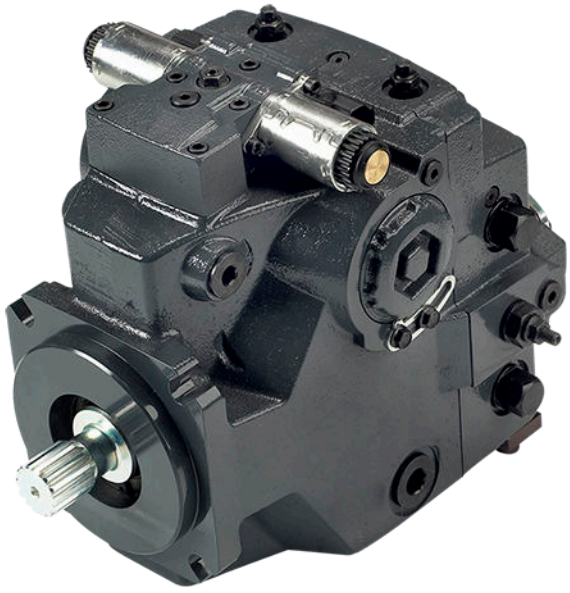
ENGINEERING
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Technical Information

# H1P 069/078
## Axial Piston Single Pumps



## Revision history

*Table of revisions*

| Date | Changed | Rev |
|---|---|---|
| June 2025 | Added HLC control | 1401 |
| August 2023 | Various updates, updated thread information for aux pads | 1302 |
| May 2022 | Corrected HDC control information | 1301 |
| December 2021 | Added HDC control | 1201 |
| April 2021 | Removed case pressure ports | 1105 |
| April 2020 | Corrected swash plate angle sensor connector and CCO connector descriptions | 1104 |
| February 2020 | Added NFPE control options and changed document number from BC00000058 | 1103 |
| June 2019 | Major revision. | 1001 |
| June 2018 | FDC topic added. | 0902 |
| May 2018 | Angle sensor for EDC; FDC note added. | 0901 |
| May 2017 | NFPE gen. 3 changes. | 0801 |
| November 2015 | Master Model Code changes. | 0700 |
| 2010-2014 | Various changes. | BA-GB |
| Jul 2009 | First edition | AA |

## Contents

**Technical Specifications**

H1 Pumps General Specification....6
H1P 069/078 Technical Data....6
Operating Parameters....7
Fluid Specification....8
Mounting Flange Loads....8
Bearing Life and External Radial Shaft Loads....9
Charge pump....10
- Charge Pump Selection....10
- 14/17 $cm^3$ Charge Pump – Flow and Power Curves....10

**Master Model Code**

Displacement, A—Rotation, B—Product Version, Z—Port Configuration....11
D—Controls....12
- Electronic Displacement Controls....12
- Fan Drive Controls....12
- Forward-Neutral-Reverse (FNR) Controls....12
- Non-Feedback Proportional Electric (NFPE) Controls....12
- Hybrid Load Controls (HLC)....13
- Automotive Controls....13
- Manual Displacement Control....13
- Hydraulic Displacement Control....13

F—Orifices, E—Displacement Limiters....14
G—Endcap....15
H—Mounting Flange, J—Input Shaft, K—Aux Pad....16
M, N—Overpressure Protection Settings....17
S—Charge Pump, T—Filtration, V—Charge Pressure Relief....18
W—Special Hardware, X—Paint, Y—Special Features....19

**Control Options**

Electrical Displacement Control (EDC)....20
- EDC Operation....20
- Control signal requirements....21
- Control Solenoid Data....21
- Single Pump Output Flow Direction....21
- Connector....22
- Control response....22
- Response Time....22

Manual Displacement Control (MDC)....23
- MDC operation....23
- MDC shaft rotation....24
- MDC Torque....24
- Control response....24
- Response time....25
- Neutral start switch (NSS)....25
- Connector....25
- Case Gauge Port M14....26
- Lever....26

Hydraulic Displacement Control (HDC)....27
- HDC principle....27
- HDC operation....27
- Hydraulic signal pressure range....28
- Pump output flow direction vs. control pressure....28
- Control response....28
- Response time, HDC 069/078....29

Forward-Neutral-Reverse Control (FNR)....30
- FNR Solenoid Data....30
- Single Pump Output Flow Direction....31
- Connector....31
- Control response....31

## Contents

Response Time....31
Non feedback proportional electric control (NFPE)....32
Control Signal Requirements....32
Control Solenoid Data....33
Single Pump Output Flow Direction....33
Connector....33
Control response....34
Response Time....34
Hybrid Load Control (HLC)....35
HLC Operation....35
Control mode actuation, EDC vs. NFPE....36
HLC Control signal requirements....36
HLC Single Pump Output Flow Direction....37
Connector....37
Control response....38
HLC Response Time....38
Automotive Control (AC)....38
Mode types....38
Basic functions....39
Performance functions....39
Protection and safety functions....39
Engine control and protection....39
Installation features....40
Fan Drive Control (FDC)....41
Control Signal Requirements....42
Control Solenoid Data....42
Single Pump Output Flow Direction....43
Connector....43
Control response....43
Response Time....43
Manual Override (MOR)....44
Swashplate angle sensor for EDC controls....45
Swash plate angle sensor parameters (EDC)....45
Swashplate Angle Sensor Connector....46
Interface with ECU (EDC)....46
Swash Plate Angle Sensor for NFPE and AC2 Controls....47
Swash Plate Angle Characteristic....47
Swash Plate Angle Sensor Parameters (NFPE/AC)....48
Swash Plate Angle Sensor Connector (NFPE)....48
Interface with ECU (NFPE)....48
Control Cut Off Valve (CCO)....49
Brake gauge port with MDC....49
CCO Connector (MDC)....50
H1P CCO Connector (EDC, NFPE)....50
CCO solenoid data....50
Displacement Limiter....51
H1P 069/078 Displacement Change (approximately)....51

**Dimensions and Data**

H1P 069/078 Input Shaft Option G1 (SAE C, 14 teeth)....52
H1P 069/078 Input Shaft Option G9 (SAE C-C, 23 teeth)....53
H1P 069/078 Input Shaft Option F1 (SAE C, 21 teeth)....54
H1P 069/078 Input Shaft Option F4, Code 38–3....55
Tapered shaft customer acknowledgement....55
H1P Auxiliary Mounting, Option H1, A2 (SAE A, 11 teeth)....56
H1P Auxiliary Mounting, Option H2, A2 (SAE A, 9 teeth)....57
H1P Auxiliary Mounting, Option H3, A3 (SAE B, 13 teeth)....58
H1P Auxiliary Mounting, Option H5, A4 (SAE B-B, 15 teeth)....59
H1P Auxiliary Mounting, Option H6, A5 (SAE C, 14 teeth)....60
H1P Displacement Limiter, Option B....61

## Contents

Single Pump Ports....62
H1P Dimensions....63
Controls....66
EDC Options A2 and A3 (12/24 V)....66
EDC with MOR, Options A4 and A5 (12/24 V)....67
EDC with CCO (key C), Options E7 and E8 (12/24 V)....68
EDC with ASNSR, Options: H2 and H3 (12/24 V)....69
EDC with MOR and ASNSR, Options H6 and H7 (12/24 V)....70
EDC with CCO and ASNSR, Options H8 and H9 (12/24 V)....71
MDC Option: M1....72
MDC with Neutral Start Switch Option: M2....73
MDC with CCO, Options: M3, M4....74
MDC with NSS and CCO Options: M5, M6....75
HDC, Options: T1, T2....76
NFPE with MOR, Options: N1, N2 (12/24 V)....77
NFPE with MOR, CCO, ASNSR, Options: N3, N4 (12/24 V)....78
NFPE with MOR and ASNSR, Options: N5, N6 (12/24 V)....79
NFPE with MOR and CCO, Options: N7, N8 (12/24 V)....80
HLC Options V1 and V2 (12/24 V)....81
HLC with ASNSR, Options: V3 and V4 (12/24 V)....82
Automotive control (AC)....83
AC connectors dimensions....84
Filtration....85
Suction Filtration Option L....85
Remote Full Charge Pressure Filtration Option P....85
Integral Full Flow Charge Pressure Filtration, Option M....86
External Full Flow Charge Pressure Filtration, Option S....87

## Technical Specifications

### H1 Pumps General Specification

Axial piston closed circuit variable displacement pumps of cradle swash-plate design with clockwise or counterclockwise direction of rotation.

#### Pipe connections

- Main pressure ports: ISO split flange boss
- Remaining ports: SAE straight thread O-ring boss

#### Recommended installation position

Pump installation position is discretionary, however the recommended control position is on the top or at the side with the top position preferred. If the pump is installed with the control at the bottom, flushing flow must be provided through port M14 located on the EDC, FNR and NFPE control.

Vertical input shaft installation is acceptable. If input shaft is at the top, 1 bar case pressure must be maintained during operation. The housing must always be filled with hydraulic fluid. Recommended mounting for a multiple pump stack is to arrange the highest power flow towards the input source. Consult Danfoss for nonconformance to these guidelines.

#### Auxiliary cavity pressure

Auxiliary cavity pressure will be inlet pressure with internal charge pump or case pressure with external charge supply. For reference see Operating Parameters. Please verify mating pump shaft seal capability.

### H1P 069/078 Technical Data

| Feature | Size 069 | Size 078 | Size |
|---|---|---|---|
| **Displacement** | 69.2 $cm^3$ [4.22 $in^3$] | 78.1 $cm^3$ [4.77 $in^3$] | $cm^3$ [ $in^3$] |
| **Flow at rated speed** | 243 l/min [53.5 US gal/min] | 273 l/min [72 US gal/min] | l/min [ US gal/min] |
| **Torque at maximum displacement (theoretical)** | 1.1 N•m/bar [672 lbf•in/1000 psi] | 1.24 N•m/bar [758 lbf•in/1000 psi] | N•m/bar [ lbf•in/1000 psi] |
| **Mass moment of inertia of rotating components** | 0.0077 kg•$m^2$ [0.0057 slug•$ft^2$] | 0.0094 kg•$m^2$ [0.0069 slug•$ft^2$] | kg•$m^2$ [ slug•$ft^2$] |
| **Mass (dry–no charge pump)** | 56 kg [123 lb] | 56 kg [123 lb] | 56 kg [123 lb] |
| **Oil volume** | 2.0 l [0.5 US gal] | 2.0 l [0.5 US gal] | 2.0 l [0.5 US gal] |

*Shaft, flange and ports description*

| | |
|---|---|
| **Input shaft per ISO 3019-1 (outer diameter)** | • Outer Ø32 mm – 4 (SAE C, 14 teeth)<br>• Outer Ø35 mm – 4 (SAE C, 21 teeth)<br>• Outer Ø38 mm – 4 (SAE C-C, 23 teeth)<br>• Conical key code 38-3, taper 1:8 |
| **Mounting flange per ISO 3019-1** | Flange 127-4 (SAE C) |
| **Auxiliary mounting flange with metric fasteners, with shaft outer diameter** | • Flange 82-2 (SAE A, 9 teeth and 11 teeth)<br>• Flange 101-2 (SAE B, 13 teeth and SAE B-B, 15 teeth)<br>• Flange 127-4 (SAE C, 14 teeth) |
| **Suction port per ISO 3019-1** | $1^5/_{16}$–12 (SAE O-ring boss) |
| **Main configuration port** | Ø25.4 mm – 450 bar; Split flange boss per ISO 6162; M12x1.75; 20 min. full thread depth |
| **Case drain ports L2, L4 per ISO 3019-1** | $1^1/_{16}$–12 (SAE O-ring boss) |

## Technical Specifications

*Shaft, flange and ports description (continued)*

| | |
|---|---|
| **Other ports** | SAE O-ring boss |
| **Customer interface threads** | Metric fasteners |

### Operating Parameters

| **Parameter** | | **Unit** | **Size 147/165** | **Size 180** |
|---|---|---|---|---|
| **Input speed** | **Min. for internal[1] and external[2] charge supply** | $min^{-1}$ (rpm) | 500 | |
| | **Min. for full performance, internal charge supply** | | 1200 | |
| | **Rated** | | 3500 | |
| | **Maximum** | | 4000 | |
| **System pressure** | **Maximum working** | bar [psi] | 450 [6527 ] | [ ] |
| | **Maximum** | | 480 [6962] | [] |
| | **Max./Min. low loop** | | 45/10 [650/145] | |
| **Charge pressure** | **Minimum** | bar [psi] | 16 [232] | |
| | **Maximum** | | 35 [508] | |
| **Control pressure** | **Minimum (at corner power for EDC, MDC, HDC, FNR)** | | 14 [203] | |
| | **Minimum (at corner power for NFPE, FDC, AC)** | | 25 [363] | |
| | **Maximum** | | 40 [580] | |
| **Charge pump inlet pressure** | **Rated** | bar (absolute) [in Hg vacuum] | 0.7 [9.0] | |
| | **Minimum (cold start)** | | 0.2 [24.0] | |
| | **Maximum** | bar [psi] | 4.0 [58.0] | |
| **Case pressure** | **Rated** | | 3.0 [44.0] | |
| | **Maximum** | | 5.0 [73.0] | |
| **Lip seal maximum pressure (external)** | | | 0.4 [5.8] | |

[1] Performance (displacement and pressure) may be limited due to limited control pressure.

[2] Full performance (displacement and pressure) possible at minimum charge and control pressure supply.

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

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

## Technical Specifications

### Fluid Specification

*Viscosity*

| | |
|---|---|
| **Intermittent[1)]** | 5 $mm^2/s$ [42 SUS] |
| **Minimum** | 7 $mm^2/s$ [49 SUS] |
| **Recommended range** | 12 – 80 $mm^2/s$ [66 – 370 SUS] |
| **Maximum** | 1600 $mm^2/s$ [7500 SUS] |

[1)] Intermittent = Short term t < 1 min per incident and not exceeding 2 % of duty cycle based load-life.

*Temperature*

| | |
|---|---|
| **Minimum [1)]** | -40°C [-40°F] |
| **Rated** | 104°C [220°F] |
| **Recommended range[2)]** | 60 – 85°C [140 – 185°F] |
| **Maximum Intermittent** | 115°C [240°F] |

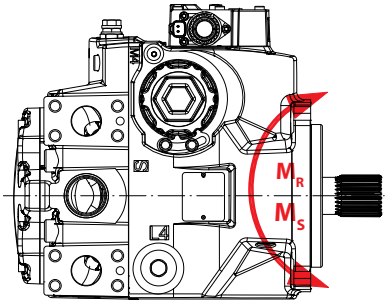
[1)] Cold start = Short term t > 3 min, p ≤ 50 bar [725 psi], n ≤ 1000 min-1 (rpm).

[2)] At the hottest point, normally case drain port.

### Mounting Flange Loads

The Rated and Shock load moments apply for top or side orientation of control.

*Mounting flange load with control on top*




| | |
|---|---|
| **Rated moment** | $\mathbf{M_R}$ = 3700 N•m [32 750 lbf•in] |
| **Shock load moment** | $\mathbf{M_S}$ = 7900 N•m [ 69920 lbf•in] |

For more information, see *H1 Axial Piston Pumps, Basic Information,* **BC152886483968**, the section "Mounting flange loads".

## Technical Specifications

### Bearing Life and External Radial Shaft Loads

All external shaft loads affect bearing life. The pumps are designed with bearings that can accept some external radial loads. The external radial shaft load limits are a function of the load position and orientation, and the operating conditions of the unit.

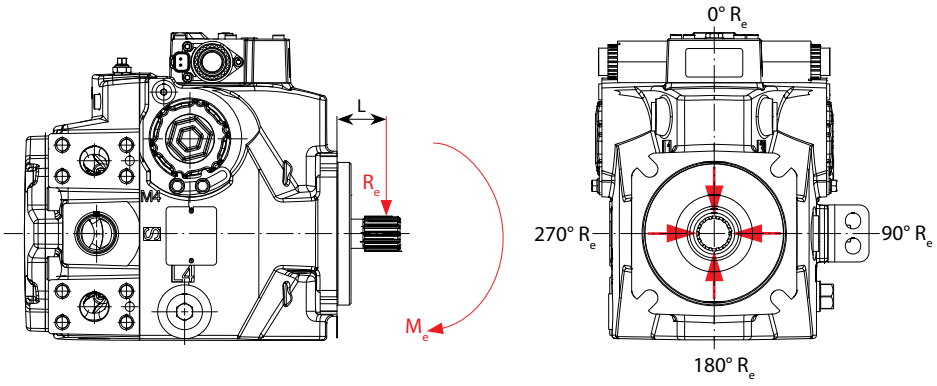
Danfoss recommends clamp-type couplings for applications with radial shaft loads. Contact your Danfoss representative for an evaluation of unit bearing life if you have continuously applied external loads exceeding 25 % of the maximum allowable radial load ($R_e$) or the pump swash-plate is positioned on one side of center all or most of the time.

*Maximum external shaft load based on shaft deflection*

| External radial moment | Unit | Size 069/078 |
|---|---|---|
| $M_e$ | N•m [lbf•in] | 109 [965] |

External radial shaft loads impact lifetime. For lifetime calculations please contact your Danfoss representative. In applications with external shaft loads, minimize the impact by positioning the load at 0° or 180° as shown below.

*Radial load position*




The maximum allowable radial shaft load ($R_e$) is based on the maximum external moment ($M_e$) and the distance (L) from the mounting flange to the load. It may be determined using the following formula:

$$R_e = \frac{M_e}{L}$$

Thrust loads should be avoided. Contact your Danfoss representative in the event thrust loads are anticipated.

## Technical Specifications

### Charge pump

#### Charge Pump Selection

In most applications a general guideline is that the charge pump displacement should be at least 10% of the total displacement of all components in the system. Unusual application conditions may require a more detailed review of charge flow requirements. System features and conditions which may invalidate the 10% guideline include (but are not limited to):

- Continuous operation at low input speeds < 1500 $min^{-1}$ (rpm)
- High shock loading and/or long loop lines
- High flushing flow requirements
- Multiple low speed high torque motors
- High input shaft speeds

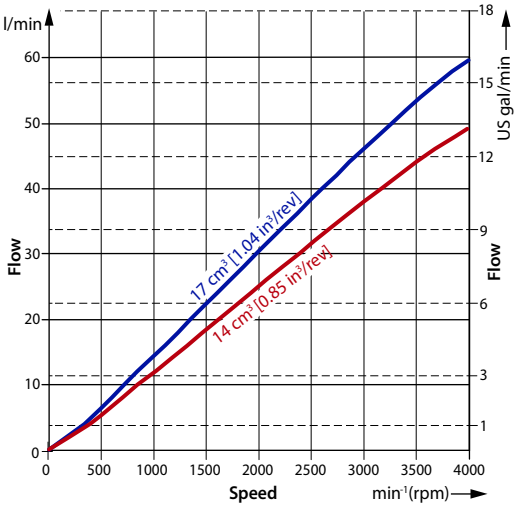
Contact your Danfoss representative for application assistance if your application includes any of these conditions.

#### 14/17 $cm^3$ Charge Pump – Flow and Power Curves

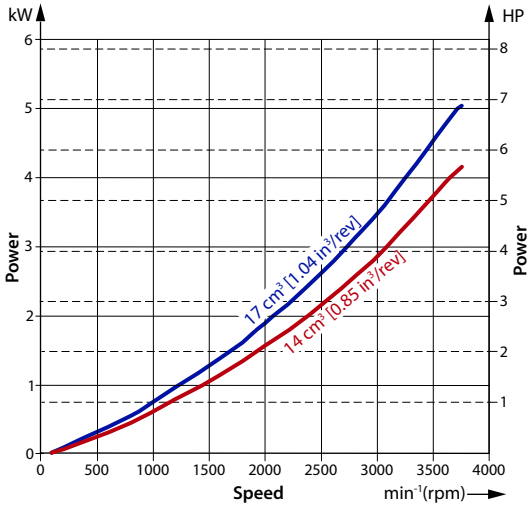
Charge pump flow and power requirements curves shown below at the following conditions:

Charge pressure = 20 bar [290 psi]
Viscosity = 11 $mm^2/s$ [63 SUS]
Temperature = 80°C [176°F]

*Charge pump flow*

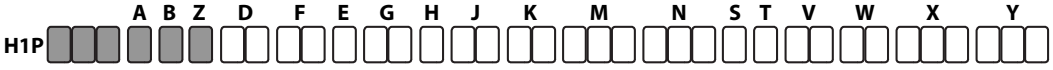



*Charge pump power requirements*



## Master Model Code

### Displacement, A—Rotation, B—Product Version, Z—Port Configuration




*Displacement*

| | |
|---|---|
| **069** | 69.2 $cm^3$ [4.22 $in^3$] |
| **078** | 78.1 $cm^3$ [4.77 $in^3$] |

*A – Direction of Rotation*

| | |
|---|---|
| **L** | Left hand (counter clockwise) |
| **R** | Right hand (clockwise) |

*B – Product version*

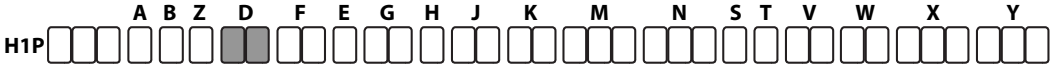
| | |
|---|---|
| **B** | Revision code |

*Z – Port configuration*

| | |
|---|---|
| **A** | Inch, Customer O-ring port sealing according to ISO 11926-1 |

## Master Model Code

### D—Controls




#### Electronic Displacement Controls

| Code | Control type | Voltage | MOR | CCO with key C | Angle sensor | Connector |
|---|---|---|---|---|---|---|
| **A2** | EDC | 12 V | — | — | — | DEUTSCH |
| **A3** | EDC | 24 V | — | — | — | DEUTSCH |
| **A4** | EDC | 12 V | ● | — | — | DEUTSCH |
| **A5** | EDC | 24 V | ● | — | — | DEUTSCH |
| **E7** | EDC | 12 V | — | ● | — | DEUTSCH |
| **E8** | EDC | 24 V | — | ● | — | DEUTSCH |
| **H2** | EDC | 12 V | — | — | ● | DEUTSCH |
| **H3** | EDC | 24 V | — | — | ● | DEUTSCH |
| **H6** | EDC | 12 V | ● | — | ● | DEUTSCH |
| **H7** | EDC | 24 V | ● | — | ● | DEUTSCH |
| **H8** | EDC | 12 V | — | ● | ● | DEUTSCH |
| **H9** | EDC | 24 V | — | ● | ● | DEUTSCH |

● – To be used for the control; — Not to be used for the control

#### Fan Drive Controls

| | | | |
|---|---|---|---|
| **F1** | FDC | 12 V | DEUTSCH Connector |
| **F2** | FDC | 24 V | DEUTSCH Connector |

*Align with options:* **F:** Orifices, **E:** Displacement limiters, **M, N:** Overpressure protection, and **W:** Special hardware.

#### Forward-Neutral-Reverse (FNR) Controls

| | | | | |
|---|---|---|---|---|
| **A9** | FNR | 12 V | with MOR | DEUTSCH Connector |
| **B1** | FNR | 24 V | with MOR | DEUTSCH Connector |

#### Non-Feedback Proportional Electric (NFPE) Controls

| Code | Control type | Voltage | MOR | CCO with key C | Angle sensor | Connector |
|---|---|---|---|---|---|---|
| **N1** | NFPE | 12 V | ● | — | — | DEUTSCH |
| **N2** | NFPE | 24 V | ● | — | — | DEUTSCH |
| **N3** | NFPE | 12 V | ● | ● | ● | DEUTSCH |
| **N4** | NFPE | 24 V | ● | ● | ● | DEUTSCH |
| **N5** | NFPE | 12 V | ● | — | ● | DEUTSCH |
| **N6** | NFPE | 24 V | ● | — | ● | DEUTSCH |
| **N7** | NFPE | 12 V | ● | ● | — | DEUTSCH |
| **N8** | NFPE | 24 V | ● | ● | — | DEUTSCH |

*Align with options:* **E:** Displacement limiters and **W:** Special hardware.

## Master Model Code

### Hybrid Load Controls (HLC)

*Hybrid Load Controls (HLC)*

| Code | Control type | Voltage | MOR | CCO with key C | Angle sensor | Connector |
|---|---|---|---|---|---|---|
| **V1** | HLC | 12 V | — | — | — | DEUTSCH |
| **V2** | HLC | 24 V | — | — | — | DEUTSCH |
| **V3** | HLC | 12 V | — | — | ● | DEUTSCH |
| **V4** | HLC | 24 V | — | — | ● | DEUTSCH |

### Automotive Controls

*Automotive Control (AC)*

| Code | AC type | Voltage | MOR | Speed sensor | Wire harness | Angle sensor | Connector |
|---|---|---|---|---|---|---|---|
| **P6** | AC–1 | 12 V | ● | ● | ● | — | DEUTSCH |
| **P7** | AC–1 | 24 V | ● | ● | ● | — | DEUTSCH |
| **P8** | AC–2 | 12 V | ● | ● | ● | ● | DEUTSCH |
| **P9** | AC–2 | 24 V | ● | ● | ● | ● | DEUTSCH |
| **P5** | AC–1 | 12 V | ● | — | — | — | DEUTSCH |
| **R3** | AC–1 | 24 V | ● | — | — | — | DEUTSCH |
| **R4** | AC–2 | 12 V | ● | — | — | ● | DEUTSCH |
| **R5** | AC–2 | 24 V | ● | — | — | ● | DEUTSCH |

● – To be used for the control; — Not to be used for the control

### Manual Displacement Control

*Manual Displacement Control (MDC)*

| Code | Control type | CCO Voltage | CCO | Neutral Start Switch | Connector |
|---|---|---|---|---|---|
| **M1** | MDC | — | — | — | — |
| **M2** | MDC | — | — | ● | DEUTSCH |
| **M3** | MDC | 12 V | ● | — | DEUTSCH |
| **M4** | MDC | 24 V | ● | — | DEUTSCH |
| **M5** | MDC | 12 V | ● | ● | DEUTSCH |
| **M6** | MDC | 24 V | ● | ● | DEUTSCH |

*Align with options* **F:** Orifices and **Y:** Settings for adjustment (if applicable).

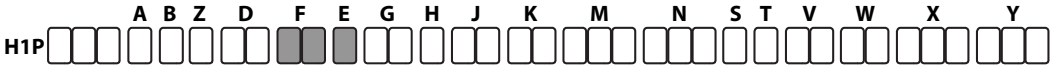
### Hydraulic Displacement Control

*Hydraulic Displacement Control (HDC)*

| Code | Pressure range | Ports |
|---|---|---|
| T1 | 4.2 - 16.2 bar | Inch ports 9/16-18 |
| T2 | 3.0 - 11.6 bar | Inch ports 9/16-18 |

## Master Model Code

### F—Orifices, E—Displacement Limiters




### F – Orifices Options

*Orifices options related to control type*

| Code | Tank (A+B) | P orifice | A/B orifices | EDC, FNR, HDC | MDC | NFPE, AC | FDC |
|---|---|---|---|---|---|---|---|
| **C3** | No orifice | | | ● | ● | – | – |
| **C1** | – | – | 0.8 mm | ● | ● | ● | – |
| **C2** | – | – | 1.3 mm | ● | ● | ● | ● |
| **C4** | – | – | 1.8 mm | ● | ● | ● | – |
| **C6** | 1.0 mm | – | – | – | ● | – | |
| **C7** | 1.3 mm | – | – | – | ● | – | – |
| **D1** | 0.8 mm | 1.0 mm | – | – | ● | – | – |
| **D2** | 0.8 mm | 1.3 mm | – | – | ● | – | – |
| **D3** | 1.0 mm | 1.3 mm | – | – | ● | – | – |
| **D4** | 1.0 mm | 1.3 mm | 1.3 mm | – | ● | – | – |
| **D5** | 0.6 mm | 0.6 mm | 0.8 mm | – | ● | – | – |
| **D6** | 1.3 mm | 1.3 mm | – | – | ● | – | – |
| **D7** | – | – | 3.0 mm | – | – | ● | – |

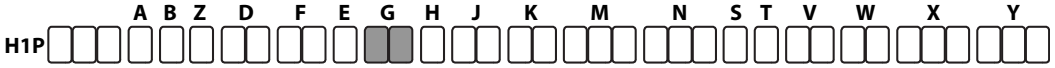
### E – Displacement Limiter Options

| | |
|---|---|
| **N** | None |
| **B** | Adjustable externally |
| **C** | No limiters, with nested springs, required for NFPE, AC, FDC* |
| **D** | Adjustable externally with nested springs, required for NFPE, AC, FDC* |

* Align with option **Y:** Settings for adjustment (if applicable).

## Master Model Code

### G—Endcap



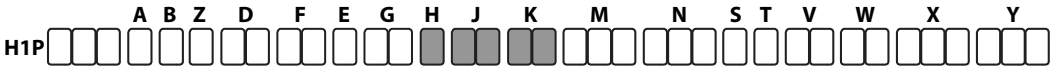

**G – End-cap Options**

*Split flange twin ports ISO 6162; Align with T: Filtration*

| | |
|---|---|
| **D3** | Integral pressure filtration, Code 62 |
| **D6** | Suction filtration, Code 62 |
| **D8** | Remote filtration, Code 62 |

## Master Model Code

### H—Mounting Flange, J—Input Shaft, K—Aux Pad




#### H – Mounting options

*Mounting to be aligned with option W: Special hardware*

| | |
|---|---|
| **H** | ISO 3019-1 flange 127–4 (SAE C) |
| **K** | ISO 3019-1 flange 127–4 (SAE C), 4-bolt, with speed sensor |

#### J – Input Shaft options

| | |
|---|---|
| **G1** | ISO 3019-1, outer Ø32 mm - 4 (14 teeth splined shaft 12/24 pitch) |
| **G9** | ISO 3019-1, outer Ø38 mm - 4 (23 teeth splined shaft 16/32 pitch |
| **F1** | ISO 3019-1, outer Ø35 mm - 4 (21 teeth splined shaft 16/32 pitch) |
| **F4** | Conical keyed shaft end, code 38-3 (similar to ISO 3019-1), taper 1:8 (key not supplied with pump) |

#### K – Auxiliary Mounting Pad options for 26cc and 34cc options (ISO 3019-1)

*Mounting to be aligned with option S: Charge pump options*

| | |
|---|---|
| **NN** | None |
| **H1** | Flange 82–2 (SAE A, 11 teeth, 16/32 coupling); shipping cover |
| **H2** | Flange 82–2 (SAE A, 9 teeth, 16/32 coupling); shipping cover |
| **H3** | Flange 101–2 (SAE B, 13 teeth, 16/32 coupling); shipping cover |
| **H5** | Flange 101–2 (SAE B-B, 15 teeth, 16/32 coupling); shipping cover |
| **H6** | Flange 127–4 (SAE C, 14 teeth, 12/24 coupling); shipping cover |

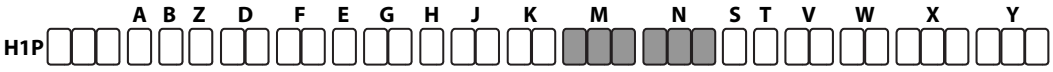
#### K – Auxiliary Mounting Pad options for 40cc option (ISO 3019-1)

*Mounting to be aligned with option S: Charge pump options*

| | |
|---|---|
| **AN** | None for 40cc charge pump |
| **A1** | Flange 82–2 (SAE A, 9 teeth, 16/32 coupling); shipping cover |
| **A2** | Flange 82–2 (SAE A, 11 teeth, 16/32 coupling); shipping cover |
| **A3** | Flange 101–2 (SAE B, 13 teeth, 16/32 coupling); shipping cover |
| **A4** | Flange 101–2 (SAE B-B, 15 teeth, 16/32 coupling); shipping cover |
| **A5** | Flange 127–4 (SAE C, 14 teeth, 12/24 coupling); shipping cover |

## Master Model Code

### M, N—Overpressure Protection Settings




**M and N – Overpressure protection options**

| L | Pressure limiter setting | HPRV with bypass setting[1)] |
|---|---|---|
| **L15** | 150 bar [2176 psi] | 200 bar [2900 psi] |
| **L18** | 180 bar [2610 psi] | 230 bar [3336 psi] |
| **L20** | 200 bar [2900 psi] | 250 bar [3630 psi] |
| **L23** | 230 bar [3336 psi] | 280 bar [4061 psi] |
| **L25** | 250 bar [3630 psi] | 300 bar [4350 psi] |
| **L28** | 280 bar [4061 psi] | 330 bar [4786 psi] |
| **L30** | 300 bar [4350 psi] | 350 bar [5076 psi] |
| **L33** | 330 bar [4786 psi] | 380 bar [5510 psi] |
| **L35** | 350 bar [5080 psi] | 400 bar [5800 psi] |
| **L38** | 380 bar [5510 psi] | 420 bar [6090 psi] |
| **L40** | 400 bar [5800 psi] | 450 bar [6526 psi] |
| **L42** | 420 bar [6090 psi] | 450 bar [6526 psi] |
| **L43** | 430 bar [6237 psi] | 480 bar [6962 psi] |
| **L44** | 440 bar [6382 psi] | 480 bar [6962 psi] |
| **L45** | 450 bar [6526 psi] | 480 bar [6962 psi] |
| **Overpressure protection type and setting for FDC** | | |
| **F01** | 150 bar [2175 psi] | 250 bar [3630 psi] |
| **F02** | 150 bar [2175 psi] | 300 bar [4350 psi] |
| **F03** | 150 bar [2175 psi] | 350 bar [5076 psi] |

[1)] Pressure limiter and HPRV with bypass, over-pressure protection type must be the same for both sides “A” and “B”.

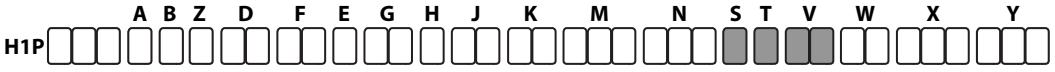
| K | Pressure setting [1)] |
|---|---|
| **K18** | 180 bar [2610 psi] |
| **K20** | 200 bar [2900 psi] |
| **K23** | 230 bar [3336 psi] |
| **K25** | 250 bar [3630 psi] |
| **K28** | 280 bar [4061 psi] |
| **K30** | 300 bar [4350 psi] |
| **K33** | 330 bar [4786 psi] |
| **K35** | 350 bar [5076 psi] |
| **K38** | 380 bar [5510 psi] |
| **K40** | 400 bar [5800 psi] |
| **K42** | 420 bar [6090 psi] |
| **K45** | 450 bar [6526 psi] |

[1)] Pressure limiter and HPRV with bypass, over-pressure protection type must be the same for both sides “A” and “B”.

## Master Model Code

Please contact Danfoss Power Solutions for pressures not shown or for applied pressure above max. working pressure.

### S—Charge Pump, T—Filtration, V—Charge Pressure Relief




#### S – Charge pump options

*Charge pump to be aligned with option K: auxiliary mounting pad options*

| | |
|---|---|
| **F** | 14 $cm^3$/rev [0.85 $in^3$/rev] |
| **C** | 17 $cm^3$/rev [1.03 $in^3$/rev] |
| **N** | No charge pump, external charge supply (*Align with options:* **E, T**) |

#### T – Filtration options

*Filtration to be aligned with G: End cap selection*

| | |
|---|---|
| **L** | Suction filtration |
| **M** | Integral full charge flow filtration with bypass sensor, medium filter length **11004918** |
| **N** | Integral full charge flow filtration with bypass sensor, without filter |
| **P** | Remote full charge flow filtration |
| **E** | External full charge flow filtration (Align with options **N, S**) |

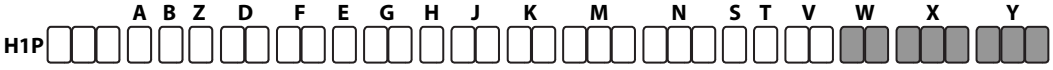
#### V – Charge pressure relief valve (CPRV) setting

| | |
|---|---|
| **20*** | 20 bar [290 psi] |
| **22*** | 22 bar [319 psi] |
| **24*** | 24 bar [348 psi] |
| **26** | 26 bar [377 psi] |
| **28** | 28 bar [406 psi] |
| **30** | 30 bar [435 psi] |
| **32** | 32 bar [464 psi] |
| **34** | 34 bar [493 psi] |

* Not to be used for **NFPE, AC** and **FDC** controls.

## Master Model Code

### W—Special Hardware, X—Paint, Y—Special Features




### W – Special Hardware features

*Hardware features to be aligned with options D, E*

| | |
|---|---|
| **P1** | NFPE/FDC valve plate |
| **P2** | NFPE/FDC/AC valve plate and speed ring on the cylinder block |
| **P4** | EDC/FNR/MDC valve plate and speed ring on the cylinder block |
| **PN** | EDC/FNR/MDC valve plate |
| **H1** | MDC/EDC/FNR valve plate with MDC handle |

### X – Paint and Name-tag

| | |
|---|---|
| **NNN** | Black paint and Danfoss name-tag |
| **C08** | Paint none and Danfoss name-tag |

### Y – Special settings (SIL-2 non-certifiable, without customer files)

| Code | CAN J1939 | ECO fuel saving mode | Functional option | Cruise control | Control | AC type |
|---|---|---|---|---|---|---|
| **D3E** | in/out | ● | E | – | N1 (12 $V_{DC}$) | AC–1 |
| **D3F** | in/out | – | F | – | | |
| **D4E** | in/out | ● | E | – | N2 (24 $V_{DC}$) | |
| **D4F** | in/out | – | F | – | | |
| **D5F** | in/out | – | F | – | P8 (12 $V_{DC}$) | AC–2 (with swash plate angle sensor) |
| **D5J** | in/out | ● | J | ● | | |
| **D6F** | in/out | – | F | – | P9 (24 $V_{DC}$) | |
| **D6J** | in/out | ● | J | ● | | |
| **M00** | MDC handle standard position | | | | | |
| **NNN** | None | | | | | |

● – To be used for the control; — Not to be used for the control

## Control Options

### Electrical Displacement Control (EDC)

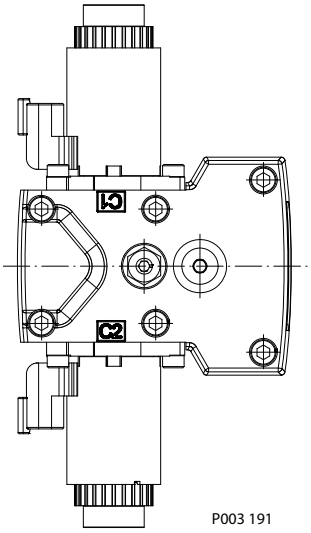
An EDC is a displacement (flow) control. Pump swash plate position is proportional to the input command and therefore vehicle or load speed (excluding influence of efficiency), is dependent only on the prime mover speed or motor displacement.

The Electrical Displacement Control (**EDC**) consists of a pair of proportional solenoids on each side of a three-position, four-way porting spool. The proportional solenoid applies a force input to the spool, which ports hydraulic pressure to either side of a double acting servo piston. Differential pressure across the servo piston rotates the swash plate, changing the pump's displacement from full displacement in one direction to full displacement in the opposite direction.

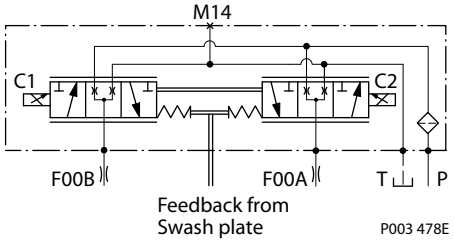
A serviceable 170 µm screen is located in the supply line immediately before the control porting spool.

Under some circumstances, such as contamination, the control spool could stick and cause the pump to stay at some displacement.

*Electrical Displacement Control*




*EDC schematic, feedback from swash plate*




### EDC Operation

H1 EDC's are current driven controls requiring a Pulse Width Modulated (PWM) signal. Pulse width modulation allows more precise control of current to the solenoids.

The PWM signal causes the solenoid pin to push against the porting spool, which pressurizes one end of the servo piston, while draining the other. Pressure differential across the servo piston moves the swashplate.

A swashplate feedback link, opposing control links, and a linear spring provide swashplate position force feedback to the solenoid. The control system reaches equilibrium when the position of the swashplate spring feedback force exactly balances the input command solenoid force from the operator. As hydraulic pressures in the operating loop change with load, the control assembly and servo/swashplate system work constantly to maintain the commanded position of the swashplate.

The EDC incorporates a positive neutral deadband as a result of the control spool porting, preloads from the servo piston assembly, and the linear control spring. Once the neutral threshold current is reached, the swashplate is positioned directly proportional to the control current. To minimize the effect of the control neutral deadband, we recommend the transmission controller or operator input device incorporate a jump up current to offset a portion of the neutral deadband.

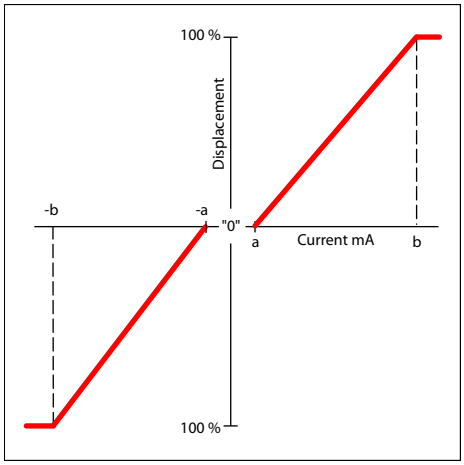
The neutral position of the control spool does provide a positive preload pressure to each end of the servo piston assembly.

When the control input signal is either lost or removed, or if there is a loss of charge pressure, the spring-loaded servo piston will automatically return the pump to the neutral position.

## Control Options

### Control signal requirements

*Pump displacement vs. control current*




*EDC control current*

| Voltage | | 12 $V_{DC}$ | 24 $V_{DC}$ |
|---|---|---|---|
| Minimum current to stroke pump | **a*** | 640 mA | 330 mA |
| | **b** | 1640 mA | 820 mA |
| Pin connections | | any order | |

* Factory test current, for vehicle movement or application actuation expect higher or lower value.

### Control Solenoid Data

| 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* | 100 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.

### Single Pump Output Flow Direction

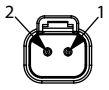
| Shaft rotation | Clock-Wise (CW) | | Counter-Clock-Wise (CCW) | |
|---|---|---|---|---|
| **Coil energized*** | **C1** | **C2** | **C1** | **C2** |
| Port A | out | in | in | out |
| Port B | in | out | out | in |
| Servo port pressurized | M4 | M5 | M4 | M5 |

* For coil location see installation drawings.

## Control Options

### Connector

*Connector DEUTSCH, 2-pin*




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

### Control response

H1P controls are available with optional control passage orifices to assist in matching the rate of swash-plate response to the application requirements (e.g. in the event of electrical failure).

The time required for the pump output flow to change from zero to full flow (acceleration) or full flow to zero (deceleration) is a net function of spool porting, orifices, and charge pressure.

A swash-plate response times table is available for each frame size. Testing should be conducted to verify the proper orifice selection for the desired response. Typical response times at the following conditions:

Δ p = 250 bar [3626 psi]
Charge pressure = 20 bar [290 psi]
Viscosity and temperature = 30 $mm^2/s$ [141 SUS] and 50 °C [122 °F]
Speed = 1800 $min^{-1}$ (rpm)

### Response Time

| Stroking direction | 0.8 mm [0.03 in] orifice | 1.3 mm [0.05 in] orifice | No orifice |
|---|---|---|---|
| Neutral to full flow | 1.9 s | 0.9 s | 0.6 s |
| Full flow to neutral | 1.6 s | 0.9 s | 0.5 s |

## Control Options

### Manual Displacement Control (MDC)

A Manual proportional Displacement Control (**MDC**) consists of a handle on top of a rotary input shaft. The shaft provides an eccentric connection to a feedback link. This link is connected on its one end with a porting spool. On its other end the link is connected the pumps swashplate.

This design provides a travel feedback without spring. When turning the shaft the spool moves thus providing hydraulic pressure to either side of a double acting servo piston of the pump.

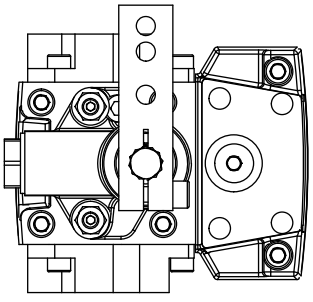
Differential pressure across the servo piston rotates the swash plate, changing the pump's displacement. Simultaneously the swashplate movement is fed back to the control spool providing proportionality between shaft rotation on the control and swash-plate rotation. The MDC changes the pump displacement between no flow and full flow into opposite directions.

Under some circumstances, such as contamination, the control spool could stick and cause the pump to stay at some displacement.

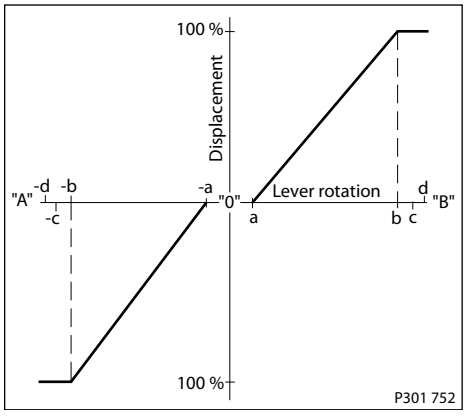
For the MDC with CCO option the brake port (X7) provides charge pressure when the coil is energized to activate static function such as a brake release. The X7 port must not be used for any continuous oil consumption.

The MDC is sealed by means of a static O-ring between the actuation system and the control block. Its shaft is sealed by means of a special O-ring which is applied for low friction. The special O-ring is protected from dust, water and aggressive liquids or gases by means of a special lip seal.

*Manual Displacement Control*



*Pump displacement vs. control lever rotation*




Deadband on **B** side: **a = 3° ±1°**
Maximum pump stroke: **b = 30° +2/-1°**
Required customer end stop: **c = 36° ±3°**
Internal end stop: **d = 40°**

### MDC operation

The MDC provides a mechanical dead-band required to overcome the tolerances in the mechanical actuation. The MDC contains an internal end stop to prevent turning the handle into any inappropriate position.

The MDC provides a permanent restoring moment appropriate for turning the MDC input shaft back to neutral position only. This is required to take the backlash out of the mechanical connections between the Bowden cable and the control.

High case pressure may cause excessive wear and the NSS to indicate that the control is not in neutral position. In addition, if the case pressure exceeds 5 bar there is a risk of an insufficient restoring moment. The MDC is designed for a maximum case pressure of 5 bar and a rated case pressure of 3 bar.

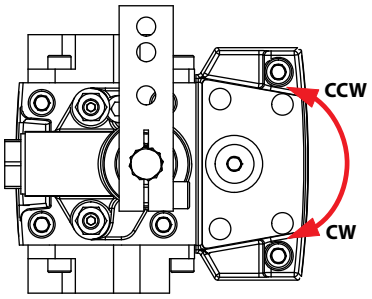
## Control Options

- Customers must install some support to limit the setting range of their Bowden cable to avoid an overload of the MDC.
- Customers can apply their own handle design but they must care about a robust clamping connection between their handle and the control shaft and avoid overload of the shaft.
- Customers can connect two MDC's on a tandem unit in such a way that the actuation force will be transferred from the pilot control to the second control. The kinematic of the linkages must ensure that either control shaft is protected from torque overload.

**Caution**

Using the internal spring force on the input shaft is not an appropriate way to return the customer connection linkage to neutral, or to force a Bowden cable or a joystick back to neutral position. It is not applicable for any limitation of the Bowden cable stroke, except the applied torque to the shaft will never exceed 20 N•m.

### MDC shaft rotation




| Pump shaft rotation* | Clockwise (CW) | | Counter-clockwise (CCW) | |
|---|---|---|---|---|
| **MDC shaft rotation** | **CW** | **CCW** | **CW** | **CCW** |
| Port A | in (low) | out (high) | out (high) | in (low) |
| Port B | out (high) | in (low) | in (low) | out (high) |
| Servo port high pressure | M5 | M4 | M5 | M4 |

* As seen from shaft side.

### MDC Torque

| Description | Value |
|---|---|
| Torque required to move handle to maximum displacement | 1.4 N•m [12.39 lbf•in ] |
| Torque required to hold handle at given displacement | 0.6 N•m [5.31 lbf•in] |
| Maximum allowable input torque | 20 N•m [177 lbf•in] |

**Caution**

Volumetric efficiencies of the system will have impacts on the start and end input commands.

### Control response

H1P controls are available with optional control passage orifices to assist in matching the rate of swash-plate response to the application requirements (e.g. in the event of electrical failure).

The time required for the pump output flow to change from zero to full flow (acceleration) or full flow to zero (deceleration) is a net function of spool porting, orifices, and charge pressure.

A swash-plate response times table is available for each frame size. Testing should be conducted to verify the proper orifice selection for the desired response. Typical response times at the following conditions:

Δ p = 250 bar [3626 psi]

## Control Options

Charge pressure = 20 bar [290 psi]
Viscosity and temperature = 30 $mm^2/s$ [141 SUS] and 50 °C [122 °F]
Speed = 1800 $min^{-1}$ (rpm)

### Response time

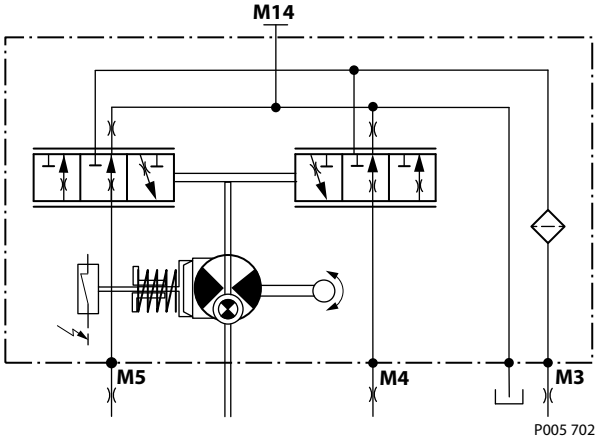
| Code | Orifice description (mm) | | | Stroking direction | |
|---|---|---|---|---|---|
| | Tank (A+B) | P | A/B | Neutral to full flow | Full flow to neutral |
| C3 | No orifice | | | 0.4 s | 0.5 s |
| C6 | 1 | – | – | 1.4 s | 1.1 s |
| C7 | 1.3 | – | – | 0.9 s | 0.8 s |
| D1 | 0.8 | 1 | – | 2.5 s | 1.9 s |
| D2 | 0.8 | 1.3 | – | 2.2 s | 1.7 s |
| D3 | 1 | 1.3 | – | 1.6 s | 1.2 s |
| D4 | 1 | 1.3 | 1.3 | 1.9 s | 1.5 s |

For further data please contact your Danfoss representative.

### Neutral start switch (NSS)

The Neutral Start Switch **(NSS)** contains an electrical switch that provides a signal of whether the control is in neutral. The signal in neutral is Normally Closed **(NC)**.

*Neutral start switch schematic*

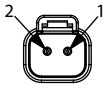



*Neutral start switch data*

| | |
|---|---|
| **Max. continuous current with switching** | 8.4 A |
| **Max. continuous current without switching** | 20 A |
| **Max. voltage** | 36 $V_{DC}$ |
| **Electrical protection class** | IP67 / IP69K with mating connector |

### Connector

*Connector DEUTSCH, 2-pin*



## Control Options

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

### Case Gauge Port M14

The drain port should be used when the control is mounted on the unit's bottom side to flush residual contamination out of the control.

### Lever

MDC-controls are available with an integrated lever.

## Control Options

### Hydraulic Displacement Control (HDC)

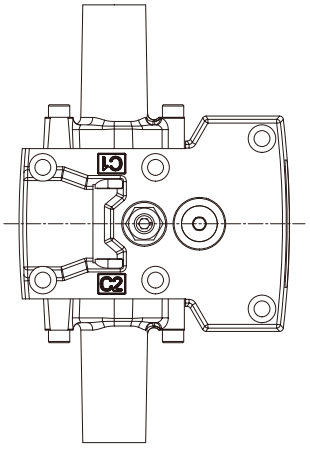
#### HDC principle

An HDC is a Hydraulic Displacement Control. Pump swashplate position is proportional to the input command and therefore vehicle speed or load speed (excluding influence of efficiency), is dependent only on the prime mover speed or motor displacement.

The HDC control uses a hydraulic input signal to operate a porting spool, which ports hydraulic pressure to either side of a double acting servo piston. The hydraulic signal applies a force input to the spool which ports hydraulic pressure to either side of a double acting servo piston. Differential pressure across the servo piston rotates the swashplate, changing the pump's displacement from full displacement in one direction to full displacement in the opposite direction. Under some circumstances, such as contamination, the porting spool could stick and cause the pump to stay at some displacement.

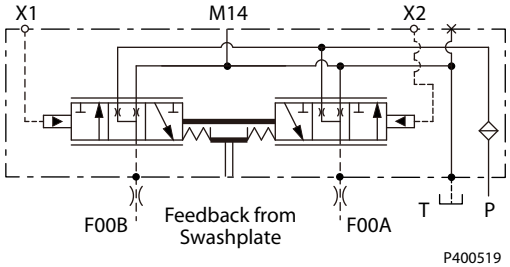
A serviceable 175 µm screen is located in the supply line immediately before the control porting spool.

*HDC control*




P400520

*HDC schematic*




P400519

#### HDC operation

HDC's are hydraulically driven control which ports hydraulic pressure to either side of a porting spool, which pressurizes one end of the servo piston, while draining the other end to case. Pressure differential across the servo piston moves the swashplate.

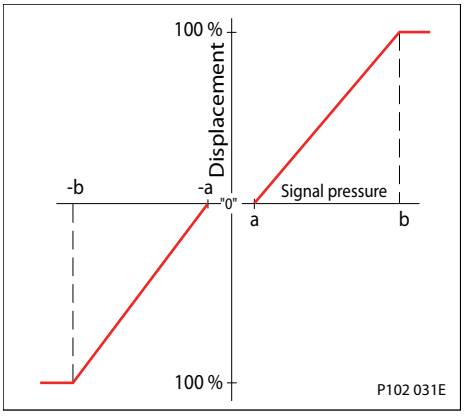
A swashplate feedback link, opposing control linkage, and a linear spring provide swashplate position force feedback to the hydraulic pressure. As hydraulic pressures in the operating loop change with load, the control assembly and servo/swashplate system work constantly to maintain the commanded position of the swashplate.

## Control Options

The HDC incorporates a positive neutral dead band as a result of the control spool porting, preloads from the servo piston assembly, and the linear control spring. Once the neutral threshold point is reached, the swashplate is positioned directly proportional to the control pressure.

When the control input is either lost or removed, or if there is a loss of charge pressure, the spring loaded servo piston will automatically return the pump to the neutral position.

*Pump displacement vs signal pressure*




### Hydraulic signal pressure range

| Option | Type | a* | b* | Max. pressure |
|---|---|---|---|---|
| T1 | Standard | 4.2 bar | 16.2 bar | 30 bar |
| T2 | Option | 3 bar | 11.6 bar | 30 bar |

* Factory test current, for vehicle movement or application actuation expect a higher or lower value.

### Pump output flow direction vs. control pressure

| Shaft rotation HDC | Clockwise (CW) seen from shaft | | Counter Clockwise (CCW) seen from shaft | |
|---|---|---|---|---|
| Port energized | X1 | X2 | X1 | X2 |
| Port A | Out (high) | In (low) | In (low) | Out (high) |
| Port B | In (low) | Out (high) | Out (high) | In (low) |
| Servo port high pressure | M4 | M5 | M4 | M5 |

For appropriate performance of HDC characteristic, keep the drain pressure of pilot valve to be equal or slightly higher than pump case pressure.

### Control response

H1P controls are available with optional control passage orifices to assist in matching the rate of swash-plate response to the application requirements (e.g. in the event of electrical failure).

The time required for the pump output flow to change from zero to full flow (acceleration) or full flow to zero (deceleration) is a net function of spool porting, orifices, and charge pressure.

A swash-plate response times table is available for each frame size. Testing should be conducted to verify the proper orifice selection for the desired response. Typical response times at the following conditions:

Δ p = 250 bar [3626 psi]
Charge pressure = 20 bar [290 psi]
Viscosity and temperature = 30 $mm^2/s$ [141 SUS] and 50 °C [122 °F]
Speed = 1800 $min^{-1}$ (rpm)

## Control Options

### Response time, HDC 069/078

| Stroking direction | 0.8 mm [0.03 in] orifice | 1.3 mm [0.05 in] orifice | No orifice |
|---|---|---|---|
| Neutral to full flow | 2.1s | 1s | 0.7s |
| Full flow to neutral | 1.5s | 0.7s | 0.4s |

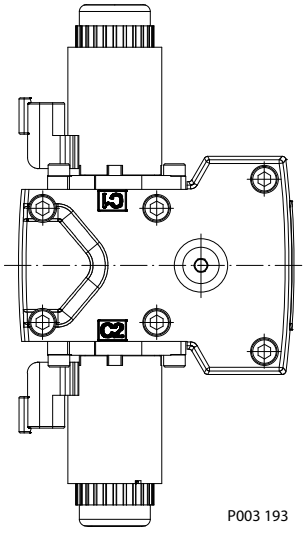
## Control Options

### Forward-Neutral-Reverse Control (FNR)

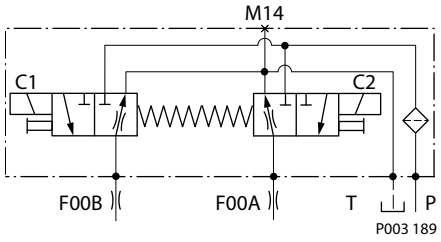
The 3-position FNR control options **A9** (12 V) and **B1** (24 V) uses an electric input signal to switch the pump to a full stroke position. A serviceable 125 µm screen is located in the supply line immediately before the control porting spool.

Under some circumstances, such as contamination, the control spool can stick and cause the pump to stay at some displacement.

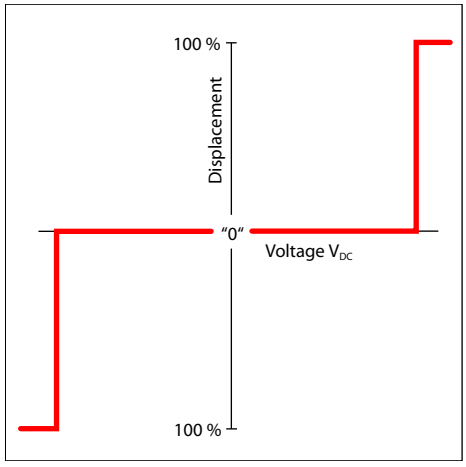
*Forward-Neutral-Reverse electric control (FNR)*




*FNR hydraulic schematic*




*Pump displacement vs. electrical signal*




*FNR control current*

| Voltage | 12 $V_{DC}$ | 24 $V_{DC}$ |
|---|---|---|
| Minimum current to stroke pump | 750 mA | 380 mA |
| Pin connections | any order | |

### FNR Solenoid Data

*Solenoid data*

| Voltage | 12 $V_{DC}$ | 24 $V_{DC}$ |
|---|---|---|
| **Minimum supply voltage** | 9.5 $V_{DC}$ | 19 $V_{DC}$ |
| **Maximum supply voltage (continuous)** | 14.6 $V_{DC}$ | 29 $V_{DC}$ |
| **Bi-directional diode cut off voltage** | 28 $V_{DC}$ | 53 $V_{DC}$ |
| **Maximum current** | 1050 mA | 500 mA |
| **Nominal coil resistance @ 20°C** | 8.4 Ω | 34.5 Ω |

## Control Options

*Solenoid data (continued)*

| Voltage | 12 $V_{DC}$ | 24 $V_{DC}$ |
|---|---|---|
| PWM Range | 70 – 200 Hz | |
| PWM Frequency (preferred)* | 100 Hz | |

* PWM signal required for optimum control performance.

| Electrical Protection | Standard | Class |
|---|---|---|
| IP Rating | IEC 60 529 | IP 67 |
| | DIN 40 050, part 9 | IP 69K with mating connector |

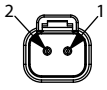
### Single Pump Output Flow Direction

| Shaft rotation | Clock-Wise (CW) | | Counter-Clock-Wise (CCW) | |
|---|---|---|---|---|
| Coil energized* | C1 | C2 | C1 | C2 |
| Port A | in | out | out | in |
| Port B | out | in | in | out |
| Servo port pressurized | M5 | M4 | M5 | M4 |

* For coil location see installation drawings.

### Connector

*Connector DEUTSCH, 2-pin*




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

### Control response

H1P controls are available with optional control passage orifices to assist in matching the rate of swash-plate response to the application requirements (e.g. in the event of electrical failure).

The time required for the pump output flow to change from zero to full flow (acceleration) or full flow to zero (deceleration) is a net function of spool porting, orifices, and charge pressure.

A swash-plate response times table is available for each frame size. Testing should be conducted to verify the proper orifice selection for the desired response. Typical response times at the following conditions:

Δ p = 250 bar [3626 psi]
Charge pressure = 20 bar [290 psi]
Viscosity and temperature = 30 $mm^2/s$ [141 SUS] and 50 °C [122 °F]
Speed = 1800 $min^{-1}$ (rpm)

### Response Time

| Stroking direction | 0.8 [0.03] orifice | 1.3 [0.05] orifice | No orifice |
|---|---|---|---|
| Neutral to full flow | 0.9 s | 1.0 s | 1.1 s |
| Full flow to neutral | 0.8 s | 0.9 s | 0.8 s |

## Control Options

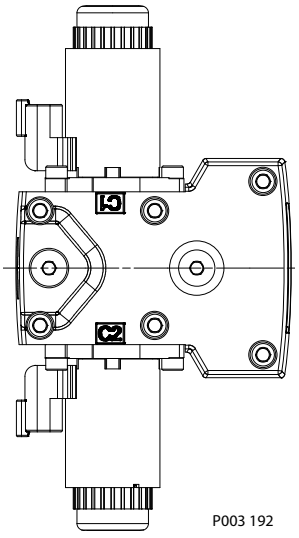
### Non feedback proportional electric control (NFPE)

The Non Feedback Proportional Electric (**NFPE**) control is an electrical automotive control in which an electrical input signal activates one of two proportional solenoids that port charge pressure to either side of the pump servo cylinder. The NFPE control has no mechanical feedback mechanism.

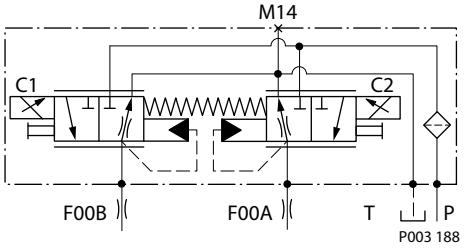
A serviceable 170 µm screen is located in the supply line immediately before the control porting spool.

Under some circumstances, such as contamination, the control spool could stick and cause the pump to stay at some displacement.

*NFPE control*




*NFPE schematic*

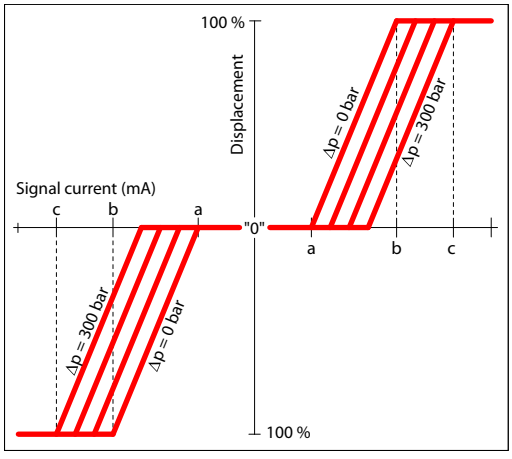



### Control Signal Requirements

The pump displacement is proportional to the solenoid signal current, but it also depends upon pump input speed and system pressure. This characteristic also provides a power limiting function by reducing the pump swash-plate angle as system pressure increases.

A typical response characteristic is shown in the accompanying graph below:

*Pump displacement vs. input signal*



## Control Options

*Control current requirements*

| Voltage* | a | b | c | Pin config. |
|---|---|---|---|---|
| 12 $V_{DC}$ | 694 mA | 1168 mA | 1540 mA | any order |
| 24 $V_{DC}$ | 347 mA | 600 mA | 770 mA | |

* Factory test current, for vehicle movement or application actuation expect higher or lower value.

### Control Solenoid Data

| 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* | 100 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.

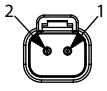
### Single Pump Output Flow Direction

| Shaft rotation | Clock-Wise (CW) | | Counter-Clock-Wise (CCW) | |
|---|---|---|---|---|
| Coil energized* | C1 | C2 | C1 | C2 |
| Port A | in | out | out | in |
| Port B | out | in | in | out |
| Servo port pressurized | M5 | M4 | M5 | M4 |

* For coil location see installation drawings.

### Connector

*Connector DEUTSCH, 2-pin*




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

## Control Options

### Control response

H1P controls are available with optional control passage orifices to assist in matching the rate of swash-plate response to the application requirements (e.g. in the event of electrical failure).

The time required for the pump output flow to change from zero to full flow (acceleration) or full flow to zero (deceleration) is a net function of spool porting, orifices, and charge pressure.

A swash-plate response times table is available for each frame size. Testing should be conducted to verify the proper orifice selection for the desired response. Typical response times at the following conditions:

Δ p = 250 bar [3626 psi]
Charge pressure = 20 bar [290 psi]
Viscosity and temperature = 30 $mm^2/s$ [141 SUS] and 50 °C [122 °F]
Speed = 1800 $min^{-1}$ (rpm)

### Response Time

| Stroking direction | 0.8 mm [0.03 in] orifice | 1.3 mm [0.05 in] orifice | 2.3 mm [0.09 in] orifice |
|---|---|---|---|
| Neutral to full flow | 2.9 s | 1.3 s | 0.6 s |
| Full flow to neutral | 1.6 s | 0.8 s | 0.3 s |

## Control Options

### Hybrid Load Control (HLC)

The Hybrid Load Control (**HLC**) is a displacement (flow) control that combines two basic behaviors in one unit:

- Load independent EDC behavior (EDC mode).
- Load dependent NFPE behavior (NFPE mode).

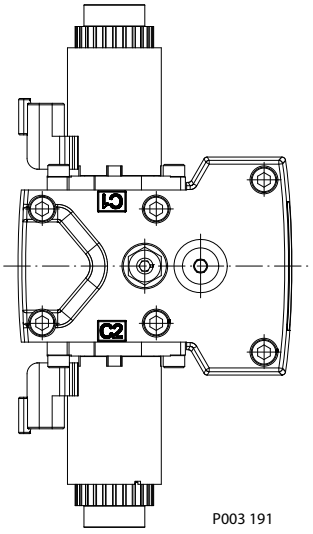
Pump swash plate position is proportional to the input command. The feedback link for the swashplate position is active when a bias current is applied. This enables the EDC control behavior in pumping mode.

Due to the two operation modes, the vehicle or load speed is dependent on pump displacement, the prime mover speed, and motor displacement in EDC mode. In NFPE mode it depends on pump displacement, prime mover speed, motor displacement, and **system load** (pressure).

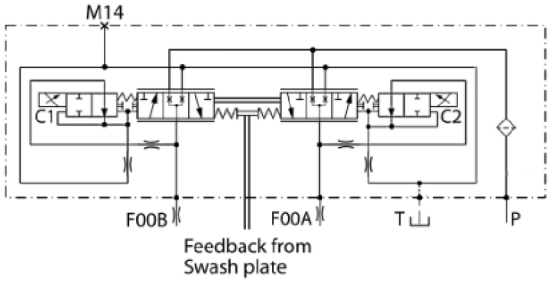
When the pump is in motoring mode (vehicle deceleration / braking), even in NFPE mode the pump almost behaves like in EDC mode. The load dependency in these operating conditions is a lot less compared to a standard NFPE control. This leads to a stronger and more controllable hydraulic braking of the application.

Under some circumstances, such as contamination, the control spool could stick and cause the pump to stay at some displacement.

*Hybrid load control*




*NFPE schematic*




#### HLC Operation

H1 pump HLC's are current driven controls requiring a Pulse Width Modulated (PWM) signal.

The PWM signal causes the solenoid pin to push against the porting spool, which pressurizes one end of the servo piston, while draining the other. Pressure differential across the servo piston moves the swashplate.

Based on the control spool design and two control characteristics, the current ranges for EDC and NFPE mode differ from each other (see section: *HLC Control signal requirements* on page 36 )

The HLC has a positive neutral deadband because of the control spool porting, preloads from the servo piston assembly, and the linear control spring. Once the neutral threshold current is reached, the swashplate is positioned directly proportional to the control current. To minimize the effect of the control neutral deadband, we recommend the transmission controller or operator input device to apply a jump up current close to offset a portion of the neutral deadband.

The neutral position of the control spool does provide a positive preload pressure to each end of the servo piston assembly.

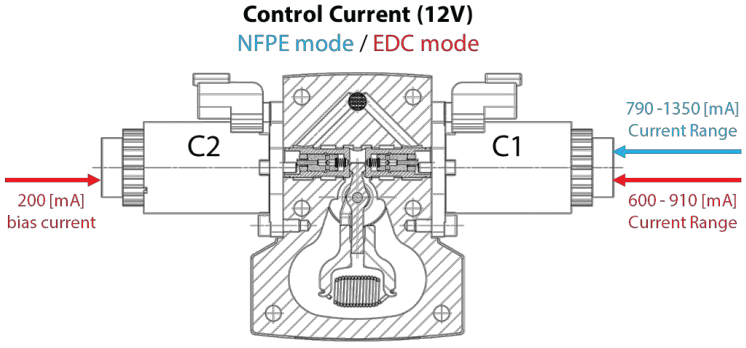
## Control Options

When the control input signal is either lost or removed, or if there is a loss of charge pressure, the spring-loaded servo piston will automatically return the pump to the neutral position.

### Control mode actuation, EDC vs. NFPE

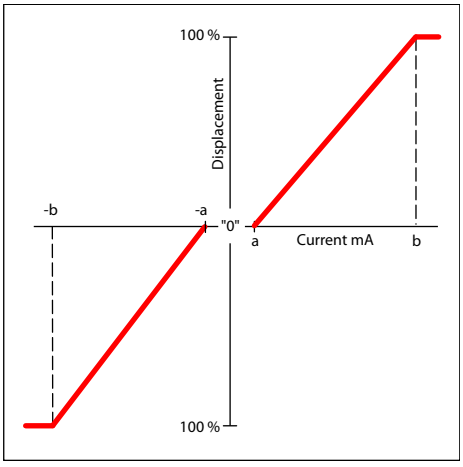
In standard operations, if there is only one coil activated the control is in NFPE mode. To activate the EDC mode a bias current of 200mA must be applied to both coils.

*HLC actuation*




### HLC Control signal requirements

*Pump displacement vs. control current in EDC mode*



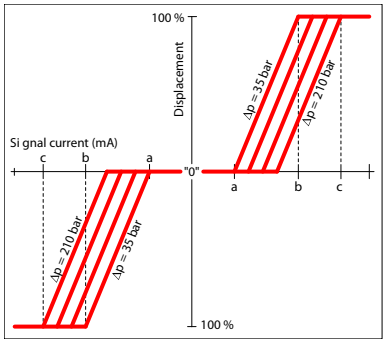

*EDC control current*

| **Voltage EDC mode** | | **12 $V_{DC}$** | **24 $V_{DC}$** |
|---|---|---|---|
| **Standby currrent (bias currrent)** | | **200mA** | **100mA** |
| Minimum current to stroke pump | **a*** | 600mA ± 80 mA | 300mA ± 55mA |
| | **b** | 910mA ± 55 mA | 455mA ± 55 mA |
| Pin connections | | any order | |

* Factory test current, for vehicle movement or application actuation expect higher or lower value.

## Control Options

*Pump displacement vs. control currrent, in NFPE mode*




| Voltage EDC mode | | 12 $V_{DC}$ | 24 $V_{DC}$ |
|---|---|---|---|
| Minimum current to stroke pump | **a*** | 790mA ± 80 mA | 395mA ± 40mA |
| | **b** | 1300mA ± 110 mA | 650mA ± 55 mA |
| | **c** | 1350mA ± 110 mA | 675mA ± 55 mA |
| Pin connections | | any order | |

* Factory test current, for vehicle movement or application actuation expect higher or lower value.

### HLC Single Pump Output Flow Direction

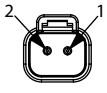
*Single Pump Output Flow Direction (NFPE and EDC)*

| Shaft rotation | Clock-Wise (CW) | | Counter-Clock-Wise (CCW) | |
|---|---|---|---|---|
| **Coil energized*** | **C1** | **C2** | **C1** | **C2** |
| Port A | out | in | in | out |
| Port B | in | out | out | in |
| Servo port pressurized | M4 | M5 | M4 | M5 |

* For coil location see installation drawings.

### Connector

*Connector DEUTSCH, 2-pin*




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

## Control Options

### Control response

H1P controls are available with optional control passage orifices to assist in matching the rate of swash-plate response to the application requirements (e.g. in the event of electrical failure).

The time required for the pump output flow to change from zero to full flow (acceleration) or full flow to zero (deceleration) is a net function of spool porting, orifices, and charge pressure.

A swash-plate response times table is available for each frame size. Testing should be conducted to verify the proper orifice selection for the desired response. Typical response times at the following conditions:

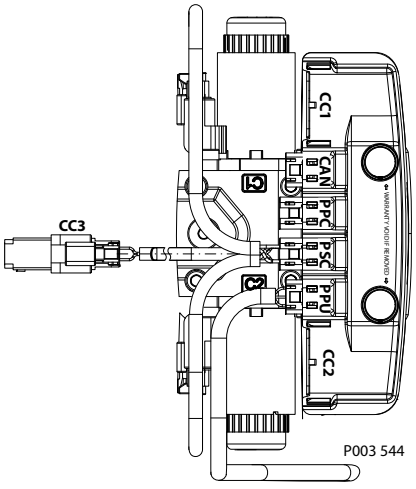
Δ p = 250 bar [3626 psi]
Charge pressure = 20 bar [290 psi]
Viscosity and temperature = 30 $mm^2/s$ [141 SUS] and 50 °C [122 °F]
Speed = 1800 $min^{-1}$ (rpm)

### HLC Response Time

| Stroking direction | 0.8 mm [0.03 in] orifice | 1.3 mm [0.05 in] orifice | No orifice |
|---|---|---|---|
| Neutral to full flow | 2.1 s | 1.0 s | 0.6 s |
| Full flow to neutral | 1.7 s | 0.8 s | 0.5 s |

## Automotive Control (AC)

The H1 **A**automotive **C**ontrol (AC) is an electric NFPE Control with an integrated micro-controller, installed on the pump. The integrated micro-controller enhanced control performance with a flexible, configurable control scheme for an entire single path propel transmission. It can be used in combination with fixed and variable displacement hydraulic-motors. With the pre-installed application software and easily changeable control parameters, it is possible to tailor the vehicle's driving behavior to the individual requirements of the customer.




The H1 Automotive Control is divided into 2 systems:

- AC-1
- AC-2

AC-2 is an extension of AC-1 that features an integrated pump swash plate angle sensor and software enabled functions such as Swash Plate Control.

### Mode types

The application software provides 3 different hydrostatic propel methods, defined as mode types, which can be used individually.

## Control Options

- **Automotive Load dependent** (torque controlled) driving behavior. Setpoint for the drive curve is the engine rpm.
- **Non-Automotive Load independent** (speed controlled) driving mode. Setpoint for the drive curve is a Joystick or drive pedal signal, independent of the engine rpm. The best performance will achieved with an AC-2 Swash Plate Angle Sensor.
- **Creep-Automotive Load dependent** (torque controlled) driving behavior (like Automotive). Setpoint for the drive curve is the engine rpm. The setpoint can be reduced by the creep potentiometer if a high engine rpm in combination with low vehicle speed is needed.

### Basic functions

- Four selectable system modes, selectable via switch.
- Individual settings for forward and reverse driving direction (4 x 2 curves).
- Independent pump and hydraulic-motor profiling and ramping for each mode.
- Electric drive pedal connection
- Electronic inching function without separate control valve
- Electric creep mode potentiometer
- Configurable System Mode & Direction change
- Load independent pump displacement control with integrated Swash Plate Angle Sensor (AC-2)
- Hydraulic-motor displacement control including brake pressure defeat function

### Performance functions

- ECO fuel saving mode with automatic reduction of the engine speed during transport (Cruise control)
- Vehicle constant speed drive control
- Vehicle speed limitation
- Dynamic brake light, automatic park brake, reverse buzzer and status LED outputs
- Vehicle speed controlled output function.
- Temperature compensation for predictable performance
- Advanced CAN J1939 interface for the information exchange with the vehicle control system

### Protection and safety functions

- Safety controlled vehicle start protection with engine speed check, battery check and FNR must be in neutral, etc..
- Operator presence detection
- Hydraulic system overheat and low-temperature protection
- Hydraulic motor over speed protection
- Park brake test mode for roller applications to fulfill SAE J1472 / EN500-4.
- SIL2 compliant

### Engine control and protection

- CAN J1939 engine interface
- Engine speed control via drive pedal with safety controlled monitoring function
- Engine antistall protection
- Engine over speed protection during inching
- Engine speed dependent Retarder control
- Engine cold start protection

## Control Options

### Installation features

- Factory calibration for hysteresis compensation.
- Starting current adjustment in the factory
- Pre-installed application software and parameter files

For more information, see *Automotive Control for H1 Single Pumps Technical Information*, **BC152986482596**.

## Control Options

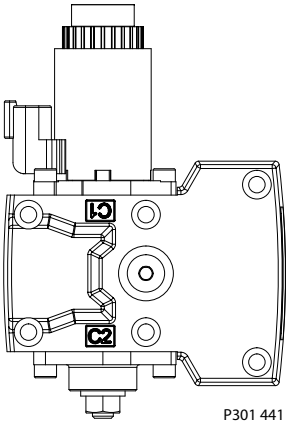
### Fan Drive Control (FDC)

The Fan Drive Control (**FDC**) is a non-feedback control in which an electrical input signal activates the proportional solenoid that ports charge pressure to either side of the pump servo cylinder. The single proportional solenoid is used to control pump displacement in the forward or reverse direction.

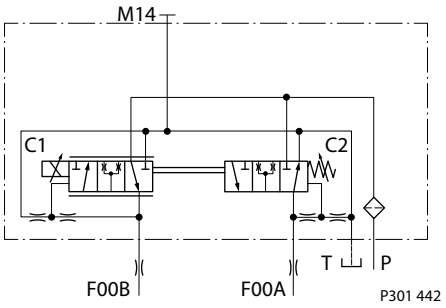
The control spool is spring biased to produce maximum forward pump displacement in the absence of an electrical input signal. Based on the spring bias spool default forward flow for a CW rotation pump is out of port B while default forward flow for a CCW rotation pump is out of port A.

Under some circumstances, such as contamination, the control spool could stick and cause the pump to stay at some displacement.

*FDC control*




*FDC schematic*




The pump should be configured with 0.8 mm control orifices to provide slowest response and maximize system stability. Additionally, pressure limiter (PL) valves are used to limit maximum fan trim speed in both (forward and reverse) directions.

H1 pumps with FDC will be delivered from factory with nominal pressure limiter setting of 150 bar [2175 psi]. The PL must be re-adjusted to ensure that the fan reaches the desired fan speed to satisfy the cooling needs of the system. HPRV setting must be always at least 30 bar [435 psi] higher than PL setting.

For more information necessary to properly size and configure a hydraulic fan drive system, see *Hydraulic Fan Drive Design Guidelines* **AB152886482265**.

**Warning**

Use in other systems could result in unintended movement of the machine or it's elements. Loss of the input signal to this control will cause the pump to produce maximum flow.
The FDC is for Fan Drive systems only!

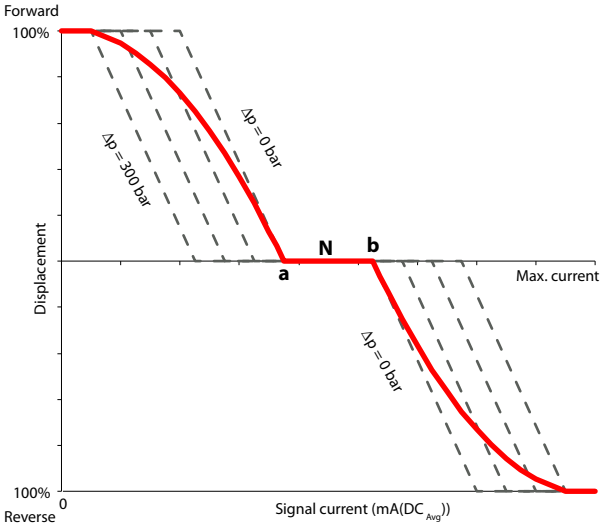
Due to the fail-safe functionality of the FDC control the pump will stroke to max. displacement in case the input signal to the pump control and the Diesel engine will be switched off at the same time. In this situation a low loop event can occur which may damage the pump. Therefore, it's strictly recommended to keep the input signal to the pump control alive while switching off the engine.

For further information please contact your Danfoss representative.

## Control Options

### Control Signal Requirements

The pump displacement is proportional to the solenoid signal current, but it also depends upon pump input speed and system pressure. This characteristic also provides a power limiting function by reducing the pump swash plate angle as system pressure increases. A typical response characteristic is shown in the accompanying graph below:




**a** – Forward threshold

**b** – Reverse threshold

**N** – Neutral override current

*Control current requirements*

| **Voltage*** | **a** | **N** | **b** | **Pin config.** |
|---|---|---|---|---|
| 12 $V_{DC}$ | 780 mA | 1100 mA | 1300 mA | any order |
| 24 $V_{DC}$ | 400 mA | 550 mA | 680 mA | |

* Factory test current, for fan movement expect higher or lower value.

### Control Solenoid Data

| **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* | 100 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.

## Control Options

### Single Pump Output Flow Direction

*Pump output flow direction vs. control signal*

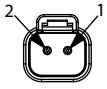
| Shaft rotation | | ClockWise | | | CounterClockWise | | |
|---|---|---|---|---|---|---|---|
| Control Logic | 12 V | 0-780 mA | 1100 mA | 1300-1800 mA | 0-780 mA | 1100 mA | 1300-1800 mA |
| | 24 V | 0-400 mA | 550 mA | 680-920 mA | 0-400 mA | 550 mA | 680-920 mA |
| Port A | | in | no flow | out | out | no flow | in |
| Port B | | out | no flow | in | in | no flow | out |
| Servo port pressurized | | M5 | n/a | M4 | M5 | n/a | M4 |

**Warning**

Loss of input signal to the control will cause the pump to produce maximum flow.

### Connector

*Connector DEUTSCH, 2-pin*




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

### Control response

H1P controls are available with optional control passage orifices to assist in matching the rate of swash-plate response to the application requirements (e.g. in the event of electrical failure).

The time required for the pump output flow to change from zero to full flow (acceleration) or full flow to zero (deceleration) is a net function of spool porting, orifices, and charge pressure.

A swash-plate response times table is available for each frame size. Testing should be conducted to verify the proper orifice selection for the desired response. Typical response times at the following conditions:

Δ p = 250 bar [3626 psi]
Charge pressure = 20 bar [290 psi]
Viscosity and temperature = 30 $mm^2/s$ [141 SUS] and 50 °C [122 °F]
Speed = 1800 $min^{-1}$ (rpm)

### Response Time

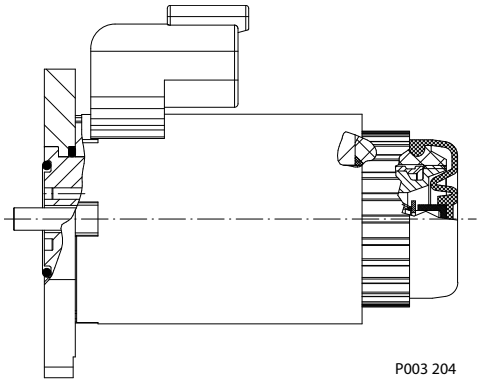
| Stroking direction | 0.8 mm [0.03 in] orifice |
|---|---|
| Full flow to neutral | 2.9 s |
| Full forward flow to full reverse flow | 4.3 s |

## Control Options

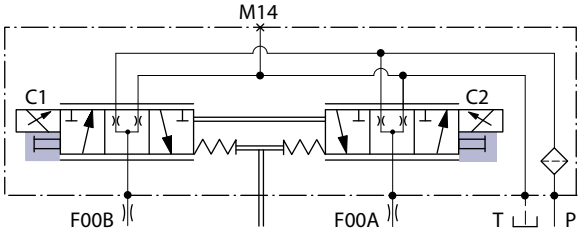
### Manual Override (MOR)

All controls are available with a manual override functionality, either as a standard or as an option for temporary actuation of the control to aid in diagnostics.

*Control with manual override*




*MOR schematic (EDC control shown)*




Feedback from swash plate.

The MOR plunger has a 4 mm diameter and must be manually depressed to be engaged. Depressing the plunger mechanically moves the control spool which allows the pump to go on stroke. The MOR should be engaged anticipating a full stroke response from the pump.

An o-ring seal is used to seal the MOR plunger where initial actuation of the function will require a force of 45 N to engage the plunger. Additional actuation typically require less force to engage the MOR plunger.

Proportional control of the pump using the MOR should not be expected.

**Warning**

Unintended MOR operation will cause the pump to go into stroke; *example:* vehicle lifted off the ground. The vehicle or device must always be in a safe condition when using the MOR function.

Refer to the pump output flow direction vs. control signal table for the relationship of solenoid to direction of flow.

## Control Options

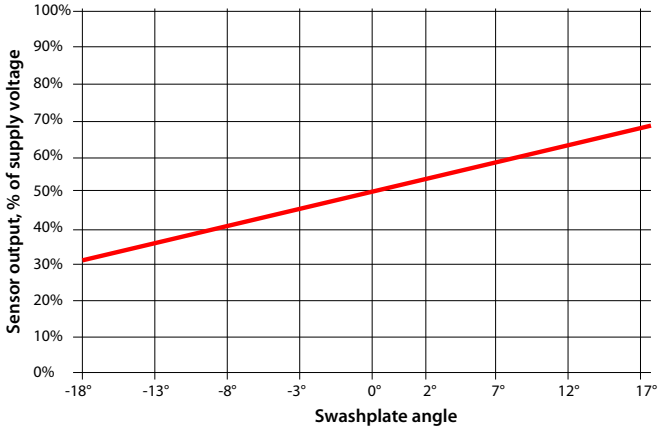
### Swashplate angle sensor for EDC controls

The angle sensor detects the swash plate position with an accuracy dependent upon the calibration effort done for the application and direction of rotation from the neutral position. At minimum the sensor can be used for forward, neutral and reverse (FNR) detection.

The sensor works on the hall-effect technology. The implemented technology is based on a measurement of the magnetic field direction in parallel to the chip surface. This field direction is converted to a voltage signal at the output.

Enhanced calibration of the non-linear behavior leads to more exact calculation of the pump swashplate angle. The 4-pin DEUTSCH connector is part of the sensor housing. The swashplate angle sensor is available for all EDC controls for 12 V and 24 V.

*Swashplate angle vs. output of supply voltage*




**Warning**

Strong magnetic fields in the proximity of the sensor can influence the sensor signal and must be avoided.

Contact your Danfoss representative in case the angle sensor will be used for safety functions.

### Swash plate angle sensor parameters (EDC)

| Parameter | Minimum | Typical | Maximum |
|---|---|---|---|
| **Supply voltage range** | 4.5 $V_{DC}$ | 5 $V_{DC}$ | 5.5 $V_{DC}$ |
| **Supply protection** | – | – | 18 $V_{DC}$ |
| **Pump neutral output (% of supply voltage)** | – | 50% | – |
| **Working range (swash plate angle)** | –18° | – | 18° |
| **Required supply current** | – | – | 30 mA |
| **Output current signal** | – | 9 mA | 11 mA |
| **Working temperature** | –40 °C | 80 °C | 115 °C |

| Electrical Protection | Standard | Class |
|---|---|---|
| IP Rating | IEC 60 529 | IP 67 |
| | DIN 40 050, part 9 | IP 69K with mating connector |
| EMC Immunity | ISO 11452-2 | 100 V/m |

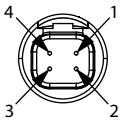
## Control Options

Calibration of the sensor output within the software is mandatory. Vehicle neutral thresholds in the software (±0.5°) are vehicle dependent and must consider different conditions, example: system temperature, system pressure and/or shaft speed.

**For safety function:** If the sensor fails (invalid signal <10% or >90% of supply voltage), it must be sure that the ECU will go into a diagnostic mode and shift into limited mode in order for the driver to take the full control or the mechanical breaks should be activated. Strong magnetic fields in the proximity of the sensor can influence the sensor signal and must be avoided.

### H1P Swash Plate Angle Sensor Connector

*Connector DEUTSCH, 4-pin*




**1** Ground (GND)

**2** Not connected

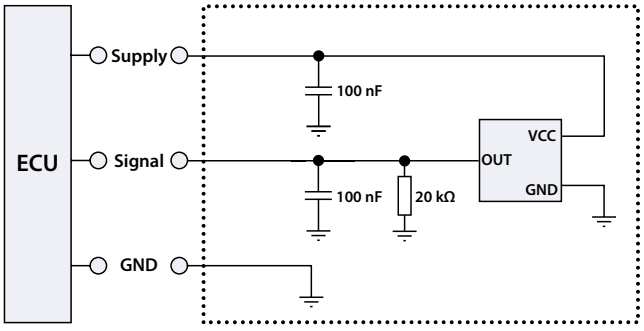
**3** Output signal 1 (SIG 1)

**4** Supply (V+)

| Description | Quantity | Order number |
|---|---|---|
| Mating connector | 1 | DEUTSCH DTM06-4S-E004 |
| Wedge lock | 1 | DEUTSCH WM-4S |
| Socket contact | 4 | DEUTSCH 0462-201-2031 |
| Blind socket | 1 | DEUTSCH 0413-204-2005 |
| Danfoss mating connector kit | 1 | 11212713 |

### Interface with ECU (EDC)

*Interface with ECU diagram*

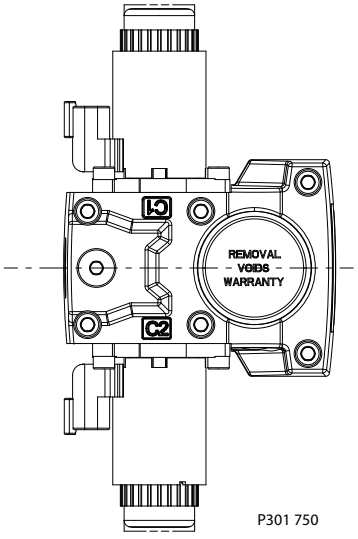


## Control Options

### Swash Plate Angle Sensor for NFPE and AC2 Controls

The angle sensor detects the swash plate angle position and direction of rotation from the zero position. The swash angle sensor works on the AMR sensing technology. Under the saturated magnetic field, the resistance of the element varies with the magnetic field direction.

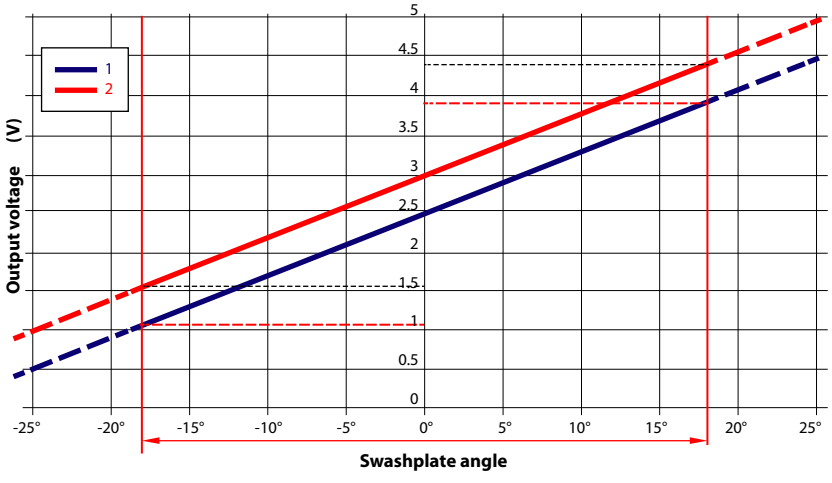
The output signal give a linear output voltage for the various magnet positions in the sensing range.




### Swash Plate Angle Characteristic

The volumetric losses depend on pump max. displacement, actual displacement, speed, delta pressure, viscosity and temperature.

*Swashplate angle vs. output voltage (calibrated at 50 °C)*




**1.** Signal 1 (nominal)

**2.** Signal 2 (redundant)

The displacement can be calculated by:

$$V = \frac{\tan \alpha \bullet V}{\tan 18°} \ (cm^3)$$

The corresponding flow is:

$$Q = \frac{V \bullet n \bullet \eta_{vol}}{1000} \ (l/min)$$

## Control Options

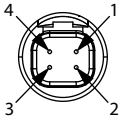
### Swash Plate Angle Sensor Parameters (NFPE/AC)

| Parameter | Minimum | Typical | Maximum |
|---|---|---|---|
| **Supply voltage range** | 4.75 V | 5 V | 5.25 V |
| **Supply protection** | – | – | 28 V |
| **Supply current** | – | 22 mA | 25 mA |
| **Output current (Signal 1, 2)** | – | 0.1 mA | – |
| **Short circuit output current to supply or GND[1)]** | – | – | 7.5 mA |
| **Sensitivity** | 70.0 mV/deg | 78.0 mV/deg | 85.8 mV/deg |
| **Working range (swash plate angle)** | –18° | 0° | 18° |
| **Correlation between signals 1 and 2[2)]** | 475 mV | 500 mV | 525 mV |

[1)] Up to duration of 2.5 seconds at 25°C

[2)] Signal 1 (nominal) is lower than signal 2 (redundant)

### Swash Plate Angle Sensor Connector (NFPE)




**1** Ground (GND)

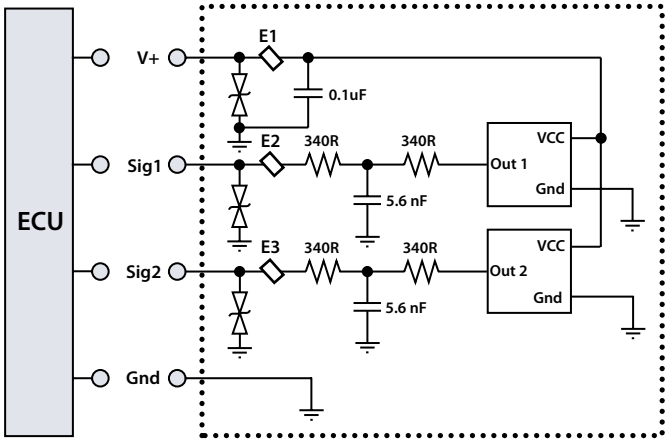
**2** Output Signal 2 (SIG 2) – Secondary (redundant)

**3** Output signal 1 (SIG 1)

**4** Supply (V+)

| Description | Quantity | Order number |
|---|---|---|
| Mating connector | 1 | DEUTSCH DTM06-4S-E004 |
| Wedge lock | 1 | DEUTSCH WM-4S |
| Socket contact | 4 | DEUTSCH 0462-201-2031 |
| Blind socket | 1 | DEUTSCH 0413-204-2005 |
| Danfoss mating connector kit | 1 | 11212713 |

### Interface with ECU (NFPE)




Minimum recommended load resistance is 100 kΩ.

## Control Options

### Control Cut Off Valve (CCO)

The H1 pump offers an optional control cut off valve integrated into the control. All EDC, NFPE and MDC controls are available with a CCO valve. This valve will block charge pressure to the control, allowing the servo springs to de-stroke both pumps regardless of the pump´s primary control input.

There is also a hydraulic logic port, X7, which can be used to control other machine functions, such as spring applied pressure release brakes. The pressure at X7 is controlled by the control cut off solenoid. The X7 port would remain plugged if not needed.

In the normal (de-energized) state of the solenoid charge flow is prevented from reaching the controls. At the same time the control passages and the X7 logic port are connected and drained to the pump case. The pump will remain in neutral, or return to neutral, independent of the control input signal. Return to neutral time will be dependent on oil viscosity, pump speed, swashplate angle, and system pressure.

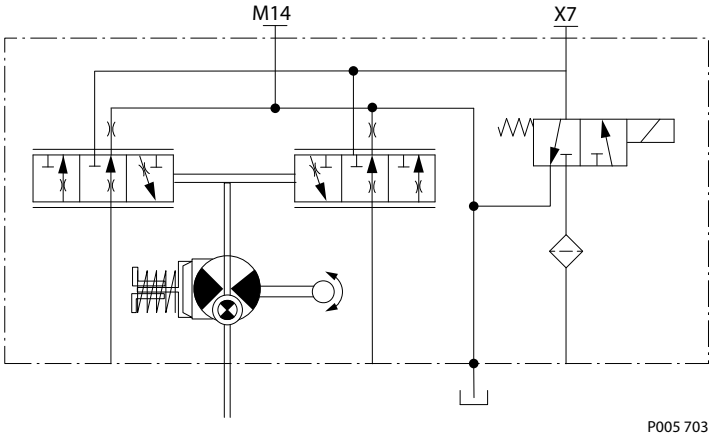
When the solenoid is energized, charge flow and pressure is allowed to reach the pump control. The X7 logic port will also be connected to charge pressure and flow.

The solenoid control is intended to be independent of the primary pump control making the control cut off an override control feature. It is however recommended that the control logic of the CCO valve be maintained such that the primary pump control signal is also disabled whenever the CCO valve is de-energized. Other control logic conditions may also be considered.

The CCO valve is available with 12 V or 24 V solenoid.

The response time of the unit depends on the control type and the used control orifices.

*CCO schematic (MDC shown)*




### Brake gauge port with MDC

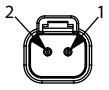
**Caution**

It is not recommended to use brake port for any external flow consumption to avoid malfunction of CCO function.

## Control Options

### CCO Connector (MDC)

*Connector DEUTSCH, 2-pin*




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

### H1P CCO Connector (EDC, NFPE)

*Connector CCO DEUTSCH, 2-pin with key C*




| Description | Quantity | Order number |
|---|---|---|
| Mating connector | 1 | DEUTSCH DT06-2S-C015 |
| Wedge lock | 1 | DEUTSCH W2SC-P012 |
| Socket contact | 4 | DEUTSCH 0462-201-16141 |
| Danfoss mating connector kit | 1 | 11212714 |

### CCO solenoid data

| Nominal supply voltage | | 12 V | 24 V |
|---|---|---|---|
| Supply voltage | Maximum | 14.6 V | 29 V |
| | Minimum | 9.5 V | 19 V |
| Bi-directional diode cut off voltage | | 28 V | 53 V |
| Nominal coil resistance at 20 °C | | 10.7 Ω | 41.7 Ω |
| Supply current | Maximum | 850 mA | 430 mA |
| | Minimum | 580 mA | 300 mA |
| PWM frequency | Range | 50 – 200 Hz | |
| | Preferred | 100 Hz | |
| Electrical protection class | | IP67 / IP69K with mating connector | |

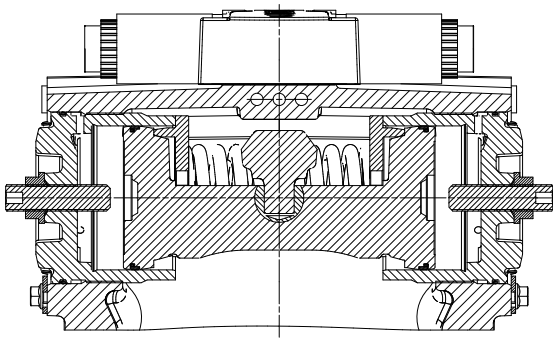
CCO solenoids are design for battery voltage application within the voltage range in the table above, in consideration of a wide range of environmental temperature common for known hydraulic applications. Closed loop PWM current supply can be also applied and is helpful in case that the voltage range is exceeded, or ambient temperature could rise in an unusual manner.

## Control Options

### Displacement Limiter

H1 pumps are designed with optional mechanical displacement (stroke) limiters factory set to max. displacement. The maximum displacement of the pump can be set independently for forward and reverse using the two adjustment screws to mechanically limit the travel of the servo piston down to 50% displacement.

Adjustments under operating conditions may cause leakage. The adjustment screw can be completely removed from the threaded bore if backed out to far.



P003 266

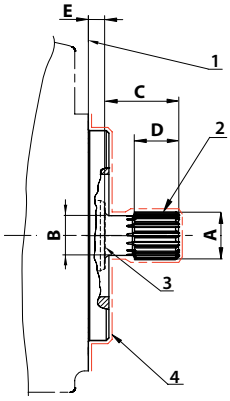
**H1P 069/078 Displacement Change (approximately)**

| Parameter | Size 069 | Size 078 | Size |
|---|---|---|---|
| **1 turn of displacement limiter screw** | 7.4 $cm^3$ [0.45 $in^3$] | 7.4 $cm^3$ [0.45 $in^3$] | |
| **Internal wrench size** | 4 mm | | |
| **External wrench size** | 13 mm | | |
| **Torque for external hex seal lock nut** | 24 N•m [212 lbf•in] | | |

For more information, see *H1 Axial Piston Pumps, Service Manual,* **AX152886482551**, the section "Displacement Limiter Adjustment".

## Dimensions and Data

### H1P 069/078 Input Shaft Option G1 (SAE C, 14 teeth)




1. Surface of mounting flange 127 – 4 per ISO 3019-1; to be paint free
2. **Spline Data:** 14 teeth, Pressure angle: 30°, Pitch: 12/24, Ø29.633 [1.167]; Fillet root side fit per ANSI B92.1-1996, Class 6H; minimum active spline length 31.45 mm [1.238 in]
3. Coupling must not protrude beyond this point
4. Shaft to be paint free

*Dimensions*

| A | B | C | D[1)] | E |
|---|---|---|---|---|
| Ø31.14 ±0.08 [1.226 ±0.003] | Ø26.0 ±0.25 [1.024 ±0.01] | 48.0 ±1.0 [1.89 ±0.039] | 31.5 ±0.5 [1.24 ±0.02] | 8.05 ±0.08 [0.317 ±0.003] |

[1)] Minimum active spline length for the specified torque ratings.

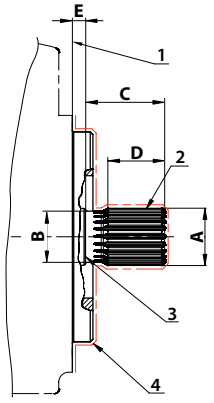
*Torque rating*

| Rated torque | Maximum torque |
|---|---|
| 534 N•m [4720 lb•in] | 816 N•m [7220 lb•in] |

For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information,* **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

## Dimensions and Data

### H1P 069/078 Input Shaft Option G9 (SAE C-C, 23 teeth)




1. Surface of mounting flange 127 – 4 per ISO 3019-1 (SAE C); to be paint free
2. **Spline Data:** 23 teeth, Pressure angle: 30°, Pitch: 16/32, Ø36.513 [1.438]; Fillet root side fit per ANSI B92.1-1996, Class 6H
3. Coupling must not protrude beyond this point
4. Shaft to be paint free

*Dimensions*

| A | B | C | D[1)] | E |
|---|---|---|---|---|
| Ø37.59 ±0.08 [1.746 ±0.004] | Ø33.6 ±0.13 [1.323 ±0.005] | 54.0 ±1.0 [2.126 ±0.039] | 40.5 ±1.0 [1.594 ±0.039] | 8.05 ±0.8 [0.317 ±0.03] |

[1)] Minimum active spline length for the specified torque ratings.

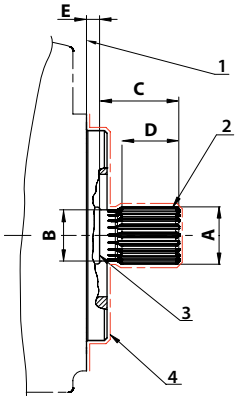
*Torque rating*

| Rated torque | Maximum torque |
|---|---|
| 999 N•m [8840 lb•in] | 1818 N•m [16 090 lb•in] |

For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information,* **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

## Dimensions and Data

### H1P 069/078 Input Shaft Option F1 (SAE C, 21 teeth)




1. Surface of mounting flange 127 – 4 per ISO 3019-1; to be paint free
2. **Spline Data:** 21 teeth, Pressure angle: 30°, Pitch: 16/32, Ø33.337 [1.313]; Fillet root side fit per ANSI B92.1-1996, Class 6H; minimum active spline length 34.5 mm [1.358 in]
3. Coupling must not protrude beyond this point
4. Shaft to be paint free

*Dimensions*

| A | B | C | D[1)] | E |
|---|---|---|---|---|
| Ø34.42 ±0.09 [1.355 ±0.004] | Ø30.4 ±0.25 [1.197 ±0.01] | 48.0 ±1 [1.89 ±0.039] | 34.5 ±1 [1.358 ±0.0039] | 8.05 ±0.8 [0.317 ±0.03] |

[1)] Minimum active spline length for the specified torque ratings.

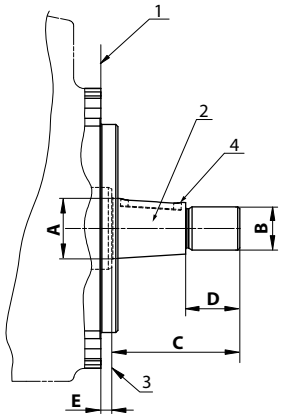
*Torque rating*

| Rated torque | Maximum torque |
|---|---|
| 760 N•m [6730 lbf•in] | 1137 N•m [10 060 lbf•in] |

For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information,* **BC152886483968**, the section “Shaft Torque Ratings and Spline Lubrication”.

## Dimensions and Data

### H1P 069/078 Input Shaft Option F4, Code 38–3




1. Surface of mounting flange 127 – 4 per ISO 3019-1; to be paint free
2. **Tapered shaft:** Conical keyed shaft end, code 38–3 similar to ISO 3019-1; Cone 125 ±10.5 : 1000; Suitable key: $^{3}/_{8}$ x $^{3}/_{8}$ x 1½ per ANSI B17.1
3. Coupling must not protrude beyond this point
4. Shaft to be paint free

*Dimensions*

| A | B | C | D | E |
|---|---|---|---|---|
| Ø38.1 ±0.09 [1.5 ±0.004] | $1^{1}/_{8}$ –12UNF | 81.9 ±1.0 [3.224 ±0.039] | 34.9 ±1.0 [1.374 ±0.039] | 7.88 ±0.8 [0.31 ±0.03] |

*Torque rating*

| Rated torque[1)] | Maximum torque[2)] |
|---|---|
| 1116 N•m [9880 lbf•in] | 1488 N•m [13 170 lbf•in] |

[1)] Rated torque includes just the capability of the press-fit in accordance with an assumed fastener grade 5

[2)] Mating part must maintain a minimum gap width of 1.0 mm with the shaft shoulder after installation of the part. Transmittable torque will be reduced if the minimum gap requirement is not met.

For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information,* **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

#### Tapered shaft customer acknowledgement

The Danfoss H1 tapered shaft has been designed using the industry standard ISO 3019-1, minus the through-hole in the end of the shaft. Danfoss guarantees the design and manufactured quality of the tapered shaft.

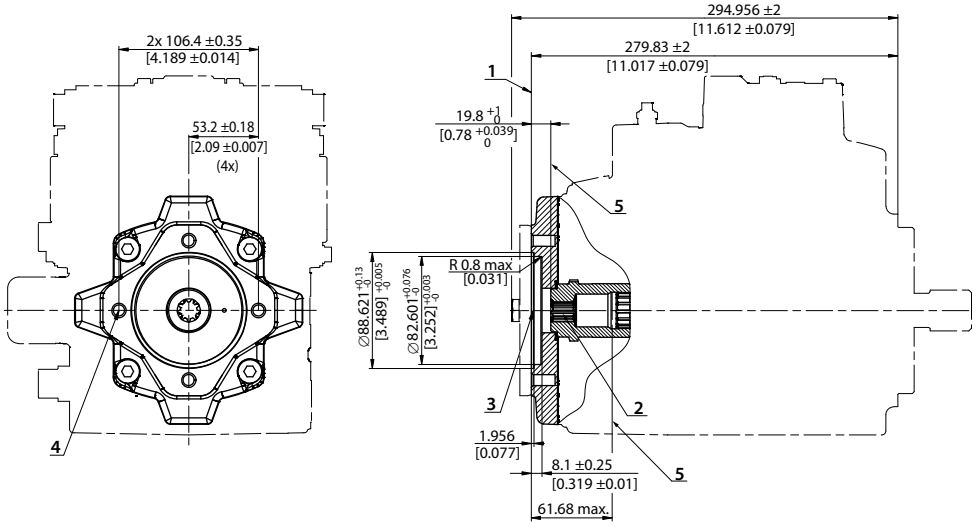
Danfoss recommends a self-locking nut instead of a castle nut and pin. The nut and mating square-cut key are customer supplied. The specified torque rating of the tapered shaft is based on the cross-sectional diameter of the shaft, through the keyway, and assumes the proper clamp and fit between shaft and coupling. The customer is responsible for the design and manufactured quality of the mating female coupling and key and applied torque on the nut. Danfoss has made provisions for the key in accordance to the ISO specification with the understanding that the key is solely to assist in the installation of the mating coupling.

**Caution**

Possible hazard because torque or loading inadvertently transmitted by the customer supplied key may lead to premature shaft failure. Torque must be transmitted by the taper fit between the shaft and it's mating coupling, not the key.

## Dimensions and Data

### H1P Auxiliary Mounting, Option H1, A2 (SAE A, 11 teeth)




1. Auxiliary mounting pad for mating flange 82-2 per ISO 3019-1 (SAE A); Paint free
2. **Spline Data:** 11 teeth, Pressure angle: 30°; Pitch: 16/32, Ø17.463 [0.6875]; Fillet root side fit per ANSI B92.1-1996, Class 6; minimum active spline length 10.5 mm
3. O-ring seal required; Ref. Ø82.22 ID x 2.62, cross section
4. Thread: M10x1.5-6H; 15 [0.59] depth;
5. Mating shaft and shaft shoulder must not protrude beyond this point

| | |
|---|---|
| **Maximum Torque** | 296 N•m [2620 lbf•in] |

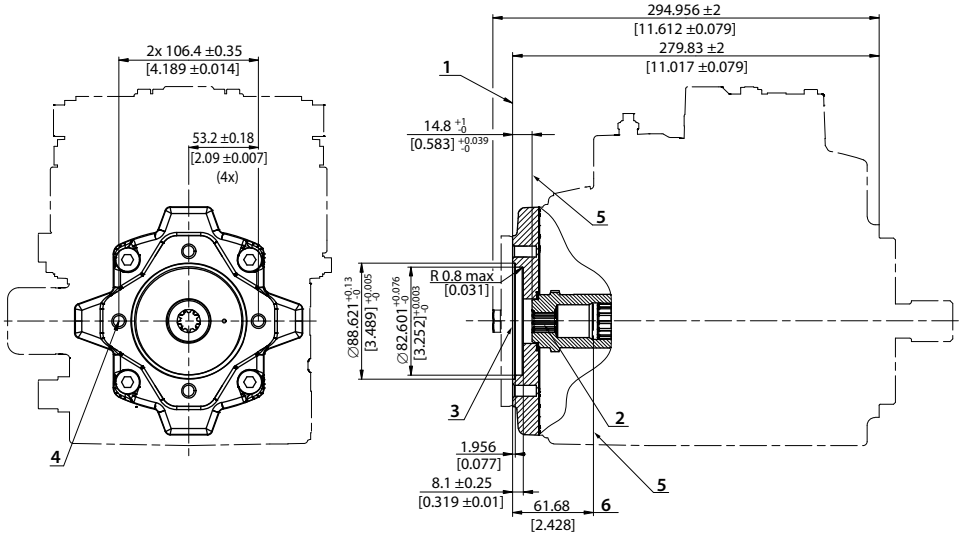
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information,* **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

**Caution**

Standard pad cover is installed only to retain coupling during shipping. Do not operate pump without an auxiliary pump or running cover installed.

## Dimensions and Data

### H1P Auxiliary Mounting, Option H2, A2 (SAE A, 9 teeth)




1. Auxiliary mounting pad for mating flange 82-2 per ISO 3019-1 (SAE A); Paint free
2. **Spline Data:** 9 teeth, Pressure angle: 30°; Pitch: 16/32, Ø14.288 [0.5625]; Fillet root side fit per ANSI B92.1-1996, Class 6; minimum active spline length 8.6 mm
3. O-ring seal required; Ref. Ø82.22 ID x 2.62, cross section
4. Thread: M10x1.5-6H; 15 [0.59] depth;
5. Mating shaft and shaft shoulder must not protrude beyond this point

| | |
|---|---|
| **Maximum Torque** | 162 N•m [1430 lbf•in] |

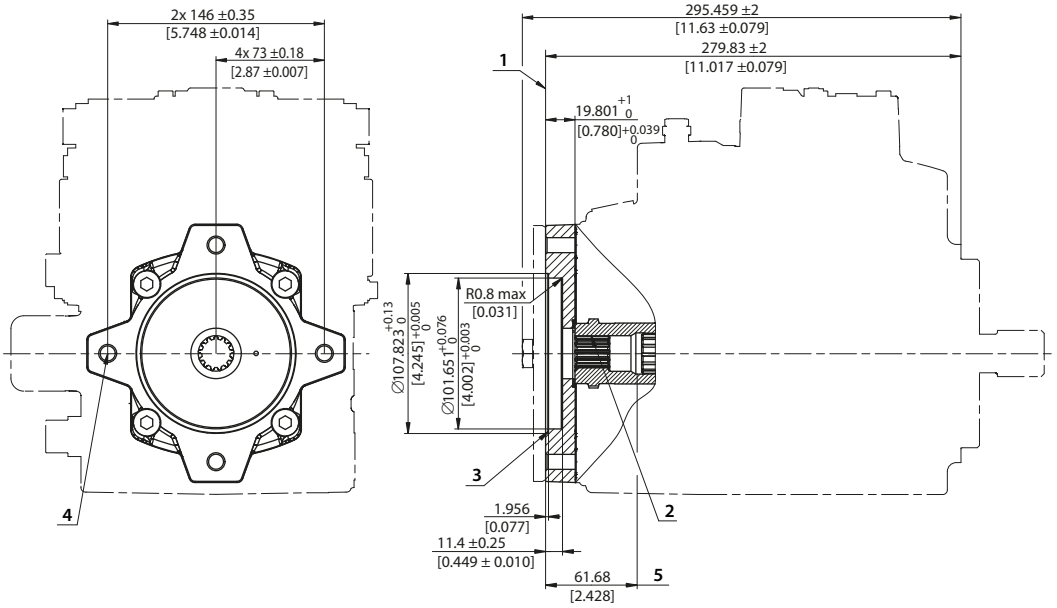
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information,* **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

**Caution**

Standard pad cover is installed only to retain coupling during shipping. Do not operate pump without an auxiliary pump or running cover installed.

## Dimensions and Data

### H1P Auxiliary Mounting, Option H3, A3 (SAE B, 13 teeth)




1. Auxiliary mounting pad for mating flange 101-2 per ISO 3019-1 (SAE B); Paint free
2. **Spline Data:** 13 teeth, Pressure angle: 30°; Pitch: 16/32, Ø20.638 [0.813]; Fillet root side fit per ANSI B92.1-1996, Class 6; minimum active spline length 12.4 mm
3. O-ring seal required; Ref. Ø94.92 ID x 2.62, cross section
4. Thread: M12x1.75-6H; 20 [0.787] depth;
5. Mating shaft and shaft shoulder must not protrude beyond this point

| | |
|---|---|
| **Maximum Torque** | 395 N•m [3500 lbf•in] |

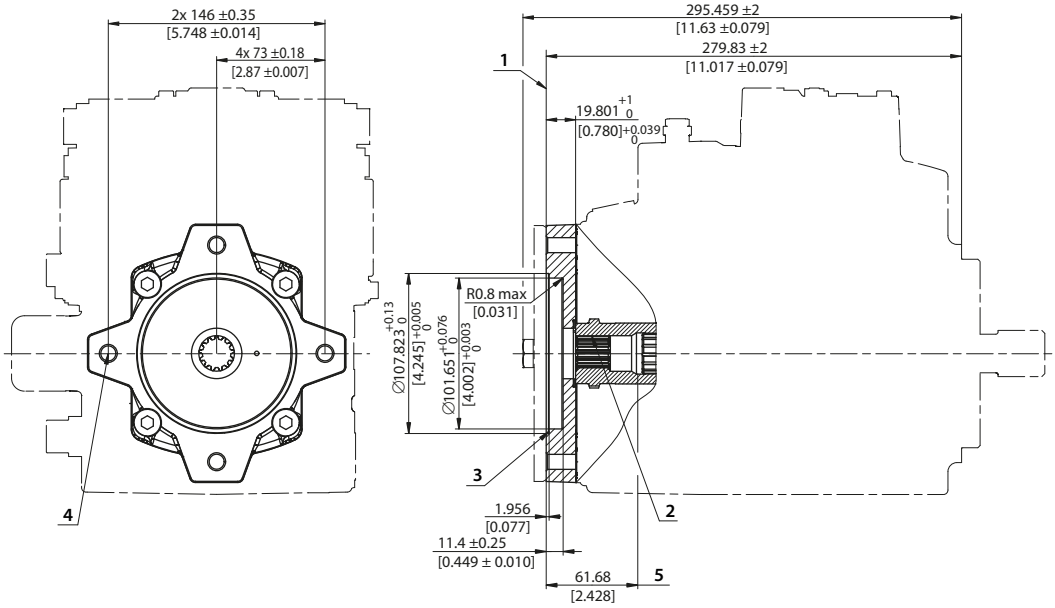
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information,* **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

**Caution**

Standard pad cover is installed only to retain coupling during shipping. Do not operate pump without an auxiliary pump or running cover installed.

## Dimensions and Data

### H1P Auxiliary Mounting, Option H5, A4 (SAE B-B, 15 teeth)




1. Auxiliary mounting pad for mating flange 101-2 per ISO 3019-1 (SAE B); Paint free
2. **Spline Data:** 15 teeth, Pressure angle: 30°; Pitch: 16/32, Ø23.813 [0.938]; Fillet root side fit per ANSI B92.1b, Class 6
3. O-ring seal required; Ref. Ø94.92 ID x 2.62, cross section
4. Thread: M12x1.75-6H; 20 [0.787] depth;
5. Mating shaft and shaft shoulder must not protrude beyond this point

| | |
|---|---|
| **Maximum Torque** | 693 N•m [6130 lbf•in] |

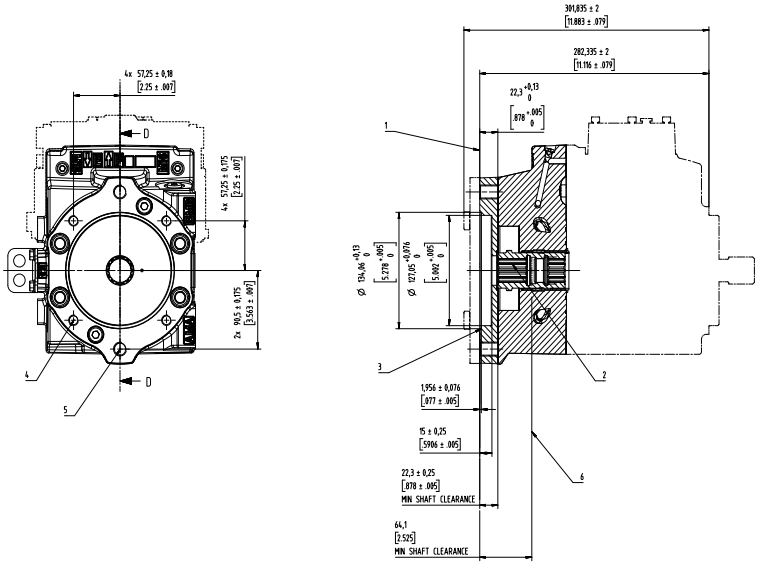
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information,* **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

**Caution**

Standard pad cover is installed only to retain coupling during shipping. Do not operate pump without an auxiliary pump or running cover installed.

## Dimensions and Data

### H1P Auxiliary Mounting, Option H6, A5 (SAE C, 14 teeth)




1. Auxiliary mounting pad for mating flange 127-4 per ISO 3019-1 (SAE C); Paint free
2. **Spline Data:** 14 teeth, Pressure angle: 30°; Pitch: 12/24, Ø29.633 [1.667]; Fillet root side fit per ANSI B92.1-1996, Class 6; minimum active spline length 14.3 mm
3. O-ring seal required; Ref. Ø120.32 ID x 2.62, cross section
4. Thread: M12x1.75-6H; 22.25 [0.876] depth;
5. Thread: M16x2-6H; 22.25 [0.876] depth;
6. Mating shaft and shaft shoulder must not protrude beyond this point

| | |
|---|---|
| **Maximum torque** | 816 N•m [7220 lbf•in] |

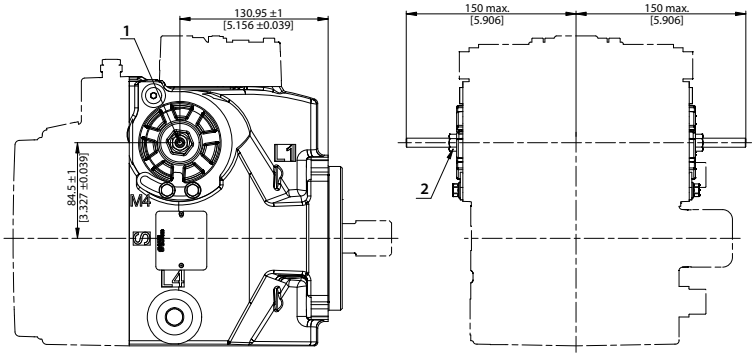
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information*, **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

**Caution**

Standard pad cover is installed only to retain coupling during shipping. Do not operate pump without an auxiliary pump or running cover installed.

## Dimensions and Data

### H1P Displacement Limiter, Option B




**1.** Displacement limiter screw (2x)

**2.** Displacement limiter seal nut (2x)

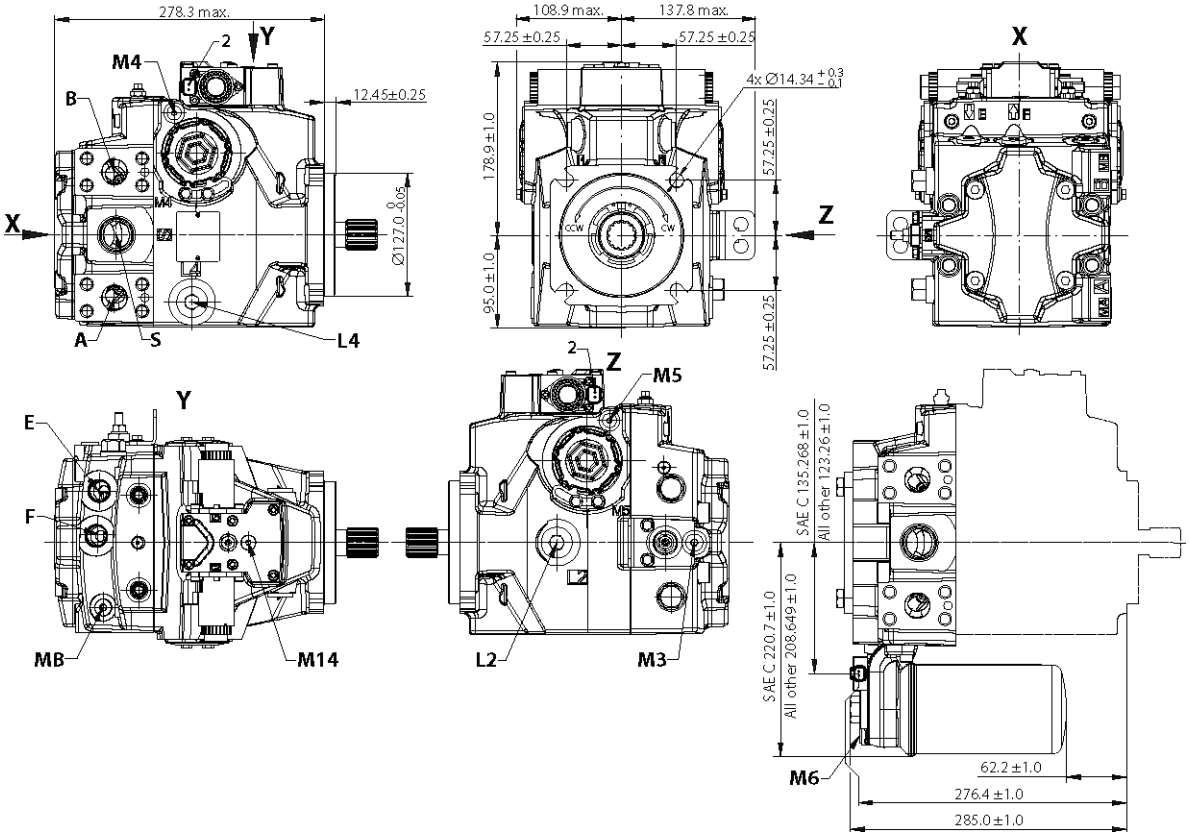
*Wrench size, torque*

| Wrench size for DL screw | Wrench size for DL seal nut | Torque |
|---|---|---|
| 4 internal hex | 13 external hex | 24 N•m [18 lb•ft] |

Please contact Danfoss representative for specific installation drawings.

## Dimensions and Data

### Single Pump Ports



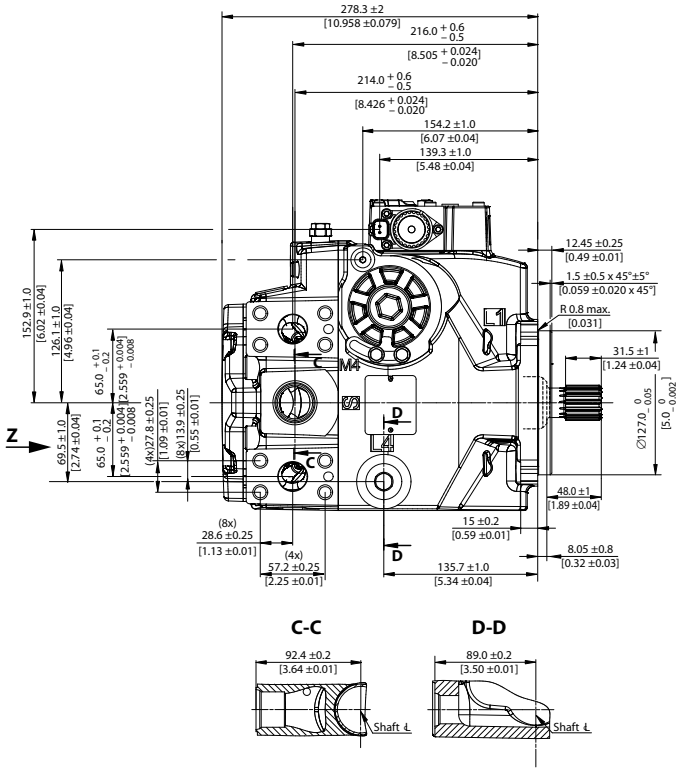

*Ports per ISO 11 926-1*

| Port | Description | Size |
|---|---|---|
| A, B | System ports | Ø25.4 – 450 bar, Split flange boss ISO 6162; M1 2x 1.75, 20 min full thread depth<br>Recommended screw in depth 1.5 x thread dia |
| L2, L4 | Case drain ports | $1^{1}/_{16}$–12 |
| MA, MB | System **A/B** gauge ports | $^{9}/_{16}$–18 |
| E/F | Charge filtration ports | $^{7}/_{8}$–14 |
| M3 | Charge pressure gauge port | $^{9}/_{16}$–18 |
| M4, M5 | Servo gauge port | $^{7}/_{16}$–20 |
| M14 | Case gauge port (EDC, FNR, NFPE) | $^{7}/_{16}$–20 |
| S | Charge inlet port | $1^{5}/_{16}$–12 |
| 2 | Connector DEUTSCH DTM04-2P, to be paint free | |

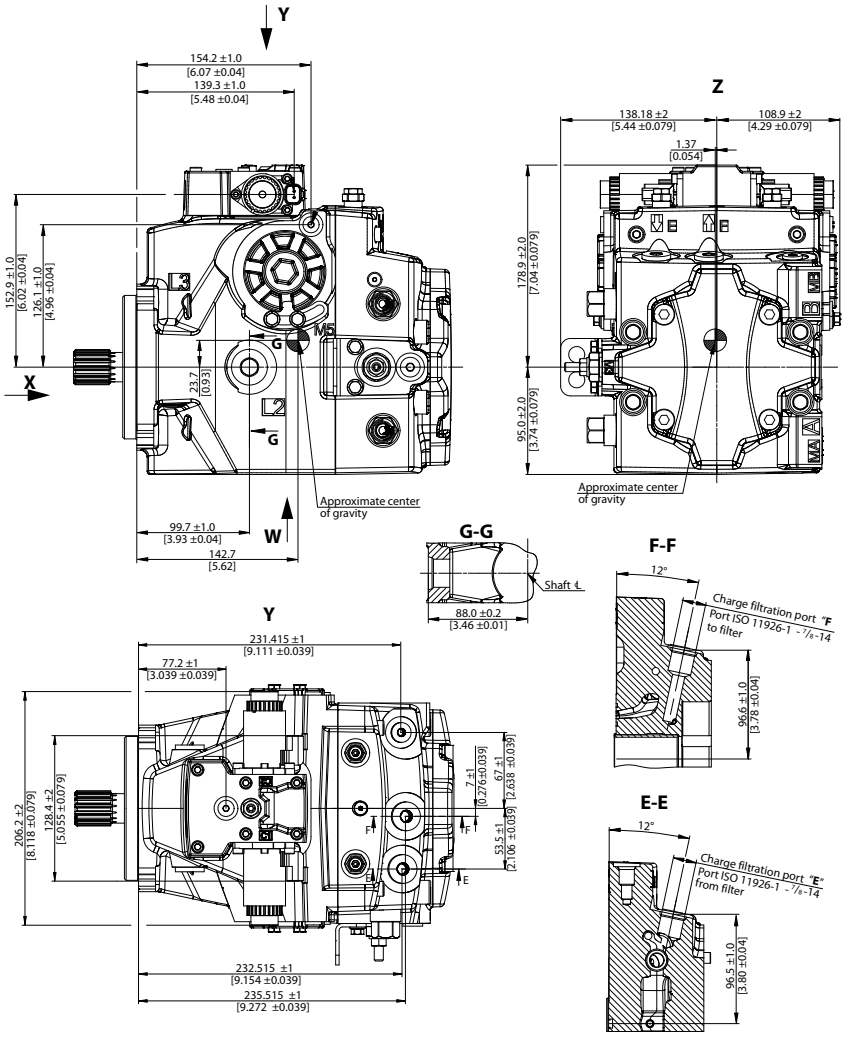
Please contact Danfoss representative for specific installation drawings.

## Dimensions and Data

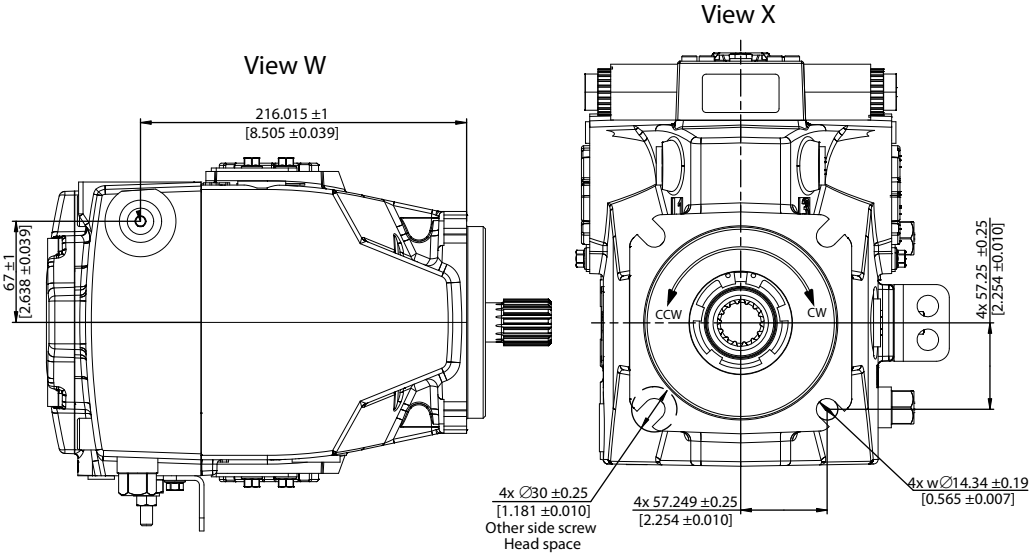
### H1P Dimensions



## Dimensions and Data




**1** — Approximate center of gravity



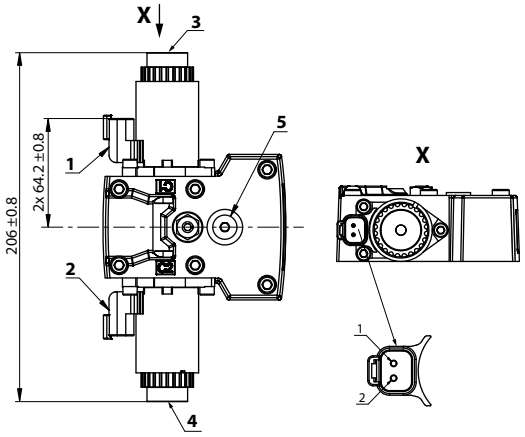

**1** — Other side screw head space

## Dimensions and Data

## Dimensions and Data

### Controls

**EDC Options A2 and A3 (12/24 V)**



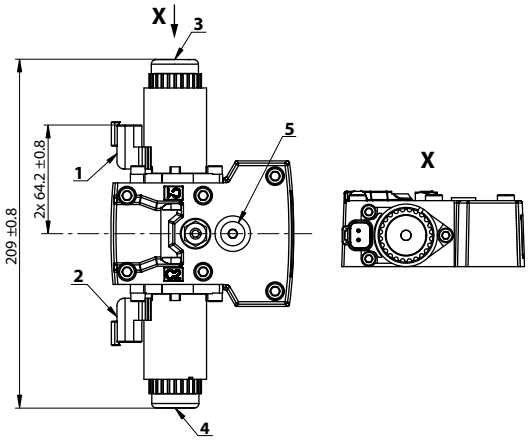

1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
3. Control Manual OverRide **C1**
4. Control Manual OverRide **C2**
5. Case gauge port **M14** per ISO 1926-1: $^{7}/_{16}$–20

| Pin | Assignment | Alternative | Pin | Assignment |
|---|---|---|---|---|
| 1 | Supply | OR | 1 | Ground |
| 2 | Ground | | 2 | Supply |

Please contact Danfoss representative for specific installation drawings.

## Dimensions and Data

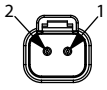
**EDC with MOR, Options A4 and A5 (12/24 V)**




1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
3. Control Manual OverRide **C1**
4. Control Manual OverRide **C2**
5. Case gauge port **M14** per ISO 1926-1: $^{7}/_{16}$–20

Depressing the plunger mechanically moves the control spool. Actuation allows full stroke pump response as per coil and rotation dependent control logic.

*Connector **C1/C2**: DEUTSCH DTM04-2P*

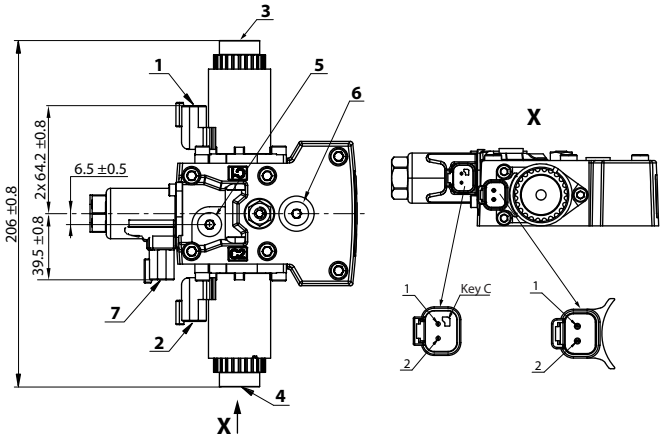



| Pin | Assignment | Alternative | Pin | Assignment |
|---|---|---|---|---|
| 1 | Supply | OR | 1 | Ground |
| 2 | Ground | | 2 | Supply |

Please contact Danfoss representative for specific installation drawings.

## Dimensions and Data

**EDC with CCO (key C), Options E7 and E8 (12/24 V)**



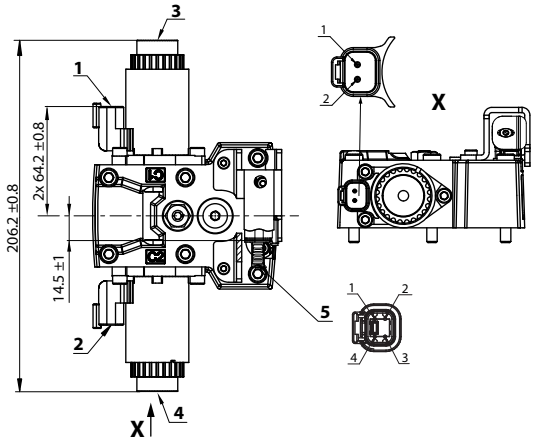

1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
3. Control Manual OverRide **C1**
4. Control Manual OverRide **C2**
5. Brake gauge port **X7** per ISO 1926-1: $^{7}/_{16}$–20
6. Case gauge port **M14** per ISO 1926-1: $^{7}/_{16}$–20
7. Control-Cut-Off with C-key connector **C4** DEUTSCH DT04-2P, paint free

| Pin | Assignment | Alternative | Pin | Assignment |
|---|---|---|---|---|
| 1 | Supply | OR | 1 | Ground |
| 2 | Ground | | 2 | Supply |

Please contact Danfoss representative for specific installation drawings.

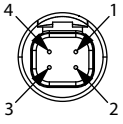
## Dimensions and Data

**EDC with ASNSR, Options: H2 and H3 (12/24 V)**



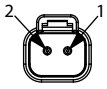

1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
3. Control Manual OverRide **C1**
4. Control Manual OverRide **C2**
5. Angle sensor connector **S2** DEUTSCH DT04-4P, paint free

*Connector DEUTSCH, 4-pin*




*4-pin assignment:*
1. Ground (GND)
2. Not connected
3. Output signal 1 (SIG 1)
4. Supply (V+)

*Connector **C1/C2**: DEUTSCH DTM04-2P*

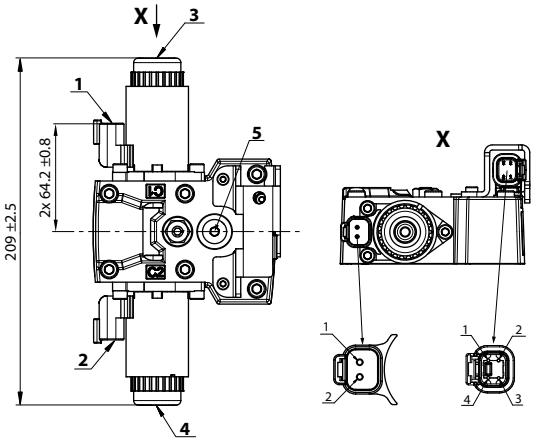



| Pin | Assignment | Alternative | Pin | Assignment |
|---|---|---|---|---|
| 1 | Supply | OR | 1 | Ground |
| 2 | Ground | | 2 | Supply |

Please contact Danfoss representative for specific installation drawings.

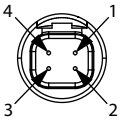
## Dimensions and Data

### EDC with MOR and ASNSR, Options H6 and H7 (12/24 V)



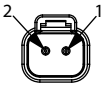

1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
3. Control Manual OverRide **C1**
4. Control Manual OverRide **C2**
5. Case gauge port **M14** per ISO 1926-1: $^{7}/_{16}$–20

*Connector DEUTSCH, 4-pin*




*4-pin assignment:*
1. Ground (GND)
2. Not connected
3. Output signal 1 (SIG 1)
4. Supply (V+)

*Connector **C1/C2**: DEUTSCH DTM04-2P*

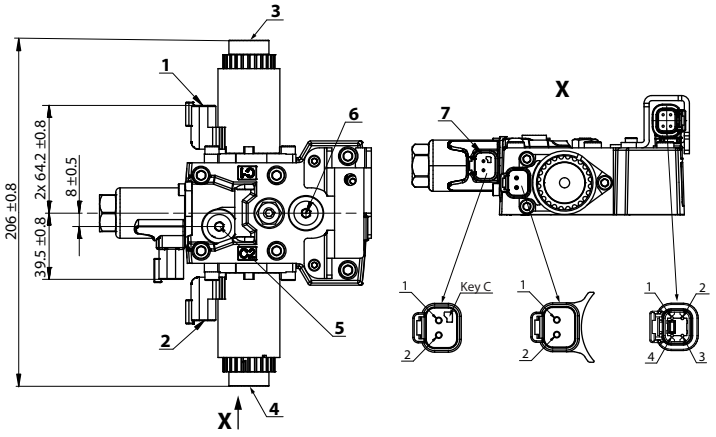



| Pin | Assignment | Alternative | Pin | Assignment |
|---|---|---|---|---|
| 1 | Supply | OR | 1 | Ground |
| 2 | Ground | | 2 | Supply |

Please contact Danfoss representative for specific installation drawings.

## Dimensions and Data

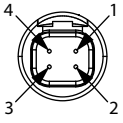
**EDC with CCO and ASNSR, Options H8 and H9 (12/24 V)**




1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
3. Control Manual OverRide **C1**
4. Control Manual OverRide **C2**
5. Case gauge port **M14** per ISO 1926-1: $^{7}/_{16}$–20
6. Brake gauge port **X7** per ISO 1926-1: $^{7}/_{16}$–20
7. Control-Cut-Off with C-key connector **C4** DEUTSCH DT04-2P, paint free

Depressing the plunger mechanically moves the control spool. Actuation allows full stroke pump response as per coil and rotation dependent control logic.

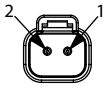
*Connector DEUTSCH, 4-pin*




*Angle sensor connector S2: DEUTSCH DTM04-4P*

1. Ground (GND)
2. Not connected
3. Output signal 1 (SIG 1)
4. Supply (V+)

*Connectors C1/C2/C4: DEUTSCH DTM04-2P*

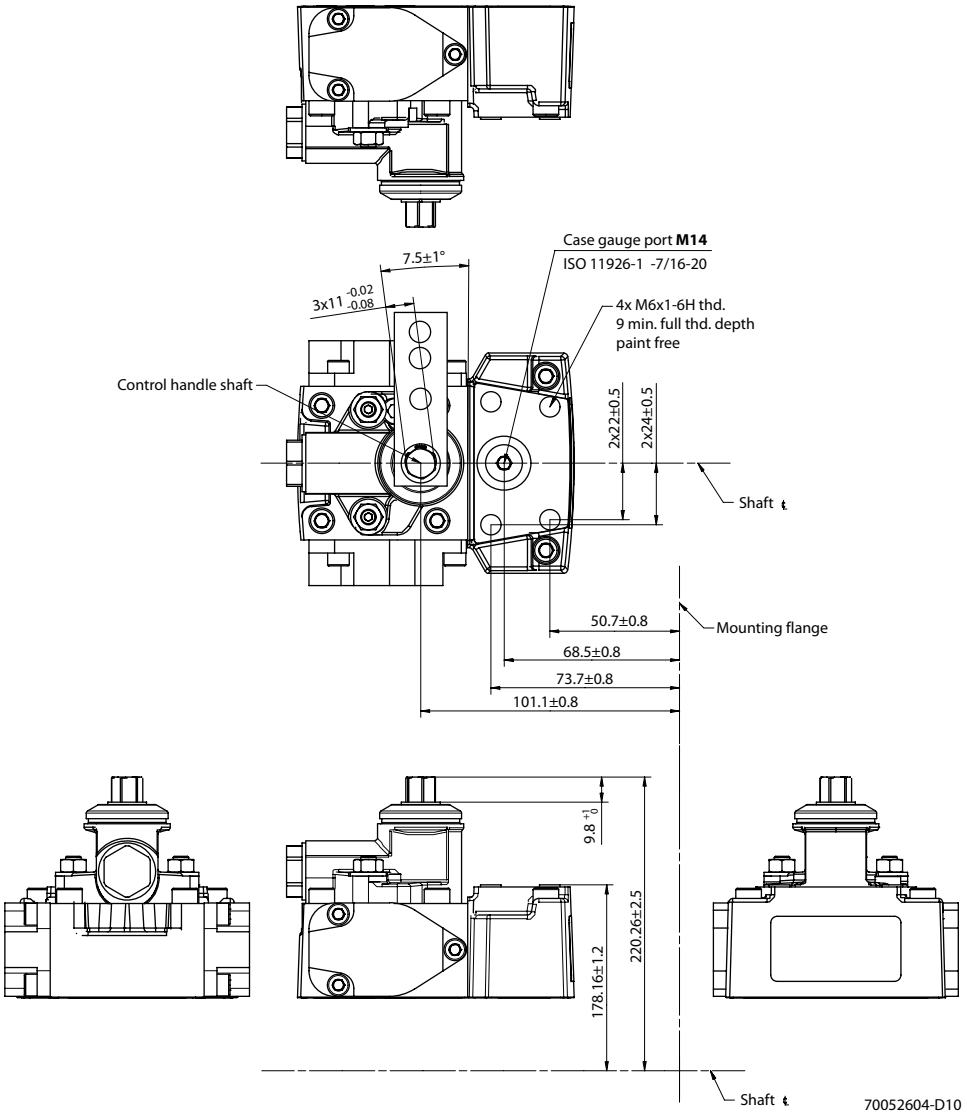



| Pin | Assignment | Alternative | Pin | Assignment |
|---|---|---|---|---|
| 1 | Supply | OR | 1 | Ground |
| 2 | Ground | | 2 | Supply |

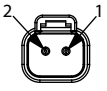
Please contact Danfoss representative for specific installation drawings.

## Dimensions and Data

**MDC Option: M1**




*Connector DEUTSCH, 2-pin*

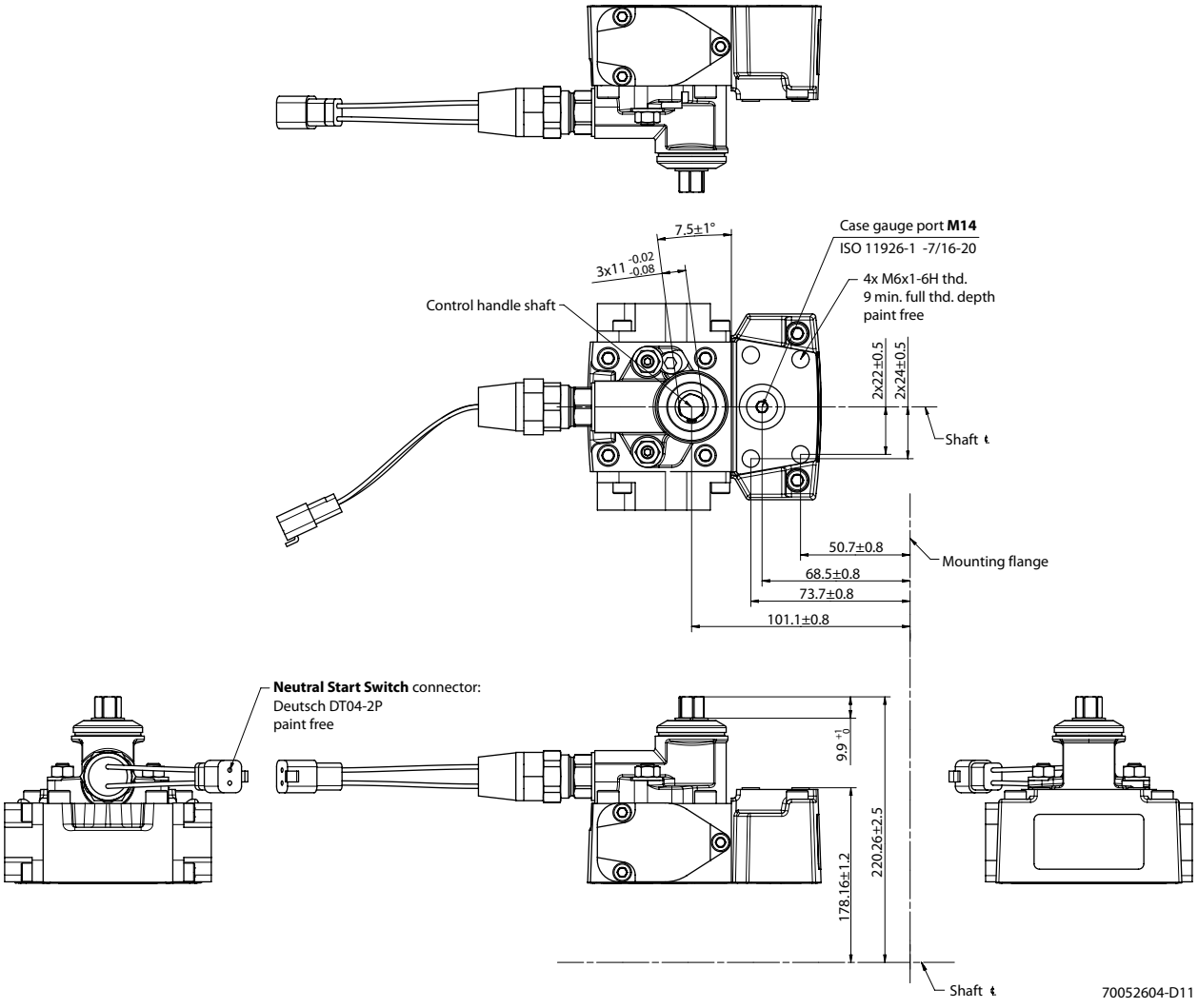



| Pin | Assignment | Alternative | Pin | Assignment |
|---|---|---|---|---|
| 1 | Supply | OR | 1 | Ground |
| 2 | Ground | | 2 | Supply |

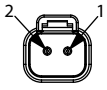
Please contact Danfoss representative for specific installation drawings.

## Dimensions and Data

**MDC with Neutral Start Switch Option: M2**




*Connector DEUTSCH, 2-pin*

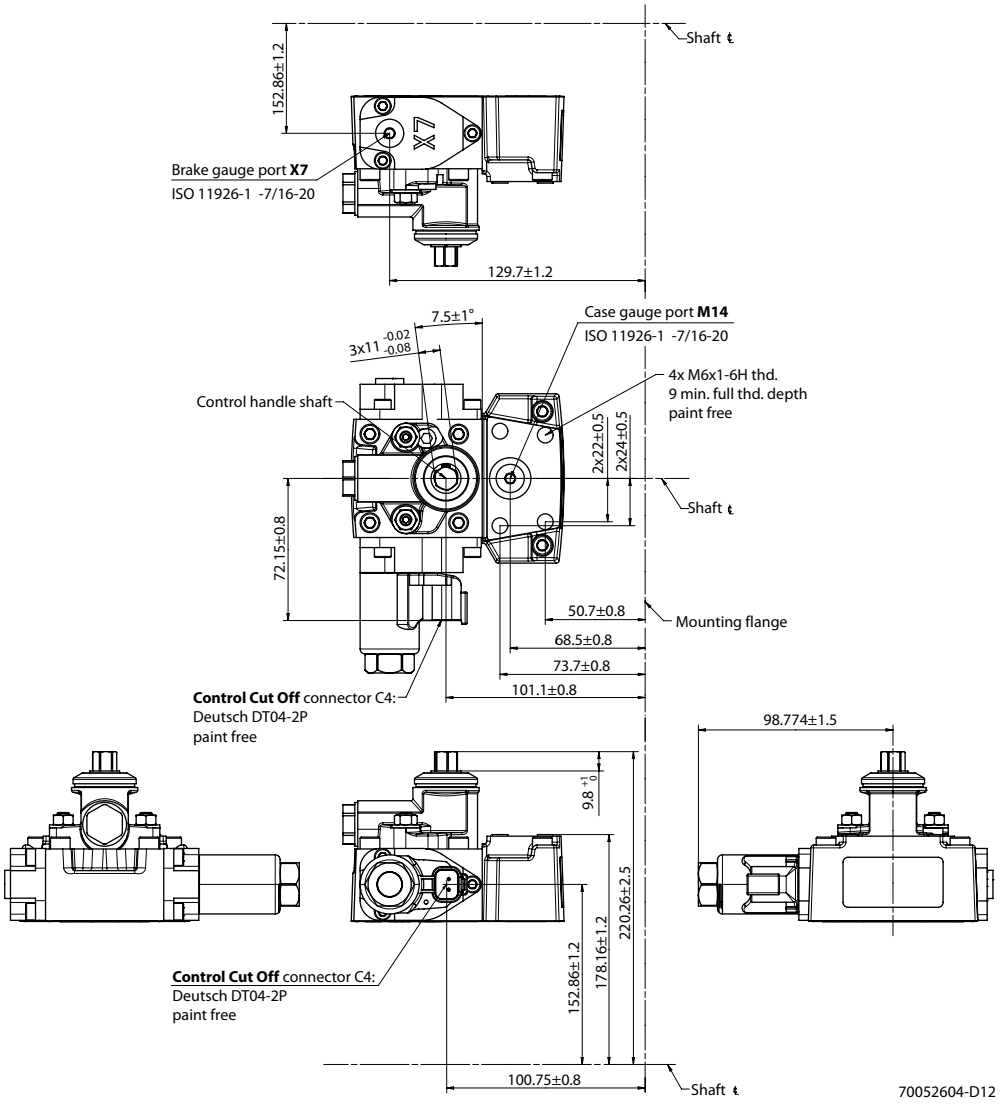



| Pin | Assignment | Alternative | Pin | Assignment |
|---|---|---|---|---|
| 1 | Supply | OR | 1 | Ground |
| 2 | Ground | | 2 | Supply |

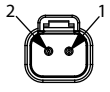
Please contact Danfoss representative for specific installation drawings.

## Dimensions and Data

### MDC with CCO, Options: M3, M4




*Connector DEUTSCH, 2-pin*

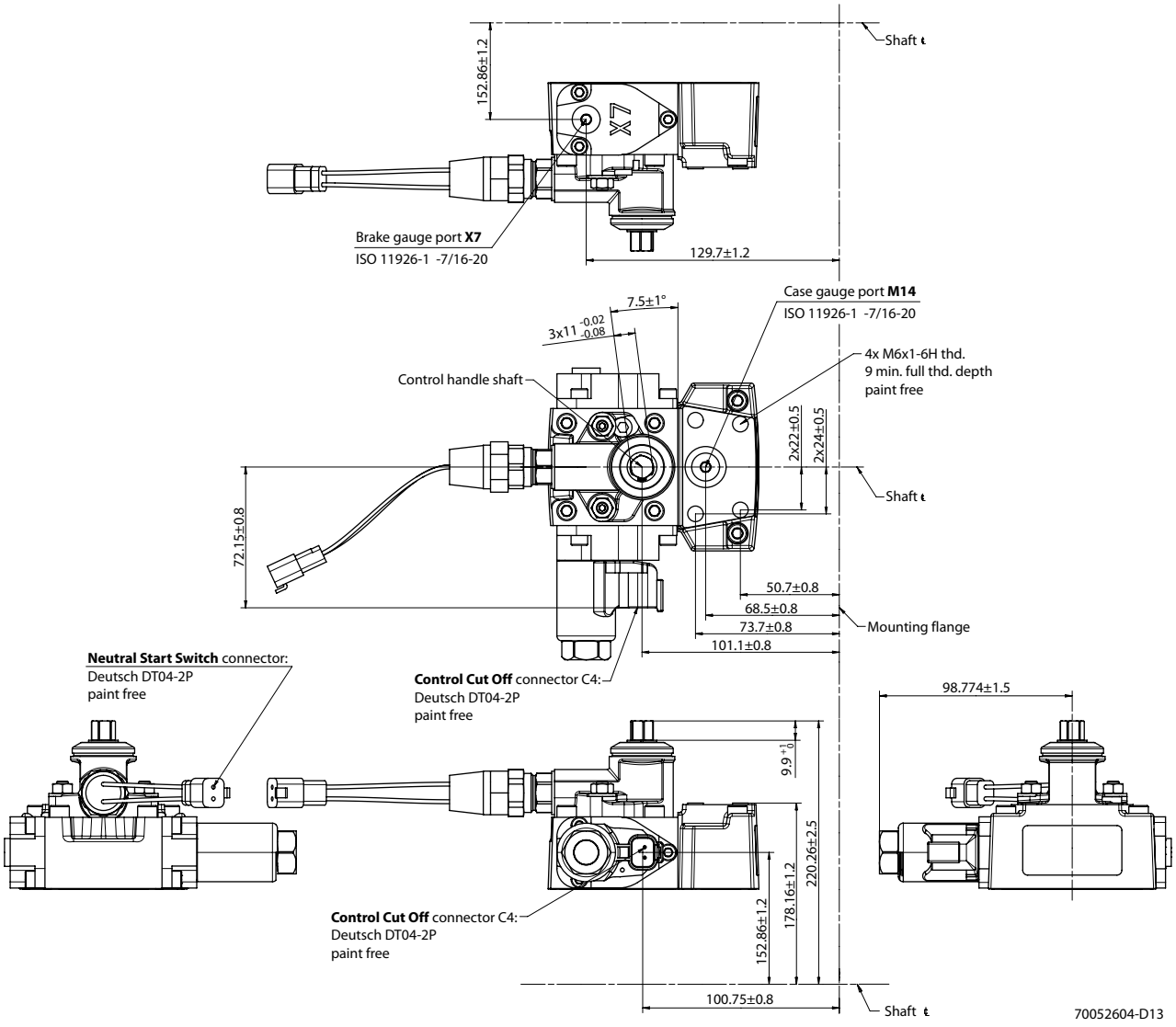



| Pin | Assignment | Alternative | Pin | Assignment |
|---|---|---|---|---|
| 1 | Supply | OR | 1 | Ground |
| 2 | Ground | | 2 | Supply |

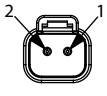
Please contact Danfoss representative for specific installation drawings.

## Dimensions and Data

### MDC with NSS and CCO Options: M5, M6




*Connector DEUTSCH, 2-pin*



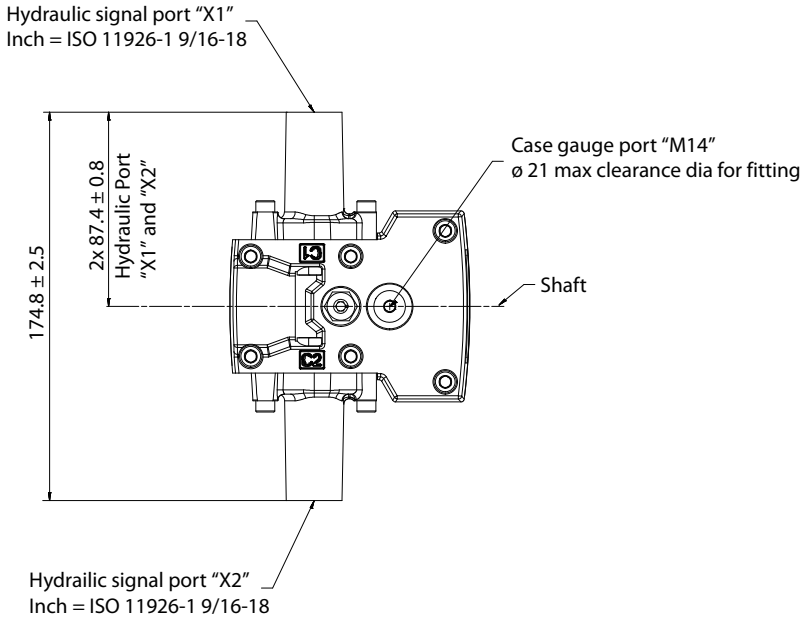

| Pin | Assignment | Alternative | Pin | Assignment |
|---|---|---|---|---|
| 1 | Supply | OR | 1 | Ground |
| 2 | Ground | | 2 | Supply |

Please contact Danfoss representative for specific installation drawings.

## Dimensions and Data

### H1P HDC, Options: T1, T2

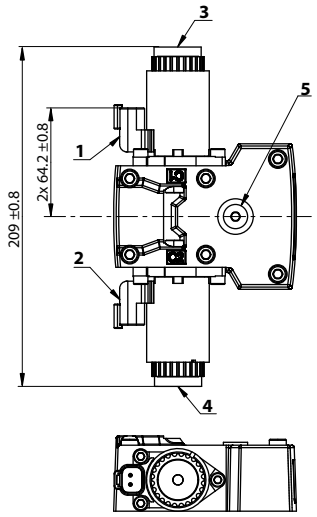
*Dimensions in mm*



## Dimensions and Data

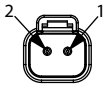
### NFPE with MOR, Options: N1, N2 (12/24 V)

Non-Feedback Proportional Electric control with Manual Over Ride options N1 (12 V) and N2 (24 V).




1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
3. Control Manual OverRide **C1**
4. Control Manual OverRide **C2**
5. Case gauge port **M14** per ISO 1926-1: $^{7}/_{16}$–20

*Control solenoid connectors **C1/C2** DEUTSCH DTM04-2P pin/assignment*



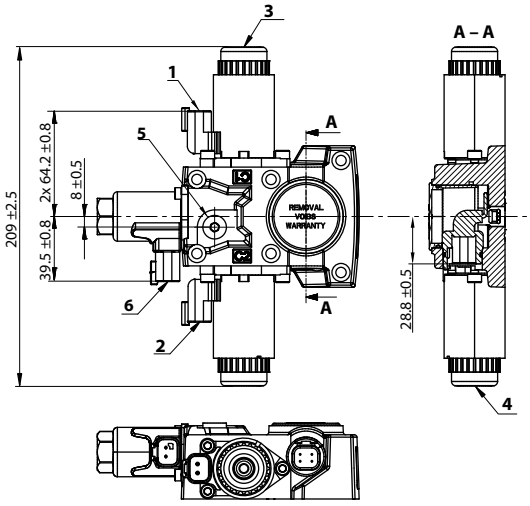

| Pin | Assignment | Alternative | Pin | Assignment |
|---|---|---|---|---|
| 1 | Supply | OR | 1 | Ground |
| 2 | Ground | | 2 | Supply |

Please contact Danfoss representative for specific installation drawings.

## Dimensions and Data

### NFPE with MOR, CCO, ASNSR, Options: N3, N4 (12/24 V)

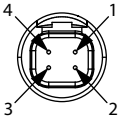
Non-Feedback Proportional Electric control with Control-Cut-Off valve with key C, Manual Over Ride and Angle Sensor, options N3 (12 V) and N4 (24 V).




1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
3. Control Manual OverRide **C1**
4. Control Manual OverRide **C2**
5. Case gauge port **M14** per ISO 1926-1: $^{7}/_{16}$–20
6. Control-Cut-Off with C-key connector **C4** DEUTSCH DT04-2P, paint free

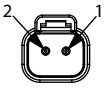
Depressing the plunger mechanically moves the control spool. Actuation allows full stroke pump response as per coil and rotation dependent control logic.

*Connector DEUTSCH, 4-pin*




*Pin/assignment:*
1. Ground (GND)
2. Output Signal 2 (SIG2) – Secondary (redundant)
3. Output signal 1 (SIG 1)
4. Supply (V+)

*Control solenoid connectors **C1/C2/C4** DEUTSCH DTM04-2P pin/assignment*



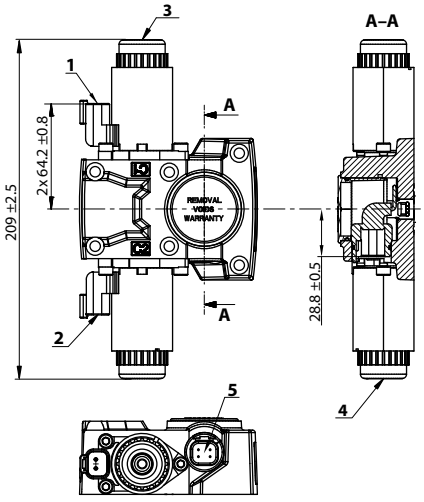

| Pin | Assignment | Alternative | Pin | Assignment |
|---|---|---|---|---|
| 1 | Supply | OR | 1 | Ground |
| 2 | Ground | | 2 | Supply |

Please contact Danfoss representative for specific installation drawings.

## Dimensions and Data

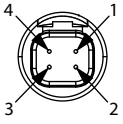
### NFPE with MOR and ASNSR, Options: N5, N6 (12/24 V)

Non-Feedback Proportional Electric control with Manual Over Ride and Angle Sensor, options N5 (12 V) and N6 (24 V).



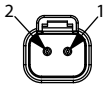

1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
3. Control Manual OverRide **C1**
4. Control Manual OverRide **C2**
5. Angle sensor connector **S2** DEUTSCH DT04-4P, paint free

*Connector DEUTSCH, 4-pin*




*Pin/assignment:*
1. Ground (GND)
2. Output Signal 2 (SIG2) – Secondary (redundant)
3. Output signal 1 (SIG 1)
4. Supply (V+)

*Control solenoid connectors C1/C2 DEUTSCH 2-pin/assignment*



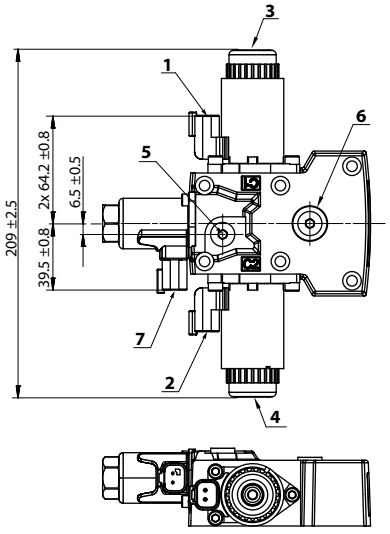

| Pin | Assignment | Alternative | Pin | Assignment |
|---|---|---|---|---|
| 1 | Supply | OR | 1 | Ground |
| 2 | Ground | | 2 | Supply |

Please contact Danfoss representative for specific installation drawings.

## Dimensions and Data

### NFPE with MOR and CCO, Options: N7, N8 (12/24 V)

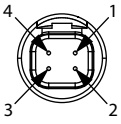
Non Feedback Proportional Electric control with Manual Over Ride and Control-Cut-Off valve key C, options N7 (12 V) and N8 (24 V).




1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
3. Control Manual OverRide **C1**
4. Control Manual OverRide **C2**
5. Brake gauge port **X7** per ISO 1926-1: $^{7}/_{16}$–20
6. Case gauge port **M14** per ISO 1926-1: $^{7}/_{16}$–20
7. Control-Cut-Off with C-key connector **C4** DEUTSCH DT04-2P, paint free

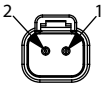
Depressing the plunger mechanically moves the control spool. Actuation allows full stroke pump response as per coil and rotation dependent control logic.

*Connector DEUTSCH, 4-pin*




*Pin/assignment:*
1. Ground (GND)
2. Output Signal 2 (SIG2) – Secondary (redundant)
3. Output signal 1 (SIG 1)
4. Supply (V+)

*Control solenoid connectors **C1/C2** DEUTSCH DTM04-2P pin assignment*

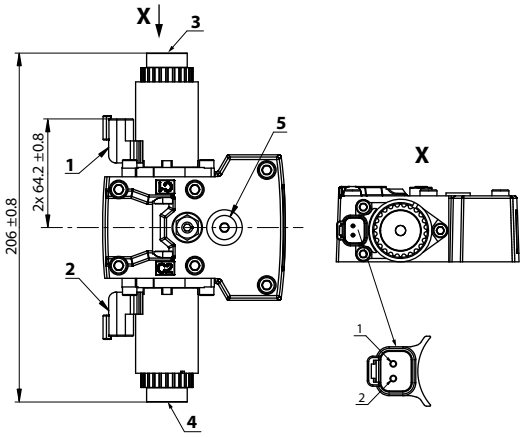



| Pin | Assignment | Alternative | Pin | Assignment |
|---|---|---|---|---|
| 1 | Supply | OR | 1 | Ground |
| 2 | Ground | | 2 | Supply |

Please contact Danfoss representative for specific installation drawings.

## Dimensions and Data

### HLC Options V1 and V2 (12/24 V)



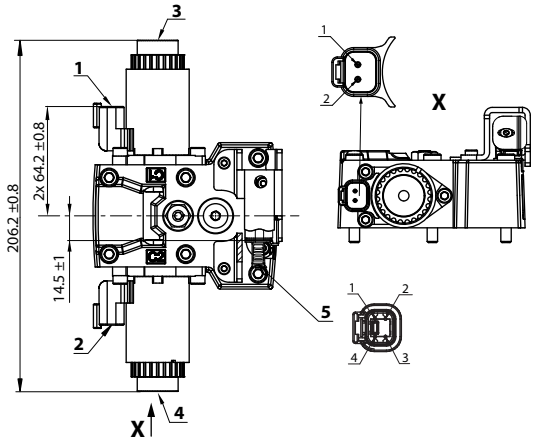

1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
3. Control Manual OverRide **C1**
4. Control Manual OverRide **C2**
5. Case gauge port **M14** per ISO 1926-1: $^{7}/_{16}$–20

| Pin | Assignment | Alternative | Pin | Assignment |
|---|---|---|---|---|
| 1 | Supply | OR | 1 | Ground |
| 2 | Ground | | 2 | Supply |

Please contact Danfoss representative for specific installation drawings.

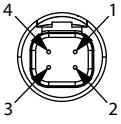
## Dimensions and Data

### HLC with ASNSR, Options: V3 and V4 (12/24 V)



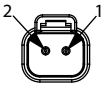

1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
3. Control Manual OverRide **C1**
4. Control Manual OverRide **C2**
5. Angle sensor connector **S2** DEUTSCH DT04-4P, paint free

*Connector DEUTSCH, 4-pin*




*4-pin assignment:*
1. Ground (GND)
2. Not connected
3. Output signal 1 (SIG 1)
4. Supply (V+)

*Connector **C1/C2**: DEUTSCH DTM04-2P*

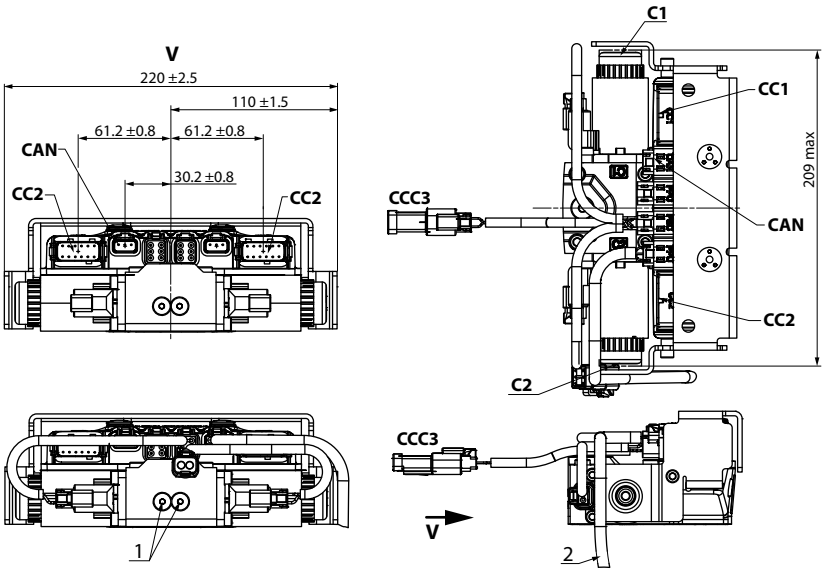



| Pin | Assignment | Alternative | Pin | Assignment |
|---|---|---|---|---|
| 1 | Supply | OR | 1 | Ground |
| 2 | Ground | | 2 | Supply |

Please contact Danfoss representative for specific installation drawings.

## Dimensions and Data

### Automotive control (AC)




**1** Plug removing can cause contamination issues

**2** PPU wire harness is factory installed to speed sensor

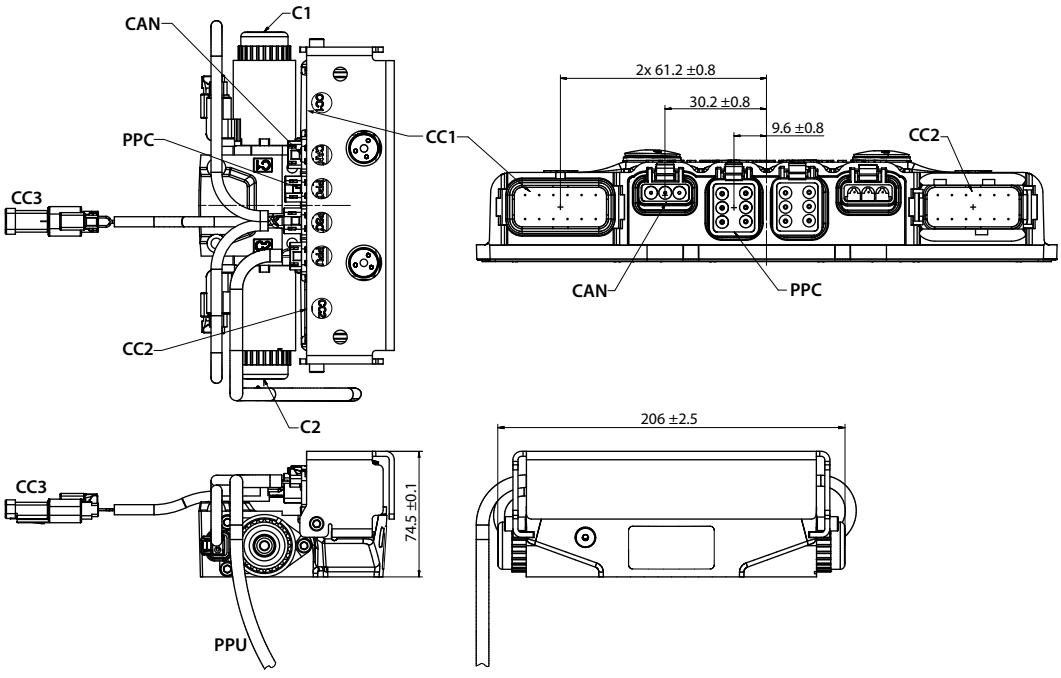
*Connectors description*

| Port | Description |
|---|---|
| **C1 and C2** | **1.** Control manual override **C1**<br>**2.** Control Manual Override **C2** |
| **CC1** | Port A control connector DEUTSCH DTM04-12P; paint free |
| **CC2** | Port B control connector DEUTSCH DTM04-12P; paint free |
| **CC3** | Control connector DEUTSCH DT06-2S; paint free; For using connector, the plug may be removed. |
| **CAN** | Control connector DEUTSCH DTM04-3P; paint free; For using connector, the plug may be removed. |

Please contact Danfoss representative for specific installation drawings.

## Dimensions and Data

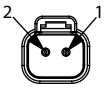
***AC connectors dimensions***




PPU wire harness is factory installed to speed sensor.

**CC3**

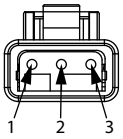
*Connector DEUTSCH, 2-pin*




**1.** Digital output A1 (+)
**2.** Digital output A2 (-)

**CAN**

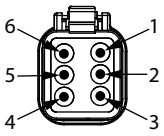
*Connector DEUTSCH, 3-pin*




**1.** CAN High
**2.** CAN Low
**3.** CAN Shield

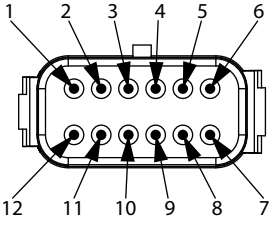
**PPC**

*Connector DEUTSCH, 6-pin*




**1.** Sensor A (+)
**2.** Analog input A
**3.** Sensor A (-)
**4.** Sensor B (-)
**5.** Analog input B
**6.** Sensor B (+)

*Connector DEUTSCH, 12-pin*




**CC1**

**1.** Battery (-)
**2.** Battery (+)
**3.** Sensor (+)
**4.** Sensor (-)
**5.** Motor rpm input (frequency)
**6.** Forward input (digital)
**7.** Reverse input (digital)
**8.** Sensor (+)
**9.** Sensor (-)
**10.** Drive pedal input (analog – nominal)
**11.** Drive pedal input (analog – red)
**12.** Neural input (digital)

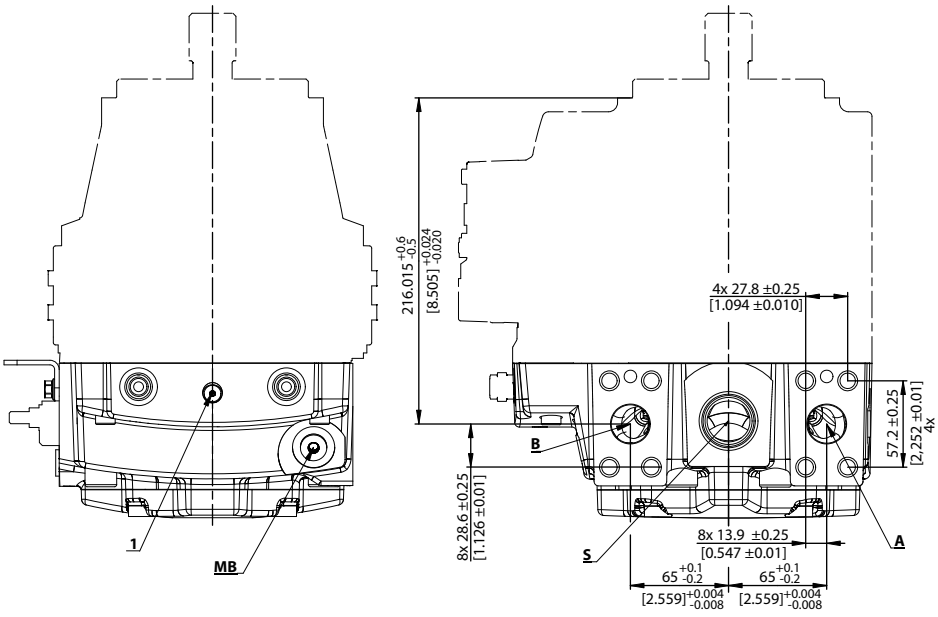
**CC2**

**1.** Inch input (analog – red)
**2.** Mode switch B input (digital – nominal)
**3.** Motor prop/PCOR driver
**4.** Motor direction input (analog)
**5.** Sensor (+)
**6.** Sensor (-)
**7.** Inch input (analog – nominal)
**8.** Motor BPD driver
**9.** Digital output B2 (-)
**10.** Digital output B1 (+)
**11.** Mode switch A input (digital)
**12.** Mode switch B input (digital – red)

## Dimensions and Data

### Filtration

**H1P 69/78 Suction Filtration Option L**




**A** System port split flange boss per ISO 6162; M12 x 1.75, 20 min full thread depth

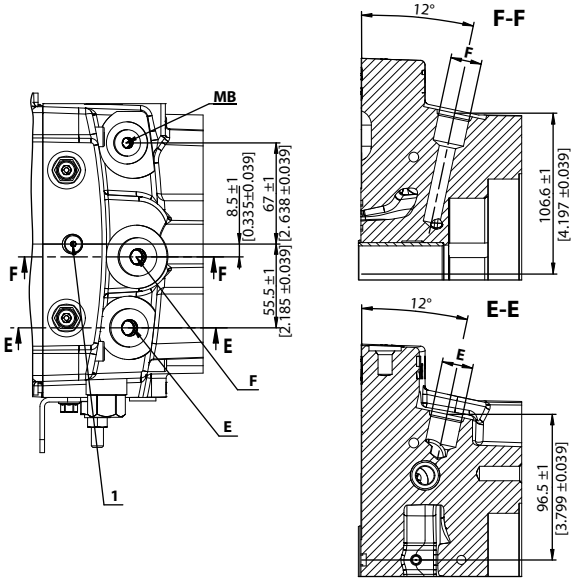
**B** System port split flange boss per ISO 6162; M12 x 1.75, 20 min. full thread depth

**MB** System B gauge port per ISO 1192601; 9/16-18

**S** Charge inlet port per ISO 11926-1; 1 5/16-12

**H1P 69/78 Remote Full Charge Pressure Filtration Option P**

*Remote Filtration for end cap option F5 (SAE-C PTO)*



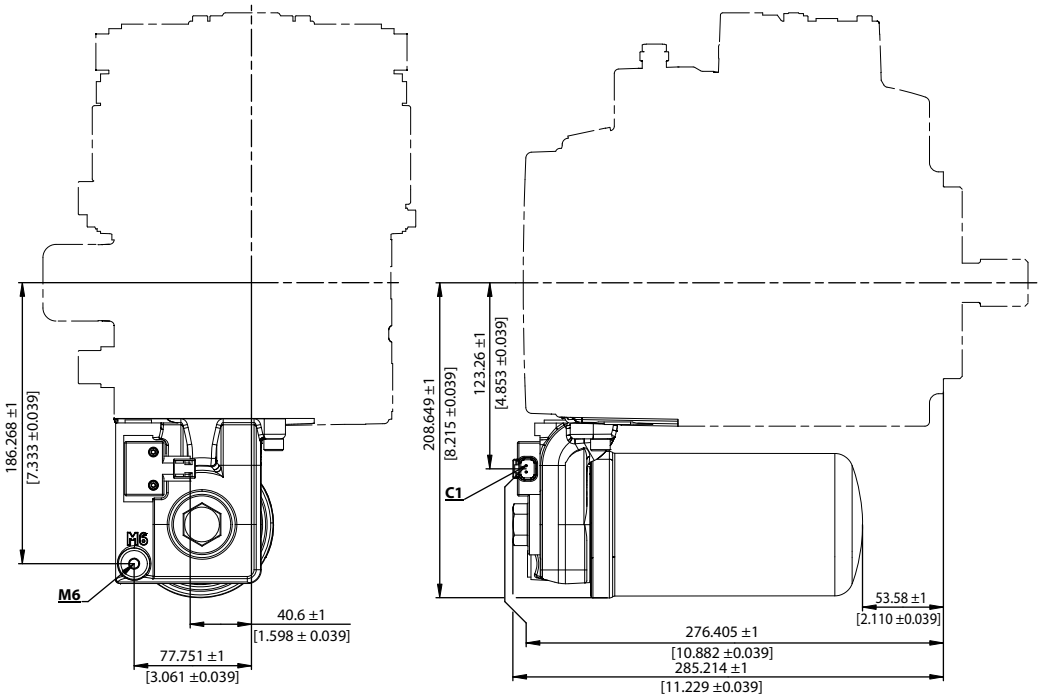

**E** Charge filtration port per ISO 11926-1; 7/8-14 from filter

## Dimensions and Data

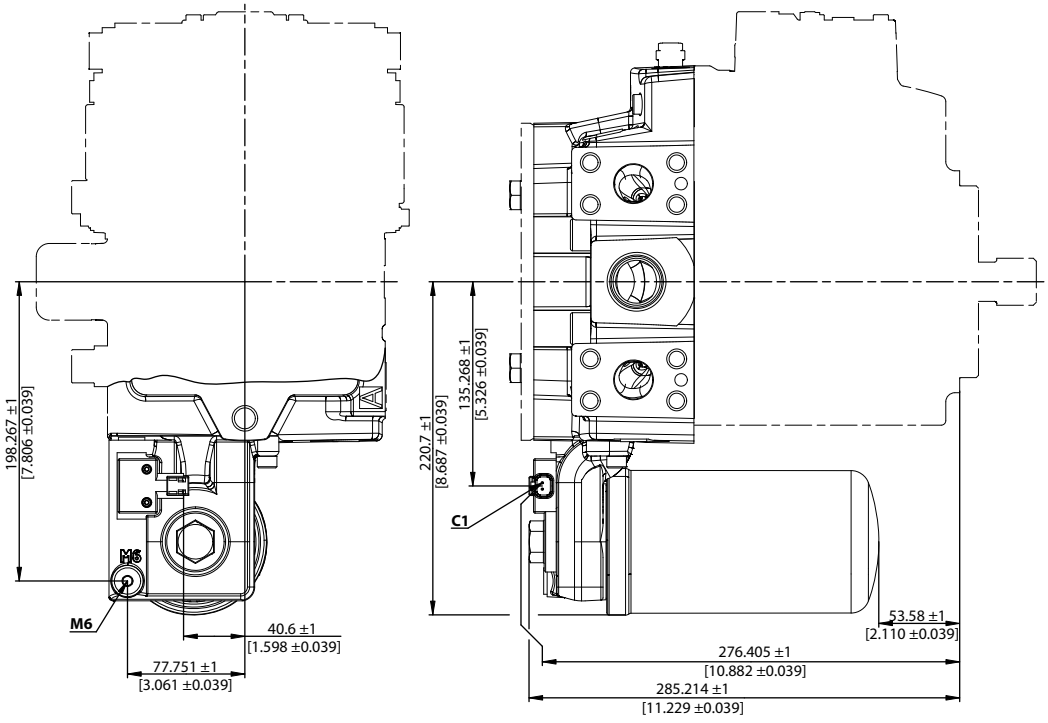
| | |
|---|---|
| **F** | Charge filtration port per ISO 11926-1; 7/8-14 to filter |
| **MB** | System B gauge port per ISO 11926-1; 9/16-18 |

### Integral Full Flow Charge Pressure Filtration, Option M

*Integral filtration with filter bypass sensor, option M, for end cap option D3*




*Integral charge filtration with filter bypass sensor, option M, for end cap option F4 (SAE-C PTO)*

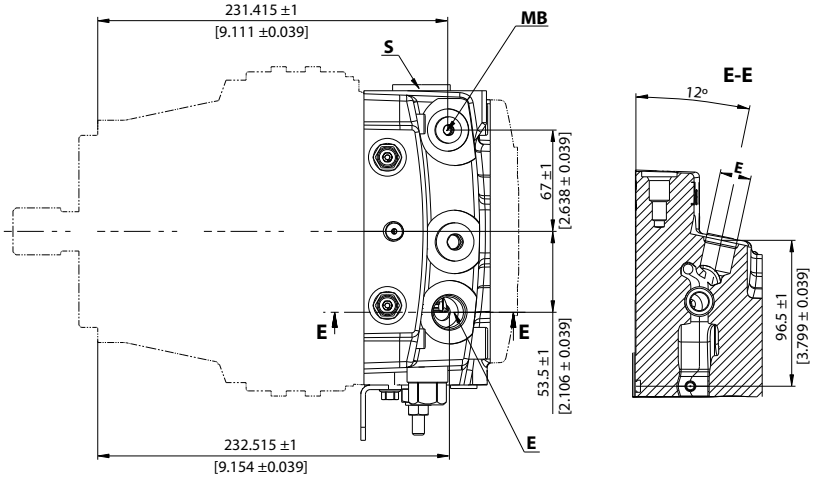


## Dimensions and Data

Please contact Danfoss representative for specific installation drawings.

### External Full Flow Charge Pressure Filtration, Option S

*External filtration, option S for end cap options D8 or F5*




| | |
|---|---|
| **E** | Charge filtration ports per ISO 11926-1: $^{7}/_{8}$–14 from filter |
| **MB** | System gauge port per ISO 11926-1: $^{9}/_{16}$–18 |
| **S** | Charge inlet port per ISO 11926-1: $1^{5}/_{16}$–12 |

Please contact Danfoss representative for specific installation drawings.

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