Application Guidelines

Copeland™ Scroll Variable-Speed Compressors for R32 Applications

YPV066* & YPV096*

COPELAND™

EMERSON™

About these guidelines

The purpose of these guidelines is to provide guidance in the application of Copeland™ scroll variable-speed compressors and Emerson motor control drives 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 and motor control drives. The performance and reliability of the product may be impacted if the product is not used according to these guidelines or is misused.

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

1 Safety instructions

Copeland scroll variable-speed compressors and Emerson motor control drives are manufactured according to the latest relevant European and US safety standards. Particular emphasis has been placed on the user's safety.

The YPV066/096 variable-speed compressors are intended for installation in systems in accordance with the European Machinery Directive MD 2006/42/EC, Pressure Equipment Directive PED 2014/68/EU, Low Voltage Directive LVD 2014/35/EU and Electromagnetic Compatibility Directive EMC 2014/30/EU. They may be put to service only if they have been installed in systems according to instructions and conform to the corresponding provisions of legislation.

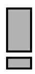
***NOTE:* Only dedicated compressors are allowed to be used with flammable refrigerants. Emerson marks all compressors that are qualified for flammable refrigerants with a sticker indicating the usage of such refrigerants. Systems using flammable refrigerants must be executed correctly while observing safety rules, as specified in corresponding safety standards such as, but not limited to EN 378. They must comply with any and all applicable legislation and regulations. Ensuring compliance remains the user's responsibility.**

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

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

You are strongly advised to follow these safety instructions.

1.1 Icon explanation

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

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. Only competent personnel (as specified in EN 13313) qualified for flammable refrigerant handling are permitted to commission, initiate and maintain the compressor/refrigeration systems; non-trained personnel, including the user, are not allowed to do so and must call on an expert.**
- **The maximum refrigerant charge is specified in standards such as, but not limited to EN 378, EN 60335-2-40 and EN 60335-2-89. The system designer shall implement all safety measures defined by the applicable standards and the maximum refrigerant charge shall not be exceeded.**
- **If a flammable atmosphere is detected, immediately take all necessary precautions to mitigate the risk as determined in the risk assessment.**
- **Electrical connections must be made by qualified electrical personnel.**
- **All valid standards for connecting electrical and refrigeration equipment must be observed.**
- **The national legislation and regulations regarding personnel protection must be observed.**

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

1.3 General instructions

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

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

WARNING
Earth leakage current! Danger of electric shock! This product can cause both AC and DC earth leakage current. To protect against both kinds of leakage current it is recommended to use an AC/DC sensitive RCD on the power supply side.

WARNING
High voltage! Danger of electric shock and/or system breakdown! Disconnect and lock out power before servicing. Allow drive components to electrically discharge before servicing. Respect the time according to drive application guidelines before servicing the drive. Use compressor with grounded system only. Refer to original equipment wiring diagrams. Electrical connections must be made by qualified electrical personnel.

WARNING
High shell temperature! Burning! Do not touch the compressor or piping until they have 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
Contact with POE! Material damage! POE lubricants must be handled carefully and the proper protective equipment (gloves, eye protection, etc.) must be used at all times. POE must not come into contact with any surface or material that it might damage, including without limitation, certain polymers, eg, PVC/CPVC and polycarbonate.

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

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

2 Product description

2.1 Compressor range

These application guidelines deal with Copeland™ scroll variable-speed compressor models YPV066 & YPV096 for use with R32. These compressors are intended for use in commercial air-conditioning, chiller and heat-pump applications.

The YPV066 models have a speed range of 1000 to 7200 revolutions per minute, corresponding to 16 up to 120 Hz, and the YPV096 models have a speed range of 1200 to 7200 revolutions per minute, corresponding to 20 up to 120 Hz.

The cooling capacity delivered by the YPV066/096 compressors at various speeds is given in **Table 1**. The cooling capacity does not vary with the drive power and power supply.

Compressor	Cooling capacity at dew 5/50 °C, 5 K SH and 4 K SC				
	1800 rpm	3000 rpm	4500 rpm	6000 rpm	7200 rpm
YPV066	9.41	16.9	25.54	33.98	40.56
YPV096	13.94	24.95	37.89	50.58	60.39

Table 1: Cooling capacity

For larger capacity modulation, YPV066 & YPV096 compressors can be used in tandem applications, ie, two scroll compressors in parallel, one fixed-speed and one variable-speed. Paralleling of YPV066/096 is made with the fixed-speed models in the range from YP104K1T to YP292K1T.

Tandem name	Model A	Model B
YPVU1621T	YPV066	YP104K1T
YPVU1781T	YPV066	YP122K1T
YPVU1921T	YPV096	YP104K1T
YPVU2081T	YPV096	YP122K1T
YPVU1931T	YPV066	YP137K1T
YPVU2091T	YPV066	YP154K1T
YPVU2231T	YPV096	YP137K1T
YPVU2331T	YPV066	YP182K1T
YPVU2391T	YPV096	YP154K1T
YPVU2631T	YPV096	YP182K1T
YPVU2761T	YPV066	YP232K1T
YPVU3061T	YPV066	YP292K1T
YPVU3591T	YPV096	YP232K1T
YPVU3591T	YPV096	YP292K1T

Table 2: Paralleling options for YPV066/096 compressors

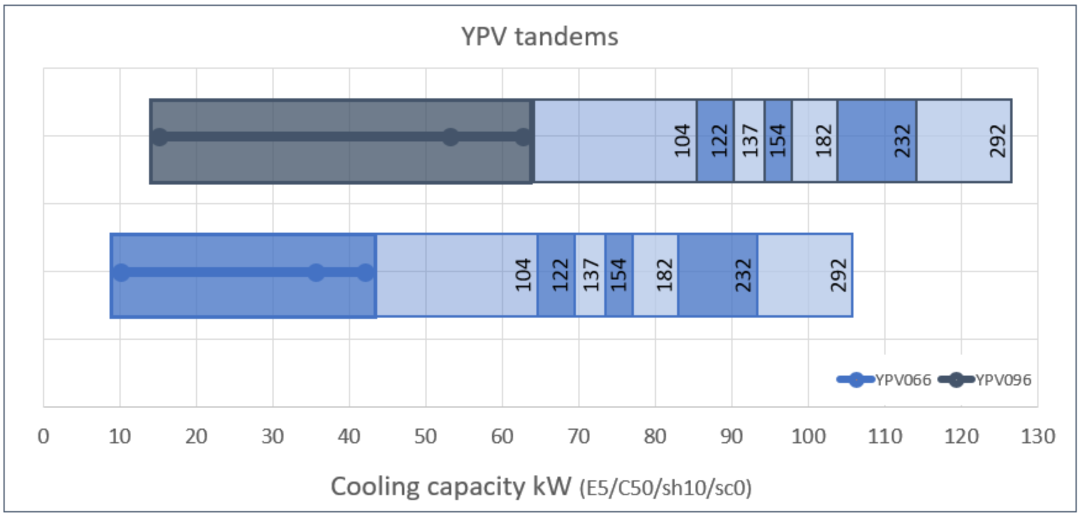


Figure 1: Paralleling options for YPV066/096 compressors showing cooling capacity per circuit

The YPV066/096 compressors are qualified for use with the Emerson EV3 drive, which has been developed and qualified for brushless permanent magnet (BPM) motor-compressors. The BPM motor in the variable-speed scroll comprises a three-phase stator and a rotor embedded with high energy permanent magnets.

Figure 2: Variable-speed scroll compressor YPV066 with Emerson EV3 drive

2.2 Matched pairs of compressor and drive

The YPV* compressors with motor code "E9" are supplied as matched pairs with the EV3 drive, designed in accordance with EN 60335-1, as listed in **Table 3**. The motor protection is implemented in the EV3 drive.

Compressor	Drive	Drive power supply	Maximum input power @ 380 V (kW)	Maximal input/output current @ 50 °C (A)
YPV0661T-4E9	EV3150B	3~, 380-460 V, 50-60 Hz	15	27
YPV0961T-4E9	EV3185B	3~, 380-460 V, 50-60 Hz	18.5	38

Table 3: Emerson compressor and drive selection

The matched pairs have been designed for maximum efficiency and reliability. If a non-Emerson qualified drive is required, please work with the Application Engineering department at Emerson to select an appropriate drive for the compressor application. That drive has to integrate all the same protection features as the EV3 drive qualified by Emerson.

The YPV* compressors with motor code "X9" listed in **Table 4** are sold as unprotected compressors. They are dedicated for use with a third-party drive. The motor protection is under the responsibility of the system manufacturer/installer.

Compressor models
YPV0661T-4X9
YPV0961T-4X9

Table 4: Emerson unprotected YPV066/096 compressor models

NOTE: **The Emerson EV3 drive is not covered in detail in this document. For more information on the motor control drive features, installation and communication, please refer to the Application Guidelines AGL_Sol_EV3 "EV3 Inverter Drive for YPV* Variable-Speed Compressors".**

2.3 Variable speed advantages

The variable speed scroll is a key component in the variable capacity system. A variable capacity system will use less electrical energy by minimizing On/Off cyclical losses, maximizing heat exchanger efficiency by operating at part load during a majority of the total operating hours, and by operating with reduced airflow rates and fan power.

The variable-speed scroll and drive are suitable for a variety of "best-in-class" applications. Both may be used in other types of applications provided that the envelope and other operating restrictions are met. The primary benefit of this product is to substantially reduce electrical energy consumption and associated expenses.

Additionally, a variable-speed scroll offers the capability of controlling temperatures to ranges exceeding simple On/Off control, improving overall comfort levels and system conditions. The onboard electronics embedded in the drive greatly reduce the possibility of operation outside the designed parameters which in turn increases overall system reliability.

2.4 Compressor and drive nomenclature

The model designation contains the following technical information:

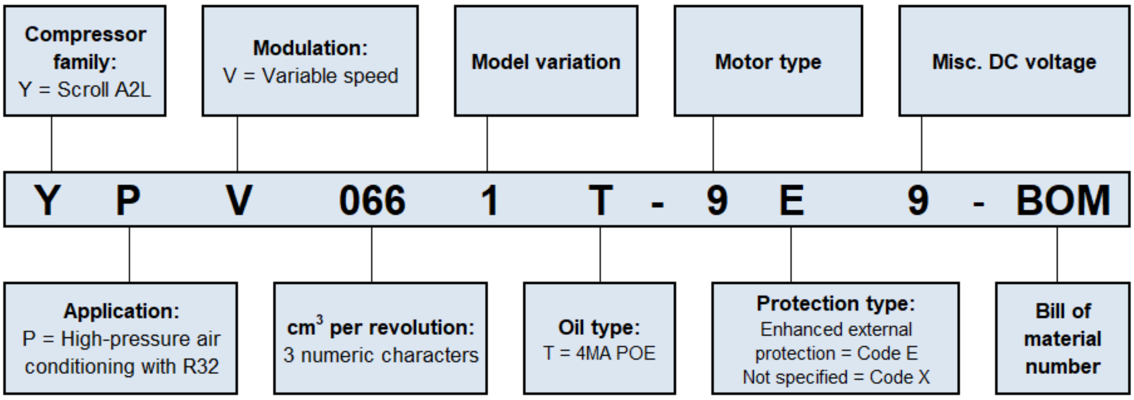


Figure 3: Compressor nomenclature

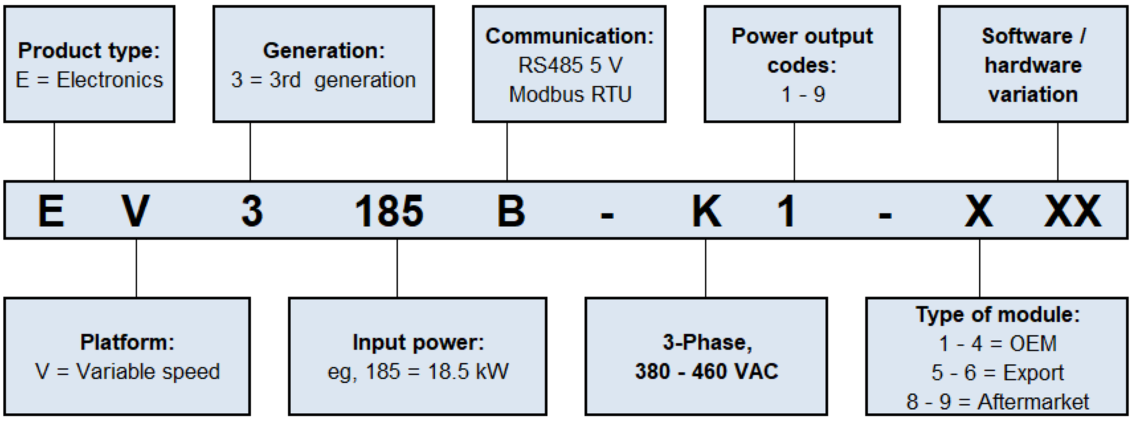


Figure 4: EV3 drive nomenclature

2.5 BOM variations

The BOM (bill of material) marking at the end of the compressor designation indicates the different compressor layouts and details. YPV066/096 compressors are available in the following BOM versions:

BOM	Suction and discharge connections	T-Box	Mounting parts	Schraeder valve	Rotalock sight glass	TPTL* fitting brazed	GEL** fitting brazed
				Single application		Tandem Application	
GBP	Brazed	IP54	Without	Yes	Yes	No	No
GCN				No	No	Yes	Yes

TPTL: Two-Phase Tube Line*
*GEL**: Gaz Equalisation Line*

Table 5: Available BOMs for YPV066/096 compressors

2.6 Application considerations

2.6.1 Qualified refrigerant and oil

The YPV066/096 compressors are approved for use with R32 only.

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

Compressors	**YPV066/096**
Qualified refrigerant	**R32**
Standard & servicing oil	4MA POE
Oil quantity (in litres)	2.51

Table 6: Qualified refrigerant and oil

***NOTE:* R32 is classified as A2L (mildly flammable) refrigerant.**

2.6.2 PED category and maximum allowable pressure PS

The YPV066/096 compressors covered in these guidelines are PED Class 3, according to the Pressure Equipment Directive PED 2014/68/EU.

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

Compressor	**PS High-pressure side**	**PS Low-pressure side**	**TS Low-pressure side (min/max)**	**PED Class**
YPV066 YPV096	50 bar(g)	30.4 bar(g)	-35/50 °C	3

Table 7: Maximum allowable pressures and PED category

2.6.3 Admissible ambient temperature and humidity ranges

The scroll compressor as well as the drive must comply with the ambient temperature and humidity ranges specified in **Tables 8 & 9** below, both for storage and in operation.

	Compressor		
Compressor model	**Min/max relative humidity**	**Min/max ambient temperatures in storage or at standstill**	**Min/max ambient temperatures in operation**
YPV066/096	30 % / 95 % No condensing	- 40 °C / 50 °C	- 40 °C / 60 °C

Table 8: Acceptable ambient temperature and humidity range for the compressor

	Drive			
Drive model	**Min/max relative humidity**	**Min/max ambient temperatures in storage or at standstill**	**Min/max ambient temperatures in operation**	**Min/max ambient temperatures in operation for full performance**
EV3150B EV3185B	0% / 95 % No condensing	- 40 °C / 85 °C	- 25 °C / 65 °C	- 20 °C / 50 °C

Table 9: Acceptable ambient temperature and humidity range for the drive

2.6.4 *Application limits – Operating envelopes*

CAUTION
Inadequate lubrication! Compressor breakdown! Copeland scroll compressors are qualified for operation inside the envelope published by Emerson. The envelope is defined according to Emerson testing and experience. Operating a compressor outside the envelope might lead to compressor failure which would be the system manufacturer's responsibility. 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. In the same way, the superheat at the compressor suction must always stay below a maximum limit specified by Emerson, depending on the model and for which the operating envelope is defined.

The operating envelopes of the YPV066/096 compressors depend upon the running speed. The envelope limitations are mainly related to lubrication and drive power limitation. They are shown in **Figures 5 & 6** below.

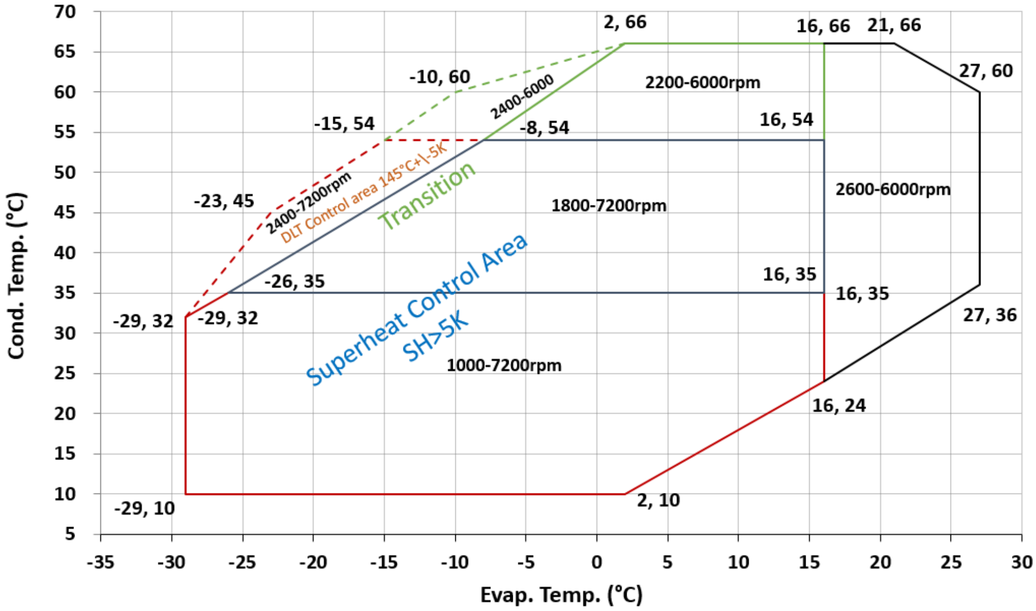


Figure 5: Operating envelope for the YPV066 with R32

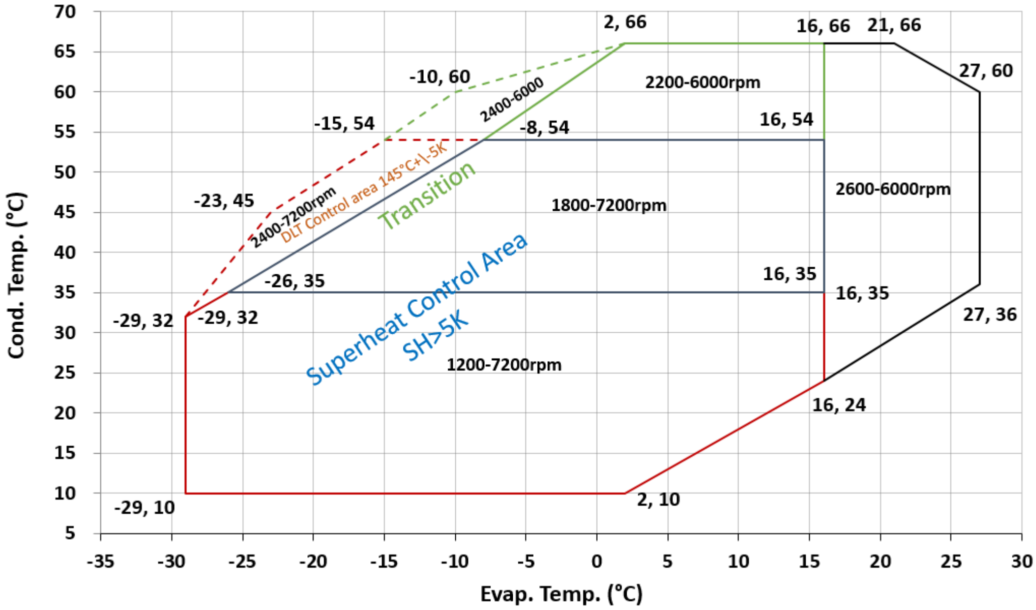


Figure 6: Operating envelope for the YPV096 with R32

Please consider the following about operating envelopes:

- The use of 1000/1200 rpm for low condensing temperatures is possible as shown in the envelope.
- When the compressor is operated for more than 120 minutes with a speed below 1800 rpm it has to run for at least 5 minutes with a speed of 3600 rpm to make sure that there is enough oil circulation inside the compressor.
- An oil return test for the system must be performed. If required, the system design must be improved to ensure sufficient oil return from the system to the compressor.
- At start-up the system should be able to bring the compressor to a point inside the envelope as fast as possible and to keep the compressor running there. Running outside the envelope is not allowed. Emerson's recommendation is to start with a speed of 3000 rpm.
- Running/oscillating the compressor in and out of the envelope borders is not allowed and should be avoided.
- Running the compressor below the envelope at low condensing temperatures is possible for no longer than 30 minutes but the user must be aware that unloading noise from the compressor can occur. In this area the speed limits according to the evaporating temperatures in the envelope should be respected.
- The minimum speed at the current condition should be linear interpolated between the lines, eg, to go above the line with the minimum speed of 1000 (1200) rpm the user should start interpolating the minimum speed linear from 1000 (1200) rpm to 1800 rpm before crossing the next speed limit line.
- To run inside the area with a high evaporating temperature (> 16 °C) the minimum speed (2600 rpm) must be reached before entering this area.
- The user should adequately take care of controlling the envelope.

Before first start, each drive has to be set with the compressor model. This provides a speed-dependent maximum torque protection related to the compressor model. The maximum torque requirement will follow, with some margin, the maximum condensing temperature line for each speed. If the torque exceeds the maximum torque allowed for a specific speed, the drive will reduce the speed of the compressor in an attempt to keep the operating condition within the operating envelope. If reducing the speed of the compressor does not bring the condensing temperature back down within the envelope, the drive will go to the next level of protection and shut down the compressor.

This drive feature aims at protecting the drive and the compressor. It cannot be used in the system as an operating envelope limitation.

Operating the compressor at evaporating temperatures that are higher than those specified in the envelopes for the given speed will result in a higher oil circulation rate. A higher oil circulation rate can reduce heat exchanger efficiency and possibly result in oil pump-out if the system has long interconnecting piping. Users who choose to operate in these higher evaporating temperature areas should use a compressor sample with a sight-tube during system development testing to ensure that an adequate level of oil is maintained in the compressor sump. Sight-tubed compressors for monitoring the oil level are available from Emerson; contact Application Engineering.

The lower right boundary of the operating envelope is the minimum compression ratio required to keep the scrolls loaded. Operation below this limit could result in the compressor intermittently loading and unloading and noisy operation.

The upper left boundary of the envelope represents the maximum compression ratio when operating with adequate suction superheat. If the operating condition approaches this boundary of the envelope the compressor discharge temperature will begin to approach the maximum scroll temperature allowed (150 °C).

2.6.5 Emerson EV3 drive functionality

The Emerson EV3 drive follows a defined start-up and shutdown procedure. Please refer to the EV3 drive Application Guidelines AGL_Sol_EV3 "EV3 Inverter Drive for YPV* Variable-Speed Compressors" for detailed information.

2.6.6 Discharge line temperature control mode

In the superheated controlled area (below the transition zone) all the operating conditions should have a superheat above 5 K (ensuring the absence of liquid droplets at compressor suction). In this area, with minimum 5 K superheat, the discharge line temperature will remain below 150 °C.

For operating conditions close to the high discharge temperature boundary (the transition zone), any superheat above 5 K could lead to a DLT above 150 °C.

In the transition zone, during operation at low evaporating and high condensing temperatures, the discharge temperature could exceed the limit of 150 °C if the circuit control is purely based on a superheat setpoint. It is therefore advised to control the expansion valve around a different operating parameter, for example, the discharge line temperature. In this way, the discharge line temperature can be precisely controlled. Note that a decrease in discharge line temperature will also lead to a reduction in the compressor suction temperature, and both need to be controlled tightly in order to avoid excess droplets entering the compressor. If a "DLT Control" mode is chosen, the DLT must stay in the range of 145 °C ± 5 °C, while paying attention to the fact that the superheat decrease must also be gradual.

The transition from superheat control to discharge line temperature control is demand-driven by the discharge line temperature. In this transition phase, the discharge line temperature control and superheat control must be balanced by the system controller.

As the requirement to move to discharge line temperature control depends on several variables (system design, ambient temperature, load, …), there is no precise and universal boundary in the compressor envelope where this will systematically happen. It is therefore up to the user to define if and when (where in the envelope) the DLT control is required.

The transition between superheat control and discharge line temperature control must be managed to avoid any abrupt change from one control mode to the other. This is mandatory to ensure smooth operation and to avoid sudden temperature changes as well as compressor wear.

Figure 7 represents the expected behaviour of the electronic expansion valve based on superheat and DLT, for both control modes (DLT dependant). In case the controller cannot keep the DLT below the 150 °C threshold, the compressor must be stopped – also see **section 3.6 "Discharge gas temperature protection"**.

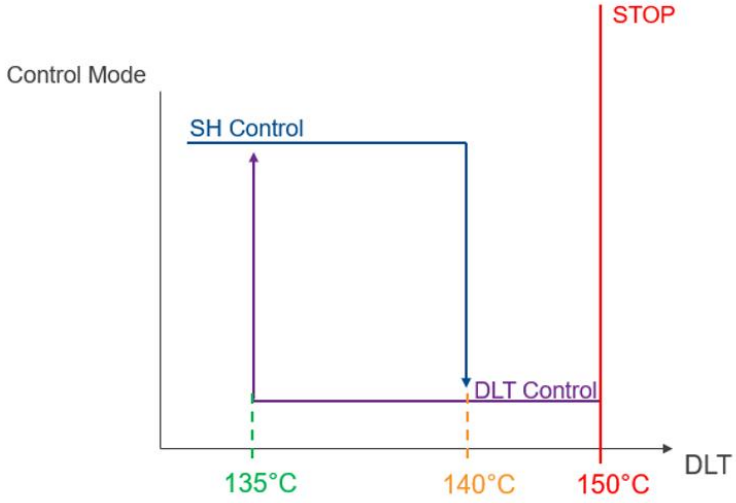


Figure 7: DLT control mode

2.7 Compressor design

2.7.1 Compressor features

The variable-speed scroll compressors YPV066/096 have a number of design features that improve efficiency and reliability.

The scroll is equipped with a positive displacement oil pump to ensure an adequate supply of oil to the bearing system throughout the operating speed range from 1000 to 7200 rpm for the YPV066 and from 1200 to 7200 rpm for the YPV096.

The YPV066/096 compressors use a shutdown valve located in the discharge fitting. This check valve is not a low-leak-back check valve and will leak when pressure differential across the check valve is low.

2.7.2 Compressor dimensions

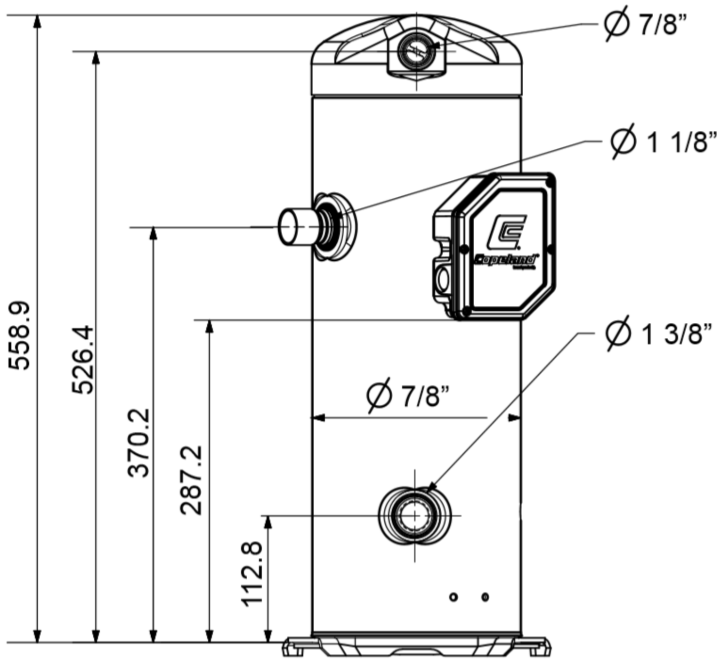


Figure 8: External dimensions of YPV066/096 compressors – Front view

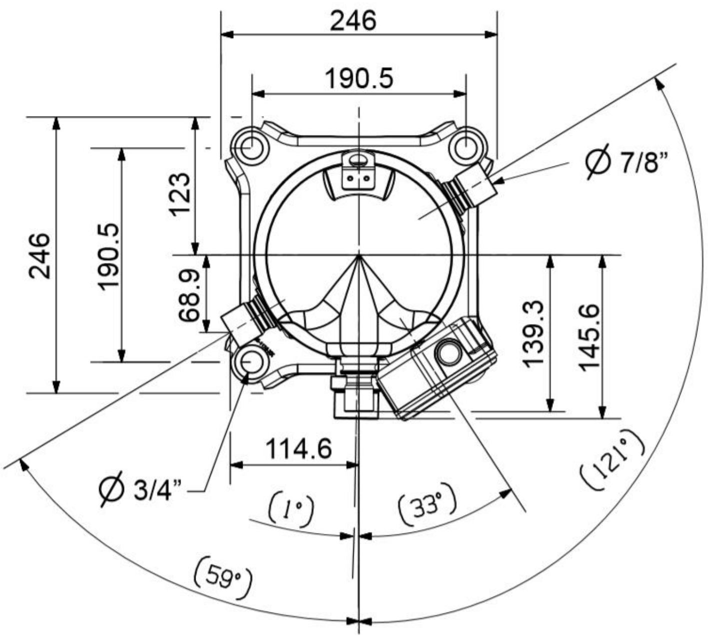


Figure 9: External dimensions of YPV066/096 compressors – Upper view

3 Installation

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

IMPORTANT
The compressor mounting area must be in **Zone 2** or outside of any ATEX zone and in line with the requirements of **"Pollution Degree 3"** classification.

3.1 Compressor and drive handling

WARNING
Static electricity! Personal injuries! Personnel handling the drives in a manufacturing plant environment should guard against static electricity by using the appropriate equipment - antistatic wrist straps and mats.

3.1.1 Compressor and drive transport and storage

WARNING
Risk of collapse! Personal injuries! Move compressors only with appropriate mechanical or handling equipment according to weight. Keep in the upright position. Respect stacking loads according to **Figure 10**. 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 10: 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.

The drive can weigh up to 15 kg. Failure to exercise caution when lifting and installing the drive can result in physical injury.

3.1.2 Compressor 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 as much as possible during handling.

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

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

As oil might spill out of the suction connection located low on the shell, the suction connection plug must be left in place until the compressor is set into the unit.

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

3.1.3 Installation location

The package (compressor and drive) is capable of operating correctly at altitudes up to 1000 metres.

Ensure that the compressor and drive are installed on a solid level base. If required by the application, the compressor tilt angle during operation should not be more than 15° to allow adequate lubrication.

3.2 Mounting parts

The compressors are designed to be mounted on vibration absorber grommets (part of the standard delivery). The grommets 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 suit a M8 screw. The mounting torque should be 13 ± 1 Nm. It is critically important that the grommet is not compressed.

Figure 11: Rubber mounting part with sleeve

NOTE: **For more information please refer to Technical Information C7.11.2 "Scroll Mounting Parts".**

3.3 Brazing procedure

WARNING
Air/flammable refrigerant mixture! Creation of a potentially flammable atmosphere! Fire hazard! Remove all refrigerant before opening the system. When working on a refrigerant-filled system, make sure to follow the safety and working instructions given in **Chapter 6 "Maintenance & repair"**.

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.

IMPORTANT
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.

3.3.1 General brazing procedure

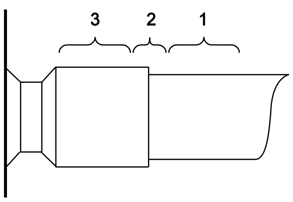


Figure 12: Suction tube brazing areas

Copeland Scroll compressors have copper-plated steel suction and discharge tubes. These tubes are far more robust and less prone to leaks than copper tubes. Steel and copper have different thermal properties; this must be taken into account when considering brazing procedures.

Refer to **Figure 12** and procedure below for the brazing of the stub tube connections of a scroll compressor.

- For systems with flammable A2L refrigerant, it is mandatory to flush oxygen-free nitrogen through the piping during the brazing process.
- The copper-coated steel tubes on scroll compressors can be brazed in approximately the same manner as any copper tube.
- Recommended brazing materials: any Silfos material is recommended, preferably with a minimum of 5 % silver. However, 0 % silver is acceptable.
- Be sure tube fitting inner diameter and tube outer diameter are clean prior to assembly.
- Using a double-tipped torch, apply heat in area 1.
- As the tube approaches brazing temperature, move the torch flame to area 2.
- Heat area 2 until braze temperature is attained, moving the torch up and down and rotating around the tube as necessary to heat the tube evenly. Add braze material to the joint while moving the torch around the joint to flow braze material around the circumference.
- After the braze material flows around the joint, move the torch to heat area 3. This will draw the braze material down into the joint. The time spent heating area 3 should be minimal.
- As with any brazed joint, overheating may be detrimental to the final result.

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

***NOTE*: YPV066/096 compressors include a suction funnel to guide the suction gas internally directly to the scrolls. Since the funnel is made of plastic, a wet rag or any other suitable heat protection must be used when brazing the suction line to the compressor.**

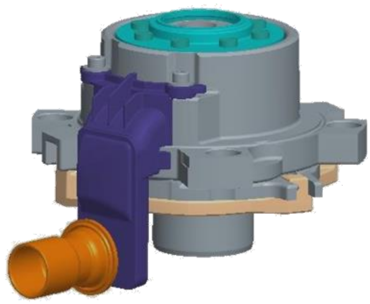


Figure 13: Suction funnel (purple part) in YPV* compressors

3.3.2 Brazing procedures for YPV compressors in parallel applications*

WARNING
Air/flammable refrigerant mixture! Creation of a potentially flammable atmosphere! Fire hazard! Remove all refrigerant before opening the system. When working on a refrigerant-filled system, make sure to follow the safety and working instructions given in **Chapter 6 "Maintenance & repair"**.

Only compressor models officially approved by Emerson in the qualified configuration may be used for parallel applications. In such applications, additional precautions shall be taken before brazing the oil and gas equalization ports. The sequence shall be as follows:

First, install the compressors on the base frame and tilt the assembly so that oil will not be lost when opening the cap. The gas-and-oil equalization line assembly should be ready for brazing at this point.

For new compressors, release the protective gas charge: the rubber plug from the discharge port of the compressor has to be removed first, then the rubber plug from the oil port.

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

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

Tilt the tandem assembly back approximately 12° from horizontal so the oil flows away from the oil fittings and sight glasses on the compressors. If the oil manifold is a TPTL the compressor sight glasses needs to be removed prior to installing the TPTL. The TPTL Rotalock fitting should be torqued.

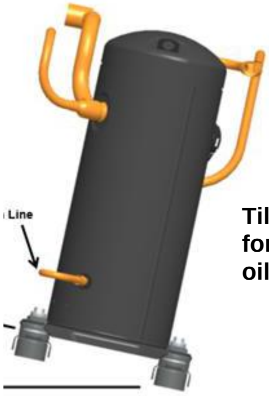


Figure 14: TPTL fitting tilt

If the oil manifold is an OEL the Schraeder fittings can now be removed by unscrewing them. Removing the Schraeder fittings exposes the stub that is used to braze the OEL to each compressor. The oil equalization stubs of both compressors should be wiped clean with a lint-free towel to remove any oil residue before brazing. Install the oil manifold to the individual compressors and torque the Rotalock fittings to the value specified in the individual compressor bulletin.

If the oil manifold is a braze TPTL fitting tilt the tandem assembly back approximately 20° from horizontal so the oil flows away from the oil fittings.

3.4 Pressure protection devices

3.4.1 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 pressure limit.

High-pressure protection is required to stop the compressor operating outside the allowable pressure limit. The high-pressure control must be installed correctly, 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.

3.4.2 Low-pressure protection

WARNING
Operation below ambient pressure! Fire hazard! During operation below ambient pressure, a flammable mixture can form inside the system. Make sure that air does not enter the system.

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

Make sure that the pressure never falls below atmospheric pressure. If it does, immediately de-energize the power supply of the compressor and check the cause of the low pressure before restarting the compressor.

Emerson requires that YPV* compressors be fitted with a low-pressure control, with no service valve between the low-pressure side and the pressure control.

For hermetically sealed system, in the case the approved application envelope is below atmospheric pressure, the following rules shall be observed:

- valid only for hermetically sealed systems – see safety standards for definition;
- the minimum absolute pressure is 0.5 bar;
- a discharge temperature control is mandatory to stop the compressor when the maximum discharge temperature is exceeded – see **paragraph 3.6 "Discharge gas temperature protection"**.

3.5 Crankcase heating function

CAUTION
Motor overheating! Compressor damage! The crankcase heating function must not be energized when the system is in a vacuum or if there is no refrigerant charge in the system. The system low-pressure cut-out control can be used as an indicator of the presence of refrigerant charge.

IMPORTANT
Oil dilution! Bearing malfunction! Follow the off-cycle migration statement described below for long-term reliability and to minimize nuisance associated with flooded start conditions.

Contrary to standard fixed-speed scroll compressors, the YPV066/096 models do not require any optional external crankcase heater to be mounted around the compressor. Instead, the EV3 drive has a programmable feature that will utilize the motor windings to provide 10 to 150 Watts of heating to serve as a crankcase heater.

The crankcase heating function activation is required when the system charge exceeds the refrigerant charge limit indicated in **Table 10** below:

Compressor model	Refrigerant charge limit
YPV066/096	7 kg
YPV* tandem assemblies	8 kg

Table 10: Refrigerant charge limit for use of crankcase heating function

If this function is required and no off-cycle migration testing across the range of expected cold and hot sources temperatures is performed, the crankcase heating function should always be powered to at least 100 Watts when the compressor is off.

To use less than 100 Watts, off-cycle migration testing must be performed. To perform migration testing, a compressor fitted with a sight-tube showing the oil level and any accumulation of liquid in the compressor is required and can be ordered from Emerson. The pass criterion is a liquid level in the compressor that is not higher than 30 millimetres above the normal oil level at all expected cold and hot sources conditions.

NOTE: **At first start, the crankcase heating function must be turned on a minimum of 12 hours prior to starting the compressor.**

3.6 Discharge gas temperature protection

IMPORTANT
Overheating and inadequate lubrication! Compressor damage! YPV* compressors must be equipped with an external discharge gas temperature protection.

Emerson recommends including discharge line temperature protection at system level to avoid excessive temperatures in compressor and other system components (4-way valves etc.).

YPV* compressors need an external discharge line temperature sensor. The correct reading of this sensor is fundamental for discharge line temperature control. The sensor must guarantee a high degree of accuracy and an acceptable dynamic behaviour.

Please ensure the recommendations below are followed:

- The discharge temperature sensor must be positioned 120 mm from the compressor outlet.
- The sensor must be installed in a copper sleeve, to improve response time and to reduce setoff. The copper sleeve must be brazed on the surface of the pipe.
- Protect the sensor from being moved or removed by transport, vibration etc.
- Use thermal compound to improve heat transfer from the sleeve to the sensor. The thermal compound must be approved for the maximum system operating temperatures (usually 150°C for R32).
- To reduce the impact of ambient temperature, the pipe, including the sensor, must be insulated.
- The sensor should be positioned on the upper side of the pipe in a region of 45° as shown in **Figure 15** below.
- If a sensor is placed after a bend it should be on the inner side of the bend at around 22.5° from the top of the pipe.

- Make sure the sensor cables are not installed along with other high voltage cables.

Figure 15: Sensor installation

NOTE: **For more information on sensor mounting please refer to Assembly Instructions C30.11 "NTC Mounting Recommendations".**

3.7 Off-cycle power consumption

The drive will consume approximately 10 Watts from the drive power input line when it is powered and there is no command for compressor or crankcase heating operation. The off-cycle power can be eliminated by installing a contactor upstream of the drive and energizing the contactor only when there is a call for compressor, capacitor or crankcase heating.

3.8 Drive cooling

Due to the power electronics used in the drive and the heat they generate, cooling is required to keep the drive components within their design temperature range. A variable-speed heatsink fan is integrated in the Emerson EV3 drive. The drive controls the speed at which the fan runs based on the temperature of the heatsink and the drive's thermal model system.

In order to ensure an adequate cooling of the EV3 drive, heatsink and drive fan have to be cleaned of dust and the allowable surrounding air temperature (from -25 to 65 °C) has to be respected through an appropriate drive enclosure design. The lifetime of the fan is reduced in dusty and unacceptable temperature environments.

3.9 Filter screens

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

The use of screens finer than 30 x 30 meshes (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.

3.10 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 testing determines that a muffler is needed to attenuate discharge pulse, 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. 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.

For a variable-speed compressor, discharge pulse will generally decrease as speed increases or if compression ratio decreases. As speed decreases or if compression ratio increases the discharge pulse will increase. Fixed-capacity or two-step capacity units have typically had discharge gas pulsation mufflers only in heat pump applications. A variable-capacity heat pump and/or air conditioner may require a discharge gas pulsation muffler. Discharge pulse amplitude and frequency and their effects on the piping system must be taken into account.

3.11 Sound shell

For the selection of sound reduction material in A2L applications, attention shall be paid to the electrostatic charge of the material, which could be a potential ignition source.

The standard Emerson sound shell material is not an ignition source for A2L refrigerants (R454C, R455A and R454A).

Please see Emerson spare parts software at www.climate.emerson.com/en-gb/tools-resources to check the available sound shell kits according to compressor model.

3.12 Insulation material

Insulation material is commonly used in a system to insulate the suction line, suction accumulator, expansion valve bulb or discharge line thermostat. When choosing the insulation material for A2L applications, particular attention shall be paid to its non-electrostatic properties, as it could be a potential ignition source.

3.13 Reversing valves

A variable-speed scroll brings a significant benefit during the defrost cycle. By taking advantage of the higher speeds and flow rates, the defrost time will typically be shorter than in a fixed-speed compressor system, which will reduce the time electric resistance heat is used during the defrost cycle.

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 lead to a condition where the compressor appears not to be pumping, ie, balanced pressures. It can also cause elevated compressor sound levels.

Since Copeland scroll compressors have a very high volumetric efficiency, their displacements are lower than those of comparable capacity reciprocating compressors. As a result, Emerson 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.

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 a condition of system 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.

3.14 Sound and vibrations

WARNING
Vibrations! Creation of flammable atmosphere! Carefully check the system for vibrations.

Vibrations during compressor operation can cause cracks which could lead to refrigerant leakage. This situation must be avoided by the system manufacturer/installer. To this end, the pipework must be carefully designed when connecting a scroll compressor to a system.

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

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

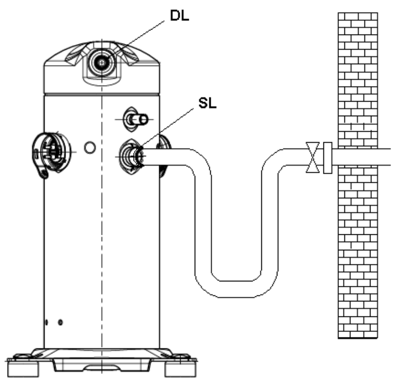


Figure 16: Flexible tube design

Since the variable-speed scroll has a broad running frequency range, it is almost impossible to avoid all of the natural frequencies that may exist in the system piping. The system designer must carefully evaluate these resonant frequency conditions and either a) avoid them by not allowing the compressor speed to align with the resonant frequency, or b) evaluate the risk and life of the piping system when the compressor is allowed to run at frequencies that are coincident with the natural frequencies of the piping system. If option "b" is chosen, strain gauging of the system piping is required.

The Emerson EV3 drive integrates a resonance avoidance feature to avoid the motor running at speeds that cause mechanical resonance effect. For more information refer to the EV3 Application Guidelines.

The sound level of a system is the result of design, quality and application. Scroll compressors sound power levels generally increase with the compressor model capacity and the condition pressure ratio. For variable-speed scroll compressors, the sound level also and mainly increases with the compressor speed.

NOTE: **In order to properly determine if a design is appropriate for a given application, samples should be tested and evaluated for stress under various conditions of use including frequency, load fluctuations, and shipping vibration. The guidelines above will help; however, testing should be performed for each system designed. For further assistance and analysis of test results please contact the Application Engineering department at Emerson.**

3.15 Compressor oil return, oil balancing, floodback and oil dilution tests

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

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 level, mass flow, and density.

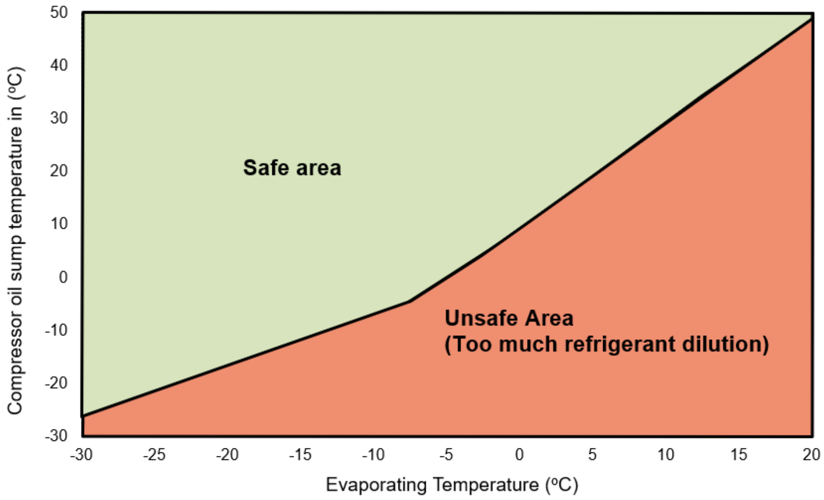
Once a new system design is set and assembled, a functional test is required. The functional test includes a qualification for the general system oil return and a refrigerant floodback test. Systems with multiple compressor applications (two, three, or more) require additional oil balancing qualification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

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

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 the different operation modes and varying loads. If the system is reversible, the tests should be conducted in cooling, heating and defrost modes.

System engineers should review the system design and operation to identify the critical conditions and to check oil return, oil balancing and liquid floodback. 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, 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, please refer to the oil dilution chart in **Figure 17**. Liquid level and superheat at compressor inlet have to be checked.



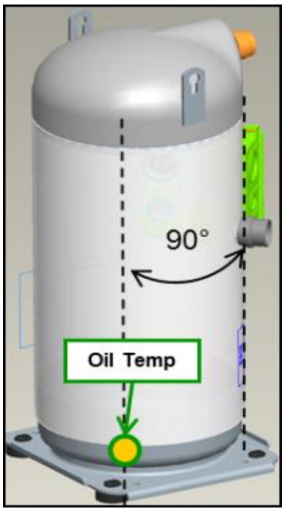


Figure 17: Oil dilution chart and position for oil temperature sensor

The bottom shell temperature together with the evaporating temperature gives an indication whether liquid refrigerant is returning or diluted in the compressor oil sump. The compressor sump temperature must remain in the (green) safe area, as shown in the oil dilution chart in **Figure 17** above. In case of operation in the (red) unsafe area, adjustments are required in order to modify the system design, refrigerant charge or superheat setting of the expansion device(s). The bottom shell temperature should be measured accurately. The thermo-probe must be positioned on the opposite side of the sight glass or at an angle of 90° clockwise from the suction inlet with view on the top.

3.16 Suction line accumulator

Due to Copeland scroll's inherent ability to handle liquid refrigerant, for example in flooded start and defrost cycle operation, an accumulator is not required in most systems.

To determine if a suction line accumulator is required, the system designer must check this with an appropriate test scenario – see **section 3.15 "Compressor oil return, oil balancing, floodback and oil dilution tests"**.

If an accumulator is used, the oil-return orifice should be from 1 to 1.4 mm in diameter for all YPV066/096 compressors depending on compressor size and 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. If it is needed, pre-charge additional oil to the system accordingly.

3.17 Compressor paralleling

An example of tandem configuration is shown in **Figure 18**.

It is essential to carefully check the oil balancing between the compressors and to verify that piping stresses are acceptable at any condition.

The suction manifold is close to a symmetrical layout with the design intent of equal pressure drop to each compressor. A straight length of pipe is connected to the suction manifold "T" connection to serve as a flow straightener to make the flow as uniform as possible. The discharge manifold is the less critical of the two manifolds in terms of pressure drop. Low pipe stress and reliability are its critical design characteristics. Support for the discharge manifold between the compressors should be no closer than a straight distance of 356 mm from the discharge tee.

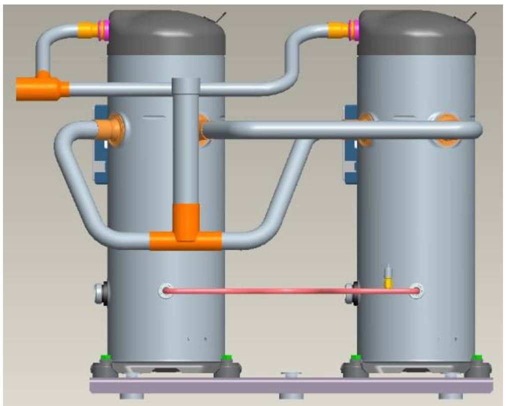


Figure 18:Oil and gas balancing achieved through both the oil and gas equalization lines

For tandem compressor applications, tubing stress levels should be closely evaluated. If excess stress levels occur, the Resonance Avoidance Feature in the EV3 drive may be used.

Tandem compressors follow the same application guidelines as single compressors outlined in this document. The refrigerant charge limit for compressors in parallel is shown in **Table 11** below. A manifolded circuit with charge over the limit must have a crankcase heater or stator heating applied to compressors. Oil levels in the individual sight glasses will vary, depending on whether one or more compressors in the manifolded set are operating and if the tandem set is made up of equal or unequal compressor capacities. Because of the unequal oil levels that can exist, oil levels should be viewed with the compressors off to allow the oil level to stabilize between the compressor sumps. With the compressors off, oil should be visible in the individual compressor sight glasses.

Compressor model	Refrigerant charge limit for tandem assemblies
YPV066/096	8 kg

Table 11: Refrigerant charge limit for use of crankcase heating function in tandem assemblies

Suction and discharge manifolds are not designed to support system piping. Support means must be provided by the system designer to support suction and discharge lines so that stress is not placed on the manifolds. The compressors in a manifolded set can be started/stopped in any desired sequence. To help reduce inrush current, starting the compressors individually is recommended.

Should a compressor fail in the tandem set, the complete tandem should be removed from the unit and replaced with a new tandem set. Replacing individual compressors is discouraged because of the care that must be used when installing the oil equalization tube and the availability of manifolds to the aftermarket.

The OEM has the option to purchase the tandem-ready compressors to assemble the compressors into a tandem configuration. Tandem-ready compressors are designated with a **GCN** bill-of-material number at the end of the model number, eg, YPV0661T-4E9-**GCN**. Drawings of the tandem assemblies are available upon request from the Application Engineering department at Emerson.

Figure 19 below shows an example of tandem assembly. No oil separator or oil level device is needed in this 4-pipe design.

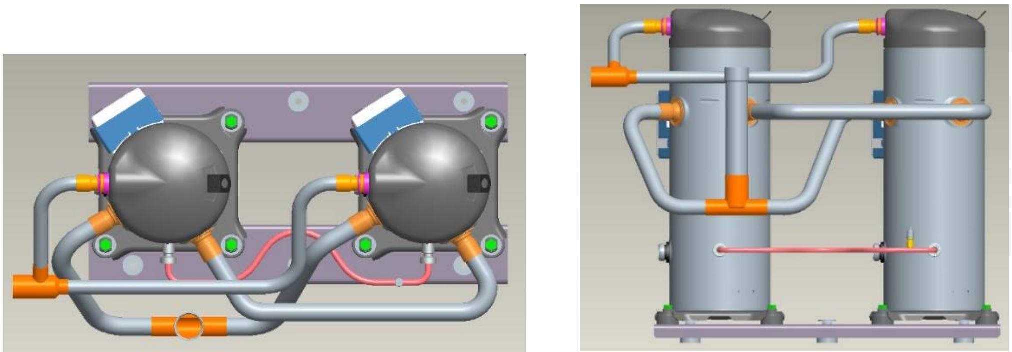


Figure 19: Example of a tandem with one variable-speed YPV066/096 and one fixed-speed compressor

NOTE: **Please consult with Application Engineering during the development of systems with trio compressor assemblies. Trio compressor assemblies are sensitive to system operating conditions and configurations which will affect oil balancing. Trio compressor assemblies must be qualified for each application.**

NOTE: **Users who choose to design and build their own manifolds for tandem compressors are ultimately responsible for the reliability of those manifold sets.**

NOTE: **For more information, please refer to Technical Information TI_Scroll_Oil_Bal_Test "Tandem & Trio: Oil System Test & Qualification" and TI_AC_YP_Multiple_02 "Paralleling of YP Copeland™ Scroll Compressors for Air-Conditioning Applications".**

4 Electrical connection

4.1 General recommendations

WARNING
High voltage! Electrical shock hazard! Serious personal injuries and/or system breakdown! The compressor must always have the ground wire attached to the compressor terminal fence. The other end of the ground wire must be connected to the appropriate ground terminal on the drive. Moulded electrical plugs must be used in all applications.
Disconnect and lock out power before servicing. Allow drive components to electrically discharge before servicing. Respect the time according to drive application guidelines before servicing the drive. Use compressor with grounded system only. Refer to original equipment wiring diagrams. Electrical connections must be made by qualified electrical personnel.

WARNING
Ignition source in a potentially flammable atmosphere! Fire hazard! The electrical connection of the scroll compressors is not an ignition source during normal operation but could become one if not installed properly according to installation instructions. Ensure correct mechanical and electrical installation. System capacitors may remain charged for several minutes after shutdown. Before starting to work on the electrical installation make sure sparking is not possible. Continuously check if the ambient atmosphere is non-flammable when working on the electrical installation.

CAUTION
High voltage! Drive damage! The unit contactor must be installed upstream of the drive, ie, not between the drive and the compressor. Major faults and irreversible damage to the drive could occur if the drive output is open-circuit while the compressor is running.

Before connecting the drive to the power network, make sure that all the cables to and from the drive and to the compressor are correctly connected and that the supply voltage, phases and frequency match the drive nameplate data.

The wiring should remain physically separated to minimize the introduction of electrical noise.

For safety reasons, Emerson recommends that the electrical installation be executed in compliance with standard EN 60204-1 and/or other standards and regulations of application when dealing with A2L refrigerants. The wiring must conform to local regulations and codes of practice.

4.2 Electrical wiring

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

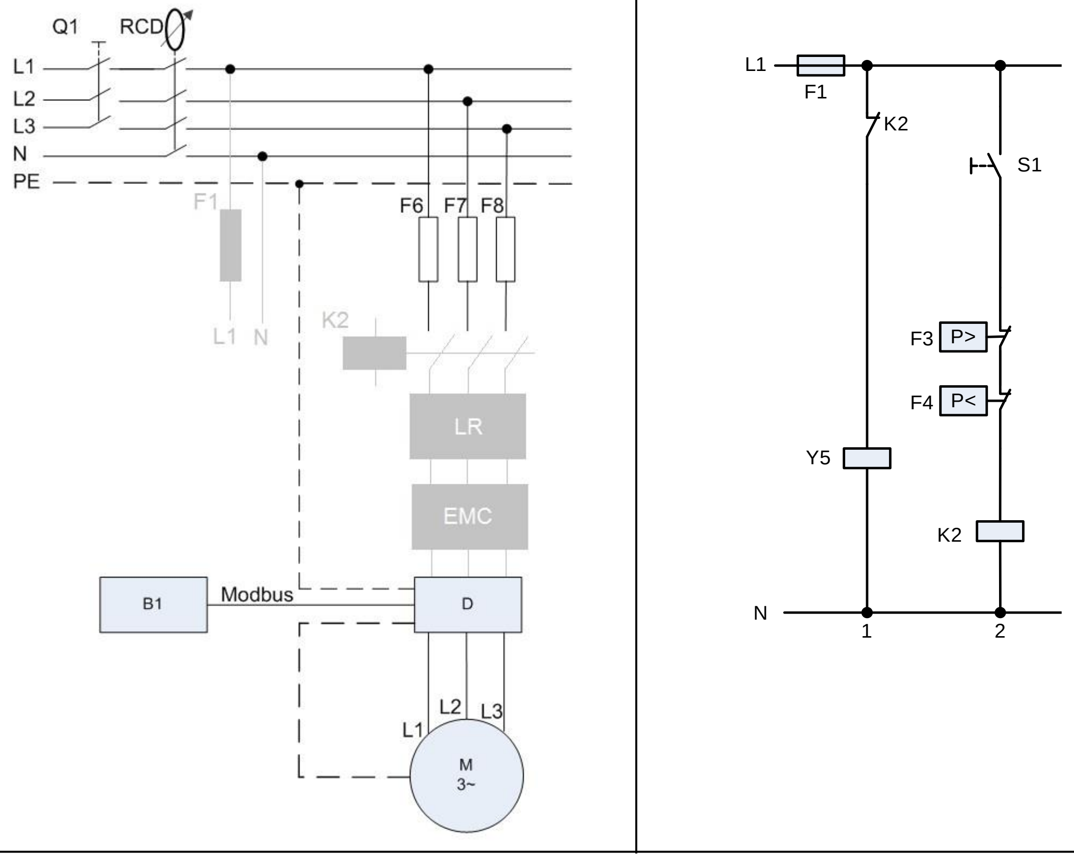
WARNING
Ignition source in a potentially flammable atmosphere! Fire hazard! Any work on the energized terminals in the compressor terminal box could create an ignition. Do not touch the energized terminals with a tool or cable when the compressor is energized

WARNING
Earth leakage current! Electrical shock hazard! The combination of compressor and drive can cause both AC and DC earth leakage current. To protect against both kinds of leakage current it is recommended to use an AC/DC sensitive RCD on the power supply side.

The combination of YPV066/096 compressors and inverters can cause earth leakage currents, both AC and DC, due to the presence of the inverter and an EMC filter in the system. Therefore, an AC/DC-sensitive Residual Current Device (RCD) must be used on the power supply side. The RCD can be either **type B or B+**.

NOTE: **Emerson recommends the use of a contactor K2 for the safety chain in order to comply with EN 60335.**

Power circuit | **Control circuit**



Legend

B1	System controller	K2	Contactors
CH	Choke	LR	Line reactor (optional)
D	Drive	Q1	Main switch
EMC	EMC filter (optional)	R2	Crankcase heating function
F1, F6, F7, F8	Fuses	RCD	Residual current device
F3	HP switch	S1	Auxiliary switch
F4	LP switch	Y5	Solenoid valve for injection (optional)

Figure 20: wiring diagrams for YPV066/096 compressors with EV3 drive

NOTE: **The input line reactor and EMC filter are part of the EV3 drive. Please refer to the EV3 Application Guidelines for more information.**

NOTE**: For additional recommendations about electromagnetic compatibility and how to wire up the drive assembly please refer to the EV3 Application Guidelines.**

4.3 Terminal box

WARNING
Ignition source in a potentially flammable atmosphere! Fire hazard! Any work on the energized terminals in the compressor terminal box could create an ignition. Do not touch the energized terminals with a tool or cable when the compressor is energized.
Compressors operating with flammable refrigerants shall use only the qualified terminal box supplied with the compressor.
Mechanical stress or shock! Overheating! Terminal Fusite damage and leakage! Mechanical stress and shocks to the Fusite must be avoided as they could damage the glass and/or ceramic. This might result in hermetic failure or loss of terminal performance. Precautions are required to prevent striking or bending of pins. Bent or damaged pins may result in loss of hermeticity and/or terminal performance.
Ensure correct connection of cables to the compressor terminal Fusite to avoid local overheating of Fusite pins which might lead to refrigerant leaks.

The terminal box rating is IP54 for YPV066/096 compressors.

When installing YPV066/096 compressors in a system, the following measures must be taken:

- To ensure the wires are properly terminated, the correct terminal and clamping tool for the selected wire size must be used.
- The ground wiring must conform to local regulations and codes of practice (only the provided parts must be used).
- The grounding screw must be torqued to 2.4 to 2.6 Nm.
- A cable strain-relief device must be added.
- Cable and wires must be protected against sharp edges.

***NOTE:* The wiring should remain physically separated to minimize the introduction of electrical noise.**

***NOTE:* For recommendations specific to the EV3 drive please refer to the EV3 Application Guidelines AGL_Sol_EV3 "EV3 Inverter Drive for YPV* Variable-Speed Compressors".**

4.4 Motor windings

YPV066/096 compressors feature a three-phase brushless permanent magnet motor. The motor is connected in star.

4.5 Motor insulation

The motor insulation material is class "B" (maximum allowable operating temperatures according to IEC 34-1 or DIN 57530).

4.6 Protection devices

Fuses must be installed before the drive.

The selection of fuses has to be made according to EN 60269-1 or EN 60204-1 and drive maximum operating current (MOC). Not installing fuses or selecting inappropriate fuses may result in compressor and/or drive failure.

4.7 High-potential testing

WARNING
High-potential testing in a potentially flammable atmosphere! Fire hazard! Make sure the atmosphere is non-flammable before performing high-potential testing. Do not perform any high-potential test when the compressor is charged with flammable refrigerant.

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.

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

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

Special attention should be paid when performing a high-potential test and reading the Megohm resistance on A2L compressors, as such tests can induce an electrical arc and cause a fire hazard.

For the same reason, compressors removed from a system with A2L refrigerant will need to have the oil drained and a nitrogen purge introduced to flush any remaining refrigerant from the compressor prior to high-potential testing and Megohm resistance reading.

5 Start-up & operation

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

WARNING
Air/flammable refrigerant mixture! Creation of a flammable atmosphere! Make sure the atmosphere is non-flammable before starting the system. Ensure that the system contains only refrigerant.

IMPORTANT
Oil dilution! Bearing malfunction! It is important to ensure that new compressors are not subjected to liquid abuse. It is mandatory to use the crankcase heating function of the drive if the refrigerant charge exceeds 7 kg (8 kg in tandem configuration). Turn the crankcase heating on 12 hours before starting the compressor.

5.1 Strength-pressure test

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

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

5.1.1 Compressor strength-pressure test

The compressor has been strength-pressure tested in the Emerson 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.

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

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

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

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

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

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

5.3 Drive leak testing

CAUTION
Air expansion! Drive damage! Do not use the drive under vacuum. Small enclosed cavities full of air could expand and damage the electronics.

5.4 System evacuation

Before the installation is put into commission, it has to be evacuated with a vacuum pump. The vacuum pump and all tools have to be approved for A2L refrigerant/air mixture. 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.

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

5.5 Preliminary checks – Pre-starting

WARNING
Air/A2L refrigerant mixture in a potentially flammable atmosphere! Fire hazard! Whenever starting up a system charged with A2L refrigerant, eg, after filling, repair, or maintenance, make sure not to start and operate accidentally in a flammable atmosphere.

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:

- no flammable gas in the ambient;
- suitable ventilation according to the room volume and to the refrigerant charge;
- 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 main switch location & position.

5.6 Charging procedure

WARNING
Air/A2L refrigerant mixture in a potentially flammable atmosphere! Fire hazard! Only use filling equipment designed and approved for use and operation with A2L refrigerants. Make sure all connections are tight to avoid leakage. Make sure to fill with pure A2L refrigerant.

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

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

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

The system manufacturer/installer must respect the charge limitations according to valid standards, such as EN 378.

5.7 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 YPV* compressors to attain the published performance are 16 hours at the standard conditions.

5.8 Initial start-up

CAUTION
High discharge pressure operation! Compressor damage! Do not use compressor to test opening setpoint of high-pressure cut-out. Bearings and moving 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. Switch function can be tested with nitrogen prior to installation and wiring can be checked by disconnecting the high-pressure switch during the run test.

5.9 Rotation direction

Scroll compressors, like several other types of compressors, will only compress in one rotational direction. Variable-speed compressors have three phases and the drive is either for 1- or 3-phase external power supply. Swapping phases between compressor and drive can result in reverse direction, please read carefully compressor and drive applications guidelines. **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.

5.10 Start-and-stop routine

The Emerson EV3 drive controls the start-and-stop routine of the variable-speed scroll. This routine allows for soft starting and controlled stopping, an advantage over traditional On/Off control of fixed-capacity units.

5.11 Starting sound and shut-off sound

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

Variable-speed scroll compressors incorporate a fluid brake design to help mitigate reverse rotation during shutdown. A momentary reverse rotation sound may be heard, but it is entirely normal and has no effect on compressor durability.

NOTE: **More details about starting and stopping routines can be found in the EV3 Application Guidelines AGL_Sol_EV3 "EV3 Inverter Drive for YPV* Variable Speed Compressors"**.

5.12 Deep vacuum operation

WARNING
Operation below ambient pressure! Fire hazard! During operation below ambient pressure, a flammable mixture can form inside the system. Make sure that air does not enter the system and that the pressure never falls below atmospheric pressure.

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

5.13 Shell temperature

During normal operation, the discharge gas as well as the compressor top shell and discharge line can reach temperatures up to the maximum discharge gas temperature of 150 °C – 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.

5.14 Pumpdown cycle

WARNING
Operation below ambient pressure! Fire hazard! During operation below ambient pressure, a flammable mixture can form inside the system. Extreme attention shall be paid to system tightness. Make sure that air does not enter the system and that the pressure never falls below atmospheric pressure.

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 hysteresis of the low-pressure control differential has to be reviewed since a relatively large volume of gas will re-expand from the high side of the compressor into the low side after shutdown.

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

5.15 Minimum run time

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

5.16 Oil level

The YPV066/096 compressors are equipped with an oil sight glass and an oil Schraeder valve.

The oil level should be maintained at mid-point of the sight glass. If an oil regulator is used the level should be set within the top half of the sight glass. An oil level higher than the top of the sight glass is not sustainable in the compressor as the extra oil will be pumped out into the system causing a reduction in system efficiency and a higher-than-normal oil circulation rate.

During the system development phase, adequate oil return from the system to the compressor in any operation should be evaluated and qualified. For this purpose, a sample compressor for lab testing, equipped with an external oil sight tube, is available from Emerson. Oil return check test recommendations are also available on request from Application Engineering. The compressor oil level should be checked with the compressor off to avoid the sump turbulence when the compressor is running.

If testing shows a gradual, continuous loss of oil in the compressor sight tube over long run cycles at low speed, an oil recovery cycle should be incorporated into the system logic. A recovery cycle is accomplished by ramping the compressor speed up to a higher speed to increase the refrigerant flow rate to flush or sweep oil back to the compressor. Frequency and duration of a recovery cycle depends on many variables and would have to be determined through testing for each system type and configuration. A default method could be to initiate a recovery cycle at regular intervals.

See also the information in **section 3.15 "Compressor oil return, oil balancing, floodback and oil dilution tests"**.

5.17 Defrost control

The Emerson EV3 drive software allows to set defrost speed requirements that will be reached by the drive when a defrost request is communicated by Modbus.

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
Ignition source in a potentially flammable atmosphere! Fire hazard! When opening the system, the atmosphere could be flammable. All electrical components that are a source of ignition must always be switched off during service and maintenance. Ensure that the surface temperatures of the components never exceed the limits set by the applicable safety standard, eg, EN 378-2.
Air/flammable refrigerant mixture! Fire hazard! Remove all refrigerant before opening the system. Make sure to remove refrigerant completely from all components such as heat exchangers, refrigerant accumulators, etc. Flush the system and the components with inert gas before undertaking any work and before brazing.

WARNING
Open flame in a potentially flammable atmosphere! Fire hazard! The area shall be checked with an appropriate refrigerant detector prior to and during work, to ensure the technician is aware of a potentially toxic or flammable atmosphere. Ensure that the leak detection equipment being used is suitable for use with all applicable refrigerants.
Personnel performing work on a refrigeration system that involves exposing the pipework shall avoid using any ignition source in a way that could lead to a fire or explosion hazard. All sources of ignition shall be kept sufficiently far from the site of installation, repair, removal or disposal during the entire time when refrigerant could be released into the surrounding space.
Open flames and smoking are strictly forbidden at all times.
During service make sure that:
- the area is well ventilated;
- the materials and equipment used are suitable for use under flammable conditions;
- only non-sparking tools are used;
- antistatic gloves and clothes are used;
- build-up of electrostatic charges is avoided;
- no unshielded or naked flame is used;

If parts of the refrigeration system are charged with flammable refrigerant, make sure that all the valves are tightly closed and that the open pipes after the valves are free of refrigerant and oil.

A risk analysis to evaluate all possible risks shall be carried out by the service technician before any repair work on the A2L systems.

6.1 Qualification of workers

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

Examples of such work procedures are:

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

6.2 Preparation and work procedure

A work procedure shall be provided in the preparation stage. All maintenance staff and other personnel working at the site shall be instructed on the nature of the work being carried out.

If any work is to be conducted on the refrigeration systems or any associated parts, appropriate fire extinguishing equipment shall be provided. Dry powder or CO_2 fire extinguishers are considered appropriate. Confirm that appropriate fire extinguishing equipment is available near the work area.

Prior to starting to work on systems containing flammable refrigerants, safety checks are necessary to ensure that the risk of ignition is minimized.

Work shall be undertaken under a controlled procedure so as to minimize the risk of a flammable gas or vapour being present while the work is being performed.

Avoid working on systems filled with flammable refrigerant in a confined space.

6.3 Disassembling system components

When disassembling system components, the main steps described hereunder shall be followed:

1. Recover refrigerant and evacuate system using an A2L-dedicated recovery unit and vacuum pump. All the refrigerant shall be recovered to avoid significant release. Ensure that the outlet of the vacuum pump is not close to any potential ignition source and that ventilation is available.
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.

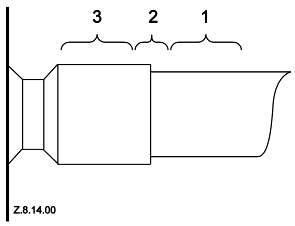


Figure 21: Tube connecting areas

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.**

6.4 Exchanging the refrigerant

WARNING
Air/A2L mixture in a potentially flammable atmosphere! Fire hazard! In any case avoid air/A2L mixture in the refrigeration system. Make sure that the system is filled with pure A2L refrigerant. In the event that the refrigerant needs replacing, the charge should be recovered using A2L-qualified refrigerant recovery unit and recycling bottles.

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

For qualified refrigerant and oil, see **section 2.6.1.**

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

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

6.5 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 the case of A2L refrigerant compressor replacement, the oil has to be drained out of the compressor and the compressor should be flushed with dry nitrogen. DO NOT close the stubs with plugs.

In the case of a motor burnout, the majority of contaminated oil will be removed with the compressor. The rest of the oil will be cleaned through the use of suction and liquid line filter driers. A 100 % activated alumina suction line filter drier is recommended but must be removed after 72 hours.

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 single compressor or tandem is exchanged in the field, it is possible that a major portion of the oil may still be in the system. While this may not affect the reliability of the replacement compressor, the extra oil will add to rotor drag and increase power usage.

6.5.2 Start-up of a new or replacement compressor

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

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

6.5.3 Compressors return procedure

If a compressor has to be returned to the manufacturer for analysis the procedure below shall be followed:

- During the entire working procedure continuously check if the ambient atmosphere is flammable. If a flammable atmosphere is detected, ensure proper ventilation of the working space and immediately cut-off the power supply.
- Resume working after the atmosphere is no longer dangerous.
- Recover the refrigerant from the system using a suitable recovery unit. During this action, the compressor crankcase heating function could be energized – immediately de-energize in case a flammable atmosphere is detected.
- Recover to 3 mbar absolute or lower. For best results and to recover also the refrigerant solved in the oil, run the recovery unit two or three times as necessary.
- Flush the whole system with oxygen-free dry nitrogen (OFDN).
- Open the system with a cutting tool and flush the entire system with OFDN.
- Disassemble the compressor with a cutting tool. Drain and recover compressor oil properly. Flush the compressor with OFDN for a few minutes.
- The compressor should be returned free of oil and with connections open – do not close connections with plugs.
- Collect and secure the oil properly. Provide information about the quantity of oil drained from the compressor and its colour. Ideally, send a good picture.
- Dispose of the oil according to local rules and regulations.
- Use a proper cardboard box package when preparing the compressor for shipment. Place warning icons on each side and on the top of the box. Mention the following message on the box: **"Warning! Flammable A2L refrigerant compressor for analysis"**.
- The compressor package must be kept in the upright position – mark it accordingly.
- If more than one compressor have to be returned, each compressor must be packed individually.

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

6.6 Lubrication and oil removal

WARNING
Air/A2L flammable refrigerant mixture in a flammable atmosphere! Fire hazard! Use suitable recovery unit and recycling bottles also for oil disposal as A2L refrigerant may still be solved in the oil.

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 for use with R32 is a polyolester 4MA POE lubricant. See nameplate for original oil charge shown in litres. A field recharge is from 0.05 to 0.1 litre less.

All compressors get a factory holding charge of dry air to prevent humidity entering the compressor during transport and storage (about 1 to 2,5 bar, relative pressure). An intact holding charge serves as a proof of quality against penetrating moisture.

One disadvantage of POE is that it is far more hygroscopic than mineral oil – see **Figure 22**. Only brief exposure to ambient air is needed for POE to absorb sufficient moisture to make it unacceptable for use in a refrigeration system. Since POE holds moisture more readily than mineral oil it is more difficult to remove it through the use of vacuum. The compressors supplied by Emerson contain oil with low moisture content, which may rise during the system assembling process. Therefore, it is recommended that a properly sized filter-drier be installed in all POE systems. This will maintain the moisture level in the oil to less than 50 ppm. If oil is charged into a system, it is recommended to use POE with a moisture content no higher than 50 ppm.

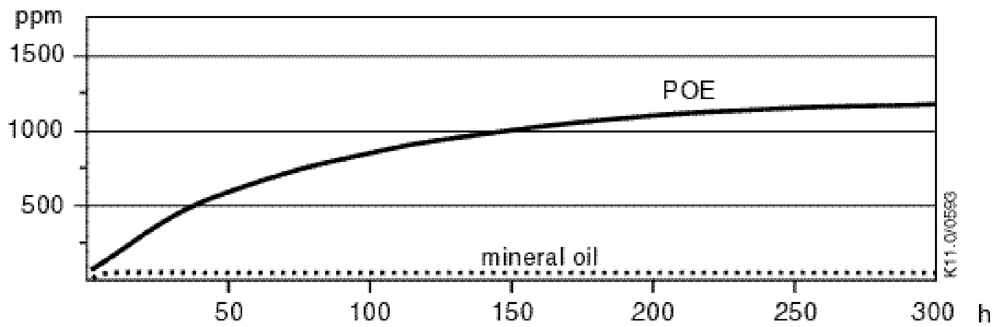


Figure 22: Absorption of moisture in ester oil in comparison to mineral oil in ppm by weight at 25 °C and 50 % relative humidity (h= hours)

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

6.7 Oil additives

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

6.8 Provisions of legislation & leak check requirements

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

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

Leak checking shall be carried out with the following frequency:

a) once per year if the system contains between 5 and <50 tonnes CO_2e;
b) once every 6 months if the system contains between 50 and <500 tonnes CO_2e;
c) once every 3 months if the system contains more than 500 tonnes CO_2e.

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

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

Table 12 below sets out the:

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

Refrigerant	GWP	Maximum interval between leak checks 1 year	Maximum interval between leak checks 6 months	Maximum interval between leak checks 3 months
		5 to <50 T CO_2e	50 to <500 T CO_2e	>500 T CO_2e
R32	675	7.41 kg	74.07 kg	740.7 kg

Table 12: F-gas Regulation leak check intervals (based on refrigerant type and system charge thresholds)

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

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

7 Troubleshooting

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

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

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

When troubleshooting a compressor in combination with a drive please follow the recommendations below:

- Read and analyse the alarm registers from the drive and the system controller.
- Before servicing, shut off and secure the power supply and allow drive components to electrically discharge. Discharge times are given in the drive manual and must be respected.
- Drive: Check all the external wiring for miswiring, broken leads or a cable short circuit. Check for loose or burned contacts. Check for burned components on the board.
- Chokes/PFC: Check all the wiring and check for loose or burned contacts.
- External sensors: Make sure that the external sensors are properly connected and still working (discharge temperature sensor and high-pressure switch).
- Drive cooling: For air-cooled drives, make sure that the airflow is not obstructed.
- EMI filter: Check all the wiring and check for loose or burned contacts on the board.
- Compressor: Make sure the compressor is running within the envelope. Check the winding resistances from the compressor motor and the cables between compressor and drive. Check for loose or burned contacts.

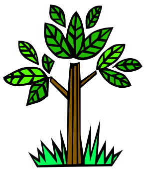
Condition	Cause	Corrective action
The scroll compressor does not run, instead a buzz sound can be heard	Wired incorrectly	Check the power supply on the compressor terminals if there is voltage measured. Trace the wiring diagram to see where the circuit is interrupted.
	Low supply voltage	If the voltage falls below 90 % of the nameplate voltage, the motor may develop insufficient torque. Make sure the compressor is supplied with rated nominal voltage.
	Defective capacitor or relay	For a single-phase motor, a defective capacitor or relay may prevent the compressor from starting. Check these components by substituting “a known-to-be-good” component if available. Make sure that the capacitors are electrically discharged before checking.
	Shorted or grounded motor windings	Check the motor for ground by means of a continuity check between the terminals. If grounded replace compressor.
	Internal compressor mechanical damage	▪ Refrigerant migration: When the compressor is switched off for a long period refrigerant can condense in the crankcase. If the compressor body is colder than the evaporator, refrigerant will move from the evaporator to the compressor crankcase. Refrigerant migration normally occurs when the compressor is installed in a cold area. A crankcase heater and/or a pump-down cycle provide good protection against refrigerant migration.

Condition	Cause	Corrective action
The scroll compressor does not run, instead a buzz sound can be heard	Internal compressor mechanical damage	▪ Acid formation: Acid forms in the presence of moisture, oxygen, metal, salts, metal oxides and/or high discharge temperatures. The chemical reactions are accelerated at higher temperatures. Oil and acid react with each other. Acid formation leads to damage of the moving parts and in extreme cases to motor burnout. Several different test methods can be used to test for acid formation. If acid is present a complete oil change (including the oil in the oil separator) will help. A suction filter which removes acid should also be fitted. Check filter-drier condition.
The scroll compressor does not run, no buzz sound can be heard	Defective system control components	Check if the pressure control or thermostat works properly or if the controls are open.
	Power circuit open	Check the fuse for a tripped circuit breaker or for an open disconnected switch.
	Burned motor winding	▪ If motor burned due to undersized contactors, you will observe that the contacts welded together. Complete motor burnout on all three phases despite the presence of a functioning protection system can be the result. For sizing information please consult with Contactor manufacturer data sheet. If the application of the compressor is changed the contactor sizing should be rechecked. ▪ Check for unbalanced voltage.
	High discharge pressure / suction pressure	▪ For high discharge pressure: - Check for system leaks. - Check the system design. Make sure the discharge line is correctly sized: undersized discharge line can increase discharge pressure. This is also true for an undersized condenser. Correct the component selection as needed. - Check the fan motor, make sure it is running properly in the right direction. Check the condenser: if dirt has been accumulated it will clog the airflow; clean as necessary. High discharge pressure is also caused by an overcharged system and high ambient temperature surrounding the condenser. ▪ For high suction pressure, check the “evaporator superheat” first to diagnose the problem: - High superheat at the evaporator outlet: this is likely in case of excessive pressure-drop in the liquid line or too much vertical lift on the pipe work. ▪ Low superheat at the evaporator outlet is characterized by oversized selection of the expansion valve or incorrect bulb sensor mounting. The valve may freeze up in the open position due to accumulation of debris in the system. For a system with very short refrigeration lines an accumulator is recommended.

Condition	Cause	Corrective action
The scroll compressor trips on motor protection	Compressor operating outside the design limits	Check the compressor suction and discharge pressures while it is running. Make sure they are within the operating envelope.
	Defective motor protector	If all operating conditions are normal, the voltage supply at the compressor terminals is balanced and within limits, the compressor crankcase temperature is within normal limits, and the amperage drawn is within the specified range, the motor protector may be defective.
Excessive discharge temperature	Insufficient cooling medium injected	For compressors using vapour injection, make sure the expansion valve is connected at a distance between 150 mm and 200 mm from the economizer inlet and at a position not lower than inlet connection. The injection line economizer to compressor should be properly sized to avoid pressure drop. For good refrigerant distribution in the economizer respect the recommendations especially those regarding the inlet pipes for the vapour injection according to BHE-manufacturer. The liquid line from the BHE to the expansion valve(s) need to be well insulated as well. A solenoid valve should be installed on the liquid line to prevent refrigerant migration.
	Too high compressor superheat	Make sure the compressor operates within the acceptable superheat range published by Emerson.
The scroll compressor runs continuously	Excessive cooling/heating load or inadequate insulation	Check the load design; make sure that proper insulation is applied. Correct it as necessary.
	Control circuit inoperative	Check the thermostat, measure the temperature of the room and compare with the thermostat; replace or re-calibrate the thermostat. Check the LP control switch and replace it if it is found defective.
Compressor lubrication problem	Oil trap due to incorrect piping layout / sizing	Check the piping layout design. Installations of pipe being routed over or around obstacles can inadvertently create unwanted traps for the oil return. As much as possible the refrigerant line should travel a direct and straight course between the evaporator and compressor. It should also be remembered that the entire system will be coated in oil to some extent. Oil viscosity changes with temperature. More oil stays in the system than was originally expected. Make sure the line is correctly sized.
	Oil pump out due to high cycling rate	A high cycling rate will pump oil into the system and lead to lubrication failure. Oil leaves the compressor at start-up and the short running time is insufficient to return the oil to the compressor via the suction side. Try to limit the number of cycles to maximum 10 per hour.
	Low gas velocity	System gas velocity changes depending on temperature and load (capacity control). In low load conditions gas velocity may not be high enough to return oil to the compressor.

Condition	Cause	Corrective action
Low discharge pressure	Low ambient temperature	Fit a fan cycling control system.
	Refrigerant undercharge	Check the system for leaks. Observe sight glass for bubbles. Add refrigerant until the sight glass is clear.
Low suction pressure	System design load too small	If the compressor is running in a tandem or in parallel, modulate the running process.
	Inadequate refrigerant going to the evaporator	Lower normal discharge pressure values can lead to insufficient refrigerant flow to the system. This can also be verified by checking the evaporator outlet superheat, if it is found unusually high. Check the selection of the expansion valve (likely undersized).
Noise during shut-off	Anti-reverse device	This does not have any effect on the durability of the compressor, no action is necessary.

8 Dismantling & disposal



Removing oil and refrigerant:

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

Dispose of compressor and drive in accordance with national legislation and regulations.

9 References

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

Performance and technical data:

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

Spare parts and accessories:

An online version of the Emerson spare parts and accessories software is available from the webpage www.climate.emerson.com/en-gb/tools-resources.

DISCLAIMER

1. The contents of this publication are presented for informational purposes only and are not to be construed as warranties or guarantees, express or implied, regarding the products or services described herein or their use or applicability.
2. Emerson Climate Technologies GmbH and/or its affiliates (collectively "Emerson"), as applicable, reserve the right to modify the design or specifications of such products at any time without notice.
3. Emerson does not assume responsibility for the selection, use or maintenance of any product. Responsibility for proper selection, use and maintenance of any Emerson product remains solely with the purchaser or end user.
4. Emerson does not assume responsibility for possible typographic errors contained in this publication.

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

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

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

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

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

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

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

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

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

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

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

POLAND
ul. Konstruktorska 13
PL-02673 Warsaw
Tel: +48 22 458 92 05
Fax: +48 22 458 92 55
poland.sales@emerson.com

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

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

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

AGL_AC_VS_YPV_1T_EN_Rev01

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

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