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Application Engineering Europe

DEMAND COOLING™ FOR COPELAND™ STREAM COMPRESSORS WITH LIQUID INJECTION EXTENSION MODULE "C"

1 Introduction

Experience has shown that many refrigerants can cause problems in low temperature applications because under some conditions the internal compressor discharge temperature exceeds the safe temperature limit for long term stability of refrigeration oil.

The Demand Cooling™ system uses modern electronics to provide an effective solution to this problem. It is required for low evaporating temperatures with R407A, R407F, R448A, R449A, and all R22 applications with saturated suction temperatures below -20 °C (operating envelopes with Demand Cooling are available in Copeland Select software at www.climate.emerson.com/en-gb).

2 Demand Cooling operation

The Demand Cooling system uses the signal of the discharge head temperature sensor to monitor discharge gas temperature. If a critical temperature is reached, the Copeland Compressor Electronics module energizes a long life injection valve which meters a controlled amount of saturated refrigerant into the compressor suction cavity to cool the suction gas.

To minimize the amount of refrigerant that has to be injected, the suction gas cooling process is performed after the gas has passed around and through the motor.

This process controls the discharge temperature to a safe level. If, for some reason, the discharge temperature rises above a pre-set maximum level for 2 seconds, the Copeland Compressor Electronics module will switch the compressor off for 2 minutes before automatic resetting.

3 Components

The Demand Cooling system consists of an injection expansion valve, the extension module C for liquid injection, the tubing sight glass and filter dryer, and mounting brackets.

This system can be delivered as a variation together with the compressor or as a separate kit.

3.1 Temperature sensor

The Demand Cooling system uses the discharge temperature sensor (PT1000) pre-installed at the factory and connected to the Copeland Compressor Electronics module, but the discharge temperature sensor position has to be changed to the other hole of the cylinder head where it is already located.

PT1000 sensor technical data:

- Measuring range: -40 to 155 °C, 170 °C for 30 minutes max
- Resistance at 25 °C: 1097,34Ω
- Tightening torque: 15 Nm
- Protection class: IP65

Figure 1: Discharge temperature sensor

In case of sensor open circuit (or disconnected) or short circuit (resistance too low), an alarm is set. There are 2 methods for checking the sensor.

3.1.1 Checking the discharge temperature sensor with the mobile application

Discharge temperature and sensor status can be checked with the mobile application.

3.1.2 Checking the discharge temperature sensor with resistance measurement

Disconnect the electrical supply and unplug the sensor from the Copeland Compressor Electronics module. Measure the resistance of the sensor with an ohmmeter .

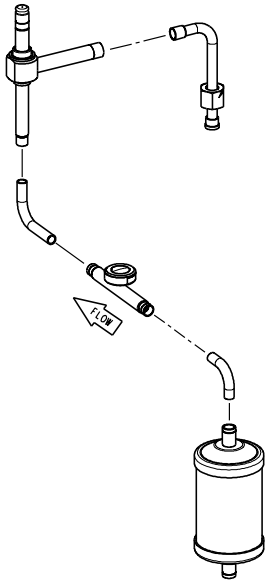
Then the temperature sensor is connected to the compressor, resistance can read from more than 100,000 Ohms (very cold compressor) to less than 1600 Ohms (very hot compressor). Readings within these limits usually indicate a satisfactory sensor.

3.2 Injection valve kit

The injection valve was developed to operate under the usual voltage and ambient conditions plus withstand any vibration that can be expected from being mounted to a compressor.

The injection valve kit comprises of the tubing, filter dryer, mounting brackets, solenoid coil with PG9 cable gland. The parts are **NOT pre-assembled** for transport reasons.

Injection valve kit for 4M* compressors



Injection valve kit for 6M* compressors

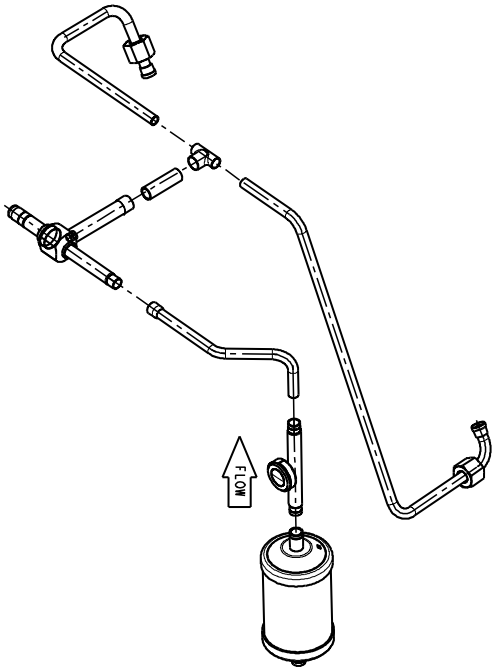
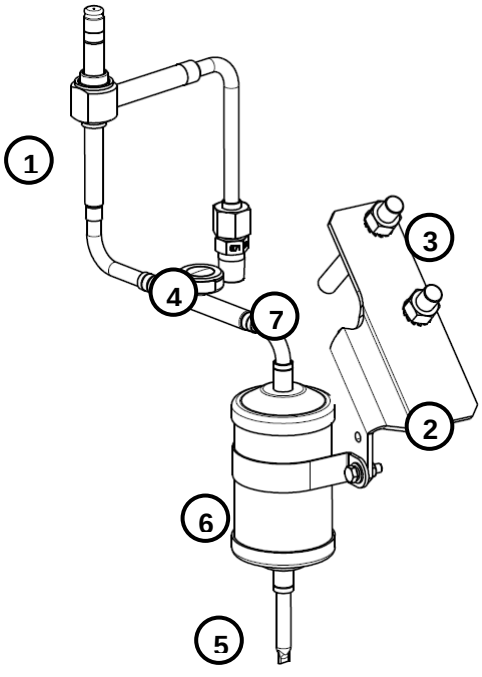


Figure 1: Injection valve kit parts

The parts need to be assembled before installation as shown below.



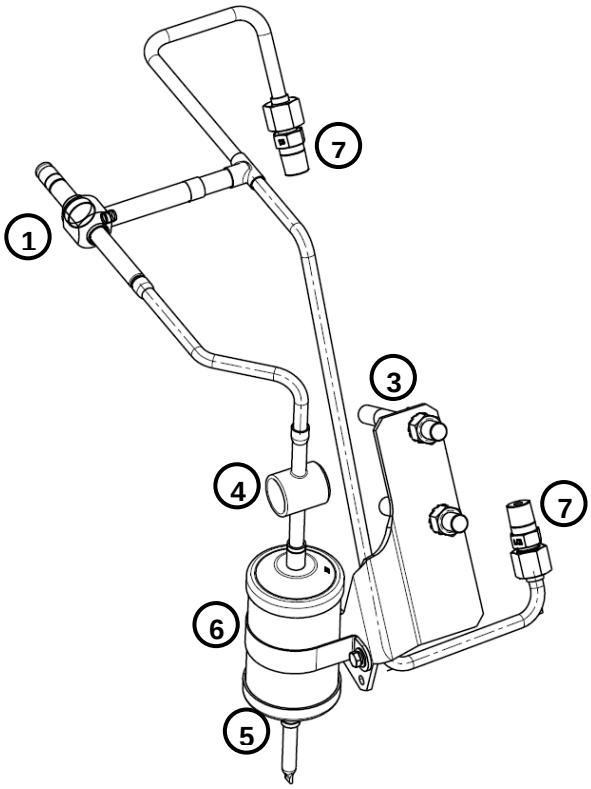


Figure 2: Injection valve kits when assembled

	Designation	4M* compressors	6M* compressors
1	Demand Cooling expansion valve	Alco Controls EX2-I00	
2	Mounting bracket to mount the injection valve to the cylinder head		
3	Head studs with washers to fasten mounting bracket to compressor		
4	Sight glass	Alco Controls MIA 038	Alco Controls MIA M10S
5	Filter dryer	Alco Controls ADK 1610 MMS	
6	Clamp for Demand Cooling fixing		
7	Male flare union 3/8"-NPT to 3/8"		

Table 1: Legend

3.3 Liquid Injection extension module C

The Demand Cooling allows monitoring of the compressor head temperature (measured by a temperature sensor) and acts on a cold gas injection valve (through a TRIAC or a digital output) placed directly in the head, if the measured temperature is higher than a set value.

The Liquid Injection extension module C delivered in the kit is automatically detected when inserted in the Copeland Compressor Electronics module which is connected to the discharge sensor.

Switch off/on Copeland Compressor Electronics before/after inserting the module into its dedicated slot.

Module C is to be inserted into the slot located in the middle of the module as shown in **Figure 4** below. The correct slot for the Liquid Injection extension module is marked with the letter **C.**

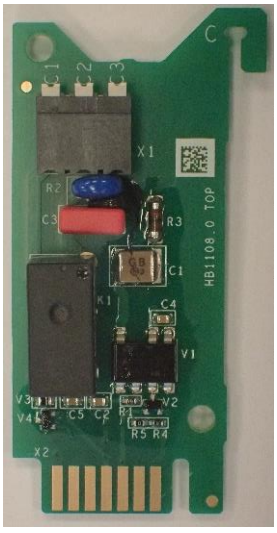


Figure 3:Liquid Injection extension module C

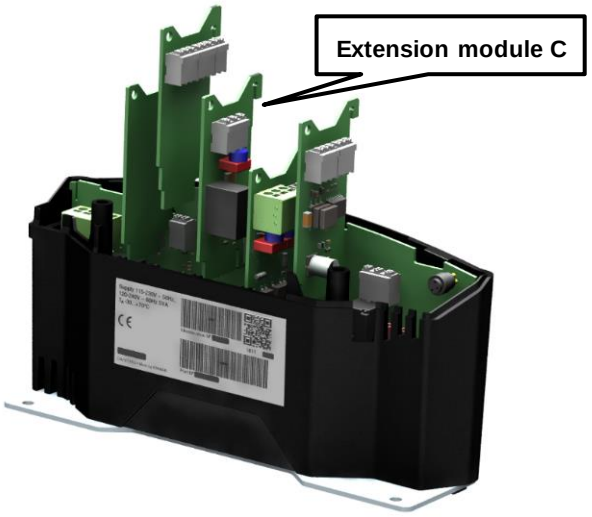


Figure 4: Copeland Compressor Electronic with modules

The module has a modulating output (TRIAC type) on Terminal C3.

3.4 Module electrical connection

WARNING
Electrical connections must be made by qualified electrical personnel.
All valid standards for connecting electrical and refrigeration equipment must be observed. Connected sensors and connection lines that extend from the terminal box have to feature at least a basic insulation.

Terminals are suitable for 0.75 mm^2 cables with a length of maximum 10 m.

- Terminal C2: phase
- Terminal C3: triac output for liquid injection valve
  - 10-30 VA
  - 115-240 V AC / 50-60 Hz

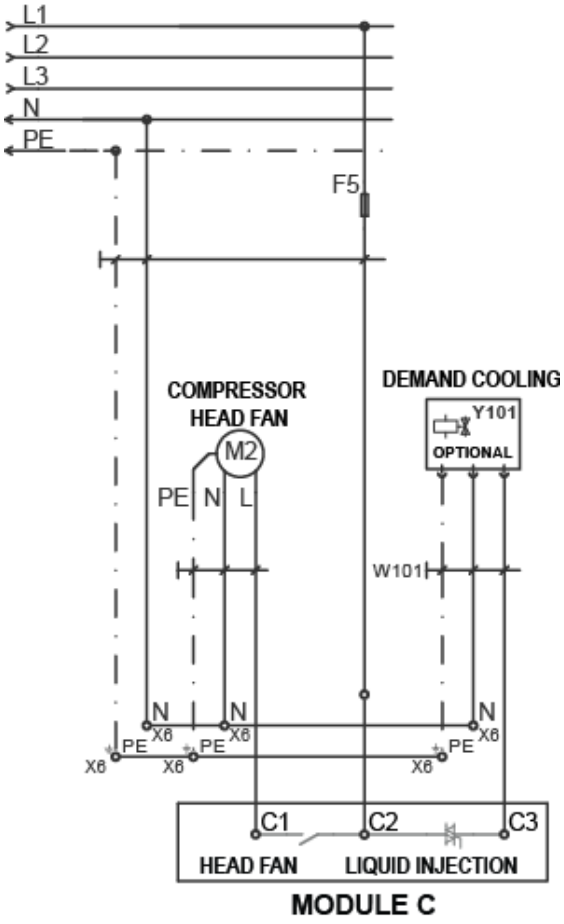


Figure 5: Wiring diagram for liquid injection and/or head fan monitored via module C

4 Demand Cooling application

The Demand Cooling system should be considered as the back-up for a well-designed low temperature refrigeration system.

Normally the Demand Cooling valve only operates during high condensing temperature conditions. The refrigerant injected by the valve cools the compressor to operate safely.

Due to the relatively small amounts of liquid injected, no excessive system pressure fluctuations (normally < 0.15 bar) occur during injection valve cycling.

Compressor capacity and efficiency drops are almost insignificant since the suction gas is cooled by the liquid and becomes denser. This enables the compressor to handle the additional mass flow with a minimal loss of evaporator capacity.

Performance data for Demand Cooling compressors include the effects of injection. They can therefore be used in the conventional manner for compressor and condenser selection.

***NOTE:* Liquid subcooling must be sufficient at the Demand Cooling injection valve to prevent flashing.**

4.1 Reducing the demand for injected cooling

There are several methods to reduce Demand Cooling operation in order to optimize the energy efficiency.

Suction lines should be well insulated to reduce suction line heat gain. Return gas superheat should be as low as possible but consistent with safe compressor operation.

Evaporator and system control settings should provide the maximum suction pressure consistent with the application in order to have as low a compression ratio as possible.

The condensing temperature should be kept as low as possible to reduce the compression ratio as well as the discharge temperature. Otherwise, condensers should be sized using conventional methods.

The exact application range must be taken from Select software.

***NOTE:* A vertical cylinder head fan is always required for usage with R22!**

***NOTE:* Demand Cooling is not approved for compressors with capacity modulation.**

4.2 Demand Cooling operation setpoints

The Demand Cooling module controls the liquid.

4.2.1 Liquid injection control

- Liquid injection modulation starts at 130 °C.
- Liquid injection valve permanently opened at 140 °C

5 Demand Cooling installation

Check that the Demand Cooling kit is complete before installation.

The Demand Cooling kit is delivered with an installation manual. The various parts should be installed according to the installation manual for proper operation and warranty of the compressor.

5.1 Temperature sensor

The discharge temperature sensor is already fitted in a cylinder; **this position has to be changed** to the other hole of the cylinder head where it is already located.

5.2 Injection valve parts

The injection valve is not pre-assembled: the injection tubing assembly has to be assembled before installation according to section 3.2 and to the installation manual delivered together with the Demand Cooling kit.

The white Teflon washer included in the kit can be fitted between the solenoid coil and the blue clip to prevent the coil from moving.

5.3 Installation procedure

IMPORTANT
Protect valve against excessive heat while brazing (using inert gas). Do not swage the inlet tubing on the injection valve itself.

1) Before the Demand Cooling system can be installed the compressor has to be depressurized by qualified service personnel and in accordance with local regulations.
2) On a brand new compressor, the holding charge must be removed.
3) Before installing the Demand Cooling kit, braze securely the injection parts (expansion valve filter dryer, sight glass, tubing...). Use Solder Fontargen A3005V for brazing copper on copper.
4) Swap the discharge sensor and the plug on the cylinder head where the discharge sensor is pre-fitted. Torque to 15 Nm.

5) Remove the 2 cylinder head bolts to mount the filter dryer bracket with the studs provided. Place the washers and nuts on the studs. Do not fully tighten nuts.
6) Remove the 3/8"-NPT plug on the compressor body. Mount male flare union (3/8"-NPT/3/8") instead.
7) Connect the female flare fitting to the male flare union mounted to the compressor body. Do not tighten fully.
8) Fix the filter dryer with the clamp on the bracket.
9) Torque the flare fitting of step 6. Torque to 21 Nm with Loctite 192026.
10) Torque the stud nuts of the mounting bracket. Torque to 62 Nm.
11) Torque the bolts between the filter dryer clamp and the bracket. Torque to 10 Nm.
12) Braze the liquid line to the inlet tubing of the injection expansion valve (use inert gas when brazing).

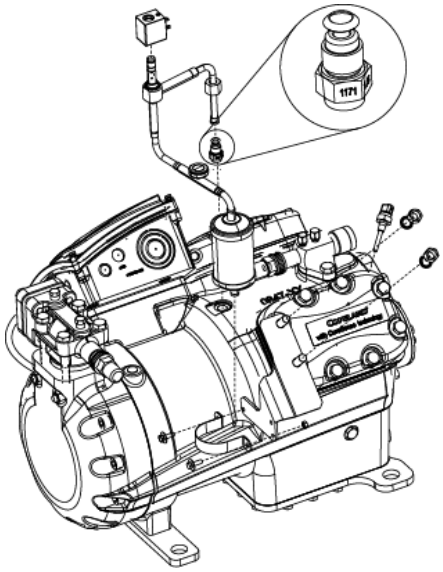


Figure 6: Injection parts on 4M* compressors

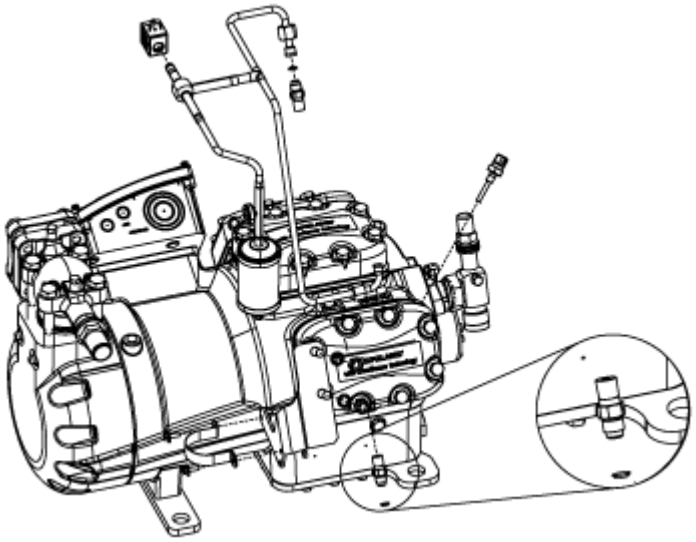
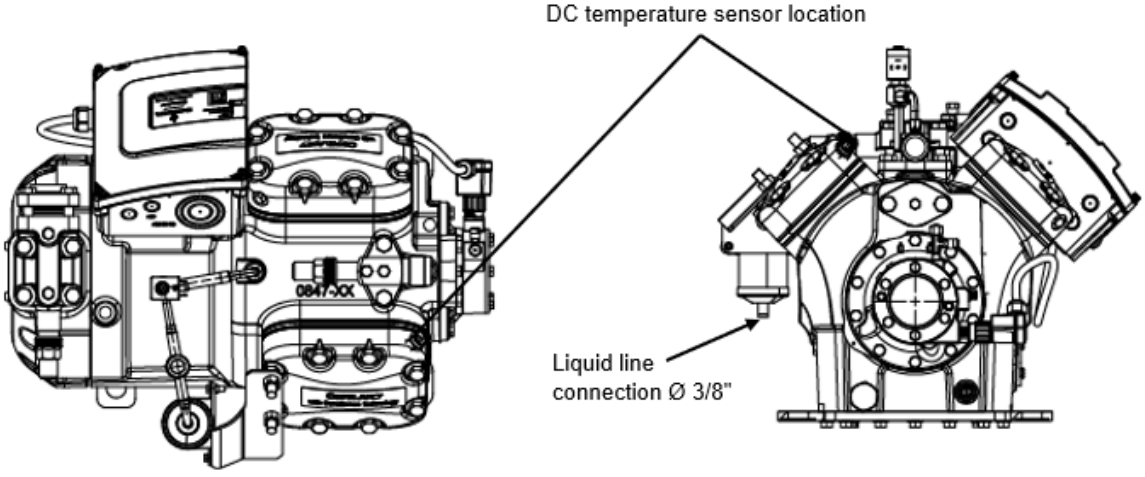
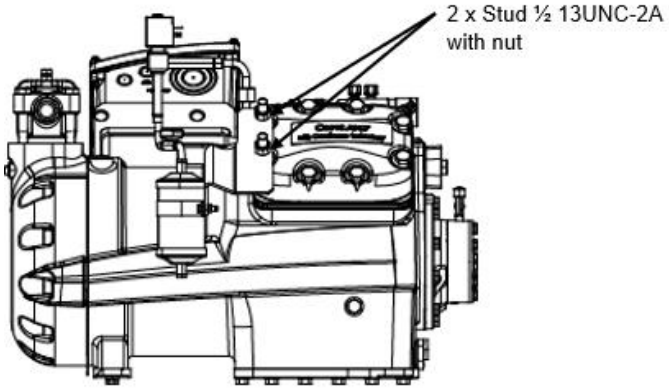


Figure 7: Injection parts on 6M* compressors

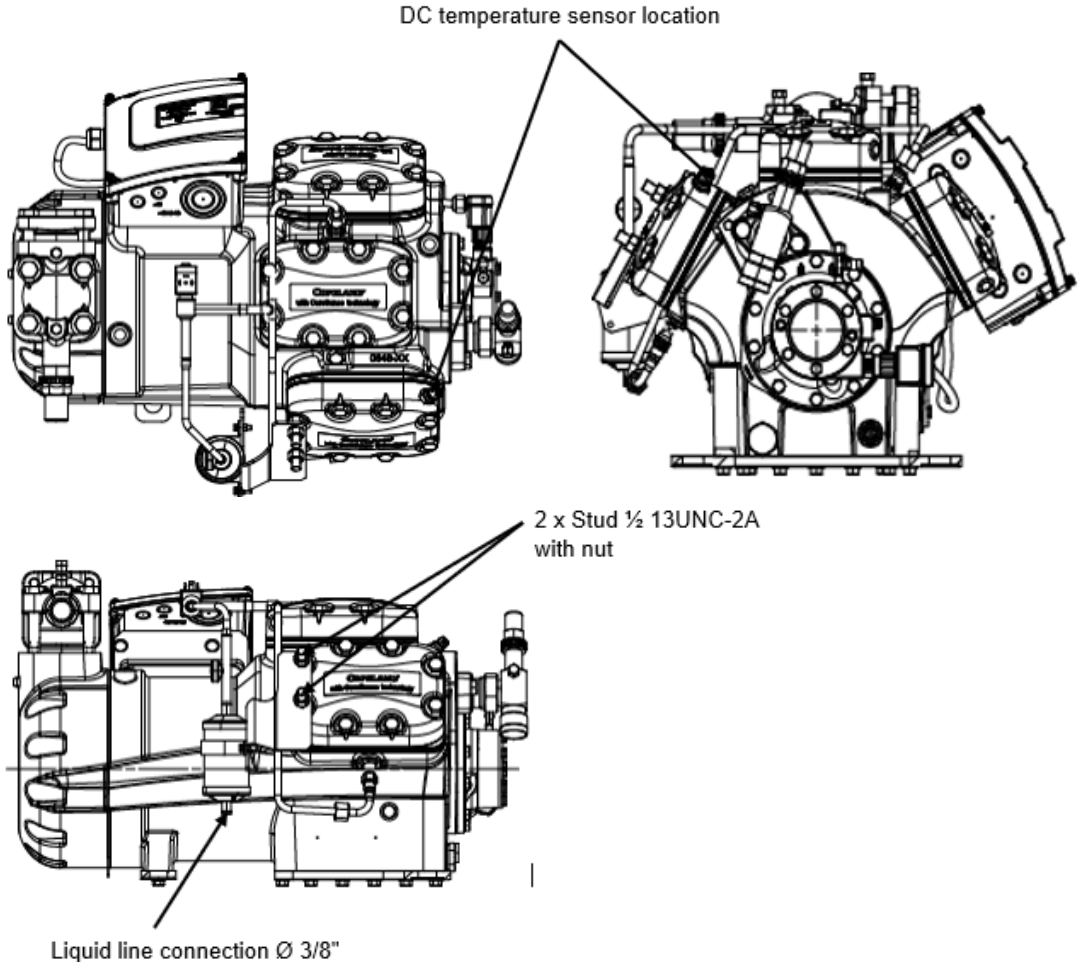
5.4 Installation of Demand Cooling on 4M* Stream compressors





NOTE: **An additional fan is required only for application of Demand Cooling with R22.**

5.5 Installation of Demand Cooling on 6M* Stream compressors



NOTE: **An additional fan is required only for application of Demand Cooling with R22.**

5.6 Use of inverter

Demand Cooling is not compatible with speed variation/inverter applications.