



Application Guideline

Semi-Hermetic Stream Digital Compressors

4MFD-13X to 6MKD-50X



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1 Safety instructions

Copeland® brand products semi-hermetic compressors are manufactured according to the latest European safety standards. Particular emphasis has been placed on the user's safety.

These compressors are intended for installation in systems according to the EC Machines directive. They may be put to service only if they have been installed in these systems according to instructions and conform to the corresponding provisions of legislation. For relevant standards please refer to Manufacturers Declaration, available on request.

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

You are strongly advised to follow these safety instructions.

1.1 Icon explanation

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

1.2 Safety statements

- Refrigerant compressors must be employed only for their intended use.
- Only qualified and authorized HVAC or refrigeration personnel are permitted to install, commission and maintain this equipment.
- Electrical connections must be made by qualified electrical personnel.
- All valid standards for connecting electrical and refrigeration equipment must be observed.



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

1.3 General instructions



WARNING

System breakdown! Personal injuries! 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 electrically locking out the system.

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



WARNING

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



CAUTION

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



IMPORTANT

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

2 Product description

2.1 Common information about Copeland® brand products semi-hermetic Stream Digital compressors

This manual covers semi-hermetic Stream Digital compressors. The semi-hermetic reciprocating compressor family consists of different ranges. The Stream Digital series of 4M*D and 6M*D models range from 13 hp to 50 hp.

Model	Nominal Horsepower (hp)	Displacement m ³ /h	Medium temperature ¹⁾		Low temperature ²⁾		Net Weight (kg)	Footprint mm
			Cooling Capacity (kW)	COP	Cooling Capacity (kW)	COP		
4MFD-13X	13	62	33.4	2.4	11.4	1.4	177	381 x 305
4MAD-22X	22		33.6	2.4	10.8	1.4	178	
4MLD15X	15	71	38.7	2.3	13.2	1.5	180	
4MHD-25X	25		38.8	2.4	12.5	1.4	187	
4MMD-17X	17	78	42.6	2.3	14.7	1.5	182	
4MID-27X	27		42.8	2.4	13.9	1.4	188	
4MTD-22X	22	88	47.8	2.3	16.5	1.5	183	
4MJD-30X	30		48	2.3	16	1.4	190	
4MUD-25X	25	99	54.2	2.3	18.7	1.5	186	
4MKD-32X	32		54.2	2.4	17.7	1.4	202	
6MMD-27X	27	120	61.8	2.3	21.6	1.4	215	
6MID-35X	35		64.2	2.4	20.3	1.4	219	
6MTD-32X	32	135	70.4	2.3	25.1	1.5	221	
6MJD-40X	40		72.4	2.3	23.6	1.4	223	
6MUD-40X	40	153	79.8	2.3	28.4	1.4	225	
6MKD-50X	50		82.1	2.3	26.6	1.4	230	

1) R404A Evaporating -10°C, Condensing 45°C, Suction Gas Temperature 20°C, Subcooling 0K

2) R404A Evaporating -35°C, Condensing 40°C, Suction Gas Temperature 20°C, Subcooling 0K

Table 1: Stream Digital compressors range and performance - for full load (100%)

Semi-hermetic Stream Digital compressors are suitable for a wide range of applications in the form of either single compressors, condensing units or as multi-compressor equipment.

The compressor is only one component which must be combined with many others to build a functional and efficient refrigeration system.

Therefore the information in this manual relates to all semi-hermetic Stream Digital compressors with standard equipment and accessories only.

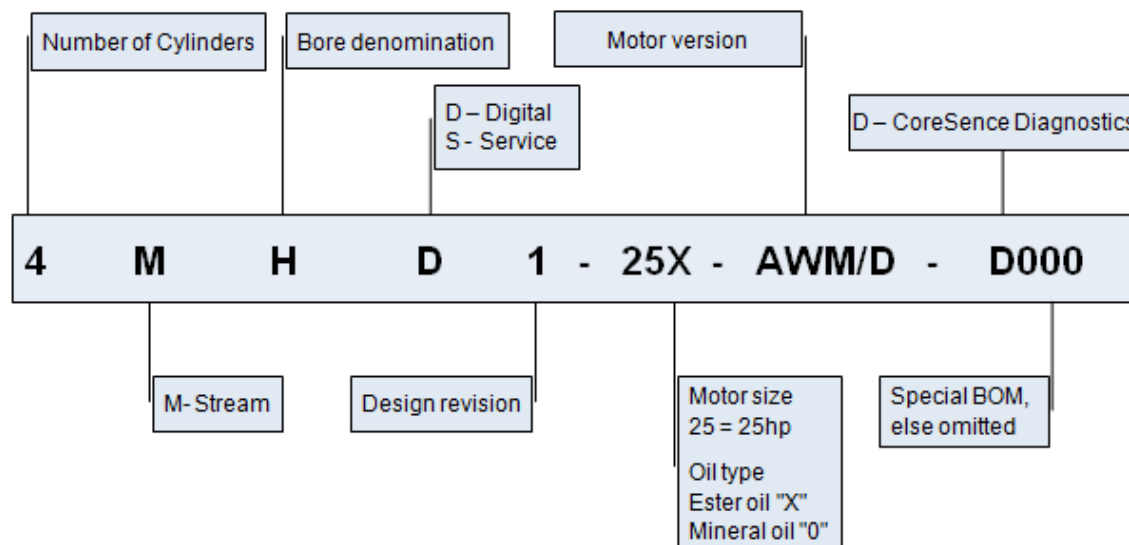
2.2 About this guideline

This guideline is intended to enable users to ensure the safe installation, starting, operation and maintenance of Digital semi-hermetic compressors.

This guideline is not intended to replace the system expertise available from system manufacturers.

2.3 Nomenclature

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



2.4 Nameplate information

All important information for identification of the compressor is printed on the nameplate located below the compressor oil pump.

The type of refrigerant used should be stamped on the nameplate by the installer.

The date of production consists of the year and week of production. The year and month of production are also part of the serial number (Jan. = A, Feb. = B, ... Dec. = L).



Figure 1: Nameplate position

2.5 Application range

2.5.1 Qualified refrigerants and oils



IMPORTANT

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

Oil recharge values can be taken from Copeland® brand products Selection Software on www.emersonclimate.eu.

Qualified refrigerants	R404A, R407A, R407C, R134a, R22, R507
Copeland® brand products standard oil	Emkarate RL 32 3MAF
Servicing oil	Emkarate RL 32 3MAF Mobil EAL Arctic 22 CC

Table 2: Qualified refrigerants and oils for recharging and topping up

To recharge:

- When the compressor is completely empty of oil, the amount of oil to be “recharged” is typically 0.12 litre less than the original oil charge (oil will already be around the system).

To top up:

- During commissioning, planned maintenance or servicing, add oil so that the compressor oil level is correct.

2.6 Design features

2.6.1 Compressor construction

All compressors are fitted with Discus valve plates which cannot be dismantled. To maintain the high capacity of these compressors the correct valve-plate-to-body gasket must always be selected in case of exchange.



Figure 2: Exploded view of Digital mechanism

Factory delivered 4M*D and 6M*D compressors include as standard configuration:

- one standard bank;
- one Digital modulated bank;
- one capacity-controlled bank (blocked suction std) **only for 6M*D**.

2.6.2 Digital theory of operation

Digital technology is now available on the 4M*D and 6M*D Stream compressors. Applied to one bank on a 4M*D compressor it provides 50 to 100% capacity modulation. When combined with a blocked suction bank on a 6M*D compressor, it provides 33 to 100%.

Digital capacity control is achieved by using a proven internal unloading method, based on blocking gas to the valve plate suction area. Capacity control can be achieved by varying the percentage of duty cycle when the compressor is loaded and unloaded. The unloader piston mechanism that controls the flow of suction gas into the cylinders is driven by a solenoid valve.

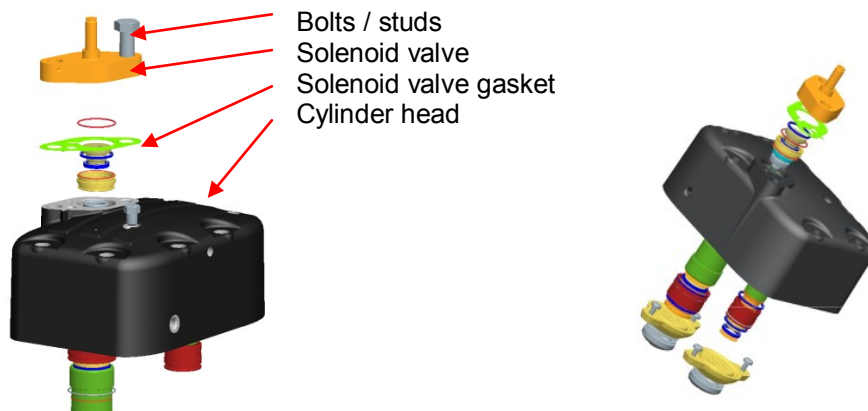


Figure 3: Digital modulation components

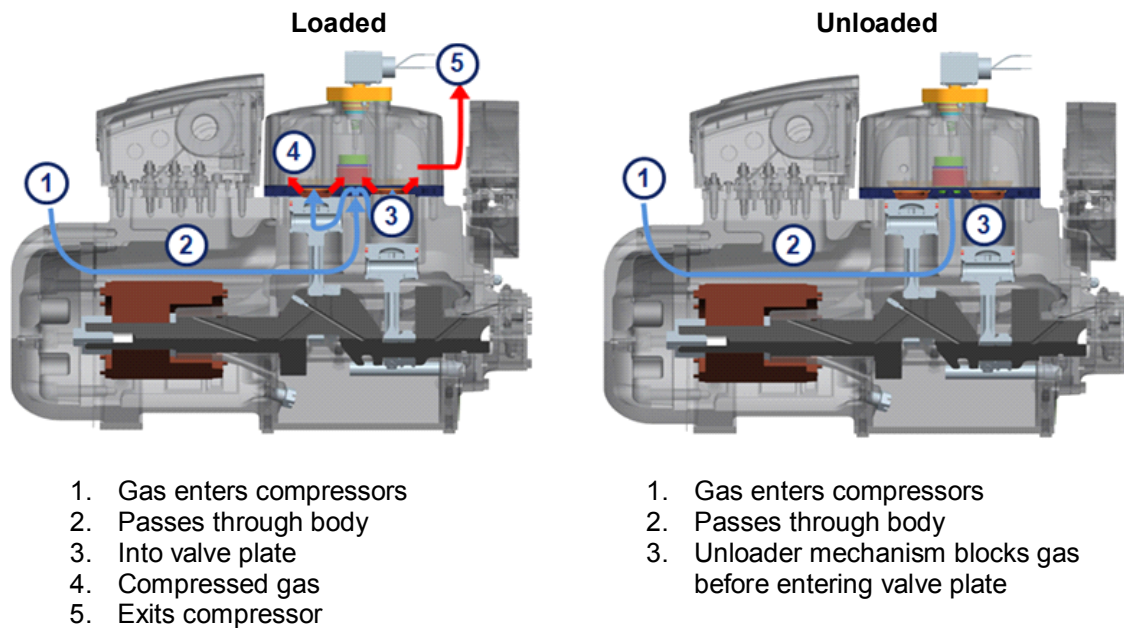


Figure 4: Gas flow

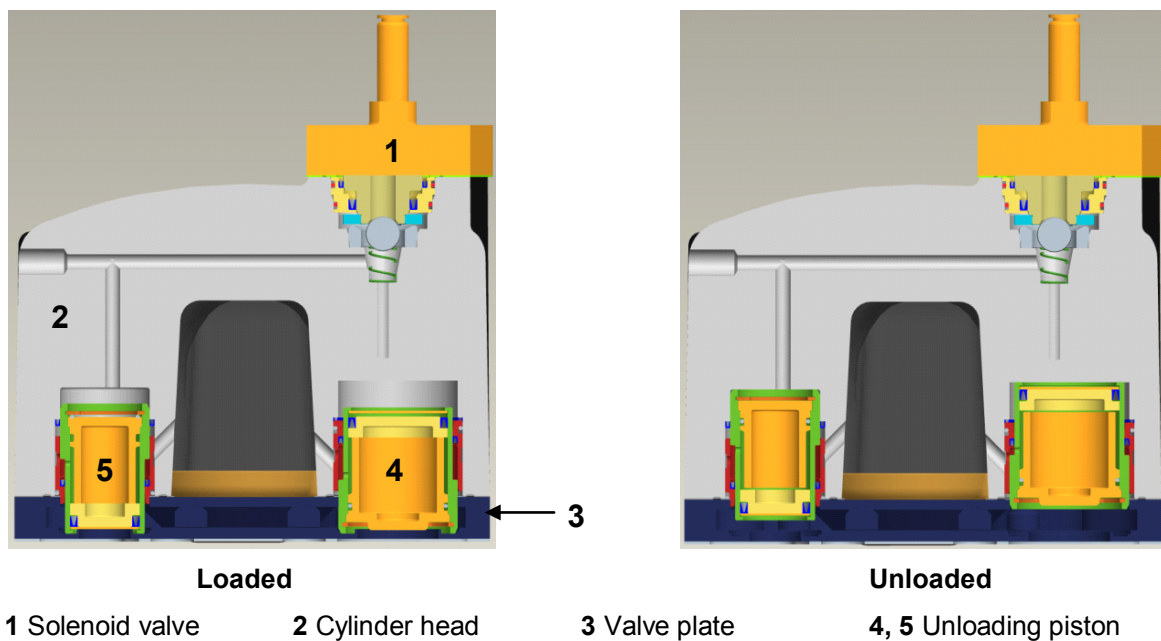


Figure 5: Cutaway view of the Digital cylinder head, loaded and unloaded

2.6.3 Digital control

Capacity modulation is achieved by energizing and de-energizing the solenoid valve. When the solenoid valve is de-energized, the digital bank capacity is 100%. When the solenoid valve is energized, the digital bank capacity is zero. Therefore, the capacity achieved is the time average capacity.

Example: In a 20-second cycle, if the solenoid is de-energized for 16 seconds, and then energized for 4 seconds, the resulting capacity will be approximately 80%.

For 4M*D Stream compressors, one bank of the compressor remains loaded 100% while the digital bank will modulate 0 to 100% to provide the additional capacity. The capacity is 50 to 100% as one bank is modulating.

On a 6M*D with blocked suction the blocked suction bank will unload when demand capacity is less than 67% and load when the demand capacity is higher than 67%. The digital bank will continue to load and unload providing continuous capacity across the 33 to 100% range.

2.6.4 Recommended application settings for modulation on Stream Digital compressors

The digital modulation recommended cycle time is 20 seconds. For other values, check with Application Engineering.

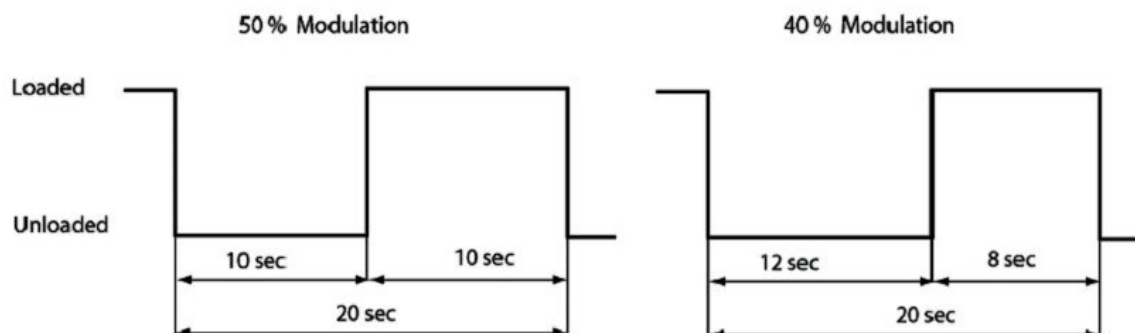


Figure 6: The digital signal from the controller activates the unloading

The load and unload times will give the compressor an operating range during a 20-second cycle. Minimum percent capacity would be 50% for 4M*D and 33% or 67% for 6M*D, depending on compressor configuration. The compressor can also operate at a 100% load for the full modulation sequence.

2.6.5 Digital solenoid valve / Gaskets

Due to the high life cycle requirements in a hot gas environment, a special valve has been developed. Due to reliability requirements, only Emerson solenoid valves may be used. All compressor warranties are null and void if the Emerson valve is not used. Solenoid coils will be sold separately for all Stream Digital compressors.

The solenoid coil is available for several voltages: 24V, 120V and 240V.

Stream Digital compressors use special head and valve plate gaskets which have modifications to ensure gas flow for proper digital modulation. Only Emerson gaskets may be used. All compressor warranties are null and void if the Emerson gaskets are not used.

2.6.6 Compressor cooling

Compressor motors must always be cooled, and cylinder head cooling may also be needed at certain operating conditions.

All Stream Digital compressors are suction-gas cooled. With suction-gas cooled compressors, the motor is cooled by refrigerant gas that is led over the motor. An additional fan may be required depending upon the operation conditions (see Copeland® brand products Selection Software on www.emersonclimate.eu).

2.6.7 Unloaded start

With direct starting the motor of a compressor is switched directly into the mains by means of a switch. The resulting breakaway starting current amounts to multiple times the rated motor current (operating maximum), without consideration being given to transient phenomena. In the case of high-powered motors the breakaway starting currents become so large that they lead to disruptive voltage dips in the mains. The compressors that are subject to current limitation must therefore by all means be equipped with starting load reduction to guarantee perfect starting even when the voltages amount to less than approximately 85% of the voltage on the nameplate.

2.6.8 Oil pumps

The oil pumps used for Stream Digital compressors are independent of their rotating direction. Stream Digital compressors are delivered with CoreSense™ Diagnostics. The oil pump integrates the electronic switch for integrating oil pressure safety functionality.

2.6.9 Oil pressure

Normal oil pressure is between 1.05 and 4.2 bar higher than crankcase pressure. Net oil pressure can be read by connecting two pressure gauges to the compressor and comparing the readings. One gauge should be connected to the oil pump. The second gauge should be

connected to the crankcase (T-fitting instead of plug on the compressor crankcase) or the suction service valve.

During irregular operating conditions, eg, a blockage of the suction filter, the pressure measured at the suction shut-off valve of the compressor may differ widely from that measured at the crankcase therefore pressure drops have to be avoided.

2.6.10 Oil circulation

Oil returns with the suction gases through a suction strainer and separates in the motor chamber reaching the crankcase by way of an oil return relief valve in the partition between motor housing and crankcase. This relief valve closes on compressor start-up due to the pressure difference arising between motor side and crankcase, thus slowing down pressure decrease in the crankcase over a certain period of time. It reduces the foaming of the oil/refrigerant mixture that would occur if the pressure decreased rapidly. The valve does not reopen until the pressure has been equalized by means of a crankcase ventilating valve. This second valve connects the crankcase and suction side cylinder head. It reduces the pressure difference by means of a very small bore in the plate of the valve so slowly that oil foams less and only limited oil/refrigerant foam is transferred to the oil pump. Compressors with four and six cylinders have one crankcase ventilating valve on the left cylinder bank.

2.6.11 Oil level

All compressors are delivered with sufficient oil for normal operation. The optimum oil level should be checked by operating the compressor until the system is stable and then comparing the sight glass reading with the appropriate diagram below. Oil level should be min $\frac{1}{8}$ and max $\frac{1}{4}$ of sight glass. For service compressors when an oil regulator is used the oil level should be min $\frac{1}{8}$ and max $\frac{3}{4}$ of sight glass. The level can also be checked within 10 seconds of compressor shut-down. For 4M*D and 6M*D compressors a higher oil level may be accepted when an oil regulator is in use because the oil separator will reduce excessive oil circulation.

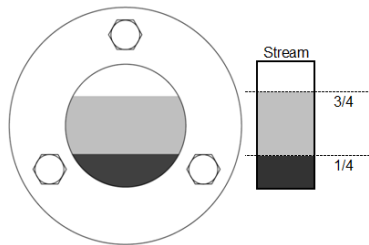


Figure 7: 4M*D and 6M*D compressors

2.6.12 Application limits

4MAD1-22X, 4MHD1-25X, 4MID1-30X, 4MJD1-30X2, 4MKD1-32X
6MID1-40X, 6MJD1-45X, 6MKD1-50X

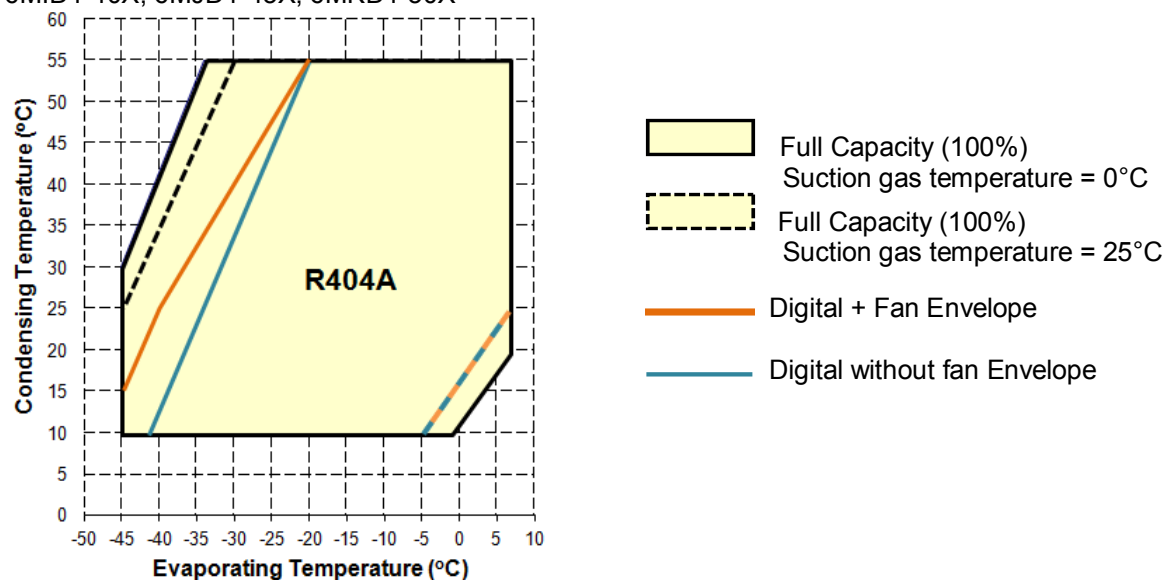


Figure 8: Application envelopes for High and Medium temperature compressors used with R404A

4MFD1-13X, 4MLD1-15X, 4MMD1-20X, 4MTD1-22X, 4MUD1-25X,
6MMD1-30X, 6MTD1-35X, 6MUD1-40X

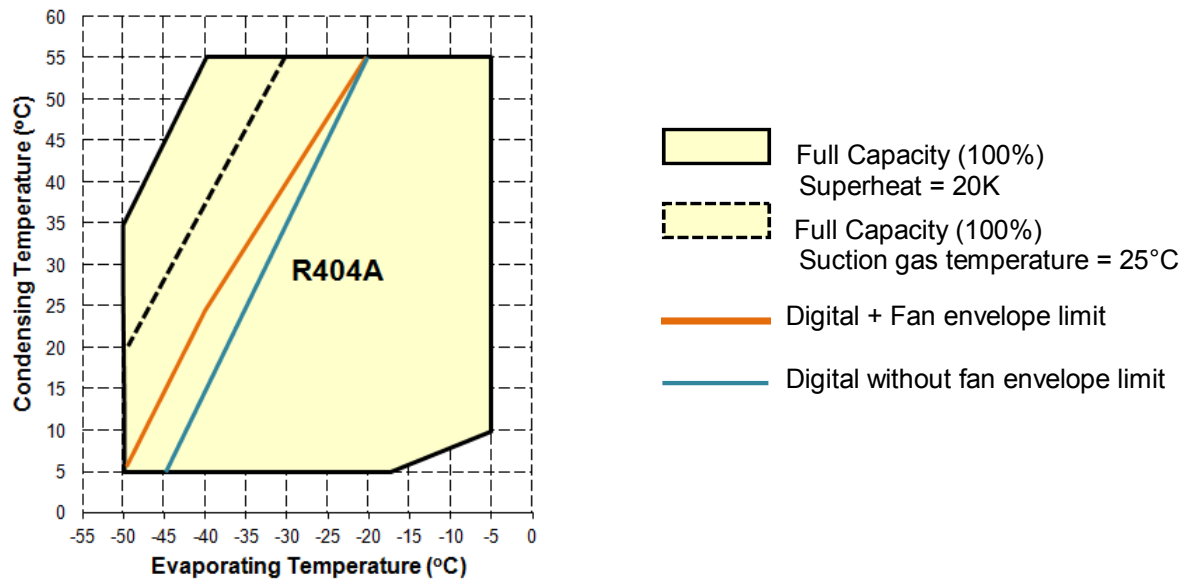


Figure 9: Application envelopes for Medium and Low temperature compressors used with R404A

NOTE: Application envelopes with other refrigerants are available on request.

2.6.13 Multiple compressor application

To ensure smooth and continuous modulation, selection of the digital and non digital compressors capacities can be made according to the following rule.

Rule: For optimum suction pressure control, the following guideline is recommended in the selection of fixed capacity and Digital compressors, per suction header:

- $D > F1$
- $F2 < D + F1$
- $F3 < D + F1 + F2$
-
- $FN < D + F1 + 2 + \dots + FN - 1$

where **D** = Capacity of the Stream Digital compressor

F1 --- FN = Capacity of the standard Stream compressor

The compressor selected should be the smallest compressor capacity that still covers all the gaps between steps to ensure the most efficient system control.

Example: A 4M*D has a continuous capacity from 50 to 100%, therefore, when a 4M*D Stream Digital compressor is selected, the fixed-capacity compressor beside it should have 50% to 100% of the full load of the digital compressor.

NOTE: For best results, the digital compressor needs to be the lead compressor. It must be the first compressor “On” and last compressor “Off” in multiple compressor applications.

3 Installation



WARNING

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

3.1 Compressor handling

3.1.1 Delivery

Please check whether the delivery is correct and complete. Any deficiency should be reported immediately in writing.

Standard delivery:

- Suction and discharge shut-off valves
- Oil charge, oil sight glass
- Mounting kit
- CoreSense™ Diagnostics module
- Holding charge up to 2.5 bar(g) (dry air)
- Digital Solenoid valve (delivered mounted)

3.1.2 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. Stack pallets on top of each other when not exceeding 300 kg. Do not stack single boxes on top of each other. Keep the packaging dry at all times.

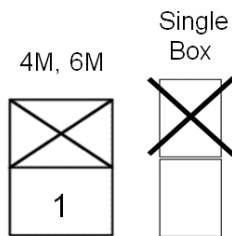


Figure 109

Compressors are individually packed and may be delivered on pallets depending on quantity and size. Cooling fans are delivered in separate cartons. Accessories may be mounted or delivered loose. Solenoid valves are never mounted (except the Digital head one).

3.1.3 Positioning and securing



IMPORTANT

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

If possible, the compressor should be kept vertical during handling.

For safety reasons two lifting eyes should be fitted before moving a compressor ($\frac{1}{2}$ " - 13 UNC). Refer to drawings on **Figure 11** to see how to apply other lifting methods.

In order to avoid refrigerant leaks or other damage the compressors should not be lifted by the service valves or other accessories.

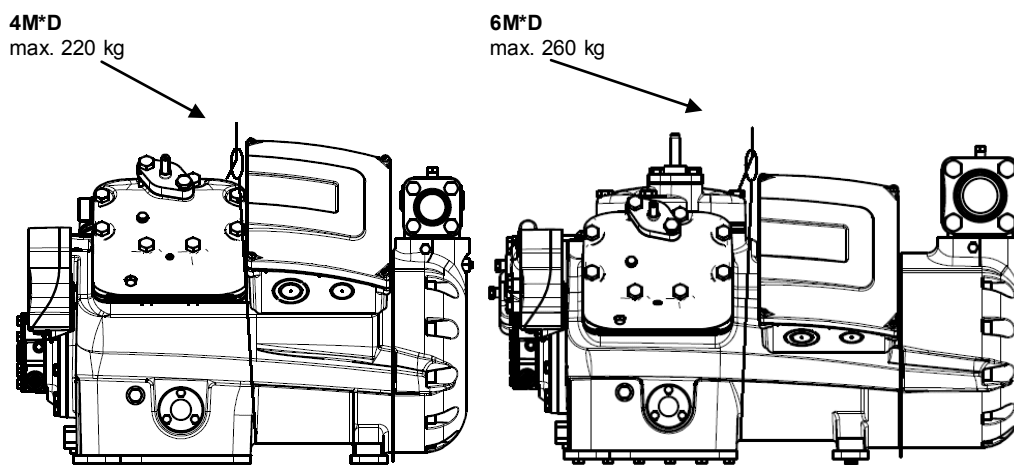


Figure 101

3.1.4 Installation location

Ensure the compressors are installed on a solid level base.

3.1.5 Mounting parts

To minimize vibration and start/stop impulses flexible mounting should be used. For this purpose one set of spring mounting parts for each of the Stream models is delivered with each 4M* and 6M* compressor.

Due to differences in weight (cylinder/motor side) different springs have to be used on both sides. Springs have different colours for easier identification: violet on motor side and orange on cylinder side.

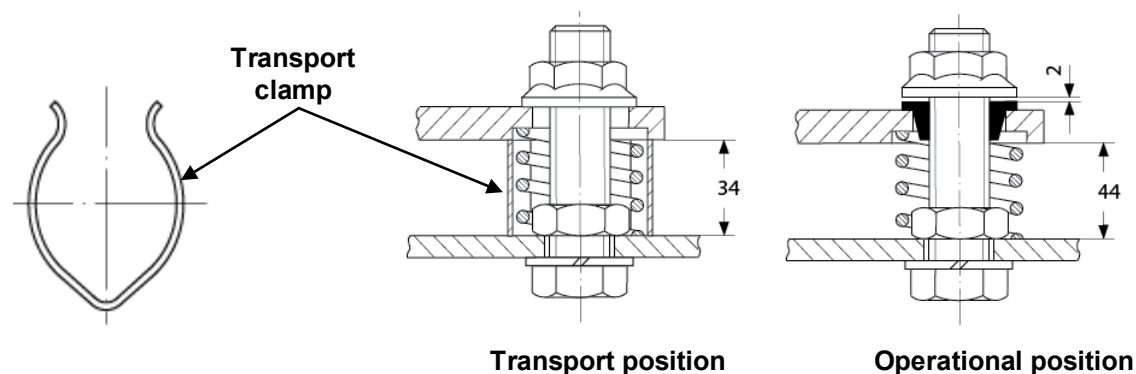


Figure 112

When Stream Digital compressors are mounted in racks rubber mounting parts should be used.

A compressor may be rigidly mounted, ie, without springs. In this case more shock and vibration loading will be transmitted to the frame.

If the installation requires a very high level of vibration absorption, additional vibration absorbers - available on the market - can be fitted between the rails and the foundation.

3.2 Pressure safety controls

3.2.1 High-pressure control

A high-pressure control with a maximum cut-out setting of 28 bar(g) is required.

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

3.2.2 Low-pressure control

The normal minimum cut-out setting is 0.1 bar(g) for R404A.

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

3.2.3 Maximum operating pressures

Maximum operating pressures according to EN 12693 shown on the compressor nameplate are obligatory and must not be exceeded.

- High-pressure side (HP): 28.0 bar
- Low-pressure side (LP): 22.5 bar

NOTE: The compressor operating range may be restricted for various reasons. Check the application range limitations in Copeland® brand products Selection Software on www.emersonclimate.eu.

3.3 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 12 shows the proper procedures for brazing the suction and discharge lines.

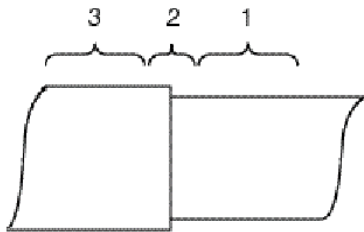


Figure 12: Suction tube brazing

- The copper-coated steel tubes on Stream Digital 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.

3.4 Screens



CAUTION

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

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

4 Electrical connection

4.1 General recommendations

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

4.2 Electrical installation

4.2.1 Three-phase motors

All compressors can be started direct-on-line.

The necessary position of bridges for direct-on-line start (depending on type of motor and/or mains voltage) is shown in Chapter 4.3 Wiring diagrams.

4.2.2 Star / Delta motors (Y/Δ) – Code E

With the help of bridges, this motor is interchangeable for star (Y) or delta (Δ) operation. It is suitable for two voltages, eg, 230V in delta, 400V in star connection. If the supply voltage and the nominal voltage of the motor in Δ-connection are identical, the star connection motor can also be used for starting (remove the bridges!).

4.2.3 Part winding motors (YY/Y) – Code A

PWS motors contain two separate windings (2/3 + 1/3) which are internally connected in star and operated in parallel. You cannot change the voltage by changing the electrical connections as the motor is only suitable for one voltage.

The first part winding, ie, the 2/3 winding on terminals 1-2-3, can be used for part-winding start (remove the bridges!). After a time delay of 1 ± 0.1 seconds the second part winding, ie, the 1/3 winding on terminals 7-8-9, must be brought on line.

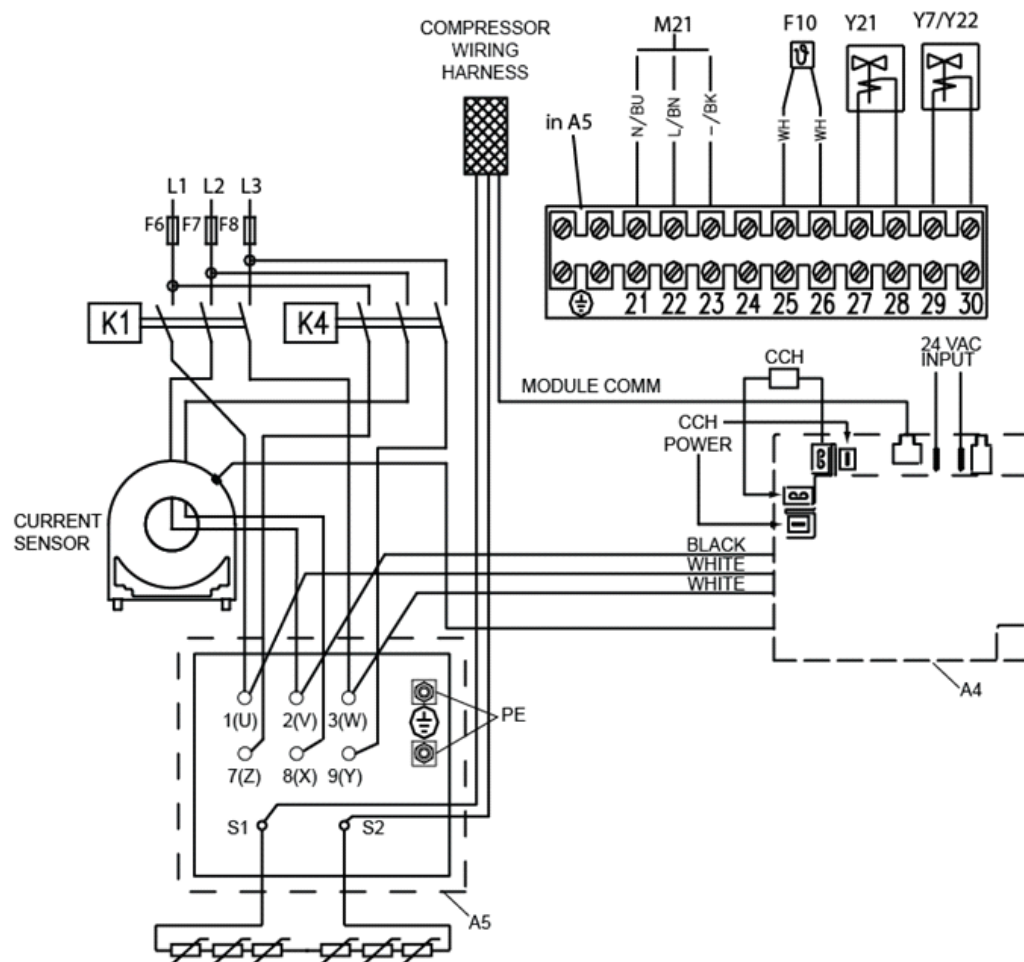
4.3 Wiring diagrams

The position of the jumpers in the terminal box and the recommended wiring diagrams are shown in **Figures 13 and 14**.

4.3.1 Wiring diagram for part winding motors (AW...)

Part winding motors can be connected direct-on-line or part-winding start.

Part-winding motor: Y - Y Code A	Direct-on-line start Y - Y	Part-winding start First start step 1-2-3 Y - Y



Legend

A4.....Sensor module

A5.....Terminal box compressor

CCH.....Crankcase heater

F6 Fuse for control circuit

F7Fuse for control circuit

F8Fuse for control circuit

F10 Thermal protection switch M2

K1 Contactor M1

K4 Contactor M1 for second part winding

M2..... Fan motor/condenser

M21..... Fan motor/condenser

Y7 Solenoid valve digital discus head

Y21 Solenoid valve capacity control 1

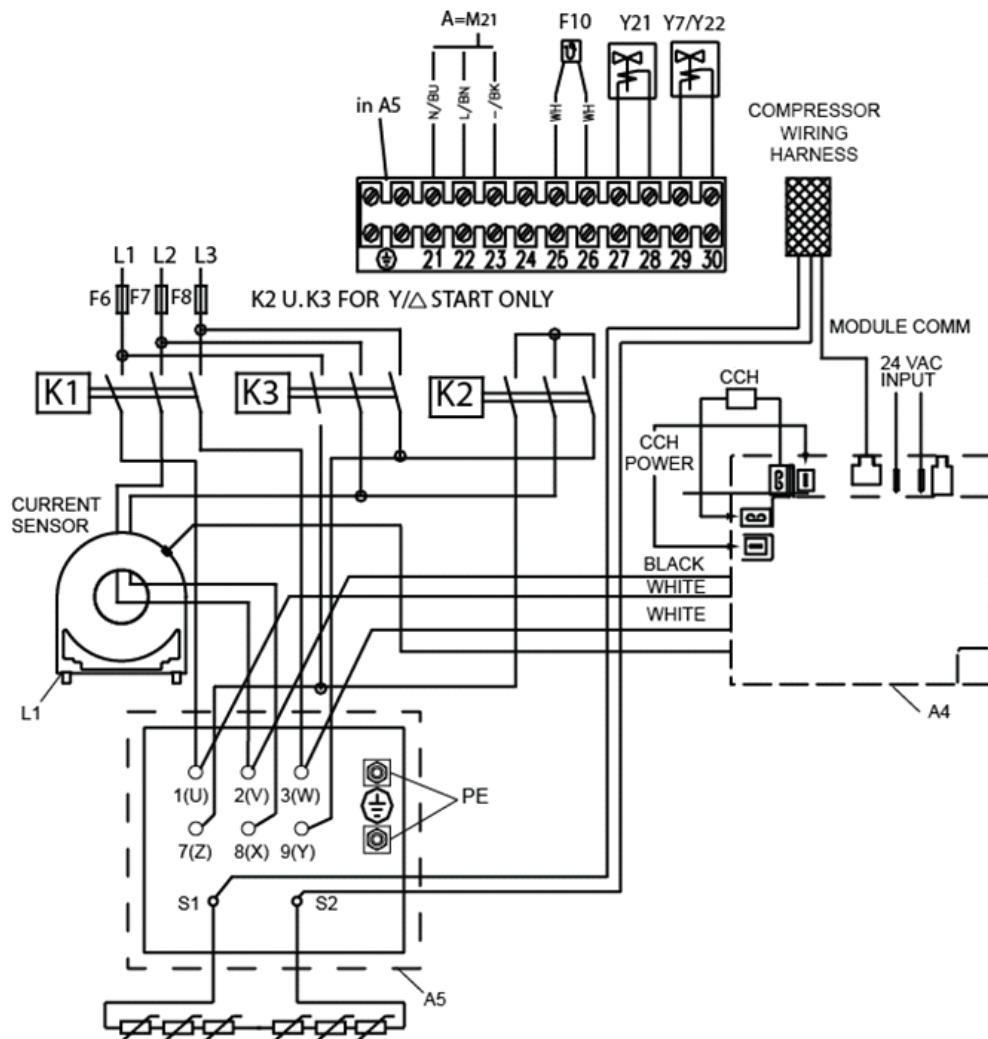
Y22 Solenoid valve capacity control 2

Figure 134

4.3.2 Wiring diagram for Star / Delta motors (EW...)

Star / Delta motors can be connected direct-on-line or Star / Delta start.

Star / Delta motor Y - Δ Code E	Direct-on-line start Δ	Direct-on-line start Y	Star / Delta start Y - Δ



Legend

A4.....Sensor module	K2 Y - Contactor M1
A5.....Terminal box compressor	K3 Δ - Contactor M1
CCH.....Crankcase heater	M2..... Fan motor/condenser
F6Fuse for control circuit	M21..... Fan motor/condenser
F7Fuse for control circuit	Y7 Solenoid valve digital discus head
F8Fuse for control circuit	Y21 Solenoid valve capacity control 1
F10.....Thermal protection switch M2	Y22 Solenoid valve capacity control 2
K1.....Contactor M1	

Figure 145

4.4 Protection devices

Independently from the internal motor protection, fuses must be installed before the compressor. The selection of fuses has to be carried out according to VDE 0635, DIN 57635, IEC 269-1 or EN 60-269-1.

4.5 CoreSense™ Diagnostics

CoreSense™ Diagnostics for all 4M*D and 6M*D semi-hermetic Stream compressors combines oil and motor protection into one module, replacing OPS1/2 and the electronic module INT69TM. In addition to diagnostics, it provides advanced protection against faults such as high discharge temperature, locked rotor, single/missing phase, voltage imbalance, low voltage. The module is capable of communication via Modbus® protocol. An external overload protection is not necessary.

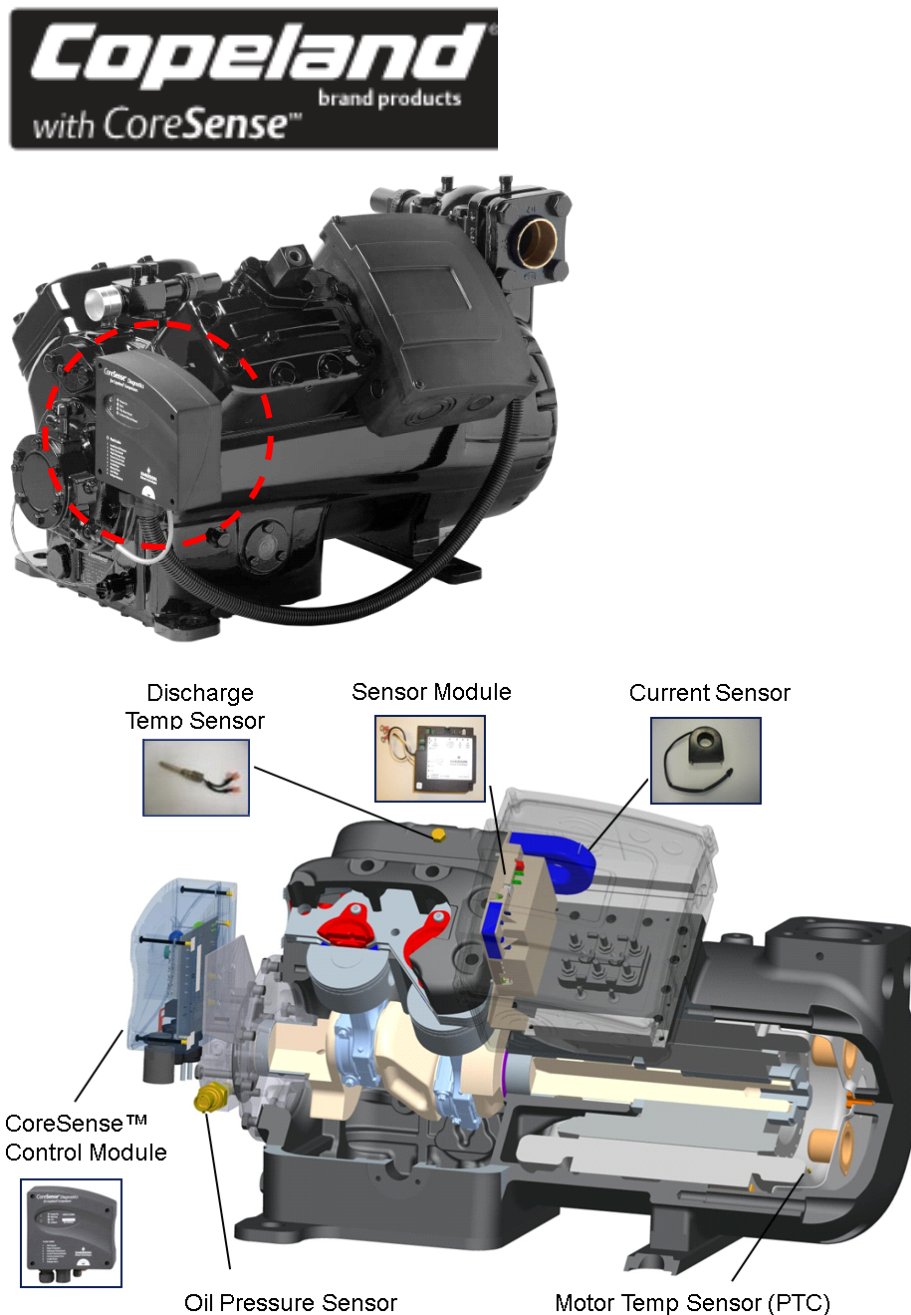


Figure 156: CoreSense™ Diagnostics module

For the electrical connection of the CoreSense™ Diagnostics module, please refer to the wiring diagram below:

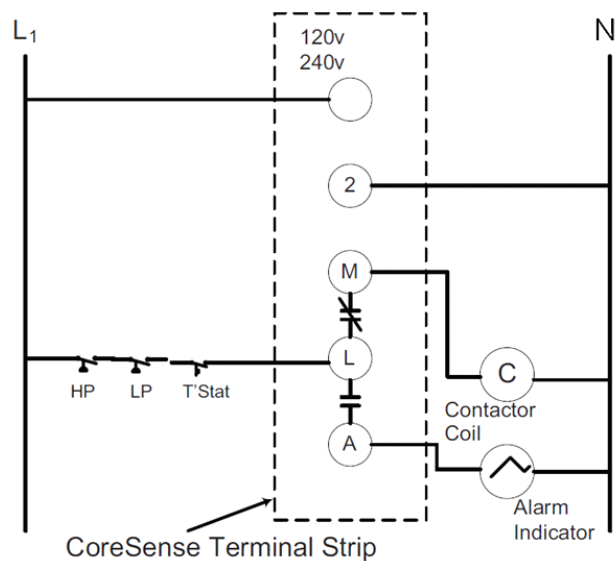
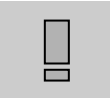


Figure 167: CoreSense™ wiring diagram

NOTE: For more information please refer to Technical Information D7.8.4 “CoreSense™ Diagnostics for Stream refrigeration compressors”.

4.6 Crankcase heaters



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

A crankcase heater is used to prevent refrigerant migrating into the shell during standstill periods. Heaters for 4M* and 6M* compressors are screwed into a sleeve (**see Figure 18**).

The crankcase heater is available in 120V, 230V and 480V.

The operation of 120V and 230V crankcase heater is controlled by the CoreSense™ Diagnostics module, this is not possible with the 480V heater.

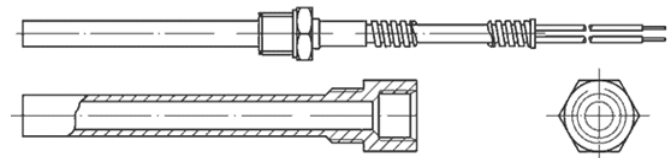


Figure 178: 100 Watt crankcase heater element

Safety instructions

Product description

Installation

Electrical connection

Starting up & operation

Maintenance & repair

Dismantling & disposal

5 Starting up & operation



WARNING

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

5.1 Leak test

The suction shut-off valve and discharge shut-off valve on the compressor must remain closed during pressure testing to prevent air and moisture from entering the compressor. The test pressure (dried nitrogen) must not exceed 20.5 bar provided no other system component's pressure is lower. In this case the lower pressure is the test pressure.

5.2 System evacuation

Before the installation is put into commission, remove the holding charge then evacuate with a vacuum pump. Proper evacuation reduces residual moisture to 50 ppm. The installation of adequately sized access valves at the furthest point from the compressor in the suction and liquid lines is advisable. To achieve undisturbed operation the compressor valves are closed and the system is evacuated down to 0.3 mbar / 0.225 Torr. Pressure must be measured using a vacuum pressure (Torr) 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. Then the compressor must be evacuated.

Due to the factory holding charge of dry air the compressor is under pressure (about 1 to 2.5 bar), this is to indicate the compressor does not leak.

When plugs are removed from the compressor in order to connect a pressure gauge or to fill in oil, the plug may pop out under pressure and oil can spurt out.

5.3 Preliminary checks – Pre-starting

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

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

5.4 Charging procedure



CAUTION

Low suction pressure operation! Compressor Damage! Do not operate with a restricted suction. Do not operate with the low-pressure cut-out bridged.

The system should be liquid-charged through the liquid-receiver shut-off valve or through a valve in the liquid line. The use of a filter drier in the charging line is highly recommended. The majority of the charge should be placed in the high side of the system to prevent bearing washout during first-time start on the assembly line.

5.5 Initial start-up



CAUTION

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



CAUTION

High discharge pressure operation! Compressor damage! Do not use compressor to test opening set point of high-pressure cut-out.

The compressor must be equipped according to our technical documentation considering the application intended. Make sure of this before start-up.

For brazing connections where dissimilar or ferric metals are joined a silver alloy rod with a minimum of 30% silver shall be used being either flux coated or with a separate flux.

Bolt torque settings are listed in **Appendix**.

With the exception of rubber-coated metallic gaskets (Wolverine) all gaskets should be oiled before fitting. O-rings should also be oiled.

A compressor should never be operated beyond its approved application range! Check by consulting the appropriate data sheet. To avoid motor damage the compressor MUST NOT be started, nor may high-potential testing be carried out under vacuum

5.6 Minimum run time

Emerson Climate Technologies recommends a maximum of 10 starts per hour. The most critical consideration is the minimum run time required to return oil to the compressor after start-up.

6 Maintenance & repair

6.1 Exchanging the refrigerant

Qualified refrigerants and oils are given in Chapter 2.5.1.

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

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

In the event that R22 in a system with mineral oil is to be replaced with R407C or R404A, the oil must also be changed. Please refer to Technical Information C7.26.1 "Refrigerant Changeover from HCFC to HFC Refrigerants".

6.2 Replacing a compressor



CAUTION

Inadequate lubrication! Bearing destruction! 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.

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

6.3 Lubrication and oil removal



CAUTION

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

The compressor is supplied with an initial oil charge. The standard oil charge for use with refrigerants R404A / R407A / R407C / R407F / R134a is a polyolester (POE) lubricant Emkarate RL 32 3MAF. In the field the oil level could be topped up with Mobil EAL Arctic 22 CC if 3MAF is not available. The standard mineral oil for R22 is Suniso 3GS.

One disadvantage of POE is that it is far more hygroscopic than mineral oil (see **Figure 19**). Only brief exposure to ambient air is needed for POE to absorb sufficient moisture to make it unacceptable for use in a refrigeration system. Since POE holds moisture more readily than mineral oil it is more difficult to remove it through the use of vacuum. Compressors supplied by Emerson Climate Technologies contain oil with low moisture content, and it may rise during the system assembling process. Therefore it is recommended that a properly sized filter-drier is installed in all POE systems. This will maintain the moisture level in the oil to less than 50 ppm. If oil is charged into a system, it is recommended to use POE with a moisture content no higher than 50 ppm.

The diagram below compares the hygroscopic characteristics of POE oil with mineral oil (moisture absorption in PPM at 25°C and 50% relative humidity).

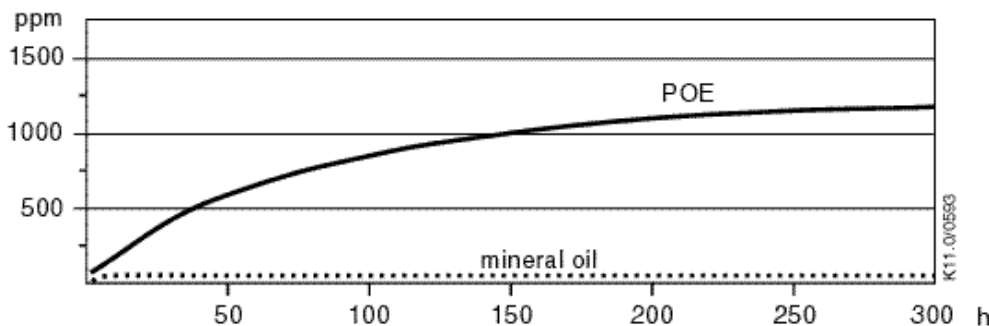


Figure 189: Absorption of moisture in ester oil in comparison to mineral oil in ppm by weight at 25°C and 50% relative humidity (h=hours)

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.

6.4 Oil additives

Although Emerson Climate Technologies 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.

6.5 Unbrazing system components



WARNING

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

Before opening up a system it is important to remove all refrigerant from both the high and low sides of the system. If the refrigerant charge is removed from a scroll-equipped unit from the high side only, it is possible for the scrolls to seal, preventing pressure equalization through the compressor. This may leave the low side shell and suction line tubing pressurized. If a brazing torch is then applied to the low side while the low side shell and suction line contain pressure, the pressurized refrigerant and oil mixture could ignite when it escapes and contacts the brazing flame. To prevent this occurrence, it is important to check both the high and low sides with manifold gauges before unbrazing. Instructions should be provided in appropriate product literature and assembly (line repair) areas. If compressor removal is required, the compressor should be cut out of system rather than unbrazed.

7 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 properly.

Dispose of compressor properly.

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