ENGINEERING
TOMORROW

Application guidelines

# Danfoss scroll compressor
# **PSH 065/105**

50 Hz - R410A

http://cc.danfoss.com

Danfoss scroll 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:

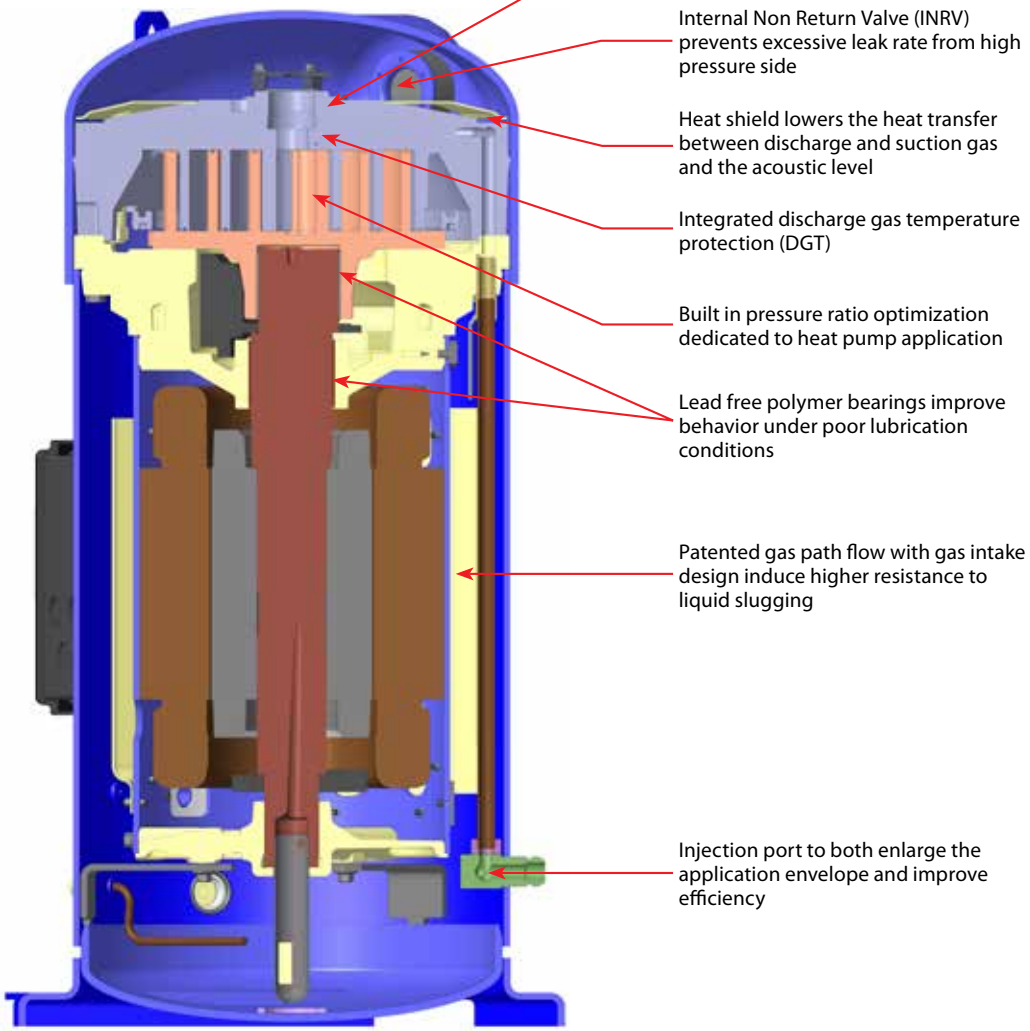
This icon indicates instructions to avoid reliability risk.


This icon indicates instructions to avoid safety risk.

The purpose of this guideline is to help customers qualify compressors in the unit. You are strongly advised 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.

## Overview

Danfoss PSH 065/105 compressor is optimized for heat pump application. Moreover, it benefits from an improved design to achieve the highest efficiency and increased life time.



## Vapor injection

The PSH 065/105 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.

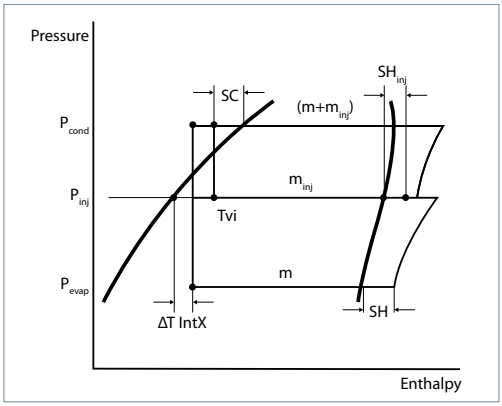
**ΔT IntX:** Difference of temperature between the outlet of intermediate exchanger and the intermediate pressure bubble point.

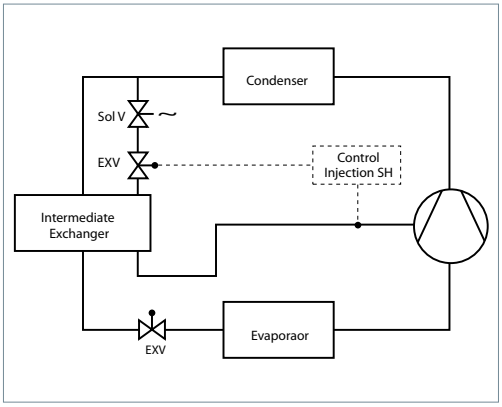
**Suct SH:** Superheat at compressor suction.

**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.




The injection massflow must be regulated through an EXV piloted by the injection superheat which must be above 5K

It is 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.

The vapor injection must not be activated during inversion cycles.

## 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 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 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.

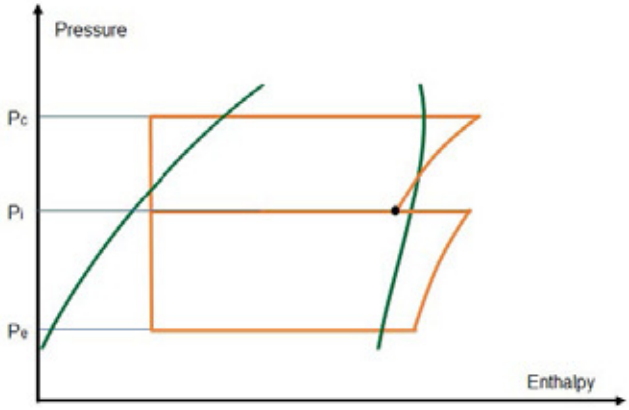
## Liquid injection

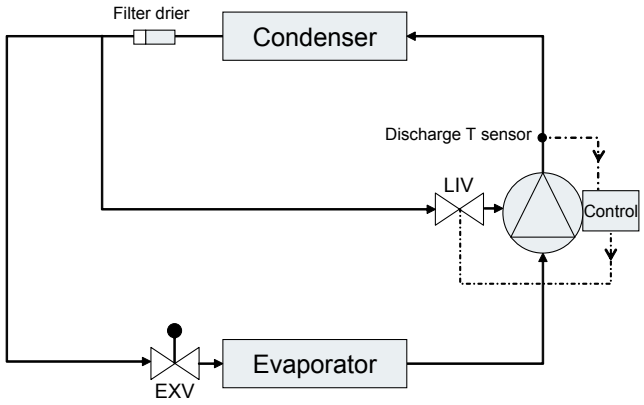
Danfoss PSH 065/105 requires liquid injection to maintain sufficiently low discharge gas temperature in the operating envelope. The PSH 065/105 compressors are provided with a liquid injection connection.

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.

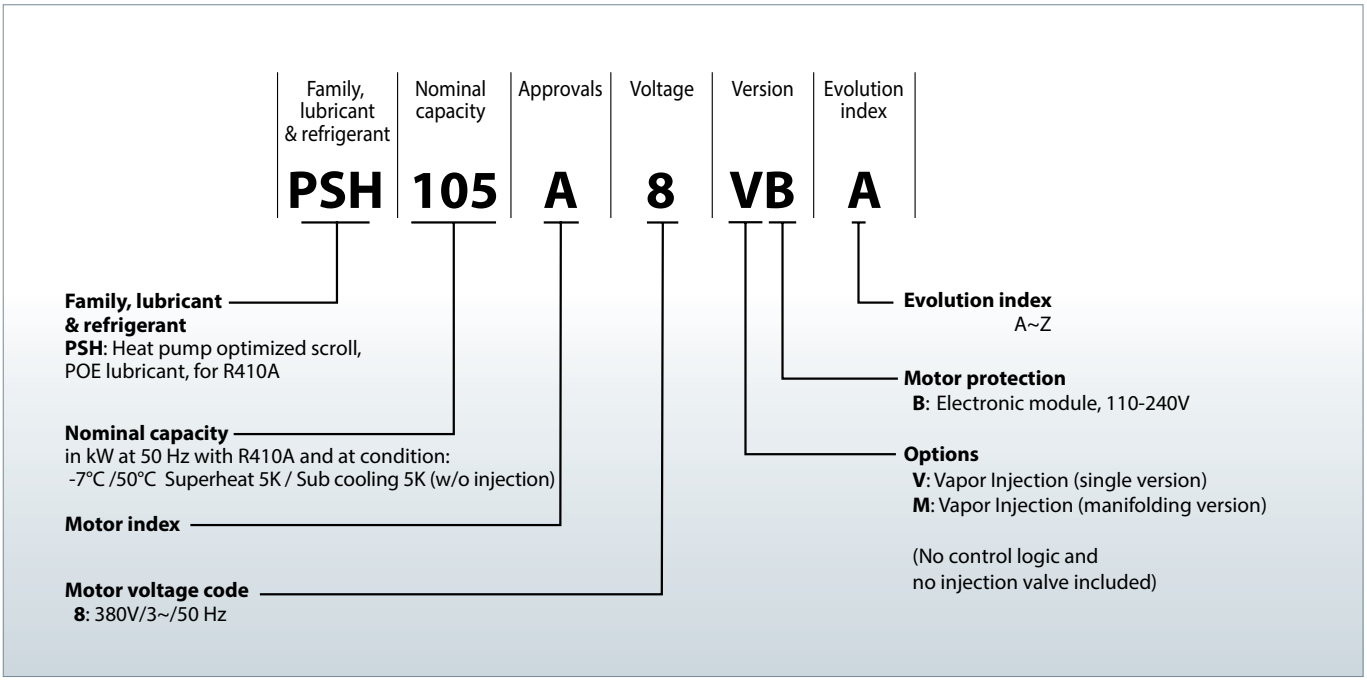


## Compressor model designation

Danfoss scroll compressor PSH 065/105 is available as single compressor. This compressor is only for no split application. 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 codes".

### Nomenclature



## 50Hz data

| Model | Swept volume | Displacement* | Oil charge | Net weight** |
|---|---|---|---|---|
| | $cm^3/rev$ | $m^3/h$ | $dm^3$ | kg |
| PSH065 | 272.8 | 47.5 | 6.1 | 117 |
| PSH105 | 442.6 | 77 | 6.1 | 179 |

* at 2900 tr/min
** net weight with oil charge

## With vapor injection performance

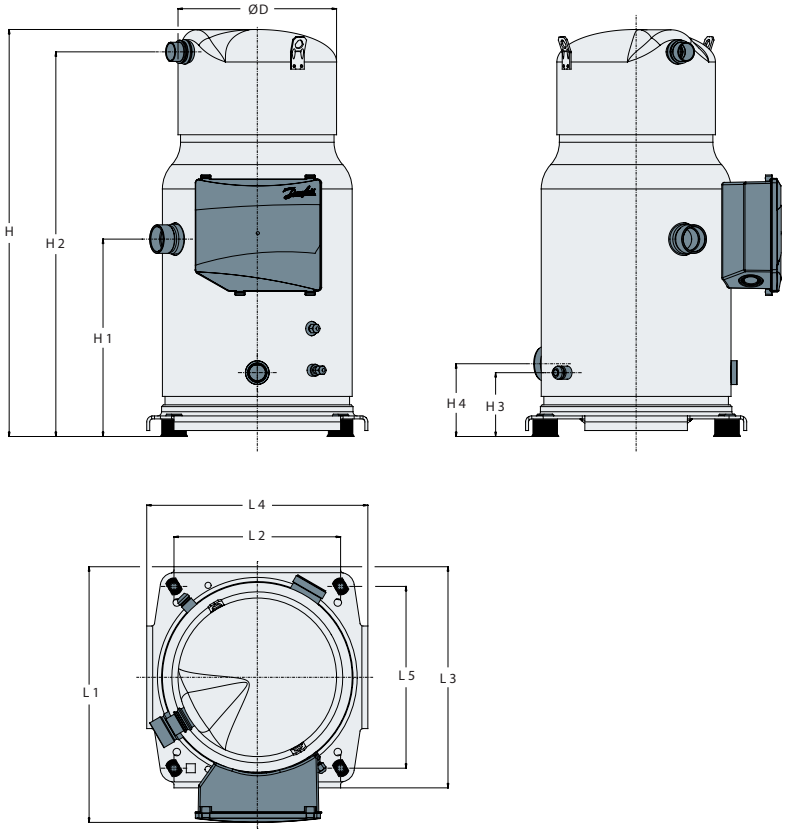
| Model | Conditions | | | | | | Nominal heating capacity | Power input | Heating COP |
|---|---|---|---|---|---|---|---|---|---|
| | Evap temp | Cond temp | ΔT intX | Suction Superheat | Injection Superheat | Subcooling | | | |
| | °C | °C | K | K | K | K | W | W | W/W |
| PSH065 | -8 | 58 | 5 | 10 | 5 | 5 | 70994 | 25795 | 2.8 |
| | -7 | 50 | 5 | 10 | 5 | 5 | 73075 | 21686 | 3.4 |
| PSH105 | -8 | 58 | 5 | 10 | 5 | 5 | 116701 | 42141 | 2.8 |
| | -7 | 50 | 5 | 10 | 5 | 5 | 119793 | 35747 | 3.4 |

## Without vapor injection performance

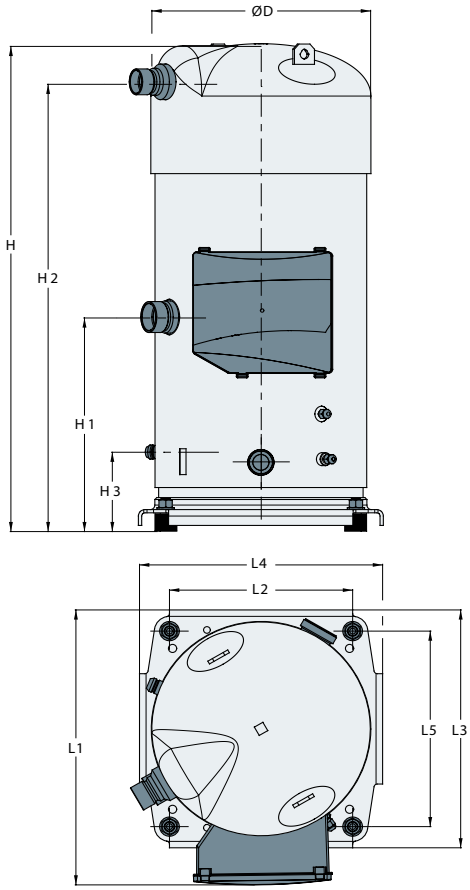
| Model | Conditions | | | | Nominal cooling capacity | Power input | Cooling COP |
|---|---|---|---|---|---|---|---|
| | Evap temp | Cond temp | Suction Superheat | Subcooling | | | |
| | °C | °C | K | K | W | W | W/W |
| PSH065 | 3 | 50 | 10 | 5 | 62100 | 20065 | 3.1 |
| PSH105 | 3 | 50 | 10 | 5 | 101574 | 32740 | 3.1 |

## Dimensions

### Single compressors




PSH065

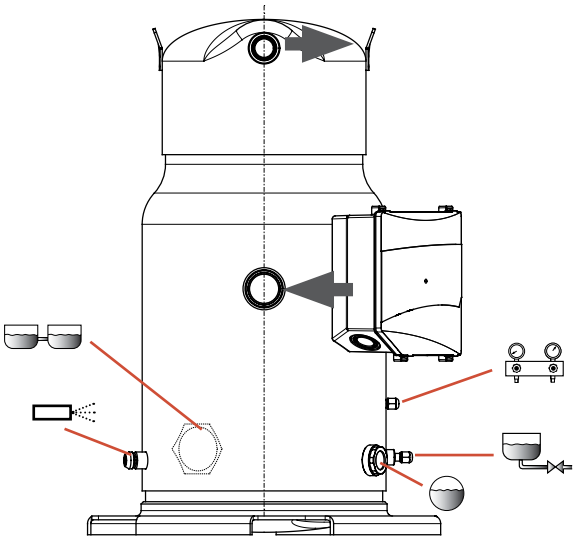



PSH105

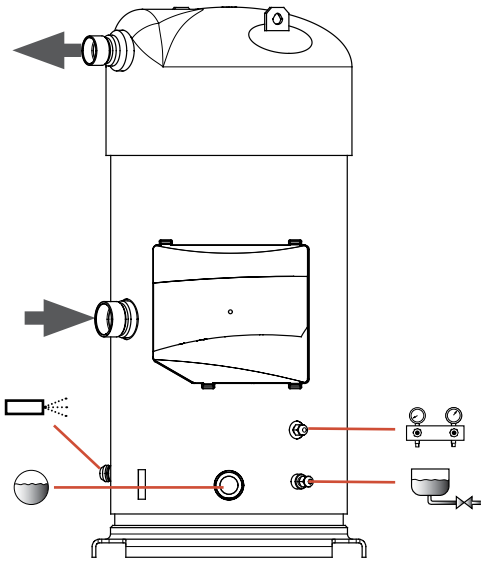
| Compressor model | D (mm) | H (mm) | H1 (mm) | H2 (mm) | H3 (mm) | H4 (mm) | L1 (mm) | L2 (mm) | L3 (mm) | L4 (mm) | L5 (mm) | Outline drawing number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PSH065 Single version | 265.9 | 682.5 | 331 | 645 | 107 | - | 429 | 279.4 | 371 | 370.8 | 305 | 8556305 |
| PSH065 manifolding version | 265.9 | 682.5 | 331 | 645 | 107 | 122 | 429 | 279.4 | 371 | 370.8 | 305 | 8556341 |
| PSH105 | 333 | 755.5 | 332.5 | 696.5 | 123.5 | - | 429 | 279.4 | 371 | 370.8 | 305 | 8556300 |

## Connection details

| Connection Details | PSH065 Single | PSH065 Manifolding | PSH105 |
|---|---|---|---|
| Suction connection | Brazed 1" 5/8 | Brazed 1" 5/8 | Brazed 1" 5/8 |
| Discharge connection | Brazed 1" 1/8 | Brazed 1" 1/8 | Brazed 1" 3/8 |
| Oil sight glass | None | Threaded (1"1/8 - 18 UNEF) | Threaded (1"1/8 - 18 UNEF) |
| Oil equalization connection | None | Rotolock 2" 1/4 | 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 | 1/2" ODF |



**PSH065**



**PSH105**

## Motor voltage

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

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:

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

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.

## Wiring connections

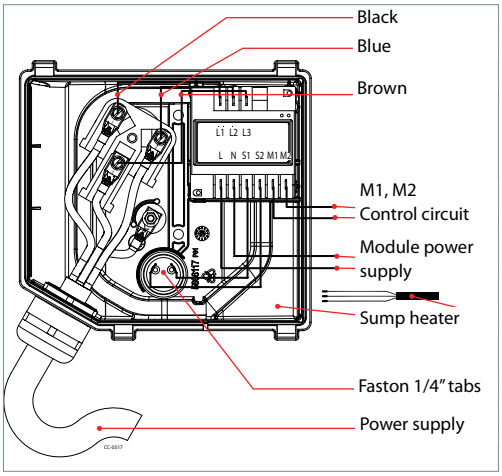
For PSH065, electrical power is connected to the compressor terminals by Ø 4.8 mm (3/16") screws. For PSH105,electrical power is connected to the compressor terminals by M5 studs and nuts.

The maximum tightening torque is 3 Nm. Use a 1/4" ring terminal on the power leads.

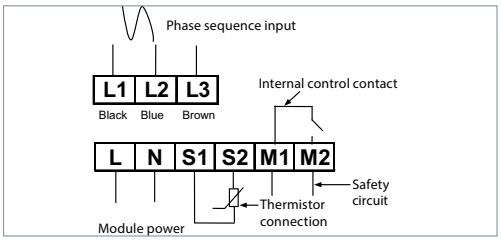
The terminal box is provided with 2 triple knockouts and 1 single knockout for power supply and 4 double knockouts for the safety control circuit.

The 3 power supply knockouts accommodate the following diameters:
- Ø 50.8 mm (UL 1"1/2 conduit) & Ø 43.7 mm (UL 1"1/4 conduit) & Ø 34.5 mm (UL 1" conduit)
- Ø 40.5 mm (ISO40) & Ø 32,2 mm (ISO32) & Ø 25.5 mm (ISO25)
- Ø 25.5 mm (ISO25)

The 4 others knockouts are as follows:
- Ø 22.5 mm (PG16) (UL 1/2") & Ø 16.5 mm (ISO16) (x2)
- Ø 20.7 mm (ISO20 or PG13.5) (x2)



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 6.3-mm size Faston type.




## IP rating

The compressor terminal box according to IEC529 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. 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.

## Three phase electrical characteristics

| Compressor model | | LRA | Max. operating current | Winding resistance |
|---|---|---|---|---|
| | | A | A | Ω |
| Motor voltage code 8 380V / 3ph / 50 Hz | PSH065 | 250 | 56 | 0.496 |
| | PSH105 | 349 | 91 | 0.285 |

**LRA (Locked Rotor Amp)**

Locked Rotor Amp value is the highest average current 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.

**Max. operating Current**

The MOC is the maximum amperage that the compressor will draw staying in its application envelope.

MOC can be used to select cables and contactors. In normal operation, the compressor current consumption is often less than the MOC value.

**Winding resistance**

Winding resistance is the resistance between phases at 25°C (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, the measured resistance must be corrected using the following formula:

$$R_{tamb} = R_{25°C} \frac{a + t_{amb}}{a + t_{25°C}}$$

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

**Motor protection**

Compressor PSH065/105 is 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.

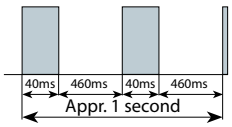
The motor protector comprises a control module and PTC sensors embedded in the motor winding.

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 (4.500 Ω) and the output relay then trips – i.e. contacts M1-M2 are open. After cooling to below the response temperature (resistance < 2.750 Ω), a 5-minute time delay is activated.

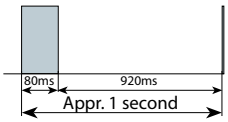
After this delay has elapsed, the relay is once again pulled in – i.e. contacts M1-M2 are closed. The time delay may be cancelled by means of resetting the mains (L-N -disconnect) for approximately 5 sec.

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:

PTC overheat




Delay timer active (after PTC over temp.)

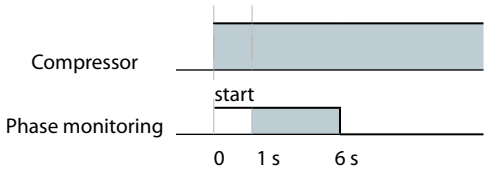


**Phase sequence and reverse rotation protection**

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 PSH065/105 is delivered with an electronic module which provides protection against phase reversal and phase loss at start-up.

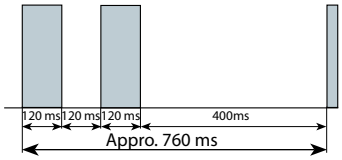
The phase sequencing and phase loss monitoring functions are active during a 5-sec window 1 second after compressor start-up (power on L1-L2-L3).



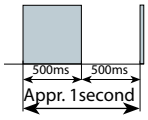

Phase sequence module logic

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:

In case of phase reverse error:




In case of phase loss error:




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" FRCC.PI.031.

## Pressure requirement

| Products | PSH065/105 |
|---|---|
| Maximum/Minimum temperature - Ts | -35°C < Ts < 52°C |
| Maximum allowable pressure (Low side) - Ps | 31.1 bar(g) |

## Internal free volume

| Products | Internal free volume without oil (liter) | | |
|---|---|---|---|
| | Low pressure side | High pressure side | Total |
| PSH065 | 27.1 | 2.8 | 29.9 |
| PSH105 | 28.2 | 3.8 | 32 |

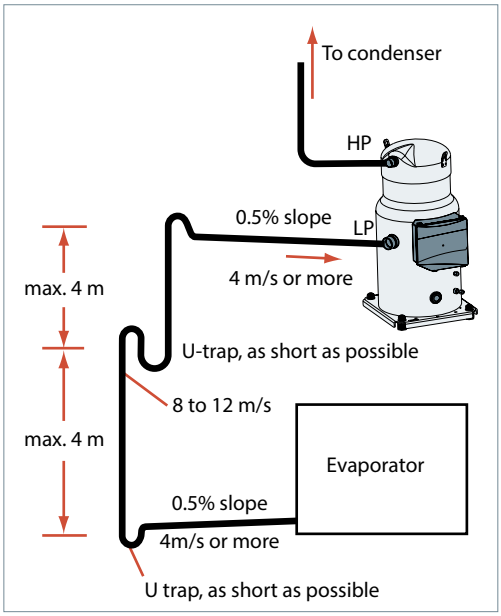
## General requirements

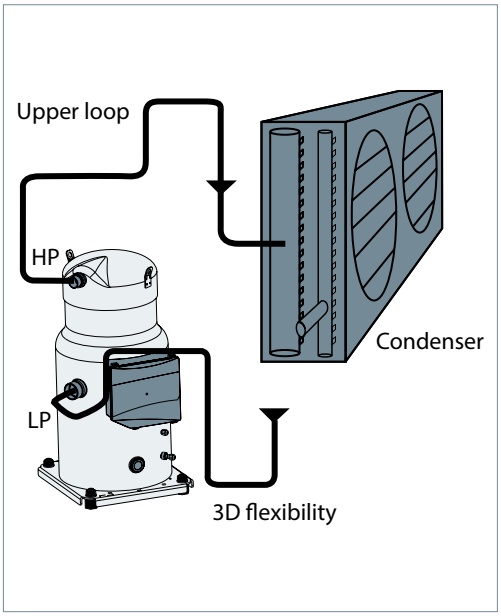
Proper piping practices should be employed to:

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".

General recommendations are described in the figures below:




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 on: "Sound and vibration management".

## General requirements

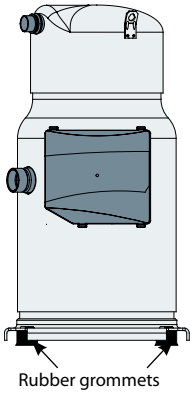
During operation, the maximum inclination from the vertical plan must not exceed 3 degrees.

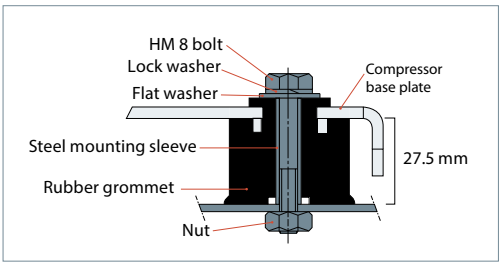
## Single requirements

### Mounting of PSH065

Compressors PSH065 is delivered with rubber grommets and steel mounting sleeve used to isolated 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 PSH065 compressors is HM8-55. This bolt must be tightened to a torque of 21Nm.

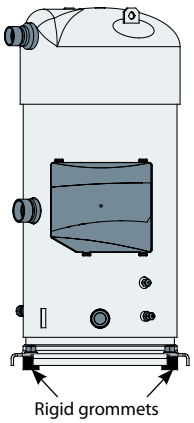


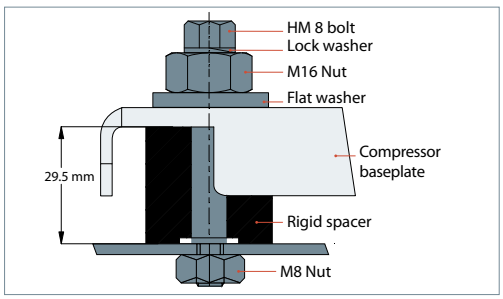




### Mounting of PSH105

Compressors PSH105 is delivered with rigid grommets used to isolated the compressor from the base frame.

The M16 nut must be tightened to a torque of 55 Nm. The HM8 bolt must be tightened to a torque of 16Nm.

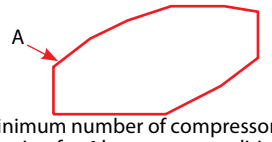
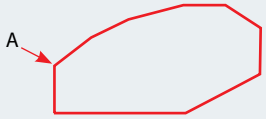


**Requirement**

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.

## Test, criteria and solutions

| Test N° | Purpose | Test condition | Pass criteria | Solutions |
|---|---|---|---|---|
| 1 | Check proper oil return |  Minimum number of compressor running for 6 hours, at a condition corresponding to highest pressure ratio foreseeable on the system application | 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.<br>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")<br>3. Oil separator can be added |
| 2 | Check oil balancing |  Lowest foreseeable evaporation and highest foreseeable condensation and nominal capacity condition for tandem 2 compressors running for 6 hours.<br><br>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).<br>2. Check that manifold piping is conform to Danfoss requirements.<br>3. Integrate a function in control logic to stop manifold periodically in order to balance oil (for more details see section Control logic) |

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

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

Sound levels are as follows:
- For compressors running alone:

| Compressor model | Composition | 50 Hz |
|---|---|---|
| | | Sound power dB(A) |
| PSH065 | - | 85 |
| PSH105 | - | 89 |
| PSH130E | 2XPSH065 | 88 |

Sound power and attenuation are given at conditions -7/50/5/5, measured in free space
Maximum sound is +3dB(A)

| | | |
|---|---|---|
| | 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. |
| **Mechanical vibrations** | A compressor generates vibrations that propagate into the surrounding parts and structure. The vibration level of the PSH065/105 compressor alone does not exceed 154 µm peak to peak. However, when system structure natural frequencies are close to running frequency, vibrations are amplified due to resonance phenomenon.<br>A high vibration level is damageable for piping reliability and generates high sound levels.<br><br>**Mitigations methods:**<br>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".<br><br>2. Ensure that there is no direct contact (without insulation) between vibrating components and structure.<br><br>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…) |
| **Gas pulsation** | PSH065/105 compressor has been designed and tested to ensure that gas pulsation is optimized for the most commonly encountered air conditioning pressure ratio. | **Mitigations methods:**<br>If an unacceptable level is identified, a discharge muffler with the appropriate resonant volume and mass can be installed. |

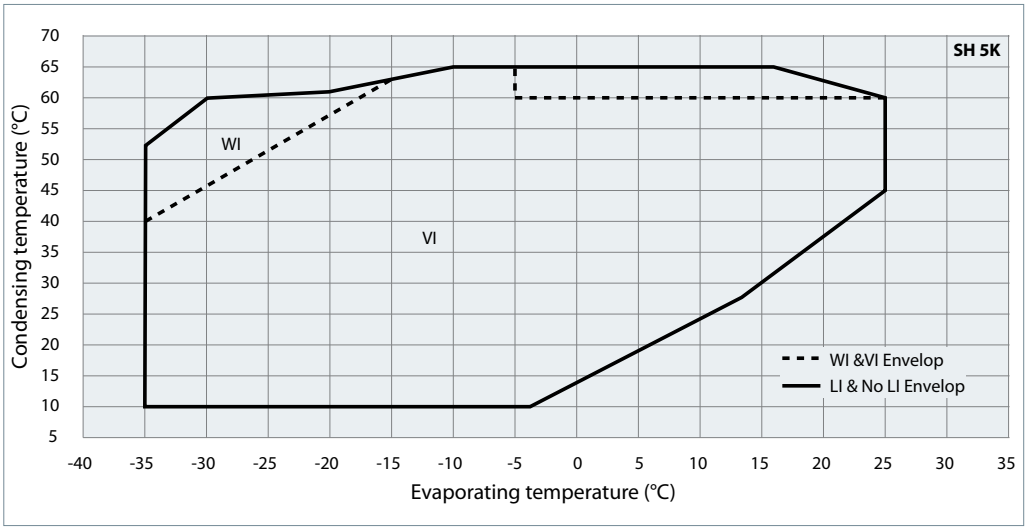
## Requirement

R The operating envelope for PSH065/105 compressors is given in the figures below and guarantees reliable operation of the compressor for steady-state and transient operation.

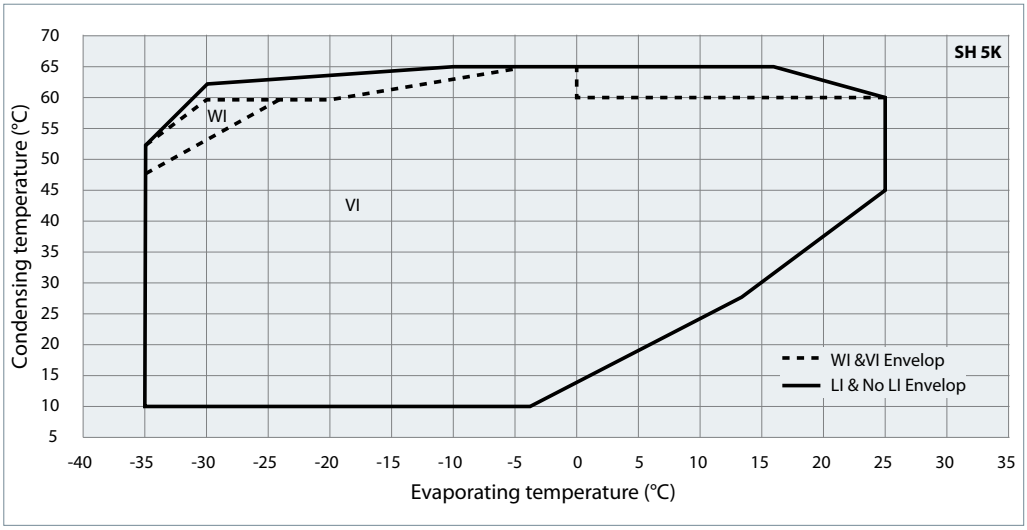
R In every instance, the discharge temperature must be kept below 135°C

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

## operating envelop PSH065




## operating envelop PSH105



## Manage operating envelope

| Pressure settings | | PSH065/105 |
|---|---|---|
| Working range high side | bar(g) | 9.9 - 41.7 |
| Working range low side | bar(g) | 1.2 - 15.5 |
| Maximum high pressure safety switch setting | bar(g) | 43.1 |
| Minimum low pressure safety switch setting | bar(g) | 1.0 |

R LP and HP safety switches must never be bypassed nor delayed and must stop all the compressors.

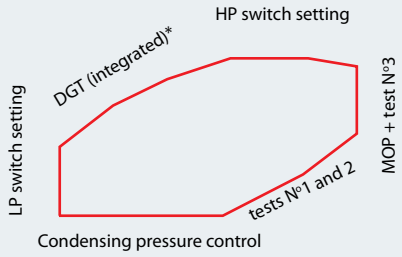
LP switch auto restart must be limited to 5 times within 12 hours.

! 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.

## System evaluation

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

| Basic: | Advanced: |
|---|---|
| • HP and LP switch<br>• MOP (Max Operating Pressure) ensured by expansion device<br>• Condensing pressure control<br>• Discharge gas sensor piloting injection expansion device | • HP and LP sensor<br>• Operating envelope limits integrated into control logic |
| See "Test, criteria and solutions"<br>  | No additional test are required |

PSH 065/105 compressor includes an integrated Discharge Gas Temperature protection (DGT).

Excessive discharge temperature will result in tripping of electronic module output relay.

## Test, criteria and solutions

| Test N° | Purpose | Test condition | Pass criteria | Solutions |
|---|---|---|---|---|
| 1 | Check that Area 1 is reached within maximum transient time | Start test at minimum foreseeable evaporating temperature (minimum ambient temperature...) | Continuous running within area 1. At start-up or for any map exit, respect max. transient time according to area number. | Work on compressor staging,fan staging, water flow etc. |
| 2 | | Perform a defrost test if reversible unit | | |
| 3 | | Perform a start-up test at maximum foreseeable evaporating temperature (max ambient temperature, or start up with hot water…) | | Improve MOP function.<br>Work on compressor staging,fan staging, water flow etc. |

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.

**Requirement**

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

**System evaluation**

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

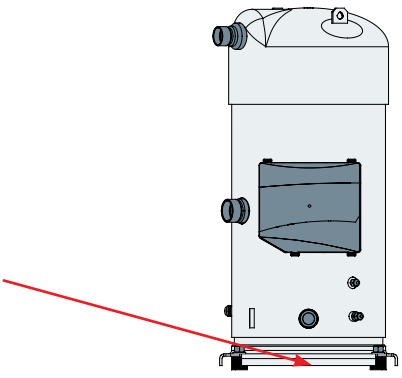
| Application | Tests to perform |
|---|---|
| Non reversible | Liquid flood back test |
| Reversible | Liquid flood back test<br>Defrost test |

## Test, criteria and solutions

R Suction accumulator must be added in system *

| 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: a high pressure ratio and minimum evaporator load.   | Suction superheat >5 K | 1. 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, start-up, 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 condition (at 0°C outdoor ambient 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"). |

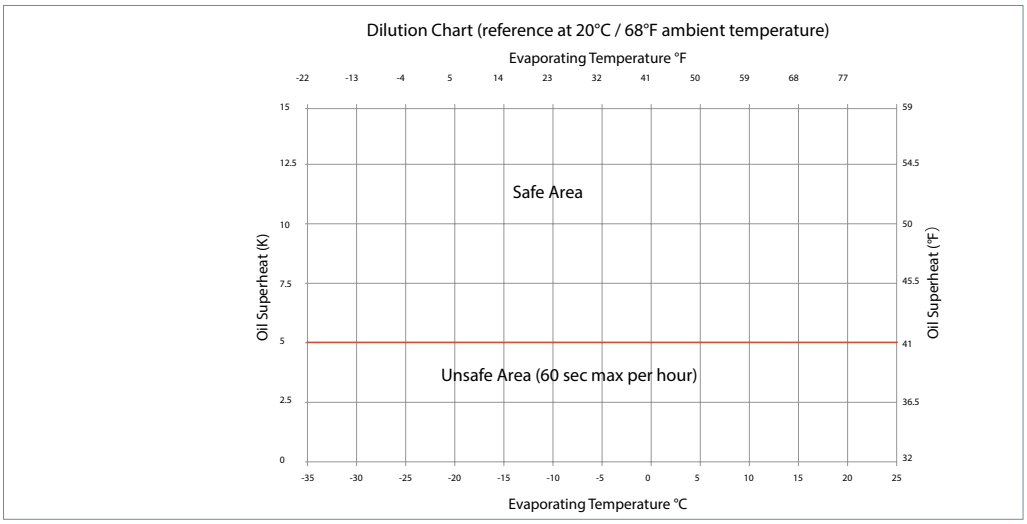
*Suction accumulator offers protection by trapping the liquid refrigerant upstream from the compressor. The accumulator should be sized at least 50 % of the total system charge. Suction accumulator dimensions can impact oil return (gas velocity, oil return hole size, etc.), therefore oil return has to be checked according to section "Manage oil in the circuit".



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)



It is recommended to add a solenoid valve on the injection line to isolate the compressor from the condensing stage when the compressor is off.

R When compressor stop, injection path need be closed by system control

## Requirement

At start-up, the amount of liquid refrigerant in the compressors must not exceed an acceptable level.

## System evaluation

Use the tables below in relation with the system charge and the application to quickly define necessary safeties to implement and test to perform:

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

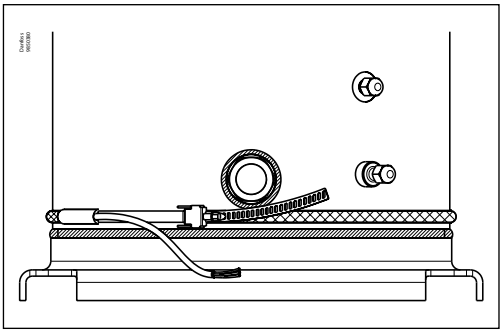
R Off -cycle refrigerant migration happens:
• when the compressor is located at the coldest part of the installation, refrigerant vapor condenses in the compressor.
• or directly in liquid-phase by gravity or pressure difference.

When the compressor starts running again, the refrigerant diluted in the oil generates poor lubrication conditions. In extreme situations, this leads to liquid slugging that can damage the compressor.

*Crankcase heater (CCH)
The crankcase heaters are designed to protect the compressor against off-cycle migration of refrigerant.

For PSH065/105 the use of a 75W belt heater is recommended. if the ambient temperature is between -5°C and -23°C. For ambient temperatures below -23°C a 130W belt heater must be used.

Belt heater accessories are available from Danfoss (see section "Accessories").



| T ambiance | SSH |
|---|---|
| -23~-5 | 75 W |
| -28~-23 | 130 W |

**Liquid Line Solenoid Valve (LLSV)
A LLSV is used to isolate the liquid charge on the condenser side, thereby preventing against charge transfer to the compressor during off -cycles.

Charge limit is defined in table below:

| Models | Refrigerant charge limit (kg) |
|---|---|
| PSH065 | 13.5 |
| PSH105 | 17 |
| PSH130E | 25 |

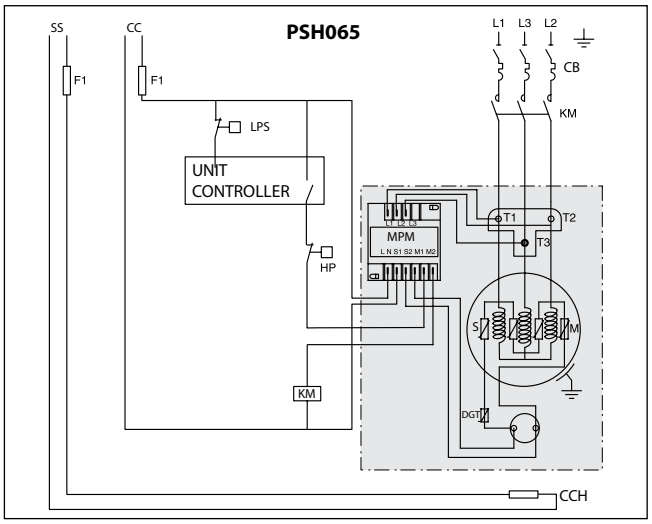
## Wiring information

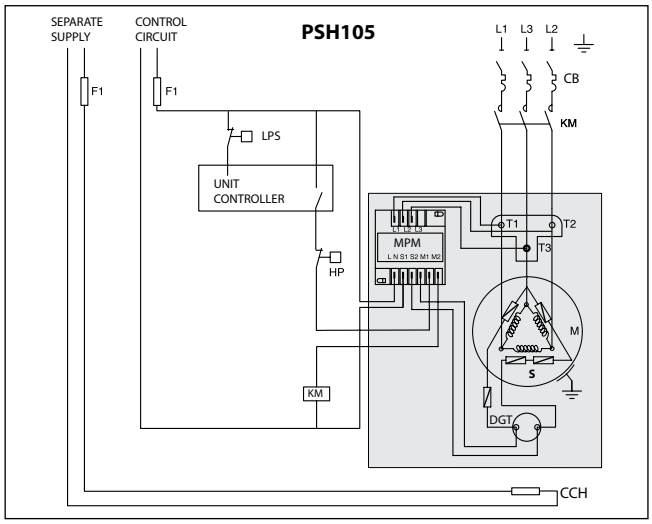
Requirements:

- 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 PSH065/105 is 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.
- 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 diagram below is an example for a safe and reliable compressor wiring:

### Suggested wiring diagrams logic




***Legend***

| | |
|---|---|
| *Fuses* | *F1* |
| *Compressor contactor* | *KM* |
| *High pressure safety switch* | *HP* |
| *Discharge gas thermistor (embedded in CH485)* | *DGT* |
| *Crankcase heater* | *CCH* |
| *Compressor motor* | *M* |
| *Motor Protection Module* | *MPM* |
| *Thermistor chain* | *S* |
| *Safety pressure switch* | *LPS* |
| *Thermal magnetic circuit breaker* | *CB* |

## Safety control logic requirements

| Safeties | Tripping conditions | | Re-start conditions | |
|---|---|---|---|---|
| | Value | Time | Value | Time |
| HP 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 | | | Maximum 5 auto reset during a period of 12 hours, then manual reset. |

## 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 no 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.

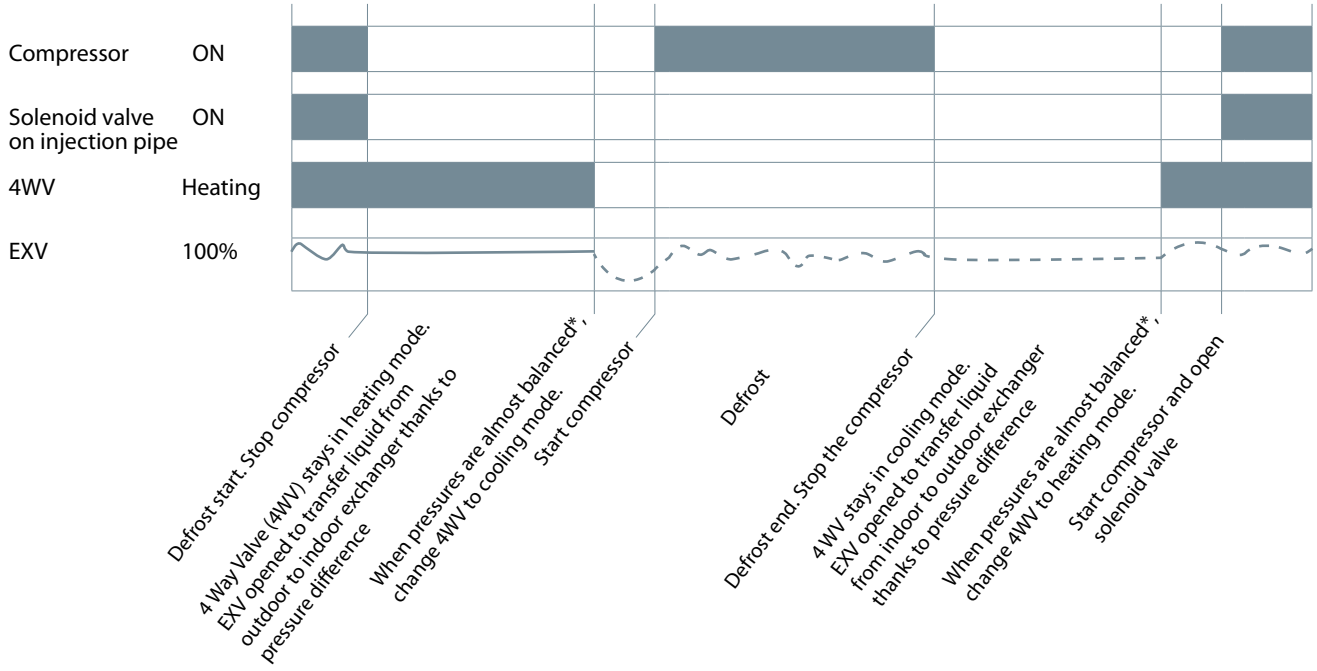
## Oil management logic recommendations

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.

## Defrost logic recommendations

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. Transferring liquid refrigerant from one exchanger to the other one thanks to pressures.

The following defrost logic combines both advantages:




* 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 "Manage operating envelope".

R During inversion cycle of defrost mode, the injection must be stopped.
To ensure compressor reliability, the 4-way valve must not reverse when the compresor is stopped due to heating or cooling demand (stop on thermostat).

| | | |
|---|---|---|
| | R Excessive air and moisture<br>• can increase condensing pressure and cause excessive high discharge temperatures.<br>• can create acid giving rise to copper platting.<br>• can destroy the lubricating properties of the oil. | All these phenomena reduce compressor life time and cause mechanical and electrical compressor failure. |
| **Requirements** | PSH065/105 compressor is delivered with < 100 ppm moisture level.<br>At the time of commissioning, system moisture content may be up to 100 ppm. | During operation, the filter drier must reduce this to a level between 20 and 50 ppm. |
| **Solutions** | To achieve this requirement, a properly sized and type of drier is required. Important selection criteria includes:<br>• driers water content capacity,<br>• system refrigeration capacity,<br>• system refrigerant charge. | Danfoss recommends using the Danfoss DML (100% molecular sieve) solid core filter drier. |

**Compressor storage**

The compressor must not be exposed to rain, nor corrosive or flammable atmosphere during storage. Store the compressor between -35°C and 70°C when charged with nitrogen and between -35°C and Ts max value (see section "Pressure equipment directive") when charged with R410A refrigerant.

**Compressor holding charge**

Each compressor is shipped with a nominal dry nitrogen holding charge between 0.3 and 0.7 bar 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.

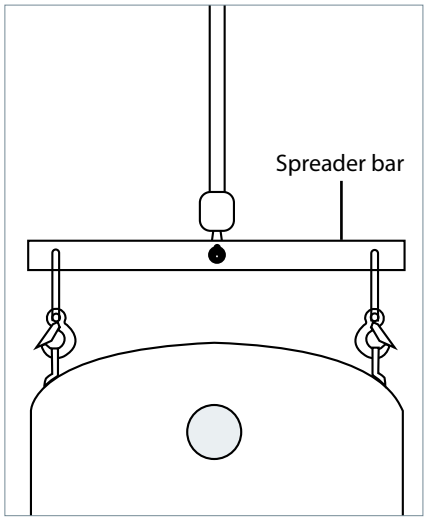
R An opened compressor must not be exposed to air for more than 20 minutes to avoid moisture is captured by the oil.

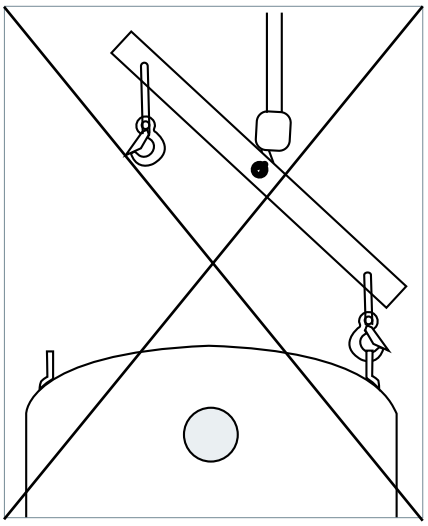
**Handling**

! The PSH065/105 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 of the compressors to lift the full unit.

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

## Piping assembly

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

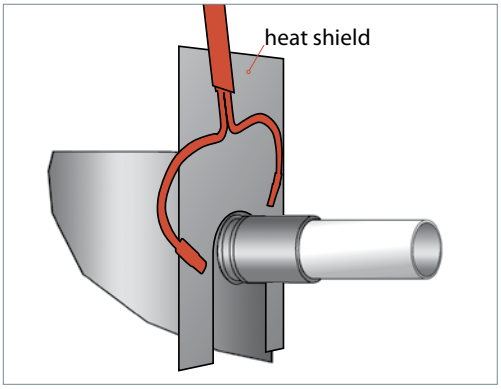
### System cleanliness

| 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<br>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.

DSH 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" FRCC.EN.182.

Before eventual un-brazing of the compressor or any system component, the refrigerant charge must be removed and the installation vacuumed.

## System pressure test and leak detection

The compressor has been strength tested and leak proof tested (<3g/year) at the factory.
For system tests:
- Do not exceed the following pressures indicated in table below:
- Pressurize the system on HP side first then LP side.
- Always use an inert gas such as nitrogen or helium.

| Maximum compressor test pressures | PSH065/105 |
|---|---|
| Maximum compressor test pressure high side (HP) | 53.6 bar (g)<br>HP-LP<37bar |
| Maximum compressor test pressure low side (LP) | 34.2bar(g)<br>LP-HP<5bar<br>Maximum speed 4.8 bar/second* |

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 vacuum 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) 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" reference 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.

## 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 20 megohm.

Recommendations:
- Additional dielectric test is not recommended as it may reduce motor lifetime. Nevertheless, if such a 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.

## Preliminary check

Check electrical power supply:
- Phase order: The PSH065/105 compressor is 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 from oil.
- 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 (depending on running conditions see www.coolselector.danfoss.com).
- 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 160SZ from new cans.
For more detailed information see "Lubricants filling in instructions for Danfoss Commercial Compressors" reference TI 2-025-0402.

## Tandem application

### 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.

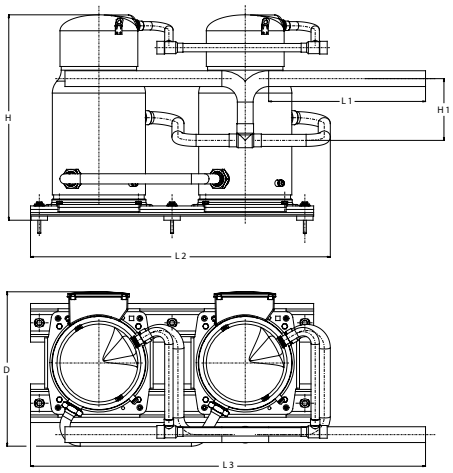
The discharge line has no impact on oil balancing. It is shown with tee, to indicate that both left and right side discharge headers are possible.

By default, PSH 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.
- Tandem accessory kit.
- Compressors

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

R when tandem part load running, idle compressor injection path (the path connected to compressor injection port) must be closed by the solenoid valve or EXV.

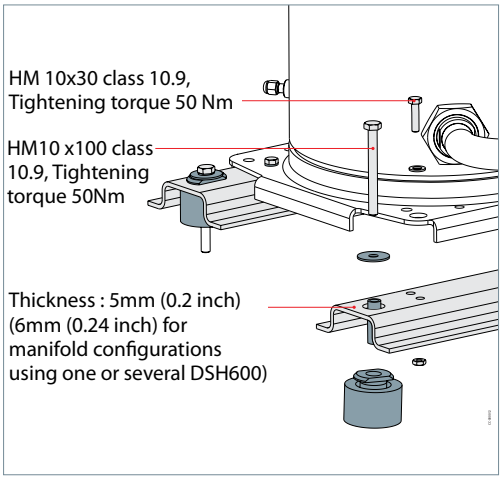
### Tandem assembly




| tandem model | composition | suction form | Suction | discharge | oil equalization | D (mm) | H (mm) | L1 (mm) | L2 (mm) | L3 (mm) | H1 (mm) | outline drawing number | tandem kit code |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PSH130E | PSH065+PSH065 | 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 | | |

### Tandem requirements mounting

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.

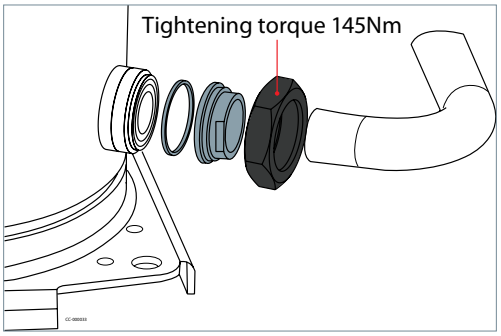



Included in tandem kit
Not supplied

### Oil equalization design

The oil level is balanced by a pipe of 1"3/8 oil equalization line.

To connect the equalization line on rotolock connections, the adaptor sleeves included in the tandem accessory kit must be used.




Supplied with the compressor
Included in tandem kit

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

### Single pack

| Compressor model | Length (mm) | Width (mm) | Height (mm) | Gross weight (kg) |
|---|---|---|---|---|
| PSH065 | 760 | 600 | 992 | 127 |
| PSH105 | 760 | 600 | 992 | 191 |

### Industrial pack

| Compressor model | Nbr* | Length (mm) | Width (mm) | Height (mm) | Gross weight (kg) | Static stacking pallets |
|---|---|---|---|---|---|---|
| PSH065 | 6 | 1150 | 965 | 800 | 712 | 2 |
| PSH105 | 4 | 1150 | 965 | 800 | 744 | 2 |

* nbr: number of compressors per pack

## Ordering codes

**Compressor code numbers**

The PSH065/105 can be ordered in either industrial or single packs. Please use the code numbers from below tables for ordering.

### Single pack

| Compressor model | Connections | Motor protection | Code no. |
|---|---|---|---|
| | | | 8 |
| | | | 380/3/50 |
| PSH065 Single | Brazed | Module 110-240V * | 120H1589 |
| PSH065 Manifolding | Brazed | Module 110-240V * | 120H1777 |
| PSH105 | Brazed | Module 110-240V * | 120H1473 |

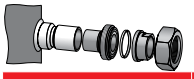
* Electronic motor protection, module located in terminal box

### Industrial pack

| Compressor model | Connections | Motor protection | Code no. |
|---|---|---|---|
| | | | 8 |
| | | | 380/3/50 |
| PSH065 Single | Brazed | Module 110-240 V * | 120H1588 |
| PSH065 Manifolding | Brazed | Module 110-240 V * | 120H1778 |
| PSH105 | Brazed | Module 110-240 V * | 120H1472 |

* Electronic motor protection, module located in terminal box

### Solder sleeve adapter set



| Code no. | Description | Application | Packaging | Pack size |
|---|---|---|---|---|
| 120Z0504 | Rotolock adaptor set (2"1/4 ~ 1"5/8) , (1"3/4 ~ 1"3/8) | PSH105 | Multipack | 6 |
| 7765028 | Rotolock adaptor set (2″1/4 ~ 1″5/8) , (1″3/4 ~ 1″1/8) | PSH065 | Multipack | 6 |

### Rotolock adapter

| Code no. | Description | Application | Packaging | Pack size |
|---|---|---|---|---|
| 120Z0431 | Adaptor (1"3/4 Rotolock - 1"3/8 ODS) | Models with 1"3/8 ODF | Multipack | 10 |
| 120Z0432 | Adaptor (2"1/4 Rotolock - 1"5/8 ODS) | Models with 1"5/8 ODF | Multipack | 10 |
| 120Z0364 | Adaptor (1″3/4 Rotolock - 1″1/8 ODS) | Models with 1″1/8 ODF | Multipack | 10 |

### 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

| Code no. | Description | Application | Packaging | Pack size |
|---|---|---|---|---|
| 8153003 | Solder sleeve P10 (1"3/4 Rotolock - 1"3/8 ODF) | Models with 1"3/4 rotolock connection | Multipack | 10 |
| 8153004 | Solder sleeve P10 (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

| 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 |

### Rotolock service valve set

| Code no. | Description | Application | Packaging | Pack size |
|---|---|---|---|---|
| 120Z0547 | Valve set, V03 (2"1/4 ~ 1"5/8), V10 (1"3/4 ~ 1"3/8) | PSH105 | Multipack | 4 |
| 7703383 | Valve set, V03 (2″1/4 ~ 1″5/8), V10 (1″3/4 ~ 1″1/8) | PSH065 | Multipack | 4 |

### Motor protection modules

| Code no. | Description | Application | Packaging | Pack size |
|---|---|---|---|---|
| 120Z0585 | Electronic motor protection module, 115/240 V | PSH065/105 | Single pack | 1 |

### Terminal boxes, covers and T-block connectors

| Code no. | Description | Application | Packaging | Pack Size |
|---|---|---|---|---|
| 120Z0458 | Terminal box 210 x 190 mm, incl. cover | PSH065/105 | Single Pack | 1 |
| 120Z0774 | T block connector 80 x 80 mm | PSH105 | Multipack | 10 |
| 8173021 | T block connector 60 x 75 mm | PSH065 | Multipack | 10 |

### Belt heater

| Code no. | Accessory description | Application | Packaging | Pack size |
|---|---|---|---|---|
| 7773108 | Belt type crankcase heater,75W,230 V,CE & UL | PSH065/105 | Multipack | 6 |
| 7773118 | Belt type crankcase heater,75W,400 V,CE & UL | PSH065/105 | Multipack | 6 |
| 7773122 | Belt type crankcase heater, 130W, 230V, CE & UL | PSH065/105 | Multipack | 4 |
| 7773123 | Belt type crankcase heater, 130W, 400V, CE & UL | PSH065/105 | Multipack | 4 |

### Lubricant

| Code no. | Description | Packaging | Pack Size |
|---|---|---|---|
| 7754023 | POE lubricant, 1 litre can | Multi pack | 12 |
| 120Z0571 | POE lubricant, 2.5 litre can | Multi pack | 4 |

### Miscellaneous

| Code no. | Description | Packaging | Pack Size |
|---|---|---|---|
| 8156019 | Sight glass with gaskets | 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 |

### Mounting hardware

| Code no. | Description | Application | Packaging | Pack Size |
|---|---|---|---|---|
| 8156138 | Mounting kit for scroll compressors. Grommets, sleeves, bolts, washers | PSH065 | Single pack | 1 |
| 7777045 | Mounting kit for 1 scroll compressors including 4 hexagon rigid spacer, 4 sleeves, 4 bolts, 4 washers | PSH105 | Single pack | 1 |

### Tandem kit

| Code no. | Description | Application | Packaging | Pack size |
|---|---|---|---|---|
| 120Z0792 | Kit Tandem, Solid, OEL 1'' 3/8 | PSH130E | Singlepack | 1 |

## Updates

| Release date (Year/Month) | Guideline codification number | List of changes | Reason for change |
|---|---|---|---|
| 2020/11 | AB328937813817en-000101 | First release | - |
| 2021/08 | AB328937813817en-000201 | Update PSH105 power connection<br>Add PSH065 manifolding application | - |
| 2022/04 | AB328937813817en-000301 | Crankcase heater (CCH) updated | - |
| 2022/10 | AB328937813817en-000302 | T-block connector Accessory code updated | - |
| | | | |
| | | | |
| | | | |

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is a worldwide manufacturer of compressors and condensing units for refrigeration and HVAC applications. With a wide range of high quality and innovative products we help your company to find the best possible energy efficient solution that respects the environment and reduces total life cycle costs.

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Danfoss Scrolls

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