TC-940R*i plus*

DIGITAL CONTROLLER FOR REFRIGERATION AND DEFROST WITH ALARM OUTPUT

Ver.01

TC940PLV01-01T-11744

1. DESCRIPTION

The **TC-940R*i plus*** is a temperature controller that manage cycles of defrost, start and finish, when only necessary, based in evaporator temperature, and they have one output for alarm or shutdown lamps. They have function to wait residual refrigerant fluid returns in defrost. Thus, it is possible to save energy and increase the efficiency of the system.

The **TC-940R*i plus*** have one digital input for extern synchronize defrost. This same input can change setpoint to nigthtime mode. This digital input can generate a visual and audible alarm too, to indicate open door, for exemple.

The **TC-940R*i plus*** have a digital filter that simulates an increase response time of sensor S1 to avoid the compressor action in fast changes of temperature.

They have one serial port to comunicate whith Sitrad®.

2. APPLICATION

- Counters
- Refrigerated balcony

3. TECHNICAL SPECIFICATIONS

- Power supply: 12Vdc
- Control temperature: -50 to 75° C / -58 to 167°F
- Resolution: 0.1°C from -10 to 75°C and 1°C outside this range / 1°F
- Operating temperature: 0 to 50°C / 32 to 122°F
- Operating humidity: 10 to 90% RH (without condensation)
- Dimensions: 71 x 28 x 71mm
- Load current (outputs):
  - COMP: 16(8)A / 250Vac 1HP (compressor, solenoid valve or contactor)
  - FANS: 5(3)A / 250Vac 1/8HP (evaporator fans)
  - DEFR: 5(3)A / 250Vac (defrost - resistance or hot gas)
  - ALRM: 3A / 250Vac resistive load (external alarm)

4. CONFIGURATIONS

4.1 - Setting the control temperature (SETPOINT)

Press SET for two seconds, until the message SEt appears, and then release. The current working temperature will be displayed. Use the keys ▼ and ▲ to change the value and then press SET to save.

If the operating mode of the digital input is configured for nighttime setpoint (F31=3), the message SP1 will be displayed after the message SEt to allow setting the daytime setpoint. Use the keys ▼ or ▲ to change the value and then press SET to save. Then SP2 will be displayed to allow setting the nighttime setpoint, use the same procedure above to adjust it and leave the setup mode.

4.2 - Parameters table

		CELSIUS				FAHRENHEIT			
Fun	Description	Min	Max	Unit	Standard	Min	Max	Unit	Standard
F01	Access code: 123 (one hundred and twenty-three)	-99	999	-	-	-99	999	-	-
F02	Control differential (hysteresis)	0.1	20.0	°C	1.5	1	36	°F	3
F03	Offset indication for ambient sensor	-20	20.0	°C	0.0	-36	36	°F	0
F04	Indication offset of the evaporator temperature (offset)	-20	20.0	°C	0.0	-36	36	°F	0
F05	Minimum setpoint allowed to the end user	-50	75.0	°C	-50	-58	167	°F	-58
F06	Maximum setpoint allowed to the end user	-50	75.0	°C	75.0	-58	167	°F	167
F07	Defrost type (0 = resistance; 1 = hot gas)	0	1	-	0	0	1	-	0
F08	Initial defrost condition (0 = time; 1 = temperature)	0	1	-	0	0	1	-	0
F09	Period between defrost (if F08 = 0)	1	999	min.	240	1	999	min.	240
F10	Maximum time in refrigeration (for security, if F08 = 1)	1	240	hours	24	1	240	hours	24
F11	Temperature in the evaporator for defrost start (if F08 = 1)	-50	75.0	°C	-5.0	-58	167	°F	23
F12	Time of pre-defrost (if F08 = 1)	0	90	min.	10	0	90	min.	10
F13	Defrost when the instrument is powered on (0 - no; 1 - yes)	0	1	-	0	0	1	-	0
F14	Evaporator temperature (S2) for end defrost	-50	75.0	°C	40.0	-58	167	°F	104
F15	Maximum defrost duration (for security)	0	90	min.	45	0	90	min.	45
F16	Fan turned on during defrost (0 - no; 1 - yes)	0	1	-	0	0	1	-	0
F17	Delay to do the first defrost (if F07 = 0)	0	999	min.	0	0	999	-	0
F18	Locked temperature indication (S1) during defrost (0 - no; 1 - yes)	0	1	-	0	0	1	-	0
F19	Draining time (dripping of defrost water)	0	30	min.	10	0	30	min.	10
F20	Evaporator temperature (S2) for fan return after draining	-50	75.0	°C	0.0	-58	167	°F	32
F21	Maximum time for fan return after draining (fan-delay)	0	30	min.	1	0	30	min.	1
F22	Fan on with compressor off (0 - no; 1 - yes)	0	1	-	1	0	1	-	1
F23	Fan stop for high temperature in evaporator	-50	75.0	°C	75.0	-58	167	°F	167
F24	Hysteresis for fan return (after stoping for high temperature in evaporator)	0.1	20.0	°C	2.0	1	36	°F	4
F25	Low temperature alarm (S1)	-50	75.0	°C	-50	-58	167	°F	-58
F26	Alarm hysteresis of low temperature	0.1	20.0	°C	1.0	1	36	°F	2
F27	High temperature alarm (S1)	-50	75.0	°C	75.0	-58	167	°F	167
F28	Alarm hysteresis of high temperature	0.1	20.0	°C	1.0	1	36	°F	2
F29	Inhibition time of alarm when the instrument is powered on	0	999	min.	0	0	999	min.	0
F30	Inhibition time of alarm after draining	0	999	min.	0	0	999	min.	0
F31	Digital input operating mode	0	3	-	0	0	3	-	0
F32	Time for inhibiting the open door alarm	0	99	min.	0	0	99	min.	0
F33	Time for collecting the defrost gas	0	90	min.	0	0	90	min.	0
F34	Delay when the instrumet is powered on	0	999	min.	0	0	999	min.	0
F35	Minimum time of compressor turned on	0	999	sec.	0	0	999	sec.	0
F36	Minimum time of compressor turned off	0	999	sec.	0	0	999	sec.	0
F37	Compressor status with detached ambient sensor (0 = off; 1 = on)	0	1	-	1	0	1	-	1
F38	Intensity of the digital filter applied to ambient sensor (S1)	0	9	-	0	0	9	-	0
F39	Network equipment address RS - 485	0	247	-	1	0	247	-	1

4.3 - Parameters description

F01 - Access code (123)
It is necessary to change the configuration parameters. To visualize the adjusted parameters, it is not necessary to insert this access code.

F02 - Control differential (hysteresis)
It is the difference of temperature (hysteresis) between ON and OFF the refrigeration.
Example: You need to control temperature in 4.0 ºC with differential of 1.0 ºC.
So, the refrigeration is turned off in 4.0 ºC and will be turned on in 5.0 ºC (4.0 +1.0).

F03 - Indication offset of the ambient temperature
It allows to compensate eventual shuting lines on reading of ambient temperature (S1), proceeding of sensor exchange or cable length alteration.

F04 - Indication offset of the evaporator temperature
It allows to compensate eventual shuting lines on reading of ambient temperature (S2), proceeding of sensor exchange or cable length alteration.

F05 - Minimum setpoint allowed to the end user

F06 - Maximum setpoint allowed to the end user
It is to prevent that incorrect high or low temperatures be regulated.

F07 - Defrost type
"0" = Electrical defrost (resistances),where is kept on only the defrost output.
"1" = Hot gas defrost, where defrost and compressor outputs are kept on.

F08 - Initial defrost condition
It defines if the defrost start will be for temperature or time. Is this function has the value "1", when the evaporator temperature reaches the configured value in "F11" the instrument starts to count the pre-defrost time and, after, will do the defrost.

F09 - Period between defrosts (if F08 = 0)
It determines the time between two consecutives defrost cycles, and starts to be counted from the last defrost. Attention, the defrost only will start if the temperture in S2 (evaporator sensor) is lower than F14.

F10 - Maximum time in refrigeration (for security, if F08 = 1)
It acts as security time (if F08 = 1) and evaporator temperature will not reach the configured value in "F11". This function determines the maximum time that controller will stay without defrost.

F11 - Temperature in the evaporator for defrost start (if F08 = 1)
When evaporator temperature reaches the configured value in this function the controller will start to count the pre-defrost period (F12).

F12 - Time of pre-defrost (if F08=1)
At the moment that the temperature in evaporator decreases and reaches the configured value in "F11", start to be counted the pre-defrost time. During the pre-defrost stage, if the temperature is kept low the defrost starts, else if the temperature increase at least 1 ºC in relation to configured value, the system returns to refrigeration stage.

F13 - Defrost when the instrument is powered on
It possibilities the defrost at the moment that the controller is turned on, for example, in return of electrical energy (in case of energy lacks).

F14 - Evaporator temperature (S2) for end defrost
If evaporator temperature (sensor S2) reaches the adjusted value, the end defrost will happen for temperature. With this , the defrost process is optimized.

F15 - Maximum defrost duration
This function serves to adjust the maximum value of time to defrost. If in this period the evaporator temperature will not reach the configured value in F14 a point will be blinking on inferior down right side of display indicating that the end defrost ocurred for time and not for temperature.
This can happen when the adjusted temperature is very high, the limit time will be not enough, the S2 sensor is detached or not in contact with the evaporator.

F16 - Fan turned on during defrost
It possibilities the fan functioning during defrost.
Example: Natural defrost or by resistances installed outside the evaporator.

F17 - Delay to do first defrost (if F08=0)
This function defines an extra time that the instrument will keep in refrigeration before do the first defrost, to prevent that lot of counters enter in defrost at the same time. This time only appears before the first defrost, when F08 = 0 (initial defrost for time).

F18 - Locked temperature indication (S1) during defrost
This function prevents that ambient temperature elevation be visualized. During defrost the last measured temperature in refrigeration cycle will be locked on display. The indication will be released when this temperature will be reached again or 15 minutes after the begin of next refrigeration cycle.

F19 - Draining time (dripping of defrost water)
Necessary time for dripping, it means, to drain the last water drops of the evaporator. All the outputs keep turned off. If you do not need this stage, adjust this time for "zero".

F20 - Evaporator temperature (S2) for fan return after draining(fan-delay)
After the draining, the fan-delay cycle starts. The refrigeration (COMP) output is turned on, because the evaporator temperature is high, but the fan only is turned on after evaporator temperature decreases the adjusted value. This process is necessary to remove the heat that exists in the evaporator because the defrost, preventing to pass it to the ambient.

F21 - Maximum time for fan return after draining (fan-delay)
For security, if the evaporator temperature does not reach the adjusted value in F20 or the S2 sensor is detached, the fan-delay will happen after passed the adjusted time in this function.

F22 - Fan on with compressor off
During refrigeration, the fan can be depend of the compressor status.
"0" = The fan keeps turned on while compressor is turned on (this alternative, in some cases, Possibilities a great economy of electrical energy).
"1" = The fan keeps turned on during all refrigeration cycle.

F23 - Fan stop for high temperature in evaporator
This function cycles the evaporator fan until that ambient temperature approaches of the temperature desired in the refrigerating installation project. This preventing high temperature and suction pressures that can damage the compressor. If the temperature in evaporator pass the adjusted value, the fan is turned off, turning on again with a configurable hysteresis in F24.

F24 - Hysteresis for fan-delay (after stopping for high temperature in evaporator)
It allows to determine the difference of temperature to fan-delay had to a stop for temperature above desired in evaporator.

F25 - Low temperature alarm (S1)
If the ambient temperature (sensor S1) decreases above this point during refrigeration, this will be signalized through the message AL o on display and the output (NO/NC) of alarm will be turned on.

F26 - Alarm hysteresis of low ambient temperature
It is the difference of temperature to turn off the alarm output for low ambient temperature.

F27 - High temperature alarm (S1)
If the ambient temperature (sensor) reaches this point during the refrigeration, this will be signalized through the message AH i on display and the output (NO/NC) of alarm will be turn on.

F28 - Alarm hysteresis of high temperature
It is the temperature to turn off the alarm output for high ambient temperature.

F29 - Inhibition time of alarm when the instrument is powered on
During this time the alarm is kept turned off waiting that the system starts to working. .

F30 - Inhibition time of alarm after draining
This function serves to inhibit the alarm during a period after draining, because it is normal an elevation of the temperature proceeding of the defrost.

F31 - Digital input operating mode
The digital input can be configured to operate as follows:
0=none;
1=defrost synchronization;
2=open door alarm,
3=nighttime setpoint.

F32 - Time for inhibiting the open door alarm
During this time the door open alarm is kept off.

F33 - Time for collecting the defrost gas
After starting the defrost the controller will keep only the fan on for this time to use the remaining energy of the gas.

F34 - Delay when the instrument is powered on
When the instrument is turned on, it can keep a time with its control disabled, delaying the process initial. During this time it functions only as temperature indicator. It serves to prevent demand peaks of electrical energy, in case of lack or return of the same, when a lot of equipments are connected in the same line. For this, adjust different times for each equipment. This delay can be of compressor or defrost (when exists defrost on start).

F35 - Minimum time of compressor turned on
It is the time that the compressor will keep turned on, it means, the time period between the last started and the next stopped.

F36 - Minimum time of compressor turned off
It is the minimum time that the compressor will keep turned off, it means, the time period between the last stopped and the next started. It serves to alliviate the pressure and to increase the useful life of the compressor.

F37 - Compressor status with detached ambient sensor (S1)
If the ambient sensor (S1) is detached or out specified range, the compressor assumes the configured status in this function.
Exemple: For counters that storage fruits it is better that the compressor keeps turned off, but in counters that storage meats it is better that the compressor keeps turned on.

F38 - Intensity of the digital filter applied to the ambient sensor (S1)
This filter aims at simulating an increase of environment sensor (S1) mass, thus increasing its response time (thermal inertia). The larger the value adjusted in this function, the longest the response time of sensor S1.
A typical application requiring this filter is the freezer for ice cream or frozen goods, because when the door is opened a hot air mass reaches the sensor directly, causing a quick rise in the indication of the measured temperature, causing the compressor to be activated unnecessarily many times.

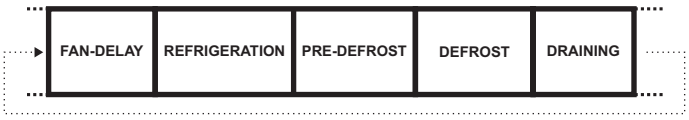
F39 - Network equipment address RS - 485
Equipment's network address for communicating with Sitrad® software.
Note: One network must not have different equipment with the same address.

4.3.1 - Unit selection (ºC/ºF)
To determine the unit that the instrument will work, access the function "F01" with the access cod 231 and confirm with the key SET . Press the key ▲ . Uni will appear. Press SET than use ▼ or ▲ to choose between °C or °F and confirm with SET . After select the unit FAC will appear and the instrument returns to the function "F01". Every time that the unit is changed, the parameters must be configurated again, because they assume the standard values (item 4.2).

5. OPERATION
5.1 - Parameters visualization
a) Press at the same time the keys ▼ and ▲ for 2 seconds until appear Fun , releasing them after that. Soon, appears F01 .
b) Use the keys ▼ and ▲ to access the desired function.
c) After select the function, press SET (short touch) to visualize the configured value.
d) Press again SET (short touch) to return the functions menu.
e) To reset the menu and return to normal operation (temperature indication), press SET until appear - - - .

5.2 - Parameters alteration
a) Access the function F01 pressing at the same time ▼ and ▲ for 2 seconds until appear Fun , releasing then after that. Soon will appear F01 , and then press SET (short touch).
b) Use ▼ and ▲ to enter the access code (123), and then press SET .
c) Select the desired function and visualize the configured value, like explained the itens"5.1-b" and "5.1-c".
d) Use ▼ and ▲ to change the value and then press SET to record the configured value and return to the functions menu.
e) To reset the menu and return to normal operation (temperature indication), press SET until appear - - - .

5.3 - Process stage, elapsed time and evaporator temperature (S2)
Press ▼ .The stage of the process will appear, the elapsed time (in minutes) and evaporator temperature (S2).
In case of detached sensor or temperature out specified range will appear Er2 .
Process stages: dEL Initial delay (delay to start the control)
FAn Fan-delay (delay to fan return)
rEF Refrigeration
PrE Pre-defrost (only if F08 = 1)
dEF Defrost
drE Draining



5.4 - Initial defrost condition
The function "F08" determines if the start of the defrost will be for time or temperature.
F08 = 0 The start of defrost will happen after elapsed the configured time in F09.
F08 = 1 When the temperature in the evaporator reaches the configured value in F11, the count of pre-defrost period will start (F12). After elapsed this time, if the temperature keeps low the defrost will start. If the temperature increases, the controller returns to refrigeration stage.

5.5 - How to determine the end defrost for temperature
a) Adjust the follow functions with maximum values:
- Interval between defrosts (F09 = 999 min)
- Evaporator temperature for end defrost (F14 = 75 ºC)
- Defrost maximum duration (F15 = 90 min)
b) Wait until an ice layer to be created on the evaporator.
c) Do a manual defrost, pressing ▲ for 4 seconds, until appear dEF On .
d) Observe the melting process.
e) Wait until melt all defrost on evaporator to consider the defrost finalized.
F) Check the temperature in evaporator read by the sensor S2 at this moment, pressing ▼ and copy this value to the function F14 - Evaporator temperature (S2) for end defrost.
g) As security, adjust again the function F15 - Maximum duration of defrost, that depends of the defrost type. *Exemple: Electrical defrost (resistance) = 45 minutes as maximum*
Defrost for hot gas = 20 minutes as maximum
h) Now adjust the function F09 -Interval between defrosts as desired value.

5.6 - Manual defrost
To do a manual defrost, regardless of the programming, keep pressed ▲ for 4 seconds, until appears the indication dEF On .
If the instrument is in defrost and you want to finish it, follow the above instructions, until appears the indication dEF OFF .

5.7 - Indicators and Alarms
The leds indicate the control outputs status:
COMP: Compressor or solenoid of liquid gas
FANS: Evaporator fans
DEFR: Defrost (resistances or hot gas)
ALRM: Alarm output
Er1 Detached ambient sensor or temperature (S1) out the range
Er2 Detached evaporator sensor or temperature (S2) out the range
AL o Low ambient temperature alarm
AH i High ambient temperature alarm
* Always that the defrost is finished by time and not for temperature a point located on right inferior side of display will be blinking until the next defrost, indicating that:
- The interval between defrost is too long.
- There are burned resistances
- The hot gas is not circulating
- There is an inoperative fan
- The adjusted time for maximum duration of defrost is short.
PPP Invalid configuration parameters.
- In this situation the outputs will be turned off.
- Check which parameter have invalid information and correct it to return to normal operation.

5.8 - Registers of minimum and maximum temperatures

Press ▲. Will appear [t-1] and minimum and maximum temperatures of black sensor (ambient). After appear [t-2] and minimum and maximum temperatures of gray sensor (evaporator).
Note: To reset the registers, keep pressed ▲ during visualization of minimum and maximum temperatures until appear [rSt].

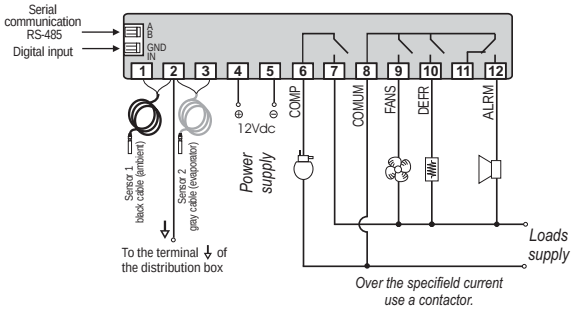
5.9 - Alarm inhibition

To inhibit the alarm output press the key SET . The messages [ALr OFF] will appear.
After the inhibition, the alarm output returns to be enabled when the instrument leaves the alarm status.

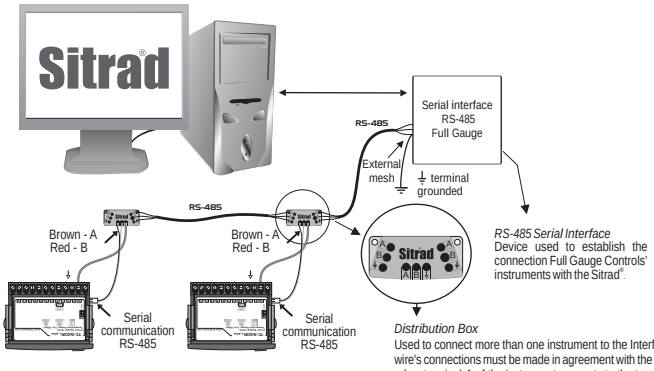
5.10 - Inhibition of the alarm sound

To inhibit the audible alarm press the key ▼ for two seconds. After the inhibition, the audible alarm returns to be enabled when the instrument leaves the alarm status.

6. WIRING DIAGRAM



Integrating Controllers, RS-485 Serial Interface and Computer

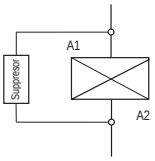


RS-485 Serial Interface
Device used to establish the connection Full Gauge Controls' instruments with the Sitrad®.

Distribution Box
Used to connect more than one instrument to the Interface. The wire's connections must be made in agreement with the following rules: terminal A of the instrument connects to the terminal A of the distribution box, that must be connected with the terminal A of the Interface. Repeat the action for terminals B and ⏚ , being ⏚ the cable shield.
the terminal ⏚ of distribution box must be connected to the respective terminals ⏚ of each instrument.

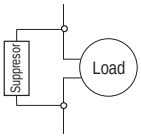
IMPORTANT
According to the chapters of norm IEC 60364:
1: Install protector against overvoltage on the power supply
2: Sensor cables and signal cables of the computer may be joined, but not in the same electric conduit through which the electric input and the activation of the loads run
3: Install transient suppresors (RC filters) parallel to the loads as to increase the product life of the relays.
For more information, please contact our Technical Support by e-mail: support@fullgauge.com or by phone +55 51 3475.3308

Schematic for the connection of supresors to contactors



A1 and A2 are the contactor coil terminals.

Schematic for the connection of supresors to direct activation loads



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

Note: The sensor cable lenght can be increased by the user until 200 meters using 2 x 24 AWG cable.

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.