

Technical Information

# **Axial Piston Open Circuit** Reverse Displacement Motor (RDM)



**Revision history***Table of revisions*

| Date          | Changed                                  | Rev  |
|---------------|------------------------------------------|------|
| May 2016      | corrections to Installation drawings     | 0208 |
| July 2015     | corrections to Installation drawings     | 0007 |
| May 2015      | corrections to Electrical Parameters     | AG   |
| April 2015    | various minor edits                      | AF   |
| February 2015 | add Port location and gauge installation | AD   |
| December 2014 | add K Frame                              | AC   |
| July 2014     | Correction to schematic - page 20        | AB   |
| May 2014      | First Edition                            | AA   |

## Contents

### General Information

|                         |   |
|-------------------------|---|
| Basic Design.....       | 4 |
| Key Features.....       | 5 |
| Schematic Diagrams..... | 5 |

### Technical Specifications

|                            |   |
|----------------------------|---|
| Overview.....              | 6 |
| Features and Options.....  | 6 |
| Specifications.....        | 6 |
| Operating Parameters.....  | 6 |
| Electrical Parameters..... | 7 |
| Fluid Specifications.....  | 7 |

### Operating Parameters

|                             |   |
|-----------------------------|---|
| Fluids.....                 | 8 |
| Viscosity.....              | 8 |
| Temperature.....            | 8 |
| Open Circuit Operation..... | 8 |
| Case Pressure.....          | 8 |
| System Pressure.....        | 9 |
| Output Speed.....           | 9 |

### System Design Parameters

|                                                      |    |
|------------------------------------------------------|----|
| RDM application guideline.....                       | 11 |
| Installation.....                                    | 11 |
| Filtration.....                                      | 11 |
| Reservoir.....                                       | 11 |
| Overpressure Protection.....                         | 11 |
| Series Operation.....                                | 12 |
| Shaft Loads.....                                     | 12 |
| Radial load formula.....                             | 12 |
| Duty Cycle and Bearing Life.....                     | 12 |
| Hydraulic Equations Helpful for Motor Selection..... | 12 |
| Name Plate.....                                      | 13 |

### Product Coding

|                     |    |
|---------------------|----|
| RDM Model Code..... | 15 |
|---------------------|----|

### Features and Options

|                                      |    |
|--------------------------------------|----|
| Shaft Torque.....                    | 18 |
| Shaft torque for tapered shafts..... | 18 |
| Dust Seal Option.....                | 18 |
| Output Shafts.....                   | 19 |
| Anti-Cavitation Valve.....           | 19 |
| Speed Sensor.....                    | 20 |
| Displacement Limiters.....           | 21 |
| Motor Rotation.....                  | 21 |
| Controls.....                        | 22 |

### Installation Drawings

|                                            |    |
|--------------------------------------------|----|
| Cartridge (LM/KM) Dimensions.....          | 24 |
| Port locations and gauge installation..... | 25 |

## General Information

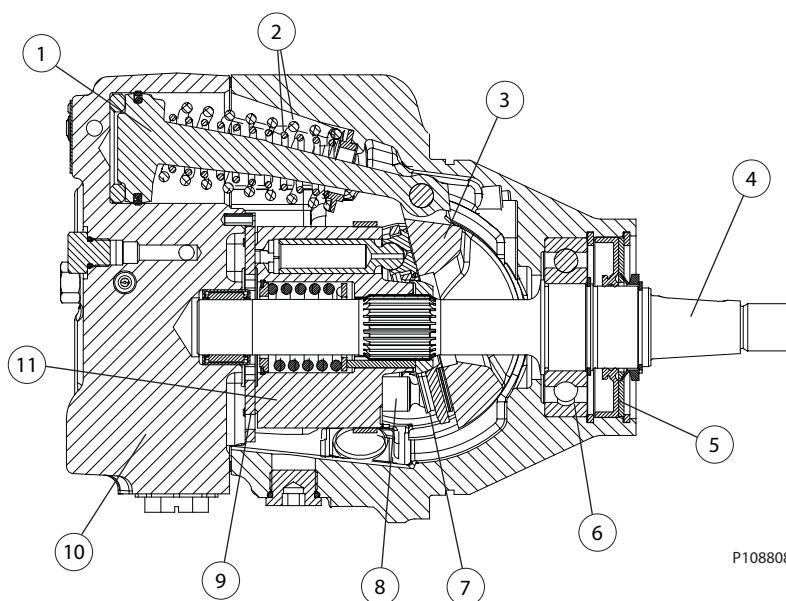
### Basic Design

The Reverse Displacement Motors (RDM) are medium power two-position axial piston motors incorporating an integral servo piston. They are especially designed for operation in open circuit, non propel applications. With the ability to shift over center, this motor combines reversing functionality and the simplicity of open circuit design without the need for additional, external valves (HIC's). For fan drive system design guidelines refer to Danfoss publication: *Hydraulic Fan Drive Systems - Design Guidelines*, **520L0926**

The RDM uses the existing and proven technology of the Danfoss L/K motor. These motors have been optimized with regard to options, life, package size and installed cost. The RDM consists of five unique rotating groups (displacements) in two housings with cartridge mounting flanges. Maximum speeds and maximum applied pressures for each displacement vary. The standard control is an integrated shift valve that uses system pressure. The integral servo piston controls motor displacement. The motor is spring biased to forward displacement and hydraulically shifted to reverse displacement.

Displacement for both directions is set with fixed internal stops. The integrated shifting valve in combination with large diameter servo piston allows smooth shifting between forward and reverse rotation. For system protection the motors are equipped with an integrated anti-cavitation and shock valve. The motor is ideally configured for installations requiring compact packaging and optimized plumbing with one face of the motor containing all hydraulic porting.

*K Frame Cross Section*



P108808

- |                |                   |
|----------------|-------------------|
| 1 Servo piston | 7 Slipper         |
| 2 Bias springs | 8 Piston          |
| 3 Swashplate   | 9 Valve plate     |
| 4 Output shaft | 10 Endcap         |
| 5 Shaft seal   | 11 Cylinder block |
| 6 Bearing      |                   |

## General Information

### Key Features

#### Designed For Durability and Flexibility

- Designed for open circuit applications
- Five displacements allow the optimum selection of a hydraulic motor to fit your application
- Uses the existing and proven technology of Danfoss L/K motors, for maximum reliability

#### Installation and Packaging Benefits

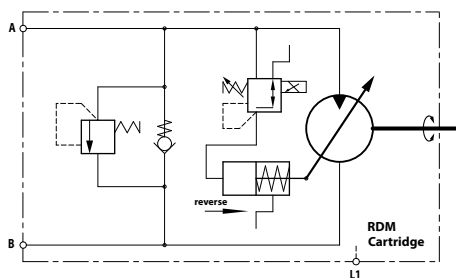
- Short and compact total installed package
- High Efficiency - nine piston rotating groups with a positive and negative 18 degree maximum angle
- Uses system pressure for shifting - no external pressure supply needed
- Integrated shifting valve enables reversing - no external valves needed, which means less hoses, less losses providing a simple and clean installation
- 12Vdc and 24 Vdc shifting valves

#### Wide Range of Options

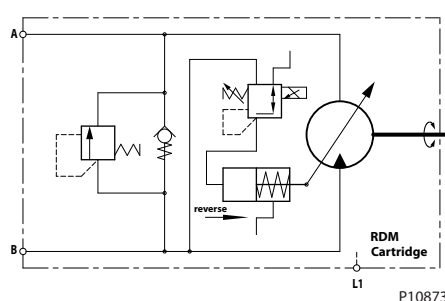
- Fail Safe: Without control signal, the motor is biased to maximum forward speed
- Damped shifting
- Shaft options with dust seal protector
- Integrated system protection - anti-cavitation and shock valve
- High capacity bearings to withstand axial fan forces
- Complimentary to Danfoss Series 45 open circuit pumps with electronic proportional control
- PLUS+1 micro controller with fan drive software available
- Variety of porting options allow for easier system configurations
  - Metric O-Ring boss
  - SAE O-Ring boss
  - Split flange
- A speed sensor is available

## Schematic Diagrams

Pressure port A (CW rotation)



Pressure port B (CCW rotation)



## Technical Specifications

### Overview

Specifications and operating parameters for RDM motors are given here for quick reference. For additional information, see *Operating Parameters, Features and Options*, and *Product Coding*.

### Features and Options

|                              |                                                                                                                                                    |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Mount</b>                 | Cartridge                                                                                                                                          |
| <b>Motor type</b>            | Inline, axial piston, open circuit, Reversing Displacement Motors                                                                                  |
| <b>Displacement</b>          | <b>L:</b> 25, 30, or 35 cm <sup>3</sup> [1.50, 1.83, or 2.14 in <sup>3</sup> ] <b>K:</b> 38 or 45 cm <sup>3</sup> [2.32, or 2.75 in <sup>3</sup> ] |
| <b>Rotation</b>              | Bidirectional                                                                                                                                      |
| <b>Installation position</b> | Discretionary: Housing must always be filled with hydraulic fluid                                                                                  |
| <b>Porting</b>               | Split flange, SAE O-ring boss, Metric O-ring boss                                                                                                  |
| <b>Output shafts</b>         | Tapered, 0.875 in Dia, 1.5 in/ft taper; Straight key, 0.875 in Dia, with dust seal                                                                 |
| <b>Control options</b>       | Integrated shift valve, 12Vdc/24Vdc                                                                                                                |
| <b>Displacement limiter</b>  | Fixed forward and reverse displacement limiters available                                                                                          |
| <b>Dust seal</b>             | Standard - refer to <a href="#">Dust Seal Option</a> on page 18                                                                                    |
| <b>High capacity bearing</b> | Standard - more options available                                                                                                                  |
| <b>Speed sensor</b>          | Available - refer to <a href="#">Speed Sensor</a> on page 20                                                                                       |
| <b>Anti-Cavitation-Valve</b> | Standard - refer to <a href="#">Anti-Cavitation Valve</a> on page 19                                                                               |

### Specifications

| Parameter                                     | Unit                                         | LM25               | LM30               | LM35               | KM38               | KM45               |
|-----------------------------------------------|----------------------------------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| Displacement (maximum)                        | cm <sup>3</sup> [in <sup>3</sup> ]           | 25 [1.50]          | 30 [1.83]          | 35 [2.14]          | 38 [2.32]          | 45 [2.75]          |
| Weight (cartridge and SAE-B)                  | kg [lb]                                      | 17.5 [38.6]        |                    |                    |                    |                    |
| Mass moment of inertia of rotating components | kg•m <sup>2</sup><br>[slug•ft <sup>2</sup> ] | 0.0017<br>[0.0012] | 0.0016<br>[0.0012] | 0.0015<br>[0.0011] | 0.0023<br>[0.0017] | 0.0023<br>[0.0017] |
| Theoretical torque                            | N•m/bar<br>[lbf•in/1000psi]                  | 0.40<br>[244]      | 0.48<br>[293]      | 0.56<br>[347]      | 0.60<br>[366]      | 0.72<br>[439]      |

### Operating Parameters

| Parameter                       |                  | Unit                    | LM25                                                   | LM30       | LM35       | KM38       | KM45       |
|---------------------------------|------------------|-------------------------|--------------------------------------------------------|------------|------------|------------|------------|
| System pressure                 | rated/continuous | bar [psi]               | 260 [3770]                                             | 260 [3770] | 260 [3770] | 260 [3770] | 260 [3770] |
|                                 | maximum          |                         | 350 [5075]                                             | 350 [5075] | 325 [4715] | 350 [5075] | 325 [4715] |
| Output speed<br>(at max. disp.) | rated            | min <sup>-1</sup> (rpm) | 3400                                                   | 3500       | 3600       | 3600       | 3500       |
|                                 | maximum          |                         | 3950                                                   | 4150       | 4300       | 4000       | 3900       |
| Case pressure limits            | Rated            | bar [psi]               | 0.5 [7] above outlet pressure, 2 [29] maximum pressure |            |            |            |            |
|                                 | Maximum          |                         | 2 [29] above outlet pressure, 6 [87] maximum pressure  |            |            |            |            |

## Technical Specifications

### Electrical Parameters

| Description               | Voltage                     |           |
|---------------------------|-----------------------------|-----------|
|                           | 12Vdc                       | 24Vdc     |
| Maximum current           | 1500mA                      | 750mA     |
| Nominal coil resistance   | 5.3 Ohms                    | 21.2 Ohms |
| PWM range                 | 70-200 Hz or straight 12Vdc |           |
| PWM frequency recommended | 100 Hz                      |           |
| Connector                 | Deutsch connector DT04-2P   |           |
| IP rating                 | IP 65                       |           |
| Ambient temperature limit | 80° C (175° F)              |           |

### Fluid Specifications

| Parameter             | Unit                             | Minimum                                     | Continuous     | Maximum     |
|-----------------------|----------------------------------|---------------------------------------------|----------------|-------------|
| Viscosity             | mm <sup>2</sup> /sec (cSt) [SUS] | 7 [47]                                      | 12-60 [70-278] | 1600 [7500] |
| Temperature           | °C [°F]                          | -40 [-40]                                   | 82 [180]       | 104 [220]   |
| Cleanliness           |                                  | ISO 4406 Class 18/13 or better              |                |             |
| Filtration efficiency | suction filtration               | $\beta_{35-44}=75$ ( $\beta_{10}\geq 1.5$ ) |                |             |

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

---

## Operating Parameters

### Fluids

Ratings and performance data for these motors are based on operating with premium hydraulic fluids containing oxidation, rust, and foam inhibitors. These include premium turbine oils, API CD engine oils per SAE J183, M2C33F or G automatic transmission fluids (ATF), Dexron II (ATF) meeting Allison C-3 or Caterpillar T0-2 requirements, and certain specialty agricultural tractor fluids. For more information on hydraulic fluid selection, see Danfoss publications:

*Hydraulic Fluids and Lubricants, Technical Information, 520L0463,*

*Experience with Biodegradable Hydraulic Fluids, Technical Information, 520L465.*

### Viscosity

Maintain fluid viscosity within the recommended range for maximum efficiency and bearing life.

**Minimum viscosity** should only occur during brief occasions of maximum ambient temperature and severe duty cycle operation. **Maximum viscosity** should only occur at cold start. Limit speeds until the system warms up.

#### Fluid viscosity limits

| Condition  | mm <sup>2</sup> /s (cSt) | SUS    |
|------------|--------------------------|--------|
| Minimum    | 7                        | 47     |
| Continuous | 12-60                    | 70-278 |
| Maximum    | 1600                     | 7500   |

### Temperature

Maintain fluid temperature within the limits shown in the table. **Minimum temperature** relates to the physical properties of the component materials. Cold oil will not affect the durability of the motor components. However, it may affect the ability of the motor to transmit power. **Maximum temperature** is based on material properties. Exceeding the maximum temperature may result in damage to the unit. Measure maximum temperature at the hottest point in the system. This is usually the case drain.

#### Temperature limits

|                                              |                   |
|----------------------------------------------|-------------------|
| <b>Minimum</b><br>(intermittent, cold start) | - 40° C [- 40° F] |
| <b>Continuous</b>                            | 85° C [185° F]    |
| <b>Maximum</b>                               | 105° C [221° F]   |

Ensure fluid temperature and viscosity limits are concurrently satisfied.

### Open Circuit Operation

The motors are designed to operate in open circuits with zero outlet pressure. In open circuits, the maximum allowed case pressure is 0.5 bar [7 psi] above outlet pressure and 2 bar [29 psi] maximum pressure. Case drain lines must be plumbed accordingly to insure that case pressure limits are not exceeded under any circumstances.

### Case Pressure

Maintain case pressure within the limits shown in the table. The housing must always be filled with hydraulic fluid.

## Operating Parameters

### Caution

Operating outside of case pressure limits will damage the motor. To minimize this risk, use full size inlet and case drain plumbing, and limit line lengths.

#### Case pressure limits

|                                  |                                                          |
|----------------------------------|----------------------------------------------------------|
| <b>Maximum (continuous)</b>      | 0.5 [7] above outlet pressure<br>2 [29] maximum pressure |
| <b>Intermittent (cold start)</b> | 2 [29] above outlet pressure<br>6 [87] maximum pressure  |

## System Pressure

The specification tables in each section give maximum pressure ratings for each displacement. Not all displacements within a given frame operate under the same pressure limits. Definitions of the operating pressure limits appear below.

Open Circuit Continuous working pressure is the average, regularly occurring operating pressure. Operating at or below this pressure should yield satisfactory product life. For all applications, the load should move below this pressure. This will correspond to the maximum allowable PC setting on the open circuit variable pump supplying the RDM.

As the RDM will be commonly applied into fan drive systems, the maximum pressure experienced is generally the pressure at fan trim speed. If this pressure exceeds the continuous pressure rating, a more thorough duty cycle analysis is recommended.

Maximum (peak) pressure is the highest intermittent pressure allowed.

Maximum machine load should never exceed this pressure, and pressure overshoots should not exceed this pressure.

[Pressure spikes are normal and must be considered when reviewing maximum working pressure.](#)

[The RDM is designed for open circuits. Due to the shifting valve pressure limits the maximum system pressure is absolute pressure. Differential pressure referenced to outlet pressure is just relevant for the maximum case pressure.](#)

## Output Speed

Smooth operation and output torque ripple determine the acceptable low speed operating condition. Generally Danfoss axial piston motors will operate smoothly down to 150 rpm. In some instances, it is possible to operate smoothly at less than 150 rpm, but performance must be verified for the specific application. We do not recommend that any axial piston motor be sized to operate continuously at speeds less than 100 rpm.

**Rated speed** is the highest input speed recommended at full power condition. Operating at or below this speed should yield satisfactory product life.

**Maximum speed rating** is the highest operating speed recommended and cannot be exceeded without severe reduction of unit life, or without risking premature failure.

Operating conditions between continuous and maximum speed ratings should be restricted to less than full power and to limited periods of time.

For more information consult *Pressure and Speed Limits* **BLN-9884**, when determining speed limits for a particular application.

**Operating Parameters** **Warning****Over speed hazard**

Especially in fan drive systems, the fan speed and accordingly motor speed is directly related to system pressure. The maximum system pressure is defined by Pressure Compensator (PC) setting of S45 pump.

To prevent motor overspeed the PC setting needs to be calculated upfront. The maximum fan speed should be checked at first machine start up.

---

 **Warning****Unintended vehicle or machine movement hazard**

When using the RDM in combination with S45 open circuit pumps with LS or EPC controls, be aware that there will likely be motor movement as long as the engine is turning. Due to the LS-setting of the pump, a standby pressure will remain in the system even when the normally closed control is fully energized.

Lowest standby pressures to the motor (15-18 bar, or above) may be enough to turn the RDM and has the potential to cause injury or damage.

---

## System Design Parameters

### RDM application guideline

RDM allows immediate reversing from maximum speed forward to maximum speed backward by supplying voltage to the control valve. In general but especially for load with high inertia the shifting will influence the system in terms of pressure spikes and possibly noise. To reduce this influence the shifting should follow some guidelines.

### Installation

RDM motors may be installed in any position. The motor housing must always remain full of hydraulic fluid.

Take care to ensure air is removed and proper fluid level is achieved during system installation and use.

Fill the motor housing and system lines with clean fluid during installation. Connect the case drain line to the uppermost drain port to keep the housing full during operation.

To allow unrestricted flow to the reservoir, use a dedicated drain line. Connect it below the minimum reservoir fluid level and as far away from the reservoir outlet as possible. Use plumbing adequate to maintain case pressure within prescribed limits (see [Case Pressure](#) on page 8).

### Filtration

To prevent damage to the motor, including premature wear, fluid entering the motor must be free of contaminants. RDM motors require system filtration capable of maintaining fluid cleanliness at ISO 4406-1999 class 22/18/13 or better.

Consider these factors when selecting a system filter:

- Cleanliness specifications
- Contaminant ingress rates
- Flow capacity
- Desired maintenance interval

Typically, a filter with a beta ratio of  $\beta_{10} = 1.5$  to 2.0 is adequate. However, open circuit systems supplied from a common reservoir may have considerably higher requirements. Because each system is unique, only a thorough testing and evaluation program can fully validate the filtration system. For more information, see Danfoss publication *Design Guidelines for Hydraulic Fluid Cleanliness*, **520L0467**.

### Reservoir

The reservoir provides clean fluid, dissipates heat, and removes entrained air from the hydraulic fluid. It allows for fluid volume changes associated with fluid expansion and cylinder differential volumes. Minimum reservoir capacity depends on the volume needed to perform these functions. Typically, a capacity of one half the charge pump flow (per minute) is satisfactory for a closed circuit system reservoir. Open circuit systems sharing a common reservoir will require greater fluid capacity.

Locate the reservoir outlet (suction line) near the bottom, allowing clearance for settling foreign particles. Place the reservoir inlet (return lines) below the lowest expected fluid level, as far away from the outlet as possible.

### Overpressure Protection

Reverse Displacement Motors with anti-cavitation and shock valve have internal overpressure protection against pressure spikes, but the maximum flow across this valve is limited. For flow rates greater than 25 l/min. external relief valves are recommended to maintain system pressure within prescribed limits. Shock valves are adequate to protect against transient or unusually rapid load application, but excessive or continuous flow through them adds heat to the system and can damage the fluid. Applications that are expected to operate near the shock valve setting should use a pressure compensated pump to minimize the risk of heat build up.

## System Design Parameters

### Series Operation

These motors may be operated in series configuration as long as system, charge, and case pressure limits are satisfied. Operating motors in series significantly impacts bearing life. Contact your Danfoss representative for assistance when applying these motors in series configuration.

### Shaft Loads

Reverse Displacement Motors have bearings capable of accepting some external radial and thrust loads. The external radial shaft load limits are a function of the load position, orientation, and the operating conditions of the motor.

The RDM has been designed to handle typical external shaft loads from the fan drive and similar systems. Contact your Danfoss representative to ensure proper selection of bearings and load orientation for optimum life.

### Radial load formula

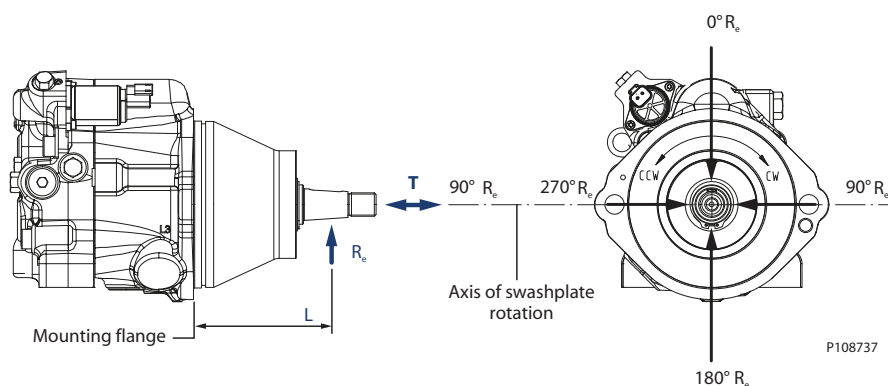
$$M_e = R_e \cdot L$$

$L$  = Distance from mounting flange to point of load

$M_e$  = Maximum external moment

$R_e$  = Maximum radial side load

*Shaft load orientation*



### Duty Cycle and Bearing Life

All shaft loads affect bearing life. We recommend tapered shafts or clamp-type couplings for applications with radial shaft loads.

Knowing the operating conditions of your application is the best way to ensure proper motor selection. With accurate duty cycle information, your Danfoss representative can assist in calculating expected motor life.

### Hydraulic Equations Helpful for Motor Selection

Use the following equations to compute output power, torque, speed, and input flow. Selecting the right motor starts with an evaluation of system requirements such as speed and torque. Select a motor that will transmit the required torque, then select a pump that will meet the flow and pressure requirements of the motor.

## System Design Parameters

### Based on SI units

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

$$\text{Motor speed } n = \frac{Q \cdot 1000 \cdot \eta_v}{V_g} \quad \text{min}^{-1}(\text{rpm})$$

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

$$\text{Output power } P = \frac{Q \cdot \Delta p \cdot \eta_t}{600} \quad (\text{kW})$$

### Based on US units

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

$$\text{Motor speed } n = \frac{Q \cdot 231 \cdot \eta_v}{V_g} \quad \text{min}^{-1}(\text{rpm})$$

$$\text{Output torque } M = \frac{V_g \cdot \Delta p \cdot \eta_m}{2 \cdot \pi} \quad (\text{lbf}\cdot\text{in})$$

$$\text{Output power } P = \frac{Q \cdot \Delta p \cdot \eta_t}{1714} \quad (\text{hp})$$

### Where:

SI units [US units]

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

P108720

## Name Plate

These motors are identified by a name plate affixed to the motor housing. The nameplate contains the model number, model code, serial number, and country of manufacture.

### Serial number

Every unit is identified by a unique serial number. The serial number gives manufacturing location, year and week built, and a unique sequence number. The serial number in the example is decoded as:

|       |                 |
|-------|-----------------|
| A     | Ames, Iowa, USA |
| 14    | Year 2014       |
| 20    | Week 20         |
| 23456 | Sequence number |

### Model number

A Danfoss model number is issued for every unique configuration. Use this number when placing orders.

### Model code

The model code completely defines the options for a specific unit. See *Model Code* section, for available options and codes.

## System Design Parameters

*Name plate*



# Technical Information

## Reverse Displacement Motor (RDM)

### Product Coding

#### RDM Model Code

|                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| A                    | B                    | C1                   | C2                   | D                    | E1                   | E2                   | E3                   | F                    | G                    | H1                   | J                    | K1                   | K2                   | L                    | M                    | N                    |
| <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> |

#### A Frame

| Code | Description                                                                                      |
|------|--------------------------------------------------------------------------------------------------|
| L    | Frame size: displacements 25, 30, and 35 cm <sup>3</sup> [1.50, 1.83, and 2.14 in <sup>3</sup> ] |
| K    | Frame size: displacements 38, and 45 cm <sup>3</sup> [2.32, and 2.75 in <sup>3</sup> ]           |

#### B Mount

| Code | Description                                                       |
|------|-------------------------------------------------------------------|
| M    | Motor, Variable Displacement-Reversing, Cartridge Mounting Flange |

#### C1 Displacement

| Code | Displacement                                        |
|------|-----------------------------------------------------|
| 25C  | 25 cm <sup>3</sup> /rev [1.50 in <sup>3</sup> /rev] |
| 30D  | 30 cm <sup>3</sup> /rev [1.83 in <sup>3</sup> /rev] |
| 35E  | 35 cm <sup>3</sup> /rev [2.14 in <sup>3</sup> /rev] |
| 38C  | 38 cm <sup>3</sup> /rev [2.32 in <sup>3</sup> /rev] |
| 45D  | 45 cm <sup>3</sup> /rev [2.75 in <sup>3</sup> /rev] |

#### C2 Speed Sensing Ring

| Code | Description                                                                                  |
|------|----------------------------------------------------------------------------------------------|
| N    | None                                                                                         |
| S    | Speed ring installed, L Frame = 41 pulses per revolution, K Frame = 44 pulses per revolution |

#### D Output Shaft

| Code | Description                                                               |
|------|---------------------------------------------------------------------------|
| F    | Tapered, 0.875 inch Dia, 1.5 in/ft taper, uses Square key, with dust seal |
| K    | Straight key, 0.875 inch Dia, with dust seal                              |

#### E1 Endcap Porting

| Code | Description                                   |
|------|-----------------------------------------------|
| E    | Twin Radial, 19mm per ISO 6162 (split flange) |
| M    | Twin Radial M27x2 per ISO 6149 (metric ORB)   |
| R    | Twin Radial, 1 1/16 in-12 O-ring boss         |

#### E2 Valving

| Code | Description                                                                       |
|------|-----------------------------------------------------------------------------------|
| D    | Anti-Cavitation, Port A, 345 Bar Shock Valve (CW rotation at de-energized valve)  |
| E    | Anti-Cavitation, Port B, 345 Bar Shock Valve (CCW rotation at de-energized valve) |

## Product Coding

### E2 Valving (continued)

| Code | Description                                                                       |
|------|-----------------------------------------------------------------------------------|
| F    | Anti-Cavitation, Port A, 280 Bar Shock Valve (CW rotation at de-energized valve)  |
| G    | Anti-Cavitation, Port B, 280 Bar Shock Valve (CCW rotation at de-energized valve) |
| H    | Anti-Cavitation, Port A, 230 Bar Shock Valve (CW rotation at de-energized valve)  |
| I    | Anti-Cavitation, Port B, 230 Bar Shock Valve (CCW rotation at de-energized valve) |

### E3 Optional Features

| Code | Description                 |
|------|-----------------------------|
| 1    | 12 V Integrated Shift Valve |
| 2    | 24 V Integrated Shift Valve |

### F Reverse Angle/Displacement Setting

| Code | Angle         | % of Max. | L25C                 | L30D               | L35E               | K38C               | K45C               |
|------|---------------|-----------|----------------------|--------------------|--------------------|--------------------|--------------------|
| N18  | 18° Reverse   | 100%      | 25 cm <sup>3</sup>   | 30 cm <sup>3</sup> | 35 cm <sup>3</sup> | 38 cm <sup>3</sup> | 45 cm <sup>3</sup> |
| N24  | 14.5° Reverse | 79.5%     | 19,9 cm <sup>3</sup> | N/A                | N/A                | N/A                | N/A                |

### G Control Type

| Code | Description |
|------|-------------|
| S    | Standard    |

### H Supply Orifice

| Code | Description     |
|------|-----------------|
| N    | None (standard) |

### J Drain Orifice

| Code | Description     |
|------|-----------------|
| N    | None (standard) |

### K1 Speed Sensor Connector

| Code | Description                                                                                              |
|------|----------------------------------------------------------------------------------------------------------|
| B    | None: Housing machined for speed sensor. Port plugged                                                    |
| D    | Speed Sensor (KPPG 13704); 4.5-8.5V; 4 pin Deutsch DT04 Connector; Option 'C2' must include a speed ring |

### K2 Housing Optional Features

| Code | Description                                                                                    |
|------|------------------------------------------------------------------------------------------------|
| F    | None (includes case drain per SAE)                                                             |
| M    | Metric ORB Case Drain ISO 6149, M18 Option 'E1' must be: Twin Radial per ISO 6149 (metric ORB) |

## Product Coding

### *L Forward angle/displacement setting*

| Code | Angle | % of Max. | L25C                 | L30D               | L35E               | K38C               | K45D               |
|------|-------|-----------|----------------------|--------------------|--------------------|--------------------|--------------------|
| F18  | 18°   | 100%      | 25 cm <sup>3</sup>   | 30 cm <sup>3</sup> | 35 cm <sup>3</sup> | 38 cm <sup>3</sup> | 45 cm <sup>3</sup> |
| N24  | 14.5° | 79.5%     | 19,9 cm <sup>3</sup> | N/A                | N/A                | N/A                | N/A                |

### *M Special Hardware*

| Code | Description                                             |
|------|---------------------------------------------------------|
| NNN  | None                                                    |
| NNA  | High capacity ball bearing, recommended for fan drive   |
| NNB  | High capacity roller bearing, recommended for fan drive |

### *N Special Features*

| Code | Description                                                |
|------|------------------------------------------------------------|
| FNN  | Black paint, cartridge is completely painted - Standard    |
| NNN  | Black paint, Danfoss Tag, Layout Q                         |
| NNT  | Black paint, Danfoss Tag, Layout T                         |
| FNT  | Black paint, Danfoss Tag, Layout T paint in front of pilot |

## Features and Options

### Shaft Torque

RDM motors are available with tapered, and straight-keyed shafts.

#### Shaft torque for tapered shafts

The rated torque is based on the contact pressure between the shaft and hub surfaces with poor surface contact areas. With an increased quality of the contact areas, the contact pressure between the shaft and hub is increased and allows higher torque to be transmitted.

When a key is used for orientation of the hub on the shaft in conjunction with poor quality contact surfaces, the transmitted torque rating will drop significantly. This is due to the key carrying the torque, which limits the shaft torque carrying capability.

Maximum torque rating is based on an ideal contact area of 100 % and the retaining nut properly torqued. This allows for the highest contact pressure between the shaft and the hub.

Complete a detailed bolted joint analysis to ensure proper contact pressure, load and torque retention characteristics are achieved.

Shaft taper: 1:8 per SAE J501

Maximum retaining nut tightening torque: 250 lb•ft (340 Nm)

Any torque in excess of this may lead to shaft damage.

This maximum torque is based on using an SAE J429 Grade 8 standard, non-self-locking nut with a clean/oiled interface.

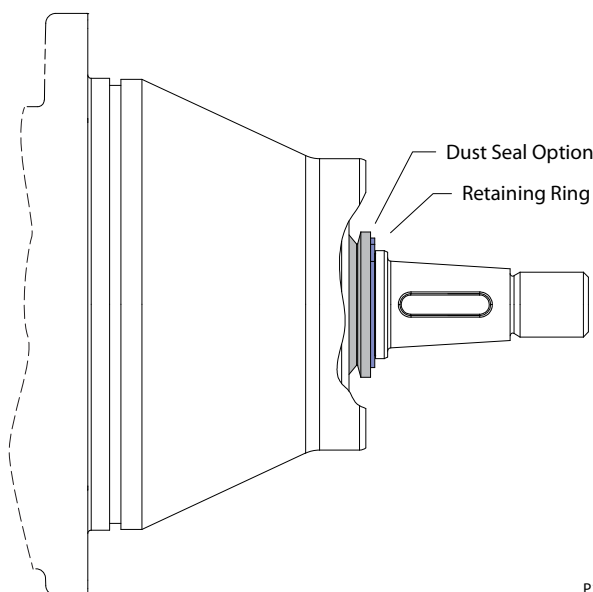
### Dust Seal Option

The dust seal option has been designed to increase the resistance to airborne particulates which could contaminate and potentially damage the motor output shaft seal. The speed rating of the dust seal is the same as the motor speed rating.

---

Dust seal is standard for all RDM shaft options..

---



P108749

## Features and Options

### Output Shafts

RDM motors are available with tapered, and straight-keyed shafts. See the following table for details.

#### Shaft options

| Code | Description                                                                                                                                                                                  | Torque rating              |                         | Drawing |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|-------------------------|---------|
|      |                                                                                                                                                                                              | Continuous<br>N·m [lbf·in] | Maximum<br>N·m [lbf·in] |         |
| F    | Ø 22.23 mm [0.875 in]<br>1:8 Taper with Dust Seal Option<br>(does not ship with key)<br>Refer to Shaft Torque For Tapered<br>Shafts pg 17 for information<br>regarding retaining nut torque. | N/A                        | 362 [3200]              |         |
| K    | Ø 22.225 mm [0.875 in]<br>Straight Keyed Shaft with Dust<br>Seal Option<br>(does not ship with key)                                                                                          | N/A                        | 362 [3200]              |         |

### Anti-Cavitation Valve

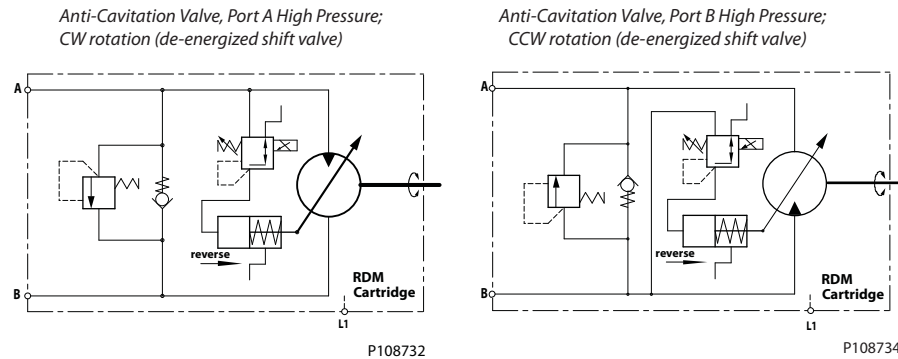
RDM motors are available with an anti-cavitation valve option. The key application for this option is for high inertia loads.

The anti-cavitation valve combines the function of a shock valve and check valve within the same cavity which is integrated into the endcap. The check valve function provides protection against cavitation which can occur upon introduction of an overrunning load or due to loss of input flow. In such case, the system delta pressure becomes negative and the check valve opens connecting the motor inlet and outlet, effectively short-circuiting the motor. The shock valve function is intended to be used for system over-pressure protection events of limited duration only. It is not intended for continuous system pressure limitation.

The shock valve is available with 280 bar or 345 bar setting.

## Features and Options

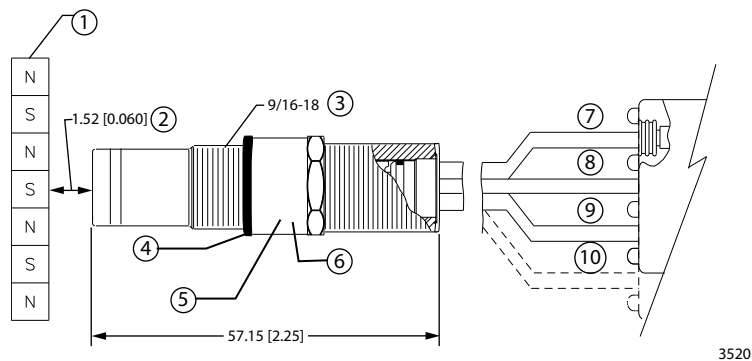
Because of this option, the high pressure port needs to be predefined to get the correct motor rotation. Refer to Minimum/Maximum Displacement Setting in the *Model Code* chapter.



## Speed Sensor

RDM motors are available with an optional speed sensor. This hall-effect pick-up senses motor speed and direction of rotation via a magnetic ring mounted to the cylinder block. The sensor is available with a 4-pin Deutsch connector. For more information, refer to *KPP Pulse Pick-up Technical Information*, **11029257**.

*Common lead wire configuration (flat end)*



*Common lead wire configuration (flat end) callouts*

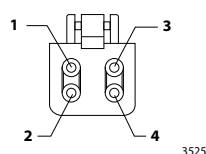
| Callout | Description                                             |
|---------|---------------------------------------------------------|
| 1       | Speed ring                                              |
| 2       | gap approximately half to full turn of thread (maximum) |
| 3       | 9/16-18 UNF-2A THD (all models)                         |
| 4       | O-ring part number 90042013700                          |
| 5       | Locking nut part number K13988                          |
| 6       | Torque lock nut $13 \pm 1.3$ N·m                        |
| 7       | Red                                                     |
| 8       | White                                                   |
| 9       | Black                                                   |
| 10      | Green                                                   |

## Features and Options

### Specifications

|                                          |                                         |
|------------------------------------------|-----------------------------------------|
| <b>Type</b>                              | KPPG 13704                              |
| <b>Supply voltage</b>                    | 4.5 to 8.5 Vdc (regulated)              |
| <b>Output voltage (high)</b>             | Supply minus 0.5 Vdc, minimum (no load) |
| <b>Output voltage (low)</b>              | 0.5 Vdc Maximum (no load)               |
| <b>Maximum frequency</b>                 | 15 kHz                                  |
| <b>Max. operating current</b>            | 20 mA at 1 kHz                          |
| <b>Load</b>                              | 15 kΩ to both ground and supply         |
| <b>Peak reverse voltage</b>              | -15 Vdc continuous                      |
| <b>Peak transient voltage</b>            | 80 Vdc for 2 ms (max.)                  |
| <b>Pulses per rev.</b>                   | 41 (LM motor) 44 (KM motor)             |
| <b>Operating and storage temperature</b> | -40° to 110° C [-40° to 230° F]         |

### Deutsch® Plug DT series 4-pin assignments



### Pin assignments

| Deutsch® Plug DT series 4-pin |           |
|-------------------------------|-----------|
| Pin                           | Function  |
| 1                             | Power +   |
| 2                             | Speed     |
| 3                             | Ground    |
| 4                             | Direction |

## Displacement Limiters

Reverse Displacement Motors can be equipped with optional fixed (non-adjustable) displacement limiters. Refer to Forward Angle/Displacement Setting in *Model Code* chapter, for available displacement settings.

## Motor Rotation

The RDM rotation with a de-energized shifting valve is related to the high pressure port of the motor. Because of the Anti-Cavitation Valve, this port needs to be predefined. The chart gives the direction of rotation with respect to the high pressure port of the motor.

| High Pressure Port | Rotation | Valve Option            |
|--------------------|----------|-------------------------|
| Flow A             | CW       | Anti-Cavitation, port A |
| Flow B             | CCW      | Anti-Cavitation, port B |

## Features and Options

### Controls

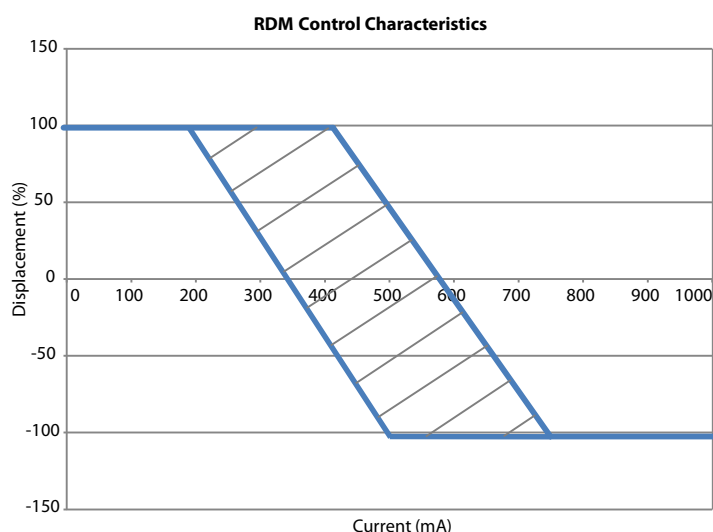
Reverse Displacement Motors are designed to operate in two positions: maximum forward and maximum reverse displacement. The motors are spring biased to maximum forward displacement and hydraulically shifted to reverse.

Reverse Displacement Motors have an integrated shifting valve to go from forward to reverse rotation.

The shifting valve is a proportional pressure reducing valve using system pressure to pilot the servo piston.

The proportional controllability can be used to achieve a smooth shifting between forward and reverse rotation. The diagram below shows the motor control characteristics related to valve current (12 Volt solenoid).

The shaded portion is indicative of the possible variation in shift characteristics. Variation is caused by differences in system pressure, speed and temperature.

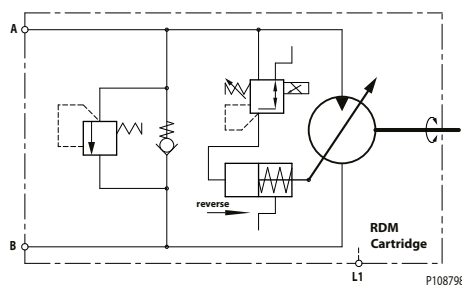


P108736

For information regarding Electrical Specifications see [Electrical Parameters](#) on page 7.

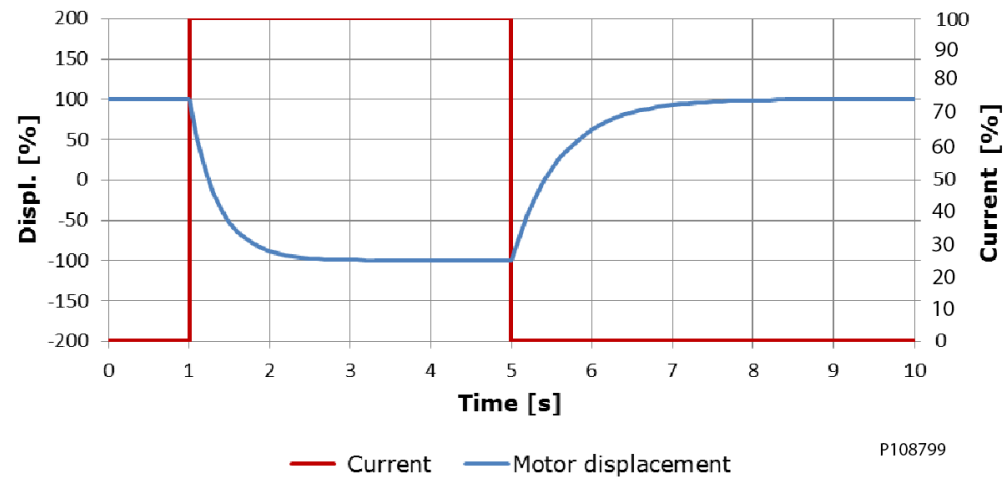
The RDM control has a failsafe design. The integrated shift valve acts like an orifice to dampen the shifting between maximum forward to maximum reverse and back. This feature protects the system components against fatal damage in case the control signal changes without ramping or if it gets lost immediately while reversing.

*Control orifice, port A high pressure; CW rotation (de-energized shift valve)*



Features and Options

Fail Safe Control Characteristic



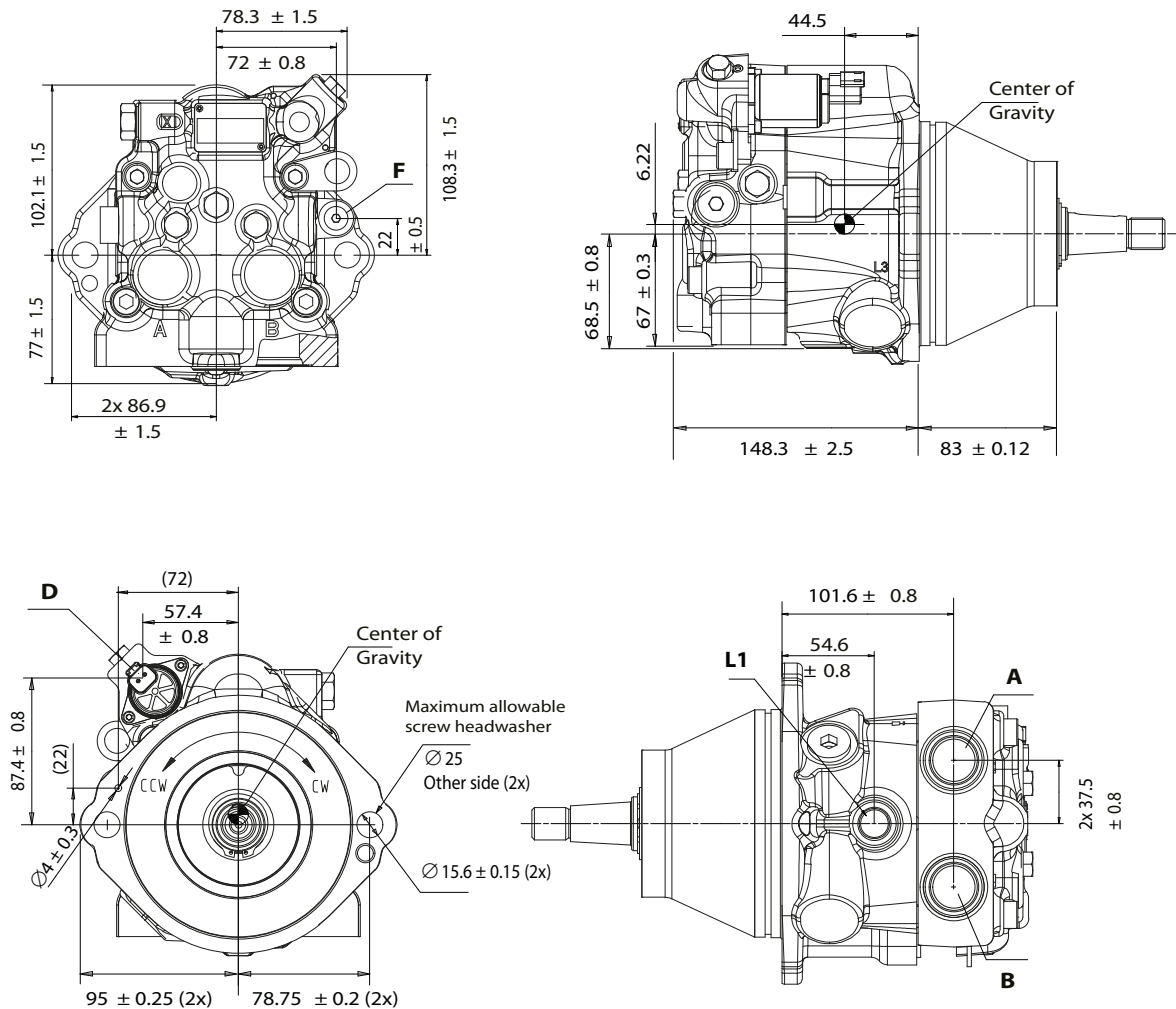
Control current

| Supply Voltage (Vdc) | Current Range 0-100% [mA] |
|----------------------|---------------------------|
| 12                   | 0-1500                    |
| 24                   | 0-750                     |

## Installation Drawings

### Cartridge (LM/KM) Dimensions

Refer to the table in the following topic [Port locations and gauge installation](#) on page 25 for port identification.



P108800

#### Recommended mounting hardware

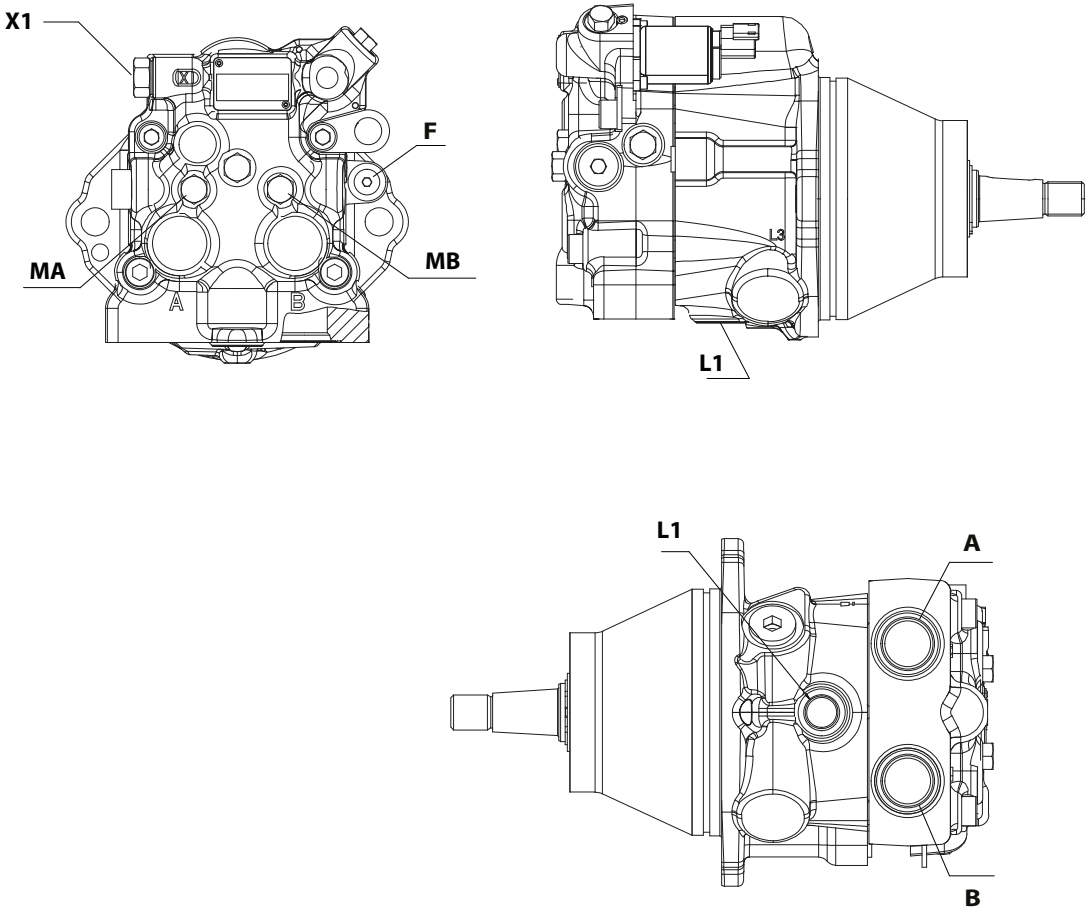
| Bolt size                                 | Grade | Torque N·m [lbf·ft] |
|-------------------------------------------|-------|---------------------|
| 1/2 inch                                  | 5     | 86 [64]             |
|                                           | 8     | 122 [90]            |
| Use hardened washer under each bolt head. |       |                     |

## Installation Drawings

### Port locations and gauge installation

Pressure measurements can be obtained by installing tee fittings to the connections at the locations listed in the table below. Recommended gauge sizes are listed.

#### *Twin radial port locations*



P108844

#### *Port information*

| Port identifier | Metric                 | Inch                   | Pressure obtained  | Gauge size, bar [psi] |
|-----------------|------------------------|------------------------|--------------------|-----------------------|
| X1              | ISO 6941-1, M 18x1.5   | ISO 11926-1, 3/4-16    | Control signal     | 600 [10 000]          |
| L1              | ISO 6941-1, M 14x1.5   | ISO 11926-1, 9/16-18   | Case drain         | 10 [100]              |
| A/B             | ISO 6941-1, M 27x2     | ISO 11926-1, 1-1/16-12 | System pressure    | 600 [10 000]          |
| MA/MB           | ISO 11926-1, 7/16 - 20 |                        | System gauge port  | 600 [10,000]          |
| F               | ISO 11926-1, 7/16-20   |                        | Brake release port | -                     |





**Products we offer:**

- Bent Axis Motors
- Closed Circuit Axial Piston Pumps and Motors
- Displays
- Electrohydraulic Power Steering
- Electrohydraulics
- Hydraulic Power Steering
- Integrated Systems
- Joysticks and Control Handles
- Microcontrollers and Software
- Open Circuit Axial Piston Pumps
- Orbital Motors
- PLUS+1® GUIDE
- Proportional Valves
- Sensors
- Steering
- Transit Mixer Drives

**Danfoss Power Solutions** is a global manufacturer and supplier of high-quality hydraulic and electronic components. We specialize in providing state-of-the-art technology and solutions that excel in the harsh operating conditions of the mobile off-highway market. Building on our extensive applications expertise, we work closely with our customers to ensure exceptional performance for a broad range of off-highway vehicles.

We help OEMs around the world speed up system development, reduce costs and bring vehicles to market faster.

Danfoss – Your Strongest Partner in Mobile Hydraulics.

**Go to [www.powersolutions.danfoss.com](http://www.powersolutions.danfoss.com) for further product information.**

Wherever off-highway vehicles are at work, so is Danfoss. We offer expert worldwide support for our customers, ensuring the best possible solutions for outstanding performance. And with an extensive network of Global Service Partners, we also provide comprehensive global service for all of our components.

Please contact the Danfoss Power Solution representative nearest you.

**Comatrol**

[www.comatrol.com](http://www.comatrol.com)

**Schwarzmüller-Inverter**

[www.schwarzmueller-inverter.com](http://www.schwarzmueller-inverter.com)

**Turolla**

[www.turollaocg.com](http://www.turollaocg.com)

**Hydro-Gear**

[www.hydro-gear.com](http://www.hydro-gear.com)

**Daikin-Sauer-Danfoss**

[www.daikin-sauer-danfoss.com](http://www.daikin-sauer-danfoss.com)

Local address:

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

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

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

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

Danfoss can accept no responsibility for possible errors in catalogues, brochures and other printed material. Danfoss reserves the right to alter its products without notice. This also applies to products already on order provided that such alterations can be made without changes being necessary in specifications already agreed.  
All trademarks in this material are property of the respective companies. Danfoss and the Danfoss logotype are trademarks of Danfoss A/S. All rights reserved.