down. When pilot pressure difference on the control pressure ports of the BPD is too low the position of the porting spool is not defined.

### H1B control response

H1 controls are available with orifices to assist in matching the rate of stroking time from maximum displacement (100 %) to minimum displacement (20 %) and vice versa to application requirements.

Stroking times for other pressure levels could be calculated at simulation model of request.

Typical response times shown below at the following conditions:

System and charge pressure = 210 bar [3046 psi] and 20 bar [290 psi]  
 Viscosity and temperature = 20 mm<sup>2</sup>/s [97 SUS] and 60°C [140°F]  
 Speed = 1500 min<sup>-1</sup> (rpm)

#### *H1B typical response times*

| Orifice                  | Stroking direction | Size   |        |        |        |        |        |
|--------------------------|--------------------|--------|--------|--------|--------|--------|--------|
|                          |                    | 060    | 080    | 110    | 160    | 210    | 250    |
| Ø0.6 mm<br>[Dia 0.02 in] | Max. to min.       | 0.70 s | 1.04 s | 1.31 s | 1.97 s | 2.15 s | 2.21 s |
|                          | Min. to max.       | 0.75 s | 1.04 s | 1.41 s | 2.03 s | 2.23 s | 2.30 s |
| Ø0.8 mm<br>[Dia 0.03 in] | Max. to min.       | 0.41 s | 0.61 s | 0.76 s | 1.14 s | 1.25 s | 1.28 s |
|                          | Min. to max.       | 0.44 s | 0.60 s | 0.81 s | 1.16 s | 1.27 s | 1.31 s |
| Ø1.2 mm<br>[Dia 0.05 in] | Max. to min.       | 0.22 s | 0.32 s | 0.40 s | 0.59 s | 0.65 s | 0.67 s |
|                          | Min. to max.       | 0.24 s | 0.32 s | 0.43 s | 0.60 s | 0.66 s | 0.69 s |

## Control operation and description

### Applications related to controls

The following table is provided to assist in selecting controls for various applications. The recommendation is based on experience with a wide range of applications.

#### Selecting controls for various applications

| Application                    | Control / PCOR, BPD options |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |
|--------------------------------|-----------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
|                                | L*<br>BA                    | D*<br>MA | D*<br>M* | M*<br>CA | K*<br>K* | K*<br>KA | E*<br>AA | F*<br>EA | TA<br>DA | TA<br>D* | T*<br>D* | P*<br>D* | T*<br>DA | P*<br>DA | HE<br>HE | HF<br>HF | LH<br>BA | DH<br>MA | DH<br>MH |
| Wheel loader <sup>1)</sup>     |                             |          | ●        |          | ●        |          |          |          |          |          | ●        | ●        |          |          | ●        |          |          |          | ●        |
| Roller compactor <sup>1)</sup> |                             |          |          |          |          |          | ●        | ●        |          |          |          |          |          |          | ●        |          |          |          |          |
| Paver-wheeled <sup>1)</sup>    |                             |          |          |          |          |          | ●        | ●        |          |          |          |          |          |          |          |          |          |          | ●        |
| Paver-tracked <sup>1)</sup>    |                             |          |          |          |          |          | ●        | ●        |          |          |          |          |          |          |          |          |          |          |          |
| Crawler <sup>1)</sup>          | ●                           |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          | ●        |          |
| Sweeper <sup>1)</sup>          |                             |          |          |          | ●        |          |          |          |          |          | ●        | ●        |          |          |          |          |          |          | ●        |
| Trencher <sup>1)</sup>         | ●                           |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          | ●        |          | ●        |
| Fork lift truck <sup>1)</sup>  |                             |          | ●        |          | ●        |          |          |          |          | ●        |          | ●        |          |          |          |          |          |          |          |
| Agricultural <sup>1)</sup>     | ●                           |          |          |          | ●        |          |          |          | ●        |          |          |          |          |          |          | ●        |          |          | ●        |
| Wheel assist <sup>1)</sup>     |                             |          | ●        | ●        |          |          |          |          |          | ●        |          |          |          |          |          | ●        |          |          |          |
| Forestry <sup>1)</sup>         |                             |          |          |          | ●        |          |          |          |          |          |          |          |          |          |          |          |          |          | ●        |
| Tele-handler <sup>1)</sup>     |                             |          |          |          | ●        |          |          |          |          |          |          | ●        |          |          |          |          |          |          |          |
| Railroad <sup>1)</sup>         |                             |          | ●        |          |          |          | ●        | ●        |          | ●        | ●        |          |          |          |          |          |          |          | ●        |
| Snow groomer <sup>1)</sup>     | ●                           |          |          |          |          |          |          |          |          |          |          |          |          |          |          |          | ●        |          |          |
| Snow blower <sup>2)</sup>      |                             |          |          |          |          | ●        |          |          |          |          |          |          | ●        | ●        |          |          |          |          |          |
| Crane <sup>3)</sup>            | ●                           |          |          |          |          |          | ●        |          |          |          |          |          |          |          |          |          |          |          |          |
| Crusher/Shredder <sup>4)</sup> |                             | ●        |          |          |          | ●        |          |          | ●        |          |          |          | ●        | ●        |          |          |          |          |          |

<sup>1)</sup> Propel function

<sup>2)</sup> Blow drive function

<sup>3)</sup> Winch function

<sup>4)</sup> Roll function

\* means option **1** = 12 V<sub>DC</sub> or **2** = 24 V<sub>DC</sub>

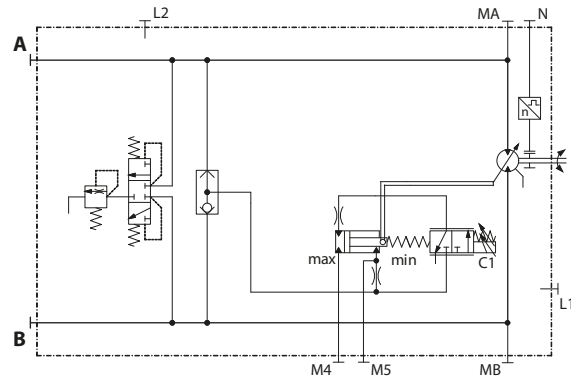
**Electric proportional and two-position controls**

**L1BA and L2BA options**

**L1** – electric proportional 12 V / **de-energized = max. displacement**  
**BA** – without Pressure Compensator Over Ride / without Brake Pressure Defeat

**L2** – electric proportional 24 V / **de-energized = max. displacement**  
**BA** – without Pressure Compensator Over Ride / without Brake Pressure Defeat

Hydraulic schematic



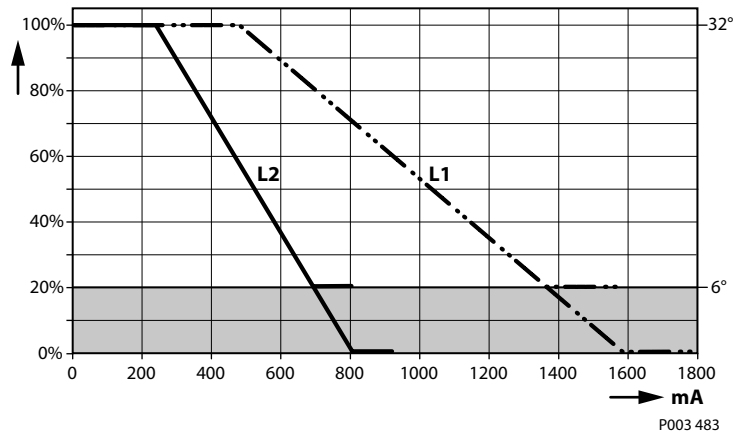
Options L1BA, L2BA



**Solenoid C1**  
 De-energized = max. displacement  
 Full-energized = min. displacement

- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- N** Speed sensor (optional)

Displacement (%) versus Input Command (mA)



**L1, L2** = L1, L2 Control  
 Grey area = Intended to be used for zero degree capability.

Formulas how to calculate start and end input command (mA) dependent on displacements

| Input command (mA)  | % displ.      | Control *1                                | Control *2                               |
|---------------------|---------------|---|--|
| Start input command | from 100 %    | 480 ± 10                                  | 240 ± 5                                  |
|                     | from y % max. | $(1 - V_{gy}/V_{gmax}) \times 1110 + 480$ | $(1 - V_{gy}/V_{gmax}) \times 570 + 240$ |



## Electric proportional and two-position controls

Formulas how to calculate start and end input command (mA) dependent on displacements (continued)

| Input command (mA)      | % displ.    | Control *1                                | Control *2                               |
|-------------------------|-------------|---|--|
| End input command       | at 0 %      | 1590 ± 130                                | 810 ± 67                                 |
|                         | at x % min. | $(1 - V_{gx}/V_{gmax}) \times 1110 + 480$ | $(1 - V_{gx}/V_{gmax}) \times 570 + 240$ |
| Maximum allowed current |             | 1800                                      | 920                                      |

*Where:*

**V<sub>gmax</sub>** Maximum, theoretic possible motor displacement per revolution (cm<sup>3</sup>/rev)

**V<sub>gx</sub>** Minimum displacement setting of desired unit (cm<sup>3</sup>/rev)

**V<sub>gy</sub>** Maximum displacement setting of desired unit (cm<sup>3</sup>/rev)

**x** Minimum displacement (%)

**y** Maximum displacement (%)

### Proportional solenoid data C1

| Description             |                    | 12 V                         | 24 V    |
|-------------------------|--------------------|------------------------------|---------|
| Maximum current         |                    | 1800 mA                      | 920 mA  |
| Nominal coil resistance | @ 20 °C [68 °F]    | 3.66 Ω                       | 14.20 Ω |
|                         | @ 80 °C [176 °F]   | 4.52 Ω                       | 17.52 Ω |
| Inductance              |                    | 33 mH                        | 140 mH  |
| PWM signal frequency    | Range              | 70 – 200 Hz                  |         |
|                         | Recommended*       | 150 Hz                       |         |
| IP Rating               | IEC 60 529         | IP 67                        |         |
|                         | DIN 40 050, part 9 | IP 69K with mating connector |         |
| Connector color         |                    | Black                        |         |

\* PWM signal required for optimum control performance.

### **Warning**

Zero degree capability results in a high risk of overspeed and drops in efficiency if the motor operates between 0–20% displacement.

**Electric proportional and two-position controls**

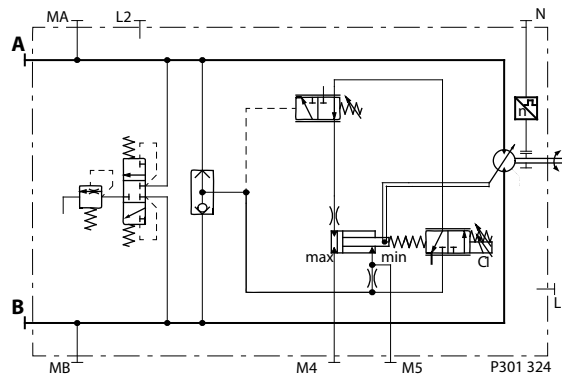
**D1MA and D2MA options with PCOR**

- D1** – electric proportional 12 V / **de-energized = max. displacement**
- MA** – with Pressure Compensator Over Ride / without Brake Pressure Defeat
  
- D2** – electric proportional 24 V / **de-energized = max. displacement**
- MA** – with Pressure Compensator Over Ride / without Brake Pressure Defeat

**! Caution**

This control is not for use in propel applications.

Hydraulic schematic



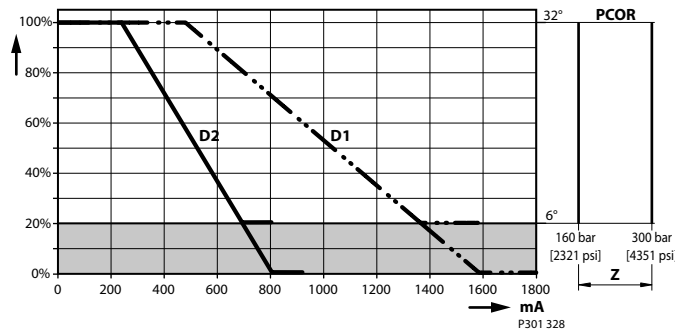
Options D1MA, D2MA



**Solenoid C1**  
 De-energized = max. displacement  
 Full-energized = min. displacement

- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- N** Speed sensor (optional)

Displacement (%) versus Input Command (mA)



- D1, D2** = D1, D2 Control
- Z** = Start setting range
- Grey area* = Intended to be used for zero degree capability.

## Electric proportional and two-position controls

*Formulas how to calculate start and end input command (mA) dependent on displacements*

| Input command (mA)      | % displ.      | Control *1                                | Control *2                               |
|-------------------------|---------------|---|--|
| Start input command     | from 100 %    | 480 ± 10                                  | 240 ± 5                                  |
|                         | from y % max. | $(1 - V_{gy}/V_{gmax}) \times 1110 + 480$ | $(1 - V_{gy}/V_{gmax}) \times 570 + 240$ |
| End input command       | at 0 %        | 1590 ± 130                                | 810 ± 67                                 |
|                         | at x % min.   | $(1 - V_{gx}/V_{gmax}) \times 1110 + 480$ | $(1 - V_{gx}/V_{gmax}) \times 570 + 240$ |
| Maximum allowed current |               | 1800                                      | 920                                      |

*Where:*

- $V_{gmax}$**  Maximum, theoretic possible motor displacement per revolution (cm<sup>3</sup>/rev)
- $V_{gx}$**  Minimum displacement setting of desired unit (cm<sup>3</sup>/rev)
- $V_{gy}$**  Maximum displacement setting of desired unit (cm<sup>3</sup>/rev)
- x** Minimum displacement (%)
- y** Maximum displacement (%)

### Proportional solenoid data C1

| Description             |                    | 12 V                         | 24 V    |
|-------------------------|--------------------|------------------------------|---------|
| Maximum current         |                    | 1800 mA                      | 920 mA  |
| Nominal coil resistance | @ 20 °C [68 °F]    | 3.66 Ω                       | 14.20 Ω |
|                         | @ 80 °C [176 °F]   | 4.52 Ω                       | 17.52 Ω |
| Inductance              |                    | 33 mH                        | 140 mH  |
| PWM signal frequency    | Range              | 70 – 200 Hz                  |         |
|                         | Recommended*       | 150 Hz                       |         |
| IP Rating               | IEC 60 529         | IP 67                        |         |
|                         | DIN 40 050, part 9 | IP 69K with mating connector |         |
| Connector color         |                    | Black                        |         |

\* PWM signal required for optimum control performance.

### Warning

Zero degree capability results in a high risk of overspeed and drops in efficiency if the motor operates between 0–20% displacement.

**Electric proportional and two-position controls**

**D1M1 and D2M2 options with PCOR and electric BPD**

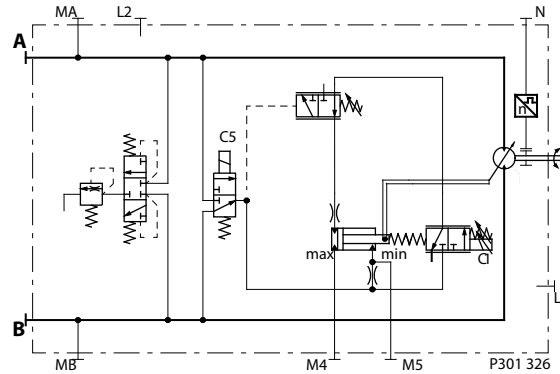
**D1** – electric proportional 12 V / **de-energized = max. displacement**

**M1** – with PCOR / with electric BPD 12 V / de-energized BPD = PCOR active at port B

**D2** – electric proportional 24 V / **de-energized = max. displacement**

**M2** – with PCOR / with electric BPD 24 V / de-energized BPD = PCOR active at port B

Hydraulic schematic



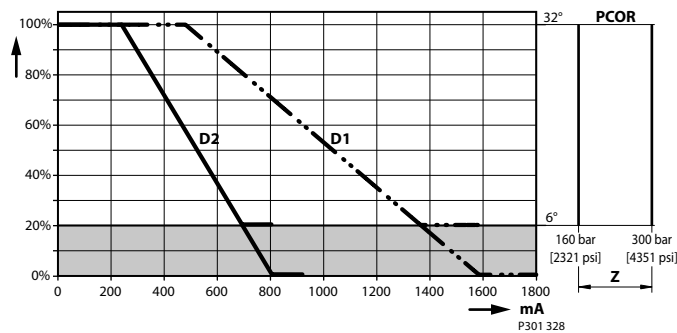
- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- N** Speed sensor (optional)

D1M1, D2M2 option



**Solenoid C1**  
 De-energized = max. displacement  
 Full-energized = min. displacement

Displacement (%) versus Input Command (mA)



**D1, D2** = D1, D2 Control

**Z** = Start setting range

Grey area = Intended to be used for zero degree capability.

For the formulas to calculate an input command dependent on displacement, please see [D1MA and D2MA options with PCOR](#) on page 50.

## Electric proportional and two-position controls

### Proportional control solenoid data C1

| Description             |                    | 12 V                         | 24 V    |
|-------------------------|--------------------|------------------------------|---------|
| Maximum current         |                    | 1800 mA                      | 920 mA  |
| Nominal coil resistance | @ 20 °C [68 °F]    | 3.66 Ω                       | 14.20 Ω |
|                         | @ 80 °C [176 °F]   | 4.52 Ω                       | 17.52 Ω |
| Inductance              |                    | 33 mH                        | 140 mH  |
| PWM signal frequency    | Range              | 70 – 200 Hz                  |         |
|                         | Recommended*       | 150 Hz                       |         |
| IP Rating               | IEC 60 529         | IP 67                        |         |
|                         | DIN 40 050, part 9 | IP 69K with mating connector |         |
| Connector color         |                    | Black                        |         |

\* PWM signal required for optimum control performance.

### Two-position solenoid data C5 (Brake pressure defeat)

| Description                             |                    | 12 V                         | 24 V               |
|---|--------------------|------------------------------|--------------------|
| Supply voltage                          | Minimum            | 9.5 V <sub>DC</sub>          | 19 V <sub>DC</sub> |
|   | Max. (continuous)  | 14.6 V <sub>DC</sub>         | 29 V <sub>DC</sub> |
| Nominal coil resistance @ 20 °C [68 °F] |                    | 8.4 Ω                        | 34.5 Ω             |
| Input current                           | Recommended        | 1050 mA                      | 500 mA             |
| IP Rating                               | IEC 60 529         | IP 67                        |                    |
|   | DIN 40 050, part 9 | IP 69K with mating connector |                    |
| Bi-directional diode                    |                    | yes                          |                    |
| Connector color                         |                    | Black                        |                    |

### **Warning**

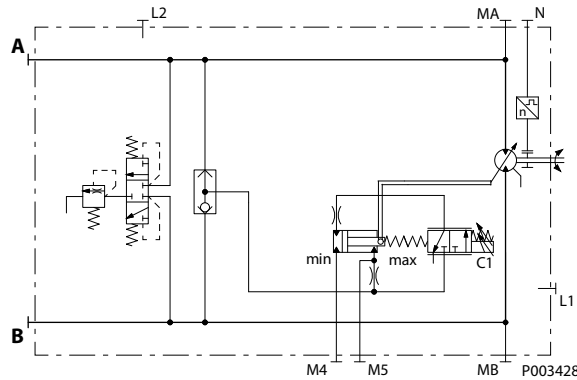
Zero degree capability results in a high risk of overspeed and drops in efficiency if the motor operates between 0–20% displacement.

**Electric proportional and two-position controls**

**M1CA and M2CA options**

- M1** – electric proportional 12 V / **de-energized = minimum displacement**
- CA** – without Pressure Compensator Over Ride / without Brake Pressure Defeat
  
- M2** – electric proportional 24 V / **de-energized = minimum displacement**
- CA** – without Pressure Compensator Over Ride / without Brake Pressure Defeat

Hydraulic schematic



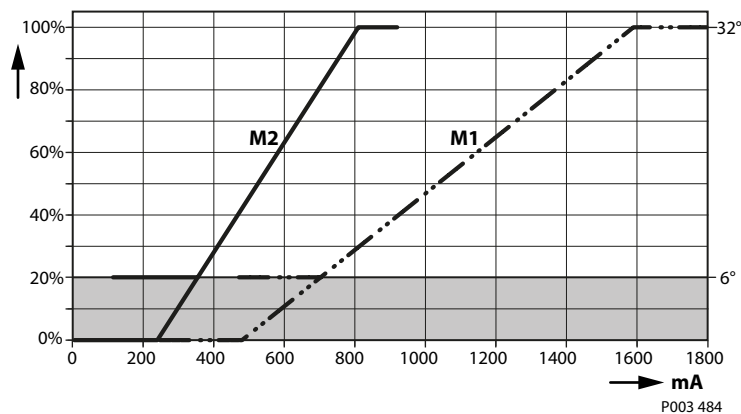
Options: M1CA, M2CA



**Solenoid C1**  
 De-energized = min. displacement  
 Full-energized = max. displacement

- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- N** Speed sensor (optional)

Displacement (%) versus Input Command (mA)



**M1, M2** = M1, M2 Control  
 Grey area = Intended to be used for zero degree capability.

Formulas how to calculate start and end input command (mA) dependent on displacements

| Input command (mA)  | % displ.      | Control *1                            | Control *2                           |
|---------------------|---------------|---------------------------------------|--------------------------------------|
| Start input command | from 0 %      | 480 ± 10                              | 240 ± 5                              |
|                     | from x % min. | $(V_{gx}/V_{gmax}) \times 1110 + 480$ | $(V_{gx}/V_{gmax}) \times 570 + 240$ |

## Electric proportional and two-position controls

Formulas how to calculate start and end input command (mA) dependent on displacements (continued)

| Input command (mA)      | % displ.    | Control *1                            | Control *2                           |
|-------------------------|-------------|---------------------------------------|--------------------------------------|
| End input command       | at 100 %    | 1590 ± 130                            | 810 ± 67                             |
|                         | at y % max. | $(V_{gy}/V_{gmax}) \times 1110 + 480$ | $(V_{gy}/V_{gmax}) \times 570 + 240$ |
| Maximum allowed current |             | 1800                                  | 920                                  |

*Where:*

**V<sub>gmax</sub>** Maximum, theoretic possible motor displacement per revolution (cm<sup>3</sup>/rev)

**V<sub>gx</sub>** Minimum displacement setting of desired unit (cm<sup>3</sup>/rev)

**V<sub>gy</sub>** Maximum displacement setting of desired unit (cm<sup>3</sup>/rev)

**x** Minimum displacement (%)

**y** Maximum displacement (%)

### Proportional solenoid data C1

| Description             |                    | 12 V                         | 24 V    |
|-------------------------|--------------------|------------------------------|---------|
| Maximum current         |                    | 1800 mA                      | 920 mA  |
| Nominal coil resistance | @ 20 °C [68 °F]    | 3.66 Ω                       | 14.20 Ω |
|                         | @ 80 °C [176 °F]   | 4.52 Ω                       | 17.52 Ω |
| Inductance              |                    | 33 mH                        | 140 mH  |
| PWM signal frequency    | Range              | 70 – 200 Hz                  |         |
|                         | Recommended*       | 150 Hz                       |         |
| IP Rating               | IEC 60 529         | IP 67                        |         |
|                         | DIN 40 050, part 9 | IP 69K with mating connector |         |
| Connector color         |                    | Black                        |         |

\* PWM signal required for optimum control performance.

### **Warning**

Zero degree capability results in a high risk of overspeed and drops in efficiency if the motor operates between 0–20% displacement.

**Electric proportional and two-position controls**

**K1KA and K2KA options with PCOR**

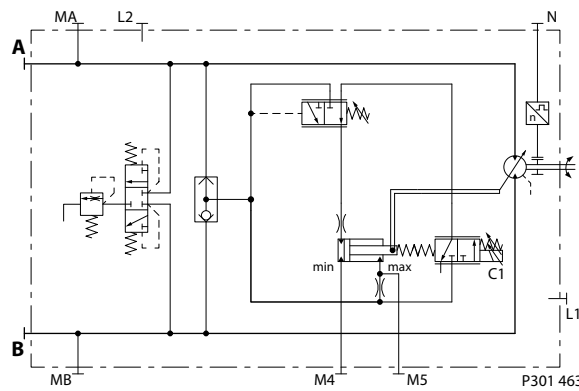
**K1** – electric proportional 12 V / **de-energized = min. displacement** / with PCOR  
**KA** – with Pressure Compensator Over Ride / without Brake Pressure Defeat

**K2** – electric proportional 24 V / **de-energized = min. displacement** / with PCOR  
**KA** – with Pressure Compensator Over Ride / without Brake Pressure Defeat

**Warning**

This control is not for use in propel applications.

Hydraulic schematic



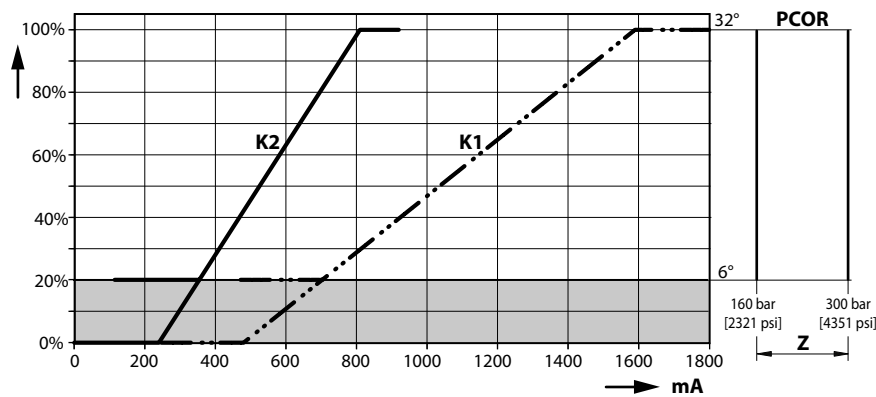
Options K1KA, K2KA



**Solenoid C1**  
 De-energized = min. displacement  
 Full-energized = max. displacement

- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- N** Speed sensor (optional)

Displacement (%) versus Input Command (mA)



**K1, K2** = K1, K2 Control  
**Z** = Start setting range  
 Grey area = Intended to be used for zero degree capability.



## Electric proportional and two-position controls

Formulas how to calculate start and end input command (mA) dependent on displacements

| Input command (mA)      | % displ.      | Control *1                            | Control *2                           |
|-------------------------|---------------|---------------------------------------|--------------------------------------|
| Start input command     | from 0 %      | 480 ± 10                              | 240 ± 5                              |
|                         | from x % min. | $(V_{gx}/V_{gmax}) \times 1110 + 480$ | $(V_{gx}/V_{gmax}) \times 570 + 240$ |
| End input command       | at 100 %      | 1590 ± 130                            | 810 ± 67                             |
|                         | at y % max.   | $(V_{gy}/V_{gmax}) \times 1110 + 480$ | $(V_{gy}/V_{gmax}) \times 570 + 240$ |
| Maximum allowed current |               | 1800                                  | 920                                  |

Where:

- $V_{gmax}$**  Maximum, theoretic possible motor displacement per revolution (cm<sup>3</sup>/rev)
- $V_{gx}$**  Minimum displacement setting of desired unit (cm<sup>3</sup>/rev)
- $V_{gy}$**  Maximum displacement setting of desired unit (cm<sup>3</sup>/rev)
- x** Minimum displacement (%)
- y** Maximum displacement (%)

### Proportional solenoid data C1

| Description             |                    | 12 V                         | 24 V    |
|-------------------------|--------------------|------------------------------|---------|
| Maximum current         |                    | 1800 mA                      | 920 mA  |
| Nominal coil resistance | @ 20 °C [68 °F]    | 3.66 Ω                       | 14.20 Ω |
|                         | @ 80 °C [176 °F]   | 4.52 Ω                       | 17.52 Ω |
| Inductance              |                    | 33 mH                        | 140 mH  |
| PWM signal frequency    | Range              | 70 – 200 Hz                  |         |
|                         | Recommended*       | 150 Hz                       |         |
| IP Rating               | IEC 60 529         | IP 67                        |         |
|                         | DIN 40 050, part 9 | IP 69K with mating connector |         |
| Connector color         |                    | Black                        |         |

\* PWM signal required for optimum control performance.

### Warning

Zero degree capability results in a high risk of overspeed and drops in efficiency if the motor operates between 0–20% displacement.

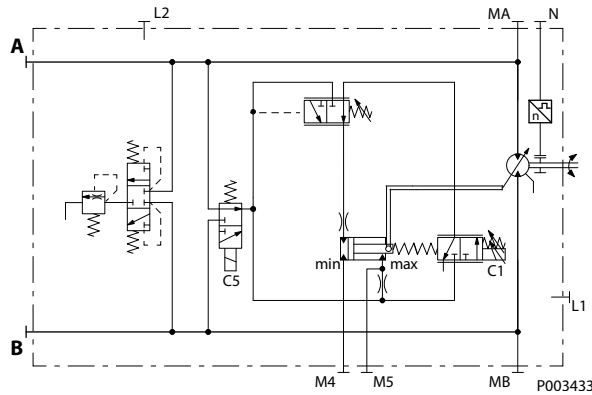
**Electric proportional and two-position controls**

**K1K1 and K2K2 options with PCOR and electric BPD**

**K1** – electric proportional 12 V / **de-energized = min. displacement** / with PCOR  
**K1** – with PCOR / with electric BPD 12 V / de-energized BPD = PCOR active at port A

**K2** – electric proportional 24 V / **de-energized = min. displacement** / with PCOR  
**K2** – with PCOR / with electric BPD 24 V / de-energized BPD = PCOR active at port A

Hydraulic schematic



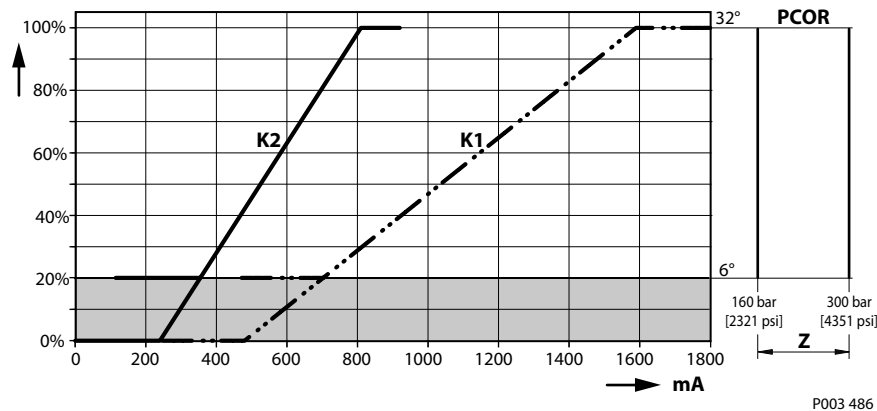
Options K1K1, K2K2



**Solenoid C1**  
De-energized = min. displacement  
Full-energized = max. displacement

- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- N** Speed sensor (optional)

Displacement (%) versus Input Command (mA)



**K1, K2** = K1, K2 Control  
**Z** = Start setting range  
Grey area = Intended to be used for zero degree capability.

For the formulas to calculate start and end input command dependent on displacements please see [K1KA](#) and [K2KA options with PCOR](#) on page 56.

## Electric proportional and two-position controls

### Proportional control solenoid data C1

| Description             |                    | 12 V                         | 24 V    |
|-------------------------|--------------------|------------------------------|---------|
| Maximum current         |                    | 1800 mA                      | 920 mA  |
| Nominal coil resistance | @ 20 °C [68 °F]    | 3.66 Ω                       | 14.20 Ω |
|                         | @ 80 °C [176 °F]   | 4.52 Ω                       | 17.52 Ω |
| Inductance              |                    | 33 mH                        | 140 mH  |
| PWM signal frequency    | Range              | 70 – 200 Hz                  |         |
|                         | Recommended*       | 150 Hz                       |         |
| IP Rating               | IEC 60 529         | IP 67                        |         |
|                         | DIN 40 050, part 9 | IP 69K with mating connector |         |
| Connector color         |                    | Black                        |         |

\* PWM signal required for optimum control performance.

### Two-position solenoid data C5 (Brake pressure defeat)

| Description                             |                    | 12 V                         | 24 V               |
|---|--------------------|------------------------------|--------------------|
| Supply voltage                          | Minimum            | 9.5 V <sub>DC</sub>          | 19 V <sub>DC</sub> |
|   | Max. (continuous)  | 14.6 V <sub>DC</sub>         | 29 V <sub>DC</sub> |
| Nominal coil resistance @ 20 °C [68 °F] |                    | 8.4 Ω                        | 34.5 Ω             |
| Input current                           | Recommended        | 1050 mA                      | 500 mA             |
| IP Rating                               | IEC 60 529         | IP 67                        |                    |
|   | DIN 40 050, part 9 | IP 69K with mating connector |                    |
| Bi-directional diode                    |                    | yes                          |                    |
| Connector color                         |                    | Black                        |                    |

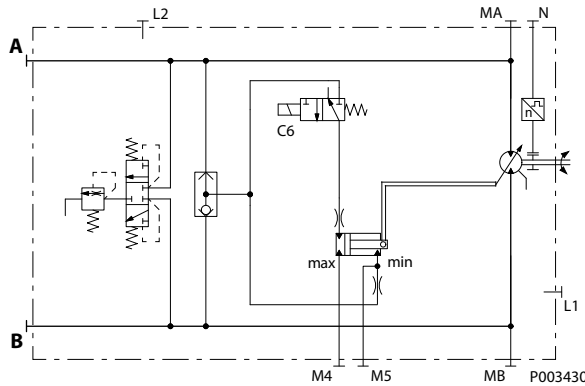
### **Warning**

Zero degree capability results in a high risk of overspeed and drops in efficiency if the motor operates between 0–20% displacement.

**Electric proportional and two-position controls**

**E1AA and E2AA options**

- E1** – electric two-position 12 V / **de-energized = max. displacement**
- E2** – electric two-position 24 V / **de-energized = max. displacement**
- AA**– without Pressure Compensator Over Ride / without Brake Pressure Defeat



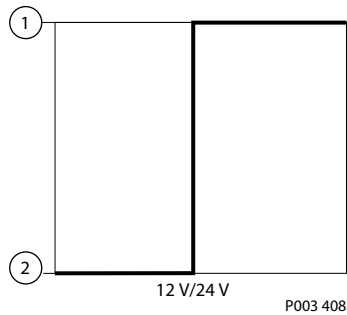
Options E1AA, E2AA



**Solenoid C6**  
 De-energized = max. displacement  
 Energized = min. displacement

- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- N** Speed sensor (optional)

*Displacement versus control signal*



*Where:*

- 1** Minimum displacement
- 2** Maximum displacement

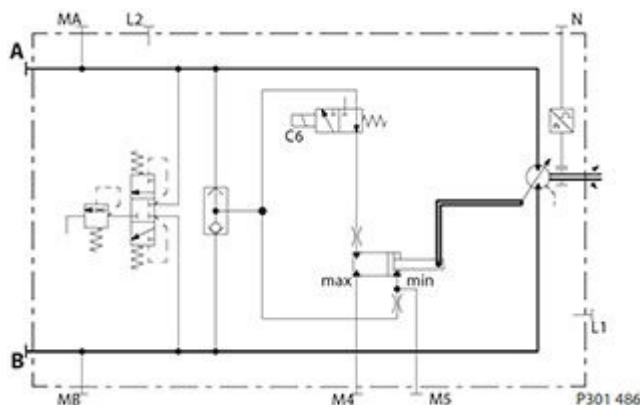
**Two-position control solenoid C6 technical data**

| Description                             |                    | 12 V                         | 24 V               |
|---|--------------------|------------------------------|--------------------|
| Supply voltage                          | Minimum            | 9.5 V <sub>DC</sub>          | 19 V <sub>DC</sub> |
|   | Max. (continuous)  | 14.6 V <sub>DC</sub>         | 29 V <sub>DC</sub> |
| Nominal coil resistance @ 20 °C [68 °F] |                    | 8.4 Ω                        | 34.5 Ω             |
| Input current                           | Recommended        | 1050 mA                      | 500 mA             |
| IP Rating                               | IEC 60 529         | IP 67                        |                    |
|   | DIN 40 050, part 9 | IP 69K with mating connector |                    |
| Bi-directional diode                    |                    | yes                          |                    |
| Connector color                         |                    | Black                        |                    |

**Electric proportional and two-position controls**

**F1EA and F2EA options**

- F1** – electric two-position 12 V / **de-energized = min. displacement**
- F2** – electric two-position 24 V / **de-energized = min. displacement**
- EA** – without Pressure Compensator Over Ride / without Brake Pressure Defeat



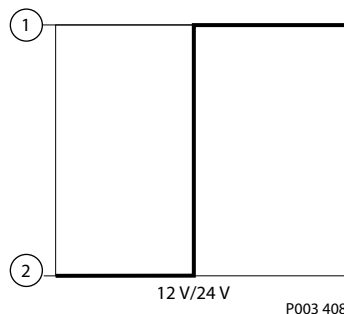
Options F1EA, F2EA



**Solenoid C6**  
 De-energized = min. displacement  
 Energized = max. displacement

- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- N** Speed sensor (optional)

*Displacement versus control signal*



Where:

- 1** Maximum displacement
- 2** Minimum displacement

**Two-position control solenoid C6 technical data**

| Description                             |                    | 12 V                         | 24 V               |
|---|--------------------|------------------------------|--------------------|
| Supply voltage                          | Minimum            | 9.5 V <sub>DC</sub>          | 19 V <sub>DC</sub> |
|   | Max. (continuous)  | 14.6 V <sub>DC</sub>         | 29 V <sub>DC</sub> |
| Nominal coil resistance @ 20 °C [68 °F] |                    | 8.4 Ω                        | 34.5 Ω             |
| Input current                           | Recommended        | 1050 mA                      | 500 mA             |
| IP Rating                               | IEC 60 529         | IP 67                        |                    |
|   | DIN 40 050, part 9 | IP 69K with mating connector |                    |
| Bi-directional diode                    |                    | yes                          |                    |
| Connector color                         |                    | Black                        |                    |

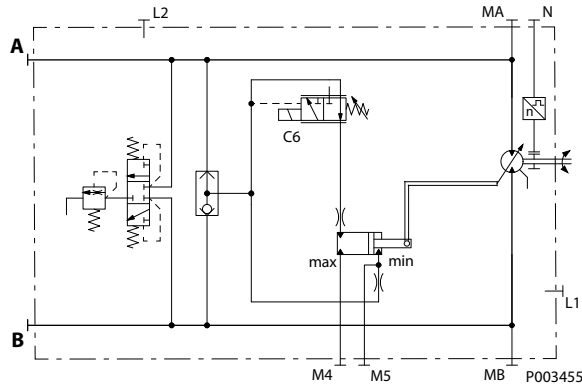
**Electric proportional and two-position controls**

**T1DA and T2DA options with PCOR**

- T1** – electric two-position 12 V / **de-energized = minimum displacement**
- T2** – electric two-position 24 V / **de-energized = minimum displacement**
- DA** – with PCOR / without Brake Pressure Defeat

**Warning**

This control is not for use in propel applications.



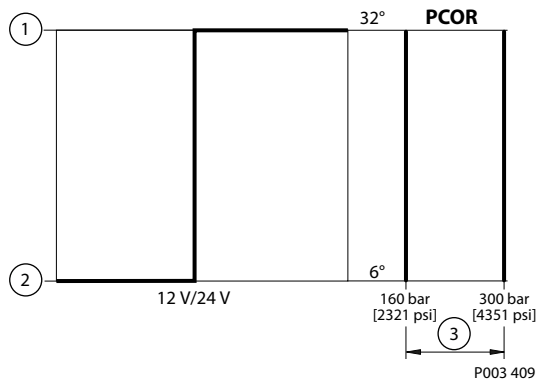
- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- N** Speed sensor (optional)

Options T1DA, T2DA



**Solenoid C6**  
 De-energized = min. displacement  
 Full-energized = max. displacement

Displacement versus PCOR pressure



Where:

- 1** Maximum displacement
- 2** Minimum displacement
- 3** Start setting range

**Two-position solenoid data C6**

| Description                             |                    | 12 V                         | 24 V               |
|---|--------------------|------------------------------|--------------------|
| Supply voltage                          | Minimum            | 9.5 V <sub>DC</sub>          | 19 V <sub>DC</sub> |
|   | Max. (continuous)  | 14.6 V <sub>DC</sub>         | 29 V <sub>DC</sub> |
| Nominal coil resistance @ 20 °C [68 °F] |                    | 8.4 Ω                        | 34.5 Ω             |
| Input current                           | Recommended        | 1050 mA                      | 500 mA             |
| IP Rating                               | IEC 60 529         | IP 67                        |                    |
|   | DIN 40 050, part 9 | IP 69K with mating connector |                    |

**Electric proportional and two-position controls**

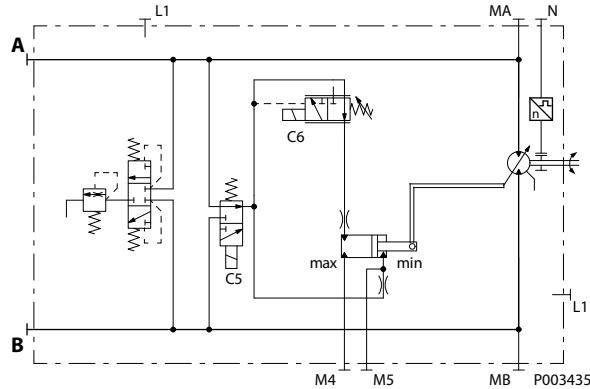
| <b>Description</b>   | <b>12 V</b> | <b>24 V</b> |
|----------------------|-------------|-------------|
| Bi-directional diode | yes         |             |
| Connector color      | Black       |             |

**Electric proportional and two-position controls**

**T1D1 and T2D2 options with PCOR and electric BPD**

- T1** – electric two-position 12 V / **de-energized = min. displacement**
- D1** – with PCOR / with electric 12 V BPD, de-energized BPD = PCOR active at port A
- T2** – electric two-position 24 V / **de-energized = min. displacement**
- D2** – with PCOR / with electric 24 V BPD, de-energized BPD = PCOR active at port A

Hydraulic schematic



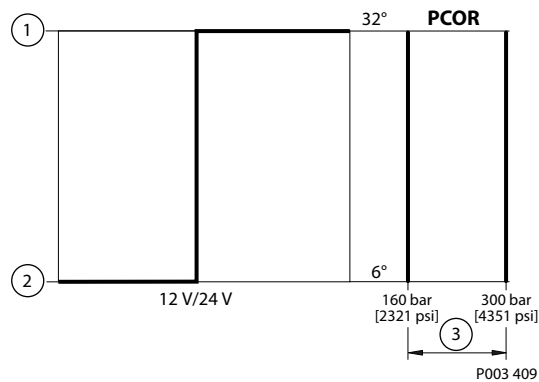
- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- N** Speed sensor (optional)

Options T1D1, T2D2



**Solenoid C6**  
 De-energized = min. displacement  
 Full-energized = max. displacement

Displacement versus PCOR pressure



Where:

- 1** Maximum displacement
- 2** Minimum displacement
- 3** Start setting range

**Two-position solenoids C5 (Brake pressure defeat) and C6 technical data**

| Description                             |                    | 12 V                         | 24 V               |
|---|--------------------|------------------------------|--------------------|
| Supply voltage                          | Minimum            | 9.5 V <sub>DC</sub>          | 19 V <sub>DC</sub> |
|   | Max. (continuous)  | 14.6 V <sub>DC</sub>         | 29 V <sub>DC</sub> |
| Nominal coil resistance @ 20 °C [68 °F] |                    | 8.4 Ω                        | 34.5 Ω             |
| Input current                           | Recommended        | 1050 mA                      | 500 mA             |
| IP Rating                               | IEC 60 529         | IP 67                        |                    |
|   | DIN 40 050, part 9 | IP 69K with mating connector |                    |



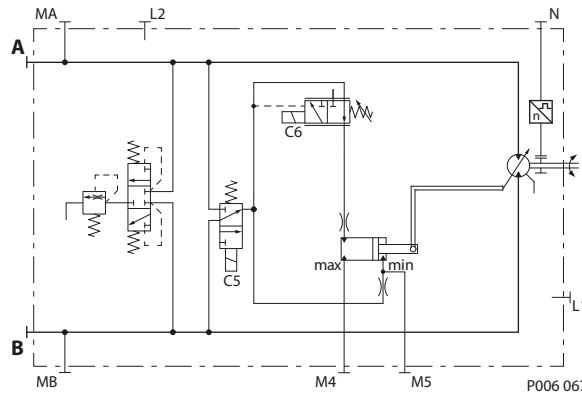
**Electric proportional and two-position controls**

| Description          | 12 V  | 24 V |
|----------------------|-------|------|
| Bi-directional diode | yes   |      |
| Connector color      | Black |      |

**Electric proportional and two-position controls**

**T1G1 and T2G2 options with PCOR and electric BPD**

- T1** – electric two-position 12 V / **de-energized = min. displacement**
- G1** – with PCOR / with electric 12 V BPD, **de-energized BPD = PCOR active at port B**
- T2** – electric two-position 24 V / **de-energized = min. displacement**
- G2** – with PCOR / with electric 24 V BPD, **de-energized BPD = PCOR active at port B**



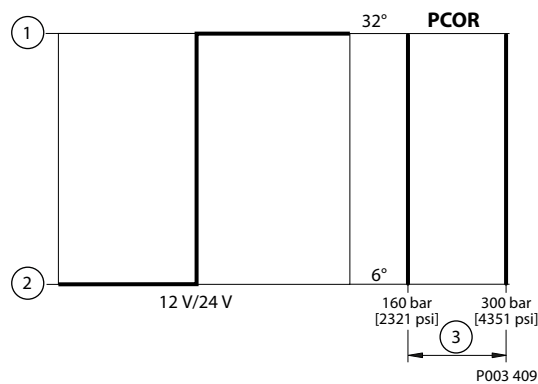
Options T1G1, T2G2



**Solenoid C6**  
 De-energized = min. displacement  
 Full-energized = max. displacement

- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- N** Speed sensor (optional)

Displacement versus PCOR pressure



Where:

- 1** Maximum displacement
- 2** Minimum displacement
- 3** Start setting range

**Two-position solenoids C5 (Brake pressure defeat) and C6 technical data**

| Description                             |                    | 12 V                         | 24 V               |
|---|--------------------|------------------------------|--------------------|
| Supply voltage                          | Minimum            | 9.5 V <sub>DC</sub>          | 19 V <sub>DC</sub> |
|   | Max. (continuous)  | 14.6 V <sub>DC</sub>         | 29 V <sub>DC</sub> |
| Nominal coil resistance @ 20 °C [68 °F] |                    | 8.4 Ω                        | 34.5 Ω             |
| Input current                           | Recommended        | 1050 mA                      | 500 mA             |
| IP Rating                               | IEC 60 529         | IP 67                        |                    |
|   | DIN 40 050, part 9 | IP 69K with mating connector |                    |

**Electric proportional and two-position controls**

| <b>Description</b>   | <b>12 V</b> | <b>24 V</b> |
|----------------------|-------------|-------------|
| Bi-directional diode | yes         |             |
| Connector color      | Black       |             |

**Electric proportional and two-position controls**

**P1DA and P2DA options with PCOR**

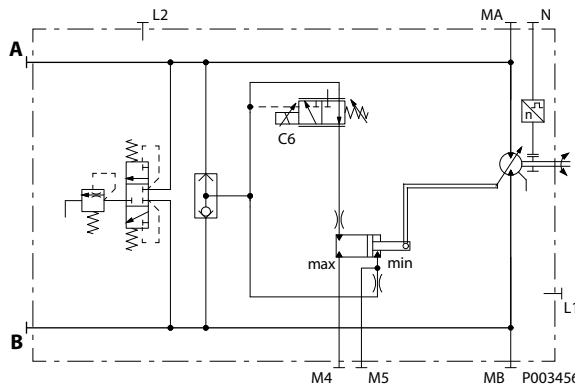
**P1** – electric two-position control 12 V, **de-energized = minimum displacement** with electric proportional PCOR 12 V

**P2** – electric two-position control 24 V, **de-energized = minimum displacement** with electric proportional PCOR 24 V

**DA** – with electric proportional PCOR, without Brake Pressure Defeat

**Warning**

This control is not for use in propel applications.



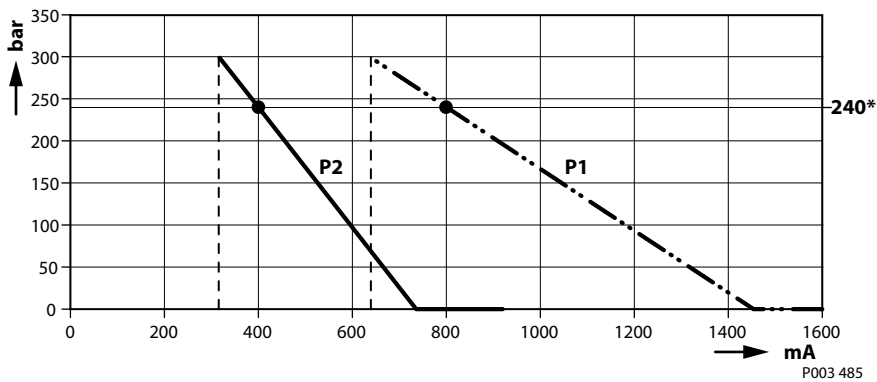
Options P1DA, P2DA



**Solenoid C6**  
 De-energized = min. displacement  
 Full-energized = max. displacement

- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- N** Speed sensor (optional)

PCOR pressure (bar) versus Input command (mA)



Maximum PCOR setting = 300 bar [4351 psi], \* Production test setting = 240 bar

**Caution**

If the signal to the PPCOR is lost or drops below the range shown in the chart, the PCOR setting will potentially increase to pressure levels above the recommended application limits or the regulated pressure control of the pump, and in effect, disable the PCOR function.

The PCOR pressure level can be proportionally changed with the input current to the solenoid.

## Electric proportional and two-position controls

*Formulas to calculate pressure level dependent on input current*

| Voltage     | All sizes (mA)                               | Variables:  |
|-------------|--|---|
| <b>12 V</b> | $I_{PCOR} = -2.724 \times P_{PCOR} + 1453.8$ | $P_{PCOR}$ = PCOR pressure level (bar)                        |
| <b>24 V</b> | $I_{PCOR} = -1.399 \times P_{PCOR} + 735.7$  | $I_{PCOR}$ = Current input to proportional PCOR solenoid (mA) |

### Proportional control solenoid data C6

| Description             |                    | 12 V                         | 24 V    |
|-------------------------|--------------------|------------------------------|---------|
| Maximum current         |                    | 1800 mA                      | 920 mA  |
| Nominal coil resistance | @ 20 °C [68 °F]    | 3.66 Ω                       | 14.20 Ω |
|                         | @ 80 °C [176 °F]   | 4.52 Ω                       | 17.52 Ω |
| Inductance              |                    | 33 mH                        | 140 mH  |
| PWM signal frequency    | Range              | 70 – 200 Hz                  |         |
|                         | Recommended*       | 150 Hz                       |         |
| IP Rating               | IEC 60 529         | IP 67                        |         |
|                         | DIN 40 050, part 9 | IP 69K with mating connector |         |
| Connector color         |                    | Black                        |         |

\* PWM signal required for optimum control performance.

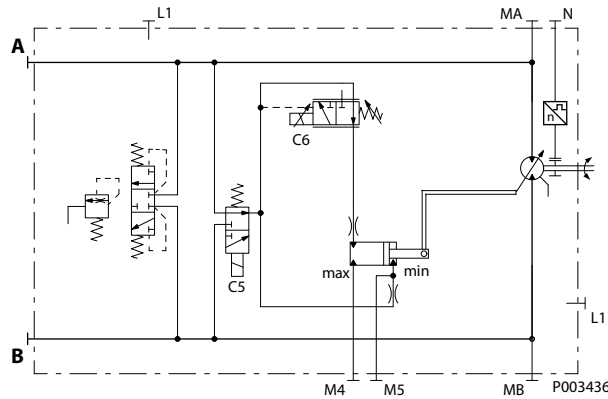
**Electric proportional and two-position controls**

**P1D1 and P2D2 options with PCOR and electric BPD**

**P1** – electric two-position 12 V, **de-energized = min. displacement** with electric prop. PCOR 12 V  
**D1** – with electric prop. PCOR, with electric BPD 12 V, **de-energized BPD = PCOR active at port A**

**P2** – electric two-position 24 V, **de-energized = min. displacement** with electric prop. PCOR 24 V  
**D2** – with electric prop. PCOR, with electric BPD 24 V, **de-energized BPD = PCOR active at port A**

Hydraulic schematic



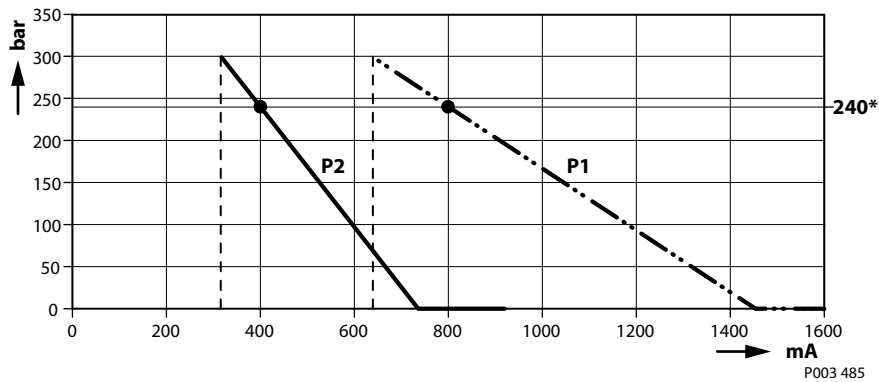
Options P1D1, P2D2



**Solenoid C6**  
 De-energized = min. displacement  
 Full-energized = max. displacement

- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- N** Speed sensor (optional)

PCOR pressure (bar) versus Input command (mA)



Maximum PCOR setting = 300 bar [4351 psi], \* Production test setting = 240 bar

**! Caution**

If the signal to the PPCOR is lost or drops below the range shown in the chart, the PCOR setting will potentially increase to pressure levels above the recommended application limits or the regulated pressure control of the pump, and in effect, disable the PCOR function.

The PCOR pressure level can be proportionally changed with the input current to the solenoid.

For formulas to calculate pressure level dependent on input current please see [P1DA and P2DA options with PCOR](#) on page 68.

**Electric proportional and two-position controls**
**Two-position solenoid data C5 (Brake pressure defeat)**

| Description                             |                    | 12 V                         | 24 V               |
|---|--------------------|------------------------------|--------------------|
| Supply voltage                          | Minimum            | 9.5 V <sub>DC</sub>          | 19 V <sub>DC</sub> |
|   | Max. (continuous)  | 14.6 V <sub>DC</sub>         | 29 V <sub>DC</sub> |
| Nominal coil resistance @ 20 °C [68 °F] |                    | 8.4 Ω                        | 34.5 Ω             |
| Input current                           | Recommended        | 1050 mA                      | 500 mA             |
| IP Rating                               | IEC 60 529         | IP 67                        |                    |
|   | DIN 40 050, part 9 | IP 69K with mating connector |                    |
| Bi-directional diode                    |                    | yes                          |                    |
| Connector color                         |                    | Black                        |                    |

**Proportional control solenoid data C6**

| Description             |                    | 12 V                         | 24 V    |
|-------------------------|--------------------|------------------------------|---------|
| Maximum current         |                    | 1800 mA                      | 920 mA  |
| Nominal coil resistance | @ 20 °C [68 °F]    | 3.66 Ω                       | 14.20 Ω |
|                         | @ 80 °C [176 °F]   | 4.52 Ω                       | 17.52 Ω |
| Inductance              |                    | 33 mH                        | 140 mH  |
| PWM signal frequency    | Range              | 70 – 200 Hz                  |         |
|                         | Recommended*       | 150 Hz                       |         |
| IP Rating               | IEC 60 529         | IP 67                        |         |
|                         | DIN 40 050, part 9 | IP 69K with mating connector |         |
| Connector color         |                    | Black                        |         |

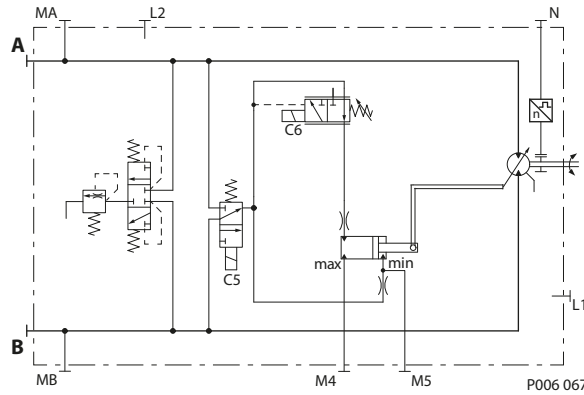
\* PWM signal required for optimum control performance.

**Electric proportional and two-position controls**

**P1G1 and P2G2 options with PCOR and electric BPD**

- P1** – electric prop. 12V / **de-energized = min. displacement** with electric prop. PCOR 12V
- G1** – with electric propor. PCOR / with electric BPD 12V, **de-energized BPD = PCOR active at port B**
- P2** – electric prop. 24V / **de-energized = min. displacement** with electric prop. PCOR 24V
- G2** – with electric propor. PCOR / with electric BPD 24V, **de-energized BPD = PCOR active at port B**

Hydraulic schematic



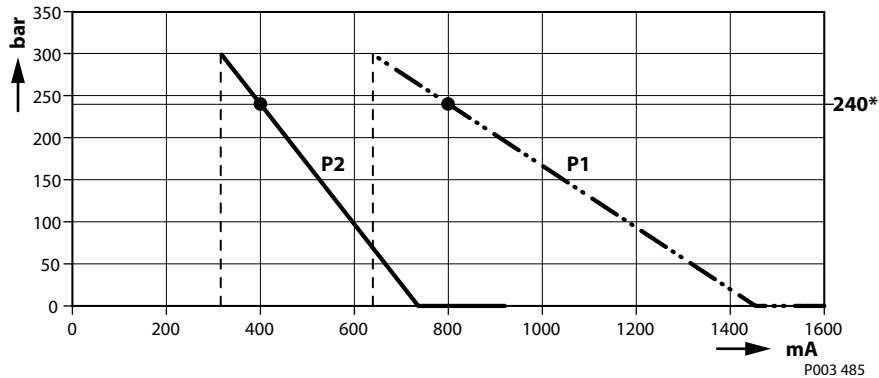
Options P1G1, P2G2



**Solenoid C6**  
 De-energized = min. displacement  
 Full-energized = max. displacement

- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- N** Speed sensor (optional)

PCOR pressure (bar) versus Input command (mA)



Maximum PCOR setting = 300 bar [4351 psi], \* Production test setting = 240 bar

**! Caution**

If the signal to the PPCOR is lost or drops below the range shown in the chart, the PCOR setting will potentially increase to pressure levels above the recommended application limits or the regulated pressure control of the pump, and in effect, disable the PCOR function.

The PCOR pressure level can be proportionally changed with the input current to the solenoid.

For formulas to calculate pressure level dependent on input current please see [P1DA and P2DA options with PCOR](#) on page 68.



**Electric proportional and two-position controls**
**Two-position solenoid data C5 (Brake pressure defeat)**

| Description                             |                    | 12 V                         | 24 V               |
|---|--------------------|------------------------------|--------------------|
| Supply voltage                          | Minimum            | 9.5 V <sub>DC</sub>          | 19 V <sub>DC</sub> |
|   | Max. (continuous)  | 14.6 V <sub>DC</sub>         | 29 V <sub>DC</sub> |
| Nominal coil resistance @ 20 °C [68 °F] |                    | 8.4 Ω                        | 34.5 Ω             |
| Input current                           | Recommended        | 1050 mA                      | 500 mA             |
| IP Rating                               | IEC 60 529         | IP 67                        |                    |
|   | DIN 40 050, part 9 | IP 69K with mating connector |                    |
| Bi-directional diode                    |                    | yes                          |                    |
| Connector color                         |                    | Black                        |                    |

**Proportional control solenoid data C6**

| Description             |                    | 12 V                         | 24 V    |
|-------------------------|--------------------|------------------------------|---------|
| Maximum current         |                    | 1800 mA                      | 920 mA  |
| Nominal coil resistance | @ 20 °C [68 °F]    | 3.66 Ω                       | 14.20 Ω |
|                         | @ 80 °C [176 °F]   | 4.52 Ω                       | 17.52 Ω |
| Inductance              |                    | 33 mH                        | 140 mH  |
| PWM signal frequency    | Range              | 70 – 200 Hz                  |         |
|                         | Recommended*       | 150 Hz                       |         |
| IP Rating               | IEC 60 529         | IP 67                        |         |
|                         | DIN 40 050, part 9 | IP 69K with mating connector |         |
| Connector color         |                    | Black                        |         |

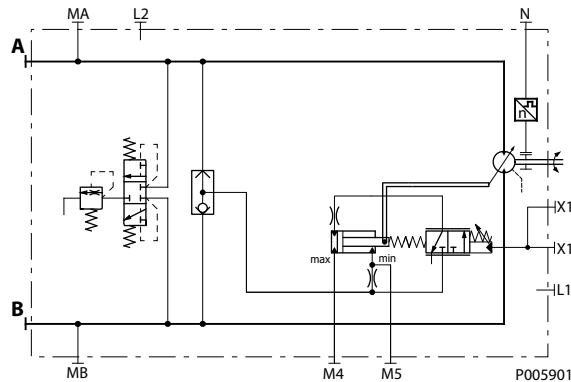
\* PWM signal required for optimum control performance.

**Hydraulic proportional and two-position controls**

**LHBA option**

**LH** – hydraulic proportional **non-pressurized** = **max. displacement**  
**BA** – without Pressure Compensator Over Ride / without Brake Pressure Defeat

Hydraulic schematic



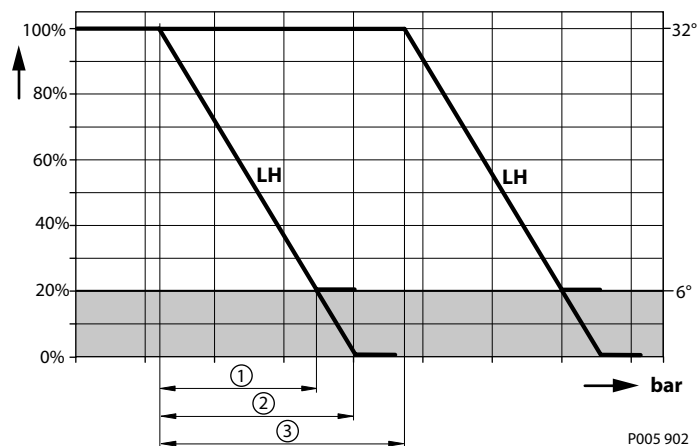
Option LHBA



**Hydraulic actuator X1**  
 Non-pressurized = max. displacement.  
 Full-pressurized = min. displacement.

- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- X1** Control pressure port
- N** Speed sensor (optional)

Displacement (%) versus Input command (bar)



- 1** = Control ramp, 100% - 20% (14 bar [203 psi])
  - 2** = Control ramp, 100% - 0% (17.5 bar [254 psi])
  - 3** = Control start setting range
- Grey arealf the signal to = Intended to be used for zero degree capability.

| Control start setting range (pressure above case pressure)  |  |
|---|--|
| P <sub>start</sub> (possible settings per MMC.- adjustable) | 2 to 30 bar [29 to 435 psi]              |
| P <sub>max</sub> allowable                                  | Control start setting + 50 bar [725 psi] |

**Hydraulic proportional and two-position controls**

| Control ramp                  |                    |
|-------------------------------|--------------------|
| From 100% to 20% displacement | 14 bar [203 psi]   |
| From 100% to 0% displacement  | 17.5 bar [254 psi] |

Below are formulas to calculate start and end input command dependent on displacement:

*Formulas to calculate start and end input command*

| Control type | Input command (bar) | % displacement | All sizes (bar)   |
|--------------|---------------------|----------------|---|
| LH           | Start input command | from 100%      | $p_{start} \pm 0.5$                                     |
|              |                     | from y% max.   | $(1 - V_{gy}/V_{gmax}) \times 17.5 + p_{start} \pm 0.5$ |
|              | End input command   | at 0 %         | $p_{start} + 17.5 \pm 2.5$                              |
|              |                     | at x % min.    | $(1 - V_{gx}/V_{gmax}) \times 17.5 + p_{start} \pm 2.5$ |

*Where:*

- $V_{gmax}$**  Maximum, theoretic possible motor displacement per revolution ( $cm^3/rev$ )
- $V_{gx}$**  Minimum displacement setting of desired unit ( $cm^3/rev$ )
- $V_{gy}$**  Maximum displacement setting of desired unit ( $cm^3/rev$ )
- x** Minimum displacement (%)
- y** Maximum displacement (%)

** Warning**

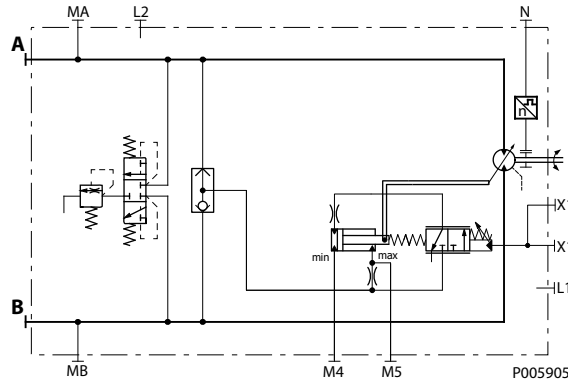
Zero degree capability results in a high risk of overspeed and drops in efficiency if the motor operates between 0–20% displacement.

**Hydraulic proportional and two-position controls**

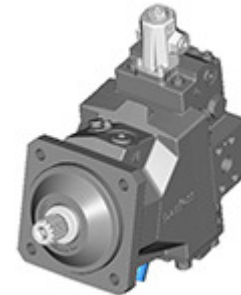
**MHCA option**

**MH** – hydraulic proportional **non-pressurized = min. displacement**  
**CA** – without Pressure Compensator Over Ride / without Brake Pressure Defeat

Hydraulic schematic



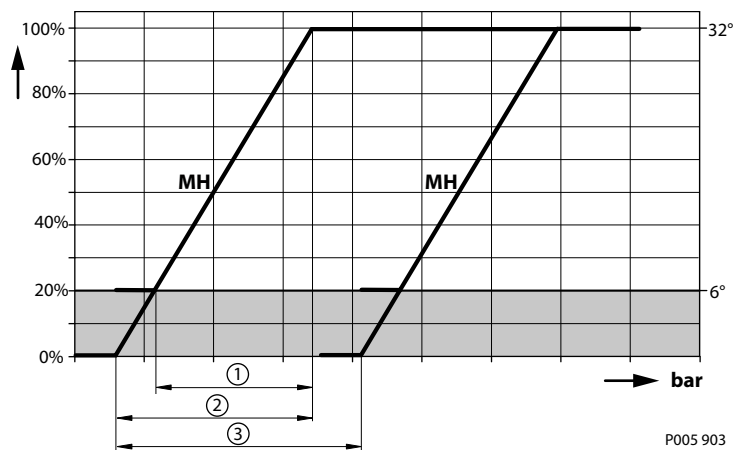
Option MHCA



**Hydraulic actuator X1**  
 Non-pressurized = min. displacement.  
 Full-pressurized = max. displacement.

- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- X1** Control pressure port
- N** Speed sensor (optional)

Displacement (%) versus Input Command (bar)



- 1** = Control ramp, 100% - 20% (14 bar [203 psi])
  - 2** = Control ramp, 100% - 0% (17.5 bar [254 psi])
  - 3** = Control start setting range
- Grey area if the signal to = Intended to be used for zero degree capability.

| Control start setting range (pressure above case pressure)  |  |
|---|--|
| P <sub>start</sub> (possible settings per MMC.- adjustable) | 2 to 30 bar [29 to 435 psi]              |
| P <sub>max</sub> allowable                                  | Control start setting + 50 bar [725 psi] |

**Hydraulic proportional and two-position controls**

| Control ramp                  |                    |
|-------------------------------|--------------------|
| From 100% to 20% displacement | 14 bar [203 psi]   |
| From 100% to 0% displacement  | 17.5 bar [254 psi] |

*Formulas to calculate start and end input command*

| Control type | Input command (bar) | % displacement | All sizes (bar)                                     |
|--------------|---------------------|----------------|---|
| <b>MH</b>    | Start input command | from 0%        | $p_{start} \pm 0.5$                                 |
|              |                     | from x% max.   | $(V_{gx}/V_{gmax}) \times 17.5 + p_{start} \pm 0.5$ |
|              | End input command   | at 100%        | $p_{start} + 17.5 \pm 2.5$                          |
|              |                     | at y% min.     | $(V_{gy}/V_{gmax}) \times 17.5 + p_{start} \pm 2.5$ |

*Where:*

- $V_{gmax}$**  Maximum, theoretic possible motor displacement per revolution ( $cm^3/rev$ )
- $V_{gx}$**  Minimum displacement setting of desired unit ( $cm^3/rev$ )
- $V_{gy}$**  Maximum displacement setting of desired unit ( $cm^3/rev$ )
- x** Minimum displacement (%)
- y** Maximum displacement (%)

** Warning**

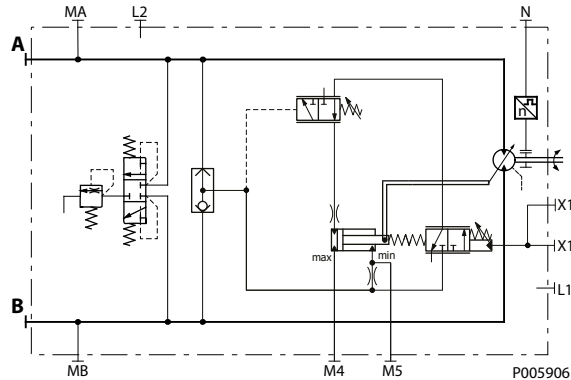
Zero degree capability results in a high risk of overspeed and drops in efficiency if the motor operates between 0–20% displacement.

**Hydraulic proportional and two-position controls**

**DHMA option with PCOR**

**DH** – hydraulic proportional / **non-pressurized = max. displacement**  
**MA** – with Pressure Compensator Over Ride / without Brake Pressure Defeat

Hydraulic schematic



Option DHMA

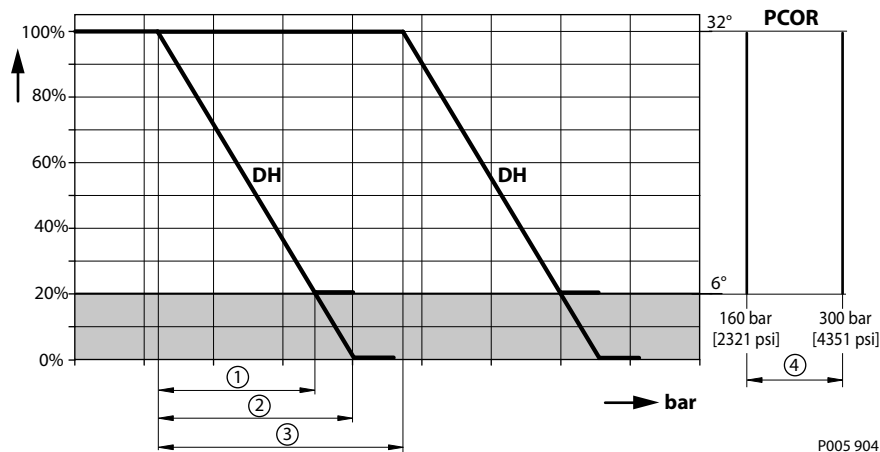


**Hydraulic actuator X1**  
 Non-pressurized = max. displacement.  
 Full-pressurized = min. displacement.

Where:

- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- X1** Control pressure port
- N** Speed sensor (optional)

Displacement (%) versus Input Command (bar)



- 1** = Control ramp, 100% - 20% (14 bar [203 psi])
  - 2** = Control ramp, 100% - 0% (17.5 bar [254 psi])
  - 3** = Control start setting range
  - 4** = PCOR start setting range
- Grey area = Intended to be used for zero degree capability.

### Hydraulic proportional and two-position controls

| Control start setting range (pressure above case pressure) |  |
|--|--|
| $P_{start}$ (possible settings per MMC.- adjustable)       | 2 to 30 bar [29 to 435 psi]              |
| $P_{max}$ allowable  | Control start setting + 50 bar [725 psi] |

| Control ramp                  |                    |
|-------------------------------|--------------------|
| From 100% to 20% displacement | 14 bar [203 psi]   |
| From 100% to 0% displacement  | 17.5 bar [254 psi] |

*Formulas to calculate start and end input command*

| Control type | Input command (bar) | % displacement | All sizes (bar)   |
|--------------|---------------------|----------------|---|
| DH           | Start input command | from 100%      | $P_{start} \pm 0.5$                                     |
|              |                     | from y% max.   | $(1 - V_{gy}/V_{gmax}) \times 17.5 + P_{start} \pm 0.5$ |
|              | End input command   | at 0 %         | $P_{start} + 17.5 \pm 2.5$                              |
|              |                     | at x % min.    | $(1 - V_{gx}/V_{gmax}) \times 17.5 + P_{start} \pm 2.5$ |

*Where:*

- $V_{gmax}$**  Maximum, theoretic possible motor displacement per revolution ( $cm^3/rev$ )
- $V_{gx}$**  Minimum displacement setting of desired unit ( $cm^3/rev$ )
- $V_{gy}$**  Maximum displacement setting of desired unit ( $cm^3/rev$ )
- x** Minimum displacement (%)
- y** Maximum displacement (%)

**⚠ Warning**

Zero degree capability results in a high risk of overspeed and drops in efficiency if the motor operates between 0–20% displacement.

Hydraulic proportional and two-position controls

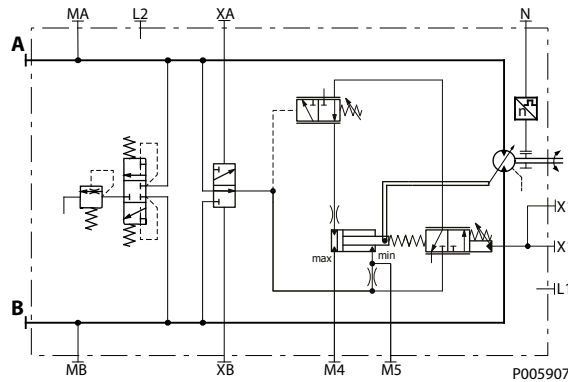
DHMH option with PCOR and BPD

**DH** – hydraulic proportional / **non-pressurized** = **max. displacement**

**MH** – with Pressure Compensator Over Ride / with Brake Pressure Defeat (non-pressurized BPD =

PCOR active port not defined without pilot pressure difference on XA or XB)

Hydraulic schematic



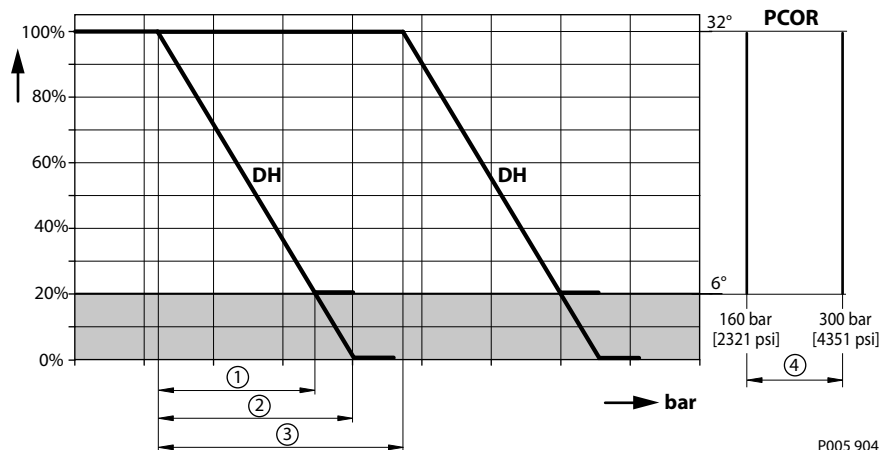
Option DHMH



**Hydraulic actuator X1**  
Non-pressurized = max. displacement.  
Full-pressurized = min. displacement.

- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- XA, XB** Control pressure ports brake pressure defeat
- X1** Control pressure port
- N** Speed sensor (optional)

Displacement (%) versus Input Command (bar)



- 1** = Control ramp, 100% - 20% (14 bar [203 psi])
  - 2** = Control ramp, 100% - 0% (17.5 bar [254 psi])
  - 3** = Control start setting range
  - 4** = PCOR start setting range
- Grey area = Intended to be used for zero degree capability.



## Hydraulic proportional and two-position controls

| Control start setting range (pressure above case pressure) |  |
|--|--|
| $P_{start}$ (possible settings per MMC.- adjustable)       | 2 to 30 bar [29 to 435 psi]              |
| $P_{max}$ allowable  | Control start setting + 50 bar [725 psi] |

| Control ramp                  |                    |
|-------------------------------|--------------------|
| From 100% to 20% displacement | 14 bar [203 psi]   |
| From 100% to 0% displacement  | 17.5 bar [254 psi] |

Formulas to calculate start and end input command

| Control type | Input command (bar) | % displacement | All sizes (bar)   |
|--------------|---------------------|----------------|---|
| DH           | Start input command | from 100%      | $P_{start} \pm 0.5$                                     |
|              |                     | from y% max.   | $(1 - V_{gy}/V_{gmax}) \times 17.5 + P_{start} \pm 0.5$ |
|              | End input command   | at 0%          | $P_{start} + 17.5 \pm 2.5$                              |
|              |                     | at x% min.     | $(1 - V_{gx}/V_{gmax}) \times 17.5 + P_{start} \pm 2.5$ |

Where:

- $V_{gmax}$  Maximum, theoretic possible motor displacement per revolution ( $cm^3/rev$ )
- $V_{gx}$  Minimum displacement setting of desired unit ( $cm^3/rev$ )
- $V_{gy}$  Maximum displacement setting of desired unit ( $cm^3/rev$ )
- $x$  Minimum displacement (%)
- $y$  Maximum displacement (%)

### Pressure Compensator OverRide (PCOR) with Brake Pressure Defeat (BPD) configuration

A brake pressure defeat (BPD) shuttle valve ahead of the pressure compensator prevents operation in the deceleration direction (when motor is running in pump mode). This is designed to prevent rapid or uncontrolled deceleration while the vehicle/machine is slowing down.

Pressure compensator override with brake pressure defeat is mainly used in systems with pumps having electric or hydraulic proportional controls or automotive controls.

The brake pressure defeat must be controlled by a 2-line external signal based on direction of motor rotation, see the following table:

Pressure Compensator OverRide (PCOR) operation

| Motor rotation | High pressure port | Control pressure on port <sup>1)</sup> | PCOR function |
|----------------|--------------------|--|---------------|
| CW             | A                  | XA                                     | no            |
| CW             | A                  | XB                                     | yes           |
| CCW            | B                  | XA                                     | yes           |
| CCW            | B                  | XB                                     | no            |

<sup>1)</sup> Differential control pressure between ports XA and XB:  $p_{min} = 2.5$  bar [36 psi] and  $p_{max} = 50$  bar [725 psi]

### Warning

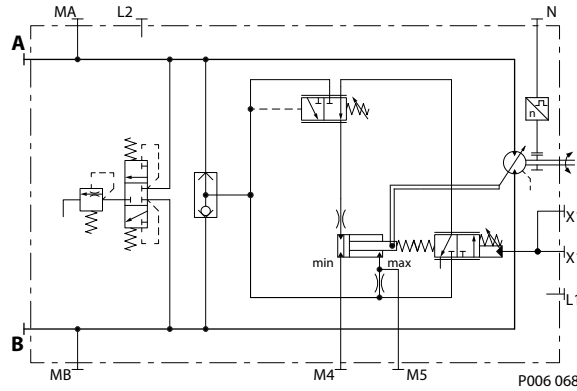
Zero degree capability results in a high risk of overspeed and drops in efficiency if the motor operates between 0–20% displacement.

**Hydraulic proportional and two-position controls**

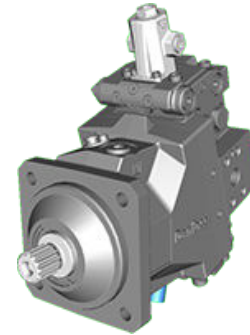
**KHKA option with PCOR**

**KH** – hydraulic proportional / **non-pressurized = min. displacement**  
**KA** – with Pressure Compensator Over Ride / without Brake Pressure Defeat

Hydraulic schematic



Option KHKA

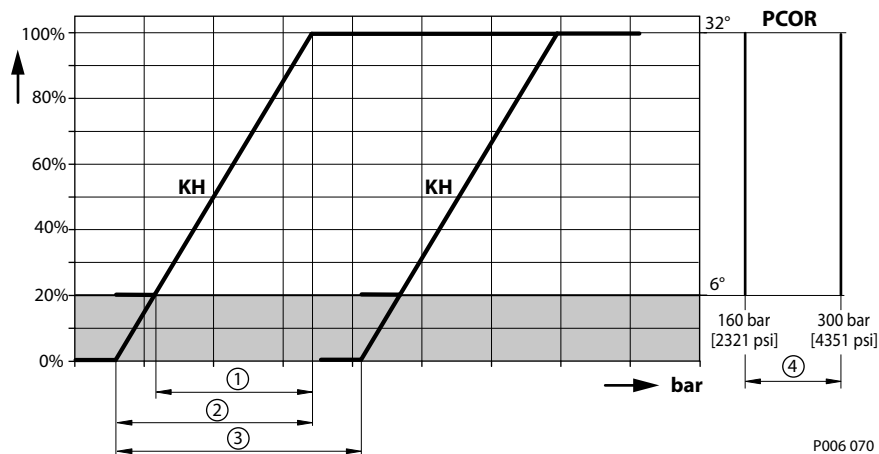


**Hydraulic actuator X1**  
 Non-pressurized = min. displacement.  
 Full-pressurized = max. displacement.

*Where:*

- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- XA, XB** Control pressure ports brake pressure defeat
- X1** Control pressure port
- N** Speed sensor (optional)

Displacement (%) versus Input Command (bar)



- 1** = Control ramp, 100% - 20% (14 bar [203 psi])
  - 2** = Control ramp, 100% - 0% (17.5 bar [254 psi])
  - 3** = Control start setting range
  - 4** = PCOR start setting range
- Grey area = Intended to be used for zero degree capability.

### Hydraulic proportional and two-position controls

| Control start setting range (pressure above case pressure) |  |
|--|--|
| $P_{start}$ (possible settings per MMC.- adjustable)       | 2 to 30 bar [29 to 435 psi]              |
| $P_{max}$ allowable  | Control start setting + 50 bar [725 psi] |

| Control ramp                  |                    |
|-------------------------------|--------------------|
| From 100% to 20% displacement | 14 bar [203 psi]   |
| From 100% to 0% displacement  | 17.5 bar [254 psi] |

*Formulas to calculate start and end input command*

| Control type | Input command (bar) | % displacement | All sizes (bar)   |
|--------------|---------------------|----------------|---|
| KH           | Start input command | from 100%      | $P_{start} \pm 0.5$                                     |
|              |                     | from y% max.   | $(1 - V_{gy}/V_{gmax}) \times 17.5 + P_{start} \pm 0.5$ |
|              | End input command   | at 0%          | $P_{start} + 17.5 \pm 2.5$                              |
|              |                     | at x% min.     | $(1 - V_{gx}/V_{gmax}) \times 17.5 + P_{start} \pm 2.5$ |

*Where:*

- $V_{gmax}$**  Maximum, theoretic possible motor displacement per revolution ( $cm^3/rev$ )
- $V_{gx}$**  Minimum displacement setting of desired unit ( $cm^3/rev$ )
- $V_{gy}$**  Maximum displacement setting of desired unit ( $cm^3/rev$ )
- x** Minimum displacement (%)
- y** Maximum displacement (%)

**⚠ Warning**

Zero degree capability results in a high risk of overspeed and drops in efficiency if the motor operates between 0–20% displacement.

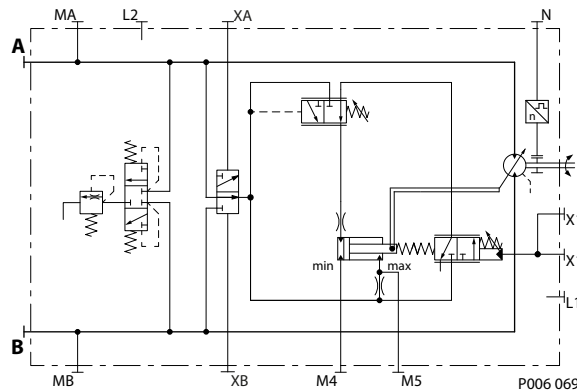
**Hydraulic proportional and two-position controls**

**KHKH option with PCOR and BPD**

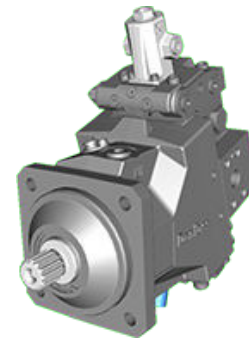
**KH** – hydraulic proportional / **non-pressurized** = **min. displacement**

**KH** – with Pressure Compensator Over Ride / with Brake Pressure Defeat (non-pressurized BPD = PCOR active port not defined without pilot pressure difference on XA or XB)

Hydraulic schematic



Option KHKH

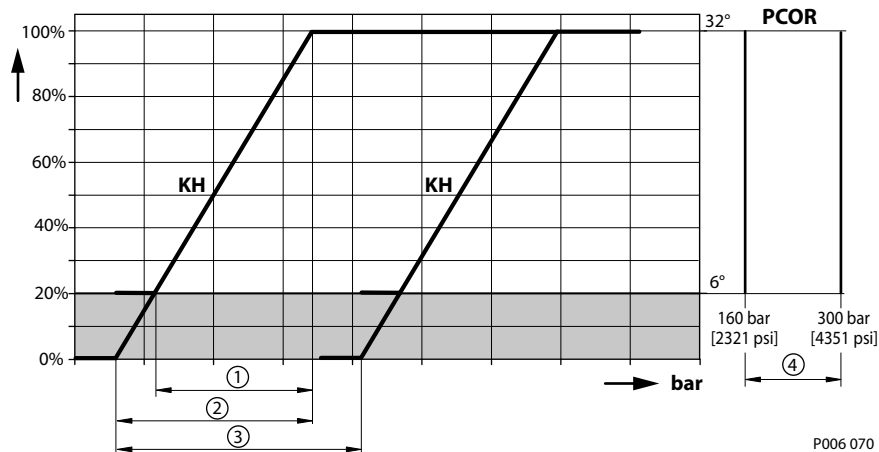


**Hydraulic actuator X1**  
 Non-pressurized = min. displacement.  
 Full-pressurized = max. displacement.

Where:

- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- XA, XB** Control pressure ports brake pressure defeat
- X1** Control pressure port
- N** Speed sensor (optional)

Displacement (%) versus Input Command (bar)



- 1** = Control ramp, 100% - 20% (14 bar [203 psi])
  - 2** = Control ramp, 100% - 0% (17.5 bar [254 psi])
  - 3** = Control start setting range
  - 4** = PCOR start setting range
- Grey area = Intended to be used for zero degree capability.

## Hydraulic proportional and two-position controls

| Control start setting range (pressure above case pressure) |  |
|--|--|
| $P_{start}$ (possible settings per MMC.- adjustable)       | 2 to 30 bar [29 to 435 psi]              |
| $P_{max}$ allowable  | Control start setting + 50 bar [725 psi] |

| Control ramp                  |                    |
|-------------------------------|--------------------|
| From 100% to 20% displacement | 14 bar [203 psi]   |
| From 100% to 0% displacement  | 17.5 bar [254 psi] |

Formulas to calculate start and end input command

| Control type | Input command (bar) | % displacement | All sizes (bar)   |
|--------------|---------------------|----------------|---|
| DH           | Start input command | from 100%      | $P_{start} \pm 0.5$                                     |
|              |                     | from y% max.   | $(1 - V_{gy}/V_{gmax}) \times 17.5 + P_{start} \pm 0.5$ |
|              | End input command   | at 0%          | $P_{start} + 17.5 \pm 2.5$                              |
|              |                     | at x% min.     | $(1 - V_{gx}/V_{gmax}) \times 17.5 + P_{start} \pm 2.5$ |

Where:

- $V_{gmax}$  Maximum, theoretic possible motor displacement per revolution ( $cm^3/rev$ )
- $V_{gx}$  Minimum displacement setting of desired unit ( $cm^3/rev$ )
- $V_{gy}$  Maximum displacement setting of desired unit ( $cm^3/rev$ )
- $x$  Minimum displacement (%)
- $y$  Maximum displacement (%)

### Pressure Compensator OverRide (PCOR) with Brake Pressure Defeat (BPD) configuration

A brake pressure defeat (BPD) shuttle valve ahead of the pressure compensator prevents operation in the deceleration direction (when motor is running in pump mode). This is designed to prevent rapid or uncontrolled deceleration while the vehicle/machine is slowing down.

Pressure compensator override with brake pressure defeat is mainly used in systems with pumps having electric or hydraulic proportional controls or automotive controls.

The brake pressure defeat must be controlled by a 2-line external signal based on direction of motor rotation, see the following table:

Pressure Compensator OverRide (PCOR) operation

| Motor rotation | High pressure port | Control pressure on port <sup>1)</sup> | PCOR function |
|----------------|--------------------|--|---------------|
| CW             | A                  | XA                                     | no            |
| CW             | A                  | XB                                     | yes           |
| CCW            | B                  | XA                                     | yes           |
| CCW            | B                  | XB                                     | no            |

<sup>1)</sup> Differential control pressure between ports XA and XB:  $p_{min} = 2.5$  bar [36 psi] and  $p_{max} = 50$  bar [725 psi]

### Warning

Zero degree capability results in a high risk of overspeed and drops in efficiency if the motor operates between 0–20% displacement.

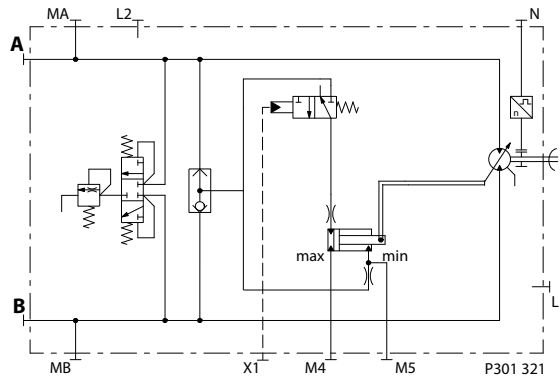
**Hydraulic proportional and two-position controls**

**HEHE option**

**HE** – hydraulic two-position control, default (without control pressure) = max. disp. / external control pressure supply

**HE** – without PCOR / without BPD, internal servo pressure supply

*Hydraulic schematic*



*Option HEHE*



Where:

- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- X1** Control pressure port
- N** Speed sensor (optional)

**Control pressure X1**

Non-pressurized = max. displacement.

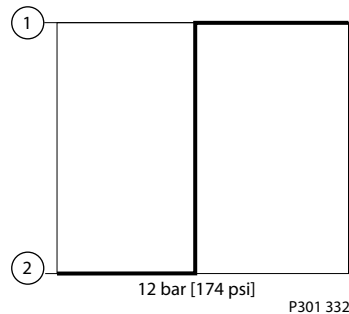
Pressurized = min. displacement.

Control pressure > 12 bar [174 psi] to ensure minimum displacement (above case pressure)

Control pressure < 0.9 bar [13 psi] to ensure maximum displacement (above case pressure)

Maximum control pressure: 100 bar [1450 psi]

*Displacement versus control signal*



Where:

- 1** Min. displacement
- 2** Max. displacement

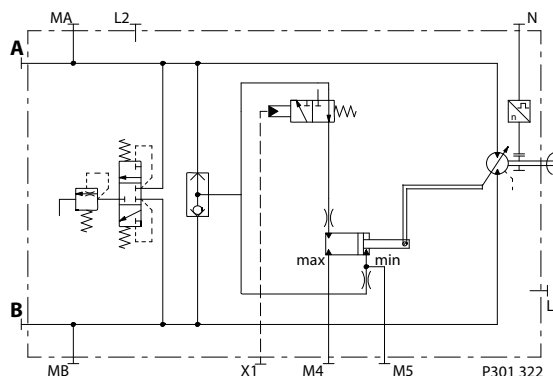
## Hydraulic proportional and two-position controls

### HFHF option

**HF** – hydraulic two-position control, non-pressurized = minimum displacement / external control pressure supply

**HF** – without PCOR / without BPD, internal servo pressure supply

Hydraulic schematic



Option HFHF



Where:

- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- X1** Control pressure port
- N** Speed sensor (optional)

### Control pressure X1

Non-pressurized = Minimum displacement.

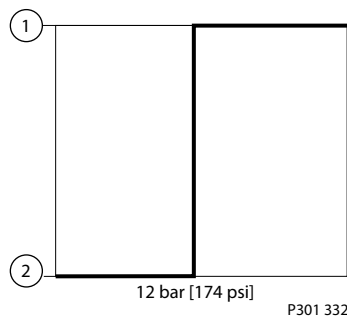
Pressurized = Maximum displacement.

Control pressure > 12 bar [174 psi] to ensure maximum displacement (above case pressure)

Control pressure < 0.9 bar [13 psi] to ensure minimum displacement (above case pressure)

Maximum control pressure: 100 bar [1450 psi]

Displacement versus control signal



Where:

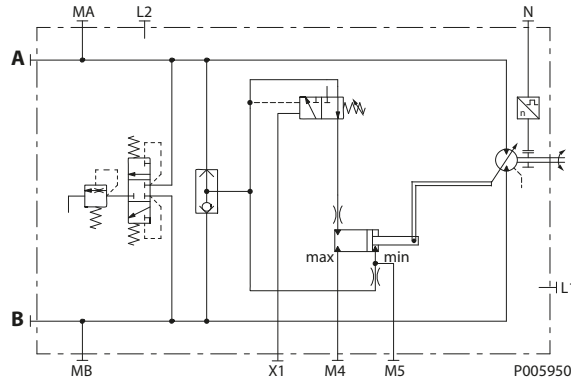
- 1** Maximum displacement
- 2** Minimum displacement

**Hydraulic proportional and two-position controls**

**THHA option with PCOR**

**TH** – hydraulic two-position control, **non-pressurized** = **min. displacement** / external pressure supply

**HA** – with Pressure Compensator Over Ride, without BPD



Option THHA



- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- X1** Control pressure port
- N** Speed sensor (optional)

**Hydraulic actuator X1**

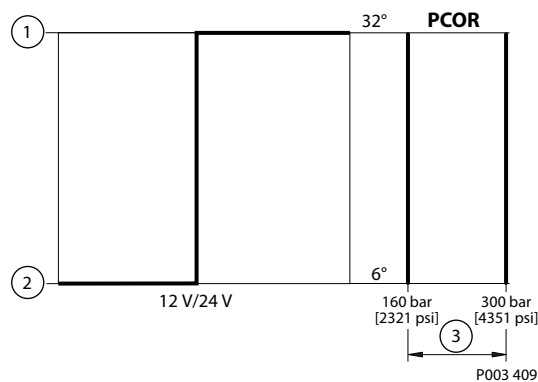
Non-pressurized = min. displacement. Full-pressurized = max. displacement.

Min. pressure for activation = 10 bar above case pressure

Max. pressure for activation = 35 bar above motor case pressure

Max. pressure at non-pressurized control port X1 = case pressure

*Displacement versus PCOR pressure*



- 1** Maximum displacement
- 2** Minimum displacement
- 3** Start setting range



### Hydraulic proportional and two-position controls

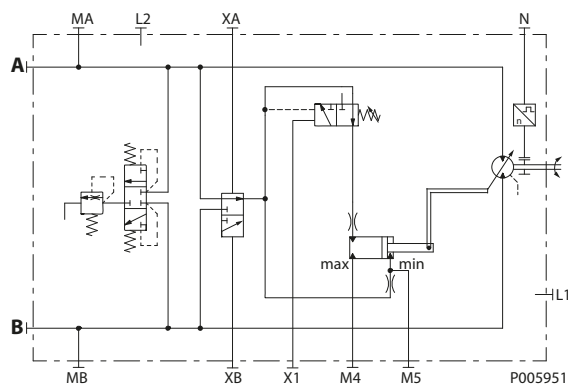
**⚠ Warning**

Zero degree capability results in a high risk of overspeed and drops in efficiency if the motor operates between 0–20% displacement.

#### THHB option with PCOR and hydraulic BPD

**TH** – hydraulic two-position control, **non-pressurized = min. displacement**/external pressure supply

**HB** – with Pressure Compensator Over Ride, with hydraulic BPD



Option THHB



- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- XA, XB** Control pressure ports brake pressure defeat
- X1** Control pressure port
- N** Speed sensor (optional)

#### Hydraulic actuator X1

Non-pressurized = min. displacement.

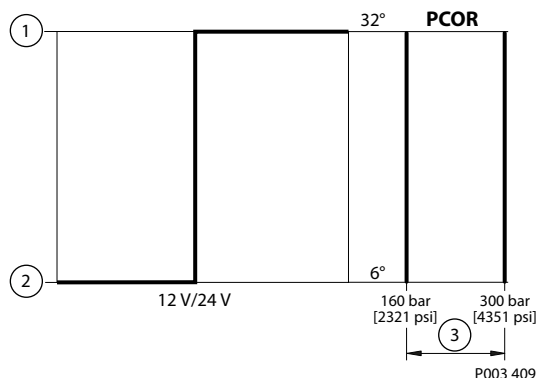
Pressurized = max. displacement.

Min. pressure for activation = 10 bar above case pressure

Max. pressure for activation = 35 bar above motor case pressure

Max. pressure at non-pressurized control port X1 = case pressure

*Displacement versus PCOR pressure*



**Hydraulic proportional and two-position controls**

- 1 Maximum displacement
- 2 Minimum displacement
- 3 Start setting range

**Pressure Compensator OverRide with Brake Pressure Defeat configuration**

A brake pressure defeat (BPD) shuttle valve ahead of the pressure compensator prevents operation in the deceleration direction (when motor is running in pump mode). This is designed to prevent rapid or uncontrolled deceleration while the vehicle/machine is slowing down.

Pressure compensator override with brake pressure defeat is mainly used in systems with pumps having electric or hydraulic proportional controls or automotive controls.

The brake pressure defeat must be controlled by a 2-line external signal based on direction of motor rotation, see the following table:

*Pressure Compensator OverRide (PCOR) operation*

| Motor rotation | High pressure port | Control pressure on port <sup>1)</sup> | PCOR function |
|----------------|--------------------|--|---------------|
| CW             | A                  | XA                                     | yes           |
| CW             | A                  | XB                                     | no            |
| CCW            | B                  | XA                                     | no            |
| CCW            | B                  | XB                                     | yes           |

<sup>1)</sup> Differential control pressure between ports XA and XB:  $p_{min} = 2.5 \text{ bar [36 psi]}$  and  $p_{max} = 50 \text{ bar [725 psi]}$

PCOR active port not defined without minimum pressure difference between XA and XB.

** Warning**

Zero degree capability results in a high risk of overspeed and drops in efficiency if the motor operates between 0–20% displacement.

**Pressure compensator over-ride and electric BPD**

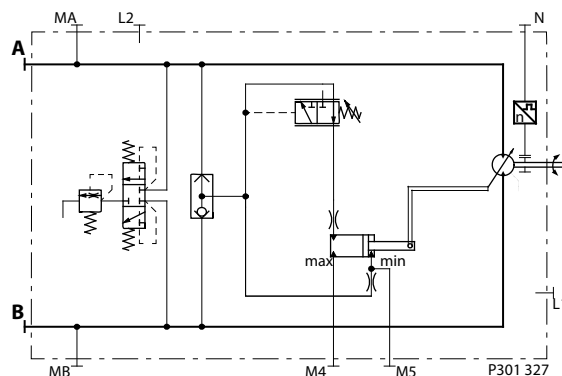
**TADA option**

**TA** – PCOR default; **high pressure below PCOR pressure = min. displacement**  
**DA** – with Pressure Compensator Over Ride / without Brake Pressure Defeat

**Warning**

This control is not for use in propel applications.

Hydraulic schematic



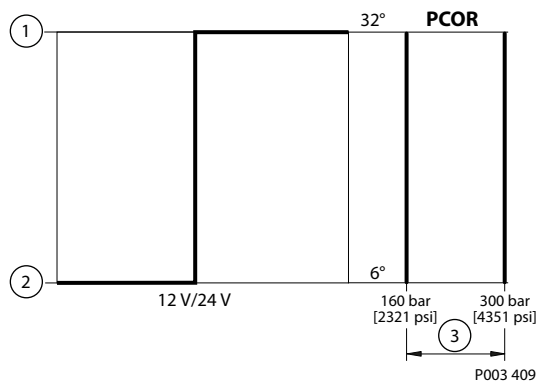
- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- N** Speed sensor (optional)

Option TADA



**Hydraulic actuator X1**  
 Non-pressurized = min. displacement.  
 Pressurized = max. displacement.

Displacement versus PCOR pressure



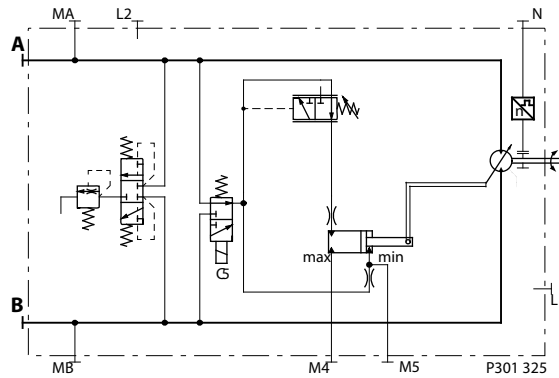
- 1** Maximum displacement
- 2** Minimum displacement
- 3** Start setting range

**Pressure compensator over-ride and electric BPD**

**TAD1 and TAD2 options with electric BPD**

- TA** – PCOR default; **high pressure below PCOR pressure = min. displacement**
- D1** – with PCOR / with electric 12V BPD / de-energized BPD = PCOR active at port A
- D2** – with PCOR / with electric 24V BPD / de-energized BPD = PCOR active at port A

Hydraulic schematic

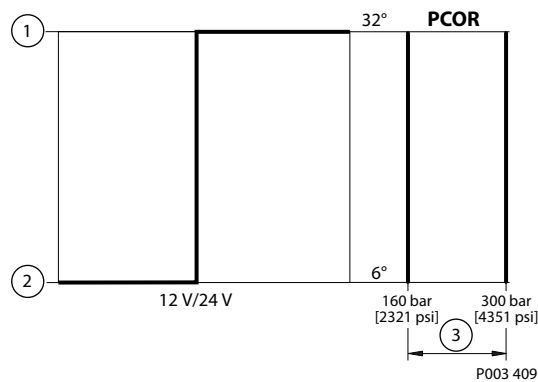


Option TAD1



- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- N** Speed sensor (optional)

Displacement versus PCOR pressure



- 1** Maximum displacement
- 2** Minimum displacement
- 3** Start setting range

**Two-position control solenoid C5 (BPD) technical data**

| Description                             |                   | 12 V                 | 24 V               |
|---|-------------------|----------------------|--------------------|
| Supply voltage                          | Minimum           | 9.5 V <sub>DC</sub>  | 19 V <sub>DC</sub> |
|   | Max. (continuous) | 14.6 V <sub>DC</sub> | 29 V <sub>DC</sub> |
| Nominal coil resistance @ 20 °C [68 °F] |                   | 8.4 Ω                | 34.5 Ω             |
| Input current                           | Recommended       | 1050 mA              | 500 mA             |

**Pressure compensator over-ride and electric BPD**

| Description          |                    | 12 V                         | 24 V |
|----------------------|--------------------|------------------------------|------|
| IP Rating            | IEC 60 529         | IP 67                        |      |
|                      | DIN 40 050, part 9 | IP 69K with mating connector |      |
| Bi-directional diode |                    | yes                          |      |
| Connector color      |                    | Black                        |      |

**Pressure compensator over-ride and electric BPD**

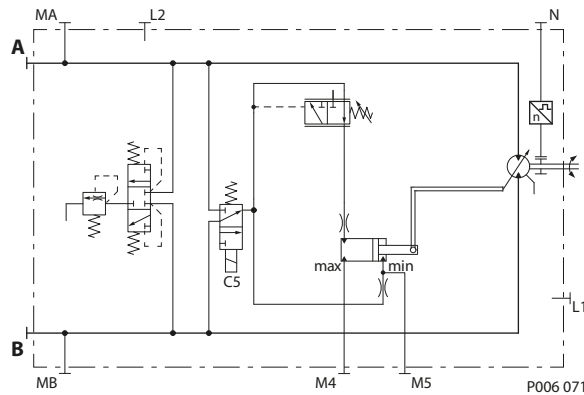
**TAG1 and TAG2 options**

**TA** – PCOR default; **High pressure below PCOR pressure = min. displacement**

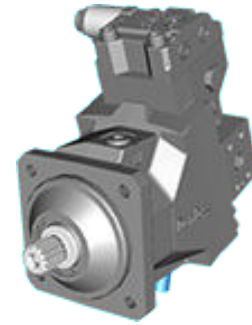
**G1** – with PCOR / with electric 12 V BPD / de-energized BPD = PCOR active at port B

**G2** – with PCOR / with electric 24 V BPD / de-energized BPD = PCOR active at port B

*Hydraulic schematic*

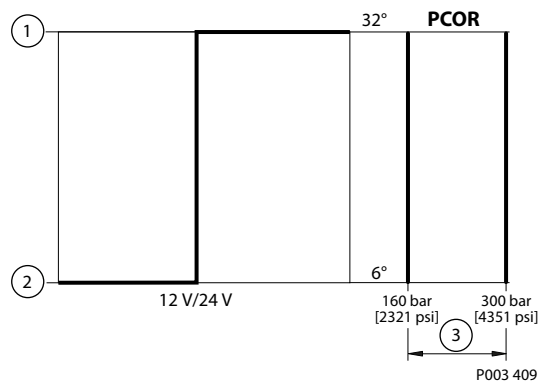


*Option TAG1, TAG2*



- A, B** Main pressure lines
- L1, L2** Drain lines
- M4, M5** Gauge port servo pressure
- MA, MB** Gauge port system pressure
- N** Speed sensor (optional)

*Displacement versus PCOR pressure*



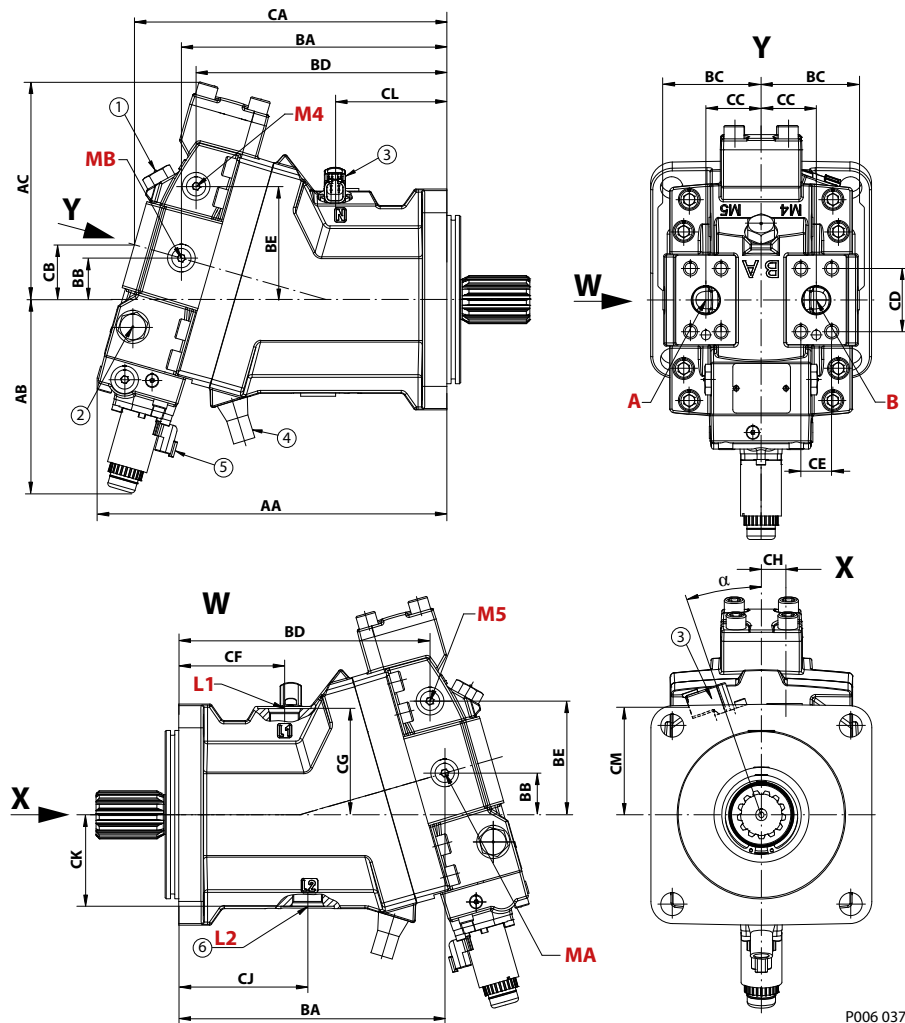
- 1** Maximum displacement
- 2** Minimum displacement
- 3** Start setting range

Default: High pressure below PCOR pressure = min. displacement

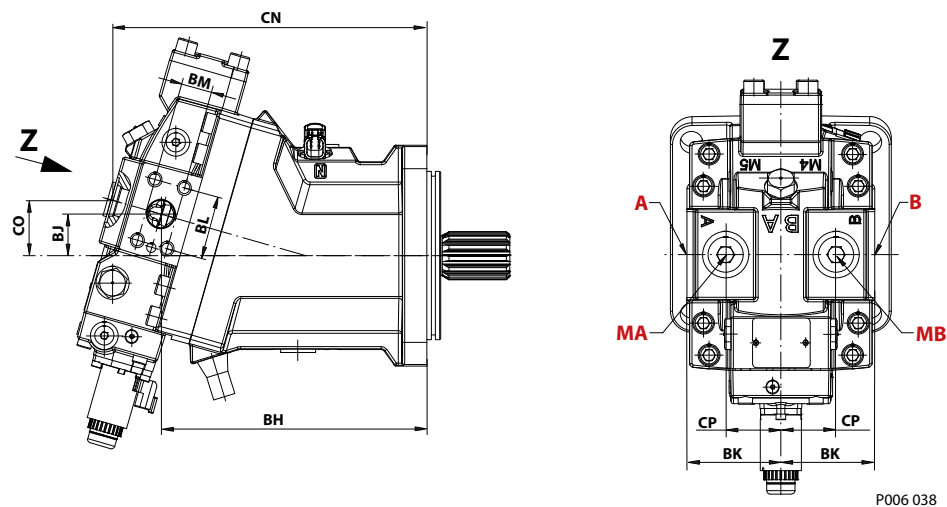
**Flange and housing dimensions**

**SAE flange design – option L\* (proportional control)**

*Axial ports*



*Radial ports*



**Flange and housing dimensions**
*Axial and radial ports dimensions, mm [in]*

| Callout  | Size 060      | Size 080      | Size 110      | Size 160      | Size 210      | Size 250     |
|----------|---------------|---------------|---------------|---------------|---------------|--------------|
| AA       | 272.3 [10.72] | 289.9 [11.41] | 316.4 [12.46] | 343.6 [13.53] | 368.4 [14.5]  | 387 [15.24]  |
| AB       | 164.7 [6.48]  | 170.6 [6.72]  | 175.0 [6.89]  | 183.8 [7.24]  | 190.9 [7.52]  | 197 [7.76]   |
| AC       | 167.5 [6.59]  | 179.9 [7.08]  | 196.9 [7.75]  | 219.7 [8.65]  | 232.6 [9.16]  | 239 [9.41]   |
| BA       | 204.8 [8.06]  | 218.8 [8.61]  | 240.3 [9.46]  | 263.9 [10.39] | 288.1 [11.34] | 302 [11.89]  |
| BB       | 32.3 [1.27]   | 34.7 [1.37]   | 37.5 [1.49]   | 42.0 [1.65]   | 46.4 [1.83]   | 48 [1.89]    |
| BC       | 74.4 [2.93]   | 78.4 [3.09]   | 88.9 [3.50]   | 99.9 [3.93]   | 108.2 [4.26]  | 108 [4.25]   |
| BD       | 191.0 [7.52]  | 203.9 [8.03]  | 226.9 [8.93]  | 247.9 [9.76]  | 268.3 [10.56] | 284 [11.18]  |
| BE       | 84.0 [3.30]   | 92.4 [3.64]   | 102.5 [4.04]  | 115.4 [4.54]  | 123.5 [4.86]  | 127 [5.00]   |
| BH       | 204.8 [8.06]  | 218.8 [8.61]  | 240.3 [9.46]  | 263.9 [10.39] | 288.1 [11.34] | 302 [11.89]  |
| BJ       | 32.3 [1.27]   | 34.7 [1.37]   | 37.5 [1.48]   | 42.0 [1.65]   | 46.4 [1.83]   | 48 [1.89]    |
| BK       | 69.5 [2.74]   | 75.2 [2.96]   | 85.0 [3.35]   | 96.0 [3.78]   | 104.3 [4.11]  | 108 [4.25]   |
| BL       | 50.8 [2.00]   | 57.2 [2.25]   | 57.2 [2.25]   | 66.6 [2.62]   | 66.6 [2.62]   | 66.6 [2.62]  |
| BM       | 23.8 [0.94]   | 27.8 [1.09]   | 27.8 [1.09]   | 31.8 [1.25]   | 31.8 [1.25]   | 31.8 [1.25]  |
| CA       | 243.7 [9.59]  | 258.7 [10.19] | 282.6 [11.13] | 306.9 [12.08] | 327.9 [12.91] | 345 [13.58]  |
| CB       | 43.4 [1.71]   | 46.2 [1.82]   | 49.6 [1.95]   | 54.4 [2.14]   | 57.8 [2.28]   | 60 [2.36]    |
| CC       | 48 [1.89]     | 50 [1.97]     | 50 [1.97]     | 60 [2.36]     | 65 [2.56]     | 65 [2.56]    |
| CD       | 50.8 [2.00]   | 57.2 [2.25]   | 57.2 [2.25]   | 66.6 [2.62]   | 66.6 [2.62]   | 66.6 [2.62]  |
| CE       | 23.8 [0.94]   | 27.8 [1.09]   | 27.8 [1.09]   | 31.8 [1.25]   | 31.8 [1.25]   | 31.8 [1.25]  |
| CF       | 69.5 [2.74]   | 67.7 [2.67]   | 95.5 [3.76]   | 86.4 [3.40]   | 98.9 [3.89]   | 107 [4.21]   |
| CG       | 85.8 [3.38]   | 90 [3.54]     | 96 [3.78]     | 102.2 [4.02]  | 108.5 [4.27]  | 112 [4.41]   |
| CH       | 18 [0.71]     | 17 [0.67]     | 21 [0.83]     | 23 [0.91]     | 25 [0.98]     | 25 [0.98]    |
| CJ       | 92.5 [3.64]   | 104 [4.09]    | 119.5 [4.70]  | 122.8 [4.83]  | 136.3 [5.37]  | 141.5 [5.57] |
| CK       | 70 [2.76]     | 75 [2.95]     | 83 [3.27]     | 96.5 [3.80]   | 103.5 [4.07]  | 107.5 [4.23] |
| CL       | 83.4 [3.28]   | 89.3 [3.52]   | 101.3 [3.99]  | 107.7 [4.24]  | 116.9 [4.6]   | 124 [4.88]   |
| CM       | 89.3 [3.52]   | 93.7 [3.69]   | 97.2 [3.83]   | 105.6 [4.16]  | 111.2 [4.38]  | 130 [5.12]   |
| CN       | 244.8 [9.64]  | 258.7 [10.19] | 283.6 [11.17] | 307.9 [12.12] | 328.9 [12.95] | 346 [12.83]  |
| CO       | 43.7 [1.72]   | 46.2 [1.82]   | 49.9 [1.96]   | 54.6 [2.15]   | 48.1 [1.89]   | 61 [2.4]     |
| CP       | 48 [1.89]     | 50 [1.97]     | 50 [1.97]     | 60 [2.36]     | 65 [2.56]     | 65 [2.56]    |
| $\alpha$ | 17°           | 17°           | 19°           | 17°           | 17°           | 17°          |

For further detailed information about SAE ports dimensions see the [SAE flange design ports per ISO 11926-1](#) on page 101.

Legend:

- 1** Loop flushing relief valve
- 2** Loop flushing shuttle spool
- 3** Speed sensor

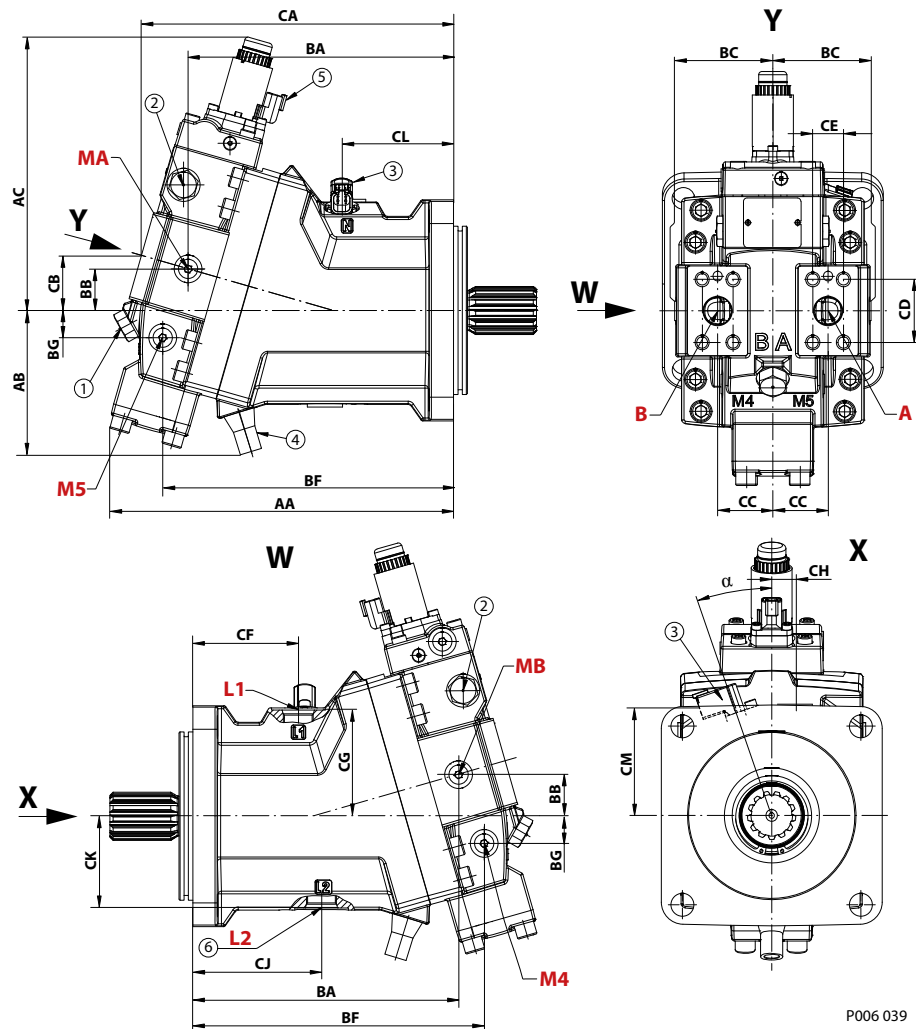
- 4** Minimum angle stop adjustment
- 5** Connector: DEUTSCH DT04-2P
- 6** Alternate position of case drain port



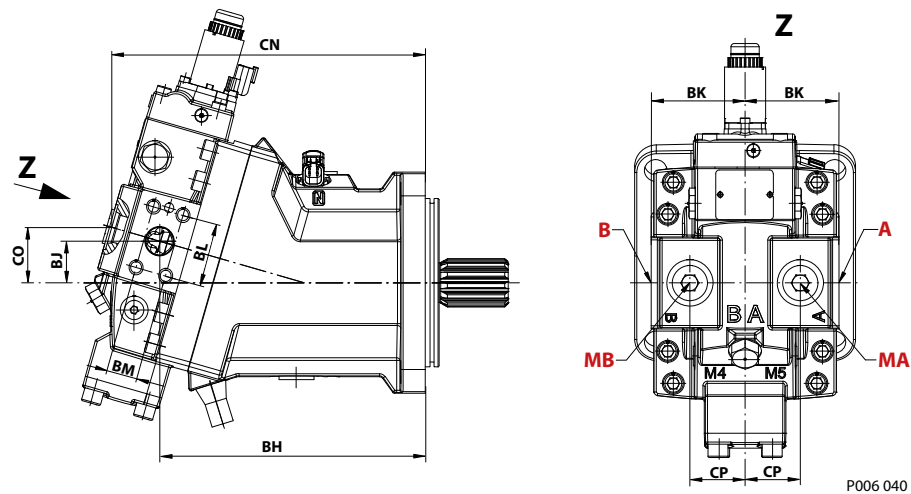
**Flange and housing dimensions**

**SAE flange design – option M\* (proportional control)**

*Axial ports*



*Radial ports*



**Flange and housing dimensions**
*Axial and radial ports dimensions, mm [in]*

| Measure  | Size 060      | Size 080      | Size 110      | Size 160      | Size 210      | Size 250      |
|----------|---------------|---------------|---------------|---------------|---------------|---------------|
| AA       | 265.0 [10.43] | 283.2 [11.15] | 311.0 [12.24] | 339.7 [13.37] | 363.9 [14.33] | 381.0 [15.00] |
| AB       | 114.7 [4.52]  | 119.4 [4.70]  | 130.8 [5.15]  | 138.2 [5.44]  | 145.5 [5.73]  | 152.0 [5.98]  |
| AC       | 224.2 [8.83]  | 235.7 [9.28]  | 247.2 [9.73]  | 265.0 [10.43] | 279.4 [11]    | 290.0 [11.42] |
| BA       | 204.8 [8.06]  | 218.8 [8.61]  | 240.3 [9.46]  | 263.9 [10.39] | 288.1 [11.34] | 302.0 [11.89] |
| BB       | 32.3 [1.27]   | 34.7 [1.37]   | 37.5 [1.48]   | 42.0 [1.65]   | 46.4 [1.83]   | 48.0 [1.89]   |
| BC       | 74.4 [2.93]   | 78.4 [3.09]   | 88.9 [3.50]   | 99.9 [3.93]   | 108.2 [4.26]  | 108.0 [4.25]  |
| BF       | 220.5 [8.68]  | 236.7 [9.32]  | 263.4 [10.37] | 289.2 [11.39] | 312.1 [12.29] | 329.0 [12.95] |
| BG       | 18.9 [0.74]   | 22.0 [0.87]   | 24.8 [0.98]   | 28.6 [1.13]   | 29.5 [1.16]   | 28.0 [1.1]    |
| BH       | 204.7 [8.06]  | 218.8 [8.61]  | 240.3 [9.46]  | 263.9 [10.39] | 288.1 [11.34] | 302.0 [11.89] |
| BJ       | 32.3 [1.27]   | 34.7 [1.37]   | 37.5 [1.48]   | 42.0 [1.65]   | 46.4 [1.83]   | 48.0 [1.89]   |
| BK       | 69.5 [2.74]   | 75.2 [2.96]   | 85.0 [3.35]   | 96.0 [3.78]   | 104.3 [4.11]  | 108.0 [4.25]  |
| BL       | 50.8 [2.00]   | 57.2 [2.25]   | 57.2 [2.25]   | 66.6 [2.62]   | 66.6 [2.62]   | 66.6 [2.62]   |
| BM       | 23.8 [0.94]   | 27.8 [1.09]   | 27.8 [1.09]   | 31.8 [1.25]   | 31.8 [1.25]   | 31.8 [1.25]   |
| CA       | 243.7 [9.59]  | 258.7 [10.19] | 282.6 [11.13] | 306.9 [12.08] | 327.9 [12.91] | 345.0 [13.58] |
| CB       | 43.4 [1.71]   | 46.2 [1.82]   | 49.6 [1.95]   | 54.4 [2.14]   | 57.8 [2.28]   | 60.0 [2.36]   |
| CC       | 48.0 [1.89]   | 50.0 [1.97]   | 50.0 [1.97]   | 60.0 [2.36]   | 65 [2.56]     | 65.0 [2.56]   |
| CD       | 50.8 [2.00]   | 57.2 [2.25]   | 57.2 [2.25]   | 66.6 [2.62]   | 66.6 [2.62]   | 66.6 [2.62]   |
| CE       | 23.8 [0.94]   | 27.8 [1.09]   | 27.8 [1.09]   | 31.8 [1.25]   | 31.8 [1.25]   | 31.8 [1.25]   |
| CF       | 69.5 [2.74]   | 67.7 [2.67]   | 95.5 [3.76]   | 86.4 [3.40]   | 98.9 [3.89]   | 107.0 [4.21]  |
| CG       | 85.8 [3.38]   | 90.0 [3.54]   | 96.0 [3.78]   | 102.2 [4.02]  | 108.5 [4.27]  | 112.0 [4.41]  |
| CH       | 18.0 [0.71]   | 17.0 [0.67]   | 21.0 [0.83]   | 23.0 [0.91]   | 25 [0.98]     | 25.0 [0.98]   |
| CJ       | 92.5 [3.64]   | 104.0 [4.09]  | 119.5 [4.70]  | 122.8 [4.83]  | 136.3 [5.37]  | 141.5 [5.57]  |
| CK       | 70.0 [2.76]   | 75.0 [2.95]   | 83.0 [3.27]   | 96.5 [3.80]   | 103.5 [4.07]  | 107.5 [4.23]  |
| CL       | 83.4 [3.28]   | 89.3 [3.52]   | 101.3 [3.99]  | 107.7 [4.24]  | 116.9 [4.6]   | 124.0 [4.88]  |
| CM       | 89.3 [3.52]   | 93.7 [3.69]   | 97.2 [3.83]   | 105.6 [4.16]  | 111.2 [4.38]  | 130.0 [5.12]  |
| CN       | 244.8 [9.64]  | 258.7 [10.19] | 283.6 [11.17] | 307.9 [12.12] | 328.9 [12.95] | 346.0 [12.83] |
| CO       | 43.7 [1.72]   | 46.2 [1.82]   | 49.9 [1.96]   | 54.6 [2.15]   | 58.1 [2.29]   | 61.0 [2.4]    |
| CP       | 48.0 [1.89]   | 50.0 [1.97]   | 50.0 [1.97]   | 60.0 [2.36]   | 65 [2.56]     | 65.0 [2.56]   |
| $\alpha$ | 17°           | 17°           | 19°           | 17°           | 17°           | 17°           |

For further detailed information about SAE ports dimensions see the [SAE flange design ports per ISO 11926-1](#) on page 101.

Legend:

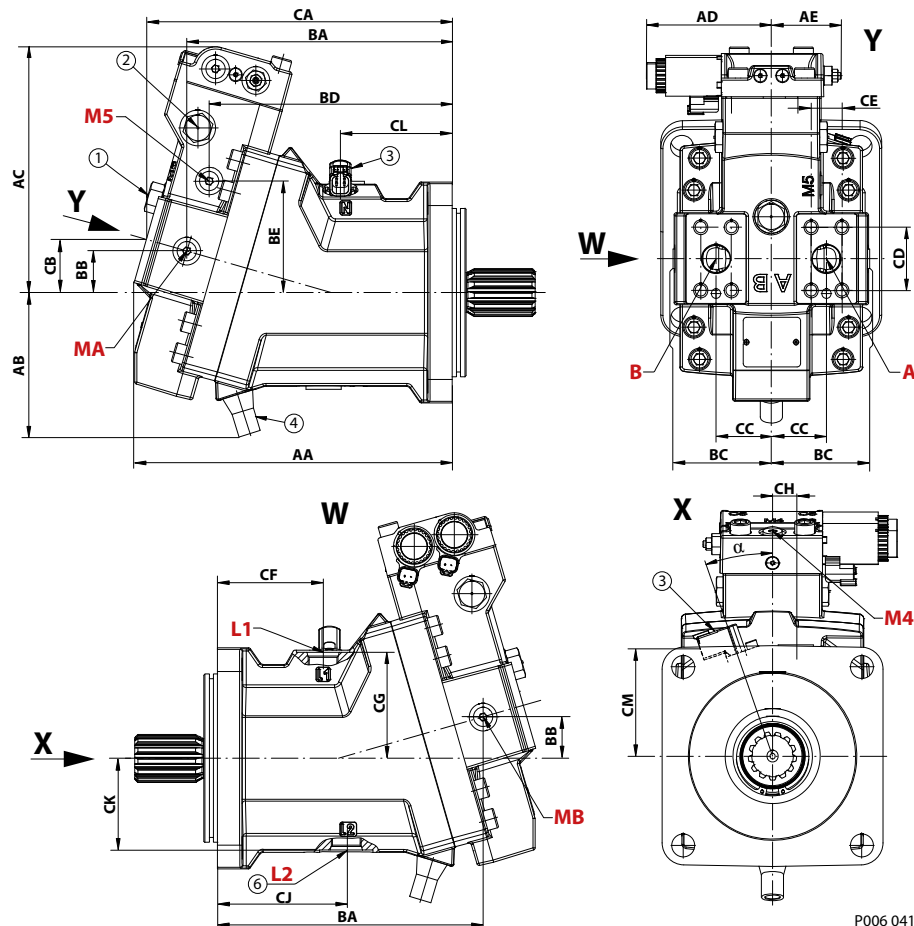
- 1 Loop flushing relief valve
- 2 Loop flushing shuttle spool
- 3 Speed sensor

- 4 Minimum angle stop adjustment
- 5 Connector: DEUTSCH DT04-2P
- 6 Alternate position of case drain port

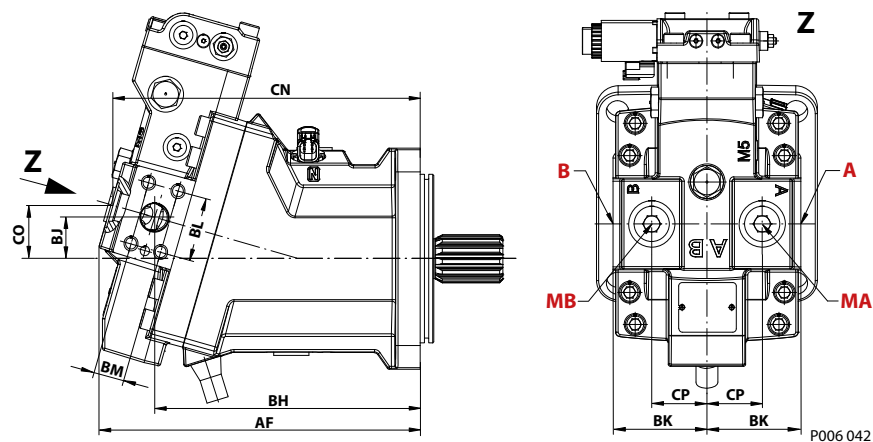
**Flange and housing dimensions**

**SAE flange design – options T\* D\* and P\* D\* (two-position control, PCOR, electric BPD)**

*Axial ports*



*Radial ports*



Legend:

- 1 Loop flushing relief valve
- 2 Loop flushing shuttle spool
- 3 Speed sensor

- 4 Minimum angle stop adjustment
- 5 Connector: DEUTSCH DT04-2P
- 6 Alternate position of case drain port

**Flange and housing dimensions**
*Axial and radial ports dimensions, mm [in]*

| Code                               | Size 060        | Size 080        | Size 110        | Size 160        | Size 210        | Size 250        |
|------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| AA                                 | 243 [9.57]      | 261.4 [10.29]   | 288 [11.34]     | 314.9 [12.4]    | 341.1 [13.43]   | 359 [14.13]     |
| AB (without min. adjustment screw) | 114.7 [4.52]    | 119.4 [4.7]     | 130.8 [5.15]    | 138.2 [5.44]    | 145.5 [5.73]    | 152 [5.98]      |
| AB (MB0)                           | 86.5 [3.41]     | 92.2 [3.63]     | 102.6 [4.04]    | 109.8 [4.32]    | 130 [5.12]      | 145.7 [5.74]    |
| AC                                 | 193.6 [7.62]    | 206.6 [8.13]    | 224.1 [8.82]    | 242.5 [9.55]    | 257.7 [10.15]   | 267 [10.51]     |
| AD                                 | 112.7 [4.44]    | 112.7 [4.44]    | 112.7 [4.44]    | 112.7 [4.44]    | 112.7 [4.44]    | 112.7 [4.44]    |
| AE                                 | max 67.3 [2.65] | max 67.3 [2.65] | max 67.3 [2.65] | max 67.3 [2.65] | max 67.3 [2.65] | max 67.3 [2.65] |
| AF                                 | 254.3 [9.66]    | 263.5 [10.37]   | 290.4 [11.43]   | 314.9 [12.39]   | 341.1 [13.43]   | 359 [14.13]     |
| BA                                 | 205.1 [8.07]    | 219.1 [8.63]    | 240.3 [9.46]    | 263.9 [10.39]   | 288.1 [11.34]   | 302 [11.89]     |
| BB                                 | 32.3 [1.27]     | 34.7 [1.37]     | 37.5 [1.49]     | 42 [1.65]       | 46.4 [1.83]     | 48 [1.89]       |
| BC                                 | 74.4 [2.93]     | 78.4 [3.09]     | 88.9 [3.5]      | 99.9 [3.93]     | 108.2 [4.26]    | 108 [4.25]      |
| BD                                 | 189.8 [7.47]    | 198 [7.8]       | 220 [8.66]      | 243.9 [9.6]     | 268 [10.55]     | 281 [11.06]     |
| BE                                 | 83.8 [3.30]     | 90.6 [3.57]     | 100.9 [3.97]    | 111.7 [4.4]     | 120.8 [4.76]    | 125 [4.92]      |
| BH                                 | 205.1 [8.07]    | 218.8 [8.61]    | 240.3 [9.46]    | 263.9 [10.39]   | 288.1 [11.34]   | 302 [11.89]     |
| BJ                                 | 32.3 [1.27]     | 34.7 [1.37]     | 37.5 [1.48]     | 42.0 [1.65]     | 46.4 [1.83]     | 48 [1.89]       |
| BK                                 | 69.5 [2.74]     | 75.2 [2.96]     | 85.0 [3.35]     | 96.0 [3.78]     | 104.3 [4.11]    | 108 [4.25]      |
| BL                                 | 50.8 [2.00]     | 57.2 [2.25]     | 57.2 [2.25]     | 66.6 [2.62]     | 66.6 [2.62]     | 66.6 [2.62]     |
| BM                                 | 23.8 [0.94]     | 27.8 [1.09]     | 27.8 [1.09]     | 31.8 [1.25]     | 31.8 [1.25]     | 31.8 [1.25]     |
| CA                                 | 233.8 [9.2]     | 250.2 [9.85]    | 276.8 [10.9]    | 298.9 [11.78]   | 323.1 [12.72]   | 338 [13.31]     |
| CB                                 | 40.6 [1.6]      | 43.7 [1.72]     | 48 [1.89]       | 52.1 [2.05]     | 56.1 [2.21]     | 59 [2.32]       |
| CC                                 | 48 [1.89]       | 50 [1.97]       | 50 [1.97]       | 60 [2.36]       | 65 [2.56]       | 65 [2.56]       |
| CD                                 | 50.8 [2.00]     | 57.2 [2.25]     | 57.2 [2.25]     | 66.6 [2.62]     | 66.6 [2.62]     | 66.6 [2.62]     |
| CE                                 | 23.8 [0.94]     | 27.8 [1.09]     | 27.8 [1.09]     | 31.8 [1.25]     | 31.8 [1.25]     | 31.8 [1.25]     |
| CF                                 | 69.5 [2.74]     | 67.7 [2.67]     | 95.5 [3.76]     | 86.4 [3.40]     | 98.9 [3.89]     | 107 [4.21]      |
| CG                                 | 85.8 [3.38]     | 90 [3.54]       | 96 [3.78]       | 102.2 [4.02]    | 108.5 [4.27]    | 112 [4.41]      |
| CH                                 | 18 [0.71]       | 17 [0.67]       | 21 [0.83]       | 23 [0.91]       | 25 [0.98]       | 25 [0.98]       |
| CJ                                 | 92.5 [3.64]     | 104 [4.09]      | 119.5 [4.70]    | 122.8 [4.83]    | 136.3 [5.37]    | 141.5 [5.57]    |
| CK                                 | 70 [2.76]       | 75 [2.95]       | 83 [3.27]       | 96.5 [3.80]     | 103.5 [4.07]    | 107.5 [4.23]    |
| CL                                 | 83.4 [3.28]     | 89.3 [3.52]     | 101.3 [3.99]    | 107.7 [4.24]    | 116.9 [4.6]     | 124 [4.88]      |
| CM                                 | 89.3 [3.52]     | 93.7 [3.69]     | 97.2 [3.83]     | 105.6 [4.16]    | 111.2 [4.38]    | 130 [5.12]      |
| CN                                 | 234.1 [9.22]    | 250.6 [9.87]    | 277.8 [10.94]   | 298.9 [11.78]   | 323.8 [12.75]   | 339 [13.35]     |
| CO                                 | 40.7 [1.6]      | 43.8 [1.72]     | 48.2 [1.9]      | 52.3 [2.06]     | 56.6 [2.23]     | 59 [2.32]       |
| CP                                 | 48 [1.89]       | 50 [1.97]       | 50 [1.97]       | 60 [2.36]       | 65 [2.56]       | 65 [2.56]       |
| $\alpha$                           | 17°             | 17°             | 19°             | 17°             | 17°             | 17°             |

For further detailed information about SAE ports dimensions see the [SAE flange design ports per ISO 11926-1](#) on page 101.

## Flange and housing dimensions

### SAE flange design ports per ISO 11 926-1

Ports dimensions per ISO 11 926-1; mm [in]

| Ports   | Port Config | Size 060   | Size 080  | Size 110  | Size 160 | Size 210   | Size 250 |
|---|-------------|--|---|---|----------|--|----------|
| L1, L2 Case drain   | Inch        | $\frac{7}{8}$ -14; Ø42 [1.65] <sup>1)</sup>        |   | $1 \frac{1}{16}$ -12; Ø48.5 [1.91] <sup>1)</sup>    |          | $1 \frac{5}{16}$ -12; Ø50.1 [1.97] <sup>1)</sup> |          |
|   | Metric      | M22x1.5  |   | M27x2.0   |          | M33x2.0  |          |
| A, B Split flange boss system                                     | Inch        | DN 19 (Ø19 mm) <sup>2)</sup><br>M10x1.5; 18 [0.71] | DN 25 (Ø25 mm) <sup>2)</sup><br>M12x1.75; 23 [0.91] | DN 32 (Ø32 mm) <sup>2)</sup><br>M12x1.75; 23 [0.91] |          |  |          |
|   | Metric      |  |   |   |          |  |          |
| MA, MB (axial HP ports) System pressure A, B gauge <sup>3)</sup>  | Inch        | $\frac{9}{16}$ -18; Ø25.0 [0.984] <sup>1)</sup>    |   |   |          |  |          |
|   | Metric      | M14x1.5  |   |   |          |  |          |
| MA, MB (radial HP ports) System pressure A, B gauge <sup>3)</sup> | Inch        | $\frac{7}{8}$ -14<br>Ø34.0 [1.34] <sup>1)</sup>    | $1 \frac{1}{16}$ -12; Ø42.0 [1.65] <sup>1)</sup>    |   |          |  |          |
|   | Metric      | M22x1.5  | M27x2.0   |   |          |  |          |
| M4, M5 Servo pressure supply gauge                                | Inch        | $\frac{9}{16}$ -18; Ø25.0 [0.984] <sup>1)</sup>    |   |   |          |  |          |
|   | Metric      | M14x1.5  |   |   |          |  |          |

<sup>1)</sup> Max. clearance DIA for fitting.

<sup>2)</sup> Typ 1, 40 MPa series per ISO 6162. Full thread depth.

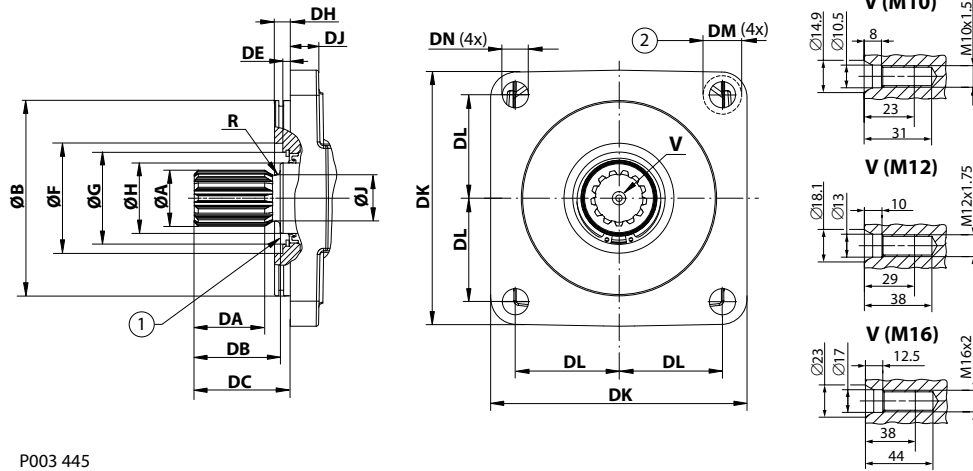
<sup>3)</sup> Countersink may be deeper than specified in the standard.

For further detailed information about SAE dimensions see:

- [SAE flange design – option L\\* \(proportional control\)](#) on page 95
- [SAE flange design – option M\\* \(proportional control\)](#) on page 97
- [SAE flange design – options T\\* D\\* and P\\* D\\* \(two-position control, PCOR, electric BPD\)](#) on page 99

**Flange and housing dimensions**

**SAE mounting flange design per ISO 3019/1**



P003 445

1. Coupling must not protrude beyond this surface
2. Maximum screw head space other side

*SAE flange dimensions mm [in]*

| Measure | Size 060/080 – Flange 127-4                    | Size 110/160 – Flange 152-4 | Size 210/250 – Flange 165-4 |
|---------|--|-----------------------------|-----------------------------|
| ØB      | 126.975 [4.999]                                | 152.375 [5.999]             | 165.075 [6.5]               |
| ØF      | 80 [3.15]                                      | 86 [3.386]                  | 100 [3.937]                 |
| ØG      | 62 [2.441]                                     | 72 [2.835]                  | 72 [2.835]                  |
| DE      | 6.4 [0.252]                                    | 6.0 [0.236]                 | 6.4 [0.252]                 |
| DH      | 12.5 [0.492]                                   | 12.5 [0.492]                | 15.65 [0.62]                |
| DJ      | 18 [0.709] - size 060<br>19 [0.748] - size 080 | 22.0 [0.866]                | 25 [0.98]                   |
| DK      | 142.5 [5.61]                                   | 200 [7.874]                 | 260.0 [10.24]               |
| DL      | 57.3 [2.256]                                   | 80.8 [3.181]                | 112.2 [4.42]                |
| DM      | 19.5 [0.768]                                   | 30 [1.181]                  | 30 [1.181]                  |
| DN      | 14.3 [0.563]                                   | 20.6 [0.811]                | 20.6 [0.811]                |

*Shaft options overview (Number of teeth)*

| Size | AN/AS (14T) | BN/BS (21T) | CN/CS (23T) | DN/DS (27T) | EN/ES (13T) | FN/FS (15T) |
|------|-------------|-------------|-------------|-------------|-------------|-------------|
| 060  | ●           | ●           | —           | —           | —           | —           |
| 080  | ●           | ●           | ●           | —           | —           | —           |
| 110  | —           | —           | —           | ●           | ●           | —           |
| 160  | —           | —           | —           | ●           | ●           | ●           |
| 210  | —           | —           | —           | ●           | —           | ●           |
| 250  | —           | —           | —           | ●           | —           | ●           |

● = available option, — = not available option

## Flange and housing dimensions

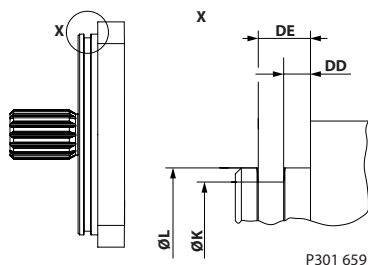
Shaft dimensions; mm [in]

| Shaft option   | EN/ES                                      | AN/AS          | FN/FS                         | BN/BS          | CN/CS          | DN/DS                         |
|----------------|--|----------------|-------------------------------|----------------|----------------|-------------------------------|
| <b>Teeth</b>   | <b>13</b>                                  | <b>14</b>      | <b>15</b>                     | <b>21</b>      | <b>23</b>      | <b>27</b>                     |
| <b>Module</b>  | 8/16                                       | 12/24          | 8/16                          | 16/32          | 16/32          | 16/32                         |
| <b>Pitch-Ø</b> | 41.275 [1.625]                             | 29.633 [1.167] | 47.625 [1.875]                | 33.337 [1.312] | 36.513 [1.438] | 42.862 [1.687]                |
| <b>Spline</b>  | ANSI B92.1-1970 Class 5 flat root side fit |                |                               |                |                |                               |
| <b>ØA</b>      | 43.6 [1.717]                               | 31.2 [1.228]   | 49.96 [1.966]                 | 34.4 [1.315]   | 37.61 [1.48]   | 44.0 [1.732]                  |
| <b>ØH</b>      | 55.0 [2.165]                               | 44.5 [1.752]   | 55.0 [2.165]                  | 44.5 [1.752]   | 44.5 [1.752]   | 55.0 [2.165]                  |
| <b>ØJ</b>      | 36.0 [1.417]                               | 25.8 [1.016]   | 42.2 [1.661]                  | 30.0 [1.181]   | 32.0 [1.260]   | 39.6 [1.559]                  |
| <b>DA</b>      | 55.0 [2.165]                               | 37.5 [1.476]   | 53.0 [2.087]                  | 37.5 [1.476]   | 37.5 [1.476]   | 55.0 [2.165]                  |
| <b>DB</b>      | 67.0 [2.638]                               | 47.5 [1.870]   | 67.0 [2.638]                  | 47.5 [1.870]   | 47.5 [1.870]   | 67.0 [2.638]                  |
| <b>DC</b>      | 75.0 [2.953]<br>75.4 [2.968]*              | 55.5 [2.185]   | 75.0 [2.953]<br>75.4 [2.968]* | 55.5 [2.185]   | 55.5 [2.185]   | 75.0 [2.953]<br>75.4 [2.968]* |
| <b>R</b>       | 3.0 [0.118]                                | 3.0 [0.118]    | 3.0 [0.118]                   | 3.0 [0.118]    | 3.0 [0.118]    | 3.0 [0.118]                   |
| <b>V</b>       | M12  | M10            | M16                           | M10            | M12            | M16                           |
| <b>Angle</b>   | Pressure angle 30°                         |                |                               |                |                |                               |

\* Size 160 only

For DIN 5480 shaft used in combination with SAE flanges, please contact your local Danfoss Power Solutions representative.

## O-ring groove dimensions



O-ring groove dimensions; mm [in]

| Measure             | Size 060/080 | Size 110/160 | Size 210/250  |
|---------------------|--------------|--------------|---------------|
| <b>Ø K</b>          | 122.3 [4.81] | 147.7 [5.81] | 160.4 [6.31]  |
| <b>Ø L</b>          | 127.0 [5.0]  | 152.4 [6.0]  | 165.1 [6.5]   |
| <b>DD</b>           | 4.45 [0.175] | 4.45 [0.175] | 6.65 [0.262]  |
| <b>DE</b>           | 8.65 [0.341] | 8.65 [0.341] | 10.85 [0.427] |
| <b>O-ring*</b>      | 3 x 116      | 3 x 142      | 3 x 154       |
| <b>Material Nr.</b> | 930511       | 729285       | 729319        |

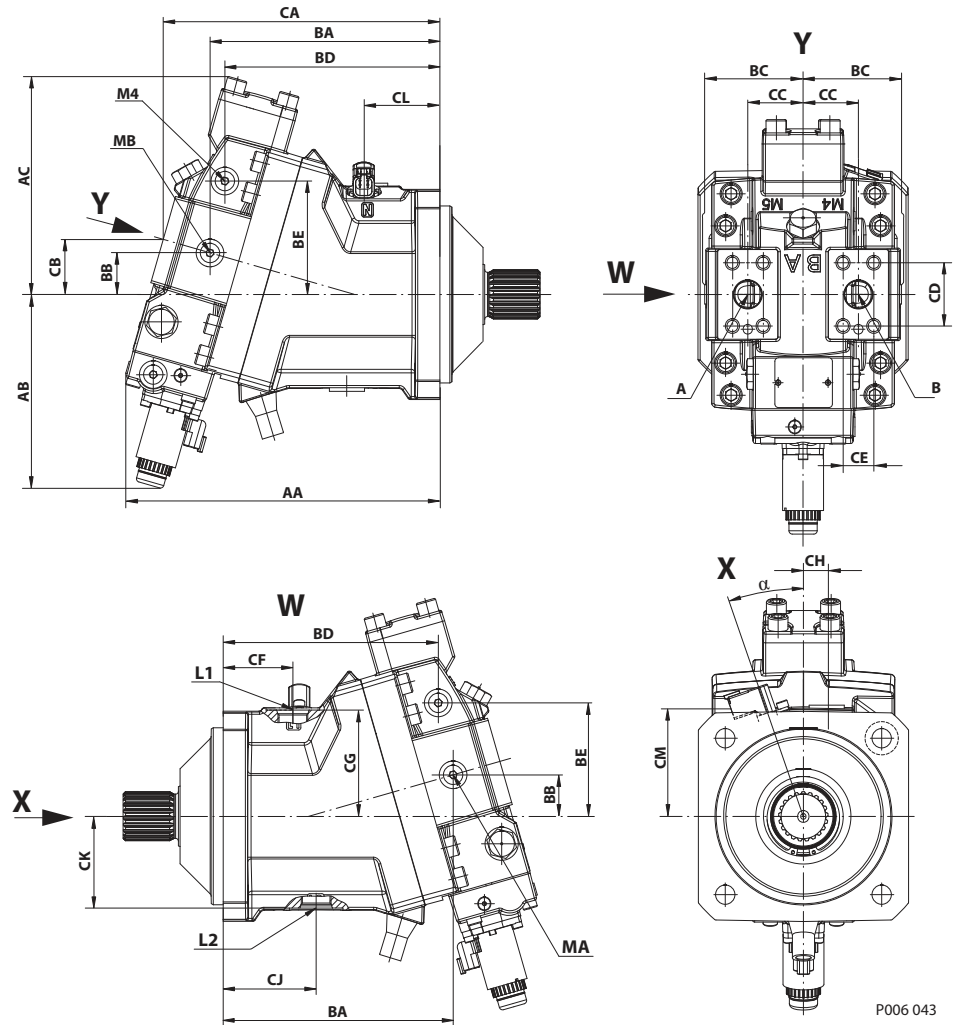
\* Recommended O-ring. It is not part of the shipment.

An O-ring groove was added to the SAE housing in September 2013 to facilitate sealing between the motor and mating structures. Motor installations will vary by application. It is the customer's responsibility to evaluate each application for proper mounting and sealing.

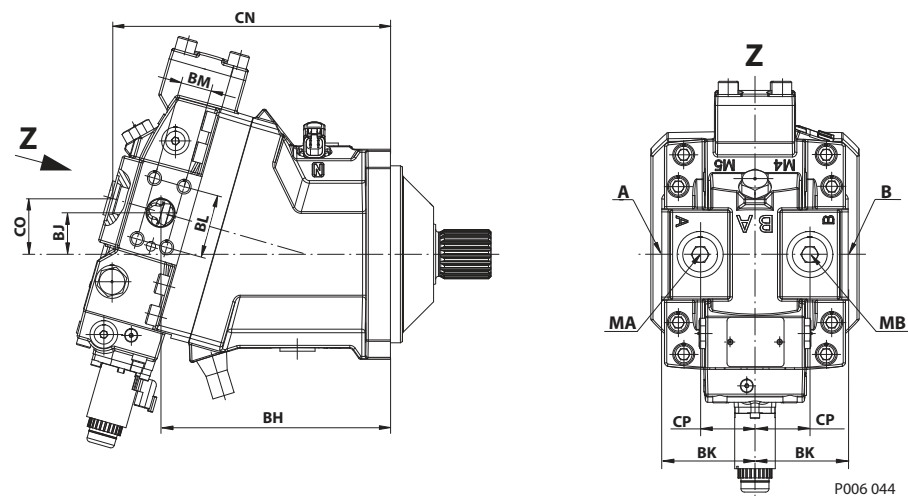
**Flange and housing dimensions**

**DIN flange design – option L\* (proportional control)**

*Axial ports*



*Radial ports*





## Flange and housing dimensions

*Axial and radial ports dimensions, mm [in]*

| Measure  | Size 060     | Size 080      | Size 110      | Size 160      | Size 210      | Size 250      |
|----------|--------------|---------------|---------------|---------------|---------------|---------------|
| AA       | 247.8 [9.76] | 265.9 [10.47] | 283.9 [11.18] | 311.7 [12.27] | 336.6 [13.25] | 345.2 [13.60] |
| AB       | 164.7 [6.48] | 170.6 [6.72]  | 175.0 [6.89]  | 183.8 [7.24]  | 190.9 [7.52]  | 197.0 [7.76]  |
| AC       | 167.5 [6.59] | 179.9 [7.08]  | 196.9 [7.75]  | 219.7 [8.65]  | 232.6 [9.16]  | 238.4 [9.39]  |
| BA       | 180.3 [7.10] | 194.8 [7.67]  | 207.8 [8.18]  | 232.0 [9.13]  | 256.1 [10.08] | 260.0 [10.24] |
| BB       | 32.3 [1.27]  | 34.7 [1.37]   | 37.5 [1.49]   | 42.0 [1.65]   | 46.4 [1.83]   | 48.1 [1.89]   |
| BC       | 74.4 [2.93]  | 78.4 [3.09]   | 88.9 [3.50]   | 99.9 [3.93]   | 108.2 [4.26]  | 108.8 [4.28]  |
| BD       | 165.5 [6.56] | 179.9 [7.08]  | 194.4 [7.65]  | 216.0 [8.50]  | 236.3 [9.3]   | 242.2 [9.54]  |
| BE       | 84.0 [3.30]  | 92.4 [3.64]   | 102.5 [4.04]  | 115.4 [4.54]  | 123.5 [4.86]  | 126.9 [5.00]  |
| BH       | 180.3 [7.10] | 194.8 [7.67]  | 207.8 [8.18]  | 232.0 [9.13]  | 256.1 [10.08] | 260.0 [10.24] |
| BJ       | 32.3 [1.27]  | 34.7 [1.37]   | 37.5 [1.48]   | 42.0 [1.65]   | 46.4 [1.83]   | 48.1 [1.89]   |
| BK       | 69.5 [2.74]  | 75.2 [2.96]   | 85.0 [3.35]   | 96.0 [3.78]   | 104.3 [4.11]  | 107.8 [4.24]  |
| BL       | 50.8 [2.00]  | 57.2 [2.25]   | 57.2 [2.25]   | 66.6 [2.62]   | 66.6 [2.62]   | 66.6 [2.62]   |
| BM       | 23.8 [0.94]  | 27.8 [1.09]   | 27.8 [1.09]   | 31.8 [1.25]   | 31.8 [1.25]   | 31.8 [1.25]   |
| CA       | 219.2 [8.63] | 234.7 [9.24]  | 250.1 [9.84]  | 275.0 [10.83] | 295.9 [11.65] | 302.6 [11.91] |
| CB       | 43.4 [1.71]  | 46.2 [1.82]   | 49.6 [1.95]   | 54.4 [2.14]   | 57.8 [2.28]   | 60.3 [2.37]   |
| CC       | 48.0 [1.89]  | 50.0 [1.97]   | 50.0 [1.97]   | 60.0 [2.36]   | 65 [2.56]     | 65.0 [2.56]   |
| CD       | 50.8 [2.00]  | 57.2 [2.25]   | 57.2 [2.25]   | 66.6 [2.62]   | 66.6 [2.62]   | 66.6 [2.62]   |
| CE       | 23.8 [0.94]  | 27.8 [1.09]   | 27.8 [1.09]   | 31.8 [1.25]   | 31.8 [1.25]   | 31.8 [1.25]   |
| CF       | 45.0 [1.77]  | 46.0 [1.81]   | 63.0 [2.48]   | 54.5 [2.15]   | 66.9 [2.63]   | 65.0 [2.56]   |
| CG       | 85.8 [3.38]  | 90.0 [3.54]   | 96.0 [3.78]   | 102.2 [4.02]  | 108.5 [4.27]  | 112.2 [4.42]  |
| CH       | 18.0 [0.71]  | 22.0 [0.87]   | 21.0 [0.83]   | 23.0 [0.91]   | 25 [0.98]     | 25.0 [0.98]   |
| CJ       | 68.0 [2.68]  | 80.0 [3.15]   | 87.0 [3.43]   | 90.9 [3.58]   | 104.3 [4.11]  | 99.4 [3.91]   |
| CK       | 70.0 [2.76]  | 75.0 [2.95]   | 83.0 [3.27]   | 96.5 [3.80]   | 103.5 [4.07]  | 107.5 [4.23]  |
| CL       | 58.9 [2.32]  | 65.3 [2.57]   | 68.8 [2.71]   | 75.8 [2.98]   | 84.9 [3.34]   | 82.3 [3.24]   |
| CM       | 89.3 [3.52]  | 93.7 [3.69]   | 97.2 [3.83]   | 105.6 [4.16]  | 111.2 [4.38]  | 118.0 [4.65]  |
| CN       | 220.3 [8.67] | 234.7 [9.24]  | 251.1 [9.89]  | 276.0 [10.87] | 296.9 [11.69] | 303.6 [11.95] |
| CO       | 43.7 [1.72]  | 46.2 [1.82]   | 49.9 [1.96]   | 54.6 [2.15]   | 58.1 [2.29]   | 60.6 [2.39]   |
| CP       | 48.0 [1.89]  | 50.0 [1.97]   | 50.0 [1.97]   | 60.0 [2.36]   | 65 [2.56]     | 65.0 [2.56]   |
| $\alpha$ | 17°          | 17°           | 19°           | 17°           | 17°           | 17°           |

For further detailed information about DIN ports dimensions see the [DIN flange design ports per ISO 11926-1](#) on page 110.

*Legend:*

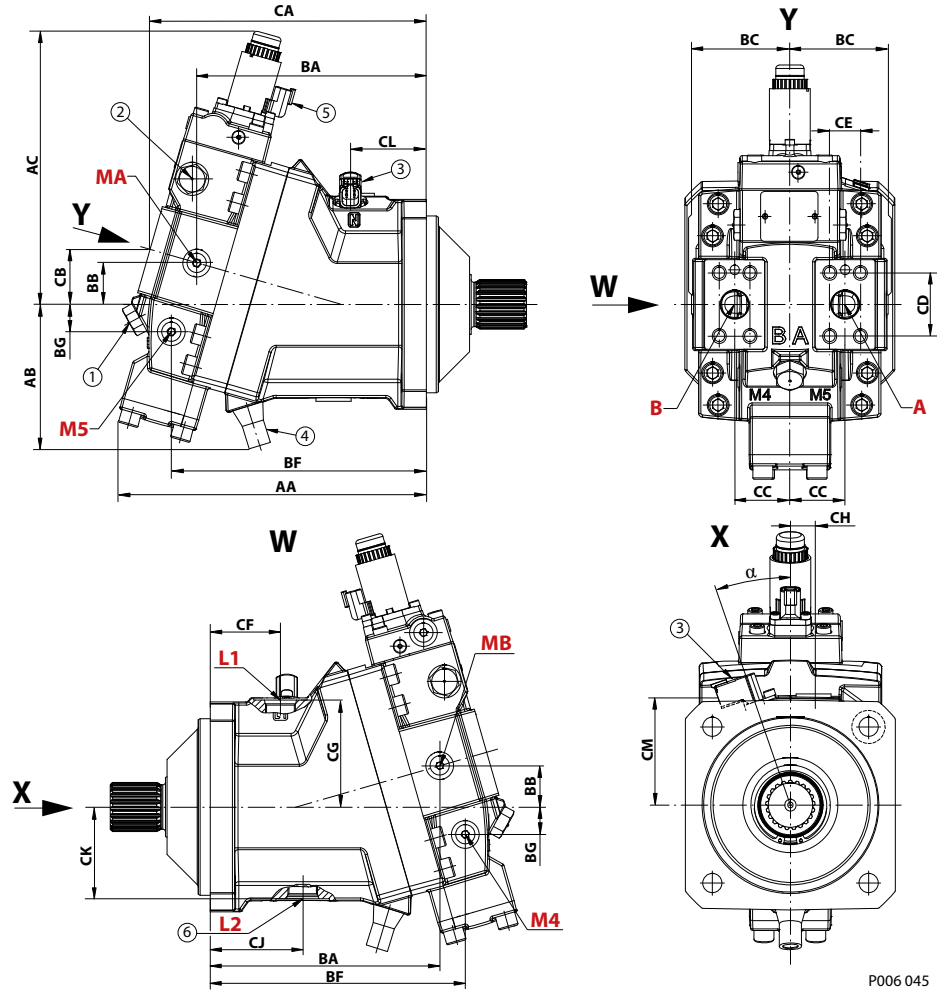
- 1** Loop flushing relief valve
- 2** Loop flushing shuttle spool
- 3** Speed sensor

- 4** Minimum angle stop adjustment
- 5** Connector: DEUTSCH DT04-2P
- 6** Alternate position of case drain port

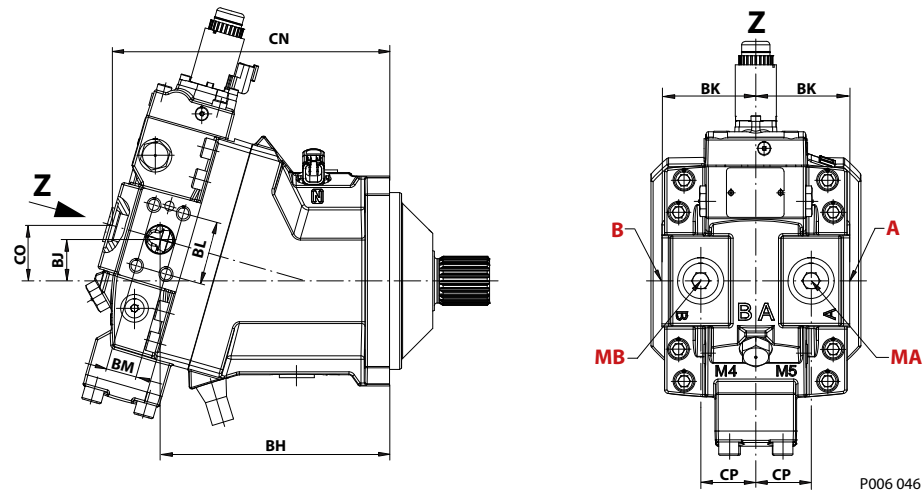
**Flange and housing dimensions**

**DIN flange design – option M\* (proportional control)**

*Axial ports*



*Radial ports*



## Flange and housing dimensions

*Axial and radial ports dimensions, mm [in]*

| Measure  | Size 060     | Size 080      | Size 110      | Size 160      | Size 210      | Size 250      |
|----------|--------------|---------------|---------------|---------------|---------------|---------------|
| AA       | 240.5 [9.47] | 259.2 [10.20] | 278.5 [10.96] | 307.8 [12.12] | 331.9 [13.07] | 339.3 [13.36] |
| AB       | 114.7 [4.52] | 119.4 [4.70]  | 130.8 [5.15]  | 138.2 [5.44]  | 145.5 [5.73]  | 151.7 [5.97]  |
| AC       | 224.2 [8.83] | 235.7 [9.28]  | 247.2 [9.73]  | 265.0 [10.43] | 279.4 [11]    | 290.1 [11.42] |
| BA       | 180.3 [7.10] | 194.8 [7.67]  | 207.8 [8.18]  | 232.0 [9.13]  | 256.1 [10.08] | 260.0 [10.24] |
| BB       | 32.3 [1.27]  | 34.7 [1.37]   | 37.5 [1.48]   | 42.0 [1.65]   | 46.4 [1.83]   | 48.1 [1.89]   |
| BC       | 74.4 [2.93]  | 78.4 [3.09]   | 88.9 [3.50]   | 99.0 [3.93]   | 108.2 [4.26]  | 108.8 [4.28]  |
| BF       | 196.0 [7.72] | 212.7 [8.38]  | 230.9 [9.90]  | 257.3 [10.13] | 280.1 [11.03] | 286.7 [11.29] |
| BG       | 18.9 [0.74]  | 22.0 [0.87]   | 24.8 [0.98]   | 28.6 [1.13]   | 29.5 [1.16]   | 28.2 [1.11]   |
| BH       | 180.3 [7.10] | 194.8 [7.67]  | 207.8 [8.18]  | 232.0 [9.13]  | 256.1 [10.08] | 260.0 [10.24] |
| BJ       | 32.3 [1.27]  | 34.7 [1.37]   | 37.5 [1.48]   | 42.0 [1.65]   | 46.4 [1.83]   | 48.1 [1.89]   |
| BK       | 69.5 [2.74]  | 75.2 [2.96]   | 85.0 [3.35]   | 96.0 [3.78]   | 104.3 [4.11]  | 107.8 [4.24]  |
| BL       | 50.8 [2.00]  | 57.2 [2.25]   | 57.2 [2.25]   | 66.6 [2.62]   | 66.6 [2.62]   | 66.6 [2.62]   |
| BM       | 23.8 [0.94]  | 27.8 [1.09]   | 27.8 [1.09]   | 31.8 [1.25]   | 31.8 [1.25]   | 31.8 [1.25]   |
| CA       | 219.2 [8.63] | 234.7 [9.24]  | 250.1 [9.85]  | 275.0 [10.83] | 295.9 [11.65] | 202.6 [11.91] |
| CB       | 43.4 [1.71]  | 46.2 [1.82]   | 49.6 [1.95]   | 54.4 [2.14]   | 57.8 [2.28]   | 60.3 [2.37]   |
| CC       | 48.0 [1.89]  | 50.0 [1.97]   | 50.0 [1.97]   | 60.0 [2.36]   | 65 [2.56]     | 65.0 [2.56]   |
| CD       | 50.8 [2.0]   | 57.2 [2.25]   | 57.2 [2.25]   | 66.6 [2.62]   | 66.6 [2.62]   | 66.6 [2.62]   |
| CE       | 23.8 [0.94]  | 27.8 [1.09]   | 27.8 [1.09]   | 31.8 [1.25]   | 31.8 [1.25]   | 31.8 [1.25]   |
| CF       | 45.0 [1.77]  | 46.0 [1.81]   | 63.0 [2.48]   | 54.5 [2.15]   | 66.9 [2.63]   | 65.0 [2.56]   |
| CG       | 85.8 [3.38]  | 90.0 [3.54]   | 96.0 [3.78]   | 102.2 [4.02]  | 108.5 [4.27]  | 112.2 [4.42]  |
| CH       | 18.0 [0.71]  | 22.0 [0.87]   | 21.0 [0.83]   | 23.0 [0.91]   | 25.0 [0.98]   | 25.0 [0.98]   |
| CJ       | 68.0 [2.68]  | 80.0 [3.15]   | 87.0 [3.43]   | 90.9 [3.58]   | 104.3 [4.11]  | 99.4 [3.91]   |
| CK       | 70.0 [2.76]  | 75.0 [2.95]   | 83.0 [3.27]   | 96.5 [3.80]   | 103.5 [4.07]  | 107.5 [4.23]  |
| CL       | 58.9 [2.32]  | 65.3 [2.57]   | 68.8 [2.71]   | 75.8 [2.98]   | 84.9 [3.34]   | 82.3 [3.24]   |
| CM       | 89.3 [3.52]  | 93.7 [3.69]   | 97.2 [3.83]   | 105.6 [4.16]  | 111.2 [4.38]  | 118.0 [4.65]  |
| CN       | 220.3 [8.67] | 234.7 [9.24]  | 251.1 [9.89]  | 276.0 [10.87] | 296.9 [11.69] | 303.6 [11.95] |
| CO       | 43.7 [1.72]  | 46.2 [1.82]   | 49.9 [1.96]   | 54.6 [2.15]   | 58.1 [2.29]   | 60.6 [2.39]   |
| CP       | 48.0 [1.89]  | 50.0 [1.97]   | 50.0 [1.97]   | 60.0 [2.36]   | 65.0 [2.56]   | 65.0 [2.56]   |
| $\alpha$ | 17°          | 17°           | 19°           | 17°           | 17°           | 17°           |

For further detailed information about DIN ports dimensions see the [DIN flange design ports per ISO 11926-1](#) on page 110.

Legend:

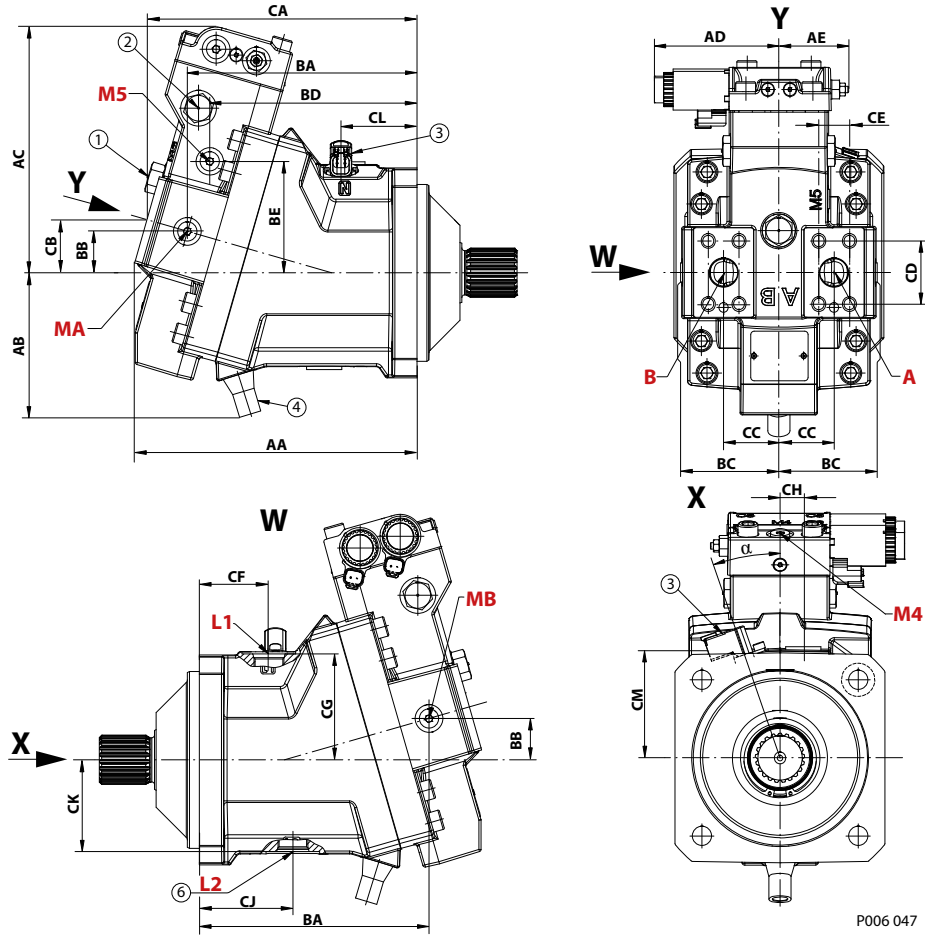
- 1** Loop flushing relief valve
- 2** Loop flushing shuttle spool
- 3** Speed sensor

- 4** Minimum angle stop adjustment
- 5** Connector: DEUTSCH DT04-2P
- 6** Alternate position of case drain port

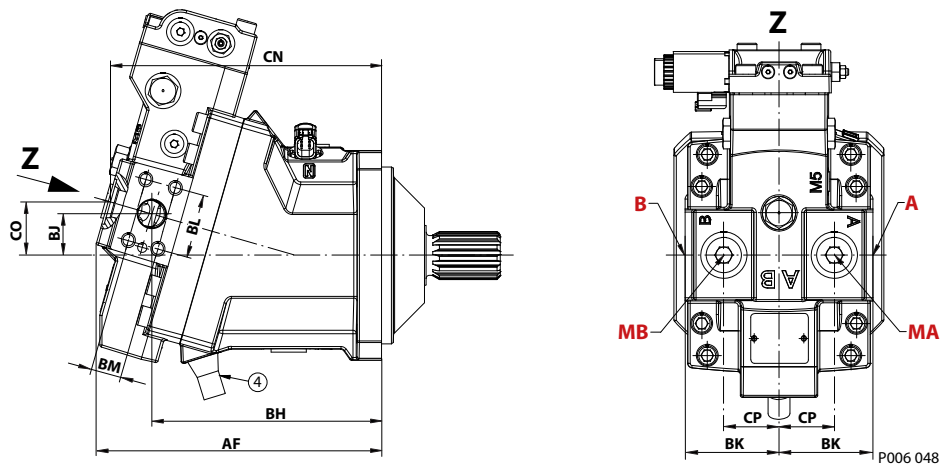
**Flange and housing dimensions**

**DIN flange design – options T\* D\* and P\* D\* (two-position control, PCOR, electric BPD)**

*Axial ports*



*Radial ports*



## Flange and housing dimensions

*Axial and radial ports dimensions, mm [in]*

| Callout  | Size 060        | Size 080        | Size 110        | Size 160        | Size 210        | Size 250        |
|----------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| AA       | 219.1 [8.63]    | 237.4 [9.35]    | 255.5 [10.06]   | 283.0 [11.14]   | 308.9 [12.16]   | 316.9 [12.59]   |
| AB       | 114.7 [4.52]    | 119.4 [4.70]    | 130.8 [5.15]    | 138.2 [5.44]    | 145.5 [5.73]    | 151.7 [5.97]    |
| AB (MBO) | 86.5 [3.41]     | 92.2 [3.63]     | 102.6 [4.04]    | 109.8 [4.32]    | 118 [4.65]      |                 |
| AC       | 193.6 [7.62]    | 206.6 [8.13]    | 224.1 [8.82]    | 242.5 [9.55]    | 257.7 [10.15]   | 267.3 [10.52]   |
| AD       | 112.7 [4.44]    | 112.7 [4.44]    | 112.7 [4.44]    | 112.7 [4.44]    | 112.7 [4.44]    | 112.7 [4.44]    |
| AE       | 67.3 [2.65] max | 67.3 [2.65] max | 67.3 [2.65] max | 67.3 [2.65] max | 67.3 [2.65] max | 67.3 [2.65] max |
| AF       | 220.8 [8.69]    | 239.5 [9.43]    | 257.9 [10.15]   | 283.0 [11.14]   | 308.9 [12.16]   | 316.9 [12.48]   |
| BA       | 180.6 [7.11]    | 195.1 [7.68]    | 207.8 [8.18]    | 232.0 [9.13]    | 256.1 [10.08]   | 260.0 [10.24]   |
| BB       | 32.3 [1.27]     | 34.7 [1.38]     | 37.5 [1.48]     | 42.0 [1.65]     | 46.4 [1.83]     | 48.1 [1.89]     |
| BC       | 74.4 [2.93]     | 78.0 [3.07]     | 88.9 [3.50]     | 99.9 [3.93]     | 108.2 [4.26]    | 108.8 [4.28]    |
| BD       | 165.3 [6.51]    | 174.0 [6.85]    | 187.5 [7.38]    | 212.1 [8.35]    | 236 [9.29]      | 238.7 [9.40]    |
| BE       | 83.8 [3.30]     | 90.6 [3.54]     | 100.9 [3.97]    | 111.7 [4.40]    | 120.8 [4.76]    | 125.2 [4.93]    |
| BH       | 180.6 [7.11]    | 194.8 [7.67]    | 207.8 [8.18]    | 232.0 [9.13]    | 256.1 [10.08]   | 260.0 [10.24]   |
| BJ       | 32.3 [1.27]     | 34.7 [1.37]     | 37.5 [1.48]     | 42.0 [1.65]     | 46.4 [1.83]     | 48.1 [1.89]     |
| BK       | 69.5 [2.74]     | 75.2 [2.96]     | 85.0 [3.35]     | 96.0 [3.78]     | 104.3 [4.11]    | 107.8 [4.24]    |
| BL       | 50.8 [2.0]      | 57.2 [2.25]     | 57.2 [2.25]     | 66.6 [2.62]     | 66.6 [2.62]     | 66.6 [2.62]     |
| BM       | 23.8 [0.94]     | 27.8 [1.09]     | 27.8 [1.09]     | 31.8 [1.25]     | 31.8 [1.25]     | 31.8 [1.25]     |
| CA       | 209.3 [8.24]    | 226.2 [8.91]    | 244.3 [9.62]    | 267.0 [10.51]   | 291.1 [11.46]   | 296.6 [11.68]   |
| CB       | 40.6 [1.6]      | 43.7 [1.72]     | 48.0 [1.89]     | 52.1 [2.05]     | 56.1 [2.21]     | 58.5 [2.30]     |
| CC       | 48.0 [1.89]     | 50.0 [1.97]     | 50.0 [1.97]     | 60.0 [2.36]     | 65 [2.56]       | 65.0 [2.56]     |
| CD       | 50.8 [2.0]      | 57.2 [2.25]     | 57.2 [2.25]     | 66.6 [2.62]     | 66.6 [2.62]     | 66.6 [2.62]     |
| CE       | 23.8 [0.94]     | 27.8 [1.09]     | 27.8 [1.09]     | 31.8 [1.25]     | 31.8 [1.25]     | 31.8 [1.25]     |
| CF       | 45.0 [1.77]     | 46.0 [1.81]     | 63.0 [2.48]     | 54.5 [2.15]     | 66.9 [2.63]     | 65.0 [2.56]     |
| CG       | 85.8 [3.38]     | 90.0 [3.54]     | 96.0 [3.78]     | 102.2 [4.02]    | 108.5 [4.27]    | 112.2 [4.42]    |
| CH       | 18.0 [0.71]     | 22.0 [0.87]     | 21.0 [0.83]     | 23.0 [0.91]     | 25.0 [0.98]     | 25.0 [0.98]     |
| CJ       | 68.0 [2.68]     | 80.0 [3.15]     | 87.0 [3.43]     | 90.9 [3.58]     | 104.3 [4.11]    | 99.4 [3.91]     |
| CK       | 70.0 [2.76]     | 75.0 [2.95]     | 83.0 [3.27]     | 96.5 [3.8]      | 103.5 [4.07]    | 107.5 [4.23]    |
| CL       | 58.9 [2.32]     | 65.3 [2.57]     | 68.8 [2.71]     | 75.8 [2.98]     | 84.9 [3.34]     | 82.3 [3.24]     |
| CM       | 89.3 [3.52]     | 93.7 [3.69]     | 97.2 [3.83]     | 105.6 [4.16]    | 111.2 [4.38]    | 118.0 [4.65]    |
| CN       | 209.6 [8.25]    | 226.6 [8.92]    | 245.3 [9.66]    | 267.9 [10.55]   | 291.8 [11.49]   | 297.5 [11.71]   |
| CO       | 40.7 [1.60]     | 43.8 [1.72]     | 48.2 [1.90]     | 52.3 [2.06]     | 56.6 [2.23]     | 58.8 [2.31]     |
| CP       | 48.0 [1.89]     | 50.0 [1.97]     | 50.0 [1.97]     | 60.0 [2.36]     | 65.0 [2.56]     | 65.0 [2.56]     |
| α        | 17°             | 17°             | 19°             | 17°             | 17°             | 17°             |

For further detailed information about DIN ports dimensions see the [DIN flange design ports per ISO 11926-1](#) on page 110.

*Legend:*

- 1** Loop flushing relief valve
- 2** Loop flushing shuttle spool
- 3** Speed sensor

- 4** Minimum angle stop adjustment
- 5** Connector: DEUTSCH DT04-2P
- 6** Alternate position of case drain port

**Flange and housing dimensions**
**DIN flange design ports per ISO 11 926-1**

Ports dimensions per ISO 11 926-1; mm [in]

| Ports  | Port config | Size 060  | Size 080   | Size 110   | Size 160 | Size 210   | 250 |
|--|-------------|---|--|--|----------|--|-----|
| L1, L2 Case drain  | Inch        | $\frac{7}{8}$ -14; Ø42 [1.65] <sup>1)</sup>     |  | 1 $\frac{1}{16}$ -12; Ø48.5 [1.91] <sup>1)</sup> |          | 1 $\frac{5}{16}$ -12; Ø50.1 [1.97] <sup>1)</sup> |     |
|  | Metric      | M22 x 2   |  | M27 x 2  |          | M33 x 2  |     |
| A, B Split flange boss system  | Inch        | DN 19 (Ø19 mm) <sup>2)</sup>                    | DN 25 (Ø25 mm) <sup>2)</sup>                     | DN 32 (Ø32 mm) <sup>2)</sup>                     |          |  |     |
|  | Metric      | M10x1.5; 18 [0.71]                              | M12x1.75; 23 [0.91]                              | M12x1.75; 23 [0.91]                              |          |  |     |
| MA, MB (axial HP ports)<br>System pressure A, B gauge <sup>3)</sup>  | Inch        | $\frac{9}{16}$ -18; Ø25.0 [0.984] <sup>1)</sup> |  |  |          |  |     |
|  | Metric      | M14 x 1.5                                       |  |  |          |  |     |
| MA, MB (radial HP ports)<br>System pressure A, B gauge <sup>3)</sup> | Inch        | $\frac{7}{8}$ -14<br>Ø34.0 [1.34] <sup>1)</sup> | 1 $\frac{1}{16}$ -12; Ø42.0 [1.65] <sup>1)</sup> |  |          |  |     |
|  | Metric      | M22 x 1.5                                       | M27 x 2.0  |  |          |  |     |
| M4, M5 Servo pressure supply gauge                                   | Inch        | $\frac{9}{16}$ -18; Ø25.0 [0.984] <sup>1)</sup> |  |  |          |  |     |
|  | Metric      | M14 x 1.5                                       |  |  |          |  |     |

<sup>1)</sup> Max. clearance DIA for fitting.

<sup>2)</sup> Typ 1, 40 MPa series per ISO 6162. Full thread depth.

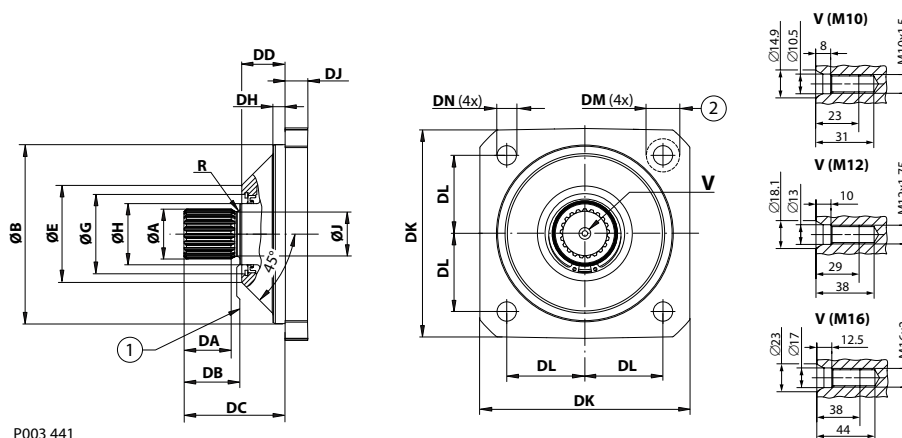
<sup>3)</sup> Countersink may be deeper than specified in the standard.

For further detailed information about DIN dimensions see:

- [DIN flange design – option L\\* \(proportional control\)](#) on page 104
- [DIN flange design – option M\\* \(proportional control\)](#) on page 106
- [DIN flange design – options T\\*D\\* and P\\*D\\* \(two-position control, PCOR, electric BPD\)](#) on page 108

**Flange and housing dimensions**

**DIN mounting flange design per ISO 3019/2**



P003 441

1. Coupling must not protrude beyond this surface
2. Maximum screw head space other side

*DIN mounting flange per ISO 3019/2 dimensions, mm [in]*

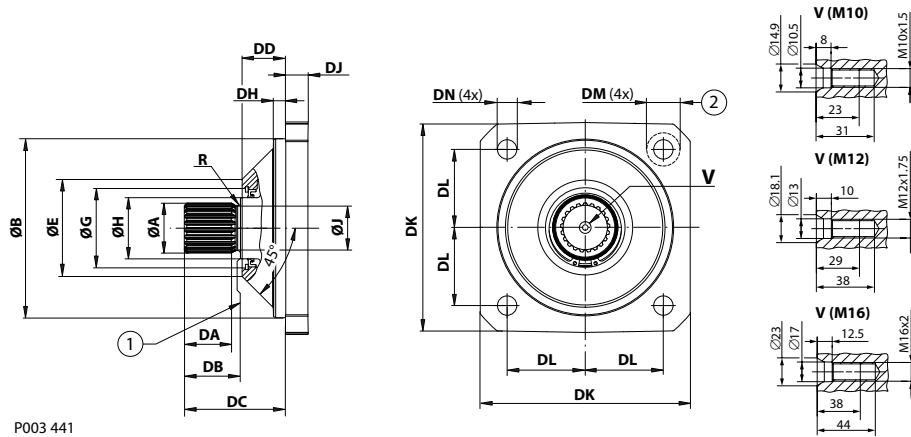
| Code | Size 060<br>125 B4 HL | Size 080<br>140 B4 HL | Size 110<br>160 B4 HL | Size 160<br>180 B4 HL | Size 210<br>200 B4 HL | Size 250<br>200 B4 HL |
|------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| ØB   | 125.0 [4.921]         | 140.0 [5.512]         | 160.0 [6.299]         | 180.0 [7.087]         | 200.0 [7.874]         | 200.0 [7.874]         |
| ØE   | 72.0 [2.835]          | 76.6 [3.016]          | 85.9 [3.382]          | 98.8 [3.890]          | 102.0 [4.016]         | 111.4 [4.386]         |
| ØG   | 62.0 [2.441]          | 62.0 [2.441]          | 72.0 [2.835]          | 72.0 [2.835]          | 72.0 [2.835]          | 72.0 [2.835]          |
| DD   | 30.0 [1.181]          | 31.2 [1.228]          | 39.0 [1.535]          | 38.8 [1.528]          | 38.9 [1.531]          | 48.4 [1.91]           |
| DH   | 11.2 [0.441]          | 11.1 [0.437]          | 10.8 [0.425]          | 10.1 [0.398]          | 11.0 [0.433]          | 11.0 [0.433]          |
| DJ   | 17.0 [0.669]          | 19.0 [0.748]          | 22.2 [0.874]          | 22.0 [0.866]          | 25 [0.984]            | 25 [0.984]            |
| DK   | 150.0 [5.905]         | 165.0 [6.496]         | 190.0 [7.840]         | 212.0 [8.346]         | 236.0 [9.291]         | 236.0 [9.291]         |
| DL   | 56.6 [2.228]          | 63.7 [2.509]          | 70.7 [2.783]          | 79.2 [3.118]          | 88.4 [3.480]          | 88.4 [3.480]          |
| DM   | 19.5 [0.768]          | 19.5 [0.768]          | 30.0 [1.181]          | 30.0 [1.181]          | 37.0 [1.457]          | 37.0 [1.457]          |
| DN   | 13.5 [0.531]          | 13.5 [0.531]          | 17.5 [0.689]          | 17.5 [0.689]          | 22 [0.866]            | 22 [0.866]            |

*Shaft options overview*

| Size | Shaft option (Number of teeth) |             |             |             |             |
|------|--------------------------------|-------------|-------------|-------------|-------------|
|      | GN/GS (14T)                    | HN/HS (16T) | JN/JS (18T) | KN/KS (21T) | LN/LS (24T) |
| 060  | ●                              | ●           | —           | —           | —           |
| 080  | —                              | ●           | ●           | —           | —           |
| 110  | —                              | —           | ●           | ●           | —           |
| 160  | —                              | —           | —           | ●           | ●           |
| 210  | —                              | —           | —           | —           | ●           |

● = available option, — = not available option

**Flange and housing dimensions**



P003 441

1. Coupling must not protrude beyond this surface
2. Maximum screw head space other side

*Shaft dimensions, mm [in]*

| Shaft option<br>Teeth      | GN/GS<br>14        | HN/HS<br>16    | JN/JS<br>18                                | KN/KS<br>21                                | LN/LS<br>24    |
|----------------------------|--------------------|----------------|--|--|----------------|
| <b>Pitch Ø</b>             | 28.0 [1.102]       | 32.0 [1.260]   | 36.0 [1.417]                               | 42.0 [1.654]                               | 48.0 [1.890]   |
| <b>Spline<sup>1)</sup></b> | W30x2x30x14x9g     | W35x2x30x16x9g | W40x2x30x18x9g                             | W45x2x30x21x9g                             | W50x2x30x24x9g |
| <b>ØA</b>                  | 29.6 [1.165]       | 34.6 [1.362]   | 39.6 [1.559]                               | 44.6 [1.756]                               | 49.6 [1.953]   |
| <b>ØH</b>                  | 44.5 [1.752]       | 44.5 [1.752]   | 44.5 [1.752]<br>55.0 [2.165] <sup>2)</sup> | 55.0 [2.165]                               | 55.0 [2.165]   |
| <b>ØJ</b>                  | 25.0 [0.984]       | 30.0 [1.181]   | 35.0 [1.378]                               | 40.0 [1.575]                               | 45.0 [1.772]   |
| <b>DA</b>                  | 27.0 [1.063]       | 32.0 [1.260]   | 37.0 [1.457]                               | 42.0 [1.654]                               | 47.0 [1.850]   |
| <b>DB</b>                  | 35.0 [1.378]       | 40.0 [1.575]   | 45.0 [1.772]                               | 50.0 [1.968]                               | 55.0 [2.165]   |
| <b>DC</b>                  | 67.5 [2.657]       | 72.0 [2.835]   | 77.0 [3.031]<br>85.5 [3.366] <sup>2)</sup> | 90.3 [3.555]<br>90.5 [3.563] <sup>2)</sup> | 95.3 [3.752]   |
| <b>R</b>                   | 1.6 [0.063]        | 1.6 [0.063]    | 1.6 [0.063]<br>2.5 [0.098] <sup>2)</sup>   | 2.5 [0.098]                                | 1.6 [0.063]    |
| <b>V</b>                   | M10                | M10            | M12  | M16  | M16            |
| <b>Angle</b>               | Pressure angle 30° |                |  |  |                |

<sup>1)</sup> Spline per DIN 5480; side fit.

<sup>2)</sup> For size **110** only.

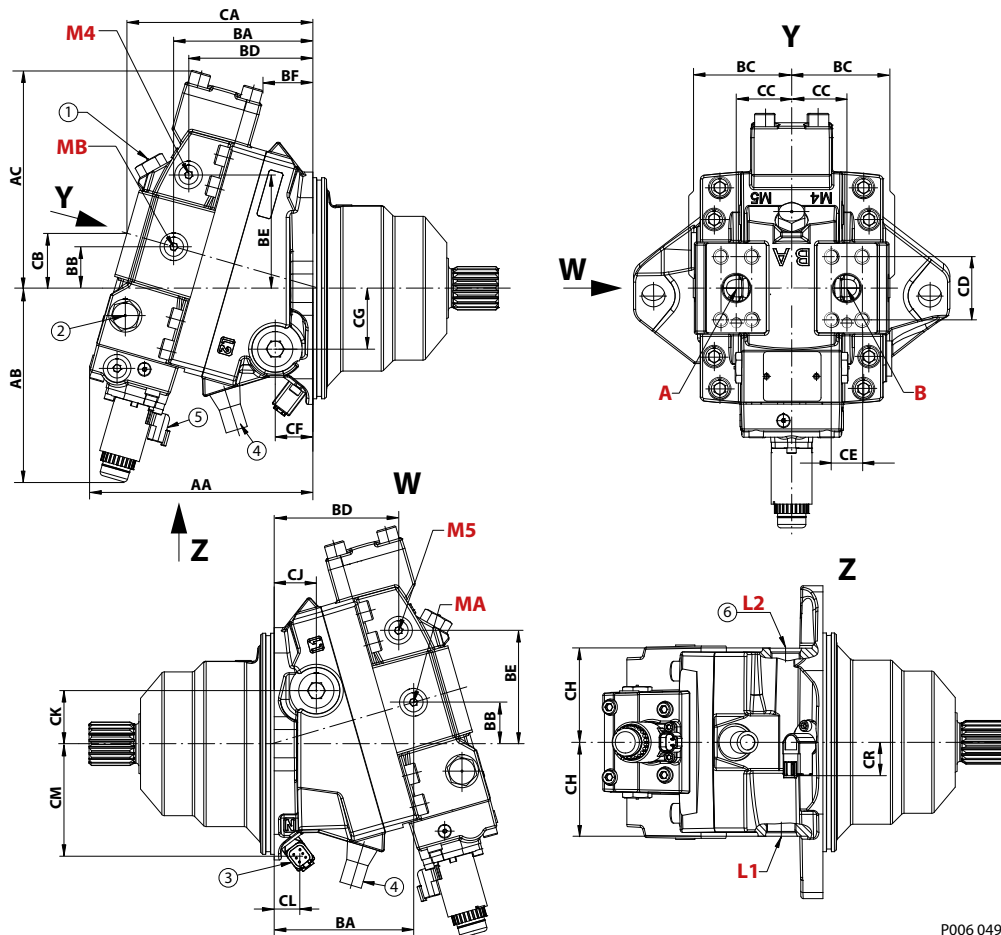
[For ANSI B92.1-1970 class 5 shaft used in combination with DIN flanges, please contact your local Danfoss Power Solutions representative.](#)



**Flange and housing dimensions**

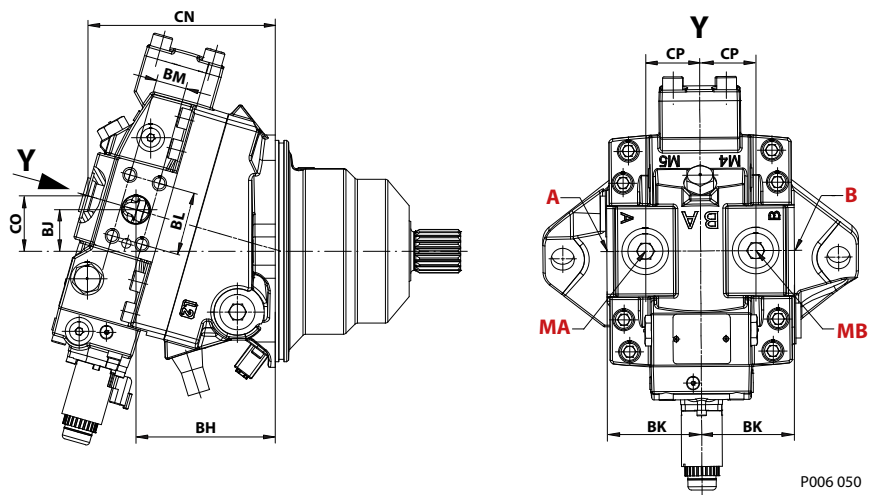
**Cartridge flange design – option L\* (proportional control)**

*Axial ports*



P006 049

*Radial ports*



P006 050

## Flange and housing dimensions

*Axial and radial ports dimensions, mm [in]*

| Measure  | Size 060     | Size 080     | Size 110     | Size 160     |
|----------|--------------|--------------|--------------|--------------|
| AA       | 188.1 [7.41] | 187.5 [7.38] | 201.9 [7.95] | 229.3 [9.03] |
| AB       | 164.7 [6.48] | 170.6 [6.72] | 175.0 [6.89] | 183.8 [7.24] |
| AC       | 167.5 [6.59] | 179.9 [7.08] | 196.9 [7.75] | 219.7 [8.65] |
| BA       | 120.6 [4.75] | 116.4 [4.58] | 125.8 [4.95] | 149.6 [5.89] |
| BB       | 32.3 [1.27]  | 34.7 [1.37]  | 37.5 [1.49]  | 42.0 [1.65]  |
| BC       | 74.4 [2.93]  | 78.4 [3.09]  | 88.9 [3.50]  | 99.9 [3.93]  |
| BD       | 106.8 [4.20] | 101.5 [4.00] | 112.4 [4.43] | 133.6 [5.26] |
| BE       | 84.0 [3.30]  | 92.4 [3.64]  | 102.5 [4.04] | 115.4 [4.54] |
| BF       | 43.0 [1.69]  | 37.0 [1.46]  | 46.0 [1.81]  | 64.0 [2.52]  |
| BH       | 120.6 [4.75] | 116.4 [4.58] | 125.8 [4.95] | 149.6 [5.89] |
| BJ       | 32.3 [1.27]  | 34.7 [1.37]  | 37.5 [1.48]  | 42.0 [1.65]  |
| BK       | 69.5 [2.74]  | 75.2 [2.96]  | 85.0 [3.35]  | 96.0 [3.78]  |
| BL       | 50.8 [2.00]  | 57.2 [2.25]  | 57.2 [2.25]  | 66.6 [2.62]  |
| BM       | 23.8 [0.94]  | 27.8 [1.09]  | 27.8 [1.09]  | 31.8 [1.25]  |
| CA       | 159.5 [6.28] | 156.3 [6.15] | 168.1 [6.62] | 192.6 [7.58] |
| CB       | 43.4 [1.71]  | 46.2 [1.82]  | 49.6 [1.95]  | 54.4 [2.14]  |
| CC       | 48.0 [1.89]  | 50.0 [1.97]  | 50.0 [1.97]  | 60.0 [2.36]  |
| CD       | 50.8 [2.00]  | 57.2 [2.25]  | 57.2 [2.25]  | 66.6 [2.62]  |
| CE       | 23.8 [0.94]  | 27.8 [1.09]  | 27.8 [1.09]  | 31.8 [1.25]  |
| CF       | 32.2 [1.27]  | 31.0 [1.22]  | 34.1 [1.34]  | 51.8 [2.04]  |
| CG       | 44.0 [1.73]  | 56.8 [2.24]  | 55.0 [2.17]  | 50.0 [1.97]  |
| CH       | 75.0 [2.95]  | 78.0 [3.07]  | 86.0 [3.39]  | 97.0 [3.82]  |
| CJ       | 44.2 [1.74]  | 36.0 [1.42]  | 38.1 [1.50]  | 52.8 [2.09]  |
| CK       | 35.0 [1.38]  | 46.0 [1.81]  | 47.9 [1.89]  | 51.0 [2.01]  |
| CL       | 26.1 [1.03]  | 21.5 [0.85]  | 22.9 [0.90]  | 25.1 [0.99]  |
| CM       | 74.8 [2.94]  | 74.4 [2.93]  | 79.0 [3.11]  | 87.7 [3.45]  |
| CN       | 160.6 [6.32] | 156.3 [6.15] | 169.1 [6.66] | 193.6 [7.62] |
| CO       | 43.7 [1.72]  | 46.2 [1.82]  | 49.9 [1.96]  | 54.6 [2.15]  |
| CP       | 48.0 [1.89]  | 50.0 [1.97]  | 50.0 [1.97]  | 60.0 [2.36]  |
| CR       | 68.4 [2.69]  | 68.2 [2.69]  | 70.4 [2.77]  | 74.4 [2.93]  |
| $\alpha$ | 25°          |              |              |              |

For further detailed information about Cartridge ports dimensions see the [Cartridge flange design ports per ISO 11 926-1](#) on page 119.

Legend:

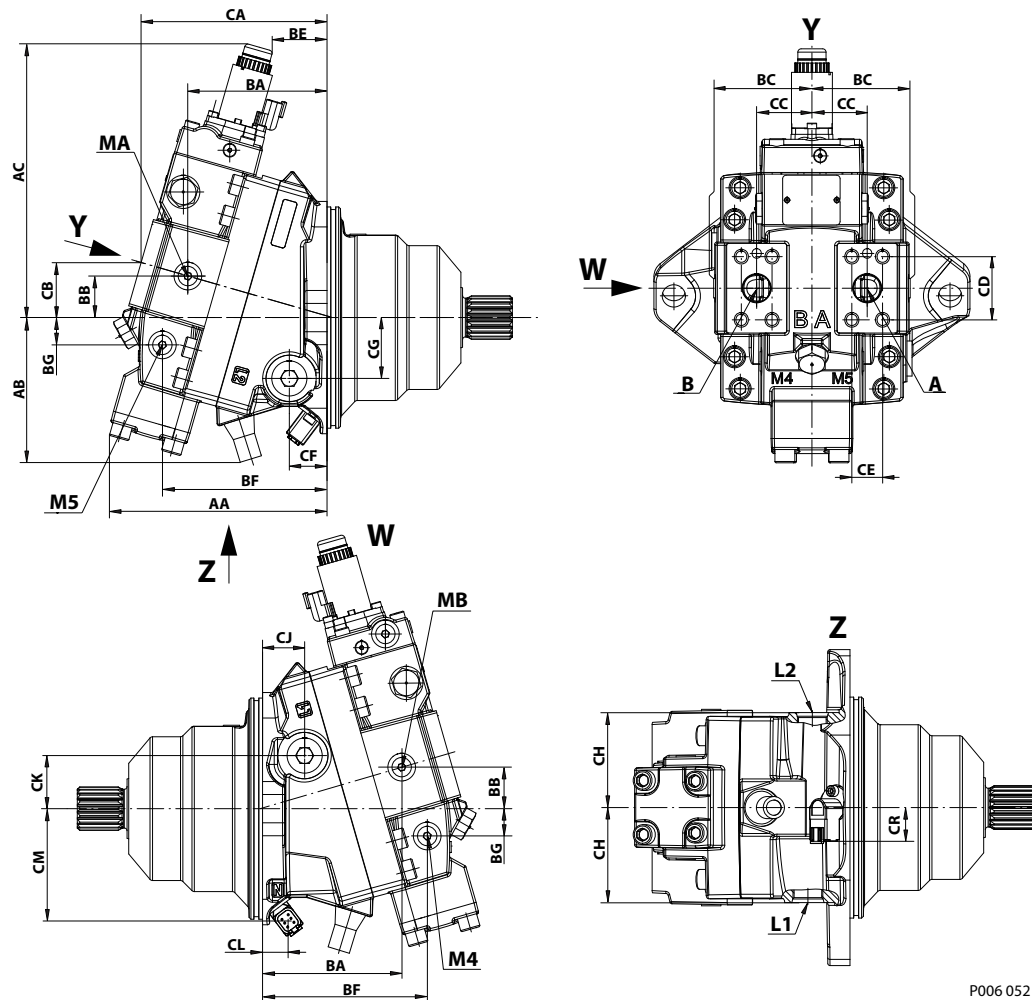
- 1 Loop flushing relief valve
- 2 Loop flushing shuttle spool
- 3 Speed sensor

- 4 Minimum angle stop adjustment
- 5 Connector: DEUTSCH DT04-2P
- 6 Alternate position of case drain port

**Flange and housing dimensions**

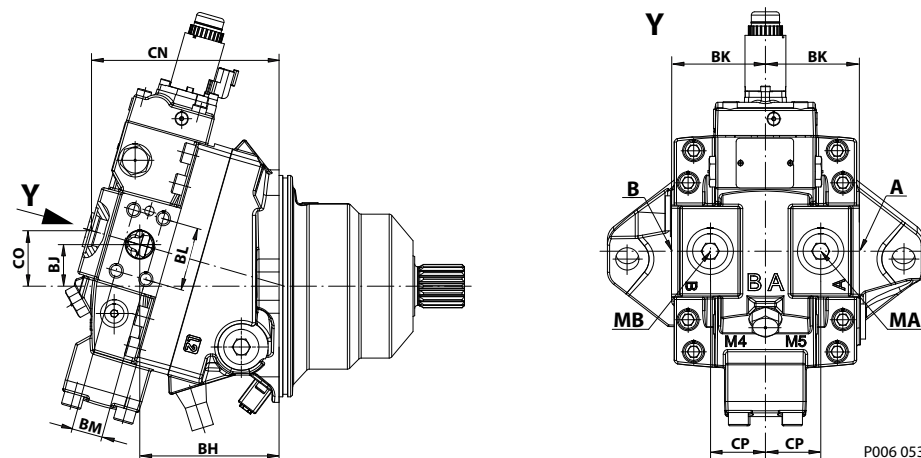
**Cartridge flange design – option M\* (proportional control)**

*Axial ports*



P006 052

*Radial ports*



P006 053

## Flange and housing dimensions

*Axial and radial ports dimensions, mm [in]*

| Measure | Size 060     | Size 080     | Size 110     | Size 160      |
|---------|--------------|--------------|--------------|---------------|
| AA      | 180.8 [7.12] | 180.8 [7.12] | 196.5 [7.74] | 225.4 [8.87]  |
| AB      | 114.7 [4.52] | 119.4 [4.70] | 130.8 [5.15] | 138.2 [5.44]  |
| AC      | 224.2 [8.83] | 235.7 [9.28] | 247.2 [9.73] | 265.0 [10.43] |
| BA      | 120.6 [4.75] | 116.4 [4.58] | 125.8 [4.95] | 149.6 [5.89]  |
| BB      | 32.3 [1.27]  | 34.7 [1.37]  | 37.5 [1.48]  | 42.0 [1.65]   |
| BC      | 74.4 [2.93]  | 78.4 [3.09]  | 88.9 [3.50]  | 99.9 [3.93]   |
| BE      | 32.0 [1.26]  | 27.0 [1.06]  | 36.0 [1.42]  | 56.0 [2.20]   |
| BF      | 136.3 [5.37] | 134.3 [5.29] | 148.9 [5.86] | 174.9 [6.89]  |
| BG      | 18.9 [0.74]  | 22.0 [0.87]  | 24.8 [0.98]  | 28.6 [1.13]   |
| BH      | 126.6 [4.75] | 116.4 [4.58] | 125.8 [4.95] | 149.6 [5.89]  |
| BJ      | 32.3 [1.27]  | 34.7 [1.37]  | 37.5 [1.48]  | 42.0 [1.65]   |
| BK      | 69.5 [2.74]  | 75.2 [2.96]  | 85.0 [3.35]  | 96.0 [3.78]   |
| BL      | 50.8 [2.00]  | 57.2 [2.25]  | 57.2 [2.25]  | 66.6 [2.62]   |
| BM      | 23.8 [0.94]  | 27.8 [1.09]  | 27.8 [1.09]  | 31.8 [1.25]   |
| CA      | 159.9 [6.30] | 156.3 [6.15] | 168.1 [6.62] | 192.6 [7.58]  |
| CB      | 43.3 [1.71]  | 46.2 [1.82]  | 49.6 [1.95]  | 54.4 [2.14]   |
| CC      | 48.0 [1.89]  | 50.0 [1.97]  | 50.0 [1.97]  | 60.0 [2.36]   |
| CD      | 50.8 [2.00]  | 57.2 [2.25]  | 57.2 [2.25]  | 66.6 [2.62]   |
| CE      | 23.8 [0.94]  | 27.8 [1.09]  | 27.8 [1.09]  | 31.8 [1.25]   |
| CF      | 32.2 [1.27]  | 31.0 [1.22]  | 34.1 [1.34]  | 51.8 [2.04]   |
| CG      | 44.0 [1.73]  | 56.8 [2.24]  | 55.0 [2.17]  | 50.0 [1.97]   |
| CH      | 75.0 [2.95]  | 78.0 [3.07]  | 86.0 [3.39]  | 97.0 [3.82]   |
| CJ      | 44.2 [1.74]  | 36.0 [1.42]  | 38.1 [1.50]  | 52.8 [2.09]   |
| CK      | 35.0 [1.38]  | 46.0 [1.81]  | 47.9 [1.89]  | 51.0 [2.01]   |
| CL      | 26.1 [1.03]  | 21.5 [0.85]  | 22.9 [0.90]  | 25.1 [0.99]   |
| CM      | 74.8 [2.94]  | 74.4 [2.93]  | 79.0 [3.11]  | 87.7 [3.45]   |
| CN      | 160.6 [6.32] | 156.3 [6.15] | 169.1 [6.66] | 193.6 [7.62]  |
| CO      | 43.7 [1.72]  | 46.2 [1.82]  | 49.9 [1.96]  | 54.6 [2.15]   |
| CP      | 48.0 [1.89]  | 50.0 [1.97]  | 50.0 [1.97]  | 60.0 [2.36]   |
| CR      | 68.4 [2.69]  | 68.2 [2.69]  | 70.4 [2.77]  | 30.0 [1.18]   |
| α       | 25°          |              |              |               |

For further detailed information about Cartridge ports dimensions see the [Cartridge flange design ports per ISO 11 926-1](#) on page 119.

Legend:

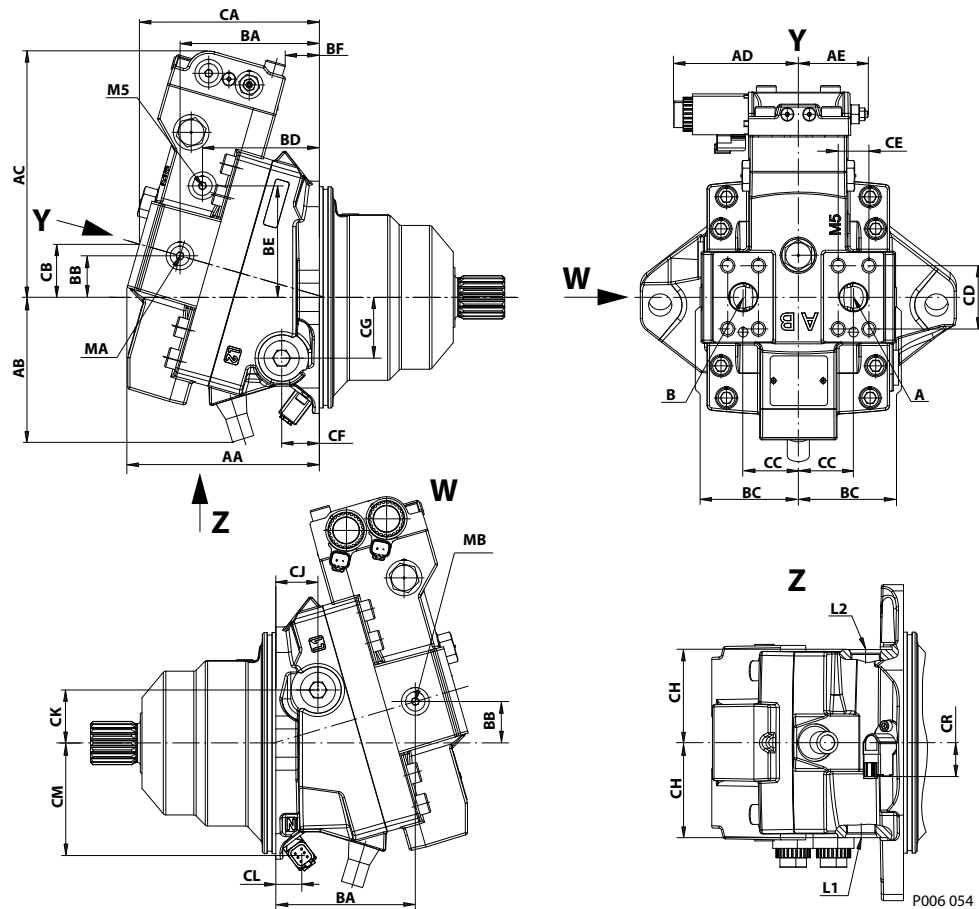
- 1 Loop flushing relief valve
- 2 Loop flushing shuttle spool
- 3 Speed sensor

- 4 Minimum angle stop adjustment
- 5 Connector: DEUTSCH DT04-2P
- 6 Alternate position of case drain port

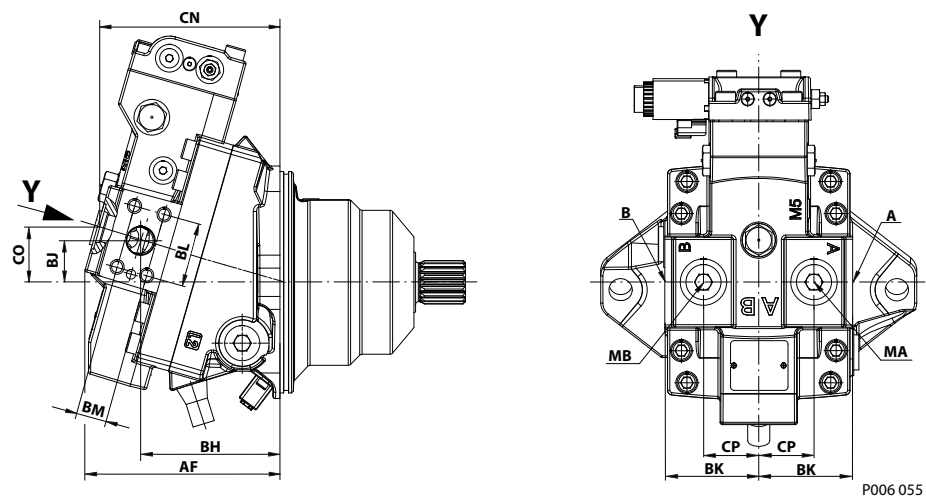
**Flange and housing dimensions**

**Cartridge flange design – options T\* D\* and P\* D\* (two-position control, PCOR, electric BPD)**

*Axial ports*



*Radial ports*



## Flange and housing dimensions

*Axial and radial ports dimensions, mm [in]*

| Callout  | Size 060        | Size 080        | Size 110        | Size 160        |
|----------|-----------------|-----------------|-----------------|-----------------|
| AA       | 158.9 [6.26]    | 159.0 [6.26]    | 173.5 [6.83]    | 200.6 [7.90]    |
| AB       | 114.7 [4.52]    | 119.4 [4.70]    | 130.8 [5.15]    | 138.2 [5.44]    |
| AB (MBO) | 100.6 [3.96]    | 100.1 [3.94]    | 104.6 [4.12]    | 113.4 [4.46]    |
| AC       | 193.6 [7.62]    | 206.6 [8.13]    | 224.1 [8.82]    | 242.5 [9.55]    |
| AD       | 112.7 [4.44]    | 112.7 [4.44]    | 112.7 [4.44]    | 112.7 [4.44]    |
| AE       | 67.3 [2.65] max | 67.3 [2.65] max | 67.3 [2.65] max | 67.3 [2.65] max |
| AF       | 161.1 [6.34]    | 161.1 [6.34]    | 175.9 [6.93]    | 200.6 [7.90]    |
| BA       | 120.9 [4.76]    | 116.7 [4.59]    | 125.8 [4.95]    | 149.6 [5.89]    |
| BB       | 32.3 [1.27]     | 34.7 [1.38]     | 37.5 [1.48]     | 42.0 [1.65]     |
| BC       | 74.4 [2.93]     | 78.4 [3.09]     | 88.9 [3.50]     | 99.9 [3.93]     |
| BD       | 105.6 [4.16]    | 95.6 [3.76]     | 105.5 [4.15]    | 129.7 [5.11]    |
| BE       | 83.8 [3.30]     | 90.6 [3.54]     | 100.9 [3.97]    | 111.7 [4.40]    |
| BF       | 29.0 [1.14]     | 20.0 [0.79]     | 31.0 [1.22]     | 50.0 [1.97]     |
| BH       | 120.9 [4.76]    | 116.4 [4.58]    | 125.8 [4.95]    | 149.6 [5.89]    |
| BJ       | 32.3 [1.27]     | 34.7 [1.37]     | 37.5 [1.48]     | 42.0 [1.65]     |
| BK       | 69.5 [2.74]     | 75.2 [2.96]     | 85.0 [3.35]     | 96.0 [3.78]     |
| BL       | 50.8 [2.0]      | 57.2 [2.25]     | 57.2 [2.25]     | 66.6 [2.62]     |
| BM       | 23.8 [0.94]     | 27.8 [1.09]     | 27.8 [1.09]     | 31.8 [1.25]     |
| CA       | 149.6 [5.89]    | 147.8 [5.82]    | 162.3 [6.39]    | 184.6 [7.27]    |
| CB       | 40.6 [1.6]      | 43.7 [1.72]     | 48.0 [1.89]     | 52.1 [2.05]     |
| CC       | 48.0 [1.89]     | 50.0 [1.97]     | 50.0 [1.97]     | 60.0 [2.36]     |
| CD       | 50.8 [2.0]      | 57.2 [2.25]     | 57.2 [2.25]     | 66.6 [2.62]     |
| CE       | 23.8 [0.94]     | 27.8 [1.09]     | 27.8 [1.09]     | 31.8 [1.25]     |
| CF       | 32.2 [1.27]     | 31.0 [1.22]     | 34.1 [1.34]     | 51.8 [2.04]     |
| CG       | 44.0 [1.73]     | 56.8 [2.24]     | 55.0 [2.17]     | 50.0 [1.97]     |
| CH       | 75.0 [2.95]     | 78.0 [3.07]     | 86.0 [3.39]     | 97.0 [3.82]     |
| CJ       | 44.2 [1.74]     | 36.0 [1.42]     | 38.1 [1.50]     | 52.8 [2.09]     |
| CK       | 35.0 [1.38]     | 46.0 [1.81]     | 47.9 [1.89]     | 51.0 [2.01]     |
| CL       | 26.1 [1.03]     | 21.5 [0.85]     | 22.9 [0.9]      | 25.1 [0.99]     |
| CM       | 74.8 [2.94]     | 74.4 [2.93]     | 79.0 [3.11]     | 87.7 [3.45]     |
| CN       | 149.9 [5.9]     | 148.2 [5.83]    | 163.3 [6.43]    | 184.6 [7.27]    |
| CO       | 40.7 [1.60]     | 43.8 [1.72]     | 48.2 [1.90]     | 52.3 [2.06]     |
| CP       | 48.0 [1.89]     | 50.0 [1.97]     | 50.0 [1.97]     | 60.0 [2.36]     |
| CR       | 68.4 [2.69]     | 68.2 [2.69]     | 70.4 [2.77]     | 30.0 [1.18]     |
| <b>α</b> | 25°             |                 |                 |                 |

Legend:

- 1 Loop flushing relief valve
- 2 Loop flushing shuttle spool
- 3 Speed sensor

- 4 Minimum angle stop adjustment
- 5 Connector: DEUTSCH DT04-2P
- 6 Alternate position of case drain port

## Flange and housing dimensions

### Cartridge flange design ports per ISO 11 926-1

Ports dimensions per ISO 11 926-1; mm [in]

| Ports  | Port config | Size 060  | Size 080  | Size 110  | Size 160 |
|--|-------------|---|---|---|----------|
| L1, L2 Case drain  | Inch        | $\frac{7}{8}$ -14; Ø42 [1.65] <sup>1)</sup>     |   | $1\frac{1}{16}$ -12; Ø48.5 [1.91] <sup>1)</sup> |          |
|  | Metric      | M22 x 1.5                                       |   | M27 x 2.0                                       |          |
| A, B Split flange boss system  | Inch        | DN 19 (Ø19 mm) <sup>2)</sup>                    | DN 25 (Ø25 mm) <sup>2)</sup>                    | DN 32 (Ø32 mm) <sup>2)</sup>                    |          |
|  | Metric      | M10x1.5; 18 [0.71]                              | M12x1.75; 23 [0.91]                             | M12x1.75; 23 [0.91]                             |          |
| MA, MB (axial HP ports)<br>System pressure A, B gauge <sup>3)</sup>  | Inch        | $\frac{9}{16}$ -18; Ø25.0 [0.984] <sup>1)</sup> |   |   |          |
|  | Metric      | M14 x 1.5                                       |   |   |          |
| MA, MB (radial HP ports)<br>System pressure A, B gauge <sup>3)</sup> | Inch        | $\frac{7}{8}$ -14; Ø34.0 [1.34] <sup>1)</sup>   | $\frac{9}{16}$ -18; Ø25.0 [0.984] <sup>1)</sup> |   |          |
|  | Metric      | M22 x 1.5                                       | M27 x 2.0                                       |   |          |
| M4, M5 Servo pressure supply<br>gauge                                | Inch        | $\frac{9}{16}$ -18; Ø25.0 [0.984] <sup>1)</sup> |   |   |          |
|  | Metric      | M14 x 1.5                                       |   |   |          |

<sup>1)</sup> Max. clearance DIA for fitting.

<sup>2)</sup> Typ 1, 40 MPa series per ISO 6162. Full thread depth.

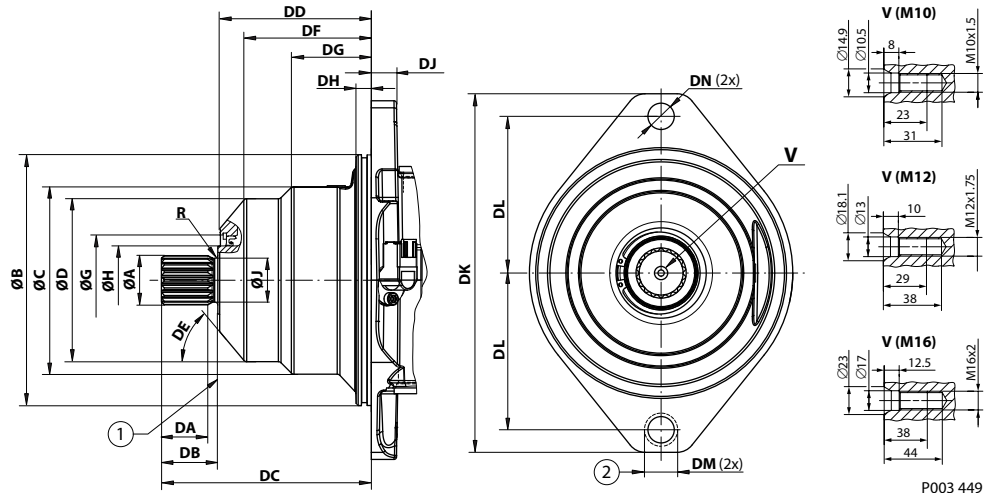
<sup>3)</sup> Countersink may be deeper than specified in the standard.

For further detailed information about Cartridge dimensions see:

- [Cartridge flange design – option L\\* \(proportional control\)](#) on page 113
- [Cartridge flange design – option M\\* \(proportional control\)](#) on page 115
- [Cartridge flange design – options T\\* D\\* and P\\* D\\* \(two-position control, PCOR, electric BPD\)](#) on page 117

**Flange and housing dimensions**

**Cartridge mounting flange design**



1. Coupling must not protrude beyond this surface
2. Maximum screw head space other side

*Cartridge flange dimensions, mm [in]*

| Measure      | Size 060                     | Size 080                      | Size 110                      | Size 160                      |
|--------------|------------------------------|-------------------------------|-------------------------------|-------------------------------|
| ØB           | 160 [6.299]                  | 190 [7.480]                   | 200 [7.874]                   | 200.0 [7.874]                 |
| ØC           | 121.0 [4.764]                | 134.0 [5.276]                 | 150.0 [5.905]                 | 170.0 [6.693]                 |
| ØD           | 104.0 [4.094]                | 116.0 [4.567]                 | 130.0 [5.118]                 | 146.0 [5.748]                 |
| ØG           | 62.0 [2.441]                 | 62.0 [2.441]                  | 72.0 [2.835]                  | 72.0 [2.835]                  |
| DE           | 53°                          | 54°                           | 40°                           | 45°                           |
| DD           | 90.4 [3.559]                 | 109.2 [4.299]                 | 121.0 [4.764]                 | 121.0 [4.772]                 |
| DF           | 71.1 [2.799]                 | 80.9 [3.185]                  | 101.8 [4.008]                 | 98.0 [3.858]                  |
| DG           | 40.7 [1.602]                 | 56.6 [2.228]                  | 63.8 [2.512]                  | 61.5 [2.423]                  |
| DH           | 12.6 [0.496]                 | 11.2 [0.441]                  | 11.2 [0.441]                  | 11.2 [0.441]                  |
| DJ           | 16.2 [0.638]                 | 18.0 [0.709]                  | 20.1 [0.791]                  | 20.0 [0.787]                  |
| DK           | 235.0 [9.252]                | 260.0 [10.236]                | 286.0 [11.260]                | 286.0 [11.260]                |
| DL           | 100.0 [3.937]                | 112.0 [4.409]                 | 125.0 [4.921]                 | 125.0 [4.921]                 |
| DM           | 30.0 [1.181]                 | 30.0 [1.181]                  | 30.0 [1.181]                  | 30.0 [1.181]                  |
| DN           | 17.0 [0.669]                 | 21.0 [0.827]                  | 21.0 [0.827]                  | 21.0 [0.827]                  |
| O-Ring*      | 3.0 x 150.0<br>[0.12 x 5.91] | 3.0 x 179.0<br>[0.12 x 7.047] | 3.0 x 192.0<br>[0.12 x 7.559] | 3.0 x 192.0<br>[0.12 x 7.559] |
| Material Nr. | <b>726927</b>                | <b>502205</b>                 | <b>502206</b>                 | <b>502206</b>                 |

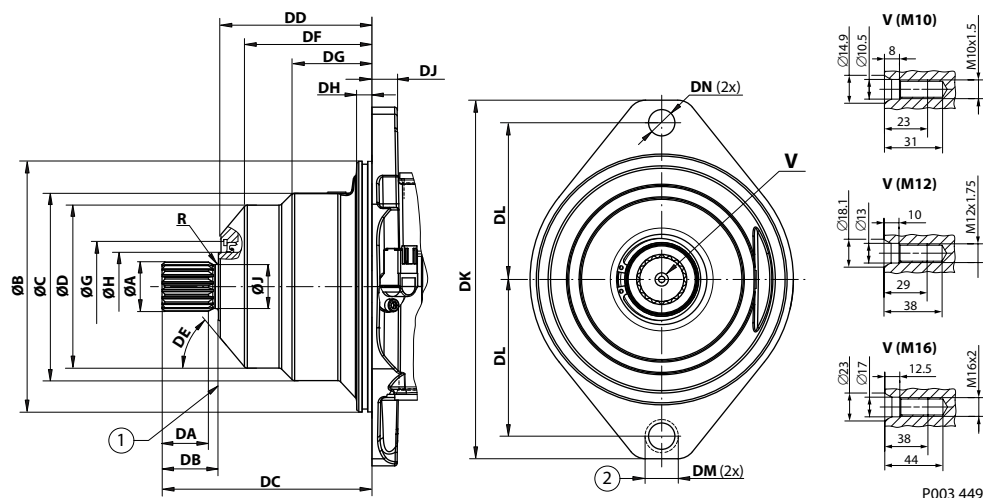
\* O-Ring is not part of the shipment.

Motor installations will vary by application. It is the customer's responsibility to evaluate each application for proper mounting and sealing.



**Flange and housing dimensions**

**Frame size 060 and 080 shaft options**



1. Coupling must not protrude beyond this surface
2. Maximum screw head space other side

*Shaft dimensions for frame sizes 060 and 080, mm [in]*

| Option          | AN/AS                                      | BN/BS          | CN/CS          | GN/GS          | HN/HS          | JN/JS          |
|-----------------|--|----------------|----------------|----------------|----------------|----------------|
| <b>Teeth</b>    | <b>14</b>                                  | <b>21</b>      | <b>23</b>      | <b>14</b>      | <b>16</b>      | <b>18</b>      |
| <b>Pitch-Ø</b>  | 29.633 [1.167]                             | 33.337 [1.312] | 36.513 [1.438] | 28.0 [1.102]   | 32.0 [1.260]   | 36.0 [1.417]   |
| <b>Spline*</b>  | ANSI B92.1-1970 Class 5 flat root side fit |                |                | W30x2x30x14x9g | W35x2x30x16x9g | W40x2x30x18x9g |
| <b>A</b>        | 34.4 [1.315]                               | 34.4 [1.315]   | 37.6 [1.48]    | 29.6 [1.165]   | 34.6 [1.362]   | 39.6 [1.559]   |
| <b>ØH</b>       | 44.5 [1.752]                               | 44.5 [1.752]   | 44.5 [1.752]   | 44.5 [1.752]   | 44.5 [1.752]   | 44.5 [1.752]   |
| <b>ØJ</b>       | 25.8 [1.016]                               | 30.0 [1.181]   | 32.0 [1.260]   | 25.0 [0.984]   | 30.0 [1.181]   | 35.0 [1.378]   |
| <b>DA</b>       | 37.5 [1.476]                               | 37.5 [1.476]   | 37.5 [1.476]   | 27.0 [1.063]   | 32.0 [1.260]   | 37.0 [1.457]   |
| <b>DB</b>       | 47.5 [1.87]                                | 47.5 [1.87]    | 47.5 [1.87]    | 35.0 [1.378]   | 40.0 [1.575]   | 45.0 [1.772]   |
| <b>DC (060)</b> | 139.7 [5.500]                              | 139.7 [5.500]  | —              | 127.2 [5.008]  | 132.2 [5.205]  | —              |
| <b>DC (080)</b> | 157.9 [6.217]                              | 157.9 [6.217]  | 157.9 [6.217]  | —              | 150.4 [5.921]  | 155.4 [6.118]  |
| <b>R</b>        | 3.0 [0.118]                                | 3.0 [0.118]    | 3.0 [0.118]    | 1.6 [0.063]    | 1.6 [0.063]    | 1.6 [0.063]    |
| <b>V</b>        | M10  | M10            | M12            | M10            | M10            | M12            |
| <b>Angle</b>    | Pressure angle 30°                         |                |                |                |                |                |

\* Spline per DIN 5480, side fit.

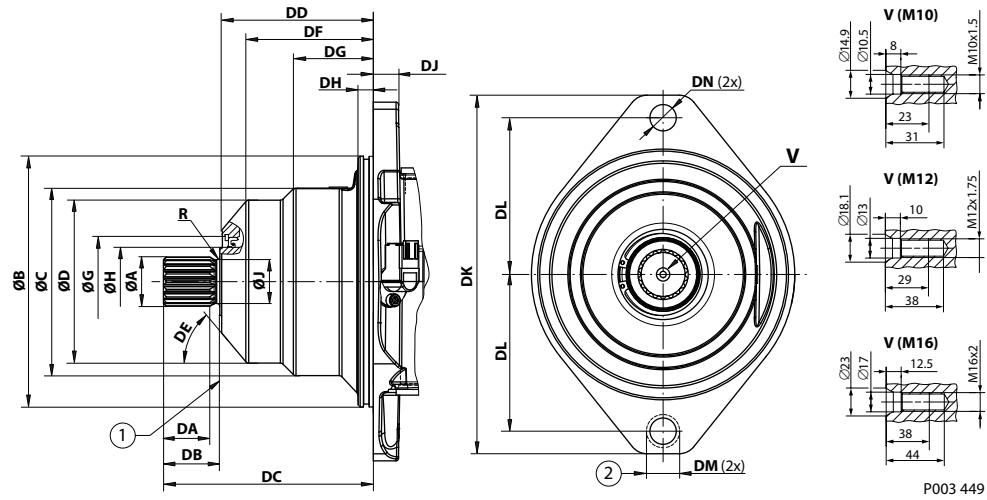
*Shaft options overview for frame sizes 060 and 080*

| Size       | Shaft option |       |       |       |       |       |
|------------|--------------|-------|-------|-------|-------|-------|
|            | AN/AS        | BN/BS | CN/CS | GN/GS | HN/HS | JN/JS |
| <b>060</b> | ●            | ●     | —     | ●     | ●     | —     |
| <b>080</b> | ●            | ●     | ●     | —     | ●     | ●     |

● = available option; — = not available option

**Flange and housing dimensions**

**Frame size 110 and 160 shaft options**



1. Coupling must not protrude beyond this surface
2. Maximum screw head space other side

*Shaft dimensions for frame sizes 110 and 160, mm [in]*

| Option         | DN/DS                                      | EN/ES          | FN/FS          | JN/JS          | KN/KS          | LN/LS          |
|----------------|--|----------------|----------------|----------------|----------------|----------------|
| <b>Teeth</b>   | <b>27</b>                                  | <b>13</b>      | <b>15</b>      | <b>18</b>      | <b>21</b>      | <b>24</b>      |
| <b>Pitch-Ø</b> | 42.862 [1.687]                             | 41.275 [1.625] | 47.625 [1.875] | 36.0 [1.417]   | 42.0 [1.654]   | 48.0 [1.890]   |
| <b>Spline*</b> | ANSI B92.1-1970 Class 5 flat root side fit |                |                | W40x2x30x18x9g | W45x2x30x21x9g | W50x2x30x24x9g |
| <b>ØA</b>      | 44.0 [1.732]                               | 43.6 [1.717]   | 50.0 [1.968]   | 39.6 [1.559]   | 44.6 [1.756]   | 49.6 [1.953]   |
| <b>ØH</b>      | 55.0 [2.165]                               | 55.0 [2.165]   | 55.0 [2.165]   | 55.0 [2.165]   | 55.0 [2.165]   | 55.0 [2.165]   |
| <b>ØJ</b>      | 39.6 [1.559]                               | 36.0 [1.417]   | 42.2 [1.661]   | 35.0 [1.378]   | 40.0 [1.575]   | 45.0 [1.772]   |
| <b>DA</b>      | 55.0 [2.165]                               | 55.0 [2.165]   | 55.0 [2.165]   | 37.0 [1.457]   | 42.0 [1.654]   | 47.0 [1.850]   |
| <b>DB</b>      | 67.0 [2.638]                               | 67.0 [2.638]   | 67.0 [2.638]   | 45.0 [1.772]   | 50.0 [1.968]   | 55.0 [2.165]   |
| <b>DC</b>      | 189.5 [7.461]                              | 189.5 [7.461]  | 189.5 [7.461]  | 167.5 [6.594]  | 172.7 [6.799]  | 177.7 [6.996]  |
| <b>R</b>       | 3.0 [0.118]                                | 3.0 [0.118]    | 3.0 [0.118]    | 2.5 [0.098]    | 2.5 [0.098]    | 2.5 [0.098]    |
| <b>V</b>       | M16  | M12            | M16            | M12            | M16            | M16            |
| <b>Angle</b>   | Pressure angle 30°                         |                |                |                |                |                |

\* Spline per DIN 5480, side fit.

*Shaft options overview for frame sizes 110 and 160*

| Size       | Shaft option |       |       |       |       |       |
|------------|--------------|-------|-------|-------|-------|-------|
|            | DN/DS        | EN/ES | FN/FS | JN/JS | KN/KS | LN/LS |
| <b>110</b> | ●            | ●     | —     | ●     | ●     | —     |
| <b>160</b> | ●            | ●     | ●     | —     | ●     | ●     |

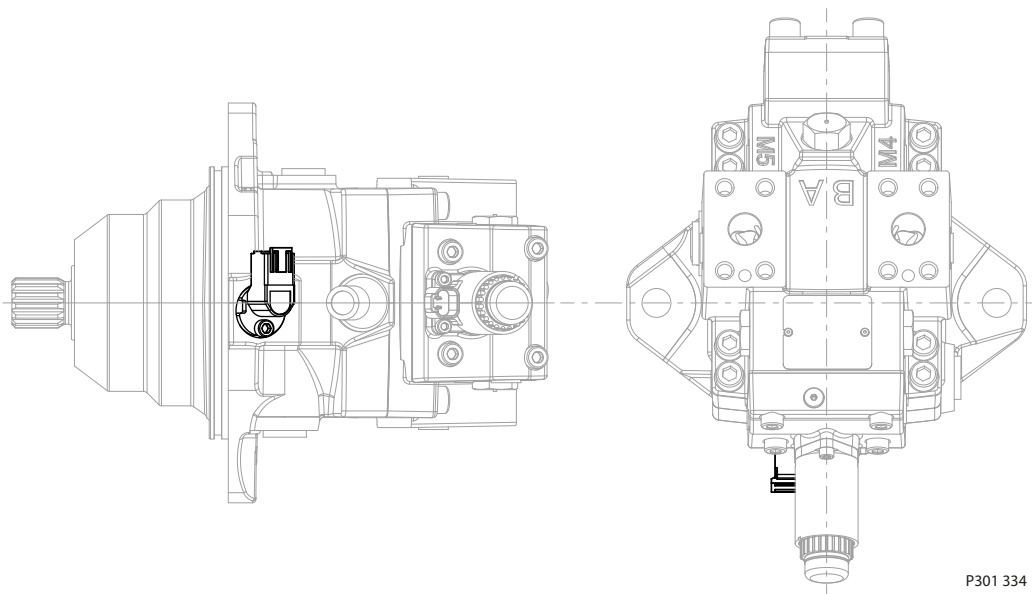
● = available option; — = not available option

**Flange and housing dimensions**

**H1B cartridge motors with speed sensor**

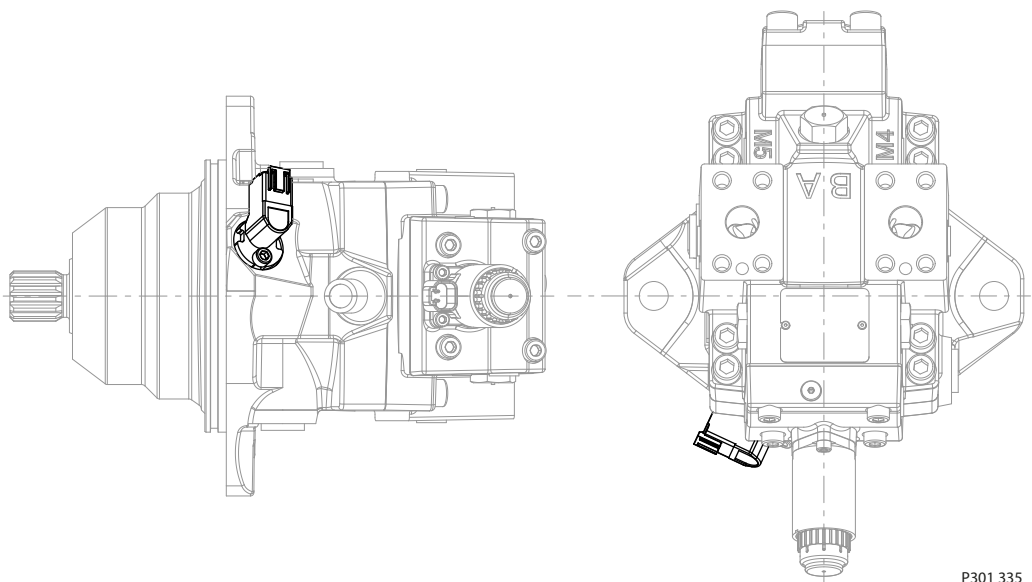
To eliminate potential interference of the speed sensor and some gearbox parking brakeports, we have made/will make a slight modification to the speed sensor location. The speed sensor location is rotated by 25° to eliminate the potential interference.

*Old speed sensor location: 0°*



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*New speed sensor location: rotated by 25°*



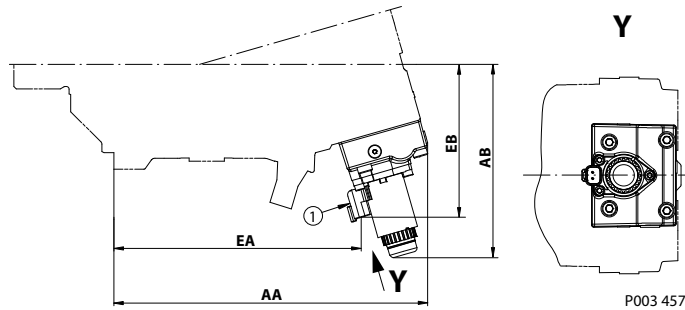
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*Introduction date of H1B cartridge motor with speed sensor rotated by 25°:*

- Size 060 – May 15, 2011
- Size 080 – August 1, 2011
- Size 110 – June 1, 2011
- Size 160 – March 30, 2011

**Control dimensions**

**Options L1BA and L2BA (Electric proportional control)**



1. Connector: DEUTSCH DT04-2P

SAE mounting flange per ISO 3019/1 dimensions (mm [in])

|           | Size 060<br>SAE 127-4 | Size 080<br>SAE 127-4 | Size 110<br>SAE 152-4 | Size 160<br>SAE 152-4 | Size 210<br>SAE 165-4 | Size 250<br>SAE 165-4 |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| <b>AA</b> | 272.3 [10.72]         | 289.9 [11.41]         | 316.4 [12.46]         | 343.8 [13.53]         | 368.4 [14.5]          | 387.0 [15.24]         |
| <b>AB</b> | 164.7 [6.48]          | 170.6 [6.72]          | 175.0 [6.89]          | 183.8 [7.24]          | 190.9 [7.52]          | 197.0 [7.76]          |
| <b>EA</b> | 212.2 [8.35]          | 229.8 [9.05]          | 256.3 [10.09]         | 283.5 [11.16]         | 309.2 [12.17]         | 327.0 [12.87]         |
| <b>EB</b> | 128.1 [5.04]          | 134.0 [5.28]          | 138.4 [5.45]          | 147.1 [5.79]          | 153.9 [6.06]          | 160.0 [6.30]          |

DIN B4 HL mounting flange per ISO 3019/2 dimensions, (mm [in])

|           | Size 060 – DIN 125 | Size 080 – DIN 140 | Size 110 – DIN 160 | Size 160 – DIN 180 | Size 210 – DIN 200 |
|-----------|--------------------|--------------------|--------------------|--------------------|--------------------|
| <b>AA</b> | 247.8 [9.76]       | 265.9 [10.47]      | 283.9 [11.18]      | 311.7 [12.27]      | 336.6 [13.25]      |
| <b>AB</b> | 164.7 [6.48]       | 170.6 [6.72]       | 175.0 [6.89]       | 183.8 [7.24]       | 190.9 [7.52]       |
| <b>EA</b> | 187.7 [7.39]       | 205.8 [8.10]       | 223.8 [8.81]       | 251.6 [9.91]       | 277.2 [10.91]      |
| <b>EB</b> | 128.1 [5.04]       | 134.0 [5.28]       | 138.4 [5.45]       | 147.1 [5.79]       | 153.9 [6.06]       |

Size 250 is not available.

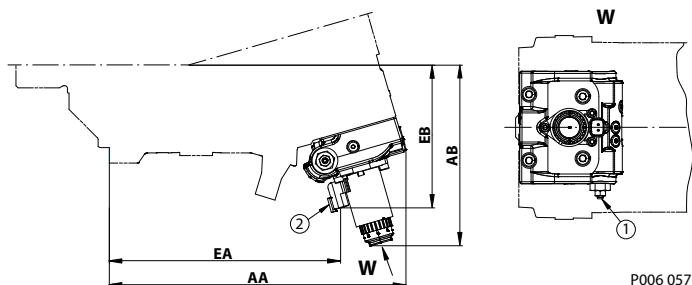
Cartridge mounting flange dimensions (mm [in])

|           | Size 060<br>Cartridge 160 | Size 080<br>Cartridge 190 | Size 110<br>Cartridge 200 | Size 160<br>Cartridge 200 |
|-----------|---------------------------|---------------------------|---------------------------|---------------------------|
| <b>AA</b> | 188.1 [7.41]              | 187.5 [7.38]              | 201.9 [7.95]              | 229.3 [9.03]              |
| <b>AB</b> | 164.7 [6.48]              | 170.6 [6.72]              | 175.0 [6.89]              | 183.8 [7.24]              |
| <b>EA</b> | 128.0 [5.04]              | 127.4 [5.02]              | 141.8 [5.58]              | 169.2 [6.66]              |
| <b>EB</b> | 128.1 [5.04]              | 134.0 [5.28]              | 138.4 [5.45]              | 147.1 [5.79]              |

Size 210 and 250 are not available.

## Control dimensions

### Option D\*MA (Electric proportional control)



1. PCOR adjustment
2. Connector: DEUTSCH DT04-2P

SAE mounting flange per ISO 3019/1 dimensions (mm [in])

|           | Size 060<br>SAE 127-4 | Size 080<br>SAE 127-4 | Size 110<br>SAE 152-4 | Size 160<br>SAE 152-4 | Size 210<br>SAE 165-4 | Size 250<br>SAE 165-4 |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| <b>AA</b> | 275.6 [10.85]         | 293.2 [11.54]         | 319.7 [12.59]         | 346.7 [13.65]         | 371.6 [14.63]         | 390.0 [15.35]         |
| <b>AB</b> | 164.7 [6.48]          | 170.6 [6.72]          | 175.0 [6.89]          | 183.8 [7.24]          | 190.9 [7.52]          | 197.0 [7.76]          |
| <b>EA</b> | 212.2 [8.35]          | 230.0 [9.05]          | 256.3 [10.09]         | 283.5 [11.16]         | 309.2 [12.17]         | 327.0 [12.87]         |
| <b>EB</b> | 128.1 [5.04]          | 134.0 [5.28]          | 138.4 [5.45]          | 147.1 [5.79]          | 153.9 [6.06]          | 160.0 [6.30]          |

DIN B4 HL mounting flange per ISO 3019/2 dimensions, (mm [in])

|           | Size 060 – DIN 125 | Size 080 – DIN 140 | Size 110 – DIN 160 | Size 160 – DIN 180 | Size 210 – DIN 200 |
|-----------|--------------------|--------------------|--------------------|--------------------|--------------------|
| <b>AA</b> | 251.1 [9.89]       | 269.2 [10.60]      | 287.2 [11.31]      | 314.8 [12.39]      | 339.6 [13.37]      |
| <b>AB</b> | 164.7 [6.48]       | 170.6 [6.72]       | 175.0 [6.89]       | 183.8 [7.24]       | 190.9 [7.52]       |
| <b>EA</b> | 187.7 [7.39]       | 205.8 [8.10]       | 223.8 [8.81]       | 251.6 [9.91]       | 277.2 [10.91]      |
| <b>EB</b> | 128.1 [5.04]       | 134.0 [5.28]       | 138.4 [5.45]       | 147.1 [5.79]       | 153.9 [6.06]       |

Size 250 is not available.

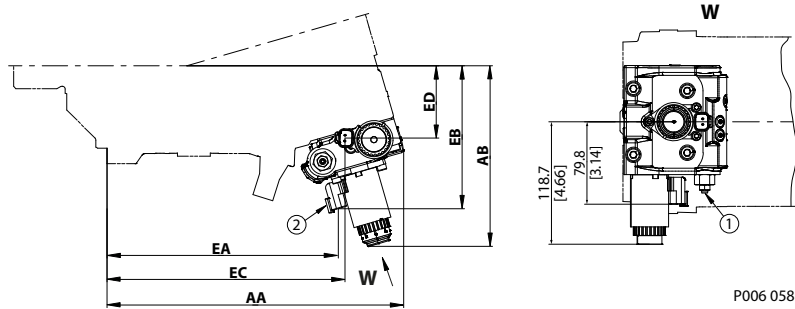
Cartridge mounting flange dimensions (mm [in])

|           | Size 060<br>Cartridge 160 | Size 080<br>Cartridge 190 | Size 110<br>Cartridge 200 | Size 160<br>Cartridge 200 |
|-----------|---------------------------|---------------------------|---------------------------|---------------------------|
| <b>AA</b> | 191.4 [7.54]              | 190.8 [7.51]              | 205.2 [8.08]              | 232.4 [9.15]              |
| <b>AB</b> | 164.7 [6.48]              | 170.6 [6.72]              | 175.0 [6.89]              | 183.8 [7.24]              |
| <b>EA</b> | 128.0 [5.03]              | 127.4 [5.02]              | 141.8 [5.58]              | 169.2 [6.66]              |
| <b>EB</b> | 128.1 [5.04]              | 134.0 [5.28]              | 138.4 [5.45]              | 147.1 [5.79]              |

Size 210 and 250 are not available.

**Control dimensions**

**Option D\*M\* (Electric proportional control)**



1. PCOR adjustment
2. Connector: DEUTSCH DT04-2P

*SAE mounting flange per ISO 3019/1 dimensions (mm [in])*

|           | <b>Size 060<br/>SAE 127-4</b> | <b>Size 080<br/>SAE 127-4</b> | <b>Size 110<br/>SAE 152-4</b> | <b>Size 160<br/>SAE 152-4</b> | <b>Size 210<br/>SAE 165-4</b> | <b>Size 250<br/>SAE 165-4</b> |
|-----------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| <b>AA</b> | 275.6 [10.85]                 | 293.2 [11.54]                 | 319.7 [12.59]                 | 346.7 [13.65]                 | 371.6 [14.63]                 | 390.0 [15.35]                 |
| <b>AB</b> | 164.7 [6.48]                  | 170.6 [6.72]                  | 175.0 [6.89]                  | 183.8 [7.24]                  | 190.9 [7.52]                  | 197.0 [7.76]                  |
| <b>EA</b> | 212.2 [8.35]                  | 230.0 [9.05]                  | 256.3 [10.09]                 | 283.5 [11.16]                 | 309.2 [12.17]                 | 327.0 [12.87]                 |
| <b>EB</b> | 128.1 [5.04]                  | 134.0 [5.28]                  | 138.4 [5.45]                  | 147.1 [5.79]                  | 153.9 [6.06]                  | 160.0 [6.30]                  |
| <b>EC</b> | 218.6 [8.61]                  | 236.3 [9.30]                  | 262.8 [10.35]                 | 290.0 [11.42]                 | 314.7 [12.39]                 | 333.0 [13.11]                 |
| <b>ED</b> | 59.8 [2.35]                   | 65.7 [2.59]                   | 70.1 [2.76]                   | 78.8 [3.10]                   | 86.9 [3.42]                   | 92.0 [3.62]                   |

*DIN B4 HL mounting flange per ISO 3019/2 dimensions, (mm [in])*

|           | <b>Size 060 – DIN 125</b> | <b>Size 080 – DIN 140</b> | <b>Size 110 – DIN 160</b> | <b>Size 160 – DIN 180</b> | <b>Size 210 – DIN 200</b> |
|-----------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| <b>AA</b> | 251.1 [9.89]              | 269.2 [10.60]             | 287.2 [11.31]             | 314.8 [12.39]             | 339.6 [13.37]             |
| <b>AB</b> | 164.7 [6.48]              | 170.6 [6.72]              | 175.0 [6.89]              | 183.8 [7.24]              | 190.9 [7.52]              |
| <b>EA</b> | 187.7 [7.39]              | 205.8 [8.10]              | 223.8 [8.81]              | 251.6 [9.91]              | 277.2 [10.91]             |
| <b>EB</b> | 128.1 [5.04]              | 134.0 [5.28]              | 138.4 [5.45]              | 147.1 [5.79]              | 153.9 [6.06]              |
| <b>EC</b> | 194.1 [7.64]              | 212.3 [8.36]              | 230.3 [9.07]              | 258.1 [10.16]             | 282.7 [11.13]             |
| <b>ED</b> | 59.8 [2.35]               | 65.7 [2.59]               | 70.1 [2.76]               | 78.8 [3.10]               | 86.9 [3.42]               |

Size 250 is not available.

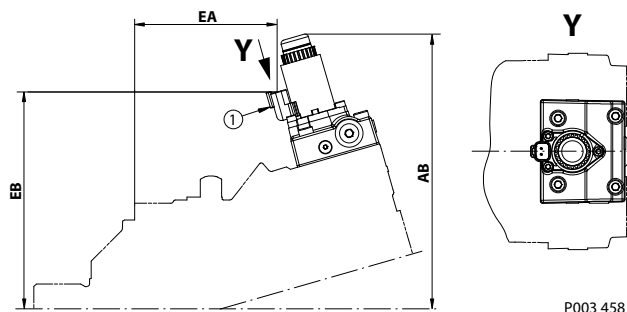
*Cartridge mounting flange dimensions (mm [in])*

|           | <b>Size 060<br/>Cartridge 160</b> | <b>Size 080<br/>Cartridge 190</b> | <b>Size 110<br/>Cartridge 200</b> | <b>Size 160<br/>Cartridge 200</b> |
|-----------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| <b>AA</b> | 191.4 [7.54]                      | 190.8 [7.51]                      | 205.2 [8.08]                      | 232.4 [9.15]                      |
| <b>AB</b> | 164.7 [6.48]                      | 170.6 [6.72]                      | 175.0 [6.89]                      | 183.8 [7.24]                      |
| <b>EA</b> | 128.0 [5.03]                      | 127.4 [5.02]                      | 141.8 [5.58]                      | 169.2 [6.66]                      |
| <b>EB</b> | 128.1 [5.04]                      | 134.0 [5.28]                      | 138.4 [5.45]                      | 147.1 [5.79]                      |
| <b>EC</b> | 134.4 [5.29]                      | 133.9 [5.27]                      | 148.3 [5.84]                      | 175.7 [6.92]                      |
| <b>ED</b> | 59.8 [2.35]                       | 65.7 [2.59]                       | 70.1 [2.76]                       | 78.8 [3.10]                       |

Size 210 and 250 are not available.

## Control dimensions

### Options M1CA and M2CA (Electric proportional control)



1. Connector: DEUTSCH DT04-2P

### H1 B Dimensions reused tables

SAE mounting flange per ISO 3019/1 dimensions (mm [in])

|           | Size 060<br>SAE 127-4 | Size 080<br>SAE 127-4 | Size 110<br>SAE 152-4 | Size 160<br>SAE 152-4 | Size 210<br>SAE 165-4 | Size 250<br>SAE 165-4 |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| <b>AB</b> | 224.2 [8.83]          | 235.7 [9.28]          | 247.2 [9.73]          | 265.0 [10.43]         | 279.4 [11]            | 290.0 [11.42]         |
| <b>EA</b> | 126.1 [4.96]          | 138.8 [5.46]          | 160.7 [6.33]          | 180.4 [7.10]          | 199.9 [7.87]          | 213.0 [8.39]          |
| <b>EB</b> | 172.2 [6.78]          | 183.6 [7.23]          | 195.1 [7.68]          | 212.8 [8.38]          | 227.5 [8.96]          | 238.0 [9.37]          |

DIN B4 HL mounting flange per ISO 3019/2 dimensions, (mm [in])

|           | Size 060 – DIN 125 | Size 080 – DIN 140 | Size 110 – DIN 160 | Size 160 – DIN 180 | Size 210 – DIN 200 |
|-----------|--------------------|--------------------|--------------------|--------------------|--------------------|
| <b>AB</b> | 224.2 [8.83]       | 235.7 [9.28]       | 247.2 [9.73]       | 265.0 [10.43]      | 279.4 [11]         |
| <b>EA</b> | 101.6 [4.0]        | 114.8 [4.52]       | 128.2 [5.05]       | 148.5 [5.85]       | 167.9 [6.61]       |
| <b>EB</b> | 172.2 [6.78]       | 183.6 [7.23]       | 195.1 [7.68]       | 212.8 [8.38]       | 227.5 [8.96]       |

Size 250 is not available.

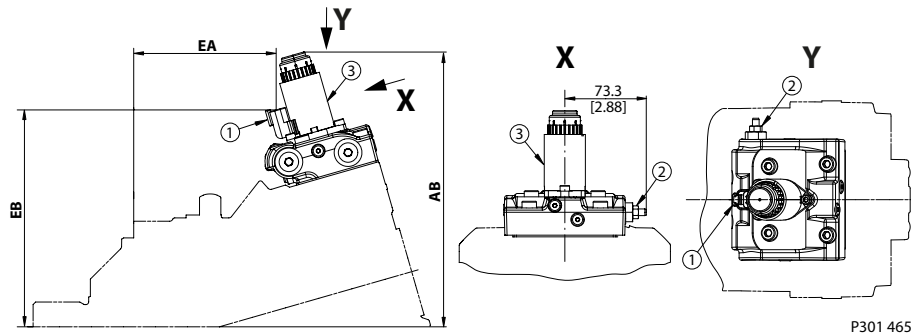
Cartridge mounting flange dimensions (mm [in])

|           | Size 060<br>Cartridge 160 | Size 080<br>Cartridge 190 | Size 110<br>Cartridge 200 | Size 160<br>Cartridge 200 |
|-----------|---------------------------|---------------------------|---------------------------|---------------------------|
| <b>AB</b> | 224.2 [8.83]              | 235.7 [9.28]              | 247.2 [9.73]              | 265.0 [10.43]             |
| <b>EA</b> | 41.9 [1.65]               | 36.4 [1.43]               | 46.2 [1.82]               | 66.1 [2.60]               |
| <b>EB</b> | 172.2 [6.78]              | 183.6 [7.23]              | 195.1 [7.68]              | 212.8 [8.38]              |

Size 210 and 250 are not available.

**Control dimensions**

**Option K\*KA (Electric proportional control)**



1. Connector: DEUTSCH DT04-2P
2. PCOR adjustment
3. Electric proportional solenoid

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**H1 B Dimensions reused tables**

*SAE mounting flange per ISO 3019/1 dimensions (mm [in])*

|           | <b>Size 060</b><br><b>SAE 127-4</b> | <b>Size 080</b><br><b>SAE 127-4</b> | <b>Size 110</b><br><b>SAE 152-4</b> | <b>Size 160</b><br><b>SAE 152-4</b> | <b>Size 210</b><br><b>SAE 165-4</b> | <b>Size 250</b><br><b>SAE 165-4</b> |
|-----------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| <b>AB</b> | 224.2 [8.83]                        | 235.7 [9.28]                        | 247.2 [9.73]                        | 265.0 [10.43]                       | 279.4 [11]                          | 290.0 [11.42]                       |
| <b>EA</b> | 126.1 [4.96]                        | 138.8 [5.46]                        | 160.7 [6.33]                        | 180.4 [7.10]                        | 199.9 [7.87]                        | 213.0 [8.39]                        |
| <b>EB</b> | 172.2 [6.78]                        | 183.6 [7.23]                        | 195.1 [7.68]                        | 212.8 [8.38]                        | 227.5 [8.96]                        | 238.0 [9.37]                        |

*DIN B4 HL mounting flange per ISO 3019/2 dimensions, (mm [in])*

|           | <b>Size 060 – DIN 125</b> | <b>Size 080 – DIN 140</b> | <b>Size 110 – DIN 160</b> | <b>Size 160 – DIN 180</b> | <b>Size 210 – DIN 200</b> |
|-----------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| <b>AB</b> | 224.2 [8.83]              | 235.7 [9.28]              | 247.2 [9.73]              | 265.0 [10.43]             | 279.4 [11]                |
| <b>EA</b> | 101.6 [4.0]               | 114.8 [4.52]              | 128.2 [5.05]              | 148.5 [5.85]              | 167.9 [6.61]              |
| <b>EB</b> | 172.2 [6.78]              | 183.6 [7.23]              | 195.1 [7.68]              | 212.8 [8.38]              | 227.5 [8.96]              |

Size 250 is not available.

*Cartridge mounting flange dimensions (mm [in])*

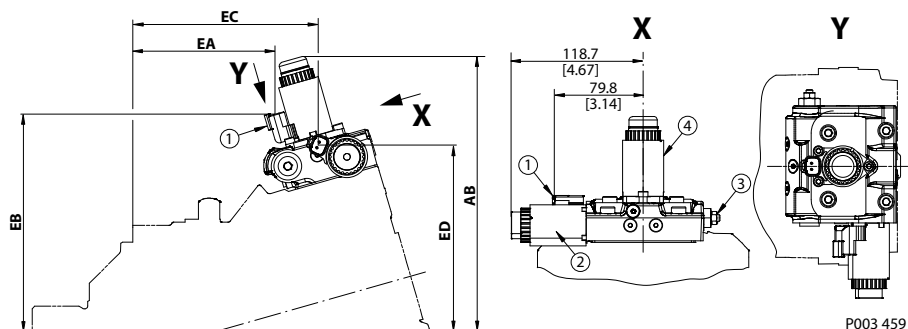
|           | <b>Size 060</b><br><b>Cartridge 160</b> | <b>Size 080</b><br><b>Cartridge 190</b> | <b>Size 110</b><br><b>Cartridge 200</b> | <b>Size 160</b><br><b>Cartridge 200</b> |
|-----------|---|---|---|---|
| <b>AB</b> | 224.2 [8.83]                            | 235.7 [9.28]                            | 247.2 [9.73]                            | 265.0 [10.43]                           |
| <b>EA</b> | 41.9 [1.65]                             | 36.4 [1.43]                             | 46.2 [1.82]                             | 66.1 [2.60]                             |
| <b>EB</b> | 172.2 [6.78]                            | 183.6 [7.23]                            | 195.1 [7.68]                            | 212.8 [8.38]                            |

Size 210 and 250 are not available.



**Control dimensions**

**Options K1K1 and K2K2 (Electric proportional control with PCOR and BPD)**



1. Connector: DEUTSCH DT04-2P
2. BPD solenoid
3. PCOR adjustment
4. Proportional solenoid

SAE mounting flange per ISO 3019/1 dimensions (mm [in])

|           | Size 060<br>SAE 127-4 | Size 080<br>SAE 127-4 | Size 110<br>SAE 152-4 | Size 160<br>SAE 152-4 | Size 210<br>SAE 165-4 | Size 250<br>SAE 165-4 |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| <b>AB</b> | 224.2 [8.83]          | 235.7 [9.28]          | 247.2 [9.73]          | 265.0 [10.43]         | 279.4 [11]            | 290.0 [11.42]         |
| <b>EA</b> | 126.1 [4.96]          | 138.8 [5.46]          | 160.7 [6.33]          | 180.4 [7.10]          | 199.9 [7.87]          | 213.0 [8.39]          |
| <b>EB</b> | 172.2 [6.78]          | 183.6 [7.23]          | 195.1 [7.68]          | 212.8 [8.38]          | 227.5 [8.96]          | 238.0 [9.37]          |
| <b>EC</b> | 164.8 [6.49]          | 177.4 [6.98]          | 199.4 [7.85]          | 219.0 [8.62]          | 238 [9.37]            | 251.0 [9.88]          |
| <b>ED</b> | 144.5 [5.69]          | 156.0 [6.14]          | 167.5 [6.59]          | 185.1 [7.29]          | 200.6 [7.9]           | 210.0 [8.27]          |

DIN B4 HL mounting flange per ISO 3019/2 dimensions, (mm [in])

|           | Size 060 – DIN 125 | Size 080 – DIN 140 | Size 110 – DIN 160 | Size 160 – DIN 180 | Size 210 – DIN 200 |
|-----------|--------------------|--------------------|--------------------|--------------------|--------------------|
| <b>AB</b> | 224.2 [8.83]       | 235.7 [9.28]       | 247.2 [9.73]       | 265.0 [10.43]      | 279.4 [11]         |
| <b>EA</b> | 101.6 [4.0]        | 114.8 [4.52]       | 128.2 [5.05]       | 148.5 [5.85]       | 167.9 [6.61]       |
| <b>EB</b> | 172.2 [6.78]       | 183.6 [7.23]       | 195.1 [7.68]       | 212.8 [8.38]       | 227.5 [8.96]       |
| <b>EC</b> | 140.3 [5.52]       | 153.4 [6.04]       | 166.9 [6.57]       | 187.1 [7.37]       | 206.0 [8.11]       |
| <b>ED</b> | 144.5 [5.69]       | 156.0 [6.14]       | 167.5 [6.59]       | 185.1 [7.29]       | 200.6 [7.9]        |

Size 250 is not available.

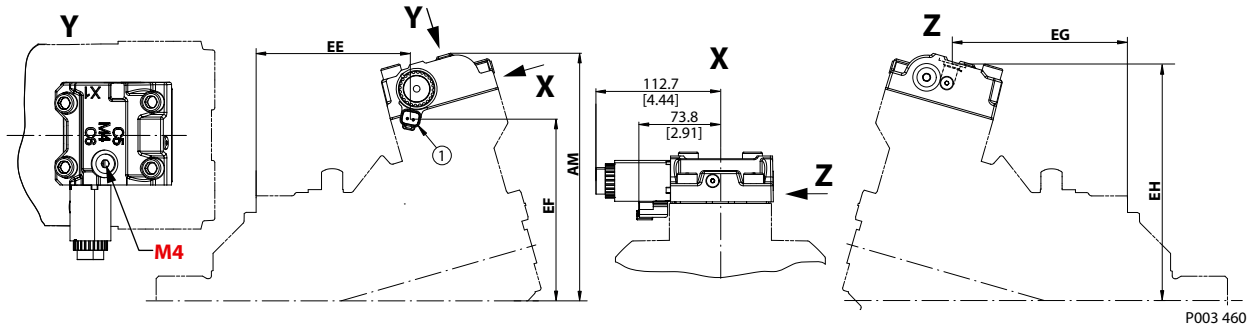
Cartridge mounting flange dimensions (mm [in])

|           | Size 060<br>Cartridge 160 | Size 080<br>Cartridge 190 | Size 110<br>Cartridge 200 | Size 160<br>Cartridge 200 |
|-----------|---------------------------|---------------------------|---------------------------|---------------------------|
| <b>AB</b> | 224.2 [8.83]              | 235.7 [9.28]              | 247.2 [9.73]              | 265.0 [10.43]             |
| <b>EA</b> | 41.9 [1.65]               | 36.4 [1.43]               | 46.2 [1.82]               | 66.1 [2.60]               |
| <b>EB</b> | 172.2 [6.78]              | 183.6 [7.23]              | 195.1 [7.68]              | 212.8 [8.38]              |
| <b>EC</b> | 80.6 [3.17]               | 75.0 [2.95]               | 84.9 [3.34]               | 104.7 [4.12]              |
| <b>ED</b> | 144.5 [5.69]              | 156.0 [6.14]              | 167.5 [6.59]              | 185.1 [7.29]              |

Size 210 and 250 are not available.

**Control dimensions**

**Options E1AA and E2AA (Electric two-position control)**



**M4** Servo gauge port: ISO 11926-1 SAE 9/16 -18UNF-2B or ISO6149 M14 x 1.5; Ø25.0 [0.98] max. clearance DIA for fitting

**1** Electric two-position control

*SAE mounting flange per ISO 3019/1 dimensions (mm [in])*

|           | <b>Size 060<br/>SAE 127-4</b> | <b>Size 080<br/>SAE 127-4</b> | <b>Size 110<br/>SAE 152-4</b> | <b>Size 160<br/>SAE 152-4</b> | <b>Size 210<br/>SAE 165-4</b> | <b>Size 250<br/>SAE 165-4</b> |
|-----------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| <b>AM</b> | 193.6 [7.62]                  | 206.6 [8.13]                  | 224.1 [8.82]                  | 224.1 [8.82]                  | 257.7 [10.15]                 | 267.0 [10.51]                 |
| <b>EE</b> | 139.8 [5.50]                  | 149.7 [5.89]                  | 172.1 [6.78]                  | 191.3 [7.53]                  | 210.1 [8.27]                  | 225.0 [8.86]                  |
| <b>EF</b> | 133.9 [5.27]                  | 146.9 [5.78]                  | 164.4 [6.47]                  | 182.9 [7.20]                  | 198.3 [7.81]                  | 208.0 [8.19]                  |
| <b>EG</b> | 158.8 [6.25]                  | 168.8 [6.65]                  | 191.1 [7.52]                  | 210.4 [8.28]                  | 230.2 [9.06]                  | 244.0 [9.61]                  |
| <b>EH</b> | 184.0 [7.24]                  | 196.9 [7.75]                  | 214.4 [8.44]                  | 214.4 [8.44]                  | 210.1 [8.27]                  | 258.0 [10.16]                 |

*DIN B4 HL mounting flange per ISO 3019/2 dimensions, (mm [in])*

|           | <b>Size 060 – DIN 125</b> | <b>Size 080 – DIN 140</b> | <b>Size 110 – DIN 160</b> | <b>Size 160 – DIN 180</b> | <b>Size 210 – DIN 200</b> |
|-----------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| <b>AM</b> | 193.6 [7.62]              | 206.6 [8.13]              | 224.1 [8.82]              | 224.1 [8.82]              | 257.7 [10.15]             |
| <b>EE</b> | 115.3 [4.54]              | 125.7 [4.95]              | 139.6 [5.50]              | 159.4 [6.28]              | 178.1 [7.01]              |
| <b>EF</b> | 133.9 [5.27]              | 146.9 [5.78]              | 164.4 [6.47]              | 182.9 [7.20]              | 198.3 [7.81]              |
| <b>EG</b> | 134.3 [5.29]              | 144.8 [5.70]              | 158.6 [6.24]              | 178.5 [7.03]              | 198.2 [7.8]               |
| <b>EH</b> | 184.0 [7.24]              | 196.9 [7.75]              | 214.4 [8.44]              | 214.4 [8.44]              | 178.1 [7.01]              |

Size 250 is not available.

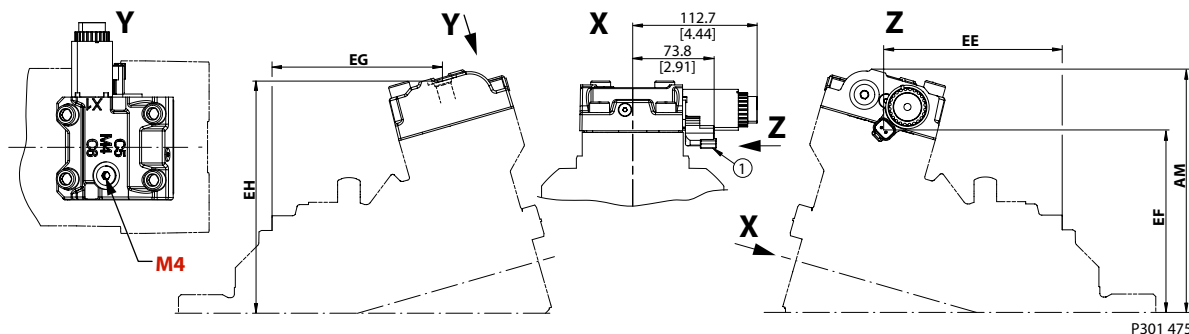
*Cartridge mounting flange dimensions (mm [in])*

|           | <b>Size 060<br/>Cartridge 160</b> | <b>Size 080<br/>Cartridge 190</b> | <b>Size 110<br/>Cartridge 200</b> | <b>Size 160<br/>Cartridge 200</b> |
|-----------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| <b>AM</b> | 193.6 [7.62]                      | 206.6 [8.13]                      | 224.1 [8.82]                      | 224.1 [8.82]                      |
| <b>EE</b> | 55.6 [2.19]                       | 47.3 [1.86]                       | 57.6 [2.27]                       | 77.0 [3.03]                       |
| <b>EF</b> | 133.9 [5.27]                      | 146.9 [5.78]                      | 164.4 [6.47]                      | 182.9 [7.20]                      |
| <b>EG</b> | 74.6 [2.94]                       | 66.4 [2.61]                       | 76.6 [3.02]                       | 96.1 [3.78]                       |
| <b>EH</b> | 184.0 [7.24]                      | 196.9 [7.75]                      | 214.4 [8.44]                      | 214.4 [8.44]                      |

Size 210 and 250 are not available.

**Control dimensions**

**Options F1EA and F2EA (Electric two-position control)**



**M4** Servo gauge port: ISO 11926-1 SAE 9/16 -18UNF-2B or ISO6149 M14 x 1.5; Ø25.0 [0.98] max. clearance DIA for fitting

**1** Connector: DEUTSCH DT04-2P

SAE mounting flange per ISO 3019/1 dimensions (mm [in])

|           | Size 060<br>SAE 127-4 | Size 080<br>SAE 127-4 | Size 110<br>SAE 152-4 | Size 160<br>SAE 152-4 | Size 210<br>SAE 165-4 | Size 250<br>SAE 165-4 |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| <b>AM</b> | 193.6 [7.62]          | 206.6 [8.13]          | 224.1 [8.82]          | 242.5 [9.55]          | 257.7 [10.15]         | 267.3 [10.53]         |
| <b>EE</b> | 165.7 [6.55]          | 175.8 [6.92]          | 198.0 [7.80]          | 217.3 [8.56]          | 237.1 [9.33]          | 250.8 [9.87]          |
| <b>EF</b> | 141.9 [5.59]          | 154.9 [6.10]          | 172.4 [6.79]          | 190.9 [7.52]          | 206.1 [8.11]          | 215.7 [8.49]          |
| <b>EG</b> | 158.8 [6.25]          | 168.8 [6.65]          | 191.1 [7.52]          | 210.4 [8.28]          | 230.2 [9.06]          | 243.9 [9.60]          |
| <b>EH</b> | 184.0 [7.24]          | 196.9 [7.75]          | 214.4 [8.44]          | 232.9 [9.17]          | 248.1 [9.77]          | 257.7 [10.15]         |

DIN B4 HL mounting flange per ISO 3019/2 dimensions, (mm [in])

|           | Size 060 – DIN 125 | Size 080 – DIN 140 | Size 110 – DIN 160 | Size 160 – DIN 180 | Size 210 – DIN 200 |
|-----------|--------------------|--------------------|--------------------|--------------------|--------------------|
| <b>AM</b> | 193.6 [7.62]       | 206.6 [8.13]       | 224.1 [8.82]       | 242.5 [9.55]       | 257.7 [10.15]      |
| <b>EE</b> | 141.2 [5.56]       | 151.7 [5.97]       | 165.5 [6.52]       | 185.4 [7.30]       | 205.1 [8.07]       |
| <b>EF</b> | 141.9 [5.59]       | 154.9 [6.10]       | 172.4 [6.79]       | 190.9 [7.52]       | 206.1 [8.11]       |
| <b>EG</b> | 134.3 [5.29]       | 144.8 [5.70]       | 158.6 [6.24]       | 178.5 [7.03]       | 198.2 [7.8]        |
| <b>EH</b> | 184.0 [7.24]       | 196.9 [7.75]       | 214.4 [8.44]       | 232.9 [9.17]       | 248.1 [9.77]       |

Size 250 is not available.

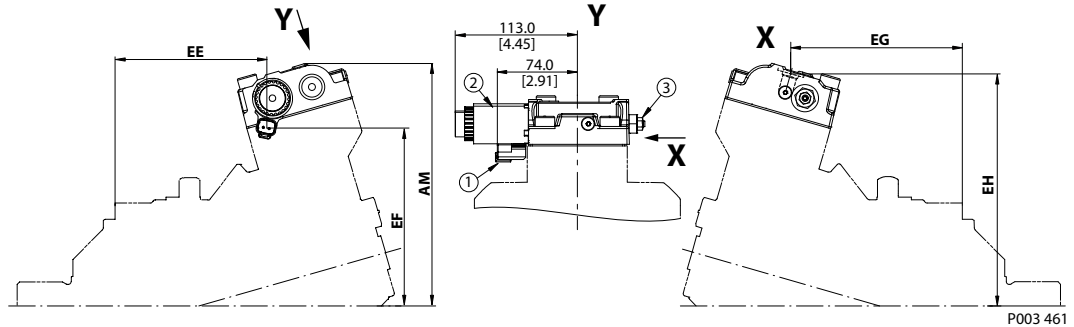
Cartridge mounting flange dimensions (mm [in])

|           | Size 060<br>Cartridge 160 | Size 080<br>Cartridge 190 | Size 110<br>Cartridge 200 | Size 160<br>Cartridge 200 |
|-----------|---------------------------|---------------------------|---------------------------|---------------------------|
| <b>AM</b> | 193.6 [7.62]              | 206.6 [8.13]              | 224.1 [8.82]              | 242.5 [9.55]              |
| <b>EE</b> | 81.5 [2.19]               | 73.3 [2.89]               | 83.5 [3.29]               | 103.0 [4.06]              |
| <b>EF</b> | 141.9 [5.59]              | 154.9 [6.10]              | 172.4 [6.79]              | 190.9 [7.52]              |
| <b>EG</b> | 74.6 [2.94]               | 66.4 [2.61]               | 76.6 [3.02]               | 96.1 [3.78]               |
| <b>EH</b> | 184.0 [7.24]              | 196.9 [7.75]              | 214.4 [8.44]              | 232.9 [9.17]              |

Size 210 and 250 are not available.

**Control dimensions**

**Options T1DA, T2DA and P1DA, P2DA (Electric two-position controls with PCOR and electric proportional PPCOR)**



1. Connector: DEUTSCH DT04-2P
2. Two-position solenoid "T" or Proportional PCOR "P"
3. PCOR adjustment

SAE mounting flange per ISO 3019/1 dimensions (mm [in])

|           | Size 060<br>SAE 127-4 | Size 080<br>SAE 127-4 | Size 110<br>SAE 152-4 | Size 160<br>SAE 152-4 | Size 210<br>SAE 165-4 | Size 250<br>SAE 165-4 |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| <b>AM</b> | 193.6 [7.62]          | 206.6 [8.13]          | 224.1 [8.82]          | 242.5 [9.55]          | 257.7 [10.15]         | 267.3 [10.53]         |
| <b>EE</b> | 139.8 [5.50]          | 149.7 [5.89]          | 172.1 [6.78]          | 191.3 [7.53]          | 210.1 [8.27]          | 225.0 [8.86]          |
| <b>EF</b> | 133.9 [5.27]          | 146.9 [5.78]          | 164.4 [6.47]          | 182.9 [7.20]          | 198.3 [7.81]          | 208.0 [8.19]          |
| <b>EG</b> | 158.8 [6.25]          | 168.8 [6.65]          | 191.1 [7.52]          | 210.4 [8.28]          | 230.2 [9.06]          | 244.0 [9.61]          |
| <b>EH</b> | 183.9 [6.71]          | 196.9 [7.75]          | 214.4 [8.44]          | 232.9 [9.17]          | 248.1 [9.77]          | 258.0 [10.16]         |

DIN B4 HL mounting flange per ISO 3019/2 dimensions, (mm [in])

|           | Size 060 – DIN 125 | Size 080 – DIN 140 | Size 110 – DIN 160 | Size 160 – DIN 180 | Size 210 – DIN 200 |
|-----------|--------------------|--------------------|--------------------|--------------------|--------------------|
| <b>AM</b> | 193.6 [7.62]       | 206.6 [8.13]       | 224.1 [8.82]       | 242.5 [9.55]       | 257.7 [10.15]      |
| <b>EE</b> | 115.3 [4.54]       | 125.7 [4.95]       | 139.6 [5.50]       | 159.4 [6.28]       | 178.1 [7.01]       |
| <b>EF</b> | 133.9 [5.27]       | 146.9 [5.78]       | 164.4 [6.47]       | 182.9 [7.20]       | 198.3 [7.81]       |
| <b>EG</b> | 134.3 [5.29]       | 144.8 [5.70]       | 158.6 [6.24]       | 178.5 [7.03]       | 198.2 [7.8]        |
| <b>EH</b> | 183.9 [6.71]       | 196.9 [7.75]       | 214.4 [8.44]       | 232.9 [9.17]       | 248.1 [9.77]       |

Size 250 is not available.

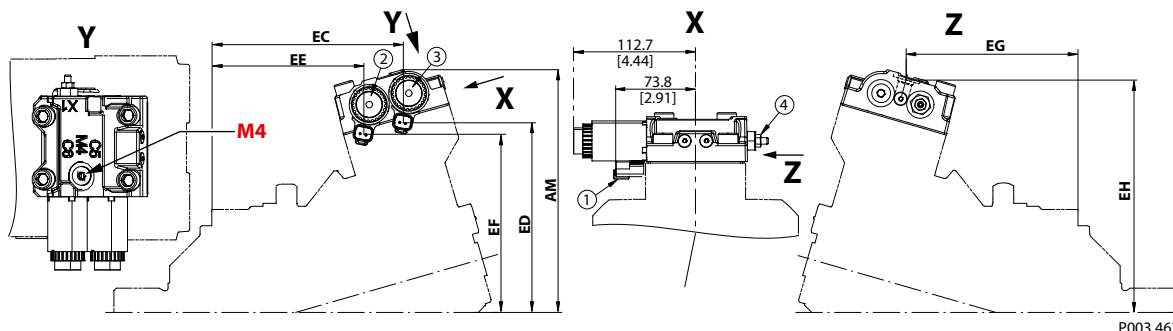
Cartridge mounting flange dimensions (mm [in])

|           | Size 060<br>Cartridge 160 | Size 080<br>Cartridge 190 | Size 110<br>Cartridge 200 | Size 160<br>Cartridge 200 |
|-----------|---------------------------|---------------------------|---------------------------|---------------------------|
| <b>AM</b> | 193.6 [7.62]              | 206.6 [8.13]              | 224.1 [8.82]              | 242.5 [9.55]              |
| <b>EE</b> | 55.6 [2.19]               | 47.3 [1.86]               | 57.6 [2.27]               | 77.0 [3.03]               |
| <b>EF</b> | 133.9 [5.27]              | 146.9 [5.78]              | 164.4 [6.47]              | 182.9 [7.20]              |
| <b>EG</b> | 74.6 [2.94]               | 66.4 [2.61]               | 76.6 [3.02]               | 96.1 [3.78]               |
| <b>EH</b> | 183.9 [6.71]              | 196.9 [7.75]              | 214.4 [8.44]              | 232.9 [9.17]              |

Size 210 and 250 are not available.

**Control dimensions**

**Options T1D1, T2D2 and P1D1, P2D2 (Electric two-position controls with PCOR, BPD and electric proportional PCOR, BPD)**



**M4** Servo gauge port: ISO 11926-1 SAE 9/16 -18UNF-2B or ISO6149 M14 x 1.5; Ø25.0 [0.98] max. clearance DIA for fitting

1. Connector: DEUTSCH DT04-2P
2. Two-position solenoid "T" or Proportional PCOR "P"
3. BPD solenoid
4. PCOR adjustment

SAE mounting flange per ISO 3019/1 dimensions (mm [in])

|           | Size 060<br>SAE 127-4 | Size 080<br>SAE 127-4 | Size 110<br>SAE 152-4 | Size 160<br>SAE 152-4 | Size 210<br>SAE 165-4 | Size 250<br>SAE 165-4 |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| <b>AM</b> | 193.6 [7.62]          | 206.6 [8.13]          | 224.1 [8.82]          | 242.5 [9.55]          | 257.7 [10.15]         | 267.3 [10.53]         |
| <b>EC</b> | 176.3 [6.94]          | 186.3 [7.33]          | 208.6 [8.21]          | 227.9 [8.97]          | 246.6 [9.71]          | 261.0 [10.0]          |
| <b>ED</b> | 144.4 [5.69]          | 157.3 [6.19]          | 174.9 [6.89]          | 193.3 [7.61]          | 208.8 [8.22]          | 218.0 [8.58]          |
| <b>EE</b> | 139.8 [5.50]          | 149.7 [5.89]          | 172.1 [6.78]          | 191.3 [7.53]          | 210.1 [8.27]          | 225.0 [8.86]          |
| <b>EF</b> | 133.9 [5.27]          | 146.9 [5.78]          | 164.4 [6.47]          | 182.9 [7.20]          | 198.3 [7.81]          | 208.0 [8.19]          |
| <b>EG</b> | 158.8 [6.25]          | 168.8 [6.65]          | 191.1 [7.52]          | 210.4 [8.28]          | 230.2 [9.06]          | 244.0 [9.61]          |
| <b>EH</b> | 183.9 [6.71]          | 196.9 [7.75]          | 214.4 [8.44]          | 232.9 [9.17]          | 248.1 [9.77]          | 258.0 [10.16]         |

DIN B4 HL mounting flange per ISO 3019/2 dimensions, (mm [in])

|           | Size 060 DIN 125 | Size 080 DIN 140 | Size 110 DIN 160 | Size 160 DIN 180 | Size 210 DIN 200 |
|-----------|------------------|------------------|------------------|------------------|------------------|
| <b>AM</b> | 193.6 [7.62]     | 206.6 [8.13]     | 224.1 [8.82]     | 242.5 [9.55]     | 257.7 [10.15]    |
| <b>EC</b> | 151.8 [5.98]     | 162.3 [6.39]     | 176.1 [6.93]     | 196.0 [7.72]     | 214.6 [8.45]     |
| <b>ED</b> | 144.4 [5.69]     | 157.3 [6.19]     | 174.9 [6.89]     | 193.3 [7.61]     | 208.8 [8.22]     |
| <b>EE</b> | 115.3 [4.54]     | 125.7 [4.95]     | 139.6 [5.50]     | 159.4 [6.28]     | 178.1 [7.01]     |
| <b>EF</b> | 133.9 [5.27]     | 146.9 [5.78]     | 164.4 [6.47]     | 182.9 [7.20]     | 198.3 [7.81]     |
| <b>EG</b> | 134.3 [5.29]     | 144.8 [5.70]     | 158.6 [6.24]     | 178.5 [7.03]     | 198.2 [7.8]      |
| <b>EH</b> | 183.9 [6.71]     | 196.9 [7.75]     | 214.4 [8.44]     | 232.9 [9.17]     | 248.1 [9.77]     |

Cartridge mounting flange dimensions (mm [in])

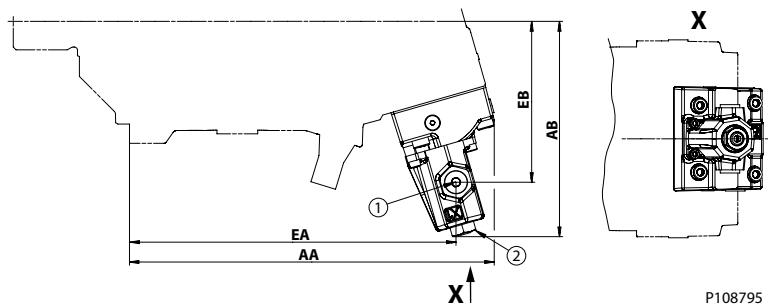
|           | Size 060 Cartridge 160 | Size 080 Cartridge 190 | Size 110 Cartridge 200 | Size 160 Cartridge 200 |
|-----------|------------------------|------------------------|------------------------|------------------------|
| <b>AM</b> | 193.6 [7.62]           | 206.6 [8.13]           | 224.1 [8.82]           | 242.5 [9.55]           |
| <b>EC</b> | 92.1 [3.63]            | 83.9 [3.30]            | 94.1 [3.70]            | 113.6 [4.47]           |
| <b>ED</b> | 144.4 [5.69]           | 157.3 [6.19]           | 174.9 [6.89]           | 193.3 [7.61]           |

**Control dimensions***Cartridge mounting flange dimensions (mm [in]) (continued)*

|           | <b>Size 060 Cartridge 160</b> | <b>Size 080 Cartridge 190</b> | <b>Size 110 Cartridge 200</b> | <b>Size 160 Cartridge 200</b> |
|-----------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| <b>EE</b> | 55.6 [2.19]                   | 47.3 [1.86]                   | 57.6 [2.27]                   | 77.0 [3.03]                   |
| <b>EF</b> | 133.9 [5.27]                  | 146.9 [5.78]                  | 164.4 [6.47]                  | 182.9 [7.20]                  |
| <b>EG</b> | 74.6 [2.94]                   | 66.4 [2.61]                   | 76.6 [3.02]                   | 96.1 [3.78]                   |
| <b>EH</b> | 183.9 [6.71]                  | 196.9 [7.75]                  | 214.4 [8.44]                  | 232.9 [9.17]                  |

## Control dimensions

### Option LHBA (Hydraulic proportional control)



P108795

1. Pilot Pressure Gauge Port "X1": ISO 11926-1 9/16-8 or ISO 6149 M14 x 1.5
2. Start pressure adjustment screw

SAE mounting flange per ISO 3019/1 dimensions (mm [in])

|           | Size 060<br>SAE 127-4 | Size 080<br>SAE 127-4 | Size 110<br>SAE 152-4 | Size 160<br>SAE 152-4 | Size 210<br>SAE 165-4 | Size 250<br>SAE 165-4 |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| <b>AA</b> | 272.3 [10.72]         | 289.9 [11.41]         | 316.4 [12.46]         | 343.8 [13.53]         | 371.6 [14.63]         | 390.3 [15.37]         |
| <b>AB</b> | 157.4 [6.20]          | 163.3 [6.43]          | 167.7 [6.60]          | 176.4 [6.94]          | 183.5 [7.22]          | 189.6 [7.46]          |
| <b>EA</b> | 242.6 [9.55]          | 260.3 [10.25]         | 286.8 [11.29]         | 314.00 [12.36]        | 337.8 [13.3]          | 357.4 [14.07]         |
| <b>EB</b> | 115.0 [4.53]          | 120.9 [4.76]          | 138.4 [4.93]          | 134.0 [5.28]          | 141.1 [5.56]          | 147.3 [5.80]          |

DIN B4 HL mounting flange per ISO 3019/2 dimensions, (mm [in])

|           | Size 060 – DIN 125 | Size 080 – DIN 140 | Size 110 – DIN 160 | Size 160 – DIN 180 | Size 210 – DIN 200 |
|-----------|--------------------|--------------------|--------------------|--------------------|--------------------|
| <b>AA</b> | 247.8 [9.76]       | 265.9 [10.47]      | 283.9 [11.18]      | 311.7 [12.27]      | 339.6 [13.37]      |
| <b>AB</b> | 157.4 [6.20]       | 163.3 [6.43]       | 167.7 [6.60]       | 176.4 [6.94]       | 183.5 [7.22]       |
| <b>EA</b> | 218.1 [8.59]       | 236.3 [9.30]       | 254.3 [10.01]      | 282.1 [11.11]      | 306.7 [12.07]      |
| <b>EB</b> | 115.0 [4.53]       | 120.9 [4.76]       | 125.3 [4.93]       | 134.0 [5.28]       | 141.1 [5.56]       |

Size 250 is not available.

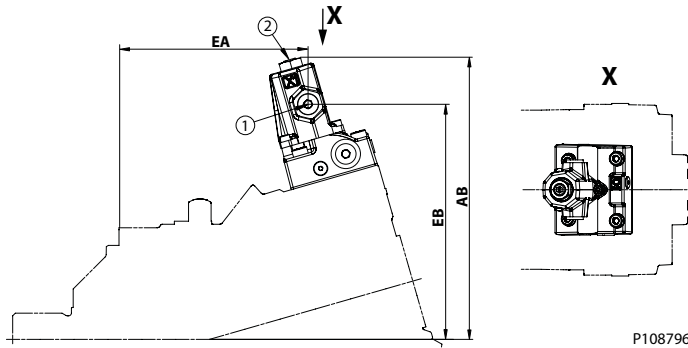
Cartridge mounting flange dimensions (mm [in])

|           | Size 060<br>Cartridge 160 | Size 080<br>Cartridge 190 | Size 110<br>Cartridge 200 | Size 160<br>Cartridge 200 |
|-----------|---------------------------|---------------------------|---------------------------|---------------------------|
| <b>AA</b> | 188.1 [7.41]              | 187.5 [7.38]              | 201.9 [7.95]              | 229.3 [9.03]              |
| <b>AB</b> | 157.4 [6.20]              | 163.3 [6.43]              | 167.7 [6.60]              | 176.4 [6.94]              |
| <b>EA</b> | 158.4 [6.24]              | 169.1 [6.66]              | 172.3 [6.78]              | 199.7 [7.86]              |
| <b>EB</b> | 115.0 [4.53]              | 120.9 [4.76]              | 138.4 [4.93]              | 134.0 [5.28]              |

Size 210 and 250 are not available.

**Control dimensions**

**Option MHCA (Hydraulic proportional control)**



1. Pilot Pressure Gauge Port "X" ISO 11926-1 9/16-8
2. Start pressure adjustment screw

*SAE mounting flange per ISO 3019/1 dimensions (mm [in])*

|           | <b>Size 060<br/>SAE 127-4</b> | <b>Size 080<br/>SAE 127-4</b> | <b>Size 110<br/>SAE 152-4</b> | <b>Size 160<br/>SAE 152-4</b> | <b>Size 210<br/>SAE 165-4</b> | <b>Size 250<br/>SAE 165-4</b> |
|-----------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| <b>AB</b> | 224.2 [8.83]                  | 228.4 [8.99]                  | 239.9 [9.44]                  | 257.6 [10.14]                 | 272 [10.71]                   | 282.8 [11.13]                 |
| <b>EA</b> | 158.8 [6.25]                  | 171.5 [6.75]                  | 193.4 [7.61]                  | 213.1 [8.39]                  | 231.7 [9.12]                  | 245.5 [9.67]                  |
| <b>EB</b> | 172.2 [6.78]                  | 188.7 [7.43]                  | 200.2 [7.88]                  | 217.8 [8.57]                  | 232.2 [9.14]                  | 243.0 [9.57]                  |

*DIN B4 HL mounting flange per ISO 3019/2 dimensions, (mm [in])*

|           | <b>Size 060 – DIN 125</b> | <b>Size 080 – DIN 140</b> | <b>Size 110 – DIN 160</b> | <b>Size 160 – DIN 180</b> | <b>Size 210 – DIN 200</b> |
|-----------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| <b>AB</b> | 224.2 [8.83]              | 228.4 [8.99]              | 239.9 [9.44]              | 257.6 [10.14]             | 272 [10.71]               |
| <b>EA</b> | 134.4 [5.28]              | 147.5 [5.81]              | 160.9 [6.33]              | 181.2 [7.13]              | 199.7 [7.86]              |
| <b>EB</b> | 172.2 [6.78]              | 188.7 [7.43]              | 200.2 [7.88]              | 217.8 [8.57]              | 232.2 [9.14]              |

Size 250 is not available.

*Cartridge mounting flange dimensions (mm [in])*

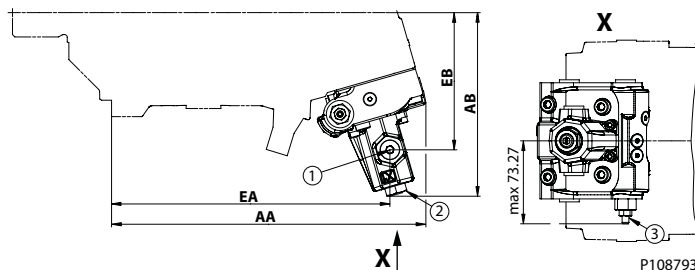
|           | <b>Size 060<br/>Cartridge 160</b> | <b>Size 080<br/>Cartridge 190</b> | <b>Size 110<br/>Cartridge 200</b> | <b>Size 160<br/>Cartridge 200</b> |
|-----------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| <b>AB</b> | 224.2 [8.83]                      | 228.4 [8.99]                      | 239.9 [9.44]                      | 257.6 [10.14]                     |
| <b>EA</b> | 74.6 [2.94]                       | 69.1 [2.72]                       | 78.9 [3.11]                       | 98.8 [3.89]                       |
| <b>EB</b> | 172.2 [6.78]                      | 188.7 [7.43]                      | 200.2 [7.88]                      | 217.8 [8.57]                      |

Size 210 and 250 are not available.



## Control dimensions

### Option DHMA (Hydraulic proportional control)



1. Pilot Pressure Gauge Port "X1" ISO 11926-1 9/16-8
2. Start pressure adjustment screw
3. PCOR adjustment screw

SAE mounting flange per ISO 3019/1 dimensions (mm [in])

|           | Size 060<br>SAE 127-4 | Size 080<br>SAE 127-4 | Size 110<br>SAE 152-4 | Size 160<br>SAE 152-4 | Size 210<br>SAE 165-4 | Size 250<br>SAE 165-4 |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| <b>AA</b> | 275.6 [10.85]         | 293.2 [11.54]         | 224.1 [8.82]          | 346.9 [13.78]         | 371.6 [14.63]         | 390.3 [15.37]         |
| <b>AB</b> | 157.4 [6.20]          | 163.3 [6.43]          | 167.7 [6.60]          | 176.4 [6.94]          | 183.5 [7.22]          | 189.6 [7.46]          |
| <b>EA</b> | 242.6 [9.55]          | 260.3 [10.25]         | 216.0 [8.50]          | 314.00 [12.36]        | 337.8 [13.3]          | 357.4 [14.07]         |
| <b>EB</b> | 115.0 [4.53]          | 120.9 [4.76]          | 125.3 [4.93]          | 133.99 [5.28]         | 141.1 [5.56]          | 147.3 [5.80]          |

DIN B4 HL mounting flange per ISO 3019/2 dimensions, (mm [in])

|           | Size 060 – DIN 125 | Size 080 – DIN 140 | Size 110 – DIN 160 | Size 160 – DIN 180 | Size 210 – DIN 200 |
|-----------|--------------------|--------------------|--------------------|--------------------|--------------------|
| <b>AA</b> | 251.1 [9.89]       | 269.2 [10.60]      | 287.2 [11.31]      | 315.0 [12.40]      | 339.6 [13.37]      |
| <b>AB</b> | 157.4 [6.20]       | 163.3 [6.43]       | 167.7 [6.60]       | 176.4 [6.94]       | 183.5 [7.22]       |
| <b>EA</b> | 218.1 [8.59]       | 236.3 [9.30]       | 254.3 [10.01]      | 282.1 [11.11]      | 306.7 [12.07]      |
| <b>EB</b> | 115.0 [4.53]       | 120.9 [4.76]       | 125.3 [4.93]       | 133.99 [5.28]      | 141.1 [5.56]       |

Size 250 is not available.

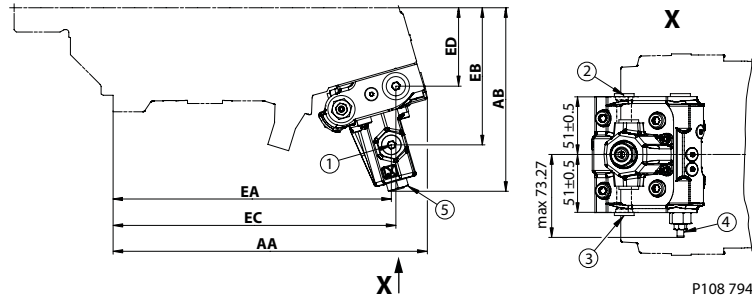
Cartridge mounting flange dimensions (mm [in])

|           | Size 060<br>Cartridge 160 | Size 080<br>Cartridge 190 | Size 110<br>Cartridge 200 | Size 160<br>Cartridge 200 |
|-----------|---------------------------|---------------------------|---------------------------|---------------------------|
| <b>AA</b> | 191.3 [7.54]              | 190.8 [7.51]              | 224.1 [8.82]              | 232.6 [9.16]              |
| <b>AB</b> | 157.4 [6.20]              | 163.3 [6.23]              | 167.7 [6.60]              | 176.4 [6.94]              |
| <b>EA</b> | 158.4 [6.24]              | 169.1 [6.66]              | 216.0 [8.50]              | 199.7 [7.86]              |
| <b>EB</b> | 115.0 [4.53]              | 120.9 [4.76]              | 125.3 [4.93]              | 133.99 [5.28]             |

Size 210 and 250 are not available.

**Control dimensions**

**Option DHMH (Hydraulic proportional control)**



1. Pilot pressure gauge port "X1" ISO 11926-1 9/16-8
2. Pilot pressure BPD port "XA" ISO 11926-1 9/16-8
3. Pilot pressure BPD port "XB" ISO 11926-1 9/16-8
4. PCOR adjustment
5. Start pressure adjustment screw

SAE mounting flange per ISO 3019/1 dimensions (mm [in])

|           | Size 060<br>SAE 127-4 | Size 080<br>SAE 127-4 | Size 110<br>SAE 152-4 | Size 160<br>SAE 152-4 | Size 210<br>SAE 165-4 | Size 250<br>SAE 165-4 |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| <b>AA</b> | 275.6 [10.85]         | 293.2 [11.54]         | 224.1 [8.82]          | 346.9 [13.78]         | 371.6 [14.63]         | 390.3 [15.37]         |
| <b>AB</b> | 157.4 [6.20]          | 163.3 [6.43]          | 167.7 [6.60]          | 176.4 [6.94]          | 183.5 [7.22]          | 189.6 [7.46]          |
| <b>EA</b> | 242.6 [9.55]          | 260.3 [10.25]         | 216.0 [8.50]          | 314.00 [12.36]        | 337.8 [13.3]          | 357.4 [14.07]         |
| <b>EB</b> | 115.0 [4.53]          | 120.9 [4.76]          | 125.3 [4.93]          | 133.99 [5.28]         | 141.1 [5.56]          | 147.3 [5.80]          |
| <b>EC</b> | 246.7 [9.71]          | 264.3 [10.41]         | 290.8 [11.45]         | 318.1 [12.52]         | 342.8 [13.5]          | 361.5 [14.23]         |
| <b>ED</b> | 61.3 [2.41]           | 67.2 [2.65]           | 74.6 [2.94]           | 80.3 [3.16]           | 87.4 [3.44]           | 93.6 [3.69]           |

DIN B4 HL mounting flange per ISO 3019/2 dimensions, (mm [in])

|           | Size 060 – DIN 125 | Size 080 – DIN 140 | Size 110 – DIN 160 | Size 160 – DIN 180 | Size 210 – DIN 200 |
|-----------|--------------------|--------------------|--------------------|--------------------|--------------------|
| <b>AA</b> | 251.1 [9.89]       | 269.2 [10.60]      | 287.2 [11.31]      | 315.0 [12.40]      | 339.6 [13.37]      |
| <b>AB</b> | 157.4 [6.20]       | 163.3 [6.43]       | 167.7 [6.60]       | 176.4 [6.94]       | 183.5 [7.22]       |
| <b>EA</b> | 218.1 [8.59]       | 236.3 [9.30]       | 254.3 [10.01]      | 282.1 [11.11]      | 306.7 [12.07]      |
| <b>EB</b> | 115.0 [4.53]       | 120.9 [4.76]       | 125.3 [4.93]       | 133.99 [5.28]      | 141.1 [5.56]       |
| <b>EC</b> | 222.2 [8.75]       | 240.3 [9.46]       | 258.3 [10.17]      | 286.2 [11.27]      | 310.8 [12.24]      |
| <b>ED</b> | 61.3 [2.41]        | 67.2 [2.65]        | 74.6 [2.94]        | 80.3 [3.16]        | 87.4 [3.44]        |

Size 250 is not available.

Cartridge mounting flange dimensions (mm [in])

|           | Size 060<br>Cartridge 160 | Size 080<br>Cartridge 190 | Size 110<br>Cartridge 200 | Size 160<br>Cartridge 200 |
|-----------|---------------------------|---------------------------|---------------------------|---------------------------|
| <b>AA</b> | 191.3 [7.54]              | 190.8 [7.51]              | 224.1 [8.82]              | 232.6 [9.16]              |
| <b>AB</b> | 157.4 [6.20]              | 163.3 [6.23]              | 167.7 [6.60]              | 176.4 [6.94]              |
| <b>EA</b> | 158.4 [6.24]              | 169.1 [6.66]              | 216.0 [8.50]              | 199.7 [7.86]              |
| <b>EB</b> | 115.0 [4.53]              | 120.9 [4.76]              | 125.3 [4.93]              | 133.99 [5.28]             |

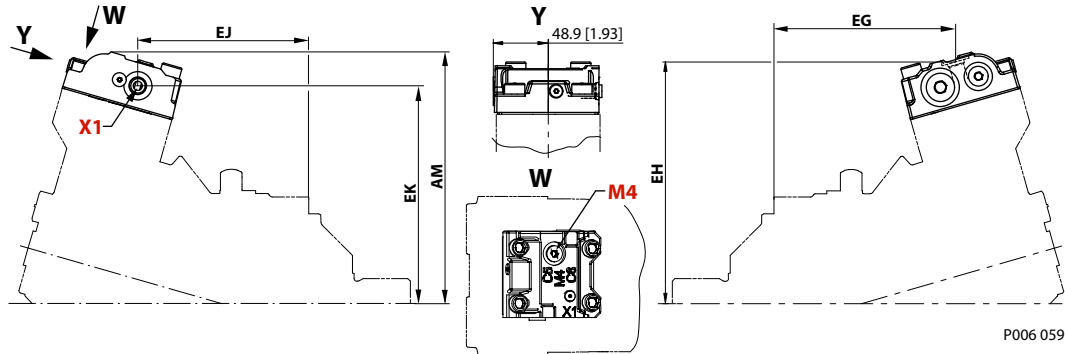
**Control dimensions***Cartridge mounting flange dimensions (mm [in]) (continued)*

|           | <b>Size 060<br/>Cartridge 160</b> | <b>Size 080<br/>Cartridge 190</b> | <b>Size 110<br/>Cartridge 200</b> | <b>Size 160<br/>Cartridge 200</b> |
|-----------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| <b>EC</b> | 162.5 [6.40]                      | 173.1 [6.81]                      | 176.3 [6.94]                      | 203.8 [8.02]                      |
| <b>ED</b> | 61.3 [2.41]                       | 67.2 [2.65]                       | 74.6 [2.94]                       | 80.3 [3.16]                       |

Size 210 and 250 are not available.

**Control dimensions**

**Option HEHE (Hydraulic two-position control)**



P006 059

- X1** Control pressure port: ISO 11926-1 9/16 -18 or ISO 6149 M14 x 1.5
- M4** Servo pressure supply gauge port: ISO 11926-1 9/16 -18 or ISO 6149 M14 x 1.5

*SAE mounting flange per ISO 3019/1 dimensions (mm [in])*

|           | <b>Size 060<br/>SAE 127-4</b> | <b>Size 080<br/>SAE 127-4</b> | <b>Size 110<br/>SAE 152-4</b> | <b>Size 160<br/>SAE 152-4</b> | <b>Size 210<br/>SAE 165-4</b> | <b>Size 250<br/>SAE 165-4</b> |
|-----------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| <b>AM</b> | 193.6 [7.62]                  | 206.6 [8.13]                  | 224.1 [8.82]                  | 242.5 [9.55]                  | 257.7 [10.15]                 | 267.0 [10.51]                 |
| <b>EG</b> | 161.9 [6.37]                  | 171.8 [6.76]                  | 194.2 [7.65]                  | 213.5 [8.41]                  | 203.5 [8.01]                  | 247.0 [9.72]                  |
| <b>EH</b> | 184.8 [7.28]                  | 197.8 [7.79]                  | 215.3 [8.48]                  | 233.8 [9.20]                  | 249.6 [9.83]                  | 259.0 [10.2]                  |
| <b>EJ</b> | 152.2 [5.99]                  | 162.2 [6.39]                  | 185.5 [7.30]                  | 203.8 [8.02]                  | 223.7 [8.81]                  | 237.0 [9.33]                  |
| <b>EK</b> | 163.3 [6.43]                  | 176.3 [6.94]                  | 193.8 [7.63]                  | 212.3 [8.36]                  | 227.5 [8.96]                  | 237.0 [9.33]                  |

*DIN B4 HL mounting flange per ISO 3019/2 dimensions, (mm [in])*

|           | <b>Size 060 – DIN 125</b> | <b>Size 080 – DIN 140</b> | <b>Size 110 – DIN 160</b> | <b>Size 160 – DIN 180</b> | <b>Size 210 – DIN 200</b> |
|-----------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| <b>AM</b> | 193.6 [7.62]              | 206.6 [8.13]              | 224.1 [8.82]              | 242.5 [9.55]              | 257.7 [10.15]             |
| <b>EG</b> | 137.4 [5.41]              | 147.8 [5.82]              | 161.7 [6.37]              | 181.6 [7.15]              | 203.5 [8.01]              |
| <b>EH</b> | 184.8 [7.28]              | 197.8 [7.79]              | 215.3 [8.48]              | 233.8 [9.20]              | 249.6 [9.83]              |
| <b>EJ</b> | 127.7 [5.03]              | 138.2 [5.44]              | 152.0 [5.98]              | 171.9 [6.77]              | 191.7 [7.55]              |
| <b>EK</b> | 163.3 [6.43]              | 176.3 [6.94]              | 193.8 [7.63]              | 212.3 [8.36]              | 227.5 [8.96]              |

Size 250 is not available.

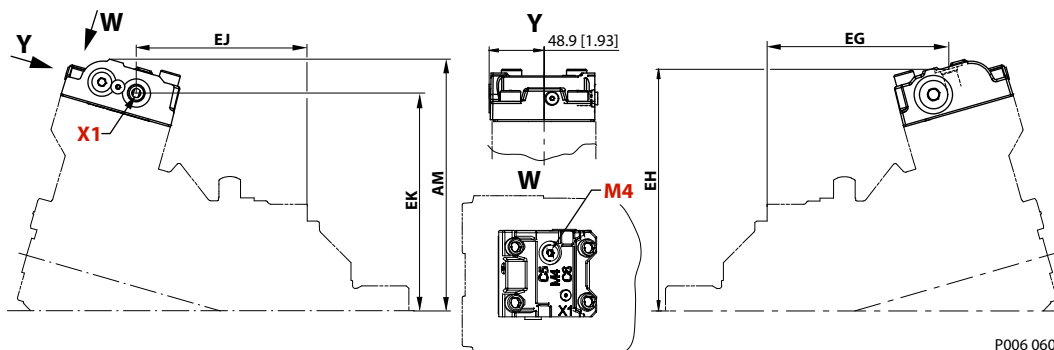
*Cartridge mounting flange dimensions (mm [in])*

|           | <b>Size 060<br/>Cartridge 160</b> | <b>Size 080<br/>Cartridge 190</b> | <b>Size 110<br/>Cartridge 200</b> | <b>Size 160<br/>Cartridge 200</b> |
|-----------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| <b>AM</b> | 193.6 [7.62]                      | 206.6 [8.13]                      | 224.1 [8.82]                      | 242.5 [9.55]                      |
| <b>EG</b> | 77.7 [3.06]                       | 69.4 [2.73]                       | 79.7 [3.14]                       | 99.2 [3.91]                       |
| <b>EH</b> | 184.8 [7.28]                      | 197.8 [7.79]                      | 215.3 [8.48]                      | 233.8 [9.20]                      |
| <b>EJ</b> | 68.0 [2.68]                       | 59.8 [2.35]                       | 70.0 [2.76]                       | 89.5 [3.52]                       |
| <b>EK</b> | 163.3 [6.43]                      | 176.3 [6.94]                      | 193.8 [7.63]                      | 212.3 [8.36]                      |

Size 210 and 250 are not available.

## Control dimensions

### Option HFHF (Hydraulic two-position control)



P006 060

**X1** Control pressure port: ISO 11926-1 9/16 -18 or ISO 6149 M14 x 1.5

**M4** Servo pressure supply gauge port: ISO 11926-1 9/16 -18 or ISO 6149 M14 x 1.5

#### SAE mounting flange per ISO 3019/1 dimensions (mm [in])

|           | Size 060<br>SAE 127-4 | Size 080<br>SAE 127-4 | Size 110<br>SAE 152-4 | Size 160<br>SAE 152-4 | Size 210<br>SAE 165-4 | Size 250<br>SAE 165-4 |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| <b>AM</b> | 193.6 [7.62]          | 206.6 [8.13]          | 224.1 [8.82]          | 242.5 [9.55]          | 257.7 [10.15]         | 267.0 [10.51]         |
| <b>EG</b> | 164.1 [6.46]          | 174.0 [6.85]          | 194.4 [7.73]          | 215.7 [8.49]          | 216.9 [8.54]          | 249.0 [9.80]          |
| <b>EH</b> | 185.5 [7.30]          | 198.4 [7.81]          | 216.0 [8.50]          | 234.4 [9.23]          | 225.6 [8.88]          | 259.0 [10.2]          |
| <b>EJ</b> | 152.2 [5.99]          | 162.2 [6.39]          | 184.5 [7.26]          | 203.8 [8.02]          | 230.2 [9.06]          | 237.0 [9.33]          |
| <b>EK</b> | 163.3 [6.43]          | 176.3 [6.94]          | 193.8 [7.63]          | 212.3 [8.36]          | 248.1 [9.77]          | 237.0 [9.33]          |

#### DIN B4 HL mounting flange per ISO 3019/2 dimensions, (mm [in])

|           | Size 060 – DIN 125 | Size 080 – DIN 140 | Size 110 – DIN 160 | Size 160 – DIN 180 | Size 210 – DIN 200 |
|-----------|--------------------|--------------------|--------------------|--------------------|--------------------|
| <b>AM</b> | 193.6 [7.62]       | 206.6 [8.13]       | 224.1 [8.82]       | 242.5 [9.55]       | 257.7 [10.15]      |
| <b>EG</b> | 139.6 [5.50]       | 150.0 [5.91]       | 163.9 [6.45]       | 183.8 [7.24]       | 184.9 [7.28]       |
| <b>EH</b> | 185.5 [7.30]       | 198.4 [7.81]       | 216.0 [8.50]       | 234.4 [9.23]       | 225.6 [8.88]       |
| <b>EJ</b> | 127.7 [5.03]       | 138.2 [5.44]       | 152.0 [5.98]       | 171.9 [6.77]       | 198.2 [7.8]        |
| <b>EK</b> | 163.3 [6.43]       | 176.3 [6.94]       | 193.8 [7.63]       | 212.3 [8.36]       | 248.1 [9.77]       |

Size 250 is not available.

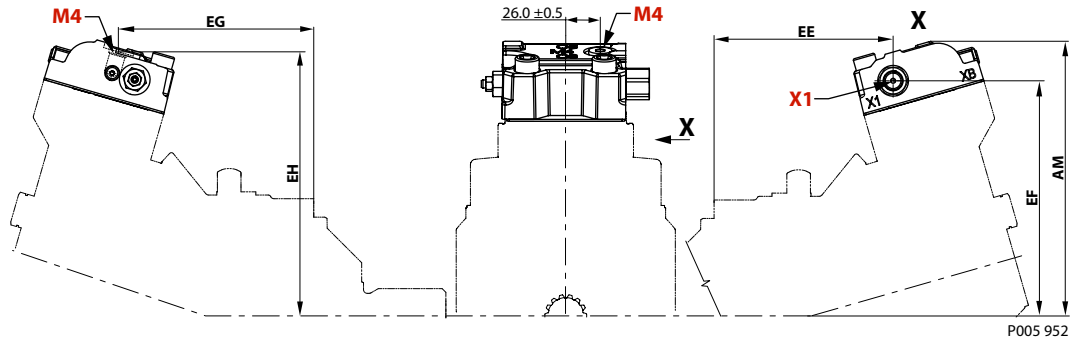
#### Cartridge mounting flange dimensions (mm [in])

|           | Size 060<br>Cartridge 160 | Size 080<br>Cartridge 190 | Size 110<br>Cartridge 200 | Size 160<br>Cartridge 200 |
|-----------|---------------------------|---------------------------|---------------------------|---------------------------|
| <b>AM</b> | 193.6 [7.62]              | 206.6 [8.13]              | 224.1 [8.82]              | 242.5 [9.55]              |
| <b>EG</b> | 79.9 [3.15]               | 71.6 [2.82]               | 81.9 [3.22]               | 101.4 [3.99]              |
| <b>EH</b> | 185.5 [7.30]              | 198.4 [7.81]              | 216.0 [8.50]              | 234.4 [9.23]              |
| <b>EJ</b> | 68.0 [2.68]               | 59.8 [2.35]               | 70.0 [2.76]               | 89.5 [3.52]               |
| <b>EK</b> | 163.3 [6.43]              | 176.3 [6.94]              | 193.8 [7.63]              | 212.3 [8.36]              |

Size 210 and 250 are not available.

**Control dimensions**

**Option THHA (Hydraulic two-position control)**



**M4** Servo gauge port ISO 11926-1; 9/16 -18UNF-2B

**X1** Pilot pressure gauge port ISO 11926-1 9/16-8

*SAE mounting flange per ISO 3019/1 dimensions (mm [in])*

|           | Size 060<br>SAE 127-4 | Size 080<br>SAE 127-4 | Size 110<br>SAE 152-4 | Size 160<br>SAE 152-4 | Size 210<br>SAE 165-4 | Size 250<br>SAE 165-4 |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| <b>AM</b> | 193.6 [7.62]          | 206.6 [8.13]          | 224.1 [8.82]          | 242.5 [9.55]          | 257.7 [10.15]         | 267.3 [10.52]         |
| <b>EE</b> | 145.5 [5.73]          | 155.5 [6.12]          | 177.8 [7.0]           | 197.1 [7.76]          | 216.9 [8.54]          | 230.6 [9.08]          |
| <b>EF</b> | 161.4 [6.35]          | 174.4 [6.87]          | 191.9 [7.56]          | 210.4 [8.28]          | 225.6 [8.88]          | 235.2 [9.26]          |
| <b>EG</b> | 158.8 [6.25]          | 168.8 [6.65]          | 191.1 [7.52]          | 210.4 [8.28]          | 230.2 [9.06]          | 243.9 [9.60]          |
| <b>EH</b> | 184.0 [7.24]          | 196.9 [7.75]          | 214.4 [8.44]          | 232.9 [9.17]          | 248.1 [9.77]          | 257.8 [10.15]         |

*DIN B4 HL mounting flange per ISO 3019/2 dimensions, (mm [in])*

|           | Size 060 – DIN 125 | Size 080 – DIN 140 | Size 110 – DIN 160 | Size 160 – DIN 180 | Size 210 – DIN 200 |
|-----------|--------------------|--------------------|--------------------|--------------------|--------------------|
| <b>AM</b> | 193.6 [7.62]       | 206.6 [8.13]       | 224.1 [8.82]       | 242.5 [9.55]       | 257.7 [10.15]      |
| <b>EE</b> | 121.0 [4.76]       | 131.5 [5.18]       | 145.3 [5.72]       | 165.2 [6.50]       | 184.9 [7.28]       |
| <b>EF</b> | 161.4 [6.35]       | 174.4 [6.87]       | 191.9 [7.56]       | 210.4 [8.28]       | 225.6 [8.88]       |
| <b>EG</b> | 134.3 [5.29]       | 144.8 [5.70]       | 158.6 [6.24]       | 178.5 [7.03]       | 198.2 [7.8]        |
| <b>EH</b> | 184.0 [7.24]       | 196.9 [7.75]       | 214.4 [8.44]       | 232.9 [9.17]       | 248.1 [9.77]       |

Size 250 is not available.

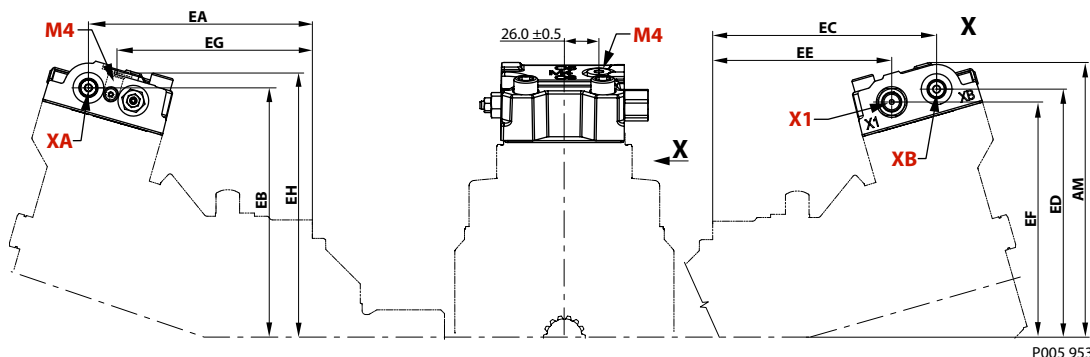
*Cartridge mounting flange dimensions (mm [in])*

|           | Size 060<br>Cartridge 160 | Size 080<br>Cartridge 190 | Size 110<br>Cartridge 200 | Size 160<br>Cartridge 200 |
|-----------|---------------------------|---------------------------|---------------------------|---------------------------|
| <b>AM</b> | 193.6 [7.62]              | 206.6 [8.13]              | 224.1 [8.82]              | 242.5 [9.55]              |
| <b>EE</b> | 61.3 [2.41]               | 53.1 [2.09]               | 63.3 [2.49]               | 82.8 [3.26]               |
| <b>EF</b> | 161.4 [6.35]              | 174.4 [6.87]              | 191.9 [7.56]              | 210.4 [8.28]              |
| <b>EG</b> | 74.6 [2.94]               | 66.4 [2.61]               | 76.6 [3.02]               | 96.1 [3.78]               |
| <b>EH</b> | 184.0 [7.24]              | 196.9 [7.75]              | 214.4 [8.44]              | 232.9 [9.17]              |

Size 210 and 250 are not available.

## Control dimensions

### Option THHB (Hydraulic two-position control)



- X1** Pilot pressure gauge port ISO 11926-1; 9/16 -18
- XA, XB** Pilot pressure BPD port ISO 11926-1 9/16-8
- M4** Servo pressure supply gauge port ISO 11926-1; 9/16 -18

#### SAE mounting flange per ISO 3019/1 dimensions (mm [in])

|               | Size 060<br>SAE 127-4 | Size 080<br>SAE 127-4 | Size 110<br>SAE 152-4 | Size 160<br>SAE 152-4 | Size 210<br>SAE 165-4 | Size 250<br>SAE 165-4 |
|---------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| <b>AM</b>     | 193.6 [7.62]          | 206.6 [8.13]          | 224.1 [8.82]          | 242.5 [9.55]          | 257.7 [10.15]         | 267.3 [10.52]         |
| <b>EA, EC</b> | 182 [7.17]            | 192 [7.56]            | 214.3 [8.44]          | 233.6 [9.20]          | 253.6 [9.98]          | 267.1 [10.52]         |
| <b>EB, ED</b> | 171.9 [6.77]          | 184.9 [7.28]          | 202.4 [7.97]          | 210.4 [8.28]          | 236 [9.29]            | 245.7 [9.67]          |
| <b>EE</b>     | 145.5 [5.73]          | 155.5 [6.12]          | 177.8 [7.00]          | 197.1 [7.76]          | 216.9 [8.54]          | 230.6 [9.08]          |
| <b>EF</b>     | 161.4 [6.35]          | 174.4 [6.87]          | 191.9 [7.56]          | 210.4 [8.28]          | 225.6 [8.88]          | 235.2 [9.26]          |
| <b>EG</b>     | 158.8 [6.25]          | 168.8 [6.65]          | 191.1 [7.52]          | 210.4 [8.28]          | 230.2 [9.06]          | 243.9 [9.60]          |
| <b>EH</b>     | 184.0 [7.24]          | 196.9 [7.75]          | 214.4 [8.44]          | 232.9 [9.17]          | 248.1 [9.77]          | 257.8 [10.15]         |

#### DIN B4 HL mounting flange per ISO 3019/2 dimensions, (mm [in])

|               | Size 060 – DIN 125 | Size 080 – DIN 140 | Size 110 – DIN 160 | Size 160 – DIN 180 | Size 210 – DIN 200 |
|---------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| <b>AM</b>     | 193.6 [7.62]       | 206.6 [8.13]       | 224.1 [8.82]       | 242.5 [9.55]       | 257.7 [10.15]      |
| <b>EA, EC</b> | 157.5 [6.20]       | 168 [6.61]         | 181.8 [7.16]       | 201.7 [7.94]       | 221.5 [8.72]       |
| <b>EB, ED</b> | 171.9 [6.77]       | 184.9 [7.28]       | 202.4 [7.97]       | 210.4 [8.28]       | 236 [9.29]         |
| <b>EE</b>     | 121.0 [4.76]       | 131.5 [5.18]       | 145.3 [5.72]       | 165.2 [6.50]       | 184.9 [7.28]       |
| <b>EF</b>     | 161.4 [6.35]       | 174.4 [6.87]       | 191.9 [7.56]       | 210.4 [8.28]       | 225.6 [8.88]       |
| <b>EG</b>     | 134.3 [5.29]       | 144.8 [5.70]       | 158.6 [6.24]       | 178.5 [7.03]       | 198.2 [7.8]        |
| <b>EH</b>     | 184.0 [7.24]       | 196.9 [7.75]       | 214.4 [8.44]       | 232.9 [9.17]       | 248.1 [9.77]       |

Size 250 is not available.

#### Cartridge mounting flange dimensions (mm [in])

|               | Size 060<br>Cartridge 160 | Size 080<br>Cartridge 190 | Size 110<br>Cartridge 200 | Size 160<br>Cartridge 200 |
|---------------|---------------------------|---------------------------|---------------------------|---------------------------|
| <b>AM</b>     | 193.6 [7.62]              | 206.6 [8.13]              | 224.1 [8.82]              | 242.5 [9.55]              |
| <b>EA, EC</b> | 97.8 [3.85]               | 89.6 [3.53]               | 99.8 [3.93]               | 119.3 [4.70]              |

**Control dimensions**

*Cartridge mounting flange dimensions (mm [in]) (continued)*

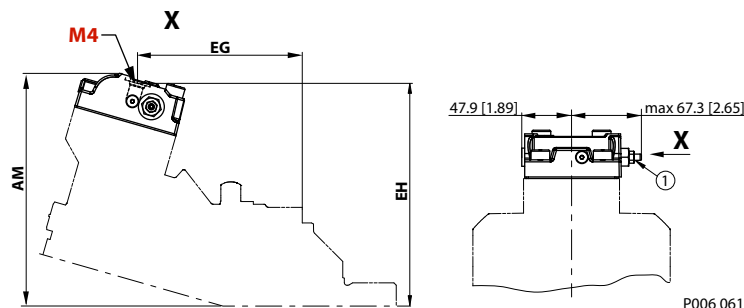
|               | <b>Size 060<br/>Cartridge 160</b> | <b>Size 080<br/>Cartridge 190</b> | <b>Size 110<br/>Cartridge 200</b> | <b>Size 160<br/>Cartridge 200</b> |
|---------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| <b>EB, ED</b> | 171.9 [6.77]                      | 184.9 [7.28]                      | 202.4 [7.97]                      | 210.4 [8.28]                      |
| <b>EE</b>     | 61.3 [2.41]                       | 53.1 [2.09]                       | 63.3 [2.49]                       | 82.8 [3.26]                       |
| <b>EF</b>     | 161.4 [6.35]                      | 174.4 [6.87]                      | 191.9 [7.56]                      | 210.4 [8.28]                      |
| <b>EG</b>     | 74.6 [2.94]                       | 66.4 [2.61]                       | 76.6 [3.02]                       | 96.1 [3.78]                       |
| <b>EH</b>     | 184.0 [7.24]                      | 196.9 [7.75]                      | 214.4 [8.44]                      | 232.9 [9.17]                      |

Size 210 and 250 are not available.



## Control dimensions

### Option TADA (Hydraulic two-position control)



**M4** Servo gauge port: ISO 11926-1 9/16 -18UNF-2B or ISO 6149 M14 x 1.5

**1** PCOR adjustment

*SAE mounting flange per ISO 3019/1 dimensions (mm [in])*

|           | Size 060<br>SAE 127-4 | Size 080<br>SAE 127-4 | Size 110<br>SAE 152-4 | Size 160<br>SAE 152-4 | Size 210<br>SAE 165-4 | Size 250<br>SAE 165-4 |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| <b>AM</b> | 193.6 [7.62]          | 206.6 [8.13]          | 224.1 [8.82]          | 242.5 [9.55]          | 257.7 [10.15]         | 267.3 [10.52]         |
| <b>EG</b> | 158.8 [6.25]          | 168.8 [6.65]          | 191.1 [7.52]          | 210.4 [8.28]          | 230.2 [9.06]          | 243.9 [9.60]          |
| <b>EH</b> | 184.0 [7.24]          | 196.9 [7.75]          | 214.4 [8.44]          | 232.9 [9.17]          | 248.1 [9.77]          | 257.8 [10.15]         |

*DIN B4 HL mounting flange per ISO 3019/2 dimensions, (mm [in])*

|           | Size 060 – DIN 125 | Size 080 – DIN 140 | Size 110 – DIN 160 | Size 160 – DIN 180 | Size 210 – DIN 200 |
|-----------|--------------------|--------------------|--------------------|--------------------|--------------------|
| <b>AM</b> | 193.6 [7.62]       | 206.6 [8.13]       | 224.1 [8.82]       | 242.5 [9.55]       | 257.7 [10.15]      |
| <b>EG</b> | 134.3 [5.29]       | 144.8 [5.70]       | 158.6 [6.24]       | 178.5 [7.03]       | 198.2 [7.8]        |
| <b>EH</b> | 184.0 [7.24]       | 196.9 [7.75]       | 214.4 [8.44]       | 232.9 [9.17]       | 248.1 [9.77]       |

Size 250 is not available.

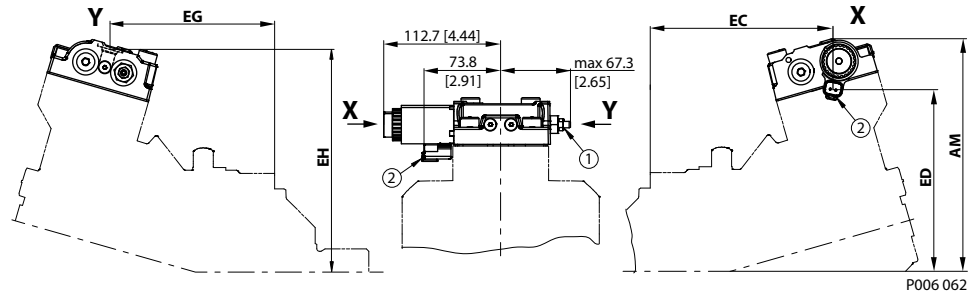
*Cartridge mounting flange dimensions (mm [in])*

|           | Size 060<br>Cartridge 160 | Size 080<br>Cartridge 190 | Size 110<br>Cartridge 200 | Size 160<br>Cartridge 200 |
|-----------|---------------------------|---------------------------|---------------------------|---------------------------|
| <b>AM</b> | 193.6 [7.62]              | 206.6 [8.13]              | 224.1 [8.82]              | 242.5 [9.55]              |
| <b>EG</b> | 74.6 [2.94]               | 66.4 [2.61]               | 76.6 [3.02]               | 96.1 [3.78]               |
| <b>EH</b> | 184.0 [7.24]              | 196.9 [7.75]              | 214.4 [8.44]              | 232.9 [9.17]              |

Size 210 and 250 are not available.

**Control dimensions**

**Option TAD1 and TAD2 (Hydraulic two-position control)**



1. PCOR adjustment
2. Electric BPD

SAE mounting flange per ISO 3019/1 dimensions (mm [in])

|           | Size 060<br>SAE 127-4 | Size 080<br>SAE 127-4 | Size 110<br>SAE 152-4 | Size 160<br>SAE 152-4 | Size 210<br>SAE 165-4 | Size 250<br>SAE 165-4 |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| <b>AM</b> | 193.6 [7.62]          | 206.6 [8.13]          | 224.1 [8.82]          | 242.5 [9.55]          | 257.7 [10.15]         | 267.3 [10.52]         |
| <b>EC</b> | 176.3 [6.94]          | 186.3 [7.33]          | 208.6 [8.21]          | 227.9 [8.97]          | 246.6 [9.71]          | 261.0 [10.0]          |
| <b>ED</b> | 144.4 [5.69]          | 157.3 [6.19]          | 174.9 [6.89]          | 193.3 [7.61]          | 208.8 [8.22]          | 218.0 [8.58]          |
| <b>EG</b> | 158.8 [6.25]          | 168.8 [6.65]          | 191.1 [7.52]          | 210.4 [8.28]          | 230.2 [9.06]          | 243.9 [9.60]          |
| <b>EH</b> | 184.0 [7.24]          | 196.9 [7.75]          | 214.4 [8.44]          | 232.9 [9.17]          | 248.1 [9.77]          | 257.8 [10.15]         |

DIN B4 HL mounting flange per ISO 3019/2 dimensions, (mm [in])

|           | Size 060 – DIN 125 | Size 080 – DIN 140 | Size 110 – DIN 160 | Size 160 – DIN 180 | Size 210 – DIN 200 |
|-----------|--------------------|--------------------|--------------------|--------------------|--------------------|
| <b>AM</b> | 193.6 [7.62]       | 206.6 [8.13]       | 224.1 [8.82]       | 242.5 [9.55]       | 257.7 [10.15]      |
| <b>EC</b> | 151.8 [5.98]       | 162.3 [6.39]       | 176.1 [6.93]       | 196.0 [7.72]       | 214.6 [8.45]       |
| <b>ED</b> | 144.4 [5.69]       | 157.3 [6.19]       | 174.9 [6.89]       | 193.3 [7.61]       | 208.8 [8.22]       |
| <b>EG</b> | 134.3 [5.29]       | 144.8 [5.70]       | 158.6 [6.24]       | 178.5 [7.03]       | 198.2 [7.8]        |
| <b>EH</b> | 184.0 [7.24]       | 196.9 [7.75]       | 214.4 [8.44]       | 232.9 [9.17]       | 248.1 [9.77]       |

Size 250 is not available.

Cartridge mounting flange dimensions (mm [in])

|           | Size 060<br>Cartridge 160 | Size 080<br>Cartridge 190 | Size 110<br>Cartridge 200 | Size 160<br>Cartridge 200 |
|-----------|---------------------------|---------------------------|---------------------------|---------------------------|
| <b>AM</b> | 193.6 [7.62]              | 206.6 [8.13]              | 224.1 [8.82]              | 242.5 [9.55]              |
| <b>EC</b> | 92.1 [3.63]               | 83.9 [3.30]               | 94.1 [3.70]               | 113.6 [4.47]              |
| <b>ED</b> | 144.4 [5.69]              | 157.3 [6.19]              | 174.9 [6.89]              | 193.3 [7.61]              |
| <b>EG</b> | 74.6 [2.94]               | 66.4 [2.61]               | 76.6 [3.02]               | 96.1 [3.78]               |
| <b>EH</b> | 184.0 [7.24]              | 196.9 [7.75]              | 214.4 [8.44]              | 232.9 [9.17]              |

Size 210 and 250 are not available.

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