

Copeland scroll compressors for refrigeration

*ZB50KCE to ZB114KCE, ZB66K5E to ZB114K5E
ZF34K5E to ZF54K5E*



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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 Copeland as other considerations may apply.

1 Safety instructions

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

The compressors covered in these guidelines are intended for installation in systems in accordance with the following directives and regulations:

Machinery Directive MD 2006/42/EC	Supply of Machinery (Safety) Regulations 2008
Pressure Equipment Directive PED 2014/68/EU	Pressure Equipment (Safety) Regulations 2016
Low Voltage Directive LVD 2014/35/EU	Electrical Equipment (Safety) Regulations 2016

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. For relevant standards please refer to the Manufacturer's Declaration, available at www.copeland.com/en-gb.

These instructions should 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 (refrigeration, air conditioning and heat pump) 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 under 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 come into contact with it. Lock and mark accessible sections.



CAUTION

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



CAUTION

Contact with refrigerant oil! Material damage! Polyolester (POE) lubricants 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, some 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 vertical single Copeland scroll compressors ZB50KCE to ZB114KCE & ZB66K5E to ZB114K5E for medium temperature refrigeration applications, and ZF34K5E to ZF54K5E for low temperature refrigeration applications.

These compressors have one scroll compression set driven by a three-phase induction motor. The scroll set is mounted at the upper end of the rotor shaft of the motor. The rotor shaft axis is in the vertical plane.

2.2 Nomenclature

The model designation contains the following technical information about the standard and vapour injection compressors:

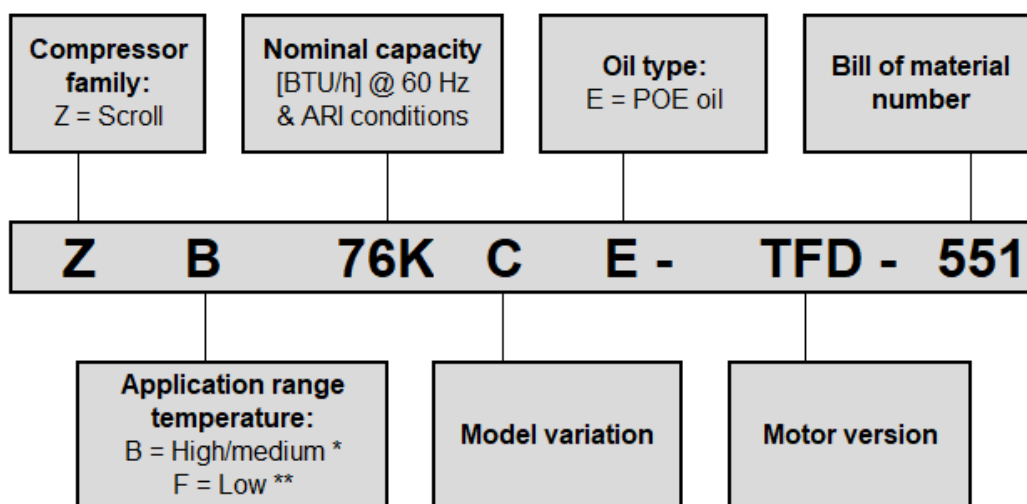


Figure 1: Nomenclature

* ARI Conditions high/medium temperature:

Evaporating temperature	-6.67 °C	Liquid sub-cooling	0 K
Condensing temperature	48.90 °C	Ambient temperature	35 °C
Suction gas return	18.33 K		

** ARI Conditions low temperature:

Evaporating temperature	-31.67 °C	Liquid sub-cooling	0 K
Condensing temperature	40.56 °C	Ambient temperature	35 °C
Suction gas return	18.33 K		

2.3 BOM variations

The BOM (bill of material) number at the end of the compressor designation indicates the different compressor layouts and details. The compressors covered in these guidelines are available in the following BOM versions:

Compressors	BOM	Suction & discharge connections	Electrical connections	Mounting parts	Features
ZB50-114KCE	551	Rotalock	T-box, IP54	Rubber mounting parts for single operation	Oil sight glass, ASTP discharge temperature control
	651	Rotalock	Moulded plug, IP 66		Oil sight glass
ZB66-114K5E ZF34-54K5E	567	Rotalock	T-box, IP54	Rubber mounting parts for single operation	Oil sight glass, discharge line thermostat

Table 1: BOM variations

More information about BOM versions can be found in Technical Information TI_Scroll_BOM_EN "Copeland scroll compressors – BOM Overview", available at www.copeland.com/en-gb and in the Copeland price list.

2.4 Application range

2.4.1 Qualified refrigerants and oils



IMPORTANT

It is essential to carefully consider the glide of the refrigerant blends (primarily R407A & R407F) when adjusting pressure and superheat controls.

Compressors	ZB*KCE	ZB*K5E	ZF*K5E
Qualified refrigerants	R404A, R407A, R407F, R448A, R449A, R134a		R404A, R407A, R407F, R448A, R449A
	R22	R407C	
Qualified oil (factory charged)	Emkarate RL32 3MAF		
Servicing oils	Emkarate RL32 3MAF, Mobil EAL Arctic 22 CC		

Table 2: Qualified refrigerants and oils

Oil recharge values can be taken from Copeland scroll compressors brochures or Copeland Select software available at www.copeland.com/en-gb/tools-resources.

2.4.2 Comparison between ZB*KCE and ZB*K5E compressors

ZB*KCE and ZB*K5E models are based on the same compressor platform, but there are slight differences. **Table 3** hereunder details the differences and similarities between the two series.

Equipment	ZB*KCE compressors	ZB*K5E compressors
Suction and discharge connections	Rotalock	Rotalock, raised suction fitting
Oil connections	Oil sight glass and Schraeder oil valve	
Electrical connection	Traditional (3 screws) Option = Moulded plug	Traditional (3 screws)
Terminal box protection class	IP21 (standard) IP66 (with moulded plug)	IP54 (standard)
Motor protection	Klixon internal protection	
Discharge temperature protection	ASTP	External thermostat

Table 3: Comparison of ZB*KCE and ZB*K5E compressor features

2.4.3 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.copeland.com/en-gb/tools-resources.

2.5 PED category and maximum allowable pressure PS

The nameplate of the compressor contains information about the maximum allowable pressure PS, the minimum and maximum allowed temperature TS, the internal free volumes and the refrigerants qualified for the compressor model range. Values are given for both pressure ranges on low- and high-pressure sides.

The PED category is assigned according to the Pressure Equipment Directive PED 2014/68/EU. Requirements apply to the relevant pressure levels in the compressor when the product of "pressure relative to the environment" by "related internal free volume" ($P \times V$) exceeds given limits. When calculating the PED category, the high- and low-pressure sides have to be calculated separately. The highest of the calculation results is considered.

Compressor	PS low pressure side	PS high pressure side	TS max. low pressure side	Internal free volume	
				LP side	HP side
ZB50KCE to ZB76KCE	22.6 bar(g)	32 bar(g)	50 °C	12.6 L	1.5 L
ZB95KCE, ZB114KCE	22.6 bar(g)	32 bar(g)	50 °C	12.9 L	1.5 L
ZB66K5E, ZB76K5E	22.6 bar(g)	32 bar(g)	50 °C	12.6 L	1.5 L
ZB95K5E, ZB114K5E	22.6 bar(g)	32 bar(g)	50 °C	12.9 L	1.5 L
ZF34K5E, ZF41K5E	22.6 bar(g)	32 bar(g)	50 °C	12.6 L	1.5 L
ZF48K5E, ZF54K5E	22.6 bar(g)	32 bar(g)	50 °C	12.9 L	1.5 L

Table 4: Maximum allowable pressures, temperatures and internal free volumes

The PED category also depends on the fluid group of the qualified refrigerants. A distinction is made between refrigerants of fluid group 1 (flammable) and fluid group 2 (non-flammable). The compressors covered in these guidelines are operated with A1 (group 2) refrigerants.

Compressor range	Refrigerants	Fluid group	PED category
ZB*KCE	R404A, R407A, R407F, R448A, R449A, R134a, R22	2	II
ZB*K5E	R404A, R407A, R407F, R448A, R449A, R134a, R407C	2	II
ZF*K5E	R404A, R407A, R407F, R448A, R449A	2	II

Table 5: PED category based on refrigerant used and fluid group

2.6 Dimensions

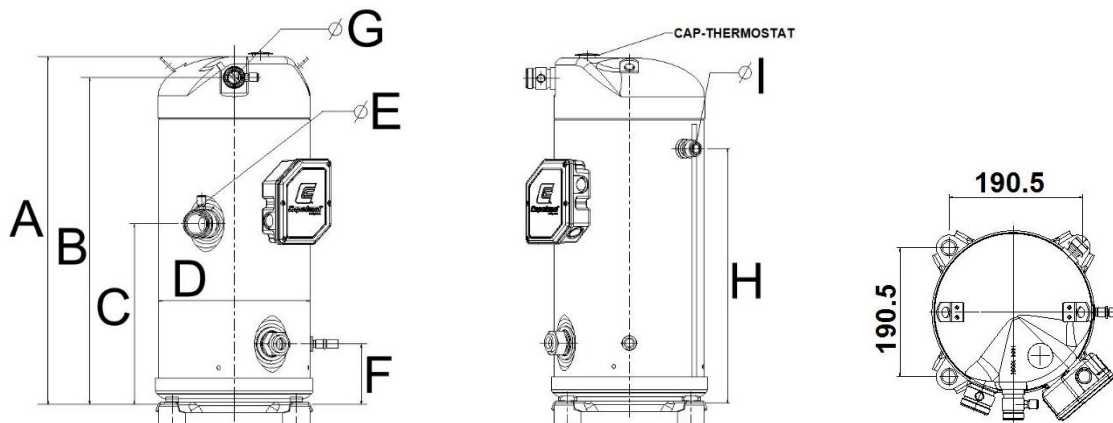


Figure 2: Compressor dimensions, front and top views

Position	ZB50KCE ZB58KCE	ZB66K5E ZB76K5E	ZB66K5E ZB76K5E	ZB95KCE ZB114KCE	ZB95K5E ZB114K5E	ZF34K5E ZF41K5E	ZF49K5E ZF54K5E
A (mm)	476.3	533.2	532.9	551.5	551.0	533.6	551.5
B (mm)	444.3	501.2	500.8	519.4	518.9	501.8	519.5
C (mm)	93.6	122.1	277.3	140.4	295	277.3	295
D (mm)	232.2			232.2		232.2	
E (inches)	Rotalock 1 ¾"						
F (mm)	74.3	92.3	93	92.6	93	93	93
G (inches)	Rotalock 1 ¼"						
H (mm)	---					393.3	441.0
I (inches)	---					Rotalock 1"	

Table 6: Compressor dimensions

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 handling equipment according to weight. Keep in the upright position. Respect stacking loads according to **Figure 3**. Check the tilting stability and if needed take action to ensure the stability of the stacked loads. Keep the packaging dry at all times.



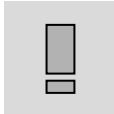
Respect the maximum number of identical packages which may be stacked on one another, where "n" is the limiting number:

- **Transport: n = 2**
- **Storage: n = 3**

Figure 3: Maximum stacking loads for transport and storage

The compressor tilt angle should not exceed 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.

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.

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

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 °C to allow adequate lubrication. For multiple-compressor parallel configurations, the compressors must be positioned completely vertically on a totally horizontal surface or rail.

3.2 Mounting parts

The compressors are designed to be mounted on vibration absorber grommets (4 supplied 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 grommets 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. It is possible to deliver these hard-mounting parts as a kit.

See Copeland spare parts and accessories catalogue at www.copeland.com/en-gb/tools-resources for references.

Mounting parts for ZB50K* to ZB114K* and ZF34K* to ZF54K* - Soft mountings



Figure 4: Mounting parts

NOTE: For more information, please refer to Technical Information TI_Scroll_Mounting_01 "Copeland scroll compressors – 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 orifices.

Contamination or moisture! Bearing failure! Do not remove the connection plugs until the compressor is set into the unit. This minimises any entry of contaminants and moisture.

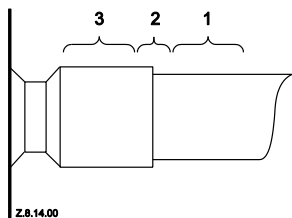


Figure 5: Suction tube brazing areas

Copeland scroll compressors have copper-plated steel suction, injection and discharge tubes. These tubes are far more robust and less prone to leaks than copper tubes. Make sure brazing is carried out in an appropriate manner taking into account the different thermal properties of steel and copper.

Refer to **Figure 5** and procedure below for the brazing of the suction and discharge lines to 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.

To disconnect:

- Heat joint areas 2 and 3 slowly and uniformly until the braze material softens and the tube can be pulled out of the fitting.

To reconnect:

- Recommended brazing materials: 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.

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 compressors are delivered with a discharge check valve fitted inside the discharge port and rubber plugs fitted to the suction and discharge ports as standard. There are options to fit either Rotalock valves or Rotalock adaptors. Using either straight or angled adaptors provides a way to convert a Rotalock into a brazing connection.

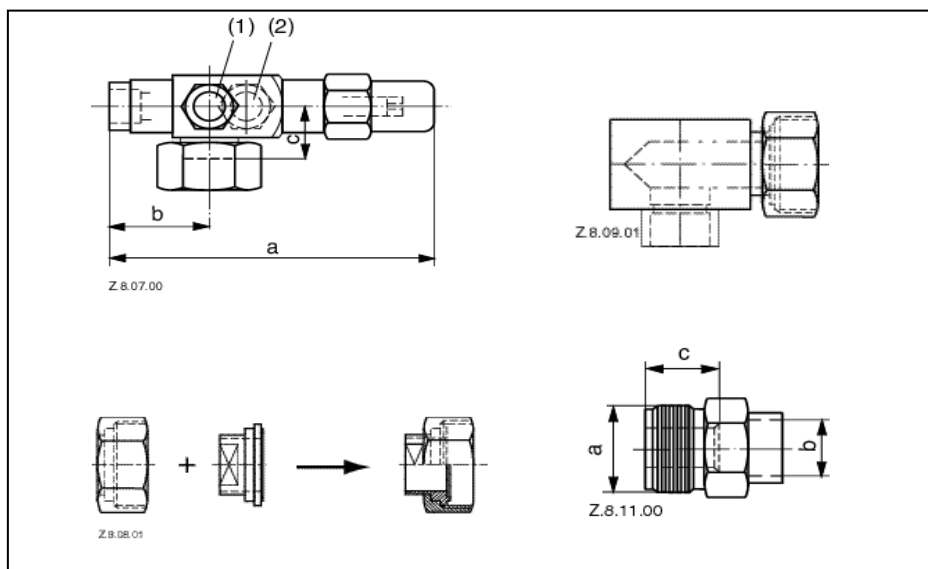


Figure 6: Shut-off valves and adaptors

Torque settings of system valves and adaptors with Rotalock connections might decrease significantly after some time in operation. Recurring temperature changes, vibration and other influencing parameters can lead to expansion and contraction of the metal material and a relaxation of the gaskets. It is recommended to periodically retorque the Rotalock connections to the original settings.

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

Refer to **Table 7** hereunder for proper tightening torques:

	Torque
Rotalock 1 1/4" – 12 UNF	100 – 110 Nm
Rotalock 1 3/4" – 12 UNF	170 – 180 Nm

Table 7

NOTE: More information about adaptors and shut-off valves can be found in the spare parts catalogue available at www.copeland.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 and ensure that the pressure never exceeds the maximum limit.

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

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.

The high-pressure control should have a manual reset feature for the highest level of system protection.

3.5.2 Low pressure protection



CAUTION

Operation outside the application envelope! Compressor breakdown! A low-pressure protection should be fitted in the suction line in order to stop the compressor when it operates outside the envelope limits. Do not bridge or by-pass the low-pressure limiter.

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

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

The minimum cut-out setting shall be determined according to the refrigerant and the allowed operation envelope – see Select software at www.copeland.com/en-gb/tools-resources. For example, a minimum cut-out setting of 0.3 bar(g) is required for ZF* compressors using R404A.

The low-pressure cut-out should have a manual reset feature for the highest level of system protection.

3.6 Crankcase heaters



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 avoid refrigerant migrating into the shell during standstill periods. The installation of a crankcase heater is required when the system charge exceeds 7.5 kg. This requirement is independent from system type and configuration.

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.**

The crankcase heater must be mounted below the oil Schraeder valve located on the bottom shell, 40 mm above compressor feet – see **Figure 7**.

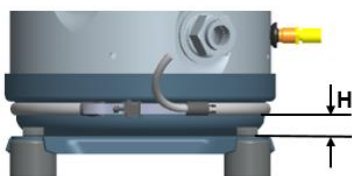


Figure 7: Crankcase heater location

Please refer to the Copeland spare parts & accessories catalogue available at www.copeland.com/en-gb/tools-resources to select the correct crankcase heater model.

Caution: Crankcase heaters must be properly grounded!

Assembly instructions

- Choose the appropriate model according to compressor size and required wattage.
- Position the crankcase heater between the lower cover and the lower bearing weld projection (**Fig. 8**).
- 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. 9 & 10**).
- Avoid having the assembly heater inclined (**Fig. 11**).
- 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 8



Figure 9



Figure 10



Figure 11

Electrical connection

- 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 Discharge gas temperature protection



CAUTION

Inadequate lubrication! Scroll set damage! All ZB* and ZF* 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 ensure positive compressor protection, discharge gas temperature protection is required for any application with Copeland compressors.

The maximum discharge gas temperature value depends on the compressor model and protection type (please refer to the following chapters).

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 protection device; it is not designed to control the operating envelope. For compressor envelope control, an additional control device or regulation must be used.

3.7.1 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 described above frequently occur simultaneously, particularly since the chemical reaction speed approximately doubles with every 10 °C 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.

3.7.2 Advanced Scroll Temperature Protection (ASTP)

Copeland scroll compressor models ZB50KCE to ZB114KCE 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 purposes.

Compressors with Advanced Scroll Temperature Protection can be identified by a dedicated label located above the terminal box.

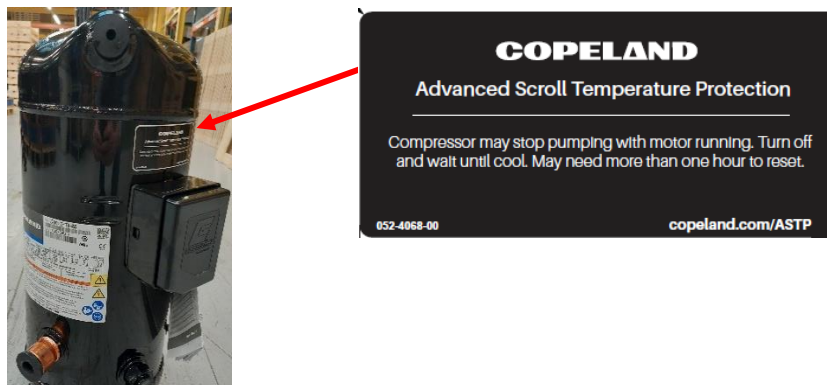


Figure 12: Scroll compressor with Advanced Scroll Temperature Protection (ASTP) sticker

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.

Applications where compressors are used in the upper left corner of the operation envelope may lead to undesired downtime and cut-offs for safety. Therefore the envelope needs to be controlled properly. For such applications, it is strongly advised to install an additional external discharge thermostat.

3.7.3 Discharge line thermostat

The use of an external discharge thermostat is required for all ZF*K5E and ZB*K5E compressors and a discharge thermostat is included in the standard delivery of all these models.

Internal discharge temperatures can reach unacceptable values under some extreme operating conditions (such as loss of refrigerant injection charge or extremely high compression ratio). This could cause compressor damage.

The ZF*K5E and ZB*K5E dedicated discharge thermostat has a cut-out setting of 130 °C ± 4 K with closing at 101 °C ± 8 K and should be installed approximately 120 mm from the discharge valve outlet – see **Figure 13**. In order to avoid improper functioning due to false readings, the thermostat must be properly insulated – see "X" in **Figure 13**.

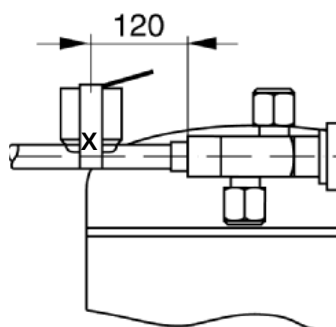


Figure 13: Recommended position for discharge temperature protection

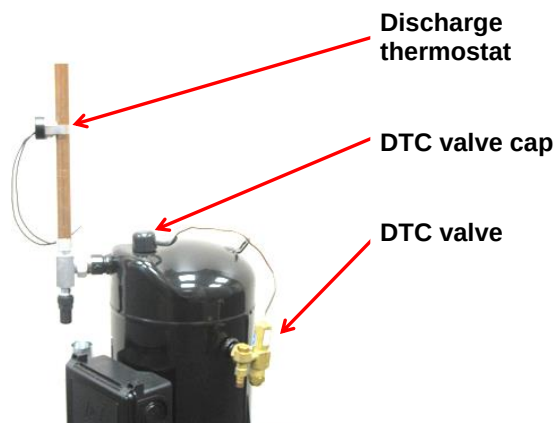


Figure 14: Example of ZF*K5E-TFD installation, liquid injection with DTC valve and discharge thermostat on the discharge line

Assembly of the discharge line thermostat

For installation, please follow the recommendations below.

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 touch 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 and secure it with plastic straps.	

3.8 Screens



CAUTION

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

The use of filter 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.

3.9 Mufflers

Gas flow through scroll compressors is continuous with relatively low pulsation. External mufflers may not 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.

3.10 Sound and vibration

Copeland scroll compressors inherently have low sound and vibration characteristics. However in some respects the sound and vibration characteristics differ from reciprocating compressors and in rare instances could result in unexpected sound generation. One difference is that the vibration characteristic of the scroll compressor, although low, includes two very close frequencies, one of which is normally isolated from the shell by the suspension of an internally-suspended compressor. These frequencies, which are present in all compressors, may result in a low-level "beat" frequency that can be detected as noise coming along the suction line into the building under some conditions. Elimination of the beat can be achieved by attenuating either of the contributing frequencies. This is easily done by using one of the common combinations of recommended design configurations. The scroll compressor makes both a rocking and twisting motion and enough flexibility must be provided in the line to prevent vibration transmission into any lines attached to the unit. In a split system, the most important goal is to ensure minimal vibration in all directions at the service valve to avoid transmitting vibrations to the structure to which the lines are fastened.

A second difference of the Copeland scroll is that under some conditions the normal rotational starting motion of the compressor can transmit an "impact" noise along the suction line. This may be particularly pronounced in three-phase models due to their inherently higher starting torque. This phenomenon, like the one described previously, also results from the lack of internal suspension and can be easily avoided by using standard suction line isolation techniques as described below.

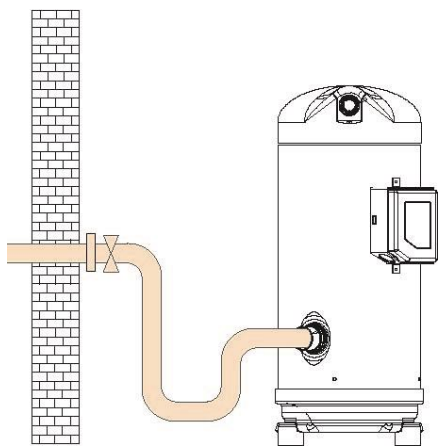


Figure 15: Example of suction tube design

Recommended configuration

- Tubing configuration: small shock loop
- Service valve: "angled" valve fastened to unit / wall
- Suction muffler: not required

Alternative configuration

- Tubing configuration: small shock loop
- Service valve: "straight through" valve fastened to unit / wall
- Suction muffler: may be required (acts as dampening mass)

3.11 Suction accumulators



CAUTION

Inadequate lubrication! Bearing destruction! Minimise liquid refrigerant returning to the compressor. Too much refrigerant dilutes the oil. Liquid refrigerant can wash the oil off the bearings leading to overheating and bearing failure.

Irrespective of system charge, oil dilution may occur if large amounts of liquid refrigerant repeatedly flood back to the compressor during:

- normal off cycles
- defrost
- varying loads

In such a case an accumulator must be used to reduce floodback to a safe level that the compressor can handle. The use of an accumulator is dependent on the application. If an accumulator is used, the oil-return orifice should be 2.0 mm in diameter for all models.

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. Check with supplier whether an extra charge of oil for the suction accumulator is required. Pre-charge additional oil to the system accordingly.

3.12 ZF*K5E compressors for low temperature applications

ZF*K5E compressors are designed and applicable for both liquid injection and vapour injection (EVI).

For low temperature applications of ZF*K5E models, liquid or vapour injection is required to keep discharge gas temperatures within safe limits. The documented application limits (see technical data in Select software) are based on ZF* scroll compressors equipped with liquid injection or vapour injection.

Injection takes place into two distinct pockets of the spirals without affecting the suction process. Both types of injection slightly increase the mass flow through the condenser.

All ZF*K5E compressor models are equipped with a 1" – 14 UNS 2A diameter injection port.

3.12.1 ZF*K5E compressors with liquid injection

Liquid injection is achieved by means of a Discharge Temperature Control (DTC) valve. The same DTC valve can be used for all ZF*K5E compressors and approved refrigerants. The purpose of the DTC valve is to eliminate the need for a standard capillary tube.

ZF*K5E compressors with BOM 567 include a well in the top cap combined with a valve cap. The DTC valve is equipped with a custom bulb profile, which must be installed in the top well of the compressor sensing the temperature closest to the discharge port. The bulb/bellows combination injects only when cooling is needed and in the required quantity. The DTC valve connections are 1" Rotalock for the compressor injection port and 3/8" braze for the connection to the liquid line.

To prevent a partial or full blockage at the injection port caused by shavings, foreign bodies, etc a filter should be installed in the liquid line prior to the DTC valve inlet.

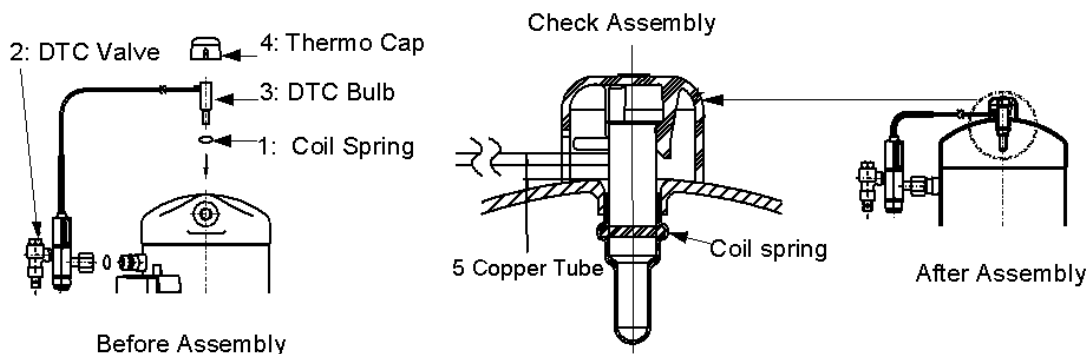


Figure 16: DTC valve assembly

3.12.1.1 DTC valve specifications

- Opening setpoint: $121\text{ }^{\circ}\text{C} \pm 3\text{ K}$
- Liquid line connection: 3/8"

3.12.1.2 Valve installation

The valve bulb must be installed in the top cap to adequately control scroll temperatures. The DTC valve should be tightened on the injection fitting to a torque of 24-27 Nm. It is recommended that the valve be located perpendicular to the compressor orientation. However it will function properly in any orientation. The capillary tube connecting the valve to the bulb should be positioned at least 13 mm away from the side of the scroll to avoid contact during operation.

The DTC valve is supplied with a Teflon gasket for the injection port connection and an insulating cap which is applied to the top of the compressor.

For most efficient thermal sensing, a thin film of thermal grease could be spread around the DTC valve bulb before installation into the top cap well. However this is not absolutely required for proper functioning of the valve.

If the additional height from the insulating cap is an issue, the valve cap can be replaced with high temperature insulation. This should be applied to insulate and protect the valve remote bulb assembly. This will reduce the total height requirement by 12.7 mm.

3.12.1.3 Compressor or valve service

When replacing a ZF* compressor using the DTC valve it is recommended to replace the DTC valve at the same time. The filter in the liquid line should also be replaced.

3.12.2 ZF*K5E compressors with vapour injection

3.12.2.1 Economized Vapour Injection technology (EVI)

The Economized Vapour Injection (EVI) technology has been developed to provide improved capacity and efficiency.

ZF*K5E compressors are equipped with a 1" - 14 UNS 2A injection connection, which can also be used as a vapour injection connection for economizer operation. Economizing can be achieved by using a sub-cooling circuit similar to that shown in **Figure 17**. The line diagram shows a system configuration for the economizer cycle. A heat exchanger is used to provide additional sub-cooling to the refrigerant before it enters the evaporator. This sub-cooling process provides the increased capacity gain measured in the system. The refrigerant evaporated through the heat exchanger is injected into the compressor and provides additional cooling at higher compression ratios.

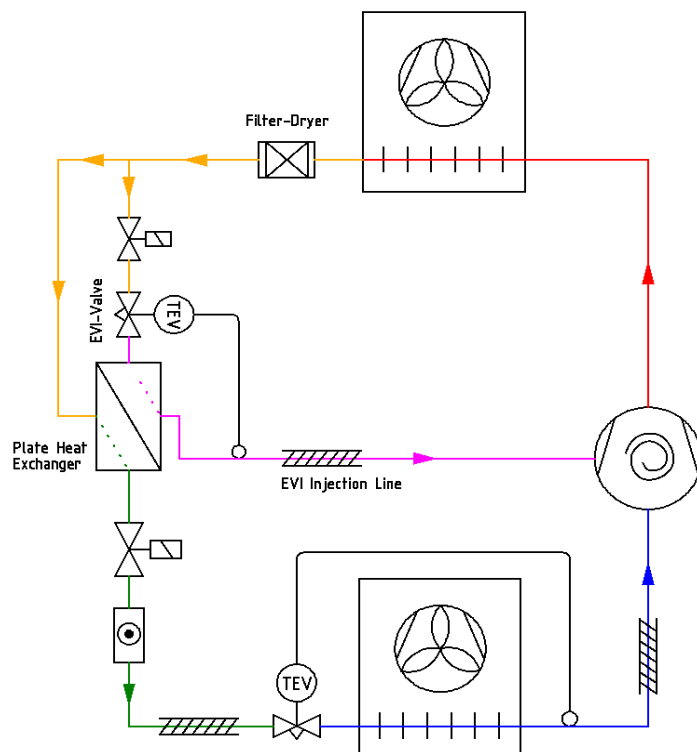


Figure 17: Vapour injection line diagram

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.

For safety reasons, Copeland recommends that the electrical installation be executed in compliance with standard EN 60204-1 and/or other standards and regulations of application.

4.2 Electrical installation



WARNING

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

The recommended wiring diagrams are shown in figures hereunder.

Three-phase compressors (TF*):

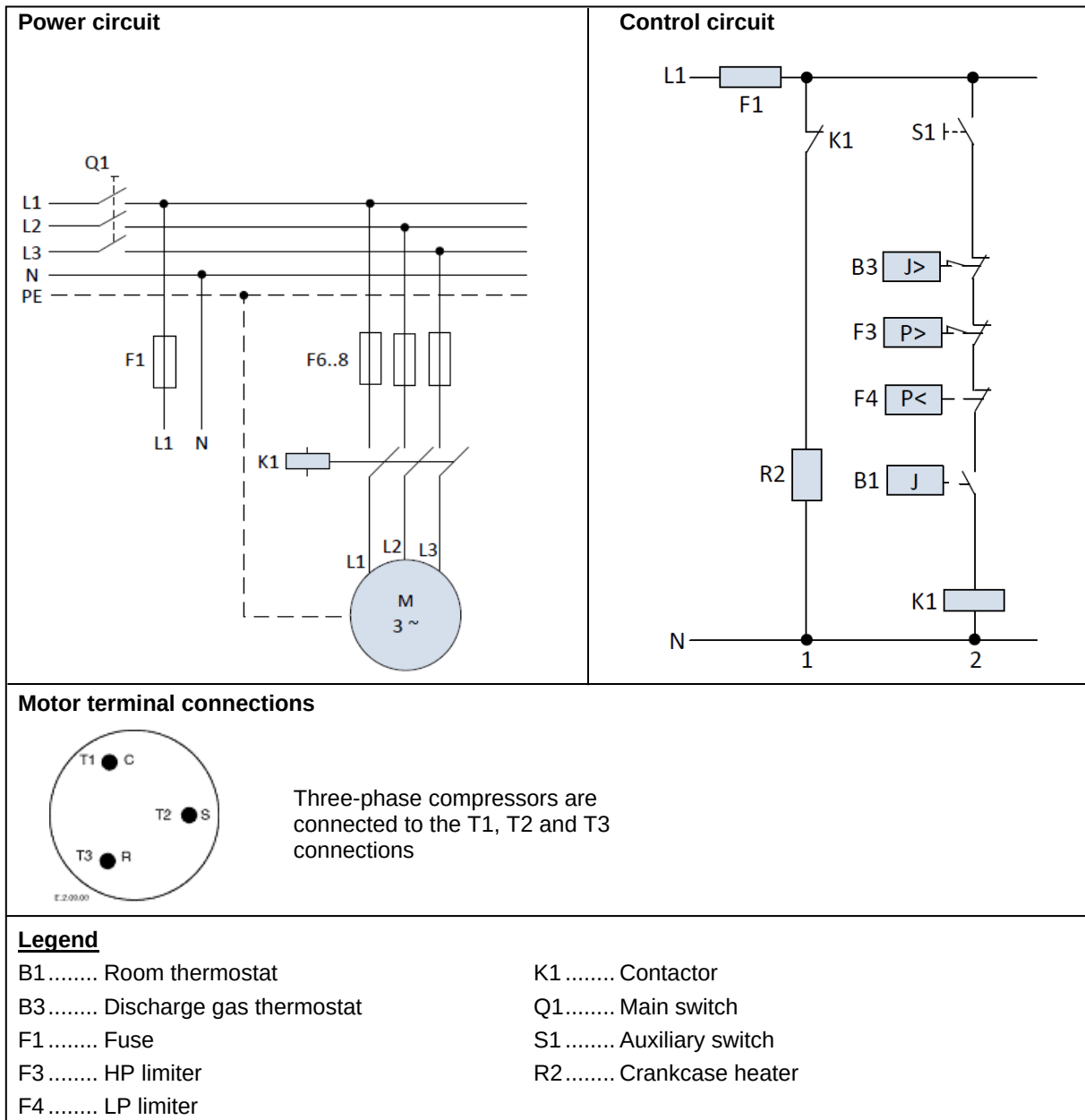


Figure 19: Wiring diagrams for three-phase compressors with internal motor protection

4.3 Terminal box

The standard terminal box is IP21 for all ZB*KCE compressors in BOM 551 version, and IP54 for all ZB*K5E and ZF*K5E models, according to IEC 60034-5.

Cable glands have an influence on the protection class of the terminal box. It is strongly recommended to use appropriate cable glands in order to reach the rated protection class. Copeland recommends that installers/service providers pay attention to this aspect and use cable glands according to EN standards or any other relevant standard of application in their country/region every time they install or replace a scroll compressor. **Figures 20 & 21** show examples of correct electrical installations.



Figure 20: Electrical installation with cable glands, terminal box IP21

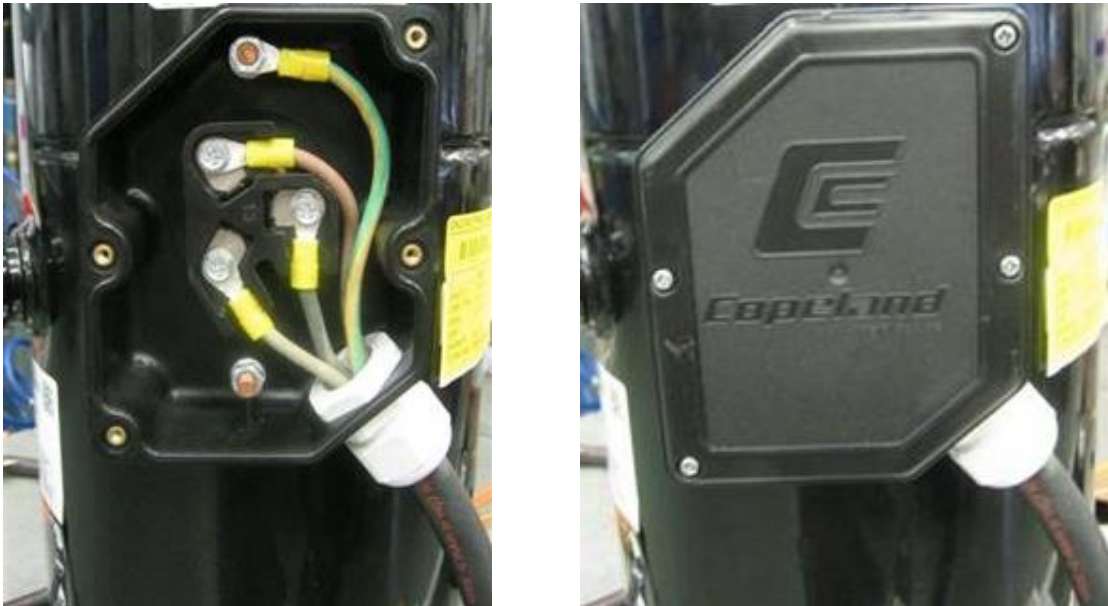


Figure 21: Electrical installation with cable glands, terminal box IP54

A moulded plug version is available as an option for compressor models ZB*KCE in BOM 651 version. The moulded plug version is compliant with all CE and safety regulations and its protection class is IP66.

The benefits of the moulded plug version include ease of installation, reduced assembly time and consequent reduced customer's applied costs. Several conductor cable diameters and lengths are available.

4.4 Motor windings

The ZB*KCE, ZB*K5E and ZF*K5E compressors covered in these guidelines have a three-phase induction motor. All three-phase motors are connected in star.

4.5 Motor insulation

The motor insulation material is class "B" (**TF***) for all ZB*KCE, ZB*K5E and ZF*K5E compressor models.

4.6 Motor protection

In addition to 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 all the compressor models covered in these guidelines.

4.7 High-potential testing



WARNING

Conductor cables! Electrical shock hazard! 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.

Copeland 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.

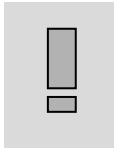
Since high-voltage tests lead to premature ageing of the winding insulation, further additional tests of that nature are not recommended. However, if absolutely needed, they should be conducted with a lower voltage than described above. DO NOT perform any high-potential test when the compressor is charged with refrigerant. Disconnect all electronic devices prior to testing.

5 Starting up & operation



WARNING

Diesel effect! System explosion! 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 7.5 kg. Turn the crankcase heater on 12 hours before starting the compressor.

5.1 Strength pressure test

5.1.1 Compressor strength-pressure test

The compressor has been strength-pressure tested in the Copeland factory. Therefore, it is not necessary for the system manufacturer/installer to strength-pressure test the compressor again.

Scroll compressors are divided into two pressure zones. The compressor high-side and low-side maximum allowable pressures PS have to be respected at all times.

5.1.2 System strength-pressure test

A strength-pressure test of individual sections of the entire system is permitted. Once the compressor is isolated, the rest of the system can be tested with the required pressure values. The strength-pressure test can also be conducted with the compressor connected, but in that case the two pressure zones of the scroll compressor need to be respected:

- System high-pressure section:
 - Define the system high-side PS $\leq$ compressor high-side PS.
 - Isolate the high- and low-pressure sections of the system by closing valves, solenoid valves, expansion valves or by other means.
 - Use the internal check valve of the compressor on the discharge side or add an external check valve. To protect the compressor internal check valve, observe a maximum pressure delta of ≤ 40 bar between the high-pressure side and the low-pressure side.
 - Activate the check valve with a fast pressure increase. Once the check valve is activated, the pressure increase can be slowed down.
 - At this stage the system test pressure of $1.1 \times$ system high-side PS can be applied for a short time.
 - During the system test, make sure the pressure inside the compressor does not exceed the maximum PS value, which corresponds to the compressor low-pressure PS.
- System low-pressure section:
 - Define the system low-side PS $\leq$ compressor low-side PS.
 - The system test pressure of $1.1 \times$ system low-side PS can be applied for a short time.

5.2 Compressor tightness test



WARNING

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



CAUTION

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

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

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.

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

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. 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. 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.

The installation should be evacuated down to an absolute pressure of 3 mbar. Subsequently, the factory holding charge of dry air in the compressor is released to the ambient. The shut-off valves are opened and the installation - including the compressor - is once more evacuated as described after the system has been recharged with dry nitrogen.

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.

When working on systems filled with refrigerant, it may be necessary to repeat the evacuation process several times. Refrigerant may have dissolved in the refrigerant oil and will only gradually condense out.

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 compressor with a restricted suction or with the low-pressure limiter bridged. Do not operate compressor without enough system charge to maintain at least 0.3 bar suction pressure. Allowing the suction pressure to drop below 0.3 bar 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 refrigerant system must be leak- and pressure-tested with appropriate purging gas.

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

The system should be liquid-charged through the liquid-receiver shut-off valve or through a valve in the liquid line. The use of a filter-dryer in the charging line is highly recommended. Because scrolls have discharge check valves, systems should 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 should 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 system with refrigerant.

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 ZB*KCE, ZB*K5E and ZF*K5E compressors to attain the published performance are 16 hours at the standard conditions.

5.7 Initial start-up



CAUTION

Oil dilution! Bearing malfunction! It is important to ensure that new compressors are not subjected to liquid abuse. Turn the crankcase heater on 12 hours before starting the compressor.



CAUTION

High discharge pressure operation! Compressor damage! Do not use compressor to test opening set point of high-pressure cut-out. Bearings 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 the 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. 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 or heating. 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 Start-up and shut-off sound

During the very brief start-up, a clicking sound resulting from the initial contacting of the spirals is audible; this sound is normal. Thanks 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.

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 too and it has no effect on compressor durability.

5.10 Deep vacuum operation



CAUTION

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

The scroll compressor can be used to pump down refrigerant in a unit as long as the pressures remain within the operating envelope. Low suction pressures will result in overheating of the scrolls and permanent damage to the compressor drive bearing or will cause the ASTP to activate. Copeland scroll compressors incorporate internal low vacuum protection; the floating seal unloads when the pressure ratio exceeds approximately 10:1 for ZB* and 20:1 for ZF* compressors.

5.11 Shell temperature

The top shell and discharge line can briefly but repeatedly reach temperatures above 177 °C if the compressor cycles on its internal protection devices. This only happens under rare circumstances and can be caused by the failure of system components such as the condenser or evaporator fan or loss of

charge and depends upon the type of expansion control. 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.

To control refrigerant migration a pumpdown system should be used. The discharge check valve with a refrigeration scroll compressor is designed for low leak back and will allow the use of a pumpdown without the addition of an external check valve.

If the compressor is stationary for prolonged periods, refrigerant could migrate into the compressor and therefore a crankcase heater must be installed.

If cold air is constantly drawn over the compressor this could make the crankcase heater ineffective and therefore a pumpdown system is recommended.

Caution: in ZB* models, the scroll sets will unload at a pressure ratio of approximately 10:1. If the unit fails to pump down, the pumpdown pressure should be reset to a higher value. The low-pressure control differential for all models needs to be reviewed since a relatively lower volume of gas will re-expand from the discharge plenum of the compressor into the low side on shutdown.

5.13 Minimum run time

Copeland 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 Copeland. Install the sample compressor in a system with the longest connecting lines that are approved for the system. 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 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 3rd letter of the motor code indicates which supplied frequency and voltage must be applied – see **section 2.2 "Nomenclature"**.

For example, motor code TFD:

- T = Three-phase motor
- F = Internal motor protection
- D = Voltage and frequency range

50 Hz	60 Hz	Code
220-240 V / 1 ph	265 V / 1 ph	J
380-420 V / 3 ph	460 V / 3 ph	D
220-220 V / 3 ph	200-230 V / 3 ph	5

Table 8: Explanation of the 3rd letter of the electrical code

5.15 Oil level

The oil level should be maintained at mid-point of the sight glass. If an oil regulator is used the level should be set within the top half of the sight glass.

6 Maintenance & repair



WARNING

Conductor cables! Electrical shock hazard! 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 the refrigerant before opening the system. Avoid working with an unshielded flame in a refrigerant-charged system.

6.1 Qualification of workers

Personnel working on the maintenance, repair and decommissioning of the system shall be adequately trained. Any work procedure affecting safety shall only be executed by qualified and trained personnel in compliance with national or other equivalent certification systems. Examples of such work procedures are:

- breaking into the refrigerating circuit;
- opening sealed components;
- opening ventilated enclosures;
- etc...

6.2 Rotalock valves

Rotalock valves should be periodically re-torqued to ensure that leak tightness is maintained.

6.3 Exchanging the refrigerant



CAUTION

Low suction pressure operation! Compressor damage! Do not operate compressor with a restricted suction or with the low-pressure limiter bridged. Do not operate 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.

Qualified refrigerants and oils are shown in **section 2.4.1**.

It is not necessary to replace the refrigerant with new unless contamination due to an error such as topping up the system with an incorrect refrigerant is suspected. To verify correct refrigerant composition, a sample can be taken for chemical analysis. A check can be made during shutdown 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.

In the event that the refrigerant needs replacing, the charge should be recovered using a suitable recovery unit.

6.4 Disassembling system components

The recommendations below shall be observed when disassembling system components:

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.

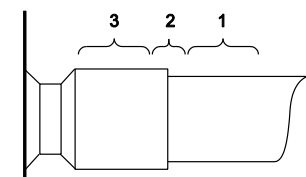


Figure 22: Tube connecting areas

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 re-connected into 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.

6.5 Replacing a compressor



CAUTION

Inadequate lubrication! Bearing destruction! For systems with a 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 refrigerant and oil completely from the replaced compressor.

6.5.1 Compressor replacement

In case of motor burnout, most of the contaminated oil will be removed with the compressor. The rest of the oil is cleaned through the use of suction and liquid line filter-dryers. A 100 % activated alumina filter-dryer is recommended for the suction line. It must be removed after 72 hours.

It is highly recommended that the suction accumulator be replaced if the system contains one. This is because the accumulator oil return orifice or screen may be plugged with debris or may become plugged shortly after a compressor failure. This will result in starvation of oil to the replacement compressor and a second failure.

When a compressor is exchanged in the field, it is possible that a large portion of the oil remains 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.

6.5.2 Start-up of a new or replacement compressor

Rapid charging only on the suction side of a scroll-equipped system or condensing unit can occasionally result in a temporary no start condition for the compressor. The reason for this is that, if the flanks of the compressor 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 of 1.75 bar must be maintained during charging. Allowing the suction pressure to drop below 0.3 bar for more than a few seconds 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 flow. **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.

6.5.3 Compressor return procedure

Compressors from systems with A1 refrigerant can be sent back to Copeland for diagnosis with closed connections and the oil filling inside. However, the refrigerant should be removed.

- The compressor must be kept in the upright position – mark the box accordingly.
- If more than one compressor must be returned, each compressor has to be packed individually.

NOTE: Check with the transport company that all the requirements applying to such shipments are complied with.

6.6 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 R404A, R407A, R407C, R407F, R448A, R449A, R134a and R22 is a polyolester (POE) lubricant Emkarate RL32 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 oil is that it is far more hygroscopic than mineral oil – see **Figure 22**. 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.

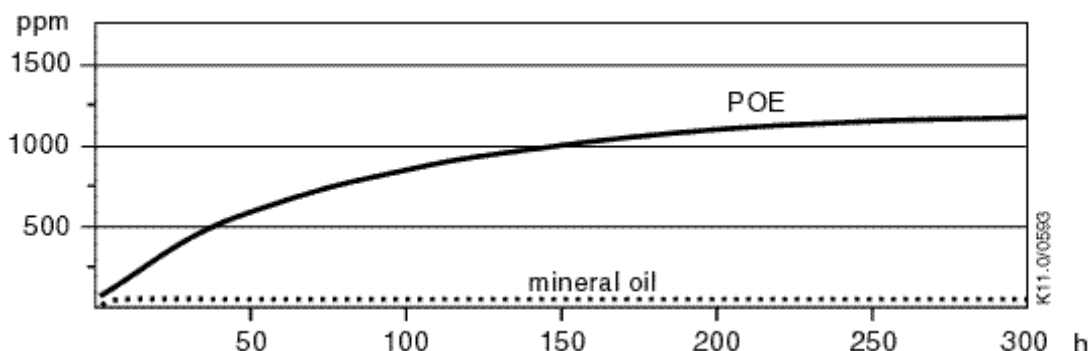


Figure 23: Absorption of moisture in ester oil in comparison to mineral oil in ppm by weight at 25 °C and 50 % relative humidity (h=hours)

Copeland compressors contain oil with low moisture content, which however may rise during the system assembling process. Therefore, it is recommended to install a properly sized filter-dryer in all POE systems to maintain the moisture level in the oil to less than 50 ppm. If POE oil is charged into a system, it is recommended that its moisture content be no higher than 50 ppm.

If the moisture content of the oil reaches unacceptably high levels, corrosion and copper plating may occur. The system should be evacuated down to 3 mbar in accordance with EN 378-4. Sight glass/moisture indicators can be used with HFC refrigerants and lubricants. However, they will only show the moisture content of the refrigerant. The actual moisture level in the oil is likely to be higher than indicated by the sight glass. This is due to the high hygroscopicity of POE oil. If there is uncertainty as to the moisture content in the system, or to measure the actual moisture level, oil samples should be taken and analysed.

6.7 Oil additives

Although Copeland 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 Dismantling & disposal



Removing oil and refrigerant:

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

Dispose of compressor in accordance with national legislation and regulations.

8 References

Please visit www.copeland.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.copeland.com/en-gb/tools-resources.

Spare parts and accessories:

An online version of the Copeland spare parts and accessories catalogue is available from the webpage www.copeland.com/en-gb/tools-resources.

Appendix 1: Tightening torques

Connection	Torque (Nm)
Rotalock 1 ¼"	100 - 110
Rotalock 1 ¾"	170 - 180
External sight glass 1 ¼"	46 - 53
Mounting bolts M8 (grommets for single operation)	13 ± 1
Mounting bolts M9, 5/16" (hard mounting parts for parallel operation)	27 ± 1
Crankcase heater	2.3 - 2.5
DTC valve on ZF injection fitting	24 - 27
Terminal block screw	2.8 / 1.5 - 2.1
Ground screw	2.4 - 2.6

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