ENGINEERING
TOMORROW

Technical Information

Transit Mixer Axial Piston Motor
Size 070/084/089

Revision history

Table of revisions

Date	Changed	Rev
June 2017	Update to Engineering Tomorrow	0202
Mar 2014	Converted to Danfoss layout – DITA CMS	BA
10 Aug 2012	New TMM images	AD
15 Feb 2012	TMM detail view added	AC
20 Jan 2012	Pictures` numbers were added, MMC change.	AB
08 Dec 2011	First edition	AA

Contents

Revisions

Technical Specifications

Literature reference

Further available literature

Title	Type	Literature number
Speed and Temperature Sensor	Technical Information	11046759
Hydraulic Fluids and Lubricants	Technical Information	520L0463
Design Guideline for Hydraulic Fluid Cleanliness	Technical Information	520L0467
TMM Axial Piston Motor	Service Manual	L1211037

General description

This motor is designed primarily to be combined with others pumps in closed circuit system to transfer hydraulic power, especially for Transit Mixer Application.

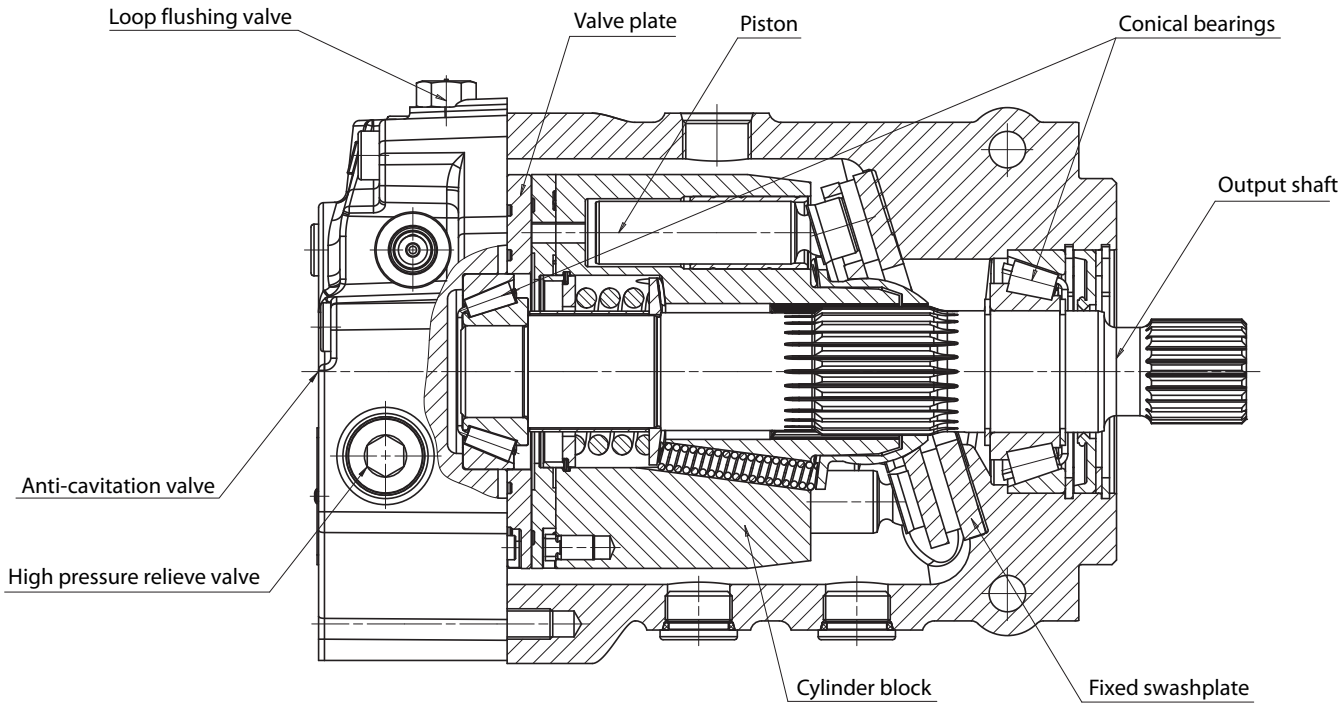
- Innovation with reliable technology
- Loop flushing device integrated
- High pressure relieve valves integrated
- Anti-cavitation valves – optional
- Speed and temperature sensor – optional
- Speed sensor
- Metric / Inch connections
- High pressure ports for 3000 and 6000 psi on one side
- Sizes: 70 cm^3, 84 cm^3 and 89 cm^3

TMM fixed displacement motor

Technical Specifications

TMM fixed displacement motor sectional view

TMM cross-sectional view

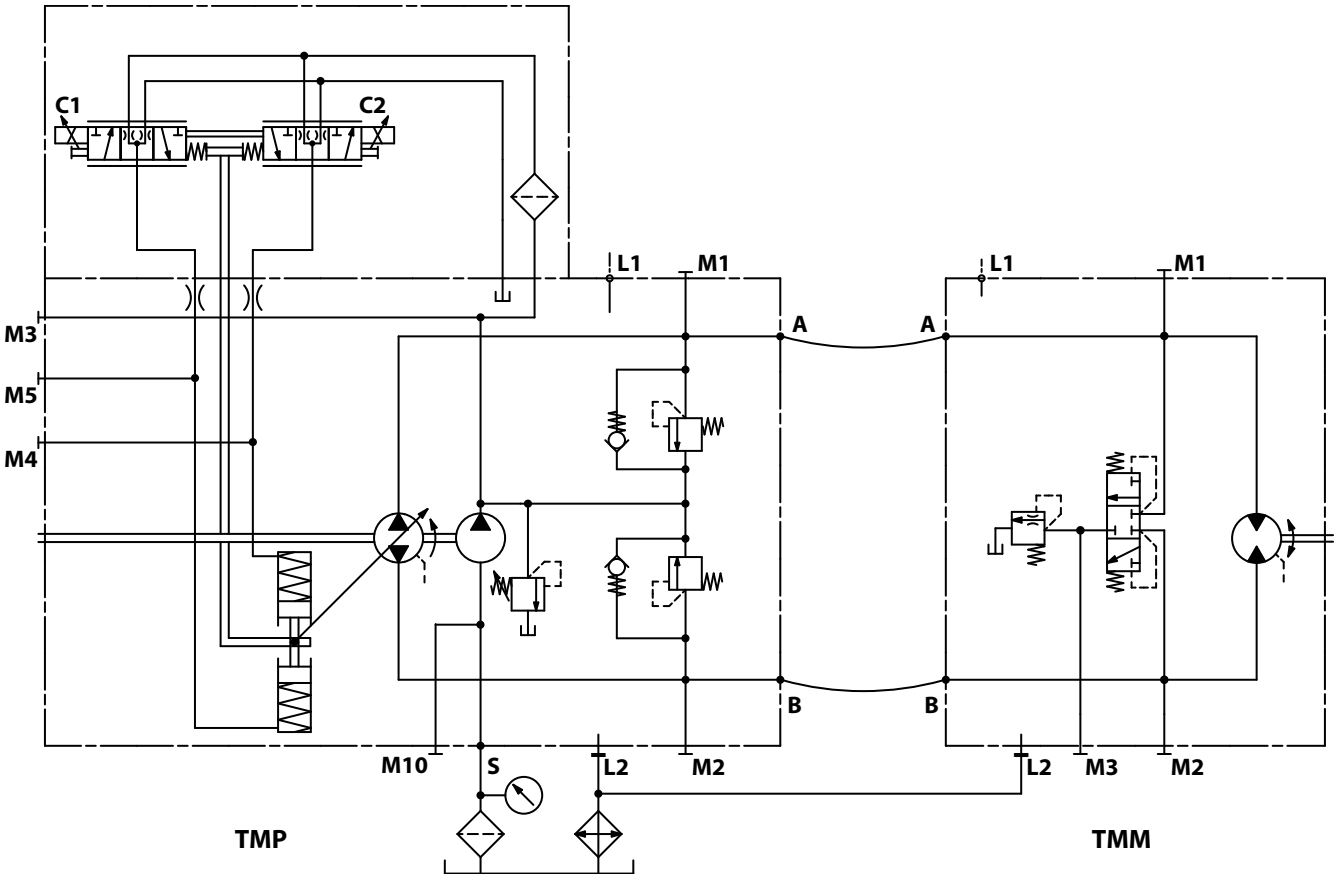


System schematic

The schematic below shows the function of a hydrostatic transmission using a TMP axial variable displacement pump with electric proportional displacement control (EDC) and a TMM fixed displacement motor with integrated loop flushing device.

Technical Specifications

TMM with TMP EDC



Legend:
A, B – System ports
L1, L2 – Case drain ports
M1, M2 – System A/B gage ports
M3 – Charge gage port, after filtering
M4, M5 – Servo gage ports
M10 – Charge pump inlet pressure port
S – Charge inlet port

Detailed information about ports see the section Installation drawings, pages *Dimensions* on page 22.

TMM technical data

General specifications

Design	Axial piston motor with fixed swashplate design with fixed displacement
Direction of rotation	Bi-directional
Pipe connections	Main pressure ports: ISO split flange boss
	Remaining ports: ISO/SAE straight thread O-ring boss
Recommended installation position	Motor installation position is discretionary The housing must always be filled with hydraulic fluid. .

Warning

The front shaft seal must not be exposed to oil pressure from outside of the unit.

Technical Specifications

Technical data

Features	Unit	Size		
		070	084	089
Displacement maximum	cm^3 [in^3]	68.3 [4.17]	83.8 [5.11]	89.0 [5.43]
Flow at rated (continuous) speed	l/min [US gal/min]	171 [45.2]	209.5 [55.3]	222.5 [58.8]
Torque (theoretical)	N•m/bar [lbf•in/1000 psi]	1.09 [665]	1.33 [812]	1.42 [867]
Mass moment of inertia of rotating components	$kg•m^2$ [$lbf•ft^2$]	0.0209 [0.0159]	0.0209 [0.0159]	0.0209 [0.0159]
Weight dry (standard)	kg [lb]	34.8 [76.9]	34.8 [76.9]	34.8 [76.9]
Oil volume	l [US gal]	2 [0.53]	2 [0.53]	2 [0.53]
Mounting flange	SAE ISO 3019/1 flange 127-4 (SAE C), M12x1,75			
Output shaft	Spline shaft SAE, 21 teeth, pitch = 16/32 Spline shaft SAE, 23 teeth, pitch = 16/32			
Main port configuration	Twin ports SAE J518b Size 1, with metric or inch screws			
Case drain ports L1, L2	M22x1,5 (O-ring boss) or 7/8–14 UNF-2B			
Other ports	ISO straight thread O-ring boss or SAE. See Installation drawings, page *Dimensions* on page 22.			

Operating parameters

Features		Unit	070/084/089
Output speed	Minimum	min^{-1} (rpm)	100
	Rated		2500
	Maximum		2900
System pressure	Max. working pressure	bar [psi]	420 [6090]
	Maximum pressure		450 [6525]
	Minimum pressure		10 [145]
Case pressure	Rated	bar [psi]	3.0 [44]
	Maximum		5.0 [73]
Lip seal external pressure	Maximum		0.4 [5.8]

Fluid specifications

Features		Unit	070/084/089
Viscosity	Intermittent [1]	mm^2/s [SUS]	5 [42]
	Minimum		7 [49]
	Recommended range		12-80 [66-370]
	Maximum		1600 [7500]
Temperature range [2]	Minimum (cold start) [3]	°C [°F]	-40 [-40]
	Recommended range		60-85 [140-185]
	Rated		104 [220]
	Maximum intermittent [1]		115 [240]

Technical Specifications

Fluid specifications (continued)

Features		Unit	070/084/089
Filtration (recommended minimum)	Cleanliness per ISO 4406		22/18/13
	Efficiency (charge pressure filtration)	β-ratio	β15-20 = 75 (β10 ≥ 10)
	Efficiency (suction and return line filtration)		β35-45 = 75 (β10 ≥ 2)
	Recommended inlet screen mesh size	µm	100 – 125

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

Output Speed

Minimum speed is the lowest output speed. Operating below minimum speed limits the system can be unstable.

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 is the highest operating speed permitted. Exceeding maximum speed reduces product life and can cause loss of hydrostatic power and braking capacity. Never exceed the maximum speed limit under any operating conditions.

System Pressure

Maximum working pressure is the highest recommended application pressure; and it is not intended to be a continuous pressure. Propel systems with application pressures at, or below, this pressure should yield satisfactory unit life given proper component sizing.

Maximum pressure is the highest allowable application pressure under any circumstance. Application pressures above maximum working pressure will only be considered with duty cycle analysis and factory approval.

Minimum pressure must be maintained under all operating conditions to avoid cavitation.

Case Pressure

Under normal operating conditions, the rated case pressure must not be exceeded. During cold start, case pressure must be kept below maximum intermittent case pressure.

External Shaft Seal Pressure

In certain applications, the input shaft seal may be exposed to external pressures.

The shaft seal is designed to withstand an external pressure up to 0.4 bar [5.8 psi] above the case pressure.

The case pressure limits must also be followed to ensure the shaft seal is not damaged.

Temperature

High temperature limits apply at the inlet port of the motor. The motor should run 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.

Maximum continuous temperature is the allowed temperature at which normal life can be expected.

Technical Specifications

Peak (intermittent) **temperature**: the overheating temperature that is tolerable by the machine for a transient/limited time.

Viscosity

Minimum viscosity occurs only during brief occasions of maximum ambient temperature and severe duty cycle operation. It's the minimum acceptable viscosity to allow normal motor life.

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

Temperature and viscosity requirements must be concurrently satisfied. Use petroleum/mineral-based fluids.

Filtration

To prevent premature wear, ensure only clean fluid enters the hydrostatic transmission circuit. A filter capable of controlling the fluid cleanliness to ISO 4406 class 22/18/13

(SAE J1165) or better, under normal operating conditions, is recommended.

These cleanliness levels can not be applied for hydraulic fluid residing in the component housing/case or any other cavity after transport.

Filtration strategies for TMP include only suction filtration. The selection of a filter depends on a number of factors including the contaminant ingression rate, the generation of contaminants in the system, the required fluid cleanliness, and the desired maintenance interval. Filters are selected to meet the above requirements using rating parameters of efficiency and capacity.

Filter efficiency can be measured with a Beta ratio[1] (βX). For simple suction-filtered closed circuit transmissions and open circuit transmissions with return line filtration, a filter with a β-ratio within the range of β35-45 = 75 (β10 ≥ 2) or better has been found to be satisfactory. For some open circuit systems, and closed circuits with cylinders being supplied from the same reservoir, a considerably higher filter efficiency is recommended.

This also applies to systems with gears or clutches using a common reservoir.

For these systems, a charge pressure or return filtration system with a filter β-ratio in the range of β15-20 = 75 (β10 ≥ 10) or better is typically required.

Because each system is unique, only a thorough testing and evaluation program can fully validate the filtration system. Please see *Design Guidelines for Hydraulic Fluid Cleanliness Technical Information*, **520L0467** for more information.

[1] Filter βX-ratio is a measure of filter efficiency defined by ISO 4572. It is defined as the ratio of the number of particles greater than a given diameter (“x” in microns) upstream of the filter to the number of these particles downstream of the filter.

Case Drain

All TM pumps and motors are equipped with two case drain ports. Port selection and case drain routing must enable the pump housing to maintain a volume of oil not less than half full and normal operating case pressure limits of the unit are maintained. Case drain routing and design must consider unit case pressure ratings.

A case drain line must be connected to one of the case outlets to return internal leakage to the system reservoir.

Reservoir

The **reservoir** provides clean fluid, dissipates heat, removes entrained air, and allows for fluid volume changes associated with fluid expansion during system operation. A correctly sized reservoir also accommodates maximum volume changes during all system operating modes. It promotes de-aeration

Technical Specifications

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 oil, 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 lines promotes de-aeration and reduces fluid surges.

Determination of nominal motor sizes

Use these formulae to determine the nominal motor size for a specific application:

Input flow: Q_e
l/min [US gal/min]
Output torque: M_e
N•m [lbf•in]
Output power: P_e
kW [hp]
Speed: n
min^{-1}

	Based on SI units	Based on US units
Q_e	$\frac{V_g \cdot n}{1000 \cdot \eta_v}$	$\frac{V_g \cdot n}{231 \cdot \eta_v}$
M_e	$\frac{V_g \cdot \Delta p \cdot \eta_{mh}}{20 \cdot \pi}$	$\frac{V_g \cdot \Delta p \cdot \eta_{mh}}{2 \cdot \pi}$
P_e	$\frac{M_e \cdot n}{9550} = \frac{Qe \cdot \Delta p}{600}$	$\frac{Qe \cdot \Delta p \cdot \eta_t}{1714}$
n	$\frac{Q_e \cdot 1000 \cdot \eta_v}{V_g}$	$\frac{Q_e \cdot 231 \cdot \eta_v}{V_g}$

Variables:			*SI units [US units]*
V_g	=	Motor displacement per rev.	cm^3/rev [in^3/rev]
p_{high}	=	High pressure	bar [psi]
p_{low}	=	Low pressure	bar [psi]
Δp	=	$p_{high} - p_{low}$	bar [psi]
n	=	Speed	min^{-1} (rpm)
η_v	=	Motor volumetric efficiency	
η_{mh}	=	Mechanical (torque) efficiency	
η_t	=	Overall efficiency ($\eta_v \cdot \eta_{mh}$)	

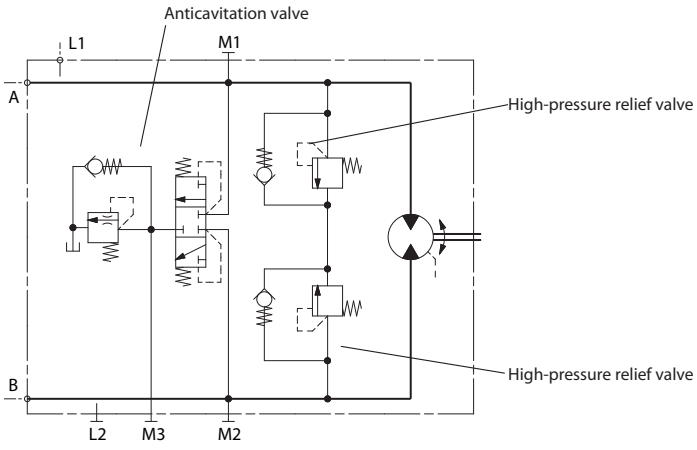
High-pressure relief valve (HPRV)

The TM motors are optionally equipped with a combination of high-pressure relief and check valve. The high-pressure relief function is a dissipative pressure control valve for the purpose of limiting excessive system pressures. Each side of the transmission loop has a dedicated HPRV valve that is non-adjustable with a factory set pressure.

When system pressure exceeds the factory setting of the valve, oil is passed from the high pressure system loop into the low pressure system loop via the check valve.

Technical Specifications

TMM with High-pressure relief Valves and Anticavitation Valve



Anti-cavitation valve

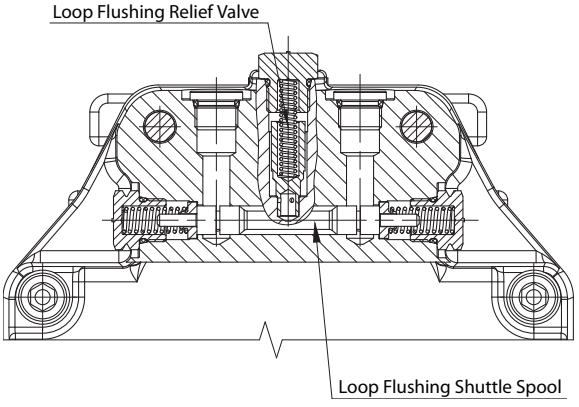
The TM motors are optional equipment with anti-cavitation valve (ACV). ACV has to garantee a minimum oil pressure in the low pressure side in case of low engine speed and high oil temperature.

Loop flushing shuttle spool

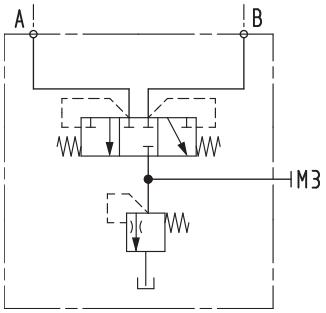
An integral loop flushing shuttle spool is used to separate system A and system B pressures, see the schematic below.

System delta pressure will cause the shuttle spool to shift, allowing the low side system pressure to flow to the loop flushing relief valve.

Loop flushing shuttle valve section



Schematic



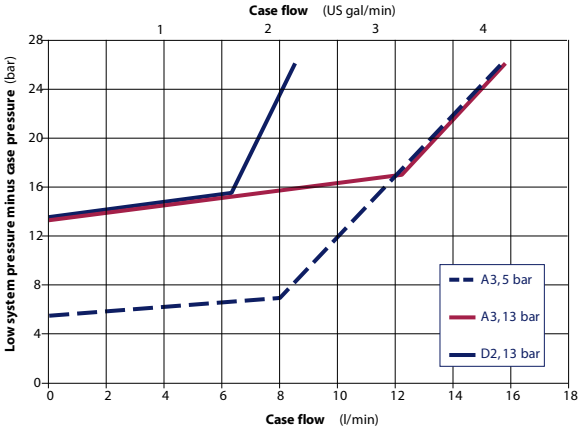
Loop flushing relief valve

The loop flushing relief valve is incorporated into all TMM motors. Use the loop flushing option in Installations that require fluid to be removed from the low pressure side of the system circuit due to cooling requirements and also used to facilitate the removal of contaminants from the loop.

Technical Specifications

The loop flushing valve is equipped with an orificed charge pressure relief valve designed with a cracking pressure of 5.5, 13 and 16 bar. Valves are available with several orifice sizes to meet the flushing flow requirements of all system operating conditions.

Loop flushing flow curves



Speed sensor description

Speed and temperature sensor

Function of the speed sensor is to detect the shaft speed and the direction of rotation.Typically the sensor will be mounted to the housing of a Danfoss pump or motor and senses the speed from a target ring that is rotating inside the pump or pistons in cylinder block in motor. Because of the digital output signals for speed and direction and a non speed dependent output voltage level, the sensor is ideal for high and low speed measurements.

For diagnostics and other purposes, the sensor also has the capability to detect the case oil temperature.

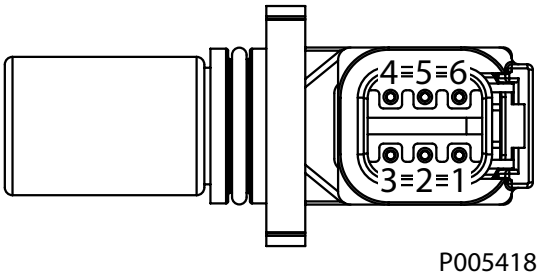
The speed sensor is designed for rugged outdoor, mobile or heavy industrial speed sensing applications. The detection of the speed is contactless. It is custom-designed for Danfoss. It is a “plug and perform” device that does not need any calibration or adjustments.

Connector, type DEUTSCH DTM-Series 6-Pin (DTM06-6S) pins need to be gold plated;

9 pistons (impulses per revolution);

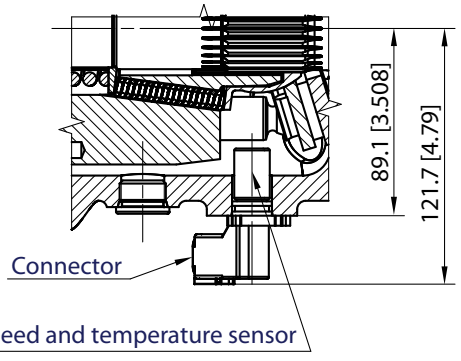
Order number: **149055**.

Connector, type DEUTSCH DTM-Series 6-Pin (DTM06-6S)



P005418

Speed and temperature sensor



Sensor pinout:
1 – Speed signal 2
2 – Direction signal
3 – Speed signal 1
4 – Supply
5 – Ground

Technical Specifications

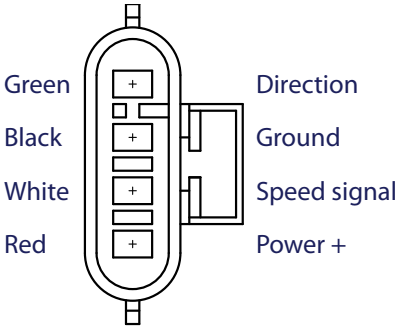
6 – Temperature

Sensor PPU, KPP*13808

Function of the speed sensor is to detect the shaft speed and the direction of rotation.

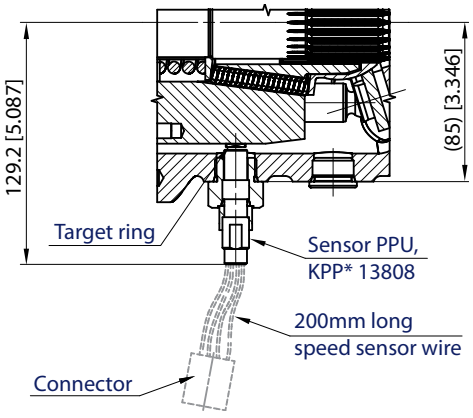
Number of teeth on target ring: 65 (impulses per revolution)

Connector terminal



Packard Metri-Pack 150 Series
4-way Connector (male)
Connector: 12162144
Terminals: 12048074
Seals: 12048086

*Sensor PPU, KPP*13808*



Master Model Code

TMM master model code

A – Product

TMM	Transit Mixer Motor

B – Frame size / Displacement

070	68.3 cm^3/rev [4.17 in^3/rev]
084	83.8 cm^3/rev [5.11 in^3/rev]
089	89.0 cm^3/rev [5.43 in^3/rev]

C – Sense of rotation

B	Bi-directional

G – End cap ports; High pressure setting

6MNN	Ports DN 25, Type 1, 420 bar [6000 psi], ISO 6162-2 Metric connections, without High-pressure relief valve
3C35	Ports DN 25, Type 2, 350 bar [3000 psi], ISO 6162-1 Inch connections, with High-pressure relief valve
6C42	Ports DN 25, Type 2, 420 bar [6000 psi], ISO 6162-2 Inch connections, with High-pressure relief valve

W – Special hardware features

NNN	Sensor- none, without Anticavitation valve
NNC	Sensor-none, with Anticavitation valve
2BN	Sensor PPU: KPP*13808 DIR SIGNAL "HIGH"/RIGHT, 65 impulsions/rev., without Anticavitation valve
9PN	Sensor none, Speed and temperature sensor of H1 ready (plugged), without Anticavitation valve
9HN	Speed and temperature sensor of H1, 9 impulsions/rev., without Anticavitation valve

L – Shaft

C	Splined shaft, 23 teeth, pitch = 16/32
D	Splined shaft, 21 teeth, pitch = 16/32

K – Loop flushing valve settings

A3F	Valve cone with 3x orifice ø1,5 mm and flow of 14,5 l/min by 25 bar, Opening pressure 5,5 bar, (in conjunction with SPV, ACV)
A3M	Valve cone with 3x orifice ø1,5 mm and flow of 14,5 l/min by 25 bar, Opening pressure 13 bar (in conjunction with SPV)
D2M	Valve cone with 2x orifice ø1,3 mm and flow of 10 l/min by 25 bar, Opening pressure 13 bar(in conjunction with TMP)

Master Model Code

F *– Special features*

NSN	No paint, Name plate "Slovakia"
NDN	No paint, Name plate "Danfoss"
BSN	Black paint, Name plate "Slovakia"
BDN	Black paint, Name plate "Danfoss"
GSN	Gray paint, Name plate "Slovakia"
GDN	Gray paint, Name plate "Danfoss"

Operation

Bearing life

Bearing life with no external shaft side load

Normal bearing life with no external shaft side load in L_{20} hours is shown in the table below. The figures reflect a continuous delta pressure, shaft speed, maximum displacement, and no external shaft side load. The data is based on a standard charge pressure of 20 bar [290 psi].

Bearing life with no external shaft side load

	Unit	Size 070	Size 084	Size 089
Shaft speed	min^{-1} (rpm)	1800	1800	1800
Delta pressure – Δp	bar [psi]	240 [3480]	240 [3480]	240 [3480]
Bearing life – L_{20}	hours	33 727	17 090	13 952

Conversion of bearing life for other pressure (p) and speed (n):

$$\text{Size 070} \quad L_{20} = 33\,727 \cdot \left(\frac{240}{p}\right)^{10/3} \cdot \left(\frac{1800}{n}\right)$$

$$\text{Size 084} \quad L_{20} = 17\,090 \cdot \left(\frac{240}{p}\right)^{10/3} \cdot \left(\frac{1800}{n}\right)$$

$$\text{Size 089} \quad L_{20} = 13\,952 \cdot \left(\frac{240}{p}\right)^{10/3} \cdot \left(\frac{1800}{n}\right)$$

External radial shaft loads

TM motors are designed with bearings that can accept some external radial and axial loads.

The external radial shaft load limits are a function of the load position and orientation, and the operating conditions of the unit. The maximum allowable radial load (Re) is based on the maximum external moment (Me) and the distance (L) from the mounting flange to the load. In applications with external radial shaft loads, minimize the impact by positioning the load at 0° or 180° as shown in the figure below.

The external radial and axial shaft load are limited by the bearing life L_{20} =10 000 [h], delta system pressure 240 bar, speed 1800 min-1 and external radial load at 270°.

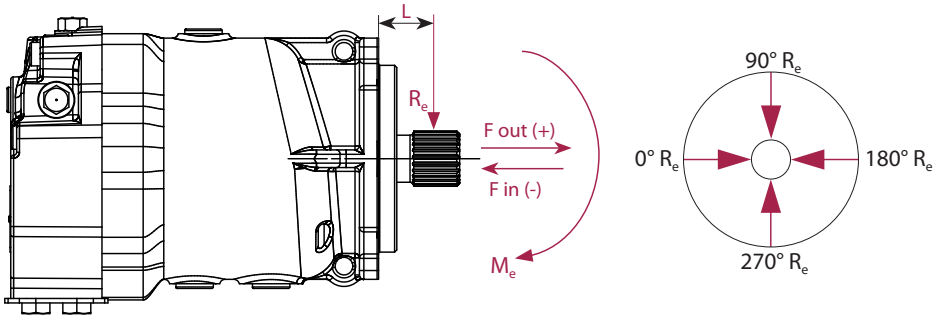
It may be determined using the following table and formula below.

Maximum external shaft load for size 089

External radial moment – M_e	N•m [lbf•in]	0	32.6 [288]
External axial force – F_{in}	N [lbf]	-2440 [-548]	-2020 [-454]
External axial force – F_{out}		2790 [627]	2400 [539]

Operation

Radial load position



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

Where:

M_e = shaft moment

L = flange distance

R_e = external force to the shaft

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

Mounting Flange Loads

Estimating overhung load moments

Based on SI units:

$$M = g \cdot G \cdot W \cdot L$$

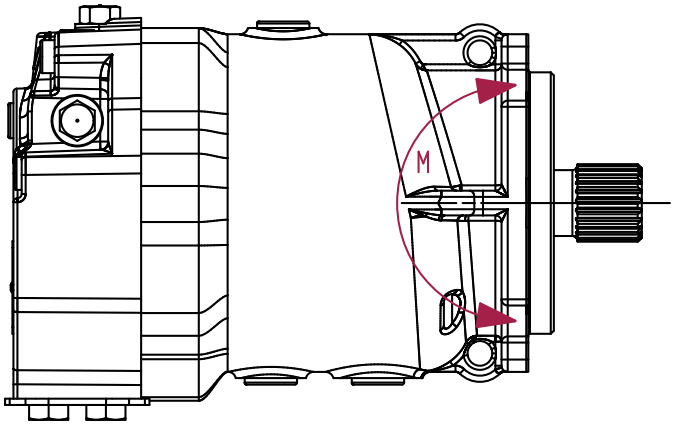
Based on US units:

$$M = G \cdot W \cdot L$$

Where:

M	=	Rated load moment	N•m [lbf•in]
g	=	Gravity	9.81 m/s^2
G	=	Calculation factor for max. acceleration	30
W	=	Weight of pump	kg [lb]
L	=	Distance from mounting f ange to pump center of gravity	m [in]

TMM load moment M



Operation

Rated and maximum torque ratings

W	L	Max. load moment M
35 kg [77 lb]	0,1338 mm [5.268 in]	1378 N•m [12 170 lbf•in]

Output shafts

Rated and maximum torque ratings for each available shaft is shown in the following table:

Specifications

Spline	Min active spline length		Rated torque*		Maximum torque**	
	mm	[in]	N•m	[lbf•in]	N•m	[lbf•in]
21 teeth, 16/32 pitch	30.7	[1.21]	660	[5840]	1200	[10 620]
23 teeth, 16/32 pitch	30.7	[1.21]	790	[6990]	1600	[14 160]

[1]

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

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

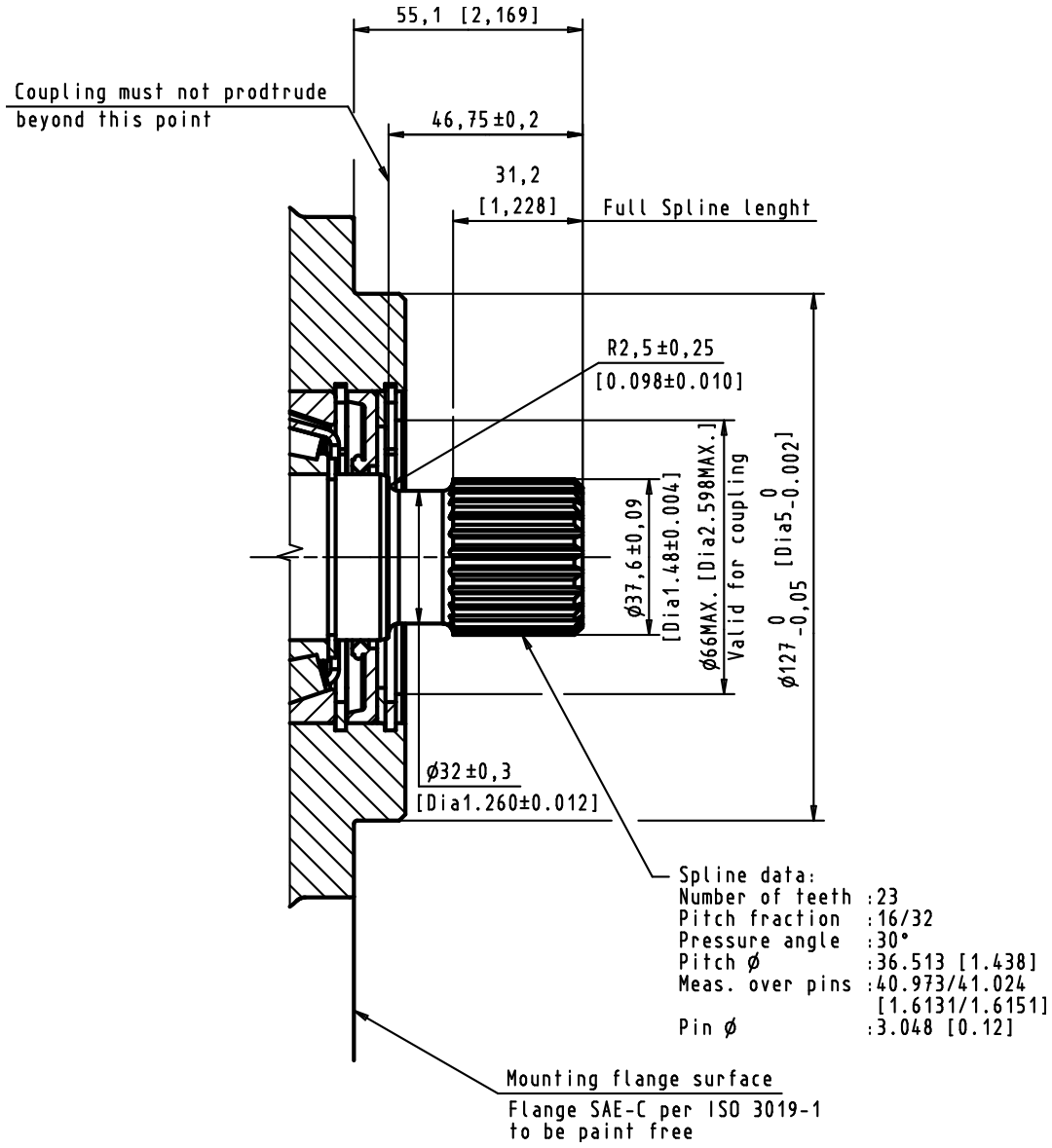
Warning

Torque or loading inadvertently transmitted by the customer supplied key may lead to premature shaft failure.

[1] * Rated torque - measure of teeth wear. ** Maximum torque - ratings are based on torsional fatigue strength

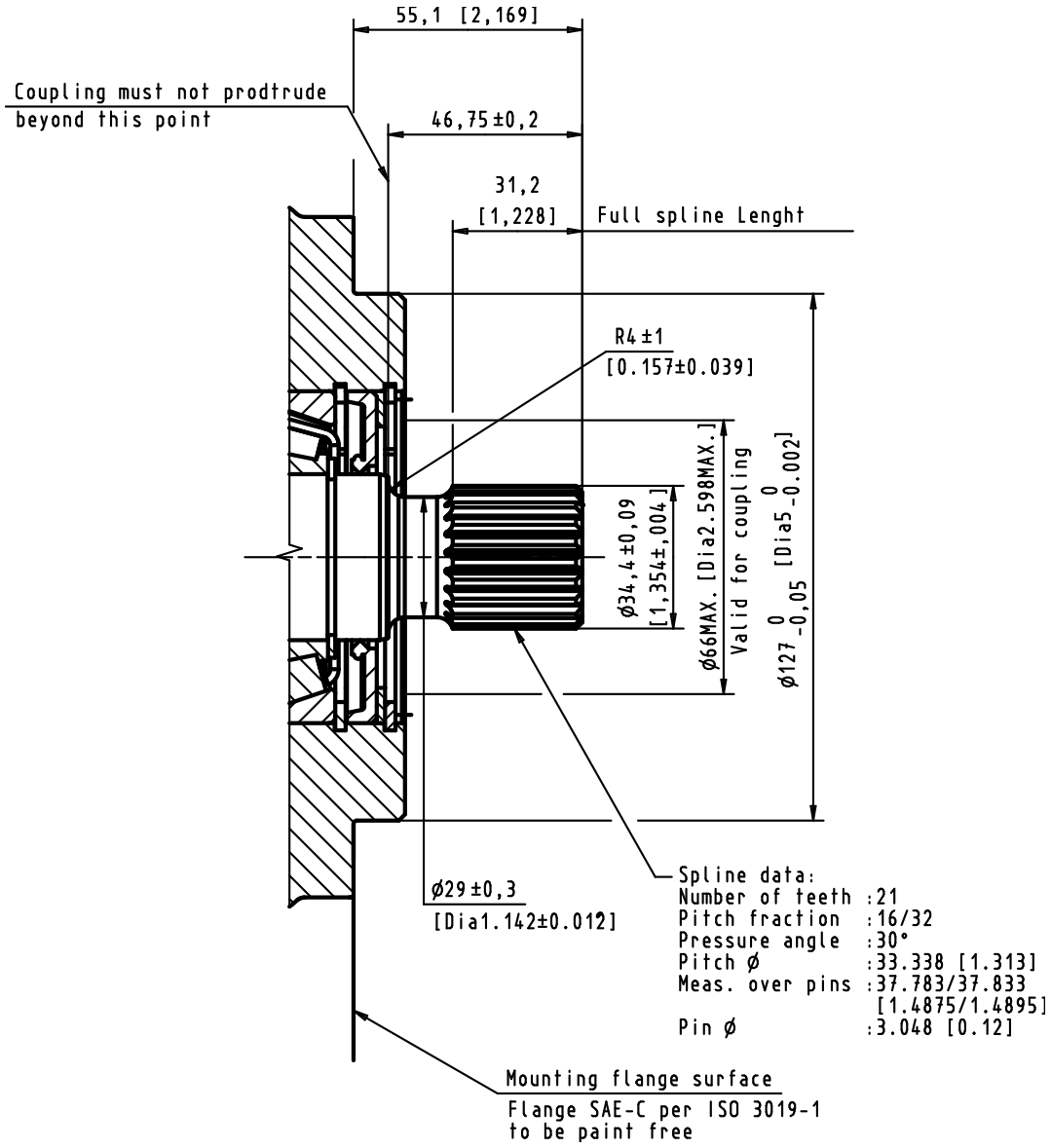
Operation

ISO 3019-1 (SAE C, 23-teeth)



Operation

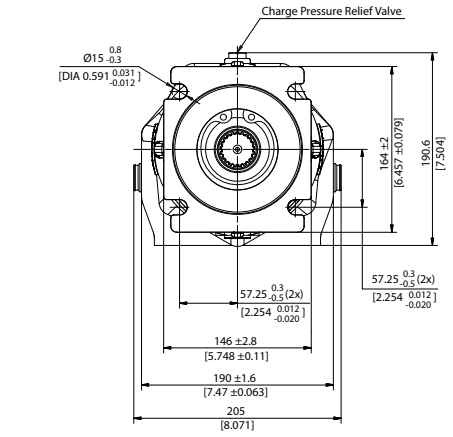
ISO 3019-1 (SAE C, 21-teeth)

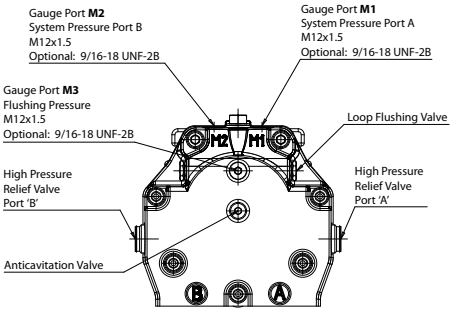


Installation drawings

Dimensions

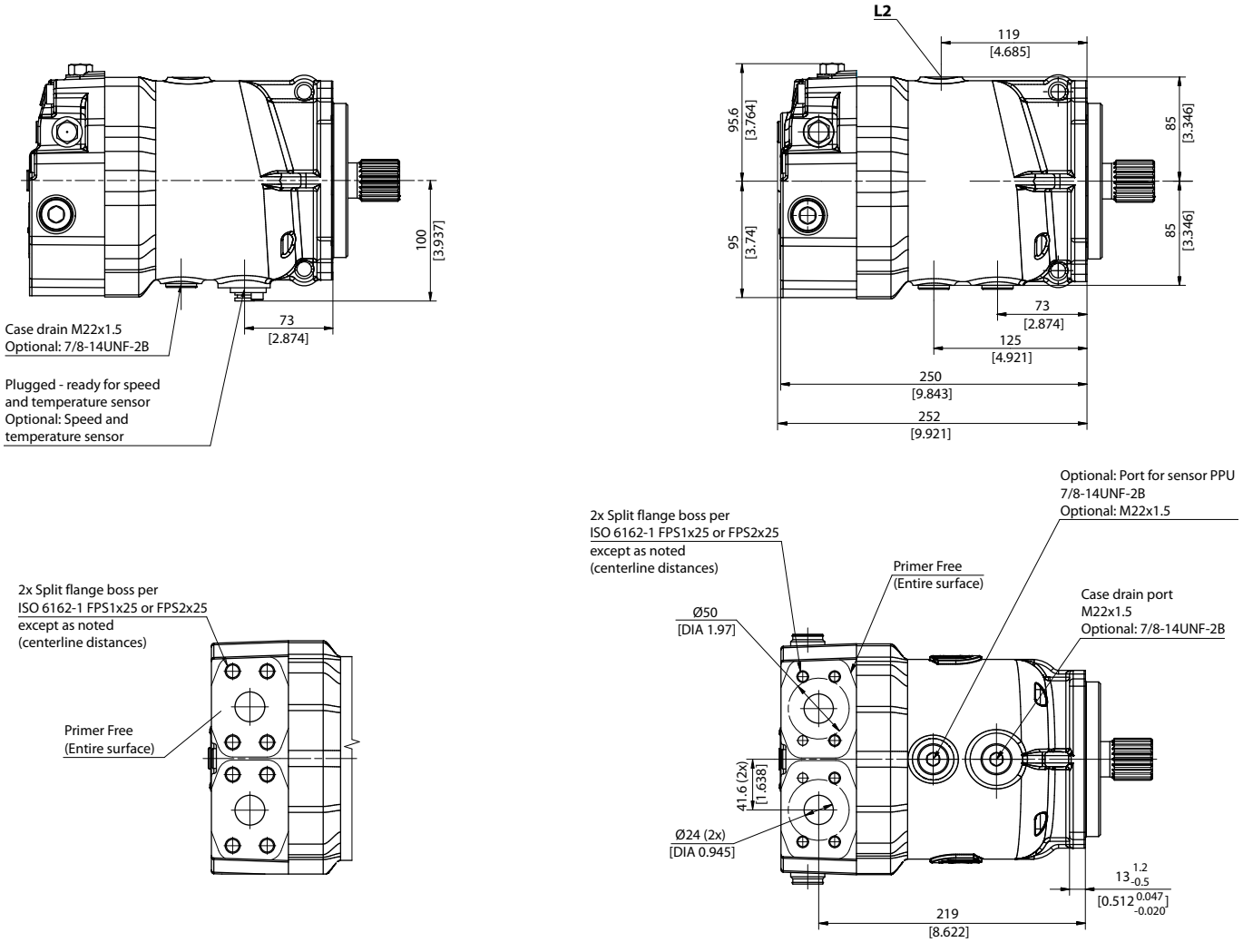
TMM ports





Installation drawings

TMM dimensions



Ports description

Port	Description	TMM without HPRV	TMM with HPRV
A, B	System ports	ISO DN25	SAE Ø 25.4 mm
L1, L2	Case drain ports	M22x1.5	7/8-14
M1, M2	System A/B gauge ports	M12x1.5	9/16-18
M3	Flushing pressure port	M12x1.5	

Please contact Danfoss for specific installation drawings.

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www.daikin-sauer-danfoss.com

Local address:

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

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

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

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

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