

Application guidelines

# Danfoss Heat Pump scroll compressors, **HHP-Series**

50Hz - R407C







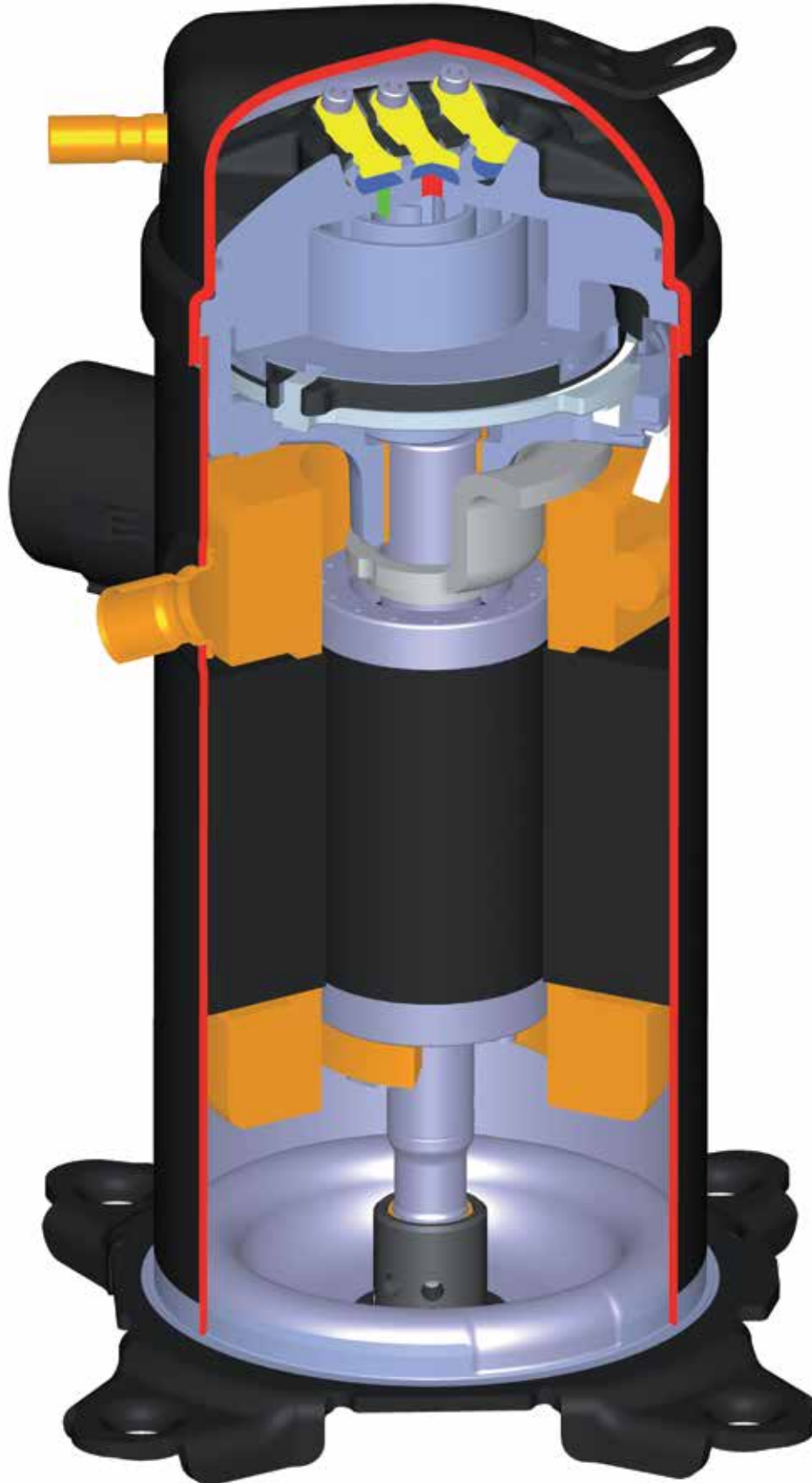
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**Application Guidelines**      **Scroll compression principle**

**Scroll compressor components**

The motor stator is rigidly attached to the shell. The rotor is shrink-fit onto the eccentric shaft. The shaft is supported by two bearings, one in the crankcase and the second below the motor.



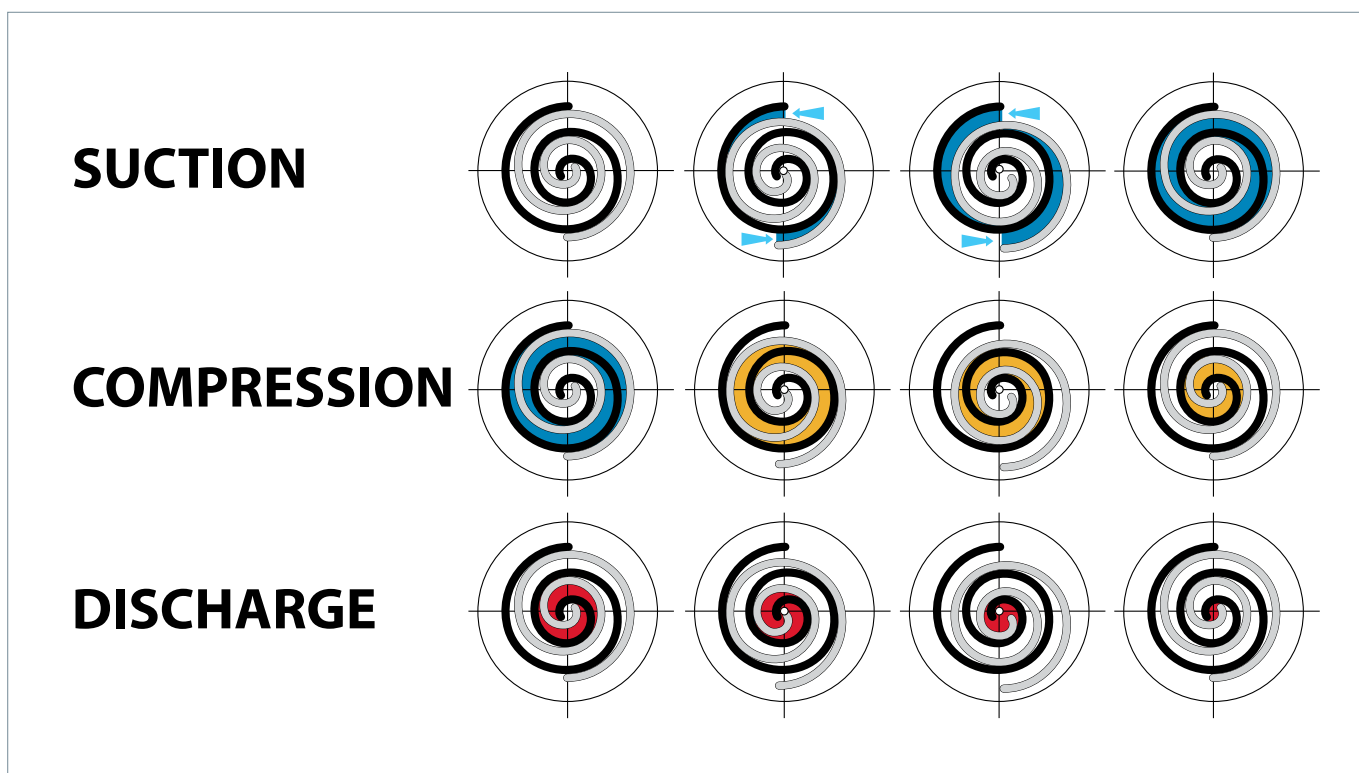
**The scroll compression process**

The entire scroll compression process is illustrated below. The centre of the orbiting scroll traces a circular path around the centre of the fixed scroll. This movement creates compression pockets between the two scroll elements.

Low pressure suction gas is trapped within each crescent-shaped pocket as it forms; continuous motion of the orbiting scroll serves to seal the pocket, which decreases in volume as the

pocket moves towards the centre of the scroll set, with corresponding increase in gas pressure. Maximum compression is achieved, as the pocket reaches the discharge port at the centre.

Scroll compression is a continuous process: when one pocket of gas is being compressed during the second orbit, another gas quantity enters a new pocket formed at the periphery, and simultaneously, another is being discharged.



Danfoss Heat Pump scroll compressors are manufactured using the most advanced machining, assembly, and process control techniques. In design of both the compressor

and the factory, very high standards of reliability and process control were first priority. The result is a highly efficient product with the highest reliability obtainable, and a low sound level.

**Performance**

The Danfoss Heat Pump scroll compressor referenced in this guide is a fully compliant scroll and actually improves with run time in

its early commissioning. A seventy-two hour run-in is recommended to meet performance expectations.

Nomenclature

	Type	Size	Motor	Features
	<b>HHP</b>	<b>030</b>	<b>T4L</b>	<b>P6</b>
<b>Application:</b> H: high temperature				
<b>Family:</b> HP: heat pump R407C PVE				
<b>Nominal capacity:</b>				
<b>Model variation</b> T motor design				

**Other features**

	Oil sight glass	Oil equalisation	Oil drain	LP gauge port	Gas equalisation port
6	None	None	None	None	None

**Tubing and electrical connections**  
**P:** brazed connections, spade terminals  
**C:** brazed connections, screw terminals

**Motor protection**  
**L:** internal motor protection

**Motor voltage code**  
**4:** 380-400V/3~/50 Hz  
**5:** 220-240V/1~/50 Hz

Label

**Danfoss Commercial Compressors**

**Model no: HHP030T4LC6**

**Tech no: HRH302BE01**

**Serial no: S0410K90085**

MADE IN USA

380-400 V 3~ 50 Hz  
 Run Cap: N/A  
 LR: 60.0 A Max Oper: 8.6 A  
 Lubricant: PVE- 53 oz / 1.6 L  
 Refrigerant: R407C

2010

CE c RU US

PERFORMER  
SCROLL COMPRESSORS

THERMALLY PROTECTED  
PROTECTED BY DOMESTIC AND FOREIGN PATENTS

**⚠ WARNING**

Installation and servicing shall be performed by trained personnel only. Failure to observe these safety warnings could result in serious injury or death.

**ELECTRICAL SHOCK HAZARD:** Turn off power before servicing. (Discharge all capacitors.)

Keep terminal cover in place and securely fastened whenever power is applied to the compressor. Use this equipment on a grounded system only.

**HIGH PRESSURE:** System contains refrigerant and oil under pressure. Remove pressure from both the high and low side before servicing. Wear safety goggles.

**FIRE HAZARD:** Use tubing cutter to remove compressor. Do not use torch as oil may catch fire.

**⚠ CAUTION**

Use only manufacturer's approved refrigerants, lubricants, and electrical components. Unauthorized refrigerant / lubricant / electrical component could cause fires, explosions, electrical shorting.

For details refer to multi language instructions and technical documentation available on Danfoss website at <http://cc.danfoss.com>

ZZ2003B01

Serial number

S 03 09 K 12345

<p>Production week _____</p> <p>Production year _____</p>		<p>_____</p> <p>_____</p>		<p>_____</p> <p>_____</p>
				<p>Incremental number</p> <p>Manufacturing location</p>



**50-Hz data**

Model	Heating capacity	Power input	Max. A.	Heating efficiency	Swept volume	Displacement	Oil charge	Net weight
	W	W	A	COP W/W	(cm <sup>3</sup> /rev)	m <sup>3</sup> /hr @2900 rpm	L	kg
HHP015T4LP6	4800	1540	5.1	3.13	34	5.9	1.06	31
HHP015T5LP6	4880	1660	14.2	2.93	34	5.9	1.06	31
HHP019T4LP6	5780	1910	5.8	3.02	41	7.1	1.06	33
HHP019T5LP6	5830	2040	17.7	2.86	41	7.1	1.06	33
HHP021T4LP6	6410	2030	5.8	3.16	46	8	1.06	33
HHP021T5LP6	6630	2110	18.2	3.15	46	8	1.06	33
HHP026T4LP6	8100	2520	7.1	3.22	57	10	1.06	33
HHP026T5LP6	8160	2680	22.7	3.04	57	10	1.06	33
HHP030T4LC6	9700	3070	8.6	3.17	67	11.7	1.57	33
HHP030T5LC6	9790	3190	27.7	3.07	67	11.7	1.57	42
HHP038T4LC6	12050	3730	10.8	3.23	82	14.2	1.57	42
HHP038T5LC6	12140	3850	35.2	3.16	82	14.2	1.57	42
HHP045T4LC6	13940	4300	12.6	3.25	99	17.2	1.57	42

Evaporating temperature: -7° C

Condensing temperature: 50° C

Superheat: 10 K

Subcooling: 5 K

Subject to modification without prior notification

Conditions: 400V/3ph/50Hz (motor T4), 230V/1 ph/50 Hz (motor T5)

 For full data details and capacity tables refer to Online Datasheet Generator : [www.danfoss.com/odsg](http://www.danfoss.com/odsg)
**Performance table**

Model	To	-25		-20		-15		-10		-5		0		5		10		15	
	Tc	H	Pe	H	Pe	H	Pe	H	Pe	H	Pe	H	Pe	H	Pe	H	Pe	H	Pe
HHP015T4	40	2 550	1.1	3 070	1.1	3 720	1.2	4 510	1.3	5 450	1.3	6 520	1.4	7 730	1.4	9 080	1.4	10 570	1.4
	50	2 620	1.5	3 050	1.5	3 620	1.5	4 320	1.5	5 150	1.6	6 120	1.6	7 220	1.7	8 460	1.7	9 840	1.7
	60	-	-	-	-	3 860	2.2	4 410	2.1	5 090	2.1	5 890	2.1	6 830	2.1	7 900	2.1	9 100	2.1
HHP019T4	40	3 070	1.3	3 680	1.4	4 450	1.5	5 400	1.5	6 520	1.6	7 810	1.7	9 270	1.7	10 900	1.7	12 690	1.7
	50	3 180	1.7	3 680	1.7	4 340	1.8	5 180	1.9	6 180	1.9	7 340	2.0	8 670	2.1	10 160	2.2	11 830	2.2
	60	-	-	-	-	4 660	2.3	5 300	2.4	6 110	2.4	7 070	2.5	8 200	2.6	9 480	2.7	10 930	2.8
HHP021T4	40	3 530	1.4	4 250	1.5	5 090	1.6	6 080	1.7	7 230	1.7	8 570	1.8	10 100	1.8	11 840	1.7	13 820	1.7
	50	3 430	1.6	4 080	1.8	4 860	1.9	5 770	2.0	6 830	2.1	8 070	2.1	9 500	2.2	11 140	2.2	13 000	2.2
	60	-	-	-	-	4 710	2.2	5 530	2.3	6 510	2.5	7 650	2.6	8 970	2.7	10 490	2.8	12 240	2.8
HHP026T4	40	4 540	1.7	5 410	1.9	6 440	2.0	7 650	2.1	9 070	2.1	10 740	2.2	12 690	2.2	14 950	2.1	17 550	2.0
	50	4 590	2.0	5 350	2.1	6 260	2.3	7 330	2.4	8 610	2.6	10 120	2.6	11 900	2.7	13 970	2.7	16 370	2.7
	60	-	-	-	-	6 240	2.7	7 150	2.9	8 250	3.0	9 560	3.2	11 130	3.3	12 980	3.3	15 150	3.3
HHP030T4	40	4 910	2.1	6 100	2.3	7 480	2.4	9 050	2.6	10 830	2.6	12 830	2.7	15 060	2.7	17 520	2.8	20 240	2.9
	50	4 830	2.3	5 940	2.6	7 230	2.8	8 690	3.0	10 350	3.1	12 200	3.2	14 270	3.4	16 560	3.5	19 090	3.6
	60	-	-	-	-	7 000	3.1	8 330	3.4	9 850	3.6	11 550	3.8	13 440	4.0	15 540	4.2	17 870	4.4
HHP038T4	40	6 150	2.4	7 600	2.8	9 360	3.0	11 390	3.2	13 660	3.2	16 130	3.3	18 750	3.3	21 510	3.4	24 360	3.6
	50	5 730	2.2	7 120	2.8	8 800	3.3	10 740	3.6	12 890	3.8	15 220	4.0	17 700	4.1	20 280	4.2	22 940	4.4
	60	-	-	-	-	8 090	3.2	9 930	3.8	11 970	4.2	14 170	4.5	16 500	4.7	18 920	5.0	21 400	5.2
HHP045T4	40	7 110	3.0	8 800	3.1	10 830	3.3	13 180	3.5	15 800	3.7	18 660	3.8	21 700	3.9	24 890	3.8	28 180	3.7
	50	6 630	3.5	8 240	3.7	10 190	3.9	12 420	4.2	14 910	4.4	17 610	4.6	20 480	4.7	23 460	4.8	26 540	4.8
	60	-	-	-	-	9 360	4.5	11 490	4.8	13 850	5.1	16 400	5.5	19 100	5.7	21 890	6.0	24 760	6.1

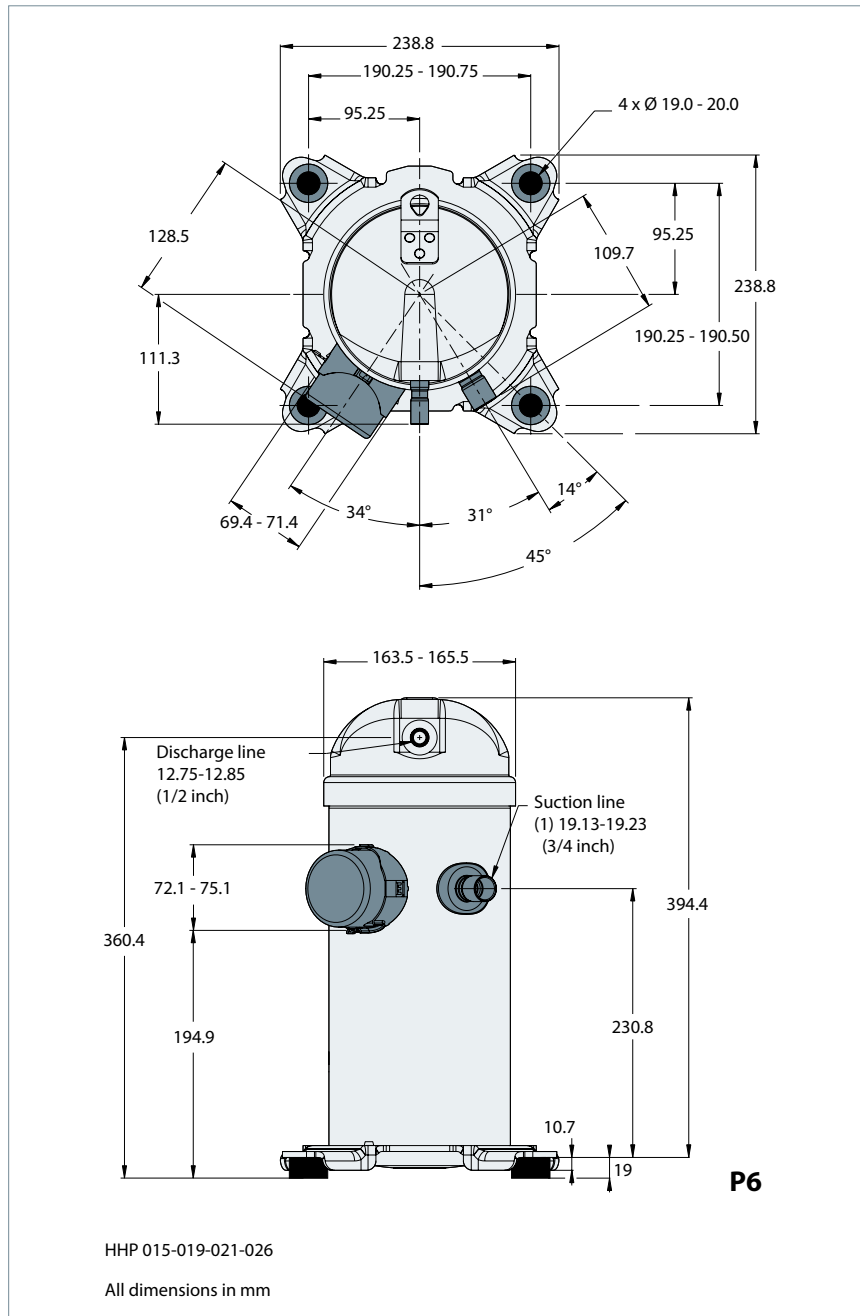
**Legend:**

 To: Evaporating temperature in °C  
 Tc: Condensing temperature in °C

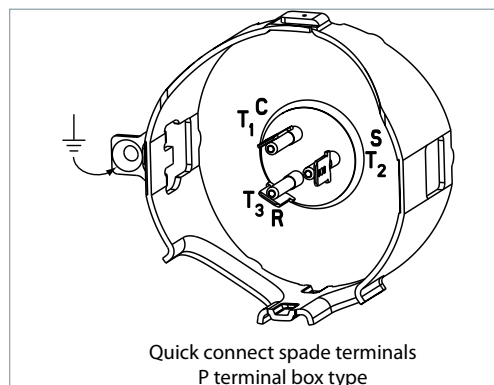
 H: Heating capacity in W  
 Pe: Power input in kW

 Superheat = 5 K  
 Subcooling = 5 K

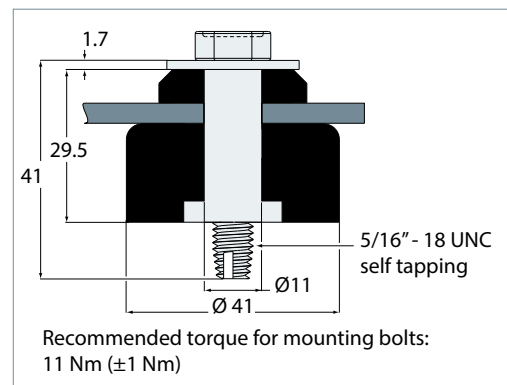
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Terminal box

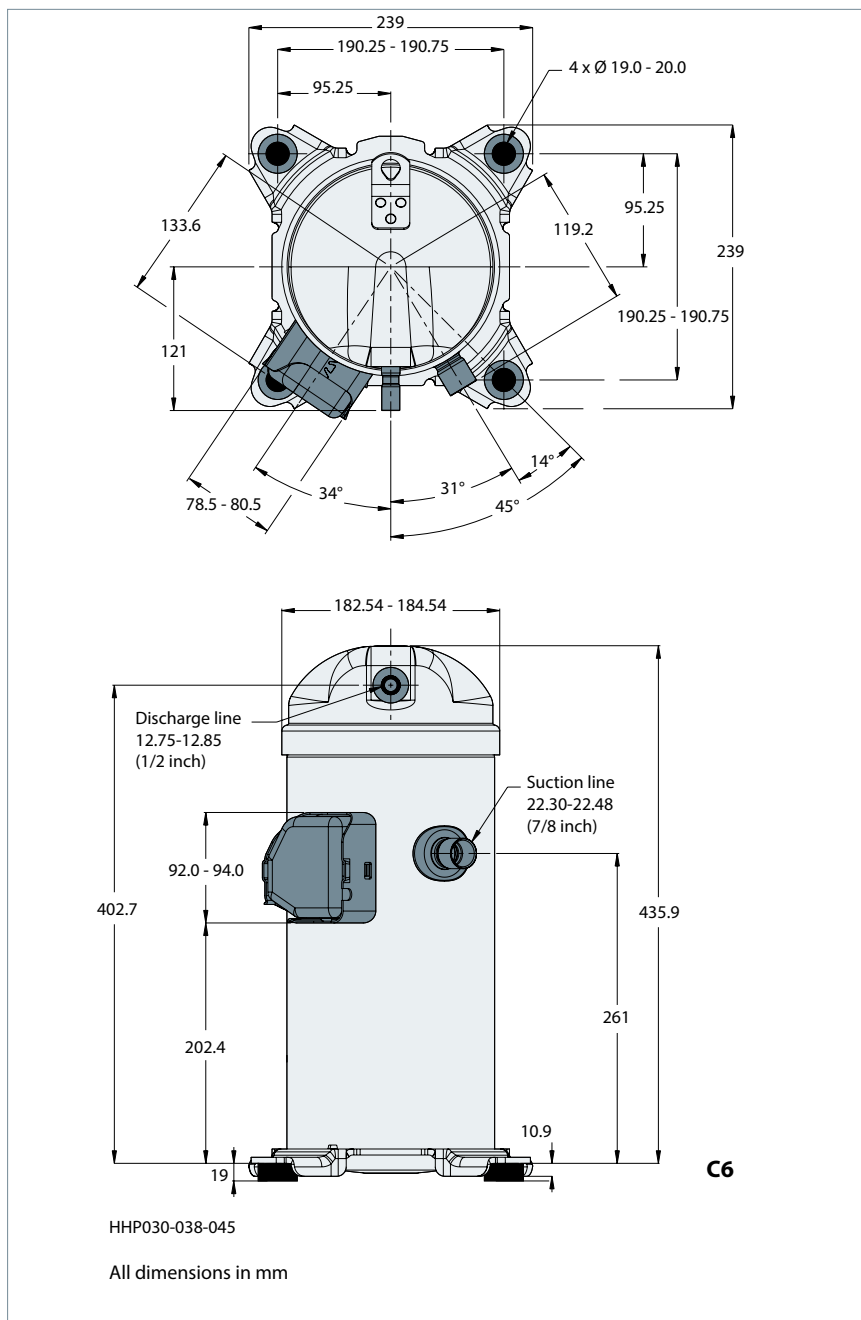


Mounting grommet

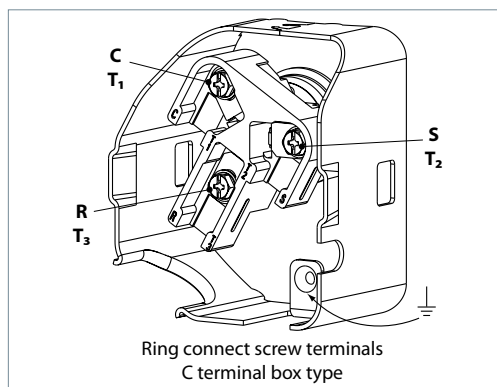


Refer to section "Spare parts and accessories" for overview of shipped mounting accessories

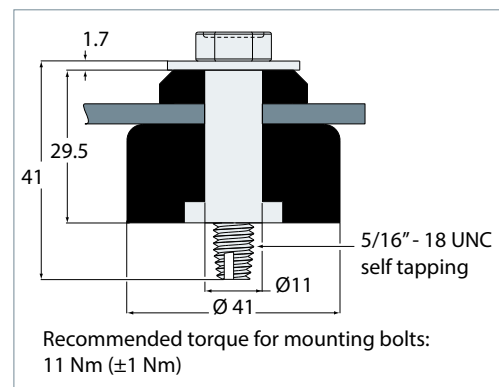
HHP030-038-045



**Terminal boxes**



**Mounting grommet**



Refer to section "Spare parts and accessories" for overview of shipped mounting accessories

**Motor voltage**

Danfoss Heat Pump scroll compressors are available in 2 different motor voltages.

	Motor voltage code 4	Motor voltage code 5
Nominal voltage 50 Hz	380-400V-3-50 Hz	220-240V-1-50 Hz
Voltage range 50 Hz	340 - 440	198 - 264

Prior to energizing, verify that leads and terminal connectors are in proper working condition.

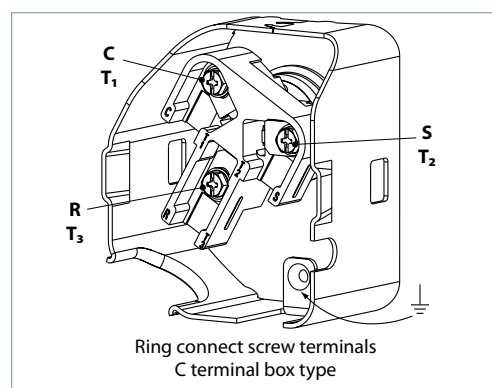
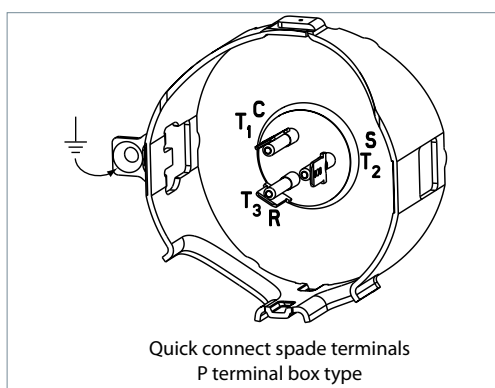
Warning: For safety reasons, make voltage measurements at the unit contactor, not at compressor terminals. Always keep the terminal cover in place when the compressor is energized.

**Wiring connections**

Danfoss Heat Pump scroll compressors will only compress gas while rotating counter-clockwise (when viewed from the compressor top). Since single-phase motors will start and run in only one direction, reverse rotation is not a major consideration. Three-phase motors, however, will start and run in either direction, depending on the phase angles of the supplied power. Care must be taken during installation to ensure that the compressor operates in the correct direction

(see "Phase sequence and reverse rotation protection").

The drawings below show electrical terminal labelling and should be used as a reference when wiring the compressor. For three phase applications, the terminals are labelled T1, T2, and T3. For single-phase applications the terminals are labelled C (common), S (start), and R (run).

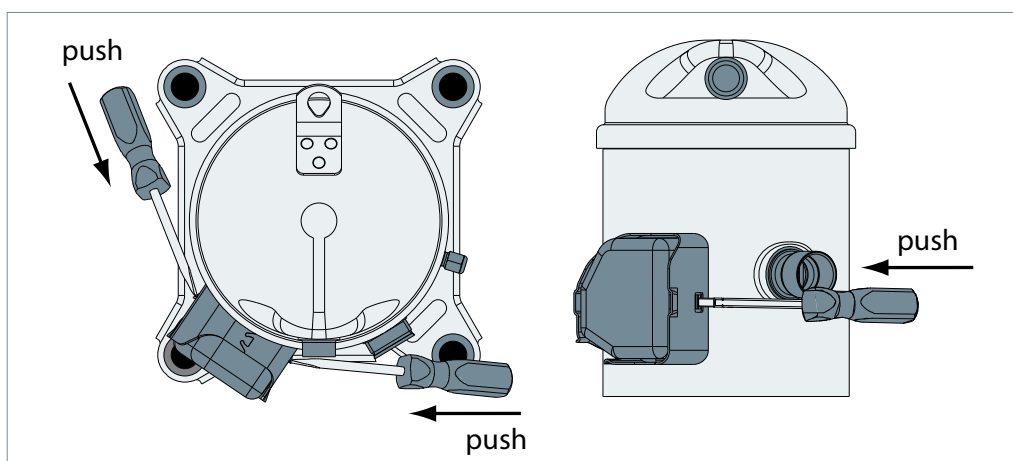


**Terminal cover mounting**

The terminal cover and gasket should be installed prior to operation of the compressor. The terminal cover has two outside tabs, 180 degrees apart, that engage the terminal fence. When installing

the cover, check that it is not pinching the lead wires. Both the inside of the terminal cover and the gasket have labels for the terminal pins: C (common), R (run), and S (start).

**Terminal cover removal**



**IP rating**

The compressor terminal box IP rating according to CEI 529 is **IP22** for all models. IP ratings is only valid when correctly sized cable glands of the IP rating is applied.

- First numeral, level of protection against contact and foreign objects  
**2** protection against object size over 12.5 mm (fingers of similar)
- Second numeral, level of protection against water  
**2** protection against dripping water when tilted up to 15°

**LRA (Locked Rotor Amp)**

LRA is the higher average current as measured on a mechanically blocked compressor tested under nominal voltage. LRA is printed on the nameplate.

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. Many countries have defined limits for the starting current in domestic use. A soft starter can be applied to reduce starting current.

**MCC (Maximum Continuous Current)**

The MCC is the current at which the internal motor protection trips under maximum load and low voltage conditions.

This MCC value is the maximum at which the compressor can be operated in transient conditions and out of the application envelope. Above this value the overload will switch off to protect the motor.

**Max Oper. A (Maximum Operating Amp)**

The Max Oper. A is the current when the compressor operates at maximum load conditions and 10% below nominal voltage.

Max Oper. A can be used to select cables and contactors.

This value which is the max rated load current for the compressor is new on the nameplate.

In normal operation, the compressor current consumption is always less than the Max Oper. A value.

**Winding resistance**

Winding resistance is the resistance between indicated terminal pins 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 with following formula:

$$R_{t_{amb}} = R_{25^{\circ}\text{C}} \frac{a + t_{amb}}{a + t_{25^{\circ}\text{C}}}$$

$t_{25^{\circ}\text{C}}$ : reference temperature = 25°C

$t_{amb}$ : temperature during measurement (°C)

$R_{25^{\circ}\text{C}}$ : winding resistance at 25°C

$R_{amb}$ : winding resistance at  $t_{amb}$

coefficient  $a = 234.5$

**Electrical connections**

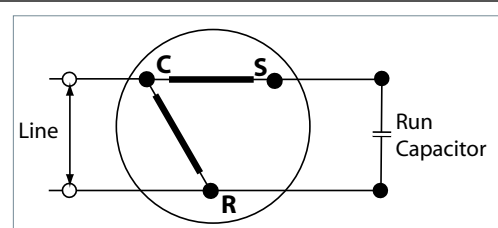
The Danfoss Heat Pump scroll compressors are designed to operate without any assistance if

running within the defined nominal voltage. PSC wiring is sufficient (see below).

**PSC wiring**

The start winding (C-S) of the motor remains in circuit through a permanent (run) capacitor.

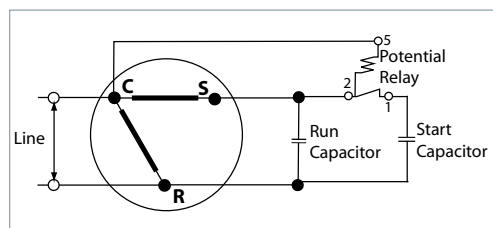
This permanent (run) capacitor is connected between the start winding (C-S) and the run winding (C-R).



**CSR wiring**

If start assist is required, in case of operating below the nominal voltage, a CSR starting device is required.

During start-up, the start winding (C-S) is energised through an electromagnetic potential relay and a start capacitor.



A permanent (run) capacitor is wired between the start winding (C-S) and the run winding (C-R).

**Nominal capacitor value**

	PSC wiring Run capacitor
HHP015T5LP6	40
HHP019T5LP6	60
HHP021T5LP6	60
HHP026T5LP6	70
HHP030T5LC6	50
HHP038T5LC6	55

**Internal motor protection**

The Danfoss Heat Pump scroll compressors are equipped with an internal line break protector mounted on the motor windings. The protector is an automatic reset device, containing a snap action bimetal switch.

Internal protectors respond to over-current and overheating. They are designed to interrupt motor current under a variety of fault conditions, such as failure to start, running overload, and fan failure.

If the internal overload protector trips out, it must cool down to about 60°C to reset. Depending on ambient temperature, this may take up to several hours.

In single-phase compressors, internal protectors guard against external miswiring, such as reversing electrical connections to the Run (R) and Start (S) terminals. In three-phase compressors the internal protectors provide protection during secondary single-phase conditions (loss of phase).

**Phase sequence and reverse rotation protection**

The Danfoss Heat Pump scroll compressors will only operate properly in a single direction. Use a phase meter to establish the phase orders and connect line phases L1, L2 and L3 to terminals T1, T2 and T3, respectively. For three-phase compressors, the motor will run equally well in both directions. Reverse rotation results in excessive noise; no pressure differential between suction and discharge; and suction line warming rather than immediate cooling. A service technician should be present at initial start-up to verify that supply power is properly phased and that compressor and auxiliaries are rotating in the correct direction.

Danfoss Heat Pump scroll compressors are designed to operate for a maximum of 150 hours in reverse, but as a reverse rotation situation can go unnoticed for longer periods, phase monitors are recommended.

At brief power interruptions, reverse rotation can occur with single phase compressors. In this case the internal protector will stop the compressor. It will have to cool down and will restart safely afterwards.

**Voltage imbalance**

For three-phase applications the voltage measured at the compressor terminals for each

phase should be within  $\pm 2\%$  of the average for all phases.

**Approvals and certificates** The Danfoss Heat Pump scroll compressors comply with the following approvals and certificates. Certificates are listed on the product datasheets: <http://www.danfoss.com/odsg>

CE 0062 or CE 0038 (European Directive)		All models
UL (Underwriters Laboratories)		All models
Other approvals / certificates		CB certificate available upon request

**Pressure equipment directive 97/23/EC**

Products	HHP015-019-021-026-030-038
Refrigerating fluids	Group 2
Category PED	I
Evaluation module	no scope

**Low voltage directive 73/23/EC, 93/68/EC**

Products	
Manufacturer's declaration of incorporation ref. EC Machines Directives 98/392/CE	Contact Danfoss

**Internal free volume**

Products	Internal free volume at LP side without oil (litre)
HHP015-019-021-026	2.93
HHP030-038-045	3.44

The Danfoss Heat Pump scroll compressors application range is influenced by several parameters which need to be monitored for a safe and reliable operation.

These parameters and the main recommendations for good practice and safety devices are explained hereunder.

- **Refrigerant and lubricants**
- **Motor supply**
- **Compressor ambient temperature**
- **Application envelope** (evaporating temperature, condensing temperature, return gas temperature)

**Refrigerant and lubricants**
**General information**

When choosing a refrigerant, different aspects must be taken into consideration:

- Legislation (now and in the future)
- Safety
- Application envelope in relation to expected running conditions
- Compressor capacity and efficiency
- Compressor manufacturer recommendations & guidelines

Additional points could influence the final choice:

- Environmental considerations
- Standardisation of refrigerants and lubricants
- Refrigerant cost
- Refrigerant availability

**Oil type - PVE**

Polyvinyl ether (PVE) is an innovative refrigeration lubricant for HFC refrigerant systems. PVE is as hygroscopic as existing polyolester lubricants (POE), but PVE doesn't chemically react with water; no acids are formed and compressor evacuation is easier.

The compressor technology applied in the Danfoss Heat Pump scroll compressors in combination with PVE lubricant provides the best possible result in terms of reliability and compressor lifetime.

The PVE lubricant is compatible with R22 which makes the Danfoss Heat Pump scroll compressors a very versatile multi-refrigerant solution.

**Motor supply**

The Danfoss Heat Pump scroll compressors can be operated at nominal voltages as indicated in section "Electrical data, connections and wiring". Under-voltage and over-voltage operation is allowed within the indicated voltage ranges. In

case of risk of under-voltage operation, special attention must be paid to current draw and start assist for single-phase compressors may be required.

**Compressor ambient temperature**

The Danfoss Heat Pump scroll compressors can be applied from -35°C to 50°C ambient temperature. The compressors are designed

as 100 % suction gas cooled without need for additional fan cooling. Ambient temperature has very little effect on the compressor performance.

**High ambient temperature**

In case of enclosed fitting and high ambient temperature it's recommend to check the temperature of power wires and conformity to their insulation specification.

In case of safe tripping by the internal compressor overload protection the compressor must cool down to about 60°C before the overload will reset. A high ambient temperature can strongly delay this cool-down process.

**Low ambient temperature**

Although the compressor itself can withstand low ambient temperature, the system may require specific design features to ensure safe and reliable

operation. See section 'Specific application recommendations'.

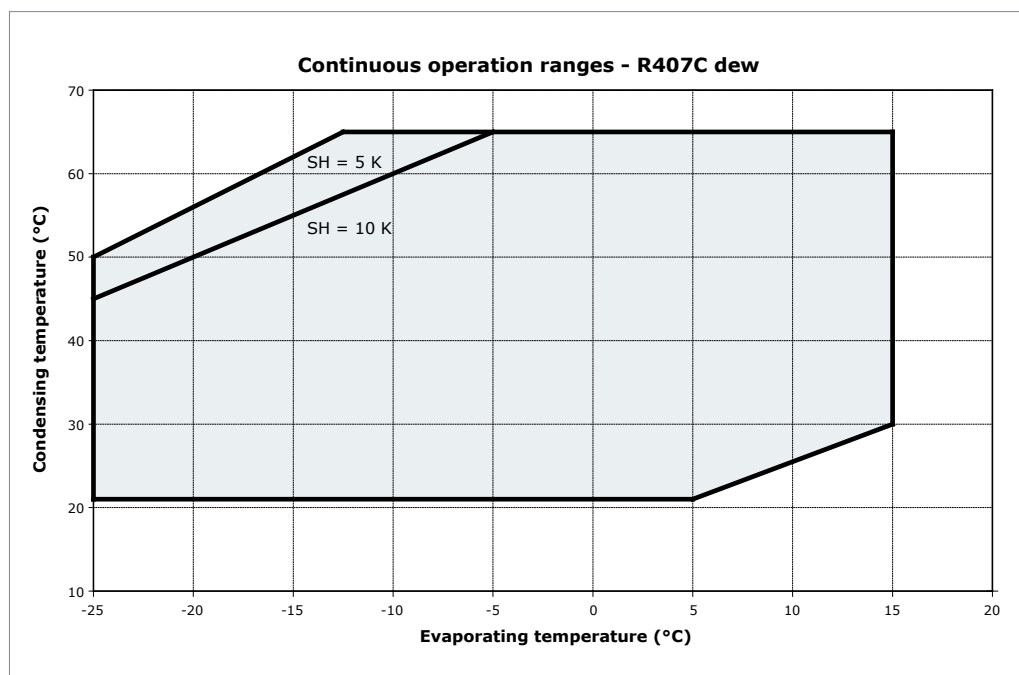


**Application envelope**

The operating envelope for Danfoss Heat Pump scroll compressors are given in the figure below, where the condensing and evaporating temperatures represent the range for steady-state operation. Under transient conditions, such as start-up and defrost for heat pump applications, the compressor may operate outside this envelope for short periods.

- Maximum discharge gas flow temperature: 140°C,
- A suction superheat below 5 K is not recommended due to the risk of liquid flood back,
- Maximum superheat of 30 K as long as maximum discharge gas temperature is not exceeded,
- Minimum and maximum evaporating and condensing temperatures as per the operating envelopes.

The operating limits serve to define the envelope within which reliable operations of the compressor are guaranteed:

**R407C**

**Maximum discharge gas temperature**

The discharge temperature depends mainly on the combination of evaporating temperature, condensing temperature and suction gas superheat. Discharge gas temperature should be controlled with an isolated thermocouple or

thermostat attached to the discharge line 15 cm from the compressor shell. Maximum discharge gas temperature must not exceed 140°C when the compressor is running within the approved operating envelope.

**Discharge gas temperature protection (DGT)**

DGT protection is required if the high and low pressure switch settings do not protect the compressor against operations beyond its specific application envelope. Please refer to the examples below, which illustrate where DGT protection is required (n°1) and where it is not (n°2).

The compressor must not be allowed to cycle on the discharge gas thermostat. Continuous operations beyond the compressor's operating range will cause serious damage to the compressor!

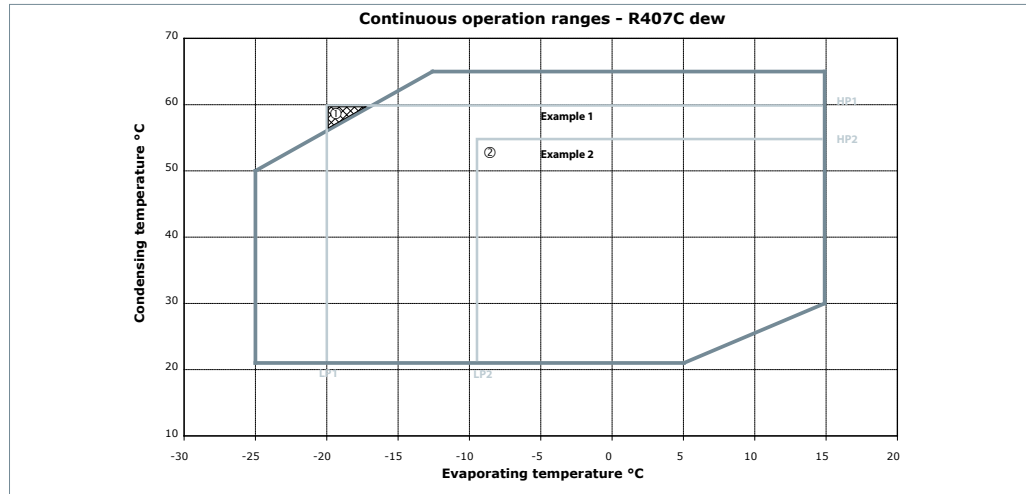
A DGT accessory is available from Danfoss: refer to section "Spare parts and accessories".

**Example 1 (R407C)**

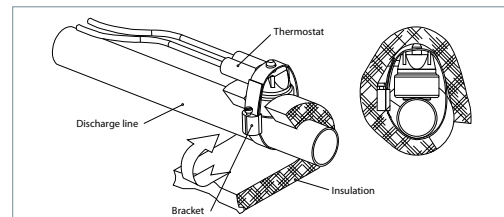
LP switch setting: LP1= 1.1 bar (g) (-20°C)  
 HP switch setting: HP1= 24.3 bar (g) (60°C)  
 ① The LP and HP switches don't protect sufficiently from operation outside the envelope. A DGT protection is required to avoid operation in the hatched area.

**Example 2 (R407C)**

LP switch setting: LP2 = 2.3 bar (g) (-9°C)  
 HP switch setting: HP2 = 18.8 bar (g) (50°C)  
 ② The LP and HP switches protect from operation outside the envelope. No DGT protection required.



The discharge gas thermostat accessory kit includes all components required for installation, as shown below. The thermostat must be attached to the discharge line within 150 mm from the compressor discharge port.



**High and low pressure protection**

		R407C
Working pressure range high side	bar (g)	7.8 - 27.4 <sup>②</sup>
Working pressure range low side	bar (g)	0.7 - 6.6 <sup>②</sup>
Maximum high pressure safety switch setting	bar (g)	30
Minimum low pressure safety switch setting <sup>①</sup>	bar (g)	0.5
Maximum test pressure	bar (g)	30

① LP safety switch shall never be bypassed.

② Depends on the models, check on the nameplate

**High pressure**

A high-pressure (HP) safety switch is recommended to shut down the compressor should the discharge pressure exceed the values shown in the table below. The high-pressure switch can be set to lower values depending on the application and ambient conditions. The HP switch must either be placed in a lockout circuit or consist of a manual reset device to prevent cycling around the high-pressure limit. If a discharge valve is used, the HP switch must be connected

to the service valve gauge port, which must not be isolated.

Note: because power consumption of scroll compressors is almost directly proportional to discharge pressure, the high-pressure control can be used to indirectly limit the maximum current draw. A high-pressure control used in this manner however can never replace an external overload protector.

**Low pressure**

A low pressure (LP) safety switch is recommended. Deep vacuum operations of a scroll compressor can cause internal electrical arcing and scroll instability. Danfoss Heat Pump scroll compressors exhibit high volumetric efficiency and may draw very low vacuum levels, which could induce such a problem. The minimum low-pressure safety switch (loss of charge safety switch) setting is

given in the above table. For systems without pump-down, the LP safety switch must either be a manual lockout device or an automatic switch wired into an electrical lockout circuit. The LP switch tolerance must not allow for vacuum operations of the compressor. LP switch settings for pump-down cycles with automatic reset are also listed in the table above.

**On/off cycling (cycle rate limit)**

Danfoss recommends a restart delay timer to limit compressor cycling. The timer prevents reverse compressor rotation, which may occur during brief power interruptions.

cooling after start-up along with proper oil return. Note that the oil return may vary since it depends upon system design.

The system must be designed in a way that guarantees a minimum compressor running time of 2 minutes so as to provide for sufficient motor

There must be no more than 12 starts per hour, a number higher than 12 reduces the service life of the motor-compressor unit. A three-minute (180-sec) time out is recommended.

**General**

Successful application of scroll compressors is dependent on careful selection of the compressor for the application. If the compressor is not correct

for the system, it will operate beyond the limits given in this manual. Poor performance, reduced reliability, or both may result.

**Essential piping design considerations**

Proper piping practices should be employed to ensure adequate oil return, even under minimum load conditions with special consideration given to the size and slope of the tubing coming from the evaporator. Tubing returns from the evaporator should be designed so as not to trap oil and to prevent oil and refrigerant migration back to the compressor during off-cycles.

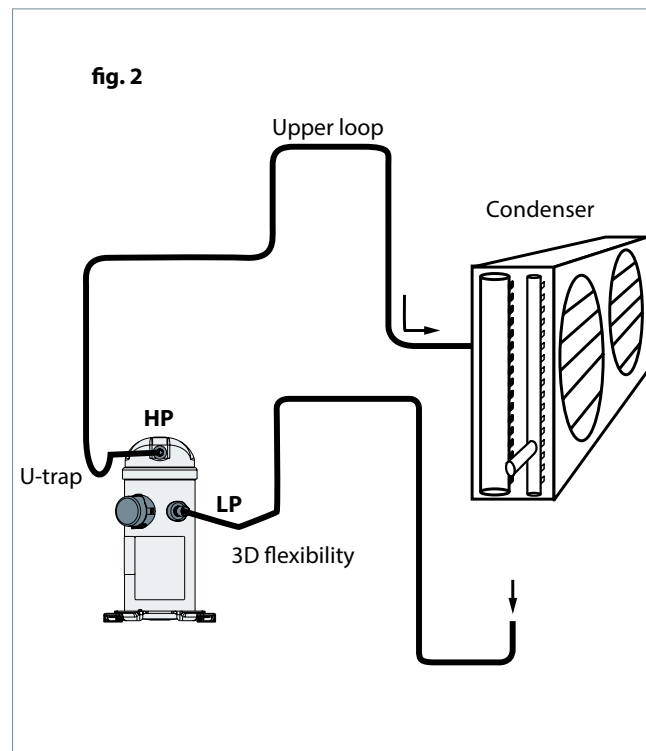
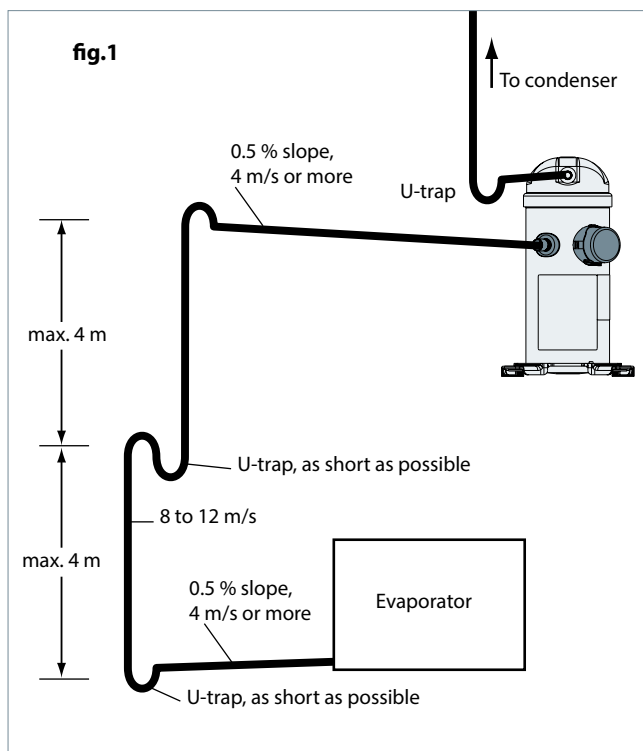
If the evaporator lies above the compressor, the suction line must have a loop at the evaporator outlet to prevent refrigerant from draining into the compressor during off-cycles.

If the evaporator were situated below the compressor, the suction riser must be trapped so as to prevent liquid refrigerant from collecting at the thermal bulb location (see fig. 1).

When the condenser is mounted at a higher position than the compressor, a suitably sized «U»-shaped trap close to the compressor is necessary to prevent oil leaving the compressor

from draining back to the discharge side of the compressor during off cycle. The upper loop also helps avoid condensed liquid refrigerant from draining back to the compressor when stopped (see fig. 2). The maximum elevation difference between the indoor and outdoor section cannot exceed 8 m. System manufacturers should specify precautions for any applications that exceed these limits to ensure compressor reliability.

Piping should be designed with adequate three-dimensional flexibility. It should not be in contact with the surrounding structure, unless a proper tubing mount has been installed. This protection proves necessary to avoid excess vibration, which can ultimately result in connection or tube failure due to fatigue or wear from abrasion. Aside from tubing and connection damage, excess vibration may be transmitted to the surrounding structure and generate an unacceptable noise level within that structure as well (for more information on noise and vibration, see the section on: "Sound and vibration management").



**Refrigerant charge limit**

Danfoss Heat Pump scroll compressors can tolerate liquid refrigerant up to a certain extent without major problems. However, excessive liquid refrigerant in the compressor is always unfavourable for service life. Besides, the installation cooling capacity may be reduced because of the evaporation taking place in the compressor and/or the suction line instead of the evaporator. System design must be such that the amount of liquid refrigerant in the compressor is limited. In this respect, follow the guidelines given in the section: "Essential piping design recommendations" in priority.

Use the tables below to quickly evaluate the required compressor protection in relation with the system charge and the application. More detailed information can be found in the paragraphs hereafter. Please contact Danfoss for any deviation from these guidelines.

**Notes:** for reversible heat pump systems and other specific applications, please refer to section "Specific application recommendations".

Compressor models	Refrigerant charge limit (kg)
HHP015-019-021-026	3.6
HHP030-038-045	5.4

Depending on test results, crankcase heaters, Liquid Line Solenoid Valve or suction accumulator must be applied see below.

	BELOW charge limit	ABOVE charge limit
Packaged units	<input checked="" type="checkbox"/> No test or additional safeties required	<b>REQ</b> Off cycle migration test <b>REQ</b> Liquid flood back test
System with remote heat exchanger	<b>REC</b> Off cycle migration test	<b>REQ</b> Off cycle migration test <b>REQ</b> Liquid flood back test

**REC** Recommended    **REQ** Required     No test or additional safeties required

Note: for special conditions such as low ambient temperature, low load operation or brazed plate heat exchangers please refer to corresponding sections

**Reversible heat pump systems**

Transients are likely to occur in reversible heat pump systems, i.e. a changeover cycle from cooling to heating, defrost or low-load short cycles. These transient modes of operation may lead to liquid refrigerant carryover (or flood back) or excessively wet refrigerant return conditions. As such, reversible cycle applications require specific precautions for ensuring a long compressor life and satisfactory operating characteristics. Regardless of the refrigerant charge in the system, specific tests for repetitive flood back are required to confirm whether or not a suction

accumulator needs to be installed. A crankcase heater and discharge gas thermostat are required for reversible heat pump applications.

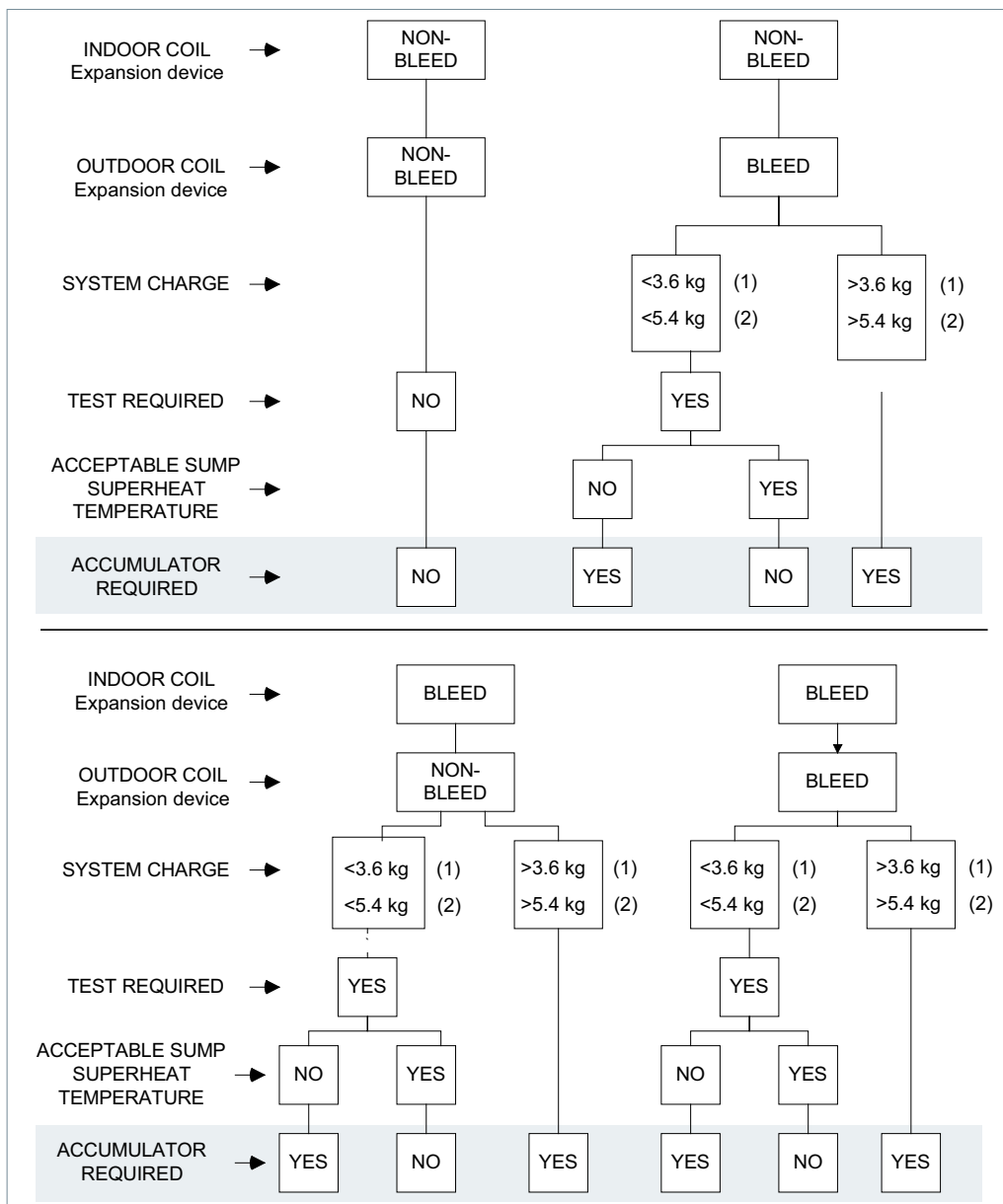
These considerations cover the most important issues in the realm of common applications. Each application design however should be thoroughly tested to ensure acceptable operating characteristics.

**Split unit heating mode**

Repeat the test, but with the system in heating mode and the outdoor temperature at -18°C dry bulb. If the sump superheat is not in the "ACCEPTABLE ZONE" shown in the Flood back

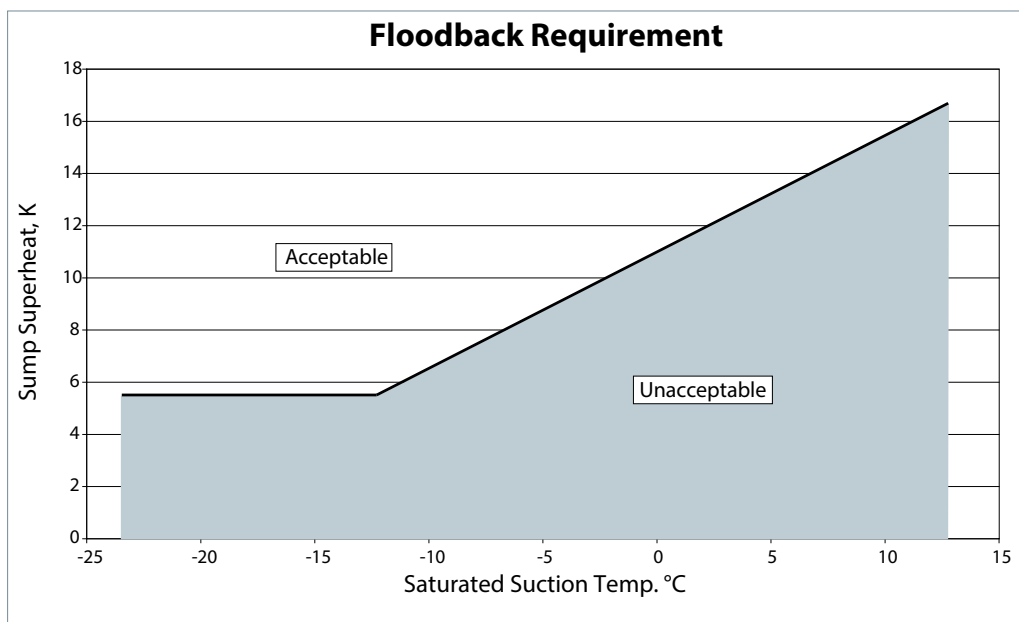
Requirement graph on the next page, a suction accumulator is required.

Heat pumps



(1) HHP015-019-021-026

(2) HHP030-038-045



**Application Guidelines**
**System design recommendations**

<b>Crankcase heater</b>	<p>Crankcase heaters provide extra compressor protection, and should be considered for all applications. For initial installation of precharged</p>	<p>systems and for any extended power interruptions, the crankcase heater should be energized for 24 hours prior to compressor startup.</p>
<b>Minimum sump superheat</b>	<p>The minimum sump temperature is in the range from 6K to 17K above saturated suction</p>	<p>temperature. Refer to the flood back test criteria section "System design recommendations".</p>
<b>Loss of charge protection</b>	<p>Danfoss Heat Pump scroll compressors do not include a thermal valve protection; therefore, all applications should consider loss of charge protection :</p> <ul style="list-style-type: none"> <li>• A low pressure switch in the low pressure side of the system is required.</li> </ul>	<ul style="list-style-type: none"> <li>• A discharge line thermostat set no higher than 140°C is recommended. The thermostat must be a manual lockout type device (or electrical lockout circuit) and be located within 150 mm of the compressor discharge connection. The discharge line thermostat must be insulated to insure proper sensing and operation.</li> </ul>
<b>Oil level checking and top-up</b>	<p>In installations with good oil return and line runs up to 15 m, no additional oil is required. If installation lines exceed 15 m, additional oil may be needed. 1 or 2% of the total system refrigerant charge (in weight) can be used to roughly define the required oil top-up quantity.</p>	<p>Always use oil from new cans. Top-up the oil while the compressor is idle. Use any accessible connector on the compressor suction line and a suitable pump.</p>
<b>High pressure ratio</b>	<p>Danfoss Heat Pump scroll compressors are machines with fixed volume ratio, and operate more efficiently near the design pressure ratio. In the extreme, do not exceed a 11:1 pressure ratio (absolute discharge pressure to absolute suction</p>	<p>pressure) for extended periods. The Danfoss Heat Pump scroll compressor is equipped with an internal pressure relief valve for protection against blocked condenser and fan failure conditions.</p>
<b>Preventing liquid flood back</b>	<p>Danfoss recommends the use of a thermostatic expansion valve for all air conditioning and heat pump applications. A TXV has two key benefits: it provides modulating control of the system under varying load conditions, and it protects the compressors from flood back during adverse running conditions.</p>	<p>Excessive liquid refrigerant flood back during steady state operation is a major system design consideration for all types of compressors. Oil dilution that occurs with excessive flood back can have a significant adverse effect on bearing reliability. Suction accumulators may be required in some applications to prevent flood back.</p>
<b>Testing for excessive liquid flood back</b>	<p>When the use of fixed orifice devices is specified in the system design, and when a TXV is applied at the limit of its control range, the following tests should be conducted to determine if a suction</p>	<p>accumulator is needed. Refer to the flowcharts section "System design recommendations" to determine when to apply the excessive liquid flood back test.</p>
<b>Water utilising systems</b>	<p>Apart from residual moisture in the system after commissioning, water could also enter the refrigeration circuit during operation. Water in the system shall always be avoided. Not only because it can shortly lead to electrical failure, sludge in sump and corrosion but in particular because it can cause serious safety risks.</p> <p>Common causes for water leaks are corrosion and freezing.</p> <p>Corrosion: Materials in the system shall be compliant with water and protected against corrosion.</p>	<p>Freezing: When water freezes into ice its volume expands which can damage heat exchanger walls and cause leaks. During off periods water inside heat exchangers could start freezing when ambient temperature is lower than 0°C. During on periods ice banking could occur when the circuit is running continuously at too low load. Both situations should be avoided by connecting a pressure and thermostat switch in the safety line.</p>

**Running sound level**

Danfoss Heat Pump scroll compressors are designed with optimised discharge ports and wrap geometry to reduce the sound level when a compressor is running.

Model	Code 4		Code 5	
	Sound power (dBA) Without jacket	Sound power (dBA) With jacket	Sound power (dBA) Without jacket	Sound power (dBA) With jacket
HHP015	70	62	70	62
HHP019	70	62	70	62
HHP021	71	63	71	63
HHP026	71	63	71	63
HHP030	72	64	72	64
HHP038	72	64	72	64
HHP045	73	65	-	-

**Sound generation in a refrigeration system / air conditioning system**

Typical sound and vibration in refrigeration and air conditioning systems encountered by design and service engineers may be broken down into the following three source categories.

**Sound radiation:** This generally takes an airborne path.

**Mechanical vibrations:** These generally extend along the parts of the unit and structure.

**Gas pulsation:** This tends to travel through the cooling medium, i.e. the refrigerant.

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

**Compressor sound radiation**

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

The Danfoss Heat Pump scroll compressor is designed to be quiet and the frequency of the sound generated is pushed into the higher ranges, which not only are easier to reduce but also do not generate the penetrating power of lower-frequency sound.

Use of sound-insulation materials on the inside of unit panels is an effective means of substantially reducing the sound being transmitted to the outside. Ensure that no components capable of transmitting sound/vibration within the unit come into direct contact with any non-insulated parts on the walls of the unit.

Because of the Danfoss's unique design of a full-suction gas & oil cooled motor, compressor body insulation across its entire operating range is possible.

**Mechanical vibrations**

Vibration isolation constitutes the primary method for controlling structural vibration. Danfoss Heat Pump scroll compressors are designed to produce minimal vibration during operations. The use of rubber isolators on the compressor base plate or on the frame of a manifolded unit is very effective in reducing vibration being transmitted from the compressor(s) to the unit. Rubber grommets are supplied with all Danfoss compressors. Once the supplied rubber grommets have been properly mounted, vibration transmitted from the compressor base plate to the unit are held to a strict minimum. In addition, it is extremely

important that the frame supporting the mounted compressor be of sufficient mass and stiffness to help dampen any residual vibration potentially transmitted to the frame. The tubing should be designed so as to both reduce the transmission of vibrations to other structures and withstand vibration without incurring any damage. Tubing should also be designed for three-dimensional flexibility. For more information on piping design, please see the section entitled "Essential piping design considerations".

**Gas pulsation**

The Danfoss Heat Pump scroll compressors have been designed and tested to ensure that gas pulsation has been optimised for the most commonly encountered pressure ratio. On heat pump installations and other installations where the pressure ratio lies beyond the typical range, testing should be conducted under all expected

conditions and operating configurations to ensure that minimum gas pulsation is present. If an unacceptable level is identified, a discharge muffler with the appropriate resonant volume and mass should be installed. This information can be obtained from the component manufacturer.

Each Danfoss Heat Pump scroll compressor is shipped with printed Instructions for installation.

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**System cleanliness**

The refrigerant compression system, regardless of the type of compressor used, will only provide high efficiency and good reliability, along with a long operating life, if the system contains solely the refrigerant and oil it was designed for. Any other substances within the system will not improve performance and, in most cases, will be highly detrimental to system operations.

The presence of non-condensable substances and system contaminants, such as metal shavings, solder and flux, have a negative impact on compressor service life. Many of these contaminants are small enough to pass through a mesh screen and can cause considerable damage within a bearing assembly. The use of highly hygroscopic POE and PVE oils in R407C and R410A compressors requires that the oil be exposed to the atmosphere just as little as possible.

System contamination is one of main factors affecting equipment reliability and compressor service life. It is important therefore to take system cleanliness into account when assembling a refrigeration system.

During the manufacturing process, circuit contamination may be caused by:

- Brazing and welding oxides,
- Filings and particles from the removal of burrs in pipe-work,
- Brazing flux,
- Moisture and air.

Consequently, when building equipment and assemblies, the following precautions must be taken: never drill holes into the pipe-work after installation.

---

**Compressor handling and storage**

Compressors are provided with a lifting lug. This lug should always be used to lift the compressor. Once the compressor is installed, the lifting lug should never be used to lift the complete installation. The compressor must be handled

with caution in the vertical position, with a maximum inclination of 15° from vertical. Store the compressor between -35°C and 50°C, not exposed to rain or corrosive atmosphere.

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**Compressor mounting**

Maximum inclination from the vertical plane, while operating must not exceed 7 degrees. All compressors are delivered with 4 rubber

grommets and metal sleeves. Compressors must always be mounted with these grommets.

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**Compressor holding charge**

Each compressor is shipped with a nominal dry nitrogen holding charge between 0.4 bar and 0.7 bar, and is sealed with elastomer plugs. The plugs should be removed with care to avoid oil loss when the holding charge is released. Remove the suction plug first and the discharge

plug afterwards. The plugs shall be removed only just before connecting the compressor to the installation in order to avoid moisture entering the compressor. When the plugs are removed, it is essential to keep the compressor in an upright position to avoid oil spillage.

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**Tube brazing procedure**

Do not bend the compressor discharge or suction lines or force system piping into the compressor connections, because this will increase stresses

that are a potential cause of failure. Recommended brazing procedures and material, are described on following page.

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**Brazing material**

For copper suction and discharge fittings, use copper-phosphorus brazing material. Sil-Fos® and other silver brazing materials are also acceptable.

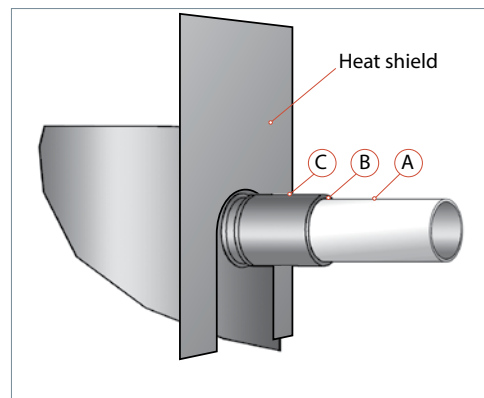
If flux is required for the brazing operation, use coated rod or flux core wire. To avoid system contamination, do not brush flux on.



**Compressor connection**

When brazing the compressor fittings, do not overheat the compressor shell, which could severely damage certain internal components due to excessive heating. Use of a heat shield and/or a heat-absorbent compound is highly recommended. For brazing the suction and discharge connections, the following procedure is advised:

- Make sure that no electrical wiring is connected to the compressor.
- Protect the terminal box and compressor painted surfaces from torch heat damage (see diagram).
- Use only clean refrigeration-grade copper tubing and clean all connections.
- Purge nitrogen or CO<sub>2</sub> through the compressor in order to prevent against oxidation and flammable conditions. The compressor should not be exposed to the open air for extended periods.
- Use of a double-tipped torch is recommended.
- Apply heat evenly to Area (A) until the brazing temperature is reached. Move the torch to Area (B) and apply heat evenly until the brazing temperature has been reached there as well, and then begin adding the brazing material. Move the torch evenly around the joint, in applying only enough brazing material to flow the full circumference of the joint.
- Move the torch to area (C) only long enough to draw the brazing material into the joint, but not into the compressor.
- Remove all remaining flux once the joint has been soldered with a wire brush or a wet cloth. Remaining flux would cause corrosion of the tubing.



Ensure that no flux is allowed to enter into the tubing or compressor. Flux is acidic and can cause substantial damage to the internal parts of the system and compressor.

The PVE oil used in Danfoss Heat Pump scroll compressors is highly hygroscopic and will rapidly absorb moisture from the air. The compressor must therefore not be left open to the atmosphere for a long period of time. The compressor fitting plugs shall be removed just before brazing the compressor.

**⚠ Before eventual unbrazing the compressor or any system component, the refrigerant charge must be removed from both the high and low pressure sides. Failure to do so may result in serious personal injury. Pressure gauges must be used to ensure all pressures are at atmospheric level.**

For more detailed information on the appropriate materials required for brazing or soldering, please contact the product manufacturer or distributor. For specific applications not covered herein, please contact Danfoss for further information.

**Vacuum evacuation and moisture removal**

Moisture obstructs the proper functioning of both the compressor and the refrigeration system.

Air and moisture reduce service life and increase condensing pressure, which causes abnormally high discharge temperatures that are then capable of degrading the lubricating properties of the oil. The risk of acid formation is also increased by air and moisture, and this condition can also lead to copper plating. All these phenomena may

cause both mechanical and electrical compressor failures. The typical method for avoiding such problems is a vacuum pump-down executed with a vacuum pump, thus creating a minimum vacuum of 500 microns (0.67 mbar). Please refer to Bulletin "Vacuum pump down and dehydration procedure".

Be sure to follow all government regulations regarding refrigerant reclamation and storage.

**Liquid line filter driers**

A properly sized filter drier is required for all Danfoss scroll applications. Danfoss recommends DML (100% molecular sieves) driers for HFC refrigerants R407C with PVE oil. For servicing of existing installations where acid formation is present the Danfoss DCL solid core filter driers

containing activated alumina are recommended. The drier is to be oversized rather than under sized. When selecting a drier, always take into account its capacity (water content capacity), the system refrigeration capacity and the system refrigerant charge.

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**Refrigerant charging**

It is recommended that system charging be done using the weighed charge method, adding refrigerant to the high side of the system. Charging the high and low sides of a system

with gas simultaneously at a controlled rate is also an acceptable method. Do not exceed the recommended unit charge, and never charge liquid to the low side.

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**Insulation resistance and dielectric strength**

Insulation resistance must be greater than 1 megohm when measured with a 500 volt direct current megohm tester.

Each compressor motor is tested at the factory with a high potential voltage (hi-pot) that exceeds the UL requirement both in potential and in duration. Leakage current is less than 0.5 mA.

Danfoss Heat Pump scroll compressors are configured with the pump assembly at the top of the shell, and the motor below. As a result, the motor can be partially immersed in refrigerant

and oil. 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, and should not be cause for concern.

In testing insulation resistance, Danfoss recommends that the system be first operated briefly to distribute refrigerant throughout the system. Following this brief operation, retest the compressor for insulation resistance or current leakage.

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**Compressor replacement after motor burn out**

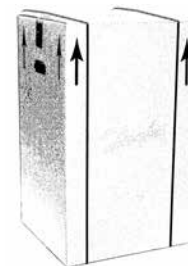
If there has been a motor burnout follow the evacuation procedure described on previous page. Remove and replace the liquid line filter drier and install a Danfoss type DAS burnout drier of appropriate capacity.

Refer to the DAS drier instructions and technical information on correct use and monitoring of the burnout drier and the liquid line and suction line filter driers.

**Packaging**
**Single pack**

Compressors are packed individually in a cardboard box. They can be ordered in any quantity. Minimum ordering quantity = 1. As far as possible, Danfoss will ship the boxes on full pallets of 6 compressors according below table.

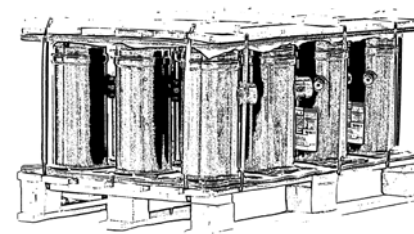
- Each box also contains following accessories:
- 4 grommets
- 4 assemblies of self tapping US thread bolts, washers and sleeves
- 4 additional sleeves
- 1 screw for earth connection
- start capacitor for single phase (individual pack)


**Industrial pack**

Compressors are not packed individually but are shipped all together on one pallet. They can be ordered in quantities of full pallets only, multiples of 12.

Each industrial pack pallet contains following accessories:

- 4 grommets per compressor
- 4 sleeves per compressor


**Packaging details**

Model	Weight for single pack (kg)	Weight for Industrial pack (kg)
HHP015-019-021-026	198	407
HHP030-038-045	249	504

**Ordering information and packaging**


Model	Model Variation	Connections	Features	Single pack		Industrial pack	
				4	5	4	5
HHP015	T	P	6	121U9002	121U9004	121U9001	121U9003
HHP019	T	P	6	121U9006	121U9008	121U9005	121U9007
HHP021	T	P	6	121U9010	121U9012	121U9009	121U9011
HHP026	T	P	6	121U9014	121U9016	121U9013	121U9015
HHP030	T	C	6	121U9018	121U9020	121U9017	121U9019
HHP038	T	C	6	121U9022	121U9024	121U9021	121U9023
HHP045	T	C	6	121U9026	-	121U9025	-

**Run capacitors for PSC wiring**


Type	Code n°	Description	Application	Packaging	Pack size
40 µF	8173231	Run capacitor (µF)	HHP015	Multipack	10
60 µF	120Z0050	Run capacitor (µF)	HHP019, HHP021	Multipack	10
70 µF	120Z0051	Run capacitor (µF)	HHP026	Multipack	10
50 µF	8173233	Run capacitor (µF)	HHP030	Multipack	10
55 µF	8173234	Run capacitor (µF)	HHP038	Multipack	10

**Rotolock adaptor set**


Type	Code n°	Description	Application	Packaging	Pack size
	120Z0126	Rotolock adaptor set (1-1/4" ~ 3/4"), (1" ~ 1/2")	HHP015-019-021-026	Multipack	6
	120Z0127	Rotolock adaptor set (1-1/4" ~ 7/8"), (1" ~ 1/2")	HHP030-038-045	Multipack	6

**Rotolock adaptor**


Type	Code n°	Description	Application (see above group)	Packaging	Pack size
	120Z0366	Rotolock adaptor (1-1/4" ~ 3/4")	HHP015-019-021-026 suction	Multipack	10
	120Z0367	Rotolock adaptor (1-1/4" ~ 7/8")	HHP030-038-045 suction	Multipack	10
	120Z0365	Rotolock adaptor (1" ~ 1/2")	HHP - all discharge	Multipack	10

**Crankcase heater**


Type	Code No	Description	Application	Packaging	Pack Size
	120Z0055	Belt type crankcase heater, 40 W, 230 V, CE mark	HHP015-019-021-026	Multipack	6
	120Z0056	Belt type crankcase heater, 40 W, 400 V, CE mark		Multipack	6
	120Z0057	Belt type crankcase heater, 50 W, 230 V, CE mark	HHP030-038-045	Multipack	6
	120Z0058	Belt type crankcase heater, 50 W, 400 V, CE mark		Multipack	6

**Start capacitors for CSR wiring**


Code n°	Description	Application	Packaging	Pack size
120Z0399	CSR wiring Start Capacitor 145-175 µF, motor voltage code 5 - 220-240V / 1 / 50Hz	HHP015-019-021-026	Multipack	10
120Z0400	CSR wiring Start Capacitor 161-193 µF, motor voltage code 5 - 220-240V / 1 / 50Hz	HHP030	Multipack	10
8173001	CSR wiring Start Capacitor 88-108 µF, motor voltage code 5 - 220-240V / 1 / 50Hz	HHP038	Multipack	10

**Starting relays for CSR wiring**


Code n°	Description	Application	Packaging	Pack size
120Z0393	Starting relay RVA9CKL	HHP015-019-021-026	Multipack	10
120Z0394	Starting relay RVA3EKL	HHP030	Multipack	10
120Z0395	Starting relay RVA4GKL	HHP038	Multipack	10

**Discharge temperature protection**


Type	Code No	Description	Application	Packaging	Pack Size
	7750009	Discharge thermostat kit	All models	Multipack	10
	7973008	Discharge thermostat kit	All models	Industry pack	50

**Lubricant**


Type	Code No	Description	Application	Packaging	Pack Size
	120Z5034	PVE (0.95 liter can)	HHP015 to 045	Multipack	1

**Mounting hardware**


Type	Code No	Description	Application	Packaging	Pack Size
	120Z5005	Mounting kit for 1 scroll compressor including 4 grommets, 4 sleeves, 4 bolts, 4 washers	All models	Single pack	1





# Danfoss Commercial Compressors

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.

We have 40 years of experience within the development of hermetic compressors which has brought us amongst the global leaders in our business, and positioned us as distinct variable speed technology specialists. Today we operate from engineering and manufacturing facilities spread across three continents.



Our products can be found in a variety of applications such as rooftops, chillers, residential air conditioners, heatpumps, coldrooms, supermarkets, milk tank cooling and industrial cooling processes.

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