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Technical Information

H1P 045/053

Axial Piston Single Pumps



Revision history*Table of revisions*

Date	Changed	Rev
May 2022	Corrected HDC control information	1601
December 2021	Added HDC control	1501
April 2021	Added missing Jxx pressure protection settings to model code	1401
September 2020	corrected dimensions and mounting screws information	1306
June 2020	Added caution note to mounting dimensions	1305
April 2020	Corrected swash plate angle sensor connector and CCO connector descriptions	1304
February 2020	Added NFPE control options and changed document number from BC00000059	1303
June 2019	Major revision.	1201
May 2018	Major revision.	1101
May 2017	NFPE gen. 3 changes.	1001
November 2015	Master Model Code changes.	0900
2010-2014	Various changes.	BA-IA
Jul 2009	First edition	AA

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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 045/053 Technical Data

Feature	Size 045	Size 053
Displacement	45.0 cm ³ [2.75 in ³]	53.8 cm ³ [3.28 in ³]
Flow at rated speed (continuous)	153 l/min [40 US gal/min]	183 l/min [48 US gal/min]
Torque at maximum displacement (theoretical)	0.72 N·m/bar [437.7 lbf·in/1000 psi]	0.86 N·m/bar [522.0 lbf·in/1000 psi]
Mass moment of inertia of rotating components	0.00465 kg·m ² [0.00343 slug·ft ²]	0.00458 kg·m ² [0.00338 slug·ft ²]
Mass (dry-no charge pump)	41 kg [90 lb]	41 kg [90 lb]
Oil volume	1.3 l [0.34 US gal]	1.3 l [0.34 US gal]

Shaft, flange and ports description

Input shaft per ISO 3019-1 (outer diameter)	<ul style="list-style-type: none"> • Outer Ø22 mm – 4 (SAE B, 13 teeth) • Outer Ø25 mm – 4 (SAE B-B, 15 teeth) • Outer Ø32 mm – 4 (SAE B, 14 teeth)
Mounting flange per ISO 3019-1	Flange 101-2 (SAE B)
Auxiliary mounting flange with metric fasteners, with shaft outer diameter	<ul style="list-style-type: none"> • Flange 82-2 (SAE A, 9 teeth and 11 teeth) • Flange 101-2 (SAE B, 13 teeth and SAE B-B, 15 teeth)
Suction port per ISO 3019-1	1 ⁵ / ₁₆ -12 (SAE O-ring boss)
Main configuration port	Ø19 mm, 450 bar Split flange boss per ISO 6162, M10x1.5
Case drain ports L2, L4 per ISO 3019-1	1 ¹ / ₁₆ -12 (SAE O-ring boss)
Other ports	SAE O-ring boss
Customer interface threads	Metric fasteners

Technical Specifications

H1P 045/053 Operating Parameters

Parameter		Unit	Size 045	Size 053
Input speed	Min. for internal ¹⁾ and external ²⁾ charge supply	min ⁻¹ (rpm)	500	500
	Min. for full performance, internal charge supply		1175	1250
	Rated		3400	3400
	Maximum		3500	3500
System pressure	Maximum working	bar [psi]	420 [6092]	380 [5511]
	Maximum		450 [6527]	400 [5802]
	Max./Min. low loop		45/10 [653/145]	
Charge pressure	Minimum		16 [232]	
	Maximum		35 [508]	
Control pressure	Minimum (at corner power for EDC, MDC, FNR)	bar [psi]	21.5 [312]	
	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		4.0 [58.0]	
Case pressure	Rated	bar [psi]	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 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 μm

Technical Specifications

Fluid Specification

Viscosity

Intermittent¹⁾	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

Minimum¹⁾	-40°C [-40°F]
Rated	104°C [220°F]
Recommended range²⁾	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).

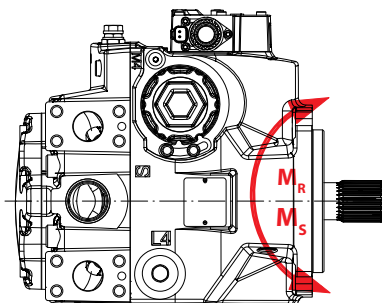
²⁾ At the hottest point, normally case drain port.

Technical Specifications

H1P 045/053 Mounting Flange Loads

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

Mounting flange load with control on top



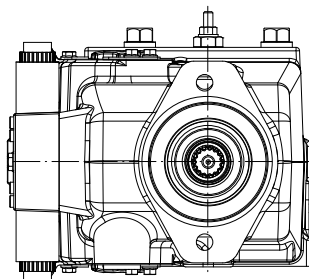
Rated moment

$$M_R = 2020 \text{ N}\cdot\text{m} [17\ 880 \text{ lbf}\cdot\text{in}]$$

Shock load moment

$$M_S = 4110 \text{ N}\cdot\text{m} [36\ 380 \text{ lbf}\cdot\text{in}]$$

Mounting flange load with control on side



P301 214b

Rated moment

$$M_R = 1300 \text{ N}\cdot\text{m} [11\ 510 \text{ lbf}\cdot\text{in}]$$

Shock load moment

$$M_S = 2930 \text{ N}\cdot\text{m} [25\ 935 \text{ lbf}\cdot\text{in}]$$

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.

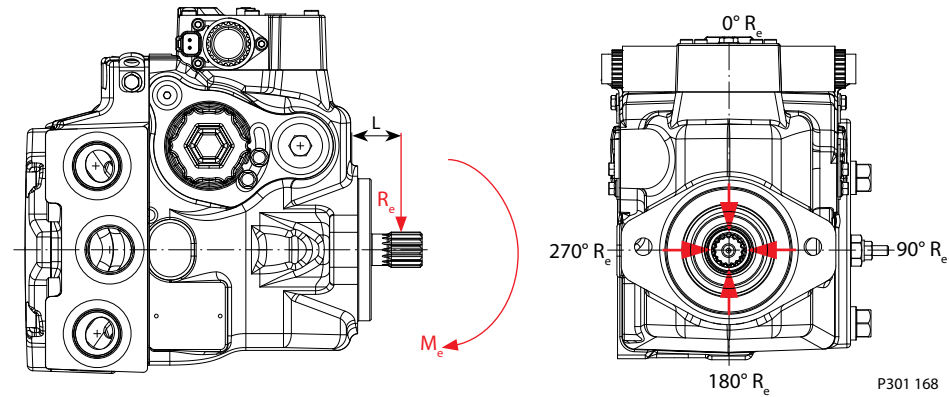
Danfoss recommends clamp-type couplings for applications with radial shaft loads. Contact your Danfoss representative for an evaluation of unit bearing life if you have continuously applied external loads exceeding 25 % of the maximum allowable radial load (R_e) or the pump swash-plate is positioned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

Maximum external shaft load based on shaft deflection

External radial moment	Unit	Size 045/053
M_e	N·m [lbf·in]	TBD

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.

12 cm³ Charge Pump – Flow and Power Curves

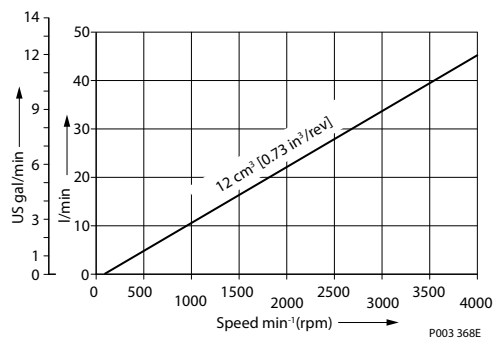
Charge pump flow and power requirements curves shown below at the following conditions:

Charge pressure = 20 bar [290 psi]

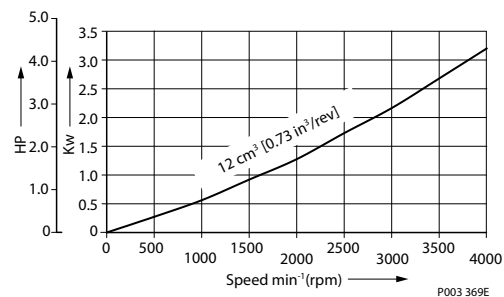
Viscosity = 11 mm²/s [63 SUS]

Temperature = 80°C [176°F]

Charge pump flow

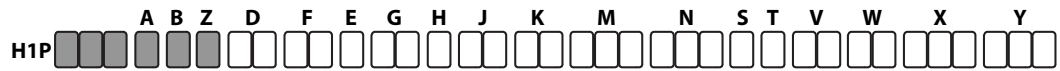


Charge pump power requirements



Master Model Code

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



Displacement

045	45.0 cm ³ [2.75 in ³]
053	53.8 cm ³ [3.28 in ³]

A – Direction of Rotation

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

B – Product version

A	Revision code
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Z – Port configuration

A	Inch, Customer O-ring port sealing according to ISO 11926-1
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Master Model Code

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).

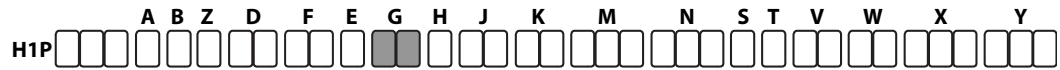
Hydraulic Displacement Control

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

G—Endcap



G – End-cap Options

Twin port, ISO 6162 split flange ports; Align with T: Filtration

D6	Suction filtration, Code 62
E6	Suction filtration, ORB
F1	Suction filtration, ORB, HPRV only
F3	Suction filtration, Code 62, HPRV only
D8	Remote filtration, Code 62
E5	Remote filtration, ORB
E9	Remote filtration, ORB, HPRV only
F2	Remote filtration, Code 62, HPRV only

Master Model Code

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



H – Mounting options

Mounting to be aligned with option W: Special hardware

F	ISO 3019-1 flange 101–2 (SAE B)
J	ISO 3019-1 flange 101–2 (SAE B), 2-bolt, with speed sensor

J – Input Shaft options

G1	ISO 3019-1, outer Ø32 mm - 4 (14 teeth splined shaft 12/24 pitch)
G4	ISO 3019-1, outer Ø22 mm - 4 (13 teeth splined shaft 16/32 pitch)
G5	ISO 3019-1, outer Ø25 mm - 4 (15 teeth splined shaft 16/32 pitch)

K – Auxiliary Mounting Pad options (ISO 3019-1)

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

Master Model Code

K	Pressure setting ¹⁾
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] (available for H1P 045 <u>only</u>)
K41	410 bar [5946 psi] (available for H1P 045 <u>only</u>)
K42	420 bar [6090 psi] (available for H1P 045 <u>only</u>)

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

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

Control Options

Electrical Displacement Control (EDC)

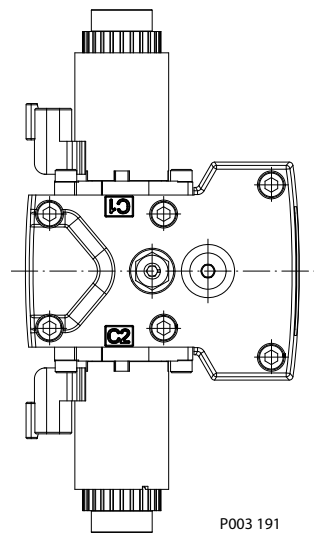
An EDC is a displacement (flow) control. Pump swash plate position is proportional to the input command and therefore vehicle or load speed (excluding influence of efficiency), is dependent only on the prime mover speed or motor displacement.

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.

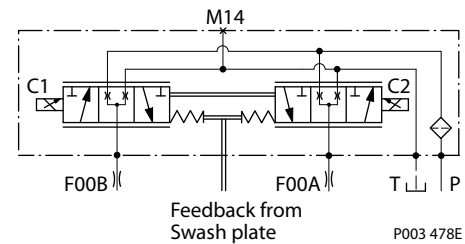
A serviceable 170 µm screen is located in the supply line immediately before the control porting spool.

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

Electrical Displacement Control

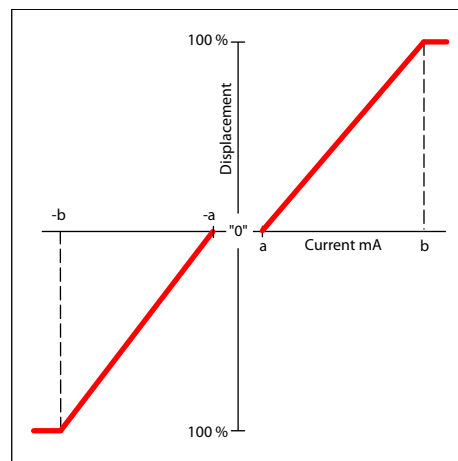


EDC schematic, feedback from swash plate



Control signal requirements, EDC 045/053

Pump displacement vs. control current



Control Options

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.

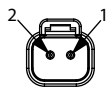
Single Pump Output Flow Direction

Shaft rotation	Clock-Wise (CW)		Counter-Clock-Wise (CCW)	
	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.

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:

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

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 045/053

Stroking direction	0.8 mm [0.03 in] orifice	1.3 mm [0.05 in] orifice	No orifice
Neutral to full flow	1.7 s	0.9 s	0.5 s
Full flow to neutral	1.1 s	0.6 s	0.3 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 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.

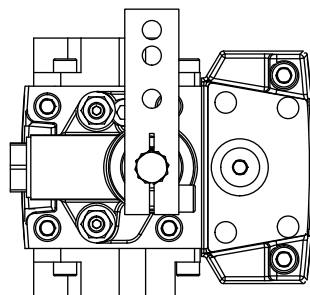
Differential pressure across the servo piston rotates the swash plate, changing the pump's displacement. Simultaneously the swashplate movement is fed back to the control spool providing proportionality between shaft rotation on the control and swash-plate rotation. The MDC changes the pump displacement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

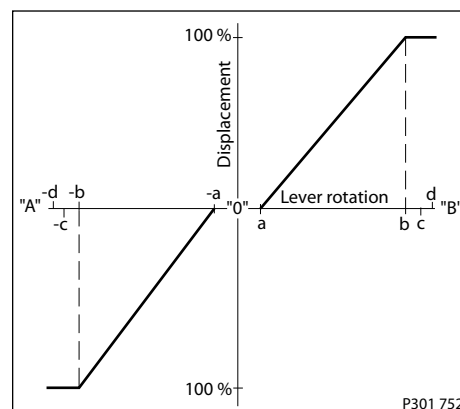
For the MDC with CCO option the brake port (X7) provides charge pressure when the coil is energized to activate static function such as a brake release. The X7 port must not be used for any continuous oil consumption.

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.

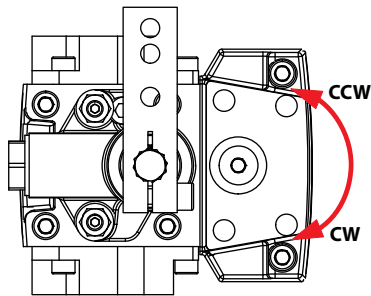
High case pressure may cause excessive wear and the NSS to indicate that the control is not in neutral position. In addition, if the case pressure exceeds 5 bar there is a risk of an insufficient restoring moment. The MDC is designed for a maximum case pressure of 5 bar and a rated case pressure of 3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

$\Delta p = 250 \text{ bar}$ [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)

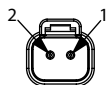
Response time, MDC 045/053

Code	Orifice description (mm)			Stroking direction	
	Tank (A+B)	P	A/B	Neutral to full flow	Full flow to neutral
C3	No orifice			0.3 s	0.4 s
C6	1	–	–	0.9 s	0.8 s
C7	1.3	–	–	0.6 s	0.6 s
D1	0.8	1	–	1.7 s	1.2 s
D2	0.8	1.3	–	1.5 s	1.1 s
D3	1	1.3	–	1.1 s	0.8 s
D4	1	1.3	1.3	1.3 s	1.0 s

[For further data please contact your Danfoss representative.](#)

Connector

Connector DEUTSCH, 2-pin



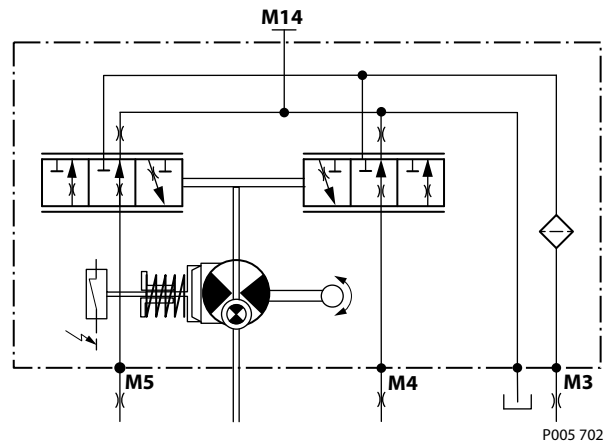
Description	Quantity	Order data
Mating connector	1	DEUTSCH DT06-25
Wedge lock	1	DEUTSCH W2S
Socket contact (16–18 AWG)	2	DEUTSCH 0462-201-16141
Danfoss mating connector kit	1	K29657

Control Options

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.

Lever

MDC-controls are available with an integrated lever.

Control Options

Hydraulic Displacement Control (HDC)

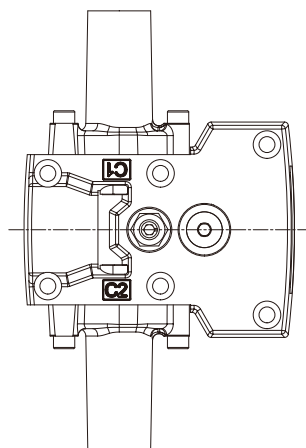
HDC principle

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.

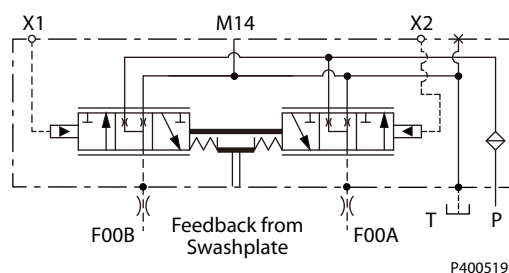
A serviceable 175 µm screen is located in the supply line immediately before the control porting spool.

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.

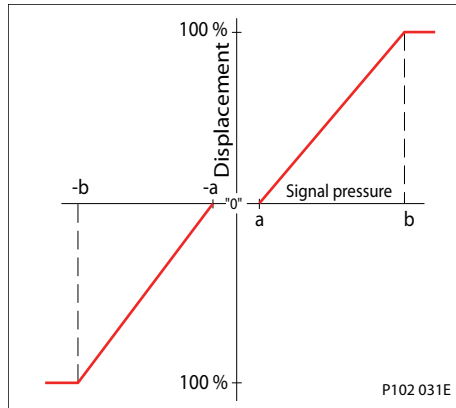
A swashplate feedback link, opposing control linkage, and a linear spring provide swashplate position force feedback to the hydraulic pressure. As hydraulic pressures in the operating loop change with load, the control assembly and servo/swashplate system work constantly to maintain the commanded position 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	
	X1	X2	X1	X2
Port energized	Out (high)	In (low)	Out (high)	In (low)
Port A	In (low)	Out (high)	In (low)	Out (high)
Port B	Out (high)	In (low)	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 swashplate 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:

$\Delta p = 250 \text{ bar}$ [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)

Control Options

Response Time, HDC 045/053

Stroking direction	0.8 mm [0.03 in] orifice	1.3 mm [0.05 in] orifice	No orifice
Neutral to full flow	1.6s	0.7s	0.4s
Full flow to neutral	0.9s	0.4s	0.2s

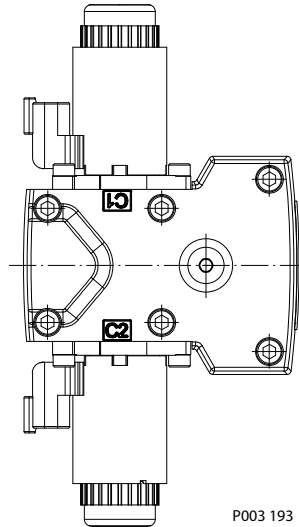
Control Options

Forward-Neutral-Reverse Control (FNR)

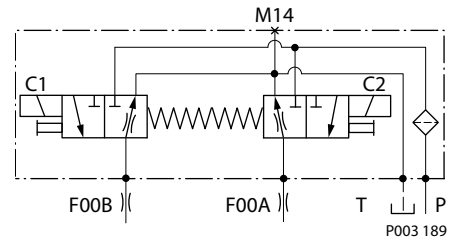
The 3-position FNR control options **A9** (12 V) and **B1** (24 V) uses an electric input signal to switch the pump to a full stroke position. A serviceable 125 µm screen is located in the supply line immediately before the control porting spool.

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

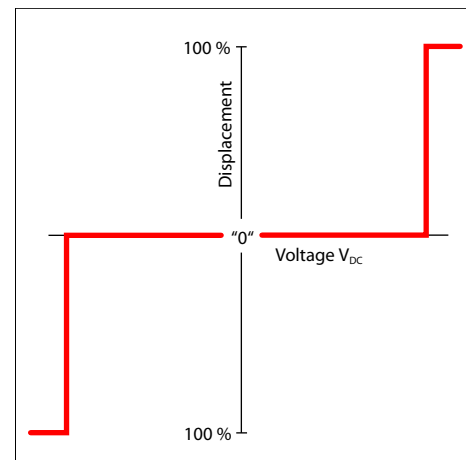
Forward-Neutral-Reverse electric control (FNR)



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	

Single Pump Output Flow Direction

Shaft rotation	Clock-Wise (CW)		Counter-Clock-Wise (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 Options

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
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

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:

$\Delta p = 250 \text{ bar}$ [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)

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

Response Time, FNR 045/053

Stroking direction	0.8 [0.03] orifice	1.3 [0.05] orifice	No orifice
Neutral to full flow	1.8 s	0.9 s	0.5 s
Full flow to neutral	1.6 s	0.8 s	0.4 s

Control Options

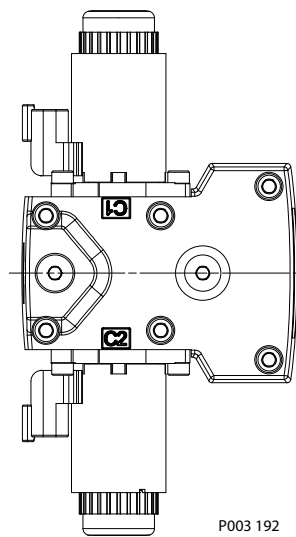
Non feedback proportional electric control (NFPE)

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.

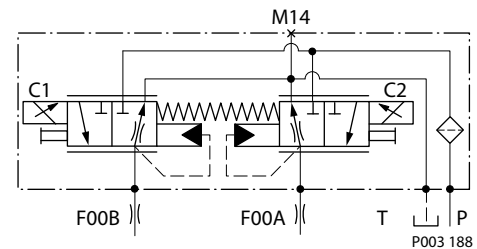
A serviceable 170 μm screen is located in the supply line immediately before the control porting spool.

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

NFPE control



NFPE schematic

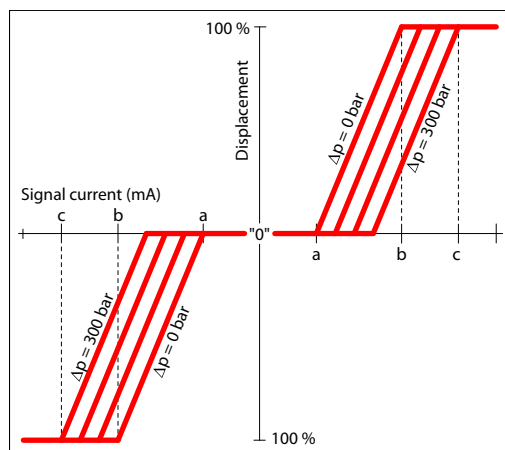


Control Signal Requirements, NFPE 045/053

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}	310 mA	1050 mA	1540 mA	any order
24 V _{DC}	309 mA	551 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.

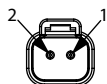
Single Pump Output Flow Direction

Shaft rotation	Clock-Wise (CW)		Counter-Clock-Wise (CCW)	
	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.

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:

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

Charge pressure = 20 bar [290 psi]

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

Speed = 1800 min⁻¹ (rpm)

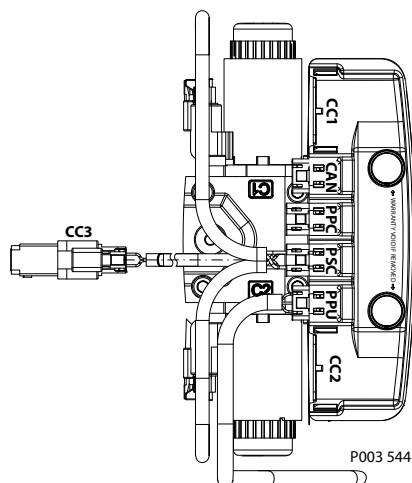
Response Time, NFPE 045/053

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	1.8 s	0.8 s	0.3 s
Full flow to neutral	1.2 s	0.5 s	0.2 s

Control Options

Automotive Control (AC)

The H1 **A**utomotive Control (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.

- **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, BC152986482596](#).

Control Options

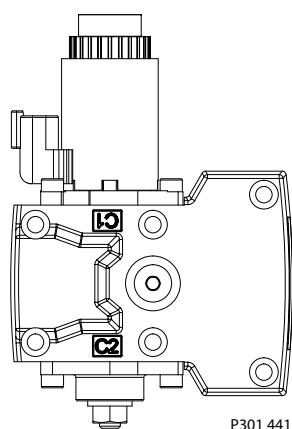
Fan Drive Control (FDC)

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.

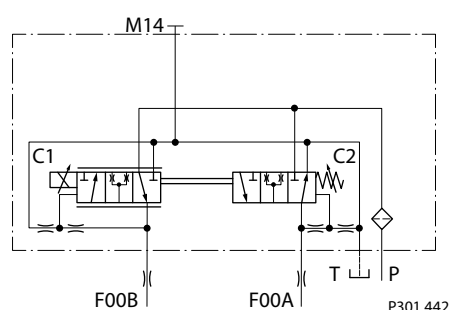
The control spool is spring biased to produce maximum forward pump displacement in the absence of an electrical input signal. Based on the spring bias spool default forward flow for a CW rotation pump is out of port B while default forward flow for a CCW rotation pump is out of port A.

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!

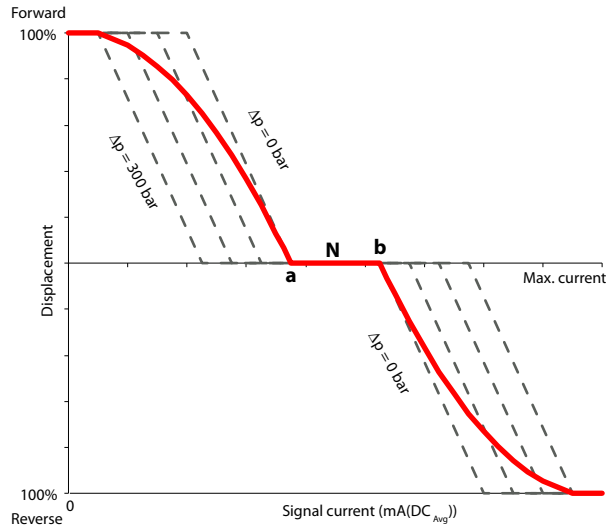
Due to the fail-safe functionality of the FDC control the pump will stroke to max. displacement in case the input signal to the pump control and the Diesel engine will be switched off at the same time. In this situation a low loop event can occur which may damage the pump. Therefore, it's strictly recommended 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, FDC 045/053

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:

$\Delta p = 250 \text{ bar}$ [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 045/053

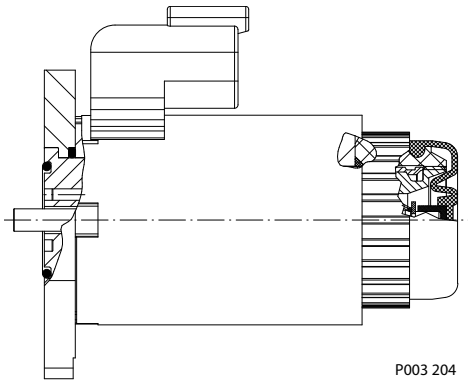
Stroking direction	0.8 mm [0.03 in] orifice
Full flow to neutral	1.9 s
Full forward flow to full reverse flow	2.8 s

Control Options

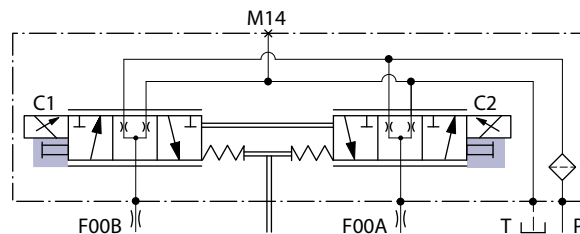
Manual Override (MOR)

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

Control Options

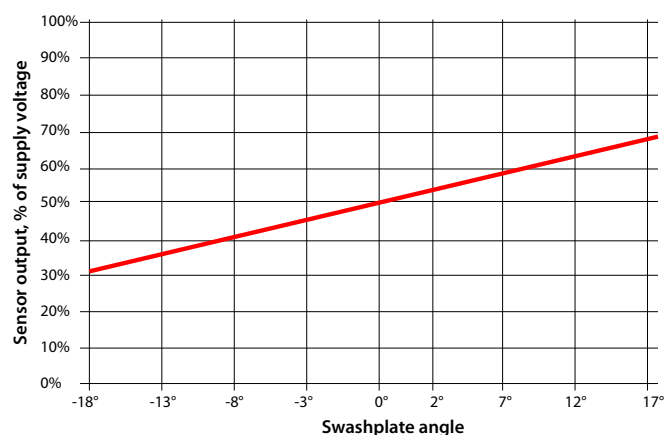
Swashplate angle sensor for EDC controls

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

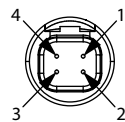
Control Options

Calibration of the sensor output within the software is mandatory. Vehicle neutral thresholds in the software ($\pm 0.5^\circ$) 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.

H1P Swash Plate Angle Sensor Connector

Connector DEUTSCH, 4-pin

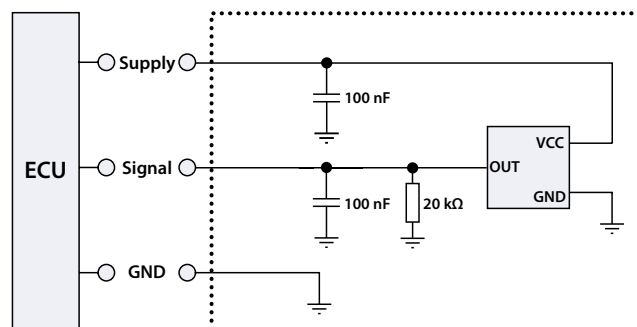


- 1** Ground (GND)
- 2** Not connected
- 3** Output signal 1 (SIG 1)
- 4** Supply (V+)

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

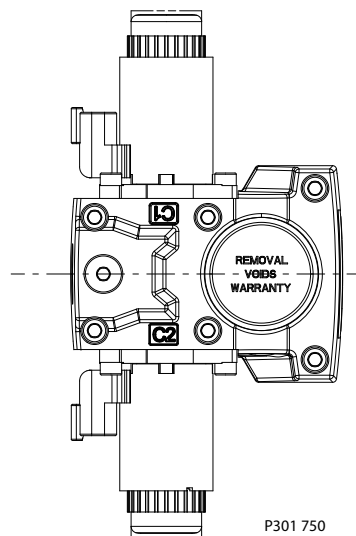


Control Options

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.

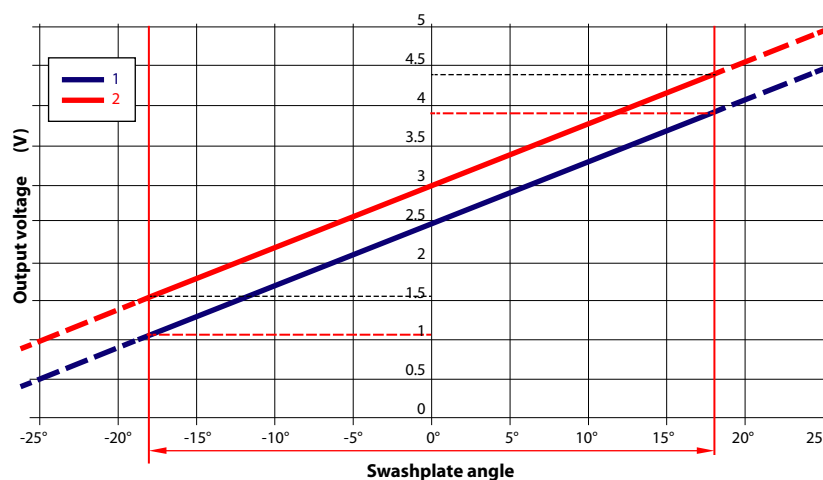
The output signal give a linear output voltage for the various magnet positions in the sensing range.



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:

$$V = \frac{\tan \alpha \cdot V}{\tan 18^\circ} \text{ (cm}^3\text{)}$$

The corresponding flow is:

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

Control Options

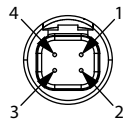
Swash Plate Angle Sensor Parameters (NFPE/AC)

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)

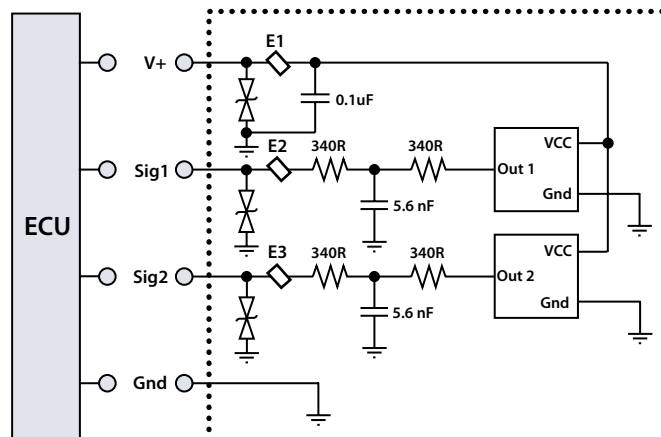
H1P Swash Plate Angle Sensor Connector (NFPE)



- 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.

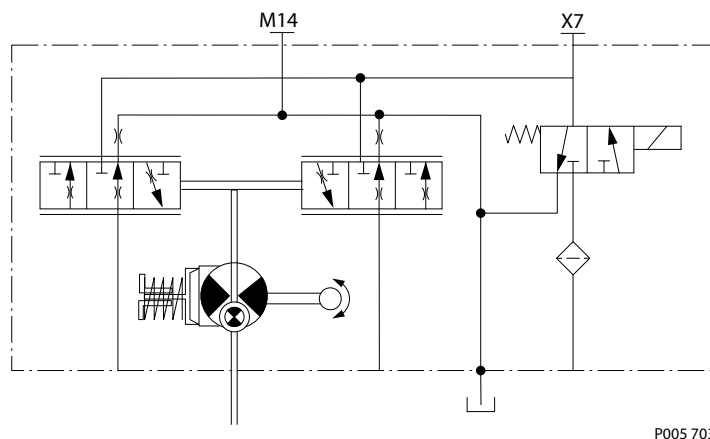
When the solenoid is energized, charge flow and pressure is allowed to reach the pump control. The X7 logic port will also be connected to charge pressure and flow.

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	

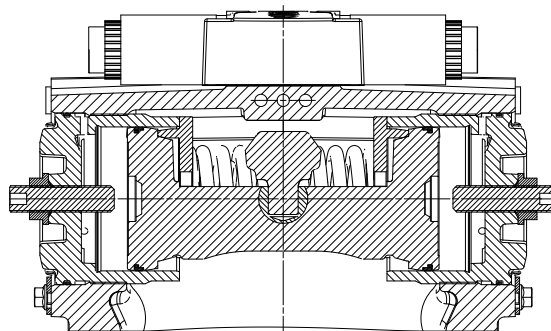
CCO solenoids are design for battery voltage application within the voltage range in the table above, in consideration of a wide range of environmental temperature common for known hydraulic applications. Closed loop PWM current supply can be also applied and is helpful in case that the voltage range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

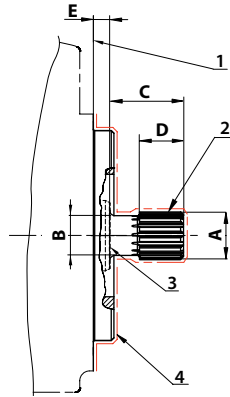


P003 266

H1P 045/053 Displacement Change (approximately)

Parameter	Size 045	Size 053
1 turn of displacement limiter screw	5.1 cm ³ [0.31 in ³]	6.0 cm ³ [0.37 in ³]
Internal wrench size	4 mm	
External wrench size	13 mm	
Torque for external hex seal lock nut	23 N•m [204 lbf•in]	

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

Dimensions and Data
H1P 045/053 Input Shaft Option G1 (SAE C, 14 teeth)


1. Surface of mounting flange 101 – 2 per ISO 3019-1 (SAE B); to be paint free
2. **Spline Data:** 14 teeth, Pressure angle: 30°, Pitch: 12/24, $\text{Ø}29.633$ [1.167]; Fillet root side fit per ANSI B92.1b, Class 6e
3. Coupling must not protrude beyond this point
4. Shaft to be paint free

Dimensions

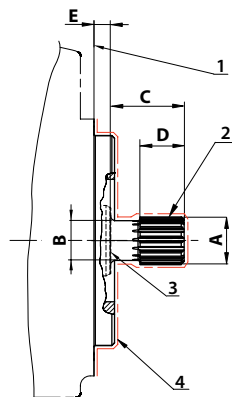
A	B	C	D ¹⁾	E
$\text{Ø}31.58 \pm 0.09$ [1.243 ± 0.004]	$\text{Ø}25.72 \pm 0.12$ [1.024 ± 0.005]	48.0 ± 0.68 [1.89 ± 0.003]	30.6 ± 0.15 [1.205 ± 0.006]	8.0 ± 0.8 [0.315 ± 0.03]

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

Torque rating

Rated torque	Maximum torque
534 N·m [4720 lb·in]	592 N·m [5240 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 045/053 Input Shaft Option G4 (SAE B, 13 teeth)


1. Surface of mounting flange 101 – 2 per ISO 3019-1 (SAE B); to be paint free
2. **Spline Data:** 13 teeth, Pressure angle: 30°, Pitch: 16/32, $\text{Ø}20.6375$ [0.813]; Fillet root side fit per ANSI B92.1b, Class 6e
3. Coupling must not protrude beyond this point
4. Shaft to be paint free

Dimensions

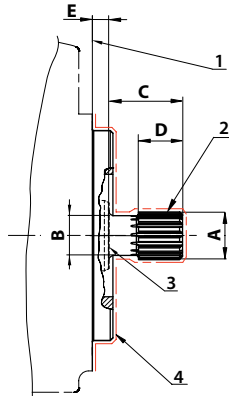
A	B	C	D ¹⁾	E
$\text{Ø}22.085 \pm 0.09$ [0.869 ± 0.004]	$\text{Ø}18.5 \pm 0.12$ [0.728 ± 0.005]	33.0 ± 0.68 [1.3 ± 0.003]	16.5 ± 0.15 [0.65 ± 0.006]	8.0 ± 0.8 [0.315 ± 0.03]

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

Torque rating

Rated torque	Maximum torque
180 N·m [1600 lbf·in]	222 N·m [1970 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 045/053 Input Shaft Option G5 (SAE B-B, 15 teeth)


1. Surface of mounting flange 101 – 2 per ISO 3019-1 (SAE B); to be paint free
2. **Spline Data:** 15 teeth, Pressure angle: 30°, Pitch: 16/32, $\text{Ø}23.813$ [0.938]; Fillet root side fit per ANSI B92.1b, Class 6e
3. Coupling must not protrude beyond this point
4. Shaft to be paint free

Dimensions

A	B	C	D ¹⁾	E
$\text{Ø}25.23 \pm 0.09$ [0.993 ± 0.004]	$\text{Ø}21.98 \pm 0.12$ [0.865 ± 0.005]	38.0 ± 0.68 [1.496 ± 0.003]	22.0 ± 0.15 [0.866 ± 0.006]	8.0 ± 0.8 [0.315 ± 0.03]

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

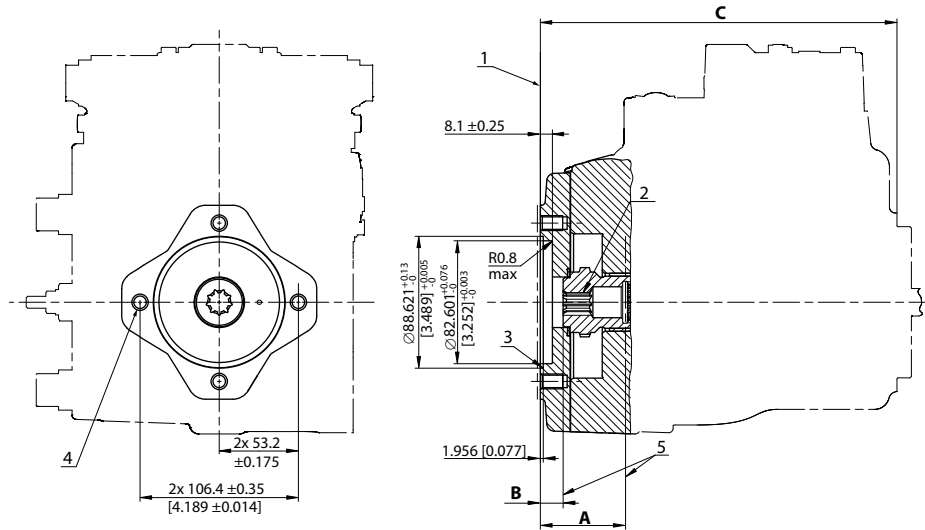
Torque rating

Rated torque	Maximum torque
277 N·m [2450 lbf·in]	370 N·m [3270 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 Auxiliary Mounting, Option H2 (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 [0.563]; Fillet root side fit per ANSI B92.1b, Class 7e
3. O-ring seal required; Ref. Ø82.22 ID x 2.62, cross section
4. Thread: M10x1.5-6H; 15 [0.59] min. depth (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Dimensions and torque

A	B	C	Max. Torque
57.2 min.; Shaft clearance	14.5 min.; Shaft clearance	239.6 ±2.5 [9.43 ±0.003]	162 N•m [1430 lbf•in]

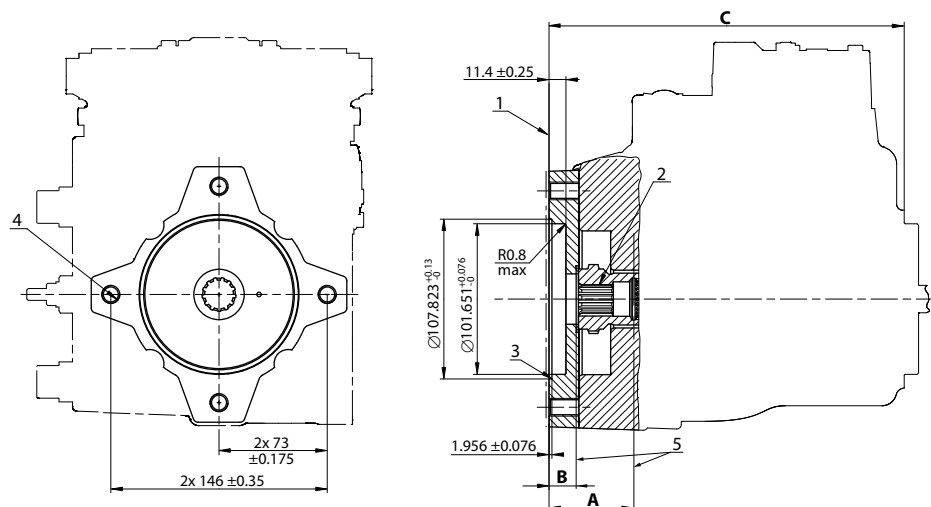
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information, BC152886483968*, the section "Shaft Torque Ratings and Spline Lubrication".

⚠ 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 (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
3. O-ring seal required; Ref. Ø94.92 ID x 2.62, cross section
4. Thread: M12x1.75-6H; 19.75 [0.778] min. depth (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Bolt length > 19.75 mm could result in a leak or damage to the unit.

Dimensions and torque

A	B	C	Max. Torque
57.2 min.; Shaft clearance	14.5 min.; Shaft clearance	239.6 ± 2.5 [9.43 ± 0.003]	395 N·m [3500 lbf·in]

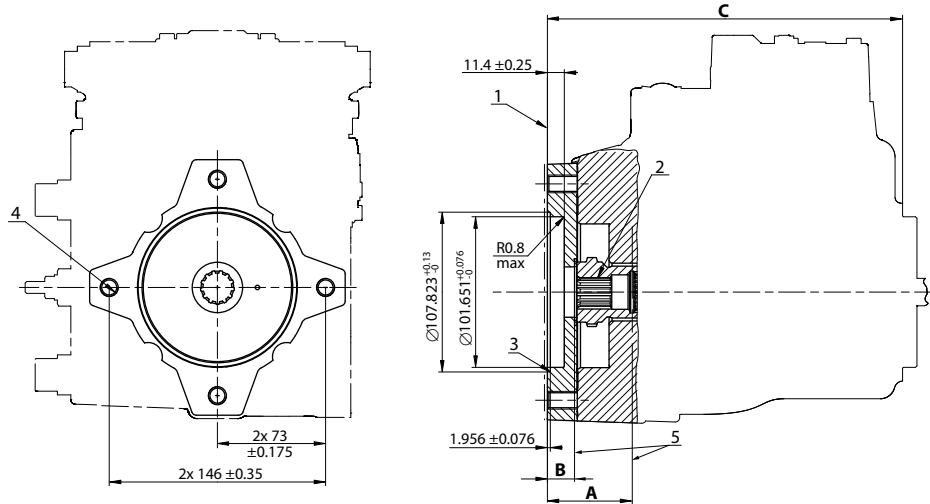
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information*, **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

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 (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 7e
3. O-ring seal required; Ref. Ø94.92 ID x 2.62, cross section
4. Thread: M12x1.75-6H; 19.75 [0.778] min. depth (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Bolt length > 19.75 mm could result in a leak or damage to the unit.

Dimensions and torque

A	B	C	Max. Torque
57.2 min.; Shaft clearance	14.5 min.; Shaft clearance	239.6 ± 2.5 [9.43 ± 0.003]	405 N·m [3580 lbf·in]

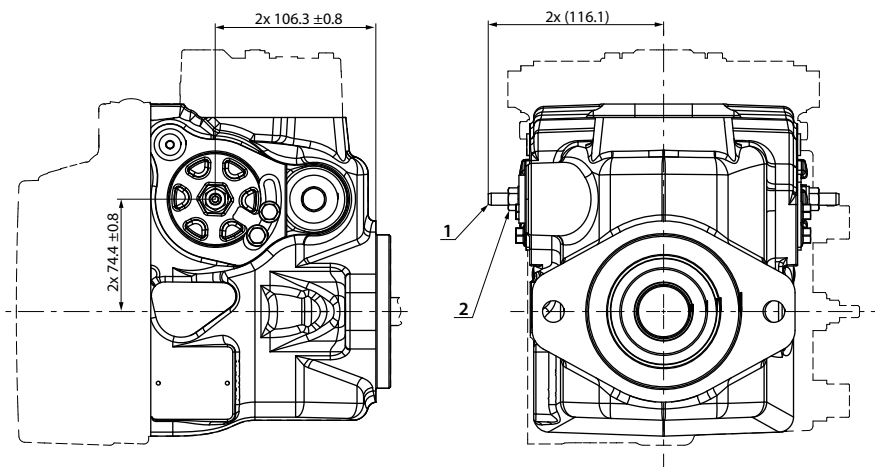
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information*, **BC152886483968**, the section “Shaft Torque Ratings and Spline Lubrication”.

! 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 and D



- 1. Displacement limiter screw (2x)
- 2. Displacement limiter seal nut (2x)

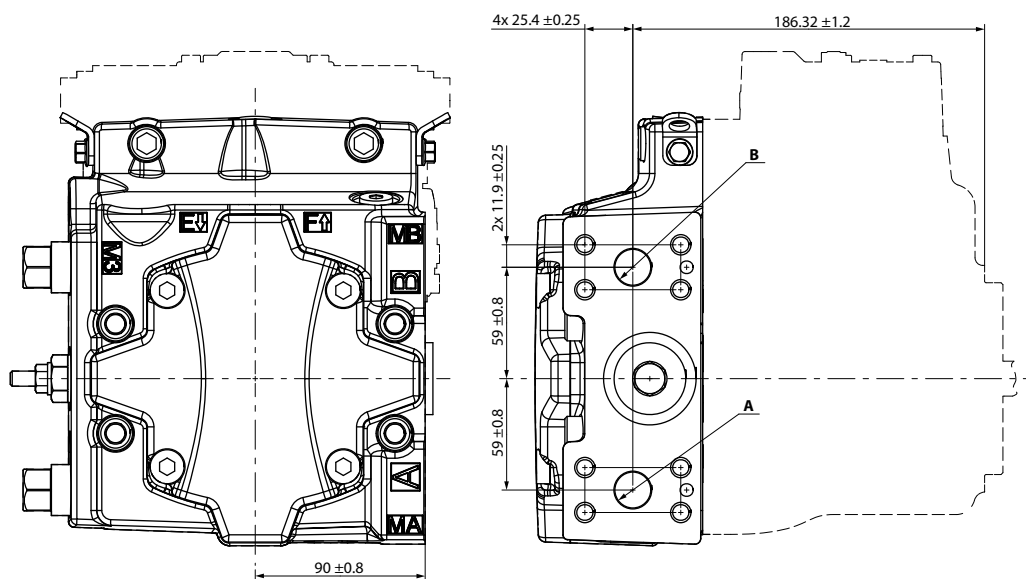
Wrench size, torque

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.](#)

H1P 045/053 End Cap, Options D6, D8, F2, F3

End cap, twin port Code 62, metric 4-bolt flange

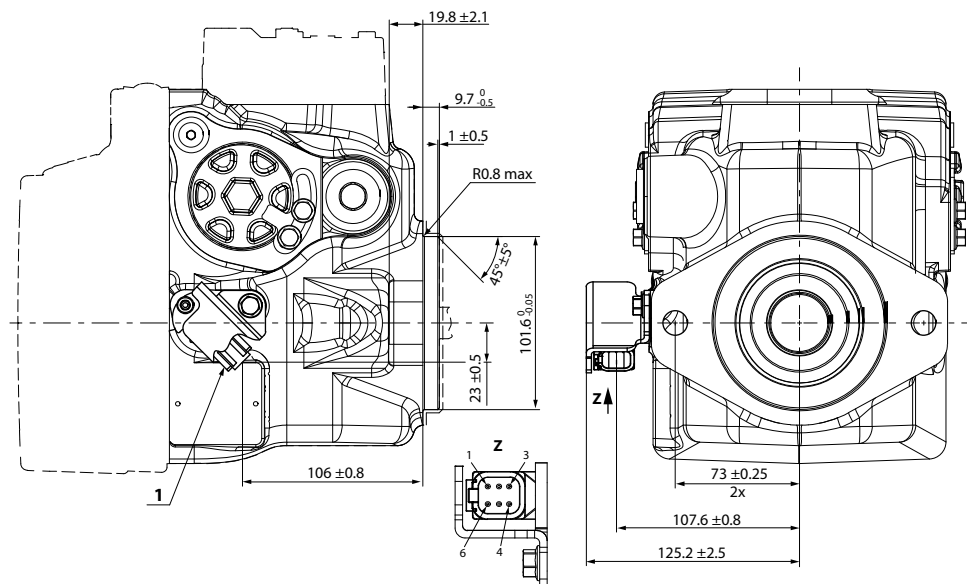


- A/B** System port Ø19 – 450 bar; Split flange boss per ISO 6162
M10x1.5; 18 full thread depth

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

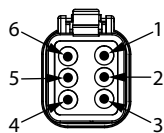
Dimensions and Data

Speed and temperature sensor, option H (for mounting flange option K)



1. Speed sensor connector DEUTSCH DTM04-6P, paint free

Connector DEUTSCH, 6-pin



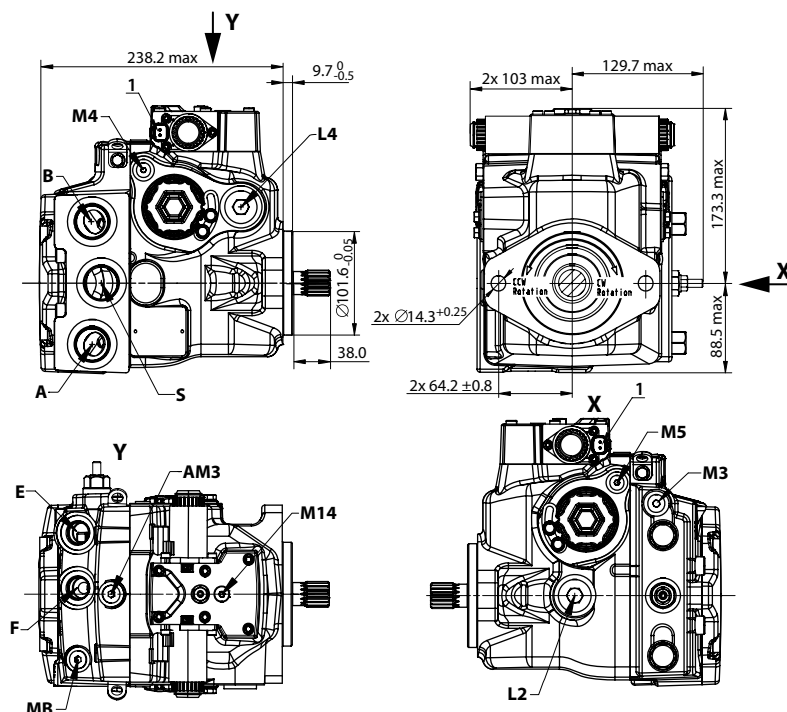
Pinout:

- 1. Speed signal 1
- 2. Direction signal
- 3. Speed signal 2
- 4. Ground (GND)
- 5. Supply
- 6. Temperature

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

Single Pump Ports

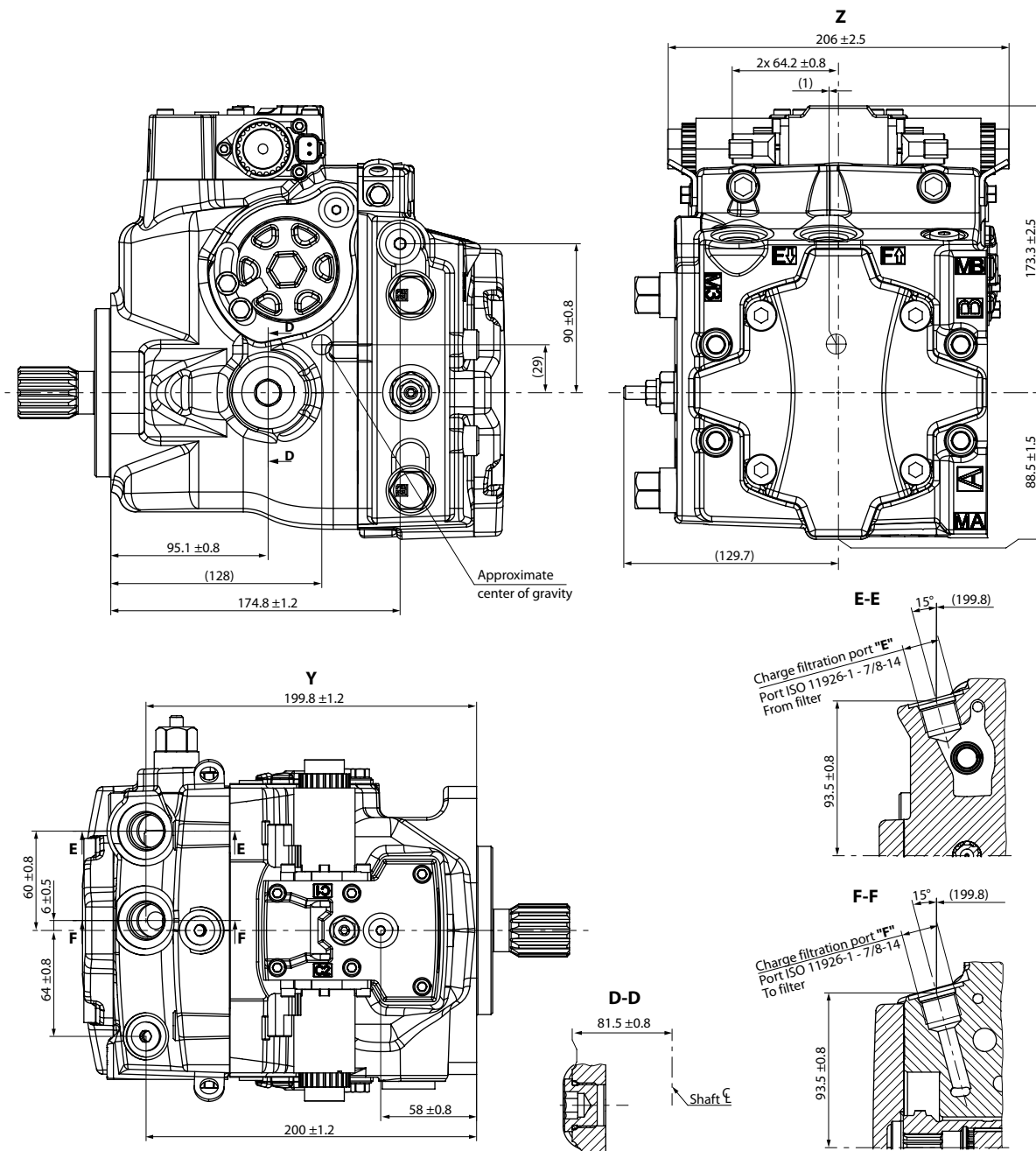


Ports per ISO 11 926-1

Port	Description	Size
A, B	System ports	1 ⁵ / ₁₆ -12
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, AM3	Charge pressure port (AM3-Alternate)	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
1	Connector DEUTSCH DT04-2P, to be paint free	

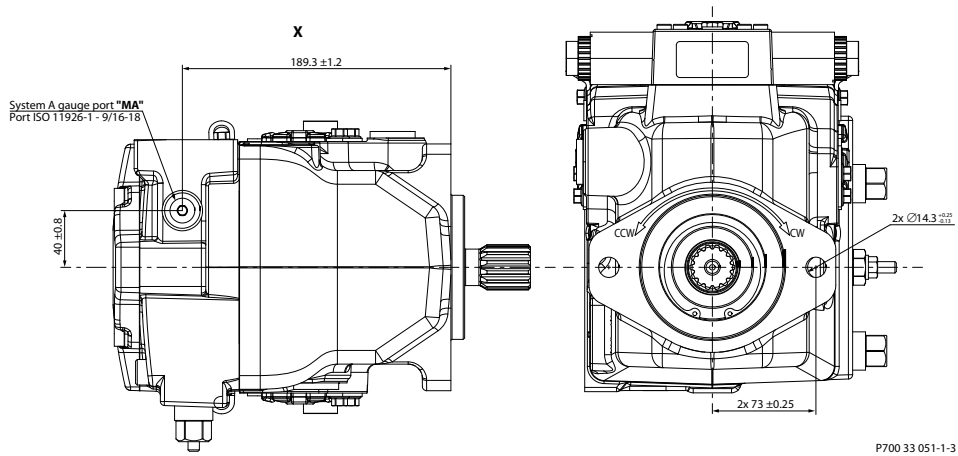
Please contact Danfoss representative for specific installation drawings.

Dimensions and Data



1 — Approximate center of gravity

Dimensions and Data



1 — Other side screw head space

⚠ Caution

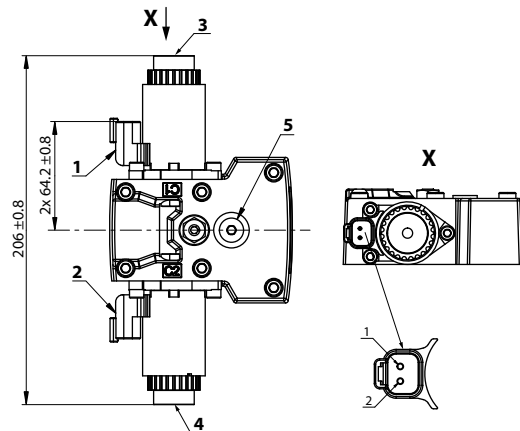
M12X1.75 or 1/2" screws with hardened washer (ASTM F436M or ISO 7089 300HV) must be used to mount the pump. Using M14 screws may cause issues when mounting.

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

Controls

EDC Options A2 and A3 (12/24 V)



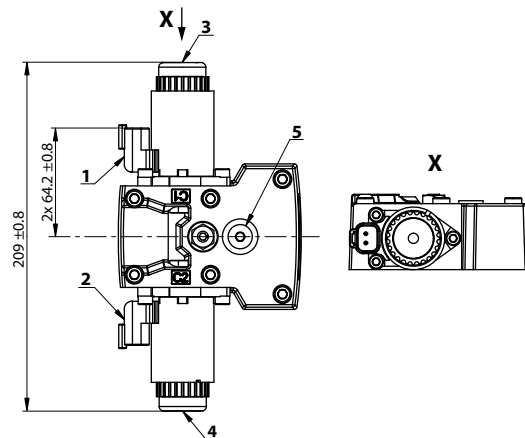
- 1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
- 2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
- 3. Control Manual OverRide **C1**
- 4. Control Manual OverRide **C2**
- 5. Case gauge port **M14** per ISO 1926-1: 7/16-20

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

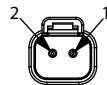
EDC with MOR, Options A4 and A5 (12/24 V)



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: $\frac{7}{16}$ -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

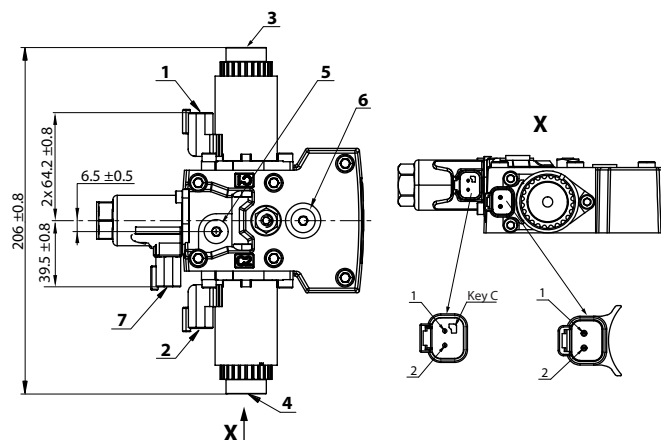


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

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



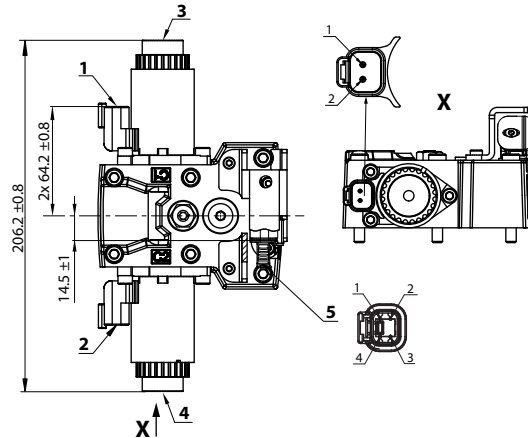
- 1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
- 2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
- 3. Control Manual OverRide **C1**
- 4. Control Manual OverRide **C2**
- 5. Brake gauge port **X7** per ISO 1926-1: $\frac{7}{16}$ -20
- 6. Case gauge port **M14** per ISO 1926-1: $\frac{7}{16}$ -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.

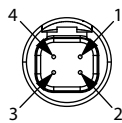
Dimensions and Data

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

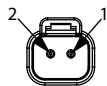
Connector DEUTSCH, 4-pin



4-pin assignment:

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

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

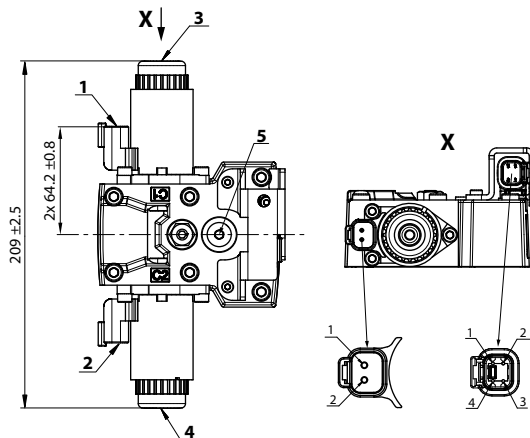


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

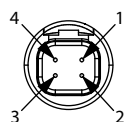
Dimensions and Data

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: $\frac{7}{16}$ -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

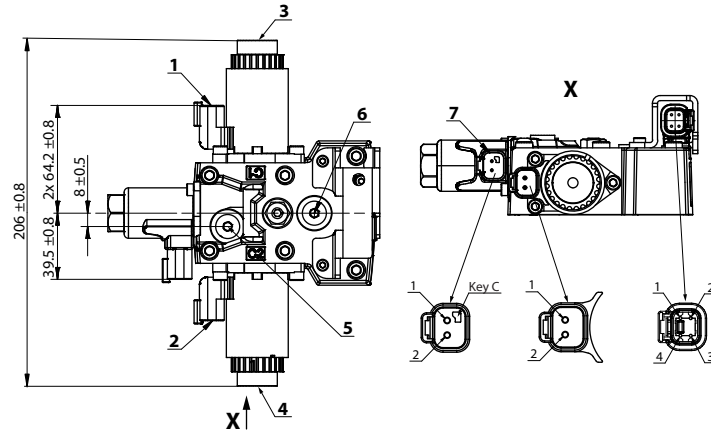


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

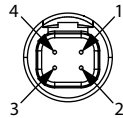
EDC with CCO and ASNSR, Options H8 and H9 (12/24 V)



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: $\frac{7}{16}$ -20
6. Brake gauge port **X7** per ISO 1926-1: $\frac{7}{16}$ -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.

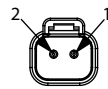
Connector DEUTSCH, 4-pin



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

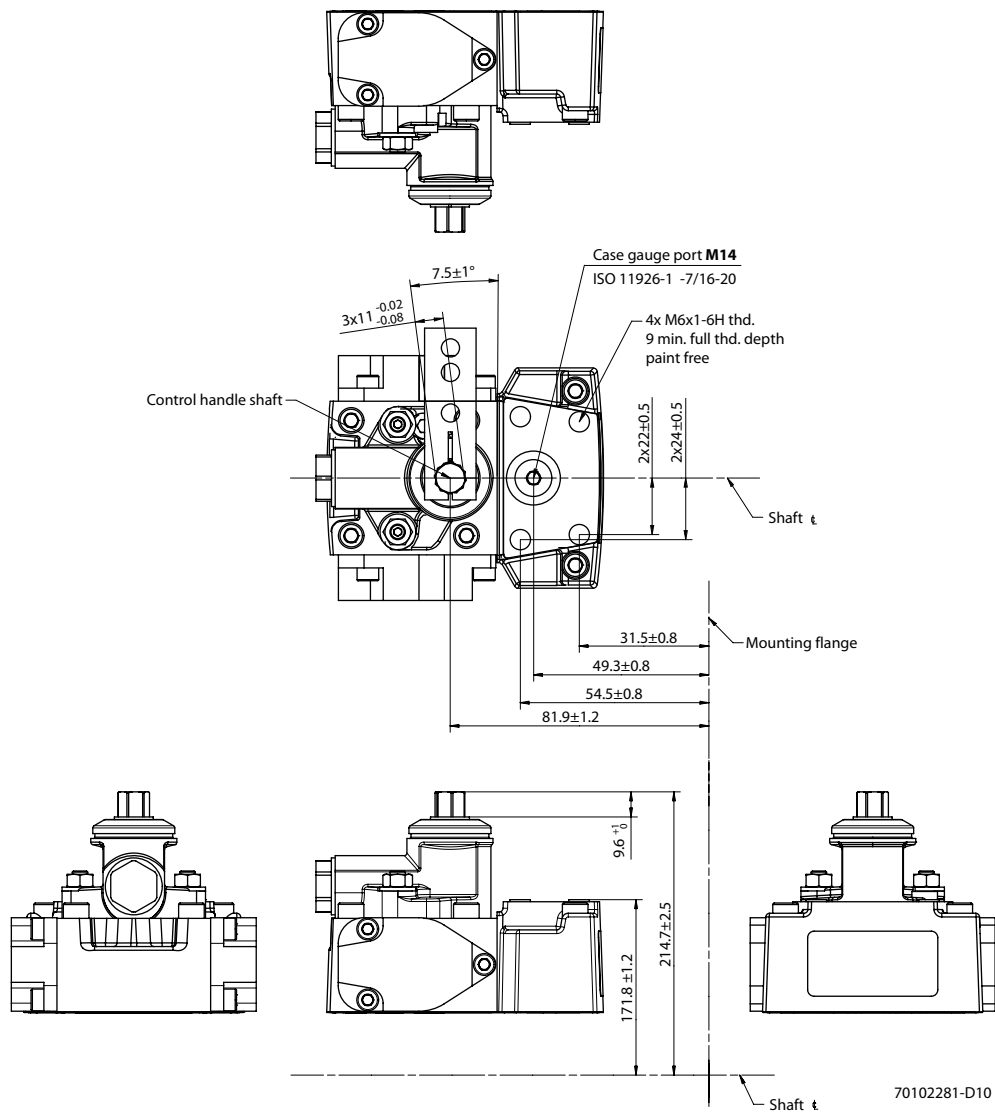


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

MDC Option: M1



Connector DEUTSCH, 2-pin

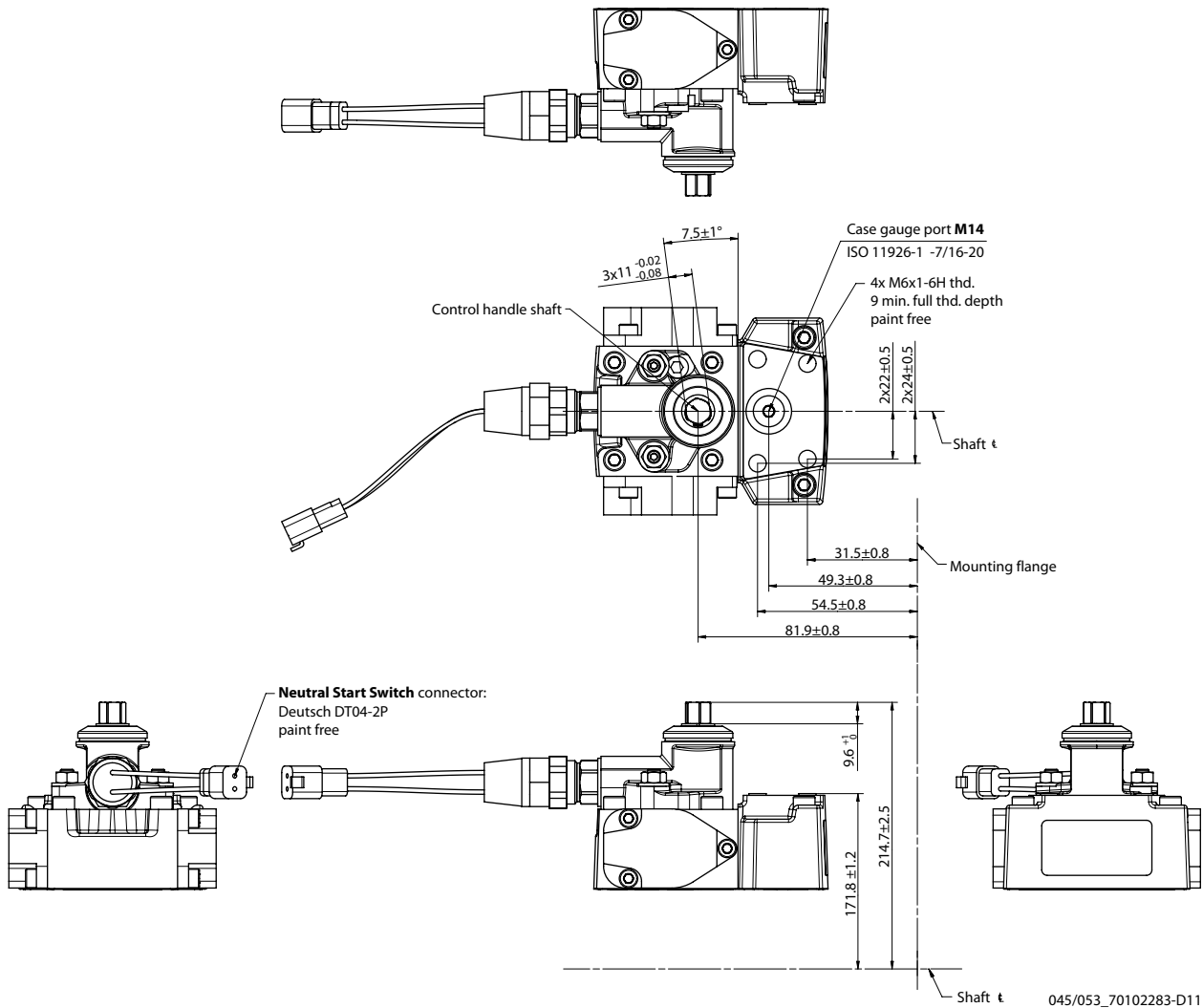


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

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

Dimensions and Data

MDC with Neutral Start Switch Option: M2



Connector DEUTSCH, 2-pin

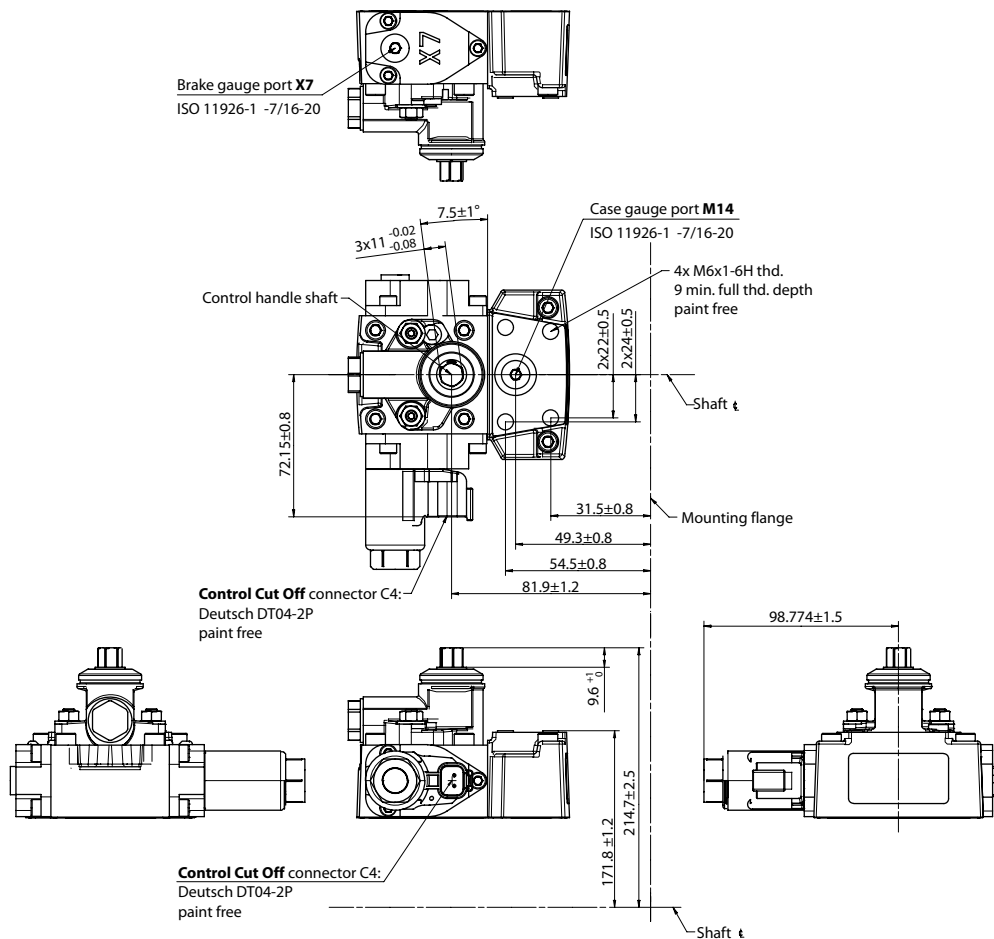


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

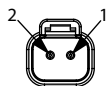
Dimensions and Data

MDC with CCO, Options: M3, M4



045/053_70102283-D12

Connector DEUTSCH, 2-pin

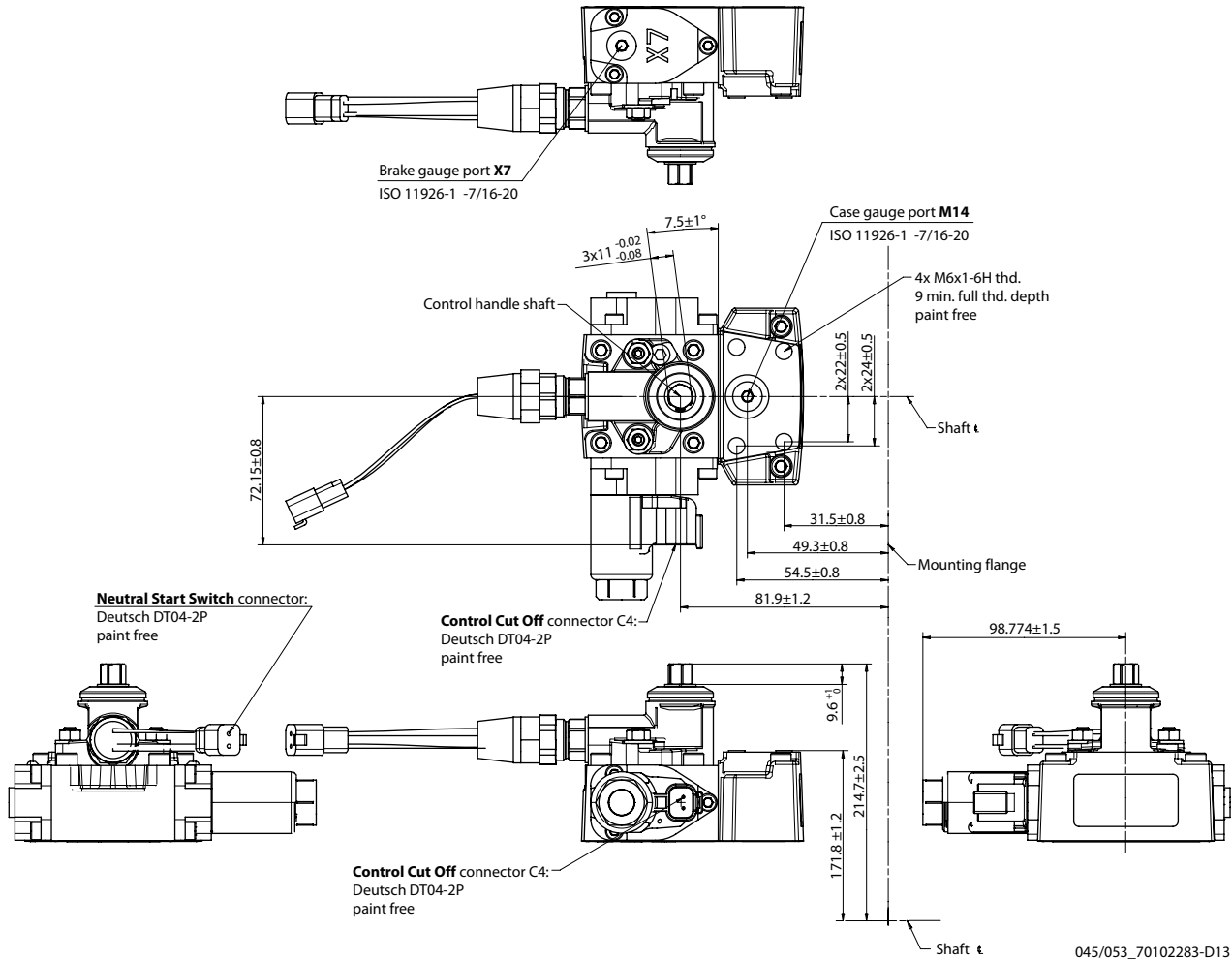


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

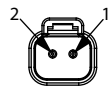
[Please contact Danfoss representative for specific installation drawings.](#)

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

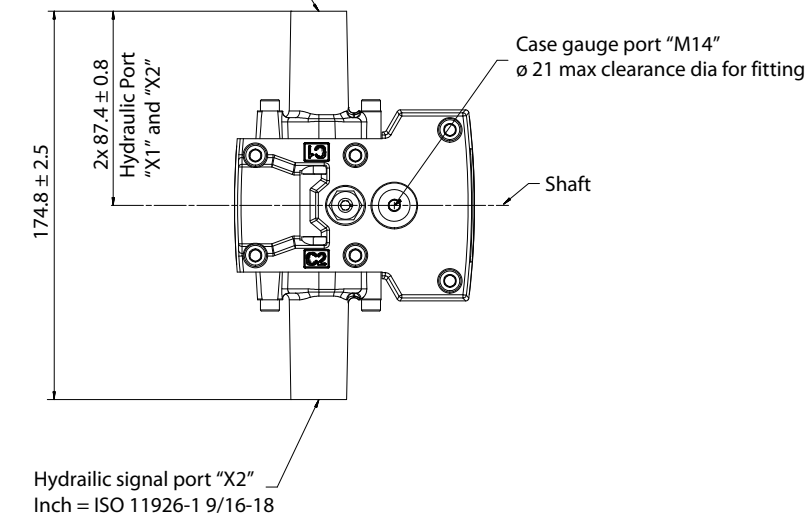
Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

H1P HDC, Options: T1, T2

Dimensions in mm

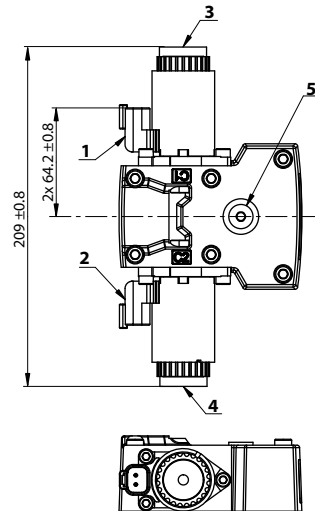
Hydraulic signal port "X1"
 Inch = ISO 11926-1 9/16-18



Dimensions and Data

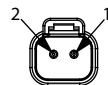
NFPE with MOR, Options: N1, N2 (12/24 V)

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



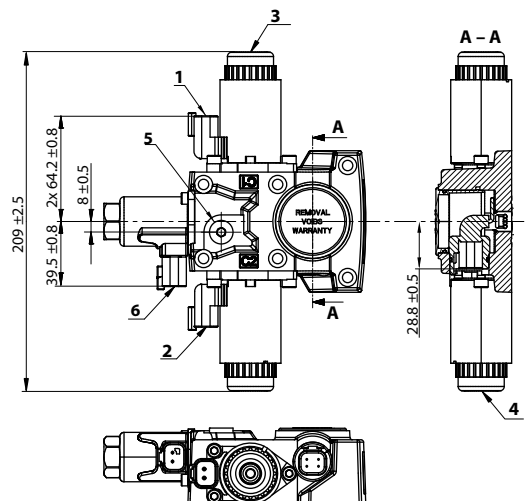
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

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

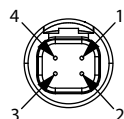
Non-Feedback Proportional Electric control with Control-Cut-Off valve with key C, Manual Over Ride and Angle Sensor, options N3 (12 V) and N4 (24 V).



- 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: $\frac{7}{16}$ -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



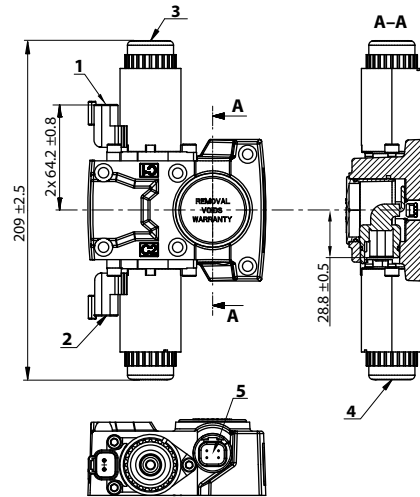
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

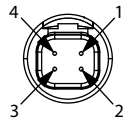
NFPE with MOR and ASNSR, Options: N5, N6 (12/24 V)

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

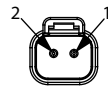
Connector DEUTSCH, 4-pin



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



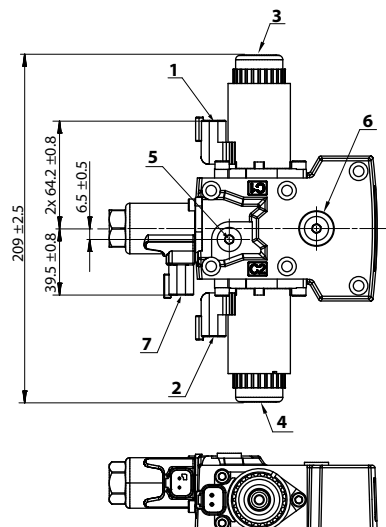
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

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

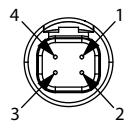
Non Feedback Proportional Electric control with Manual Over Ride and Control-Cut-Off valve key C, options N7 (12 V) and N8 (24 V).



- 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

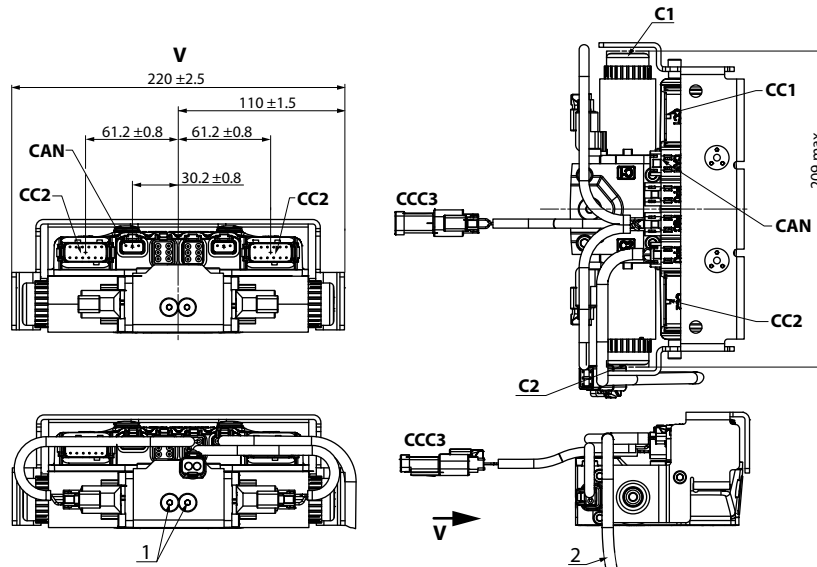


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

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

Dimensions and Data

Automotive control (AC)



- 1 Plug removing can cause contamination issues
- 2 PPU wire harness is factory installed to speed sensor

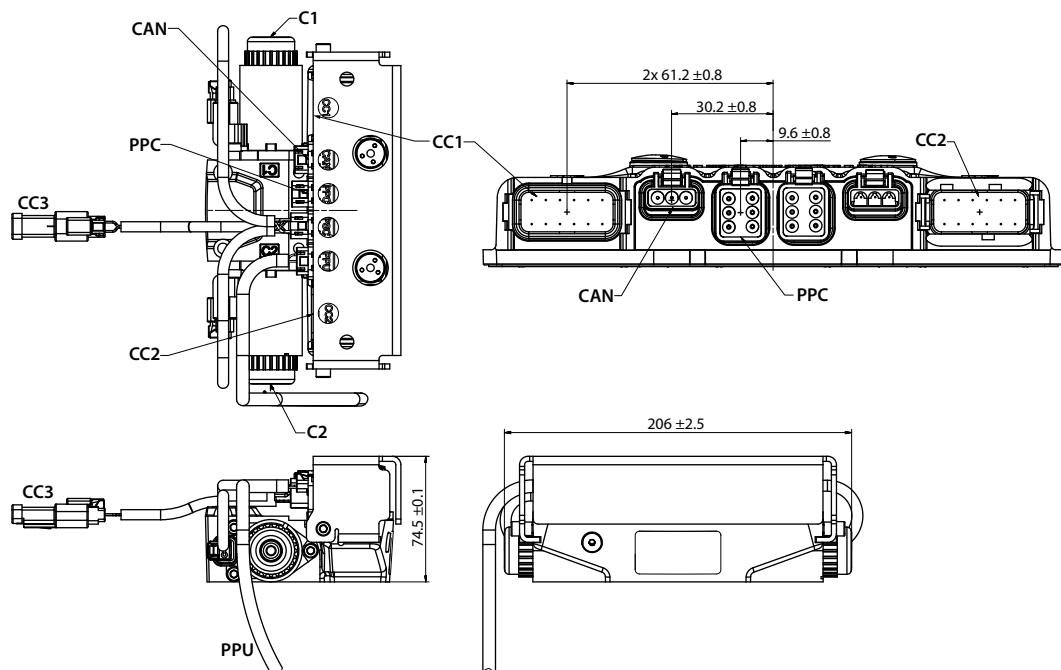
Connectors description

Port	Description
C1 and C2	1. Control manual override C1 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

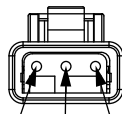
Connector DEUTSCH, 2-pin



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

CAN

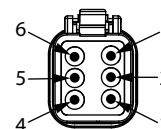
Connector DEUTSCH, 3-pin



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

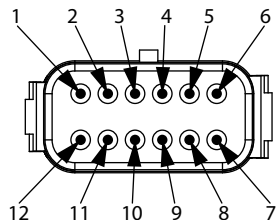
PPC

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)

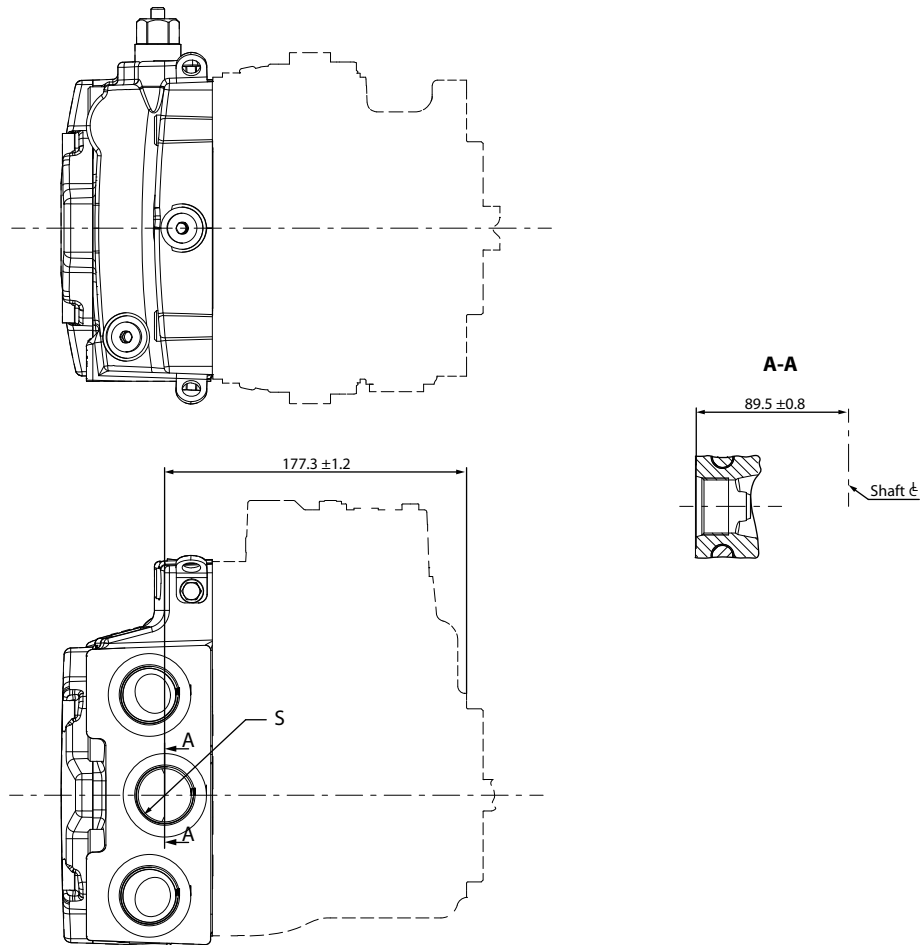
CC2

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 45/53 Suction Filtration Option L

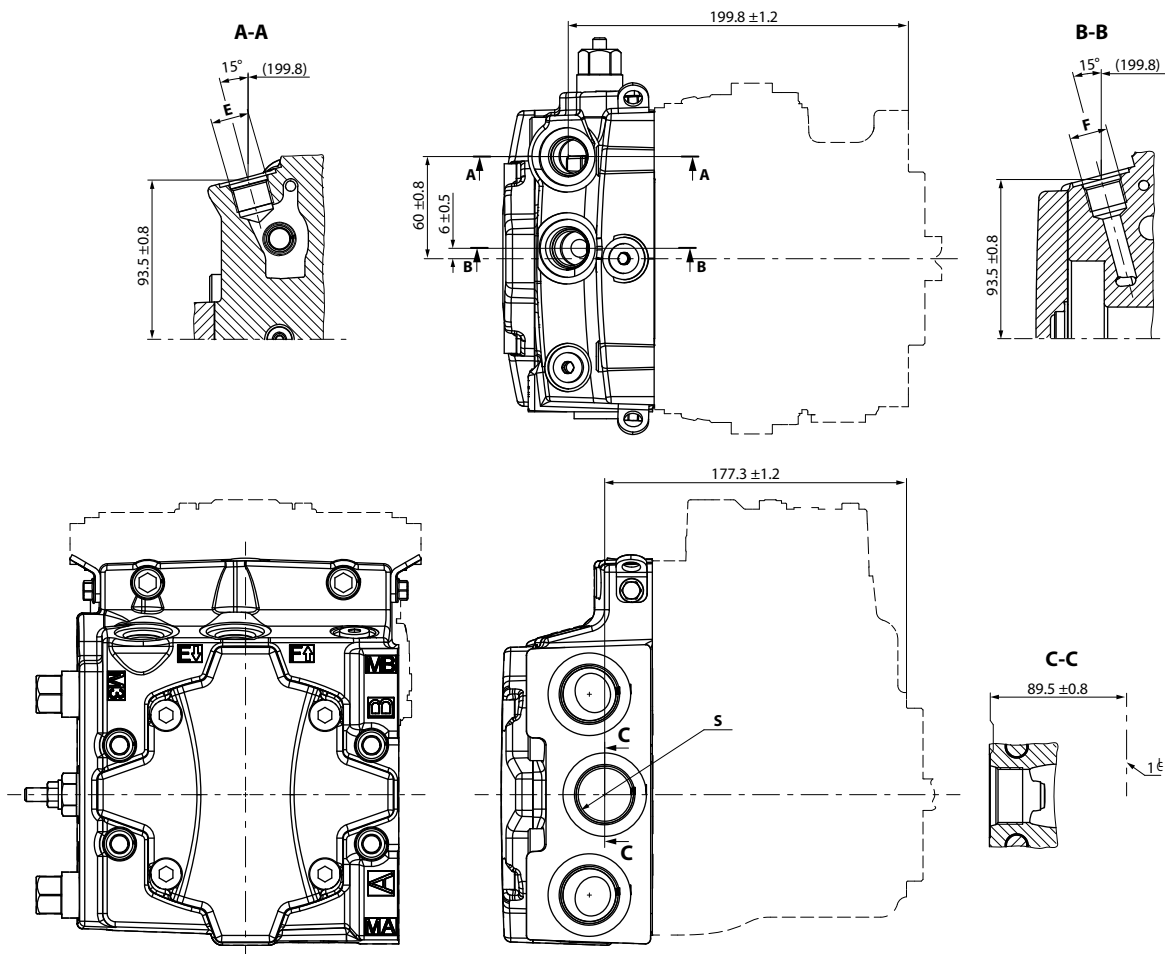


S Charge inlet port per ISO 1926-1; 1 5/16-12

Dimensions and Data

H1P 45/53 Full Flow Charge Pressure Filtration Option P

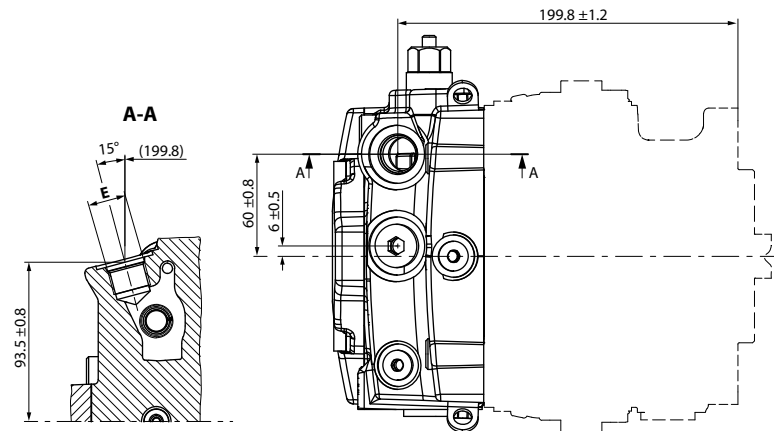
Remote full flow charge pressure filtration, option P (for endcap option F)



- E** Charge filtration port per ISO 11926-1; 7/8-14 from filter
- F** Charge filtration port per ISO 11926-1; 7/8-14 to filter
- S** Charge inlet port per ISO 11926-1; 5/16-12

Dimensions and Data

External Full Flow Charge Pressure Filtration, Option E



E Charge filtration ports per ISO 11926-1: $\frac{7}{8}$ -14 from filter

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

Products we offer:

- Cartridge valves
- DCV directional control valves
- Electric converters
- Electric machines
- Electric motors
- Gear motors
- Gear pumps
- Hydraulic integrated circuits (HICs)
- Hydrostatic motors
- Hydrostatic pumps
- Orbital motors
- PLUS+1® controllers
- PLUS+1® displays
- PLUS+1® joysticks and pedals
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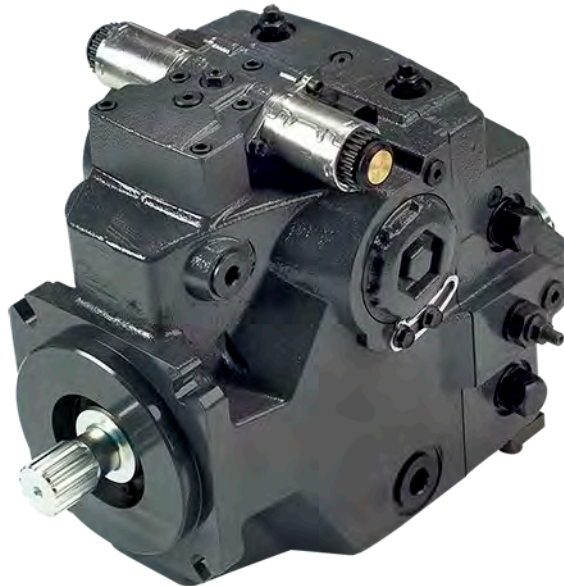
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Technical Information

H1P 060/068

Axial Piston Single Pumps



Revision history*Table of revisions*

Date	Changed	Rev
May 2022	Corrected HDC control information	1201
December 2021	Added HDC control	1101
April 2021	Corrected interface with EDU (EDC) graphic	1005
April 2020	Corrected swash plate angle sensor connector and CCO connector descriptions	1004
February 2020	Added NFPE control options and changed the document number from BC00000074	1003
June 2019	Major update.	0901
May 2018	Angle sensor for EDC; FDC note added.	0801
May 2017	NFPE gen. 3 changes.	0701
November 2015	Master Model Code changes.	0600
2010-2014	Various changes.	BA-GB
Nov 2010	First edition	AA

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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 060/068 Technical Data

Feature	Size 060	Size 068
Displacement	60.4 cm ³ [3.69 in ³]	68.0 cm ³ [4.15 in ³]
Flow at rated speed (continuous)	210 l/min [55.5 US gal/min]	238 l/min [62.8 US gal/min]
Torque at maximum displacement (theoretical)	0.96 N·m/bar [590 lbf·in/1000 psi]	1.08 N·m/bar [610 lbf·in/1000 psi]
Mass moment of inertia of rotating components	0.00709 kg·m ² [0.00523 slug·ft ²]	0.00707 kg·m ² [0.00522 slug·ft ²]
Mass (dry-no charge pump)	50 kg [110 lb]	50 kg [110 lb]
Oil volume	2.1 l [0.55 US gal]	2.1 l [0.55 US gal]

Shaft, flange and ports description

Input shaft per ISO 3019-1 (outer diameter)	<ul style="list-style-type: none"> • Outer Ø32 mm – 4 (SAE C, 14 teeth) • Outer Ø35 mm – 4 (SAE C, 21 teeth)
Mounting flange per ISO 3019-1	Flange 127-4 (SAE C)
Auxiliary mounting flange with metric fasteners, with shaft outer diameter	<ul style="list-style-type: none"> • Flange 82-2 (SAE A, 9 teeth and 11 teeth) • Flange 101-2 (SAE B, 13 teeth and SAE B-B, 15 teeth) • 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
Case drain ports L2, L4 per ISO 3019-1	1 ¹ / ₁₆ -12 (SAE O-ring boss)
Other ports	SAE O-ring boss
Customer interface threads	Metric fasteners

Technical Specifications

H1P 060/068 Operating Parameters

Parameter		Unit	Size 060	Size 068
Input speed	Min. for internal ¹⁾ and external ²⁾ charge supply	min ⁻¹ (rpm)	500	500
	Min. for full performance, internal charge supply		1200	1250
	Rated		3500	3500
	Maximum		4000	4000
System pressure	Maximum working	bar [psi]	420 [6090]	380 [5510]
	Maximum		450 [6525]	400 [5800]
	Max./Min. low loop		45/10 [650/145]	
Charge pressure	Minimum		14.5 [210]	
	Maximum		34 [493]	
Control pressure	Minimum (at corner power for EDC, MDC, FNR)	bar [psi]	18.5 [270]	
	Minimum (at corner power for NFPE, FDC, AC)		26 [377]	
	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		4.0 [58.0]	
Case pressure	Rated	bar [psi]	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 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 μm

Technical Specifications

Fluid Specification

Viscosity

Intermittent¹⁾	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

Minimum¹⁾	-40°C [-40°F]
Rated	104°C [220°F]
Recommended range²⁾	60 – 85°C [140 – 185°F]
Maximum Intermittent	115°C [240°F]

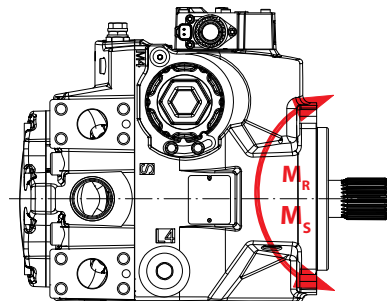
¹⁾ Cold start = Short term t > 3 min, p ≤ 50 bar [725 psi], n ≤ 1000 min⁻¹ (rpm).

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

H1P 060/068 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

$$M_R = 2110 \text{ N}\cdot\text{m} [18\ 680 \text{ lbf}\cdot\text{in}]$$

Shock load moment

$$M_S = 5275 \text{ N}\cdot\text{m} [46\ 690 \text{ lbf}\cdot\text{in}]$$

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.

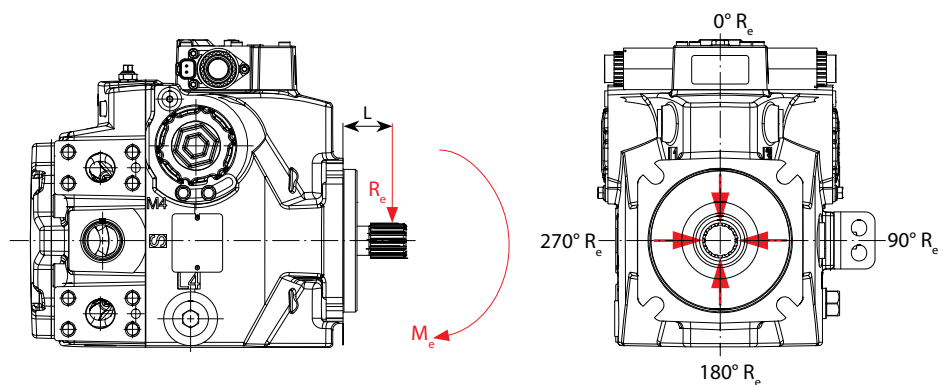
Danfoss recommends clamp-type couplings for applications with radial shaft loads. Contact your Danfoss representative for an evaluation of unit bearing life if you have continuously applied external loads exceeding 25 % of the maximum allowable radial load (R_e) or the pump swash-plate is positioned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

Maximum external shaft load based on shaft deflection

External radial moment	Unit	Size 060/068
M_e	N·m [lbf·in]	104 [920]

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.

For more information, see *Selection of Drive line Components*, [BC157786484430](#).

14/17 cm³ Charge Pump – Flow and Power Curves

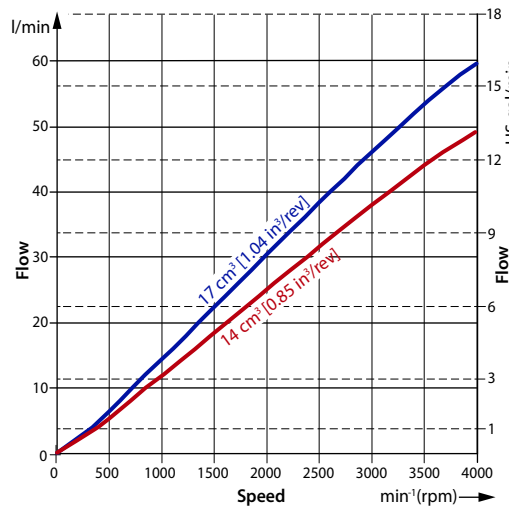
Charge pump flow and power requirements curves shown below at the following conditions:

Charge pressure = 20 bar [290 psi]

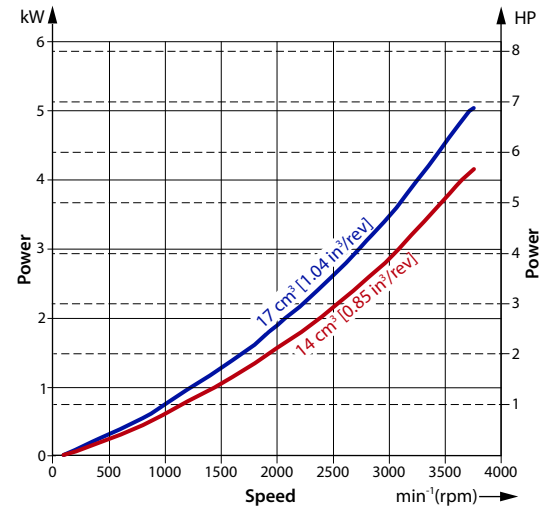
Viscosity = 11 mm²/s [63 SUS]

Temperature = 80°C [176°F]

Charge pump flow



Charge pump power requirements



Master Model Code

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



Displacement

060	60.4 cm ³ [3.69 in ³]
068	68.0 cm ³ [4.15 in ³]

A – Direction of Rotation

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

B – Product version

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

Z – Port configuration

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

Master Model Code

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).

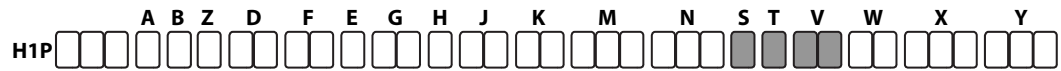
Hydraulic Displacement Control

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

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



S – Charge pump 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 (<i>Align with options: E, T</i>)

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
P	Remote full charge flow filtration
E	External full charge flow filtration (<i>Align with options N, S</i>)

V – Charge pressure relief valve (CPRV) setting

18*	18 bar [261 psi]
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]

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

Control Options

Electrical Displacement Control (EDC)

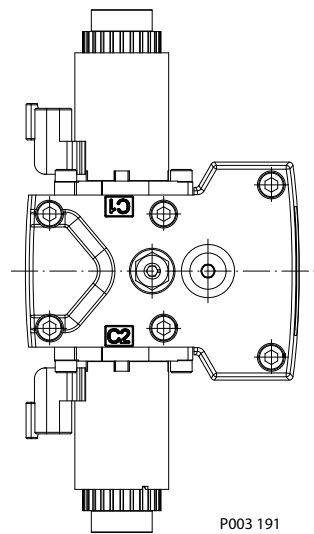
An EDC is a displacement (flow) control. Pump swash plate position is proportional to the input command and therefore vehicle or load speed (excluding influence of efficiency), is dependent only on the prime mover speed or motor displacement.

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.

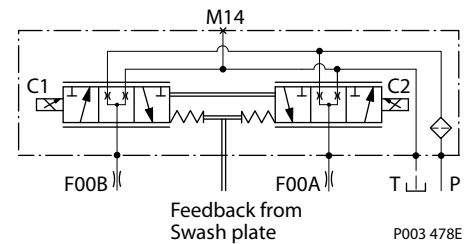
A serviceable 170 µm screen is located in the supply line immediately before the control porting spool.

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

Electrical Displacement Control

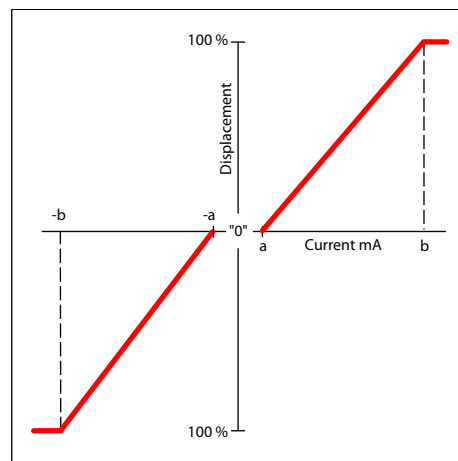


EDC schematic, feedback from swash plate



Control signal requirements, EDC 060/068

Pump displacement vs. control current



Control Options

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.

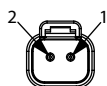
Single Pump Output Flow Direction

Shaft rotation	Clock-Wise (CW)		Counter-Clock-Wise (CCW)	
	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.

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:

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

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 060/068

Stroking direction	0.8 mm [0.03 in] orifice	1.3 mm [0.05 in] orifice	No orifice
Neutral to full flow	2.6 s	1.2 s	0.8 s
Full flow to neutral	1.7 s	0.8 s	0.4 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.

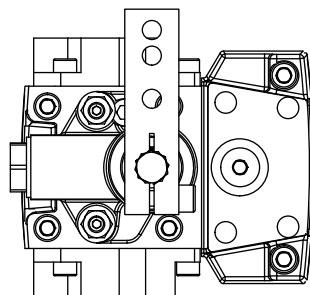
Differential pressure across the servo piston rotates the swash plate, changing the pump's displacement. Simultaneously the swashplate movement is fed back to the control spool providing proportionality between shaft rotation on the control and swash-plate rotation. The MDC changes the pump displacement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

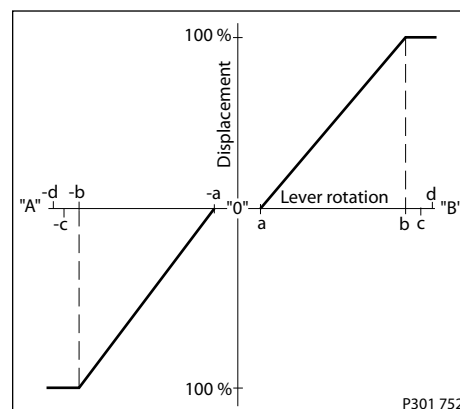
For the MDC with CCO option the brake port (X7) provides charge pressure when the coil is energized to activate static function such as a brake release. The X7 port must not be used for any continuous oil consumption.

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.

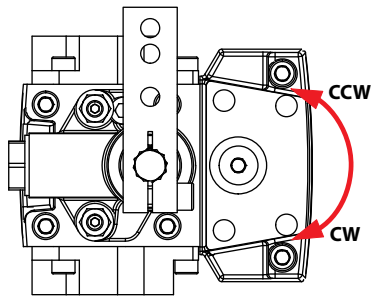
High case pressure may cause excessive wear and the NSS to indicate that the control is not in neutral position. In addition, if the case pressure exceeds 5 bar there is a risk of an insufficient restoring moment. The MDC is designed for a maximum case pressure of 5 bar and a rated case pressure of 3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

$\Delta p = 250 \text{ bar}$ [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, MDC 060/068

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	0.4 s
C6	1	–	–	1.1 s	1.0 s
C7	1.3	–	–	0.7 s	0.7 s
D1	0.8	1	–	2.1 s	1.5 s
D2	0.8	1.3	–	1.8 s	1.4 s
D3	1	1.3	–	1.3 s	1.0 s
D4	1	1.3	1.3	1.6 s	1.2 s

[For further data please contact your Danfoss representative.](#)

Connector

Connector DEUTSCH, 2-pin



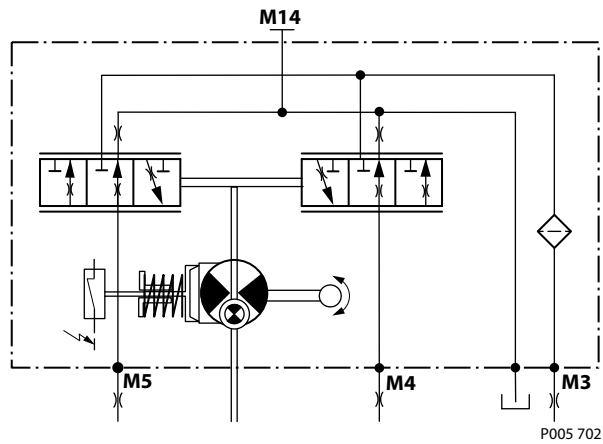
Description	Quantity	Order data
Mating connector	1	DEUTSCH DT06-25
Wedge lock	1	DEUTSCH W25
Socket contact (16–18 AWG)	2	DEUTSCH 0462-201-16141
Danfoss mating connector kit	1	K29657

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**).

Control Options

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.

Lever

MDC-controls are available with an integrated lever.

Control Options

Hydraulic Displacement Control (HDC)

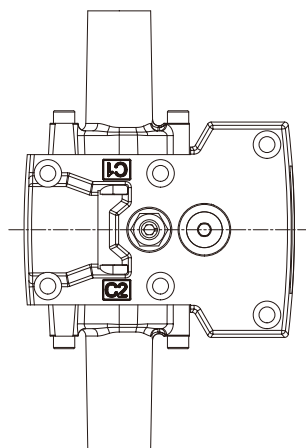
HDC principle

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.

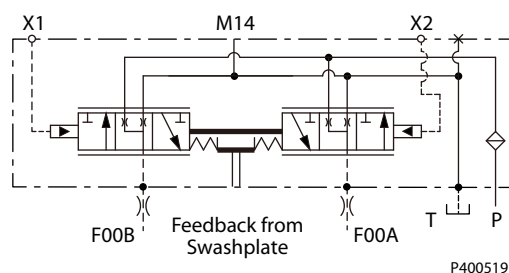
A serviceable 175 µm screen is located in the supply line immediately before the control porting spool.

HDC control



P400520

HDC schematic



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.

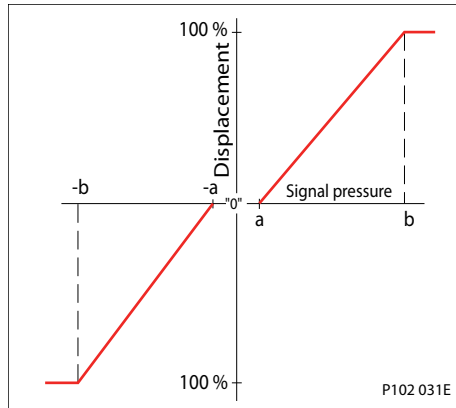
A swashplate feedback link, opposing control linkage, and a linear spring provide swashplate position force feedback to the hydraulic pressure. As hydraulic pressures in the operating loop change with load, the control assembly and servo/swashplate system work constantly to maintain the commanded position 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	
	X1	X2	X1	X2
Port energized	Out (high)	In (low)	In (low)	Out (high)
Port A	In (low)	Out (high)	Out (high)	In (low)
Port B	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 swashplate 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 mm²/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	0.5s
Full flow to neutral	1.2s	0.5s	0.3s

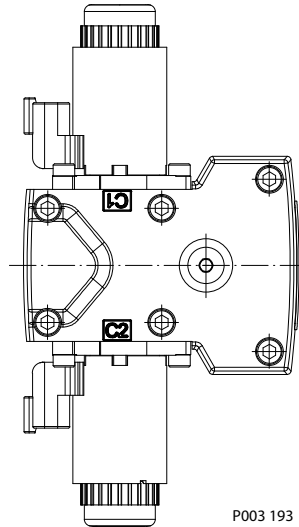
Control Options

Forward-Neutral-Reverse Control (FNR)

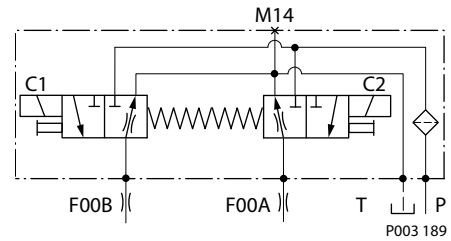
The 3-position FNR control options **A9** (12 V) and **B1** (24 V) uses an electric input signal to switch the pump to a full stroke position. A serviceable 125 µm screen is located in the supply line immediately before the control porting spool.

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

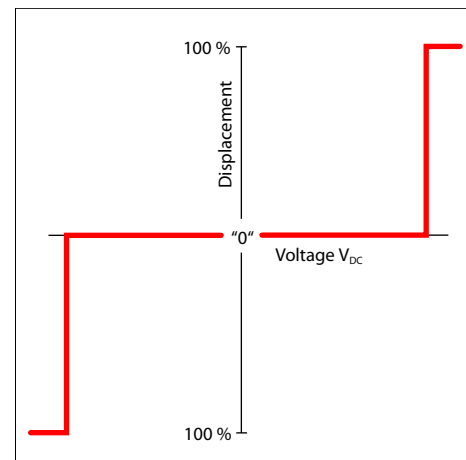
Forward-Neutral-Reverse electric control (FNR)



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	

Single Pump Output Flow Direction

Shaft rotation	Clock-Wise (CW)		Counter-Clock-Wise (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 Options

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
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

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:

$\Delta p = 250 \text{ bar}$ [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)

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

Response Time, FNR 060/068

Stroking direction	0.8 [0.03] orifice	1.3 [0.05] orifice	No orifice
Neutral to full flow	2.7 s	0.9 s	0.8 s
Full flow to neutral	2.3 s	1.1 s	0.5 s

Control Options

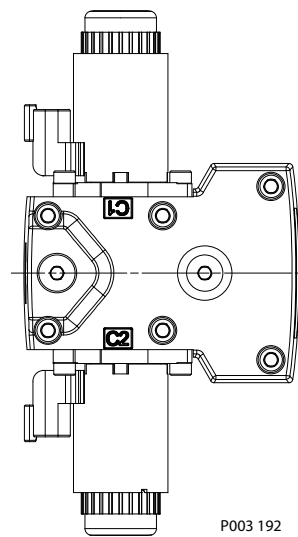
Non feedback proportional electric control (NFPE)

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.

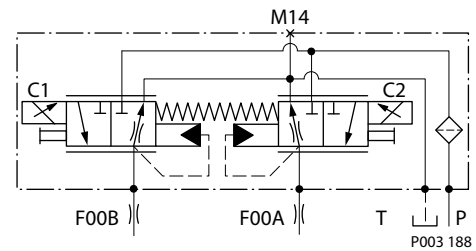
A serviceable 170 μm screen is located in the supply line immediately before the control porting spool.

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

NFPE control



NFPE schematic

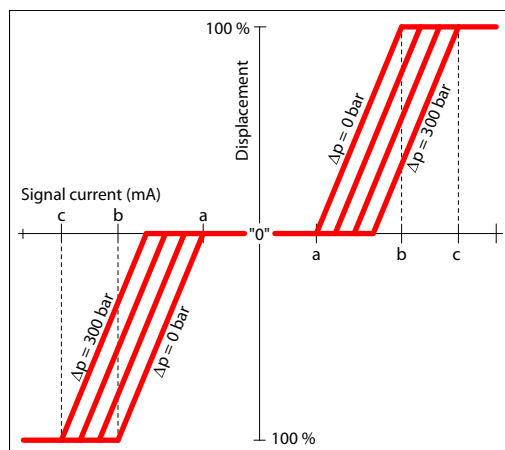


Control Signal Requirements, NFPE 060/068

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	1114 mA	1490 mA	any order
24 V _{DC}	347 mA	583 mA	745 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)	
	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 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:

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

Charge pressure = 20 bar [290 psi]

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

Speed = 1800 min⁻¹ (rpm)

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

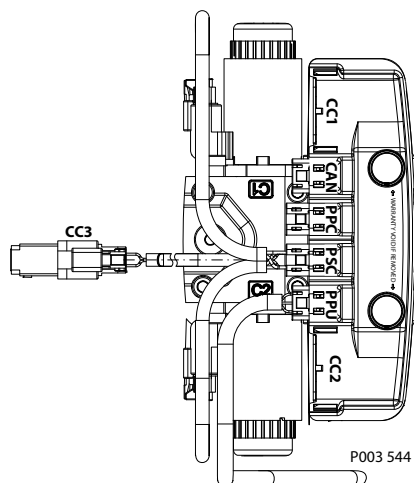
Response Time, NFPE 060/068

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	2.5 s	1.1 s	0.6 s
Full flow to neutral	1.9 s	0.6 s	0.3 s

Control Options

Automotive Control (AC)

The H1 **A**utomotive Control (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.

- **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, BC152986482596](#).

Control Options

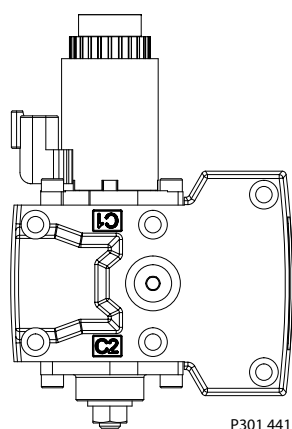
Fan Drive Control (FDC)

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.

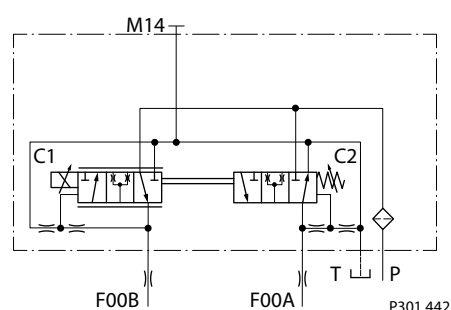
The control spool is spring biased to produce maximum forward pump displacement in the absence of an electrical input signal. Based on the spring bias spool default forward flow for a CW rotation pump is out of port B while default forward flow for a CCW rotation pump is out of port A.

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!

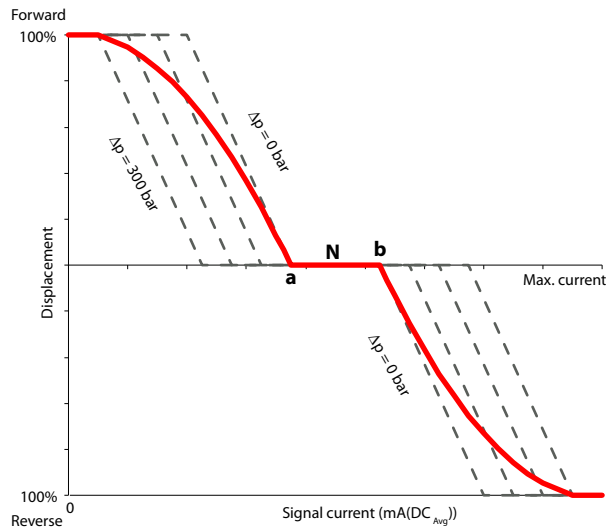
Due to the fail-safe functionality of the FDC control the pump will stroke to max. displacement in case the input signal to the pump control and the Diesel engine will be switched off at the same time. In this situation a low loop event can occur which may damage the pump. Therefore, it's strictly recommended 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, FDC 060/068

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.

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:

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

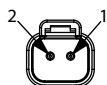
Charge pressure = 20 bar [290 psi]

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

Speed = 1800 min⁻¹ (rpm)

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

Response Time, FDC 060/068

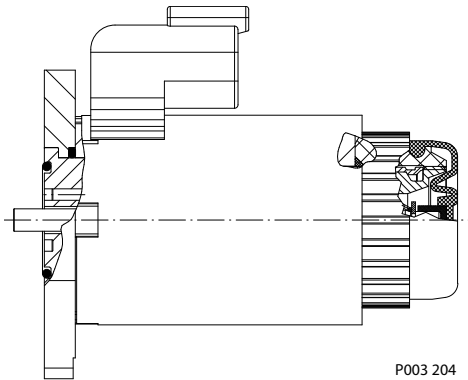
Stroking direction	0.8 mm [0.03 in] orifice
Full flow to neutral	2.6 s
Full forward flow to full reverse flow	3.7 s

Control Options

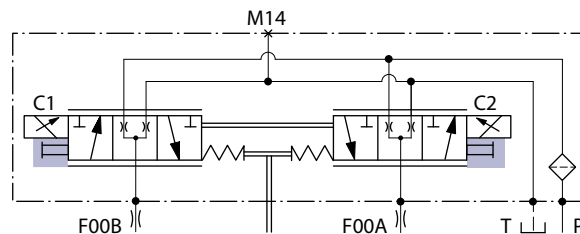
Manual Override (MOR)

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

Control Options

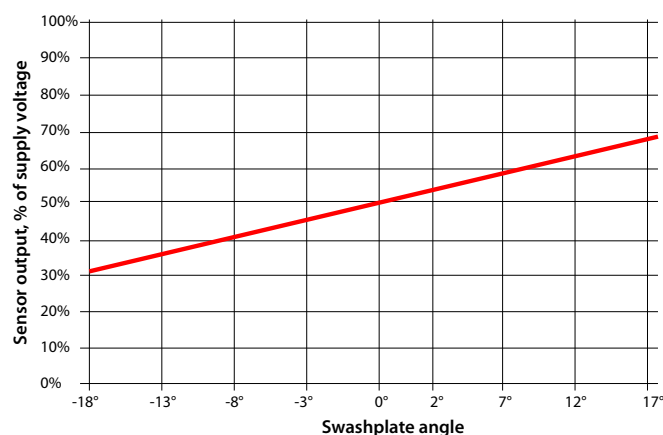
Swashplate angle sensor for EDC controls

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

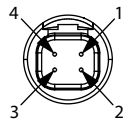
Control Options

Calibration of the sensor output within the software is mandatory. Vehicle neutral thresholds in the software ($\pm 0.5^\circ$) 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.

H1P Swash Plate Angle Sensor Connector

Connector DEUTSCH, 4-pin

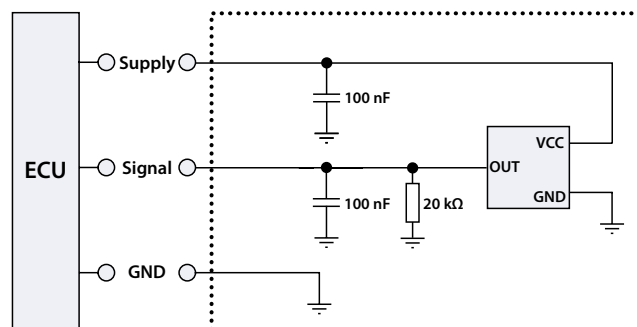


- 1** Ground (GND)
- 2** Not connected
- 3** Output signal 1 (SIG 1)
- 4** Supply (V+)

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

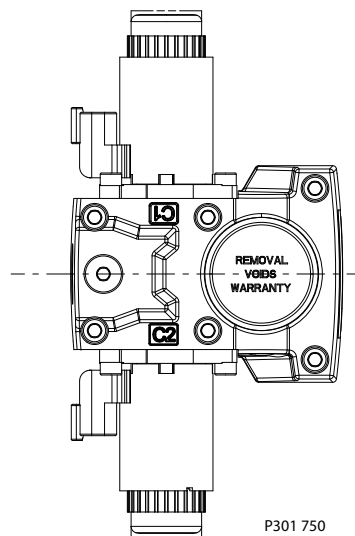


Control Options

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.

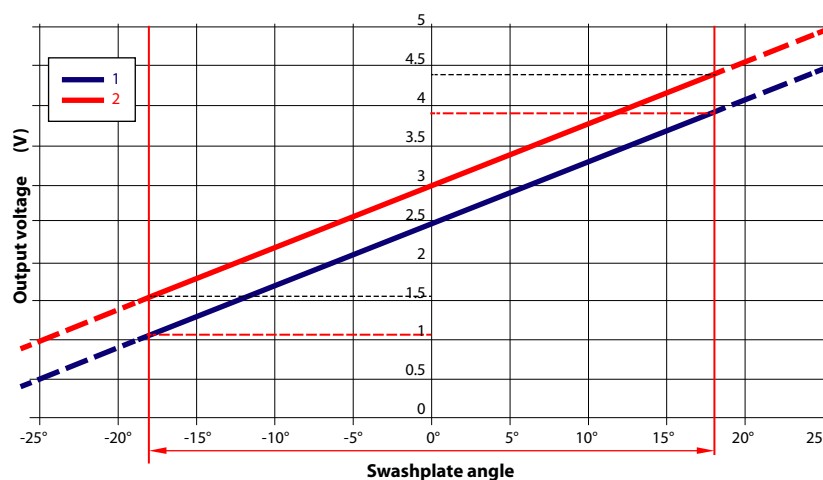
The output signal give a linear output voltage for the various magnet positions in the sensing range.



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:

$$V = \frac{\tan \alpha \cdot V}{\tan 18^\circ} \text{ (cm}^3\text{)}$$

The corresponding flow is:

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

Control Options

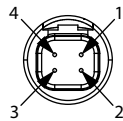
Swash Plate Angle Sensor Parameters (NFPE/AC)

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)

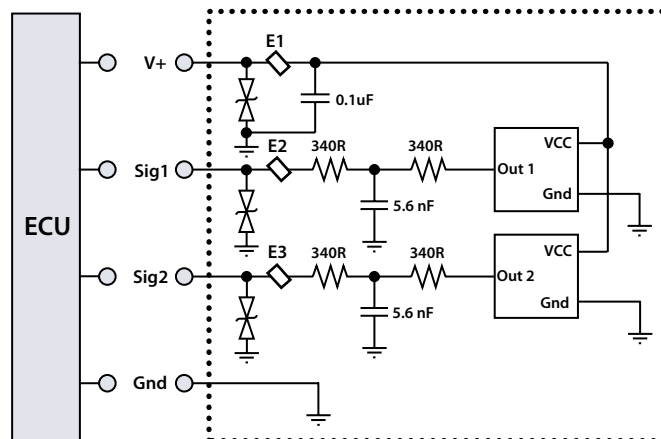
H1P Swash Plate Angle Sensor Connector (NFPE)



- 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.

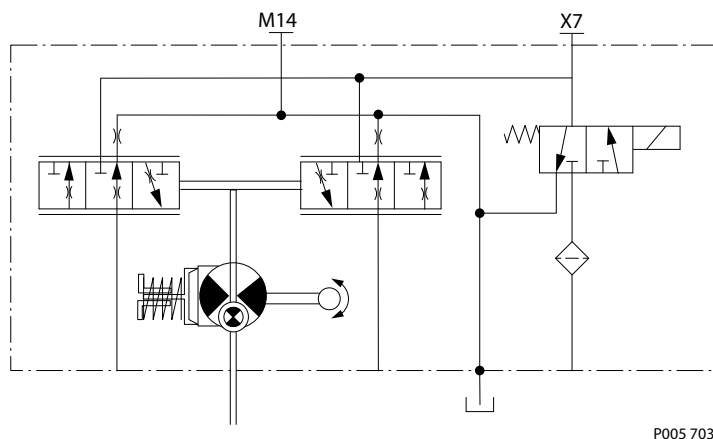
When the solenoid is energized, charge flow and pressure is allowed to reach the pump control. The X7 logic port will also be connected to charge pressure and flow.

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.

CCO Connector (MDC)

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

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	

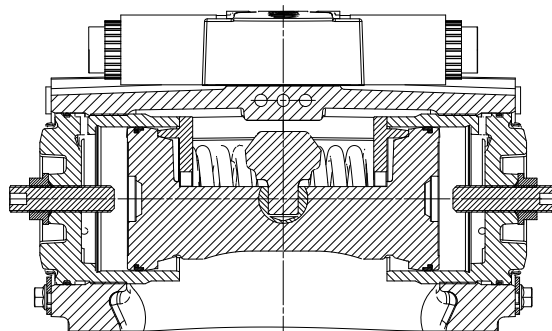
CCO solenoids are design for battery voltage application within the voltage range in the table above, in consideration of a wide range of environmental temperature common for known hydraulic applications. Closed loop PWM current supply can be also applied and is helpful in case that the voltage range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

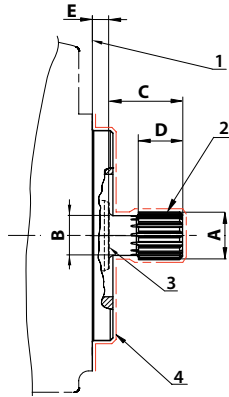
H1P 060/068 Displacement Change (approximately)

Parameter	Size 060	Size 068
1 turn of displacement limiter screw	5.9 cm ³ [0.36 in ³]	6.6 cm ³ [0.40 in ³]
Internal wrench size	4 mm	
External wrench size	13 mm	
Torque for external hex seal lock nut	23 N•m [204 lbf•in]	

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

Dimensions and Data

H1P 060/068 Input Shaft Option G1 (SAE C, 14 teeth)



1. Surface of mounting flange 127 – 4 per ISO 3019-1 (SAE C); to be paint free
2. **Spline Data:** 14 teeth, Pressure angle: 30°, Pitch: 12/24, $\varnothing 29.633$ [1.167]; Fillet root side fit per ANSI B92.1-1996, Class 6
3. Coupling must not protrude beyond this point
4. Shaft to be paint free

Dimensions

A	B	C	D ¹⁾	E
$\varnothing 31.58 \pm 0.09$ [1.243 ±0.004]	$\varnothing 25.72 \pm 0.12$ [1.024 ±0.005]	48.0 ± 0.68 [1.89 ±0.003]	28.8 ± 1.0 [1.134 ±0.039]	8.0 ± 0.8 [0.315 ±0.03]

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

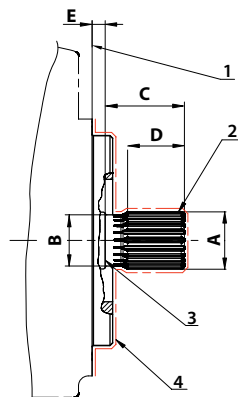
Torque rating

Rated torque	Maximum torque
534 N·m [4720 lb·in]	592 N·m [5240 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 060/068 Input Shaft Option F1 (SAE C, 21 teeth)



1. Surface of mounting flange 127 – 4 per ISO 3019-1 (SAE C); to be paint free
2. **Spline Data:** 21 teeth, Pressure angle: 30°, Pitch: 16/32, $\text{Ø}33.338$ [1.313]; Fillet root side fit per ANSI B92.1-1996, Class 6
3. Coupling must not protrude beyond this point
4. Shaft to be paint free

Dimensions

A	B	C	D ¹⁾	E
$\text{Ø}34.42 \pm 0.09$ [1.335 ± 0.004]	$\text{Ø}31.0 \pm 0.12$ [1.22 ± 0.005]	48.0 ± 0.5 [1.89 ± 0.02]	34.5 ± 0.15 [1.433 ± 0.01]	8.0 ± 0.8 [0.315 ± 0.03]

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

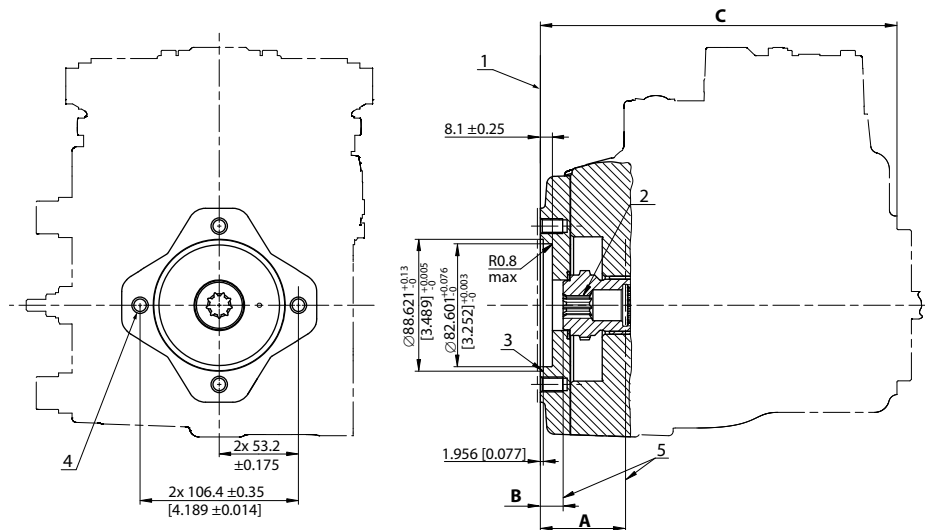
Torque rating

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 Auxiliary Mounting, Option H1 (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 [0.688]; Fillet root side fit per ANSI B92.1b, Class 7e
3. O-ring seal required; Ref. Ø82.22 ID x 2.62, cross section
4. Thread: M10x1.5-6H; 15 [0.59] min. depth (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Dimensions and torque

A	B	C	Max. Torque
68.4 [2.693] min.; Shaft clearance	19.4 [0.764] min.; Shaft clearance	258.5 ± 2.5 [10.177 ± 0.003]	296 N•m [2620 lbf•in]

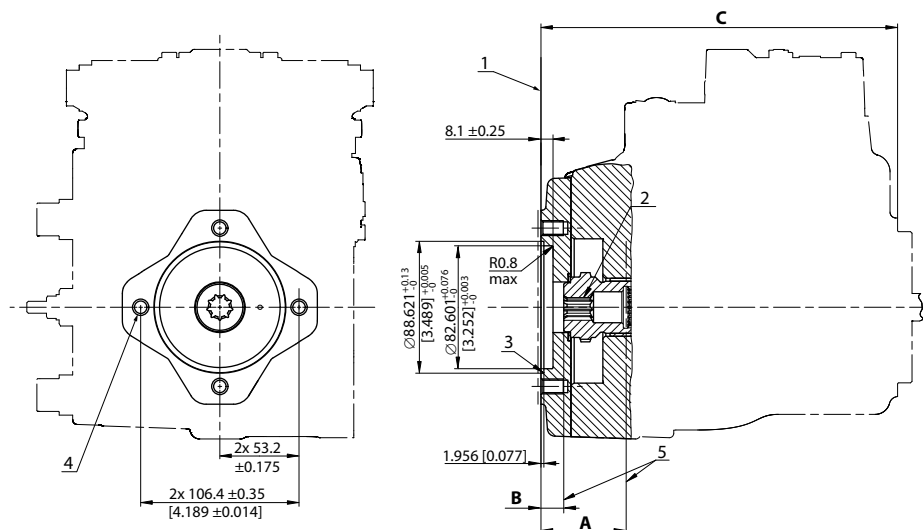
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information, BC152886483968*, the section "Shaft Torque Ratings and Spline Lubrication".

! 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 (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, $\varnothing 14.288$ [0.563]; Fillet root side fit per ANSI B92.1b, Class 7e
3. O-ring seal required; Ref. $\varnothing 82.22$ ID x 2.62, cross section
4. Thread: M10x1.5-6H; 15 [0.59] min. depth (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Dimensions and torque

A	B	C	Max. Torque
68.4 [2.693] min.; Shaft clearance	19.4 [0.764] min.; Shaft clearance	258.5 ± 2.5 [10.177 ± 0.003]	162 N·m [1430 lbf·in]

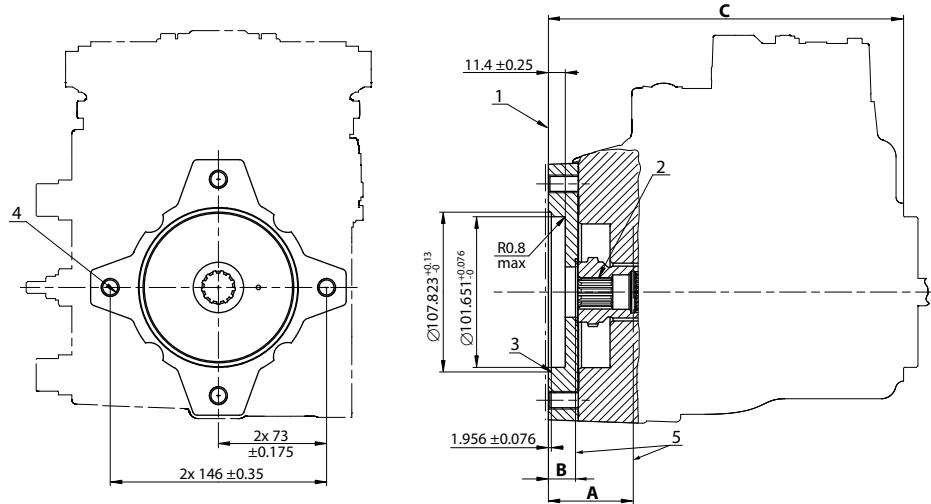
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information*, **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

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 (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
3. O-ring seal required; Ref. Ø94.92 ID x 2.62, cross section
4. Thread: M12x1.75-6H; 19.75 [0.778] min. depth (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Bolt length > 19.75 mm could result in a leak or damage to the unit.

Dimensions and torque

A	B	C	Max. Torque
68.4 [2.693] min.; Shaft clearance	19.4 [0.764] min.; Shaft clearance	258.5 ± 2.5 [10.177 ± 0.003]	395 N·m [3500 lbf·in]

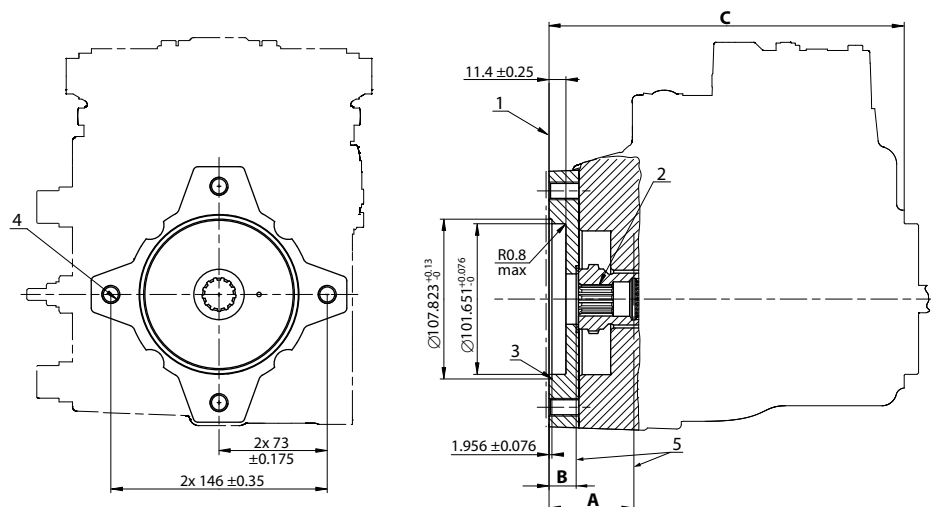
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information, BC152886483968*, the section "Shaft Torque Ratings and Spline Lubrication".

⚠ 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 (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 7e
3. O-ring seal required; Ref. Ø94.92 ID x 2.62, cross section
4. Thread: M12x1.75-6H; 19.75 [0.778] min. depth (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Bolt length > 19.75 mm could result in a leak or damage to the unit.

Dimensions and torque

A	B	C	Max. Torque
68.4 [2.693] min.; Shaft clearance	19.4 [0.764] min.; Shaft clearance	258.5 ± 2.5 [10.177 ± 0.003]	693 N·m [6130 lbf·in]

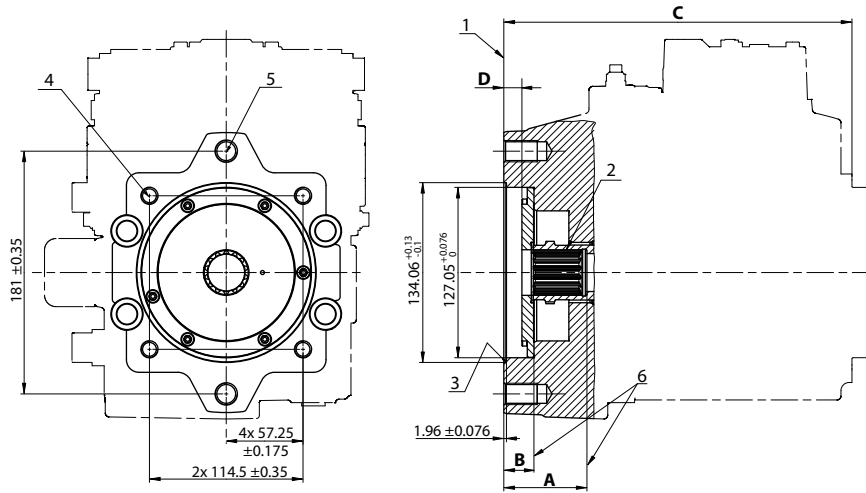
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information*, **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

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 (SAE C, 14 teeth)



1. Auxiliary mounting pad for mating flanges: 127-2, 127-4 per ISO 3019-1 (SAE C); Paint free
2. **Spline Data:** 14 teeth, Pressure angle: 30°, Pitch: 12/24, Ø29.6334 [0.813]; Fillet root side fit per ANSI B92.1-1996, Class 7
3. O-ring seal required; Ref. Ø120.32 ID x 2.62, cross section
4. Thread: M12x1.75-6H; 21 [0.827] min. depth (4x)
5. Thread: M16x2-6H; 25 [0.984] min. depth (2x)
6. Mating shaft and shaft shoulder must not protrude beyond this point

Bolt length > 19.75 mm could result in a leak or damage to the unit.

Dimensions and torque

A	B	C	D	Torque
61.25 [2.41] min.; Shaft clearance	21.75 [0.856] min.; Shaft clearance	259.6 ± 2.5 [10.22 ± 0.003]	13.5 ± 0.5 [0.532 ± 0.02]	816 N·m [7220 lbf·in]

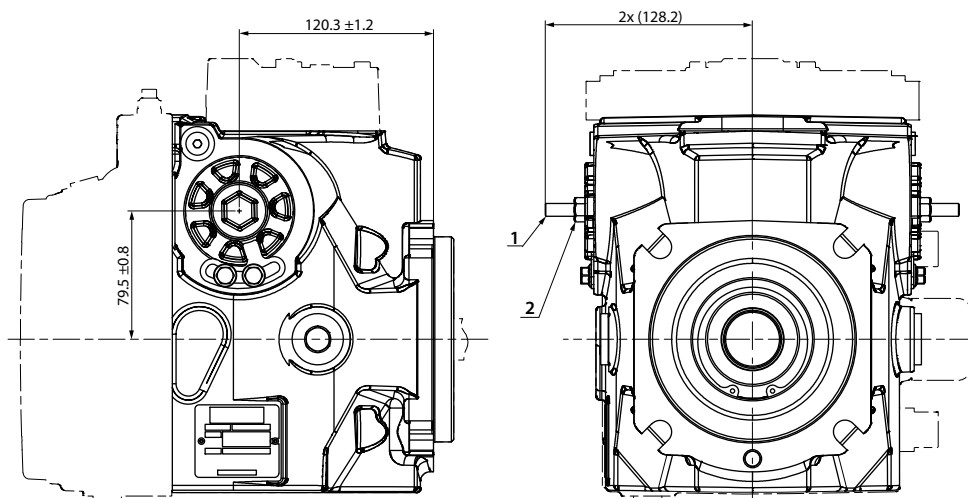
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information*, **BC152886483968**, the section “Shaft Torque Ratings and Spline Lubrication”.

! 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)

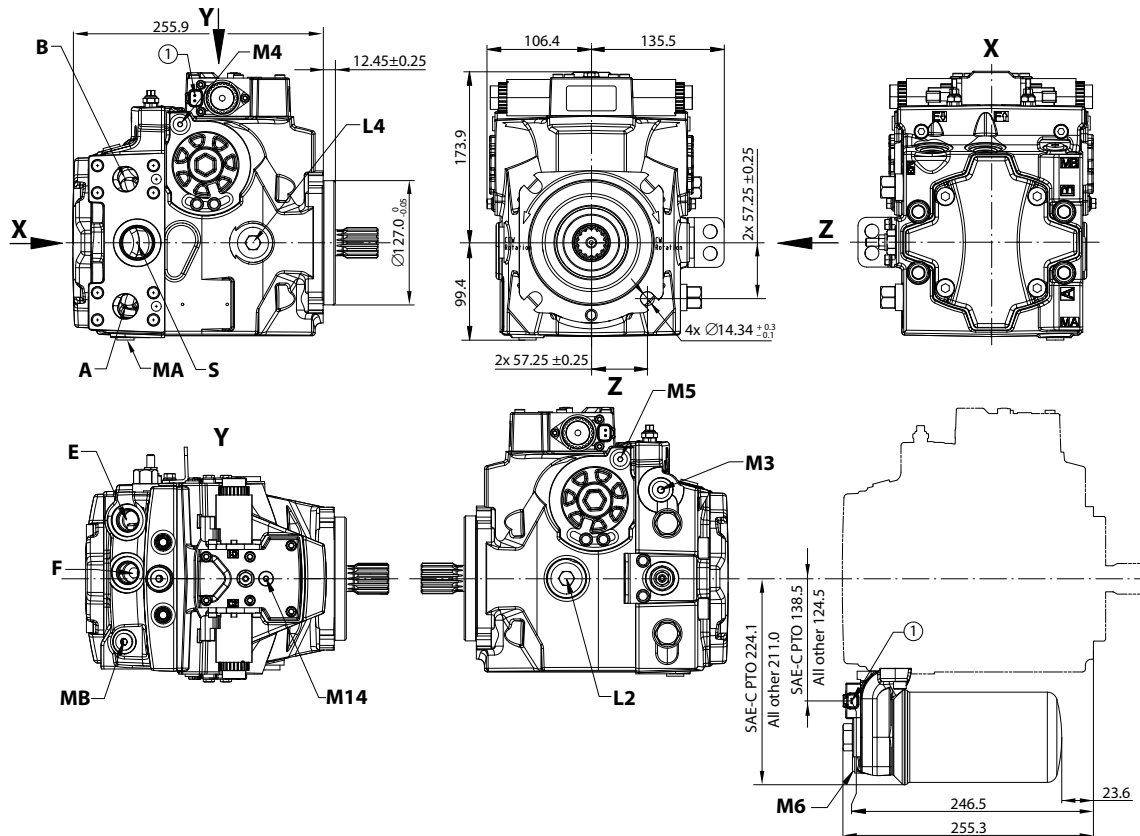
Wrench size, torque

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



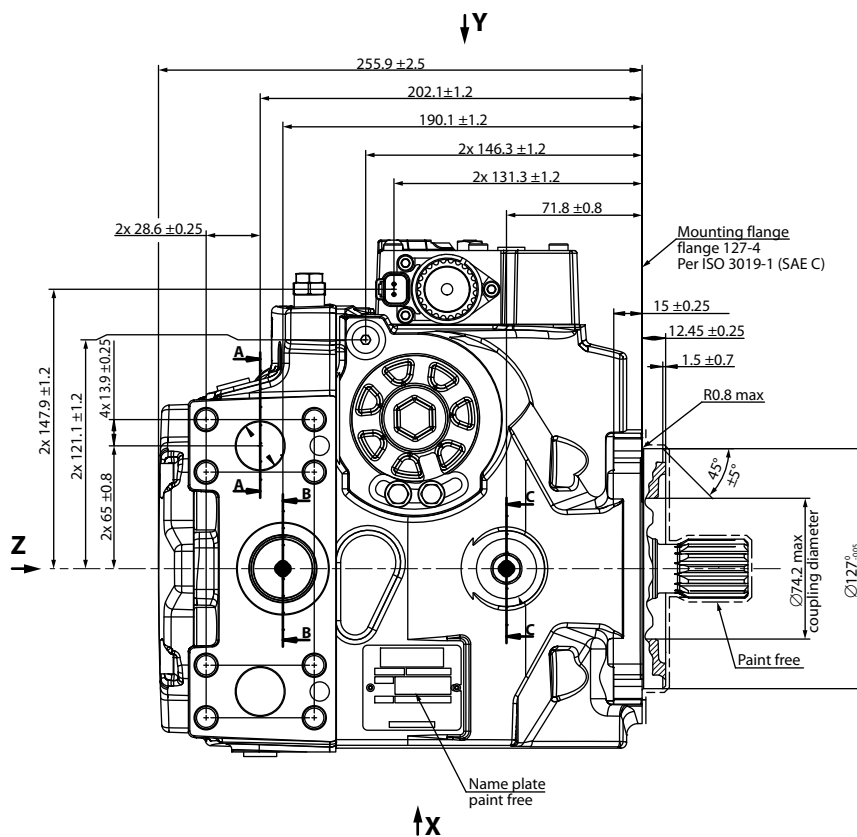
Ports per ISO 11 926-1

Port	Description	Size
A, B	System ports	Ø25.4–450 bar; Split flange boss per ISO 6162
L2, L4	Case drain ports	1 ¹ / ₁₆ –12
MA, MB	System A/B gauge ports	9 ¹ / ₁₆ –18
E/F	Charge filtration ports	7 ¹ / ₈ –14
M3	Charge pressure gauge port	9 ¹ / ₁₆ –18
M4, M5	Servo gauge port	7 ¹ / ₁₆ –20
M14	Case gauge port (EDC, FNR, NFPE)	7 ¹ / ₁₆ –20
S	Charge inlet port	1 ⁵ / ₁₆ –12
1	Connector DEUTSCH DT04-2P, to be paint free	

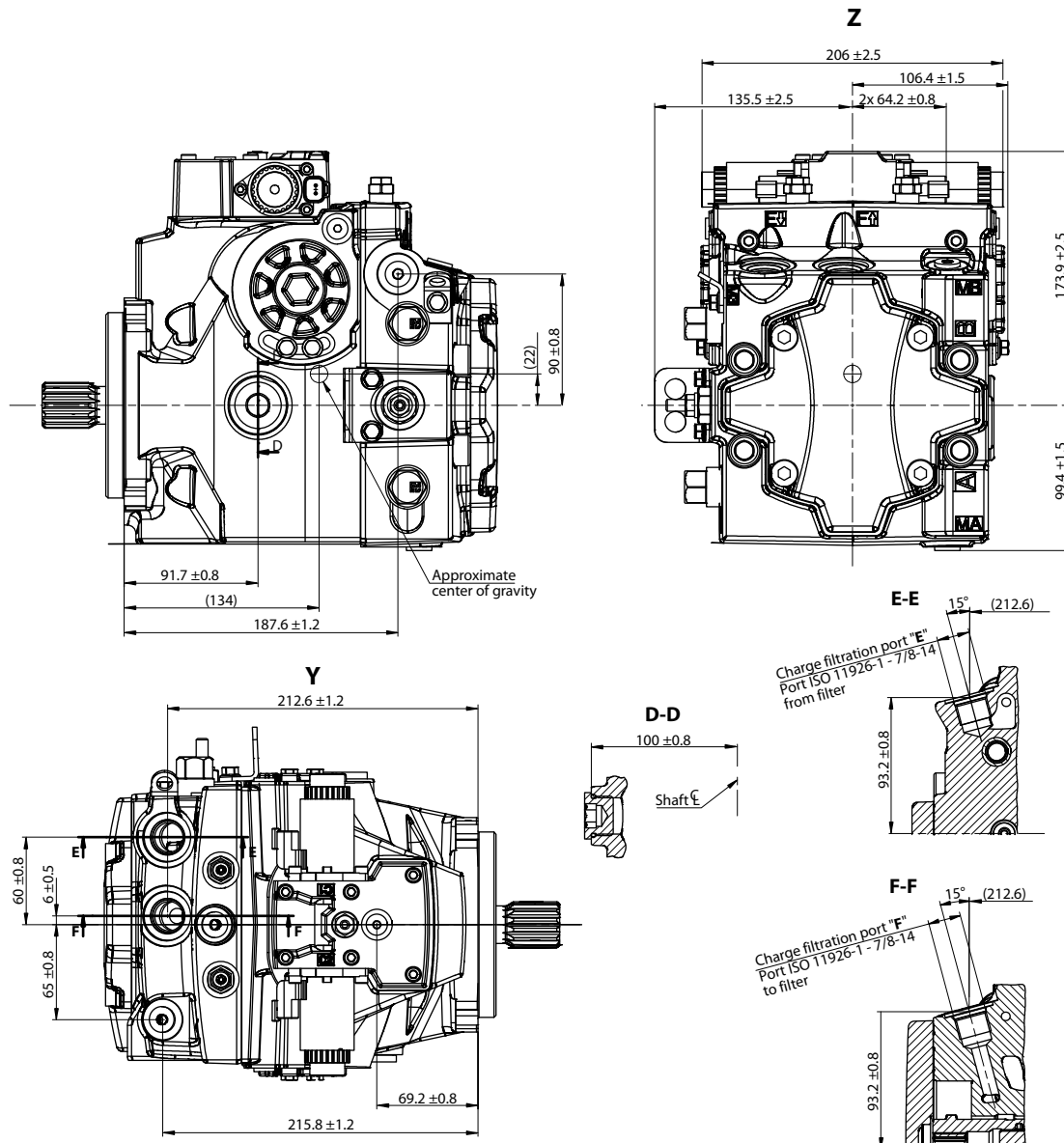
Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

H1P Dimensions

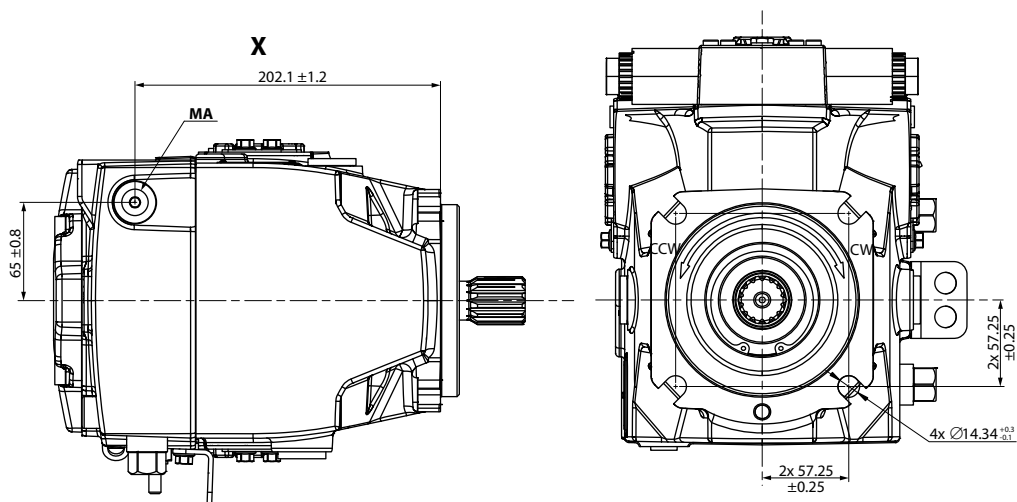


Dimensions and Data



1 — Approximate center of gravity

Dimensions and Data

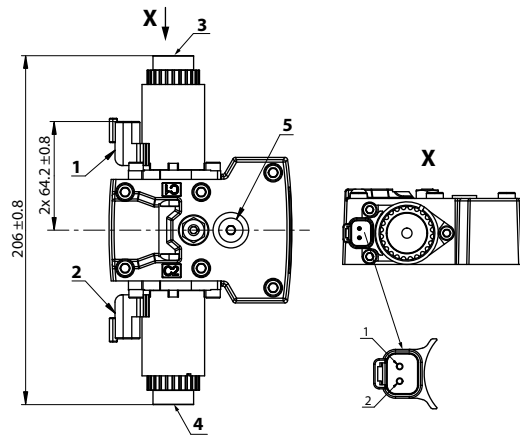


1 — Other side screw head space

Dimensions and Data

Controls

EDC Options A2 and A3 (12/24 V)



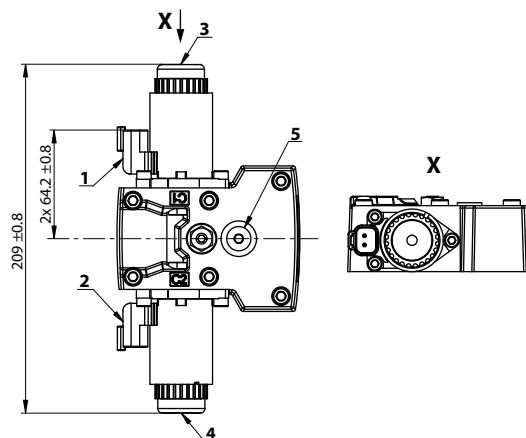
1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
3. Control Manual OverRide **C1**
4. Control Manual OverRide **C2**
5. Case gauge port **M14** per ISO 1926-1: $\frac{7}{16}$ -20

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: $\frac{7}{16}$ -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

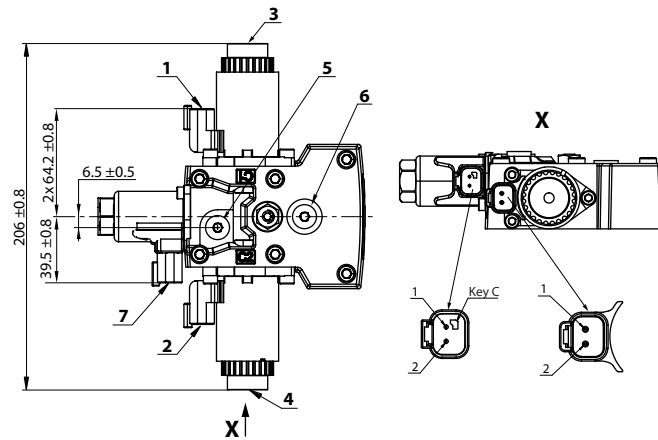


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

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



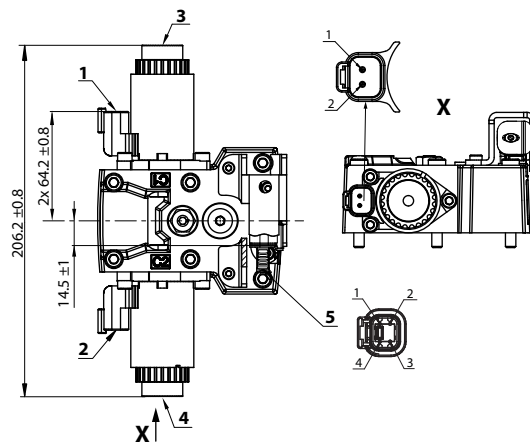
1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
3. Control Manual OverRide **C1**
4. Control Manual OverRide **C2**
5. Brake gauge port **X7** per ISO 1926-1: $\frac{7}{16}$ -20
6. Case gauge port **M14** per ISO 1926-1: $\frac{7}{16}$ -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.](#)

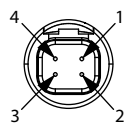
Dimensions and Data

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

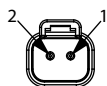
Connector DEUTSCH, 4-pin



4-pin assignment:

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

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

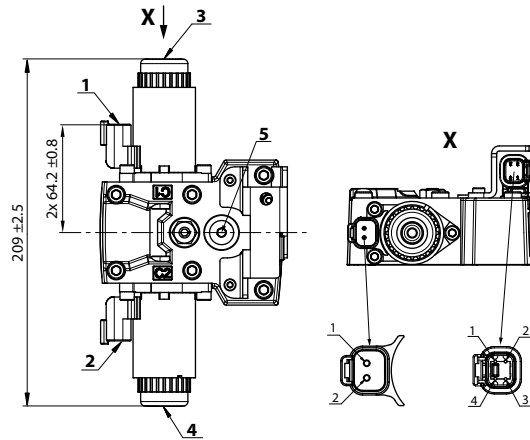


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

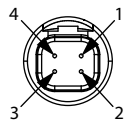
Dimensions and Data

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: $\frac{7}{16}$ -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

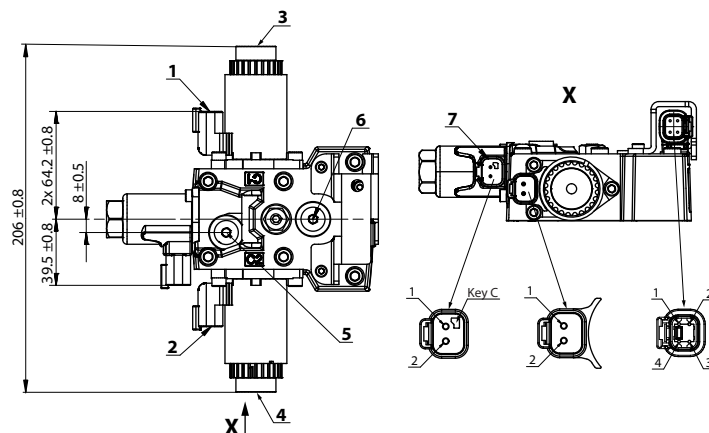


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

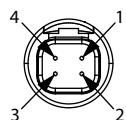
EDC with CCO and ASNSR, Options H8 and H9 (12/24 V)



- 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

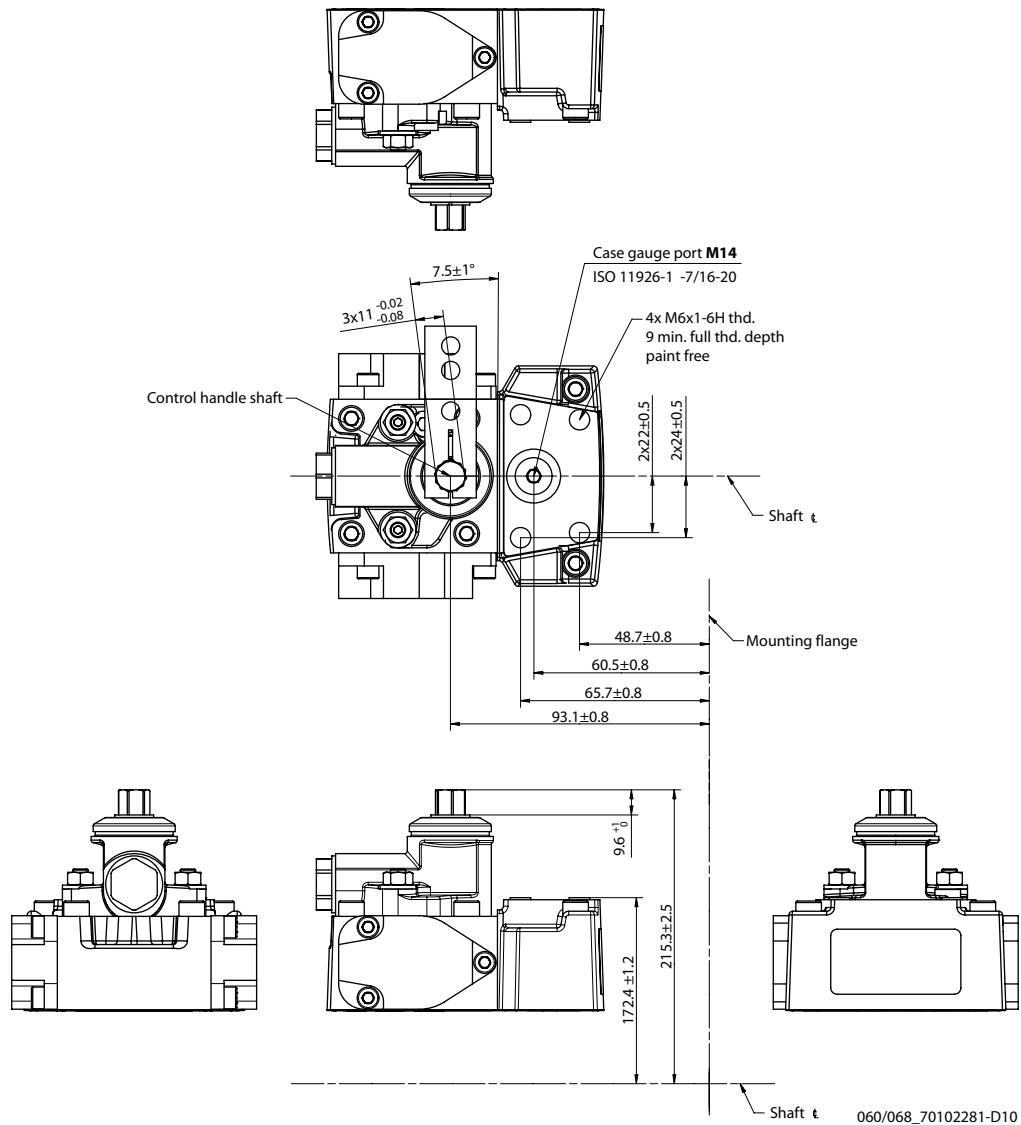


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

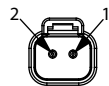
[Please contact Danfoss representative for specific installation drawings.](#)

Dimensions and Data

MDC Option: M1



Connector DEUTSCH, 2-pin

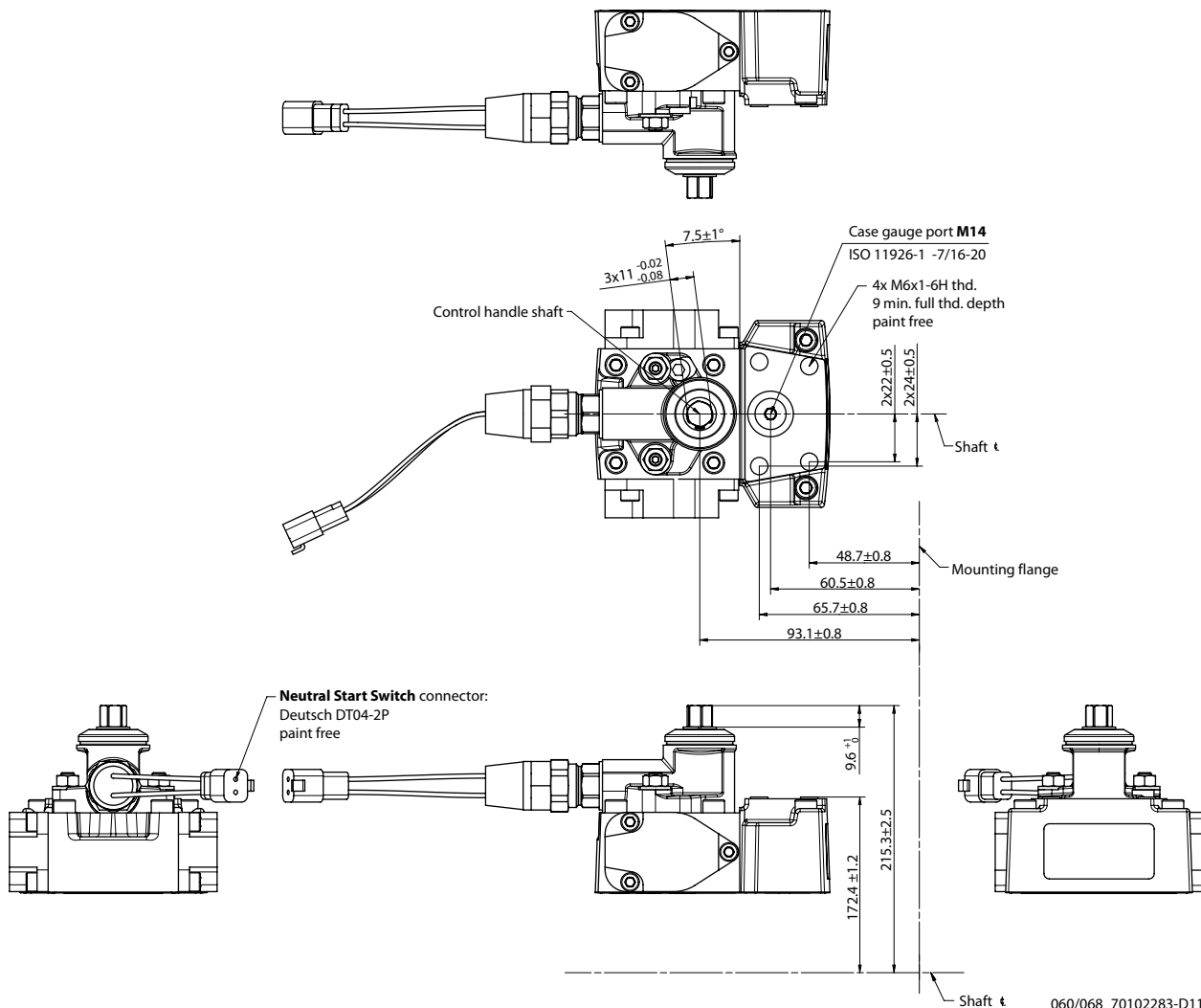


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

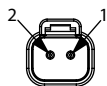
Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

MDC with Neutral Start Switch Option: M2



Connector DEUTSCH, 2-pin

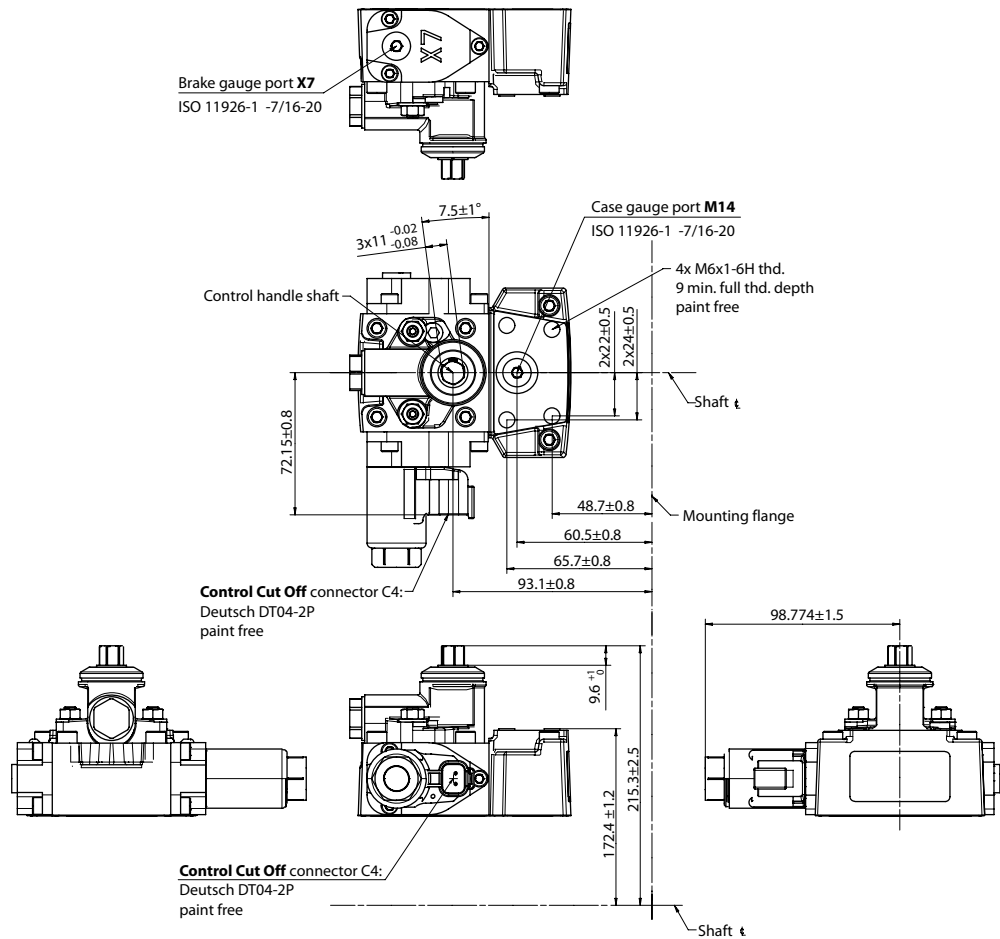


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

MDC with CCO, Options: M3, M4



060/068_70102283-D12

Connector DEUTSCH, 2-pin

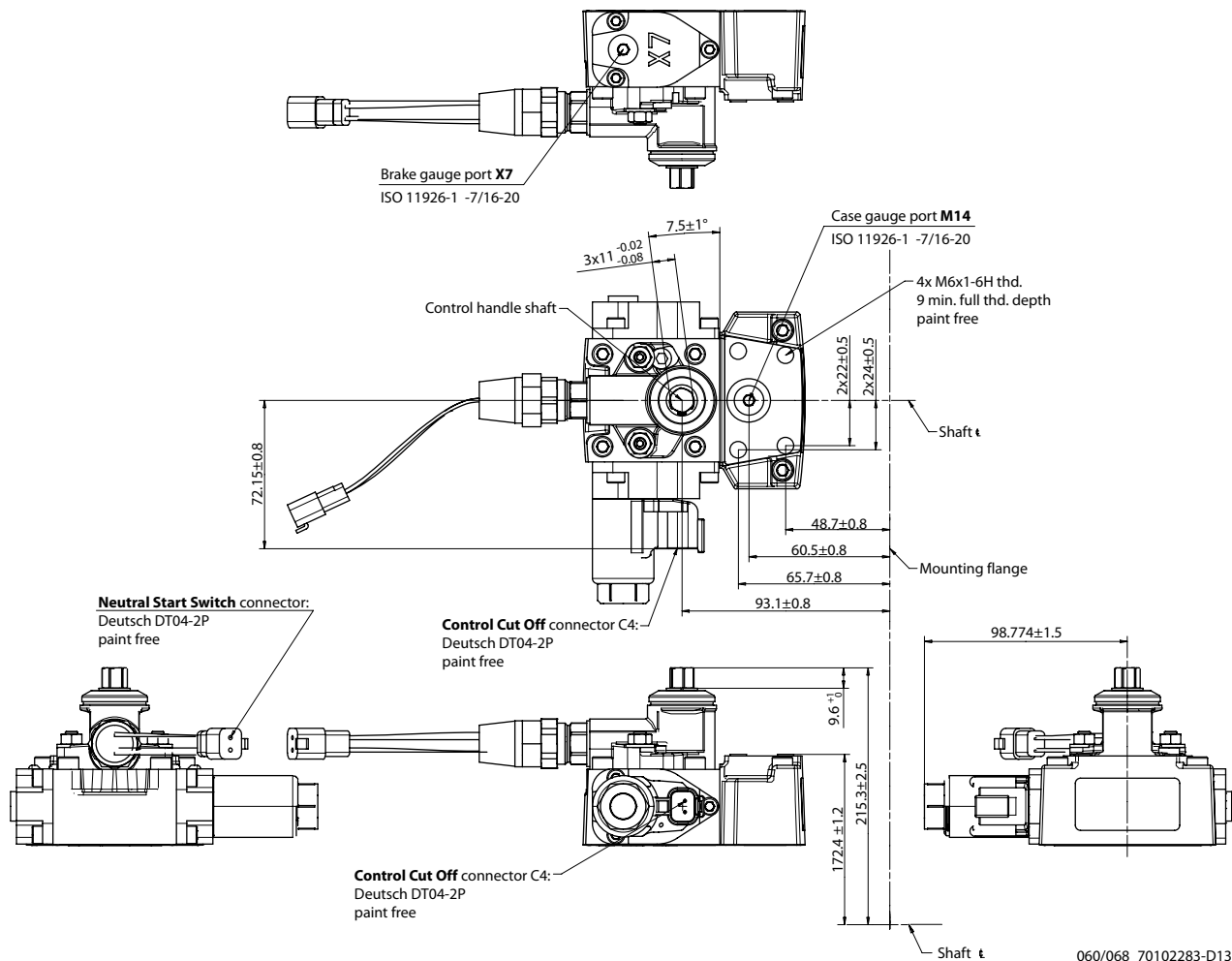


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

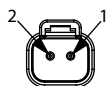
Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

MDC with NSS and CCO Options: M5, M6



Connector DEUTSCH, 2-pin



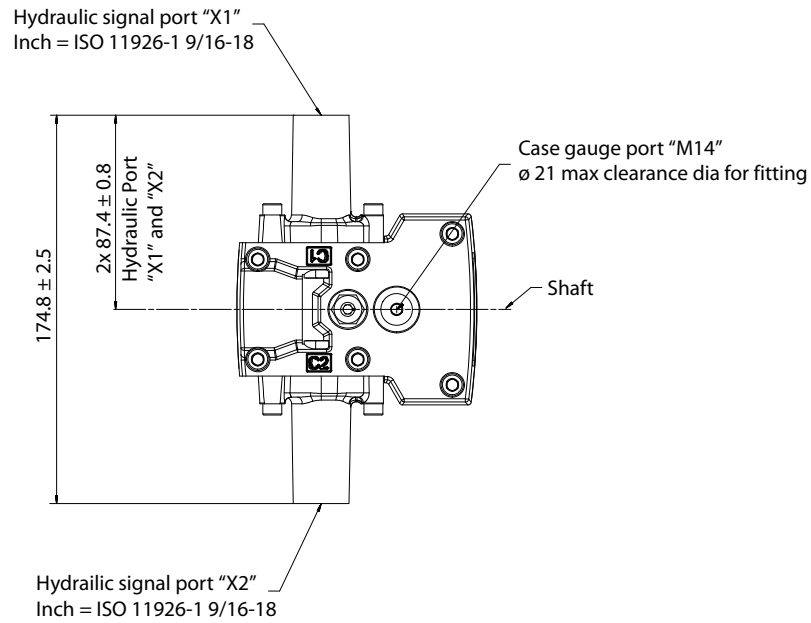
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

H1P HDC, Options: T1, T2

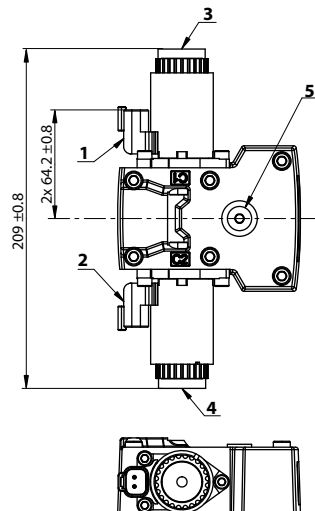
Dimensions in mm



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: $\frac{7}{16}$ -20
- Control solenoid connectors **C1/C2** DEUTSCH DTM04-2P pin/assignment



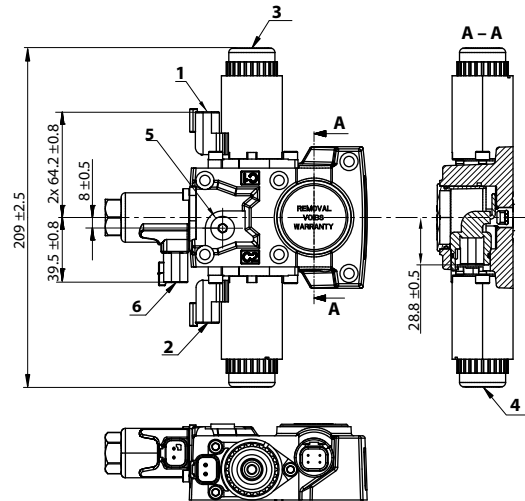
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

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

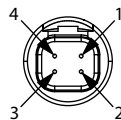
Non-Feedback Proportional Electric control with Control-Cut-Off valve with key C, Manual Over Ride and Angle Sensor, options N3 (12 V) and N4 (24 V).



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: $\frac{7}{16}$ -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.

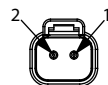
Connector DEUTSCH, 4-pin



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



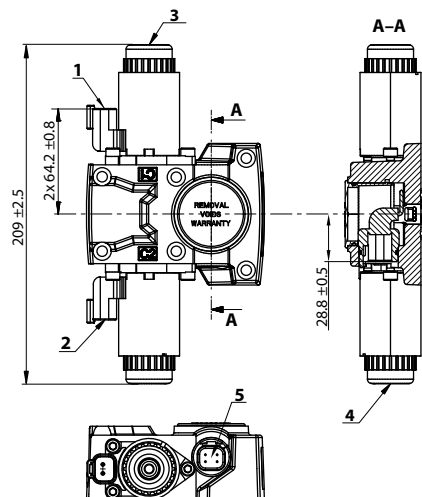
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

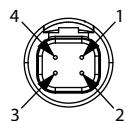
NFPE with MOR and ASNSR, Options: N5, N6 (12/24 V)

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

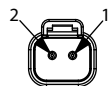
Connector DEUTSCH, 4-pin



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



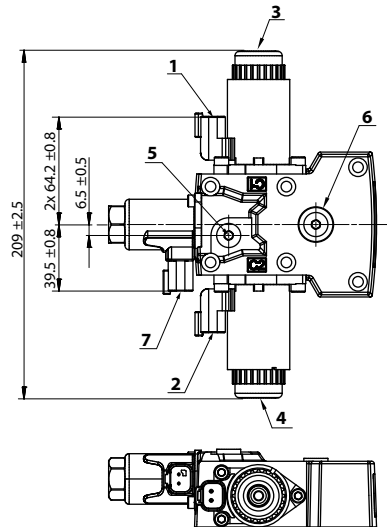
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

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

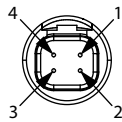
Non Feedback Proportional Electric control with Manual Over Ride and Control-Cut-Off valve key C, options N7 (12 V) and N8 (24 V).



- 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.

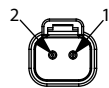
Connector DEUTSCH, 4-pin



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

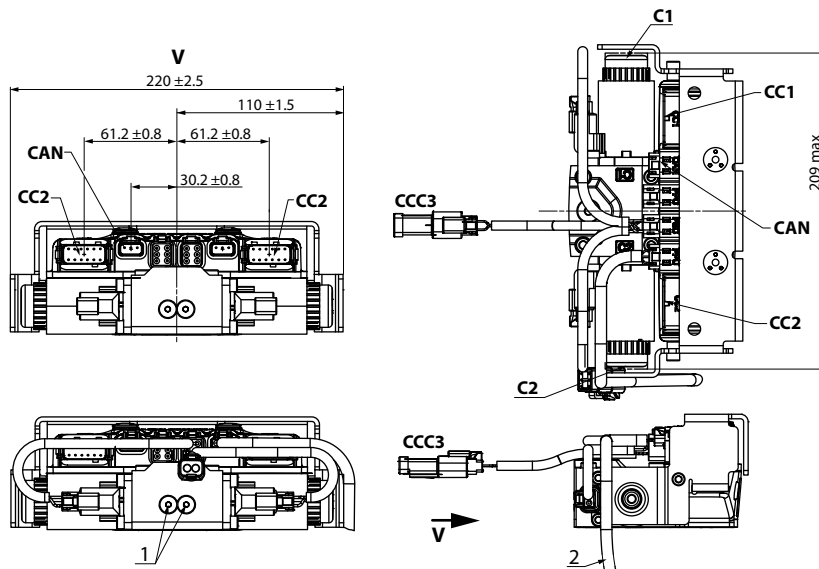


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

Automotive control (AC)



- 1 Plug removing can cause contamination issues
- 2 PPU wire harness is factory installed to speed sensor

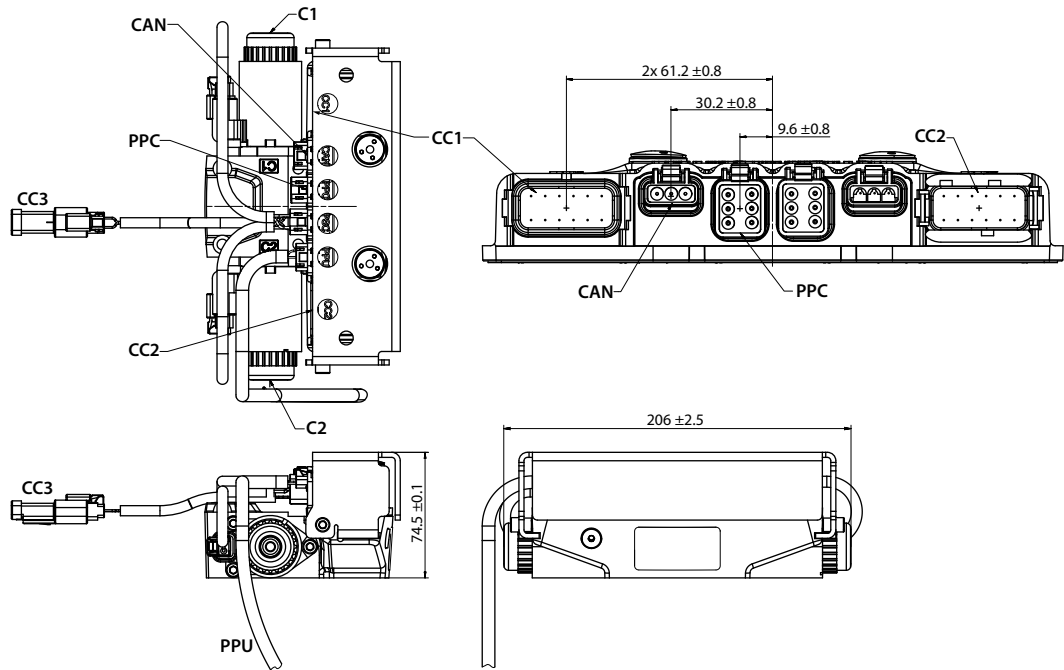
Connectors description

Port	Description
C1 and C2	1. Control manual override C1 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

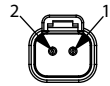
AC connectors dimensions



PPU wire harness is factory installed to speed sensor.

CC3

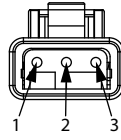
Connector DEUTSCH, 2-pin



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

CAN

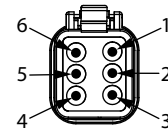
Connector DEUTSCH, 3-pin



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

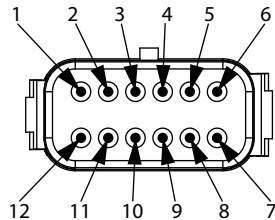
PPC

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)

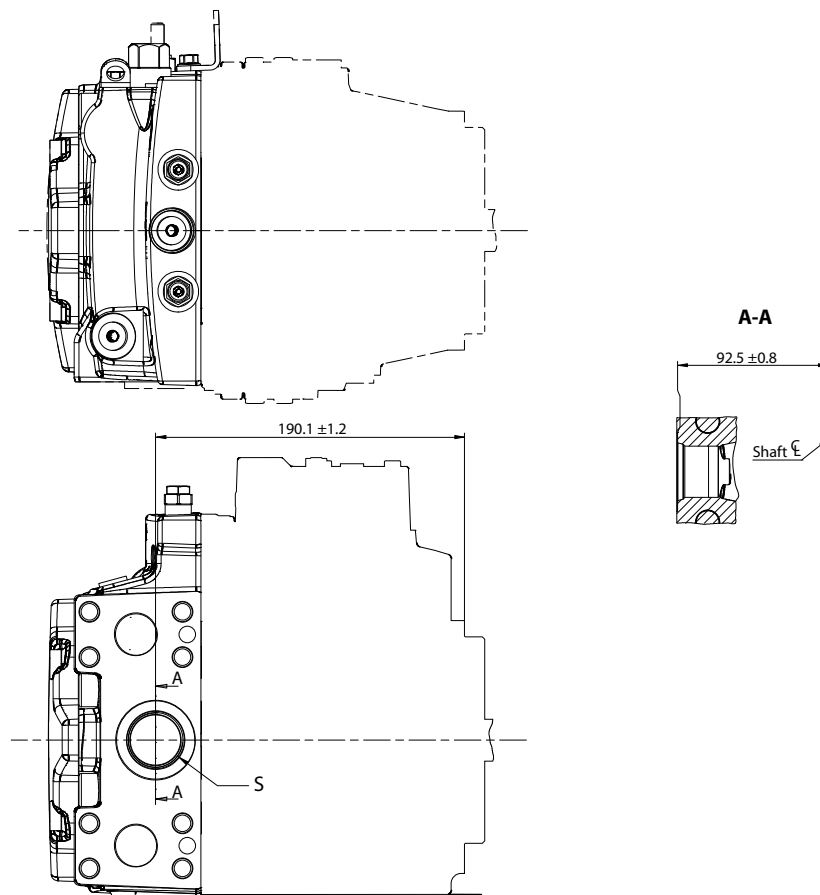
CC2

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 60/68 Suction Filtration Option L

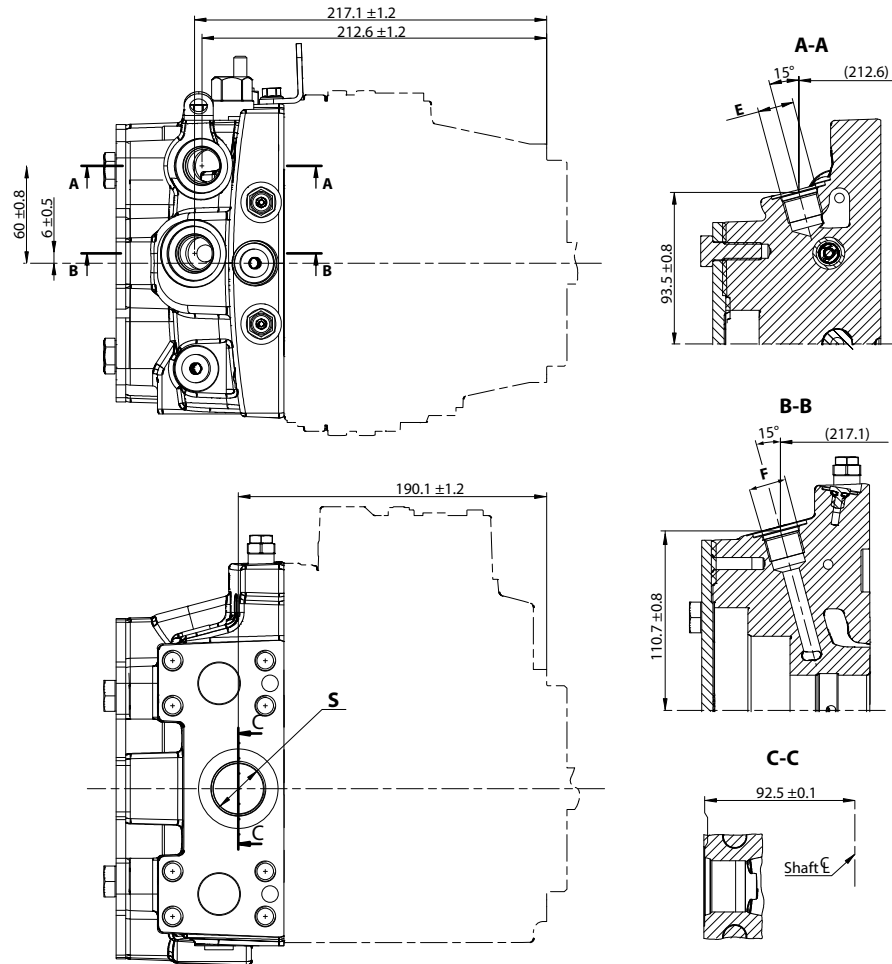


S Charge inlet port per ISO 11926-1; 1 5/16-12

Dimensions and Data

H1P 60/68 Remote Full Charge Pressure Filtration Option P

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

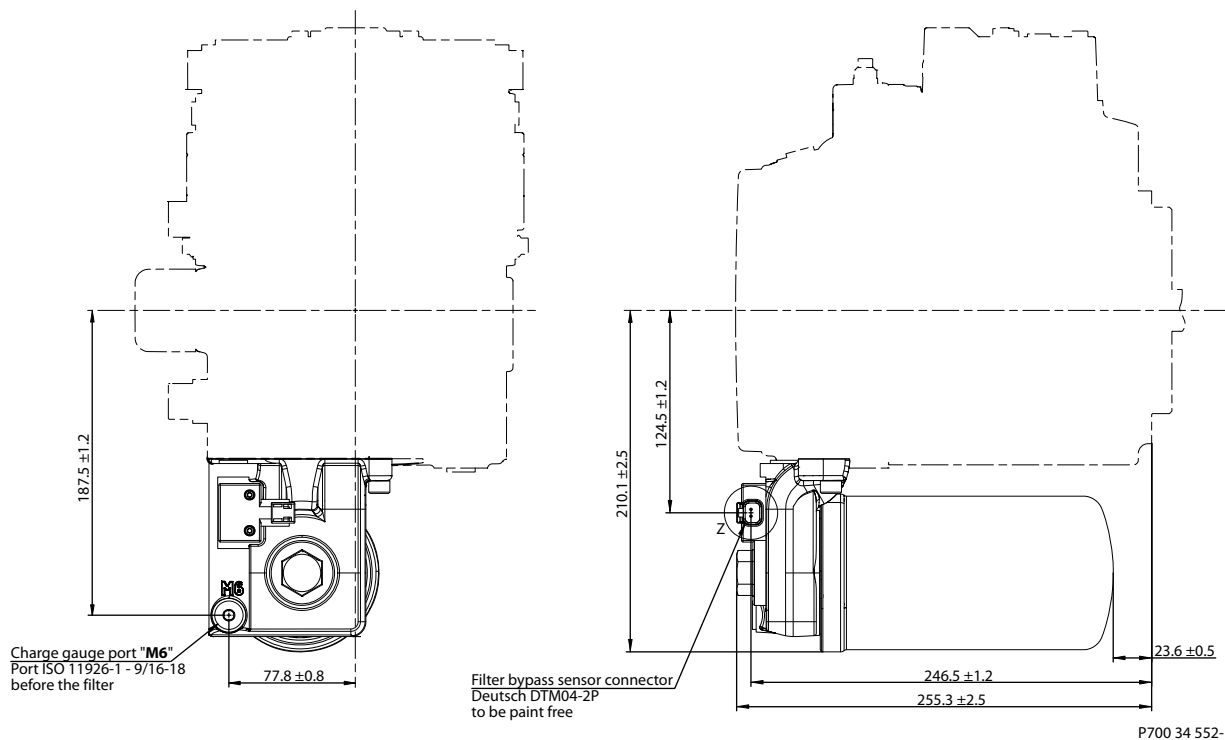


- E** Charge filtration port per ISO 11926-1; 7/8-14 from filter
- F** Charge filtration port per ISO 11926-1; 7/8-14 to filter
- S** Charge inlet port per ISO 11926-1; 1 5/16-12

Dimensions and Data

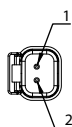
Internal Filtration Option M (End Cap Option: D3)

The Filtration option M for end cap option D3 – Internal full flow charge pressure filtration with filter bypass sensor.



Z (2:1)

FILTER BYPASS SENSOR CONNECTOR				
PIN	ASSIGNMENT	OR	PIN	ASSIGNMENT
1	SUPPLY			1
2	GROUND		2	SUPPLY

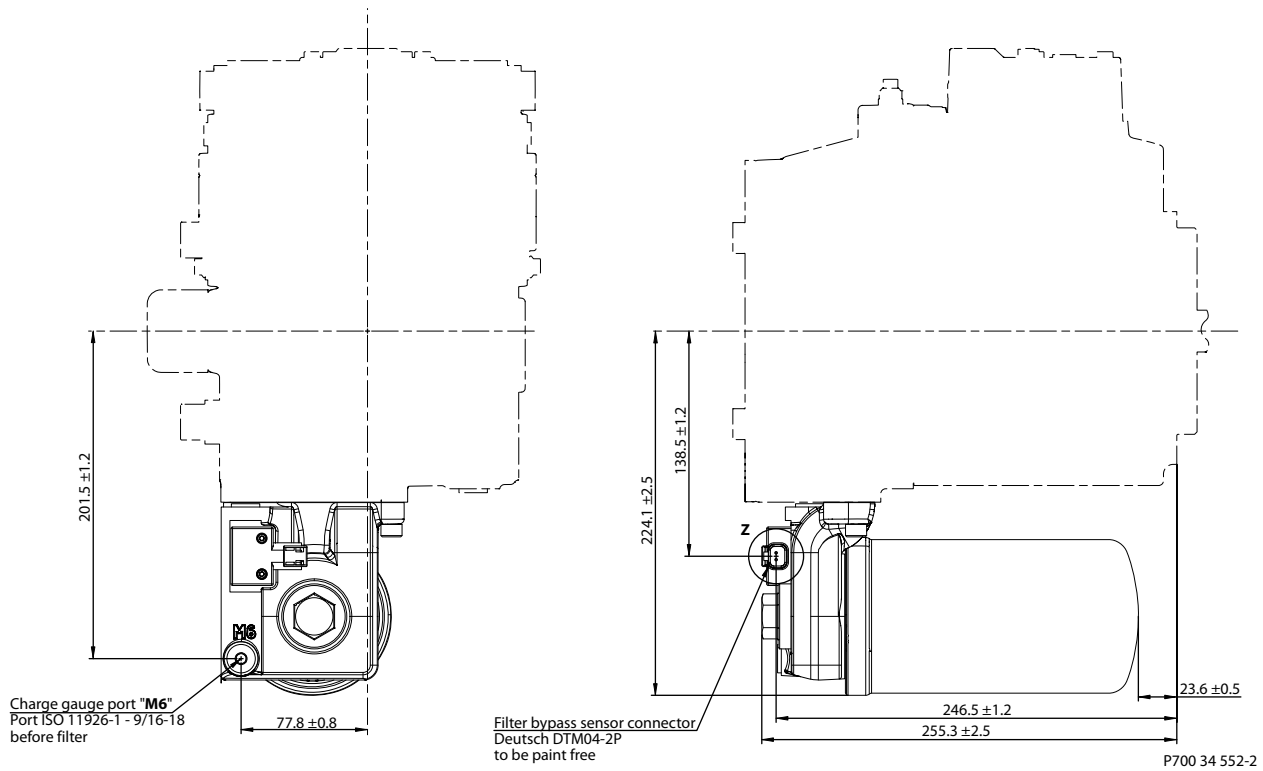


Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

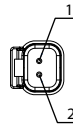
Internal Filtration Option M (End Cap Option: F4)

The Filtration option M for end cap option F4 – Internal full flow charge pressure filtration with filter bypass sensor.



Z (2:1)

FILTER BYPASS SENSOR CONNECTOR			
PIN	ASSIGNMENT	OR	ASSIGNMENT
1	SUPPLY		1 GROUND
2	GROUND		2 SUPPLY

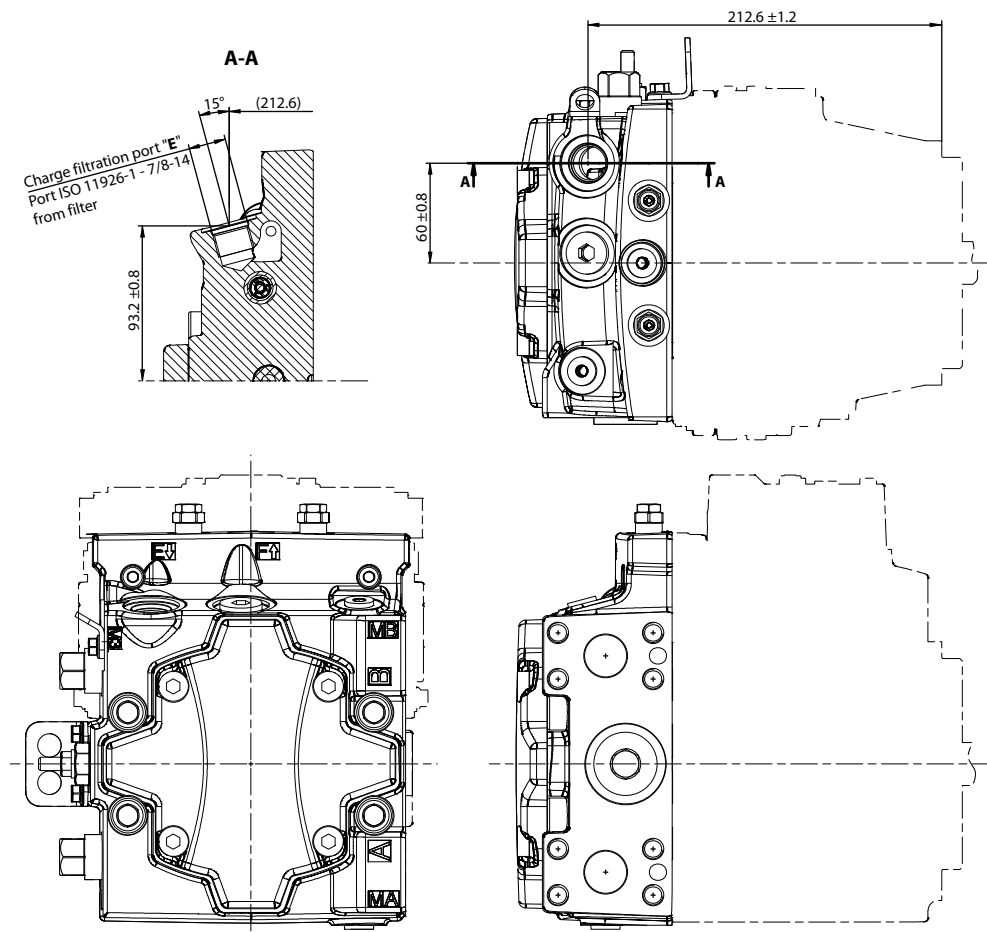


Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

External Filtration Option E (End Cap Option: D8)

The outlines of External full flow charge pressure filtration option E for end cap option D8.



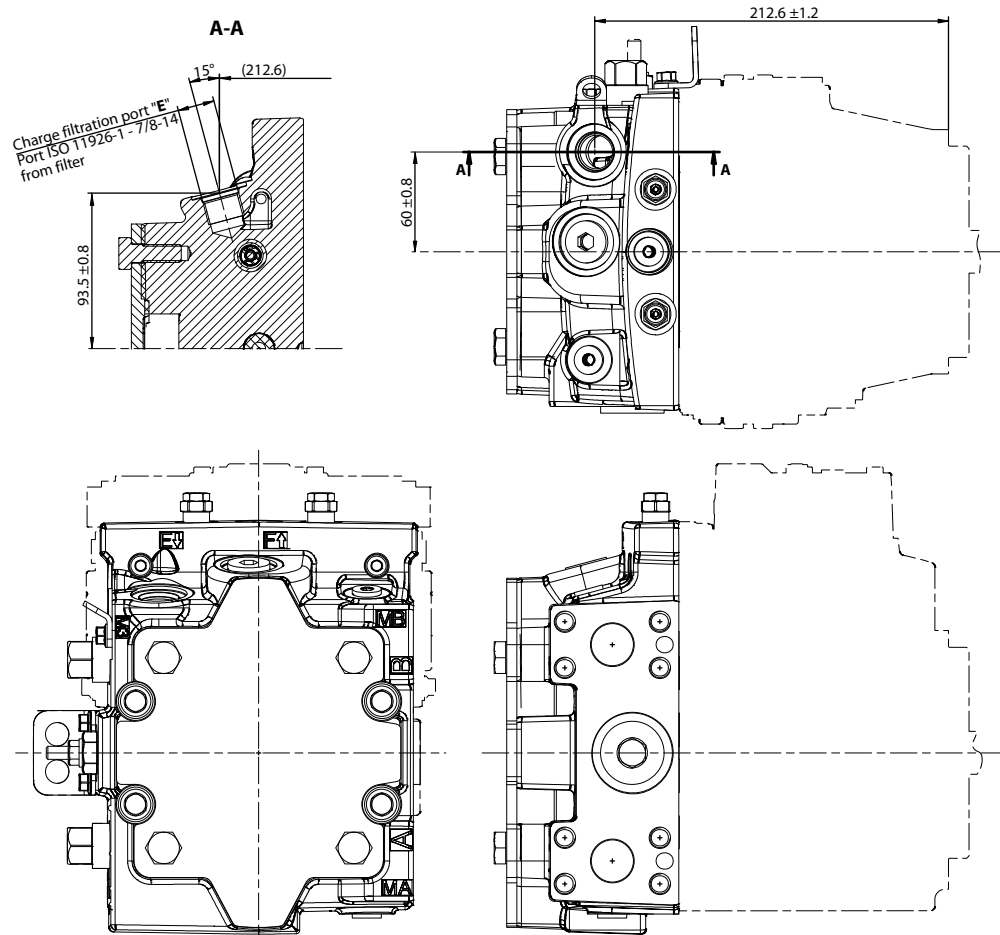
P700 45 736-1

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

External Filtration Option E (End Cap Option: F5)

The outlines of External full flow charge pressure filtration option E for end cap option F5 (SAE-C PTO).



P700 45 736-2

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- Electric converters
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- Gear pumps
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- PVG proportional valves
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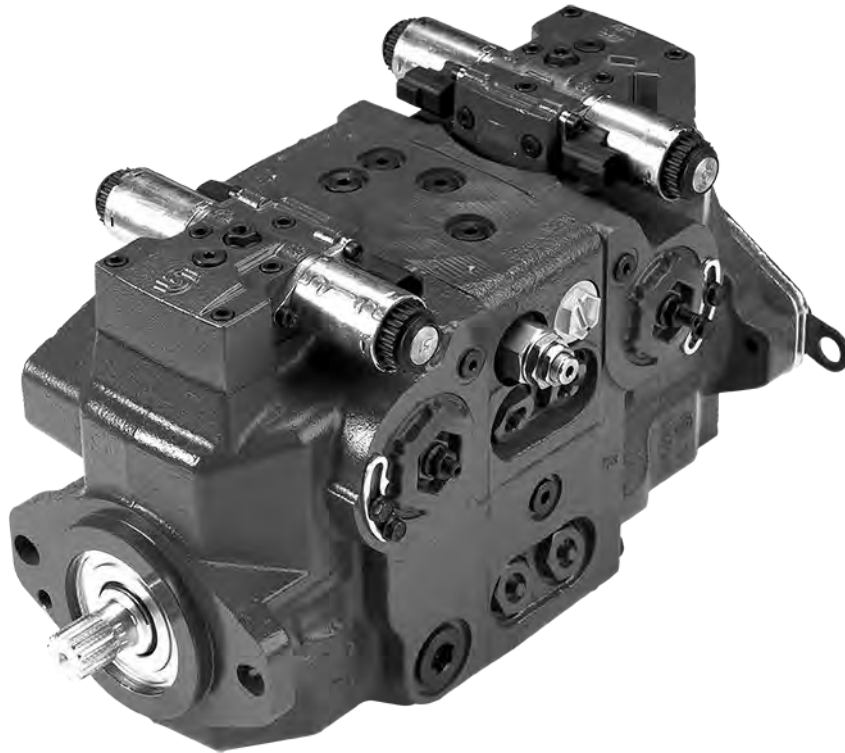
ENGINEERING
TOMORROW



Technical Information

H1T 045/053/060/068

Axial Piston Tandem Pumps



Revision history*Table of revisions*

Date	Changed	Rev
December 2021	Added HDC control	1001
April 2021	Corrected interface with ECU graphic	0905
June 2020	Added section title in ports chapter for clarity	0904
March 2020	Updated port information and changed document number from BC00000060	0903
July 2018	Major revision.	0801
June 2018	Angle sensor chapters added.	0701
September 2017	add G6 option	0603
June 2017	minor edit page 40	0602
April 2017	add 60-68	0601
November 2015	Master Model Code changes	0501
2010-2014	Various changes.	BA-EA
Jul 2009	First edition	AA

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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 H1P 045/053: SAE straight thread O-ring boss
- Main pressure ports H1P 060/068: 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.

Technical Data for H1 Tandem Pumps

Technical Data

Feature	Unit	045	053	060	068
Displacement	cm ³ [in ³]	45.0 [2.75]	53.8 [3.28]	60.4 [3.69]	68.0 [4.15]
Flow at rated (continuous) speed*	l/min [US gal/min]	153 [40]	183 [48]	210 [55.5]	238 [62.8]
Torque at maximum displacement (theoretical)	N·m/bar [lb·in/1000 psi]	0.8 [488]	0.9 [549]0.007 8 [0.00575]	0.96 [590]	1.08 [610]
Mass moment of inertia of rotating components	kg·m ² [slug·ft ²]	0.0077 [0.00568]	0.0078 [0.00575]	0.0143 [0.01055]	0.0143 [0.01052]
Mass (weight dry, without charge pump or auxiliary flange)	kg [lb]	65 [143]	65 [143]	96.2 [212]	96.2 [212]
Oil volume	l [US gal]	2.3 [0.61]	2.3 [0.61]	4.2 [1.1]	4.2 [1.1]

* Applies for each rotating group.

Physical properties

Description	045/053	060/068
Mounting flange per ISO 3019-1	Flange 101-2 (SAE B), special bolt	Flange 127-4 (SAE C)
Input shaft outer diameter, splines per ISO 3019-1	<ul style="list-style-type: none"> • Ø25 mm - 4 (SAE B-B, 15 teeth) • Ø32 mm - 4 (SAE-C, 14 teeth) • Ø31 mm - 4 (19 teeth) 	<ul style="list-style-type: none"> • Ø32 mm - 4 (SAE C, 14 teeth) • Ø35 mm - 4 (SAE C, 21 teeth)

Technical Specifications
Physical properties (continued)

Description	045/053	060/068
Auxiliary mounting flange with metric fasteners, shaft outer diameter and splines per ISO 3019-1	Flange 82-2 outer dia: • Ø16 mm - 4 (SAE A, 9 teeth) • Ø19 mm - 4 (SAE A, 11 teeth) Flange 101-2 outer dia: • Ø22 mm - 4 (SAE B, 13 teeth) • Ø25 mm - 4 (SAE B-B, 15 teeth)	Flange 101-2 outer dia: • Ø22 mm - 4 (SAE B, 13 teeth) • Ø25 mm - 4 (SAE B-B, 15 teeth)
Charge inlet port per ISO 11926-1	7/8 -14 (SAE O-ring boss)	1 1/16 -14 (SAE O-ring boss)
Main port configuration	ISO 11926-1: 1 5/16 -12 (SAE O-ring boss)	ISO 6162: M12 x 1.75 (Split flange)
Other ports	SAE O-ring boss	
Customer interface threads	Metric fasteners	

Operating parameters for H1 Tandem Pumps
Input Speed (at minimum charge/control pressure)

Description	Size 045/053	Size 060/068
Minimum for external charge supply ¹⁾	min ⁻¹ (rpm)	500 min ⁻¹ (rpm)
Rated	3400 min ⁻¹ (rpm)	3500 min ⁻¹ (rpm)
Maximum	3500 min ⁻¹ (rpm)	4000 min ⁻¹ (rpm)

¹⁾ Full performance (pressure and displacement) possible at minimum charge and control pressure supply.

System pressure

Description		Size 045	Size 053	Size 060	Size 068
System pressure	Max. working	420 bar [6092 psi]	380 bar [5511 psi]	420 bar [6090 psi]	380 bar [5510 psi]
	Maximum (peak)	450 bar [6527 psi]	400 bar [5802 psi]	450 bar [6525 psi]	400 bar [5800 psi]
	Max. low loop	45 bar [653 psi]		45 bar [650 psi]	
	Min. low loop	10 bar [145 psi]		10 bar [145 psi]	
Control pressure	Min. at corner power (EDC, MDC, FNR)	21.5 bar [312 psi]		18.5 bar [270 psi]	
	Maximum	40 bar [580 psi]		40 bar [580 psi]	

Other pressure type for all tandem pumps

Description	045-068	
Charge pressure	Minimum without CCO valve	14.5 bar [210 psi]
	Minimum with CCO valve	18 bar [265 psi]
	Maximum	34 bar [493 psi]
Case pressure	Rated	3.0 bar [44.0 psi]
	Maximum	5.0 bar [73.0 psi]
Lip seal external	Maximum	0.4 bar [5.8 psi]

Technical Specifications

Fluid Specification

Viscosity

Intermittent¹⁾	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 range²⁾	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.

External radial shaft loads H1 Tandem

External radial shaft loads

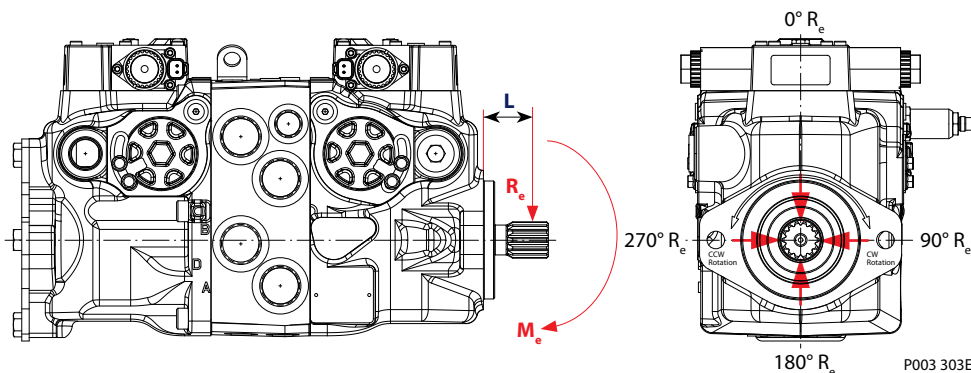
H1 pumps are designed with bearings that can accept some external radial loads. The external radial shaft load limits are a function of the load position and orientation, and the operating conditions of the unit. External radial shaft loads impact lifetime. For lifetime calculations please contact Danfoss representative.

The **maximum allowable radial load (R_e)** is based on the maximum external moment (M_e) and the distance (L) from the mounting flange to the load.

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

It may be determined using the following formula:

Radial load position (045/053 shown)



M_e = shaft moment

L = flange distance

R_e = external force to the shaft

Thrust loads should be avoided. Contact factory in the event thrust loads are anticipated.

Technical Specifications

Bearing Life

Maximum external shaft load based on shaft deflection

External radial moment	Unit	Size 045 / 053	Size 060 / 068
M_e	N·m [lbf·in]	104 [920]	104 [920]

All external shaft loads affect bearing life. In applications with external shaft loads, minimize the impact by positioning the load at 0° or 180° as shown in the figure.

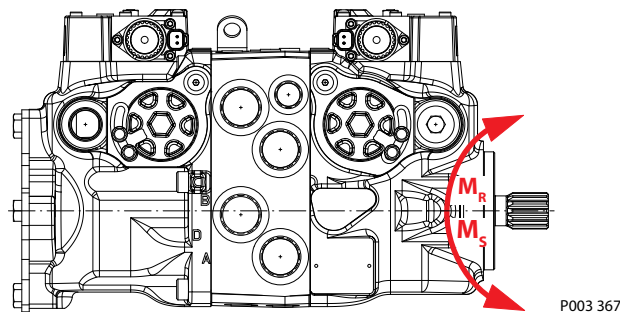
Danfoss recommends clamp-type couplings for applications with radial shaft loads.

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 swashplate is positioned on one side of center all or most of the time.

Mounting flange loads H1T 045/053

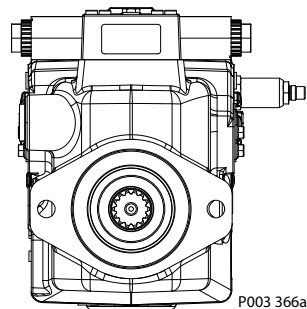
H1 tandem pump front flange load

Mounting flange loads H1T 045/053, Controls on top



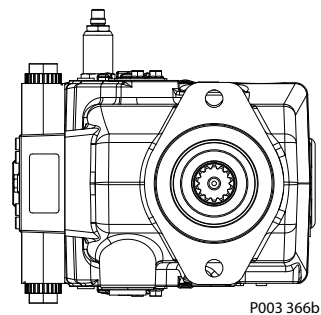
The moments shown below apply for the control orientation on top or side.

Mounting flange loads, Control on top



Rated moment:
 $M_R = 2020 \text{ N}\cdot\text{m}$ [17 880 lbf·in]
 Shock load moment:
 $M_S = 4110 \text{ N}\cdot\text{m}$ [36 380 lbf·in]

Mounting flange loads, Control on side



Rated moment:
 $M_R = 1300 \text{ N}\cdot\text{m}$ [11 510 lbf·in]
 Shock load moment:
 $M_S = 2930 \text{ N}\cdot\text{m}$ [25 935 lbf·in]

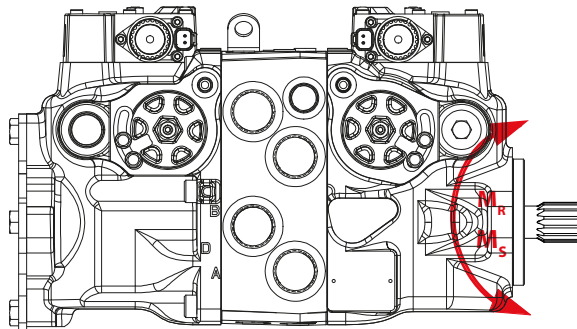
For more information, see *H1 Axial Piston Pumps, Basic Information*, [BC152886483968](#), the section "Mounting flange loads".

Technical Specifications

Mounting flange loads H1T 060/068

H1 tandem pump front flange load

Mounting flange loads H1T 060/068, Controls on top



Rated moment:

$M_R = 2190 \text{ N}\cdot\text{m}$ [19 380 lbf·in]

Shock load moment:

$M_S = 6560 \text{ N}\cdot\text{m}$ [58 060 lbf·in]

P109515

The moments shown apply for the control orientation on top or side.

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

Case drain

The tandem housings are connected through the center section via a drilled hole. The charge relief valve discharges oil into the front housing. In order to provide positive flow through both housings, use of the rear housing case drain is required. The front housing case pressure ports should only be used if the pump is used as a common drain manifold for the vehicle where external drain flow is brought into the rear housing and discharged out the front.

The allowable case pressures must be met accordingly.

Master Model Code
H1T rotation, ports, and second pump options

Displacement (Front pump, second pump see "C")

Code	Description
045	45 cm ³ [2.75 in ³]
053	53.8 cm ³ [3.28 in ³]
060	60 cm ³ [3.66 in ³]
068	68 cm ³ [4.15 in ³]

A – Rotation

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

B – Product version

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

Z – Port configuration

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

C – Second pump size

N	Frame size of rear stage equal front stage (default)
A	Rear stage kit 45cc/rev (only use with 53cc/rev front stage)
B	Rear stage kit 60cc/rev (only use with 68cc/rev front stage)

H1T Controls Options

D – Controls

Code	Control type	Input	Miscellaneous options	Connector
A2	EDC	12 V	—	DEUTSCH
A3	EDC	24 V	—	DEUTSCH
A4	EDC	12 V	MOR	DEUTSCH
A5	EDC	24 V	MOR	DEUTSCH
A9	FNR	12 V	MOR	DEUTSCH
H3	EDC	24 V	Angle sensor	DEUTSCH
H4	MDC front unit	—	Gain 0.52 with NSS	—
	FNR rear unit	12 V	Gain 0.52 with MOR	DEUTSCH
H6	EDC	12 V	Angle sensor + MOR	DEUTSCH
H7	EDC	24 V	Angle sensor + MOR	DEUTSCH
B1	FNR	24 V	MOR	DEUTSCH
B6	FNR front unit	12 V	—	DEUTSCH
	EDC rear unit	12 V	Gain 0.52	DEUTSCH
D7	EDC front unit	12 V	MOR	DEUTSCH
	FNR rear unit	12 V	MOR	DEUTSCH
D9	MDC front unit	—	Gain 0.52 with NSS	—
	MDC rear unit	—	Gain 0.52	DEUTSCH
N1	NFPE ¹	12 V	MOR	DEUTSCH

Master Model Code

D – Controls (continued)

Code	Control type	Input	Miscellaneous options	Connector
N2	NFPE ¹	24 V	MOR	DEUTSCH
N5	NFPE ¹	12 V	Angle sensor + MOR	DEUTSCH
N6	NFPE ¹	24 V	Angle sensor + MOR	DEUTSCH
M1	MDC	—	—	—
M2	MDC	—	NSS	—
T1	HDC	4.2 - 11.6 bar	—	—
T2	HDC	3.0 - 11.6 bar	—	—

¹ Align with options: E: Displacement limiters and W: Special hardware.

H1T Orifice and Displacement Limiter Options

F – Orifices (mm)

Code	Tank (A+B)	P	A / B	Note
C3	No orifice			Not to be used for FDC controls and mobile applications.
C1	–	–	0.8	Not to be used for FDC controls.
C6	1	–	–	To be used for MDC controls only.
C7	1.3	–	–	
C8	0.6	0.8	–	
C9	0.6	1	–	
D1	0.8	1	–	
D2	0.8	1.3	–	
D3	1	1.3	–	
D4	1	1.3	1.3	
D5	0.6	0.6	0.8	

E – Displacement limiter

N	None
C	No limiters, with nested springs, required for NFPE
B	Adjustable externally
D	Adjustable externally with nested springs, required for NFPE

H1T Endcap and Mounting Options

G – Endcap options

Code	Description	045/053	060/068
E7	Tandem same-sided SAE O-ring boss ports, (HPRV only) standard	●	—
D1	Tandem same-sided SAE O-ring boss ports with Control Cut Off (HPRV only), 12 V	●	—
F7	Tandem same-sided SAE O-ring boss ports with Control Cut Off (HPRV only), 24 V	●	—
H3	Tandem Opp. Port Code 62, 12V CCO & Brake	—	●
H4	Tandem Opp. Port Code 62, 24V CCO & Brake	—	●
H5	Tandem Opp. Port Code 62, 12V CCO	—	●
H6	Tandem Opp. Port Code 62, 24V CCO	—	●

Master Model Code
G – Endcap options (continued)

Code	Description	045/053	060/068
H7	Tandem Opp. Port Code 62	—	●
H8	Tandem Opp Port Code 62, Opposite Charge Inlet	—	●

H – Mounting

F	ISO 3019-1, flange 101-2 SAE B (045/053)
H	ISO 3019-1, flange 127-4 SAE C (060/068)
J	ISO 3019-1, flange 101-2 SAE B and speed sensor (045/053)

H1T Input Shaft and Aux Mounting Options
J – Input shaft

Code	Description	045/053	060/068
G1	ISO 3019-1, outer Ø32 mm - 4 (SAE C, 14 teeth splined shaft 12/24 pitch)	●	●
G5	ISO 3019-1, outer Ø25 mm - 4 (SAE B-B, 15 teeth splined shaft 16/32 pitch)	●	—
G6	ISO 3019-1, outer Ø31 mm - 4 (19 teeth splined shaft 16/32 pitch) (45/53 only)	●	—
F1	ISO 3019-1 outer diameter 35mm -4 (SAE C, 21 teeth splined shaft 16/32 pitch) (60/68 only)	—	●

K – Auxiliary mounting pad ISO 3019-1 without charge pump, with shipping cover

Code	Description	045/053	060/068
NN	No auxiliary mounting pad, No shipping cover	●	—
H2	Flange 82 - 2, outer Ø16 mm - 4 (SAE A, 9 teeth 16/32 coupling) (45/53)	●	●
H1	Flange 82 - 2, outer Ø19 mm - 4 (SAE A, 11 teeth 16/32 coupling) (45/53)	●	●
H3	Flange 101 - 2, outer Ø22 mm - 4 (SAE B, 13 teeth 16/32 coupling)	●	●
H5	Flange 101 - 2, outer Ø25 mm - 4 (SAE B-B, 15 teeth 16/32 coupling)	●	●

Align with options: S – Charge pump and Y – Special settings.

H1T High Pressure Relief Valve Options
M – High pressure relief valve setting

Code	Pressure setting (Use the selection for ports A, B, C and D)	045	053	60	68
13	130 bar [1885 psi]	●	●	—	—
15	150 bar [2175 psi]	●	●	—	—
18	180 bar [2610 psi]	●	●	●	●
20	200 bar [2900 psi]	●	●	●	●
23	230 bar [3336 psi]	●	●	●	●
25	250 bar [3630 psi]	●	●	●	●
28	280 bar [4061 psi]	●	●	●	●
30	300 bar [4350 psi]	●	●	●	●

Master Model Code

M – High pressure relief valve setting (continued)

Code	Pressure setting (Use the selection for ports A, B, C and D)	045	053	60	68
33	330 bar [4786 psi]	●	●	●	●
35	350 bar [5080 psi]	●	●	●	●
38	380 bar [5510 psi]	●	●	●	●
40	400 bar [5800 psi]	●	—	●	—
41	410 bar [5946 psi]	●	—	—	—
42	420 bar [6090 psi]	●	—	●	—

NO bypass, side “A” (front pump) N – High pressure relief valve setting, NO bypass side “B” (front pump) P – High pressure relief valve setting, NO bypass, side “C” (rear pump) R – High pressure relief valve setting, NO bypass, side “D” (rear pump).

H1T Pressure Limiter, Charge Pump, and Filtration Options

Pressure limiter 060/068

Code	Pressure setting (Use the selection for ports A, B, C and D)	060	068
AE	150 bar PL / 200 bar HPRV	●	●
AH	180 bar PL / 250 bar HPRV	●	●
BK	200 bar PL / 250 bar HPRV	●	●
BC	230 bar PL / 280 bar HPRV	●	●
BE	250 bar PL / 300 bar HPRV	●	●
BH	280 bar PL / 330 bar HPRV	●	●
CK	300 bar PL / 350 bar HPRV	●	●
CC	330 bar PL / 380 bar HPRV	●	●
CE	350 bar PL / 400 bar HPRV	●	●
CH	380 bar PL / 430 bar HPRV	●	●
DK	400 bar PL / 450 bar HPRV	●	-
DA	410 bar PL / 450 bar HPRV	●	-
DB	420 bar PL / 450 bar HPRV	●	-

S – Charge pump

N	No charge pump, external charge supply (Align with options: T – Filtration)
---	---

T – Filtration

P	Remote full charge flow filtration (045/053 only)
E	External charge filtration (060/068 only)

Master Model Code

H1T Charge Pressure Relief, Special Hardware and Settings

V – Charge pressure relief setting

Code	Description
18	18 bar [261 psi]
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** controls.

W – Special hardware features

PN	EDC/FNR/MDC valve plate (without a handle)
P1	NFPE valve plate (Align with options: D – Control selection and E – Displacement limiters)
P4	EDC/FNR/MDC Valve Plate and Speed Ring (045/053 only)
H1	EDC/FNR/MDC Valve Plate, included MDC Handle (All frames)
H2	EDC/FNR/MDC Valve Plate, MDC Handle Front, System Loop Bypass (045/053 only)

X – Paint and nametag

NNN	Black paint and Danfoss nametag
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Y – Special settings

NNN	None
M00	MDC (handle in standard position)

Control Options

Electrical Displacement Control (EDC)

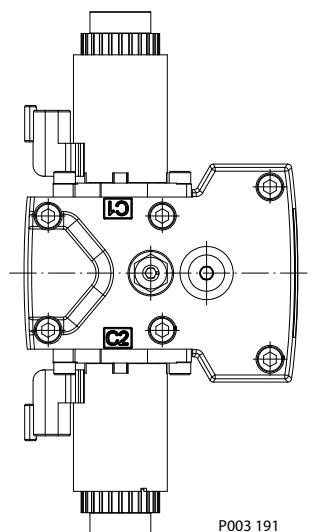
An EDC is a displacement (flow) control. Pump swash plate position is proportional to the input command and therefore vehicle or load speed (excluding influence of efficiency), is dependent only on the prime mover speed or motor displacement.

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.

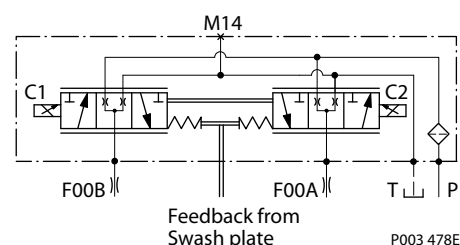
A serviceable 170 µm screen is located in the supply line immediately before the control porting spool.

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

Electrical Displacement Control

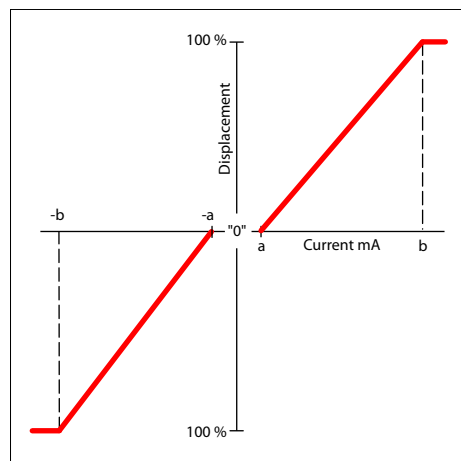


EDC schematic, feedback from swash plate



Control signal requirements, EDC H1T

Pump displacement vs. control current



Control Options
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.

Control response

H1T 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 mm²/s [141 SUS] and 50 °C [122 °F]
- Speed = 1800 min⁻¹ (rpm)

Response time, EDC 045/053

Stroking direction	0.8 mm [0.03 in] orifice	1.3 mm [0.05 in] orifice	No orifice
Neutral to full flow	1.7 s	0.9 s	0.5 s
Full flow to neutral	1.1 s	0.6 s	0.3 s

Response time, EDC 060/068

Stroking direction	0.8 mm [0.03 in] Orifice	1.3 mm [0.05 in] Orifice	No orifice
Neutral to full flow	2.6 s	1.2 s	0.8 s
Full flow to neutral	1.7 s	0.8 s	0.4 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.

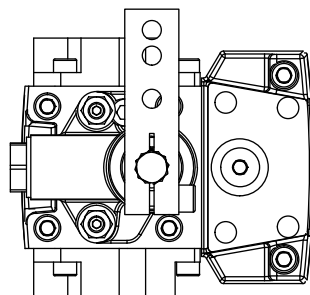
Differential pressure across the servo piston rotates the swash plate, changing the pump's displacement. Simultaneously the swashplate movement is fed back to the control spool providing proportionality between shaft rotation on the control and swash-plate rotation. The MDC changes the pump displacement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

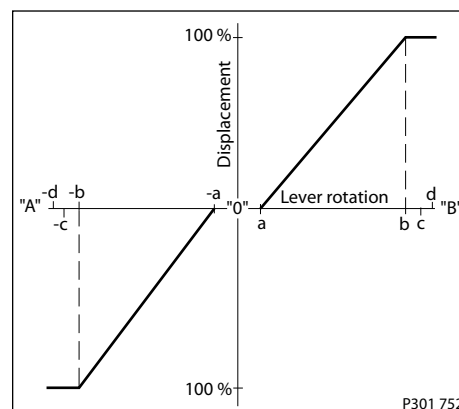
For the MDC with CCO option the brake port (X7) provides charge pressure when the coil is energized to activate static function such as a brake release. The X7 port must not be used for any continuous oil consumption.

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.

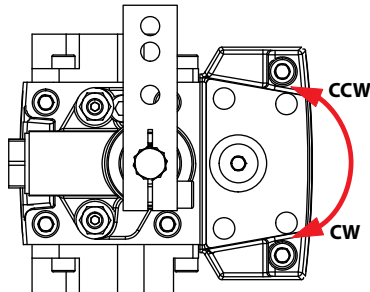
MDC Torque

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 shaft rotation



Pump shaft rotation*	Clockwise (CW)		Counter-clockwise (CCW)	
	CW	CCW	CW	CCW
MDC shaft rotation				
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

H1T 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:

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

Control Options

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, MDC 045/053

Code	Orifice description (mm)				Stroking direction (sec)	
	P	A	B	Tank (A+B)	Neutral to full flow	Full flow to neutral
C3	–	–	–	–	0.3	0.4
C6	–	–	–	1	0.9	0.8
C7	–	–	–	1.3	0.6	0.6
C8	0.8	–	–	0.6	2.9	2.0
C9	1	–	–	0.6	2.7	1.9
D1	1	–	–	0.8	1.7	1.2
D2	1.3	–	–	0.8	1.5	1.1
D3	1.3	–	–	1	1.1	0.8
D4	1.3	1.3	1.3	1	1.3	1.0
D5	0.6	0.8	0.8	0.6	5.4	2.8

Response time, MDC H1T

Code	Orifice description (mm)			Stroking direction	
	Tank (A+B)	P	A/B	Neutral to full flow	Full flow to neutral
C3	No orifice			s	s
C6	1	–	–	s	s
C7	1.3	–	–	s	s
D1	0.8	1	–	s	s
D2	0.8	1.3	–	s	s
D3	1	1.3	–	s	s
D4	1	1.3	1.3	s	s

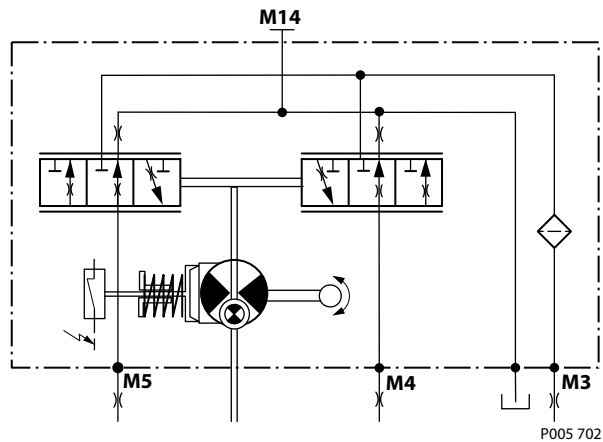
[For further data please contact your Danfoss representative.](#)

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**).

Control Options

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

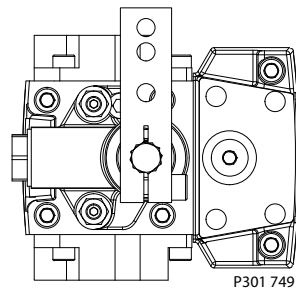
Case Gauge Port M14

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.

Lever

MDC controls are available with optional lever/handle. Align with Settings: Y module in the model code.

Standard orientation 90° from input shaft



Control Options

Hydraulic Displacement Control (HDC)

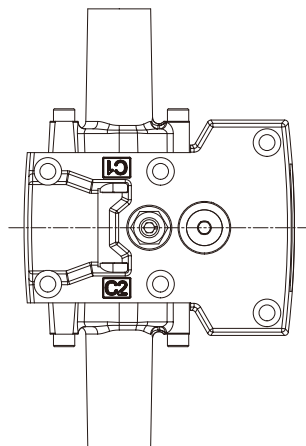
HDC principle

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.

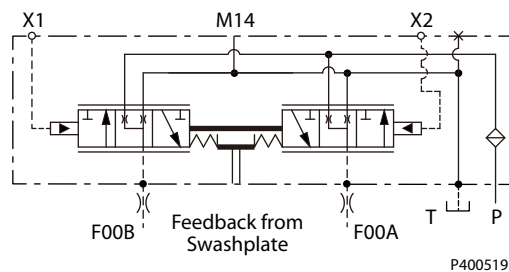
A serviceable 175 μ m screen is located in the supply line immediately before the control porting spool.

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.

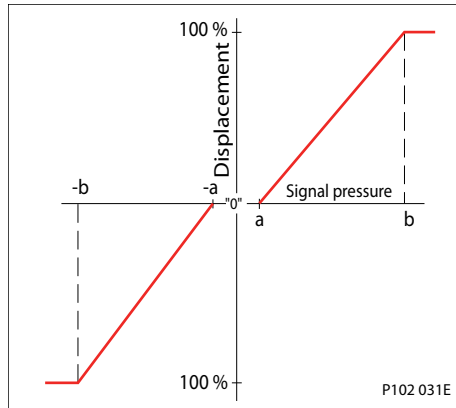
A swashplate feedback link, opposing control linkage, and a linear spring provide swashplate position force feedback to the hydraulic pressure. As hydraulic pressures in the operating loop change with load, the control assembly and servo/swashplate system work constantly to maintain the commanded position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

Type	Unit	Start of control	End of control
Option	bar	3.0	11.6
Standard		4.2	16.2

Pump output flow direction vs. control pressure

Shaft rotation HDC	Clockwise (CW) seen from shaft		Counter Clockwise (CCW) seen from shaft	
	X1	X2	X1	X2
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

H1T controls are available with optional control passage orifices to assist in matching the rate of swashplate 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:

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

Charge pressure = 20 bar [290 psi]

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

Speed = 1800 min⁻¹ (rpm)

Control Options**Response time, HDC 047/053, 060/068***HDC 047/053*

Stroking direction	0.8 mm [0.03 in] orifice	1.3 mm [0.05 in] orifice	No orifice
Neutral to full flow	1.6s	0.7s	0.4s
Full flow to neutral	0.9s	0.4s	0.2s

HDC 060/068

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	0.5s
Full flow to neutral	1.2s	0.5s	0.3s

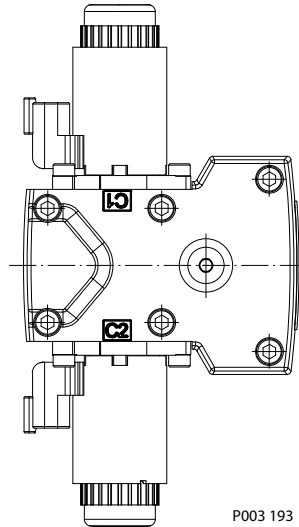
Control Options

Forward-Neutral-Reverse Control (FNR)

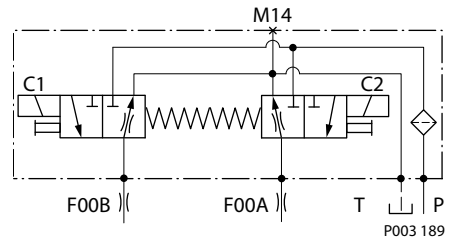
The 3-position FNR control options **A9** (12 V) and **B1** (24 V) uses an electric input signal to switch the pump to a full stroke position. A serviceable 125 µm screen is located in the supply line immediately before the control porting spool.

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

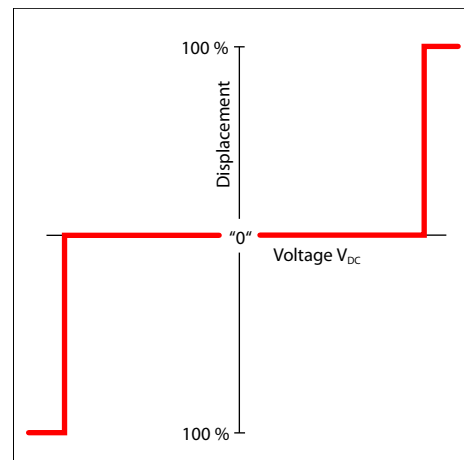
Forward-Neutral-Reverse electric control (FNR)



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	

Control Options

Control response

H1T 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:

$\Delta p = 250 \text{ bar}$ [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, FNR

Stroking direction	Size combo	0.8 [0.03] orifice	1.3 [0.05] orifice	No orifice
Neutral to full flow	045/053	1.8 s	0.9 s	0.5 s
	060/068	2.7 s	1.3 s	0.8 s
Full flow to neutral	045/053	1.6 s	0.8 s	0.4 s
	060/068	2.3 s	1.1 s	0.5 s

Control Options

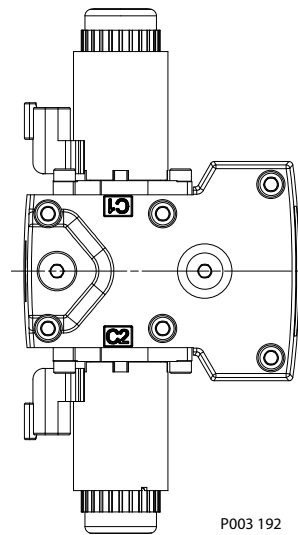
Non feedback proportional electric control (NFPE)

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.

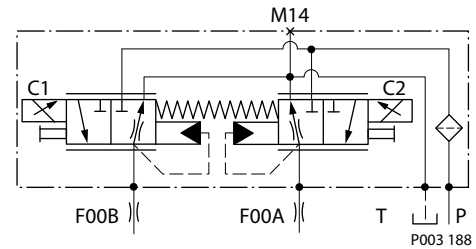
A serviceable 170 µm screen is located in the supply line immediately before the control porting spool.

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

NFPE control



NFPE schematic



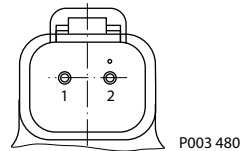
Control signal requirements, NFPE 045/053 Tandem

Control current

Voltage	a* mA	b mA	c mA	Pin connections
12 V	870	1290	1550	any order
24 V	440	670	775	

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

DEUTSCH connector, 2-pin



Connector ordering data

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

Control Options

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.

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

H1T 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:

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

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

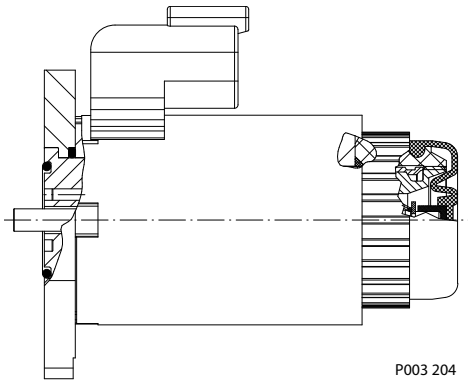
Stroking direction	Size combo	0.8 [0.03] orifice	1.3 [0.05] orifice	No orifice
Neutral to full flow	045/053	2.2 s	1.2 s	0.8 s
	060/068	3.3 s	1.6 s	1.0 s
Full flow to neutral	045/053	1.5 s	0.7 s	0.4 s
	060/068	1.9 s	0.8 s	0.4 s

Control Options

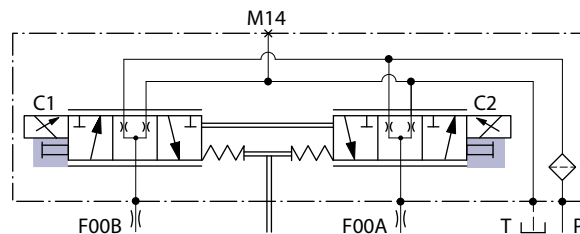
Manual Override (MOR)

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

Control Options

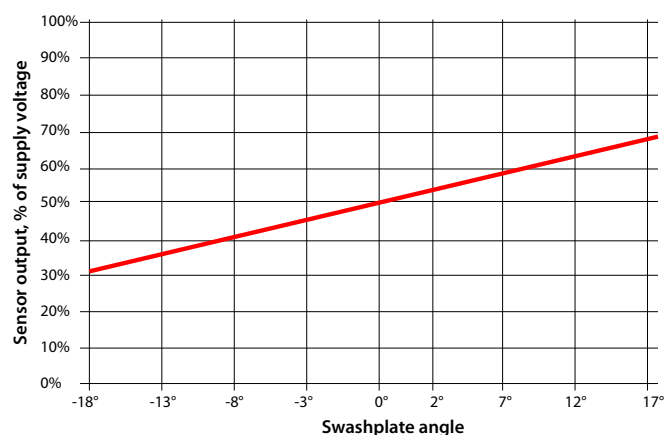
Swashplate angle sensor for EDC controls

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

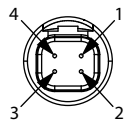
Calibration of the sensor output within the software is mandatory. Vehicle neutral thresholds in the software ($\pm 0.5^\circ$) are vehicle dependent and must consider different conditions, example: system temperature, system pressure and/or shaft speed.

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

Connector DEUTSCH, 4-pin

Pin assignment:



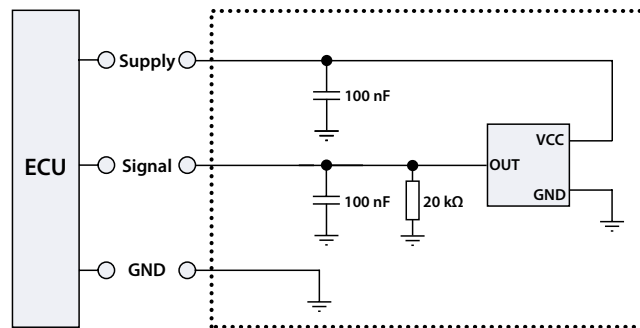
1. Ground (GND)
2. Not connected
3. Output signal 1 (SIG 1)
4. Supply (V+)

Connector order numbers

Description	Quantity	Order number
Mating connector DEUTSCH DTM06-4S-E004	1	11105824
Wedge lock WM-4S	1	not available
Socket contact 0462-201-2031	3	
Mating connector kit	1	11212713

Interface with ECU (EDC)

Interface with ECU diagram

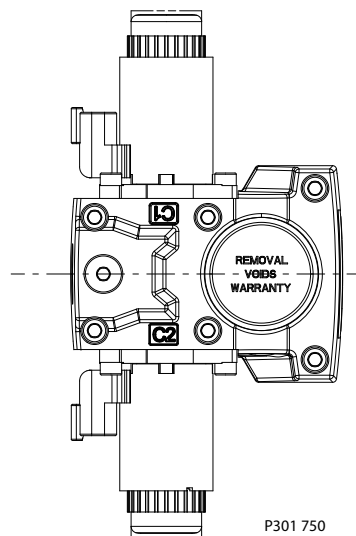


Control Options

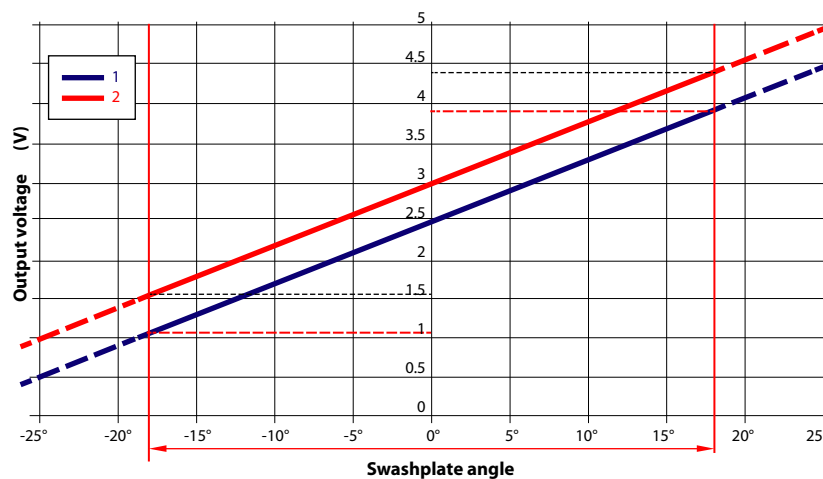
Swash Plate Angle Sensor for NFPE and AC2 Controls

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 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
Sensitivity	70.0 mV/deg	78.0 mV/deg	85.8 mV/deg

Control Options

Parameter	Minimum	Typical	Maximum
Working range (swash plate angle)	-18°	0°	18°
Correlation between signals 1 and 2 ¹⁾	475 mV	500 mV	525 mV

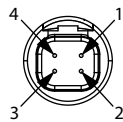
¹⁾ Up to duration of 2.5 seconds at 25°C

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

Swash-plate Angle Sensor Connector (NFPE/AC2)

Connector DEUTSCH, 4-pin

Pin assignment:

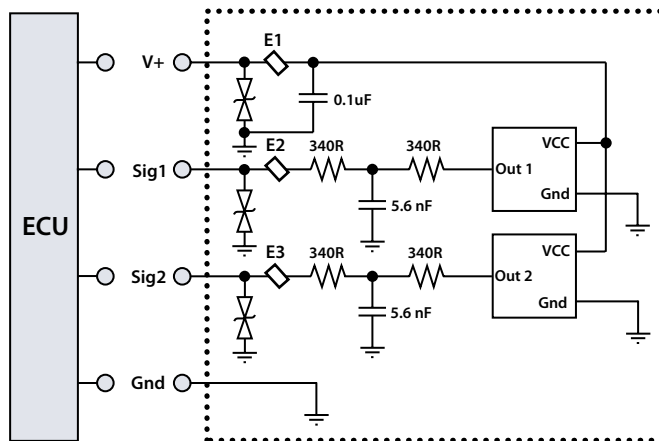


1. Ground (GND)
2. Output Signal 2 (SIG2) – Secondary (redundant)
3. Output signal 1 (SIG 1)
4. Supply (V+)

Connector order numbers

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

Interface with ECU (NFPE)



Minimum recommended load resistance is 100 kΩ.

Control Options

Control-Cut-Off (CCO) and Brake Release Valves

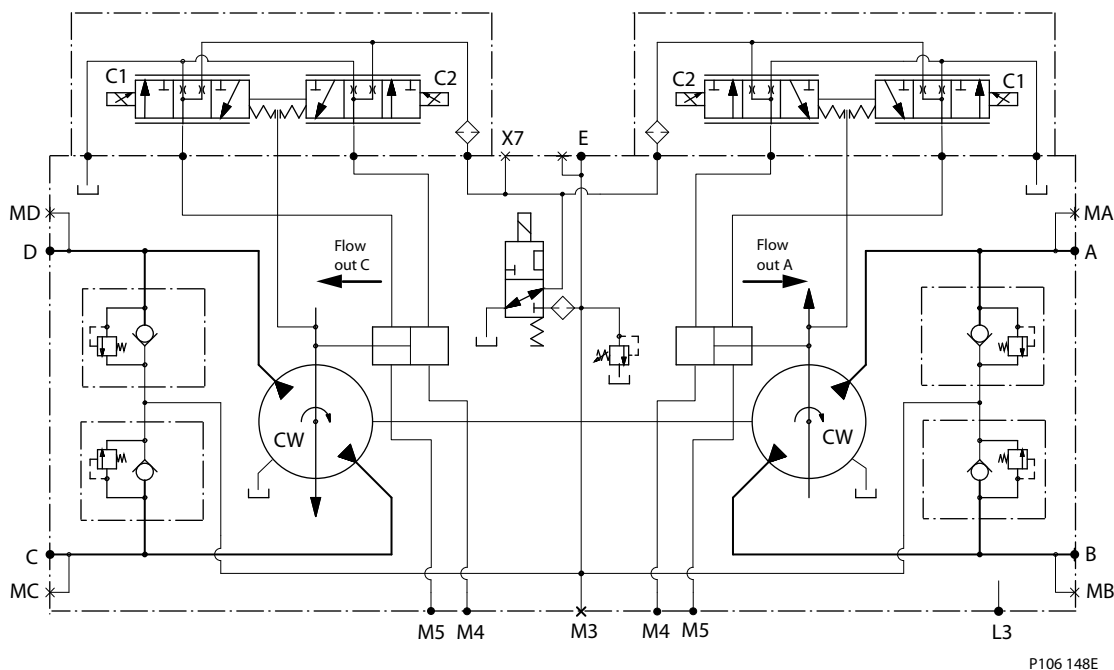
The H1 tandem pumps offer an optional **Control-Cut-Off** valve integrated into the pump center section and a separate brake release valve allowing the controls to be activated before activating any auxiliary functions.

The CCO valve shunts charge pressure from the pump controls allowing the servo springs to de-stroke both pumps. The valve is normally open for fail-safe operation. The solenoid must be energized for the pump to operate. When the machine control circuits energize the CCO solenoid, it connects charge supply from the charge gallery to the pump controls.

The 045/053 tandem also supplies charge pressure to the port X7 for auxiliary operation of devices such as spring applied/pressure released brakes. The control cut off valve also shunts pressure away from port X7.

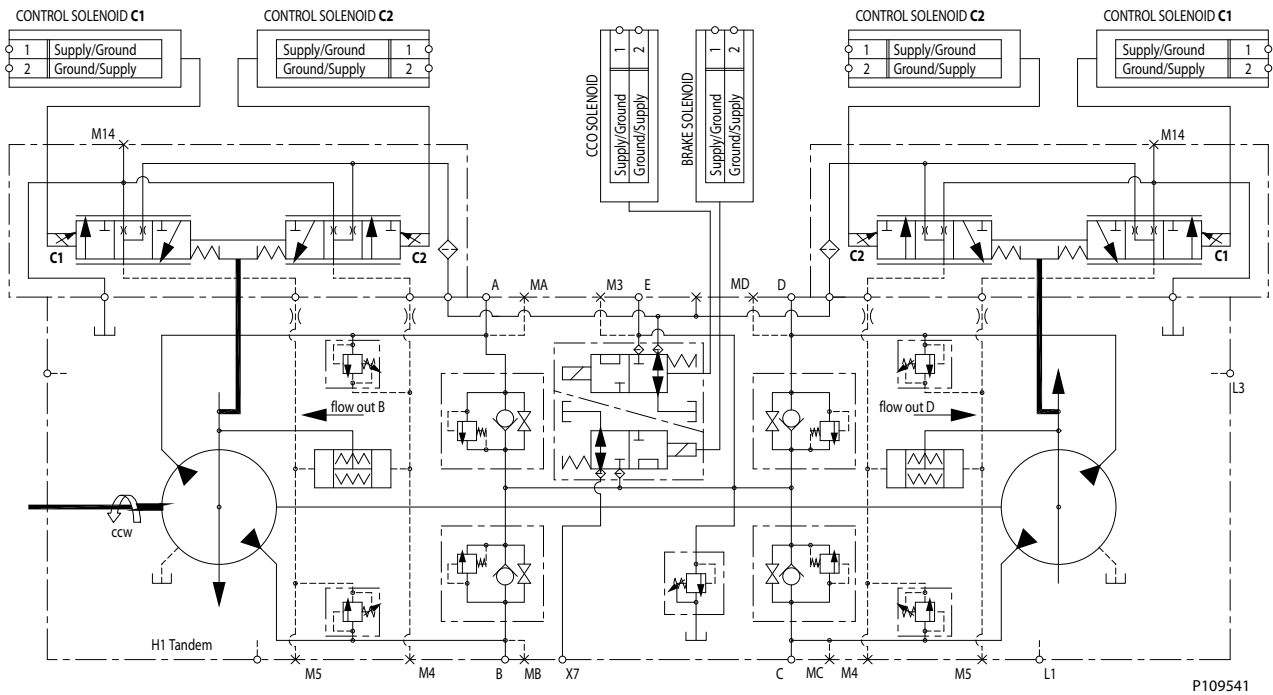
The 060/068 tandem offers a separate brake release valve that operates independently of the CCO valve allowing the controls to be activated before activating any auxiliary functions. When the 60/68 brake valve is deactivated the X7 port shunts to case.

045/053 Tandem



Control Options

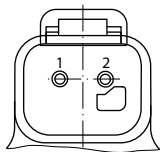
060/068 Tandem



Solenoid data

Description		12 V	24 V
Minimum supply voltage		9 V _{DC}	18 V _{DC}
Maximum supply voltage (continuous)		16 V _{DC}	32 V _{DC}
IP Rating	IEC 60 529	IP 67	
	DIN 40 050, part 9	IP 69K with mating connector	
Pin connector		any order	

[For additional information, please contact Danfoss.](#)

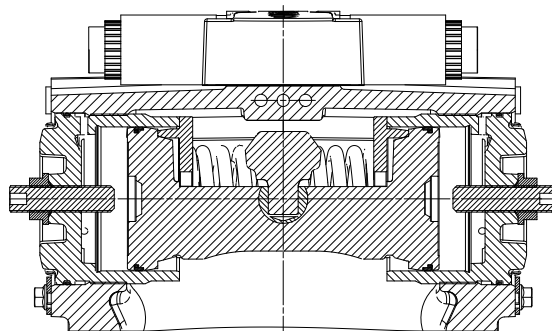


Control Options

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.

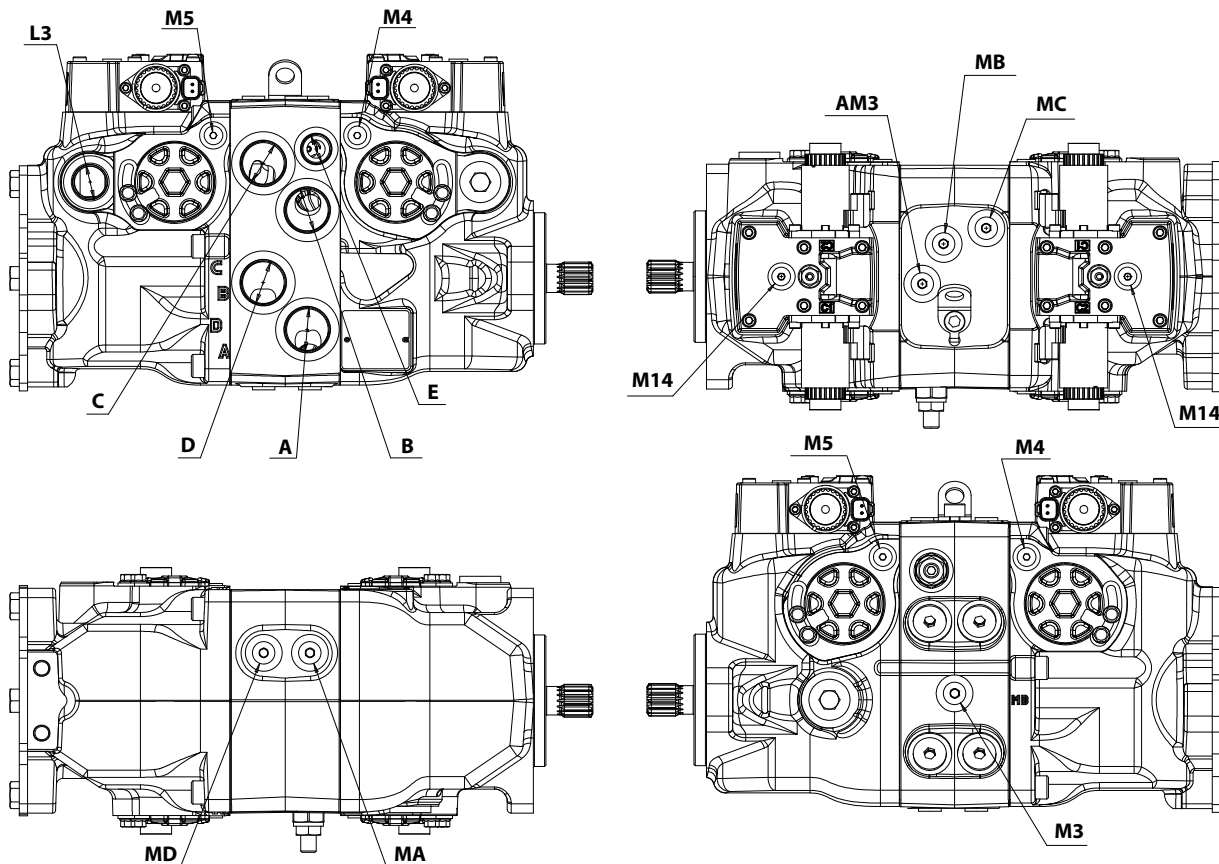


P003 266

Displacement change (approximately)

Parameter	Size 045	Size 053	Size 060	Size 068
1 Turn of displacement limiter screw	5.1 cm ³ [0.31 in ³]	6.0 cm ³ [0.37 in ³]	5.9 cm ³ [0.36 in ³]	6.6 cm ³ [0.40 in ³]
Internal wrench size	4 mm			
External wrench size	13 mm			
Torque for external hex seal lock nut	23 N•m [204 lbf•in]			

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

Port Locations
Port Locations H1T 045/053 Tandem


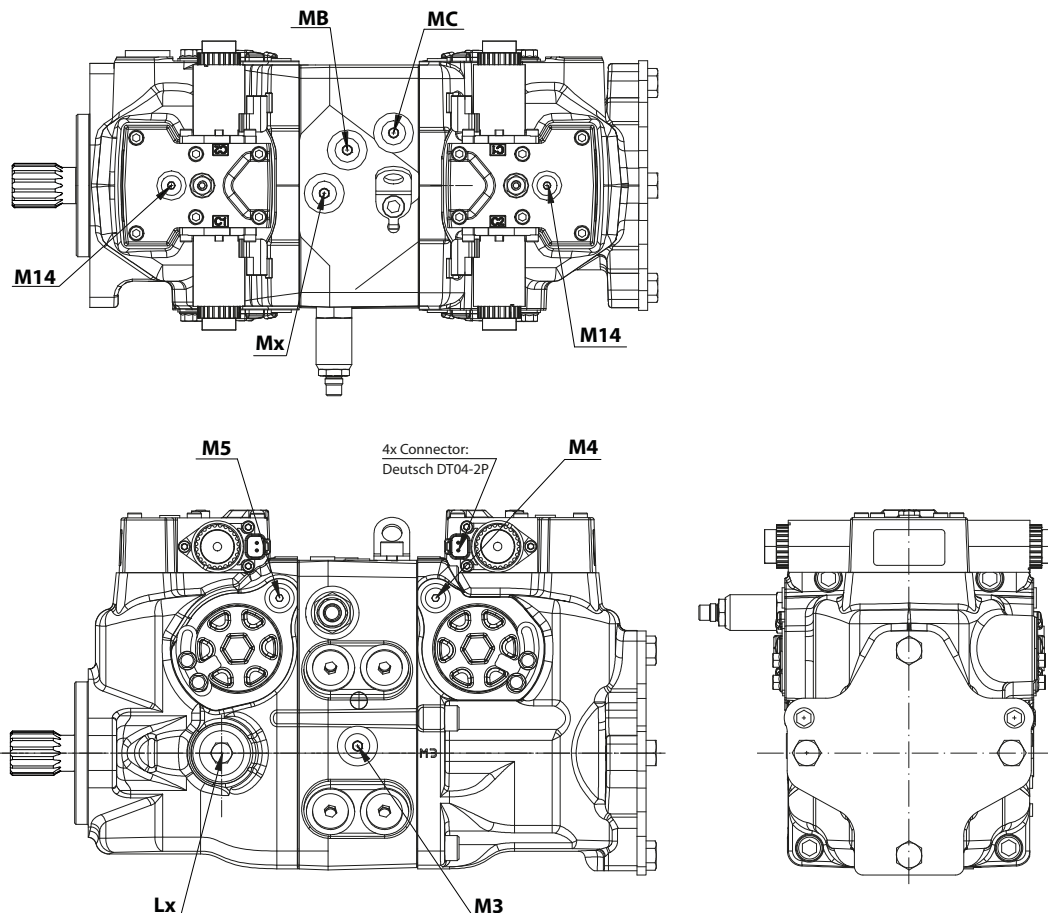
Mounting flange, shaft and connector surfaces to be paint free.

Ports description, ISO 11926-1

Ports	Description	Sizes
A, B, C, D	System ports: A, B, C and D; Ø48.5 max. clearance for fitting	1 ⁵ / ₁₆ - 12
MA, MB, MC, MD	System gauge ports A, B, C and D; Ø28 max. clearance for fitting	9 ¹ / ₁₆ - 18
E	Charge filtration inlet port from filter; Ø36 max. clearance for fitting	7 ⁷ / ₈ - 14
L3	Case drain port; Ø48.5 max. clearance for fitting	1 ¹ / ₁₆ - 12
M3	Charge gauge / constr. port; Ø28 max. clearance for fitting	9 ¹ / ₁₆ - 18
M4, M5	Servo gauge ports; Ø24.5 max. clearance for fitting	7 ¹ / ₁₆ - 20
M14	Case gauge port; Ø21 max. clearance for fitting (EDC, MDC, FNR, NFPE)	7 ¹ / ₁₆ - 20
AM3	Alternate charge pressure port	9 ¹ / ₁₆ - 18

Port Locations

Port Locations H1T 045/053 Tandem



Mounting flange, shaft and connector surfaces to be paint free.

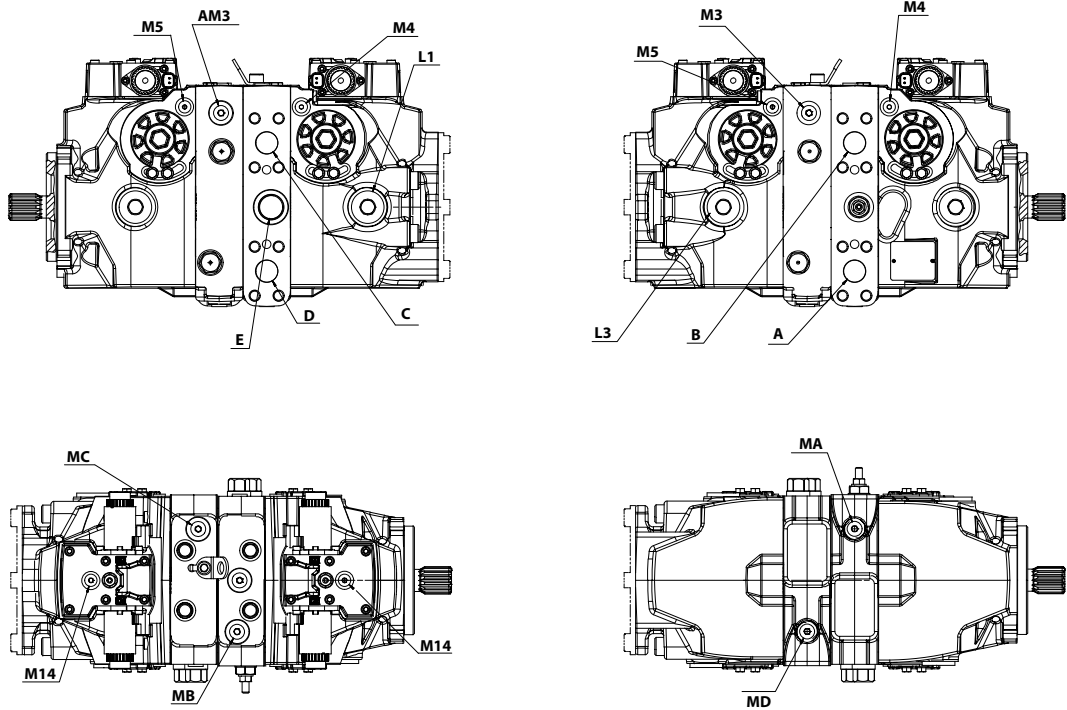
Ports description, ISO 11926-1

Ports	Description	Sizes
MA, MB, MC, MD	System gauge ports A, B, C and D; Ø28 max. clearance for fitting	$\frac{9}{16}$ – 18
M3, Mx	Charge gauge / constr. port; Ø28 max. clearance for fitting	$\frac{9}{16}$ – 18
M4, M5	Servo gauge ports; Ø24.5 max. clearance for fitting	$\frac{7}{16}$ – 20
M14	Case gauge port; Ø21 max. clearance for fitting (EDC, MDC, FNR, NFPE)	$\frac{7}{16}$ – 20

Please contact Danfoss representative for specific installation drawings.

Port Locations

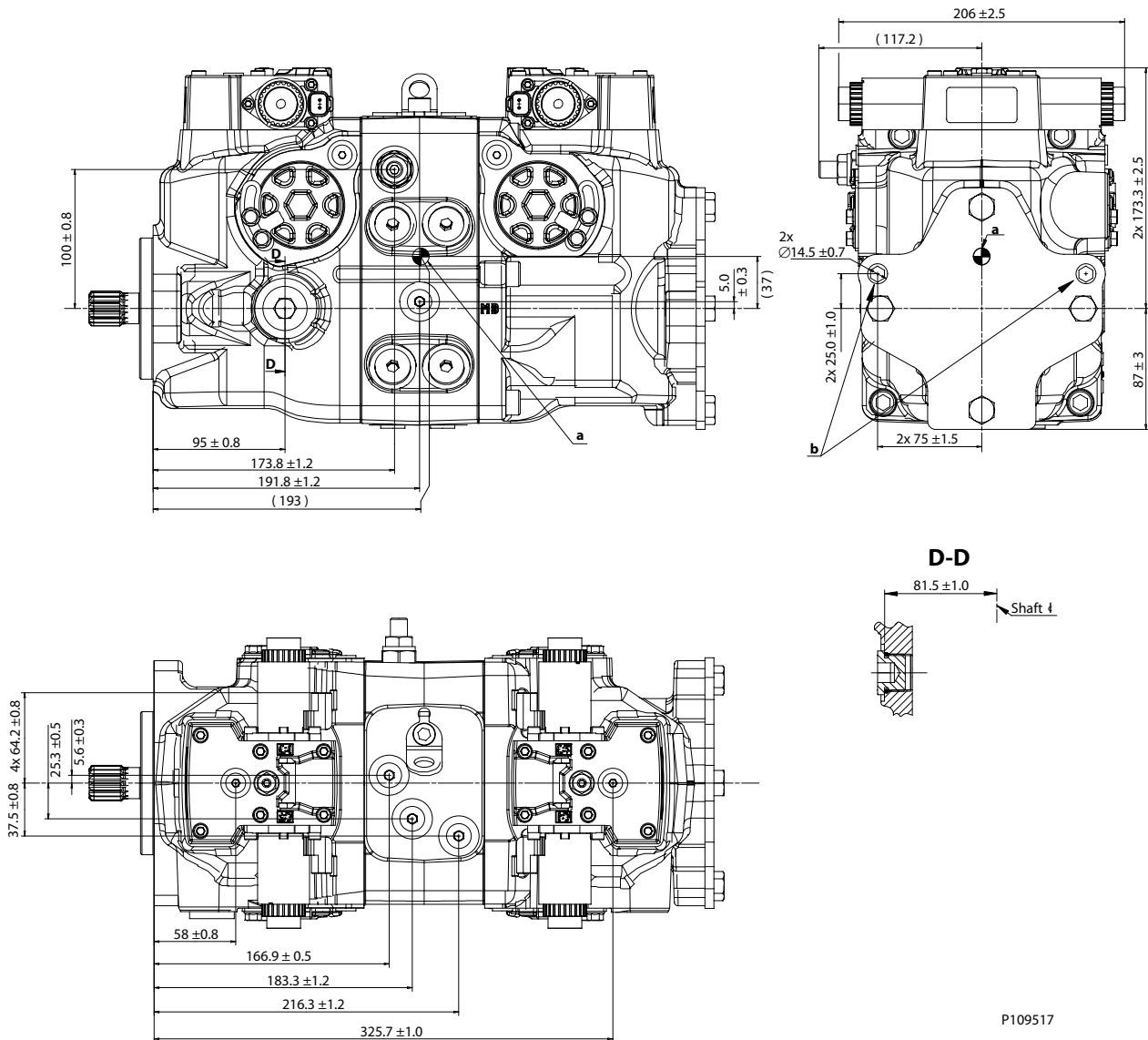
Port Locations H1T 060/068 Tandem



Ports description, ISO 11926-1

Ports	Description	Size
A, B, C, D	System ports: A, B, C and D	Split flange, M12 x 1.75
MA, MB, MC, MD	System gauge ports A, B, C and D	9/16 - 18
E	Charge filtration inlet port from filter	1 1/16 - 12
L1, L3	Case drain port	1 5/16 - 12
M3, Mx	Charge gauge / constr. port	9/16 - 18
M4, M5	Servo gauge ports	7/16 - 20
M14	Case gauge port; (EDC, MDC, FNR, NFPE)	7/16 - 20
AM3	Alternate charge pressure port	9/16 - 18

Dimensions



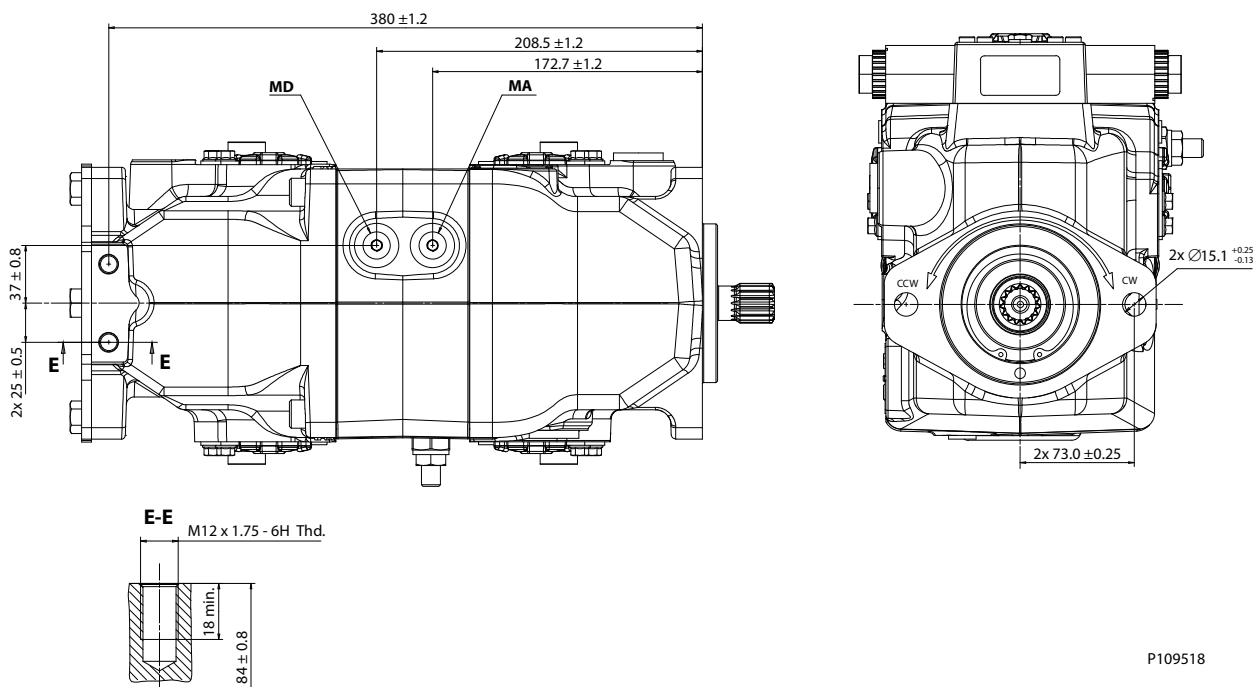
P109517

Notes in the drawing:

- a** – Approximate center of gravity
- b** – Lifting holes weight limit not to exceed 75 kg [165 lb]

Please contact Danfoss representative for specific installation drawings.

Dimensions



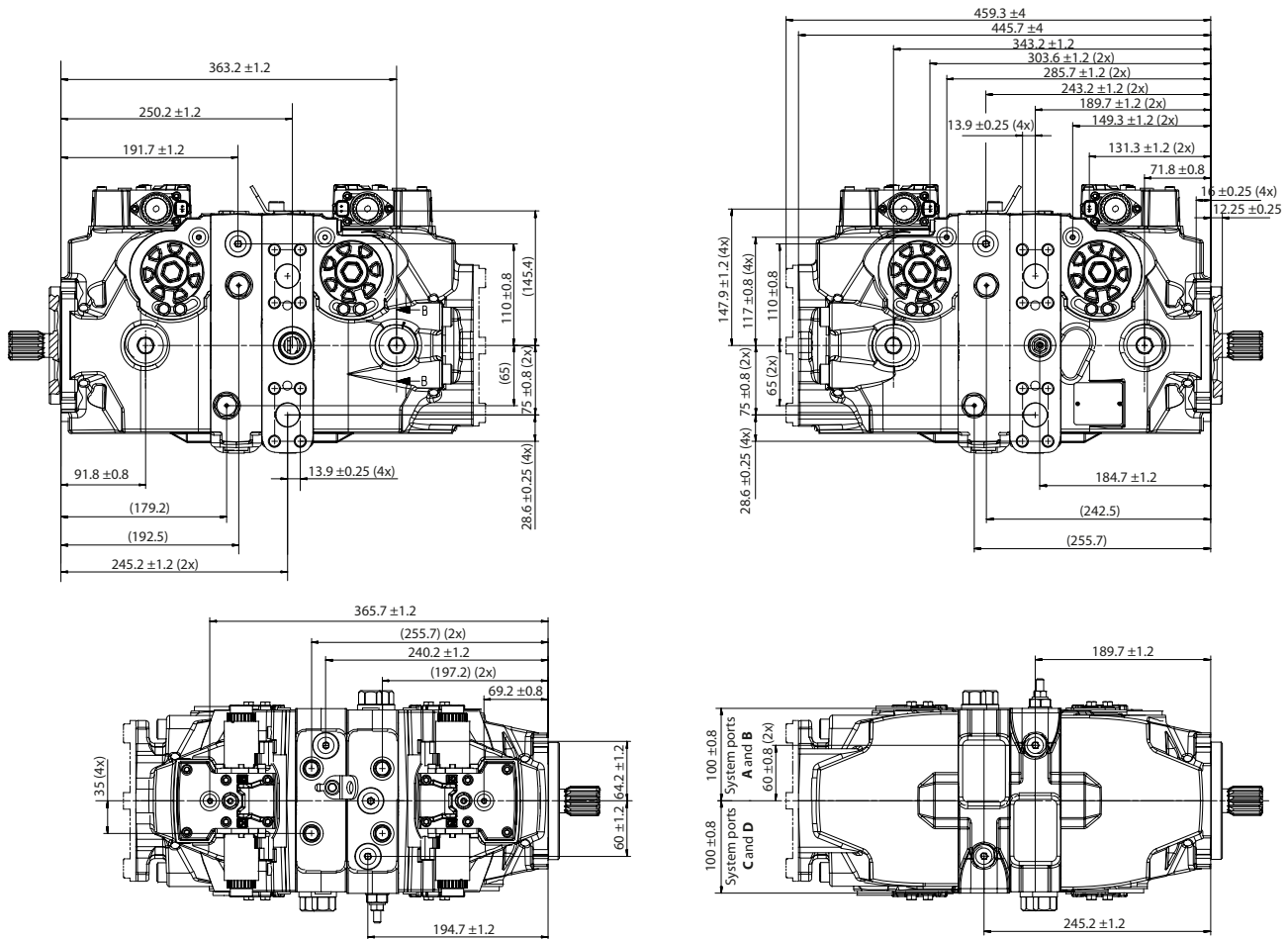
P109518

Mounting bolt holes are sized for 14 mm fasteners. M12 or ½ inch can be used, but require a hardened washer.

Please contact Danfoss representative for specific installation drawings.

Dimensions

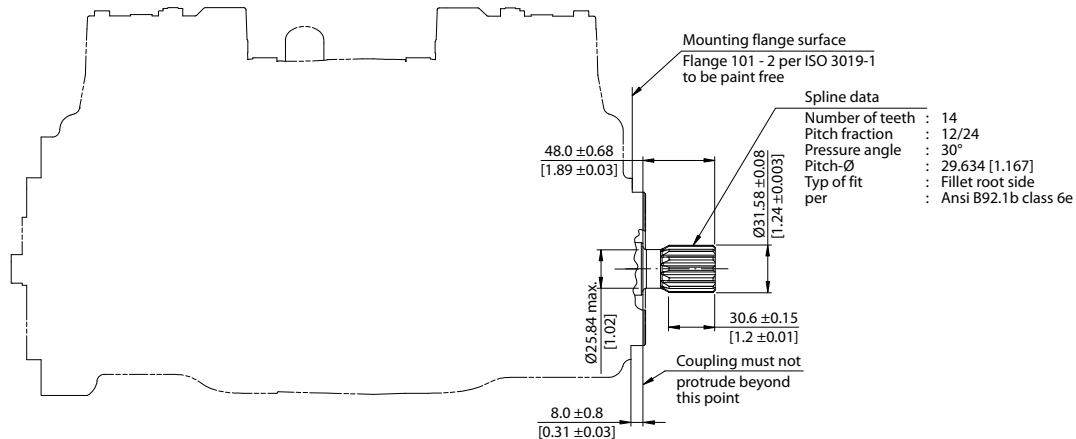
Dimensions H1T 060/068 Tandem



Dimensions

Input shaft, option G1 (SAE C, 14 teeth) (045/053/060/068)

Option G1



Specifications

Option		G1
Spline		14 teeth, 12/24 pitch
Min. active spline length ¹⁾		30.6 mm [1.205 in]
Torque rating ²⁾	Rated	534 N•m [4720 lbf•in]
	Maximum	592 N•m [5240 lbf•in]

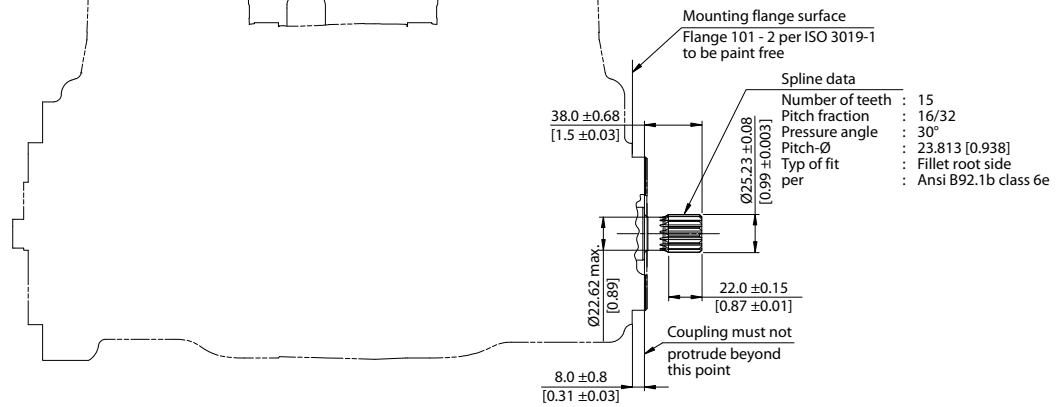
¹⁾ Minimum active spline length for the specified torque ratings.

²⁾ For definitions of maximum and rated torque values, refer to *Basic Information BC152886483968*, section Shaft Torque Ratings and Spline Lubrication.

Dimensions

Input shaft, option G5 (SAE B-B, 15 teeth) (045/053 only)

Option G5



Specifications

Option	G5	
Spline	15 teeth, 16/32 pitch	
Min. active spline length¹⁾	22 mm [0.866 in]	
Torque rating²⁾	Rated	277 N·m [2450 lbf·in]
	Maximum	370 N·m [3270 lbf·in]

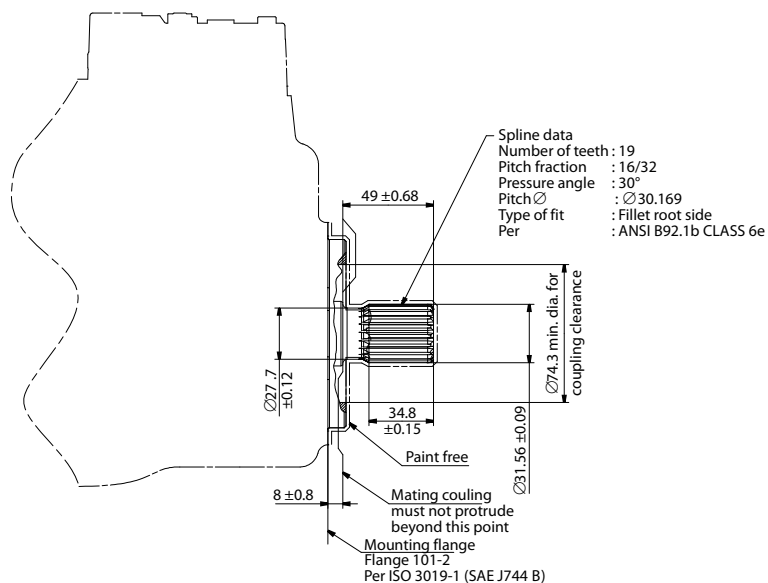
¹⁾ Minimum active spline length for the specified torque ratings.

²⁾ For definitions of maximum and rated torque values, refer to *Basic Information BC152886483968*, section Shaft Torque Ratings and Spline Lubrication.

Dimensions

Input shaft, option G6, (19 teeth-long) (045/053 only)

Option G6, 045/053



Specifications

Option	G6	
Spline	19 teeth, 16/32 pitch	
Min. active spline length ¹⁾	34.8 mm [1.370 in]	
Torque rating ²⁾	Rated	563 N•m [4980 lbf•in]
	Maximum	732 N•m [6478 lbf•in]

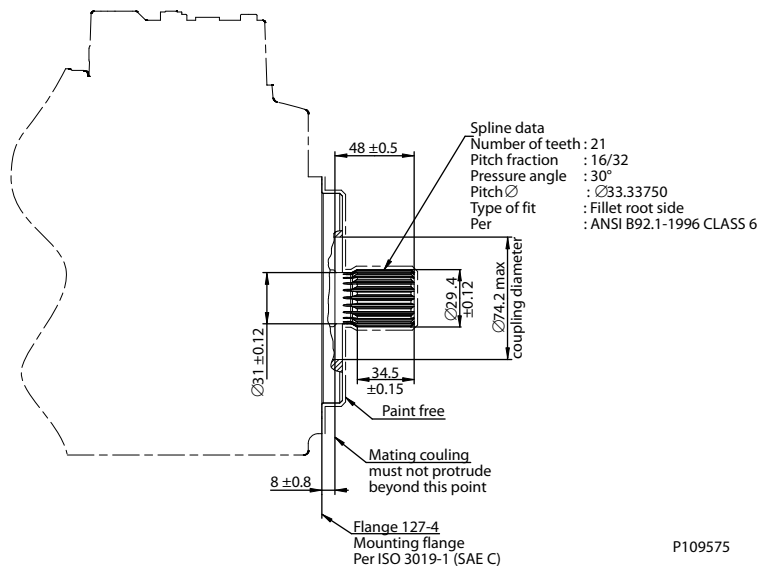
¹⁾ Minimum active spline length for the specified torque ratings.

²⁾ For definitions of maximum and rated torque values, refer to *Basic Information BC152886483968*, section Shaft Torque Ratings and Spline Lubrication.

Dimensions

Input shaft, option F1, (060/068 only)

Option F1, ISO 3019-1, outer dia 32 mm-4 (SAE C, 21 teeth)



Specifications

Option	F1	
Spline	21 teeth, 16/32 pitch	
Min. active spline length ¹⁾	31.5 mm [1.358 in]	
Torque rating ²⁾	Rated	760 N·m [6730 lb·in]
	Maximum	1137 N·m [10060 lb·in]

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

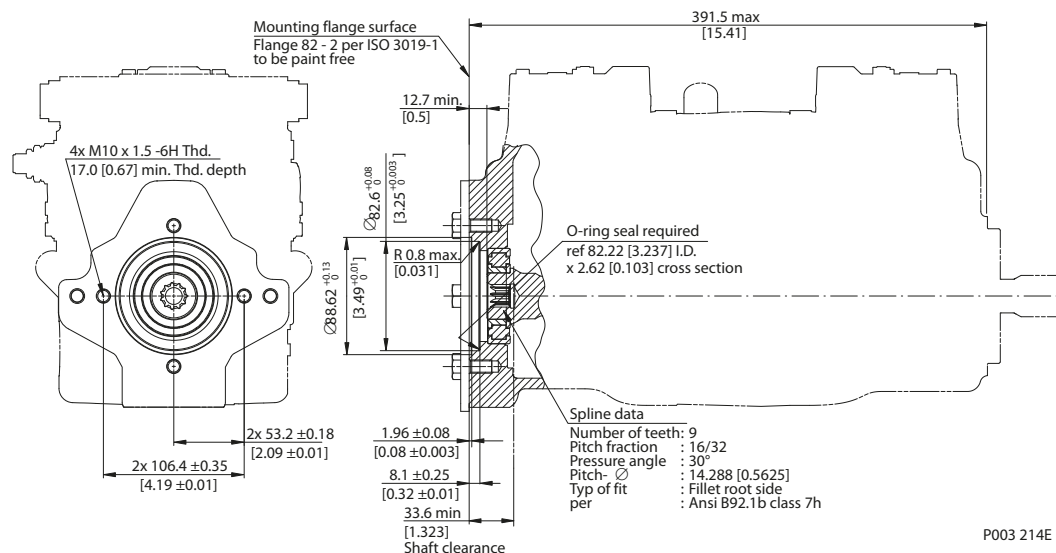
²⁾ For definitions of maximum and rated torque values, refer to *Basic Information BC152886483968*, section Shaft Torque Ratings and Spline Lubrication.

Dimensions

Auxiliary mounting pads

Option H2 (SAE A, 9 teeth) 045/053

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



Specifications

Option	H2
Spline	9 teeth, 16/32 pitch
Maximum torque ¹⁾	162 N·m [1430 lbf·in]

¹⁾ For definitions of maximum and rated torque values, refer to *Basic Information BC152886483968*, section Shaft Torque Ratings and Spline Lubrication.

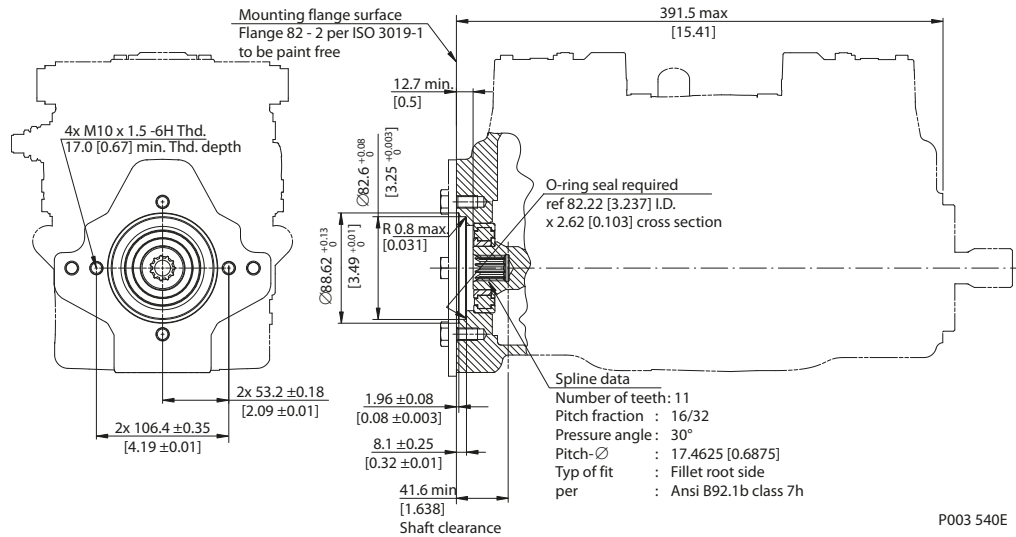
⚠ Caution

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

Dimensions

Option H1 (SAE A, 11 teeth) 045/053

Option H1, ISO 3019-1, Flange 82-2 (SAE A, 11 Teeth)



Specifications

Option	H1
Spline	11 teeth, 16/32 pitch
Maximum torque¹⁾	296 N·m [2620 lbf·in]

¹⁾ For definitions of maximum and rated torque values, refer to *Basic Information BC152886483968*, section Shaft Torque Ratings and Spline Lubrication.

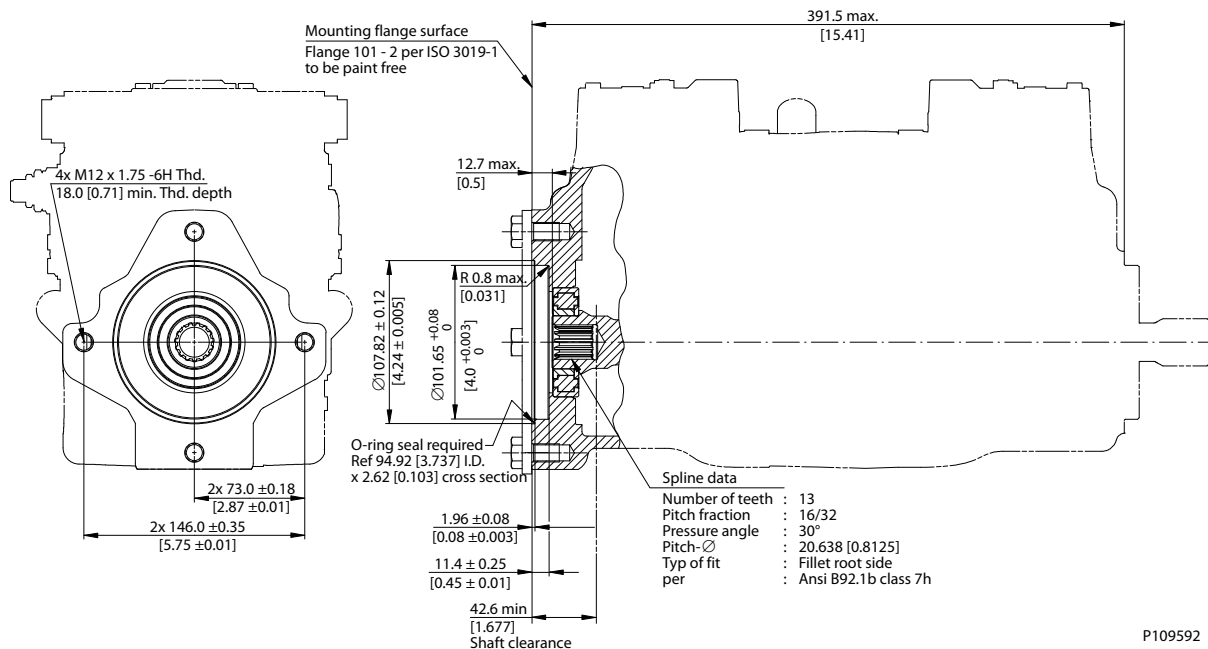
! Caution

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

Dimensions

Option H3 (SAE B, 13 teeth) 045/053

Option H3, ISO 3019-1, Flange 101-2 (SAE B, 13 Teeth)



Specifications

Option	H3
Spline	13 teeth, 16/32 pitch
Maximum torque¹⁾	395 N·m [3500 lbf·in]

¹⁾ For definitions of maximum and rated torque values, refer to *Basic Information BC152886483968*, section Shaft Torque Ratings and Spline Lubrication.

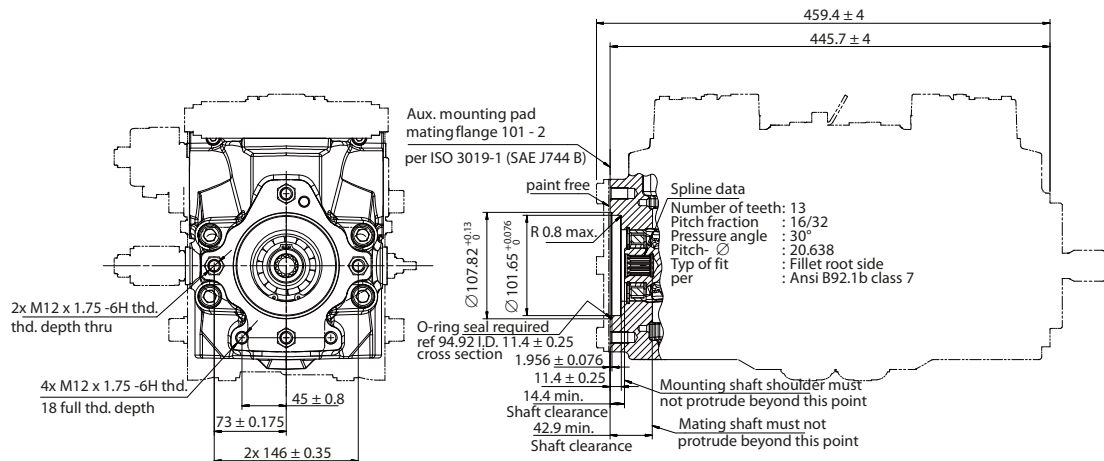
⚠ Caution

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

Dimensions

Option H3 (SAE B, 13 teeth) 060/068

Option H3, ISO 3019-1, Flange 101-2 (SAE B, 13 Teeth)



P109521

Specifications

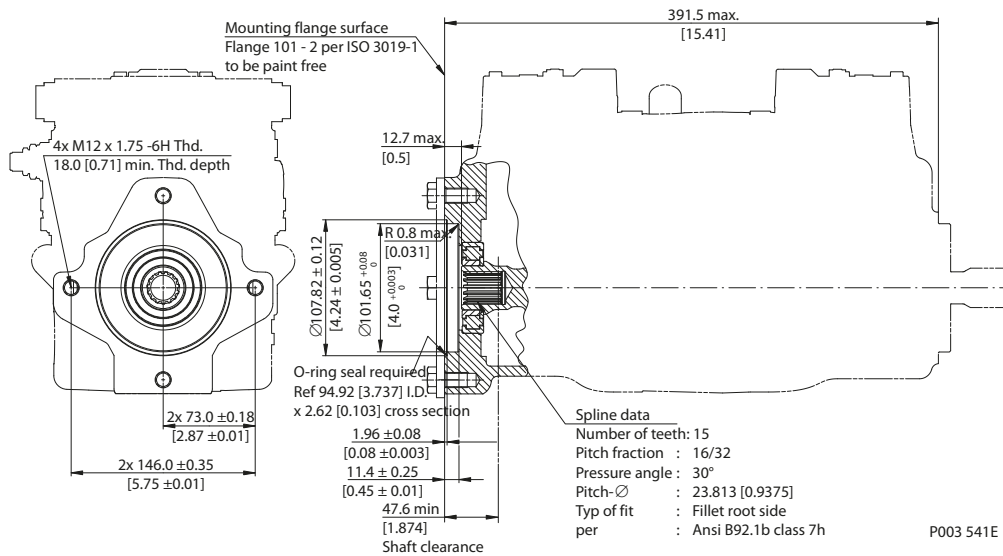
Option	H3
Spline	13 teeth, 16/32 pitch
Maximum torque¹⁾	395 N·m [3500 lbf·in]

¹⁾ For definitions of maximum and rated torque values, refer to *Basic Information BC152886483968*, section Shaft Torque Ratings and Spline Lubrication.

Dimensions

Option H5 (SAE B-B, 15 teeth) 045/053

Option H5, ISO 3019-1, Flange 101-2 (SAE B-B, 15 Teeth)



Specifications

Option	H5
Spline	15 teeth, 16/32 pitch
Maximum torque¹⁾	405 N•m [3580 lbf•in]

¹⁾ For definitions of maximum and rated torque values, refer to *Basic Information BC152886483968*, section Shaft Torque Ratings and Spline Lubrication.

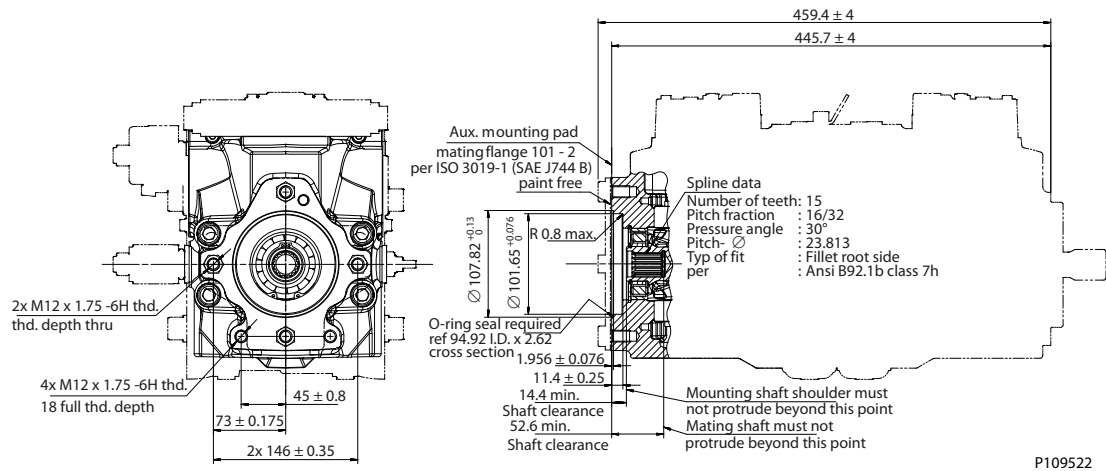
⚠ Caution

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

Dimensions

Option H5 (SAE B-B, 15 teeth) 060/068

Option H5, ISO 3019-1, Flange 101-2 (SAE B-B, 15 Teeth)



Specifications

Option	H5
Spline	15 teeth, 16/32 pitch
Maximum torque ¹⁾	592 N•m [5240 lbf•in]

¹⁾ For definitions of maximum and rated torque values, refer to *Basic Information BC152886483968*, section Shaft Torque Ratings and Spline Lubrication.

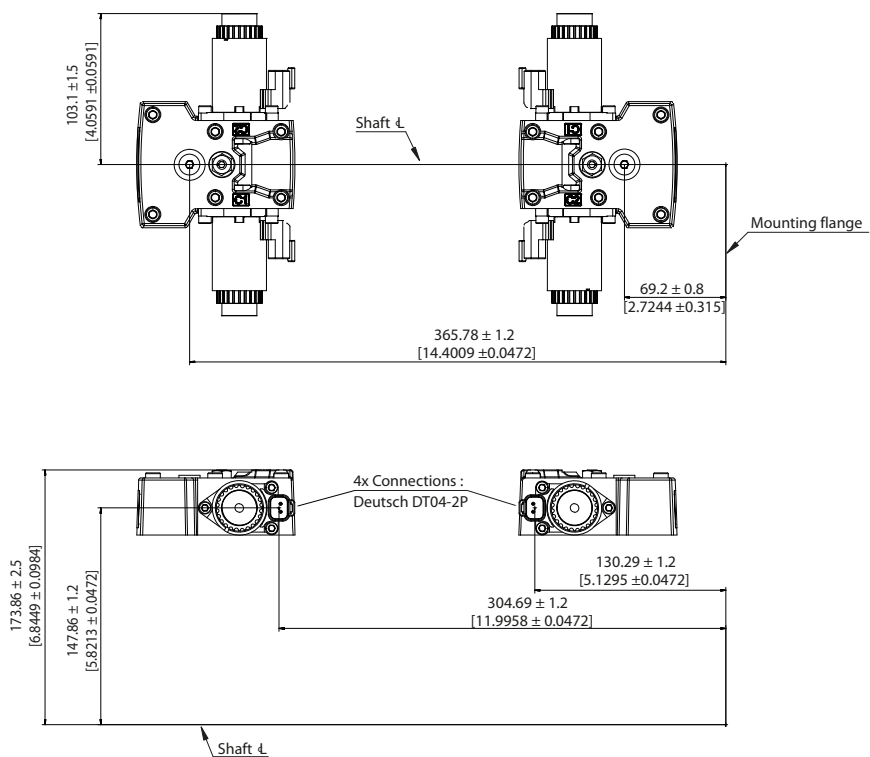
! Caution

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

Dimensions

060/068 Control dimensions

Electric Displacement Control (EDC), option A2 (12V) / A3 (24V) (060/068)



P109544

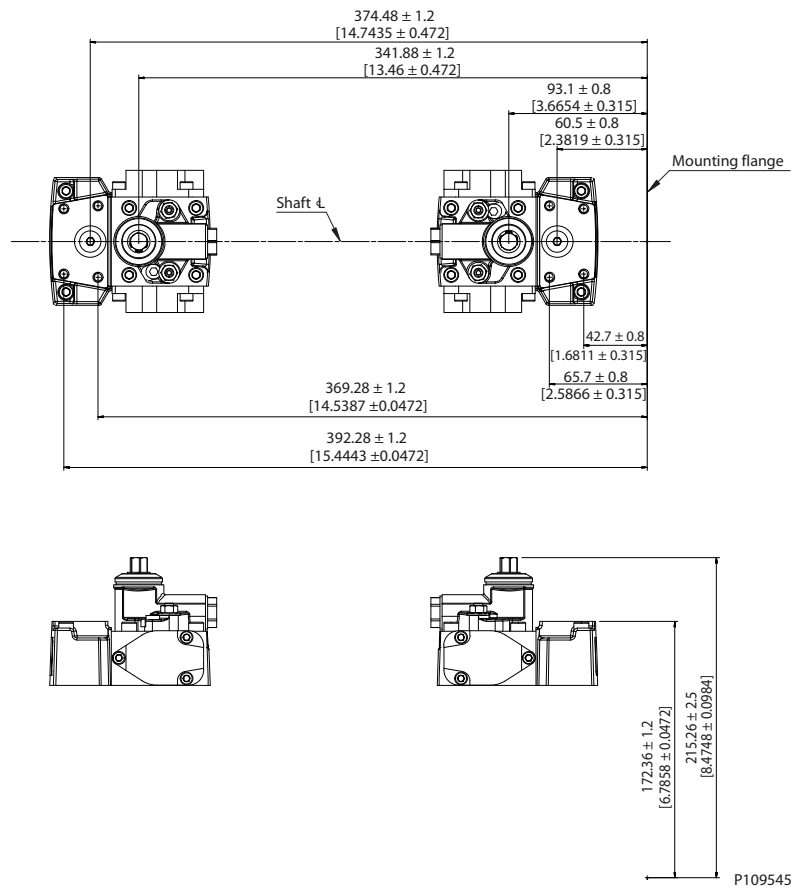
2x Case gauge port **M14**: ISO 11926-1 – 7/16 -20; $\varnothing 21.0$ max clearance dia for fitting

4x Connectors Deutsch DT04-2P to be paint free

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

Dimensions

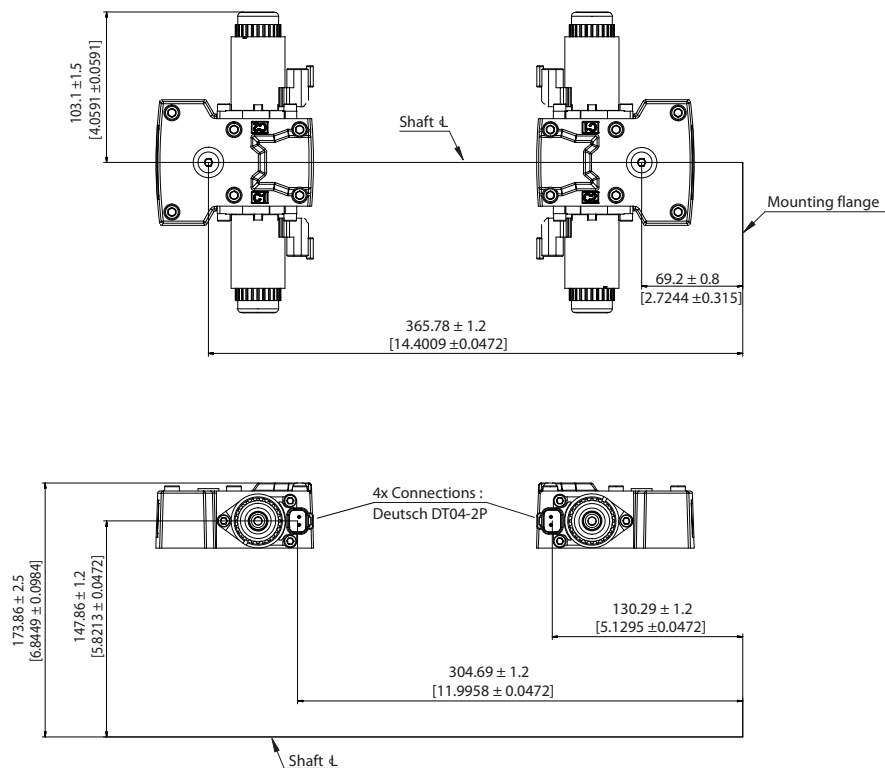
Manual Displacement Control (MDC), option M1 (060/068)



Please contact Danfoss representative for specific installation drawings.

Dimensions

Forward-Neutral-Reverse (FNR) with MOR, option A9 (12 V)/ B1 (24 V) (060/068)



P109546

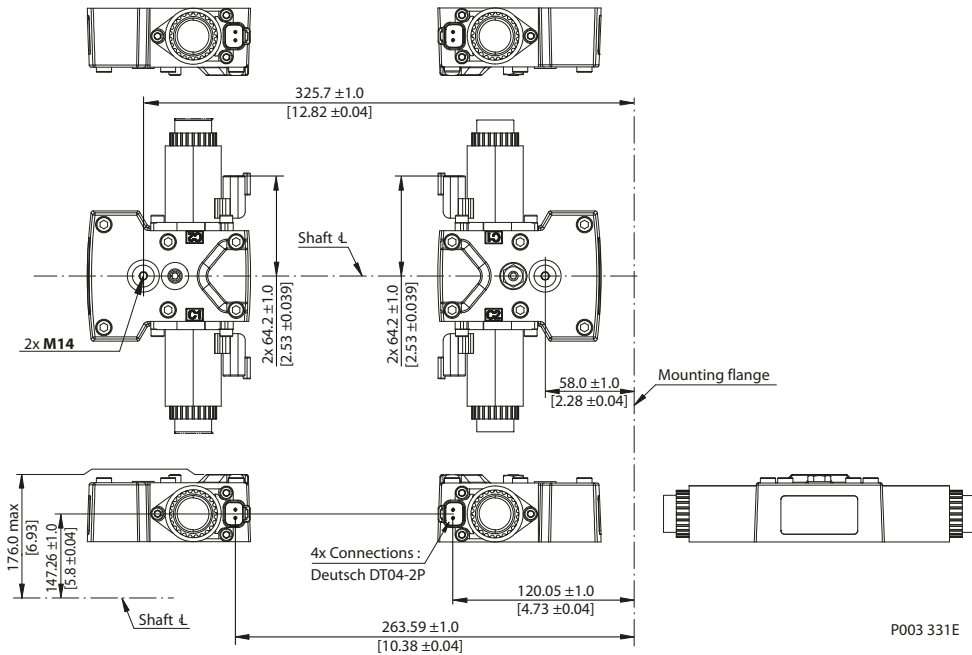
2x Case gauge port **M14**: ISO 11926-1; $\frac{7}{16}$ -20; \varnothing 21.0 max clearance dia for fitting.
 4x Connectors Deutsch DT04-2P to be paint free.

Please contact Danfoss representative for specific installation drawings.

Dimensions

045/053 Control dimensions

Electric Displacement Control (EDC), option A2 (12V) / A3 (24V) H1T (045/053)



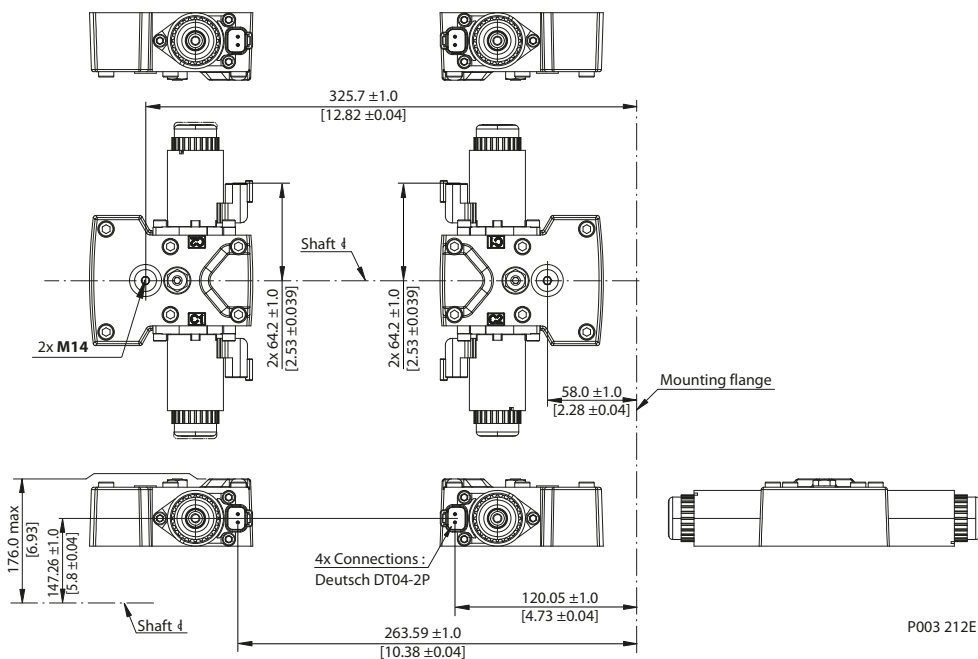
2x Case gauge port **M14**: ISO 11926-1 – 7/16 -20; Ø21.0 max clearance dia for fitting

4x Connectors Deutsch DT04-2P to be paint free

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

Dimensions

Electric Displacement Control (EDC) with MOR, option A4 (12 V) / A5 (24 V) H1T (045/053)



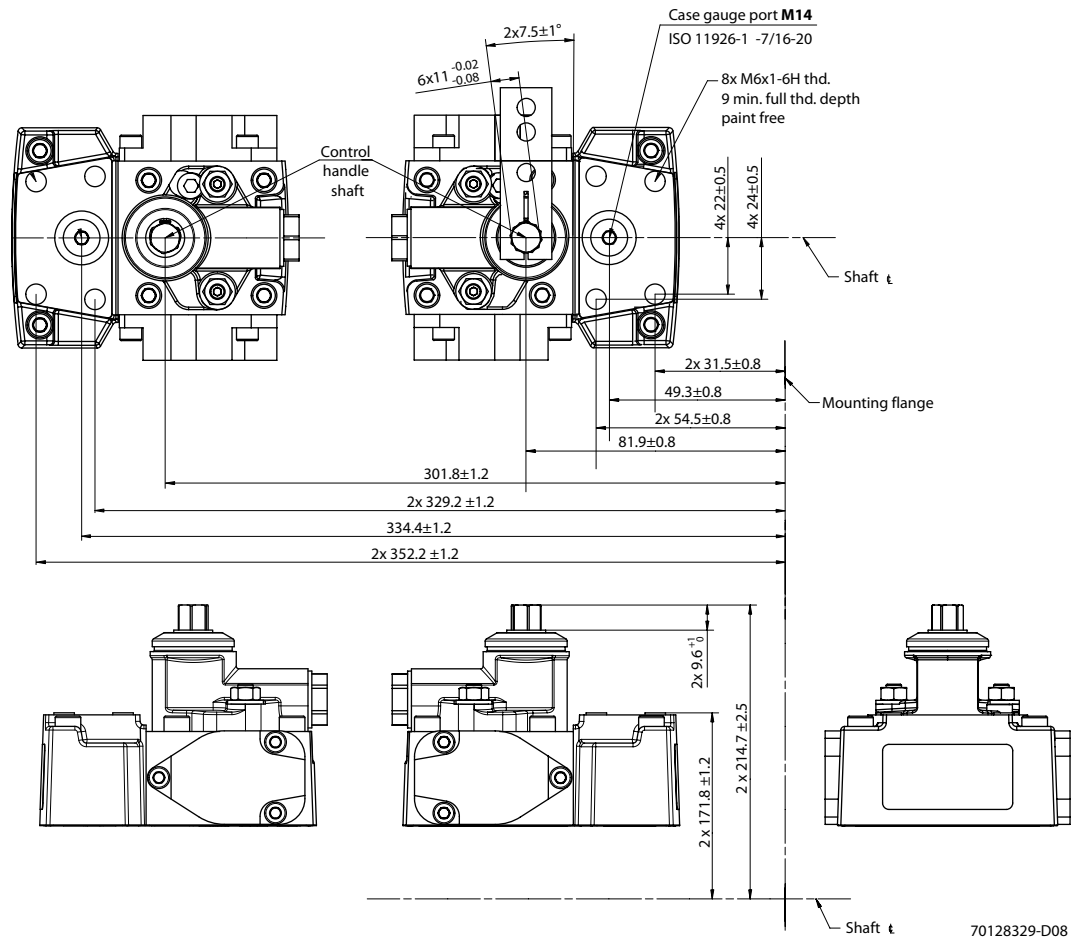
2x Case gauge port **M14**: ISO 11926-1 – 7/16 -20; Ø21.0 max clearance dia for fitting

4x Connectors Deutsch DT04-2P to be paint free

Please contact Danfoss representative for specific installation drawings.

Dimensions

Manual Displacement Control (MDC), option M1, H1T (045/053)

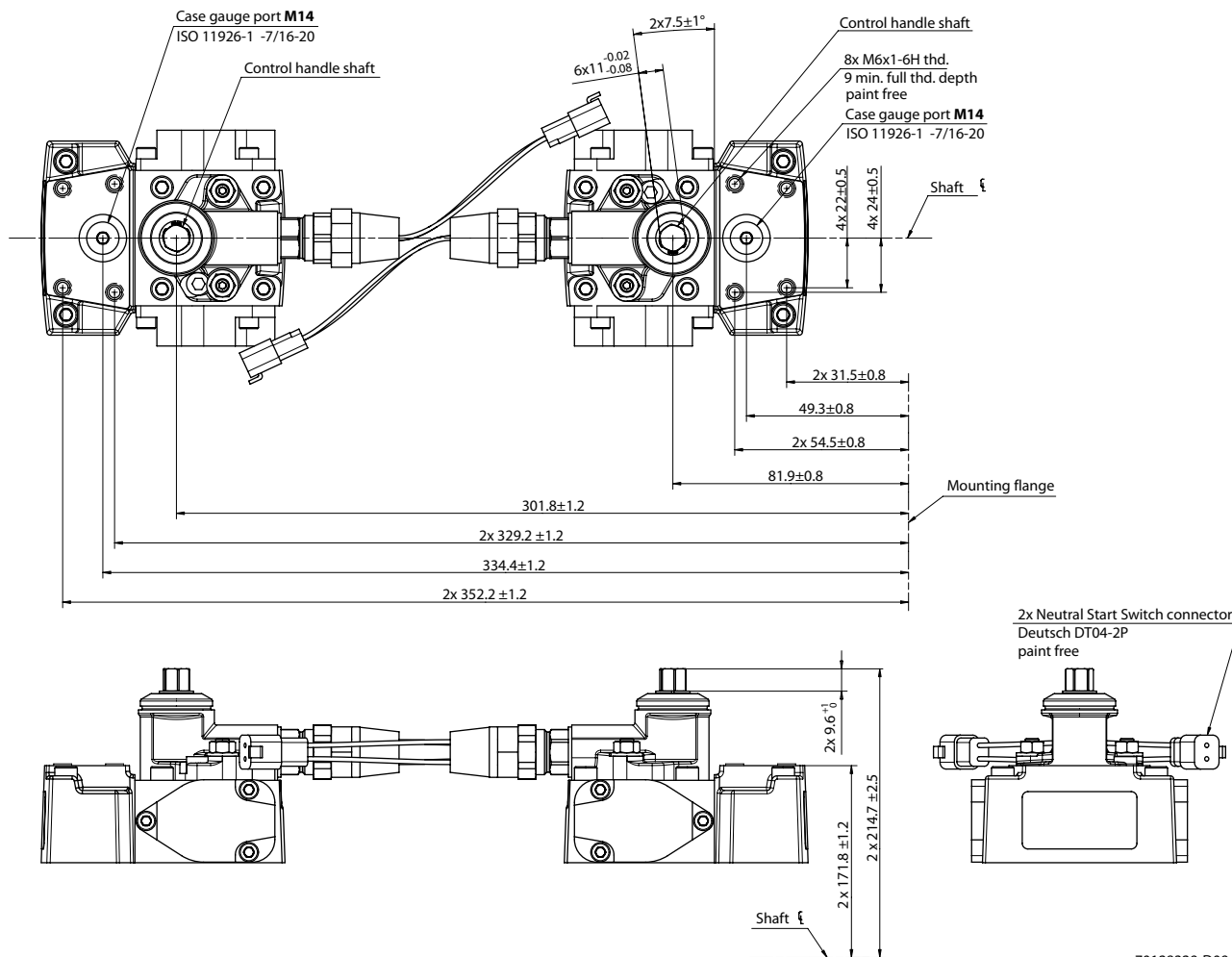


Please contact Danfoss representative for specific installation drawings.

Dimensions

Manual Displacement Control (MDC) with NSS, option M2, H1T (045/053)

H1 Tandem 045/053 Manual Displacement Control (MDC) with NSS, option M2



Neutral Start Switch connector:

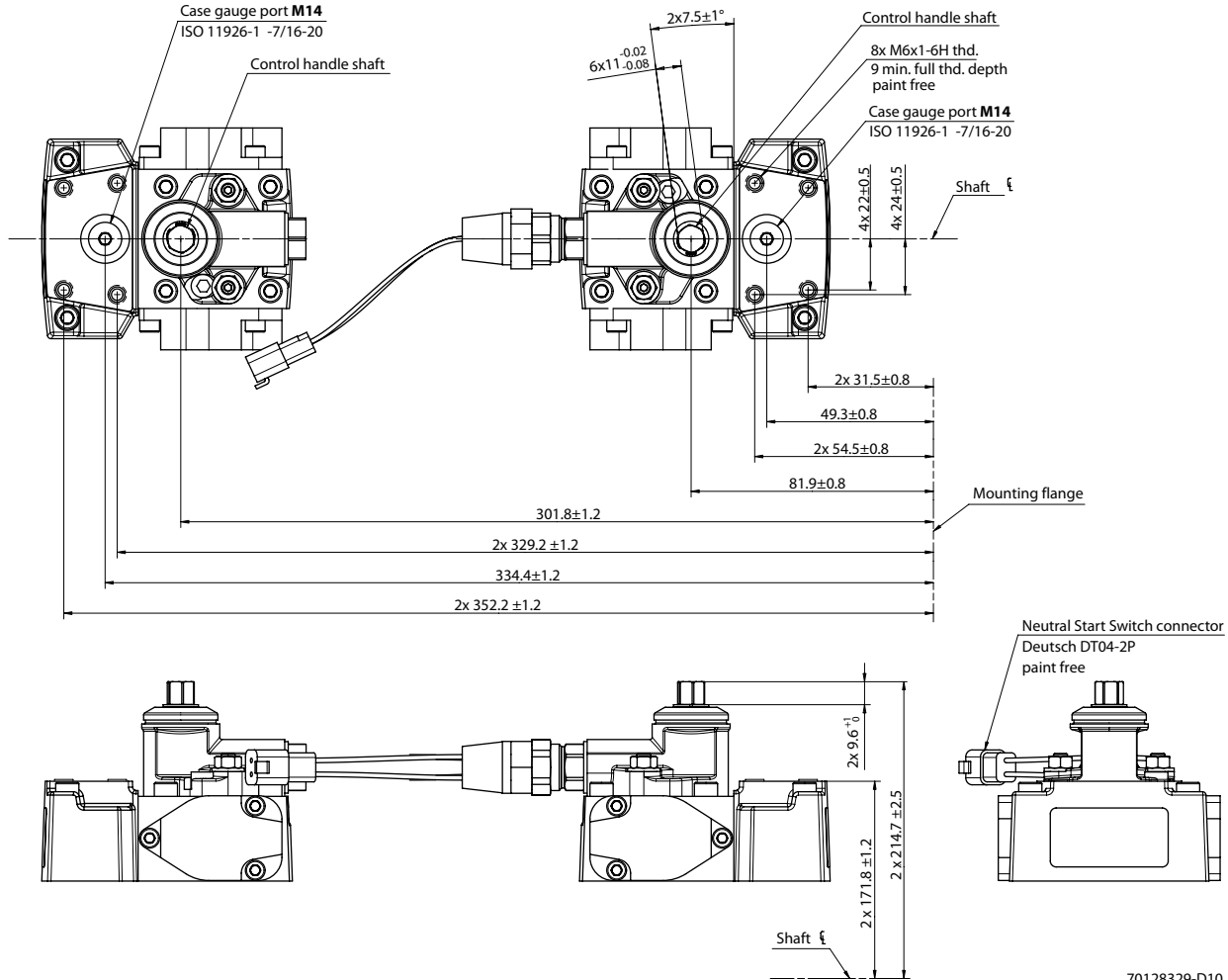
Pin	Assignment		Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions

Manual Displacement Control (MDC) with NSS, option D9, H1T (045/053)

H1 Tandem 045/053 Manual Displacement Control (MDC) with NSS, option D9



70128329-D10

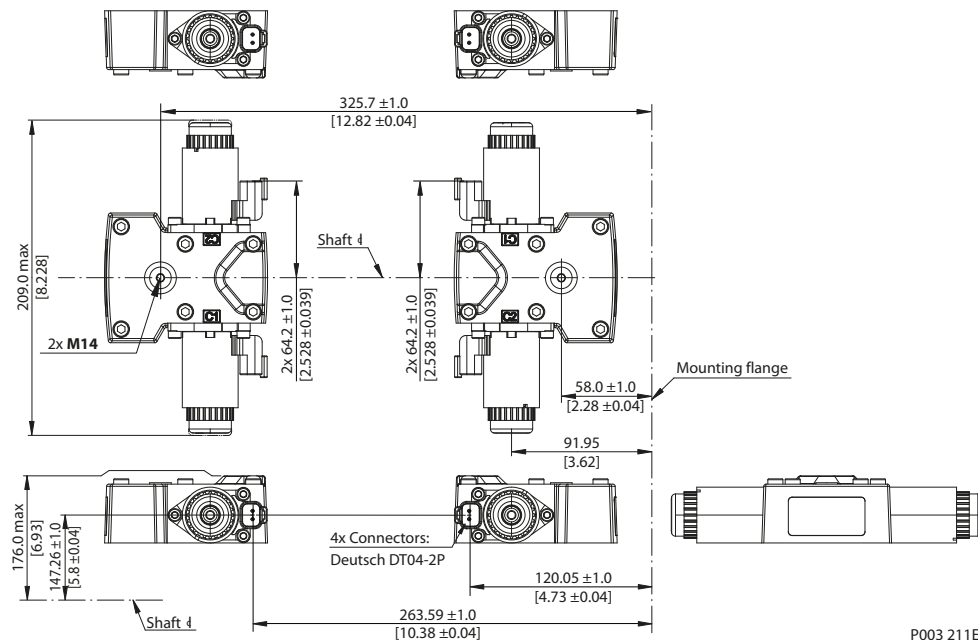
Neutral Start Switch connector:

Pin	Assignment		Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions

Forward-Neutral-Reverse (FNR) with MOR, option A9 (12 V) / B1 (24 V) H1T (045/053)

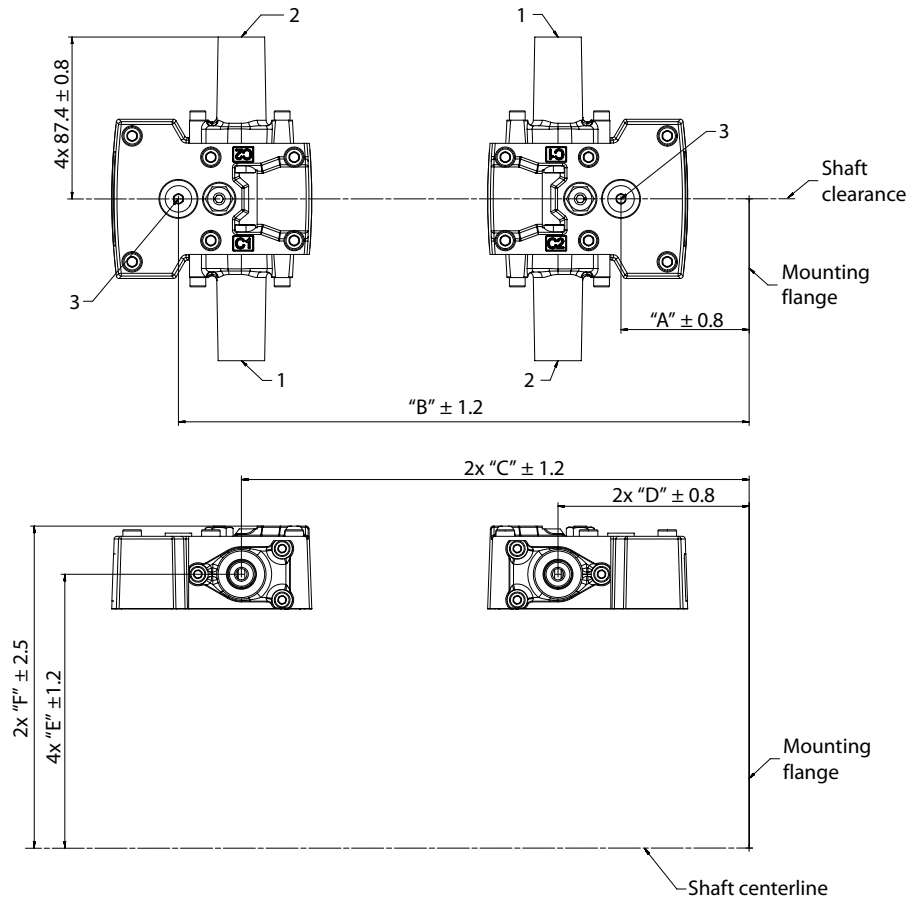


2x Case gauge port **M14**: ISO 11926-1; $\frac{7}{16}$ -20; $\varnothing 21.0$ max clearance dia for fitting.
 4x Connectors Deutsch DT04-2P to be paint free.

Please contact Danfoss representative for specific installation drawings.

Dimensions

HDC, Options: T1, T2



Ports

Item	Description
1	Control signal pressure inlet port "X1" Port ISO 11926-1 - 9/16-18UNF-2B
2	Control signal pressure inlet port "X2" Port ISO 11926-1 - 9/16-18UNF-2B
3	Case gauge port "M14" Port ISO 11926-1 - 7/16-20UNF-2

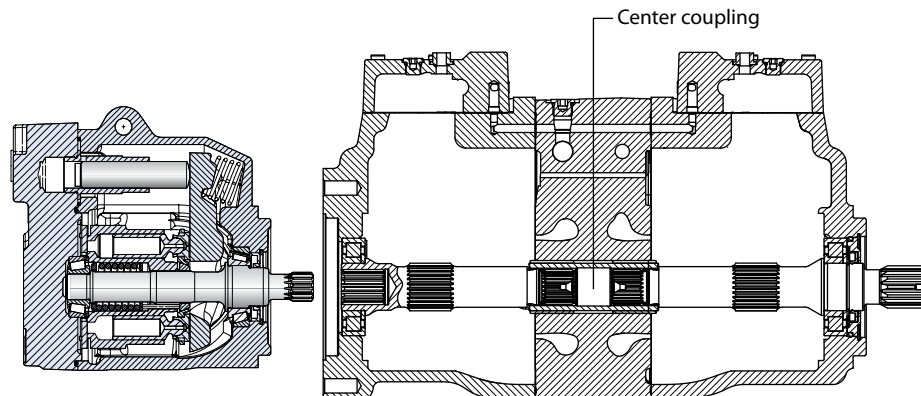
Dimensions in mm [in]

Size	A	B	C	D	E	F
H1T 45/53	58 [2.3]	325.7 [12.8]	291.7 [11.5]	92 [3.6]	147.3 [5.8]	173.3 [6.8]
H1T 60/68	69.2 [2.7]	365.8 [14.4]	331.8 [13.1]	103.2 [4.1]	147.9 [5.8]	173.9 [6.8]

Dimensions

Center section coupling, torque rating

Torque rating for center section coupling



P003 203E

Maximum torque for center coupling

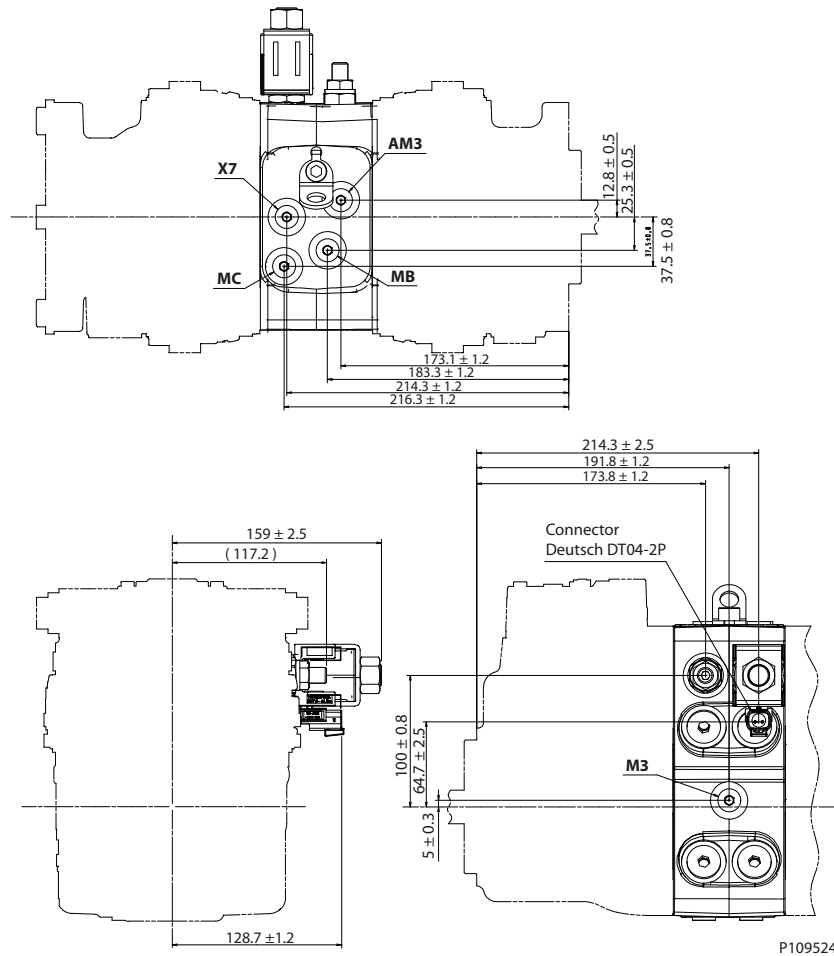
Model	Max. torque
045/053	405 N•m [3580 lbf•in]
060/068	592 N•m [5040 lbf•in]

For definitions of maximum and rated torque values, refer to *Basic Information* [BC152886483968](#), section *Shaft Torque Ratings and Spline Lubrication*.

Dimensions

Control Cut Off (CCO)

045/053 CCO



Mounting flange, shaft and connector surfaces to be paint free.

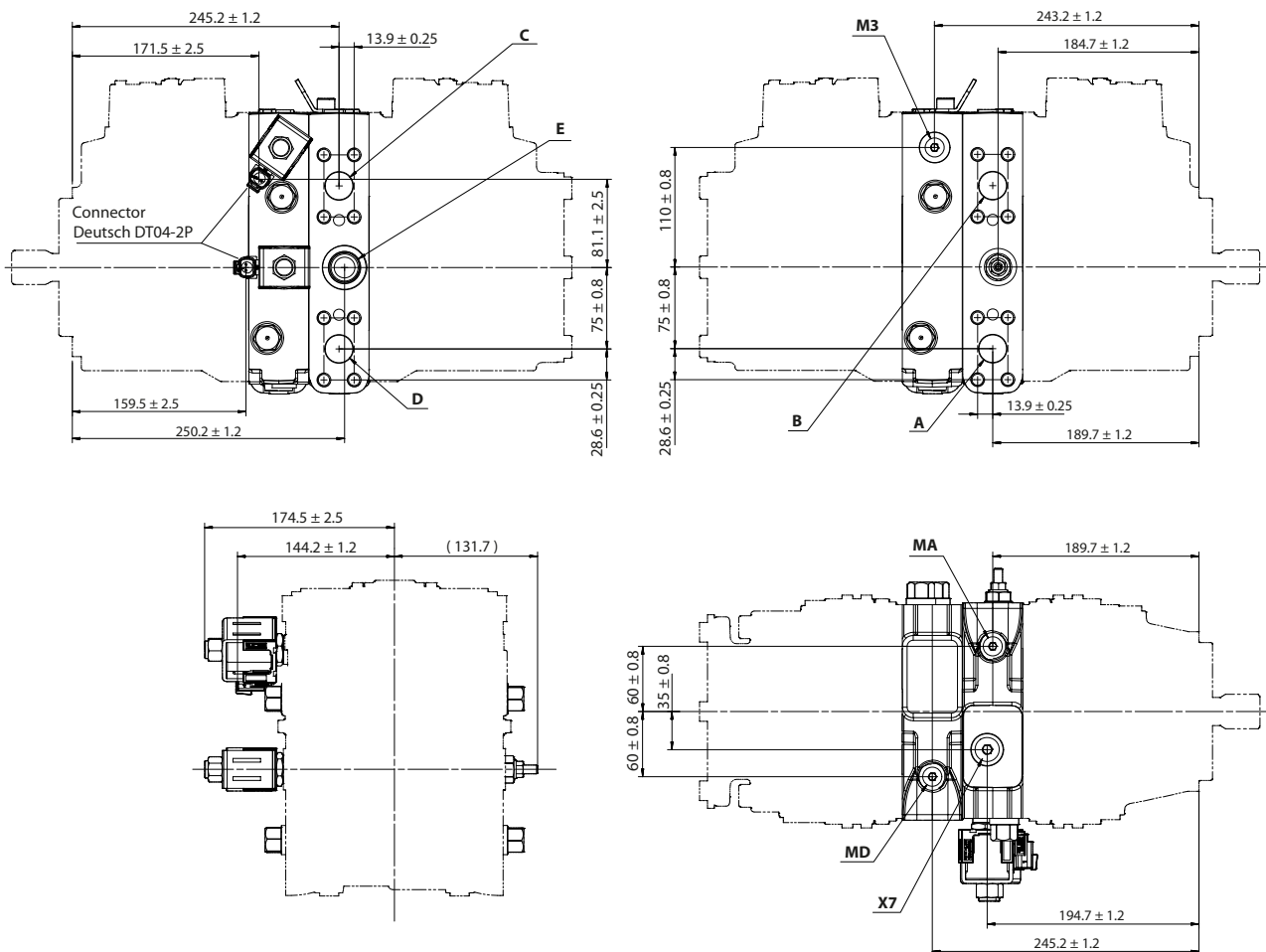
Ports description, ISO 11926-1

Ports	Description	Size
MB, MC	System gauge ports B, C ; $\text{Ø}28$ max. clearance for fitting	$\frac{9}{16} - 18$
AM3	Charge constr. port; $\text{Ø}28$ max. clearance for fitting	$\frac{9}{16} - 18$
X7	Brake gauge port	$\frac{9}{16} - 18$
M3	Charge Gauge Port	$\frac{9}{16} - 18$

Please contact Danfoss representative for specific installation drawings.

Dimensions

060/068 CCO



P109525

Mounting flange, shaft and connector surfaces to be paint free.

Ports description, ISO 11926-1

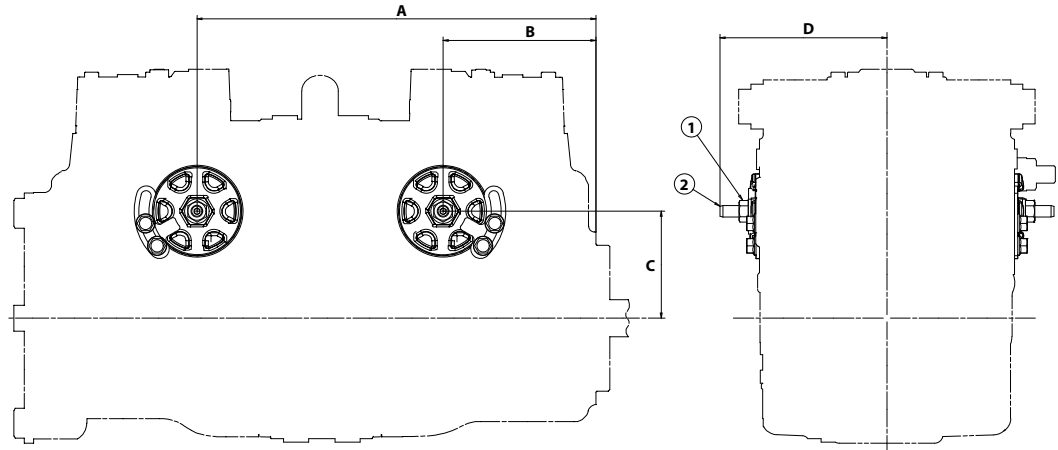
Ports	Description	Size
A, B, C, D	System ports	Split flange, M12 x 1.75
MA, MD	System gauge ports A, D	9/16 - 18
E	Charge inlet port	1 1/16 - 12
X7	Brake gauge port	3/4 - 16
M3	Charge Gauge Port	9/16 - 18

Please contact Danfoss representative for specific installation drawings.

Dimensions

Displacement limiter, H1 Tandem, option B

045/053 shown



P109539

	Description	Wrench size	Torque
1	Seal nut	13 mm external hex	23 Nm [17 lbf·ft]
2	Adjustment screw	4 mm internal hex	-

Dimensions

	045/053	060/068
A	277.4 ± 1.2	314 ± 1.2
B	106.2 ± 0.8	120 ± 1.2
C	74.4 ± 0.8	79.5 ± 0.8
D	(116.1)	128.2

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

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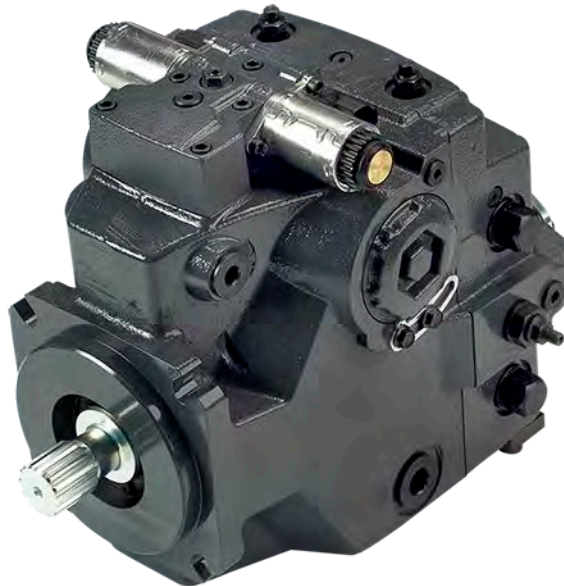
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Technical Information

H1P 069/078

Axial Piston Single Pumps



Revision history*Table of revisions*

Date	Changed	Rev
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

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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
Displacement	69.2 cm ³ [4.22 in ³]	78.1 cm ³ [4.77 in ³]
Flow at rated speed (continuous)	243 l/min [53.5 US gal/min]	273 l/min [72 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]
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]
Mass (dry-no charge pump)	56 kg [123 lb]	56 kg [123 lb]
Oil volume	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)	<ul style="list-style-type: none"> • Outer Ø32 mm – 4 (SAE C, 14 teeth) • Outer Ø35 mm – 4 (SAE C, 21 teeth) • Outer Ø38 mm – 4 (SAE C-C, 23 teeth) • 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	<ul style="list-style-type: none"> • Flange 82-2 (SAE A, 9 teeth and 11 teeth) • Flange 101-2 (SAE B, 13 teeth and SAE B-B, 15 teeth) • 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)
Other ports	SAE O-ring boss
Customer interface threads	Metric fasteners

Technical Specifications

H1P 069/078 Operating Parameters

Parameter		Unit	Size 069/078
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		16 [232]
	Maximum		35 [508]
Control pressure	Minimum (at corner power for EDC, MDC, FNR)	bar [psi]	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		4.0 [58.0]
Case pressure	Rated	bar [psi]	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 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 μm

Technical Specifications

Fluid Specification

Viscosity

Intermittent¹⁾	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

Minimum¹⁾	-40°C [-40°F]
Rated	104°C [220°F]
Recommended range²⁾	60 – 85°C [140 – 185°F]
Maximum Intermittent	115°C [240°F]

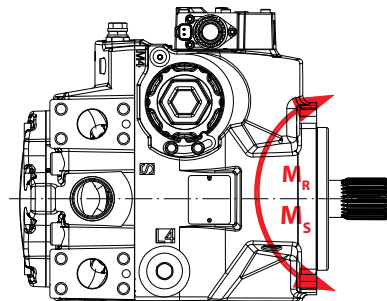
¹⁾ Cold start = Short term t > 3 min, p ≤ 50 bar [725 psi], n ≤ 1000 min⁻¹ (rpm).

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

H1P 069/078 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

$$M_R = 3700 \text{ N}\cdot\text{m} [32\,750 \text{ lbf}\cdot\text{in}]$$

Shock load moment

$$M_S = 7900 \text{ N}\cdot\text{m} [69\,920 \text{ lbf}\cdot\text{in}]$$

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.

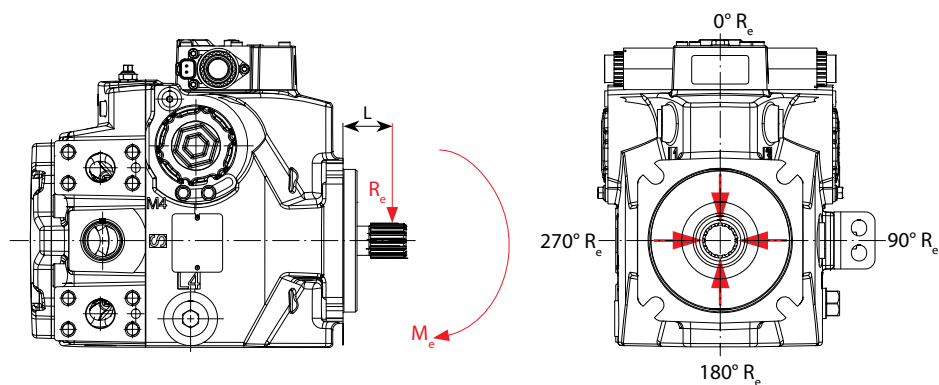
Danfoss recommends clamp-type couplings for applications with radial shaft loads. Contact your Danfoss representative for an evaluation of unit bearing life if you have continuously applied external loads exceeding 25 % of the maximum allowable radial load (R_e) or the pump swash-plate is positioned 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 cm³ Charge Pump – Flow and Power Curves

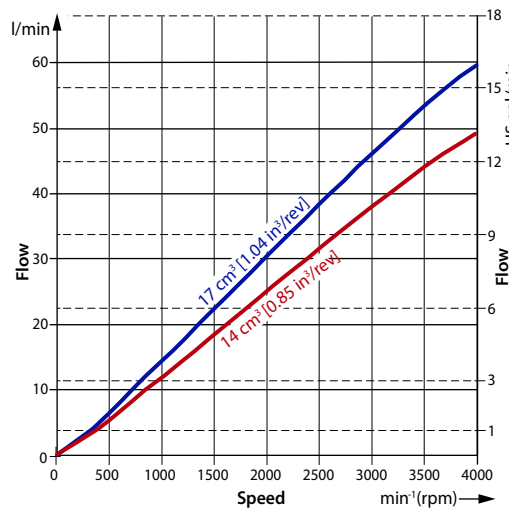
Charge pump flow and power requirements curves shown below at the following conditions:

Charge pressure = 20 bar [290 psi]

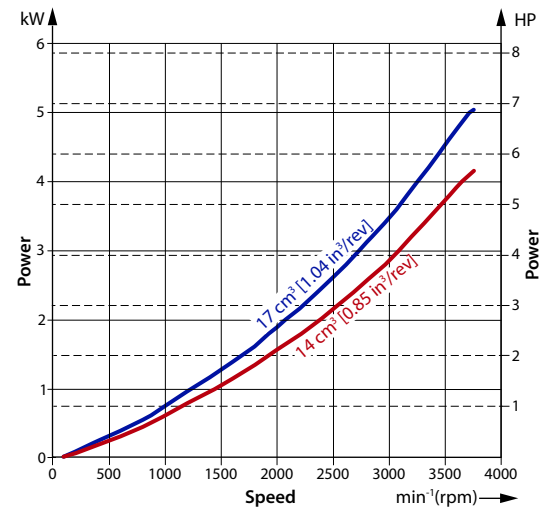
Viscosity = 11 mm²/s [63 SUS]

Temperature = 80°C [176°F]

Charge pump flow



Charge pump power requirements



Master Model Code

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

M, N—Overpressure Protection Settings



M and N – Overpressure protection options

L	Pressure limiter setting	HPRV with bypass setting ¹⁾
L15	150 bar [2900 psi]	230 bar [3336 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”.

Control Options

Electrical Displacement Control (EDC)

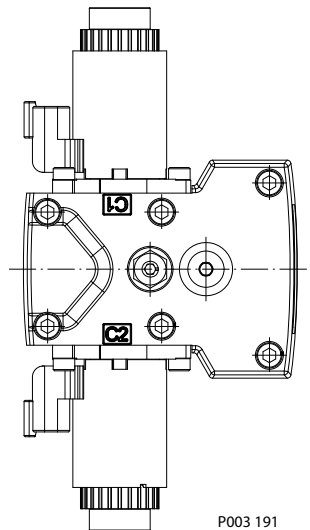
An EDC is a displacement (flow) control. Pump swash plate position is proportional to the input command and therefore vehicle or load speed (excluding influence of efficiency), is dependent only on the prime mover speed or motor displacement.

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.

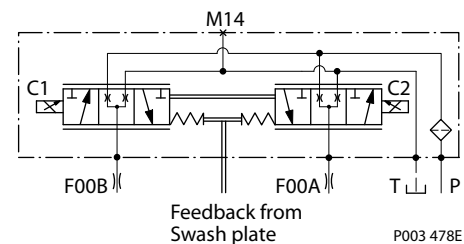
A serviceable 170 μm screen is located in the supply line immediately before the control porting spool.

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.

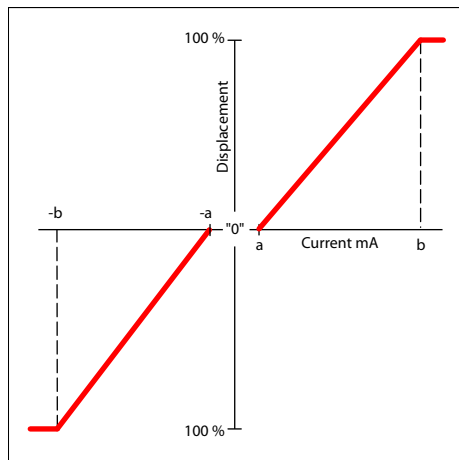
The neutral position of the control spool does provide a positive preload pressure to each end of the servo piston assembly.

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, EDC 069/078

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)	
	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 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:

$\Delta p = 250 \text{ bar}$ [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 069/078

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.

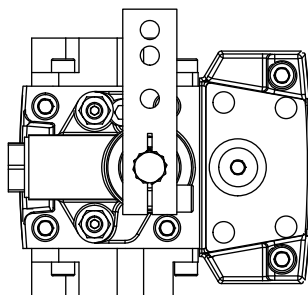
Differential pressure across the servo piston rotates the swash plate, changing the pump's displacement. Simultaneously the swashplate movement is fed back to the control spool providing proportionality between shaft rotation on the control and swash-plate rotation. The MDC changes the pump displacement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

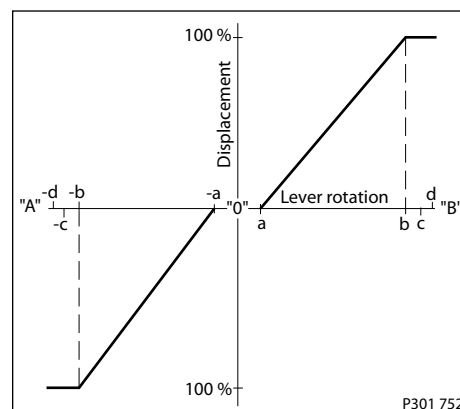
For the MDC with CCO option the brake port (X7) provides charge pressure when the coil is energized to activate static function such as a brake release. The X7 port must not be used for any continuous oil consumption.

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.

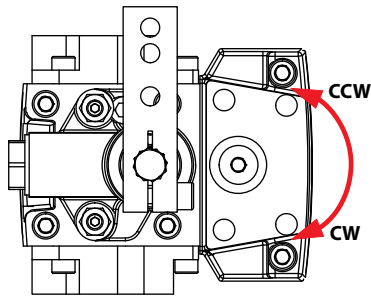
High case pressure may cause excessive wear and the NSS to indicate that the control is not in neutral position. In addition, if the case pressure exceeds 5 bar there is a risk of an insufficient restoring moment. The MDC is designed for a maximum case pressure of 5 bar and a rated case pressure of 3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

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

Control Options

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, MDC 069/078

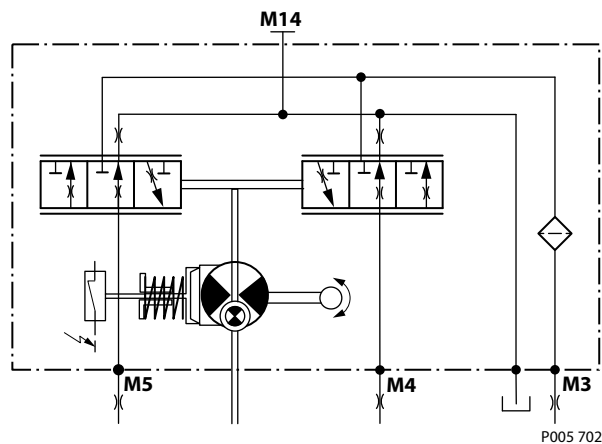
Code	Orifice description (mm)			Stroking direction	
	Tank (A+B)	P	A/B	Neutral to full flow	Full flow to neutral
C3	No orifice			0.4 s	0.5 s
C6	1	–	–	1.4 s	1.1 s
C7	1.3	–	–	0.9 s	0.8 s
D1	0.8	1	–	2.5 s	1.9 s
D2	0.8	1.3	–	2.2 s	1.7 s
D3	1	1.3	–	1.6 s	1.2 s
D4	1	1.3	1.3	1.9 s	1.5 s

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)

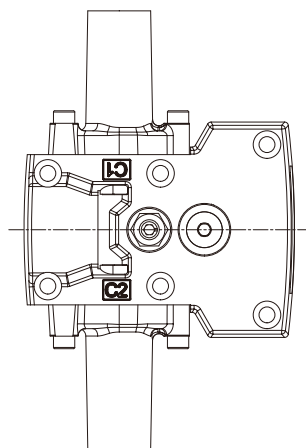
HDC principle

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.

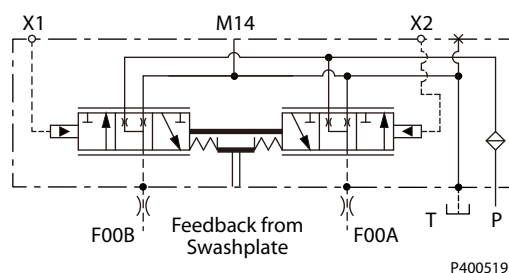
A serviceable 175 µm screen is located in the supply line immediately before the control porting spool.

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.

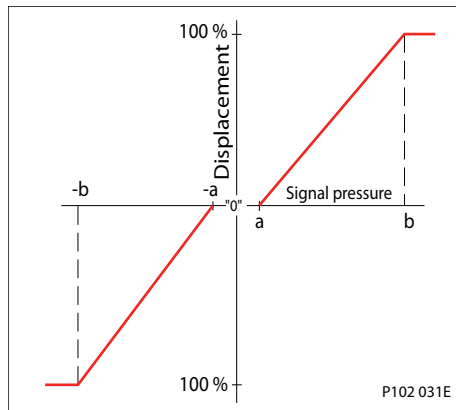
A swashplate feedback link, opposing control linkage, and a linear spring provide swashplate position force feedback to the hydraulic pressure. As hydraulic pressures in the operating loop change with load, the control assembly and servo/swashplate system work constantly to maintain the commanded position 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	
	X1	X2	X1	X2
Port energized	Out (high)	In (low)	Out (high)	In (low)
Port A	In (low)	Out (high)	In (low)	Out (high)
Port B	Out (high)	In (low)	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 swashplate 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:

$\Delta p = 250 \text{ bar}$ [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)

Control Options

Response time, HDC 069/078

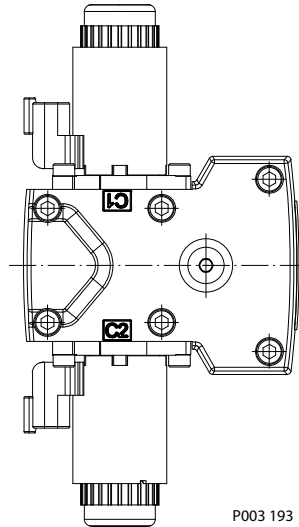
Stroking direction	0.8 mm [0.03 in] orifice	1.3 mm [0.05 in] orifice	No orifice
Neutral to full flow	2.1s	1s	0.7s
Full flow to neutral	1.5s	0.7s	0.4s

Control Options
Forward-Neutral-Reverse Control (FNR)

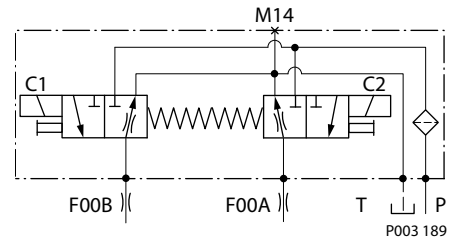
The 3-position FNR control options **A9** (12 V) and **B1** (24 V) uses an electric input signal to switch the pump to a full stroke position. A serviceable 125 μm screen is located in the supply line immediately before the control porting spool.

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

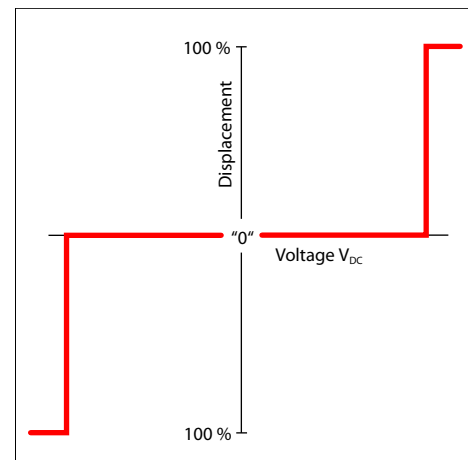
Forward-Neutral-Reverse electric control (FNR)



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

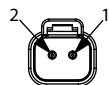
Single Pump Output Flow Direction

Shaft rotation	Clock-Wise (CW)		Counter-Clock-Wise (CCW)	
	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.

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

Response Time, FNR 069/078

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

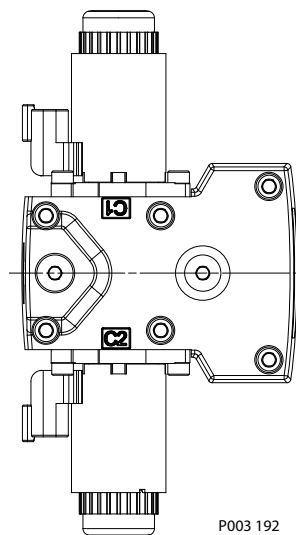
Non feedback proportional electric control (NFPE)

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.

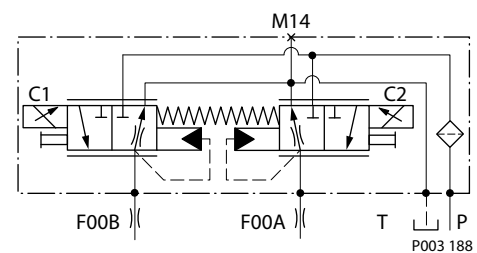
A serviceable 170 μm screen is located in the supply line immediately before the control porting spool.

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

NFPE control



NFPE schematic

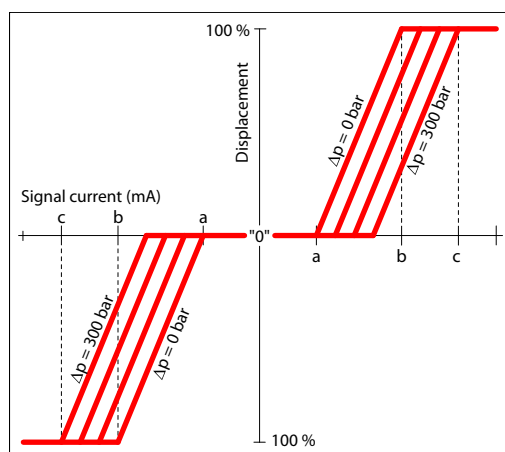


Control Signal Requirements, NFPE 069/078

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)	
	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.

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:

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

Charge pressure = 20 bar [290 psi]

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

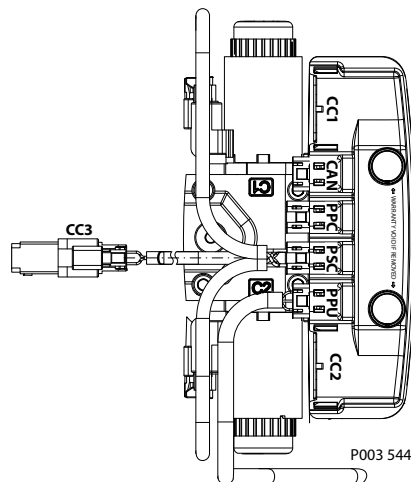
Speed = 1800 min⁻¹ (rpm)

Response Time, NFPE 069/078

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

Automotive Control (AC)

The H1 **Automotive Control (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 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
- 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

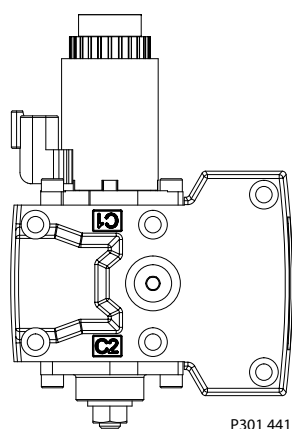
Fan Drive Control (FDC)

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.

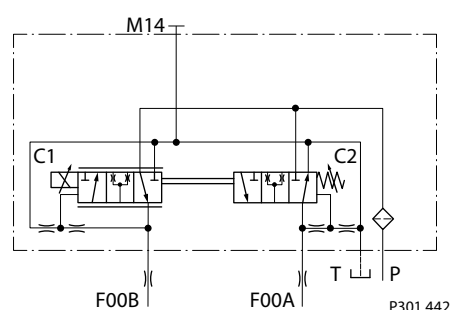
The control spool is spring biased to produce maximum forward pump displacement in the absence of an electrical input signal. Based on the spring bias spool default forward flow for a CW rotation pump is out of port B while default forward flow for a CCW rotation pump is out of port A.

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!

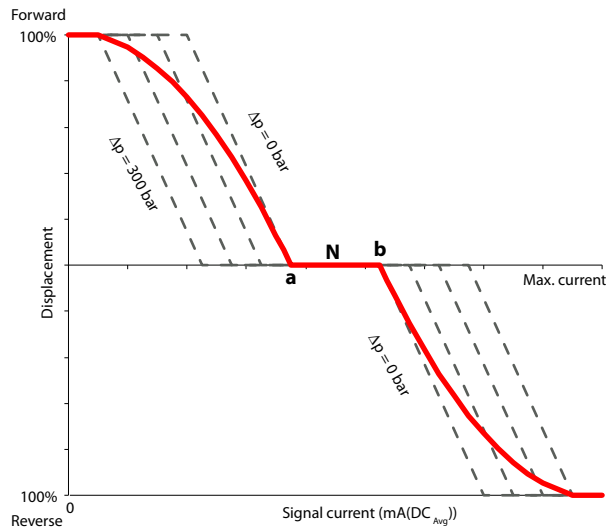
Due to the fail-safe functionality of the FDC control the pump will stroke to max. displacement in case the input signal to the pump control and the Diesel engine will be switched off at the same time. In this situation a low loop event can occur which may damage the pump. Therefore, it's strictly recommended 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, FDC 069/078

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:

$\Delta p = 250 \text{ bar}$ [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 069/078

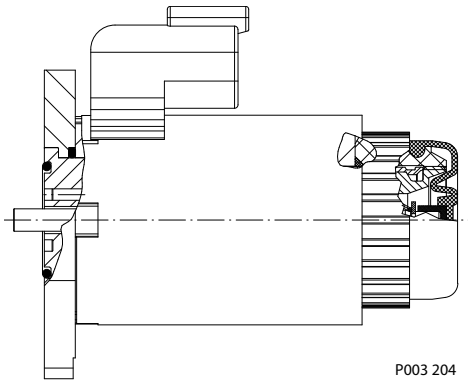
Stroking direction	0.8 mm [0.03 in] orifice
Full flow to neutral	2.9 s
Full forward flow to full reverse flow	4.3 s

Control Options

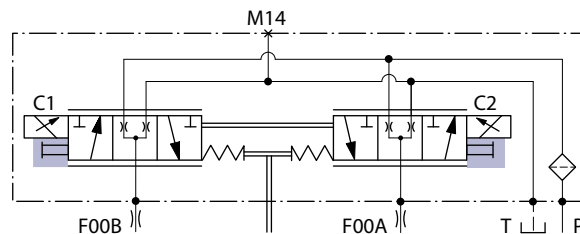
Manual Override (MOR)

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

Control Options

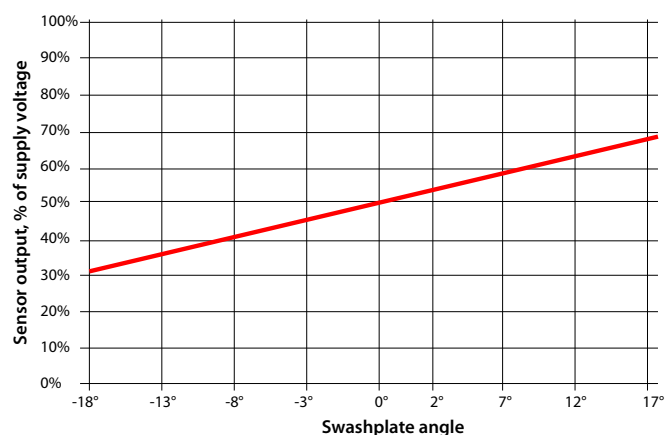
Swashplate angle sensor for EDC controls

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

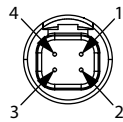
Control Options

Calibration of the sensor output within the software is mandatory. Vehicle neutral thresholds in the software ($\pm 0.5^\circ$) 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.

H1P Swash Plate Angle Sensor Connector

Connector DEUTSCH, 4-pin

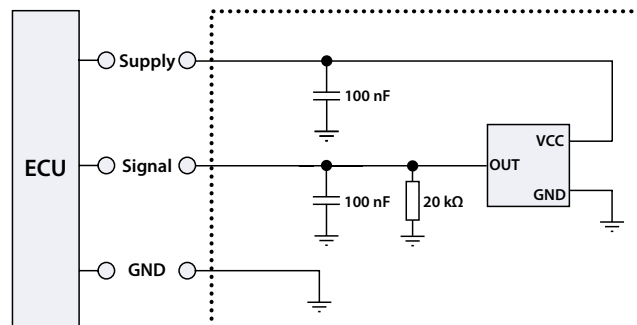


- 1** Ground (GND)
- 2** Not connected
- 3** Output signal 1 (SIG 1)
- 4** Supply (V+)

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

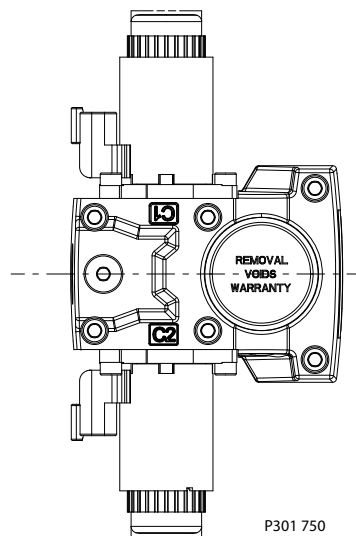


Control Options

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.

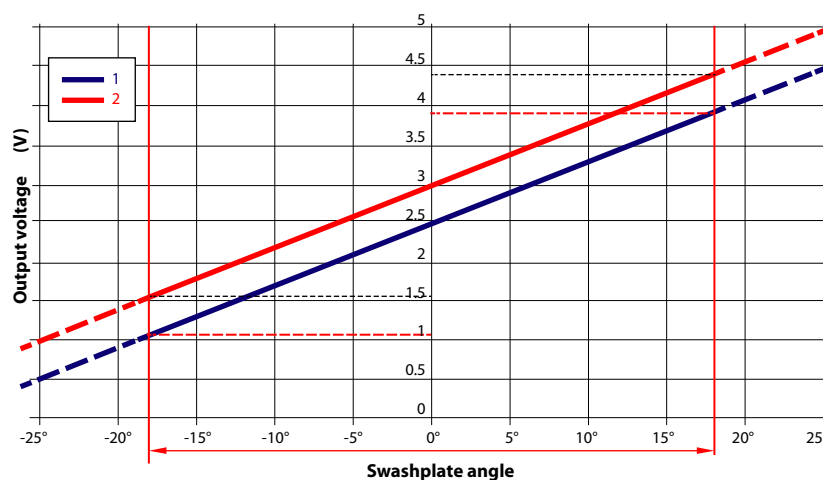
The output signal give a linear output voltage for the various magnet positions in the sensing range.



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:

$$V = \frac{\tan \alpha \cdot V}{\tan 18^\circ} \text{ (cm}^3\text{)}$$

The corresponding flow is:

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

Control Options

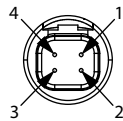
Swash Plate Angle Sensor Parameters (NFPE/AC)

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)

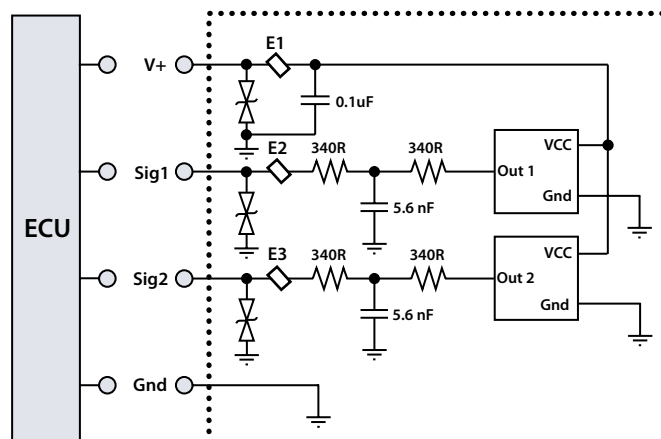
H1P Swash Plate Angle Sensor Connector (NFPE)



- 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.

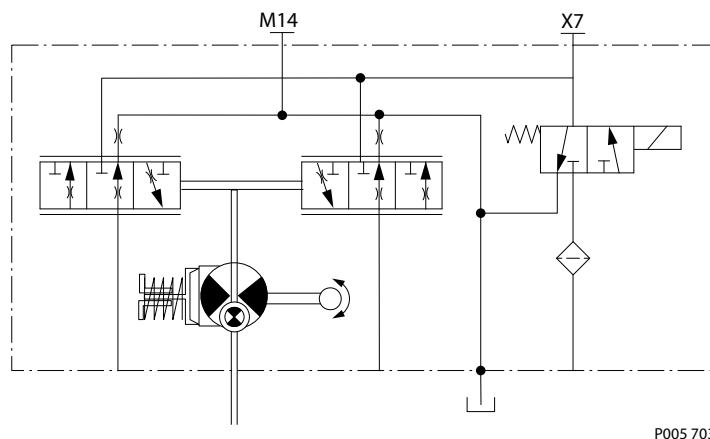
When the solenoid is energized, charge flow and pressure is allowed to reach the pump control. The X7 logic port will also be connected to charge pressure and flow.

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	

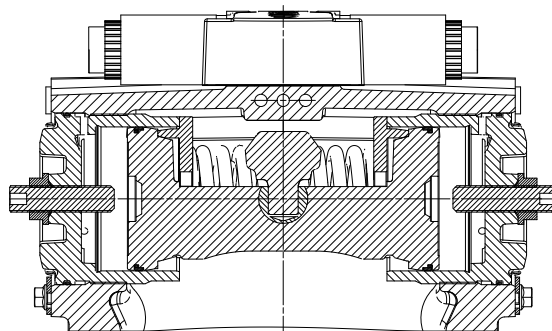
CCO solenoids are design for battery voltage application within the voltage range in the table above, in consideration of a wide range of environmental temperature common for known hydraulic applications. Closed loop PWM current supply can be also applied and is helpful in case that the voltage range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

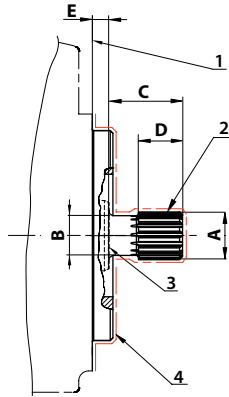


P003 266

H1P 069/078 Displacement Change (approximately)

Parameter	Size 069	Size 078
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, $\text{Ø}29.633$ [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
$\text{Ø}31.14 \pm 0.08$ [1.226 ±0.003]	$\text{Ø}26.0 \pm 0.25$ [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.

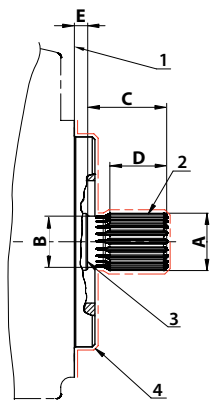
Torque rating

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.

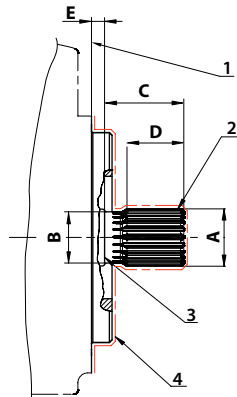
Torque rating

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.

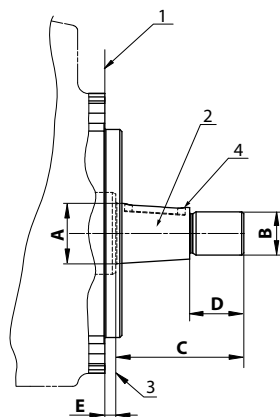
Torque rating

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 $125 \pm 10.5 : 1000$;
 Suitable key: $\frac{3}{8} \times \frac{3}{8} \times 1\frac{1}{2}$ per ANSI B17.1
3. Coupling must not protrude beyond this point
4. Shaft to be paint free

Dimensions

A	B	C	D	E
$\text{Ø}38.1 \pm 0.09$ [1.5 ± 0.004]	$1\frac{1}{8} - 12\text{UNF}$	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.

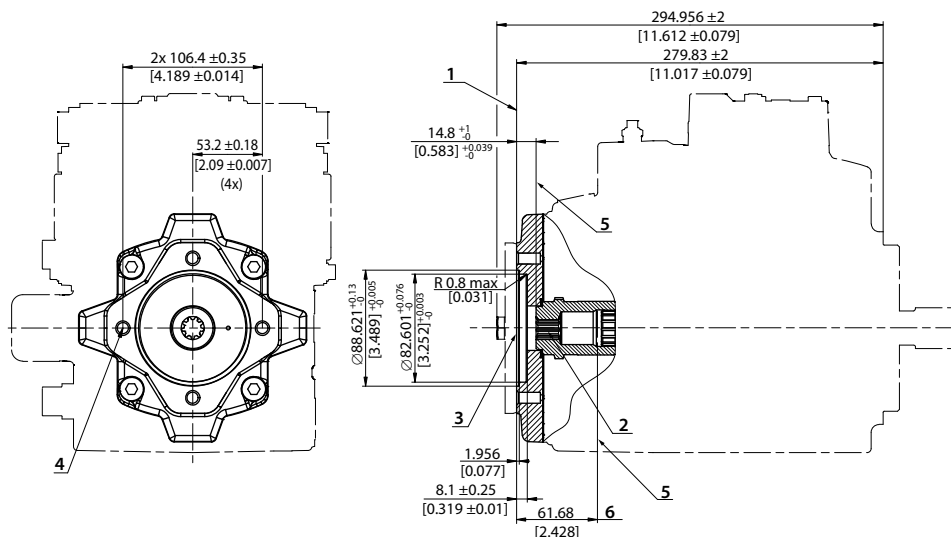
Danfoss recommends a self-locking nut instead of a castle nut and pin. The nut and mating square-cut key are customer supplied. The specified torque rating of the tapered shaft is based on the cross-sectional diameter of the shaft, through the keyway, and assumes the proper clamp and fit between shaft 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 H2 (SAE A, 9 teeth)



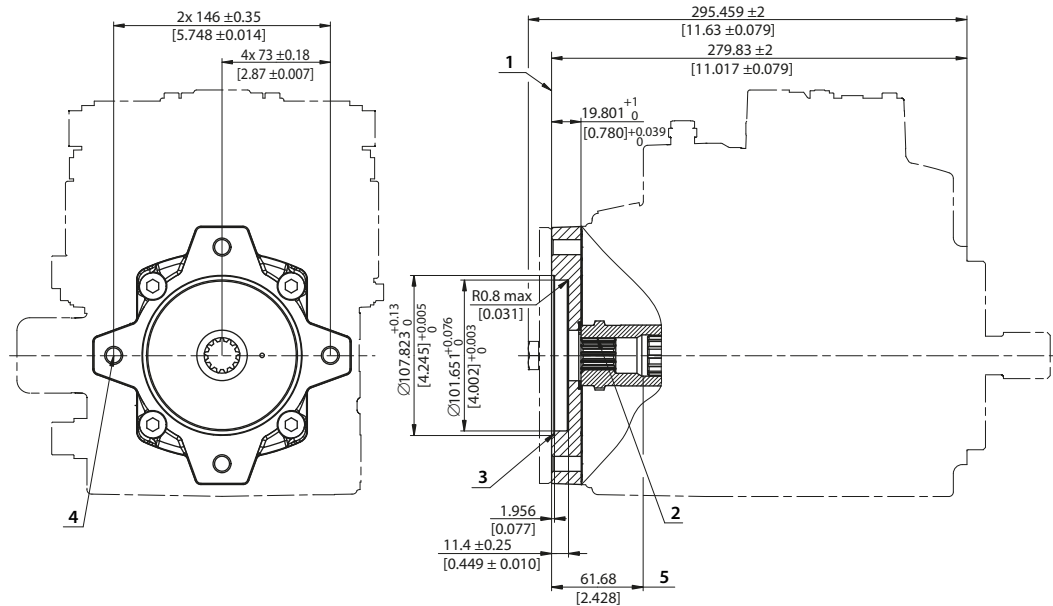
1. Auxiliary mounting pad for mating flange 82-2 per ISO 3019-1 (SAE A); Paint free
2. **Spline Data:** 9 teeth, Pressure angle: 30°; Pitch: 16/32, Ø14.288 [0.5625]; Fillet root side fit per ANSI B92.1-1996, Class 6; minimum active spline length 8.6 mm
3. O-ring seal required; Ref. Ø82.22 ID x 2.62, cross section
4. Thread: M10x1.5-6H; 15 [0.59] min. depth; Recommended screw in depth 1.5 x thread dia (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum Torque	162 N·m [1430 lbf·in]
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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 (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, $\varnothing 20.638$ [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. $\varnothing 94.92$ ID x 2.62, cross section
4. Thread: M12x1.75-6H; 20 [0.787] min. depth; Recommended screw in depth 1.5 x thread dia (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum Torque	395 N·m [3500 lbf·in]
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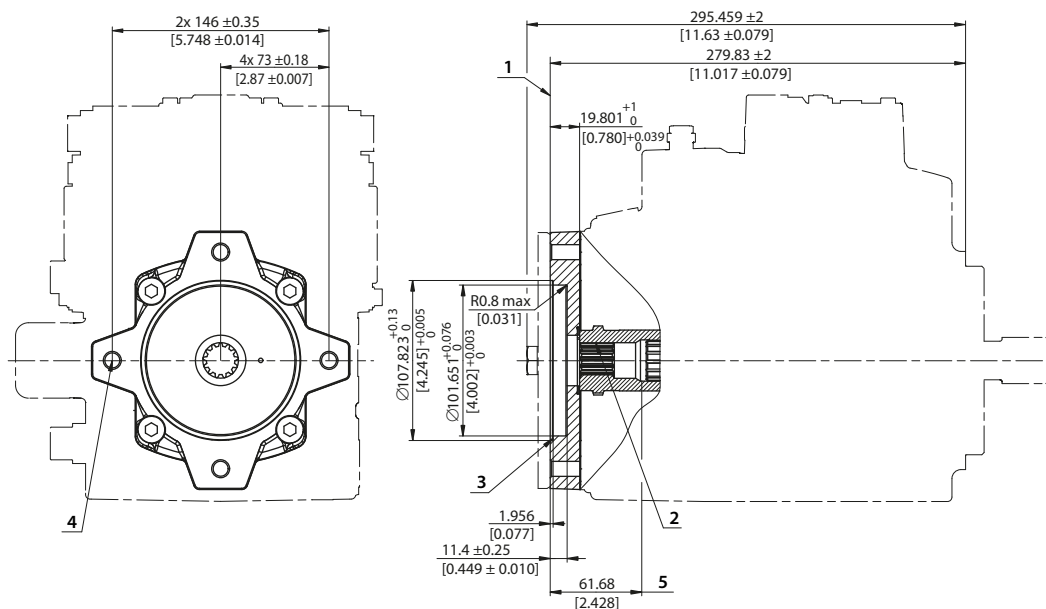
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information*, **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

! 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 (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] min. depth; Recommended screw in depth 1.5 x thread dia (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum Torque	693 N·m [6130 lbf·in]
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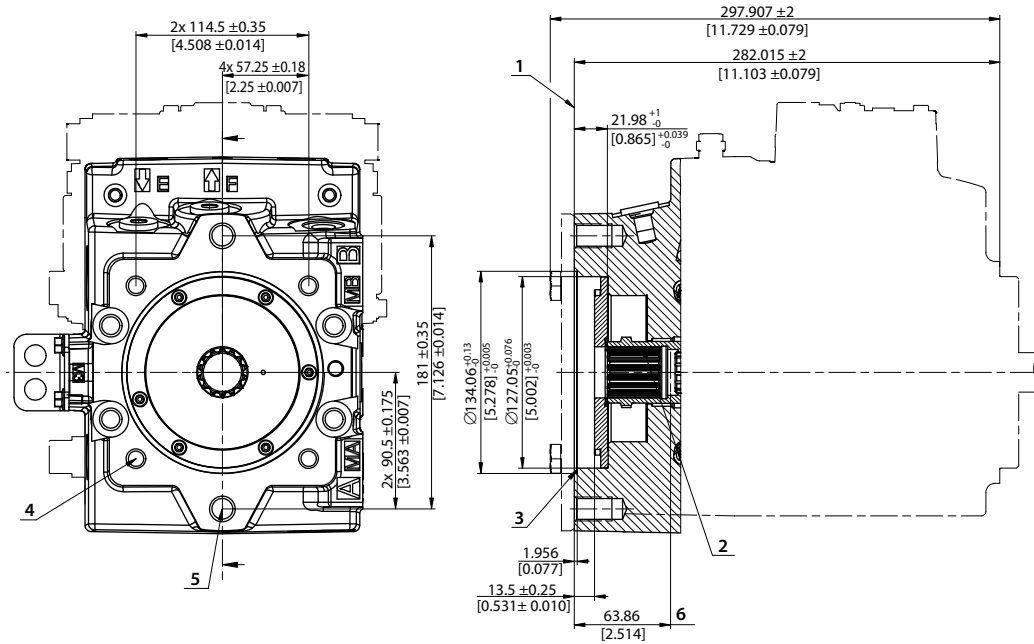
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information*, **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

! 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 (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; 21 [0.827] min. depth; Recommended screw in depth 1.5 x thread dia (4x)
5. Thread: M16x2-6H; 25 [0.984] min. depth; Recommended screw in depth 1.5 x thread dia (2x)
6. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum torque	816 N•m [7220 lbf•in]
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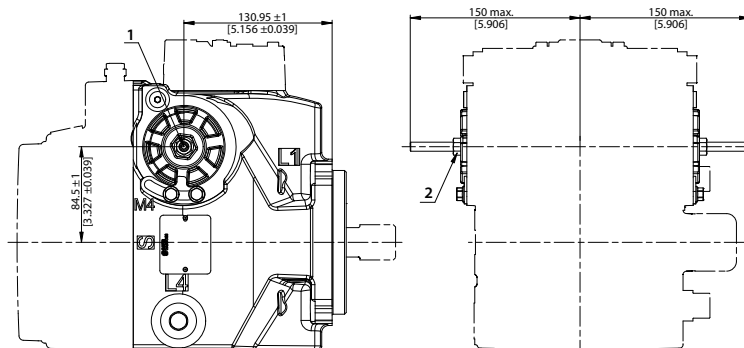
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information, BC152886483968*, the section "Shaft Torque Ratings and Spline Lubrication".

! 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)

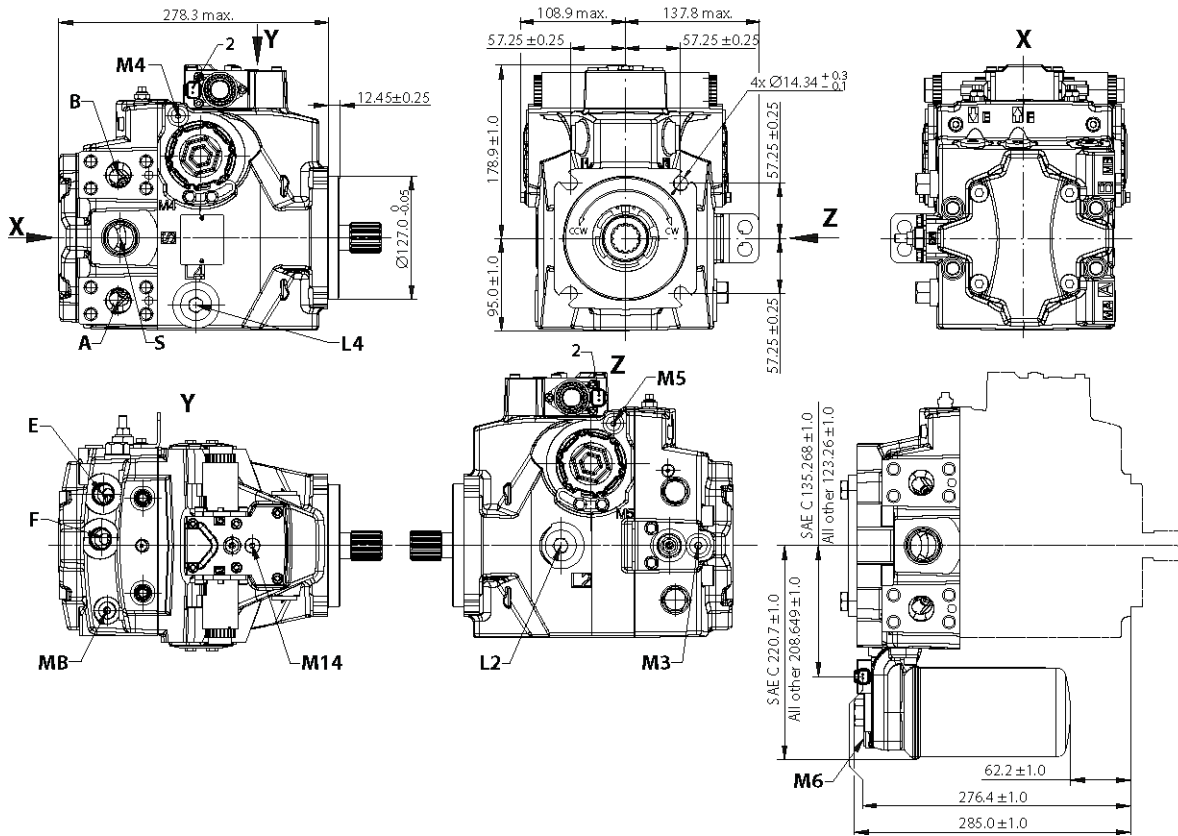
Wrench size, torque

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



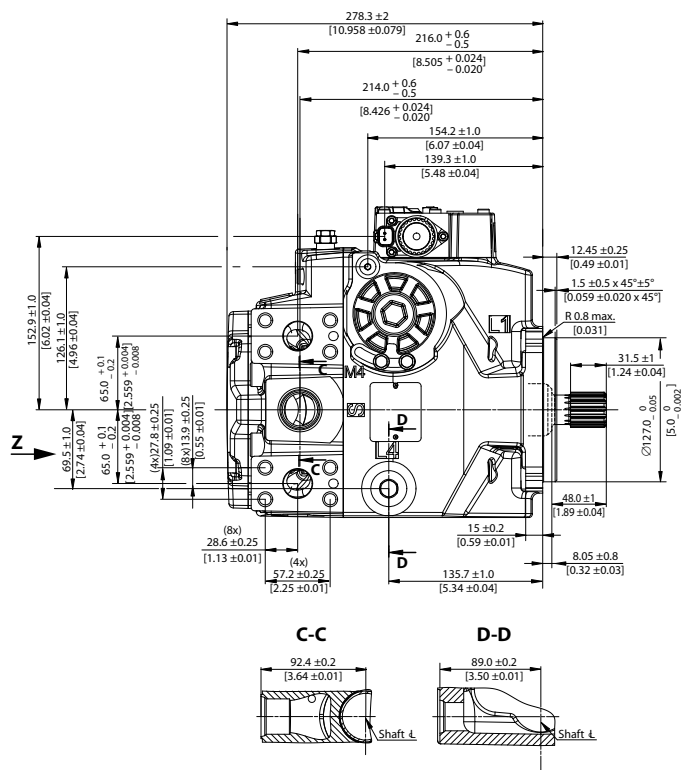
Ports per ISO 11 926-1

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 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 ¹ / ₁₆ -18
E/F	Charge filtration ports	7 ¹ / ₈ -14
M3	Charge pressure gauge port	9 ¹ / ₁₆ -18
M4, M5	Servo gauge port	7 ¹ / ₁₆ -20
M14	Case gauge port (EDC, FNR, NFPE)	7 ¹ / ₁₆ -20
S	Charge inlet port	1 ⁵ / ₁₆ -12
2	Connector DEUTSCH DTM04-2P, to be paint free	

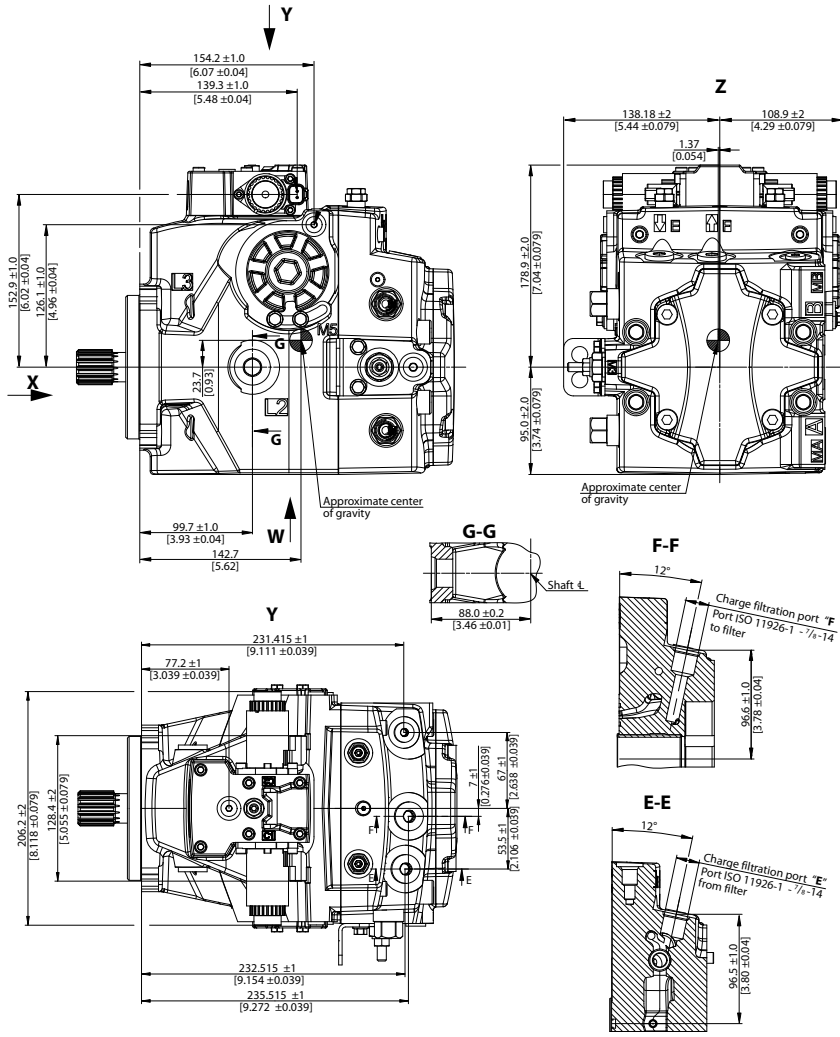
Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

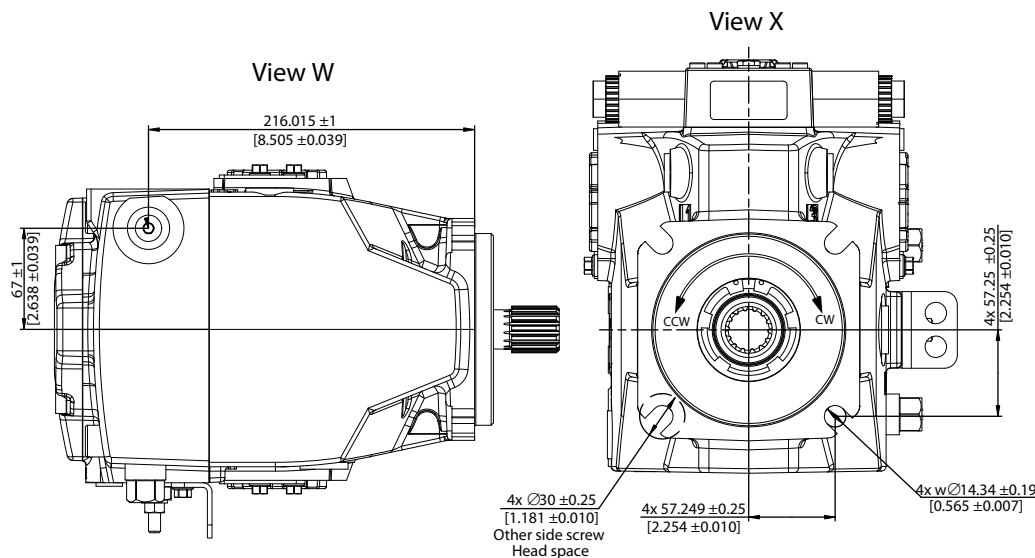
H1P Dimensions



Dimensions and Data



1 — Approximate center of gravity



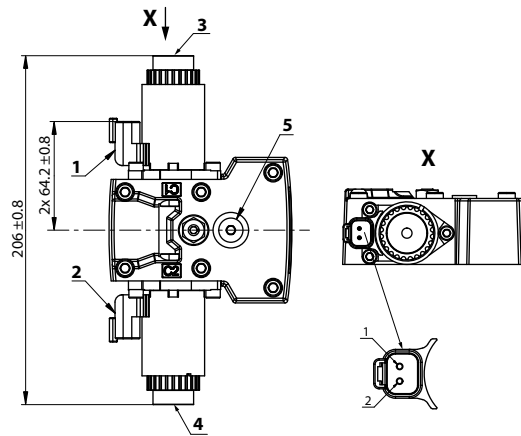
1 — Other side screw head space

Dimensions and Data

Dimensions and Data

Controls

EDC Options A2 and A3 (12/24 V)



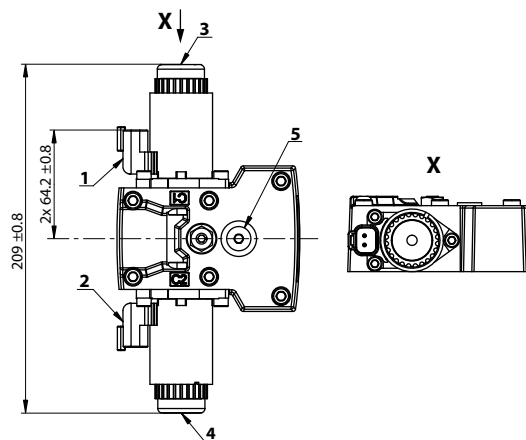
1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
3. Control Manual OverRide **C1**
4. Control Manual OverRide **C2**
5. Case gauge port **M14** per ISO 1926-1: $\frac{7}{16}$ -20

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: $\frac{7}{16}$ -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

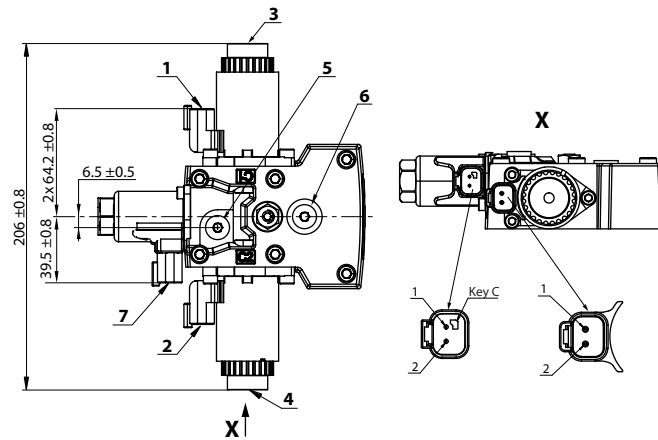


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

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



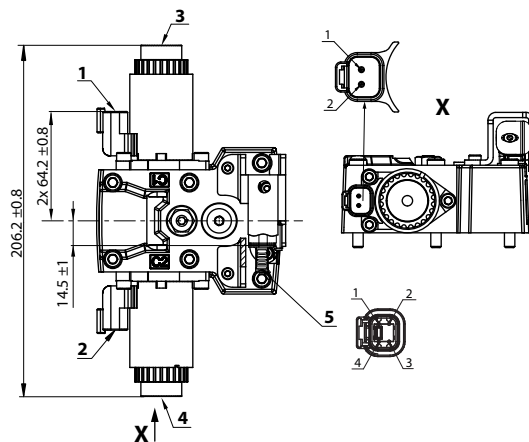
1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
3. Control Manual OverRide **C1**
4. Control Manual OverRide **C2**
5. Brake gauge port **X7** per ISO 1926-1: $\frac{7}{16}$ -20
6. Case gauge port **M14** per ISO 1926-1: $\frac{7}{16}$ -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.](#)

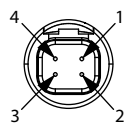
Dimensions and Data

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

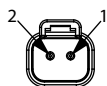
Connector DEUTSCH, 4-pin



4-pin assignment:

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

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

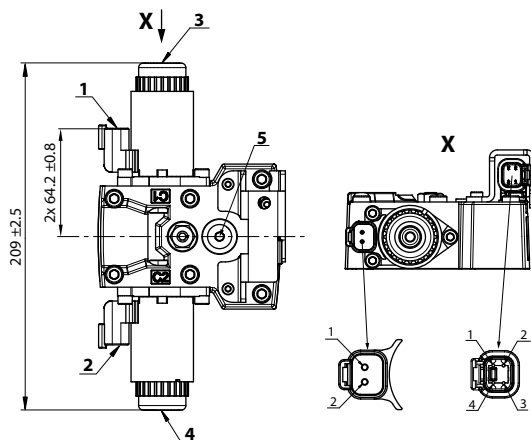


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

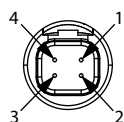
Dimensions and Data

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: $\frac{7}{16}$ -20

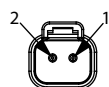
Connector DEUTSCH, 4-pin



4-pin assignment:

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

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

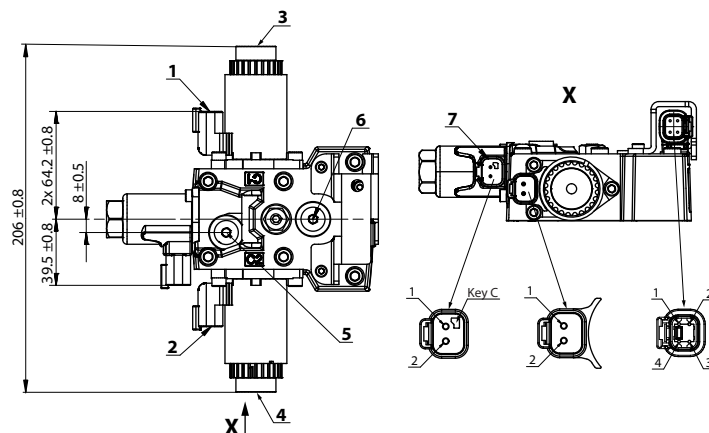


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

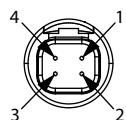
EDC with CCO and ASNSR, Options H8 and H9 (12/24 V)



- 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

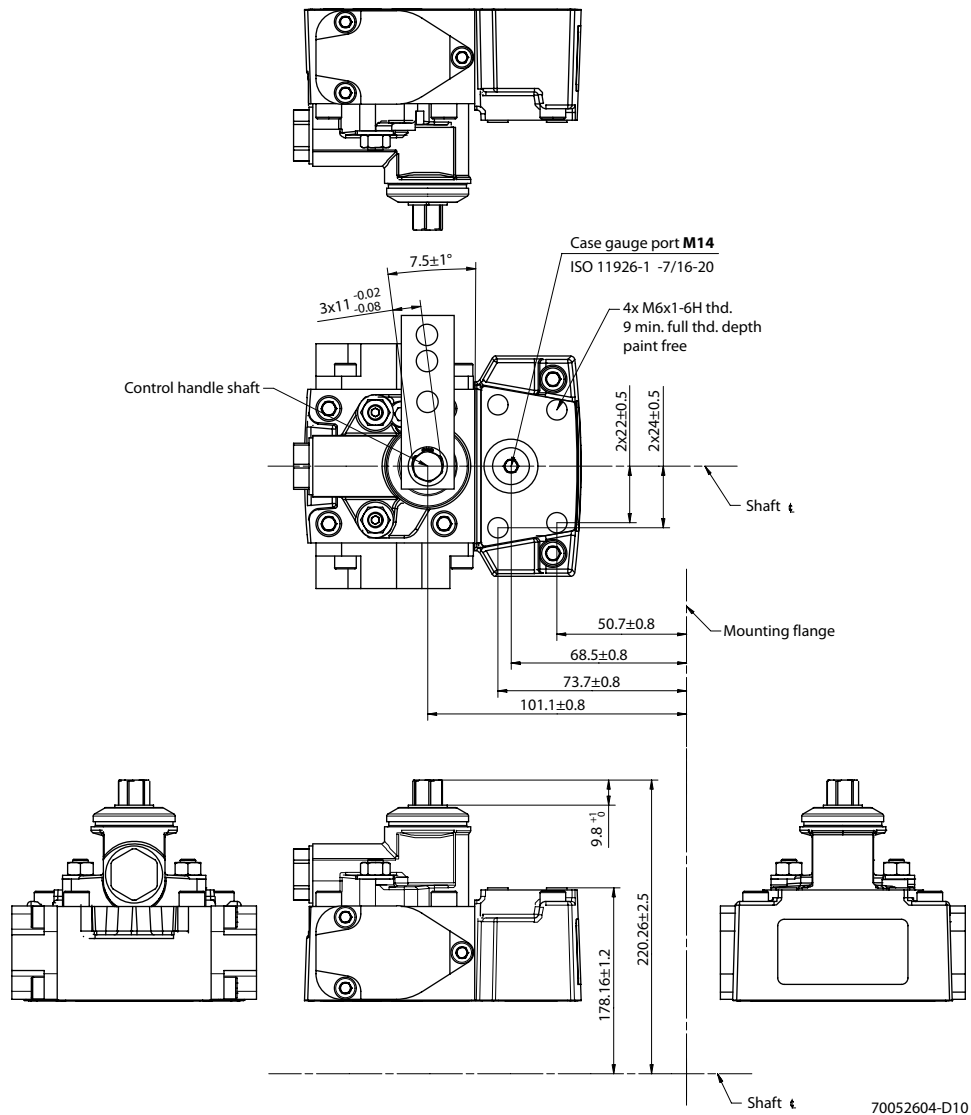


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

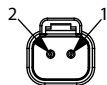
[Please contact Danfoss representative for specific installation drawings.](#)

Dimensions and Data

MDC Option: M1



Connector *DEUTSCH*, 2-pin

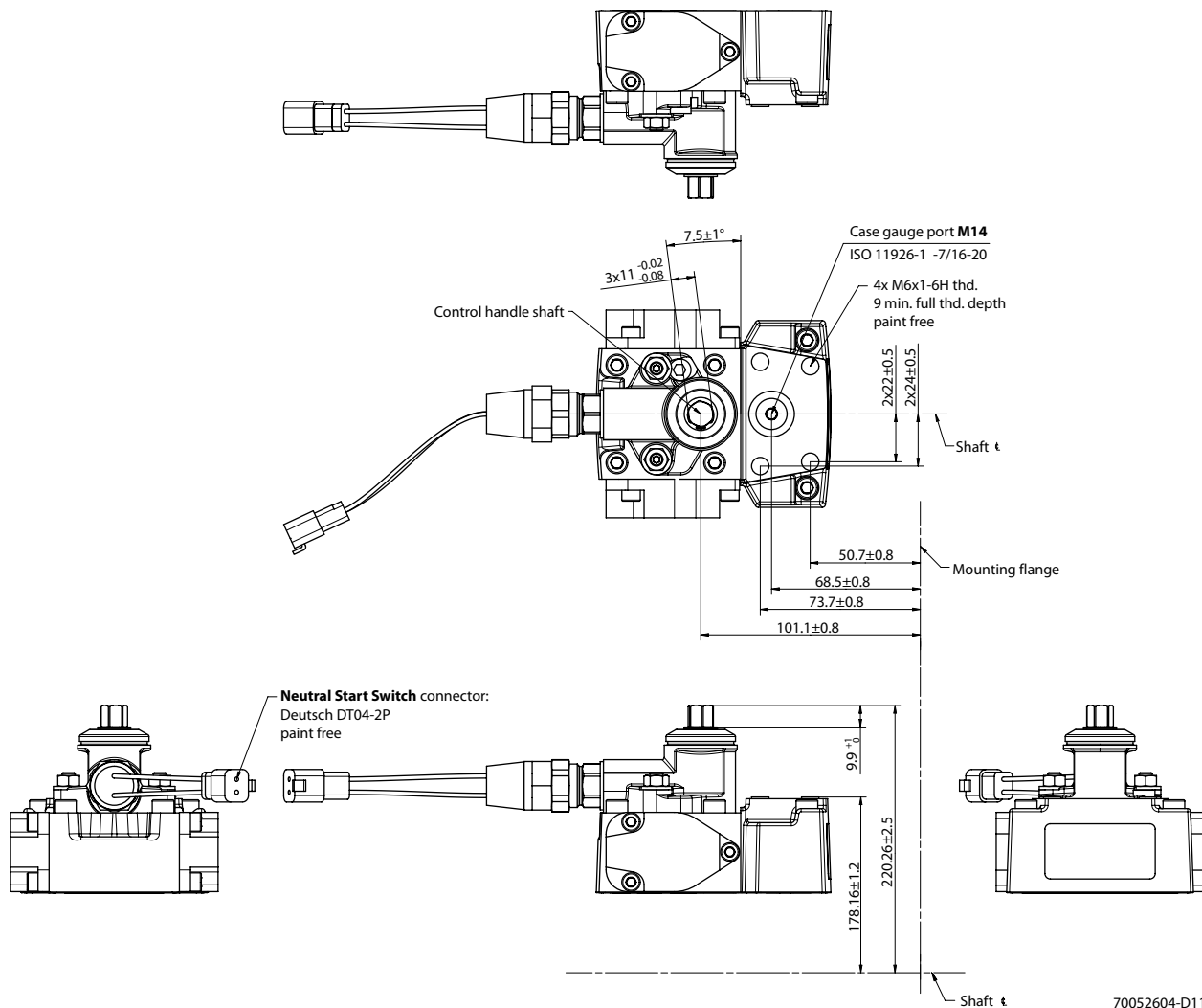


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

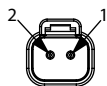
Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

MDC with Neutral Start Switch Option: M2



Connector DEUTSCH, 2-pin

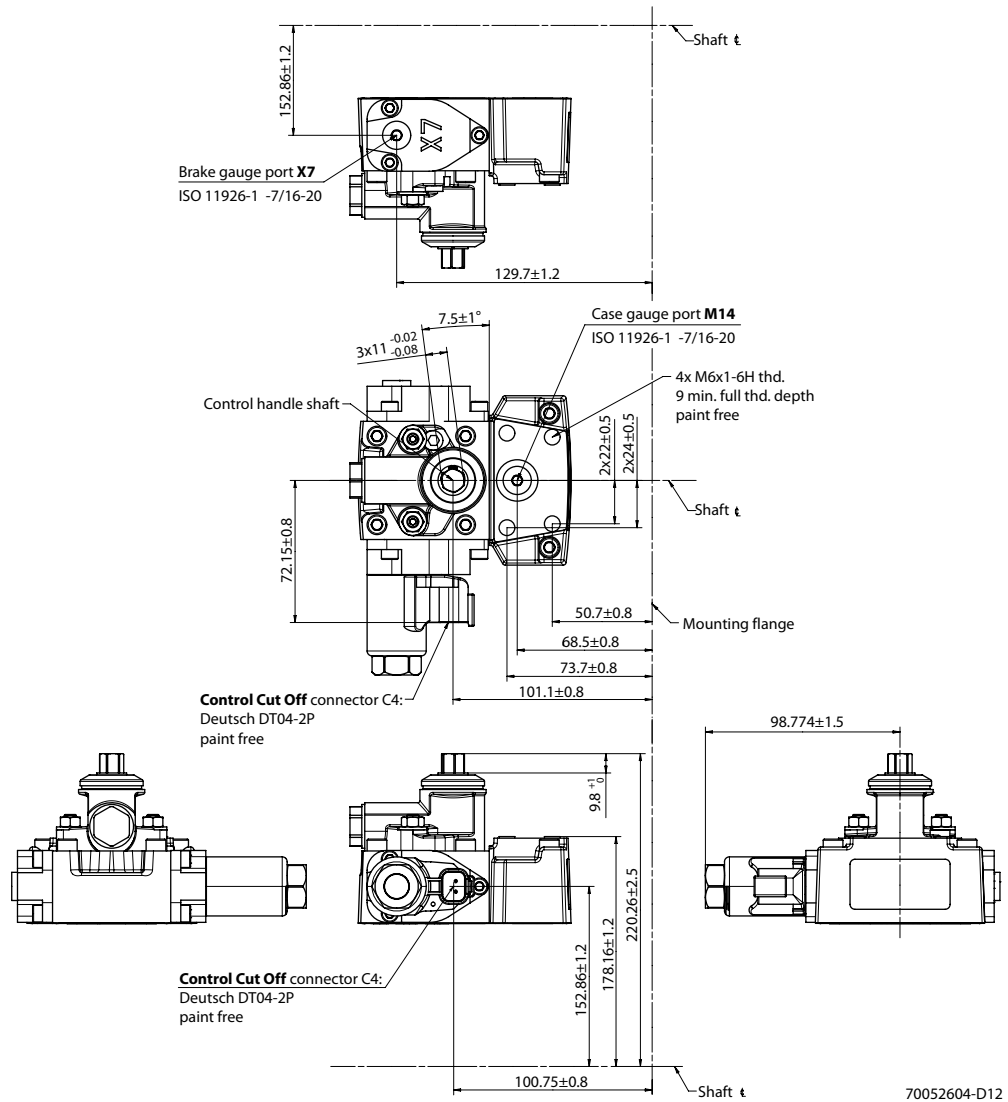


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

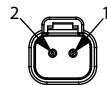
Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

MDC with CCO, Options: M3, M4



Connector DEUTSCH, 2-pin

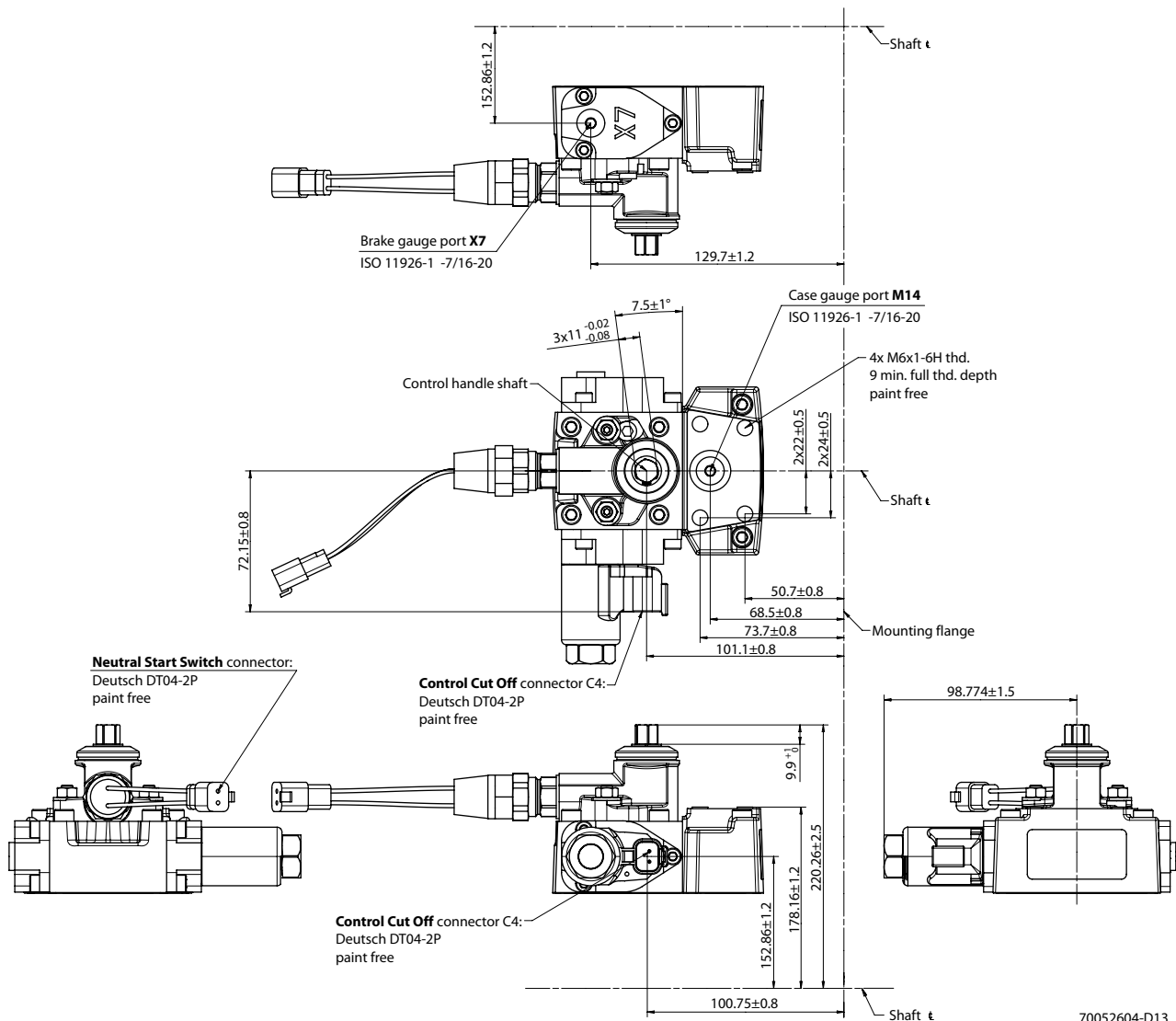


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

MDC with NSS and CCO Options: M5, M6



70052604-D13

Connector DEUTSCH, 2-pin



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

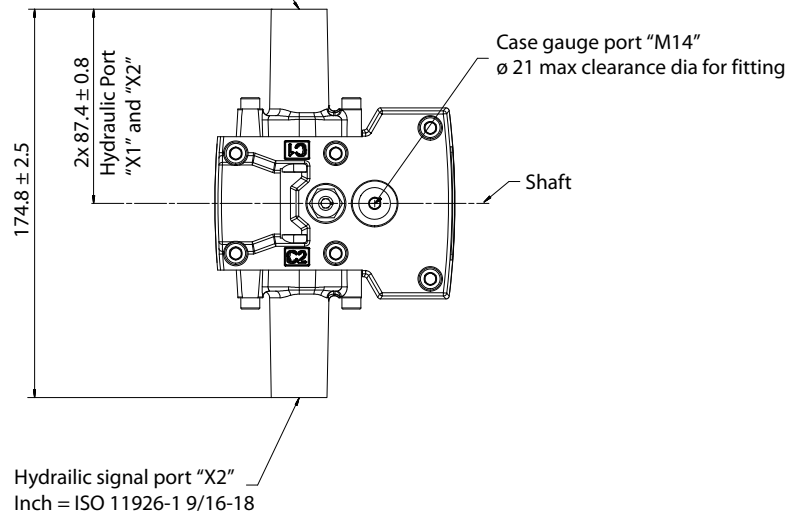
Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

H1P HDC, Options: T1, T2

Dimensions in mm

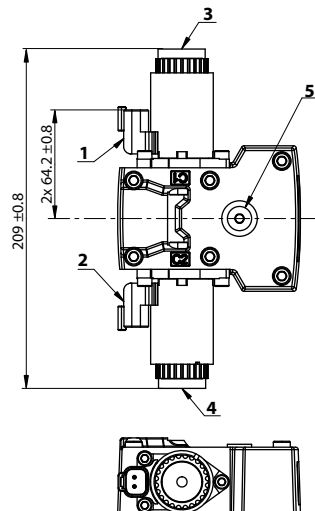
Hydraulic signal port "X1"
Inch = ISO 11926-1 9/16-18



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: $\frac{7}{16}$ -20
- Control solenoid connectors **C1/C2** DEUTSCH DTM04-2P pin/assignment



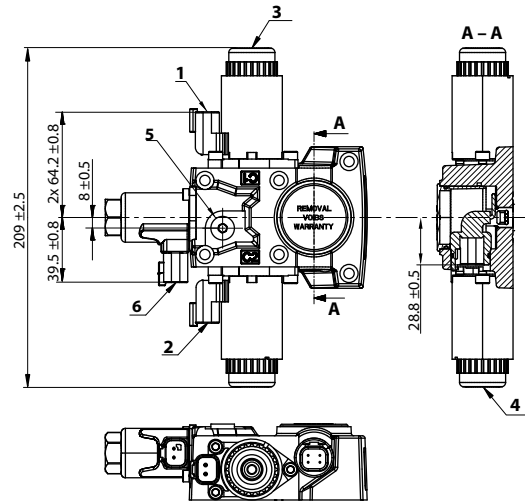
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

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

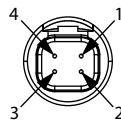
Non-Feedback Proportional Electric control with Control-Cut-Off valve with key C, Manual Over Ride and Angle Sensor, options N3 (12 V) and N4 (24 V).



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: $\frac{7}{16}$ -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.

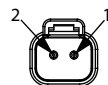
Connector *DEUTSCH*, 4-pin



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



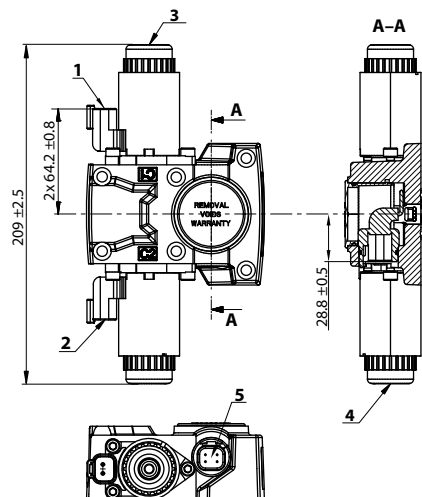
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

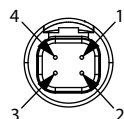
NFPE with MOR and ASNSR, Options: N5, N6 (12/24 V)

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

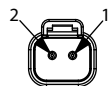
Connector DEUTSCH, 4-pin



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



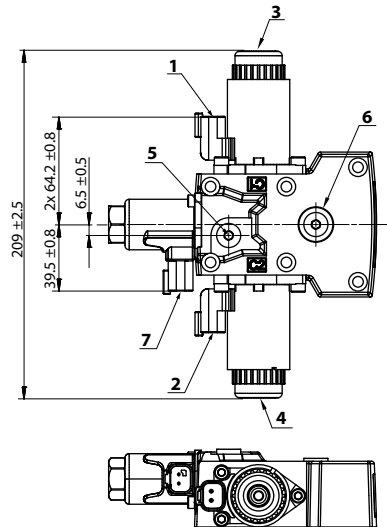
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

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

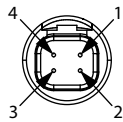
Non Feedback Proportional Electric control with Manual Over Ride and Control-Cut-Off valve key C, options N7 (12 V) and N8 (24 V).



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.

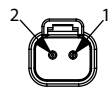
Connector DEUTSCH, 4-pin



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

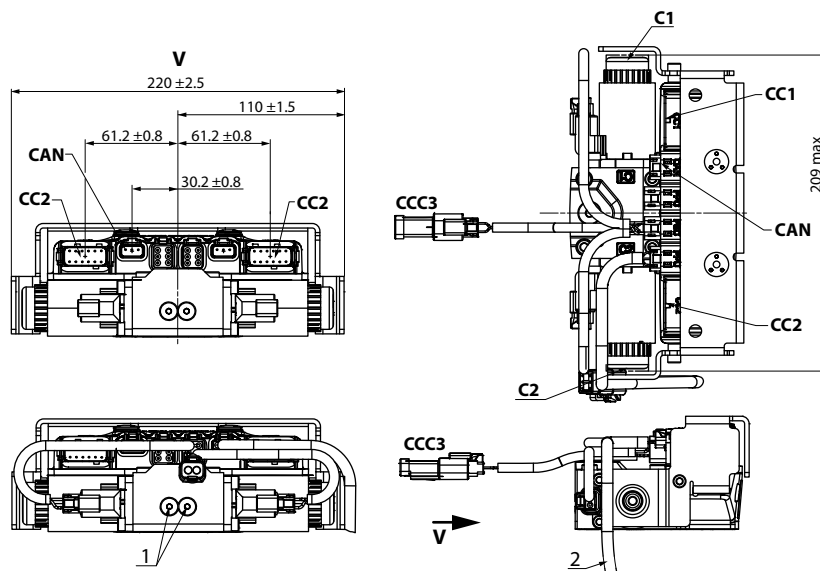


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

Automotive control (AC)



- 1 Plug removing can cause contamination issues
- 2 PPU wire harness is factory installed to speed sensor

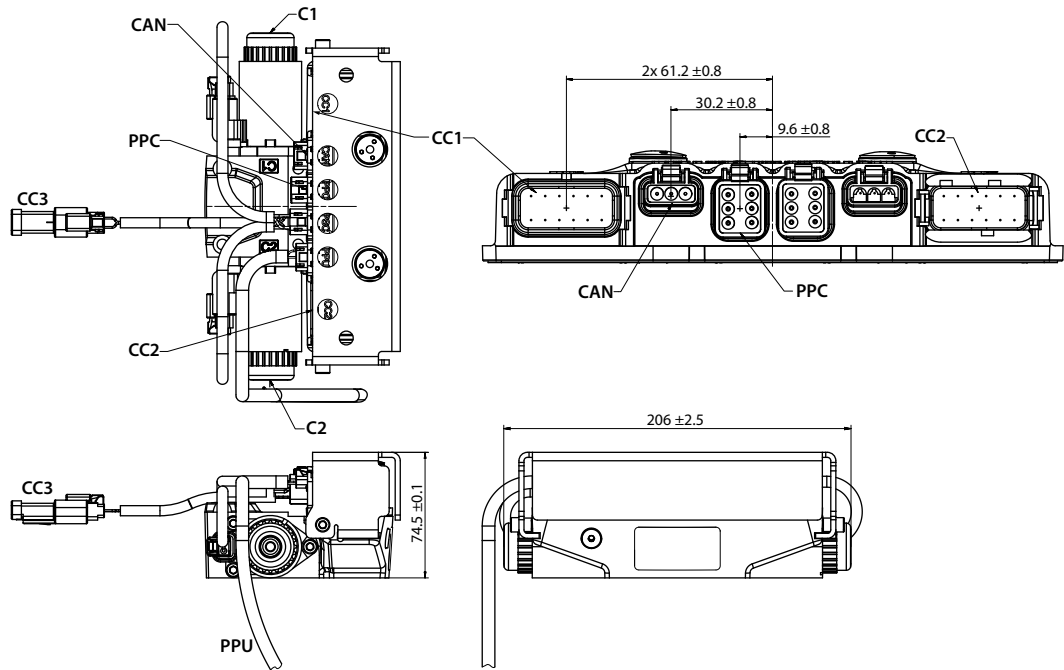
Connectors description

Port	Description
C1 and C2	1. Control manual override C1 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

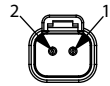
AC connectors dimensions



PPU wire harness is factory installed to speed sensor.

CC3

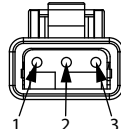
Connector DEUTSCH, 2-pin



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

CAN

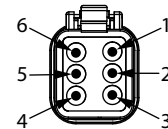
Connector DEUTSCH, 3-pin



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

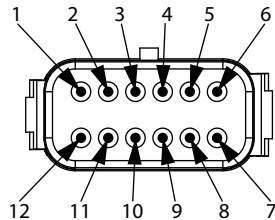
PPC

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)

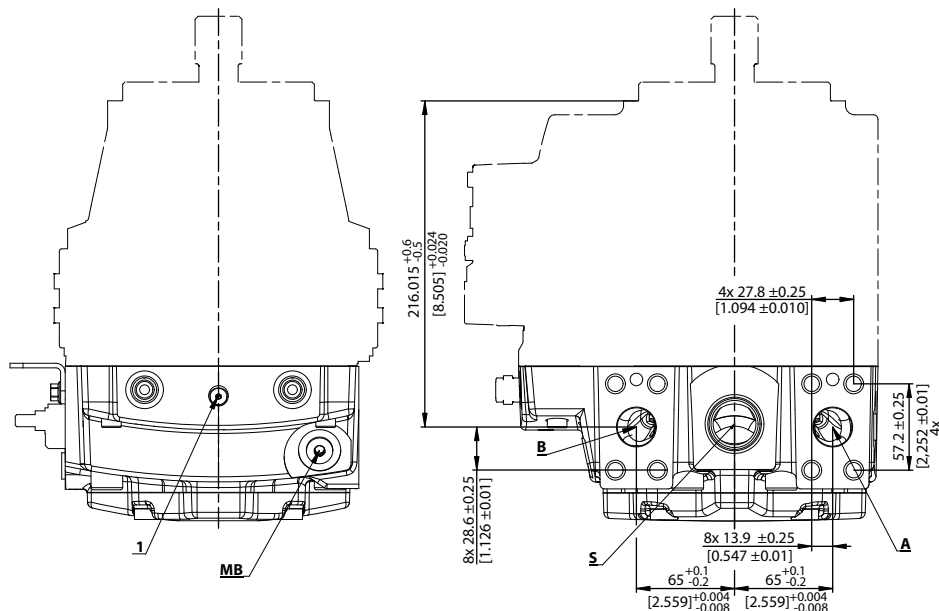
CC2

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

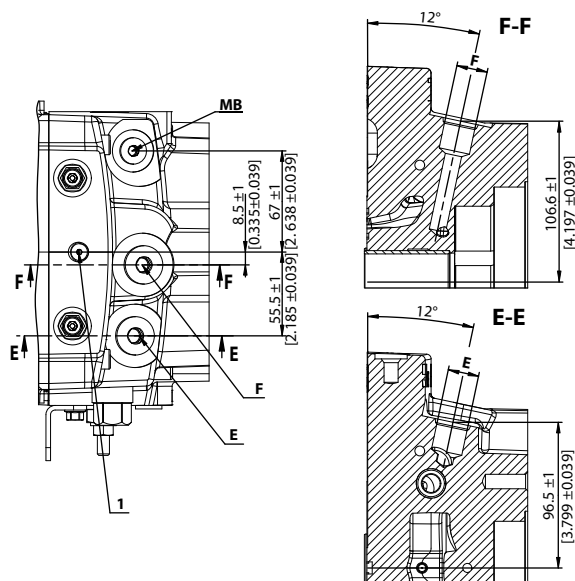
H1P 69/78 Suction Filtration Option L



- 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

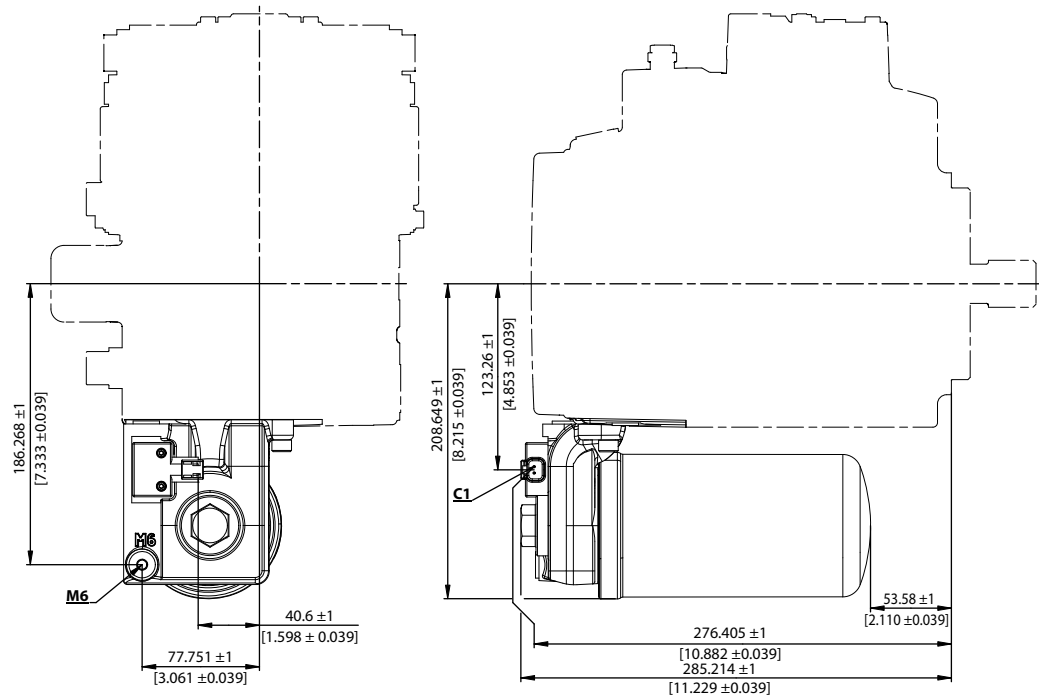
Dimensions and Data

F Charge filtration port per ISO 11926-1; 7/8-14 to filter

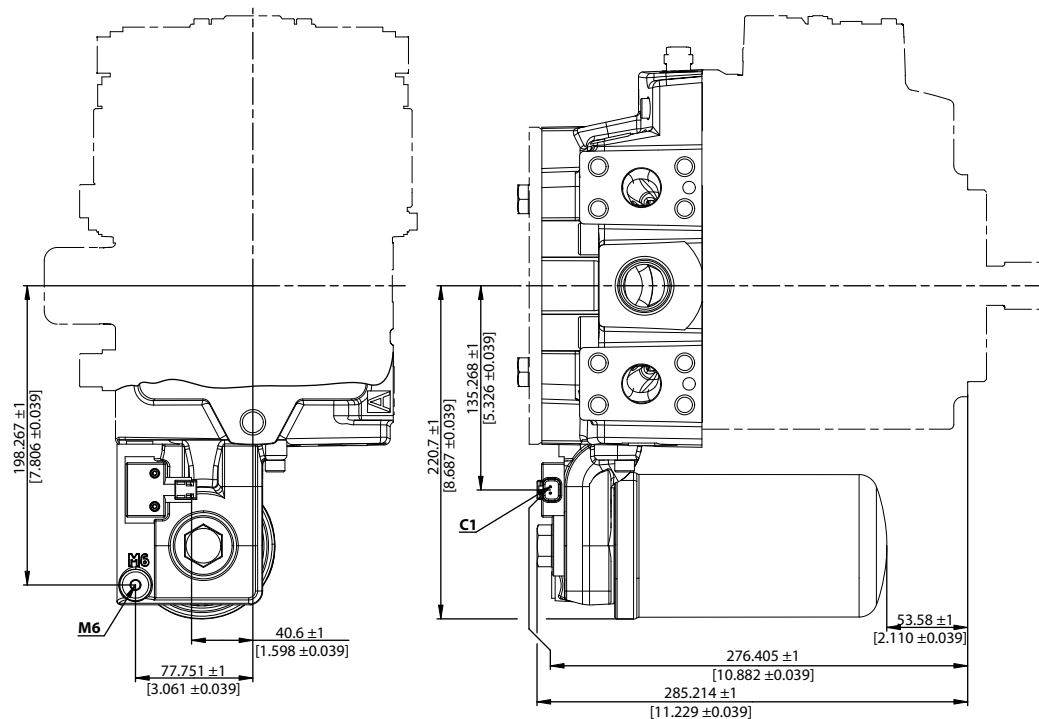
MB System B gauge port per ISO 11926-1; 9/16-18

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)

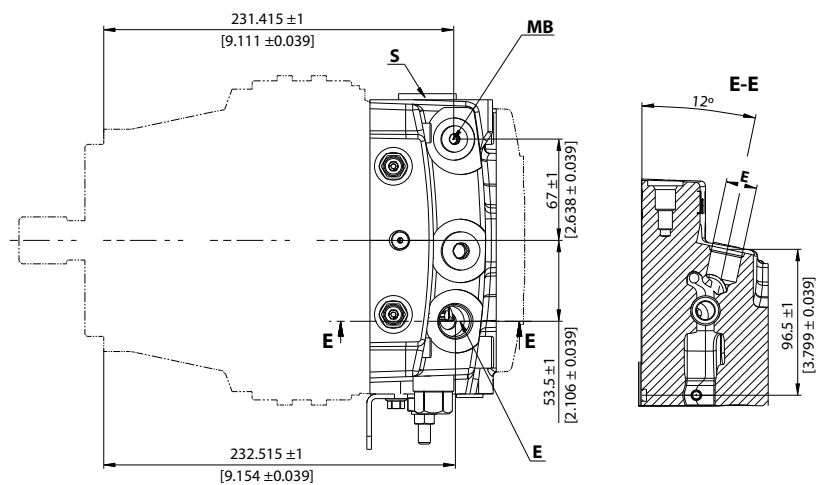


Dimensions and Data

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: $\frac{7}{8}$ -14 from filter
- MB** System gauge port per ISO 11926-1: $\frac{9}{16}$ -18
- S** Charge inlet port per ISO 11926-1: $1\frac{5}{16}$ -12

Please contact Danfoss representative for specific installation drawings.

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- PLUS+1® software
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Technical Information

H1P 089/100

Axial Piston Single Pumps



Revision history*Table of revisions*

Date	Changed	Rev
May 2022	Corrected HDC control information	1401
December 2021	Added HDC control	1301
April 2021	Corrected interface with ECU (EDC) graphic	1208
January 2021	Corrected unit conversion errors	1207
June 2020	Corrected E/F charge filtration port size	1206
April 2020	Corrected swash plate angle sensor connector and CCO connector descriptions	1205
February 2020	Added NFPE options and changed document number from BC00000067	1204
September 2019	G3 Input shaft option added.	1102
June 2019	Major revision.	1101
May 2018	Angle sensor for EDC; FDC note added.	1001
June 2017	port size changes	0902
May 2017	NFPE gen. 3 changes.	0901
November 2015	Master Model Code changes.	0800
2010-2014	Various changes.	BA-GB
Aug 2009	First edition	AA

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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 089/100 Technical Data

Feature	Size 089	Size 100
Displacement	89.2 cm ³ [5.44 in ³]	101.7 cm ³ [6.21 in ³]
Flow at rated speed (continuous)	294 l/min [77.7 US gal/min]	335 l/min [88.5 US gal/min]
Torque at maximum displacement (theoretical)	1.42 N·m/bar [870 lbf·in/1000 psi]	1.62 N·m/bar [990 lbf·in/1000 psi]
Mass moment of inertia of rotating components	0.0116 kg·m ² [0.0086 slug·ft ²]	0.0116 kg·m ² [0.0086 slug·ft ²]
Mass (dry-no charge pump)	62 kg [137 lb]	62 kg [137 lb]
Oil volume	2.6 l [0.67 US gal]	2.6 l [0.67 US gal]

Shaft, flange and ports description

Input shaft per ISO 3019-1 (outer diameter)	<ul style="list-style-type: none"> • Outer Ø32 mm – 4 (SAE C, 14 teeth) • Outer Ø35 mm – 4 (SAE C, 21 teeth) • Outer Ø38 mm – 4 (SAE C-C, 23 teeth) • Conical keyed shaft end similar to ISO 3019-1 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	<ul style="list-style-type: none"> • Flange 82-2 (SAE A: 9 teeth and 11 teeth) • Flange 101-2 (SAE B, 13 teeth and SAE B-B, 15 teeth) • Flange 127-4 (SAE C, 14 teeth)
Suction port per ISO 3019-1	ISO 11926-1 – 1 5/8 -12 (SAE O-ring boss)
Main configuration port	Ø25.4 mm; M12 x 1.75; 20 min. full thread depth
Case drain ports L2, L4 per ISO 3019-1	ISO 11926-1 – 1 ⁵ / ₁₆ -12
Other ports	SAE O-ring boss
Customer interface threads	Metric fasteners

Technical Specifications

H1P 089/100 Operating Parameters

Parameter		Unit	Size 089/100
Input speed	Min. for internal ¹⁾ and external ²⁾ charge supply	min ⁻¹ (rpm)	500
	Min. for full performance, internal charge supply		1200
	Rated		3300
	Maximum		3800
System pressure	Maximum working	bar [psi]	450 [6528]
	Maximum		480 [6960]
	Max./Min. low loop		45/10 [650/145]
Charge pressure	Minimum		18 [261]
	Maximum		34 [493]
Control pressure	Minimum (at corner power for EDC, MDC, FNR)	bar [psi]	17 [247]
	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		4.0 [58.0]
Case pressure	Rated	bar [psi]	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 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 μm

Technical Specifications

Fluid Specification

Viscosity

Intermittent¹⁾	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

Minimum¹⁾	-40°C [-40°F]
Rated	104°C [220°F]
Recommended range²⁾	60 – 85°C [140 – 185°F]
Maximum Intermittent	115°C [240°F]

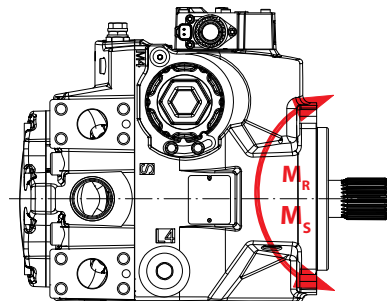
¹⁾ Cold start = Short term $t > 3$ min, $p \leq 50$ bar [725 psi], $n \leq 1000$ min⁻¹ (rpm).

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

H1P 089/100 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

$$M_R = 5630 \text{ N}\cdot\text{m} [49\ 830 \text{ lbf}\cdot\text{in}]$$

Shock load moment

$$M_S = 12\ 190 \text{ N}\cdot\text{m} [107\ 900 \text{ lbf}\cdot\text{in}]$$

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.

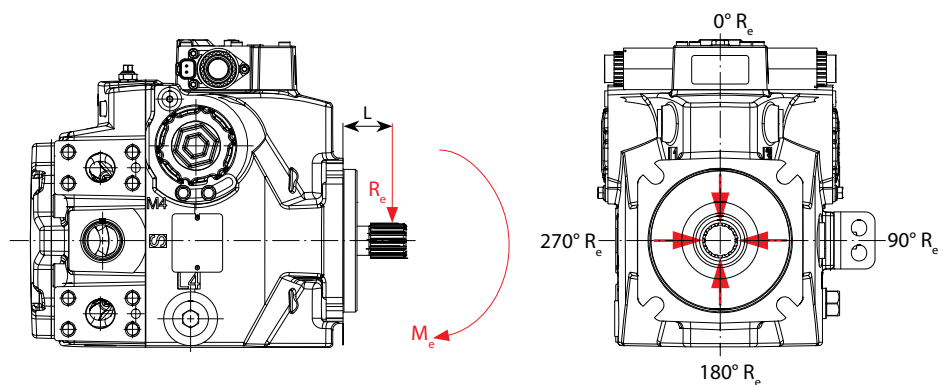
Danfoss recommends clamp-type couplings for applications with radial shaft loads. Contact your Danfoss representative for an evaluation of unit bearing life if you have continuously applied external loads exceeding 25 % of the maximum allowable radial load (R_e) or the pump swash-plate is positioned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

Maximum external shaft load based on shaft deflection

External radial moment	Unit	Size 089/100
M_e	N·m [lbf·in]	118 [1044]

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 $< 1500 \text{ min}^{-1}$ (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.

For more information, see *Selection of Drive line Components*, **BC157786484430**.

20/24 cm³ Charge Pump – Flow and Power Curves

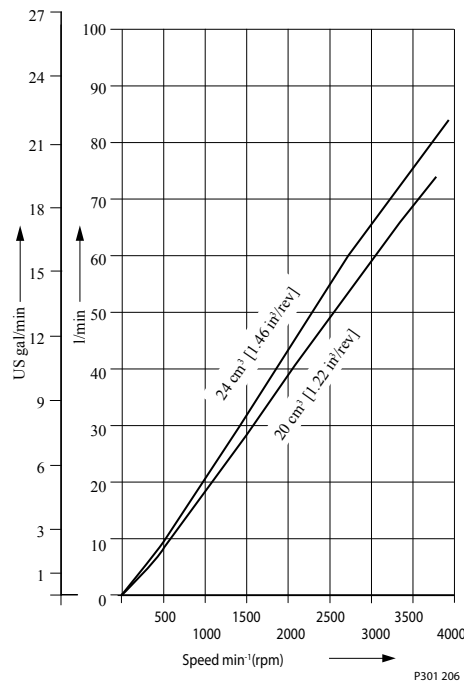
Charge pump flow and power requirements curves shown below at the following conditions:

Charge pressure = 20 bar [290 psi]

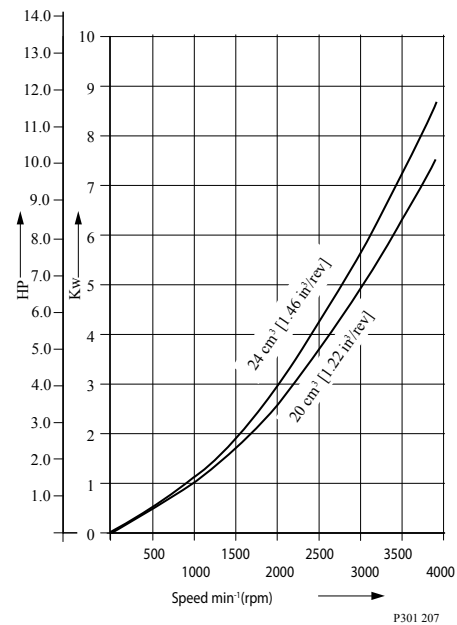
Viscosity = 11 mm²/s [63 SUS]

Temperature = 80°C [176°F]

Charge pump flow



Charge pump power requirements



Master Model Code

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



Displacement

089	89.2 cm ³ [5.44 in ³]
100	101.7 cm ³ [6.21 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
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Master Model Code

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).

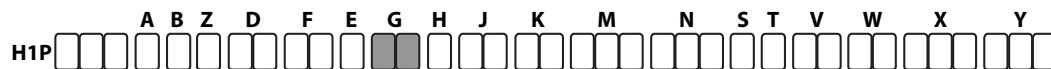
Hydraulic Displacement Control

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

G—Endcap



G – End-cap Options

Twin port, ISO 6162 split flange ports; Align with T: Filtration

D3	Integral pressure filtration
D6	Suction filtration
D8	Remote filtration or external charge supply

Control Options

Electrical Displacement Control (EDC)

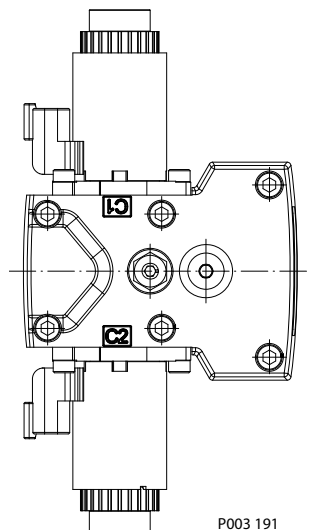
An EDC is a displacement (flow) control. Pump swash plate position is proportional to the input command and therefore vehicle or load speed (excluding influence of efficiency), is dependent only on the prime mover speed or motor displacement.

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.

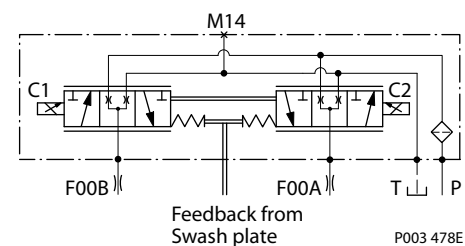
A serviceable 170 μm screen is located in the supply line immediately before the control porting spool.

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.

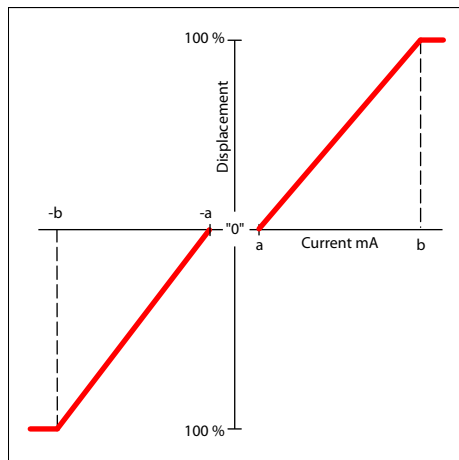
The neutral position of the control spool does provide a positive preload pressure to each end of the servo piston assembly.

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, EDC 089/100

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)	
	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 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:

$\Delta p = 250 \text{ bar}$ [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 089/100

Stroking direction	0.8 mm [0.03 in] orifice	1.3 mm [0.05 in] orifice	No orifice
Neutral to full flow	3.8 s	1.8 s	1.0 s
Full flow to neutral	2.2 s	1.0 s	0.6 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.

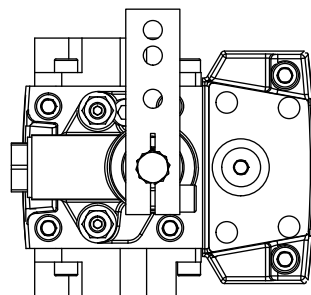
Differential pressure across the servo piston rotates the swash plate, changing the pump's displacement. Simultaneously the swashplate movement is fed back to the control spool providing proportionality between shaft rotation on the control and swash-plate rotation. The MDC changes the pump displacement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

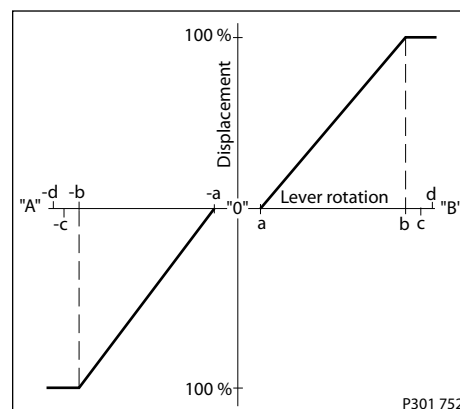
For the MDC with CCO option the brake port (X7) provides charge pressure when the coil is energized to activate static function such as a brake release. The X7 port must not be used for any continuous oil consumption.

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** = $3^\circ \pm 1^\circ$
 Maximum pump stroke: **b** = $30^\circ +2/-1^\circ$
 Required customer end stop: **c** = $36^\circ \pm 3^\circ$
 Internal end stop: **d** = 40°

Control Options
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.

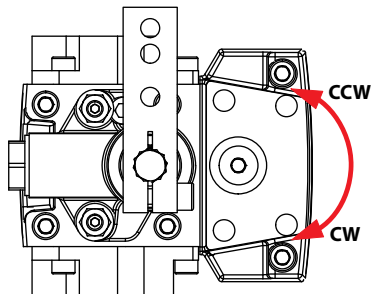
The MDC provides a permanent restoring moment appropriate for turning the MDC input shaft back to neutral position only. This is required to take the backlash out of the mechanical connections between the Bowden cable and the control.

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.

- 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)	
	CW	CCW	CW	CCW
MDC shaft rotation				
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 Options

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:

$\Delta p = 250 \text{ bar}$ [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, MDC 089/100

Code	Orifice description (mm)			Stroking direction	
	Tank (A+B)	P	A/B	Neutral to full flow	Full flow to neutral
C3	No orifice			0.5 s	0.6 s
C6	1	–	–	1.7 s	1.5 s
C7	1.3	–	–	1.1 s	1.0 s
D1	0.8	1	–	3.1 s	2.4 s
D2	0.8	1.3	–	2.8 s	2.2 s
D3	1	1.3	–	2.0 s	1.6 s
D4	1	1.3	1.3	2.4 s	1.9 s

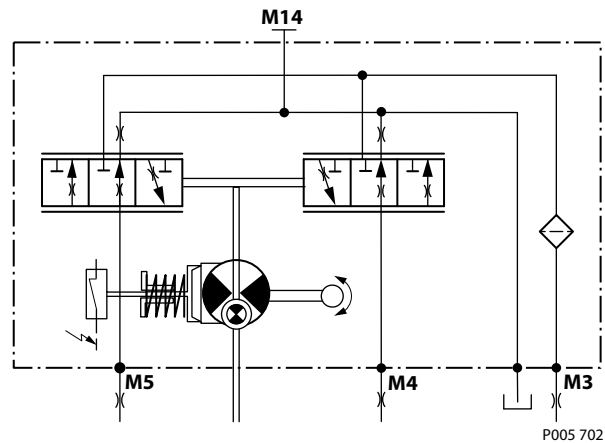
For further data please contact your Danfoss representative.

Control Options

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

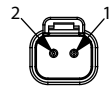


Neutral start switch data

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



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)

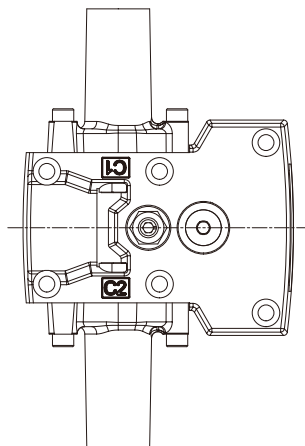
HDC principle

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.

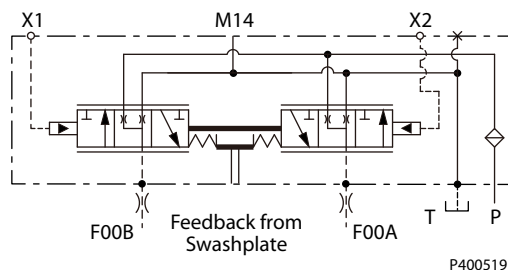
A serviceable 175 µm screen is located in the supply line immediately before the control porting spool.

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.

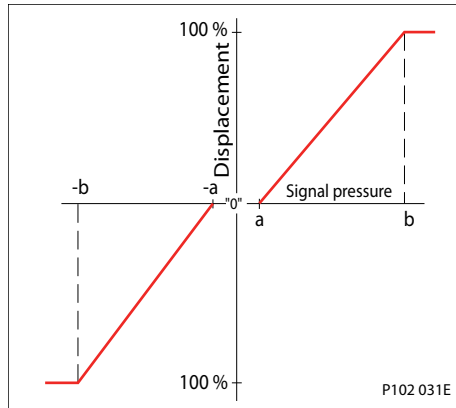
A swashplate feedback link, opposing control linkage, and a linear spring provide swashplate position force feedback to the hydraulic pressure. As hydraulic pressures in the operating loop change with load, the control assembly and servo/swashplate system work constantly to maintain the commanded position 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	
	X1	X2	X1	X2
Port energized	Out (high)	In (low)	Out (high)	In (low)
Port A	In (low)	Out (high)	In (low)	Out (high)
Port B	Out (high)	In (low)	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 swashplate 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:

$\Delta p = 250 \text{ bar}$ [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)

Control Options

Response time, HDC 089/100

Stroking direction	0.8 mm [0.03 in] orifice	1.3 mm [0.05 in] orifice	No orifice
Neutral to full flow	2.8s	1.3s	0.7s
Full flow to neutral	1.9s	0.9s	0.5s

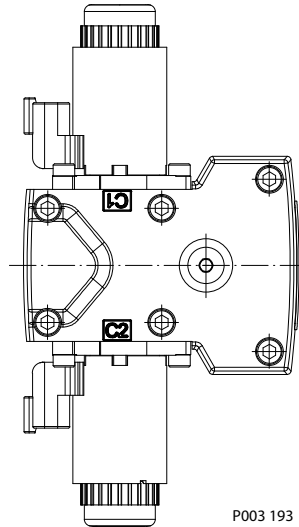
Control Options

Forward-Neutral-Reverse Control (FNR)

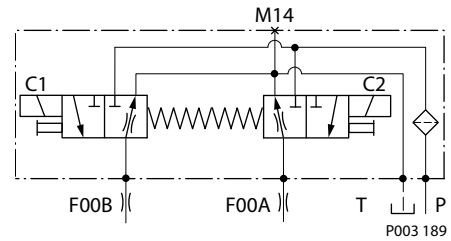
The 3-position FNR control options **A9** (12 V) and **B1** (24 V) uses an electric input signal to switch the pump to a full stroke position. A serviceable 125 µm screen is located in the supply line immediately before the control porting spool.

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

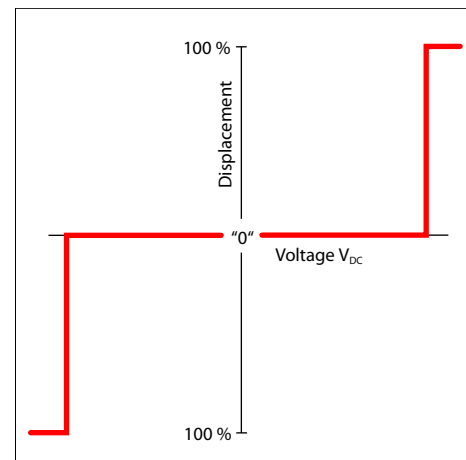
Forward-Neutral-Reverse electric control (FNR)



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	

Control Options

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
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)	
	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.

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:

$\Delta p = 250 \text{ bar}$ [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, FNR 089/100

Stroking direction	0.8 [0.03] orifice	1.3 [0.05] orifice	No orifice
Neutral to full flow	3.7 s	1.7 s	1.1 s
Full flow to neutral	3.0 s	1.3 s	0.6 s

Control Options

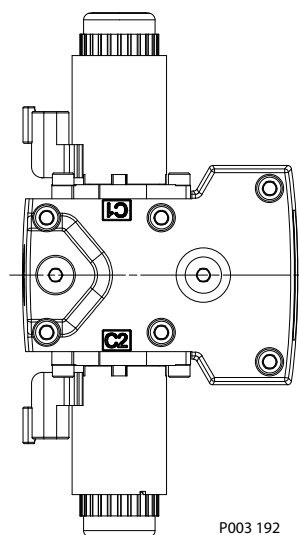
Non feedback proportional electric control (NFPE)

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.

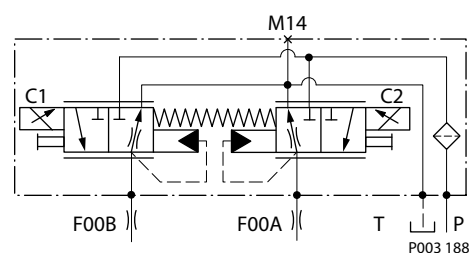
A serviceable 170 μm screen is located in the supply line immediately before the control porting spool.

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

NFPE control



NFPE schematic

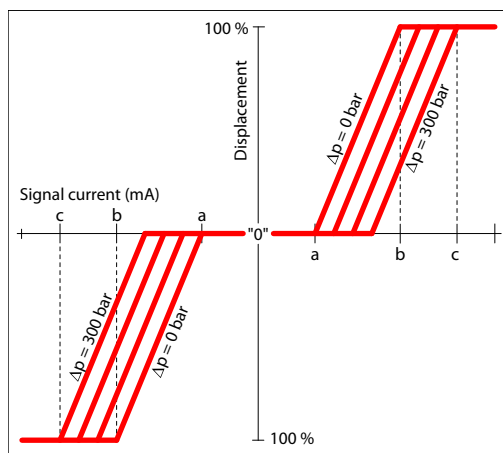


Control Signal Requirements, NFPE 089/100

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.

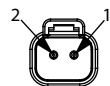
Single Pump Output Flow Direction

Shaft rotation	Clock-Wise (CW)		Counter-Clock-Wise (CCW)	
	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.

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:

$\Delta p = 250 \text{ bar}$ [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)

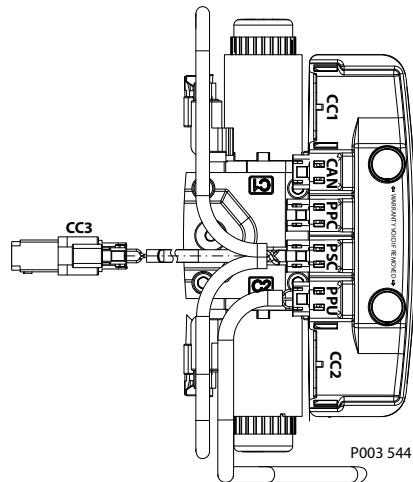
Response Time, NFPE 089/100

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	4.3 s	1.9 s	0.8 s
Full flow to neutral	2.6 s	1.1 s	0.5 s

Control Options

Automotive Control (AC)

The H1 **Automotive Control (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.

- **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*, [BC152986482596](#).

Control Options

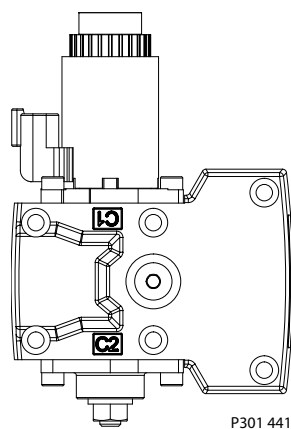
Fan Drive Control (FDC)

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.

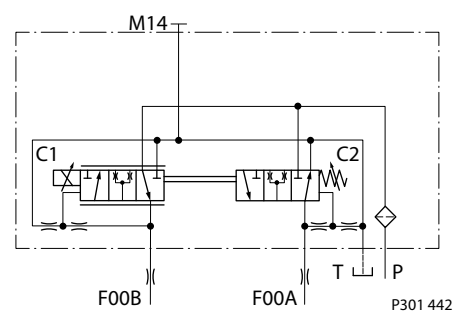
The control spool is spring biased to produce maximum forward pump displacement in the absence of an electrical input signal. Based on the spring bias spool default forward flow for a CW rotation pump is out of port B while default forward flow for a CCW rotation pump is out of port A.

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!

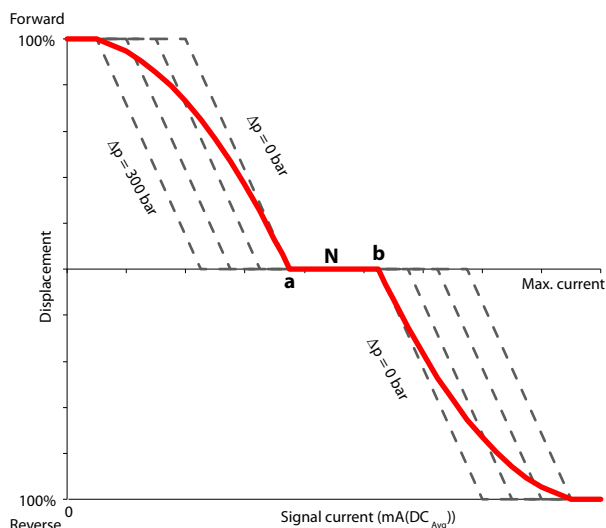
Due to the fail-safe functionality of the FDC control the pump will stroke to max. displacement in case the input signal to the pump control and the Diesel engine will be switched off at the same time. In this situation a low loop event can occur which may damage the pump. Therefore, it's strictly recommended 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, FDC 089/100

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

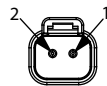
Shaft rotation		ClockWise			CounterClockWise		
Control Logic	12 V	0-780 mA	1100 mA	1300-1800 mA	0-780 mA	1100 mA	1300-1800 mA
	24 V	0-400 mA	550 mA	680-920 mA	0-400 mA	550 mA	680-920 mA
Port A		in	no flow	out	out	no flow	in
Port B		out	no flow	in	in	no flow	out
Servo port pressurized		M5	n/a	M4	M5	n/a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

- $\Delta p = 250 \text{ bar}$ [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 089/100

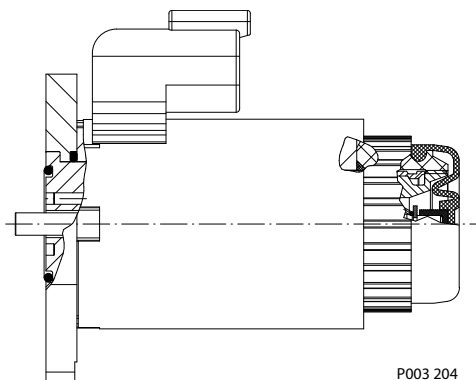
Stroking direction	0.8 mm [0.03 in] orifice
Full flow to neutral	3.9 s
Full forward flow to full reverse flow	5.6 s

Control Options

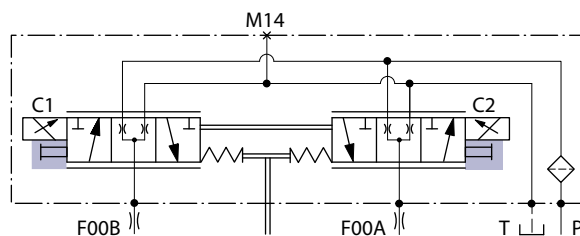
Manual Override (MOR)

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

Control Options

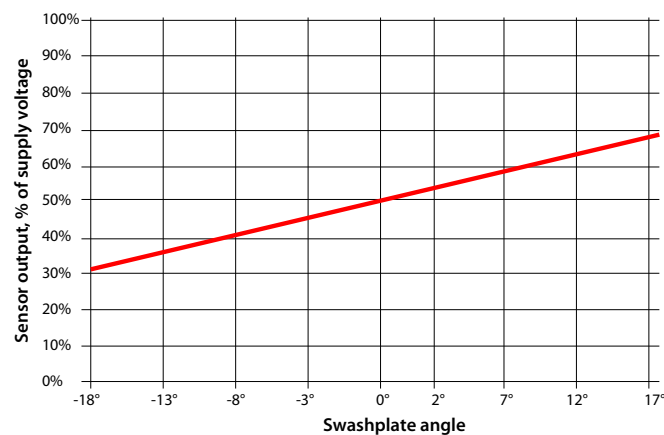
Swashplate angle sensor for EDC controls

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

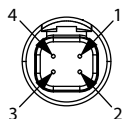
Control Options

Calibration of the sensor output within the software is mandatory. Vehicle neutral thresholds in the software ($\pm 0.5^\circ$) 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.

H1P Swash Plate Angle Sensor Connector

Connector DEUTSCH, 4-pin

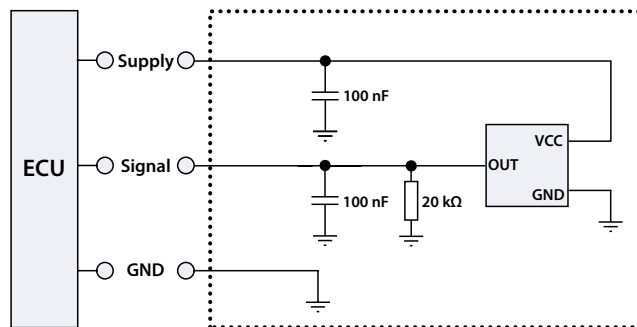


- 1** Ground (GND)
- 2** Not connected
- 3** Output signal 1 (SIG 1)
- 4** Supply (V+)

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

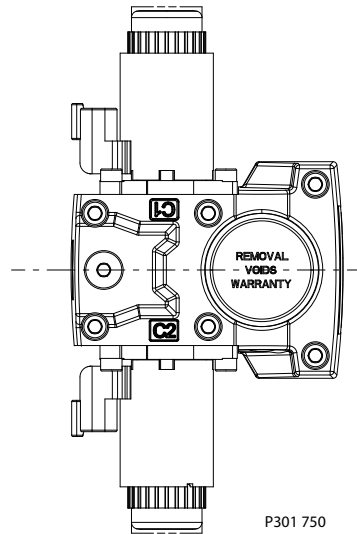


Control Options

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.

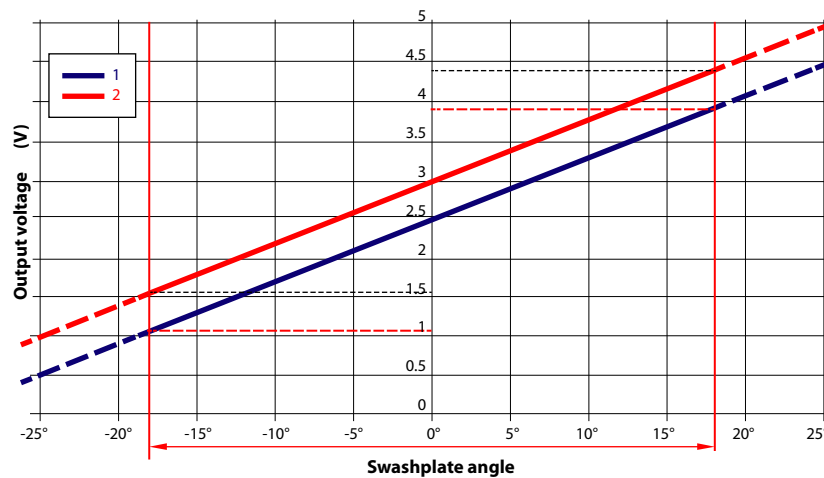
The output signal give a linear output voltage for the various magnet positions in the sensing range.



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:

$$V = \frac{\tan \alpha \cdot V}{\tan 18^\circ} \text{ (cm}^3\text{)}$$

The corresponding flow is:

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

Control Options

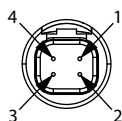
Swash Plate Angle Sensor Parameters (NFPE/AC)

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)

H1P Swash Plate Angle Sensor Connector (NFPE)

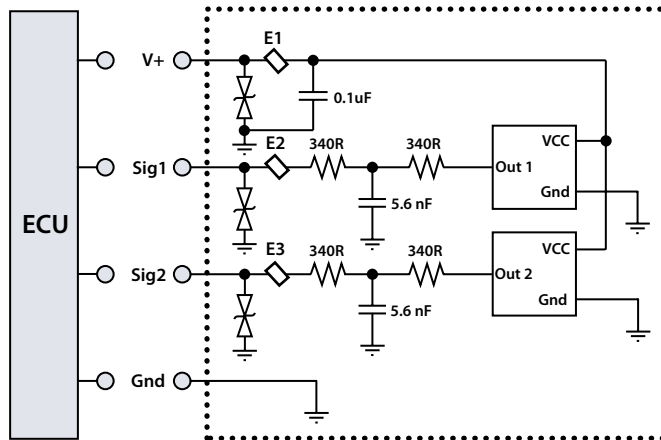


- 1** Ground (GND)
- 2** Output Signal 2 (SIG 2) – Secondary (redundant)
- 3** Output signal 1 (SIG 1)
- 4** Supply (V+)

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

Control Options

Interface with ECU (NFPE)



Minimum recommended load resistance is 100 kΩ.

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.

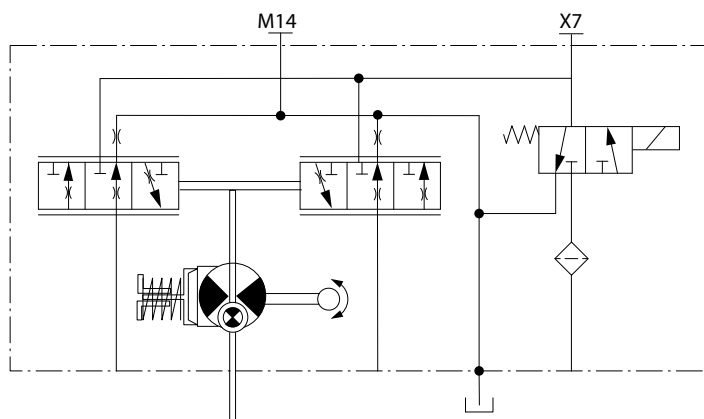
When the solenoid is energized, charge flow and pressure is allowed to reach the pump control. The X7 logic port will also be connected to charge pressure and flow.

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)



P005 703

Control Options

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	

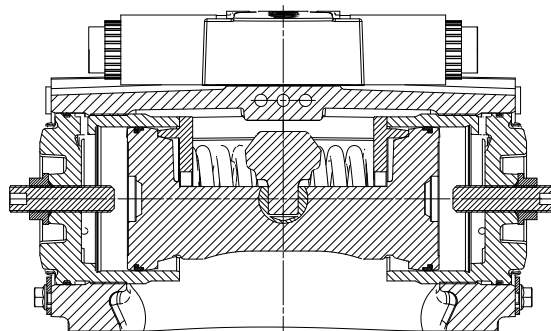
CCO solenoids are design for battery voltage application within the voltage range in the table above, in consideration of a wide range of environmental temperature common for known hydraulic applications. Closed loop PWM current supply can be also applied and is helpful in case that the voltage range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

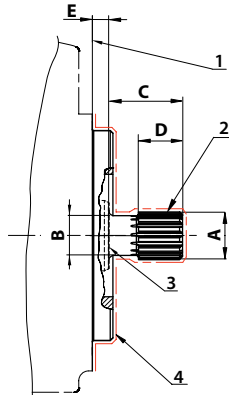


P003 266

H1P 089/100 Displacement Change (approximately)

Parameter	Size 089	Size 100
1 turn of displacement limiter screw	9.3 cm ³ [0.57 in ³]	10.7 cm ³ [0.65 in ³]
Internal wrench size	5 mm	
External wrench size	17 mm	
Torque for external hex seal lock nut	48 N•m [424 lbf•in]	

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

Dimensions and Data
H1P 089/100 Input Shaft Option G1 (SAE C, 14 teeth)


1. Mounting flange 127 – 4 per ISO 3019-1; surface to be paint free
2. **Spline Data:** 14 teeth, Pressure angle: 30°, Pitch: 12/24, $\text{Ø}29.633$ [1.167]; 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
$\text{Ø}31.14 \pm 0.08$ [1.226 ± 0.003]	$\text{Ø}26 \pm 0.13$ [1.024 ± 0.005]	48.1 ± 1.0 [1.894 ± 0.039]	28.8 ± 1.0 [1.134 ± 0.039]	7.94 ± 0.8 [0.313 ± 0.03]

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

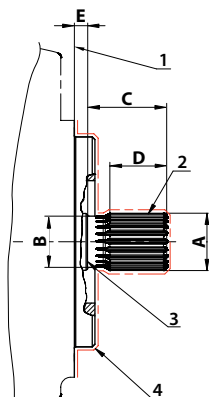
Torque rating

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 Input Shaft Option G3 (SAE C, 13 teeth)



1. Mounting flange 127 – 4 per ISO 3019-1; surface to be paint free
2. **Spline Data:** 13 teeth, Pressure angle: 30°, Pitch: 8/16, $\text{Ø}41.275$ [1.625]; Fillet root side fit per ANSI B92.1-1996, Class 5
3. Coupling must not protrude beyond this point
4. Shaft to be paint free

Dimensions

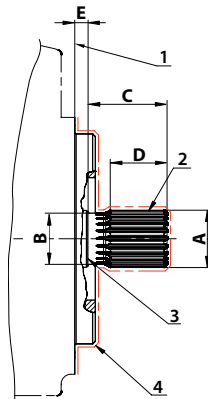
A	B	C	D ¹⁾	E
$\text{Ø}44.4 \pm 0.09$ [1.746 ± 0.004]	$\text{Ø}36.4 \pm 0.25$ [1.433 ± 0.01]	67.0 ± 1.0 [2.638 ± 0.039]	39.5 ± 1.0 [1.555 ± 0.039]	8.05 ± 0.8 [0.317 ± 0.03]

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

Torque rating

Rated torque	Maximum torque
1442 N·m [12 800 lbf·in]	2206 N·m [19 500 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 089/100 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, $\text{Ø}36.513$ [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
$\text{Ø}37.59 \pm 0.08$ [1.480 ± 0.003]	$\text{Ø}33.6 \pm 0.13$ [1.323 ± 0.005]	54.0 ± 1.0 [2.126 ± 0.039]	38.2 ± 1.0 [1.504 ± 0.039]	7.94 ± 0.8 [0.313 ± 0.03]

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

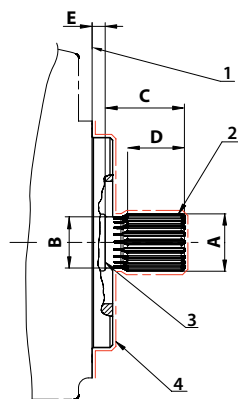
Torque rating

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 089/100 Input Shaft Option F1 (SAE C, 21 teeth)



1. Mounting flange 127 – 4 per ISO 3019-1; surface to be paint free
2. **Spline Data:** 21 teeth, Pressure angle: 30°, Pitch: 16/32, $\text{Ø}33.338$ [1.313]; 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
$\text{Ø}34.42 \pm 0.08$ [1.355 ± 0.003]	$\text{Ø}30.4 \pm 0.13$ [1.197 ± 0.005]	48.0 ± 1 [1.894 ± 0.039]	30.7 ± 1 [1.209 ± 0.0039]	7.94 ± 0.8 [0.313 ± 0.031]

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

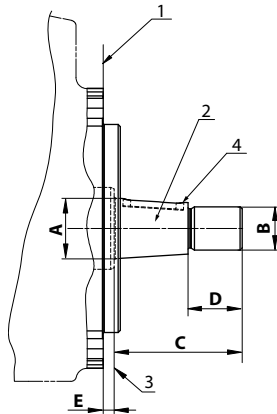
Torque rating

Rated torque	Maximum torque
760 N•m [6730 lbf•in]	1297 N•m [11 479 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 089/100 Input Shaft Option F4, Code 38-3



1. Mounting flange 127 – 4 per ISO 3019-1; surface to be paint free
2. **Tapered shaft:** Conical keyed shaft end similar to ISO3019-1 code 38-3; Suitable key $\frac{3}{8} \times \frac{3}{8} \times 1 \frac{1}{2}$ per ANSI B17.1
3. Coupling must not protrude beyond this point
4. Shaft to be paint free

Dimensions

A	B	C	D	E
$\text{Ø}38.1 \pm 0.09$ [1.5 ± 0.004]	$1\frac{1}{8}$ –12	81.9 ± 1.0 [3.224 ± 0.039]	34.9 ± 1.0 [1.374 ± 0.039]	8.025 ± 0.8 [0.36 ± 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.

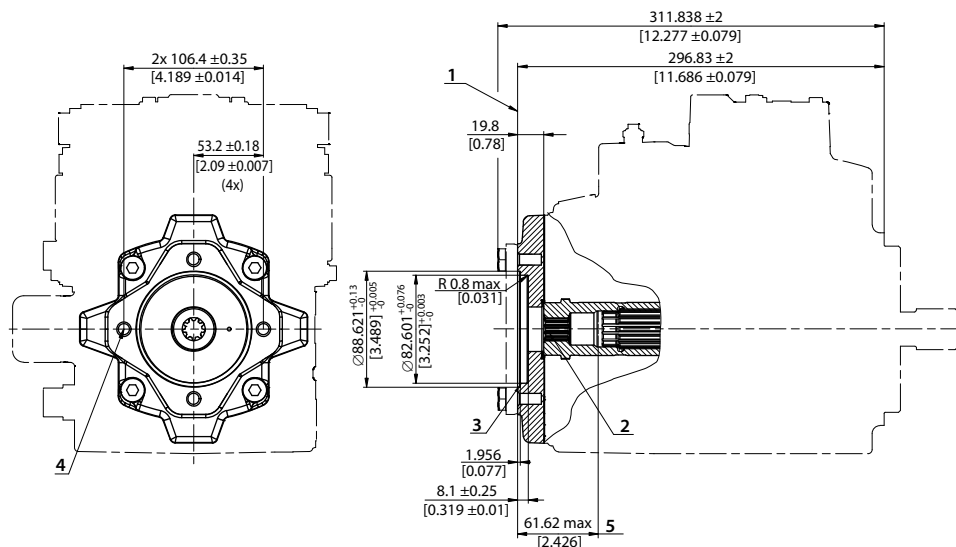
Danfoss recommends a self-locking nut instead of a castle nut and pin. The nut and mating square-cut key are customer supplied. The specified torque rating of the tapered shaft is based on the cross-sectional diameter of the shaft, through the keyway, and assumes the proper clamp and fit between shaft 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 (SAE A, 11 teeth)



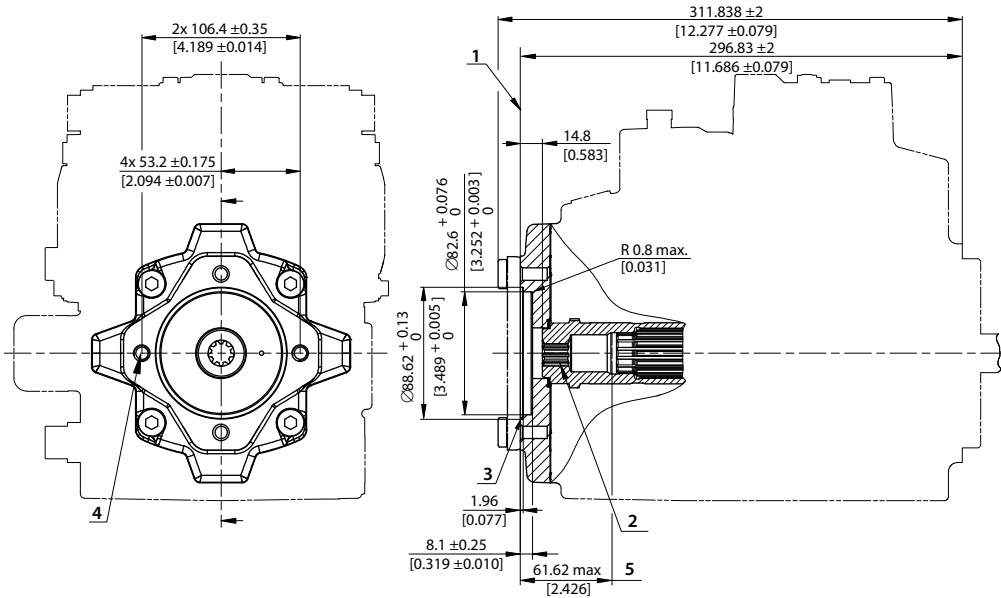
1. Auxiliary mounting pad for mating flange 82-2 per ISO 3019-1 (SAE A); Paint free
2. **Spline Data:** 11 teeth, Pressure angle: 30°, Pitch: 16/32, Ø17.463 [0.6875]; Fillet root side fit per ANSI B92.1-1996, Class 6; minimum active spline length 10.5 mm
3. O-ring seal required; Ref. Ø82.22 [3.237] ID x 2.62, cross section
4. Thread: M10x1.5-6H; 15 [0.59] min. depth (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum Torque	296 N·m [2620 lbf·in]
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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 (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, $\varnothing 14.288$ [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. $\varnothing 82.22$ [3.237] ID x 2.62, cross section
4. Thread: M10x1.5-6H; 15 [0.59] min. depth (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum Torque	162 N·m [1430 lbf·in]
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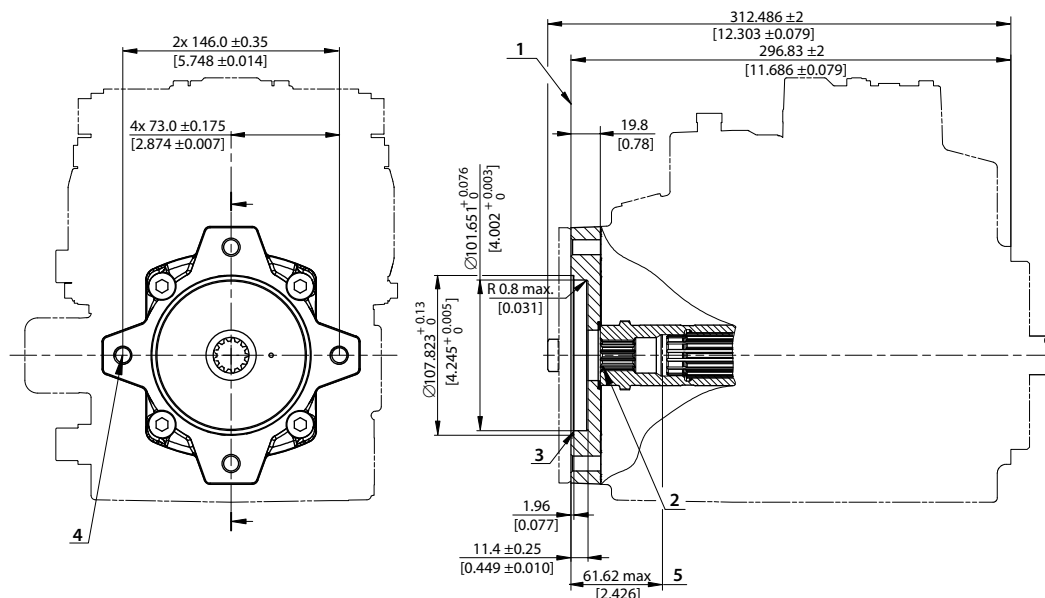
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information*, **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

! 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 (SAE B, 13 teeth)



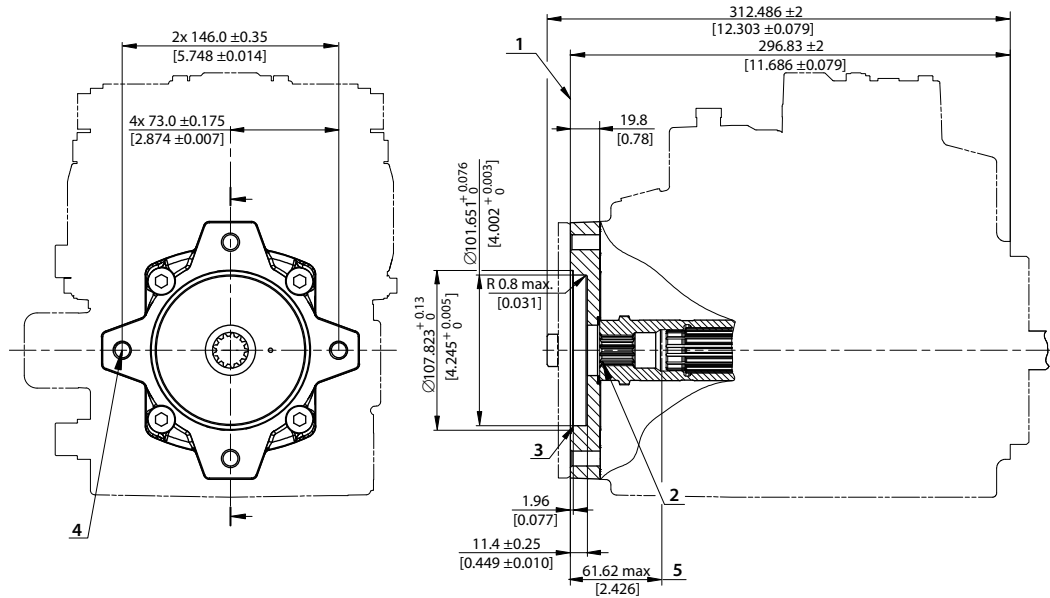
1. Auxiliary mounting pad for mating flange 101-2 per ISO 3019-1 (SAE B); Paint free
2. **Spline Data:** 13 teeth, Pressure angle: 30°, Pitch: 16/32, Ø20.638 [0.813]; Fillet root side fit per ANSI B92.1-1996, Class 6; minimum active spline length 12.4 mm
3. O-ring seal required; Ref. Ø94.92 [3.737] ID x 2.62, cross section
4. Thread: M12x1.75-6H; 20 [0.787] min. depth (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum Torque	395 N·m [3500 lbf·in]
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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 (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 B92.1-1996, Class 6; minimum active spline length 14.3 mm
3. O-ring seal required; Ref. Ø94.92 [3.737] ID x 2.62, cross section
4. Thread: M12x1.75-6H; 20 [0.787] min. depth (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum Torque	693 N•m [6130 lbf•in]
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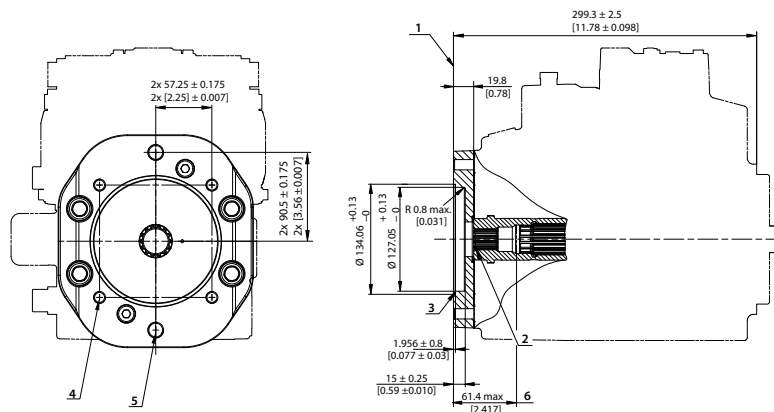
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information*, **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

! 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 (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 17.8 mm
3. O-ring seal required; Ref. Ø120.32 ID x 2.62, cross section
4. Thread: M12x1.75-6H; 22.25 [0.876] min. depth (4x)
5. Thread: M16x2-6H; 22.25 [0.876] min. depth (2x)
6. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum torque	816 N·m [7220 lbf·in]
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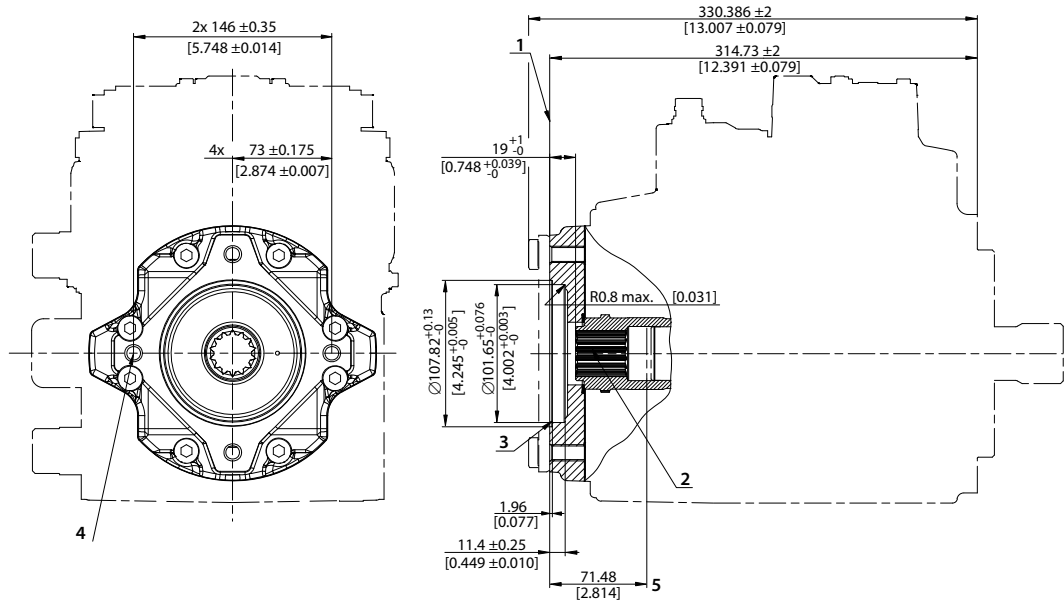
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information*, **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

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 089/100 Auxiliary Mounting, Option S1 (SAE B-B, 14 teeth)



1. Auxiliary mounting pad for mating flange 101-2 per ISO 3019-1 (SAE B); 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 17.8 mm
3. O-ring seal required; Ref. Ø101.32 ID x 2.62, cross section
4. Thread: M12x1.75-6H; 20 [0.787] min. depth (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum torque	816 N·m [7220 lbf·in]
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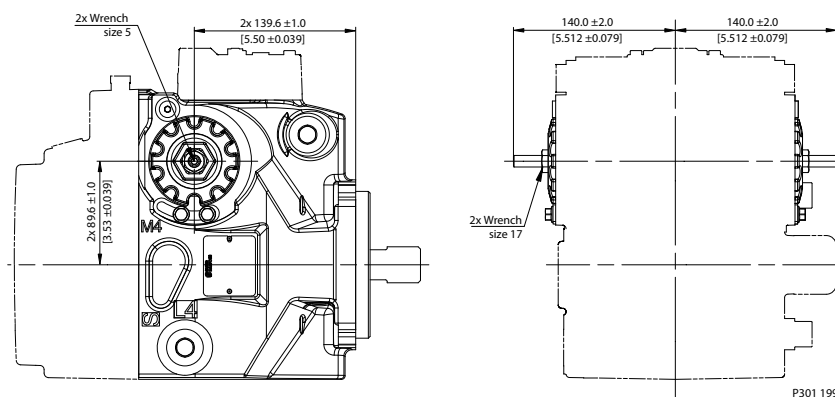
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information, BC152886483968*, the section "Shaft Torque Ratings and Spline Lubrication".

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

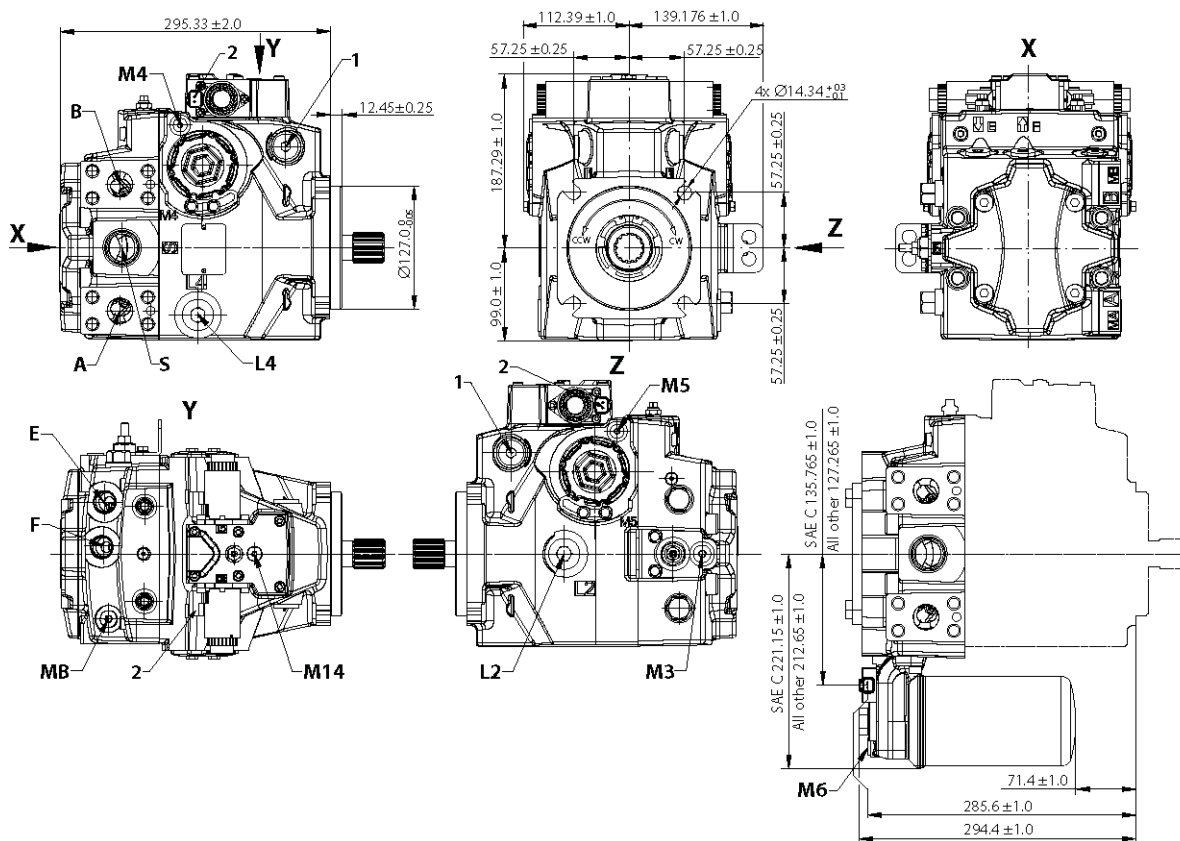


1. Displacement limiter screw (2x)
2. Displacement limiter seal nut (2x)

Wrench size, torque

Wrench size for DL screw	Wrench size for DL seal nut	Torque
5 internal hex	17 external hex	48 N·m [35 lb·ft]

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

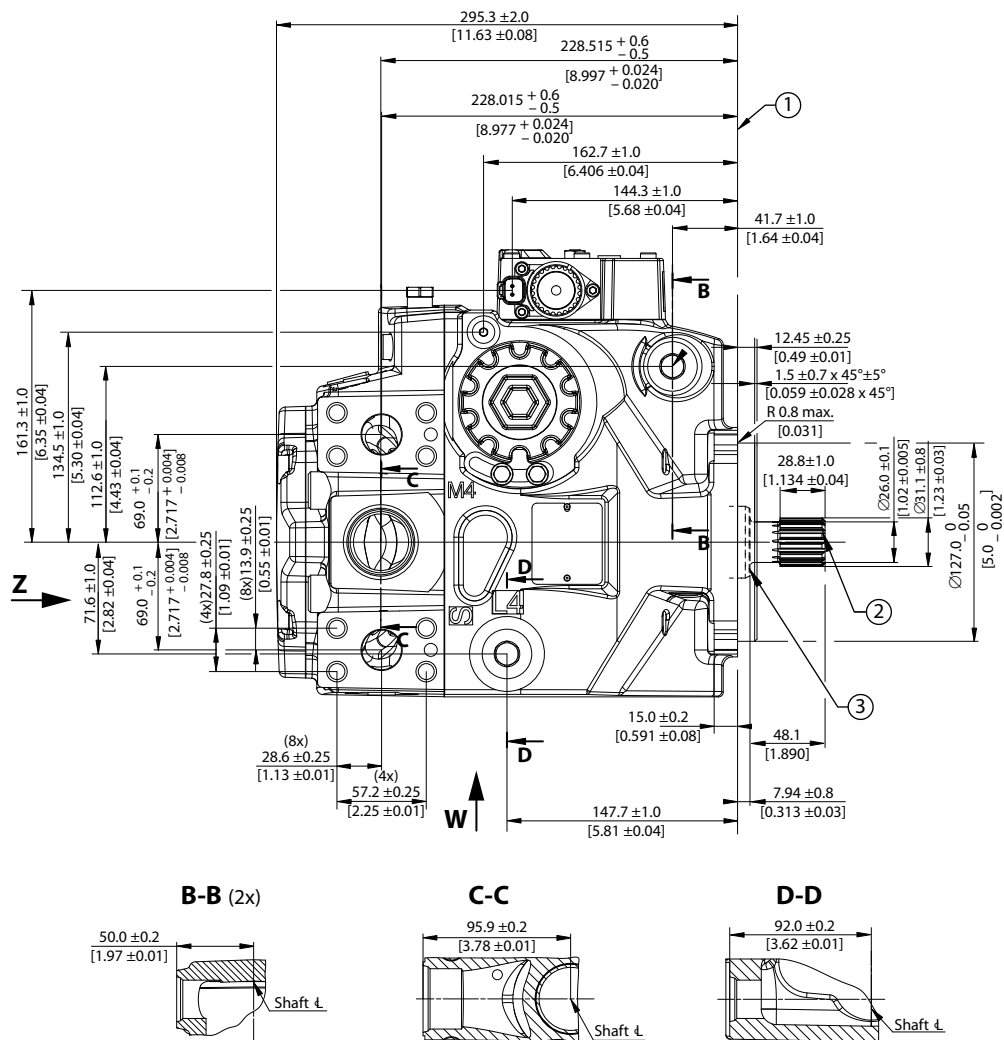
Dimensions and Data
Single Pump Ports

Ports per ISO 11 926-1

Port	Description	Size
A, B	System ports	Ø25.4 mm; M12 x 1.75; 20 min. full thread depth 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 ¹ / ₁₆ -18
E/F	Charge filtration ports	7 ¹ / ₈ -14
M3	Charge pressure gauge port	9 ¹ / ₁₆ -18
M4, M5	Servo gauge port	7 ¹ / ₁₆ -20
M14	Case gauge port (EDC, FNR, NFPE)	7 ¹ / ₁₆ -20
S	Charge inlet port	1 ⁵ / ₈ -12 Recommended screw in depth 1.5 x thread dia
1	Case pressure port	1 ¹ / ₁₆ -12
2	Connector DEUTSCH DT04-2P, to be paint free	

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

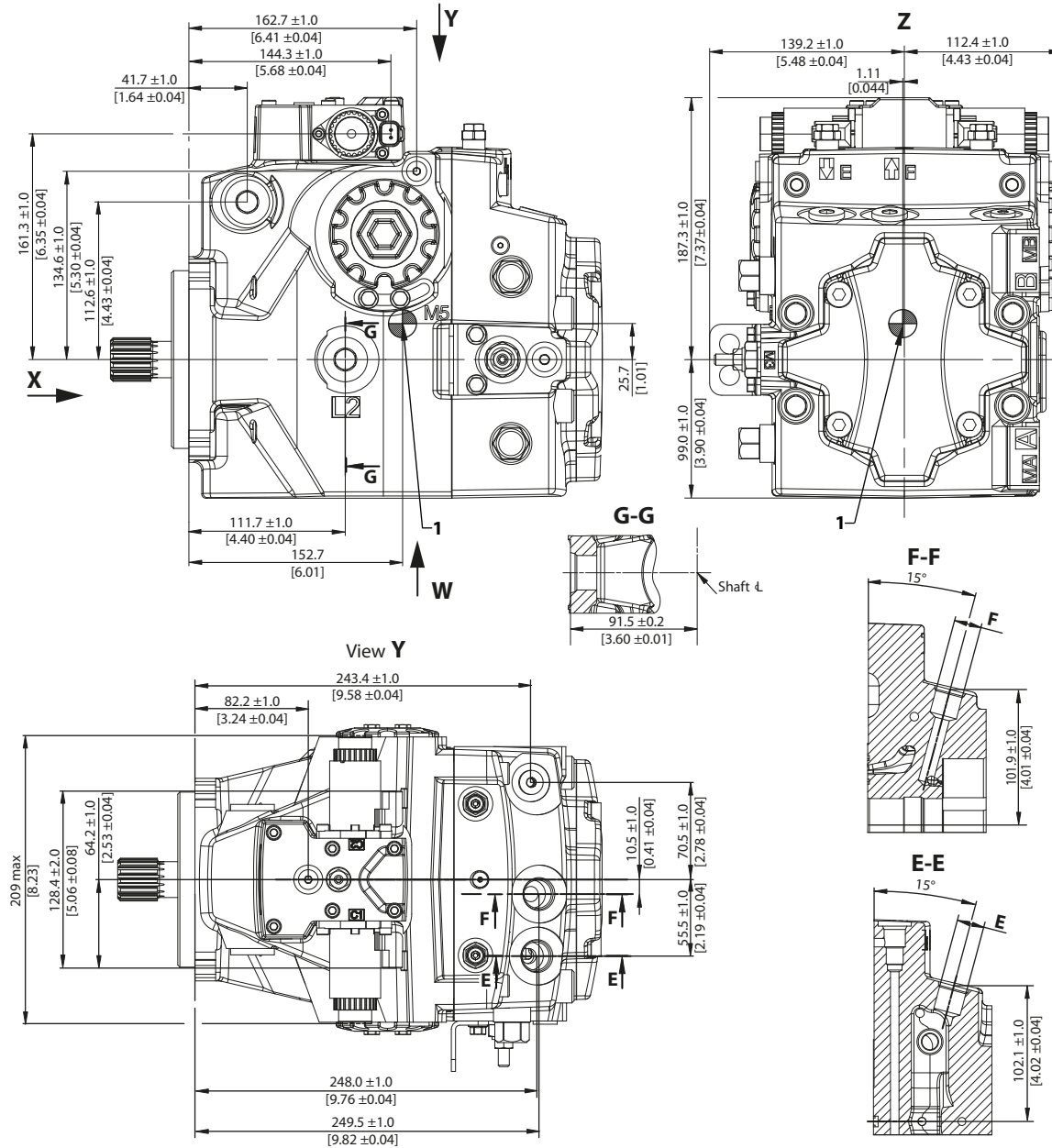
H1P Dimensions



P005 934

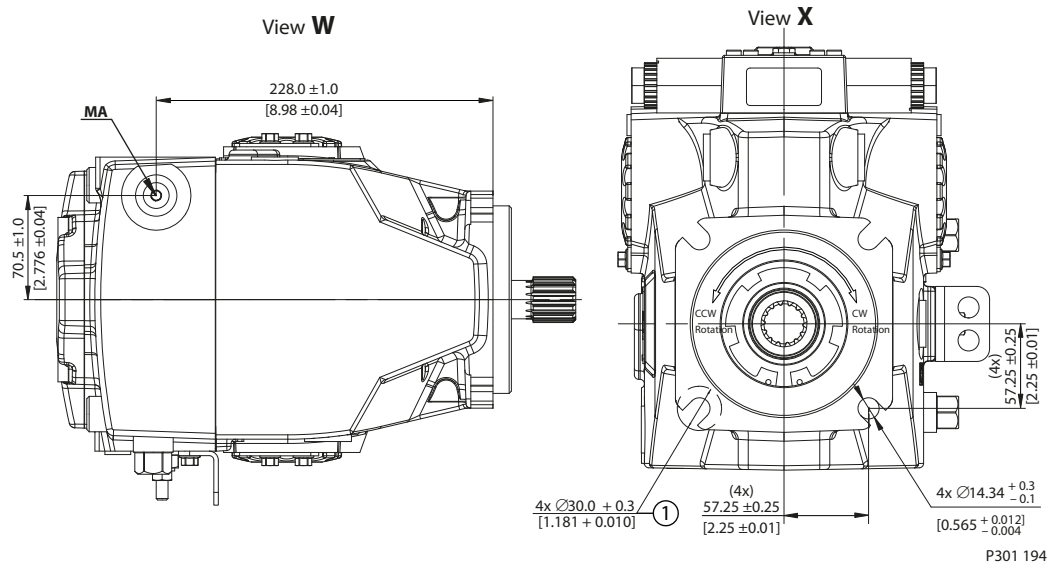
1. Mounting flange 127 – 4 per ISO 3019-1; surface to be paint free
2. Shaft to be paint free
3. Coupling must not protrude beyond this point

Dimensions and Data



1 — Approximate center of gravity

Dimensions and Data

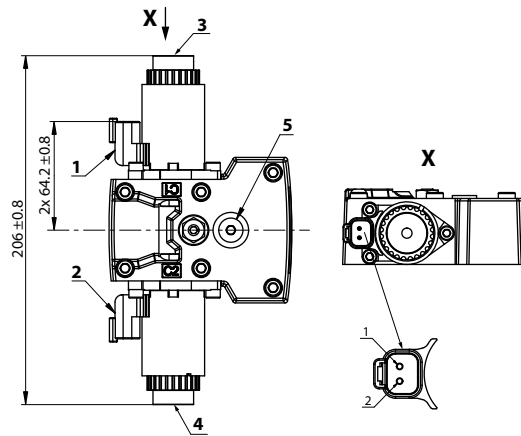


1 — Other side screw head space

Dimensions and Data

Controls

EDC Options A2 and A3 (12/24 V)



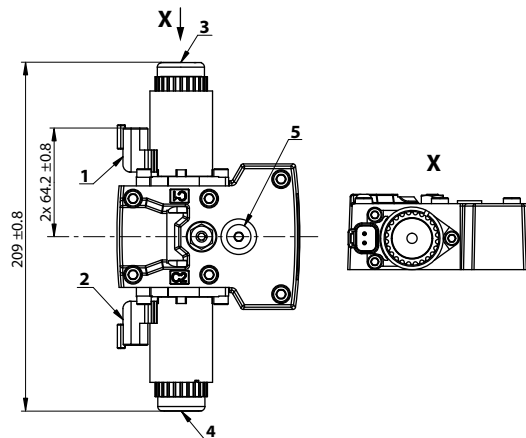
1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
3. Control Manual OverRide **C1**
4. Control Manual OverRide **C2**
5. Case gauge port **M14** per ISO 1926-1: $\frac{7}{16}$ -20

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: $\frac{7}{16}$ -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

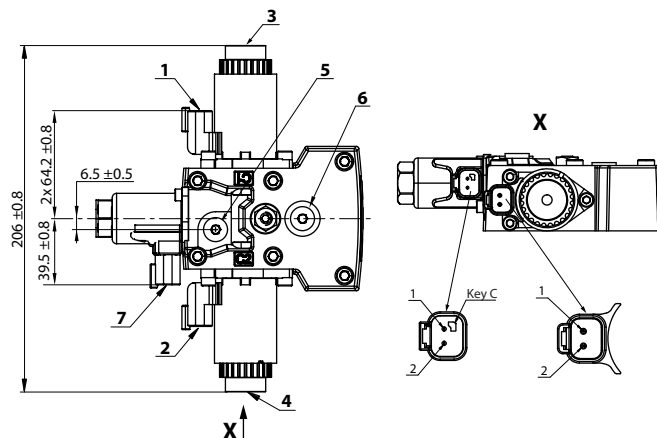


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

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



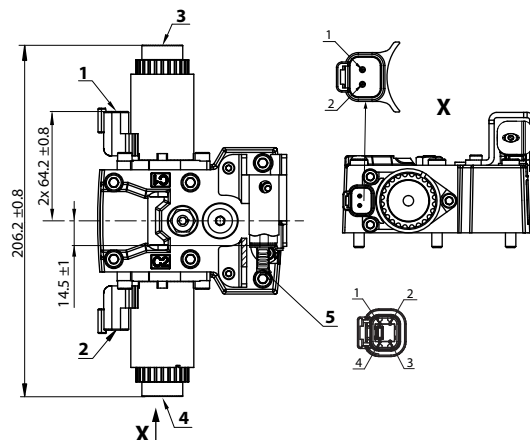
1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
3. Control Manual OverRide **C1**
4. Control Manual OverRide **C2**
5. Brake gauge port **X7** per ISO 1926-1: $\frac{7}{16}$ -20
6. Case gauge port **M14** per ISO 1926-1: $\frac{7}{16}$ -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.

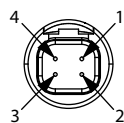
Dimensions and Data

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

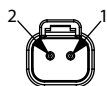
Connector DEUTSCH, 4-pin



4-pin assignment:

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

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

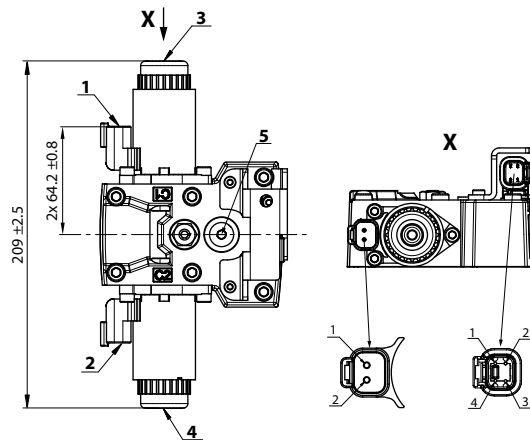


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

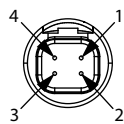
Dimensions and Data

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: $\frac{7}{16}$ -20

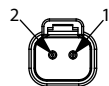
Connector DEUTSCH, 4-pin



4-pin assignment:

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

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

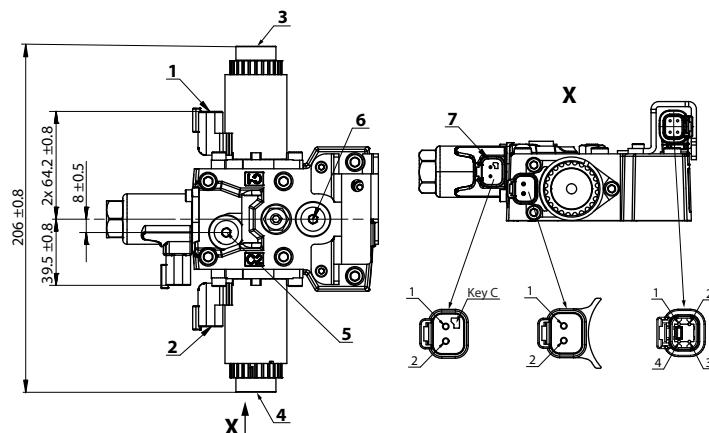


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

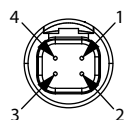
EDC with CCO and ASNSR, Options H8 and H9 (12/24 V)



- 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

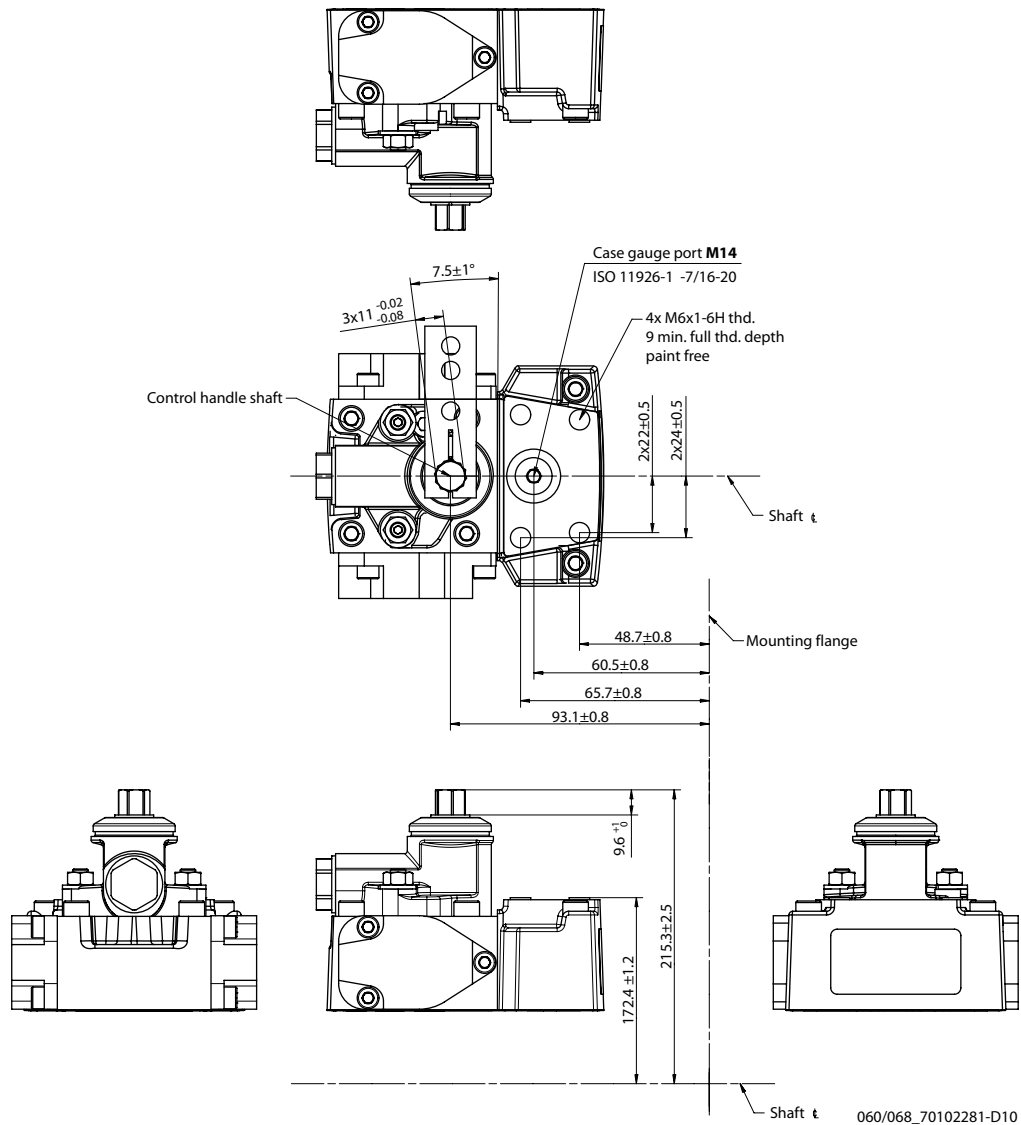


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

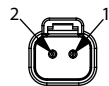
Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

MDC Option: M1



Connector DEUTSCH, 2-pin

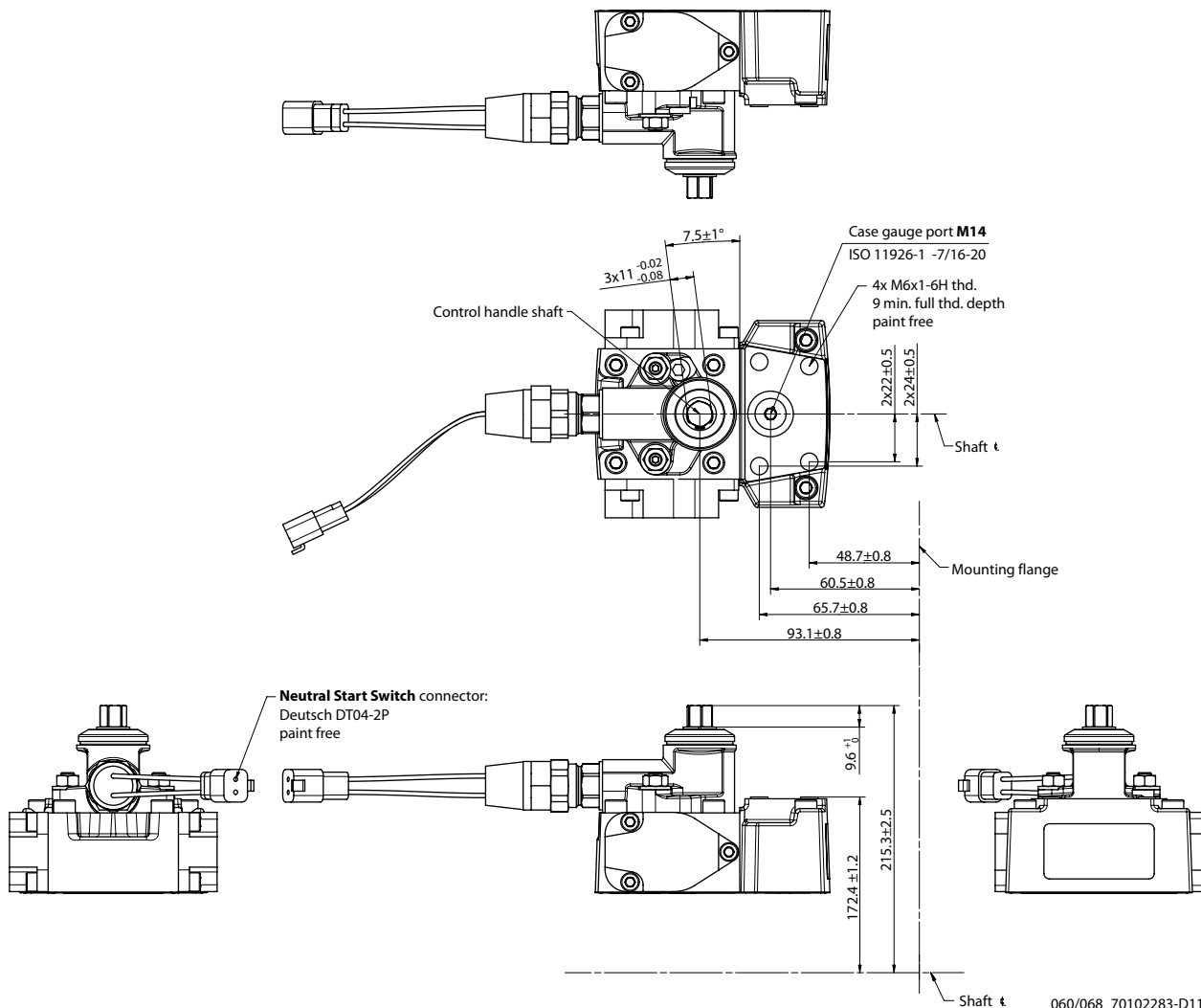


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

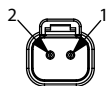
Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

MDC with Neutral Start Switch Option: M2



Connector DEUTSCH, 2-pin

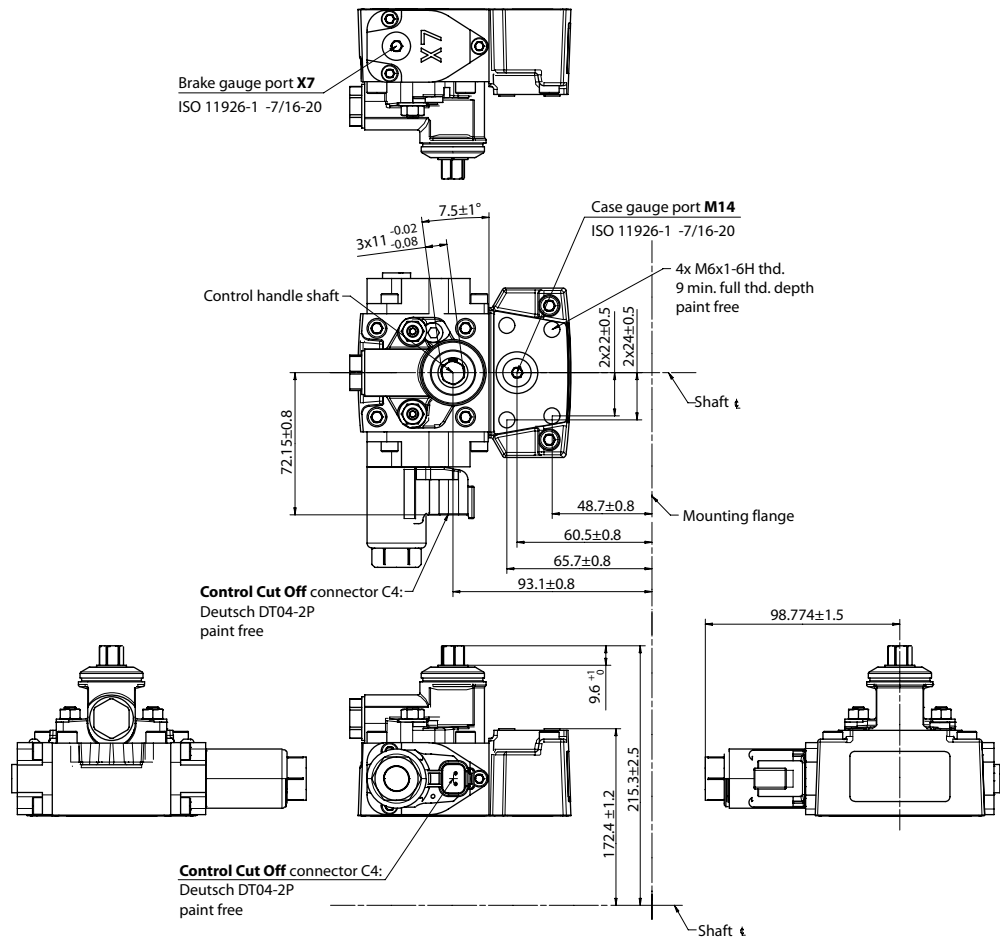


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

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

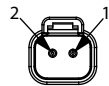
Dimensions and Data

MDC with CCO, Options: M3, M4



060/068_70102283-D12

Connector DEUTSCH, 2-pin

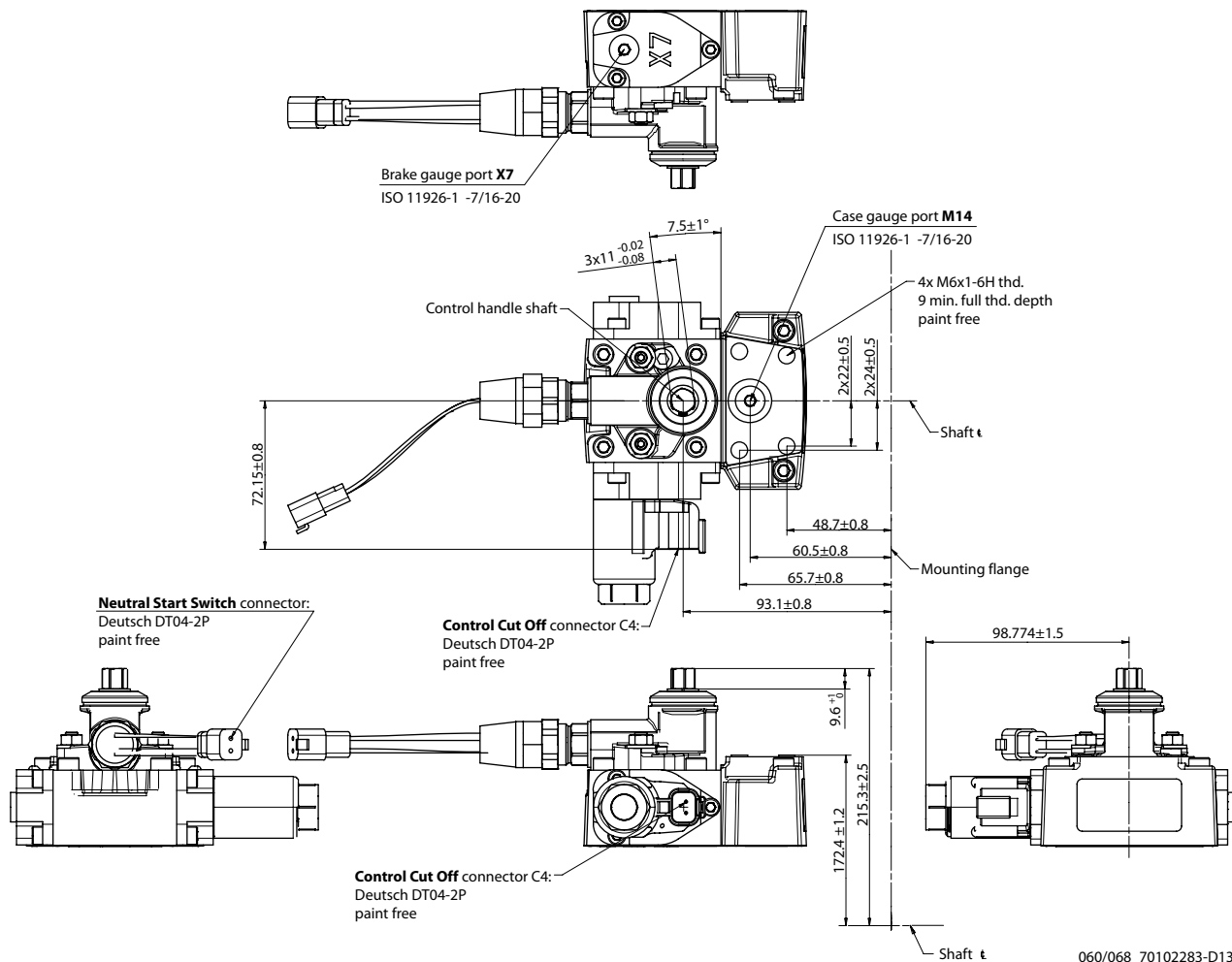


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

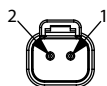
Dimensions and Data

MDC with NSS and CCO Options: M5, M6



060/068_70102283-D13

Connector DEUTSCH, 2-pin



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

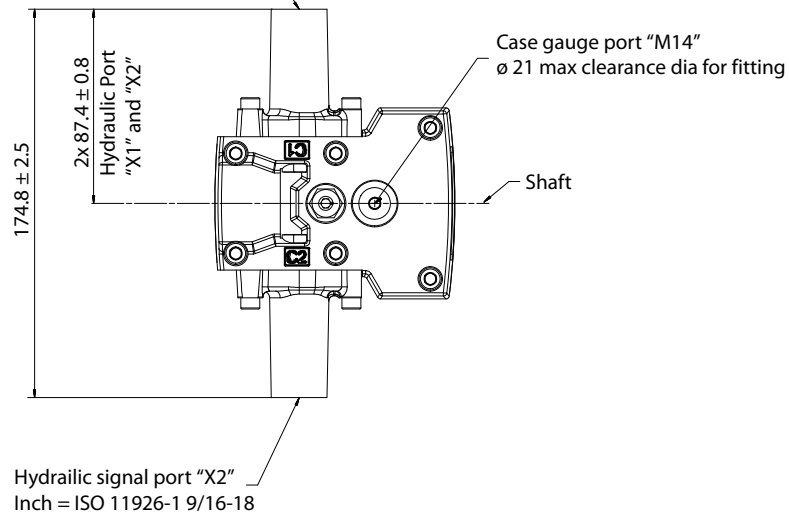
Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

H1P HDC, Options: T1, T2

Dimensions in mm

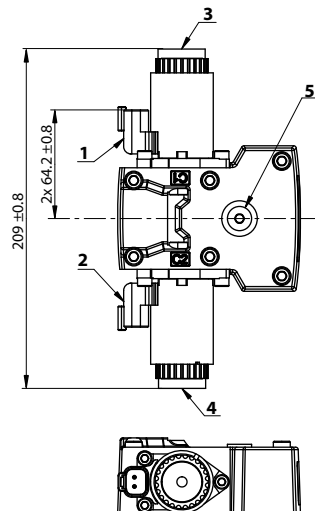
Hydraulic signal port "X1"
Inch = ISO 11926-1 9/16-18



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: $\frac{7}{16}$ -20
- Control solenoid connectors **C1/C2** DEUTSCH DTM04-2P pin/assignment



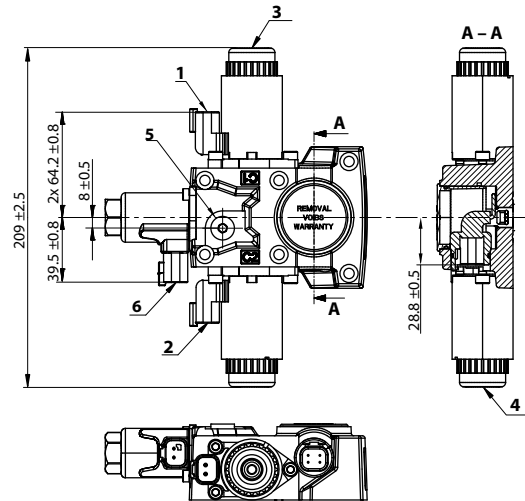
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

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

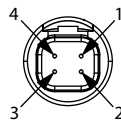
Non-Feedback Proportional Electric control with Control-Cut-Off valve with key C, Manual Over Ride and Angle Sensor, options N3 (12 V) and N4 (24 V).



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: $\frac{7}{16}$ -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.

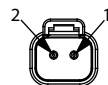
Connector *DEUTSCH*, 4-pin



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



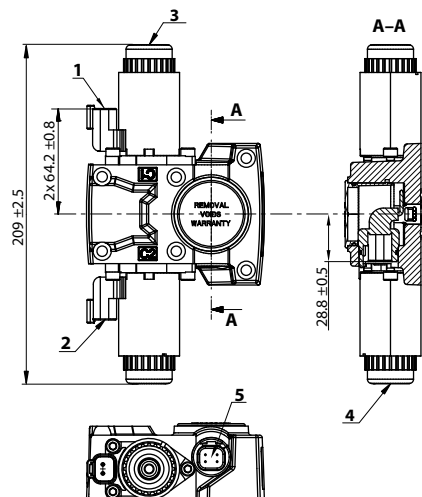
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

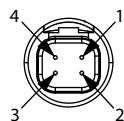
NFPE with MOR and ASNSR, Options: N5, N6 (12/24 V)

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



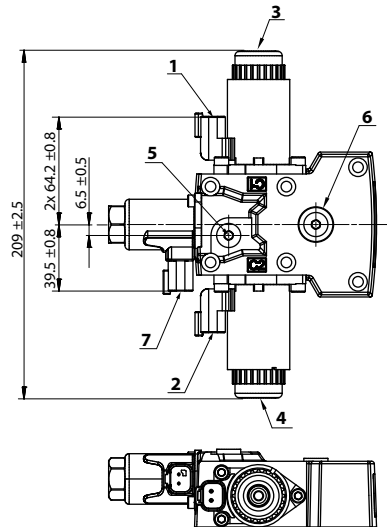
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

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

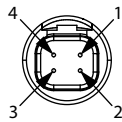
Non Feedback Proportional Electric control with Manual Over Ride and Control-Cut-Off valve key C, options N7 (12 V) and N8 (24 V).



- 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.

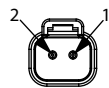
Connector *DEUTSCH*, 4-pin



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

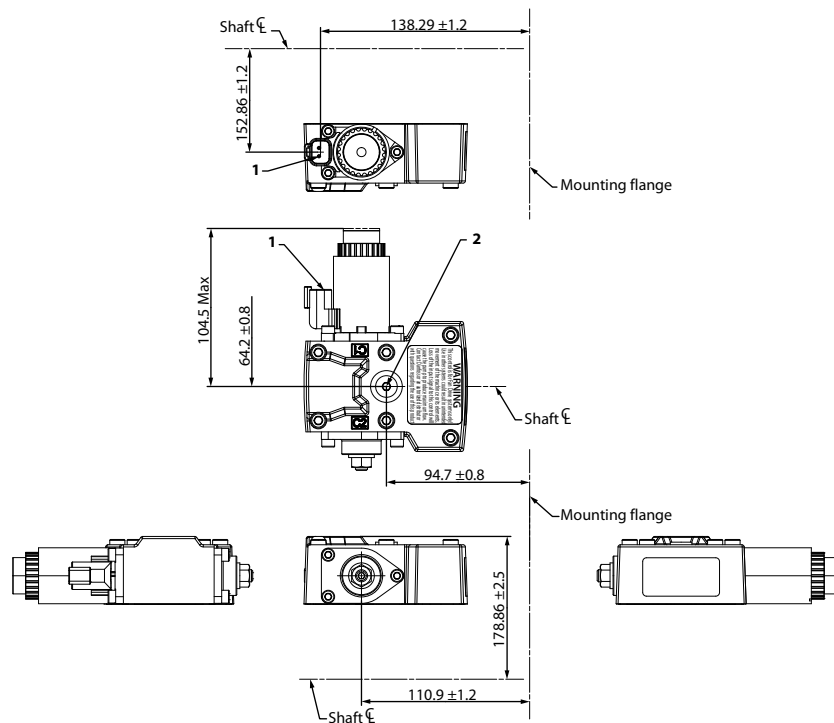


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

FDC Options: F1, F2 (12/24V)



1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free

2. Case gauge port **M14** per ISO 1926-1: $\frac{7}{16}$ -20

Control solenoid connectors *DEUTSCH*, 2-pin assignment

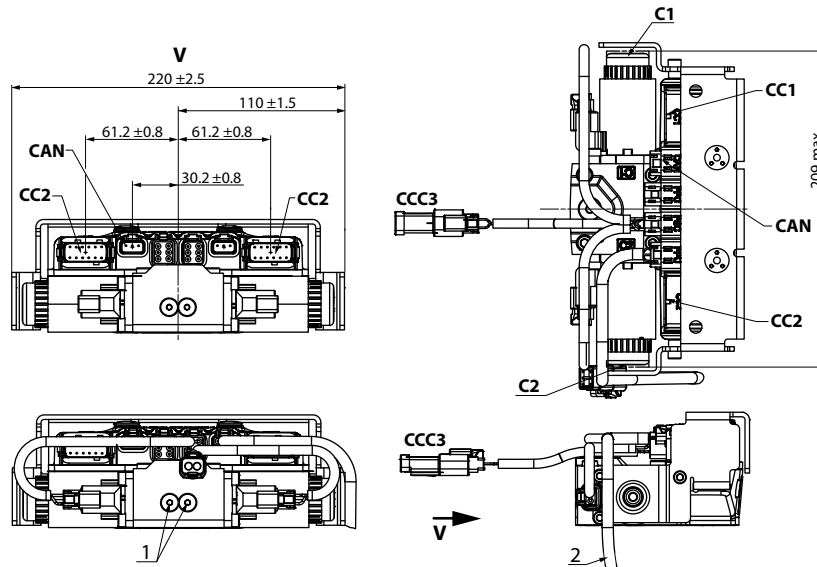


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

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

Dimensions and Data

Automotive control (AC)



- 1 Plug removing can cause contamination issues
- 2 PPU wire harness is factory installed to speed sensor

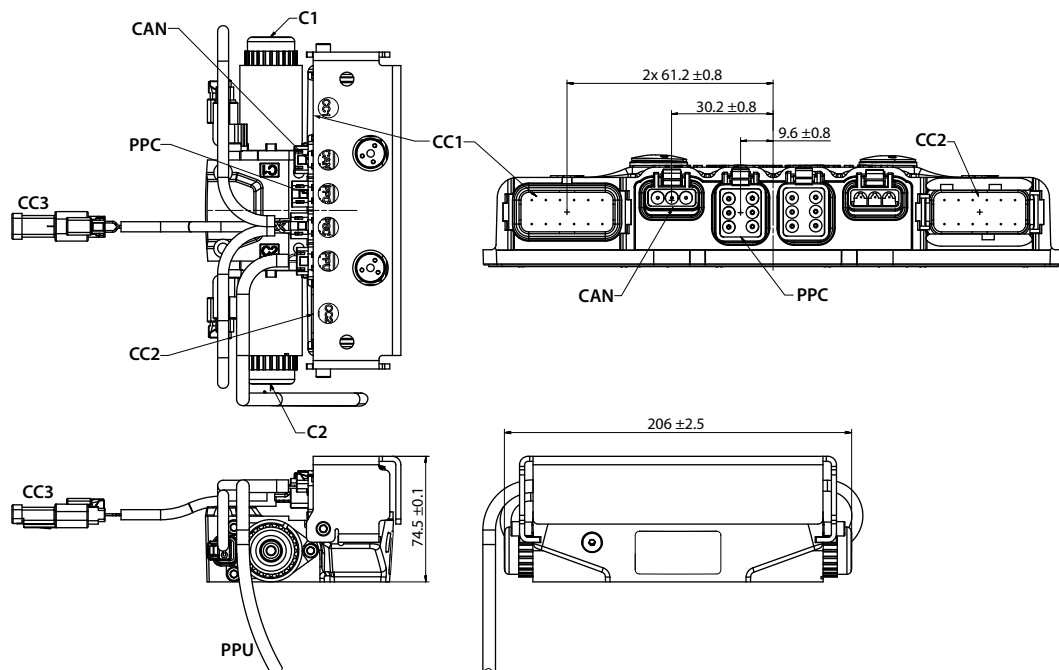
Connectors description

Port	Description
C1 and C2	1. Control manual override C1 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

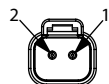
AC connectors dimensions



PPU wire harness is factory installed to speed sensor.

CC3

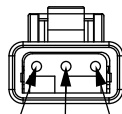
Connector DEUTSCH, 2-pin



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

CAN

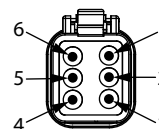
Connector DEUTSCH, 3-pin



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

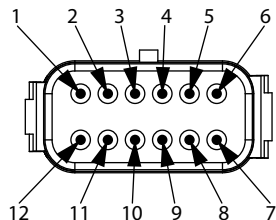
PPC

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)

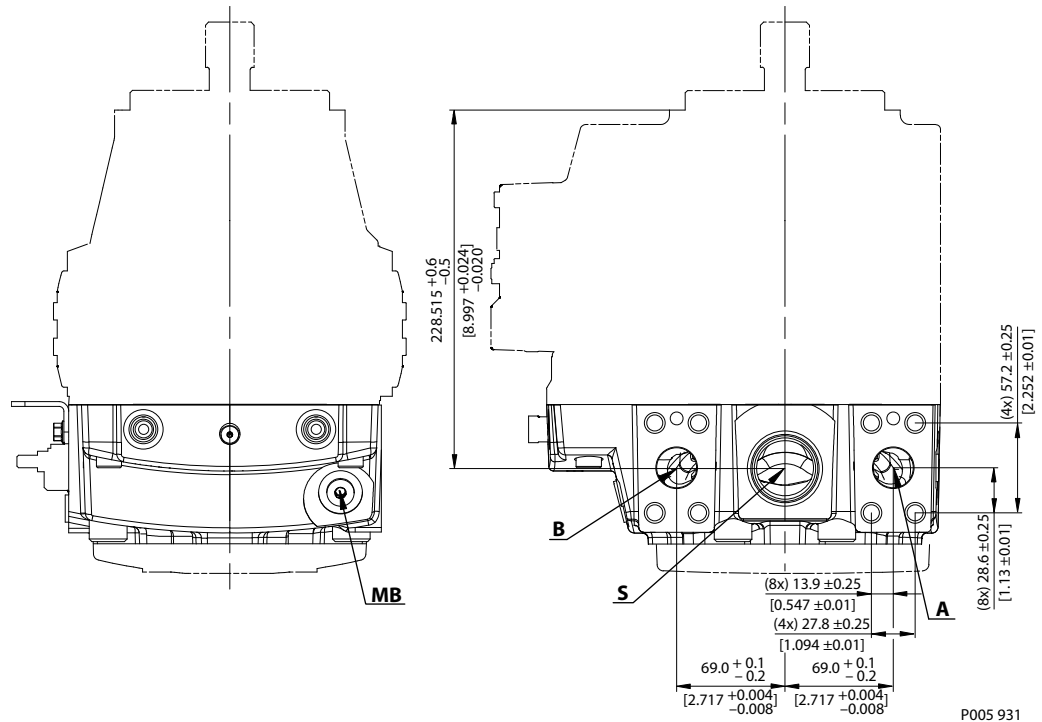
CC2

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 89/100 Suction Filtration Option L



A, B System ports; 450 bar, split flange boss per ISO 6162

MB System B gauge port

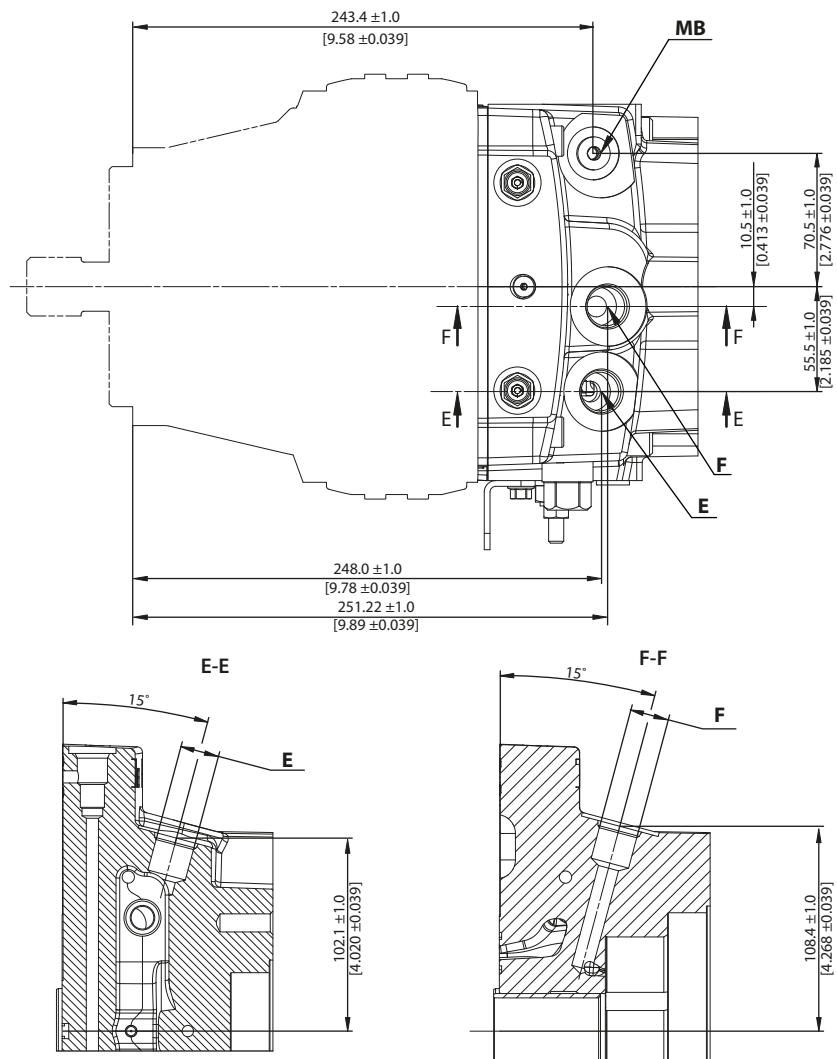
S Charge inlet port per ISO 11926-1: $1\frac{5}{8}$ -12

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

H1P 89/100 Remote Full Flow Charge Pressure Filtration Option P

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



P301 287

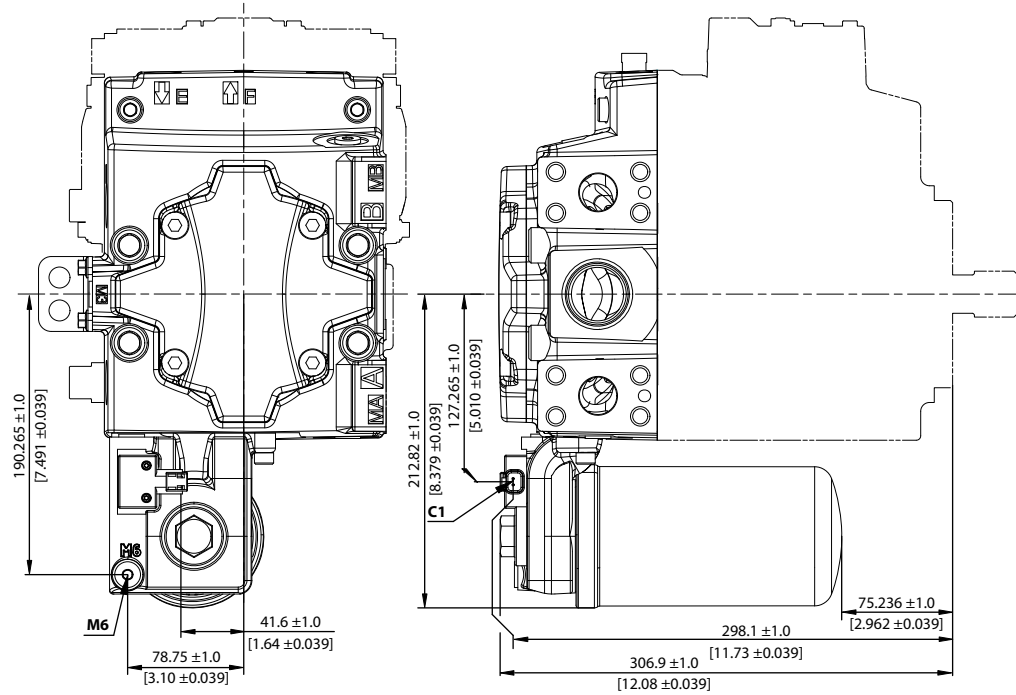
- MB** System B gauge port per ISO 11926-1
- F** Charge filtration port to filter
- E** Charge filtration port from filter

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

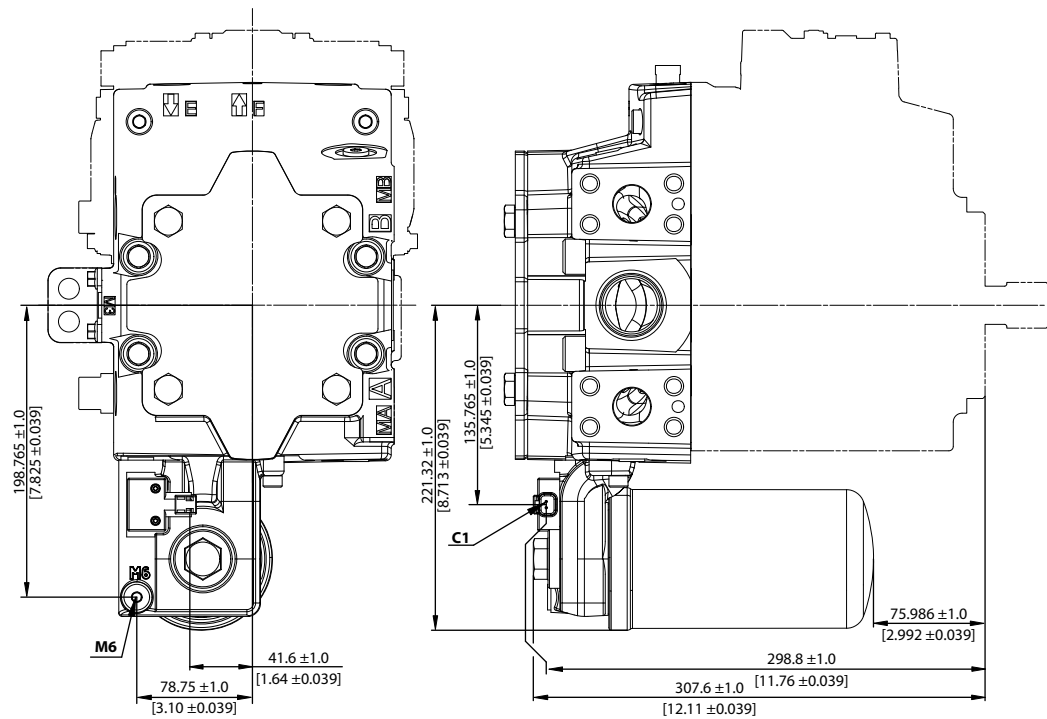
Dimensions and Data

Integral Full Flow Charge Pressure Filtration, Option M

Integral full flow charge pressure filtration with filter bypass sensor, option M, for end cap option D3



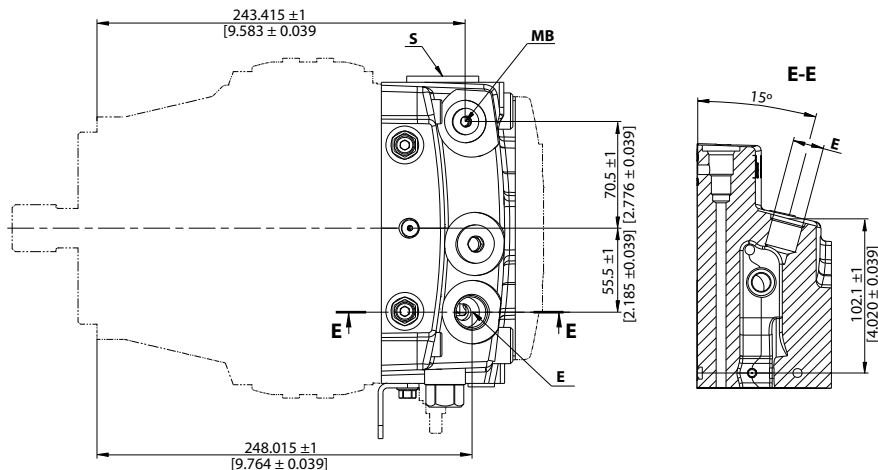
Integral charge filtration with filter bypass sensor, option M, for end cap option F4 (SAE-C PTO)



Dimensions and Data

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: $\frac{7}{8}$ -14 from filter
- MB** System gauge port per ISO 11926-1: $\frac{9}{16}$ -18
- S** Charge inlet port per ISO 11926-1: $1\frac{5}{8}$ -12

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

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- Electric converters
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- PLUS+1® software services, support and training
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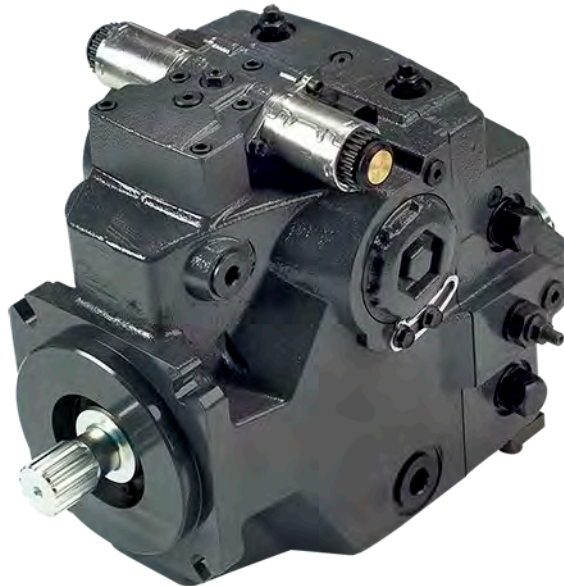
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Technical Information

H1P 115/130

Axial Piston Single Pumps



Revision history*Table of revisions*

Date	Changed	Rev
May 2022	Corrected HDC control information	1301
December 2021	Added HDC control	1201
April 2021	Corrected interface with ECU (EDC) graphic	1105
April 2020	Corrected swash plate angle sensor connector and CCO connector descriptions	1104
February 2020	Added NFPE control options and changed the document number from BC00000198	1103
June 2019	Major revision.	1001
May 2018	Angle sensor for EDC, FDC note added.	0901
May 2017	NFPE gen. 3 changes.	0801
March 2016	Minor edit	0701
November 2015	Master Model Code changes.	0700
2010-2014	Various changes.	BA-GB
Jul 2009	First edition	AA

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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 115/130 Technical Data

Feature	Size 115	Size 130
Displacement	115.2 cm ³ [7.03 in ³]	130.0 cm ³ [7.93 in ³]
Flow at rated speed (continuous)	371 l/min [98 US gal/min]	419 l/min [111 US gal/min]
Torque at maximum displacement (theoretical)	1.83 N·m/bar [1120 lbf·in/1000 psi]	2.07 N·m/bar [1260 lbf·in/1000 psi]
Mass moment of inertia of rotating components	0.021 kg·m ² [0.0155 slug·ft ²]	0.021 kg·m ² [0.0155 slug·ft ²]
Mass (dry-no charge pump)	83 kg [187 lb]	83 kg [187 lb]
Oil volume	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)	<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)
Auxiliary mounting flange with metric fasteners, with shaft outer diameter	<ul style="list-style-type: none"> • Flange 82-2 (SAE A, 9 teeth and 11 teeth) • Flange 101-2 (SAE B, 13 teeth and SAE B-B, 15 teeth) • Flange 127-4 (SAE C, 14 teeth) • Flange 152-4 (SAE D, 13 teeth)
Suction port per ISO 3019-1	ISO 11926-1 – 1 ⁵ / ₈ –12 (SAE O-ring boss)
Main configuration port	Ø31.5 mm; M12 x 1.75; 20 min. full thread depth
Case drain ports L2, L4 per ISO 3019-1	ISO 11926-1 – 1 ⁵ / ₁₆ –12 (SAE O-ring boss)
Other ports	SAE O-ring boss
Customer interface threads	Metric fasteners

Technical Specifications

H1P 115/130 Operating Parameters

Parameter		Unit	Size 115/130
Input speed	Min. for internal ¹⁾ and external ²⁾ charge supply	min ⁻¹ (rpm)	500
	Min. for full performance, internal charge supply		1200
	Rated		3200
	Maximum		3400
System pressure	Maximum working	bar [psi]	450 [6528]
	Maximum		480 [6960]
	Max./Min. low loop		45/10 [650/145]
Charge pressure	Minimum		16 [232]
	Maximum		34 [493]
Control pressure	Minimum (at corner power for EDC, MDC, FNR)	bar [psi]	17 [247]
	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		4.0 [58.0]
Case pressure	Rated	bar [psi]	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 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 μm

Technical Specifications

Fluid Specification

Viscosity

Intermittent¹⁾	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

Minimum¹⁾	-40°C [-40°F]
Rated	104°C [220°F]
Recommended range²⁾	60 – 85°C [140 – 185°F]
Maximum Intermittent	115°C [240°F]

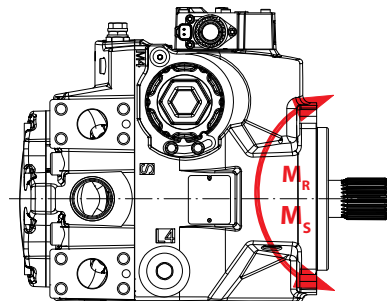
¹⁾ Cold start = Short term $t > 3$ min, $p \leq 50$ bar [725 psi], $n \leq 1000$ min⁻¹ (rpm).

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

H1P 115/130 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

$$M_R = 5933 \text{ N}\cdot\text{m} [52\ 510 \text{ lbf}\cdot\text{in}]$$

Shock load moment

$$M_S = 12\ 640 \text{ N}\cdot\text{m} [111\ 870 \text{ lbf}\cdot\text{in}]$$

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.

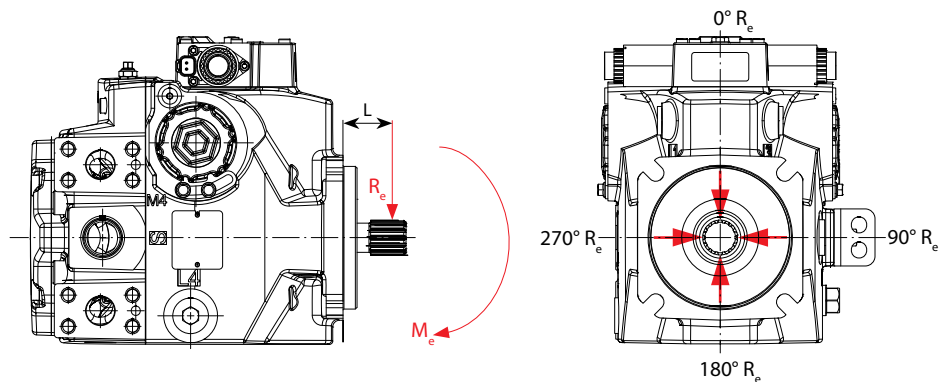
Danfoss recommends clamp-type couplings for applications with radial shaft loads. Contact your Danfoss representative for an evaluation of unit bearing life if you have continuously applied external loads exceeding 25 % of the maximum allowable radial load (R_e) or the pump swash-plate is positioned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

Maximum external shaft load based on shaft deflection

External radial moment	Unit	Size 115/130
M_e	N·m [lbf·in]	129 [1140]

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

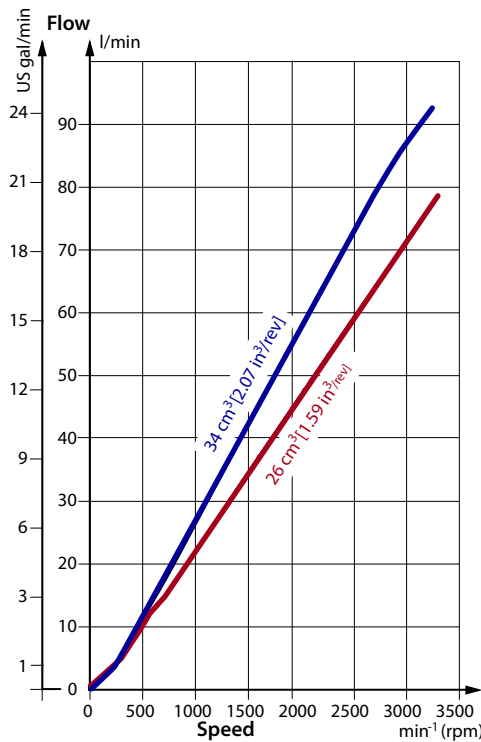
Contact your Danfoss representative for application assistance if your application includes any of these conditions.

26/34 cm³ Charge Pump – Flow and Power Curves

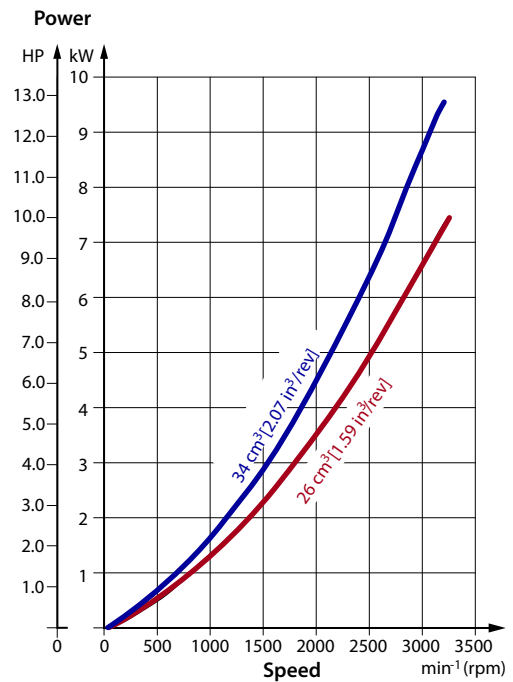
Charge pump flow and power requirements curves shown below at the following conditions:

- 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, A—Rotation, B—Product Version, Z—Port Configuration



Displacement

115	115.2 cm ³ [7.03 in ³]
130	130.0 cm ³ [7.93 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

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).

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

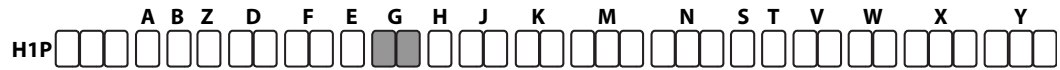
Align with options **F**: Orifices and **Y**: Settings for adjustment (if applicable).

Master Model Code**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

G—Endcap



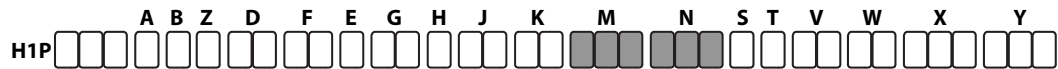
G – End-cap Options

Twin port, ISO 6162 split flange ports; Align with T: Filtration

D3	Integral pressure filtration
D6	Suction filtration
D8	Remote filtration or external charge supply

Master Model Code

M, N—Overpressure Protection Settings



M and N – Overpressure protection options

L	Pressure limiter setting	HPRV with bypass setting ¹⁾
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]
F04	150 bar [2175 psi]	400 bar [5800 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”.

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

Control Options

Electrical Displacement Control (EDC)

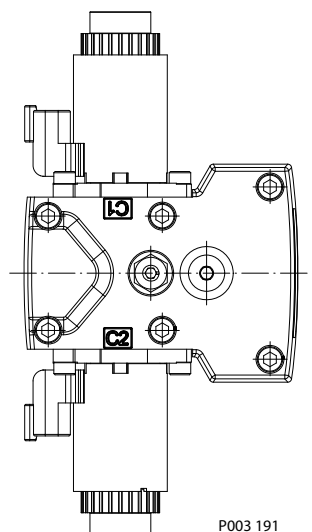
An EDC is a displacement (flow) control. Pump swash plate position is proportional to the input command and therefore vehicle or load speed (excluding influence of efficiency), is dependent only on the prime mover speed or motor displacement.

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.

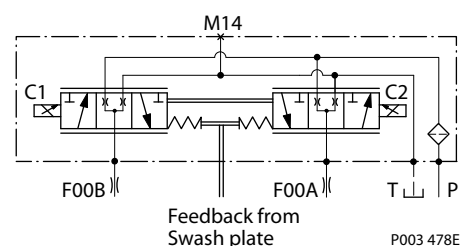
A serviceable 170 µm screen is located in the supply line immediately before the control porting spool.

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.

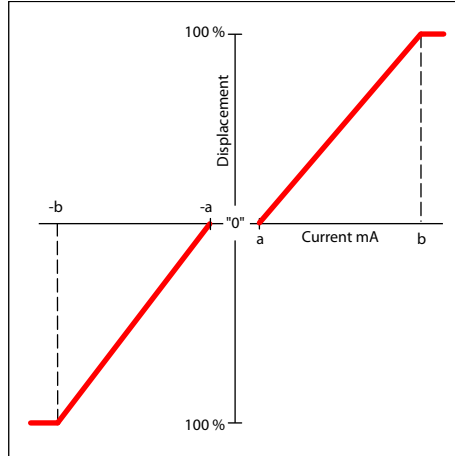
The neutral position of the control spool does provide a positive preload pressure to each end of the servo piston assembly.

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, EDC 115/130

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)	
	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 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:

$\Delta p = 250 \text{ bar}$ [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 115/130

Stroking direction	0.8 mm [0.03 in] orifice	1.3 mm [0.05 in] orifice	No orifice
Neutral to full flow	4.4 s	2.0 s	1.0 s
Full flow to neutral	2.9 s	1.3 s	0.8 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.

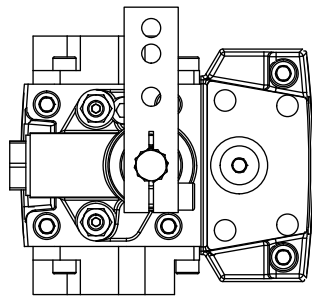
Differential pressure across the servo piston rotates the swash plate, changing the pump's displacement. Simultaneously the swashplate movement is fed back to the control spool providing proportionality between shaft rotation on the control and swash-plate rotation. The MDC changes the pump displacement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

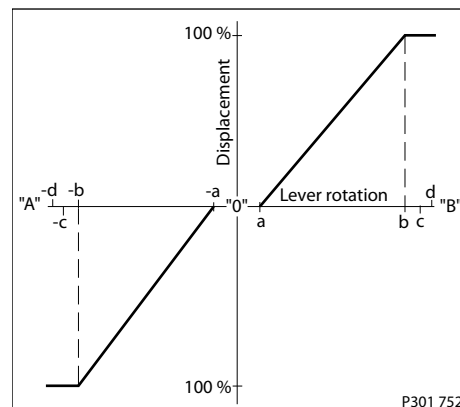
For the MDC with CCO option the brake port (X7) provides charge pressure when the coil is energized to activate static function such as a brake release. The X7 port must not be used for any continuous oil consumption.

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: $a = 3^\circ \pm 1^\circ$

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

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

Internal end stop: $d = 40^\circ$

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.

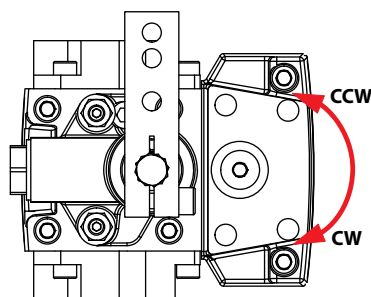
Control Options

- 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)	
	CW	CCW	CW	CCW
MDC shaft rotation				
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:

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

Control Options

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, MDC 115/130

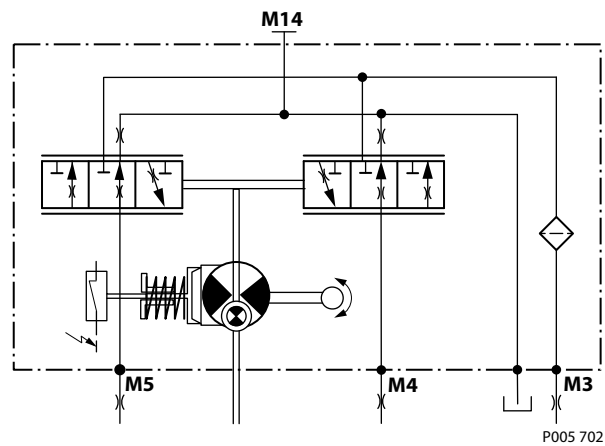
Code	Orifice description (mm)			Stroking direction	
	Tank (A+B)	P	A/B	Neutral to full flow	Full flow to neutral
C3	No orifice			0.4 s	0.4 s
C6	1	–	–	1.1 s	1.0 s
C7	1.3	–	–	0.7 s	0.7 s
D1	0.8	1	–	2.1 s	1.5 s
D2	0.8	1.3	–	1.8 s	1.4 s
D3	1	1.3	–	1.3 s	1.0 s
D4	1	1.3	1.3	1.6 s	1.2 s

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

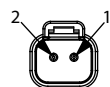


Neutral start switch data

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)

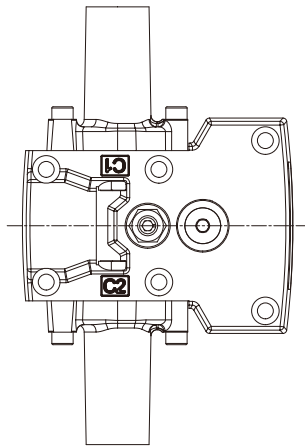
HDC principle

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.

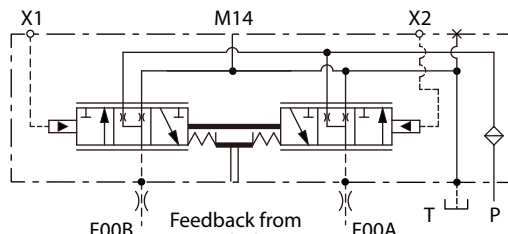
A serviceable 175 µm screen is located in the supply line immediately before the control porting spool.

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.

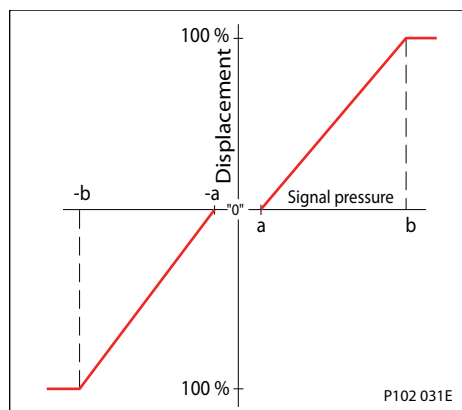
A swashplate feedback link, opposing control linkage, and a linear spring provide swashplate position force feedback to the hydraulic pressure. As hydraulic pressures in the operating loop change with load, the control assembly and servo/swashplate system work constantly to maintain the commanded position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

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

Control Options**Response time, HDC 115/130**

Stroking direction	0.8 mm [0.03 in] orifice	1.3 mm [0.05 in] orifice	No orifice
Neutral to full flow	3.7s	1.7s	1s
Full flow to neutral	2.4s	1.1s	0.6s

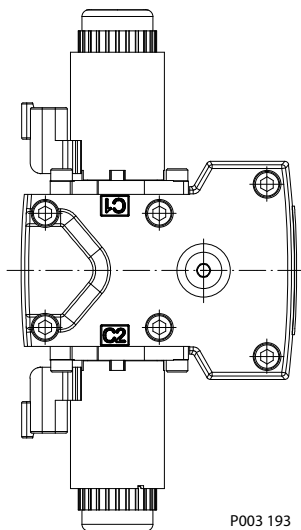
Control Options

Forward-Neutral-Reverse Control (FNR)

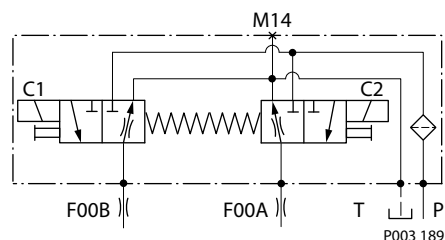
The 3-position FNR control options **A9** (12 V) and **B1** (24 V) uses an electric input signal to switch the pump to a full stroke position. A serviceable 125 μm screen is located in the supply line immediately before the control porting spool.

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

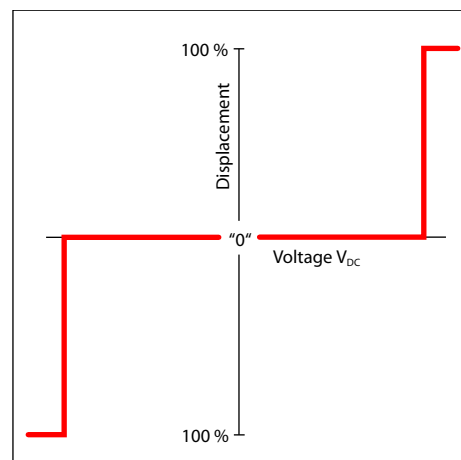
Forward-Neutral-Reverse electric control (FNR)



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	

Control Options

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
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)	
	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.

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:

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

Charge pressure = 20 bar [290 psi]

Control OptionsViscosity and temperature = 30 mm²/s [141 SUS] and 50 °C [122 °F]Speed = 1800 min⁻¹ (rpm)**Response Time, FNR 115/130**

Stroking direction	0.8 [0.03] orifice	1.3 [0.05] orifice	No orifice
Neutral to full flow	4.2 s	1.9 s	1.2 s
Full flow to neutral	5.2 s	2.2 s	1.1 s

Control Options

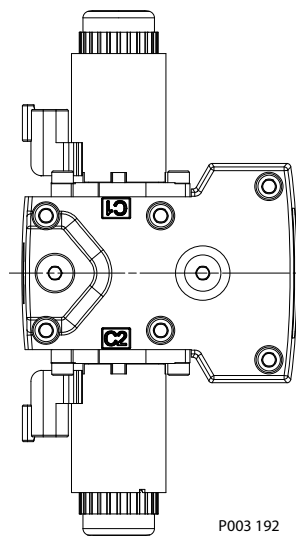
Non feedback proportional electric control (NFPE)

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.

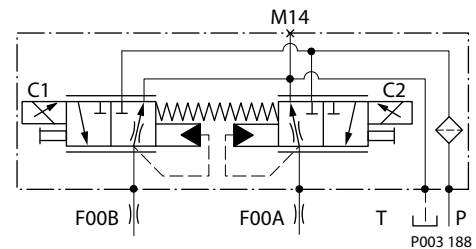
A serviceable 170 μm screen is located in the supply line immediately before the control porting spool.

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

NFPE control



NFPE schematic

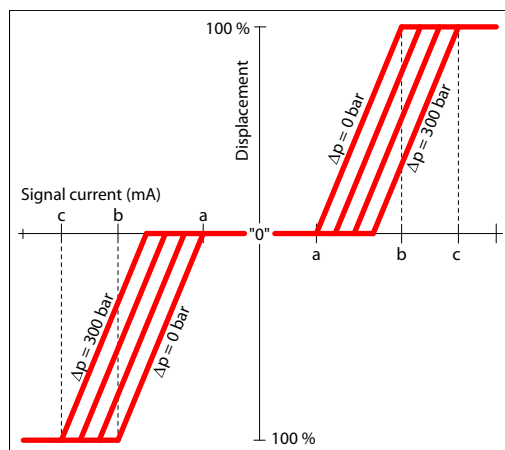


Control Signal Requirements, NFPE 115/130

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}	870 mA	1290 mA	1540 mA	any order
24 V _{DC}	440 mA	670 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.

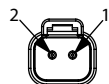
Single Pump Output Flow Direction

Shaft rotation	Clock-Wise (CW)		Counter-Clock-Wise (CCW)	
	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.

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:

$\Delta p = 250 \text{ bar}$ [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)

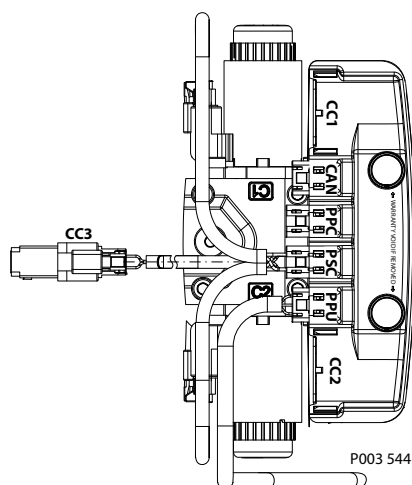
Response Time, NFPE 115/130

Stroking direction	0.8 mm [0.03 in] orifice	1.3 mm [0.05 in] orifice	3.0 mm [0.12 in] orifice
Neutral to full flow	5.0 s	2.3 s	0.9 s
Full flow to neutral	2.5 s	1.1 s	0.4 s

Control Options

Automotive Control (AC)

The H1 **A**utomotive Control (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.

- **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, BC152986482596](#).

Control Options

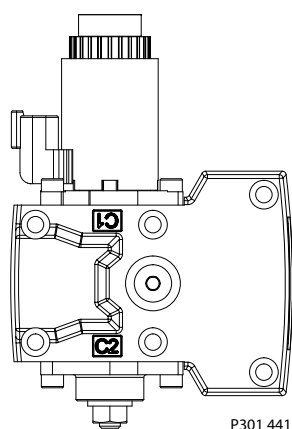
Fan Drive Control (FDC)

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.

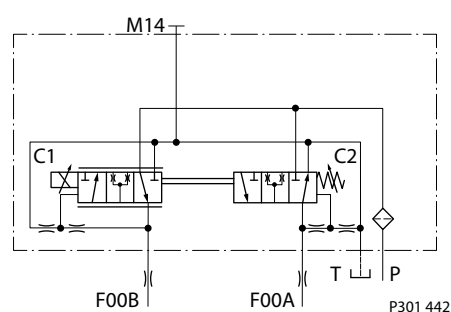
The control spool is spring biased to produce maximum forward pump displacement in the absence of an electrical input signal. Based on the spring bias spool default forward flow for a CW rotation pump is out of port B while default forward flow for a CCW rotation pump is out of port A.

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!

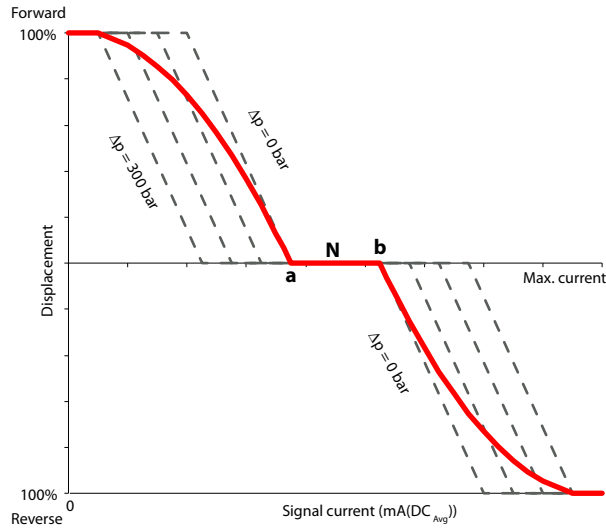
Due to the fail-safe functionality of the FDC control the pump will stroke to max. displacement in case the input signal to the pump control and the Diesel engine will be switched off at the same time. In this situation a low loop event can occur which may damage the pump. Therefore, it's strictly recommended 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, FDC 115/130

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:

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

Charge pressure = 20 bar [290 psi]

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

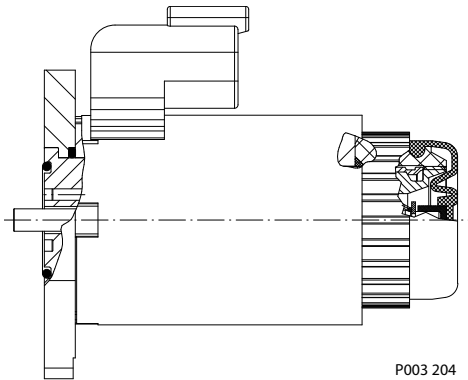
Speed = 1800 min⁻¹ (rpm)

Control Options

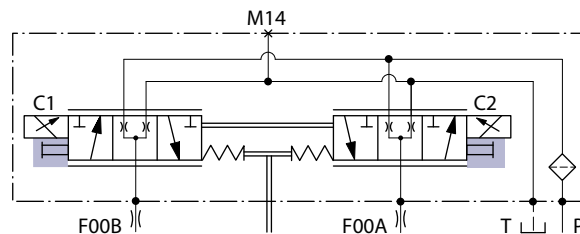
Manual Override (MOR)

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

Control Options

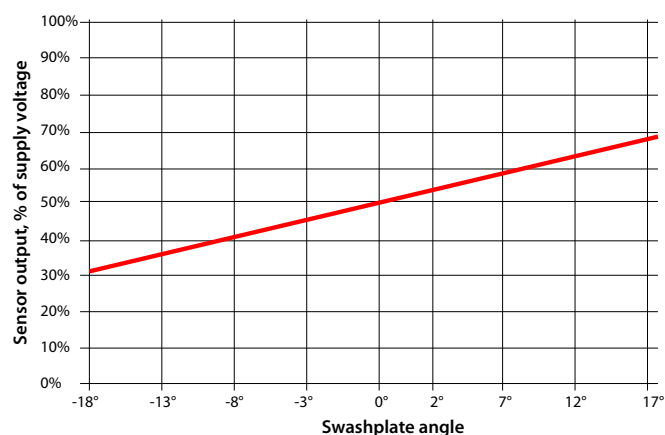
Swashplate angle sensor for EDC controls

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

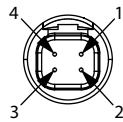
Control Options

Calibration of the sensor output within the software is mandatory. Vehicle neutral thresholds in the software ($\pm 0.5^\circ$) 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.

H1P Swash Plate Angle Sensor Connector

Connector DEUTSCH, 4-pin

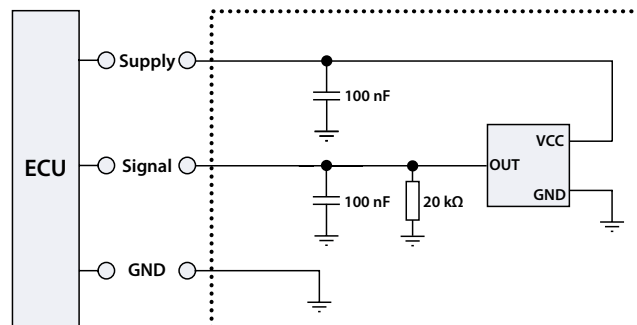


- 1** Ground (GND)
- 2** Not connected
- 3** Output signal 1 (SIG 1)
- 4** Supply (V+)

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

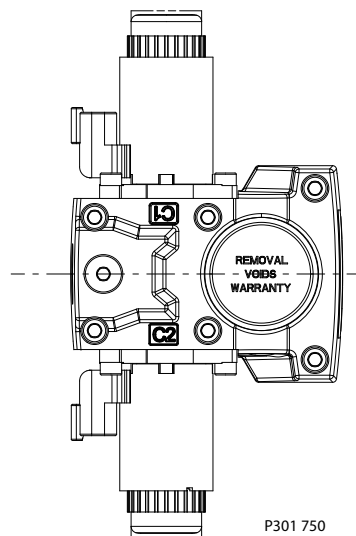


Control Options

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.

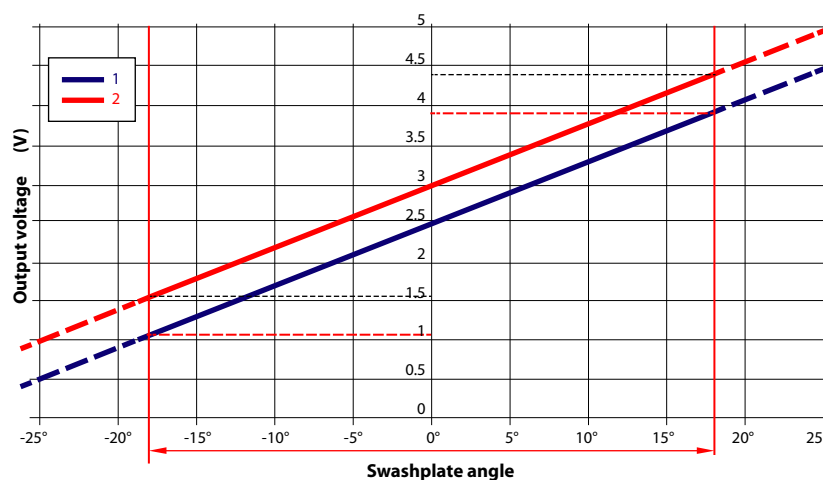
The output signal give a linear output voltage for the various magnet positions in the sensing range.



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:

$$V = \frac{\tan \alpha \cdot V}{\tan 18^\circ} \text{ (cm}^3\text{)}$$

The corresponding flow is:

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

Control Options

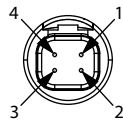
Swash Plate Angle Sensor Parameters (NFPE/AC)

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)

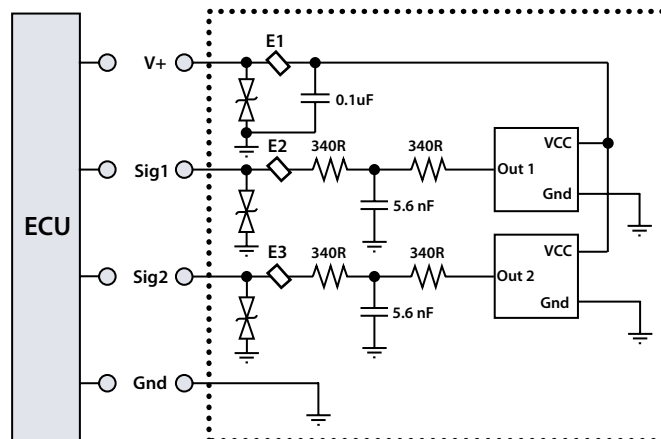
H1P Swash Plate Angle Sensor Connector (NFPE)



- 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.

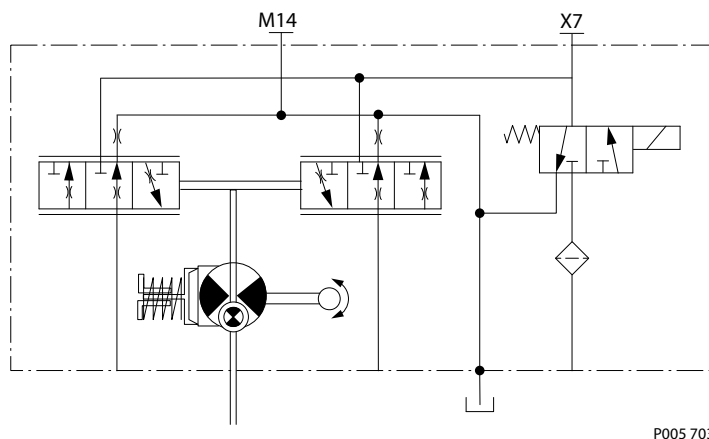
When the solenoid is energized, charge flow and pressure is allowed to reach the pump control. The X7 logic port will also be connected to charge pressure and flow.

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)



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

Control Options
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	

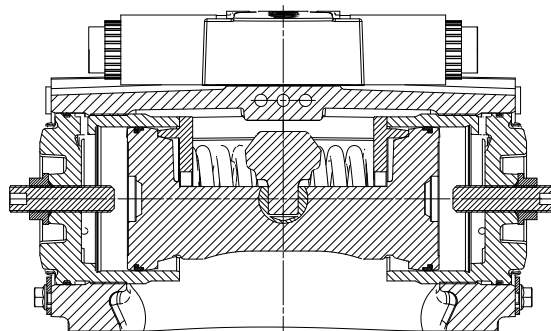
CCO solenoids are design for battery voltage application within the voltage range in the table above, in consideration of a wide range of environmental temperature common for known hydraulic applications. Closed loop PWM current supply can be also applied and is helpful in case that the voltage range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



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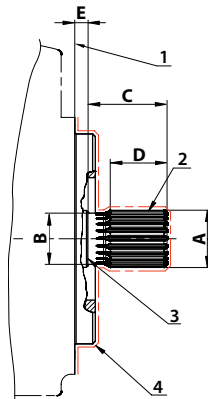
H1P 115/130 Displacement Change (approximately)

Parameter	Size 115	Size 130
1 turn of displacement limiter screw	10.8 cm ³ [0.66 in ³]	12.2 cm ³ [0.74 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*, **AX152886482551**, the section "Displacement Limiter Adjustment".

Dimensions and Data

H1P Input Shaft Option G2 (SAE D, 27 teeth)



1. Mounting flange 152-4 per ISO 3019-1; surface to be paint free
2. **Spline Data:** 27 teeth, Pressure angle: 30°, Pitch: 16/32, $\text{Ø}42.863$ [1.688]; Fillet root side fit, per ANSI B92.1-1996, Class 5;
3. Coupling must not protrude beyond this point
4. Shaft to be paint free

Dimensions

A	B	C	D ¹⁾	E
$\text{Ø}44.36 \pm 0.09$ [1.746 ± 0.004]	$\text{Ø}39.5 \pm 0.13$ [1.555 ± 0.05]	67.0 ± 1.0 [2.638 ± 0.039]	42.0 ± 1.0 [1.654 ± 0.039]	8.05 ± 0.8 [0.317 ± 0.03]

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

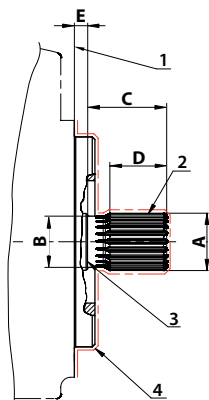
Torque rating

Rated torque	Maximum torque
1615 N·m [14 300 lbf·in]	3000 N·m [26 550 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 Input Shaft Option G3 (SAE D, 13 teeth)



1. Mounting flange 152–4 per ISO 3019-1; surface to be paint free
2. **Spline Data:** 13 teeth, Pressure angle: 30°, Pitch: 8/16, $\text{Ø}41.275$ [1.625]; Fillet root side fit, per ANSI B92.1-1996, Class 5
3. Coupling must not protrude beyond this point
4. Shaft to be paint free

Dimensions

A	B	C	D ¹⁾	E
$\text{Ø}44.4 \pm 0.09$ [1.746 ± 0.004]	$\text{Ø}36.4 \pm 0.25$ [1.433 ± 0.01]	67.0 ± 1.0 [2.638 ± 0.039]	39.5 ± 1.0 [1.555 ± 0.039]	8.05 ± 0.8 [0.317 ± 0.03]

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

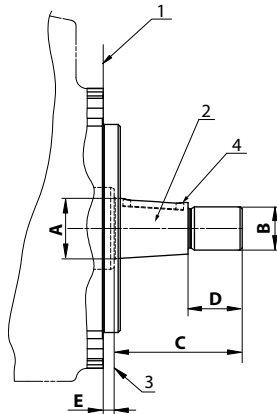
Torque rating

Rated torque	Maximum torque
1442 N·m [12 800 lbf·in]	2206 N·m [19 500 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 115/130 Input Shaft Option F3, Code 44-3



1. Mounting flange 152-4 per ISO 3019-1; surface to be paint free
2. **Tapered shaft:** Conical keyed shaft end, code 44-3 (similar to ISO 3019-1 code 38-3); Suitable key $7/16 \times 7/16 \times 1 \frac{3}{4}$ per ANSI B17.1; to be paint free
3. Coupling must not protrude beyond this point
4. Cone $125 \pm 0.5:1000$

Dimensions

A	B	C	D	E
$\text{Ø}44.45 \pm 0.09$ [1.746 ±0.004]	1¼ -12	93.7 ± 1.0 [3.69 ±0.039]	39.7 ± 1.0 [1.563 ±0.039]	8.025 ± 0.8 [0.361 ±0.031]

Torque rating

Rated torque ¹⁾	Maximum torque ²⁾
1766 N·m [15 630 lbf·in]	2354 N·m [20 830 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.

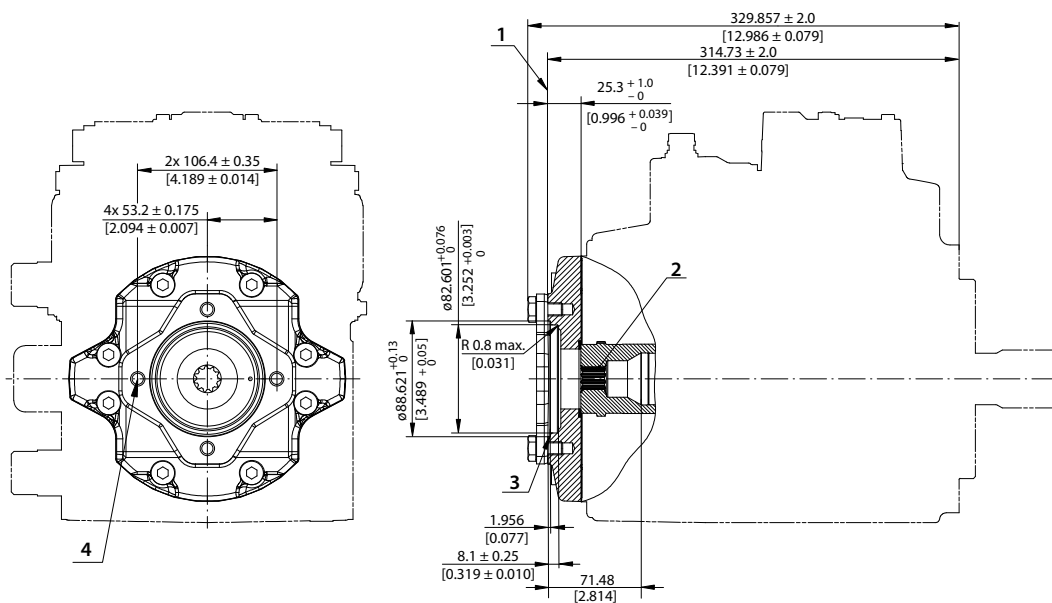
Danfoss recommends a self-locking nut instead of a castle nut and pin. The nut and mating square-cut key are customer supplied. The specified torque rating of the tapered shaft is based on the cross-sectional diameter of the shaft, through the keyway, and assumes the proper clamp and fit between shaft 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 (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 [0.688]; 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; 16 mm [0.63 in] min. depth (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum Torque	296 N·m [2620 lbf·in]
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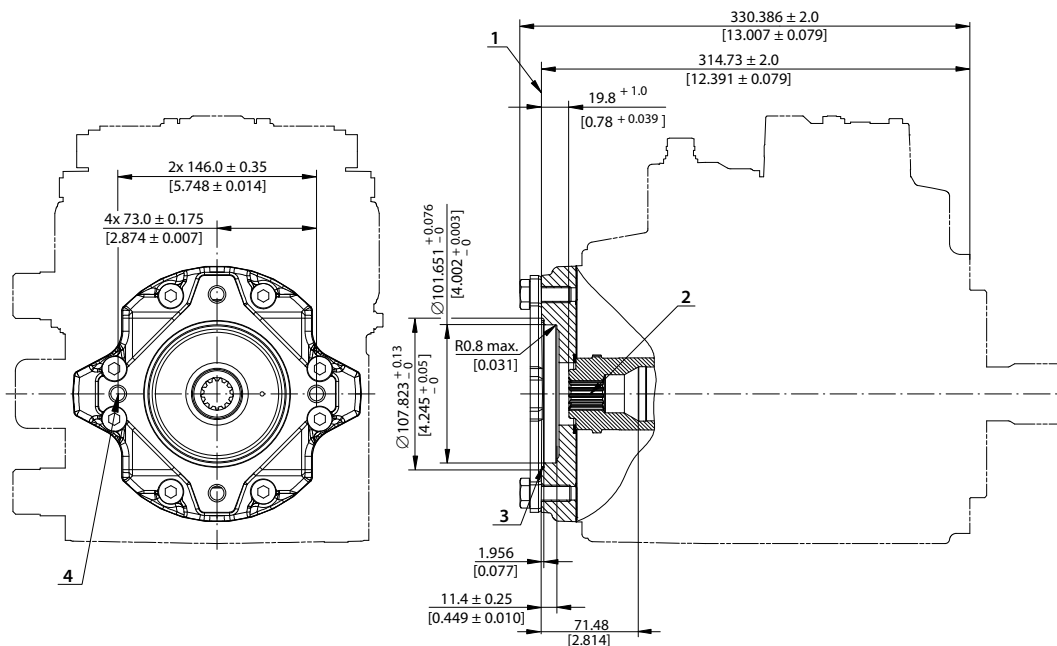
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information, BC152886483968*, the section "Shaft Torque Ratings and Spline Lubrication".

⚠ 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 (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. Ø101.32 ID x 2.62, cross section
4. Thread: M12x1.75-6H; 25 mm [0.984 in] min. depth (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum Torque	395 N·m [3500 lbf·in]
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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”.

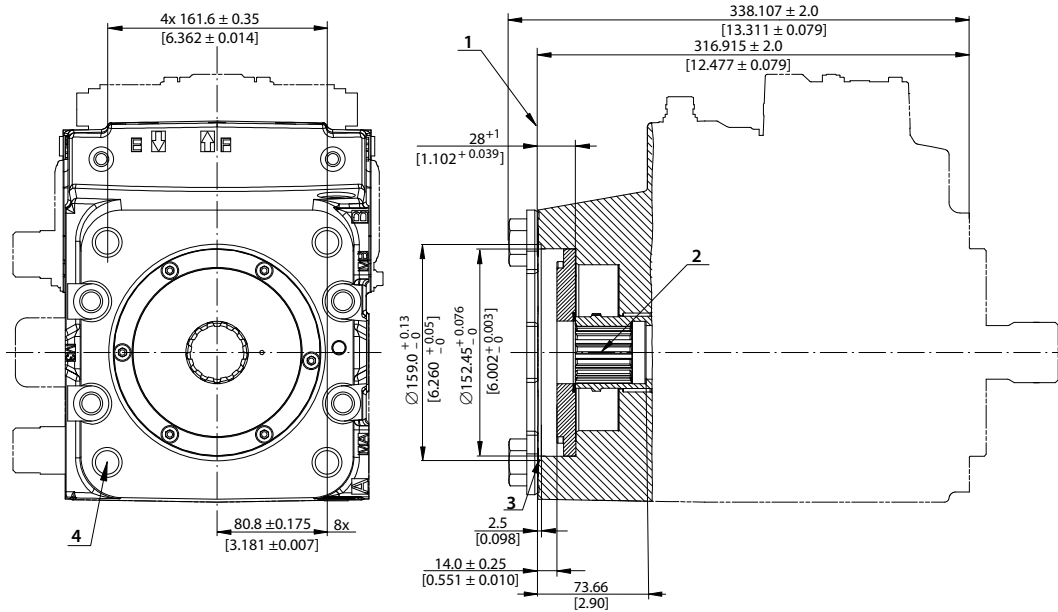
Caution

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 H4 (SAE D, 13 teeth)

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



- 1. Spline Data:** 13 teeth, Pressure angle: 30°, Pitch: 8/16, Ø41.275 [1.625]; Fillet root side fit; per ANSI B92.1-1996, Class 6; Minimum active spline length 24.8 mm
- 2.** O-ring seal required; Ref. Ø150.0 ID x 3.0, cross section
- 3.** Thread: M20x2.5-6H; 30 mm [1.181 in] min. depth (4x)
- 4.** Mating shaft and shaft shoulder must not protrude beyond this point

Maximum Torque	2206 N·m [19 525 lbf·in]
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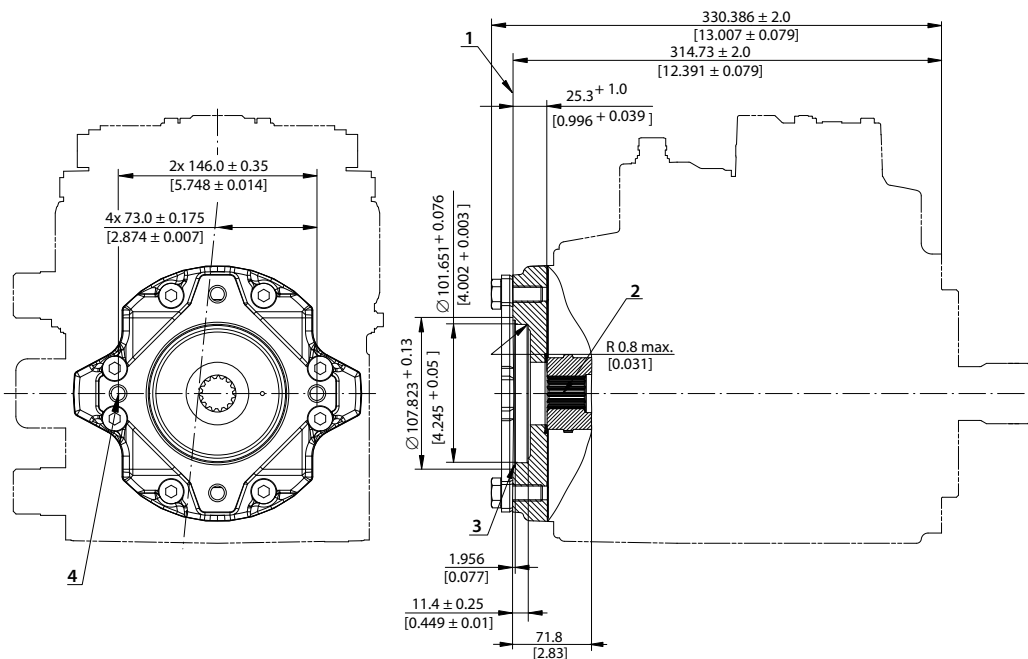
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information, BC152886483968*, the section "Shaft Torque Ratings and Spline Lubrication".

⚠ 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 (SAE B-B, 15 teeth)



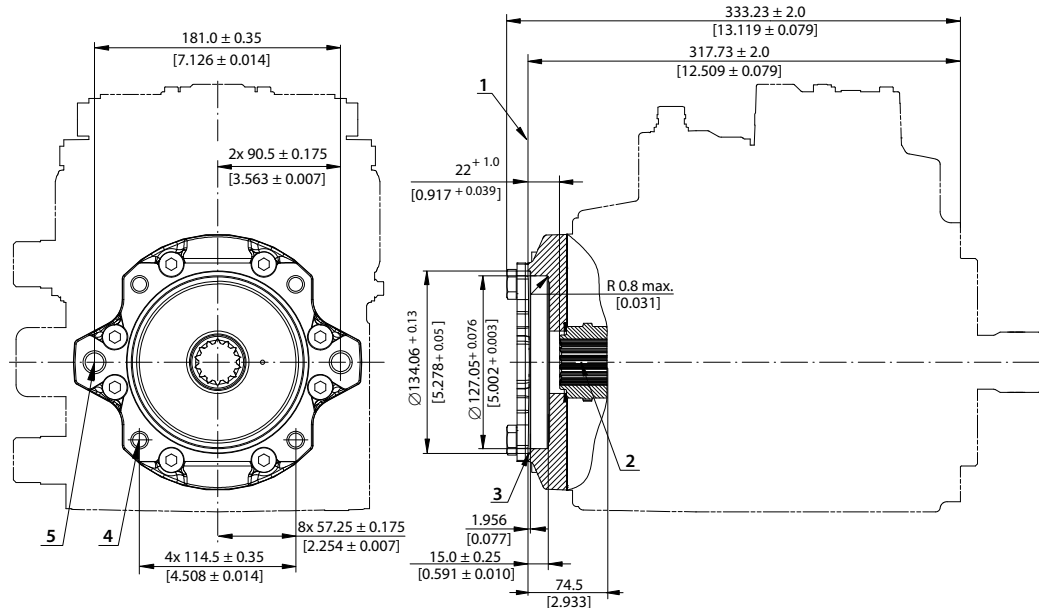
1. Auxiliary mounting pad for mating flange 101-2 per ISO 3019-1 (SAE B); Paint free
2. **Spline Data:** 15 teeth, Pressure angle: 30°, Pitch: 16/32, Ø23.813 [0.938]; Fillet root side fit; per ANSI B92.1-1996, Class 6; Minimum active spline length 14.3 mm
3. O-ring seal required; Ref. Ø101.32 ID x 2.62, cross section
4. Thread: M12x1.75-6H; 25 mm [0.984 in] min. depth (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum Torque	693 N·m [6130 lbf·in]
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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 (SAE C, 14 teeth)


1. Auxiliary mounting pad for mating flanges: 127-2, 127-4 per ISO 3019-1 (SAE C); Paint free
2. **Spline Data:** 14 teeth, Pressure angle: 30°, Pitch: 12/24, $\text{Ø}29.633$ [1.167]; Fillet root side fit; per ANSI B92.1-1996, Class 6; Minimum active spline length 17.8 mm
3. O-ring seal required; Ref. $\text{Ø}120.32$ ID x 2.62, cross section
4. Thread: M12x1.75-6H; 21 mm [0.827 in] min. depth (4x)
5. Thread: M16x2-6H; 28.5 mm [1.122 in] min. depth (2x)
6. Mating shaft and shaft shoulder must not protrude beyond this point

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

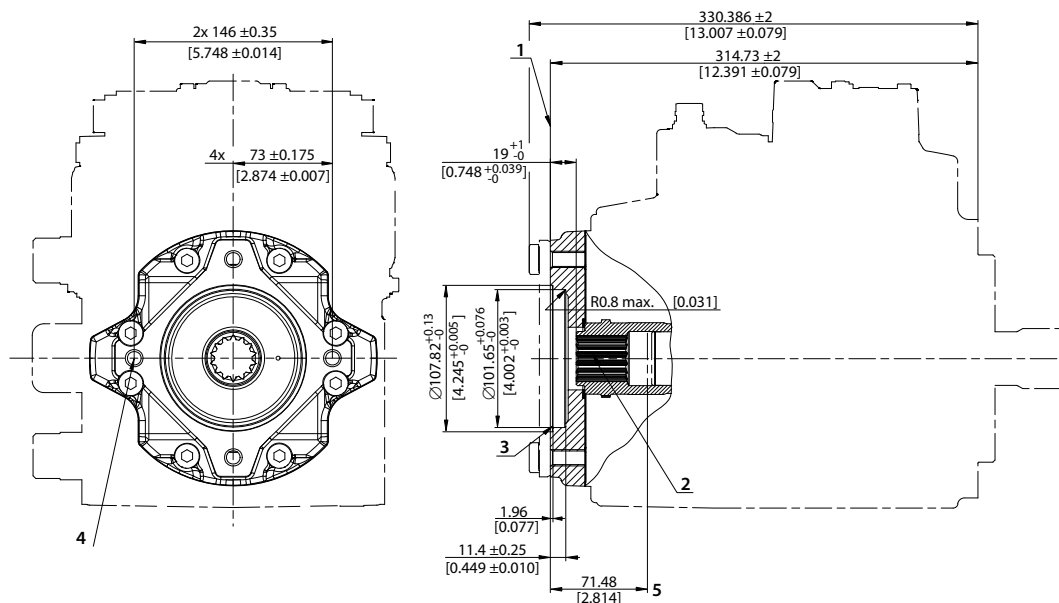
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information*, **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

! 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 115/130 Auxiliary Mounting, Option S1 (SAE B-B, 14 teeth)



1. Auxiliary mounting pad for mating flange 101-2 per ISO 3019-1 (SAE B); 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 6; Minimum active spline length 17.8 mm
3. O-ring seal required; Ref. Ø101.32 ID x 2.62, cross section
4. Thread: M12x1.75-6H; 25 mm [0.984 in] min. depth (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum torque	816 N·m [7220 lbf·in]
-----------------------	-----------------------

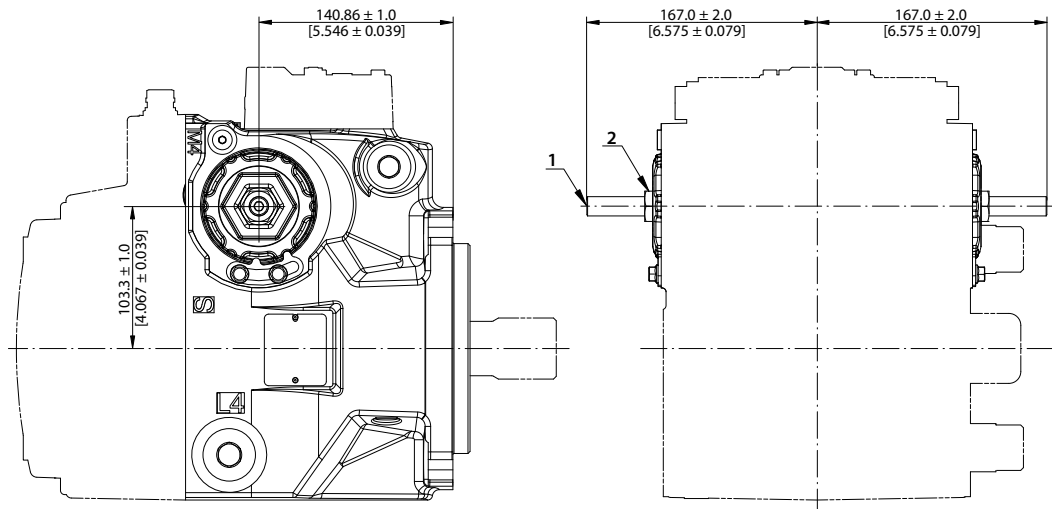
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information*, **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

⚠ 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 and D



- 1. Displacement limiter screw (2x)
- 2. Displacement limiter seal nut (2x)

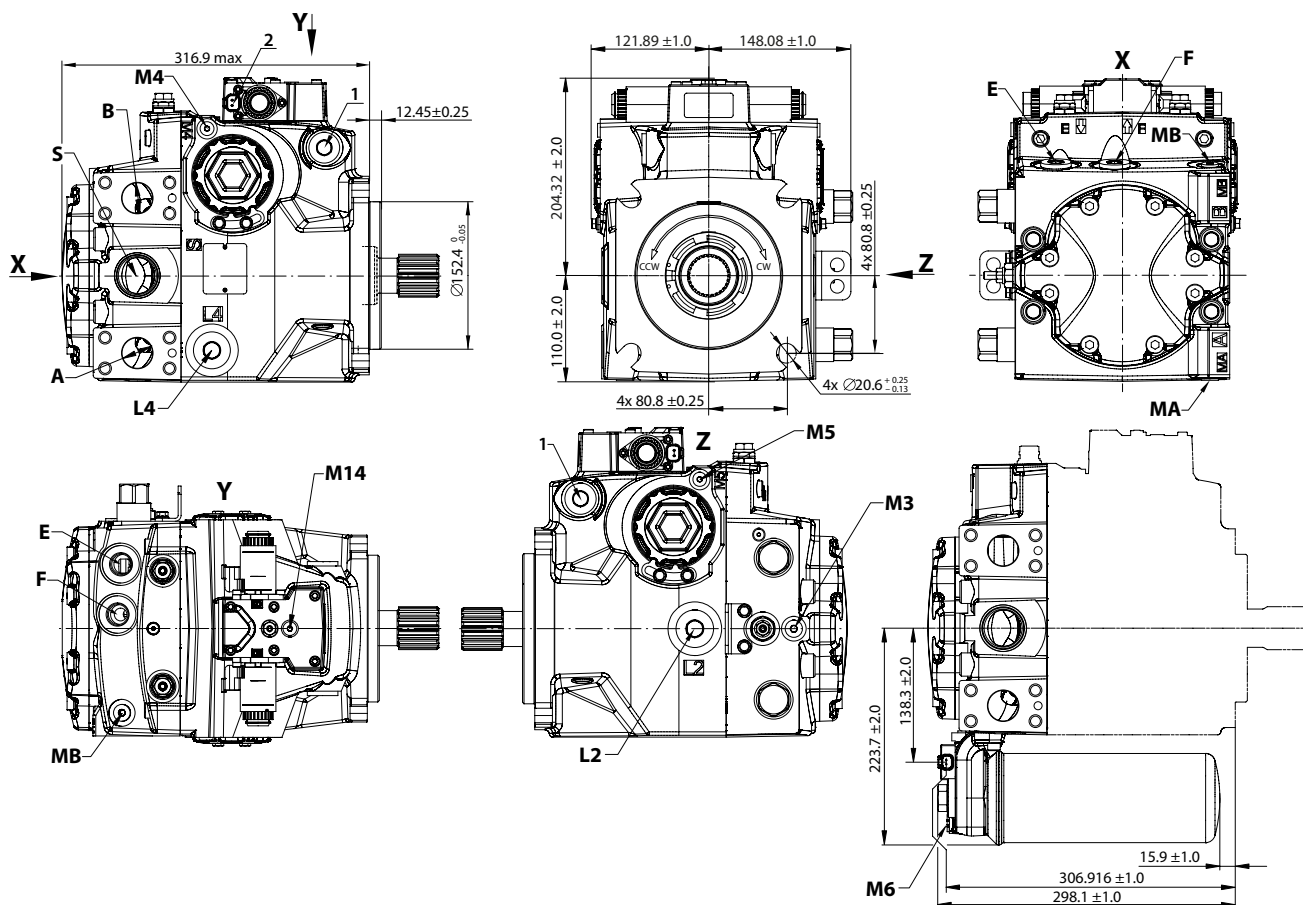
Wrench size, torque

Wrench size for DL screw	Wrench size for DL seal nut	Torque
6 internal hex	22 external hex	80 N·m [708 lbf·in]

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

Dimensions and Data

Single Pump Ports



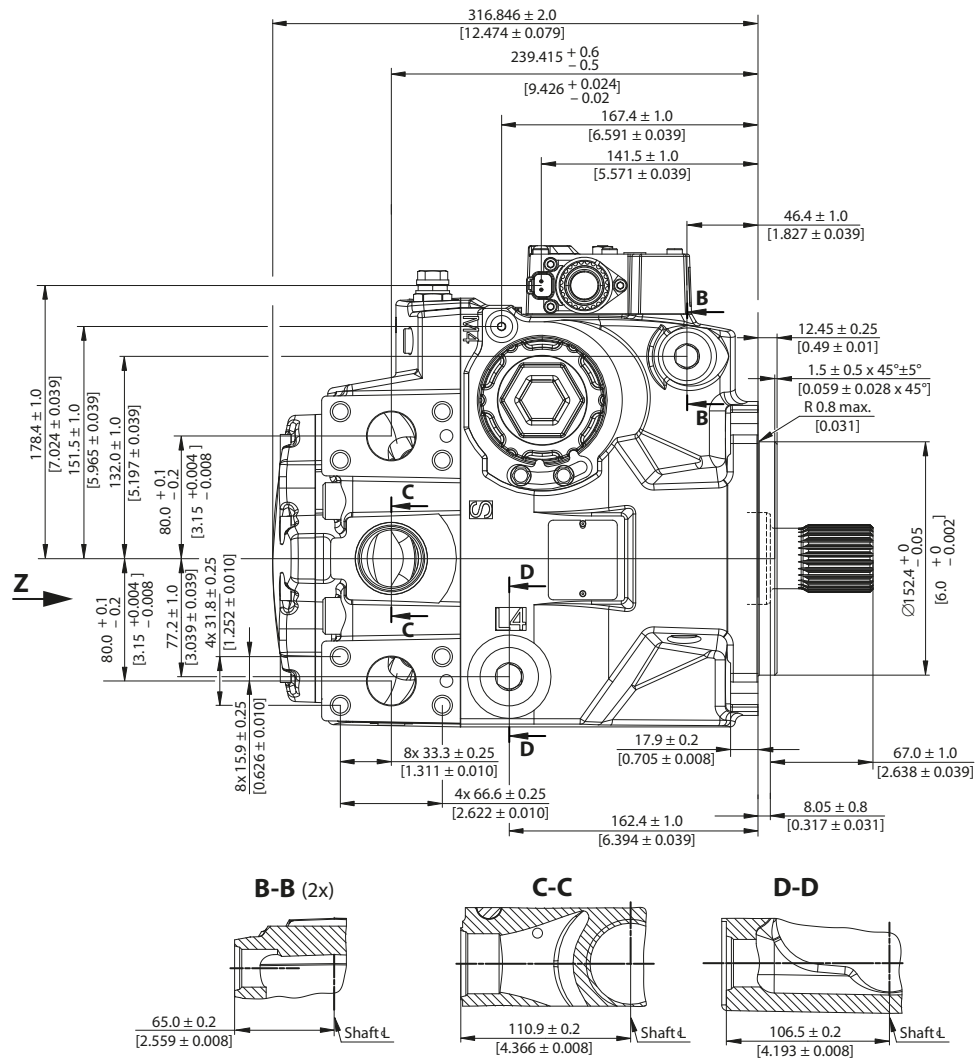
Ports per ISO 11 926-1

Port	Description	Size
A, B	System ports	Ø31.5 mm; M12 x 1.75; 20 min. full thread depth Recommended screw in depth 1.5 x thread dia
L2, L4	Case drain ports	1 ⁵ / ₁₆ -12
MA, MB	System A/B gauge ports	9/ ₁₆ -18
E/F	Charge filtration ports	1 ¹ / ₁₆ -12
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 / ₈ -12 (SAE O-ring boss) Recommended screw in depth 1.5 x thread dia
1	Case pressure port	1 ¹ / ₁₆ -2
2	Connector DEUTSCH DT04-2P, to be paint free	

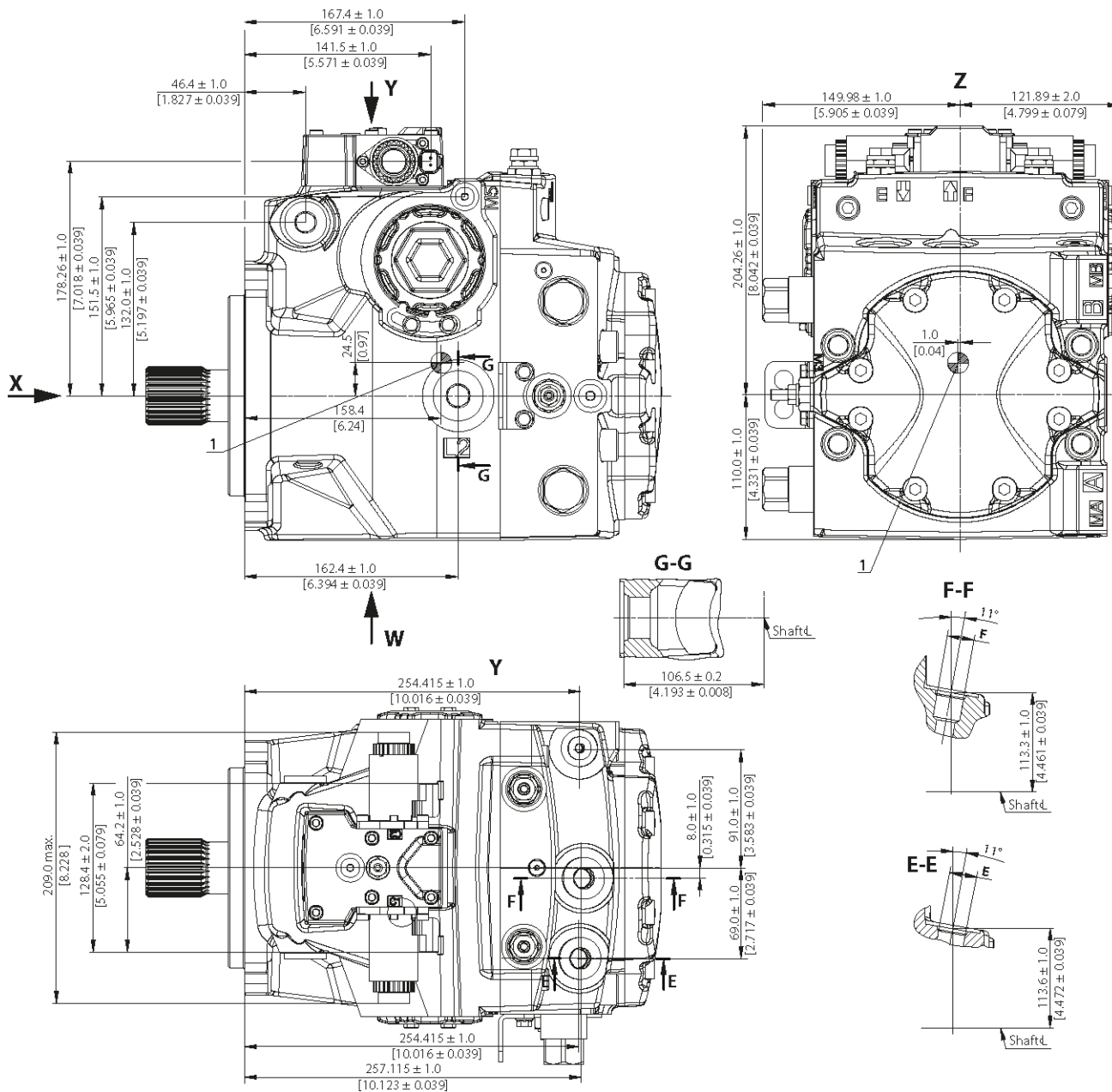
Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

H1P Dimensions

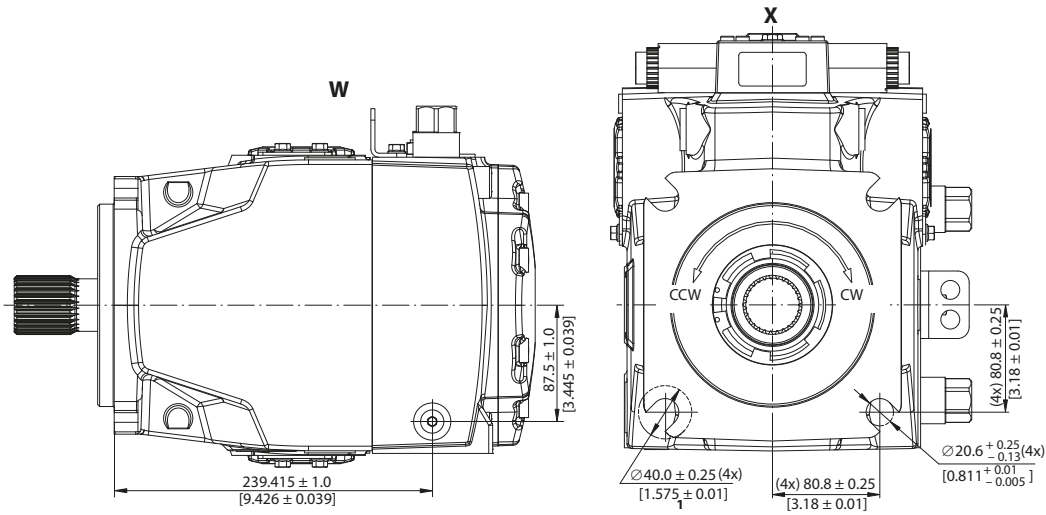


Dimensions and Data



1 — Approximate center of gravity

Dimensions and Data

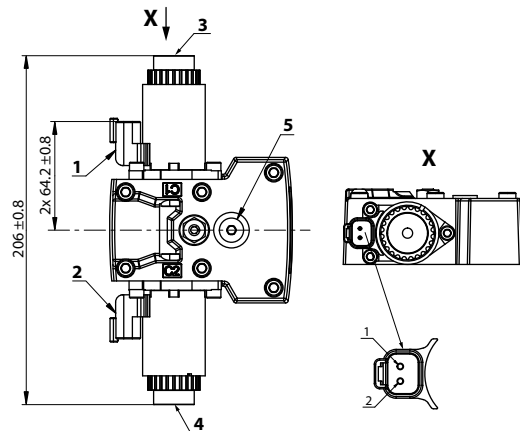


1 — Other side screw head space

Dimensions and Data

Controls

EDC Options A2 and A3 (12/24 V)



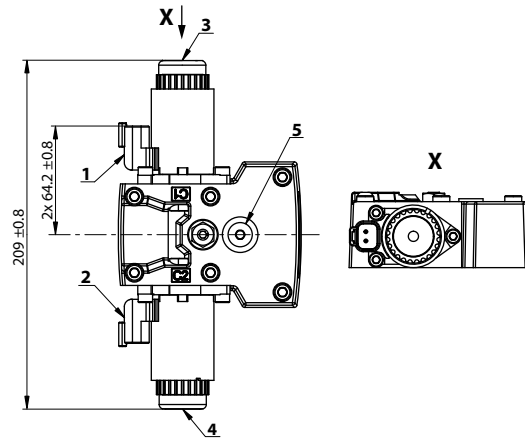
- 1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
- 2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
- 3. Control Manual OverRide **C1**
- 4. Control Manual OverRide **C2**
- 5. Case gauge port **M14** per ISO 1926-1: $\frac{7}{16}$ -20

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

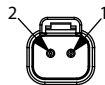
EDC with MOR, Options A4 and A5 (12/24 V)



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: $\frac{7}{16}$ -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

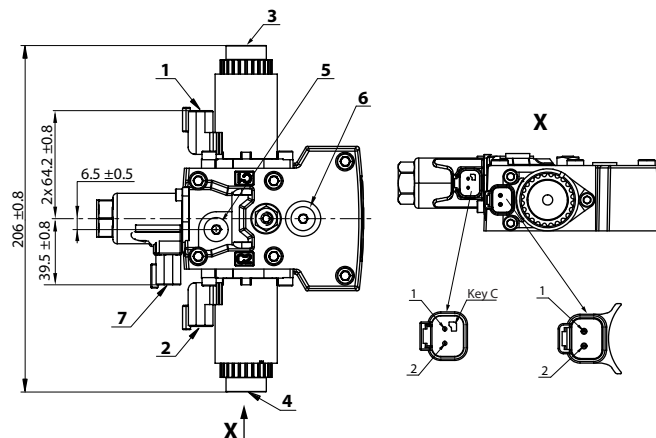


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

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



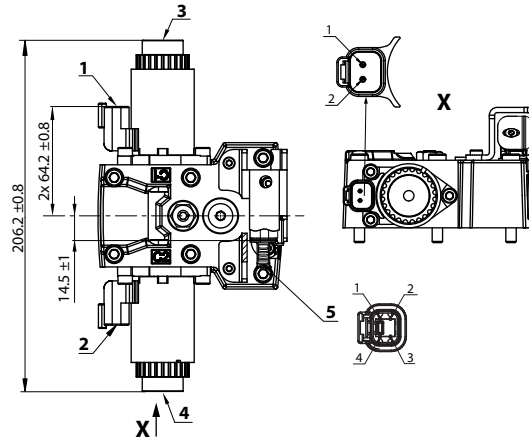
- 1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
- 2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
- 3. Control Manual OverRide **C1**
- 4. Control Manual OverRide **C2**
- 5. Brake gauge port **X7** per ISO 1926-1: $\frac{7}{16}$ -20
- 6. Case gauge port **M14** per ISO 1926-1: $\frac{7}{16}$ -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.

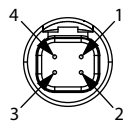
Dimensions and Data

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

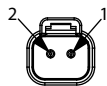
Connector DEUTSCH, 4-pin



4-pin assignment:

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

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

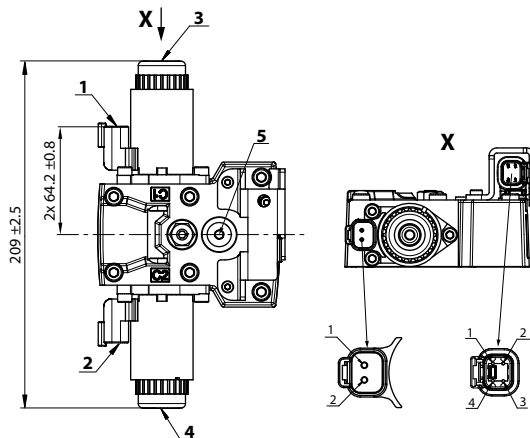


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

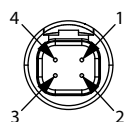
Dimensions and Data

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: $\frac{7}{16}$ -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

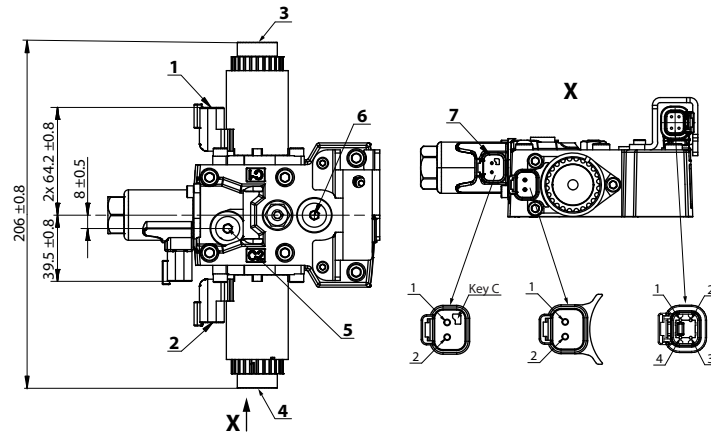


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

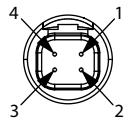
EDC with CCO and ASNSR, Options H8 and H9 (12/24 V)



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: $\frac{7}{16}$ -20
6. Brake gauge port **X7** per ISO 1926-1: $\frac{7}{16}$ -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.

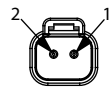
Connector DEUTSCH, 4-pin



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

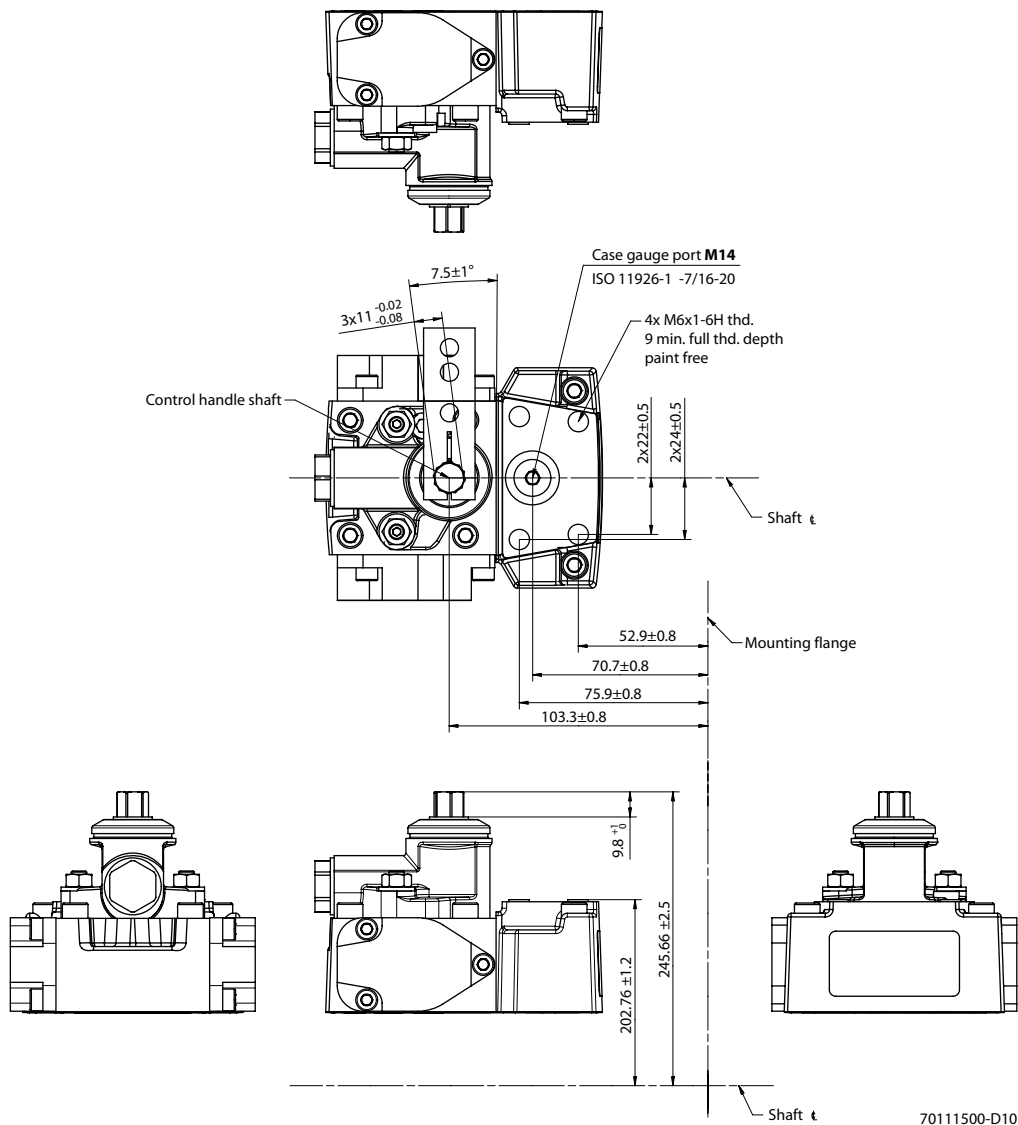


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

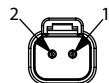
Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

MDC Option: M1



Connector DEUTSCH, 2-pin

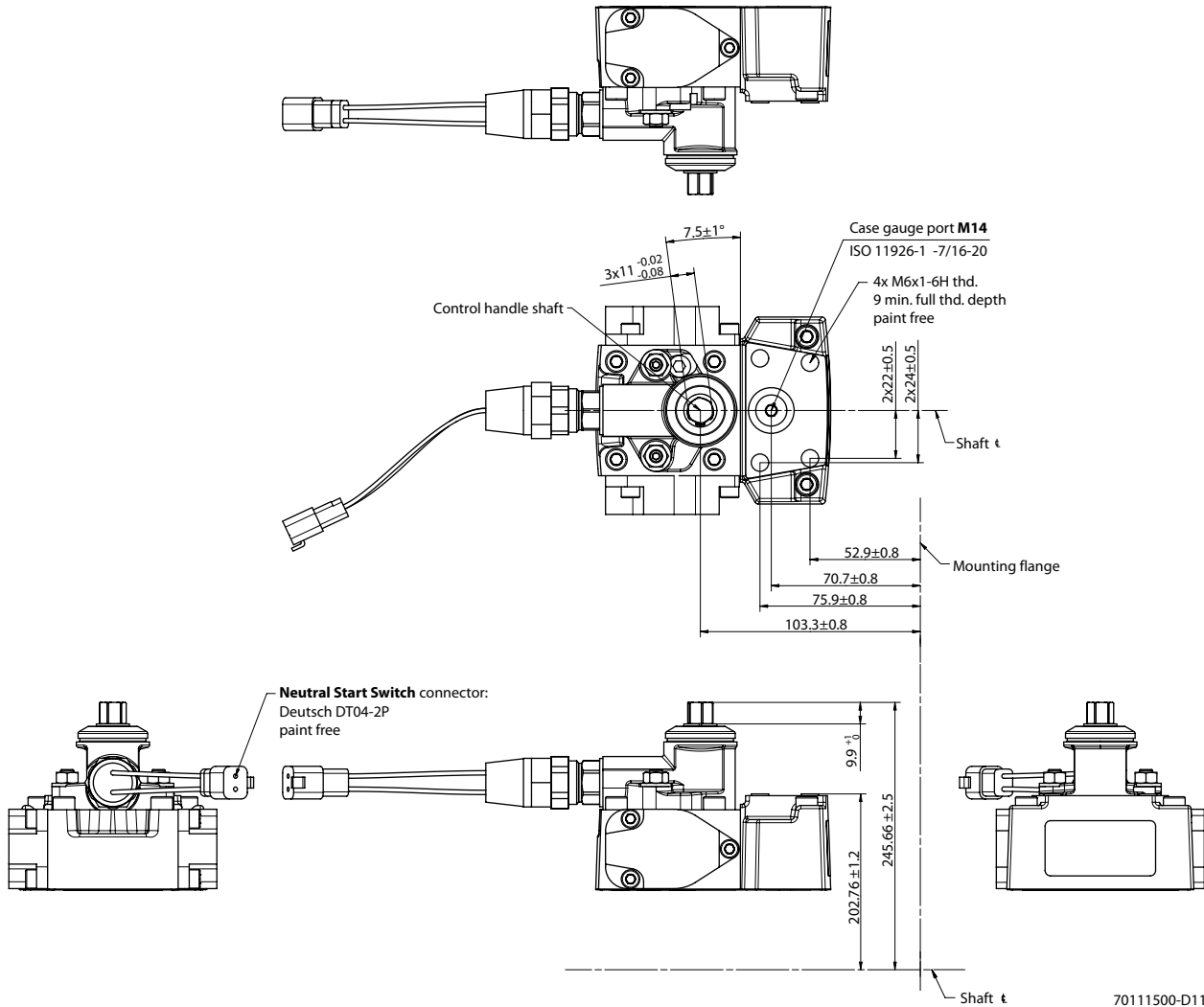


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

MDC with Neutral Start Switch Option: M2



Connector DEUTSCH, 2-pin

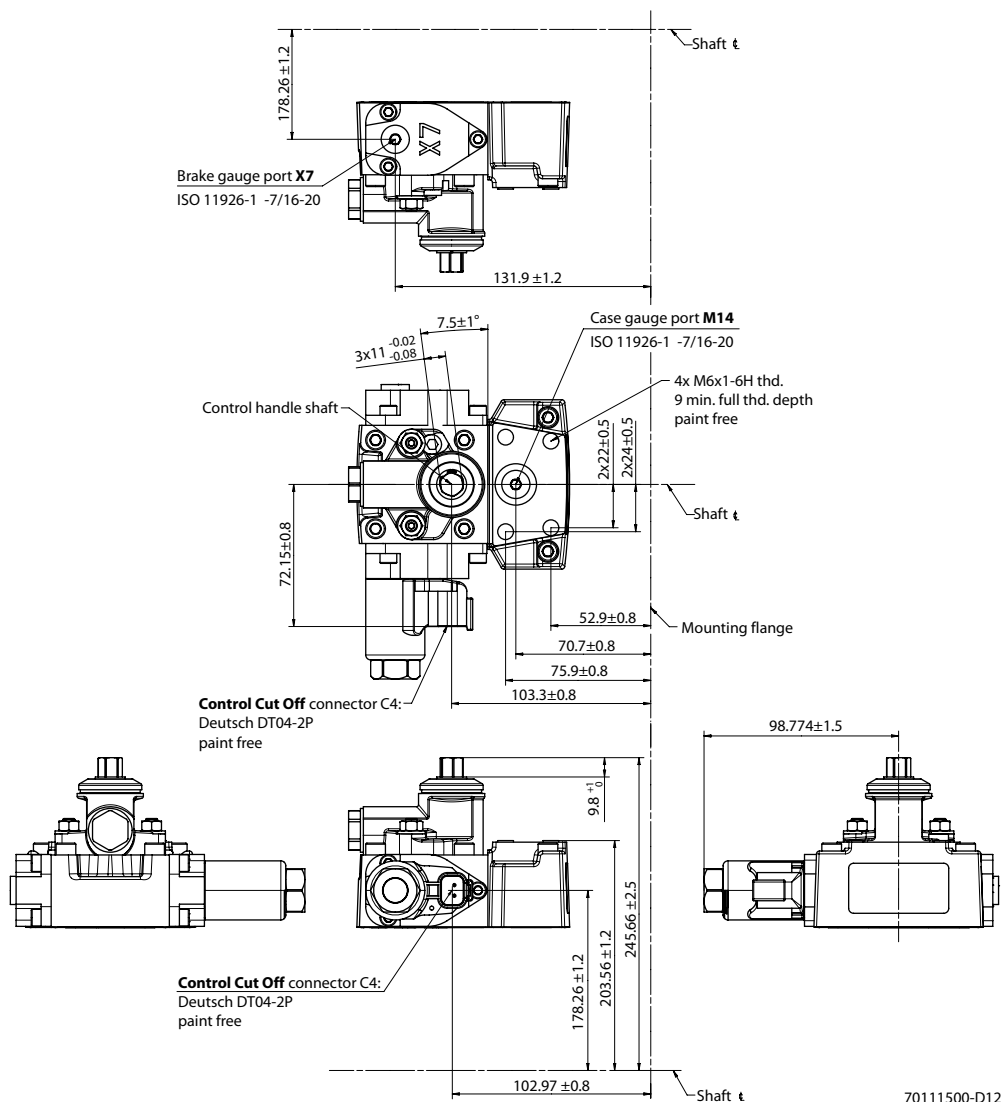


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

MDC with CCO, Options: M3, M4



Connector DEUTSCH, 2-pin

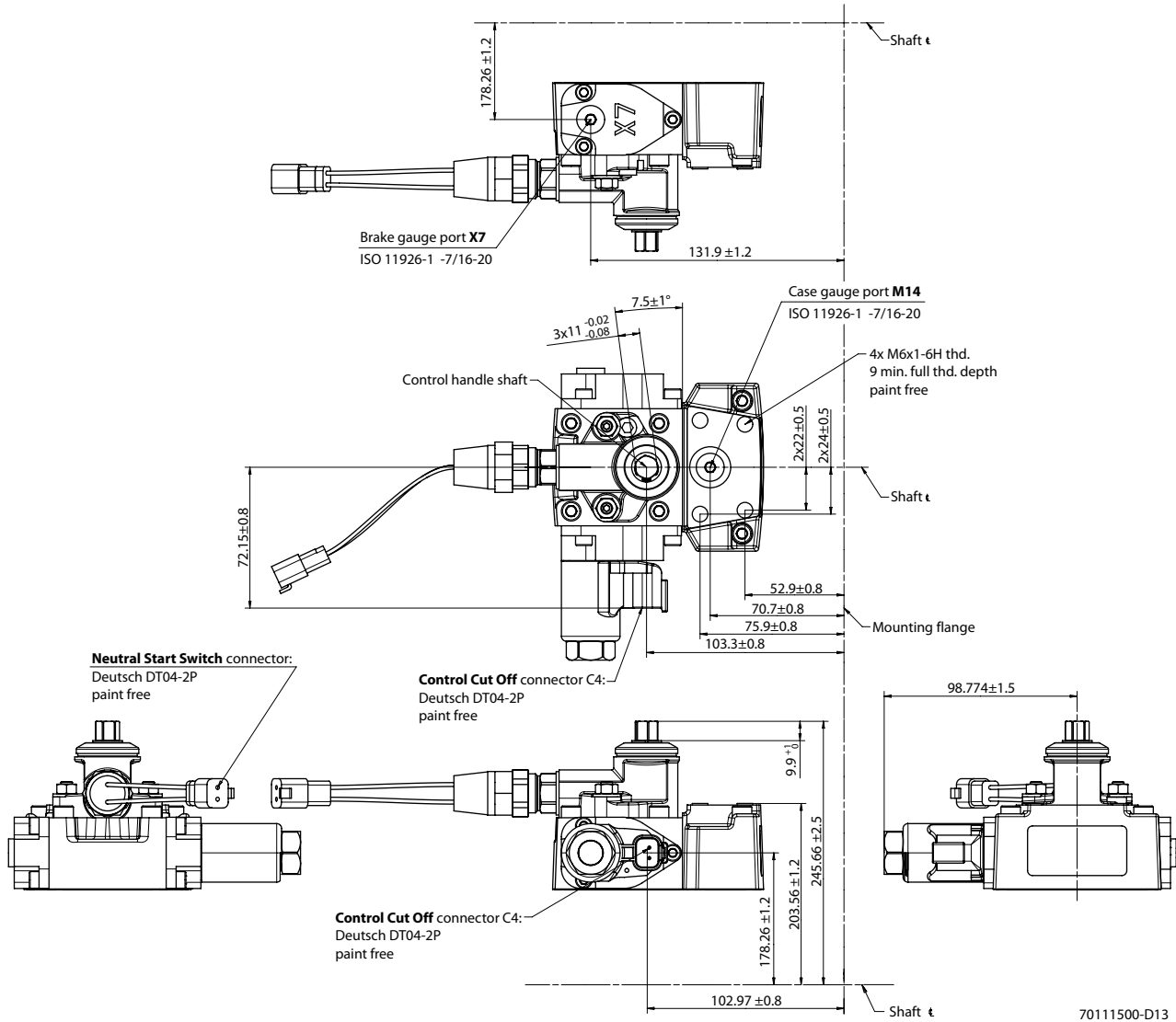


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

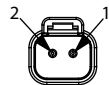
Please contact Danfoss representative for specific installation drawings.

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

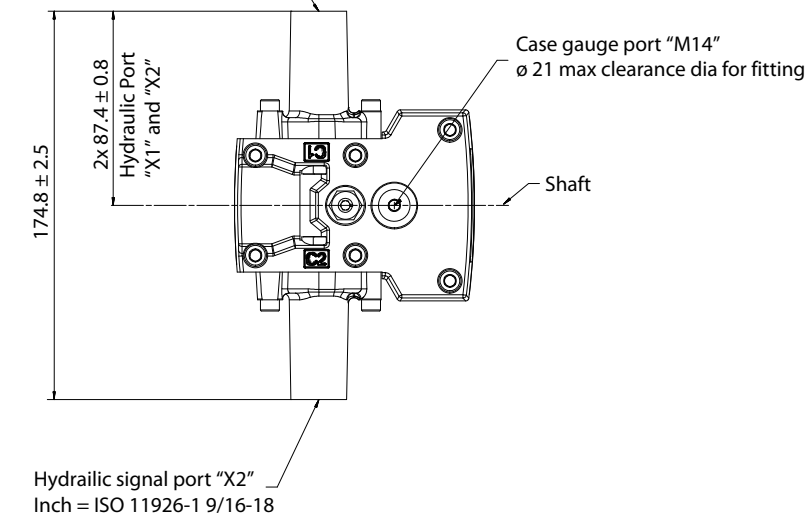
Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

H1P HDC, Options: T1, T2

Dimensions in mm

Hydraulic signal port "X1"
 Inch = ISO 11926-1 9/16-18

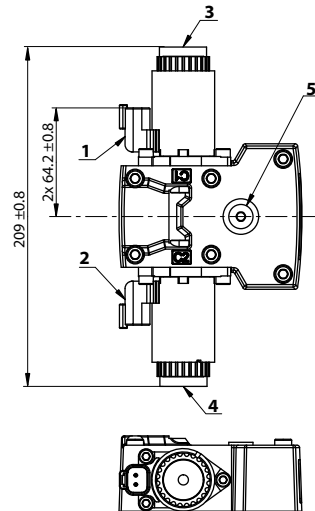


Hydraulic signal port "X2"
 Inch = ISO 11926-1 9/16-18

Dimensions and Data

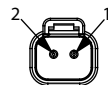
NFPE with MOR, Options: N1, N2 (12/24 V)

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: $\frac{7}{16}$ -20

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



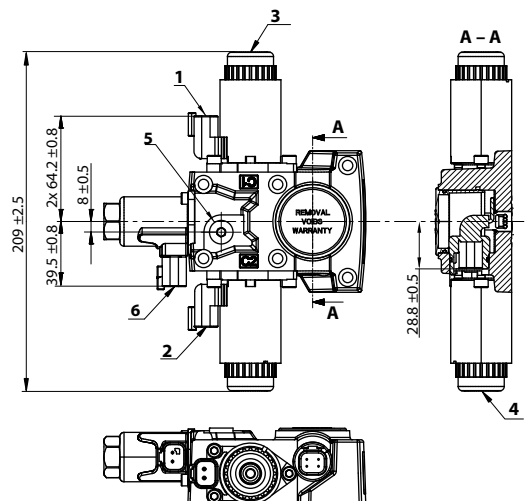
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

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

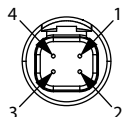
Non-Feedback Proportional Electric control with Control-Cut-Off valve with key C, Manual Over Ride and Angle Sensor, options N3 (12 V) and N4 (24 V).



- 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: $\frac{7}{16}$ -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.

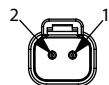
Connector DEUTSCH, 4-pin



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



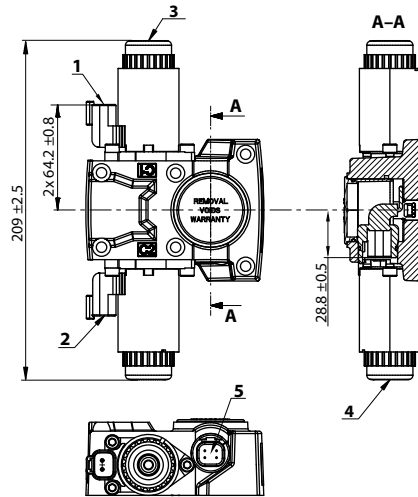
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

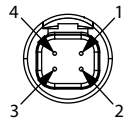
NFPE with MOR and ASNSR, Options: N5, N6 (12/24 V)

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

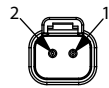
Connector DEUTSCH, 4-pin



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



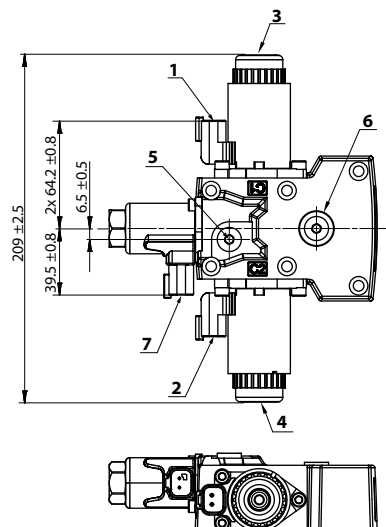
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

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

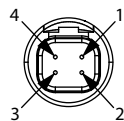
Non Feedback Proportional Electric control with Manual Over Ride and Control-Cut-Off valve key C, options N7 (12 V) and N8 (24 V).



- 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

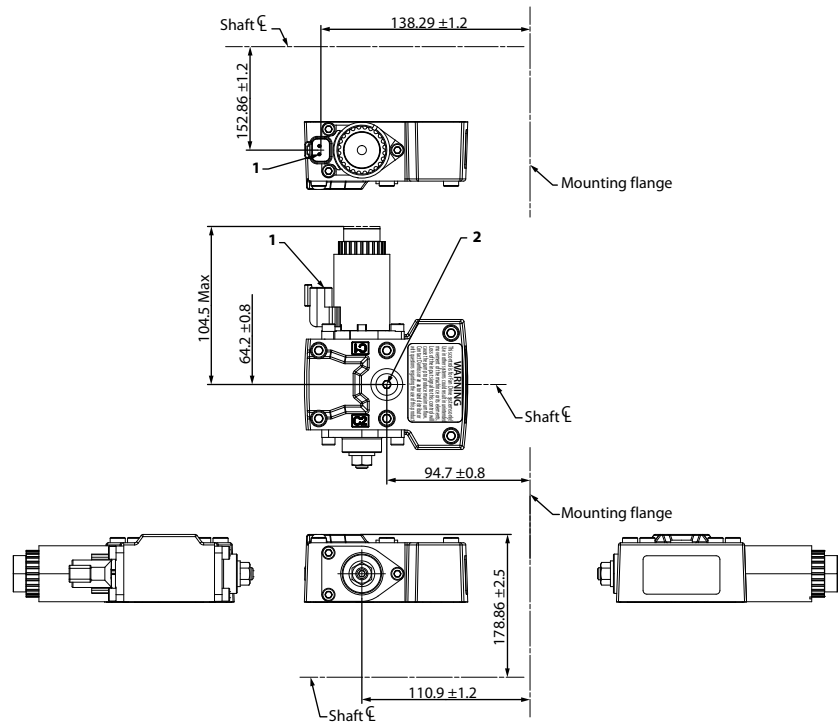


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

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

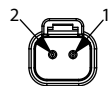
Dimensions and Data

FDC Options: F1, F2 (12/24V)



1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
2. Case gauge port **M14** per ISO 1926-1: $\frac{7}{16}$ -20

Control solenoid connectors *DEUTSCH*, 2-pin assignment

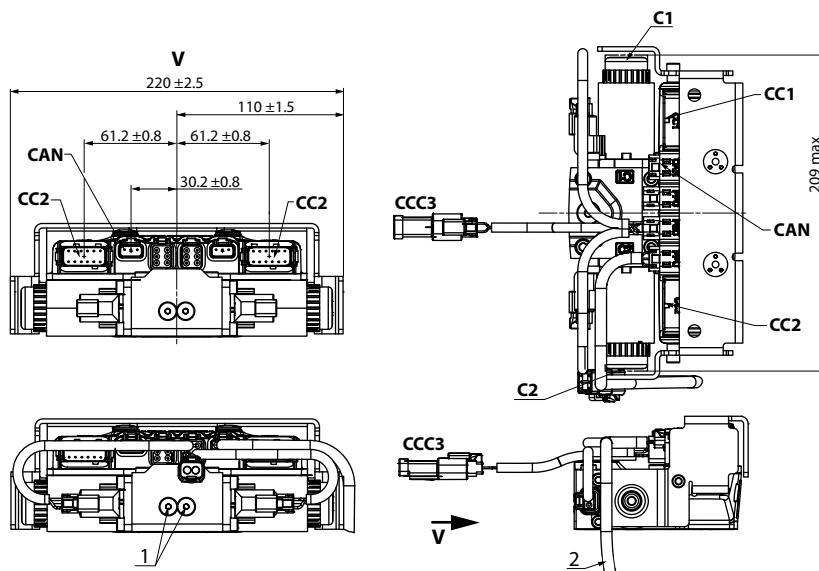


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

Automotive control (AC)



- 1 Plug removing can cause contamination issues
- 2 PPU wire harness is factory installed to speed sensor

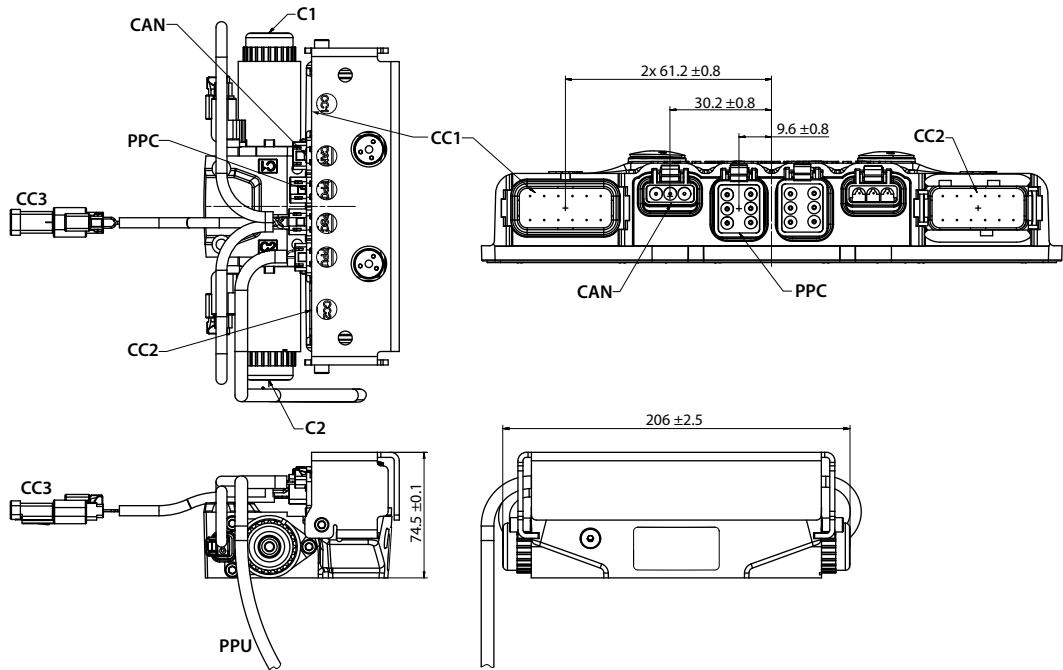
Connectors description

Port	Description
C1 and C2	1. Control manual override C1 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

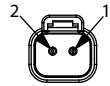
AC connectors dimensions



PPU wire harness is factory installed to speed sensor.

CC3

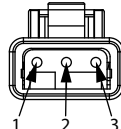
Connector DEUTSCH, 2-pin



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

CAN

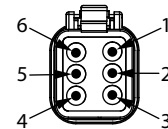
Connector DEUTSCH, 3-pin



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

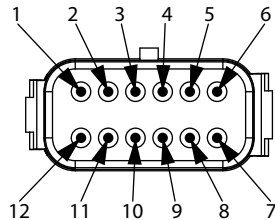
PPC

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)

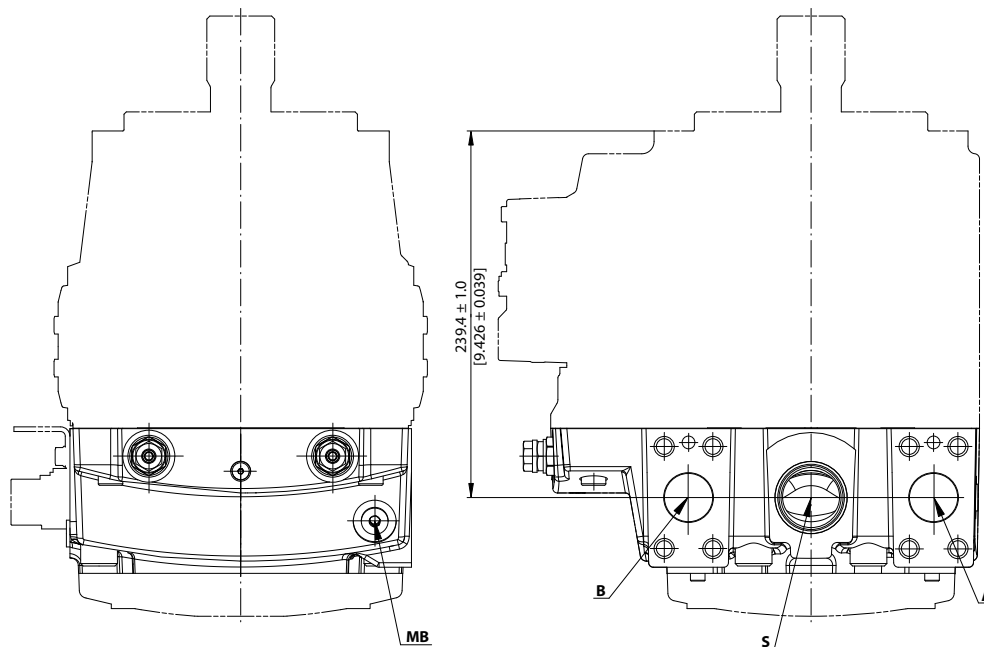
CC2

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 115/130 Suction Filtration Option L

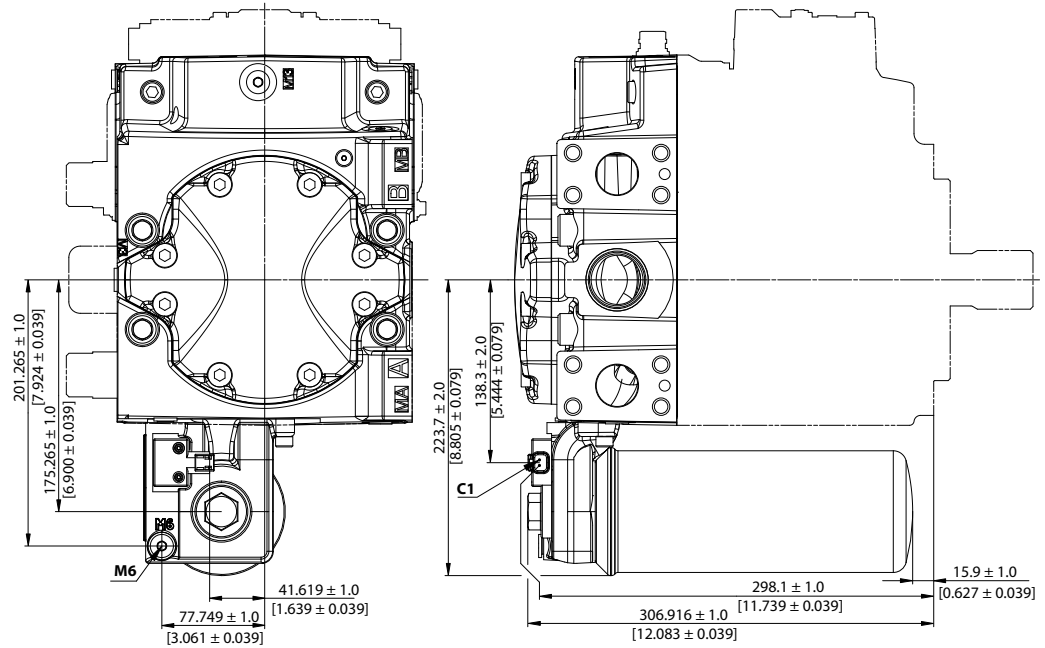


- A** System port split flange boss per ISO 6162; M12 x 1.75; 20 min full thread depth
- B** System port split flange boss per ISO 6162; M12 x 1.75; 20 min full thread depth
- MB** System B gage port per ISO 11926-1; 9/16-18
- S** Charge inlet port per ISO 11926-1; 1 5/8-12

Dimensions and Data

Integral Full Flow Charge Pressure Filtration, Option M

Integral full flow charge pressure filtration with filter bypass sensor, option M



Please contact Danfoss representative for specific installation drawings.

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Technical Information

H1P 147/165

Axial Piston Single Pumps



Revision history*Table of revisions*

Date	Changed	Rev
May 2022	Corrected HDC control information	1201
December 2021	Added HDC control	1101
April 2021	Corrected interface with ECU (EDC) graphic	1006
September 2020	Corrected input shaft option F3 key dimensions	1005
April 2020	Corrected swash plate angle sensor connector and CCO connector descriptions	1004
February 2020	Added NFPE control options and changed document number from BC00000061	1003
May 2019	Major update.	0901
May 2018	Angle sensor for EDC; FDC note added.	0801
May 2017	NFPE gen. 3 changes.	0701
2009-2016	First edition-Varios updates.	AA to FA

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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 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)	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 per ISO 3019-1 (outer diameter)	<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)
Auxiliary mounting flange with metric fasteners, with shaft outer diameter	<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 per ISO 3019-1	1 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 per ISO 3019-1	ISO 11926-1 – 1 5/16-12

Technical Specifications

Shaft, flange and ports description (continued)

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

H1P 147/165 Operating Parameters

Parameter		Unit	Size 147/165
Input speed	Min. for internal¹⁾ and external²⁾ charge supply	min ⁻¹ (rpm)	500
	Min. for full performance, internal charge supply		1200
	Rated		3000
	Maximum		3100
System pressure	Maximum working	bar [psi]	450 [6527]
	Maximum		480 [6962]
	Max./Min. low loop		45/10 [650/145]
Charge pressure	Minimum		16 [232]
	Maximum		34 [493]
Control pressure	Minimum (at corner power for EDC, MDC, FNR)	bar [psi]	17 [247]
	Minimum (at corner power for NFPE, FDC, AC)		26 [377]
	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		4.0 [58.0]
Case pressure	Rated	bar [psi]	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 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 μm

Technical Specifications

Fluid Specification

Viscosity

Intermittent¹⁾	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

Minimum¹⁾	-40°C [-40°F]
Rated	104°C [220°F]
Recommended range²⁾	60 – 85°C [140 – 185°F]
Maximum Intermittent	115°C [240°F]

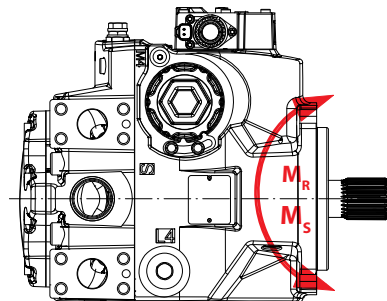
¹⁾ Cold start = Short term $t > 3$ min, $p \leq 50$ bar [725 psi], $n \leq 1000$ min⁻¹ (rpm).

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

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



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*, **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.

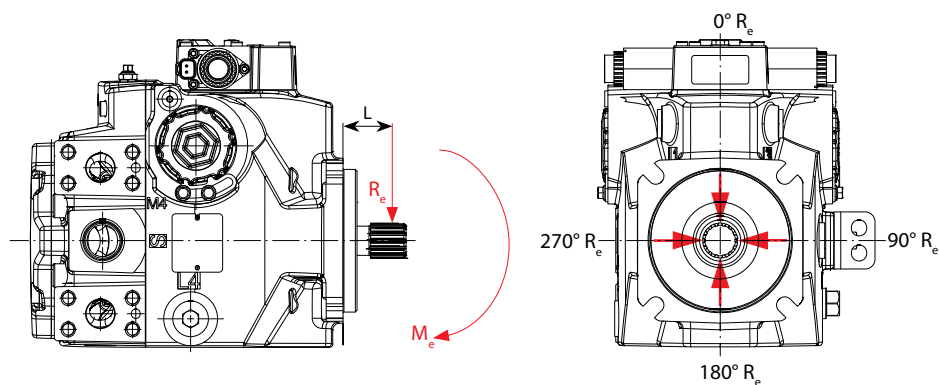
Danfoss recommends clamp-type couplings for applications with radial shaft loads. Contact your Danfoss representative for an evaluation of unit bearing life if you have continuously applied external loads exceeding 25 % of the maximum allowable radial load (R_e) or the pump swash-plate is positioned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

Maximum external shaft load based on shaft deflection

External radial moment	Unit	Size 147/165
M_e	N·m [lbf·in]	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



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.

For more information, see *Selection of Drive line Components*, **BC157786484430**.

26/34 cm³ Charge Pump – Flow and Power Curves

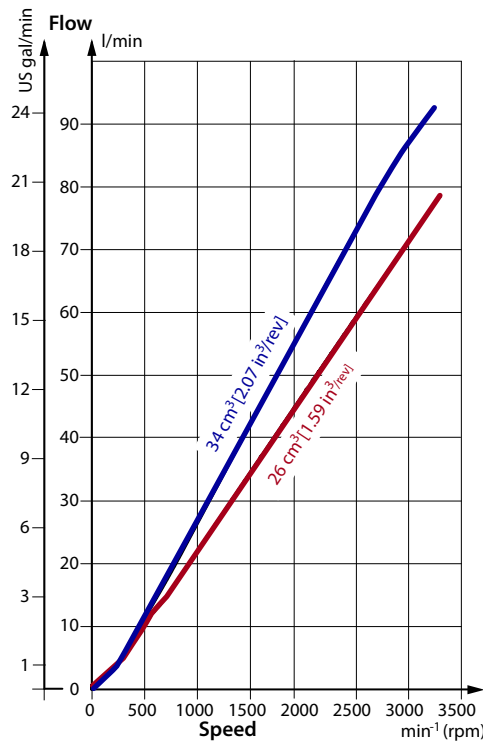
Charge pump flow and power requirements curves shown below at the following conditions:

Charge pressure = 20 bar [290 psi]

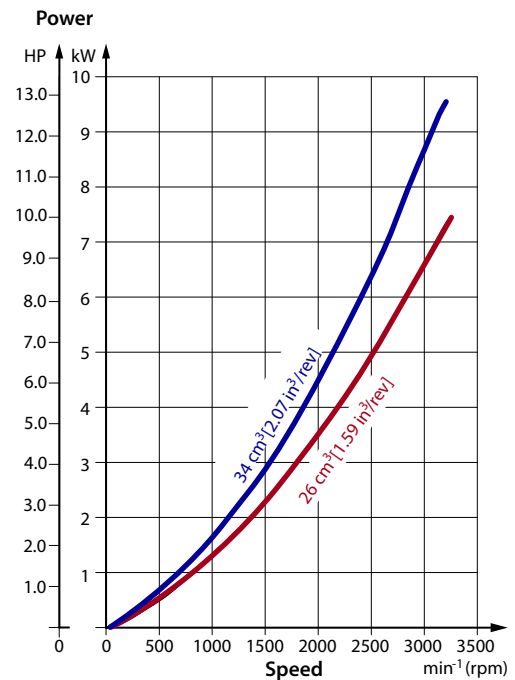
Viscosity = 11 mm²/s [63 SUS]

Temperature = 80°C [176°F]

Charge pump flow



Charge pump power requirements



Master Model Code

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).

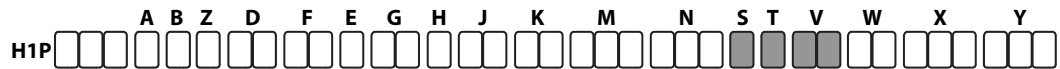
Hydraulic Displacement Control

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

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



S – Charge pump options

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 options

Filtration to be aligned with G: End cap selection

L	Suction filtration
M	Integral full charge flow filtration with bypass sensor, long filter length 11004919
N	Integral full charge flow filtration with bypass sensor, without filter
P	Remote full charge flow filtration
E	External full charge flow filtration (<i>Align with options N, S</i>)

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.

Control Options

Electrical Displacement Control (EDC)

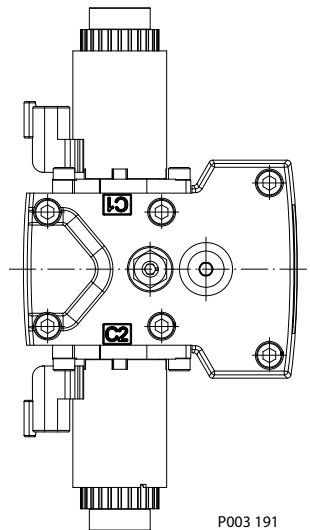
An EDC is a displacement (flow) control. Pump swash plate position is proportional to the input command and therefore vehicle or load speed (excluding influence of efficiency), is dependent only on the prime mover speed or motor displacement.

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.

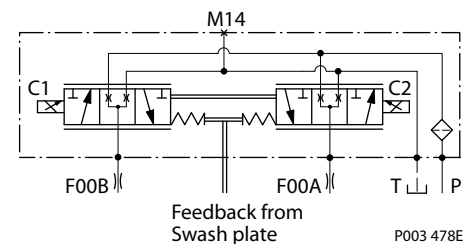
A serviceable 170 μm screen is located in the supply line immediately before the control porting spool.

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.

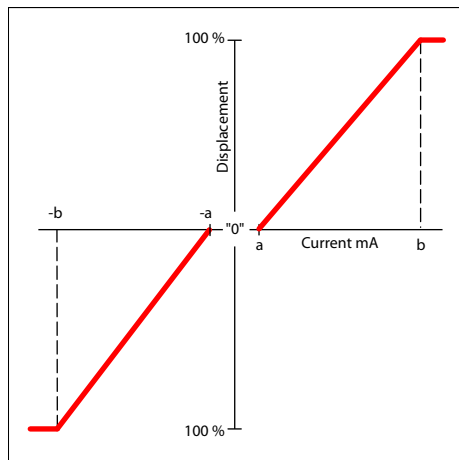
The neutral position of the control spool does provide a positive preload pressure to each end of the servo piston assembly.

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, EDC 147/165

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)	
	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 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:

$\Delta p = 250 \text{ bar}$ [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	1.6 s	1.2 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.

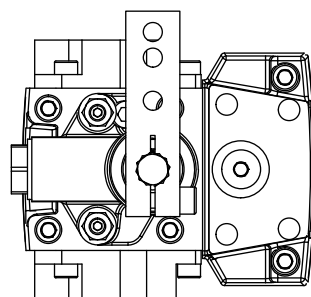
Differential pressure across the servo piston rotates the swash plate, changing the pump's displacement. Simultaneously the swashplate movement is fed back to the control spool providing proportionality between shaft rotation on the control and swash-plate rotation. The MDC changes the pump displacement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

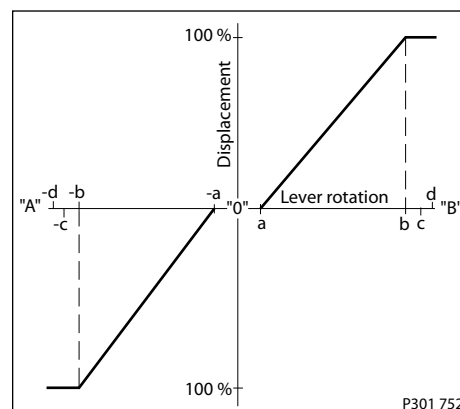
For the MDC with CCO option the brake port (X7) provides charge pressure when the coil is energized to activate static function such as a brake release. The X7 port must not be used for any continuous oil consumption.

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.

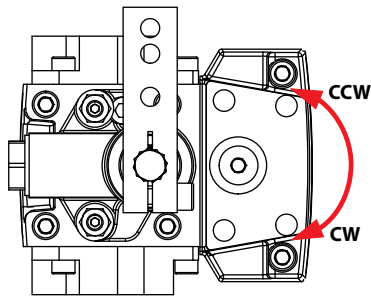
Control Options

- 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)	
	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 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:

$\Delta p = 250 \text{ bar}$ [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, MDC 147/165

Code	Orifice description (mm)			Stroking direction	
	Tank (A+B)	P	A/B	Neutral to full flow	Full flow to neutral
C3	No orifice			0.9 s	1.0 s
C5	–	–	2.5	0.9 s	1.0 s
C6	1	–	–	3.3 s	2.9 s
C7	1.3	–	–	2.1 s	1.9 s
D1	0.8	1	–	5.0 s	3.9 s
D2	0.8	1.3	–	4.4 s	4.4 s
D3	1	1.3	–	3.8 s	3.2 s
D4	1	1.3	1.3	4.6 s	3.8 s

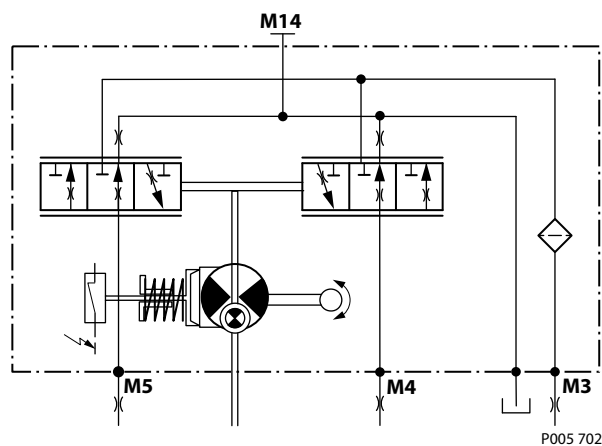
D1, D2 – for H1P 147 cc pump only.

[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



P005 702

Control Options

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



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)

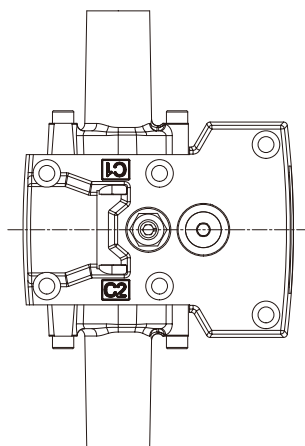
HDC principle

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.

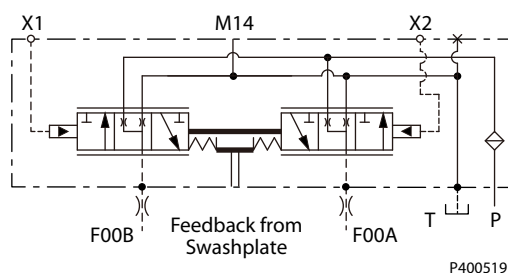
A serviceable 175 µm screen is located in the supply line immediately before the control porting spool.

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.

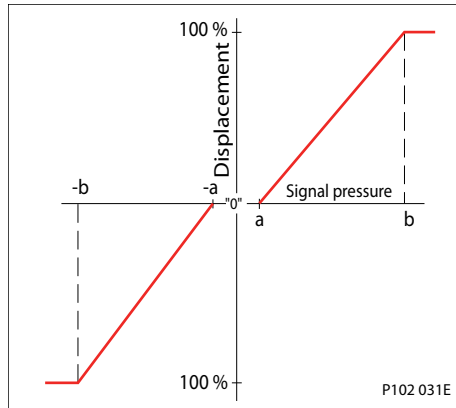
A swashplate feedback link, opposing control linkage, and a linear spring provide swashplate position force feedback to the hydraulic pressure. As hydraulic pressures in the operating loop change with load, the control assembly and servo/swashplate system work constantly to maintain the commanded position 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	
	X1	X2	X1	X2
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 swashplate 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 mm²/s [141 SUS] and 50 °C [122 °F]
- Speed = 1800 min⁻¹ (rpm)

Control Options

Response time, HDC 147/165

Stroking direction	0.8 mm [0.03 in] orifice	1.3 mm [0.05 in] orifice	No orifice
Neutral to full flow	4.8s	2.2s	1.3s
Full flow to neutral	3s	1.4s	0.8s

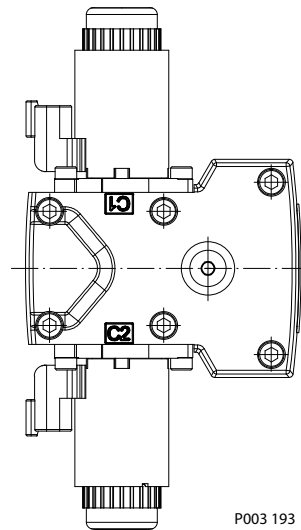
Control Options

Forward-Neutral-Reverse Control (FNR)

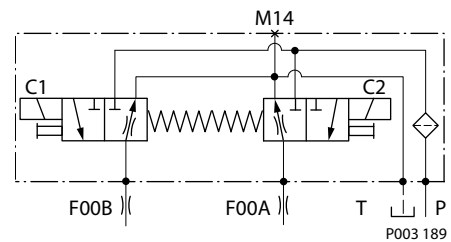
The 3-position FNR control options **A9** (12 V) and **B1** (24 V) uses an electric input signal to switch the pump to a full stroke position. A serviceable 125 µm screen is located in the supply line immediately before the control porting spool.

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

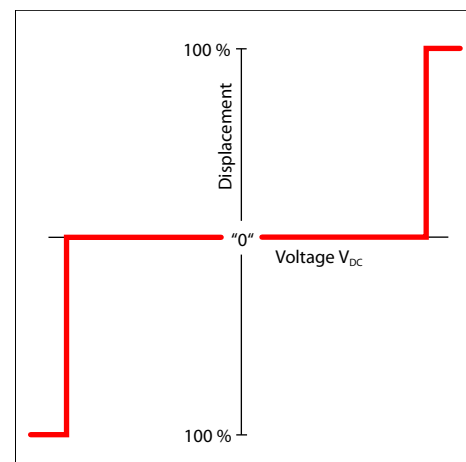
Forward-Neutral-Reverse electric control (FNR)



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	

Control Options

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
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)	
	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.

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:

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

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, FNR 147/165

Stroking direction	0.8 [0.03] orifice	1.3 [0.05] orifice	No orifice
Neutral to full flow	3.7 s	2.7 s	1.6 s
Full flow to neutral	5.7 s	2.4 s	1.1 s

Control Options

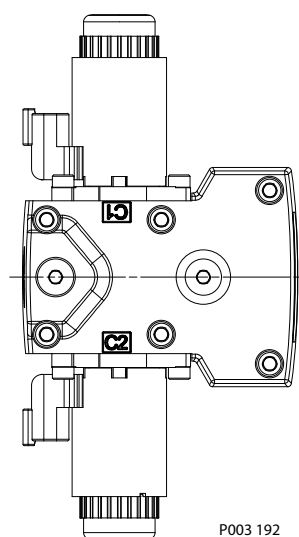
Non feedback proportional electric control (NFPE)

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.

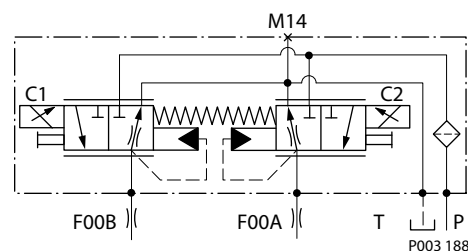
A serviceable 170 μm screen is located in the supply line immediately before the control porting spool.

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

NFPE control



NFPE schematic

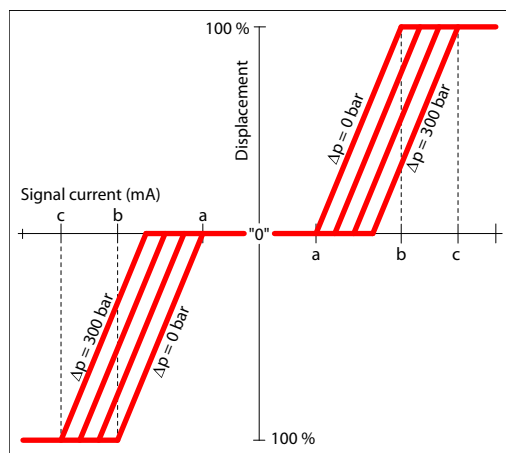


Control Signal Requirements, NFPE 147/165

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 config.
12 V _{DC}	666 mA	1168 mA	1540 mA	any order
24 V _{DC}	320 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.

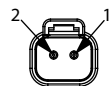
Single Pump Output Flow Direction

Shaft rotation	Clock-Wise (CW)		Counter-Clock-Wise (CCW)	
	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.

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:

$\Delta p = 250 \text{ bar}$ [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)

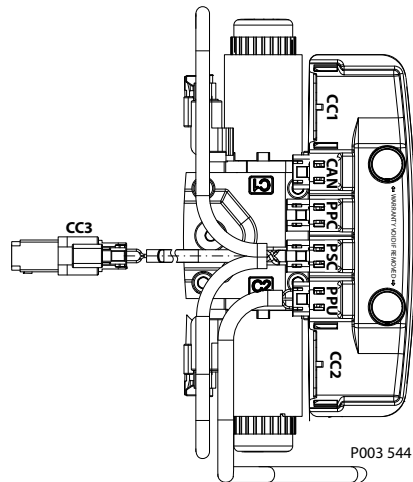
Response Time, NFPE 147/165

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 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.

- **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*, [BC152986482596](#).

Control Options

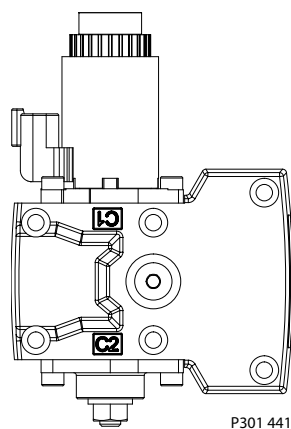
Fan Drive Control (FDC)

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.

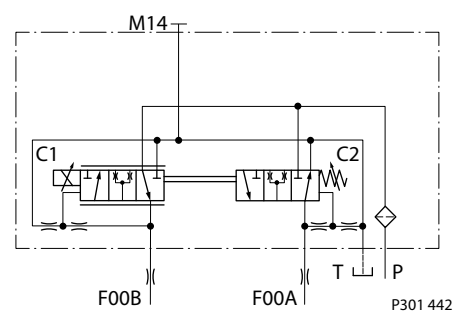
The control spool is spring biased to produce maximum forward pump displacement in the absence of an electrical input signal. Based on the spring bias spool default forward flow for a CW rotation pump is out of port B while default forward flow for a CCW rotation pump is out of port A.

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!

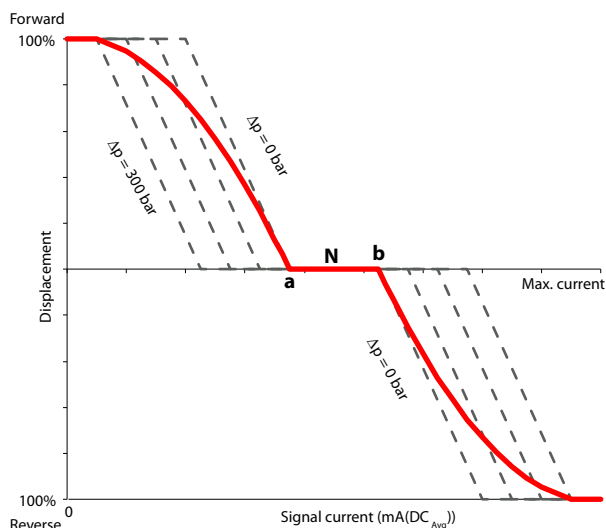
Due to the fail-safe functionality of the FDC control the pump will stroke to max. displacement in case the input signal to the pump control and the Diesel engine will be switched off at the same time. In this situation a low loop event can occur which may damage the pump. Therefore, it's strictly recommended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



- 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

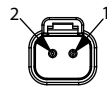
Shaft rotation		ClockWise			CounterClockWise		
Control Logic	12 V	0-780 mA	1100 mA	1300-1800 mA	0-780 mA	1100 mA	1300-1800 mA
	24 V	0-400 mA	550 mA	680-920 mA	0-400 mA	550 mA	680-920 mA
Port A		in	no flow	out	out	no flow	in
Port B		out	no flow	in	in	no flow	out
Servo port pressurized		M5	n/a	M4	M5	n/a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

- $\Delta p = 250 \text{ bar}$ [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

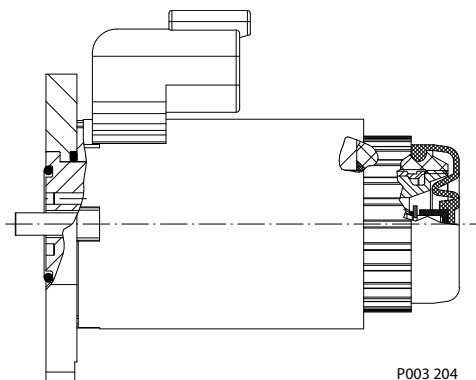
Stroking direction	0.8 mm [0.03 in] orifice
Full flow to neutral	3.9 s
Full forward flow to full reverse flow	5.6 s

Control Options

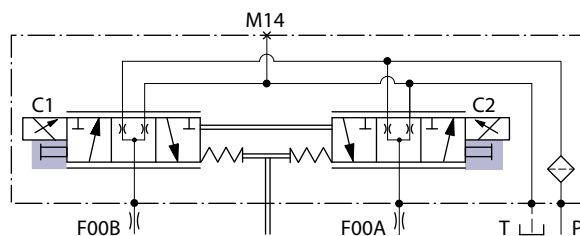
Manual Override (MOR)

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

Control Options

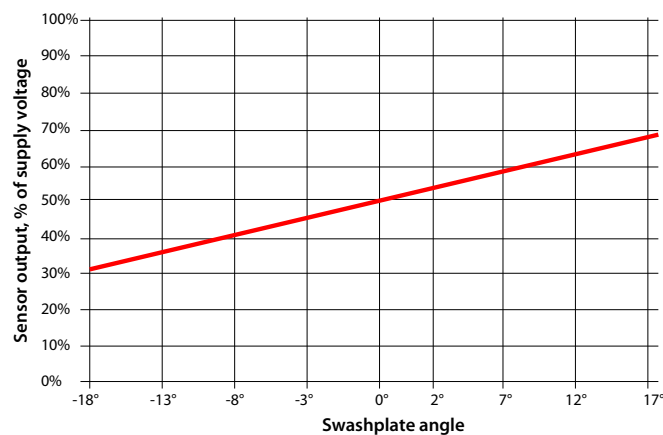
Swashplate angle sensor for EDC controls

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

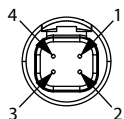
Control Options

Calibration of the sensor output within the software is mandatory. Vehicle neutral thresholds in the software ($\pm 0.5^\circ$) 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.

H1P Swash Plate Angle Sensor Connector

Connector DEUTSCH, 4-pin

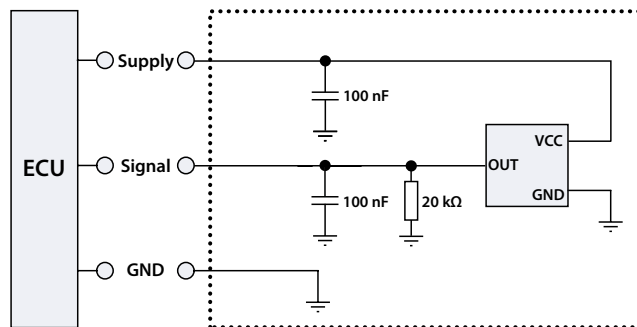


- 1** Ground (GND)
- 2** Not connected
- 3** Output signal 1 (SIG 1)
- 4** Supply (V+)

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

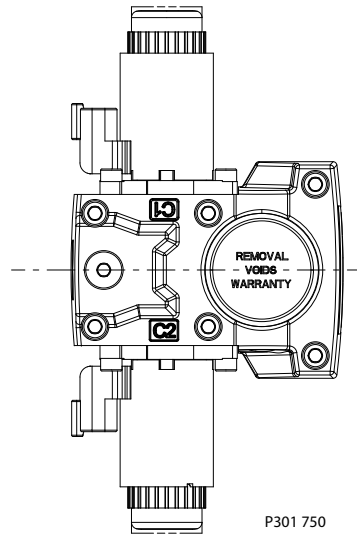


Control Options

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.

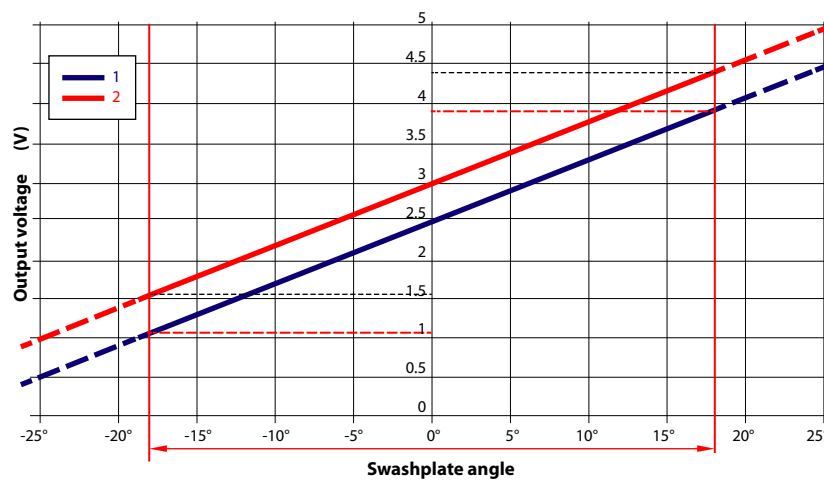
The output signal give a linear output voltage for the various magnet positions in the sensing range.



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:

$$V = \frac{\tan \alpha \cdot V}{\tan 18^\circ} \text{ (cm}^3\text{)}$$

The corresponding flow is:

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

Control Options

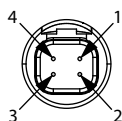
Swash Plate Angle Sensor Parameters (NFPE/AC)

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)

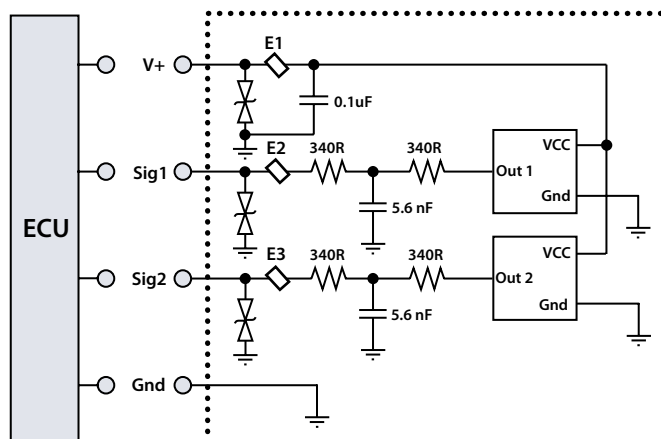
H1P Swash Plate Angle Sensor Connector (NFPE)



- 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.

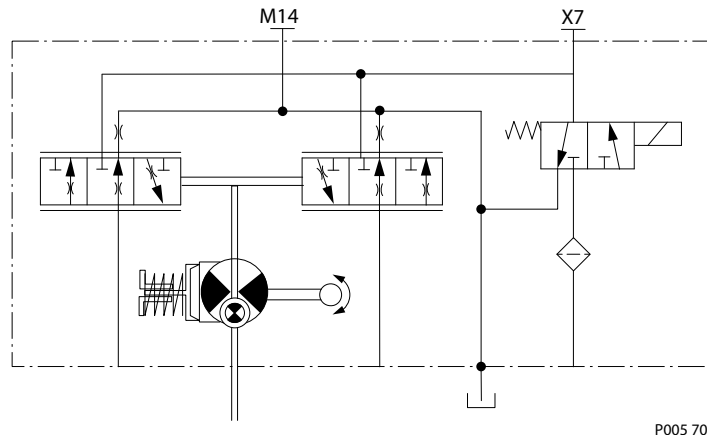
When the solenoid is energized, charge flow and pressure is allowed to reach the pump control. The X7 logic port will also be connected to charge pressure and flow.

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)



P005 703

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	

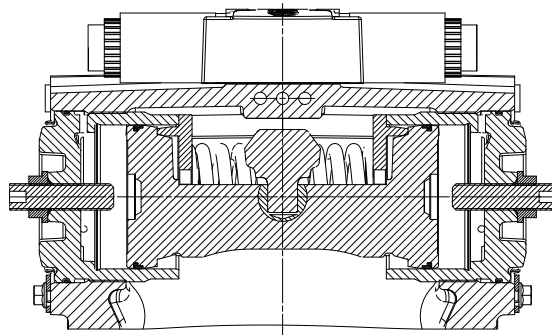
CCO solenoids are design for battery voltage application within the voltage range in the table above, in consideration of a wide range of environmental temperature common for known hydraulic applications. Closed loop PWM current supply can be also applied and is helpful in case that the voltage range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

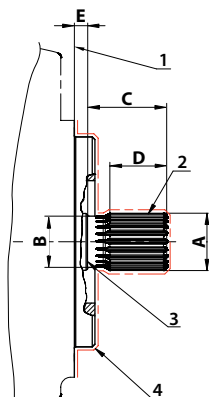
H1P 147/165 Displacement Change (approximately)

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*, **AX152886482551**, the section "Displacement Limiter Adjustment".

Dimensions and Data

H1P Input Shaft Option G2 (SAE D, 27 teeth)



1. Mounting flange 152–4 per ISO 3019-1; surface to be paint free
2. **Spline Data:** 27 teeth, Pressure angle: 30°, Pitch: 16/32, $\text{Ø}42.863$ [1.688]; Fillet root side fit per ANSI B92.1-1996, Class 5
3. Coupling must not protrude beyond this point
4. Shaft to be paint free

Dimensions

A	B	C	D ¹⁾	E
$\text{Ø}44.36 \pm 0.09$ [1.746 ± 0.004]	$\text{Ø}39.5 \pm 0.25$ [1.555 ± 0.01]	67.0 [2.638]	42.0 [1.654]	8.05 [0.317]

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

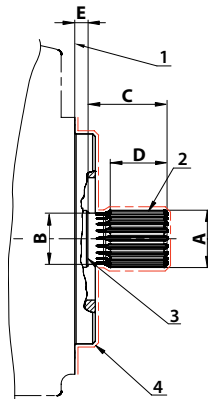
Torque rating

Rated torque	Maximum torque
1615 N·m [14 300 lbf·in]	3000 N·m [26 550 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 Input Shaft Option G3 (SAE D, 13 teeth)



1. Mounting flange 152-4 per ISO 3019-1; surface to be paint free
2. **Spline Data:** 13 teeth, Pressure angle: 30°, Pitch: 8/16, $\text{Ø}41.275$ [1.625]; Fillet root side fit per ANSI B92.1-1996, Class 5
3. Coupling must not protrude beyond this point
4. Shaft to be paint free

Dimensions

A	B	C	D ¹⁾	E
$\text{Ø}44.4 \pm 0.09$ [1.746 ± 0.004]	$\text{Ø}36.4 \pm 0.25$ [1.433 ± 0.01]	67.0 [2.638]	39.5 [1.555]	8.0 [0.316]

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

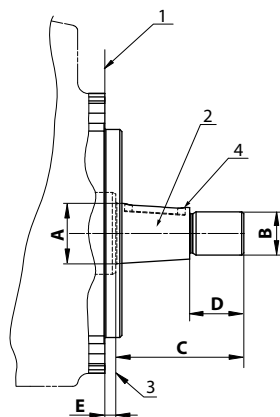
Torque rating

Rated torque	Maximum torque
1442 N·m [12 800 lbf·in]	2206 N·m [19 500 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 147/165 Input Shaft Option F3, Code 44-3



1. Mounting flange 152-4 per ISO 3019-1; surface to be paint free
2. **Tapered shaft:** Conical keyed shaft end, code 44-3 (similar to ISO 3019-1 code 38-3) without key, no through-hole in the end of the shaft. Suitable key: 7/16 x 7/16 x 1¼ per ANSI B17.1; surface to be paint free
3. Coupling must not protrude beyond this point
4. **Cone:** 125 ±0.5:1000

Dimensions

A	B	C	D	E
Ø44.45 ±0.09 [1.746 ±0.004]	1¼-12	93.7 ±1 [3.689 ±0.039]	39.7 ±1 [1.563 ±0.039]	8.0 [0.316]

Torque rating

Rated torque ¹⁾	Maximum torque ²⁾
1766 N·m [15 630 lbf·in]	2354 N·m [20 830 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.

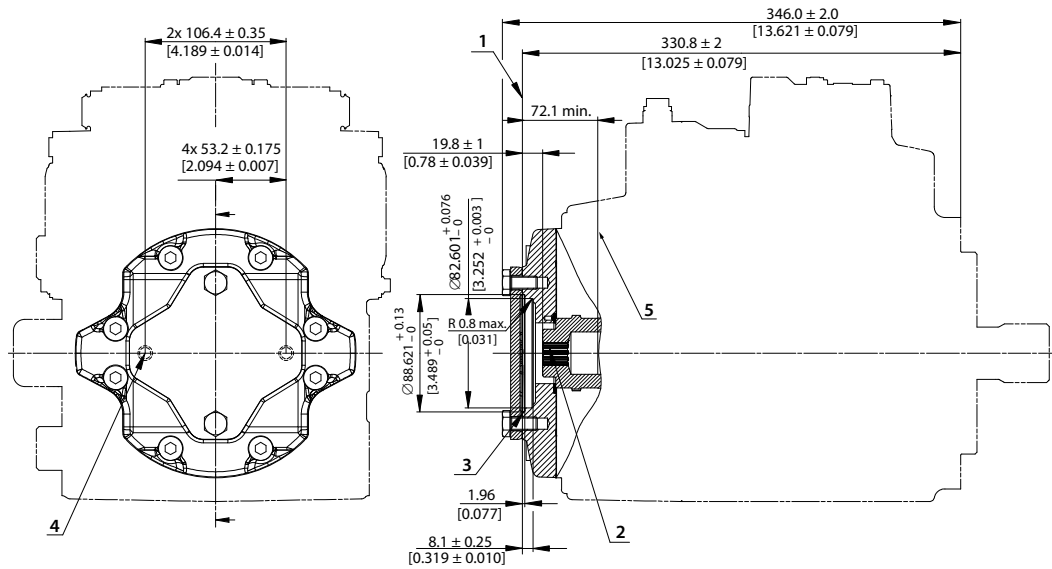
Danfoss recommends a self-locking nut instead of a castle nut and pin. The nut and mating square-cut key are customer supplied. The specified torque rating of the tapered shaft is based on the cross-sectional diameter of the shaft, through the keyway, and assumes the proper clamp and fit between shaft 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 (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 [3.237] ID x 2.62, cross section
4. Thread: M10x1.5-6H; 16 [0.63] min. depth; Recommended screw-in depth 1.5 x thread dia (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum Torque	296 N•m [2620 lbf•in]
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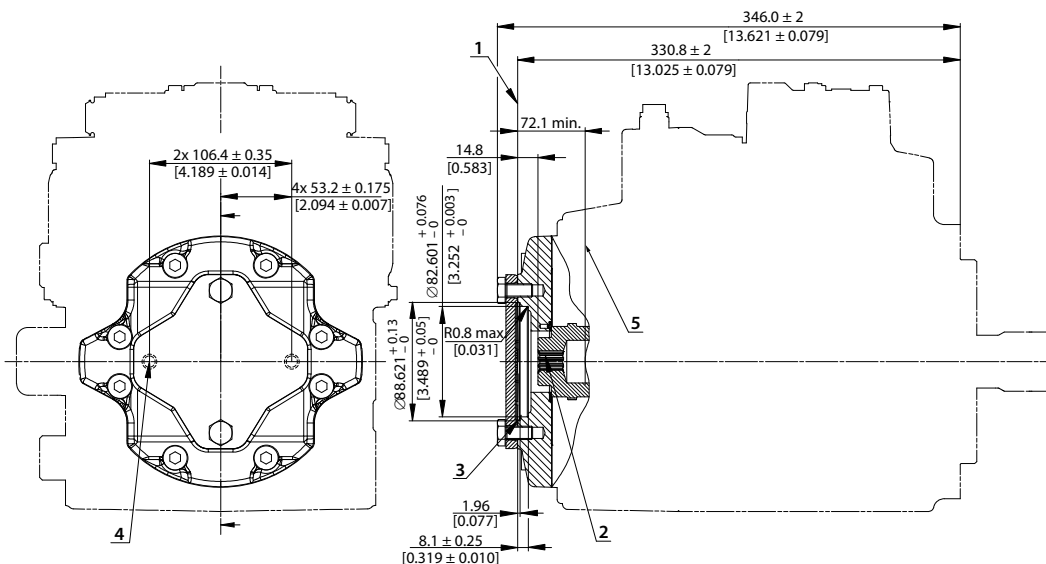
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information*, **BC152886483968**, the section “Shaft Torque Ratings and Spline Lubrication”.

! 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 (SAE A, 9 teeth)



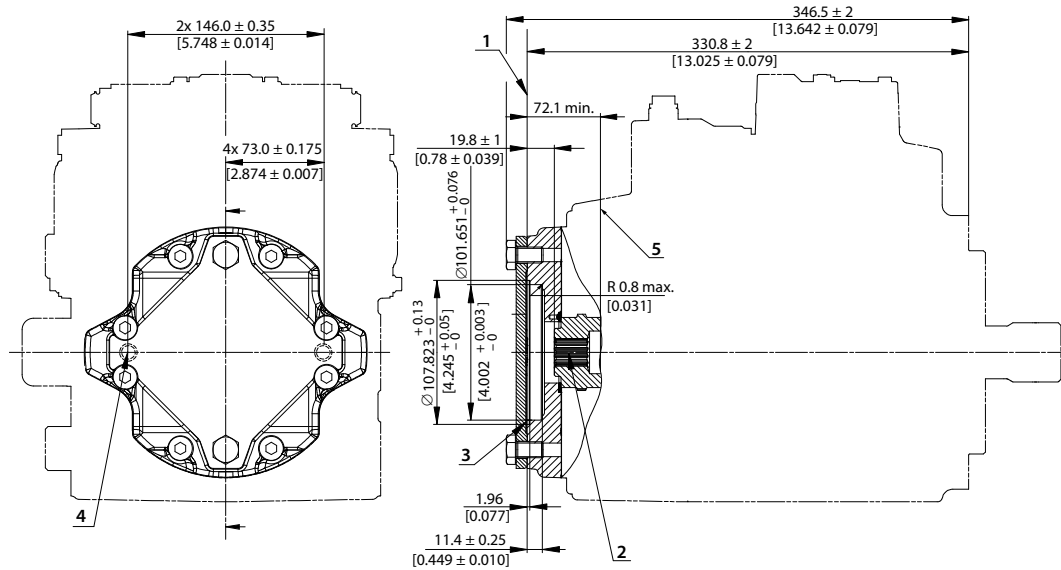
1. Auxiliary mounting pad for mating flange 82-2 per ISO 3019-1 (SAE A); Paint free
2. **Spline Data:** 9 teeth, Pressure angle: 30°, Pitch: 16/32, Ø14.288 [0.5625]; Fillet root side fit per ANSI B92.1-1996, Class 6; minimum active spline length 8.6 mm
3. O-ring seal required; Ref. Ø82.22 [3.237] ID x 2.62, cross section
4. Thread: M10x1.5-6H; 15 [0.59] min. depth; Recommended screw-in depth 1.5 x thread dia (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum Torque	162 N·m [1430 lbf·in]
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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 (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, $\text{Ø}20.638$ [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. $\text{Ø}94.92$ [3.737] ID x 2.62, cross section
4. Thread: M12x1.75-6H; 25 [0.787] min. depth; Recommended screw-in depth 1.5 x thread dia (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Bolt length > 19.75 mm could result in a leak or damage to the unit.

Maximum Torque	395 N•m [3500 lbf•in]
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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”.

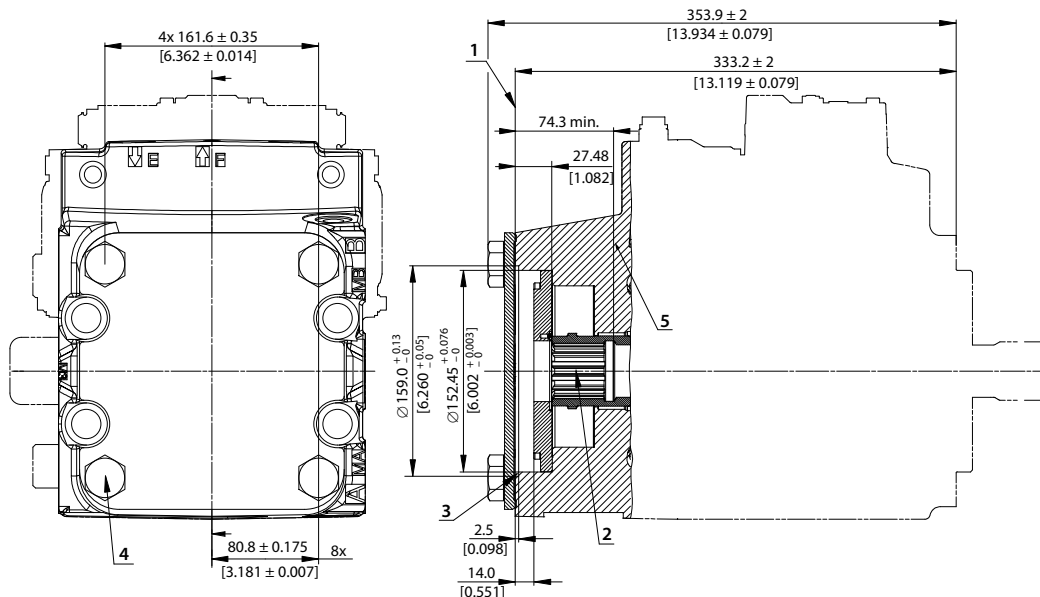
! Caution

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 H4 (SAE D, 13 teeth)

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



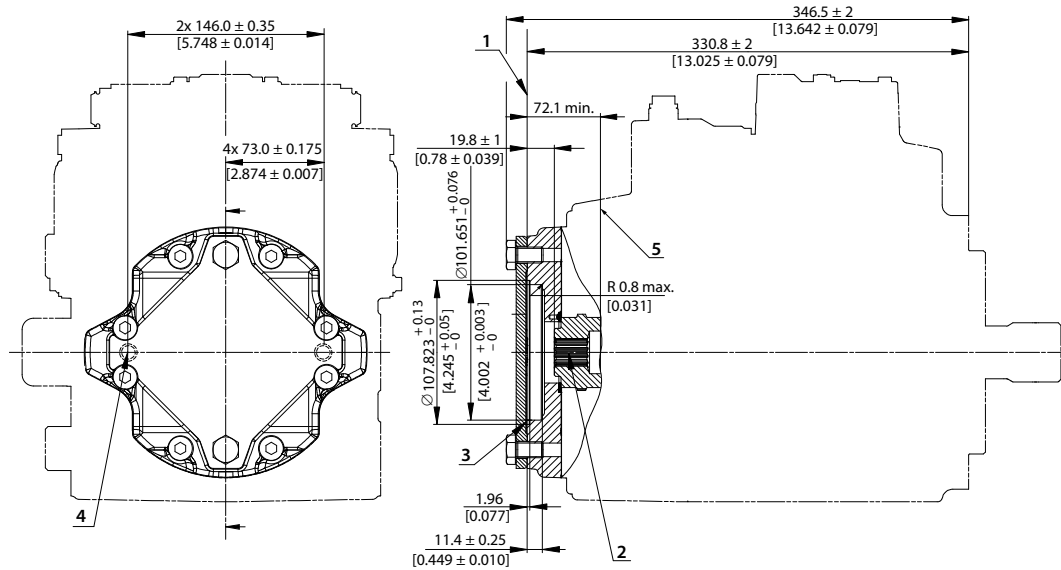
1. Auxiliary mounting pad for mating flange 152-4 per ISO 3019-1 (SAE D); Paint free
2. **Spline Data:** 13 teeth, Pressure angle: 30°, Pitch: 8/16, Ø41.275; Fillet root side fit per ANSI B92.1-1996, Class 6; minimum active spline length 12.4 mm
3. O-ring seal required; Ref. Ø150 ID x 3, cross section
4. Thread: M20x2.5-6H; 30 [1.181] min. depth; Recommended screw-in depth 1.5 x thread dia (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum Torque	2206 N·m [19 525 lbf·in]
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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 (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, $\text{Ø}23.813$ [0.938]; Fillet root side fit per ANSI B92.1-1996, Class 6; minimum active spline length 14.3 mm
3. O-ring seal required; Ref. $\text{Ø}94.92$ [3.737] ID x 2.62, cross section
4. Thread: M12x1.75-6H; 25 [0.787] min. depth; Recommended screw-in depth 1.5 x thread dia (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum Torque	693 N·m [6130 lbf·in]
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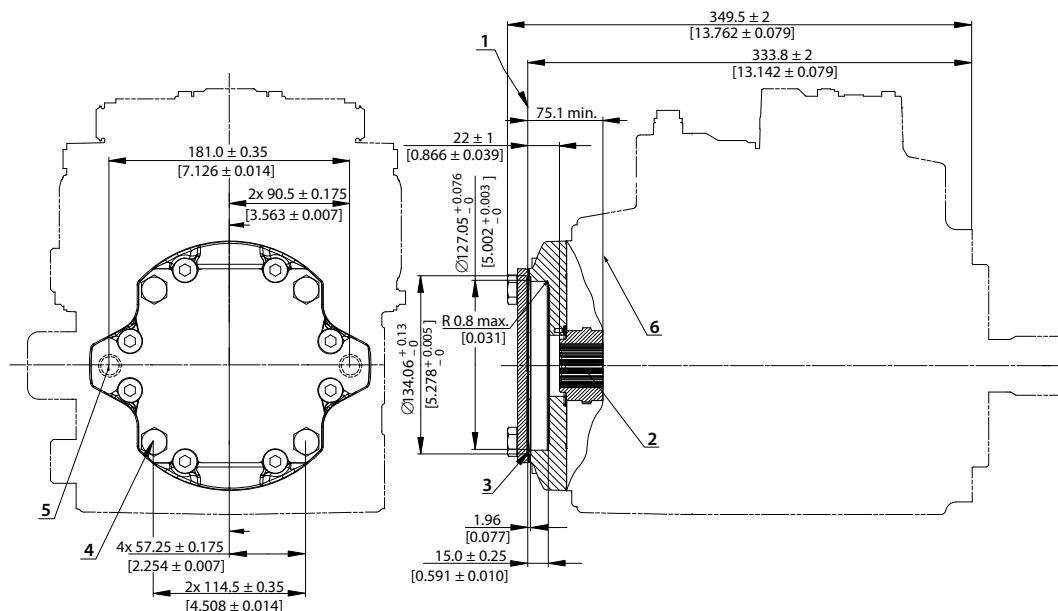
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information*, **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

⚠ 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 (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 17.8 mm
3. O-ring seal required; Ref. Ø120.32 ID x 2.62, cross section
4. Thread: M12x1.75-6H; 21 [0.827] min. depth; Recommended screw-in depth 1.5 x thread dia (4x)
5. Thread: M16x2-6H; 25 [0.984] min. depth; Recommended screw-in depth 1.5 x thread dia (2x)
6. Mating shaft and shaft shoulder must not protrude beyond this point

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

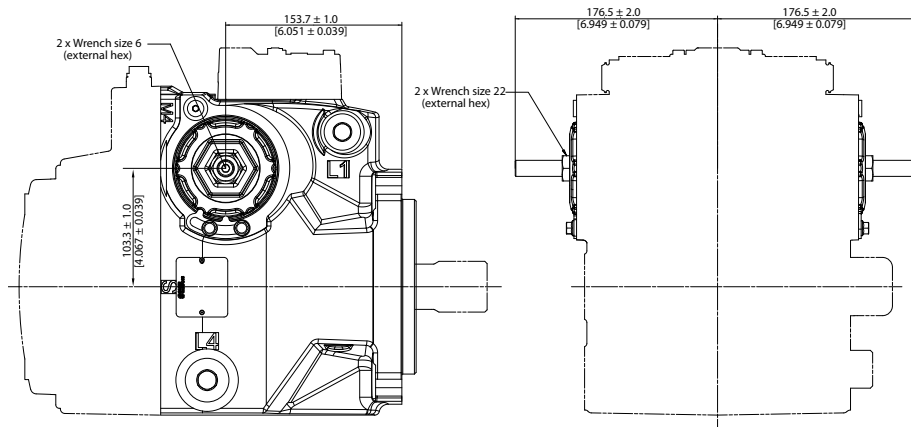
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information*, **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

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



P003 344E

1. Displacement limiter screw (2x)
2. Displacement limiter seal nut (2x)

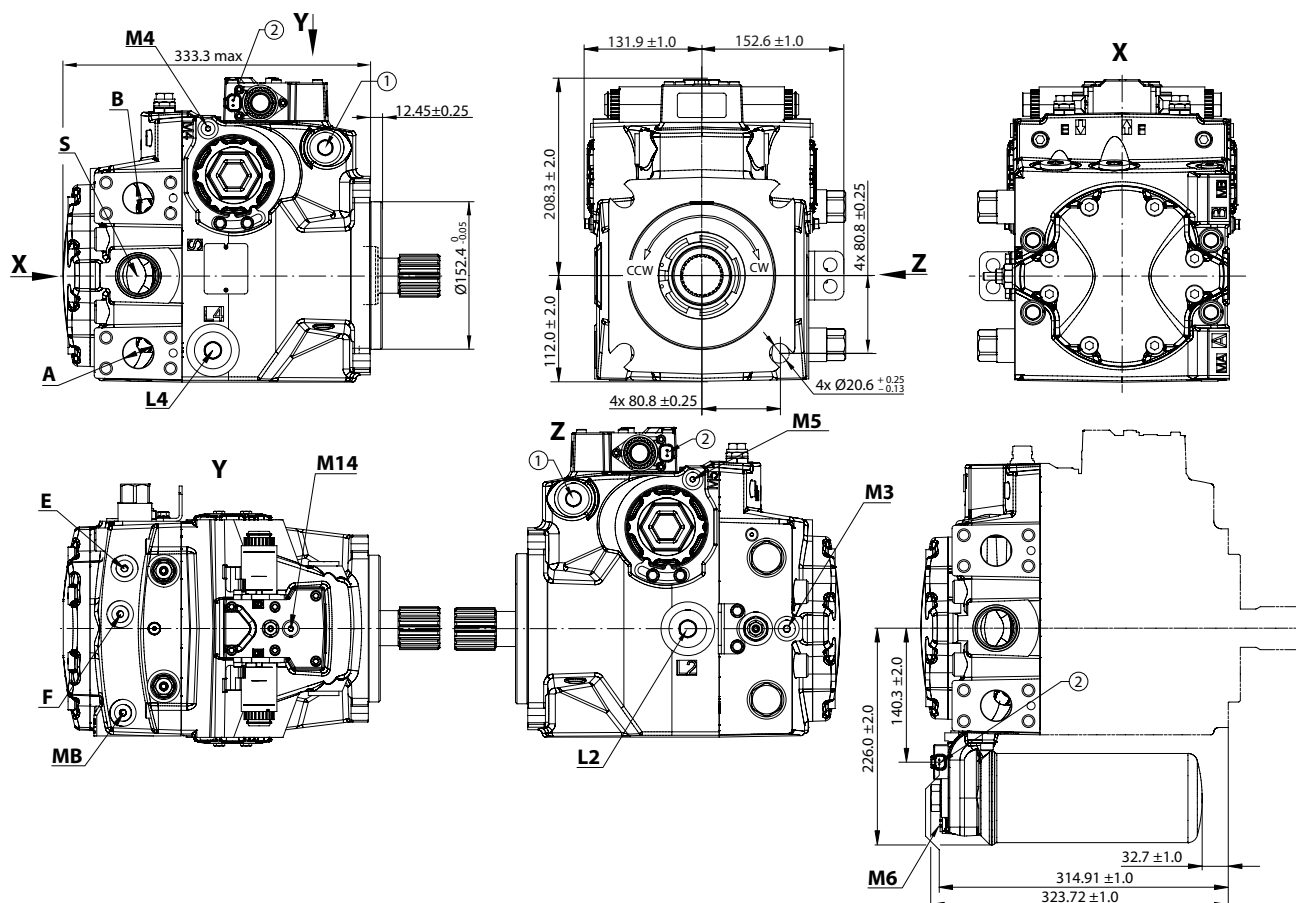
Wrench size, torque

Wrench size for DL screw	Wrench size for DL seal nut	Torque
6 internal hex	22 external hex	80 N·m [708 lbf·in]

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

Dimensions and Data

Single Pump Ports

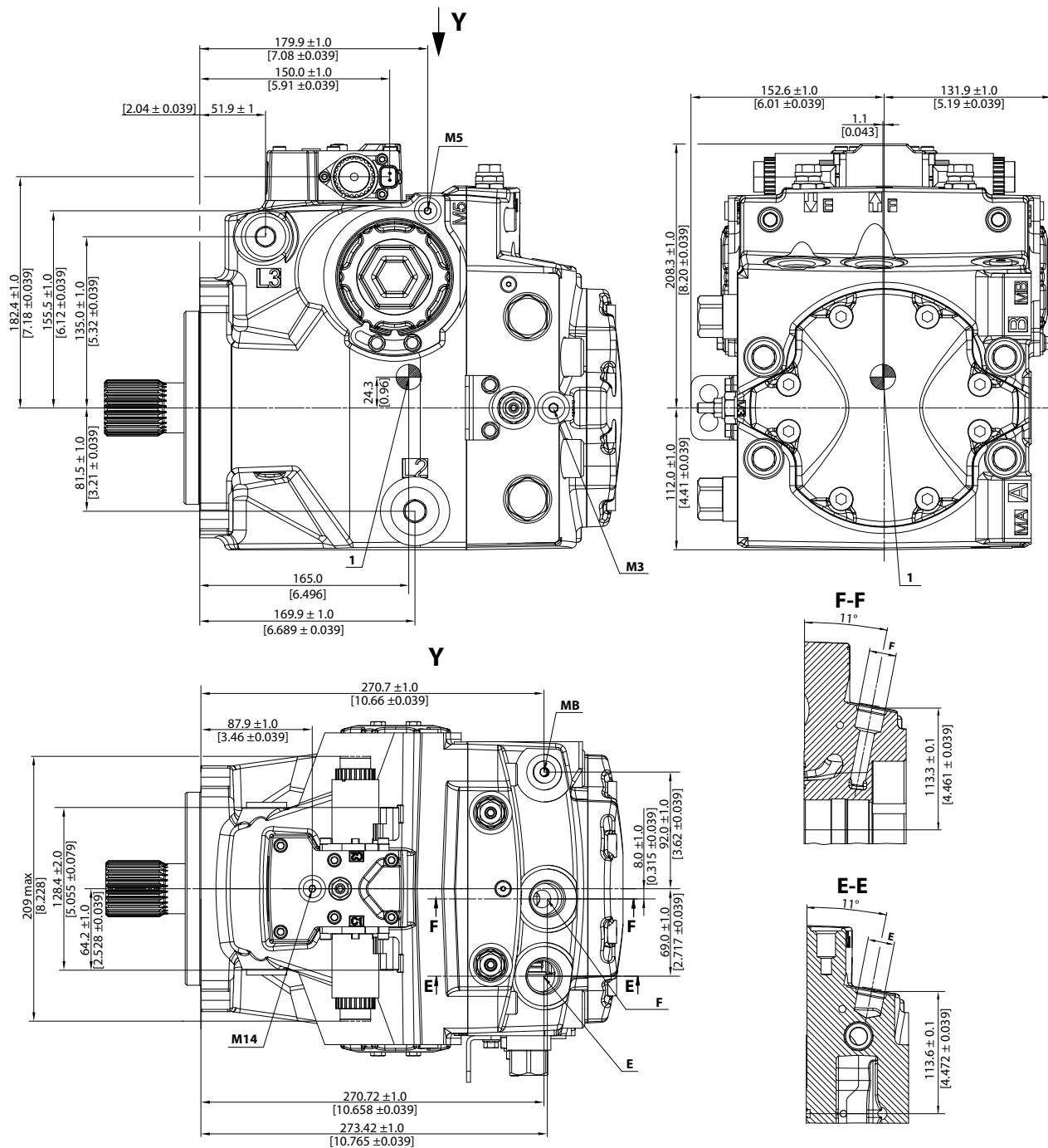


Ports per ISO 11 926-1

Port	Description	Size
A, B	System ports	Ø31.5 mm; M12 x 1.75; 20 min. full thread depth Recommended screw in depth 1.5 x thread dia
L2, L4	Case drain ports	1 ⁵ / ₁₆ -12
MA, MB	System A/B gauge ports	9/ ₁₆ -18
E/F	Charge filtration ports	1 ¹ / ₁₆ -12
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 / ₈ -12 Recommended screw in depth 1.5 x thread dia
1	Case pressure port	1 ¹ / ₁₆ -12
2	Connector DEUTSCH DT04-2P; Paint free	

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

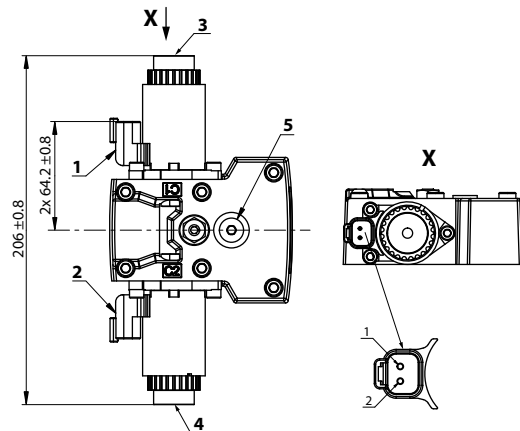


1 — Approximate center of gravity

Dimensions and Data

Controls

EDC Options A2 and A3 (12/24 V)



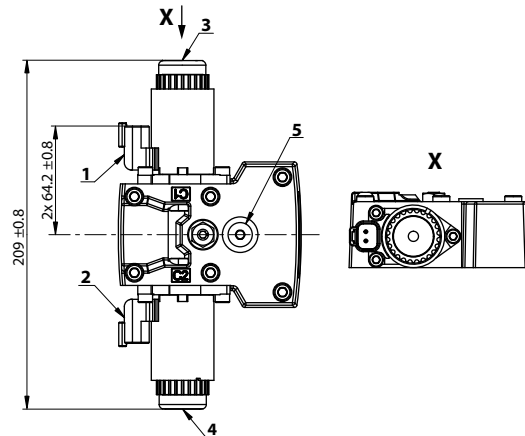
- 1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
- 2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
- 3. Control Manual OverRide **C1**
- 4. Control Manual OverRide **C2**
- 5. Case gauge port **M14** per ISO 1926-1: $\frac{7}{16}$ -20

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: $\frac{7}{16}$ -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

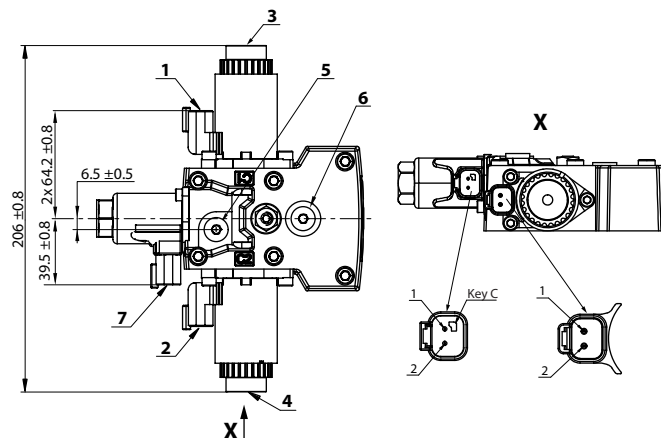


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

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



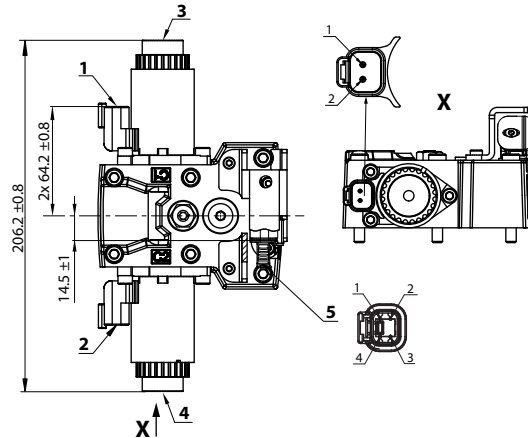
- 1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
- 2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
- 3. Control Manual OverRide **C1**
- 4. Control Manual OverRide **C2**
- 5. Brake gauge port **X7** per ISO 1926-1: $\frac{7}{16}$ -20
- 6. Case gauge port **M14** per ISO 1926-1: $\frac{7}{16}$ -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.

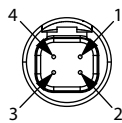
Dimensions and Data

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

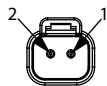
Connector DEUTSCH, 4-pin



4-pin assignment:

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

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

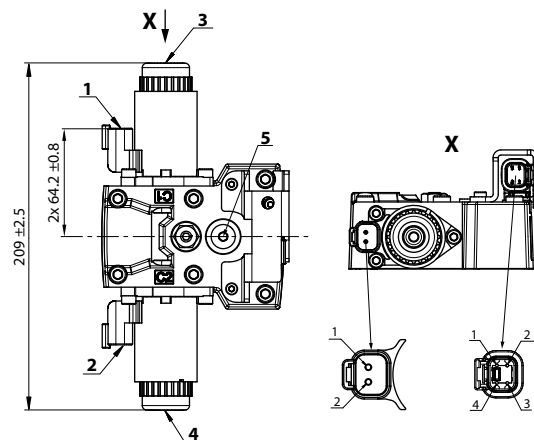


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

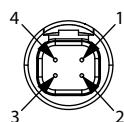
Dimensions and Data

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: $\frac{7}{16}$ -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

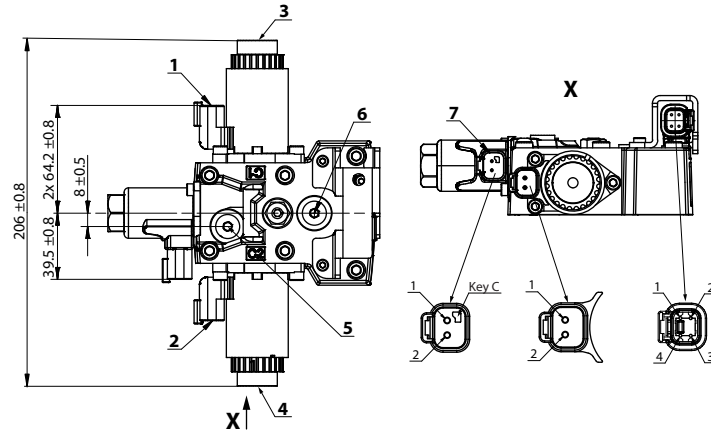


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

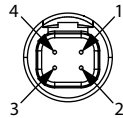
EDC with CCO and ASNSR, Options H8 and H9 (12/24 V)



- 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.

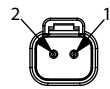
Connector DEUTSCH, 4-pin



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

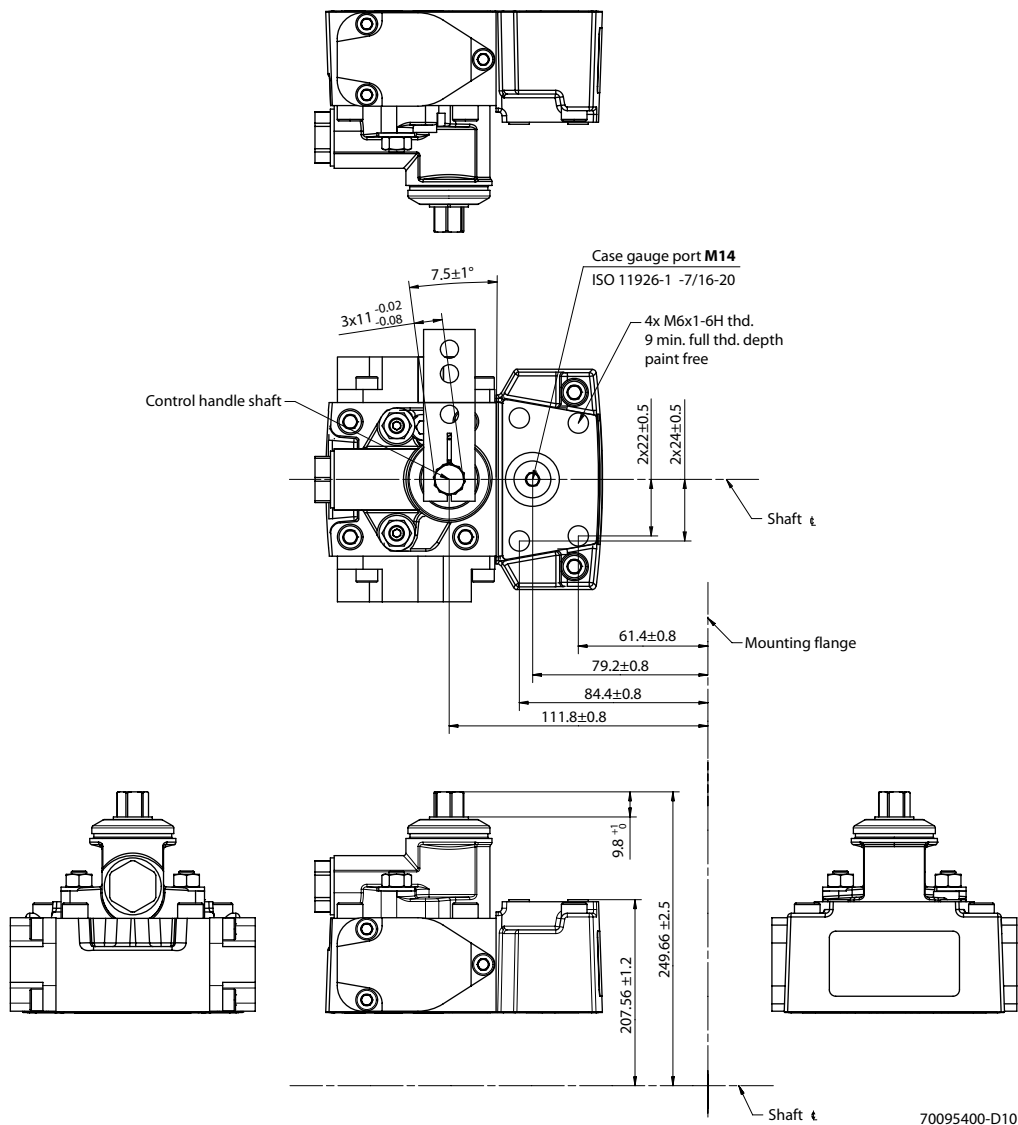


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

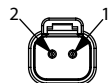
Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

MDC Option: M1



Connector DEUTSCH, 2-pin

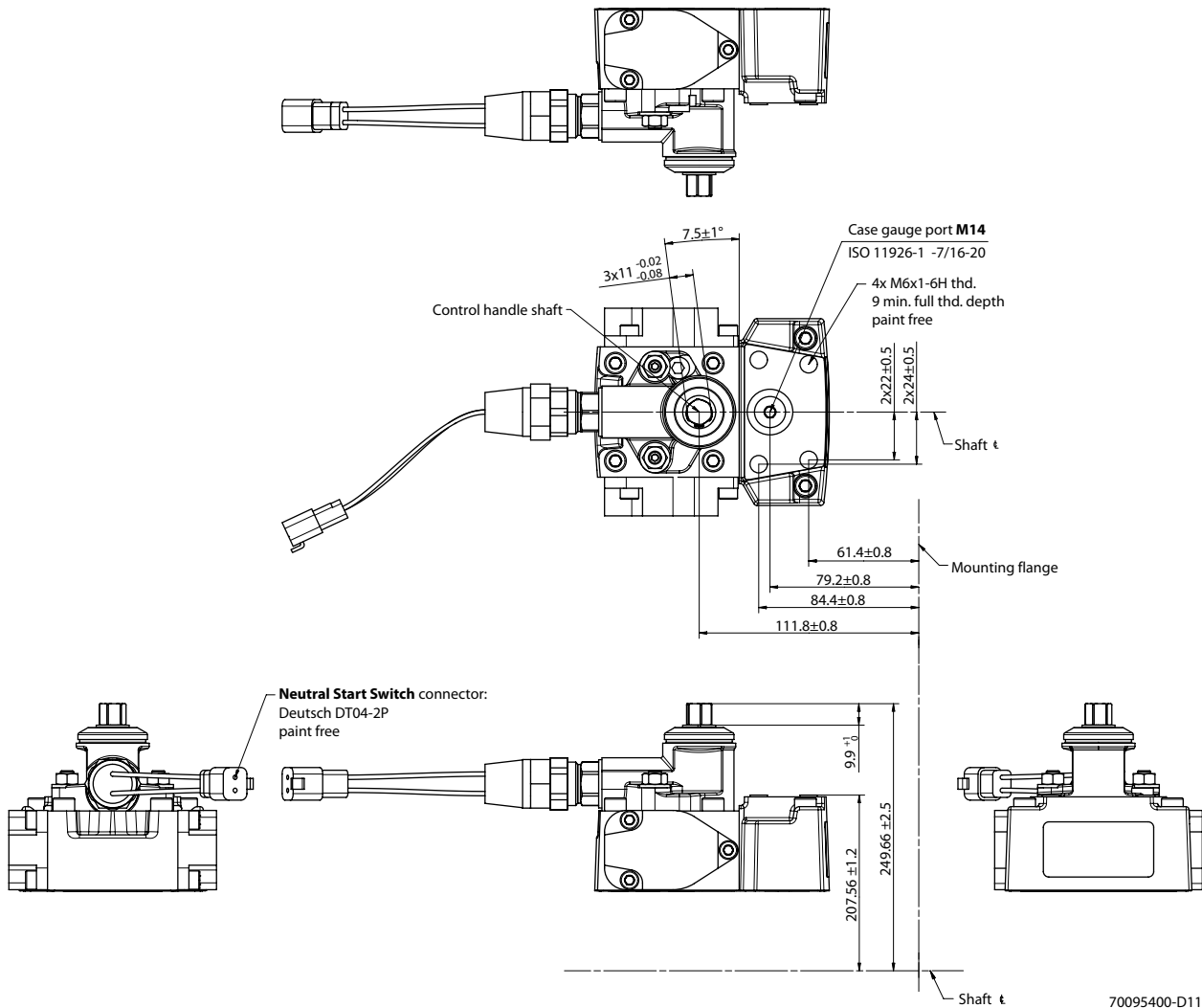


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

MDC with Neutral Start Switch Option: M2



Connector DEUTSCH, 2-pin

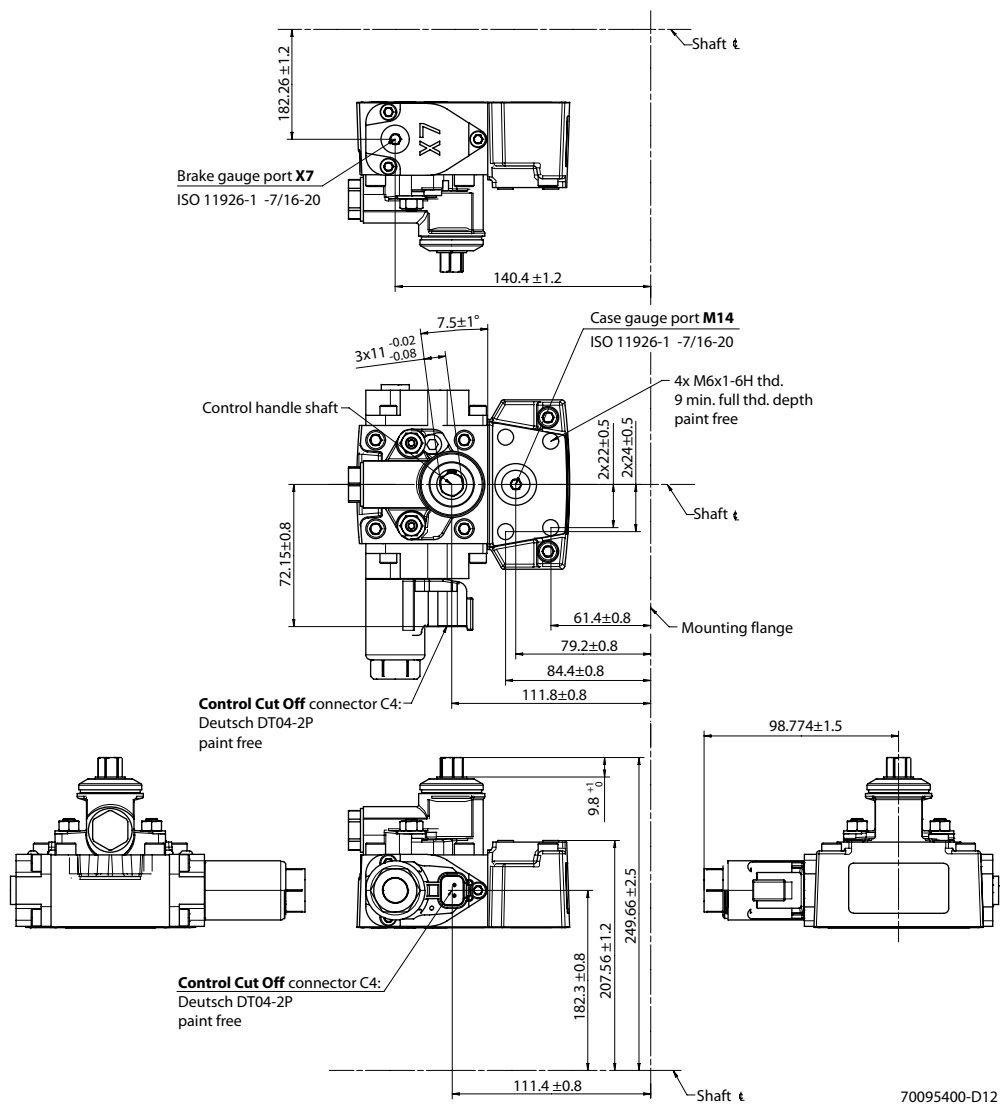


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

MDC with CCO, Options: M3, M4



Connector DEUTSCH, 2-pin

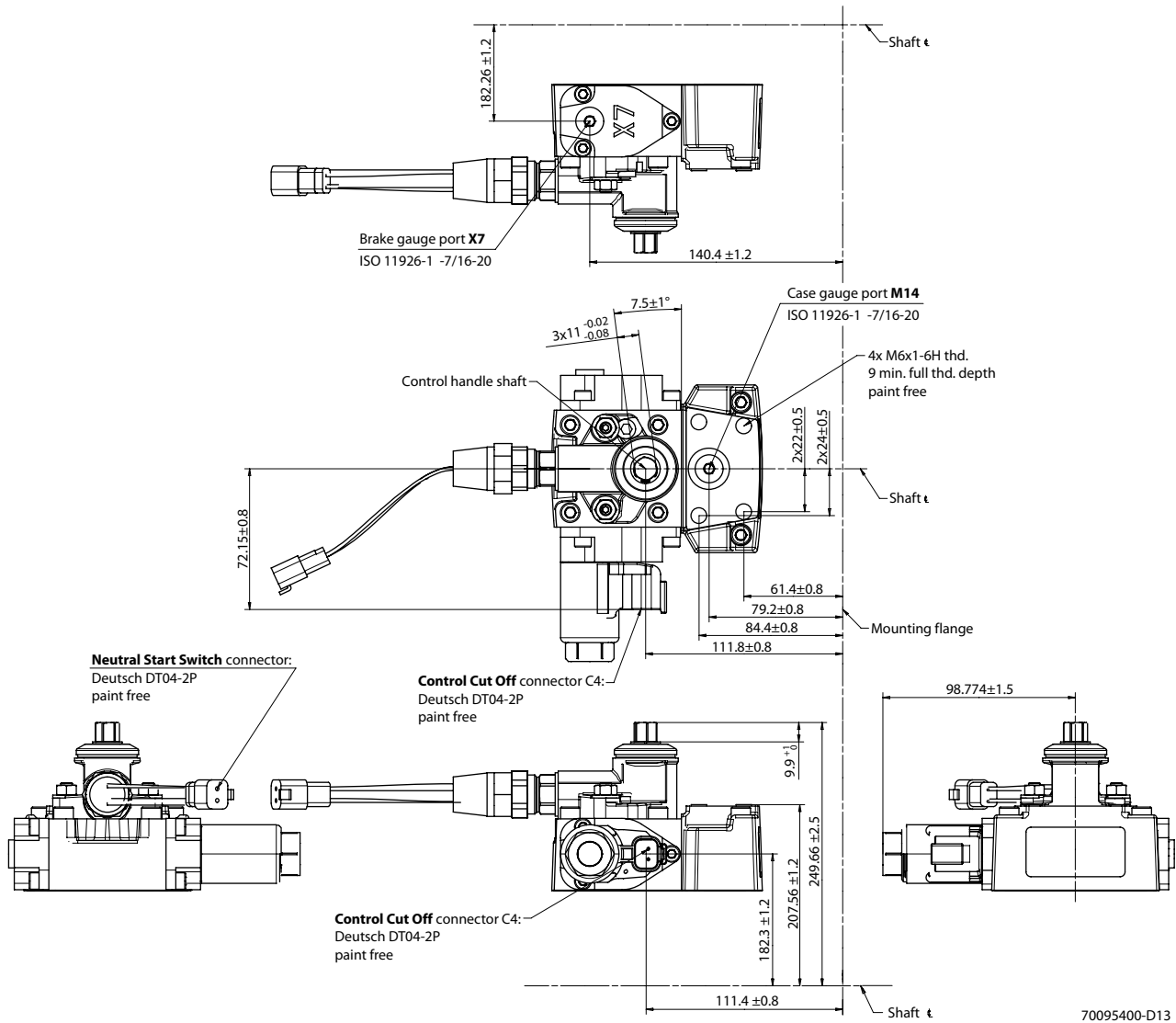


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

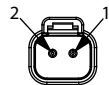
Please contact Danfoss representative for specific installation drawings.

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

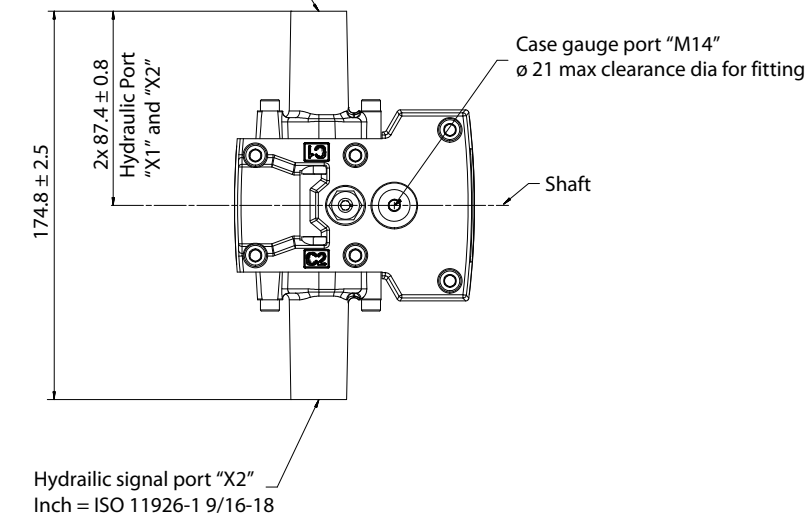
Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

H1P HDC, Options: T1, T2

Dimensions in mm

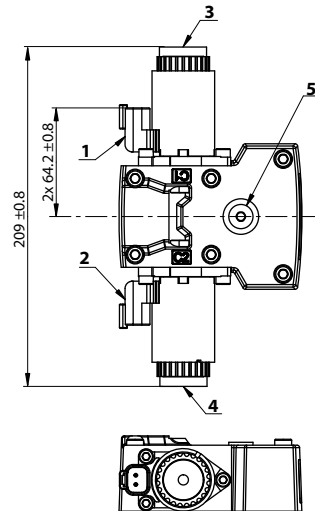
Hydraulic signal port "X1"
 Inch = ISO 11926-1 9/16-18



Dimensions and Data

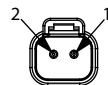
NFPE with MOR, Options: N1, N2 (12/24 V)

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: $\frac{7}{16}$ -20

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



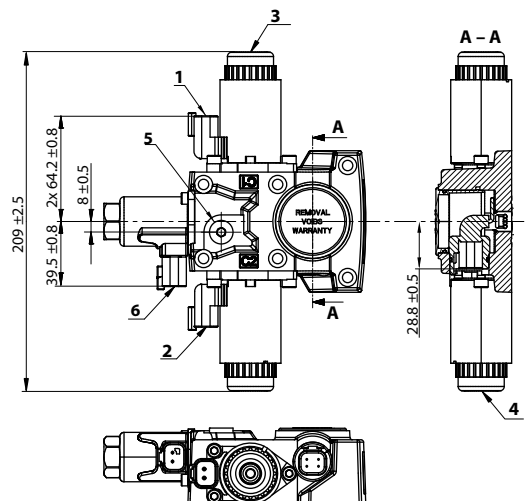
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

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

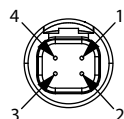
Non-Feedback Proportional Electric control with Control-Cut-Off valve with key C, Manual Over Ride and Angle Sensor, options N3 (12 V) and N4 (24 V).



- 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: $\frac{7}{16}$ -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.

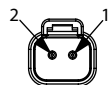
Connector DEUTSCH, 4-pin



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



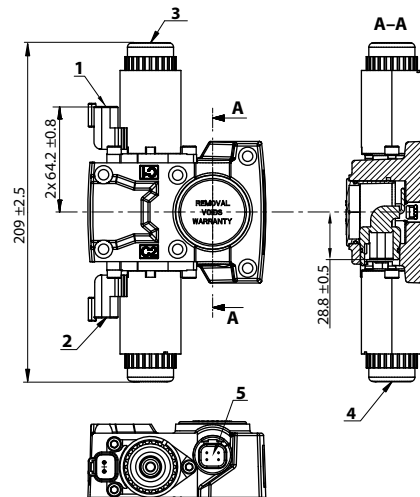
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

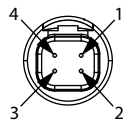
NFPE with MOR and ASNSR, Options: N5, N6 (12/24 V)

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

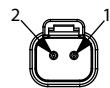
Connector DEUTSCH, 4-pin



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



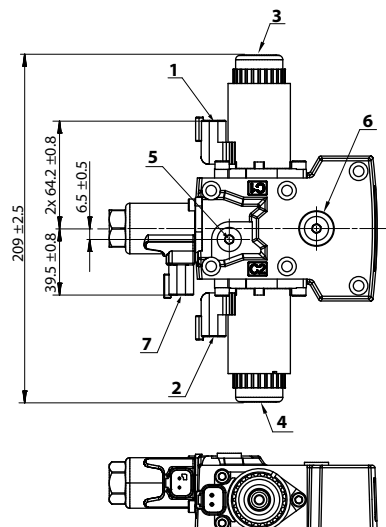
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

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

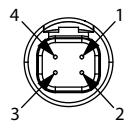
Non Feedback Proportional Electric control with Manual Over Ride and Control-Cut-Off valve key C, options N7 (12 V) and N8 (24 V).



- 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

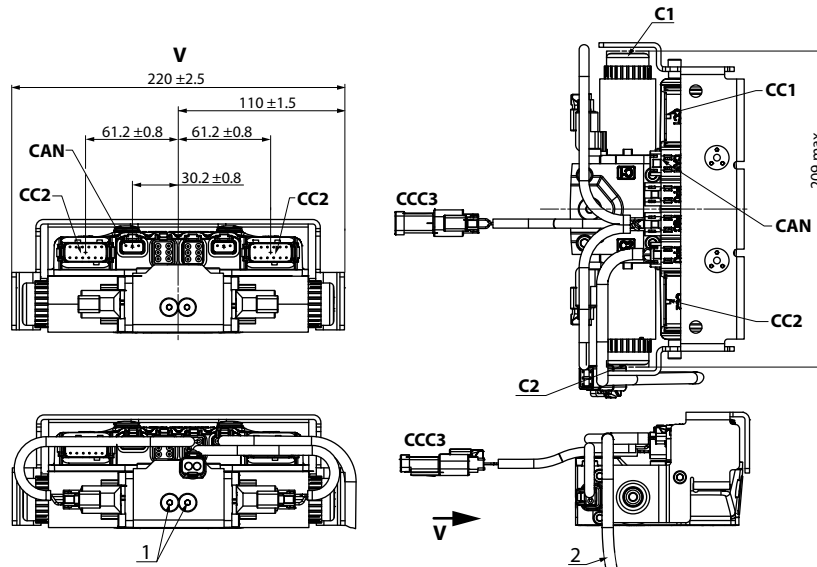


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

Automotive control (AC)



- 1 Plug removing can cause contamination issues
- 2 PPU wire harness is factory installed to speed sensor

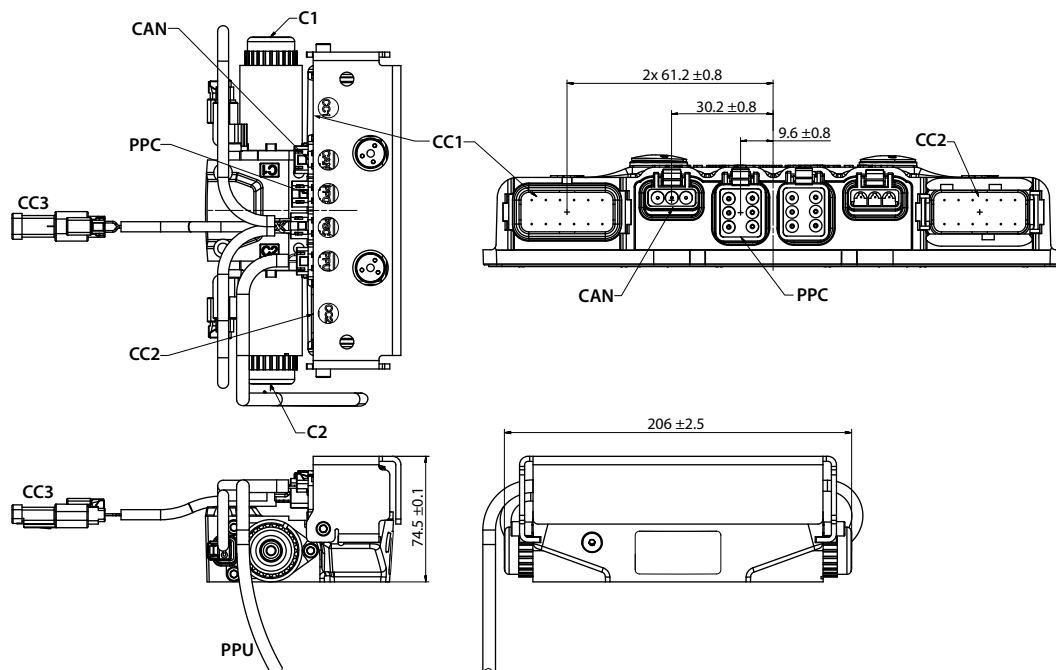
Connectors description

Port	Description
C1 and C2	1. Control manual override C1 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

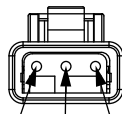
Connector DEUTSCH, 2-pin



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

CAN

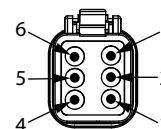
Connector DEUTSCH, 3-pin



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

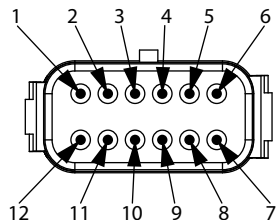
PPC

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)

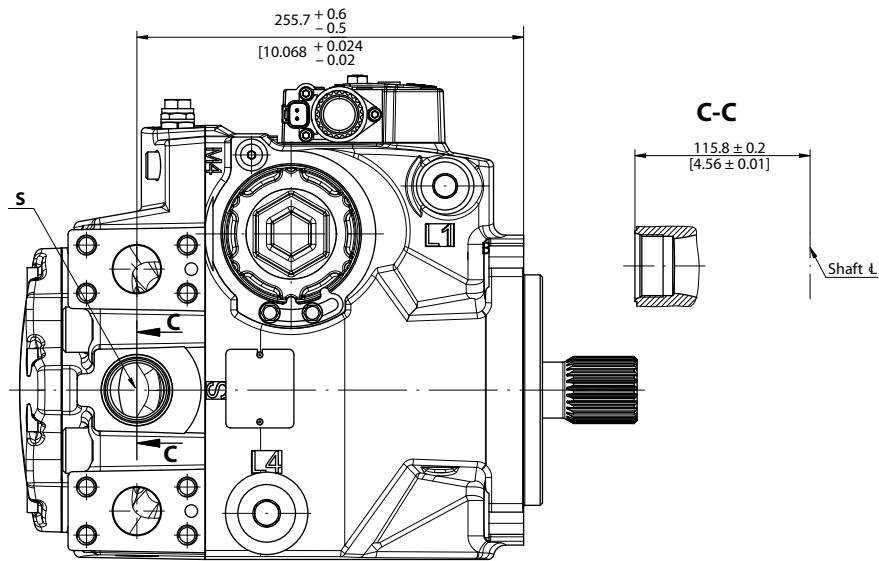
CC2

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

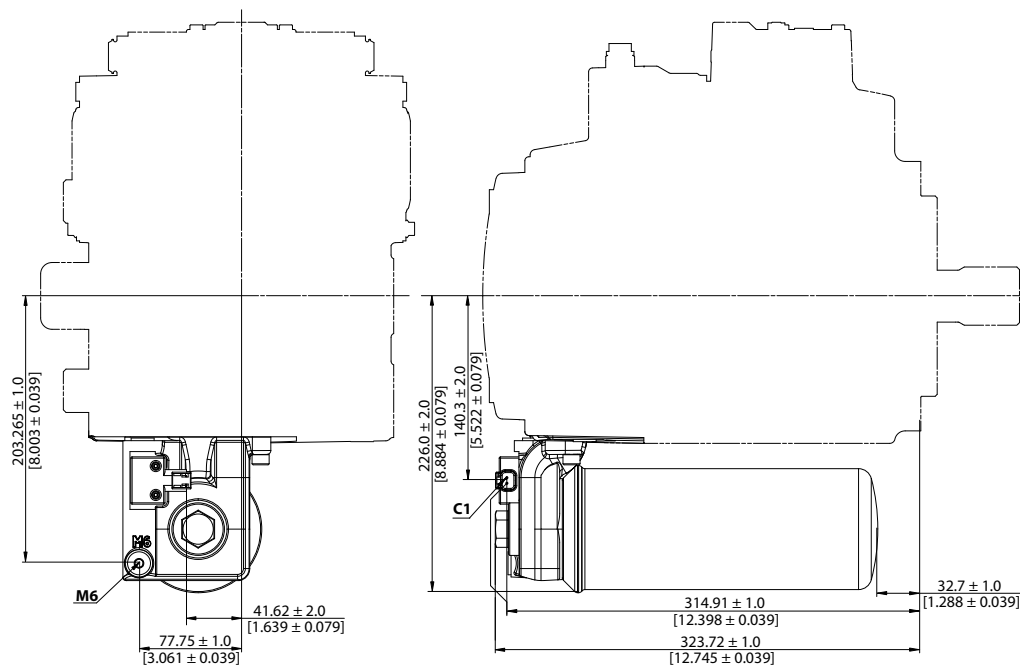
Filtration

H1P 147/165 Suction Filtration Option L



S Charge pump inlet per ISO 11926-1; 1 5/8-12

Integral Full Flow Charge Pressure Filtration, Option M



Please contact Danfoss representative for specific installation drawings.

Products we offer:

- Cartridge valves
- DCV directional control valves
- Electric converters
- Electric machines
- Electric motors
- Gear motors
- Gear pumps
- Hydraulic integrated circuits (HICs)
- Hydrostatic motors
- Hydrostatic pumps
- Orbital motors
- PLUS+1® controllers
- PLUS+1® displays
- PLUS+1® joysticks and pedals
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ENGINEERING
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Technical Information

H1P 210/250/280

Axial Piston Single Pumps



Revision history*Table of revisions*

Date	Changed	Rev
May 2022	Corrected HDC control information	1101
December 2021	Added HDC control	1001
June 2021	Updated input shaft errors	0903
April 2021	Corrected interface with ECU (EDC) graphic	0902
January 2021	Added 280cc information	0901
April 2020	Corrected swash plate angle sensor connector and CCO connector descriptions	0804
February 2020	Added NFPE control options and changed document number from BC00000207	0803
June 2019	Major update.	0701
May 2018	Angle sensor for EDC; FDC note added.	0601
July 2017	B option change in MMC.	0503
May 2017	K option change in MMC.	0502
May 2017	NFPE gen. 3 changes.	0501
November 2015	Master Model Code changes.	0401
October 2014	Installation drawings change	0302
September 2014	MDC, CCO, and Swash Angle Sensor options added	0301
Mar 2014	Converted to Danfoss layout - DITA CMS	0201
Aug 2013	First edition	0101

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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 210/250/280 Technical Data

Feature	Size 210	Size 250	Size 280
Displacement	211.5 cm ³ [12.91 in ³]	251.7 cm ³ [15.36 in ³]	280.2 cm ³ [17.1 in ³]
Flow at rated speed (continuous)	549 l/min [145 US gal/min]	654 l/min [172.8 US gal/min]	728 l/min [192.3 US gal/min]
Torque at maximum displacement (theoretical)	3.34 N·m/bar [2042 lbf·in/1000 psi]	3.98 N·m/bar [2433 lbf·in/1000 psi]	4.46 N·m/bar [2727 lbf·in/1000 psi]
Mass moment of inertia of rotating components	0.0606 kg·m ² [0.1039 slug·ft ²]	0.0606 kg·m ² [0.1039 slug·ft ²]	0.0606 kg·m ² [0.1039 slug·ft ²]
Mass (dry–no charge pump)	163 kg [359.4 lb]	163 kg [359.4 lb]	163 kg [359.4 lb]
Oil volume	7.2 l [1.9 US gal]	7.2 l [1.9 US gal]	7.2 l [1.9 US gal]

Shaft, flange and ports description

Input shaft per ISO 3019-1 (outer diameter)	<ul style="list-style-type: none"> • Outer Ø44 mm – 4 (13 teeth) • Outer Ø44 mm – 4 (27 teeth) • Outer Ø57 mm – 4 (17 teeth)
Mounting flange per ISO 3019-1	Flange 165-4 (SAE-E)
Auxiliary mounting flange with metric fasteners, with shaft outer diameter	<ul style="list-style-type: none"> • Flanges 82-2 (SAE A, 9 teeth and 11 teeth) • Flanges 101-2 (SAE B, 13 teeth and SAE B-B, 15 teeth) • Flange 127-4 (SAE C, 14 teeth) • Flange 152-4 (SAE D, 13 teeth) • Flange 165-4 (SAE E, 13 teeth and 27 teeth)
Suction port per ISO 3019-1	Ø38 mm, 350 bar split flange boss per ISO 6162, M12x1.75
Main configuration port	Ø38 mm, 450 bar split flange boss per ISO 6162, M16x2
Case drain ports L2, L4 per ISO 3019-1	ISO 11926-1: 1 ⁵ / ₁₆ -12
Other ports	SAE O-ring boss
Customer interface threads	Metric fasteners

Technical Specifications

H1P 210/250/280 Operating Parameters

Parameter		Unit	Size 210/250	Size 280
Input speed	Min. for internal¹⁾ and external²⁾ charge supply	min ⁻¹ (rpm)	500	
	Min. for full performance, internal charge supply		1200	
	Rated		2600	
	Maximum		2800	
System pressure	Maximum working	bar [psi]	450 [6527]	420 [6091]
	Maximum		480 [6962]	450 [6527]
	Max./Min. low loop		45/10 [653/145]	
Charge pressure	Minimum	bar [psi]	18 [261]	
	Maximum		40 [580]	
Control pressure	Minimum (at corner power for EDC, MDC, FNR)	bar [psi]	16 [232]	
	Minimum (at corner power for NFPE, FDC, AC)		25 [363]	
	Maximum		60 [870]	
Charge pump inlet pressure	Rated	bar (absolute) [in Hg vacuum]	0.7 [9.0]	
	Minimum (cold start)		0.2 [24.0]	
	Maximum		4.0 [58.0]	
Case pressure	Rated	bar [psi]	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 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 μm

Technical Specifications

Fluid Specification

Viscosity

Intermittent¹⁾	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

Minimum¹⁾	-40°C [-40°F]
Rated	104°C [220°F]
Recommended range²⁾	60 – 85°C [140 – 185°F]
Maximum Intermittent	115°C [240°F]

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

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

H1P 210/250/280 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.

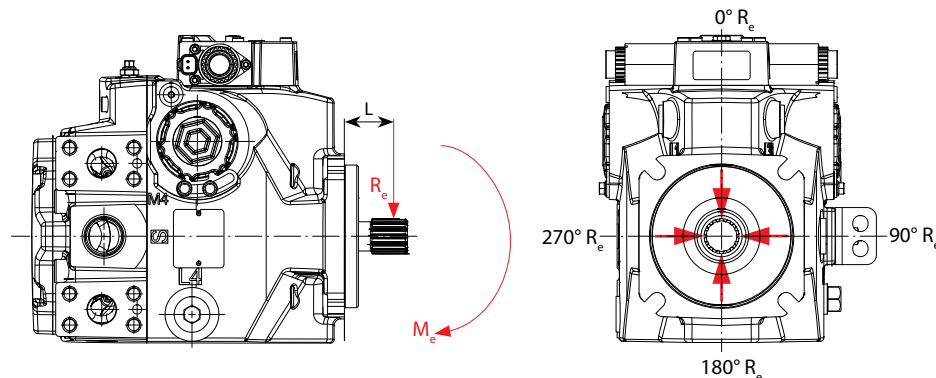
Danfoss recommends clamp-type couplings for applications with radial shaft loads. Contact your Danfoss representative for an evaluation of unit bearing life if you have continuously applied external loads exceeding 25 % of the maximum allowable radial load (R_e) or the pump swash-plate is positioned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

Maximum external shaft load based on shaft deflection

External radial moment	Unit	Size 210	Size 250	Size 280
M_e	N·m [lbf·in]	168 [1478]	167 [1478]	167 [1478]

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:

Technical Specifications

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

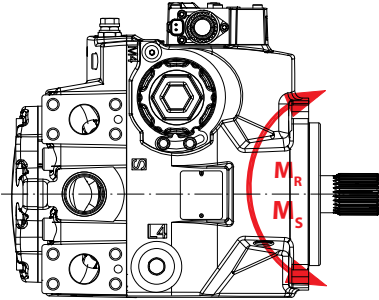
Thrust loads should be avoided. Contact your Danfoss representative in the event thrust loads are anticipated.

Technical Specifications

H1P 210/250/280 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

$$M_R = 6176 \text{ N}\cdot\text{m} [54\,662 \text{ lbf}\cdot\text{in}]$$

Shock load moment

$$M_S = 13\,003 \text{ N}\cdot\text{m} [115\,086 \text{ lbf}\cdot\text{in}]$$

For more information, see *H1 Axial Piston Pumps, Basic Information*, **BC152886483968**, 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.

For more information, see *Selection of Drive line Components*, **BC157786484430**.

52/60 cm³ Charge Pump – Flow and Power Curves

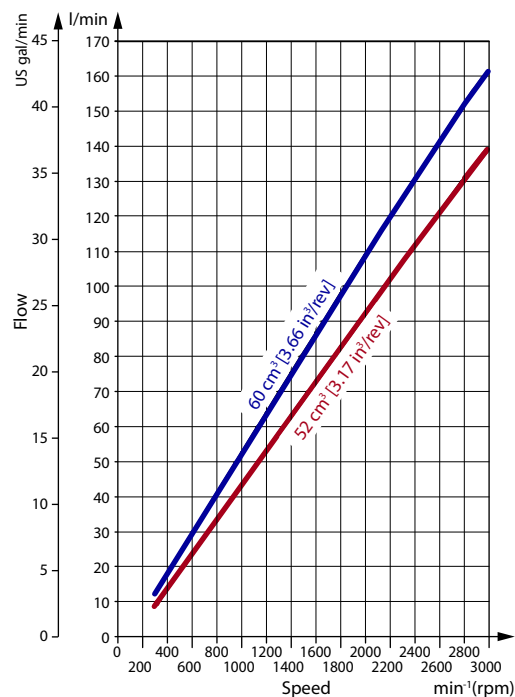
Charge pump flow and power requirements curves shown below at the following conditions:

Charge pressure = 20 bar [290 psi]

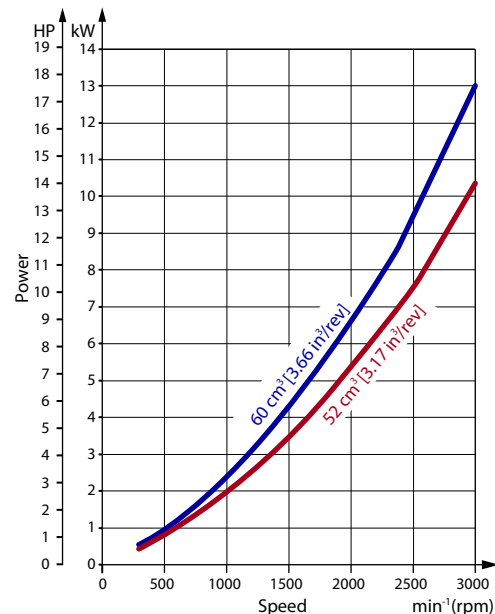
Viscosity = 11 mm²/s [63 SUS]

Temperature = 80°C [176°F]

Charge pump flow

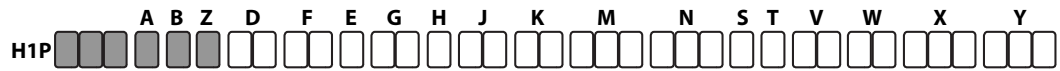


Charge pump power requirements



Master Model Code

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



Displacement

210	211.5 cm ³ [12.91 in ³]
250	251.7 cm ³ [15.36 in ³]
280	280.2 cm ³ [17.10 in ³]

A – Direction of Rotation

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

B – Product version

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

Z – Port configuration

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

Master Model Code

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).

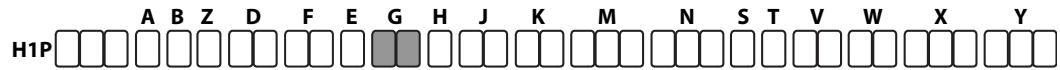
Hydraulic Displacement Control

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

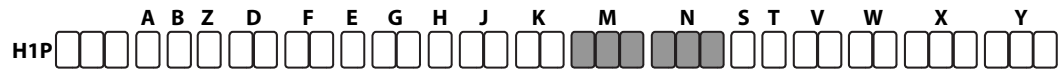
G—Endcap



G – End-cap Options

Twin port, ISO 6162 split flange ports; Align with T: Filtration

D6	Suction filtration
D8	Remote filtration or external charge supply

Master Model Code
M, N—Overpressure Protection Settings

M and N – Overpressure protection options

L	Pressure limiter setting	HPRV with bypass setting ¹⁾
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]
F04	150 bar [2175 psi]	400 bar [5800 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⁾
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".

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

Control Options

Electrical Displacement Control (EDC)

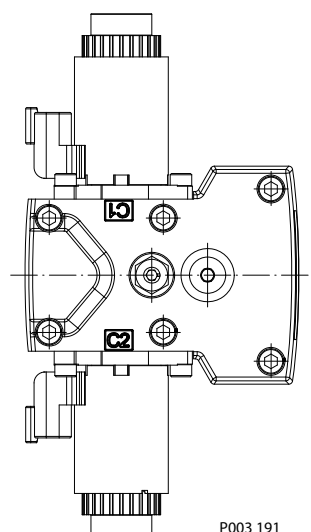
An EDC is a displacement (flow) control. Pump swash plate position is proportional to the input command and therefore vehicle or load speed (excluding influence of efficiency), is dependent only on the prime mover speed or motor displacement.

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.

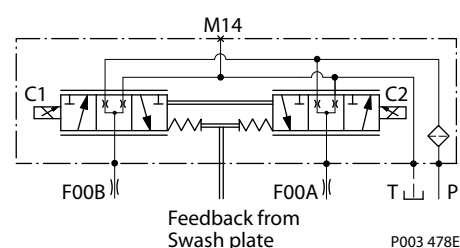
A serviceable 170 µm screen is located in the supply line immediately before the control porting spool.

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.

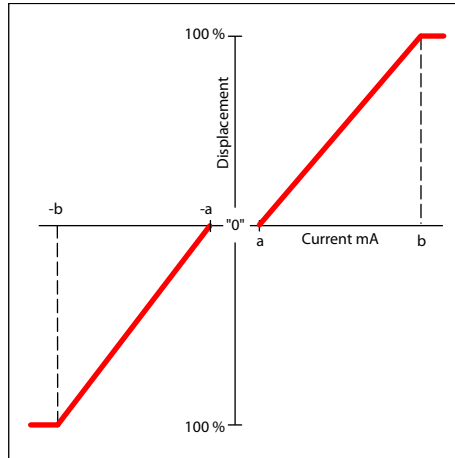
The neutral position of the control spool does provide a positive preload pressure to each end of the servo piston assembly.

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, EDC 210/250/280

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)	
	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 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:

$\Delta p = 250 \text{ bar}$ [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 210/250/280

Stroking direction	0.8 mm [0.03 in] orifice	1.3 mm [0.05 in] orifice	No orifice
Neutral to full flow	7.4 s	3.5 s	2.1 s
Full flow to neutral	5.0 s	2.4 s	1.4 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.

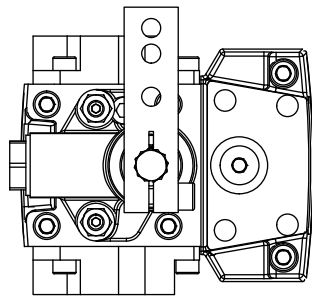
Differential pressure across the servo piston rotates the swash plate, changing the pump's displacement. Simultaneously the swashplate movement is fed back to the control spool providing proportionality between shaft rotation on the control and swash-plate rotation. The MDC changes the pump displacement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

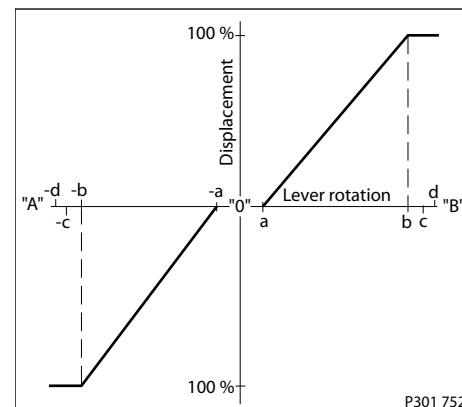
For the MDC with CCO option the brake port (X7) provides charge pressure when the coil is energized to activate static function such as a brake release. The X7 port must not be used for any continuous oil consumption.

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: $a = 3^\circ \pm 1^\circ$

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

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

Internal end stop: $d = 40^\circ$

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.

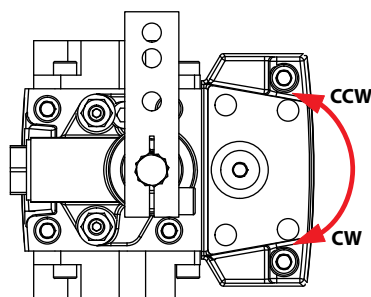
Control Options

- 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)	
	CW	CCW	CW	CCW
MDC shaft rotation				
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:

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

Control Options

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, MDC 210/250/280

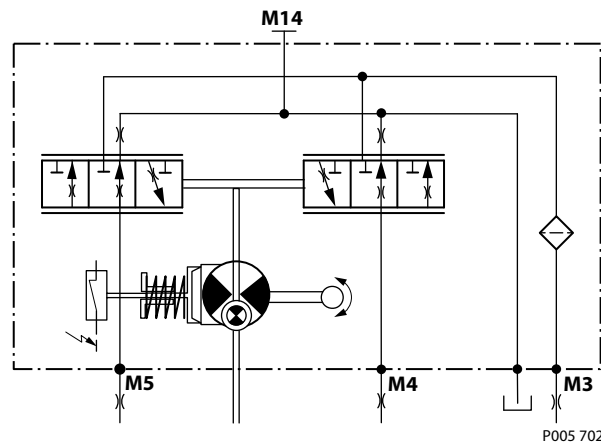
Code	Orifice description (mm)			Stroking direction	
	Tank (A+B)	P	A/B	Neutral to full flow	Full flow to neutral
C3	No orifice			0.9 s	1.0 s
C5	–	–	2.5	0.9 s	1.0 s
C6	1	–	–	3.3 s	2.9 s
C7	1.3	–	–	2.1 s	1.9 s
D1	0.8	1	–	2.1 s	1.5 s
D2	0.8	1.3	–	1.8 s	1.4 s
D3	1	1.3	–	3.8 s	3.2 s
D4	1	1.3	1.3	4.6 s	3.8 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

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

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)

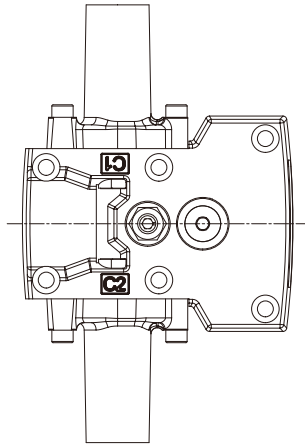
HDC principle

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.

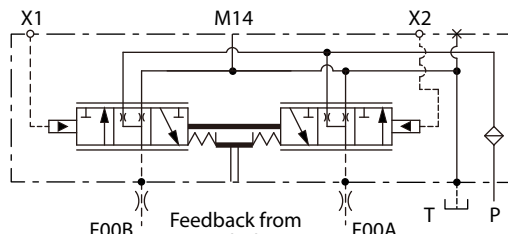
A serviceable 175 µm screen is located in the supply line immediately before the control porting spool.

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.

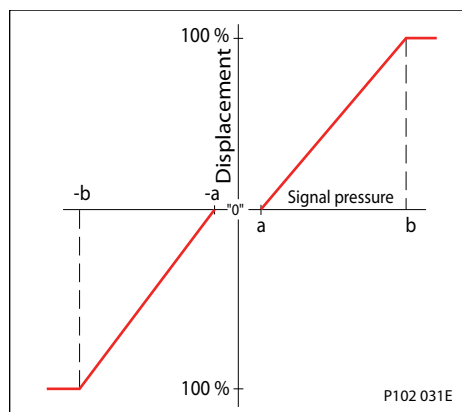
A swashplate feedback link, opposing control linkage, and a linear spring provide swashplate position force feedback to the hydraulic pressure. As hydraulic pressures in the operating loop change with load, the control assembly and servo/swashplate system work constantly to maintain the commanded position 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	
	X1	X2	X1	X2
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 swashplate 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:

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

Charge pressure = 20 bar [290 psi]

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

Speed = 1800 min⁻¹ (rpm)

Control Options**Response time, HDC 210/250/280**

Stroking direction	0.8 mm [0.03 in] orifice	1.3 mm [0.05 in] orifice	No orifice
Neutral to full flow	7.1s	3.2s	1.8s
Full flow to neutral	4.7s	2.1s	1.2s

Control Options

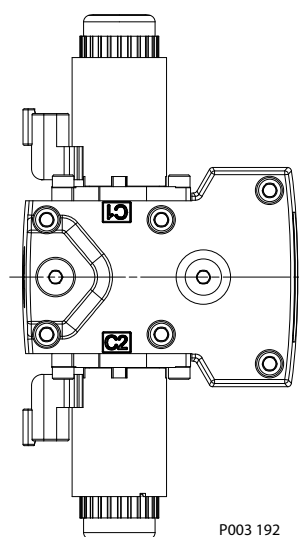
Non feedback proportional electric control (NFPE)

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.

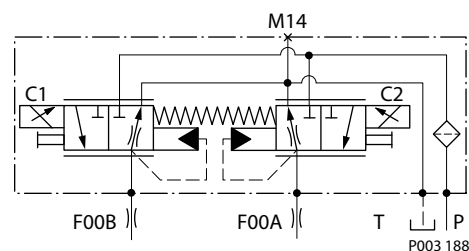
A serviceable 170 μm screen is located in the supply line immediately before the control porting spool.

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

NFPE control



NFPE schematic

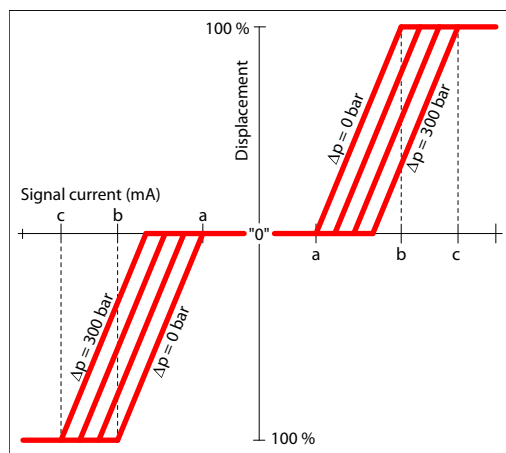


Control Signal Requirements, NFPE 210/250/280

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}	666 mA	1168 mA	1540 mA	any order
24 V _{DC}	320 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.

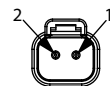
Single Pump Output Flow Direction

Shaft rotation	Clock-Wise (CW)		Counter-Clock-Wise (CCW)	
	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.

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:

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)

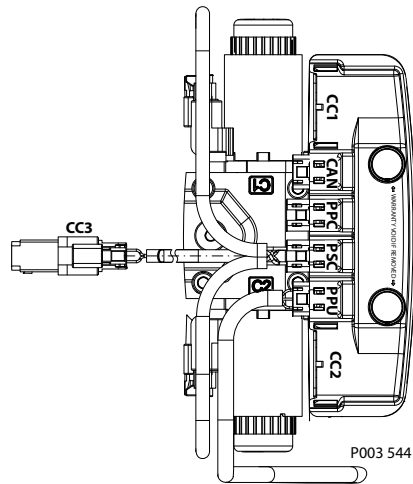
Response Time, NFPE 210/250/280

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	9.6 s	3.7 s	1.1 s
Full flow to neutral	5.9 s	2.5 s	0.6 s

Control Options

Automotive Control (AC)

The H1 **Automotive Control (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.

- **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*, [BC152986482596](#).

Control Options

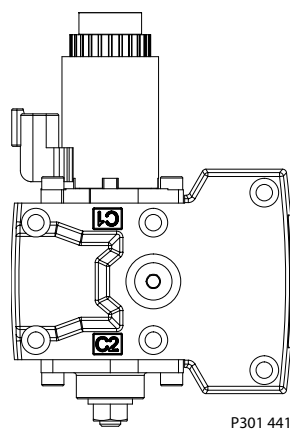
Fan Drive Control (FDC)

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.

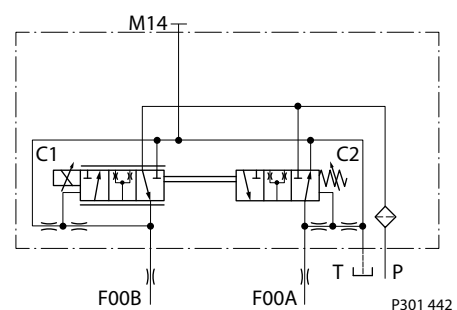
The control spool is spring biased to produce maximum forward pump displacement in the absence of an electrical input signal. Based on the spring bias spool default forward flow for a CW rotation pump is out of port B while default forward flow for a CCW rotation pump is out of port A.

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!

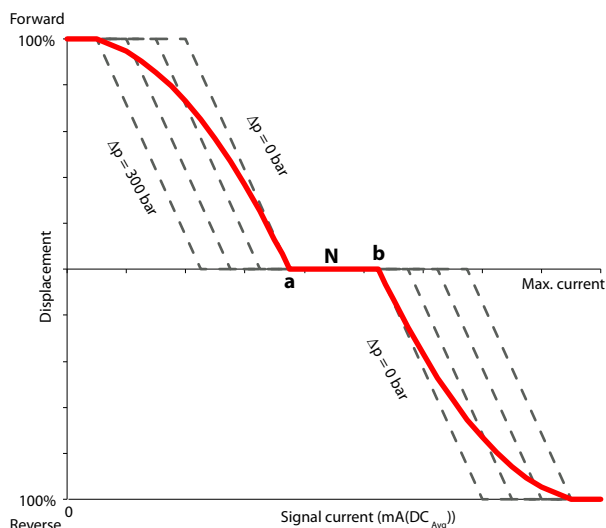
Due to the fail-safe functionality of the FDC control the pump will stroke to max. displacement in case the input signal to the pump control and the Diesel engine will be switched off at the same time. In this situation a low loop event can occur which may damage the pump. Therefore, it's strictly recommended 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, FDC 210/250/280

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

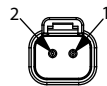
Shaft rotation		ClockWise			CounterClockWise		
Control Logic	12 V	0-780 mA	1100 mA	1300-1800 mA	0-780 mA	1100 mA	1300-1800 mA
	24 V	0-400 mA	550 mA	680-920 mA	0-400 mA	550 mA	680-920 mA
Port A		in	no flow	out	out	no flow	in
Port B		out	no flow	in	in	no flow	out
Servo port pressurized		M5	n/a	M4	M5	n/a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

- $\Delta p = 250 \text{ bar}$ [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 210/250/280

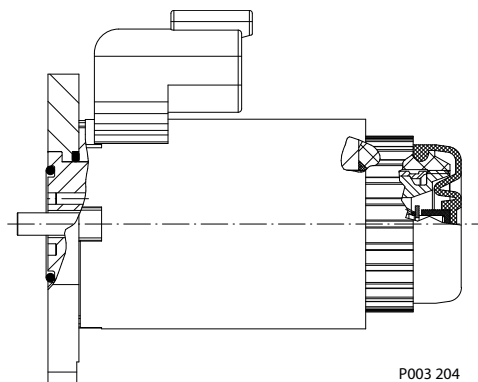
Stroking direction	0.8 mm [0.03 in] orifice
Full flow to neutral	3.9 s
Full forward flow to full reverse flow	5.6 s

Control Options

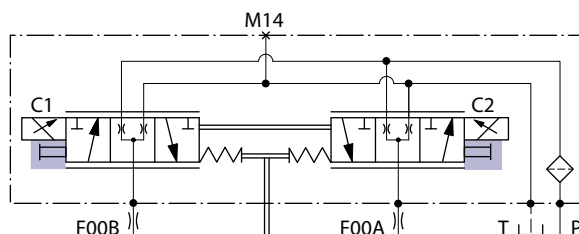
Manual Override (MOR)

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

Control Options

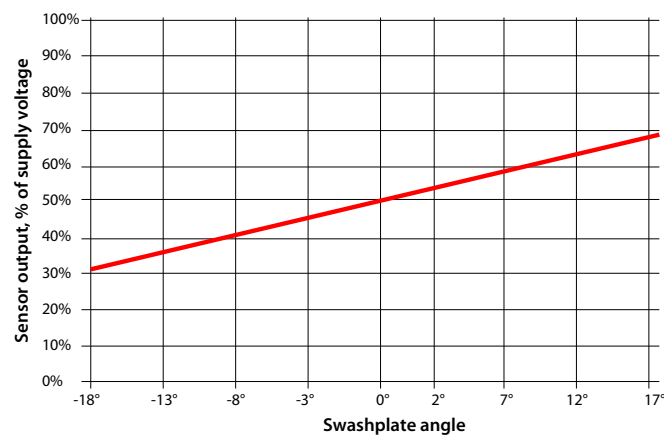
Swashplate angle sensor for EDC controls

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

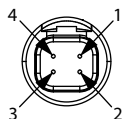
Control Options

Calibration of the sensor output within the software is mandatory. Vehicle neutral thresholds in the software ($\pm 0.5^\circ$) 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.

H1P Swash Plate Angle Sensor Connector

Connector DEUTSCH, 4-pin

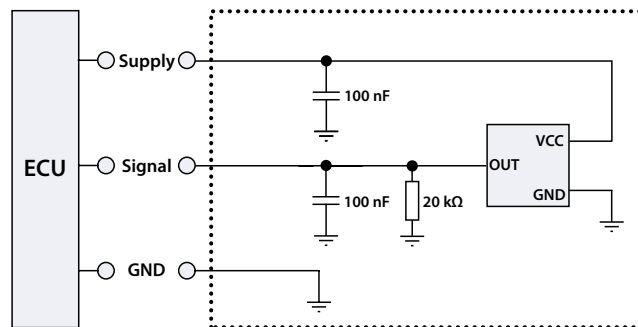


- 1** Ground (GND)
- 2** Not connected
- 3** Output signal 1 (SIG 1)
- 4** Supply (V+)

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

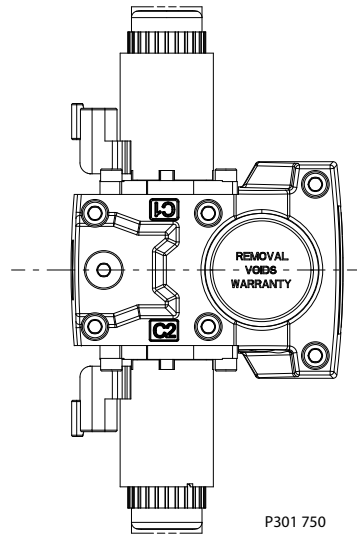


Control Options

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.

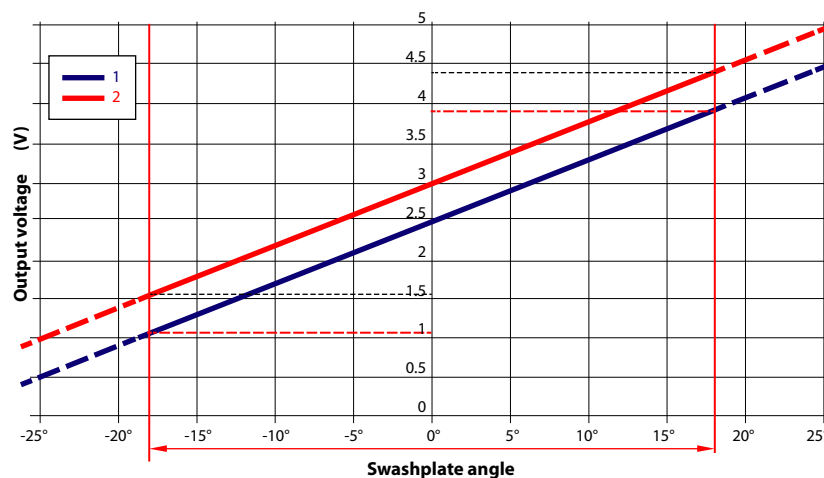
The output signal give a linear output voltage for the various magnet positions in the sensing range.



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:

$$V = \frac{\tan \alpha \cdot V}{\tan 18^\circ} \text{ (cm}^3\text{)}$$

The corresponding flow is:

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

Control Options

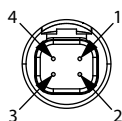
Swash Plate Angle Sensor Parameters (NFPE/AC)

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)

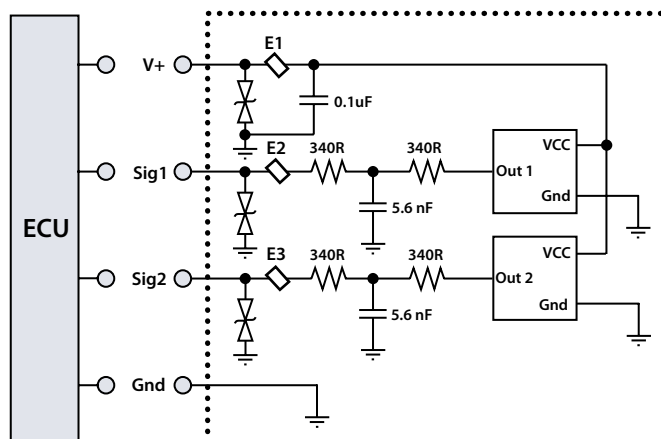
H1P Swash Plate Angle Sensor Connector (NFPE)



- 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.

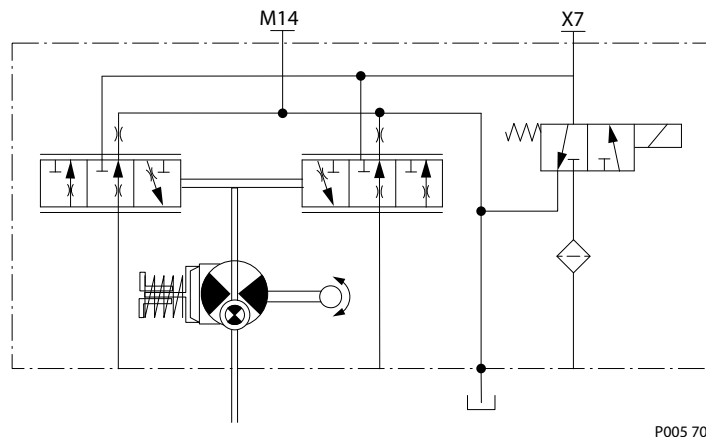
When the solenoid is energized, charge flow and pressure is allowed to reach the pump control. The X7 logic port will also be connected to charge pressure and flow.

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)



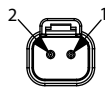
Brake gauge port with MDC

! Caution

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

CCO Connector (MDC)

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

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

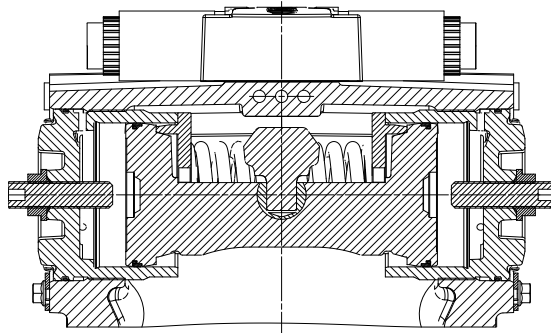
Nominal supply voltage		12 V	24 V
Supply voltage	Maximum	14.6 V	29 V
	Minimum	9.5 V	19 V
Bi-directional diode cut off voltage		28 V	53 V
Nominal coil resistance at 20 °C		10.7 Ω	41.7 Ω
Supply current	Maximum	850 mA	430 mA
	Minimum	580 mA	300 mA
PWM frequency	Range	50 – 200 Hz	
	Preferred	100 Hz	
Electrical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

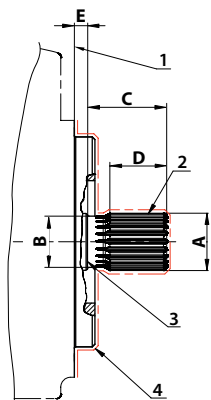
H1P 210/250/280 Displacement Change (approximately)

Parameter	Size 210	Size 250	Size 280
1 turn of displacement limiter screw	17.4 cm ³ [1.06 in ³]	20.6 cm ³ [1.26 in ³]	23.1 cm ³ [1.41 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*, **AX152886482551**, the section "Displacement Limiter Adjustment".

Dimensions and Data

H1P Input Shaft Option G2 (SAE E, 27 teeth)



1. Mounting flange 165 – 4 per ISO 3019-1 (SAE J744–E); surface to be paint free
2. **Spline Data:** 27 teeth, Pressure angle: 30°, Pitch: 8/16, $\text{Ø}42.863$ [1.688]; Fillet root side fit per ANSI B92.1-1996, Class 5
3. Coupling must not protrude beyond this point
4. Shaft to be paint free

Dimensions

A	B	C	D ¹⁾	E
$\text{Ø}44.36 \pm 0.09$ [1.746 ± 0.004]	$\text{Ø}36.4 \pm 0.025$ [1.433 ± 0.01]	67.0 ± 0.8 [2.638 ± 0.03]	42.0 ± 0.5 [1.654 ± 0.02]	8.05 ± 0.8 [0.317 ± 0.03]

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

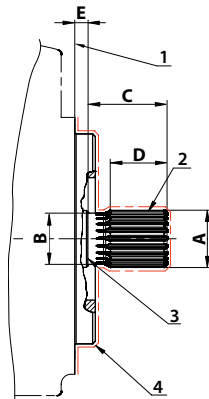
Torque rating

Rated torque	Maximum torque
1615 N·m [14 300 lbf·in]	3000 N·m [26 550 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 Input Shaft Option G3 (SAE E, 13 teeth)



1. Mounting flange 165 – 4 per ISO 3019-1 (SAE J744–E); surface to be paint free
2. **Spline Data:** 13 teeth, Pressure angle: 30°, Pitch: 8/16, $\text{Ø}41.275$ [1.625]; Fillet root side fit per ANSI B92.1-1996, Class 5
3. Coupling must not protrude beyond this point
4. Shaft to be paint free

Dimensions

A	B	C	D ¹⁾	E
$\text{Ø}44.36 \pm 0.09$ [1.746 ± 0.004]	$\text{Ø}36.4 \pm 0.025$ [1.433 ± 0.01]	67.0 ± 0.8 [2.638 ± 0.03]	39.5 [1.555]	8.05 ± 0.8 [0.317 ± 0.03]

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

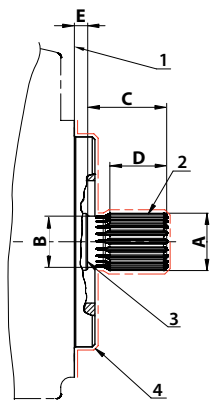
Torque rating

Rated torque	Maximum torque
1442 N·m [12 800 lbf·in]	2206 N·m [19 500 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 Input Shaft Option F8 (SAE E, 17 teeth)



- 1.** Mounting flange 165 – 4 per ISO 3019-1 (SAE J744–E); surface to be paint free
- 2. Spline Data:** 17 teeth, Pressure angle: 30°, Pitch: 8/16, Ø48.26 [1.9]; Fillet root side fit per ANSI B92.1-1996, Class 5
- 3.** Coupling must not protrude beyond this point
- 4.** Shaft to be paint free

Dimensions

A	B	C	D ¹⁾	E
Ø57.15 ±0.09 [2.25 ±0.004]	Ø48.6 ±0.025 [1.913 ±0.01]	80.0 ±0.8 [3.15 ±0.03]	52.5 ±0.5 [2.067 ±0.02]	8.025 ±0.8 [0.36 ±0.03]

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

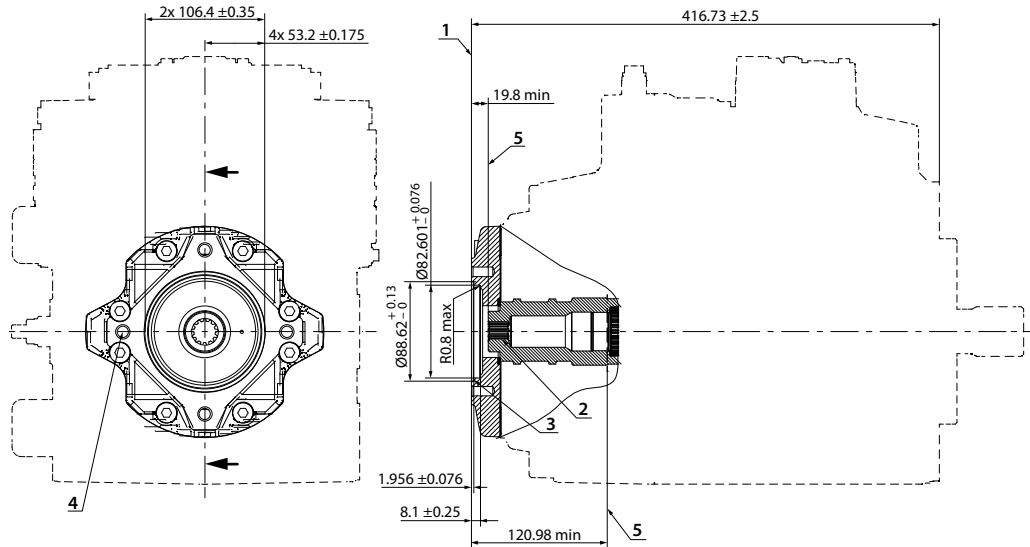
Torque rating

Rated torque	Maximum torque
3226 N·m [28 553 lbf·in]	5946 N·m [52 627 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 Auxiliary Mounting, Option H1 (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 [3.237] ID x 2.62; cross section
4. Thread: M10x1.5-6H; 15 [0.59] min. depth; Recommended screw-in depth 1.5 x thread dia (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum Torque	296 N•m [2620 lbf•in]
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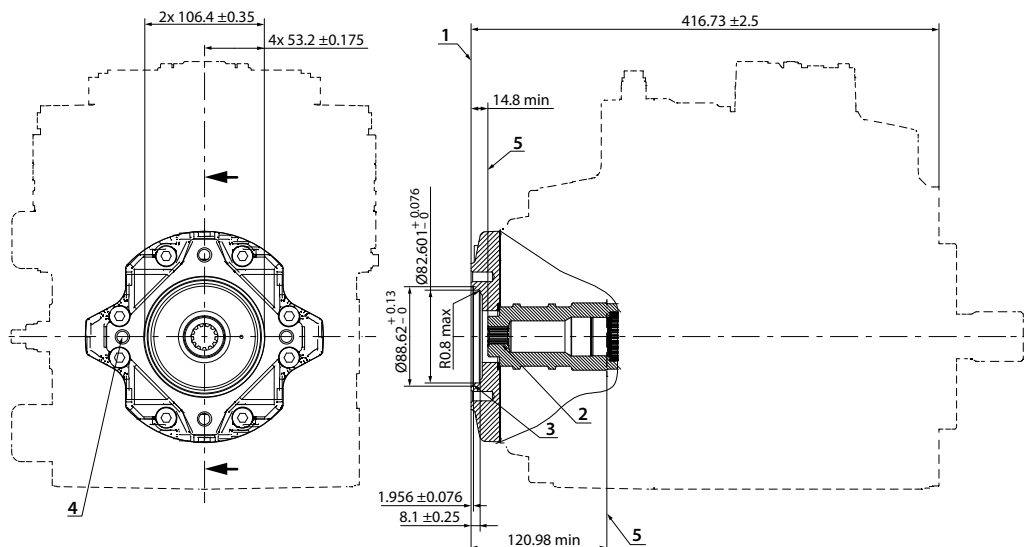
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information, BC152886483968*, the section "Shaft Torque Ratings and Spline Lubrication".

! 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 (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 [3.237] ID x 2.62; cross section
4. Thread: M10x1.5-6H; 15 [0.59] min. depth; Recommended screw-in depth 1.5 x thread dia (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum Torque	162 N·m [1430 lbf·in]
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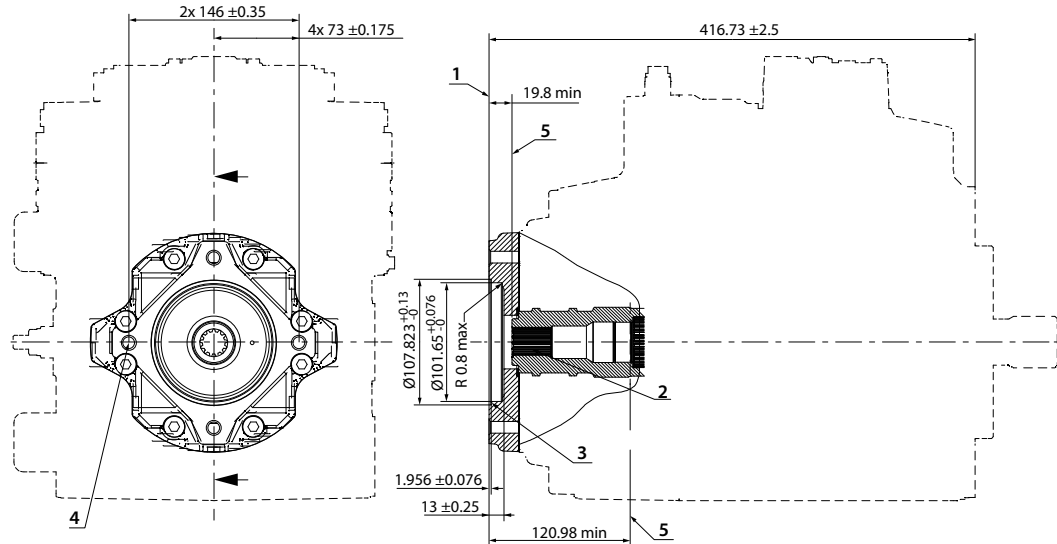
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information*, **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

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 (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 [3.737] ID x 2.62; cross section
4. Thread: M12x1.75-6H; 20 [0.787] min. depth; Recommended screw-in depth 1.5 x thread dia (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum Torque	395 N·m [3500 lbf·in]
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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".

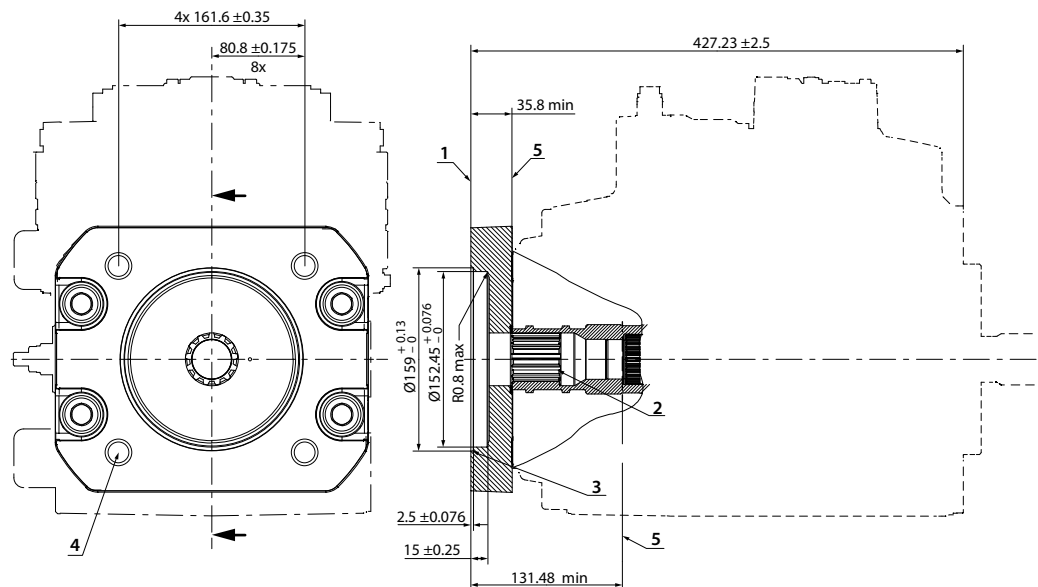
! Caution

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 H4 (SAE D, 13 teeth)

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



1. Auxiliary mounting pad for mating flange 152-4 per ISO 3019-1 (SAE D); Paint free
2. **Spline Data:** 13 teeth, Pressure angle: 30°, Pitch: 8/16, Ø41.275; Fillet root side fit per ANSI B92.1-1996, Class 6; minimum active spline length 12.4 mm
3. O-ring seal required; Ref. Ø150 ID x 3.0; cross section
4. Thread: M20x2.5-6H; 30 min. depth; Recommended screw-in depth 1.5 x thread dia (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum Torque	2206 N·m [19 525 lbf·in]
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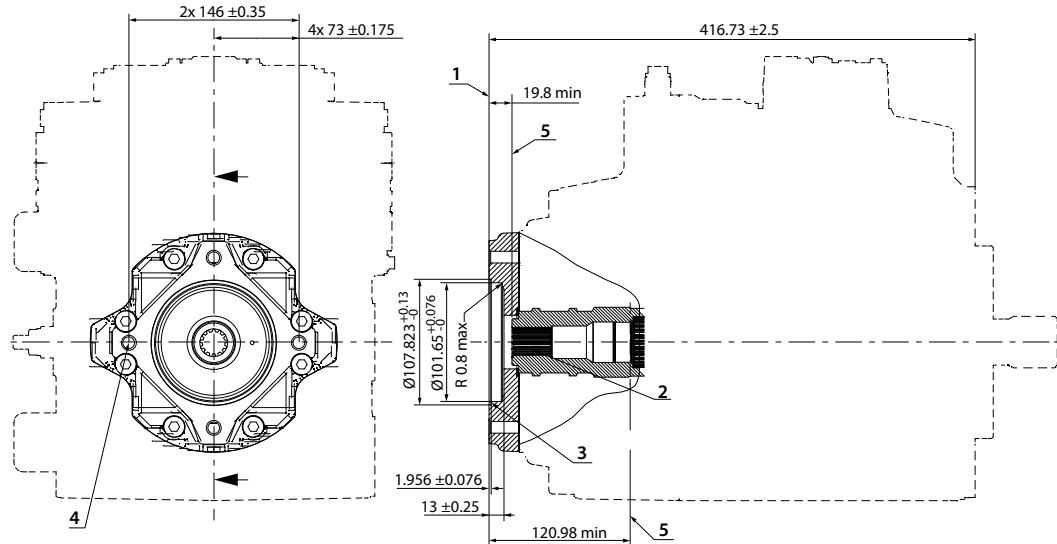
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information*, **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

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 (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 B92.1-1996, Class 6; minimum active spline length 14.3 mm
3. O-ring seal required; Ref. Ø94.92 [3.737] ID x 2.62; cross section
4. Thread: M12x1.75-6H; 20 [0.787] min. depth; Recommended screw-in depth 1.5 x thread dia (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum Torque	693 N•m [6130 lbf•in]
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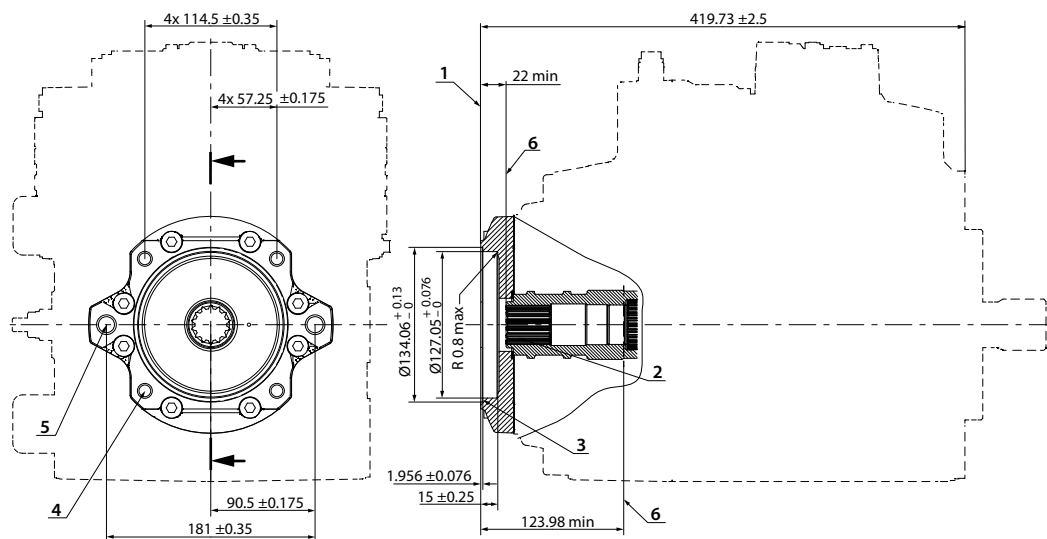
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information, BC152886483968*, the section “Shaft Torque Ratings and Spline Lubrication”.

! 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 (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 17.8 mm
3. O-ring seal required; Ref. Ø120.32 ID x 2.62; cross section
4. Thread: M12x1.75-6H; 21 [0.827] min. depth; Recommended screw-in depth 1.5 x thread dia (4x)
5. Thread: M16x2-6H; 25 [0.984] min. depth; Recommended screw-in depth 1.5 x thread dia (2x)
6. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum torque	816 N·m [7220 lbf·in]
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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”.

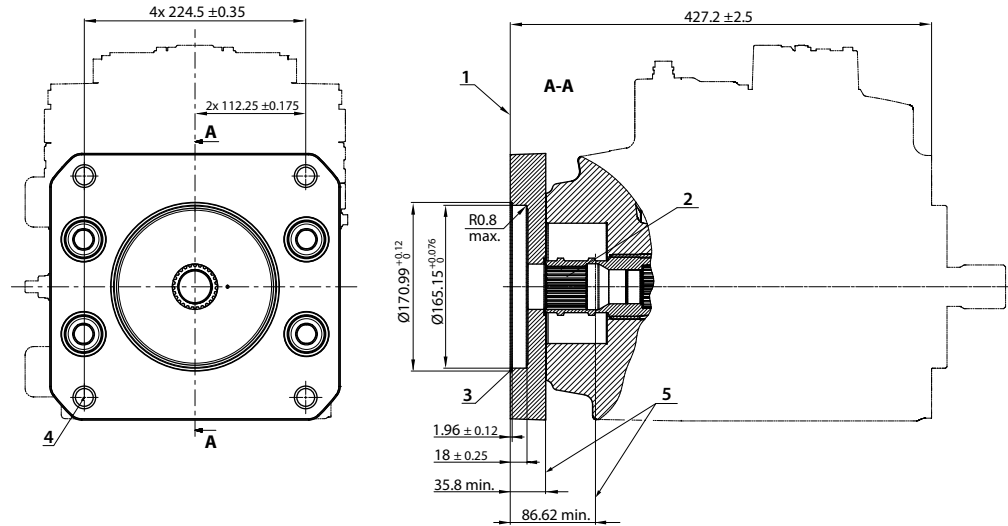
Caution

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 E1 (SAE E, 13 teeth)

Option E1, ISO 3019-1, flange 165-4 (SAE E, 13 teeth)



1. Auxiliary mounting pad for mating flange 165-4 per ISO 3019-1 (SAE E); Paint free
2. **Spline Data:** 13 teeth, Pressure angle: 30°, Pitch: 8/16, Ø41.275; Fillet root side fit per ANSI B92.1-1996, Class 6; minimum active spline length 12.4 mm
3. O-ring seal required; Ref. Ø164.77 ID x 2.62; cross section
4. Thread: M20x2.5-6H; 36 min. depth; Recommended screw-in depth 1.5 x thread dia (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum torque	2206 N·m [19 525 lbf·in]
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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".

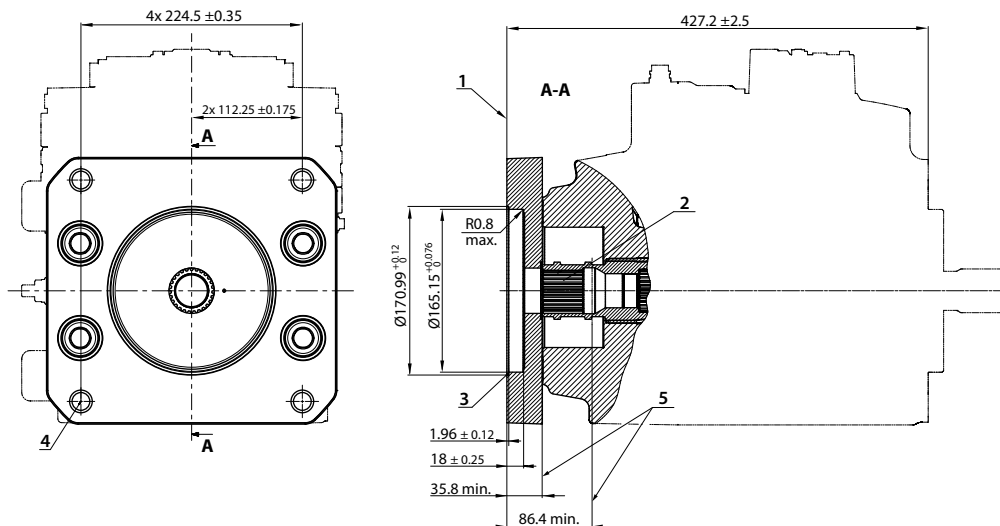
Caution

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 E2 (SAE E, 27 teeth)

Option E2, ISO 3019-1, flange 165-4 (SAE E, 27 teeth)



1. Auxiliary mounting pad for mating flange 165-4 per ISO 3019-1 (SAE E); Paint free
2. **Spline Data:** 27 teeth, Pressure angle: 30°; Pitch: 16/32, Ø42.863; Fillet root side fit per ANSI B92.1b-1996, Class 6; min. active spline length 25.7 mm
3. O-ring seal required; Ref. Ø164.77 ID x 2.62; cross section
4. Thread: M20x2.5-6H; 36 min. depth; Recommended screw-in depth 1.5 x thread dia (4x)
5. Mating shaft and shaft shoulder must not protrude beyond this point

Maximum torque	3360 N·m [29 739 lbf·in]
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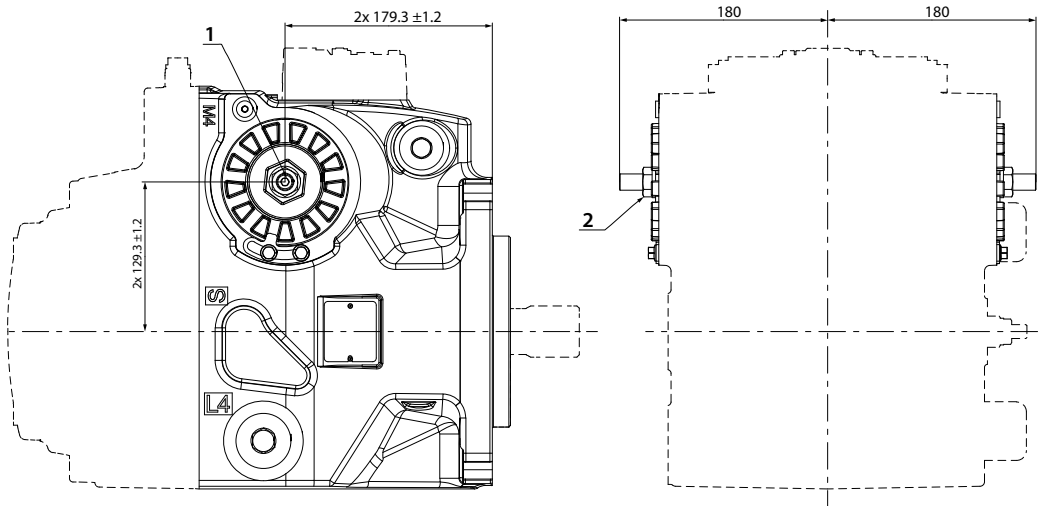
For definitions of maximum and rated torque values, refer to *H1 Axial Piston Pumps Basic Information*, **BC152886483968**, the section "Shaft Torque Ratings and Spline Lubrication".

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



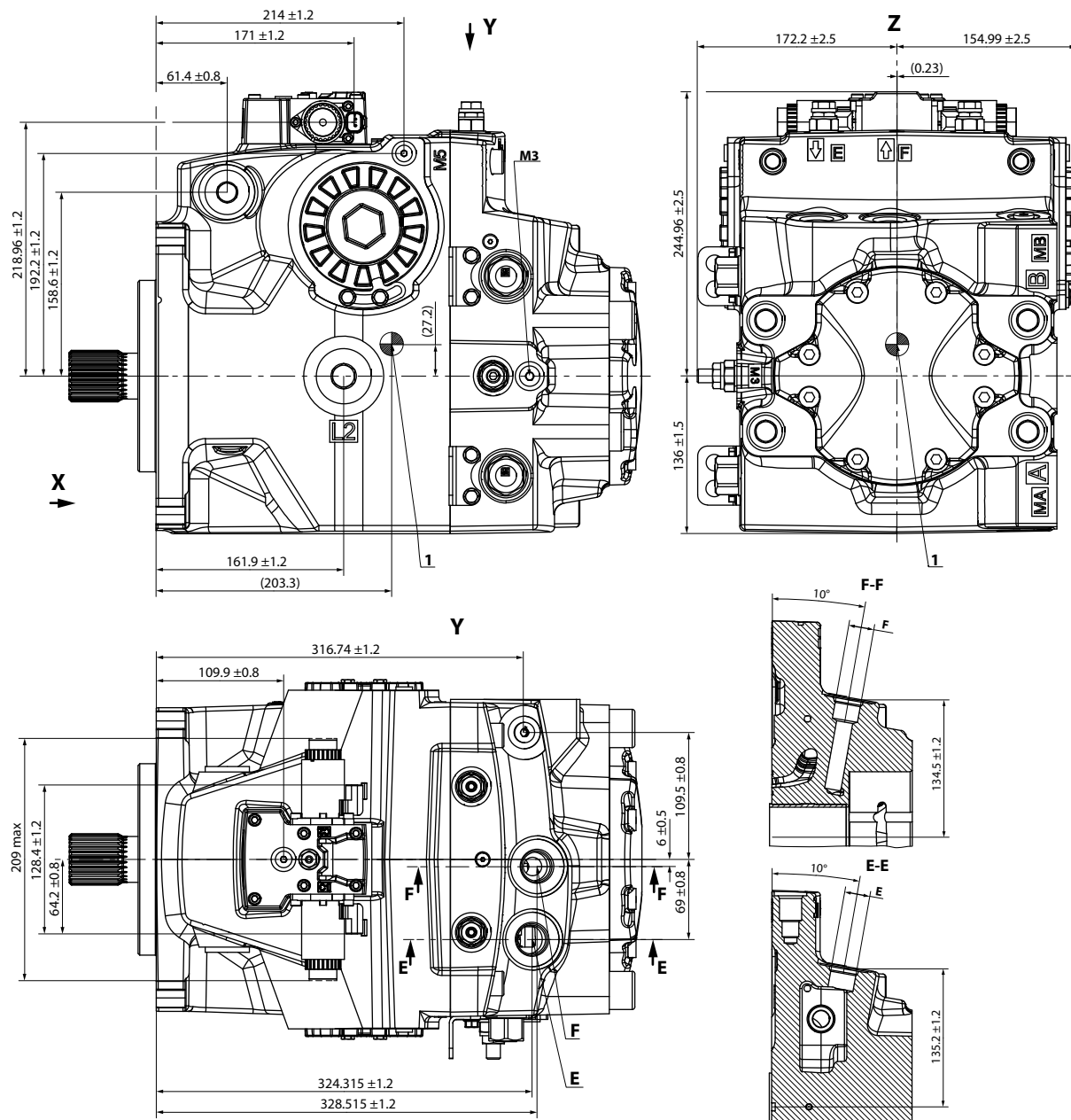
- 1. Displacement limiter screw (2x)
- 2. Displacement limiter seal nut (2x)

Wrench size, torque

Wrench size for DL screw	Wrench size for DL seal nut	Torque
6 internal hex	22 external hex	80 N·m [708 lbf·in]

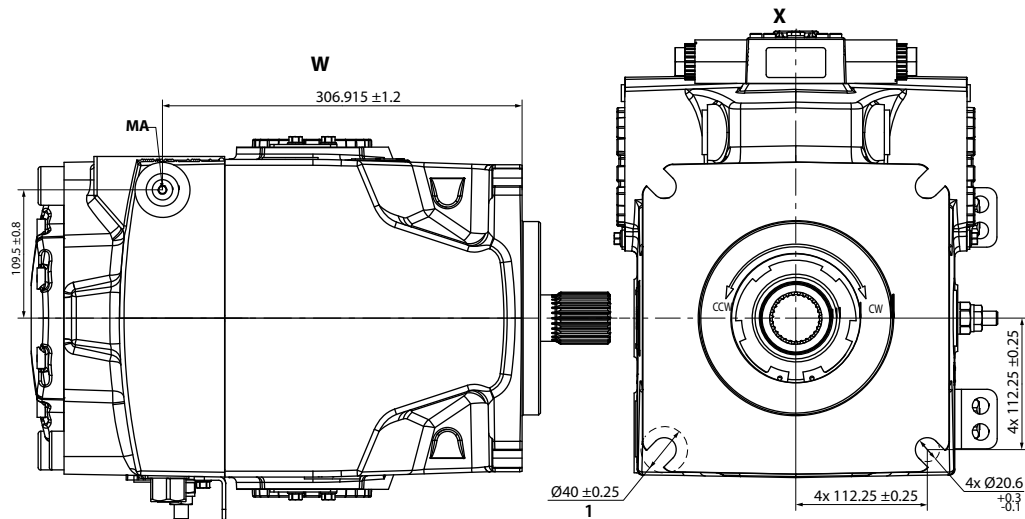
[Please contact Danfoss representative for specific installation drawings.](#)

Dimensions and Data



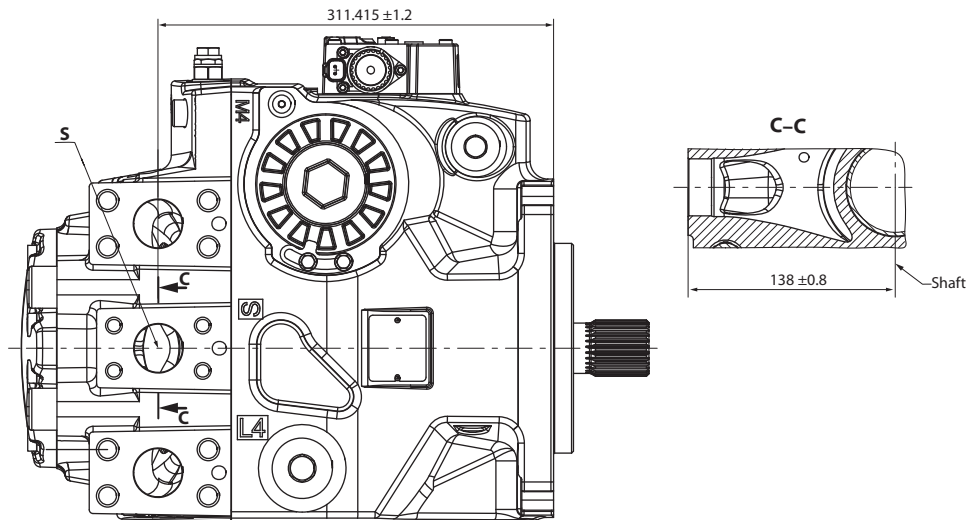
1 — Approximate center of gravity

Dimensions and Data



1 — Other side screw head space

H1P 210/250/280 Suction Filtration Option L

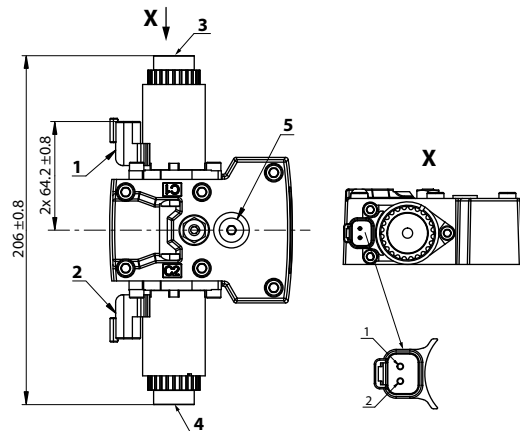


S Charge pump inlet port split flange boss per ISO 6162; M12 x 1.75; 21 min full thread depth

Dimensions and Data

Controls

EDC Options A2 and A3 (12/24 V)



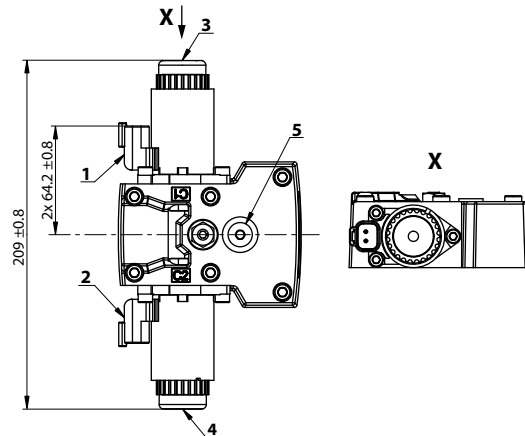
- 1. Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
- 2. Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
- 3. Control Manual OverRide **C1**
- 4. Control Manual OverRide **C2**
- 5. Case gauge port **M14** per ISO 1926-1: 7/16-20

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

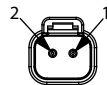
EDC with MOR, Options A4 and A5 (12/24 V)



- 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: $\frac{7}{16}$ -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

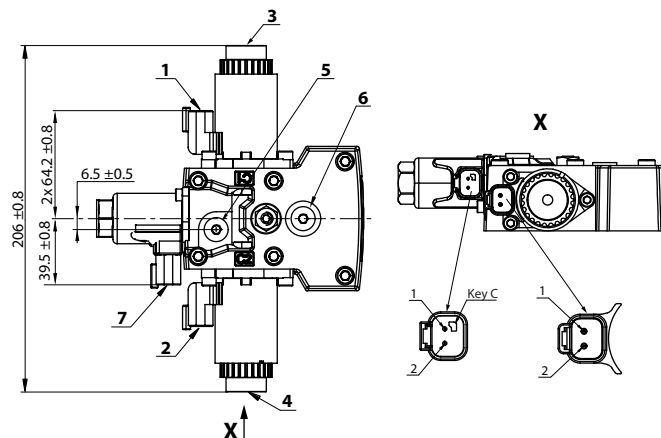


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

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



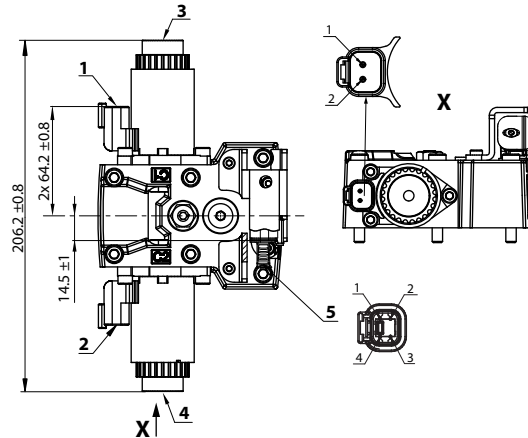
- 1.** Control solenoid connector **C1** DEUTSCH DT04-2P, paint free
- 2.** Control solenoid connector **C2** DEUTSCH DT04-2P, paint free
- 3.** Control Manual OverRide **C1**
- 4.** Control Manual OverRide **C2**
- 5.** Brake gauge port **X7** per ISO 1926-1: $\frac{7}{16}$ -20
- 6.** Case gauge port **M14** per ISO 1926-1: $\frac{7}{16}$ -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.](#)

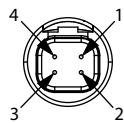
Dimensions and Data

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

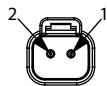
Connector DEUTSCH, 4-pin



4-pin assignment:

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

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

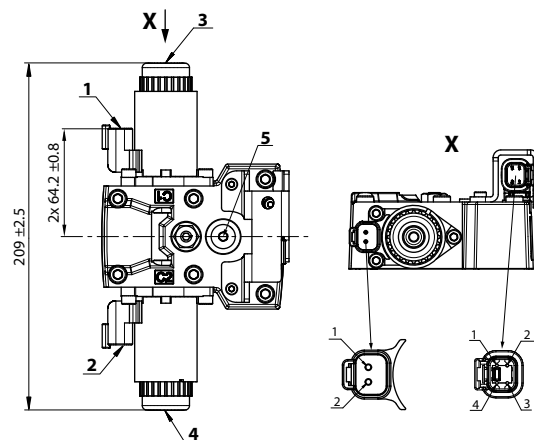


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

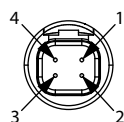
Dimensions and Data

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: $\frac{7}{16}$ -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

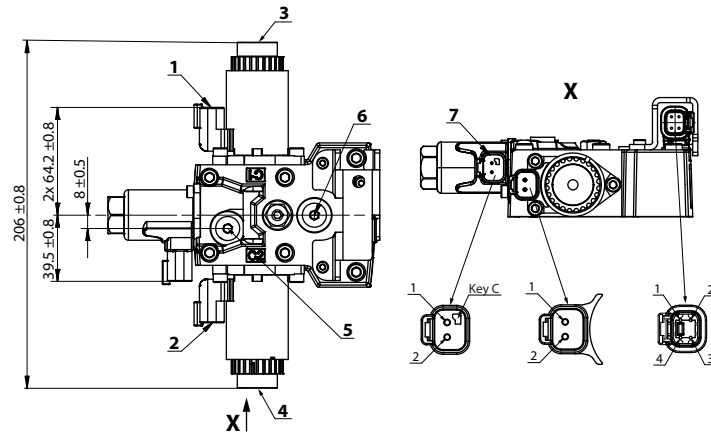


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

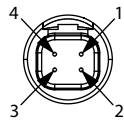
EDC with CCO and ASNSR, Options H8 and H9 (12/24 V)



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.

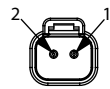
Connector DEUTSCH, 4-pin



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

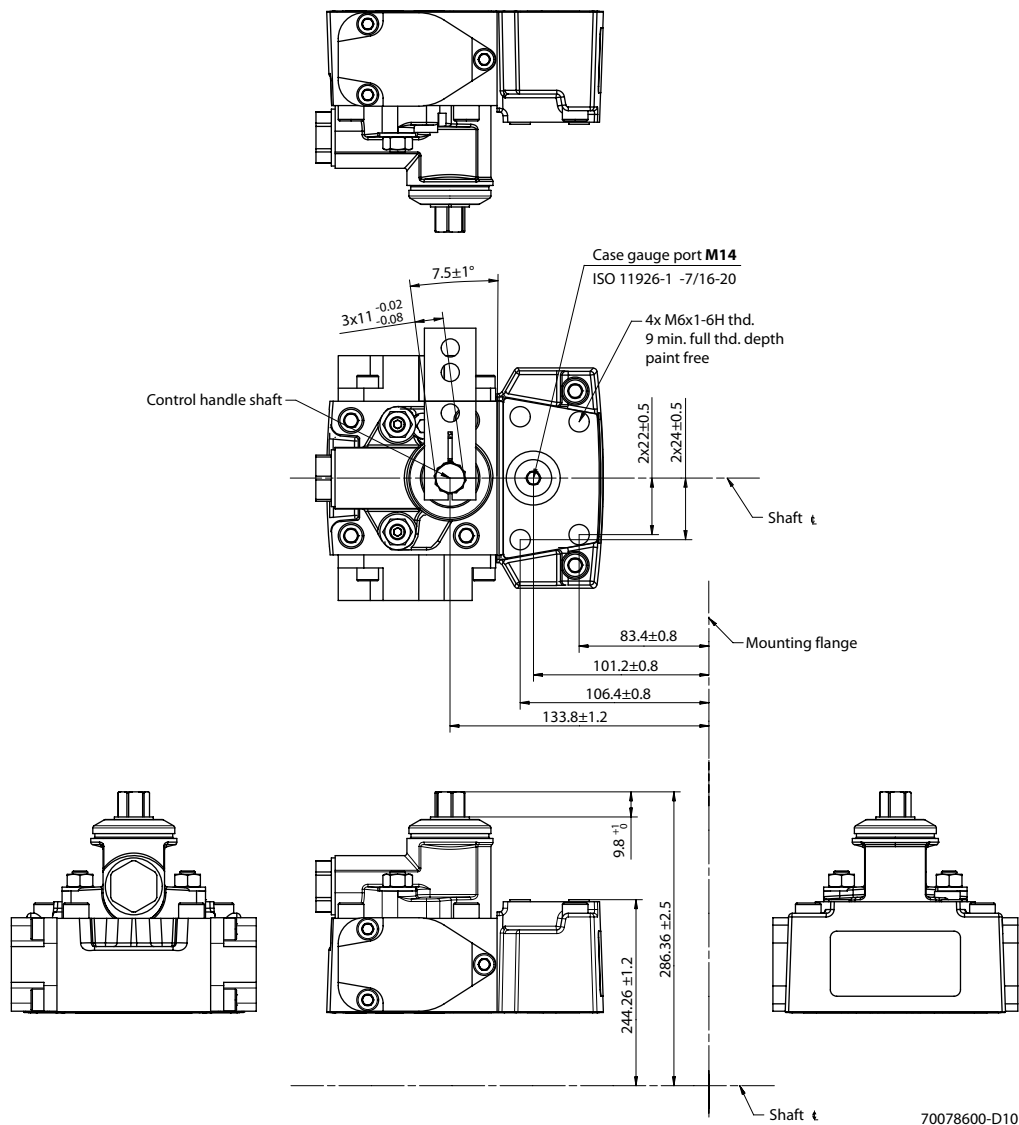


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

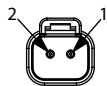
Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

MDC Option: M1



Connector DEUTSCH, 2-pin

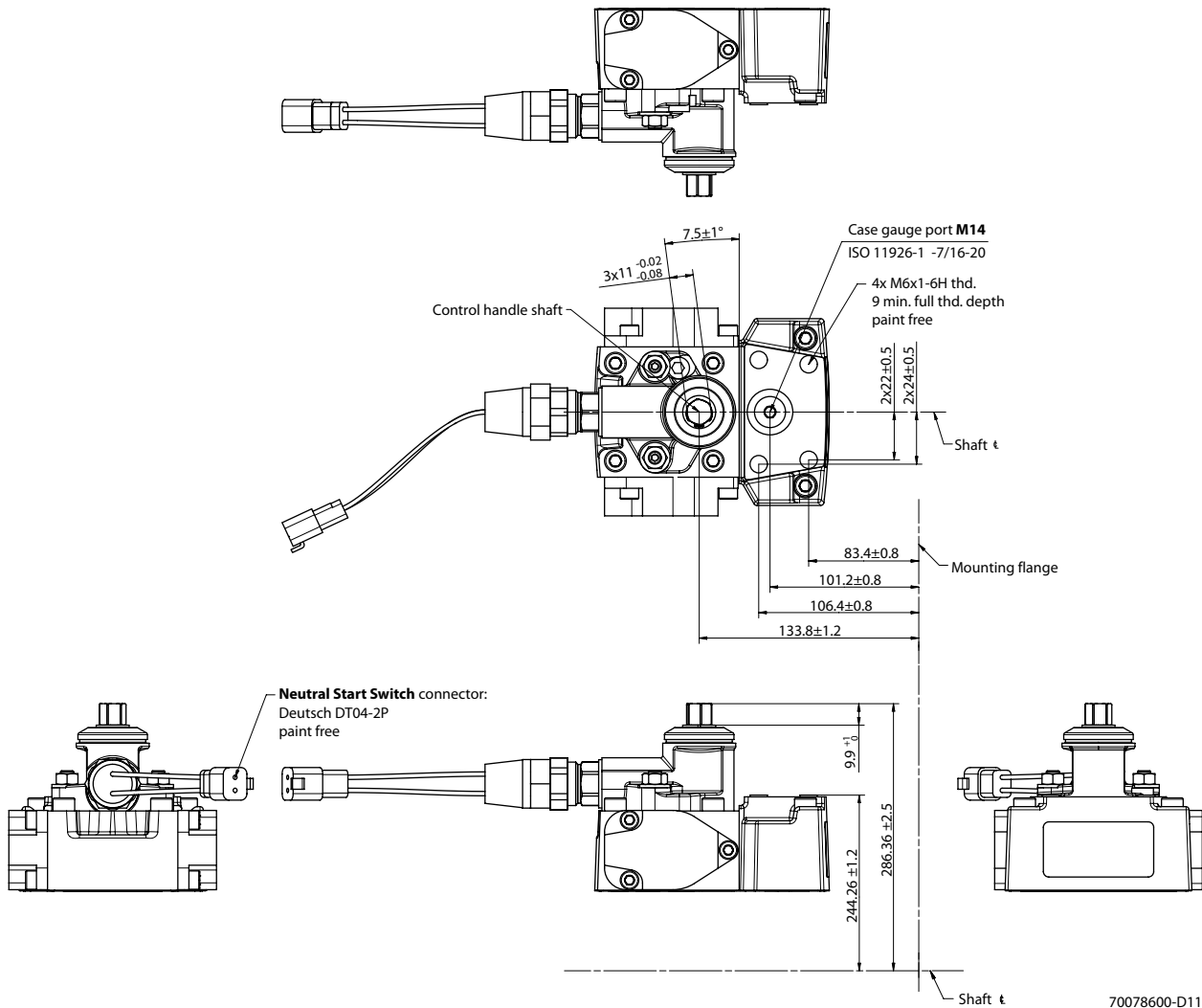


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

MDC with Neutral Start Switch Option: M2



Connector DEUTSCH, 2-pin

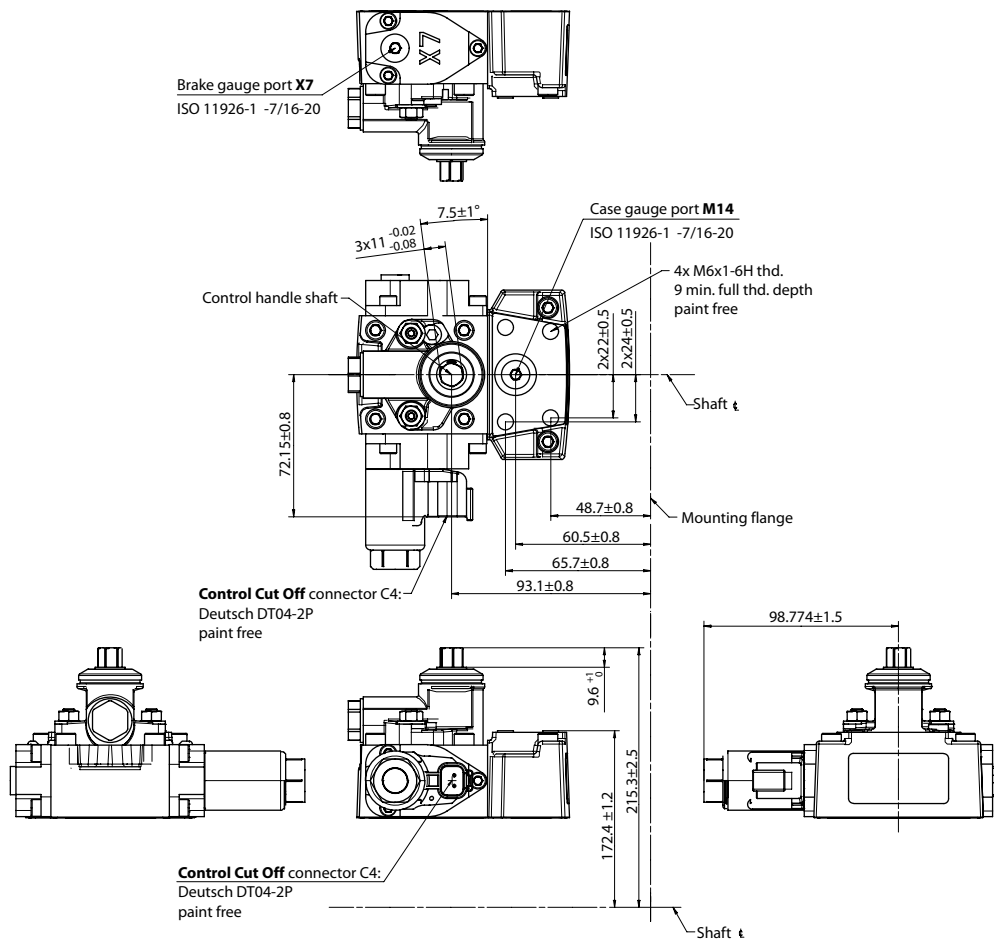


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

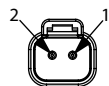
Dimensions and Data

MDC with CCO, Options: M3, M4



060/068_70102283-D12

Connector DEUTSCH, 2-pin

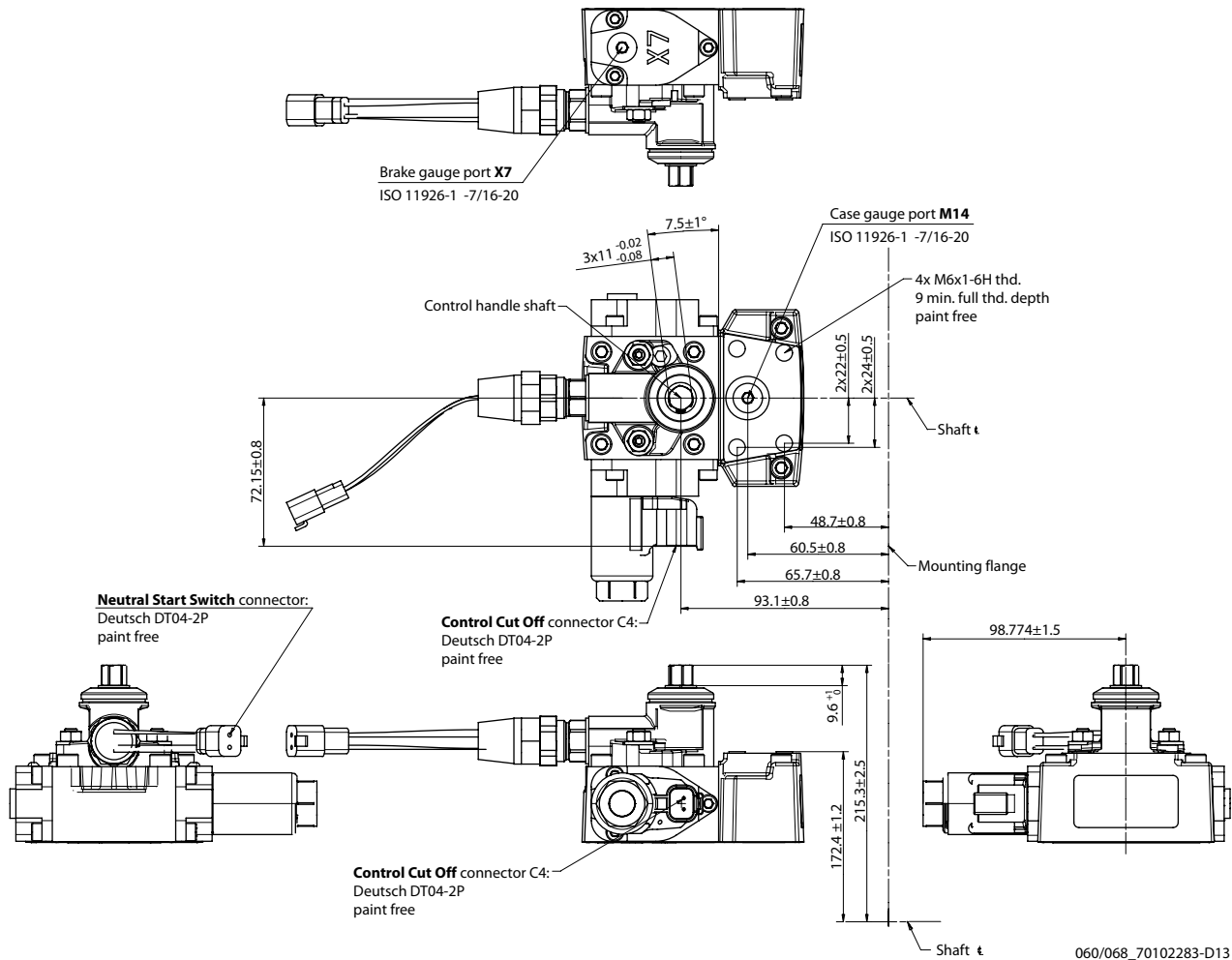


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

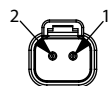
Please contact Danfoss representative for specific installation drawings.

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

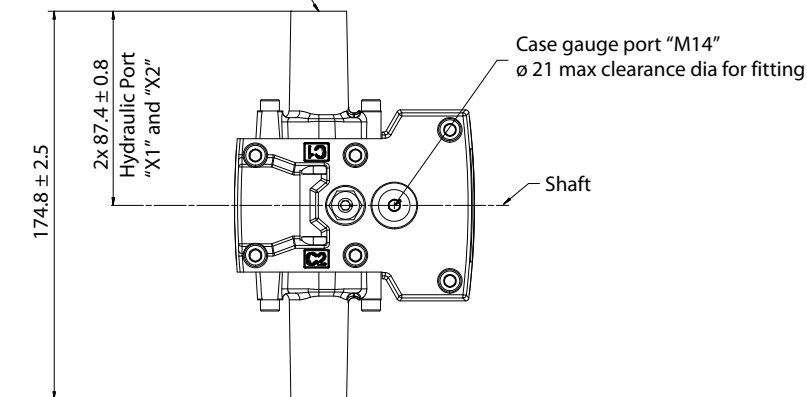
Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

H1P HDC, Options: T1, T2

Dimensions in mm

Hydraulic signal port "X1"
 Inch = ISO 11926-1 9/16-18

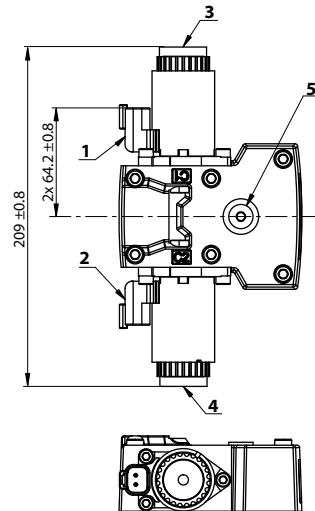


Hydraulic signal port "X2"
 Inch = ISO 11926-1 9/16-18

Dimensions and Data

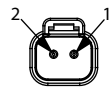
NFPE with MOR, Options: N1, N2 (12/24 V)

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: $\frac{7}{16}$ -20

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



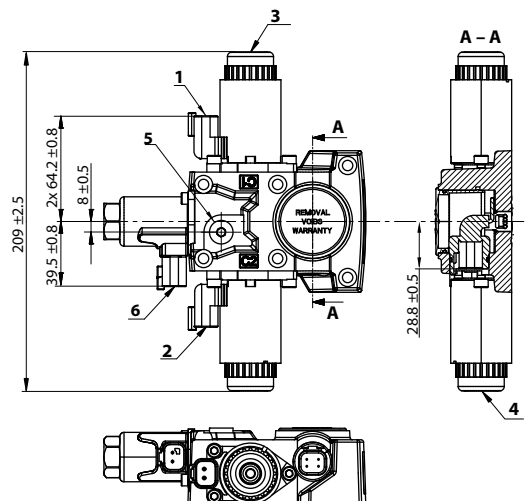
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

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

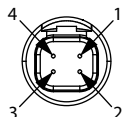
Non-Feedback Proportional Electric control with Control-Cut-Off valve with key C, Manual Over Ride and Angle Sensor, options N3 (12 V) and N4 (24 V).



- 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: $\frac{7}{16}$ -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



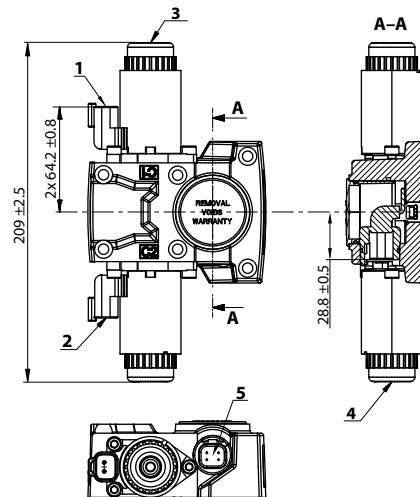
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

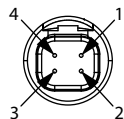
NFPE with MOR and ASNSR, Options: N5, N6 (12/24 V)

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

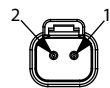
Connector DEUTSCH, 4-pin



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



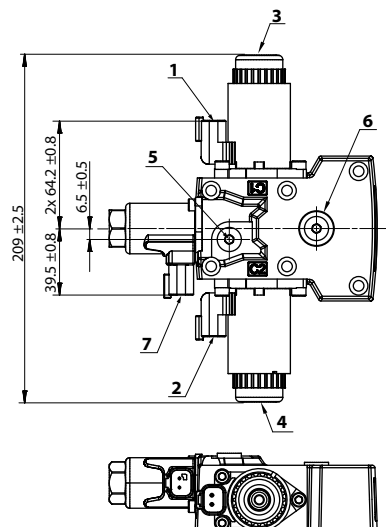
Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions and Data

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

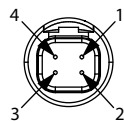
Non Feedback Proportional Electric control with Manual Over Ride and Control-Cut-Off valve key C, options N7 (12 V) and N8 (24 V).



- 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: $\frac{7}{16}$ -20
- 6. Case gauge port **M14** per ISO 1926-1: $\frac{7}{16}$ -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.

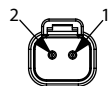
Connector DEUTSCH, 4-pin



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

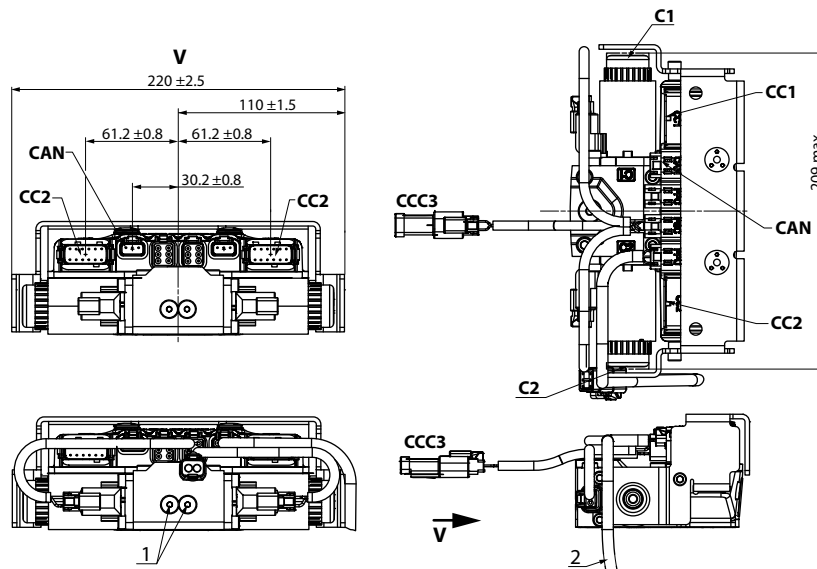


Pin	Assignment	Alternative	Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

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

Dimensions and Data

Automotive control (AC)



- 1 Plug removing can cause contamination issues
- 2 PPU wire harness is factory installed to speed sensor

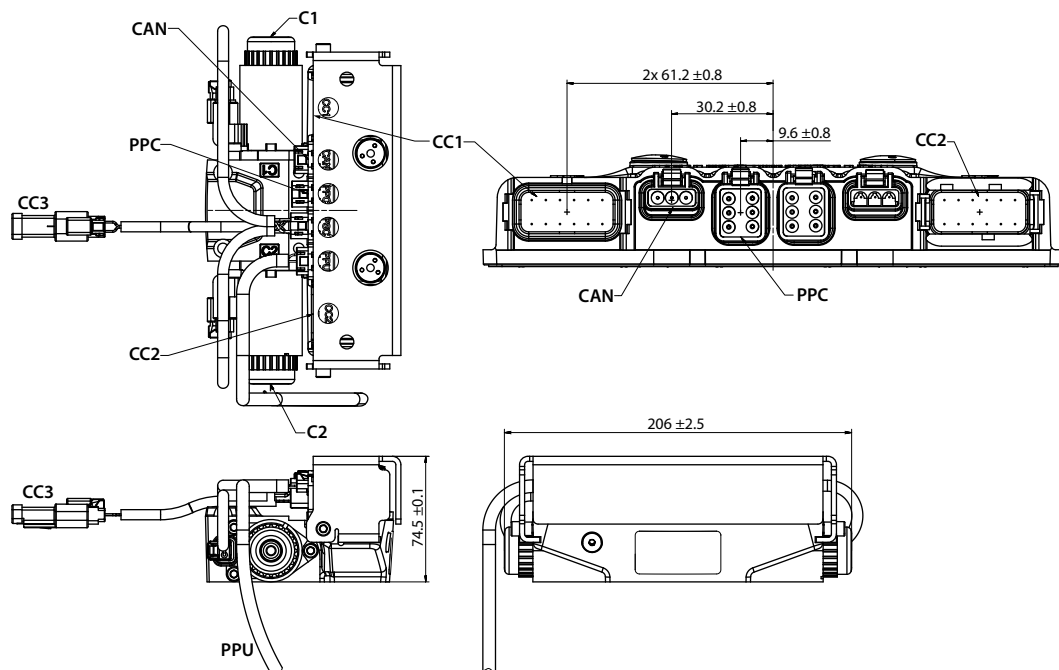
Connectors description

Port	Description
C1 and C2	1. Control manual override C1 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

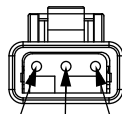
Connector DEUTSCH, 2-pin



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

CAN

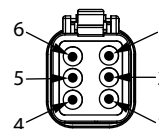
Connector DEUTSCH, 3-pin



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

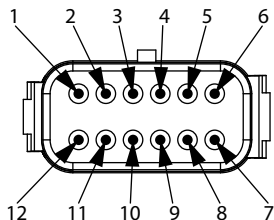
PPC

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)

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- Gear pumps
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