

ENGINEERING  
TOMORROW

*Danfoss*

Technical Information

# H1 Axial Piston Single Pumps

## Size 089/100



**Revision history***Table of revisions*

<b>Date</b>	<b>Changed</b>	<b>Rev</b>
June 2017	port size changes	0902
May 2017	NFPE gen. 3 changes.	0901
November 2015	Master Model Code changes.	0800
September 2014	MDC, CCO, and Swash Angle Sensor options added	HA
Mar 2014	Converted to Danfoss layout - DITA CMS	GA
Apr 2013	FDC option added	FA
Apr 2013	AC section updated	EA
Dec 2012	AC added	DA
Jun 2010	New EC directive	CA
Apr 2010	Different updates	BA
Aug 2009	First edition	AA

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## Technical specifications

### H1 Pump General Specification

<b>Design</b>	Axial piston pump of cradle swashplate design with variable displacement
<b>Direction of rotation</b>	Clockwise, Counterclockwise
<b>Pipe connections</b>	<i>Main pressure ports:</i> ISO split flange boss <i>Remaining ports:</i> SAE straight thread O-ring boss
<b>Recommended installation position</b>	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 for nonconformance to these guidelines.
<b>Auxiliary cavity pressure</b>	Will be inlet pressure with internal charge pump. For reference see <a href="#">H1P 089/100 Operating Parameters</a> . Will be case pressure with external charge supply. Please verify mating pump shaft seal capability.

### H1P 089/100 Technical Data

Feature	Size 089	Size 100
<b>Displacement</b>	89.2 cm <sup>3</sup> [5.44 in <sup>3</sup> ]	101.7 cm <sup>3</sup> [6.21 in <sup>3</sup> ]
<b>Flow at rated (continuous) speed</b>	294 l/min [77.7 US gal/min]	335 l/min [88.5 US gal/min]
<b>Torque at maximum displacement (theoretical)</b>	1.42 N·m/bar [870 lbf·in/1000 psi]	1.62 N·m/bar [990 lbf·in/1000 psi]
<b>Mass moment of inertia of rotating components</b>	0.0116 kg·m <sup>2</sup> [0.0086 slug·ft <sup>2</sup> ]	
<b>Mass (dry)</b>	62 kg [137 lb] (without charge pump or auxiliary mounting flange)	
<b>Oil volume</b>	2.6 l [0.67 US gal]	
<b>Mounting flange</b>	ISO 3019-1 Flange 127-4 (SAE C)	
<b>Input shaft outer diameter, splines and tapered shafts</b>	ISO 3019-1: <ul style="list-style-type: none"> <li>Outer Ø32 mm – 4 (SAE C, 14 teeth)</li> <li>Outer Ø35 mm – 4 (SAE C, 21 teeth)</li> <li>Outer Ø38 mm – 4 (SAE C-C, 23 teeth)</li> <li>Conical keyed shaft end similar to ISO 3019-1 code 38-3, taper 1:8</li> </ul>	
<b>Auxiliary mounting flange with metric fasteners, Shaft outer diameter and splines</b>	ISO 3019-1: <ul style="list-style-type: none"> <li>Flange 82-2 Outer Ø16 mm – 4 (SAE A, 9 teeth)</li> <li>Flange 82-2 Outer Ø19 mm – 4 (SAE A, 11 teeth)</li> <li>Flange 101-2 Outer Ø22 mm – 4 (SAE B, 13 teeth)</li> <li>Flange 101-2 Outer Ø25 mm – 4 (SAE B-B, 15 teeth)</li> <li>Flange 127-4 Outer Ø32 mm – 4 (SAE C, 14 teeth)</li> </ul>	
<b>Suction port</b>	ISO 11926-1 – 1 5/8 -12 (SAE O-ring boss)	
<b>Main port configuration</b>	Ø25.4 mm, 450 bar Split flange boss per ISO 6162, M12x1.75	
<b>Case drain ports L2, L4</b>	ISO 11926-1 – 1 1/16 -12 (SAE O-ring boss)	
<b>Other ports</b>	SAE O-ring boss	
<b>Customer interface threads</b>	Metric fasteners	

## Technical specifications

### H1P 089/100 Operating Parameters

Feature		Size 089/100
Input speed	Minimum for internal <sup>1)</sup> and external <sup>2)</sup> charge supply.	500 min <sup>-1</sup> (rpm)
	Minimum for full performance for internal charge supply.	1200 min <sup>-1</sup> (rpm)
	Rated	3300 min <sup>-1</sup> (rpm)
	Maximum	3800 min <sup>-1</sup> (rpm)
System pressure	Maximum working	450 bar [ 6528 psi]
	Maximum	480 bar [ 6960 psi]
	Maximum low loop	45 bar [ 650 psi]
	Minimum low loop	10 bar [ 145 psi]
Charge pressure	Minimum	18 bar [ 261 psi]
	Maximum	34 bar [ 493 psi]
Control pressure	Minimum (at corner power for EDC and MDC)	17 bar [ 247 psi]
	Minimum (at corner power for NFPE)	25 bar [ 363 psi]
	Maximum	34 bar [ 493 psi]
Charge pump inlet pressure	Rated	0.7 bar (absolute) [ 9.0 in Hg vacuum]
	Minimum (cold start)	0.2 bar (absolute) [ 24.0 in Hg vacuum]
	Maximum	4.0 bar [ 58.0 psi]
Case pressure	Rated	3.0 bar [ 44.0 psi]
	Maximum	5.0 bar [ 73.0 psi]
Lip seal external maximum pressure		0.4 bar [ 5.8 psi]

<sup>1)</sup> Performance (displacement and pressure) may be limited due to limited control pressure.

<sup>2)</sup> Full performance (displacement and pressure) possible at (at minimum charge pressure and control pressure supply).

## Fluid Specifications

### Viscosity and Temperature range

Feature		Unit	Data
Viscosity	Intermittent <sup>1)</sup>	mm <sup>2</sup> /s [ SUS]	5 [42]
	Minimum		7 [49]
	Recommended range		12 – 80 [66 – 370]
	Maximum		1600 [7500]
Temperature range <sup>2)</sup>	Minimum <sup>3)</sup> (Cold start)	°C [ °F]	-40 [-40]
	Recommended range		60 – 85 [140 – 185]
	Rated		104 [220]
	Maximum Intermittent <sup>1)</sup>		115 [240]

<sup>1)</sup> Intermittent = Short term t < 1 min per incident and not exceeding 2 % of duty cycle based load-life

<sup>2)</sup> At the hottest point, normally case drain port

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

## Technical specifications

*Filtration, Cleanliness level and Efficiency  $\beta_x$ -ratio ( Recommended Minimum)*

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

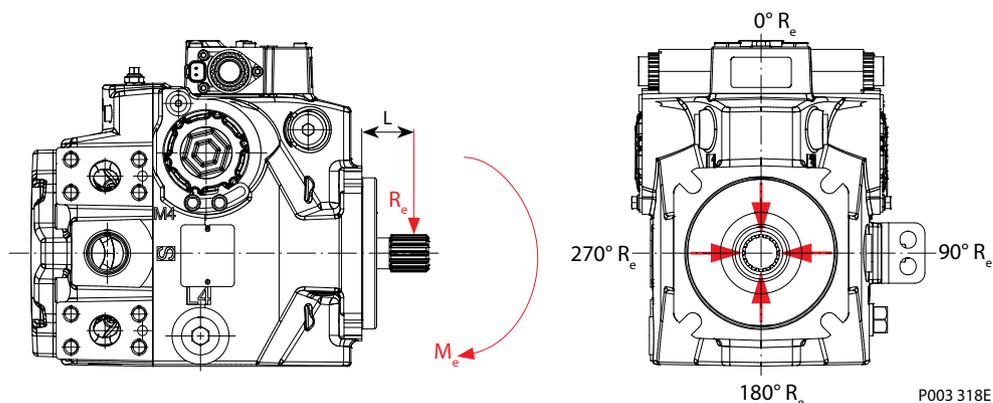
## External Radial Shaft Loads

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. External radial shaft loads impact lifetime. For lifetime calculations please contact your 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 formula:

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

*Radial load position*



- $M_e$  = shaft moment
- $L$  = flange distance
- $R_e$  = external force to the shaft

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

## H1P 089/100 Bearing Life

*Maximum external shaft load based on shaft deflection*

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

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.

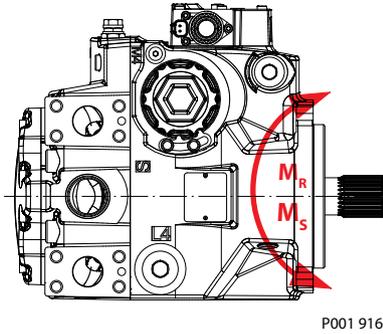
Danfoss recommends clamp-type couplings for applications with radial shaft loads.

Contact your 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.

**Technical specifications**

**H1P 089/100 Mounting Flange Loads**

*Mounting flange load*



The moments shown below apply for top or side control orientation:

<b>Rated moment</b>	$M_R = 5630 \text{ N}\cdot\text{m}$ [49 830 lbf·in]
<b>Shock load moment</b>	$M_S = 12\,190 \text{ N}\cdot\text{m}$ [ 107 900 lbf·in]

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For more information, see *H1 Axial Piston Pumps, Basic Information*, **BC00000057**, the section “Mounting flange loads”.

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## Technical specifications

### 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 <math>1500 \text{ min}^{-1}</math> (rpm)
- High shock loading and/or long loop lines
- High flushing flow requirements
- Multiple low speed high torque motors
- High input shaft speeds

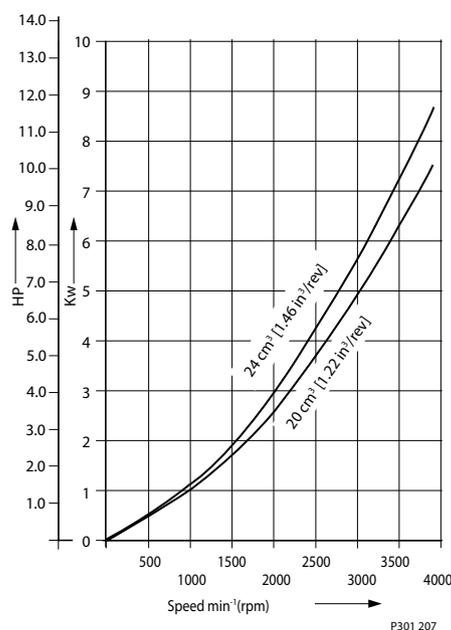
Contact your representative for application assistance if your application includes any of these conditions.

### Charge pump 20 cm<sup>3</sup> and 24 cm<sup>3</sup> flow and power curves

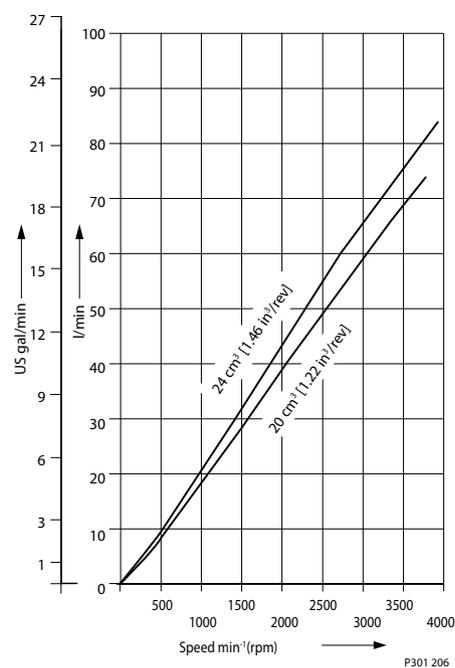
Charge pressure: 20 bar [290 psi]

Viscosity and temperature: 11 mm<sup>2</sup>/s [63 SUS] and 80 °C [180 °F]

Charge pump power requirements



Charge pump flow



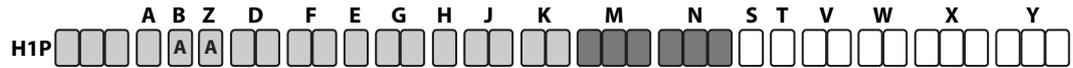








**Master Model Code**



*M – Overpressure protection type, side “A” / N – Overpressure protection type, side “B”*

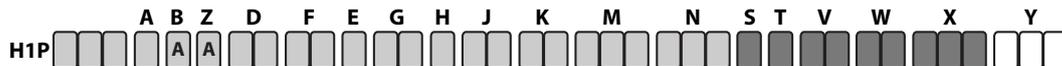
<b>Pressure limiter and HPRV with bypass, pressure protection type must be the same for side “A” and “B”</b>		
<b>L<sup>1)</sup></b>	<b>Pressure limiter setting</b>	<b>HPRV setting</b>
<b>L15</b>	150 bar [2900 psi]	200 bar [2900 psi]
<b>L18</b>	180 bar [2610 psi]	250 bar [3630 psi]
<b>L20</b>	200 bar [2900 psi]	250 bar [3630 psi]
<b>L23</b>	230 bar [3336 psi]	280 bar [4061 psi]
<b>L25</b>	250 bar [3630 psi]	300 bar [4350 psi]
<b>L28</b>	280 bar [4061 psi]	330 bar [4786 psi]
<b>L30</b>	300 bar [4350 psi]	350 bar [5080 psi]
<b>L33</b>	330 bar [4786 psi]	380 bar [5510 psi]
<b>L35</b>	350 bar [5080 psi]	400 bar [5800 psi]
<b>L38</b>	380 bar [5510 psi]	420 bar [6090 psi]
<b>L40</b>	400 bar [5800 psi]	450 bar [6526 psi]
<b>L42</b>	420 bar [6090 psi]	450 bar [6526 psi]
<b>L45</b>	450 bar [6526 psi]	480 bar [6962 psi]
<b>Overpressure protection type and setting for FDC</b>		
<b>F01</b>	150 bar [2175 psi]	250 bar [3630 psi]
<b>F02</b>	150 bar [2175 psi]	300 bar [4350 psi]
<b>F03</b>	150 bar [2175 psi] (Available for 089 only.)	350 bar [5080 psi]

<b>High pressure relief valve with bypass, pressure protection type must be the same for side “A” and “B”</b>	
<b>K<sup>1)</sup></b>	<b>Pressure setting<sup>2)</sup></b>
<b>K18</b>	180 bar [2610 psi]
<b>K20</b>	200 bar [2900 psi]
<b>K23</b>	230 bar [3336 psi]
<b>K25</b>	250 bar [3630 psi]
<b>K28</b>	280 bar [4061 psi]
<b>K30</b>	300 bar [4350 psi]
<b>K33</b>	330 bar [4786 psi]
<b>K35</b>	350 bar [5080 psi]
<b>K38</b>	380 bar [5510 psi]
<b>K40</b>	400 bar [5800 psi]
<b>K42</b>	420 bar [6090 psi]
<b>K45</b>	450 bar [6526 psi]

<sup>1)</sup> L, F – with pressure limiter; K – without pressure limiter.

<sup>2)</sup> Please contact for pressures not shown or for applied pressure above max. working pressure.

**Master Model Code**



*S – Charge pump*

<b>D</b>	20 cm <sup>3</sup> /rev [1.21 in <sup>3</sup> /rev]
<b>M</b>	24 cm <sup>3</sup> /rev [1.42 in <sup>3</sup> /rev]
<b>N</b>	No charge pump, external charge supply ( <i>Align with options: E and T</i> )

*T – Filtration (Align with option G – Endcap selection)*

<b>L</b>	Suction filtration (see <i>H1P 089/100 Suction filtration, option L</i> on page 62)
<b>M</b>	Integral full charge flow filtration with bypass, bypass sensor, medium filter length, <b>11004918</b>
<b>N</b>	Integral full charge flow filtration with bypass, bypass sensor, no filter
<b>P</b>	Remote full charge flow filtration
<b>E</b>	External charge flow filtration ( <i>Align with options: N and S</i> )

*V – Charge pressure relief setting*

<b>20</b>	20 bar [290 psi]	<a href="#">Not to be used for NFPE, AC and FDC controls.</a>
<b>22</b>	22 bar [319 psi]	
<b>24</b>	24 bar [348 psi]	
<b>26</b>	26 bar [377 psi]	
<b>28</b>	28 bar [406 psi]	
<b>30</b>	30 bar [435 psi]	
<b>32</b>	32 bar [464 psi]	
<b>34</b>	34 bar [493 psi]	

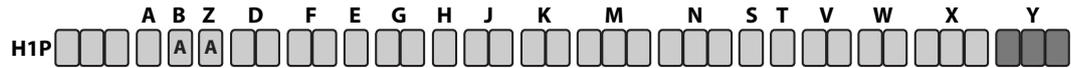
*W – Special hardware features*

<b>PN</b>	EDC / FNR / MDC valve plate
<b>P1</b>	NFPE valve plate ( <i>Align with options: D and E</i> )
<b>P2</b>	NFPE / FDC / AC valve plate and speed ring on the cylinder block
<b>P4</b>	EDC / FNR / MDC valve plate with speed ring on the cylinder block ( <i>Align with options: D and E</i> )
<b>H1</b>	MDC / EDC / FNR valve plate with MDC handle

*X – Paint and nametag*

<b>NNN</b>	Black paint and nametag
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**Master Model Code**



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

Code	CAN J1939	ECO fuel saving mode	Functional option	Cruise control	Control	AC type
<b>D3E</b>	in/out	●	E	–	N1 (12 V <sub>DC</sub> )	AC-1
<b>D3F</b>	in/out	–	F	–		
<b>D4E</b>	in/out	●	E	–	N2 (24 V <sub>DC</sub> )	
<b>D4F</b>	in/out	–	F	–		
<b>D5F</b>	in/out	–	F	–	P8 (12 V <sub>DC</sub> )	AC-2 with Swash Plate Angle Sensor
<b>D5J</b>	in/out	●	J	●		
<b>D6F</b>	in/out	–	F	–	P9 (24 V <sub>DC</sub> )	
<b>D6J</b>	in/out	●	J	●		
<b>M00</b>	MDC handle standard position					
<b>NNN</b>	None					

● = available option  
 – = not available option

## Control Options

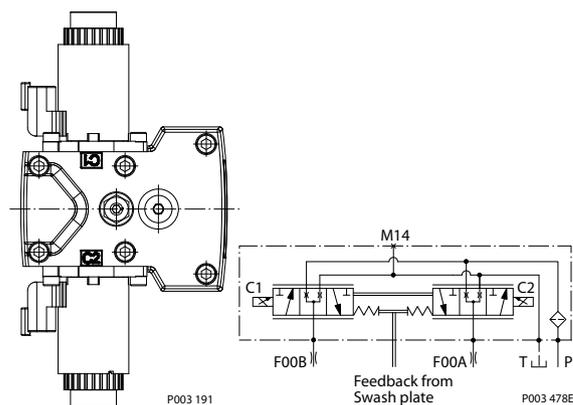
### Electrical Displacement Control (EDC)

The Electrical Displacement Control (EDC) consists of a pair of proportional solenoids on each side of a three-position, four-way porting spool. The proportional solenoid applies a force input to the spool, which ports hydraulic pressure to either side of a double acting servo piston.

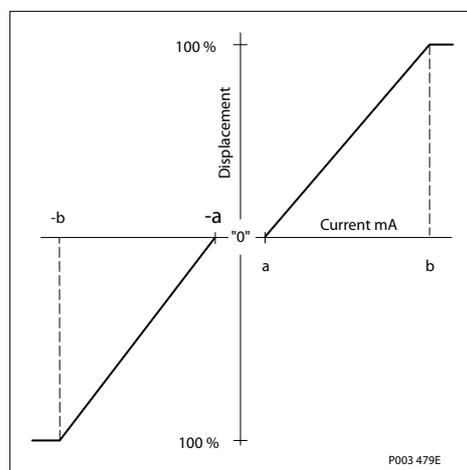
Differential pressure across the servo piston rotates the swashplate, changing the pump's displacement from full displacement in one direction to full displacement in the opposite direction.

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.

*Electrical Displacement Control, with hydraulic schematic*



*Pump displacement vs. control current*



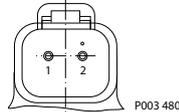
## Control Options

### EDC Control Signal Requirements

*Control minimum current to stroke pump*

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

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



*Connector ordering data*

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

### EDC Solenoid Data

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

\* PWM signal required for optimum control performance.

*Pump output flow direction vs. control signal*

Shaft rotation	CW		CCW	
	C1	C2	C1	C2
Coil energized*				
Port A	out	in	in	out
Port B	in	out	out	in
Servo port pressurized	M4	M5	M4	M5

\* For coil location see Installation drawings.

## Control Options

### 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). 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 orifice selection for the desired response.

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

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*Typical response times at the following conditions:*

<b><math>\Delta p</math></b>	250 bar [3626 psi]
<b>Viscosity and temperature</b>	30 mm <sup>2</sup> /s [141 SUS] and 50 °C [122 °F]
<b>Charge pressure</b>	20 bar [290 psi]
<b>Speed</b>	1800 min <sup>-1</sup> (rpm)

### EDC Response Time

<b>Stroking direction</b>	<b>0.8 mm [0.03 in] orifice</b>	<b>1.3 mm [0.05 in] orifice</b>	<b>No orifice</b>
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.

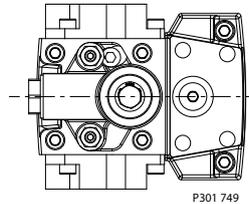
Differential pressure across the servo piston rotates the swash plate, changing the pump's displacement. Simultaneously the swashplate movement is fed back to the control spool providing proportionality between shaft rotation on the control and swashplate rotation.

The MDC changes the pump displacement between no flow and full flow into opposite directions. Under some circumstances, such as contamination, the control spool could stick and cause the pump to stay at some displacement.

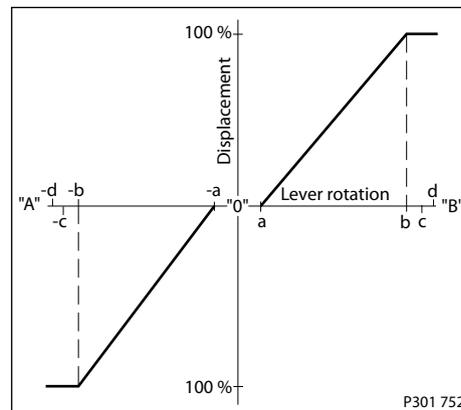
A serviceable 125 µm screen is located in the supply line immediately before the control porting spool.

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

#### Manual Displacement Control



#### Pump displacement vs. control lever rotation



#### Legend:

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

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

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

Internal end stop –  $d = 40^\circ$

#### 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]

## Control Options

**! Caution**

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

### MDC General Information

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

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

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

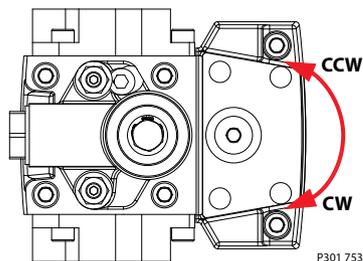
Customers can apply their own handle design but they must care about a robust clamping connection between their handle and the control shaft and avoid overload of the shaft.

Customers can connect two MDC's on a tandem unit in such a way that the actuation force will be transferred from the pilot control to the second control but the kinematic of the linkages must ensure that either control shaft is protected from torque overload. To avoid an overload of the MDC, customers must install any support to limit the setting range of the Bowden cable.

**! Caution**

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

### MDC Shaft Rotation



MDC shaft rotation data

Pump shaft rotation*	Clock Wise (CW)		Counter Clock Wise (CCW)	
	CW	CCW	CW	CCW
Port A	in (low)	out (high)	out (high)	in (low)
Port B	out (high)	in (low)	in (low)	out (high)
Servo port high pressure	M5	M4	M5	M4

\* As seen from shaft side.

## Control Options

### 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). 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 orifice selection for the desired response.

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

*Typical response times at the following conditions:*

<b><math>\Delta p</math></b>	250 bar [3626 psi]
<b>Viscosity and temperature</b>	30 mm <sup>2</sup> /s [141 SUS] and 50 °C [122 °F]
<b>Charge pressure</b>	20 bar [290 psi]
<b>Speed</b>	1800 min <sup>-1</sup> (rpm)

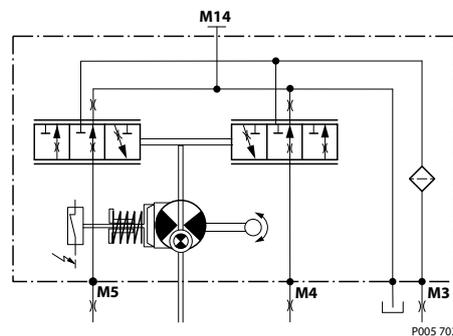
### MDC Response Time

Code	Orifice description (mm)				Stroking direction (sec)	
	P	A	B	Tank (A+B)	Neutral to full flow	Full flow to neutral
<b>C3</b>	–	–	–	–	0.5	0.6
<b>C6</b>	–	–	–	1	1.7	1.5
<b>C7</b>	–	–	–	1.3	1.1	1.0
<b>D1</b>	1	–	–	0.8	3.1	2.4
<b>D2</b>	1.3	–	–	0.8	2.8	2.2
<b>D3</b>	1.3	–	–	1	2.0	1.6
<b>D4</b>	1.3	1.3	1.3	1	2.4	1.9

### 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*

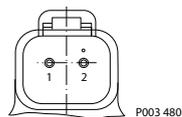
<b>Max. continuous current with switching</b>	8.4 A
<b>Max. continuous current without switching</b>	20 A

## Control Options

### Neutral Start Switch data (continued)

<b>Max. voltage</b>	36 V <sub>DC</sub>
<b>Electrical protection class</b>	IP67 / IP69K with mating connector

### Connector



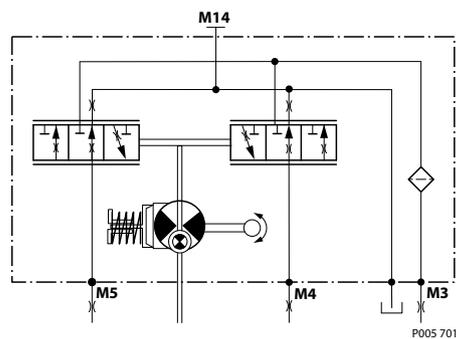
### Connector ordering data

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

### MDC schematic diagram



### Lever

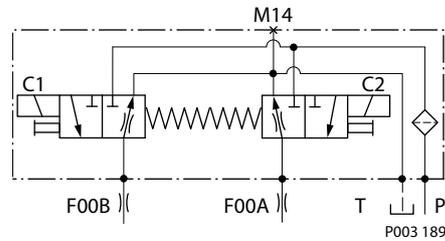
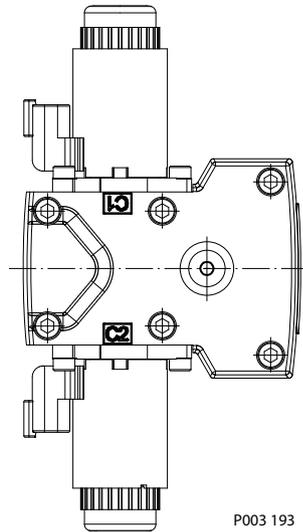
MDC-controls are available with an integrated lever.

## Control Options

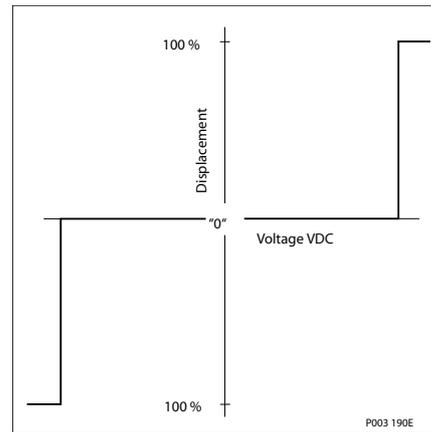
### Forward-Neutral-Reverse electric control (FNR), options: A9 (12 V) and B1 (24 V)

The 3-position **FNR** 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.

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

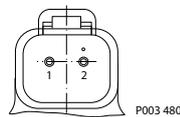


*Pump displacement vs. electrical signal*



### Control current

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



### Connector ordering data

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

## Control Options

### Solenoid data

Voltage	12 V	24 V
Minimum supply voltage	9.5 V <sub>DC</sub>	19 V <sub>DC</sub>
Maximum supply voltage (continuous)	14.6 V <sub>DC</sub>	29 V <sub>DC</sub>
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 69K (part 9 with mating connector)	
Bi-directional diode cut off voltage	28 V <sub>DC</sub>	53 V <sub>DC</sub>

\* 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](#) on page 49.

### 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). 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 orifice selection for the desired response.

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

Typical response times at the following conditions:

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

### FNR Response Time

Stroking direction	0.8 [0.03] orifice	1.3 [0.05] orifice	No orifice
Neutral to full flow	3.7 s	1.8 s	0.8 s
Full flow to neutral	2.3 s	0.8 s	0.3 s

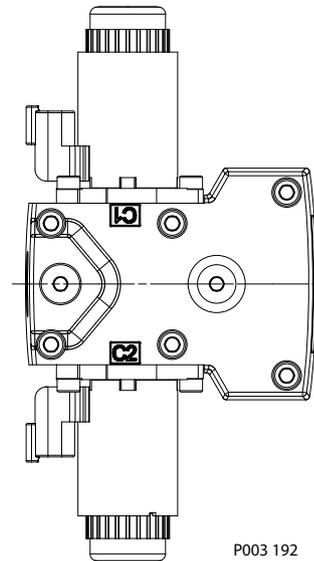
## Control Options

### 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.

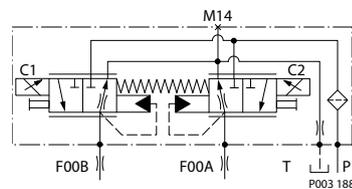
A serviceable 170  $\mu\text{m}$  screen is located in the supply line immediately before the control porting spool.

#### *Non Feedback Proportional Electric Control*



P003 192

#### *NFPE schematic*

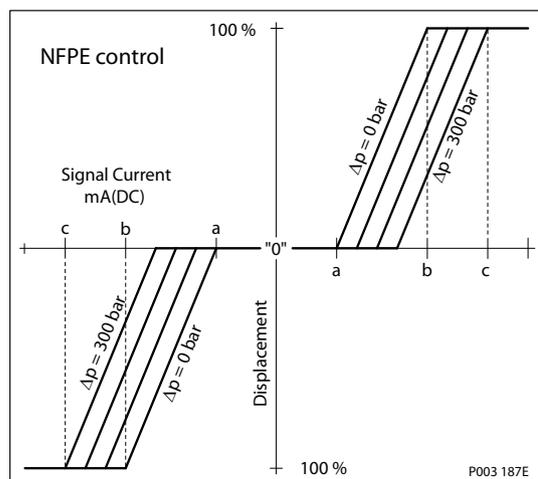


P003 188

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.

## Control Options

*Pump displacement vs. input signal*

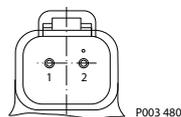


### NFPE Control Signal Requirements

*Control current*

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

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



*Connector ordering data*

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

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

<b>Shaft rotation</b>	<b>CW</b>		<b>CCW</b>	
<b>Coil energized*</b>	<b>C1</b>	<b>C2</b>	<b>C1</b>	<b>C2</b>
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

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). 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 orifice selection for the desired response.

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

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*Typical response times at the following conditions:*

<b><math>\Delta p</math></b>	250 bar [3626 psi]
<b>Viscosity and temperature</b>	30 mm <sup>2</sup> /s [141 SUS] and 50 °C [122 °F]
<b>Charge pressure</b>	20 bar [290 psi]
<b>Speed</b>	1800 min <sup>-1</sup> (rpm)

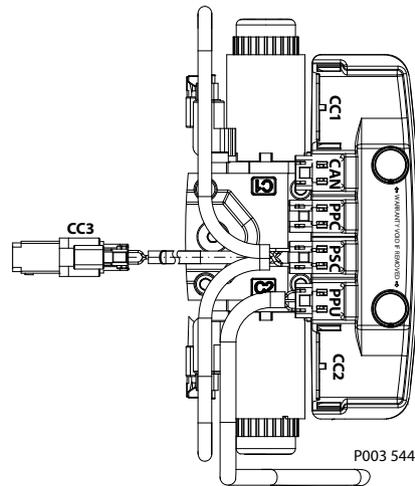
### NFPE Response Time

<b>Stroking direction</b>	<b>0.8 [0.03] orifice</b>	<b>1.3 [0.05] orifice</b>	<b>No orifice</b>
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 microcontroller, installed on the pump. The integrated microcontroller enhanced control performance with a flexible, configurable control scheme for an entire single path propel transmission. It can be used in combination with fixed and variable displacement hydraulic-motors. With the pre-installed application software and easily changeable control parameters, it is possible to tailor the vehicle's driving behavior to the individual requirements of the customer.



The H1 Automotive Control is divided into 2 systems:

- AC-1
- AC-2

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

### Mode types

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

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

### Basic functions

- Four selectable system modes, selectable via switch.
- Individual settings for forward and reverse driving direction (4 x 2 curves).
- Independent pump and hydraulic-motor profiling and ramping for each mode.
- Electric drive pedal connection
- Electronic inching function without separate control valve
- Electric creep mode potentiometer

## Control Options

- Configurable System Mode & Direction change
- Load independent pump displacement control with integrated Swash Plate Angle Sensor (AC-2)
- Hydraulic-motor displacement control including brake pressure defeat function

### Performance functions

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

### Protection and safety functions

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

### Engine control and protection

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

### Installation features

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

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

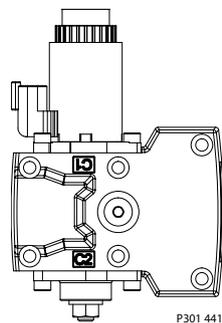
## Control Options

### Fan Drive Control (FDC)

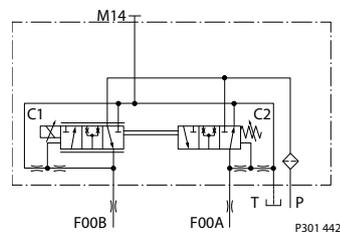
The Fan Drive Control (**FDC**) is a non-feedback control in which an electrical input signal activates the proportional solenoid that ports charge pressure to either side of the pump servo cylinder. The single proportional solenoid is used to control pump displacement in the forward or reverse direction. The control spool is spring biased to produce maximum forward pump displacement in the absence of an electrical input signal. Based on the spring bias spool default forward flow for a CW rotation pump is out of Port B while default forward flow for a CCW rotation pump is out of Port A.

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.

#### FDC control



#### FDC hydraulic schematic



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.

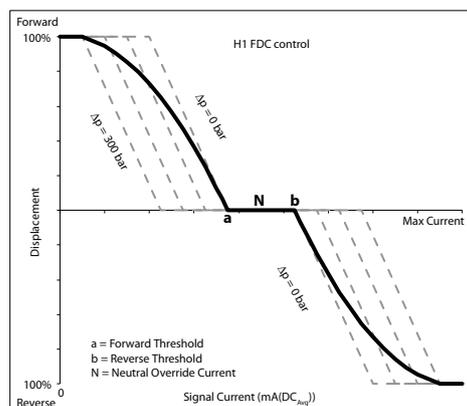
For more information necessary to properly size and configure a hydraulic fan drive system, see [Hydraulic Fan Drive Design Guidelines AB00000019](#).

Use in other systems could result in unintended movement of the machine or it's elements. Loss of the input signal to this control will cause the pump to produce maximum flow.

The FDC is for Fan Drive systems only!

## Control Options

*Pump displacement vs. control current*



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### 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). 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 orifice selection for the desired response.

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

*Typical response times at the following conditions:*

<b><math>\Delta p</math></b>	250 bar [3626 psi]
<b>Viscosity and temperature</b>	30 mm <sup>2</sup> /s [141 SUS] and 50 °C [122 °F]
<b>Charge pressure</b>	20 bar [290 psi]
<b>Speed</b>	1800 min <sup>-1</sup> (rpm)

### FDC Response Time

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

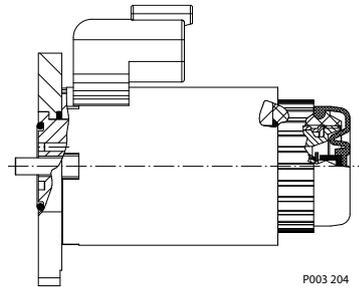
## Control Options

### Manual Over Ride (MOR)

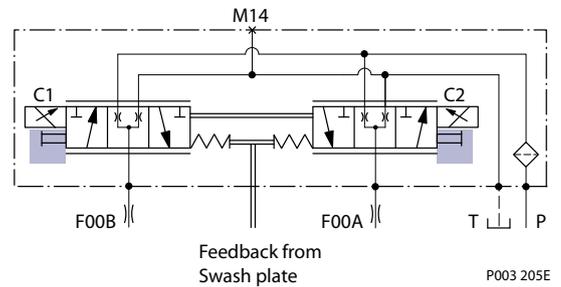
All controls are available with a Manual Over Ride (MOR) either standard or as an option for temporary actuation of the control to aid in diagnostics.

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

Manual OverRide (MOR)



MOR schematic diagram (EDC shown)



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

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

The MOR should be engaged anticipating a full stroke response from the pump.

### Warning

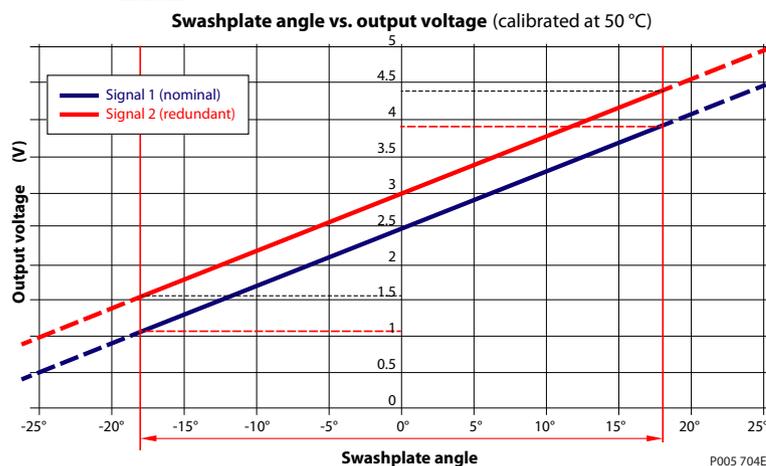
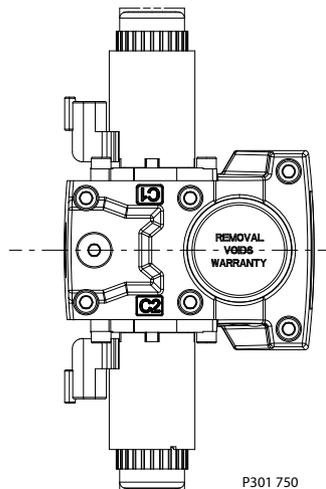
An o-ring seal is used to seal the MOR plunger where initial actuation of the function will require a force of 45 N to engage the plunger. Additional actuations typically require less force to engage the MOR plunger. Proportional control of the pump using the MOR should not be expected.

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

## 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. The swashplate angle sensor is available for all NFPE and AC2 controls.



### Swash Plate Angle Sensor Parameters

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 <sup>1)</sup>	–	–	7.5 mA
Sensitivity	70.0 mV/deg	78.0 mV/deg	85.8 mV/deg
Working range (swashplate angle)	–18°C	0°C	18°C
Correlation between signals 1 and 2 <sup>2)</sup>	475 mV	500 mV	525 mV

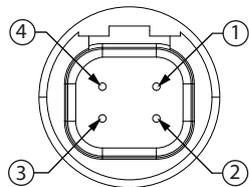
<sup>1)</sup> Up to duration of 2.5 seconds at 25°C

<sup>2)</sup> Signal 1 (nominal) is lower than signal 2 (redundant)

## Control Options

### Swash plate angle sensor connector

#### Pin assignment



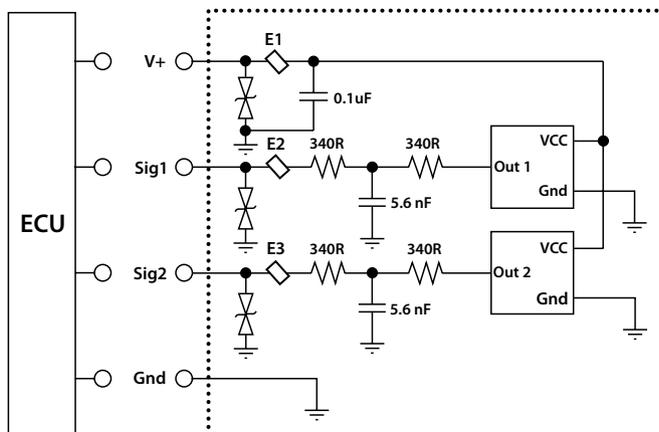
1. Ground (GND)
2. Output Signal 2 (SIG2) – Secondary (redundant)
3. Output Signal 1 (SIG1) – Primary (nominal)
4. Supply (V+)

#### Swash angle sensor connector order numbers

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

### Interface with ECU

#### Interface with ECU schematic



Minimum recommended load resistance is 100 kΩ.

## Control Options

### Control-Cut-Off valve (CCO valve)

The H1 pump offers an optional control cut off valve integrated into the control. 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.

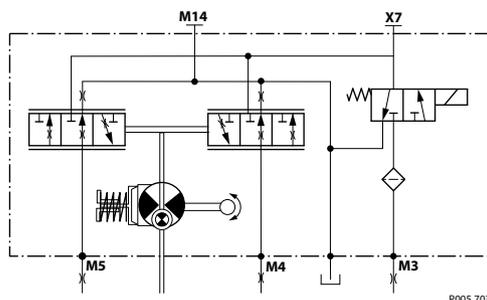
When the solenoid is energized, charge flow and pressure is allowed to reach the pump control. The X7 logic port will also be connected to charge pressure and flow.

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.

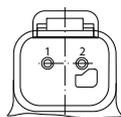
All EDC and MDC controls are available with a CCO valve. The CCO-valve is available with 12 V or 24 V solenoid.

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

*CCO schematic (MDC shown)*



### CCO connector



*Connector ordering data*

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

### CCO solenoid data

Nominal supply voltage		12 V	24 V
Supply voltage	Maximum	14.6 V	29 V
	Minimum	9.5 V	19 V
Nominal coil resistance at 20°C		10.7 Ω	41.7 Ω

### Control Options

Nominal supply voltage		12 V	24 V
Supply current	Maximum	850 mA	430 mA
	Minimum	580 mA	300 mA
PWM frequency	Range	50-200 Hz	50-200 Hz
	Preferred	100 Hz	100 Hz
Electrical protection class		IP67 / IP69K with mating connector	
Bi-directional diode cut off voltage		28 V	53 V

#### Brake gauge port with MDC

 **Caution**

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

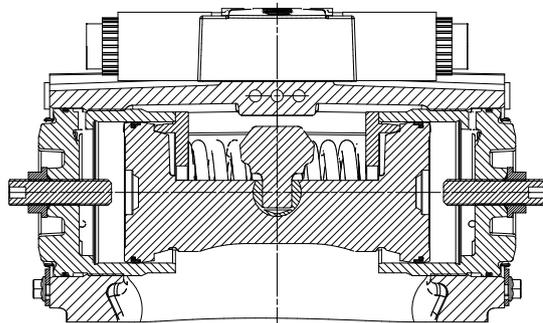
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## Control Options

### 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 089/100 Displacement Change (Approximately)

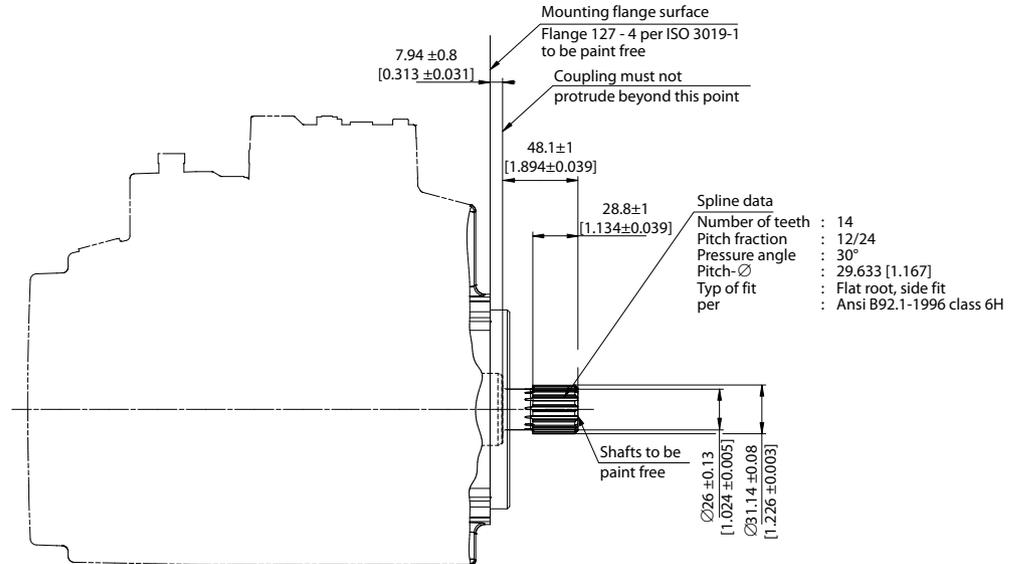
Parameter	Size 089	Size 100
<b>1 Turn of displacement limiter screw</b>	17.4 cm <sup>3</sup> [1.06 in <sup>3</sup> ]	20.7 cm <sup>3</sup> [1.26 in <sup>3</sup> ]
<b>Internal wrench size</b>	6 mm	
<b>External wrench size</b>	22 mm	
<b>Torque for external hex seal lock nut</b>	80 N·m [708 lbf·in]	

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

**Dimensions**

**H1P 089/100 input shaft - Option G1, (SAE C, 14 teeth)**

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



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*Specifications*

<b>Option</b>	<b>G1</b>	
<b>Spline</b>	14 teeth, 12/24 pitch	
<b>Min. active spline length<sup>1)</sup></b>	28.8 mm [1.134 in]	
<b>Torque rating<sup>2)</sup></b>	<b>Rated</b>	534 N·m [4720 lbf·in]
	<b>Maximum</b>	816 N·m [7220 lbf·in]

<sup>1)</sup> Minimum active spline length for the specified torque ratings.

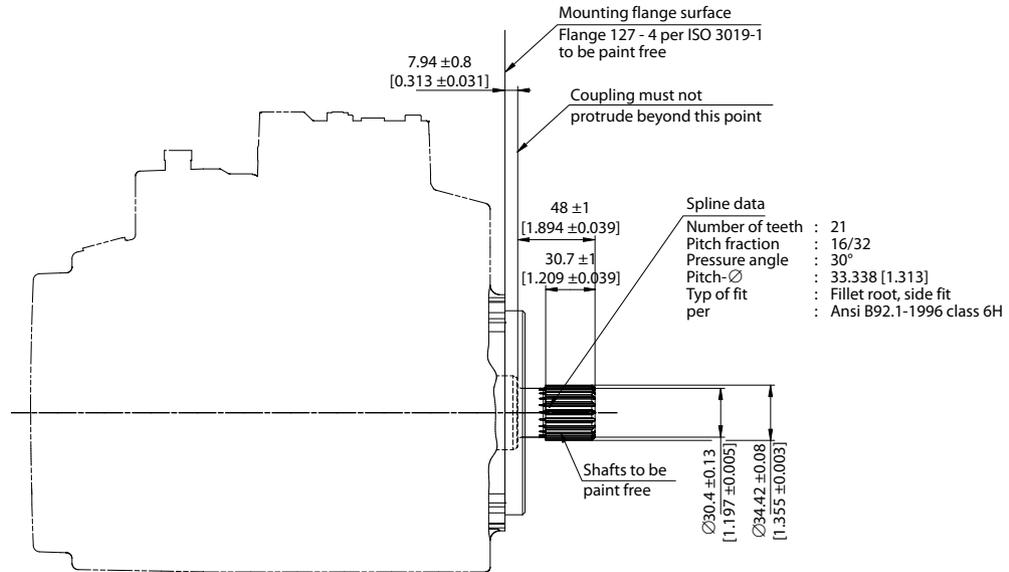
<sup>2)</sup> For definitions of maximum and rated torque values, refer to *Basic Information 11062168*, section Shaft Torque Ratings and Spline Lubrication.



**Dimensions**

**H1P 089/100 input shaft - Option F1, (SAE C, 21 teeth)**

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



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*Specifications*

<b>Option</b>	<b>F1</b>	
<b>Spline</b>	21 teeth, 16/32 pitch	
<b>Min. active spline length<sup>1)</sup></b>	30.7 mm [1.209 in]	
<b>Torque rating<sup>2)</sup></b>	<b>Rated</b>	760 N·m [6730 lbf·in]
	<b>Maximum</b>	1137 N·m [10 060 lbf·in]

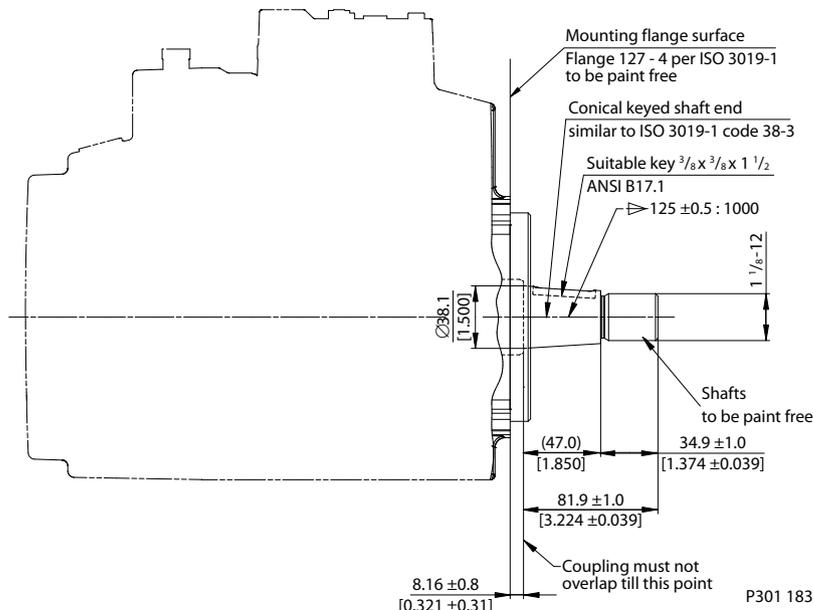
<sup>1)</sup> Minimum active spline length for the specified torque ratings.

<sup>2)</sup> For definitions of maximum and rated torque values, refer to *Basic Information 11062168*, section Shaft Torque Ratings and Spline Lubrication.

## Dimensions

### H1P 089/100 input shaft - Option F4, Code 38-3

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



### Specifications

Option	F4	
Tapered shaft <sup>1)</sup>	38.1 taper without key	
Torque rating <sup>2)</sup>	Rated <sup>3)</sup>	1116 N·m [9880 lbf·in]
	Maximum	1488 N·m [13 170 lbf·in]

<sup>1)</sup> Mating part must maintain a minimum gap width of 1 mm with the shaft shoulder after installation of the part. Transmittable torque will be reduced if the minimum gap requirement is not met.

<sup>2)</sup> For definitions of max. and rated torque values, refer to *Basic Information 11062168*, section *Shaft Torque Ratings, Spline Lubrication*.

<sup>3)</sup> Rated torque includes just the capability of the press-fit in accordance with an assumed fastener grade 5.

### Tapered shaft customer acknowledgement

The H1 tapered shaft has been designed using the industry standard ISO 3019-1, minus the through-hole in the end of the shaft. 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.

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

### ⚠ Caution

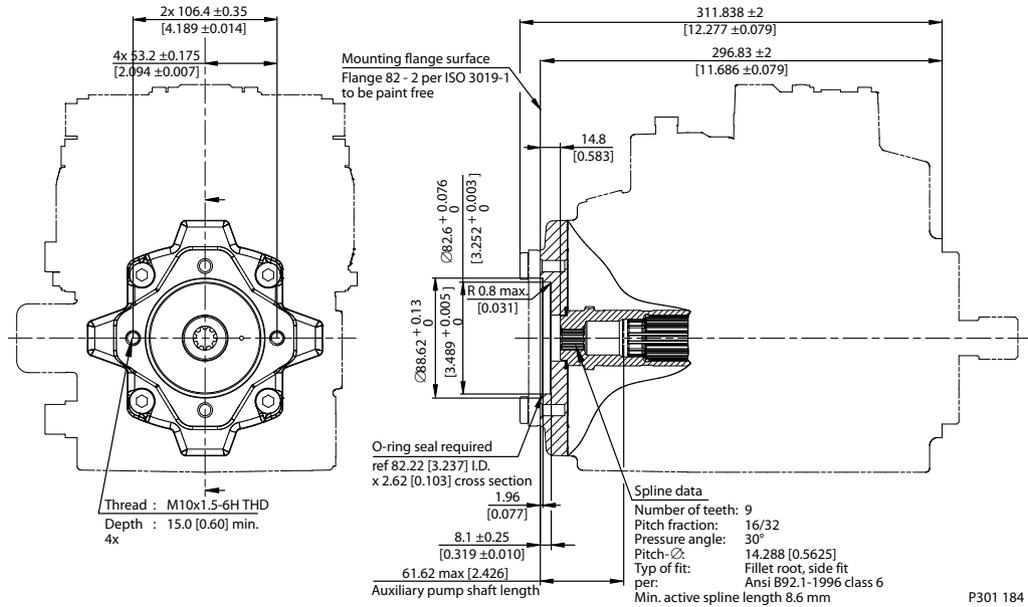
Possible hazard because torque or loading inadvertently transmitted by the customer supplied key may lead to premature shaft failure.

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

**Dimensions**

**H1P 089/100 Auxiliary mounting - Option H2 (SAE A, 9 teeth)**

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



*Specifications*

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

<sup>1)</sup> For definitions of maximum and rated torque values, refer to *Basic Information 11062168*, section Shaft Torque Ratings and Spline Lubrication.

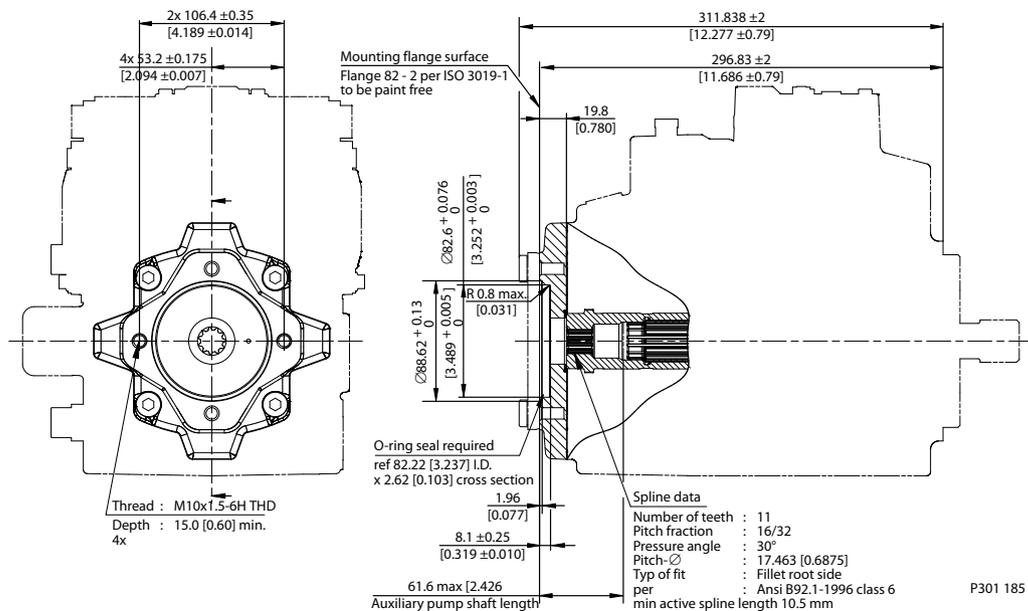
**Warning**

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 089/100 Auxiliary mounting - Option H1 (SAE A, 11 teeth)**

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



*Specifications*

<b>Option</b>	<b>H1</b>
<b>Spline</b>	11 teeth, 16/32 pitch
<b>Maximum torque<sup>1)</sup></b>	296 N·m [2620 lbf·in]

<sup>1)</sup> For definitions of maximum and rated torque values, refer to *Basic Information 11062168*, section Shaft Torque Ratings and Spline Lubrication.

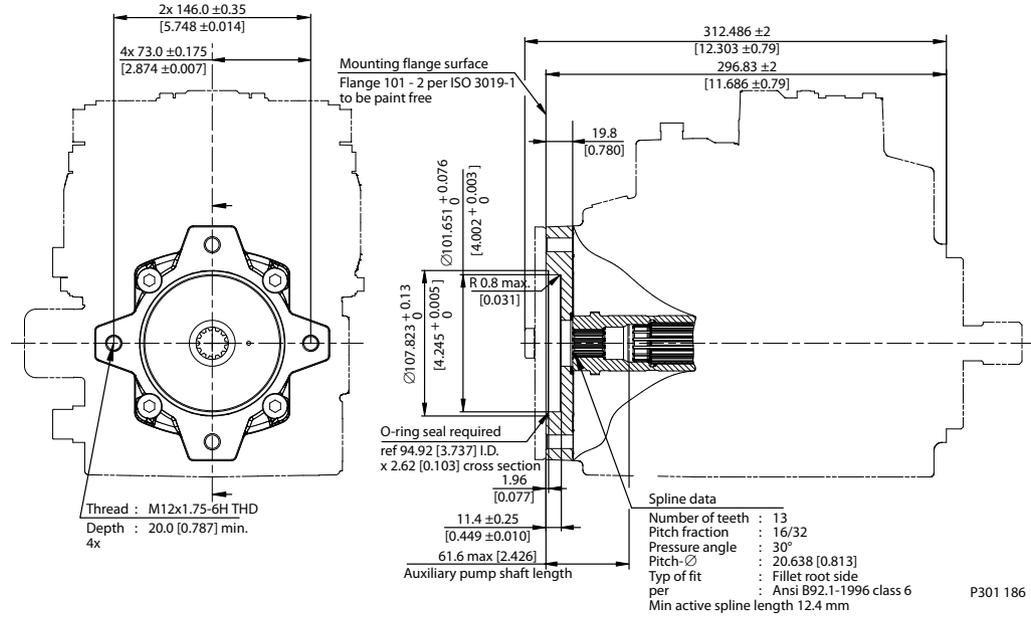
**Warning**

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 089/100 Auxiliary mounting - Option H3 (SAE B, 13 teeth)**

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



*Specifications*

Option	H3
Spline	13 teeth, 16/32 pitch
Maximum torque <sup>1)</sup>	395 N•m [3500 lbf•in]

<sup>1)</sup> For definitions of maximum and rated torque values, refer to *Basic Information 11062168*, section Shaft Torque Ratings and Spline Lubrication.

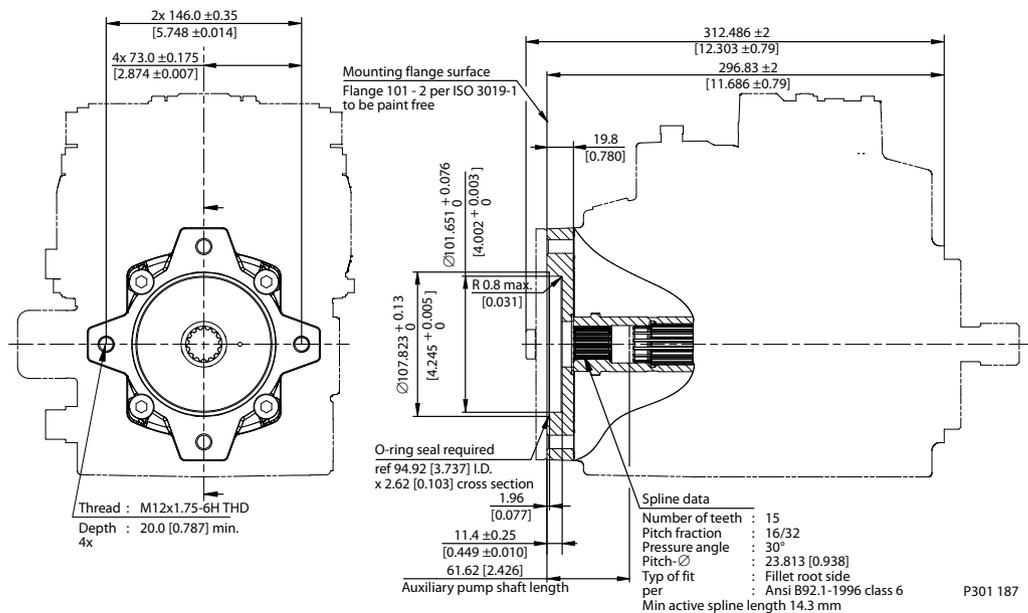
**Warning**

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 089/100 Auxiliary mounting - Option H5 (SAE B-B, 15 teeth)**

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



*Specifications*

<b>Option</b>	<b>H5</b>
<b>Spline</b>	15 teeth, 16/32 pitch
<b>Maximum torque<sup>1)</sup></b>	693 N·m [6130 lbf·in]

<sup>1)</sup> For definitions of maximum and rated torque values, refer to *Basic Information 11062168*, section Shaft Torque Ratings and Spline Lubrication.

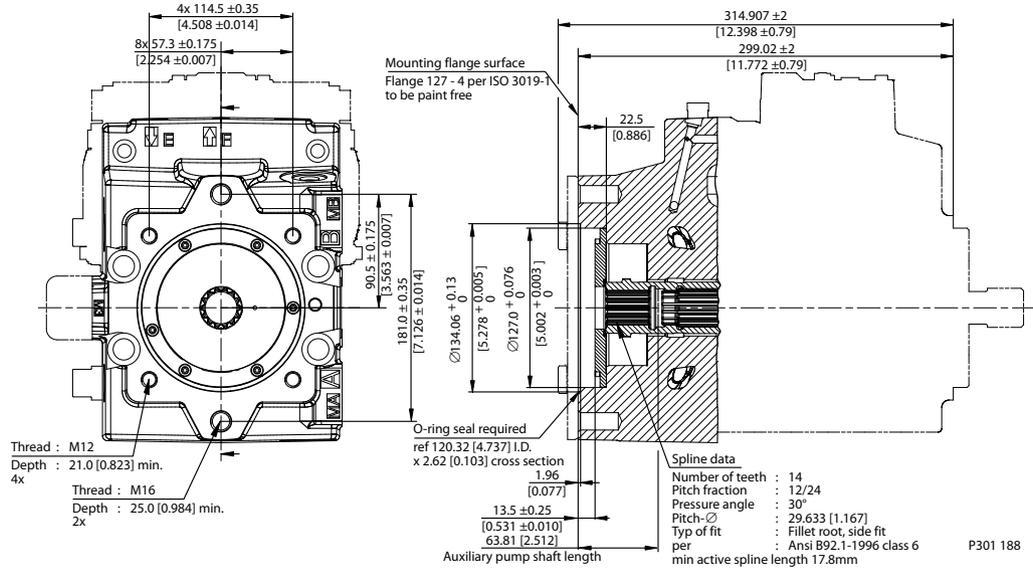
**Warning**

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 089/100 Auxiliary mounting - Option H6 (SAE C, 14 teeth)**

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



**Specifications**

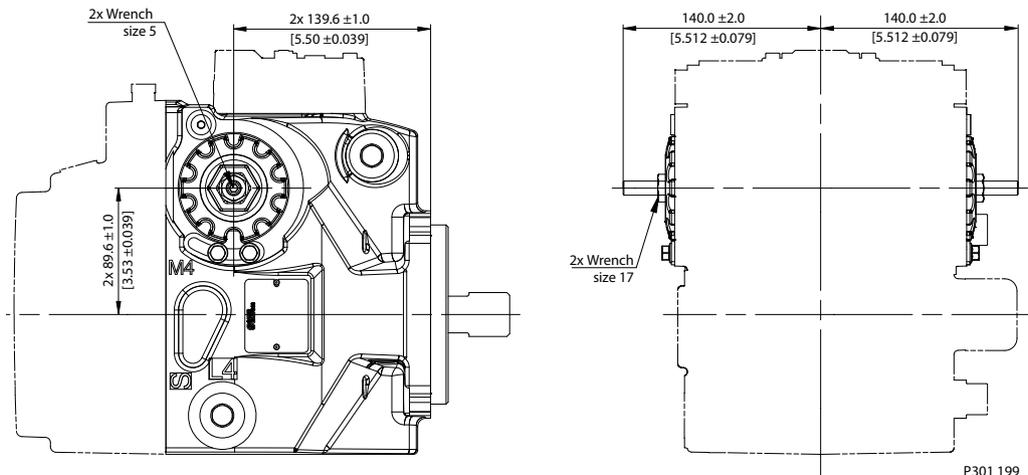
<b>Option</b>	<b>H6</b>
<b>Spline</b>	14 teeth, 12/24 pitch
<b>Maximum torque<sup>1)</sup></b>	816 N·m [7220 lbf·in]

<sup>1)</sup> For definitions of maximum and rated torque values, refer to *Basic Information 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.

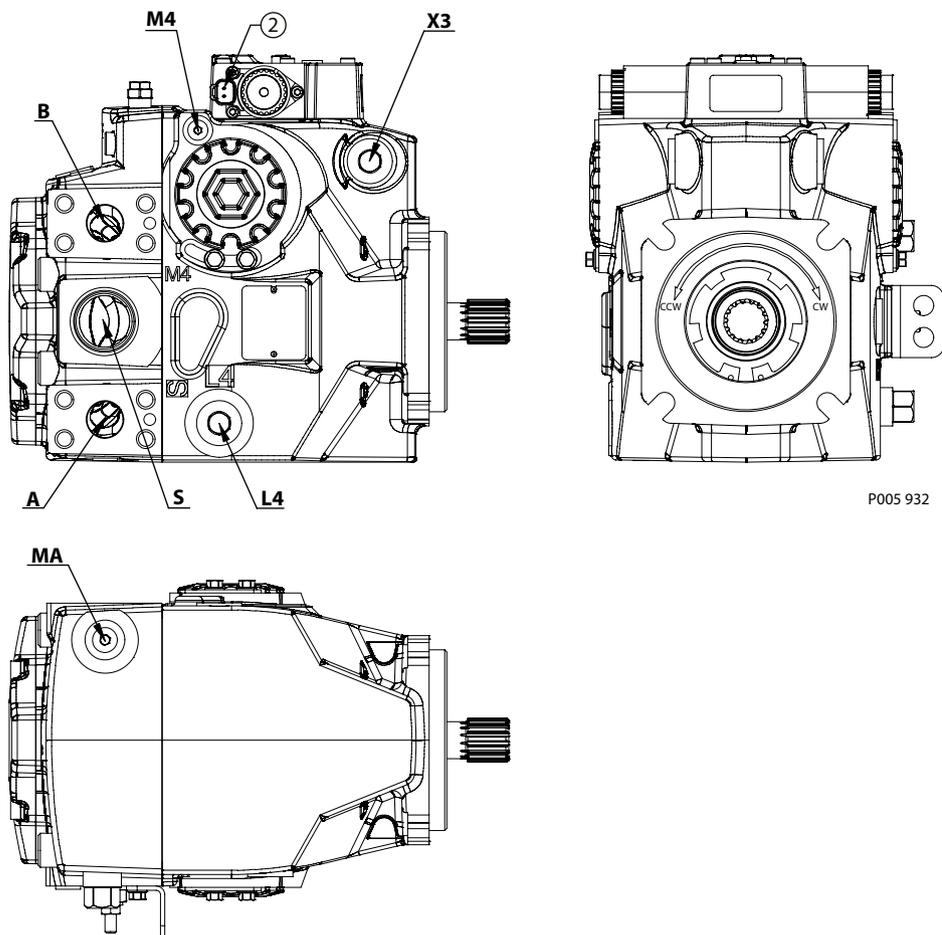
**H1P 089/100 displacement limiters, option B**



Please contact representative for specific installation drawings.

**Installation drawings**

**Port description H1P 089/100**

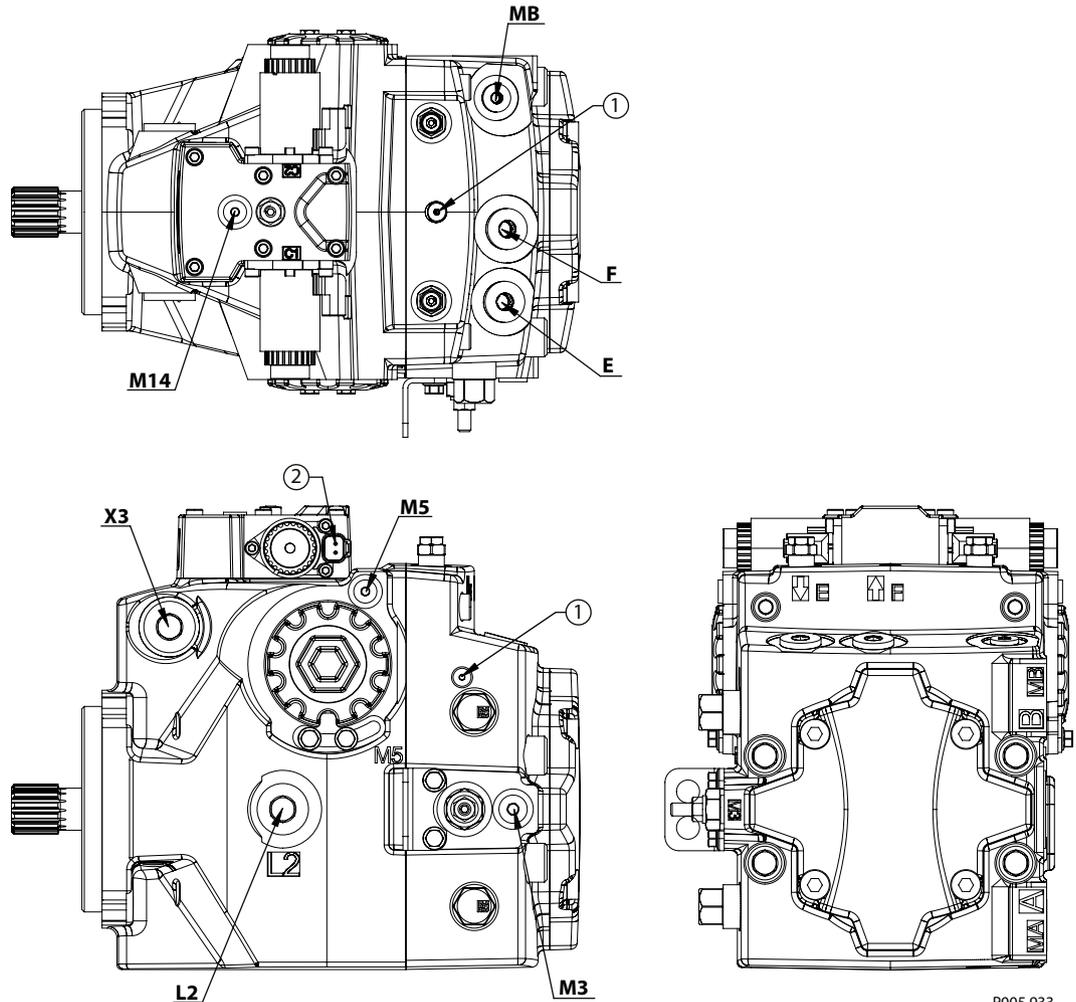


Ports per ISO 11926-1 description

Port	Description	Size 089/100
<b>A, B</b>	System ports <b>A</b> and <b>B</b> 450 bar, Split flange boss per ISO 6162	Ø 25.4 mm; M12 x 1.75; 20 min. full thread depth; Recommended screw in depth 1.5 x thread dia
<b>MA</b>	System <b>A</b> gauge port	$\frac{9}{16}$ -18; Ø28 max clearance for fitting
<b>L1</b>	Case pressure port	$1\frac{1}{16}$ -12; Ø48 max clearance for fitting
<b>L4</b>	Case drain port	$1\frac{1}{16}$ -12; Ø48 max clearance for fitting
<b>M4</b>	Servo gauge port	$\frac{7}{16}$ -20; Ø21 max clearance for fitting
<b>S</b>	Charge inlet port	$1\frac{5}{8}$ -12; Ø69 max clearance for fitting

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

**Installation drawings**



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

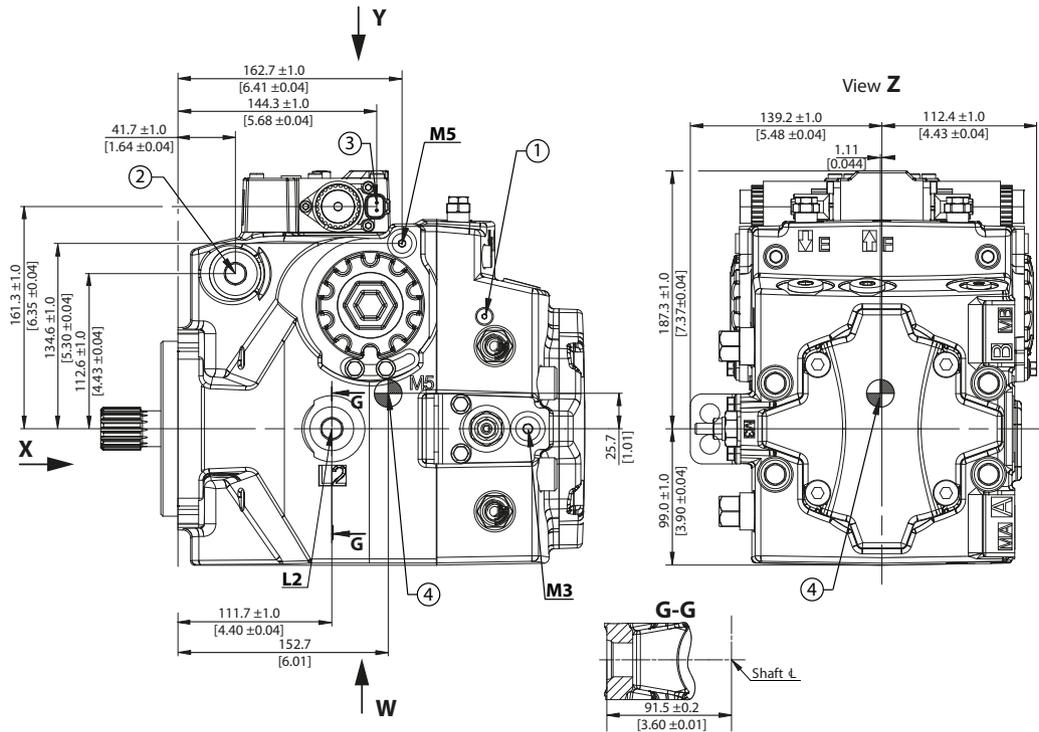
Ports per **ISO 11926-1** description

Port	Description	Size 089/100
E, F	Charge filtration port from/to filter	$\frac{7}{8}$ -12; Ø42 max clearance for fitting
L2, L3	Case drain/pressure port	$\frac{7}{8}$ -12; Ø48 max clearance for fitting
MB	System B gauge port	$\frac{9}{16}$ -18; Ø28 max clearance for fitting
M3	Charge gauge port, after filtering	$\frac{9}{16}$ -18; Ø28 max clearance for fitting
M5	Servo gauge port	$\frac{7}{16}$ -20; Ø21 max clearance for fitting
M14	Case gauge port	$\frac{7}{16}$ -20; Ø21 max clearance for fitting

Please contact representative for specific installation drawings.

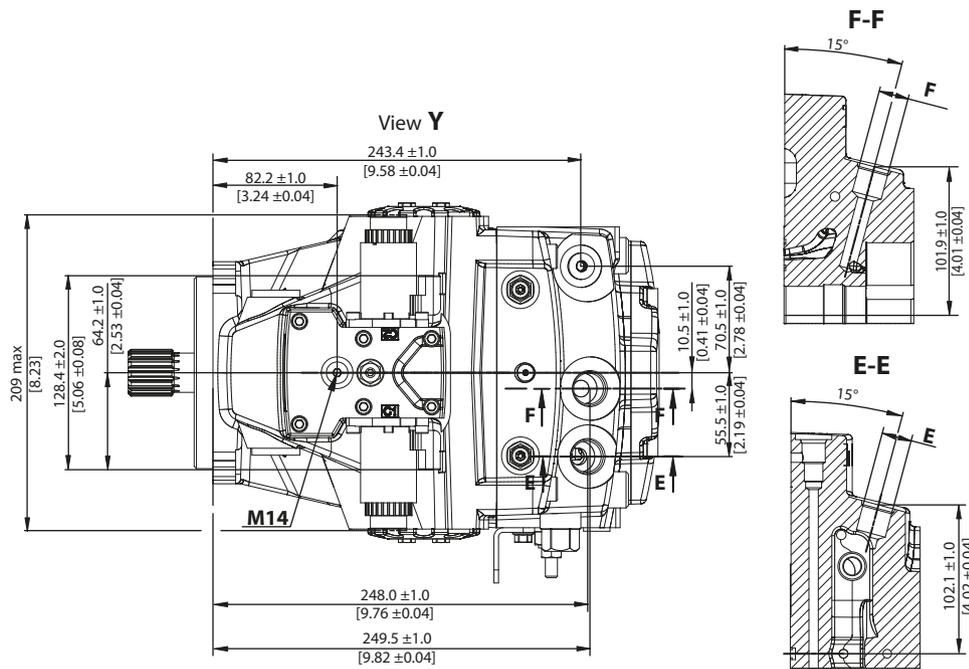


**Installation drawings**



P005 936

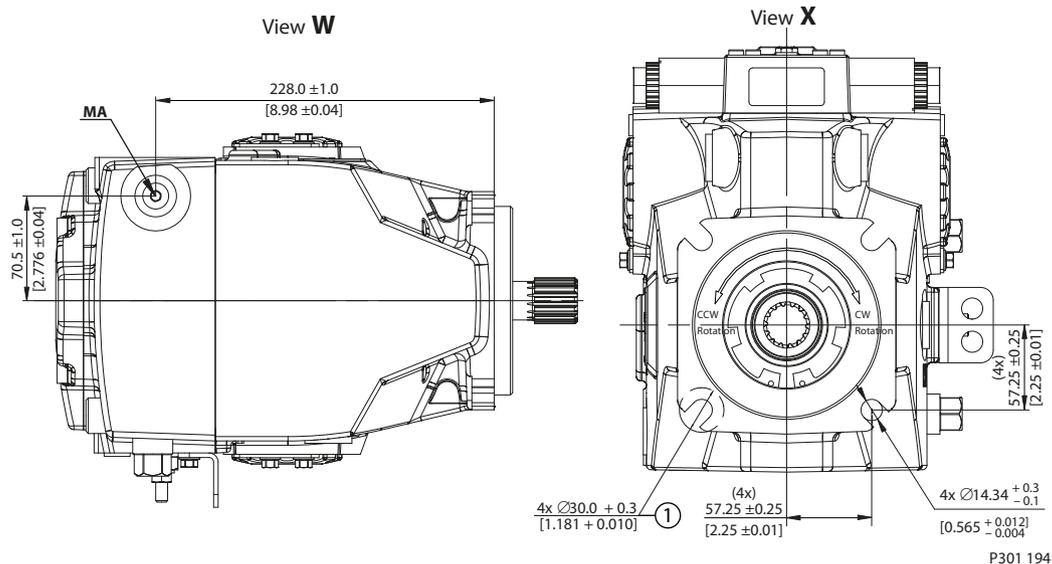
1. Charge pressure construction port  $\frac{5}{16}$ -24
2. Case pressure port  $1\frac{1}{16}$ -12;  $\varnothing 48$  max clearance for fitting
3. Connector (Deutsch DT04-2P) to be paint free
4. Approximate center of gravity



P005 935

Please contact representative for specific installation drawings.

**Installation drawings**

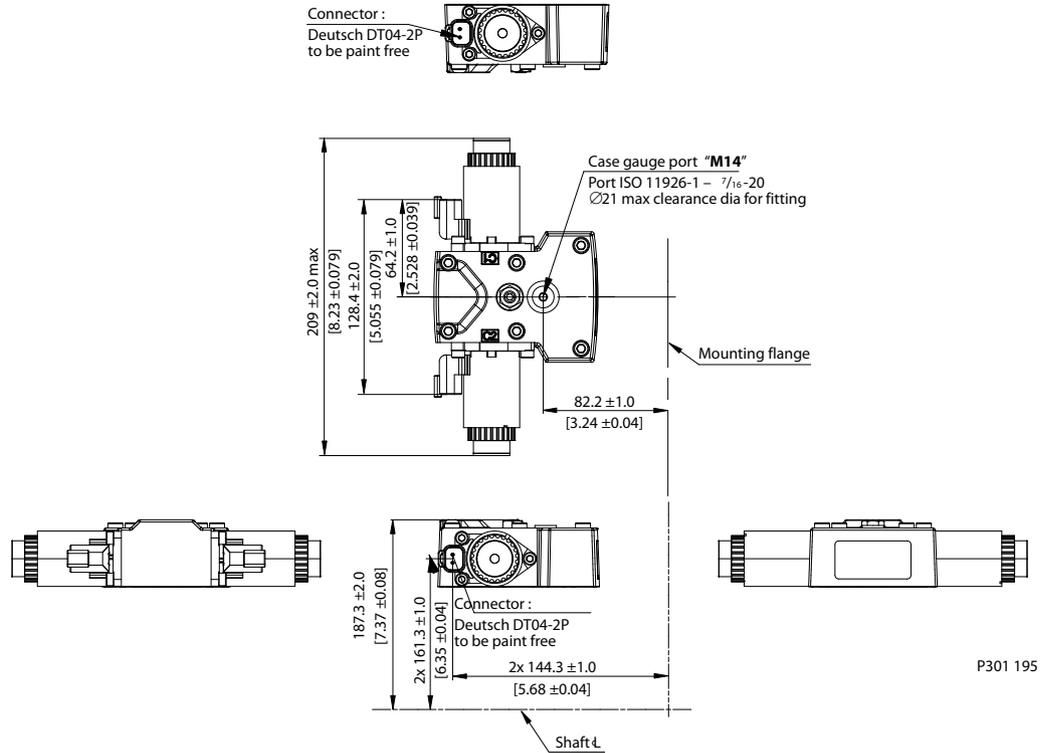


**1. Other side screw head space**

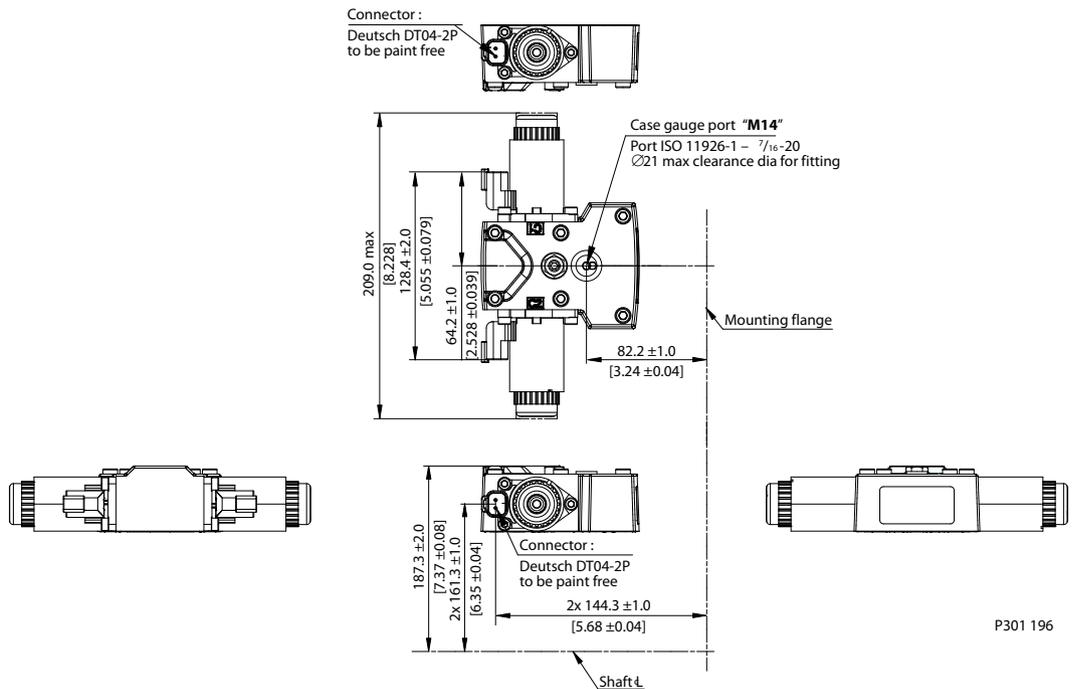
[Please contact representative for specific installation drawings.](#)

**Controls**

**Electric Displacement Control (EDC), option A2 (12V) and A3 (24V) for H1P 089/100**



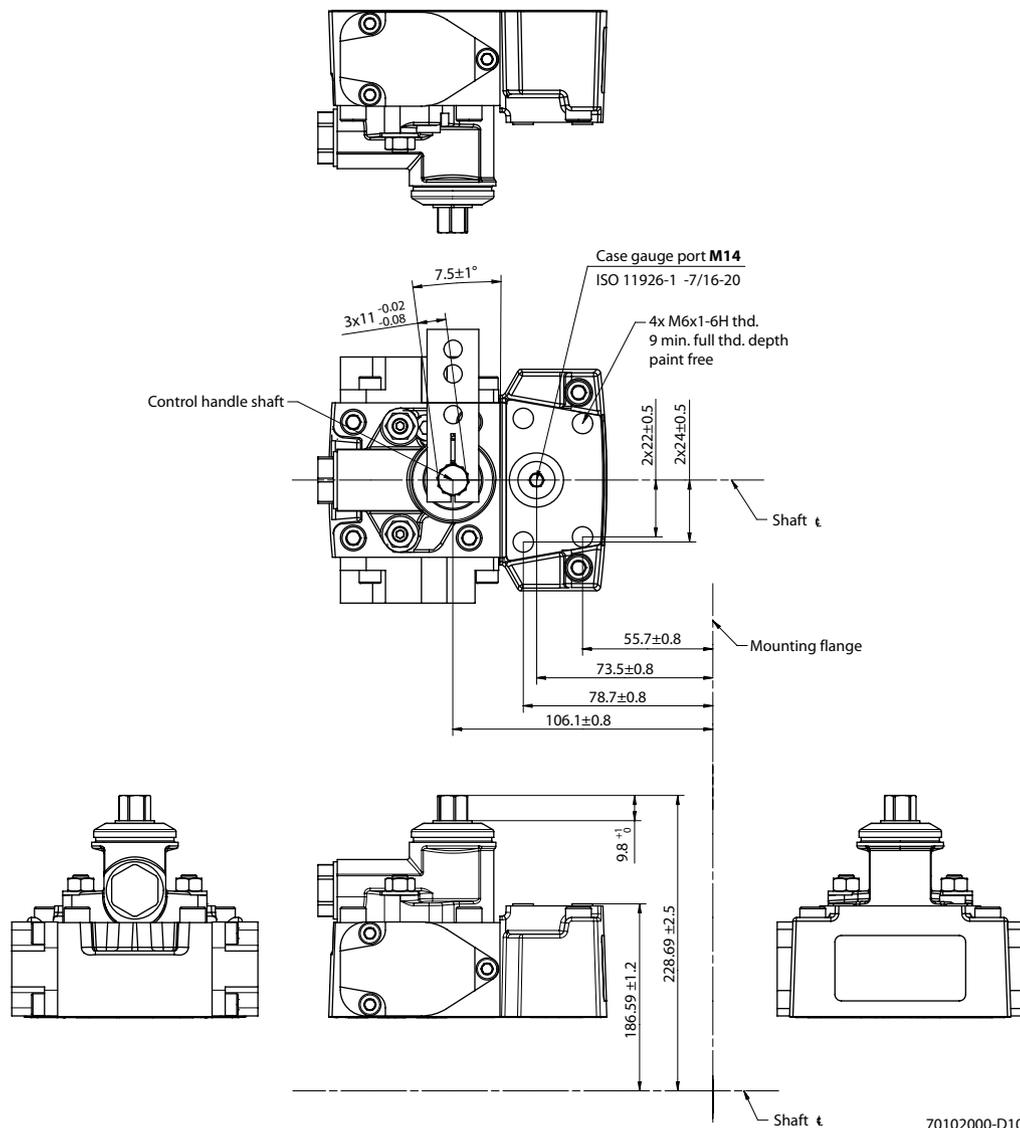
**Electric Displacement Control (EDC) with MOR, option A4 (12V) and A5 (24V) for H1P 089/100**



Please contact representative for specific installation drawings.

**Controls**

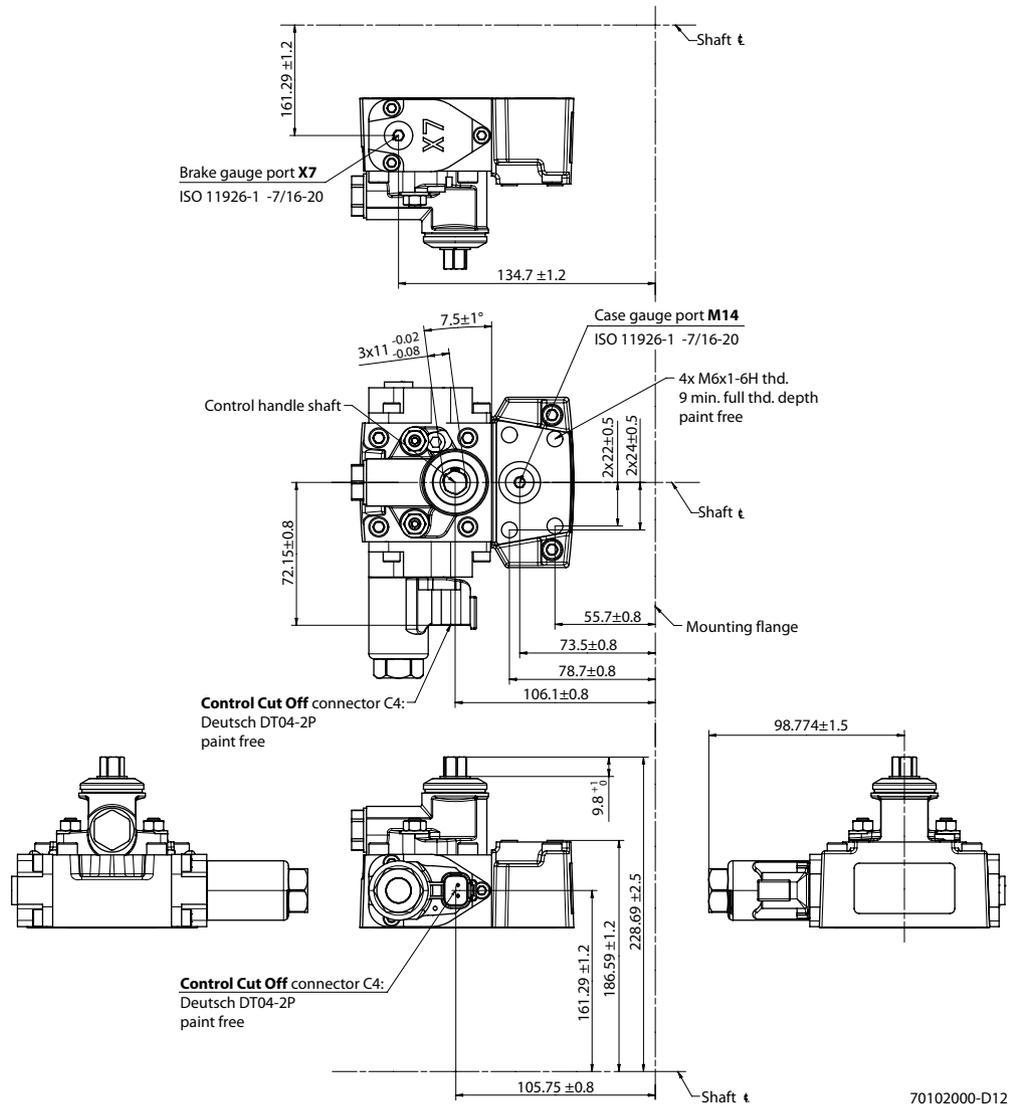
**Manual Displacement Control (MDC), option M1 for H1P 089/100**



Please contact representative for specific installation drawings.

**Controls**

**Manual Displacement Control (MDC) with CCO, option M3 and M4 for H1P 089/100**



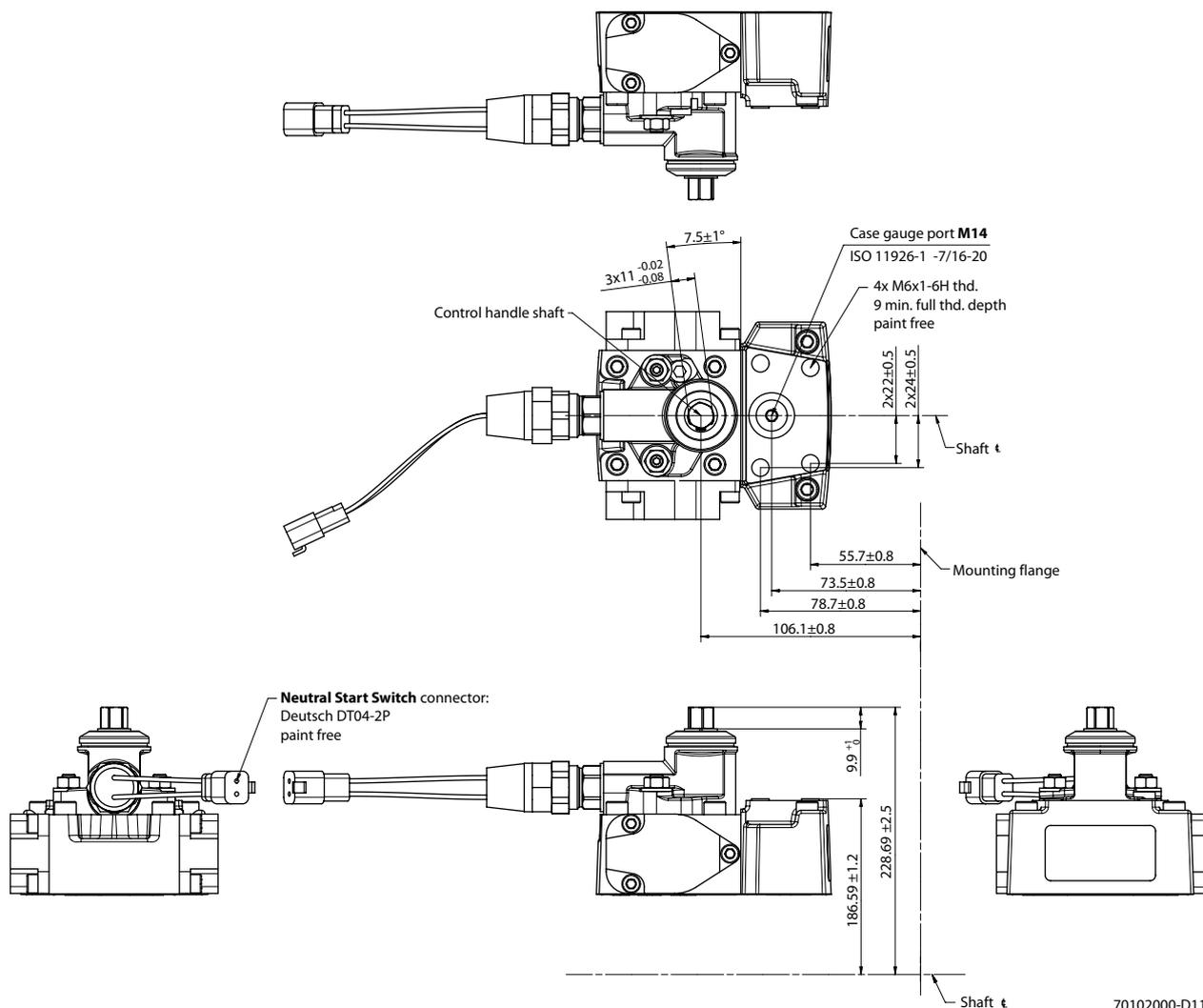
Control Cut Off connector C4:

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

Please contact representative for specific installation drawings.

**Controls**

**Manual Displacement Control (MDC) with NSS, option M2 for H1P 089/100**



70102000-D11

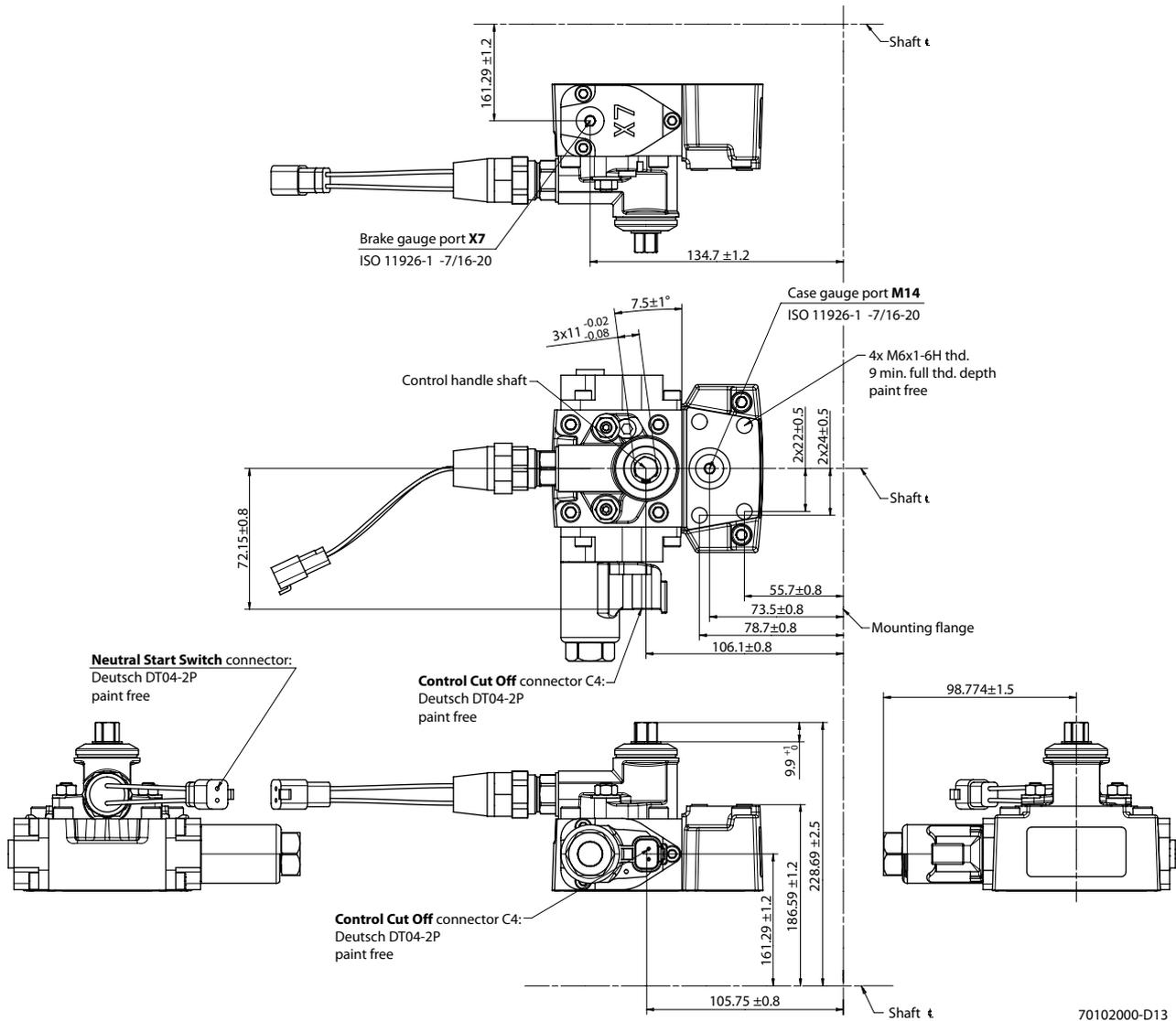
*Neutral Start Switch connector:*

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

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

**Controls**

**Manual Displacement Control (MDC) with NSS and CCO, options M5 and M6 for H1P 089/100**



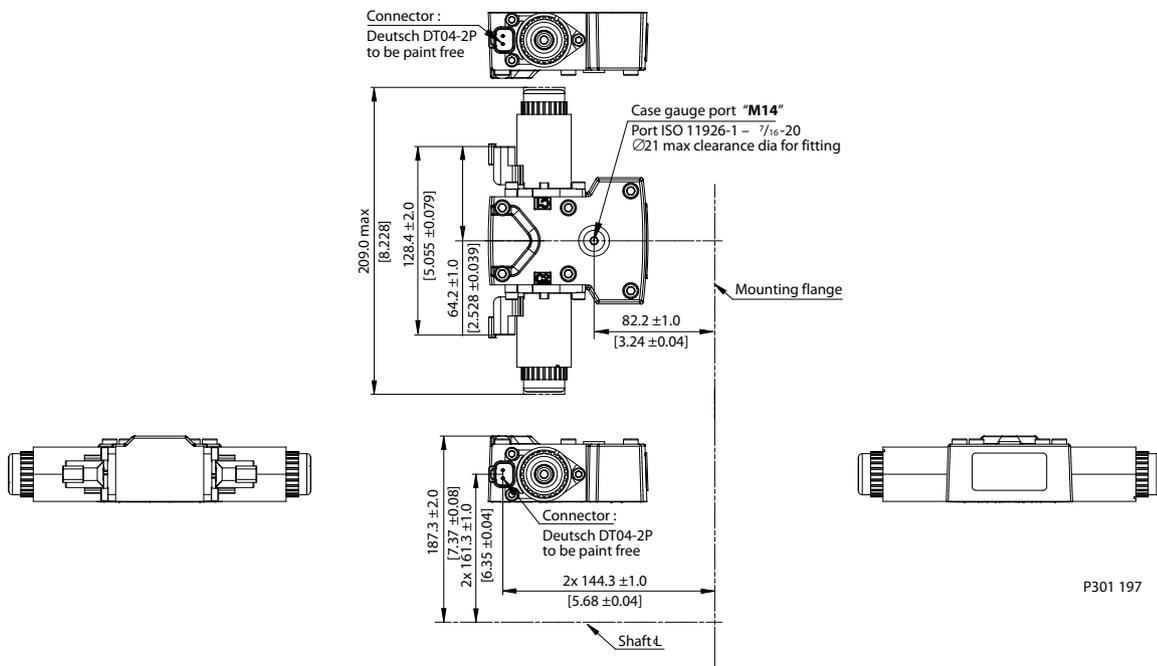
Neutral Start Switch connector / Control Cut Off connector C4:

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

Please contact representative for specific installation drawings.

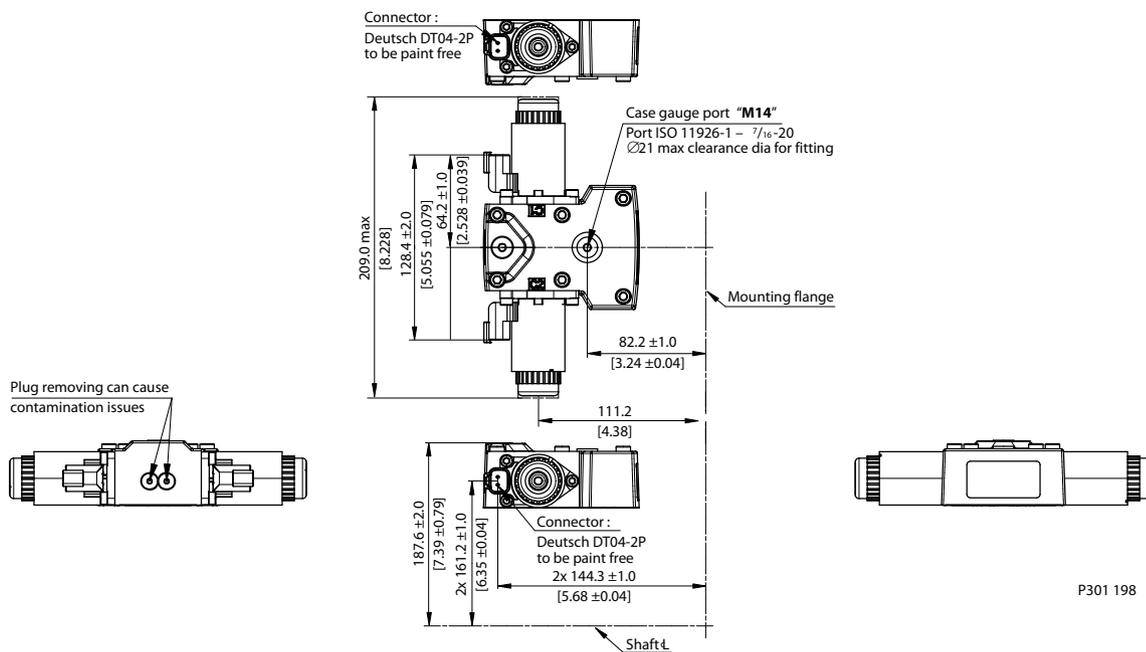
**Controls**

**Forward-Neutral-Reverse control (FNR) with MOR, option A9 (12V) and B1 (24V) for H1P 089/100**



Please contact representative for specific installation drawings.

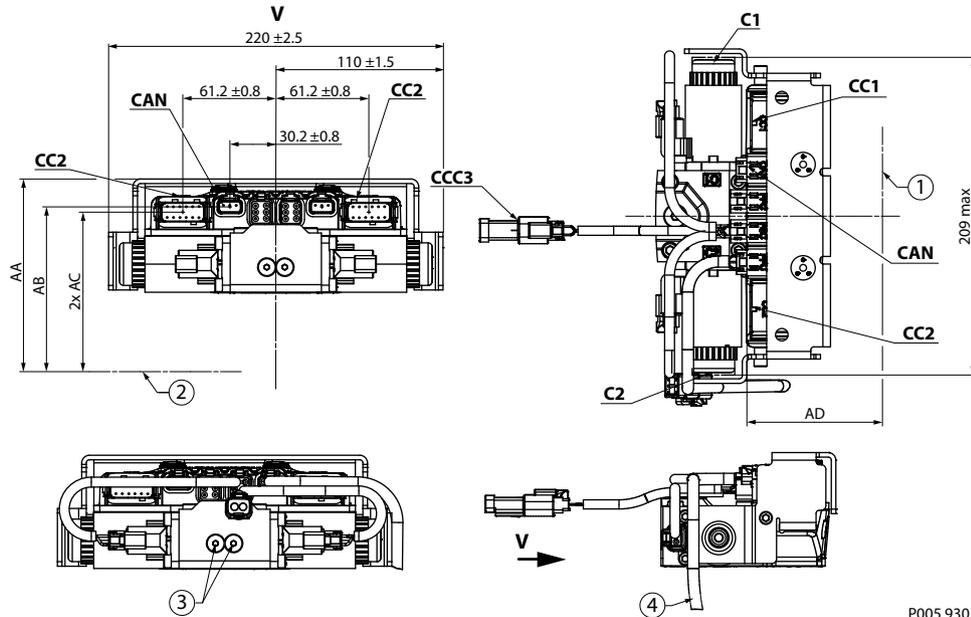
**Non Feedback Proportional Electric control (NFPE) with MOR, option A8 (12V) and B8 (24V) for H1P 089/100**



Please contact representative for specific installation drawings.

**Controls**

**Automotive Control (AC) Dimensions**



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

*Dimensions, (mm)*

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

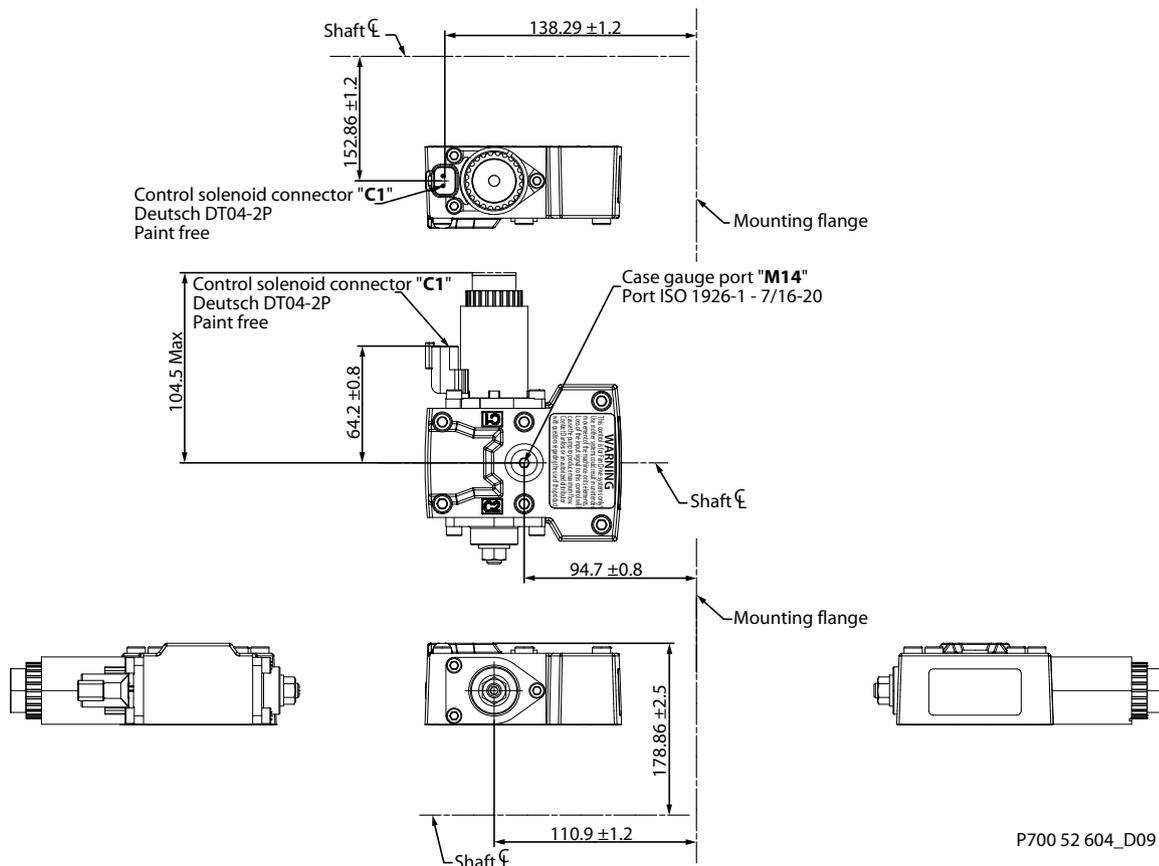
*Connectors description*

Port	Description
C1 C2	Control MOR; Depressing the plunger mechanically moves the control spool. Actuation allows full stroke pump response as per coil and rotation dependent control logic.
CC1	Control connector Deutsch DTM04-12P -A; Paint free
CC2	Control connector Deutsch DTM04-12P -B; Paint free
CCC3	Control connector Deutsch DT06-2S; Paint free; For using connector the plug may be removed.
CAN	Control connector Deutsch DTM04-3P; Paint free; For using connector the plug may be removed.

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

**Controls**

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



P700 52 604\_D09

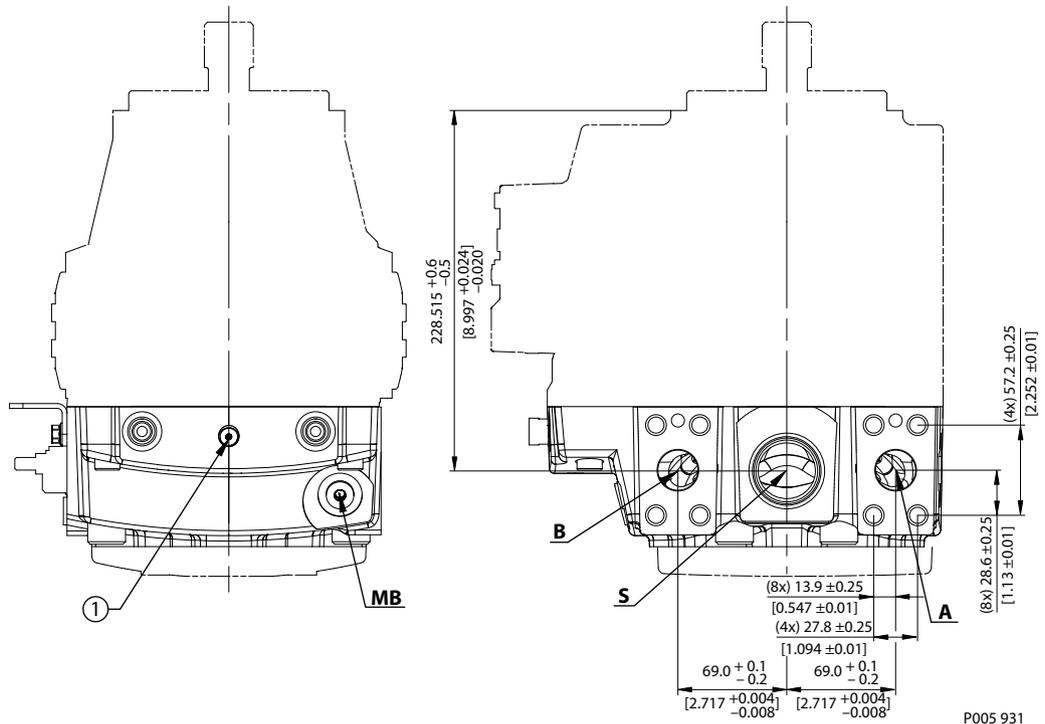
*Control solenoid connector C1 and C2:*

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

Please contact representative for specific installation drawings.

**Filtration**

**H1P 089/100 Suction filtration, option L**



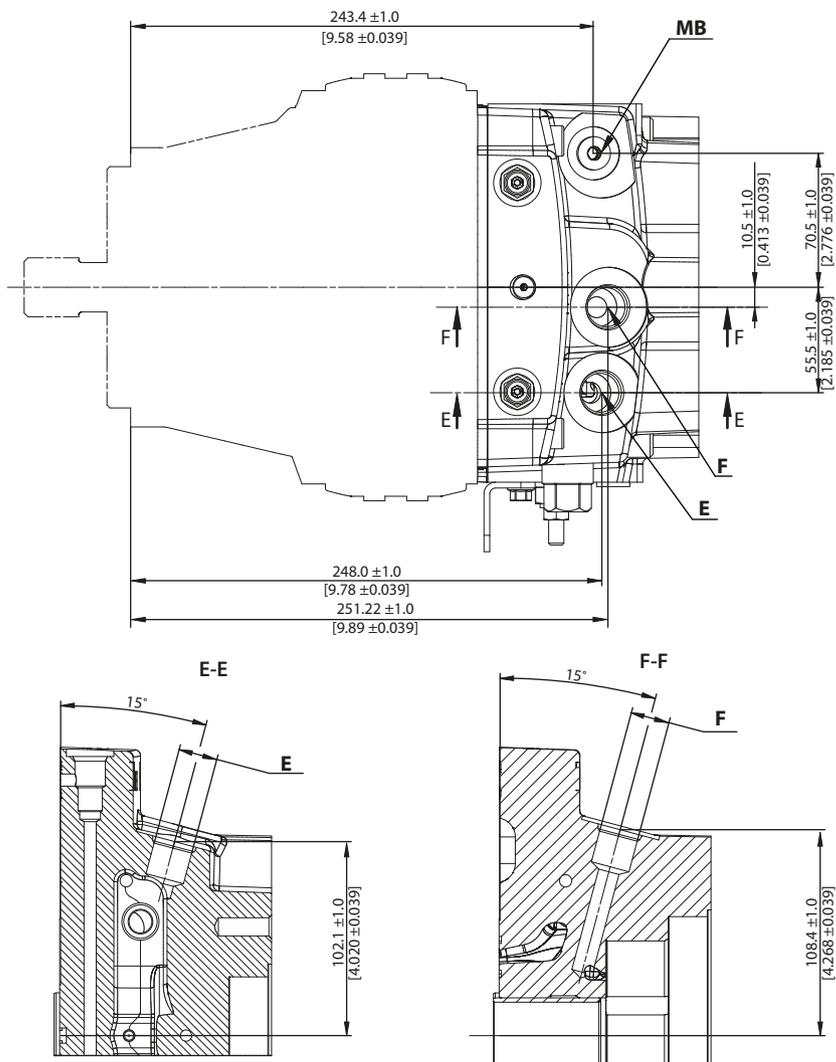
Ports per ISO 11926-1 description

Port	Description	Size 089/100
<b>A, B</b>	System ports <b>A / B</b> ; 450 bar, Split flange boss per ISO 6162	Ø 25.4 mm; M12 x 1.75; 20 min. full thread depth;
<b>MB</b>	System <b>B</b> gauge port	$\frac{9}{16}$ -18; Ø28 max clearance for fitting
<b>S</b>	Charge inlet port	$1\frac{5}{8}$ -12; Ø69 max clearance for fitting
<b>1</b>	Charge pressure construction port	$\frac{5}{16}$ -24; Ø21 max clearance for fitting

Please contact representative for specific installation drawings.

**Filtration**

**H1P 089/100 Remote full flow charge pressure filtration, option P for end cap option F5 (SAE-C PTO)**



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Ports per ISO 11926-1 description

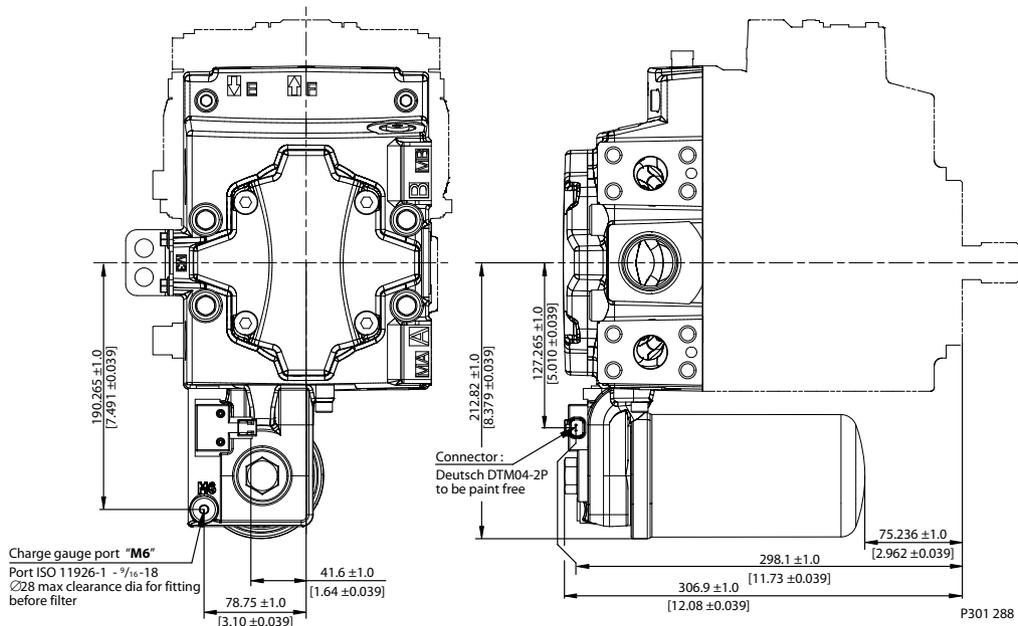
Port	Description	Size 089/100
MB	System B gauge port	$\frac{9}{16}$ -18; Ø28 max clearance for fitting
F	Charge filtration port to filter	$\frac{7}{8}$ -14; Ø42 max clearance for fitting
E	Charge filtration port from filter	

Please contact representative for specific installation drawings.

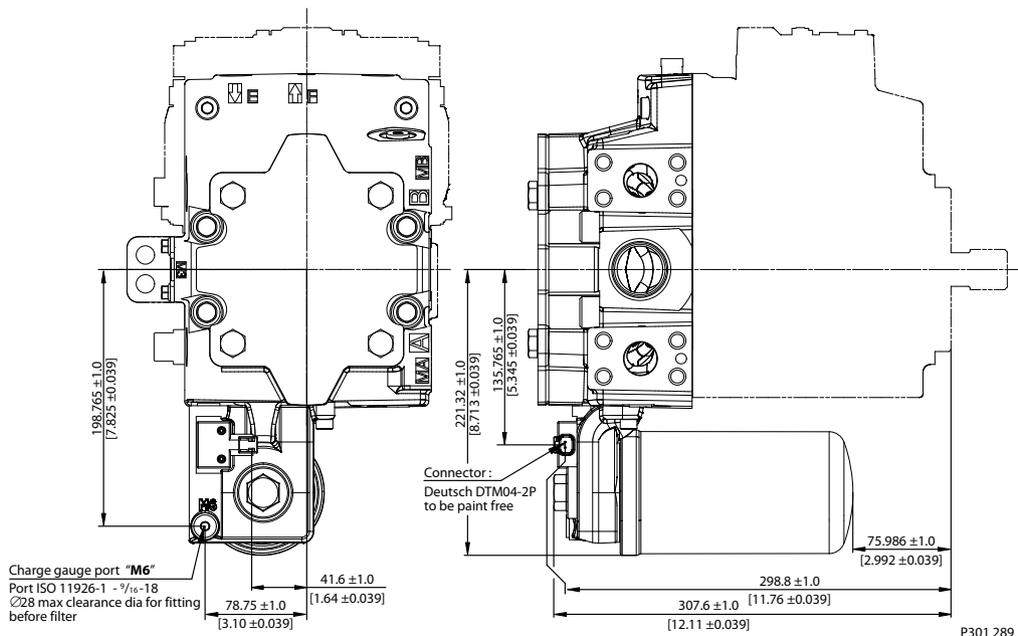
**Filtration**

**H1P 089/100 Integral full flow charge pressure filtration, option M (for end cap options D3, F4)**

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



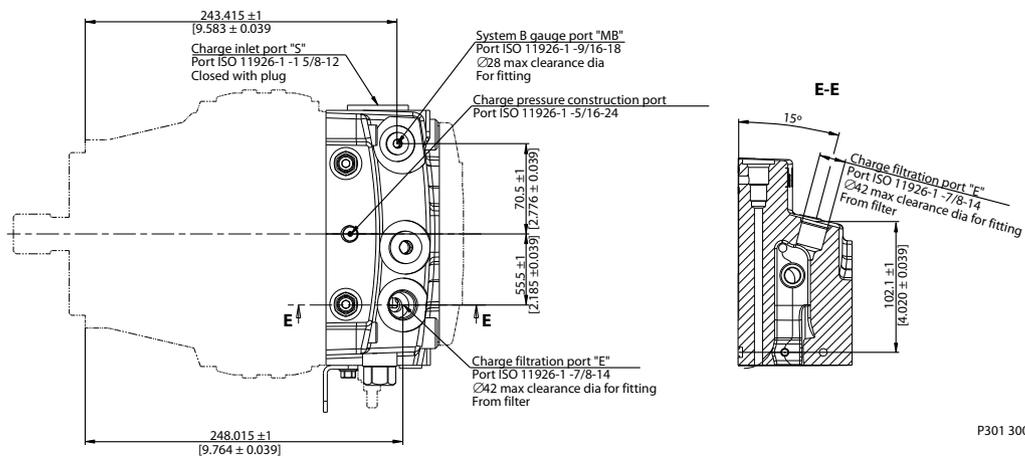
*Integral full flow charge pressure filtration with filter bypass sensor, option M, for end cap option F4 (SAE-C PTO)*



Please contact representative for specific installation drawings.

**Filtration**

**H1P 089/100 External full flow charge pressure filtration, option S, for end cap option D8 or F5**



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Please contact representative for specific installation drawings.





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- Transit Mixer Drives

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