KYSOR WARREN EPTA US
INSTALLATION AND OPERATION MANUAL
FOR ECO_2 MINI CONDENSING UNIT ™

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This manual provides guidelines for equipment inspection, installation, start-up, operation, service, and maintenance of Kysor Warren Epta US ECO_2 Mini ™, Single Compressor CO2 Transcritical Condensing Units. For evaporator or case installation and operation, please consult the manufacturer’s guidelines, respectively.
Kysor Warren Epta US (KWE) will not guarantee the performance and reliability of the product if it is misused in view of these guidelines.
Please read through this manual before the installation and operation of the unit and consult KWE if you have any questions.

1. Safety Statement

KWE highly recommends that customers using this product have a strong safety program. The keys to the safe operation of a refrigeration system are:

- A visible and vigorous safety program.
- The installation and operation of the system with all safety concerns recognized, evaluated, and incorporated.
- Well trained technicians and operators.
- Refrigerant compressors and units must be used in accordance with their intended use.
- Only qualified and authorized refrigeration technicians personnel are allowed to install, start-up and maintain this equipment.
- Qualified electricians must make electrical connections.
- All valid standards for connecting electrical and refrigeration equipment must follow local and national codes and/or regulations.
- Personnel protection policies must be observed.

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

1.1 General Safety Considerations

- The installation, commissioning, maintenance, and disassembly must be carried out by trained and qualified personnel with sufficient knowledge of this type of equipment.

- When maintenance is performed, equipment must be pressurized with dry air or inert gas.
- All equipment piping must be evacuated before charging the system with refrigerant.
- Make sure that all field wiring conforms to the requirements of the equipment and all applicable national and local codes.
- Avoid contact with sharp edges and coil surfaces. They are a potential injury hazard.
- Before working on the system, make sure all power sources are disconnected.
- CO_2 liquid has a high coefficient of thermal expansion. Consequently, care must be taken to ensure that liquid CO_2 is not trapped in the system between shutoff valves or any other components. An increase in temperature of CO_2 liquid will cause hydrostatic expansion that readily generates pressures that could cause the rupture of the refrigerant pressure containment components.

1.2 On Site Warning Signage

Owners are responsible for displaying cautionary / safety signage. Caution signage should be installed on the premise at entrances to the equipment room or areas near installed equipment.

Figure 1-1. Examples of cautionary and safety signage

Below are the explanations of some safety symbols:

WARNING This icon indicates instructions to avoid personal injury and material damage.

High voltage This icon indicates operations with a danger of electric shock.

Explosion hazard This icon indicates operations with a danger of explosion.

1.3 Personal Protective Gear

Technicians and support staff are responsible for using proper protective gear. It is recommended that all staff working on this type of installation use personal protective equipment such as safety shoes, gloves and safety glasses.

Figure 1-2. Examples of types of protective equipment

1.4 CO2 Safety and Environmental Characteristics

CO_2 is unique among natural refrigerants for having good safety characteristics. It is non-flammable, and non-toxic in low concentrations as are other refrigerants.
It exists naturally in the atmosphere at around 400 ppm. As a natural substance, CO_2 has no Ozone Depletion Potential (ODP) and a very low Global Warming Potential (GWP) of only 1.

It is classified as safety group A1, according to ASHRAE34. This A1 group has the least toxic and hazardous refrigerants.
Since R744 (CO_2) is heavier than air, it will sink to the floor. Exposure to high concentrations of CO2 can cause acute health problems, like headache, drowsiness, rapid breathing, elevated blood pressure or even suffocation. Therefore, the use of CO2 detectors is highly recommended on walk-in coolers and freezers as we as machine rooms. A good ventilation system should be installed indoors in case of CO2 leaks from the unit. Refrigeration contractors must comply with local and national codes for leak sensors.

1.4.1 CO2 Concentrations

According to ASHRAE 34, a CO2 concentration of 1000 ppm is the recommended limit to ensure occupant comfort. Higher concentration than found naturally (400 ppm) may be the result of human activities or the use of machinery. In a CO2 controlled ventilation system, fresh air should be supplied so that the CO2 concentration level does not exceed 1000 ppm. A very high leakage rate in indoor supermarket spaces or in the machine room could result in hazardous health conditions and additional safety measures are required.
OSHA lists 5000 ppm as the TLV-TWA (Threshold Limit Value - Time Weighted Average).
Table 1-1 is a list of selected concentration levels of CO2 and the expected effects on human health.
These instructions should be retained throughout the lifetime of both the compressor and the refrigeration unit.

CO2 Concentration		Symptoms and effects on humans
%	ppm	
0.04%	400	Normal concentration in the atmosphere
0.1%	1000	Recommended upper limit for comfortable indoor air quality
0.5%	5000	8 hours – long term exposure limit TLV-TWA (OSHA)
1%	10,000	Drowsiness
1.5%	15,000	10 minutes – short term exposure limit TLV-TWA
2%	20,000	50% increase of breathing
3%	30,000	OSHA STEL 10 minute TWA exposure, 100% increase of breathing
5%	50,000	IDLH – Immediate Danger to Life or Health
10%	100,000	Lowest lethal concentration, few minutes exposure causes unconsciousness
30%	300,000	Brief exposure causes unconsciousness and death

Table 1-1 CO2 Concentration Chart

2 Product Description

ECO2 Mini is a single compressor CO2 Transcritical air-cooled refrigeration condensing units that meets the demands of the food retail and food service sectors. This unit works with R744 (CO2) as refrigerant and is designed for Transcritical operating conditions such as pressures of 1740psi on the high side and 1305psi on the low side.
This product family consists of 10 different model numbers based on capacity, voltage and application, it will have 6 models for medium temperature application, 40,000, 70,000 and 100,000Btu/h capacity; available in 208-230V/60/3 and 460V/60/3. Will have 4 models for low temperature application, only 40,000 and 70,000Btu/h capacity also available in 208-230V/60/3 and 460V/60/3.
The ECO2 mini unit will have all components; compressor, gas cooler, oil separation system, flash tank, etc integrated in a single enclosed cabinet, being this with same overall dimensions (see figure 2.1) for all 10 model numbers allowing for repeatability and standardization from the installation point of view. This will also allow for simple plug and play installation of ECO2 mini.
This unit will be managed and operated by a Carel pRack controller

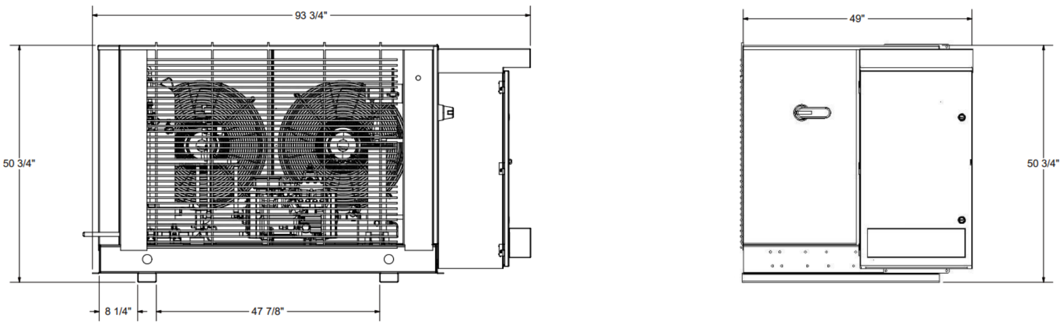


Figure 2.1 Overall Dimensions of the Condensing Units

Dorin CO2 Transcritical compressors are being applied for ECO2 mini units. Carel electronic controls and all electrical protection and diagnostics features are built into an electrical panel. The design is UL/cUL listed for indoor and outdoor use.

Figure 2.2 ECO_2 Mini Condensing Unit

2. Nomenclature

The model designation contains technical information about ECO2 Mini units for easy identification and use, for example:
Model number: ED-010-040-CM-4-OXV-A

This unit utilizes one Dorin medium temperature compressor, 40,000 BTU/h nominal capacity, R744 (CO2 refrigerant), medium temperature application, 460V/3Ph/60Hz, Outdoor Transcritical system with vertical flash tank and is designated as unit A.
See figure 2.3 for full description of model numbers for all units of ECO2 Mini family.

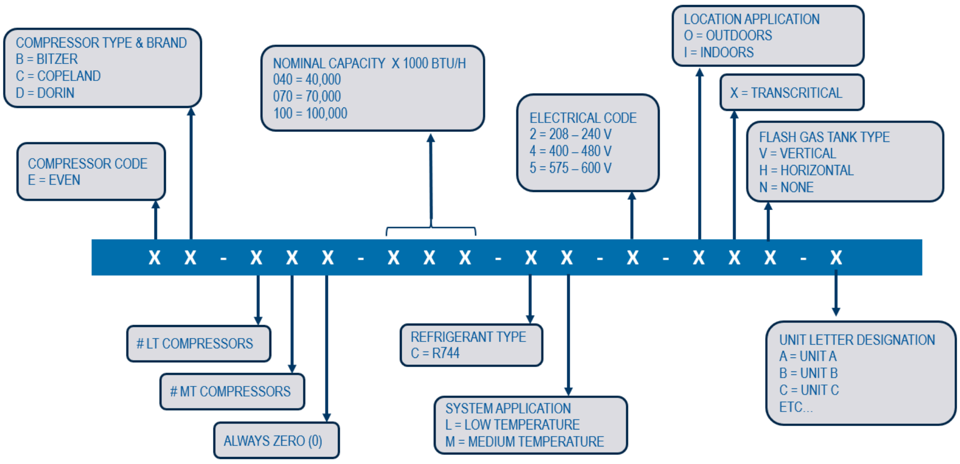
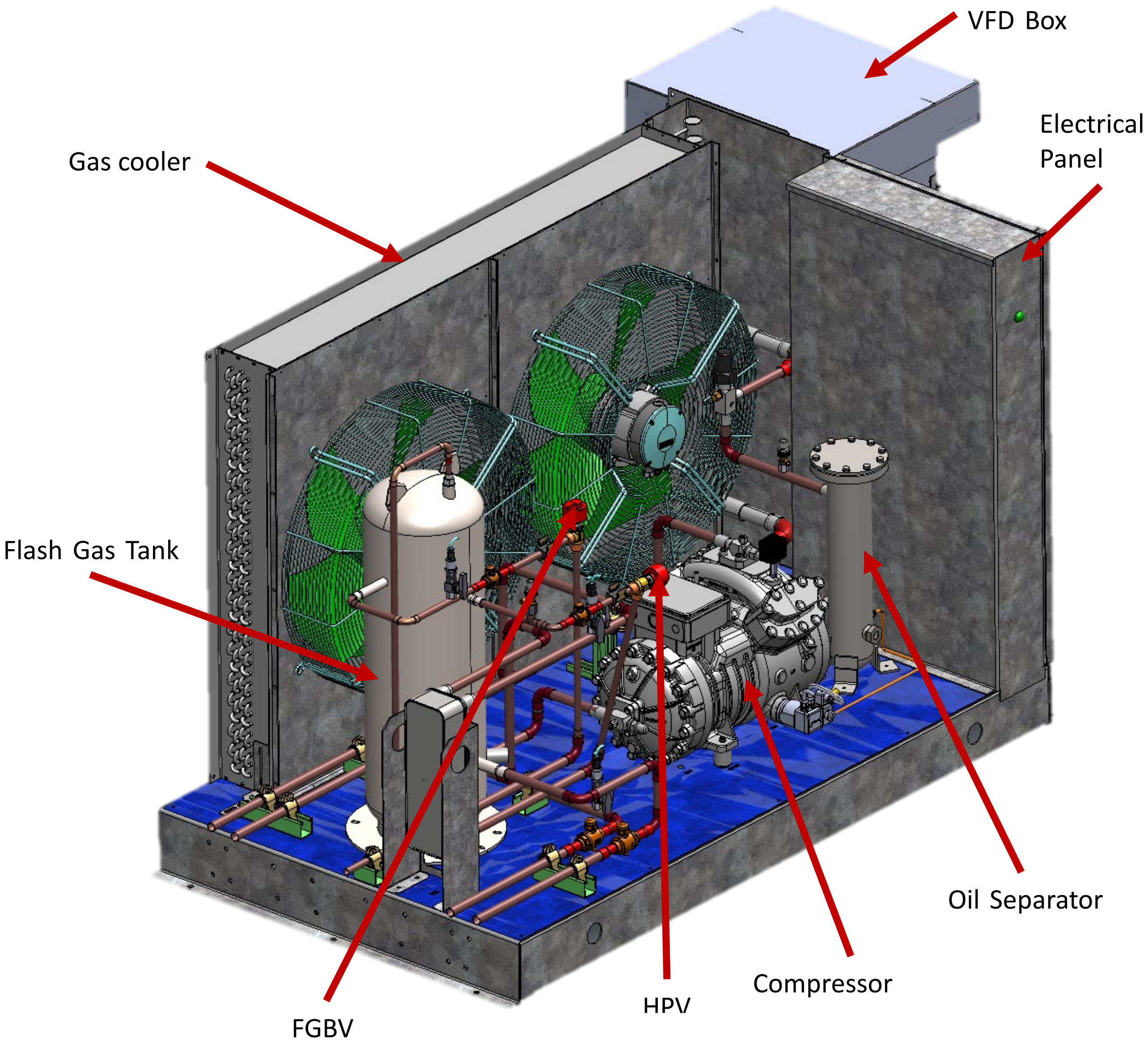


Figure 2.3 Nomenclature of KW CO2 Condensing Units.
Note: only Dorin compressors are available for this unit until further notice.

Product Standard Features

Kysor Warren condensing units are designed to use only R744 (CO2) refrigerant.

- One-size cabinet for all models
- Integrated gas cooler that is equipped with one or two Electronically Commutated Motor (ECM) fans depending on the capacity of the units, 40,000 Btu/h unit will have one fan motor however 70,000 and 100,000Btu/h units will have two fan motors.
- Carel pRack300T D controller and Carel EEVs for high pressure valve and flash gas bypass.
- Oil separation system consists of a coalescing oil separator and a Teklab TK4 oil regulator.
- The design pressure of the unit is 1740psi on the high side and 1305psi on the low side including the flash gas tank.
- Dorin compressor is a single stage compression for MT units and two stage compression for LT units.
- Variable Frequency Drive (VFD) for compressors in all units
- The units currently consist of 6 medium temperature and 4 low temperature models.



2.4 Carbon Dioxide grade requirements

2.4.1 Requirements of CO2 refrigerant and Pipe Sizing

Carbon Dioxide is produced as a byproduct of several different manufacturing processes including the formation of hydrocarbons and various distillations, fermentation and some combustion processes. CO_2 also naturally exists in wells. After the CO_2 gas has been isolated, it is purified into different levels through the filtration of impurities and removal of moisture and non-condensable gases that result in different grades of CO_2 for different applications.

The required quality for carbon dioxide is based on the level of purity ≥ 99.99%, and the moisture content H_2O ≤ 10 ppm, O_2 ≤ 10 ppm, N_2 ≤ 50 ppm or higher.

The recommended grades of CO_2 purity for ECO2 mini are Coleman, Instrumentation or Refrigerant grade. CO_2 of less purity or higher moisture content is not recommended.

2.4.2 Pipe Sizing

Due to CO2 thermophysical properties the liquid and suction lines are smaller than those for use with synthetic refrigerants like HFC/HFO refrigerants because the cooling capacity per unit of mass flow of CO2 is higher.
Piping lines, liquid and suction shall be sized for the proper loads considering both pressure drop and refrigerant velocity to provide proper oil return.
Liquid lines have minimal impact on systems energy consumption. Design concerns are vapor and liquid locking, flash gas generation and liquid hammer.
Vapor lines have a direct influence on system power consumption as their friction pressure drop reduces the required compressor suction pressure and increases the required compressor discharge pressure. Minimizing the pressure drop of these lines will reduce power consumption over the life of the plant. The lines that return a miscible lubricant film back to the compressors must meet a minimum required velocity to carry the oil regardless of the pressure drop of those lines.
An online software such as Parker Virtual Engineer or Coolselector2 can be used to calculate and select the liquid and suction line sizes. Pipe sizing for installation is the responsibility of the Engineer of Record (EOR) or Refrigeration Installing Contractor (RC), as applicable.
Piping needs to be selected per best refrigeration practices to provide proper oil return and meet the pressure rating requirements as indicated by installation drawings provided by the EOR or RC. For the particular case of the ECO2 mini, all the field piping and components shall meet a minimum design pressure of 1305psi.

2.4.2 Compressor Oil

Dorin compressors are used in the current product design, the recommended lubricant oils below are suitable for all Dorin CO2 Transcritical compressors; Bitzer oil BSE85K is also approved and recommended.

Refrigerant	Compressor	Approved Oils	
CO2 (R744) Transcritical	All Models	POE 85	BITZER BSE85K ERRECOM LR-POE85-CO2 FUCHS RENISO C 85 E XAERUS – XR544-80

Table 2-3 Approved Lubricant Oil

Lack of oil in the compressor crankcase will trigger an oil failure alarm and shut off the unit to protect the compressor. An oil separator and a TEKLAB oil regulator control are installed on each unit to manage the oil injection, refer to TEKLAB instructions and the control wiring schematic for more information.

2.4.3 Suction Superheat Requirements

Two superheat definitions are commonly used in refrigeration: the Evaporator Suction Superheat and the Compressor Suction Superheat. A low compressor suction superheat will cause harm to the compressor, as there is the potential for liquid flood back and oil dilution that may damage the motor bearing and internal parts. The minimum compressor suction superheat for these condensing units is 20^{o}F. The compressor suction temperature is measured at the suction line about 6” upstream of the service valve.

2.5 Description of Major Components

2.5.1 Compressors

Dorin single stage semi-hermetic compressors are used for medium temperature applications and Dorin two stage compressors are used for low temperature applications. Both medium temp and low temp compressors

have a stand still design pressure of 1450psi and maximum discharge pressure of 2175psi.
Compressors are equipped with a PTC probe installed on every motor winding set at 248F (120°C), combined with electronic protection module (REL)
Dorin CO_2 compressors are suction-gas-cooled compressors. The suction gas returns from the motor side and cools the motor winding first before reaching the suction chamber of piston compression. There are two advantages for suction cooled compressors: (1) to prevent motor winding from overheating; (2) to vaporize the potential liquid before entering the compression cylinders.

2.5.2 Air-Cooled Gas Cooler or Condenser

When the system is running at conditions above the CO_2 critical point, temperature of 87.8ºF and pressure of 1054psi, the CO_2 fluid cannot be defined as either a liquid or vapor; it is considered a supercritical fluid and cannot be condensed. For this reason, the part of the unit that rejects the heat to the ambient is called gas cooler and not a condenser, however when the system runs below CO_2 critical point or in subcritical mode the CO_2 will be condensed and at this point the heat rejection equipment will operate as a condenser.
For medium temperature application, the gas cooler is a single circuit coil. For low temperature applications, the gas cooler is a two circuit coil, one circuit for the low pressure stage which is called intercooler and another circuit for the high-pressure stage which would be the gas cooler. Typical materials for a gas cooler are aluminum fins and copper tubes.

The air or dry gas cooler rejects heat to the ambient when ambient air passes through it. Therefore, the selection of this equipment is based on the dry bulb temperature of the location where the system will be running.
The air cooler gas cooler would have one fan motor for some units and two fan motor for other units, however when two fans are present, they both are driven with same signal meaning that both will ramp up or down at the same time.

2.5.3 Flash Gas Tank (FGT)

The flash gas tank is a vertical pressure vessel that is connected to multiple parts of the system, the main connections are: a) high pressure valve (HPV), b) Flash gas bypass valve and c) Main liquid supply line, d) pressure relief valves. The FGT is normally maintained at a constant predefined pressure and has multiple functions:

a) Separates CO_2 vapor and liquid, the expanded fluid from high pressure valve is a mix of vapor and liquid and this tank allows the separation letting the liquid settle at the bottom and vapor rising to the top then the liquid is fed to the display cases and unit coolers, and the vapor is sent to the compressor suction through the flash gas bypass line.
b) It helps to manage refrigerant variations in the system, for example, when circuits are pumped down during defrost. Normally it is not intended to hold the entire system charge.
c) Since it operates at higher pressure than compressors suction pressure, it ensures there is enough positive differential pressure with respect to the fixtures' saturation temperature for the EEVs to operate properly.
d) This is the main component where CO_2 should be charged in the system

2.5.4 Oil Separator and Oil Management Control

This ECO2 mini uses a high pressure oil system, consisting of a coalescent oil separator and an electronic oil regulator. Since the oil separator will be subjected to the compressor discharge pressure, the oil system will always have a positive pressure differential allowing the oil regulator to inject oil when needed.
The electronic oil regulator Teklab is installed at the sight glass location of the compressor crankcase. It watches the oil level of the crank case and opens a solenoid valve to inject oil into the crank case depending on the oil level.

2.5.5 High Pressure Valve (HPV)

The HPV is a high pressure electronic expansion valve; it is a stepper type valve and is rated for high operating pressures such as 2000psi or sometimes higher.
It is installed in between the gas cooler and the gas flash tank to depressurize the CO2 fluid coming from the gas cooler into the flash tank as a lower pressure liquid and vapor mixture.
The main controller (pRack300T) manages the operation of this valve, it will be managed on two different modes, transcritical and subcritical conditions.
For transcritical mode the valve will be modulated to match the actual gas cooler pressure with a calculated optimum pressure by the controller. This calculated optimum pressure is based on an internal algorithm that uses the gas cooler outlet temperature as input.
For subcritical mode, the valve will modulate to maintain a predefined subcooling setpoint which is defined by the manufacturer.
The valve is normally driven by a 0-10V signal coming from a valve driver which is built-in in the main controller.

2.5.6 Flash Gas Bypass Valve (FGBV)

The FGBV is a high pressure electronic expansion valve; it is a stepper type valve and is rated for high operating pressures such as 1305psi or higher.
This valve is installed between the flash tank and the compressor suction. This valve regulates the flash gas tank pressure by allowing the gas that builds up in the flash tank to travel to the compressor suction line, maintaining a stable pressure inside the tank.
The operation of this valve is managed by the main controller (pRack300T), it will be constantly reading the flash gas tank pressure, and if the pressure differs from the setpoint it will modulate the valve opening or closing trying to match the predefined setpoint.
The valve is normally driven by a 0-10V signal coming from a valve driver which is built-in in the main controller.

2.6 System Control

2.6.1 Carel pRack pR300T D Controller Description

A Carel electronic controller pR300T (Carel P/N# PRK30TD3F0) is used as the ECO2 Mini system controller, if needed it can be found with following link https://www.carel.com/documents/10191/0/+0300018EN/aabf1c2a-858d-4496-ba25-bba895f1b65b?version=1.6.

Picture below shows the layout of the controller and its connection terminals.

Carel pRack300T D Controller

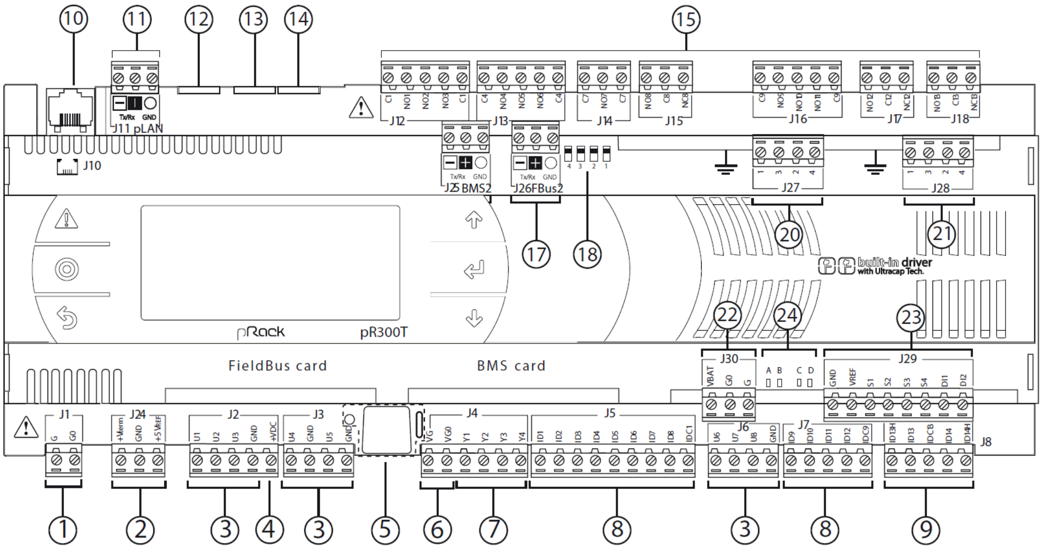


Table 2-4

Key:

Ref.	Description	Ref.	Description
1	Power supply connector [G(+), G0(-)]	13	Reserved
2	+Vterm: power supply for additional terminal +5 VREF power supply for ratiometric probes	14	Reserved
3	Universal inputs/outputs	15	Relay digital outputs
4	+VDC: power supply for active probes	16	BMS2 connector
5	Button for setting pLAN address, second display, LED	17	FieldBus2 connector
6	VG: power supply at voltage A(*) for opto-isolated analogue output VG0: power to opto-isolated analogue output, 0 Vac/Vdc	18	Jumpers for selecting FieldBus/ BMS
7	Analogue outputs	20	Electronic valve A connector
8	ID: digital inputs for voltage A (*)	21	Electronic valve B connector
9	ID..: digital inputs for voltage A (*); IDH..: digital inputs for voltage B (**)	22	Connector for external Ultracap module (accessory)
10	pLAN telephone connector for terminal/downloading application	23	Valve driver analogue and digital inputs
11	pLAN plug-in connector	24	Valve status signal LED
12	Reserved		
(*) Voltage A: 24 Vac or 28 to 36 Vdc; (**) Voltage B: 230 Vac - 50/60 Hz.			Tab. 2.b

This controller has built-in two stepper motor drivers identified as valve A and valve B to manage the two main valves, High Pressure Valve (HPV) and the Flash Gas Bypass Valve (FGBV); it also has the Ultracap capacitor that will allow the controller to close those two valves if the unit shuts off or in case of power failure.
pRack300T D is a very powerful controller. It can be applied to many applications. In this manual, we use pRack300T D to focus on a single compressor condensing unit for medium temperature or low temperature applications only.

The pRack300T D will be managing the condensing unit only and it will be based on compressor demand capacity (suction pressure) and ambient conditions, it does not have the capability to manage display cases or walk-ins, those will or can be managed by the main controller system in the store which can be a different brand name.
<u>If there is a need to manage display cases or walk-ins then additional devices and case controllers can be added to the system to make this a whole package.</u>

2.6.2 ECO2 Mini, MT and LT I/O list

Here below are examples for MT and LT Input / Output list

MT I/O List

pR300T CAREL					
Digital Output					
Connector	**Signal**	**Application**			
J12-1	**NO1**	Run Compressor			
J13-4	**NO6**	General Status Red Light			
J14-7	**NO7**	EC- Fan Motor			
J27 (Stepper Output)			**J28 (Stepper Output)**		
Connector	**Signal**	**Application**	**Connector**	**Signal**	**Application**
J27-1	**1**	HPV Green	**J28-1**	**1**	FGBV Green
J27-3	**3**	HPV Brown	**J28-3**	**3**	FGBV Brown
J27-2	**2**	HPV Yellow	**J28-2**	**2**	FGBV Yellow
J27-4	**4**	HPV White	**J28-4**	**4**	FGBV White
J2 (Analog Inputs)			**J3 (Analog Inputs)**		
Connector	**Signal**	**Application**	**Connector**	**Signal**	**Application**
			J3-2	**GND**	Common
J2-3	**U3**	TS3 Ambient Temp Sensor	**J3-3**	**U5**	TS5 Discharge Temp Sensor
J2-4	**GND**	Common			
J5 (Digital Inputs)			**J6 (Analog Inputs)**		
Connector	**Signal**	**Application**	**Connector**	**Signal**	**Application**
J5-2	**ID2**	Compressor VDF Fault	**J6-1**	**U6**	TS4. Suction Temp Sensor
J5-3	**ID3**	Compressor INT69 Fault	**J6-2**	**U7**	PT3 Suction Pressure
J5-4	**ID4**	HPC	**J6-4**	**GND**	Common
J5-6	**ID6**	TK4 Oil Regulator			
J5-9	**IDC1**	Common (- VDC) Power supply			
J29 (Analog Inputs)			**J4 (Analog Outputs)**		
Connector	**Signal**	**Application**	**Connector**	**Signal**	**Application**
J29-1	**GND**	Common	**J4-1**	**VG**	24 VDC Power Supply (+)
J29-2	**VREF**	5 VDC, PS Comm. PS for PT1 & PT4	**J4-2**	**VG0**	24 VDC Power Supply (-)
J29-3	**S1**	PT1, Gas Cooler Pressure Transd	**J4-3**	**Y1**	Compressor VDF (+)
J29-4	**S2**	TS2 Gas Cooler Outlet Sensor	**J4-4**	**Y2**	EC-Fan Motor (+)
J29-5	**S3**	PT4, Flash Gas Tank Pressure Transd.			

LT I/O List

pR300T CAREL					
Digital Output					
Connector	**Signal**	**Application**			
J12-1	**NO1**	Run Compressor			
J13-4	**NO6**	General Status Red Light			
J14-7	**NO7**	EC- Fan Motor			
J27 (Stepper Output)			**J28 (Stepper Output)**		
Connector	**Signal**	**Application**	**Connector**	**Signal**	**Application**
J27-1	**1**	HPV Green	**J28-1**	**1**	FGBV Green
J27-3	**3**	HPV Brown	**J28-3**	**3**	FGBV Brown
J27-2	**2**	HPV Yellow	**J28-2**	**2**	FGBV Yellow
J27-4	**4**	HPV White	**J28-4**	**4**	FGBV White
J2 (Analog Inputs)			**J3 (Analog Inputs)**		
Connector	**Signal**	**Application**	**Connector**	**Signal**	**Application**
J2-1	**U1**	TS6. Suction Temp Sensor 2nd Stage			
J2-2	**U2**	PT2 Interstate Pressure	**J3-2**	**GND**	Common
J2-3	**U3**	TS3 Ambient Temp Sensor	**J3-3**	**U5**	TS5 Discharge Temp Sensor 1st Stage
J2-4	**GND**	Common	**J3-4**	**GND**	Common
			J3-5	U4	TS1 Discharge Temp Sensor 2nd Stage
J5 (Digital Inputs)			**J6 (Analog Inputs)**		
Connector	**Signal**	**Application**	**Connector**	**Signal**	**Application**
J5-2	**ID2**	Compressor VDF Fault	**J6-1**	**U6**	TS4. Suction Temp Sensor 1st Stage
J5-3	**ID3**	Compressor INT69 Fault	**J6-2**	**U8**	PT3 Suction Pressure 1st Stage
J5-4	**ID4**	HPC			
J5-6	**ID6**	TK4 Oil Regulator And Oil Sensor	**J6-4**	**U9**	Common
J5-7	**ID7**	Oil Pressure Sensor			
J5-9	**IDC1**	Common (- VDC) Power supply			
J29 (Analog Inputs)			**J4 (Analog Outputs)**		
Connector	**Signal**	**Application**	**Connector**	**Signal**	**Application**
J29-1	**GND**	Common	**J4-1**	**VG**	24 VDC Power Supply (+)
J29-2	**VREF**	5 VDC, PS Comm. PS for PT1 & PT4	**J4-2**	**VG0**	24 VDC Power Supply (-)
J29-3	**S1**	PT1, Gas Cooler Pressure Transd	**J4-3**	**Y1**	Compressor VDF (+)
J29-4	**S2**	TS2 Gas Cooler Outlet Sensor	**J4-4**	**Y2**	EC-Fan Motor (+)
J29-5	**S3**	PT4, Flash Gas Tank Pressure Transd.			

Carel pRack controller is preprogrammed from factory and will have setpoints loaded with default values.

2.6.3 Controller Power Supply

The requirement of power supply to the pRack PR300T is 24VAC +10%/-15%, 50/60Hz, 40VA Minimum.

• Power supply out of range could seriously damage the controller.

• A Class II safety transformer must be used in the installation to only supply power to the pRack PR300T controller.

• The power supply to the pRack PR300T controller and terminal should be separated from the power supply to the other electrical devices (contactors and other electromechanical components) inside the electrical panel.

• A yellow LED indicates that power is connected to the pRack PR300T

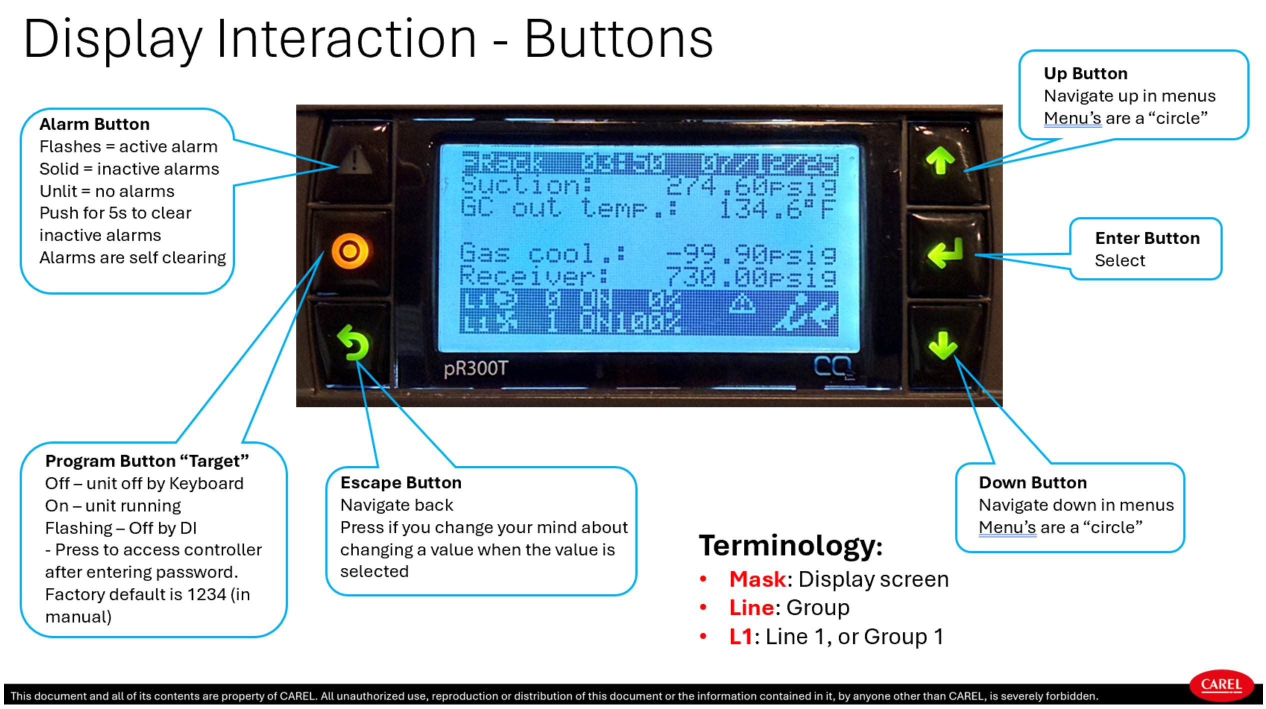
2.7 Carel Controller User Reference Guide

2.7.1 Graphic Terminal

The pRack PR300T user interface is represented by the pGDE terminal, panel or built-in versions. The functions associated with the 6 buttons on the pGDE terminal are the same on all the screens and are described in the table below.

During normal operation, the controller pR300T will modulate the two valves, the HPV and FGBV, around the control set points.
There are 6 buttons on the user interface to interact with the controller. The functions of these 6 buttons are:

Button		Function associated
⚠	(ALARM)	displays the list of active alarms and accesses the alarm log
◉		used to enter the main menu tree
↺		return to the higher level screen
↑	(UP)	Scrolls a list upwards or increase the value highlighted by the cursor
↓	(DOWN)	Scrolls a list downwards or decrease the value highlighted by the cursor
↵	(ENTER)	enter the selected submenu or confirm the set value



The LEDs associated with the buttons have the following meanings.

Meaning of LEDs

LED	Button	Meaning
Red	⚠	Flashing: active alarms present and not acknowledged Steady: alarms present and acknowledged
Yellow	◉	pRack PR300T on
Green	↺	pRack PR300T powered

2.7.2 Description of the display

There are three fundamental types of screens shown to the user:
· Main screen
· Menu screen
· Screen for displaying/setting the parameters

Main screen

The main screen is the screen that the software on board pRack PR300T automatically returns to 5 minutes after the last button was pressed. An example of the main screen is shown in the figure below, highlighting the fields and icons used:

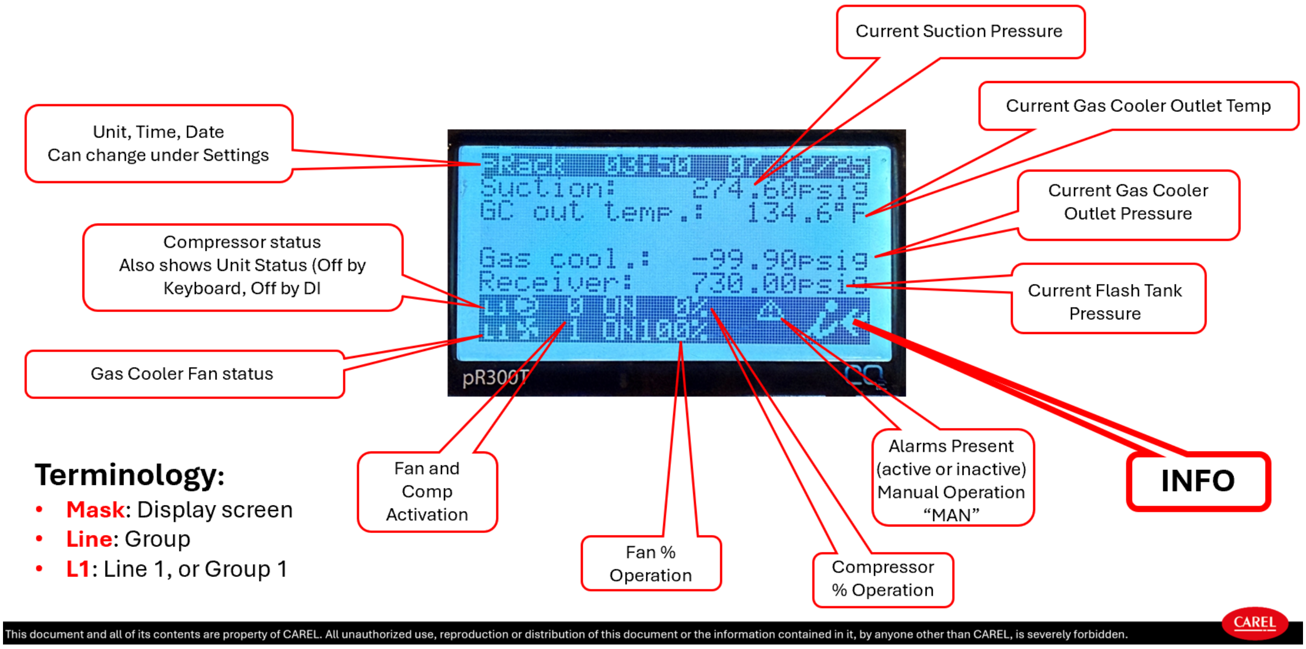
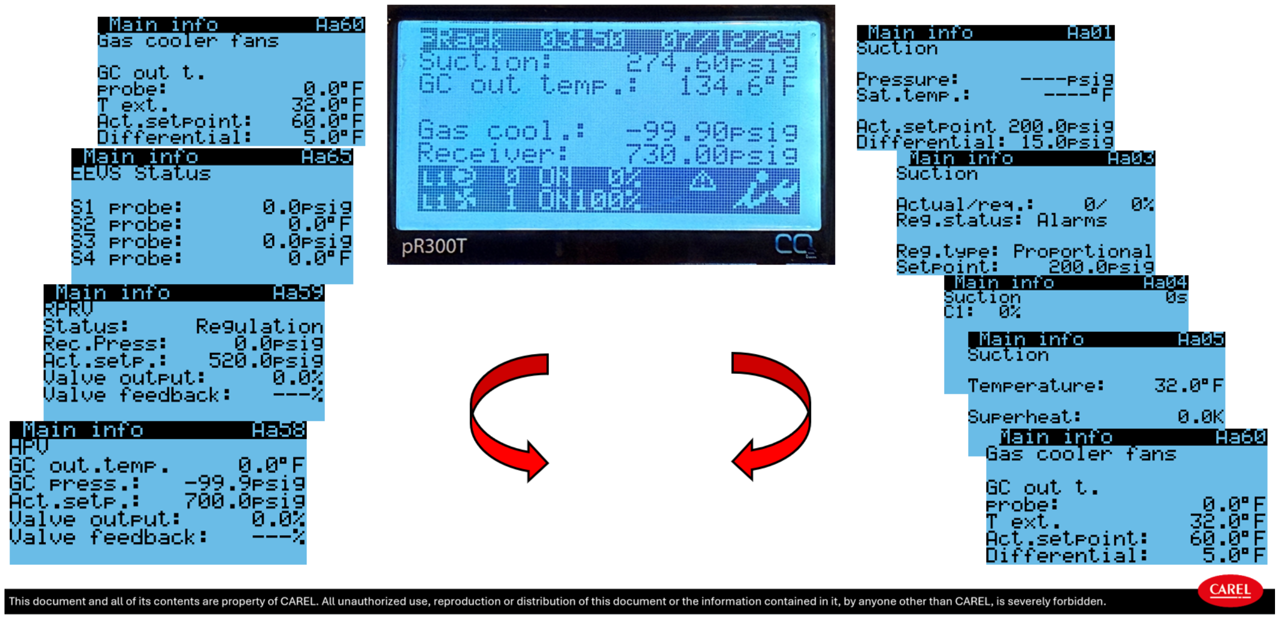


Figure 2-7 Controller main screen

The information relating to the main values (Fig. 2-7) shown on the main screen when first starting vary according to the system configuration (one line, two lines, two lines with shared condenser) and the type of control value (pressure, temperature).
The main screen or the default screen is the screen that the software on board pRack PR300T automatically returns to 5 minutes after the last button has been pressed.

The figure below shows how to navigate and what information can be found under the main info screen, this capability allows you to see multiple mask and information regarding the operation and status of the unit without the need to navigate to specific menu to find that particular information.

Navigation – Main Info



Password

pRack PR300T manages three levels of password:

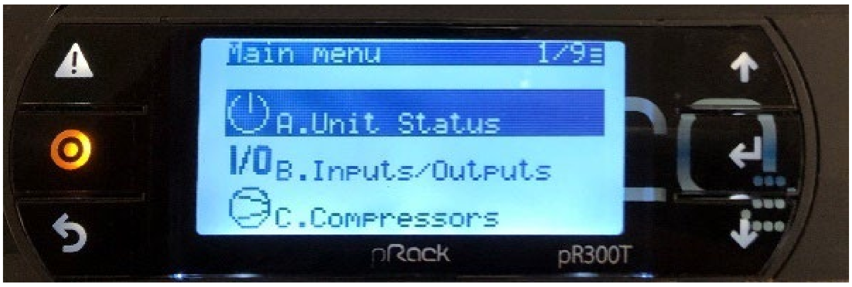
• User
• Maintenance
• Manufacturer

Each level includes the same rights as the lower levels, that is, the Manufacturer can access all the screens and parameters, the Maintenance can access the screens and parameters available in the Maintenance and User levels, while the User can only access the screens and parameters available in the User level.

How to Enter a Password:

To enter Menu Screen, password is required. Press yellow ⊙ button once to allow user to enter password mode:

Press ↑ once will change the first digit value to "1"; press ↵ button once and the cursor will move to the second digit; press ↑ twice will change the second digit value to "2"; press ↵ button once and the cursor will move to the third digit; press ↑ three times will change the third digit value to "3"; press ↵ button once and the cursor will moves to the fourth digit; press ↑ four times will change the fourth digit value to "4". "1234" is the password. Press ↵ again will allow the controller to enter Main Menu Screen as below:

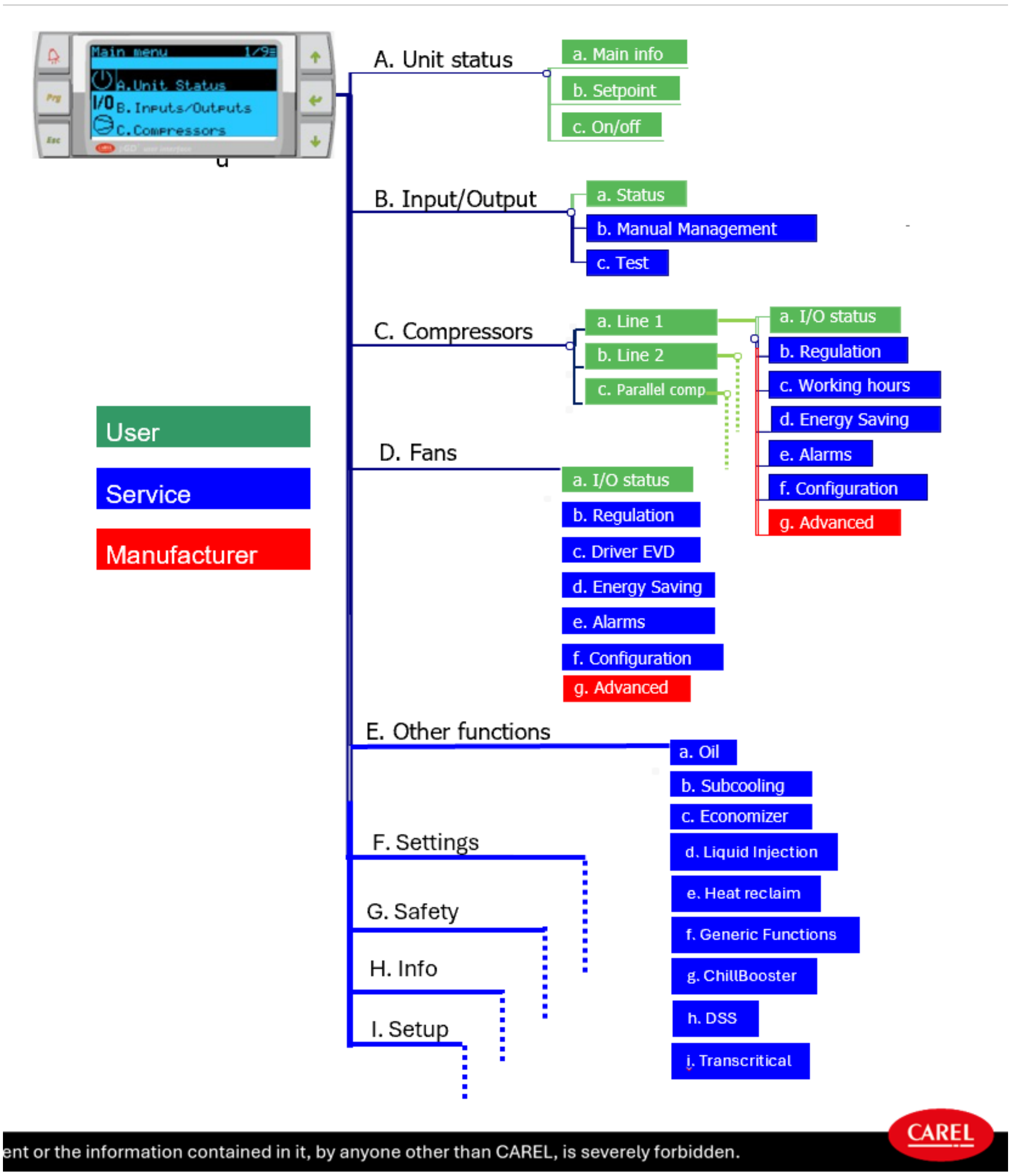


Menu Screen

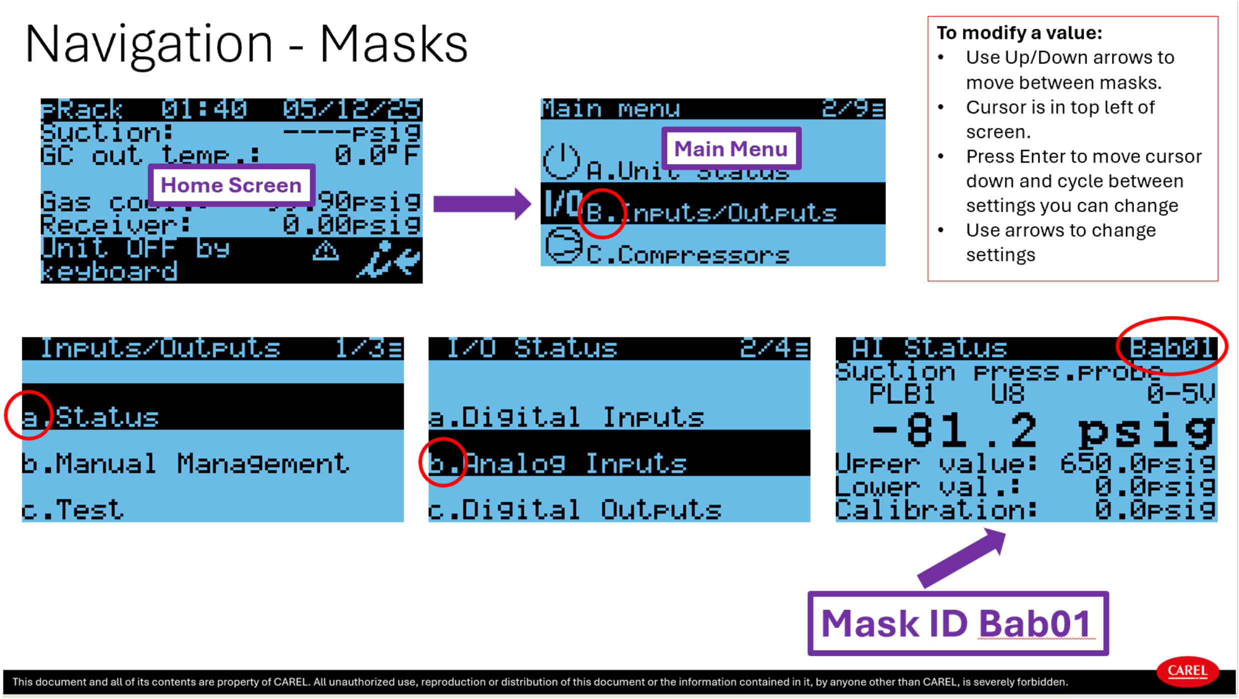
MASK ID (Screens):

Branches of menu divided per functions: inside every branch there are parameters and variables relative to the specific function.

There are 9 sections under the Main Menu, from A to I.



An example of how to navigate between manus and masks is shown below.

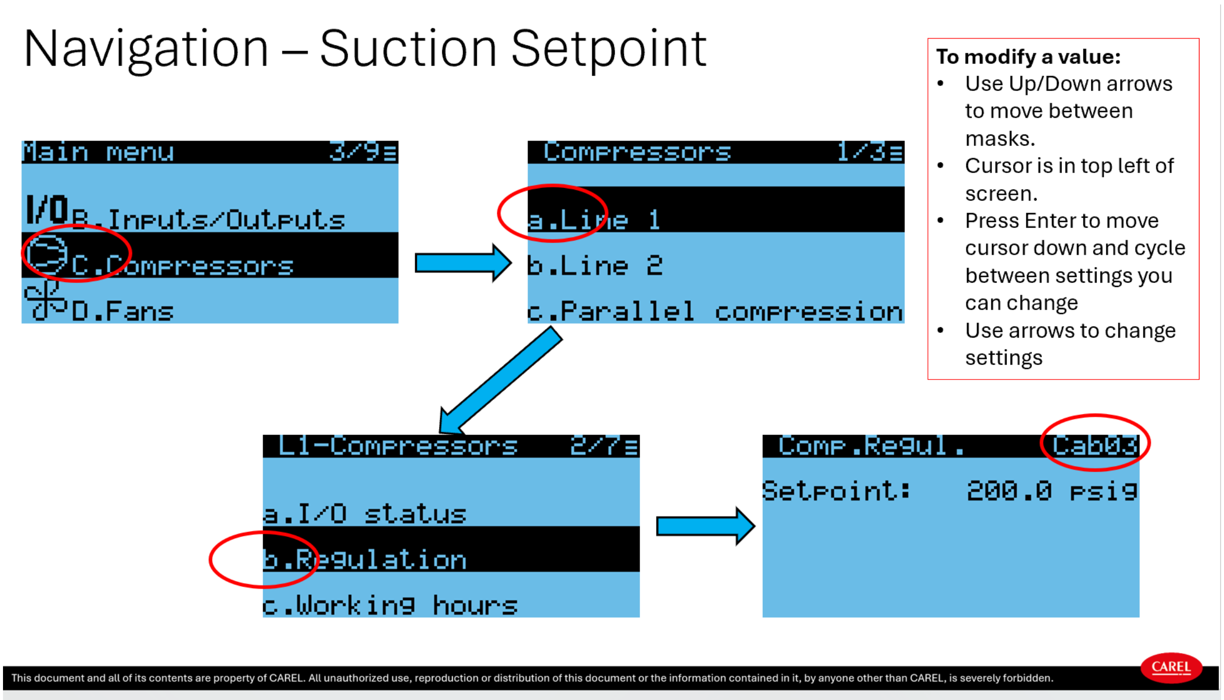


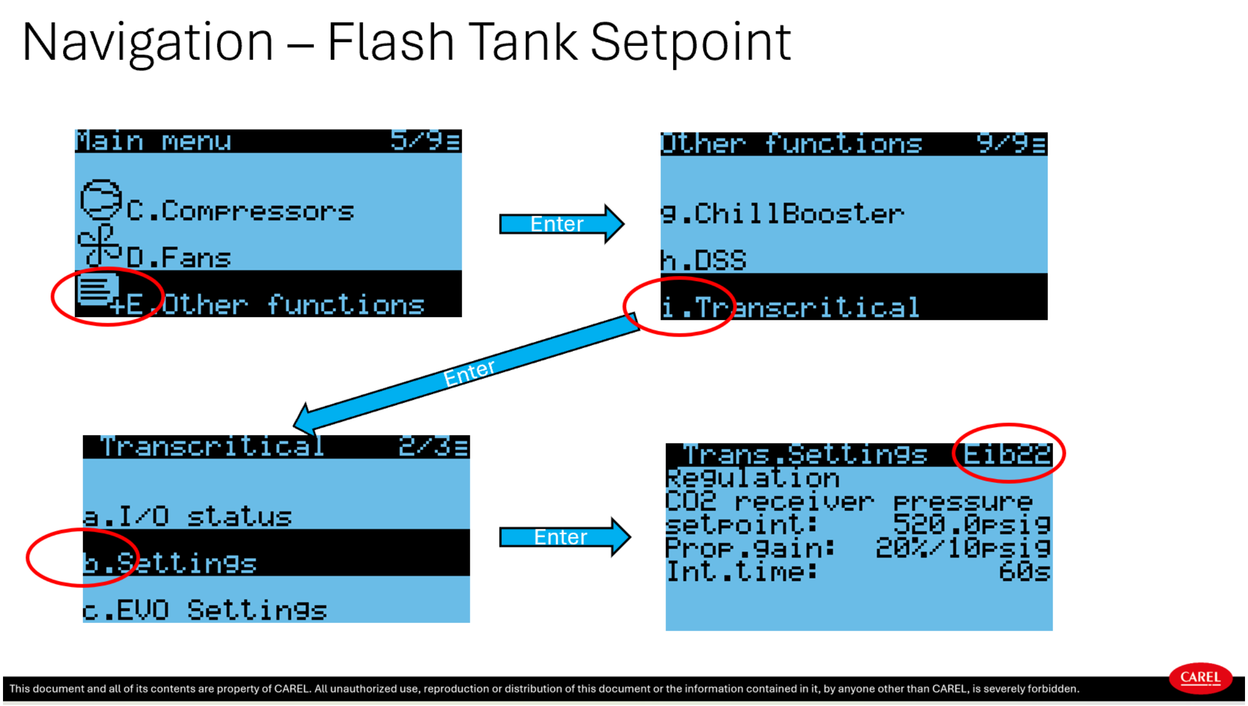
How to Change a Setpoint:

To change the suction pressure setpoint, go to Page Ab12 by scrolling pages with ↓ or ↑ button. Once on Page Ab12, press ↵ button will activate the changing mode. Using ↓ or ↑ button to change the value until the setpoint is seen. Then hit ↵ to accept the set point value.

To change the gas cooler outlet temperature setpoint, go to Page Ab13 by scrolling pages with ↓ or ↑ button. Once on Page Ab13, press ↵ button will activate the changing mode. Using ↓ or ↑ button to change the value until the setpoint is seen. Then hit ↵ to accept the set point value.

Here below are couple of examples of how to change the suction and the flash gas setpoints; the suction set point is something that may need to be changed per site depending on the application. Whereas for the flash tank this is a parameter that may need to change only on Low temperature units depending on the design conditions, consult table XX for proper flash gas tank value for Low Temperature units.





2.7.3 Set Points - Temperatures and Pressures

Typical temperature and pressure values in our refrigeration applications are defined by the operating conditions.
The ECO2 Mini units will be programmed with default values as shown below:

MEDIUM TEMPERATURE UNITS

- Saturation evaporating temperature = +20°F

- Saturated pressure at evaporating saturation temperature = 407.2 psig
- Flash Tank Pressure = 521.2 psig
- Flash Tank temperature = 36F
- Gas Cooler outlet temperature = 95F

LOW TEMPERATURE UNITS

- Saturation evaporating temperature = -20°F
- Saturated pressure at evaporating temperature = 200.2psig
- Flash Tank Pressure = 521.2 psig
- Flash Tank temperature = 36F
- Actual Flash tank pressure depends on operation/design conditions; see Appendix 2.
- Actual Flash Tank temperature depends on operation/design conditions; see Appendix 2.
- Gas Cooler outlet temperature = 95F

CO_2 REFRIGERANT PROPERTIES

- Critical Temperature = 87.7°F
- Critical Pressure = 1054.4 psig
- Triple point pressure = 60.4 psig

3. Inspection and Placement of the Unit

When the condensing unit arrives at the job site, it should be thoroughly inspected upon unloading for damage or missing parts. If there is any damage, notify the carrier immediately and file a claim.

3.1 Accessories

Be sure that you receive all items. Accessories may be packaged separately. Check the packing list against the contents. If parts are missing, contact the Technical Sales Support (TSS) or the point of contact provided on the packing list.

Normally the unit is shipped with three subassembly sets of pressure relief valves that shall be installed in the field by the refrigeration contractor or others; 2 of those sets rated for 1305psi which will be installed in the SUCTION PRV line and the FGT PRV line as labeled in the side panel of the unit, the other set will be rated for 1740psi and should be installed in the GAS COOLER PRV line as labeled in the same side panel.

Liquid dryer and suction filters are optional per RC, or end user.

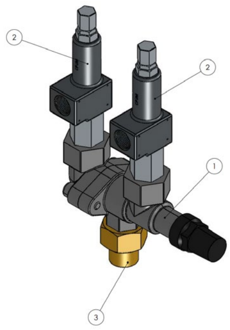
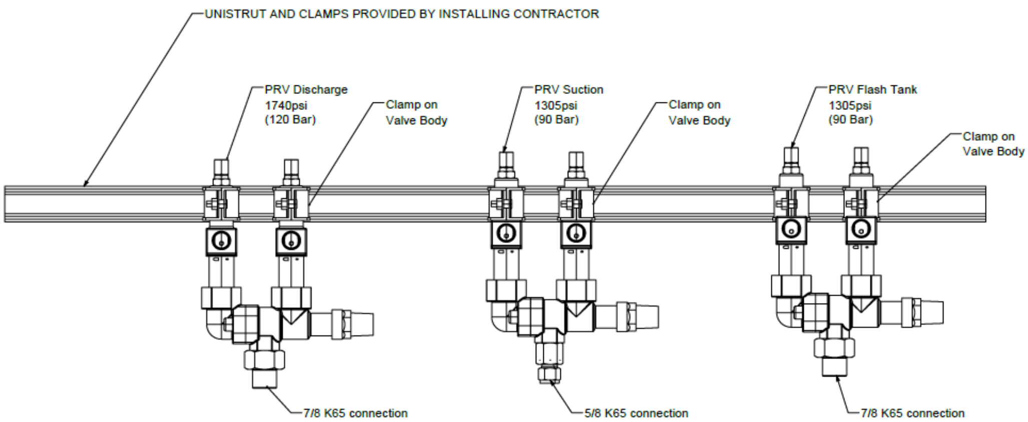


Fig. 3.1 Example of ship loose Pressure Relief Valves (PRV) set

Pressure relief valve sets are recommended to be installed as shown on figure below, meaning that the valves should be clamped at the valve body and not on the pipe to prevent the PRVs from being knocked down in case of relief.



3.2 Holding System Pressure

The system is shipped with a holding charge of dry nitrogen at 50 psig. Report on the lack of charge or reduced pressure in the unit immediately to the Kysor Warren Technical Sales Support.

3.3 Electrical

Check all electrical ratings. All specifications on the electrical rating plate must match the on-site power configuration. Field wiring sizes and the power supply protection device must match the name plate ratings.
The ECO2 Mini unit is a single connection point, and it would be 208-230/60/3 or 460/60/3 depending on the unit, verify all paperwork and ensure the supply power matches what is required for the unit.
Refer to electrical information for each unit model as shown in Appendix 3 of this manual.

3.4 Copper Tubes and Materials

All copper tubes and materials on liquid and suction lines used during field installation including ball valves, expansion valves, sight glass, pressure controls, pressure transducers, etc. must be rated for 1305psig working pressure or higher.
The piping material used between compressor discharge up the high pressure valve inlet is factory installed and is rated for 1740psi.

3.5 Placement of the Unit

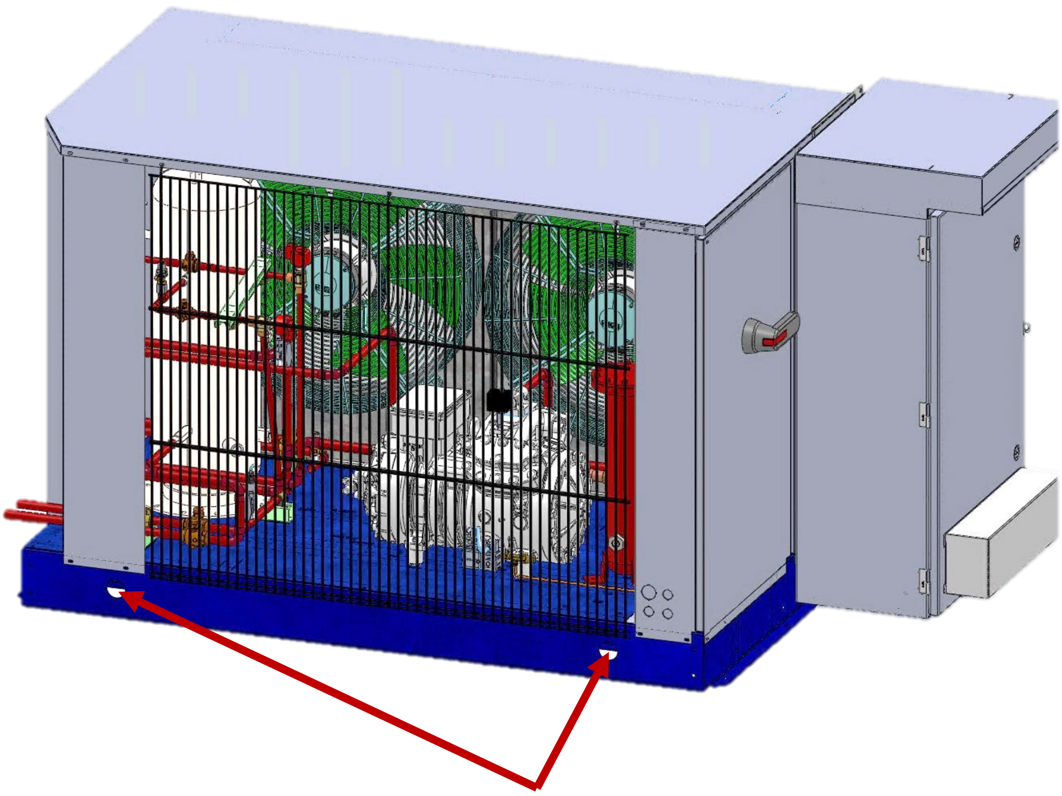
The ECO2 Mini condensing unit should be placed where abundant fresh air flow is available around the unit. Below are some recommendations:

- The mounting platform should be level and easy to access for service.
- The unit should not be located near steam, hot air or fume exhaust.
- The unit should have adequate support to avoid vibration and to reduce noise transmission into the building. Some rubber vibration isolator pads may be used for that purpose.
- If the unit is mounted on the roof, a mounting curb or a steel channel base is necessary and should support the weight of the unit.

3.6 Lifting instructions

KWE provides information on the weight of the equipment and the location of lifting points.
Being at the site, the contractor is best qualified to decide the specific materials needed to lift the equipment.

Figure below shows lifting holes for the refrigeration equipment,



Lifting (passing through) holes in four corners

4. Installation and Start-Up

4.1 General

Installation of the refrigeration unit must follow the “Safety Standard for Refrigeration Systems” (ANSI/ASHRAE Standard 15), ASME B31.5 Refrigeration Piping Standard, and local building codes.

- Properly sized refrigeration lines are essential for operation and oil return in the system. Consult Engineer of Record (EOR) drawings for line sizing and store piping layout.
- Do not run refrigeration lines from one system through cases for another system.
- Refrigeration lines should never be placed in the ground unless they are protected from moisture and electrolysis attack.
- Main trunk lines should enter a line-up of cases in the center.

4.2 Field Piping

The installer and EOR are responsible for selection of tubing materials, and sizing of the liquid and suction lines. Parker Sporlan’s Virtual Engineer Sizing and Selection Tool or Danfoos Coolselector can be used as good guidance to select line sizes.

- Liquid and suction lines should be installed according to equipment layouts and customer specifications.
- Liquid and suction lines should be insulated with Armaflex 1” thickness minimum or follow the customer specifications.
- Any changes to diameters and materials should be confirmed and documented.

4.2.1 Pipe Pressure Ratings

This specification is used in conjunction with the customer specifications. It is intended to supplement and clarify the scope of work and technical specifications for field refrigerant piping for Transcritical CO2 Refrigeration System as well as leak testing, approval of local authorities, charging, start-up and commissioning of the entire system.

The ECO2 Mini unit is designed with stand still pressures of 1305psi, therefore all piping and components installed between the unit and display cases, cooler or freezer should meet this requirement of 1305psi design working pressure as well.

The piping should be installed with adequate clearance between pipe and adjacent walls and hangers to allow for service and inspection. Use pipe sleeves through walls, floors, and ceilings. These should be sized to permit installation of pipes with full thickness insulation.

Liquid Lines

The CO2 liquid lines must be rated at 1305psi (90 bar). Since the lubricant is miscible with the liquid refrigerant and because there is positive pressure driving the flow of the liquid refrigerant, these lines do not require special arrangements for oil return. Pipe sizing specifications are designed to achieve the proper velocity and minimum pressure drop. Increasing the pipe size results in greater demand for the refrigerant. Decreasing the pipe size results in a higher-pressure drop. Refer to site-specific piping drawings for liquid piping installation information.

Suction Lines

The CO2 suction lines must be rated at 1305psi (90bar). Refrigeration suction lines should be sloped approximately **½ inch per 10 feet** (or 1 inch per 20 feet) towards the compressor to ensure proper oil return.

Suction lines carry vapor back to the compressor from the evaporator(s), the suction lines may travel horizontally or vertically to the ECO2 Mini. All CO2 suction horizontal return lines must be installed with a slope or pitch downward of 1 inch per 20 feet towards the ECO2 Mini unit. This slope is crucial for the system's health, as it prevents oil from pooling in the evaporator or other horizontal runs, which can reduce efficiency and damage the compressor.

Any suction line that travels vertically such that the direction of refrigerant flow is against gravity, is called a suction riser. Refrigerant flowing through suction risers present more difficulty to carry the lubrication oil back to the compressor therefore those lines need to be sized for the proper velocity to carry the oil back to the compressor. Oil traps are therefore included in the suction lines to help carry the oil.

Isolation Valves

If the customer requires isolation valves for individual circuits, they must be full port ball valves with check bypass valves and rated for 1305 psi minimum. Check valves and liquid and suction lines point towards the compressor. The RC should obtain verification (sign-off) from the customer construction manager to confirm the proper direction before proceeding with the insulation. The bypass check valves are required for instances when the isolation valves are closed while the pressure of the refrigerant rises. In these cases, the check valves open and distribute the pressure (towards the rack) avoiding any damage to the pipelines and other equipment. Figure 4-1 illustrates the positioning of check valves.

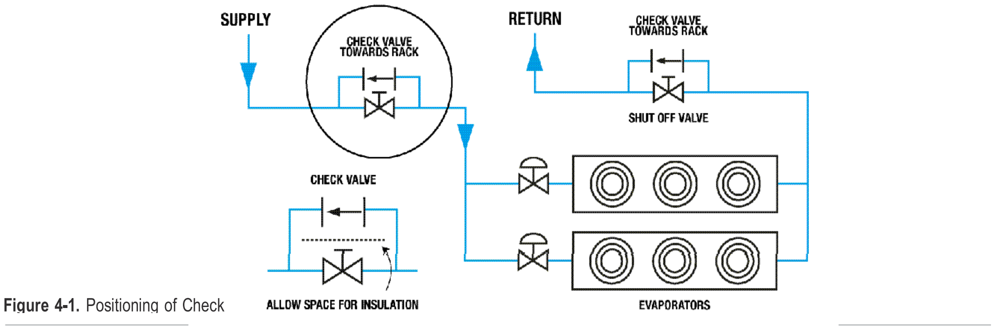


Figure 4-1. Position of Check Valves

Relief Valve Installation

Kysor Warren will provide ship loose pressure relief valves assembly kits for 3 different points, a) Gas cooler which requires 1740 psi (120Bar) pressure relief valves, b) Flash tank which requires 1305 psi (90Bar) pressure relief valves and c) Compressor suction line which requires 1305 psi (90Bar) pressure relief valves. Piping connecting the pressure relief assemblies shall conform with pressure rating according to the valve they are serving.

It is responsibility of the refrigeration contractor to install pressure relief valves to comply with ASHRAE Standard 15 latest version and any applicable local codes.

Also refer to EOR drawings for PRV installation.

Brazed Joints

Kysor Warren recommends using brazed joints.

Copper joints are brazed with a minimum of 15% silver brazing alloy (filler) and for dissimilar metals use minimum 45% silver brazing alloy (filler). While brazing, pass nitrogen gas through the pipe or tubing to prevent oxidation as each joint is brazed.

NOTE

Cap the system with a reusable plug after each brazing operation to retain the nitrogen and prevent the entry of air and moisture.

The following are some considerations for brazed joints. When in doubt, consult the technical manual or legend sheet.

- Suction and liquid lines are not taped or soldered together. Instead, use a heat exchanger.
- There is no flux present on the soldered joint.
- P traps are at the bottom of suction line risers that are 10 feet or longer.

- For P-traps, reduce in the vertical line, never reduce in the horizontal line; see figure 4-2 for proper trap construction.

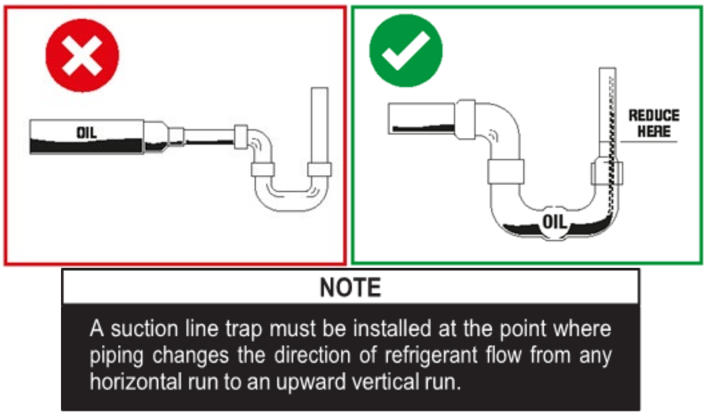


Figure 4-2. Placement of Oil Traps on Suction Lines

- Double riser may be needed when multiple loads are combined in a single raiser
- Double P traps may be needed if the riser is 20-foot or longer.
- Use long radius ells and avoid 45° ells.
- Flux only the male part of the connection line never the female part. Remove the flux after brazing.
- Horizontal suction lines should be sloped approximately ½" per 10 ft (or 1" per 20ft) toward the compressor to ensure oil return.

Piping should not disrupt or restrict refrigerant flow. Allow sufficient "play" in the piping system and minimize abrupt changes in refrigerant direction to reduce internal stress and pressure drop. Short radius elbows, for example, should be avoided if possible because they increase stress on the piping and cause the refrigerant to lose pressure.

4.3 Leak Check

Follow the steps below and do a throughout leak check.

Step 1. Pre-Check

- Visually inspect refrigerant lines and joints for proper piping assembly and installation
- Proper bracing is used throughout the system. Inspect for any metal-to-metal contact.
- Manually verify that all mechanical joints are tight. Ensure all electrical connections are tight.
- Check the phase monitor for correct polarity

Step 2. Isolate Components Not Suitable for the Pressure Levels

Step 3. Disconnect or Bypass All Defrost Heaters

Step 4. Open All Valves Including Solenoid Valves

Step 5. Perform Leak Check

- System pressure is brought to a minimum of 300 psig.
- Verify pressurization at multiple system access points.

If Leak Is Found:

- Leak is isolated from the rest of system and is repaired
- Area of repair is retested
- The area is re-pressurized to a minimum 300 psig All valves are re-opened
- After all leaks are repaired and retested, the system stands unaltered for 24 hours with no greater than a +- 3 PSIG change
- When the system is ready to be evacuated, the nitrogen charge is released.

4.4 Evacuation

- System is depressurized
- Check for evacuation pump and sensors working properly
- No contamination is introduced
- Copper lines or approved vacuum hoses are needed.
- Vacuum pumps have enough capacity to reach and evacuate all parts of the system.
- Vacuum pump oil as recommended by manufacturer (use new and clean oil)
- Electrical connections are secure and uninterrupted
- Evacuation pump is connected to the system
- There are no leaks at the vacuum pump connections.
- All access valve caps are tightened
- Micro Vacuum Gauge is properly calibrated
- Verify with gauge that pump can pull a vacuum of at least 300 microns
- Vacuum is measured at a minimum of two points which are at extreme points within the system

4.4.1 Triple Evacuation Procedures

1st Evacuation

- Pull a system down to at least 1,000 microns (+/- 50 microns) and close the vacuum header valves.
- If the system cannot maintain vacuum and returns to atmospheric pressure, check and correct leak(s) as previously described.
- When system maintains 1,000-micron vacuum for 30 minutes, break the vacuum with dry nitrogen to a pressure of 2 psi.

2nd Evacuation

- Pull a second vacuum to a minimum of 500 microns.
- Close vacuum header valves
- If the 500-micron vacuum holds for a minimum of 30 minutes, then break the vacuum with the CO2 vapor to a pressure of 2psig
- Install system suction and liquid drier cores if needed. (optional)
- Add proper oil to the compressor and oil separator Dorin Compressors use oil as listed on Table 2.3 Approved Lubricant Oil. BITZER POE oil BSE85K is also approved.

3rd Evacuation

- Pull a third vacuum to 300 microns.
- Close vacuum header valves and allow system to stand for a minimum of 24 hours
- The system is ready to be charged with refrigerant if the vacuum conditions are held for 24 hours with a maximum drift of 100 microns over the 24-hour period.
- Break the vacuum with CO2 vapor until the gauge pressure of 150psig is observed in all parts of the system.

4.5 Initial Start-up and Charging CO2

4.5.1 Initiate System Power

Before charging the system on startup, please confirm that:

- Power has been turned on to the system
- Control Panel is energized
- Panel switches are set with compressor OFF
- Make sure the gas cooler fans are operational

- Evaporator fans are operational
- Verify display cases and walk-in cooler case controllers are programmed and operational
- Double check the controller with correct setpoints per specifications
- Controls, gauges, and thermometers are displaying temperatures and pressures (Check values expected without refrigeration system operating)

4.5.2 Required Equipment and Materials

The following materials and tools are needed to charge the system. The refrigeration installation contractor is responsible for having these materials and tools.

CO2 Vapor Cylinders

R744 Refrigerant, Instrument or Coleman Grade vapor. Used to break vacuum and pressurize the system to 100 to 150 psig (see vacuum 3rd evacuation). Tanks are stored at room temperature; it is not recommended to store tanks outside.

CO2 Liquid Cylinders (w/dip tube)

Instrument or Coleman Grade CO2 for remainder of charge – reference refrigeration legend for estimated charge

Charging Hoses

3/8" hose recommended for faster charging

Rated for 1740 psig working pressure

Manifold Gauges

Rated for 2000 psig working pressure

CGA-320 Adapter Fitting

CO2 cylinders (liquid and vapor) have CGA-320 fittings. An adaptor is required to connect the CO2 cylinder to a flare connection on charging hoses for liquid charging.

Filter/Dryer

Provide optional filter/dryer in field charge line. Change filter/dryer about every 500lb CO2

Refrigerant Scale

Measures the quantity and rate of CO2 charging from the cylinders. The scale needs to be rugged enough for the weight and handling of the cylinders.

Oil

4.5.3 Oil Charge

Oil Charge to the Oil Separator

Oil is recommended to be added to the system on the second evacuation as listed above.

Confirm that oil is compatible with compressors

Close valves to isolate oil separator

Open oil separator

Fill the separator with oil based on manufacturers' recommendation.

Oil Charge to Compressors

Oil to compressor based on the manufacturers recommended.

Confirm that the compressor crankcase heaters are energized 24h before startup

NOTE

Crankcase heater must be operating to warm the oil prior to starting the compressor.

4.5.4 Charge the CO2 Vapor

Break the vacuum only with vapor CO2 to 150psig

DO NOT break the vacuum with liquid CO2 since it will form dry ice potentially causing damage to the equipment.

Leave all valves open, complete system and piping distribution network with vapor charge

Continue charging vapor until the whole system is charged with CO2 vapor at 150psig or higher.

Check that any rack gauges and control pressures read 150 psig.

Gauges or sensors that are reading less than 150 psig indicate that some valves might be closed, or faulty pressure transducer

Gauges or sensors reading greater than 150 psig indicate faulty pressure transducer reading

NOTE

For CO2, saturation temperature = -34°F @ 150 psig

4.5.5 Checking Control Devices

When power is first applied to the system, the system controller pRack 300T will go through a start-up check. If there's no alarm occurring, the controller will energize the compressor relay and start the compressor. The controller will follow the Sequence of Operation (SOO) and system will go to normal operation.

Mechanical Pressure Switches

Confirm that mechanical switches are operating properly. All pressure controls should be adjusted until they actuate, and it is verified that the desired result is achieved. The controls should then be set to their proper setpoints (reference SOO).

Compressor High Pressure Controls – reference SOO for setpoints

Tag or Label preset Mechanical High Pressure Cut-off Switches

Compressor and/or Low-Pressure Controls – reference SOO for setpoints

Tag or Label preset Mechanical Low Pressure Cut-off Switches

Pressure & Temperature Sensors

Check that all pressure and temperature sensors are calibrated and provide accurate readings at the controller

Cases or evaporators

Gas Cooler Outlet

Walk-ins

Flash Tank

Oil Supply

Gas Cooler

Suction

Discharge

Ambient Air Temperature

Oil Separator Outlet Pressure (if applicable)

Digital Input Verification

Check that all digital inputs are reading open or closed as expected. Exercise each component as possible and verify the results at the proper input point.

Compressor Fails

VFD Faults

Oil Separator Level Switch

Relay Output Verification

All relay outputs should be exercised, and the proper results verified.

Compressor Runs

VFD Bypasses (when provided)

Valve Gas Cooler Bypass Valve

Analog Output Verification

All analog outputs should be exercised, and proper results verified.

Compressor Speed Reference

Gas Cooler Fan Speed Reference

High Pressure Regulator Valve (HPV)

Flash Gas Bypass Valve (FGV)

VFD Set-up Verification

Verify all Control Setpoints.

Suction Pressure Targets

Gas Cooler Outlet Temperature Differential Target (Supercritical)

Flash Gas Pressure Target

Gas Cooler Bypass Valve

Electrical Connections

Connections to the display cases and walk-in freezers have been completed and proper operation of lights, fans, and anti-sweat heaters have been established.

Connections to the display cases and walk-in freezers are completed

Verify the operation of lights Verify the operation of fans

Verify the operation of anti-sweat heaters

4.5.6 Charge CO2 Liquid to Flash Tank

Safety Precaution Note: Charging CO2 refrigerant increases pressure in the system.

Close the main CO2 liquid line valve

Check that EEVs at cases and walk-ins are also in the closed position

Purge air from refrigerant tank supply hoses before attaching to the flash tank

Fill liquid CO2 directly into the flash tank

Adjust the flow of CO2 refrigerant by adjusting the valve on the refrigerant tank

Typical tanks should be fully released in approximately 5 minutes (releasing CO2 refrigerant too quickly may cause some solids to form in the valves resulting in sputtering)

The Flah Gas Bypass Valve should begin opening around 520 psig

Do not exceed the second sight glass of the flash tank (~50%) during charging

Frost should form on the base of the refrigerant tank when the tank is close to empty

Check to purge air from hoses when adding new refrigerant tank(s)

4.5.7 Start Compressor

Turn on the power to compressor so it is able to run as needed

Turn on the case controllers or evaporator control

Gradually open the liquid line valve

The suction pressure should rise to the compressor cut-in pressure.

The compressor starts running and pulls down case or cooler room temperatures.

Add CO_2 liquid to maintain the flash tank level just above first sight glass (no more than 25%) after the system is running at operating temperatures.

Check the case temperature or evaporator room temperature to make sure the system meets the required design conditions.

4.6 Start Up Check List

Check the liquid line and suction line service valves.

Make sure they are fully open.

Check HPV and FGBV. Make sure they are functioning properly.

Check refrigerant liquid level at the flash gas tank

5. Replacement Part List

Below is a list of replacement parts. Please contact Kysor Warren service department for availability and delivery.

6. APPENDIX 1 - ECO2 Mini Selection table for capacities at different conditions

Model Number	Voltage	Application	Ambient Temp [ºF]	GC Outlet Temp [ºF]	Medium Temperature Units – Evaporator Cooling Capacity [kBTU/h]					
					SST 10ºF	SST 15ºF	SST 20ºF	SST 23ºF	SST 25ºF	SST 30ºF
ED-010-040-CM-4-OXV-A	460V / 3 P / 60H	MT	90	95	33.1	36.8	40.8	43.3	45.0	49.3
ED-010-070-CM-4-OXV-A		MT			68.8	76.6	84.8	90.0	93.4	102.3
ED-010-100-CM-4-OXV-A		MT			86.2	96.0	106.2	112.6	117.0	128.1
ED-010-040-CM-4-OXV-A		MT	95	100	30.0	33.4	37.0	39.3	40.8	44.8
ED-010-070-CM-4-OXV-A		MT			62.3	69.4	77.0	81.6	84.8	93.0
ED-010-100-CM-4-OXV-A		MT			78.1	87.0	96.4	102.2	106.1	116.3
ED-010-040-CM-4-OXV-A		MT	100	105	26.8	29.9	33.1	35.2	36.6	40.1
ED-010-070-CM-4-OXV-A		MT			55.7	62.1	68.9	73.1	76.0	83.3
ED-010-100-CM-4-OXV-A		MT			69.9	77.9	86.3	91.6	95.1	104.3
ED-010-040-CM-4-OXV-A		MT	105	110	23.7	26.5	29.4	31.2	32.5	35.6
ED-010-070-CM-4-OXV-A		MT			49.4	55.1	61.1	64.9	67.5	74.0
ED-010-100-CM-4-OXV-A		MT			62.0	69.1	76.6	81.3	84.5	92.7
ED-010-040-CM-2-OXV-A	230V / 3 P / 60H	MT	90	95	33.7	37.6	41.7	44.3	46.0	50.5
ED-010-070-CM-2-OXV-A		MT			66.2	73.8	81.8	86.9	90.3	99.1
ED-010-100-CM-2-OXV-A		MT			87.9	98.0	108.5	115.1	120.0	131.2
ED-010-040-CM-2-OXV-A		MT	95	100	30.5	34.1	37.8	40.2	41.8	45.9
ED-010-070-CM-2-OXV-A		MT			60.0	66.9	74.2	78.8	82.0	90.0
ED-010-100-CM-2-OXV-A		MT			79.7	88.8	98.5	104.5	108.6	119.1
ED-010-040-CM-2-OXV-A		MT	100	105	27.3	30.5	33.9	36.0	37.4	41.1
ED-010-070-CM-2-OXV-A		MT			53.6	60.0	66.5	70.6	73.4	80.7
ED-010-100-CM-2-OXV-A		MT			71.3	79.5	88.2	93.6	97.3	106.8
ED-010-040-CM-2-OXV-A		MT	105	110	24.2	27.0	30.0	31.9	33.2	36.5
ED-010-070-CM-2-OXV-A		MT			47.5	53.1	59.0	62.7	65.2	71.6
ED-010-100-CM-2-OXV-A		MT			63.2	70.5	78.3	83.1	86.4	94.9

Model Number	Voltage	Application	Ambient Temp [ºF]	GC Outlet Temp [ºF]	Low Temperature Units - Evaporator Cooling Capacity [kBTU/h]					
					SST -30ºF	SST -25ºF	SST -22ºF	SST -20ºF	SST -15ºF	SST -10ºF
ED-100-040-CL-4-OXV-A	460V / 3 P / 60H	LT	90	95	33.3	37.0	39.4	41.1	45.5	49.7
ED-100-070-CL-4-OXV-A		LT			55.4	61.6	65.6	68.0	73.2	78.4
ED-100-040-CL-4-OXV-A		LT	95	100	32.9	36.6	39.0	40.6	44.7	48.1
ED-100-070-CL-4-OXV-A		LT			55.6	61.7	64.5	66.5	71.3	76.3
ED-100-040-CL-4-OXV-A		LT	100	105	32.4	36.1	38.4	40.0	43.1	46.3
ED-100-070-CL-4-OXV-A		LT			55.6	60.1	62.8	64.6	69.2	73.7
ED-100-040-CL-4-OXV-A		LT	105	110	31.8	35.4	37.1	38.3	41.2	44.2
ED-100-070-CL-4-OXV-A		LT			54.1	58.2	60.7	62.4	66.5	70.5
ED-100-040-CL-2-OXV-A	230V / 3 P / 60H	LT	90	95	28.2	31.4	33.5	34.9	38.7	42.4
ED-100-070-CL-2-OXV-A		LT			46.8	52.1	55.6	57.8	62.4	66.9
ED-100-040-CL-2-OXV-A		LT	95	100	27.9	31.0	33.0	34.5	38.1	41.1
ED-100-070-CL-2-OXV-A		LT			47.0	52.4	55.0	56.6	60.8	65.2
ED-100-040-CL-2-OXV-A		LT	100	105	27.5	30.6	32.6	34.0	36.7	39.6
ED-100-070-CL-2-OXV-A		LT			47.2	51.1	53.5	55.1	59.0	63.0
ED-100-040-CL-2-OXV-A		LT	105	110	27.0	30.0	31.6	32.6	35.2	37.8
ED-100-070-CL-2-OXV-A		LT			46.0	49.6	51.8	53.2	56.8	60.4

Notes:

a) The capacity listed is considering 10F SH at evaporator and 20F Total Superheat
b) If MT and LT loads are combined, an EEPR will be needed for each MT load.
c) Unit has variable capacity for compressors from 50% to 100%
d) Gas cooler fan has EC motors
e) Recommended to use ASHRAE 2021 0.4% Cooling DB/MCWB; Annual Cooling, Dehumidification, and Enthalpy Design Conditions.
f) SST Refers to Compressor saturation suction temperature

7. **APPENDIX 2 -** Flash tank liquid temperature for ECO2 Mini LT Units

Model Number	Voltage	Application	Ambient Temp	GC Outlet Temp	Low Temperature Units - Liquid Temperature					
					SST -30°F	SST -25°F	SST -22°F	SST -20°F	SST -15°F	SST -10°F
ED-100-040-CL-4-OXV-A	460/3/60	LT	90	95	36.0	36.0	36.0	36.0	36.0	37.7
ED-100-070-CL-4-OXV-A	460/3/60	LT	90	95	36.0	36.0	36.0	36.9	41.4	45.8
ED-100-040-CL-4-OXV-A	460/3/60	LT	95	100	36.0	36.0	36.0	36.0	37.0	41.2
ED-100-070-CL-4-OXV-A	460/3/60	LT	95	100	36.0	36.6	39.4	41.2	45.9	50.3
ED-100-040-CL-4-OXV-A	460/3/60	LT	100	105	36.0	36.0	36.0	36.7	41.2	45.8
ED-100-070-CL-4-OXV-A	460/3/60	LT	100	105	36.6	41.2	44.5	46.4	51.1	55.8
ED-100-040-CL-4-OXV-A	460/3/60	LT	105	110	36.0	36.0	39.4	41.2	45.9	50.6
ED-100-070-CL-4-OXV-A	460/3/60	LT	105	110	41.5	47.3	50.3	52.3	57.3	62.1
ED-100-040-CL-2-OXV-A	230/3/60 +N	LT	90	95	36.0	36.0	36.0	36.0	36.0	37.2
ED-100-070-CL-2-OXV-A	230/3/60 +N	LT	90	95	36.0	36.0	36.0	36.0	40.7	45.1
ED-100-040-CL-2-OXV-A	230/3/60 +N	LT	95	100	36.0	36.0	36.0	36.0	36.9	40.6
ED-100-070-CL-2-OXV-A	230/3/60 +N	LT	95	100	36.0	36.0	38.5	40.3	45.1	49.5
ED-100-040-CL-2-OXV-A	230/3/60 +N	LT	100	105	36.0	36.0	36.0	36.0	40.6	45.0
ED-100-070-CL-2-OXV-A	230/3/60 +N	LT	100	105	36.0	40.6	43.6	45.5	50.2	54.9
ED-100-040-CL-2-OXV-A	230/3/60 +N	LT	105	110	36.0	36.0	38.6	40.4	45.2	49.9
ED-100-070-CL-2-OXV-A	230/3/60 +N	LT	105	110	41.2	46.3	49.2	51.3	56.2	61.0

8. **APPENDIX 3 -** ECO2 Mini Units Electrical Information

ECO2 Mini Model #	VOLTAGE	APPLICATION	LRA [A]	RLA (MCC/1.4) [A]	RLA (MCC/1.56) [A]	FANS QTY	FAN (FLA) [A]	CONTROLS [A]	MCA [A]	MOPD [A]
ED-010-040-CM-4-OXV	460/3/60	MT	86	14.4	12.9	1.0	3.2	2.0	23.2	30.0
ED-010-070-CM-4-OXV	460/3/60	MT	171	29.5	26.5	2.0	6.4	2.0	45.3	60.0
ED-010-100-CM-4-OXV	460/3/60	MT	177	34.9	31.3	2.0	6.4	2.0	52.0	70.0
ED-010-040-CM-2-OXV	230/3/60 +N	MT	178.7	29.8	26.4	1.0	3.2	2.0	42.5	60.0
ED-010-070-CM-2-OXV	230/3/60 +N	MT	226	49	44.0	2.0	6.4	2.0	69.7	100.0
ED-010-100-CM-2-OXV	230/3/60 +N	MT	367	73.1	65.6	2.0	6.4	2.0	99.8	150.0

ECO2 Mini Model #	VOLTAGE	APPLICATION	LRA [A]	RLA (MCC/1.4) [A]	RLA (MCC/1.56) [A]	FANS QTY	FAN (FLA) [A]	CONTROLS [A]	MCA [A]	MOPD [A]
ED-100-040-CL-4-OXV	460/3/60	LT	165	16.7	15.0	1.0	3.2	2.0	26.1	30.0
ED-100-070-CL-4-OXV	460/3/60	LT	177	32.8	29.4	2.0	6.4	2.0	49.4	70.0
ED-100-040-CL-2-OXV	230/3/60 +N	LT	280	34.6	31.1	1.0	3.2	2.0	48.5	70.0
ED-100-070-CL-2-OXV	230/3/60 +N	LT	367	68.3	61.3	2.0	6.4	2.0	93.8	140.0