TC-940R*i plus*

DIGITAL CONTROLLER FOR REFRIGERATION (E) AND WITH DEFROST WITH ALARM OUTPUT

Ver.02

E251415

TC940PLV02-05T-12897

1. DESCRIPTION

The **TC940R*i plus*** is a temperature controller for frozen products that manages the defrost start and end cycles only when necessary, based on the temperature of the evaporator. It has a timing function for collection of the residual refrigerant gas before defrost starts, improving performance of the refrigeration cycle and reducing power consumption. Its fourth output is used to trigger an alarm or turn off lamps.
It also features a configurable digital filter, which increases the response time of the S1 sensor to avoid activating the compressor by quick temperature changes, and a serial output for communication with the Sitrad - management software via internet.

The **TC940R*i plus*** also has a configurable digital input used for performing one of the following functions:
-Perform external defrost synchronism;
-Change the setpoint for night mode;
-Generate a visual and audible alarm to indicate the opening of the freezer door, for example;
-Inhibit control functions (standby mode).

*In the F43 description in this manual, each of the above functions is defined in detail.

Product complies with UL Inc. (USA and Canada) and NSF (EUA).

2. APPLICATIONS

- Refrigerated chambers
- Display freezers

3. TECHNICAL SPECIFICATIONS

Supply voltage: 12 Vdc +/- 10% Control
Temperature: -50ºC to 75ºC / -58°F to 167°F
Operating temperature: 0ºC to 50 ºC / 32°F to 122°F
Resolution: 0.1 ºC from -10ºC to 75ºC, 1ºC in the rest of the range / 1°F over the entire range.
Operating humidity: 10 to 90% RH (without condensation)
Maximum load currents: (outputs)
COMP: 12(8)A/240 Vac 1 HP (compressor, solenoid valve or breaker)
FANS: 5(3)A/240 Vac 1/8 HP (evaporator fan)
DEFR: 5(3)A/240 Vac (defrost through resistance or hot gas).
AUX: 3A/240 Vac resistive load (external alarm, lamp activation, cycle reversing valve).
Dimensions: 71 x 28 x 71 mm

4. CONFIGURATIONS

4.1 - Setting the control temperature (SETPOINT)

Press the SET key for 2 seconds until the message SEt SP1 appears on the display, then release it. The working temperature for daytime mode will appear (setpoint 1). Use the ▼ or ▲ keys to change the value and, when ready, press the SET key to save.
After setpoint 1 temperature has been set, the message SP2 is displayed, and then the working temperature for nighttime mode (setpoint 2) will be shown. Use the same procedure to change the value and, when ready, press the SET key to save.

4.2 - PARAMETERS TABLE

		CELSIUS				FAHRENHEIT			
Fun	Description	Min	Max	Unit	Standard	Min	Max	Unit	Standard
F01	Access code (123)	-99	999	-	-	-99	999	-	-
F02	Controller operating mode	0	2	-	0	0	2	-	0
F03	Control differential (hysteresis) in refrigeration	0.1	20.0	°C	1.5	1	36	°F	3
F04	Control differential (hysteresis) in heating	0.1	20.0	°C	1.5	1	36	ºF	3
F05	Offset indication of ambient temperature	-20	20.0	°C	0.0	-36	36	ºF	0
F06	Offset indication of evaporator temperature	-20	20.1	°C	0.0	-36	37	ºF	0
F07	Minimum setpoint allowed to the end user	-50	75.0	°C	-50	-58	167	ºF	-58
F08	Maximum setpoint allowed to the end user	-50	75.0	°C	75.0	-58	167	ºF	167
F09	Control delay at start (energizing)	0	999	min.	0	0	999	min.	0
F10	Defrost type (Refrigeration)	0	2	-	0	0	2	-	0
F11	Condition for starting defrost (Refrigeration)	0	1	-	0	0	1	-	0
F12	Interval between defrosts (Refrigeration) 1	1	999	min.	240	1	999	min.	240
F13	Interval between defrosts (Heating)	1	999	min.	240	1	999	min.	240
F14	Maximum time in refrigeration 2	1	240	hrs	24	1	240	hrs	24
F15	Temperature in the evaporator for defrost start (Refrigeration) 2	-50	75.0	°C	-5.0	-58	167	ºF	23
F16	Time of pre-defrost (Refrigeration) 2	0	90	min.	10	0	90	min.	10
F17	Time for gas collection in defrost (Heating/Refrigeration)	0	90	min.	0	0	90	min.	0
F18	Defrost at start (Heating/Refrigeration)	0	1	-	0	0	1	-	0
F19	Temperature in the evaporator (S2) for end of defrost (Refrigeration) 3	-50	75.0	°C	40.0	-58	167	ºF	104
F20	Maximum defrost time (for safety) (Refrigeration)	0	90	min.	45	0	90	min.	45
F21	Defrost time (Heating)	0	90	min.	30	0	90	min.	30
F22	Fan on during defrost (Heating/Refrigeration)	0	1	-	0	0	1	-	0
F23	Delay for first defrost (Heating/Refrigeration) 1	0	999	min.	0	0	999	min.	0
F24	Locked temperature indication (S1) during defrost (Heating/Refrigeration)	no	60	min.	0	no	60	min.	0
F25	Draining time (dripping of defrost water (Refrigeration)	0	30	min.	10	0	30	min.	10
F26	Fan and compressor operating mode after drainage	0	1	-	0	0	1	-	0
F27	Evaporator temperature (S2) for fan return after drainage (fan-delay) 4	-50	75.0	°C	0.0	-58	167	ºF	32
F28	Maximum time for fan return after drainage (fan-delay) 4	0	30	min.	1	0	30	min.	1
F29	Maximum time f/ compressor return after drainage 5	0	30	min.	0	0	30	min.	0
F30	Fan operating mode during Refrigeration/Heating	0	2	-	0	0	2	-	0
F31	Time of fan on 6	0	999	min.	2	0	999	min.	2
F32	Time of fan off 6	0	999	min.	4	0	999	min.	4
F33	Fan stop for high temperature in evaporator	-50	75.0	°C	75.0	-58	167	ºF	167
F34	Hysteresis for fan return (after stopping for high temperature in evaporator)	0.1	20.0	°C	2.0	1	36	ºF	4
F35	Low ambient temperature alarm 7	-50	75.0	°C	-50	-58	167	ºF	-58
F36	Low ambient temperature alarm hysteresis 7	0.1	20.0	°C	1.0	1	36	ºF	4
F37	High ambient temperature alarm 7	-50	75.0	°C	75.0	-58	167	ºF	167
F38	High ambient temperature alarm hysteresis 7	0.1	20.0	°C	1.0	1	36	ºF	4
F39	Alarm inhibition time when energizing the instrument	0	999	min.	0	0	999	min.	0
F40	Alarm inhibition time after draining	0	999	min.	0	0	999	min.	0
F41	Alarm inhibition time for open door	0	99	min.	0	0	99	min.	0
F42	Alarm inhibition time for low/high temperature	0	999	min.	0	0	999	.min.	0
F43	Digital input operating mode	0	8	-	0	0	8	-	0
F44	AUX output operating mode	0	3	-	0	0	3	-	0
F45	Closed door time for turning off lamp (0=no)	0	999	min.	60	0	999	min.	60
F46	Closed door time to activate the nighttime setpoint (0=no) 8	0	999	min.	90	0	999	min.	90
F47	Minimum time for compressor on	0	999	sec.	0	0	999	sec.	0
F48	Minimum time for compressor off	0	999	sec.	0	0	999	sec.	0
F49	Time of compressor on in case of error in sensor S1	0	999	min.	20	0	999	min.	20
F50	Time of compressor off in case of error in sensor S1	0	999	min.	10	0	999	min.	10
F51	Intensity of the digital filter applied to the ambient sensor (S1)	0	9	-	0	0	9	-	0
F52	Time for keylock	14-no	60	sec.	14-no	14-no	60	sec.	14-no
F53	Control functions shutdown	0	2	-	0	0	2	-	0
F54	Address in RS-485 network	1	247	-	1	1	247	-	1

Notes:
1 - Active function if F11=0 (Condition to start defrost (refrigeration mode): time)
2 - Active function if F11=1 (Condition to start defrost (refrigeration mode): temperature)
3 - In item 5.7 it is shown how to determine the final defrost temperature, and the respective recording in this parameter automatically.
4 - Active function if F26=0 (Fan and compressor operating mode after drainage: control by F27 and F28).
5 - Active function if F26=1 (Fan and compressor operating mode after drainage: control by F29).
6 - Active function if F30=0 (Fan operating mode during Refrigeration/Heating: Automatic).
7 - The alarms will always be shown on the display, but the AUX output will be activated for alarms only if F44=1 (AUX output operating mode: Output for alarm)
8- Active function if F43=2 or F43=6 (Digital input operating mode: Door opening, contact (NC) or (NO), respectively).

4.3 - Parameters description

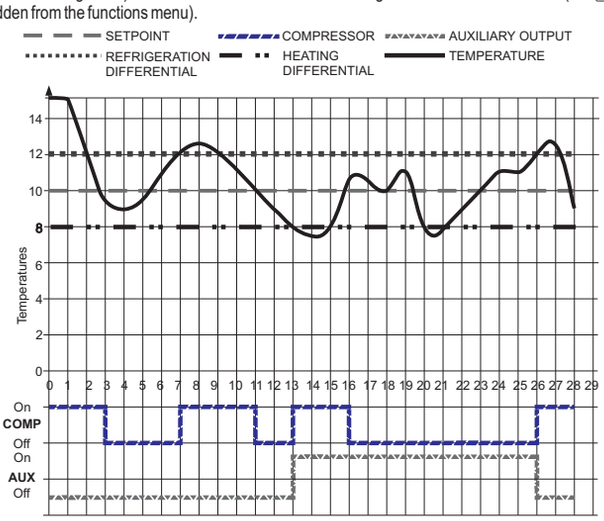
F01 - Access code
In case the user wants to change the set value in any function, it is necessary to enter access code "123" in this function. In case you want to visualize the set values, it is not necessary to insert this code.

F02 - Controller operating mode
Set the operating mode of the controller:
0 - Refrigeration
The compressor goes off when the temperature of sensor S1 is equal to "Setpoint"
The compressor turns on when the temperature of sensor S1 is equal to the Setpoint + F03 (Control differential (hysteresis) – refrigeration)
1 - Heating
The compressor goes off when the temperature of sensor S1 is equal to "Setpoint"
The compressor turns on when the temperature of sensor S1 is equal to the Setpoint - F04 (Control differential (hysteresis) in heating)
2 - Automatic
In this operating mode the AUX output set for the cycle reversing valve (F43 =3), and it is not possible to change the value set in F43 .

In case refrigeration is active (AUX relay off):
The compressor goes off when the temperature of sensor S1 is equal to "Setpoint".
The compressor turns on when the temperature of sensor S1 is equal to the Setpoint + F03 (Control differential (hysteresis) in refrigeration).
If the temperature drops to the Setpoint - F04 (Control differential (hysteresis) in heating), the cycle is reversed, and the controller starts to control the temperature by heating the environment. At this point the AUX relay is switched on. As the COMP relay was already off, since the temperature in S1 was already lower than the Setpoint, the function F48 (Minimum time for compressor off) will be respected.

In case the heating is active (AUX relay off):
The compressor goes off when the temperature of sensor S1 is equal to "Setpoint".
The compressor turns on when the temperature of sensor S1 is equal to the Setpoint + F04 (Control differential (hysteresis) in heating).
If the temperature rises to the Setpoint + F04 (Control differential (hysteresis) in refrigeration), the cycle is reversed, and the controller starts to control the temperature by cooling the environment. At this point the AUX relay is switched off. As the COMP relay was already off when the temperature in S1 was higher than the Setpoint, the function F48 (Minimum time for compressor off) will be respected.

Notes:
If the function F02 is modified, the function F44 is automatically changed according to the conditions described below:
-If F02 is changed to 0 or 1 (Controller operating mode: Refrigeration or Heating), the function F44 is automatically modified to 1 (AUX output for alarm) and the user will be able to change this value to 0, 1, 2 or 3.
-If F02 is changed to 2 (Automatic), the function F44 is automatically modified to 3 (AUX output to cycle reversing valve) and the user will not be able to change the value of this function (the F44 is hidden from the functions menu).



F03 - Control differential (hysteresis) in refrigeration
It sets the control differential in refrigeration. It is used when the function F02 =0 (refrigeration) or F02 =2 (automatic).
It is the temperature difference (hysteresis) between TURNING OFF and TURNING BACK ON heating. Example: You want to control the temperature in 4.0 ºC with differential of 1.0 ºC. Then, refrigeration will be switched off at 4.0 ºC and switched back on at 5.0 ºC (4.0 + 1.0).

F04 - Control differential (hysteresis) in heating
It sets the control differential in heating. It is used when the function F02 =1 (heating) or F02 =2 (automatic).
It is the temperature difference (hysteresis) between TURNING OFF and TURNING BACK ON heating. Example: You want to control the temperature in 4.0 ºC with differential of 1.0 ºC. Then, heating will be switched off at 4.0 ºC and switched back on at 3.0 ºC (4.0 - 1.0).

F05 - Offset indication of ambient temperature
This function allows you to compensate eventual deviations in the ambient temperature reading (S1), resulting from the change of sensor or modification of the cable length.

F06 - Offset indication of evaporator temperature
This function allows you to compensate eventual deviations in the evaporator temperature reading (S2), resulting from the change of sensor or modification of the cable length. In case you want to disable sensor S2, simply increase the value of this function to the maximum, until the message OFF appears on the display.

F07 - Minimum setpoint allowed to the end user
F08 - Maximum setpoint allowed to the end user
It sets the minimum and maximum setpoint limits in order to prevent the user from setting an excessively high or low setpoint temperature by mistake.

F09 – Control delay at start (energizing)
It sets the time at which the controller will remain with its control disabled when you turn it on in order to delay the start of the process. During this time the controller works only as a temperature indicator. The purpose of this function is to be able to avoid voltage spikes in case the return of power is necessary and there are multiple devices connected to the same power supply. To avoid this situation, simply set different start control delay times for each device. This delay serves both to delay the start of the refrigeration/heating cycle and to delay defrost at start, in case it is active (F 18 =1).

F10 - Defrost type (Refrigeration)
It sets the type of defrost, in case the controller is working in refrigeration (F02 =0 or F02 =2):
0 - Electrical defrost (resistance) or hot gas defrost in refrigeration rack systems (exclusive hot gas and liquid lines), where only the defrost output is activated.
1 - Hot gas defrost in plug-in systems (with reversing valve), where the compressor and defrost outputs are driven. The compressor is necessarily switched off before the defrost cycle starts, respecting the minimum compressor off time before starting it (in order to reduce coolant waterhammer in the ducts).
2 - Hot gas defrost in plug-in systems (with reversing valve), where the compressor and defrost outputs are driven. The compressor is not switched off, in case it is on, before starting the defrost cycle.

F11 - Condition for starting defrost (Refrigeration)
It sets the condition to start defrost, in case the controller is working in refrigeration (F02 =0 or F02 =2):
0 - Defrost start by time
1 - Defrost start by temperature in S2
In case the defrost start condition is by temperature, when the evaporator temperature reaches the value set in , the instrument switches to the pre-defrost state.

F12 - Interval between defrosts (Refrigeration)
It sets how often the controller will perform a defrost if it is working in refrigeration (F02 =0 or F02 =2) and if the defrost start condition is "Defrost start by time" (F11 =0). This time begins to run from the previous defrost (refrigeration mode). Defrost will only start if the temperature in S2 (evaporator sensor) is lower than that indicated in F 19 .

F13 - Interval between defrosts (Heating)
It sets the time in which the controller will perform a defrost, in case it is running in heating (F02 =1 or F02 =2), and starts to run from the previous defrost (heating mode).

F14 - Maximum time in refrigeration
It sets the maximum time in which the controller can remain in refrigeration state (F02 =0 or F02 =2) before it mandatorily performs a defrost. This function only works if the defrost start condition is "Defrost start by temperature in S2" (F11 =1), and if the evaporator temperature (temperature in S2) never reaches the "Evaporator temperature for defrost start" (F 15).

F15 - Temperature in the evaporator for defrost start (Refrigeration)
It sets the necessary evaporator temperature (sensor S2) for the controller to enter the state of pre-defrost, in case it operates in refrigeration mode (F02 =0 or F02 =2). This function only works if the defrost start condition is "Defrost start by temperature in S2" (F11 =1).

F16 - Time of pre-defrost (Refrigeration)
It sets the time in which the controller will remain in a pre-defrost state, in case it operates in refrigeration mode (F02 =0 or F02 =2). This function only works if the defrost start condition is "Defrost start by temperature in S2" (F11 =1).
If during all the defrost stage the temperature in S2 remains below the value set in function F 15 , defrost starts. In case the temperature in S2 increases 1ºC (2ºF) in relation to the temperature set in F 15 , the controller returns to the refrigeration state.

F17 - Time for gas collection in defrost (Heating/Refrigeration)
It sets the time in which the controller will only stay with the fan on at the start of defrost (defrost in Refrigeration mode Cooling or Heating mode), in order to take advantage of the residual energy of the gas.

F18 - Defrost at start (Heating/Refrigeration)
This function sets if the controller must perform (or not) defrost at start (controller energizing). The purpose of this function is to prevent the controller from remaining for too long in refrigeration/heating, in case there is a failure and energy return.
If the controller is operating in refrigeration mode (F02 =0), defrost at start only runs if the temperature in S2 is below the temperature specified in function F 19 (Temperature in S2 for end of defrost).
If the controller is operating in heating mode (F02 =1), defrost at start is run after the start control delay (F09) has elapsed.
If the controller is operating in automatic mode (F02 =2), defrost at start is disabled.

F19 - Temperature in the evaporator (S2) for end of defrost (Refrigeration)
It sets the necessary evaporator temperature (sensor S2) to complete defrost (refrigeration mode). The purpose of this function is to optimize the defrost process.

F20 - Maximum defrost time (for safety) (Refrigeration)
It sets the maximum time in which the controller will remain in defrost state (refrigeration mode). If the temperature in S2 does not reach the value set in F 19 during the time set in this function, a dot will be flashing at the bottom right-hand corner of the display indicating that the end of defrost occurred by time and not by temperature. This can happen in the following situations:
-If the temperature set in F 19 was very high,
-If the time set in F20 was too short
-If sensor S2 is disconnected
-If sensor S2 is disabled (F06 = OFF)
-If sensor S2 is in contact with the evaporator.

F21 – Defrost time (Heating)
It sets the maximum time in which the controller will remain in defrost state (heating mode).

F22 - Fan on during defrost (Heating/Refrigeration)
This function sets if the fan must remain on or off during defrost (either in refrigeration mode or in heating mode).

-Natural defrost: fan on.
-Defrost by finned resistors installed outside the evaporator: fan off.

F23 - Delay for first defrost (Heating/Refrigeration)
It sets an extra time in which the instrument will remain in refrigeration/heating before performing the first defrost, to prevent multiple chambers from entering into defrost at the same time. This function does not interfere with function F18 (Defrost at start). If the controller is operating in refrigeration mode (F02=0 or F02=2), so that this function is respected, F11=0 (defrost (refrigeration mode) by time).

F24 - Locked temperature indication (S1) during defrost (Heating/Refrigeration)
This function sets if the ambient temperature shown on the display is frozen during (and after) a defrost (either in refrigeration mode or in heating mode). The purpose of this function is to avoid visualizing a variation in ambient temperature due to the defrost, and the operation of the function will depend on the type of defrost being done:
Defrost (Refrigeration mode):
no - Function disabled (temperature S1 is never locked due to defrost)
0 - When starting defrost, the controller records the ambient temperature and freezes the display. The display will remain frozen until the end of defrost.
1 to 60 - When starting defrost, the controller records the ambient temperature and freezes the display. The display will remain frozen until one of the following conditions occur: If the ambient temperature reaches a value lower than the value recorded at the beginning of defrost; or if the time set in this function elapses. This time starts to run when defrost is finished.
Defrost (Heating mode):
no - Function disabled (temperature S1 is never locked due to defrost)
0 - When starting defrost, the controller records the ambient temperature and freezes the display. The display will remain frozen until the end of defrost.
1 to 60 - When starting defrost, the controller records the ambient temperature and freezes the display. The display will remain frozen until one of the following conditions occur: If the ambient temperature reaches a value higher than the value recorded at the beginning of defrost; or if the time set in this function elapses. This time starts to run when defrost is finished.

F25 - Draining time (dripping of defrost water (Refrigeration))
It sets the dripping time, so that the last drops of water from the evaporator flow when the controller finishes a defrost (refrigeration mode). All outputs remain off. If this step is not desired, set this function with value 0 (zero).

F26 - Fan and compressor operating mode after drainage
This function sets the operating mode of the fan and compressor after drainage:
0 - The compressor is switched on and the fan remains off. Functions and define the time F27 and F28 temperature to finish this fan-delay stage.
1 - The Compressor is switched off and the fan remains on. The function F29 sets the time in which the compressor will remain off and only the fan will stay on, decreasing pressure due to the reverse cycle during defrost.

F27 - Evaporator temperature (S2) for fan return after drainage (fan-delay)
It sets the evaporator temperature (sensor S2) to complete the fan-delay. This stage is done at the end of the draining stage, and is applicable only if the controller is operating in refrigeration mode (F02=0 or F02=2) and F26=0.
In the fan-delay state with F26=0, the compressor output (COMP) is triggered immediately because the evaporator temperature is high, but the fan is only triggered after the evaporator temperature drops below the set value in function F27. This process is necessary to remove the heat still existing in the evaporator because of the defrost, thus avoiding throwing it into the environment.

F28 - Maximum time for fan return after drainage (fan-delay)
It sets the maximum time in which the controller will be able to remain in the fan-delay state. This stage is done at the end of the draining stage, and is applicable only if the controller is operating in refrigeration mode (F02=0 or F02=2) and F26=0.
If the evaporator temperature (sensor S2) does not reach the value set in F27 or if sensor S2 is disconnected/inhibited during fan-delay, the fan return will happen after the time set in this function elapses.

F29 - Maximum time f/ compressor return after drainage
It sets the time in which the controller keeps the fan on and the compressor off after the end of the draining stage, and is applicable only if the controller is operating in refrigeration mode (F02=0 or F02=2) and F26=1.

F30 - Fan operating mode during Refrigeration/Heating
This function sets the fan operating mode during the refrigeration/heating stage:
0 (Automatic) - the fan will constantly stay on while the compressor is engaged. When the compressor is off, the fan will switch status (on/off) according to the times set in the functions in F31 and F32 .
1 (Continuous) - the fan will remain constantly on.
2 (Dependent) - the fan will constantly stay on while the compressor is engaged. When the compressor is off the fan will remain constantly disconnected.

F31 - Time of fan on
It sets the "fan on" time, in case F30=0 (Fan operating mode: Automatic), and in case the compressor is off before disconnecting the fan.

F32 - Time of fan off
It sets the "fan off" time, in case F30=0 (Fan operating mode: Automatic), and in case the compressor is off before reconnecting the fan.

F33 - Fan stop for high temperature in evaporator
It sets the maximum temperature in sensor S2 to turn off the fan in case the controller is operating in refrigeration mode (F02=0 or F02=2). The purpose of this function is to switch the fan status (on/off) until the ambient temperature approaches that predicted in the refrigerating installation project, avoiding high temperatures and suction pressures that can damage the compressor.
If the temperature in sensor S2 reaches the value set in this function, the fan is turned off regardless of the set value in function F30 (Fan operating mode during Refrigeration/Heating). For the fan to be turned on again, it is necessary that the temperature in S2 reaches the value of F33 - F34 (Hysteresis for fan return).
Note: This feature is valuable when, for example, refrigerating equipment that has been idle for days is put into operation or when chambers or display freezers are replenished with proper merchandise.

F34 - Hysteresis for fan return (after stopping for high temperature in evaporator)
It sets the temperature differential for fan return, in case it has stopped due to high temperature in S2. See function description F33 for more details.

F35 - Low ambient temperature alarm
It sets the temperature in sensor S1 (ambient temperature) required to activate the low ambient temperature alarm. This alarm is signaled through the message AL0 on the display, via a audible signal (buzzer), and through the activation of the AUX output, in case F44 =1 (AUX output for alarm).

F36 - Low ambient temperature alarm hysteresis
It sets the temperature differential to turn off the low ambient temperature alarm, in case this alarm has been detected. For the low temperature alarm is switched off, it is necessary that the temperature in S1 reaches a value greater than or equal to the value of F35 + F36. .

F37 - High ambient temperature alarm
It sets the temperature in sensor S1 (ambient temperature) required to activate the high ambient temperature alarm. This alarm is signaled through the message AH1 on the display, via a audible signal (buzzer), and through the activation of the AUX output, in case F44 =1 (AUX output for alarm).

F38 - High ambient temperature alarm hysteresis
It sets the temperature differential to turn off the high ambient temperature alarm, in case this alarm has been detected. For the high temperature alarm is switched off, it is necessary that the temperature in S1 reaches a value lower than or equal to the value of F37 - F38 .

F39 - Alarm inhibition time when energizing the instrument
It sets how long the controller waits, when energized, before connecting any high/low ambient temperature alarm, ie, during this time the alarm is kept off, waiting for the system to go into work regime.

F40 - Alarm inhibition time after draining
It sets the time the controller waits at the end of the draining stage, before turning on any high/low ambient temperature alarm. The purpose of this function is to inhibit the alarm due to a possible rise in temperature as a result of defrost, considering that during the defrost and draining stages the alarm does not work.

F41 - Alarm inhibition time for open door
It sets how long the controller waits when it detects that the door has been opened before turning on the door open alarm. This function only works if F43=2 or F43=6 (Digital input operating mode: Door opening).

F42 - Alarm inhibition time for low/high temperature
It sets how long the controller waits upon detection of a low/high ambient temperature alarm, before connecting the respective alarm. This inhibition delay is respected during normal operation of the instrument (refrigeration/heating).

F43 - Digital input operating mode
It sets the digital input operating mode:
0 No function: The AUX input has no associated function
1 Defrost synchronism (NC): It allows defrost actuation (heating or refrigeration) via external actuation (open switch: defrost start, closed switch: normal operation)
2 Door opening (NC): It allows the detection of the door opening/closing (open switch: open door, closed switch: door closed).
3 Nighttime setpoint (NC): It allows nighttime mode actuation synchronized with other refrigeration chambers (open switch: nighttime mode, closed switch: daytime mode).
4 Control functions shutdown (NC): It allows the inhibition of control functions through the activation of the digital input (open switch: inhibited control functions, closed switch: normal operation) In this operating status only the temperature readings are carried out.
5 Defrost synchronism (NO): It allows defrost actuation (heating or refrigeration) via external actuation (open switch: normal operation, closed switch: defrost start).
6 Door opening (NO): It allows the detection of the door opening/closing (open switch: closed door, closed switch: door open).
7 Nighttime setpoint (NO): It allows nighttime mode actuation synchronized with other refrigeration chambers (open switch: daytime mode, closed switch: nighttime mode).
8 Control functions shutdown (NO): It allows the inhibition of control functions through the activation of the digital input (open switch: normal operation, closed switch: control functions inhibited). In this operating status only the temperature readings are carried out.

Note 1: See item 5.14 for more details on the operation of the instrument when the control functions are disabled.
Note 2: If F43=1 or F43=5 (defrost synchronism) the controller will perform the respective defrost (refrigeration/heating) that will depend on the operating mode in which it is now:
Operation in refrigeration (F02=0 or F02=2): If the temperature in S2 is above the value specified in F19 and this entry is triggered, the message dEF OFF will be shown periodically on the display, indicating that the defrost command was received, but the controller does not have authorization to perform defrost.
Operation in heating (F02=1 or F02=2): This entry can be used in conjunction with a thermostat-type key to activate the condenser defrost, in case it reaches a very low temperature.

F44 - AUX output operating mode
It sets the digital output operating mode:
0 No Function: The AUX output has no associated function
1 AUX output for alarm: The AUX output is triggered in case there is an active alarm
2 AUX output for lamp: The AUX output triggers a lamp. If F43 = 2 or F43 = 6 (Digital input operating mode: Door opening), the lamp on time is determined by the function value F45 (Door closed time to turn the lamp off). If the controller is operating in nighttime mode, the lamp will remain off regardless of the value set in function F45 .
3 AUX output for cycle reversing valve: The AUX output controls the cycle reversing valve (Refrigeration/Heating).
Notes:
-If the function F02 is modified, the function F44 is automatically changed according to the conditions described below:
-If F02 is changed to 0 or 1 (Controller operating mode: Refrigeration or Heating), the function F44 is automatically modified to 1 (AUX output for alarm) and the user will be able to change this value to 0, 1, 2 or 3.

-If F02 is changed to 2 (Automatic), the function F44 is automatically modified to 3 (AUX output to cycle reversing valve) and the user will not be able to change the value of this function (the F44 is hidden from the functions menu).

F45 - Closed door time for turning off lamp (0= no)
It sets how long the controller waits after the door has been closed, before disconnecting the lamp, which is automatically switched on when the door is opened. This function only works if F43 =2 or F43 =6 (Digital input operating mode: Door opening) and F44 =2 (AUX output operating mode: AUX output for lamp).
If F45 = no , the lamp will always remain on.
If the controller is operating in nighttime mode, the lamp will always remain off (regardless of the value set in the function).

F46 - Closed door time to activate the nighttime setpoint (0 = no)
It sets the time the controller waits after the door has been closed, before activating the nighttime mode. This function only works if F43 = 2 or F43 = 6 (Digital input operating mode: Door opening).
If F46 = no , the controller will always remain in daytime mode.

F47 - Minimum time for compressor on
It sets the minimum time the compressor will stay on, that is, the time interval between the last start and the next stop. It serves to reduce the generation of voltage/current surges in the electrical grid.

F48 - Minimum time for compressor off
It sets the minimum time the compressor will stay off, that is, the time interval between the last stop and the next start. It serves to reduce the generation of voltage/current surges in the electrical grid.

F49 - Time of compressor on in case of error in sensor S1
F50 - Time of compressor off in case of error in sensor S1
It sets the minimum time the compressor will stay on/off, respectively, if the ambient sensor (sensor S1) is disconnected or out of the measurement range.

F51 - Intensity of the digital filter applied to the ambient sensor (S1)
It sets the intensity of the digital filter, which has the purpose of increasing the response time of the controller to a quick change in temperature measured in S1, ie increasing the thermal inertia of the sensor. The higher the value set in this function, the greater the response time of sensor S1.
A typical application that needs this filter is a freezer for ice cream and frozen products, as when opening the door, a warm air mass reaches the sensor directly, causing a quick rise in the measured temperature indication and, many times, unnecessarily triggering the compressor.

F52 - Time for keylock
This function sets the operation of key lock feature. See item 5.13 (Locking/Unlocking of keys) where there is a complete description of how to perform key locking/unlocking.

F53 - Control functions shutdown
It sets the operating mode of the feature "Control functions shutdown":
0 It does not allow the shutdown of the control functions: Configured this way, the instrument disables the functionality of control functions shutdown through the easy access menu.
1 It allows to turn on/off the control functions only if the keys are unlocked: Configured this way, the instrument enables the functionality of turning on/off the control functions through the easy access menu in case the keys are unlocked.
2 It allows to turn on/off the control functions even if the keys are locked: Configured this way, the instrument enables the functionality of turning on/off the control functions through the easy access key, even if the keys are locked.
See item 5.14 (Control functions activation/deactivation) where there is a complete description of how to perform the activation/deactivation of the control functions.

F54 - Address in RS-485 network
It sets the address of the controller in the communication network RS-485, for it to communicate with the Sitrad software.
Note: In the same network, there cannot be more than one instrument with the same address.

5 - Operation

5.1 - Parameter visualization

To visualize the controller parameters, access the functions menu. To access it, simultaneously press keys ▲ and ▼ for 2 seconds, until the message Fun is shown on the display. When this occurs, release the keys; after they have been released the message F01 will appear on the display.
To access the desired function, use the keys ▲ or ▼ .
After selecting the desired function, press the key SET (short touch) to visualize the set value. Press the key again SET (short touch) to return to the functions menu.
To exit the functions menu and return to normal operation of the controller (temperature indication), press the key SET (long touch) until the message --- appears on the display.

5.2 - Parameter Alteration

To change the controller parameters, access the functions menu. To access it, simultaneously press keys ▲ and ▼ for 2 seconds, until the message Fun is shown on the display. When this occurs, release the keys; after they have been released the message F01 will appear on the display.
With the function F01 selected, press the key SET (short touch). Use the keys ▲ or ▼ to change the value F01 of the 123 (access code to modify the parameters). When ready, press to SET confirm.
Use the keys ▲ or ▼ to select the function you want to set, then, press the key SET (short touch) to visualize the set value.
Use the keys ▲ or ▼ to change the value to be set in the selected function, and when ready, press the key SET to save the new value and return to the functions menu.
To exit the functions menu and return to normal operation of the controller (temperature indication), press the key SET (long touch) until the message --- appears on the display.

5.3 - Selection of the unit (ºC/ºF)

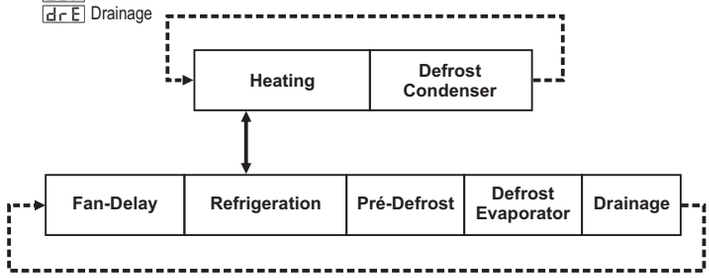
To set which temperature measurement unit is the one that the controller will use (°C or °F), access the function F01 , enter the access code 231 , and confirm this value by pressing the key SET (short touch) to return to the functions menu. Press the key ▲ (short touch) to select the temperature unit selection function; when this occurs, the message Uni appears on the display. To enter the function, press the key SET (short touch). Use the keys ▲ or ▼ to choose between °C or °F and confirm the selection by pressing the key SET (short touch). After selecting the unit, the message FAC is displayed and the instrument will return to the function F01 . Every time the unit is changed, the parameters must be re-configured, as they assume the default values, as described in the table in item 4.2.

5.4 - Process stage, elapsed time and temperature in the evaporator (S2)

To access this information, press the key ▼ (short touch). On the display, the following will appear: the stage in which the controller is, the time (in minutes) elapsed in this stage, the active setpoint (daytime SP1 or nighttime SP2) and the temperature in sensor S2 t-2 .
In the case sensor S2 is disconnected, disabled (OFF), or if the temperature in S2 is outside the operating range of the sensor (-50ºC to 75ºC), Er2 will appear in place of the temperature in S2.

Setpoints:
SP1 Daytime setpoint
SP2 Nighttime setpoint

Stages of the process:
--- Disabled control functions (Stand by)
dEL Initial delay (delay at start of the instrument)
FAn Fan-delay (delay for return of the fan)
rEF or hAt Refrigeration /Heating
PrE Pre-defrost (only if F10 = 1)
dEF Defrost
drE Drainage



5.5 - Condition for starting defrost

5.5.1 - If F02 =0 (Controller operating mode: Refrigeration)

The function F11 determines whether the defrost start will be by time or temperature.
F11 =0: The defrost start will occur after the time set in F12 elapses.
F11 =1: When the evaporator temperature reaches the value set in F15 , the pre-defrost period count (F16) is triggered, if this time has been set. After that time has elapsed, if the temperature in sensor S2 remains below the specified temperature in F15 the defrost start will occur. If the temperature increases above the specified value in F15 , the controller returns to the stage of refrigeration.

5.5.2 - If F02 =1 (Controller operating mode: Heating)

Defrost (heating mode) will occur after the system runs in heating mode for the time specified in function F13 . To disable defrost (heating mode), just set the function F21 with value 0.

5.5.3 - If F02 =2 (Controller operating mode: Automatic)

When the controller is set to automatic, it can operate refrigerating or heating the atmosphere. In case the controller is refrigerating the environment, it will respect the conditions for defrost start (refrigeration mode). If the controller stops refrigerating the environment and starts to heat it, the times relative to the functions F12 (interval between defrosts (Refrigeration)) and F14 (Maximum time in refrigeration) are restarted.
In case the controller is heating the environment, it will respect the conditions for defrost start (heating mode). If the controller stops heating the environment to start refrigerating it, the time relative to the function F13 (Interval between defrosts (Heating)) is restarted.

5.6 - Manual defrost (via easy access key or via Sitrad)

To perform a manual defrost, regardless of the programming, press and hold the SET key for 10 seconds, until the message dEF On appears on the display.
If the controller is in defrost, and has been started manually, by pressing the SET key again for 10s, defrost will be terminated with the message dEF OFF and at the same time it will be recorded in function "F19 – Evaporator temperature (S2) to end defrost" the temperature of sensor S2, followed by the messages F19 t-2 and the temperature of sensor S2.
The temperature of sensor S2 will not be recorded in F19 if the interval between the start and end of manual defrost is less than 2 minutes, then appearing F19 OFF . If the controller is in defrost (initiated by time/temperature) and it is necessary to interrupt it, press the key SET until the indication dEF OFF appears on the display.

5.6.1- If the controller is heating the environment (F02 =1 or F02 =2).

To perform a manual defrost, regardless of the programming, press and hold the SET key for 10 seconds until the message dEF is shown on the controller display, then release the key, and finally the message On is shown indicating the start of defrost.
The controller will remain in defrost (heating mode) for the period specified in the function in F21 (Duration of defrost (Heating)), or if the user manually interrupts the defrost (heating mode).
If the controller is in defrost (initiated manually or by time) and the user wants to interrupt it, press the SET key for 10 seconds until the message dEF is shown on the display, then release the key, and finally the message OFF is shown indicating the end of defrost.

5.7- How to determine the end of defrost (Refrigeration) by temperature

a) Set the following functions with maximum values:
- F12 =999 (Interval between defrosts (Refrigeration))
- F19 =75 (Evaporator temperature for end of defrost (Refrigeration))
- F20 =90 (Maximum duration of defrost (Refrigeration))

b) Wait until a layer of ice forms in the evaporator.
c) Perform a manual defrost (refrigeration mode) manually, by pressing the SET key for 10 seconds until the message dEF is shown on the display, then release the key, and finally the message On is shown indicating the start of defrost.
d) Follow the melting.
e) Wait until all of the ice in the evaporator has melted (defrost terminated).
f) Press the SET key for 10 seconds until the message dEF is shown on the display, then release the key, and finally the message OFF is shown indicating the end of defrost. At that moment the temperature measured in sensor S2 is recorded in function F19 (Evaporator temperature (S2) to end defrost). If the operation has been executed successfully, the message F19 t-2 00.0 (temperature of sensor S2) will be shown on the display.

g) For safety, re-configure the function value [F20] (Maximum duration of defrost (Refrigeration)). This value depends on the type of defrost performed. Examples:
-Electrical defrost (by resistors) = 45 minutes maximum
-Hot gas defrost in plug-in systems = 20 minutes maximum
h) Re-configure the value of function [F12] (interval between defrosts (Refrigeration)), with the desired value.

5.8 - Record of maximum and minimum temperatures and door open counter

Press the key ▲ (short touch), then the following messages will appear on the controller display:
[t-1] [00.0] (minimum temperature in sensor S1) [00.0] (maximum temperature in sensor S1)
[t-2] [00.0] (minimum temperature in sensor S2) [00.0] (maximum temperature in sensor S2)
[OPn] [000] (number of times the door was opened)*
* - The number of times the door was opened only appears if [F43]=2 or [F43]=6 (Digital input operating mode: Door opening).
Note: To reset the records (maximum and minimum temperatures, and door open counter), just hold down the ▲ key during the visualization of minimum and maximum temperatures and the number of times the door was opened until the message [rSt] is shown on the display.
The record of the number of times the door was opened is not reset in the event of power failure.

5.9 - Turning on / off the nighttime Setpoint manually

If [F43]=2 or [F43]=6 (Digital input operating mode: Door opening):

-The controller will respect the time set in function [F46] (closed door time to activate nighttime setpoint) before changing the setpoint.

-If the nighttime setpoint is active, and the door is open, the controller returns to daytime setpoint.

If [F43]=3 or [F43]=7 (Digital input operating mode: Nighttime setpoint):

-If the input is on, and the daytime mode is active, the nighttime mode is activated

-If the input is off, and the nighttime mode is active, the daytime mode is activated Regardless of being in daytime or nighttime mode. It is possible to modify the operating setpoint through an easy access key:

-To activate the nighttime setpoint via the easy access key, press ▲ for 2 seconds until the message [SP2] is shown on the display, then release the key, and finally the message [On] is displayed indicating that the controller started to work in nighttime mode.

-To deactivate the nighttime setpoint via the easy access key, press ▲ for 2 seconds until the message [SP2] is shown on the display, then release the key, and finally the message [OFF] is displayed indicating that the controller started to work in daytime mode.

5.10 - Turning on / off the lamp manually

This functionality is only available if [F44]=2 (AUX output operating mode: AUX output for lamp).
If [F43]=2 or [F43]=6 (Digital input operating mode: Door opening):
-If the lamp is off, and the door is open, the controller will turn on the lamp, and will remain on while the door is open.
-If the lamp is on and the door is closed, the controller will respect the time specified in function [F45] (closed door time to turn off lamp) before turning off the lamp.
-If the lamp is on and the nighttime mode is activated (either manually or due to function [F46] (Closed door time to activate the nighttime setpoint)), function [F45] is ignored; then the lamp will be turned off immediately after switching from daytime mode to nighttime mode.
Regardless of being in daytime or nighttime mode, it is possible to turn on/off the lamp through the easy access key:
-To turn on the lamp manually, press the ▼ key for 2 seconds until the message [Lit] is shown on the display, then release the key, and finally the message [On] is shown indicating that the lamp was turned on.
-To turn off the lamp manually, press the ▼ key for 2 seconds until the message [Lit] is shown on the display, then release the key, and finally the message [OFF] is shown indicating that the lamp was turned off.
If the lamp is turned on manually, it will remain on until it is manually turned off, or if the door is opened and then closed (in this situation, the lamp will remain on for the time specified in [F45] and/or [F46], whatever happens first).

5.11 - Enable / inhibit audible signal (buzzer)

To inhibit the audible signal (buzzer), press the ▼ and SET keys (short touch). By inhibiting the audible signal (buzzer), the following messages will appear on the controller display: [bu] [OFF]. The buzzer will be restored automatically when there is no longer any active alarm.

5.12 - Enable / inhibit alarms

To inhibit the alarm output in case an alarm is active and if [F44]=1 (AUX output operating mode: AUX output for alarm), and press keys ▲ and SET (short touch). By inhibiting the alarm output, the following messages will appear on the controller display: [ALr] [OFF]. The visual and audible signals (buzzer) still remain active, even if the alarm output is inhibited. Sensor alarms disconnected ([Er1], [Er2]),) cannot be inhibited. The Sitrad software will still record the alarm, even if it has been manually inhibited. The alarm output will be re-enabled automatically when there is no longer any active alarm.
Note 1: The alarms for high/low temperature are automatically inhibited during defrost and drainage cycles, but they will not be inhibited if they have been detected before the instrument starts the defrost/drainage cycle.

5.13 - Key Locking / Unlocking

The aim of key locking is to protect the controller against undue changes of its configuration parameters.
To perform the key lock it is necessary, initially, that parameter "F52 - Time for key locking" is set to the value other than '14 - [no]' (15 to 60 seconds). If F52 is set as [no] key locking will not be not allowed. To lock, press the ▼ key for the time programmed in function F52, until the controller displays the message [LOC], then release the key, and finally the message [On] appears indicating that the key lock was turned on.
If the keys are locked, the user will only be able to visualize the current value of the setpoint and parameters configured in the controller. In this condition, if the user attempts to change the configuration of any of these parameters, the message [LOC] will appear on the display.
To unlock the keys, turn off the controller and reconnect it with the key ▼ pressed. Hold down the ▼ key for 10s until the message [LOC] appears on the display, then release the key, and finally the message [OFF] is displayed indicating that the key lock was turned off.

5.14 - Activation / Deactivation of control functions

The activation/deactivation of functions allows to place the controller in a state of "Stand-by", where it only performs the temperature readings of the sensors. All control functions are disabled (including the alarms), and all outputs remain off. Communication with the Sitrad Software remains operative.
The shutdown of the compressor, if the control functions are disabled, will respect function [F47] (Minimum time for compressor on), or [F49] (Compressor on time in case of error in sensor S1).
The actuation of the compressor, in case the control functions are activated, will respect function [F48] (Minimum time for compressor off), or [F50] (Compressor off time in case of error in sensor S1).
If the control functions are turned off through the easy access key and the instrument is de-energized, when energizing it again, it will operate again with control functions off.
If the control functions are turned off, when they are reconnected, the instrument will respect the functions [F09] (Control delay at start) and [F18] (defrost at controller start), and the stage timer is restarted.
Permission to activate/deactivate the control functions of the instrument through the easy access key will depend on the value configured in function [F53] (Control functions shutdown), but the activation/deactivation of the control functions via the digital input ([F43]=4 or [F43]=8) will not depend on the value set in function [F53].
To deactivate the control functions via the easy access key, the user must press the ▲ key for 10 seconds until the message [CtL] is shown on the display, then release the button, and finally the message [OFF] is displayed, indicating that the control functions were deactivated.
While the control functions are off, the controller will alternate the following messages on the display: [000] (Temperature in Sensor 1) and [OFF].
To reactivate the control functions in case they have been deactivated via the access key, the user must press the same ▲ key for 10 seconds until the message [CtL] is shown on the display, then release the key, and finally the message [On] is displayed, indicating that the control functions were reactivated.
To reactivate the control functions in case they have been deactivated by the digital input ([F43]=4 or [F43]=8) and also by the easy access key ▲ (pressing of for 10 s), it is necessary that the control functions are re-enabled through the easy access key and by the digital input; so that both methods of activation/deactivation of the system allow the control functions to be activated.
If [F53]=1 or [F53]=2 (control functions shutdown allowed) and the control functions have been switched off via the easy access key, when changing the function [F53] to '0'(control functions shutdown not allowed), the instrument will switch the control functions and the control functions deactivation through the easy access key.

5.15 - Signals

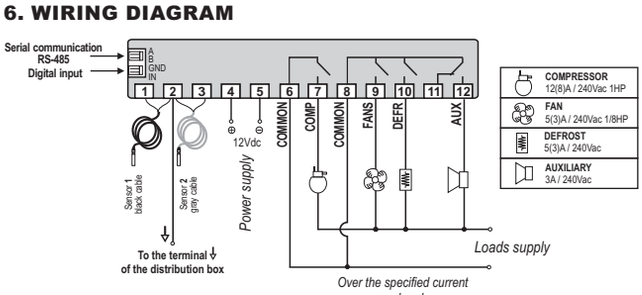
The light signals indicate the status of the control outputs:
COMP: Compressor or liquid gas solenoid
FANS: Evaporator fans
DEFR: Defrost (resistor or hot gas)
AUX: Auxiliary output
[Er1]: Ambient sensor disconnected or out of range
[Er2]: Evaporator sensor disconnected or out of range
[ALo]: Low ambient temperature alarm
[AHi]: High ambient temperature alarm
[ ]: When defrost ends by time and not by temperature, a dot located in the lower right-hand corner of the display will remain flashing until the next defrost. When defrost ends by time and not by temperature, this indicates that one (or more) of the cases below is(are) happening:

- The interval between defrosts is too long
- There are burned resistors
- The hot gas is not circulating
- There is an inoperative or short-circuited fan
- The time set for maximum of defrost is too short

[PPP]: Invalid configuration parameters.
- In this situation, the outputs are automatically turned off.
- Check which parameter has invalid data and correct it to return to normal operation.

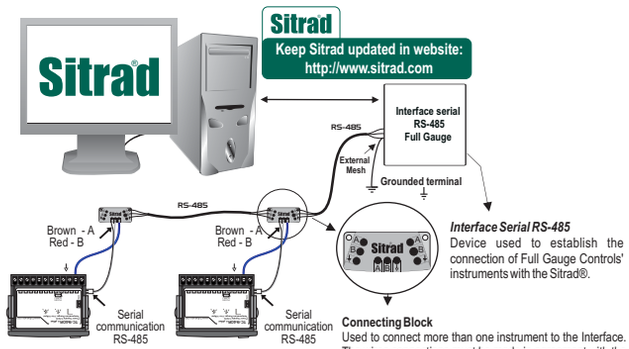
[OPn]: Door open alarm.
[OFF] (when shown in alternation with the temperature in S1): Control functions off.

6. WIRING DIAGRAM



- The sensor S1 (black) must be in the ambient.
- The sensor S2 (gray) must be placed in the evaporator through metallic cramp.

7. INTEGRATING CONTROLLERS, RS-485 SERIAL INTERFACE AND COMPUTER



Connecting Block
Used to connect more than one instrument to the Interface. The wires connections must be made in agreement with the following rules: Terminal **A** of the instrument connects to terminal **A** of the connecting block, which in turn must be connected to terminal **A** of the Interface.
Repeat the procedure for terminals **B** and ⏚, being ⏚ the cable shield (optional ground). Terminal ⏚ of connecting block must be connected to the respective terminals ⏚ of each instrument.

IMPORTANT

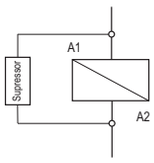
According to the chapters of norm IEC 60364:

1: Install protector against overvoltage on the power supply.

2: Sensor cables and signal cables of the computer may be joined, but not in the same electric conduit through which the electric input and the activation of the loads run.

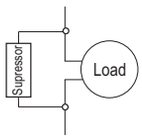
3: Install transient suppressors (RC filters) parallel to the loads as to increase the product life of the relays.

Contact suppressor connection diagram



A1 and A2 are the contactor coils

Diagram for suppressor installation for direct drive load inputs



For direct activation the maximum specified current should be taken into consideration.

Suppressors on offer from Full Gauge Controls

Note: The length of the sensor cable may be increased by the user up to 200 meters, using a PP 2 x 24 AWG cable. For immersion in water, use thermometric well.

ENVIRONMENTAL INFORMATION

Package:

The packages material are 100% recyclable. Just dispose it through specialized recyclers.

Products:

The electro components of Full Gauge Controls controllers can be recycled or reused if it is disassembled for specialized companies.

Disposal:

Do not burn or throw in domestic garbage the controllers which have reached the end-of-life. Observe the respectively law in your region concerning the environmental responsible manner of dispose its devices. In case of any doubts, contact Full Gauge Controls for assistance.

PROTECTIVE VINYL:

This adhesive vinyl (included inside the packing) protects the instruments against water drippings, as in commercial refrigerators, for example. Do the application after finishing the electrical connections.

Remove the protective paper and apply the vinyl on the entire superior part of the device, folding the flaps as indicated by the arrows.