MAKING MODERN LIVING POSSIBLE

Danfoss

Selection
& Application Guidelines

Performer® scroll compressors Single SH090 to SH300 50 - 60 Hz

R410A

Performer
SCROLL COMPRESSORS

REFRIGERATION &
AIR CONDITIONING DIVISION

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The new reference for refrigerants: R410A

Danfoss Commercial Compressors, along with the whole refrigeration and air conditioning industry, shares today's concern about the environmental issues that are ozone depletion, global warming and overall energy consumption. Usual HCFCs refrigerant fluids such as R22 are known to be implicated in these harmful phenomena, especially ozone depletion due to their chlorinated content. These substances are scheduled to be phased-out from production and use in coming years, in accordance with the international Montreal Protocol (1984).

As a result, new chlorine-free molecules have been recently developped and are now ready to replace former fluids. Among those refrigerants, the HFC blend R410A is admitted by a great majority of manufacturers to be the most promising in terms of environmental impact, stability and efficiency, and is already seen as the R22 replacement.

	Refrigerant	R22	R407C	R410A
Chemical properties	Chlorine content	yes	no	no
	Zeotropic	pure refrigerant	zeotropic mixture	near azeotropic mixture
	Composition	R22	R32/R125/R134a	R32/R125
Environmental impact	ODP	0.05	0	0
	GWP	1500	1526	1725
Thermodynamic properties	Vapor pressure (bar) at 25°C	10.4	11.9	16.5
	Cooling capacity of liquid (kJ/kg.K) at 25°C	1.24	1.54	1.84
	Cooling capacity of vapor (kJ/kg.K) at 1 atm, 25 °C	0.657	0.829	0.833
	Temperature glide (°C)	0	7.4	<0.2

- R410A's superior thermodynamical properties compared to R22 and R407C refrigerants allow for today's massive – and necessary – switch to high efficiency systems.

- Zero Ozone Depletion Potential (ODP): R410A doesn't harm the ozone layer.

- Global warming potential (GWP): R410A shows a relatively high warming potential. However, the GWP index denotes direct warming effect, which is relevant only in case of release to the atmosphere. A more accurate index is T.E.W.I., for Total Equivalent Warming Impact, which takes into account indirect contributions due to running energy costs. Because of the higher system efficiency it allows to achieve, R410A is in this regard the best refrigerant.

- As a near-azeotropic mixture, refrigerant R410A behaves like an homogeneous substance, whereas other zeotropic mixtures such as R407C and other blends suffer a temperature glide during phase change that lessens thermal efficiency and makes them difficult to transfer from a container to another.

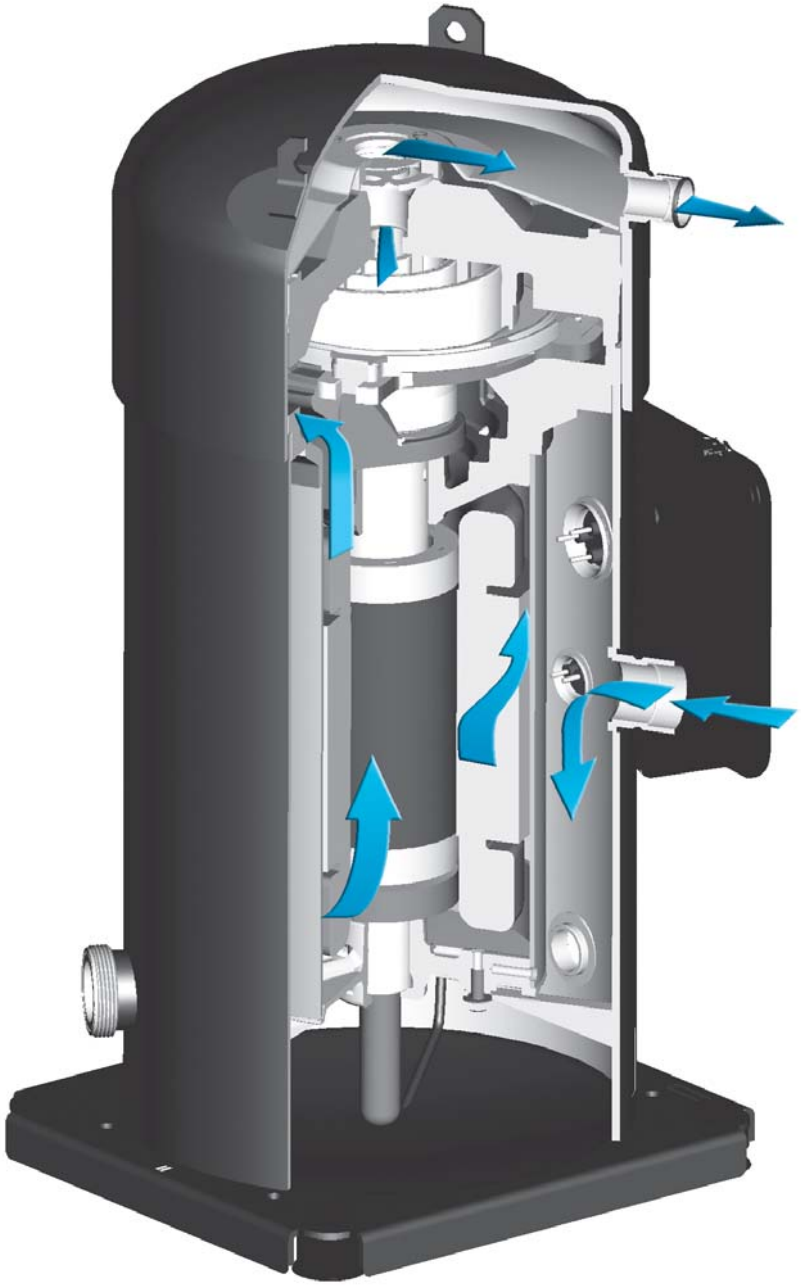
- Reduced refrigerant mass flow, permitted by a higher heat capacity, induce a lower sound level of the installation as well as more compact and lighter systems.

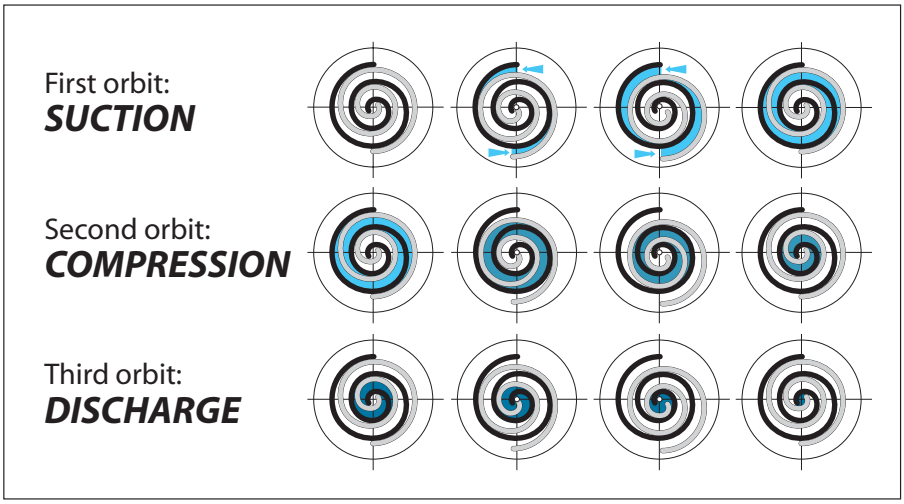
PERFORMER® SCROLL COMPRESSION PRINCIPLE

In a Danfoss Performer® SH scroll compressor, the compression is performed by two scroll elements located in the upper part of the compressor.

Suction gas enters the compressor at the suction connection. As all of the gas flows around and through the electrical motor, thus ensuring complete motor cooling in all applications, oil droplets separate and fall into the oil sump. After exiting the electrical motor, the gas enters the scroll elements where compression takes place. Ultimately, the discharge gas leaves the compressor at the discharge connection.

The figure below illustrates the entire compression process. The center of the orbiting scroll (in grey) traces a circular path around the center of the fixed scroll (in black). This movement creates symmetrical compression pockets between the two scroll elements. Low-pressure suction gas is trapped within each crescent-shaped pocket as it gets formed; continuous motion of the orbiting scroll serves to seal the pocket, which decreases in volume as the pocket moves towards the center of the scroll set increasing the gas pressure. Maximum compression is achieved once a pocket reaches the center where the discharge port is located; this stage occurs after three complete orbits. Compression is a continuous process: the scroll movement is suction, compression and discharge all at the same time.



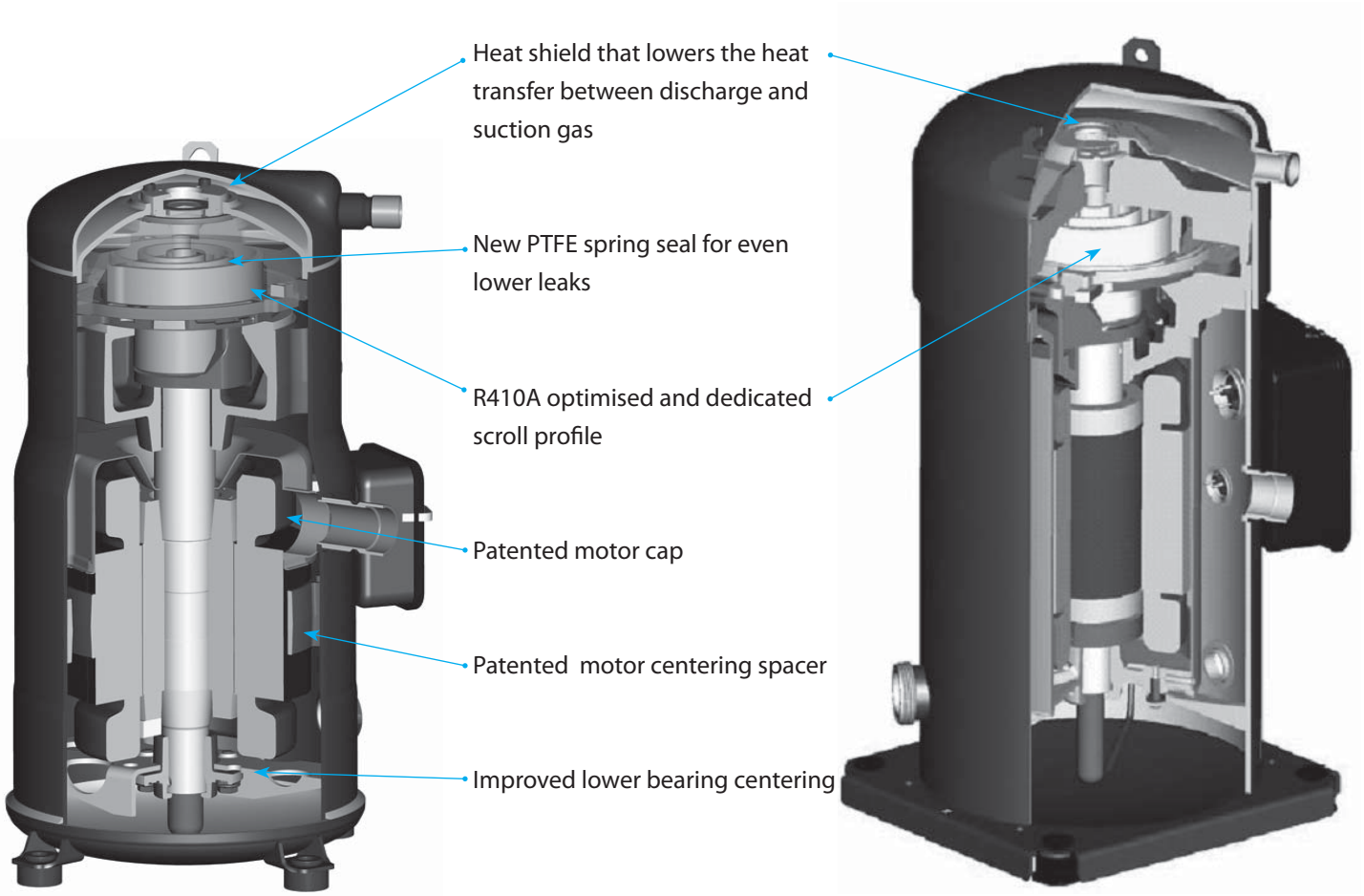


LIGHT COMMERCIAL COMPRESSORS INNOVATIONS

In addition to the 15 to 25 tons SH compressors previously available, Danfoss is completing its scope of applications with compressors ranging from 7.5 to 13 tons of cooling.

The news SH090 to 161 compressors benefit from a further improved design to achieve the highest efficiency.

- Better gas circulation, motor cooling and oil behaviour insured by a new patented motor cap design.
- Better part protection and assembly for reduced internal leaks and increased life durability.
- Improved part isolation reduces greatly acoustic levels.
- Higher resistance to liquid slugging induced by gas intake design.



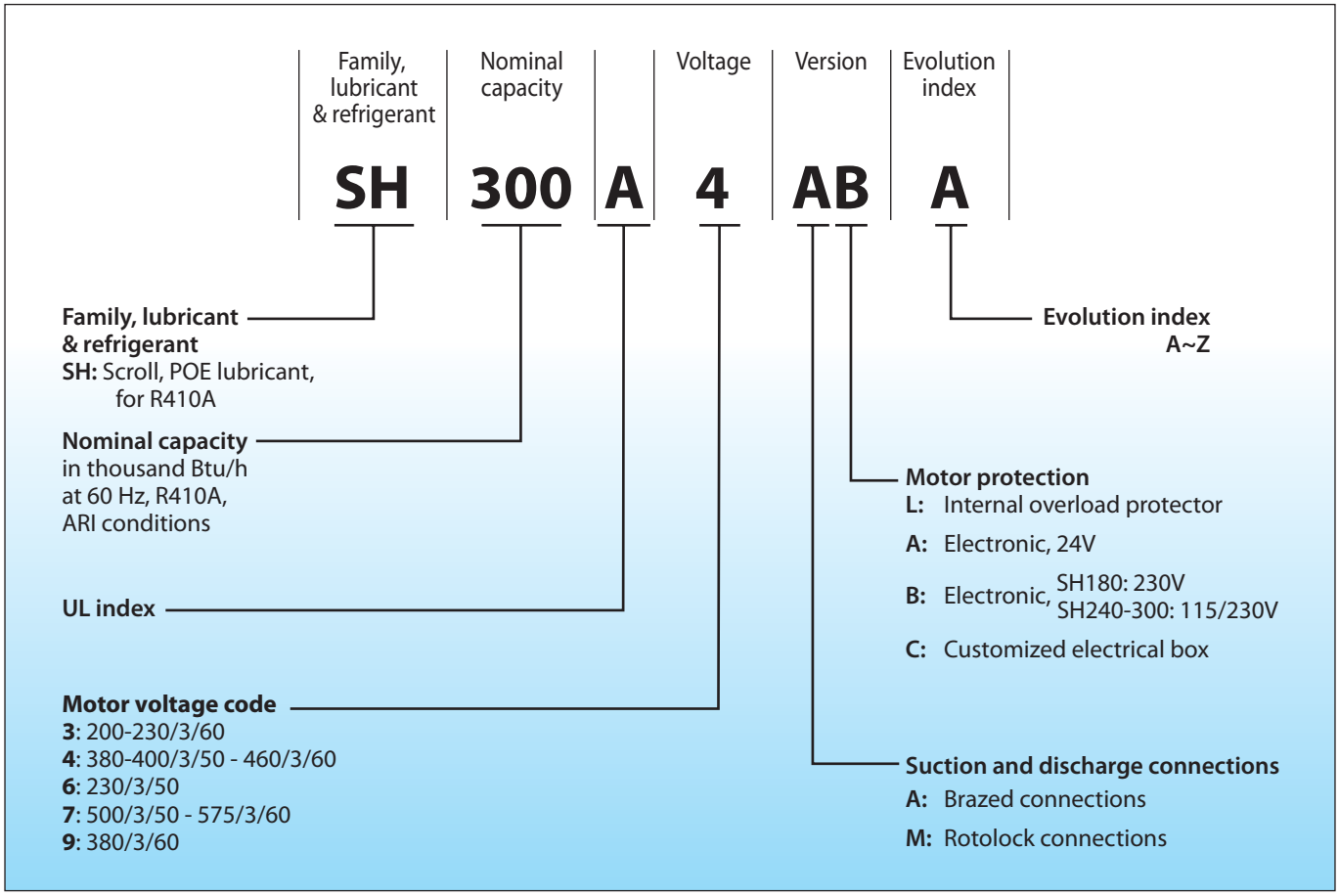
SH090 - 120 - 161

SH180 - 240 - 300

COMPRESSOR MODEL DESIGNATION

Performer® SH scroll compressors for R410A are available as single compressors. The example below presents the compressor nomenclature which equals the technical reference as shown on the compressor nameplate. Code numbers for ordering are listed on page 33.
For tandem and trio assemblies, please refer to the Performer® SH scroll compressor Parallel Application Guidelines.

Nomenclature



Connection details

MODEL	SH 090 - 120 - 161	SH 180 - 240 - 300	
Version	AL	AA AB	MA MB
Suction and discharge connection	brazed	brazed	rotolock
Oil sight glass	threaded	threaded	threaded
Oil equalisation connection	rotolock 1"3/4	rotolock 2"1/4	rotolock 2"1/4
Oil drain connection	none	1/4" NPT	1/4" NPT
Low pressure gauge port (schrader)	1/4" flare	1/4" flare	1/4" flare

TECHNICAL SPECIFICATIONS

50-60 Hz data

Model		Nominal tons 60 Hz	Nominal cooling capacity		Power input	A max (code 4)	COP	E.E.R.	Sound power	Swept volume	Displace-ment	Oil charge	Net weight
		TR	W	Btu/h	kW	A	W/W	Btu/h/W	dB(A)	cm³/rev	m³/h	dm³	kg
50 Hz	SH090*	7.5	22 300	76 100	7.19	22	3.10	10.59	69.8	88.4	15.4	3	58
	SH120*	10	30 000	102 200	9.46	29	3.17	10.80	72	116.9	20.3	3.3	60
	SH161*	13	38 800	132 400	12.15	35	3.19	10.90	71	151.7	26.4	3.3	64
	SH180	15	44 000	150 300	13.73	36	3.21	10.95	80	170.2	29.6	6.2	106
	SH240	20	59 900	204 500	18.77	51	3.19	10.90	82	227.6	39.6	6.2	106
	SH300	25	76 000	259 300	24.01	65	3.16	10.80	82	285.5	49.7	6.2	153
60 Hz	SH090*	7.5	26 700	91 200	8.52	22	3.14	10.71	71.5	88.4	18.6	3	58
	SH120*	10	36 800	125 400	11.25	29	3.27	11.15	75.5	116.9	24.6	3.3	60
	SH161*	13	47 200	160 900	14.43	35	3.27	11.15	74	151.7	31.9	3.3	64
	SH180	15	53 700	183 400	16.45	36	3.27	11.15	85	170.2	35.7	6.2	106
	SH240	20	73 100	249 500	22.48	51	3.25	11.10	86	227.6	47.8	6.2	106
	SH300	25	92 100	314 400	28.71	65	3.21	10.95	86	285.5	60.0	6.2	153

	SH compressors
Refrigerant	R410A
Frequency	50 Hz / 60 Hz
Standard rating conditions	ARI standard
Evaporating temperature	7.2 °C
Condensing temperature	54.4 °C
Subcooling	8.3 K
Superheat	11.1 K

TR = Ton of Refrigeration, COP = Coefficient Of Performance, EER = Energy Efficiency Ratio
* Preliminary performance data for SH090, SH120 and SH161.

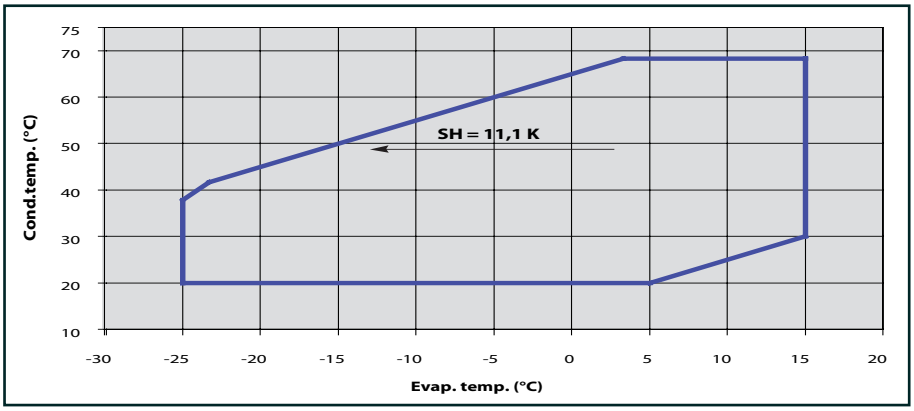
Subject to modification without prior notification.
For full data details and capacity tables refer to Online Datasheet Generator: **www.danfoss.com/odsg**

OPERATING ENVELOPE

The figure below shows the operating envelope for SH compressors with refrigerant R410A. SH compressors must always be operated within the indicated limits.
The operating limits serve to define the envelope within which reliable operations of the compressor are guaranteed:

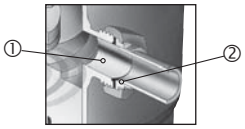
- Maximum discharge gas temperature: +135°C
- A suction superheat below 5 K is not recommended due to the risk of liquid floodback
- Maximum superheat of 30 K.
- Minimum and maximum evaporating and condensing temperatures as per the operating envelopes.

Additionnally, the maximum ambient temperature for SH compressors is: +55°C for SH090 to 161, +51°C for SH180 to 300 .



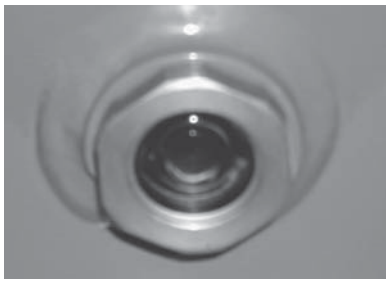
PIPING CONNECTIONS

Suction and discharge connections

		Brazed version	Rotolock version	
				
		Tube ODF	Tube ODF	
		Brazed	**Rotolock ①**	**Adaptor ②**
SH090	Suction	1"1/8	-	-
	Discharge	7/8"	-	-
SH120	Suction	1"3/8	-	-
	Discharge	7/8"	-	-
SH161	Suction	1"3/8	-	-
	Discharge	7/8"	-	-
SH180	Suction	1" 5/8	2" 1/4	1" 5/8
	Discharge	1" 1/8	1" 3/4	1" 1/8
SH240	Suction	1" 5/8	2" 1/4	1" 5/8
	Discharge	1" 1/8	1" 3/4	1" 1/8
SH300	Suction	1" 5/8	2" 1/4	1" 5/8
	Discharge	1" 1/8	1" 3/4	1" 1/8

Sight glass

All Performer® SH scroll compressors come equipped with a sight glass which may be used to determine the amount and condition of the oil contained within the sump.

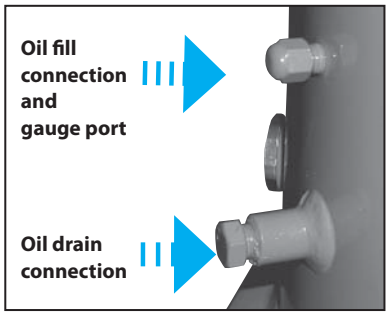


Schrader

The oil fill connection and gauge port is a 1/4" male flare connector incorporating a schrader valve.

Oil drain

The oil drain connection allows oil to be removed from the sump for changing, testing, etc. The fitting contains an extension tube into the oil sump to more effectively remove the oil. The connection is a female 1/4" NPT fitting and is mounted on SH180 - 240 - 380 models only.



Oil equalisation

SH090 to 161: 1"3/4 rotolock connector allowing use of 1"3/4 - 7/8 or 1"3/4 - 1"1/8 sleeve.
SH180 to 300: 2"1/4 rotolock connector allowing the use of 2"1/4 - 1"3/8 or 2"1/4 - 1"5/8 sleeve.
This connection must be used to mount an oil equalisation line when two or more compressors are mounted in parallel (please refer to Performer® SH Parallel Application Guidelines for details).

ELECTRICAL CONNECTIONS AND WIRING

Motor voltage

Performer® SH scroll compressors are available in five different motor voltages as listed below.

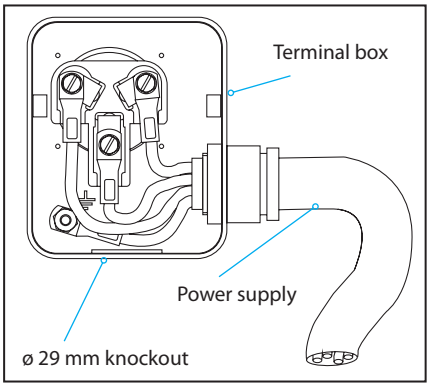
Motor voltage code		Code 3	Code 4 with internal overload protector (SH090 to 161)	Code 4 with PTC and electronic module (SH180 to 240)	Code 6	Code 7	Code 9
50 Hz	Nominal voltage	-	380-400V - 3	380-400V - 3	230V - 3	500V - 3	-
	Voltage range	-	340-440 V	360-440 V	207-253 V	450 - 550 V	-
60 Hz	Nominal voltage	200-230V - 3	460V - 3	460V - 3	-	575 V-3	380V- 3
	Voltage range	180-253 V	414-506 V	414-506 V	-	517-632 V	342-418 V

Electrical connections for SH090 to 161

Electrical power is connected to the compressor terminals by Ø 4.8 mm (3/16") screws. The maximum tightening torque is 3 Nm. Use a 1/4" ring terminal on the power leads.

• The terminal box is provided with a Ø 29 mm hole for the power supply and a Ø 29 mm knockout.

• The protection rating of the terminal box is IP54 when correctly sized IP54-rated cable glands are used. IP ratings according to IEC 529.



Electrical connections SH180

Electrical power is connected to the compressor terminals by Ø 4.8 mm (3/16") screws. The maximum tightening torque is 3 Nm. Use a 1/4" ring terminal on the power leads.

The terminal box is provided with 2 double knockouts for the power supply and 3 knockouts for the safety control circuit. The 2 power supply, double knockouts accommodate the following diameters:

Ø 44 mm / Ø 1"3/4 (for a 1"1/4 conduit) and Ø 34mm / Ø 1"3/8 (for a 1" conduit),

Ø 32.1 mm / Ø 1.26" and Ø 25.4 mm / Ø 1".

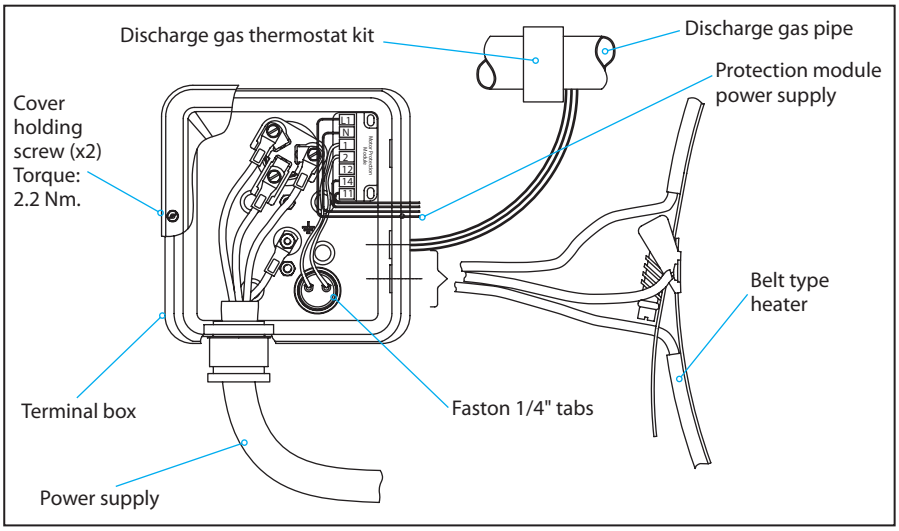
The 3 other knockouts are as follows:

Ø 20.5 mm / Ø 0.81"

Ø 22 mm / Ø 7/8" (for a 1/2" conduit)

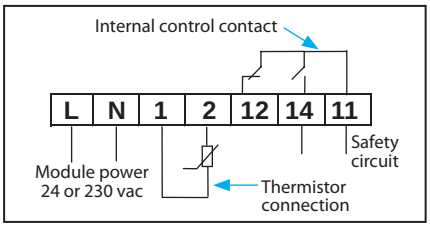
Ø 16.5 mm / Ø 0.65"

The protection rating of the terminal box is IP54 when correctly sized IP54 rated cable glands are used (IP rating according to IEC 529).



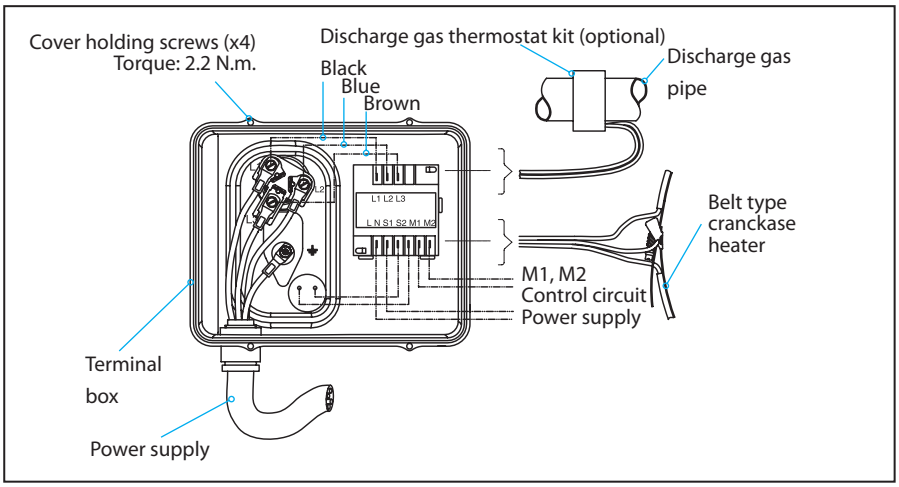
Electronic protection module wiring

The motor protection module comes preinstalled within the terminal box and has pre-wired thermistor connections. The module must be connected to a power supply of the appropriate voltage. The module terminals are 6.3-mm size Faston type.



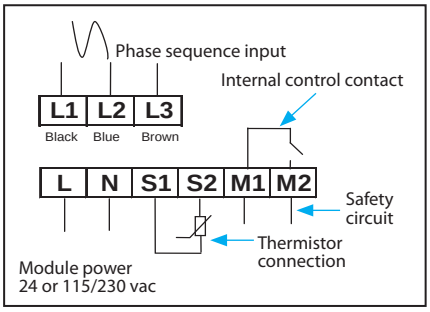
Electrical connections for SH240 - 300

Electrical power is connected to the compressor terminals by Ø 4.8 mm (3/16") screws. The maximum tightening torque is 3 Nm. Use a 1/4" ring terminal on the power leads.
The terminal box is provided with 4 double knockouts and 4 single knockouts for power supply and the safety control circuit. The 4 power supply knockouts accommodate the following diameters:
Ø 50 mm / Ø 1" 31/32
Ø 25.2 mm / 0.99"
Ø 43.7 mm / Ø 1"23/32 and Ø 34.5 mm / 1"23/64
Ø 40.5 mm / Ø 1.59" and Ø 32.2 mm / 1.27"
The 4 others knockouts are as follows:
Ø 20.5 mm / Ø 0.81" (2x)
Ø 22 mm / Ø 7/8" and Ø 16.5 mm / 0.65" (2x)
The protection rating of the terminal box is IP54 when correctly sized IP54-rated cable glands are used. (IP rating according to IEC 529).



Electronic protection module wiring

The motor protection module comes preinstalled within the terminal box. Phase sequence protection connections and thermistor connections are pre-wired. The module must be connected to a power supply of the appropriate voltage. The module terminals are 6.3-mm size Faston type.

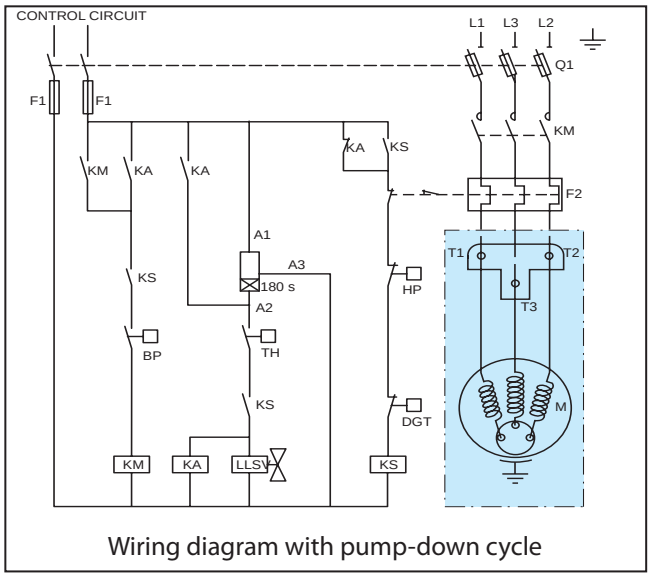


Terminal box temperature

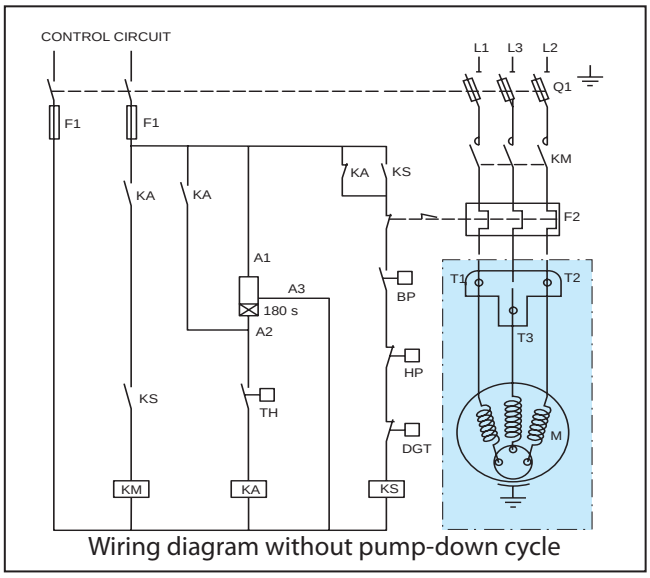
The temperature inside the terminal box may not exceed 70°C. Consequently, if the compressor is installed in an enclosure, precautions must be taken to avoid that the temperature around the compressor and in the terminal box would rise too much. The installation of ventilation on the enclosure panels 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.

Suggested wiring diagrams logic

Compressor model SH090 - 120 - 161



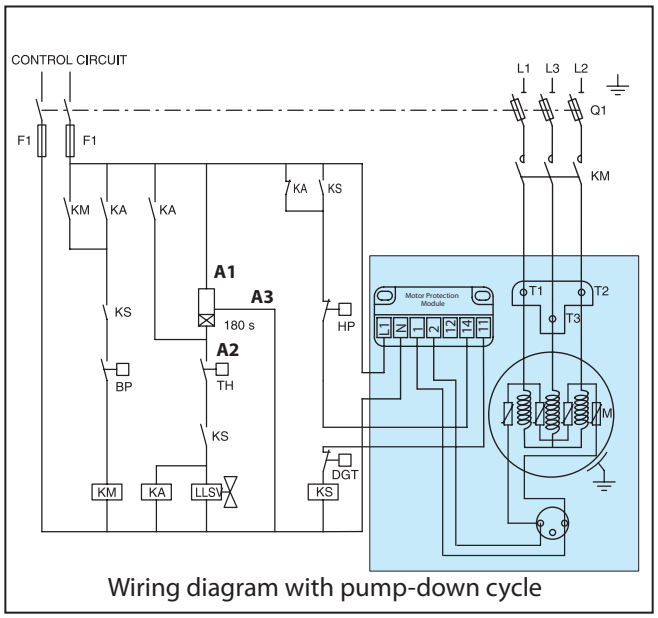
Wiring diagram with pump-down cycle



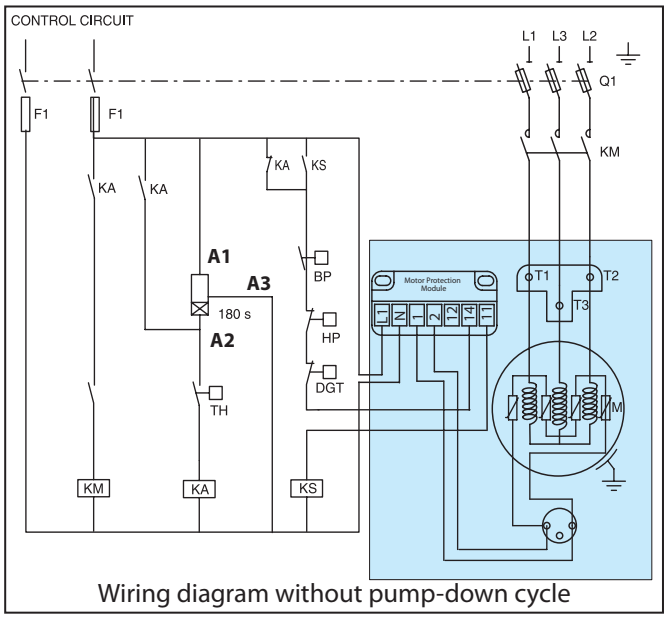
Wiring diagram without pump-down cycle

Suggested wiring diagrams logic

Compressor models SH 180



Wiring diagram with pump-down cycle



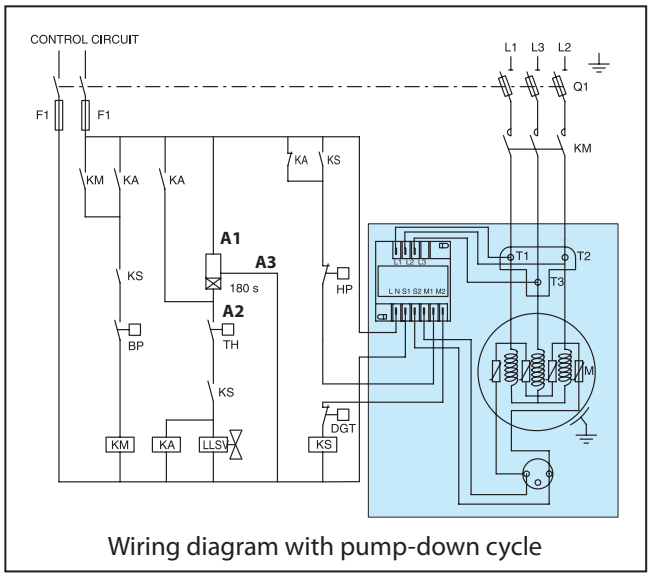
Wiring diagram without pump-down cycle

Legend

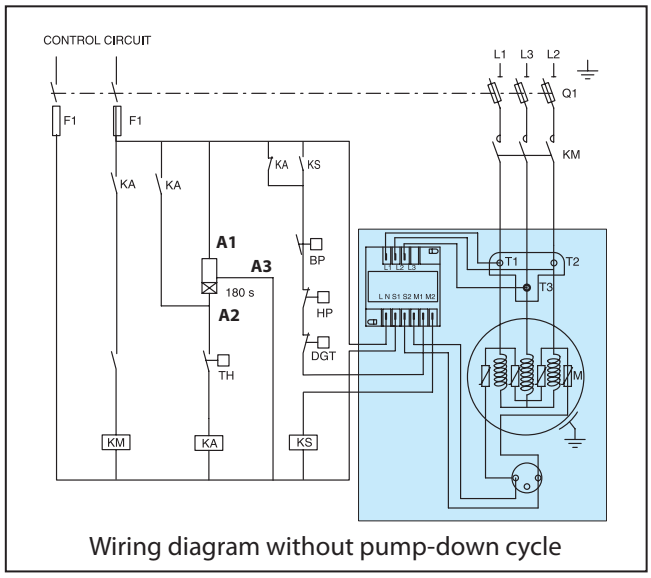
Control device	*TH*
Optional short cycle timer (3 min)	*180 s*
Control relay	*KA*
Liquid Line Solenoid valve	*LLSV*
Compressor contactor	*KM*
Safety lock out relay	*KS*
Pump-down control & L.P. switch	*BP*
H.P. safety switch	*HP*
Fused disconnect	*Q1*
Fuses	*F1*
External overload protection	*F2*
Compressor motor	*M*
Motor safety thermostat	*thM*
Discharge gas thermostat	*DGT*
Motor Protection Module	*MPM*
Thermistor chain	*S*

Suggested wiring diagrams logic

Compressor model SH240-300



Wiring diagram with pump-down cycle



Wiring diagram without pump-down cycle

Legend

Control device	*TH*
Optional short cycle timer (3 min)	*180 s*
Control relay	*KA*
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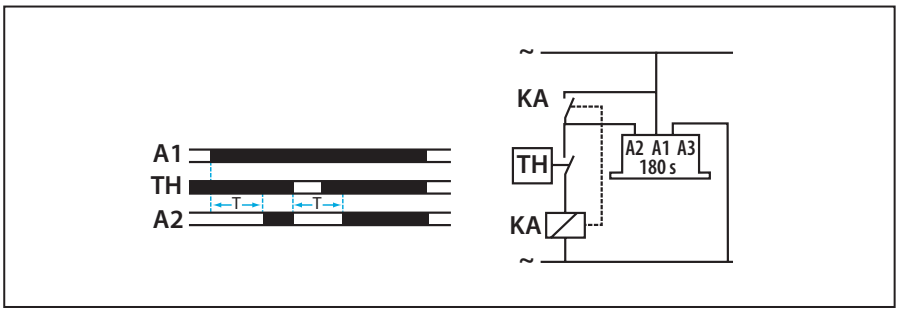
Compressor contactor	*KM*
Safety lock out relay	*KS*
Pump-down control & L.P. switch	*BP*
H.P. safety switch	*HP*
Fused disconnect	*Q1*
Fuses	*F1*
External overload protection	*F2*
Compressor motor	*M*
Motor safety thermostat	*thM*
Discharge gas thermostat	*DGT*
Motor Protection Module	*MPM*
Thermistor chain	*S*

Short cycle timer function



Danfoss MCI soft-start controller

The inrush current for the Performer® SH scroll compressors with motor code 4 (400V / 3ph / 50Hz or 460V / 3ph / 60Hz) can be reduced using the Danfoss digitally-controlled MCI compressor soft starter. MCI soft starters are designed to reduce the starting and stopping current of 3-phase AC motors; they can reduce the inrush current by up to 40%, thereby eliminating the detrimental effects of high starting torque surges and costly demand charges from the resultant current spike. Upon starting, the controller gradually increases the voltage supplied to the motor until full-line voltage has been reached. All settings, such as ramp-up time and initial torque, are preset at the factory and do not require modification.

Essential piping design considerations

The working pressure in systems with R410A is about 60% higher than in systems with R22 or R407C. Consequently, all system components and piping must be designed for this higher pressure level.

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.

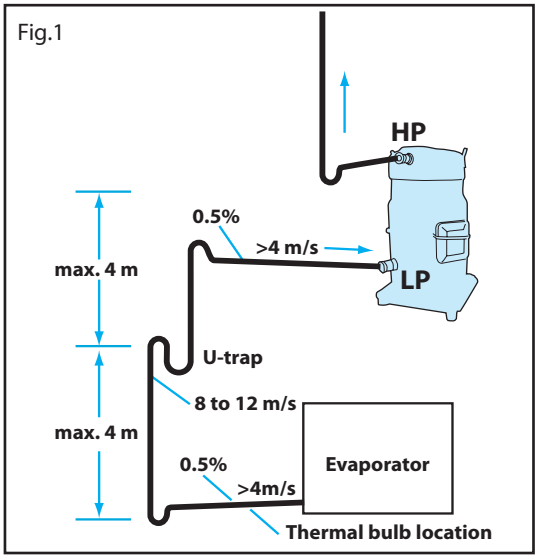
In systems with R410A, the refrigerant mass flow will be lower compared to R22/R407C systems. To maintain acceptable pressure drops and acceptable minimum gas velocities, the refrigerant piping must be reduced in size compared to R22/R407C systems. Take care not to create too high pressure drops neither since in R410A systems the negative impact of high pressure drops on the system efficiency is stronger than in R22/R407C systems.
If the evaporator lies above the compressor, as is often the case in split or remote condenser systems, the addition of a pump-down cycle is strongly recommended. If a pump-down cycle were to be omitted, 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 outlet of the evaporator while the system is idle, which would mislead the expansion valve's sensor (thermal bulb) at start-up (see figure 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 figure 2).

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» p.25.)

Fig.1



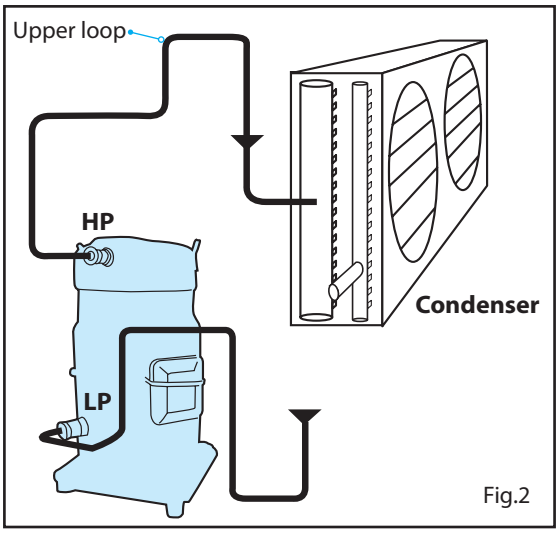


Fig.2

SYSTEM DESIGN RECOMMENDATIONS

Heat exchangers

To obtain optimum efficiency of the complete refrigerant system, optimized R410A heat exchangers must be used. R410A refrigerant has good heat transfer properties: it is worthwhile designing specific heat exchangers to gain in size and efficiency.

An evaporator with optimized R410A distributor and circuit will give correct superheat at outlet and optimal use of the exchange surface. This is critical for plate evaporators that have generally a shorter circuit and a lower volume than shell & tubes and air cooled coils. For all evaporator types a special care is required for superheat control leaving the evaporator and oil return.

A subcooler circuit in the condenser that creates high subcooling will increase efficiency at high condensing pressure. In R410A systems the positive effect of subcooling on system efficiency will be significantly larger than in R22/R407C systems.

Furthermore, for good operation of the expansion device and to maintain good efficiency in the evaporator it is important to have a high degree of liquid subcooling. Without adequate subcooling, flash gas will be formed at the expansion device resulting in a high degree of vapor at the evaporator inlet leading to low efficiency.

Refrigerant charge limit

Performer® SH compressors can tolerate liquid refrigerant up to a certain extend without major problems. However, excessive liquid refrigerant in the compressor is always unfavorable 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 technical support for any deviation from these guidelines.

Model	Refrigerant charge limit (kg)
SH090	5.9
SH120	7.9
SH161	9
SH180-240-300	13.5

	BELOW charge limit	ABOVE charge limit
Cooling only systems, Packaged units	✓ No test or additional safeties required	**REQ** Refrigerant migration & floodback test **REQ** Crankcase heater
Cooling only systems with remote condensor and split system units	**REC** Refrigerant migration & floodback test **REC** Crankcase heater, because full system charge is not definable (risk of overcharging)	**REQ** Refrigerant migration & floodback test **REQ** Crankcase heater **REC** Liquid receiver
Reversible heat pump system	**REQ** Specific tests for repetitive floodback **REQ** Crankcase heater For more details, refer to section "reversible heat pump systems" page 23	

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

Note: for special conditions such as low ambient temperature, low refrigerant load or brazed plate heat exchangers please refer to corresponding sections page 22.

Off-cycle migration

Liquid refrigerant can find its way into the compressor by means of off-cycle migration or liquid floodback during operation.

Off-cycle refrigerant migration is likely to occur when the compressor is located at the coldest part of the installation, when the system uses a bleed-type expansion device, or if liquid is allowed to migrate from the evaporator into the compressor sump by gravity. If too much liquid refrigerant accumulates in the sump it will saturate the oil and lead to a flooded start: when the compressor starts running again, the refrigerant evaporates abruptly under the sudden decrease of the bottom shell pressure, causing the oil to foam. In extreme situations, this might result in liquid slugging (liquid entering the scroll elements), which must be avoided as it causes irreversible damage to the compressor. The presence of liquid in the crankcase can be easily detected by checking the sump level through the oil sight glass. Foam in the oil sump indicates a flooded start.

Performer® SH scroll compressors can tolerate occasional flooded starts as long as the total system charge does not exceed the maximum compressor refrigerant charge.

Off-cycle migration can be prevented by implementing a crankcase heater or adding a pump-down cycle to the operation cycle.

Crankcase heater

When the compressor is idle, the oil temperature in the sump of the compressor must be maintained at no lower than 10 K above the saturation temperature of the refrigerant on the low-pressure side. This requirement ensures that the liquid refrigerant is not accumulating in the sump. A crankcase heater is only effective if capable of sustaining this level of temperature difference. Tests must be conducted to ensure that the appropriate oil temperature is maintained under all ambient conditions (temperature and wind). Note that below –5°C ambient temperature and a wind speed of above 5m/sec, we recommend that the heaters be thermally insulated in order to limit the surrounding energy losses.

Since the total system charge may be undefined, a crankcase heater is recommended on all stand-alone compressors and split systems. In addition, any system containing a refrigerant charge in excess of the maximum recommended system charge for compressors requires a crankcase heater. A crankcase heater is also required on all reversible cycle applications.

Notes: Belt-type crankcase heater accessories are available from Danfoss (see page 31).

The heater must be energized whenever the compressor is off. For initial start up, due to R410A specific behavior it is not recommended to energize the crankcase heaters in advance.

⚠ Provide separate electrical supply for the heaters so that they remain energized even when the machine is out of service (eg. seasonal shutdown).

Liquid line solenoid valve (LLSV)

An LLSV may be used to isolate the liquid charge on the condenser side, thereby preventing against charge transfer or excessive migration to the compressor during off-cycles. The quantity of refrigerant on the low-pressure side of the system can be further reduced by using a pump-down cycle in association with the LLSV.

Pump-down cycle

A pump-down cycle represents one of the most effective ways to protect against the off-cycle migration of liquid refrigerant. Once the system has reached its set point and is about to shut off, the LLSV on the condenser outlet closes. The compressor then pumps the majority of the refrigerant charge into the condenser and receiver before the system stops on the low pressure pump-down switch. This step reduces the amount of charge on the low side in order to prevent off-cycle migration. The recommended low-pressure pump-down switch setting is 1.5 bar below the nominal evaporating pressure. It shall not be set lower than 2.0 bar. For suggested wiring diagrams, please see page 13.

Liquid receiver

A liquid receiver is highly recommended on split systems and remote condenser systems with a total refrigerant charge in excess of the compressor refrigerant charge limit. Because of the long refrigerant lines these systems have a relatively high system charge which is hard to define with accuracy. Further these types of systems quite often tend to be overcharged. By installing a liquid receiver, a pump-down cycle can then be introduced in order to safely store the refrigerant charge during the off-cycles, which greatly reduces the chance of refrigerant migration back to the compressor.

On unitary or close-coupled systems, where the system refrigerant charge is expected to be both correct and definable the entire system charge may be stored in the condenser during pump-down if all components have been properly sized.

Liquid floodback during operation

Liquid floodback occurs when liquid refrigerant returns to the compressor when it is running. During normal operation, refrigerant leaves the evaporator and enters the compressor as a superheated vapour. The suction gas can still contain liquid refrigerant for example with a wrong dimensioning, a wrong setting or malfunction of the expansion device or in case of evaporator fan failure or blocked air filters. A continuous liquid floodback will cause oil dilution and, in extreme situations, lead to liquid slugging.

Performer SH scroll compressors can tolerate occasional liquid floodback. However system design must be such that repeated and excessive floodback is not possible.

During operations, liquid floodback may be detected by measuring either the oil sump temperature or the discharge gas temperature. If at any time during operations, the oil sump temperature drops to within 10 K or less above the saturated suction temperature, or should the discharge gas temperature be less than 35 K above the saturated discharge temperature, this indicates liquid floodback. Repetitive liquid floodback testing must be carried out under TXV threshold operating conditions: a high pressure ratio and minimum evaporator load, along with the measurement of suction superheat, oil sump temperature and discharge gas temperature.

Suction accumulator

A suction accumulator offers protection against refrigerant floodback at start-up, during operations or after defrosting (heat pump), by trapping the liquid refrigerant upstream from the compressor. The suction accumulator also protects against off-cycle migration by providing additional internal free volume to the low side of the system. The accumulator should be sized for at least 50% of the total system charge. Tests must be conducted to determine the actual refrigerant holding capacity needed for the application.

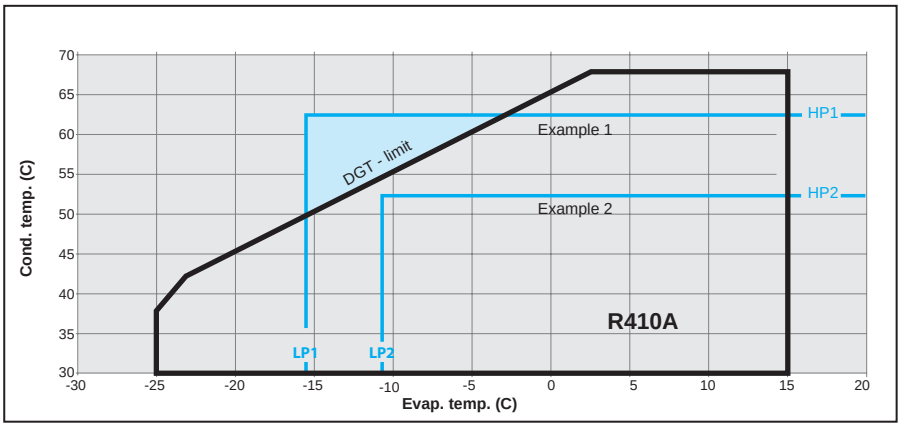
Discharge gas temperature protection (DGT)

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 (Example 1) and where it is not (Example 2).

A discharge gas temperature protection device must be installed on all heat pumps. In reversible air-to-air and air-to-water heat pumps the discharge temperature must be monitored during development test by the equipment manufacturer. The DGT should be set to open at a discharge gas temperature of 135°C.

⚠ 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 page 32.



Example 1 (R410A, SH = 11 K)
LP switch setting:
LP1 = 3.3 bar (g) (-15.5°C)
HP switch setting:
HP1 = 38 bar (g) (62°C)
Risk of operation beyond the application envelope.
DGT protection required.

Example 2 (R410A, SH = 11 K)
LP switch setting:
LP2 = 4.6 bar (g) (-10.5°C)
HP switch setting:
HP2 = 31 bar (g) (52°C)
No risk of operation beyond the application envelope.
No DGT protection required.

Motor protection

Internal motor protection

Compressor models SH 090 – 120 – 161 have been provided with an internal overload motor protection to prevent against excessive current and temperature caused by overloading, low refrigerant flow or phase loss. The cutout current is the MCC value listed in the datasheets. While not compulsory, an additional external overload is still advisable for either alarm or manual reset. The protector is located in the star point of the motor and, should it be activated, will cut out all three phases. It will be reset automatically.

Compressor model SH 180 - 240 - 300 are delivered with a preinstalled motor protection module inside the terminal box. This device provides for efficient and reliable protection against overheating and overloading (as well as phase loss/reversal on SH240 and 300).

The motor protector comprises a control module and PTC sensors embedded in the motor winding. The close contact between thermistors and windings ensures a very low level of thermal inertia.

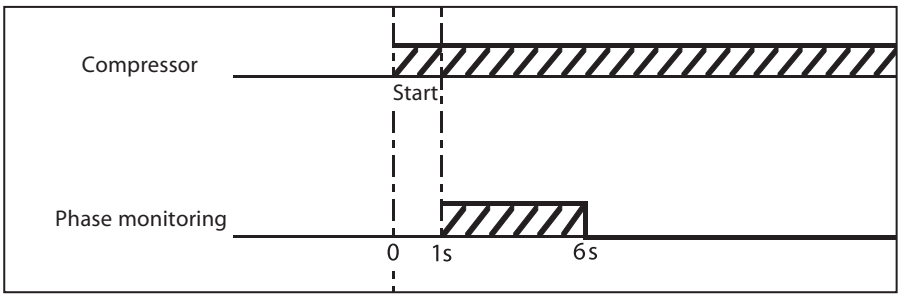
The motor temperature is being constantly measured by a PTC thermistor loop connected on S1-S2 (called 1-2 on SH180). If any thermistor exceeds its response temperature, its resistance increases above the trip level (4,500 Ω) and the output relay then trips – i.e. contacts M1-M2 (or 11-14 for SH180) 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 (11-14 for SH180) are closed. The time delay may be cancelled by means of resetting the mains (L-N -disconnect) for approximatively 5 sec.

Compressor model	Overheating protection	Overcurrent protection	Locked rotor protection	Single-phasing protection
SH090 - 120 - 161	Internal motor protection			
SH180 - 240 - 300	Electronic protection module located in terminal box			

Phase sequency 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. The compressor will only operate properly in a single direction, and the motor is wound so that if the connections are correct, the rotation will also be correct.
Compressor models SH090 - 120 - 161 have no internal reverse rotation protection. If reverse rotation occurs it will be obvious as soon as power is turned on. The compressor will not build up any pressure, the sound level will be abnormally high and power consumption will be minimal. In such case, shut down the compressor immediately and connect the phases to their proper terminals. Prolonged reverse rotation over 6 hours will damage the compressor.
Compressor model SH180 incorporates an internal reverse vent valve which will react in the presence of reverse rotation and will allow refrigerant to circulate through a by-pass from the suction to the discharge. Although reverse rotation is not destructive for the SH180, even over long periods of time, it should be corrected as soon as possible. If reverse rotation is not halted, the SH180 will cycle off on the internal motor protection.

Compressor models SH 240 and 300 are delivered with an electronic module which provides protection against phase reversal and phase loss at start-up. Apply the recommended wiring diagrams from page 13. The circuit should be thoroughly checked in order to determine the cause of the phase problem before reenergizing the control circuit.



The phase sequencing and phase loss monitoring functions are active during a 5-sec window 1 sec after compressor start-up (power on L1-L2-L3).
Should one of these parameters be incorrect, the relay would lock out (contact M1-M2 open).
The lockout may be cancelled by resetting the power mains (disconnect L-N) for approximately 5 sec.

SYSTEM DESIGN RECOMMENDATIONS

Cycle rate limit

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 cooling after start-up along with proper oil return. Note that the oil return may vary since it depends upon system design. There must be no more than 12 starts per hour; a number higher than 12 reduces the service life of the motor-compressor unit. If necessary, place an anti-short-cycle timer in the control circuit, connected as shown in the wiring diagram (p12). A minimum three-minute (180-sec) timeout is recommended.

Voltage imbalance

The operating voltage limits are shown in the table on page 10. The voltage applied to the motor terminals must lie within these table limits during both start-up and normal operations. 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 & 2.
V1-3 = Voltage between phases 1 & 3.
V2-3 = Voltage between phases 2 & 3.

High and low pressure protection

High pressure

A high-pressure (HP) safety switch is required 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.

Low pressure

A low-pressure (LP) safety switch must be used. Deep vacuum operations of a scroll compressor can cause internal electrical arcing and scroll instability. Performer SH 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 following 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 below.

Pressure settings		**R410A**
Working pressure range high side	bar (g)	18 - 44.5
Working pressure range low side	bar (g)	2.3 - 11.6
Maximum high pressure safety switch setting	bar (g)	45
Minimum low pressure safety switch setting *	bar (g)	0.5
Minimum low pressure pump-down switch setting **	bar (g)	2.0

*LP safety switch shall never be bypassed.
**Recommended pump-down switch settings: 1.5 bar below nominal evaporating temperature.

Low ambient compressor operations

Low ambient operations and minimum pressure differential at steady running conditions

The Performer® R410A scroll compressor requires a minimum pressure differential of 6 to 7 bar between the suction and discharge pressures to force the orbiting scroll-down against the oil film on the thrust bearing. Anything less than this differential and the orbiting scroll can lift up, causing a metal-to-metal contact. It is therefore necessary to maintain sufficient discharge pressure in order to ensure this pressure differential. Care should be taken during low ambient operations when heat removal from air-cooled condensers is greatest and head pressure control may be required for low ambient temperature applications. Operation under low pressure differential may be observed by a significant increase in the sound power level generated by the compressor.

Low ambient start-up

Under cold ambient conditions (<0°C), upon start-up the pressure in the condenser may be so low that a sufficient pressure differential across the expansion device cannot be developed to properly feed the evaporator. As a result, the compressor may go into a deep vacuum, which can lead to compressor failure due to internal arcing and instability in the scroll members. Under no circumstances should the compressor be allowed to operate under vacuum. The low-pressure control must be set in accordance with the table on page 21 in order to prevent this from happening.

Low pressure differentials can also cause the expansion device to «hunt» erratically, which might cause surging conditions within the evaporator, with liquid spillover into the compressor. This effect is most pronounced during low load conditions, which frequently occur during low ambient conditions.

Head pressure control under low ambient conditions

Several possible solutions are available to prevent the compressor from drawing down to a vacuum upon start-up under low ambient conditions. In air-cooled machines, cycling the fans with a head pressure controller will ensure that the fans remain off until the condensing pressure has reached a satisfactory level. In water-cooled units, the same can be performed using a water regulator valve that is also operated by head pressure, thereby ensuring that the water valve does not open until the condensing pressure reaches a satisfactory level.

Note: The minimum condensing pressure must be set at the minimum saturated condensing temperature shown in the application envelopes.

Under very low ambient conditions, in which testing has revealed that the above procedures might not ensure satisfactory condensing and suction pressures, the use of a liquid receiver with condenser and receiver pressure regulators would be possible.

For further information, please contact Danfoss Technical support.

Crankcase heaters

Crankcase heaters are strongly recommended on all refrigerant systems where the compressor is exposed to cold ambient temperatures, especially split and remote condenser installations. The crankcase heater will minimize refrigerant migration caused by the large temperature gradient between the compressor and the remainder of the system, please refer to p17.

Low load operations

It is recommended that the unit be tested and monitored at minimum load and, if possible, during low ambient conditions as well. During conditions of low load on the system, the following considerations should be taken into account to ensure proper system operating characteristics.

- The superheat setting of the expansion device should be sufficient to ensure proper superheat levels during low loading periods. A minimum of 5K stable superheat is required. In addition, the refrigerant charge should be sufficient to ensure proper subcooling within the condenser so as to avoid the risk of flashing in the liquid line before the expansion device. The expansion device should be sized to ensure proper control of the refrigerant flow into the evaporator. An oversized valve may result in erratic control. This consideration is especially important in manifolded units where low load conditions may require the frequent cycling of compressors. This can lead to liquid refrigerant entering the compressor if the expansion valve does not provide stable refrigerant superheat control under varying loads.
- Condenser fans should be cycled in such a way that the minimum pressure differential is maintained between the suction and discharge pressures. Variable speed fans can also be used to control the amount of heat to be removed from the condenser.
- The compressors should be run for a minimum period in order to ensure that the oil has sufficient time to properly return to the compressor sups and that the motor has sufficient time to cool under conditions of lowest refrigerant mass flows.

Brazed plate heat exchangers

A brazed plate heat exchanger needs very little internal volume to satisfy the set of heat transfer requirements. Consequently, the heat exchanger offers very little internal volume for the compressor to draw vapor from on the suction side. The compressor can then quickly enter into a vacuum condition. It is therefore important that the expansion device be sized correctly and that a sufficient pressure differential across the expansion device be available to ensure adequate refrigerant feed into the evaporator. This aspect is of special concern when operating the unit under low ambient and load conditions. For further information on these conditions, please refer to the previous sections.

Due to the small volume of the brazed plate heat exchanger, no pump-down cycle is normally required. The suction line running from the heat exchanger to the compressor must be trapped to avoid refrigerant migration to the compressor.

When using a brazed plate condenser heat exchanger, a sufficient free volume for the discharge gas to accumulate is required in order to avoid excess pressure buildup. At least 1 meter of discharge line is necessary to generate this volume. To help reduce the gas volume immediately after start-up even further, the supply of cooling water to the heat exchanger may be opened before the compressor starts up so as to remove superheat and condense the incoming discharge gas more quickly.

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 floodback) 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 floodback are required to confirm whether or not a suction accumulator needs to be installed.

The following considerations cover the most important issues when dealing with common applications. Each application design however should be thoroughly tested to ensure acceptable operating characteristics.

SPECIFIC APPLICATION RECOMMENDATIONS

Crankcase heaters

Crankcase heaters are mandatory on reversible cycle applications given the high probability of liquid migration back to the compressor sump during off-cycles due to the outdoor location of most units and operations during low ambient conditions.

Discharge temperature thermostat

Heat pumps frequently utilize high condensing temperatures in order to achieve a sufficient temperature rise in the medium being heated. At the same time, they often require low evaporating pressures to obtain sufficient temperature differentials between the evaporator and the outside temperature. This situation may result in high discharge temperature; as such, it is mandatory that a discharge gas thermostat be installed on the discharge line to protect the compressor from excessive temperatures. Operating the compressor at too high discharge temperatures can result in mechanical damage to the compressor as well as thermal degradation of the compressor lubricating oil and a lack of sufficient lubrication.
The discharge gas thermostat should be set to shut down the compressor in the event discharge gas rises above 135°C.

Discharge line and reversing valve

The Performer® R410A scroll compressor is a high volumetric machine and, as such, can rapidly build up pressure in the discharge line if gas in the line becomes obstructed even for a very short period of time which situation may occur with slow-acting, reversing valves in heat pumps. Discharge pressures exceeding the operating envelope may result in nuisance high-pressure switch cutouts and place excess strain on both the bearings and motor.
To prevent such occurrences, it is important that a 1-meter minimum discharge line length be allowed between the compressor discharge port and the reversing valve or any other restriction. This gives sufficient free volume for the discharge gas to collect and to reduce the pressure peak during the time it takes for the valve to change position. At the same time, it is important that the selection and sizing of the reversing or 4-way valve ensure that the valve switches quickly enough to prevent against too high discharge pressure and nuisance high-pressure cutouts.
Check with the valve manufacturer for optimal sizing and recommended mounting positions.

Defrost and reverse cycle

Thanks to its specific internal design the Performer® R410A scroll compressor has the ability to withstand a certain amount of liquid refrigerant dynamic slug. However we advise that the system is unloaded to the minimum capacity step for defrost or when the cycle is reversed.

Suction line accumulator

The use of a suction line accumulator is strongly recommended in reversible-cycle applications. This because of the possibility of a substantial quantity of liquid refrigerant remaining in the evaporator, which acts as a condenser during the heating cycle.
This liquid refrigerant can then return to the compressor, either flooding the sump with refrigerant or as a dynamic liquid slug when the cycle switches back to a defrost cycle or to normal cooling operations.
Sustained and repeated liquid slugging and floodback can seriously impair the oil's ability to lubricate the compressor bearings. This situation can be observed in wet climates where it is necessary to frequently defrost the outdoor coil in an air source heat pump. In such cases a suction accumulator becomes mandatory.

Sound generation in a refrigeration or 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 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 traveling directly from the machine in all directions.
The Performer® R410A croll 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 Performer®'s unique design of a full-suction gas-cooled motor, compressor body insulation across its entire operating range is possible. Acoustic hoods are available from Danfoss as accessories. These hoods are quick and easy to install and do not increase the overall size of the compressors to a great extend.

Mechanical vibrations

Vibration isolation constitutes the primary method for controlling structural vibration. Performer® R410A 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 Performer® compressors. Once the supplied rubber grommets have been properly mounted, vibrations 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. For further information on mounting requirements, please refer to the section on mounting assembly.
Note: for parallel assemblies see specific recommendations in Performer® R410A parallel application guidelines (rigid mounting).
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" page 15.

Gas pulsation

The Performer® R410A scroll compressor has been designed and tested to ensure that gas pulsation has been optimized for the most commonly-encountered air conditioning 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.

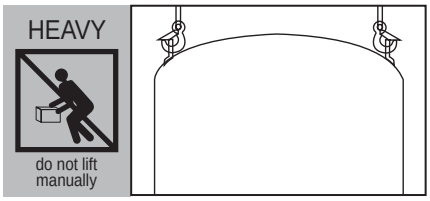
Compressor handling

Each Performer® SH scroll compressor is equipped with two lift rings on the top shell. Always use both these rings when lifting the compressor. Use lifting equipment rated and certified for the weight of the compressor. 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 and certified to lift the weight of the compressor is also highly recommended. Always respect the appropriate rules concerning lifting objects of the type and weight of these compressors. Maintain the compressor in an upright position during all handling maneuvers.

⚠ Never use only one lifting lug to lift the compressor. The compressor is too heavy for the single lug to handle, and the risk is run that the lug could separate from the compressor with extensive damage and possible personal injury as a result.

⚠ When the compressor is mounted as part of an installation, never use the lift rings on the compressor to lift the installation. The risk is run that the lugs could separate from the compressor or that the compressor could separate from the base frame with extensive damage and possible personal injury as a result.

Never apply force to the terminal box with the intention of moving the compressor, as the force placed upon the terminal box can cause extensive damage to both the box and the components contained inside.

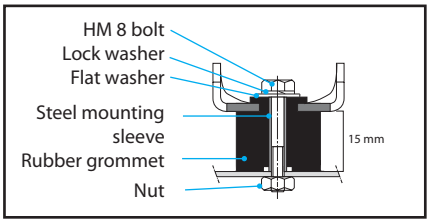


Mounting

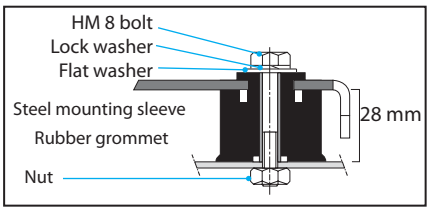
All compressors come delivered with four rubber-mounting grommets and metal sleeve liners that serve to isolate the compressor from the base frame. These grommets must always be used to mount the compressor.

The grommets must be compressed until contact between the flat washer and the steel mounting sleeve is established. The grommets attenuate to a great extent the transmission of compressor vibrations to the base frame.

The required bolt size for the SH 090-120-161 compressors is HM8-40. This bolt must be tightened to a torque of 15 Nm.



The required bolt size for the SH 180 – 240 - 300 compressors is HM8-55. This bolt must be tightened to a torque of 21 Nm.



Note: For parallel assemblies see specific recommendations in Performer® R410A parallel application guidelines (rigid mounting).

Removing connections shipping plugs

Before the suction and discharge plugs are removed, the nitrogen holding charge must be released via the suction schrader valve to avoid an oil mist blowout. 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 from entering the compressor. When the plugs are removed, it is essential to keep the compressor in an upright position so as to avoid oil spillage.

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 polyolester oil in R410A compressors requires that the oil be exposed to the atmosphere 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 precautions listed in the following paragraphs must be taken.

Tubing

Only use clean and dehydrated refrigeration-grade copper tubing. Tube-cutting must be carried out so as not to deform the tubing roundness and to ensure that no foreign debris remains within the tubing. Only refrigerant-grade fittings should be used and these must be of both a design and size to allow for a minimum pressure drop through the completed assembly. Follow the brazing instructions on next pages. Never drill holes into parts of the pipe-work where filings and particles can not be removed.

Filter driers

For new installations with SH compressors with polyolester oil, Danfoss recommends using the Danfoss DML 100%-moleculair sieve, solid core filter drier. Molecular sieve filter driers with loose beads from third party suppliers shall be avoided. 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 undersized. When selecting a drier, always take into account its capacity (water content capacity), the system refrigeration capacity and the system refrigerant charge.

Brazing and soldering

Copper to copper connections

When brazing copper-to-copper connections, the use of copper/phosphorus brazing alloy containing 5% silver or more with a melting temperature of below 800°C is recommended. No flux is required during brazing.

Dissimilar metals connection

When manipulating dissimilar metals such as copper and brass or steel, the use of silver solder and anti-oxidant flux is necessary.

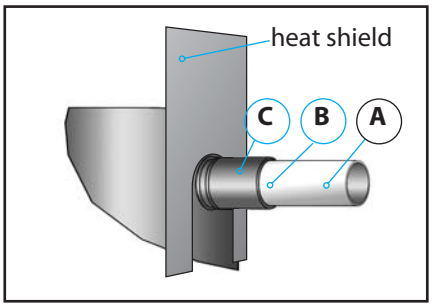
Compressor connection

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. Due to the relatively sizable tubing and fitting diameters a double-tipped torch using acetylene is recommended for brazing operation on SH compressors.

For rotolock version compressors, solder sleeves are available.

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).
- Remove the Teflon gaskets when brazing rotolock connectors with solder sleeves.
- Use only clean refrigeration-grade copper tubing and clean all connections.
- Use brazing material with a minimum of 5% silver content.
- Purge nitrogen or CO2 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 polyolester oil used in SH 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. The compressor should always be the last component brazed into the system

⚠ 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.

System pressure test

Always use an inert gas such as nitrogen for pressure testing. Never use other gasses such as oxygen, dry air or acetylene as these may form an inflammable mixture. Do not exceed the following pressures:

Maximum compressor test pressure (low side)	30 bar (g)
Maximum compressor test pressure (high side)	45 bar (g)
Maximum pressure difference between high and low side of the compressor	24 bar

Pressurize the system on HP side first then LP side to prevent rotation of the scroll.

Leak detection

Leak detection must be carried out using a mixture of nitrogen and refrigerant or nitrogen and helium, as indicated in the table below. Never use other gasses such as oxygen, dry air or acetylene as these may form an inflammable mixture.
Pressurize the system on HP side first then LP side.

Leak detection with refrigerant	Leak detection with a mass spectrometer
Nitrogen & R410A	Nitrogen & Helium

Note 1: Leak detection with refrigerant may be forbidden in some countries. Check local regulations.
Note 2: The use of leak detecting additives is not recommended as they may affect the lubricant properties.

Vacuum pump-down and moisture removal

Moisture obstructs the proper functioning of both the compressor and the refrigeration system. Air and moisture reduce service life and increase condensation 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 News bulletin "Vacuum pump down and dehydration procedure".

Refrigerant charging

For the initial charge the compressor must not run and eventual service valves must be closed. Charge refrigerant as close as possible to the nominal system charge before starting the compressor. This initial charging operation must be done in liquid phase as far away as possible from the compressor. The best location is on the liquid line between the condenser outlet and the filter drier. Then during commissioning, when needed, a complement of charge can be done in liquid phase: slowly throttling liquid in on the low pressure side as far away as possible from the compressor suction connection. The refrigerant charge quantity must be suitable for both summer and winter operations.

Commissioning

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

- Proper metering device operation and desired superheat readings
- Suction and discharge pressure are within acceptable levels
- Correct oil level in compressor sump indicating proper oil return
- Low foaming in sight glass and compressor sump temperature 10 K above saturation temperature to show that there is no refrigerant migration taking place
- Acceptable cycling rate of compressors, including duration of run times
- Current draw of individual compressors within acceptable values (RLA ratings)
- No abnormal vibrations and noise.

Oil level checking and top-up

In installations with good oil return and line runs up to 20 m, no additional oil is required. If installation lines exceed 20 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 but in any case the oil charge has to be adjusted based on the oil level in the compressor sight glass.

When the compressor is running under stabilized conditions the oil level must be visible in the sight glass.

The presence of foam filling in the sight glass indicates large concentration of refrigerant in the oil and / or presence of liquid returning to the compressor.

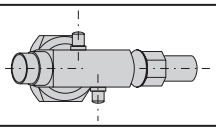
The oil level can also be checked a few minutes after the compressor stops, the level must be between ¼ and ¾ of sight glass.

When the compressor is off, the level in the sight glass can be influenced by the presence of refrigerant in the oil.

Always use original Danfoss POE oil 160SZ from new cans.

Top-up the oil while the compressor is idle. Use the schrader connector or any other accessible connector on the compressor suction line and a suitable pump. See News bulletin «Lubricants filling in instructions for Danfoss Commercial Compressors».

Connectors and valves



Model	Solder sleeve		Rotolock valve set			
	Suct. ODF	Disch. ODF	Suct. ODF	Disch. ODF	Type	Code no.
SH090	No rotolock available on these models					
SH120						
SH161						
SH180	1"5/8	1"1/8	1"5/8	1"1/8	V03-V02	7703383
SH240	1"5/8	1"1/8	1"5/8	1"1/8	V03-V02	7703383
SH300	1"5/8	1"1/8	1"5/8	1"1/8	V03-V02	7703383

ODF: Outer diameter female.

Solder sleeves Sizes of solder sleeves included in the solder sleeve adaptor set accessory. Also denotes the standard sleeve sizes supplied with rotolock version compressors.

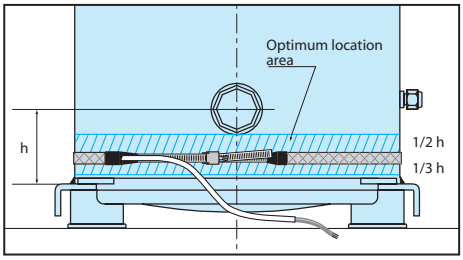
Rotolock valves Standard rotolock valve sets.

Lubricants

SH compressors use polyolester oil, type 160SZ. Always use original Danfoss POE oil 160SZ from new cans. Please refer to "Lubricant, filling in instructions for Danfoss Commercial Compressors" for detailed oil specifications and top-up method.

Compressor model	Oil type	Oil name	Code number		
			1 litre can	2 litre can	5 litre can
SH compressors	P.O.E.	160 SZ	7754023	7754024	-

Crankcase heaters



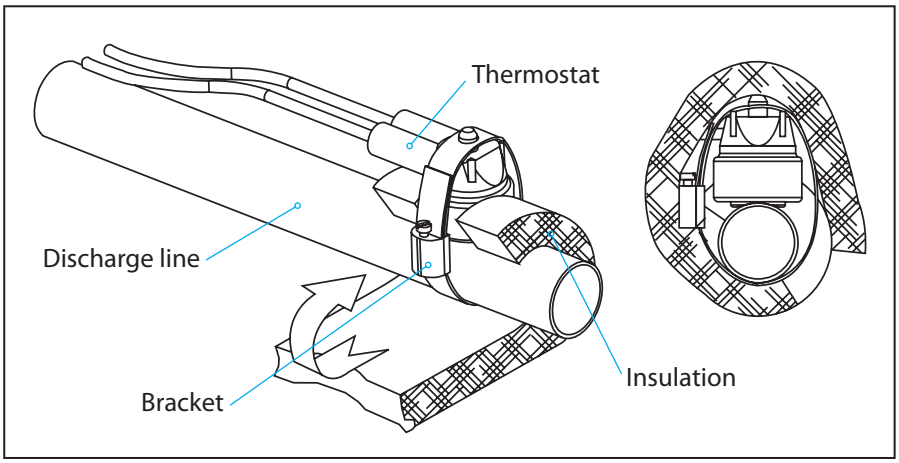
The belt-type crankcase heaters are designed to protect the compressor against off-cycle migration of refrigerant.

Application	Belt type cranckase heater type	Code no.	Pack size
SH090 - 161	65 W, 110V, CE mark, UL	773109	6
	65 W, 110V, CE mark, UL	7973001	50
	65 W, 230V, CE mark, UL	7773107	6
	65 W, 230V, CE mark, UL	7973002	50
	65 W, 400V, CE mark, UL	7773117	6
SH180 - 300	75 W, 110 V, CE mark, UL	7773110	6
	75 W, 230 V, CE mark, UL	7773108	6
	75 W, 230 V, CE mark, UL	7973005	50
	75 W, 400 V, CE mark, UL	7773118	6

Discharge temperature protection

The discharge gas temperature must not exceed 135°C.

The discharge gas thermostat accessory kit (code no.7750009) 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 and must be thermally insulated and tightly fixed on the pipe.



Compressor acoustic hoods

Compressor acoustic hoods have been developed to meet specific extra-low noise requirements. The covers incorporate soundproofing materials and offer excellent high and low frequency attenuation.

Compressor model	Attenuation* (at 50Hz) dB(A)	Hood code number
SH090	Please contact Danfoss	
SH120-161		
SH180		
SH 240 - 300		

* Attenuation of compressor sound power level measured in free space

ORDERING INFORMATION AND PACKAGING

Ordering information

Performer® SH scroll compressors can be ordered in either industrial packs or in single packs.

Please use the code numbers from below tables for ordering.

Industrial pack

Compressor model	Connections	Motor protection	Code no.				
			3	4	6	7	9
			200-230/3/60	460/3/60 400/3/50	230/3/50	575/3/60 500/3/50	380/3/60
SH090	Brazed	Internal	120H0002	120H0004	120H0006	120H0008	120H0010
SH120	Brazed	Internal	120H0012	120H0014	120H0016	120H0018	120H0020
SH161	Brazed	Internal	120H0022	120H0024	120H0026	120H0028	120H0030
SH180	Brazed	M 24	120H0032	120H0040		120H0048	120H0056
	Brazed	M 230	120H0034	120H0042		120H0050	120H0058
	Rotolock	M 24	120H0036	120H0044		120H0052	120H0060
	Rotolock	M 230	120H0038	120H0046		120H0054	120H0062
SH240	Brazed	M 24	120H0064	120H0075		120H0086	120H0097
	Brazed	M 115 - 230	120H0066	120H0077		120H0088	120H0099
	Rotolock	M 24	120H0071	120H0082		120H0093	120H0104
	Rotolock	M 115 - 230	120H0073	120H0084		120H0095	120H0106
SH300	Brazed	M 24	120H0108	120H0119		120H0130	120H0141
	Brazed	M 115 - 230	120H0110	120H0121		120H0132	120H0143
	Rotolock	M 24	120H0115	120H0126		120H0137	120H0148
	Rotolock	M 115 - 230	120H0117	120H0128		120H0139	120H0150

Single pack

Compressor model	Connections	Motor protection	Code no.				
			3	4	6	7	9
			200-230/3/60	460/3/60 400/3/50	230/3/50	575/3/60 500/3/50	380/3/60
SH090	Brazed	Internal	120H0001	120H0003	120H0005	120H0007	120H0009
SH120	Brazed	Internal	120H0011	120H0013	120H0015	120H0017	120H0019
SH161	Brazed	Internal	120H0021	120H0023	120H0025	120H0027	120H0029
SH180	Brazed	M 24	120H0031	120H0039		120H0047	120H0055
	Brazed	M 230	120H0033	120H0041		120H0049	120H0057
	Rotolock	M 24	120H0035	120H0043		120H0051	120H0059
	Rotolock	M 230	120H0037	120H0045		120H0053	120H0061
SH240	Brazed	M 24	120H0063	120H0074		120H0085	120H0096
	Brazed	M 115 - 230	120H0065	120H0076		120H0087	120H0098
	Rotolock	M 24	120H0070	120H0081		120H0092	120H0103
	Rotolock	M 115 - 230	120H0072	120H0083		120H0094	120H0105
SH300	Brazed	M 24	120H0107	120H0118		120H0129	120H0140
	Brazed	M 115 - 230	120H0109	120H0120		120H0131	120H0142
	Rotolock	M 24	120H0114	120H0125		120H0136	120H0147
	Rotolock	M 115 - 230	120H0116	120H0127		120H0138	120H0149

M24: Electronic motor protection, module located in terminal box 24 V,

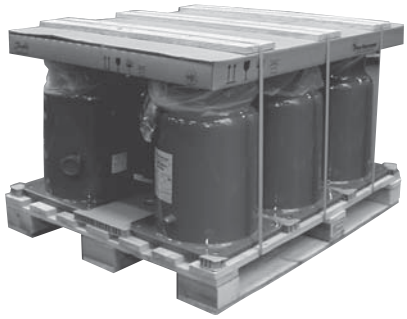
M230: Electronic motor protection, module located in terminal box 230 V,

M115-230: Electronic motor protection, module located in terminal box 115/230 V,

ORDERING INFORMATION AND PACKAGING

Packaging

Industrial pack



Compressor models	Nbr*	Length (mm)	Width (mm)	Height (mm)	Gross weight (kg)	Static stacking pallets
SH090	8	1150	800	695	500	2
SH120	8	1150	800	740	515	2
SH161	8	1150	800	740	547	2
SH180	6	1140	965	768	669	2
SH240	6	1140	965	768	669	2
SH300	4	1140	965	768	669	2

Single pack

Compressor models	Length (mm)	Width (mm)	Height (mm)	Gross weight (kg)
SH090	380	316	510	60
SH120	380	316	567	62
SH161	380	316	567	66
SH180	470	400	698	109
SH240	470	400	698	109
SH300	570	475	736	156

* nbr: number of compressors per pack

Danfoss Commercial Compressors http://cc.danfoss.com

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