EVD evolution

electronic expansion valve driver

CAREL

ENG **User manual**

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Integrated Control Solutions & Energy Savings

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- prevent the electronic circuits from getting wet. Rain, humidity and all types of liquids or condensate contain corrosive minerals that may damage the electronic circuits. In any case, the product should be used or stored in environments that comply with the temperature and humidity limits specified in the manual;
- do not install the device in particularly hot environments. Too high temperatures may reduce the life of electronic devices, damage them and deform or melt the plastic parts. In any case, the product should be used or stored in environments that comply with the temperature and humidity limits specified in the manual;
- do not attempt to open the device in any way other than described in the manual;
- do not drop, hit or shake the device, as the internal circuits and mechanisms may be irreparably damaged;
- do not use corrosive chemicals, solvents or aggressive detergents to clean the device;
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DISPOSAL

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In reference to European Union directive 2002/96/EC issued on 27 January 2003 and the related national legislation, please note that:

1. WEEE cannot be disposed of as municipal waste and such waste must be collected and disposed of separately;
2. the public or private waste collection systems defined by local legislation must be used. In addition, the equipment can be returned to the distributor at the end of its working life when buying new equipment;
3. the equipment may contain hazardous substances: the improper use or incorrect disposal of such may have negative effects on human health and on the environment;
4. the symbol (crossed-out wheeled bin) shown on the product or on the packaging and on the instruction sheet indicates that the equipment has been introduced onto the market after 13 August 2005 and that it must be disposed of separately;
5. in the event of illegal disposal of electrical and electronic waste, the penalties are specified by local waste disposal legislation.

Warranty on the materials: 2 years (from the date of production, excluding consumables).

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Content

1. INTRODUCTION

EVD evolution is a driver for double pole stepper motors designed for to control the electronic expansion valve in refrigerant circuits. It is designed for DIN rail assembly and is fitted with plug-in screw terminals. It controls refrigerant superheat and optimises the efficiency of the refrigerant circuit, guaranteeing maximum flexibility, being compatible with various types of refrigerants and valves, in applications with chillers, air-conditioners and refrigerators, the latter including subcritical and transcritical CO2 systems. It features low superheat, high evaporation pressure (MOP), low evaporation pressure (LOP) and high condensing temperature protection, and can manage, as an alternative to superheat control, special functions such as the hot gas bypass, the evaporator pressure control (EPR) and control of the valve downstream of the gas cooler in transcritical CO2 circuits. Together with superheat control, it can manage an auxiliary control function selected between condensing temperature protection and "modulating thermostat". As regards network connectivity, the driver can be connected to either of the following:

- a pCO programmable controller to manage the driver via pLAN;
- a pCO programmable controller or PlantVisorPRO supervisor for supervision only, via tLAN or RS485/Modbus® respectively. In this case, On/Off control is performed via digital input 1.

The second digital input is available for optimised defrost management. Another possibility involves operation as a simple positioner with 4 to 20 mA or 0 to 10 Vdc analogue input signal. EVD evolution comes with a LED board to indicate the operating status, or a graphic display (accessory) that can be used to perform installation, following a guided commissioning procedure involving setting just 4 parameters: refrigerant, valve, pressure sensor, type of main control (chiller, showcase, etc.). The procedure can also be used to check that the sensor and valve motor wiring is correct. Once installation is complete, the display can be removed, as it is not necessary for the operation of the driver, or alternatively kept in place to display the significant system variables, any alarms and when necessary set the control parameters. The driver can also be setup using a computer via the service serial port. In this case, the VPM program (Visual Parameter Manager) needs to be installed, downloadable from http://ksa.carel.com, and the USB-tLAN converter EVDCNV00E0 connected.

1.1 Models

Code	Description
EVD0000E00	EVD evolution - tLAN
EVD0000E10	EVD evolution - pLAN
EVD0000E20	EVD evolution - RS485/Modbus®
EVD0000E01	EVD evolution - tLAN, multiple pack of 10 pcs (*)
EVD0000E11	EVD evolution - pLAN, multiple pack of 10 pcs (*)
EVD0000E21	EVD evolution - RS485/Modbus®, multiple pack of 10 pcs (*)
EVDIS00DE0	Display for EVD evolution, German
EVDIS00EN0	Display for EVD evolution, English
EVDIS00ES0	Display for EVD evolution, Spanish
EVDIS00FR0	Display for EVD evolution, French
EVDIS00IT0	Display for EVD evolution, Italian
EVDIS00PT0	Display for EVD evolution, Portuguese
EVDCON0021	EVD evolution, connector kit (10 pcs) for multiple pack (*)

Tab. 1.a

(*)The codes with multiple packages are sold without connectors, available separately in code EVDCON0021.

1.2 Functions and main characteristics

In summary:

- electrical connections by plug-in screw terminals;
- serial card incorporated in the driver, based on the model (tLAN, pLAN, RS485/Modbus®);
- compatibility with various types of valves and refrigerants;
- activation/deactivation of control via digital input 1 or remote control via pLAN, from pCO programmable controller;
- superheat control with protection functions for low superheat, MOP, LOP, high condensing temperature;
- configuration and programming by display (accessory), by computer using the VPM program or by PlantVisor/PlantVisorPro supervisor and pCO programmable controller;
- commissioning simplified by display with guided procedure for setting the parameters and checking the electrical connections;
- multi-language graphic display, with "help" function on various parameters;
- management of different units of measure (metric/imperial);
- parameters protected by password, accessible at a service (installer) and manufacturer level;
- copy the configuration parameters from one driver to another using the removable display;
- ratiometric or electronic 4 to 20 mA pressure transducer, the latter can be shared between a series of driver, useful for multiplexed applications;
- possibility to use S3 and S4 as backup sensors in the event of faults on the main sensors S1 and S2;
- 4 to 20 mA or 0 to 10 Vdc input to use the driver as a positioner controlled by an external signal;
- management of power failures with valve closing (if the EVBAT200/ EVBAT300 accessory is fitted);
- advanced alarm management.

Series of accessories for EVD evolution

Display (code EVDIS00**0)

Easily applicable and removable at any time from the front panel of the driver, during normal operation displays all the significant system variables, the status of the relay output and recognises the activation of the protection functions and alarms. During commissioning, it guides the installer in setting the parameters required to start the installation and, once completed, can copy the parameters to other drivers. The models differ in the first settable language, the second language for all models is English. EVDIS00**0 can be used to configure and monitor all the control parameters, accessible via password at a service (installer) and manufacturer level.

Fig. 1.a

USB/tLAN converter (code EVDCNV00E0)

The USB-tLAN converter is connected, once the LED board cover has been removed, to the service serial port underneath. Fitted with cables and connectors, it can connect EVD evolution directly to a computer, which, using the VPM program, can configure and program the driver. VPM can also be used to update the driver and display firmware. See appendix I.

Fig. 1.b

Battery module (code EVBAT*****)

EVBAT00200 is an electronic device that guarantees temporary power to the driver in the event of mains power failures. Supplied with a 12 Vdc lead battery, it delivers 22 Vdc to the driver for the time required to completely close the electronic valve being controlled, while during normal operation the battery is recharged. The complete module with batteries (code EVBAT00300) and the box for batteries (code EVBATBOX*0) are available.

EVBAT00300

EBVAT00200 Batteria 12 V

Fig. 1.c

Valve cable E2VCABS*00 (IP67)

Shielded cable with built-in connector for connection to the valve motor. The connector code E2VCON0000 (IP65) can also be purchased on its own, to be wired.

Fig. 1.d

2. INSTALLATION

2.1 DIN rail assembly and dimensions

EVD evolution is supplied with screen-printed connectors to simplify wiring. The shield is connected with a spade terminal.

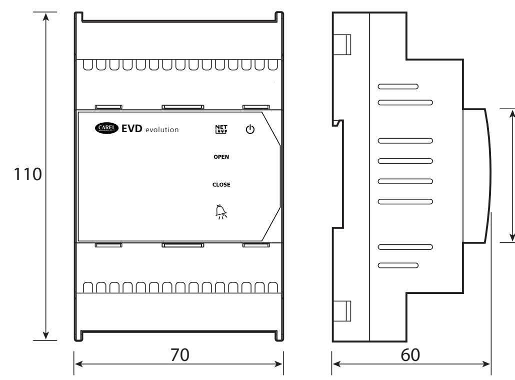

Fig. 2.a

2.2 Description of the terminals

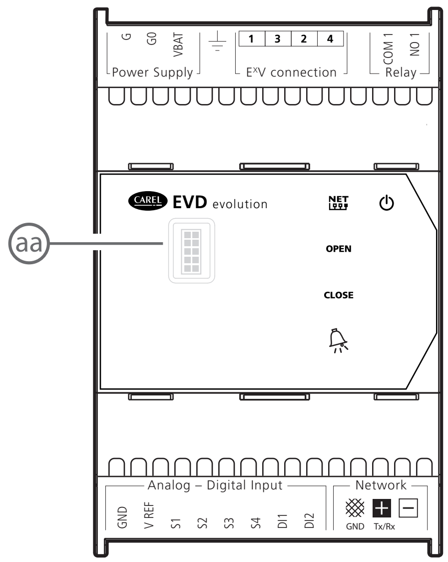

Fig. 2.b

Terminal	Description
⏚	Functional earth
G, G0	Power supply
VBAT	Emergency power supply
1,3,2,4	Stepper motor power supply
COM1, NO1	Alarm relay
GND	Earth for the signals
VREF	Power to active sensors
S1	Sensor 1 (pressure) or 4 to 20 mA external signal
S2	Sensor 2 (temperature) or 0 to 10 V external signal
S3	Sensor 3 (pressure)
S4	Sensor 4 (temperature)
DI1	Digital input 1
DI2	Digital input 2
⊠	Terminal for tLAN, pLAN, RS485, Modbus® connection
⊞	Terminal for tLAN, pLAN, RS485, Modbus® connection
⊟	Terminal for pLAN, RS485, Modbus® connection
aa	porta seriale di servizio (rimuovere il coperchio per potervi accedere)

Tab. 2.a

2.3 Connection diagram - superheat control

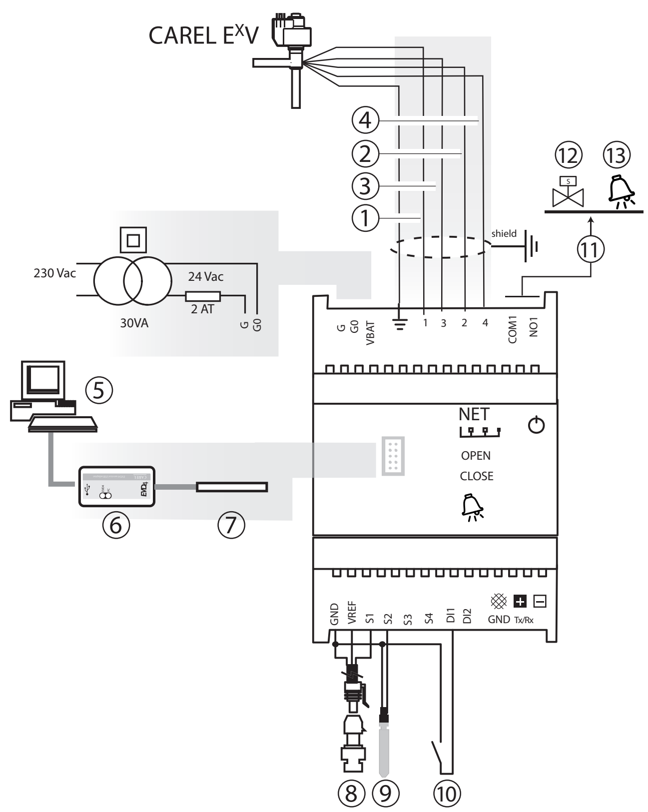

Fig. 2.c

Key:

1	green
2	yellow
3	brown
4	white
5	personal computer for configuration
6	USB/tLAN converter
7	adapter
8	ratiometric pressure transducer - evaporation pressure
9	NTC suction temperature
10	digital input 1 to enable control
11	free contact (up to 230 Vac)
12	solenoid valve
13	alarm signal

Note:

- the use of the driver for the superheat control requires the use of the evaporation pressure sensor S1 and the suction temperature sensor S2, which will be fitted after the evaporator, and digital input 1 to enable control. As an alternative to digital input 1, control can be enabled via remote signal (tLAN, pLAN, RS485). For the positioning of the sensors relating to other applications, see the chapter on "Control";
- inputs S1, S2 are programmable and the connection to the terminals depends on the setting of the parameters. See the chapters on "Commissioning" and "Functions";
- pressure sensor S1 in the diagram is ratiometric. See the general connection diagram for the other electronic sensors, 4 to 20 mA or combined.

2.4 Installation

For installation proceed as follows, with reference to the wiring diagrams:

1. connect the sensors and power supply: the sensors can be installed a maximum distance of 10 metres away from the controller, as long as shielded cables are used with minimum cross-section of 1 mm^2 (connect only one end of the shield to the earth in the electrical panel);
2. connect any digital inputs, maximum length 30 m;
3. connect the power cable to the valve motor: recommended 4-wire shielded cable, AWG 18/22, Lmax=10 m;
4. carefully evaluate the maximum capacity of the relay output specified in the chapter "Technical specifications";
5. program the driver, if necessary: see the chapter "User interface";
6. connect the serial network, if featured: follow to the diagrams below for the earth connection.

Case 1: multiple drivers connected in a network powered by the same transformer. Typical application for a series of drivers inside the same electrical panel.

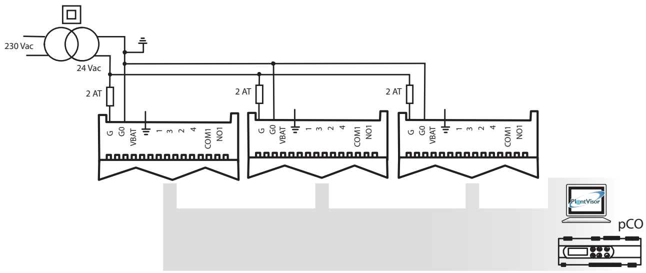

Fig. 2.d

Case 2: multiple drivers connected in a network powered by different transformers (G0 not connected to earth). Typical application for a series of drivers in different electrical panels.

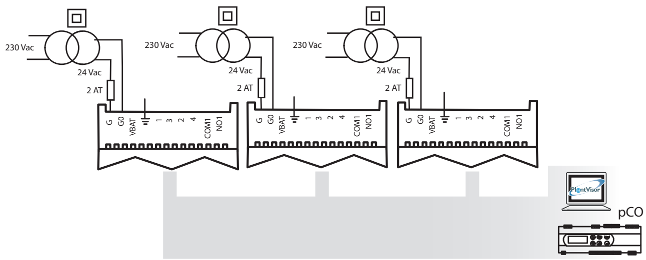

Fig. 2.e

Case 3: multiple drivers connected in a network powered by different transformers with just one earth point. Typical application for a series of drivers in different electrical panels.

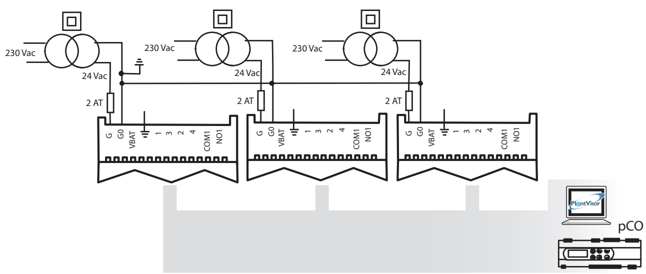

Fig. 2.f

Important: avoid installing the driver in environments with the following characteristics:

- relative humidity greater than the 90% or condensing;
- strong vibrations or knocks;
- exposure to continuous water sprays;
- exposure to aggressive and polluting atmospheres (e.g.: sulphur and ammonia fumes, saline mist, smoke) to avoid corrosion and/or oxidation;
- strong magnetic and/or radio frequency interference (avoid installing the appliances near transmitting antennae);
- exposure of the driver to direct sunlight and to the elements in general.

Important: When connecting the driver, the following warnings must be observed:

- incorrect connection to the power supply may seriously damage the driver;
- use cable ends suitable for the corresponding terminals. Loosen each screw and insert the cable ends, then tighten the screws and lightly tug the cables to check correct tightness;
- separate as much as possible (at least 3 cm) the sensor and digital input cables from the power cables to the loads so as to avoid possible electromagnetic disturbance. Never lay power cables and sensor cables in the same conduits (including those in the electrical panels);
- avoid installing the sensor cables in the immediate vicinity of power devices (contactors, circuit breakers, etc.). Reduce the path of the sensor cables as much as possible and avoid enclosing power devices;
- avoid powering the driver directly from the main power supply in the panel if this supplies different devices, such as contactors, solenoid valves, etc., which will require a separate transformer.

2.5 Connecting the USB-tLAN converter

- remove the LED board cover by pressing on the fastening points;
- plug the adapter into the service serial port;
- connect the adapter to the converter and then this in turn to the computer.

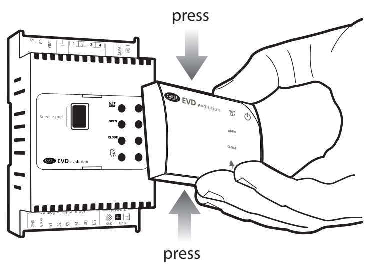

Fig. 2.g

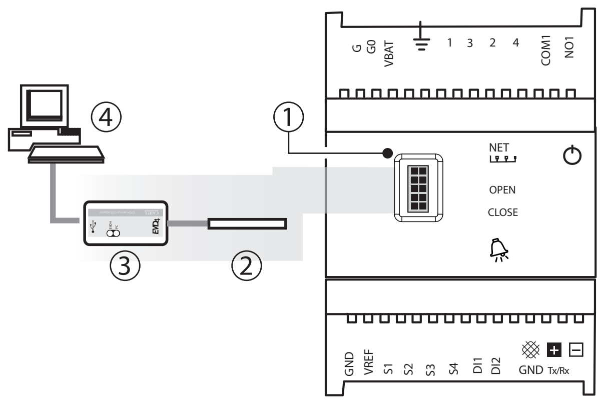

Fig. 2.h

Key:

1	service serial port
2	adapter
3	USB/tLAN converter
4	personal computer

Note: when using the service serial port connection, the VPM program can be used to configure the driver and update the driver and display firmware, downloadable from http://ksa.carel.com. See appendix 1.

2.6 Upload, Download and Reset parameters (display)

1. press the Help and Enter buttons together for 5 seconds;
2. a multiple choice menu will be displayed, use UP/DOWN to select the required procedure;
3. confirm by pressing ENTER;
4. the display will prompt for confirmation, press ENTER;
5. at the end a message will be shown to notify the operation if the operation was successful.

- UPLOAD: the display saves all the values of the parameters on the source driver;
- DOWNLOAD:the display copies all the values of the parameters to the target driver;
- RESET: all the parameters on the driver are restored to the default values. See the table of parameters in chapter 8.

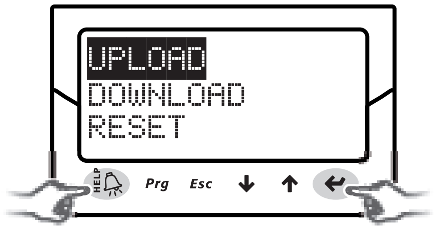

Fig. 2.i

Important:

- the procedure must be carried out with driver powered;
- DO NOT remove the display from the driver during the UPLOAD, DOWNLOAD, RESET procedure;
- the parameters cannot be downloaded if the source driver and the target driver have incompatible firmware.

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2.7 General connection diagram

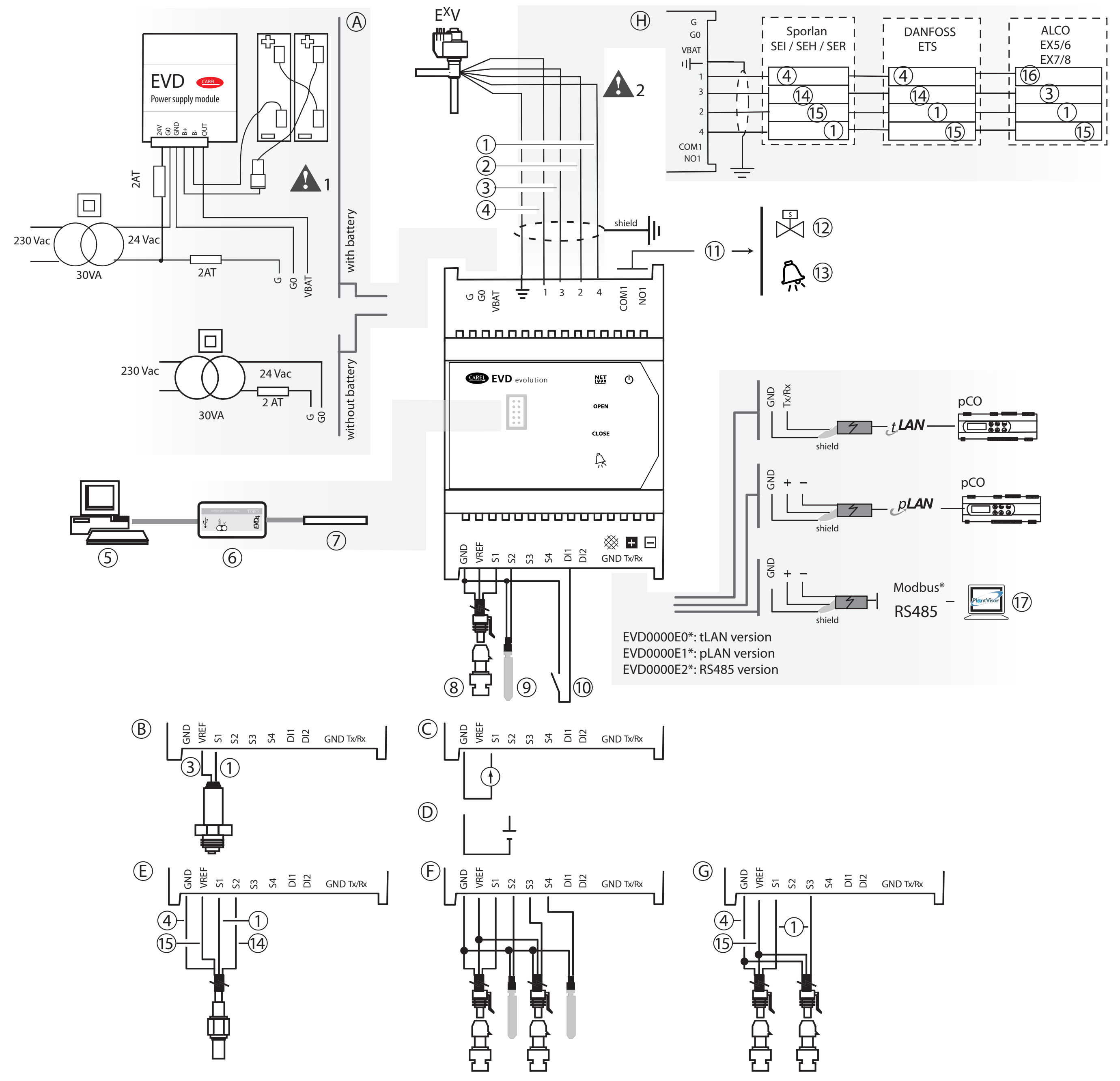


Fig. 2.j

Key:

1	white	A	Connection to EVBAT200/300
2	yellow	B	Connection to electronic pressure sensor (SPK**0000) or piezoresistive pressure transducer (SPKT00**C0)
3	brown		
4	green	C	Connection as positioner (4 to 20 mA input)
5	configuration computer	D	Connection as positioner (0 to 10 Vdc input)
6	USB/tLAN converter	E	Connection to combined pressure/temperature sensor (SPKP00**T0)
7	adapter		
8	ratiometric pressure transducer	F	Connection to backup sensors (S3, S4)
9	NTC sensor	G	Ratiometric pressure transducer connections (SPKT00**R0)
10	digital input 1 to enable control	H	Connections o other types of valves
11	free contact (up to 230 Vac)	⚠1	The maximum length of the connection cable to the EVBAT200/300 module is 5 m.
12	solenoid valve		
13	alarm signal	⚠2	The connection cable to the valve motor must be 4-wire shielded, AWG 18/22 Lmax= 10 m
14	red		
15	black		
16	blue		
17	supervision computer		

3. USER INTERFACE

The user interface consists of 5 LEDs that display the operating status, as shown in the table:

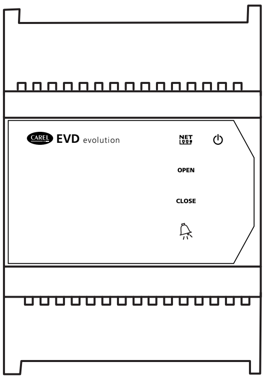


Fig. 3.a

Legenda:

LED	ON	OFF	Flashing
NET	Connection available	No connection	Communication error
OPEN	Opening valve	-	Driver disabled (*)
CLOSE	Closing valve	-	Driver disabled (*)
	Active alarm	-	-
	Driver powered	Driver not powered	-

Tab. 3.a

(*) Awaiting completion of the initial configuration

3.1 Assembling the display board (accessory)

The display board, once installed, is used to perform all the configuration and programming operations on the driver. It displays the operating status, the significant values for the type of control that the driver is performing (e.g. superheat control), the alarms, the status of the digital inputs and the relay output. Finally, it can save the configuration parameters for one driver and transfer them to a second driver (see the procedure for upload and download parameters).

For installation:

- remove the cover, pressing on the fastening points;
- fit the display board, as shown;
- the display will come on, and if the driver is being commissioned, the guided configuration procedure will start.

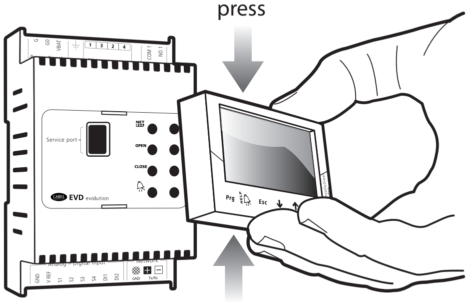


Fig. 3.b

Important: the driver is not activated if the configuration procedure has not been completed.

The front panel now holds the display and the keypad, made up of 6 buttons that, pressed alone or in combination, are used to perform all the configuration and programming operations on the driver.

3.2 Display and keypad

The graphic display shows 2 system variables, the control status of the driver, the activation of the protectors, any alarms and the status of the relay output.

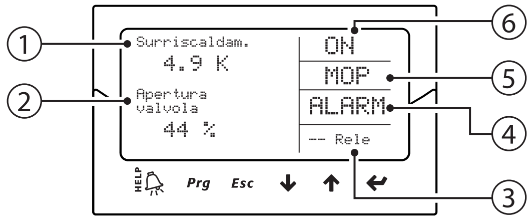


Fig. 3.c

Key:

1	1st variable displayed
2	2nd variable displayed
3	relay status
4	alarm (press "HELP")
5	protector activated
6	control status

Display writings

	Control status		Protection active
ON	Operation	LowSH	Low superheat
OFF	Standby	LOP	Low evaporation temperature
POS	Positioning	MOP	High evaporation temperature
WAIT	Wait	HiTcond	High condensing temperature
CLOSE	Closing		

Tab. 3.b

Keypad

Button	Function
Prg	opens the screen for entering the password to access programming mode.
HELP	• if in alarm status, displays the alarm queue; • in the "Manufacturer" level, when scrolling the parameters, shows the explanation screens (Help).
Esc	• exits the Programming (Service/Manufacturer) and Display modes; • after setting a parameter, exits without saving the changes.
↓ / ↑ UP/ DOWN	• navigates the display screens; • increases/decreases the value.
↵ Enter	• switches from the display to parameter programming mode; • confirms the value and returns to the list of parameters.

Tab. 3.c

Note: the variables displayed as standard can be selected by configuring the parameters "Variable 1 on display" and "Variable 2 on display" accordingly. See the list of parameters.

3.3 Display mode (display)

Display mode is used to display the useful variables showing the operation of the system.

The variables displayed depend on the type of control selected.

1. press Esc to switch to the standard display;
2. press UP/DOWN: the display shows a graph of the superheat, the percentage of valve opening, the evaporation pressure and temperature and the suction temperature variables;
3. press UP/DOWN: the variables are shown on the display;
4. press Esc to exit display mode.

For the complete list of the variables shown on the display, see the chapter: "Table of parameters".

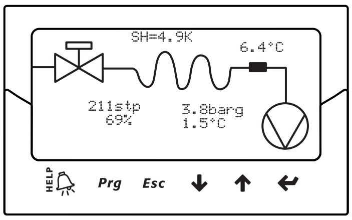


Fig. 3.d

3.4 Programming mode (display)

The parameters can be modified using the front keypad. Access differs according to the user level: Service (Installer) and manufacturer.

Modifying the Service parameters

IThe Service parameters, as well as the parameters for commissioning the driver, also include those for the configuration of the inputs, the relay output, the superheat set point or the type of control in general, and the protection thresholds. See the table of parameters.

Procedure:

1. press Esc one or more times to switch to the standard display;
2. press Prg: the display shows a screen with the PASSWORD request;
3. press ENTER and enter the **password for the Service level: 22**, starting from the right-most figure and confirming each figure with ENTER;
4. if the value entered is correct, the first modifiable parameter is displayed, network address;
5. press UP/DOWN to select the parameter to be set;
6. press ENTER to move to the value of the parameter;
7. press UP/DOWN to modify the value;
8. press ENTER to save the new value of the parameter;
9. repeat steps 5, 6, 7, 8 to modify the other parameters;
10. press Esc to exit the procedure for modifying the Service parameters.

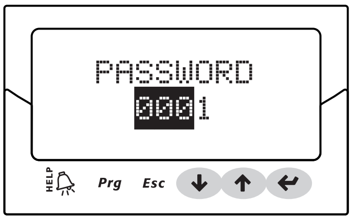


Fig. 3.e

Note: if no button is pressed, after 5 min the display automatically returns to the standard mode.

Modifying the Manufacturer parameters

The Manufacturer level is used to configure all the driver parameters, and consequently, in addition to the Service parameters, the parameters relating to alarm management, the sensors and the configuration of the valve. See the table of parameters.

1. press Esc one or more times to switch to the standard display;
2. press Prg : the display shows a screen with the PASSWORD request;
3. press ENTER and enter the Manufacturer level password: 66, starting from the right-most figure and confirming each figure with ENTER;
4. if the value entered is correct, the list of parameter categories is shown:
   - Configuration
   - Sensors
   - Control
   - Special
   - Alarm configuration
   - Valve
5. press the UP/DOWN buttons to select the category and ENTER to access the first parameter in the category;
6. press UP/DOWN to select the parameter to be set and ENTER to move to the value of the parameter;
7. press UP/DOWN to modify the value;
8. press ENTER to save the new value of the parameter;
9. repeat steps 6, 7, 8 to modify the other parameters;
10. press Esc to exit the procedure for modifying the Manufacturer parameters.

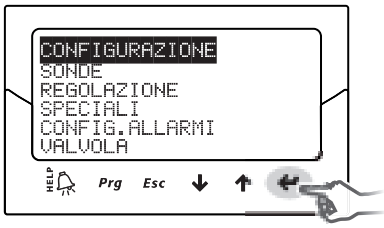


Fig. 3.f

Note:

- all the driver parameters can be modified by entering the Manufacturer level;
- if no button is pressed, after 5 min the display automatically returns to the standard mode.

4. COMMISSIONING

4.1 Commissioning

Once the electrical connections have been completed (see the chapter on installation) and the power supply has been connected, the operations required for commissioning the driver depend on the type of interface used, however essentially involve setting just 4 parameters: refrigerant, valve, type of pressure sensor S1 and type of main control.

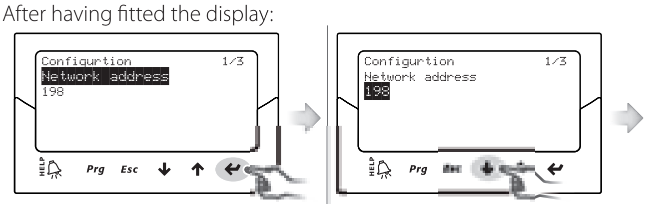
Types of interfaces:

- DISPLAY: after having correctly configured the setup parameters, confirmation will be requested. Only after confirmation will the driver be enabled for operation, the main screen will be shown on the display and control will be able to commence when requested by the pCO controller via pLAN or when digital input DI1 closes. See paragraph 4.2;
- VPM: to enable control of the driver via VPM, set “Enable EVD control” to 1; this is included in the safety parameters, in the special parameters menu, under the corresponding access level. However, the setup parameters should first be set in the related menu. The driver will then be enabled for operation and control will be able to commence when requested by the pCO controller via pLAN or when digital input DI1 closes. If due to error or for any other reason “Enable EVD control” should be set to 0 (zero), the driver will immediately stop control and will remain in standby until re-enabled, with the valve stopped in the last position;
- SUPERVISOR: to simplify the commissioning of a considerable number of drivers using the supervisor, the setup operation on the display can be limited to simply setting the network address. The display will then be able to be removed and the configuration procedure postponed to a later stage using the supervisor or, if necessary, reconnecting the display. To enable control of the driver via supervisor, set “Enable EVD control”; this is included in the safety parameters, in the special parameters menu, under the corresponding access level. However, the setup parameters should first be set in the related menu. The driver will then be enabled for operation and control will be able to commence when requested by the pCO controller via pLAN or when digital input DI1 closes. As highlighted on the supervisor, inside of the yellow information field relating to the “Enable EVD control” parameter, if due to error or for any other reason “Enable EVD control” should be set to 0 (zero), the driver will immediately stop control and will remain in standby until re-enabled, with the valve stopped in the last position;
- pCO PROGRAMMABLE CONTROLLER: the first operation to be performed, if necessary, is to set the network address using the display. If a pLAN, tLAN or Modbus® driver is used, connected to a pCO family controller, the setup parameters will not need to be set and confirmed. In fact, the application running on the pCO will manage the correct values based on the unit controlled. Consequently, simply set the pLAN, tLAN or Modbus® address for the driver as required by the application on the pCO, and after a few seconds communication will commence between the two instruments and the driver automatically be enabled for control. The main screen will shown on the display, which can then be removed, and control will be commence when requested by the pCO controller or digital input DI1.

The pLAN driver is the only version that can start control with a signal from the pCO controller over the pLAN. If there is no communication between the pCO and the driver (see the paragraph “pLAN error alarm”), the driver will be able to continue control based on the status of digital input 1. The tLAN and RS485/Modbus® drivers can be connected to a pCO controller, but only in supervisor mode. Control can only start when digital input 1 closes.

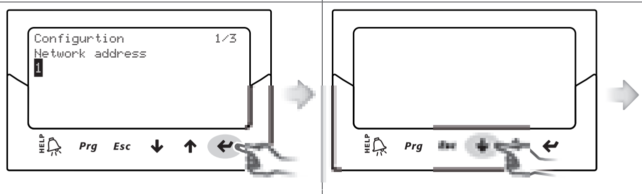
4.2 Guided commissioning procedure (display)

After having fitted the display:



❶ the first parameter is displayed: network address;
❷ press Enter to move to the value of the parameter

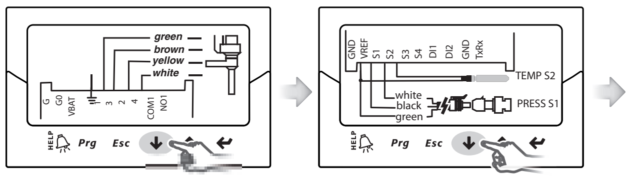
❸ press UP/DOWN to modify the value



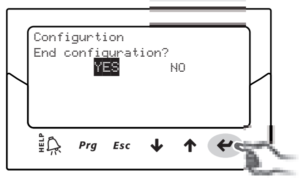
❹ press Enter to confirm the value

❺ press UP/DOWN to move to the next parameter, refrigerant

❻ repeat steps 2, 3, 4, 5 to modify the values of the parameters: refrigerant, valve, pressure sensor S1, main control;



❼ check that the electrical connections are correct;



❽ if the configuration is correct exit the procedure, otherwise choose NO and return to step 2;

To simplify commissioning and avoid possible malfunctions, the driver will not start until the following have been configured:

1. network address;
2. refrigerant;
3. valve;
4. pressure sensor S1;
5. type of main control, that is, the type of unit the superheat control is applied to.

Note:

- to exit the guided commissioning procedure press the DOWN button repeatedly and finally confirm that configuration has been completed. The guided procedure CANNOT be ended by pressing Esc;
- if the configuration procedure ends with a configuration error, access Service parameter programming mode and modify the value of the parameter in question;
- if the valve and/or the pressure sensor used are not available in the list, select any model and end the procedure. Then the driver will be enabled for control, and it will be possible to enter Manufacturer programming mode and set the corresponding parameters manually.

Network address

The network address assigns to the driver an address for the serial connection to a supervisory system via RS485, and to a pCO controller via pLAN, tLAN, Modbus®.

Parameter/description	Def.	Min.	Max.	UOM
Configuration				
Network address	198	1	207	-

Tab. 4.a

Refrigerant

The type of refrigerant is essential for calculating the superheat. In addition, it is used to calculate the evaporation and condensing temperature based on the reading of the pressure sensor.

Parameter/description	Def.
Configuration	
Refrigerant: R22; R134a; R404A; R407C; R410A; R507A; R290; R600; R600a; R717; R744; R728; R1270; R417A; R422D	R404A

Tab. 4.b

Valve

Setting the type of valve automatically defines all the control parameters based on the manufacturer's data for each model.
In Manufacturer programming mode, the control parameters can then be fully customised (see the paragraph "valve parameters") if the valve used is not in the standard list. In this case, the driver will detect the modification and indicate the type of valve as "Customised".

Parameter/description	Def.
Configuration	
Valve: CAREL ExV; Alco EX4; Alco EX5; Alco EX6; Alco EX7; Alco EX8 330Hz suggested by CAREL; Alco EX8 500Hz specified by Alco; Sporlan SEI 0.5-11; Sporlan SER 1.5-20; Sporlan SEI 30; Sporlan SEI 50; Sporlan SEH 100; Sporlan SEH 175; Danfoss ETS 25B; Danfoss ETS 50B; Danfoss ETS 100B; Danfoss ETS 250; Danfoss ETS 400	CAREL E^XV

Tab. 4.c

Pressure sensor S1

Setting the type of pressure sensor S1 defines the range of measurement and the alarm limits based on the manufacturer's data for each model, usually indicated on the rating plate on the sensor.

Parameter/description		Def.
Configuration		
Sensor S1		Ratiom.: -1 to 9.3 barg
Ratiometric (OUT=0 to 5V)	Electronic (OUT=4 to 20mA)	
-1 to 4.2 barg	-0.5 to 7barg	
-0.4 to 9.2 barg	0 to 10barg	
-1 to 9.3 barg	0 to 18.2barg	
0 to 17.3 barg	0 to 25barg	
-0.4 to 34.2 barg	0 to 30barg	
0 to 34.5 barg	0 to 44.8barg	
0 to 45 barg	remote, -0.5 to 7 barg	
	remote, 0 to 10 barg	
	remote, 0 to 18.2 barg	
	remote, 0 to 25 barg	
	remote, 0 to 30 barg	
	remote, 0 to 44.8 barg	
External signal (4 to 20mA)		

Tab. 4.d

Attention: in case two pressure sensors are installed S1 and S3, they must be of the same type. It is not allowed to use a ratiometric sensor and an electronic one.

Note: in the case of multiplexed systems where the same pressure sensor is shared between multiple drivers, choose the normal option for the first driver and the "remote" option for the remaining drivers. The same pressure transducer can be shared between a maximum of 5 drivers.

Example: to use the same pressure sensor, -0.5 to 7 bars, for 3 drivers
For the first driver, select: -0.5 to 7 barg
For the second and third driver select: remote -0.5 to 7 barg.

Note:
- the range of measurement by default is always in bar gauge (barg).In the manufacturer menu, the parameters corresponding to the range of measurement and the alarms can be customised if the sensor used is not in the standard list. If modifying the range of measurement, the driver will detect the modification and indicate the type of sensor S1 as "Customised".
- The software on the driver takes into consideration the unit of measure. If a range of measurement is selected and then the unit of measure is changed (from bars to psi), the driver automatically updates in limits of the range of measurement and the alarm limits.BY default, the main control sensor S2 is set as "CAREL NTC". Other types of sensors can be selected in the service menu.

- Unlike the pressure sensors, the temperature sensors do not have any modifiable parameters relating to the range of measurement, and consequently only the models indicated in the list can be used (see the chapter on "Functions" and the list of parameters). In any case, in manufacturer programming mode, the limits for the sensor alarm signal can be customised.

Main control

Setting the main control defines the operating mode of the driver.

Parameter/description	Def.
Configuration	
Main control	multiplexed cabinet/cold room
Superheat control	
multiplexed cabinet/cold room	
cabinet/cold room with on-board compressor	
"perturbed" cabinet/cold room	
cabinet/cold room with sub-critical CO2	
R404A condenser for sub-critical CO2	
air-conditioner/chiller with plate heat exchanger	
air-conditioner/chiller with tube bundle heat exchanger	
air-conditioner/chiller with finned coil heat exchanger	
air-conditioner/chiller with variable cooling capacity	
"perturbed" air-conditioner/chiller	
Special control	
EPR back-pressure	
hot gas bypass by pressure	
hot gas bypass by temperature	
transcritical CO_2 gas cooler	
analogue positioner (4 to 20 mA)	
analogue positioner (0 to 10 V)	

Tab. 4.e

The superheat set point and all the parameters corresponding to PID control, the operation of the protectors and the meaning and use of sensors S1 and/or S2 will be automatically set to the values recommended by CAREL based on the selected application.
During this initial configuration phase, only the superheat control mode can be set, which differs based on the application (chiller, refrigerated cabinet, etc.).
In the event of errors in the initial configuration, these parameters can later be accessed and modified inside the service or manufacturer menu.
If the driver default parameters are restored (RESET procedure, see the chapter on Installation), when next started the display will again show the guided commissioning procedure.

4.3 Checks after commissioning

After commissioning:
- check that the valve completes a full closing cycle to perform alignment;
- set, if necessary, in Service or Manufacturer programming mode, the superheat set point (otherwise keep the value recommended by CAREL based on the application) and the protection thresholds (LOP, MOP, etc.). See the chapter on Protectors.

4.4 Other functions

By entering Service programming mode, other types of main control can be selected (transcritical CO_2, hot gas bypass, etc.), as well as so-called special control functions, which do not involve the superheat, activating auxiliary controls that use sensors S3 and/or S4 and setting the suitable values for the control set point and the LowSH, LOP and MOP protection thresholds (see the chapter on "Protectors"), which depend on the specific characteristics of the unit controlled.
By entering Manufacturer programming mode, finally, the operation of the driver can be completely customised, setting the function of each parameter. If the parameters corresponding to PID control are modified, the driver will detect the modification and indicate the main control as "Customised".

5. CONTROL

5.1 Main and auxiliary control

EVD evolution features two types of control
- main;
- auxiliary.

Main control is always active, while auxiliary control can be activated by parameter. Main control defines the operating mode of the driver. The first 10 settings refer to superheat control, the others are so-called "special" settings and are pressure or temperature settings or depend on a control signal from an external controller.

Parameter/description	Def.
Configuration	
Main control	multiplexed cabinet/ cold room
Superheat control	
multiplexed cabinet/cold room	
cabinet/cold room with on-board compressor	
"perturbed" cabinet/cold room	
cabinet/cold room with sub-critical CO_2	
R404A condenser for sub-critical CO_2	
air-conditioner/chiller with plate heat exchanger	
air-conditioner/chiller with tube bundle heat exchanger	
air-conditioner/chiller with finned coil heat exchanger	
air-conditioner/chiller with variable cooling capacity	
"perturbed" air-conditioner/chiller	
Special control	
EPR back-pressure	
hot gas bypass by pressure	
hot gas bypass by temperature	
transcritical CO_2 gas cooler	
analogue positioner (4 to 20 mA)	
analogue positioner (0 to 10 V)	

Tab. 5.a

Note:
- R404A condensers with subcritical CO_2 refer to superheat control for valves installed in cascading systems where the flow of R404A (or other refrigerant) in an exchanger acting as the CO_2 condenser needs to be controlled;
- "perturbed" cabinet/cold room or air-conditioner/chiller refer to units that momentarily or permanently operate with swinging condensing or evaporation pressure.

Auxiliary control features the following settings:

Parameter/description	Def.
Configuration	
Auxiliary control	Disabled
Disabled	
High condensing temperature protection on S3	
Modulating thermostat on S4	
Backup sensors on S3 & S4	

Tab. 5.b

Important: the "High condensing temperature protection" and "Modulating thermostat" auxiliary settings can only be enabled if the main control is superheat control (first 10 settings). On the other hand, "Backup sensors on S3 & S4" can always be activated, once the related sensors have been connected.

The following paragraphs explain all the types of control that can be set on EVD evolution.

5.2 Superheat control

The primary purpose of the electronic valve is ensure that the flow-rate of refrigerant that flows through the nozzle corresponds to the flow-rate required by the compressor. In this way, the evaporation process will take place along the entire length of the evaporator and there will be no liquid at the outlet and consequently in the branch that runs to the compressor.
As liquid is not compressible, it may cause damage to the compressor and even breakage if the quantity is considerable and the situation lasts some time.

Superheat control

The parameter that the control of the electronic valve is based on is the superheat temperature, which effectively tells whether or not there is liquid at the end of the evaporator.
The superheat temperature is calculated as the difference between: superheated gas temperature (measured by a temperature sensor located at the end of the evaporator) and the saturated evaporation temperature (calculated based on the reading of a pressure transducer located at the end of the evaporator and using the Tsat(P) conversion curve for each refrigerant).

Superheat= Superheated gas temperature(*) – Saturated evaporation temperature

(*) suction

If the superheat temperature is high it means that the evaporation process is completed well before the end of the evaporator, and therefore flow-rate of refrigerant through the valve is insufficient. This causes a reduction in cooling efficiency due to the failure to exploit part of the evaporator. The valve must therefore be opened further.
Vice-versa, if the superheat temperature is low it means that the evaporation process has not concluded at the end of the evaporator and a certain quantity of liquid will still be present at the inlet to the compressor. The valve must therefore be closed further. The operating range of the superheat temperature is limited at the lower end: if the flow-rate through the valve is excessive the superheat measured will be near 0 K. This indicates the presence of liquid, even if the percentage of this relative to the gas cannot be quantified. There is therefore un undetermined risk to the compressor that must be avoided. Moreover, a high superheat temperature as mentioned corresponds to an insufficient flow-rate of refrigerant.
The superheat temperature must therefore always be greater than 0 K and have a minimum stable value allowed by the valve-unit system. A low superheat temperature in fact corresponds to a situation of probable instability due to the turbulent evaporation process approaching the measurement point of the sensors. The expansion valve must therefore be controlled with extreme precision and a reaction capacity around the superheat set point, which will almost always vary from 3 to 14 K. Set point values outside of this range are quite infrequent and relate to special applications.

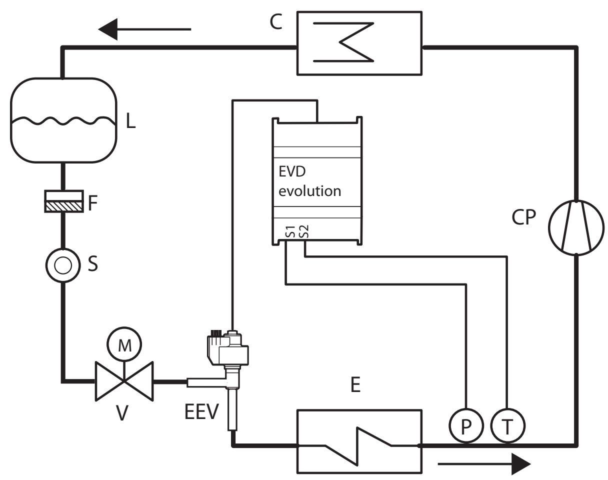


Fig. 5.a

Key:

CP	compressor	EEV	electronic expansion valve
C	condenser	V	solenoid valve
L	liquid receiver	E	evaporator
F	dewatering filter	P	pressure sensor (transducer)
S	liquid indicator	T	temperature sensor

For the wiring, see paragraph 2.7 "General connection diagram".

PID parameters

Superheat control, as for any other mode that can be selected with the "main control" parameter, is performed using PID control, which in its simplest form is defined by the law:

$$u(t) = K\left(e(t) + \frac{1}{T_i}\int e(t)dt + T_d\frac{de(t)}{dt}\right)$$

Key:

u(t)	Valve position	Ti	Integration time
e(t)	Error	Td	Derivative time
K	Proportional gain		

Note that control is calculated as the sum of three separate contributions: proportional, integral and derivative.

- the proportional action opens or closes the valve proportionally to the variation in the superheat temperature. Thus the greater the K **(proportional gain)** the higher the response speed of the valve. The proportional action does not consider the superheat set point, but rather only reacts to variations. Therefore if the superheat value does not vary significantly, the valve will essentially remain stationary and the set point cannot be reached;
- the integral action is linked to time and moves the valve in proportion to the deviation of the superheat value from the set point. The greater the deviations, the more intense the integral action; in addition, the lower the value of T (**integration time**), the more intense the action will be. The integration time, in summary, represents the intensity of the reaction of the valve, especially when the superheat value is not near the set point;
- the derivative action is linked to the speed of variation of the superheat value, that is, the gradient at which the superheat changes from instant to instant. It tends to react to any sudden variations, bringing forward the corrective action, and its intensity depends on the value of the time Td (**derivative time**).

Parameter/description	Def.	Min.	Max.	UOM
CONTROL				
Superheat set point	11	LowSH: soglia	180 (320)	K (°R)
PID: proportional gain	15	0	800	-
PID: integration time	150	0	1000	s
PID: derivative time	5	0	800	s

Tab. 5.c

See the "EEV system guide" +030220810 for further information on calibrating PID control.

Note: when selecting the type of main control (both superheat control and special modes), the PID control values suggested by CAREL will be automatically set for each application.

Protector control parameters

See the chapter on "Protectors". Note that the protection thresholds are set by the installer/manufacturer, while the times are automatically set based on the PID control values suggested by CAREL for each application.

Parameter/description	Def.	Min.	Max.	UOM
CONTROL				
LowSH protection: threshold	5	-40 (-72)	superh. set point.	K(°R)
LowSH protection: integ. time	15	0	800	s
LOP protection: threshold	-50	-60 (-76)	MOP: threshold	°C(°F)
LOP protection: integ. time	0	0	800	s
MOP protection: threshold	50	LOP: threshold	200 (392)	°C(°F)
MOP protection: integ. time	20	0	800	s
SPECIAL				
HiTcond: threshold	80	-60 (-76)	200 (392)	°C (°F)
HiTcond: integration time	20	0	800	s

Tab. 5.d

5.3 Special control

EPR back-pressure

This type of control can be used in many applications in which a constant pressure is required in the refrigerant circuit. For example, a refrigeration system may include different showcases that operate at different temperatures (showcases for frozen foods, meat or dairy). The different temperatures of the circuits are achieved using pressure regulators installed in series with each circuit. The special EPR function (Evaporator Pressure Regulator) is used to set a pressure set point and the PID control parameters required to achieve this.

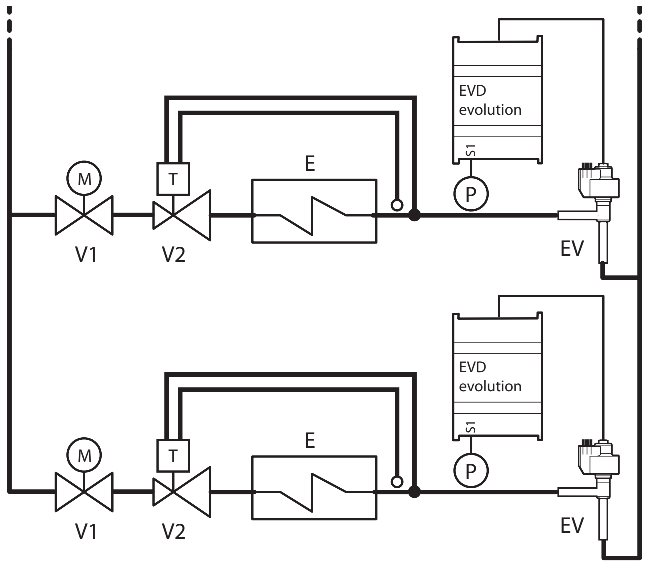


Fig. 5.b

Key:

V1	Solenoid valve	E	Evaporator
V2	Thermostatic expasnion valve	EV	Electronic valve

For the wiring, see paragraph 2.7 "General connection diagram".

This involves PID control without any protectors (LowSH, LOP, MOP, HiTcond, see the chapter on Protectors), without any valve unblock procedure and without auxiliary control. Control is performed on the pressure sensor value read by input S1, compared to the set point: "EPR pressure set point". Control is direct, as the pressure increases, the valve opens and vice-versa.

Parameter/description	Def.	Min.	Max.	UOM
CONTROL				
EPR pressure set point	3,5	-20 (-290)	200 (2900)	barg (psig)
PID: proportional gain	15	0	800	-
PID: integration time	150	0	1000	s
PID: derivative time	5	0	800	s

Tab. 5.e

Hot gas bypass by pressure

This control function can be used to control cooling capacity. If there is no request from circuit B, the compressor suction pressure decreases and the bypass valve opens to let a greater quantity of hot gas flow and decrease the capacity of the circuit.

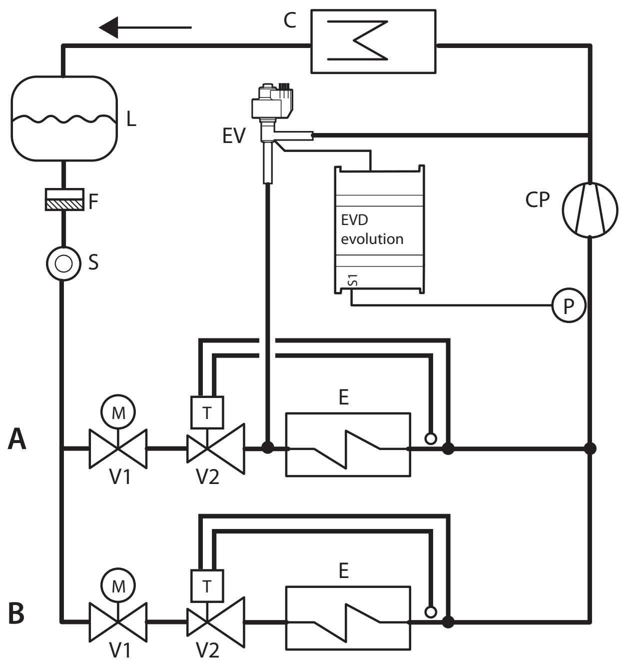


Fig. 5.c

Key:

CP	Compressor	V1	Solenoid valve
C	Condenser	V2	Thermostatic expasnion valve
L	Liquid receiver	EV	Electronic valve
F	Dewatering filter	E	Evaporator
S	Liquid indicator		

For the wiring, see paragraph 2.7 "General connection diagram".

This involves PID control without any protectors (LowSH, LOP, MOP, HiTcond, see the chapter on Protectors), without any valve unblock procedure and without auxiliary control. Control is performed on the hot gas bypass pressure sensor value read by input S1, compared to the set point: "Hot gas bypass pressure set point".
Control is reverse, as the pressure increases, the valve closes and vice-versa.

Parameter/description	Def.	Min.	Max.	UOM
CONTROL				
Hot gas bypass pressure set point	3	-20 (290)	200 (2900)	barg (psig)
PID: proportional gain	15	0	800	-
PID: integration time	150	0	1000	s
PID: derivative time	5	0	800	s

Tab. 5.f

Hot gas bypass by temperature

This control function can be used to control cooling capacity. On a refrigerated cabinet, if the ambient temperature sensor measures an increase in the temperature, the cooling capacity must also increase, and so the valve must close.

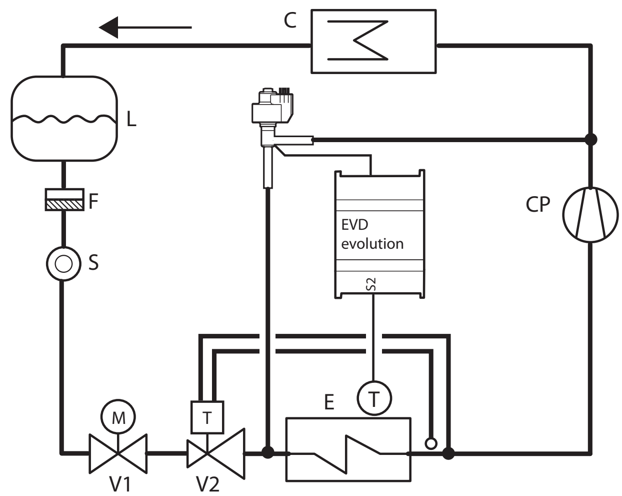


Fig. 5.d

Key:

CP	Compressor	V1	Solenoid valve
C	Condenser	V2	Thermostatic expasnion valve
L	Liquid receiver	EV	Electronic valve
F	Dewatering filter	E	Evaporator
S	Liquid indicator		

For the wiring, see paragraph 2.7 "General connection diagram".

This involves PID control without any protectors (LowSH, LOP, MOP, HiTcond, see the chapter on Protectors), without any valve unblock procedure and without auxiliary control. Control is performed on the hot gas bypass temperature sensor value read by input S2, compared to the set point: "Hot gas bypass temperature set point".
Control is reverse, as the temperature increases, the valve closes.

Parameter/description	Def.	Min.	Max.	UOM
CONTROL				
Hot gas bypass temperature set point	10	-60 (-76)	200 (392)	°C (°F)
PID: proportional gain	15	0	800	-
PID: derivative time	150	0	1000	s
PID: integration time	5	0	800	s

Tab. 5.g

Transcritical CO_2 gas cooler

This solution for the use of CO_2 in refrigerating systems with a transcritical cycle involves using a gas cooler, that is a refrigerant/air heat exchanger resistant to high pressures, in place of the condenser. In transcritical operating conditions, for a certain gas cooler outlet temperature, there is pressure that optimises the efficiency of the system:

$$Set = A \bullet T + B$$

Set= pressure set point in a gas cooler with transcritical CO_2
T= gas cooler outlet temperature
Default value: A= 3.3, B= -22.7.
In the simplified diagram shown below, the simplest solution in conceptual terms is shown. The complications in the systems arise due to the high pressure and the need to optimise efficiency.

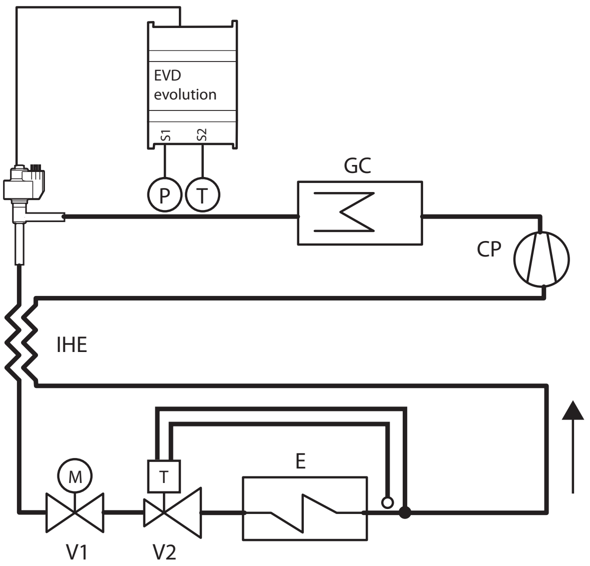


Fig. 5.e

Key:

CP	Compressor	V2	Thermostatic expasnion valve
GC	Gas cooler	EV	Electronic valve
E	Evaporator	IHE	Inside heat exchanger
V1	Solenoid valve		

For the wiring, see paragraph 2.7 "General connection diagram".
This involves PID control without any protectors (LowSH, LOP, MOP, HiTcond, see the chapter on Protectors), without any valve unblock procedure and without auxiliary control. Control is performed on the gas cooler pressure sensor value read by input S1, with a set point depending on the gas cooler temperature read by input S2; consequently there is not a set point parameter, but rather a formula:
"CO_2 gas cooler pressure set point"= Coefficient A * Tgas cooler (S2) + Coefficient B. The set point calculated will be a variable that is visible in display mode. Control is direct, as the pressure increases, the valve opens.

Parameter/description	Def.	Min.	Max.	UOM
SPECIAL				
Transcritical CO2: coefficient A	3,3	-100	800	-
Transcritical CO2 coefficient B	-22,7	-100	800	-
CONTROL				
PID: proportional gain	15	0	800	
PID: derivative time	150	0	1000	s
PID: integration time	5	0	800	s

Analogue positioner (4 to 20 mA)

The valve will be positioned linearly depending on the value of the "4 to 20 mA input for analogue valve positioning" read by input S1.
There is no PID control nor any protection (LowSH, LOP, MOP, HiTcond, see the chapter on Protectors), no valve unblock procedure and no auxiliary control.

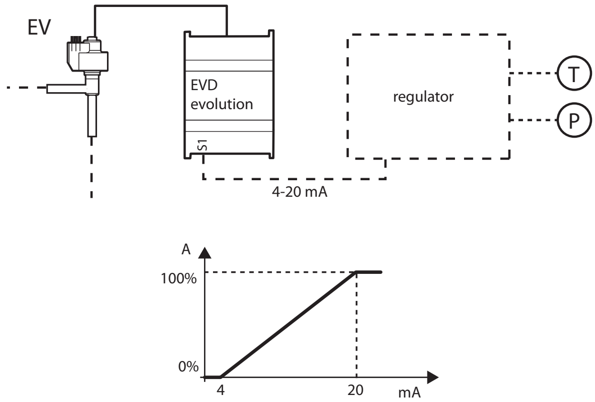


Fig. 5.f

Key:

EV	Electronic valve	A	Valve opening

For the wiring, see paragraph 2.7 "General connection diagram".
Forced closing will only occur when digital input DI1 opens, thus switching between control status and standby. The pre-positioning and repositioning procedures are not performed. Manual positioning can be enabled when control is active or in standby.

Analogue positioner (0 to 10 Vdc)

The valve will be positioned linearly depending on the value of the "0 to 10 V input for analogue valve positioning" read by input S1.
There is no PID control nor any protection (LowSH, LOP, MOP, HiTcond), no valve unblock procedure and no auxiliary control, with corresponding forced closing of the valve and changeover to standby status.

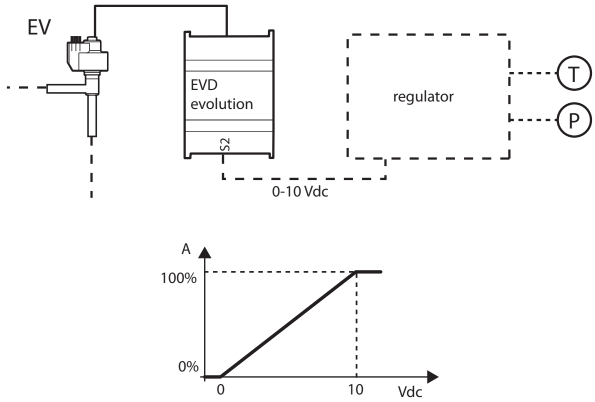


Fig. 5.g

Key:

EV	Electronic valve	A	Valve opening

For the wiring, see paragraph 2.7 "General connection diagram".

Important: the pre-positioning and repositioning procedures are not performed. Manual positioning can be enabled when control is active or in standby.

5.4 Auxiliary control

Auxiliary control can be activated at the same time as main control, and uses the sensors connected to inputs S3 and/or S4.

Parameter/description	Def.
CONFIGURATION	
Auxiliary control: Disabled; High condensing temperature protection on S3; Modulating thermostat on S4; Backup sensors on S3 & S4	Disabled

Tab. 5.h

For the high condensing temperature protection (only available with superheat control), an additional pressure sensor is connected to S3 that measures the condensing pressure.
For the modulating thermostat function (only available with superheat control), an additional temperature sensor is connected to S4 that measures the temperature on used to perform temperature control (see the corresponding paragraph).
The last option (available always) requires the installation of both sensors S3 & S4, the first pressure and the second temperature.

Note: if only one backup sensor is fitted, under the manufacture parameters, the sensor thresholds and alarm management can be set separately.

HITCond protection (high condensing temperature)

The functional diagram is shown below.

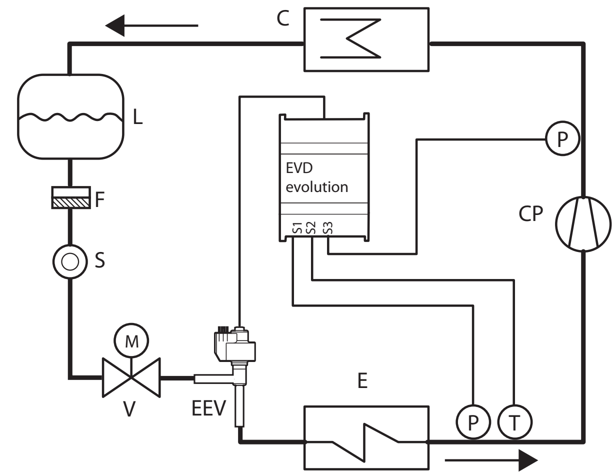


Fig. 5.h

Key:

CP	Compressor	EEV	Electronic expansion valve
C	Condenser	V	Solenoid valve
L	Liquid receiver	E	Evaporator
F	Dewatering filter	P	Pressure sensor (transducer)
S	Liquid indicator	T	Temperature sensor

For the wiring, see paragraph 2.7 "General connection diagram".
As already mentioned, the HITCond protection can only be enabled if the control measures the condensing pressure/temperature, and responds moderately by closing the valve in the event where the condensing temperature reaches excessive values, to prevent the compressor from shutting down due to high pressure. The condensing pressure sensor must be connected to input S3.

Modulating thermostat

This function is used, by connecting a temperature sensor to input S4, to modulate the opening of the electronic valve so as to limit the lowering of the temperature read and consequently reach the control set point. This is useful in applications such as the multiplexed cabinets to avoid the typical swings in air temperature due to the ON/OFF control (thermostatic) of the solenoid valve. A temperature sensor must be connected to input S4, located in a similar position to the one used for the traditional temperature control of the cabinet. In practice, the close the controlled temperature gets to the set point, the more the control function decreases the cooling capacity of the evaporator by closing the expansion valve.
By correctly setting the related parameters (see below), a very stable cabinet temperature can be achieved around the set point, without ever closing the solenoid valve. The function is defined by three parameters: set point, differential and offset.

Parameter/description	Def.	Min.	Max.	UOM
SPECIAL				
Modulating thermostat: set point	0	-60 (-76)	200 (392)	°C (°F)
Modulating thermostat: differential	0,1	0,1 (0,2)	100 (180)	°C (°F)
Modulating thermostat: superheat set point offset (0= function disabled)	0	0 (0)	100 (180)	K (°R)

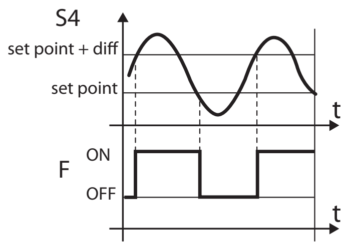
Tab. 5.i

The first two should have values similar to those set on the controller for the cabinet or utility whose temperature is being modulated.
The offset, on the other hand, defines the intensity in closing the valve as the temperature decreases: the greater the offset, the more the valve will be modulated. The function is only active in a temperature band between the set point and the set point plus the differential.

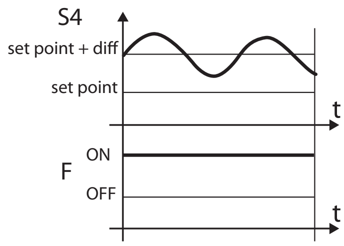
Important: the "Modulating thermostat" function should not be used on stand-alone refrigeration units, but only in centralised systems. In fact, in the former case closing the valve would cause a lowering of the pressure and consequently shut down the compressor.

Examples of operation:

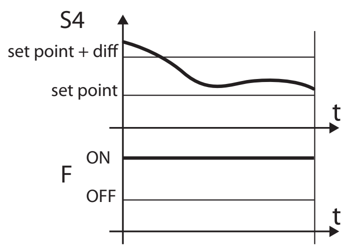
1. offset too low (or function disabled)



2. offset too high



3. offset correct



Key:
diff= differential
F= modulating thermostat function
S4= temperature

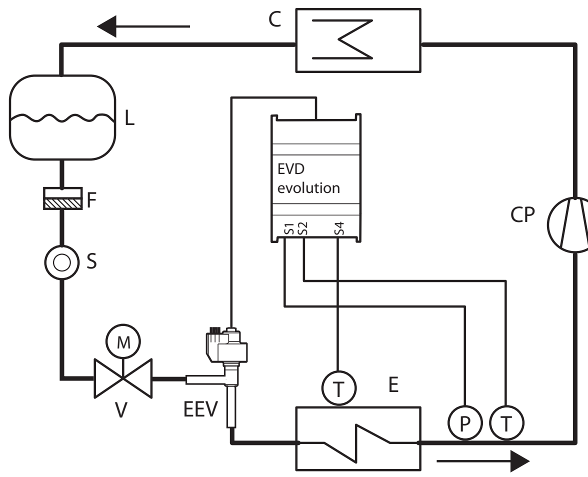


Fig. 5.i

Key:

CP	Compressor	EEV	Electronic expansion valve
C	Condenser	V	Solenoid valve
L	Liquid receiver	E	Evaporator
F	Dewatering filter	P	Pressure sensor (transducer)
S	Liquid indicator	T	Temperature sensor

For the wiring, see paragraph 2.7 "General connection diagram".

Backup sensors on S3 & S4

In this case, pressure sensor S3 and temperature sensor S4 will be used to replace sensors S1 and S2 respectively in the event of faults on one or both, so as to guarantee a high level of reliability of the controlled unit.

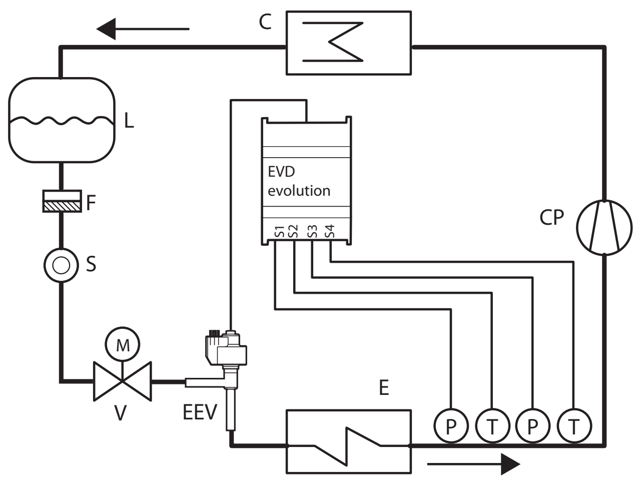


Fig. 5.j

Key:

CP	Compressor	EEV	Electronic expansion valve
C	Condenser	V	Solenoid valve
L	Liquid receiver	E	Evaporator
F	Dewatering filter	P	Pressure sensor (transducer)
S	Liquid indicator	T	Temperature sensor

For the wiring, see paragraph 2.7 "General connection diagram".

6. FUNCTIONS

6.1 Inputs and outputs

Analogue inputs

The parameters in question concern the choice of the type of pressure sensor S1 and S3 and the choice of the temperature sensor S2 and S4, as well as the possibility to calibrate the pressure and temperature signals. As regards the choice of pressure sensor S1, see the chapter on "Commissioning".

Inputs S2, S4

The options are standard NTC sensors, high temperature NTC, combined temperature and pressure sensors and 0 to 10 Vdc input. For S4 the 0 to 10 Vdc input is not available. When choosing the type of sensor, the minimum and maximum alarm values are automatically set. See the chapter on "Alarms". The auxiliary sensor S4 is associated with the Modulating thermostat function or can be used as a backup sensor for the main sensor S2.

Type	CAREL code	Range
CAREL NTC (10KΩ at 25°C)	NTC0**HP00	
NTC0**WF00		
NTC0**HF00	-50T105°C	
CAREL NTC-HT HT (50KΩ at 25°C)	NTC0**HT00	0T120°C (150 °C per 3000 h)
Combined NTC	SPKP**T0	-40T120°C

Attention: in case of combined NTC sensor, select also the parameter relevant to the corresponding ratiometric pressure sensor.

Parameter/description	Def.
CONFIGURATION	
Sensor S2: CAREL NTC; CAREL NTC-HT high T; Combined NTC SPKP**T0; 0-10 V external signal	CAREL NTC
Sensor S4: CAREL NTC; CAREL NTC-HT high T; Combined NTC SPKP**T0	CAREL NTC

Tab. 6.a

Input S3

The auxiliary sensor S3 is associated with the high condensing temperature protection or can be used as a backup sensor for the main sensor S1. If the sensor being used is not included in the list, select any 0 to 5 V ratiometric or electronic 4 to 20 mA sensor and then manually modify the minimum and maximum measurement in the manufacturer parameters corresponding to the sensors.

Important: sensors S3 and S4 appear as NOT USED if the "auxiliary control" parameter is set as " disabled".
If "auxiliary control" has any other setting, the manufacturer setting for the sensor used will be shown, which can be selected according to the type.

Auxiliary control	Variable displayed
High condensing temperature protection	S3
Modulating thermostat	S4
Backup sensors	S3,S4

Tab. 6.b

Parameter/description		Def.
Configuration		
Sensor S3:		Ratiom.: -1 to 9.3 barg
Ratiometric (OUT=0 to 5 V)	Electronic (OUT=4 to 20 mA)	
-1 to 4.2 barg	-0.5 to 7 barg	
-0.4 to 9.2 barg	0 to 10 barg	
-1 to 9.3 barg	0 to 18.2 bar	
0 to 17.3 barg	0 to 25 barg	
-0.4 to 34.2 barg	0 to 30 barg	
0 to 34.5 barg	0 to 44.8 barg	
0 to 45 barg	remote, -0.5 to 7 barg	
	remote, 0 to 10 barg	
	remote, 0 to 18.2 barg	
	remote, 0 to 25 barg	
	remote, 0 to 30 barg	
	remote, 0 to 44.8 barg	

Tab. 6.c

Calibrating pressure sensors S1, S3 and temperature sensors S2 and S4 (offset and gain parameters)

In case it is necessary to make a calibration:
- of the pressure sensor, S1 and/or S3 it is possible to use the offeset parameter, which represents a constant that is added to the signal across the entire range of measurement, and can be expressed in barg/psig. If the 4 to 20 mA signal coming from an external controller on input S1 needs to be calibrated, both the offset and the gain parameters can be used, the latter which modifies the gradient of the line in the field from 4 to 20 mA.
- of the temperature sensor, S2 and/or S4 it is possible to use the offset parameter, which represents a constant that is added to the signal across the entire range of measurement, and can be expressed in °C/°F. If the 0 to 10 Vdc signal coming from an external controller on input S2 needs to be calibrated, both the offset and the gain parameters can be used, the latter which modifies the gradient of the line in the field from 0 to 10 Vdc.

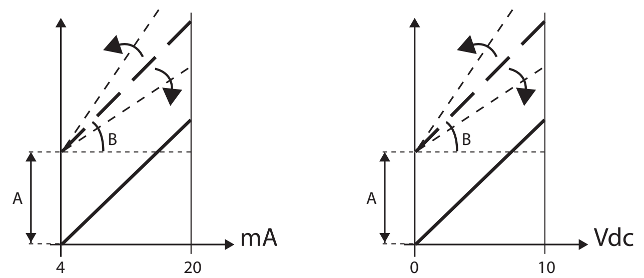


Fig. 6.a

Key:
A= offset,
B= gain

Parameter/description	Def.	Min.	Max.	UOM
Sonde				
S1: calibration offset	0	-60 (-870), -60	60 (870), 60	barg (psig), mA
S1: calibration gain, 4 to 20 mA	1	-20	20	-
S2: calibration offset	0	-20 (-290), 20	20 (290), 20	°C (°F), volt
S2: calibration gain, 0 to 10 V	1	-20	20	-
S3: calibration offset	0	-60 (-870)	60 (870)	barg (psig)
S4: calibration offset	0	-20 (-36)	20 (36)	°C (°F)

Tab. 6.d

Digital inputs

Digital input DI1 is used to activate the control:
- digital input 1 closed: control activated;
- digital input 1 open: driver in standby (see paragraph "Control status").

As regards digital input 2, if configured, this is used to tell the driver the active defrost status:
Defrost active= contact DI2 closed.
When entering Manufacturer programming mode, the start delay after defrost can be set (see the following paragraphs).

Parameter/description	Def.	Min.	Max.	UOM
Configuration				
Configuration of DI2				
Disabled; Optimise valve control after defrost.	Disabled	-	-	-
Control				
Start delay after defrost	10	0	60	min

Tab. 6.e

Output

The relay output can be configured to control the solenoid valve or as an alarm relay output. See the chapter on "Alarms".

Parameter/description	Def.
Configuration	
Relay configuration: Disabled; Alarm relay (open when alarm active); Solenoid valve relay (open in standby); Valve relay +alarm (open in standby and control alarms)	Alarm relay

Tab. 6.f

6.2 Control status

The electronic valve driver has 6 different types of control status, each of which may correspond to a specific phase in the operation of the refrigeration unit and a certain status of the driver-valve system.
The status may be as follows:

- **forced closing:** initialisation of the valve position when switching the instrument on;
- **standby:** no temperature control, unit OFF;
- **wait:** opening of the valve before starting control, also called pre-positioning, when powering the unit and in the delay after defrosting;
- **control:** effective control of the electronic valve, unit ON;
- **positioning:** step-change in the valve position, corresponding to the start of control when the cooling capacity of the controlled unit varies (only for pLAN EVD connected to a pCO);
- **stop:** end of control with the closing of the valve, corresponds to the end of temperature control of the refrigeration unit, unit OFF.

Forced closing

Forced closing is performed after the driver is powered-up and corresponds to a number of closing steps equal to the parameter "Closing steps", based on the type valve selected. This is used to realign the valve to the physical position corresponding to completely closed. The driver and the valve are then ready for control and both aligned at 0 (zero). On power-up, first a forced closing is performed, and then the standby phase starts.

Parametro/description	Def.	Min.	Max.	UOM
Valve				
EEV closing steps	500	0	9999	step

Tab. 6.g

Standby

Standby corresponds to a situation of rest in which no signals are received to control the electronic valve. This normally occurs:

- when the refrigeration unit stops operating, either when switched off manually (e.g. from the button, supervisor) or when reaching the control set point;
- during defrosts, except for those performed by reversing of the cycle (or hot gas bypass).

In general, it can be said that the electronic valve driver is in standby when the compressor stops or the control solenoid valve closes. The valve is closed or open, delivering around 25% of the flow-rate of refrigerant, based on the setting of the "valve open in standby" parameter.
In this phase, manual positioning can be activated.

Parameter/description	Def.	Min.	Max.	UOM
Valve open in standby 0=disabled=valve closed; 1=enabled = valve open 25%	0	0	1	-

Tab. 6.h

Pre-positioning/start control

If during standby a control request is received, before starting control the valve is moved to a precise initial position.

Parameter/description	Def.	Min.	Max.	UOM
Control				
Valve opening at start (evaporator/valve capacity ratio)	50	0	100	%

Tab. 6.i

This parameter should be set based on the ratio between the rated cooling capacity of the evaporator and the valve (e.g. rated evaporator cooling capacity: 3kW, rated valve cooling capacity: 10kW, valve opening = 3/10 = 33%).

If the capacity request is 100%:
Opening (%)= (Valve opening at start-up);

If the capacity request is less than 100% (capacity control):
Opening (%)= (Valve opening at start-up) · (Current unit cooling capacity),
where the current unit cooling capacity is sent to the driver via pLAN by the pCO controller. If the driver is stand-alone, this is always equal to 100%.

Note:

- this procedure is used to anticipate the movement and bring the valve significantly closer to the operating position in the phases immediately after the unit starts;
- if there are problems with liquid return after the refrigeration unit starts or in units that frequently switch on-off, the valve opening at start-up must be decreased. If there are problems with low pressure after the refrigeration unit starts, the valve opening must be increased.

Wait

When the calculated position has been reached, regardless of the time taken (this varies according to the type of valve and the objective position), there is a constant 5 second delay before the actual control phase starts. This is to create a reasonable interval between standby, in which the variables have no meaning, as there is no flow of refrigerant, and the effective control phase.

Control

The control request can be received by the closing of digital input 1 or via the network (pLAN). The solenoid or the compressor are activated when the valve, following the pre-positioning procedure, has reached the calculated position. The following figure represents the sequence of events for starting control of the refrigeration unit.

Control delay after defrost

Some types of refrigerating cabinets have problems controlling the electronic valve in the operating phase after defrost. In this period (10 to 20 min after defrosting), the superheat measurement may be altered by the high temperature of the copper pipes and the air, causing excessive opening of the electronic valve for extended periods, in which there is return of liquid to the compressors that is not detected by the sensors connected to the driver. In addition, the accumulation of refrigerant in the evaporator in this phase is difficult to dissipate in a short time, even after the sensors have started to correctly measure the presence of liquid (superheat value low or null).
The driver can receive information on the defrost phase in progress, via digital input 2. The "Start delay after defrost" parameter is used to set a delay when control resumes so as to overcome this problem. During this delay, the valve will remain in the pre-positioning point, while all the normal sensor alarms procedures, etc. managed.

Parameter/description	Def.	Min.	Max.	UOM
Control				
Start delay after defrost	10	0	60	min

Tab. 6.j

Important: if the superheat temperature should fall below the set point, control resumes even if the delay has not yet elapsed.

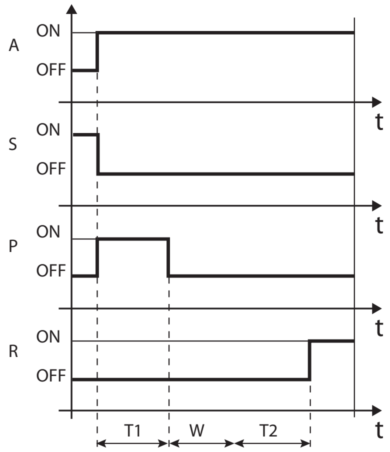


Fig. 6.b

Key:

A	Control request	W	Wait
S	Standby	T1	Pre-positioning time
P	Pre-positioning	T2	Start delay after defrost
R	Control	t	Time

Positioning (change cooling capacity)

This control status is only valid for the pLAN driver.
If there is a change in unit cooling capacity of at least 10%, sent from the pCO via the pLAN, the valve is positioned proportionally. In practice, this involves repositioning starting from the current position in proportion to how much the cooling capacity of the unit has increased or decreased in percentage terms. When the calculated position has been reached, regardless of the time taken (this varies according to the type of valve and the position), there is a constant 5 second delay before the actual control phase starts.

Note: if information is not available on the variation in unit cooling capacity, this will always be considered as operating at 100% and therefore the procedure will never be used. In this case, the PID control must be more reactive (see the chapter on Control) so as to react promptly to variations in load that are not communicated to the driver.

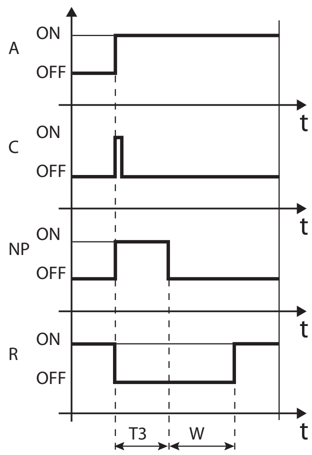


Fig. 6.c

Key:

A	Control request	T3	Repositioning time
C	Change capacity	W	Wait
NP	Repositioning	t	Time
R	Control		

Stop/end control

The stop procedure involves closing the valve from the current position until reaching 0 steps, plus a further number of steps so as to guarantee complete closing. Following the stop phase, the valve returns to standby.

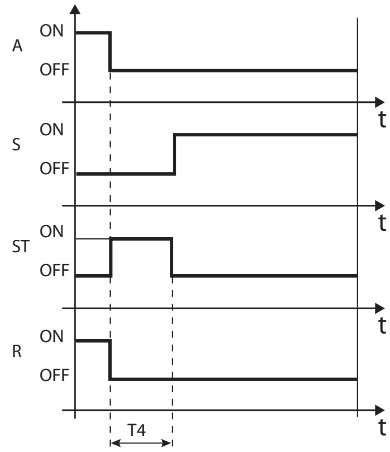


Fig. 6.d

Key:

A	Control request	R	Control
S	Standby	T4	Stop position time
ST	Stop	t	Time

6.3 Special control status

As well as normal control status, the driver can have 3 special types of status related to specific functions:

- **manual positioning:** this is used to interrupt control so as to move the valve, setting the desired position;
- **recover physical valve position:** recover physical valve steps when fully opened or closed;
- **unblock valve:** forced valve movement if the driver considers it to be blocked.

Manual positioning

Manual positioning can be activated at any time during the standby or control phase. Manual positioning, once enabled, is used to freely set the position of the valve using the corresponding parameter.

Parameter/description	Def.	Min.	Max.	UOM
Control				
Enable manual valve positioning	0	0	1	-
Manual valve position	0	0	9999	step

Tab. 6.k

Control is placed on hold, all the system and control alarms are enabled, however neither control nor the protectors can be activated. Manual positioning thus has priority over any status/protection of the driver.

Note:

- the manual positioning status is NOT saved when restarting after a power failure.
- in for any reason the valve needs to be kept stationary after a power failure, proceed as follows:
  - remove the valve stator;
  - in Manufacturer programming mode, under the configuration parameters, set the PID proportional gain= 0. The valve will remain stopped at the initial opening position, set by corresponding parameter.

Recover physical valve position

Parameter/description	Def.	Min.	Max.	UOM
Valve				
Synchronise valve position in opening	1	0	1	-
Synchronise valve position in closing	1	0	1	-

Tab. 6.l

This procedure is necessary as the stepper motor intrinsically tends to lose steps during movement. Given that the control phase may last continuously for several hours, it is probable that from a certain time on the estimated position sent by the valve driver does not correspond exactly to the physical position of the movable element. This means that when the driver reaches the estimated fully closed or fully open position, the valve may physically not be in that position. The "Synchronisation" procedure allows the driver to perform a certain number of steps in the suitable direction to realign the valve when fully opened or closed.

Note:

- realignment is in intrinsic part of the forced closing procedure and is activated whenever the driver is stopped/started and in the standby phase;
- the possibility to enable or disable the synchronisation procedure depends on the mechanics of the valve. When the setting the "valve" parameter, the two synchronisation parameters are automatically defined. The default values should not be changed.

Unblock valve

This procedure is only valid when the driver is performing superheat control. Unblock valve is an automatic safety procedure that attempts to unblock a valve that is supposedly blocked based on the control variables (superheat, valve position). The unblock procedure may or may not succeed depending on the extent of the mechanical problem with the valve. If for 10 minutes the conditions are such as to assume the valve is blocked, the procedure is run a maximum of 5 times. The symptoms of a blocked valve doe not necessarily mean a mechanical blockage. They may also represent other situations:

- mechanical blockage of the solenoid valve upstream of the electronic valve (if installed);
- electrical damage to the solenoid valve upstream of the electronic valve;
- blockage of the filter upstream of the electronic valve (if installed);
- electrical problems with the electronic valve motor;
- electrical problems in the driver-valve connection cables;
- incorrect driver-valve electrical connection;
- electronic problems with the valve control driver;
- secondary fluid evaporator fan/pump malfunction;
- insufficient refrigerant in the refrigerant circuit;
- refrigerant leaks;
- lack of subcooling in the condenser;
- electrical/mechanical problems with the compressor;
- processing residues or moisture in the refrigerant circuit.

Note: the valve unblock procedure is nonetheless performed in each of these cases, given that it does not cause mechanical or control problems. Therefore, also check these possible causes before replacing the valve.

7. PROTECTORS

These are additional functions that are activated in specific situations that are potentially dangerous for the unit being controlled. They feature an integral action, that is, the action increases gradually when moving away from the activation threshold. They may add to or overlap (disabling) normal PID superheat control. By separating the management of these functions from PID control, the parameters can be set separately, allowing, for example, normal control that is less reactive yet much faster in responding when exceeding the activation limits of one of the protectors.

7.1 Protectors

The protectors are 4:
- LowSH, low superheat;
- LOP, low evaporation temperature;
- MOP, high evaporation temperature;
- HiTcond, high condensing temperature.

Note: The HITCond protection requires an additional sensor (S3) to those normally used, either installed on the driver, or connected via tLAN or pLAN to a controller.

The protectors have the following main features:
- activation threshold: depending on the operating conditions of the controlled unit, this is set in Service programming mode;
- integration time, which determines the intensity (if set to 0, the protector is disabled): set automatically based on the type of main control;
- alarm, with activation threshold (the same as the protector) and delay (if set to 0 disables the alarm signal).

Note: The alarm signal is independent from the effectiveness of the protector, and only signals that the corresponding threshold has been exceeded. If a protector is disabled (null integration time), the relative alarm signal is also disabled.

Each protector is affected by the proportional gain parameter (K) for the PID superheat control. The higher the value of K, the more intense the reaction of the protector will be.

Characteristics of the protectors

Protection	Reaction	Reset
LowSH	Intense closing	Immediate
LOP	Intense opening	Immediate
MOP	Moderate closing	Controlled
HiTcond	Moderate closing	Controlled

Tab. 7.a

Reaction: summary description of the type of action in controlling the valve.
Reset: summary description of the type of reset following the activation of the protector. Reset is controlled to avoid swings around the activation threshold or immediate reactivation of the protector.

LowSH (low superheat)

The protector is activated so as to prevent the return of liquid to the compressor due to excessively low superheat valves from.

Parameter/description	Def.	Min.	Max.	UOM
CONTROL				
LowSH protection: threshold	5	-40 (-72)	set point superheat	K (°R)
LowSH protection: integration time	15	0	800	s
ALARM CONFIGURATION				
Low superheat alarm delay (LowSH) (0= alarm disabled)	300	0	18000	s

Tab. 7.b

When the superheat value falls below the threshold, the system enters low superheat status, and the intensity with which the valve is closed is increased: the more the superheat falls below the threshold, the more intensely the valve will close. The LowSH threshold, must be less than or equal to the superheat set point. The low superheat integration time indicates the intensity of the action: the lower the value, the more intense the action.
The integration time is set automatically based on the type of main control.

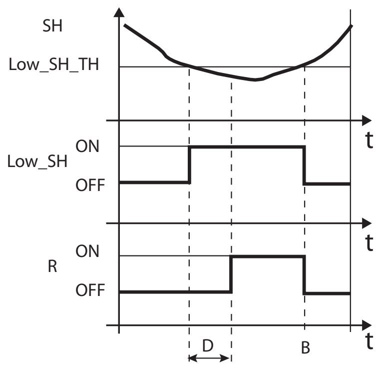


Fig. 7.a

Key:

SH	Superheat	A	Alarm
Low_SH_TH	Low_SH protection threshold	D	Alarm delay
Low_SH	Low_SH protection	t	Time
B	Automatic alarm reset		

LOP (low evaporation pressure)

LOP= Low Operating Pressure
The LOP protection threshold is applied as a saturated evaporation temperature value so that it can be easily compared against the technical specifications supplied by the manufacturers of the compressors. The protector is activated so as to prevent too low evaporation temperatures from stopping the compressor due to the activation of the low pressure switch. The protector is very useful in units with compressors on board (especially multi-stage), where when starting or increasing capacity the evaporation temperature tends to drop suddenly.
When the evaporation temperature falls below the low evaporation temperature threshold, the system enters LOP status and is the intensity with which the valve is opened is increased. The further the temperature falls below the threshold, the more intensely the valve will open. The integration time indicates the intensity of the action: the lower the value, the more intense the action.

Parameter/description	Def.	Min.	Max.	UOM
CONTROL				
LOP protection: threshold	-50	-60 (-72)	Protection MOP: threshold	°C (°F)
LOP protection: integration time	0	0	800	s
ALARM CONFIGURATION				
Low evaporation temperature alarm delay (LOP) (0= alarm disabled)	300	0	18000	s

Tab. 7.c

The integration time is set automatically based on the type of main control.

Note:
- the LOP threshold must be lower then the rated evaporation temperature of the unit, otherwise it would be activated unnecessarily, and greater than the calibration of the low pressure switch, otherwise it would be useless. As an initial approximation it can be set to a value exactly half-way between the two limits indicated;
- the protector has no purpose in multiplexed systems (showcases) where the evaporation is kept constant and the status of the individual

electronic valve does not affect the pressure value;
- the LOP alarm can be used as an alarm to highlight refrigerant leaks by the circuit. A refrigerant leak in fact causes an abnormal lowering of the evaporation temperature that is proportional, in terms of speed and extent, to the amount of refrigerant dispersed.

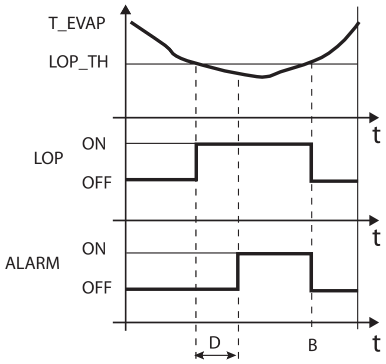


Fig. 7.b

Key:

T_EVAP	Evaporation temperature	D	Alarm delay
LOP_TH	Low evaporation temperature protection threshold	ALARM	Alarm
LOP	LOP protection	t	Time
B	Automatic alarm reset		

MOP (high evaporation pressure)

MOP= Maximum Operating Pressure.

The MOP protection threshold is applied as a saturated evaporation temperature value so that it can be easily compared against the technical specifications supplied by the manufacturers of the compressors. The protector is activated so as to prevent too high evaporation temperatures from causing an excessive workload for the compressor, with consequent overheating of the motor and possible activation of the thermal protector. The protector is very useful in units with compressor on board if starting with a high refrigerant charge or when there are sudden variations in the load. The protector is also useful in multiplexed systems (showcases), as allows all the utilities to be enabled at the same time without causing problems of high pressure for the compressors. To reduce the evaporation temperature, the output of the refrigeration unit needs to be decreased. This can be done by controlled closing of the electronic valve, implying superheat is no longer controlled, and an increase in the superheat temperature. The protector will thus have a moderate reaction that tends to limit the increase in the evaporation temperature, keeping it below the activation threshold while trying to stop the superheat from increasing as much as possible. Normal operating conditions will not resume based on the activation of the protector, but rather on the reduction in the refrigerant charge that caused the increase in temperature. The system will therefore remain in the best operating conditions (a little below the threshold) until the load conditions change.

Parameter/description	Def.	Min.	Max.	UOM
CONTROL				
MOP protection: threshold	50	Protection LOP: threshold	200 (392)	°C (°F)
MOP protection: integration time	20	0	800	s
ALARM CONFIGURATION				
High evaporation temperature alarm delay (MOP) (0= alarm disabled)	600	0	18000	s

Tab. 7.d

The integration time is set automatically based on the type of main control.

When the evaporation temperature rises above the MOP threshold, the system enters MOP status, superheat control is interrupted to allow the pressure to be controlled, and the valve closes slowly, trying to limit the evaporation temperature. As the action is integral, it depends directly on the difference between the evaporation temperature and the activation threshold. The more the evaporation temperature increases with reference to the MOP threshold, the more intensely the valve will close. The integration time indicates the intensity of the action: the lower the value, the more intense the action.

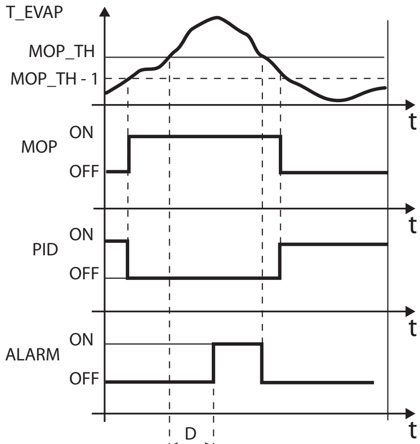


Fig. 7.c

Key:

T_EVAP	Evaporation temperature	MOP_TH	MOP threshold
PID	PID superheat control	ALARM	Alarm
MOP	MOP protection	t	Time
D	Alarm delay		

Important: the MOP threshold must be greater than the rated evaporation temperature of the unit, otherwise it would be activated unnecessarily. The MOP threshold is often supplied by the manufacturer of the compressor. It is usually between 10 °C and 15 °C.

Important: if the closing of the valve also causes an excessive increase in the suction temperature (S2), the valve will be stopped to prevent overheating the compressor windings, awaiting a reduction in the refrigerant charge.

At the end of the MOP protection function, superheat control restarts in a controlled manner to prevent the evaporation temperature from exceeding the threshold again.

HiTcond (high condensing temperature)

To activate the high condensing temperature protector (HiTcond), a pressure sensor must be connected to input S3.
The protector is activated so as to prevent too high evaporation temperatures from stopping the compressor due to the activation of the high pressure switch.

Parameter/description	Def.	Min.	Max.	UOM
SPECIAL				
HiTcond: threshold	80	-60 (-76)	200 (392)	°C (°F)
HiTcond: integration time	20	0	800	s
ALARM CONFIGURATION				
High condensing temperature alarm delay (HiTcond) (0= alarm disabled)	600	0	18000	s

Tab. 7.e

The integration time is set automatically based on the type of main control.

Note:
- the protector is very useful in units with compressors on board if the air-cooled condenser is undersized or dirty/malfunctioning in the more critical operating conditions (high outside temperature);
- the protector has no purpose in multiplexed systems (showcases), where the condensing pressure is maintained constant and the status of the individual electronic valves does not affect the pressure value.

To reduce the condensing temperature, the output of the refrigeration unit needs to be decreased. This can be done by controlled closing of the electronic valve, implying superheat is no longer controlled, and an increase in the superheat temperature. The protector will thus have a moderate reaction that tends to limit the increase in the condensing temperature, keeping it below the activation threshold while trying to stop the superheat from increasing as much as possible. Normal operating conditions will not resume based on the activation of the protector, but rather on the reduction in the outside temperature. The system will therefore remain in the best operating conditions (a little below the threshold) until the environmental conditions change.

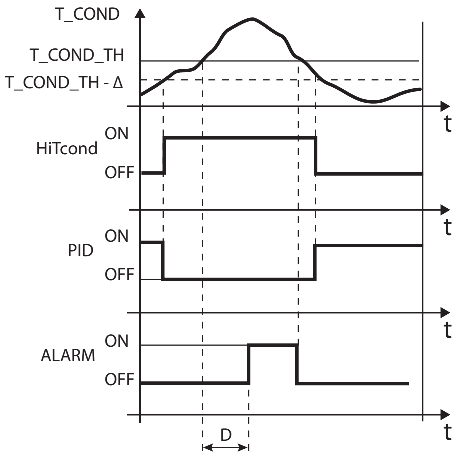


Fig. 7.d

Key:

T_COND	Condensing temperature	T_COND_TH	HiTcond: threshold
HiTcond	HiTcond protection status	ALARM	Alarm
PID	PID superheat control	t	Time
D	Alarm delay		

Note:

- the HiTcond threshold must be greater than the rated condensing temperature of the unit and lower then the calibration of the high pressure switch;
- the closing of the valve will be limited if this causes an excessive decrease in the evaporation temperature.

8. PARAMETERS TABLE

user*	Parameter/description	Def.	Min.	Max.	UOM	Type **	CAREL SVP	Modbus®	Notes
	CONFIGURAZIONE								
A	Network address	198	1	207	-	I	11	138	
A	Refrigerant: R22 R134a R404A R407C R410A R507A R290 R600 R600a R717 R744 R728 R1270 R417A R422D	R404A	-	-	-	I	13	140	
A	Valve: CAREL E^XV Alco EX4 Alco EX5 Alco EX6 Alco EX7 Alco EX8 330Hz suggested by CAREL Alco EX8 500Hz specified by Alco Sporlan SEI 0.5-11 Sporlan SER 1.5-20 Sporlan SEI 30 Sporlan SEI 50 Sporlan SEH 100 Sporlan SEH 175 Danfoss ETS 25B Danfoss ETS 50B Danfoss ETS 100B Danfoss ETS 250 Danfoss ETS 400	CAREL E^XV	-	-	-	I	14	141	
A	Sensor S1: Ratiometric (OUT=0 to 5 V) / Electronic (OUT=4 to 20 mA) -1 to 4.2 barg / -0.5 to 7 barg -0.4 to 9.2 barg / 0 to 10 barg -1 to 9.3 barg / 0 to 18.2 bar 0 to 17.3 barg / 0 to 25 barg -0.4 to 34.2 barg / 0 to 30 barg 0 to 34.5 barg / 0 to 44.8 barg 0 to 45 barg / remote, -0.5 to 7 barg remote, 0 to 10 barg remote, 0 to 18.2 barg remote, 0 to 25 barg remote, 0 to 30 barg remote, 0 to 44.8 barg External signal, 4 to 20 mA	Ratiometric: -1 to 9.3 barg	-	-	-	I	16	143	
A	Main control: Multiplexed cabinet/cold room Cabinet/cold room with on-board compressor "Perturbed" cabinet/cold room Cabinet/cold room with sub-critical CO_2 R404A condenser for sub-critical CO2 Air-conditioner/chiller with plate heat exchanger Air-conditioner/chiller with tube bundle heat exchanger Air-conditioner/chiller with finned coil heat exchanger Air-conditioner/chiller with variable cooling capacity "Perturbed" air-conditioner/chiller EPR back-pressure Hot gas bypass by pressure Hot gas bypass by temperature Transcritical CO2 gas cooler Analogue positioner (4 to 20 mA) Analogue positioner (0 to 10 V) Analogue positioner (0 to 10 V)	Multiplexed cabinet/cold room	-	-	-	I	15	142	
A	Sensor S2: CAREL NTC / CAREL NTC-HT high temp. Combined NTC SPKP**T0 / 0 to 10 V external signal	CAREL NTC	-	-	-	I	17	144	
A	Auxiliary control: Disabled High condensing temperature protection on S3 Modulating thermostat on S4 Backup sensors on S3 & S4	Disabled	-	-	-	I	18	145	

user*	Parameter/description	Def.	Min.	Max.	UOM	Type **	CAREL SVP	Modbus®	Notes
A	Sensor S3 Ratiometric (OUT=0 to 5 V): -1 to 4.2 barg -0.4 to 9.2 barg -1 to 9.3 barg 0 to 17.3 barg -0.4 to 34.2 barg 0 to 34.5 barg 0 to 45 barg Electronic (OUT=4 to 20 mA): -0.5 to 7 barg 0 to 10 barg 0 to 18.2 bar 0 to 25 barg 0 to 30 barg 0 to 44.8 barg remote, -0.5 to 7 barg remote, 0 to 10 barg remote, 0 to 18.2 barg remote, 0 to 25 barg remote, 0 to 30 barg remote, 0 to 44.8 barg	Ratiometric: -1 to 9.3 barg	-	-	-	I	19	146	
A	Relay configuration: Disabled Alarm relay (open when alarm active) Solenoid valve relay (open in standby) Valve relay +alarm (open in standby & control alarms)	Alarm relay	-	-	-	I	12	139	
A	Sensor S4: CAREL NTC CAREL NTC-HT high temperature Combined NTC SPKP**T0	CAREL NTC	-	-	-	I	20	147	
A	Configuration of DI2: Disabled Optimise valve control after defrost	Disabled	-	-	-	I	10	137	
C	Variable 1 on display: Valve opening Valve position Current cooling capacity Control set point Superheat Suction temperature Evaporation temperature Evaporation pressure Condensing temperature Condensing pressure Modulating thermostat temperature EPR pressure Hot gas bypass pressure Hot gas bypass temperature CO_2 gas cooler outlet temperature CO_2 gas cooler outlet pressure CO_2 gas cooler pressure set point Sensor S1 reading Sensor S2 reading Sensor S3 reading Sensor S4 reading 4 to 20 mA input 0 to 10 V input	Superheat	-	-	-	I	45	172	
C	Variable 2 on display (vedere variable 1 on display)	Valve opening	-	-	-	I	46	173	
C	Sensor S1 alarm management: No action Forced valve closing Valve in fixed position Use backup sensor S3	Valve in fixed position	-	-	-	I	24	151	
C	Sensor S2 alarm management: No action Forced valve closing Valve in fixed position Use backup sensor S4	Valve in fixed position	-	-	-	I	25	152	
C	Sensor S3 alarm management: No action Forced valve closing Valve in fixed position	No action	-	-	-	I	26	153	
C	Sensor S4 alarm management: No action Forced valve closing Valve in fixed position	No action	-	-	-	I	27	154	
C	Language: Italiano; English	Italiano	-	-	-				
C	Unit of measure: °C(K), barg; °F(°R), psig	°C(K), barg	-	-	-	I	21	148	

user*	Parameter/description	Def.	Min.	Max.	UOM	Type **	CAREL SVP	Modbus®	Notes
	SONDE								
C	S1: calibration offset	0	-60 (-870), -60	60 (870), 60	barg (psig) mA	A	34	33	
C	S1: calibration gain, 4 to 20 mA	1	-20	20	-	A	36	35	
C	Pressure S1: MINIMUM value	-1	-20 (-290)	Pressure S1: MAXIMUM value	barg (psig)	A	32	31	
C	Pressure S1: MAXIMUM value	9,3	Pressure S1: MINIMUM value	200 (2900)	barg (psig)	A	30	29	
C	Pressure S1: MINIMUM alarm value	-1	-20 (-290)	Pressure S1: MAXIMUM alarm value	barg (psig)	A	39	38	
C	Pressure S1: MAXIMUM alarm value	9,3	Pressure S1: MINIMUM alarm value	200 (2900)	barg (psig)	A	37	36	
C	S2: calibration offset	0	-20 (-290), -20	20 (290), 20	°C (°F), volt	A	41	40	
C	S2: calibration gain, 0 to 10 V	1	-20	20	-	A	43	42	
C	Temperature S2: MINIMUM alarm value	-50	-60	Temperature S2: alarm MA-XIMUM value	°C(°F)	A	46	45	
C	Temperature S2: MAXIMUM alarm value	105	Temperature S2: MINIMUM alarm value	200 (392)	°C(°F)	A	44	43	
C	S3: calibration offset	0	-60 (-870)	60 (870)	barg (psig)	A	35	34	
C	Pressure S3: MINIMUM value	-1	-20 (-290)	Pressure S3: MAXIMUM value	barg (psig)	A	33	32	
C	Pressure S3: MAXIMUM value	9,3	Pressure S3: MINIMUM value	200 (2900)	barg (psig)	A	31	30	
C	Pressure S3: MINIMUM alarm value	-1	-20 (-290)	Pressure S3: MAXIMUM alarm value	barg (psig)	A	40	39	
C	Pressure S3: MAXIMUM alarm value	9,3	Pressure S3: MINIMUM alarm value	200 (2900)	barg (psig)	A	38	37	
C	S4: calibration offset	0	-20 (-36)	20 (36)	°C (°F)	A	42	41	
C	Temperature S4: MINIMUM alarm value	-50	-60 (-76)	Temperature S4: MAXIMUM alarm value	°C (°F)	A	47	46	
C	Temperature S4: MAXIMUM alarm value	105	Temperature S4: MINIMUM alarm value	200 (392)	°C (°F)	A	45	44	
	CONTROL								
A	Superheat set point	11	LowSH: thre-shold	180 (324)	K(°R)	A	50	49	
A	Valve opening at start (evaporator/valve capacity ratio)	50	0	100	%	I	37	164	
C	Valve open in standby (0=disabled=valve closed; 1=enabled = valve open 25%)	0	0	1	-	D	23	22	
C	Start delay after defrost	10	0	60	min	I	40	167	
A	Hot gas bypass temperature set point	10	-60 (-76)	200 (392)	°C (°F)	A	28	27	
A	Hot gas bypass pressure set point	3	-20 (-290)	200 (2900)	barg (psig)	A	62	61	
A	EPR pressure set point	3,5	-20 (-290)	200 (2900)	barg (psig)	A	29	28	
C	PID: proportional gain	15	0	800	-	A	48	47	
C	PID: integration time	150	0	1000	s	I	38	165	
C	PID: derivative time	5	0	800	s	A	49	48	
A	LowSH protection: threshold	5	-40 (-72)	superheat set point	K(°R)	A	56	55	
C	LowSH protection: integration time	15	0	800	s	A	55	54	
A	LOP protection: threshold	-50	-60 (-76)	MOP protec-tion: threshold	°C (°F)	A	52	51	
C	LOP protection: integration time	0	0	800	s	A	51	50	
A	MOP protection: threshold	50	LOP protec-tion: threshold	200 (392)	°C (°F)	A	54	53	
C	MOP protection: integration time	20	0	800	s	A	53	52	
A	Enable manual valve positioning	0	0	1	-	D	24	23	
A	Manual valve position	0	0	9999	step	I	39	166	
	SPECIAL								
A	HiTcond: threshold	80	-60 (-76)	200 (392)	°C (°F)	A	58	57	
C	HiTcond: integration time	20	0	800	s	A	57	56	
A	Modulating thermostat: set point	0	-60 (-76)	200 (392)	°C (°F)	A	61	60	
A	Modulating thermostat: differential	0, 1	0, 1 (0,2)	100 (180)	°C (°F)	A	60	59	
C	Modulating thermostat: superheat set point offset	0	0 (0)	100 (180)	K (°R)	A	59	58	
C	Coefficient 'A' for CO_2 control	3,3	-100	800	-	A	63	62	

user*	Parameter/description	Def.	Min.	Max.	UOM	Type **	CAREL SVP	Modbus®	Notes
C	Coefficient 'B' for CO_2 control	-22,7	-100	800	-	A	64	63	
	ALARM CONFIGURATION								
C	Low superheat alarm delay (LowSH) (0= alarm disabled)	300	0	18000	s	I	43	170	
C	Low evaporation temperature alarm delay (LOP) (0= alarm disabled)	300	0	18000	s	I	41	168	
C	High evaporation temperature alarm delay (MOP) (0= alarm disabled)	600	0	18000	s	I	42	169	
C	High condensing temperature alarm delay (HiTcond) (0= alarm disabled)	600	0	18000	s	I	44	171	
C	Low suction temperature alarm threshold	-50	-60 (-76)	200 (392)	°C(°F)	A	26	25	
C	Low suction temperature alarm delay (0= alarm disabled)	300	0	18000	s	I	9	136	
	VALVE								
C	Minimum EEV steps	50	0	9999	step	I	30	157	
C	Maximum EEV steps	480	0	9999	step	I	31	158	
C	EEV closing steps	500	0	9999	step	I	36	163	
C	Rated EEV speed	50	1	2000	step/s	I	32	159	
C	Rated EEV current	450	0	800	mA	I	33	160	
C	EEV holding current	100	0	800	mA	I	35	162	
C	EEV duty cycle	30	1	100	%	I	34	161	
C	Synchronise position in opening	1	0	1	-	D	20	19	
C	Synchronise position in closing	1	0	1	-	D	21	20	

Tab. 8.a

* User: A= Service (installer), C= Manufacturer.
**Type of variable: A= analogue, D= digital, I= integer

8.1 Unit of measure

In the configuration parameters menu, with access by manufacturer password, the user can choose the unit of measure for the driver:
- international system (°C, K, barg);
- imperial system (°F, °R, psig).

Attention: the drivers EVD evolution-pLAN (code EVD000E1*), connected in pLAN to a pCO controller, do not manage the change of the unit of measure.

Note: the units of measure K and °R relate to degrees Kelvin or Rankine adopted for measuring the superheat and the related parameters.

When changing the unit of measure, all the values of the parameters saved on the driver and all the measurements read by the sensors will be recalculated. This means that when changing the units of measure, control remains unaltered.

Example 1: The pressure read is 100 barg, this will be immediately converted to the corresponding value of 1450 psig.

Example 2: The "superheat set point" parameter set to 10 K will be immediately converted to the corresponding value of 18 °R.

Example 3: The "Temperature S4: maximum alarm value" parameter, set to 150 °C, will be immediately converted to the corresponding value of 302 °F

Note: because of some internal arithmetics limitations of the driver, it will not be possible to convert the pressure values higher than 200 barg (2900 psig) and the temperature values higher than 200 °C (392 °F).

8.2 Variables shown on the display

The table below shows the variables available in display mode, depending on the setting of the "Main control" and "Auxiliary control" parameters:

- press the UP/DOWN button to enter display mode;
- press the DOWN button to move to the next variable/screen;
- press Esc to return to the standard display.

	Main control							
Variable displayed	Superheat control			Transcritical CO_2	Hot gas bypass / temperature	Hot gas bypass / pressure	EPR back-pressure	Analogue positioning
		Auxiliary control						
		HiTcond	Modulating thermostat					
Valve opening(%)	•	•	•	•	•	•	•	•
Valve position (step)	•	•	•	•	•	•	•	•
Current cooling capacity unità	•	•	•	•	•	•	•	•
Control set point	•	•	•	•		•		
Superheat	•	•	•					
Suction temperature	•	•	•					
Evaporation temperature	•	•	•					
Evaporation pressure	•	•	•					
Condensing temperature		•						
Condensing pressure		•						
Modulating thermostat temperature			•					
EPR pressure (back pressure)							•	
Hot gas bypass pressure						•		
Hot gas bypass temperature					•			
CO_2 gas cooler outlet temperature				•				
CO_2 gas cooler outlet pressure				•				
CO_2 gas cooler pressure set point				•				
Sensor S1 reading	•	•	•	•	•	•	•	•
Sensor S2 reading	•	•	•	•	•	•	•	•
Sensor S3 reading	•	•	•	•	•	•	•	•
Sensor S4 reading	•	•	•	•	•	•	•	•
4 to 20 mA input value								•
0 to 10 Vdc input value								•
Status of digital input DI1(*)	•	•	•	•	•	•	•	•
Status of digital input DI2(*)	•	•	•	•	•	•	•	•
EVD firmware version	•	•	•	•	•	•	•	•
Display firmware version	•	•	•	•	•	•	•	•

Tab. 8.b

(*) Digital input status: 0= open, 1= closed.

Note: the readings of sensors S1, S2, S3, S4 are always displayed, regardless of whether or not the sensor is connected.

8.3 Variables only accessible via serial link

Description	Default	Min	Max	Type	CAREL SVP	Modbus®	R/W
Sensor S1 reading	0	-20 (-290)	200 (2900)	A	1	0	R
Sensor S2 reading	0	-60 (-870)	200 (392)	A	2	1	R
Sensor S3 reading	0	-20 (-290)	200 (2900)	A	3	2	R
Sensor S4 reading	0	-60 (-76)	200 (392)	A	4	3	R
Suction temperature	0	-60 (-76)	200 (392)	A	5	4	R
Evaporation temperature	0	-60 (-76)	200 (392)	A	6	5	R
Evaporation pressure	0	-20 (-290)	200 (2900)	A	7	6	R
Hot gas bypass temperature	0	-60 (-76)	200 (392)	A	8	7	R
EPR pressure (back pressure)	0	-20 (-290)	200 (2900)	A	9	8	R
Superheat	0	-40 (-72)	180 (324)	A	10	9	R
Condensing pressure	0	-20 (-290)	200 (2900)	A	11	10	R
Condensing temperature	0	-60 (-76)	200 (392)	A	12	11	R
Modulating thermostat temperature	0	-60 (-76)	200 (392)	A	13	12	R
Hot gas bypass pressure	0	-20 (-290)	200 (2900)	A	14	13	R
CO_2 gas cooler outlet pressure	0	-20 (-290)	200 (2900)	A	15	14	R
CO_2 gas cooler outlet temperature	0	-60 (-76)	200 (392)	A	16	15	R
Valve opening	0	0	100	A	17	16	R
CO2 gas cooler pressure set point	0	-20 (-290)	200 (2900)	A	18	17	R
4 to 20 mA input value	4	4	20	A	19	18	R
0 to 10 V input value	0	0	10	A	20	19	R
Control set point	0	-60 (-76)	200 (392)	A	21	20	R
Driver firmware version	0	0	10	A	25	24	R
Valve position	0	0	9999	I	4	131	R
Current unit cooling capacity	0	0	100	I	7	134	R/W

	Description	Default	Min	Max	Type	CAREL SVP	Modbus®	R/W
ALARMS	Low suction temperature	0	0	1	D	1	0	R
	LAN error	0	0	1	D	2	1	R
	EEPROM damaged	0	0	1	D	3	2	R
	Sensor S1	0	0	1	D	4	3	R
	Sensor S2	0	0	1	D	5	4	R
	Sensor S3	0	0	1	D	6	5	R
	Sensor S4	0	0	1	D	7	6	R
	EEV motor error	0	0	1	D	8	7	R
	Relay status	0	0	1	D	9	8	R
ALARMS	LOP (low evaporation temperature)	0	0	1	D	10	9	R
	MOP (high evaporation temperature)	0	0	1	D	11	10	R
	LowSH (low superheat)	0	0	1	D	12	11	R
	HiTcond (high condensing temperature)	0	0	1	D	13	12	R
	Status of digital input DI1	0	0	1	D	14	13	R
	Status of digital input DI2	0	0	1	D	15	14	R
	Enable EVD control	0	0	1	D	22	21	R/W

Tab. 8.c

Type of variable:
A= analogue,
D= digital,
I= integer
SVP= variable address with CAREL protocol on 485 serial card.
Modbus®: variable address with Modbus® protocol on 485 serial card.

9. ALARMS

9.1 Alarms

There are two types of alarms:
- system: valve motor, EEPROM, sensor and communication;
- control: low superheat, LOP, MOP, high condensing temperature, low suction temperature.

The activation of the alarms depends on the setting of the threshold and activation delay parameters. Setting the delay to 0 disables the alarms. The EEPROM unit parameters and operating parameters alarm always stops control.
All the alarms are reset automatically, once the causes are no longer present. The alarm relay contact will open if the relay is configured as alarm relay using the corresponding parameter. The signalling of the alarm event on the driver depends on whether the LED board or the display board is fitted, as shown in the table below.

Note: the alarm LED only comes on for the system alarms, and not for the control alarms.

Example: display system alarm on LED board:

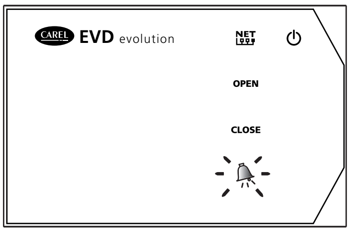


Fig. 9.a

Note: the alarm LED comes on to signal a mains power failure only if the EVBAT*** module (accessory) has been connected, guaranteeing the power required to close the valve.

The display shows both types of alarms, in two different modes:
- **system alarm:** on the main page, the ALARM message is displayed, flashing. Pressing the Help button displays the description of the alarm and, at the top right, the total number of active alarms.

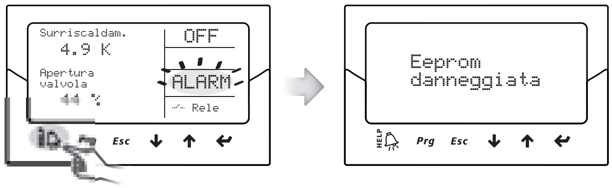


Fig. 9.b

- **control alarm:** next to the flashing ALARM message, the main page shows the type of protector activated.

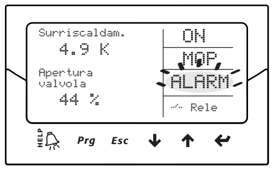


Fig. 9.c

Note:
- to display the alarm queue, press the Help button and scroll using the UP/DOWN buttons;
- the protector alarms can be disabled by setting the corresponding delay to zero.

Table of alarms

Type of alarm	Cause of alarm	LED	Display	Relay	Reset	Effect on control	Checks/ solutions
Sensor S1	Sensor S1 faulty or exceeded set alarm range	red alarm LED	ALARM flashing	Depends on configuration parameter	automatic	Depends on parameter "Sensor S1 alarm management"	Check the sensor connections. Check the "Sensor S1 alarm management", and "Pressure S1: MINIMUM & MAXIMUM alarm value" parameters
Sensor S2	Sensor S2 faulty or exceeded set alarm range	red alarm LED	ALARM flashing	Depends on configuration parameter	automatic	Depends on parameter "Sensor S2 alarm management"	Check the sensor connections. Check the "Sensor S2 alarm management", and "Temperature S2: MINIMUM & MAXIMUM alarm value" parameters
Sensor S3	Sensor S3 faulty or exceeded set alarm range	red alarm LED	ALARM flashing	Depends on configuration parameter	automatic	Depends on parameter "Sensor S3 alarm management"	Check the sensor connections. Check the "Sensor S3 alarm management", and "Pressure S3: MINIMUM & MAXIMUM alarm value" parameters
Sensor S4	Sensor S4 faulty or exceeded set alarm range	red alarm LED	ALARM flashing	Depends on configuration parameter	automatic	Depends on parameter "Sensor S4 alarm management"	Check the sensor connections. Check the "Sensor S4 alarm management", and "Temperature S4: MINIMUM and MAXIMUM alarm value" parameters
LowSH (low superheat)	LowSH protection activated	-	ALARM & LowSH flashing	Depends on configuration parameter	automatic	Protection action already active	Check the "LowSH protector: alarm threshold and delay" parameters
LOP (low evaporation temp.)	LOP protection activated	-	ALARM & LOP flashing	Depends on configuration parameter	automatic	Protection action already active	Check the "LOP protector: alarm threshold and delay" parameters
MOP (high evaporation temperature)	MOP protection activated	-	ALARM & MOP flashing	Depends on configuration parameter	automatic	Protection action already active	Check the "MOP protector: alarm threshold and delay" parameters
HiTcond (high condensing temperature)	HiTcond protection activated	-	ALARM & MOP flashing	Depends on configuration parameter	automatic	Protection action already active	Check the "LowSH protector: alarm threshold and delay" parameters
Low suction temperature	Threshold and delay time exceeded	-	ALARM flashing	Depends on configuration parameter	automatic	No effect	Check the threshold and delay parameters.

Type of alarm	Cause of alarm	LED	Display	Relay	Reset	Effect on control	Checks/ solutions
EEEPROM damaged	EEPROM for operating and/or unit parameters damaged	red alarm LED	ALARM flashing	Depends on configuration parameter	Replace driver/Contact service	Total shutdown	Replace the driver/Contact service
EEV motor error	Valve motor fault	red alarm LED	ALARM flashing	Depends on configuration parameter	automatic	Interruption	Check the connections and the condition of the motor
pLAN error (EVD pLAN only)	pLAN network communication error	green NET LED flashing	ALARM flashing	Depends on configuration parameter	automatic	Control based on ID1	Check the network address settings
	pLAN network connection error	NET LED off	ALARM flashing	Depends on configuration parameter	automatic	Control based on ID1	Check the connections and that the pCO is on and working
LAN error (EVD tLAN RS485/ModBus)	Network communication error	NET LED flashing	No message	No change	automatic	No effect	Check the network address settings
	Connection error	NET LED off	No message	No change	automatic	No effect	Check the connections and that the pCO is on and working

Tab. 9.a

9.2 Alarm relay configuration

The relay contact is open when the driver is not powered.
During normal operation, it can be disabled (and thus will be always open) or configured as:

- alarm relay: during normal operation, the relay contact is closed, and opens when any alarm is activated. It can be used to switch off the compressor and the system in the event of alarms.
- solenoid valve relay: during normal operation, the relay contact is closed, and is open only in standby. There is no change in the event of alarms.
- solenoid valve relay + alarm: during normal operation, the relay contact is closed, and opens in standby and/or for LowSH, MOP, HiTcond and low suction temperature alarms. This is because following such alarms, the user may want to protect the unit by stopping the flow of refrigerant or switching off the compressor.

The LOP alarm is excluded, as in the event of low evaporation temperature closing the solenoid valve would worsen the situation.

Parameter/description	Def.
Relay configuration: Disabled Alarm relay (open when alarm active) Solenoid valve relay (open in standby) Valve relay +alarm (open in standby & control alarms)	Alarm relay

Tab. 9.b

Note: if configured as an alarm relay, to send the alarm signal to a remote device (siren, light), connect a relay to the output, according to the following diagram:

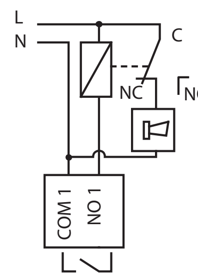


Fig. 9.d

Key:

L	Phase
N	Neutral
COM1, NO1	Alarm relay output

9.3 Sensor alarms

The sensor alarms are part of the system alarms. When the value measured by one of the sensors is outside of the field defined by the parameters corresponding to the alarm limits, an alarm is activated. The limits can be set independently of the range of measurement. Consequently, the field outside of which the alarm is signalled can be restricted, to ensure greater safety of the controlled unit.

Note:

- the alarm limits can also be set outside of the range of measurement, to avoid unwanted sensor alarms. In this case, the correct operation of the unit or the correct signalling of alarms will not be guaranteed;
- by default, after having selected the type of sensor used, the alarm limits will be automatically set to the limits corresponding to the range of measurement of the sensor.

Parameter/description	Def.	Min.	Max.	UOM
SONDE				
Pressure S1: MINIMUM alarm value (S1_AL_MIN)	-1	-20 (-290)	S1_AL_MAX	barg (psig)
Pressure S1: MAXIMUM alarm value (S1_AL_MAX)	9,3	S1_AL_MIN	200 (2900)	barg (psig)
Temperature S2: MINIMUM alarm value (S2_AL_MIN)	-50	-60	S2_AL_MAX	°C/°F
Temperature S2: MAXIMUM alarm value (S2_AL_MAX)	105	S2_AL_MIN	200 (392)	°C (°F)
Pressure S3: MINIMUM alarm value (S3_AL_MIN)	-1	-20	S3_AL_MAX	barg (psig)
Pressure S3: MAXIMUM alarm value (S3_AL_MAX)	9,3	S3_AL_MIN	200 (2900)	barg (psig)
Temperature S4: MINIMUM alarm value (S4_AL_MIN)	-50	-60	S4_AL_MAX	°C/°F
Temperature S4: MAXIMUM alarm value (S4_AL_MAX)	105	S4_AL_MIN	200 (392)	°C (°F)

Tab. 9.c

The behaviour of the driver in response to sensor alarms can be configured, using the manufacturer parameters. The options are:
- no action (control continues but the correct measurement of the variables is not guaranteed);
- forced closing of the valve (control stopped);
- valve forced to the initial position (control stopped);
- use the backup sensor (valid only for sensor S1 and S2 alarms, control continues).

Parameter/description	Def.
CONFIGURATION	
Sensor S1 alarm management: No action Forced valve closing Valve in fixed position Use backup sensor S3	Valve in fixed position
Sensor S2 alarm management: No action Forced valve closing Valve in fixed position Use backup sensor S4	Valve in fixed position
Sensor S3 alarm management: No action Forced valve closing Valve in fixed position	No action
Sensor S4 alarm management: No action Forced valve closing Valve in fixed position	No action
CONTROL	
Valve opening at start (evaporator/valve capacity ratio)	50

Tab. 9.d

9.4 Control alarms

These are alarms that are only activated during control.

Protector alarms

The alarms corresponding to the LowSH, LOP, MOP and HiTcond protectors are only activated during control when the corresponding activation threshold is exceeded, and only when the delay time defined by the corresponding parameter has elapsed. If a protector is not enabled (integration time= 0 s), no alarm will be signalled. If before the expiry of the delay, the protector control variable returns back inside the corresponding threshold, no alarm will be signalled.

Note: this is a likely event, as during the delay, the protection function will have an effect.

If the delay relating to the control alarms is set to 0 s, the alarm is disabled. The protectors are still active, however. The alarms are reset automatically.

Low suction temperature alarm

The low suction temperature alarm is not linked to any protection function. It features a threshold and a delay, and is useful in the event of sensor or valve malfunctions to protect the compressor using the relay to control the solenoid valve or to simply signal a possible risk. In fact, the incorrect measurement of the evaporation pressure or incorrect configuration of the type of refrigerant may mean the superheat calculated is much higher than the actual value, causing an incorrect and excessive opening of the valve. A low suction temperature measurement may in this case indicate the probable flooding of the compressor, with corresponding alarm signal. If the alarm delay is set to 0 s, the alarm is disabled. The alarm is reset automatically, with a fixed differential of 3°C above the activation threshold.

Relay activation for control alarms

As mentioned in the paragraph on the configuration of the relay, in the event of LowSH, MOP, HiTcond and low suction temperature alarms, the driver relay will open both when configured as an alarm relay and configured as a solenoid + alarm relay. In the event of LOP alarms, the driver relay will only open if configured as an alarm relay.

Parameter/description	Def.	Min.	Max.	UOM
CONTROL				
LowSH protection: threshold	5	-40 (-72)	superheat set point	K (°R)
LowSH protection: integration time	15	0	800	s
LOP protection: threshold	-50	-60 (-76)	MOP: threshold	°C (°F)
LOP protection: integration time	0	0	800	s
MOP protection: threshold	50	LOP: soglia	200 (392)	°C (°F)
MOP protection: integration time	20	0	800	s
SPECIAL				
HiTcond: threshold	80	-60 (-76)	200 (392)	°C (°F)
HiTcond: integration time	20	0	800	s
ALARM CONFIGURATION				
Low superheat alarm delay (LowSH) (0= alarm disabled)	300	0	18000	s
Low evaporation temperature alarm delay (LOP) (0= alarm disabled)	300	0	18000	s
High evaporation temperature alarm delay (MOP) (0= alarm disabled)	600	0	18000	s
High condensing temperature alarm delay (HiTcond) (0= alarm disabled)	600	0	18000	s
Low suction temperature alarm threshold	-50	-60 (-76)	200 (392)	°C (°F)
Low suction temperature alarm delay	300	0	18000	s

Tab. 9.e

9.5 EEV motor alarm

In the event of incorrect connection or damage to the valve motor, an alarm will be signalled (see the table of alarms) and the driver will go into wait status, as it can longer control the valve. The alarm is indicated by the LED NET and is reset automatically, after which control will resume immediately.

Important: after having resolved the problem with the motor, it is recommended to switch the driver off and on again to realign the position of the valve. If this is not possible, the automatic procedure for synchronising the position may help solve the problem, nonetheless correct control will not be guaranteed until the next synchronisation.

9.6 pLAN error alarm

If the connection to the pLAN network is offline for more than 6s due to an electrical problem, the incorrect configuration of the network addresses or the malfunction of the pCO controller, a pLAN error alarm will be signalled.

The pLAN error affects the control of the driver as follows:

- **case 1:** unit in standby, digital input DI1 disconnected; the driver will remain permanently in standby and control will not be able to start;
- **case 2:** unit in control, digital input DI1 disconnected: the driver will stop control and will go permanently into standby;
- **case 3:** unit in standby, digital input DI1 connected: the driver will remain in standby, however control will be able to start if the digital input is closed. In this case, it will start with "current cooling capacity"= 100%;
- **case 4:** unit in control, digital input DI1 connected: the driver will remain in control status, maintaining the value of the "current cooling capacity". If the digital input opens, the driver will go to standby and control will be able to start again when the input closes. In this case, it will start with "current cooling capacity"= 100%.

9.7 LAN error alarm (for tLAN and RS485/ Modbus® driver)

If the driver used is fitted for tLAN or RS485/Modbus® connection to a supervisor or other type of controller, no LAN error will be signalled, and the situation will have no affect on control. The green NET LED will however indicate any problems in the line. The NET LED flashing or off indicates the problem has lasted more than 150 s.

10. TROUBLESHOOTING

The following table lists a series of possible malfunctions that may occur when starting and operating the driver and the electronic valve. These cover the most common problems and are provided with the aim of offering an initial response for resolving the problem.

PROBLEM	CAUSE	SOLUTION
The superheat value measured is incorrect	The probe does not measure correct values	Check that the pressure and the temperature measured are correct and that the probe position is correct. Check that the minimum and maximum pressure parameters for the pressure transducer set on the driver correspond to the range of the pressure probe installed. Check the correct probe electrical connections.
	The type of refrigerant set is incorrect	Check and correct the type of refrigerant parameter.
Liquid returns to the compressor during control	The type of valve set is incorrect	Check and correct the type of valve parameter.
	The valve is connected incorrectly (rotates in reverse) and is open	Check the movement of the valve by placing it in manual control and closing or opening it completely. One complete opening must bring a decrease in the superheat and vice-versa. If the movement is reversed, check the electrical connections.
	The superheat set point is too low	Increase the superheat set point. Initially set it to 12 °C and check that there is no longer return of liquid. Then gradually reduce the set point, always making sure there is no return of liquid.
	Low superheat protection ineffective	If the superheat remains low for too long with the valve that is slow to close, increase the low superheat threshold and/or decrease the low superheat integration time. Initially set the threshold 3 °C below the superheat set point, with an integration time of 3-4 seconds. Then gradually lower the low superheat threshold and increase the low superheat integration time, checking that there is no return of liquid in any operating conditions.
	Stator broken or connected incorrectly	Disconnect the stator from the valve and the cable and measure the resistance of the windings using an ordinary tester. The resistance of both should be around 36 ohms. Otherwise replace the stator. Finally, check the electrical connections of the cable to the driver.
	Valve stuck open	Check if the superheating is always low (<2 °C) with the valve position permanently at 0 steps. If so, set the valve to manual control and close it completely. If the superheat is always low, check the electrical connections and/or replace the valve.
	The "valve opening at start" parameter is too high on many cabinets in which the control set point is often reached (for multiplexed cabinets only)	Decrease the value of the "Valve opening at start" parameter on all the utilities, making sure that there are no repercussions on the control temperature.
Liquid returns to the compressor only after defrosting (for multiplexed cabinets only)	The pause in control after defrosting is too short	Increase the value of the "valve control delay after defrosting" parameter.
	The superheat temperature measured by the driver after defrosting and before reaching operating conditions is very low for a few minutes	Check that the LowSH threshold is greater than the superheat value measured and that the corresponding protection is activated (integration time >0 s). If necessary, decrease the value of the integration time.
	The superheat temperature measured by the driver does not reach low values, but there is still return of liquid to the compressor rack	Set more reactive parameters to bring forward the closing of the valve: increase the proportional factor to 30, increase the integration time to 250 s and increase the derivative time to 10 sec.
	Many cabinets defrosting at the same time	Stagger the start defrost times. If this is not possible, if the conditions in the previous two points are not present, increase the superheat set point and the LowSH thresholds by at least 2 °C on the cabinets involved.
	The valve is significantly oversized	Replace the valve with a smaller equivalent.
Liquid returns to the compressor only when starting the controller (after being OFF)	The "valve opening at start" parameter is set too high	Check the calculation in reference to the ratio between the rated cooling capacity of the evaporator and the capacity of the valve; if necessary, lower the value.
The superheat value swings around the set point with an amplitude greater than 4°C	The condensing pressure swings	Check the controller condenser settings, giving the parameters "blander" values (e.g. increase the proportional band or increase the integration time). Note: the required stability involves a variation within +/- 0.5 bars. If this is not effective or the settings cannot be changed, adopt electronic valve control parameters for perturbed systems
	The superheat swings even with the valve set in manual control (in the position corresponding to the average of the working values)	Check for the causes of the swings (e.g. low refrigerant charge) and resolve where possible. If not possible, adopt electronic valve control parameters for perturbed systems.
	The superheat does NOT swing with the valve set in manual control (in the position corresponding to the average of the working values)	As a first approach , decrease (by 30 to 50 %) the proportional factor. Subsequently try increasing the integration time by the same percentage. In any case, adopt parameter settings recommended for stable systems.
	The superheat set point is too low	Increase the superheat set point and check that the swings are reduced or disappear. Initially set 13 °C, then gradually reduce the set point, making sure the system does not start swinging again and that the unit temperature reaches the control set point.
In the start-up phase with high evaporator temperatures, the evaporation pressure is high	MOP protection disabled or ineffective	Activate the MOP protection by setting the threshold to the required saturated evaporation temperature (high evaporation temperature limit for the compressors) and setting the MOP integration time to a value above 0 (recommended 4 seconds). To make the protection more reactive, decrease the MOP integration time.
	Refrigerant charge excessive for the system or extreme transitory conditions at start-up (for cabinets only).	Apply a "soft start" technique, activating the utilities one at a time or in small groups. If this is not possible, decrease the values of the MOP thresholds on all the utilities.

PROBLEM	CAUSE	SOLUTION
In the start-up phase the low pressure protection is activated (only for units with compressor on board)	The "Valve opening at start-up" parameter is set too low	Check the calculation in reference to the ratio between the rated cooling capacity of the evaporator and the capacity of the valve; if necessary lower the value.
	The driver in pLAN or tLAN configuration does not start control and the valve remains closed	Check the pLAN / tLAN connections. Check that the pCO application connected to the driver (where featured) correctly manages the driver start signal. Check that the driver is NOT in stand-alone mode.
	The driver in stand-alone configuration does not start control and the valve remains closed	Check the connection of the digital input. Check that when the control signal is sent that the input is closed correctly. Check that the driver is in stand-alone mode.
	LOP protection disabled	Set a LOP integration time greater than 0 s.
	LOP protection ineffective	Make sure that the LOP protection threshold is at the required saturated evaporation temperature (between the rated evaporation temperature of the unit and the corresponding temperature at the calibration of the low pressure switch) and decrease the value of the LOP integration time.
	Solenoid blocked	Check that the solenoid opens correctly, check the electrical connections and the operation of the relay.
	Insufficient refrigerant	Check that there are no bubbles in the sight glass upstream of the expansion valve. Check that the subcooling is suitable (greater than 5 °C); otherwise charge the circuit.
	The valve is connected incorrectly (rotates in reverse) and is open	Check the movement of the valve by placing it in manual control and closing or opening it completely. One complete opening must bring a decrease in the superheat and vice-versa. If the movement is reversed, check the electrical connections.
	Stator broken or connected incorrectly	Disconnect the stator from the valve and the cable and measure the resistance of the windings using an ordinary tester. The resistance of both should be around 36 ohms. Otherwise replace the stator. Finally, check the electrical connections of the cable to the driver (see paragraph 5.1).
	Valve stuck closed	Use manual control after start-up to completely open the valve. If the superheat remains high, check the electrical connections and/or replace the valve.
The unit switches off due to low pressure during control (only for units with compressor on board)	LOP protection disabled	Set a LOP integration time greater than 0 s.
	LOP protection ineffective	Make sure that the LOP protection threshold is at the required saturated evaporation temperature (between the rated evaporation temperature of the unit and the corresponding temperature at the calibration of the low pressure switch) and decrease the value of the LOP integration time.
	Solenoid blocked	Check that the solenoid opens correctly, check the electrical connections and the operation of the control relay.
	Insufficient refrigerant	Check that there are no bubbles of air in the liquid indicator upstream of the expansion valve. Check that the subcooling is suitable (greater than 5 °C); otherwise charge the circuit.
	The valve is significantly undersized	Replace the valve with a larger equivalent.
	Stator broken or connected incorrectly	Disconnect the stator from the valve and the cable and measure the resistance of the windings using an ordinary tester. The resistance of both should be around 36 ohms. Otherwise replace the stator. Finally, check the electrical connections of the cable to the driver.
	Valve stuck closed	Use manual control after start-up to completely open the valve. If the superheat remains high, check the electrical connections and/or replace the valve.
The cabinet does not reach the set temperature, despite the value being opened to the maximum (for multiplexed cabinets only)	Solenoid blocked	Check that the solenoid opens correctly, check the electrical connections and the operation of the relay.
	Insufficient refrigerant	Check that there are no bubbles of air in the liquid indicator upstream of the expansion valve. Check that the subcooling is suitable (greater than 5 °C); otherwise charge the circuit.
	The valve is significantly undersized	Replace the valve with a larger equivalent.
	Stator broken or connected incorrectly	Disconnect the stator from the valve and the cable and measure the resistance of the windings using an ordinary tester. The resistance of both should be around 36 ohms. Otherwise replace the stator. Finally, check the electrical connections of the cable to the driver.
	Valve stuck closed	Use manual control after start-up to completely open the valve. If the superheat remains high, check the electrical connections and/or replace the valve.
The cabinet does not reach the set temperature, and the position of the valve is always 0 (for multiplexed cabinets only)	The driver in pLAN or tLAN configuration does not start control and the valve remains closed	Check the pLAN/tLAN connections. Check that the pCO application connected to the driver (where featured) correctly manages the driver start signal. Check that the driver is NOT in stand-alone mode.
	The driver in stand-alone configuration does not start control and the valve remains closed	Check the connection of the digital input. Check that when the control signal is sent that the input is closed correctly. Check that the driver is in stand-alone mode.

Tab. 10.a

11. TECHNICAL SPECIFICATIONS

Power supply		24 Vac (+10/-15%) 50/60 Hz to be protected by an external 2 A type T fuse. Use a dedicated class 2 transformer (max 100 VA). Lmax=5 m.
Power input		30 VA
Emergency power supply		22 Vdc+/-5%. (If the optional EVBAT00200/300 module is installed), Lmax= 5 m
Insulation between relay output and other outputs		reinforced; 6 mm in air, 8 mm on surface; 3750 V insulation
Motor connection		4-wire shielded cable AWG 18/22, Lmax 10 m
Digital input connection		Digital input to be activated from voltage-free contact or transistor to GND. Closing current 5 mA; Lmax= 30 m
Sensors (Lmax=10 m)	S1	ratiometric pressure sensor (0 to 5 V): • resolution 0.1 % FS; • measurement error: 2% FS maximum; 1% typical
		electronic pressure sensor (4 to 20 mA): • resolution 0.5 % FS; • measurement error: 8% FS maximum; 7% typical
		combined ratiometric pressure sensor (0 to 5 V): • resolution 0.1 % FS; • measurement error: 2 % FS maximum; 1 % typical
		4 to 20 mA input (max 24 mA): • resolution 0.5 % FS; • measurement error: 8% FS maximum; 7% typical
	S2	low temperature NTC: • 10kΩ at 25°C, -50T90 °C; • measurement error: 1°C in the range -50T50°C; 3 °C in the range +50T90 °C
		high temperature NTC: • 50kΩ at 25°C, -40T150 °C; • measurement error: 1.5 °C in the range -20T115°C, 4 °C in the range outside of -20T115 °C
		combined NTC: • 10kΩ at 25 °C, -40T120 °C; • measurement error: 1 °C in the range -40T50°C; 3 °C in the range +50T90 °C
		0 to 10 V input (max 12 V): • resolution 0.1 % FS; • measurement error: 9% FS maximum; 8% typical
	S3	ratiometric pressure sensor (0 to 5 V): • resolution 0.1 % FS; • measurement error: 2% FS maximum; 1% typical
		electronic pressure sensor (4 to 20 mA): • resolution 0.5 % FS; • measurement error: 8% FS maximum; 7% typical
		electronic pressure sensor (4 to 20 mA) remote. Maximum number of controllers connected=5
		combined ratiometric pressure sensor (0 to 5 V): • resolution 0.1 % FS • measurement error: 2 % FS maximum; 1 % typical
	S4	low temperature NTC: • 10kΩ at 25°C, -50T105 °C; • measurement error: 1 °C in the range -50T50 °C; 3°C in the range 50T90°C
		high temperature NTC: • 50kΩ at 25 °C, -40T150 °C; • measurement error: 1.5 °C in the range -20T115 °C 4 °C in the range outside of -20T115 °C
		combined NTC: • 10kΩ at 25 °C, -40T120 °C; • measurement error 1 °C in the range -40T50 °C; 3 °C in the range +50T90 °C
Relay output		normally open contact; 5 A, 250 Vac resistive load; 2 A, 250 Vac inductive load (PF=0 .4); Lmax=10 m
Power to active sensors (V_{REF})		programmable output: +5 Vdc+/-2% or 12 Vdc+/-10%
RS485 serial connection		Lmax=1000 m, shielded cable
tLAN connection		Lmax=30 m, shielded cable
pLAN connection		Lmax=500 m, shielded cable
Assembly		DIN rail
Connectors		plug-in, cable size 0.5 to 2.5 mm^2 (12 to 20 AWG)
Dimensions		LxHxW= 70x110x60
Operating conditions		-10T60°C; <90% rH non-condensing
Storage conditions		-20T70°C, humidity 90% rH non-condensing
Index of protector		IP20
Environmental pollution		2 (normal)
Resistance to heat and fire		Category D
Immunity against voltage surges		Category 1
Type of relay action		1C microswitching
Class of insulation		2
Software class and structure		A
Conformity		Electrical safety: EN 60730-1, EN 61010-1
		Electromagnetic compatibility: EN 61000-6-1, EN 61000-6-2, EN 61000-6-3, EN 61000-6-4; EN61000-3-2, EN55014-1, EN55014-2, EN61000-3-3.

Tab. 11.a

12. APPENDIX: VPM (VISUAL PARAMETER MANAGER)

12.1 Installation

On the http://ksa.carel.com website, under the Parametric Controller Software section, select Visual Parameter Manager.
A window opens, allowing 3 files to be downloaded:
1. VPM_CD.zip: for burning to a CD;
2. Upgrade setup;
3. Full setup: the complete program.

For first installations, select Full setup, for upgrades select Upgrade setup. The program is installed automatically, by running setup.exe.

Note: if deciding to perform the complete installation (Full setup), first uninstall any previous versions of VPM.

12.2 Programming (VPM)

When opening the program, the user needs to choose the device being configured: EVD evolution. The Home page then opens, with the choice to create a new project or open an existing project. Choose new project and enter the password, which when accessed the first time can be set by the user.

Fig. 12.a

Then the user can choose to:
1. directly access to the list of parameters for the EVD evolution saved to EEPROM: select "tLAN";

This is done in real time (ONLINE mode), at the top right set the network address 198 and choose the guided recognition procedure for the USB communication port. Enter at the Service or Manufacturer level.

Fig. 12.b

Fig. 12.c

2. select the model from the range and create a new project or choose an existing project: select "Device model".

A new project can be created, making the changes and then connecting later on to transfer the configuration (OFFLINE mode). Enter at the Service or Manufacturer level.

- select Device model and enter the corresponding code

Fig. 12.d

- go to Configure device: the list of parameters will be displayed, allowing the changes relating to the application to be made.

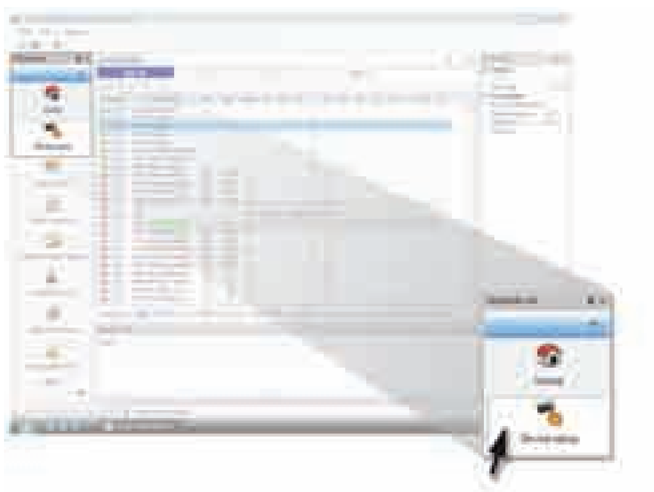


Fig. 12.e

At the end of the configuration, to save the project choose the following command, used to save the configuration as a file with the .hex extension.

File -> Save parameter list.

To transfer the parameters to the driver, choose the "Write" command. During the write procedure, the 2 LEDs on the converter will flash.

Fig. 12.f

Note: the program On-line help can be accessed by pressing F1.

12.3 Copying the setup

On the Configure device page, once the new project has been created, to transfer the list of configuration parameters to another driver:

- read the list of parameters from the source driver with the "Read" command;
- remove the connector from the service serial port;
- connect the connector to the service port on the destination driver;
- write the list of parameters to the destination driver with the "Write" command.

Important: the parameters can only be copied between controllers with the same code. Different firmware versions may cause compatibility problems.

12.4 Setting the default parameters

When the program opens:

- select the model from the range and load the associated list of parameters;
- go to "Configure device": the list of parameters will be shown, with the default settings.
- connect the connector to the service serial port on the destination driver;
- during the write procedure, the LEDs on the converter will flash.

The driver parameters driver will now have the default settings.

12.5 Updating the driver and display firmware

The driver and display firmware must be updated using the VPM program on a computer and the USB/tLAN converter, which is connected to the device being programmed (see paragraph 2.5 for the connection diagram). The firmware can be downloaded from http://ksa.carel.com. See the VPM On-line help.

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