Application Guidelines

Copeland™ Scroll Compressors for Comfort, Precision and Process Cooling

ZR24KRE to ZR190KRE

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About these guidelines

The purpose of these guidelines is to provide guidance in the application of Copeland™ scroll compressors in users' systems. They are intended to answer the questions raised while designing, assembling and operating a system with these products.

Besides the support they provide, the instructions listed herein are also critical for the proper and safe functioning of the compressors. The performance and reliability of the product may be impacted if the product is not used according to these guidelines or is misused.

These application guidelines cover stationary applications only. For mobile applications, please contact the Application Engineering department at Emerson as other considerations may apply.

1 Safety instructions

Copeland scroll compressors are manufactured according to the latest relevant European safety standards. Particular emphasis has been placed on the user's safety.

These compressors are intended for installation in systems in accordance with the European Machinery directive MD 2006/42/EC, the Pressure Equipment Directive PED 2014/68/EU and the Low Voltage Directive LVD 2014/35/EU. They may be put to service only if they have been installed in systems according to instructions and conform to the corresponding provisions of legislation.

The Material Safety Datasheet (MSDS) for the individual refrigerant shall be considered when working with this type of refrigerant – please check this document provided by the gas supplier.

These instructions shall be retained throughout the lifetime of the compressor.

You are strongly advised to follow these safety instructions.

1.1 Icon explanation

	WARNING This icon indicates instructions to avoid personal injury and material damage.		**CAUTION** This icon indicates instructions to avoid property damage and possible personal injury.
	High voltage This icon indicates operations with a danger of electric shock.		**IMPORTANT** This icon indicates instructions to avoid malfunction of the compressor.
	Danger of burning or frostbite This icon indicates operations with a danger of burning or frostbite.	***NOTE***	This word indicates a recommendation for easier operation.
	Explosion hazard This icon indicates operations with a danger of explosion.		

1.2 Safety statements

- **Refrigerant compressors must be employed only for their intended use. The system has to be labelled according to the applicable standards and legislation.**
- **Only qualified and authorized RACHP personnel are permitted to install commission and maintain this equipment.**
- **Electrical connections must be made by qualified electrical personnel.**
- **All valid standards for connecting electrical and refrigeration equipment must be observed.**
- **The national legislation and regulations regarding personnel protection must be observed.**

Use personal safety equipment. Safety goggles, gloves, protective clothing, safety boots and hard hats should be worn where necessary.

1.3 General instructions

WARNING
Pressurized system! Serious personal injuries and/or system breakdown! Accidental system start before complete set-up must be avoided. Never leave the system unattended without locking it out electrically when it is on vacuum and has no refrigerant charge, when it has a holding charge of nitrogen, or when the compressor service valves are closed.

WARNING
System breakdown! Personal injuries! Only approved refrigerants and refrigeration oils must be used.

WARNING
High shell temperature! Burning! Do not touch the compressor until it has cooled down. Ensure that other materials in the area of the compressor do not get in touch with it. Lock and mark accessible sections.

CAUTION
Overheating! Bearing damage! Do not operate compressors without refrigerant charge or without being connected to the system.

CAUTION
Contact with POE! Material damage! POE lubricant must be handled carefully and the proper protective equipment (gloves, eye protection, etc.) must be used at all times. POE must not come into contact with any surface or material that it might damage, including without limitation, certain polymers, eg, PVC/CPVC and polycarbonate.

IMPORTANT
Transit damage! Compressor malfunction! Use original packaging. Avoid collisions and tilting.

2 Product description

2.1 Compressor range

These application guidelines deal with all vertical single Copeland scroll compressors from ZR24KRE to ZR190KRE for air-conditioning applications.

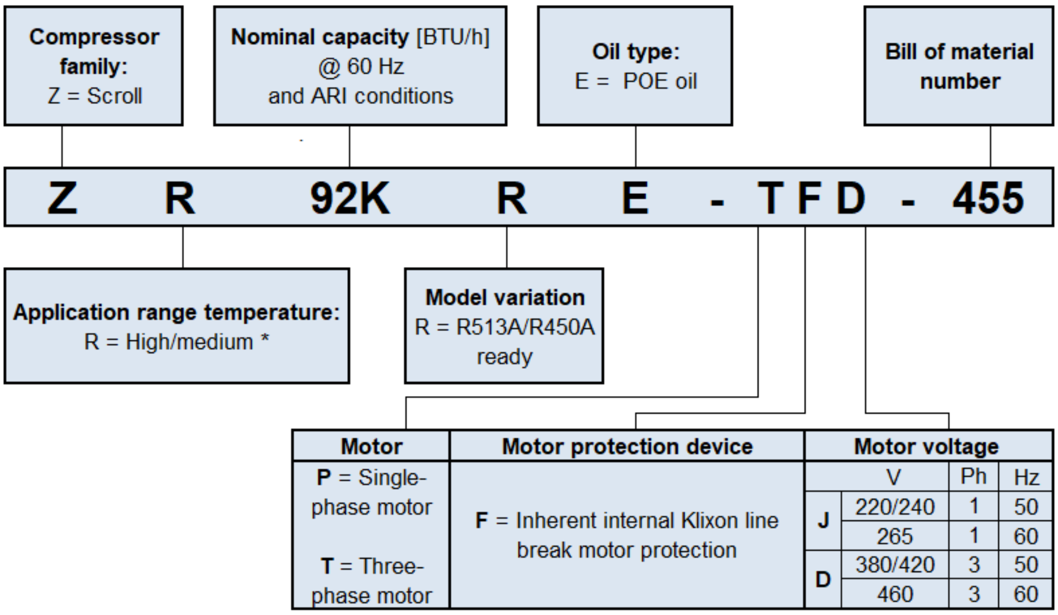
Compressor	Cooling capacity (kW)				Motor
	R450A	R513A	R134a	R407C	
ZR24KRE	3.06	3.54	3,61	5.02	PFJ/TFD
ZR28KRE	3.60	4.17	4.18	5.88	PFJ/TFD
ZR36KRE	4.58	5.21	5.25	7.59	PFJ/TFD
ZR42KRE	5.24	6.20	6.07	8.87	PFJ/TFD
ZR48KRE	6.01	6.91	6.60	10.30	TFD
ZR61KRE	7.62	9.01	8.77	13.00	TFD
ZR69KRE	8.59	10.15	9.76	14.30	PFJ
ZR72KRE	9.08	10.55	10.50	14.75	TFD
ZR81KRE	10.0	11.60	11.80	16.55	TFD
ZR92KRE	11.3	13.50	13.35	18.75	TFD
ZR108KRE	-	15.80	15.70	23.00	TFD
ZR125KRE	-	18.40	18.25	27.00	TFD
ZR144KRE	-	20.80	21.00	30.90	TFD
ZR160KRE	-	22.90	22.70	33.40	TFD
ZR190KRE	-	27.40	27.20	39.30	TFD

Refrigerant dew temperature, evaporating temperature: 5 °C; condensing temperature: 50 °C; suction gas superheat: 10 K; liquid sub-cooling: 0 K; frequency: 50 Hz

Table 1: ZR*KRE model overview for high temperature applications

2.2 Nomenclature

The model designation contains the following technical information about the compressors:



2.3 BOM Variation

The BOM (bill of material) number at the end of the compressor designation indicates the compressor layout and details.

ZR24KRE to ZR92KRE:

BOM 455 braze connections, oil sight glass, oil service connection, IP21 T-box, no mounting parts.

ZR108KRE to ZR190KRE:

BOM 455 braze connections, oil sight glass, oil service connection, IP21 T-box, no mounting parts.

BOM 411 braze connections, oil sight glass, oil service connection, IP65 T-box, no mounting parts.

Please refer to the Emerson price list for more details.

2.4 Application range

2.4.1 Qualified refrigerants and oils

IMPORTANT
It is essential that the glide of refrigerant blends (R450A, R407C) be carefully considered when adjusting pressure and superheat controls.

IMPORTANT
Refrigerant blends with low GWP containing HFOs have a low chemical stability in presence of air or humidity. This requires the same level of cleanliness, dryness and evacuation of the refrigerant circuit as in HFC and POE applications including the use of filter dryers.

Compressor	ZR24KRE to ZR92KRE	ZR108KRE to ZR190KRE
Qualified refrigerants	R450A, R513A, R134a, R407C	R513A, R134a, R407C
Copeland standard oil	Emkarate RL 32 3MAF	Emkarate RL 32 3MAF
Servicing oils	Emkarate RL 32 3MAF Mobil EAL Arctic 22 CC	Emkarate RL 32 3MAF Mobil EAL Arctic 22 CC

Table 2: Qualified refrigerants and oils.

Oil recharge values can be taken from Copeland Select software available at www.climate.emerson.com/en-gb.

2.4.2 Application limits

CAUTION
Inadequate lubrication! Compressor breakdown! The superheat at the compressor suction inlet must always be sufficient to ensure that no refrigerant droplets enter the compressor. For a typical evaporator-expansion valve configuration a minimum stable superheat of at least 5 K is required.

For application envelopes and technical data, please refer to Copeland Select software available at www.climate.emerson.com/en-gb.

2.4.3 PED category and maximum allowable pressure PS

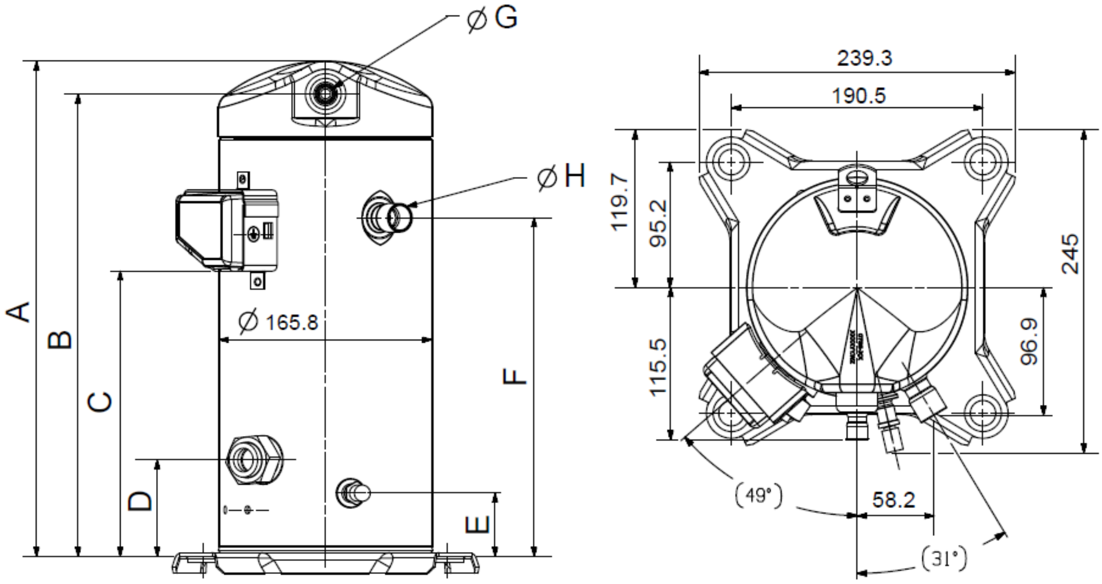
Compressor models ZR24KRE to ZR92KRE are classified as category 1 and models ZR108KRE to ZR190KRE are classified as category 2, according to the Pressure Equipment Directive PED 2014/68/EU.

Compressor	PS High-pressure side	PS Low-pressure side	TS Low-pressure side	PED category
ZR24KRE to ZR92KRE	29 bar(g)	21 bar(g)	50 °C	1
ZR108KRE to ZR190KRE	32 bar(g)	20.5 bar(g)	53 °C	2

Table 3: Maximum allowable pressures and temperatures

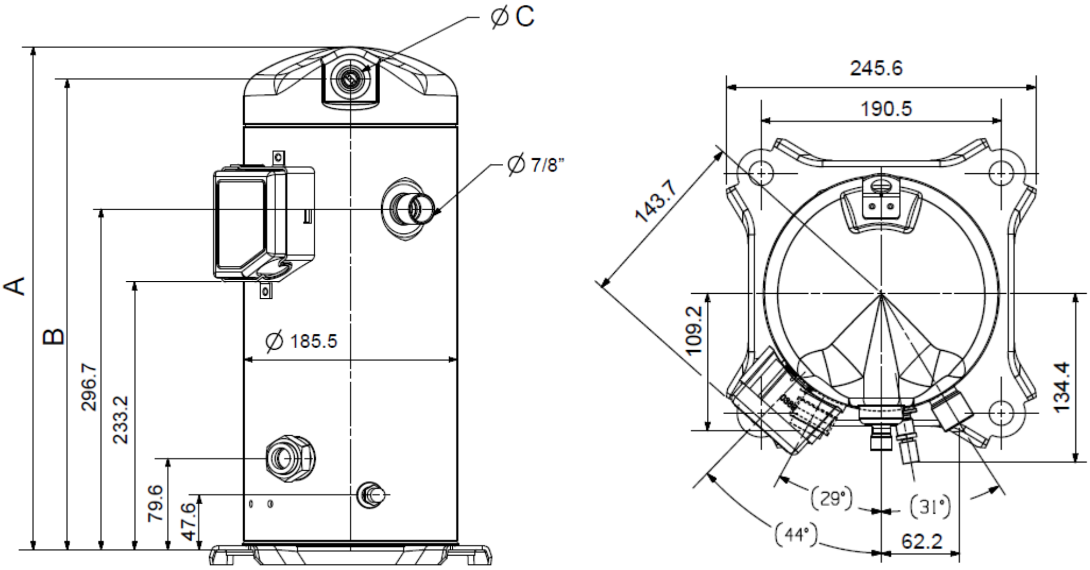
The pressure PS is the maximum allowable pressure at the low- and high-pressure sides of the compressor. The maximum pressure value PS for the individual compressor type is printed on the nameplate of the compressor. Safety is established in compliance with the relevant standards applicable to the given product.

2.5 Dimensions



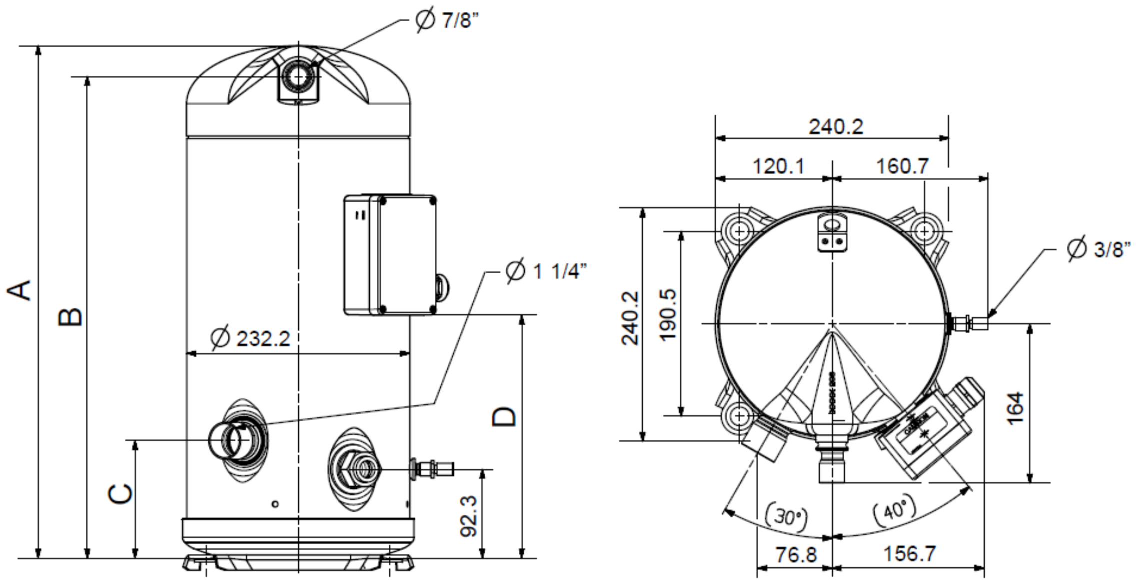
Compressor model	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)	Ø G	Ø H
ZR24KRE & ZR28KRE	364.1	338.5	202.9	69.6	43.7	244.5	1/2"	3/4"
ZR36KRE	386.7	361.1	222.8	75.3	49.4	264.4	1/2"	3/4"
ZR42KRE	400.4	374.9	235.5	75.3	49.4	277.1	1/2"	3/4"
ZR48KRE	417.4	391.9	252.5	75.3	49.4	294.1	1/2"	7/8"

Figure 1: Dimensions for models ZR24KRE to ZR48KRE



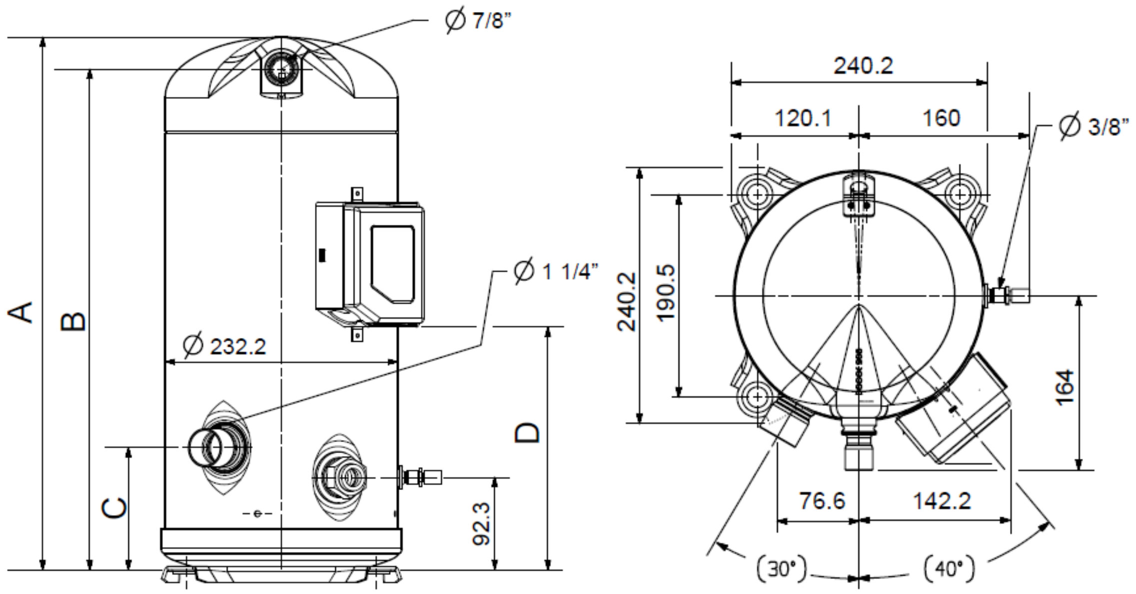
Compressor model	A (mm)	B (mm)	Ø C
ZR61KRE to ZR72KRE	437.8	409.6	1/2"
ZR81KRE & ZR92KRE	443.2	413.7	3/4"

Figure 2: Dimensions for models ZR61KRE to ZR92KRE



Compressor model	A (mm)	B (mm)	C (mm)	D (mm)
ZR108KRE to ZR144KRE	533.2	501.1	122.1	252.7
ZR160KRE & ZR190KRE	551.5	519.5	140.4	271

Figure 3: Dimensions for models ZR108KRE to ZR190KRE BOM411



Compressor model	A (mm)	B (mm)	C (mm)	D (mm)
ZR108KRE to ZR144KRE	533.2	501.1	122.1	242.8
ZR160KRE & ZR190KRE	551.5	519.5	140.4	261.2

Figure 4: Dimensions for models ZR108KRE to ZR190KRE BOM455

3 Installation

WARNING
High pressure! Injury to skin and eyes possible! Be careful when opening connections on a pressurized item.

3.1 Compressor handling

3.1.1 Transport and storage

WARNING
Risk of collapse! Personal injuries! Move compressors only with appropriate mechanical or handling equipment according to weight. Keep in the upright position. Respect stacking loads according to **Figure 5**. Check the tilting stability and if needed take action to ensure the stability of the stacked loads. Keep the packaging dry at all times.

Respect the maximum number of identical packages which may be stacked on one another, where "n" is the limiting number:

- **Transport: n = 1**
- **Storage: n = 2**

Figure 5: Maximum stacking loads for transport and storage

The compressor tilt angle should not be more than 30° during transport and handling. This will prevent oil from exiting through the suction stub. A tilt angle of maximum 45° is allowed for a very short time. Tilting the compressor more than 45° might affect its lubrication at start-up.

***NOTE*: The compressor is pre-charged with dry air to avoid any moisture contamination.**

3.1.2 Positioning and securing

IMPORTANT
Handling damage! Compressor malfunction! Only use the lifting eyes whenever the compressor requires positioning. Using discharge or suction connections for lifting may cause damage or leaks.

The compressor should be kept vertical during handling.

The discharge connection plug should be removed first before pulling the suction connection plug to allow the dry air pressure inside the compressor to escape. Pulling the plugs in this sequence prevents oil mist from coating the suction tube making brazing difficult. The copper-coated steel suction tube should be cleaned before brazing.

The plugs must be removed as late as possible before brazing so that the air humidity does not affect the oil characteristics.

For models ZR108KRE to ZR190KRE, as oil might spill out of the suction connection located low on the shell, the suction connection plug must be left in place until the compressor is set into the unit.

No object, eg, a swaging tool should be inserted deeper than 51 mm into the suction tube as it might damage the suction screen and motor.

3.1.3 Installation location

Ensure the compressors are installed on a solid level base. For single compressor applications, the compressor tilt angle during operation should not exceed 15° to allow adequate lubrication. For multiple compressor parallel configurations, the compressors must be positioned completely vertically on a totally horizontal surface or rail.

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3.2 Mounting parts

A kit of vibration absorber grommets can be ordered with each compressor. They dampen the start-up surge of the compressor and minimise sound and vibration transmission to the compressor base during operation. The metal sleeve inside is a guide designed to hold the grommet in place. It is not designed as a load-bearing member, and application of excessive torque to the bolts can crush the sleeve. Its inner diameter is approximately 8.5 mm to fit, eg, an M8 screw. The mounting torque should be 13 ± 1 Nm. It is critically important for the grommet not to be compressed.

If the compressors are mounted in tandem or used in parallel, then the hard mountings (bolt M9 5/16") are recommended. The mounting torque should be 27 ± 1 Nm.

See Emerson spare parts software for references.

Mounting parts: ZR24KRE to ZR190KRE - Soft mountings

Alternative mounting parts for ZR24KRE to ZR190KRE – Hard mountings

Figure 6: Mounting parts

3.3 Brazing procedure

WARNING
High temperature! Burning! Proceed with caution when brazing system components. Do not touch the compressor until it has cooled down. Ensure that other materials in the area of the compressor do not come into contact with it.

CAUTION
Blockage! Compressor breakdown! Maintain a flow of oxygen-free nitrogen through the system at very low pressure during brazing. Nitrogen displaces the air and prevents the formation of copper oxides in the system. If allowed to form, the copper oxide material can later be swept through the system and block screens such as those protecting capillary tubes, thermal expansion valves, and accumulator oil return holes.
Contamination or moisture! Bearing failure! Do not remove the plugs until the compressor is set into the unit. This minimises any entry of contaminants and moisture.

3.3.1 General brazing procedure

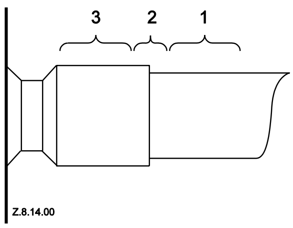


Figure 7: Brazing areas

Copeland scroll compressors have copper-plated steel suction and discharge stub tubes. These stub tubes are far more robust and less prone to leaks than copper tubes. Due to the different thermal properties of steel and copper, brazing procedures should be carried out in an appropriate manner.

Refer to **Figure 7** and the procedure below for the brazing of the stub tube connections of a scroll compressor.

- The copper-coated steel tubes on scroll compressors can be brazed in approximately the same manner as any copper tube.

- Recommended brazing materials: any silfos material is recommended, preferably with a minimum of 5 % silver. However, 0 % silver is acceptable.
- Be sure tube fitting inner diameter and tube outer diameter are clean prior to assembly.
- Using a double-tipped torch, apply heat in area 1.
- As the tube approaches brazing temperature, move the torch flame to area 2.
- Heat area 2 until braze temperature is attained, moving the torch up and down and rotating around the tube as necessary to heat the tube evenly. Add braze material to the joint while moving the torch around the joint to flow braze material around the circumference.
- After the braze material flows around the joint, move the torch to heat area 3. This will draw the braze material down into the joint. The time spent heating area 3 should be minimal.
- As with any brazed joint, overheating may be detrimental to the final result.

NOTE: **Since the discharge stub contains a check valve, care must be taken not to overheat it to prevent brazing material from flowing into it.**

*3.3.2 Brazing procedures for ZR*KRE compressors in parallel applications*

Only compressor models officially approved by Emerson in the qualified configuration may be used for parallel applications. For ZR*KRE compressors in parallel applications with passive oil management, additional precautions shall be taken before brazing the oil and gas equalization ports. The sequence shall be as follows:

First, install the compressors on the base frame and tilt the assembly so that oil will not be lost when opening the cap. The gas and oil equalization line assembly should be ready for brazing at this point. For new compressors, release the protective gas charge: the rubber plug from the discharge port of the compressor has to be removed first, then the rubber plugs from the oil port.

Most probably the oil port will be coated with some oil. It is mandatory to clean out the oil before brazing. If the inner surface is contaminated with oil the brazing material will not adhere to the surface and the joint will fail, generating leakage. The oil should be carefully wiped out with industrial absorption paper. Industrial solvents on a clean cloth can be used too but only with great care. Note that emery cloth will not remove the oil.

It is possible that the oil cannot be completely cleaned out. In this case additional measures should be taken. For instance, if a connection is coated with flux then the residual oil will be removed when brazing due to the applied heat.

If an active oil level control is to be used, eg, Alco Controls OM* Traxoil, please refer to the product documentation when brazing the connection adaptor.

3.4 Shut-off valves and adaptors

CAUTION
Leaking system! System breakdown! It is strongly recommended to periodically re-torque all pipe and fixing connections to the original setting after the system has been put into operation.

Copeland scroll ZR*KRE compressors are delivered with a discharge check valve fitted inside the discharge port and stub tubes as standard.

Brazing connections can be converted to Rotalock by means of adaptors. Rotalock shut-off valves are available for the suction as well as discharge sides.

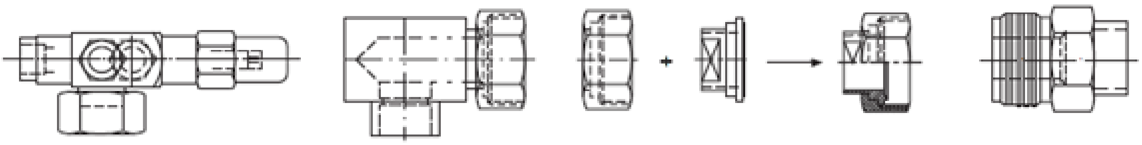


Figure 8: Shut-off valves and connection adapters

Torque settings from system valves and adaptors with Rotalock connections might decrease significantly after some time of operation. Recurring temperature changes, vibration and other influencing parameter could lead to expansion and contraction of the metal material and a relaxation of the gaskets. Periodically retorquing the Rotalock connections to the original settings is recommended.

However, pipe plugs with sealant applied at the factory are not to be retorqued or seal broken, as this may create a leak path in the cured sealant.

Refer to **Appendix 1** for proper tightening torques.

NOTE: More information about adaptors and shut-off valves can be found in the Emerson spare parts software, available at www.climate.emerson.com/en-gb/tools-resources.

3.5 Pressure safety controls

3.5.1 High-pressure protection

Applicable regulations and standards, for example EN 378-2, shall be followed to apply appropriate control to ensure that the pressure never exceeds the maximum pressure limit.

High-pressure protection is required to stop the compressor operating outside the allowable pressure limit. The high-pressure control must be installed correctly, meaning no service valve between the compressor and the pressure protection is allowed.

The high-pressure cut-out setting shall be determined according to the applicable standard, the type of system, the refrigerant and the maximum allowable pressure PS.

3.5.2 Low-pressure protection

CAUTION
Operation outside the application envelope! Compressor breakdown! A low-pressure protection shall be fitted in the suction line to stop the compressor when it operates outside the envelope limits.

Applicable regulations and standards shall be followed to apply appropriate control to ensure that the pressure is always above the required minimum limit.

Low-pressure protection is required to stop the compressor operating outside the published envelope limits. The low-pressure control must be installed correctly into the suction line, meaning no service valve between the compressor and the pressure protection is allowed.

The minimum cut-out setting shall be determined according to the refrigerant and to the allowed operation envelope – see Select software at www.climate.emerson.com/en-gb.

3.6 Crankcase heater

CAUTION
Overheating and burnout! Compressor damage! Never apply power to the crankcase heater in free air, before the crankcase heater is installed on the compressor or when it is not in complete contact with the compressor shell.

IMPORTANT
Oil dilution! Bearing malfunction! Turn the crankcase heater on 12 hours before starting the compressor.

A crankcase heater is used to prevent refrigerant migrating into the shell during standstill periods. Due to the Copeland scroll's inherent ability to handle liquid refrigerant in flooded conditions a crankcase heater is not required when the system charge does not exceed the charge limits indicated in **Table 4**.

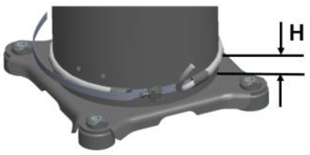
Compressor model	Refrigerant charge limit (kg)	Crankcase heater	
		Position	Height (mm])
ZR24KRE to ZR48KRE	3.6		5 - 12
ZR61KRE to ZR92KRE	4.5		9.5 - 41
ZR108KRE to ZR144KRE	7.3		14 - 24
ZR160KRE to ZR190KRE	8.2		13 - 18

Table 4: Refrigerant charge limits & crankcase heater position

The initial start-up in the field is a very critical period for any compressor because all load-bearing surfaces are new and require a short break-in period to carry high loads under adverse conditions. **The crankcase heater must be turned on a minimum of 12 hours prior to starting the compressor.** This will prevent oil dilution and bearing stress on initial start-up. **The crankcase heater must remain energized during compressor off cycles.**

NOTE: **Please refer to the Spare Parts list available at www.climate.emerson.com/en-gb/tools-resources to select the correct crankcase heater model.**

Caution: Crankcase heaters must be properly grounded!

For installation, the manufacturer/installer shall follow the recommendations below.

Assembly instructions

- Select the appropriate model according to compressor size and required wattage.
- Check the compressor application guidelines for crankcase heater connection and operation.
- Position the crankcase heater between the lower cover and the lower bearing weld projection **(Fig. 9)**.
- Fit the heater horizontally around the crankcase, ensuring that it is in close contact with the compressor housing along the entire length.
- Avoid having the heating portion of the heater in contact with any weld projection **(Fig.10 & 11)**.
- Avoid having the heater assembly inclined **(Fig. 12)**.
- Close the lock and tighten the screw, torque: 2-3 Nm.
- The excess clamp bracket may be trimmed. Sharp edges must not come into contact with wires.

The presence of the heater shall be made evident by the posting of caution signs or markings at appropriate locations.

Figure 9

Figure 10

Figure 11

Figure 12

Electrical connection

- Connect the crankcase heater according to the compressor application guidelines.
- The crankcase heater must be connected only to its rated voltage.
- The metal braid of the heater must be connected to a suitable earthing terminal.
- Check the resistance according to the technical data.
- Perform an insulation test before start-up.

Electrical security and safety measures are to be provided on site.

3.7 Soft starter and single-phase compressor start assists

Copeland scroll can generally be operated with soft starters. Soft starter versions and sizes should be selected according to the soft starter manufacturer's recommendations, taking into consideration the compressor amps. Typically, the ramp-up time should not exceed 1 second.

Due to the inherent design of the Copeland scroll, the internal compression components start unloaded, even if system pressures are not balanced. Since the compressor internal pressures are balanced at start-up, low voltage starting characteristics are excellent, and starting components are normally not required.

However, for extreme electrical conditions such as weak power supplies, single-phase start-assist components are available on request.

3.8 Discharge gas temperature protection

CAUTION
Inadequate lubrication! Scroll set damage! All ZR*KRE compressors must be equipped with a discharge gas temperature protection.

A good system control shall prevent the system from operating outside the published operating envelope and acceptable superheat range, whatever the climatic conditions and the capacity demand. However, under some extreme operating conditions such as loss of charge or improper control operation, the internal discharge gas temperature reached can cause compressor damage. In order to guarantee positive compressor protection, discharge gas temperature protection is required for any application with Copeland brand compressors.

The maximum discharge gas temperature is 130 °C for all ZR*KRE models.

Discharge gas temperature protection is the "fall-back" for failure of the system control. It is essential that proper control of both the evaporating and condensing pressures and the superheat is maintained and has the ability to cope with all likely conditions and high loads. Reliance on protectors will cause inadequate system performance and short cycling.

NOTE: **The maximum discharge gas temperatures indicated in this chapter are valid for safe operation within the approved application envelope. The discharge line thermostat has the function of a compressor safety device; it is not designed to control the operating envelope. For compressor envelope control, an additional control device or regulation must be used.**

3.8.1 Excessive discharge gas temperatures

A few of the possible consequences of excessive discharge gas temperatures are listed below:

- Since the oil circulates in the system with the refrigerant, it is subjected to high discharge gas temperatures. If the discharge gas temperature becomes too high, the so-called "cooking" effect will occur (heating of oil under exclusion of air). Carbon deposits can form at points of high temperature, for example on the valves, oil channels, oil filters, etc. The oil lubricity will be reduced and a progressive wear process will occur which will prematurely damage the compressor.
- The stability of the refrigerant can also be affected, particularly if traces of contaminant are present.

The problems listed under the first 2 points frequently occur simultaneously, particularly since the chemical reaction speed approximately doubles with every 10 K temperature rise. This directly leads to chemical reactions of the oil with the refrigerant and the compounds extracted from sealants and insulation material. As a consequence, contaminants of various types, among them acids, will form inside the system.

3.8.2 Internal thermo-disc

ZR24KRE to ZR81KRE compressors have an internal thermo-disc discharge gas temperature protection. This thermo-disc opens a gas passage from the discharge port to the suction side near the motor protector when the discharged gas reaches a critical temperature. The hot gas then causes the motor protector to trip shutting down the compressor. It opens at 146 °C ± 4 K and closes at 91 °C ± 7 K.

3.8.3 Advanced Scroll Temperature Protection (ASTP)

ZR108KRE to ZR190KRE compressors are equipped with an Advanced Scroll Temperature Protection (ASTP). ASTP is a temperature sensitive thermo-disc that acts to protect the compressor from discharge gas overheating. Once the discharge gas reaches a critical temperature, the ASTP feature will cause the scrolls to separate and stop pumping although the motor continues to run. After running for some time without pumping gas, the motor protector will open.

NOTE: **ASTP was developed to protect the compressor, not for system envelope control.**

If the system engineer wants to prevent ASTP trips and to limit the maximum compressor discharge temperature to a lower value, a discharge sensor can be used. The recommended setpoint is 130 °C. This value should be determined and verified according to the application. Any protector attached to the discharge line must be well insulated with good quality material that will last for the unit lifetime.

A label has been added above the terminal box to identify compressors with Advanced Scroll Temperature Protection – see **Figure 13** below.

Figure 13: Advanced Scroll Temperature Protection (ASTP)

***NOTE:* Depending on the heat build-up in the compressor, it may take more than one hour for the ASTP and motor protector to reset.**

3.8.4 Discharge line thermostat

ZR92KRE compressors have no internal discharge gas temperature protection. Therefore, an external discharge line thermostat must be installed.

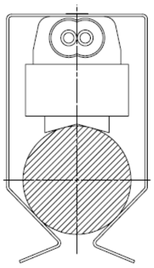


Figure 14: Discharge line thermostat with clamp

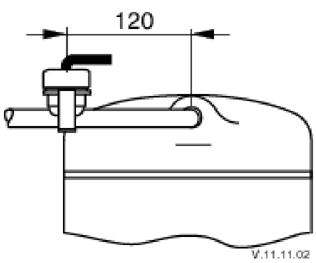
<u>Technical data of the discharge line thermostat</u>

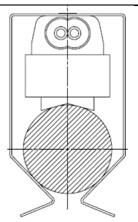
Voltage		120 - 240 V AC
Maximum amperage		5 A / 240 V
Operating temperatures	Open	130 °C (± 4 K)
	Close	101 °C (± 8 K)
Wire insulation maximum temperature		150 °C
Clips for tube		Ø 15.8 - 19.1 mm (5/8+3/4")

Table 5: Discharge line thermostat technical data

To ensure proper functioning and to avoid false readings, the discharge line thermostat must be installed and insulated according to the procedure and recommendations hereunder.

<u>Assembly of the discharge line thermostat</u>

▪ Install the discharge line thermostat on the discharge tube 120 mm from top cap.	

▪ Snap the retainer clip over the tube and onto the thermostat. ▪ The thermostat should be placed on the discharge tube so that its body is in upward position on a horizontal tube installation. ▪ Ensure that the thermostat is not tilted.	
▪ The wire must not be in contact with the top cap of the compressor or the discharge tube. Care should be taken to route wires so that they do not come into contact with sharp objects.	
▪ To avoid any impact on tripping temperature by the ambient, the discharge line thermostat must be insulated. ▪ Wrap thermal insulation around the pipe left and right of the thermostat and secure it with plastic straps.	
▪ Wrap a second layer of insulation around the first one and around the thermostat, secure it with plastic straps.	

3.9 Internal pressure relief valve

ZR24KRE to ZR92KRE compressors are equipped with an internal pressure relief valve. It opens at a differential pressure of 28 bar ± 3 bar between high- and low-pressure sides. A high-pressure protection must be provided by the system manufacturer/installer for each system and according to EN 378-2, clause 6.2.6.2. The IPR valve is a safety device, not a high-pressure switch. It is not designed for repeated operation and there is no guarantee that it will reset correctly if it does have repeated operation.

3.10 Discharge check valve

All ZR*KRE compressors contain an internal check valve on the discharge connection. The discharge check valve prevents the high-side high pressure discharge gas from flowing rapidly back through the compressor after shutdown. This check valve is not designed to be used with recycling pumpdown because it is not entirely leak-proof.

3.11 Filter screens

CAUTION
Screen blocking! Compressor breakdown! Use screens with at least 0.6 mm openings.

The use of screens finer than 30 x 30 mesh (0.6 mm openings) anywhere in the system should be avoided with these compressors. Field experience has shown that finer mesh screens used to protect thermal expansion valves, capillary tubes, or accumulators can become temporarily or permanently plugged with normal system debris and block the flow of either oil or refrigerant to the compressor. Such blockage can result in compressor failure.

3.12 Mufflers

Gas flow through scroll compressors is continuous with relatively low pulsation. External mufflers may not necessarily be required on Copeland scroll compressors. Due to system variability, individual tests should be conducted by the system manufacturer to verify acceptable levels of sound and vibration.

If adequate attenuation is not achieved, use a muffler with a larger cross-sectional area to inlet area ratio. A ratio of 20:1 to 30:1 is recommended. A hollow shell muffler will work quite well. Locate the muffler at minimum 15 cm to maximum 45 cm from the compressor for the most effective operation. The farther the muffler is placed from the compressor within these ranges, the more effective. Choose a muffler with a length of 10 to 15 cm.

3.13 Sound and vibration

Vibrations during compressor operation can cause cracks which could lead to refrigerant leakage. This situation must be avoided by the system manufacturer/installer. Therefore, proper pipe design must be achieved when connecting a scroll compressor to a system.

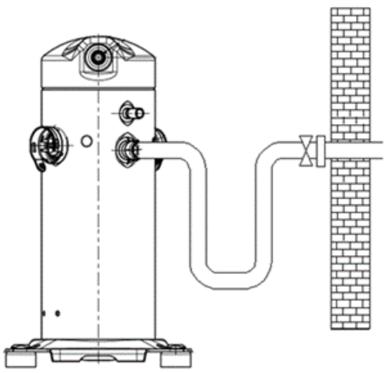


Figure 15: Example of suction tube design

A scroll compressor makes both a rocking and twisting motion and enough flexibility must be provided in the pipe-lines to allow starting, stopping and steady state running of the compressor without transmitting excessive stress into any line attached to the unit. In a split system, the most important goal is to ensure minimal vibration in all directions to avoid transmitting vibrations to the structure to which the lines are fastened.

Under some conditions, the Copeland scroll has a normal starting rotational motion that can transmit a transient noise along the lines. This may be particularly pronounced in compressors using a three-phase motor due to their inherently higher starting torque. This phenomenon, like the one described previously, can easily be avoided by using standard line isolation techniques.

The sound level of a system is the result of design, quality and application. Scroll compressors sound power levels generally increase with the compressor model capacity and the condition pressure ratio.

3.14 Compressor oil return, oil balancing and floodback tests

CAUTION
Inadequate lubrication! Bearing and moving parts destruction! Ensure adequate oil return from the system into the compressor at any time. No liquid refrigerant return to the compressor. Liquid refrigerant dilutes the oil, could wash the oil off the bearings and moving parts and could lead to overheating and compressor failure.

System piping must be carefully designed to ensure sufficient refrigerant gas velocity, so that oil returns to the compressor at all times and conditions. Individual piping diameter calculation depends on the refrigerant properties, pressure level, mass flow, or density.

Once a new system design is set and assembled, a functional test and verification is required. The functional test includes a qualification for the general system oil return and a refrigerant flood-back test. Systems with multiple compressor applications (two, three, or more) require additional oil balancing qualification between the parallel compressors.

A sample compressor equipped with an external oil sight tube can be ordered from Emerson for lab testing.

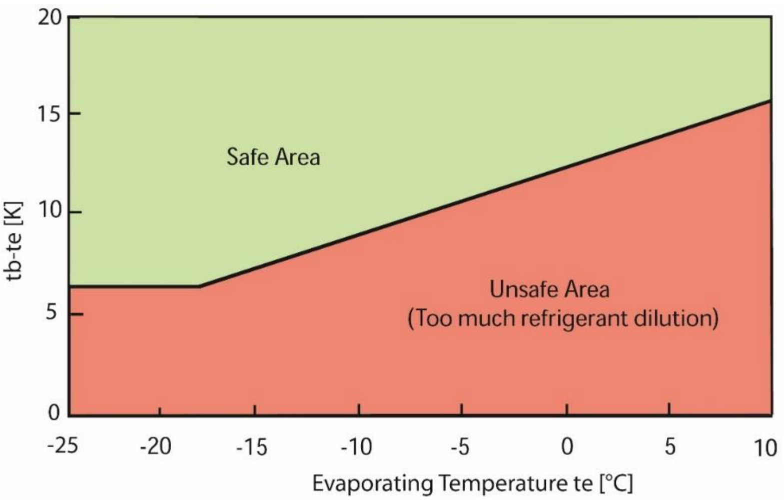
During the tests, records of the evaporating temperature and the bottom shell temperature shall be taken with a high sampling rate. The liquid level in the sight tube has to be observed and noted. If the system is reversible below tests should be conducted in both operation modes. System engineers should review the system design and operation to identify the critical conditions and to check oil return, oil balancing and liquid flood-back. Typically the following situations should be considered:

- In single compressor systems to check oil return, testing conditions shall be at minimum mass flow and minimum density of suction gas in continuous and frequent start-stop-cycling.
- In multiple compressor systems to check oil return and oil balancing in the tandem or trio, testing conditions shall be at the corner points of the system application envelope in continuous and frequent start-stop-cycling.
- In all systems to test liquid flood-back, all possible transient operation conditions in the system should be checked, eg, compressor frequent start/stop, compressor start after long off with

migration, defrost, in reversible systems switching between the operation modes, load changes, fans or pumps cycling at low load and more. To evaluate the risk of liquid flood-back please refer to the oil dilution chart in **Figure 16**. Liquid level and superheat at compressor inlet have to be checked.

During the entire oil return or oil balance testing and under all tested conditions, records of the evaporating temperatures and the bottom shell temperatures shall be taken. Testing conditions shall include defrost, reversible operation and varying loads.

The bottom shell temperature together with the evaporating temperature gives an indication whether liquid refrigerant is returning or diluted in the compressor oil sump. The compressor sump temperature must remain in the (green) safe area, as shown in the oil dilution chart, see **Figure 16** below. In case of operation in the (red) unsafe area, adjustments are required in order to modify the system design, refrigerant charge or superheat setting of the expansion device(s). The bottom shell temperature should be measured accurately. The thermo-probe must be positioned on the opposite side of the sight glass or at an angle of 90° clockwise from the suction inlet with view on the top.



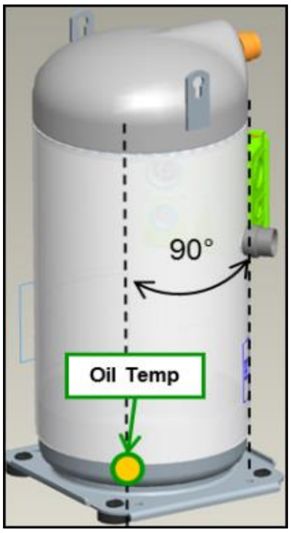


Figure 16: Oil dilution chart (tb = bottom shell temp.; te = evaporating temp.) and oil temperature

3.15 Suction line accumulator

Due to Copeland scrolls inherent ability to handle liquid refrigerant, for example in flooded start and defrost cycle operation, an accumulator is not required in most systems. To determine if a suction line accumulator is required, the system designer must check this with an appropriate test scenario – see **section 3.14 "Compressor oil return, oil balancing and floodback tests"**.

If an accumulator is used, the oil-return orifice should be from 1 to 1.4 mm in diameter for all ZR*KRE models based on compressor size and compressor flood-back results. To protect this small orifice from plugging with system debris a large-area protective screen no finer than 30 x 30 mesh (0.6 mm openings) is required. Tests have shown that a small screen with a fine mesh can easily become plugged causing oil starvation to the compressor bearings. The size of the accumulator depends upon the operating range of the system and the amount of sub-cooling and subsequent head pressure allowed by the refrigerant control. For the correct selection and size of the suction line accumulator, refer to the manufacturer's specifications.

4 Electrical connection

4.1 General recommendations

The compressor terminal box has a wiring diagram on the inside of its cover. Before connecting the compressor, ensure the supply voltage, the phases and the frequency match the nameplate data.

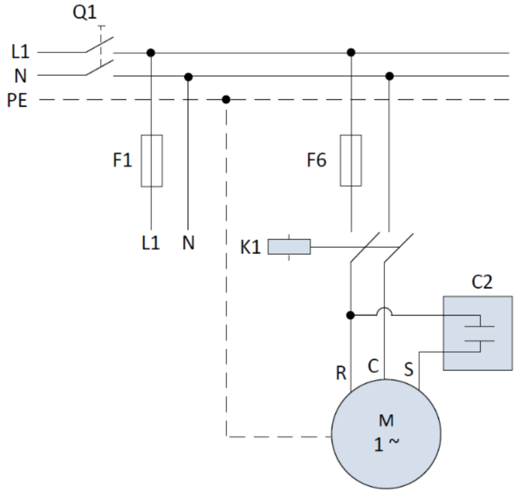
4.2 Electrical installation

WARNING
Conductor cables! Electrical shock! Shut off power supply before undertaking any task on electrical equipment.

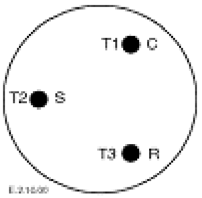
The recommended wiring diagrams are shown in figures hereunder.

Single-phase (PF*) compressors:

Power circuit

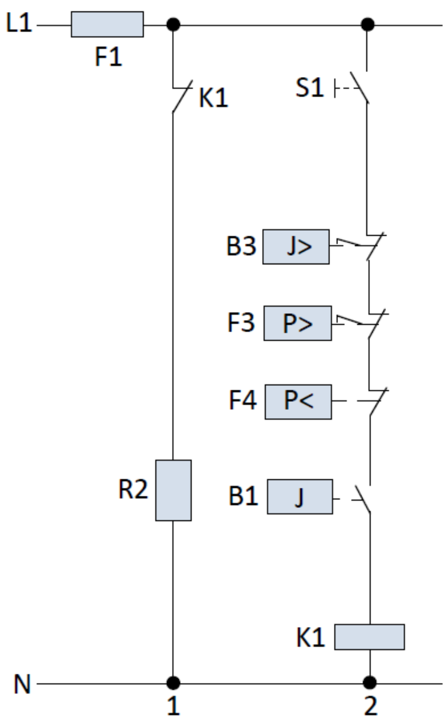


Motor terminal connections



Single-phase compressors are connected to the Common (C), Start (S) and Run (R) connections

Control circuit



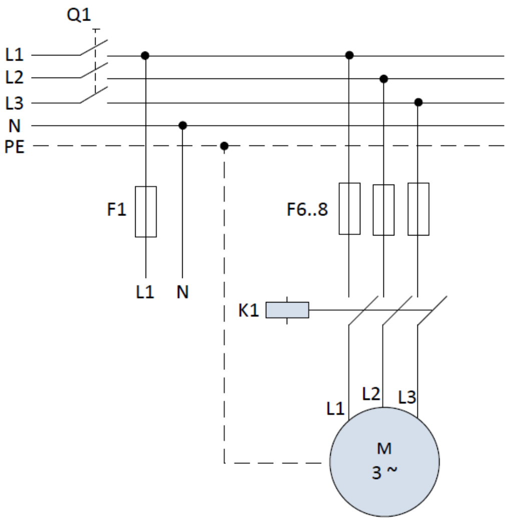
Legend

B1 .... Room thermostat
B3 .... Discharge gas thermostat
C2 .... Run capacitor
F1 .... Fuse
F3 .... HP switch
F4 .... LP switch
K1 ....Contactor
R2 ....Crankcase heater
S1 ....Auxiliary switch

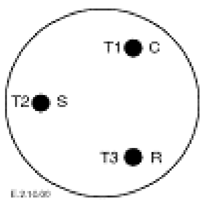
Figure 17

Three-phase compressors (TF*) with internal motor protection:

Power circuit

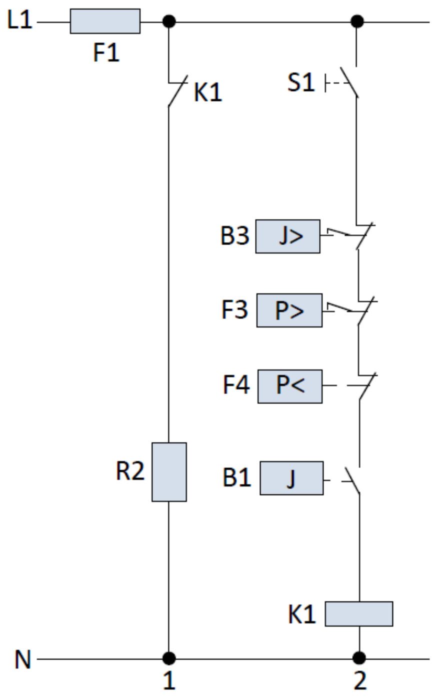


Motor terminal connections



Three-phase compressors are connected to the T1, T2 and T3 connections

Control circuit



Legend

B1 .... Room thermostat
B3 .... Discharge gas thermostat
F1 .... Fuse
F3 .... HP switch
F4 .... LP switch
K1 ....Contactor
R2 ....Crankcase heater
S1 ....Auxiliary switch

Figure 18

4.3 Terminal box

CAUTION

Mechanical stress or shock! Overheating! Terminal Fusite damage! Mechanical stress and shocks to the Fusite must be avoided as they could damage the glass and/or ceramic. This might result in hermetic failure or loss of terminal performance. Precautions are required to prevent striking or bending of pins.
Ensure correct connection of cables to the compressor terminal Fusite to avoid local overheating.

Cable glands have an influence on the protection class of the terminal box. Emerson strongly recommends to use appropriate cable glands according to EN 50262 in order to reach the rated protection class. Examples of correct electrical installations are shown in **Figures 19-21** below.

4.3.1 Terminal box – IP21

The standard terminal box is IP21 for all ZR24KRE to ZR190KRE BOM455 compressors.

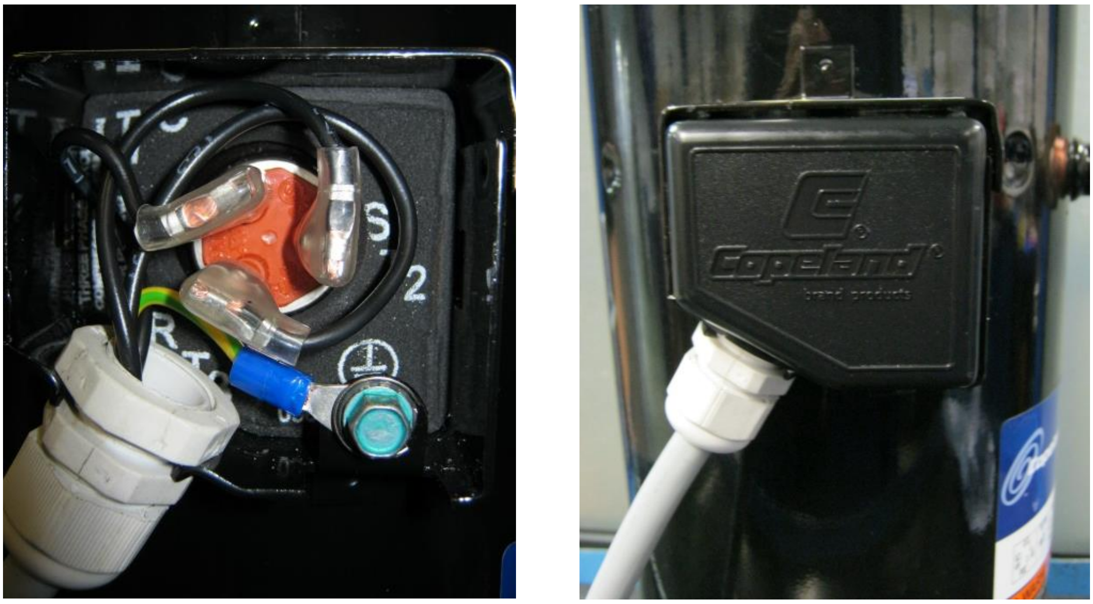


Figure 19: Correct electrical installation with cable glands for IP21 T-box, models ZR24KRE to ZR92KRE

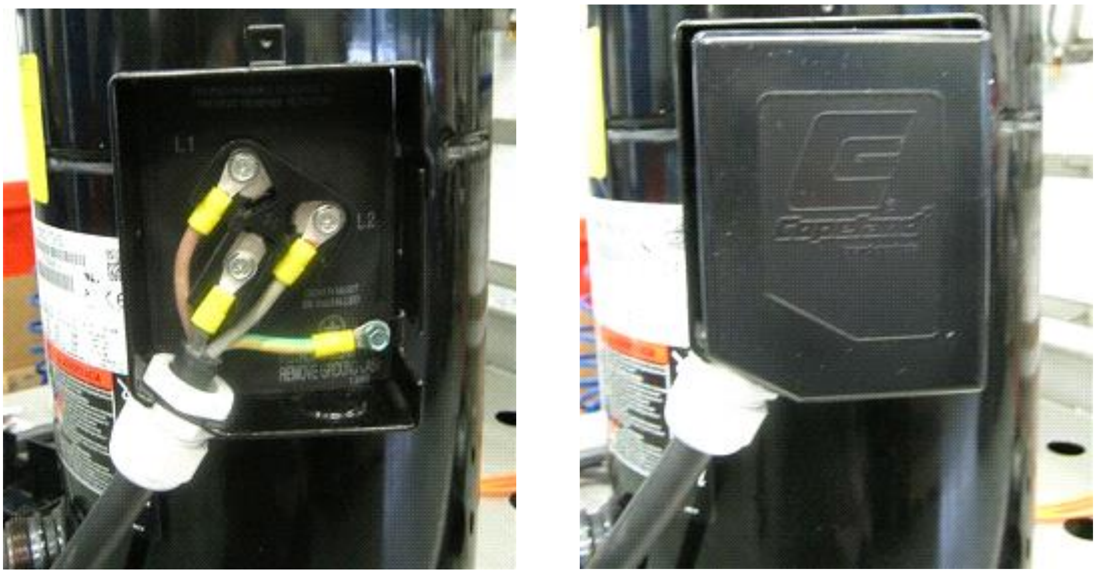
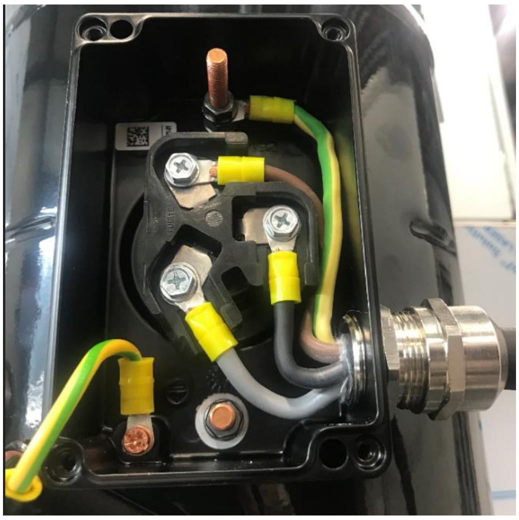


Figure 20: Correct electrical installation with cable glands for IP21 T-box, models ZR108KRE to ZR190KRE

4.3.2 Terminal box – Metal IP65

Compressor models ZR108KRE to ZR190KRE with BOM 411 have a metal terminal box IP65.

The first two nuts already installed on the Peko bolts shall not be removed, as they will ensure a good tightness of the terminal box assembly. Make sure to assemble the ground connection of the Peko bolt with a torque of 4 - 4.4 Nm and the ground connection between the cover and the body of the terminal box with a torque of 1.8 - 2 Nm.



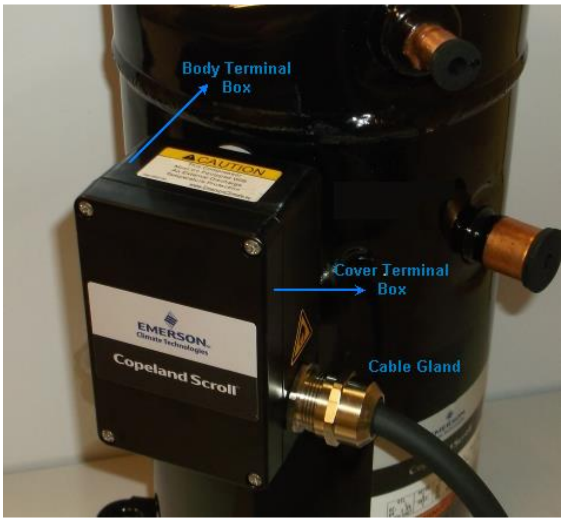


Figure 21: Correct electrical installation for IP65 T-box, models ZR108KRE to ZR190KRE BOM 411

Make sure to assemble the cable gland M25 with a torque of 9.8 - 10 Nm. The cable gland is designed for cable diameters of 10 to 17 mm – see **Figure 21**. The degree of protection (IP) will be safeguarded only if sealing and cable glands are properly assembled. Only run the compressor with permanently wired cables. The system manufacturer/installer shall provide the required strain relief.

Finally, close the cover of the terminal box applying a torque of 1.8 - 2 Nm. The degree of protection (IP) will be safeguarded only if the cover is properly assembled.

4.4 Motor insulation

The motor insulation material is class "B" (T**F***) for all ZR*KRE models within maximum allowable operating temperatures according to IEC 34-1 or DIN 57530.

4.5 Motor protection

Independently from the internal motor protection, fuses must be installed before the compressor. The selection of fuses has to be made according to EN 60269-1 or EN 60204-1 and compressor maximum operating current (MOC). Not installing fuses before the compressor or selecting inappropriate fuses may result in compressor failure.

Conventional inherent internal line break motor protection is provided for the complete range of ZR*KRE compressors.

4.6 High-potential testing

WARNING
Conductor cables! Electrical shock! Shut off power supply before high-potential testing.

CAUTION
Internal arcing! Motor destruction! Do not carry out high-voltage or insulation tests if the compressor housing is under vacuum.

Emerson subjects all scroll compressors to a high-voltage test after final assembly. Each motor phase winding is tested according to EN 60034-1 at a differential voltage of 1000 V plus twice the nominal voltage.

Since high-voltage tests lead to premature ageing of the winding insulation, further additional tests of that nature are not recommended. However, if it has to be done for any reason, it shall not be made with the compressor charged with refrigerant. Carry out the test with a lower voltage, as described above. Disconnect all electronic devices, eg, motor protection module, fan speed control, etc prior to testing.

5 Start-up & operation

WARNING
Diesel effect! Compressor destruction! The mixture of air and oil at high temperature can lead to an explosion. Avoid operating with air.

IMPORTANT
Oil dilution! Bearing malfunction! It is important to ensure that new compressors are not subjected to liquid abuse. It is mandatory to have a crankcase heater installed if the refrigerant charge exceeds 3.6 kg for compressors ZR24KRE to ZR48KRE, 4.5 kg for compressors ZR61KRE to ZR92KRE, 7.3 kg for compressors ZR108KRE to ZR144KRE and 8.2 kg for compressors ZR160KRE & ZR190KRE. Turn the crankcase heater on 12 hours before starting the compressor.

5.1 Strength pressure test

WARNING
High pressure! Personal injuries! Consider personal safety requirements and refer to test pressures prior to test.

IMPORTANT
System contamination! Bearing malfunction! Use only dry nitrogen for pressure testing. DO NOT USE other industrial gases.

The compressor has been strength-pressure tested in the Emerson factory according to EN 14276-1 and EN 60335-2-34 standards. Therefore, it is not necessary for the manufacturer/installer to strength-pressure test the compressor again on the assembly/system.

5.2 Compressor tightness test

WARNING
High pressure! Personal injuries! Consider personal safety requirements and refer to test pressures prior to test.

IMPORTANT
System contamination! Bearing malfunction! Use only dry inert gases (for example nitrogen) for leak testing. DO NOT USE other industrial gases.

The compressor has been leak-pressure tested in the Emerson factory.

All compressors get a factory holding charge of dry air (about 1 to 2.5 bar, relative pressure). An intact holding charge serves as a proof of quality against penetrating moisture.

When removing plugs from the compressor, the plugs may pop out due to pressure and oil can spurt.

Any later modification to compressor connections can have an impact on the compressor tightness. Always leak-pressure test the compressor after opening or modifying the connections.

Never add refrigerant to the test gas (as leak indicator).

5.3 System evacuation

Before the installation is put into commission, it has to be evacuated with a vacuum pump. The installation should be evacuated down to an absolute pressure of 3 mbar. Proper evacuation reduces residual moisture to 50 ppm. During the initial procedure, suction and discharge shut-off valves on the compressor remain closed. The installation of adequately sized access valves at the furthest point from the compressor in the suction and liquid lines is advisable. The pressure must be measured using a vacuum pressure gauge on the access valves and not on the vacuum pump; this serves to avoid incorrect measurements resulting from the pressure gradient along the connecting lines to the pump.

Evacuating the system only on the suction side of a scroll compressor can occasionally result in a temporary no-start condition for the compressor. The reason for this is that the floating seal could axially seal with the scroll set, with the higher pressure on the floating seal. Consequently, until the pressures equalise, the floating seal and scroll set can be held tightly together.

The highest demands are placed on the leak-proof design of the installation and on the leak testing methods – please refer to EN 378.

5.4 Preliminary checks – Pre-starting

Discuss details of the installation with the installer. If possible, obtain drawings, wiring diagrams, etc. It is ideal to use a check-list but always check the following:

- Visual check of the electrics, wiring, fuses etc.
- Visual check of the plant for leaks, loose fittings such as TXV bulbs etc.
- Compressor oil level
- Calibration of HP & LP switches and any pressure actuated valves
- Check setting and operation of all safety features and protection devices
- All valves in the correct running position
- Pressure and compound gauges fitted
- Correctly charged with refrigerant
- Compressor electrical isolator location & position

5.5 Charging procedure

CAUTION
Low suction pressure operation! Compressor damage! Do not operate with a restricted suction. Do not operate with the low-pressure limiter bridged. Do not operate compressor at pressures that are not allowed by the operating envelope. Allowing the suction pressure to drop below the envelope limit for more than a few seconds may overheat scrolls and cause early drive bearing and moving parts damage.

Prior to charging or re-charging, the system must be leak- and pressure-tested with appropriate purging gas.

Ensure that the refrigerant system is grounded prior to charging with refrigerant.

The system shall be liquid-charged through the liquid-receiver shut-off valve or through a valve in the liquid line. The use of a filter drier in the charging line is highly recommended. Systems shall be liquid-charged on both the high and low sides simultaneously to ensure a positive refrigerant pressure is present in the compressor before it runs. The majority of the charge shall be placed in the high side of the system to prevent bearing washout during first-time start on the assembly line.

Extreme care shall be taken not to overfill the refrigerant system.

5.6 Run-in time

Scroll compressors exhibit a slight decrease in input power during the initial running period. Published performance ratings are based on calorimeter testing which is carried out after run-in. Therefore, users should be aware that before the performance specified by EN 12900 is achieved the compressor needs to be run in. Recommended run-in times for ZR*KRE compressors to attain the published performance are 16 hours at the standard conditions.

5.7 Initial start-up

CAUTION
High discharge pressure operation! Compressor damage! Do not use compressor to test opening setpoint of high-pressure cut-out. Internal parts are susceptible to damage before they have had several hours of normal running in.

Liquid and high-pressure loads could be detrimental to new bearings. It is therefore important to ensure that new compressors are not subjected to liquid abuse and high-pressure run tests. It is not good practice to use the compressor to test the high-pressure switch function on the production line. The switch function can be tested with nitrogen prior to installation and wiring can be checked by disconnecting the high-pressure switch during the run test.

5.8 Rotation direction

Scroll compressors, like several other types of compressors, will only compress in one rotational direction. Direction of rotation is not an issue with single-phase compressors since they will always start and run in the proper direction. All other three-phase compressors will rotate in either direction depending upon phasing of the power. Since there is a 50-50 chance of connecting power in such a way as to cause rotation in the reverse direction, **it is important to include notices and instructions in appropriate locations on the equipment to ensure proper rotation direction when the system is installed and operated**.

Observing that suction pressure drops and discharge pressure rises when the compressor is energized allows verification of proper rotation direction. There is no negative impact on durability caused by operating three-phase Copeland scroll compressors in the reversed direction for a short period of time (under one hour) but oil may be lost. Oil loss can be prevented during reverse rotation if the tubing is routed at least 15 cm above the compressor. After several minutes of operation in reverse, the compressor's protection system will trip due to high motor temperature. The operator will notice a lack of cooling. However, if allowed to repeatedly restart and run in reverse without correcting the situation, the compressor will be permanently damaged.

All three-phase scroll compressors are identically wired internally. Therefore, once the correct phasing is determined for a specific system or installation, connecting properly phased power leads to the identified compressor terminals will ensure proper rotation direction.

5.9 Starting sound

During the very brief start-up, a clicking sound resulting from the initial contacting of the spirals is audible; it is normal. Due to the design of the Copeland scroll compressors, the internal compression components always start unloaded even if system pressures are not balanced. In addition, since internal compressor pressures are always balanced at start-up, low-voltage starting characteristics are excellent for Copeland scroll compressors.

5.10 Deep vacuum operation

CAUTION
Vacuum operation! Compressor damage! Copeland scroll compressors should never be used to evacuate refrigeration or air-conditioning systems. Operating scroll compressors in deep vacuum could damage internal motor parts and lead to unacceptable high temperatures in the compressor housing.

5.11 Shell temperature

During normal operation, the discharge gas as well as the compressor top shell and discharge line can reach temperatures up to the maximum discharge gas temperature of 130 °C – see **Chapter 3.8**. "Discharge gas temperature protection".

In a failure mode, the discharge gas temperatures can get even higher. Care must be taken to ensure that wiring or other materials that could be damaged by these temperatures do not touch the shell.

5.12 Pumpdown cycle

CAUTION
Vacuum operation! Compressor damage! Compressor operation outside the operating envelope is not allowed.

A pumpdown cycle to control refrigerant migration may have to be used for several reasons, for example when the compressor is located outdoors without any housing so that cold air blowing over the compressor makes the crankcase heater ineffective.

If a pumpdown cycle is used, a separate external check valve must be added. The scroll discharge check valve is designed to stop extended reverse rotation and prevent high-pressure gas from leaking rapidly into the low side after shut-off. The check valve might in some cases leak more than reciprocating compressor discharge reeds, normally used with pumpdown, causing the scroll compressor to recycle more frequently. Repeated short cycling of this nature can result in a low oil situation and consequent damage to the compressor. The hysteresis of the low-pressure control differential has to be reviewed since a relatively large volume of gas will re-expand from the high side of the compressor into the low side after shutdown.

NOTE: **For pressure control setting, never set the low-pressure limiter to shut off outside of the operating envelope. To prevent the compressor from running into problems during such faults as loss of charge or partial blockage, the low-pressure limiter shall not be set lower than the minimum suction pressure allowed by the operating envelope.**

5.13 Minimum run time

Emerson recommends a maximum of 10 starts per hour. There is no minimum off time because scroll compressors start unloaded, even if the system has unbalanced pressures. The most critical consideration is the minimum run time required to return oil to the compressor after start-up. To establish the minimum run time, a sample compressor equipped with an external oil sight glass is available from Emerson. The minimum on time becomes the time required for oil lost during compressor start-up to return to the compressor sump and to restore a minimal oil level that will ensure oil pick-up through the crankshaft. Cycling the compressor for a shorter period than this, for instance to maintain very tight temperature control, will result in progressive loss of oil and damage to the compressor.

5.14 Shut-off sound

Scroll compressors incorporate a device that minimizes reverse rotation. The residual momentary reversal of the scrolls at shut off will cause a clicking sound, but it is entirely normal and has no effect on compressor durability.

5.15 Supply frequency and voltage

There is no general release of standard Copeland Scroll compressors for use with variable speed AC drives. A number of considerations must be taken into account when applying Scroll compressors with variable speed, including system design, inverter selection, and operating envelopes at various conditions. Only frequencies from 50 to 60 Hz are acceptable. Operation outside this frequency range is possible but should not be done without specific Application Engineering review. The voltage must vary proportionally to the frequency.

If the inverter can only deliver a maximum voltage of 400 V, the amps will increase when the speed is above 50 Hz, and this may give rise to nuisance tripping if operation is near the maximum power limit and/or compressor discharge temperature limit.

The last digit of the model motor code indicates which frequency and voltage must be applied – see **Section 2.2 "Nomenclature"**.

Range	Code
380 - 420 V / 3 ph / 50 Hz 460 V / 3 ph / 60 Hz	D

Table 6: Electrical code for motors

5.16 Oil level

The oil level should be maintained at mid-point of the sight glass.

Some systems may contain higher than normal refrigerant charges. Systems with large coils, low ambient condenser flooding, or systems with multiple heat exchangers are among some system configurations that may require additional lubricant.

During the system development phase, adequate oil return from the system to the compressor should be evaluated and qualified. For this purpose, a sample compressor for lab testing, equipped with an external oil sight tube, is available from Emerson.

If an oil regulator is being used the oil level should be set within the top half of the oil regulator sight glass.

6 Maintenance & repair

WARNING
Conductor cables! Electrical shock! Follow the lockout/tag out procedure and the national regulations before carrying out any maintenance or service work on the system.
Use compressor with grounded system only. Screwed electrical connections must be used in all applications. Refer to original equipment wiring diagrams. Electrical connections must be made by qualified electrical personnel.

WARNING
Explosive flame! Fire hazard! Oil/refrigerant mixtures are highly flammable. Remove all refrigerant before opening the system. Avoid working with an unshielded flame in a refrigerant-charged system.

6.1 Disassembling system components

When disassembling system components please follow the main steps described hereunder:

1. Recover refrigerant and evacuate system using a recovery unit and vacuum pump. All the refrigerant shall be recovered to avoid significant release.
2. Flush system with inert gas (dry nitrogen). Compressed air or oxygen shall not be used for purging refrigerant systems.
3. Disassemble components with a cutting tool.
4. Drain, recover and dispose of compressor oil as appropriate.

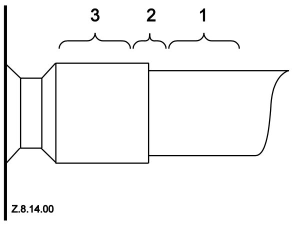


Figure 22: Tube connecting areas

To disconnect:

- Using a pipe cutting tool, cut off the suction and discharge lines in such a manner that the new compressor can easily be reconnected to the system.
- Heat joint areas 2 and 3 slowly and uniformly until the braze material softens and the tube end can be pulled out from the fitting.

To reconnect:

- Recommended brazing material: Silfos with minimum 5 % silver or silver braze used on other compressors.
- Due to the different thermal properties of steel and copper, brazing procedures may have to be changed from those commonly used.

NOTE: **Since the discharge stub contains a check valve, care must be taken not to overheat it to prevent brazing material from flowing into it.**

6.2 Provisions of legislation & leak check requirements

According to EN 378-4, systems with a refrigerant charge of 3 kg or more shall be subject to tightness inspection at least on an annual basis. The owner/operator shall keep an updated logbook of the refrigerant system containing all details with regard to maintenance and repair works (quantities and type of refrigerant changed or transferred, system components changes and replacements etc.). The EN 378 legislation covers HFO's as well as natural refrigerants.

The F-gas Regulation (EU) No 517/2014 applies to operators of equipment such as stationary refrigeration/air-conditioning equipment and heat pumps that contain fluorinated greenhouse gases. Mandatory documented leak checks must be made based on how much damage could be caused to the atmosphere if the whole charge were released. The frequency of the test inspections is based on the GWP of the refrigerant multiplied by the estimated volume contained in each individual system – this gives the CO_2e (CO_2 equivalent) figure.

Leak checking shall be carried out with the following frequency:

(a) once per year if the system contains between 5 and <50 tonnes CO_2e;

(b) once every 6 months if the system contains between 50 and <500 tonnes CO_2e;

(c) once every 3 months if the system contains more than 500 tonnes CO_2e.

***NOTE:* The leak checking frequency can be halved if permanent leak detection systems are fitted. Permanent leak detection systems are mandatory for system charges of 500 tonnes CO_2e and above.**

***NOTE*: Hermetically sealed equipment that contains fluorinated greenhouse gases in quantities of less than 10 tonnes of CO_2e, shall not be subject to leak checks, provided the equipment is labelled as hermetically sealed.**

Table 7 below sets out the

- F-gas thresholds, in tonnes CO_2 equivalent, at which leak check intervals are specified;
- maximum allowed interval between leak checks for equipment that meets each threshold;
- quantities of commonly used HFCs/refrigerant equal to each threshold.

Refrigerant	GWP	Maximum interval between leak checks 1 year	Maximum interval between leak checks 6 months	Maximum interval between leak checks 3 months
		5 to <50 T CO_2e	50 to <500 T CO_2e	>500 T CO_2e
R134a	1430	3.49 kg	34.96 kg	349.65 kg
R450A	547	9.25 kg	92.5 kg	925.92 kg
R513A	631	7.93 kg	79.36 kg	793.65 kg
R407C	1774	2.81 kg	28.18 kg	281.84 kg

Table 7: F-gas Regulation leak check intervals (based on refrigerant type and system charge thresholds)

The F-gas Regulation contains additional requirements depending on the system and stipulates training requirements for alternative refrigerants.

HFO refrigerants are covered by the F-gas Regulation as far as reporting of placing on the market is concerned.

6.3 Exchanging the refrigerant

CAUTION
Low suction pressure operation! Compressor damage! Do not operate with a restricted suction. Do not operate with the low-pressure limiter bridged. Do not operate compressor at pressures that are not allowed by the operating envelope. Allowing the suction pressure to drop below the envelope limit for more than a few seconds may overheat scrolls and cause early drive bearing and moving parts damage.

For qualified refrigerants and oils, see **Section 2.4.1**.

It is not necessary to replace the refrigerant unless contamination, for example due to an error such as topping up the system with a non-condensable gas or incorrect refrigerant, is suspected. To verify correct refrigerant composition, a sample can be taken for chemical analysis. A check can be made during shut down by comparing the refrigerant temperature and pressure using precision measurements at a location in the system where liquid and vapour phases are present and when the temperatures have stabilised.

6.4 Replacing a compressor

CAUTION
Inadequate lubrication! Bearing destruction! For systems with refrigerant accumulator, exchange the accumulator after replacing a compressor with a burned-out motor. The accumulator oil return orifice or screen may be plugged with debris or may become plugged. This will result in starvation of oil to the new compressor and a second failure.
Remove the refrigerant and oil completely from the replaced compressor.

6.4.1 Compressor replacement

In the case of a motor burnout, the majority of contaminated oil will be removed with the compressor. The rest of the oil is cleaned through the use of suction and liquid line filter driers. A 100 % activated alumina suction line filter drier is recommended but must be removed after 72 hours. When a single compressor or tandem is exchanged in the field, it is possible that a major portion of the oil may still be in the system. While this may not affect the reliability of the replacement compressor, the extra oil will add to rotor drag and increase power usage.

6.4.2 Start-up of a new or replacement compressor

Rapid charging only on the suction side of a scroll-equipped system can occasionally result in a temporary no-start condition for the compressor. The reason for this is that, if the flanks of the scrolls happen to be in a sealed position, rapid pressurisation of the low side without opposing high-side pressure can cause the scrolls to seal axially. As a result, until the pressures eventually equalise, the scrolls can be held tightly together preventing rotation. The best way to avoid this situation is to charge on both the high and low sides simultaneously at a rate which does not result in axial loading of the scrolls.

A minimum suction pressure specified in the published operating envelope must be maintained during charging. Allowing the suction pressure to drop below that value may overheat the scrolls and cause early drive bearing and moving parts damage. Never install a system in the field and leave it unattended when it has no charge, a holding charge, or with the service valves closed without securely electrically locking out the system. This will prevent unauthorised personnel from accidentally operating the system and potentially ruining the compressor by operating with no refrigerant. **Do not start the compressor while the system is in a deep vacuum.** Internal arcing may occur when a scroll compressor is started in a vacuum causing burnout of the internal lead connections.

6.5 Lubrication and oil removal

CAUTION
Chemical reaction! Compressor destruction! Do not mix up ester oils with mineral oil and/or alkyl benzene when used with chlorine-free (HFC) refrigerants.

The compressor is supplied with an initial oil charge. The standard oil charge for use with refrigerants R450A and R513A is a polyolester (POE) lubricant Emkarate RL 32 3MAF. In the field the oil level could be topped up with Mobil EAL Arctic 22 CC if 3MAF is not available. See nameplate for original oil charge shown in litres. A field recharge is from 0.05 to 0.1 litre less.

One disadvantage of POE is that it is far more hygroscopic than mineral oil – see **Figure 23**. Only brief exposure to ambient air is needed for POE to absorb sufficient moisture to make it unacceptable for use in a refrigeration system. Since POE holds moisture more readily than mineral oil it is more difficult to remove it through the use of vacuum. Compressors supplied by Emerson contain oil with low moisture content, and it may rise during the system assembling process. Therefore it is recommended that a properly sized filter-drier is installed in all POE systems. This will maintain the moisture level in the oil to less than 50 ppm. If oil is charged into a system, it is recommended to use POE with a moisture content no higher than 50 ppm.

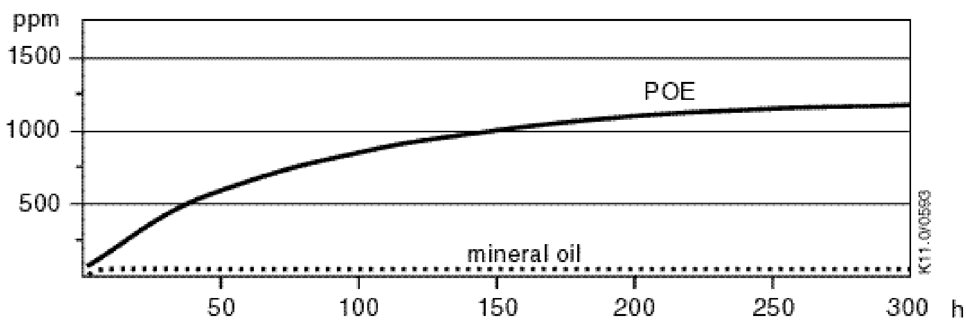


Figure 23: Absorption of moisture in ester oil in comparison to mineral oil in ppm by weight at 25 °C and 50 % relative humidity (h=hours)

If the moisture content of the oil in a refrigeration system reaches unacceptably high levels, corrosion and copper plating may occur. The system should be evacuated down to 0.3 mbar or lower. If there is uncertainty as to the moisture content in the system, an oil sample should be taken and tested for moisture. Sight glass/moisture indicators currently available can be used with the HFC refrigerants and lubricants; however, the moisture indicator will just show the moisture content of the refrigerant. The actual moisture level of POE would be higher than the sight glass indicates. This is due to the high hygroscopicity of POE oil. To determine the actual moisture content of the lubricant, samples have to be taken from the system and analysed.

6.6 Oil additives

Although Emerson cannot comment on any specific product, from our own testing and past experience, we do not recommend the use of any additives to reduce compressor bearing losses or for any other purpose. Furthermore, the long-term chemical stability of any additive in the presence of refrigerant, low and high temperatures, and materials commonly found in refrigeration systems is complex and difficult to evaluate without rigorously controlled chemical laboratory testing. The use of additives without adequate testing may result in malfunction or premature failure of components in the system and, in specific cases, in voiding the warranty on the component.

7 Troubleshooting

WARNING
Electrical cables! Electrical shock! Before attempting any electrical troubleshooting, make sure all grounds are connected and secure and there is ground continuity throughout the compressor system. Also ensure the compressor system is correctly grounded to the power supply. If you are not a qualified service person familiar with electrical troubleshooting techniques, DO NOT PROCEED until a qualified service person is available.

Most in-warranty electrical failures are a result of mechanical problems (particles in the oil, liquid refrigerant in the oil, etc.) and most mechanical problems are a result of system problems. Unless the reason for the failure is found, replacing the compressor will probably lead to another compressor failure.

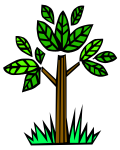
If the compressor fails to start and run properly, it is important that the compressor be tested to determine its condition. It is possible that electrical components may be defective, the protector may be open, or a safety device may have tripped. Here is a list of the most common compressor problems encountered in the field.

Condition	Cause	Corrective action
The scroll compressor does not run, instead a buzz sound can be heard	Wired incorrectly	Check the power supply on the compressor terminals if there is voltage measured. Trace the wiring diagram to see where the circuit is interrupted.
	Low supply voltage	If the voltage falls below 90 % of the nameplate voltage, the motor may develop insufficient torque. Make sure the compressor is supplied with rated nominal voltage.
	Shorted or grounded motor windings	Check the motor for ground by means of a continuity check between the terminals. If grounded replace compressor.
	Internal compressor mechanical damage	Refrigeration migration: When the compressor is switched off for a long period, refrigerant can condense in the crankcase. If the compressor body is colder than the evaporator, refrigerant will move from the evaporator to the compressor crankcase. Refrigerant migration normally occurs when the compressor is installed in a cold area. A crankcase heater and/or a pumpdown cycle provide good protection against refrigerant migration. Acid formation: Acid forms in the presence of moisture, oxygen, metal, salts, metal oxides and/or high discharge temperatures. The chemical reactions are accelerated at higher temperatures. Oil and acid react with each other. Acid formation leads to damage of the moving parts and in extreme cases to motor burnout. Several different test methods can be used to test for acid formation. If acid is present a complete oil change (including the oil in the oil separator) will help. A suction filter which removes acid should also be fitted. Check filter-drier condition.

Condition	Cause	Corrective action
The scroll compressor does not run, no buzz sound can be heard	Compressor motor protector open	Check if there is continuity on the compressor external protector. If the compressor is warm, it may require considerable time to cool down.
	Defective system control components	Check if the pressure control or thermostat works properly or if the controls are open.
	Power circuit open	Check the fuse for a tripped circuit breaker or for an open disconnected switch.
	Burned motor winding	If motor is burned due to undersized contactors, the contacts will be welded together. Complete motor burnout on all three phases despite the presence of a functioning protection system can be the result. For sizing information please consult the contactor manufacturer data sheet. If the application of the compressor is changed the contactor sizing should be rechecked. Check for unbalanced voltage.
The scroll compressor trips on motor protection	High discharge pressure / suction pressure	For high discharge pressure: ▪ Check for system leaks. With system leaks at the low-pressure side, air as non-condensable gas could enter the system and create high pressure. ▪ Check the system design. Make sure the discharge line is correctly sized: undersized discharge line can increase discharge pressure. This is also true for an undersized condenser. Correct the component selection as needed. ▪ Check the fan motor, make sure it is running properly in the right direction. Check the condenser: if dirt has been accumulated it will clog the airflow; clean as necessary. High discharge pressure is also caused by an overcharged system and high ambient temperature surrounding the condenser. For high suction pressure, check the "evaporator superheat" first to diagnose the problem: ▪ High superheat at the evaporator outlet is likely in case of excessive pressure drop in the liquid line or too much vertical lift on the pipework. ▪ Low superheat at the evaporator outlet is usually the consequence of oversized selection of the expansion valve or incorrect bulb sensor mounting. The valve may freeze up in the open position due to an accumulation of debris in the system. For a system with very short refrigeration lines a suction line accumulator is recommended.
	Compressor operating outside the design limits	Check the compressor suction and discharge pressures while it is running. Make sure they are within the operating envelope.
	Defective motor protector	If all operating conditions are normal, the voltage supply at the compressor terminals is balanced and within limits, the compressor crankcase temperature is within normal limits, and the amperage drawn is within the specified range, the motor protector may be defective.

Condition	Cause	Corrective action
Excessive discharge temperature	Too high compressor superheat	Make sure the compressor operates within the acceptable superheat range published by Emerson.
The scroll compressor runs continuously	Excessive cooling / heating load or inadequate insulation	Check the load design. Make sure that proper insulation is applied. Correct it as necessary.
	Control circuit inoperative	Check the thermostat, measure the temperature of the room and compare with the thermostat; replace or re-calibrate the thermostat. Check the LP control switch and replace it if it is found defective.
Compressor lubrication problem	Oil trap due to incorrect piping layout / sizing	Check the piping layout design. Installations of pipe being routed over or around obstacles can inadvertently create unwanted traps for the oil return. As much as possible the refrigerant line should travel a direct and straight course between the evaporator and compressor. It should also be remembered that the entire system will be coated in oil to some extent. Oil viscosity changes with temperature. More oil stays in the system than was originally expected. Make sure the line is correctly sized.
	Oil pump out due to high cycling rate	A high cycling rate will pump oil into the system and lead to lubrication failure. Oil leaves the compressor at start-up and the short running time is insufficient to return the oil to the compressor via the suction side. Try to limit the number of cycles to maximum 10 per hour.
	Low gas velocity	System gas velocity changes depending on temperature and load (capacity control). In low load conditions gas velocity may not be high enough to return oil to the compressor.
Low discharge pressure	Low ambient temperature	Fit a fan cycling control system.
	Refrigerant undercharge	Check the system for leaks. Observe sight glass for bubbles if fitted. Add refrigerant until the sight glass is clear. If no sight glass is fitted, check the evaporator superheat and fill in with refrigerant.
Low suction pressure	System design load too small	If the compressor is running in a tandem or in parallel, modulate the running process.
	Inadequate refrigerant going to the evaporator	Lower normal discharge pressure values can lead to insufficient refrigerant flow to the system. This can also be verified by checking the evaporator outlet superheat, if it is found unusually high. Check the selection of the expansion valve (likely undersized).
Noise during shut-off	Anti-reverse device	This does not have any effect on the durability of the compressor, no action is necessary.

8 Dismantling & disposal



Removing oil and refrigerant:

- **Do not disperse in the environment.**
- **Use the correct equipment and method of removal.**
- **Dispose of oil and refrigerant according to national legislation and regulations.**

Dispose of compressor according to national legislation and regulations.

9 References

Please visit www.climate.emerson.com/en-gb for free download of Application Guidelines and Technical Information.

Performance and technical data:

The latest version of Copeland Select software with performance data and technical data is available from the webpage **www.climate.emerson.com/en-gb**.

Spare parts and accessories:

Visit the webpage **www.climate.emerson.com/en-gb/tools-resources** for an online version of the Emerson spare parts and accessories software.

Appendix 1: Tightening torques

Connection	Torque [Nm]
M10	45 - 55
Rotalock ¾"	40 - 50
Rotalock 1"	70 - 80
Rotalock 1 ¼"	100 - 110
Rotalock 1 ¾"	170 - 180
Rotalock 2 ¼"	190 - 200
Sight glass external 1 ¾"	71 - 88
Sight glass fitting TPTL	34 - 41
Mounting bolts 5/16", M9	27 max
Mounting bolts M8 (grommet for single operation)	13 ± 1
Mounting bolts M8 (hard mounting parts for parallel operation)	27 ± 1
Crankcase heater	2 - 3
Digital coil screw	2
Terminal block screw	2.8
Ground screw	2.3
IP65 box ground screw (Peko bolt)	4 - 4.4
IP65 ground screw cover / T-box	1.8 - 2
IP65 cable gland M25	9.8 - 10
IP65 T-box cover screws	1.8 - 2

Table 8: Tightening torques

DISCLAIMER

BENELUX
Josephinastraat 19
NL-6462 EL Kerkrade
Tel: +31 45 535 06 73
Fax: +31 45 535 06 71
benelux.sales@emerson.com

GERMANY, AUSTRIA & SWITZERLAND
Theo-Mack Str. 3
DE-63477 Maintal
Tel: +49 6109 605 90
Fax: +49 6109 60 59 40
ECTGermany.sales@emerson.com

FRANCE, GREECE & MAGHREB
8, Allée du Moulin Berger
FR-69134 Ecully Cédex, Technoparc - CS 90220
Tel: +33 4 78 66 85 70
Fax: +33 4 78 66 85 71
mediterranean.sales@emerson.com

ITALY
Via Ramazzotti, 26
IT-21047 Saronno (VA)
Tel: +39 02 96 17 81
Fax: +39 02 96 17 88 88
italy.sales@emerson.com

SPAIN & PORTUGAL
C/ Pujades, 51-55 Box 53
ES-08005 Barcelona
Tel: +34 93 412 37 52
iberica.sales@emerson.com

CZECH REPUBLIC
Hajkova 22
CZ - 133 00 Prague
Tel: +420 733 161 651
Fax: +420 271 035 655
Pavel.Sudek@emerson.com

ROMANIA & BULGARIA
Parcul Industrial Tetarom 2
Emerson Nr. 4 400641 Cluj-Napoca
Tel: +40 374 13 23 50
Fax: +40 374 13 28 11
ro-bg.sales@emerson.com

ASIA PACIFIC
Suite 2503-8, 25/F., Exchange Tower
33 Wang Chiu Road, Kowloon Bay
Kowloon , Hong Kong
Tel: +852 2866 3108
Fax: +852 2520 6227

UK & IRELAND
Unit 17, Theale Lakes Business Park
Reading, Berkshire RG7 4GB
Tel: +44 1189 83 80 00
Fax: +44 1189 83 80 01
uk.sales@emerson.com

SWEDEN, DENMARK, NORWAY & FINLAND
Pascalstr. 65
DE-52076 Aachen
Tel: +49 2408 929 0
Fax: +49 2408 929 525
nordic.sales@emerson.com

EASTERN EUROPE & TURKEY
Pascalstr. 65
DE-52076 Aachen
Tel: +49 2408 929 0
Fax: +49 2408 929 525
easterneurope.sales@emerson.com

POLAND
Szturmowa 2
PL-02678 Warsaw
Tel: +48 22 458 92 05
Fax: +48 22 458 92 55
poland.sales@emerson.com

RUSSIA & CIS
Dubininskaya 53, bld. 5, 4th floor
RU-115054, Moscow
Tel: +7 499 403 64 03
ECT.Holod@emerson.com

BALKAN
Selska cesta 93
HR-10 000 Zagreb
Tel: +385 1 560 38 75
Fax: +385 1 560 38 79

MIDDLE EAST & AFRICA
PO Box 26382
Jebel Ali Free Zone - South, Dubai - UAE
Tel: +971 4 811 81 00
Fax: +971 4 886 54 65
mea.sales@emerson.com

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For more details, see www.climate.emerson.com/en-gb
Connect with us: facebook.com/EmersonCommercialResidentialSolutions

Emerson Commercial & Residential Solutions
Emerson Climate Technologies GmbH - Pascalstrasse 65 - 52076 Aachen, Germany
Tel. +49 (0) 2408 929 0 - Fax: +49 (0) 2408 929 570 - Internet: www.climate.emerson.com/en-gb