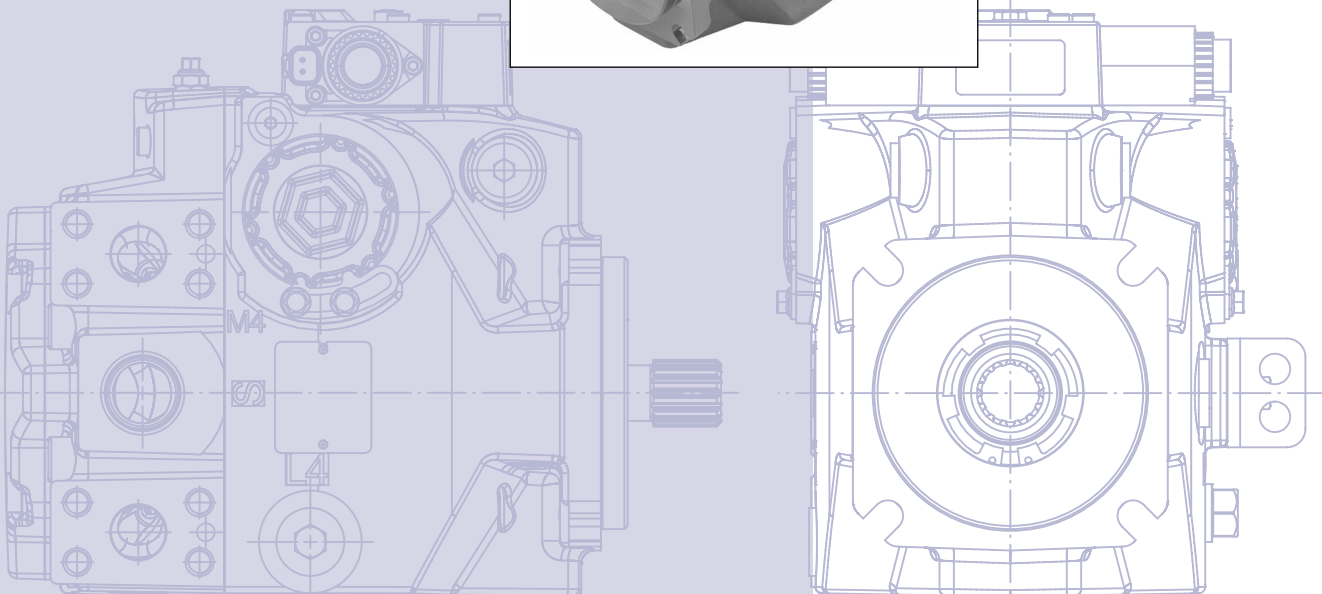
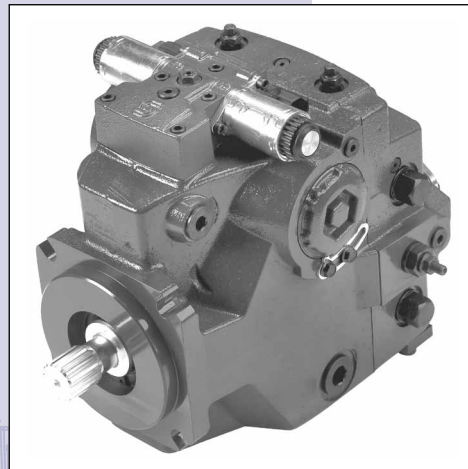




H1
Axial Piston Pump
Size 069/078,
Single

Technical
Information



Revision History

Table of revisions

| Date | Page | Changed | Rev |
|--------------|------------------------|--------------------------------------------|-----|
| 30 Jul, 2009 | — | First edition | AA |
| Jun, 2010 | 4-6, 12, 14, 16, 18-19 | New EC directive | BA |
| Dec 2012 | Various | Size 069 added, AC added, pressure changed | CA |
| Jan 2013 | | Typos | CB |

Further available literature

| Description | SD order number |
|-------------------------------------------------------------------------------|-----------------|
| Overview, H1 Axial Piston Pumps, Single and Tandem | L1012919 |
| Basic Information, H1 Axial Piston Pumps, Single and Tandem | 11062168 |
| Technical Information | |
| H1 Axial Piston Pump, Size 045/053, Single | 11063344 |
| H1 Axial Piston Pump, Size 045/053, Tandem | 11063345 |
| H1 Axial Piston Pump, Size 060/068, Single | 11071685 |
| H1 Axial Piston Pump, Size 069/078, Single | 11062169 |
| H1 Axial Piston Pump, Size 089/100, Single | 11069970 |
| H1 Axial Piston Pump, Size 115/130, Single | 11063346 |
| H1 Axial Piston Pump, Size 147/165, Single | 11063347 |
| H1 Automotive Control for Single Axial Piston Pumps 045 - 130 cc | L1223856 |
| Complementary Products | |
| External Remote Charge Pressure Filter | 11064579 |
| Speed and Temperature Sensor | 11046759 |
| Pressure Sensor | L1007019 |
| Hydraulic Fluids, Technical Information | |
| Hydraulic Fluids and Lubricants | 520L0463 |
| Experience with Biodegradable Hydraulic Fluids | 520L0465 |
| Design Guideline for Hydraulic Fluid Cleanliness | 520L0467 |
| Application Information | |
| Applications Manual, Section 1, Selection of Driveline Components | BLN-9885 |
| Applications Manual, Section 2, Pressure and Speed Limits for Hydraulic Units | BLN-9884 |
| Applications Manual, Section 4, Transmission Circuit Recommendations | BLN-9886 |
| PLUS+1 COMPLIANT (Electrical Installation) | |
| H1 Electrical Displacement Control (EDC) | 11022744 |
| H1 3-position (FNR) Electric Control | 11025001 |
| H1 Non-Feedback Proportional Electric (NFPE) Control | 11025002 |
| Service Manuals | |
| H1 Axial Piston Pump, Size 045/053, Single | 520L0958 |
| H1 Axial Piston Pump, Size 045/053, Tandem | 520L0928 |
| H1 Axial Piston Pump, Size 069/078/089/100/115/130/147/165, Single | 520L0848 |

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Front cover illustrations: F301 389, P003 515

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H1 Axial Piston Pump, Size 069/078, Single

Technical Information

Technical Specifications

Technical Specifications

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

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 | <p>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.</p> <p>The housing must always be filled with hydraulic fluid.</p> <p>Recommended mounting for a multiple pump stack is to arrange the highest power flow towards the input source.</p> <p>Consult Sauer-Danfoss for nonconformance to these guidelines.</p> |
| 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. |

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Technical data

| 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 auxiliary mounting flange and filter) | 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 | ∅25.4 - 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 <i>installation drawings at the back of this manual</i> . | | |
| Customer interface threads | Metric fasteners | | |

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Technical Specifications (continued)

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

Operating parameters

| Feature | | Unit | Size 069 | Size 078 |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|----------|----------|
| Input speed | Minimum for internal charge supply at minimum charge pressure. Performance (pressure and displacement) may be limited due to limited control pressure | min ⁻¹ (rpm) | 500 | |
| | Minimum for external 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 internal charge supply at minimum charge and control pressure | | 1200 | |
| | Rated | | 3500 | |
| | Maximum | | 4000 | |
| System pressure | Maximum working pressure | bar [psi] | 450 | [6525] |
| | Maximum pressure | | 480 | [6962] |
| | 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] |

T000 128E

Fluid specifications

| Feature | | Unit | Size 069 | Size 078 |
|----------------------------------|-------------------------------------------------|--------------------------|------------------------------------------------|-----------|
| 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 | β-ratio | 22/18/13 | |
| | Efficiency (charge pressure filtration) | | 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 < 1 min 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)

T000 129E

Shaft Loads

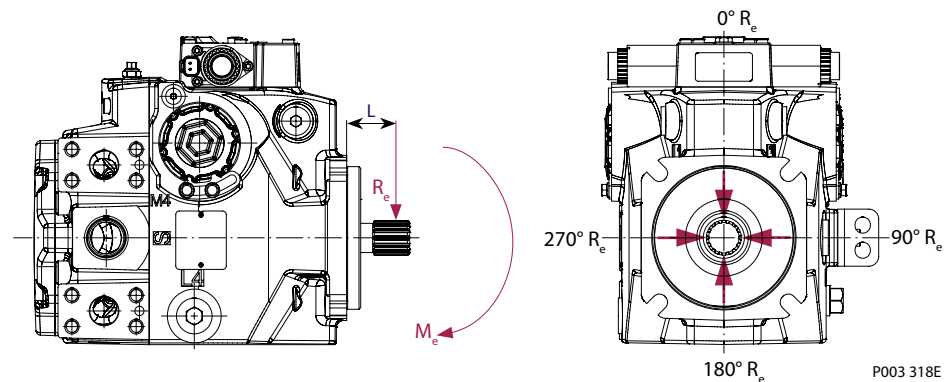
External radial shaft loads

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 Sauer-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.

H1 Axial Piston Pump, Size 069/078, Single

Technical Information

General Technical Specifications

Bearing Life (continued)

Maximum external shaft load based on shaft deflection:

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

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

Contact your Sauer-Danfoss representative for an evaluation of unit bearing life.

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

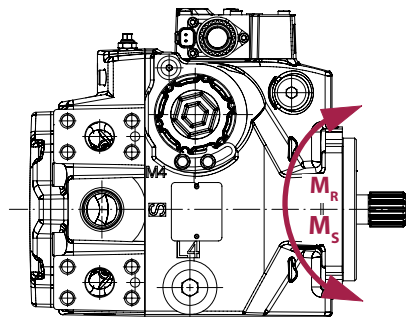
Mounting Flange Loads

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] |

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



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H1 Axial Piston Pump, Size 069/078, Single

Technical Information

General Technical Specifications

Model Code (continued)

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

H Mounting

| | |
|----------|------------------------------------|
| H | ISO 3019-1, flange 127 - 4 (SAE C) |
|----------|------------------------------------|

J Input shaft

| | |
|-----------|-------------------------------------------------------------------------------------------------|
| G1 | ISO 3019-1, outer dia 32 mm - 4 (SAE C, 14 teeth splined shaft $1\frac{1}{2}$ pitch) |
| F1 | ISO 3019-1, outer dia 35 mm - 4 (SAE C, 21 teeth splined shaft $1\frac{1}{32}$ pitch) |
| G9 | ISO 3019-1, outer dia 38 mm - 4 (SAE C-C, 23 teeth splined shaft $1\frac{1}{32}$ 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 | Shipping cover |
| H2 | ISO 3019-1, flange 82 - 2, outer dia 16 mm - 4 (SAE A, 9 teeth $1\frac{1}{32}$ coupling) | |
| H1 | ISO 3019-1, flange 82 - 2, outer dia 19 mm - 4 (SAE A, 11 teeth $1\frac{1}{32}$ coupling) | |
| H3 | ISO 3019-1, flange 101 - 2, outer dia 22 mm - 4 (SAE B, 13 teeth $1\frac{1}{32}$ coupling) | |
| H5 | ISO 3019-1, flange 101 - 2, outer dia 25 mm - 4 (SAE B-B, 15 teeth $1\frac{1}{32}$ coupling) | |
| H6 | ISO 3019-1, flange 127 - 4, outer dia 32 mm - 4 (SAE C, 14 teeth $1\frac{1}{24}$ coupling) | |

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"

| | | | |
|------------|------------|---------------------------------------------------------------|-----------------------------------------|
| L | | High pressure relief valve + pressure limiters with bypass | Use the selection for ports "A" and "B" |
| | 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)

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) |

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) |



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

Notes

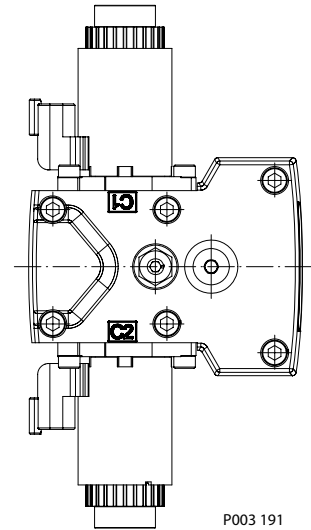
Electrical Displacement Control (EDC) Options
A2 (12 V)/A3 (24 V)

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.

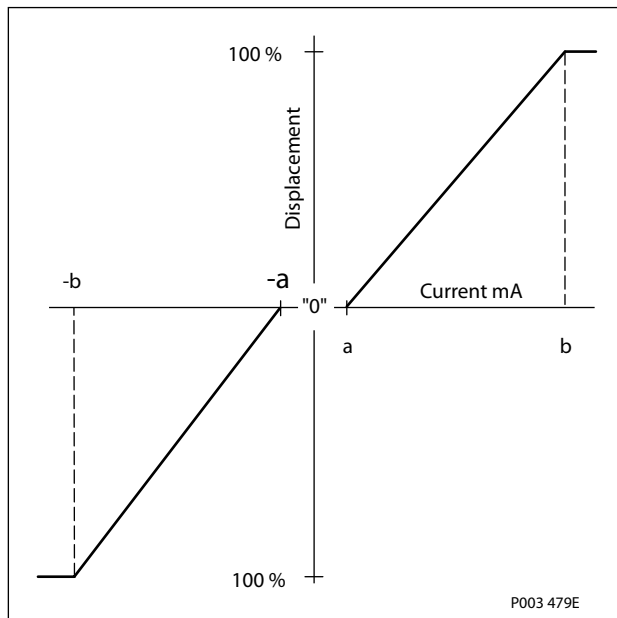
Under some circumstances, such as contamination, the control spool could stick and cause the pump to stay at some displacement.

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



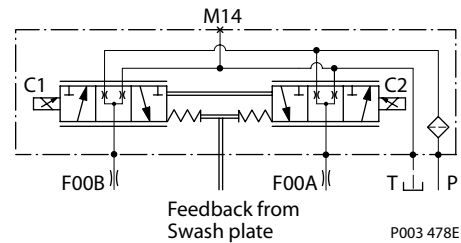
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Pump displacement vs. control current



P003 479E

EDC-Schematic diagram



P003 478E

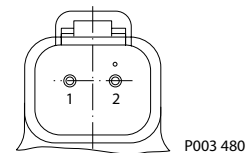
Control signal requirements

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.
 T000133E

Connector



P003 480

| 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 |
| Sauer-Danfoss mating connector kit | 1 | K29657 |

T000 134E

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

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.

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Flow table

| Shaft rotation | CW | | CCW | |
|------------------------|-----|-----|-----|-----|
| | C2 | C1 | C2 | C1 |
| 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.

T000 136E

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 times

| 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 |

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H1 Axial Piston Pump, Size 069/078, Single

Technical Information

General Technical Specifications

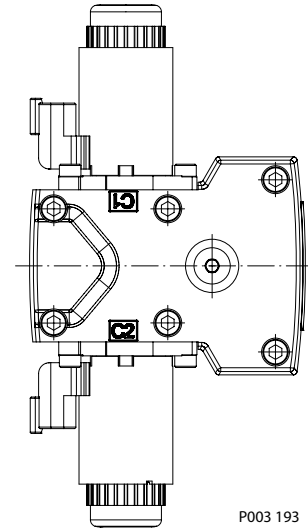
Forward-Neutral-Reverse (FNR) Electric Control Options

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.

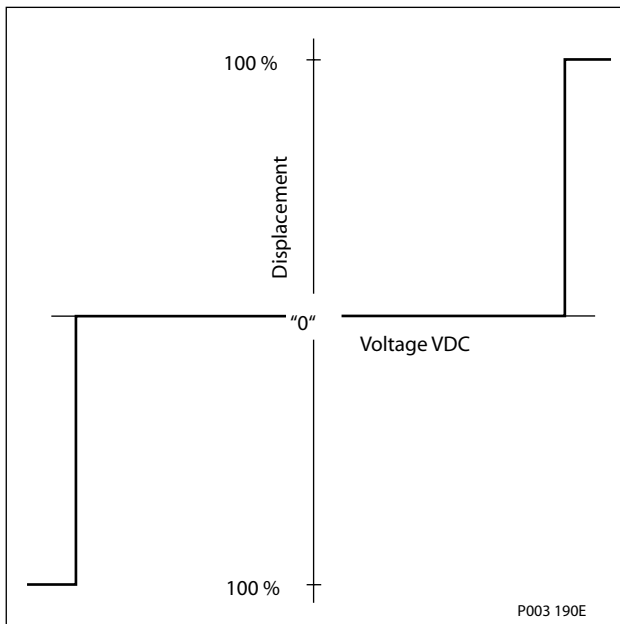
Under some circumstances, such as contamination, the control spool could stick and cause the pump to stay at some displacement.

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



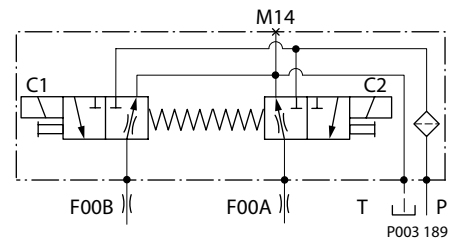
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Pump displacement vs. electrical signal



P003 190E

3-Position electric control, hydraulic schematic



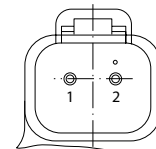
P003 189

Control current

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

T000 138E

Solenoid connector



P003 480

| 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 |
| Sauer-Danfoss mating connector kit | 1 | K29657 |

T000 134E

**Forward-Neutral-Reverse
(FNR) Electric Control
Options
A9 (12 V)/B1 (24 V)
(continued)**

Solenoid data

| Voltage | 12 V | 24 V |
|-------------------------------------------------------------------|-----------|----------|
| Minimum supply voltage | 9.5 Vdc | 19.0 Vdc |
| Maximum supply voltage (continuous) | 14.6 Vdc | 27.0 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.

T000 139E

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.

T000 140E

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 times

| 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 |

T000 141E

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

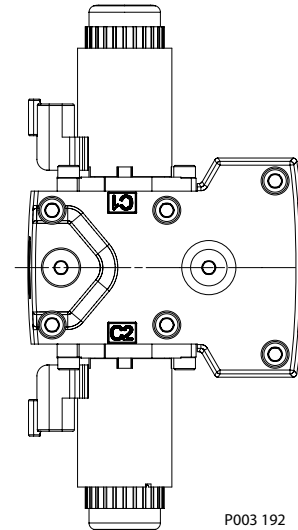
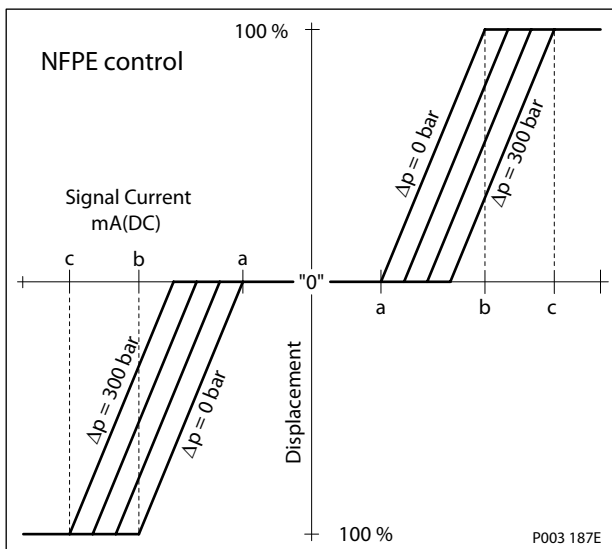
The Non Feedback Proportional Electric (NFPE) control is an electrical automotive control in which an electrical input signal activates one of two proportional solenoids that port charge pressure to either side of the pump servo cylinder. The NFPE control has no mechanical feedback mechanism.

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.

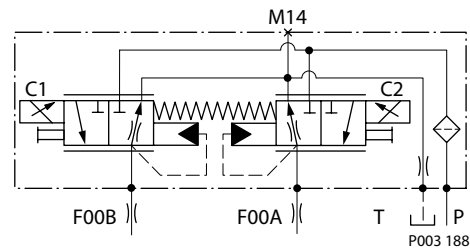
A serviceable 125 µm screen is located in the supply line immediately before the control porting spool.

Pump displacement vs. input signal



P003 192

NFPE Schematic



P003 188

Control signal requirements

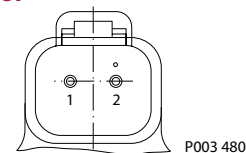
Control current

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

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

T000 142F

Connector



P003 480

| 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 |
| Sauer-Danfoss mating connector kit | 1 | K29657 |

T000 134E

H1 Axial Piston Pump, Size 069/078, Single

Technical Information

General Technical Specifications

**Non Feedback
Proportional Electric
Control (NFPE)
Options
A8 (12 V)/B8 (24 V)
(continued)**

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.

T000 135E

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.

T000 140E

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 times

| 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 |

T000 144E

H1 Axial Piston Pump, Size 069/078, Single

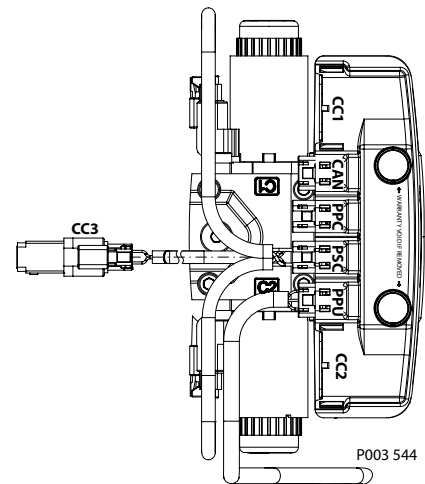
Technical Information

General Technical Specifications

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. 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 AC Control offers the following features and functions:



Driving Profiles

- Four selectable system modes, selectable via switch.
- Independent curves and settings for forward and reverse (4 x 2 curves).
- Switch selectable between automotive and engine speed independent driving modes.
- Engine speed independent drive modes for sweepers, snow blowers (non-automotive mode).
 - Load independent drive modes for off road applications (non-automotive for rollers and forestry machines).
- Load independent swash plate control via pump swash plate angle sensor to achieve EDC behavior
- Creep speed mode (slow shunting, digging operation, etc.)
- Constant speed mode (sweepers, snow-blowers, etc.)
- Integrated vehicle speed limiter function.

Advanced Control Functions

- Inch function without separate control valve.
- Integrated temperature sensor for:
 - Hydraulic systems overheat protection.
 - Low temperatures pump flow limitation.
 - Compensation of oil viscosity changes if using (radial piston motors, etc.).
 - Configurable engine anti stall protection.
 - Engine over speed protection while inching.

Integrated Motor Controller

- Integrated electric motor control for:
 - Proportional, variable PCOR or two position motor controls.
 - Brake pressure defeat, depending on the FNR position or the real vehicle driving direction.
 - Initial breakaway motor torque override.
- Separate over speed protection for the hydro motor.

Automotive control (AC) (continued)

Auxiliary Functions

- Four auxiliary outputs for :
 - Intelligent brake light control.
 - Automatic park brake function.
 - Vehicle speed dependent output to activate (load stabilizer, warning lights, etc.).
 - Reverse buzzer controlled by FNR or reverse driving.
 - System status lamp (fault detection for pump solenoids).

Economic Features

- Technology and enabler for economic driving and fuel savings.
- Easy combination options to other components of the PLUS+1 Family.

CAN Options

- Engine remote control via CAN J1939.
- Integrated signal converter (analog driving pedal into CAN signal, etc.).
- Compatible to all CAN J1939 components on market (displays, etc.).

Functional Safety

- External Safety Certification for SIL-2 (IEC 61508).
- Safety controlled Vehicle Start-Protection (engine speed check, battery check and FNR must be in neutral, etc.).
- Operator presence detection.
- Vehicle speed dependent direction change lock.
- Brake test mode for roller applications to fulfill EN500-4.

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 details about installation and wiring.

H1 Axial Piston Pump, Size 069/078, Single

Technical Information

General Technical Specifications

Manual Over Ride (MOR)

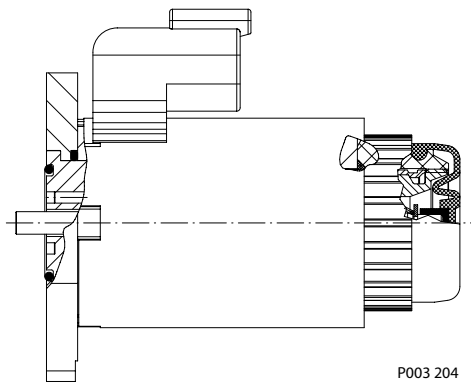
All controls are available with a Manual Over Ride (MOR) either standard or as an option for temporary actuation of the control to aid in diagnostics. Forward-Neutral-Reverse (FNR) and Non Feedback Proportional Electric (NFPE) controls are always supplied with MOR functionality.

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 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.

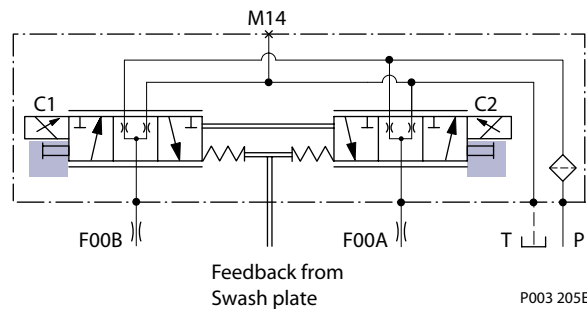
▲ Warning

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)



H1 Axial Piston Pump, Size 069/078, Single

Technical Information

General Technical Specifications

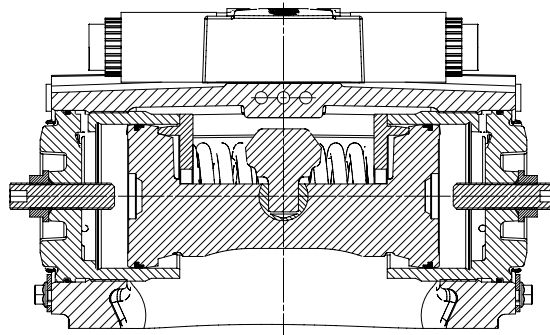
Displacement Limiter

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.

Displacement limiter



P003 266

Displacement change (approximately)

| 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] |

T000 145E

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

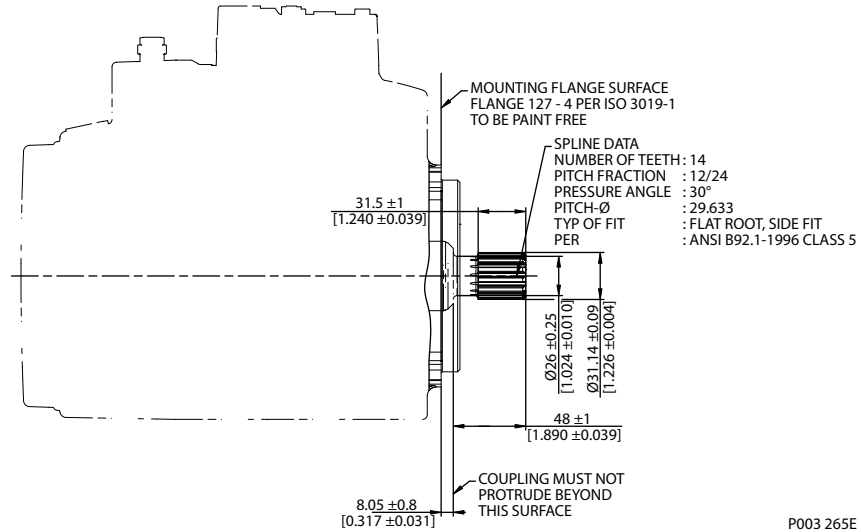
H1 Axial Piston Pump, Size 069/078, Single

Technical Information

Dimensions

Input Shafts

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



P003 265E

Specifications

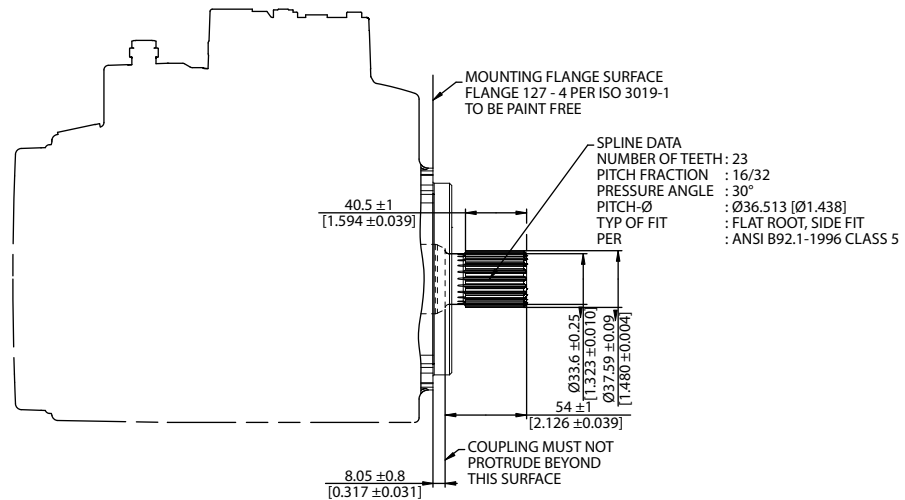
| Option | Spline | Min active spline length ² | | Torque rating ¹ | | | |
|--------|-----------------------|---------------------------------------|---------|----------------------------|----------|----------------|----------|
| | | mm | [in] | Rated torque | | Maximum torque | |
| | | | | Nm | [lbf·in] | 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.

T000 146E

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



P003 264E

Specifications

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

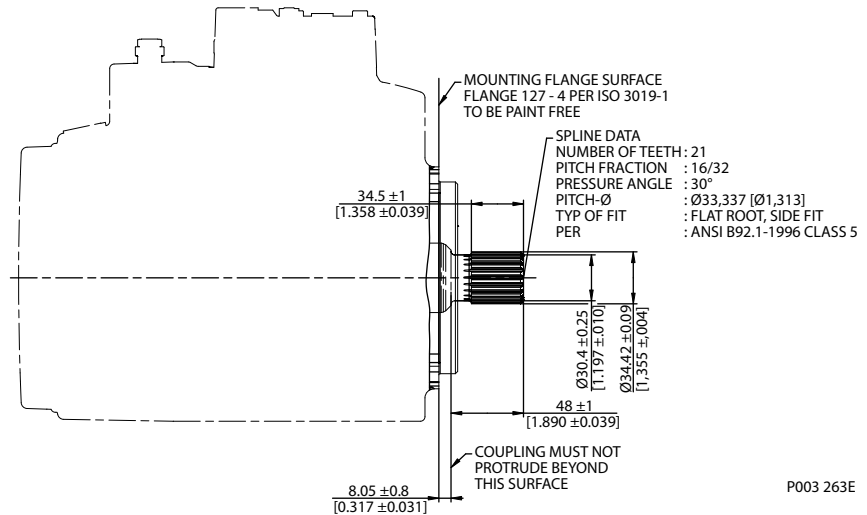
¹) For definitions of maximum and rated torque values, refer to:
Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.

²) Minimum active spline length for the specified torque ratings.

T000 147E

Input Shafts (continued)

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



Specifications

| Option | Spline | Min active spline length ² | | Torque rating ¹ | | | |
|--------|-----------------------|---------------------------------------|---------|----------------------------|----------|----------------|----------|
| | | mm | [in] | Rated torque | | Maximum torque | |
| | | | | Nm | [lbf·in] | 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:

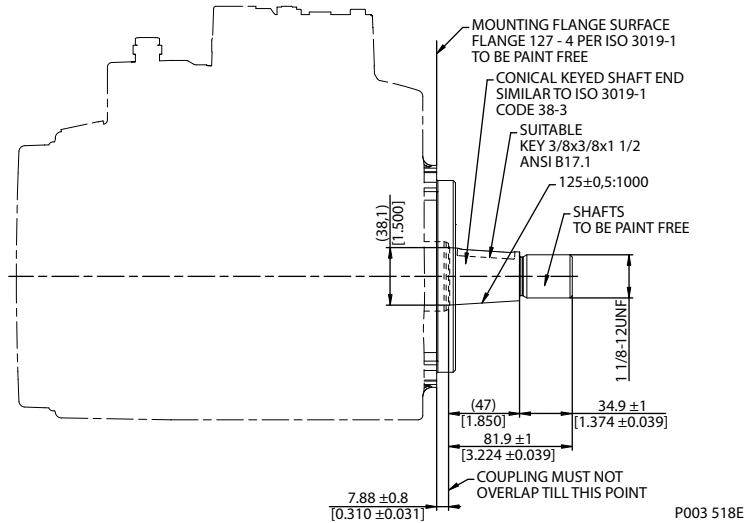
Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.

²⁾ Minimum active spline length for the specified torque ratings.

T000 148E

Input Shafts (continued)

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* | | Maximum torque | |
| | | Nm | [lbf-in] | 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.

T000 149E

Tapered shaft customer acknowledgement

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

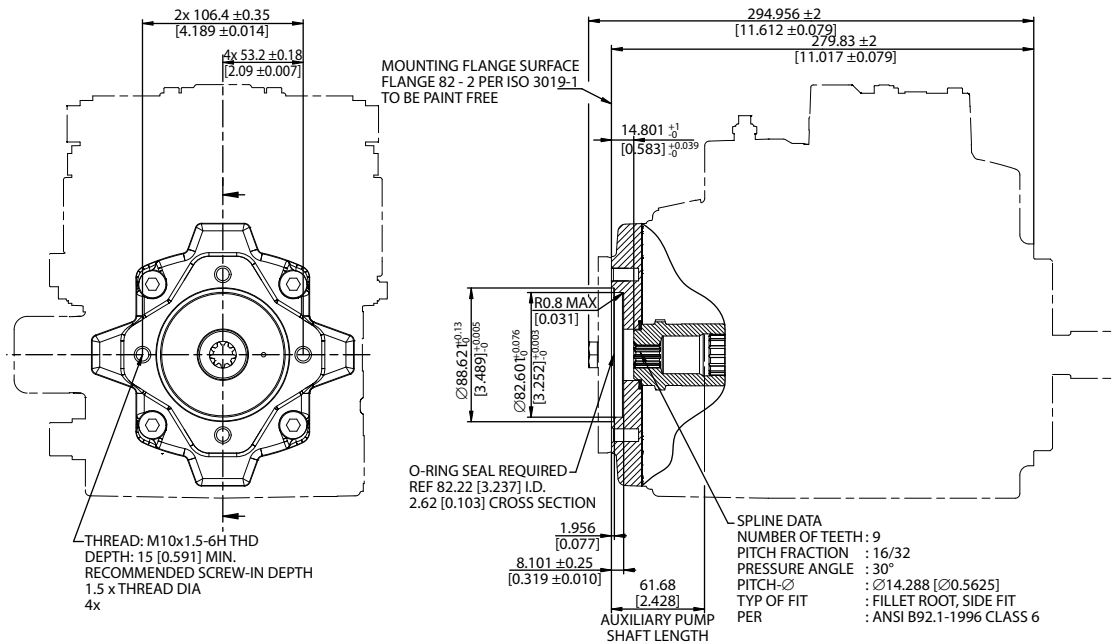
The specified torque rating of the tapered shaft documented above is based on the cross-sectional diameter of the shaft, through the keyway, and assumes the proper clamp and fit between shaft and coupling. Sauer-Danfoss guarantees the design and manufactured quality of the tapered shaft. The customer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

Sauer-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 its mating coupling, not the key. Torque or loading inadvertently transmitted by the customer supplied key may lead to premature shaft failure.

Auxiliary Mounting Pads 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:

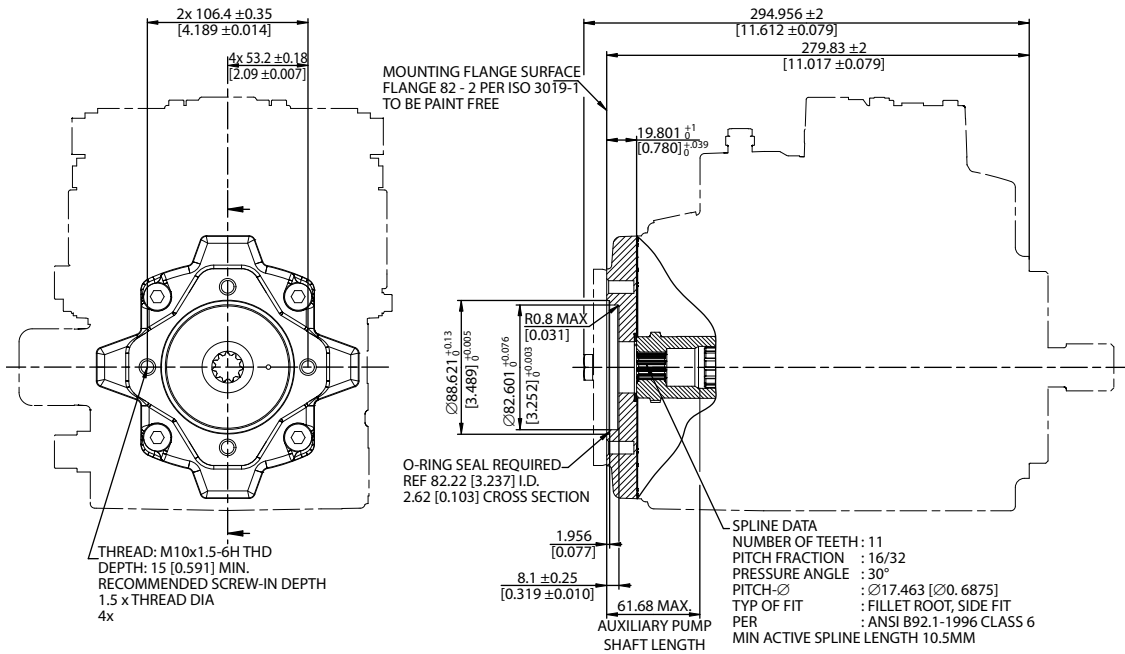
Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.

T000 150E

⚠ Caution

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

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



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:

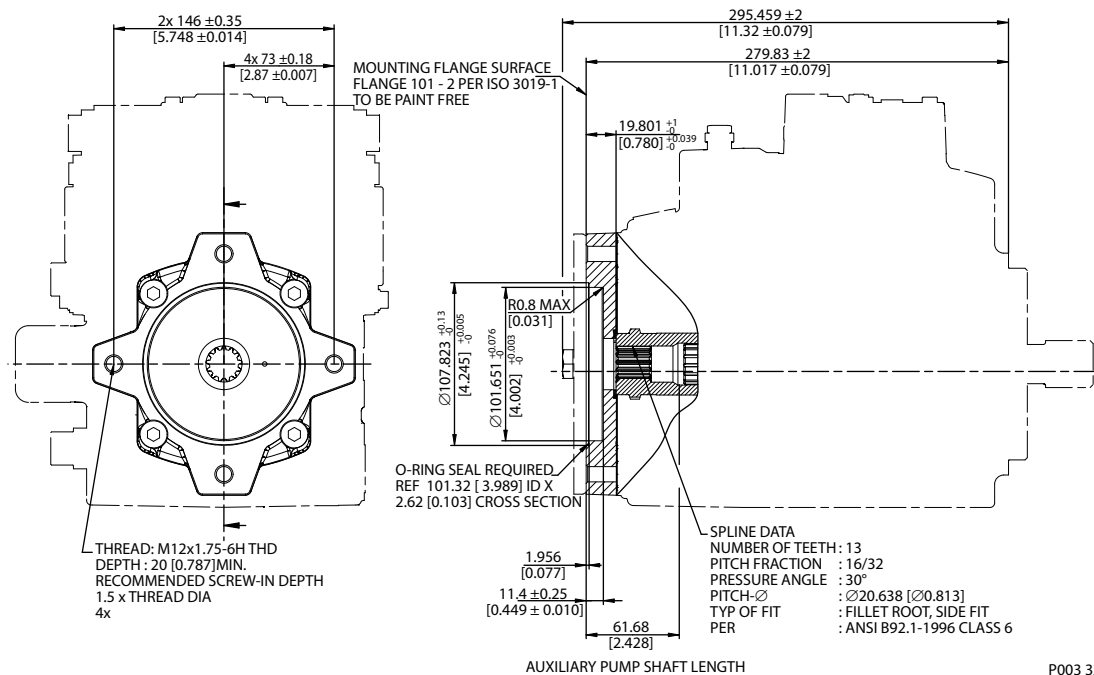
Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.

T000 151E

⚠ Caution

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

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



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:

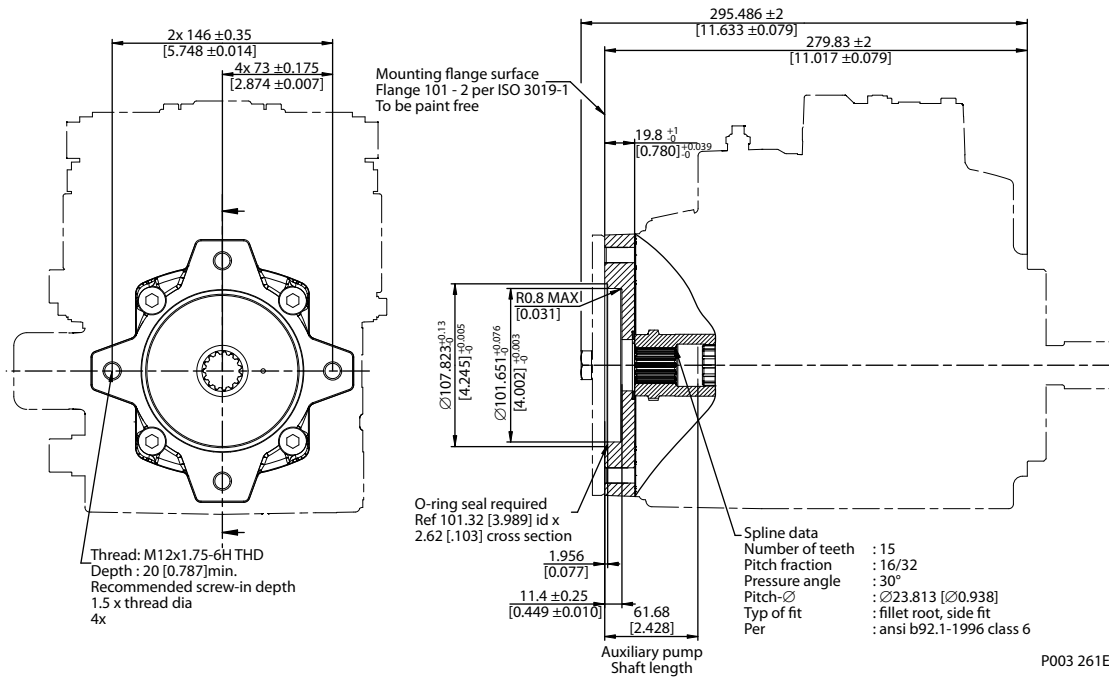
Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.

T000 152E

⚠ Caution

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

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



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:

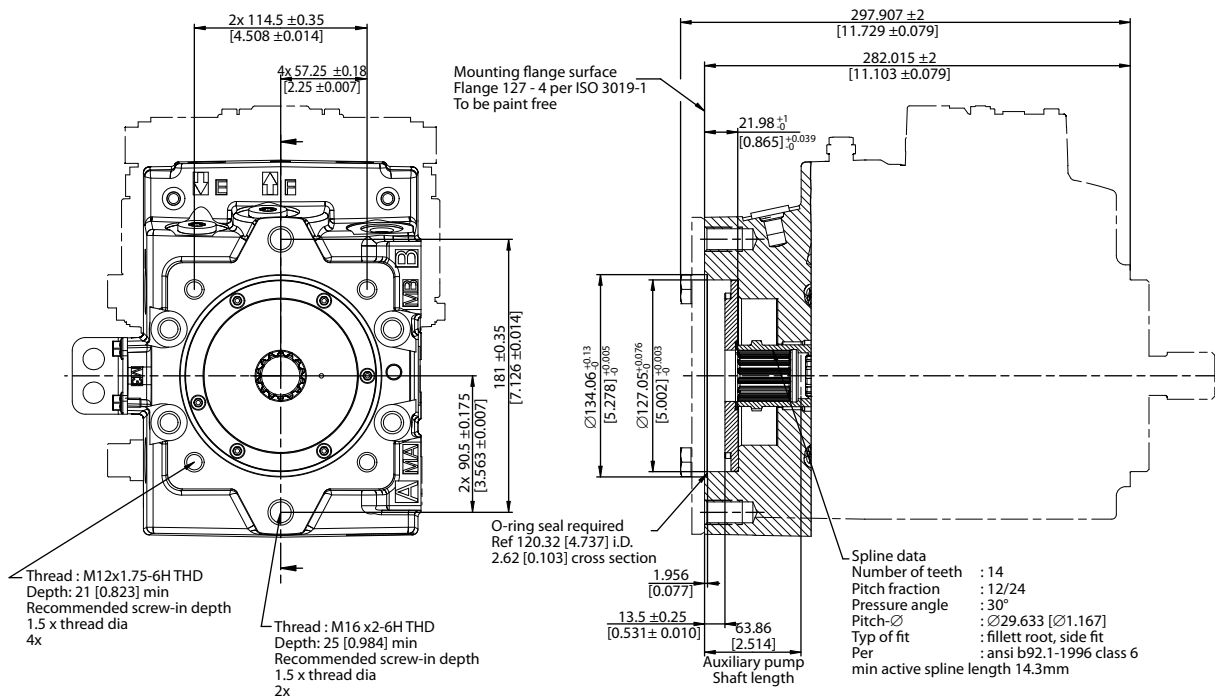
Basic Information Manual 11062168, section Shaft Torque Ratings and Spline Lubrication.

T000 153E

⚠ Caution

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

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



P003 260E

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.

T000 154E

⚠ Caution

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

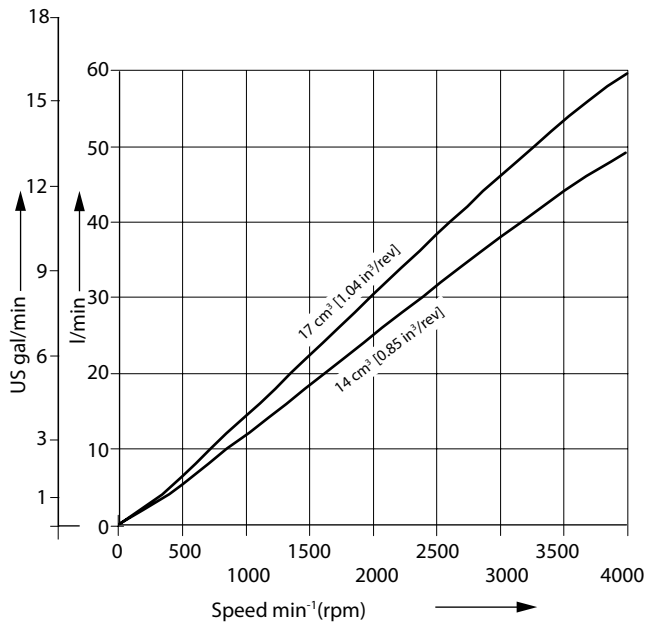
Contact your Sauer-Danfoss representative for application assistance if your application includes any of these conditions.

Charge pump flow and power curves

Charge pressure: 20 bar [290 psi]

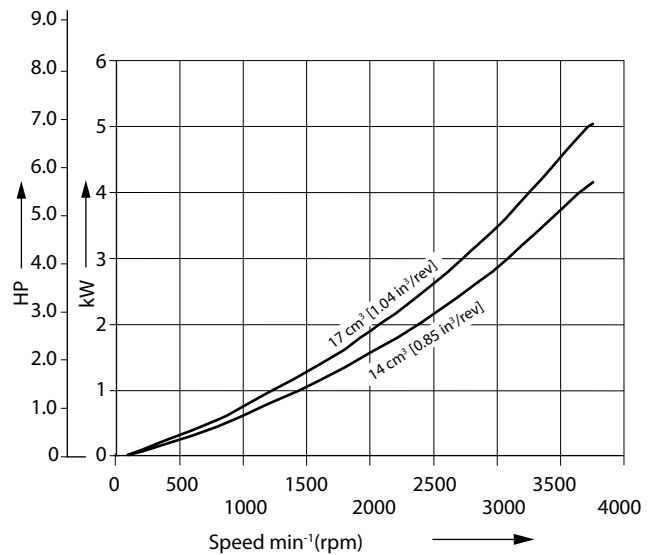
Viscosity and temperature: $11 \text{ mm}^2/\text{s}$ [63 SUS] 80 °C [180 °F]

Charge pump flow



P003 334E

Charge pump power requirements



P003 336E

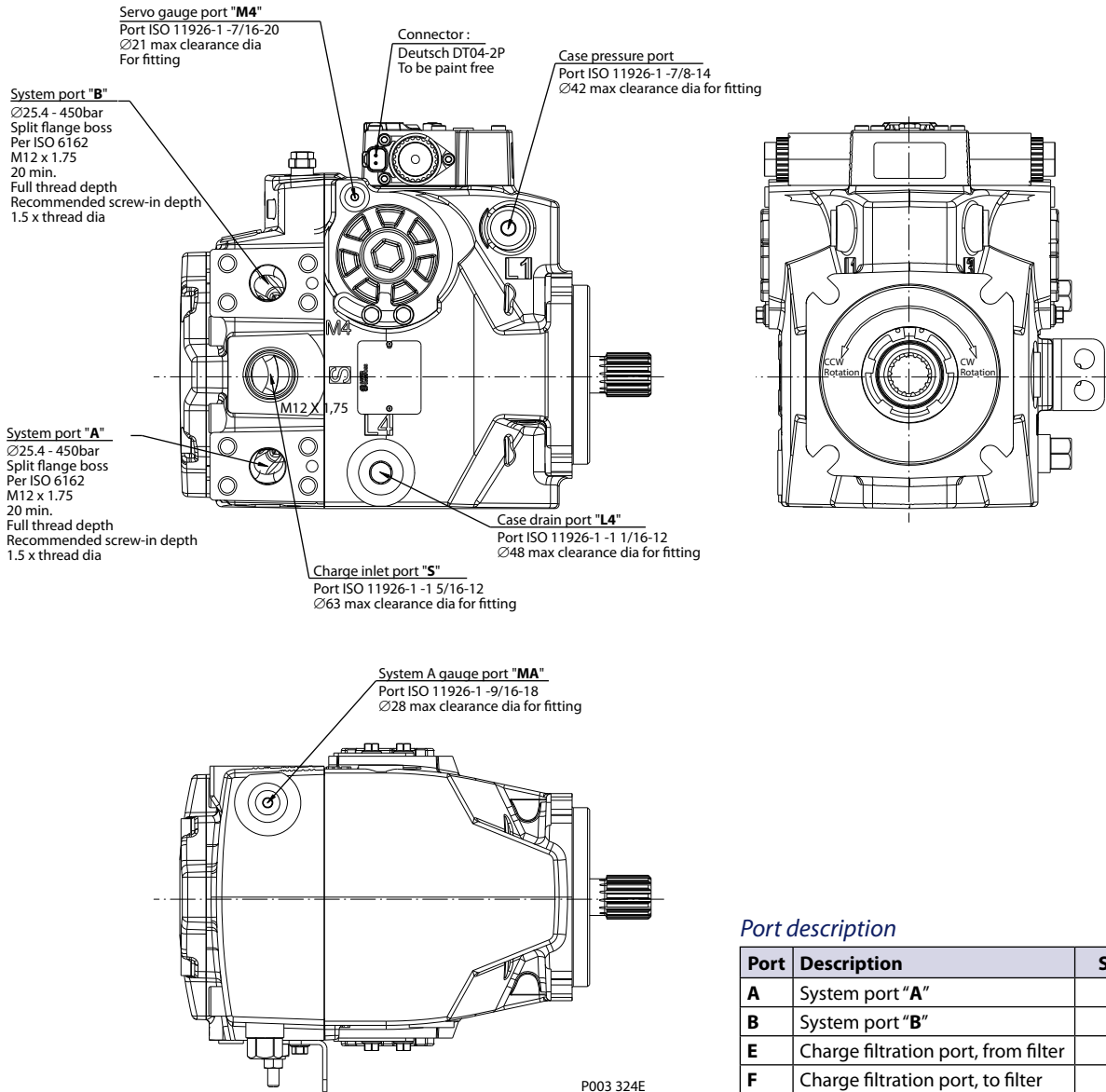


H1 Axial Piston Pump, Size 069/078, Single Technical Information

Notes

Notes

Port Description



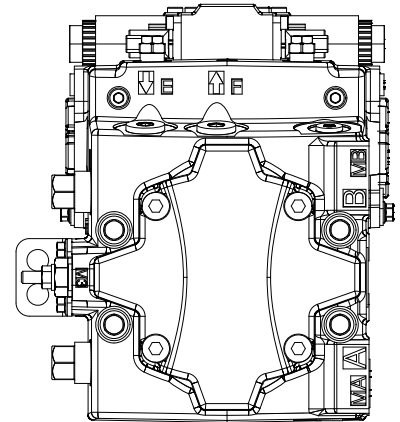
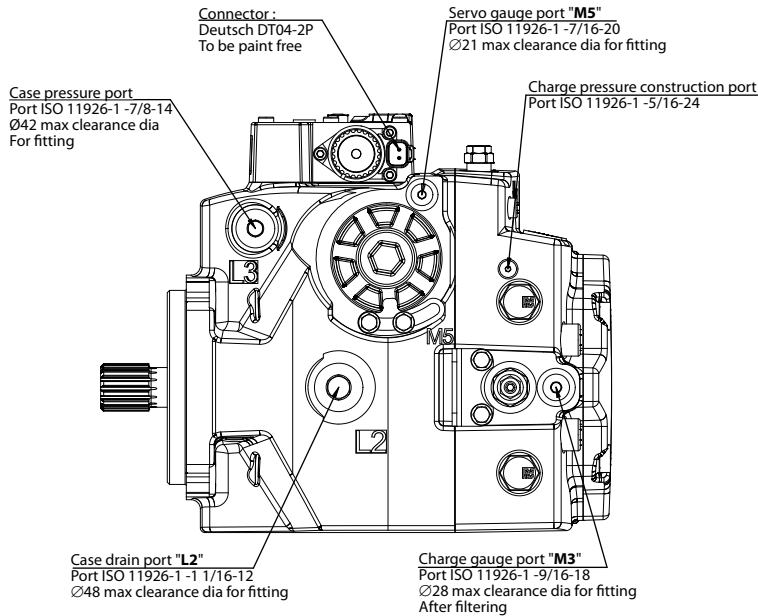
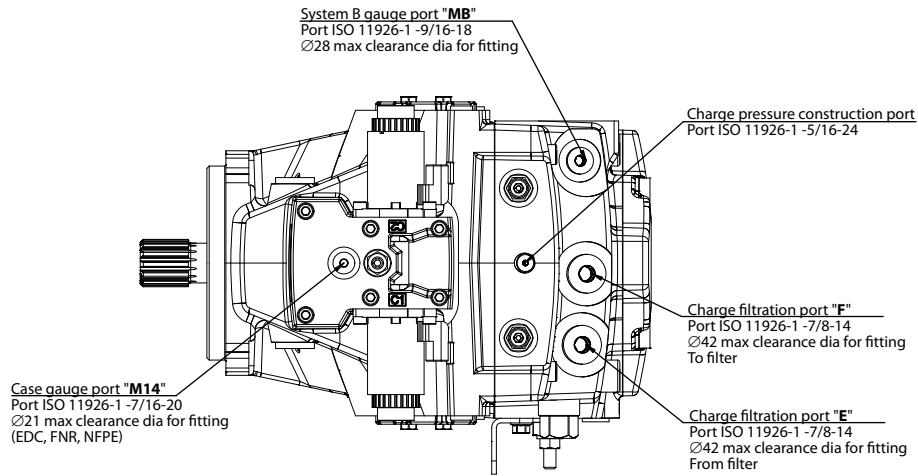
Port description

| 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 |
| 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 |

T000 204E

Please contact Sauer-Danfoss for specific installation drawings

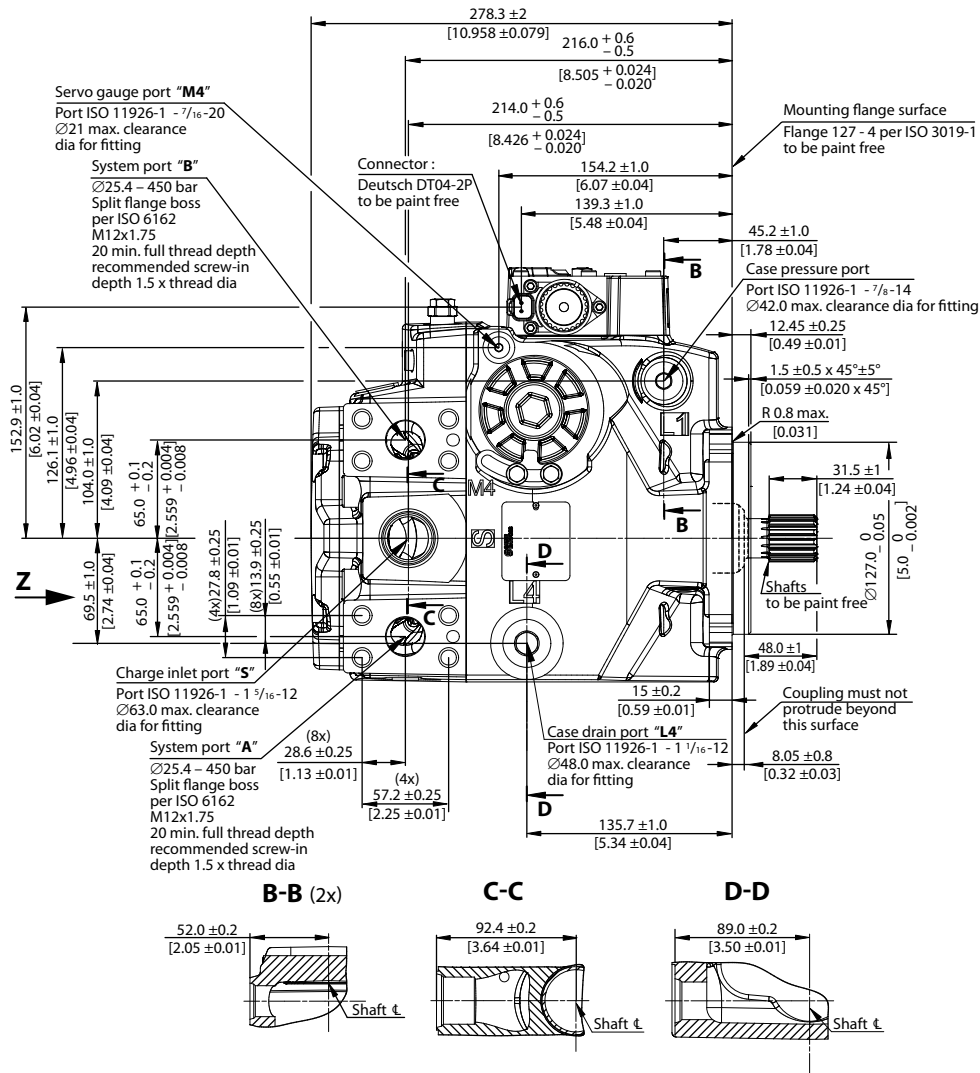
Port Description
(continued)



P003 325E

Please contact Sauer-Danfoss for specific installation drawings

Dimensions

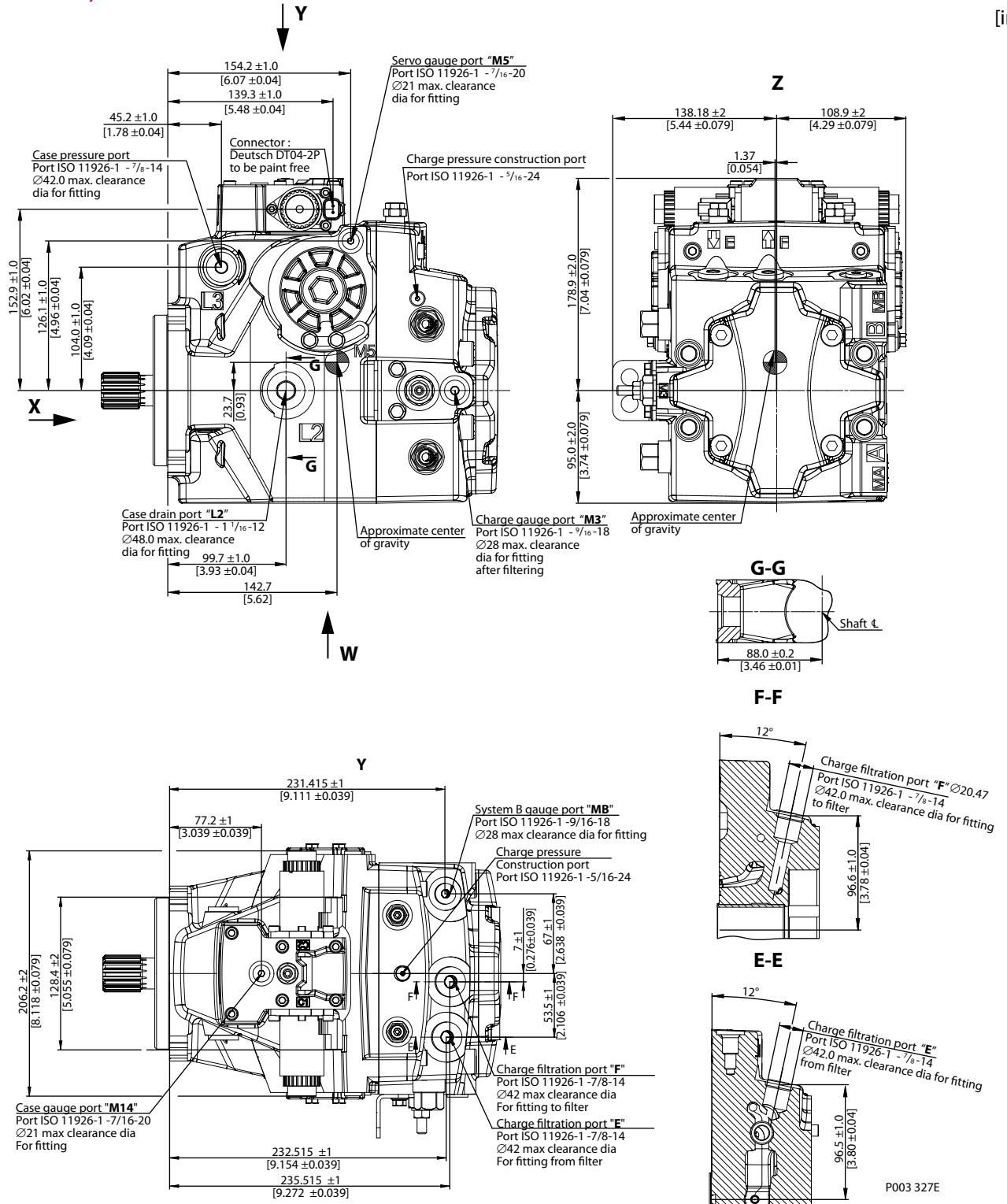


P003 326E

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Dimensions (continued)

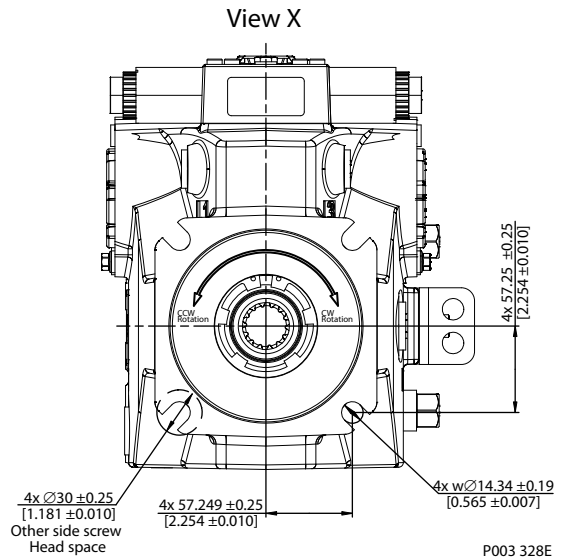
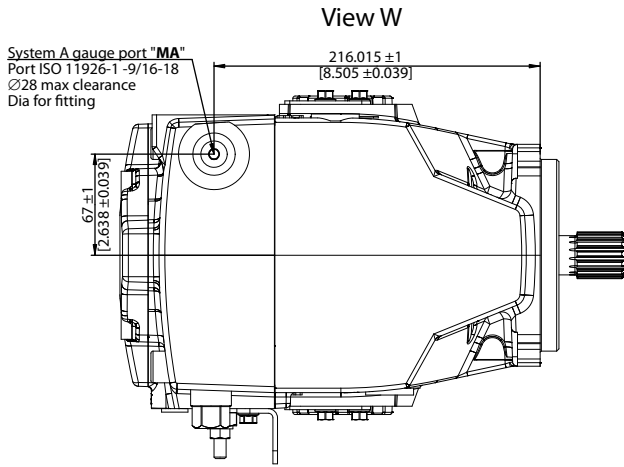
mm
[in]



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**Dimensions
(continued)**

mm
[in]

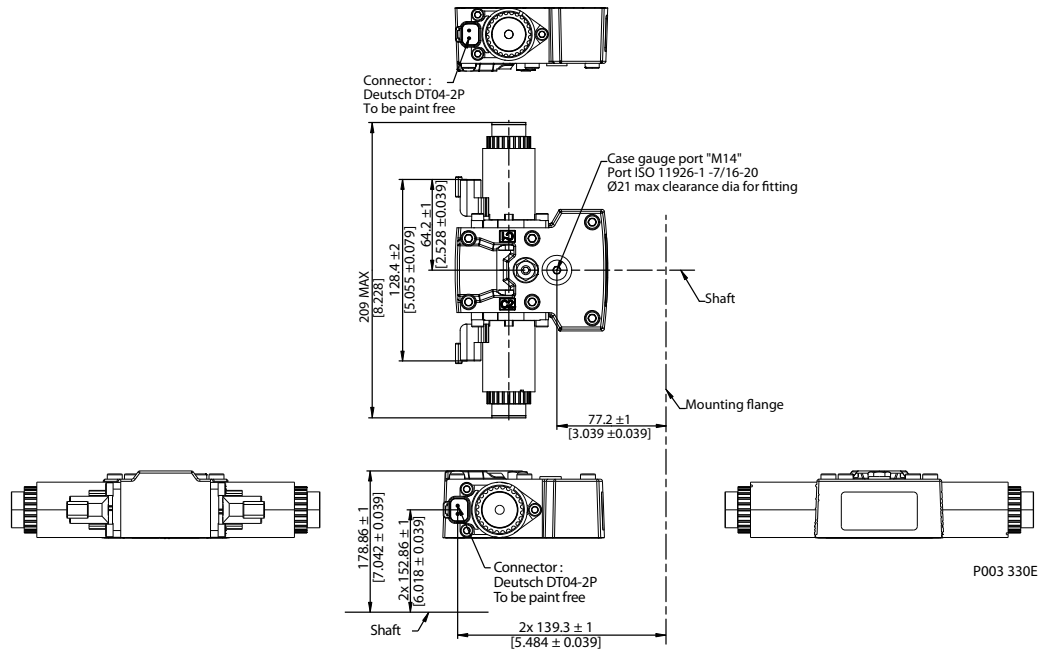


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Dimensions (continued)

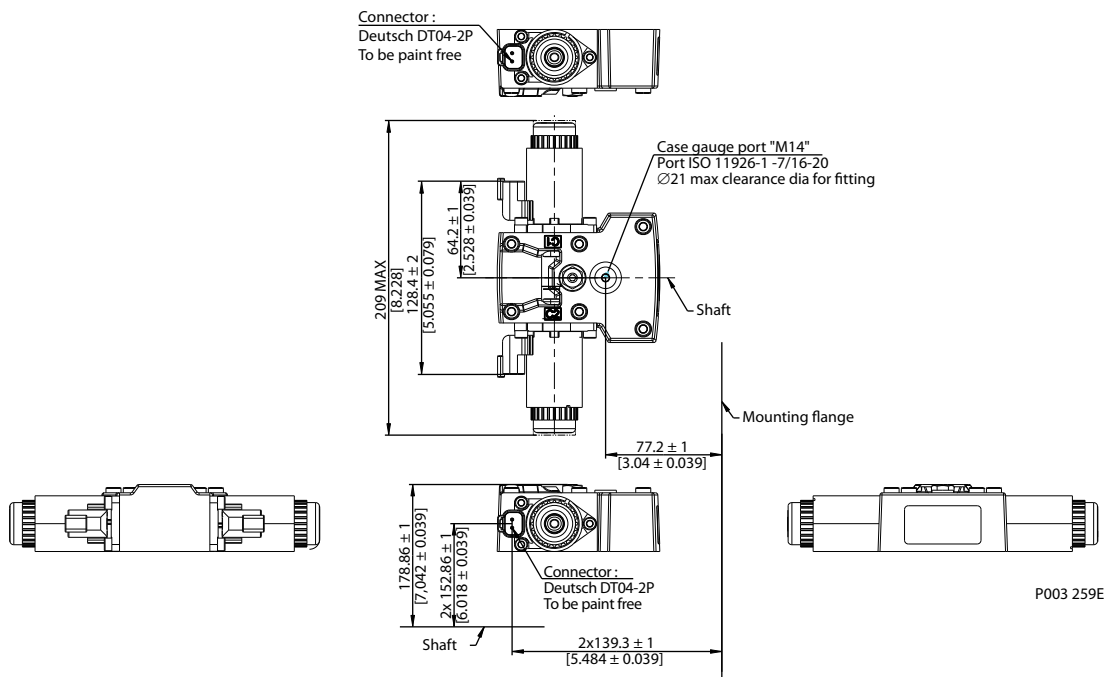
Controls

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



mm
[in]

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



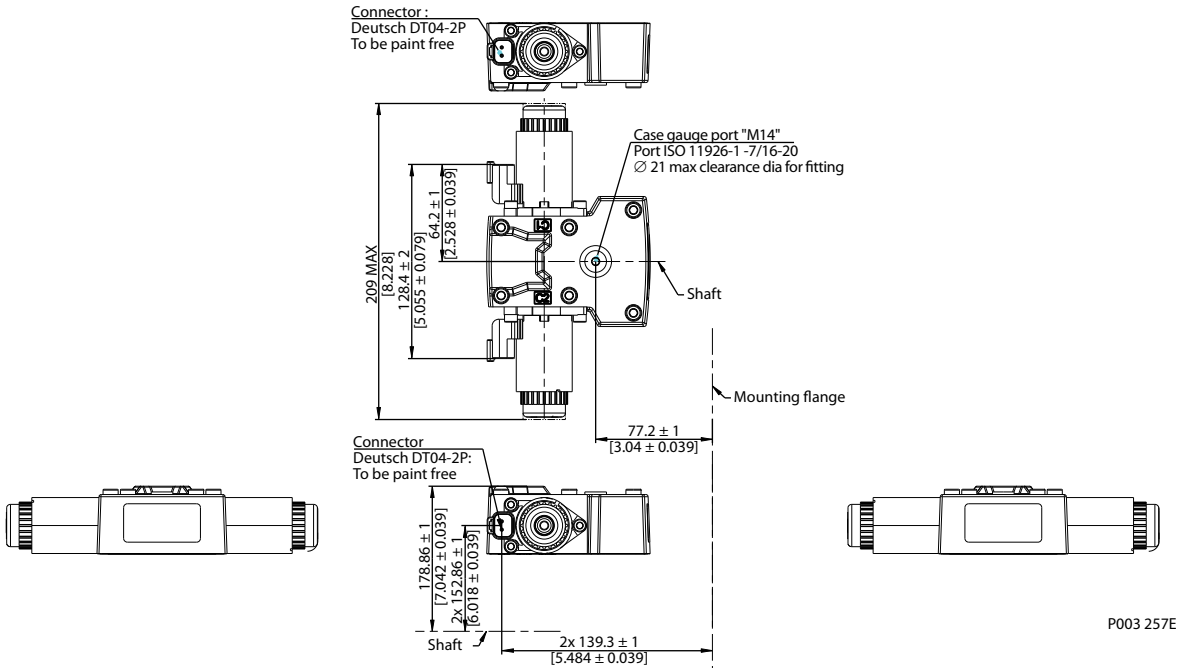
Please contact Sauer-Danfoss for specific installation drawings

Dimensions (continued)

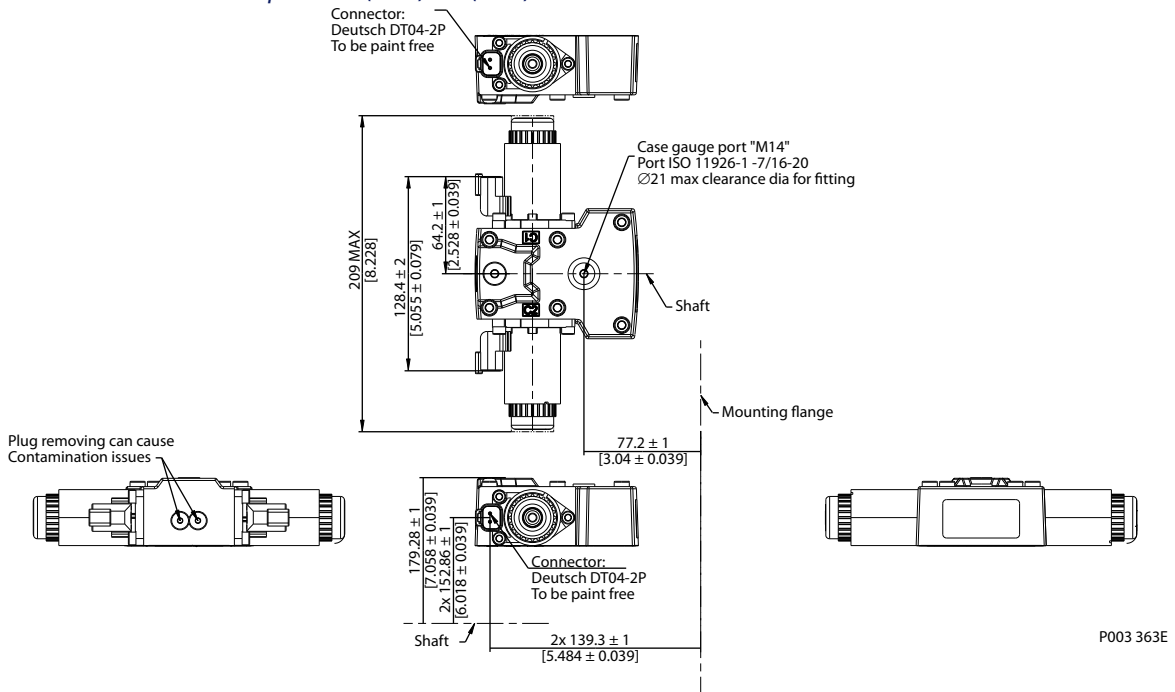
Controls

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

mm
[in]



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



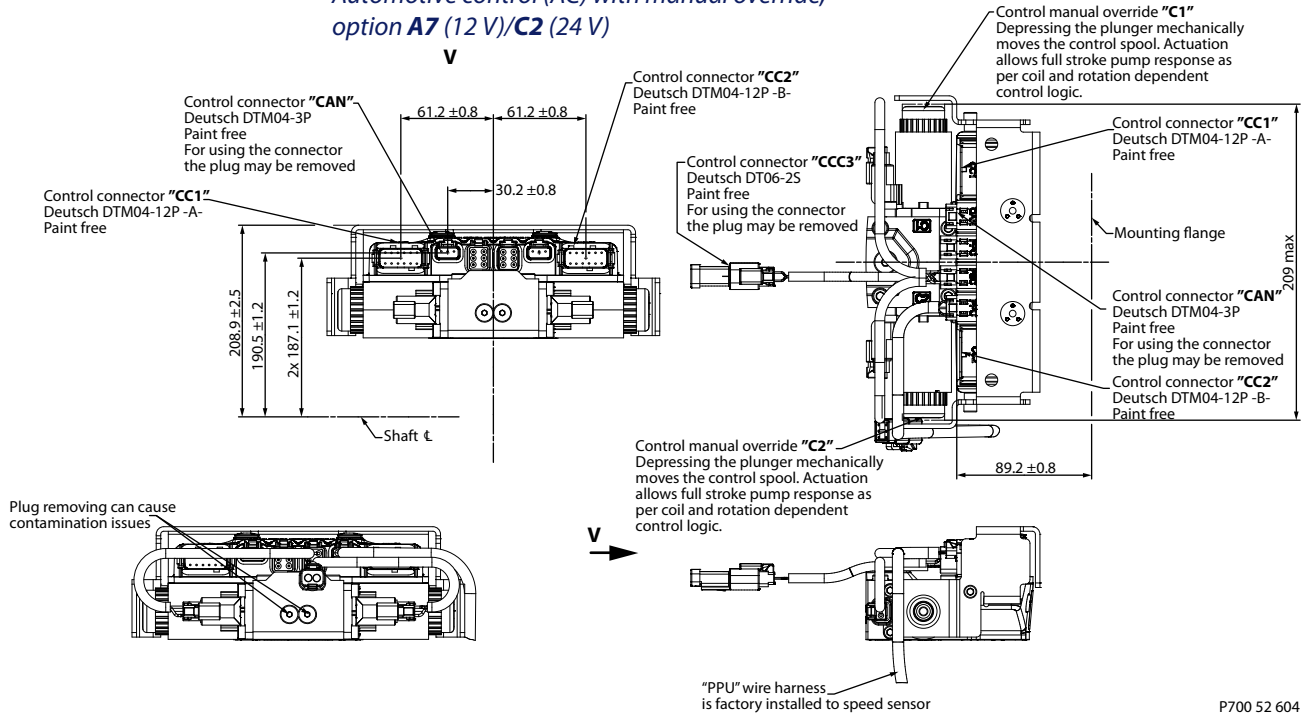
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Dimensions (continued)

Controls

mm

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



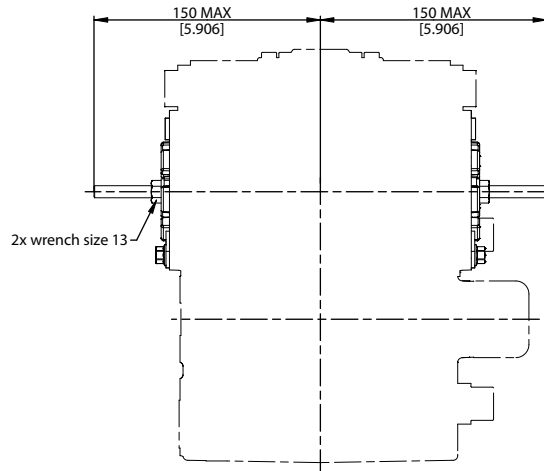
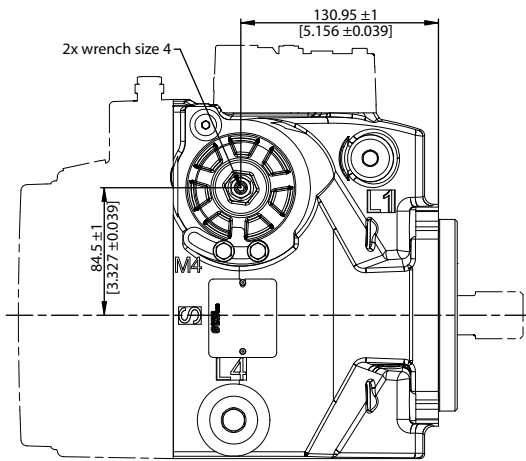
P700 52 604

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**Dimensions
(continued)**

Displacement limiters

*Displacement limiters,
option B*



mm
[in]

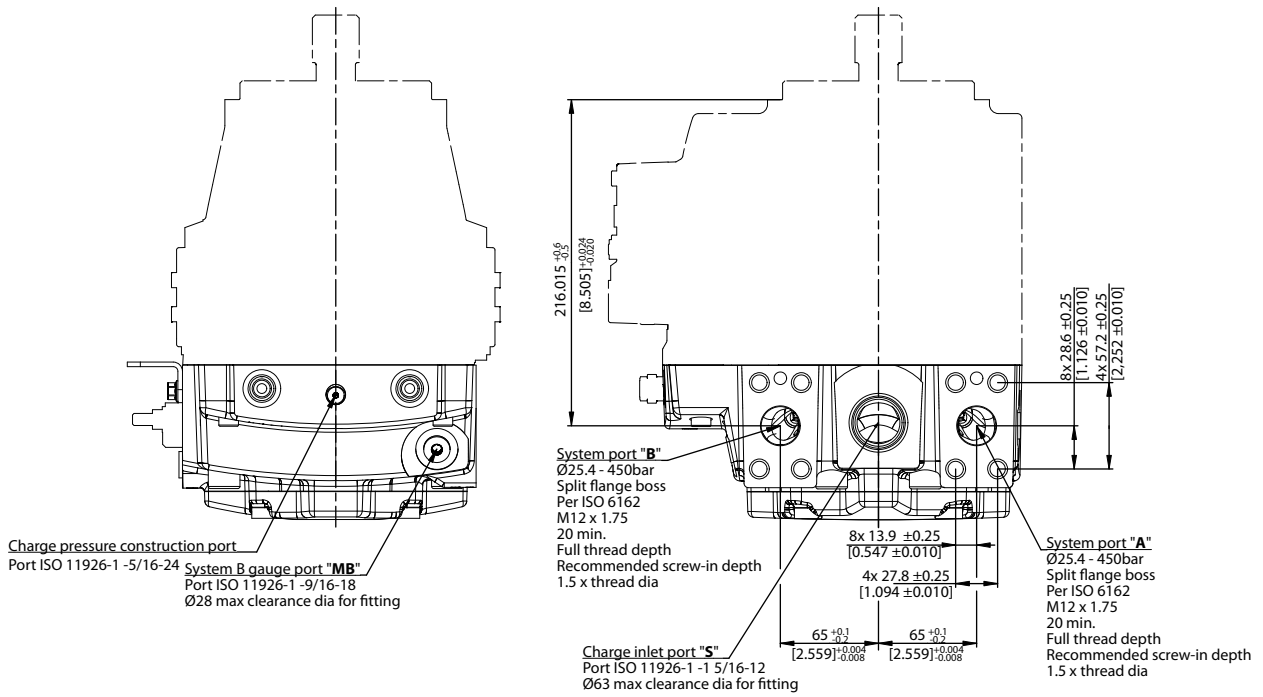
P003 255E

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Dimensions (continued)

Filtration

Suction filtration, option L



mm
[in]

P003 329E

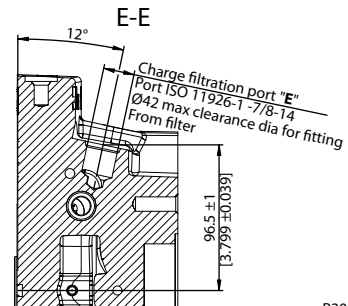
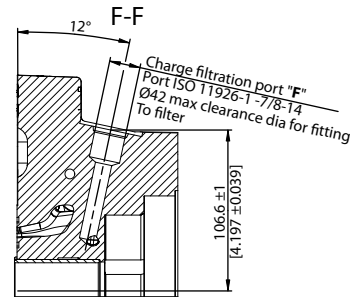
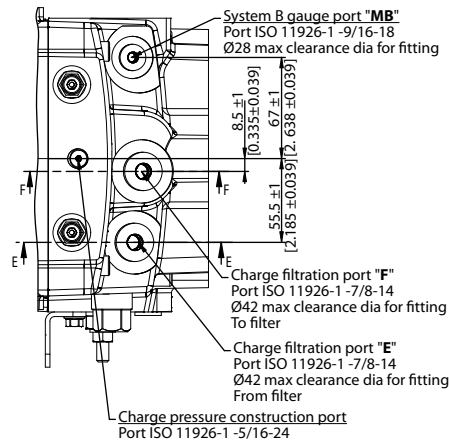
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**Dimensions
(continued)**

Filtration

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

mm
[in]



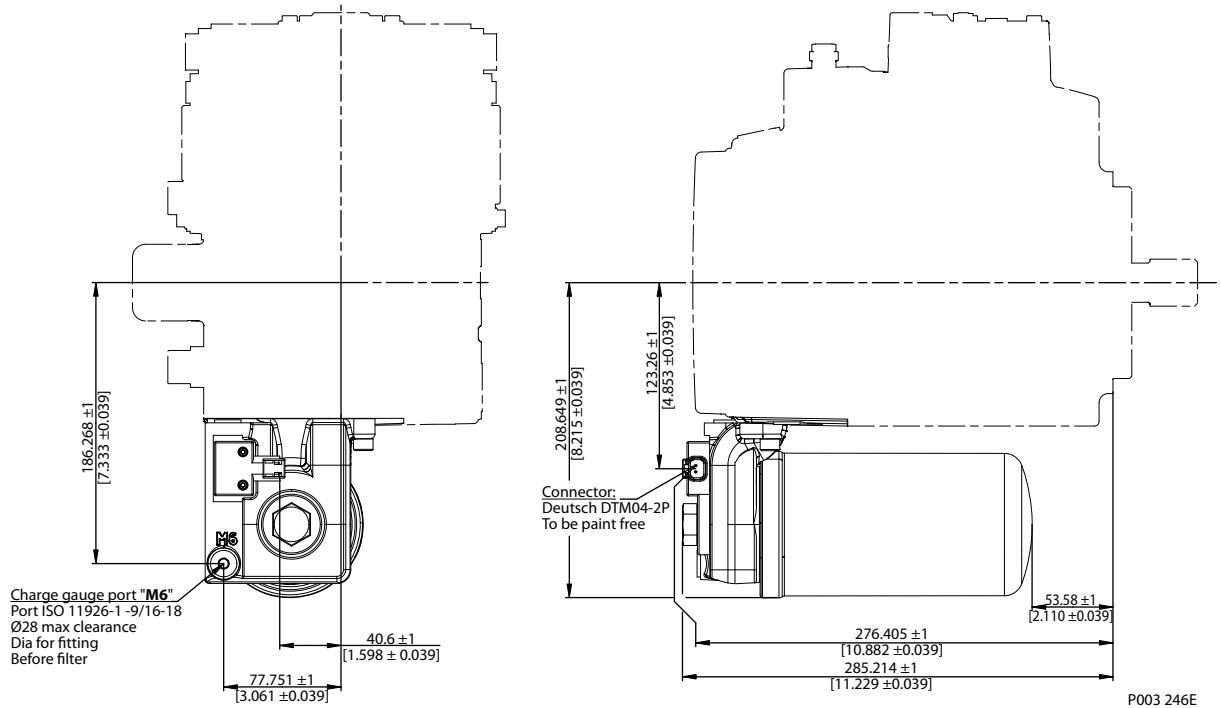
P301 298

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Dimensions (continued)

Filtration

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

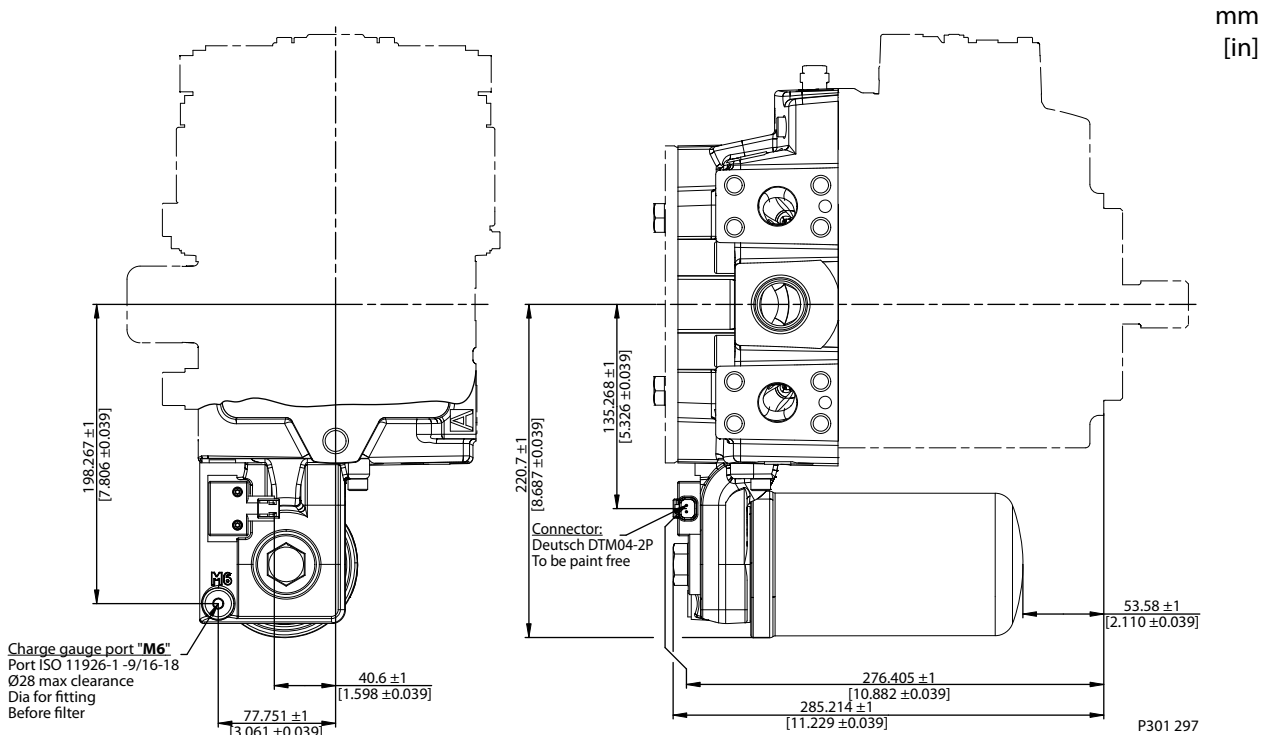


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Dimensions (continued)

Filtration

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

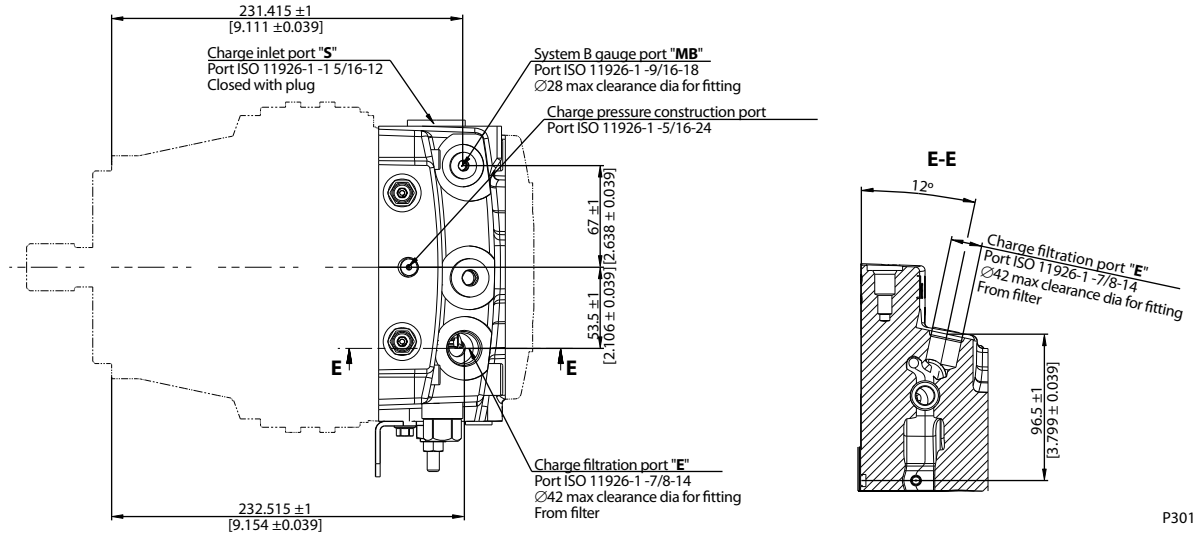


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Dimensions (continued)

Filtration

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



mm
[in]

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

Notes



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

Notes

Notes



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