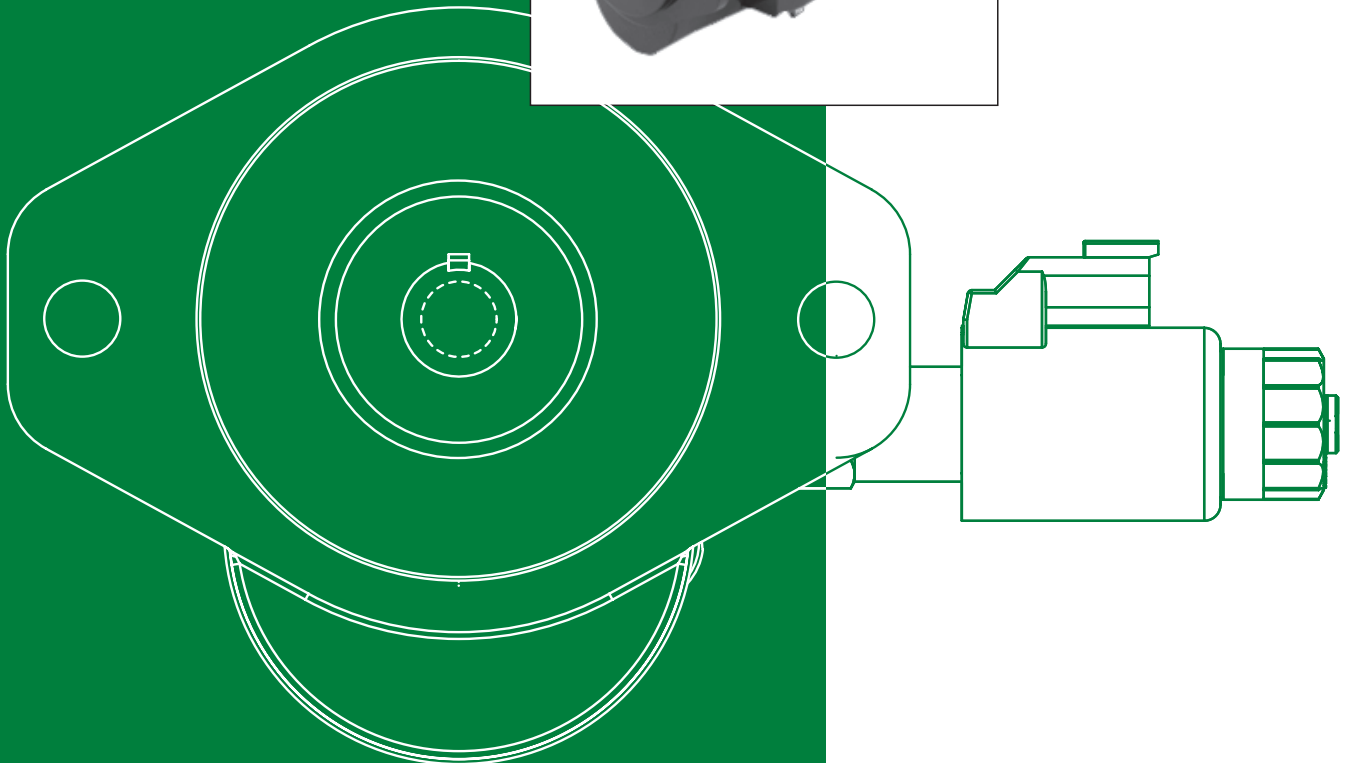
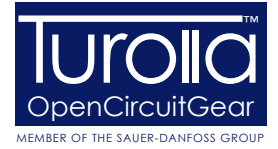
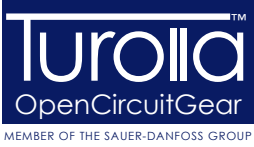


# D Series Gear Motors Including Fan Drive

## Technical Information





# D Series Gear Motors Including Fan Drive

## Technical Information

### Revisions

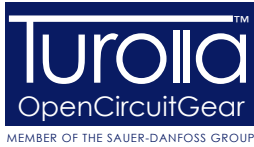
#### History of Revisions

*Table of Revisions*

| Date          | Page    | Changed   | Rev. |
|---------------|---------|---|------|
| February 2009 | -       | First edition   | AA   |
| November 2009 | 25      | TY shaft uses a #8 woodruff key                                 | AB   |
| February 2010 | last    | Fix Osaka address   | AC   |
| April 2010    | various | Add reversing fan drive motor                                   | BA   |
| November 2010 | all     | Turolla colors  | CA   |
| July 2011     | All     | TurollaOCG new layout, fonts update, Sauer-Danfoss replacement. | D    |
| October 2011  | 1       | Cover page change   | E    |

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# D Series Gear Motors Including Fan Drive

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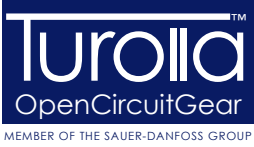
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# D Series Gear Motors Including Fan Drive

## Technical Information

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# D Series Gear Motors Including Fan Drive

## Technical Information

### General Information

#### Overview

The TurolloOCG D Series fixed displacement gear motor has been specifically designed for demanding mobile equipment applications where maximum performance is required at peak power levels and operating temperatures. The D Series motor is available in displacements of 14cm<sup>3</sup> to 45cm<sup>3</sup> [0.87 in<sup>3</sup> to 2.75 in<sup>3</sup>]. This motor delivers consistent efficiency across the entire operating range of pressure, speed, and temperature; all in an industry-leading package size that maximizes power density.

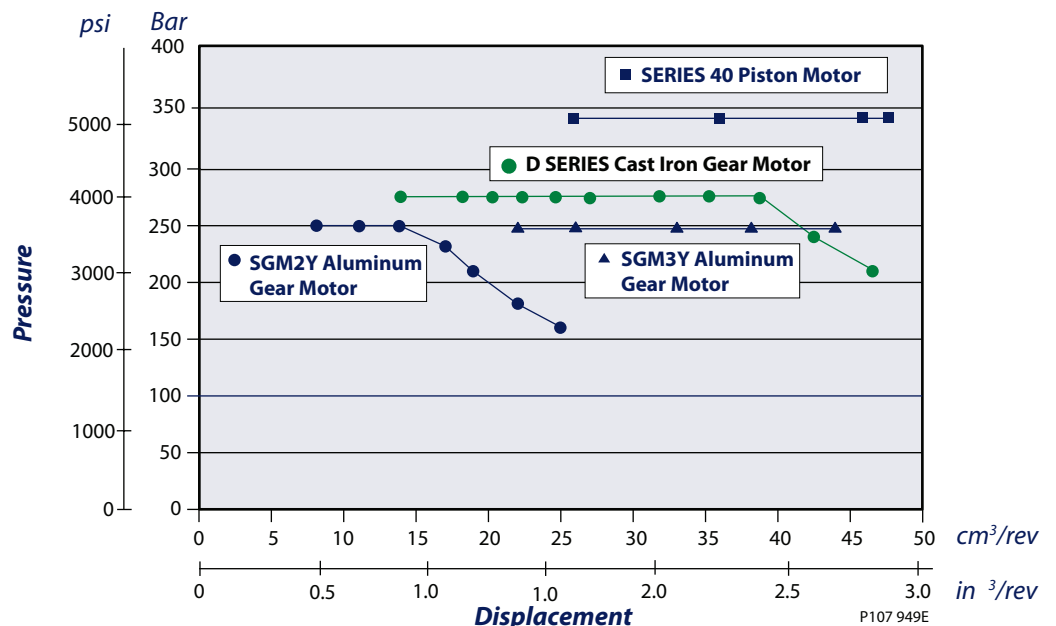
#### Features and Benefits

- High strength cast iron construction allows consistently efficient performance in continuous operation at 276 bar (4000 psi) and 110°C (230°F).
- Custom engineered shaft bearings and dual pressure-balanced thrust plates optimize internal bearing lubrication, allowing for high starting torque and long life with fluid viscosities as low as 8 mm<sup>2</sup>/sec (cSt) [36 SUS].
- Compact three-piece design with bearings located in the front flange and rear cover minimizes the overall package length and increases radial load carrying capability, eliminating the need for outrigger bearings on most applications.
- Variety of integrated valve options make the D Series motor ideally suited for high performance fan drive applications.

#### Fan Drive Motors

D Series cast iron motors complement the TurolloOCG portfolio of fan drive products. Including aluminum and cast iron pumps and motors, piston pumps and motors, valves and microcontrollers, you can apply the TurolloOCG range in various combinations to create high-performance fan drive systems. D series motors with integrated reversing and proportional relief valves are PLUS+1<sup>TM</sup> compliant for easy plug-and-perform<sup>TM</sup> installations and offer precise control of fan speed to optimize engine cooling performance.

Quick reference chart - TurolloOCG fan drive motors



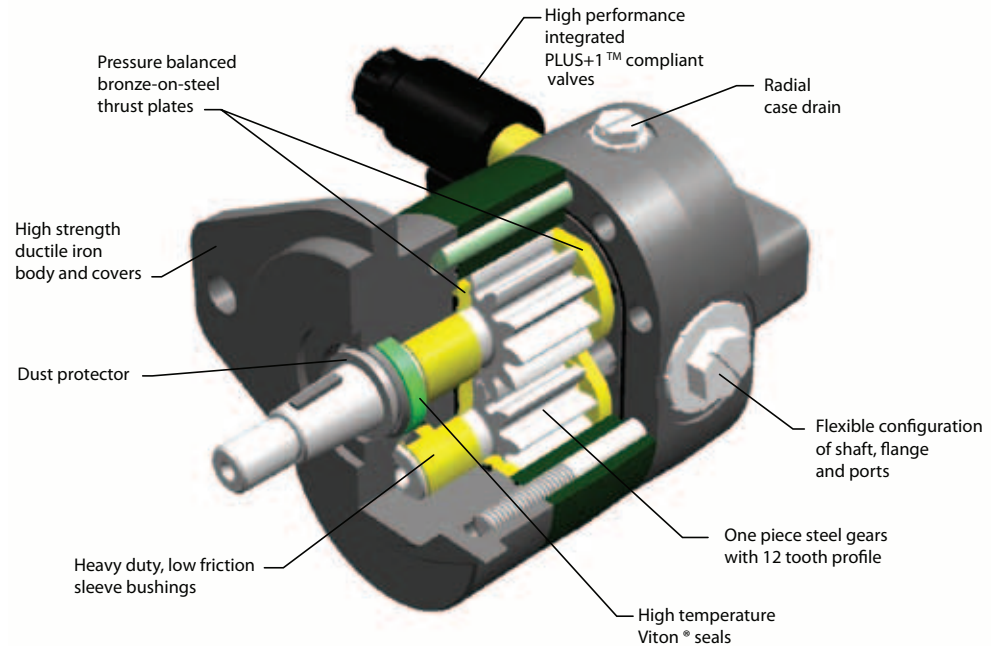
## D Series Gear Motors Including Fan Drive

### Technical Information

### General Information

#### Features

#### Quality components and construction



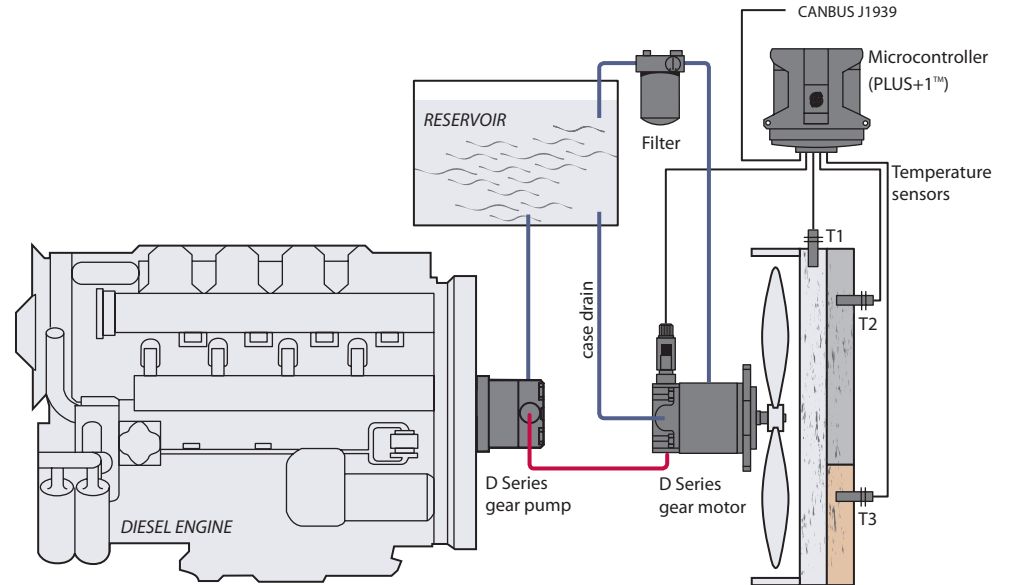
P107 920E

#### Benefits

- Pressure-balanced thrust plates for improved efficiency at extreme pressures and temperatures
- High-temperature Viton® seals for today's hotter running machines
- Three-piece ductile iron construction for increased durability, increased power density, with reduced adverse efficiency effects at high temperatures.
- High quality steel backed bronze bearings for maximum pressure handling capacity, located in the front flange, allowing extended radial loading capacity without an external roller bearing.
- Output shaft external dust seal to protect the oil seal from contamination damage
- Available side or rear ports, SAE A or B flange, with a variety of shafts for versatility.
- Integrated, normally-closed electrohydraulic proportional relief valve option for today's high-performing fan systems.

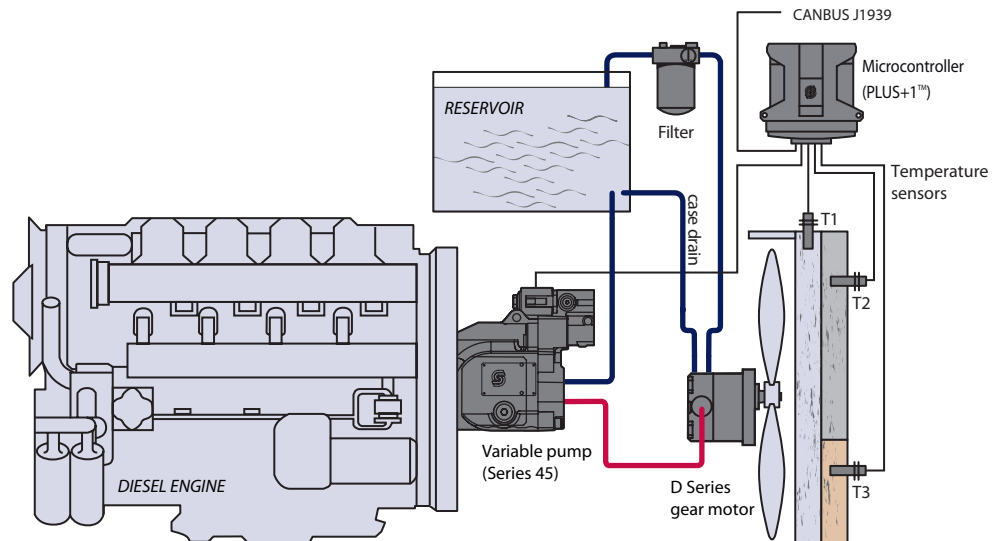
**System Schematics**

*Gear pump/gear motor system with electronic control*



P107 929E

*Piston pump/gear motor system with electronic control*



P107 931E

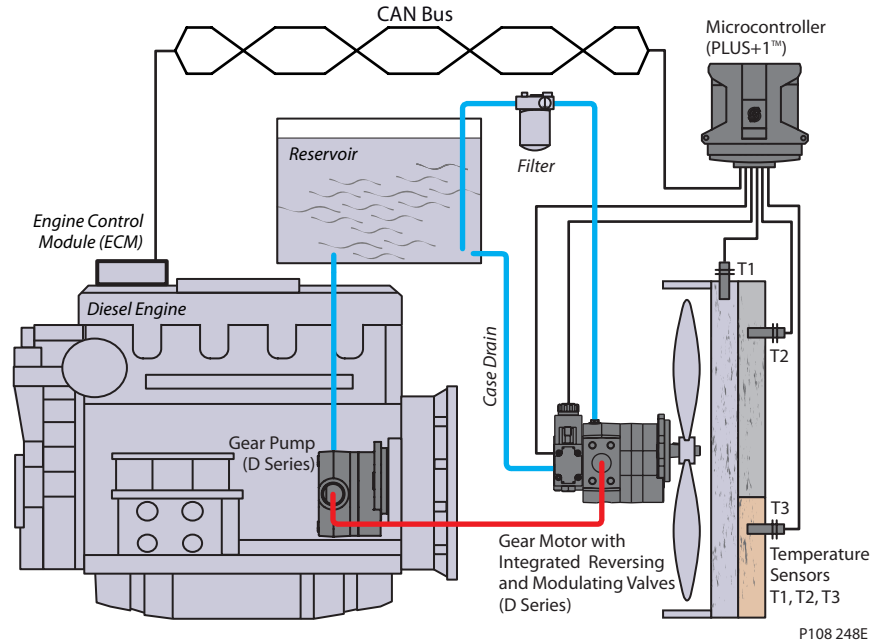
# D Series Gear Motors Including Fan Drive

## Technical Information

### General Information

#### System Schematics (continued)

*Gear pump/gear motor system with integrated reversing valve*



P108 248E

#### Product Features

| Features                        | Description   |
|---------------------------------|---|
| <b>Construction</b>             | Heavy duty ductile iron 3-piece construction  |
| <b>Displacements</b>            | 14 to 45 cm <sup>3</sup> [0.87 to 2.75 in <sup>3</sup> /rev]  |
| <b>Continuous Pressure</b>      | 276 bar [4000 psi] to 38 cm <sup>3</sup> [2.32 in <sup>3</sup> /rev]  |
| <b>Peak Pressure</b>            | 303 bar [4400 psi] to 38 cm <sup>3</sup> [2.32 in <sup>3</sup> /rev]  |
| <b>Speed</b>                    | 600 to 3400 min <sup>-1</sup> (rpm) - up to 38cm <sup>3</sup>   |
| <b>Mounting</b>                 | SAE A two bolt, SAE B two bolt  |
| <b>Shaft (types)</b>            | SAE straight keyed, 1:8 tapered keyed, splined  |
| <b>Fluid viscosity</b>          | 8 mm <sup>2</sup> /sec (cSt) [36 SUS] minimum, 1600 mm <sup>2</sup> /sec (cSt) [7500 SUS] maximum   |
| <b>Filtration requirement</b>   | 22/18/13 ISO 4406 at motor inlet  |
| <b>Inlet options</b>            | SAE O-ring boss, SAE split flange   |
| <b>Fluids</b>                   | Petroleum/mineral based   |
| <b>Operating temperature</b>    | -40°C [-40°F] minimum for cold start<br>110°C [230°F] normal operating conditions<br>115°C [239°F] peak intermittent  |
| <b>Integrated valve options</b> | Proportional relief valve, normally closed, 12 Vdc and 24 Vdc<br>two position directional control valve, 12 Vdc and 24 Vdc<br>Relief valve<br>Anti-cavitation check valve |



## Technical Specifications

### Technical data for D Motors

| Ratings  | Units                                  | 14   | 17   | 19   | 21   | 23   | 25   | 29    | 32    | 36    | 38    | 41    | 45    |
|--|--|------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|
| Displacement   | cm <sup>3</sup> /rev                   | 14.3 | 17.0 | 19.0 | 20.5 | 22.5 | 25.4 | 29.0  | 31.8  | 36.1  | 38.0  | 41.0  | 45.0  |
|  | in <sup>3</sup> /rev                   | 0.87 | 1.04 | 1.16 | 1.25 | 1.37 | 1.55 | 1.77  | 1.94  | 2.20  | 2.32  | 2.50  | 2.75  |
| Rated pressure   | bar                                    | 276  | 276  | 276  | 276  | 276  | 276  | 276   | 276   | 276   | 276   | 241   | 210   |
|  | psi                                    | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 | 4000  | 4000  | 4000  | 4000  | 3495  | 3045  |
| Peak pressure  | bar                                    | 303  | 303  | 303  | 303  | 303  | 303  | 303   | 303   | 303   | 303   | 265   | 231   |
|  | psi                                    | 4400 | 4400 | 4400 | 4400 | 4400 | 4400 | 4400  | 4400  | 4400  | 4400  | 3843  | 3350  |
| Speed at rated pressure                                | maximum                                | 3400 | 3400 | 3400 | 3400 | 3400 | 3400 | 3400  | 3400  | 3400  | 3400  | 3000  | 3000  |
|  | minimum*                               | 600  | 600  | 600  | 600  | 600  | 600  | 600   | 600   | 600   | 600   | 600   | 600   |
| Start speed at 1000 PSI                                | rpm                                    | 400  | 400  | 400  | 400  | 400  | 400  | 400   | 400   | 400   | 400   | 400   | 400   |
| Standard Weight  | kg                                     | 8.46 | 8.53 | 8.66 | 8.80 | 8.94 | 9.07 | 9.38  | 9.53  | 9.84  | 9.93  | 10.16 | 10.43 |
|  | lb                                     | 18.7 | 18.8 | 19.1 | 19.4 | 19.7 | 20.0 | 20.7  | 21.0  | 21.7  | 21.9  | 22.4  | 23.0  |
| Mass moment of inertia of internal rotating components | x10 <sup>-6</sup> kg·m <sup>2</sup>    | 113  | 127  | 138  | 146  | 156  | 172  | 191   | 206   | 228   | 239   | 255   | 276   |
|  | x10 <sup>-6</sup> slug·ft <sup>2</sup> | 83   | 94   | 102  | 107  | 115  | 127  | 141   | 152   | 168   | 176   | 188   | 204   |
| Theoretical torque at rated pressure                   | N·m                                    | 62.6 | 65.7 | 73.4 | 79.2 | 87.0 | 98.2 | 112.1 | 122.9 | 139.6 | 146.9 | 138.4 | 132.4 |
|  | lbf·ft                                 | 46.2 | 48.5 | 54.2 | 58.4 | 64.2 | 72.4 | 82.7  | 90.7  | 102.9 | 108.3 | 102.1 | 97.6  |
| Theoretical power at rated speed                       | kW                                     | 22.3 | 23.4 | 26.1 | 28.2 | 31.0 | 35.0 | 39.9  | 43.8  | 49.7  | 46.1  | 43.5  | 41.6  |
|  | hp                                     | 29.9 | 31.2 | 34.9 | 37.6 | 41.3 | 46.6 | 53.2  | 58.4  | 66.3  | 61.1  | 58.0  | 55.5  |
| Case drain pressure                                    | bar                                    | 5    | 5.0  | 5.0  | 5.0  | 5.0  | 5.0  | 5.0   | 5.0   | 5.0   | 5.0   | 5.0   | 5.0   |
|  | psi                                    | 72.5 | 72.5 | 72.5 | 72.5 | 72.5 | 72.5 | 72.5  | 72.5  | 72.5  | 72.5  | 72.5  | 72.5  |

\* minimum speed at maximum pressure

## Fluid Specifications

| Parameter             | Unit                       | Minimum                               | Continuous | Maximum   |
|-----------------------|----------------------------|---------------------------------------|------------|-----------|
| Viscosity             | mm <sup>2</sup> /sec (cSt) | 8                                     | 10 - 100   | 1600      |
|                       | [SUS]                      | [36]                                  | [50 - 212] | [7500]    |
| Temperature           | °C [°F]                    | -40 [-40]                             | 110 [230]  | 115 [239] |
| Cleanliness           |                            | ISO 4406 Class 22/18/13 or better     |            |           |
| Filtration efficiency | charge filtration          | $\beta_{15-20}=75(\beta_{10}\geq 10)$ |            |           |

Ratings are based on operation with premium petroleum-based hydraulic fluids containing oxidation, rust, and foam inhibitors.

### Sizing Equations

Use these formulas to determine the nominal motor size for a specific application.

#### Based on SI units

*Input flow*  $Q = \frac{V_g \cdot n}{1000 \cdot \eta_v}$  (l/min)

*Output torque*  $M = \frac{V_g \cdot \Delta p \cdot \eta_m}{20 \cdot \pi}$  (N·m)

*Output power*  $P = \frac{M \cdot n}{9550} = \frac{Q \cdot \Delta p \cdot \eta_t}{600}$  (kW)

*Motor speed*  $n = \frac{Q \cdot 1000 \cdot \eta_v}{V_g}$  (min<sup>-1</sup>(rpm))

#### Based on US units

$Q = \frac{V_g \cdot n}{231 \cdot \eta_v}$  (US gal/min)

$M = \frac{V_g \cdot \Delta p \cdot \eta_m}{2 \cdot \pi}$  (lbf·in)

$P = \frac{Q \cdot \Delta p \cdot \eta_t}{1714} = \frac{M \cdot n}{63\,025}$  (hp)

$n = \frac{Q \cdot 231 \cdot \eta_v}{V_g}$  (min<sup>-1</sup>(rpm))

#### Variables SI units [US units]

|            |  |   |
|------------|--|---|
| $V_g$      | = Displacement per revolution                  | cm <sup>3</sup> /rev [in <sup>3</sup> /rev] |
| $p_o$      | = Outlet pressure                              | bar [psi]                                   |
| $p_i$      | = Inlet pressure                               | bar [psi]                                   |
| $\Delta p$ | = $p_o - p_i$ (system pressure)                | bar [psi]                                   |
| $n$        | = Speed  | min <sup>-1</sup> (rpm)                     |
| $\eta_v$   | = Volumetric efficiency                        |   |
| $\eta_m$   | = Mechanical efficiency                        |   |
| $\eta_t$   | = Overall efficiency ( $\eta_v \cdot \eta_m$ ) |   |

## D Series Gear Motors Including Fan Drive Technical Information Operating Parameters

### Overview

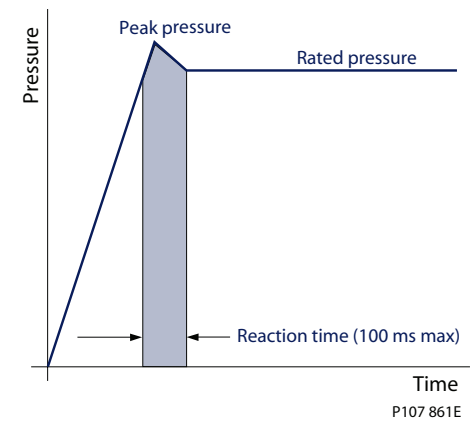
Definitions of the D Series operating parameters appear below. Consult your TurolldOCG representative for applications running outside of these parameters.

### Pressure

#### Peak Pressure

Peak pressure is the highest intermittent pressure allowed. The relief valve overshoot (reaction time) determines peak pressure. It is assumed to occur for less than 100 ms. The illustration to the right shows peak pressure in relation to rated pressure and reaction time (100 ms maximum).

Pressure vs. time



#### Rated Pressure

Rated pressure is the average, regularly occurring operating inlet pressure that should yield satisfactory product life. The maximum machine load at the motor shaft determines rated pressure.

#### System Pressure

System pressure is the differential between the inlet and outlet ports. It is a dominant operating variable affecting hydraulic unit life. High system pressure, resulting from high load at the motor shaft, reduces expected life. System pressure must remain at, or below, rated pressure during normal operation to achieve expected life.

#### Back Pressure

The hydraulic load downstream of the motor determines the back pressure. The D Series motor can work with back pressure up to 100% of the maximum rated inlet pressure.

#### Case Drain Pressure

Case drain pressure is the pressure in the case drain line. Route case drain plumbing directly to the reservoir to keep the case drain pressure as low as possible. Maximum continuous case drain pressure allowed is 5 bar [72.5 psi].

## D Series Gear Motors Including Fan Drive Technical Information Operating Parameters

### Temperature and Viscosity

Temperature and viscosity requirements must be concurrently satisfied.

#### Temperature

High temperature limits apply at the inlet port of the motor. Ensure the motor runs at or below the maximum continuous temperature.

Cold oil, generally, does not affect the durability of motor components. It may affect the ability of oil to flow and transmit power. For this reason, keep the temperature at 16°C [60 °F] above the pour point of the hydraulic fluid.

**Minimum** (cold start) **temperature** relates to the physical properties of component materials.

**Continuous temperature** is the temperature at or below which you may expect normal motor life.

**Maximum temperature** is the highest temperature that is tolerable by the machine for a transient/limited time. (Duty cycle 1% or less)

#### Viscosity

**Minimum viscosity** occurs only during brief occasions of maximum fluid temperature and severe duty cycle operation. It's the minimum acceptable viscosity to guarantee the motor life. (Duty cycle 1% or less)

**Maximum viscosity** occurs only during cold start at very low temperatures. It is the upper limit of viscosity that allows the motor to start.

**Continuous viscosity:** The viscosity range at which you may expect normal motor.

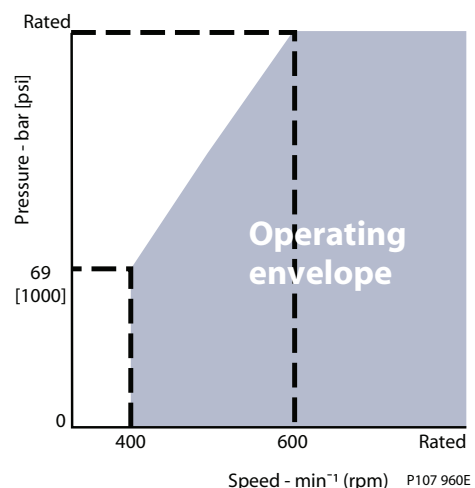
### Speed

**Maximum speed** is the limit for a particular gear motor when operating at rated pressure. It is the highest speed at which you may expect normal life.

The lower limit of operating speed is the **minimum speed**.

Minimum speed increases as operating system pressure increases. When operating under higher pressures, a higher minimum speed must be maintained, as shown.

Speed versus pressure



# D Series Gear Motors Including Fan Drive

## Technical Information

### Operating Parameters

#### Hydraulic Fluid

Ratings and data for gear motors are based on operation with premium hydraulic fluids containing oxidation, rust, and foam inhibitors. These fluids must possess good thermal and hydrolytic stability to prevent wear, and corrosion of internal components. Use petroleum/mineral-based fluids. Ensure only clean fluid enters the hydraulic system.

#### ⓘ Caution

Never mix hydraulic fluids.

For more information on hydraulic fluid selection, see TurollaOCG publication **L1021414** *Hydraulic Fluids and Lubricants, Technical Information*.

#### Filtration

##### Filters

Use a filter that conforms to Class 22/18/13 of ISO 4406 (or better). It may be on the motor outlet (discharge filtration) or inlet (pressure filtration).

##### Selecting a Filter

When selecting a filter, please consider:

- Contaminant ingress rate (determined by factors such as the number of actuators used in the system)
- Generation of contaminants in the system
- Required fluid cleanliness
- Desired maintenance interval
- Filtration requirements of other system components

Measure filter efficiency with a Beta ratio ( $\beta_x$ ).  $\beta_x$  ratio is a measure of filter efficiency defined by ISO 4572. It is the ratio of the number of particles greater than a given diameter (in microns) upstream of the filter to the number of these particles downstream of the filter.

- For discharge filtration with controlled reservoir ingress, use a  $\beta_{35-45} = 75$  filter
- For pressure filtration, use a filtration with an efficiency of  $\beta_{10} = 75$

Every system is unique. Only a thorough testing and evaluation program can fully validate the filtration system.

##### Fluid cleanliness level and $\beta_x$ ratio

|  |  |
|--|--|
| <b>Fluid cleanliness level (per ISO 4406)</b>                          | Class 22/18/13 or better                     |
| <b><math>\beta_x</math> ratio (discharge filtration)</b>               | $\beta_{35-45} = 75$ and $\beta_{10} = 2$    |
| <b><math>\beta_{35-45} = 75</math> and <math>\beta_{10} = 2</math></b> | $\beta_{10} = 75$                            |
| <b>Recommended inlet screen size</b>                                   | 100 – 125 $\mu\text{m}$ [0.0039 – 0.0049 in] |

## D Series Gear Motors Including Fan Drive Technical Information Operating Parameters

### Reservoir

The reservoir provides clean fluid, dissipates heat, removes entrained air, and allows for fluid volume changes associated with fluid expansion. A correctly sized reservoir accommodates maximum volume changes during all system operating modes. It promotes de-aeration of the fluid as it passes through, and accommodates a fluid dwell-time between 60 and 180 seconds, allowing entrained air to escape.

Minimum reservoir capacity depends on the volume required to cool and hold the fluid, allowing for expansion due to temperature changes. A fluid volume of one to three times the motor output flow (per minute) is satisfactory. The minimum recommended reservoir capacity is 125% of the fluid volume.

Put the return-line below the lowest expected fluid level to allow discharge into the reservoir for maximum dwell and efficient de-aeration. A baffle (or baffles) between the return and suction ports promotes de-aeration and accommodates fluid surges.

### Line Sizing

Choose pipe sizes that accommodate minimum fluid viscosity to reduce system noise, pressure drops and overheating in order to maximize system life and performance. Line velocity should not exceed 5.0 m/s [16.4 ft/s]. Route case drain line direct to tank.

Most systems use hydraulic oil containing 10% dissolved air by volume. Over-aeration, or entrained air is the result of flow line restrictions, where the dissolved air comes out of solution, or when air is allowed to leak into the hydraulic circuit. These include inadequate pipe sizes, sharp bends, or elbow fittings, causing reduction of flow-line cross-sectional area. This problem will not occur if these circuit recommendations are followed, rated speed requirements are maintained, and reservoir size and location are adequate.

### Motor Life

Motor life is a function of speed, system pressure, and other system parameters (such as fluid quality and cleanliness).

All TurollaOCG gear motors use hydrodynamic journal bearings that rely on an oil film between the gear shaft and bearing surfaces at all times. You can expect long life when this film is sustained through proper system maintenance and operating within recommended limits.

---

A  $B_{10}$  bearing life expectancy number is generally associated with rolling element bearings. It does not exist for hydrodynamic bearings.

---

High pressure impacts motor life. When submitting an application for review, provide machine duty cycle data that includes percentages of time at various loads and speeds. We strongly recommend a prototype testing program to verify operating parameters and their impact on life expectancy before finalizing any system design.

## D Series Gear Motors Including Fan Drive Technical Information Operating Parameters

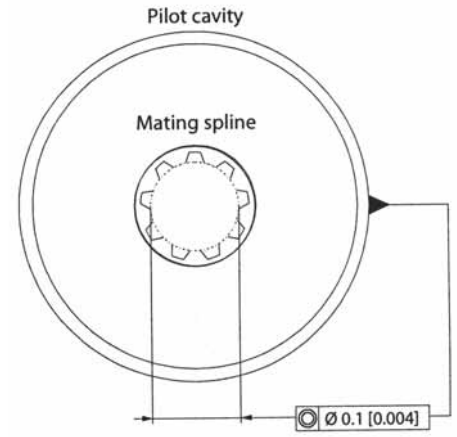
### Motor Shaft Connection

Shaft options for gear motors include tapered, splined, and parallel shafts.

Plug-in drives, with a splined shaft, can impose severe radial loads when the mating spline is rigidly supported. Increasing spline clearance does not alleviate this condition.

Use plug-in drives only if the concentricity between the mating spline and pilot diameter is within 0.1 mm [0.004 in]. Lubricate the drive by flooding with oil. A three-piece coupling minimizes radial or thrust shaft loads.

Motor shaft connection



To avoid spline shaft damage, use carburized and hardened steel couplings with 80-82 HRA surface hardness.

### Radial and Axial Loading

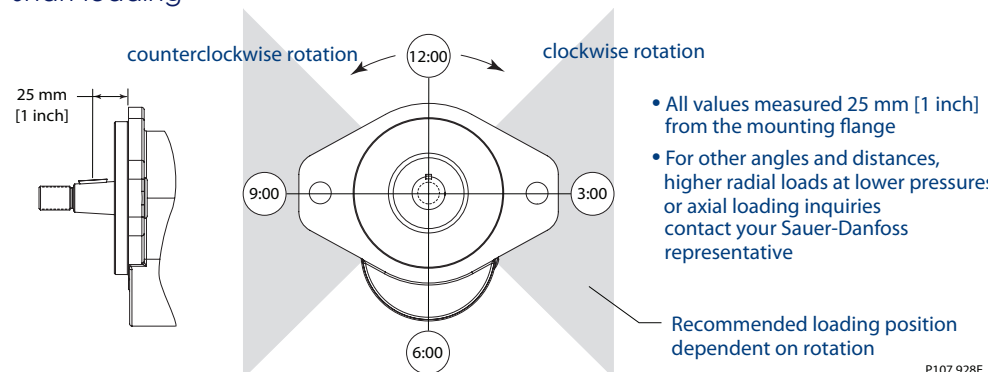
Allowable radial shaft loads are a function of the load position, load orientation, and operating pressure. All external shaft loads have an effect on bearing life, and may affect motor performance.

In applications where external shaft loads cannot be avoided, minimize the impact on the motor by optimizing the orientation and magnitude of the load. Avoid thrust loads in either direction. The table below shows the preferred orientation for radial loads assuming maximum pressure. For assistance concerning shaft loading, contact your TuroliaOCG representative.

Shaft axial and radial load ratings

| Ratings                     | Units | 14   | 17   | 19   | 21   | 23   | 25   | 29   | 32   | 36   | 38   | 41   | 45   |
|-----------------------------|-------|------|------|------|------|------|------|------|------|------|------|------|------|
| Max. radial load at 12:00 + | lbf   | 1510 | 1430 | 1360 | 1300 | 1210 | 1070 | 870  | 700  | 420  | 270  | 450  | 620  |
|                             | N     | 6717 | 6361 | 5943 | 1783 | 5382 | 4760 | 3870 | 3114 | 1868 | 1201 | 2002 | 2758 |
| Push/Pull axial load        | lbf   | 350  | 350  | 350  | 350  | 350  | 350  | 350  | 350  | 350  | 350  | 350  | 350  |
|                             | N     | 1557 | 1557 | 1557 | 1557 | 1557 | 1557 | 1557 | 1557 | 1557 | 1557 | 1557 | 1557 |

Shaft loading



P107 928E

# D Series Gear Motors Including Fan Drive

## Technical Information

### Model Code

### Order Code

### Fan drive motor code example

#### DEMR-17TY-AA-B107-P1AB-A000-N000-AN-NNN

**A** Right hand rotation, **B** 17 cm<sup>3</sup>, 1:8 taper shaft, **C** SAE A two bolt mounting, **D** 7/8-14 ports, idler side drain, **E** 12 Vdc proportional relief valve, 25 US gal/min or less at 172 bar curve, **F** anti-cavitation valve.



#### A Sense of rotation

| Code | Description                              |
|------|--|
| B    | Bidirectional rotation (reversing valve) |
| L    | Left hand rotation (CCW)                 |
| R    | Right hand rotation (CW)                 |

#### B1 Displacement

| Code | Description   |
|------|---|
| 14   | 14.3 cm <sup>3</sup> /rev [0.87 in <sup>3</sup> /rev] |
| 17   | 17.0 cm <sup>3</sup> /rev [1.04 in <sup>3</sup> /rev] |
| 19   | 19.0 cm <sup>3</sup> /rev [1.16 in <sup>3</sup> /rev] |
| 21   | 20.5 cm <sup>3</sup> /rev [1.25 in <sup>3</sup> /rev] |
| 23   | 22.5 cm <sup>3</sup> /rev [1.37 in <sup>3</sup> /rev] |
| 25   | 25.4 cm <sup>3</sup> /rev [1.55 in <sup>3</sup> /rev] |

| Code | Description   |
|------|---|
| 29   | 29.0 cm <sup>3</sup> /rev [1.77 in <sup>3</sup> /rev] |
| 32   | 31.8 cm <sup>3</sup> /rev [1.94 in <sup>3</sup> /rev] |
| 36   | 36.1 cm <sup>3</sup> /rev [2.20 in <sup>3</sup> /rev] |
| 38   | 38.0 cm <sup>3</sup> /rev [2.32 in <sup>3</sup> /rev] |
| 41   | 41.0 cm <sup>3</sup> /rev [2.50 in <sup>3</sup> /rev] |
| 45   | 45.1 cm <sup>3</sup> /rev [2.75 in <sup>3</sup> /rev] |

#### B2 Input shaft

| Code | Description   |
|------|---|
| PB   | SAE 22 mm [7/8 in] Ø x 41mm [1.62 in] Extension, 1/4 in key, with key   |
| PW   | SAE 22 mm [7/8 in] Ø x 51mm [2 in] Extension, 1/4 in key, with key  |
| TY   | SAE 1:8 taper, 22 mm [7/8 in] Ø x 59 mm [2.34 in] Extension, 5/8-18 x 21 mm [.81 in] external thread with #8 Woodruff key |
| TK   | 1:8 taper, 22 mm [7/8 in] Ø x 35 mm [1.38 in] Extension, 3/8-24 x 19 mm [.75 in] Internal thread                          |
| SM   | 11 tooth, 48 mm [1.89 in] extension, (modified length) 30 mm [1.20 in] effective spline                                   |
| SH   | 13 tooth, 41 mm [1.62 in] length  |

#### C Mounting

| Code | Description   |
|------|---------------|
| AA   | SAE A, 2 bolt |
| BB   | SAE B, 2 Bolt |

#### D1 Rear Cover Function

| Code | Description   |
|------|---|
| N    | No valves, standard cover   |
| A    | Cover with anti-cavitation check valve  |
| B    | Cover for use with low flow relief valve (P1, P3 or F) and anti-cavitation check valve  |
| C    | Cover for use with high flow relief valve (P2, P4 or G) and anti-cavitation check valve |
| P    | Cover with empty SAE 12-2 cavity and anti-cav ity (customer supplied) relief valve      |
| S    | Cover with empty SAE 10-2 cavity and anti-cav ity (customer supplied) relief valve      |
| R    | Cover for reversing function with proportional relief, primary CW rotation              |
| L    | Cover for reversing function with proportional relief, primary CW rotation              |

For the D module, the **first number** specifies the function of the rear cover.



# D Series Gear Motors Including Fan Drive

## Technical Information

### Model Code

### Order Code (continued)



For the D module, the next three numbers specify the port options for the rear cover.

### D2 Rear Cover Port Options

| Code   |       | Description               |                                  |
|--------|-------|---------------------------|----------------------------------|
| Radial | Axial | Inlet/Outlet              | Drain port                       |
| 105    | 505   | 3/4-16 SAE O-ring boss    | Radial 9/16-18 SAE (idler side*) |
| 106    | 506   | 3/4-16 SAE O-ring boss    | Radial 9/16-18 SAE (drive side*) |
| 107    | 507   | 7/8-14 SAE O-ring boss    | Radial 9/16-18 SAE (idler side*) |
| 108    | 508   | 7/8-14 SAE O-ring boss    | Radial 9/16-18 SAE (drive side*) |
| 109    | 509   | 1 1/16-12 SAE O-ring boss | Radial 9/16-18 SAE (idler side*) |
| 110    | 510   | 1 1/16-12 SAE O-ring boss | Radial 9/16-18 SAE (drive side*) |
| 111    | N/A   | 1 5/16-12 SAE O-ring boss | Radial 9/16-18 SAE (idler side*) |
| 112    | N/A   | 1 5/16-12 SAE O-ring boss | Radial 9/16-18 SAE (drive side*) |
| 330    | N/A   | 1inch SAE Split flange    | Radial 9/16-18 SAE (idler side*) |
| 331    | N/A   | 1inch SAE Split flange    | Radial 9/16-18 SAE (drive side*) |
| 332    | N/A   | 1-1/4 SAE Split flange    | Radial 9/16-18 SAE (idler side*) |
| 333    | N/A   | 1-1/4 SAE Split flange    | Radial 9/16-18 SAE (drive side*) |

\* See dimension drawings for explanation of drive and idler side.

### D Rear Cover Availability Matrix

| Code    | D1 Rear cover/valve option |   |   |   |   |   |   |   |   |
|---------|----------------------------|---|---|---|---|---|---|---|---|
|         | D2 Port options            | N | B | C | A | P | S | R | L |
| 105     | ●                          | — | — | ● | — | — | — | — | — |
| 106     | ●                          | — | — | ● | — | — | — | — | — |
| 107     | ●                          | ● | ● | ● | ● | ● | ● | ● | ● |
| 108     | ●                          | ● | ● | ● | ● | ● | ● | ● | ● |
| 109     | ●                          | ● | ● | ● | ● | ● | ● | ● | ● |
| 110     | ●                          | ● | ● | ● | ● | ● | ● | ● | ● |
| 111     | ●                          | ● | ● | ● | ● | ● | ● | ● | ● |
| 112     | ●                          | ● | ● | ● | ● | ● | ● | ● | ● |
| 330/331 | ●                          | — | — | ● | — | — | — | ● | ● |
| 332/333 | ●                          | — | — | ● | — | — | — | ● | ● |
| 505     | ●                          | — | — | ● | — | — | — | — | — |
| 506     | ●                          | — | — | ● | — | — | — | — | — |
| 507     | ●                          | — | — | ● | — | — | — | — | — |
| 508     | ●                          | — | — | ● | — | — | — | — | — |
| 509     | ●                          | — | — | ● | — | — | — | — | — |
| 510     | ●                          | — | — | ● | — | — | — | — | — |

|         |               |
|---------|---------------|
| Legend: |               |
| ●       | Standard      |
| ○       | Optional      |
| —       | Not Available |

### Order Code (continued)



### E Relief Valve Availability

| Code        | Description  | Pressure bar [psi] | Compatible with D1 - Rear cover function |   |   |   |   |   |   |   |
|-------------|--|--------------------|--|---|---|---|---|---|---|---|
|             |  |                    | N  | B | C | A | P | S | R | L |
| <b>N000</b> | No relief valve  | N/A                | ●  | — | — | ● | ● | ● | — | — |
| <b>R000</b> | Reversing, with proportional relief                                      | See module G       | —  | — | — | — | — | — | ● | ● |
| <b>F138</b> | F style - low flow, fixed setting pressure relief valve (non-reversing)  | 138 [2000]         | —  | ● | — | — | — | — | — | — |
| <b>F172</b> |  | 172 [2500]         | —  | ● | — | — | — | — | — | — |
| <b>F207</b> |  | 207 [3000]         | —  | ● | — | — | — | — | — | — |
| <b>F241</b> |  | 241 [3500]         | —  | ● | — | — | — | — | — | — |
| <b>F276</b> |  | 276 [4000]         | —  | ● | — | — | — | — | — | — |
| <b>G138</b> | G style - high flow, fixed setting pressure relief valve (non-reversing) | 138 [2000]         | —  | — | ● | — | — | — | — | — |
| <b>G172</b> |  | 172 [2500]         | —  | — | ● | — | — | — | — | — |
| <b>G207</b> |  | 207 [3000]         | —  | — | ● | — | — | — | — | — |
| <b>G241</b> |  | 241 [3500]         | —  | — | ● | — | — | — | — | — |
| <b>G276</b> |  | 276 [4000]         | —  | — | ● | — | — | — | — | — |
| <b>P1AA</b> | P1 style - low flow, proportional relief valve 12 Vdc (non-reversing)    | 138 [2000]         | —  | ● | — | — | — | — | — | — |
| <b>P1AB</b> |  | 172 [2500]         | —  | ● | — | — | — | — | — | — |
| <b>P1AC</b> |  | 207 [3000]         | —  | ● | — | — | — | — | — | — |
| <b>P1AD</b> |  | 241 [3500]         | —  | ● | — | — | — | — | — | — |
| <b>P1AF</b> |  | 276 [4000]         | —  | ● | — | — | — | — | — | — |
| <b>P2BA</b> | P2 style - high flow, proportional relief valve 12 Vdc (non-reversing)   | 138 [2000]         | —  | — | ● | — | — | — | — | — |
| <b>P2BB</b> |  | 172 [2500]         | —  | — | ● | — | — | — | — | — |
| <b>P2BC</b> |  | 207 [3000]         | —  | — | ● | — | — | — | — | — |
| <b>P2BD</b> |  | 241 [3500]         | —  | — | ● | — | — | — | — | — |
| <b>P2BF</b> |  | 276 [4000]         | —  | — | ● | — | — | — | — | — |
| <b>P3AA</b> | P3 style - low flow, proportional relief valve 24 Vdc (non-reversing)    | 138 [2000]         | —  | ● | — | — | — | — | — | — |
| <b>P3AB</b> |  | 172 [2500]         | —  | ● | — | — | — | — | — | — |
| <b>P3AC</b> |  | 207 [3000]         | —  | ● | — | — | — | — | — | — |
| <b>P3AD</b> |  | 241 [3500]         | —  | ● | — | — | — | — | — | — |
| <b>P3AF</b> |  | 276 [4000]         | —  | ● | — | — | — | — | — | — |
| <b>P4BA</b> | P4 style - high flow, proportional relief valve 24 Vdc (non-reversing)   | 138 [2000]         | —  | — | ● | — | — | — | — | — |
| <b>P4BB</b> |  | 172 [2500]         | —  | — | ● | — | — | — | — | — |
| <b>P4BC</b> |  | 207 [3000]         | —  | — | ● | — | — | — | — | — |
| <b>P4BD</b> |  | 241 [3500]         | —  | — | ● | — | — | — | — | — |
| <b>P4BF</b> |  | 276 [4000]         | —  | — | ● | — | — | — | — | — |

|         |               |
|---------|---------------|
| Legend: |               |
| ●       | Standard      |
| ○       | Optional      |
| —       | Not Available |

# D Series Gear Motors Including Fan Drive

## Technical Information

### Model Code

Order Code  
(continued)



#### F Anti-cavitation/Shock Valve Function

|                            |      | Compatible with D1 - Rear cover option |   |   |   |   |   |   |   |
|----------------------------|------|--|---|---|---|---|---|---|---|
|                            | F    | A                                      | B | C | N | P | S | R | L |
| No valves                  | N000 |  |   |   | ● | — | — | — | — |
| Anti-cavitation valve      | A000 | ●                                      | ● | ● |   | ● | ● |   |   |
| Shock with Anti-cavitation | S300 | —                                      | — | — | — | — | — | ● | ● |

Units with integrated reversing are bi-directional motors, however, valves are rotation specific. User must specify **DEMB** rotation and **R** or **L** rear cover. Integrated reversing also requires **R000** relief and **S300** anti-cavitation/shock valves.

#### G Integrated Reversing Modulating Function

| Code        | Description  | Pressure bar [psi] | A | B | C | N | P | S | R | L |
|-------------|--|--------------------|---|---|---|---|---|---|---|---|
| <b>N000</b> | No integrated reversing valve  | N/A                | ● | ● | ● | ● | ● | ● | — | — |
| <b>A1AA</b> | D03 Directional Valve<br>P1 Style - Proportional relief valve 12 VDC | 138 [2000]         | — | — | — | — | — | — | ● | ● |
| <b>A1AB</b> |  | 172 [2500]         | — | — | — | — | — | — | ● | ● |
| <b>A1AC</b> |  | 207 [3000]         | — | — | — | — | — | — | ● | ● |
| <b>A1AD</b> |  | 241 [3500]         | — | — | — | — | — | — | ● | ● |
| <b>A1AF</b> |  | 276 [4000]         | — | — | — | — | — | — | ● | ● |
| <b>A2AA</b> | D03 Directional Valve<br>P3 Style - Proportional relief valve 24 VDC | 138 [2000]         | — | — | — | — | — | — | ● | ● |
| <b>A2AB</b> |  | 172 [2500]         | — | — | — | — | — | — | ● | ● |
| <b>A2AC</b> |  | 207 [3000]         | — | — | — | — | — | — | ● | ● |
| <b>A2AD</b> |  | 241 [3500]         | — | — | — | — | — | — | ● | ● |
| <b>A2AF</b> |  | 276 [4000]         | — | — | — | — | — | — | ● | ● |
| <b>B1AA</b> | D05 Directional Valve<br>P2 Style - Proportional relief valve 12 VDC | 138 [2000]         | — | — | — | — | — | — | ● | ● |
| <b>B1AB</b> |  | 172 [2500]         | — | — | — | — | — | — | ● | ● |
| <b>B1AC</b> |  | 207 [3000]         | — | — | — | — | — | — | ● | ● |
| <b>B1AD</b> |  | 241 [3500]         | — | — | — | — | — | — | ● | ● |
| <b>B1AF</b> |  | 276 [4000]         | — | — | — | — | — | — | ● | ● |
| <b>B2AA</b> | D05 Directional Valve<br>P4 Style - Proportional relief valve 24 VDC | 138 [2000]         | — | — | — | — | — | — | ● | ● |
| <b>B2AB</b> |  | 172 [2500]         | — | — | — | — | — | — | ● | ● |
| <b>B2AC</b> |  | 207 [3000]         | — | — | — | — | — | — | ● | ● |
| <b>B2AD</b> |  | 241 [3500]         | — | — | — | — | — | — | ● | ● |
| <b>B2AF</b> |  | 276 [4000]         | — | — | — | — | — | — | ● | ● |

|         |               |
|---------|---------------|
| Legend: |               |
| ●       | Standard      |
| ○       | Optional      |
| —       | Not Available |

## D Series Gear Motors Including Fan Drive Technical Information Model Code

### Order Code (continued)



#### H Name Plate

| Code | Description                      |
|------|----------------------------------|
| AN   | Standard nameplate, radial ports |
| BN   | Standard label, axial ports      |

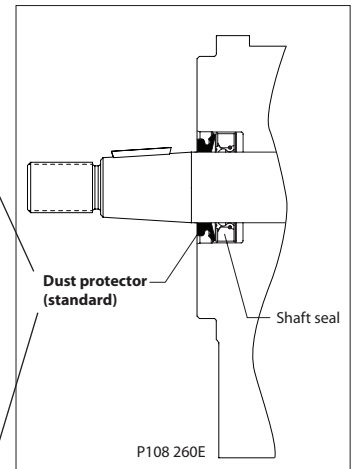
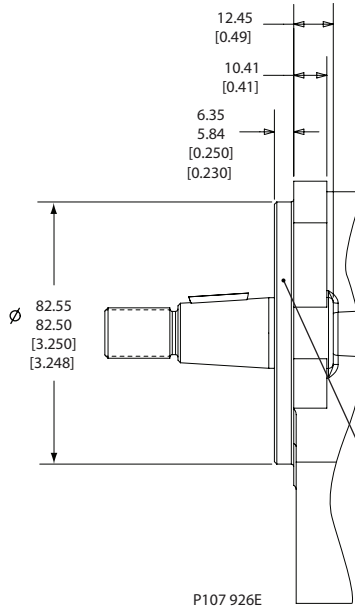
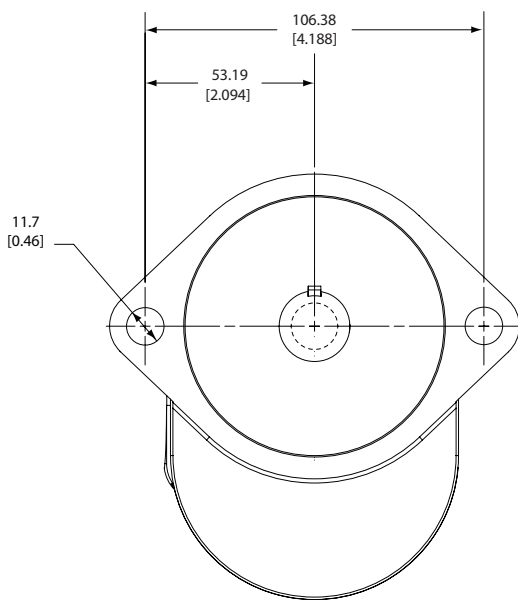
#### I Name Plate

| Code | Description                               |
|------|---|
| NNN  | No special features, standard black paint |

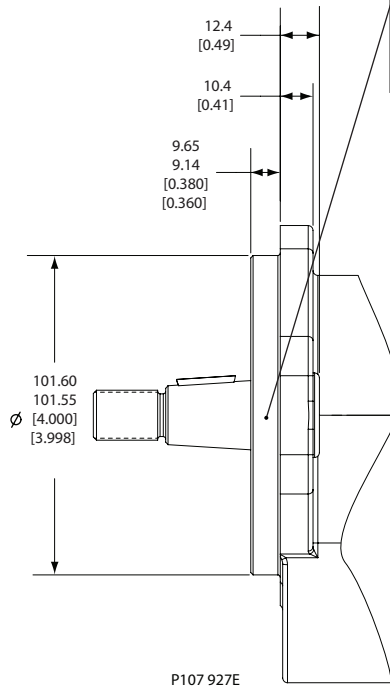
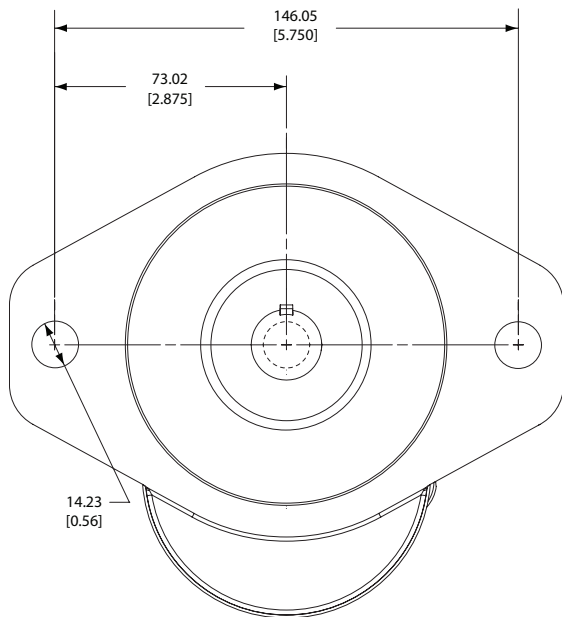
**Mounting Flanges**

SAE-A 2-bolt flange (AA)

Dimensions mm [in]

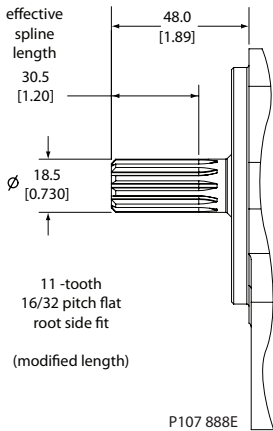


SAE-B 2-bolt flange (BB)

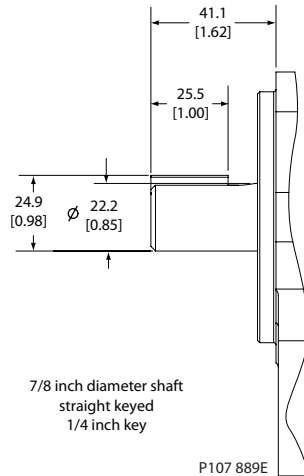


#### Shaft Options

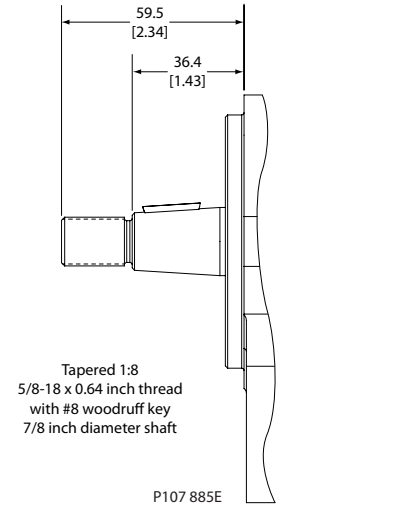
##### SM shaft option



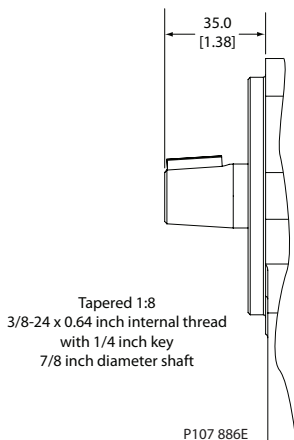
##### PB shaft option



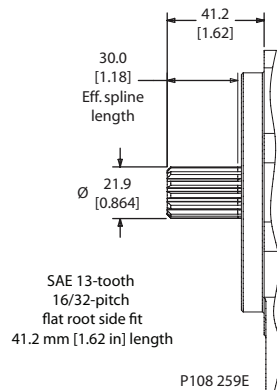
##### TY shaft option



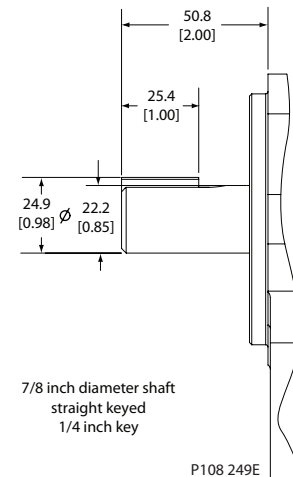
##### TK shaft option



##### SH shaft option



##### PW shaft option



#### Shaft Torque Limits

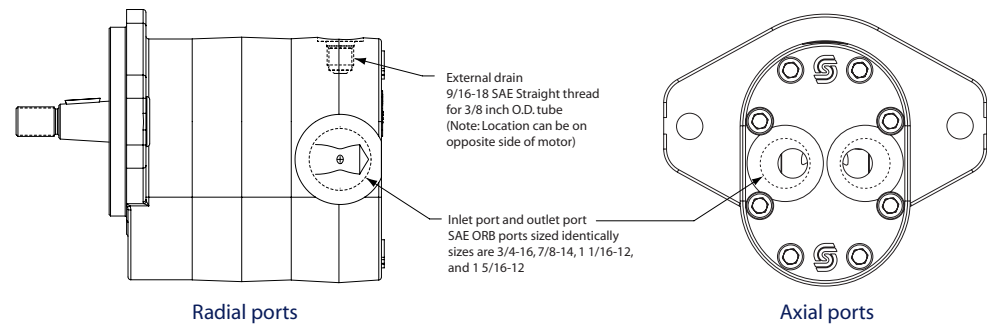
| Code | Type         | Diameter mm [in] | Length mm [in] | Description   | Allowable shaft torque N·m [lbf·in] |
|------|--------------|------------------|----------------|---|-------------------------------------|
| SM   | Spline       | 19.1 [0.75]      | 38.1 [1.50]    | 11 tooth, 48 mm [1.89 in] extension, (modified length) 30 mm [1.20 in] effective spline   | 176.3 [1560]                        |
| PB   | Straight key | 22.2 [0.875]     | 41.2 [1.62]    | SAE 22 mm [7/8 in] $\varnothing$ x 41 mm [1.62 in] Extension, 1/4 in key, with key  | 248.6 [2200]                        |
| TY   | Tapered      | 22.2 [0.875]     | 49.6 [1.95]    | SAE 1:8 taper, 22mm [7/8 in] $\varnothing$ x 59mm [2.34 in] Extension, 5/8-18 x 21 mm [.81 in] external thread with #8 Woodruff key | 225.9 [2000]                        |
| TK   | Tapered      | 22.2 [0.875]     | 49.3 [1.94]    | 1:8 taper, 22mm [7/8 in] $\varnothing$ x 35 mm [1.38 in] Extension, 3/8-24 x 19 mm [.75 in] Internal thread                         | 225.9 [2000]                        |
| SH   | Spline       | 21.9 [0.864]     | 41.2 [1.62]    | 13 tooth, 41 mm [1.62 in] length  | 248.6 [2200]                        |
| PW   | Straight key | 22.2 [0.875]     | 50.8 [2.00]    | SAE 22 mm [7/8 in] $\varnothing$ x 51 mm [2 in] Extension, 1/4 in key, with key   | 248.6 [2200]                        |

### Port Options

#### SAE O-Ring Boss

| Code   |       | SAE O-ring boss ports - No valves |               |                                    |
|--------|-------|-----------------------------------|---------------|------------------------------------|
| Radial | Axial | Inlet                             | Outlet        | Drain port                         |
| N105   | N505  | 3/4-16 SAE                        | 3/4-16 SAE    | Radial 9/16-18 SAE (on idler side) |
| N106   | N506  | 3/4-16 SAE                        | 3/4-16 SAE    | Radial 9/16-18 SAE (on drive side) |
| N107   | N507  | 7/8-14 SAE                        | 7/8-14 SAE    | Radial 9/16-18 SAE (on idler side) |
| N108   | N508  | 7/8-14 SAE                        | 7/8-14 SAE    | Radial 9/16-18 SAE (on drive side) |
| N109   | N509  | 1 1/16-12 SAE                     | 1 1/16-12 SAE | Radial 9/16-18 SAE (on idler side) |
| N110   | N510  | 1 1/16-12 SAE                     | 1 1/16-12 SAE | Radial 9/16-18 SAE (on drive side) |
| N111   | N/A   | 1 5/16-12 SAE                     | 1 5/16-12 SAE | Radial 9/16-18 SAE (on idler side) |
| N112   | N/A   | 1 5/16-12 SAE                     | 1 5/16-12 SAE | Radial 9/16-18 SAE (on drive side) |

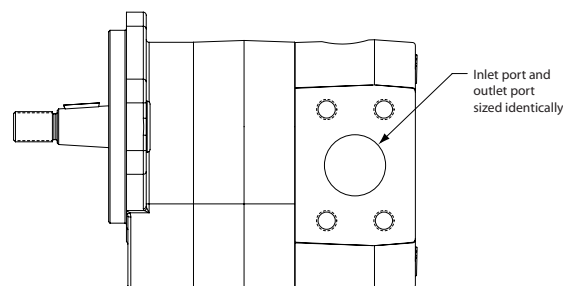
#### Port locations (SAE O-ring port shown)



#### SAE Split Flange Ports

| Code   |  | SAE Split flange ports - No valves |                     |                                    |
|--------|--|------------------------------------|---------------------|------------------------------------|
| Radial |  | Inlet                              | Outlet              | Drain port                         |
| N330   |  | 1 inch Split flange                | 1 inch Split flange | Radial 9/16-18 SAE (on idler side) |
| N331   |  | 1 inch Split flange                | 1 inch Split flange | Radial 9/16-18 SAE (on drive side) |
| N332   |  | 1-1/4 Split flange                 | 1-1/4 Split flange  | Radial 9/16-18 SAE (on idler side) |
| N333   |  | 1-1/4 Split flange                 | 1-1/4 Split flange  | Radial 9/16-18 SAE (on drive side) |

#### Split flange ports



## D Series Gear Motors Including Fan Drive Technical Information Options

### Selecting Port Options

Use the following tables for selecting port options. Recommendations assume maximum rated speed. Applications running at lower speeds may use smaller port sizes. Contact your TurollaOCG representative.

#### *Recommended part size by displacement*

| Displacement code | Recommended port size |
|-------------------|-----------------------|
| 14                | 1-1/16                |
| 17                | 1 - 1/16              |
| 19                | 1 - 5/16              |
| 21                | 1 - 5/16              |
| 23                | 1 - 5/16              |
| 25                | 1 - 5/16              |
| 29                | 1 - 5/16              |
| 32                | 1 - 5/16              |
| 36                | 1 - 5/16              |
| 38                | 1 - 5/16              |
| 41                | 1 - 5/16              |
| 45                | 1 inch split flange   |

#### *Maximum flow by port size*

| Port size           | Maximum flow l/min<br>[US gal/min] |
|---------------------|------------------------------------|
| 3/4 -16 SAE ORB     | 26 [7]                             |
| 7/8-14 SAE ORB      | 41 [11]                            |
| 1 1/16-12 SAE ORB   | 68 [18]                            |
| 1 5/16-12 SAE ORB   | 132 [35]                           |
| 1 inch Split flange | 216 [57]                           |
| 1 1/4 Split flange  | 288 [76]                           |



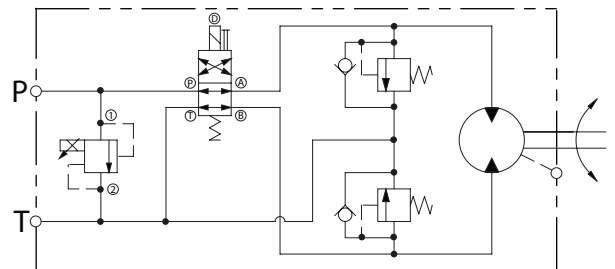
## D Series Gear Motors Including Fan Drive Technical Information Options

### Integrated Reversing Motor with Proportional Relief and Shock/Anti-cavitation Valves

The D Series Motor can be configured to include an integrated reversing option for high performance fan drive systems requiring variable speed and reversal of fan direction to purge coolers and radiators.

#### Features and Benefits

- Solenoid reversing valve directs flow to either side of the motor to reverse fan rotation. The valve uses an open transition spool to reduce the likelihood of pressure spikes during sudden reversals and is available in two flow ranges to minimize losses.
- Integrated proportional pressure control to modulate fan speed by modulating pressure across the fan motor. The valve is available in two flow ranges and is normally closed to ensure full fan speed in case of loss of electrical signal.
- Dual shock valves limit pressure spikes in both forward and reverse rotation and eliminates damage to the system during sudden fan reversals
- Dual anti-cavitation check valves bypass motor flow during fan deceleration.
- The motor is PLUS+1<sup>TM</sup> compliant allowing the user to take advantage of automatic cleaning sequences available on TurollaOCG microcontrollers
- Valves are qualified to 276 bar (4000 psi) and are contained in a steel body to ensure maximum performance and long life at elevated temperatures and pressures.
- Deutsch connectors, Viton<sup>®</sup> seals and shaft dust protector are standard for operation in severe environments
- Integrated valve design provides short length and high power density in a compact package while minimizing installation costs.



P108 250E

#### Technical Data

The directional control valve uses an internal spring to bias spool position and direct flow to the motor. As a result, the preferred motor rotation must be specified in the model code. A right hand motor would be biased for clockwise rotation with counter-clockwise reversing, while a left hand motor would be biased for counter-clockwise rotation with clockwise reversing.

The reversing valve function is available in two flow ratings. The D05 directional valve is standard with the high flow proportional valve, while the D03 directional valve is standard with the low flow proportional valve. Use the P-T pressure drop curves to minimize pressure drop at maximum flow conditions.

## D Series Gear Motors Including Fan Drive Technical Information Options

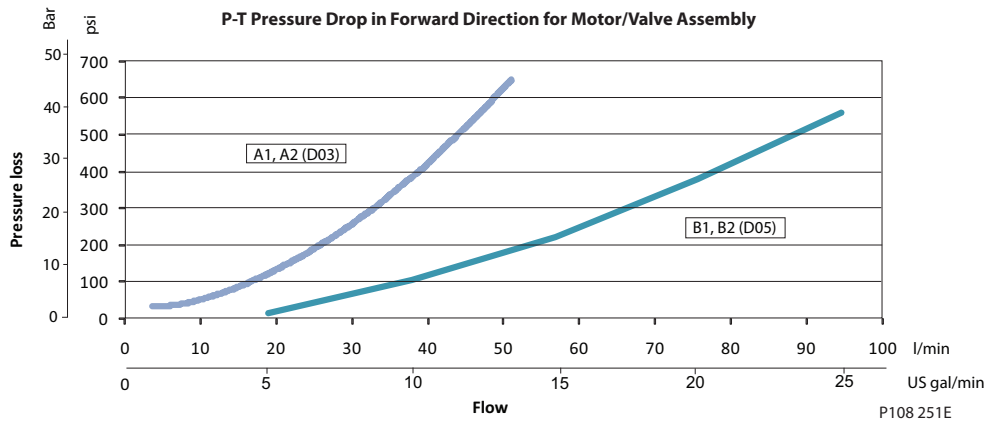
### Integrated Reversing with Proportional Relief and Shock/Anti- cavitation Valves (continued)

### Integrated Reversing Function

Select the size and voltage of the reversing valve option using the codes and P-T pressure drop curves below. The pressure settings and performance curves for the proportional relief valve can be found on the following pages.

| Code      | Description  |
|-----------|--|
| <b>A1</b> | D03 Directional valve with P1 (low flow) style proportional relief valve, 12VDC  |
| <b>A2</b> | D03 Directional valve with P3 (low flow) style proportional relief valve, 24VDC  |
| <b>B1</b> | D05 Directional valve with P2 (high flow) style proportional relief valve, 12VDC |
| <b>B2</b> | D05 Directional valve with P4 (low flow) style proportional relief valve, 24VDC  |

Pressure loss measured with Mobile DTE 24 at 105° F



Includes pressure drop across D03/D05 in default position as well as losses across unloaded gear motor

## D Series Gear Motors Including Fan Drive Technical Information Options

### Standard Relief Valve

The fixed-setting pressure relief valve limits maximum fan speed and protects the motor from over-pressurization.

Mount the motor so the relief valve is below the reservoir oil level. Keep the relief valve in a horizontal position. Be sure to bleed the system to remove entrained air.

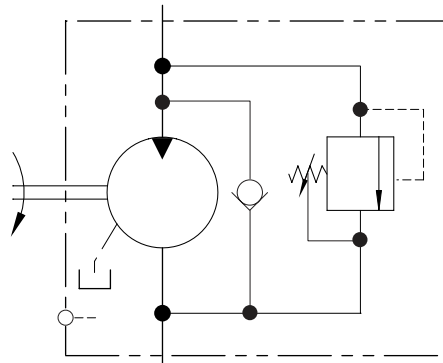
#### Relief valve codes

| Code | Description   |
|------|---|
| F    | Relief valve internally drained - applications with 95 l/min [26 US gal/min] or less flow |
| G    | Relief valve internally drained - applications with 96-190 l/min [26-50 US gal/min] flow  |

Any modification to the valve to change the factory setting will void product warranty.

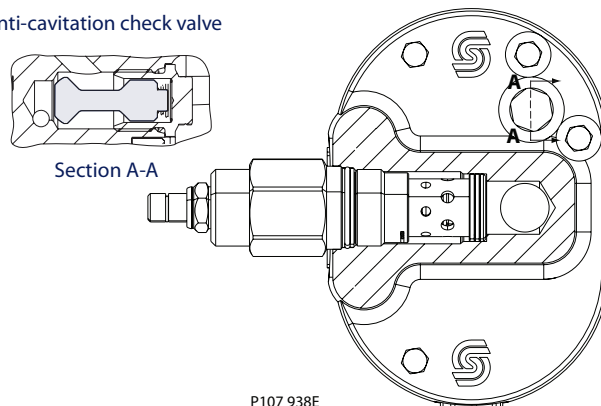
The fixed-setting relief valve can only be used to limit fan speed in one rotational direction. As a result, the preferred motor rotation must be specified in the model code - DEML or DEMR.

#### Schematic - Motor with standard relief valve with optional anti-cavitation valve



#### Standard relief valve

##### Anti-cavitation check valve



# D Series Gear Motors Including Fan Drive

## Technical Information

### Options

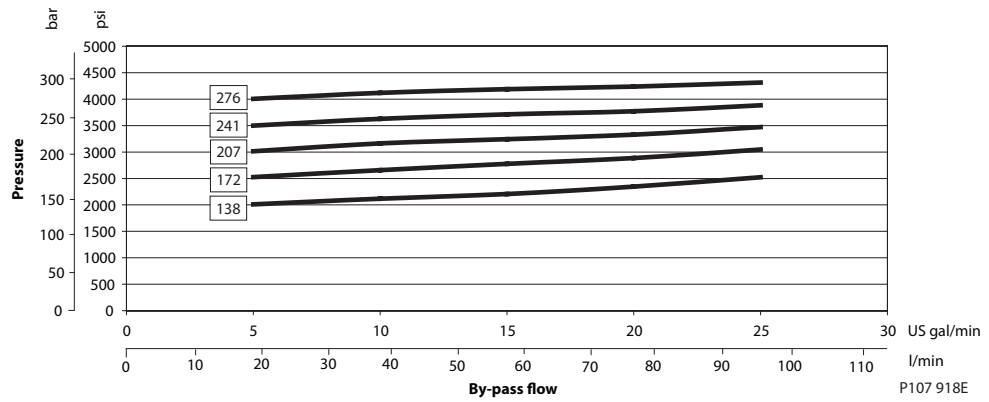
#### Standard Relief Valve (continued)

| Valve option | Pressure setting bar [psi] |
|--------------|----------------------------|
| 276          | 276 [4000]                 |
| 241          | 241 [3500]                 |
| 207          | 207 [3000]                 |
| 172          | 172 [2500]                 |
| 138          | 138 [2000]                 |

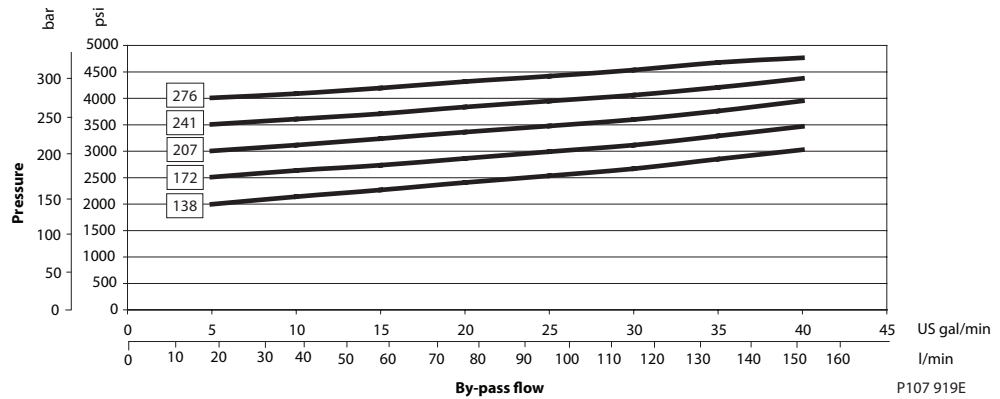
#### Valve Settings

Relief pressure vs flow at  $T_{oil}=51.7^{\circ}\text{C}$  [125°F], viscosity = 30 mm<sup>2</sup>/sec (cSt) [121 SUS] set at 19 l/min [5 US gal/min]

#### F Valve settings



#### G Valve settings



# D Series Gear Motors Including Fan Drive

## Technical Information

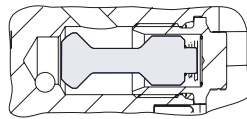
### Options

#### Anti-cavitation Check Valve

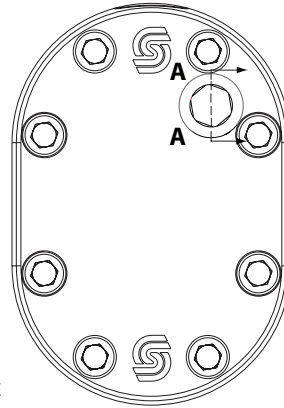
D motors are available with an optional anti-cavitation check valve. The valve is integrated into the rear cover. The anti-cavitation check valve protects the motor from cavitation in overrunning conditions.

*Standard rear cover with anti-cavitation valve*

Anti-cavitation check valve

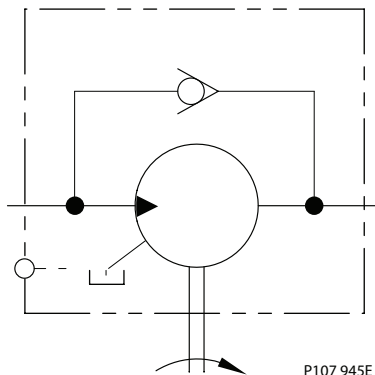


Section A-A



P107 956E

*Schematic - Motor with anti-cavitation check valve*



P107 945E

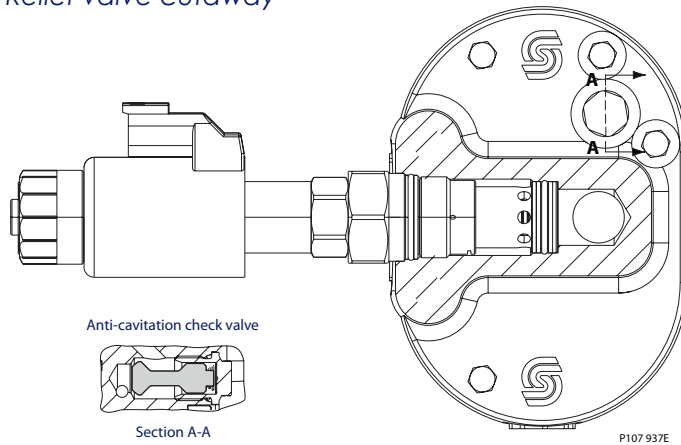
## D Series Gear Motors Including Fan Drive Technical Information Options

### Proportional Relief Valve with Anti-cavitation Valve

The D Series motor may be equipped with a normally closed proportional relief valve, which modulates the fan speed for on demand cooling in fan drive applications. This valve can also trim maximum fan speed at a pre-set pressure.

Mount the motor so the relief valve is below the reservoir oil level. Keep the relief valve in a horizontal position. Be sure to bleed the system to remove entrained air.

#### Relief valve cutaway

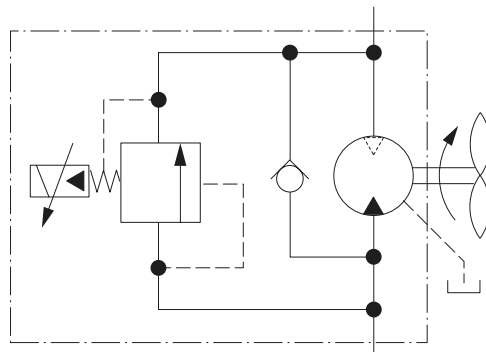


#### Technical data

|                             |   |   |
|-----------------------------|---|---|
| <b>Capacity</b>             | 95 l/min [25 US gal/min] or 96-190 l/min [25-50 US gal/min] |   |
| <b>Electrical connector</b> | Deutsch ® DT-04-2P (protection rate IP 69K DIN 40050)       |   |
| <b>Electrical supply</b>    | 0 - 1.1 A at 12 Vdc with                                    | Coil resistance of 6.4 Ohms at 20° C [68° F]  |
|                             |   | Minimum voltage 10.8 Vdc                      |
|                             | 0 - 0.55 A at 24 Vdc with                                   | Maximum voltage 13.2 Vdc                      |
|                             |   | Coil resistance of 26.2 Ohms at 20° C [68° F] |
|                             |   | Minimum voltage 21.6 Vdc                      |
|                             |   | Maximum voltage 26.4 Vdc                      |
| <b>PWM frequency</b>        | 100 - 250 Hz  |   |

The proportional relief valve can only be used to modulate fan speed in one rotational direction. As a result, the preferred motor rotation must be specified in the model code - DEML or DEMR.

#### Motor with proportional relief valve and anti-cavitation check valve



### Proportional Relief Valve (continued)

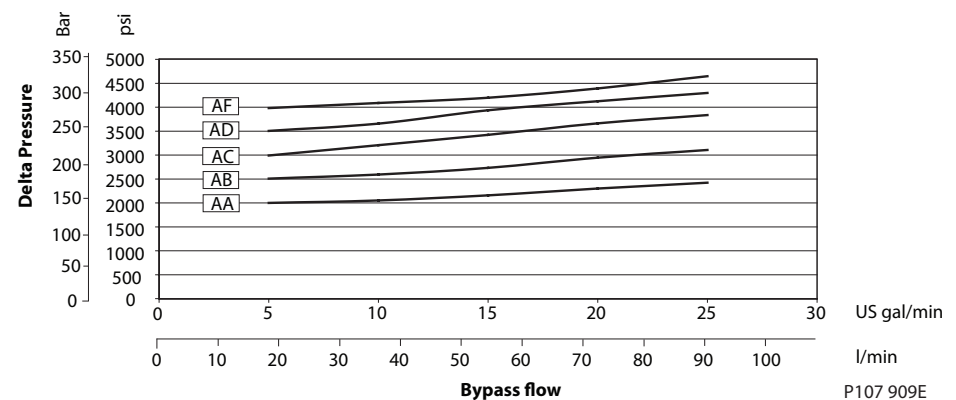
### Valve Settings

| Code      | Description  |
|-----------|--|
| <b>P1</b> | 12 Vdc Proportional relief valve internally drained, low flow  |
| <b>P2</b> | 12 Vdc Proportional relief valve internally drained, high flow |
| <b>P3</b> | 24 Vdc Proportional relief valve internally drained, low flow  |
| <b>P4</b> | 24 Vdc Proportional relief valve internally drained, high flow |

Select proportional relief valve setting using the pressure vs. bypass flow graphs. Any modification to the valve to change the factory setting will void product warranty.

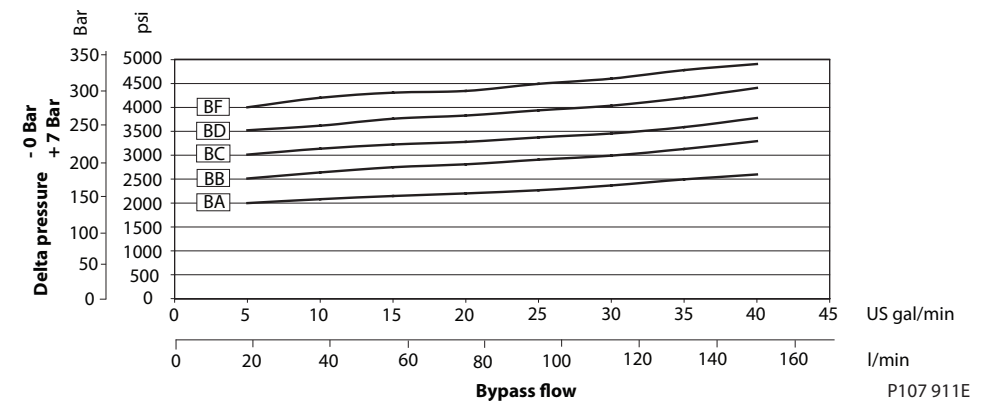
| Valve option | Pressure setting bar [psi] |
|--------------|----------------------------|
| <b>AF</b>    | 276 [4000]                 |
| <b>AD</b>    | 241 [3500]                 |
| <b>AC</b>    | 207 [3000]                 |
| <b>AB</b>    | 172 [2500]                 |
| <b>AA</b>    | 138 [2000]                 |

#### P1 and P3 valve settings, (low flow)



| Valve option | Pressure setting bar [psi] |
|--------------|----------------------------|
| <b>BF</b>    | 276 [4000]                 |
| <b>BD</b>    | 241 [3500]                 |
| <b>BC</b>    | 207 [3000]                 |
| <b>BB</b>    | 172 [2500]                 |
| <b>BA</b>    | 138 [2000]                 |

#### P2 and P4 valve settings, (high flow)



# D Series Gear Motors Including Fan Drive

## Technical Information

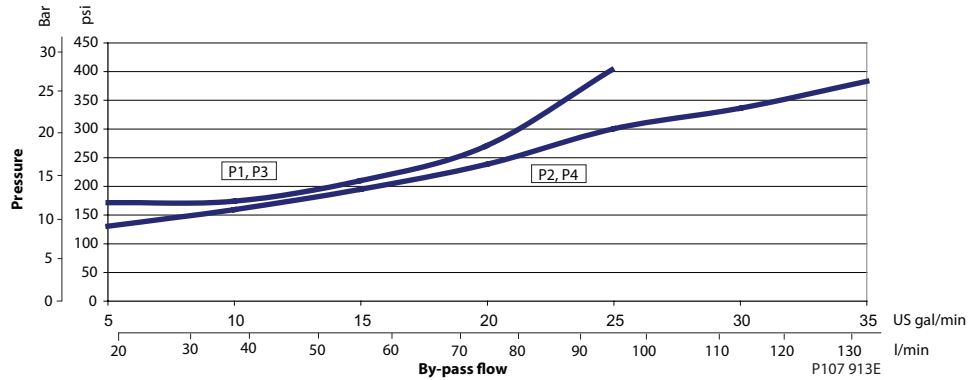
### Options

#### Proportional Relief Valve (continued)

#### Performance Graphs

Relief pressure vs flow at  $T_{oil}=51.7^{\circ}\text{C}$  [125°F], viscosity = 30 mm<sup>2</sup>/sec (cSt) [121 SUS] set at 19 l/min [5 US gal/min] and zero current

Pressure drop with coil energized, valve only



#### Valve Settings

| Code | Description  |
|------|--|
| P1   | 12 Vdc Proportional relief valve internally drained - with 95 l/min [25 US gal/min] or less flow |
| P2   | 12 Vdc Proportional relief valve internally drained - with 96-190 l/min [26-50 US gal/min] flow  |
| P3   | 24 Vdc Proportional relief valve internally drained - with 95 l/min [25 US gal/min] or less flow |
| P4   | 24 Vdc Proportional relief valve internally drained - with 96-190 l/min [26-50 US gal/min] flow  |

Any modification to the valve to change the factory setting will void product warranty.



# D Series Gear Motors Including Fan Drive

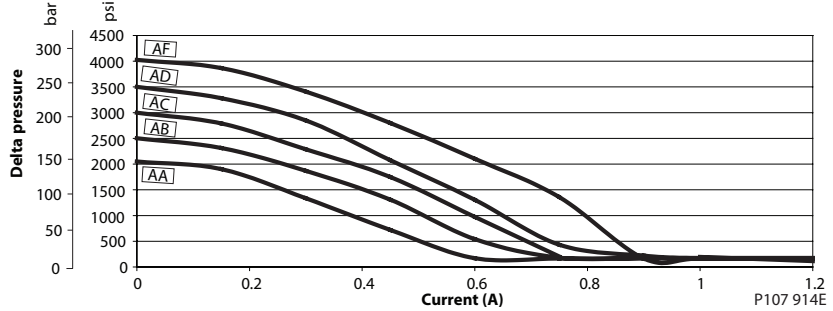
## Technical Information

### Options

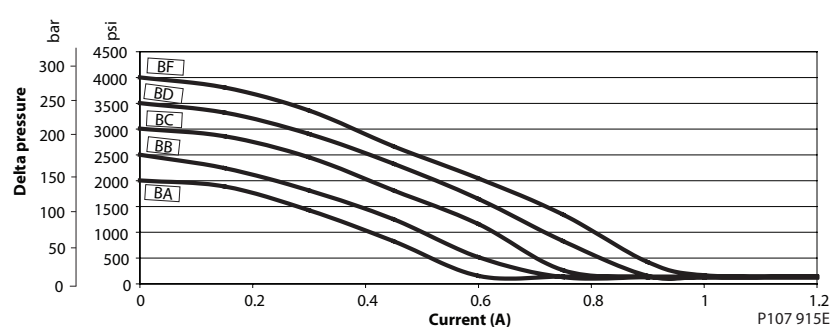
#### Proportional Relief Valve (continued)

Relief pressure vs flow at  $T_{oil}=51.7^{\circ}\text{C}$  [125°F], viscosity = 30 mm<sup>2</sup>/sec (cSt) [121 SUS] set at 19 l/min [5 US gal/min] and zero current

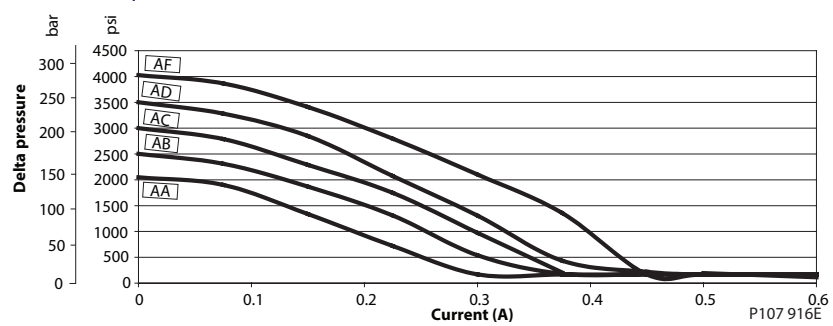
**P1, Relief pressure vs. current**



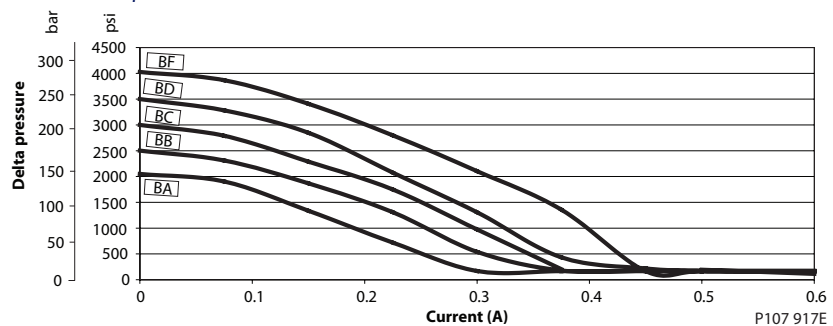
**P2, Relief pressure vs. current**



**P3, Relief pressure vs. current**



**P4, Relief pressure vs. current**



# D Series Gear Motors Including Fan Drive

## Technical Information

### Dimension Drawings

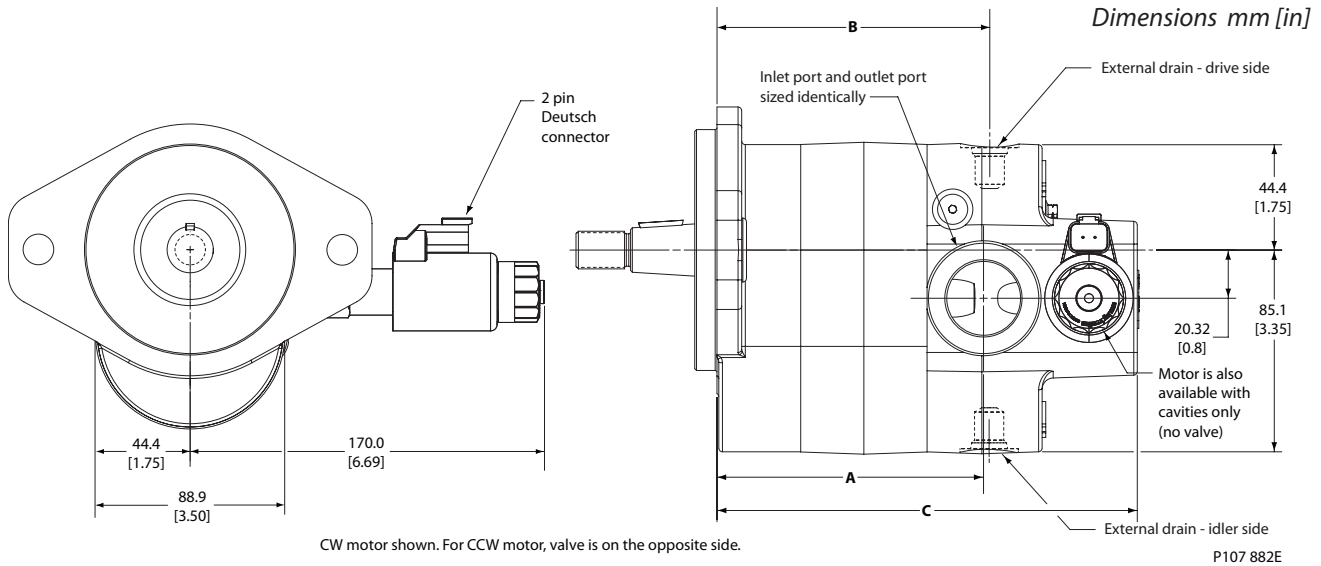
#### Fan Drive Motor

#### Fan Drive Motor Example:

Fan drive motor:

**A** Right hand rotation, **B** 17 cm<sup>3</sup>, 1:8 taper shaft, **C** SAE A two bolt mounting, **D** 7/8-14 ports, idler side drain, **E** P1 style proportional relief valve at 172 bar, **F** anti-cavitation valve.

D motor dimensions; SAE-B two bolt fan drive motor shown



CW motor shown. For CCW motor, valve is on the opposite side.

P107 882E

#### Dimensions (maximum)

| Dimension | Units | 14    | 17    | 19    | 21    | 23    | 25    | 29    | 32    | 36    | 38    | 41    | 45    |
|-----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| A         | mm    | 86.2  | 88.9  | 90.9  | 92.5  | 94.2  | 97.3  | 100.8 | 103.6 | 107.7 | 109.7 | 112.8 | 117.1 |
|           | in    | 3.40  | 3.50  | 3.58  | 3.64  | 3.71  | 3.83  | 3.97  | 4.08  | 4.24  | 4.32  | 4.44  | 4.61  |
| B         | mm    | 89.0  | 91.7  | 93.8  | 95.3  | 97.0  | 100.1 | 103.6 | 106.4 | 110.7 | 112.5 | 115.6 | 119.9 |
|           | in    | 3.51  | 3.61  | 3.69  | 3.75  | 3.82  | 3.94  | 4.08  | 4.19  | 4.36  | 4.43  | 4.55  | 4.72  |
| C         | mm    | 151.8 | 154.4 | 156.5 | 158.0 | 160.0 | 162.8 | 166.4 | 169.2 | 173.5 | 175.5 | 178.6 | 182.6 |
|           | in    | 5.89  | 6.08  | 6.18  | 6.22  | 6.30  | 6.41  | 6.55  | 6.66  | 6.83  | 6.91  | 7.03  | 7.19  |

# D Series Gear Motors Including Fan Drive

## Technical Information

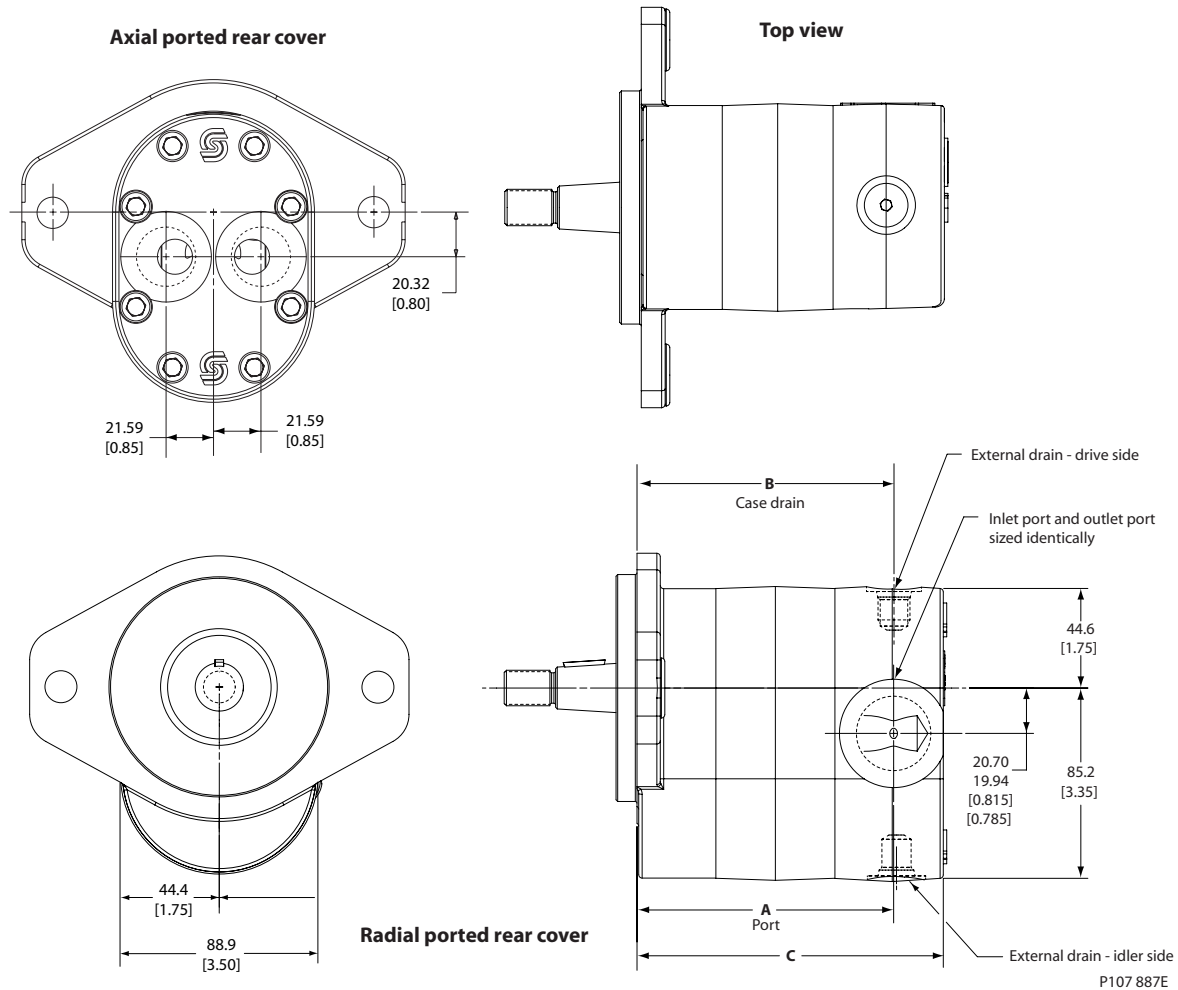
### Dimension Drawings

#### Standard Motor

#### Standard Motor Example:

**A** Right hand rotation, **B** 17 cm<sup>3</sup>, 1:8 taper shaft, **C** SAE A two bolt mounting, **D** 7/8-14 ports, idler side drain, **E** no relief valve.

Standard D motor dimensions, SAE-B two bolt motor shown



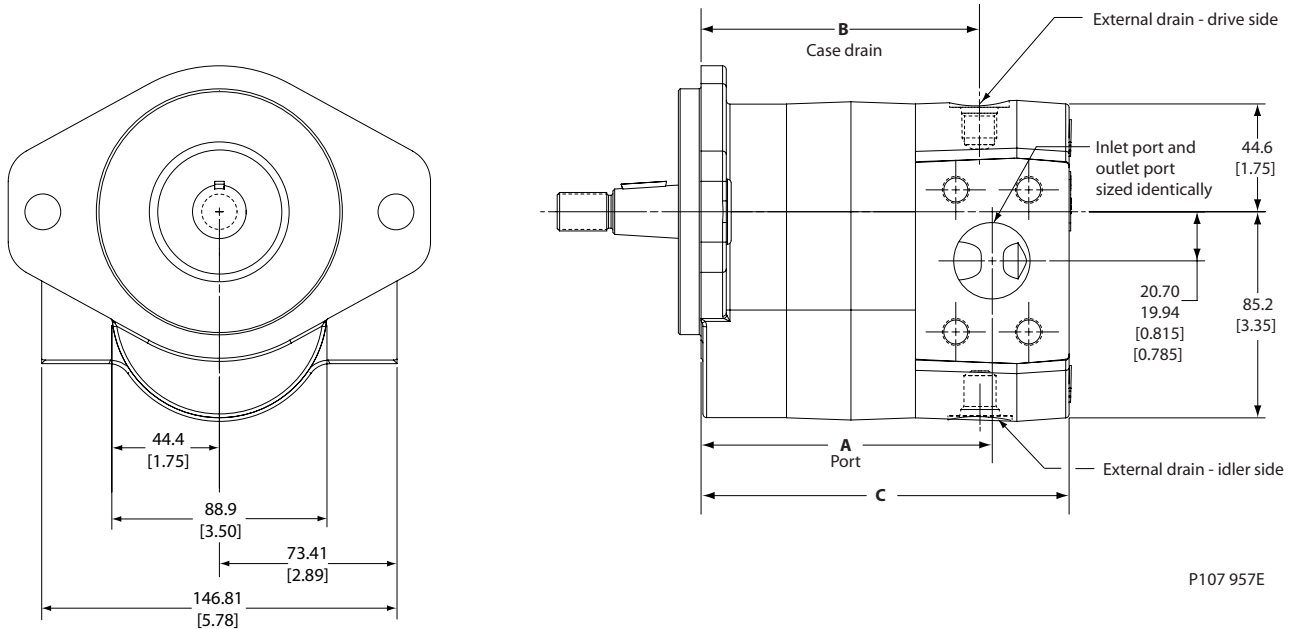
#### Dimensions (maximum)

| Dimension | Units | 14    | 17    | 19    | 21    | 23    | 25    | 29    | 32    | 36    | 38    | 41    | 45    |
|-----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| A         | mm    | 88.5  | 91.2  | 93.2  | 94.7  | 96.8  | 99.6  | 103.1 | 105.1 | 110.2 | 112.3 | 115.3 | 119.4 |
|           | in    | 3.49  | 3.59  | 3.67  | 3.73  | 3.81  | 3.92  | 4.06  | 4.17  | 4.34  | 4.42  | 4.54  | 4.70  |
| B         | mm    | 89.0  | 91.7  | 93.8  | 95.3  | 97.0  | 100.1 | 103.6 | 106.4 | 110.7 | 112.5 | 115.6 | 119.9 |
|           | in    | 3.51  | 3.61  | 3.69  | 3.75  | 3.82  | 3.94  | 4.08  | 4.19  | 4.36  | 4.43  | 4.55  | 4.72  |
| C         | mm    | 111.1 | 113.8 | 115.8 | 117.4 | 119.4 | 122.2 | 125.7 | 128.5 | 132.8 | 134.9 | 137.9 | 139.5 |
|           | in    | 4.38  | 4.48  | 4.56  | 4.62  | 4.70  | 4.81  | 4.95  | 5.06  | 5.23  | 5.31  | 5.43  | 5.49  |

### Standard Motor with Split Flange Ports

**Standard Motor with Split Flange Ports Example:** **A** Right hand rotation, **B** 17 cm<sup>3</sup>, 1:8 taper shaft, **C** SAE A two bolt mounting, **D** Split flange ports, drive side drain, **E** No valve.

Standard D motor dimensions, SAE-B two bolt motor shown with split flange ports



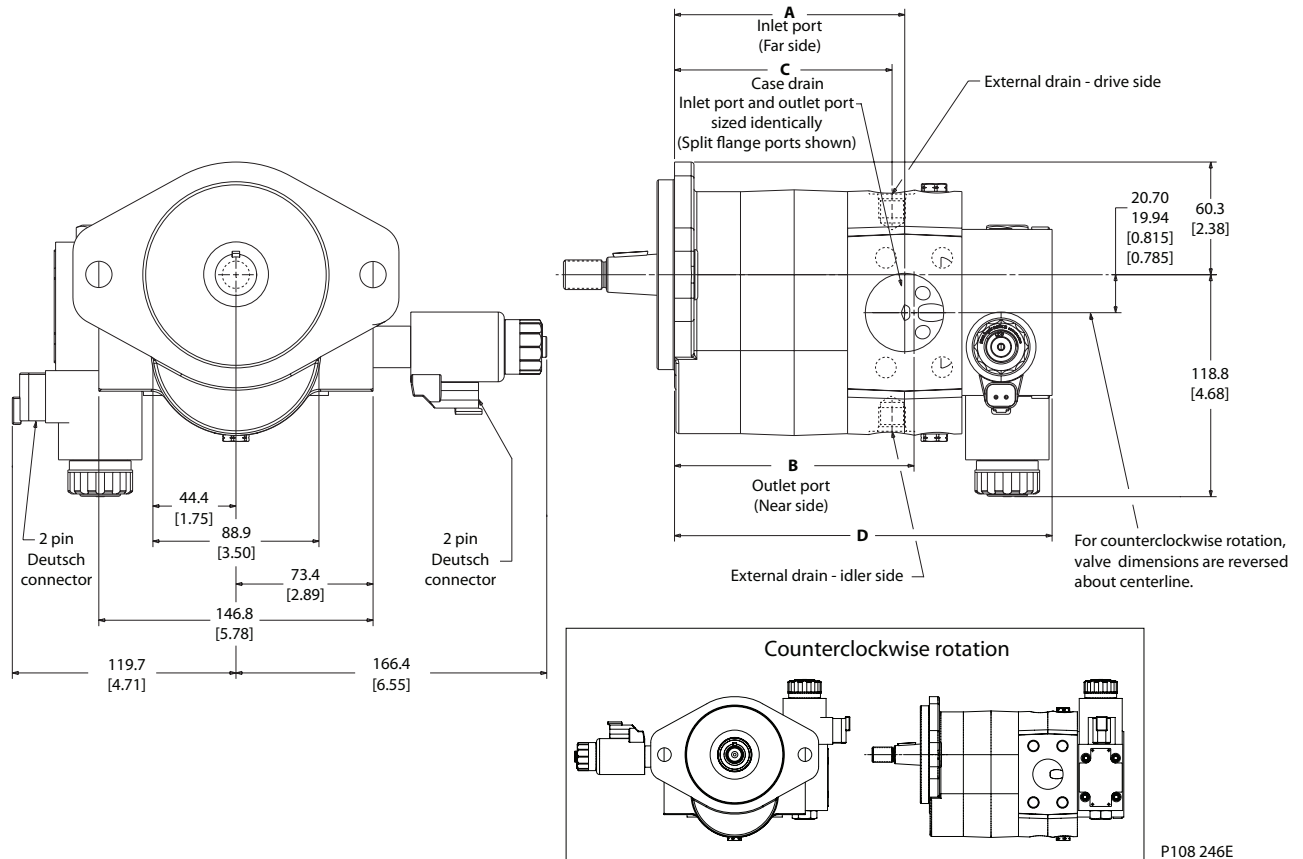
P107 957E

### Dimensions (maximum)

| Dimension | Units | 14    | 17    | 19    | 21    | 23    | 25    | 29    | 32    | 36    | 38    | 41    | 45    |
|-----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| A         | mm    | 94.1  | 96.8  | 98.8  | 100.3 | 102.1 | 105.2 | 108.7 | 111.5 | 115.8 | 117.6 | 120.6 | 125.0 |
|           | in    | 3.71  | 3.81  | 3.89  | 3.95  | 4.02  | 4.14  | 4.28  | 4.39  | 4.56  | 4.63  | 4.75  | 4.92  |
| B         | mm    | 89.0  | 91.7  | 93.8  | 95.3  | 97.0  | 100.1 | 103.6 | 106.4 | 110.7 | 112.5 | 115.6 | 119.9 |
|           | in    | 3.50  | 3.61  | 3.69  | 3.75  | 3.82  | 3.94  | 4.08  | 4.19  | 4.36  | 4.43  | 4.55  | 4.72  |
| C         | mm    | 126.1 | 128.8 | 130.8 | 132.3 | 134.4 | 137.2 | 140.7 | 143.5 | 147.8 | 149.9 | 152.9 | 157.0 |
|           | in    | 4.97  | 5.07  | 5.15  | 5.21  | 5.29  | 5.40  | 5.54  | 5.65  | 5.82  | 5.90  | 6.02  | 6.18  |

**Integrated Reversing Motor with Proportional Relief and Shock/Anti-cavitation Valves**

*Reversing Fan Drive Motor with D03 Directional Valve, Clockwise rotation*



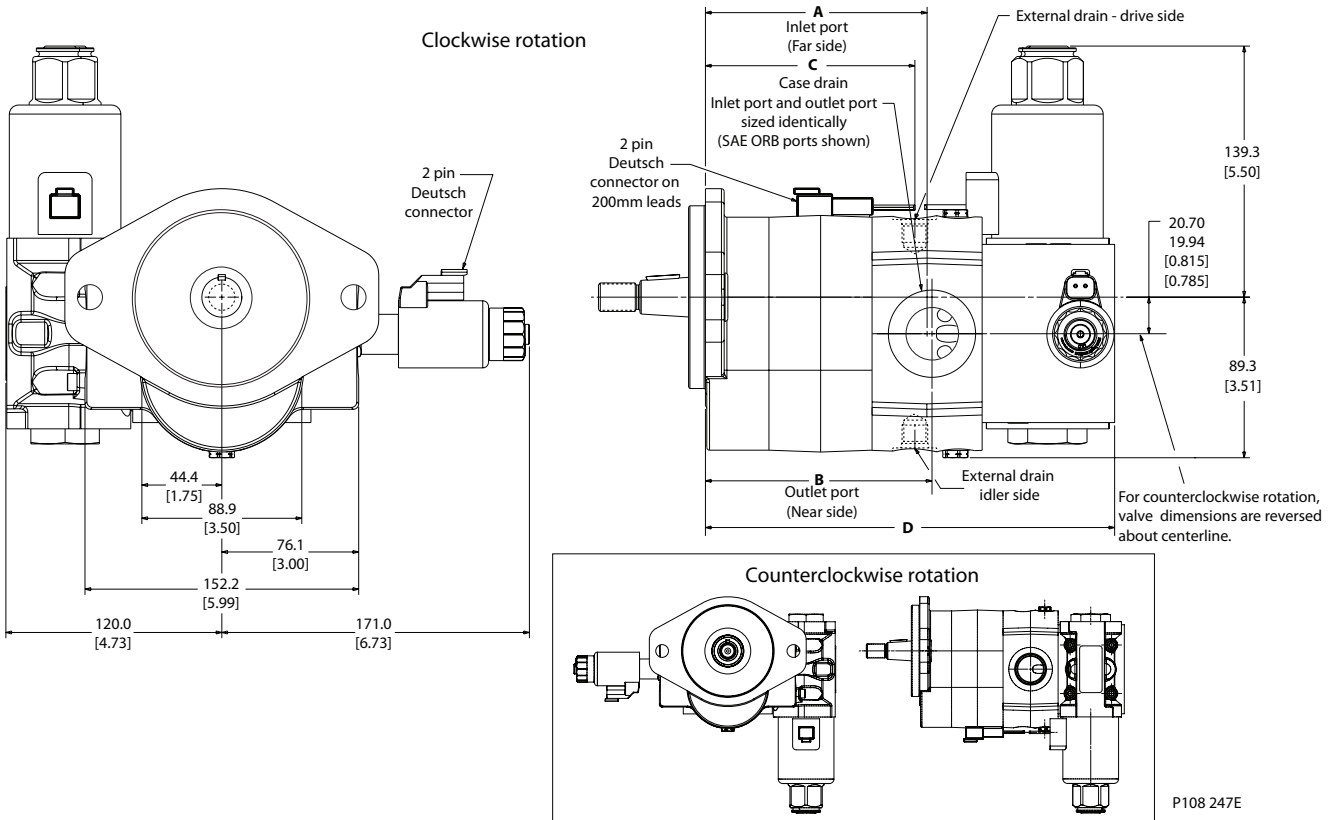
P108 246E

*Dimensions (maximum)*

| Dimensions | Port      | Units | 14    | 17    | 19    | 21    | 23    | 25    | 29    | 32    | 36    | 38    | 41    | 45    |       |
|------------|-----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| A          | All       | mm    | 92.4  | 95.0  | 97.1  | 98.6  | 100.4 | 103.4 | 107.0 | 109.8 | 114.0 | 116.0 | 119.0 | 123.2 |       |
|            |           | in    | 3.64  | 3.74  | 3.82  | 3.88  | 3.95  | 4.07  | 4.21  | 4.32  | 4.49  | 4.57  | 4.69  | 4.85  |       |
| B          | 107 - 108 | mm    | 100.6 | 103.3 | 105.3 | 106.9 | 108.7 | 111.7 | 115.3 | 118.0 | 122.3 | 124.3 | 127.3 | 131.5 |       |
|            |           | in    | 3.96  | 4.07  | 4.15  | 4.21  | 4.28  | 4.40  | 4.54  | 4.65  | 4.82  | 4.89  | 5.01  | 5.18  |       |
|            | 109 - 110 | mm    | 98.5  | 101.1 | 103.1 | 104.7 | 106.5 | 109.5 | 113.1 | 115.8 | 120.1 | 122.1 | 125.1 | 129.3 |       |
|            |           | in    | 3.88  | 3.98  | 4.06  | 4.12  | 4.19  | 4.31  | 4.45  | 4.56  | 4.73  | 4.81  | 4.93  | 5.09  |       |
|            | 111 - 112 | mm    | 95.1  | 97.7  | 99.8  | 101.3 | 103.1 | 106.1 | 109.7 | 112.5 | 116.8 | 118.7 | 121.7 | 125.9 |       |
|            |           | in    | 3.74  | 3.85  | 3.93  | 3.99  | 4.06  | 4.18  | 4.32  | 4.43  | 4.60  | 4.67  | 4.79  | 4.96  |       |
|            | 330 - 331 | mm    | 98.0  | 100.6 | 102.7 | 104.2 | 106.0 | 109.0 | 112.6 | 115.4 | 119.6 | 121.6 | 124.6 | 128.8 |       |
|            |           | in    | 3.86  | 3.96  | 4.04  | 4.10  | 4.18  | 4.29  | 4.43  | 4.54  | 4.71  | 4.79  | 4.91  | 5.07  |       |
|            | 332 - 333 | mm    | 97.4  | 100.0 | 102.1 | 103.6 | 105.4 | 108.4 | 112.0 | 114.8 | 119.0 | 121.0 | 124.0 | 128.2 |       |
|            |           | in    | 3.83  | 3.94  | 4.02  | 4.08  | 4.15  | 4.27  | 4.41  | 4.52  | 4.69  | 4.76  | 4.88  | 5.05  |       |
|            | C         | All   | mm    | 85.6  | 88.2  | 90.3  | 91.8  | 93.6  | 96.6  | 100.2 | 103.0 | 107.3 | 109.2 | 112.2 | 116.4 |
|            |           |       | in    | 3.37  | 3.47  | 3.55  | 3.61  | 3.69  | 3.80  | 3.95  | 4.05  | 4.22  | 4.30  | 4.42  | 4.58  |
| D          | All       | mm    | 171.8 | 174.4 | 176.5 | 178.0 | 179.8 | 182.8 | 186.4 | 189.2 | 193.4 | 195.4 | 198.4 | 202.6 |       |
|            |           | in    | 6.76  | 6.87  | 6.95  | 7.01  | 7.08  | 7.20  | 7.34  | 7.45  | 7.62  | 7.69  | 7.81  | 7.98  |       |

### Integrated Reversing Motor with Proportional Relief and Shock/Anti-cavitation Valves

Reversing Fan Drive Motor with D05 Directional Valve, Clockwise rotation



### Dimensions (maximum)

| Dimensions | Port      | Units | 14    | 17    | 19    | 21    | 23    | 25    | 29    | 32    | 36    | 38    | 41    | 45    |       |
|------------|-----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| A          | All       | mm    | 92.4  | 95.0  | 97.1  | 98.6  | 100.4 | 103.4 | 107.0 | 109.8 | 114.0 | 116.0 | 119.0 | 123.2 |       |
|            |           | in    | 3.64  | 3.74  | 3.82  | 3.88  | 3.95  | 4.07  | 4.21  | 4.32  | 4.49  | 4.57  | 4.69  | 4.85  |       |
| B          | 107 - 108 | mm    | 100.6 | 103.3 | 105.3 | 106.9 | 108.7 | 111.7 | 115.3 | 118.0 | 122.3 | 124.3 | 127.3 | 131.5 |       |
|            |           | in    | 3.96  | 4.07  | 4.15  | 4.21  | 4.28  | 4.40  | 4.54  | 4.65  | 4.82  | 4.89  | 5.01  | 5.18  |       |
|            | 109 - 110 | mm    | 98.5  | 101.1 | 103.1 | 104.7 | 106.5 | 109.5 | 113.1 | 115.8 | 120.1 | 122.1 | 125.1 | 129.3 |       |
|            |           | in    | 3.88  | 3.98  | 4.06  | 4.12  | 4.19  | 4.31  | 4.45  | 4.56  | 4.73  | 4.81  | 4.93  | 5.09  |       |
|            | 111 - 112 | mm    | 95.1  | 97.7  | 99.8  | 101.3 | 103.1 | 106.1 | 109.7 | 112.5 | 116.8 | 118.7 | 121.7 | 125.9 |       |
|            |           | in    | 3.74  | 3.85  | 3.93  | 3.99  | 4.06  | 4.18  | 4.32  | 4.43  | 4.60  | 4.67  | 4.79  | 4.96  |       |
|            | 330 - 331 | mm    | 98.0  | 100.6 | 102.7 | 104.2 | 106.0 | 109.0 | 112.6 | 115.4 | 119.6 | 121.6 | 124.6 | 128.8 |       |
|            |           | in    | 3.86  | 3.96  | 4.04  | 4.10  | 4.18  | 4.29  | 4.43  | 4.54  | 4.71  | 4.79  | 4.91  | 5.07  |       |
|            | 332 - 333 | mm    | 97.4  | 100.0 | 102.1 | 103.6 | 105.4 | 108.4 | 112.0 | 114.8 | 119.0 | 121.0 | 124.0 | 128.2 |       |
|            |           | in    | 3.83  | 3.94  | 4.02  | 4.08  | 4.15  | 4.27  | 4.41  | 4.52  | 4.69  | 4.76  | 4.88  | 5.05  |       |
|            | C         | All   | mm    | 85.6  | 88.2  | 90.3  | 91.8  | 93.6  | 96.6  | 100.2 | 103.0 | 107.3 | 109.2 | 112.2 | 116.4 |
|            |           |       | in    | 3.37  | 3.47  | 3.55  | 3.61  | 3.69  | 3.80  | 3.95  | 4.05  | 4.22  | 4.30  | 4.42  | 4.58  |
| D          | All       | mm    | 197.2 | 199.8 | 201.9 | 203.4 | 205.2 | 208.2 | 211.8 | 214.6 | 218.8 | 220.8 | 223.8 | 228.0 |       |
|            |           | in    | 7.76  | 7.87  | 7.95  | 8.01  | 8.08  | 8.20  | 8.34  | 8.45  | 8.62  | 8.69  | 8.81  | 8.98  |       |

# D Series Gear Motors Including Fan Drive

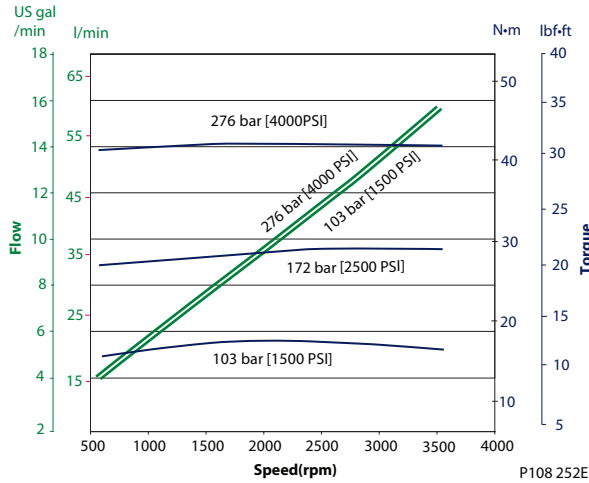
## Technical Information

### Performance Data

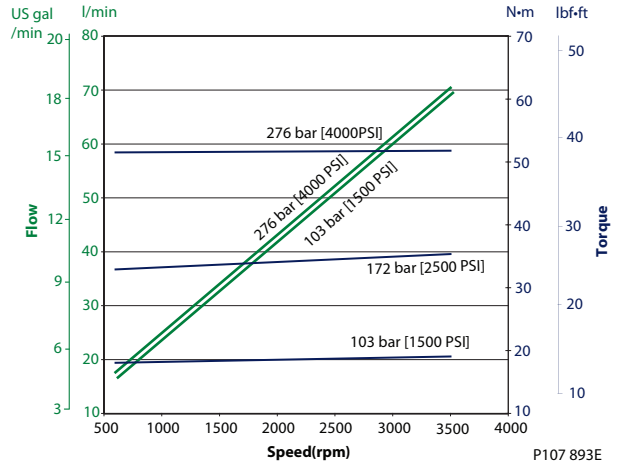
#### Motor Performance Graphs

The graphs show typical inlet flow and output power for the D series motors at various working pressures as a function of speed. Data were taken using hydraulic fluid conforming to ISO VG46 at 50°C [120° F] with viscosity at 28 mm<sup>2</sup>/sec (cSt) [132 SUS].

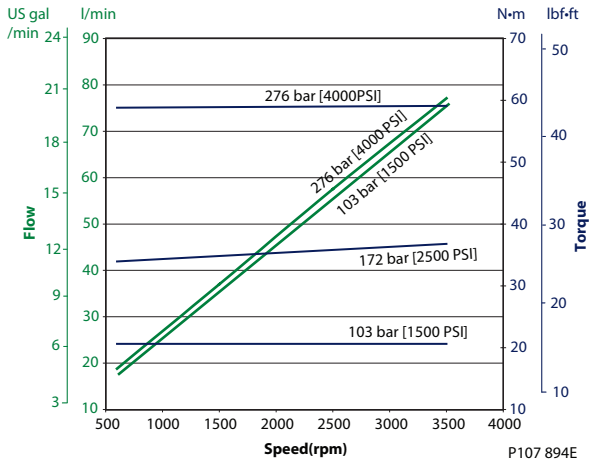
14 cm<sup>3</sup> [0.85 in<sup>3</sup>]



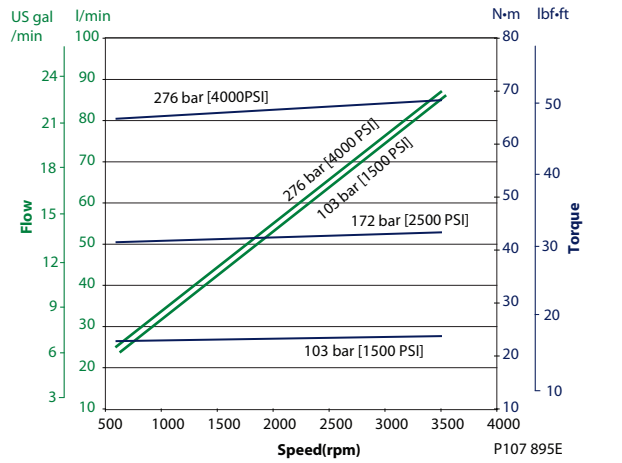
17 cm<sup>3</sup> [1.04 in<sup>3</sup>]



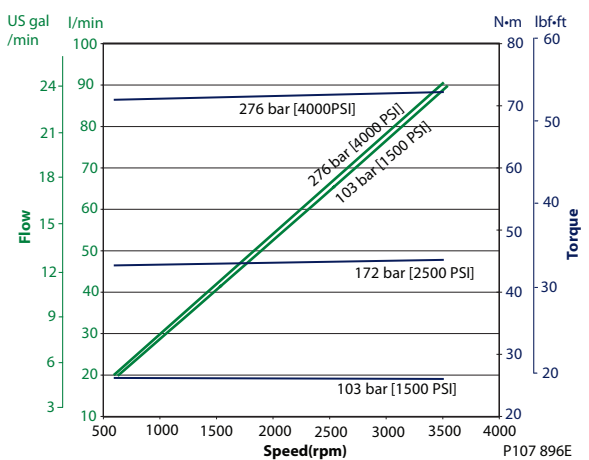
19 cm<sup>3</sup> [1.16 in<sup>3</sup>]



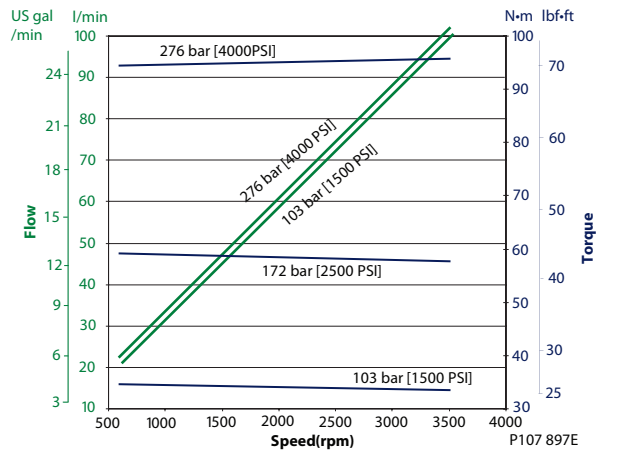
21 cm<sup>3</sup> [1.25 in<sup>3</sup>]



23 cm<sup>3</sup> [1.37 in<sup>3</sup>]

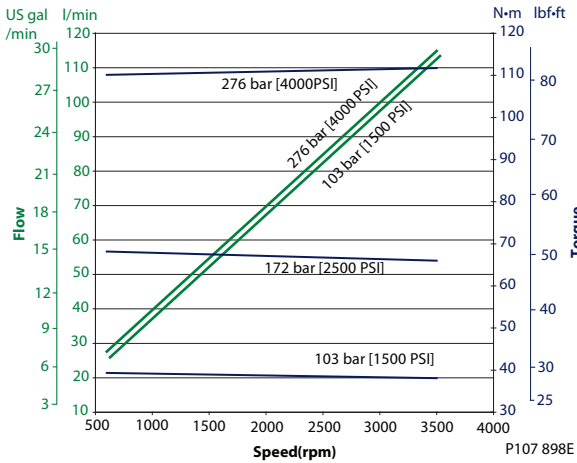


25 cm<sup>3</sup> [1.55 in<sup>3</sup>]

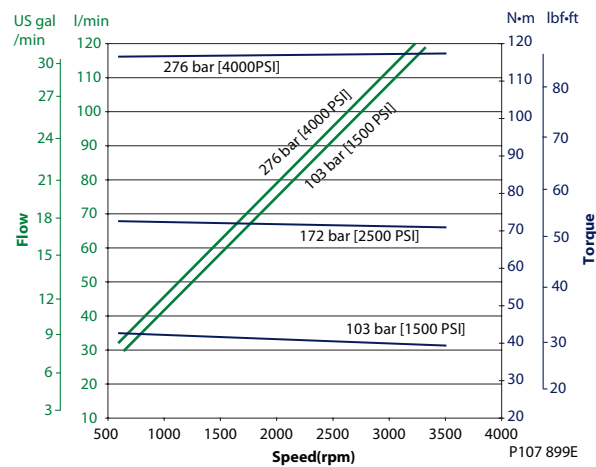


### Motor Performance Graphs (continued)

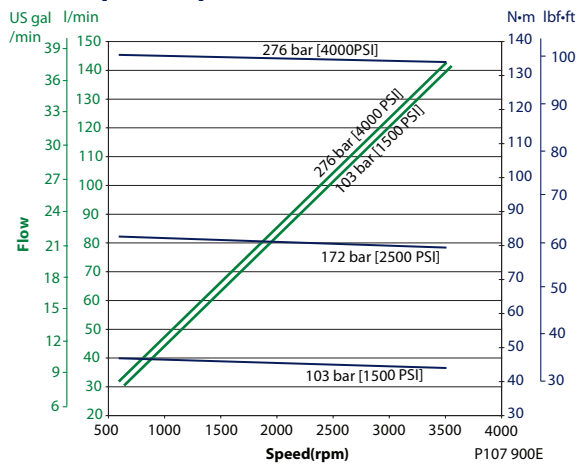
29 cm<sup>3</sup> [1.77 in<sup>3</sup>]



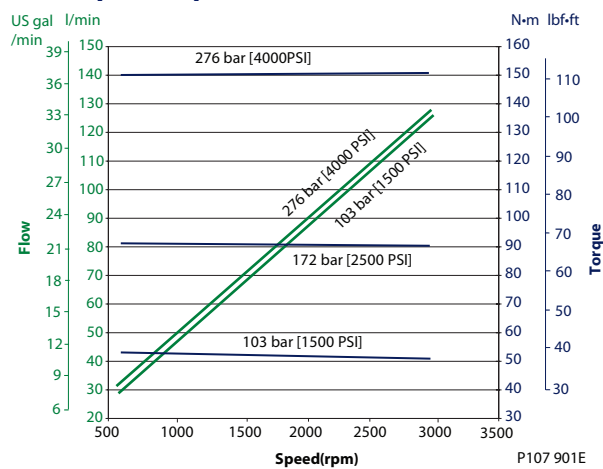
32 cm<sup>3</sup> [1.94 in<sup>3</sup>]



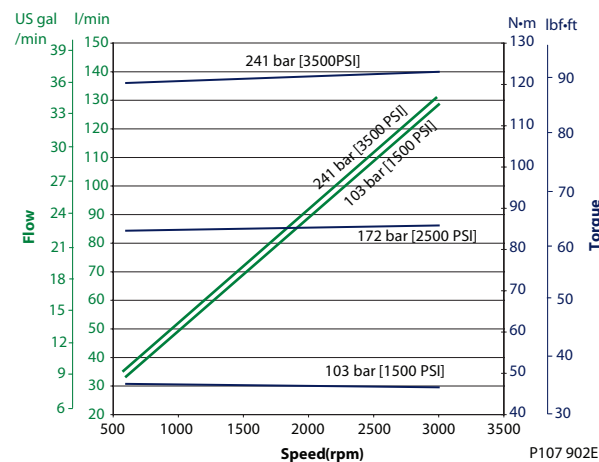
36 cm<sup>3</sup> [2.20 in<sup>3</sup>]



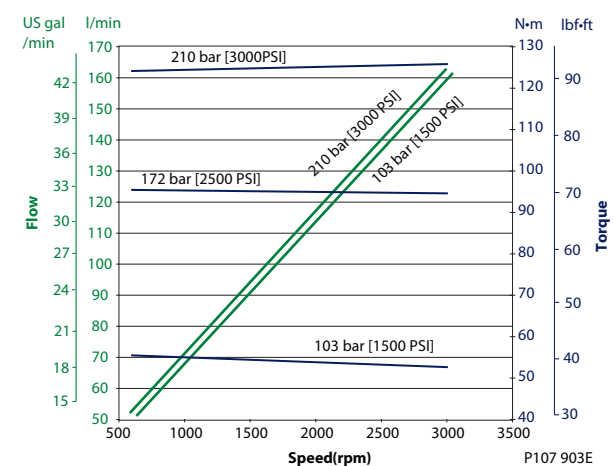
38 cm<sup>3</sup> [2.32 in<sup>3</sup>]



41 cm<sup>3</sup> [2.50 in<sup>3</sup>]



45 cm<sup>3</sup> [2.75 in<sup>3</sup>]





#### TurollaOCG Fan Drive Related Literature

##### *Literature reference - Software*

| Title                                    | Type                  | Order number |
|--|-----------------------|--------------|
| SX Microcontroller Fan Drive Personality | Technical Information | 11023458     |

##### *Literature reference - Fan Drive Controls*

| Title   | Type                  | Order number |
|---|-----------------------|--------------|
| Fan Drive Control   | Technical Information | 11005336     |
| Fan Drive Control Assembly  | Technical Information | 11005337     |
| Fan Drive Control Temperature Sensors                                 | Technical Information | BLN-95-9063  |
| PLUS+1 compliant Heavy-Duty Pressure Transmitter                      | Datasheet             | 520L0801     |
| PLUS+1 compliant Heavy-Duty Pressure Transmitter - SAE Thread Version | Datasheet             | 11005336     |
| PLUS+1 MC088 015-00000-Controller                                     | Datasheet             | 11006645     |

##### *Literature reference - Valves*

| Title                                   | Type                  | Order number |
|---|-----------------------|--------------|
| Modulating and Reversing Fan Drive HICs | Datasheet             | L1001666     |
| Cartridge Valves                        | Technical Information | 520L0588     |

##### *Literature reference - Pumps and Motors*

| Title                            | Type                  | Order number |
|----------------------------------|-----------------------|--------------|
| Series D Hydraulic Gear Pumps    | Technical Information | L1022940     |
| Group 2 Gear Pumps               | Technical Information | L1016341     |
| Group 3 Gear Pumps               | Technical Information | L1016456     |
| Group 1, 2 and 3 Gear Motors     | Technical Information | L1016082     |
| SGM2, SGM3 Fan Drive Gear Motors | Technical Information | L1016036     |
| SGM2 Fan Drive Gear Motors       | Datasheet             | 11029652     |
| SGM3 Fan Drive Gear Motors       | Datasheet             | 11056719     |
| Series 45 Open Circuit Pumps     | Technical Information | 520L0519     |

##### *Literature reference - Fluids*

| Title                           | Type                  | Order number |
|---------------------------------|-----------------------|--------------|
| Hydraulic Fluids and Lubricants | Technical Information | L1021414     |



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