

Danfoss

Selection &
Application Guidelines

Refrigeration Scroll Compressors MFZ/LFZ 50 - 60 Hz



R404A/R507A

Speerall
CHILL & FREEZE

REFRIGERATION AND
AIR CONDITIONING

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SPEERALL™ REFRIGERATION SCROLL COMPRESSORS

Introduction

Speerall™ compressors are hermetic scroll compressors designed and optimised for refrigeration applications with refrigerant R404A or R507A.

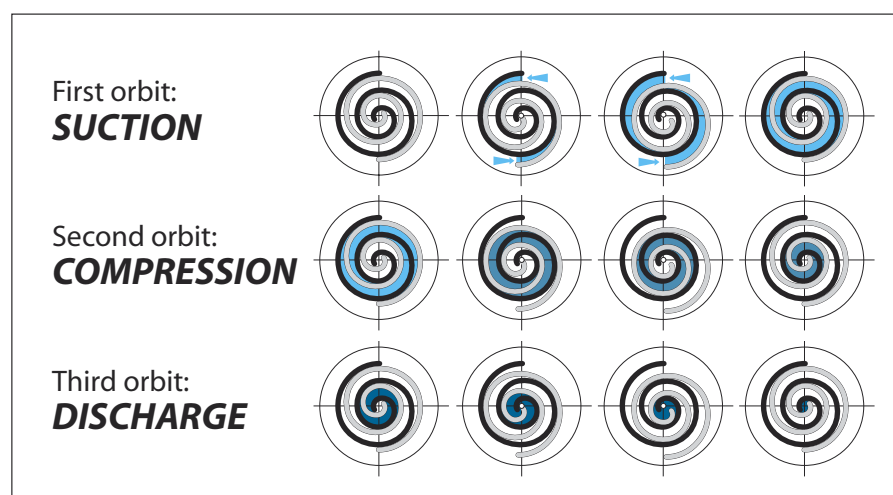
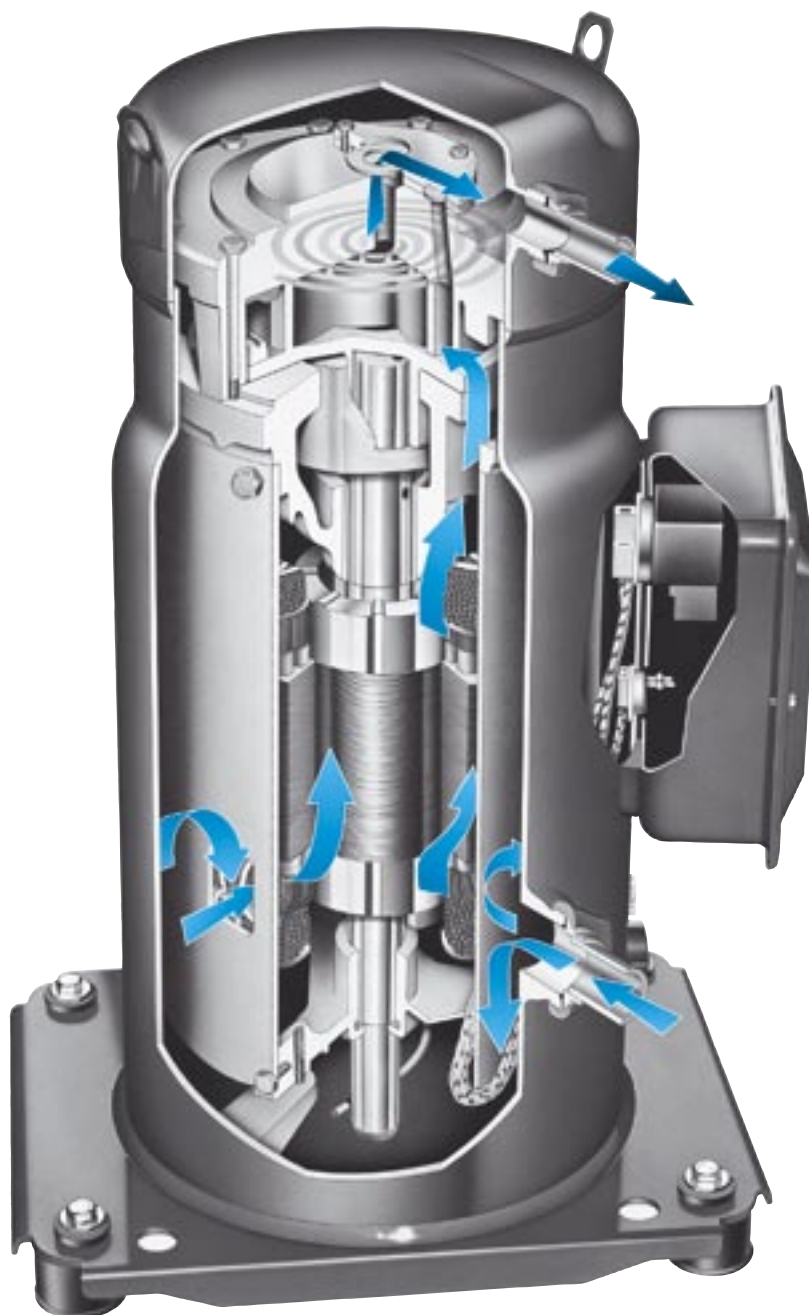
The MFZ series is designed for medium temperature applications while the LFZ series is designed for low temperature applications (LFZ series are not available for export to China, Japan and USA).

The LFZ series are not available for export to China, Japan, and USA.

In a Speerall™ refrigeration scroll compressor the compression is performed by two scroll elements located in the upper part of the compressor above the motor. Suction gas enters the compressor at the suction connection which is located in the bottom shell. The gas then flows around and through the motor providing sufficient motor cooling in most applications. Oil droplets get separated from the suction gas and fall into the oil sump.

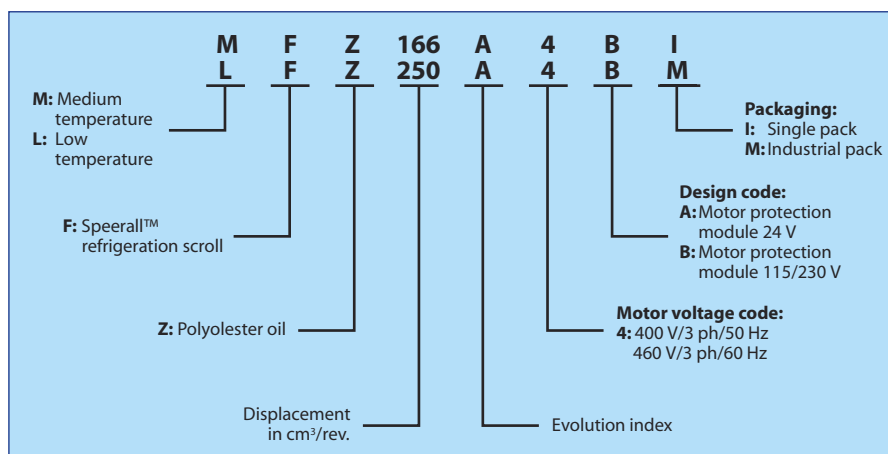
Then the gas enters the scroll elements where compression takes place. The centre of the orbiting scroll traces a circular path around the centre of the fixed scroll. This movement creates symmetrical compression pockets between the two scroll elements. Suction gas is trapped and continuous motion of the orbiting scroll increases the pressure by decreasing the volume of the pocket. Maximum compression is achieved once a pocket reaches the centre which happens after three complete orbits. The compression is a continuous and smooth process; while one quantity of gas is being compressed, another quantity is entering the scrolls and yet another is being discharged at the same time.

After compression, the gas goes through a check valve into the top shell. The check valve prevents the compressor from running backwards once the power has been switched off. Discharge gas leaves the compressor at the discharge connection located in the top shell.

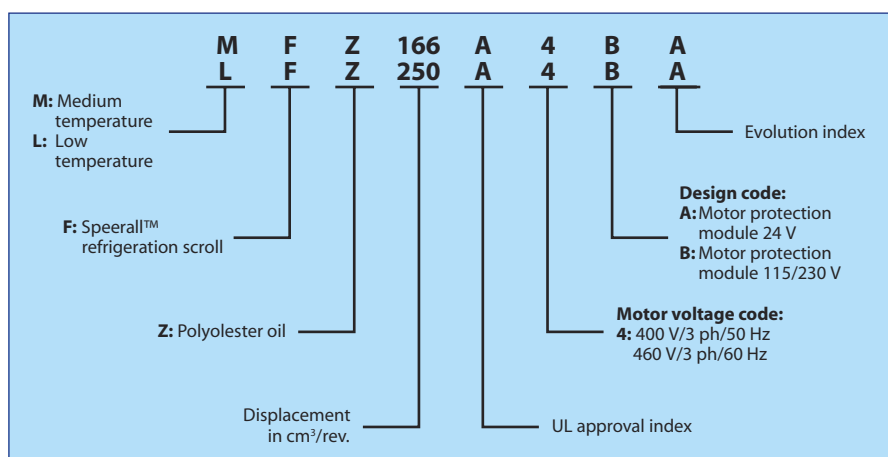


COMPRESSOR MODEL DESIGNATION

Code numbers (for ordering)



Compressor reference (indicated on the compressor nameplate)



Versions

Design code	Suction & discharge connections	Oil equalization connection	Oil sight glass	Motor protection
A	Rotolock	Rotolock	Threaded	Electronic module, 24 V
B	Rotolock	Rotolock	Threaded	Electronic module, 115/230 V

SPECIFICATIONS

Technical specifications

Model	Displacement			Oil charge (litre)	Net weight (kg)
	cm ³ /rev.	m ³ /h at 2900 rpm	m ³ /h at 3500 rpm		
MFZ 166	166.6	29	35	3.7	80
MFZ 250	249.9	43.5	52.5	6.2	103
LFZ 166	166.6	29	35	3.7	80
LFZ 250	249.9	43.5	52.5	6.2	103

Nominal performance data, 50 Hz

R404A	50 Hz, EN12900 ratings <i>To = -10°C, Tc = 45°C, SC = 0 K, RGT = 20°C</i>				50 Hz, ARI ratings <i>To = -6.67°C, Tc = 48.89°C, SC = 0 K, SH = 11.1 K</i>					
	Compressor model	Cooling capacity (W)	Power input (kW)	Current input (A)	C.O.P. (W/W)	Cooling capacity (W)	Power input (kW)	Current input (A)	C.O.P. (W/W)	E.E.R. (Btu/W.h)
	MFZ166-4	17620	8.10	13.88	2.17	17410	8.97	15.09	1.94	6.63
	MFZ250-4	26950	12.11	19.95	2.22	26710	13.33	21.64	2.00	6.84

R404A	50 Hz, EN12900 ratings <i>To = -35°C, Tc = 40°C, SC = 0 K, RGT = 20°C</i>				50 Hz, ARI ratings <i>To = -31.67°C, Tc = 40.56°C, SC = 0 K, SH = 11.1 K</i>					
	Compressor model	Cooling capacity (W)	Power input (kW)	Current input (A)	C.O.P. (W/W)	Cooling capacity (W)	Power input (kW)	Current input (A)	C.O.P. (W/W)	E.E.R. (Btu/W.h)
	LFZ166-4	6830	5.35	10.19	1.28	6910	5.64	10.55	1.23	4.18
	LFZ250-4	10710	8.08	14.61	1.32	10790	8.58	15.22	1.26	4.29

Nominal performance data, 60 Hz

R404A	60 Hz, EN12900 ratings <i>To = -10°C, Tc = 45°C, SC = 0 K, RGT = 20°C</i>				60 Hz, ARI ratings <i>To = -6.67°C, Tc = 48.89°C, SC = 0 K, SH = 11.1 K</i>					
	Compressor model	Cooling capacity (W)	Power input (kW)	Current input (A)	C.O.P. (W/W)	Cooling capacity (W)	Power input (kW)	Current input (A)	C.O.P. (W/W)	E.E.R. (Btu/W.h)
	MFZ166-4	21430	9.66	13.98	2.22	21240	10.57	15.13	2.01	6.86
	MFZ250-4	32820	14.90	20.78	2.20	32590	16.37	22.62	1.99	6.79

R404A	60 Hz, EN12900 ratings <i>To = -35°C, Tc = 40°C, SC = 0 K, RGT = 20°C</i>				60 Hz, ARI ratings <i>To = -31.67°C, Tc = 40.56°C, SC = 0 K, SH = 11.1 K</i>					
	Compressor model	Cooling capacity (W)	Power input (kW)	Current input (A)	C.O.P. (W/W)	Cooling capacity (W)	Power input (kW)	Current input (A)	C.O.P. (W/W)	E.E.R. (Btu/W.h)
	LFZ166-4	8280	6.42	10.02	1.29	8370	6.84	10.48	1.22	4.18
	LFZ250-4	12860	9.73	14.43	1.32	13010	10.38	15.21	1.25	4.28

Approvals and certificates

SpeeraTM refrigeration scroll compressors comply with:

CE (European Directive, including PED)

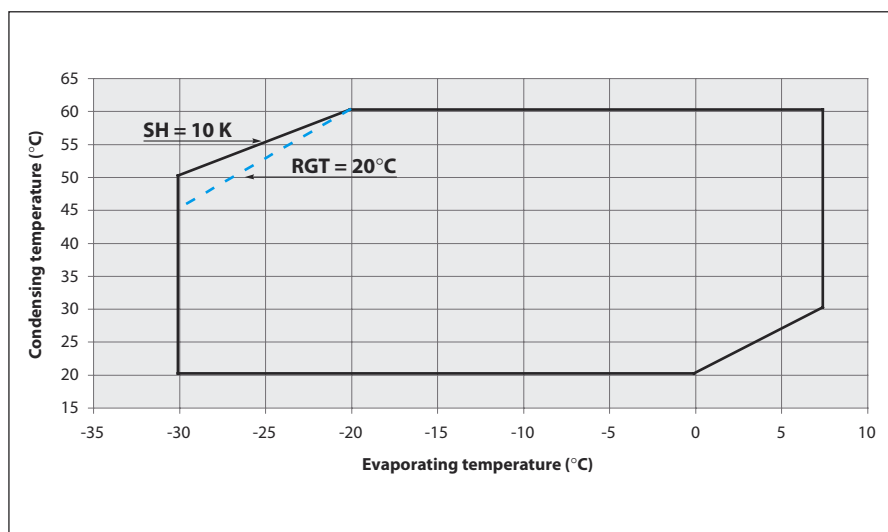


UL (Underwriters Laboratories)

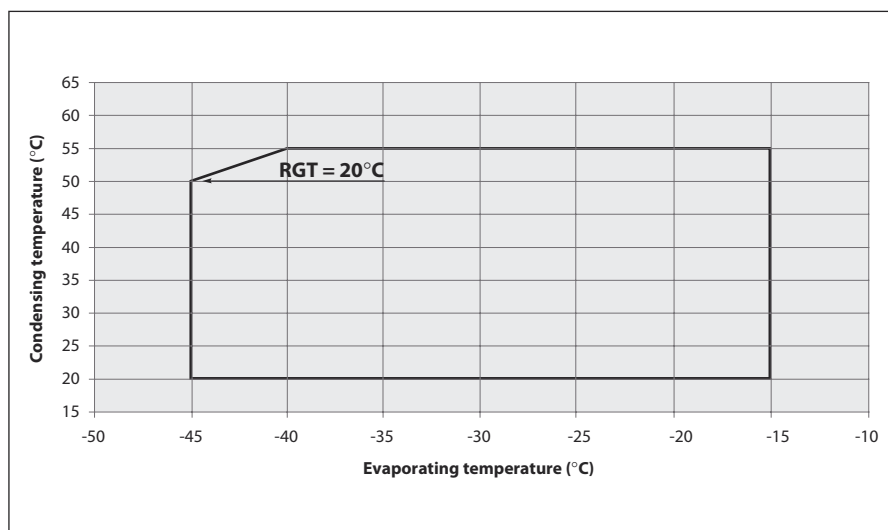


OPERATING ENVELOPES

MFZ



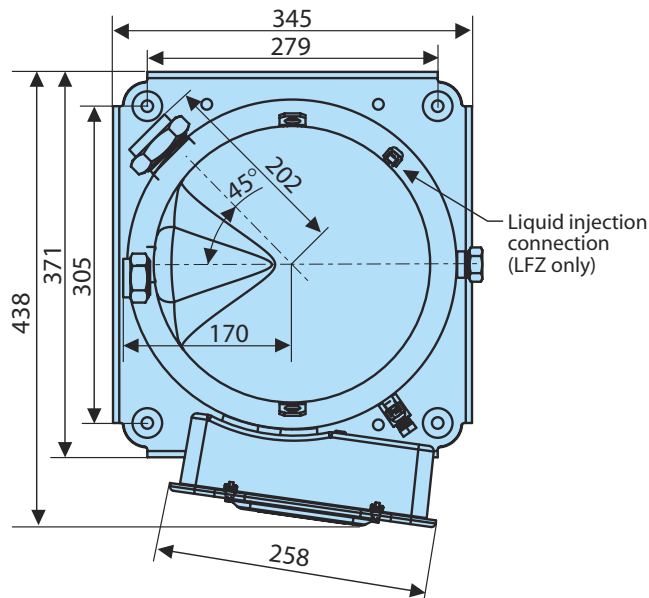
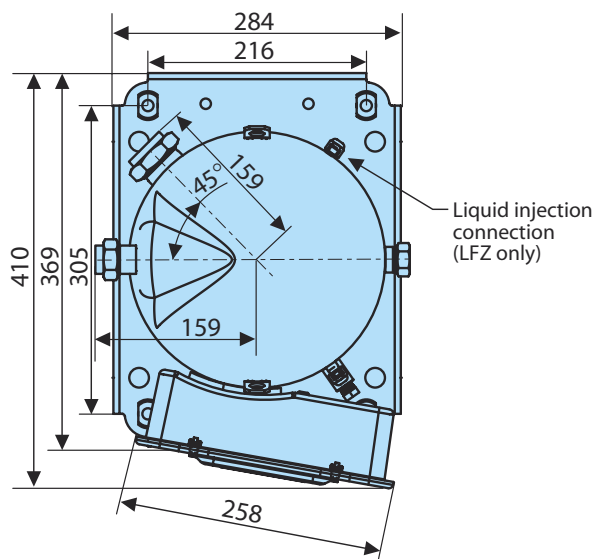
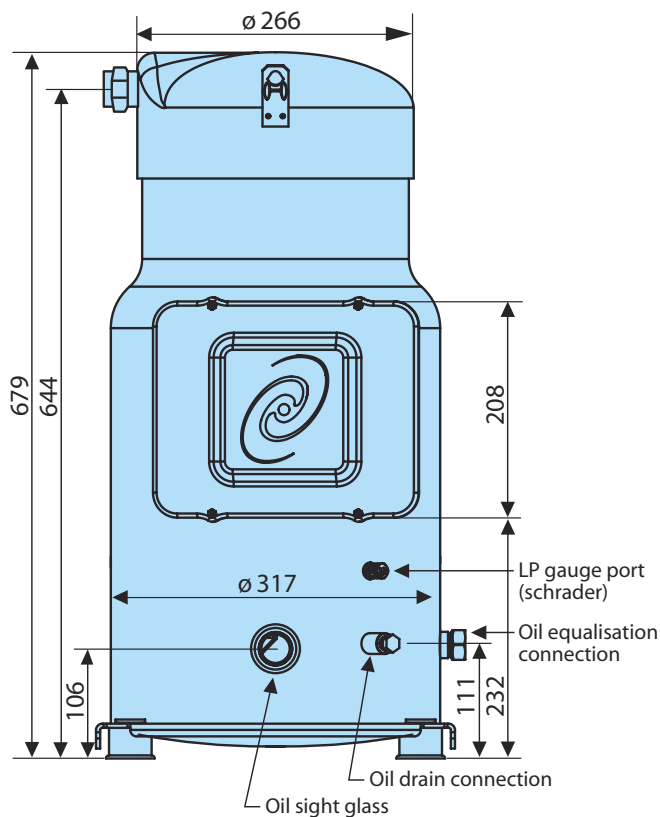
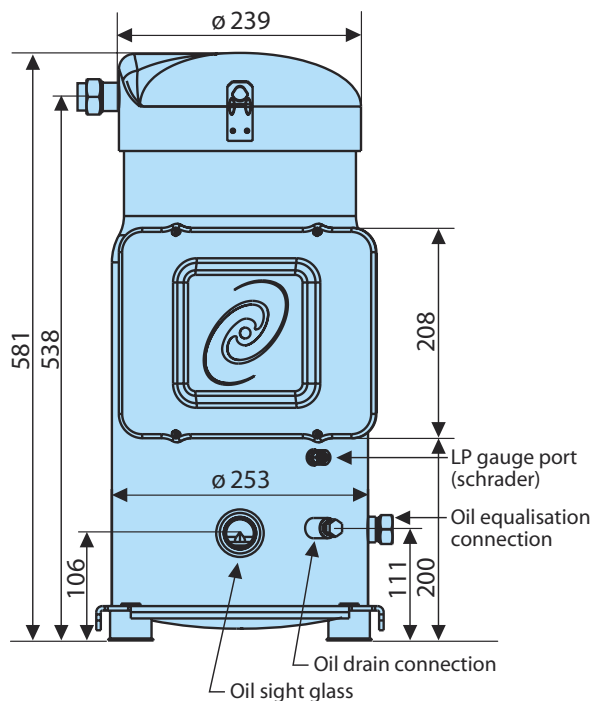
LFZ with liquid injection



OUTLINE DRAWINGS

MFZ166 - LFZ 166

MFZ250- LFZ 250



	Rotolock connections		Connection sizes with supplied sleeves		Default recommended rotolock valves		Liquid injection connection
	Suction	Discharge	Suction	Discharge	Suction	Discharge	
MFZ166	1 3/4"	1 1/4"	1 1/8"	3/4"	V02	V04	-
MFZ250	2 1/4"	1 3/4"	1 3/8"	7/8"	V08	V07	-
LFZ166	1 3/4"	1 1/4"	1 1/8"	3/4"	V02	V04	1/4" ODF, 3/8" screw
LFZ250	2 1/4"	1 3/4"	1 3/8"	7/8"	V08	V07	1/4" ODF, 3/8" screw

ELECTRICAL CONNECTIONS AND WIRING

Electrical characteristics

Compressor model	Winding resistance Ω	RLA A	MCC A	LRA A
MFZ166-4	1.05	20.7	29	130
MFZ250-4	0.77	25	35	175
LFZ 166-4	1.05	20.7	29	130
LFZ250-4	0.77	25	35	175

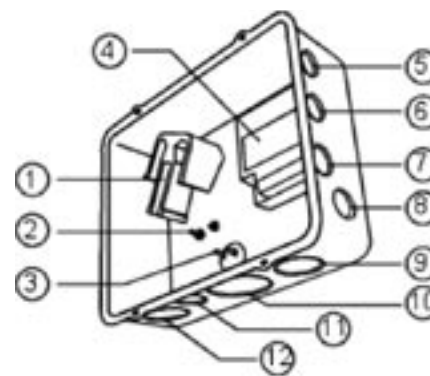
Voltage application range

Motor voltage code	Nominal voltage	Voltage application range
4	400 V/3/50 Hz	360 - 440 V
	460 V/3/60 Hz	414 - 506 V

Terminal box layout

The terminal box of Speerall™ compressors is provided with 4 double knockouts for the power supply and 4 single knockouts for the safety control circuit.

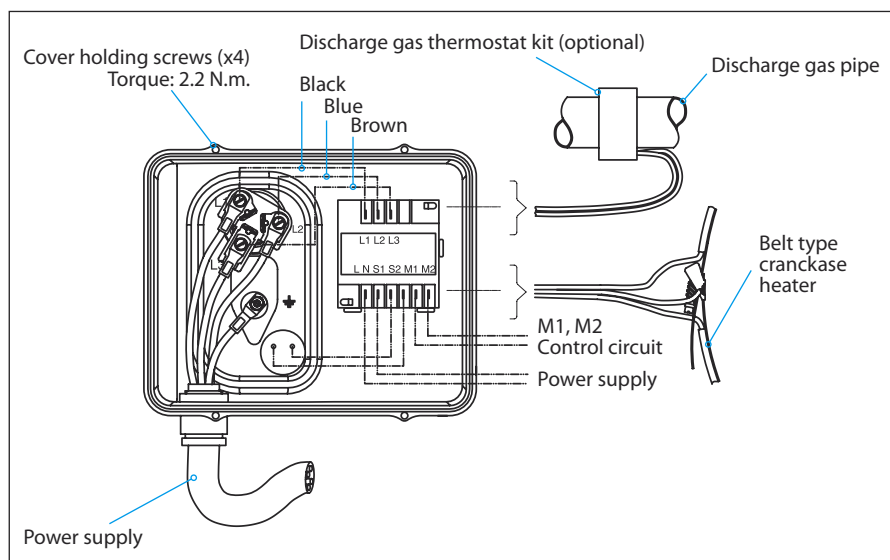
- 1: Power connection, 3 x \varnothing 4.8 mm ($3/16$ ") screws. Use a $1/4$ " ring terminal.
- 2: Earth, screw M5, Use a $1/4$ " ring terminal.
- 3: Thermostat connector.
- 4: Electronic protection module.
- 5: Knock-out \varnothing 20.5 mm (0.81").
- 6: Knock-out \varnothing 20.5 mm (0.81").
- 7: Double knock-out \varnothing 22 mm ($7/8$ ") & \varnothing 16.5 mm (0.65").
- 8: Double knock-out \varnothing 22 mm ($7/8$ ") & \varnothing 16.5 mm (0.65").
- 9: Double knock-out \varnothing 43.7 mm ($1-23/32$ ") & \varnothing 34.5 mm ($1-23/64$ ").
- 10: Knock-out \varnothing 50 mm ($1-31/32$ ").
- 11: Knock-out \varnothing 25.2 mm (0.99").



12: Double knock-out \varnothing 40.5 mm (1.59") & \varnothing 32.2 mm (1.27").

The terminal box has an IP rating of IP54. It shall not be modified in any

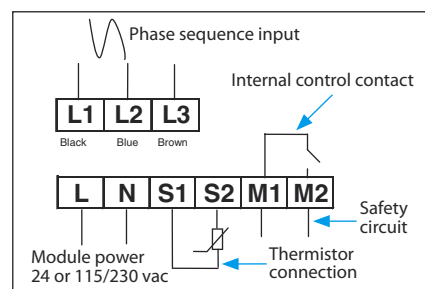
Terminal box wiring



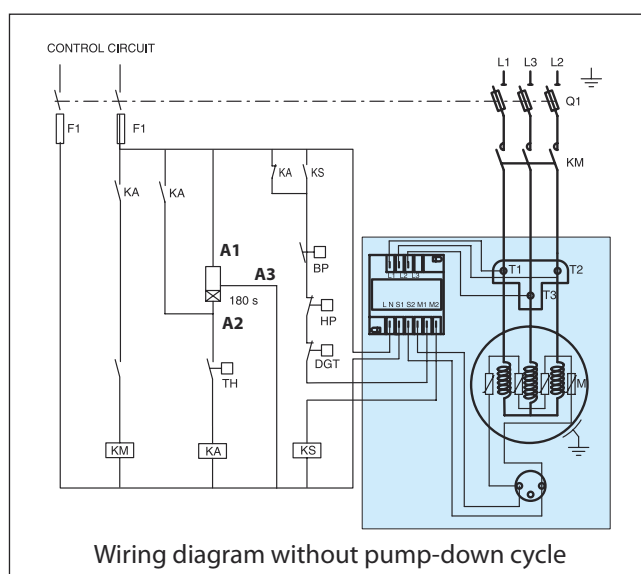
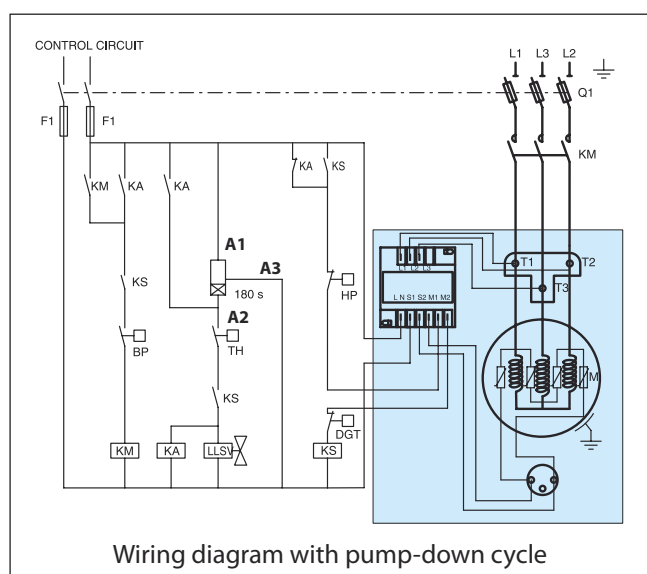
ELECTRICAL CONNECTIONS AND WIRING

Electronic protection module wiring

The motor protection module comes preinstalled within the terminal box and is accompanied with both phase sequence protection and 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.



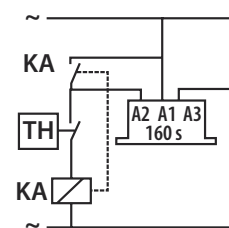
Suggested wiring diagrams



- Control device
- Optional short cycle timer (3 min)
- Control relay
- Liquid line solenoid valve
- Compressor contactor
- Safety lock out relay
- Pump-down control & LP switch
- HP safety switch
- Fused disconnect
- Fuses
- Compressor motor
- Discharge gas thermostat
- Motor protection module
- Thermistor chain

- TH
- 180 s
- KA
- LLSV
- KM
- KS
- BP
- HP
- Q1
- F1
- M
- DGT
- MPM
- S

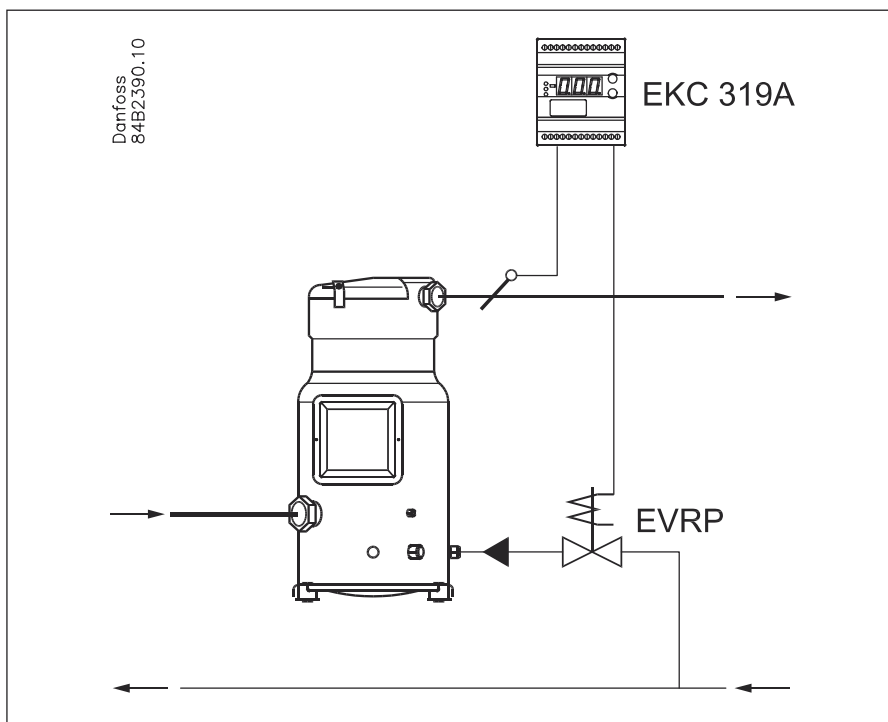
Short cycle timer



LIQUID INJECTION

Speerall™ LFZ series require liquid injection to maintain a sufficiently low discharge gas temperature. The compressors are provided with a liquid injection connection. A liquid

injection kit is available as an accessory. This system controls discharge gas temperature by injecting the required liquid via an electronically piloted pulse solenoid valve.



The liquid injection kit accessory (code n° 7704005) includes:

- One electronically piloted pulse solenoid valve, Danfoss EVRP 2.
- One electronic control, Danfoss EKC-319A (including alarm function).
- One PT100 discharge gas temperature sensor, Danfoss AKS 21.

The discharge gas temperature must not exceed 145°C in order to avoid degradation of oil, refrigerant and mechanical components.

The liquid injection connection is a combined connection of ¼" braze or ⅜" screw.

Speerall™ MFZ series, do not require liquid injection. They may be protected with a discharge gas thermostat kit (code n° 775009). This kit includes all components for installation and has a set-point of 135°C. The thermostat must be mounted to the discharge connection. The thermostat kit can also be used in combination with the EKC on LFZ compressors.

REFRIGERANT AND LUBRICANTS

Speerall™ refrigeration scroll compressors are designed and optimised for refrigerants R404A and R507A. Alternatively, refrigerants R407A and R407B can be used with Speerall™ compressors. However these may lead to a performance reduction and a limited operating envelope.

The use of other refrigerants, especially CFCs* and HCFCs* shall be avoided.

In particular, Danfoss does not authorize the use of hydrocarbons (propane, butane...) in the Speerall™ MFZ and LFZ series in any way, not even with a reduced refrigerant charge.

The Speerall™ compressors are factory charged with polyolester oil 160Z. Always use this same oil type for oil top-up or replacement.

Refrigerant	Type*	ODP**	Temperature glide*** (K)	Lubricant	Remarks
R404A	HFC	0	0.7	160Z polyolester lubricant, factory charged (160SZ allowed alternatively)	Recommended
R507A			0		
R407A			6.6		Reduced performance and envelope
R407B			4.4		

* Type: HFC: Hydrofluorcarbon (no chlorine component, long-term zero-ODP refrigerant).

CFC: Chlorofluorcarbon (with chlorine component).

HCFC: Hydrochlorofluorcarbon (with chlorine component).

**ODP: Ozone Depletion Potential (base R11; ODP = 1).

***Temperature glide is the difference between the saturated vapor temperature and saturated liquid temperature at constant pressure.

Because of their thermodynamic properties, R404A and R507A are especially suitable for low and medium temperature applications. Danfoss recommends the use of these refrigerants with MFZ and LFZ compressors.

Note that R404A has a small temperature glide. Therefore it must be charged in the liquid phase. For most other aspects however, this small glide may be neglected. R507A is an azeotropic mixture without temperature glide.

R407A and R407B have different thermodynamic properties than R404A and R507A. Especially their larger temperature glide shall not be neglected. When using these refrigerants, the MFZ and LFZ compressor capacity will be lower than the values published in this document. And because of a higher discharge temperature, the operating envelope will be reduced.

SYSTEM DESIGN RECOMMENDATIONS

Speerall™ MFZ and LFZ compressors have been designed and qualified for stationary equipment using standard alternating power supply. Danfoss

does not warrant the compressors for use on mobile applications such as trucks, railways, subways, ships etc.

Piping design

Oil in a refrigeration circuit is required to lubricate moving parts in the compressor. During normal system operation small oil quantities will continuously leave the compressor with the discharge gas. Therefore, the system piping shall be designed in such a way that allows a good oil circulation, avoiding oil being trapped in the system and ensuring a constant oil return to the compressor. As long as the amount of oil circulating through the system is small it will contribute

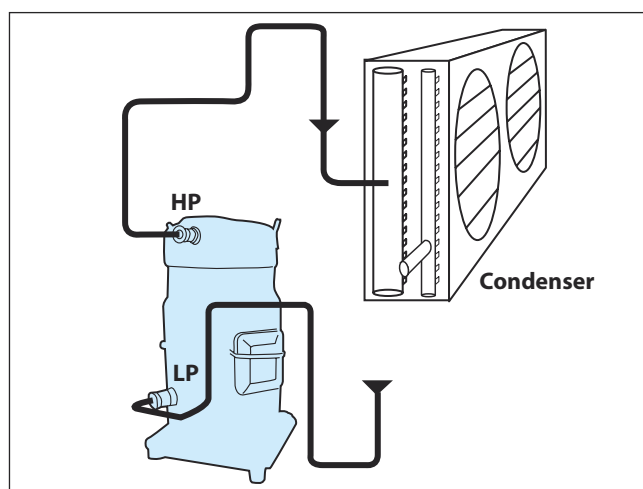
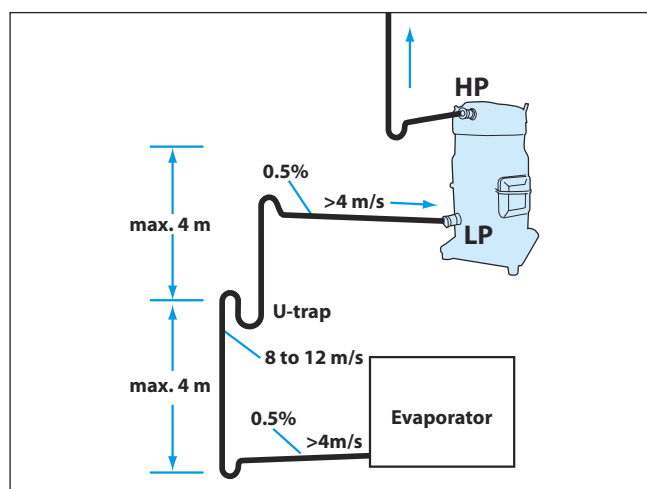
to good system operation and will improve heat transfer efficiency.

Lubricant getting trapped in the evaporator or suction lines will affect system performance and will ultimately lead to compressor lubrication failures. Where a poor oil return situation exists, adding lubricant will not help safeguard the compressor. Only a correct piping design can ensure adequate oil circulation maintaining safe oil level in the compressor.

Suction line

Horizontal suction line sections shall have a slope of 0.5% in the direction of refrigerant flow (5 mm per meter). The cross-section of horizontal suction lines shall be such that the resulting gas velocity is at least 4 m/s. In vertical risers, a gas velocity of 8 to 12 m/s is required to ensure proper oil return. A U-trap is required at the foot of each vertical riser. If the riser is higher than 4 m, additional U-traps are required for each additional 4 meters. The length of each U-trap must be as short as possible to avoid the accumulation of excessive quantities of oil.

Gas velocities higher than 12 m/s will not contribute to significantly better oil return. However they will cause higher noise levels and result in higher suction line pressure drops which will have a negative effect on the system capacity. Note that the default recommended rotolock valves (page 7) are designed for average pipe sizes, selected for systems running at nominal conditions. The pipe sizes selected for specific systems may differ from these average sizes. The suction line must always be insulated to limit suction gas superheat.



Discharge line

When the condenser is mounted above the compressor, a loop above the condenser and a U-trap close to the compressor are required to prevent

liquid draining from the condenser into the discharge line during stands-till.

SYSTEM DESIGN RECOMMENDATIONS

Oil charge and oil separator

In most installations the initial compressor oil charge will be sufficient. In installations with line runs exceeding 20 m, or with many oil traps or an oil separator, additional oil may be required. In installations with the risk

of slow oil return such as in multiple evaporator or in multiple condenser installations, an oil separator is recommended. Also refer to section "Oil charge and oil level".

Filter driers

For new installations with MFZ or LFZ compressors Danfoss recommends to use the Danfoss DML 100% molecular sieve, solid core filter drier. Molecular sieve filter driers with loose beads and filter driers with activated alumina from third party suppliers shall be avoided.

Danfoss DCL solid core filter driers containing activated aluminium are recommended.

The drier is to be oversized rather than undersized. When selecting a drier, always take into account its water content capacity, the system refrigerant capacity and the system refrigerant charge.

For servicing of existing installations where acid formation is present, the

Operating limits

Pressure ranges and settings

		MFZ	LFZ
Working pressure range high side	bar (g)	9.9 - 27.7	9.9 - 24.7
Working pressure range low side	bar (g)	1.0 - 7.6	0.05 - 2.6
Maximum high pressure safety switch setting	bar (g)	28	25
Minimum low pressure safety switch setting	bar (g)	-0.2	-0.2
Minimum low pressure pump-down switch setting	bar (g)	0.9	-0.1

High pressure

A high pressure safety switch is required to stop the compressor, should the discharge pressure exceed the values shown in the table above. The high-pressure switch can be set to lower values depending on the application and ambient conditions. The HP switch

must either be in a lockout circuit, or a manual reset device to prevent cycling around its high-pressure limit.

When a discharge valve is used, the HP switch must be connected to the service valve gauge port which cannot be isolated.

Low pressure

A low pressure safety switch must be used. Deep vacuum operation of a scroll compressor will result in failure. Speerall™ refrigeration scroll compressors have a high volumetric efficiency and can pull very low vacuum levels which could cause this problem. The minimum low-pressure safety switch (loss of charge safety switch) setting is -0.2 bar relative (-0.2 bar g). For systems without pump-down, the LP safety switch must either be a manual lockout device or an automatic LP safety switch wired into an electrical lockout circuit.

The LP switch tolerance must not allow vacuum operation of the compressor. LP safety switch settings for pump-down cycles with automatic reset, are in the table above.

For LFZ series a MOP type expansion valve or a suction pressure regulator (i.e. Danfoss KVL) must be used to limit the suction pressure at a maximum of 2.6 bar (g). Do not apply both devices in combination. In a multi-evaporator system, pressure regulators (such as Danfoss KVP) without MOP expansion valve shall be used.

Internal pressure relief valve

The MFZ and LFZ compressors have an internal pressure relief valve between the internal high and low pressure sides of the compressor. It opens when the pressure differential between the discharge and suction pressures ex-

ceeds 31 to 38 bar. This safety feature prevents the compressor from developing dangerously high pressures when the high pressure cut-out would fail.

SYSTEM DESIGN RECOMMENDATIONS

Low ambient temperature operation

At low ambient temperatures, the condensing temperature and condensing pressure in air cooled condensers will decrease. This low pressure may be insufficient to supply enough liquid refrigerant to the evaporator. As a result the evaporating temperature will decrease, leading to low capacity and eventual poor oil return. At start-up, the compressor will pull into vacuum and it will be switched off by the low pressure protection. Depending on how the low pressure switch and delay timer are set, short cycling can occur. To avoid these problems, several solutions are possible, based on reducing condenser capacity:

- Liquid flooding of condensers. Note that this solution requires extra refrigerant charge. A non-return valve in the discharge line is required and special care should be taken when designing the discharge line.
- Reduce air flow to condensers.
- Indoor installed condenser.

When the compressor is located in a low ambient temperature environment, increased refrigerant migration will occur during shut down periods. For such conditions a belt-type crankcase heater is strongly recommended. Also refer to section "Liquid refrigerant control" for more details.

Liquid refrigerant control

SpeeraTM compressors have a large internal free volume and can handle relatively large amounts of liquid refrigerant without major problems. However, even when a compressor can handle liquid refrigerant, this will not be favourable to its service life. Liquid refrigerant can dilute the oil, wash oil out of bearings and cause high oil

carry over and thus loss of oil from the sump. Good system design can limit the amount of liquid refrigerant in the compressor which will have a positive effect on the compressor service life.

Liquid refrigerant can enter the compressor by *off-cycle migration* and by *liquid flood back during operation*.

Off-cycle migration

During system standstill and after pressure equalisation, refrigerant will condense in the coldest part of the system. The compressor can easily be the coldest spot, for example when it is placed outside in low ambient temperature. After a while, the full system refrigerant charge can condense in the compressor shell. A large amount will dissolve in the oil until the oil is completely saturated with refrigerant. If other system components are located at a higher level than the compressor the gravity will even increase the migration process. When the compressor is started, the pressure in the bottom shell decreases rapidly. At lower pres-

sure the oil holds less refrigerant, and as a result a part of the refrigerant will violently evaporate from the oil, causing the oil to foam (often called "boiling").

The negative effects from migration on the compressor are:

- Oil dilution by liquid refrigerant.
- Oil foam, transported by refrigerant gas and discharged into the system, causing loss of oil and in extreme situations risk for oil slugging.
- In extreme situations with high system refrigerant charge, liquid slugging could occur (liquid entering the scroll elements).

Liquid flood back during operation

During normal and stable operation, refrigerant will leave the evaporator in a superheated condition and enter the compressor as a superheated vapour. Normal superheat values at the compressor suction connection are 5 to 30 K. However the refrigerant leaving the evaporator can still contain an amount of liquid refrigerant due to different reasons:

- Wrong dimensioning, wrong setting or malfunction of the expansion device.

- Evaporator fan failure or blocked air filters.

In these situations, liquid refrigerant will continuously enter the compressor. The negative effects from continuous liquid flood back are:

- Permanent oil dilution.
- In extreme situations with high system refrigerant charge and large amounts of flood back, liquid slugging could occur.

SYSTEM DESIGN RECOMMENDATIONS

Liquid flood back and zeotropic refrigerants

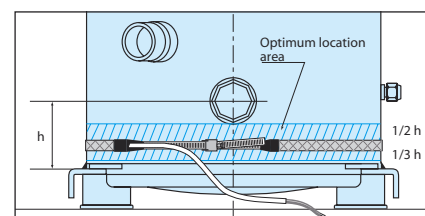
Liquid flood back in systems working with a zeotropic refrigerant introduces additional negative effects. A part of the refrigerant leaves the evaporator in liquid phase and this liquid has a

different composition than the vapour. This new refrigerant composition may result in different compressor operation pressures and temperatures.

Crankcase heater

A crankcase heater protects against the off-cycle migration of refrigerant and proves effective if oil temperature is maintained 10 K above the saturated LP temperature of the refrigerant. Test must thereby be conducted to ensure that the appropriate oil temperature is maintained under all ambient conditions. In general, ambient temperature shall not be lower than -15°C.

A belt crankcase heater is required on the Speerall™ refrigeration scroll compressor. The belt heater must be mounted on the compressor shell below the oil connections and sight glass to ensure good heat transfer to the oil sump. Belt crankcase heaters are not self-regulating. Control must be applied to energize the heater when the compressor is stopped and to de-energize



when the compressor is running. The belt heater must be energized 12 hours before restarting the compressor after an extended shut down period.

If the crankcase heater is not able to maintain the oil temperature at 10 K above the saturated LP temperature of the refrigerant during off cycles or if repetitive flood back is present, a liquid line solenoid valve (LLSV) in combination with a pump-down cycle is required, eventual in combination with a suction accumulator.

Liquid line solenoid valve & pump-down cycle

In all refrigeration applications, and in low temperature applications in particular, the Liquid Line Solenoid Valve (LLSV) is highly recommended. During the off-cycle the LLSV isolates the liquid charge in the condenser side thus preventing against refrigerant transfer or excessive migration of the refrigerant into the compressor.

Furthermore, when using an LLSV in combination with a pump-down cycle, the quantity of refrigerant in the low-pressure side of the system will be reduced. This is especially recommended in low temperature applications. A pump-down cycle design is required when evaporators are fitted with electric defrost heaters.

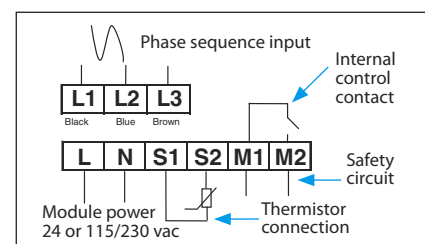
Suction accumulator

A suction accumulator offers very good protection against refrigerant flood back at start-up, during operation or after defrost operation. It also helps to protect against off-cycle migration by providing additional internal free volume to the low pressure side of the system. The accumulator must be selected in accor-

dance with the accumulator manufacturer recommendations. As a general rule, Danfoss recommends to size the accumulator for at least 50% of the total system charge. Tests must be conducted to determine the optimal size. A suction accumulator shall not be used in systems with zeotropic refrigerant mixtures.

Motor protection Internal motor protection

Speerall™ MFZ and LFZ compressors 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 and phase reversal. The motor protector consists of a control module and 4 PTC sensors (one sensor embedded in each motor winding and one sensor on top of the motor). The close contact between the thermistors



and the windings ensures a very low thermal inertia. The motor temperature is being constantly measured by a PTC thermistor loop connected on S1-S2.

SYSTEM DESIGN RECOMMENDATIONS

Overheating and overloading

If any thermistor exceeds its response temperature, the output relay trips (i.e. contacts M1-M2 open). After cooling to below the response temperature, a 5-minute time delay is activated. After this delay has elapsed, the relay is closed again (contacts M1-M2 closed).

When using the recommended control circuit, the circuit will not automatically reset.

The time delay can be cancelled by resetting the power mains (L-N disconnected) for 5 s.

External motor protection

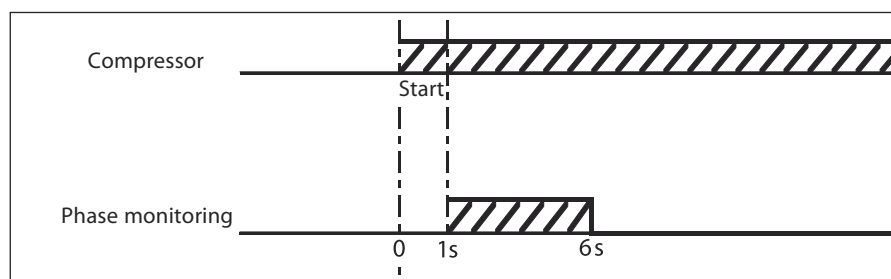
The electrical motor of a Speerall™ compressor is sufficiently protected by the electronic motor protection module. Technically, no external motor protection is required. Should external motor protection be applied anyhow,

then these safety devices must be in accordance with the requirements of the certification authorities in the country where the compressor will be used.

Phase sequence and phase reverse rotation protection

The compressor will only operate properly in a single direction. Therefore a correct connection order is required. 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 electronic motor protection module provides protection against phase reversal and phase loss at start-up. The phase sequencing and phase loss monitoring functions are active during a 5 s period, 1 s after compressor start-up (1 s after power on L1-L2-L3). Should one of these parameters be incorrect, the compressor may run for about 3 s before being shut

off by the protection module (contact M1-M2 open). The module will not reset until power has been removed from the module for 5 s (L-N disconnected).

The circuit should be thoroughly verified to determine the cause of the phase problem before re-energizing the control circuit.

Cycle rate limit

There must be no more than 12 starts per hour (6 when a soft start accessory is used). A higher number reduces the service life of the motor-compressor unit. If necessary, use an anti-short-cycle timer in the control circuit. Connect it as shown in the wiring diagram. A 3-minute (180 s) time-out is recom-

mended. The system must be designed in a way that guarantees a minimum compressor running time to provide sufficient motor cooling after its start and to provide proper oil return from the system to the compressor. Note that the oil return may vary, as it is a function of the system design.

Voltage unbalance

Refer to section "Voltage application range" for operating voltage limits. The voltage applied to the motor terminals must be within these table limits during start-up and normal operation. The maximum allowable voltage unbalance is 2%. Voltage unbalance causes high amperage on one or more phases, which leads to overheating and possible motor damage.

Voltage unbalance is given by the formula:

$$\frac{|V_{\text{avg}} - V_{1-2}| + |V_{\text{avg}} - V_{1-3}| + |V_{\text{avg}} - V_{2-3}|}{2 \times V_{\text{avg}}} \times 100$$

V_{avg} = Mean voltage of phases 1, 2, 3.

V_{1-2} = Voltage between phases 1 & 2.

V_{1-3} = Voltage between phases 1 & 3.

V_{2-3} = Voltage between phases 2 & 3.

SOUND AND VIBRATION MANAGEMENT

Sound

Running compressors cause sound and vibration. Both phenomena are closely related.

Sound produced by a compressor is transmitted in every direction by the ambient air, the mounting feet, the pipework and the refrigerant in the pipework.

Since Speerall™ refrigeration scroll compressors require no body cooling, the easiest way to reduce the sound transmitted through ambient air is to fit a Danfoss acoustic hood accessory. These hoods incorporate sound proofing materials and achieve excellent high and low frequency attenuation.

Compressor model	Attenuation at ARI conditions, 50 Hz dB(A)	Acoustic hood code number
MFZ166	8.5	7755010
MFZ250	8	7755007
LFZ166	8.5	7755010
LFZ250	8	7755007

For inside mounted compressors, sound insulation of the room is an alternative to sound insulation of the compressor. Sound transmitted by

mounting feet, pipework and refrigerant should be treated the same way as for vibration. Please refer to the next section.

Vibration

The mounting grommets delivered with the compressor shall always be used. They reduce the vibration transmitted by the compressor mounting feet to the base frame.

The base on which the compressor is mounted should be sufficiently rigid and of adequate mass to ensure the full effectiveness of the mounting grommets.

The compressor should never be directly mounted to the base frame without the grommets, otherwise high vibration transmission would occur and the compressor service life would

be reduced. Suction and discharge lines must have adequate flexibility in 3 planes. Eventually vibration absorbers may be required.

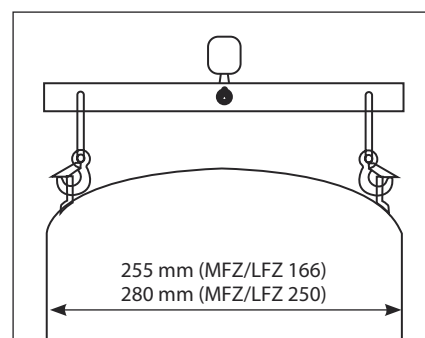
Care must be taken to avoid tubing having resonant frequencies close to those of the compressor frequency.

The scroll compression principle of a Speerall™ refrigeration scroll compressor minimizes the vibrations transmitted by the refrigerant gas compared to a reciprocating compressor. To further reduce vibrations a discharge muffler with the appropriate resonant volume and mass can be installed.

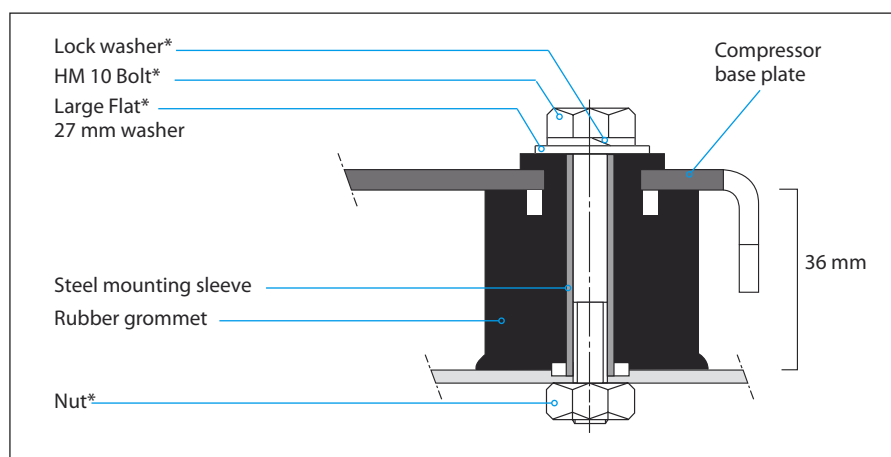
INSTALLATION AND SERVICE

Compressor handling

Speerall™ refrigeration scroll compressors are provided with two lift rings. Always use both rings when lifting the compressor. A spreader bar rated for the mass of the compressor is highly recommended to ensure a better load distribution. When the compressor is mounted as part of an installation, never use the lift rings on the compressor to lift the entire installation. Maintain the compressor in an upright position during all handling maneuvers. Never apply force to the terminal box to move the compressor.



Compressor mounting



*Not supplied with compressor

Speerall™ compressors come delivered with four rubber mounting grommets and metal sleeve liners that serve to isolate the compressor from the base frame. These grommets attenuate to a great extent the transmission of com-

pressor vibrations to the base frame and must always be used to mount the compressor. The rubber grommets must be compressed until contact between the flat washer and the steel mounting sleeve is established

Mounting torques

Designation	Torque (Nm)	
	Mini	Maxi
Rotolock nut 1" for oil equalization line tube 3/8"	45	50
Oil sight glass	45	52
Rotolock nut 2 1/4"	120	140
Rotolock nut 1 3/4"	100	120
Rotolock nut 1 1/4"	80	100
Electrical T-block screw HN°10-32 UNF x 9.5	2	3
Earth screw	2	3
Mounting grommets	-	50
Schrader nut	11.3	17
Schrader valve (internal)	0.4	0.8
Belt crankcase heater	3	4

INSTALLATION AND SERVICE

Removing 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. Keep the compressor in an upright position to avoid oil spillage.

System cleanliness

System contamination is one of the main factors affecting equipment reliability and compressor service life. Therefore, it is important to ensure system cleanliness when manufacturing a refrigeration system. During the manufacturing process, system contamination can be caused by:

- Brazing and welding oxides.
- Filings and particles from removing burrs from pipe-work.
- Brazing flux.
- Moisture and air.

Only use clean and dehydrated refrigeration grade copper tubes and silver alloy braze material. Clean all parts

before brazing and always purge nitrogen or CO₂ through the pipes during brazing to prevent oxidation. If flux is used, take every precaution to prevent leakage into the piping. Do not drill holes in parts of the system that are already completed when filings and burrs can not be removed. Carefully follow the instructions regarding brazing, mounting, leak detection, pressure test and moisture removal. All installation and service work shall be done by qualified personnel respecting all procedures and using tools (charging systems, tubes, vacuum pump, etc.) dedicated for the refrigerant that will be used.

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 inflam-

mable mixture. Pressurize the system on HP side first and then on LP side to prevent rotation of the scroll. Do not exceed the following pressures:

Maximum compressor test pressure at low pressure side	25 bar (g)
Maximum compressor test pressure at high pressure side	41 bar (g)
Maximum pressure difference between high and low pressure sides of the compressor	24 bar

Leak detection

Leak detection must be carried out using a mixture of nitrogen and refrigerant or nitrogen and helium. 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 and then on LP side.

Note 1:

Leak detection with refrigerant may not be allowed in some countries: check local regulations.

Note 2:

Leak detecting additives shall not be used as they may affect the lubricant properties. Warranty may be voided if leak detecting additives have been used.

INSTALLATION AND SERVICE

Vacuum pump down and moisture removal


Moisture obstructs the proper functioning of the compressor and the refrigeration system. Air and moisture reduce service life, increase condensing pressure and cause excessively high discharge temperatures which can destroy the lubricating properties of the oil. Air and moisture also increase the risk of acid formation, giving rise to copper plating. All these phenomena can cause mechanical and electrical compressor failure. To eliminate these factors, a vacuum pull-down according to the procedure below is recommended.

1. Whenever possible (if valves are present) the compressor must be kept isolated from the system.
2. After the leak detection, the system must be pulled-down under a vacuum of 500 microns (0.67 mbar). A two-stage vacuum pump shall be used with a capacity appropriate to the system volume. It is recommended to use connection lines with a large diameter and to connect these to the service valves and not to the schrader connection to avoid too high pressure losses.
3. When the vacuum level of 500 micron is reached, the system must be isolated from the vacuum pump. Wait 30 minutes during which the system pressure should not rise.

When the pressure rapidly increases, the system is not leak tight. A new leak detection must be performed and the vacuum pull down procedure should be restarted from step 1. When the pressure slowly increases, this indicates the presence of moisture. In this case step 2 and 3 should be repeated.

4. Connect the compressor to the system by opening the valves. Repeat step 2 and 3.
5. Break the vacuum with nitrogen or the final refrigerant.
6. Repeat step 2 and 3 on the total system.

At commissioning, system moisture content may be up to 100 ppm. During operation the filter drier must reduce this to a level < 20 ppm.

 Do not use a megohmmeter or apply power to the compressor while it is under vacuum, as this may cause motor winding damage. Never run the compressor under vacuum as it may cause compressor motor burn-out.

Also refer to bulletin "Vacuum pump down and dehydration procedure" for more detailed information.

ACCESSORIES AND SPARE PARTS

The below tables show an extract of the available accessories and Spare parts for Speerall™ refrigeration scroll compressors. For an exhaustive list, please refer to "Accessories & Spare parts catalogue", ref. FRCC.EK.002.A1.02.

Rotolock accessories

Type	Code no.	Description	Application	Pack size
V04	8168029	Rotolock valve, V04 (1-1/4" Rotolock, 3/4" ODF)	Models with 1-1/4" rotolock connection	6
V04	7968006	Rotolock valve, V04 (1-1/4" Rotolock, 3/4" ODF)	Models with 1-1/4" rotolock connection	42
V02	8168028	Rotolock valve, V02 (1-3/4" Rotolock, 1-1/8" ODF)	Models with 1-3/4" rotolock connection	6
V02	7968009	Rotolock valve, V02 (1-3/4" Rotolock, 1-1/8" ODF)	Models with 1-3/4" rotolock connection	24
V02-V04	7703009	Valve set, V02 (1-3/4"~1-1/8"), V04 (1-1/4"~3/4")	MFZ166, LFZ166	6
V02-V05	7703008	Valve set, V02 (1-3/4"~1-1/8"), V05 (1-1/4"~7/8")	MFZ166, LFZ166	6
V08-V07	7703010	Valve set, V08 (2-1/4"~1-3/8"), V07 (1-3/4"~7/8")	MFZ250, LFZ250	6
G09	8156131	Gasket, 1-1/4"	Models with 1-1/4" rotolock connection	10
G09	7956002	Gasket, 1-1/4"	Models with 1-1/4" rotolock connection	50
G07	8156132	Gasket, 1-3/4"	Models with 1-1/4" rotolock connection	10
G07	7956003	Gasket, 1-3/4"	Models with 1-1/4" rotolock connection	50
G08	8156133	Gasket, 2-1/4"	Models with 2-1/4" rotolock connection	10
G08	7956004	Gasket, 2-1/4"	Models with 2-1/4" rotolock connection	50
	8156009	Gasket set, 1", 1-1/4", 1-3/4", OSG gaskets black & white	MFZ166, LFZ166	10
	8156013	Gasket set, 1-1/4", 1-3/4", 2-1/4", OSG gaskets black & white	MFZ166.250, LFZ166.250	10

Crankcase heaters

Type	Code no.	Description	Application	Pack size
	7773109	Belt type crankcase heater, 65 W, 110 V, CE mark, UL	MFZ166, LFZ166	6
	7973001	Belt type crankcase heater, 65 W, 110 V, CE mark, UL	MFZ166, LFZ166	50
	7773107	Belt type crankcase heater, 65 W, 230 V, CE mark, UL	MFZ166, LFZ166	6
	7973002	Belt type crankcase heater, 65 W, 230 V, CE mark, UL	MFZ166, LFZ166	50
	7773117	Belt type crankcase heater, 65 W, 400 V, CE mark, UL	MFZ166, LFZ166	6
	7773010	Belt type crankcase heater, 50 W, 110 V, UL	MFZ166, LFZ166	6
	7773003	Belt type crankcase heater, 50 W, 240 V, UL	MFZ166, LFZ166	6
	7773009	Belt type crankcase heater, 50 W, 400 V, UL	MFZ166, LFZ166	6
	7773110	Belt type crankcase heater, 75 W, 110 V, CE mark, UL	MFZ250, LFZ250	6
	7773108	Belt type crankcase heater, 75 W, 230 V, CE mark, UL	MFZ250, LFZ250	6
	7973005	Belt type crankcase heater, 75 W, 230 V, CE mark, UL	MFZ250, LFZ250	50
	7773118	Belt type crankcase heater, 75 W, 400 V, CE mark, UL	MFZ250, LFZ250	6
	7773012	Belt type crankcase heater, 100 W, 110 V, UL	MFZ250, LFZ250	6
	7773007	Belt type crankcase heater, 100 W, 240 V, UL	MFZ250, LFZ250	6
	7773011	Belt type crankcase heater, 75 W, 400 V, UL	MFZ250, LFZ250	6

Motor protection modules

Type	Code no.	Description	Application	Pack size
	8169015	Electronic motor protection module, 24 V	MFZ166.250, LFZ166.250	1
	8169016	Electronic motor protection module, 115/230 V	MFZ166.250, LFZ166.250	1

Lubricants

Type	Code no.	Description	Application	Pack size
160SZ	7754023	POE lubricant, 160SZ, 1 litre can	MFZ & LFZ	12
160SZ	7754024	POE lubricant, 160SZ, 2 litre can	MFZ & LFZ	8
160SZ	7754027	POE lubricant, 160SZ, 1 gallon can	MFZ & LFZ	1

Acoustic hoods

Type	Code no.	Description	Application	Pack size
	7755010	Acoustic hood	MFZ166, LFZ166	1
	7755007	Acoustic hood	MFZ250, LFZ250	1

Miscellaneous

Type	Code no.	Description	Application	Pack size
	7704005	Injection kit for LFZ (EVRP2, EK319A, AKS21)	LFZ166.250	1
	8156138	Mounting kit with bolts for scroll compressor	MFZ166.250, LFZ166.250	1
	8173230	T block connector 52 x 57 mm	MFZ166, LFZ166	10
	8173021	T block connector 60 x 75 mm	MFZ250, LFZ250	10
	7750009	Discharge thermostat kit	All models	10

ORDERING INFORMATION AND PACKAGING

Code numbers for ordering MFZ and LFZ compressors in single pack

Compressor model	Design	Code no.				
		3	4	6	7	9
			400V/3ph/50Hz 460V/3ph/60Hz			
MFZ166	Motor protection module 24 V	-	MFZ166A4AI	-	-	-
	Motor protection module 115/230 V	-	MFZ166A4BI	-	-	-
MFZ250	Motor protection module 24 V	-	MFZ250A4AI	-	-	-
	Motor protection module 115/230 V	-	MFZ250A4BI	-	-	-
LFZ166	Motor protection module 24 V	-	LFZ166A4AI	-	-	-
	Motor protection module 115/230 V	-	LFZ166A4BI	-	-	-
LFZ250	Motor protection module 24 V	-	LFZ250A4AI	-	-	-
	Motor protection module 115/230 V	-	LFZ250A4BI	-	-	-

LFZ series are not available for export to China, Japan and USA.

MFZ and LFZ compressors in industrial pack

Compressor model	Design	Code no.				
		3	4	6	7	9
			400V/3ph/50Hz 460V/3ph/60Hz			
MFZ166	Motor protection module 24 V	-	MFZ166A4AM	-	-	-
	Motor protection module 115/230 V	-	MFZ166A4BM	-	-	-
MFZ250	Motor protection module 24 V	-	MFZ250A4AM	-	-	-
	Motor protection module 115/230 V	-	MFZ250A4BM	-	-	-
LFZ166	Motor protection module 24 V	-	LFZ166A4AM	-	-	-
	Motor protection module 115/230 V	-	LFZ166A4BM	-	-	-
LFZ250	Motor protection module 24 V	-	LFZ250A4AM	-	-	-
	Motor protection module 115/230 V	-	LFZ250A4BM	-	-	-

LFZ series are not available for export to China, Japan and USA.

Packaging

Model	Single pack		Multipack				Industrial pack			
	Dimensions (mm)	Net weight (kg)	Nbr	Dimensions (mm)	Gross weight (kg)	Static stacking	Nbr	Dimensions (mm)	Gross weight (kg)	Static stacking
MFZ166	l: 470 w: 370 h: 596	80	6	l: 1140 w: 950 h: 737	tbd	3	8	l: 1140 w: 950 h: 757	638	3
MFZ250	l: 470 w: 370 h: 698	103	6	l: 1230 w: 970 h: 839	tbd	3	6	l: 1140 w: 950 h: 877	648	2
LFZ166	l: 470 w: 370 h: 596	80	6	l: 1140 w: 950 h: 737	tbd	3	8	l: 1140 w: 950 h: 757	638	3
LFZ250	l: 470 w: 370 h: 698	103	6	l: 1230 w: 970 h: 839	tbd	3	6	l: 1140 w: 950 h: 877	648	2

Single pack: One compressor in a cardboard box.

Multipack: A full pallet of compressors, each individually packed in a cardboard box.

Industrial pack: A full pallet of unpacked compressors.

Nbr: Number of compressors in a pack.

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