ENGINEERING
TOMORROW

Application Guide

Scroll compressors
PSF065-072

R32,50Hz



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Contents

Safety and warnings **5**

Introduction **6**
- Product description 6
- How do IDVs work? 6

Injection system **7**
- Vapor injection 7
- Wet injection 8
- Liquid injection 9

Product identification **10**
- Name Plate 10
- Nomenclature 10
- Compressors serial number 11

Certificates, declarations and approvals **12**
- Pressure requirement 12
- Internal free volume 12

Refrigerants **13**
- R32 13

Technical specification **14**
- 50Hz data Single compressor 14

Performance data **15**
- R32 50 Hz, Single compressor 15

Sound and vibration data **16**
- Compressor sound radiation - Single 16
- Mechanical vibrations 16
- Mitigation methods 16

Operating envelope data **17**
- Operating envelope 17

Dimensions **18**
- Single compressors 18
- Tandem assemblies 18

Mechanical connections **20**
Connection details 20
Design compressor mounting 20
Design piping 21

Electrical connections **24**
Wiring connections 24
Electrical Specifications 25

Application **29**
Manage oil in the circuit 29
Manage sound and vibration 30
Manage Operating envelope 30
Manage superheat 32
Manage off cycle migration 34
Manage injection 35
Power supply and electrical protection 38
Control logic 40
Assembly line procedure 42
Commissioning 45
Dismantle and disposal 45

Packaging **46**
Single pack 46
Industrial pack 46

Ordering **47**
Single pack 47
Industrial pack 47

Accessories and Spare parts **48**
Solder sleeve adapter set 48
Rotolock adapter 48
Gaskets 48
Solder sleeve 48
Rotolock nut 48
Motor protection modules 49
Crankcase heaters 49
Mounting hardware 49
Lubricant 49

Terminal boxes, covers and T-block connectors 49
Miscellaneous 50
Tandem kits 50

Online support 51

Safety and warnings

Danfoss compressors are designed and manufactured according to the state of the art and to valid European and US regulations. Particular emphasis has been placed on safety and reliability. Related instructions are highlighted with the following icons:

This icon indicates instructions to avoid safety risk.

This icon indicates instructions to avoid reliability risk.

The purpose of this guideline is to help customers qualify compressors in the unit. You are strongly advise to follow these instructions. For any deviation from the guidelines, please contact Danfoss Technical Support. In any case, Danfoss accepts no liability as a result of the improper integration of the compressor into the unit by the system manufacturer.

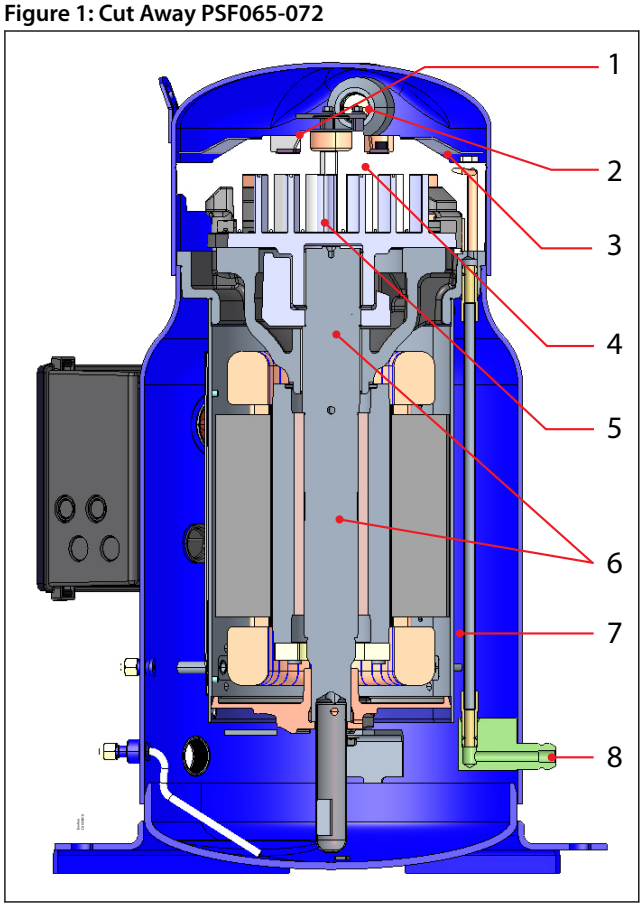
Introduction

Product description

Danfoss scroll compressor PSF for R32 is available as single compressor and can be assembled in tandem.

PSF series scroll compressor benefit from an improved design to achieve the highest efficiency and increased life time.

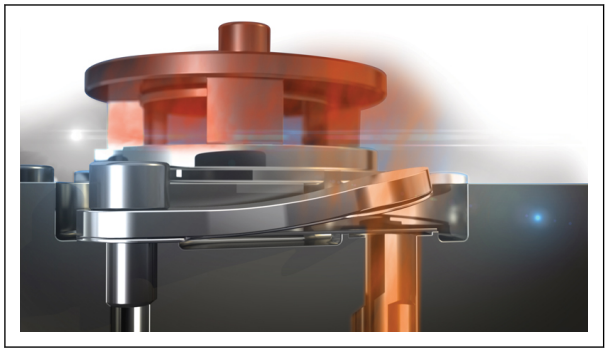
Figure 1: Cut Away PSF065-072



1	Intermediate discharge valves (IDVs) increase seasonal efficiency
2	Internal Non Return Valve (INRV) prevents excessive leak rate from high pressure side
3	Heat shield lowers the heat transfer between discharge and suction gas and the acoustic level
4	Integrated discharge gas temperature protection (DGT)
5	Built in pressure ratio optimization dedicated to heat pump application
6	Lead free polymer bearings improve behavior under poor lubrication conditions
7	Patented gas path flow with gas intake design induces higher resistance to liquid slugging
8	Injection port to both enlarge the application envelope and improve efficiency

How do IDVs work?

Figure 2: Intermediate Discharge Valve (IDV)



Danfoss Intermediate Discharge Valves (IDVs) are located close to the discharge side of the compressor. They reduce excessive compression of refrigerant under part-load conditions while maintaining the same cooling capacity. The IDVs open when discharge pressure falls below the built-in optimization point. They adapt the effort of the motor to the varying load and pressure conditions in the system, thus reducing the effort of the motor and its electrical consumption and improving the system's seasonal energy efficiency.

Injection system

Vapor injection

The PSF065-072 compressor is fitted with an injection port that enables to carry out vapor injection by connecting an intermediate exchanger.

This vapor injection will have three benefits:

- Operating envelope enlargement by reduction of resulting discharge temperature.
- Cooling capacity and cooling efficiency improvement by reduction of the liquid temperature before expansion (Intermediate exchanger acting as economizer).
- Heat capacity and heating efficiency improvement by increase of the massflow at the condenser side (condenser massflow will be the sum of the evaporator massflow and the injected massflow).

The diagrams below explain the vapor injection principle, considering:
m inj: Injected massflow
ΔT IntX: Difference of temperature between the outlet of intermediate exchanger and the intermediate pressure bubble point.
Suct SH: Superheat at compressor suction.
Inj SH: Superheat of injected gas (at intermediate pressure).
SC: Subcooling at intermediate exchanger inlet.
For system with vapor injection we should also consider, in addition of the suction superheat and the condenser subcooling, the injection superheat and Intermediate exchanger DeltaT as key influent parameters on the compressor performance.

Figure 3: Upstream exaction

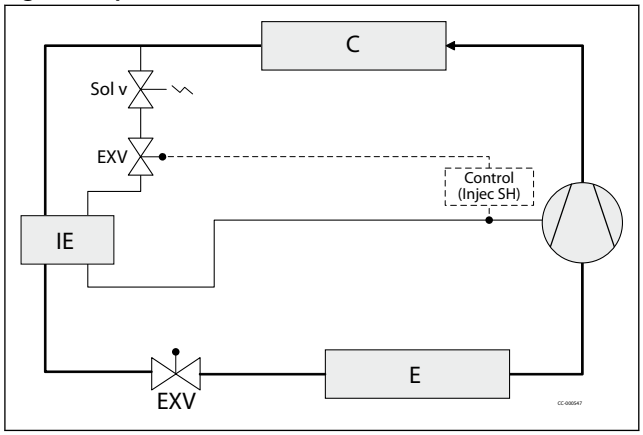
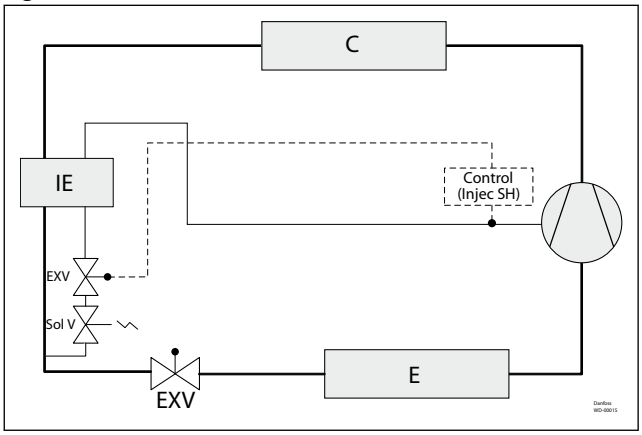


Figure 4: Downstream exaction



C	Condenser
E	Evaporator
IE	Intermediate Exchanger

Figure 5: Upstream exaction

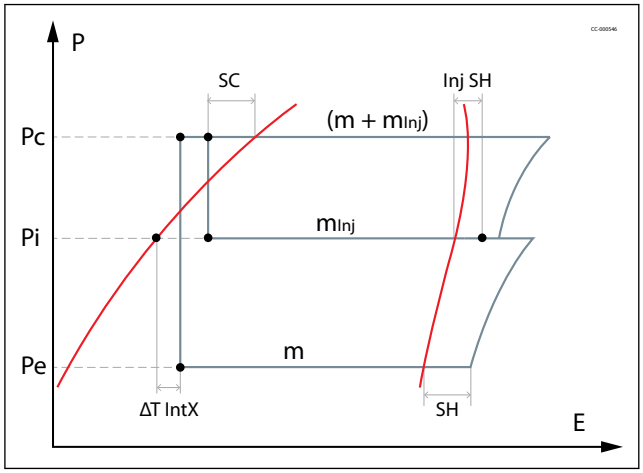
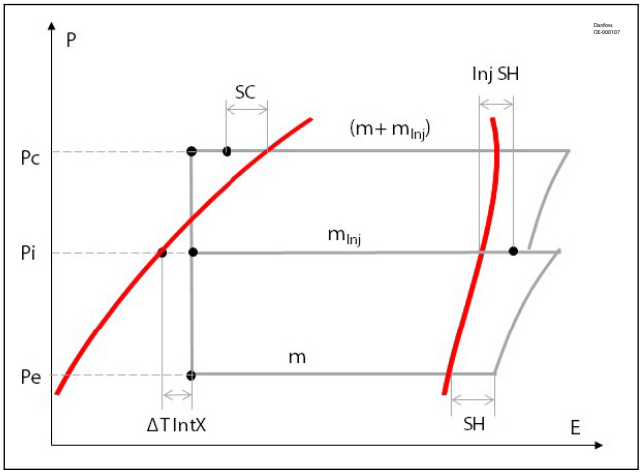


Figure 6: Downstream exaction

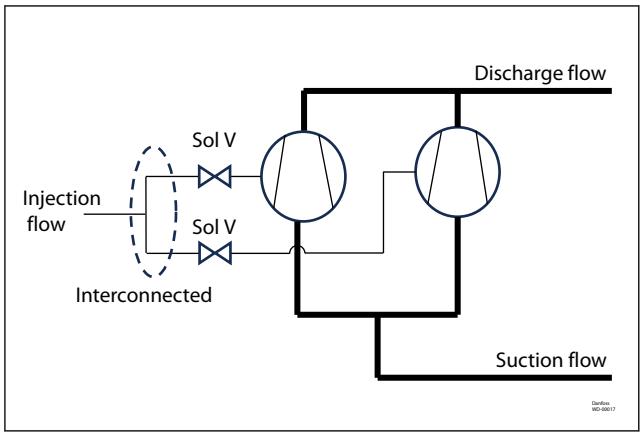


P	Pressure
E	Enthalpy

The injection massflow must be regulated through an EXV, the injection superheat must be above 5 K.

For single compressor, it is highly recommended to install an additional solenoid valve on the injection line to prevent the refrigerant to come back directly into the compressor scroll set in case of power shortage.

For manifolding, it is mandatory to install an additional solenoid valve on each compressor's injection line in case of they are interconnected. When the compressor is OFF, the related solenoid valve must shut off the branch injection line to avoid refrigerant flowing into the stand by compressor.



The vapor injection must not be activated during inversion cycle of defrost mode

For compressor start-up, vapor injection valve opening must delay than compressor start-up at least 5 seconds.

Wet injection

Whenever the vapor is no longer enough to cool the scroll and the application requires more envelope then the controller must reduce the injection SH down to zero and control the injection by reading the compressor DGT. This part is called wet (to differentiate from liquid). There is no gain in efficiency and capacity, only envelope. Considering the distance between sensor and scroll set, the wet injection is activated for when discharge temperature exceeds 121°C (250°F) at the measurement point (the surface of discharge pipe with 40mm away from the compressor discharge port). A minimum 4K (7.2°F) subcooling is necessary to ensure correct wet injection.Injection temperature at measurement point set point is 121°C (250°F), maximum safety value is 135°C (275°F).

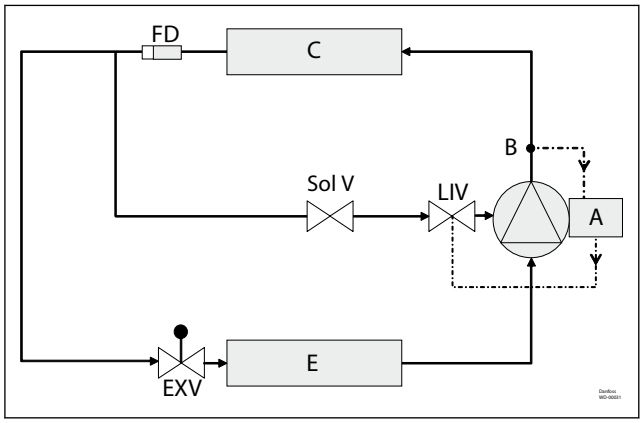
Liquid injection

Danfoss PSF065-072 requires liquid injection to maintain sufficiently low discharge gas temperature in the operating envelope. The PSF065-072 compressors are provided with a liquid injection connection.

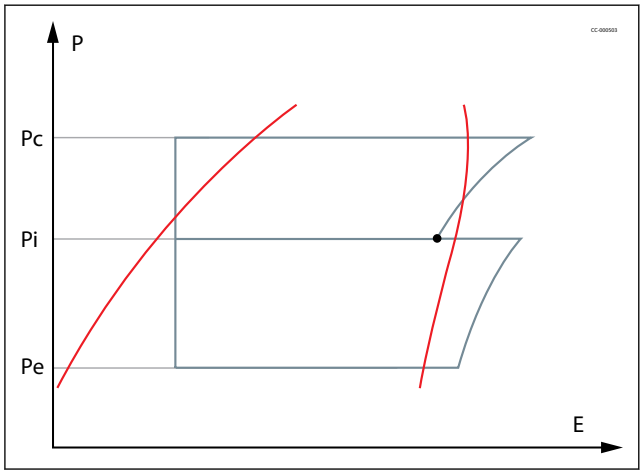
The compressor's liquid injection port should be connected to the system main liquid line after condenser & filter drier. The liquid phase refrigerant is directly injected into the compressor scroll set. Liquid refrigerant vaporize in the scroll and absorb the heat, result in cooling down the compressor's discharge temperature.

A LIV (Liquid Injection Valve) is needed to control the liquid injection mass flow, keep the constant compressor discharge gas temperature. The LIV's liquid injection regulation is based on the discharge gas temperature measured via temperature sensor located on discharge line. Considering the distance between sensor and scroll set, the liquid injection is activated for when discharge temperature exceed 121°C (250°F) at the measurement point (the surface of discharge pipe with 40mm away from the compressor discharge port).

A minimum 4K (7.2 °F) subcooling is necessary to ensure correct liquid injection.



FD	Filter drier
A	Control
B	Discharge T sensor
C	Condenser
E	Evaporator



P	Pressure
E	Enthalpy

Product identification

Name Plate

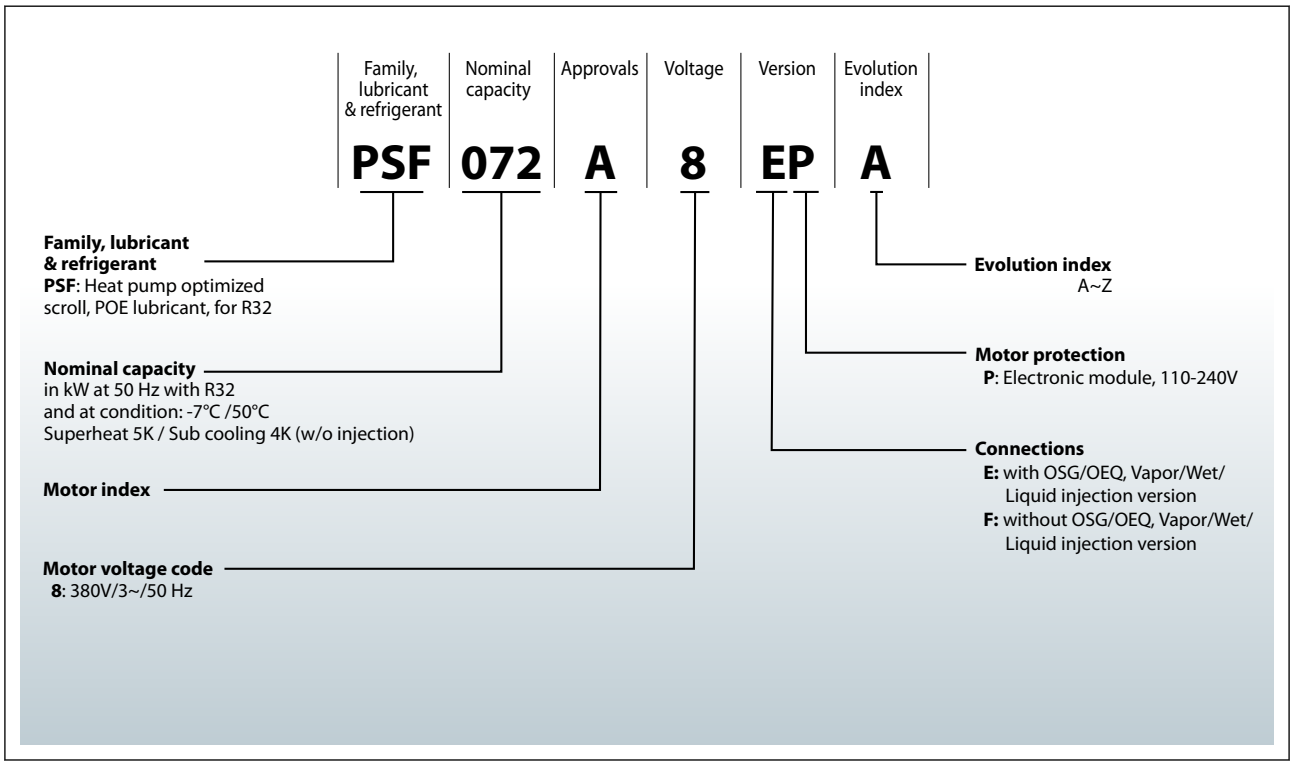
Figure 7: Name Plate



1	Model number
2	Serial number
3	Refrigerant
4	Supply voltage, Starting current & Maximum operating current
5	Housing service pressure
6	Factory charged lubricant

Nomenclature

The example below presents the compressor nomenclature which equals the technical reference as shown on the compressor nameplate. Code numbers for ordering are listed in section Ordering.



Compressors serial number

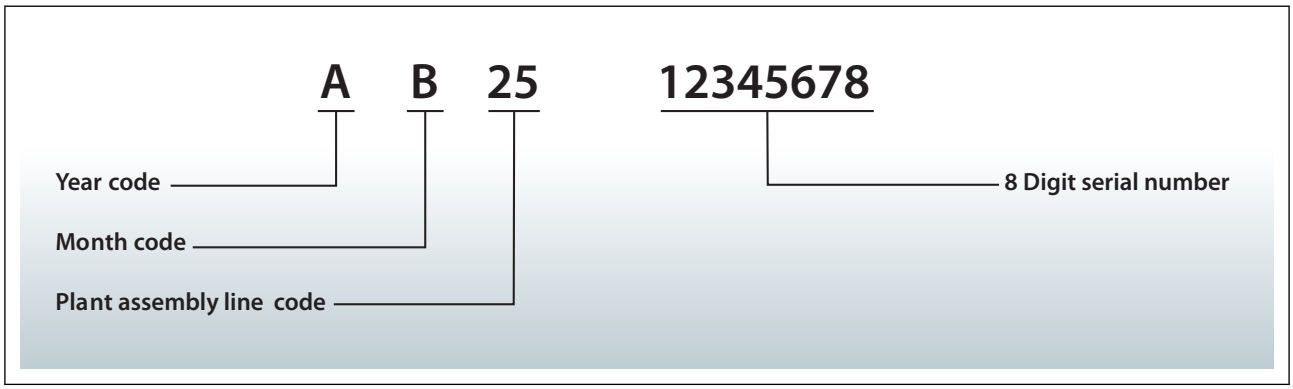


Table 1: Serial number code legend table

Year code		Month code		Plant assembly line code	
Year	Code	Month	Code	Plant	Code
1990, 2010	A	January	A	Trévoux, France	11
1991, 2011	B	February	B		
1992, 2012	C	March	C		
1993, 2013	D	April	D	Wuqing ,China	25
1994, 2014	E	May	E		
1995, 2015	F	June	F		
1996, 2016	G	July	G		
1997, 2017	H	August	H		
1998, 2018	J	September	J		
1999, 2019	K	October	K		
2000, 2020	L	November	L		
2001, 2021	M	December	M		
2002, 2022	N				
2003, 2023	P				
2004, 2024	Q				
2005, 2025	R				
2006, 2026	S				
2007, 2027	T				
2008, 2028	U				
2009, 2029	V				

Certificates, declarations and approvals

Pressure requirement

Table 2: Pressure requirement

Products	PSF065-072
Maximum / Minimum temperature - Ts	-35°C < Ts < 52°C -31°F < Ts < 125.6°F
Maximum allowable pressure (Low side) - Ps	31.1 bar(g) 451 psig
Maximum allowable pressure (High side) - Ps	48.7 bar(g) 706 psig
Declaration of conformity	Contact Danfoss

Internal free volume

Table 3: Internal free volume

Products	Internal free volume without oil					
	Low pressure side		High pressure side		Total	
	[litre]	[cu.inch]	[litre]	[cu.inch]	[litre]	[cu.inch]
PSF065-072	27.1	1654	2.8	171	29.9	1825

Refrigerants

R32

R32 is a pure HFC refrigerant with a zero Ozone Depletion Potential (ODP=0) and a low Global Warming Potential (GWP: 677/AR5; 675/AR4).

R32 leads to higher discharge temperatures than R410A but it offers higher cooling capacities and better efficiencies compared to R410A.

R32 is classified A2L with low flammability properties. Please refer to European regulations and directives about the use of refrigerant of the A2L safety group (EN378, EN60335). Outside Europe refer to the local regulation

Technical specification

50Hz data Single compressor

Table 4: Technical specification 50Hz data Single compressor

Model	Nominal tons	Swept volume		Displacement (50 Hz) [1]		Oil charge		Net weight [2]	
	TR	cm^3/rev	cu.in/rev	m^3/h	cu.ft/h	dm^3	oz	kg	lbs
PSF065	25	249	15.19	43.3	1529	6.1	206	117	258
PSF072	27	272.8	16.65	47.5	1677	6.1	206	117	258

[1] Displacement at nominal speed: 2900rpm at 50 Hz
[2] Net weight with oil charge

Performance data

R32 50 Hz, Single compressor

Table 5: 50 Hz Performance data (Heating)

Model		Nominal tons	Nominal Heating capacity		Power input	COP	E.E.R.
		TR	W	Btu/h	kW	W/W	Btu/h/W
50Hz	PSF065	25	71920	245392	22.82	3.15	10.75
	PSF072	27	78266	267042	24.53	3.19	10.88

Table 6: 50 Hz Performance data (Cooling)

Model		Nominal tons	Nominal Cooling capacity		Power input	COP	E.E.R.
		TR	W	Btu/h	kW	W/W	Btu/h/W
50Hz	PSF065	25	70645	241040	21.89	3.23	11.01
	PSF072	27	76903	262395	23.65	3.25	11.10

NOTE:
TR: Ton of Refrigeration,
COP: Coefficient Of Performance
EER: Energy Efficiency Ratio
Standard rating conditions For Heating (With injection): Evaporating temperature: -7°C (19.4°F), Condensing temperature: 53°C (127.4°F), Superheat: 8K (14.4°F), Subcooling: 5K (9°F), Injection Superheat: 5K (9°F)

For Cooling (With injection): Evaporating temperature: 3°C (37.4°F), Condensing temperature: 50°C (122°F), Superheat: 8K (14.4°F), Subcooling: 5K (9°F), Injection Superheat: 5K (9°F)

Subject to modification without prior notification.

For regular updates and detailed capacities, please refer to Coolselector®2.

Sound and vibration data

Typical sounds and vibrations in systems can be broken down into the following three categories:
- Sound radiation (through air)
- Mechanical vibrations (through parts and structure)
- Gas pulsation (through refrigerant)

The following sections focus on the causes and methods of mitigation for each of the above sources.

Compressor sound radiation - Single

For sound radiating from the compressors, the emission path is air and the sound waves are travelling directly from the machine in all directions.

Table 7: Compressor sound radiation

Compressor model	Composition	50 Hz
		Sound power dB(A)
PSF065	-	84
PSF072	-	85
PSF130E	2XPSF065	87
PSF144E	2XPSF072	88

NOTE:
Sound power are given at conditions -7/50/5/5 with vapor injection, measured in free space Maximum sound is +3dB(A)

Mechanical vibrations

A compressor generates some vibrations that propagate into the surrounding parts and structure. When system structure natural frequencies are close to running frequency, vibrations are amplified due to resonance phenomenon.

A high vibration level is damageable for piping reliability and generates high sound levels.

Mitigation methods

1. To ensure minimum vibrations transmission to the structure, strictly follow Danfoss mounting requirements (mounting feet, rails etc.). For further information on mounting requirements, please refer to section “Design compressor mounting”.
2. Ensure that there is no direct contact (without insulation) between vibrating components and structure.
3. To avoid resonance phenomenon, piping and frame must have natural frequencies as far as possible from running frequency (50Hz). Solutions to change natural frequencies are to work on structure stiffness and mass (brackets, metal sheet thickness or shape…)

Operating envelope data

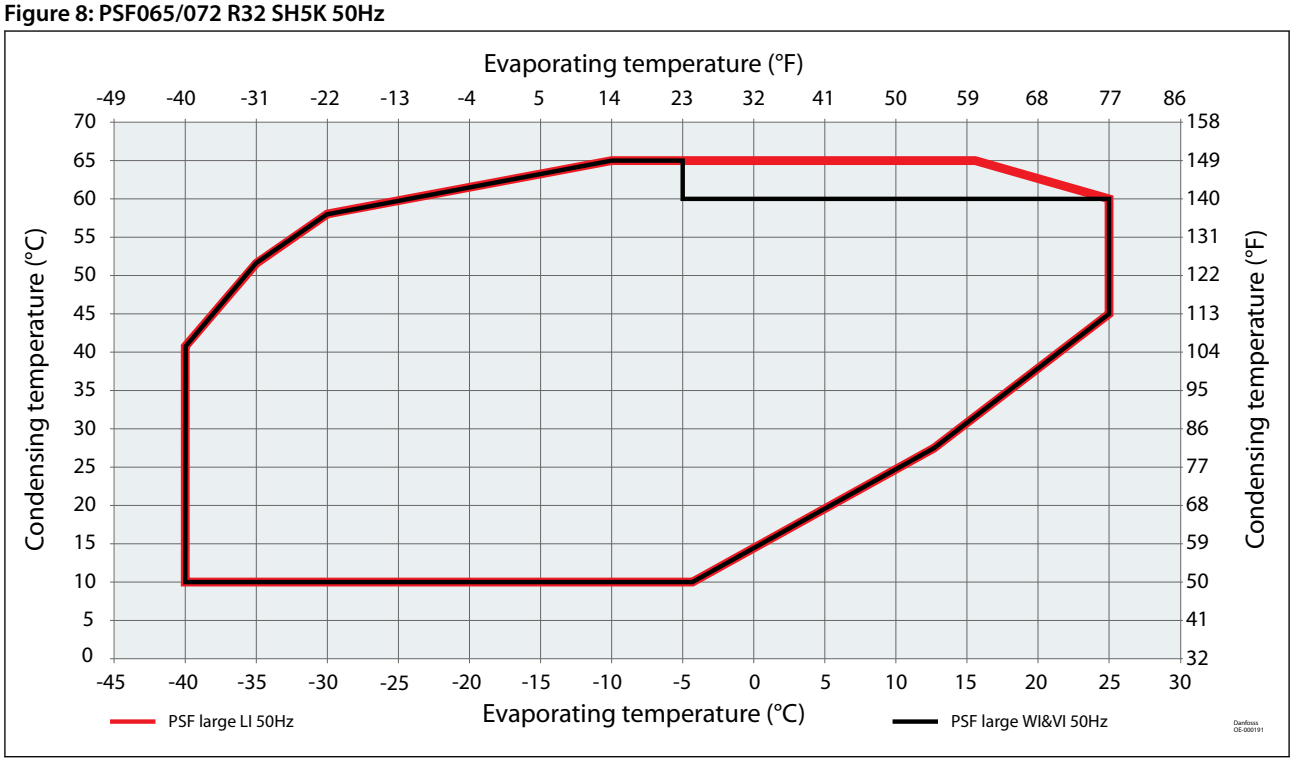
The operating envelope for PSF065/072 compressors is given in the figures below and guarantees reliable operation of the compressor for steady-state and transient operation.

In every instance, the discharge temperature must be kept below 135°C.

Steady-state operation envelope is valid for a suction superheat within 5K range at nominal Voltage. Minimum suction temperature cannot lower than -35°C. Minimum ambient temperature during start and operation cannot lower than -33°C.

Operating envelope

Figure 8: PSF065/072 R32 SH5K 50Hz



Pressure settings

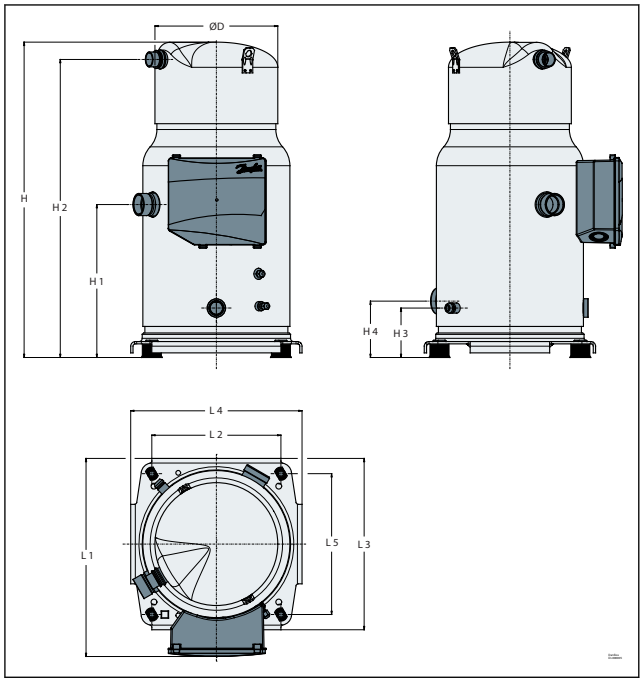
Table 8: Pressure settings

Pressure settings		R32
Working range high side	bar(g)	10.1-42.9
	psig	147-622
Working range low side	bar(g)	0.8-15.9
	psig	11-231
Maximum high pressure safety switch setting	bar(g)	44.3
	psig	643
Minimum low pressure safety switch setting	bar(g)	0.6
	psig	8
Minimum low pressure pump-down switch setting	bar(g)	1.5 bar below nominal evaporating pressure of the unit and not below the minimum low pressure safety switch setting
	psig	22 psi below nominal evap. and not below the minimum low pressure safety switch setting

Dimensions

Single compressors

Figure 9: PSF065-072



Compressor model	D (mm)	H (mm)	H1 (mm)	H2 (mm)	H3 (mm)	H4 (mm)	L1 (mm)	L2 (mm)	L3 (mm)	L4 (mm)	L5 (mm)	Outline drawing number
PSF065-072 Single version	265.9	682.5	331	645	107	-	429	279.4	371	370.8	305	8556305
PSF065-072 manifolding version	265.9	682.5	331	645	107	122	429	279.4	371	370.8	305	8556341

Tandem assemblies

Figure 10: Outline drawing

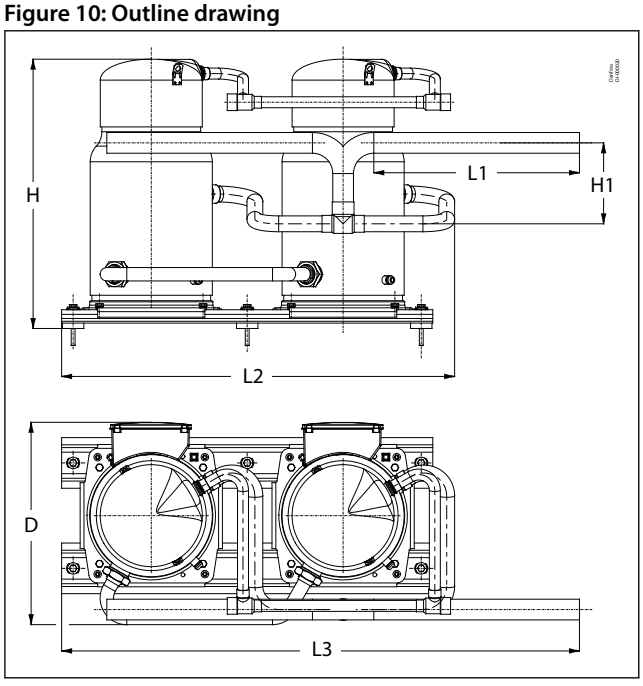


Table 9: Tandem assemblies

Tandem model	Composition	Suction form	Suction	Discharge	Oil equali-zation	D	H	L1	L2	L3	H1	Outline drawing number	Tandem kit code
						(mm)	(mm)	(mm)	(mm)	(mm)	(mm)		
PSF130E	PSF065+065	Right	2"1/8	1"5/8	1"3/8	527	701	535	1025	-	211	8556339	120Z0792
		Left	2"1/8	1"5/8	1"3/8	527	701	535	-	1350	211		
PSF144E	PSF072+072	Right	2"1/8	1"5/8	1"3/8	527	701	535	1025	-	211		
		Left	2"1/8	1"5/8	1"3/8	527	701	535	-	1350	211		

NOTE:
Tandems to be achieved by assembly of individual compressors.

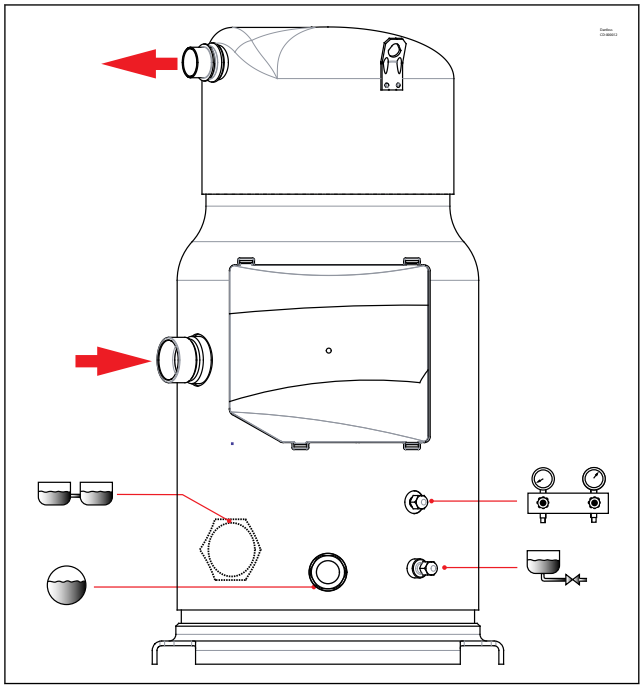
By convention, the last letter of tandems designation has been set to help to discern easily which type of manifold we are considering

E : Even tandem

Mechanical connections

Connection details

Figure 11: PSF065-072



Connection details		PSF065-072 Single version	PSF065-072 Manifolding version
Suction connection		Brazed 1" 5/8	Brazed 1" 5/8
Discharge connection		Brazed 1" 1/8	Brazed 1" 1/8
Oil sight glass		None	Threaded (1"1/8 - 18 UNEF)
Oil equalization connection		None	Rotolock 2" 1/4
Oil drain connection		None	Female ¼" Flare incorporating a Schrader valve
Low pressure gauge port (Shrader)		None	Male ¼" Flare incorporating a Schrader valve
Injection connection		3/8" ODF	3/8" ODF

Design compressor mounting

General requirements

During operation, the maximum inclination from the vertical plane must not exceed 3 degrees.

Single requirements

Mounting of PSF065-072

Compressors PSF065-072 is delivered with rubber grommets and steel mounting sleeve used to isolate the compressor from the base frame.

The grommets must be compressed until contact between the flat washer and the steel mounting sleeve is established. The required bolt size for the PSF065-072 compressors is HM8-55. This bolt must be tightened to a torque of 21Nm.

Figure 12: Rubber grommets from kit

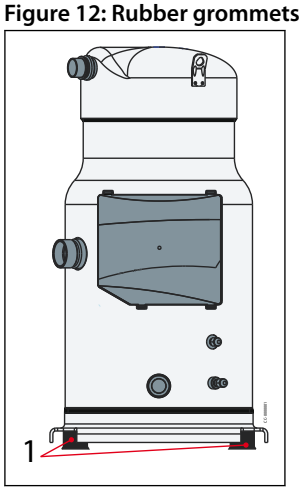
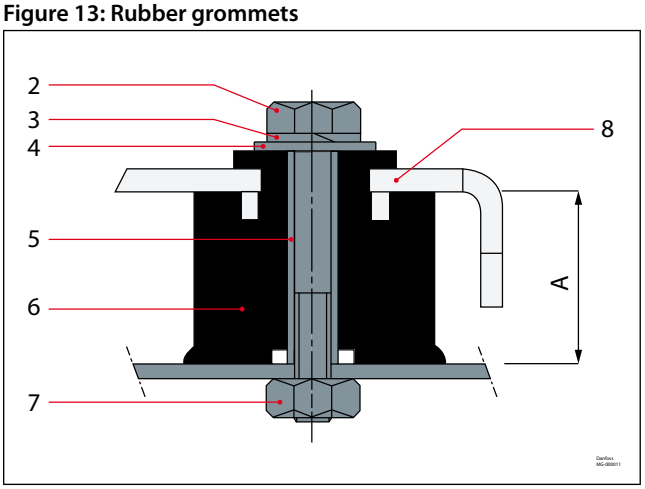


Figure 13: Rubber grommets



A	PSF065-072: 27.5 mm / 1.08 inch
1	Rubber grommets from kit
2	HM 8 bolt
3	Lock washer
4	Flat washer
5	Steel mounting sleeve
6	Rubber grommet
7	Nut
8	Compressor base plate

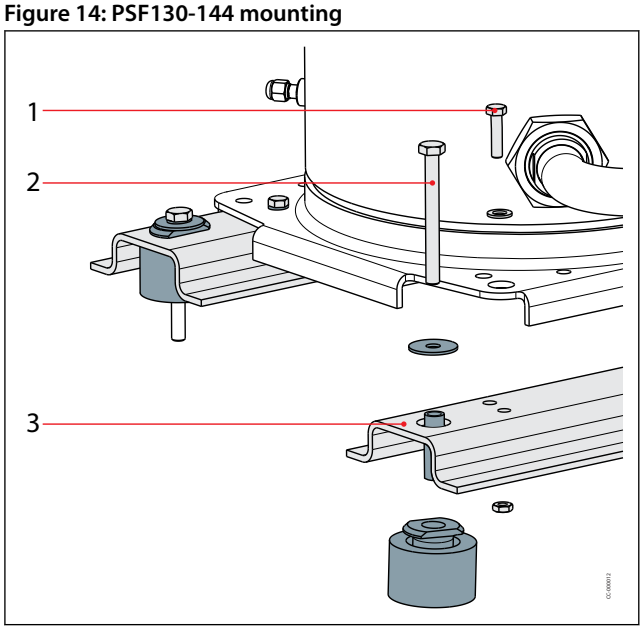
Tandem requirements

For parallel mounting, the compressors can be mounted directly on the rails. Rubber grommets and spacers must be installed below the rails.

These parts are included in accessories.

Mounting of PSF130-144

Figure 14: PSF130-144 mounting



1	HM10 x 30 class 10.9 Tightening torque 50 Nm
2	HM10 x 100 class 10.9 Tightening torque 50Nm
3	Thickness : 5mm (0.2 inch)
	Included in tandem kit
	Not supplied

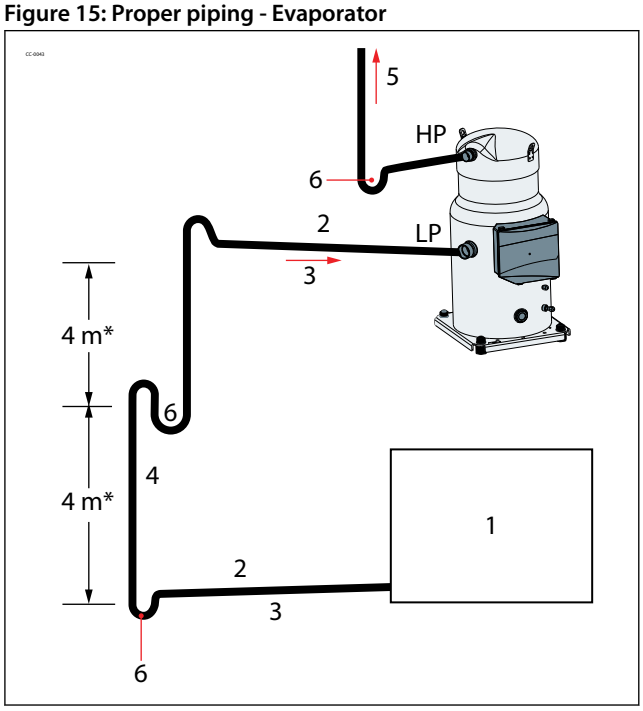
Design piping

General requirements

Proper piping practices should be employed to:

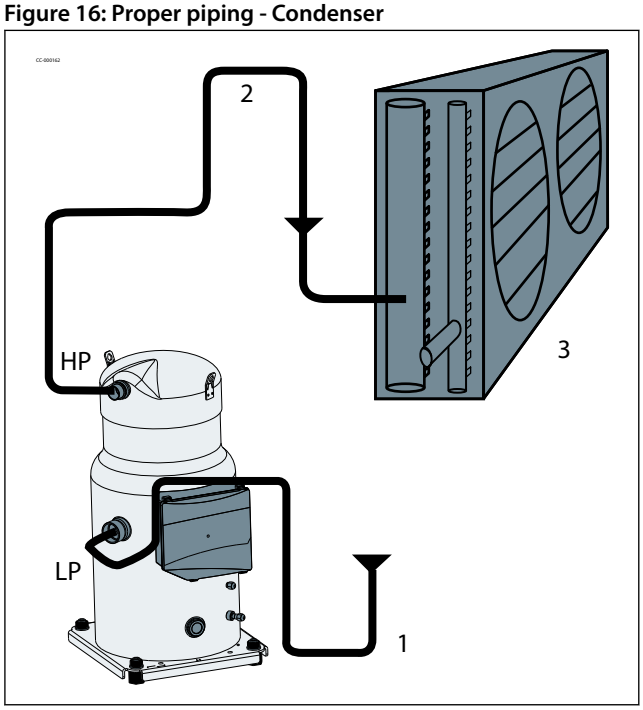
1. Ensure adequate oil return, even under minimum load conditions (refrigerant speed, piping slopes…). For validation tests see section Manage oil in the circuit.
2. Avoid condensed liquid refrigerant from draining back to the compressor when stopped (discharge piping upper loop). For validation tests see section Manage off cycle migration.
3. Piping should be designed with adequate three-dimensional flexibility to avoid excess vibration. It should not be in contact with the surrounding structure, unless a proper tubing mount has been installed. For more information on noise and vibration, see section Sound and vibration data.

Figure 15: Proper piping - Evaporator



1	Evaporator
2	0.5% slope
3	4m/s or more
4	8 to 12 m/s
5	To condenser
6	U-trap, as short as possible
*****	Max.

Figure 16: Proper piping - Condenser



1	3D flexibility
2	Upper loop
3	Condenser

Tandem requirements (Static)

Tandem use static oil balancing principle to equalize oil level between the compressors by gravity. This is ensured by a precise suction and oil equalization piping design.

The discharge line has no impact on oil balancing. It is shown with tee, to indicate that both left and right side discharge headers are possible.

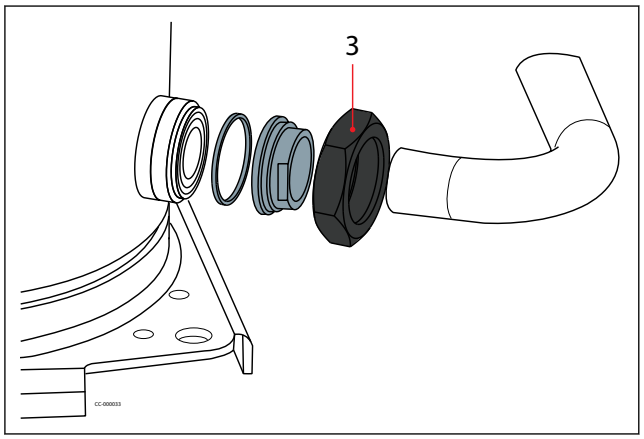
By default, PSF tandems are not factory-built. To complete an assembly in the field, you will need:

- Tubings, according to specific outline drawings indicated in the following table.
- Manifolding accessory kit.
- Compressors.

Suction and oil equalization piping drawings must be respected (diameters, minimum straight lengths, …)

Oil equalization design

The oil level is balanced by a pipe of 1"3/8. To connect the equalization line on rotolock connections, the adaptor sleeves included in the tandem accessory kit must be used.



3	Tightening torque 145Nm
	Supplied with the compressor
	Included in tandem kit

Electrical connections

Wiring connections

For PSF compressors, electrical power is connected to the compressor terminals by M5 studs and nuts. The maximum tightening torque is 3 Nm.

⚠ Cable gland or similar protection component must be used on electrical box's knockouts to against accidental contact with electrical parts inside.

PSF065-072

The terminal box is provided with 2 triple knockouts and 1 single knockout for power supply and 4 double knockouts for the safety control circuit.

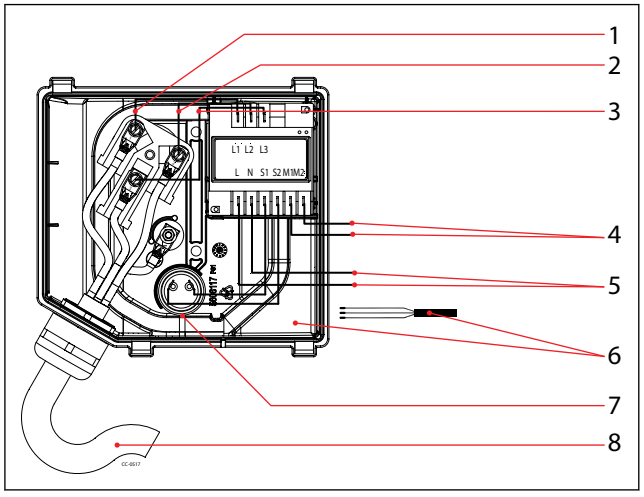
The 3 power supply knockouts accommodate the following diameters:

- Ø 50.8mm (φ 2inch) (UL 1"1/2 conduit) & Ø 43.7mm (φ 1.72inch) (UL 1"1/4 conduit) & Ø 34.5mm (φ 1.36 inch) (UL 1" conduit)
- Ø 40.5mm (φ 1.59inch) (ISO40) & Ø 32.2mm (φ 1.27inch) (ISO32) & Ø 25.5 mm (φ 1 inch) (ISO25)
- Ø 25.5 mm (φ 1 inch) (ISO25)

The 4 other knockouts are as follows:

- Ø 22.5mm (φ 0.89inch) (PG16) (UL 1/2") & Ø 16.5mm (φ 0.65inch) (ISO16) (x2)
- Ø 20.7mm (φ 0.81inch) (ISO20 or PG13.5) (x2)

Figure 17: PSF065-072



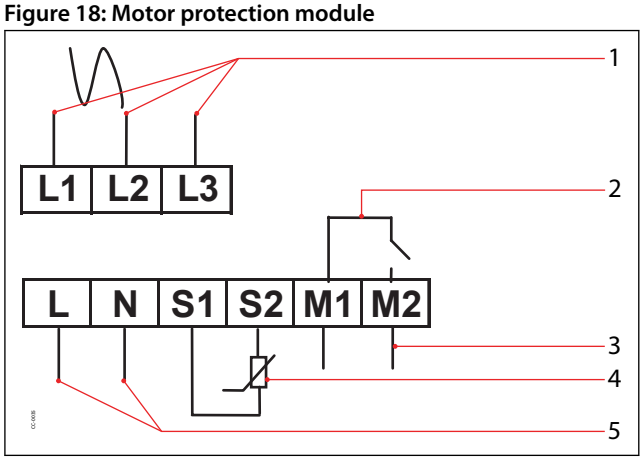
1	Black
2	Blue
3	Brown
4	M1, M2 Control circuit
5	Module power supply
6	Sump heater
7	Faston 1/4" tabs
8	Power supply

Motor protection module

The motor protection modules come preinstalled within the terminal box. Phase sequence protection connections and thermistor connections are pre-wired and should not be removed.

The module must be connected to a power supply of the appropriate voltage. The module terminals are 6.3mm (0.25inch) size Faston type.

Figure 18: Motor protection module



1	Phase sequence input
2	Internal control contact
3	Safety circuit
4	Thermistor connection
5	Module power

Electrical Specifications

Motor voltage

Danfoss scroll compressors PSF are available in four different motor voltages as listed below.

Table 10: Motor voltage

Frequency	Motor voltage code	Code 8
50 Hz	Nominal voltage	380V-3ph
	Voltage range	342-418V

NOTE:
Voltage range: Nominal voltage ± 10%. The voltage range indicates where the compressor can run in the majority of the application envelope. A boundary voltage supply which accumulates under specific conditions such as high ambiance, high superheat, or map boundary conditions, may lead to a compressor trip.

Voltage imbalance

The maximum allowable voltage imbalance is 2%. Voltage imbalance causes high amperage over one or several phases, which in turn leads to overheating and possible motor damage. Voltage imbalance is given by the formula:

$$\%\ \text{voltage imbalance} = \frac{|\ Vavg - V1{-}2\ | + |\ Vavg - V1{-}3\ | + |\ Vavg - V2{-}3\ |}{2 \times Vavg} \times 100$$

Vavg	Mean voltage of phases 1, 2, 3.
V1-2	Voltage between phases 1 and 2.
V1-3	Voltage between phases 1 and 3.
V2-3	Voltage between phases 2 and 3.

IP rating

The compressor terminal box according to IEC60529 is IP54 for all models when correctly sized IP54 rated cable glands are used.

First numeral, level of protection against contact and foreign objects

5 - Dust protected

Second numeral, level of protection against water

4 - Protection against water splashing

Terminal box temperature

The temperature inside the terminal box must not exceed 70°C (158°F). Consequently, if the compressor is installed in an enclosure, precautions must be taken to avoid that the temperature around the compressor and in the terminal box would rise too much. A ventilation installation on the enclosure panels may be necessary. If not, the electronic protection module may not operate properly. Any compressor damage related to this will not be covered by Danfoss warranty. In the same manner, cables must be selected in a way that ensures the terminal box temperature does not exceed 70°C (158°F).

Three phase electrical characteristics

Table 11: Motor voltage code 8

Compressor model	LRA	Max. operating current	Winding resistance
	A	A	Ω
PSF065	268	51	0.501
PSF072	268	56	0.501

LRA (Locked Rotor Amp)

Locked Rotor Amp value is the higher average current as measured on mechanically blocked compressors tested under nominal voltage. The LRA value can be used as a rough estimation for the starting current. However, in most cases, the real starting current will be lower. A soft starter can be applied to reduce starting current (see section Soft starts).

MOC (Maximum Operating Current)

The max operating current is the amperage the compressor will draw when it operates at maximum load of operating envelope within the voltages printed on the nameplate.

MOC can be used as a basis for contactors selection.

Winding resistance

Winding resistance is the resistance between phases at 25°C (77°F) (resistance value +/- 7%). Winding resistance is generally low and it requires adapted tools for precise measurement. Use a digital ohm-meter, a “4 wires” method and measure under stabilised ambient temperature. Winding resistance varies strongly with winding temperature. If the compressor is stabilised at a different value than 25°C (77°F), the measured resistance must be corrected using the following formula:

$$R_{tamb} = R_{25°C\ (77°F)} \frac{a + t_{amb}}{a + t_{25°C\ (77°F)}}$$

$t_{25°C}$	reference temperature = 25°C (77°F)
t_{amb}	temperature during measurement °C (°F)
$R_{25°C\ (77°F)}$	winding resistance at 25°C (77°F)
R_{amb}	winding resistance at tamb
a	Coefficient a = 234.5

Motor protection

PSF065-072

Compressor models PSF065-072 are delivered with a pre-installed motor protection module inside the terminal box. This device provides efficient and reliable protection against overheating and overloading as well as phase loss/ reversal.

The motor protector comprises a control module and PTC sensors embedded in the motor winding.

The motor temperature is being constantly measured by a PTC thermistor loop connected on S1-S2 . If any thermistor exceeds its response temperature, its resistance increases above the trip level (4500 Ω) and the output relay then trips – i.e. contacts M1-M2 are open. After cooling to below the response temperature (resistance < 2750 Ω), a 5-minute time delay is activated.

After this delay has elapsed, the relay is once again pulled in – i.e. contacts M1-M2 are closed. The time delay may be cancelled by means of resetting the mains (L-N -disconnect) for approximately 5 sec.

A red/green twin LED is visible on the module. A solid green LED denotes a fault free condition. A blinking red LED indicates an identifiable fault condition:

Figure 19: PTC Overheat

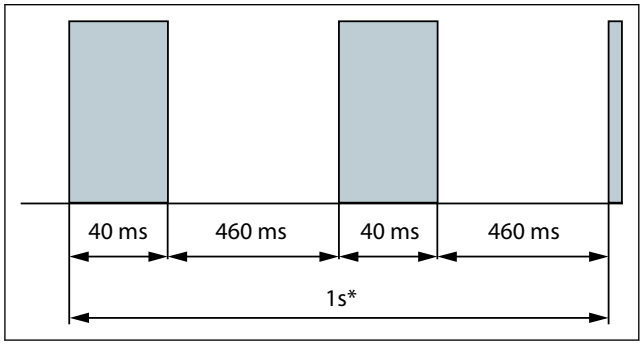
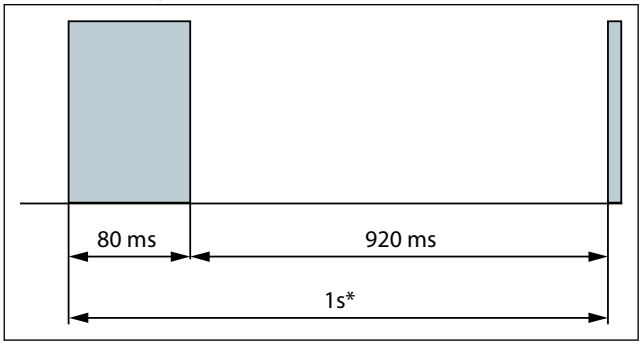


Figure 20: Delay timer active (after PTC over temp.)



*	approx. 1 second

While not compulsory, an additional thermal magnetic motor circuit breaker is still advisable for either alarm or manual reset.

Then it must be set at the Max Operating Current value (MOC) :

- When the motor temperature is too high, then the internal PTC over temp. and module is activated.
- When the current is too high the thermal magnetic motor circuit breaker will trip before the module activate therefore offering possibility of manual reset.

Phase sequence and reverse rotation protection

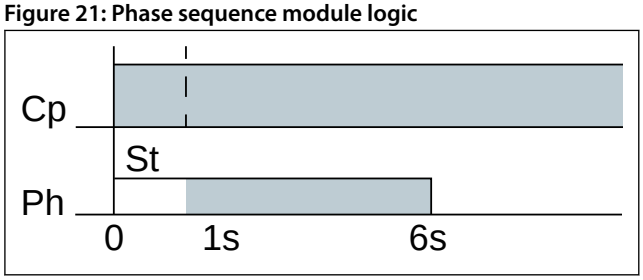
PSF065-072

Use a phase meter to establish the phase orders and connect line phases L1, L2 and L3 to terminals T1, T2 and T3, respectively.

Compressor models PSF065-072 are delivered with an electronic module which provides protection against phase reversal and phase loss at start-up.

The phase sequencing and phase loss monitoring functions are active during a 5-sec window 1 second after compressor start-up (power on L1-L2-L3).

Figure 21: Phase sequence module logic



Cp	Compressor
Ph	Phase monitoring
St	start

Should one of these parameters be incorrect, the relay would lock out (contact M1-M2 open). The red LED on the module will show the following blink code:

Figure 22: In case of phase reverse error

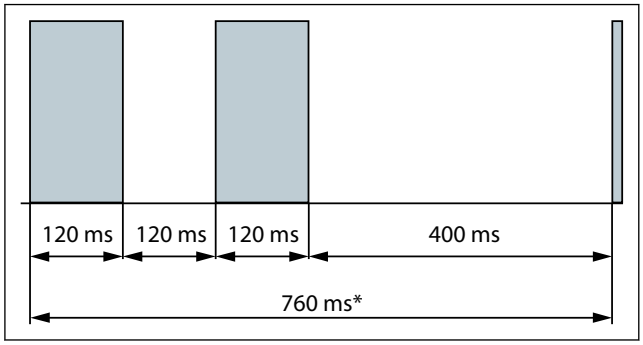
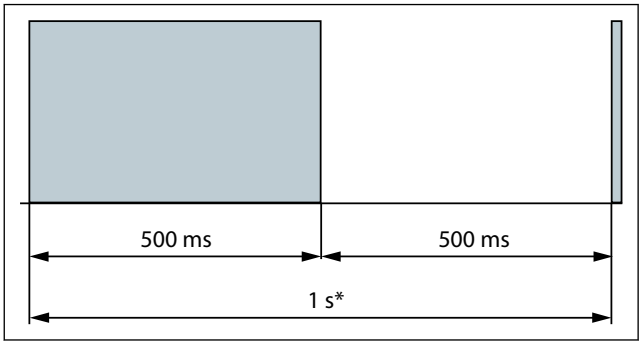


Figure 23: In case of phase loss error:



*	Approximate

The lockout may be cancelled by resetting the power mains (disconnect L-N) for approximately 5 seconds.

For more detailed information see " Instructions for electronic module" AN160986418236.

Application

Manage oil in the circuit

Requirement

R Oil level must be visible or full in the sight glass when the compressor is running and when all compressors of the circuit are stopped.

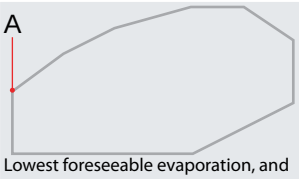
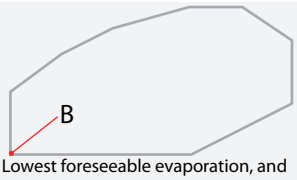
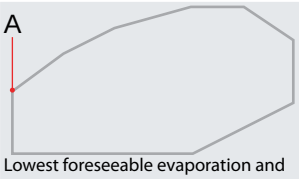
System evaluation

Table 12: Manage oil in the circuit - System evaluation

Split type	Single compressor	Manifold compressors
Non split	Test No.1+2	Test No.1+2+3
Split	Test No.1+2+4	Test No.1+2+3+4

Test, criteria and solutions

Table 13: Manage oil in the circuit - Test, criteria and solutions

Test No.	Purpose	Test conditions	Pass criteria	Solutions
1	Check proper oil return	 Lowest foreseeable evaporation, and highest foreseeable condensation. **Minimum number of compressor** running for 6 hours. For reversible system, perform test in both heating and cooling mode.	Oil level must be visible or full in the sight glass when the compressor is running and when all compressors of the circuit are stopped.	1. Top-up with oil, generally 3% of the total system refrigerant charge (in weight). Above 3% look for potential oil trap in the system. 2. Integrate a function in control logic to run all compressors simultaneously in order to boost oil return (for more details see section Control logic) 3. Oil separator can be added
2	Check proper oil return at low injection flow conditions	 Lowest foreseeable evaporation, and lowest foreseeable condensation on the injection area. **Minimum number of compressor** running for 6 hours. For reversible system, perform test in both heating and cooling mode.	Oil level must be visible or full in the sight glass when the compressor is running and when all compressors of the circuit are stopped.	1. Top-up with oil. Typically, up to 3% of the total system refrigerant charge (in weight). Above 3% look for potential oil trap in the system. 2. Check that injection line is properly sized and have no possible oil trap (for more details see section Design piping). 3. Integrate a function in control logic to run all compressors simultaneously in order to boost oil return (for more details see section Control logic) 4. Oil separator can be added
3	Check oil balancing	 Lowest foreseeable evaporation and highest foreseeable condensation and nominal capacity condition for tandem 2 compressors running for 6 hours, for trio, compressor running follow the running sequence: (1+2+3)2hrs→ (1+2)2hrs →(2+3)2hrs→ (1+3)2hrs For reversible system, perform test in both heating and cooling mode.	Oil level must be visible or full in the sight glass when the compressors are running and when all compressors of the circuit are stopped	1. Top-up with oil, generally 3% of the total system refrigerant charge (in weight). 2. Check that manifold piping is conform to Danfoss requirements. 3. Integrate a function in control logic to stop manifold periodically in order to balance oil (for more details see section Control logic)
4	Oil return in split systems	Since each installation is unique, test 1 and 2 can not fully validate the oil return. Oil level must be checked and adjusted at commissioning.	Oil level must be visible or full in the sight glass when the compressor is running and when all compressors of the circuit are stopped.	1. Pay special attention to "Piping design" 2. Oil separator is strongly recommended, espacially in case of part load.

Manage sound and vibration

Sound radiations

Mitigations methods: We can consider two means to reduce compressors sound radiations:

1. Acoustic hoods are quick and easy to install and do not increase the overall size of the compressors. Acoustic hoods are available from Danfoss as accessories. Refer to the tables above for sound levels, attenuation and code numbers.
2. Use of sound-insulation materials on the inside of unit panels is also an effective mean to reduce sound radiation.

NOTE:
During compressor shut down, a short reverse rotation sound is generated. The duration of this sound depends on the pressure difference at shut down and should be less than 3 seconds. This phenomenon has no impact on compressor reliability.

Gas pulsation

The compressor has been designed and tested to ensure that gas pulsation is optimized for the most commonly encountered air conditioning pressure ratio. Manifolded compressors are equivalents to lagged sources of gas pulsation. Therefore, pulse level can vary during time.

Mitigations methods: If an unacceptable level is identified, a discharge muffler with the appropriate resonant volume and mass can be installed.

Mitigation Methods

1. To ensure minimum vibrations transmission to the structure, strictly follow Danfoss mounting requirements (mounting feet, rails etc..). For further information on mounting requirements, please refer to section Design compressor mounting.
2. Ensure that there is no direct contact (without insulation) between vibrating components and structure.
3. To avoid resonance phenomenon, pipings and frame must have natural frequencies as far as possible from running frequencies(50 Hz). Solutions to change natural frequencies are to work on structure stiffness and mass (brackets, metal sheet thickness or shape…)

Manage Operating envelope

The Operating envelope data for PSF scroll compressors guarantees reliable operations of the compressor for steady-state operation.

Steady-state operation envelope is valid for a suction superheat within 5K range at nominal Voltage.

High and low pressure protection

Low-pressure (LP) and high-pressure (HP) safety switches must never be bypassed nor delayed and must stop all the compressors.

LP switch auto restart must be limited to 5 times within 12 hours.

HP safety switch must be reset manually.

Depending on application operating envelope, you must define HP and LP limits within operating envelope and pressure setting table above.

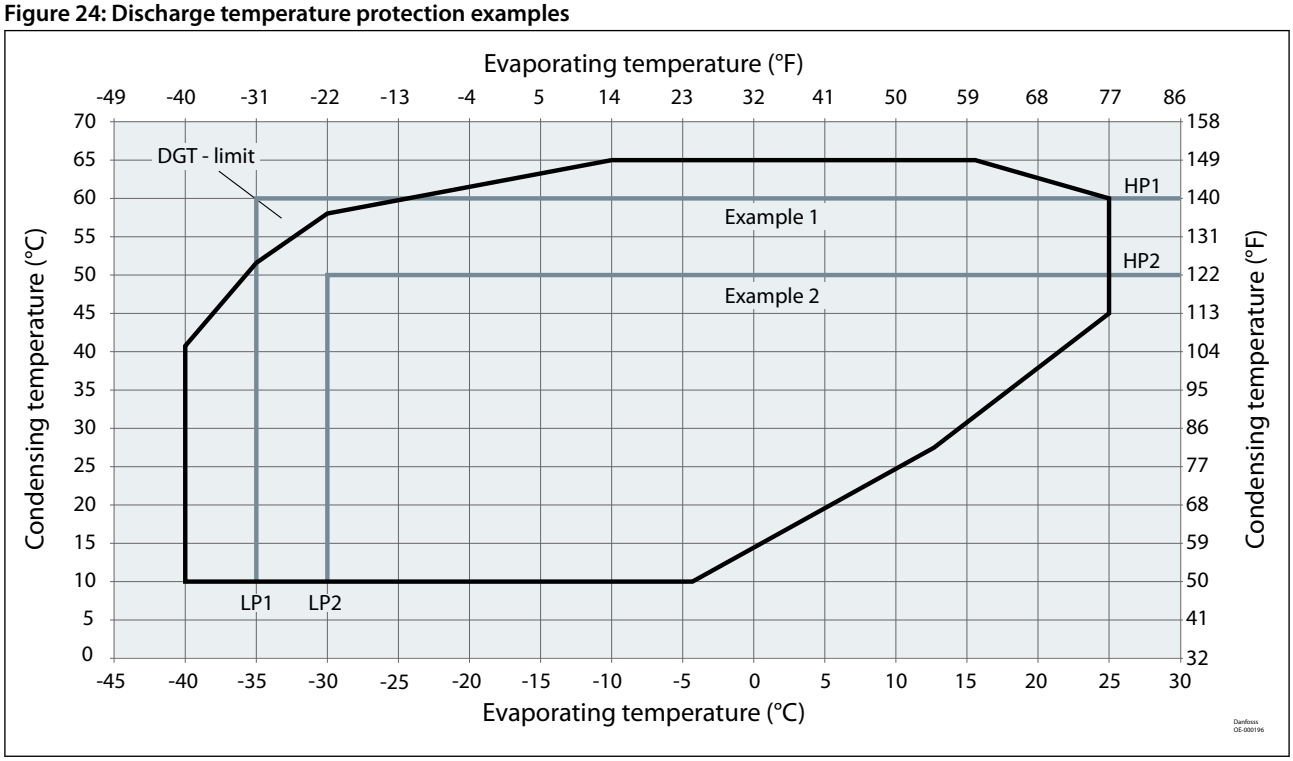
Discharge temperature protection

PSF include an integrated discharge temperature protection. Excessive discharge temperature will result in tripping of electronic module output relay.

This protection, effective for suction superheat above 5K (9°F), should be considered as a compressor safety device and its purpose is not to ensure operation map control.

In case of basic map control by pressure switches that can not ensure totally that the compressor will remain in its operating envelope, an additional external discharge protection is required. (see below Figure 24: Discharge temperature protection examples)

Figure 24: Discharge temperature protection examples



Example 1 (R32, SH = 5K)
LP switch setting: LP1 = 2.2 bar (g) (-35°C), HP switch setting: HP1 =39 bar (g) (60°C)
Risk of operation beyond the application envelope.
DGT protection required.

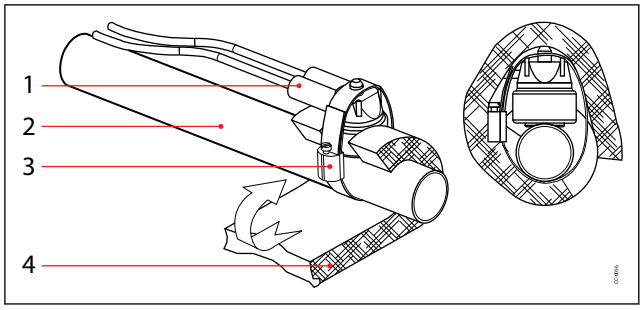
Example 2 (R32, SH = 5K)
LP switch setting: LP2 = 2.7 bar (g) (-30°C), HP switch setting: HP2 = 31 bar (g) (50°C)
No risk of operation beyond the application envelope.
No DGT protection required.

This external protection device can be a thermostat or a temperature sensor. The discharge gas temperature protection must trip the power supply when it reaches the setting point to protect the compressor from overheating.

The discharge gas protection should be set to open at a maximum discharge gas temperature of 135°C(275°F).

The discharge gas thermostat must be attached to the discharge line within 40mm (1.57 inch) from the compressor discharge port and must be thermally insulated and tightly fixed on the pipe (see Figure 25: Discharge Gas Temperature protection (DGT))

Figure 25: Discharge Gas Temperature protection (DGT)



1	Thermostat or temperature sensor
2	Discharge line
3	Bracket
4	Insulation

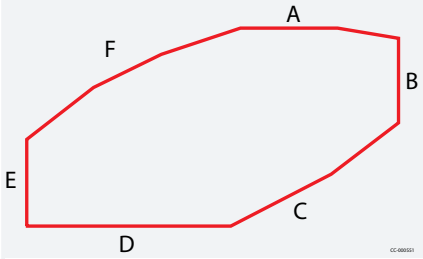
System evaluation

HP and LP must be monitored to respect operating envelope limitations. We consider two types of operating envelope management:

Table 14: Operating envelope management

Basic	Advanced
• HP and LP switch • MOP (Max Operating Pressure) ensured by expansion device • Condensing pressure control • Discharge gas sensor piloting injection expansion device	• HP and LP sensor • Operating envelope limits (permanent and transient) integrated into control logic

See Test, criteria and solutions.



A	HP switch setting
B	MOP + test No. 3
C	Tests No. 1 and 2
D	Condensing pressure control
E	LP switch setting
F	DGT (integrated)*

NOTE:
*PSF065-072 compressor includes an integrated Discharge Gas Temperature protection (DGT). Excessive discharge temperature will result in tripping of electronic module output relay.

Manage superheat

Requirement

R Suction accumulator must be added in system

R In any conditions the expansion device must ensure a suction superheat within 5 – 30 K.

Manage superheat

During normal operation, refrigerant enters the compressor as a superheated vapor. Liquid flood back occurs when a part of the refrigerant entering the compressor is still in liquid state.

Liquid flood back can cause oil dilution and, in extreme situations lead to liquid slugging that can damage the compressor.

System evaluation

Use the table in relation with the application to quickly evaluate the potential tests to perform.

Application	Tests to perform
Non reversible	Liquid flood back test
Reversible	Liquid flood back test Defrost test

Test, criteria and solutions

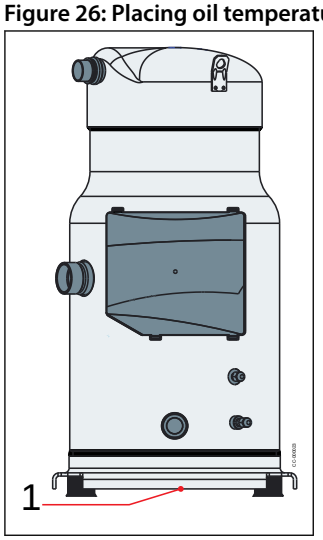
Test	Purpose	Test condition	Pass criteria	Solutions
Liquid flood back test	Steady-state	 Liquid flood back testing must be carried out under expansion valve threshold operating conditions:high pressure ratio(A) and minimum condenser and evaporator load(B).	Suction superheat >5 K	Check expansion valve selection and setting. • For Thermostatic expansion valve (TXV) check bulb position... • For Electronic expansion valve (EXV) check measurement chain and PID....
	Transient	Tests must be carried out with most unfavorable conditions : • fan staging • compressor staging • …etc.	Oil superheat shall not be more than 30 sec below the safe limit defined in the Dilution Chart (see graph below).	
Defrost test	Check liquid floodback during defrost cycle	Defrost test must be carried out in the most unfavorable conditions (at 0 °C (32 °F) evaporating temperature).	Oil superheat shall not be more than 30 sec below the safe limit defined in the Dilution Chart (see graph below).	In reversible systems, the defrost logic can be worked out to limit liquid floodback effect (for more details see Control logic).

Placing oil temperature sensor

Oil temperature sensor must be placed on the bottom of the baseplate. Some thermal paste shall be used to improve the conductivity. The sensor must also be correctly thermally insulated from the ambiance.

The Oil superheat is defined as: (Oil temperature - Evaporating temperature)

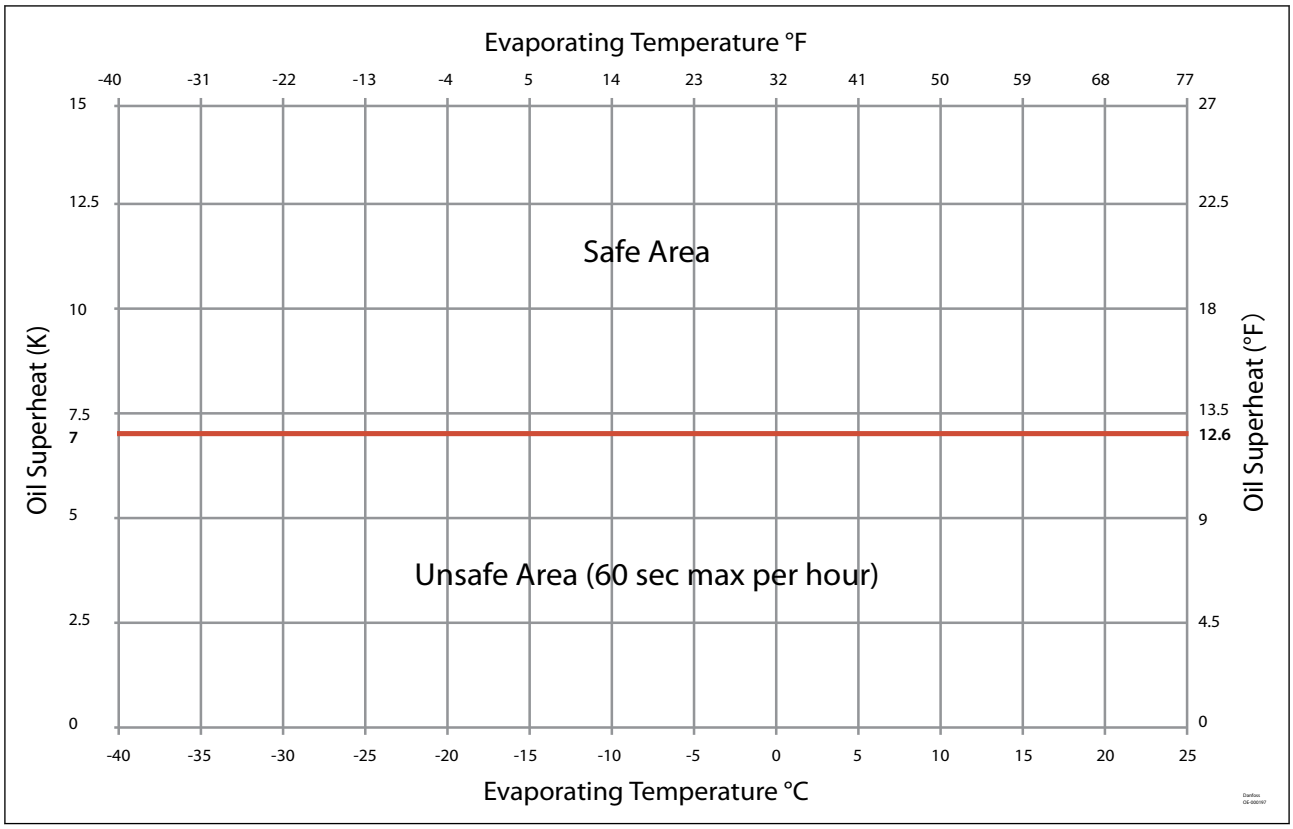
Figure 26: Placing oil temperature sensor



1	Oil temperature sensor must be placed on the bottom of the baseplate.

Dilution Chart

Dilution Chart (reference at 20 °C / 68 °F ambient temperature)



Manage off cycle migration

Off -cycle refrigerant migration happens:

- when the compressor is located at the coldest part of the installation, refrigerant vapor condenses in the compressor.
- or directly in liquid-phase by gravity or pressure difference. When the compressor restarts, the refrigerant diluted in the oil, or stored in evaporator, generates poor lubrication conditions, and may reduce bearings life time. In extreme situations, this leads to liquid slugging that can damage the compressor scroll set.

Requirement

- Compressor can tolerate occasional flooded start, but it should remain exceptional situation and unit design must prevent that this situation happen at each start.
- Right after start, liquid refrigerant must not flow massively to compressor
- The charge limit is a threshold beyond some protective measures must be taken to limit risk of liquid slugging and extreme dilution at start.
- Recommend to install an additional solenoid valve on the injection line to prevent the refrigerant coming back directly into the compressor scroll set during off-cycles.

System evaluation

Use the table below in relation with the system charge and the application to quickly define necessary safeties to implement.

Table 15: System charge

BELOW charge limit	ABOVE charge limit
Ensure tightness between condenser & evaporator when system is OFF • Thermostatic expansion Valve (TXV) , Liquid Line Solenoid Valve LLSV strongly recommended • Electronic expansion valve (EXV) must close when system stop including in power shut down situation	
No test or additional safeties required	• Crankcase heater

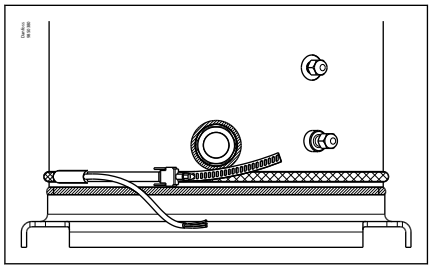
Crankcase heater

The crankcase heaters are designed to protect the compressor against off-cycle migration of refrigerant.

For PSF065-072 the use of a 75W belt heater is mandatory, if the ambient temperature is between -5°C and -23°C. For ambient temperature between -23°C and -28°C a 130W belt heater must be used. For ambient temperature below -28°C two pieces 130W belt heater must be used.

Table 16: Belt sump selection principle

T ambiance	Belt Sump Heater
-23~-5	75 W SSH
-28~-23	130 W SSH
-33~-28	130W+130W SSH



The heater must be turned on whenever all the compressors are off. Crankcase heater accessories are available from Danfoss (see section “Accessories”).

Liquid line solenoid valve (LLSV)

A Liquid line solenoid valve (LLSV) is used to isolate the liquid charge on the condenser side, thereby preventing against charge transfer to the compressor during off -cycles. The quantity of refrigerant on the low-pressure side of the system can be further reduced by using a pump down cycle in association with the LLSV.

Pump-down cycle

By decreasing pressure in the sump, pump down system:
- evacuates refrigerant from oil
- set the sump saturating pressure much lower than ambiance temperature and due to that, avoid refrigerant condensation in the compressor.

Pump-down must be set higher than the minimum low pressure safety switch setting. For more details on pump-down cycle see section Control logic.

Charge limits

Table 17: Charge limits for single models

Models	Refrigerant charge limit	
	kg	lbs
PSF065	10.5	23
PSF072	11.5	25

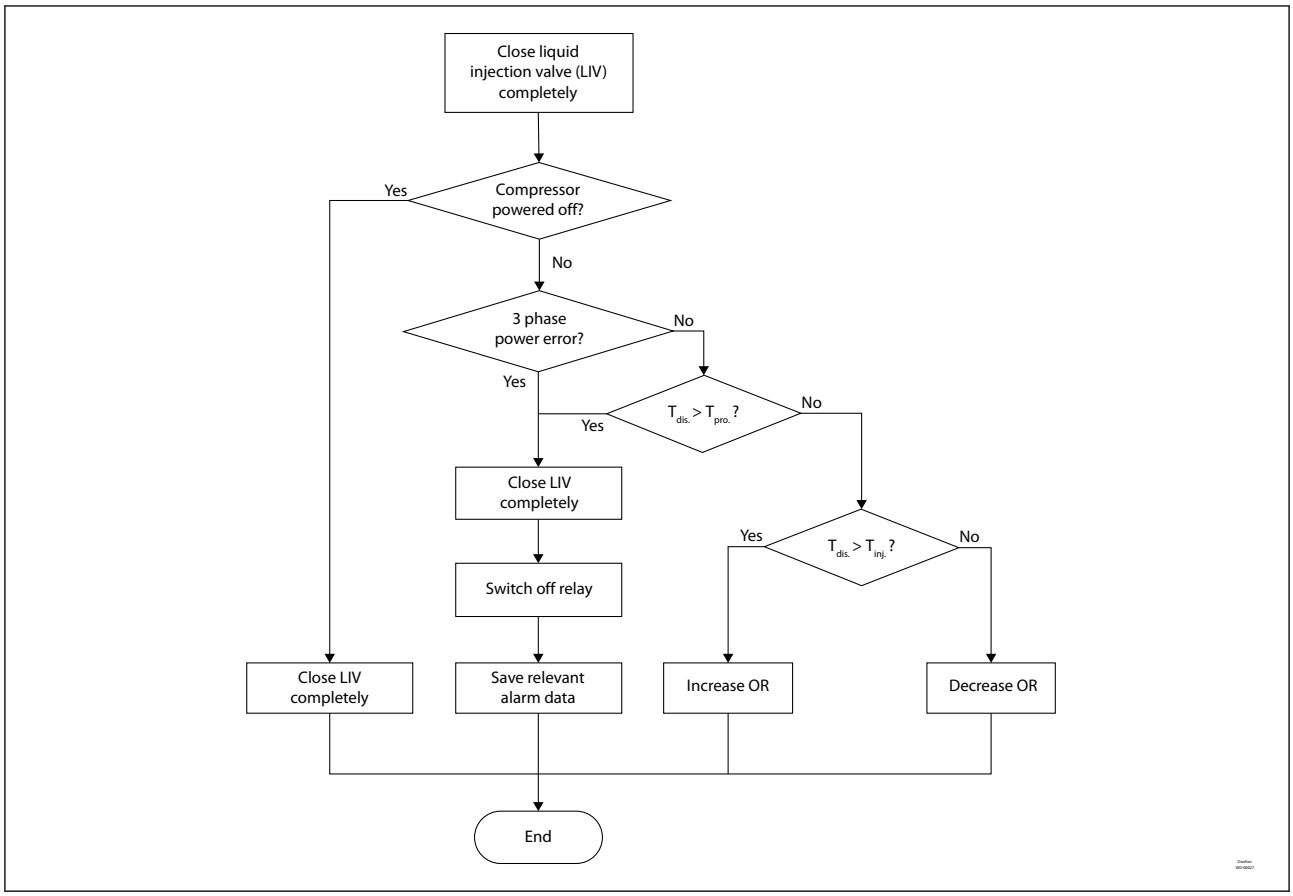
Manage injection

PSF compressors can be used on single configuration but also in tandem and trio manifold.

This paragraph focuses on single and tandem configurations. For trios configurations, please contact Danfoss.

Liquid injection only

PSF compressors can be used with only with liquid injection (see “Introduction” for a general presentation). On this configuration, the compressor is running without injection (see “Operating envelope data” - LI/Non injection operating map). A liquid injection occurs to extend the map and control the DGT. To do so, the architecture of the unit and the control logic have to manage the flow of liquid injected following the flowchart below.



OR	Opening ratio of injection valve
$T_{dis.}$	Compressor discharge temperature
$T_{pro.}$	Discharge temperature protection setpoint. It should be 135°C
$T_{inj.}$	The advice discharge temperature control point is 121°C

NOTE:
To avoid short cycling of the Liquid Injection valve, an hysteresis of [+2K/-2K] on the discharge temperature control point can be applied. It can be customizable on a range [+5K/-5K] by step of 1K.

For reliability reasons, Danfoss recommend to control each compressor. This means that an individual DGT and an LIV per compressor is recommended.

DGT criteria

The temperature sensor should be placed in contact on the discharge pipe at 40mm from the connection to the compressor. Thermal paste between the sensor and the pipe combined to a surrounded thermal insulation improve the measurement of this temperature.

The table below presents a pre-selection of LIV, DGT sensor and controller for the different configurations of PSF using R32.

The components selected based on dedicated conditions, they can cover most of the applications. Customer should always do their qualification based on different system.

If any question, please contact Danfoss technical support.

Model		LIV	DGT temperature sensor	Controller
50 Hz	PSF065	ETS 5M30	AKS21 sensor (or other PT1000) [084N2003]	EKE110 1V + EKE 2U [080G5059 + 080G5555]
	PSF072			

Vapor + Wet injection

To improve the performances, PSF compressors can use Vapor + Wet injection (see “Introduction” for a general presentation). A continuous 5K superheated vapor injection occurs on the related map (see “Operating envelope data” - VI operating map). When the DGT starts to increase due to the operating conditions, the superheat of the vapor injection shall be decreased to keep the DGT between 121°C and 135°C. A dedicated expansion valve, an Intermediate Exchanger and a solenoid valve per compressor need to be integrated on the refrigerant circuit.

The table below presents a pre-selection of EXV, IE and Sol v for the different configurations of PSF using R32.

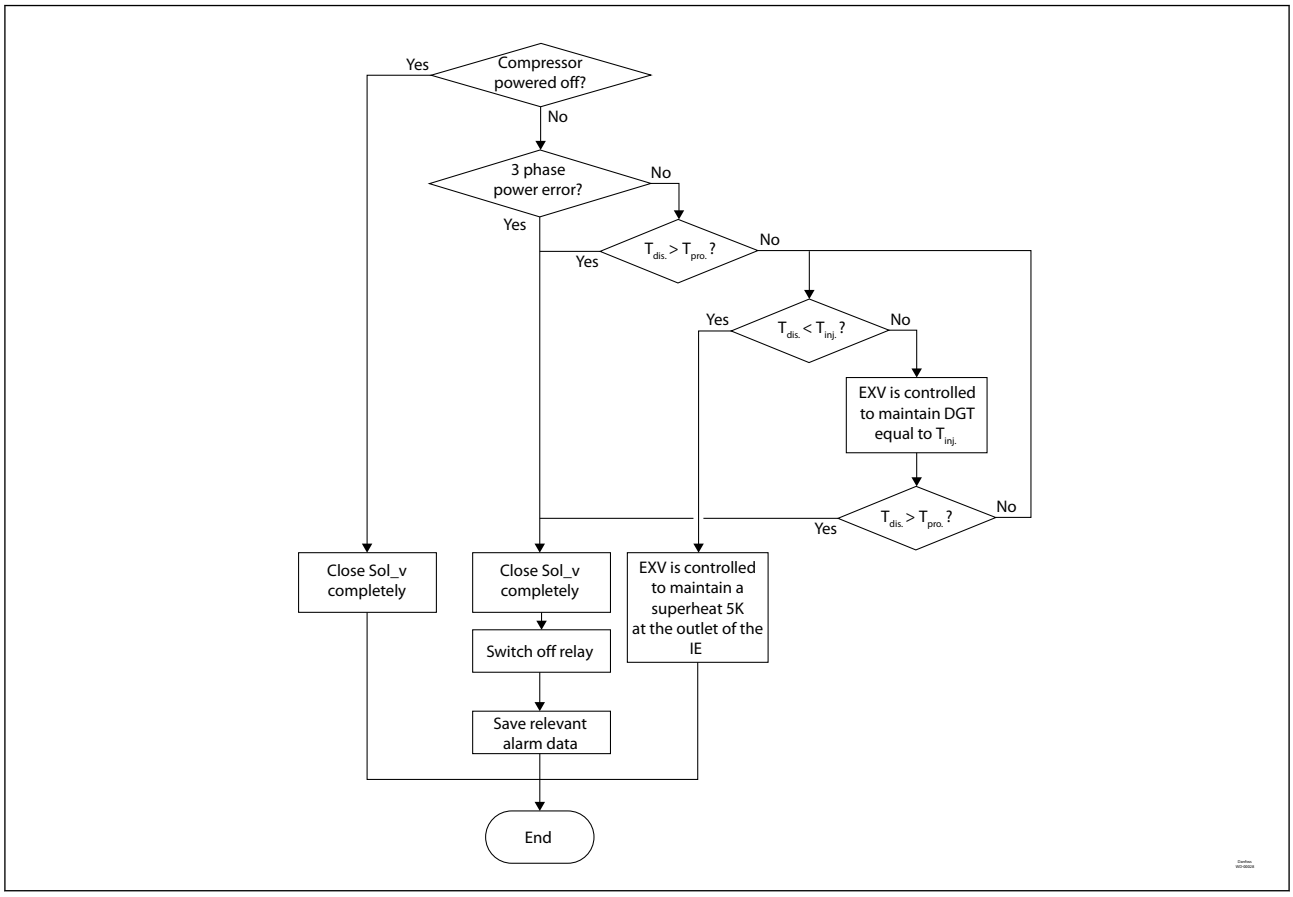
NOTE:
These selections allow to cover Vapor + Wet injection for hydronic Heat pumps for evaporating temperature up to 15°C and pressure ratio higher than 2.

For more specific applications or for optimized selection, please contact Danfoss.

Model		Architecture	Injection EXV	IE	Injection temperature sensor	DGT temperature sensor	Controller
50Hz	PSF065	Upstream	ETS 5M17	D22L-18	All type of PT1000/ NTC10K temperature sensor	AKS21 sensor (or other PT1000) [084N2003]	EKE110 1V + EKE 2U [080G5059 + 080G5555]
		Downstream		D22L-20			
	PSF072	Upstream	ETS 5M17	D22L-20			
		Downstream		D22L-22			

EXV	Electronic Expansion Valve (ETS 5M will release in Q2/2025)
IE	Intermediate Exchanger
Sol v	Solenoid Valve

In the VI+WI injection configuration, the architecture of the unit and the control logic must manage the flow of liquid injected following the flowchart below.



$T_{dis.}$	Compressor discharge temperature
$T_{pro.}$	Discharge temperature protection setpoint. It should be 135°C
$T_{inj.}$	The advice discharge temperature control point is 121°C

NOTE:
To avoid short cycling of the Liquid Injection valve, an hysteresis of [+2K/-2K] on the discharge temperature control point can be applied. It can be customizable on a range [+5K/-5K] by step of 1K.

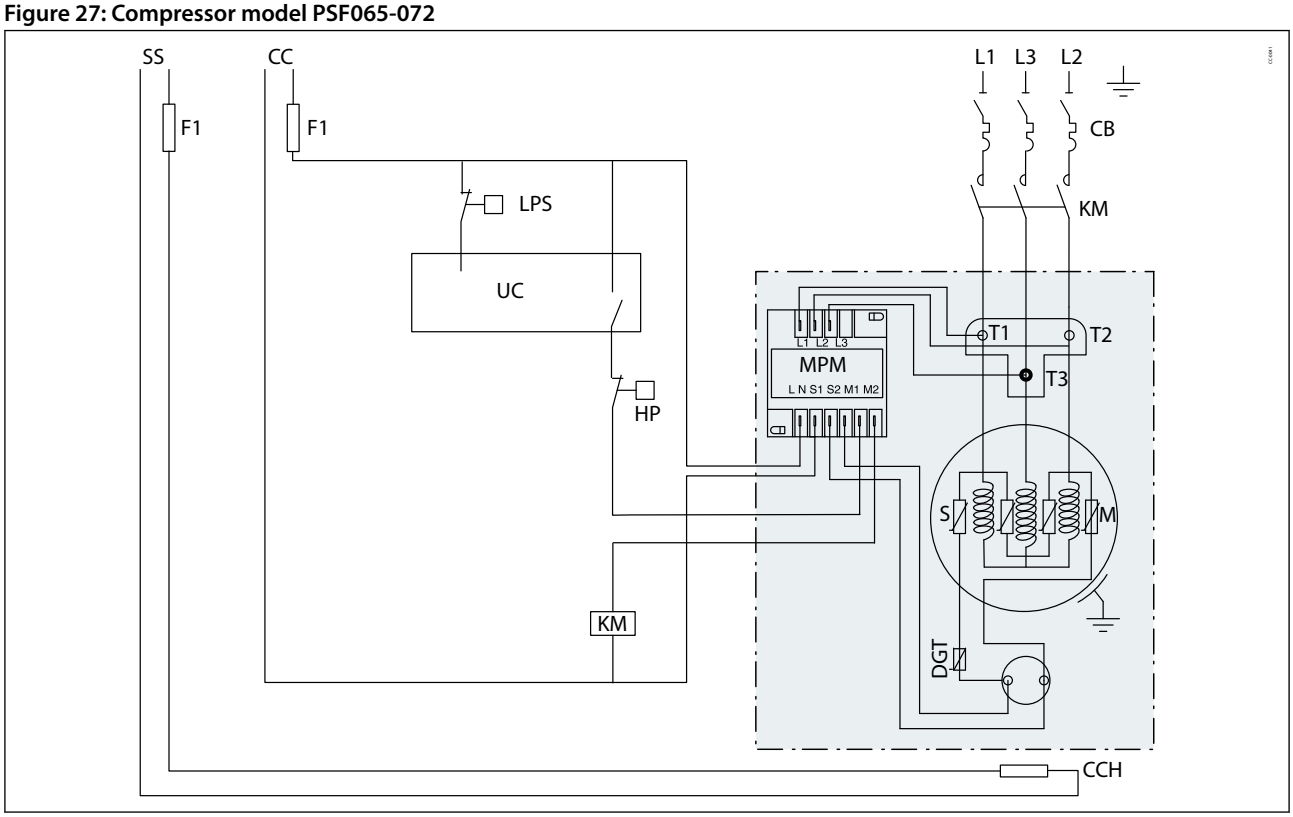
Power supply and electrical protection

Wiring information Requirements

- Protect the compressor from short circuit and overcurrent by a thermal magnetic motor circuit breaker set to Max. operating current or lower (see table in section Three phase electrical characteristics).
- Compressor models PSF065-072 are delivered with a pre-installed motor protection module inside the terminal box that must be powered on.
- HP safety switch and electronic module relay output (M1-M2) must be wired in the safety chain. Other safety devices such as LP can be either hardware or software managed.
- Provide separate electrical supply for the heaters so that they remain energized even when the machine is out of service (e.g. seasonal shutdown).

The wiring diagrams below are examples for a safe and reliable compressor wiring:

Figure 27: Compressor model PSF065-072



CB	Thermal magnetic motor circuit breaker	**M**	Compressor motor
CC	Control circuit	**MPM**	Motor Protection Module
DGT	Discharge gas thermistor (embedded in compressor)	**S**	Thermistor chain (motor and discharge temperature)
F1	Fuses	**SS**	Seprate supply
HP	High pressure safety switch	**CCH**	Crankcase heater
KM	Compressor contactor	**UC**	Unit Controller
LPS	Safety pressure switch		

Soft starts

Soft starters are designed to reduce the starting current of 3-phase AC motors. Soft starters can be used on PSF compressor but, in order to ensure proper lubrication of compressor parts, the settings must ensure that the compressor start-up time is always less than 0.5 seconds.

Ramp-down must be set to minimum to ensure proper discharge valve closing.

Make sure that the softstarter selected is compatible with A2L refrigerants.

Control logic

Safety control logic requirements

Safeties	Tripping conditions		Re-start conditions	
	Value	Time	Value	Time
HP safety switch	See Pressure settings table from section Manage operating envelope	Immediate, no delay. No by-pass	Conditions back to normal. Switch closed again.	Manual reset
LP safety switch				Maximum 5 auto reset during a period of 12 hours, then manual reset.
Electronic module (Motor protection, DGT)	Contact M1-M2 opened			

Cycle rate limit requirements

Danfoss requires a minimum compressor running time of 2 minutes to ensure proper oil return and sufficient motor cooling.

Additionally, compressor must not exceed 12 starts per hour. 12 starts per hour must not be considered as an average, this is the maximum number of starts acceptable to keep a good regulation accuracy during low load.

Oil management logic recommendations

In some cases, oil management can be enhanced by control logic:

- If oil return test failed, a function can be integrated in control logic to run all compressors simultaneously during 2 minutes every hour in order to boost oil return. Time and delay can be fine-tuned by oil return test N°1 in section Manage oil in the circuit. During oil boost, pay special attention to superheat management to avoid liquid flood back.
- In trio system, after running long time in same state with 2 or 3 compressors, (1+2+3) or (1+2), (2+3) or (3+1), oil unbalance may appears. A function can be implemented in control logic to stop all compressors during one minute every two hours in order to balance oil. Time and sequence can be fine-tuned during Oil balancing test in section Manage oil in the circuit.

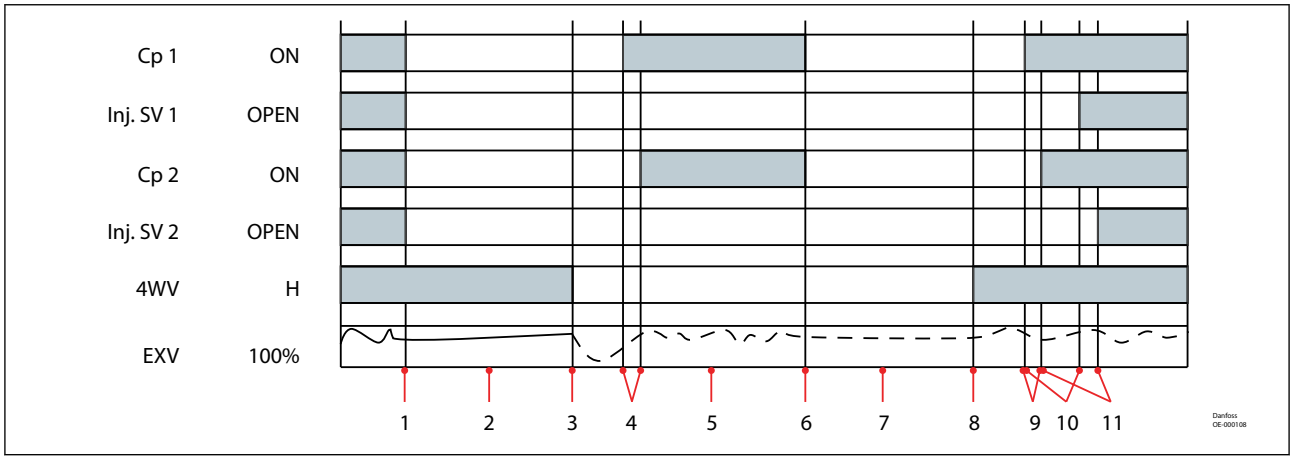
Defrost logic recommendations / Reversible systems

In reversible systems, the defrost logic can be worked out to limit liquid flood back effect by:

1. Running full load during defrost to share liquid refrigerant between all compressors.
2. Reducing refrigerant flooding to compressor by transferring liquid refrigerant from one exchanger to the other before reversing valve thanks to pressures.

The following defrost logic combines both advantages:

Figure 28: Defrost logic advantages



Cp 1	Compressor 1
Cp 2	Compressor 2
ON	On
H	Heating
Inj.SV	Injection solenoid valve
OPEN	Open
1	Defrost start. Stop all compressors
2	4 Way Valve (4WV) stays in heating mode. EXV opened to transfer liquid from outdoor to indoor exchanger thanks to pressure difference.
3	When pressures are almost balanced[1], change 4WV to cooling mode.
4	Start Cp1 and Cp 2 with 0.5 seconds delay between 2 successive starts
5	Defrost
6	Defrost end. Stop all compressors
7	4 WV stays in cooling mode. EXV opened to transfer liquid from indoor to outdoor exchanger thanks to pressure difference
8	When pressures are almost balanced[1], change 4WV to heating mode.
9	Start Cp1 and Cp2 with a minimum delay of 0.5 s between two successive starts
10	Open vapor injection valve 1 with at least 5 seconds delay than compressor 1 start-up
11	Open vapor injection valve 2 with at least 5 seconds delay than compressor 2 start-up

In reversible systems, to ensure compressor reliability, the 4-way valve must not reverse when the compressor is stopped due to heating or cooling demand (stop on thermostat).

[1] EXV Opening degree and time have to be set to keep a minimum pressure for 4 way valve moving. In any case, defrost logics must respect requirements and tests described in sections Manage superheat and Operating envelope data.

Pump-down logic recommendations

Pump down is initiated prior to shutting down the last compressor on the circuit by de-energizing a liquid line solenoid valve or closing electronic expansion valve. When suction pressure reached the cut-out pressure, compressor is stopped, and liquid solenoid valve or electronic expansion valve remains closed.The injection line should keep on working in case of the high discharge temperature during the pump down cycle.

Recommend pump down type:

- One shot pump down: when last compressor of the circuit stops, suction presssure is decreased 1.5bar (22psi) below nominal evaporating pressure with the minimum low pressure safety switch setting. Even if suction pressure increases again, the compressor will not restart.

Non Return Valve (NRV)

PSF065-072 compressors integrate tight internal non return valve (INRV), therefore no external Non Return Valve (NRV) is needed.

Assembly line procedure

Compressor storage

Store the compressor not exposed to rain, corrosive or flammable atmosphere between -35°C (-31°F) and 70°C (158°F) when charged with nitrogen and between -35°C (-31°F) and Ts max value (see section Pressure requirement) when charged with refrigerant.

Compressor holding charge

Each compressor is shipped with a nominal dry nitrogen holding charge between 0.3bar (4 psi) and 0.7bar (10psi) and is sealed with elastomer plugs.

Respect the following sequence to avoid discharge check valve gets stuck in open position:

- Remove the suction plug first
- Remove the discharge plug afterwards
- Remove the injection port plug at last

R An opened compressor must not be exposed to air for more than 20 minutes to avoid moisture is captured by the POE oil.

Handling

R Each Danfoss scroll compressor is equipped with two lift rings on the top shell.

- Always use both these rings when lifting the compressor.
- Use lifting equipment rated and certified for the weight of the compressor or compressor assembly.
- A spreader bar rated for the weight of the compressor is highly recommended to ensure a better load distribution.
- The use of lifting hooks closed with a clasp is recommended.
- For tandem and trio assemblies, use a spreader bar and all compressor rings as shown in picture below.
- Never use the lift rings on the compressor to lift the full unit.

Maintain the compressor in an upright position during all handling manoeuvres (maximum of 15° from vertical).

Figure 29: Heavy



Figure 30: Correct

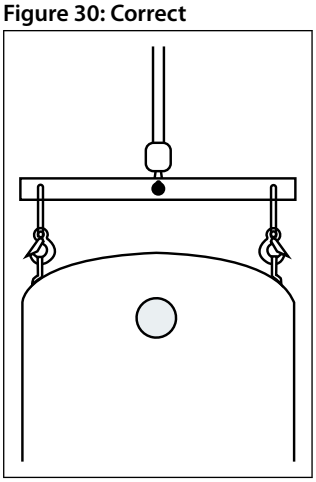


Figure 31: Incorrect

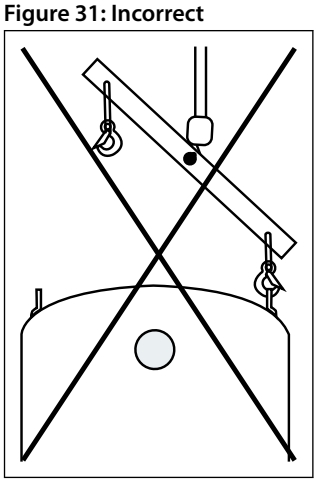
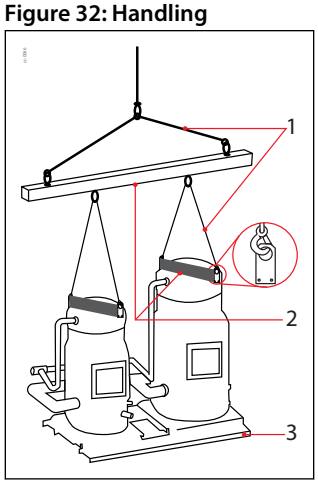


Figure 32: Handling



1	Slings
2	Spreader bars
3	Frame

Piping assembly

Good practices for piping assembly is a pre-requisite to ensure compressor life time (system cleanliness, brazing procedure etc.)

Table 18: System cleanliness

Circuit contamination possible cause:	Requirement:
Brazing and welding oxides	During brazing, flow nitrogen through the system.
Particles and burrs	Remove any particles and burrs generated by tube cutting and hole drilling.
Moisture and air	Use only clean and dehydrated refrigeration grade copper tubing. Opened compressor must not be exposed to air more than 20 minutes to avoid moisture captured by oil.

Brazing procedure:
- Brazing operations must be performed by qualified personnel.
- Make sure that no electrical wiring is connected to the compressor.
- To prevent compressor shell and electrical box overheating, use a heat shield and/or a heat-absorbent compound.
- Clean up connections with degreasing agent
- Flow nitrogen through the compressor.
- It is recommended to use double-tipped torch using acetylene to ensure a uniform heating of connection.
- For discharge connections brazing time should be less than 2 minutes to avoid NRVI damages if any.
- To enhance the resistance to rust, a varnish on the connection is recommended.

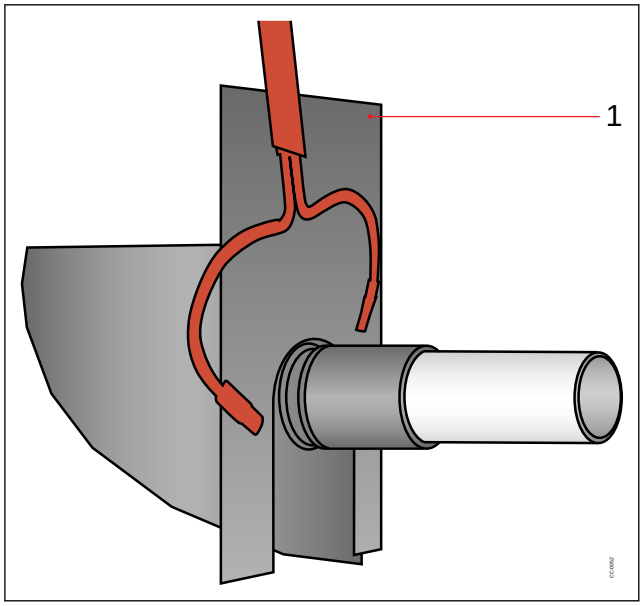
PSF compressors connectors are made of steel copper coated, which benefit to protect against corrosion and facilitate adhesion during brazing operation.

As per standards practice in the refrigeration industry, Danfoss Commercial Compressor recommend to use of silver cadmium free solder alloy and flux (added or flux coated rods). The significant silver content in these brazing alloy will help the brazing operation, providing an excellent fluidity and a limited heating temperature. It will bring also a good resistance to corrosion, a proper elongation compatible with system vibration, and good behavior under thermal variation improving the strength of connection and limiting fractures and refrigerant leaks. (Crucial with A2L refrigerants) A typical content of 34% Ag (Silver) is recommended by Danfoss.

The use of self-flux alloys (as phosphorous alloys) is not recommended by Danfoss. This type of brazing require a higher working temperature, that may overheat the connectors, damaging the thin layer of copper ,resulting in phosphides creation and joint zone embrittlement.

For more detailed information see " Brazing technique for compressors connectors" AP192186420580.

Figure 33: Brazing procedure



1	Heat shield

R Before eventual un-brazing of the compressor or any system component, the refrigerant charge must be removed and the installation vacuumed (especially with A2L refrigerants).

System pressure test and leak detection

R The compressor has been strength tested and leak proof tested (<3g/year) at the factory. For system tests:

- Always use an inert gas such as Nitrogen or Helium.
- Pressurize the system on HP side first then LP side.
- Do not exceed the following pressures indicated in table below

Table 19: System pressure test and leak detection

Maximum compressor test pressures	PSF065-072
Maximum compressor test pressure high side (HP)	53.6 bar (g) (777 psig) HP-LP<37 bar (537 psi)
Maximum compressor test pressure low side (LP)	34.3bar (g) (497psig) LP – HP <5bar (73psi) Maximum speed 4.8bar/s (70psi/s) [1]

[1] The maximum pressurizing speed must be respected to ensure pressure equalization between LP and HP side over scroll elements.

Vacuum evacuation and moisture removal

Requirements:

- Never use the compressor to evacuate the system.
- Connect a vacuum pump to both the LP and HP sides.
- Evacuate the system to a pressure of 500 µm Hg (0.67 mbar/0.02 in.Hg) absolute.

Recommendations:

- Energized heaters improve moisture removal.
- Alternate vacuum phases and break vacuum with Nitrogen to improve moisture removal.

For more detailed information see “Vacuum pump-down and dehydration procedure” TI-026-0302.

Refrigerant charging

Initial charge:

- For the initial charge, the compressor must not run.
- Charge refrigerant as close as possible to the nominal system charge.
- This initial charging operation must be done in liquid phase between the condenser outlet and the filter drier.

If needed, a complement of charge can be done before evaporator, in liquid phase while compressor is running by slowly throttling liquid in.

Never bypass safety low pressure switch.

For more detailed information see “Recommended refrigerant system charging practice“ AP000086421422.

Dielectric strength and insulation resistance tests

Several tests have been performed on each compressor at the factory between each phase and ground.

- Dielectric strength test is done with a high potential voltage (hi-pot) of 2Un +1000V AC at least, and leakage current must be less than 5 mA.
- Insulation resistance is measured with a 500 V DC megohm tester and must be higher than 1 megohm.

Recommendations:

- Additional dielectric test is not recommended as it may reduce motor lifetime. Nevertheless, if such as test is necessary, it must be performed at a lower voltage.
- Insulation resistance test can be done.
- The presence of refrigerant around the motor windings will result in lower resistance values to ground and higher leakage current readings. Such readings do not indicate a faulty compressor. To prevent this, the system can be first operated briefly to distribute refrigerant.

Do not use a megohm meter nor apply power to the compressor while it is under vacuum as this may cause internal damage.

Commissioning

Preliminary check

Check electrical power supply:

- Phase order: Reverse rotation is obvious if the compressor do not build up pressure and sound level is abnormal high.

The PSF065-072 compressors equipped with an electronic module, reverse rotation will be automatically detected. For more details refer to section Motor protection.

- Voltage and voltage unbalance within tolerance: For more details refer to section Motor voltage.

Initial start-up

- Crankcase heaters must be energized at least 6 hours in advance to remove refrigerant.
- A quicker start-up is possible by “jogging” the compressor to evacuate refrigerant. Start the compressor for 1 second, then wait for 1 to 2 minutes. After 3 or 4 jogs the compressor can be started. This operation must be repeated for each compressor individually.

System monitoring

The system must be monitored after initial startup for a minimum of 60 minutes to ensure proper operating characteristics such as:

- Correct superheat and subcooling.
- Current draw of individual compressors within acceptable values (max operating current).
- No abnormal vibrations and noise.
- Correct oil level.

If Oil Top-up is needed, it must be done while the compressor is idle. Use the schrader connector or any other accessible connector on the compressor suction line. Always use original Danfoss POE oil 185SL from new cans. For more detailed information see “Lubricants filling in instructions for Danfoss Commercial Compressors” AP000086435866.

Dismantle and disposal



Danfoss recommends that compressors and compressor oil should be recycled by a suitable company at its site.

Packaging

Single pack



Table 20: Single pack packaging

Compressor model	Length		Width		Height		Gross weight	
	mm	inch	mm	inch	mm	inch	kg	lbs
PSF065-072	750	29.5	750	29.5	1050	41.3	131	289

Industrial pack



Table 21: Industrial pack packaging

Compressor model	Compressors per pack	Length		Width		Height		Gross weight		Static stacking pallets
		mm	inch	mm	inch	mm	inch	kg	lbs	
PSF065-072	6	1150	45.3	965	38	768	30.2	712	1570	2

Ordering

Danfoss scroll compressors PSF can be ordered in either industrial packs or in single packs. Please use the code numbers from below tables for ordering.

Single pack



Table 22: Single pack compressors

Compressor model	Connections	Motor protection	Code no.
			8
			380/3/50
PSF065A8EPA	Brazed	Module 110-240V	120H2549
PSF072A8EPA	Brazed	Module 110-240V	120H2547
PSF065A8FPA	Brazed	Module 110-240V	120H2545
PSF072A8FPA	Brazed	Module 110-240V	120H2543

Industrial pack



Table 23: Industrial pack compressors

Compressor model	Connections	Motor protection	Code no.
			8
			380/3/50
PSF065A8EPA	Brazed	Module 110-240V	120H2550
PSF072A8EPA	Brazed	Module 110-240V	120H2548
PSF065A8FPA	Brazed	Module 110-240V	120H2546
PSF072A8FPA	Brazed	Module 110-240V	120H2544

Accessories and Spare parts

Solder sleeve adapter set

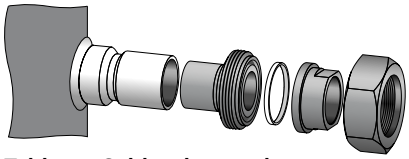


Table 24: Solder sleeve adapter set

Code no.	Description	Application	Packaging	Pack size
7765028	Rotolock adaptor set (2"1/4 ~ 1"5/8) , (1"3/4 ~ 1"1/8)	PSF065-072	Multipack	6

Rotolock adapter

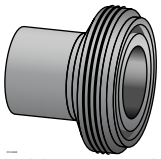


Table 25: Rotolock adapter

Code no.	Description	Application	Packaging	Pack size
120Z0364	Adaptor (1"3/4 Rotolock - 1"1/8 ODS)	Models with 1"1/8 ODF	Multipack	10
120Z0432	Adaptor (2"1/4 Rotolock - 1"5/8 ODS)	Models with 1"5/8 ODF	Multipack	10

Gaskets



Table 26: Gaskets

Code no.	Description	Application	Packaging	Pack size
8156132	Gasket, 1"3/4	Models with 1"3/4 rotolock connection	Multipack	10
7956003	Gasket, 1"3/4	Models with 1"3/4 rotolock connection	Industry pack	50
8156133	Gasket, 2"1/4	Models with 2"1/4 rotolock connection	Multipack	10
7956004	Gasket, 2"1/4	Models with 2"1/4 rotolock connection	Industry pack	50

Solder sleeve



Table 27: Solder sleeve

Code no.	Description	Application	Packaging	Pack size
8153004	Solder sleeve P02 (1"3/4 Rotolock - 1"1/8 ODF)	Models with 1"3/4 rotolock connection	Multipack	10
8153006	Solder sleeve P03 (2"1/4 Rotolock - 1"5/8 ODF)	Models with 2"1/4 rotolock connection	Multipack	10

Rotolock nut



Table 28: Rotolock nut

Code no.	Description	Application	Packaging	Pack size
8153124	Rotolock nut,1"3/4	Models with 1-3/4" rotolock connection	Multipack	10
8153126	Rotolock nut, 2"1/4	Models with 2-1/4" rotolock connection	Multipack	10

Motor protection modules



Table 29: Motor protection modules

Code no.	Description	Application	Packaging	Pack size
120Z0938	Electronic motor protection module, 110/240 V	PSF065-072	Single pack	1

Crankcase heaters



Table 30: Belt type heaters

Code no.	Description	Application	Packaging	Pack size
7773108	Belt type crankcase heater,75W,230V,CE & UL	PSF065-072	Multipack	6
7973005	Belt type crankcase heater,75W,230V,CE & UL	PSF065-072	Industry pack	50
7773118	Belt type crankcase heater,75W,400V,CE & UL	PSF065-072	Multipack	6
120Z0870	Belt type crankcase heater,75W,24V,CE & UL	PSF065-072	Multipack	6
7773122	Belt type crankcase heater, 130W, 230V, CE & UL	PSF065-072	Multipack	4
7773123	Belt type crankcase heater, 130W, 400V, CE & UL	PSF065-072	Multipack	4

Mounting hardware



Table 31: Mounting hardware

Code no.	Description	Application	Packaging	Pack size
8156138	Mounting kit for scroll compressors. Grommets, sleeves, bolts, washers	PSF065-072	Single pack	1

Lubricant



Table 32: Lubricant

Code no.	Description	Packaging	Pack size
120Z0750	POE lubricant 185SL, 1 litre can	Multipack	12

Terminal boxes, covers and T-block connectors



Table 33: Terminal boxes, covers and T-block connectors

Code no.	Description	Application	Packaging	Pack Size
120Z0774	T block connector 80 x 80 mm	PSF065-072	Multipack	10
120Z0458	Terminal box 210 x 190 mm, incl. cover	PSF065-072	Single pack	1

Miscellaneous



Table 34: Miscellaneous

Code no.	Description	Packaging	Pack Size
8156019	Sight glass with gaskets (black & white)	Multipack	4
8156129	Gasket for oil sight glass, 1"1/8 (white teflon)	Multipack	10
7956005	Gasket for oil sight glass, 1"1/8 (white teflon)	Multipack	50
8154001	Danfoss Commercial Compressors blue spray paint	Single pack	1

Tandem kits

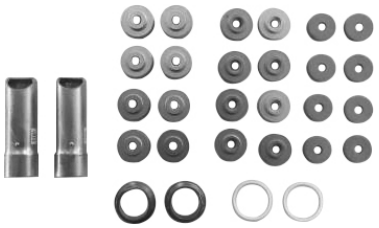


Table 35: Tandem kits

Code no.	Description	Application	Packaging	Pack Size
120Z0792	Kit Tandem, Solid, OEL 1" 3/8	PSF130-144E	Single pack	1

ENGINEERING
TOMORROW

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