

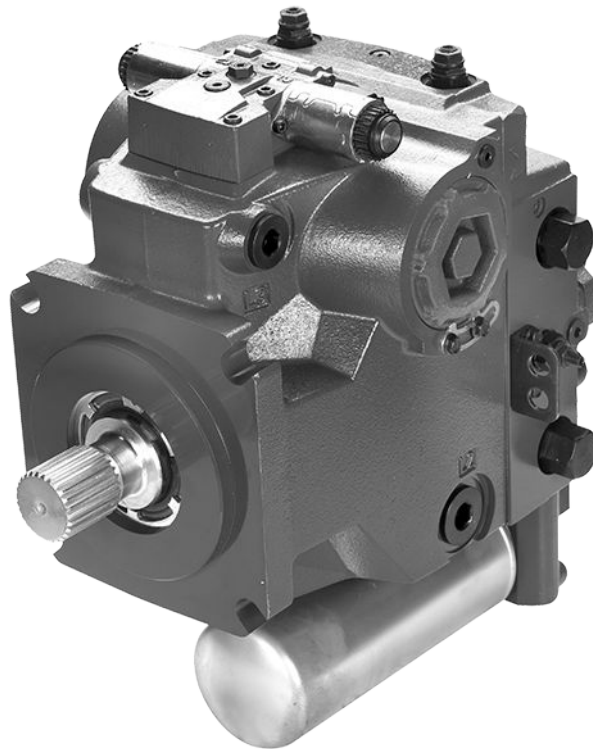
ENGINEERING
TOMORROW



Technical Information

H1 Axial Piston Single Pumps

Size 147/165



Revision history

Table of revisions

| Date | Changed | Rev |
|----------------|--|------------|
| September 2018 | MMC update for M option added. | 0802 |
| May 2018 | Angle sensor for EDC; FDC note added. | 0801 |
| May 2017 | NFPE gen. 3 changes. | 0701 |
| November 2015 | Master Model Code changes. | 0600 |
| September 2014 | MDC, CCO, and Swash Angle Sensor options added | FA |
| Mar 2014 | Converted to Danfoss layout - DITA CMS | EA |
| Apr 2013 | FDC option added | DA |
| Dec 2012 | Pressure changed | CA |
| Jul 2010 | New EC directive | BA |
| Jul 2009 | First edition | AA |

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Technical specifications

H1 Pumps General Specification

Axial piston closed circuit variable displacement pump 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 147/165 Technical Data

| Feature | Size 147 | Size 165 |
|---|---|---|
| Displacement | 147.2 cm ³ [8.98 in ³] | 165.1 cm ³ [10.08 in ³] |
| Flow at rated speed (continuous) | 441 l/min [117 US gal/min] | 495 l/min [131 US gal/min] |
| Torque at maximum displacement (theoretical) | 2.34 N•m/bar [1430 lbf•in/1000 psi] | 2.63 N•m/bar [1605 lbf•in/1000 psi] |
| Mass moment of inertia of rotating components | 0.027 kg•m ² [0.0199 slug•ft ²] | 0.027 kg•m ² [0.0199 slug•ft ²] |
| Mass (dry – no charge pump or auxiliary mounting flange) | 96 kg [211 lb] | 96 kg [211 lb] |
| Oil volume | 3.0 l [0.8 US gal] | 3.0 l [0.8 US gal] |

Shaft, flange and ports description

| | |
|--|--|
| Input shaft outer diameter, ISO 3019-1 splined or tapered shaft | <ul style="list-style-type: none"> • Outer Ø44 mm – 4 (SAE D, 13 teeth) • Outer Ø44 mm – 4 (SAE D, 27 teeth) • Conical keyed shaft end similar to ISO 3019-1 code 44-3, taper 1:8 |
| Mounting flange per ISO 3019-1 | Flange 152-4 (SAE D) |

Technical specifications

Shaft, flange and ports description (continued)

| | |
|--|---|
| Auxiliary mounting flange with metric fasteners, with shaft outer diameter and splines per ISO 3019-1 | <ul style="list-style-type: none"> • Flange 82-2 Outer Ø16 mm – 4 (SAE A, 9 teeth) • Flange 82-2 Outer Ø19 mm – 4 (SAE A, 11 teeth) • Flange 101-2 Outer Ø22 mm – 4 (SAE B, 13 teeth) • Flange 101-2 Outer Ø25 mm – 4 (SAE B-B, 15 teeth) • Flange 127-4 Outer Ø32 mm – 4 (SAE C, 14 teeth) • Flange 152-4 Outer Ø44 mm – 4 (SAE D, 13 teeth) |
| Suction port | 1 $\frac{5}{8}$ -12 (SAE O-ring boss) |
| Main configuration port | Ø31.5 mm - 450 bar split flange boss per ISO 6162, M12x1.75 |
| Case drain ports L2, L4 | ISO 11926-1 – 1 $\frac{5}{16}$ -12 |
| Other ports | SAE O-ring boss |
| Customer interface threads | Metric fasteners |

H1P 147/165 Operating Parameters

| Parameter | | Size 147/165 |
|-----------------------------------|---|--|
| Input speed | Min. for internal¹⁾ and external²⁾ charge supply | 500 min ⁻¹ (rpm) |
| | Min. for full performance, internal charge supply | 1200 min ⁻¹ (rpm) |
| | Rated | 3000 min ⁻¹ (rpm) |
| | Maximum | 3100 min ⁻¹ (rpm) |
| System pressure | Maximum working | 450 bar [6528 psi] |
| | Maximum | 480 bar [6960 psi] |
| | Maximum low loop | 45 bar [650 psi] |
| | Minimum low loop | 10 bar [145 psi] |
| Charge pressure | Minimum | 16 bar [232 psi] |
| | Maximum | 34 bar [493 psi] |
| Control pressure | Minimum (at corner power for EDC, MDC) | 17 bar [247 psi] |
| | Minimum (at corner power for NFPE) | 25 bar [363 psi] |
| | Maximum | 34 bar [493 psi] |
| Charge pump inlet pressure | Rated | 0.7 bar (absolute) [9.0 in Hg vacuum] |
| | Minimum (cold start) | 0.2 bar (absolute) [24.0 in Hg vacuum] |
| | Maximum | 4.0 bar [58.0 psi] |
| Case pressure | Rated | 3.0 bar [44.0 psi] |
| | Maximum | 5.0 bar [73.0 psi] |
| Lip seal pressure | Maximum (external) | 0.4 bar [5.8 psi] |

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

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

Technical specifications

Fluid Specifications

Viscosity

| Intermittent ¹⁾ | Minimum | Recommended range | Maximum |
|-------------------------------|-------------------------------|---|------------------------------------|
| 5 mm ² /s [42 SUS] | 7 mm ² /s [49 SUS] | 12 – 80 mm ² /s [66 – 370 SUS] | 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 (cold start) | Rated | Recommended range* | Maximum Intermittent |
|----------------------|---------------|-------------------------|----------------------|
| -40°C [-40°F] | 104°C [220°F] | 60 – 85°C [140 – 185°F] | 115°C [240°F] |

* At the hottest point, normally case drain port

Filtration, Cleanliness level and Efficiency β_x -ratio (Recommended Minimum)

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

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.

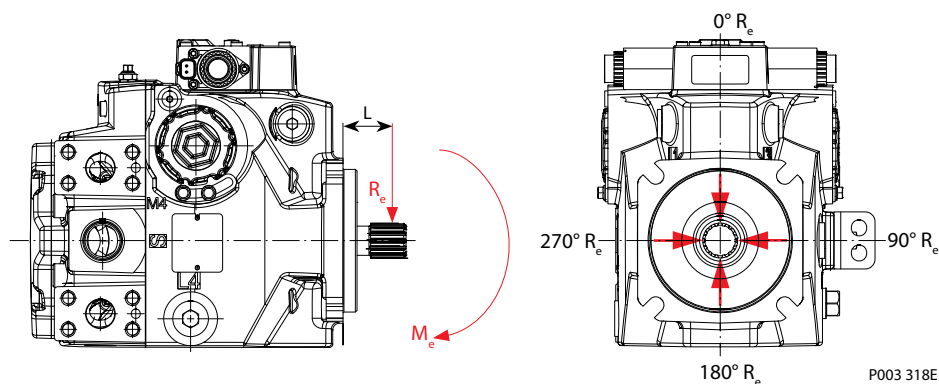
Danfoss recommends clamp-type couplings for applications with radial shaft loads. Contact your Danfoss representative for an evaluation of unit bearing life if you have continuously applied external loads exceeding 25 % of the maximum allowable radial load (R_e) or the pump swash-plate is positioned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

Maximum external shaft load based on shaft deflection

| External radial moment | Unit | Size 147 | Size 165 |
|------------------------|--------------|------------|------------|
| M_e | N·m [lbf·in] | 140 [1240] | 140 [1240] |

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



Technical specifications

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:

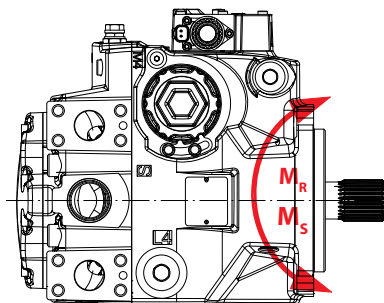
$$R_e = \frac{M_e}{L}$$

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

H1P 147/165 Mounting Flange Loads

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

Mounting flange load with control on top



P001 916

Rated moment

$$M_R = 6500 \text{ N}\cdot\text{m} [57\,500 \text{ lbf}\cdot\text{in}]$$

Shock load moment

$$M_S = 16\,300 \text{ N}\cdot\text{m} [144\,000 \text{ lbf}\cdot\text{in}]$$

For more information, see *H1 Axial Piston Pumps, Basic Information*, **BC0000057**, the section "Mounting flange loads".

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.

26/34 cm³ Charge Pump – Flow and Power Curves

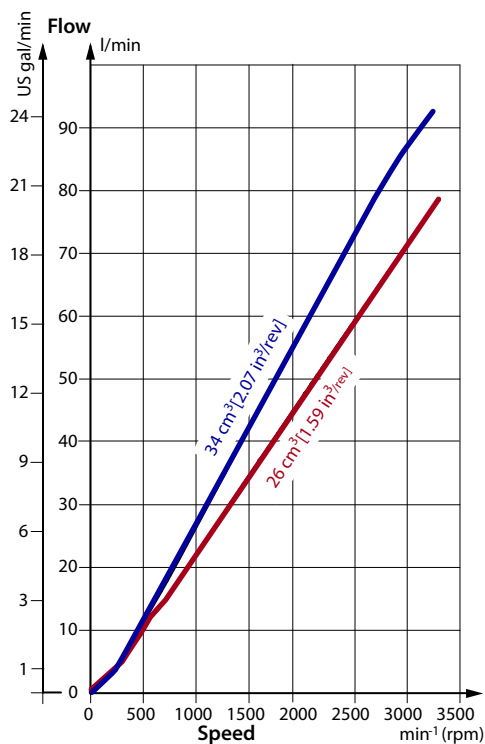
Charge pump flow and power requirements curves shown below at the following conditions:

Charge pressure = 20 bar [290 psi]

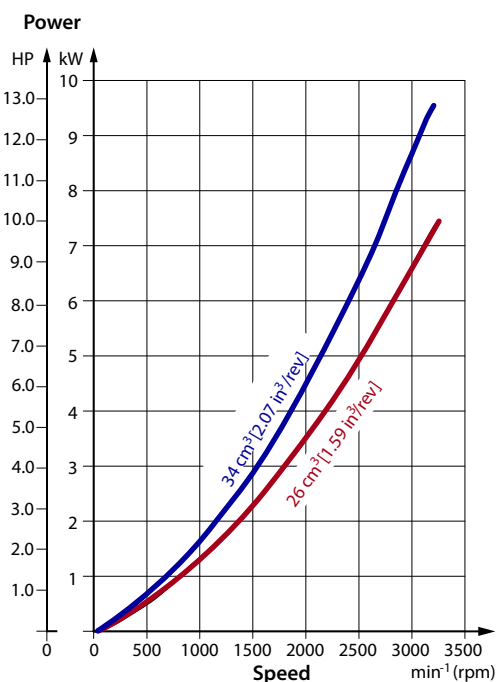
Viscosity = 11 mm²/s [63 SUS]

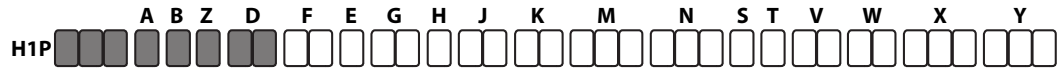
Temperature = 80°C [176°F]

Charge pump flow



Charge pump power requirements



Master Model Code

Displacement

| | |
|------------|--|
| 147 | 147.2 cm ³ [8.98 in ³] |
| 165 | 165.1 cm ³ [10.08 in ³] |

A – Rotation

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

B – Product version

| | |
|----------|---------------|
| C | Revision code |
|----------|---------------|

Z – Port configuration

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

D – Controls — Electric Displacement Control (EDC)

| 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

D – Controls (continued) — Fan Drive Control (FDC)

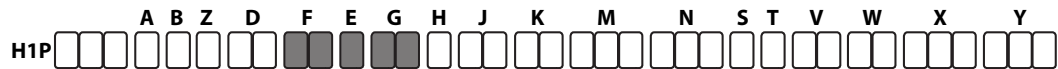
| | | | |
|-----------|------------|------|-------------------|
| F1 | FDC | 12 V | DEUTSCH Connector |
| F2 | FDC | 24 V | DEUTSCH Connector |

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

D – Controls (continued) — Forward-Neutral-Reverse Control (FNR)

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

Master Model Code



F – Orifices related to control type

| Code | Tank (A+B) | P orifice | A/B orifices | EDC, FNR | MDC | NFPE, AC | FDC |
|-----------|------------|-----------|--------------|----------|-----|----------|-----|
| C3 | No orifice | | | ● | ● | - | - |
| C1 | - | - | 0.8 mm | ● | ● | ● | - |
| C2 | - | - | 1.3 mm | ● | ● | ● | ● |
| C4 | - | - | 1.8 mm | ● | ● | ● | - |
| C5 | - | - | 2.5 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 | - | - | ● | - | - |

E – Displacement limiter

| | |
|----------|--|
| 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).

G – End-cap options (Twin port, ISO 6162 split flange ports)

| Code | Align the options: M, N, T – Filtration below and K – Auxiliary mounting pads |
|-----------|--|
| D3 | Internal charge supply for full charge flow filtration with pressure limiter ¹⁾ |
| D5 | Internal charge supply for full charge flow filtration with pressure limiter ²⁾ |
| D6 | Suction filtration with pressure limiter ¹⁾ |
| D7 | Remote or external charge supply for full charge flow filtration with pressure limiter ²⁾ |
| D8 | Remote or external charge supply for full charge flow filtration with pressure limiter ¹⁾ |
| D9 | Suction filtration with pressure limiter ²⁾ |

¹⁾ K – Auxiliary mounting pads ISO 3019-1 flanges:

- 82–2 (SAE A, 9 and 11 teeth)
- 101–2 (SAE B, 13 teeth and SAE B-B, 15 teeth)
- or None

²⁾ K – Auxiliary mounting pad ISO 3019-1 flange 127–4 (SAE C, 14 teeth)

Master Model Code



H – Mounting (Align with option W – Special hardware features)

| | |
|----------|--|
| G | ISO 3019-1 flange 152-4 (SAE D) |
| L | ISO 3019-1 flange 152-4 (SAE D), 4-bolt, with speed sensor |

J – Input shaft

| | |
|-----------|--|
| G2 | ISO 3019-1, outer Ø44 mm - 4 (SAE D, 27 teeth splined shaft 16/32 pitch) |
| G3 | ISO 3019-1, outer Ø44 mm - 4 (SAE D, 13 teeth splined shaft 8/16 pitch) |
| F3 | Conical keyed shaft end, code 44-3 (similar to ISO 3019-1), taper 1:8 (key not supplied with pump) |

K – Auxiliary mounting pad per ISO 3019-1

| | |
|-----------|---|
| NN | None |
| E5 | Flange 82-2, outer Ø16 mm - 4 (SAE C, 13 teeth 16/32 coupling); shipping cover |
| H1 | Flange 82-2, outer Ø19 mm - 4 (SAE A, 11 teeth 16/32 coupling); shipping cover |
| H2 | Flange 82-2, outer Ø16 mm - 4 (SAE A, 9 teeth 16/32 coupling); shipping cover |
| H3 | Flange 101-2, outer Ø22 mm - 4 (SAE B, 13 teeth 16/32 coupling); shipping cover |
| H4 | Flange 152-4, outer Ø44 mm - 4 (SAE D, 13 teeth 8/16 coupling); shipping cover |
| H5 | Flange 101-2, outer Ø25 mm - 4 (SAE B-B, 15 teeth 16/32 coupling); shipping cover |
| H6 | Flange 127-4, outer Ø32 mm - 4 (SAE C, 14 teeth 12/24 coupling); shipping cover |
| S1 | Flange 101-2, outer Ø22 mm - 4 (SAE B, 14 teeth 12/24 coupling); shipping cover |

Align with option **G – End cap selection**.

Master Model Code

H1P **A** **B** **Z** **D** **F** **E** **G** **H** **J** **K** **M** **N** **S** **T** **V** **W** **X** **Y**

S – Charge pump

| | |
|----------|--|
| A | 26 cm ³ /rev [1.69 in ³ /rev] |
| L | 34 cm ³ /rev [2.07 in ³ /rev] |
| N | No charge pump, external charge supply (<i>Align with options: E, T</i>) |

T – Filtration (Align with option G: End cap selection)

| | |
|----------|--|
| L | Suction filtration |
| M | Integral full charge flow filtration with bypass, bypass sensor, long filter length, 11004919 |
| N | Integral full charge flow filtration with bypass, bypass sensor, no filter |
| P | Remote full charge flow filtration |
| E | External charge flow filtration (<i>Align with options: N, S</i>) |

V – Charge pressure relief 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.

W – Special hardware features (Align with options: D and E)

| | |
|-----------|--|
| P1 | NFPE 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 nametag

| | |
|------------|---------------------------------|
| NNN | Black paint and Danfoss nametag |
|------------|---------------------------------|

Master Model Code



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

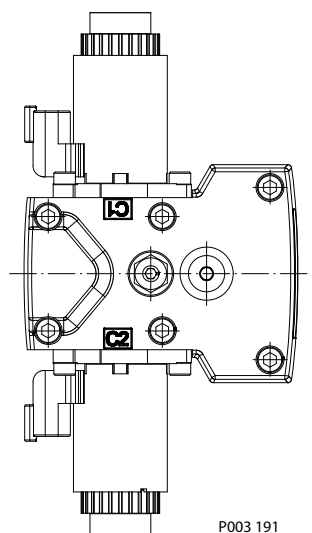
Electrical Displacement Control (EDC)

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.

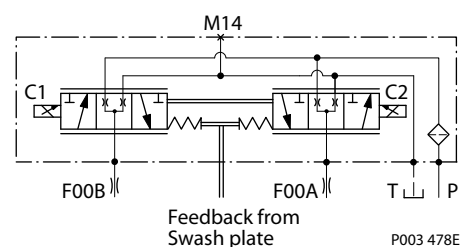
Differential pressure across the servo piston rotates the swash-plate, changing the pump's displacement from full displacement in one direction to full displacement in the opposite direction. A serviceable 125 µm screen is located in the supply line immediately before the control porting spool.

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

Electrical Displacement Control

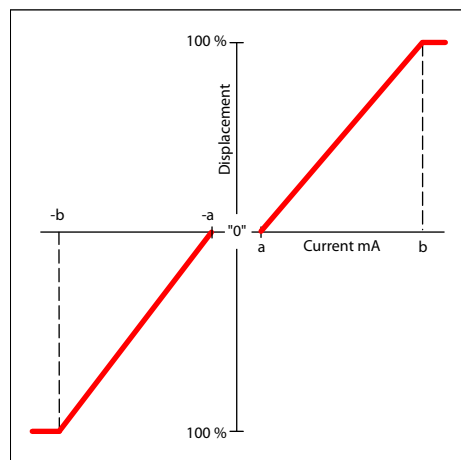


EDC schematic, feedback from swash-plate



EDC Control Signal Requirements

Pump displacement vs. control current



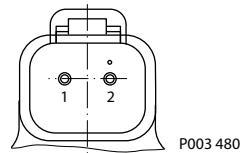
Control Options

EDC Control minimum current to stroke pump

| Voltage | a* | b | Pin connections |
|---------|--------|---------|-----------------|
| 12 V | 640 mA | 1640 mA | any order |
| 24 V | 330 mA | 820 mA | |

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

Connector



Connector ordering data

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

EDC 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* | 200 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.

Pump output flow direction vs. control signal

| Shaft rotation | CW | | CCW | |
|------------------------|-----|-----|-----|-----|
| | C1 | C2 | C1 | C2 |
| Coil energized* | | | | |
| 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 Response

H1 controls are available with optional control passage orifices to assist in matching the rate of swash-plate response to the application requirements. The time required for the pump output flow to change

Control Options

from zero to full flow (acceleration) or full flow to zero (deceleration) is a net function of spool porting, orifices, and charge pressure.

H1 pumps are limited in mechanical orifice combinations. Mechanical servo orifices are to be used only for fail-safe return to neutral in a case of an electrical failure.

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:

$\Delta p = 250 \text{ bar}$ [3626 psi]

Charge pressure = 20 bar [290 psi]

Viscosity and temperature = 30 mm²/s [141 SUS] and 50 °C [122 °F]

Speed = 1800 min⁻¹ (rpm)

Response Time, EDC 147/165

| Stroking direction | 0.8 mm [0.03 in] orifice | 1.3 mm [0.05 in] orifice | No orifice |
|----------------------|--------------------------|--------------------------|------------|
| Neutral to full flow | 5.8 s | 2.1 s | 1.3 s |
| Full flow to neutral | 2.4 s | 2.1 s | 1.3 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 swash-plate.

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.

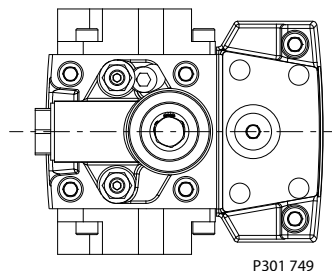
Differential pressure across the servo piston rotates the swash plate, changing the pump's displacement. Simultaneously the swash-plate movement is fed back to the control spool providing proportionality between shaft rotation on the control and swash-plate rotation.

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.

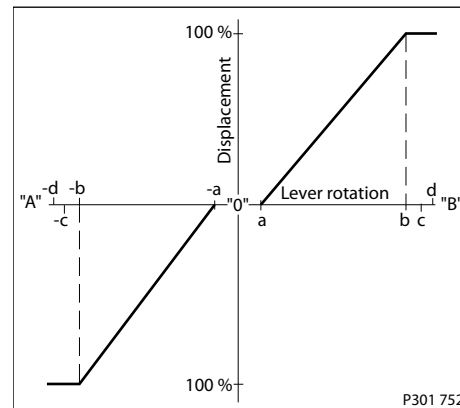
A serviceable 125 μm screen is located in the supply line immediately before the control porting spool.

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



Legend:

Deadband on **B** side – **a** = $3^\circ \pm 1^\circ$

Maximum pump stroke – **b** = $30^\circ +2/-1^\circ$

Required customer end stop – **c** = $36^\circ \pm 3^\circ$

Internal end stop – **d** = 40°

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.

MDC General Information

In difference to other controls the MDC provides a mechanical deadband. This is required to overcome the tolerances in the mechanical actuation.

Control Options

The MDC contains an internal end stop to prevent over travel. The restoring moment is appropriate for turning the MDC input shaft back to neutral only. Any linkages or cables may prevent the MDC from returning to neutral.

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

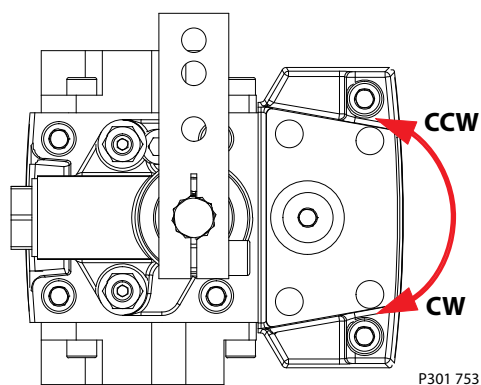
Customers can apply their own handle design but they must care about a robust clamping connection between their handle and the control shaft and avoid overload of the shaft.

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 but the kinematic of the linkages must ensure that either control shaft is protected from torque overload. To avoid an overload of the MDC, customers must install any support to limit the setting range of the Bowden cable.

Caution

Using the internal spring force on the input shaft is not an appropriate way to return the customer connection linkage to neutral.

MDC Shaft Rotation



MDC shaft rotation data

| Pump shaft rotation* | Clock Wise (CW) | | Counter Clock Wise (CCW) | |
|--------------------------|-----------------|------------|--------------------------|------------|
| | 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.

Control Response

H1 controls are available with optional control passage orifices to assist in matching the rate of swash-plate response to the application requirements. 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.

H1 pumps are limited in mechanical orifice combinations. Mechanical servo orifices are to be used only for fail-safe return to neutral in a case of an electrical failure.

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:

Control Options

$\Delta p = 250 \text{ bar [3626 psi]}$
 Charge pressure = 20 bar [290 psi]
 Viscosity and temperature = 30 mm²/s [141 SUS] and 50 °C [122 °F]
 Speed = 1800 min⁻¹ (rpm)

MDC Response Time

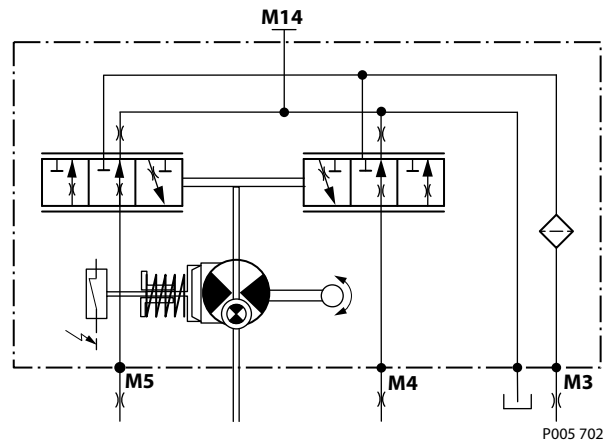
| Code | Orifice description (mm) | | | | Stroking direction (sec) | |
|------------|--------------------------|-----|-----|------------|--------------------------|----------------------|
| | P | A | B | Tank (A+B) | Neutral to full flow | Full flow to neutral |
| C3 | No orifice | | | | 0.9 | 1.0 |
| C6 | - | - | - | 1 | 3.3 | 2.9 |
| C7 | - | - | - | 1.3 | 2.1 | 1.9 |
| D1* | 1 | - | - | 0.8 | 5.0 | 3.9 |
| D2* | 1.3 | - | - | 0.8 | 4.4 | 4.4 |
| D3 | 1.3 | - | - | 1 | 3.8 | 3.2 |
| D4 | 1.3 | 1.3 | 1.3 | 1 | 4.6 | 3.8 |
| D6 | 1.3 | - | - | 1.3 | 2.5 | 2.3 |

* For 147cc pump only.

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

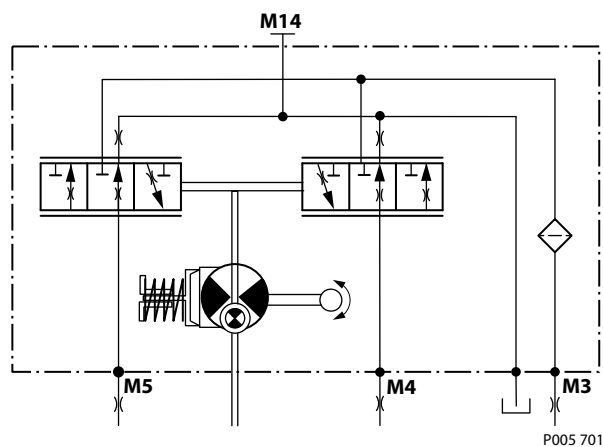
| | |
|--|------------------------------------|
| Max. continuous current with switching | 8.4 A |
| Max. continuous current without switching | 20 A |
| Max. voltage | 36 V _{DC} |
| Electrical protection class | IP67 / IP69K with mating connector |

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.

Control Options

MDC schematic diagram



Lever

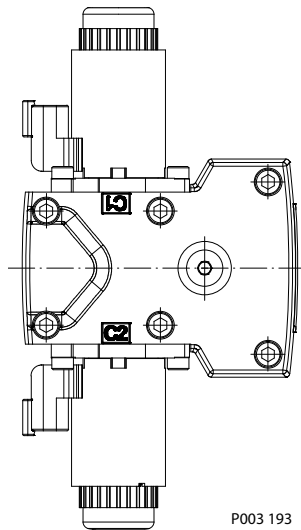
MDC-controls are available with an integrated lever.

Control Options

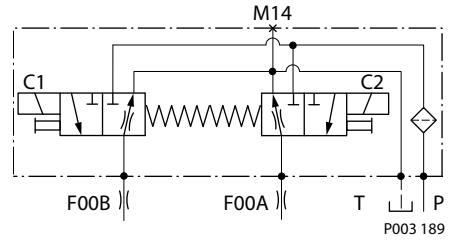
Forward-Neutral-Reverse Control (FNR)

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.

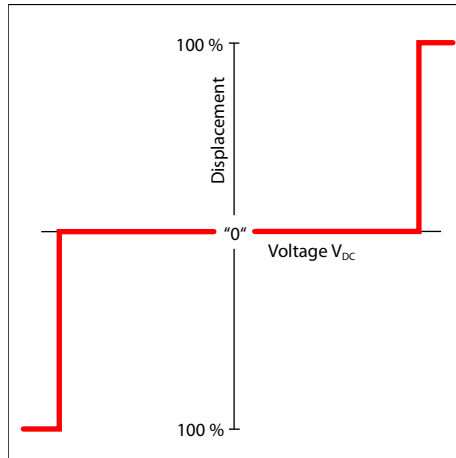
Forward-Neutral-Reverse electric control (FNR)



FNR hydraulic schematic



Pump displacement vs. electrical signal



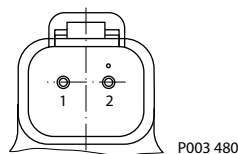
Under some circumstances, such as contamination, the control spool could stick and cause the pump to stay at some displacement.

Control current

| Voltage | 12 V _{DC} | 24 V _{DC} |
|-----------------------------|--------------------|--------------------|
| Min. current to stroke pump | 750 mA | 380 mA |
| Pin connections | any order | |

Control Options

Connector



Connector ordering data

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

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 |
| PWM Range | 70-200 Hz | |
| PWM Frequency (preferred)* | 100 Hz | |
| IP Rating (IEC 60 529) + DIN 40 050 | IP 67/IP 69K (part 9 with mating connector) | |

* PWM signal required for optimum control performance.

Pump output flow direction vs. control signal

| Shaft rotation | CW | | CCW | |
|------------------------|-----|-----|-----|-----|
| | C1 | C2 | C1 | C2 |
| Coil energized* | | | | |
| 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.

Control Response

H1 controls are available with optional control passage orifices to assist in matching the rate of swash-plate response to the application requirements. 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.

[H1 pumps are limited in mechanical orifice combinations. Mechanical servo orifices are to be used only for fail-safe return to neutral in a case of an electrical failure.](#)

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:

$\Delta p = 250 \text{ bar [3626 psi]}$
 Charge pressure = 20 bar [290 psi]

Control Options

Viscosity and temperature = 30 mm²/s [141 SUS] and 50 °C [122 °F]
Speed = 1800 min⁻¹ (rpm)

Response Time, FNR 147/165

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

Control Options

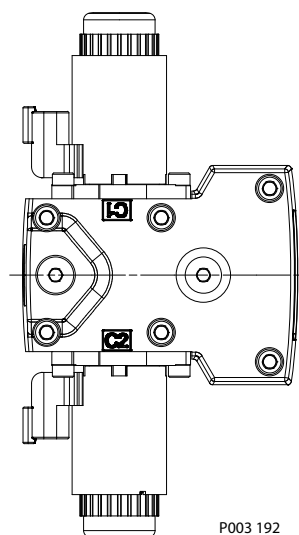
Non Feedback Proportional Electric Control (NFPE)

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.

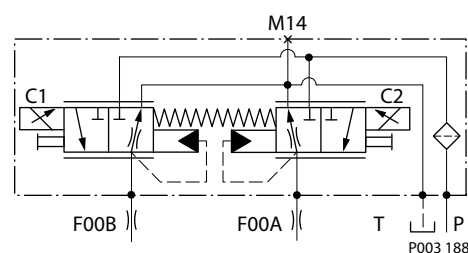
A serviceable 170 µm screen is located in the supply line immediately before the control porting spool.

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

Non Feedback Proportional Electric Control



NFPE schematic

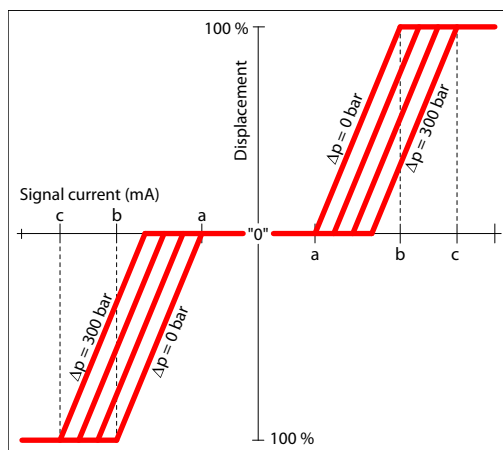


Control Signal Requirements, NFPE 147/165

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



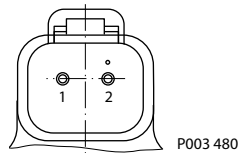
Control Options

Control current requirements

| Voltage | a* | b | c | Pin connections |
|---------|--------|---------|---------|-----------------|
| 12 V | 666 mA | 1168 mA | 1540 mA | any order |
| 24 V | 320 mA | 600 mA | 770 mA | |

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

Connector



Connector ordering data

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

| 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* | 200 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.

Pump output flow direction vs. control signal

| Shaft rotation | CW | | CCW | |
|------------------------|-----|-----|-----|-----|
| | C1 | C2 | C1 | C2 |
| Coil energized* | | | | |
| 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.

Control Response

H1 controls are available with optional control passage orifices to assist in matching the rate of swash-plate response to the application requirements. 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.

[H1 pumps are limited in mechanical orifice combinations. Mechanical servo orifices are to be used only for fail-safe return to neutral in a case of an electrical failure.](#)

Control Options

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:

$\Delta p = 250 \text{ bar}$ [3626 psi]

Charge pressure = 20 bar [290 psi]

Viscosity and temperature = 30 mm²/s [141 SUS] and 50 °C [122 °F]

Speed = 1800 min⁻¹ (rpm)

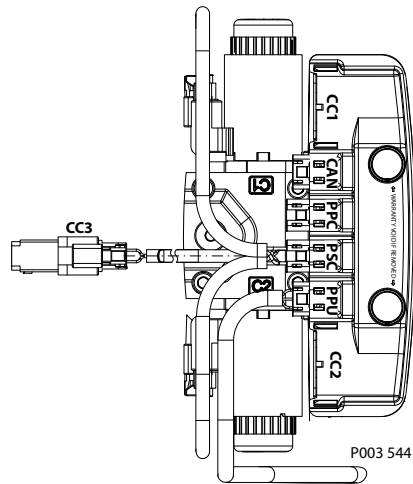
Response Time, NFPE 147/165

| 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 | 6.7 s | 2.7 s | 0.9 s |
| Full flow to neutral | 3.4 s | 1.5 s | 0.4 s |

Control Options

Automotive Control (AC)

The H1 **Automotive Control (AC)** is an electric NFPE Control with an integrated microcontroller, installed on the pump. The integrated microcontroller 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.

- **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 be 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

Control Options

- 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

Installation features

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

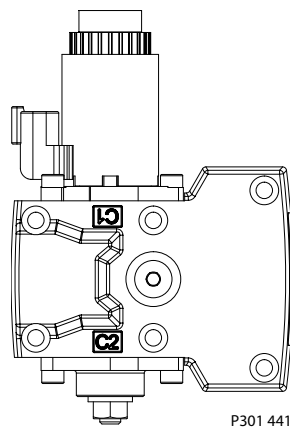
[For more information, see *Automotive Control for H1 Single Pumps Technical Information*, BC00000213.](#)

Control Options
Fan Drive Control (FDC)

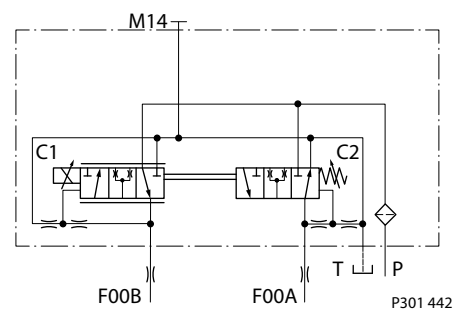
The Fan Drive Control (**FDC**) is a non-feedback control in which an electrical input signal activates the proportional solenoid that ports charge pressure to either side of the pump servo cylinder. The single proportional solenoid is used to control pump displacement in the forward or reverse direction.

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.

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.

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

For more information necessary to properly size and configure a hydraulic fan drive system, see [Hydraulic Fan Drive Design Guidelines AB00000019](#).

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.

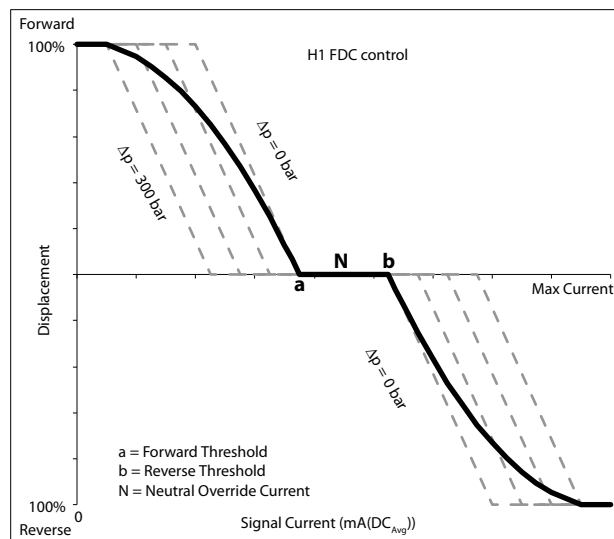
Control Signal Requirements, FDC 147/165

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:

Control Options

Pump displacement vs. control current



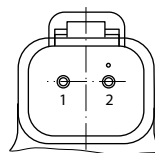
P301 443

Control current

| Voltage | a* | N | b* | Pin Config |
|---------|--------|---------|---------|------------|
| 12 V | 780 mA | 1100 mA | 1300 mA | any order |
| 24 V | 400 mA | 550 mA | 680 mA | |

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

Connector



P003 480

Connector ordering data

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

| Description | 12 V | 24 V |
|-------------------------|------------------|-------------|
| Maximum current | 1800 mA | 920 mA |
| Nominal coil resistance | @ 20 °C [68 °F] | 3.66 Ω |
| | @ 80 °C [176 °F] | 4.52 Ω |
| Inductance | 33 mH | 140 mH |
| PWM signal frequency | Range | 70 – 200 Hz |
| | Recommended* | 200 Hz |

Control Options

| Description | | 12 V | 24 V |
|-----------------|--------------------|------------------------------|------|
| 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.

Pump output flow direction vs. control signal

| Shaft rotation | | CW | | | CCW | | |
|------------------------|------|----------|---------|--------------|----------|---------|--------------|
| 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.

Control Response

H1 controls are available with optional control passage orifices to assist in matching the rate of swash-plate response to the application requirements. 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.

[H1 pumps are limited in mechanical orifice combinations. Mechanical servo orifices are to be used only for fail-safe return to neutral in a case of an electrical failure.](#)

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:

$\Delta p = 250 \text{ bar}$ [3626 psi]

Charge pressure = 20 bar [290 psi]

Viscosity and temperature = 30 mm²/s [141 SUS] and 50 °C [122 °F]

Speed = 1800 min⁻¹ (rpm)

Response Time, FDC 147/165

| Stroking direction | 0.8 mm [0.03 in] orifice |
|--|--------------------------|
| Full flow to neutral | 3.9 s |
| Full forward flow to full reverse flow | 5.6 s |

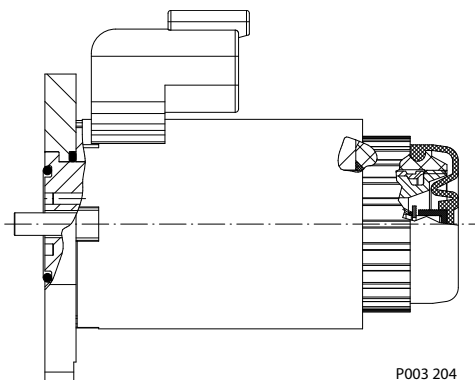
Control Options

Manual Over Ride (MOR)

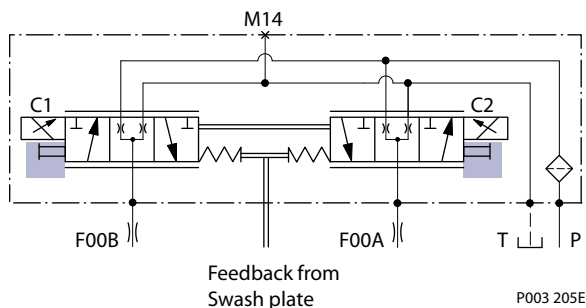
All controls are available with a Manual Over Ride (MOR) either standard or as an option for temporary actuation of the control to aid in diagnostics.

Forward-Neutral-Reverse (FNR) and Non Feedback Proportional Electric (NFPE) controls are always supplied with MOR functionality.

Manual Over Ride (MOR)



MOR schematic diagram (EDC shown)



Unintended MOR operation will cause the pump to go into stroke. The vehicle or device must always be in a „safe“ condition when using the MOR function. (Example: vehicle lifted off the ground)

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.

Warning

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.

Refer to control flow table for the relationship of solenoid to direction of flow.

Control Options

Swash Plate 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.

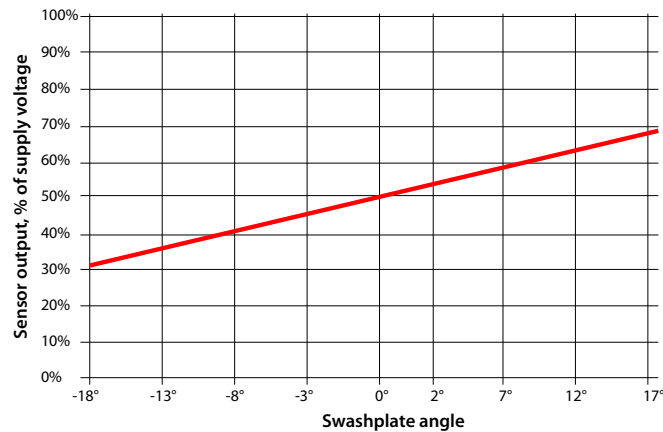
The sensor works on the hall-effect technology. The implemented technology is based on a measurement of the magnetic field direction in parallel to the chip surface. This field direction is converted to a voltage signal at the output.

Enhanced calibration of the non-linear behavior leads to more exact calculation of the pump swash plate angle.

The 4-pin DEUTSCH connector is part of the sensor housing.

The swash plate angle sensor is available for all EDC controls for 12 V and 24 V.

Swash plate angle vs. output of supply voltage



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 |

| Protection | Class |
|-----------------------------|------------------------------|
| IP rating IEC 60 529 | IP 67 |
| IP rating DIN 40050, part 9 | IP 69K with mating connector |
| EMC Immunity (ISO 11452-2) | 100 V/m |

Control Options

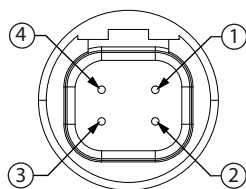
Calibration of the sensor output within the software is mandatory. Vehicle neutral thresholds in the software ($\pm 0.5^\circ$) are vehicle dependent and must consider different conditions, example: system temperature, system pressure and/or shaft speed.

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.

Swash Plate Angle Sensor Connector

DEUTSCH 4-pin connector



Legend:

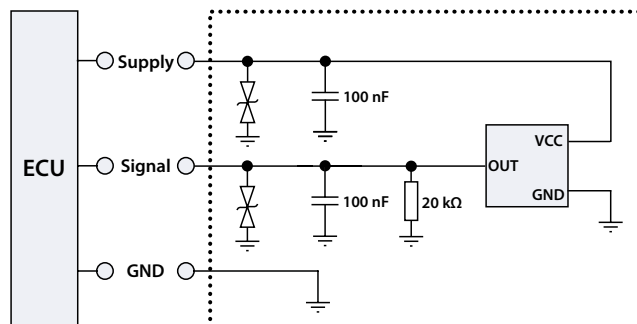
1. Ground (GND)
2. Not connected
3. Output signal 1 (SIG 1)
4. Supply (V+)

Connector order numbers

| Description | Quantity | Order number |
|--------------------------------|----------|-----------------|
| Mating connector DTM06-4S-E004 | 1 | 11105824 |
| Wedge lock WM-4S | 1 | not available |
| Socket contact 0462-201-2031 | 3 | |

Interface with ECU

Interface with ECU diagram

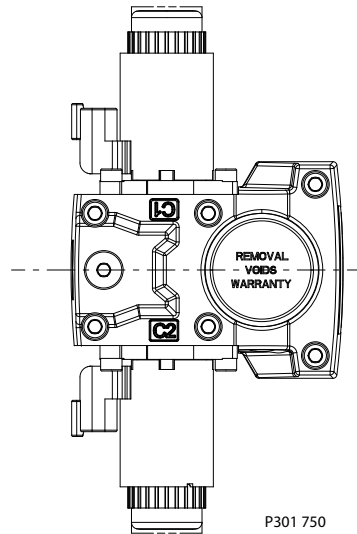


Control Options

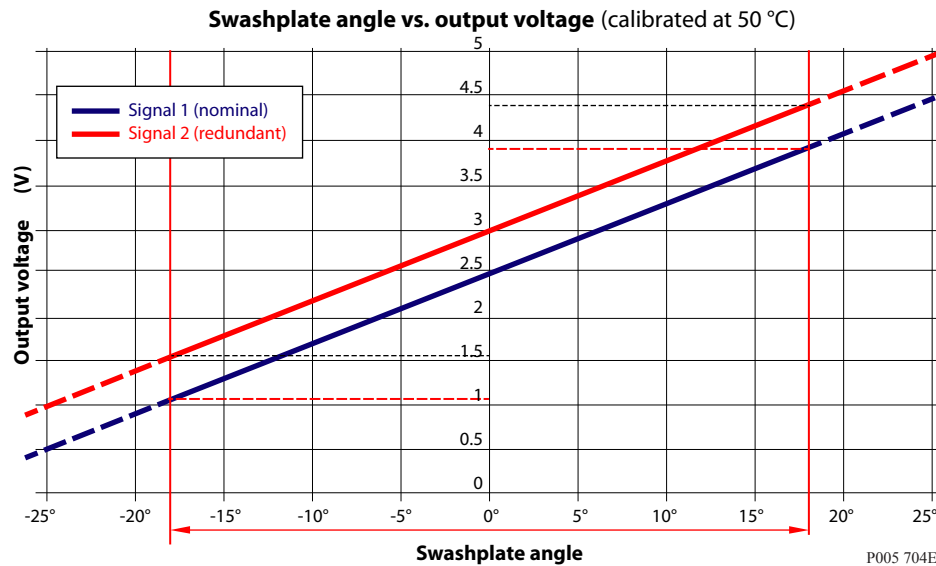
Swash plate angle sensor for NFPE and AC2 controls

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 vs. output voltage



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 |

Control Options

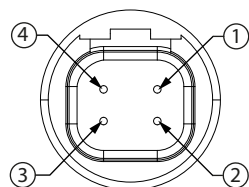
| Parameter | Minimum | Typical | Maximum |
|---|-------------|-------------|-------------|
| Sensitivity | 70.0 mV/deg | 78.0 mV/deg | 85.8 mV/deg |
| Working range (swash plate angle) | -18° | 0° | 18° |
| Correlation between signals 1 and 2²⁾ | 475 mV | 500 mV | 525 mV |

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

DEUTSCH 4-pin connector



4-Pin Legend:

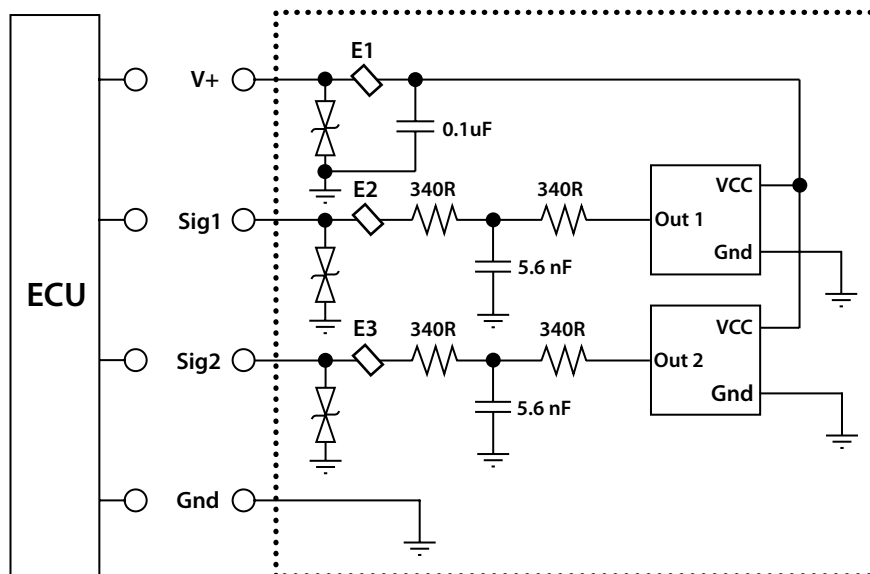
1. Ground (GND)
2. Output Signal 2 (SIG2) – Secondary (redundant)
3. Output Signal 1 (SIG1) – Primary (nominal)
4. Supply (V+)

Connector order numbers

| Description | Quantity | Order number |
|---|----------|-----------------|
| Mating connector DTM06-4S-E004 | 1 | 11105824 |
| Wedge lock W4S | 1 | 11084558 |
| Socket contact (16-18 AWG) 0462-201-16141 | 2 | K02325 |

Interface with ECU

Interface with ECU schematic



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. This valve blocks charge pressure to the control, allowing the servo springs to de-stroke pump 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.

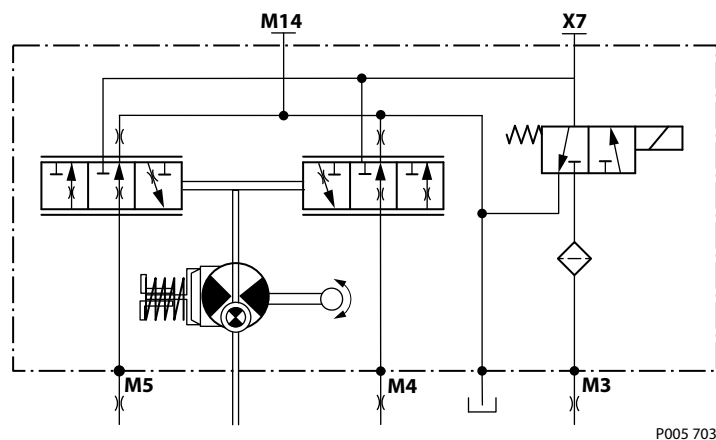
When the solenoid is energized, charge flow and pressure is allowed to reach the pump control. The X7 logic port will also be connected to charge pressure and flow.

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.

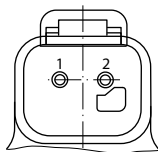
All EDC and MDC controls are available with a CCO valve. The CCO-valve is available with 12 V or 24 V solenoid.

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

CCO schematic (MDC shown)



CCO connector



Connector ordering data

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

Control Options

CCO solenoid data

| Nominal supply voltage | | 12 V | 24 V |
|--------------------------------------|-----------|------------------------------------|-----------|
| Supply voltage | Maximum | 14.6 V | 29 V |
| | Minimum | 9.5 V | 19 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 | 50-200 Hz |
| | Preferred | 100 Hz | 100 Hz |
| Electrical protection class | | IP67 / IP69K with mating connector | |
| Bi-directional diode cut off voltage | | 28 V | 53 V |

Brake gauge port with MDC

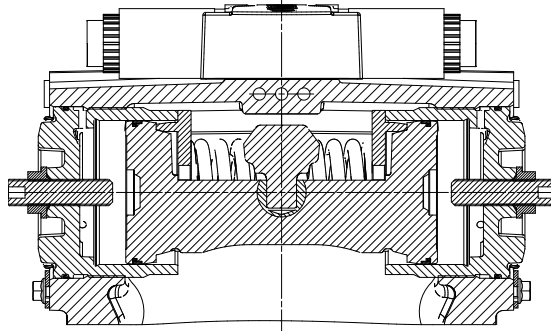
 **Caution**

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

Control Options
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.



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H1P 147/165 Displacement Change (Approximately)

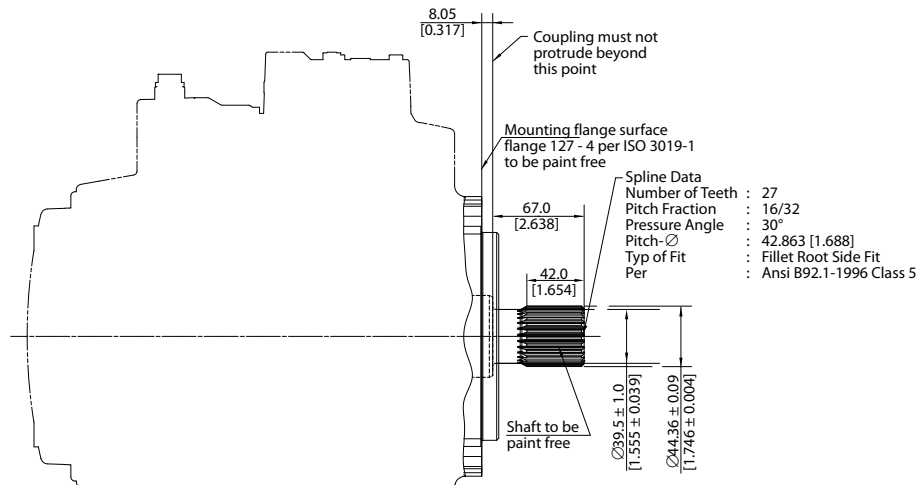
| Parameter | Size 147 | Size 165 |
|--|--|--|
| 1 Turn of displacement limiter screw | 12.4 cm ³ [0.76 in ³] | 13.9 cm ³ [0.85 in ³] |
| Internal wrench size | 6 mm | |
| External wrench size | 22 mm | |
| Torque for external hex seal lock nut | 80 N·m [708 lbf·in] | |

For more information, see *H1 Axial Piston Pumps, Service Manual*, [AX00000087](#), the section "Displacement Limiter Adjustment".

Dimensions

H1P input shaft - Option G2 (SAE D, 27 teeth)

Option G2, ISO 3019-1, outer dia 44 mm-4 (SAE D, 27 teeth)



P003 271E

Specifications

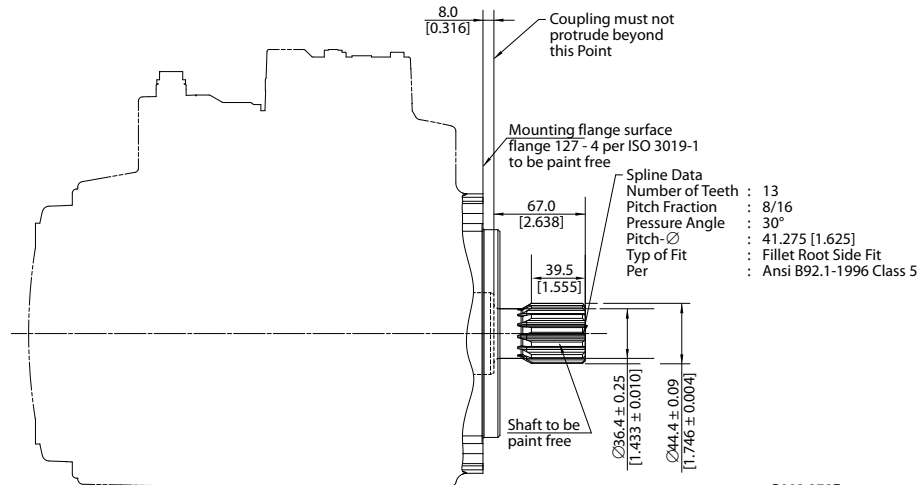
| Option | | G2 |
|--|---------|--------------------------|
| Spline | | 27 teeth, 16/32 pitch |
| Min. active spline length for the specified torque ratings | | 42.0 mm [1.654 in] |
| Torque rating | Rated | 1615 N·m [14 300 lbf·in] |
| | Maximum | 3000 N·m [26 550 lbf·in] |

For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information, BC00000057*, the section "Shaft Torque Ratings and Spline Lubrication".

Dimensions

H1P input shaft - Option G3 (SAE D, 13 teeth)

Option G3, ISO 3019-1, outer Ø 44 mm-4 (SAE D, 13 teeth)



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Specifications

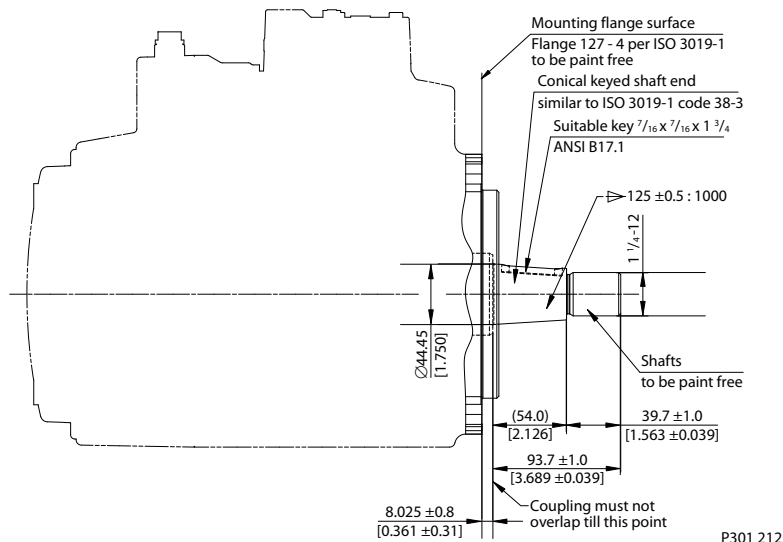
| | | |
|---|----------------------|--------------------------|
| Option | G3 | |
| Spline | 13 teeth, 8/16 pitch | |
| Min. active spline length for the specified torque ratings | 39.5 mm [1.555 in] | |
| Torque rating | Rated | 1442 N·m [12 800 lbf·in] |
| | Maximum | 2206 N·m [19 500 lbf·in] |

For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information, BC0000057*, the section "Shaft Torque Ratings and Spline Lubrication".

Dimensions

H1P input shaft - Option F3, Code 44-3

ISO 3019-1, Code 44-3, Diameter 44.5 taper 1:8, without key, no through-hole in the end of the shaft



Specifications

| Option | | F3 |
|---------------|---------|--------------------------|
| Tapered shaft | | 44-3 taper without key |
| Torque rating | Rated | 1766 N·m [15 630 lbf·in] |
| | Maximum | 2354 N·m [20 830 lbf·in] |

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.

Rated torque includes just the capability of the press-fit in accordance with an assumed fastener grade 5.

[For definitions of maximum and rated torque values, refer to H1 Axial Piston Pumps Basic Information, BC0000057, 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 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.

Danfoss guarantees the design and manufactured quality of the tapered shaft. 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

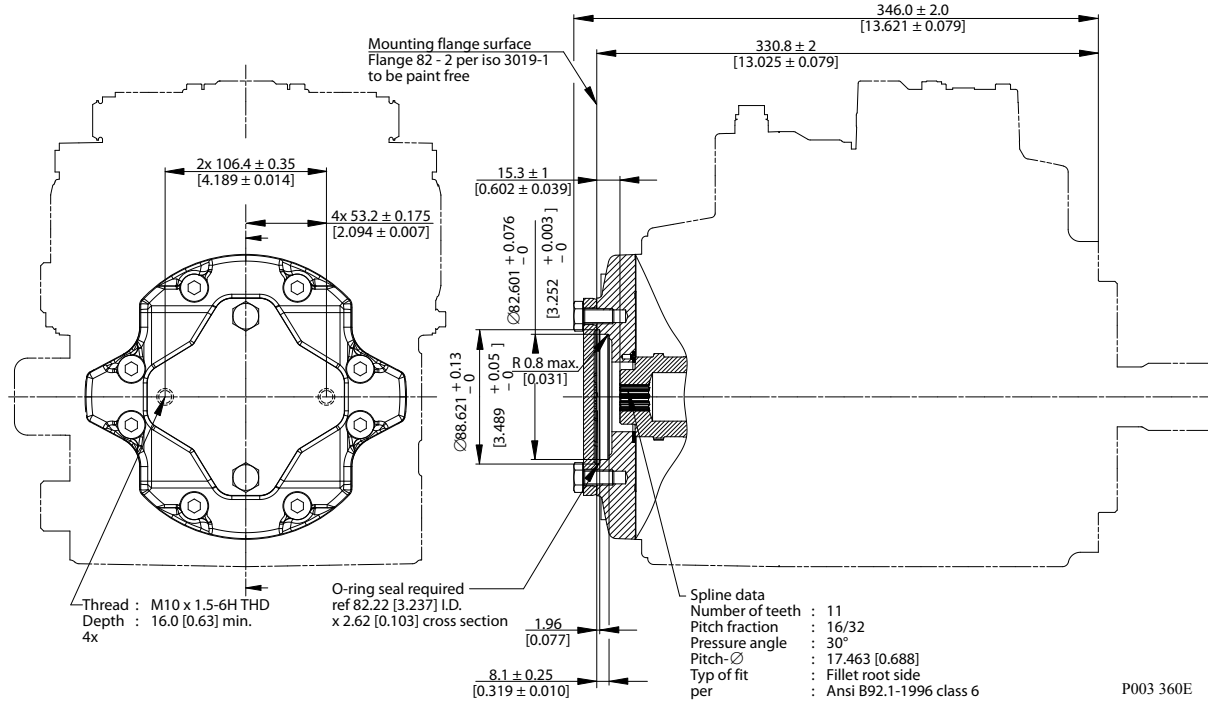
Possible hazard because torque or loading inadvertently transmitted by the customer supplied key may lead to premature shaft failure.

Torque must be transmitted by the taper fit between the shaft and it's mating coupling, not the key.

Dimensions

H1P 147/165 Auxiliary mounting, option H1 (SAE A, 11 teeth)

Option H1, ISO 3019-1, flange 82-2 (SAE A, 11 teeth)



Specifications

| Option | H1 |
|----------------|-----------------------|
| Spline | 11 teeth, 16/32 pitch |
| Maximum torque | 296 N·m [2620 lbf·in] |

For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information, BC00000057*, the section “Shaft Torque Ratings and Spline Lubrication”.

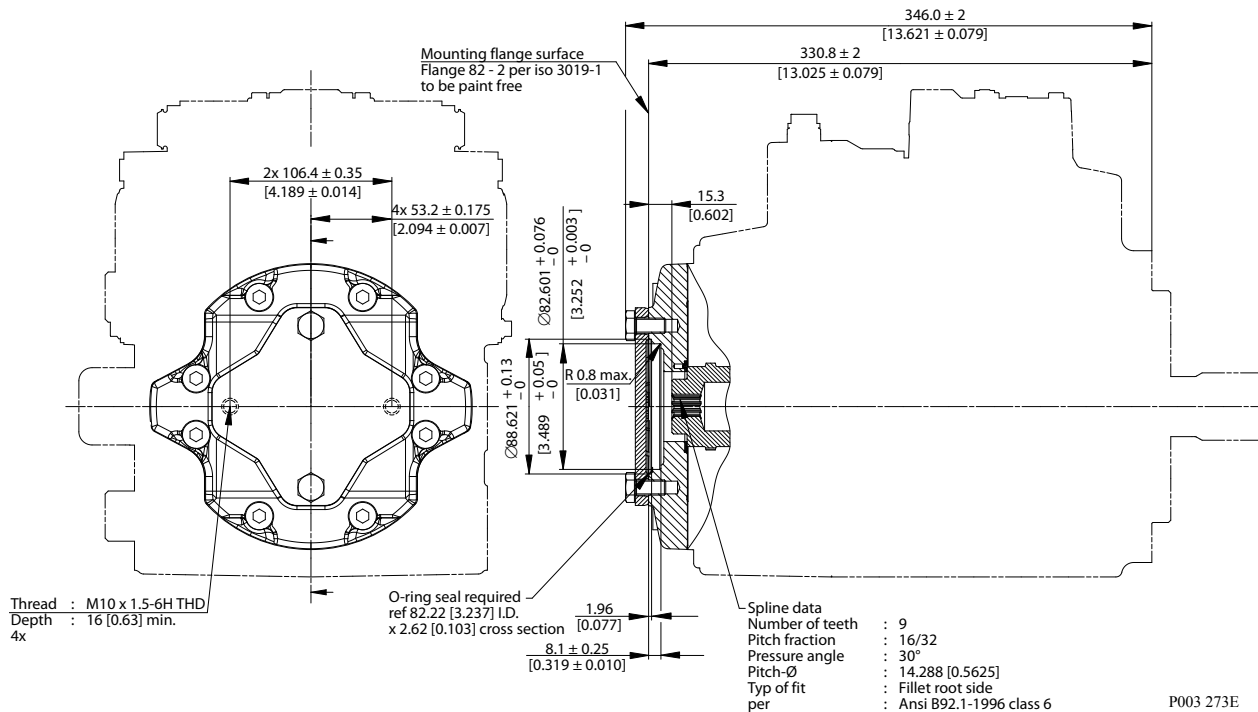
! Caution

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

Dimensions

H1P 147/165 Auxiliary mounting, option H2 (SAE A, 9 teeth)

Option H2, ISO 3019-1, flange 82-2 (SAE A, 9 teeth)



Specifications

| Option | H2 |
|----------------|-----------------------|
| Spline | 9 teeth, 16/32 pitch |
| Maximum torque | 162 N·m [1430 lbf·in] |

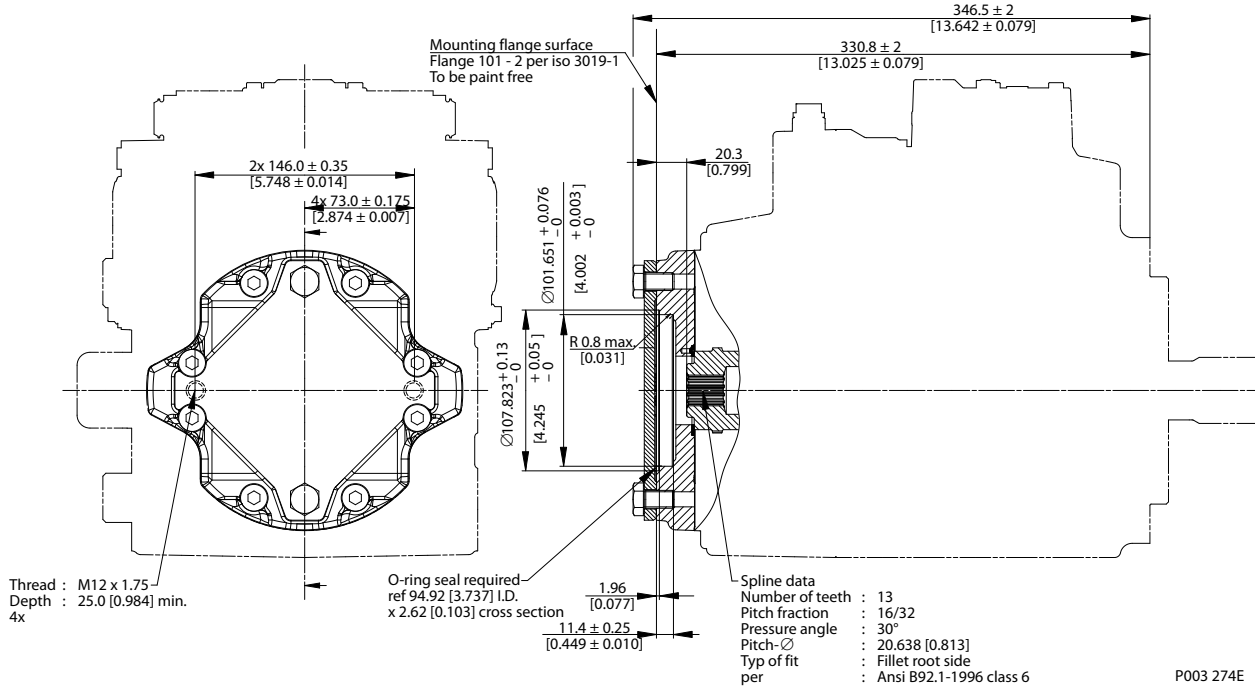
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information, BC0000057*, the section “Shaft Torque Ratings and Spline Lubrication”.

! 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
H1P 147/165 Auxiliary mounting, option H3 (SAE B, 13 teeth)

Option H3, ISO 3019-1, flange 101-2 (SAE B, 13 teeth)


Specifications

| Option | H3 |
|----------------|-----------------------|
| Spline | 13 teeth, 16/32 pitch |
| Maximum torque | 395 N•m [3500 lbf•in] |

For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information*, **BC0000057**, the section “Shaft Torque Ratings and Spline Lubrication”.

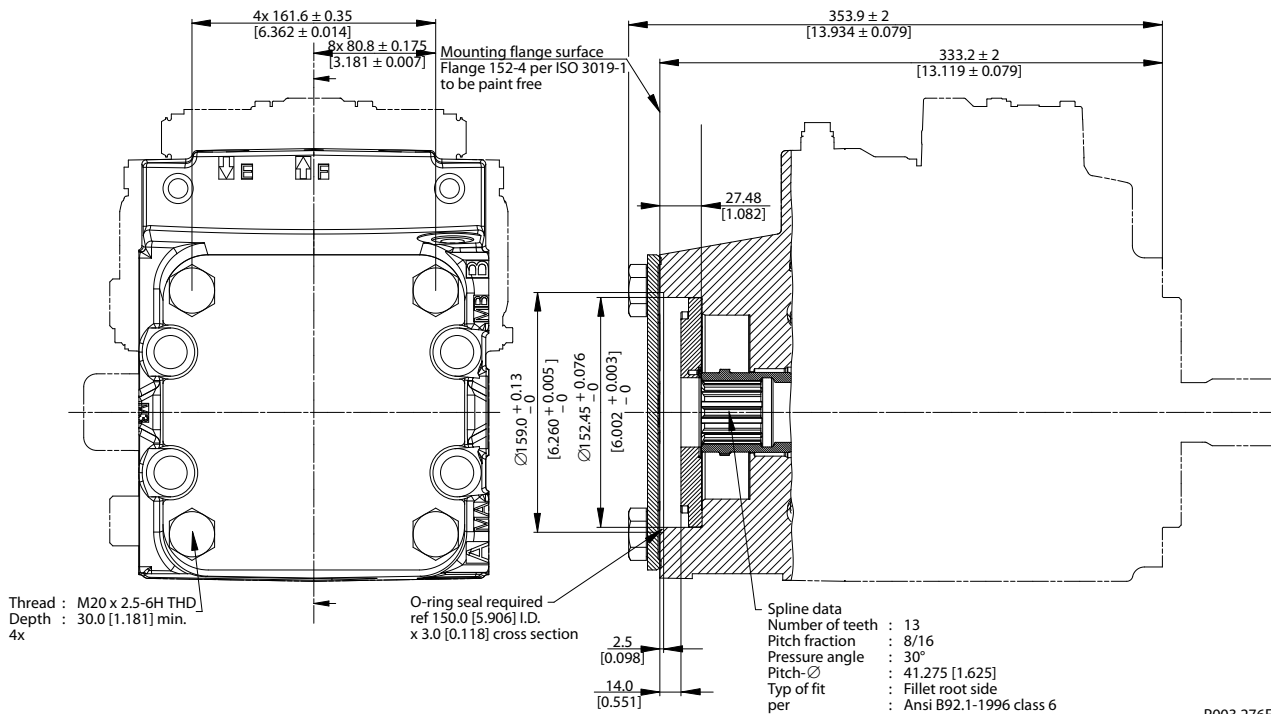
! Caution

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

Dimensions

H1P 147/165 Auxiliary mounting, option H4 (SAE D, 13 teeth)

Option H4, ISO 3019-1, flange 152-4 (SAE D, 13 teeth)



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Specifications

| | |
|-----------------------|--------------------------|
| Option | H4 |
| Spline | 13 teeth, 8/16 pitch |
| Maximum torque | 2206 N·m [19 525 lbf·in] |

For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information, BC00000057*, the section "Shaft Torque Ratings and Spline Lubrication".

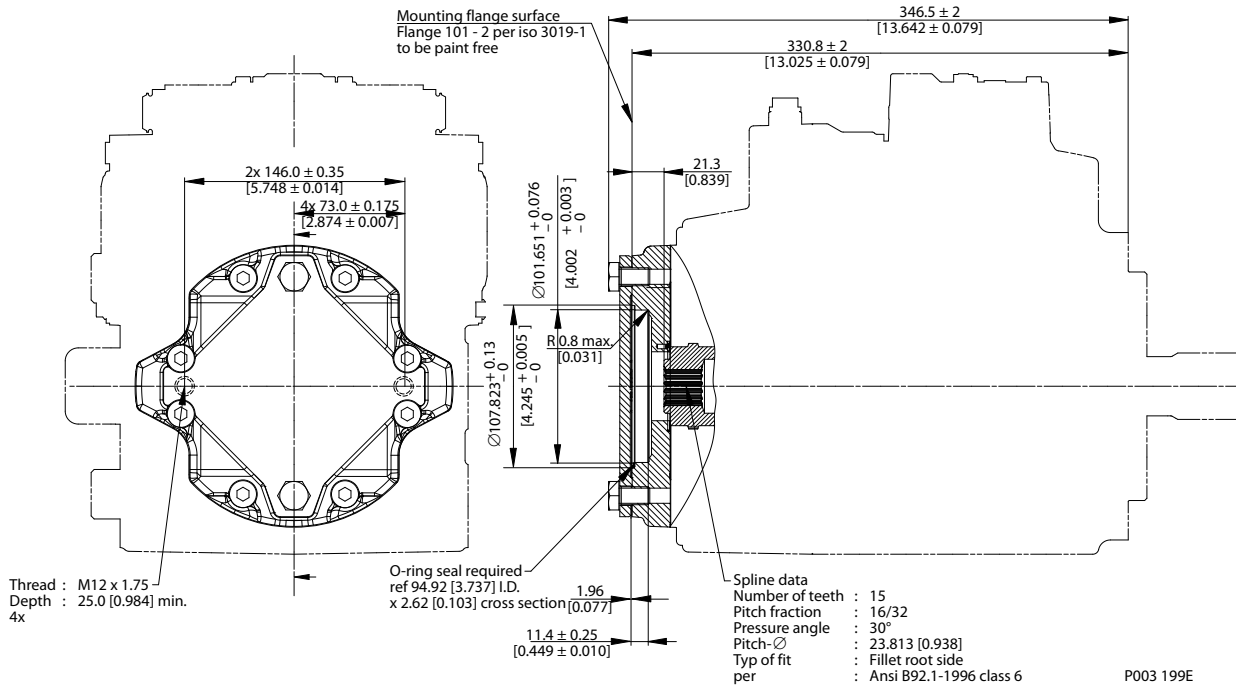
! Caution

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

Dimensions

H1P 147/165 Auxiliary mounting, option H5 (SAE B-B, 15 teeth)

Option H5, ISO 3019-1, flange 101-2 (SAE B-B, 15 teeth)



Specifications

| | |
|----------------|-----------------------|
| Option | H5 |
| Spline | 15 teeth, 16/32 pitch |
| Maximum torque | 693 N•m [6130 lbf•in] |

For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information*, **BC0000057**, the section “Shaft Torque Ratings and Spline Lubrication”.

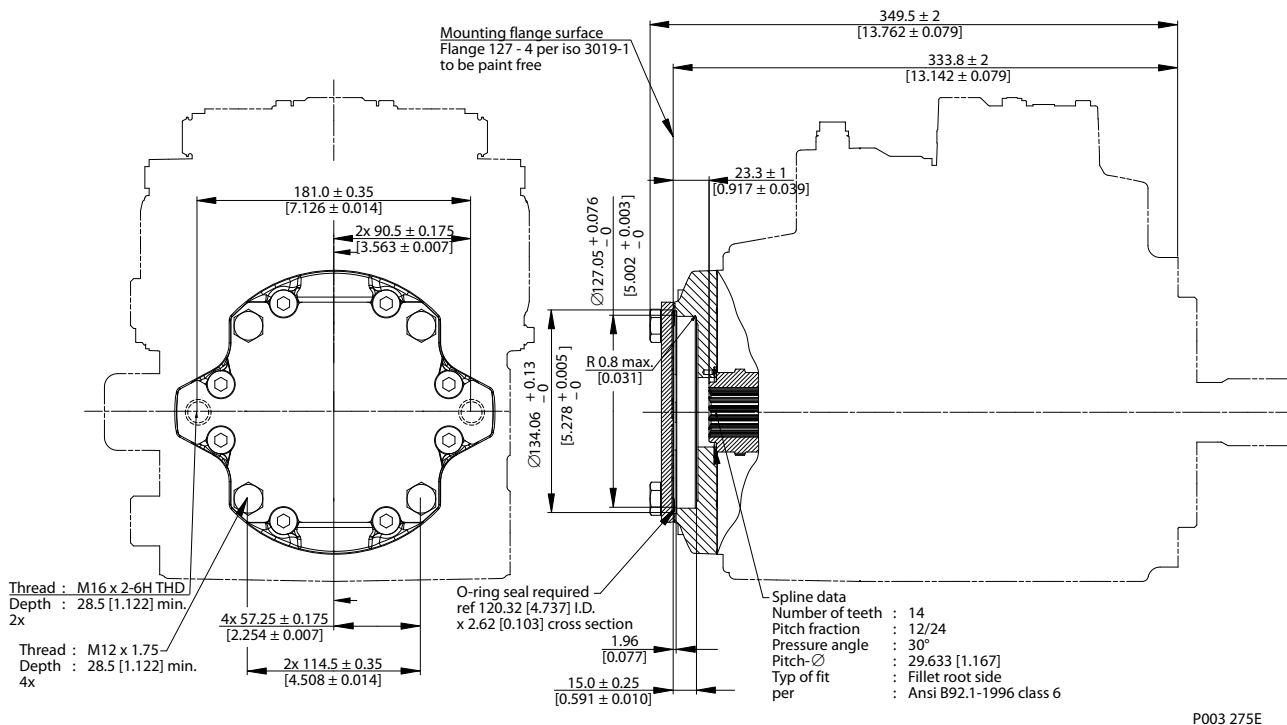
! Caution

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

Dimensions

H1P 147/165 Auxiliary mounting, option H6 (SAE C, 14 teeth)

Option H6, ISO 3019-1, flange 127-4 (SAE C, 14 teeth)



Specifications

| Option | H6 |
|----------------|-----------------------|
| Spline | 14 teeth, 12/24 pitch |
| Maximum torque | 816 N·m [7220 lbf·in] |

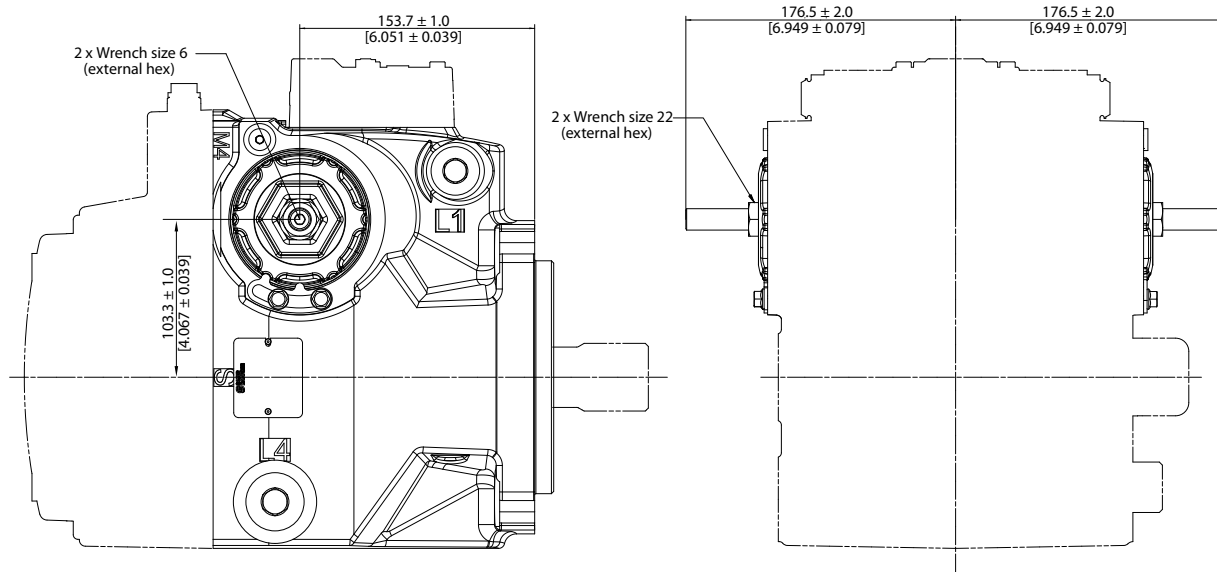
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information, BC00000057*, the section "Shaft Torque Ratings and Spline Lubrication".

! 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

H1P 147/165 displacement limiter, option B

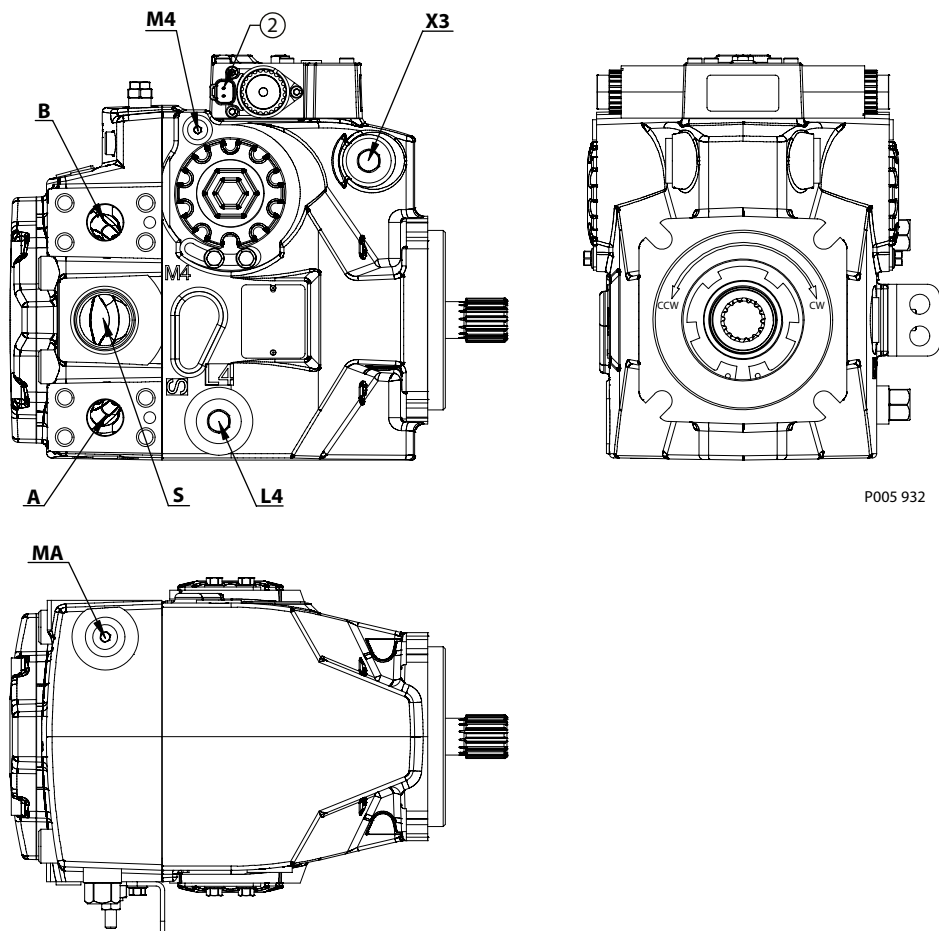


P003 344E

Please contact Danfoss representative for specific installation drawings.

Installation drawings

Port Description H1P 147/165

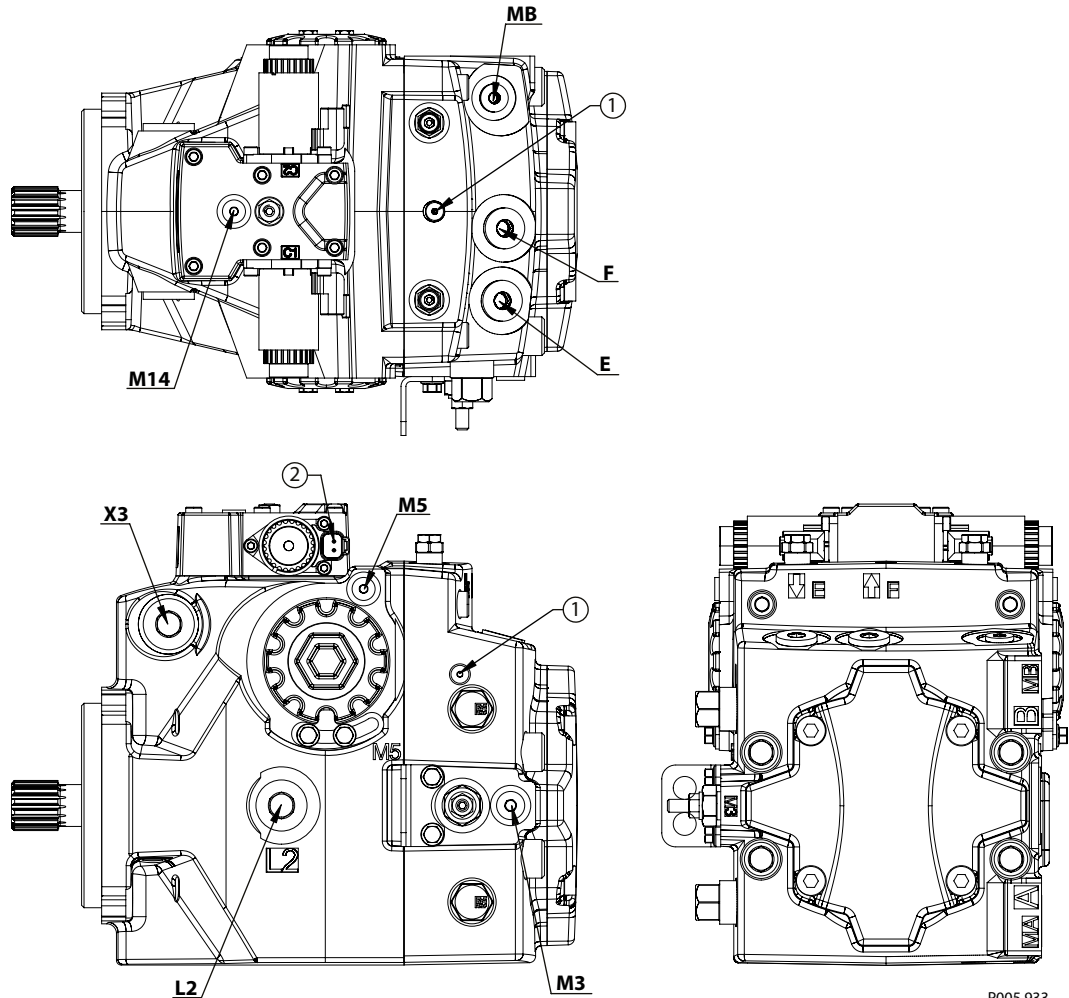


Ports per ISO 11926-1 description

| Port | Description | Size 147/165 |
|-------------|---|---|
| A, B | System ports A and B 450 bar, Split flange boss per ISO 6162 | Ø31.5 mm; M12 x 1.75; 20 min. full thread depth; Recommended screw in depth 1.5 x thread dia |
| MA | System A gauge port | $\frac{9}{16}$ -18; Ø28 max clearance dia for fitting |
| X3 | Case pressure port | $1\frac{5}{16}$ -12; Ø41 max clearance dia for fitting |
| L4 | Case drain port | $1\frac{1}{16}$ -12; Ø63 max clearance dia for fitting |
| M4 | Servo gauge port | $\frac{7}{16}$ -20; Ø24.5 max clearance dia for fitting |
| S | Charge inlet port | $1\frac{5}{8}$ -12; Ø69 max clearance dia for fitting |

[Please contact Danfoss representative for specific installation drawings.](#)

Installation drawings



P005 933

1. Charge pressure construction port $\frac{5}{16}$ -24
2. Connector DEUTSCH DT04-2P, to be paint free

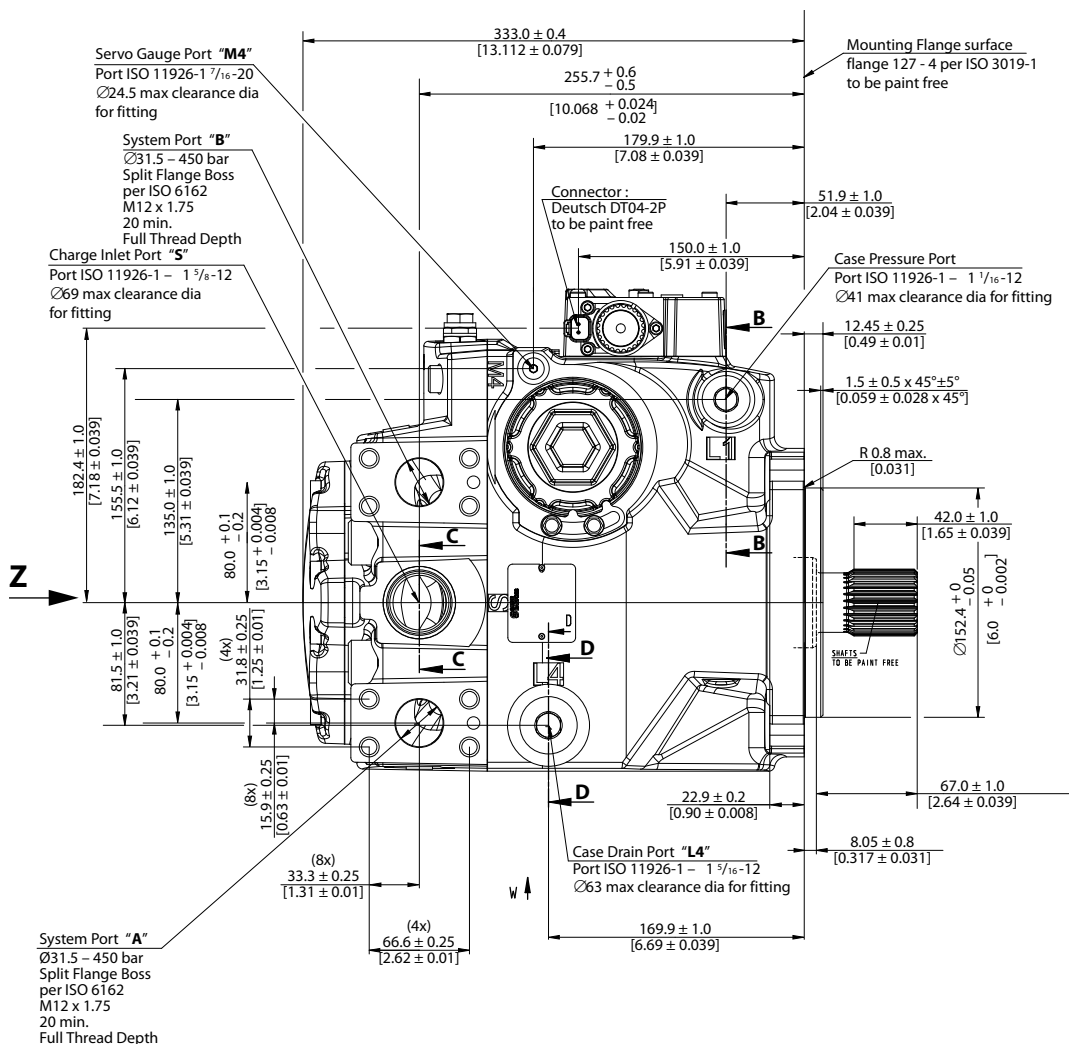
Ports per ISO 11926-1 description

| Port | Description | Size 147/165 |
|------|---------------------------------------|--|
| E, F | Charge filtration port from/to filter | $1\frac{1}{16}$ -12; Ø42 max clearance dia for fitting |
| L2 | Case drain port | $1\frac{5}{16}$ -12; Ø63 max clearance dia for fitting |
| MB | System B gauge port | $\frac{9}{16}$ -18; Ø28 max clearance dia for fitting |
| M3 | Charge gauge port, after filtering | $\frac{9}{16}$ -18; Ø28 max clearance dia for fitting |
| M5 | Servo gauge port | $\frac{7}{16}$ -20; Ø21 max clearance dia for fitting |
| M14 | Case gauge port | $\frac{7}{16}$ -20; Ø21 max clearance dia for fitting |
| X3 | Case pressure port | $1\frac{5}{16}$ -12; Ø63 max clearance dia for fitting |

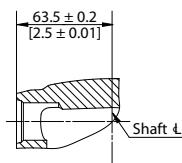
Please contact Danfoss representative for specific installation drawings.

Installation drawings

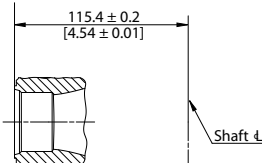
Dimensions H1P 147/165



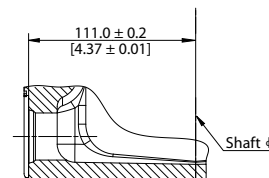
B-B (2x)



C-C



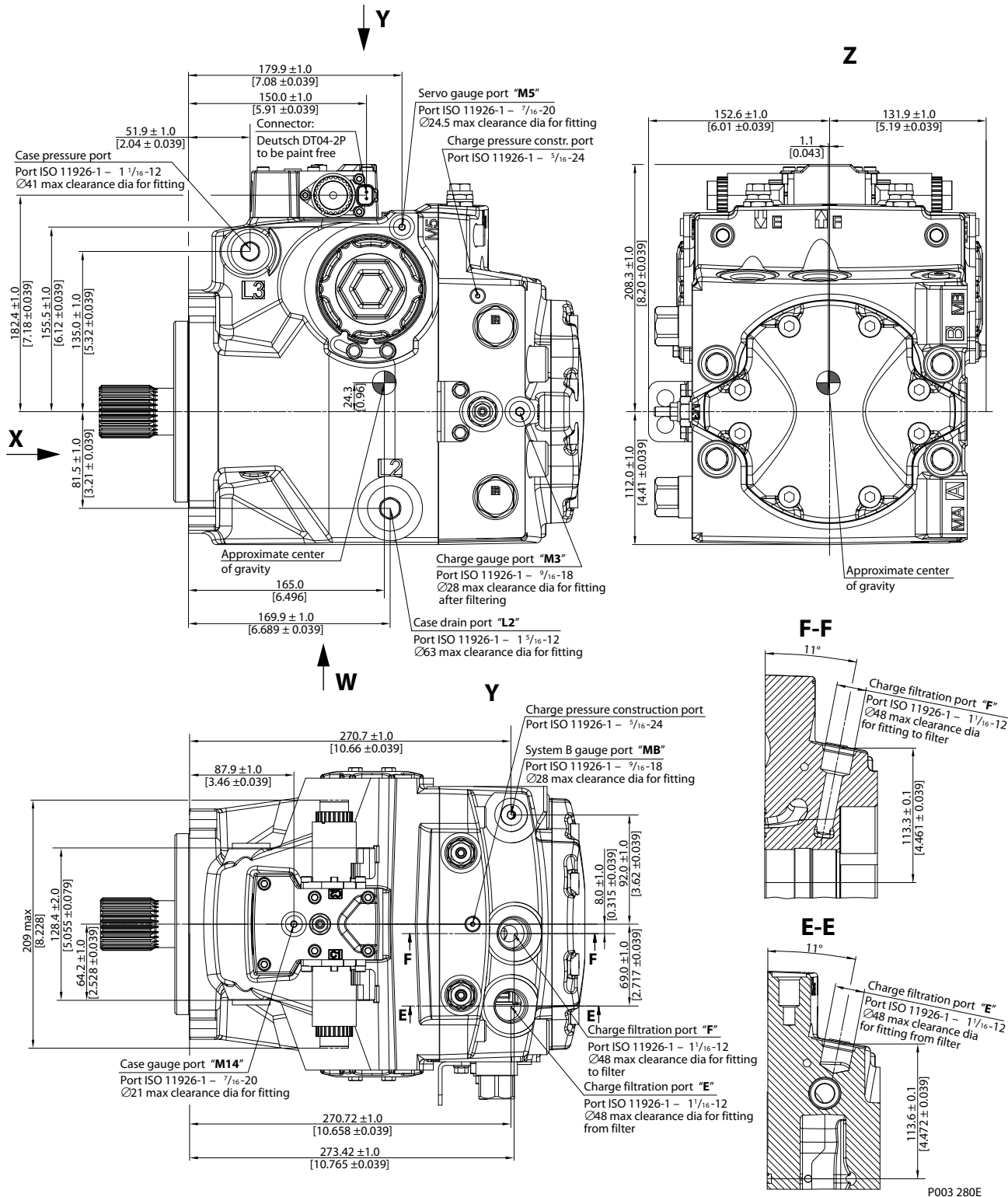
D-D (2x)



P003 279E

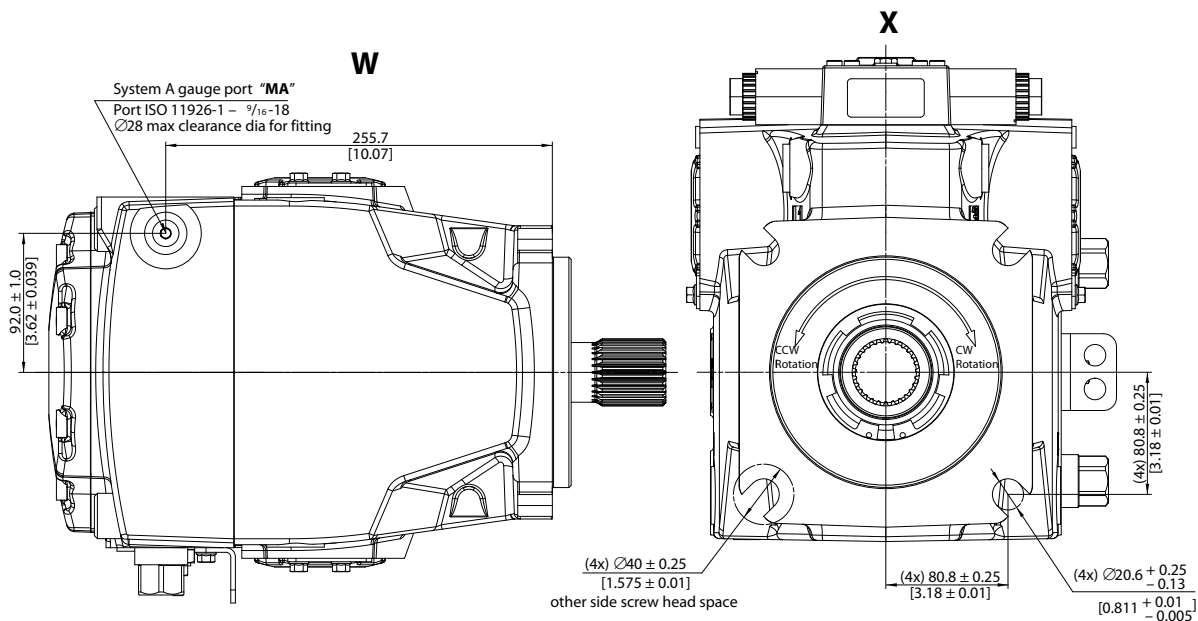
Please contact Danfoss representative for specific installation drawings.

Installation drawings



Please contact Danfoss representative for specific installation drawings.

Installation drawings

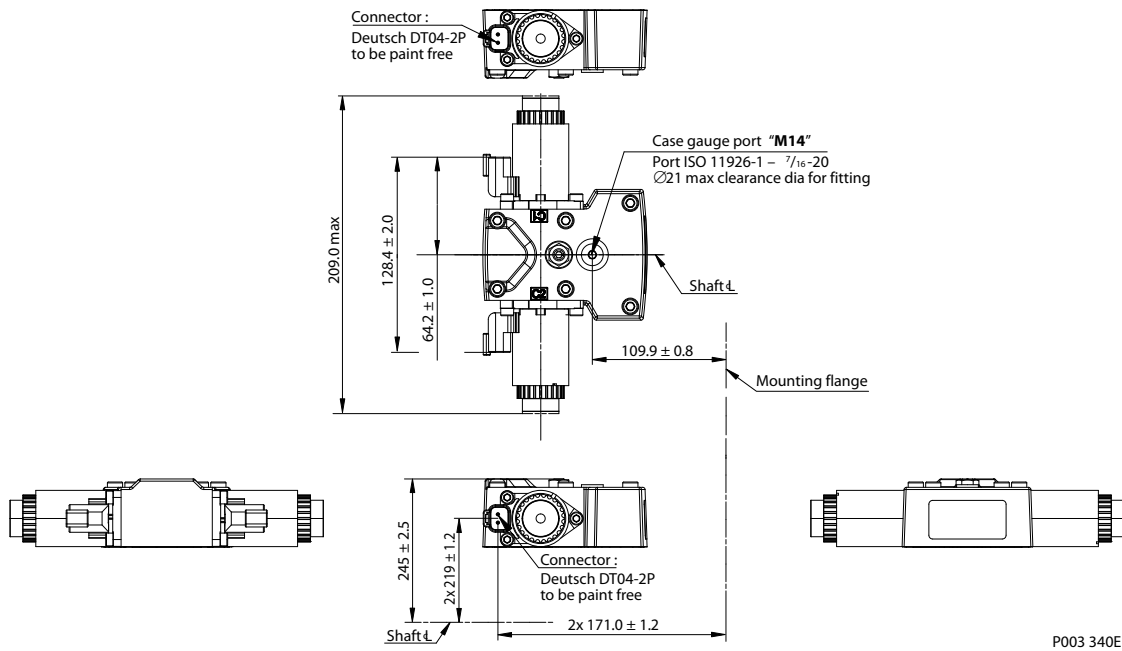


P003 281E

Please contact Danfoss representative for specific installation drawings.

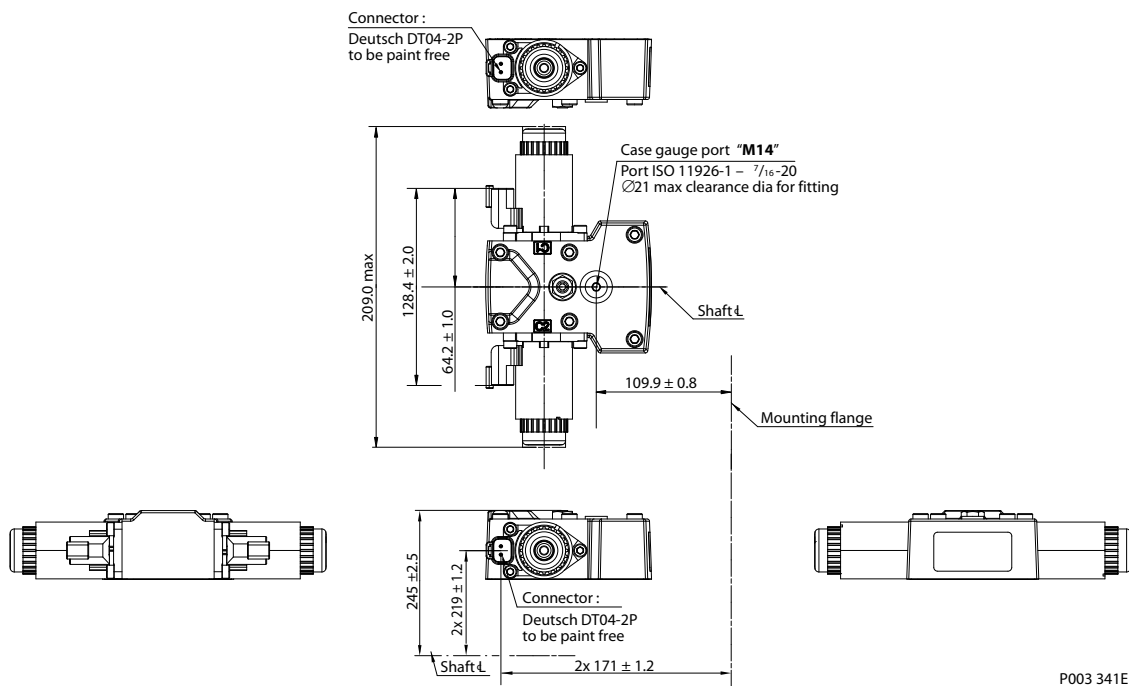
Controls

Electric Displacement Control, Options A2/A3 (12/24 V)



Please contact Danfoss representative for specific installation drawings.

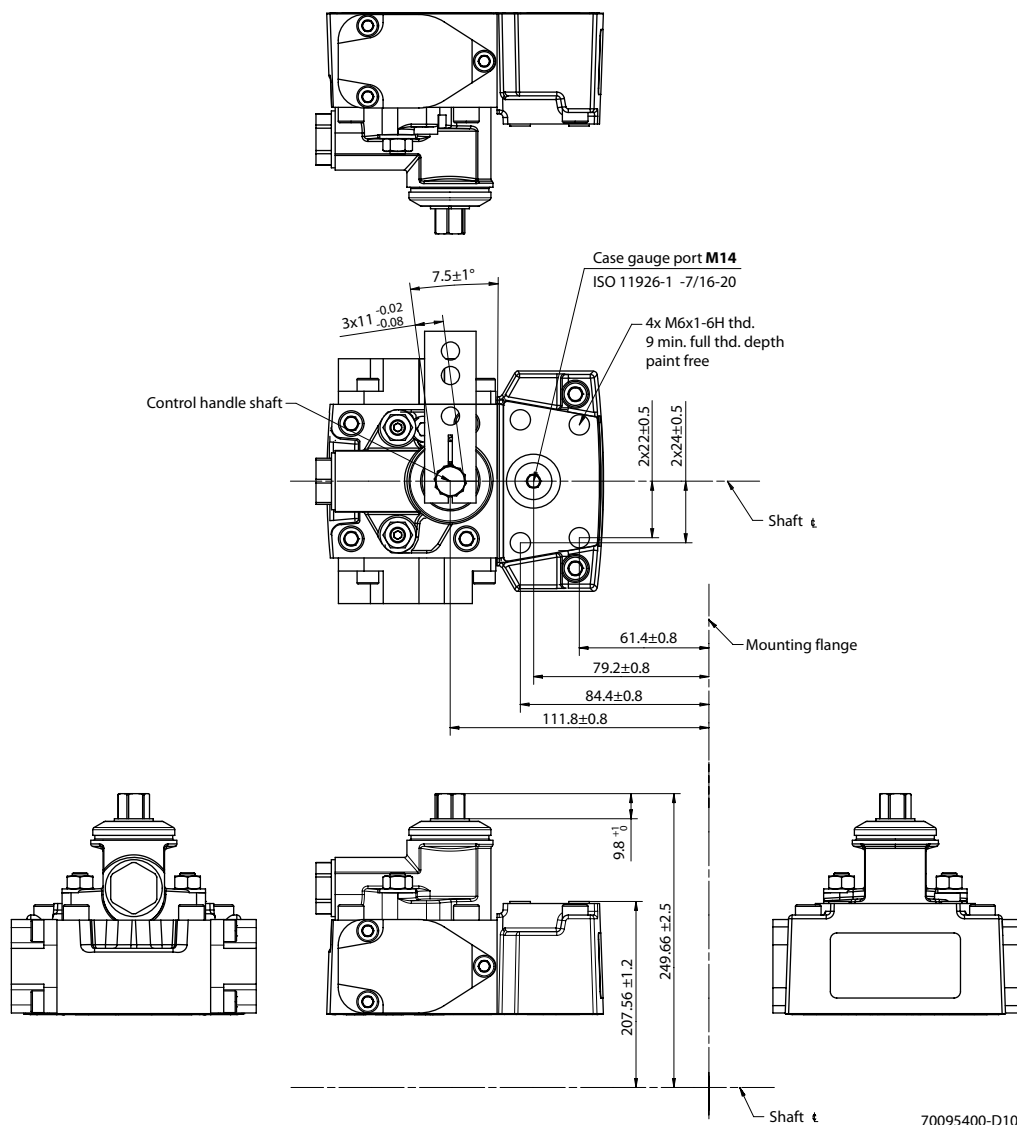
Electric Displacement Control with MOR, Options A4/A5 (12/24 V)



Please contact Danfoss representative for specific installation drawings.

Controls

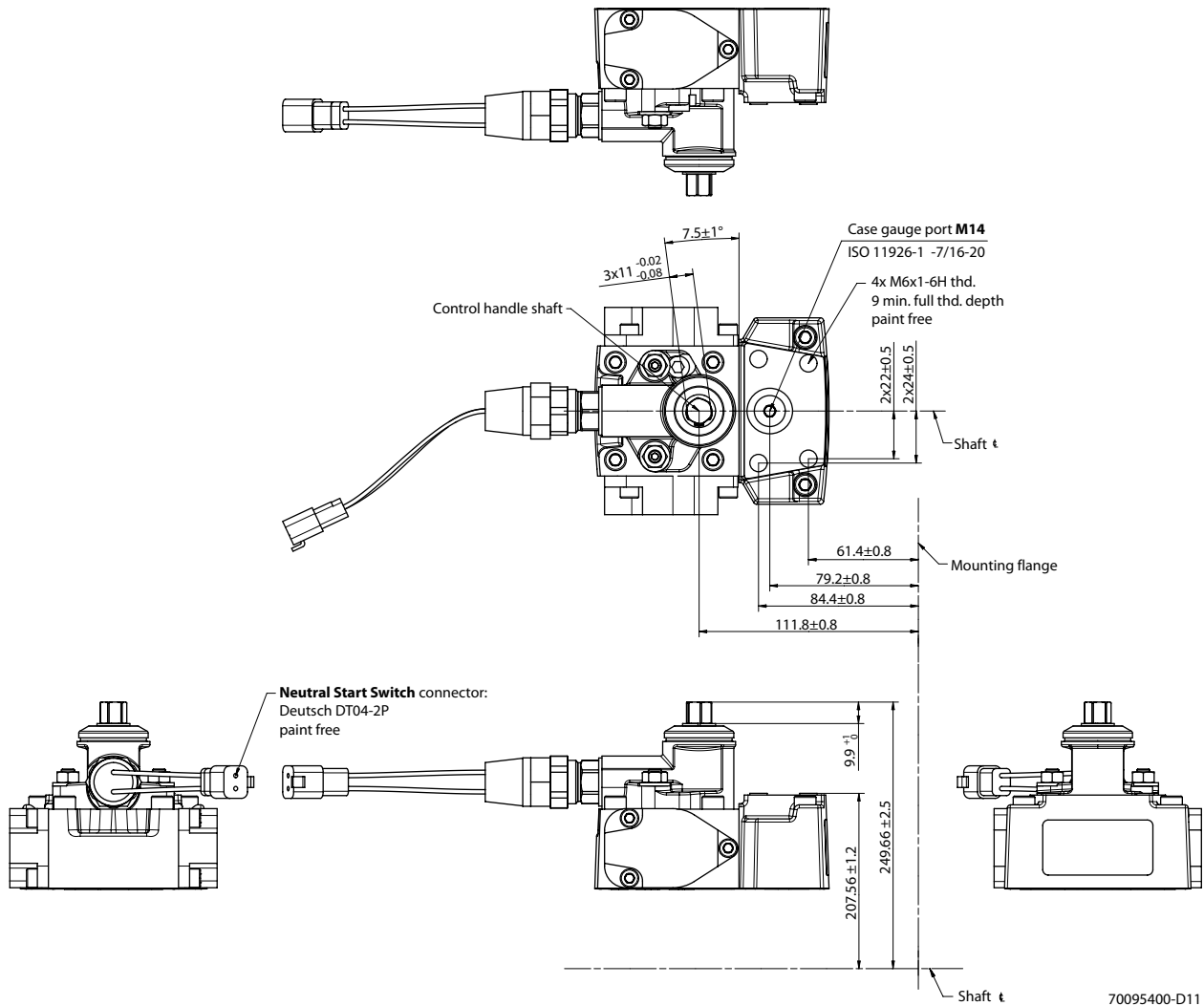
H1P 147/165 Manual Displacement Control (MDC), option M1



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Controls

H1P 147/165 Manual Displacement Control (MDC) with NSS, option M2



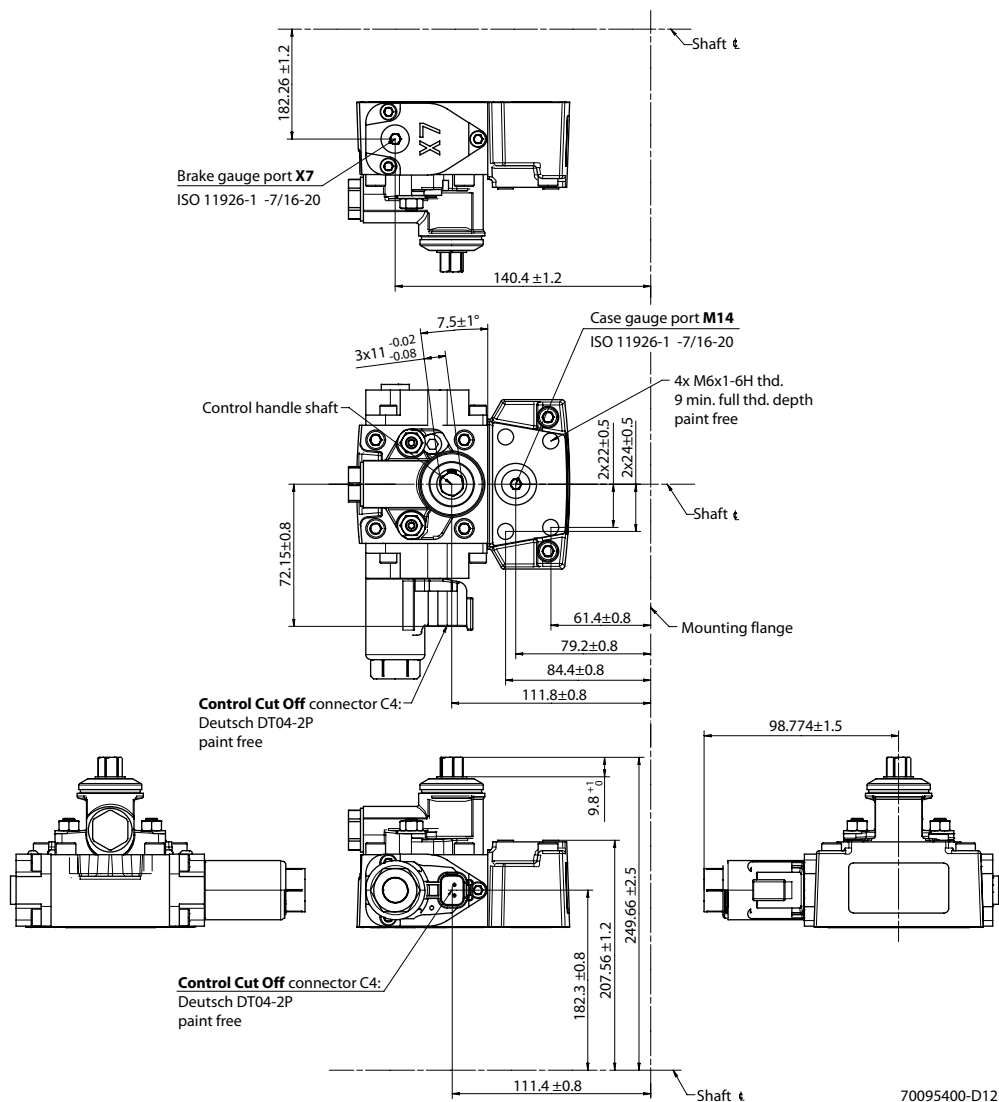
Neutral Start Switch connector:

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

Please contact Danfoss representative for specific installation drawings.

Controls

H1P 147/165 Manual Displacement Control (MDC) with CCO, option M3, M4



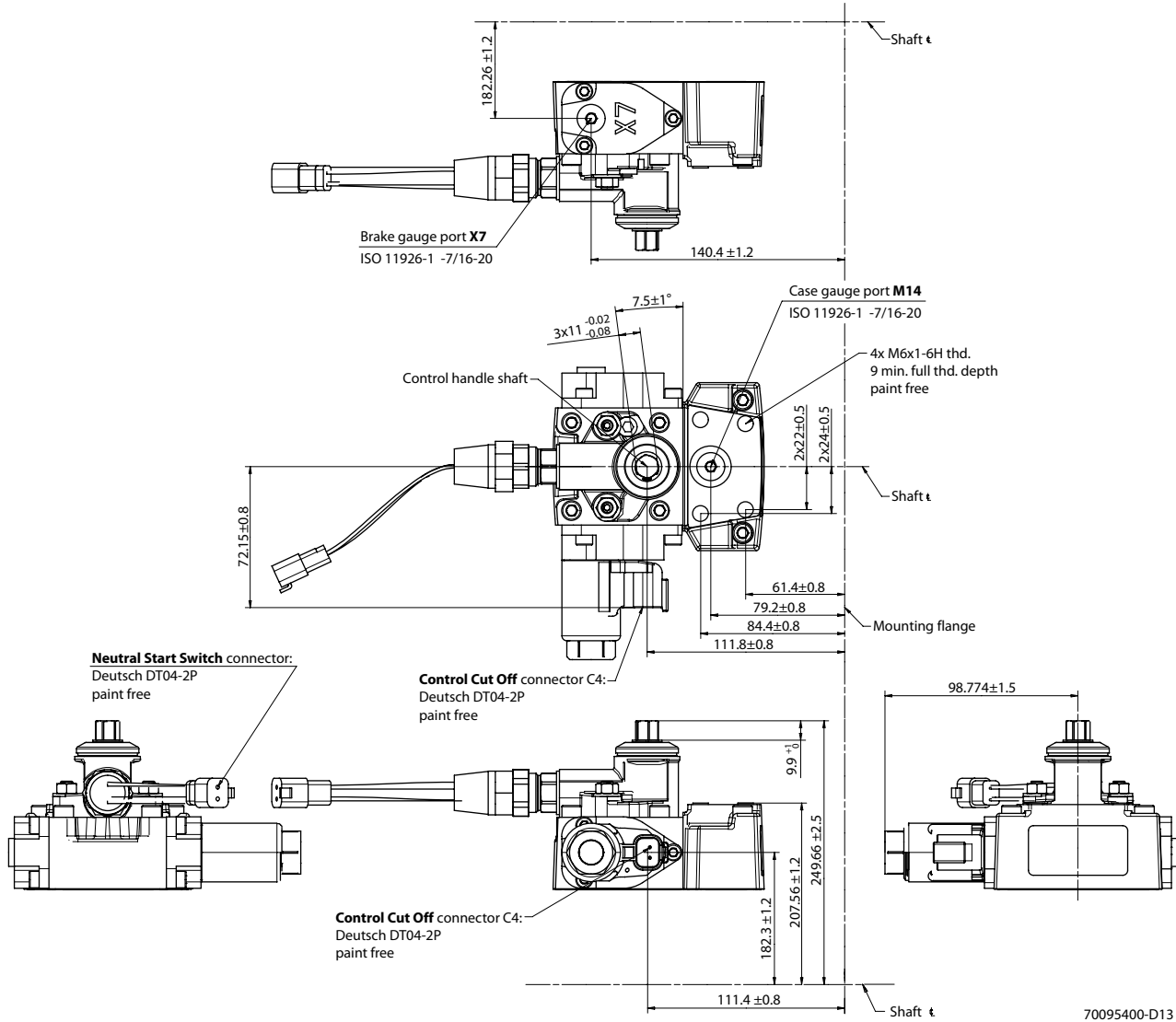
Control Cut Off connector **C4** Pin Assignment:

1. Supply
2. Ground

[Please contact Danfoss representative for specific installation drawings.](#)

Controls

H1P 147/165 Manual Displacement Control (MDC) with NSS and CCO, option M5, M6



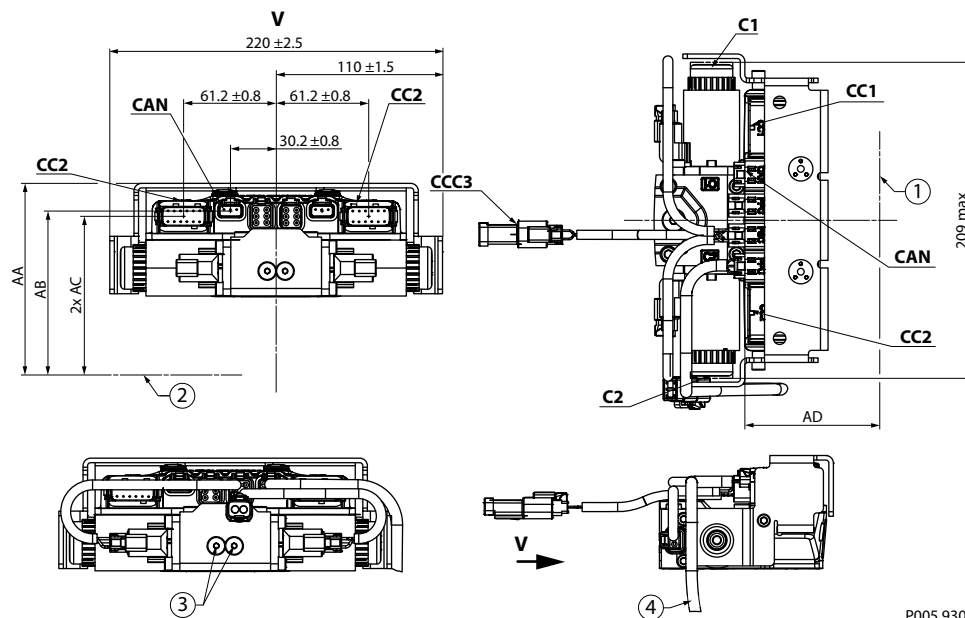
Neutral Start Switch connector / Control Cut Off connector C4:

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

Please contact Danfoss representative for specific installation drawings.

Controls

Automotive Control (AC) Dimensions



P005 930

1. Mounting flange
2. Shaft
3. Plug removing can cause contamination issues
4. PPU wire harness is factory installed to speed sensor

Dimensions, (mm)

| Callout | Value |
|---------|---------------|
| AA | 208.9 ±2.5 |
| AB | 190.5 ±1.2 |
| AC | 2x 187.1 ±1.2 |
| AD | 89.2 ±0.8 |

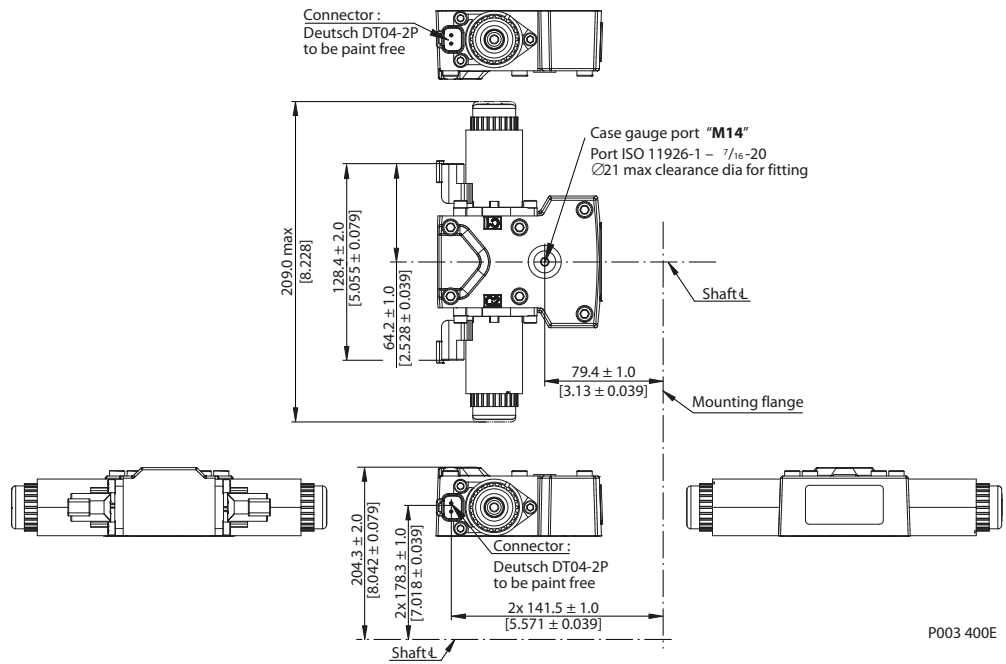
Connectors description

| Port | Description |
|----------|---|
| C1 C2 | Control MOR; Depressing the plunger mechanically moves the control spool. Actuation allows full stroke pump response as per coil and rotation dependent control logic. |
| CC1 | Control connector Deutsch DTM04-12P -A; Paint free |
| CC2 | Control connector Deutsch DTM04-12P -B; Paint free |
| CCC3 | 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. |

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Controls

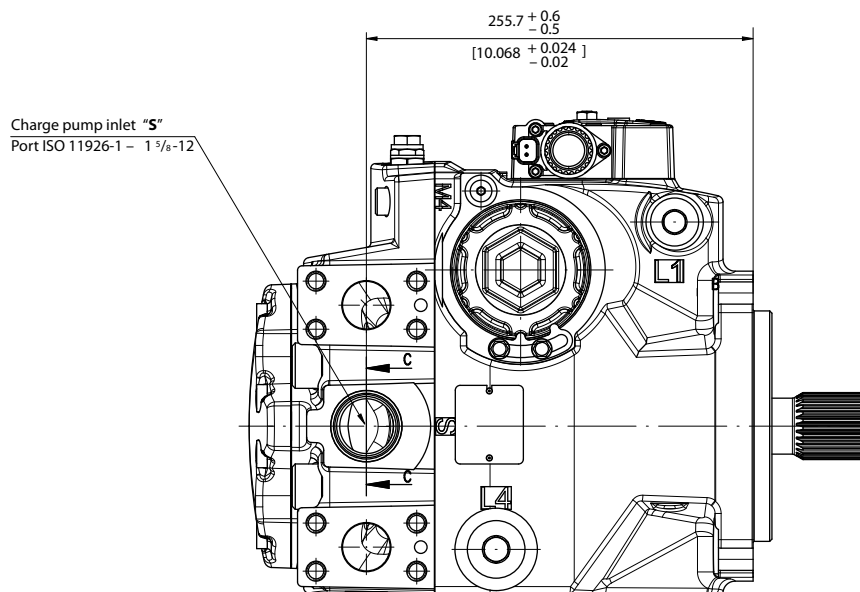
Forward-Neutral-Reverse (FNR) with manual override, options A9 (12 V) / B1 (24 V)



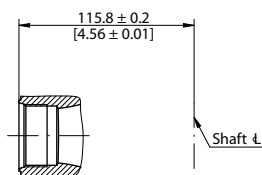
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Filtration

Suction filtration, option L, H1P 147/165



C-C

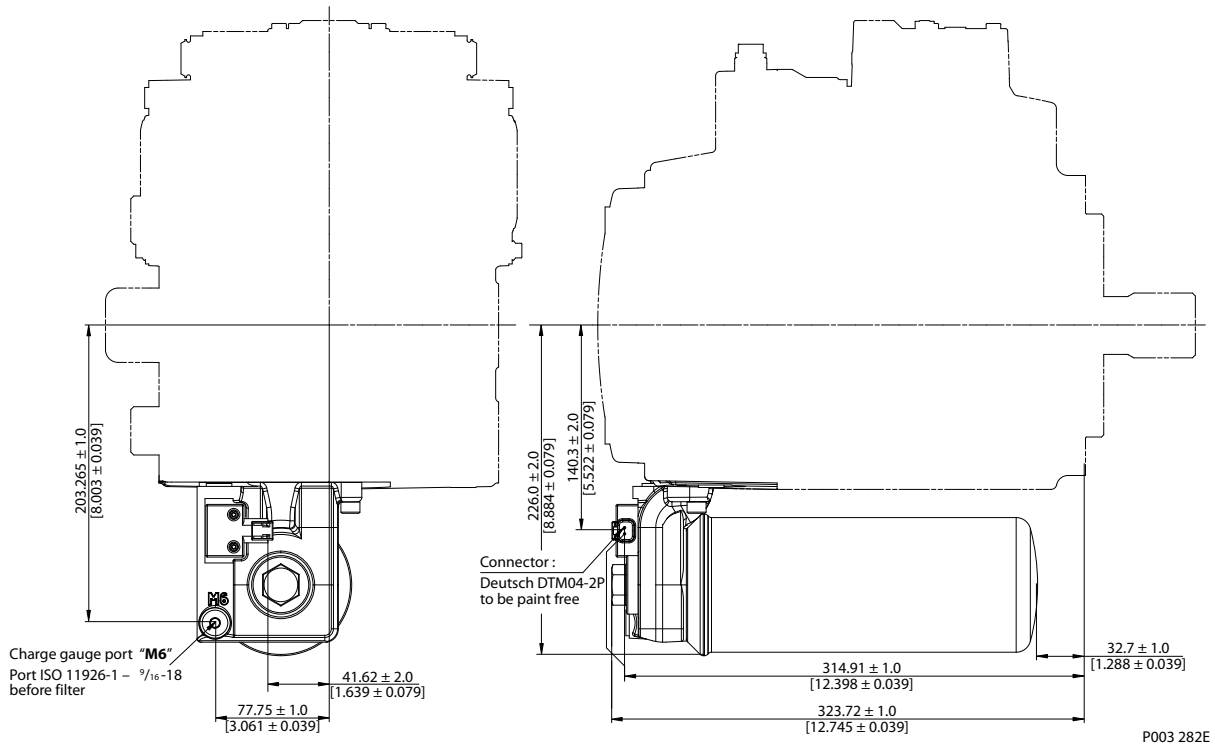


P003 202E

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Filtration

Integral full flow charge pressure filtration with filter bypass sensor, option M, H1P 147/165



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