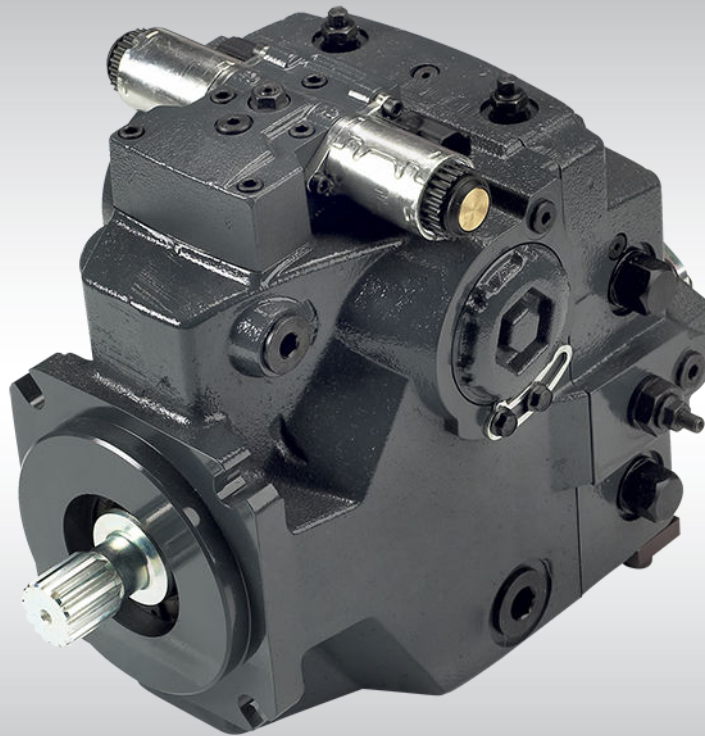




Technical Information

H1 Axial Piston Pump Size 069/078, Single



Technical Information H1 Axial Piston Pump Size 069/078, Single

Revision History*Table of Revisions*

Date	Changed	Rev
Mar 2014	Converted to Danfoss layout - DITA CMS	FA
Apr 2013	FDC option added	EA
Feb 2013	AC section added	DA
Dec 2012	Size 69 added	CA
Jun 2010	New EC directive	BA
Jul 2009	First edition	AA

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Technical Information H1 Axial Piston Pump Size 069/078, Single

Technical specifications

Technical specifications

For definitions of the following specifications, see Basic Information 11062168, Operating parameters.

H1P general specifications

Design	Axial piston pump of cradle swashplate design with variable displacement
Direction of rotation	Clockwise, counterclockwise
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	Will be inlet pressure with internal charge pump. For reference see operating parameter on next page. Will be case pressure with external charge supply. Please verify mating pump shaft seal capability.

Technical data H1P 069/078

Feature	Unit	Size 069	Size 078
Displacement*	cm ³ [in ³]	69.2 [4.22]	78.1 [4.77]
Flow at rated (continuous) speed*	l/min [US gal/min]	243 [53.5]	273 [72]
Torque at maximum displacement (theoretical)*	N·m/bar [lbf·in/1000psi]	1.1 [672]	1.24 [758]
Mass moment of inertia of rotating components	kg·m ² [slug·ft ²]	0.0077 [0.0057]	0.0094 [0.00693]
Mass [weight] dry (without charge pump or auxiliary mounting flange)	kg [lb]	56 [123]	
Oil volume	liter [US gal]	2.00 [0.5]	
Mounting flange	ISO 3019-1 flange 127-4 (SAE C)		
Input shaft outer diameter, splines and tapered shafts	ISO 3019-1, outer dia 32 mm - 4 (SAE C, 14 teeth) ISO 3019-1, outer dia 35 mm - 4 (SAE C, 21 teeth) ISO 3019-1, outer dia 38 mm - 4 (SAE C-C, 23 teeth) Conical keyed shaft end similar to ISO 3019-1 code 38-3, taper 1:8		
Auxiliary mounting flange with metric fasteners, shaft outer diameter and splines	ISO 3019-1, flange 82 - 2, outer dia 16 mm - 4 (SAE A, 9 teeth) ISO 3019-1, flange 82 - 2, outer dia 19 mm - 4 (SAE A, 11 teeth) ISO 3019-1, flange 101 - 2, outer dia 22 mm - 4 (SAE B, 13 teeth) ISO 3019-1, flange 101 - 2, outer dia 25 mm - 4 (SAE B-B, 15 teeth) ISO 3019-1, flange 127 - 4, outer dia 32 mm - 4 (SAE C, 14 teeth)		
Suction port	Port ISO 11926-1 – 1 5/8 -12 (SAE O-ring boss)		
Main port configuration	Ø25.4 - 450 bar split flange boss per ISO 6162, M12x1.75		
Case drain ports L2, L4 (SAE O-ring boss)	Port ISO 11926-1 – 1 1/16 -12 (SAE O-ring boss)		
Other ports	SAE O-ring boss. See installation drawings at the back of this manual.		
Customer interface threads	Metric fasteners		

Operating parameters H1P 069/078

Feature	Unit	Size 069	Size 078
Input speed Minimum for <i>internal</i> charge supply at minimum charge pressure. Performance (pressure and displacement) may be limited due to limited control pressure	min ⁻¹ (rpm)	500	

Technical Information H1 Axial Piston Pump Size 069/078, Single

Technical specifications

Feature		Unit	Size 069	Size 078
	Minimum for <i>external</i> charge supply at minimum charge pressure. Full performance (pressure and displacement) possible at minimum charge and control pressure supply		500	
	Minimum for full performance (pressure and displacement) for <i>internal</i> charge supply at minimum charge and control pressure		1200	
	Rated		3500	
	Maximum		4000	
System pressure	Maximum working pressure	bar [psi]	450 [6528]	
	Maximum pressure		480 [6960]	
	Maximum low loop		45 [650]	
	Minimum low loop pressure		10 [145]	
Charge pressure	Minimum	bar [psi]	16 [232]	
	Maximum		35 [508]	
Control pressure	Minimum (at corner power for EDC and FNR)	bar [psi]	14 [203]	
	Minimum (at corner power for NFPE)		22 [319]	
	Maximum		40 [580]	
Charge pump inlet pressure	Rated	bar (absolute) [in Hg vacuum]	0.7 [9]	
	Minimum (cold start)		0.2 [24]	
	Maximum	bar [psi]	4.0 [58]	
Case pressure	Rated	bar [psi]	3.0 [44]	
	Maximum		5.0 [73]	
Lip seal external pressure	Maximum	bar [psi]	0.4 [5.8]	

H1P fluid specifications

Feature		Unit	
Viscosity	Intermittent ¹⁾	mm ² /s [SUS]	5 [42]
	Minimum		7 [49]
	Recommended range		12-80 [66-370]
	Maximum		1600 [7500]
Temperature range ²⁾	Minimum (cold start) ³⁾	°C [°F]	-40 [-40]
	Recommended range		60-85 [140-185]
	Rated		104 [220]
	Maximum intermittent ¹⁾		115 [240]
Filtration (recommended minimum)	Cleanliness per ISO 4406		22/18/13
	Efficiency (charge pressure filtration)	β-ratio	β ₁₅₋₂₀ = 75 (β ₁₀ ≥ 10)
	Efficiency (suction and return line filtration)		β ₃₅₋₄₅ = 75 (β ₁₀ ≥ 2)
	Recommended inlet screen mesh size	μm	100 – 125

¹⁾ Intermittent = Short term t < 1min per incident and not exceeding 2 % of duty cycle based load-life
²⁾ At the hottest point, normally case drain port
³⁾ Cold start = Short term t < 3min, p ≤ 50 bar [725 psi], n ≤ 1000 min⁻¹(rpm)

General technical specifications

Shaft loads

External radial shaft loads

H1 pumps are designed with bearings that can accept some external radial loads.

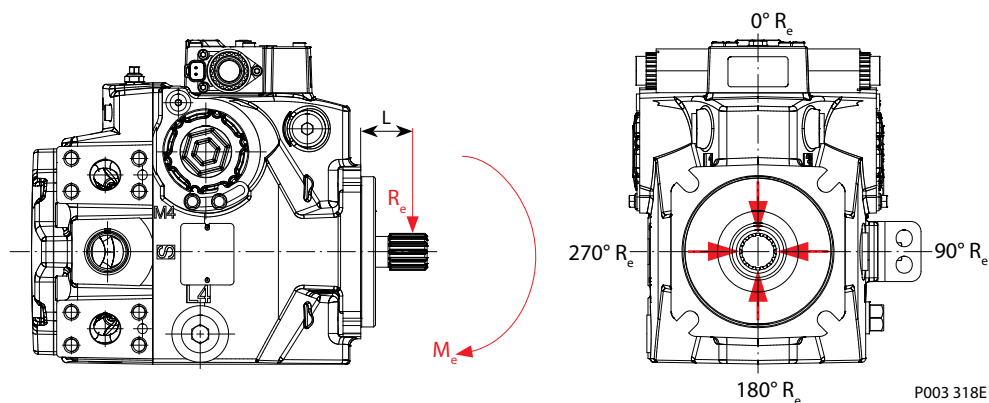
The external radial shaft load limits are a function of the load position and orientation, and the operating conditions of the unit. External radial shaft loads impact lifetime.

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. It may be determined using the following table and formula.

$$R_e = M_e / L$$

Radial load position



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.

Bearing life H1P 069/078

Maximum external shaft load based on shaft deflection

	Unit	Size 069/078
External radial moment – M_e	Nm [lbf·in]	109 [965]

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 H1P 069/078

H1 single pump front flange load

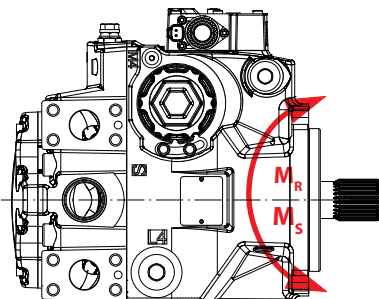
The moments shown below apply for control orientation top or side (see table and figures).

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General technical specifications

Mounting flange load

	Unit	Size 069/078
Rated moment – M_R	Nm [lbf·in]	3700 [32 750]
Shock load moment – M_S		7900 [69 920]



P001 916

For calculation details refer to *H1 Pump Basic Information Manual 11062168*, section Mounting Flange Loads.

Technical Information H1 Axial Piston Pump Size 069/078, Single

Model code

Model code H1P 069/078

	A	B	D	F	E	G	H	J	K	M	N	S	T	V	W	X	Y
H1 P																	

Displacement

069	69.2 cm ³ [4.22 in ³]
078	78.1 cm ³ [4.77 in ³]

A - Rotation

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

B - Product version

A	Revision code
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D - Control

A2	Electric Displacement Control (EDC) 12V, Deutsch connector
A3	Electric Displacement Control (EDC) 24V, Deutsch connector
A4	Electric Displacement Control (EDC) 12V, Deutsch connector, Manual override
A5	Electric Displacement Control (EDC) 24V, Deutsch connector, Manual override
A9	Forward-Neutral-Reverse (FNR) 12V, Deutsch connector, Manual override
B1	Forward-Neutral-Reverse (FNR) 24V, Deutsch connector, Manual override
A8	Non Feedback Proportional Electric (NFPE) 12V, Deutsch connector, Manual override (align with option E: Displacement Limiters & option W: Special Hardware)
B8	Non Feedback Proportional Electric (NFPE) 24V, Deutsch connector, Manual override (align with option E: Displacement Limiters & option W: Special Hardware)
A7	AC-1 (Automotive), 12V, Manual Override (align with option E: Displacement Limiters & option W: Special Hardware, Y: Special settings)
C2	AC-1 (Automotive), 24V, Manual Override (align with option E: Displacement Limiters & option W: Special Hardware, Y: Special settings)
B7	AC-2 (Automotive), 12V, with Swash Plate Angle Sensor and Manual Override (align with option E: Displacement Limiters & option W: Special Hardware, Y: Special settings)
C3	AC-2 (Automotive), 24V, with Swash Plate Angle Sensor and Manual Override (align with option E: Displacement Limiters & option W: Special Hardware, Y: Special settings)
F1	Fan Drive Control (FDC), 12 V, Deutsch connector align with option E: Displacement Limiters, option F: Orifices, option N+M: Overpressure protection type and setting, & option W: Special Hardware)
F2	Fan Drive Control (FDC), 24 V, Deutsch connector (align with option E: Displacement Limiters, option F: Orifices, option N+M: Overpressure protection type and setting, & option W: Special Hardware)

F - Orifices

C1	Orifices, 0.8 mm in servo supply 1 and 2, recommended for propel applications
C2	Orifices, 1.3 mm in servo supply 1 and 2 (Standard), recommended for propel applications
C3	No orifice, recommended for non-propel applications

Technical Information H1 Axial Piston Pump Size 069/078, Single

Model code

	A	B	D	F	E	G	H	J	K	M	N	S	T	V	W	X	Y
H1 P																	

E - Displacement limiters

N	None
C	No limiters, with nested springs (required for NFPE) (align with option Y: Settings for adjustment, if applicable)
B	Adjustable externally
D	Adjustable externally with nested springs, required for NFPE (align with option Y: Settings for adjustment, if applicable)

G - Endcap options

	Twin port, ISO 6162 Split flange ports					
Match with below options (K)	Auxiliary mounting pad None, ISO 3019-1, flange 82 - 2 (SAE A, 9 and 11 teeth) ISO 3019-1, flange 101 - 2 (SAE B, 13 teeth) ISO 3019-1, flange 101 - 2 (SAE B-B, 15 teeth)			Auxiliary mounting pad ISO 3019-1, flange 127 - 4 (SAE C, 14 teeth)		
Match with below options (T)	Suction filtration	Integral full charge flow filtration	Remote or external charge supply for full charge flow filtration	Suction filtration	Integral full charge flow filtration	Remote or external charge supply for full charge flow filtration
D3		X				
F4					X	
D6	X					
F5						X
D8			X			
F6				X		

H - Mounting

H	ISO 3019-1, flange 127 - 4 (SAE C)
K	ISO 3019-1, flange 127 - 4 (SAE C), 4 Bolt and speed sensor

J - Input shaft

G1	ISO 3019-1, outer dia 32 mm - 4 (SAE C, 14 teeth splined shaft 12/24 pitch)
F1	ISO 3019-1, outer dia 35 mm - 4 (SAE C, 21 teeth splined shaft 16/32 pitch)
G9	ISO 3019-1, outer dia 38 mm - 4 (SAE C-C, 23 teeth splined shaft 16/32 pitch)
F4	Conical keyed shaft end similar to ISO 3019-1 code 38-3, taper 1:8 (key not supplied with pump)

K - Auxiliary mounting pad (align with option G: Endcap selection)

NN	None	
H2	ISO 3019-1, flange 82 - 2, outer dia 16 mm - 4 (SAE A, 9 teeth 16/32 coupling)	Shipping cover
H1	ISO 3019-1, flange 82 - 2, outer dia 19 mm - 4 (SAE A, 11 teeth 16/32 coupling)	
H3	ISO 3019-1, flange 101 - 2, outer dia 22 mm - 4 (SAE B, 13 teeth 16/32 coupling)	
H5	ISO 3019-1, flange 101 - 2, outer dia 25 mm - 4 (SAE B-B, 15 teeth 16/32 coupling)	
H6	ISO 3019-1, flange 127 - 4, outer dia 32 mm - 4 (SAE C, 14 teeth 12/24 coupling)	

Technical Information H1 Axial Piston Pump Size 069/078, Single

Model code

	A	B	D	F	E	G	H	J	K	M	N	S	T	V	W	X	Y
H1 P																	

M Overpressure protection type and setting side "A" **

N Overpressure protection type and setting side "B" **

** Pressure protection type must be the same for side "A" and "B"

J - Input shaft

L	High pressure relief valve + pressure limiters with bypass	
	K	High pressure relief valve with bypass (no pressure limiters)
L15	K15	150 bar [2175 psi]
L18	K18	180 bar [2610 psi]
L20	K20	200 bar [2900 psi]
L23	K23	230 bar [3336 psi]
L25	K25	250 bar [3630 psi]
L28	K28	280 bar [4061 psi]
L30	K30	300 bar [4350 psi]
L33	K33	330 bar [4786 psi]
L35	K35	350 bar [5080 psi]
L38	K38	380 bar [5510 psi]
L40	K40	400 bar [5800 psi]
L42	K42	420 bar [6090 psi]
L45	K45	450 bar [6527 psi]
Contact factory for pressures not shown or for applied pressure above maximum working pressure (see System Pressure page 5)		

Overpressure protection type and setting for FDC-controls

F01	Pressure setting for FDC: PL: 150 bar [2175 psi]; HPRV; 250 bar [3630 psi]
F02	Pressure setting for FDC: PL: 150 bar [2175 psi]; HPRV; 300 bar [4350 psi]
F03	Pressure setting for FDC: PL: 150 bar [2175 psi]; HPRV; 350 bar [5080 psi]
F04	Pressure setting for FDC: PL: 150 bar [2175 psi]; HPRV; 400 bar [5800 psi]

S - Charge pump

F	14 cm ³ /rev [0.85 in ³ /rev]
C	17 cm ³ /rev [1.03 in ³ /rev]
N	No charge pump, external charge supply, (align with Option T: Filtration Options, option E)

Technical Information H1 Axial Piston Pump Size 069/078, Single

Model code

	A	B	D	F	E	G	H	J	K	M	N	S	T	V	W	X	Y
H1 P																	

T - Filtration options (align with option G: Endcap selection)

L	Suction filtration (see basic drawings)
M	Integral full charge flow filtration with bypass and bypass sensor, medium filter length, order number 11004918
P	Remote full charge flow filtration (see endcap drawings)
E	External charge flow filtration (see endcap drawings), (align with option S: Charge pump, option N)

V - Charge pressure relief setting

20	20 bar [290 psi]
24	24 bar [348 psi]
30	30 bar [435 psi]

W - Special hardware features

PN	None
P1	NFPE valve plate (align with option D: Control Selection and option E: Displacement Limiters)

X - Paint and nametag

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

Y - Special settings

NNN	None	
D3E	AC-1, control, System E: Functional basis, Motor Speed Sensor, CAN J1939 in/out, ECO Fuel Saving Mode, without Customer Files	control option A7 12V
D3F	AC-1, control, System F: Functional basis, Motor Speed Sensor, CAN J1939 in/out without Customer Files	
D3H	AC-1, control, System H: Functional basis, Motor Speed Sensor, CAN J1939 out, SIL2 certifiable without Customer Files	
D4E	AC-1, control, System E: Functional basis, Motor Speed Sensor, CAN J1939 in/out, ECO Fuel Saving Mode, without Customer Files	control option C2 24V
D4F	AC-1, control, System F: Functional basis, Motor Speed Sensor, CAN J1939 in/out without Customer Files	
D4H	AC-1, control, System H: Functional basis, Motor Speed Sensor, CAN J1939 out, SIL2 certifiable without Customer Files	
D5F	AC-2 control with Swash Plate Angle Sensor, System F: Functional basis, Motor Speed Sensor, CAN J1939 in/out without Customer Files	control option B7 12V
D5H	AC-2 control with Swash Plate Angle Sensor, System H: Functional basis, Motor Speed Sensor, CAN J1939 out, SIL2 certifiable without Customer Files	
D6F	AC-2 control with Swash Plate Angle Sensor, System F: Functional basis, Motor Speed Sensor, CAN J1939 in/out without Customer Files	control option C3 24V
D6H	AC-2 control with Swash Plate Angle Sensor, System H: Functional basis, Motor Speed Sensor, CAN J1939 out, SIL2 certifiable without Customer Files	

Control options

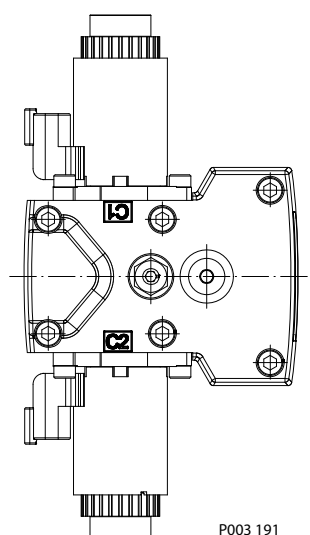
Electrical Displacement Control (EDC) options A2 (12 V)/A3 (24 V)

EDC principle

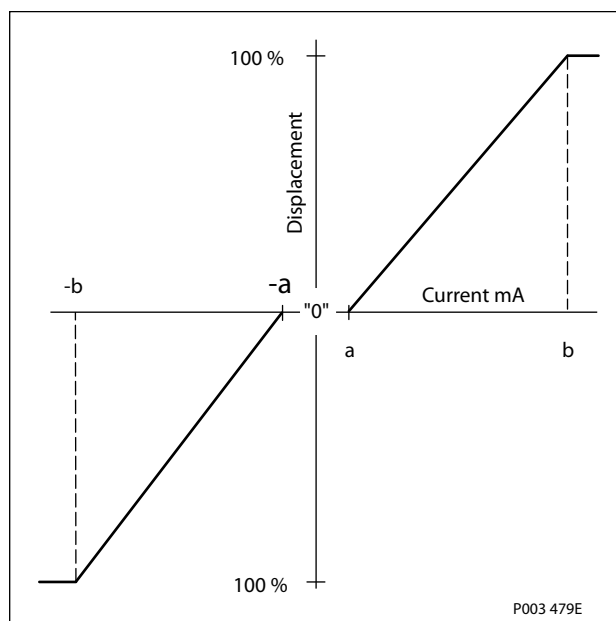
The Electrical Displacement Control (EDC) consists of a pair of proportional solenoids on each side of a three-position, four-way porting spool. The proportional solenoid applies a force input to the spool, which ports hydraulic pressure to either side of a double acting servo piston. Differential pressure across the servo piston rotates the 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 control spool could stick and cause the pump to stay at some displacement.

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



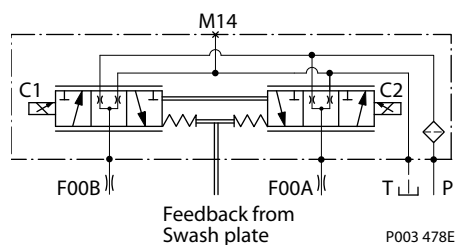
Pump displacement vs. control current



Technical Information H1 Axial Piston Pump Size 069/078, Single

Control options

EDC-schematic diagram



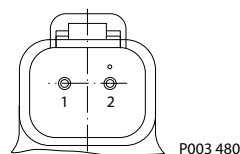
Control signal requirements

Control current

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

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

Connector



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

Solenoid data

Voltage	12V	24V
Maximum current	1800 mA	920 mA
Coil resistance @ 20 °C [70 °F]	3.66 Ω	14.20 Ω
Coil resistance @ 80 °C [176 °F]	4.52 Ω	17.52 Ω
PWM Range	70-200 Hz	
PWM Frequency (preferred)*	100 Hz	
Inductance	33 mH	140 mH
IP Rating (IEC 60 529) + DIN 40 050, part 9	IP 67	
IP Rating (IEC 60 529) + DIN 40 050, part 9 with mating connector	IP 69K	
* PWM signal required for optimum control performance.		

Technical Information H1 Axial Piston Pump Size 069/078, Single

Control options

Flow table

Shaft rotation	CW		CCW	
Coil energized*	C2	C1	C2	C1
Port A	in	out	out	in
Port B	out	in	in	out
Servo port pressurized	M5	M4	M5	M4
* For coil location see installation drawings.				

Control response

H1 controls are available with optional control passage orifices to assist in matching the rate of swashplate response to the application requirements (e.g. in the event of electrical failure). Software ramp or rate limiting should be used to control vehicle response in normal operation. 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 swashplate response table is available for each frame indicating available swashplate response times. Testing should be conducted to verify the proper software and orifice selection for the desired response.

H1 pumps are limited in mechanical orificing combinations. Software is envisioned as the means to control the swashplate response in normal operating conditions. Mechanical servo orifices are to be used only for fail-safe return to neutral in the event of an electrical failure.

Typical response times shown below at the following conditions:

Δp	= 250 bar	[3626 psi]
Viscosity and temperature	= 30 mm ² /s (50 °C)	[141 SUS (122 °F)]
Charge pressure	= 20 bar	[290 psi]
Speed	= 1800 min ⁻¹ (rpm)	

Response time, EDC H1P 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

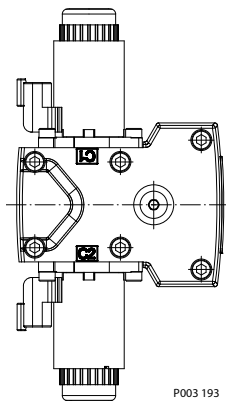
Forward-Neutral-Reverse (FNR) electric control options A9 (12 V)/B1 (24 V)

The 3-Position (F-N-R) control uses an electric input signal to switch the pump to a full stroke position.

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

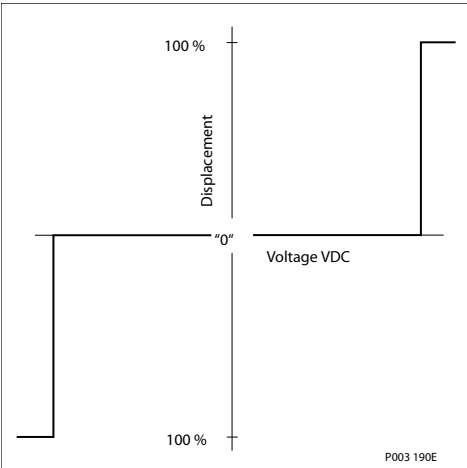
A serviceable 125 µm screen is located in the supply line immediately before the control porting spool.

Control options



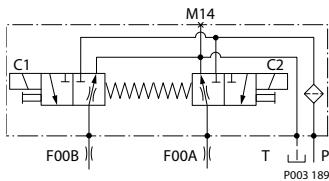
P003 193

Pump displacement vs. electrical signal



P003 190E

3-Position electric control, hydraulic schematic

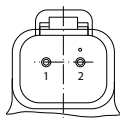


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Control current

Voltage	Min. current to stroke pump mA	Pin connections
12 V	750	any order
24 V	380	

Solenoid connector



P003 480

Technical Information H1 Axial Piston Pump Size 069/078, Single

Control options

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

Solenoid data

Voltage	12 V	24 V
Minimum supply voltage	9.5 Vdc	19.0 Vdc
Maximum supply voltage (continuous)	14.6 Vdc	29.0 Vdc
Maximum current	1050 mA	500 mA
Nominal coil resistance @ 20 °C [70 °F]	8.4 Ω	34.5 Ω
PWM Range	70-200 Hz	
PWM Frequency (preferred)*	100 Hz	
IP Rating (IEC 60 529) + DIN 40 050, part 9	IP 67	
IP Rating (IEC 60 529) + DIN 40 050, part 9 with mating connector	IP 69K	
* PWM signal required for optimum control performance.		

Pump output flow direction vs. control signal

Shaft rotation	CW		CCW	
Coil energized*	C1	C2	C1	C2
Port A	in	out	out	in
Port B	out	in	in	out
Servo port pressurized	M5	M4	M5	M4
* For coil location see installation drawings.				

Control response

H1 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). Software ramp or rate limiting should be used to control vehicle response in normal operation. 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 swashplate response table is available for each frame indicating available swashplate response times. Testing should be conducted to verify the proper software and orifice selection for the desired response.

H1 pumps are limited in mechanical orificing combinations. Software is envisioned as the means to control the swashplate response in normal operating conditions. Mechanical servo orifices are to be used only for fail-safe return to neutral in the event of an electrical failure.

Typical response times shown below at the following conditions:

Δp	= 250 bar	[3626 psi]
Viscosity and temperature	= 30 mm²/s (50 °C)	[141 SUS (122 °F)]

Control options

Charge pressure	= 20 bar	[290 psi]
Speed	= 1800 min ⁻¹ (rpm)	

Response time, FNR 069/078

Stroking direction	0.8 mm [0.03 in] Orifice	1.3 mm [0.05 in] Orifice	No orifice
Neutral to full flow	2.2 s	1.0 s	1.1 s
Full flow to neutral	2.0 s	0.9 s	0.8 s

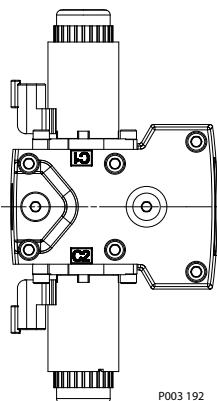
Non Feedback Proportional Electric Control (NFPE) options A8 (12 V)/B8 (24 V)

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.

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 swashplate angle as system pressure increases. A typical response characteristic is shown in the accompanying graph.

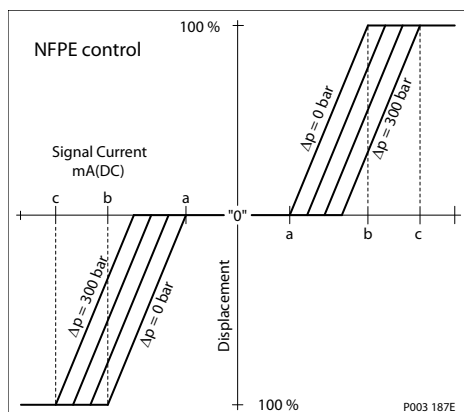
Under some circumstances, such as contamination, the control spool could stick and cause the pump to stay at some displacement.

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



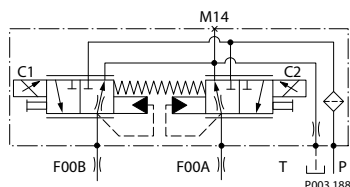
P003 192

Pump displacement vs. input signal



Control options

NFPE schematic



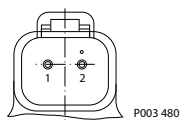
Control signal requirements

Control current

Voltage	a* mA	b mA	c mA	Pin connections
12 V	870	1290	1540	any order
24 V	440	670	770	

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

Connector



Description	Quantity	Ordering number
Mating connector	1	Deutsch® DT06-2S
Wedge lock	1	Deutsch® W2S
Socket contact (16 and 18 AWG)	2	Deutsch® 0462-201-16141
Danfoss mating connector kit	1	K29657
T000 134E		

Solenoid data

Voltage	12V	24V
Maximum current	1800 mA	920 mA
Coil resistance @ 20 °C [70 °F]	3.66 Ω	14.20 Ω
Coil resistance @ 80 °C [176 °F]	4.52 Ω	17.52 Ω
PWM Range	70-200 Hz	
PWM Frequency (preferred)*	100 Hz	
Inductance	33 mH	140 mH
IP Rating (IEC 60 529) + DIN 40 050, part 9	IP 67	
IP Rating (IEC 60 529) + DIN 40 050, part 9 with mating connector	IP 69K	
* PWM signal required for optimum control performance.		

Technical Information H1 Axial Piston Pump Size 069/078, Single

Control options

Pump output flow direction vs. control signal

Shaft rotation	CW		CCW	
Coil energized*	C1	C2	C1	C2
Port A	in	out	out	in
Port B	out	in	in	out
Servo port pressurized	M5	M4	M5	M4
* For coil location see installation drawings.				

Control response

H1 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). Software ramp or rate limiting should be used to control vehicle response in normal operation. 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 swashplate response table is available for each frame indicating available swashplate response times. Testing should be conducted to verify the proper software and orifice selection for the desired response.

H1 pumps are limited in mechanical orificing combinations. Software is envisioned as the means to control the swashplate response in normal operating conditions. Mechanical servo orifices are to be used only for fail-safe return to neutral in the event of an electrical failure.

Typical response times shown below at the following conditions:

Δp	= 250 bar	[3626 psi]
Viscosity and temperature	= 30 mm ² /s (50 °C)	[141 SUS (122 °F)]
Charge pressure	= 20 bar	[290 psi]
Speed	= 1800 min ⁻¹ (rpm)	

Response time, NFPE 069/078

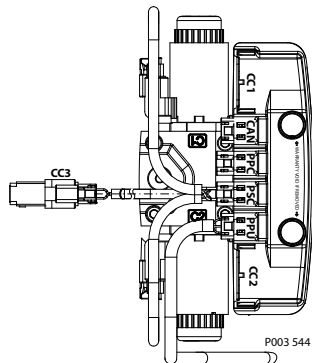
Stroking direction	0.8 mm [0.03 in] Orifice	1.3 mm [0.05 in] Orifice	No orifice
Neutral to full flow	3.1 s	1.4 s	0.8 s
Full flow to neutral	2.0 s	0.9 s	0.4 s

Automotive Control (AC)

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

The integrated Microcontroller enhanced control performance with a flexible, configurable control scheme for an entire single path propel transmission. It can be used in combination with fixed and variable displacement hydraulic-motors. With the pre-installed application software and easily changeable control parameters, it is possible to tailor the vehicle's driving behavior to the individual requirements of the customer.

Control options



The H1 Automotive Control is divided into 2 systems, AC-1 and 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 and Flow Limiter.

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. The setpoint for the drive curve is a Joystick or 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
- Proportional pump displacement control (automotive)
- Configurable System Mode & Direction change
- Load independent pump displacement control with integrated Swash Plate Angle Sensor (option AC-2)
- Hydraulic-motor displacement control including brake pressure defeat function

Control options

Performance functions

- ECO fuel saving mode with automatic reduction of the engine speed during transport (ECO fuel saving mode is only available with AC I)
- 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 certification according IEC 61508

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

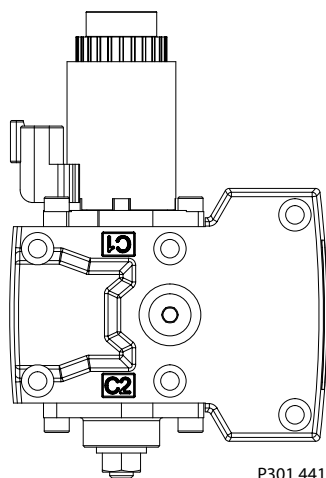
Refer to the "Technical Information – H1 Automotive Control" L1223856 for more details.

Fan Drive Control (FDC) option F1 (12V)/F2 (24V)

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.

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 swashplate angle as system pressure increases. 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.

Control options



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

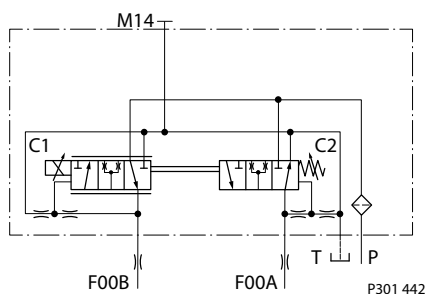
Under some circumstances, such as contamination, the control spool could stick and cause the pump to stay at some displacement.

Refer to Hydraulic Fan Drive Design Guidelines (520L0926) for detailed information necessary to properly size and configure a hydraulic fan drive system.

Warning

The FDC is for Fan Drive systems only! 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.

Schematic diagram



Control signal requirements

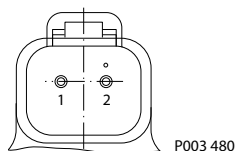
Control current

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

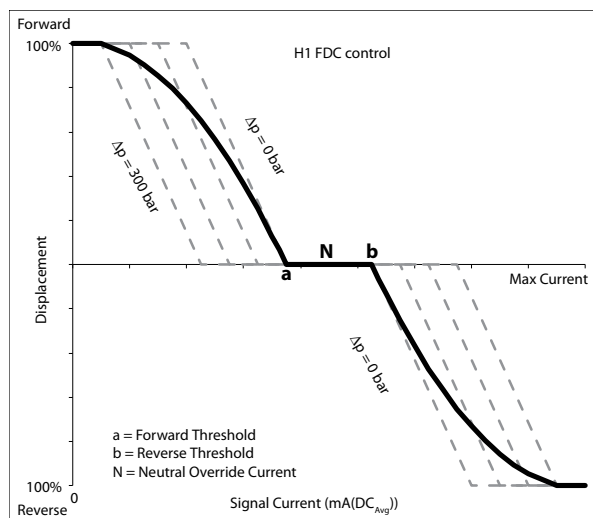
* Factory test current, for fan movement expect higher or lower value.T301 105E

Control options

Connector



Pump displacement vs. control current



P301 443

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

Solenoid data

Voltage	12V	24V
Maximum current	1800 mA	920 mA
Coil resistance @ 20 °C [70 °F]	3.66 Ω	14.20 Ω
Coil resistance @ 80 °C [176 °F]	4.52 Ω	17.52 Ω
PWM Range	70-200 Hz	
PWM Frequency (preferred)*	100 Hz	
Inductance	33 mH	140 mH
IP Rating (IEC 60 529) + DIN 40 050, part 9	IP 67	
IP Rating (IEC 60 529) + DIN 40 050, part 9 with mating connector	IP 69K	
* PWM signal required for optimum control performance.		

Technical Information H1 Axial Piston Pump Size 069/078, Single

Control options

Pump output flow direction vs. control signal

Shaft rotation		CW Rotation			CCW Rotation		
Control Logic	12V	C1 (0-780mA)	C1 (1100mA)	C1 (1300-1800mA)	C1 (0-780mA)	C1 (1100mA)	C1 (1300-1800mA)
	24V	C1 (0-400mA)	C1 (550 mA)	C1 (680-920mA)	C1 (0-400mA)	C1 (550mA)	C1 (680-920mA)
Port A flow		in	no flow	out	out	no flow	in
Port B flow		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 this control will cause the pump to produce maximum flow.							

Control response

H1 Fan Drive Control is available only with 0.8 mm [0.03 in] control passage orifice to limit the rate of swashplate response (e.g. in the event of electrical failure). Software ramp or rate limiting should be used to control system response in normal operation. 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 swashplate response table is available for each frame indicating available swashplate response times. Testing should be conducted to verify the proper software and orifice selection for the desired response.

H1 pumps are limited in mechanical orificing combinations. Software is envisioned as the means to control the swashplate response in normal operating conditions. Mechanical servo orifices are to be used only for fail-safe return to max. forward in the event of an electrical failure.

Typical response times shown below at the following conditions:

Peak Δp	= 330 bar	[4785 psi]
Viscosity and temperature	= 30 mm ² /s (50 °C)	[141 SUS (122 °F)]
Charge pressure	= 24 bar	[348 psi]
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

Manual Over Ride (MOR)

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

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

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

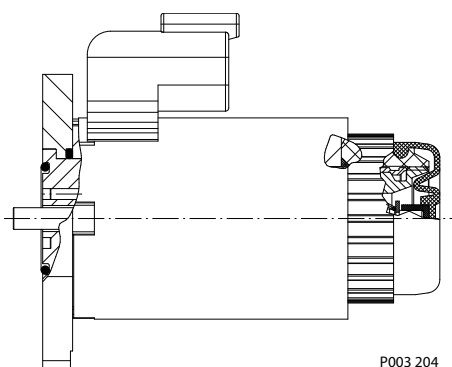
Control options

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

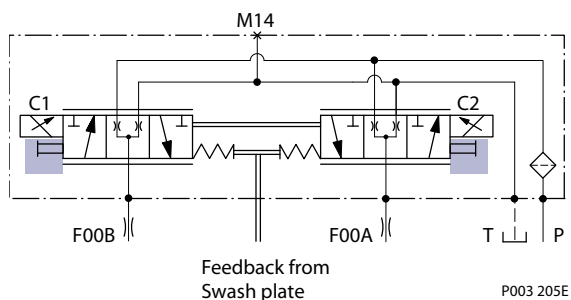
Warning

An o-ring seal is used to seal the MOR plunger where initial actuation of the function will require a force of 45 N to engage the plunger. Additional actuations typically require less force to engage the MOR plunger. Proportional control of the pump using the MOR should not be expected.

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



MOR-schematic diagram (EDC shown)



Displacement limiter

H1 pumps are designed with optional mechanical displacement (stroke) limiters factory set to max. displacement.

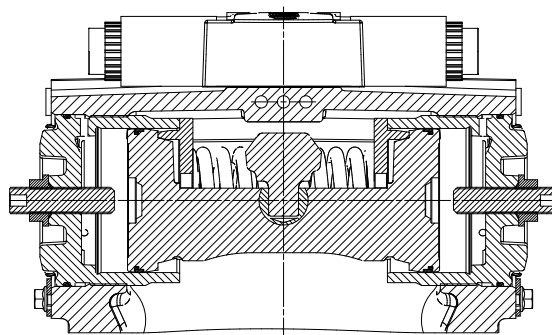
The maximum displacement of the pump can be set independently for forward and reverse using the two adjustment screws to mechanically limit the travel of the servo piston down to 50 % displacement. Adjustment procedures are found in the H1 pumps Service Manual.

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

Technical Information H1 Axial Piston Pump Size 069/078, Single

Control options

Displacement limiter



P003 266

Displacement change (approximately) H1P 069/078

Size	1 Turn of displacement limiter screw		Internal wrench size	External wrench size	Torque for external hex seal lock nut	
069/078	7.4 cm ³	[0.45 in ³]	4 mm	13 mm	24 Nm	[212 lbf·in]

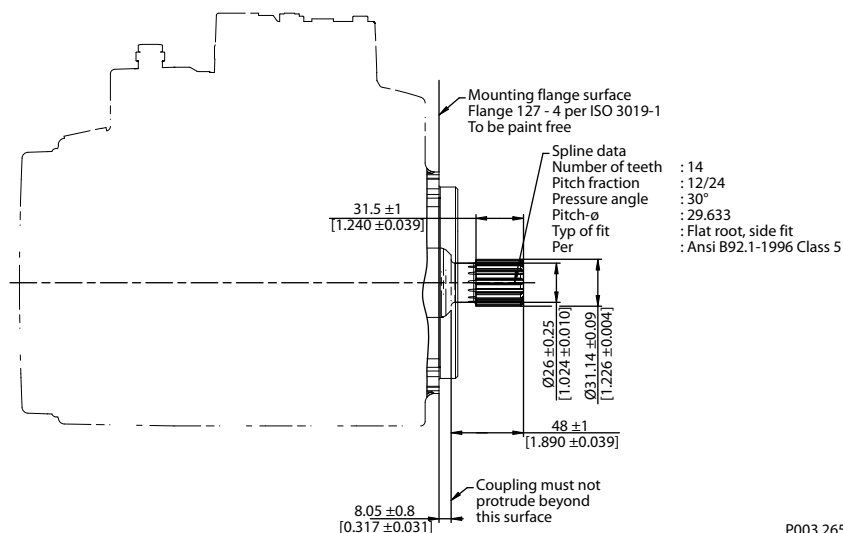
For more information refer to H1 pumps Service Manual 520L0848, section Displacement Limiter Adjustment.

Dimensions

Input shafts

H1P input shaft - Option G1 (SAE C, 14 teeth)

Option G1, ISO 3019-1, outer dia 32 mm-4 (SAE C, 14 teeth)



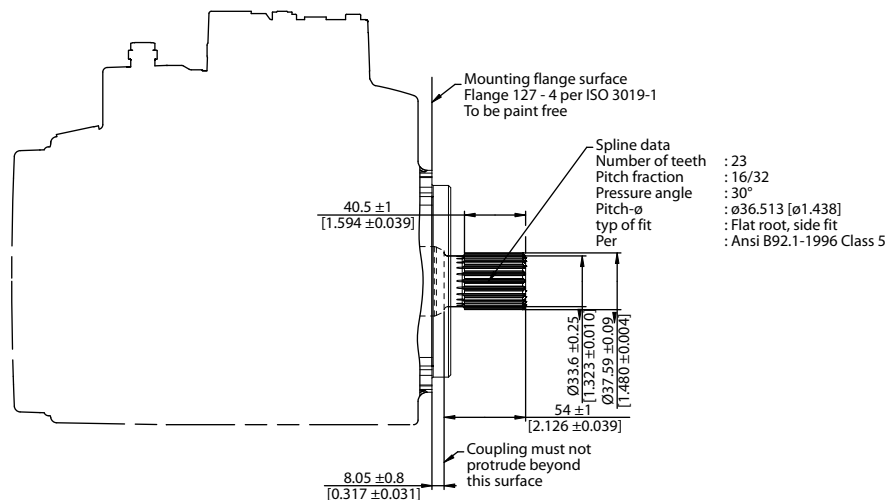
Specifications

Option	Spline	Min active spline length ² mm [in]	Torque rating ¹	
			Rated torque Nm [lbf·in]	Maximum torque Nm [lbf·in]
G1	14 teeth, 12/24 pitch	31.45 [1.238]	534 [4720]	816 [7220]

¹) For definitions of maximum and rated torque values, refer to: Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.
²) Minimum active spline length for the specified torque ratings.

H1P input shaft - Option G9 (SAE C-C, 23 teeth)

Option G9, ISO 3019-1, outer dia 38 mm-4 (SAE C-C, 23 teeth)



Technical Information H1 Axial Piston Pump Size 069/078, Single

Dimensions

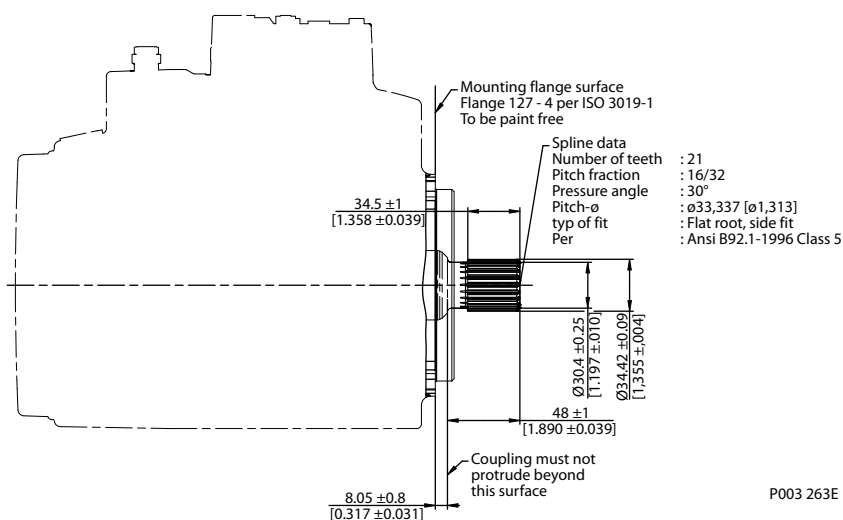
Specifications

Option	Spline	Min active spline length ² mm [in]	Torque rating ¹	
			Rated torque Nm [lbf·in]	Maximum torque Nm [lbf·in]
G9	23 teeth, 16/32 pitch	40.33 [1.588]	999 [8840]	1818 [16 090]

¹⁾ For definitions of maximum and rated torque values, refer to: Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.
²⁾ Minimum active spline length for the specified torque ratings.

H1P input shaft - Option F1 (SAE C, 21 teeth)

Option F1, ISO 3019-1, outer dia 35 mm-4 (SAE C, 21 teeth)



Specifications

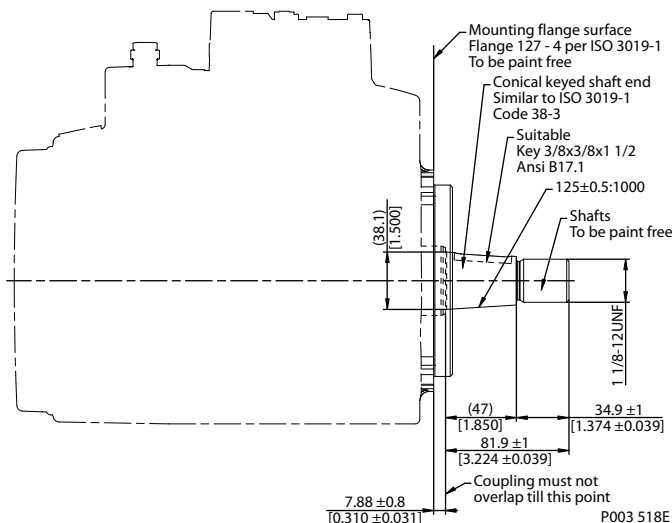
Option	Spline	Min active spline length ² mm [in]	Torque rating ¹	
			Rated torque Nm [lbf·in]	Maximum torque Nm [lbf·in]
F1	21 teeth, 16/32 pitch	34.5 [1.358]	760 [6730]	1137 [10 060]

¹⁾ For definitions of maximum and rated torque values, refer to: Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.
²⁾ Minimum active spline length for the specified torque ratings.

Dimensions

H1P input shaft - Option F4, Code 38-3

Option F4, ISO 3019-1, Code 38-3, Diameter 38.1 taper 1:8, without key and no through-hole in the end of the shaft



Specifications

Option	Tapered shaft	Torque rating ¹	
		Rated torque Nm [lbf·in]	Maximum torque Nm [lbf·in]
F4	38.1 taper without key ²⁾	1116 [9880]	1488 [13 170]

¹⁾ For definitions of maximum and rated torque values, refer to: Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.
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.
 * Rated torque includes just the capability of the press-fit in accordance with an assumed fastener grade 5.

Tapered shaft customer acknowledgement

The Danfoss H1 tapered shaft has been designed using the industry standard ISO 3019-1, minus the through-hole in the end of the shaft. Danfoss recommends a self-locking nut instead of a castle nut and pin. The nut and mating square-cut key are customer supplied.

The specified torque rating of the tapered shaft documented above is based on the cross-sectional diameter of the shaft, through the keyway, and assumes the proper clamp and fit between shaft and coupling. Danfoss guarantees the design and manufactured quality of the tapered shaft. The customer is responsible for the design and manufactured quality of the mating female coupling and key and applied torque on the nut.

Danfoss has made provisions for the key in accordance to the ISO specification with the understanding that the key is solely to assist in the installation of the mating coupling.

! Caution

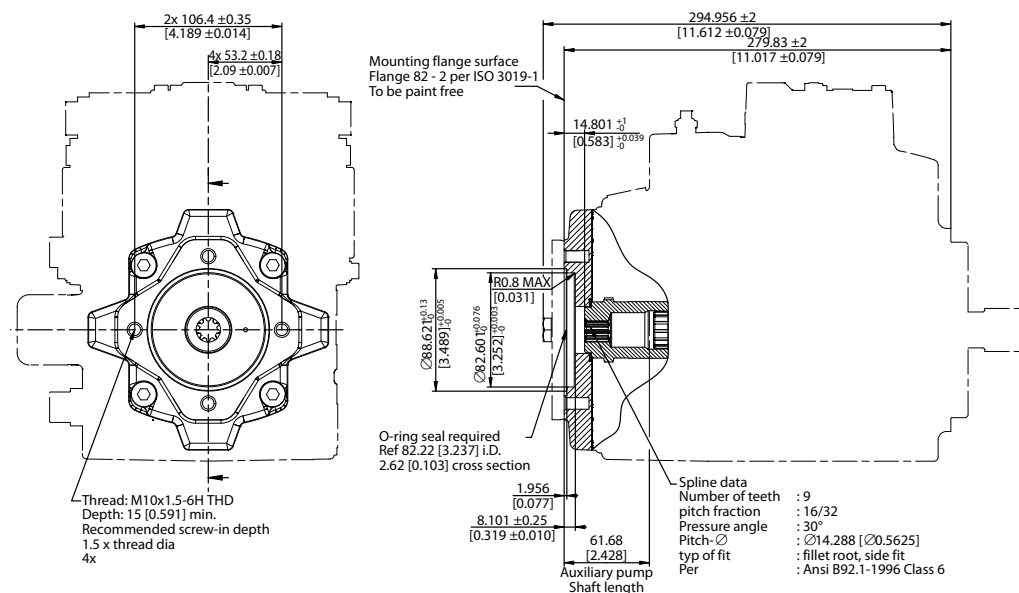
Torque must be transmitted by the taper fit between the shaft and it's mating coupling, not the key. Torque or loading inadvertently transmitted by the customer supplied key may lead to premature shaft failure.

Dimensions

Auxiliary mounting pads

H1P Auxiliary mounting - Option H2 (SAE A, 9 teeth)

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



P003 262E

Specifications

Option	Spline	Torque rating ¹ maximum torque Nm [lbf·in]
H2	9 teeth, 16/32 pitch	162 [1430]

¹⁾ For definitions of maximum torque values, refer to: Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.

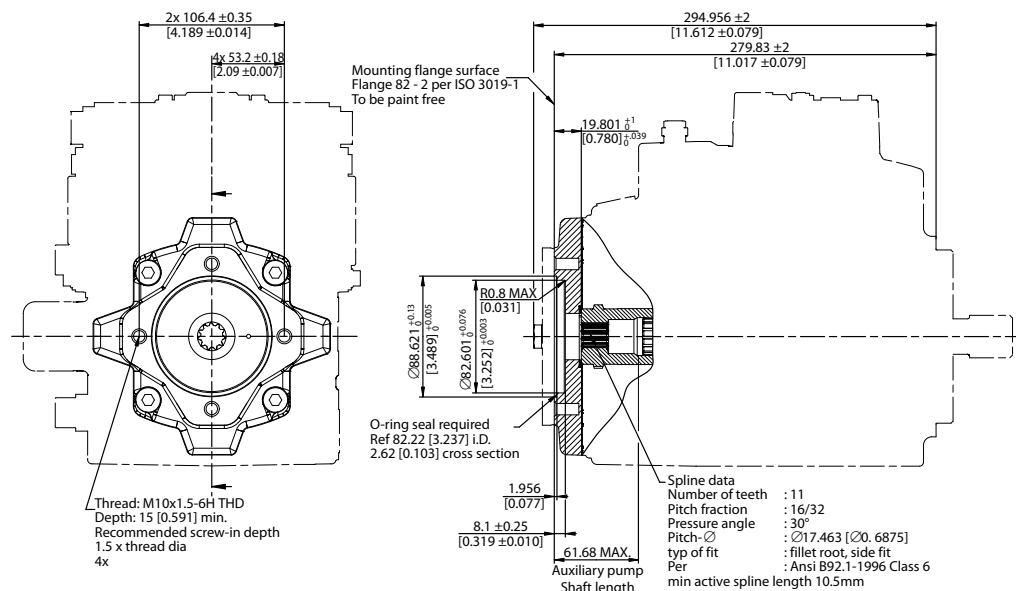
Warning

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

Dimensions

H1P Auxiliary mounting - Option H1 (SAE A, 11 teeth)

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



P003 321E

Specifications

Option	Spline	Torque rating ¹ maximum torque Nm [lbf·in]
H1	11 teeth, 16/32 pitch	296 [2620]
¹⁾ For definitions of maximum torque values, refer to: Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.		

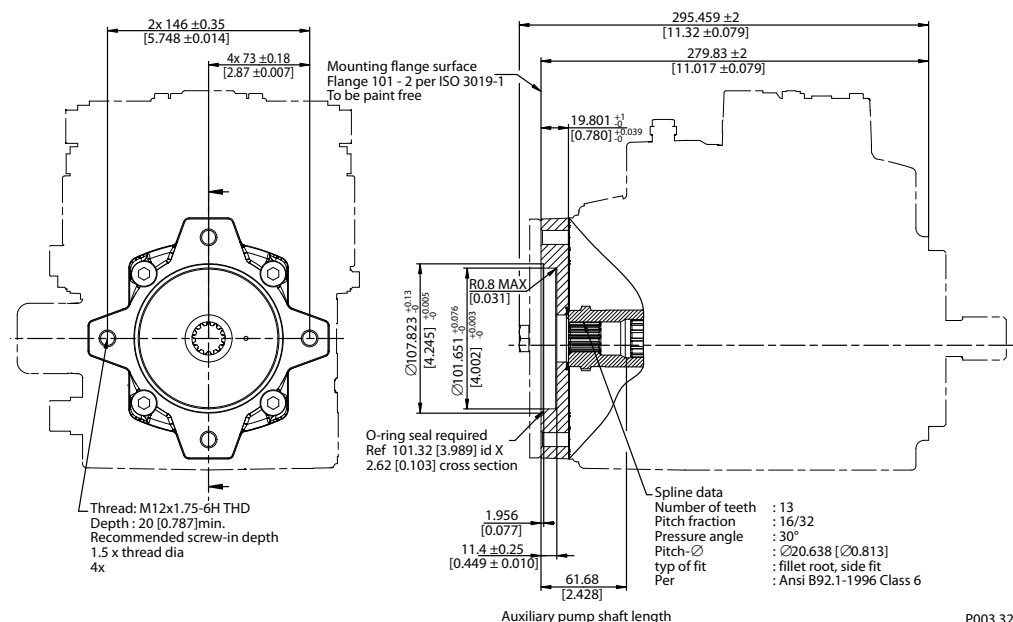
Warning

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

Dimensions

H1P Auxiliary mounting - Option H3 (SAE B, 13 teeth)

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



P003 322E

Specifications

Option	Spline	Torque rating ¹ maximum torque Nm [lbf·in]
H3	13 teeth, 16/32 pitch	395 [3500]

¹⁾ For definitions of maximum torque values, refer to: Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.

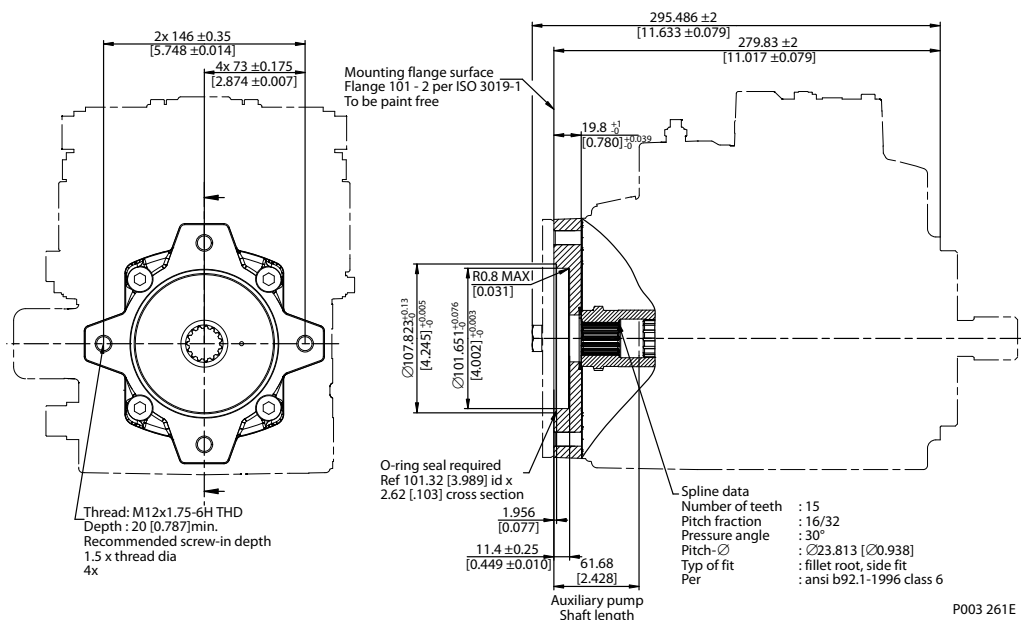
Warning

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

Dimensions

H1P Auxiliary mounting - Option H5 (SAE B-B, 15 teeth)

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



Specifications

Option	Spline	Torque rating ¹ maximum torque Nm [lbf-in]
H5	15 teeth, 16/32 pitch	693 [6130]
¹⁾ For definitions of maximum torque values, refer to: Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.		

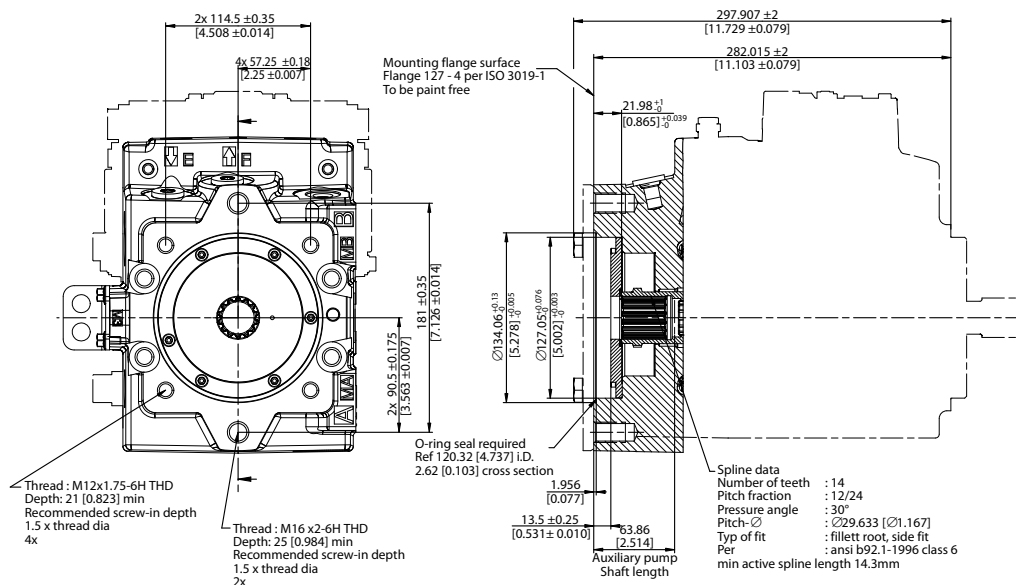
Warning

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

Dimensions

H1P Auxiliary mounting - Option H6 (SAE C, 14 teeth)

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



P003 260F

Specifications

Option	Spline	Torque rating ¹ maximum torque Nm [lbf·in]
H6	14 teeth, 12/24 pitch	816 [7220]

¹⁾ For definitions of maximum torque values, refer to: Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.

Warning

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

Charge pump

Charge pump sizing/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. Please refer to BLN-9885, Selection of Drive line Components, for a detailed procedure.

System features and conditions which may invalidate the 10 % guideline include (but are not limited to):

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

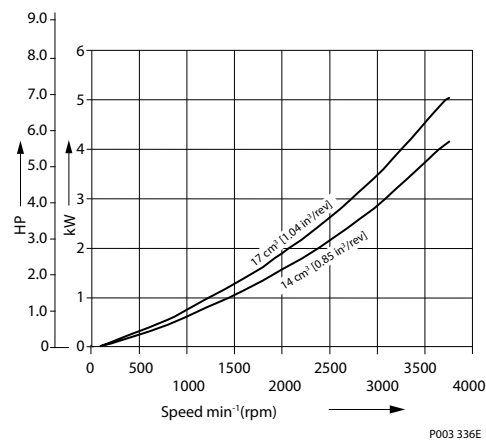
Contact your Danfoss representative for application assistance if your application includes any of these conditions.

Charge pump flow and power curves 14 cm³ and 17 cm³

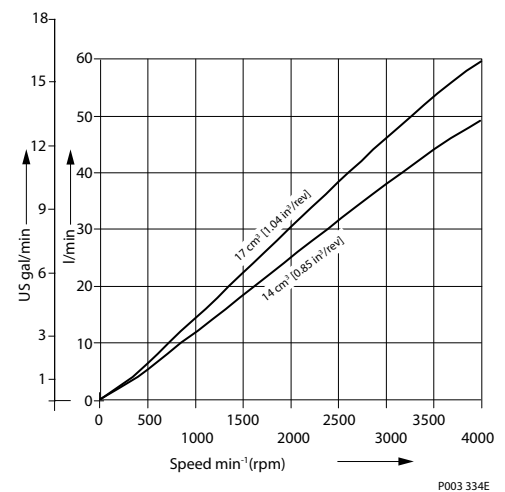
Charge pressure: 20 bar [290 psi]

Viscosity and temperature: 11 mm²/s [63 SUS] 80 °C [180 °F]

Charge pump power requirements



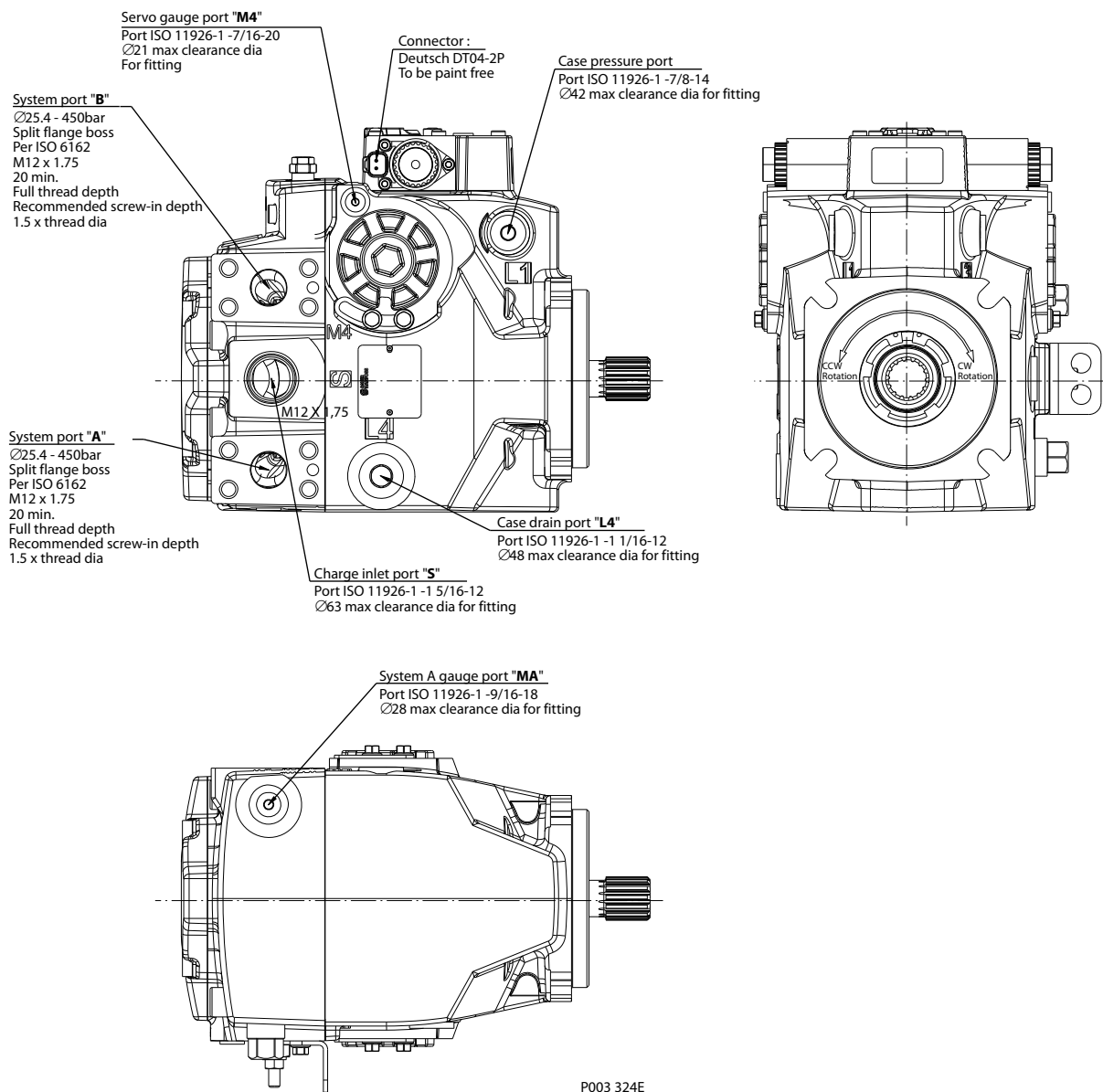
Charge pump flow



Technical Information H1 Axial Piston Pump Size 069/078, Single

Installation drawings

Port description H1P 069/078



P003 324E

Port description

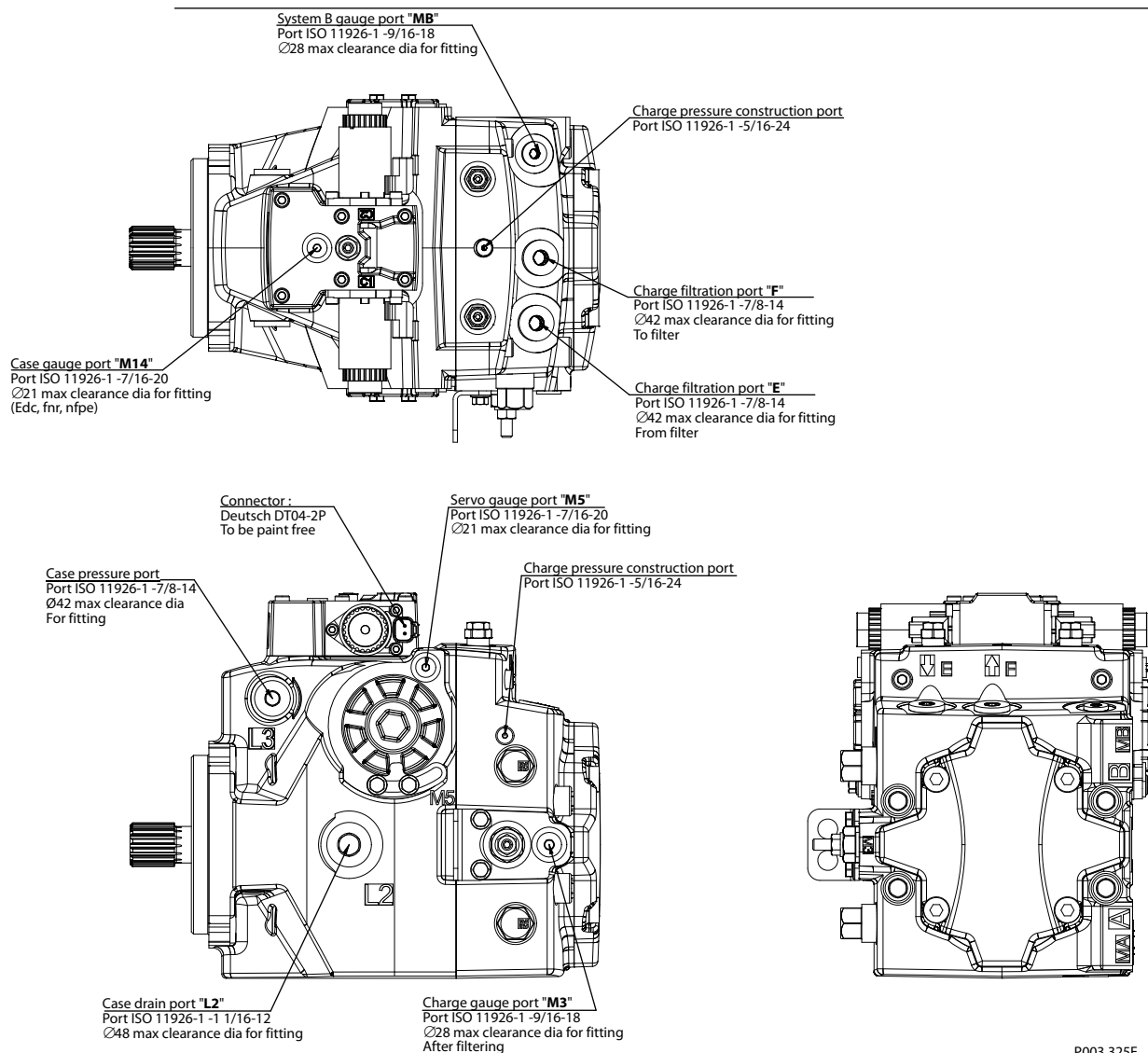
Port	Description	Sizes
A	System port "A"	Ø25.4
B	System port "B"	Ø25.4
E	Charge filtration port, from filter	7/8 -14
F	Charge filtration port, to filter	7/8 -14
L2	Case drain port	1 1/16 -12
L4	Case drain port	1 1/16 -12
MA	System A gage port	9/16 -18
MB	System B gage port	9/16 -18

Installation drawings

Port description (continued)

Port	Description	Sizes
M3	Charge gage port, after filtering	9/16 -18
M4	Servo gage port	7/16 -20
M5	Servo gage port	7/16 -20
M14	Case gage port	7/16 -20
S	Charge inlet port	1 5/16 -12

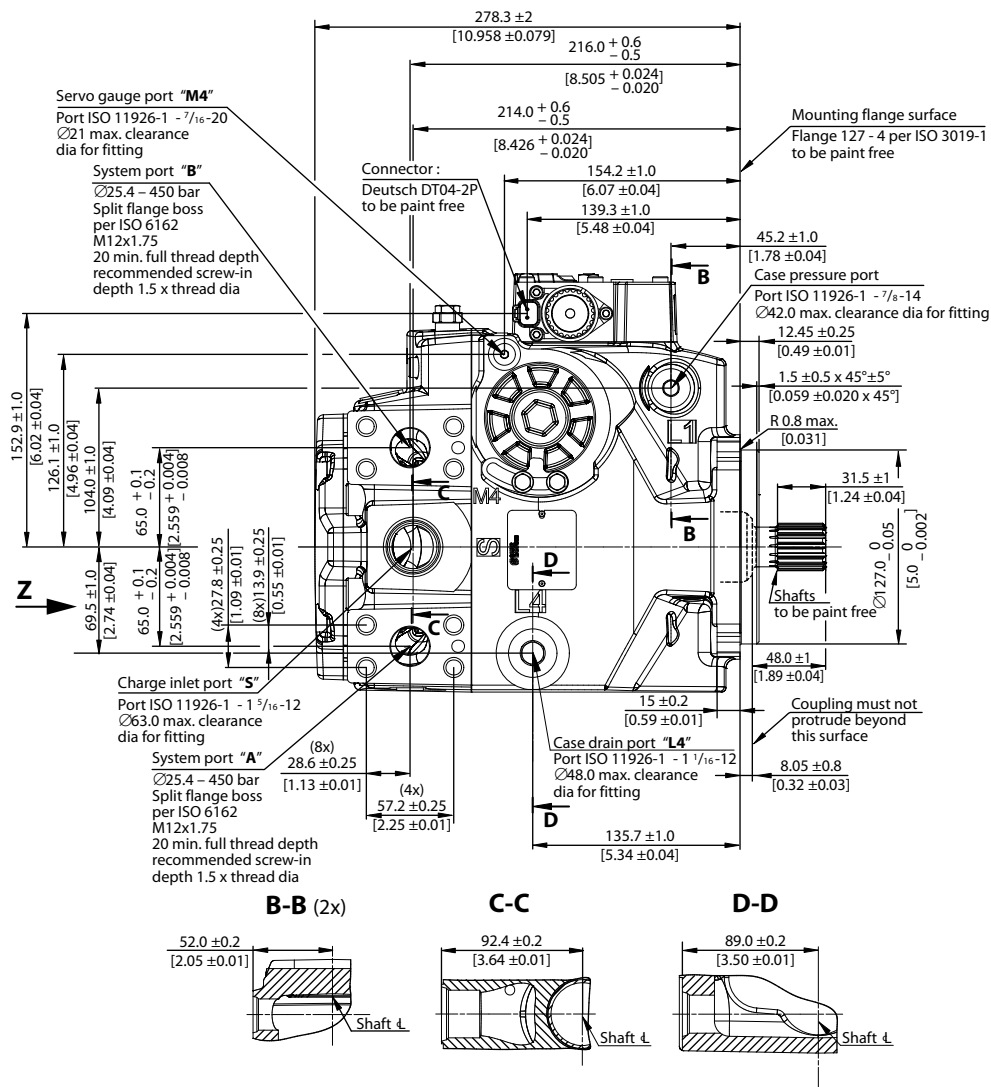
Please contact Danfoss for specific installation drawings



Please contact Danfoss for specific installation drawings

Installation drawings

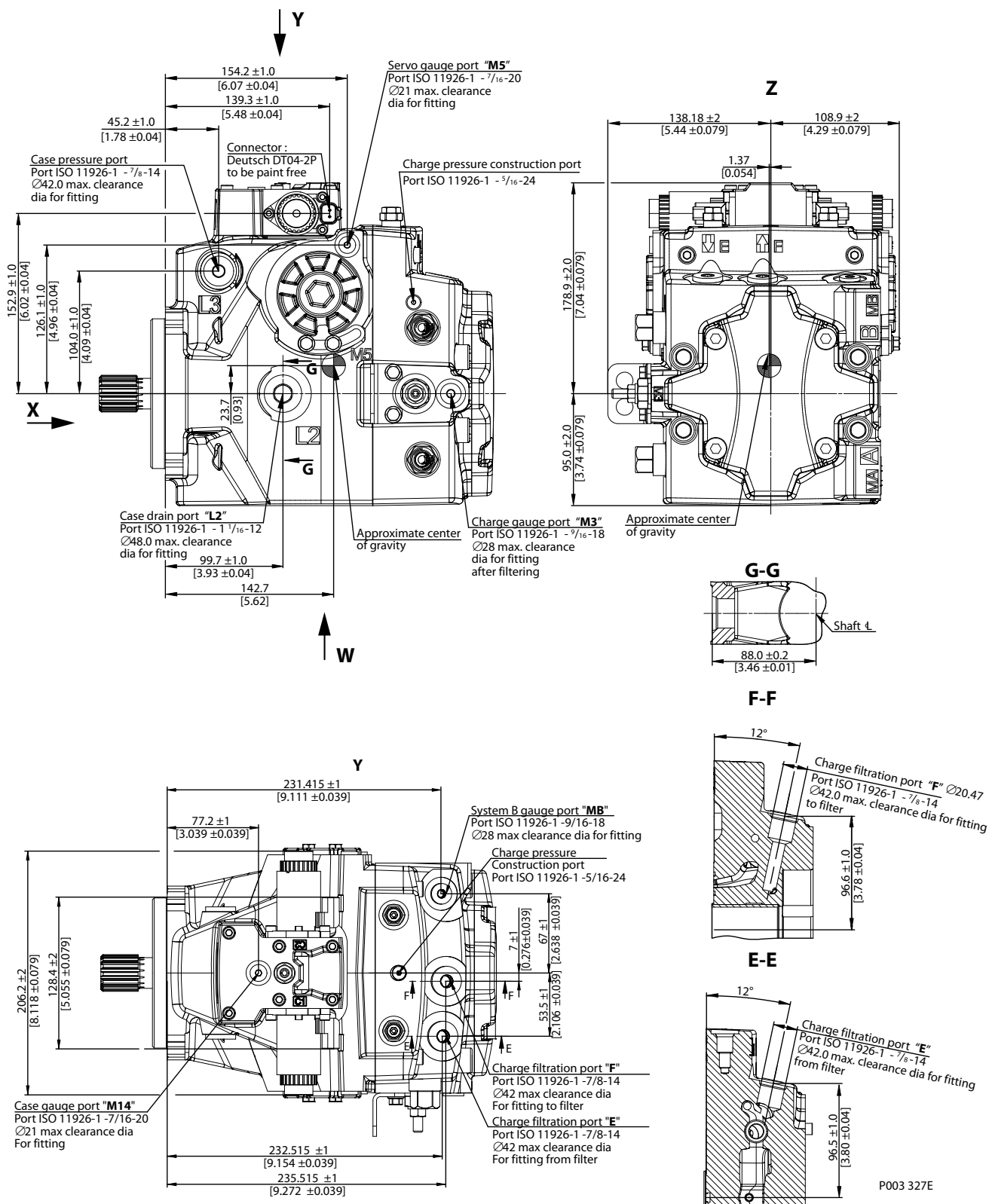
Dimensions H1P 069/078



P003 326E

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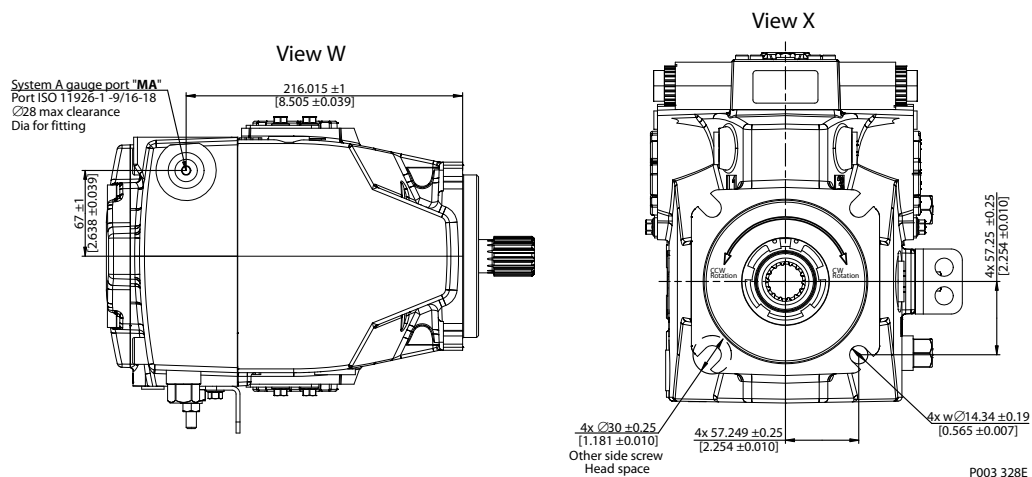
Installation drawings



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Technical Information H1 Axial Piston Pump Size 069/078, Single

Installation drawings

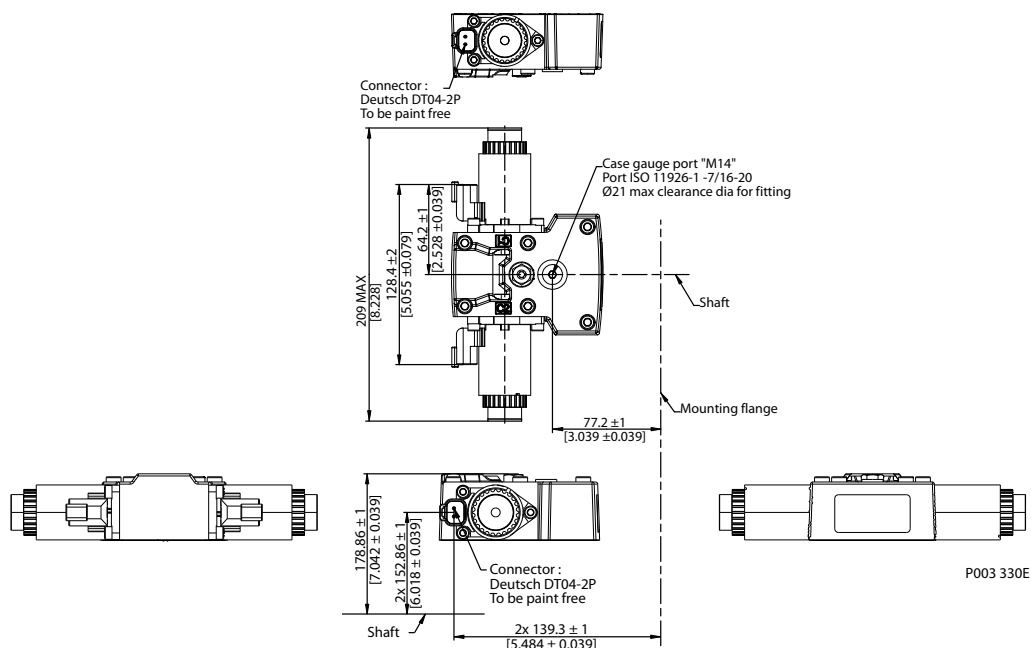


Please contact Danfoss for specific installation drawings

Technical Information H1 Axial Piston Pump Size 069/078, Single

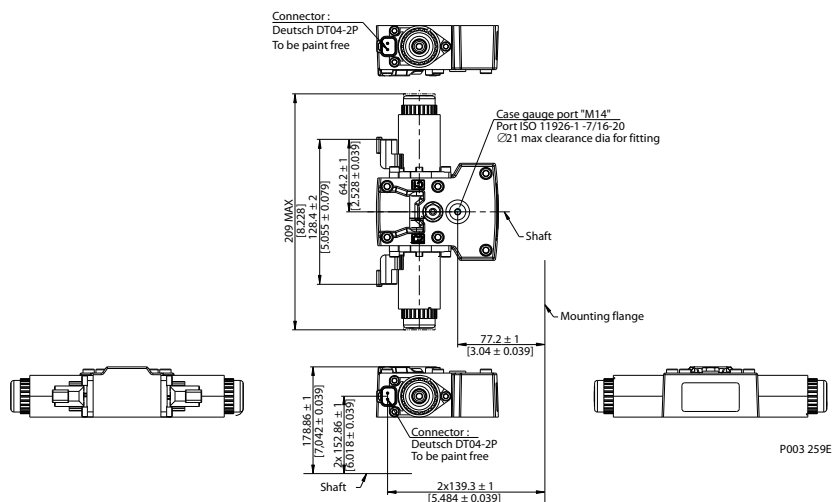
Controls

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



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Electric Displacement Control (EDC), with manual override, option A4 (12 V)/A5 (24 V)

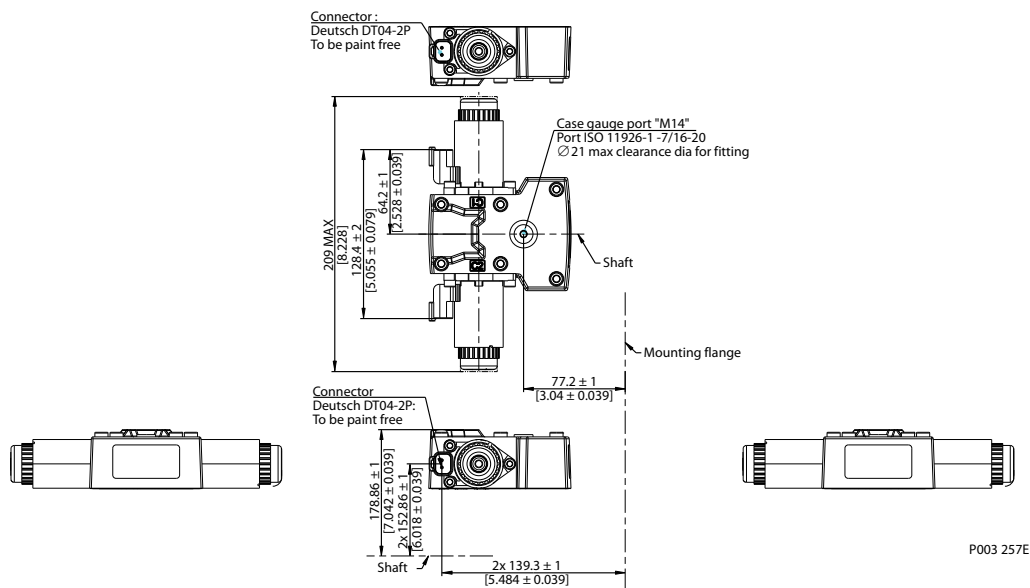


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Technical Information H1 Axial Piston Pump Size 069/078, Single

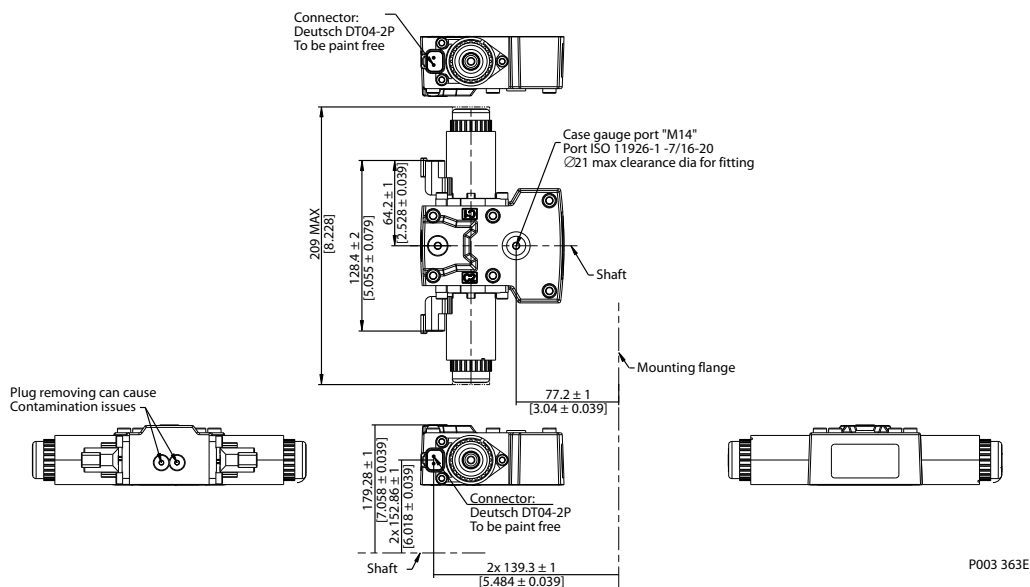
Controls

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



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Non Feedback Proportional Electric control (NFPE), with manual override, option A8 (12 V)/B8 (24 V)

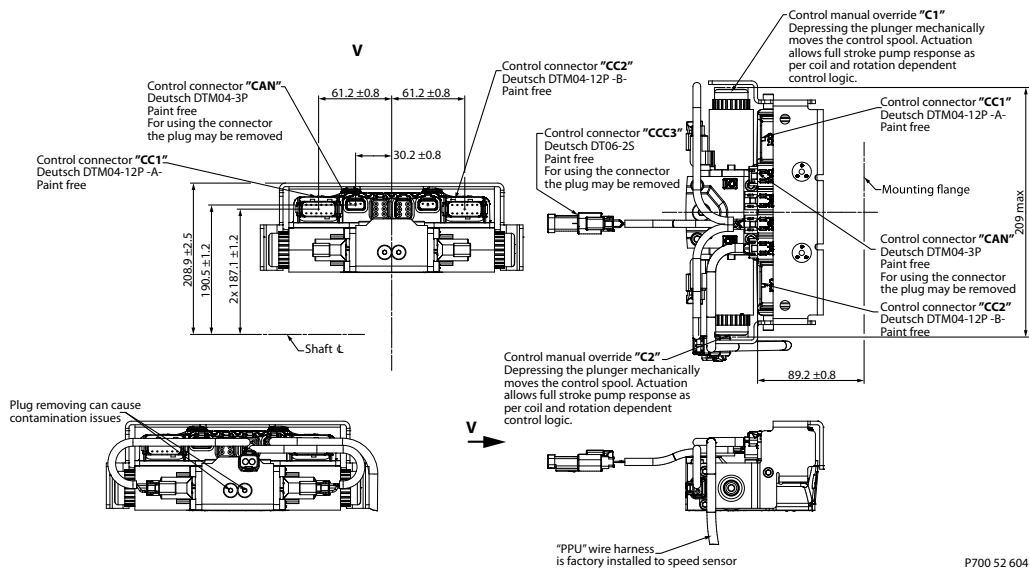


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Technical Information H1 Axial Piston Pump Size 069/078, Single

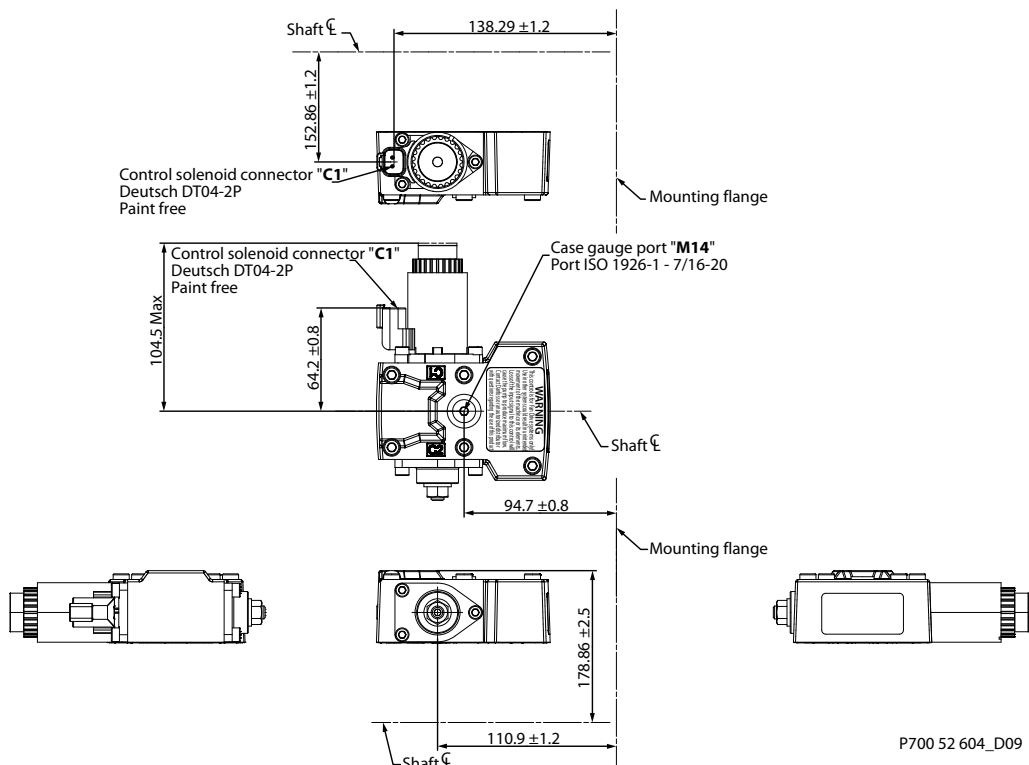
Controls

Automotive control (AC I) with manual override, option A7 (12 V)/C2 (24 V)
Automotive control (AC II) with manual override, option B7 (12V)/C3 (24V)



Please contact Danfoss for specific installation drawings

Fan Drive Control (FDC), option F1 (12 V)/F2 (24 V)



Control solenoid Connector "C1" & "C2"

Pin	Assignment	OR	Pin	Assignment
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Technical Information H1 Axial Piston Pump Size 069/078, Single

Controls

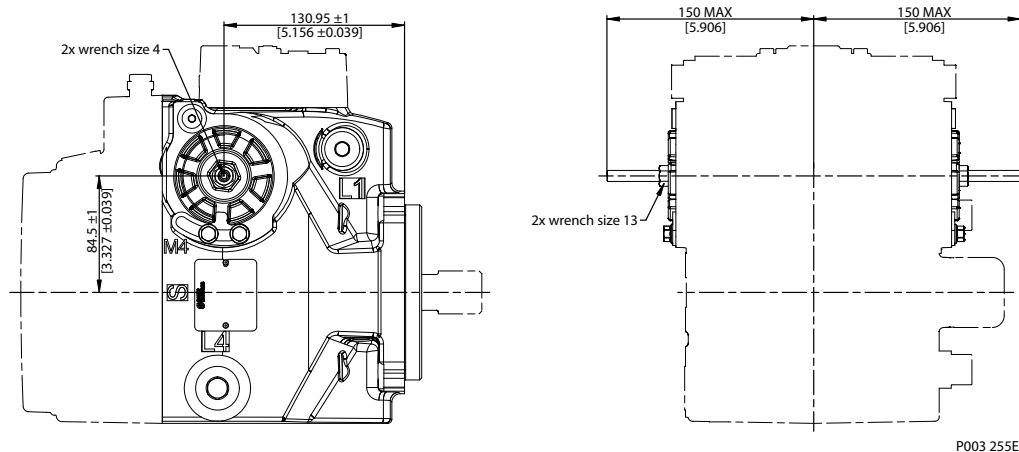
Control solenoid Connector "C1" & "C2"				
1	Supply		1	Ground
2	Ground		2	Supply

Please contact Danfoss for specific installation drawings

Technical Information H1 Axial Piston Pump Size 069/078, Single

Displacement limiters

H1P 069/078 displacement limiters, option B

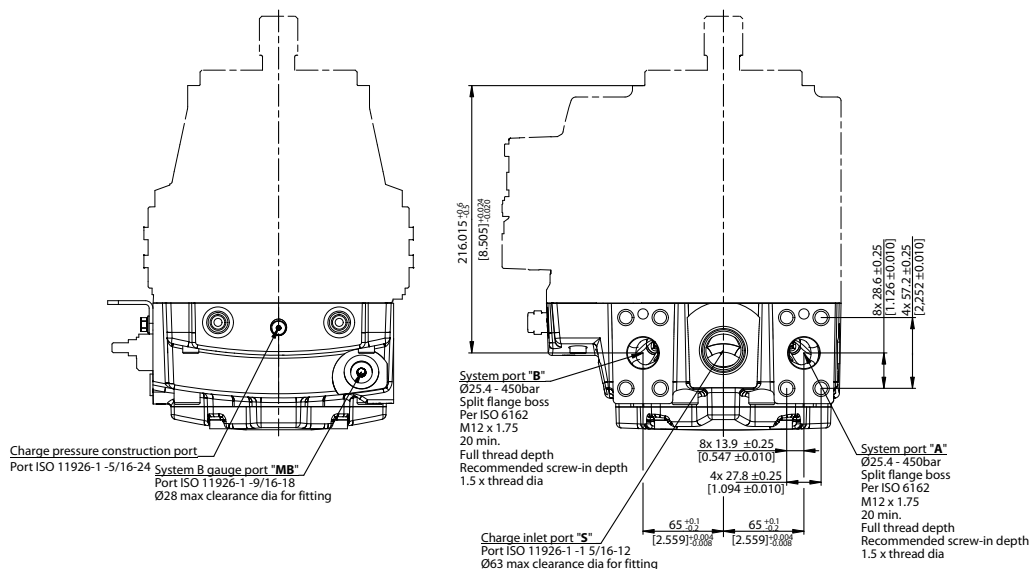


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Technical Information H1 Axial Piston Pump Size 069/078, Single

Filtration

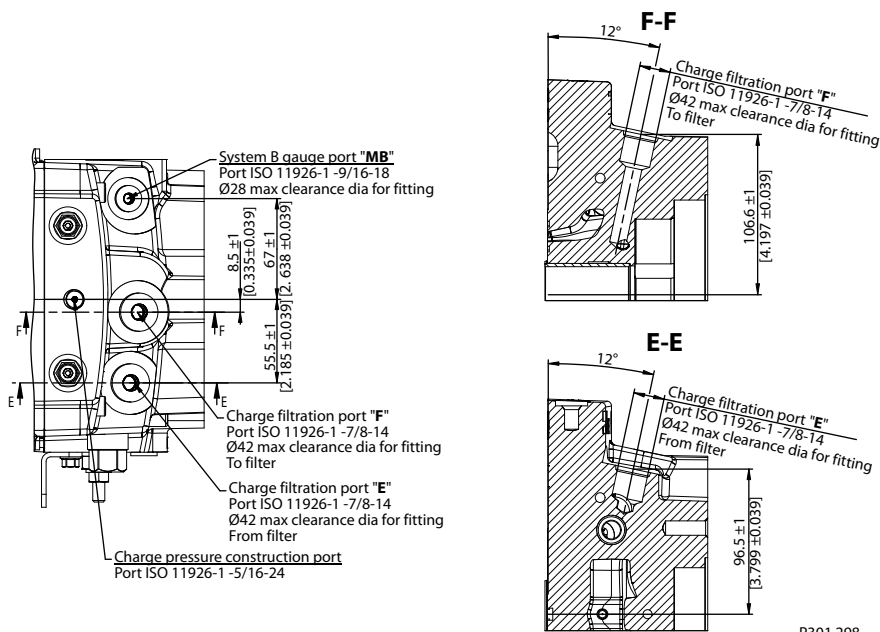
H1P 069/078, suction filtration, option L



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Remote full charge pressure filtration, option P for end cap option F5 (SAE-C PTO)

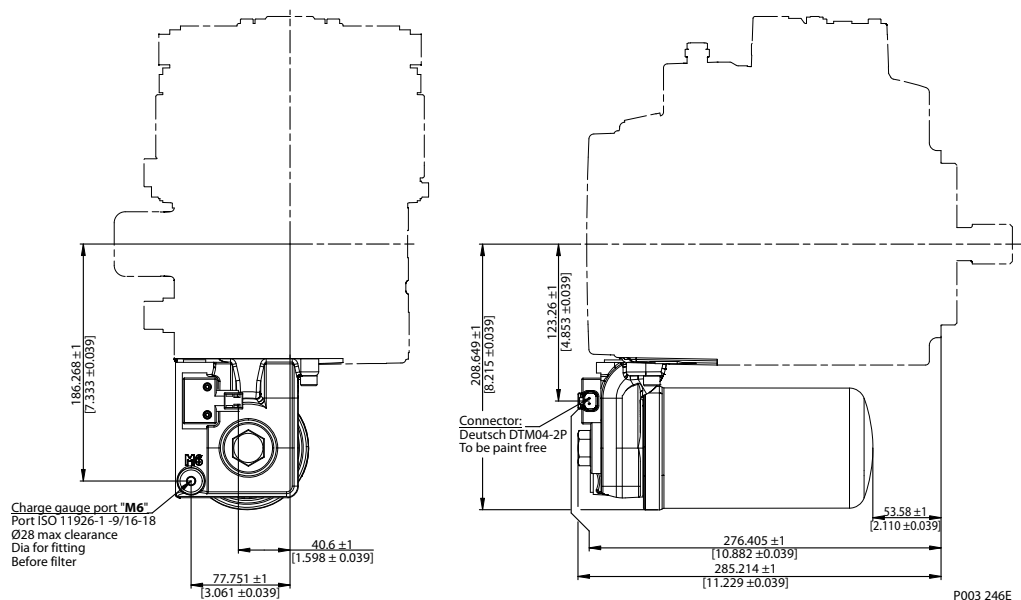


P301 298

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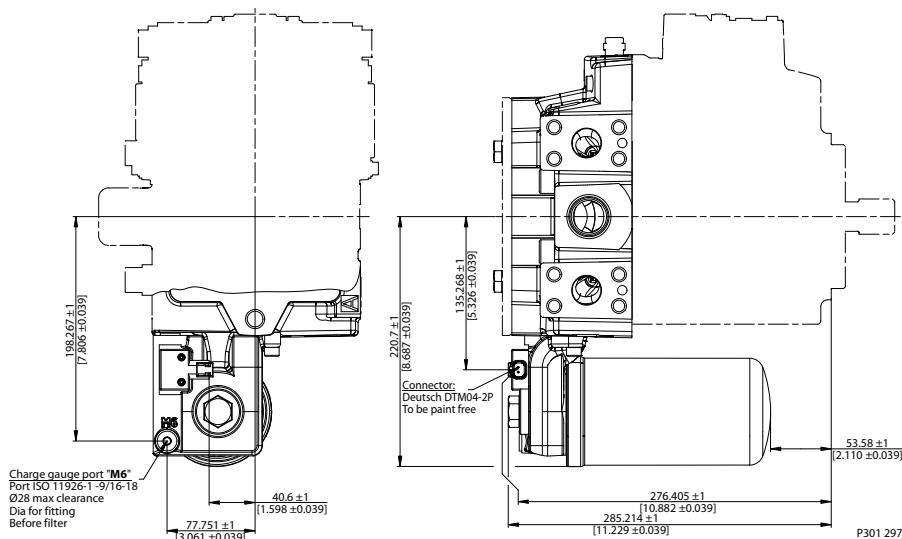
Filtration

Integral full flow charge pressure filtration with filter bypass sensor, option M



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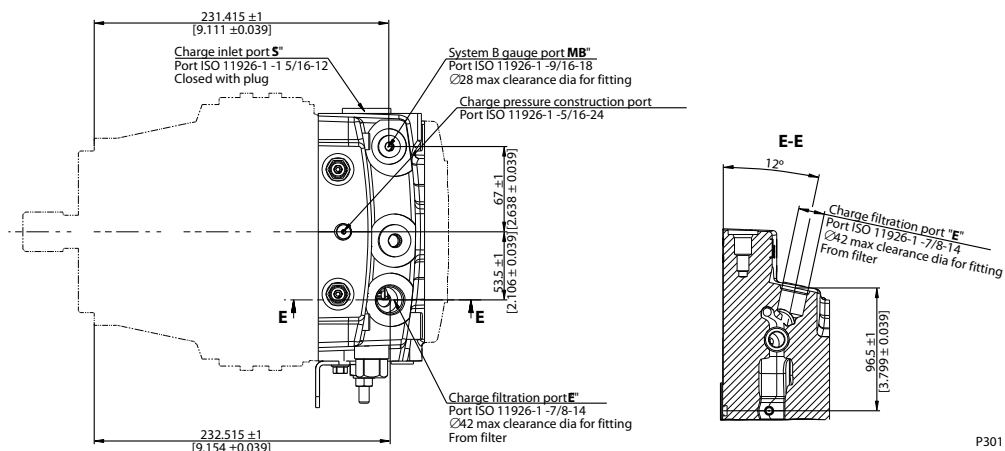
Integral full flow charge pressure filtration with filter bypass sensor, option M, for end cap option F4 (SAE-C PTO)



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Filtration

External full flow charge pressure filtration, option S for end cap options D8 or F5



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www.daikin-sauer-danfoss.com

Local address:

Danfoss Power Solutions US Company
2800 East 13th Street
Ames, IA 50010, USA
Phone: +1 515 239 6000

Danfoss Power Solutions GmbH & Co. OHG
Krokamp 35
D-24539 Neumünster, Germany
Phone: +49 4321 871 0

Danfoss Power Solutions ApS
Nordborgvej 81
DK-6430 Nordborg, Denmark
Phone: +45 7488 2222

Danfoss Power Solutions (Shanghai) Co. Ltd.
Building #22, No. 1000 Jin Hai Rd
Jin Qiao, Pudong New District
Shanghai, China 201206
Phone: +86 21 3418 5200

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