Embraco Scroll

Application Guidelines

Quick Guide

embraco
Nidec

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INTRODUCTION

This quick guide contains information on the safety, installation, operation, and maintenance of Embraco ERF, ELF, EAF, EHF, EWF, and EDF scroll compressors. It is essential to read and follow this guide before performing any procedure to ensure the correct and safe operation of the compressors. Embraco compressors are manufactured according to the latest European and American safety standards, with an emphasis on user safety. However, Embraco does not guarantee the performance and reliability of the product if it is used improperly in accordance with these guidelines.

SAFETY INSTRUCTIONS

These instructions should be kept throughout the lifetime of the compressor. You are strongly advised to follow these safety instructions. The local related regulations and rules should be obeyed, too.

GENERAL RECOMMENDATIONS

- Refrigerant compressors must be employed only for their intended use.
- Only trained personnel can perform diagnostic and maintenance procedures on refrigeration systems.
- Installation and repair requires special training, technical information, special tools and special equipment.
- Make sure in advance if the environment for maintenance is adequate and airy. Tools and process equipment should be available. The required Personal Protective Equipment (PPE) must be used by the technician.
- Before starting maintenance or diagnostics, first make sure that the cooling system is disconnected from the mains.
- After disconnecting the system from the mains, wait for the compressor to cool down. Only perform maintenance or diagnostic procedures with the cold compressor (25 ° C ± 5 ° C).
- The compressors shall be powered only in electrical installations provided with short-circuit and overload protection devices, together with a ground fault circuit interrupter (GFCI) circuit breakers, RCD (Residual Current Device) or RCBO (Residual Current Circuit breaker with Overcurrent Protection) as established in the NEC (National Electrical Code) or any regional Directives.
- Correct grounding is required for the use of compressors.


Failure to shut down the mains compressor during maintenance procedures and to apply a system without a ground fault circuit interrupter (GFCI) may cause serious physical hazards by electric shock and/or fire to the technician.

Failure to disconnect the compressor from the mains may, in the event of a short circuit in the region of the hermetic terminal of the compressor, cause expulsion of the hermetic pins causing leakage of the cooling fluid. This situation becomes more critical when applying inflammable refrigerants, because if it is associated with an ignition source, there may be flame generation and serious risks to the technician's physical integrity.

- When it is necessary to remove the capacitors, carefully disconnect these components with extra attention to the exposed electrical terminals. The capacitor must be discharged before handling.
- Never remove the compressor before removing all refrigerant from the system, from both the high- and low-pressure sides. For this, the use of a fluid collecting machine is recommended. In the case of flammable fluids, such as R290, ensure the removal of small accumulations of gas from the system.
- Use a pipe cutter to disconnect the compressor tubes.Under no circumstances use the flame of the torch to disconnect the compressor tubes. The use of a torch to disconnect compressors using flammable coolant may cause fire and release toxic vapors.
- In case of burning of the compressor and / or internal contamination of the system Clean the piping with a suitable solvent applied according to the solent manufacturer's technical guidelines.
- Use appropriate back up wrenches on Rotalock fittings when servicing
- Never install a system and leave it unattended when it has no charge, a holding charge, or with the service valves closed without electrically locking out the system.
- Use only approved refrigerants and refrigeration oils.

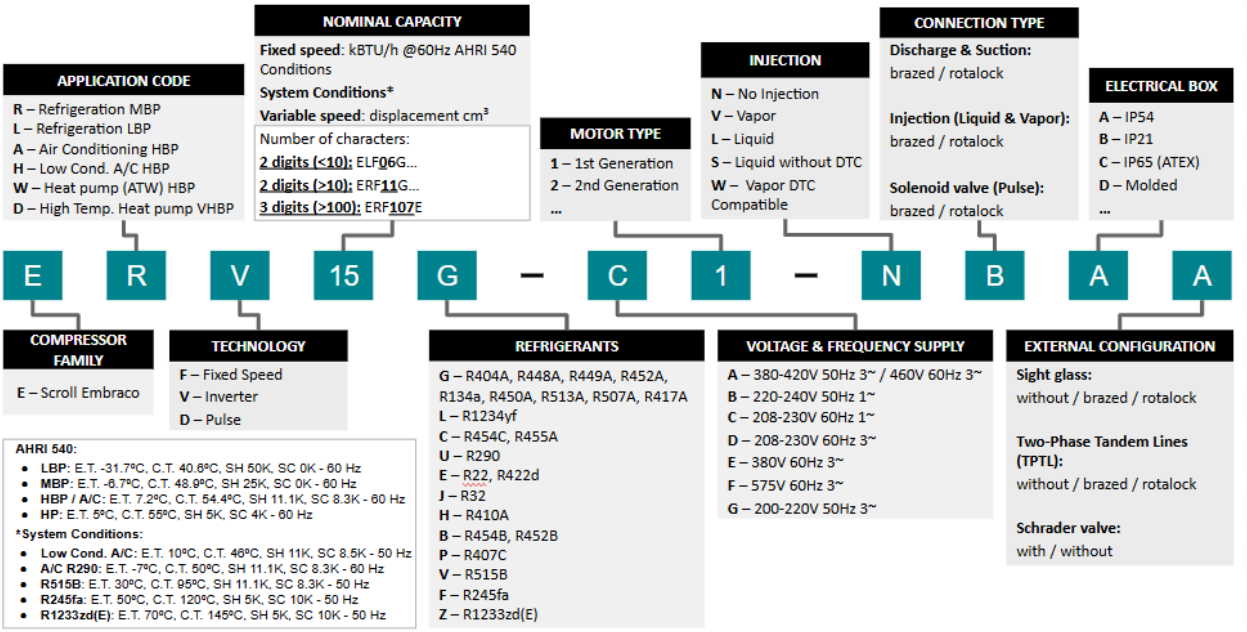
Failure to follow these warnings could result in serious personal injury.

BURN HAZARD

- High temperature on the compressor surface. Do not touch the compressor until it has cooled down.
- Ensure that materials, piping and wiring do not touch high temperature areas of the compressor.
- Use caution when brazing system components.
- Personal safety equipment must be used.
- Failure to follow these warnings could result in serious personal injury or property damage.

NOMENCLATURE

Embraco Scroll Nomenclature



Connection Type	Discharge & Suction	Injection (Liquid & Vapor)	Solenoid Valve (Pulse Scroll only)
A	brazed	without	without
B	rotalock	without	without
C	brazed	rotalock	without
D	rotalock	rotalock	without
E	brazed	brazed	without
F	rotalock	brazed	without
G	brazed	without	rotalock
H	rotalock	without	rotalock
I	brazed	rotalock	rotalock
J	rotalock	rotalock	rotalock
K	brazed	brazed	rotalock
L	rotalock	brazed	rotalock
M	brazed	without	brazed
N	rotalock	without	brazed
O	brazed	rotalock	brazed
P	rotalock	rotalock	brazed
Q	brazed	brazed	brazed
R	rotalock	brazed	brazed

External Configuration	Sight Glass	Two-Phase Tandem Lines	Schrader Valve
A	without	without	without
B	without	brazed	without
C	without	rotalock	without
D	without	without	with
E	without	brazed	with
F	without	rotalock	with
G	brazed	without	without
H	brazed	brazed	without
I	brazed	rotalock	without
J	brazed	without	with
K	brazed	brazed	with
L	brazed	rotalock	with
M	rotalock	without	without
N	rotalock	brazed	without
O	rotalock	rotalock	without
P	rotalock	without	with
Q	rotalock	brazed	with
R	rotalock	rotalock	with

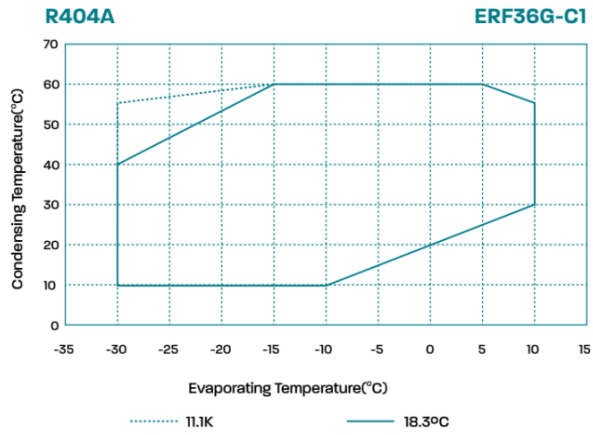
REFRIGERANTS

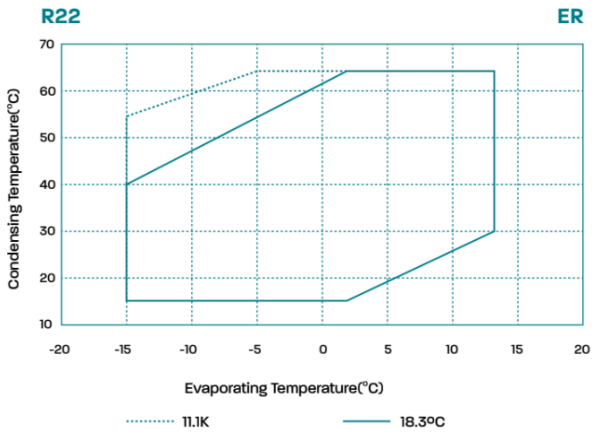
APPLICATION		LBP	MBP	A/C	Low Cond. A/C	Heat Pump	High Temp. Heat Pump
G	R404A	✓	✓				
	R448A	✓	✓				
	R449A	✓	✓				
	R452A	✓	✓				
	R134a	✓	✓	✓		✓	✓
	R450A		✓				
	R513A		✓	✓			
	R507A		✓	✓			
	R417A					✓	
L	R1234yf						
C	R454C	✓	✓				
	R455A	✓	✓				
U	R290	✓	✓	✓		✓	
E	R22	✓	✓	✓	✓	✓	
	R422d	✓	✓	✓	✓	✓	
J	R32			✓		✓	
H	R410A			✓	✓	✓	
B	R454B			✓			
	R452B			✓			
P	R407C		✓	✓		✓	
V	R515B						✓
F	R245fa						✓
Z	R1233zd(E)						✓

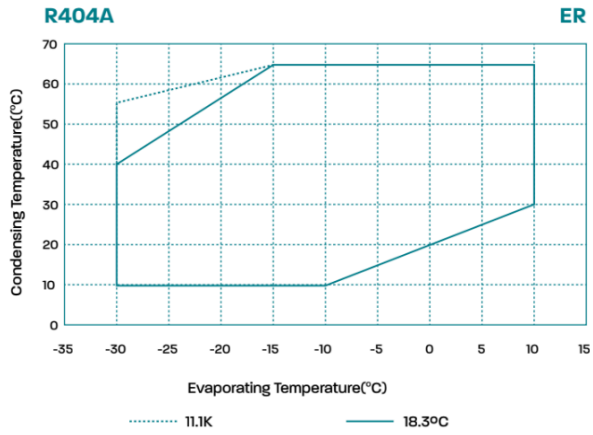
OPERATING RANGE

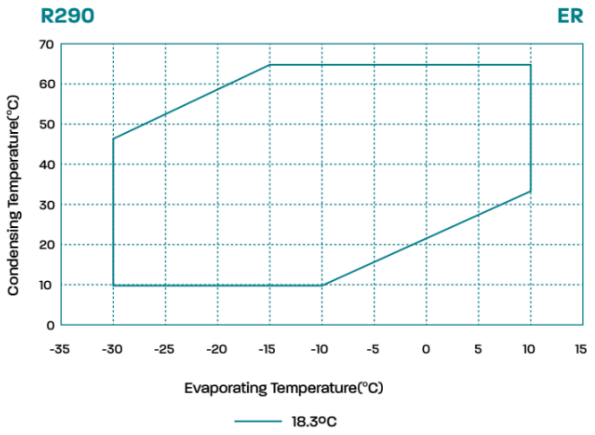
The pressures operating range in which the compressor can work depends on the compressor model and refrigerant. In the figure the envelopes for the common operating gases are presented. The figures below are only for reference only, always check the compressor datasheet for the most accurate data.

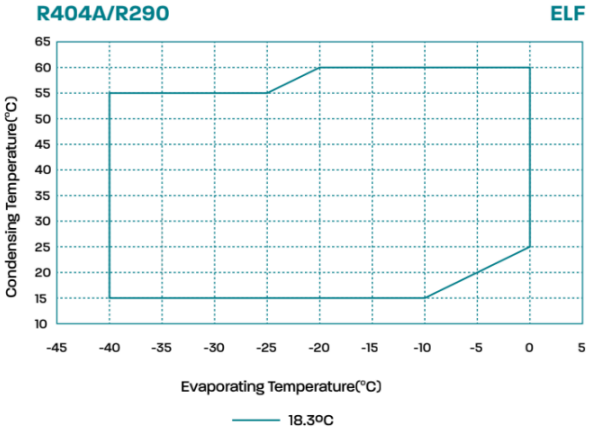
Refrigeration Application:

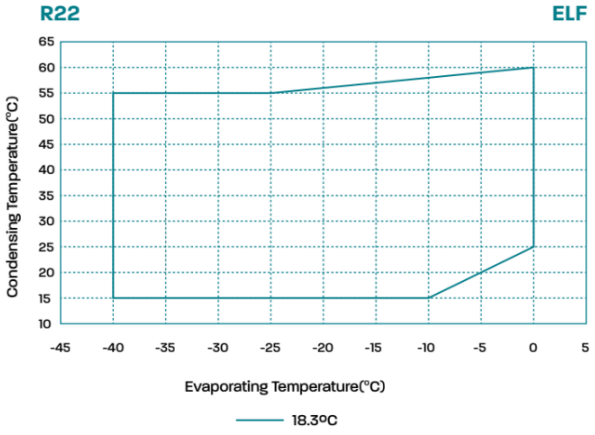




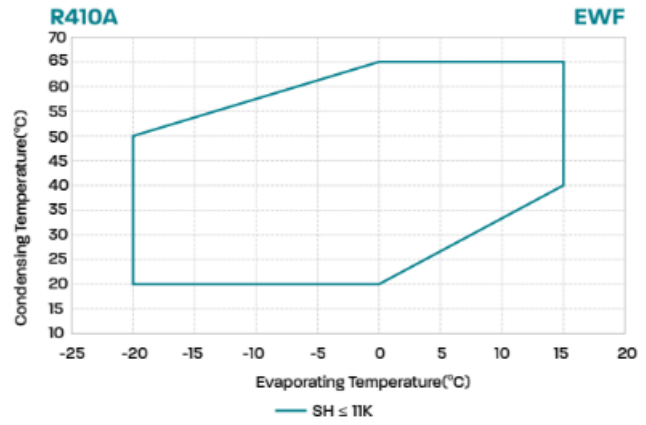


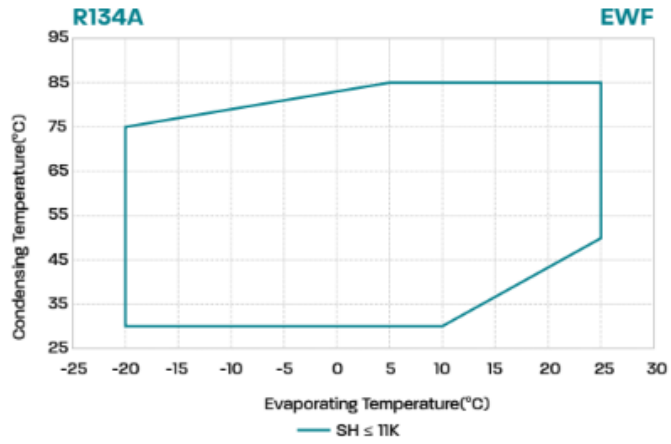




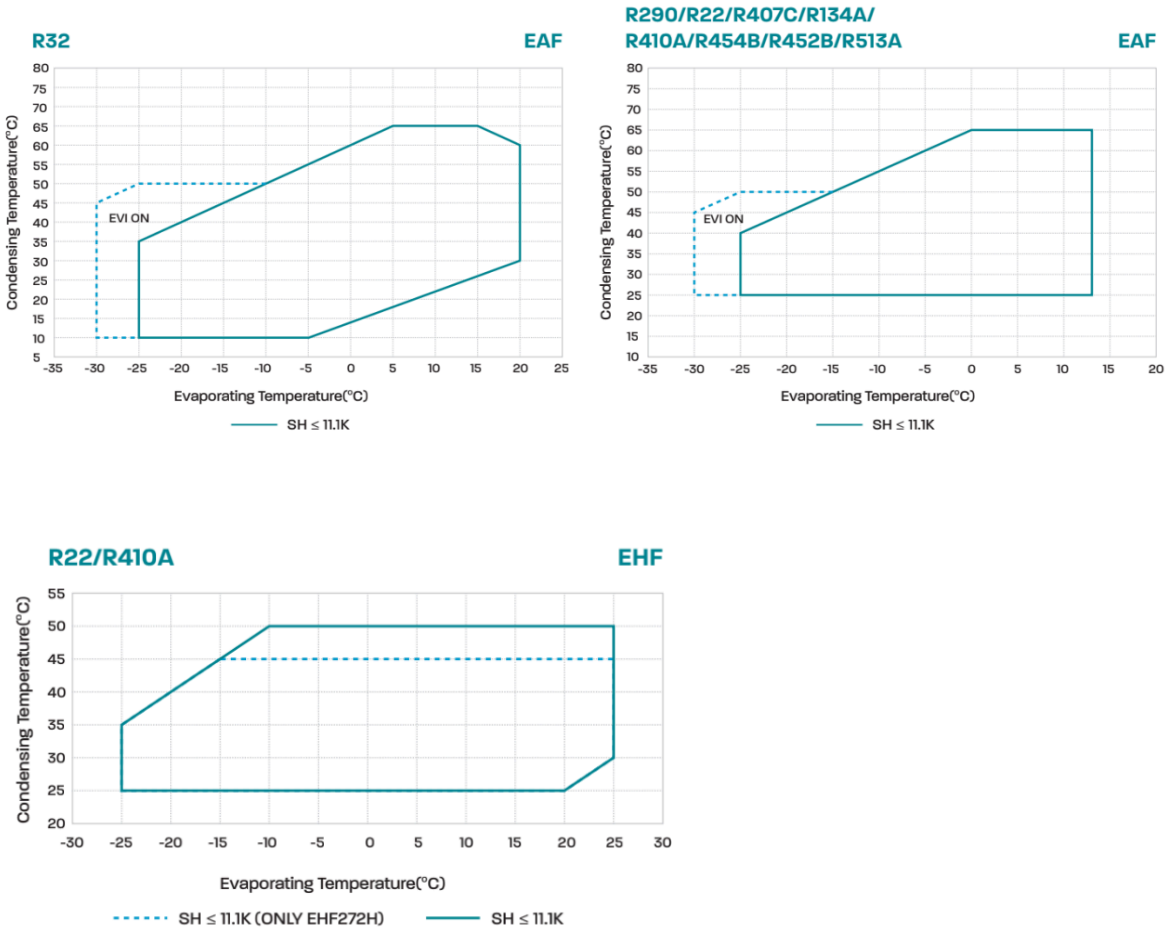


Heat Pump Application:





Air Conditioning Application:



ACCUMULATORS

Due to the inherent ability of Embraco scrolls to handle liquid refrigerant flood backs and defrost cycle operation conditions, accumulators may not be necessary. An accumulator is suggested for single compressor systems when the charge limitations exceed 4.5kg (EAF69** - EAF200*) or 7.5kg (EAF230* - EAF355**). For systems allowing prolonged uncontrolled liquid return to the compressor, an accumulator is necessary to prevent liquid migration to the compressor.

Continuous liquid flood back or repeated flooded starts will dilute the oil inside the compressor, causing inadequate lubrication on the moving parts and wear. Proper system design should minimize the possibilities of liquid flood back to ensure maximum compressor life.

To avoid liquid refrigerant returning to the compressor during the run cycle, proper superheat at the compressor suction inlet should be maintained. Embraco recommends a minimum of 6K (Celsius) superheat for EAF models. Suction line temperature is measured on the suction line 150mm from the suction inlet.

The temperature difference between the compressor crankcase and the suction line can determine if there is liquid refrigerant returning to the compressor. We recommend that this temperature difference should be a minimum of 20K (Celsius) during continuous operation.

The thermocouple should be fixed to measure oil temperature: (a) at the
opposite side of the suction port;(b) be located around 50-100mm to the compressor base, (c)insulate from the ambience.
In some cases, such as defrost cycles, there will be rapid working condition changes.
This temperature difference may drop rapidly for a short period of time. When the difference falls below the recommended value, our recommendation is the duration should not exceed a maximum (continuous) time period of three minutes and should not be lower than a 10 K (Celsius) difference.

SCREENS

Any filters with a mesh size finer than 30 x 30 (0.6mm openings) should not be used anywhere in the system with these compressors.

CRANKCASE HEATERS

The crankcase heater should be energized 12 hours before the compressor's initial start-up or restart after a long time off duration. During normal operation, the crankcase heater should be energized when the compressor is off and de-energized when the compressor is on.

DISCHARGE LINE THERMOSTAT

Operation above or on the left of the operation envelope can cause high compression ratios or excessive internal compressor temperatures. This will result in overheating the scrolls, causing excessive wear resulting in premature compressor failure.
The Scroll compressor doesn't have an internal discharge temperature control, so a discharge line thermostat is required in the compressor control circuit. The cut out setting for the discharge line thermostat should be 125°C or lower. It should be installed approximately 170mm from the discharge tube outlet, or if a service valve is installed at the discharge tube, the thermostat should be installed approximately 130mm from the valve outlet port.

HIGH PRESSURE CONTROL

The cut-out setting for the high-pressure control should be determined according to regional standards, in Europe usually EN 378, part 2.
The maximum pressure value for the individual compressor type, HP side, is printed on the nameplate of the compressor.
The high-pressure control should have a manual reset feature for the highest level of system protection.

LOW PRESSURE CONTROL

The minimum cut-out setting should be selected according to the refrigerant and to the allowed operation envelope (see technical data in Selection software).
The low-pressure cut-out should have a manual reset feature for the highest level of system Protection.

PUMP DOWN AND DEEP VACUUM OPERATION RECOMMENDATIONS

Embraco Scroll compressors should not be used to evacuate refrigeration or air-conditioning systems. The scroll compressor can be used to pump down refrigerant in a unit as long as the pressures remain within the operating envelope. Low suction pressures will result in overheating of the scrolls and permanent damage to the compressor drive bearing. Single-phase compressors have an internal check valve in its discharge connector. **For three-phase compressors, which do not have an internal check valve, it is required that a check valve is added to the discharge line to avoid short cycling after the pump down.**

COMPRESSOR CYCLING

It is recommended to use a 3 minutes delay timer to limit compressor cycling.

SUCTION LINE NOISE AND VIBRATION

Embraco Scroll compressors inherently have low sound and vibration characteristics.
However, the sound and vibration characteristics differ in some respects from those of reciprocating compressors. In rare instances, these could result in unexpected sound complaints.
One difference is the vibration characteristics of the scroll compressor, although low, includes two very close frequencies, one of which is normally isolated from the shell by the suspension of an internally suspended compressor. These frequencies, which are present in all compressors, may result in a low level "beat" frequency that may be detected as noise coming along the suction line under some conditions Elimination of the "beat" can be achieved by attenuating either of the contributing frequencies. The most important frequencies to avoid are line and twice-line frequencies for single-phase compressors and line frequency for three-phase compressors. This is easily done by using one of the common combinations of design configurations described in Table 2. The scroll compressor makes both a rocking and torsional motion, and enough flexibility must be provided in the line to prevent vibration transmission into any lines attached to the unit. In a split system the most important goal is to ensure minimal vibration in all directions at the service valve to avoid transmitting vibrations to the structure to which the lines are fastened.
A second difference of the Embraco Scroll is that under some conditions, the normal rotational starting motion of the compressor can transmit an "impact" noise along the suction line. This may be particularly pronounced in three-phase models due to their inherently higher starting torque. This phenomenon, like the one described previously also results from the lack of internal suspension, and can be easily avoided by using standard suction line isolation techniques as described in Table 3
The sound phenomena described above are not usually associated with heat pump systems because of the isolation and attenuation provided by the reversing valve and tubing bends.

Recommended Configuration	
Component	Description
Tubing Configuration	Shock loop

Service Valve	"Angled valve" fastened to unit
Suction muffler	Not required

Alternate Configuration	
Component	Description
Tubing Configuration	Shock loop
Service Valve	"Straight through" valve not fastened to unit
Suction muffler	May be required (Acts as dampening mass)

IPR VALVE

Embraco Scroll compressors have internal pressure relief valves it will open when the discharge to suction differential pressure equals 30.4bar. When this happens, the hot discharge gas gets in contact with the motor, which triggers the overload protector.

MOTOR PROTECTION

Conventional inherent internal line break motor protection is provided.

OIL TYPES

Polyol ester lubricants must be provided for the scroll compressors used with HFC refrigerants.
POE must be handled carefully and the proper protective equipment (gloves, eye protection, etc.) must be used when handling POE lubricant. POE must not encounter any surface or materials that might be harmed by POE, including without limitation, certain polymers (e.g. PVC/CPVC and polycarbonate).
A system with POE oil should not be open to the air for more than 3 minutes. Do not remove the suction/discharge plugs until the compressor is ready for brazing

OIL CHARGES

The initial oil charge is 1.4L for compressors from 1.2HP to 5HP, the re-charge volume is 1.25L;
The initial oil charge is 1.7L for compressors from 6 to 7.5HP, the re-charge volume is 1.45L;
The initial oil charge is 3.5L for compressors from 8 to 15HP, the re-charge volume is 3L;
The initial oil charge is 6L for compressors above 15HP, the re-charge volume is 5.6L;

TANDEM SCROLL COMPRESSORS

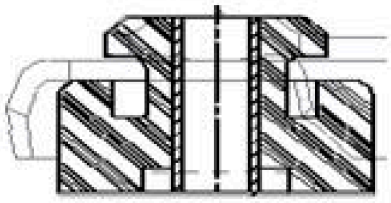
A three-phase unit with a charge over charge limitation must have crankcase heaters added to both compressors. Tighten the bolts mounting the compressor on the rail. Holes in the mounting rails may be used to mount isolation grommets under the entire tandem.
A discharge check valve must be placed in the common discharge line. Both compressors must be at the same level to prevent oil from migrating through the oil equalization line.

Compressors may be individually cycled. Individual compressors should not be replaced in the field. The entire tandem compressor unit must be replaced if it becomes necessary to replace one compressor.

MOUNTING

Four vibration absorber grommets are supplied with each compressor. They dampen the start-up surge of the compressor and minimise sound and vibration transmission to the compressor base during operation. The metal sleeve inside is a guide designed to hold the grommet in place. It is not designed as a load-bearing member, and application of excessive torque to the bolts can crush the sleeve. Its inner diameter is approximately 8.5 mm to fit, eg, an M8 screw. The mounting torque should be 15 ± 1 Nm. It is critically important for the grommet not to be compressed.
If the compressors are mounted in tandem or used in parallel, then the hard mountings (bolt M8) are recommended. The mounting torque should be 15 ± 1 Nm. It is possible to deliver these hard-mounting parts as a kit.

Mounting parts - Soft mountings



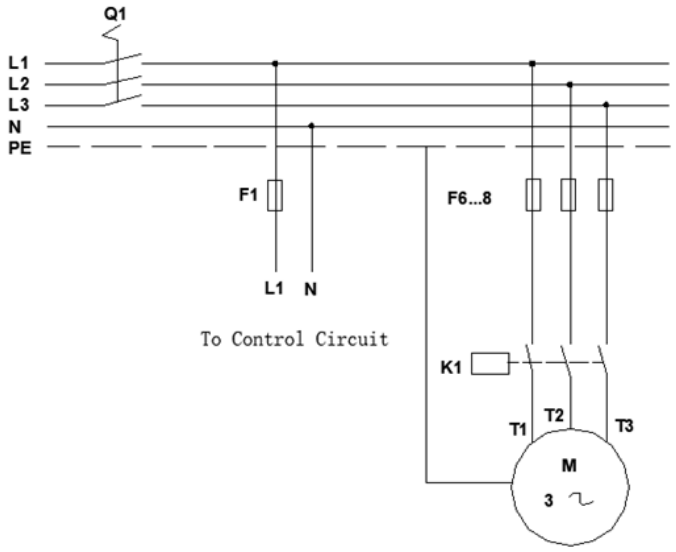
TUBING CONSIDERATIONS

Proper tube design must be taken into consideration when designing the tubing connecting the scroll to the remaining system. The tubing should provide enough "flexibility" to allow normal starting and stopping of the compressor without exerting excessive stress on the tube joints. In addition, it is desirable to design tubing with a natural frequency away from the normal running frequency of the compressor. Failure to do this can result in tube resonance and unacceptable tubing life.

ELECTRICAL CONNECTION

Before connecting the compressor, ensure the supply voltage, the phases and the frequency match the compressor label data. The electrical diagrams of the compressors can be found below and in the compressor's datasheet.

Three-phase compressors with internal motor protection:

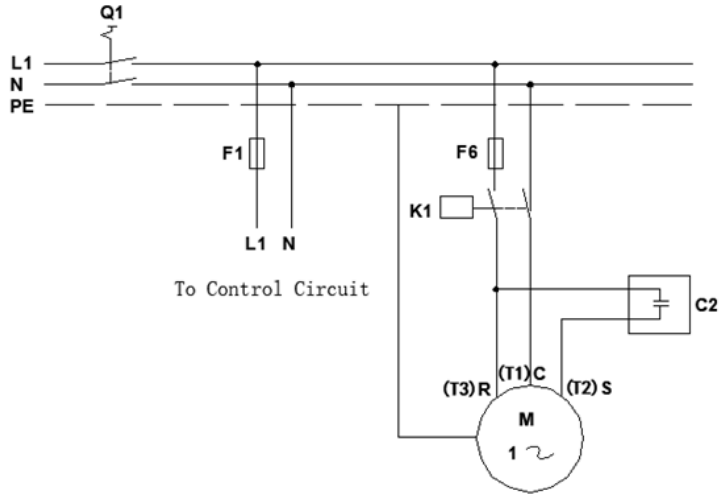


Electrical Code

L1/L2/L3/N/PE: Three Phase Lines(line/neutral/ground)

Q1:	Manual Switch
F1/F6...8:	Fuse
K1:	Compressor Contactor
M:	Compressor Motor
T1/T2/T3:	Compressor Wiring Terminal

Single phase compressors with internal motor protection:



Electrical Code

L1/N/PE: Single Phase Lines(line/neutral/ground)

Q1:	Manual Switch
F1/F6:	Fuse
K1:	Compressor Contactor
C2:	Run Capacitor
M:	Compressor Motor
R/C/S:	Compressor Wiring Terminal

SHELL TEMPERATURE

System component failure may cause the top shell and discharge line to briefly reach temperatures above 150 °C . Wiring or other materials, which could be damaged by this temperature should not come in contact with the shell or lines.

CONNECTION FITTINGS

Embraco Scroll compressors are provided with either braze connections or roto-lock adapters depending on the bill of material selected. All models have copper plated steel suction and discharge fittings for a more rugged, leak resistant connection. Rotalock valves should be periodically re-torqued to ensure that leak prevention tightness is maintained.

THREE-PHASE ROTATION DIRECTION

Scroll compressors will only compress in one rotational direction. Direction of rotation is not an issue with single-phase compressors since they will always start and run in the proper direction. Three-phase compressors will rotate in either direction depending upon phasing of the power. Since there is the chance of connecting power in such a way as to cause rotation in the reverse direction, it is important to check the phase of the supply line and ensure it is being connected correctly to the compressor by the wiring diagram above 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 also allows verification of proper rotation direction. There is no negative impact on durability caused by operating three-phase Embraco Scroll compressors in the reversed direction for a short period of time but oil may be lost. After several minutes of operation in reverse, the compressor protection system will trip due to high motor temperature. However, if allowed to repeatedly restart and run in reverse without correcting the situation, the compressor will be permanently damaged.

All three-phase compressors are wired identically internally. Once the correct phasing is determined for a specific system or installation, connecting properly phased power leads to the same hermetic terminals will maintain the proper rotation.

To avoid the risk of the compressor running in the wrong direction, it is recommended to use a sequence phase relay to identify the correct orientation and adjust the electrical connection if needed.

SPARE PARTS

Embraco Scroll				
Spare Parts	AC	HP	REF LBP	REF MBP
Terminal Seal	✓	✓	✓	✓
Sleeve Spacer	✓	✓	✓	✓
Rubber (Grommets)	✓	✓	✓	✓
Bolt	✓	✓	✓	✓
Terminal Cover	✓	✓	✓	✓
T-Box	✓	✓	✓	✓
Sound Jacket	Optional	Optional	Optional	Optional
Crank Heater	Optional	Optional	Optional	Optional
RotaLock Connector	Optional	Optional	Optional	Optional
Sight glass	Optional	Optional	✓	✓
DTC Valve			✓	

Solenoid Valve			only for Pulse Scroll
For Tandem Configuration			
Steel Grommet	Mandatory		
Oil Adapter	Mandatory		
Oil Regulator	Mandatory		
For Modulated Capacity Configuration			
Solenoid Valve	Mandatory		
Controller	Mandatory		

BRIEF POWER INTERRUPTIONS

Brief power interruptions (less than 0.5 second) may result in powered reverse rotation of single-phase refrigeration scroll compressors. High-pressure discharge gas expands backward through the scrolls at power interruption causing the scroll to orbit in the reverse direction. If power is reapplied while this reversal is occurring, the compressor may continue to run noisily in the reverse direction for several minutes until the compressor internal protector trips. For short periods, this has no effect on the durability. But if the conditions persist for longer periods, permanent damage may occur. When the protector resets, the compressor will start and run normally. Embraco recommends the use of a timer which can sense brief power interruptions and lock the compressor out of operation for two minutes. No time delay is required on three-phase models to prevent reverse rotation due to power interruptions.

SYSTEM EVACUATION

Before the installation is put into commission, it has to be evacuated with a vacuum pump. Proper evacuation reduces residual moisture to 50 ppm. During the initial procedure, suction and discharge shut-off valves on the compressor remain closed. The installation of adequately sized access valves at the furthest point from the compressor in the suction and liquid lines is advisable. Pressure must be measured using a vacuum pressure gauge on the access valves and not on the vacuum pump; this serves to avoid incorrect measurements resulting from the pressure gradient along the connecting lines to the pump. The installation should be evacuated down to 0.3 mbar.
Subsequently, the factory holding charge of Nitrogen in the compressor is released to the ambient. The shut-off valves are opened and the installation - including the compressor - is once more evacuated as described after the system has been recharged with dry nitrogen. The leak-proof design of the installation and leak testing methods should be of highest standards (refer to EN 378 for correct procedures).

CHARGING PROCESS

- Do not power on the compressor before charging the refrigerant.
- Use the scale to control charge quantity.
- One liquid drier is recommended to connect between the refrigerant cylinder and manifold to prevent moisture into system during charging
- Connect the refrigerant cylinder to both the high and low side of the refrigeration system.

- Power on the solenoid valve if possible (do not power on the compressor at this time).
- Turn the refrigerant cylinder upside down if needed to ensure only liquid can be charged into both high and low sides.
- Charge the refrigerant to the system as much as needed (at least 70% of total needed).
- Disconnect the high side charge port, turn on the compressor, and continue to charge liquid slowly from the low side to avoid liquid flooding in the compressor until adequate charge is met. Connecting a sight glass between the charging hose and the compressor suction service valve is suggested. This will allow the cylinder hand valve so that only liquid can leave the cylinder while allowing only vapor to enter the compressor.
- Never close the suction service valve when the compressor is running.

HIGH POTENTIAL (HI-POT) TESTING

The scroll compressor motors are located at the lower part of the compressor. As a result, when liquid refrigerant is within the compressor shell, the motor can be immersed in liquid refrigerant to a greater extent than compressors with the motor mounted at the upper part of the compressor. When compressors are Hi-pot tested and liquid refrigerant is in the shell, they can show higher levels of leakage current than compressors with the motor on top because of the higher electrical conductivity of liquid refrigerant than refrigerant vapor and oil. This phenomenon can occur with any compressor when the motor is immersed in refrigerant. The level of current leakage does not present any safety issue. To lower the current leakage reading, the system should be operated for a brief period of time to redistribute the refrigerant to a more normal configuration. Under no circumstances should the Hi-pot or Meg-ohm test be performed while the compressor is under a vacuum.

EMBRACO SCROLL FUNCTIONAL CHECK

Embraco Scroll compressors do not have internal suction valves. It is not necessary to perform functional compressor tests to check how low the compressor will pull suction pressure. This type of test may damage a scroll compressor. The following diagnostic procedure should be used to evaluate whether an Embraco Scroll compressor is functioning properly.

- **Step 1** - Verify if the compressor's terminal is being supplied the correct voltage.
- **Step 2** - Verify the compressor's winding continuity and if it is not short to ground. See the "Electrical Connection" section for instructions on identifying the winding terminals and the compressor's datasheet for the correct values of ohmic resistance between terminals. If the winding circuit is open, the winding can be broken or the overload protector may have been tripped. If the protector has opened, the compressor must cool sufficiently to reset.
- **Step 3** - With service gauges connected to suction and discharge connectors, turn on the compressor and verify if the compressor is building up pressure. If not, proceed to the next step.
- **Step 4A** - For Single-Phase Compressors:
  Check if the compressor electrical components are according to the specifications of the compressor datasheet and if they are working correctly.
- **Step 4B** - For Three-Phase Compressors:
  Check if the wires connections are in the right sequence. If the wires are not correctly connected, the compressor may be running in reverse and the sequence must be corrected.

BRAZING PROCEDURE

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 holes.

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

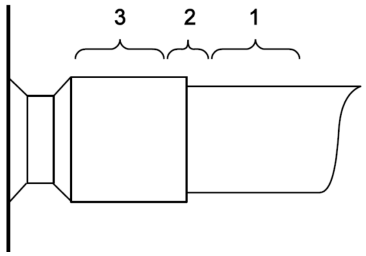


Figure 2: Suction tube brazing areas

Embraco Scroll compressors have copper-plated steel suction, injection and discharge tubes. These tubes are far more robust and less prone to leaks than copper tubes. Due to the different thermal properties of steel and copper, brazing procedures may have to be changed from those commonly used.

Refer to **Figure 2** and procedure below for the brazing of the suction and discharge lines to a scroll compressor.

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

To disconnect:

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

To reconnect:

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

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

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