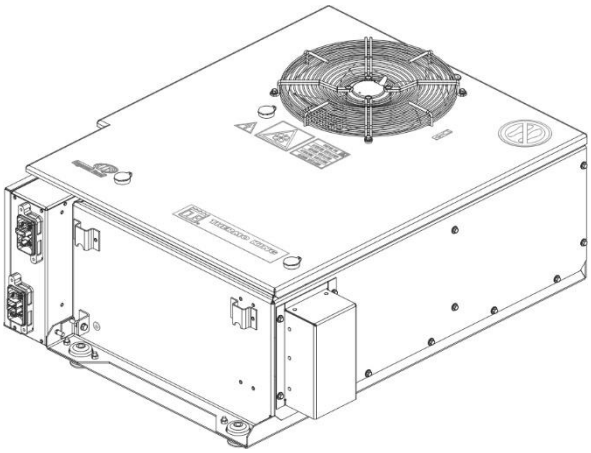
# RAC 60 INT3

Heating, ventilation and air conditioning (HVAC) unit

## Project Intamin Bologna



# MAINTENANCE MANUAL

**TK 61515-5-MM Revision 0 (Print Date: January 06, 2017)**



Electronically Printed in Czech Republic

| **The maintenance information in this manual covers unit model:** | |
|---|---|
| System Number: | 903544 |
| Project: | INT3 |
| | |
| **For further information, refer to:** | |
| Parts Manual | TK 61486-5-PM |
| Stocking Guide | TK 61485-5-SG |
| | |
| See also general documents listed in Appendix. | |

This manual is published for informational purposes only and the information so provided should not be considered as all-inclusive or covering all contingencies. If further information is required, Thermo King Company (Ingersoll Rand Corporation) should be consulted.

Sale of product shown in this manual is subject to Thermo King's terms and conditions including, but not limited to, the Thermo King Limited Express Warranty. Such terms and conditions are available upon request. Thermo King (Ingersoll Rand) warranty will not apply to any equipment which has been so repaired or altered outside the manufacturer's plants as, in the manufacturer's judgment, to effect it is stability.

*No warranties express or implied, including warranties of fitness for a particular purpose or merchantability, or warranties arising from course of dealing or usage of trade, are made regarding the information, recommendations, and descriptions contained herein. Manufacturer is not responsible and will not be held liable in contract or in tort (including negligence) for any special, indirect or consequential damages, including injury or damage caused to vehicles, contents or persons, by reason of the installation of any Thermo King product or its mechanical failure.*

# Recover Refrigerant

At Thermo King, we recognize the need to preserve the environment and limit the potential harm to the ozone layer that can result from allowing refrigerant to escape into the atmosphere.

We strictly adhere to a policy that promotes the recovery and limits the loss of refrigerant into the atmosphere.

In addition, service personnel must be aware of Federal regulations concerning the use of refrigerants and the certification of technicians. For additional information on regulations and technician certification programs, contact your local THERMO KING dealer.

# R-407C

***WARNING: Use only Polyol Ester-based (POE) refrigeration compressor oil in the R-407C system. See Thermo King Parts Manual or Stocking Guide for exact spare part number.***

***Do not mix Polyol Ester and standard synthetic compressor oils. Keep Polyol Ester compressor oil in tightly sealed containers. If Polyol Ester oil becomes contaminated with moisture or standard oils, dispose of properly – DO NOT USE!***

***When servicing Thermo King R-407C systems, use only those service tools certified for and dedicated to R-407C refrigerant and POE compressor oils. Residual non-HFC refrigerants or oils will contaminate R-407C system.***

## HISTORY

| Rev. | Description | Author | Date |
|---|---|---|---|
| 0 | Rev. 0 released | Michal Kout | 06. 01. 2017 |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

# 1. About This Manual

## Purpose

The purpose of this manual is to provide general maintenance information necessary to operate and maintain the climate control unit (HVAC unit) at peak operating standards and best lifetime. This includes safety information, unit information such as technical specification, general unit description, maintenance procedures and some diagnostic and troubleshooting information.

## Before you call Thermo King Service

Before you call Thermo King Service, have the following information on hand (for exact data see serial plate on your unit):

- Unit type (commonly typed on serial plate after code DESC).
- System or Model number (commonly coded on serial plate after code ITEM).
- System number has usually six digits format (example 901902).
- Model number is the same as System number with M letter at the end (example 901902M).
- Serial number.

Who to call: your Thermo King Dealer Representative or Thermo King Service Centre.

## Blank Pages

This manual may contain blank pages at the end of chapters. This is normal. There is no information missing from the manual.

# 2. Table of Contents

# 3. List of Figures

# 4. List of Abbreviations

| | |
|---|---|
| A/C | Air Conditioning |
| ATS | Ambient temperature (sensor) |
| BLH | High pressure cutout switch |
| BLP | Low pressure cutout switch |
| CAII | ClimaAIRE II panel |
| CFM | Condenser fan motor |
| COM | Compressor |
| DC | Direct current |
| FAFM | Fresh air fan motor |
| CH | Chassis, power supply ground |
| CR | Compressor |
| CTS | Evaporator coil temperature (sensor) |
| DVE | Discharge vibration eliminator |
| EFM | Evaporator blower (motor) |
| EXP | Expansion valve |
| FAT | Fresh air temperature |
| FD | Filter drier |
| GND | Power supply ground |
| HPCO | High pressure cutout switch |
| HVAC | Heating, Ventilation and Air Conditioning |
| HW | Hardware |
| HTR | Heater |
| IND | Indicator, liquid |
| KCOM | Contactor, compressor |
| KHTR | Contactor, heater |
| K2 | Ventilation fan relay |
| LPCO | Low pressure cutout switch |
| LV | Low voltage (see "Specifications") |
| NC | Normally closed |
| NO | Normally open |
| PWM | Pulse width modulation |
| PWR | Power supply |
| RTS | Return air temperature (sensor) |
| RPM | Routines per minute |
| SG | Sight glass |
| SPc | Set point of control system |
| SRV | Safety relief valve |
| SVE | Suction vibration eliminator |
| SW | Software |
| TK | Thermo King |
| TR | Tank receiver |
| YLL | Solenoid valve, liquid line |
| XPOW | High voltage terminal / connector |
| XLV11 | Low voltage |

# 5. Safety Precautions

Thermo King recommends that all services be performed by a Thermo King dealer. However, you should be aware of several general safety practices:

***The exclamation symbol appears next to a point that is particularly important.***

***DANGER:*** ***Denotes the possibility of serious injury or death.***

***WARNING:*** ***Denotes the possibility of serious equipment damage or serious personal injury.***

***CAUTION:*** ***Denotes the possibility of minor to severe equipment damage or personal injury.***

## 5.1. General Practices

***DANGER:*** ***Do not operate the compressor with the discharge valve closed. This condition increases internal pressure, which can cause an explosion.***

***DANGER:*** ***Never apply heat to a sealed refrigeration system or container. The heat increases internal pressure, which will cause an explosion.***

***DANGER:*** ***Refrigerant in the presence of an open flame, spark or electrical short produces toxic gases that are severe respiratory irritants.***

***DANGER:*** ***Keep your hands, clothing and tools clear of any rotating parts when working on a unit that is running. Loose clothing might entangle moving fans, pulleys, or belts, causing serious injury or possible death.***

***DANGER:*** ***Do not inhale refrigerant. Use caution when working with refrigerant or a refrigeration system in any confined area with a limited air supply. The refrigerant displaces air and can cause oxygen depletion, resulting in suffocation and possible death.***

***WARNING:*** ***Make sure your gauge manifold hoses are in good condition before using them. Never let them come in contact with moving belts, motors, pulleys or hot surfaces. Defective gauge equipment can damage components or cause serious injury.***

***WARNING:*** ***Wear goggles or safety glasses when working around air conditioning systems or batteries. Refrigerant liquid, oil and battery acid can permanently damage your eyes.***

***WARNING:*** ***Use extreme caution when drilling. Holes might weaken structural components. Holes drilled into electrical wiring can cause a fire or explosion.***

***WARNING:*** ***Exposed coil fins can cause lacerations. Service work on the evaporator or condenser coils is best left to a certified Thermo King technician.***

***WARNING: Be careful when using ladders or scaffolding to install or service air conditioning systems. Follow the manufacturer's instructions, safety labels and warnings.***

***WARNING: If is necessary to use a crane, ensure that load is balanced and stable, make a preliminary lift of a few inches. Do not allow loads to come in contact with other objects. Make sure the path of travel is free of obstructions before moving the load. Do not lift loads over people. Stay out from under the load and make sure other people remain at a distance.***

***CAUTION: Make sure all mounting bolts are tight and are the correct length for their applications. Improper torque and incorrect bolt lengths can damage equipment.***

***CAUTION: If soldering is required, use dry nitrogen to purge the system during any solder operations. Refer to chapter "Using Pressurized Nitrogen".***

## 5.2. Electrical Hazards

When servicing or repairing an air conditioning unit, the possibility of serious or even fatal injury from electrical shock exists. Extreme care must be used when working with an air conditioning unit that is connected to a source of operating power, even if the unit is not running. Lethal voltage potentials can exist at the unit power cord, inside the electric switchboard box, at the motors, at any junction box and within the wiring harnesses.

### Precautions

- Always turn the HVAC unit OFF. Then disconnect the unit from the primary power source (power supply) before attempting repair or replacement of major components.
- Use tools with insulated handles. Use tools that are in good condition. Never hold metal tools in your hand if exposed, energized conductors are within reach.
- Do not make any rapid moves when working with high voltage circuits. Do not grab a falling tool or other object. People do not contact high voltage wires on purpose. It occurs from an unplanned movement.
- Treat all wires and connections as high voltage until ammeter and wiring diagram show otherwise.
- Never work alone on high voltage circuits on the refrigeration unit. Another person should always be standing by in the event of an accident to shut OFF the HVAC unit and to aid a victim.
- Have electrically insulated gloves, cable cutters and safety glasses available in the immediate vicinity in the event of an accident.

***WARNING:** Control circuits used by air conditioners are low voltage (24 VDC for example). Use caution when working with electrical circuits that have capacitors. Some capacitors hold a significant charge that will cause burns or shocks if accidentally discharged. Make sure capacitors are discharged before working on electrical circuits.*

***WARNING:** Do not wear jewellery, watches or rings because they increase the risk of shorting out electrical circuits and damaging equipment or causing severe burns.*

***CAUTION:** When working with electrical circuits that contain microprocessors, always wear an ESD wrist strap and connect the opposite end to the chassis ground or CH terminal. This precaution will prevent electrostatic discharge from damaging circuits.*

***CAUTION:** Certain service procedures on air conditioning equipment require that the system be de-energized. When this precaution is necessary, ensure the battery's master switch or service switch is turned OFF. Confirm that power has been removed before servicing. Equipment that is connected to power is dangerous to service.*

## 5.3. Refrigerant Hazards

***DANGER:** Do not use a Halide torch. When a flame comes in contact with refrigerant, toxic gases are produced that will cause suffocation, even death*

***DANGER:** Store refrigerant in proper containers, out of direct sunlight and away from intense heat. Heat increases pressure inside storage containers, which will cause them to burst.*

***DANGER:** Do not use oxygen ($O_2$) or compressed air for leak testing systems. Oxygen mixed with refrigerant is combustible.*

***WARNING:** Wear protective garments and goggles or safety glasses when working with refrigerant to prevent frostbite and eye injuries.*

***WARNING:** Wear butyl lined gloves when handling refrigerant to help prevent frostbite.*

***CAUTION:** All charging using the new refrigerants (Azeotropic blends) must be done in a liquid state. Failure to do this will decrease the system operating efficiency. Refer to the charging procedures found in this manual for your unit.*

***CAUTION:** When recovering or transferring refrigerant, use a process that prevents refrigerant from escaping into the atmosphere. Refrigerant damages the earth's upper ozone layer.*

***CAUTION:** Refrigerant in a liquid state evaporates rapidly when exposed to the atmosphere, freezing anything it contacts. Be careful when handling refrigerant to protect your skin from frostbite.*

## 5.4. Compressor Oil Hazards

***WARNING: Protect your eyes from contact with compressor oil. The oil will cause serious eye injuries. Avoid prolonged or repeated contact with compressor oil. To prevent irritation, wash your hands and clothing thoroughly after handling the oil.***

***CAUTION: Do not mix compressor oils because that will cause system damage.***

***CAUTION: Use dedicated equipment to prevent contaminating the system with the wrong type of oil or refrigerant.***

***CAUTION: Thermo King uses a variety of compressor oils. Oil used in the system must be verified. Check "Specification" section in this manual for correct oil. Using incorrect oil will invalidate the warranty.***

***CAUTION: When servicing TK units, do not use equipment that might be contaminated with PAG oils.***

***CAUTION: Store compressor oil in an approved sealed container to avoid moisture contamination.***

***CAUTION: Do not expose compressor oil to the air any longer than necessary. The oil will absorb moisture, which results in much longer evacuation times and possible system contamination.***

***CAUTION: Wipe up spills immediately. Compressor oil can damage paints and rubber materials.***

## 5.5. First Aid

### Electrical Shock

IMMEDIATE action must be initiated after a person has received an electrical shock. CALL for emergency and medical assistance.

LOOK FIRST. DO NOT TOUCH THE VICTIM! You can receive a shock from current flowing through the victim's body. The person may still be in contact with the electrical source.

The source of shock must be removed immediately. Turn OFF the source of electricity, if possible. If not, move the source away from you and the person, using a dry, no conducting object made of cardboard, plastic or wood. The electrical wire should be cut with either an insulated instrument (e.g. wooden handled axe or cable cutters with heavy insulated handles) or by a rescuer wearing electrically insulated gloves and safety glasses. Whichever method is used, DO NOT LOOK AT THE WIRE while it is being cut. The ensuing flash can cause burns and blindness.

After separating the victim from power source, check immediately for presence of a pulse and respiration. If the victim has no pulse, start CPR (Cardio Pulmonary Resuscitation) until the emergency medical assistance arrives. If the victim has a pulse, respiration may be restored by using mouth-to-mouth resuscitation.

### Compressor and Refrigerant Oil

*Eyes*

Immediately flush with water for at least 15 minutes. CALL A PHYSICIAN. Wash skin with soap and water.

*Ingestion*

Do not induce vomiting. Immediately contact local poison control centre or physician.

### Refrigerant

In the event of frostbite, protect the frozen area from further injury, warm the area rapidly and maintain respiration.

*Eyes*

Immediately flush eyes with large amounts of water. CALL A PHYSICIAN.

*Skin*

Flush area with large amounts of warm water. Do not apply heat. Remove contaminated clothing and shoes. Wrap burns with dry, sterile, bulky dressing to protect from infection. CALL A PHYSICIAN. Wash contaminated clothing before reuse.

*Inhalation*

Move victim to fresh air and use CPR (Cardio pulmonary resuscitation) or mouth-to-mouth resuscitation to restore breathing, if necessary. Stay with victim until emergency personnel arrives.

## 5.6. Welding of Units or Rail Car

Whenever electric welding is to be performed on any portion of the air conditioning unit, unit chassis or rail car with the air conditioning unit attached, it is necessary to ensure that welding currents are NOT allowed to flow through the electronic circuits of the unit. These procedures must be rigidly adhered to when servicing these units to avoid damage or destruction.

1. Disconnect all power supply to the air conditioning unit.
2. Switch all of the electrical circuit breakers in the electric switchboard box to the OFF position.
3. Ground the unit.
4. Weld unit and/or container per normal welding procedures. Keep around return electrode as close to the area to be welded as practical. This will reduce the likelihood of stray welding currents passing through any electrical or electronic circuits.
5. When the welding operation is completed, the unit power cables (low voltage, high voltage), communication cables, disconnected wiring and circuit breakers must be restored to their normal condition.

# 6. Specifications

## 6.1. HVAC System

| | | |
|---|---|---|
| Cooling Capacity | | 5,4 kW |
| Heating Capacity | | 2.5 kW (2 x 1.25 kW) |
| Total Air Flow | | 800 $m^3$/hr at 75 Pa external static pressure |
| Fresh Air | | 150 $m^3$/hr |
| Temperature Range | | -30 °C to +45 °C |
| Refrigerant | | R-407C |
| Refrigerant Charge | | 1.9 kg (4.19 lb) |
| Compressor Model No. | | ZR28K3E-TFD-522, Hermetic Scroll |
| Compressor Oil Type | | Polyol Ester Based Type (required)<br>TK No. 203-0516[2] |
| System Compressor Oil Capacity:<br>Replacement Compressor Charge (each)[1] | | 1.12 litter (38 oz.) |
| High Pressure Cutout Switch: | Open<br>Close | 3013 ± 48 kPa (437 ± 7 psig)<br>2606 ± 262 kPa (378 ± 38 psig) |
| Low Pressure Cutout Switch: | Open<br>Close | 172 ± 48 kPa (25 ± 7 psig)<br>310 ± 48 kPa (45 ± 7 psig) |
| High Pressure Relief Valve: | Relief Pressure | 3549 + 517/-103 kPa (500 +75/-15 psig) |

[1] When the compressor is removed from the unit, oil level should be noted or the oil removed from the compressor should be measured so that the same amount of oil can be maintained in the replacement compressor.

[2] Do not use or add standard synthetic or mineral oils to the refrigeration system. If ester based oil becomes contaminated with moisture or with standard oils, dispose of properly – DO NOT USE!

## 6.2. Electrical System

| | |
|---|---|
| Power Supply | 400 V 50 Hz, 3 phase<br>For purpose of this manual is this value applied for term HIGH VOLTAGE |
| Control System Voltage | 24 VDC<br>For purpose of this manual is this value applied for term LOW VOLTAGE |

**Circuit Breakers, Fuses, Contactors**
See Principal Schematic Diagram or Mounting Assembly Electro Box Diagram in Appendix.
The set points for circuit breakers or limit value for fuses are in diagram labelled under each part, in last line is value to adjust.

| | |
|---|---|
| **Circuit Breaker** | |
| Controller Circuit | QSUP |
| Compressor Motor | QCOM |
| Evaporator Blower Motor | QEFM |
| Condenser Fan Motor | QCFM |
| Heater, Stage 1 & 2 | QHTR |
| Low Voltage | F1 |
| **Contactors** | |
| Compressor | KCOM |
| Condenser Fan Motor | KCFM |
| Evaporator Blower Motor | KEFM |
| Heater, Stage 1 | KHTR1 |
| Heater, Stage 2 | KHTR2 |
| **Compressor Motor** | |
| Type | 400 V, 50 Hz, 3 phase |
| Number | 1 |
| Kilowatts | 1.9 kW |
| Full Load | 5.1 A |
| **Condenser Fan Motor** | |
| Type | 400 V, 50 Hz, 3 phase |
| Number | 1 |
| Kilowatts | 0.185 kW |
| RPM | 1620 $min^{-1}$ |
| Full Load | 0.37 A |

| **Evaporator Blower Motor** | |
|---|---|
| Type | 24 V DC |
| Number | 1 |
| Kilowatts | 0.135 kW |
| RPM | 2645 $min^{-1}$ |
| Full Load | 5.6 A |
| **Heater** | |
| Input Voltage | 400 V, 50 Hz, 3 phase |
| Heater | 2.5 kW, 2 stages |
| Thermal Overheat Protection:<br>1st level<br>2nd level | <br>90 °C, NC, automatic reset<br>130 °C, NC, automatic reset |

## 6.3. Weights and Dimensions

| | |
|---|---|
| Base Unit Weight (net) | 130 kg |
| **Component weight (for repair and replacement)** | |
| Compressor | 25 kg |
| Condenser fan | 3.6 kg |
| Evaporator blower | 3 kg |
| Heater assembly | 15 kg |

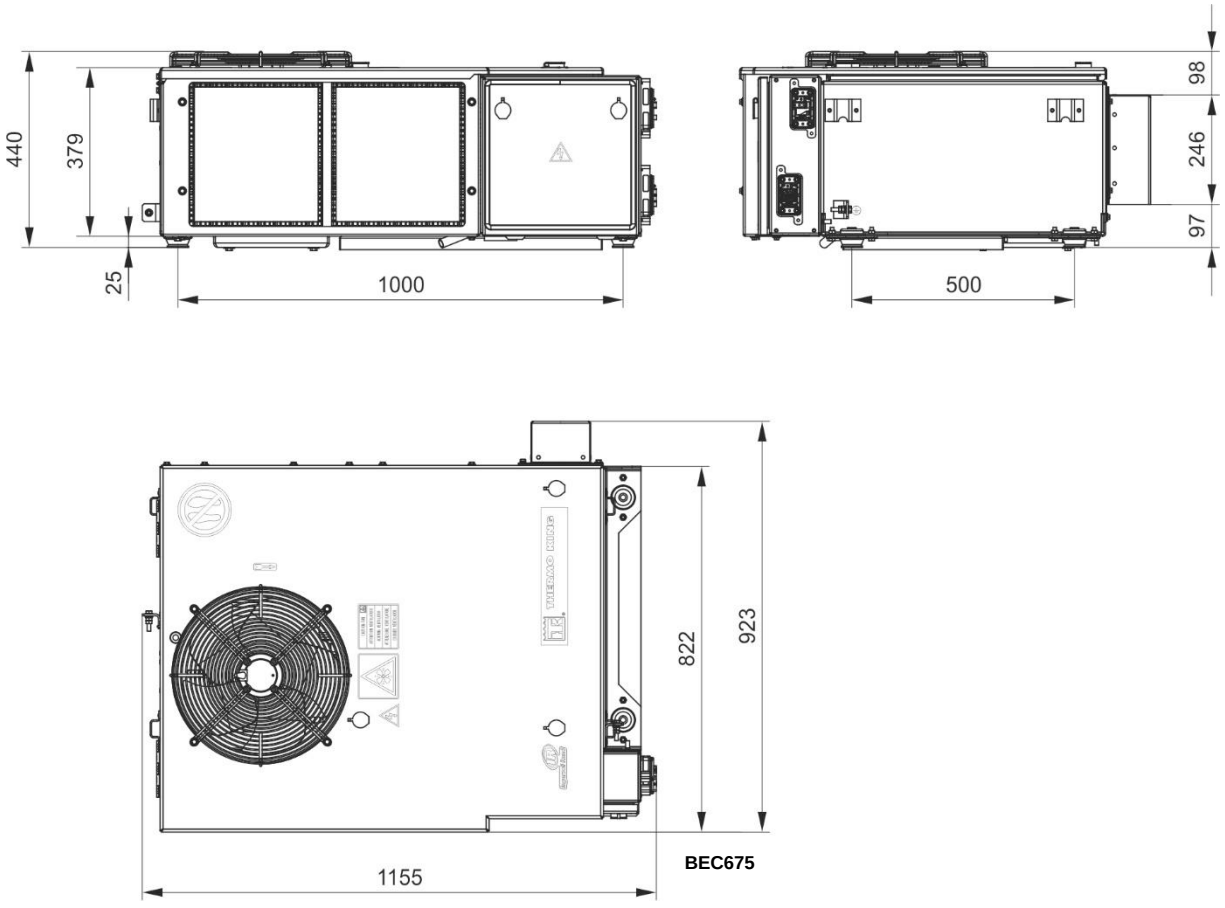
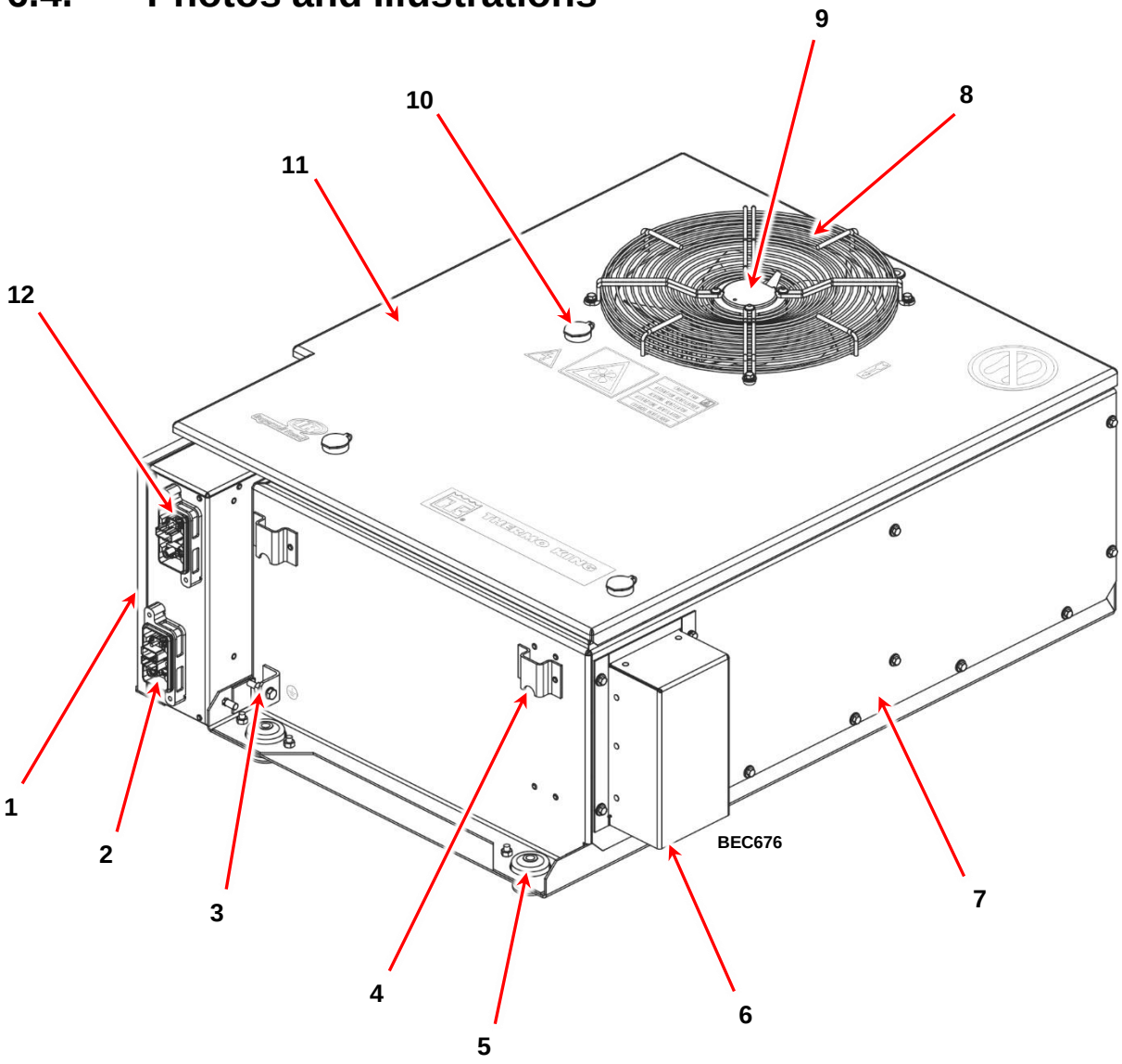


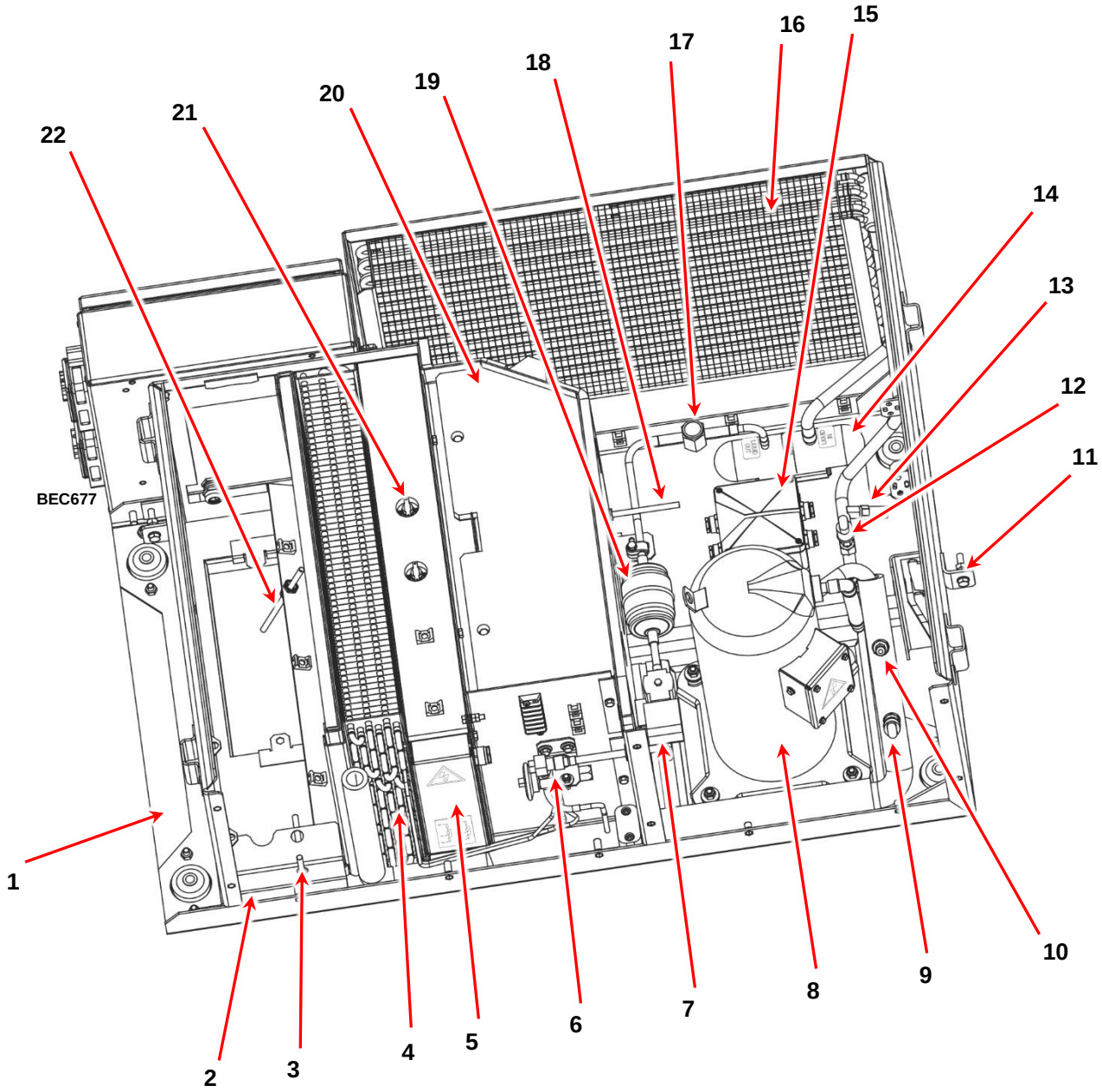

**Figure 1: Unit Dimensions**

## 6.4. Photos and Illustrations



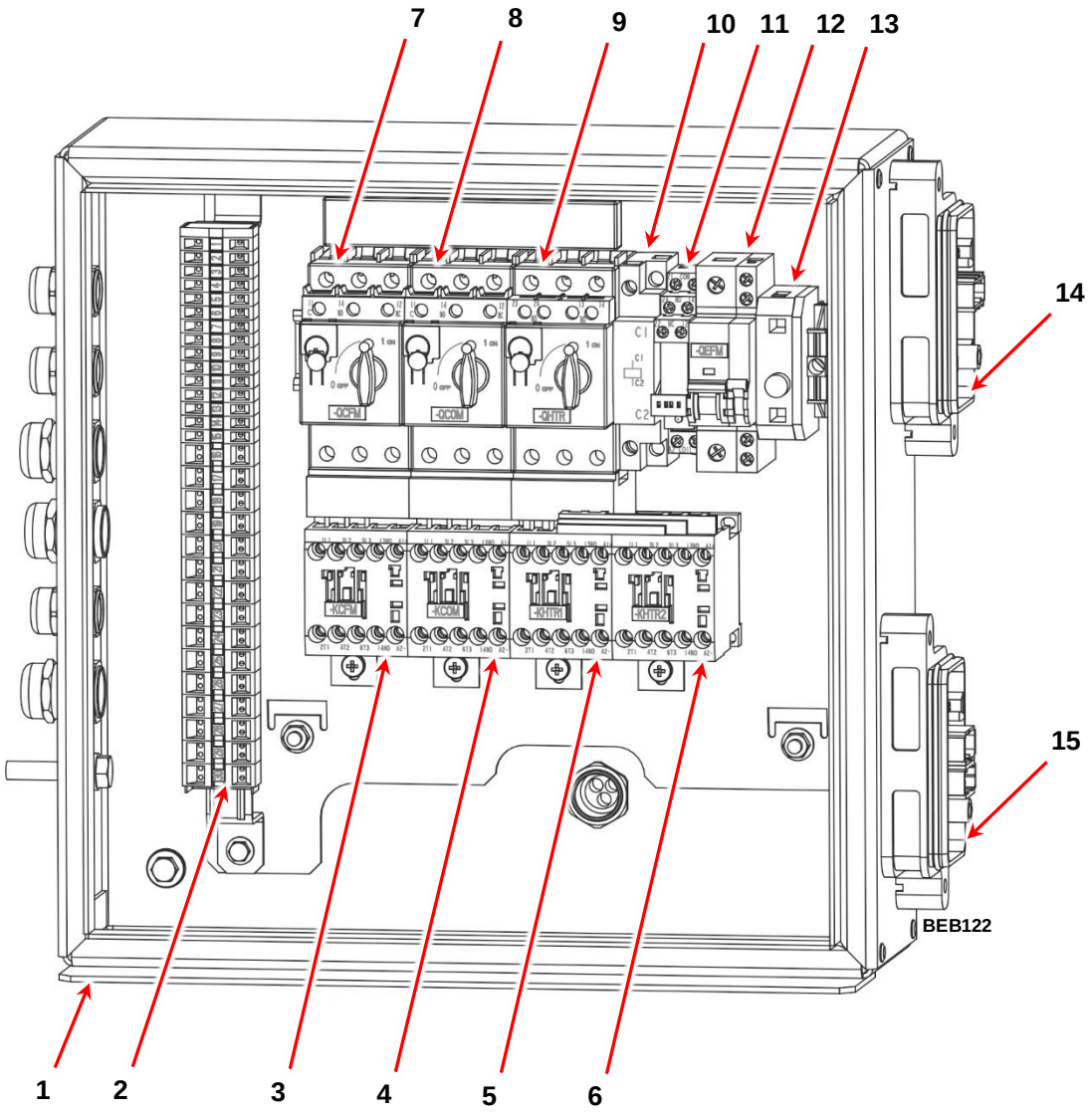

| | | | |
|---|---|---|---|
| 1 | Electrobox | 7 | Unit frame – side wall |
| 2 | Communication & LV connector (XLV1) | 8 | Condenser fan grille |
| 3 | Grounding point | 9 | Condenser fan motor |
| 4 | Lifting plate | 10 | Locking element |
| 5 | Isolator | 11 | Top cover |
| 6 | Fresh air intake with water eliminator | 12 | Power supply HV connector (XPOW) |

**Figure 2: RAC Unit – Outside View**




| | | | |
|---|---|---|---|
| 1 | Unit frame | 12 | High pressure cutout switch |
| 2 | Air intake | 13 | Safety relief valve |
| 3 | Ambient air temperature sensor (ATS) | 14 | Receiver tank |
| 4 | Evaporator coil | 15 | Junction box |
| 5 | Heater | 16 | Condenser coil |
| 6 | Thermostatic expansion valve | 17 | Sight glass |
| 7 | Liquid solenoid valve | 18 | Coil air temperature sensor (CTS) |
| 8 | Compressor | 19 | Filter-drier |
| 9 | Low pressure cutout switch | 20 | Blower compartment |
| 10 | Service port – Schrader valve | 21 | Heater temperature switch |
| 11 | Grounding point | 22 | Return air temperature sensor (RTS) |

**Figure 3: RAC Unit – Inside View**




| | | | |
|---|---|---|---|
| 1 | Electrical switchboard box | ---- | |
| 2 | Terminal block | XTB1 | |
| 3 | Contactor | KCFM | Condenser fan motor |
| 4 | Contactor | KCOM | Compressor motor |
| 5 | Contactor | KHTR1 | Heater, stage #1 |
| 6 | Contactor | KHTR2 | Heater stage #2 |
| 7 | Circuit breaker | QCFM | Condenser fan motor |
| 8 | Circuit breaker | QCOM | Compressor motor |
| 9 | Circuit breaker | QHTR | Heater |
| 10 | Relay – shunt-release | QHTSR | Heater protection |
| 11 | Relay assembly | KEFM | Evaporator blower motor |
| 12 | Circuit breaker | QEFM | Evaporator blower motor |
| 13 | Fuse | F1 | Low voltage circuit protection |
| 14 | Power supply connector | XPOW | High voltage |
| 15 | Signal & communication connector | XLV1 | Low voltage |

**Figure 4: Electrobox**

# 7. Description

## 7.1. System Description

The train HVAC system consists of more HVAC units intended to keep comfortable conditions in passenger compartments and driver cabins. This document describes the rooftop unit (RAC) for driver cabin only (the cab unit).

## 7.2. General Description of HVAC Unit

The RAC heating, ventilation and air conditioning (HVAC) unit manufactured by Thermo King is a roof-mount (rooftop) unit designed for A/C systems of the light rail vehicles. The RAC unit provides cooling, heating and ventilation of the air to keep the temperature conditions comfortable for the driver's cab.

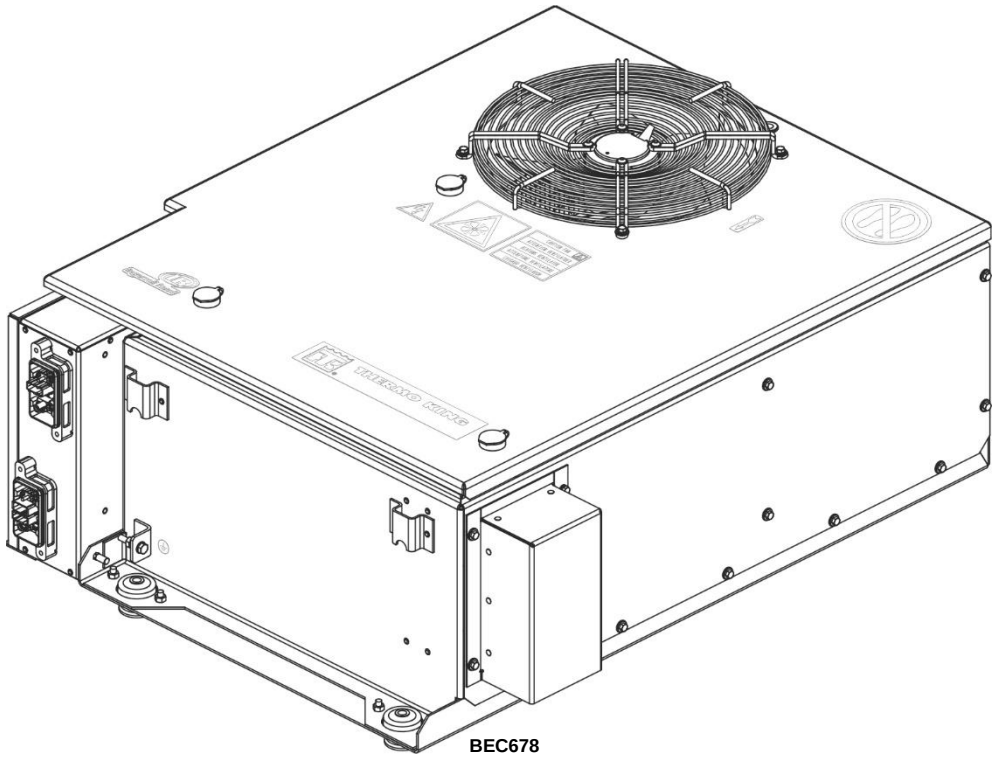



**Figure 5: RAC Unit (Illustrative Picture)**

Cooling and/or ventilation is accomplished by drawing of air (the return air) from the cab interior to the entrance chamber where is mixed with fresh air. This mixed air is filtered and then passes through the evaporator coil, heater and then enters the blower. The blower pressurizes the conditioned air (cooled or heated or dehumidified) and this pressure move the air from bottom of the unit into the vehicle air distribution (duct) system.

## 7.3. Main Parts of HVAC Unit

The RAC unit consists of hermetically sealed refrigerant circuit, air system with filters, electrical circuit, control system, unit frame and covers and auxiliary elements.

The main RAC unit is designed for mounting on rooftop level. Major components of RAC unit are arranged for easy access and service through hinged cover. The primary assemblies are:

- Compressor assembly
- Evaporator coil assembly incl. thermostatic expansion valve and solenoid valve
- Evaporator blower assembly
- Condenser coil and fan assembly
- Heater assembly
- Electric switchboard box (Electrobox)
- Control box with controller
- Refrigeration circuit accessories:
  - Filter-drier
  - Liquid receiver tank
  - Vibration eliminators
  - Sight glass
- Unit protections devices
- Fresh air intake with water eliminator and filters
- Structural frame and cover

### Compressor Assembly

The RAC unit is equipped with scroll compressor and accessories. The compressor is specially designed for use in cooling systems and provides low consumption, low vibrations and high reliability. The compressor includes internal electrical motor feeded from switchboard, an electrical junction box, built-in protection and elastic mounting for elimination of vibrations.

### Evaporator Coil Assembly and Solenoid Valve

The evaporator coil is an aluminium, wavy fin, copper tube type. Liquid refrigerant flows from the receiver tank to the evaporator coil through the thermostatic expansion valve.

The expansion valve restricts and controls the flow of liquid refrigerant to the evaporator. The pressure and temperature condition inside of the evaporator (refrigerant side) and outside of evaporator (air side) results in heat transfer from the refrigerated air to the evaporator.

The drain pan underneath the evaporator coil is intended to capture any water condensation from the coil surface. Drain lines allow the water to flow away from the unit.

The solenoid valve closes the refrigeration circuit in the moment when the system is in stand-by.

### Evaporator Blower Assembly

The blower is intended to draw the air from vehicle area and after conditioning (cooling or heating or dehumidification) discharge conditioned air back into the vehicle air distribution system.

The blower is located in centre of unit (behind the evaporator in air flow direction).

## Condenser Coil and Fan

The RAC unit contains one piece of aluminium, wavy fin, copper tube condenser coil assembly and one condenser fan assembly.

Pressurized refrigerant gas is discharged by the compressors into the condenser coil for the condensing phase of the refrigeration cycle. Air is drawn through the coils by one propeller type fans. Refrigerant gas condenses in the condenser coil, returning the refrigerant to the liquid state.

The fan is designed for pulling of fresh air from internal area RAC unit and this function effect the air flow through the condenser coil.

The fan assembly consists of fan including electrical motor, rotor with blades, permanently sealed ball bearings (all in one-piece part), protective grille and fixing parts.

## Heater Assembly

The heater assembly consists of heater frame, heating element and overheating protection switches (two levels of protection).

The heater is located between evaporator coil and evaporator blower.

## Electric Switchboard Box (Electrobox)

The electrobox contains switchboard with all electrical components for feeding, controlling and protection of electrical circuiting. The switchboard box contains both high voltage and low voltage components.

## Control Panel (Controller)

The unit is controlled by the ClimaAIRE ID controller located on the dashboard of the driver's cab. ClimaAIRE ID provides system component control and fault indication to simply system service and maintenance.

## Refrigeration Circuit Accessories

*Filter-Drier*

The filter-drier (dehydrator) is a cartridge soldered type unit intended for protection the refrigerant against:

- Moisture – by absorbing and retaining it deep within the desiccant.
- Foreign matter – the filter-drier will filter out scale, solder particles, carbon, sludge, dirt or any other foreign matter with negligible pressure drop. Fine particles that would go through an ordinary strainer are removed down to a minimum size in one pass filtration.
- Acid – the hydrochloric, hydrofluoric, and various organic acids are adsorbed and held by the desiccant in a manner similar to the adsorption of moisture.
- Oil sludge and varnish – all refrigeration oils break down to produce varnish, sludge and organic acids and here are removed.

The filter-drier is located on the side of compressor/condenser compartment near condenser coil.

*Liquid Receiver Tank*

A liquid receiver tank holds reserve liquid refrigerant that is needed to support variable system demands. The receiver tank is located in condenser compartment and is connected between the condenser coil outlet line and the filter-drier.

*Vibration Eliminators*

The compressor suction line and discharge line contain in-line vibration eliminators (situated directly before and after compressor).

Constructed of stainless steel reinforced flexible hose, the vibration eliminators remove the vibration and noise that are normally produced by the major mechanical devices and transmitted along refrigerant lines to more sensitive components.

*Sight Glass*

The sight glass is simple system equipment that permits visual inspection of oil and/or refrigerant level and condition.

In the centre of the sight glass is an indicator which changes colour from green when a system is dry, to yellow when a system is wet and indicates the need for a new drier or repair.

The sight glass is located in liquid line, accessible from return air/electro box area.

## Unit Protection Devices

*High Pressure Cutout Switch (HPCO)*

The high pressure switch is located on the output (high pressure, discharge) line from the compressor. The relay-type contact of this switch is a part of low voltage (control) circuit, under normal operation is the contact closed.

If the discharge pressure rises above limit value (see specification in chapter 6), the switch/contact will open and the compressor will stop immediately. At the same time the control system will receive the information about this situation.

*Low Pressure Cutout Switch (LPCO)*

The low pressure switch is located on input line (low pressure, suction line) before the compressor. The relay-type contact of this switch is a part of low voltage (control) circuit, under normal operation is the contact closed.

If the suction pressure drops below limit value (see specification in chapter 6), the switch/contact will open and the compressor will stop immediately. At the same time the control system will receive the information about this situation.

*Safety Relief Valve (SRV)*

A safety (high pressure) relief valve is installed on the compressor output line to avoid excessive pressure build-up within the refrigeration system from extraordinary and unforeseen circumstances.

The valve is a spring-loaded piston type that opens when refrigerant pressure exceeds limit value.

*Compressor Overload Protection*

Compressor overload protection is a built-in part of compressor.

*Heat Limiters*

The heater is protected by the heat limiters against overheating in two levels:

6. When the temperature on the top of the heater assembly is higher than first limit (1st level – for exact value see specification in chapter 6) the switch stops the heater. When a new request for heating appears, the heater can continue in operation.
7. When the temperature is higher than second limit (2nd level – for exact value see specification in chapter 6), the switch stops heater power supply – the shunt relay switches down an appropriate circuit breaker. The circuit breaker reset needs to be done manually. Before reset is necessary to check the reason of protective action.

The switch – heat limiter – is automatically reset if the temperature decreases to approximately 50 °C.

## Air Filters

The RAC unit is equipped with fresh air and mixed air filter.

This filters removes impurities from the fresh/return air entering the RAC unit, filters are is located in front of evaporator coil and on the side wall.

These filters are disposable only, for frequency of changing see the maintenance chapter in this manual. The filter element is enclosed in filter box (retainer) and can be accessible through unit top cover.

## Structural Frame and Cover

The RAC structural frame including the covers is manufactured from aluminium.

The top cover provides access into the unit, to all components. The cover is hinged and in open position can be fixed with support/beam.

Electrobox is closed with separate cover.

Both covers in closed position are secured with locks – the locking elements. For opening/closing use appropriate tool only!

*Unit Decals*

Serial number, refrigerant type and warning decals/nameplates are situated on different places on the unit. These decals provide information that may be necessary for service or repair of the unit. Service technicians should especially read and follow the instructions on all warning decals.

*Serial Number Locations*

- Electric motors – nameplate attached to the motor housing.
- Compressor – nameplate attached to the compressor housing.
- HVAC unit – nameplate on the side of the unit.

# 8. HVAC Unit Control and Operation

## 8.1. Introduction

The refrigeration components of the HVAC unit are all connected in a closed, hermetically sealed common system to form a refrigerant circuit. The refrigerant system circulates refrigerant between the evaporator and the condenser coil to provide the requested exchange of heat energy.

The evaporator coil is the heat exchanger for energy transfer from air (the return air, air for car interior) to the refrigerant. The condenser coil is the heat exchanger for energy transfer from the refrigerant to the ambient air.

If the working conditions require heating of air (air for car interior) the air is heated in the heater assembly, the cooling circuit is OFF (except mode Reheat, see below, if enabled). If the working conditions require just ventilation, the blowers are running to move the air, the fresh air can be added to return air, the cooling circuit and heater are switched OFF.

## 8.2. Basic HVAC System – Theory of Operation

The evaporator blowers drive the air with higher temperature (return air) across the evaporator coil.

- If required the cooling function the liquid line valve is open and the heat energy is absorbed by the refrigerant (a low pressure, low temperature liquid) that in the coil evaporates, the heater is out of operation.
- If required the heating function the liquid line valve is closed, the evaporator coil is out of operation, the air is heated in the heater. The cooled or heated air is discharged into the vehicle air distribution system.

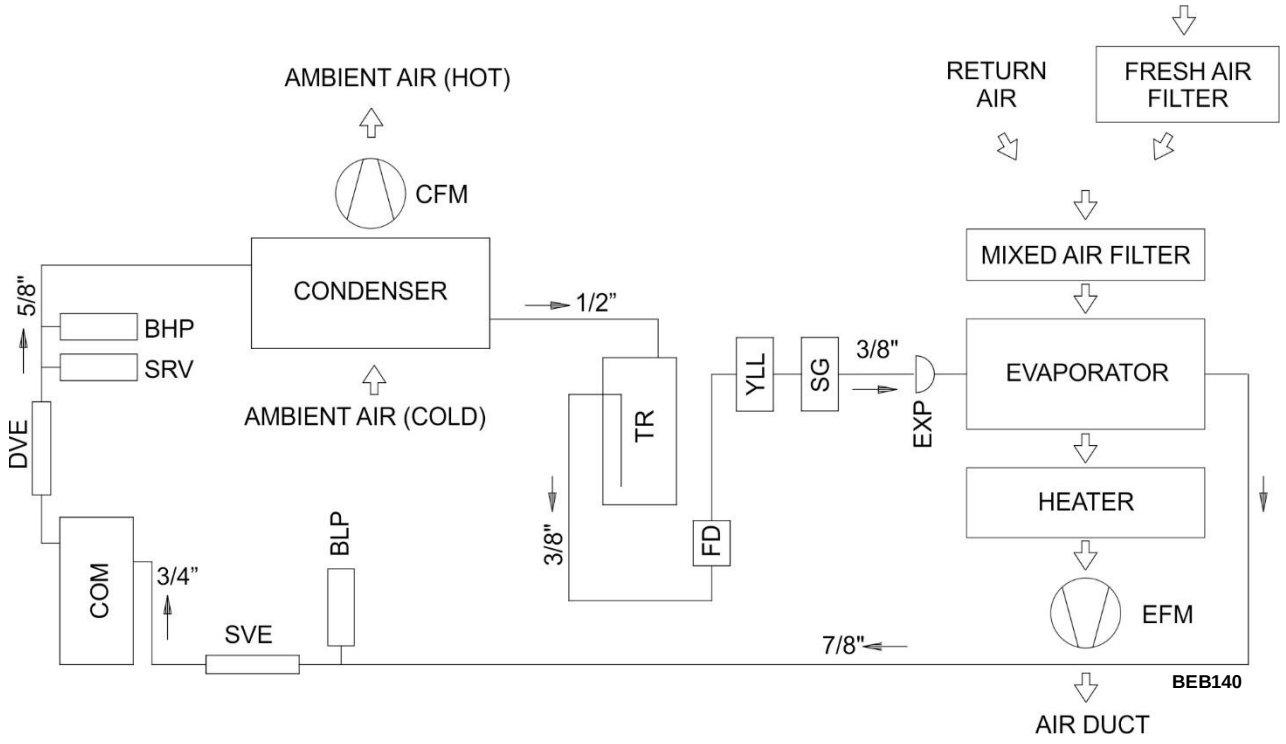
The heat energy is absorbed by the refrigerant (a low pressure, low temperature liquid) that in the coil evaporates. The cooled air is discharged into vehicle air distribution system.

As the refrigerant evaporates, a low pressure, low temperature, heat-laden vapour is formed. The refrigerant needs to release the heat energy.

The compressor's suction continuously draws the heat-laden vapours from the evaporator coil. As the vapours are compressed, it increases its pressure, changing it to high pressure, high temperature vapours. This increases the vapour temperature and pressure to facilitate heat transfer to the ambient air and establish a condensing temperature.

As the high-temperature vapours travels through the condenser coil, the heat is dispersed into the cooling fins, and ambient air is circulated by the condenser fans. As the heat is removed, the vapour condenses back into a liquid. Thus, the heat absorbed by the refrigerant from the evaporator, is transferred to the condenser and given off to ambient air.

The high temperature liquid is maintained under high pressure in the receiver, where it is stored until needed. The receiver serves as a reservoir for the variable demands of liquid refrigerant from the system.




| | | | |
|---|---|---|---|
| DVE | Discharge vibration eliminator | SG | Sight glass |
| SRV | Relief valve (safety relief valve) | EXP | Thermostatic expansion valve |
| BHP HPCO | High pressure cutout switch | BLP LPCO | Low pressure cutout switch |
| FD | Filter-drier | SVE | Suction vibration eliminator |
| YLL | Liquid line valve (solenoid valve) | COM | Compressor |
| TR | Tank receiver | CFM | Condenser fan |
| EFM | Evaporator blower | | |

**Figure 6: Refrigeration System**

From the receiver tank is flowing liquid refrigerant through the filter-drier (dehydrator), where impurities, solids and moisture are removed. From the filter-drier, the high temperature, high pressured liquid flows through the solenoid valve to the expansion valve. The expansion valve restricts and controls the flow of liquid refrigerant to the evaporator where it again absorbs heat from the car interior air (the return air).

## 8.3. Control System

The control system handles all system functions to maintain the passenger's area at the proper temperature. The control system consists of controller (driver panel) and control panel (electrical switchboard) located inside of the rooftop unit.

The controller communicates with control panel (switchboard) and compressor or other optional equipment via Thermo King uniquely designed harnesses.

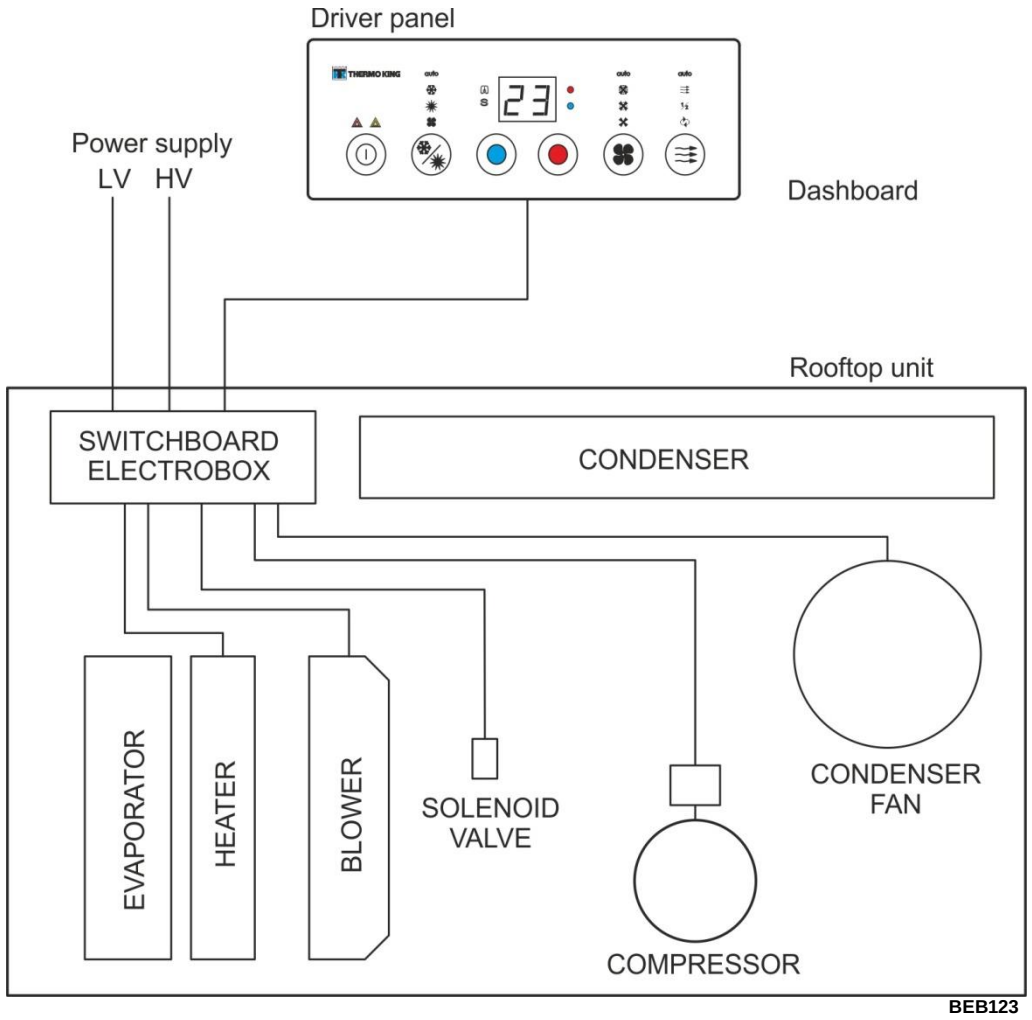
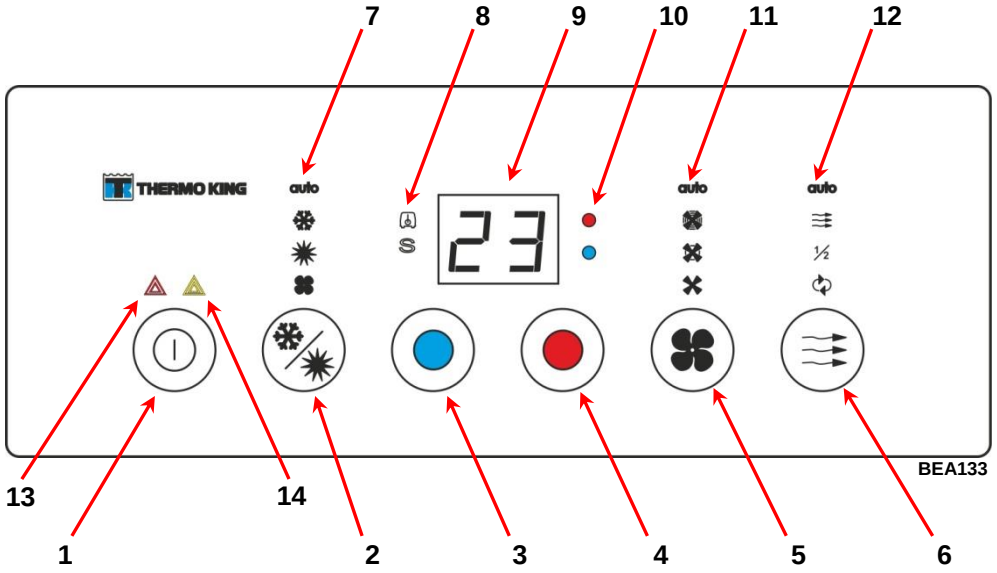



**Figure 7: Application Diagram**

## 8.4. ClimaAIRE ID Controller




| | | | | |
|---|---|---|---|---|
| 1 | ON/OFF key | | 8 | Temperature icons |
| 2 | Mode select key | (ESCAPE) | 9 | Display |
| 3 | Temperature key (blue) | (DOWN key) | 10 | Clutch & Boost pump icons |
| 4 | Temperature key (red) | (UP key) | 11 | Blower mode icons |
| 5 | Blower speed key | (ENTER) | 12 | Fresh air mode icons |
| 6 | Fresh air select key | | 13 | Red alarm |
| 7 | A/C mode icons | | 14 | Yellow alarm |

**Figure 8: CAID Driver Panel**

### 8.4.1. Operating Elements

**ON/OFF key**

When the unit is in operation this key can be used for restart of controller

Press the key to turn the unit ON

Press the key again to turn the unit OFF

Red alarm indicator

Yellow alarm indicator

**Mode select key**

auto Reheat/Auto mode

A/C mode

Heat mode

Ventilation mode

**Display**

Return air temperature icon

Setpoint icon

Red – Boost pump icon

| | | | |
|---|---|---|---|
| | | | Blue – Compressor clutch icon |
|  | **Temperature key DOWN (blue)** | Use UP or DOWN key to increase/decrease temperature setpoint | |
|  | **Temperature key UP (red)** | | |
|  | **Blower speed key** | auto | Automatic blower speed |
| | |  | High blower speed |
| | |  | Medium blower speed |
| | |  | Low blower speed |
|  | **Fresh Air select key** | auto | Auto mode |
| | |  | Open (100% fresh air) |
| | |  | Half open (50% fresh air) |
| | |  | Closed (Recirculated air only) |

### 8.4.2. Operating Concept of ClimaAIRE ID System

The controller (driver panel) ClimaAIRE ID (CAID) uses two possible operating modes:

- Normal operating mode
- Setup/Calibration/Test mode

### 8.4.3. Normal Operating Mode

After start (the power supply is activated) the driver panel is set to normal operating mode. In the normal operating mode the system is running built-in control and diagnostic system.

Functionality of driver panel can be significantly determined by parameters in set-up menu (see chapter "Function 5: Set Up of controller (SE)" below).

On display can be shown:

- setpoint value – requested temperature (default setting, labelled with setpoint icon)
- **Hi** or **Lo** text – in case of Manual mode – see description in Manual mode chapter below
- temperature of return air – when this feature is set by parameter **rt** (**rt** = 01)
  If the return air temperature is shown on display (labelled with return air temperature icon) then in case of setpoint change by pressing of UP or DOWN key the new setpoint will be shown for 3 seconds.
- no information (dark, blind display) – when this feature is set by parameter **rt** (**rt** = 02)
  If the driver panel is set to dark mode with parameter **rt** = 02 then no information is shown on display. Only in case of setpoint change by pressing of UP or DOWN key the new setpoint will be shown for 3 seconds. All other icons on driver panel are visible.

Temperature on the display is shown in °C (default setting) or in °F.

### Mode Select

In normal operating mode – Auto mode – the controller selects the right mode (cool or heat or ventilation) automatically.

- Reheat/Auto mode – unit will operate in cool or heat mode based on operating conditions to ensure proper air temperature and humidity.
- A/C mode – unit will operate in cool mode (based on operating conditions) or ventilation.
- Heat mode – unit will operate in heat mode, cooling will be disabled.
- Ventilation mode – unit will be in ventilation only, cooling will be disabled.

### Blower Speed Select

The evaporator blowers move the conditioned air from HVAC unit into interior. Selection of blower speed determines air flow (amount of air) from HVAC unit into vehicle. In AUTO position the blower speeds are controlled automatically.

***NOTE: When CA ID controller is used in HVAC system equipped with two speeds blowers the LOW and HIGH blower speeds are applicable – the MEDIUM speed position is not used and if selected than blowers run in low speed only.***

### Fresh air/ Smog (Optimal Features)

Using fresh air key driver can control amount of fresh air flows through HVAC unit or can close air damper in case of smog. This "smog mode" can be easily set by pressing fresh air button.


Automatic mode – the fresh air damper is controlled automatically

Fresh air damper open (100 % FA)


Half open – fresh air damper at 50% position (50 % FA)

Recirculated air – fresh air damper closed (0 % FA)

If no key was pressed in last 2 seconds and fresh air button is pressed once, the FA symbol and recirculated air symbol lights up together and the fresh air damper is closed for next 10 minutes. After this period the controller returns to previous FA state (indicated by FA symbol).

If FA key is pressed once more than the "smog mode" is cancelled and FA damper position can be selected.

### Automatic ON Feature

Depending on **Ao** parameter (see "Figure 18: CAID Controller Parameters") the controller (driver panel) will be switched ON or stays OFF depending on state when power supply was switched OFF:

- If the driver panel was ON when power supply was switched OFF; on next system start – power supply ON – the driver panel will also start (internal memory keeps the last operating status; parameter **Ao** is set to 00).
- If the driver panel was OFF when power supply was switched OFF; on next system start – power supply ON – the driver panel will stay OFF (internal memory keeps the last operating status; parameter **Ao** is set to 00)
  OR the driver panel always will be switched ON when the power supply is switched ON (parameter **Ao** is set to 01).

### Lock Function

Depending on **Lc** parameter (see "Figure 18: CAID Controller Parameters") the driver panel buttons functions are obvious or described further (factory settings) or:

- Blower speed key and fresh air select key are locked, have no response on pressing (**Lc =01**).
- Mode select key, blower speed key and fresh air select key are locked (**Lc=02**).
- All buttons except ON/OFF key are locked (**Lc=03**).

### Manual Mode (Optional Feature)

ClimaAIRE ID can control HVAC unit in manual mode to operate system directly. Manual mode has to be enabled by parameter **Lt** in driver panel setup.

In automatic mode operator can change the setpoint in range from **LS** (minimal value of setpoint) to **HS** (maximal value of setpoint), default range is from 17 °C to 27 °C. When the control mode is changed to Manual mode then setpoint value can be set to **Lo** command instead of **LS** or to **Hi** command instead of **HS** value:

- **Lo** command switches ON continual signal for compressor/clutch (relay output CR = 1).
- **Hi** command switches ON continual signal for boost pump (relay output BPR = 1).

With both commands red or blue icons on the right side of display are switched ON. These icons indicate heating system (boost pump) or cooling (compressor) operation.

By **Lt** parameter (**Lt=02**) Manual mode can be enabled with limited duration for 5 minutes. The function is the same as in above described Manual mode but after 5 minutes:

- **Hi** command switches back to **HS** value and thereafter driver panel operates HVAC system automatically.
- **Lo** command switches back to **LS** value and thereafter driver panel operates HVAC system automatically.

### Economic Cool Mode (Optional feature)

Depending on **EC** parameter (see "Figure 18: CAID Controller Parameters") the driver panel in STANDARD COOL mode can operate blower(s) in three speeds (low, medium, high) or in ECONOMY COOL mode can operate blower(s) in medium or high speed only. This feature affect only COOL mode when compressor is in operation.

### 8.4.4. Setup/Calibration/Test Mode

For access to Setup/Calibration/Test mode the driver panel needs to be in normal operation. Press and hold the *Temperature DOWN* key and the *Temperature UP* key simultaneously for 3 seconds till text (Function 1) "t-1" will be displayed.

In Setup/Calibration/Test mode the buttons on the panel uses different function – see following table.

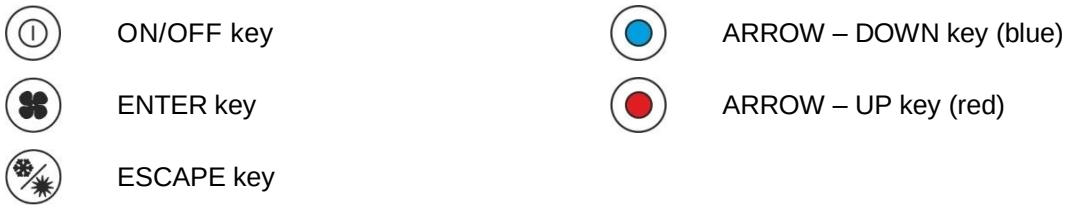



**Figure 9: CAID Keys in Setup/Calibration/Test mode**

### ClimaAIRE ID Functions

Press the UP or DOWN key repeatedly to scroll through the function menu. In the Test/Setup/Calibration mode the operator can use functions listed in following table.

In main menu of Setup/Calibration/Test mode the operator can switch the control system OFF on every time by pressing of the ON/OFF key. No changes will be applied.

When any function is selected and any value is changed by DOWN key or UP key, in the same moment is the change saved to memory.

The driver panel Setup/Calibration/Test mode always waits for switching OFF (soft restart) – the Setup/Calibration/Test mode must be finished by pressing ON/OFF key. Next start (soft restart) returns the system to the normal operating mode immediately.

***NOTE: In Setup/Calibration/Test mode the HVAC unit is out of operation.***

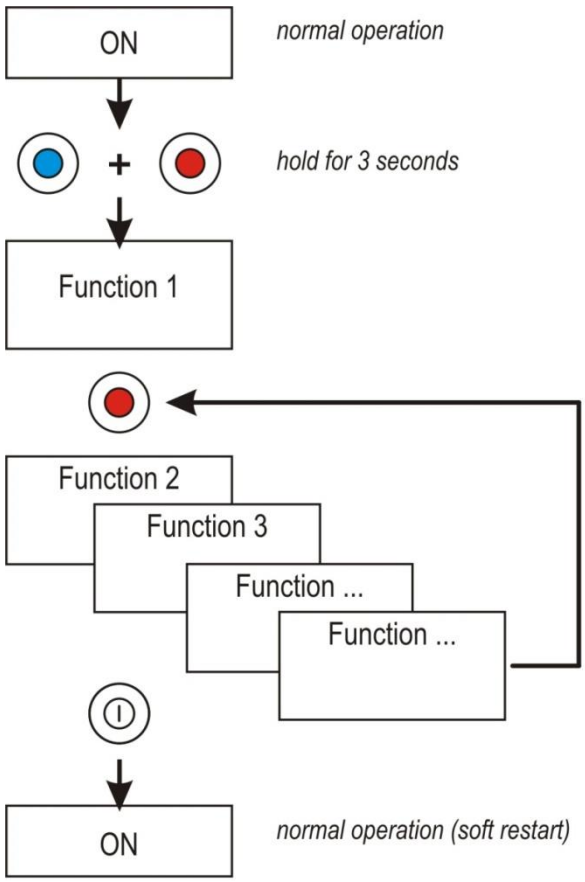



**Figure 10: CAID Function Menu Structure**

| Nr. | Symbol | Function |
|---|---|---|
| 1 | **t1** | Test mode 1 – basic test of HVAC unit |
| 2 | **rt** | Relay test |
| 3 | **Pr** | Set up of program number and reading of firmware version |
| 4 | **CA** | Calibration of temperature sensors |
| 5 | **SE** | Set Up of controller |
| 6 | **AL** | Reading and clearing of alarms |
| 7 | **Hr** | Reading of hour meter |

**Figure 11: CAID List of Functions**

## CAID – Function 1: Test Mode 1 (t1)

The TEST MODE 1 can be used for testing of basic operations. TEST MODE 1 allows to operate the unit manually independently of control system/control diagrams – for example for charging of refrigeration system or testing of HVAC unit.

In Setup/Calibration/Test mode with DOWN or UP key select "t1" and press ENTER key. In "Test mode 1" are available following tests:

1. Cooling/Heating control

Press "Mode key" to change heating and cooling outputs. The following table is used to verify of all relay outputs and function of heating and cooling

| | Function | Relay / output ON | Relay / output OFF | LED |
|---|---|---|---|---|
| | Ventilation | | | |
| | Heating | KHTR1, KHTR2 | KCOM | Red – ON |
| | Cooling | KCOM | KHTR1, 2 | Blue – ON |
| auto | Auto / Reheat | KCOM, KHTR1 | KHTR2 | Red & Blue – ON |

**Figure 12: CAID Test Mode 1 – Mode Control**

2. Blower speed control

Press "Blower speed key" to change evaporator blower speed. The following table is used to verify of all relay outputs and functions of evaporator blowers.

| | Symbol | Relay / output ON | Relay / output OFF |
|---|---|---|---|
| | LOW speed | KEFM + low speed PWM | - |
| | MEDIUM speed | KEFM + medium speed PWM | - |
| | HIGH speed | KEFM + high speed PWM | - |
| auto | Auto | - | KEFM |

**Figure 13: CAID Test Mode 1 – Blower Control**

## CAID – Function 2: Relay Test (rt)

In Setup/Calibration/Test mode select "rt" function and press ENTER key.

On the display will show the relay or output symbol and each press of the UP or DOWN key will scroll to the next item (see following figure). Press ENTER key and corresponding relay/output is energized.

| Display | Description | Signal | Note |
|---|---|---|---|
| **EL** | Evaporator low speed relay | KEFM | |
| **En** | Evaporator medium speed relay | Not used | |
| **EH** | Evaporator high speed relay | KHTR2 | |
| **CL** | Compressor clutch relay | KCOM | Blue icon is ON |
| **bP** | Boost pump relay | KHTR1 | Red icon is ON |
| **C0** | Modulating coolant valve | PWM | PWM signal OFF |
| **C1** | Modulating coolant valve | PWM | PWM signal MAX |
| **d0** | Damper output | Not used | |
| **d1** | Damper output | Not used | |

**Figure 14: CAID Scheme of Relay Test Procedure**

After test press ESCAPE key to continue with another function or press ON/OFF key.

## CAID – Function 3: Set up of Program Number (Pr)

In Setup/Calibration/Test mode with DOWN or UP key select "Pr" function and press ENTER.

First the firmware version in two steps will be displayed for and then the program number stays displayed. To change of this program number press the DOWN key or UP key as required.

***NOTE: If you want to select a program number which is not available in current firmware version, you have to upload a new firmware. For more information refer to ClimaAIRE ID Service Manual (TK 60020-3-MM).***

When the desired program number is shown press ENTER key to save a new program number to memory. To leave of program setup without any changes press ESCAPE key. Press UP or DOWN key to continue with another function or press ON/OFF key to save all changes and switch OFF (soft restart) the system.

## CAID – Function 4: Calibration (CA)

The controller is checked at factory but after HVAC unit installation the calibration mode should be used to verify and adjust temperature sensors functionality in the field.

***NOTE: Calibration is not a repair for defect sensors or bad connections.***

In Setup/Calibration/Test mode select "CA" function with UP or DOWN key and press ENTER key. On the display is shown name of parameter to calibration.

- Press ENTER again to see its current value.
- To leave the parameter unchanged press ESCAPE key.
- To change the value press DOWN key or UP key as required.

Each press of UP or DOWN key is representing value change about 0.2 degree (0.2 °C). Example: for increasing of current value for one degree up (+1 °C) press UP key five times.
Because the two digit display don't allow to shows decimal numbers every press of UP or DOWN key isn't noticeable. However on the right side of display is small orange dot, if this dot is visible the current value is higher about half degree or more than displayed value (e.g. if the value was 11 degree and the UP key was pressed three times the dot will appears, the value is now between 11.5 and 12 degree).

If the UP or DOWN key is pressed and hold than the value is changing quickly (repeatedly) until the key is released.

The calibration range/correction for temperature sensors is from -1 °C to +26 °C.

- Press ESCAPE to save new value and continue to next parameter.

If ON/OFF key is pressed now a new value is also saved and the system will restart (soft restart).

- With UP or DOWN key select next parameter to continue in calibration.

After calibration press ESCAPE key to return to Function menu or press ON/OFF key to switch OFF (soft restart) the system.

| Nr. | Display | Description / Note |
|---|---|---|
| 1 | **rA** | Return air temperature sensor |
| 2 | **Ct** | Evaporator coil air temperature sensor |
| 3 | **At** | Ambient temperature sensor |
| 4 | **CF** | Clutch feedback – no calibration |
| 5 | **Ub** | Battery voltage on PWR – no calibration |

**Figure 15: CAID List of Calibrations**

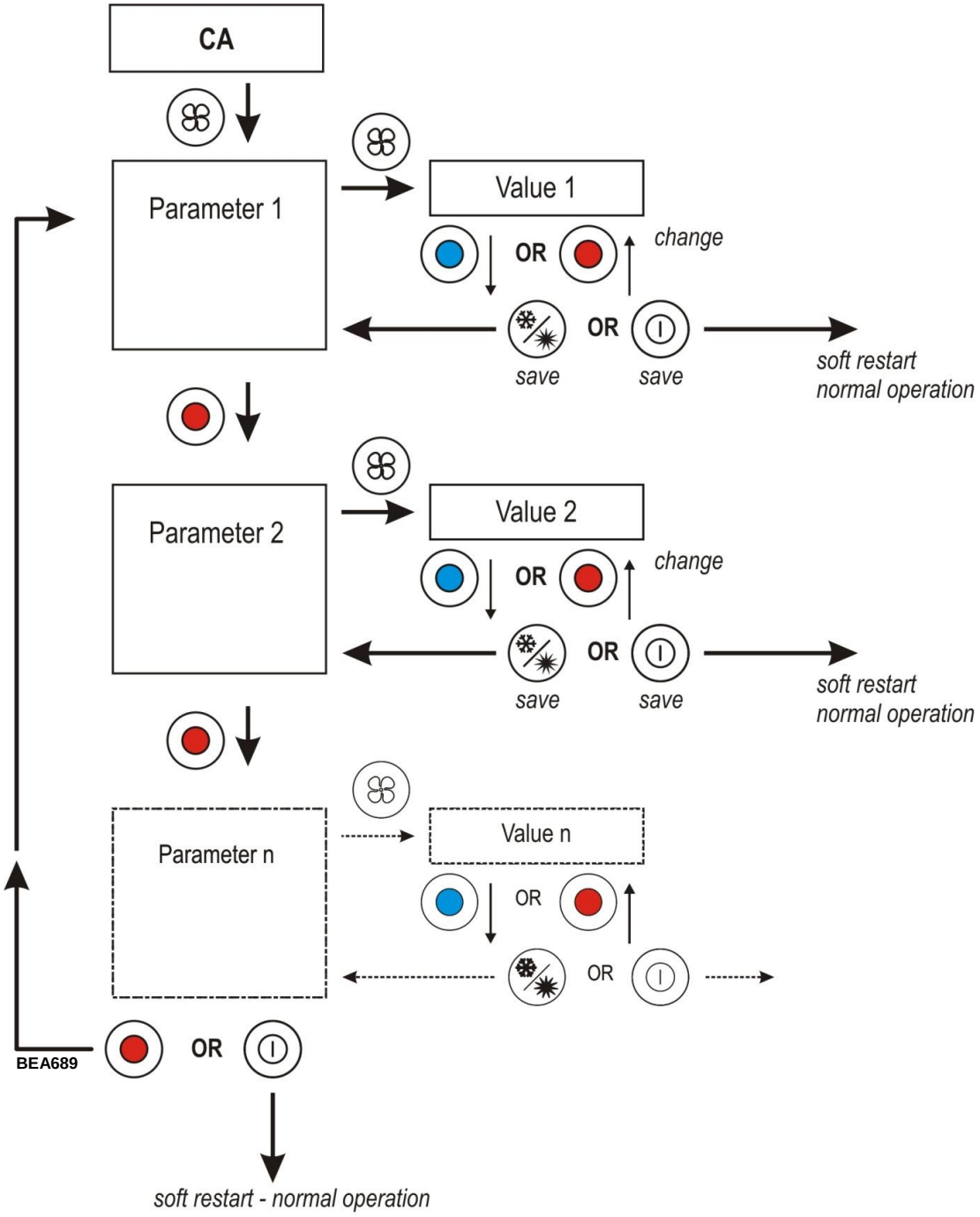



**Figure 16:** **CAID Calibration Function Structure**

### Function 5: Set Up of Controller (SE)

This setup mode can be used to configure the controller for a specific application or conditions.

In Setup/Calibration/Test mode with UP or DOWN key select "SE" function and press ENTER key. The system to check/change of the parameters is similar as for calibration. On the display will show parameter symbols and each press of the UP key will scroll to the next parameter (see following figure). If required parameter (symbol) is displayed press ENTER key to see its current value.

- To leave the parameter unchanged press ESCAPE key.
- To change the value press DOWN key or UP key to set new parameter as required.

Press MODE key to save and continue with another parameter or press ON/OFF key to switch OFF the system. At the end press ON/OFF key to save all changes and switch OFF (soft restart) the system.

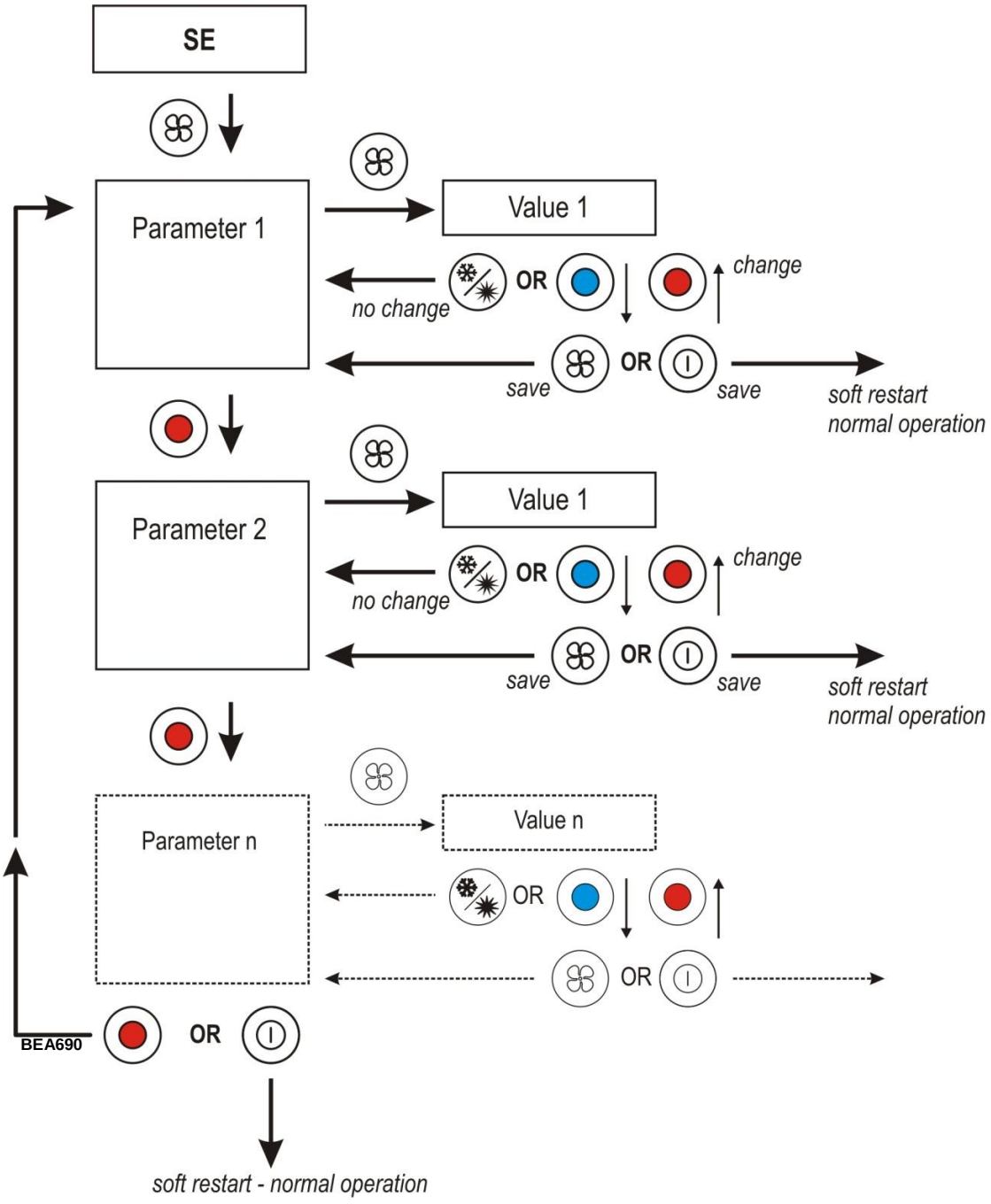



**Figure 17: CAID Setup Function Structure**

| Par. | Preset value | Unit | Min. value<br>Max. value | Name | Description |
|---|---|---|---|---|---|
| **Ab** | 07 | °C | 0 °C<br>15 °C | **Ambient switch point** | For compressor protection only. If ambient temp. is below this parameter the compressor (clutch) will not start |
| **Fr** | -3 | °C | -5 °C<br>+5 °C | **Evaporator antifreeze switch point** | Freeze protection of evaporator. If temperature on evaporator coil (CTS) is lower than this parameter the compressor will be switched OFF.<br>NOTE: It is not recommended to change this parameter. |
| **rh** | 01 | - | - | **Reheat mode** | 00 - reheat mode disabled – economy auto mode<br>01 - reheat mode enabled<br>02 - DELTA T is enabled, reheat is disabled<br>03 - DELTA T is enabled, reheat is enabled |
| **dt** | 07 | °C | 1 °C<br>15 °C | **Delta T** | Offset for control of return air temperature.<br>Set point SPc = Ambient temperature ATS minus Delta T value.<br>If the result is less than 22, then SPc = 22 °C<br>The lowest possible SPc is the set point selected |
| **Ao** | 00 | - | - | **Automatic On** | 00 = controller will operate the unit in the same mode as when power was switched OFF<br>01 = controller will start the unit every time power is switched on |
| **LS** | 17 | °C | 15 °C<br>30 °C | **Low set point** | Minimum value of set point. |
| **HS** | 27 | °C | 15 °C<br>30 °C | **High set point** | Maximum value of set point. |
| **rt** | 00 | - | - | **Default value on the display** | 00 = Set point shown on display<br>01 = Return air temperature shown on display<br>02 = Blind display – set point value shown for 3 seconds after any change |
| **0C** | 00 | - | - | **Old ClimaAIRE I replacement** | 00 = CAID as original<br>01 = CAID as replacement of ClimaAIRE I |
| **un** | °C | - | - | **Celsius/Fahrenheit** | °C = Temperature on the display in °C<br>°F = Temperature on the display in °F |
| **EL** | 45 | % | 0 %<br>100 % | **Low speed of blower** | Low value/frequency for PWM output * |
| **En** | 66 | % | 0 %<br>100 % | **Medium speed of blower** | Medium value/frequency for PWM output * |
| **Eh** | 100 | % | 0 %<br>100 % | **High speed of blower** | High value/frequency for PWM output * |
| **Lt** | 00 | - | - | **Limited temperature set point** | 00 - Automatic mode – no possibility to set Lo and Hi set point on display<br>01 - Manual mode, Lo/Hi set point available<br>02 - Manual mode limited for 5 minutes only |
| **EC** | 00 | - | - | **Economic cool mode** | 00 = Standard cool mode – default value<br>01 = Economic cool mode |
| **HO** | 0 | °C | 0 °C<br>5 °C | **Heat offset** | Set point for HEAT mode will be increased by offset compare to COOL and REHEAT mode |

| Par. | Preset value | Unit | Min. value<br>Max. value | Name | Description |
|---|---|---|---|---|---|
| **Lc** | 00 | - | - | **Lock function** | 00 - no lock (default value)<br>01 - blower speed key and fresh air select key are locked (have no function in operation)<br>02 - mode select key, blower speed key and fresh air select key are locked<br>03 - all buttons except ON/OFF key are locked |
| *** PWM output is used on the systems with blower speed controllers or brushless motors** | | | | | |

**Figure 18: CAID Controller Parameters**

## CAID – Function 6: Reading and Clearing of Alarms (AL)

In Setup/Calibration/Test mode select "AL" function with UP or DOWN key and press ENTER key. All alarm codes will be displayed for 2 seconds and at the end will be displayed "dE".

- For list of alarm codes see "Figure 20: CAID List of Alarm Codes".
- If no alarm is stored (e.g. previously alarms were cleared) the "no" label will be displayed for 1 second and no more action will be executed.

***NOTE: If necessary to keep the alarm codes in memory readable by this way, press ON/OFF key, the driver panel will be switched OFF and the alarms remains recorded.***

- Press the ENTER key to clear all alarms. On the display appears "00" for a short time and then the system returns to Function menu, on the display will show "AL".

***NOTE: Alarms cleared through driver panel remain in internal memory – in history – and can be read through connected PC with Service software.***

At the end always press ON/OFF key to switch (soft restart) the system OFF.

## CAID – Function 7: Reading of Hourmeter (Hr)

In Setup/Calibration/Test mode with UP or DOWN key select "Hr" function and press ENTER key.

The symbols and each value will be automatically displayed in following scheme and at the end will be again displayed "Hr".

***NOTE: Detailed hourmeter (with minute resolution) is available via PC connection and Service software.***

The whole procedure can be repeated by pressing ENTER key again. With UP or DOWN key select next function or press ON/OFF key to switch OFF the system.

| Display | Description | Example |
|---|---|---|
| **Un** | UNIT | |
| **Hr** | hours | |
| **XX** | number of hours in operation | 01 |
| **YY** | | 10 |
| **ZZ** | | 23 = total running time 11 023 hours |
| **CL** | COMPRESSOR (Clutch) | |
| **Hr** | hours | |
| **XX** | number of hours when the compressor (clutch) request signal was set ON | 00 |
| **YY** | | 05 |
| **ZZ** | | 22 = total "compressor" time 522 hours |
| **CL** | COMPRESSOR (Clutch) | |
| **CY** | cycles | |
| **NN** | number of ON/OFF cycles during unit operation | 00 |
| **PP** | | 44 |
| **RR** | | 11 = total 4 411 ON/OFF clutch cycles |
| **Fr** | FREEZE | |
| **CY** | cycles | |
| **NN** | number of evaporator coil freeze protection occurrences (see parameter "Fr" in "Figure 18: CAID Controller Parameters") | 00 |
| **PP** | | 00 |
| **RR** | | 15 = total 15 freeze conditions occurrences |

**Figure 19: CAID Scheme of Hourmeter**

### 8.4.5. ClimaAIRE ID Diagnostic System

After start the driver panel is in normal operating mode. In the normal operating mode is running the built-in diagnostic system.

The ClimaAIRE I D driver panel uses dual alarm system with two levels of signals:

- WARNING (yellow alarm symbol).
- ALARM (red alarm symbol).

When any red alarm (ALARM) appears the alarm code will be blinking on the display until some button is pushed. If any yellow alarm (WARNING) appears the alarm code will be blinking on the display for 5 sec.

The alarm codes are stored in the memory to identify possible fault conditions. Up to 40 alarms codes can be stored. The records can be displayed on the driver panel with the procedure described above. The complete history can be read by the PC only.

#### Alarms Description

The WARNING (yellow alarm) symbol will be ON in the case of:

- Low value of any temperature sensor:
  - temperature sensor defect
  - short circuit of the harness to sensors
  - temperature is lower than -35 °C (-31 °F) – resistance of the sensor or of the total circuit is lower than 1,25 kOhm
- High value of any temperature sensor:
  - temperature sensor defect
  - open circuit of the harness to sensors
  - temperature is higher than 75 °C (167 °F) – resistance of the sensor or of the total circuit is higher than 2,9 kOhm

With yellow alarm conditions the unit will continue in operation with the wrong data from the sensor.

The ALARM (red alarm) symbol will be ON or blinking in the case of:

- HPCO or LPCO switch is open longer than 10 minutes (alarm code 6).
- HPCO or LPCO switch is cycling – switched OFF 5 times per 10 minutes (alarm code 5).
- Inverter alarm (alarm code 31 – 37, special program for electric bus units only).

Any red alarm will switch the unit to the VENTILATION mode with automatic blower speed. The driver can change the blower speed manually. The compressor and condenser fans are stopped.

The alarm symbols can be removed by restart of control system (use the ON/OFF key to switch OFF, wait for 2 seconds, switch ON). After restart – if the reason for alarm is still in existence – the alarm symbol can appears again. If the alarm comes up again, don't restart the unit more times. In that case immediately contact the service department or Thermo King representative.

***NOTE: For more information, detail list and description of alarms refer to ClimaAIRE ID Service Manual (TK 60020-3-MM).***

| Alarm Code | Name | Symbol | Description |
|---|---|---|---|
| **01-04** | not used | **-** | |
| **05** | Cycling HPCO (BHP) or LPCO (BLP) | **RED** | HPCO or LPCO switch is switched off 5 times per 10 minutes |
| **06** | Long delay of HPCO (BHP) or LPCO (BLP) | **RED** | HPCO or LPCO switch is switched off longer than 10 minutes |
| **07** | RTS Low | **YELLOW** | RTS: Return Air Temperature<br>CTS: Evaporator Coil Temperature<br>ATS: Ambient (Fresh) Air Temperature<br><br>Low = short circuit or temperature is lower than -35 °C<br>(the limit value is -35 °C)<br><br>High = open circuit (disconnected sensor) or temperature is higher than 75 °C (the limit value is 75 °C) |
| **08** | RTS High | **YELLOW** | |
| **09** | CTS Low | **YELLOW** | |
| **10** | CTS High | **YELLOW** | |
| **11** | ATS Low | **YELLOW** | |
| **12** | ATS High | **YELLOW** | |
| **13 – 30** | not used | **-** | |
| **31 – 37** | Inverter Alarms | **RED** | for SR10E only |

**Figure 20: CAID List of Alarm Codes**

### Freeze Protection

Temperature of evaporator coil is measured by sensor (CTS). If this temperature is lower than value in parameter **Fr** for more than 30 seconds – that can be dangerous for freezing – the compressor output signal (CR) is switched OFF (see "Figure 18: CAID Controller Parameters"). The compressor (and the condenser fan also) can return to operation if temperature of evaporator coil rises approx. 5 °C above **Fr** parameter for more than 1 minute.

### Compressor Protection

Compressor output (CR) can be switch ON (compressor can start) only if ambient temperature (ATS) is higher than value of parameter **Ab** (see "Figure 18: CAID Controller Parameters").

## 8.4.6. ClimaAIRE ID Inputs and Outputs

Control system inputs are used to monitor system performance and determine operating conditions. System outputs are used to control of all system component operations.

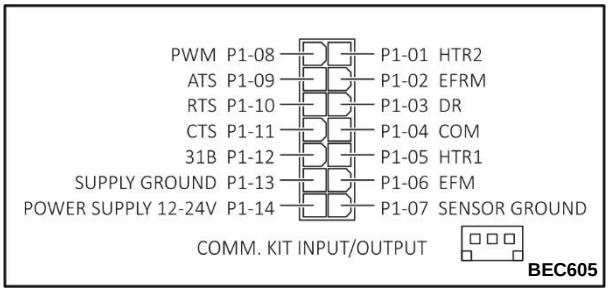



**Figure 21: CAID Driver Panel Connectors**

***NOTE: For more information and detail specification of CAID inputs/outputs refer to ClimaAIRE ID Service Manual (TK 60020-3-MM).***

| Input | Pin | Description | Operating range (min – max) | | Note |
|---|---|---|---|---|---|
| **ATS** | P1-09 | Ambient temperature sensor | -35 °C<br>-31 °F | +75 °C<br>167 °F | |
| **RTS** | P1-10 | Return air temperature sensor | -35 °C<br>-31 °F | +75 °C<br>167 °F | |
| **CTS** | P1-11 | Coil temperature sensor | -35 °C<br>-31 °F | +75 °C<br>167 °F | |
| **31B** | P1-12 | Pressure sensor/switch (LPCO, HPCO) | | | digital, high side input |
| **Supply ground** | P1-13 | Supply ground | 0 VDC | 5 VDC | |
| **Power supply** | P1-14 | Power supply | 10 VDC | 35 VDC | max.100 mA |

**Figure 22: CAID List of Inputs**

***NOTE: For temperature inputs must be used sensors TK 41-4157, TK 41-4335 or TK 41-8780 only.***

| Output | PIN | Description | Standard type |
|---|---|---|---|
| **HTR2** | P1-01 | Heater, 2nd level | 0/1 relay, low side output |
| **EFRM** | P1-02 | --- | |
| **DM (DR)** | P1-03 | --- | |
| **COM** | P1-04 | Compressor and condenser fan motor | 0/1 relay, low side output |
| **HTR1** | P1-05 | Heater, 1st level | 0/1 relay, low side output |
| **EFM** | P1-06 | Blower motor | 0/1 relay, low side output |
| | P1-07 | Sensor ground | --- |
| **PWM** | P1-08 | Evaporator blower speed | PWM 20 kHz, high side output |

**Figure 23: AID List of Outputs**

The driver panel (controller) is equipped with communication connector and can be connected to portable PC for testing and monitoring (use ClimaAIRE PC Adapter Kit TK 204-1063).

***NOTE: For more information see ClimaAIRE ID Service Manual (TK 60020-3-MM).***

## Communication Connector

D-sub 9pin connector (RS232 standard) for communication with monitor software in portable PC.

## 8.5. Application Interface

| ClimaAIRE ID | | | Application | | | |
|---|---|---|---|---|---|---|
| **Signal** | **Pin** | **Type** | **Connector, harness** | **Signal** | **Type, active value** | **Description** |
| Power supply | **P1-14** | --- | XLV1-A6 | --- | 24 VDC | Power supply |
| Supply ground | **P1-13** | --- | XLV1-A5 | --- | 0 VDC | |
| 31B | **P1-12** | DI | XLV1-B3 | 31B | DO, +24 VDC | Press. switches feedback |
| ATS | **P1-09** | AI | XLV1-B4 | ATS | AO | Ambient air temperature |
| RTS | **P1-10** | AI | XLV1-B5 | RTS | AO | Return air temperature |
| CTS | **P1-11** | AI | XLV1-B7 | CTS | AO | Cond. coil temperature |
| HTR2 | **P1-01** | DO | XLV1-B8 | KHTR2 | DO | Heater, 2nd level |
| EFRM | **P1-02** | DO | --- | --- | NOT USED | --- |
| DM (DR) | **P1-03** | DO | --- | --- | NOT USED | --- |
| COM | **P1-04** | DO | XLV1-B2 | COM, CFM | DI, +24 VDC | Compressor and condenser fan motor |
| HTR1 | **P1-05** | DO | XLV1-B7 | KHTR1 | DO | Heater, 1st level |
| EFM | **P1-06** | DO | XLV1-B1 | EFM | DI, +24 VDC | Evap. blower motor |
| GND for sensors | **P1-07** | --- | XLV1-B6 | TSB | | Common sensor ground |
| PWM | **P1-08** | DO | XLV1-A4 | | DI, PWM | Evap. blower speed |

**Figure 24: Controller – Application Interface**

## 8.6. Basic Application Description

Once the control voltage is connected to ClimaAIRE ID (PWR signal), the roof top unit is controlled according to the control diagram.

The control variable for regulation of the HVAC unit is used temperature of return air (RTS) value. The control system monitors all temperature sensors and the temperatures are evaluated for following conditions:

- Compressor can start if ambient temperature (ATS) is over 5,0°C.
- Temperature on evaporator coil sensor (CTS) – test for freezing:
  - If temperature goes down below -2,5°C (over 1 minute), the compressor output is switched OFF.
  - Return to ON state is possible if temperature increase up to 1,7°C.

The control system monitors high pressure (HPCO) and low pressure (LPCO) switches. If pressure is out of limits 3x per 10 minutes the compressor output is switched OFF. This event is evaluated like the fault and the HVAC system is switched to ventilation mode. Driver can restart the HVAC system by on/off switch back to auto mode.

In case of fault in control circuits (overcurrent of evaporator blower), the fault stage is also evaluated and unit is switched to OFF mode or ventilation mode. In this case, the responsible person must find the reason for fault (for example opened circuit breaker) and after the repair the controller can be restarted back to auto mode by ON/OFF switch.

The fault (alarm) stage is indicated on control panel by red triangle. The error on temperature sensor or sensor circuit is indicated by yellow triangle.

There is one set point (adjustable by thermostat knob) used for control of rooftop HVAC. There is possibility to control air flow from roof unit manually or automatically and there is possibility to set manually one of working mode.

After initial unit start-up, the controller regulates the compressor, condenser fan motor, solenoid valve, evaporator blower based on the set point temperature and the return air sensor temperature.
The controller can operate the rooftop HVAC unit in one of the stages listed in following overview.

| Stage | Active application outputs |
|---|---|
| **Full Cool** | Evaporator blower motor (XLV1-B1), PWM (XLV1-A4) on maximum speed, compressor (XLV1-B2) |
| **Medium Cool** | Evaporator blower motor (XLV1-B1), PWM (XLV1-A4) on medium speed, compressor (XLV1-B2) |
| **Low Cool** | Evaporator blower motor (XLV1-B1), PWM (XLV1-A4) on low speed, compressor (XLV1-B2) |
| **Ventilation** | Evaporator blower motor (XLV1-B1), PWM (XLV1-A4) on low speed |
| **Heat I** | Evaporator blower motor (XLV1-B1), PWM (XLV1-A4), heater (XLV1-B7) |
| **Heat II** | Evaporator blower motor (XLV1-B1), PWM (XLV1-A4) heater (XLV1-B8) |

**Figure 25: HVAC Operating Stages**

## HVAC Working Modes

The HVAC unit can operates in one of following working mode. Driver can select the working mode on control panel by Mode select key.

During next start of control system (ON/OFF button or START signal) is always the Auto mode activated.

- Auto Mode – according the control diagram.
- Cool Mode – actual operating stage range from Full Cool stage to Ventilation stage according the control diagram – preferred in summer time.
- Heat Mode – actual operating stage range from Ventilation stage to Heat stage according the control diagram – preferred in winter time.
- Ventilation Mode – the ventilation only – actual operating stage range from Cool stage to Heat stage according the HVAC control diagram (except the Reheat stage), but the compressor and the heater are permanently switched OFF. Automatic operation of evaporator blower will try to control the internal temperature.
- Defrost / Demist mode – the key “FRESH AIR” on control panel activate Defrost/Demist mode. Operating stage of rooftop unit is Full Cool blower speed is set to medium. In this mode is enabled all temperature protection (freezing and compressor protection). This mode is signalized on control panel by symbol “Fresh Air”. If this mode is not switched off by the same button than the function automatically disappears after 10 minutes. Driver can switch on this mode again.

## Freeze Protection

ClimaAIRE control system checks evaporator coil (by Coil Temperature Sensor – CTS) conditions for freezing. If the temperature of the cooling coils is lower or equal to -2.5°C for more than 1 minute, the compressor clutch signal and condenser fan signal is switched off. Compressor clutch signal and condenser fan signal can be switched on when coil temperature (CTS) will be higher than freeze temperature + 2°C for more than 3 minutes.
The freeze protection temperature value is adjustable in Set Up mode.

## Compressor Protection

If the ambient temperature is lower than 5 °C the compressor clutch signal will not be switched on. If the ambient temperature drops down during compressor working period then compressor does not stop although the temperature is below 5 °C.
The compressor protection temperature value is adjustable in Set Up mode.

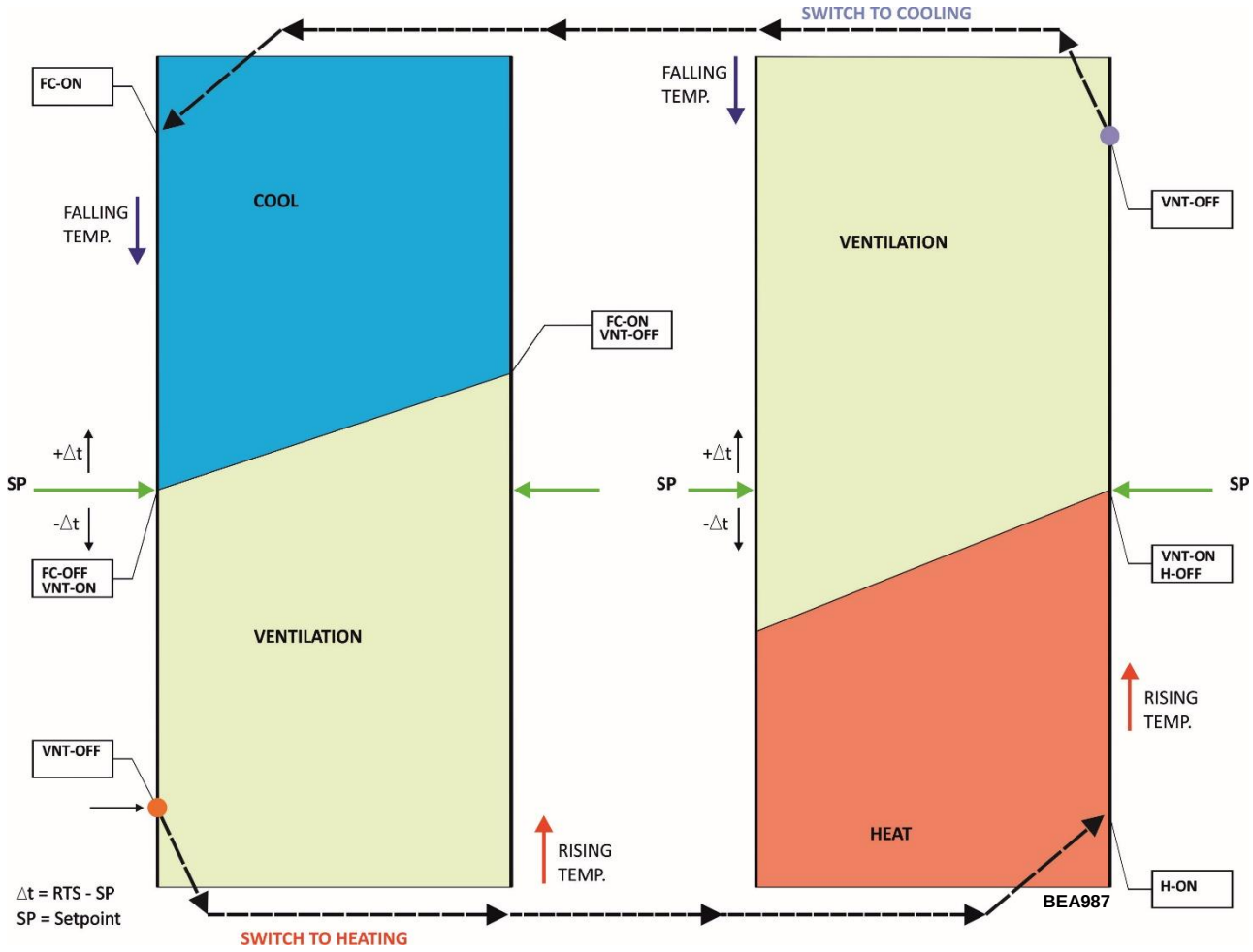



**Figure 26: Control Diagram – Auto Mode**

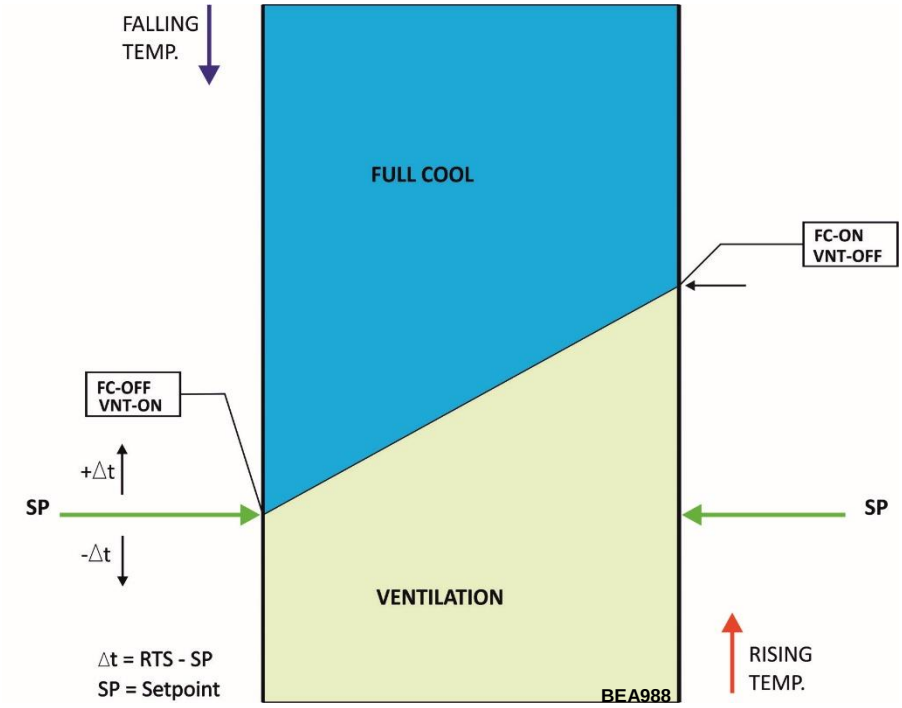



**Figure 27: Control Diagram – Cool Mode**

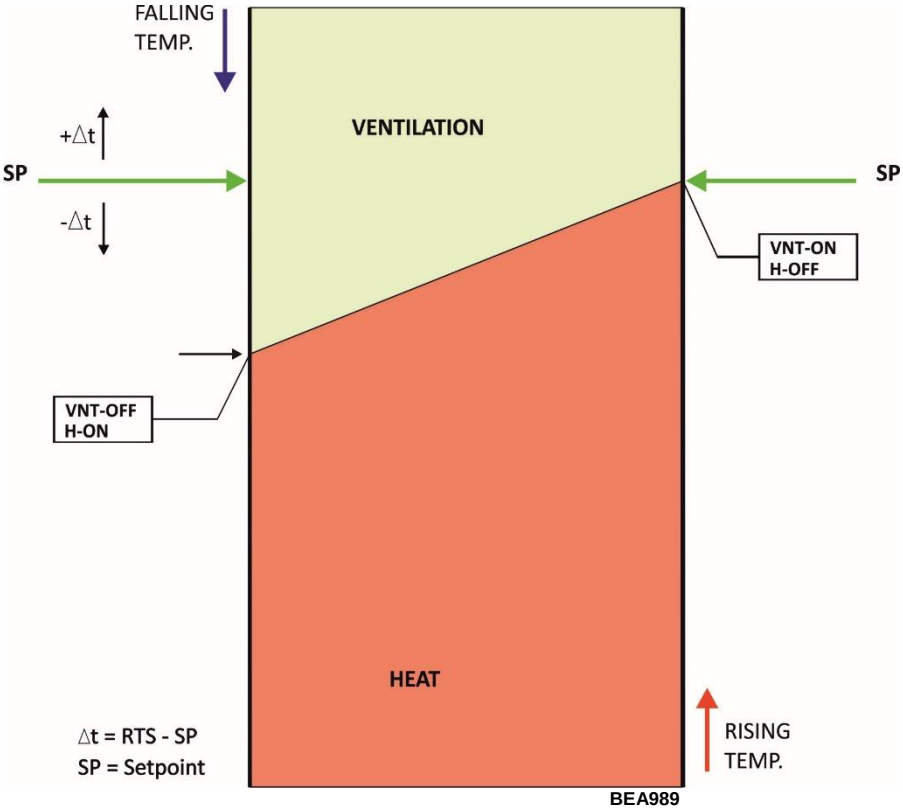



**Figure 28: Control Diagram – Heat Mode**

## 8.7. Start Up

### Normal start conditions:

- RAC unit power supply available.
- Control voltage (low voltage) available.

### Control system start-up signals:

- XLV1 input – low voltage is ON (active, +24 VDC).

In the moment when the control voltage is connected to ClimaAIRE control system, under valid conditions listed above the HVAC system will start. From the first moment the RAC rooftop unit is controlled in AUTO mode according to the control diagram (see chapters above).

On start of control system is the Full Cool stage always activated. For regulation of the RAC unit is control value the temperature of return air (RTS).

### What to check if the unit will not start:

- RAC unit power supply.
- Control voltage (low voltage).
- Control system signals.
- Working conditions.
- Main rooftop unit parts (see chapter 10).

If in a short moment after start appears some alarm symbol on the driver panel see chapter 8.4.5 or chapter 10.

## 8.8. Operation

Normal operational conditions:

- RAC unit XPOW and XLV1 power supply.
- Control voltage (low voltage) available.

Control system operational signals:

- RTS and CTS values from sensors are within limit.
- Other signals depend on operating conditions and requested working mode.

The HVAC system in normal operating mode is controlled according to the control diagrams or by manual commands.

For more information see section ”Control system ClimaAIRE ID”.

## 8.9. Shut Down

For shut down of HVAC system press ON/OFF key on driver panel.

***NOTE: Don’t switch OFF the power supply and low voltage supply before the control system is turned OFF.***

# 9. Light Repair

## 9.1. Inspection Recommendations

To keep the correct functions of the HVAC unit you must periodically execute the following maintenance procedures. The schedules should be used during the initial service periods (at least during warranty period).

***IMPORTANT: SAFETY FIRST! When servicing or repairing an air conditioning unit, the possibility of serious or even fatal injury from electrical shock exists. Extreme care must be used when working with an air conditioning unit. Always respect safety rules, follow "Safety Precautions", respect valid local laws and general Health & Safety prescripts.***

***WARNING: Before any repair action disconnect Power supply (High voltage) XC1 connector and Signal (Low voltage) connector XC2! The unit has no main ON/OFF switch! The switch on front cover of the switchboard (electro) box is "soft switch" for switching between control modes only.***

***CAUTION: Any action on electricity must be provided by electricians with proper qualifications.***

***CAUTION: Always use protective gloves when open the unit covers, the fins of the coils can be very sharp!***

Thermo King reserves the right to deny warranty coverage on claims due to lack of maintenance or neglect. Claims in question must be supported by maintenance records.

If you are not really experienced in following actions please call for help Thermo King Service Centre otherwise is here risk of damage or complications. If you have any questions, please contact your supplier, Thermo King Representatives or directly Thermo King manufacturer.

***NOTE: When removing any panels from the HVAC unit, if you remove any sealant or tie wraps, these MUST be applied back, otherwise, you may void your warranty.***

All maintenance intervals are based on normal operating conditions. Unusual or extraordinary conditions require more frequent service intervals. For example, high air pollution could require more frequent replacement of air filters.

In case of any question or unclear situation please contact Thermo King Representative.

## BEFORE ANY SERVICE ACTIVITY STOP THE HVAC UNIT OPERATION WITH:

1. ON/OFF button on driver panel.
2. Turn all the power supply OFF.
3. Disconnection of all electrical connectors.

***WARNING: The electrical disconnection is allowed only if all the power supply cables are without voltage!***

## WHEN THE LAST SERVICE ACTIVITY IS FINISHED:

1. Check the HVAC unit top cover, check if all locking elements are at a proper position.
2. Connect all electrical connectors, check the proper connection.
3. Turn the power supply ON.
4. Enable the unit operation with ON/OFF button on driver panel.
5. Check the HVAC system functionality, see chapter 8.4.4.

## 9.2. Maintenance Inspection Schedule

### 9.2.1. Intervals

The following intervals are just a recommendation. The periods may vary – this depends on ambient conditions, pollution or local transportation laws. Please use common sense then judging replacement of filters and cleanliness based on first four months of service.

If you need any help please contact Thermo King Representative or Service.

***WARNING: When inspecting or servicing the HVAC system, follow all safety rules and operating procedures, to avoid any physical harm.***

### 120 Days Interval

| Component | Task |
|---|---|
| Control system | Download unit operating data from the control system using a portable computer and service software, check alarm records.<br>For more details see ClimaAIRE ID Service Manual TK 60020-3-MM. |
| HVAC system | Perform a functional check of the HVAC system using a portable computer and service software.<br>A complete functional test includes:<br>• Testing the connection between hardware and software, use function Communication mode – see "Setup/Calibration/Test mode" on page 38. For additional information see Service manual for controller.<br>• Testing the individual functions of the HVAC system, use function Relay test (rt) – see chapter "Setup/Calibration/Test mode". |
| Rooftop unit<br>Body & frame | Visually inspect rooftop unit:<br>• Check for secure mounting to vehicle roof.<br>• Check condition of all covers and attached hardware. Install new parts and/or hardware as necessary.<br>• Clean dirt, debris or foreign particles accumulated on all grilles. |
| Fresh air intake | Visually inspect to make sure the fresh air intake is clean and free of dirt, debris or foreign particles (such as leaves, paper, etc.) |
| Condenser coil | Inspect coil and coil fin surfaces for cleanliness. Vacuum any dirt or debris from the coil. If necessary, clean with low pressure compressed air or detergent/water solution.<br>***CAUTION: Air pressure or water spray pressure must not be too high to prevent from damage of coil fins.***<br>***CAUTION: When using a water spray, isolate the return air plenum to prevent water spray from entering the passenger compartment.***<br>For more information see chapter 9.3. |

## 120 Days Interval (continue)

| Component | Task |
|---|---|
| Evaporator coil | Inspect coil and coil fin surfaces for cleanliness. Vacuum any dirt or debris from the coil. If necessary, clean with low pressure compressed air or detergent/water solution.<br><br>***CAUTION: When using a water spray do it from the inside of the coil outward (opposite direction of normal airflow) Remove all air filters before cleaning!***<br><br>For more information see chapter 9.3. |
| Heater | Inspect heater for sign of overheating. |
| Air filters | Remove and replace filters. Replace any bent or otherwise damaged support retainers.<br><br>***CAUTION: The interval of filter changing depends on external conditions and it needs to be set up based on real air pollution.***<br><br>For more information see chapter 9.8. |
| Major components | Visually inspect all major components for loose, damaged or broken parts, check if the fixing elements are tight. |
| General hardware | Visually inspect all hardware, especially screws and nut inserts, locks, hinges, isolators. Tighten or replace any loose or missing hardware. |
| Drainage pipes and openings | Inspect the drainage openings. Make sure they are clean and free of debris.<br><br>Disconnect drainage hose from channel part and clean drainage hose. |

### 360 Days Interval

| Component | Task |
|---|---|
| Electrical, wiring | Check main/power supply connector on rooftop unit, tighten if necessary.<br>Carefully check the grounding connections on all frames and covers, tighten if necessary.<br>Check integrity of wiring to main electrical system, inspect all wires and terminals for damage or corrosion. If corrosion is present, clean terminals with electrical contact cleaner.<br>Repair or replace any worn or damaged connections, fix any loosen cable.<br>Check wiring connectors on all pressure and temperature switches. |
| Switchboard box | Clean with vacuum cleaner any dust or debris from switchboard box interior.<br>Inspect electrical connections for fraying or burned condition. Replace wiring connectors as necessary.<br>Inspect contactors and relays. Make sure they are securely mounted. Replace any parts that are cracked or show sign of overheating.<br>Check contactor(s) for voltage drop/imbalance across contacts. Where voltage drop or imbalance is found (indicating high resistance), replace the contactor. |
| Refrigerant lines | Check all refrigerant lines, soldered joints, pressure switch connections for refrigerant leaks using an electronic leak detector. |
| Condenser fan | Clean any dirt and/or oil accumulations from fan blades, motor, grille.<br>Inspect fan blades for bent or broken blades. Replace the fan if any part is damaged. If any doubt exists please contact Thermo King Service for help.<br>Rotate fan wheel by hand, check for bearing noise, roughness or looseness. Replace damaged fan if necessary. If any doubt exists please contact Thermo King Service for help. |
| Evaporator blower | Vacuum accumulations of dust and/or debris from blower motors and wheels. Check motor mounting hardware. Tighten or replace hardware as necessary.<br>Check blower wheel hubs for loose or missing hardware. Tighten or replace hardware as necessary.<br>Rotate blower by hand. Determine if blower wheel is rubbing/chafing on housing. Adjust as necessary.<br>Rotate blower wheel by hand, check for bearing noise, roughness or looseness. Replace damaged blower if necessary. If any doubt exists please contact Thermo King Service for help. |

## 9.3. Inspection and Cleaning

Before any maintenance activity follow these common steps:

1. The unit switch in position OFF.
2. Turn the power supply (heater voltage, medium voltage, low voltage) OFF.
3. Disconnection of all electrical connectors (heater voltage, medium voltage, low voltage).

***WARNING: The electrical disconnection is allowed only if all the power supply cables are without voltage!***

### HVAC Unit Inspection and Cleaning

Check all covers if all of them are fixed correctly, check the latches if they are secured. Check the covers at the end of the all maintenance procedures once more.

Tighten or replace any loose or missing hardware.

Clean the impurities (dust, leaves, refuses etc.) accumulated on the grille, use the vacuum cleaner if necessary. Use a mild alkaline cleaner or common cleaning agent to clean the covers or unit body. The whole unit can be sprayed by water (under low pressure). Be sure before spraying all covers are closed and secured by all locks.

Open each cover and use vacuum cleaner to remove any dirt, debris or other impurities from unit inside area.

### Electrical Components Inspection and Cleaning

***CAUTION: Any action on electricity must be provided by electricians with proper qualifications.***

Open and remove the electrobox cover. Use appropriate key only!

Vacuum any dust/debris from box interior.

Inspect electrical connections for fraying or burned condition. Replace wiring connectors as necessary.

Inspect contactors and relays. Make sure they are securely mounted. Replace any parts that are cracked or show sign of overheating.

Check contactor(s) for voltage drop/imbalance across contacts. Where voltage drop/imbalance is found (indicating high resistance due to contact wear), replace the contactor.

Close and fix the electrobox cover. Use appropriate key only!

Restore all power-supply systems of HVAC system and return unit to service.

### Wiring and Harness Inspection

Inspect unit wiring, wire harnesses, and the controller to protect against unit malfunctions due open or short circuits. Look for loose, chaffed or broken wires on the unit; open or short circuits.

Inspect electrical contactor points for pitting or corrosion. Repair or replace as necessary.

Spray contacts and terminals with an electrical cleaner. A good grade of cleaner will also provide waterproofing that can help prevent voltage leaks.

## Evaporator Coil Inspection and Cleaning

***CAUTION: Always use protective gloves when open the unit covers, the fins of the evaporator coil can be very sharp!***

Open the top cover, secure them in open position by cover support. Use appropriate key only!

Remove mixed air filter.

Visually inspect the evaporator coils and tubing for any visual puncture, fin damage or trace of refrigerant which can be a sign of a leak. Ensure that no obvious or hidden minute leak took place within the coils fins or tube. Check with leak detector or other certified methods of leak detection. If proven to be an active leak, please repair the leak if accessible or replace complete coil (the coil assembly) as instructed in the removal and replacement procedure in corresponding section in this Maintenance Manual.

Clean the impurities (dust, leaves, refuses etc.) accumulated on all coils, use the low pressure compressed air or vacuum cleaner or detergent/water solution if necessary.

Use vacuum cleaner with flat nozzle to clean the evaporator coil or use low pressure compressed air for blowing-through from return air side.

***CAUTION: Don't use water or water spray to clean evaporator coil!***

***CAUTION: Air pressure must not be too high to prevent from damage of coil fins.***

For safety reason the pressure level must be below 30 psi. Clean the evaporator coil in the parallel direction to the fins (vertically) and then follow the direction perpendicular to the fins (horizontally). At the end inspect coil and fins for damage, and repair if necessary.

Check for clean and proper drainage from drain pan.

Install the mixed air filter.

Close and secure the top cover with latches. Use appropriate key only!

## Evaporator Blower and Blower Motor Inspection

Open the top cover, secure them in open position by cover support. Use appropriate key only!

Remove the evaporator compartment cover, save original hardware for reinstallation.

If some defects are detected such as electrical winding problems, mechanical issues e.g., bad bearing or excessive noise, to name a few, replace the damaged part if applicable or replace the full component as instructed in the removal and replacement procedure in corresponding section in this Maintenance Manual.

Try to slowly rotate the propeller by hand and observe the correct movement.

Check for bearing noise, roughness or looseness. If some irregularities show up, replace damaged propeller or replace the fan.

Visually inspect for bent or broken blades.

Clean the impurities from fan blades, use soft-bristle brush or damp (the mild cleanser can be suitable) wiping rag but do not allow the condenser fan motor to get wet.

***CAUTION: Don't use the compressed air or vacuum cleaner. This can be dangerous due the fast movement of fan blades!***

Mount the evaporator compartment cover, use original hardware, and tighten the fixing bolts. For appropriate tightening torques see chapter 9.5.

## Condenser Coil Inspection and Cleaning

***CAUTION: Always use protective gloves when open the unit covers, the fins of the condenser coil can be very sharp!***

Open the top cover, secure them in open position by cover support. Use appropriate key only!

Visually inspect the condenser coils and tubing for any visual puncture, fin damage or trace of refrigerant which can be a sign of a leak. Ensure that no obvious or hidden minute leak took place within the coils fins or tube. Check with leak detector or other certified methods of leak detection. If proven to be an active leak, please repair the leak if accessible or replace complete coil (the coil assembly) as instructed in the removal and replacement procedure in corresponding section in this Maintenance Manual.

Clean the impurities (dust, leaves, refuses etc.) accumulated on all coils, use the low pressure compressed air or vacuum cleaner with flat nozzle or detergent/water solution if necessary.

Clean the condenser coil by blowing low pressure compressed air or a medium pressure warm water spray from the inside of the coil outward (opposite direction of normal airflow). Inspect coil and fins for damage, and repair if necessary.

If a buildup of salt or debris is present on the condenser coil, the coil should be cleaned using a mild alkaline cleaner with a pH of 9.5 to 10.5. For example Thermo King Climador Coil Cleaner or a 2-3 percent solution of SIMPLE GREEN® would make a suitable cleaning solution.

Apply the solution using a pressure spray/wash type apparatus. Spray the condenser coil thoroughly from both the inside and outside of the coil. Always thoroughly rinse the coil with a fresh water spray.

***CAUTION: Air pressure or water spray pressure must not be too high to prevent from damage of coil fins.***

***CAUTION: When using a water spray, isolate the return air plenum to prevent water spray from entering the air duct.***

Close and secure the top cover with latches. Use appropriate key only!

## Condenser Fan, Grille and Fan Motor Inspection

Remove the condenser fan grille, save original hardware for reinstallation. If some defects are detected such as electrical winding problems, mechanical issues e.g., bad bearing or excessive noise, to name a few, replace the damaged part if applicable or replace the full component as instructed in the removal and replacement procedure in corresponding section in this Maintenance Manual.

Try to slowly rotate the propeller by hand and observe the correct movement.

Check for bearing noise, roughness or looseness. If some irregularities show up, replace damaged propeller or replace the fan.

Visually inspect for bent or broken blades.

Clean the impurities from fan blades, use soft-bristle brush or damp (the mild cleanser can be suitable) wiping rag but do not allow the condenser fan motor to get wet.

Use a damp cloth (with mild alkaline cleaner), soft brush, to clean the grille. If necessary, dismantle the condenser fan assembly and carefully clean the propeller/wings.

***CAUTION: Don't use the compressed air or vacuum cleaner. This can be dangerous due the fast movement of fan blades!***

Mount the condenser fan grille, use original hardware, and tighten the fixing bolts, for appropriate tightening torques see chapter **Chyba! Nenalezen zdroj odkazů.**.

## Heater Inspection Procedure

Open the top cover, secure them in open position by cover support. Use appropriate key only!

Visually check the heater and surrounding area for visible damages (e.g. slack heating parts, indication of overheating). If necessary, replace the whole heater system.

If any impurities in heater area remove them carefully, do not use any detergent, don't use the vacuum cleaner or any other mechanical equipment.

Close and secure the top cover with latches. Use appropriate key only!

## Drain Pan and Drainage Pipes Inspection Procedure

Open the top cover, secure them in open position by cover support. Use appropriate key only!

Visually check the drainage openings. Make sure they are clean and free of debris. Make sure that no part is missing or loosen.

Clean the impurities with vacuum cleaner or use the cleaning rag if necessary. Check for clean and proper drainage from drain pan.

Disconnect drainage hoses from channel part and clean drainage hose. The damaged hose must be replaced.

Close and secure the top cover with latches. Use appropriate key only!

## 9.4. Special Tools, Equipments and Supplies

For maintenance and repairs use basic hand tools in size and type corresponding to intended task. On some tasks can be necessary to use a special tools or equipment listed in following figure or in chapter 11.2.2.

For replacement parts (air filters, filter-drier etc.) please refer to Parts Manual (see the Thermo King publication number on page 3, ask for most up-to-dated version).

***NOTE: Types and suppliers of suitable tools can vary from country to country; usually more products are available in open market. In any doubt about suitable tool please contact your local Thermo King dealer or directly Thermo King Representative.***

| Nr. | Item | Description |
|---|---|---|
| 1 | Refrigerant gauge manifold set | Reads system pressures and allows for correct system servicing. |
| 2 | Quick disconnect access valves | Keep pressure in gauge lines when gauge manifold is removed from compressor. |
| 3 | 2-Stage vacuum pump | See chapter 11.2.2. |
| 4 | Portable reclaim unit | |
| 5 | Electronic micron gauge | Must have vacuum level readings from 25,000 to 50 microns. |
| 6 | Electronic leak detector | Use an electronic halogen leak detector or soap solution.<br>***WARNING:*** ***Do not use a Halide torch to detect leaks. When a flame comes in contact with refrigerant, toxic gases are produced that might cause suffocation.*** |
| 7 | Expander tool set 14297 | |
| 8 | Fin comb 14142 | |
| 9 | Digital temperature tester | |
| 10 | Digital multimeter | |
| 11 | PC Adapter Kit | Thermo King P/N 204-1063 |
| 12 | Clamp tester | |
| 13 | Pin extractor tool | |
| 14 | Heat gun | With thermometer, common type. |
| 15 | Thermometer with remote reading dial | Do not use an infrared touch-less thermometer for air temperature readings. It will give inaccurate readings. |
| 16 | Oxygen acetylene torch, solder, flux. | |
| 17 | Oil test kit | Thermo King P/N 203-457 |
| 18 | Thread locker | Loctite (TM) Type 277, Part no. 27731 |
| 19 | Sealer Technobond, black | Thermo King P/N 203-0770 |

| Nr. | Item | Description |
|---|---|---|
| 20 | Sealer Technobond, white | Thermo King P/N 203-0771 |
| 21 | Sealer tape PERMAGUM | Thermo King P/N 203-0391 |
| 22 | Sealer aktivator | Sika® Aktivator-205 |
| 23 | Sealer butyl cork | Thermo King P/N 600152A |
| 24 | Anti-seize thread lubricant | Loctite (TM) Type 8150, Part no. 15376 |
| 25 | Climador coil cleaner | Thermo King P/N 203-0779 Climador container 10l<br>Thermo King P/N 203-0778 Climador 6x 1l spray |
| 26 | Tamper proofing | Loctite (TM) Type 7414 |
| 27 | Lifting device | Thermo King P/N 98-7954 |
| 28 | Vacuum cleaner/hose | |
| 29 | Flat nozzle | |
| 30 | Hand spray | |
| 31 | Valve stem core remover | |
| 32 | Mirror | |
| 33 | Torch | |
| 34 | Latches' key | Southco E5-32-05-24-UUI |

**Figure 29: Special Tools**

## 9.5. Tightening Torque Requirements

From Thermo King manufacturing processes some bolting are marked by blue or yellow colour.

- Blue mark – simple tightening indicator (the torque stripe) – for re-tightening always use the torque wrench and set the torque by following information, use the paint again (the tamper proofing tool for example, see chapter 9.3). The hardware is marked by blue in case of rotating or vibrating parts fixation (compressors, blowers etc.) or in special cases or by customer's requests.
- Yellow mark – internal marking only, for tightening use common sense and best practice, use the marker again.
- No colour marking – for tightening use common sense and best practice.

***IMPORTANT***

***The nominal values are valid for simple connection only, e.g. metal sheet to metal sheet connection. If the technology solution is different, always contacts your Thermo King specialist for more information.***

***Every time when you will tighten stainless steel screws or nuts use anti-seize thread lubricant.***

***The torque values are not valid for the bolts used with the isolators to mounting of the HVAC unit on the vehicle roof. Refer to the installation drawing for correct tightening value.***

Step 1: Locate both groups for bolt and nut in following table:

| Group | Fastener | Material | Finish | Strength Class | Marking |
|---|---|---|---|---|---|
| A | Head bolt, machinery type | Steel | Zinc plated | 5.8 | 5.8 |
| B | Head bolt, machinery type | Steel | Zinc plated | 5.8 | 8.8 |
| C | Head bolt, machinery type | Steel | Zinc plated | 10.9 | 10.9 |
| D | Head bolt, machinery type | Steel | Black&Wax | 12.9 | 12.9 |
| **E** | **Head bolt, machinery type** | **St. Steel** | **Passivated** | **A2-70** | **A2** |
| B | Nut, Regular | Steel | Zinc plated | 8 | None |
| C | Nut, Regular | Steel | Zinc plated | 10 | None |
| **E** | **Nut, Regular** | **St. Steel** | **Passivated** | **A2** | **None** |

**Figure 30: Fastener Groups**

***NOTE: The Thermo King standard fastening hardware belongs to the Group E.***

Step 2: Select the bolt/nut torque by size & group:

| Size | Group A | Group B | Group C | Group D | Group E |
|---|---|---|---|---|---|
| | Nominal Torque in [Nm] | | | | |
| M4 | 1.5 | 2.4 | 3 | 3.8 | **2.2** |
| M5 | 3.2 | 5.1 | 6.4 | 7.4 | **4.2** |
| M6 | 5.7 | 8.7 | 11.3 | 13.2 | **7.5** |
| M8 | 13.7 | 21.1 | 27.4 | 32 | **18.4** |
| M10 | 27.2 | 27.2 | 54 | 63 | **36.6** |
| M12 | 47 | 73.5 | 98 | 107 | **63** |
| M14 | 75 | 117 | 147 | 176 | **98** |
| M16 | 117 | 186 | 235 | 275 | **157** |

**Figure 31: Nominal Tightening Torque**

Step 3: Adjust both numbers for special conditions:

- Fine threads +10 %.
- Thin or jam nut -50 % (do not add to Group E – see note #3 below).
- Anti-seize lubricant -20 %.
- Unplated carbon steel +10 %.

Step 4: Set the tighten torque in range.

**Minimum torque = 0.9 x nominal torque**

**Maximum torque = 1.2 x nominal torque**

Step 5: Set fastener to required torque.

***NOTE 1: The torque values are "First-On" and are not applicable to re-used fasteners. The "Figure 31: Nominal Tightening Torque" covers standard new fasteners. Reuse of old fasteners can follow this guideline but the strength, grade and condition of reused fasteners is not Thermo King responsibility.***

***NOTE 2: The torque values listed are seating torques (not break-away values which may be substantially different).***

***NOTE 3: The Group E torque values are based on stainless steel screws used with the anti-seize lubricant.***

## 9.6. Long-term Storage

***CAUTION: If the HVAC unit will be operated in the workshop, power supply must be equipped by residual-current device to protect operator.***

The storage for more than 6 months is defined as "long-term storage".

To keep the long-term stored HVAC units well-conditioned follow these recommendations:

- Store the HVAC unit inside in dry, tempered (the temperature should be continuous) and low dust area off direct sunlight.
- Store the HVAC unit in original wooden crate.
- The connectors must be always closed with original covers recommended by connector's manufacturer.
- The grilles must be appropriately closed to secure the unit before insect or small animals.

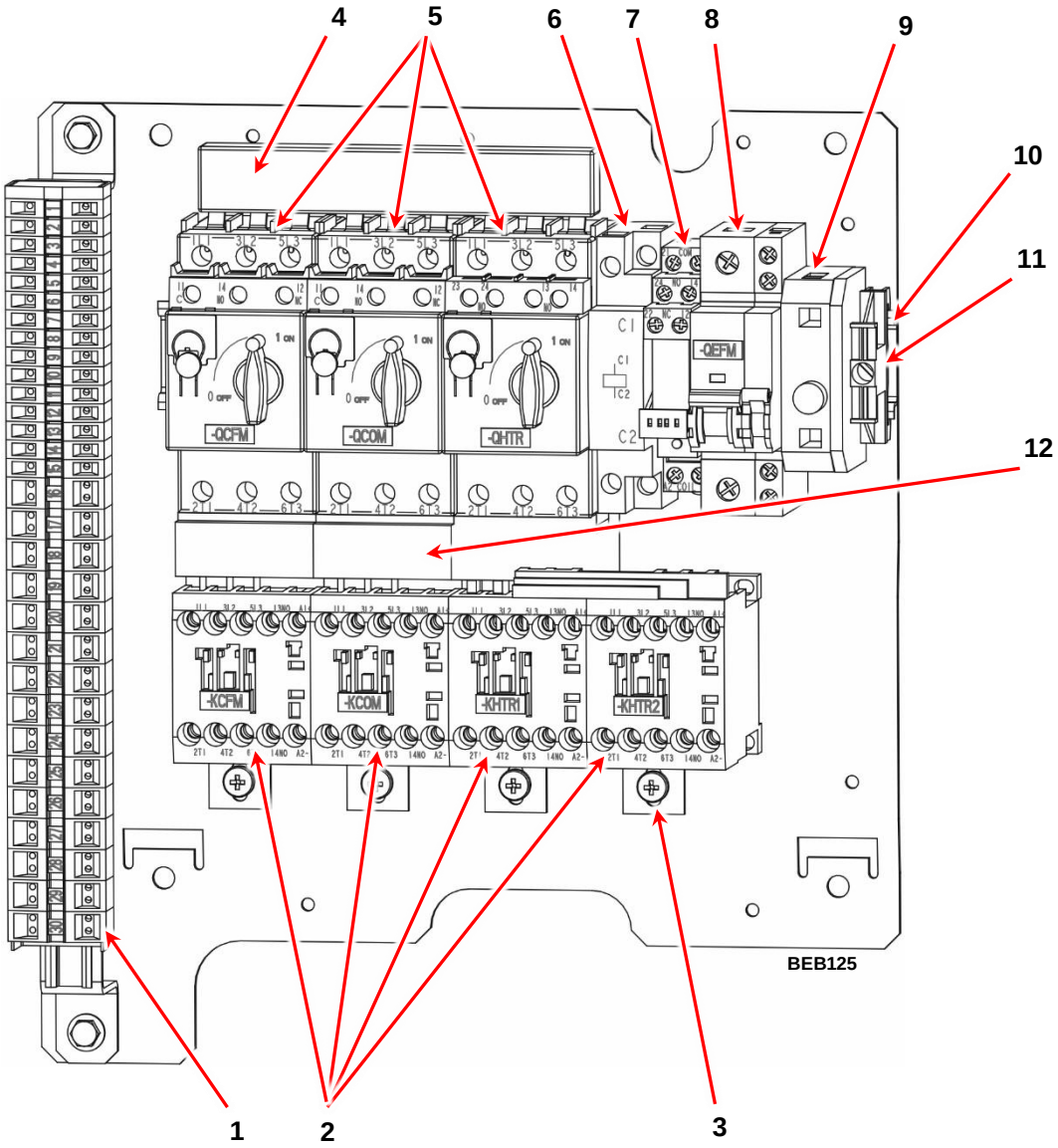
For operation after long-term storage do the following:

1. Uncover the unit.
2. Open all access covers such as evaporator and condenser (if applicable).
3. Ensure there are no debris or rodents.
4. Ensure that coils, pipes and harnesses are not damaged. Ensure there are no oil traces.
5. Close all covers.
6. Ensure all high voltage, low voltage and communication connectors are clear of dust, debris or rust.
7. Lift up the unit of the crate and inspect any under frame damage.
8. Before operating the unit ensure the condenser coils are clean.
9. Connect the unit (if applicable).
10. Operate the unit.
11. Check if alarm signal lamp does not shine.

## 9.7. Electrobox Component Replacement

### Preparation

1. Switch the unit/control system OFF, follow the steps in chapter 9.1.
2. Open the switchboard box (electro box) cover. Use appropriate key only!
3. Locate the non-functional/damaged part.

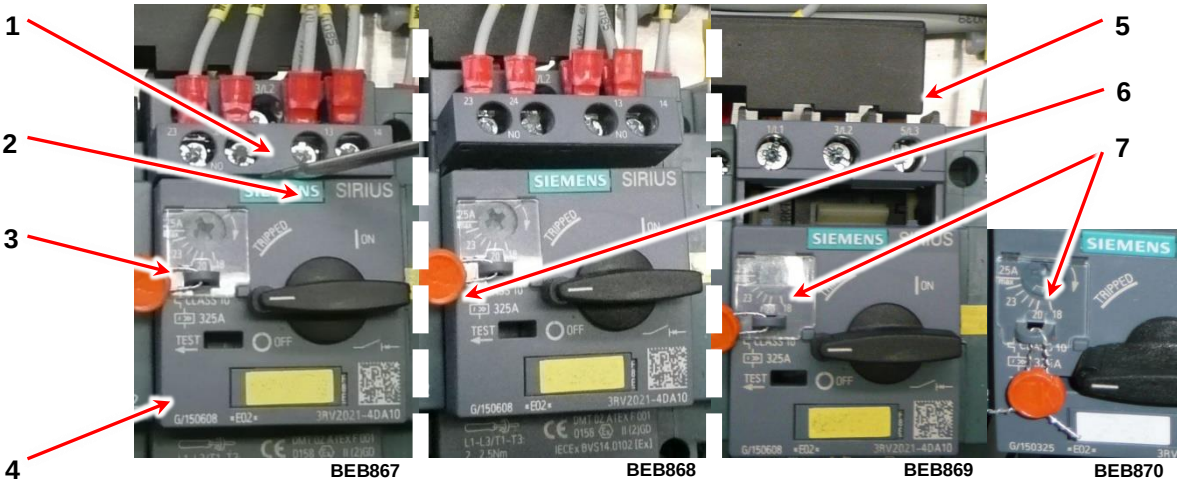



| | | | |
|---|---|---|---|
| 1 | Terminal block | 7 | Relay assembly |
| 2 | Contactors | 8 | Circuit breaker (1 phase) |
| 3 | Fixing screws | 9 | Fuse |
| 4 | Circuit breakers | 10 | DIN rail |
| 5 | Relay – Shunt-release | 11 | Clamp |
| 6 | | 12 | |

**Figure 32: Switchboard**

### 9.7.1. Circuit Breaker and Contactor Replacement

1. Remove the auxiliary contact from all the circuit breakers, use screwdriver for releasing. Insert the screwdriver into the gap between auxiliary contact and the circuit breaker and lightly extract.
2. Release screws and pull out the Busbar.
3. Release and remove push-in lugs (fixed with screw).
4. Disconnect wiring, release the screws on input/output side, and remove the wires from connection.




| | | | |
|---|---|---|---|
| 1 | Auxiliary contact | 5 | Busbar |
| 2 | Screwdriver | 6 | Seal |
| 3 | Transparent cover | 7 | Setting knob |
| 4 | Circuit breaker | | |

**Figure 33: Auxiliary Contact Installation (Example)**

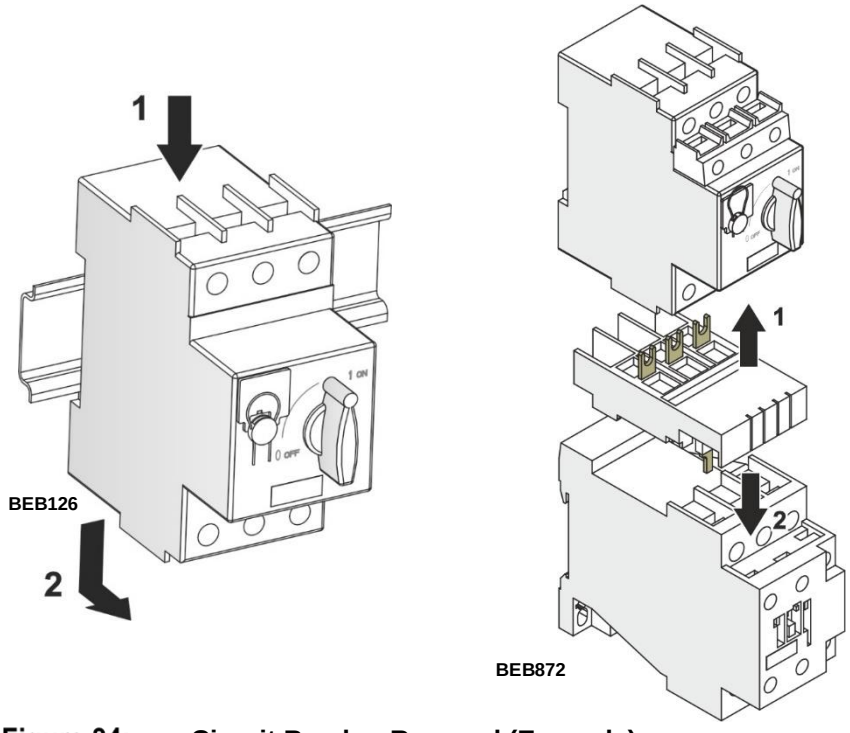



**Figure 34: Circuit Breaker Removal (Example)**

***NOTE: Releasing (not removing) of neighbouring parts, wiring and DIN-rail clamps can be helpful.***

5. Cut off the tie wraps from wiring where necessary.
6. The circuit breakers are mounted by snapping them onto 35 mm rails. To remove push down on the circuit breaker at first and then pull out/rotate/tilt the lower part with coupling element and contactor.
7. Release the screws in circuit breaker and contactor and pull out the circuit breaker and contactor from connectors of coupling element.
8. Check the electrical parameters of new parts carefully, set the load's rated current on the scale according to valid electrical diagram, use the setting knob.

***IMPORTANT: There are two possible setting marks on the adjusting knob, see "Figure 35: Circuit Breaker Adjusting Knob Position."***

- ***Dash marking: Setting mark for the motor starter protector in stand-alone design.***
- ***Triangular marking: Setting mark for the motor starter protector in side-by-side design.***

***IN OUR CASE YOU HAVE TO USE THE TRIANGULAR MARKING FOR SETTING!***

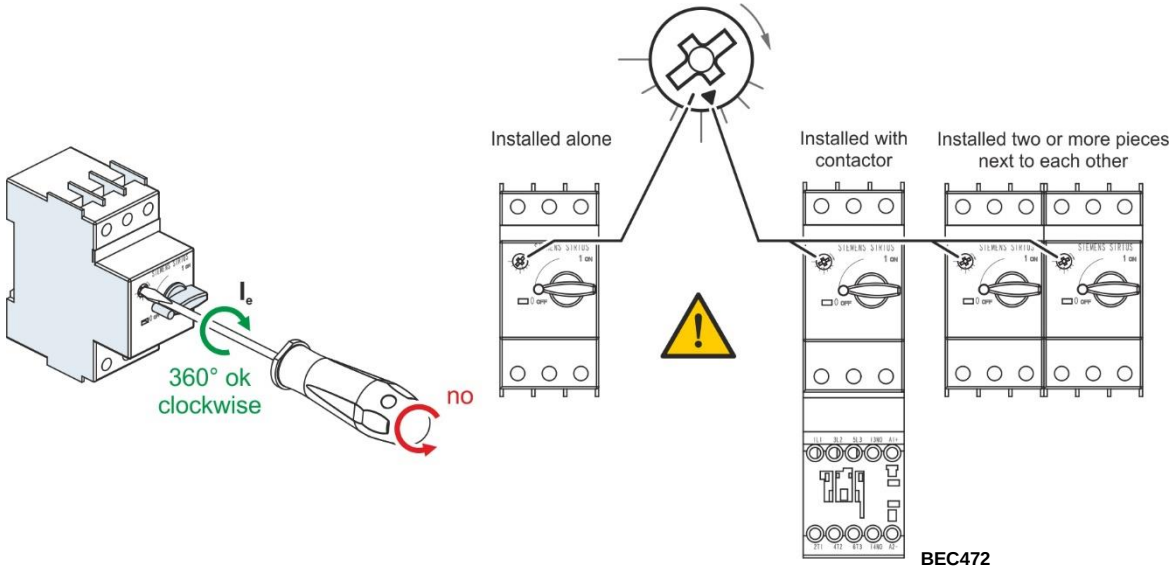


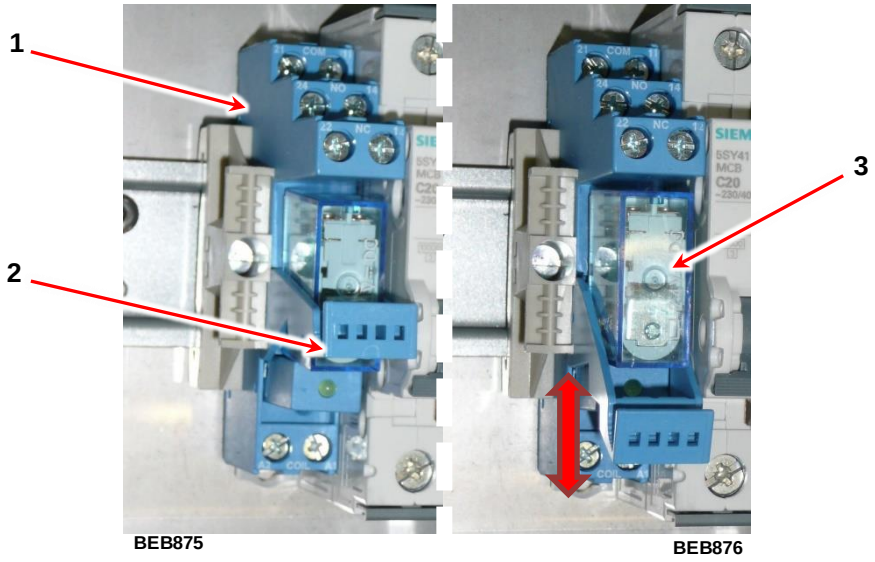

**Figure 35: Circuit Breaker Adjusting Knob Position**

9. Insert the transparent cover, secure it with the seal.
10. Assembly the coupling element, contactor and circuit breaker, fix with screws. Assure that all fixing screws are properly tightened.
11. Insert new assembly in upper rail side at first then push the lower part until the fixing teeth click.
12. Fix the pushing-lug with fixing screw. Use common sense and best practice for tightening.
13. Connect the wirings to the terminals, according valid electrical diagram, and fix the wires by all captive screws. Assure that all fixing screws are properly tightened.

14. Set the switch on body of circuit breaker to position "1" (ON).
15. Reinstall the Busbar, auxiliary contact in reverse order.
16. Fix all cables and wires with tie wraps, no loosen parts are acceptable.
17. Insert the electrobox cover and fix it with bolts.
18. Return the HVAC unit into service, see chapter 9.1 for more information.

### 9.7.2. Relay Replacement

1. Pull down the retainer clip and release the relay, remove the relay away from its socket.
2. Check the electrical parameters of new relay carefully according valid electrical diagram.
3. Insert new relay into original position. Push the relay into the socket.
4. Pull up the retainer clip, fix the relay.
5. Insert the electrobox cover and fix it with bolts.
6. Return the HVAC unit into service, see chapter 9.1 for more information.

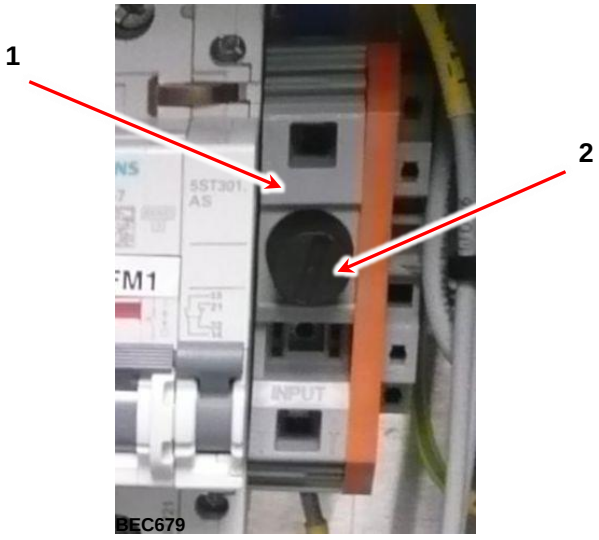



| | | | |
|---|---|---|---|
| 1 | Relay socket | 3 | Relay |
| 2 | Retainer clip | | |

**Figure 36: Relay Installation**

### 9.7.3. Fuse Replacement

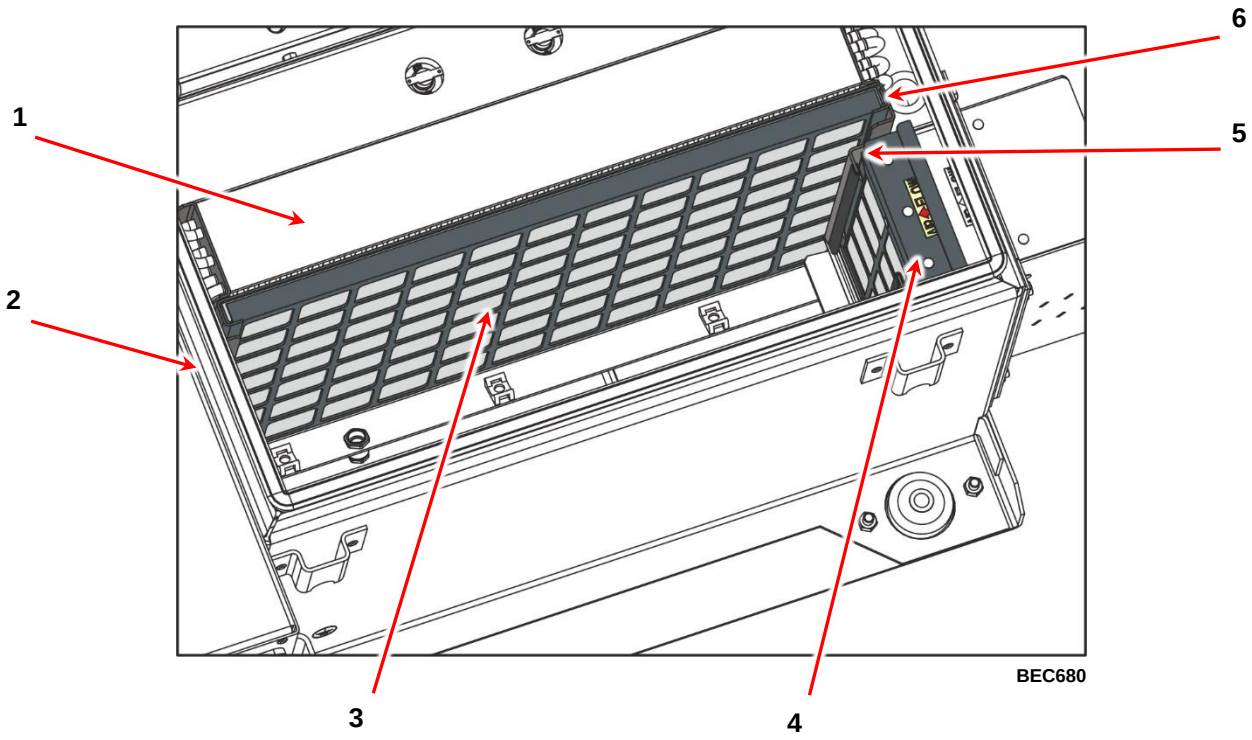
1. Unscrew the fuse cover.
2. Pull out the fuse.
3. Check the electrical parameters of new fuse carefully according valid electrical diagram.
4. Insert new fuse into fuse holder.
5. Screw the fuse cover.
6. Insert the electrobox cover and fix it with bolts.
7. Return the HVAC unit into service, see chapter 9.1 for more information.




| | | | |
|---|---|---|---|
| 1 | Fuse holder | 2 | Fuse cover |

**Figure 37: Fuse Installation**

## 9.8. Air Filters Replacement




| | | | |
|---|---|---|---|
| 1 | Evaporator compartment | 4 | Fresh air filter |
| 2 | Unit frame | 5 | Fresh air filter holder |
| 3 | Mixed air filter | 6 | Mixed air filter holder |

**Figure 38: Air Filters Installation**

### Procedure

1. Switch the unit/control system OFF.
2. Turn all power supply OFF, disconnect the XPOW and XLV1 connectors.
3. Open and fix the top cover. Use appropriate key only!
4. Locate the air filter and carefully pull the whole air filter out.
5. Install new filter medium.

   ***NOTE: Use care when removing dirty filters from the unit. Clean with vacuum cleaner any dirt, dust or foreign particles from air intake before installing of new filter.***

6. Put the filter back on its place.

   ***IMPORTANT: Used air filter medium waste disposal can be subject to local laws. Never mix the filter medium with household trash.***

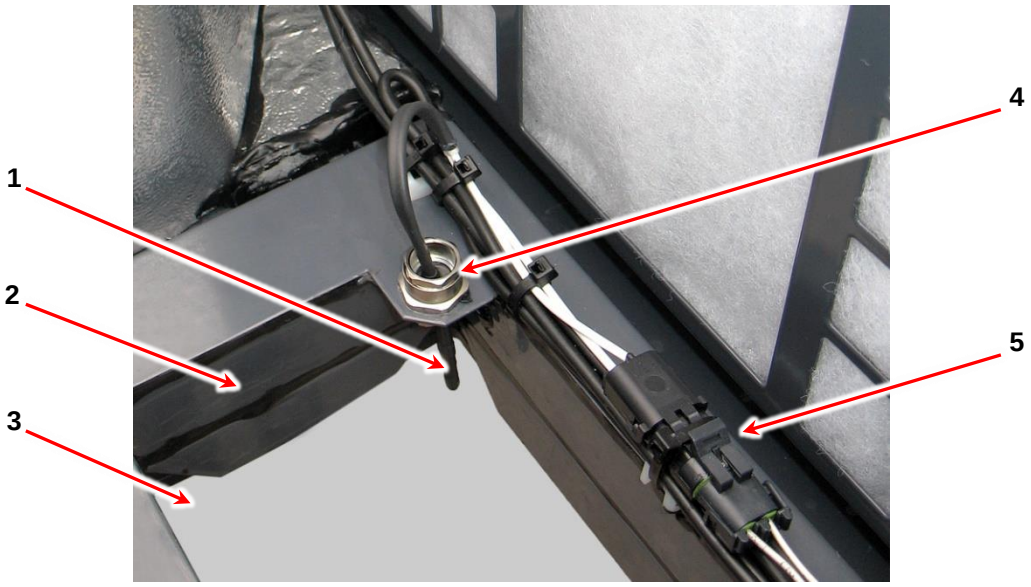
7. Close and secure the top cover with latches. Use appropriate key only!
8. Connect the XPOW and XLV1 connectors, restore the high voltage and low voltage power supply, switch ON control system.
9. Return the HVAC unit into service, see chapter 9.1 for more information.

## 9.9. Temperature Sensor Replacement

The RAC unit contains more temperature sensors:

- Ambient Air Temperature Sensor (ATS),
- Return Air Temperature Sensor (RTS),
- Coil Temperature Sensor (CTS).

***NOTE: Before replacement/installation check the parameters to be sure that a new sensor has appropriate features.***




| | | | |
|---|---|---|---|
| 1 | Temperature sensor | 4 | Temperature sensor connector |
| 2 | Unit frame | 5 | Bushing |
| 3 | Duct opening (return air channel) | | |

**Figure 39: Temperature Sensor Installation (Example)**

### Removal

1. Switch the unit/control system OFF.
2. Turn all power supply OFF, disconnect the XPOW and XLV1 connectors.
3. Open and fix the top cover. Use appropriate key only!
4. Locate the sensor:
   - ATS: in front of fresh air filter, on side of water eliminator box.
   - RTS: return air duct channel, in the corner of opening.
   - CTS: under thermostatic expansion valve and solenoid valve.
5. Locate and unplug proper sensor connector.
6. Release the bushing and remove the fixing binder when necessary, loose the cable, remove the sensor.

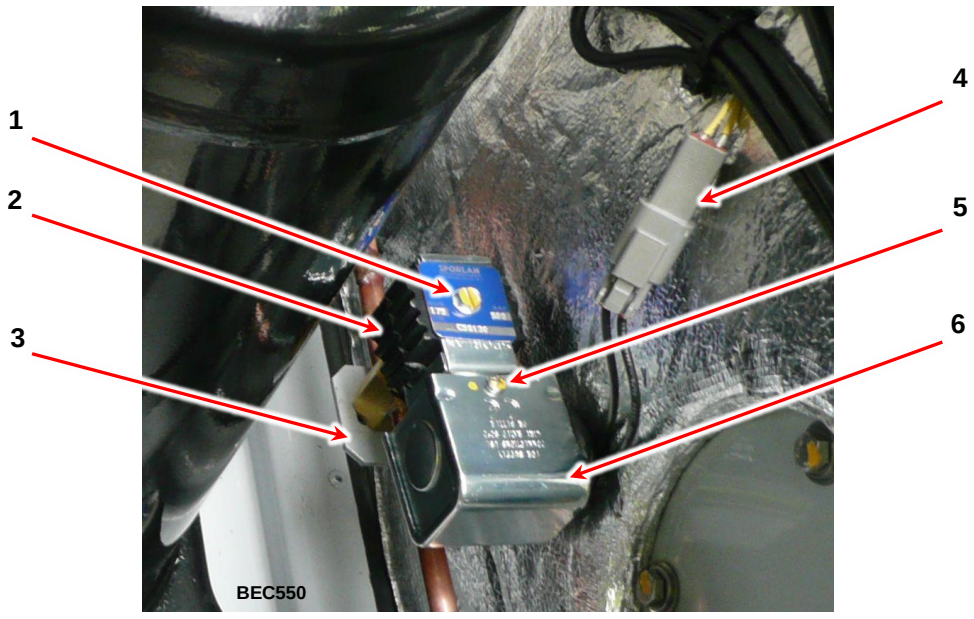
### Installation

1. Install and fix new sensor into original position, connect the sensor connector.
2. Tighten bushing and fix the cable with tie wraps where necessary.
3. Close and secure the top cover with latches. Use appropriate key only!
4. Connect the XPOW and XLV1 connectors.
5. Restore the high voltage and low voltage power supply, switch the control system ON.
6. Return the HVAC unit into service, see chapter 9.1 for more information.

## 9.10. Solenoid Coil Replacement

### Removal

1. Switch the unit/control system OFF.
2. Turn all power supply OFF, disconnect the XPOW and XLV1 connectors.
3. Open and fix the top cover. Use appropriate key only!
4. Locate the non-functional solenoid valve.
5. Disconnect solenoid valve connector.
6. Release bolt on top of solenoid valve cover, remove the cover.
7. Cut off the tie wraps from valve wiring where necessary.
8. Release bolt on top of valve/solenoid, remove the coil.




| | | | |
|---|---|---|---|
| 1 | Solenoid coil fixing bolt | 4 | Solenoid valve connector |
| 2 | Solenoid coil | 5 | Solenoid valve enclosure fixing bolt |
| 3 | Bracket | 6 | Solenoid valve enclosure |

**Figure 40: Solenoid Coil Installation**

9. Release bushing and disconnect wires from terminals in valve enclosure and disconnect diode as well, remove the solenoid coil out of unit.

### Installation

1. Reinstall the solenoid valve coil – simply push coils on the shaft, fix both solenoid coils with bolt on top of the valve. Use common sense and best practice for tightening.
2. Connect the wiring and diode to the coil terminals in solenoid valve enclosure according valid electrical diagram, tighten the bushing.
3. Properly attach and fix the bushing, fix terminal covers with fixing bolt.
4. Connect the solenoid valve connector.
5. Fix all cables and wires with tie wraps, no loosen parts are acceptable.
6. Close and secure the top cover with latches. Use appropriate key only!
7. Connect the XPOW and XLV1 connectors.
8. Restore the high voltage and low voltage power supply, switch the control system ON.
9. Return the HVAC unit into service, see chapter 9.1 for more information

# 10. Troubleshooting

## 10.1. Analysis Overview

Servicing a system consists of checking system pressures and temperatures. You should be familiar with the system you are working with.

| Condition | Possible Cause | Remedy |
|---|---|---|
| **HVAC system doesn't operate** | No power supply to unit | Locate fault and repair – check the power source, XPOW connector. |
| **(condenser fan, evaporator blower) doesn't operate – no amperage draw** | No output signal from controller | Check control circuit and controller circuit breakers. Diagnose and repair or replace wiring or controller. |
| | Rail car temperature does not demand cooling or ventilation | No action. |
| **Compressor does not operate – no amperage draw** | No power supply to unit | Locate fault and repair – check the compressor circuit breaker, contactor, terminals, motor. |
| | Open in low voltage control circuit | Check control circuit and controller circuit breakers. Repair as required. |
| | Rail car temperature does not demand cooling or ventilation | No action. |
| | No condenser fan output signal from control system | Diagnose and repair or replace control system or low voltage wiring. |
| | Defective compressor | Replace the compressor. |
| | No output signal from controller | Diagnose and repair or replace wiring or controller. |
| **Compressor does not operate properly; excessive amperage draw or intermittent cycling on overload** | Rotation scroll stuck<br>Seized or frozen compressor bearing | Replace the compressor. |
| | Improperly wired | Check / correct wiring in comparison with wiring diagram. |
| | Low line voltage | Check line voltage – determine location of voltage drop. |
| | Open circuit in compressor motor winding | Check motor stator connections or stator winding for continuity. If open, replace the compressor. |
| **Compressor contactor burned out** | Low line voltage | Increase line voltage at least 90% of compressor motor rating. |
| | Excessive line voltage | Reduce line voltage to at least 110% of compressor motor rating. |
| | Short cycling | Eliminate cause of short cycling. |

| Condition | Possible Cause | Remedy |
|---|---|---|
| **Compressor short cycles** | Low refrigerant charge | Locate and repair refrigerant leak. Recharge with the refrigerant. |
| | Restricted solenoid valve or expansion valve | Clean or replace faulty valve. |
| **Noisy compressor** | Loose fixing bolts/nuts | Tighten bolts/nuts. |
| | Damaged isolator(s) | Check, fix or replace the isolator(s). |
| | Refrigerant flooding back | Check the expansion valve adjustment. |
| | Scroll rotating backwards | Check phases of power supply and the compressor wiring. |
| | Faulty compressor | Repair or replace the compressor. |
| **Condenser fan doesn't operate** | Loose line connection | Tighten connections. |
| | No condenser fan output signal from control system | Diagnose and repair or replace control system or low voltage wiring. |
| | Defective fan motor | Replace fan assembly. |
| **Evaporator blower motor does not operate** | Loose line connection | Tighten connections. |
| | No evaporator blower output signal from control system | Diagnose and repair or replace control system or low voltage wiring. |
| | Defective motor | Replace the motor. |
| **Rail car temperature too high (unit not cooling)** | Compressor does not operate | See section “Compressor does not operate” on page 76. |
| | Shortage of refrigerant | Repair leak and recharge the refrigerant circuit. |
| | Air in refrigeration system | Evacuate and recharge the refrigeration circuit. |
| | Iced or dirty evaporator coil | Defrost or clean the evaporator coil. |
| | Restricted lines on high pressure side | Check for clogged or restricted solenoid valve. Remove the restriction, clean, repair the refrigerant line, recharge the refrigerant circuit. |
| | Plugged filter-drier | Change the filter-drier. |
| | Condenser coil dirty or airflow restricted | Clean condenser coil, remove restriction, or repair or replace condenser fan assembly. |
| | | Adjust or replace expansion valve. |

| Condition | Possible Cause | Remedy |
|---|---|---|
| | Expansion valve open too much | Replace expansion valve sensor bulb (power element). |
| | Expansion valve sensor bulb (power element) lost its charge | Correct the sensor bulb (power element) installation. |
| | Expansion valve sensor bulb (power element) improperly mounted | Correct the sensor bulb (power element) insulation. |
| | Expansion valve sensor bulb (power element) poorly insulated or making poor contact | |
| **Rail car temperature too low** | Heater does not operate | The limits switch open, correct the cause. Check or reset corresponding circuit breaker. |
| | No power supply to heater | Tighten the connections, correct the wiring (see Diagrams in Appendix). |
| | | Check the second step limit switch and corresponding circuit breaker. |
| | | Check the dead-man switch. |
| | No heater output signal from controller | Repair/replace the wiring or the controller. Check dead-man switch. |
| | Defective heater | Replace the heater if defective. |
| | Restricted air flow | Clean the parts as required. |
| **Frosted liquid line** | Restricted filter-drier | Replace filter-drier. |
| **Frosted or sweating suction line** | Expansion valve admitting excess refrigerant | Check the feeler bulb, adjust expansion valve if necessary. |
| | Iced or dirty evaporator coil | Defrost or clean evaporator coil. |
| | Evaporator blower does not operate | See “Evaporator blower motor does not operate” on page 77. |
| **Unit in vacuum. Frost on expansion valve only** | Ice plugging expansion valve orifice | Apply hot wet cloth to the expansion valve. Moisture indicated by increase in suction pressure. Replace the dehydrator. |
| **Compressor loses oil** | Refrigerant leak | Repair leak and recharge the HVAC system with refrigerant. |
| **Compressor oil migrates** | Short cycling | See “Compressor short cycles” on page 77. |

# 11. Refrigeration Repairs

## 11.1. Introduction

***CAUTION: Safety first! Always respect safety rules, follow "Safety Precautions", respect valid local laws and general Health & Safety prescripts.***

***WARNING: Make sure that HVAC unit and/or vehicle cannot start while servicing the system.***

***CAUTION: Always use protective gloves when open the unit covers, the fins of condenser and evaporator coil can be very sharp!***

Thermo King reserves the right to deny warranty coverage on claims due to lack of maintenance or neglect. Claims in question must be supported by maintenance records.

If you are not really experienced in following actions please call for help Thermo King Service Centre otherwise is here risk of damage or complications. The main repair procedures can be carried out in specialized workshop only with trained and highly experienced technicians. In case of any question or unclear situation please contact your supplier or directly Thermo King Manufacturer.

***NOTE: When removing any panels from the HVAC unit, if you remove any sealant or tie wraps, these MUST be applied back, otherwise, you may void your warranty.***

Before starting the replacement procedure, use most up-to-dated Parts Manual or Stocking Guide to identify the correct spare part suitable for your unit.

### BEFORE ANY SERVICE ACTIVITY STOP THE HVAC UNIT OPERATION WITH:

1. ON/OFF button on driver panel.
2. Turn all the power supply OFF.
3. Disconnection of all electrical connectors.

***WARNING: The electrical disconnection is allowed only if all the power supply cables are without voltage!***

### WHEN THE LAST SERVICE ACTIVITY IS FINISHED:

1. Check the HVAC unit top cover, check if all locking elements are at a proper position.
2. Connect all electrical connectors, check the proper connection.
3. Turn the power supply ON.
4. Enable the unit operation with ON/OFF button on driver panel.
5. Check the HVAC system functionality, see chapter 8.4.4.

## 11.2. Refrigeration System Fundamentals

### 11.2.1. Introduction

Some these service procedures on the refrigeration system (refrigeration circuit) can be regulated by Federal, State or Local laws. Please check the situation and coordinate all the actions with this regulations and Health & Safety rules.

All regulated refrigeration service procedures must be performed by an EPA certified technician, using approved equipment and complying with all Federal, State and Local laws.

> ***IMPORTANT: On R-407C refrigerant:***
>
> ***When charging the system, always charge from liquid side and use the refrigerant in a liquid state. Do not charge vapour in the system!***
>
> ***As R-407C is a blend of three refrigerant of different density, any major leak will imbalance the ratio, Thermo King recommends always replace the whole (remaining) refrigerant and recycle the retrieved portion properly per governing laws. Then use new refrigeration charge by correct recommended weight in liquid state. In case of leak do not "top off" the refrigeration system.***

#### Basic steps in case of troubles with refrigeration system:

1. Recovery (disposal) of remaining refrigerant
   - Vapour recovery
   - Liquid recovery
2. Leak Test – identification, location of point of trouble
3. Repair & Check
4. Evacuation
   - System preparation and hookup
   - Evacuation
   - Pressure rise test
5. Charging
6. Functional test of system

#### General information

If refrigerant has leaked or been removed from the system, check entire system for possible component damage and refrigerant oil loss.

If any system leak or damage was found, repair the system, recheck the system after repair and conduct system evacuation.

If the system has some remaining pressure (some refrigerant is present in the system), and the leak is NOT found, using a leak detector is recommended. Soap and bubbles is the best tool to check minute leaks that the electronic leak detectors cannot find.

If the leak is already found and the system is almost flat (empty), we recommend evacuating the system AFTER the repair is done (for example after tightening a fitting).

After any repair we recommend to execute the Leak Test to be sure that system is tight.

As the oil used in R-407C scroll compressor is very viscous, rarely an oil charge would be lost. If this happens, the compressor would have failed already and it that case we recommend replacing the compressor (or two compressors in sets of 2, depending on unit design), charging the proper oil charge for new compressor(s) and do the evacuation and charging procedures described further. After compressor(s) replacements recheck the system again.

It is generally good practice to replace the filter-drier whenever the system is opened and exposed to ambient for an extended period of time.

IF THERE IS A SUSPICION OF BIG LEAK, IT IS RECOMMENDED THE WHOLE CHARGE IS RETRIEVED (REMOVED) AND A NEW CHARGE IS PLACED INTO THE SYSTEM AFTER PERFORMING THE EVACUATION AND CLEANUP STEPS – SEE IMPORTANT NOTE ABOVE.

In the following text are procedures usually described by using of Thermo King evacuation station. Always follow the safety instructions, procedures and working instructions in specific equipment manufacturer's documentation.

### 11.2.2. Refrigeration Service Tools

***CAUTION: When servicing Thermo King R-407C refrigeration systems, use only service tools (i.e., vacuum pump, refrigerant recovery equipment, gauge hoses, and gauge manifold set) certified for and dedicated to R-407C refrigerant and Polyol Ester based compressor oils. Residual non-HFC refrigerants or non-Ester based oils will contaminate HFC systems.***

#### Unit Service Fittings

The unit uses a hermetically sealed refrigeration system. If you need to recover the refrigerant charge, you must use the appropriate fittings to connection on service (access) ports (if no service (access) ports are present then fittings under low (LPCO) or high (HPCO) pressure switches can be used). Install the service fittings on the suction line and discharge line process tubes located in the compressor compartment.

#### Manifold Gauge Set and Hoses

Use a manifold gauge set and hoses dedicated for use with R-407C only.

#### Evacuation Station

A key element in maintaining high efficiency and low maintenance cost in a transport refrigeration system is the ability to keep the system free of moisture and non-condensable materials. Contaminants and moisture are best removed by a vacuum system.

The Thermo King Evacuation Station TK 204-725 has been designed to efficiently evacuate the refrigeration system for all Thermo King products.

#### Vacuum Pump

Use a two-stage (for example TK 204-713 or TK 204-699) or any other or more-stage pump from respective manufacturer for the evacuation. Because residual refrigerant may be present in used pump, a new vacuum pump should be used and dedicated strictly as an R-407C refrigerant pump.

Use only recommended vacuum pump oils and change oil after every major evacuation.

Because vacuum pump oils are highly refined to obtain low vacuums, failure to follow these recommendations may result in acidic conditions that will destroy the pump.

### System Cleanup Devices

Use cleanup devices such as suction line filters if they are properly cleaned with new filters and cartridges.

### Refrigerant Recovery

Use only refrigerant recovery equipment approved for and dedicated to R-407C recovery.

### Compressor Oil Acid Test

Perform an oil acid test (oil test kit TK203-457) whenever a system has a substantial refrigerant loss, a noisy compressor, or dark/dirty oil – see chapter „Compressor Oil Colour Code“.

## 11.2.3. Contamination

When contaminants have entered the system, a thorough cleanup is required to prevent damage or loss of compressor. The purpose of evacuation is to remove moisture and air from the refrigeration system. Even small quantities of air or moisture in a system can cause severe problems.

The presence of moisture, oxygen, and heat under certain conditions can result in many forms of drainage. Corrosion, sludge, copper plating, oil breakdown, carbon formation, and eventual compressor failure can be caused by these contaminants. Things that will contaminate a system are (in order of importance):

- Air (oxygen as a contaminant). Oxygen in the air reacts with the oil. The oil begins to break down and can eventually lead to carbonization in the compressor and acid buildup. The longer this breakdown process goes on, the darker the compressor oil becomes until finally the colour is black, indicating major system contamination. Contamination occurs on the suction line.
- Moisture. Moisture in a system will cause metal corrosion and metal plating. It can freeze in the expansion valve and cause intermittent operational problems. It reacts in the oil to begin acid buildup.
- Dirt, dust, metal particles, other foreign materials. Particles in the system will cause severe damage to all close tolerance items. Do not leave a system open to the infiltration of dirt. If you must open a system for any reason, seal off the open areas as soon as possible. Do not work in a dirty environment.
- Acid. Air and moisture cause a chemical breakdown of the oil and the refrigerant. The acid will accelerate the deterioration of the softer metals (i.e., copper) and cause metal plating as the softer material begins to cover the inside of the system. This condition can result in the total destruction of your equipment.

**IF ANY OF THE ABOVE CONDITIONS ARE PRESENT PLEASE RECYCLE THE REFRIGERANT AND PERFORM A REFRIGERATION SYSTEM CLEANUP – USE A NEW REFRIGERANT THAT HAS NOT BEEN CONTAMINATED.**

### 11.2.4. Compressor Oil Color Code

When unusual colour of oil is detected or presence of moisture is signalized by moisture indicator then perform a compressor oil acid test.

- Black oil indicates carbonization caused by air in the system.
- Brown oil indicates copper plating caused by moisture in the system.
- Gray or metallic oil indicates bearing wear or piston scoring.

**IF THE COMPRESSOR OIL SHOWS AN ACID CONDITION, CHANGE THE OIL, THE IN-LINE OIL FILTER, THE FILTER-DRIER, AND PERFORM A REFRIGERATION SYSTEM CLEANUP.**

### 11.2.5. Refrigerant Recovery

***CAUTION: Use only refrigerant recovery equipment approved for and dedicated to R-407C recovery.***

It is recommended the whole charge is retrieved and a new charge is placed into the system after performing the leak and evacuation steps.

When removing refrigerant from a Thermo King refrigeration system, use a recovery process that prevents or absolutely minimizes the refrigerant that can escape to the atmosphere. Typical service procedures that require removal of refrigerant from the system include:

- Reducing the refrigerant pressure to a safe working level when maintenance must be performed on high-pressure side components.
- Emptying the system of refrigerant when an unknown amount of charge is in the system and a proper charge is required.
- Emptying the system of contaminated refrigerant when the system has become contaminated.

#### Procedure

1. Locate the service (access) ports on high-pressure side (compressor output pipe) and low pressure side (compressor input line).
2. Carefully remove the caps from ports. If no service (access) ports are present then fittings under pressure switches can be used.
3. Install a gauge manifold low pressure line to the service (access) ports on low pressure side (suction line – compressor input pipe).
4. Attach the gauge manifold high pressure line to the service (access) ports on high pressure side (discharge line – compressor output pipe).
5. Attach the service line to the recovery station.
6. Purge the lines.

#### Vapor Recovery

1. Install a gauge manifold on the system. Attach the service line to the recovery machine and purge the lines. Set the recovery machine for vapour recovery.
2. Keep the HVAC system OFF.
3. Turn ON the recovery machine and open both gauge manifold and hand valves. Continue to operate the recovery machine until the system pressure drops to 0 kPa (0 bar, 0 psig) pressure. Follow the liquid recovery instruction in next section.

### Liquid Recovery

1. Switch ON and operate the system to build discharge pressures to approx.1380 kPa (200 psig).
2. Stop the refrigeration system. Set the recovery station for liquid recovery and turn the recovery station on.
3. Open (back seat) the manifold gauge high pressure hand valve.
4. Operate the recovery machine until the system pressures reach approximately 0 kPa (0 bar, 0 psig).
5. Close the manifold gauge valves, stop the recovery station and disconnect the lines.

## 11.2.6. Using Pressurized Nitrogen

The dehydration, pressure testing, purging and soldering can be accomplished with the use of dry nitrogen ($N_2$). The proper equipment and application of equipment is of greatest importance. Always use the correct equipment in the correct way to ensure safety.

***WARNING: Nitrogen ($N_2$) in the standard gas bottle is under high pressure (20 MPa at filling, full cylinder at 15 °C, for example).***

***WARNING: The improper use of high pressure cylinders can cause a physical damage to components, or personal injury, or cause stress that would lead to failure of components.***

***WARNING: Do not use Oxygen ($O_2$), acetylene, or any other pressurized gas on refrigeration systems or any component of a system.***

## 11.2.7. Refrigerant Leak Test Procedure

Use a reliable Halogen leak detector to leak test the refrigeration system. Inspect carefully for signs of compressor oil leakage, which is the first sign of a leak in the refrigeration system.

***NOTE: Due to environmental concerns and personal safety, the use of a Halide torch is no longer recommended.***

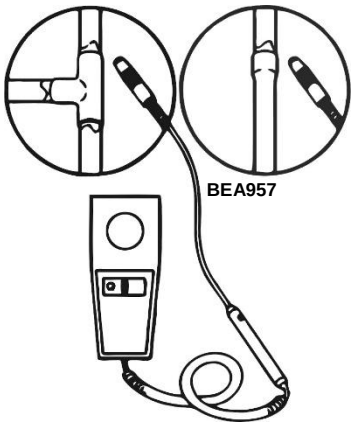



**Figure 41: Testing for Refrigeration Leaks**

### Procedure

1. Locate the service (access) ports on high pressure side (the compressor output pipe) and low

pressure side (the compressor input line). Carefully remove the caps from the ports. If no service (access) ports are present then fittings under pressure switches can be used.

2. Attach the gauge manifold compound gauge line to the port on low pressure side. Attach the high pressure gauge line to the port on high pressure side.
3. Attach the refrigerant bottle charging hose to the centre of manifold gauge set. Purge the charging hose of air.
4. Connect the charging hose to the source of nitrogen, carefully follow the safety precautions!
5. Pressurize the system with nitrogen until 345 kPa (3.45 bar) vapour pressure is achieved.
6. Close both hand valves on the manifold gauge.
7. Close the supply valve on the nitrogen bottle.

***CAUTION: Nitrogen is under 15,170 kPa (151.70 bar) pressure in a full cylinder at 21 °C. Do not use oxygen, acetylene, or any other type of pressurized gas in the system.***

8. Disconnect the refrigerant charging hose.
9. Check the refrigeration system with the electronic leak detector to inspect all joints and connections. Use a soap solution as an alternative test.
10. Release pressure and reclaim nitrogen back from system.

### 11.2.8. Evacuation

Before performing an evacuation be sure that you have conducted the leak check and the system is repaired and no leaks are found.

### System Preparation and Connecting to Evacuation Station

***CAUTION: Do not evacuate a system until you are certain that the system is leak free. A system with less than a full charge of refrigerant should be thoroughly leak tested. Leaks found must be repaired.***

1. Recover refrigerant from the system and reduce the system pressure to the proper level, follow the evacuation station manufacturer's instructions.
2. Break vacuum with refrigerant and equalize system pressure to 0 kPa (0 bar, 0 psig).
3. Replace the liquid line filter-drier (dehydrator) in refrigeration system.
4. Confirm that the evacuation station functions properly and determine “Blank Off” Pressure.

   ***The Blank Off pressure of the vacuum pump is the deepest vacuum that the vacuum pump can attain when isolated from the rest of the system. If a vacuum pump (isolated from a system) is started and the micron meter responds quickly by going to a deep vacuum, the operator can be confident that the pump and oil are in good condition. If the vacuum pump fails to reach a deep vacuum within 5 minutes, the operator should suspect the condition of the oil or the pump. It is recommended that the pump oil be changed first to see if the rate of reaching a deep vacuum is improved.***

5. Connect the evacuation station and refrigerant tank with manifold gauge set (optional) to the

system as indicated in example on the "Figure 42: Evacuation Station and Unit Hookup". Connect evacuation hoses to the fittings (service access ports) installed on the suction line and liquid line – see high pressure side (compressor output pipe) and low pressure side (discharge line – compressor output pipe). If no service (access) ports are present then fittings under low (LPCO) or high (HPCO) pressure switches can be used.

6. Open evacuation station valves (V1, V3) and valve(s) on gauge manifold. It is only necessary to open valve V2 when a reading on the micron meter is desired.
7. Open the vacuum pump „Iso Valve“ isolating the pump from refrigeration system. It is recommended that the valve be kept open at all times.
8. If connecting a refrigerant tank and gauge manifold to the evacuation station, close the manifold gauge and refrigerant tank valves to prevent refrigerant from being drawn from the tank.

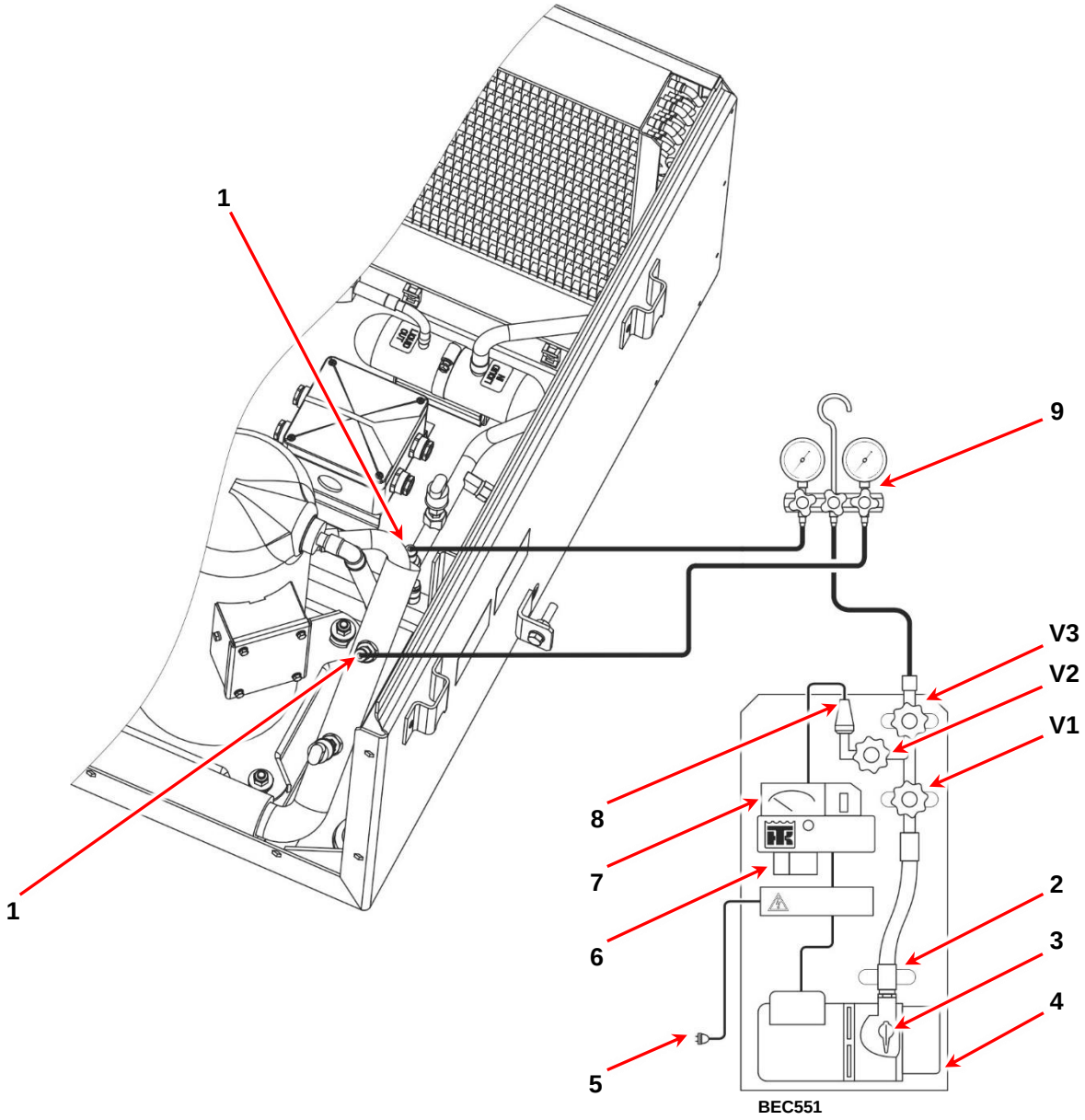
## System Evacuation

1. Turn ON the vacuum pump. Open the gas ballast valve located on top of the pump housing behind the handle (the valve is fully open at two turns counter clockwise). Evacuate the system to 500 microns to achieve a final equilibrium pressure of 2000 microns or less. The final equilibrium pressure is determined with the Thermo King Evacuation Station using the following procedure (called a pressure-rise test):
   a. Evacuate the system using the evacuation station until the vacuum level reaches 1000 microns. Then close the gas ballast valve.
   b. Continue evacuation to 500 microns or until vacuum stabilizes at its lowest level. Contamination may delay reaching the lowest level for a period of several or more hours.
   c. Close valve to isolate the vacuum pump from the system.
   d. Observe the vacuum level on the micron meter. When the meter has stabilized, the value indicated on the micron meter is the equilibrium pressure. This reading must be 2000 microns or less.

***NOTE: The presence of refrigerant in the compressor oil may prevent a low vacuum reading from being achieved. Compressor oil can continue to outages for long periods of time.***

2. If the vacuum level appears to stall above 500 microns, back seat the discharge service valve and observe the micron meter.
3. Close valve V1 when the desired vacuum level has been reached.
4. Wait five minutes and then read the micron meter.
5. If the vacuum level remained below 2000 microns for five minutes, the system is ready to charge.
   a. A system that is leak free and dry will remain below 2000 microns for five minutes.
   b. A system that rises above 2000 microns but stabilizes below atmospheric pressure is probably contaminated with moisture or has refrigerant outgassing from the compressor oil. Additional evacuation is required.
   c. A drop in pressure indicates that the compressor oil is out-gassing and further evacuation is necessary.
   d. An increase in pressure indicates that a leak exists or there is moisture in the system. Perform a “Pressure Rise Test” and evaluate.

A system that continues to rise without stabilizing has a leak and must be repaired.



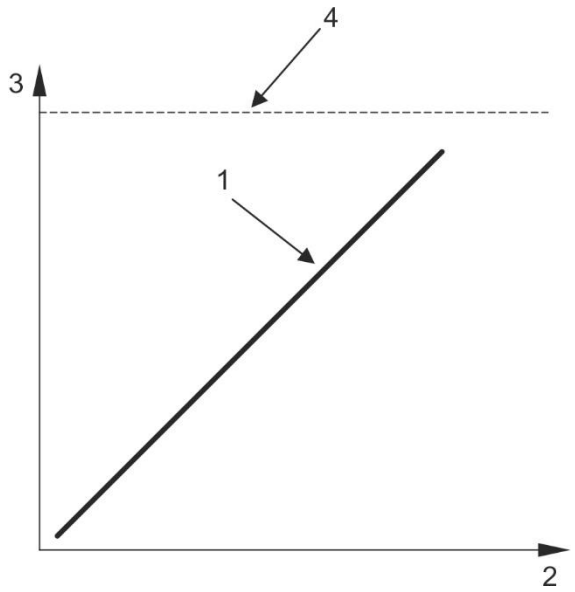

| | | | |
|---|---|---|---|
| 1 | Service connection ports | 6 | Calibration Standard |
| 2 | Gas ballast valve | 7 | Micron Meter |
| 3 | ISO valve | 8 | Sensor |
| 4 | Two stage vacuum pump | 9 | Manifold gauge |
| 5 | To electricity | Vx | Hand valves |

**Figure 42: Evacuation Station and Unit Hookup**

## Pressure Rise Test

Evacuate the system and close valve V1. With valves V3 and V2 open, the pump is isolated and the system is held under a vacuum. If the micron meter rises, one of the following conditions exists.

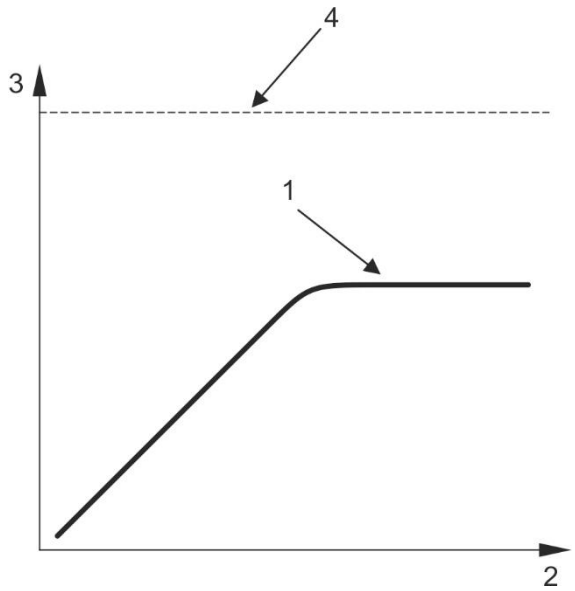
- Leak: Watch the movement of the micron meter needle indicating pressure level. If the needle continues to rise (the pressure in system increase) until it reaches atmospheric pressure, it is an indication that a leak exists somewhere in the system. When a leak is in a system, the vacuum will eventually stabilize at atmospheric pressure.




| | |
|---|---|
| 1 | Constant pressure rise indicates leak |
| 2 | Time axis |
| 3 | Pressure (vacuum) axis |
| 4 | Atmospheric pressure level |

**Figure 43: Constant Pressure Rise After Evacuation**

- Moisture: When the pressure rise and then stabilizes at a level below atmospheric pressure, this indicates that the system is vacuum tight, but is still wet and requires additional dehydration and evacuation time.




| | |
|---|---|
| 1 | Pressure rise that levels off indicates moisture in refrigeration system |
| 2 | Time axis |
| 3 | Pressure (vacuum) axis |
| 4 | Atmospheric pressure level |

**Figure 44: Pressure Rise that Levels Off After Evacuation**

### Factors Affecting the Speed of System Evacuation

The time required to evacuate a system varies. Factors that influence evacuation time are:

- System size.
- Amount of moisture contained in the system.
- Ambient temperature.
- Internal restrictions within the system.
- External restrictions between the system and the vacuum pump.
- Hose diameter and length. Laboratory tests show that the evacuation time can be significantly reduced by larger diameter hoses and shorter hoses. To obtain optimum pumping speed, keep hoses as short as possible and as large in diameter as possible.

### Heat Saves Time

Applying heat to a system decreases evacuation time. Increasing the temperature of the compressor oil and refrigerant speeds up the vaporization of any water presents in the system. Heat lamps, electric heaters, and fans can be applied to the compressor crankcase and other parts of the system to increase the temperature of the refrigerant and compressor oil.

***WARNING: Do not use a torch or other concentrated heat source to heat the compressor or other refrigeration system component.***

### End of Evacuation Process

1. Close the valve(s) on gauge manifold.
2. Open the gas ballast valve (located on top of the pump housing behind the handle).
3. Stop the vacuum pump.

## 11.2.9. System Charging from an Evacuated Condition

***IMPORTANT: On R-407C refrigerant:***

***When charging the system, always charge from liquid side and use the refrigerant in a liquid state. Do not charge vapour in the system!***

***In case of leak do not "top off" the refrigeration system. Always reclaim all remaining charge (and send it to special recycling stores) and use new refrigeration charge by correct recommended weight in liquid state.***

### Procedure

1. Connect the charging hose to the port on high pressure side (on liquid line, near high pressure cutout switch, HPCO). If no service (access) port is present then fitting under high (HPCO) pressure switch can be used.
2. Charge the proper amount of liquid R407C into system, for example by using a „push/pull" reclaim unit. For amount of the R-407C refrigerant see chapter 6 refer to HVAC system.
3. Close the refrigerant tank valve when the correct amount (by weight) of refrigerant has been added.
4. Remove charging hose and reinstall caps on service (access) ports (or high pressure cutout HPCO valve if necessary). Check these connecting points with an electronic leak detector.
5. Perform a system functional check out.

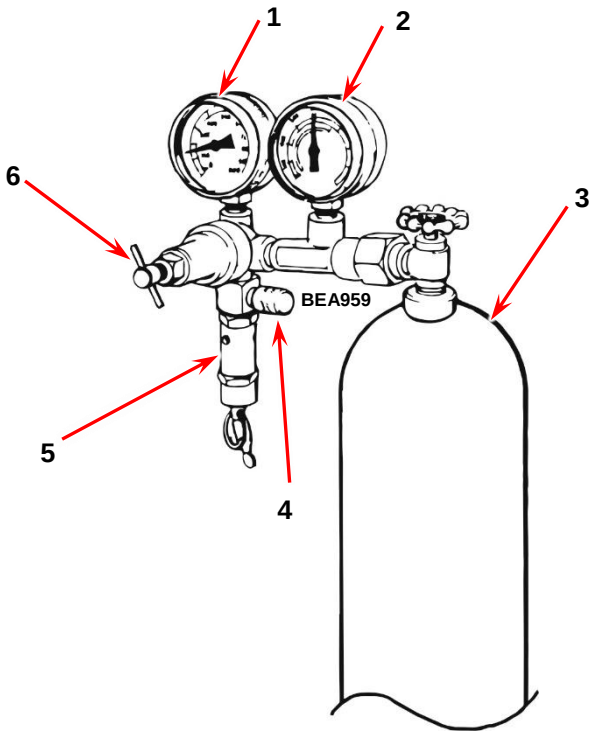
## Safety Precautions

Observe the proper handling of cylinders:

- Keep protective cap on cylinder when not in use.
- Secure cylinder in proper storage area or fastened to cart.
- Do not expose to excessive heat or direct sun light.
- Do not drop, dent, or damage cylinder.
- Use a pressure regulator and a safety pressure relief valve as part of the pressure testing equipment. The safety pressure relief valve should be the non- adjustable, non-tempering type. The valve should bypass any time the pressure exceeds its setting.
- Open valve slowly. Use regulators and safety valves that are in good working order.
- The regulator should have two gauges: one to read tank pressure, the other to read line pressure. Properly maintained equipment will allow leak testing, purging, and dehydration to be done safely.

***WARNING: All here described procedures should utilize the following MAXIMUM gas pressure:***

| | |
|---|---|
| ***Leak Testing:*** | ***1034 to 1200 kPa*** |
| ***Purging/Dehydration:*** | ***69 to 138 kPa*** |
| ***Soldering:*** | ***35 kPa*** |




| | | | |
|---|---|---|---|
| 1 | Line pressure | 4 | Pressure test line to system |
| 2 | Tank pressure | 5 | Safety valve |
| 3 | Tank | 6 | Pressure regulator |

**Figure 45: Typical Pressurized Gas Bottle with Pressure Regulator and Gauges**

## Procedure

1. Attach a gauge manifold. Close both hand valves on the gauge manifold.
2. Connect charging hose to nitrogen source. Adjust the pressure regulator to the proper pressure for the required procedure.
3. Purge system high side to low side.

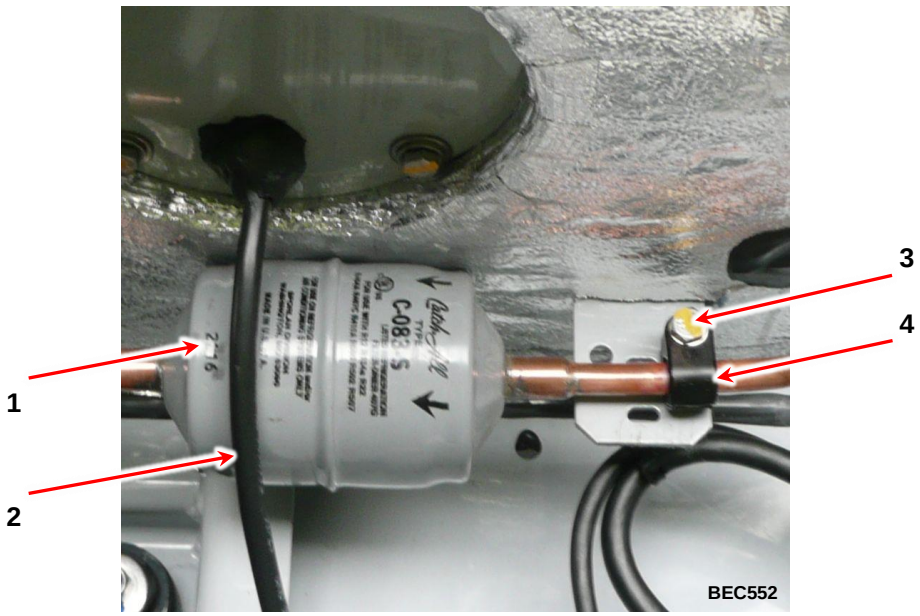
***NOTE: The specification of nitrogen technical gas should follow these parameters:***

| | | |
|---|---|---|
| ***Cleanness:*** | ***$N_2$*** | ***99,999 % or better*** |
| ***Admixtures:*** | ***$O_2$*** | ***3 ppm or less*** |
| | ***$H_2O$*** | ***5 ppm or less*** |
| | ***$C_nH_m$*** | ***5 ppm or less*** |

## 11.3. Filter-Drier Replacement

### Removal

1. Switch the unit/control system OFF.
2. Turn all power supply OFF, disconnect the XPOW and XLV1 connectors.
3. Open and fix the top cover. Use appropriate key only!
4. Recover the refrigerant from the system. See chapter 11.2.5.
5. Release and remove the fixing clamp.
6. Unsolder the inlet/outlet cartridge pipes, use a guard to protect other parts against damage from applied heat during this process (wet cloth can be also effective).
7. Remove the old filter-drier cartridge.




| | | | |
|---|---|---|---|
| 1 | Filter-drier | 3 | Fixing clamp screw |
| 2 | Blower motor power cable | 4 | Fixing clamp |

**Figure 46: Filter-drier Installation**

### Installation

1. Clean connection fittings, remove the protective plugs from the new filter-drier.
2. Align new filter-drier cartridge in original position in liquid line.
3. Clean the surfaces of joints, use brazing flux on joints.
4. Carefully solder inlet and outlet connections to new filter-drier cartridge, use a guard to protect other parts against damage from applied heat during this process (wet cloth can be also effective).

***NOTE: Use dry nitrogen to purge the system during any solder operations; see chapter 11.2.6.***

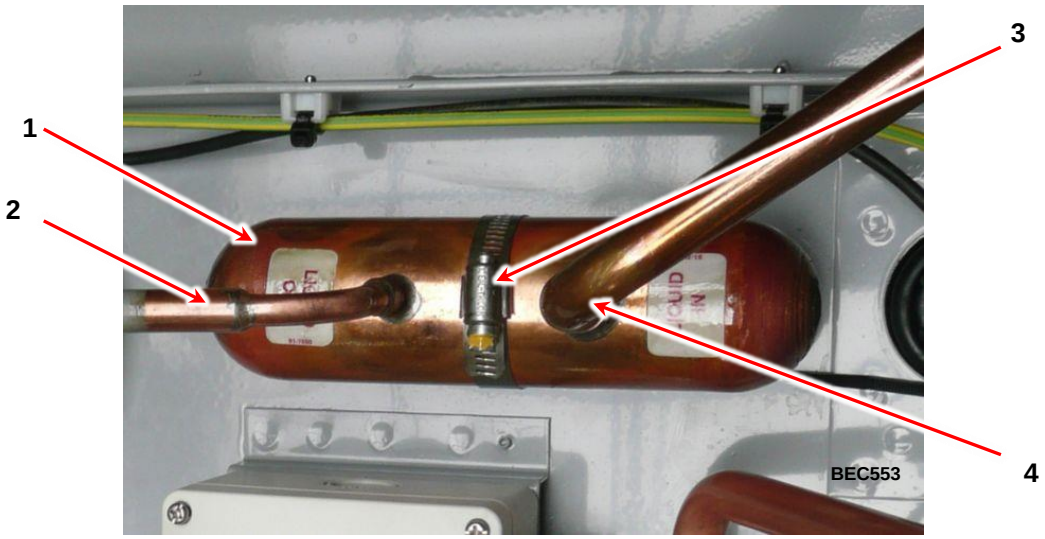
5. Check visually the joints (use a mirror for opposite or hidden sides).
6. Insert the fixing clamp, tighten the screw.

7. Reinstall the other parts/accessories.
8. Pressurize the refrigeration system and check for leaks. See chapter 11.2.7.
9. Evacuate the system. See chapter 11.2.8.
10. Recharge the system. See chapter 11.2.9.
11. Close and secure the top cover with latches. Use appropriate key only!
12. Connect high voltage (XPOW) and low voltage (XLV1) connectors, switch ON the control system.
13. Close the switchboard box (electrobox), secure the cover with locks. Use appropriate key only!
14. Turn the power supply ON, check the functionality
15. Return the HVAC unit into service, see chapter 11.1 for more information.

## 11.4. Receiver Tank Replacement

### Removal

1. Switch the unit/control system OFF.
2. Turn all power supply OFF, disconnect the XPOW and XLV1 connectors.
3. Open and fix the top cover. Use appropriate key only!
4. Recover the refrigerant from the system. See chapter 11.2.5.
5. Release and remove the fixing clamp.
6. Unsolder the inlet/outlet cartridge pipes, use a guard to protect other parts against damage from applied heat during this process (wet cloth can be also effective).
7. Remove the old receiver tank.




| | | | |
|---|---|---|---|
| 1 | Receiver tank | 3 | Fixing clamp |
| 2 | Outline pipe | 4 | Inlet pipe |

**Figure 47: Receiver Tank Installation**

### Installation

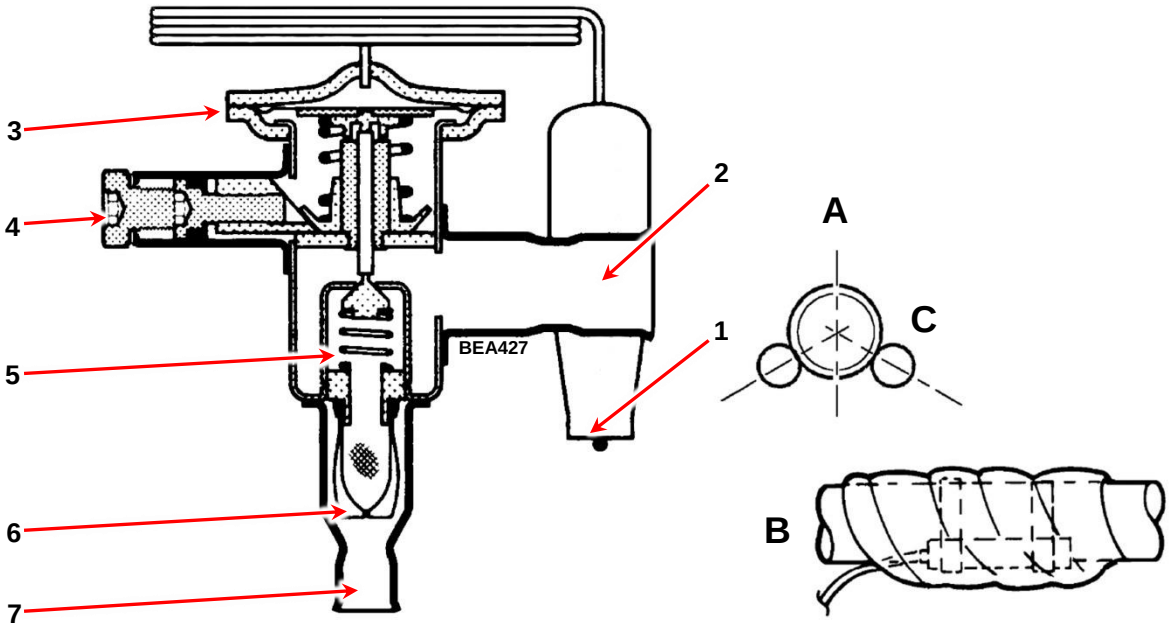
1. Clean connection fittings, remove the protective plugs from the new filter-drier.
2. Align new filter-drier cartridge in original position in liquid line.
3. Clean the surfaces of joints, use brazing flux on joints.
4. Carefully solder inlet and outlet connections to new filter-drier cartridge, use a guard to protect other parts against damage from applied heat during this process (wet cloth can be also effective).

***NOTE: Use dry nitrogen to purge the system during any solder operations; see chapter 11.2.6.***

5. Check visually the joints (use a mirror for opposite or hidden sides).
6. Insert the fixing clamp, tighten the screw.
7. Reinstall the other parts/accessories.
8. Pressurize the refrigeration system and check for leaks. See chapter 11.2.7.
9. Evacuate the system. See chapter 11.2.8.
10. Recharge the system. See chapter 11.2.9.
11. Close and secure the top cover with latches. Use appropriate key only!
12. Connect high voltage (XPOW) and low voltage (XLV1) connectors, switch ON the control system.
13. Close the switchboard box (electrobox), secure the cover with locks. Use appropriate key only!
14. Turn the power supply ON, check the functionality
15. Return the HVAC unit into service, see chapter 11.1 for more information.

## 11.5. Thermostatic Expansion Valve Replacement

The thermostatic expansion valve meters liquid refrigerant into the evaporator coil at a predetermined rate to keep the coil fully refrigerated and ensure complete vaporization of the refrigerant before it leaves the coil. The expansion valve is controlled by the temperature and the pressure in the suction line.




| | | | | | |
|---|---|---|---|---|---|
| 1 | Sensor bulb | 5 | Fixed orifice | A | Side view |
| 2 | Outlet (Typical) | 6 | Filter | B | End view |
| 3 | Power head | 7 | Inlet (Typical) | C | Location of bulb on side of suction line 4 or 8 o'clock position |
| 4 | Adjustment | | | | |

**Figure 48: Expansion Solder Type Valve and Sensor Bulb Position**

Thermo King expansion valves are factory preset and do not require adjustment. When diagnosing refrigeration problems, eliminate other possible causes before servicing the valve.

The expansion valve must be serviced by an experienced refrigeration mechanic.

Usually two services are performed on the expansion valve:

1. Replacing a damaged power element. A broken power element causes the valve to close and the unit to operate in a vacuum.
2. Cleaning and securing the power element sensor bulb to the suction line. Poor contact of the sensor bulb causes the valve to operate by air temperature, indicated by frosting of the suction line and a slight rise in suction pressure to flooding of the coil. Wrap the bulb and suction line with insulating tape, TK Part No. 203-428.

***CAUTION: Thermo King expansion valves are factory preset and do not require adjustment. Establishing controlled conditions in the field is difficult. Before adjusting the expansion valve, check the following causes for an out-of-range reading.***

### Sensor Bulb Contact

1. Remove the insulating tape from the sensor bulb.
2. Loosen two copper bands, remove the sensor bulb from the suction line.
3. Clean the suction line and the sensor bulb with fine abrasive paper or cloth. Do not use acids or polishes to clean copper.
4. Coat the sensor bulb and suction line with a light film of oil to prevent oxidation.
5. Install the sensor bulb in clamps on the side of the line in the original position. Tighten the clamps and replace the insulation on the bulb.

### Superheat: Measurement and Adjustment

***NOTE: Be sure the temperature reading instrument and compound pressure gauge are calibrated.***

### Measurement

1. Install a pressure gauge in the expansion valve external equalizer line. This will indicate the pressure.
2. Run the unit. Allow the system to run until the interior of the vehicle has cooled to within 5 degrees of thermostat set point.
3. Subtract the temperature reading obtained from the suction line near the expansion valve sensor bulb on the unit suction line to obtain the expansion valve superheat setting.
   Using the Pressure-Temperature Chart in this manual, convert the pressure measured at the equalizer line to the equivalent temperature.

Example:

Sensor Bulb Suction Line Temperature (°C/F)

\- Suction Pressure Temperature Conversion (°C/F)

= Superheat (K)

***NOTE: To properly check the superheat, you must have a stable condition. To establish a stable operating condition, run the unit at least 15 minutes so the evaporator air inlet temperature reaches 21 °C to 27 °C (70 °F to 80 °F). Read the pressure and temperature difference simultaneously. Temperature difference should be 5.5 to 8 K.***

4. Check the following:
   - Dirty air filters or other cause of reduced air flow.
   - Sensor bulb leaking, bulb placed improperly on refrigerant line, or bulb not properly wrapped with insulating tape.
   - Kinked capillary tube.
5. After the above items have been checked, replace the expansion valve with a factory preset part if necessary adjustment.

### Adjustment

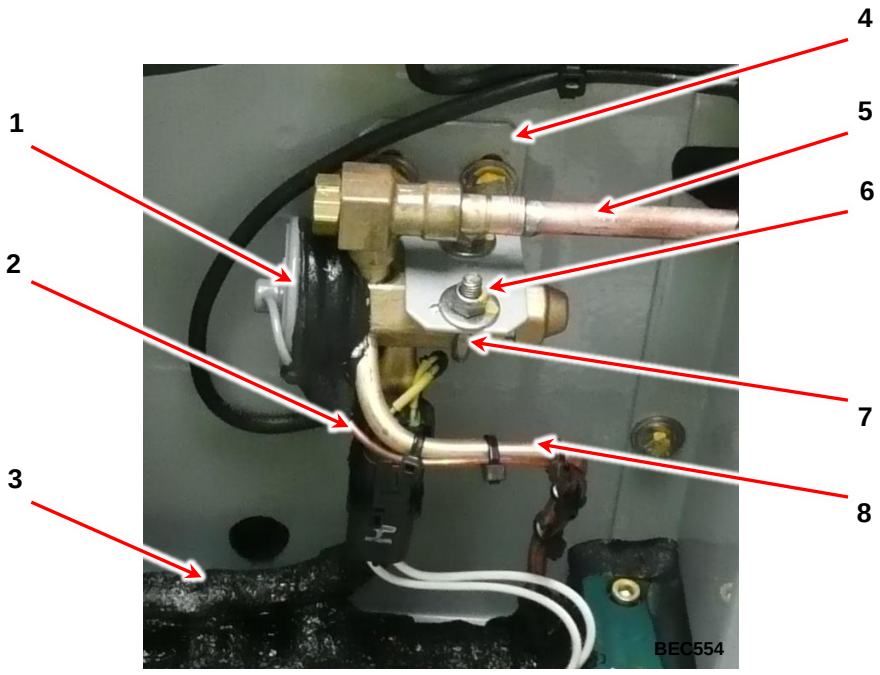
1. Remove the cap over the adjusting stem.

2. To reduce superheat, turn the adjusting stem counter clockwise.
3. Make no more than one turn of the stem at one time. Observe the change in superheat closely to prevent overshooting the desired setting. As much as 30 minutes may be required to obtain the new balance after the adjustment has been made.
4. Remove the pressure gauge and thermometer from the equalizer line.
5. Return the HVAC unit into service, see chapter 11.1 for more information.

### Removal

1. Switch the unit/control system OFF.
2. Turn all power supply OFF, disconnect the XPOW and XLV1 connectors.
3. Open and fix the top cover. Use appropriate key only!
4. Recover the refrigerant from the system. See chapter 11.2.5.
5. Disconnect temperature sensor connector, release tie wraps where necessary.
6. Carefully remove the insulation.
7. Remove the sensor bulb from the clamps, taking care not to kink the capillary tube.
8. Unsolder the equalizer and the inlet and outlet line connections, use a guard to protect other parts against damage from applied heat during this process (wet cloth can be also effective).
9. Remove the expansion valve.

***DANGER: Do not solder on a closed system. Pressure can build up and may cause an explosion. If soldering is required, use dry nitrogen to purge the system during any solder operations. See chapter 11.2.6.***




| | | | |
|---|---|---|---|
| 1 | Thermostatic expansion valve | 5 | Valve inlet pipe |
| 2 | Sensor bulb connection pipe | 6 | Fixing nut |
| 3 | Valve outlet – pipe(s) to the evaporator | 7 | U-bracket holder |
| 4 | Valve holder | 8 | Pressure equalizer line |

**Figure 49: Thermostatic Expansion Valve Installation**

## Installation

1. Compare the new valve to the one removed. Adjust the length of the sensor bulb capillary tube. Secure it to the valve body in the same manner as the original valve. This prevents damage to the tube by vibration-induced chafing. Once the length is adjusted, feed the bulb through the required routing.
2. Clean tubing connections before installing the valve, clean the surfaces of joints, use brazing flux on joints.
3. Position the valve in the unit, carefully solder inlet and outlet connections, use a guard to protect other parts against damage from applied heat during this process (wet cloth can be also effective).
4. Taking care not to kink the capillary tube, position the remote sensor bulb in the clamp on the side of the suction line in exactly the same spot from which it was removed.

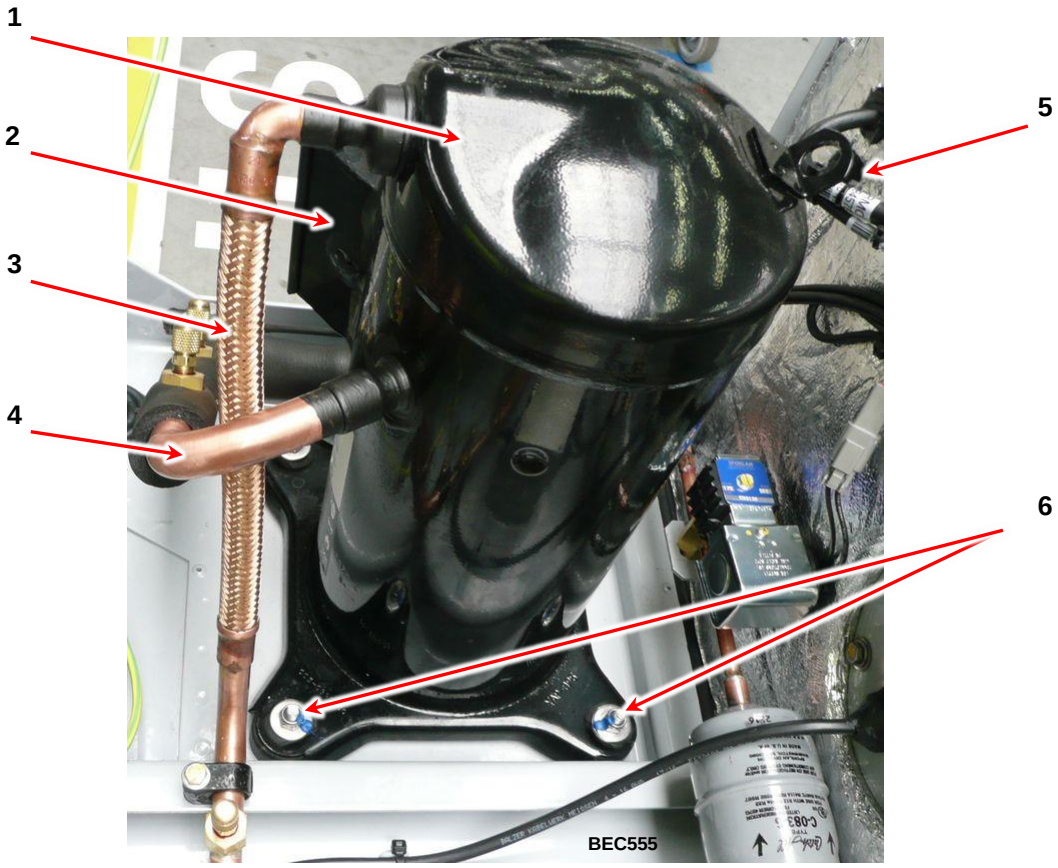
***NOTE: Use dry nitrogen to purge the system during any solder operations; see chapter 11.2.6.***

5. Check visually the joints (use a mirror for opposite or hidden sides).
6. Reinstall the temperature sensor, use tie wraps where necessary.
7. Pressurize the refrigeration system and check for leaks. See chapter 11.2.7.
8. Add insulation where necessary.
9. Evacuate the system. See chapter 11.2.8.
10. Recharge the system. See chapter 11.2.9.

11. Close and secure the top cover with latches. Use appropriate key only!
12. Return the HVAC unit into service, see chapter 11.1 for more information.

## 11.6. Compressor Replacement

***WARNING: When inspecting or servicing the HVAC system, follow all safety rules and operating procedures, to avoid any physical harm.***




| | | | |
|---|---|---|---|
| 1 | Compressor | 4 | Compressor suction line (inlet pipe) |
| 2 | Junction box | 5 | Lifting lug |
| 3 | Compressor discharge line (outlet pipe) with vibration eliminator | 6 | Compressor fixing bolts |

**Figure 50: Compressor Installation**

### Removal

1. Switch the unit/control system OFF.
2. Turn all power supply OFF, disconnect the XPOW and XLV1 connectors.
3. Open and fix the top cover. Use appropriate key only!
4. Open the junction (terminal) box on the compressor.
5. Release connections, release bushing, use appropriate tools for releasing.

6. Pull out the wires from the junction (terminal) box.
7. Recover the refrigerant from the system. See chapter 11.2.5.
8. Carefully unsolder the joints on the input/output (suction/discharge) compressor line, use a guard to protect other parts against damage from applied heat during this process (wet cloth can be also effective).
9. Check if any part will not obstruct to removing of the whole compressor assembly.
10. Release the fixing bolts from each corner of compressor.
11. Attach appropriate lifting tool/hook to the lifting lug on the top of compressors.
12. Use suitable lifting device to transport the compressor from the HVAC unit.

***WARNING: The compressor weights approximately 30 kg. Use extreme care to prevent personal injury during manipulation.***

## Installation

1. Place exactly the compressor in the unit frame on original position, set the compressor corners in isolators.
2. Use flatwashers, spring washers and nuts and slightly fix the compressor.
3. Check the whole installation and tighten the fixing bolts with appropriate torque; see chapter 9.5 for the value of torque, use torque wrench with extension bar if necessary.
4. Use a small brush and mark the threads/bolts/nuts with colour (for example nitrocellulose top paint). It is simple signage if the thread is tight or loose or was loosen.


**Figure 51: Fixing Screw Marking (Example)**

5. Put together all tubes, check if all tubes are in correct dimension and shape.
6. Use the nitrogen to purge and drying of tubing, clean the joints use brazing flux on joints.
7. Carefully braze all the joints, use any guard in case if heating can damage other parts, wet cloth can will be also necessary to prevent from heating.
8. Check visually the joints (use a mirror for opposite or hidden sides).
9. Check all accessories (pressure switches, service ports) if all parts are present and connected.
10. Attach an evacuation station hoses to the service ports, use dry nitrogen to purge the system; see chapter 11.2.6.
11. Pressurize the refrigeration system and check for leaks. See chapter 11.2.7.
12. Evacuate the system. See chapter 11.2.8.

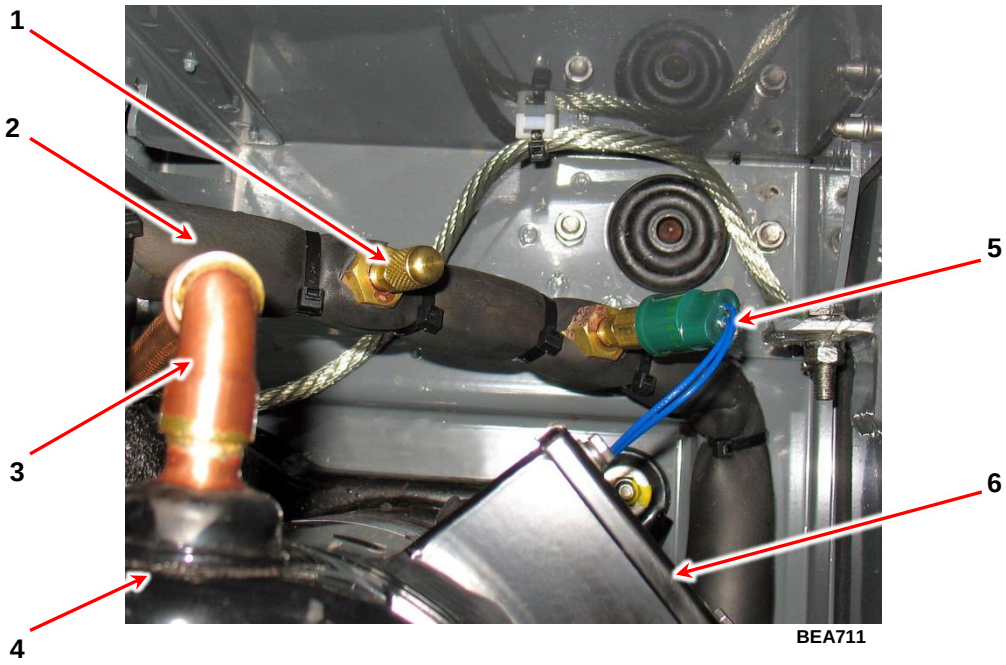
13. Recharge the system. See chapter 11.2.9.
14. Connect compressor wires in junction box according valid electrical diagram.
15. Properly attach and fix the bushing, close the junction box, fix the covers be sure the sealing under cover is present and in correct position. Fix all cables and wires with binders, no loosen parts are acceptable.
16. Connect the XPOW and XLV1 connectors, restore the high voltage and low voltage power supply, switch the control system ON and test the functionality.
17. Close and secure the top cover with latches. Use appropriate key only!
18. Return the HVAC unit into service, see chapter 11.1 for more information.

## 11.7. Low Pressure or High Pressure Switch Replacement

### Removal

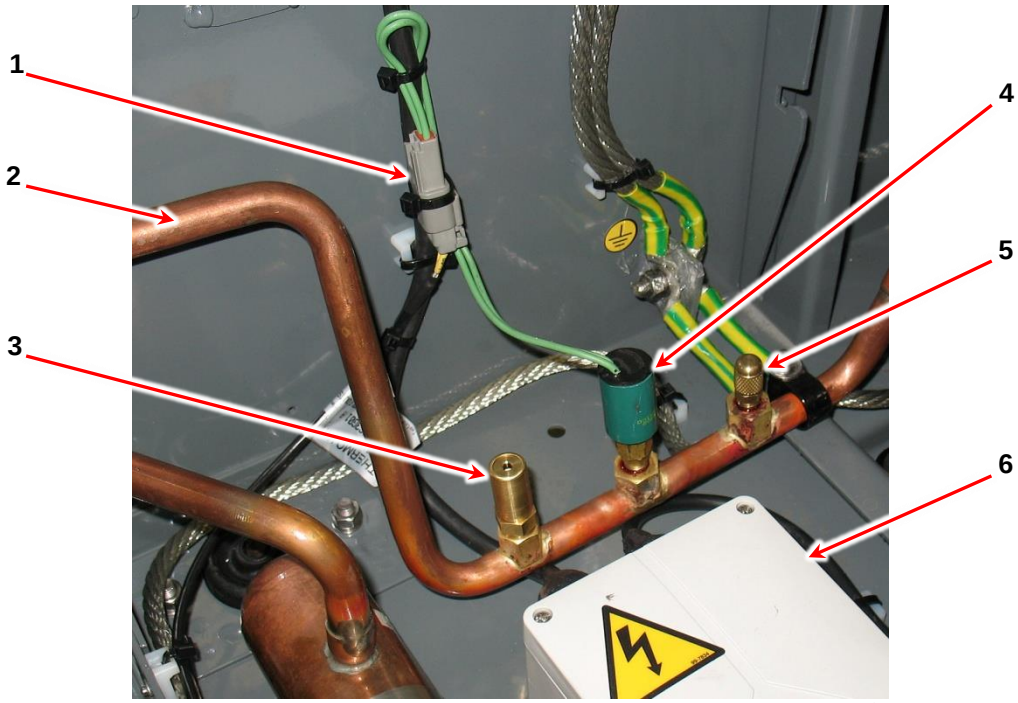
1. Switch the unit/control system OFF.
2. Turn all power supply OFF, disconnect the XPOW and XLV1 connectors.
3. Open and fix the top cover. Use appropriate key only!
4. Locate the non-functional pressure switch.
5. Remove the tie wraps from switch wiring or connectors, disconnect the connector from switch wiring.
6. Unscrew and remove the switch.

***NOTE: Install the new switch immediately to minimize the risk of refrigeration system pollution from air/oxygen.***




| | | | |
|---|---|---|---|
| 1 | Service port | 4 | Compressor |
| 2 | Compressor suction line (inlet pipe) | 5 | Pressure switch – LPCO |
| 3 | Compressor discharge line (outlet pipe) | 6 | Compressors junction box |

**Figure 52: Pressure Switch Installation (Example 1)**




| | | | |
|---|---|---|---|
| 1 | Pressure switch connector | 4 | Pressure switch – HPCO |
| 2 | Compressor discharge line (outlet pipe) | 5 | Service port |
| 3 | Safety relief valve | 6 | Junction box |

**Figure 53: Pressure Switch Installation (Example 2)**

## Installation

1. Apply compressor oil to the threads of the new switch.
2. Install new switch, connect the wires, fix the wires with binders.
3. Pressurize the refrigeration system and test for leaks. See chapter 11.2.7.
4. Release the cover support, close and secure the top cover with latches. Use appropriate key only!
5. Return the HVAC unit into service, see chapter 11.1 for more information.

## 11.8. Safety Relief Valve Replacement

The valve contains a spring loaded piston that lifts when the refrigerant pressure exceeds the spring force. When pressure drops below setpoint, the valve will reset. The valve might leak refrigerant after it has relieved excess pressure. Tapping the valve lightly may help the valve reseat and seal properly.

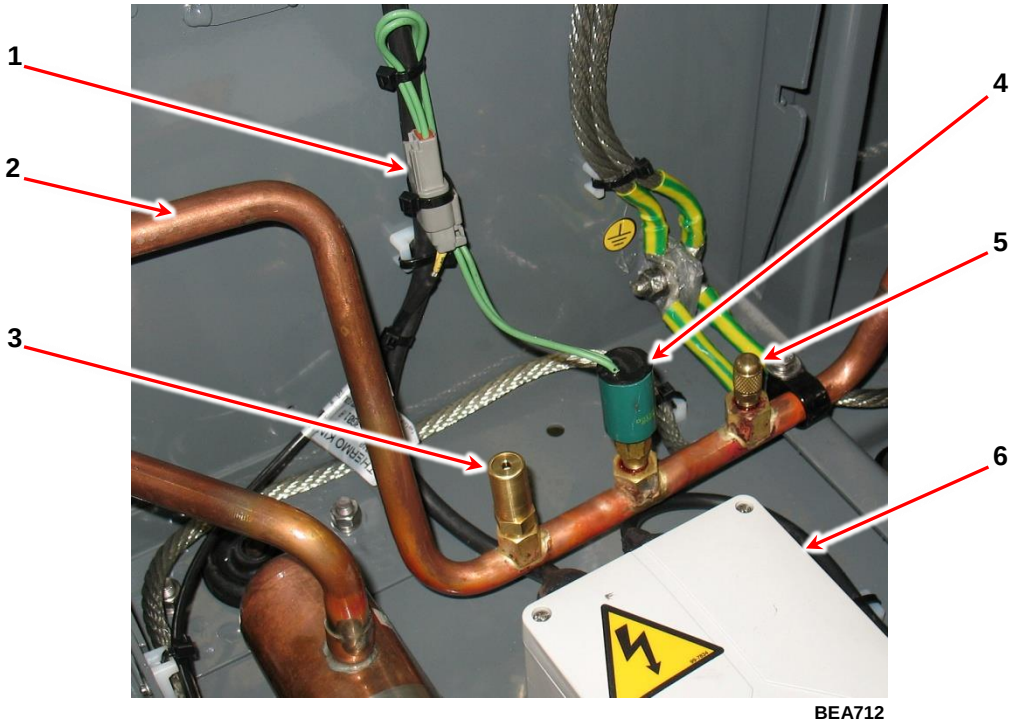
The valve is non-repairable and requires no adjustment. If the valve fails to reseat properly, the valve must be replaced.

***NOTE: Before starting replacement procedure, use your parts manual to identify the correct valve for your unit.***

### Removal

1. Switch the unit/control system OFF.
2. Turn all power supply OFF, disconnect the XPOW and XLV1 connectors.
3. Open and fix the top cover. Use appropriate key only!
4. Recover the refrigerant from the system. See chapter 11.2.5.
5. Locate the relief valve, unscrew and remove the valve.

***NOTE: Install the new switch immediately to minimize the risk of refrigeration system pollution from air/oxygen. The recommended time is 30 minutes max. 1 hour.***




| | | | |
|---|---|---|---|
| 1 | Pressure switch connector | 4 | Pressure switch – HPCO |
| 2 | Compressor discharge line (outlet pipe) | 5 | Service port |
| 3 | Safety relief valve | 6 | Junction box |

**Figure 54: Relief Valve Installation (Example)**

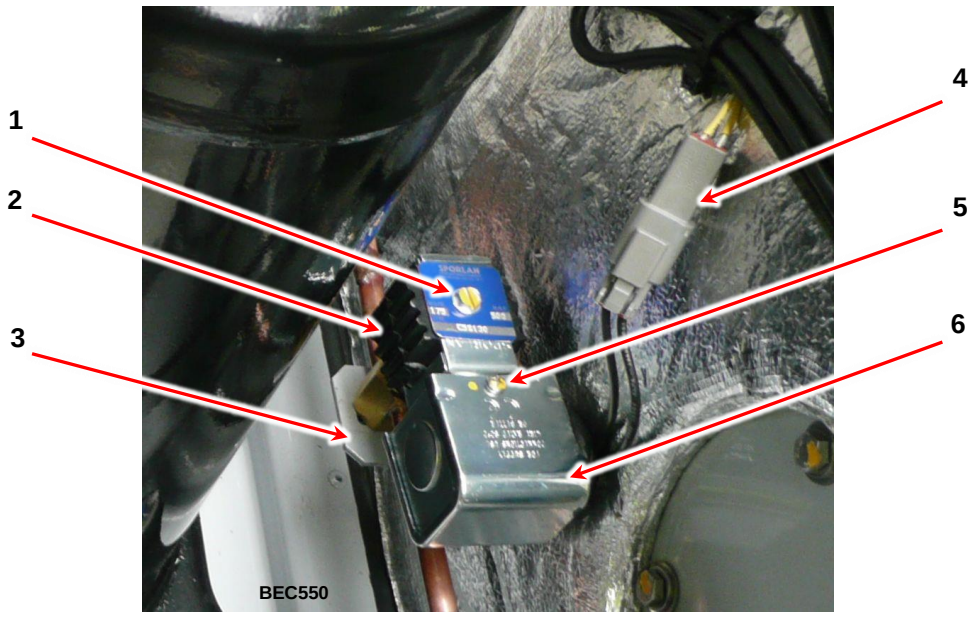
### Installation

1. Apply compressor oil to the threads of the new valve, install and tighten new valve.
2. Pressurize the refrigeration system and check for leaks. See chapter 11.2.7.
3. Evacuate the system. See chapter 11.2.8.
4. Recharge the system. See chapter 11.2.9.
5. Release the cover support, close and secure the top cover with latches. Use appropriate key only!
6. Return the HVAC unit into service, see chapter 11.1 for more information.

## 11.9. Solenoid Valve Replacement

### Removal

1. Switch the unit/control system OFF.
2. Turn all power supply OFF, disconnect the XPOW and XLV1 connectors.
3. Open and fix the top cover. Use appropriate key only!
4. Locate the non-functional solenoid valve.
5. Disconnect solenoid valve connector.
6. Release bolt on top of solenoid valve cover, remove the cover.
7. Release the tie wraps from valve wiring where necessary.
8. Release bolt on top of valve/solenoid, remove the coil.




| | | | |
|---|---|---|---|
| 1 | Solenoid coil fixing bolt | 4 | Solenoid valve connector |
| 2 | Solenoid coil | 5 | Solenoid valve |
| 3 | Bracket | 6 | Bracket |

**Figure 55: Solenoid Valve Installation**

9. Release bushing and disconnect wires from terminals in valve enclosure, remove the solenoid coil out of unit.
10. Recover the refrigerant from the system. See chapter 11.2.5.
11. Unsolder the valve inlet and outlet line connections, use a guard to protect other parts against damage from applied heat during this process (wet cloth can be also effective).
12. Release the bolts fixing the bracket to the bottom of unit.
13. Unscrew the bolt fixing the valve to bracket and remove the valve.

### Installation

1. Clean tubing connections before installing the valve, clean the surfaces of joints, use brazing flux on joints.
2. Position the valve in the unit, fix the valve to the bracket, install and tighten the bracket to bottom of unit. See chapter 9.5 for appropriate torque.
3. Carefully solder inlet and outlet connections to new solenoid valve, use a guard to protect other parts against damage from applied heat during this process (wet cloth can be also effective).

***NOTE: Use dry nitrogen to purge the system during any solder operations; see chapter 11.2.6.***

4. Check visually the joints (use a mirror for opposite or hidden sides).
5. Pressurize the refrigeration system and check for leaks. See chapter 11.2.7.
6. Evacuate the system. See chapter 11.2.8.
7. Recharge the system. See chapter 11.2.9.
8. Reinstall the solenoid valve coil, connect the cable to the coil terminal, tighten the bushing.
9. Fix the solenoid coil with bolt on top of the valve.
10. Fix the wires with binders where necessary.
11. Install the valve cover.
12. Connect the solenoid valve connector.
13. Close and secure the top cover with latches. Use appropriate key only!
14. Return the HVAC unit into service, see chapter 11.1 for more information.

## 11.10. Condenser Coil Replacement

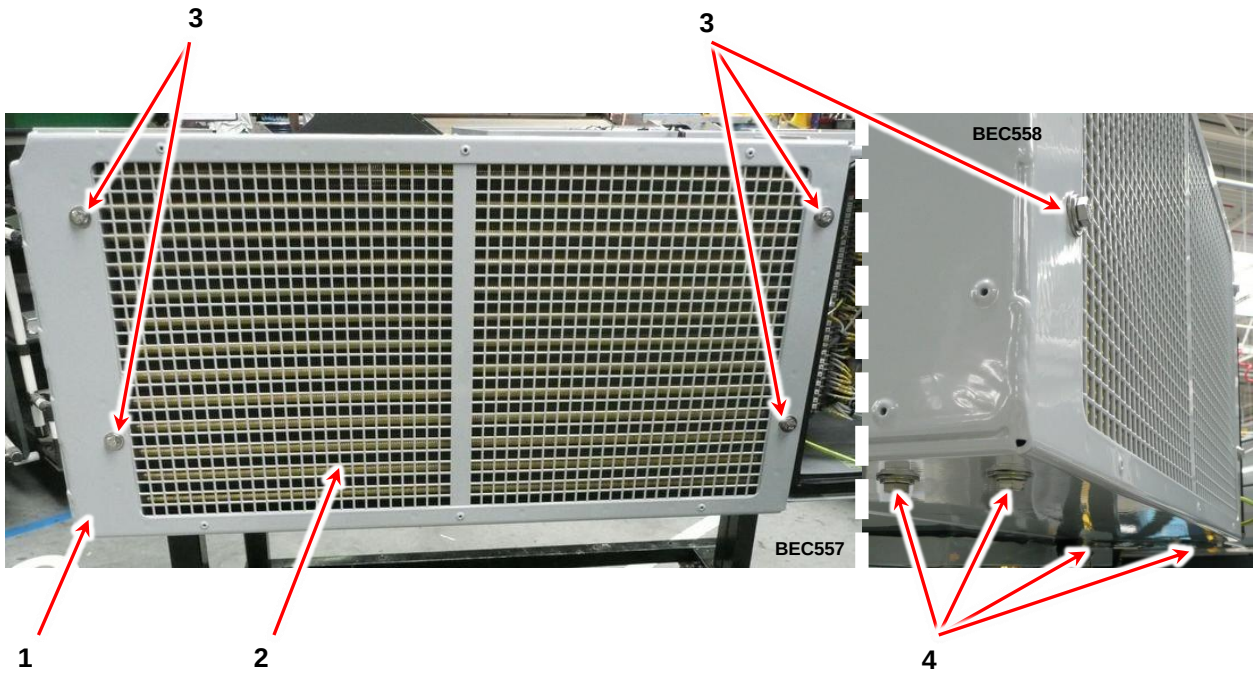
***CAUTION: Always use protective gloves when open the unit covers, the fins of the condenser coil can be very sharp!***

### Removal

1. Switch the unit/control system OFF.
2. Turn all power supply OFF, disconnect the XPOW and XLV1 connectors.
3. Open and fix the top cover. Use appropriate key only!
4. Release and remove the grounding cable.
5. Remove the top cover.
6. Recover the refrigerant from the system. See chapter 11.2.5.

***WARNING: Adhere to all safety rules!***

7. Unsolder the liquid lines before and after condenser coil, use a guard to protect other parts against damage from applied heat during this process (wet cloth can be also effective).
8. Remove any accessories if necessary.




| | | | |
|---|---|---|---|
| 1 | Unit frame | 3 | Condenser coil side fixing bolts |
| 2 | Condenser coil | 4 | Condenser coil bottom fixing bolts |

**Figure 56: Condenser Coil Installation**

9. Release and remove the fixing bolts – the bolts are accessible from outside (4 on the side and 4 on the bottom), condenser coil is fixed by 8 bolts.
10. Carefully pull out the condenser coil from unit.

### Installation

1. Carefully insert and align new condenser coil in original position.
2. Fix the condenser coil with bolts from outside. Tighten the fixing bolts; see chapter 9.5 for appropriate torque.
3. Solder inlet and outlet connections to new condenser coil, use a guard to protect other parts against damage from applied heat during this process (wet cloth can be also effective).

***NOTE: Use dry nitrogen to purge the system during any solder operations; see chapter 11.2.6.***

4. Check visually the joints (use a mirror for opposite or hidden sides).
5. Pressurize the refrigeration system and check for leaks. See chapter 11.2.7.
6. Evacuate the system. See chapter 11.2.8.
7. Recharge the system. See chapter 11.2.9.
8. Install the condenser fan assembly.
9. Connect the condenser fan, install any other accessories if necessary.
10. Insert the cover, install/fix the hinges
11. Close and secure the cover with latches. Use appropriate key only!
12. Return the HVAC unit into service, see chapter 11.1 for more information.

## 11.11. Evaporator Coil Replacement

***CAUTION: Always use protective gloves when open the unit covers, the fins of the evaporator coil can be very sharp!***

### Removal

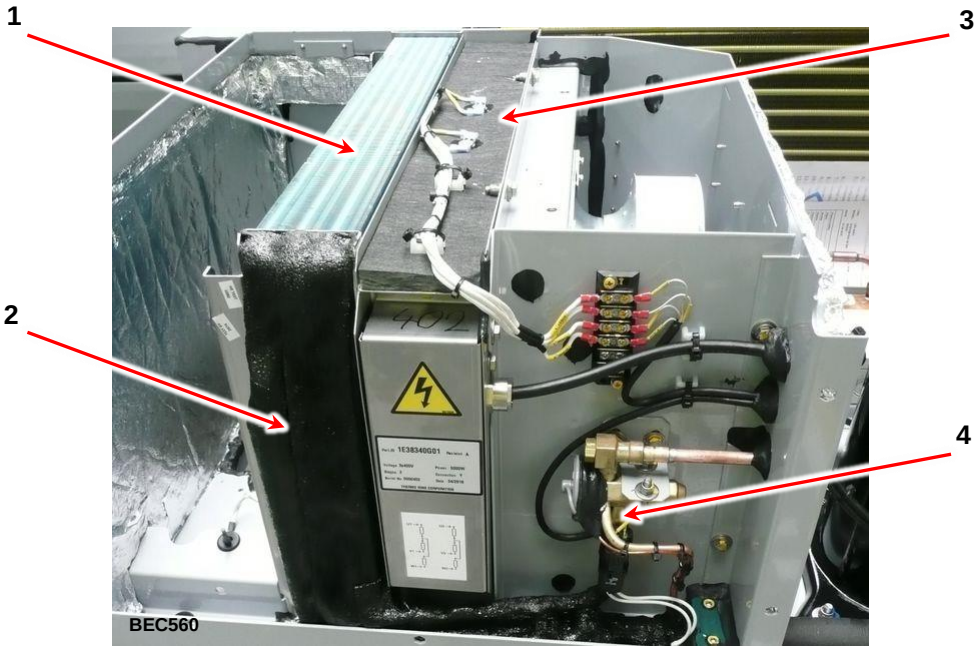
1. Switch the unit/control system OFF.
2. Turn all power supply OFF, disconnect the XPOW and XLV1 connectors.
3. Open and fix the top cover. Use appropriate key only!
4. Recover the refrigerant from the system. See chapter 11.2.5.
5. Remove the gasket from side wall.
6. Dismount the side wall of the RAC unit.

***WARNING: Adhere to all safety rules!***


| | | | |
|---|---|---|---|
| 1 | Top cover | 3 | Evaporator coil |
| 2 | Side wall | 4 | Blower compartment |

**Figure 57: Evaporator Coil Installation – A**

7. Disconnect the temperature sensor connector.
8. Remove the mixed air filter, see chapter 9.8.
9. Remove the heater, see chapter 12.4.
10. Carefully remove insulation from the evaporator coil inlet pipes, do not damage the temperature sensor.




| | | | |
|---|---|---|---|
| 1 | Evaporator coil | 3 | Heater |
| 2 | Insulation | 4 | Thermostatic expansion valve |

**Figure 58: Evaporator Coil Installation – B**

11. Unsolder the liquid lines (the inlet line together with expansion valve), use a guard to protect other parts against damage from applied heat during this process (wet cloth can be also effective).
12. Release the expansion valve, see chapter 11.5.
13. Release and remove the fixing bolts, save fixing bolts for reinstallation.
14. Carefully pull out the evaporator coil (assembly) from unit.

### Installation

1. Carefully insert and align new or repaired evaporator coil in original position.
2. Fix the coil with all bolts to the central wall and unit frame.
3. Solder inlet and outlet connections, use a guard to protect other parts against damage from applied heat during this process (wet cloth can be also effective).

***NOTE: Use dry nitrogen to purge the system during any solder operations; see chapter 11.2.6.***

4. Check visually the joints (use a mirror for opposite or hidden sides).
5. Pressurize the refrigeration system and check for leaks. See chapter 11.2.7.
6. Evacuate the system. See chapter 11.2.8.
7. Recharge the system. See chapter 11.2.9.
8. Mount the expansion valve, see chapter 11.5.
9. Install the heater, see chapter 12.4.
10. Insert gasket on the side wall, correct gasket where necessary.
11. Install mixed air filter.
12. Close and secure the top cover with latches. Use appropriate key only!
13. Return the HVAC unit into service, see chapter 11.1 for more information.

# 12. Electrical Repairs

## 12.1. Introduction

***CAUTION: Safety first! Always respect safety rules, follow "Safety Precautions", respect valid local laws and general Health & Safety prescripts.***

***WARNING: Make sure that HVAC unit and/or vehicle cannot start while servicing the system.***

***CAUTION: Always use protective gloves when open the unit covers, the fins of the condenser and evaporator coil can be very sharp!***

Thermo King reserves the right to deny warranty coverage on claims due to lack of maintenance or neglect. Claims in question must be supported by maintenance records.

If you are not really experienced in following actions please call for help Thermo King Service Centre otherwise is here risk of damage or complications. The main repair procedures can be carried out in specialized workshop only with trained and highly experienced technicians. In case of any question or unclear situation please contact your supplier or directly Thermo King Manufacturer.

Before starting the replacement procedure, use most up-to-dated Parts Manual or Stocking Guide to identify the correct spare part suitable for your unit.

### BEFORE ANY SERVICE ACTIVITY STOP THE HVAC UNIT OPERATION WITH:

1. ON/OFF button on driver panel.
2. Turn all the power supply OFF.
3. Disconnection of all electrical connectors.

***WARNING: The electrical disconnection is allowed only if all the power supply cables are without voltage!***

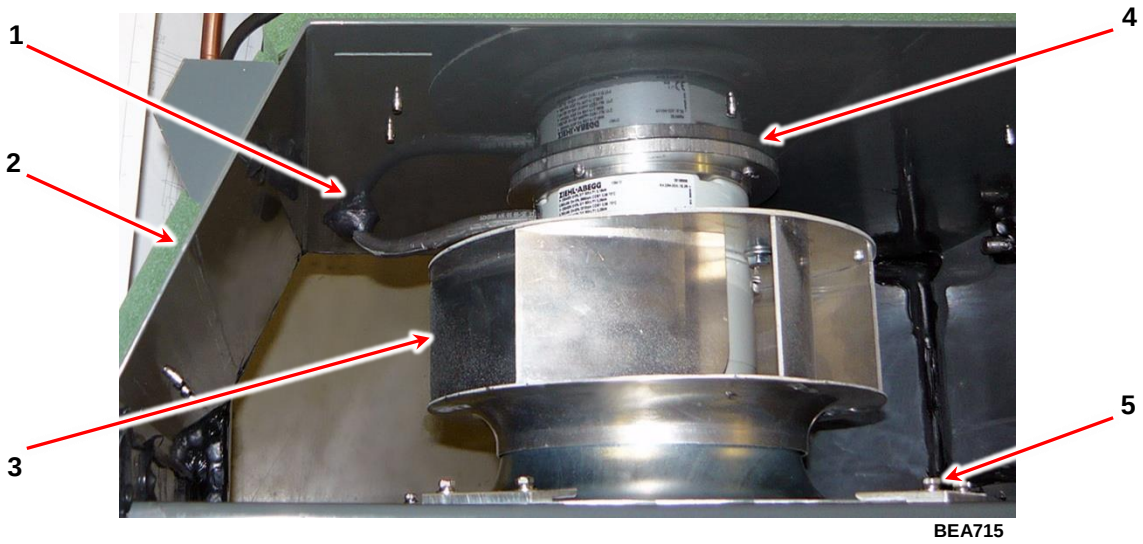
### WHEN THE LAST SERVICE ACTIVITY IS FINISHED:

1. Check the HVAC unit top cover, check if all locking elements are at a proper position.
2. Connect all electrical connectors, check the proper connection.
3. Turn the power supply ON.
4. Enable the unit operation with ON/OFF button on driver panel.
5. Check the HVAC system functionality, see chapter 8.4.4.

## 12.2. Evaporator Blower Replacement

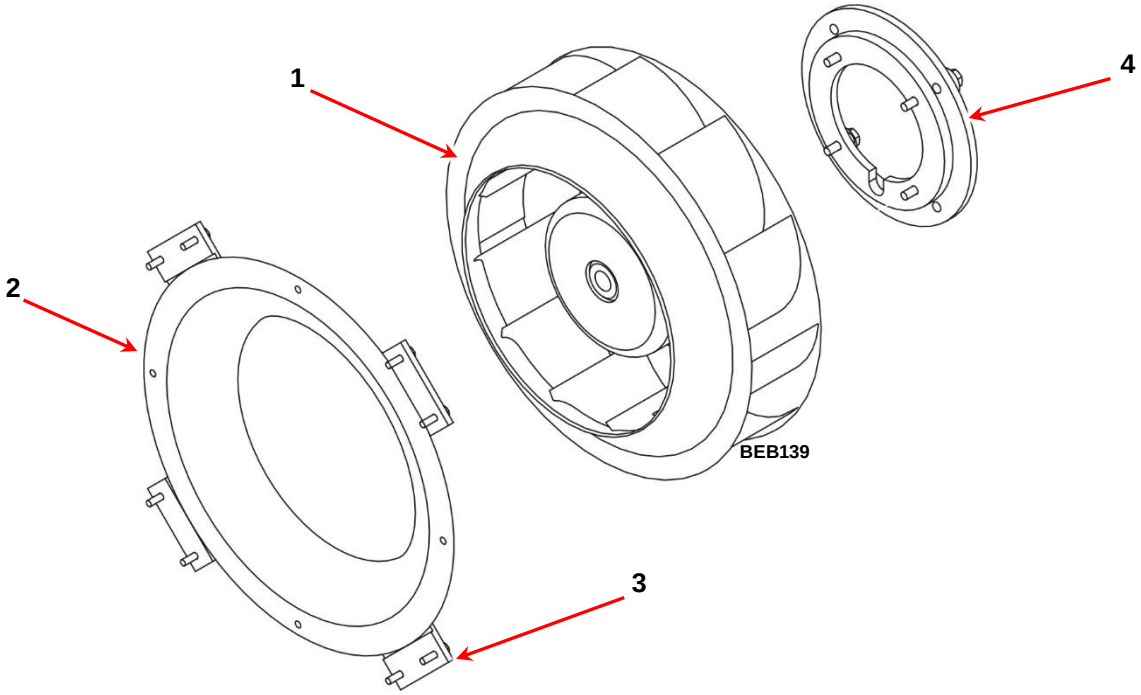
### Removal

1. Switch the unit/control system OFF.
2. Turn all power supply OFF, disconnect XPOW and XLV1 connectors.
3. Open and fix the top cover. Use appropriate key only!
4. Open the locks, release and remove the switchboard box (electrobox) cover.
5. Disconnect wires from terminals.
6. Release and remove the evaporator blower compartment cover.
7. Release the blower cable as much as possible, remove the tie wraps if applicably.
8. Remove the hardware and holder of the blower ring. Save the hardware for reinstallation.
9. Release and remove the hardware fixing the flange with cover. Save the hardware for reinstallation, remove the cover.
10. Lift the evaporator blower assembly including the ring and the flange from the HVAC unit and place on service bench.
11. Disassembly the blower body and flange.




| | | | |
|---|---|---|---|
| 1 | Blower power supply | 4 | Blower flange with cover |
| 2 | Sidewall of blower compartment | 5 | Blower ring holder and fixing hardware |
| 3 | Blower assembly | | |

**Figure 59: Evaporator Blower Installation (Example)**




| | | | |
|---|---|---|---|
| 1 | Blower assembly | 3 | Blower ring holder and fixing hardware |
| 2 | Blower ring | 4 | Blower flange with cover |

**Figure 60: Evaporator Blower Assembly**

## Installation

1. Assembly a new blower with flange, use original hardware.
2. Return the assembly and the blower ring into original position, fix the blower ring with original hardware. Tighten the fixing bolts; see chapter 9.5 for appropriate torque.
3. Insert the flange cover into original position, fix the blower, flange and cover, use original hardware. Use common sense and best practise for tightening.
4. Fix the blower cable with binders as necessary, no loosen parts are acceptable.
5. Connect the blower wires in a switchboard box (electrobox) according valid electrical diagram.
6. Properly attach and fix the cable bushing.
7. Insert the switchboard box (electrobox) cover and fix it with locks. Use appropriate key only!
8. Connect the XPOW and XLV1 connectors, restore the high voltage and low voltage power supply, switch the control system ON and test the functionality.
9. Operate the evaporator blower to confirm correct direction of rotation.

***WARNING: Extreme care must be used in this operation! Don't touch the rotating parts neither by any tool!***

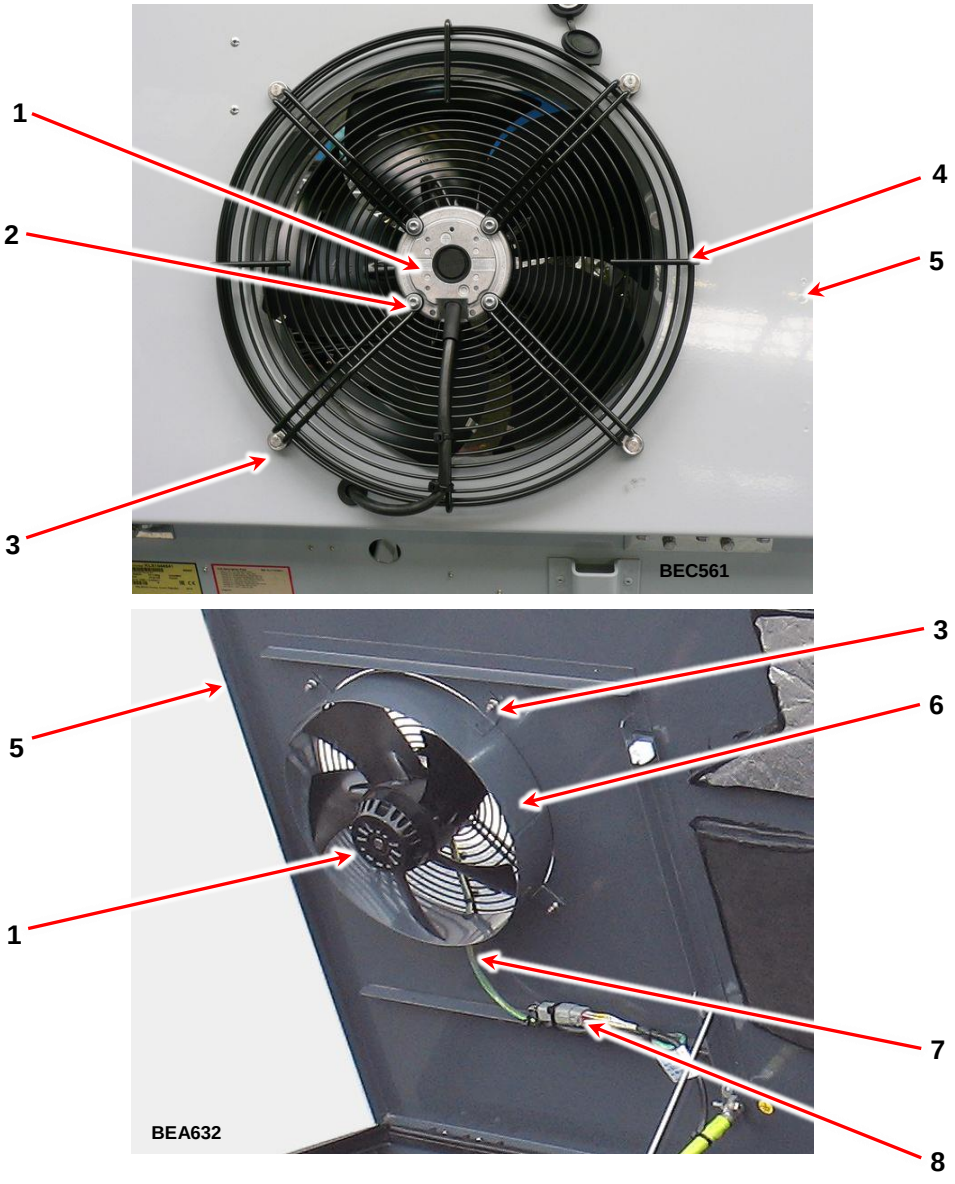
***DANGER: Keep your hands, clothing and tools clear of any rotating parts when working on a unit that is running. Loose clothing might entangle moving fans, pulleys, or belts, causing serious injury or possible death.***

10. Switch the blower and the power supply OFF.
11. If the blower is working properly return the blower cover, fix the cover with original hardware.
12. Close and secure the top cover with latches. Use appropriate key only!
13. Return the HVAC unit into service, see chapter 12.1 for more information.

## 12.3. Condenser Fan Replacement

### Removal

1. Switch the unit/control system OFF; turn all power supply OFF, disconnect the connectors.
2. Open and fix the top cover. Use appropriate key only!
3. Locate and unplug the sensor connector.




| | | | |
|---|---|---|---|
| 1 | Fan assembly (motor, propeller, grille) | 5 | Top cover |
| 2 | Fan motor mounting bolts | 6 | Diffuser |
| 3 | Fan assembly mounting bolts | 7 | Grommet |
| 4 | Fan grille | 8 | Condenser fan connector |

**Figure 61: Condenser Fan Installation (Example)**

4. Remove the fixing binder when necessary, loose the cable.
5. Partially release the four fan assembly mounting bolts – the bolts on grille perimeter only!
6. Hold the diffuser on internal side of cover, release the grommet, release more the mounting bolts, remove the diffuser.
7. Hold the fan assembly, remove the mounting bolts, lift the entire fan assembly from the unit and place on service bench.
8. Replace the damaged fan (the propeller wheel and motor is one un-detachable part) or grille.
9. For fan removal release the 4 fan motor mounting bolts, save the spacer for installation.
10. Cable of new fan assembly must be equipped with grommet.

### Installation

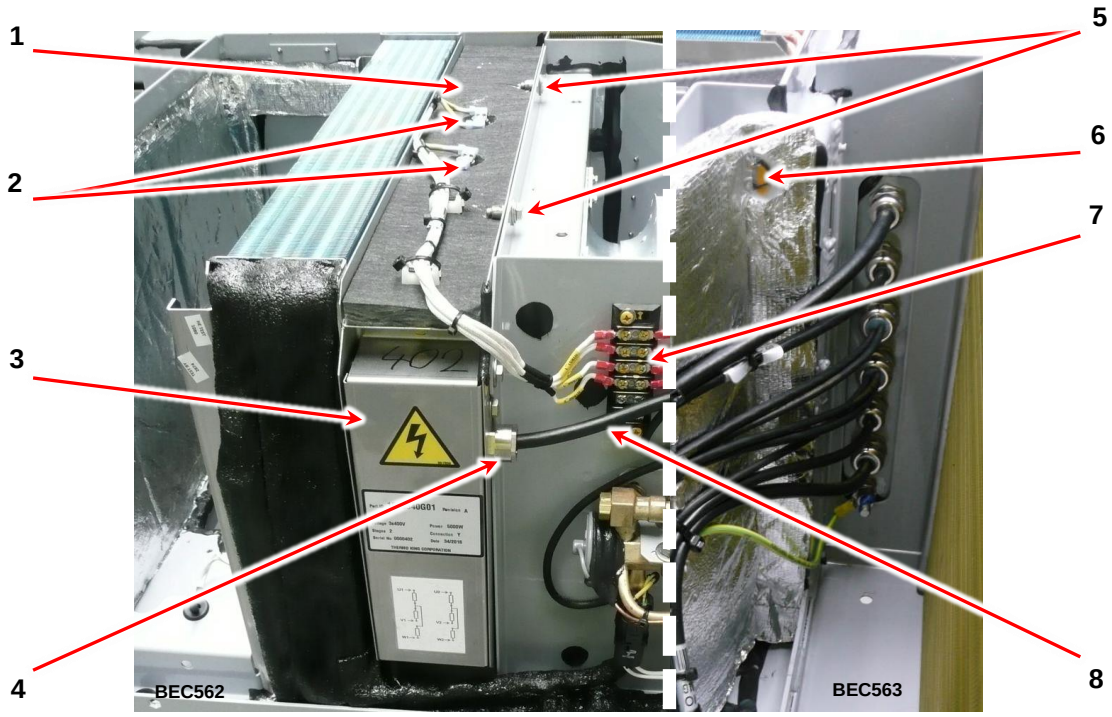
1. Check the fan replacement for complete, after fan motor exchange check if all 4 spacers are between fan motor and grille.
2. Carefully place the condenser fan assembly to the original position, insert the bolts into holes, install the diffuser (don't forget for grommet) and fix the assembly with bolts.
3. Connect the connector on fan cable, fix the cable with tie wraps where necessary.
4. Connect the XPOW and XLV1 connectors.
5. Restore the high voltage and low voltage power supply, switch the control system ON and test the functionality.
6. Close and secure the top cover with latches. Use appropriate key only!
7. Operate the condenser fan to confirm proper direction of rotation.
8. Return the HVAC unit into service, see chapter 12.1 for more information.

## 12.4. Heater Assembly Replacement

### Removal

1. Switch the unit/control system OFF.
2. Turn all power supply OFF, disconnect the XPOW and XLV1 connectors.
3. Open and fix the top cover. Use appropriate key only!
4. Open the electrobox. Use appropriate key only!
5. Disconnect the heater power supply wiring from the contactor (KHTR).
6. Release the bushing on the rear side of electrobox use an appropriate tool for releasing.
7. Release and remove heater junction box cover.
8. Release the heater power supply electrical cable, remove the cable binders where necessary.
9. Disconnect (pull out) the wires/connectors from the temperature switches.
10. Release the temperature switches low voltage cable, remove the cable binders where necessary.
11. Release all bolts fixing:
    - Hater to the evaporator coil.
    - Heater to the evaporator blower bracket.
    - Grounding cable.

12. Lift the heater from upwards and place it on service bench.
13. Remove or change the temperature switches as necessary.




| | | | |
|---|---|---|---|
| 1 | Heater | 5 | Heater fixing bolts |
| 2 | Temperature switches | 6 | Fixing bolt – common for heater and evaporator |
| 3 | Heater junction box cover | 7 | Temperature switches' terminals |
| 4 | Bushing | 8 | Heater power cable |

**Figure 62: Heater Assembly Installation**

## Installation

1. Set up all parts of the heater assembly (the heater, temperature switches, insulation, cable).

***NOTE: The temperature switches are different in case of montage carefully check the correct position – the correct wiring.***

2. Insert the heater assembly in original place.
3. Install all mounting bolts including flatwashers and lockwashers securely. Tighten the fixing bolts; see chapter 9.5 for appropriate torque.
4. Reconnect the temperature switches wiring (refer to the actual schematic diagrams), check all connections for tightness.
5. Fix the low voltage cable with tie wraps where necessary.
6. Reconnect the heater high voltage wiring, check all connections for tightness.

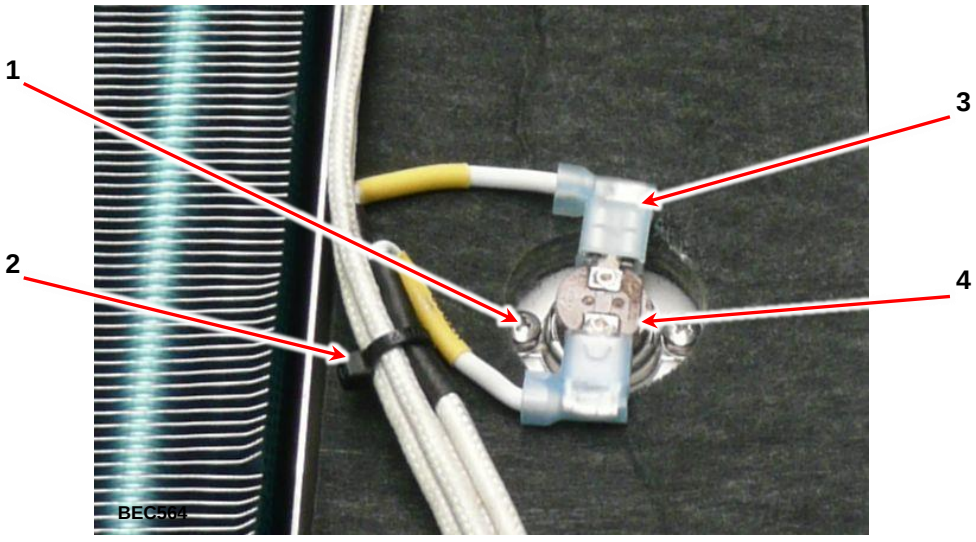
***NOTE: Loose connection will cause terminal to overheat and cause damage and or fire.***

7. Tighten the bushing on the rear side of electrobox, use an appropriate tool.
8. Fix the high voltage cable with tie wraps where necessary.
9. Insert the switchboard box (electrobox) cover and fix it with bolts.
10. Connect the heater power supply wiring to the contactor (KHTR).
11. Close the electrobox. Use appropriate key only!
12. Close and secure the top cover with latches. Use appropriate key only!
13. Return the HVAC unit into service, see chapter 12.1 for more information.

## 12.5. Heater Temperature Switch Replacement

### Removal

1. Switch the unit/control system OFF.
2. Turn all power supply OFF, disconnect the XPOW and XLV1 connectors.
3. Open and fix the top cover. Use appropriate key only!
4. Disconnect (pull out) the wires/connectors from the temperature switches.
5. Release the temperature switches low voltage cable, remove the cable binders where necessary.
6. Release or remove the insulation (if necessary), unscrew the mounting screws.
7. Remove the temperature switch.




| | | | |
|---|---|---|---|
| 1 | Temperature switch fixing bolt | 3 | Connector |
| 2 | Cable binder | 4 | Temperature switch |

**Figure 63: Heater Temperature Switch**

### Installation

1. Fix the new temperature switch in original place, use both mounting screws.
2. Repair or reinstall the insulation.
3. Reconnect the switch wires, fix wires with tie wraps where necessary.
4. Check all connections for tightness.
5. Close and secure the top cover with latches. Use appropriate key only!
6. Return the HVAC unit into service, see chapter 12.1 for more information.

# 13. Temperature-Pressure Chart

| Temperature pressure relationship – vapour pressure, kPa, psig | | | |
|---|---|---|---|
| **Temperature** | | **R-407C** | |
| **°F** | **°C** | kPa | psig |
| | | *Shaded pressure values – Inches Hg below 1 ATM* | |
| -38 | -38.9 | 23 | 3.4 |
| -36 | -37.8 | 13 | 1.9 |
| -34 | -36.7 | 2 | 0.3 |
| -32 | -35.6 | 4 | 0.6 |
| -30 | -34.4 | 10 | 1.5 |
| -28 | -33.3 | 16 | 2.3 |
| -26 | -32.2 | 22 | 3.2 |
| -24 | -31.1 | 29 | 4.2 |
| -22 | -30.0 | 36 | 5.2 |
| -20 | -28.9 | 43 | 6.2 |
| -18 | -27.8 | 50 | 7.2 |
| -16 | -26.7 | 57 | 8.3 |
| -14 | -25.6 | 66 | 9.5 |
| -12 | -24.4 | 74 | 10.7 |
| -10 | -23.3 | 82 | 11.9 |
| -8 | -22.2 | 91 | 13.2 |
| -6 | -21.1 | 100 | 14.5 |
| -4 | -20.0 | 110 | 15.9 |
| -2 | -18.9 | 120 | 17.4 |
| 0 | -17.8 | 130 | 18.9 |
| 2 | -16.7 | 141 | 20.4 |
| 4 | -15.6 | 152 | 22.0 |
| 6 | -14.4 | 163 | 23.7 |
| 8 | -13.3 | 175 | 25.4 |
| 10 | -12.2 | 187 | 27.1 |
| 12 | -11.1 | 200 | 29.0 |
| 14 | -10.0 | 212 | 30.8 |
| 16 | -8.9 | 226 | 32.8 |
| 18 | -7.8 | 240 | 34.8 |
| 20 | -6.7 | 254 | 36.9 |
| 22 | -5.6 | 270 | 39.1 |
| 24 | -4.4 | 285 | 41.3 |
| 26 | -3.3 | 301 | 43.6 |
| 28 | -2.2 | 316 | 45.9 |
| 30 | -1.1 | 334 | 48.4 |
| 32 | 0.0 | 351 | 50.9 |

| Temperature pressure relationship – vapour pressure, kPa, psig | | | |
|---|---|---|---|
| **Temperature** | | **R-407C** | |
| **°F** | **°C** | kPa | psig |
| | | *Shaded pressure values – Inches Hg below 1 ATM* | |
| 34 | 1.1 | 369 | 53.5 |
| 36 | 2.2 | 387 | 56.1 |
| 38 | 3.3 | 406 | 58.9 |
| 40 | 4.4 | 425 | 61.7 |
| 42 | 5.6 | 445 | 64.6 |
| 44 | 6.7 | 466 | 67.6 |
| 46 | 7.8 | 487 | 70.7 |
| 48 | 8.9 | 509 | 73.8 |
| 50 | 10.0 | 532 | 77.1 |
| 52 | 11.1 | 554 | 80.4 |
| 54 | 12.2 | 578 | 83.9 |
| 56 | 13.3 | 603 | 87.4 |
| 58 | 14.4 | 627 | 91.0 |
| 60 | 15.6 | 654 | 94.8 |
| 62 | 16.7 | 680 | 98.6 |
| 64 | 17.8 | 707 | 102.5 |
| 66 | 18.9 | 734 | 106.5 |
| 68 | 20.0 | 763 | 110.7 |
| 70 | 21.1 | 792 | 114.9 |
| 72 | 22.2 | 823 | 119.3 |
| 74 | 23.3 | 853 | 123.7 |
| 76 | 24.4 | 885 | 128.3 |
| 78 | 25.6 | 917 | 133.0 |
| 80 | 26.7 | 950 | 137.8 |
| 82 | 27.8 | 984 | 142.7 |
| 84 | 28.9 | 1019 | 147.8 |
| 86 | 30.0 | 1055 | 153.0 |
| 88 | 31.1 | 1091 | 158.3 |
| 90 | 32.2 | 1129 | 163.7 |
| 92 | 33.3 | 1167 | 169.2 |
| 94 | 34.4 | 1206 | 174.9 |
| 96 | 35.6 | 1246 | 180.7 |
| 98 | 36.7 | 1287 | 186.7 |
| 100 | 37.8 | 1329 | 192.8 |
| 102 | 38.9 | 1372 | 199.0 |
| 104 | 40.0 | 1415 | 205.3 |
| 106 | 41.1 | 1461 | 211.9 |
| 108 | 42.2 | 1507 | 218.5 |
| 110 | 43.3 | 1553 | 225.3 |
| 112 | 44.4 | 1602 | 232.3 |

| Temperature pressure relationship – vapour pressure, kPa, psig | | | |
|---|---|---|---|
| **Temperature** | | **R-407C** | |
| **°F** | **°C** | kPa | psig |
| | | *Shaded pressure values – Inches Hg below 1 ATM* | |
| 114 | 45.6 | 1651 | 239.4 |
| 116 | 46.7 | 1701 | 246.7 |
| 118 | 47.8 | 1752 | 254.1 |
| 120 | 48.9 | 1804 | 261.7 |
| 122 | 50.0 | 1857 | 269.4 |
| 124 | 51.1 | 1913 | 277.4 |
| 126 | 52.2 | 1968 | 285.5 |
| 128 | 53.3 | 2025 | 293.7 |
| 130 | 54.4 | 2084 | 302.2 |

# 14. Index

# 15. Appendix

## 15.1. Schemes, Diagrams and Drawings Index

| Dwg No. | Diagram / Drawing Title | Pages |
|---|---|---|
| 1E10861 | Piping Schematic Diagram RAC | 1 |
| 3E10015 | Diagram Installation RAC 60 INT3 | 1 |
| 3E13274 | Electric Schematic Diagram RAC 60 INT3 | 2 |
| 3E13342 | Electric Wiring Diagram RAC 60 INT3 | 1 |

## 15.2. Recommended Publications

***Following documents are available on ESA Info Central or contact your local Thermo King dealer or directly Thermo King Representative, please.***

http://iservice.thermoking.com/esa

***NOTE: These www pages are protected for TK people & dealers only, you need to have login name and password.***

| | Title | Nr. |
|---|---|---|
| A | Evacuation station operation and field application | TK 40612 |
| B | Silver brazing and soft soldering | TK 7949 |
| C | Tool catalog | TK 5955 |
| D | Electrostatic discharge training guide | TK 40282 |
| E | Transport temperature control systems | TK 50951 |