Copeland scroll compressors for air conditioning

ZR18K to ZR380K**

ZP24K to ZP485K**

COPELAND

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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 relevant European, UK and US safety standards. Particular emphasis has been placed on the user's safety.

These compressors 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.

The Material Safety Datasheet (MSDS) of each individual refrigerant shall be considered – please check the 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 (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. Refrigerant oil 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 for air-conditioning and heat-pump applications, from ZR18K* to ZR380K* and from ZP24K* to ZP485K*.

These compressors have one scroll compression set driven by a single or 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.

Compressor	Cooling capacity (kW)			Motor
	R407C	R134a	R22	
ZR18K5E	3.78	N/A	N/A	PFJ
ZR22K3E	4.54	3.61	5.33	PFJ/TFD
ZR28K3E	5.88	4.74	6.98	PFJ/TFD
ZR34K3E	7.04	5.55	8.32	PFJ/TFD
ZR40K3E	8.22	6.49	9.8	PFJ/TFD
ZR48K3E	10.10	7.74	11.85	PFJ/TFD
ZR61KCE	12.7	10.05	14.5	PFZ/TFD
ZR61KSE	12.80	N/A	N/A	TFD
ZR72KCE	14.75	11.8	17.6	TFD
ZR81KCE	16.7	13.3	19.9	TFD
ZR94KCE	20.6	15.2	23.3	TFD
ZR108KCE	23	17.8	26.4	TFD
ZR125KCE	27	20.7	31.1	TFD
ZR144KCE	30.9	23.3	35.2	TFD
ZR160KCE	33.4	25.7	38.1	TFD
ZR190KCE	39.3	30.7	45.3	TFD
ZR250KCE	52.2	39.5	59.8	TWD
ZR310KCE	65.0	49.2	74.2	TWD
ZR380KCE	80.1	61	91.2	TWD

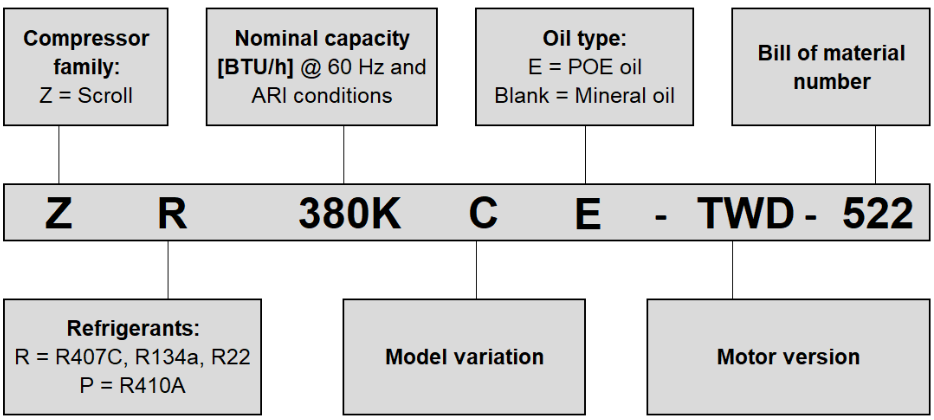
Compressor	Cooling capacity (kW)	Motor
	R410A	
ZP24K5E	5.05	PFJ/TFD
ZP29K5E	6.03	PFJ/TFD
ZP31K5E	6.50	PFJ/TFD
ZP36K5E	7.62	PFJ/TFD
ZP42K5E	8.89	PFJ/TFD
ZP54K5E	11.45	PFJ/TFD
ZP61K5E	13.35	TFD
ZP72KCE	15.25	TFD
ZP83KCE	17.65	TFD
ZP91KCE	19.25	TFD
ZP104KCE	22.70	TFD
ZP122KCE	26.50	TFD
ZP137KCE	29.00	TFD
ZP143KCE	31.60	TFD
ZP154KCE	33.10	TFD
ZP182KCE	39.00	TFD
ZP233KZE	50.60	TED
ZP293KZE	63.30	TED
ZP385KCE	82.30	TWD
ZP485KCE	105.00	TWD

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* & ZP* model overview for high temperature applications

2.2 Nomenclature

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



***ARI conditions:**

Evaporating temperature...........7.2 °C
Condensing temperature...........54.4 °C
Suction gas superheat ....11 K
Liquid sub-cooling ....8.3 K
Ambient temperature ....35 °C

2.3 BOM variations

The BOM (bill of material) number at the end of the compressor designation indicates the different compressor layouts and details. Please see below table for the most standard BOM version examples available for ZR* and ZP* compressor models:

BOM	Suction and discharge connections	Electrical connections	Mounting parts	Features
422	Brazing stub tubes	T-box, IP21	Without	Tandem-ready extra connections
455			Without	
522			Rubber mounting parts for single operation	
930				Service version
950				Service version
961	Rotalock	IP54		Service version
977	Brazing stub tubes	IP54		Service version
ZP232/292KZE & ZP233/293KZE models				
404	Brazing stub tubes	IP54	Without	24 VAC module, Rotalock gas equalization
406				230 VAC module, Rotalock gas equalization
417				24 VAC module, brazed gas equalization
429				230 VAC module, brazed gas equalization
455				24 VAC module
456				230 VAC module
468				24 VAC module, tandem ready
469				230 VAC module, tandem ready

Table 2: BOM designations

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.

2.4 Application range

2.4.1 Qualified refrigerants and oils

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

Compressors	ZR*		ZP*
Qualified refrigerants	R22	R407C, R134a, R22	R410A
Qualified oils (factory charged)	White oil Suniso 3 GS	Emkarate RL32 3MAF	
Servicing oils	White oil Suniso 3 GS	Emkarate RL32 3MAF	
		Mobil EAL Arctic 22 CC	Mobil EAL Arctic 22 CC (max 50% of total oil charge)

Table 3: 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 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 x 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 (litres)	
				LP side	HP side
ZR18K* to ZR81K*	21 bar(g)	29 bar(g)	50 °C	N/A	N/A
ZR94KCE to ZR144KCE	20 bar(g)	32 bar(g)	52 °C	12.6	1.5
ZR160/190KCE	20 bar(g)	32 bar(g)	52 °C	12.9	1.5
ZR250KCE	20 bar(g)	32 bar(g)	52 °C	21.1	4.1
ZR310KCE	20 bar(g)	32 bar(g)	52 °C	32.1	4.4
ZR380KCE	20 bar(g)	32 bar(g)	52 °C	28.7	4.4
ZP24K* to ZP143K*	29.5 bar(g)	45 bar(g)	50 °C	N/A	N/A
ZP137KCE	29.5 bar(g)	45 bar(g)	50 °C	12.6	1.5
ZP154/182KCE	29.5 bar(g)	45 bar(g)	50 °C	12.9	1.5
ZP235KCE	29.5 bar(g)	45 bar(g)	50 °C	21.1	4.1
ZP285/295KCE	29.5 bar(g)	45 bar(g)	50 °C	29.1	4.4
ZP385KCE	29.5 bar(g)	45 bar(g)	50 °C	28.7	4.4
ZP485KCE	29.5 bar(g)	45 bar(g)	50 °C	29.5	4.3
ZP233/293KZE	30.4 bar(g)	50 bar(g)	50 °C	12.8	2.5

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 ZR*/ZP* compressors covered in these guidelines are operated with A1 (group 2) refrigerants.

Compressor range	Refrigerants	Fluid group	PED category
ZR18K* to ZR81K*	R410A	2	I
ZR94KCE to ZR380KCE	R410A	2	II
ZP24K* to ZP91K*	R407C, R134a, R22	2	I
ZP104K* to ZP485K*	R407C, R134a, R22	2	II

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

2.6 Dimensions

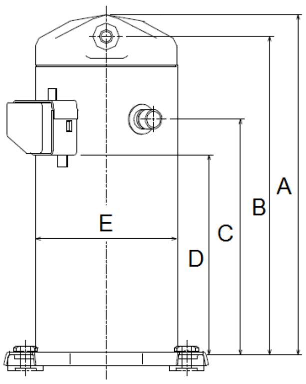


Figure 1: Drawing A

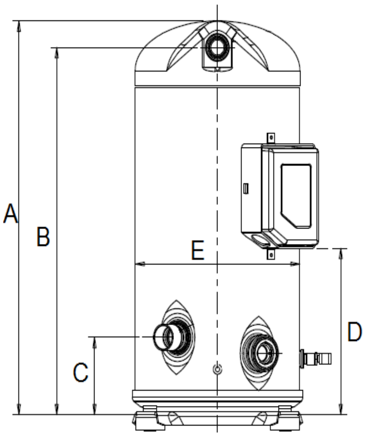


Figure 2: Drawing B

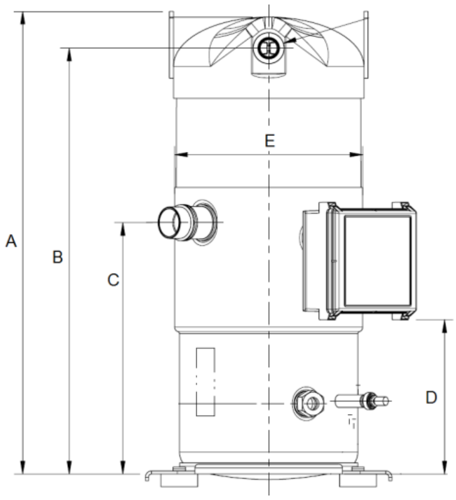


Figure 3: Drawing C

Compressor model	Drawing	A ± 3	B	C ± 3	D ± 3	E
ZR18K5E	A (Fig.1)	387.4	361.7	256.1	---	Ø 139.6
ZP24K5E, ZP29K5E, ZP31K5E		385-391	359.3-365.3	260.4-266.4	221.6-227.6	
ZR22K3E, ZR28K3E		363	338.4	244.6	202.4	Ø 165.5
ZR34K3E		386.5	361	264.5	222.3	
ZR40K3E		400.3	374.8	277.3	235.1	
ZR48K3E		417	391.7	294.2	252	
ZR61KSE		414.2-420.2	388.6-394.6	280.5-286.5	238.9-244.9	
ZP36K5E, ZP42K5E		415.2-421.2	389.6-395.6	292.1-298.1	250.5-256.5	Ø 167.1
ZP54K5E		415.2-421.2	389.6-395.6	292.1-298.1	221.4-227.4	
ZP61K5E		426.5-432.5	400.3-406.3	292.1-298.1	221.4-227.4	
ZR61KCE, ZR72KCE		434.9-440.9	409.8	296.7	230.4-236.4	Ø 185.5
ZR81KCE		440.4-446.4	413.9	296.7	230.4-236.4	
ZP72KCE, ZP83KCE, ZP91KCE		440.6-446.2	410.8	297.9	231.4-237.4	
ZP104KCE, ZP122KCE, ZP143KCE		558.9	526.5	370;2	284.7	
ZR94KCE	B (Fig. 2)	476.3	444.3	93.6	201.5	Ø 232.2
ZR108KCE, ZR125KCE, ZR144KCE ZP103KCE, ZP120KCE, ZP137KCE, ZP137KPE		533.1	501.2	122.4	242.8	
ZR160KCE, ZR190KCE, ZP154KCE, ZP182KCE, ZP154KPE, ZP182KPE		551.5	519.5	140.5	181 (TW) 261.2 (TF)	
ZP232KZE, ZP292KZE (except TND)	C (Fig. 3)	661.5	614.5	439		
ZP232KZE, ZP292KZE (TND)		691.5	642.8	444	269	
ZP233KZE, ZP293KZE		691.5	642.8	444	310.3	
ZR250KCE, ZP235KCE		717.1	667.1	333.5	277	Ø 289
ZR310KCE, ZR380KCE, ZP295KCE, ZP385KCE, ZP385KPE		715.1	659.7	375.3	273.3	Ø 331
ZP485KCE, ZP485KPE		746.1	690.7	406.3	304.1	

Table 6: Compressor dimensions in mm & corresponding drawings

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 4**. 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 4: 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.

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.

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

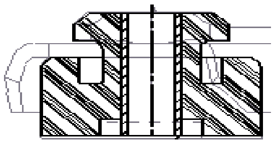
Ensure the compressors are installed on a solid level base. For single compressor applications, the compressor tilt angle during operation should not exceed 15 °C to allow adequate lubrication. For multiple compressor parallel configurations, the compressors must be positioned completely vertically on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

3.2 Mounting parts

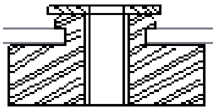
The compressors are designed to be mounted on vibration absorber grommets. Four grommets are required for each compressor. They dampen the start-up surge of the compressor and minimise sound and vibration transmission to the compressor base during operation. The metal sleeve inside is a guide designed 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.

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

Mounting parts: ZR18K* to ZR190K* & ZP24K* to ZP182K* - Soft mountings



Mounting parts: ZR250K* to ZR380K* & ZP235K* to ZP485K* - Soft mountings




Mounting parts: ZP232/292KZE, ZP233/293KZE - Soft mountings

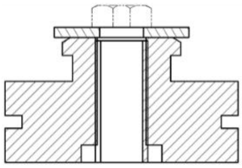



Figure 5: Mounting parts with sleeves and washers

NOTE: **For more information please refer to Technical Information TI_Scroll_Mounting_01 "Copeland scroll compressors – Mounting parts".**

NOTE: **If the compressors are mounted in tandem or used in parallel, please refer to Technical Information TI_Scroll_ZR_ZP_Multiple "Copeland scroll compressors – Multiple-compressor assemblies in air-conditioning applications".**

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.

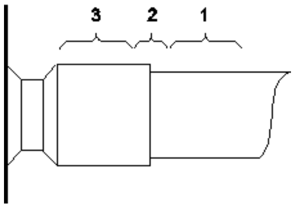


Figure 6: Brazing areas

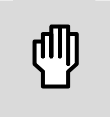
Copeland scroll compressors have copper-plated steel suction and discharge stub tubes. These stub tubes are far more robust and less prone to leaks than copper tubes. Make sure brazing is carried out in an appropriate manner taking into account the different thermal properties of steel and copper.

Refer to **Figure 6** and the 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 surface and tube outer surface 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.**

3.4 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.

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.

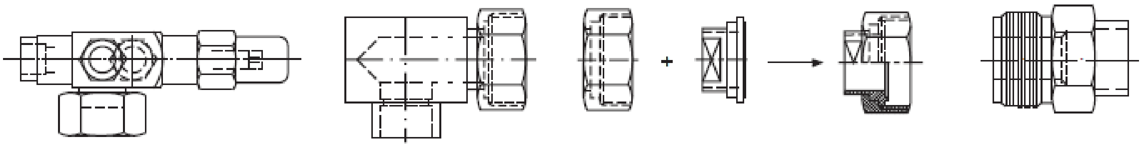


Figure 7:Shut-off valves and connection adapters

Depending on the BOM version, some compressor versions are available with Rotalock connections, others with brazing stub tubes.

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

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

More information about adaptors and shut-off valves can be found in the Copeland 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.

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.

Even though ZR*/ZP* compressors have an internal discharge temperature protection, loss of system charge etc. will result in overheating and recycling of the motor protector. Prolonged operation in this manner could result in oil pump-out and eventual bearing failure.

Normally, the low-pressure cut-out setting should be within the approved operating envelope of the compressor considering the refrigerant used.

For air-conditioning applications with R410A, a cut-out setting not lower than 4.4 bar(g) is recommended.

For heat pump applications with R410A, a cut-out setting not lower than 2 bar(g) is recommended. Operation near a saturated suction temperature of -28 °C is outside the approved operating envelope of the compressor. However, heat pumps in some geographical areas should operate in this range because of the low ambient temperatures. This is acceptable if the discharge temperature is below 130 °C.

These conditions can also be due to temporary suction blockage during reversing valve operation or lack of liquid pressure available to the metering device upon start-up in heating mode.

An alternative is to keep the low-pressure control in the suction line and provide a 60-second maximum low-pressure time delay that ignores a signal from the low-pressure control and allows the compressor to continue operating.

The low-pressure cut-out, if installed in the suction line to the compressor, can provide additional protection against an expansion valve failed in the closed position, outdoor fan failure in heating, a closed liquid line or suction line service valve, or a blocked liquid line screen, filter, orifice, or expansion valve. All of these conditions may starve the compressor for refrigerant and may result in compressor failure.

The low-pressure cut-out should be selected to prevent system failure modes such as coil icing in air conditioning systems and frozen heat exchangers in chiller systems.

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

3.5.3 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 the charge limits indicated in **Table 7** below. 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.**

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!

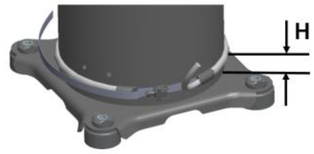
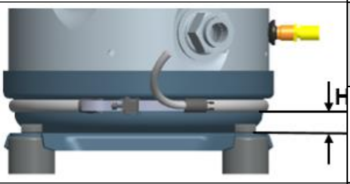
Compressors		Refrigerant charge limit	Crankcase heater	
			Position	Height
ZR18K5E	ZP24K5E to ZP31K5E	2.7 kg		5 - 31 mm
ZR223E to ZR48 3E ZR61 KSE	ZP23K3E to ZP41K3E ZP36K5E to ZP61K5E	4.5 kg		5 - 12 mm
ZR61KCE, ZR72KCE, ZR81KCE	ZP61KCE, ZP72KCE, ZP83KCE, ZP91KCE, ZP104KCE, ZP122KCE, ZP143KCE	4.5 kg		9.5 - 41 mm
ZR94KCE, ZR108KCE, ZR125KCE, ZR144KCE	ZP90KCE, ZP103KCE, ZP120KCE, ZP137K*E	7.0 kg		14 - 24 mm
ZR160KCE, ZR190KCE	ZP154K*E, ZP182K*E	7.0 kg		13 - 18 mm
	ZP232/292KZE, ZP233/293KZE	9 kg		10 - 15 mm
ZR250KCE	ZP235KCE	11.3 kg		32 - 50 mm
ZR310KCE, ZR380KCE	ZP295KCE, ZP385K*E	13.6 kg		
	ZP485K*E	16.0 kg		

Table 7: Refrigerant charge limits & crankcase heater position

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

Assembly instructions

- Choose 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. 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

- 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.

3.5.4 Soft starters

Copeland scroll fixed-speed compressors 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. Normally, 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 soft starters are available from Copeland upon request, while three-phase soft starters are available on the market.

3.6 Discharge gas temperature protection

CAUTION
Inadequate lubrication! Scroll set damage! All ZR* and ZP* 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.**

3.6.1 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.

3.6.2 Internal thermo-disc

ZR18K* to ZR81K*, ZP24K* to ZP91K*, ZP104K*, ZP122K* and ZP143K* compressor models 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.

3.6.3 Advanced Scroll Temperature Protection (ASTP)

ZR94K* to ZR190K*, ZP90K*, ZP103K*, ZP120K*, ZP137K*, ZP154K* and ZP182K* (Summit range), ZP232K* and ZP292K* 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 purposes.**

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 120 °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.

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

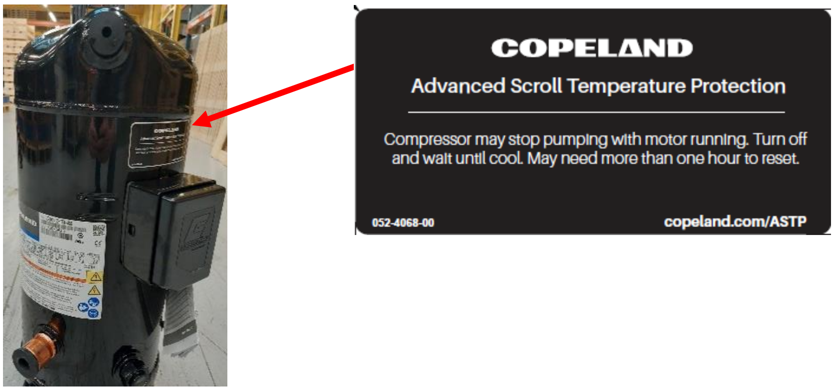


Figure 12: Scroll compressor with Advanced Scroll Temperature Protection (ASTP) sticker

***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.**

3.6.4 Temperature protection with Kriwan module

For compressors ZR250K* to ZR380K*, ZP235K*, ZP295K*, ZP385K* and ZP485K*, a thermistor (PTC) is located in the discharge port of the fixed scroll. Excessive discharge temperature will cause the electronic protector module to trip. The discharge gas thermistor is wired in series with the motor thermistor chain.

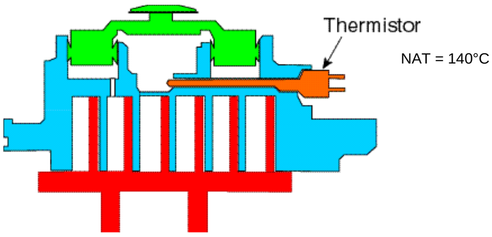


Figure 13: Internal discharge temperature thermistor

3.6.5 Thermal probe NTC protection

Models ZP232/292KZE (TN*) and ZP233/293KZE (TE*) are equipped with thermal probe NTC protection connected with the electronic module board. The module will trip when the NTC probe reaches 140 °C.

3.7 Internal pressure relief valve

There is an internal pressure relief valve on all ZR18K* to ZR81K*, ZP24* to ZP91K*, ZP104K*, ZP122K* compressors, which opens at a differential pressure of 28 ± 3 bar for ZR* compressors and 40 ± 3 bar for ZP* compressors between high- and low-pressure sides.

A high-pressure cut-out may be required according to national regulations and is strongly recommended due to the capabilities of pumping to high pressures once the discharge is obstructed.

The internal pressure relief valve is a safety device, not an HP switch. It is not designed for repeated operation and there is no guarantee that it will reset correctly if it does have repeated operation.

The following compressors DO NOT have any internal pressure relief valve: ZR94K* to ZR190K* and ZP90K* to ZP182K* (Summit range), ZR250K* to ZR380K*, ZP232/292KZE, ZP233/293KZE and ZP485K*.

3.8 Discharge check valve

ZP232/292KZE and ZP233/293KZE compressors use a shutdown check valve located on the muffler plate to prevent the high-side, high-pressure discharge gas from flowing rapidly back through the compressor after shutdown. The leak rate may not be sufficiently low for recycling pumpdown. An external discharge check valve may be necessary for such applications.

NOTE: **This check valve cannot be used with recycling pumpdown because it is not entirely leak-proof.**

3.9 Variable Volume Ratio or VVR discharge valve

ZP232/292KZE and ZP233/293KZE compressors use a Variable Volume Ratio discharge valve. This valve is optimized to increase the seasonal performance with low pressure ratio.

3.10 Filter 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.

3.11 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 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.

3.12 Reversing valves

Since Copeland scroll compressors have a very high volumetric efficiency, their displacements are lower than those of comparable capacity reciprocating compressors. As a result, Copeland recommends that the capacity rating on reversing valves be no more than 1.5 to 2 times the nominal capacity of the compressor in order to ensure proper operation of the reversing valve under all operating conditions.

Caution: Reversing valve sizing must be within the guidelines of the valve manufacturer. The pressure drop required to ensure valve shifting must be measured throughout the operating range of the unit and compared to the valve manufacturer's data. Low ambient heating conditions with low flow rates and low pressure drop across the valve can result in a valve not shifting. This can result in a condition where the compressor appears not to be pumping, ie, balanced pressures. It can also result in elevated compressor sound levels.

During a defrost cycle, when the reversing valve abruptly changes the refrigerant flow direction, the suction and discharge pressures will go outside of the normal operating envelope. The sound that the compressor makes during this transition period is normal, and the duration of the sound will depend on the coil volume, outdoor ambient, and system charge level. The preferred method of mitigating defrost sound is to shut down the compressor for 20 to 30 seconds when the reversing valve changes position going into and coming out of the defrost cycle. This technique allows the system pressures to reach equilibrium without the compressor running. The additional start-stop cycles do not exceed the compressor design limits, but suction and discharge tubing design and contactor life should be evaluated.

The reversing valve solenoid should be wired so that the valve does not reverse when the system is shut off by the operating thermostat in the heating or cooling mode. If the valve is allowed to reverse at system shut-off, suction and discharge pressures are reversed to the compressor. This results in pressures equalizing through the compressor which can cause the compressor to slowly rotate backwards until the pressures equalize. This condition does not affect compressor durability but can cause unexpected sound after the compressor is turned off.

3.13 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.

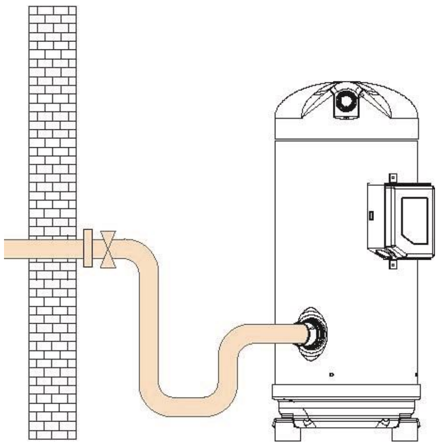


Figure 14: Suction tube design

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. The sound phenomena described above are not usually associated with reversible heat pump systems because of the isolation and attenuation provided by the reversing valve and tubing bends.

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)

3.14 Compressor oil return, oil balancing, refrigerant floodback & oil dilution tests

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

The 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, mass flow and density.

For system components such as suction accumulators, the extra amount of oil which will be required in the system must be checked with the suppliers of these components. If needed, the system should be pre-charged accordingly including the additional oil quantity.

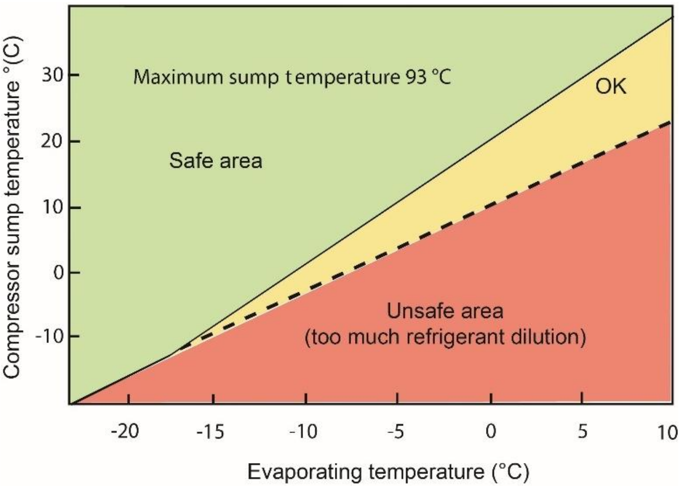
Once a new system design is set and assembled, a functional test is required. The functional test includes a qualification for the general system oil return, a refrigerant floodback test and an oil dilution test. Systems with multiple compressors (two, three, or more) require additional oil balancing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

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

Records of the evaporating temperature and the bottom shell temperature shall be taken with a high sampling rate during the entire oil return or oil balance testing and under all tested conditions. The liquid level in the sight tube has to be observed and recorded too. Testing conditions shall include defrost and varying loads. If the system is reversible, the 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, liquid floodback and oil dilution. For discussion of individual test results and system behaviour, eg, with regard to oil dilution, please contact the Application Engineering department. 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 floodback and oil dilution, all possible transient operation conditions in the system should be checked, eg, compressor frequent start/stop, compressor start after long off time with migration, defrost, switching between the operation modes in reversible systems, load changes, fans or pumps cycling at low load and more. To evaluate the risk of liquid floodback and oil dilution, please refer to the chart in **Figure 15**.



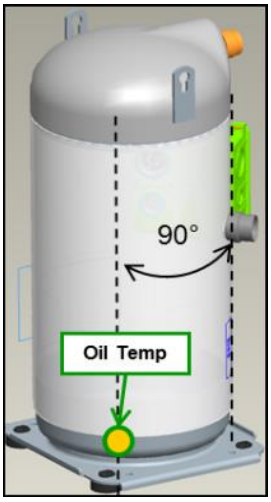


Figure 15: Dilution chart for transient operation

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 chart in **Figure 15**. 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 properly insulated and 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.

3.15 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.

Thanks to Copeland scroll compressors' inherent ability to handle liquid refrigerant in flooded start and defrost cycle operation, an accumulator is not required for durability 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, refrigerant floodback & oil dilution tests"**.

If an accumulator is used, the oil-return orifice should be sized based on compressor size and compressor floodback 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. Check with supplier whether an extra charge of oil for the suction accumulator is required. Pre-charge additional oil to the system accordingly.

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.

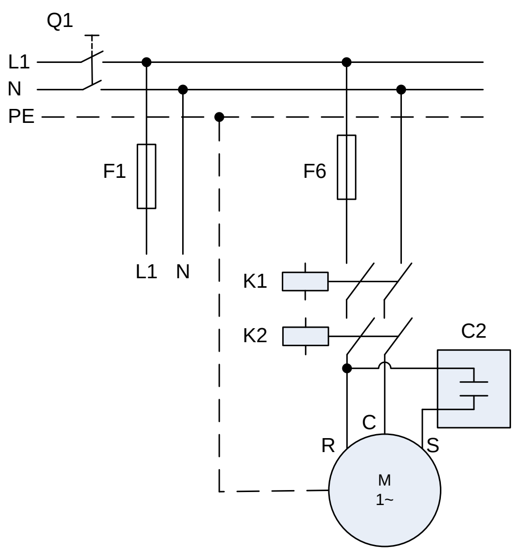
4.2 Electrical installation

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

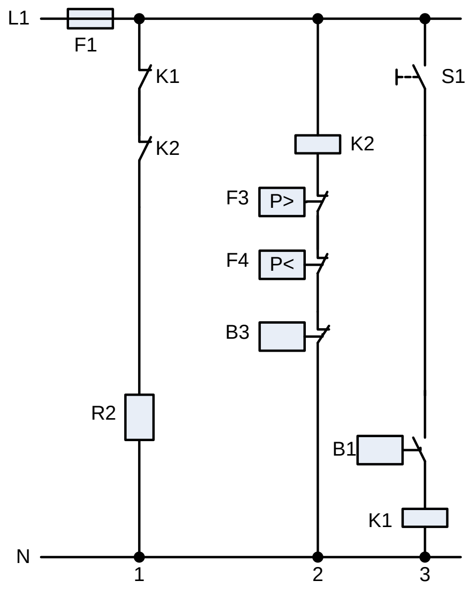
The recommended wiring diagrams are shown in figures hereunder.

Single-phase (PF*) compressors:

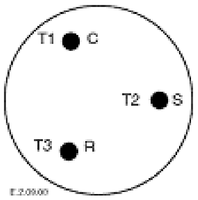
Power circuit



Control circuit



Motor terminal connections



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

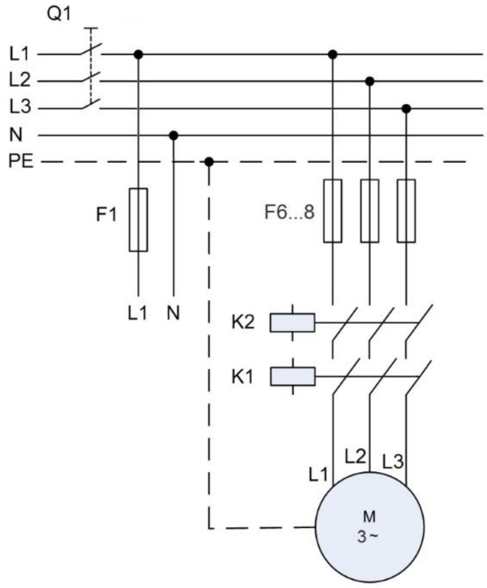
Legend

B1 .... Room thermostat	K1, K2 ....Contactors
B3 .... Discharge gas thermostat	Q1 ....Main switch
C2 .... Run capacitor	R2 ....Crankcase heater
F1, F6 .. Fuses	S1 ....Auxiliary switch
F3......... HP switch	
F4......... LP switch	

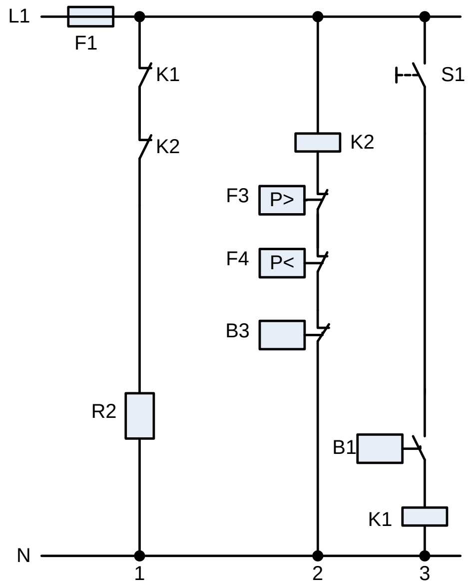
Figure 16: Wiring diagrams for single-phase compressors

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

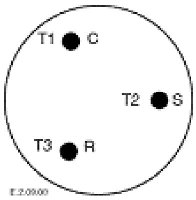
Power circuit



Control circuit



Motor terminal connections



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

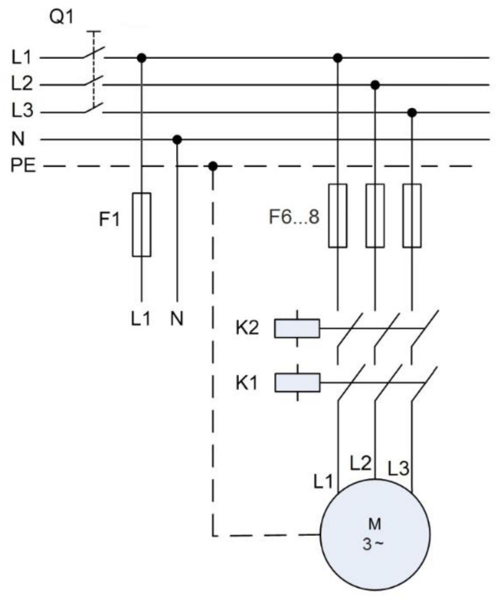
Legend

B1 .... Room thermostat
B3 .... Discharge gas thermostat
F1, F6, F8 .. Fuses
F3............... HP switch
F4............... LP switch
K1, K2 .... Contactors
Q1 .... Main switch
R2 .... Crankcase heater
S1 .... Auxiliary switch

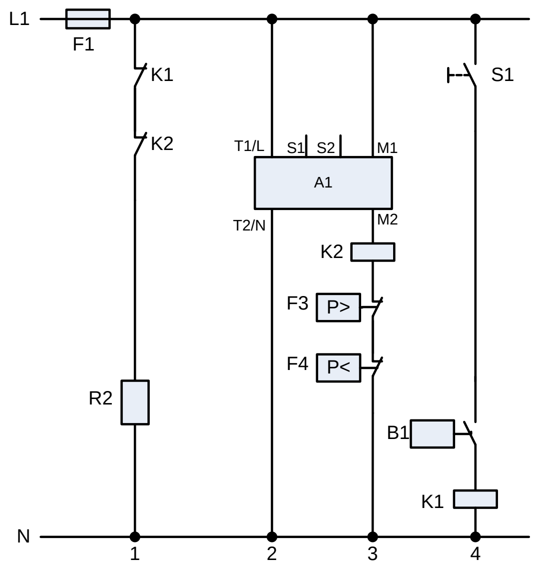
Figure 17: Wiring diagrams for three-phase compressors with internal motor protection

Three-phase compressors (TW*) with external motor protection INT69SC2:

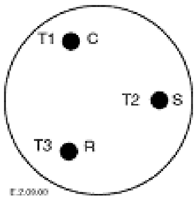
Power circuit



Control circuit



Motor terminal connections



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

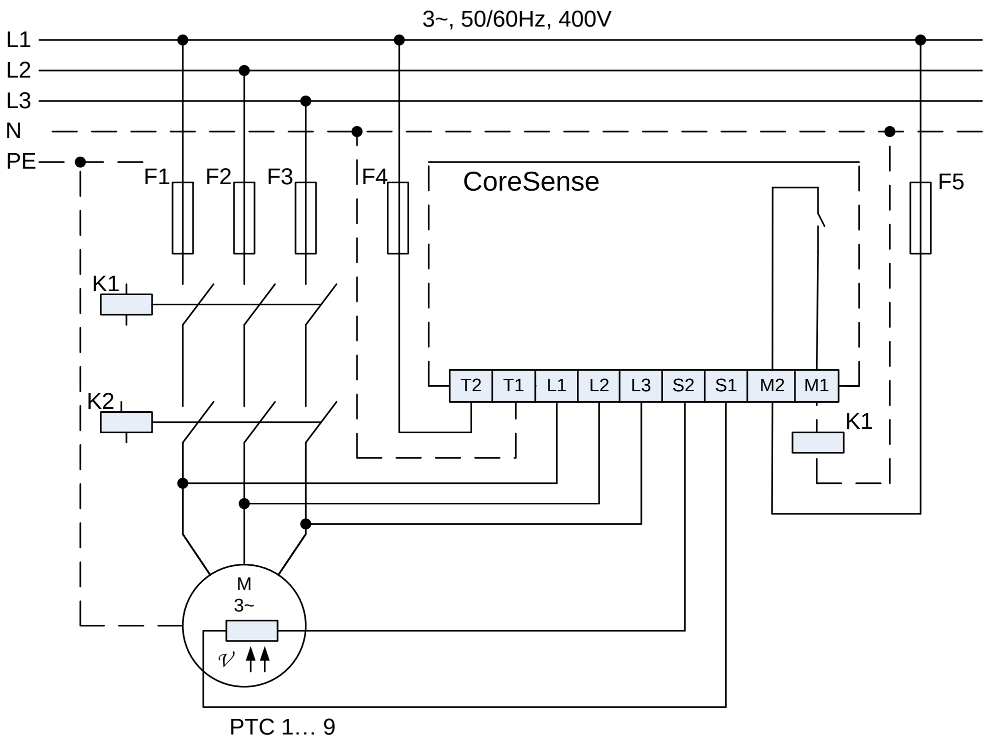
Legend

A1 .... Motor protection module INT69SC2
B1 .... Room thermostat
F1, F6, F8 .. Fuses
F3............... HP switch
F4............... LP switch
K1, K2 .... Contactors
Q1 .... Main switch
R2 .... Crankcase heater
S1 .... Auxiliary switch

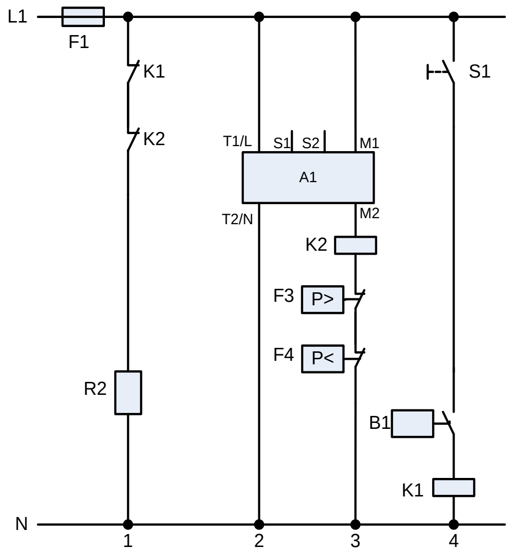
Figure 18: Wiring diagrams for three-phase compressors with Kriwan motor protection

Three-phase compressors (TE*) with external motor protection CoreSense™ Communications module (compressors ZP232/292KZE, ZP233/293KZE):

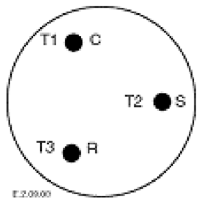
Power circuit



Control circuit



Motor terminal connections



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

Legend

A1 .... CoreSense module
B1 .... Room thermostat
F1, F6, F8 .. Fuses
F3............... HP switch
F4............... LP switch
K1, K2 ..... Contactors
Q1 .... Main switch
R2 .... Crankcase heater
S1 .... Auxiliary switch

Figure 19: Wiring diagrams for three-phase compressors with CoreSense Communications module

4.3 Terminal box

The standard terminal box is IP21 for all models with internal motor protection (T**F***/P**F***) and IP54 for all models with external motor protection (T**W***, T**E*** and T**N***), enclosure class 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 to 23** show examples of correct electrical installations.

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

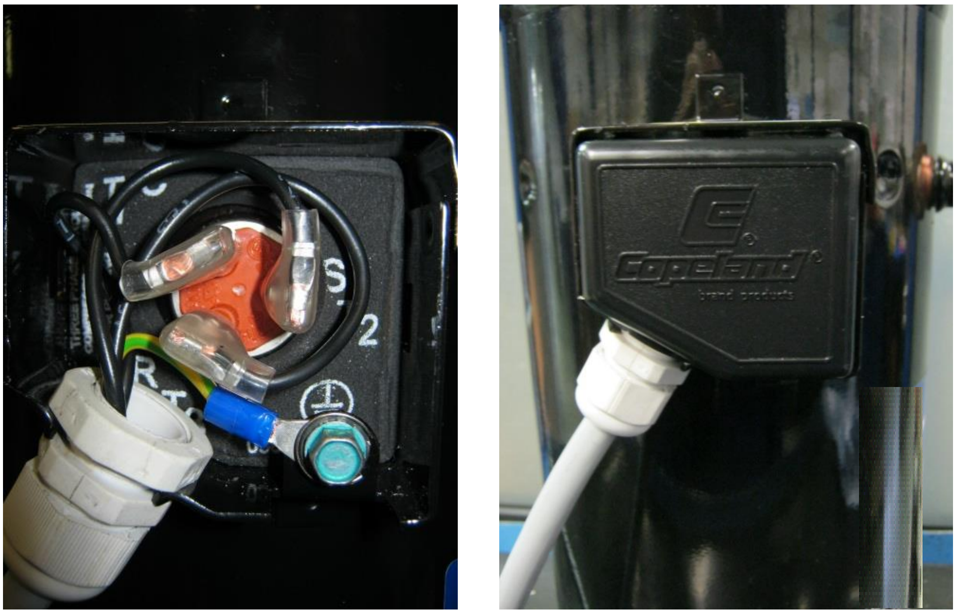


Figure 21: ZP24K* - Electrical installation with cable glands, terminal box IP21

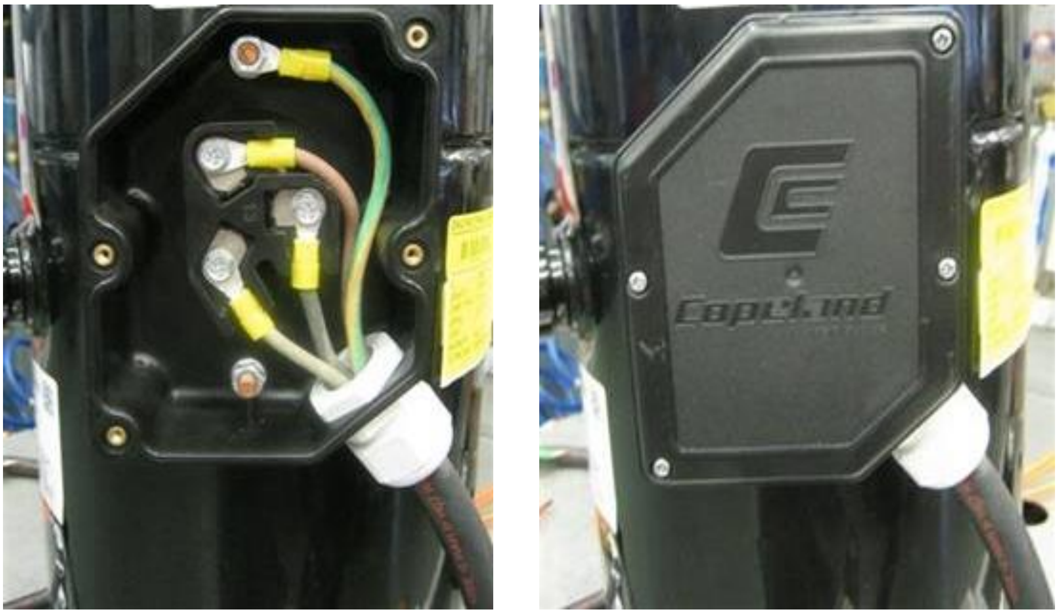


Figure 22: Electrical installation with cable glands, terminal box IP54

Examples of correct electrical installation for compressor models ZR94K* to ZR190K* and ZP90K* to ZP182K* with molded plug are shown in **Figure 23**:

Figure 23: Electrical installation with cable glands, terminal box IP66

4.4 Motor insulation

The ZR*/ZP* scroll compressors are offered either with a single-phase or a three-phase induction motor, depending on the size. All three-phase motors are connected in star; single-phase motors need a run capacitor.

The motor insulation material is class "B" (T**F*** and T**N***) or "H" (T**W*** and T**E***) for the compressor models covered in these guidelines.

4.5 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 the ZR18K* to ZR190K* and ZP24K* to ZP182K* range of compressors.

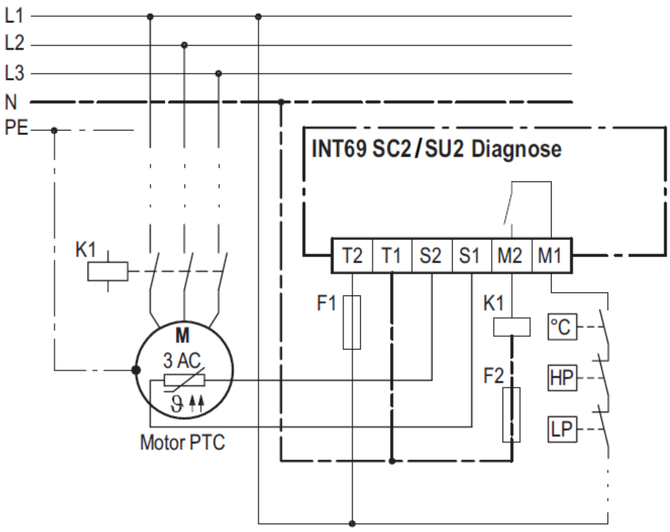
4.5.1 External protection

Compressor models ZR250K* to ZR380K* and ZP235K* to ZP485K* (TW*), ZP232/292KZE (TN*) and ZP233/293KZE (TE*) are equipped with Positive Temperature Coefficient thermistor. This system utilizes the temperature-dependent resistance of the thermistors (also called PTC-resistance) to read the winding temperature. A chain of four thermistors connected in series is embedded in the motor windings so that the temperature of the thermistors can follow the winding temperature with little inertia. An electronic module board process the resistance values and trip a control depending on the thermistor resistance.

4.5.2 Kriwan module

For protection in case of blocked rotor one thermistor for each phase is embedded in the winding heads on the upper (suction gas) side of the compressor motor. A fourth thermistor is located in a winding head at the lower end of the motor. A fifth sensor is located in the discharge port of the fixed scroll to control discharge-gas superheat. The entire chain is internally led to the fusite from where it is connected to the module connections S1 and S2. When any resistance of the thermistor chain reaches the tripping value, the module interrupts the control line and causes the compressor to switch off. After the thermistor has cooled sufficiently, its resistance drops to the reset value but the module itself resets after a time delay of 30 minutes and restarts the compressor.

Control circuit wiring



L1/T1 Neutral

L2/T2 Supply voltage

S1, S2 Chain of thermistors

M1, M2 Control circuit

Figure 24: Wiring of the motor protection module

IMPORTANT
Different sources for power supply and contact M1-M2! Module malfunction! Use the same potential for power supply and the switch contact of the control loop (M1-M2).

Supply voltage: Dual voltage	115-230 VAC 50 Hz, -15 %...+10 %, 3 VA
	120-240 VAC 60 Hz, -15 %...+10 %, 3 VA
Supply voltage	24 VAC 50/60 Hz, -15 %...+10 %, 3 VA
	24 VDC ± 20 %, 2 W
Ambient temperature range	-30…+70 °C
R_{25}, total	< 1,8 kΩ
Trip resistance	4.50 kΩ ± 20 %
Reset time delay type 1 / type 2	30 min ± 5 min / 60 min ± 5 min
Reset of running time	Power interruption / mains failure for approximately 5 seconds
Short circuit monitoring system	Typically < 30 Ω
Protection class according to EN 60529	IP00
Weight	Approximately 200 g
Mounting	Screw in or snap in
Housing material	PA66 GF25 FR

Table 8: Protection module specifications INT69SC2

4.6 Kriwan protector functional check and failure detection

WARNING
Conductor cables! Electrical shock hazard! Shut off power supply before and between each test.

Prior to start-up of the fully connected compressor a functional check shall be carried out:

- Disconnect one terminal either S1 or S2 of the protection module. If the compressor is now switched on, the motor should not start (simulation of an open thermistor chain).
- Reconnect the disconnected thermistor line. If the compressor is now switched on, the motor must start.

If the motor does not start up during the functional check, this indicates a disturbance in operation. The following steps should be followed.

4.6.1 Checking the connection

- Check the connection of the thermistor leads in the terminal box and at the protection module for possible loose connections or cable breakage.

If there is neither loose connection nor cable breakage the resistance of the thermistor chain must be checked.

4.6.2 Checking the compressor thermistor chain

Caution: Use maximum measuring voltage of 3 V!

The thermistor leads at terminals S1 and S2 of the module shall be disconnected and the resistance measured between the leads. The resistance must be between 150 Ω and 1250 Ω.

- If the thermistor chain has a higher resistance (2750 Ω or higher), the motor temperature is still too high and it must be allowed to cool. Then measure again.
- If the resistance is below 30 Ω, the compressor has to be exchanged due to shorted sensor circuit.
- An infinite value indicates an open sensor circuit and the compressor has to be replaced.

If no defect is detected in the thermistor chain the module must be checked.

4.6.3 Checking the protection module

The control connections at M1 and M2 have to be removed and the switching conditions must be checked by an ohmmeter or signal buzzer:

- Simulation of a short circuit in the thermistor chain (0 Ω): Bridge the already disconnected thermistor terminals S1 and S2 and switch on the voltage supply; the relay must switch on then off again after a short period; connection established then interrupted between terminals M1 and M2.
- Simulation of an open thermistor chain (∞ Ω): Remove the jumper used for the short-circuit simulation and switch on the voltage supply; the relay remains switched off; no connection between terminals M1 and M2.

If one of the above conditions is not met, the module is defective and has to be exchanged.

NOTE: **The function of the module should be tested each time the fuse in the control circuit breaks the power supply. This ensures the contacts did not stick.**

4.7 CoreSense Communications module

Compressor models ZP232/292KZE and ZP233/293KZE (TE*) are equipped with a CoreSense Communications module. The CoreSense Communications module has the following key features:

- Motor protection (PTC)
- Missing phase protection
- Reverse phase protection
- Low control circuit voltage protection
- Short cycling detection and alert
- Communication to system controller through RS485/Modbus
- Storage of operational history, runtime information, fault counters, etc.
- Display of status, warning, and alert information via LEDs

CoreSense Communications provides compressor and system protection through its proprietary lockout feature. Depending on the severity and frequency of the fault that caused the trip condition, the CoreSense Communications module can lockout the compressor contactor to prevent damage to the compressor and system components. Less severe fault conditions resulting in an occasional trip will not cause a lockout condition.

Flashing red and green LEDs communicate **Status, Warning** and **Alert** codes to the service technician and the master controller.

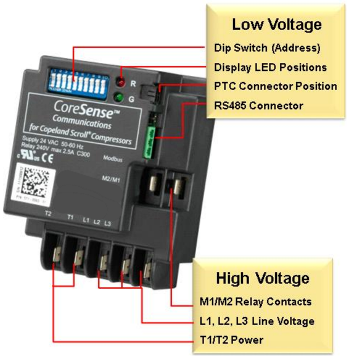


Figure 25: CoreSense Communications module

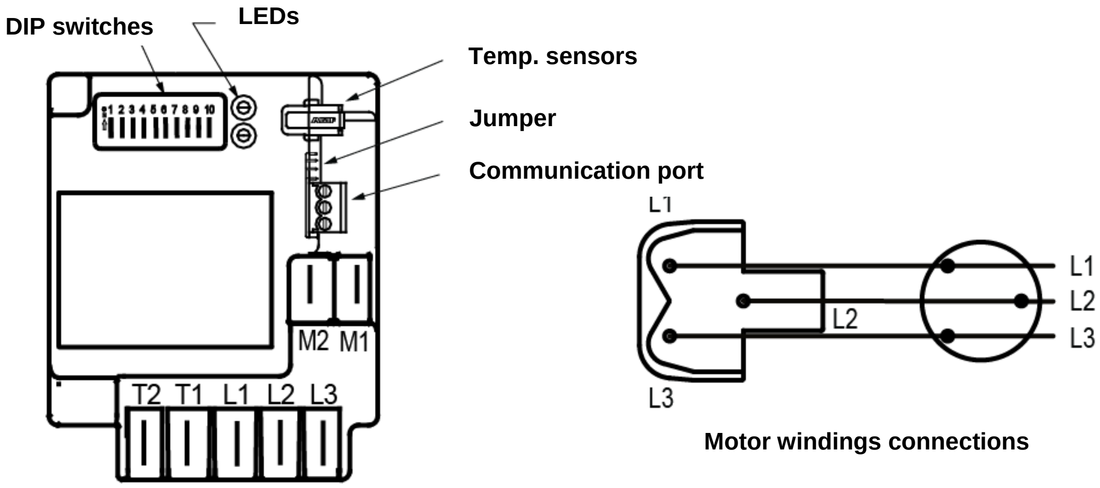


Figure 26: Compressor terminal box wiring with CoreSense Communications module

Legend

T1, T2: Protector module voltage

L1, L2, L3: Phase sensing (L1: Red, L2: Black, L3: White)

M1, M2: To control circuit

LED legend

WARNING: Green flashing + pause 2 sec

TRIP: Red flashing + pause 2 sec

LOCKOUT: Red flashing + pause 2 sec + solid 3 sec + pause 2 sec

LED status	Description	Protection		Consecutive detections until lockout	Troubleshooting
		Shutdown	Off time		
Solid green	Normal operation	N/A	N/A	N/A	N/A
Solid red	Module malfunction	Yes	N/A	N/A	1) Reset CoreSense by removing power from T2-T1 2) Replace CoreSense
Green flash code 1	Communication lost	N/A	N/A	N/A	1) Check the control wiring 2) Verify dip-switch 8 is on
Red flash code 1	High motor temperature detected	Yes	30 min	5	1) Check supply voltage 2) Check system charge & superheat 3) Check contactor
Red flash code 2	Open/short motor or scroll thermistor	Yes	30 min	6 hours	1) Check thermistor connections 2) Check continuity of thermistor wiring harness
Green flash code 3	Short cycling				1) Check system charge and pressure control setting
Red flash code 3	Short cycling	Alert only	N/A	N/A	2) Adjust setpoint of temperature controller 3) Install anti-short cycling control
Green flash code 4	Open/short scroll thermistor	N/A	N/A	N/A	1) Check for poor connections at module and thermistor Fusite 2) Check continuity of thermistor wiring harness
Red flash code 4	High scroll temperature detected	Yes	30 min	5	1) Check system charge & superheat 2) Check system operating conditions 3) Check for abnormally low suction pressure
Red flash code 6	Missing phase	Yes	30 min	10	1) Check incoming power 2) Check fuses/breakers 3) Check contactor
Red flash code 7	Reverse phase detected	Yes	Power cycle	1	1) Check incoming phase sequence 2) Check contactor 3) Check module phasing wires A-B-C
Red flash code 9	Module low voltage	Yes	5 minutes	N/A	1) Verify correct module P/N 2) Check VA rating of transformer 3) Check for blown fuse in transformer

Table 9: Protection – Alarms and troubleshooting

4.8 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 they are 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, 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 a defined value – see **Table 5**. 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 ≤ 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 x 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 ≤ compressor low-side PS.
    - The system test pressure of 1.1 x 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 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.

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. 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 on 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.

When working on systems already 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 0.5 bar suction pressure. Allowing the suction pressure to drop below 0.5 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 shall 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 R410A and R407C are blends and scrolls have discharge check valves, the system 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 ZR* and ZP* 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 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. Direction of rotation is not an issue with single-phase compressors since they will always start and run in the proper direction. Compressor models ZP232/292KZE and ZP233/293KZE have an electronic protection unit (CoreSense Communications module) that will not let the compressor operate if the phasing of the wires is incorrect. 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 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. ZP and ZR scrolls incorporate internal low vacuum protection; the floating seal unloads when the pressure ratio exceeds approximately 10:1.

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 – see **section 3.6 "Discharge gas temperature protection"**.

In a failure mode, the discharge gas temperatures can even get 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, 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 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 should not be set lower than 12 to 15 K equivalent suction pressure below the lowest design operating point.**

5.13 Pump-out cycle

A pump-out cycle has been successfully used by some manufacturers of large rooftop units. After an extended off period, a typical pump-out cycle will energize the compressor for up to one second followed by an off time of 5 to 20 seconds. This cycle is usually repeated a second time. The third time the compressor stays on for the cooling cycle.

5.14 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. 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.

5.15 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 3rd letter of the motor code indicates which 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 10: Explanation of the 3rd letter of the electrical code

5.16 Oil level

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. On the scroll compressor models provided with a sight-glass for oil level viewing, the oil level should always be checked during OEM assembly, field commissioning and field servicing.

The oil level must be carefully monitored during system development, and corrective action should be taken if the compressor oil level falls below the centre of the sight-glass. The compressor oil level should be checked with the compressor "off" to avoid the sump turbulence when the compressor is running. The compressors covered in these guidelines can also be supplied to the OEM with a production sight-tube that can be used to determine the oil level in the compressor in the end-use application.

NOTE: **No attempt should be made to increase the oil level in the sight-glass above ¾ of the full level. A high oil level in the compressor is not sustainable and the extra oil will be pumped out into the system causing a reduction in system efficiency and a higher than normal oil circulation rate.**

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…

6.2 Disassembling system components

When disassembling system components the recommendations below shall be observed:

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.

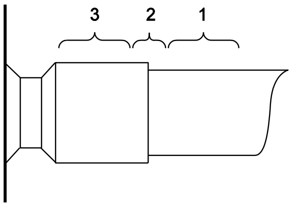


Figure 27: Tube connecting areas

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.**

6.3 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.

For qualified refrigerants and oils, see **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 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.

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

***NOTE:* If R22 in a system with mineral oil is to be replaced with R407C, the oil must also be changed. Please refer to Technical Information TI_Retrofit_01 "Copeland scroll compressors – Refrigerant changeover from HCFC to HFC refrigerants".**

6.4 Rotalock valves

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

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 – 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 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 R407C / R410A / R134a 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. The standard mineral oil for R22 is Suniso 3GS or Copeland White Oil according to compressor model. 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 28**. 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.

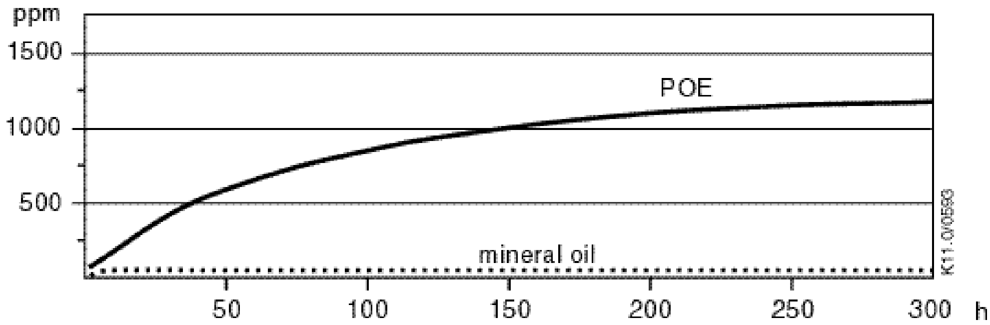


Figure 28: Absorption of moisture in ester oil in comparison to mineral oil in ppm by weight at 25 °C and 50 % relative humidity (h=hours)

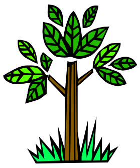
Copeland compressors contain oil with low moisture content, which however may rise during the system assembling process. Therefore, it is recommended to install a properly sized filter-dryer in all POE systems to maintain the moisture level in the oil to less than 50 ppm. If POE oil is charged into a 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.

Appendix1: Tightening torques

Connection	Torque (Nm)
M10	45 - 55
Rotalock ¾"	40 - 50
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
Terminal block screw	2.8

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