

Series TST, TSR and TSD



Specifications - Installation and Operating Instructions

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1. INTRODUCTION

Dwyer Series TSD, TSR, and TST temperature switches are electronic controllers for cold refrigeration units. The Series TSD also includes heat control. Cold regulation can be accomplished with normal (one probe) or differential (two probes) regulation. Defrost and continuous cool cycles can be performed in both cases. The switches control the refrigeration unit according to temperature data from the probes, configurable digital input, and 48 programmable parameters. The thermostats act by means of 1, 2 or 3 relays, depending on the model. The probe(s) included with the unit is a PTC thermistor with a range of -58 to 302°F (-50 to 150° C).

Temperature, parameters, and alarms are easily viewed on the red, 3-digit LED display. Temperature is shown on the display with a single decimal point (for temperatures lower than 100°) or without decimals if preferred.

The Series TSD, TSR, and TST switches are programmable via a 3-key tactile keypad. In order to simplify the programming task, 18 preset configurations are stored inside the memory and can be activated by changing one parameter, H0. Access to all parameters except for the setpoint is protected by a code which can be set by the user. An alternative to keypad programming is to control the unit via an RS485 interface. Models with the communication module permit total control and monitoring from a PC by means of a communication card. Unit-specific identifiers make it easy to establish a local network and control multiple thermostats in a single system.

Features of the Series TSx are:

- 1, 2, or 3 relays (depending on model)
- Digital Input
- Alarm or RS-485 output to control units via PC interface
- 3-digit display
- Supply Power: 12VAC/DC. Series TSD is also available with 110 VAC or 230 VAC
- 18 configurable choices of complete parameter set up
- Controllable defrost and continuous cycles with one or two probes

2. OPERATING INSTRUCTIONS

2.1 Parameter Descriptions

SET: Setpoint- -99.9 to 302°

The switch actuation temperature which can be set between the high and low setpoint limits (r1 & r2).

r0: Differential (Hysteresis)- 0.1 to 20°

The user-defined differential (hysteresis) of the setpoint.

For TSD when $d0 = re$ and for TSR and TST:

When ambient probe temperature $sd1 \geq \text{Setpoint} + r0$ (The output relay is "ON")

When ambient probe temperature $sd1 \leq \text{Setpoint}$ (The output relay is "OFF")

For TSD when $d0 = in$:

When ambient probe temperature $sd1 \leq \text{Setpoint} - r0$ (The output relay is "ON")

When ambient probe temperature $sd1 \geq \text{Setpoint}$ (The output relay is "OFF")

r1: Minimum Value for Setpoint- -99.9° to $r2$

r2: Maximum Value for Setpoint- $r1$ to 302°

r3: Type of Regulation - dif or nor

Differential (2 probes) or Normal (1 probe) regulation.

dif = Adjust the differential according to the difference between the two probes. The ambient probe is placed in the air output of the evaporator and the defrosting probe in the input.

- If the difference between these two probes is greater than $r4$, regulation is made with the setpoint (SET).

- If the difference between the two probes is less than or equal to $r4$, regulation is made with the Setpoint + $r5$.

- In both cases the differential used is $r0$.

nor = Normal regulation with Setpoint and $r0$.

r4: Differential for dif Mode- 0.1 to 20°

Critical temperature difference between the two probes.

dif mode = Setpoint+ $r5$

nor mode = Setpoint

r5: Differential Offset for Setpoint- 0 to 20°

Temperature to be added to the setpoint in differential mode to obtain an alternative setpoint.

r6: Fan Operation During Regulation- off/on/con (**only available with Series TST**)

Control the fan to be always OFF, always ON or only ON when compressor is activated.

off: Fan always off

on: Fan always on

com: Fan switches on when compressor is activated

(If the unit is to be switched on and $d12 \geq F0$ (Temperature of the ambient or defrosting probe \geq Fan stop temperature), the switch will not connect again until $d12 \leq F0 - A0$ (Temperature of the ambient or defrosting probe \leq Fan stop temperature - fan/alarm differential))

d0: Type of Defrost Cycle- re/in

The type of defrost control varies with each model. (The Series TSR and TST do not have heating control).

For TSD: Cooling or heating control

re =Cooling

in =Heating

For TSR, TST: Defrost with or without the compressor.

re = Defrost without connecting compressor

in = Defrost with connecting compressor

d1: Defrost Stop Temperature- -99.9 to 302°

The temperature that the defrost cycle will end.

d2: Maximum Defrost Time- 0 to 240 minutes

The maximum time that can elapse during a defrost cycle before the cycle will automatically end. (If $d2=0$, there will be no defrosting cycle.)

d3: Defrosting when Connecting- no/yes

Control when the first defrost cycle will begin after switch is connected.

yes: The first defrost will occur time $d4$ (delay of first defrost) after connection.

no: Defrosting will occur time $d8$ (interval time between defrost cycles) after connection.

d4: Time Delay of First Defrost- 00.0 to 18.0 h-m*

The time delay before the first defrost cycle (Only if $d3=$ yes).

d5: Display During Defrost Cycle- off/on/d

The different options of displaying the temperature during the defrost cycle.

off: The temperature will be shown during defrosting.

on: The temperature at which the defrost cycle started is frozen on display until the end of the defrost cycle or until $d6$ (display return time) elapses.

d: A “-d-“ is displayed until the end of the defrost cycle and when the temperature is \leq the initial temperature. The “-d-“ will be replaced by the temperature if time $d6$ elapses.

d6: Display Return Limit- 0 to 240 minutes

Maximum time before viewing the actual temperature during or after defrosting.

d7: Compressor Drip Time- 0 to 240 minutes

Time which must elapse after defrost cycle ends before the compressor can be reconnected.

- d8:** Interval Between Defrosting- 00.0 to 18.0 h-m*
Perform defrost periodically in timed intervals. Parameter d8 is the time which must elapse between the ending of one cycle and the beginning of another. (If d8=0, defrost by timed intervals is not performed.)
- d9:** Fan Operation During Defrosting Time- on/off (**Only for Series TST**)
Control whether or not the fan will be connected during the defrost cycle.
- d10:** Fan Drip Time- 0 to 240 minutes (**Only for Series TST**)
Time which must elapse after the defrost cycle ends before the fan can be reconnected.
**See notes at bottom of page 21 for description of parameter units*
- d11:** Manual Defrost Synchronization- no/yes
Enable the defrost cycle to be synchronized with the timed defrost (d8) via the computer RS-485 interface.
yes: The defrosting time interval, d8, is reset. After the manual defrost is concluded, the timed intervals, d8, recommence.
no: The manual defrost performed has no effect on timed defrost intervals.
- d12:** Fan & Defrost Control Probe- sd1/sd2
Choose which probe to control the fan and defrost cycling.
(There is no control of sd2 when using only one probe).
sd1: Ambient probe
sd2: Defrosting probe (To ensure the defrost is not changed by another user, set d1 to its highest value)
- A0:** Fan & Alarm Differential- 0.1 to 20°
This is the temperature difference which must be present between the ON and OFF cycle of the alarms and fans.
- A1:** Maximum Alarm Temperature- 0.1 to 99.9°
The temperature added to the setpoint to enable the high alarm.
• High alarm turns ON when the ambient temperature probe \geq SET + A1.
• High alarm turns OFF when the ambient temperature probe \leq (SET + A1) - A0
- A2:** Minimum Alarm Temperature- 0.1 to 99.9°
The temperature subtracted from the setpoint to enable the low alarm.
• Low alarm turns ON when the ambient temperature probe \leq SET - A2
• Low alarm turns OFF when the ambient temperature probe \geq (SET - A2) + A0
- A3:** Alarm Exclusion Time after Continuous Cycle- 0.0 to 18.0 h-m*
Time elapsed during and after the continuous cycle that the temperature alarms will not activate.
- A4:** Alarm Exclusion Time After Defrost Cycle- 0.0 to 18.0 h-m*
Time during and after the defrost cycle that the temperature alarms will not activate.
- A5:** Alarm Exclusion Time after Door Open-0.0 to 18.0 h-m*
Time while the door is open (if A5 > 0) and after the door is closed (A5)

that the temperature alarms will not activate.

A6: Alarm Exclusion after Connection- 0.0 to 18 h-m*

Time after the connection of the switch that the temperature alarms will not activate.

A7: Temperature Alarm Time Validation- 0.0 to 18.0 h-m*

Time after the alarm indication disappears (when there is user verification of an internal alarm occurrence) when temperature alarms can be activated again.

A8: External Alarm Time Validation- 0.0 to 18.0 h-m*

Time after the alarm indication disappears (when there is user verification of an external alarm occurrence) when the alarm can be activated again.

* See notes at bottom of page 21 for description of parameter units.

F0: Fan Temperature Limit- -99.9 to 302° (Only for Series TST)

The temperature limit to control the fan with or without the compressor activated.

Refer to parameter r6 for further information.

If r6=off: The fan will activate when $d12 \geq F0$ (control probe \geq fan limit). Otherwise, the fan will stay inactive.

If r6=on: The fan will activate when $d12 \leq F0 - A0$ (control probe \leq fan limit - fan differential). The fan will turn off when $d12 \geq F0$ (control probe \geq fan limit).

If r6=com: The fan can only activate while the compressor is ON and $d12 \leq F0 - A0$ (control probe \leq fan limit - fan differential). The fan will turn off when the compressor is OFF.

F1: Fan Operation When Door Opened- no/yes (Only for Series TST)

Choose fan operation when the machine door is open.

no: The fan continues to run during regulation and continuous cycle when the door is open

yes: The fan stops running during regulation and continuous cycle when the door is open

c0: Minimum Compressor Stop Time- 0 to 240 minutes

Time between when the compressor stops and will start again.

c1: Continuous Cycle Time- 0 to 18.0 h-m*

The continuous cold cycle is a cycle to maintain connection to the compressor for cooling for a time c1. The cold cycle cannot start if the thermostat is in heating regulation mode (if $d0=in$), if defrost is being performed, or until time c0 expires.

c2: % ON of Fault Cycle- 0 to 100 percent

Percentage of time c3 that the compressor will be ON if the ambient probe (sd1) is broken.

c3: Cycle in Case of Fault- 0 to 60 minutes

If the ambient probe (sd1) is broken, the parameter c3 determines the cycle time (ton + toff) for a default regulation.

c3 = ton + toff The total default cycle time when the ambient probe is broken.

ton = (c2 * c3)/ 100 Time the compressor will be connected

toff = c3 – ton Time the compressor will not be connected

P0: Temperature Scale- °C/°F

Temperature scale (set in °C or °F from the factory).

P1: Ambient Probe Calibration- -20.0 to 20.0°

Magnitude of displacement for the ambient probe. P1 is a feature which can be used to offset the display to read a different value than the actual probe temperature. If the probe is not placed in the exact point that is to be measured, a standard thermometer can be used to adjust the difference and set the parameter P1 accordingly.

P2: Decimal Point-no/yes

View the probe values with or without decimal places (on temperatures lower than 100°).

P3: Probe to be Viewed- sd1/sd2

Select which probe (ambient or defrost) will be viewed normally on the display.

sd1: Ambient Probe

sd2: Defrost Probe

** See notes at bottom of page 21 for description of parameter units.*

P4: Number of Probes Connected to Thermostat- 1 or 2

Choose the number of probes to be used with the unit.

E0: Digital Configuration- off/Al/In/def/ndf

Digital input configuration when the switch is short circuited.

off: Digital input deactivated.

Al: The external alarm is active if input is short circuited.

In: Short circuited input implies “open door”, no short circuited input implies “closed door”. (If the door is open, use parameter F1 to stop the fan or H2 to stop the fan and compressor. This is only valid for regulation and continuous cycling).

def: If input is short circuited, defrosting order is initiated.

ndf: No defrosting will occur if input is short-circuited.

H0: Preset Parameter Configuration- 0 to 17

Choose a preset configuration of parameters.

Access parameter H0 and select the desired preset configuration.

Configurations can be viewed in Section 2.8. Press and hold SET for 8 seconds. “Pro” will appear on the display if successfully reconfigured;

“Erp” will appear if there is a configuration error. Once a configuration is selected, all other parameters can be customized. NOTE: Programming an H0 configuration will erase any previous changes to the parameters and restore all values to those given in Section 2.8. The preset configurations cannot be modified.

H1: Keyboard Protection- no/yes

To protect parameters with the RS-485 option, use H1 to “lock” keyboard.

yes: Keyboard protected. To modify the setpoint, control defrosting, and continuous cycling, enter password. The protection activates one

minute after the last key is pressed.

no: Keyboard not password protected.

H2: Service Stops Due to Digital Input- no/yes

Control the fan and compressor when the door of machine is open.

yes: During regulation and continuous cycling, if the door is open, the fan and compressor will stop.

no: Neither fan nor compressor will stop if the door is open.

H3: Minimum Connection Stop Time- 0 to 240 minutes

Time after powering unit until thermostat starts control.

H4: Address for Serial Communication- 0 to 999

Communication address to identify the unit when more than one is being used in a system.

H5: Code to Parameters- 0 to 999

Password protection code for changing parameters.

This code is set to 0 from the factory. To reset the password, press SET key when powering up the unit.

H6: Type of Probe- ptc or pt1

****Type of probe included with the unit. Do not modify.****

2.2 Keypad Operations

The keypad features three keys:



NOTE: To press SET and an additional key, follow the instructions below:

- Press SET
- Press the desired key
- Release SET
- Release the desired key

NOTE: To exit programming mode and return to normal operation from anywhere in the menu system, simply press SET+DOWN.

2.2.1 Set Point Programming

The setpoint is the only parameter which is not password-protected; however, it is limited by the range set by the parameters r1 and r2, which are password protected.

To modify the setpoint:

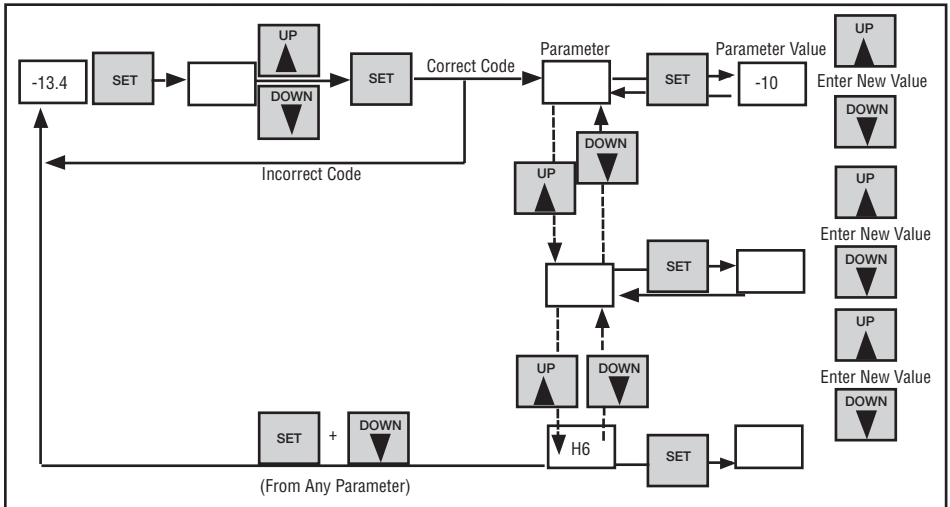
From normal temperature display:

- Press and release SET. Current setpoint value will flash.
- Press UP or DOWN to increase or decrease the setpoint value within the range r1 to r2.
- Press SET to confirm the new value.

2.2.2 Parameter Programming

- Press SET for 8 seconds. The value “0” flashes on the display.
 - Using UP and DOWN, enter the parameter code (password). This is set at “0” from the factory.
 - Press SET to confirm the code. If code is correct, the label of the first parameter will appear.
 - Using UP and DOWN, go to the desired parameter label from the list of parameters in Section 2.6.
 - Press SET to modify the parameter.
 - Using UP and DOWN, change the old value to the desired new value.
 - Press SET to confirm new the parameter value and reenter the parameter label list.
 - Press SET+DOWN to exit programming or wait one minute.

Flow Chart of Parameter Set-up



2.2.3 Choose a Preset Configuration

- Access parameter H0. (See Section 2.2.2, Parameter Programming.)
- Choose desired configuration.
- Press SET for 8 seconds. (Pro will appear on the display if configuration has been programmed or ErP if there is an error.)
- Press SET+DOWN to quit at any time or wait one minute.

2.2.4 Activate or Deactivate Defrost

- Press UP for 8 seconds on the keypad.
If defrost can be activated, DON will appear on display. If defrost cannot be activated, DOF will appear on display. If defrost is already activated, DOF will appear on the display and the cycle will finish.

2.2.5 Activate or Deactivate Continuous Cycle

- Press DOWN for 8 seconds on the keypad.

If the continuous cycle can be activated, CON will appear on display. If the continuous cycle cannot be activated, COF will appear on display. If the continuous cycle is already activated, COF will appear on the display and the cycle will finish.

2.2.6 View the Second Probe on Display

- Press SET+UP.

On the display, the temperature of the second probe will be shown alternating with the probe name (sd1 or sd2). See section 2.3.1 for more details.

2.2.7 Silence Alarm Output

- Press UP+DOWN.

If the alarm conditions continue or there is a memory or probe error, the output will deactivate automatically after the validation time, A7.

The alarm will automatically silence after one hour.

2.2.8 Resetting the Parameter Code (Password) to Zero

The code can be programmed to zero by turning off the controller, and turning it on again while the SET key is depressed.

2.2.9 Keyboard Protection (With RS485 Option Only)

The unit can be protected with parameter H1. When activated, activating/deactivating defrost and activating/deactivating continuous cold cycles will require pass code entry.

To temporarily cancel the protection, press SET for 8 seconds, enter the code and press SET+DOWN. Protection will resume one minute after the last key press.

2.3 Display Messages and Indications

2.3.1 Normal Operation

In normal operation the 'probe to be viewed' is shown on the display. This probe is called sd1. The other probe is called sd2. The probe to be viewed can be changed by accessing the P3 parameter.

2.3.2 Flashing Display

The display flashes when there is an error recording a parameter to memory or when awaiting confirmation of a value being programmed.

2.3.3 LED Indicators

- ***Out:** Compressor is connected.
- ***Def:** Defrost is activated.
- ***Fan:** Ventilator is connected (*only Series TST*).

*The LED "Out" will flash when a continuous cold cycle has to be initiated and must wait until the minimum compressor stop time, c0, has elapsed. The LED "def" will flash when the unit is waiting to initiate a defrost cycle.

2.3.4 Error and Alarm Messages

In normal operation, the probe to be viewed, P3, will be displayed.

The following messages can also appear:

- **Err:** Memory reading error
- **Erp:** Probe error not viewed on display
- **ALH:** High temperature alarm
- **ALL:** Low temperature alarm
- **ALE:** External alarm
- **AEH:** High and external alarm
- **ooo:** Probe open
- **- - -:** Probe short-circuited
- **DON:** Defrost cycle activated
- **DOF:** Defrost cycle deactivated or cannot be activated
- **CON:** Continuous cold cycle activated
- **COF:** Continuous cold cycle deactivated or cannot be activated
- **-d-:** Thermostat in defrost cycle

When viewing the second probe (the probe not chosen by P3), the value is alternated with the probe name, sd1 (ambient probe) or sd2 (defrost probe).

Front of Display of Series TSx



2.4 Digital Input Configuration

Every model has a digital input which is configurable with the E0 parameter. The options are:

- **off:** Digital input deactivated.
- **Al:** The external alarm is active if input is short circuited.
- **In:** Short circuited input implies “open door”, no short circuited input implies “closed door”. (If the door is open, use parameter F1 to stop the fan or H2 to stop the fan and compressor. This is only valid for regulation and continuous cycling).
- **def:** If input is short circuited, defrost order is initiated.
- **ndf:** No defrost will occur if input is short-circuited.

2.5 Quick Reference Control Operations

2.5.1 Limits of Modifying Setpoint (SET)

The setpoint can be adjusted between the minimum r1 (-99.9°) and the maximum r2 (302°).

2.5.2 Temperature Scale

With parameter P0, the temperature scale can be shown in degrees Celsius or Fahrenheit. Be sure that P0 is set to the same units (°F/°C) as shown on the face of the temperature switch.

2.5.3 Ambient Probe Calibration

P1 is a feature which can be used to offset the display to read a different value than the actual probe temperature. If the probe is not placed in the exact point that is to be measured, a standard thermometer can be used to adjust the difference and set the parameter P1 accordingly. This parameter can be adjusted from -20 to 20° and represents the magnitude of displacement for the ambient probe.

2.5.4 Decimal Points

With parameter P2, the probe temperatures can be displayed with (if temperature is below 100°) or without decimals.

2.5.5 Probe to View

Parameter P3 selects which probe will be viewed normally; the ambient probe (sd1) or the defrost probe (sd2).

2.5.6 Number of Probes

Parameter P4 is used to select the number of probes that will be used with the unit. Select between one and two probes.

2.5.7 Keyboard Protection

With H1, the user can block setpoint modification and activating/deactivating defrost or cold continuous cycles. This parameter can be accessed through the unit or the RS485 interface (applicable models only).

2.5.8 Delay Connection

Upon powering the unit, the switch starts controlling after time H3 has elapsed.

2.5.9 Address for Serial Communication

Parameter H4 is the address to identify a specific unit in a system via the RS-485 option and PC communication.

2.5.10 Keypad Code

Parameter H5 is the password/code to protect the parameters from being accidentally modified. This code can be set to "0" if the SET key is pressed when powering up the unit.

2.6 Control Operation

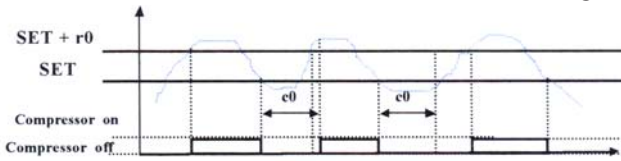
2.6.1 Cold Refrigeration Unit Control

Using the setpoint, the switch can control the temperature in the refrigeration unit. The thermostat will switch the compressor on and off in order to maintain the desired temperature. This process is called regulation. During the regulation process, defrost cycles can be calculated to remove the ice formed on the evaporator. Continuous cold cycles can be used to cool the refrigeration unit in a constant manner for a programmed time.

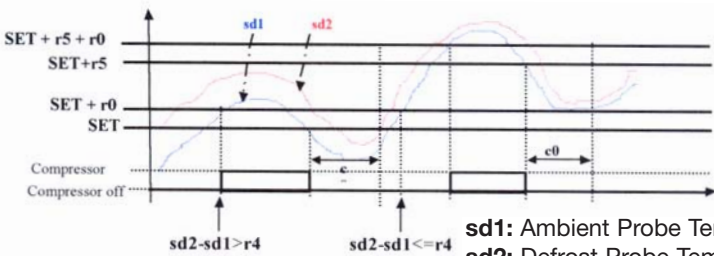
2.6.1.1 Regulation

Regulation is performed with the setpoint, SET. The compressor is connected when the ambient probe is greater than or equal to the setpoint plus differential ($sd1 \geq SET + r0$). The unit switches off when the ambient probe temperature is less than or equal to the setpoint ($sd1 \leq SET$). $r0$ is the differential and is a temperature compensation for connection of the compressor. $c0$ is the minimum compressor stop time. When the compressor stops, it will not connect again before time $c0$ has elapsed.

Differential regulation can also be chosen with parameter $r4$, the user-defined, critical temperature difference between the ambient and defrost probes. It is necessary to put the defrost probe ($sd2$) in the air input of the evaporator and the ambient probe ($sd1$) in the air output of the evaporator. If the temperature difference between the two probes is very large, the refrigeration unit is losing a lot of cool air. Use SET for regulation. However, if the difference between the two probes is not very large, the unit has not lost much cool air and regulation is performed with a higher temperature than SET. When regulated around the point $SET + r5$, energy is saved. To choose normal or differential regulation use parameter $r3$.



- SET:** Set Point
- sd1:** Ambient probe
- r0:** Differential
- c0:** Minimum compressor stop time



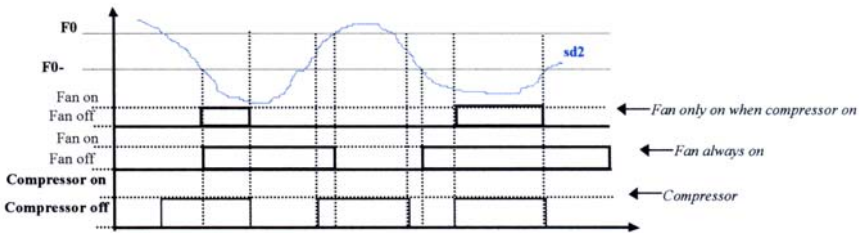
- sd1:** Ambient Probe Temperature
- sd2:** Defrost Probe Temperature
- r0:** Differential
- r4:** Critical temperature difference between $sd1$ & $sd2$; $r4 = SET + r5$
- r5:** Differential for Setpoint
- c0:** Minimum Compressor Stop Time

Fan Regulation for Series TST

There are three ways to operate the fan during regulation. This is chosen with parameter r6. Control the fan to be always OFF, always ON or only ON when compressor is activated.

- **off:** Fan always off
- **on:** Fan always on
- **com:** Fan switches on when compressor is activated

(If the unit is to be switched on and $d12 \geq F0$ (Temperature of the fan/defrost control probe \geq Fan stop temperature), the switch will not connect again until $d12 \leq F0 - A0$ (Temperature of the fan/defrost control probe \leq Fan stop temperature - fan/alarm differential))



sd2: Defrost Probe Temperature

d12: Fan & defrost control probe (sd1 or sd2)

A0: Temperature difference between alarm/fan ON and OFF cycle

F0: Temperature to control fan without activating compressor

2.6.1.2 Defrost cycle

The type of defrost control varies with each model. Parameter d0 defines the type of defrosting. Defrosting can be performed by only stopping the compressor, compressor stoppage and connecting a heating resistance in the defrosting relay, or by changing the cold cycle using an electro-valve in the defrosting regulation and connecting the compressor. While the Series TSD features heat control, the Series TSR and TST do not.

For TSD: Cooling or heating control

If **d0=re** : Cooling

If **d0=in** : Heating

For TSR, TST: Defrost with or without the compressor.

If **d0=re** : Defrost without connecting compressor

If **d0=in** : Defrost with connecting compressor

Select the ON/OFF differential (hysteresis) with parameter r0.

For TSD when d0 = re and for TSR and TST:

When ambient probe temperature $sd1 \geq$ Setpoint + r0: The output relay is "ON".

When ambient probe temperature $sd1 \leq \text{Setpoint}$: The output relay “OFF”.

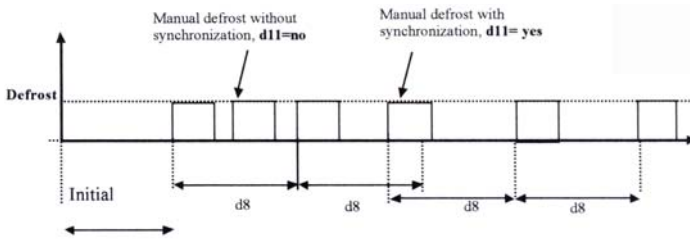
For TSD when d0 = in:

When ambient probe temperature $sd1 \leq \text{Setpoint} - r0$: The output relay is “ON”.

When ambient probe temperature $sd1 \geq \text{Setpoint}$: The output relay is “OFF”

Defrosts are periodically performed in intervals with parameter d8, Defrost interval time. (If d8=0 defrosts by time interval are not performed.) Upon switch connection, the first defrost is started after time d8 has elapsed. If d3=yes, the defrost cycle is delayed time d4 after connection.

Manual Defrost

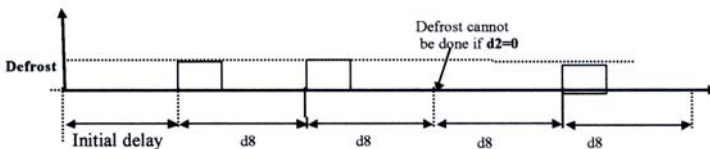


d8: Interval between defrosting
d11: Manual defrost synchronization

The parameter d11 allows the manual starting and stopping of defrost to be used with or without synchronization with the timed defrost parameter, d8. Manual defrost can be accomplished via the RS-485 interface or or by depressing UP for 8 seconds.

Defrost **cannot** be started if:

- The switch is performing a cold continuous cycle.
- The switch is in heating regulation mode.
- The switch is in automatic regulation (by memory error).
- Defrost cycle by digital input is disabled (see parameter E0).
- A defrost is already activated.
- The defrost probe temperature is greater than the defrost stop temperature ($sd2 \geq d1$).
- The maximum defrost time, d2, is zero (figure below).



d2: Maximum defrost time
d8: Interval between defrost cycles

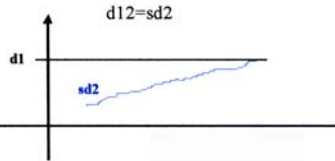
Defrost finishes when:

- End temperature of defrost cycle, $d1$, is reached (Figure 1 below).
- Maximum defrost time, $d2$, is reached (Figure 2 below).
- Manually ending the defrost cycle with the RS485 communication.

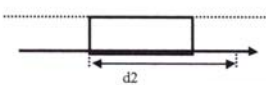
Figure 1



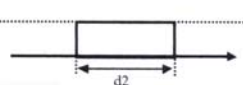
Figure 2



Defrost



Defrost



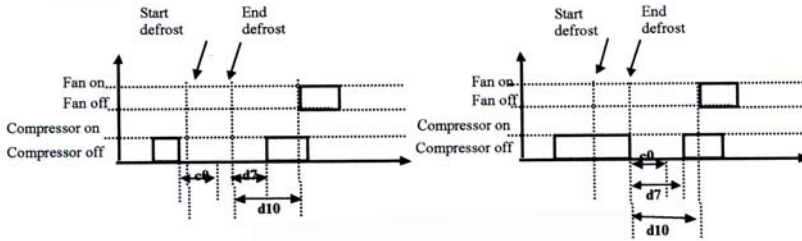
- d1:** Temperature defrost will end
- d2:** Maximum time for defrost cycle
- d12:** Defrost control probe
- sd2:** Defrost probe

Choose which probe will finish the defrost cycle with parameter $d12$. For the ambient probe, set $d12=sd1$; for the defrost probe, set $d12=sd2$. If there are two probes and the defrost cycle is to not be ended by the user, set $d1$ at the highest value.

During and after the defrost cycle, before the temperature at which the defrost cycle was started has been reached and the time $d6$ has not elapsed, several viewing options are available. It is possible to view ‘— d —’, the temperature at which the defrost cycle started, or the actual temperature. The different options of displaying the temperature during the defrost cycle are controlled by parameter $d5$.

- off: The actual temperature will be shown during defrost cycle.
- on: The temperature at which the defrost cycle started is frozen on the display until the end of defrost cycle or until $d6$ (display return time) elapses.
- d: A “-d-“ is displayed until the end of defrost cycle and when the temperature is \leq the initial temperature. The “-d-“ will disappear if $d6$ time elapses.

Once the defrost cycle has finished, the compressor will not start until a time $d7$ has elapsed, and the fan will not start until after a time $d10$.



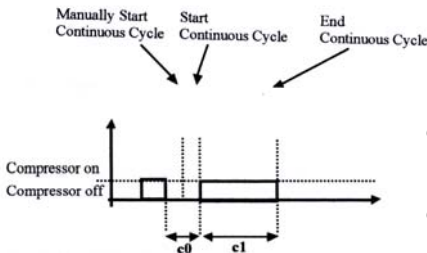
- c0:** Time elapsed after the compressor stops and is able to start running again
- d7:** Time after the defrost cycle ends before the compressor can be reconnected
- d10:** Time after defrost cycle until fan is reconnected.

2.6.1.3 Continuous Cold Cycle

The continuous cold cycle is to maintain connection to the compressor cooling for a time $c1$.

The cycle does not start if:

- The thermostat is in heating regulation mode (**when parameter $d0=in$ for TSD models only**).
- The thermostat is in automatic regulation (by memory error).
- A defrost is being performed.



- c0:** Time elapsed after the compressor stops and is able to start running again
- c1:** Time maintained connected to the compressor cooling (continuous cycle time)

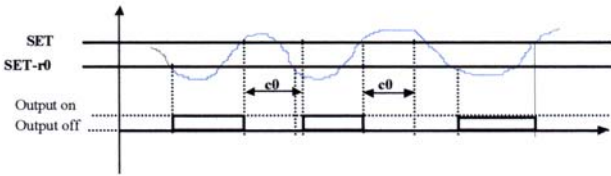
2.6.2 Heat Control (Series TSD only)

Heat control can only be used with the Series TSD. This function is

activated by programming the type of defrost cycle, $d0$, which should be set to "in".

Heat control only performs regulation cycles; neither defrost nor

continuous cycles exist. The output is activated when the temperature of the ambient probe is less than or equal to the setpoint (when $sd1 \leq SET$). The output deactivates when the temperature of the ambient probe is greater than or equal to the setpoint and remains deactivated until the probe temperature is less than or equal to the setpoint less the differential (when $SD1 \leq SET - r0$).



2.6.3 Defrost Probe (sd2) Breakage

If the defrost probe breaks and the unit is in differential regulation mode, it will change to normal regulation and use the ambient probe, sd1. If the probe is being used for programming the end of the defrost cycle and fan, the start and stop of the defrost cycle and fan cannot be properly performed.

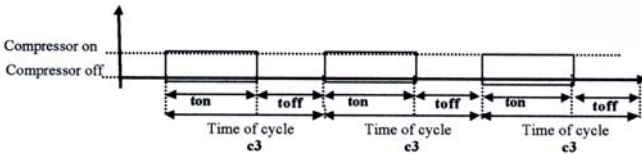
$$ton = \frac{c2 * c3}{100}$$

$$toff = c3 - ton$$

c2: 0-100 % of time c3 the compressor is on if sd1 is broken

c3: Total of ton and toff to determine default regulation when sd1 is broken

$$c3 = ton + toff$$



2.6.4 Ambient

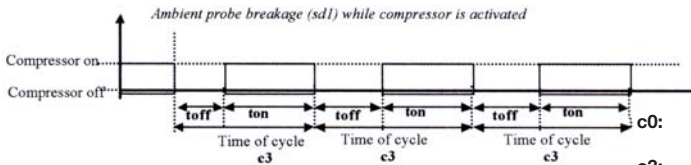
Probe (sd1) Breakage

If the ambient probe breaks, the switch will conduct a preprogrammed regulation. The compressor will connect for a time ton and will disconnect for a time toff. Parameter c3, cycle in case of fault, determines the time ton+toff. The parameter c2, % ON of fault cycle, determines the percentage of c3 that the compressor will be connected.

During the default regulation, defrost and continuous cycles can still be executed. If the probe is being used for programming the end of the defrost cycle and fan, the start and stop of the defrost cycle and fan cannot be properly performed.

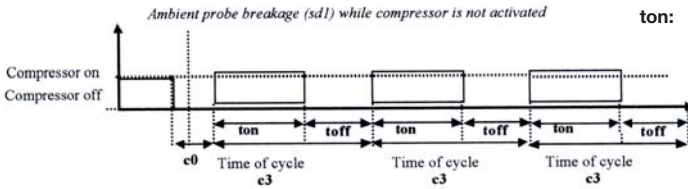
The regulation by default will start with the time of ton (Figure 1) or with the time of toff (Figure 2) depending on whether the compressor was connected or not when the fail of the probe occurred. If the ambient probe breaks during the minimum compressor stop time, c0, the default regulation will not begin until time c0 has elapsed.

Figure 1



- c0:** Time elapsed before compressor can run again.
- c3:** Total default cycle time when ambient probe is broken
- toff:** Time compressor will not be connected
- ton:** Time compressor will be connected

Figure 2



2.6.5 Memory Error

If a memory error occurs, the switch will perform an automatic regulation (the same as if a probe is broken). The compressor will connect for 5 minutes and disconnect for 5 minutes. In this case, the switch will perform neither defrost cycles nor cold continuous cycles.

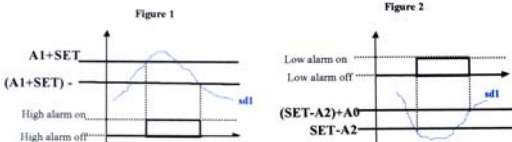
2.6.6 Temperature Alarms

If the ambient probe is greater than or equal to the desired temperature for the high alarm ($sd1 \geq A1 + SET$), the alarm will stay active until the temperature desired is reduced by the differential ($sd1 \leq (A1 + SET) - A0$).

This is shown in Figure 1.

If the ambient probe is less than the setpoint and minimum alarm temperature ($sd1 \leq SET - A2$), the low alarm will stay activated until the temperature is raised by the differential ($sd1 \geq (SET - A2) + A0$).

- SET:** Setpoint
- A0:** Alarm differential
- A1:** Maximum alarm temperature
- A2:** Minimum alarm temperature



After the alarm is activated, it will be displayed until the time A7, time of alarm verification, has elapsed. The alarm is indicated by a message on display and by activating the alarm output (applicable models only). The temperature alarms are excluded during the defrost and cold continuous cycles and during:

- A3 : Time after a continuous cycle.
- A4 : Time after the defrost cycle.
- A5 : Time elapsed while the door is open (if A5 > 0) and after the door is closed (A5) without temperature alarm activation.
- A6 : Time after connection of the switch.

Therefore, an alarm which would normally be produced will not start unless all of the afore-mentioned states are in exclusion. An alarm that has been activated, even if the 'time after alarm validation (A7)' elapses, will not have indication before all states of exclusion have passed. If the alarm situation ends during a state of exclusion, the alarm indication will not appear on the display.

The alarm indication can be deactivated manually by pressing UP+DOWN. The alarm will be shown again after time A7, the time after the alarm is verified that it can be activated again.

2.6.7 Probe or Memory Errors & Alarms

When an error is produced in the ambient probe, the defrost probe, or in the memory, the alarm is indicated by a message shown on display and activates an external alarm output (if the unit is purchased with the alarm option). To clear the message, it is necessary to press UP+DOWN. If the alarm situation persists after one hour, the alarm will be activated again.

2.6.8 External Alarms

If the digital input is configured as an alarm input, the external alarm will be indicated if this input is short-circuited. From the time the alarm condition is produced until it can be activated again time A8 will pass. The alarm is indicated by a message on the display and the activation of the alarm output (if the unit is purchased with the alarm option). When the alarm is being displayed, press UP+DOWN to remove indication manually. If time A8 has elapsed and the alarm condition continues, the alarm will be indicated again.

2.7 Parameter Specifications

	Parameter	Unit	Field	TSD	TSR	TST
SET	Setpoint	Degrees	r1 / r2	•	•	•
r0	Differential (Hysteresis)	Degrees	0.1 / 20.0	•	•	•
r1	Min. Value for Setpoint (1)	Degrees	-99.9 / r2	•	•	•
r2	Max. Value for Setpoint (1)	Degrees	r1 / 302	•	•	•
r3	Norm or Dif. Regulation Mode	Range	dif / nor	•	•	•
r4	Differential for Differential Mode	Degrees	0.1 / 20.0	•	•	•
r5	Differential Offset for Setpoint	Degrees	0.0 / 20.0	•	•	•
r6	Fan Operation During Regulation	Range	off / on/ con			•
d0	Type of Defrost Control** (Cooling/Heating)	Range	re /in	•	•	•
d1	Defrost Stop Temperature	Degrees	-99.9 / 302	•	•	•
d2	Maximum Defrost Time	Minutes	0 / 240	•	•	•
d3	Defrost After Connection	Range	no/yes	•	•	•
d4	Time Delay of First Defrost	h-m**	0 / 18.0	•	•	•
d5	Display During Defrost Cycle	Range	off/on/d	•	•	•
d6	Display Return Time	Minutes	0 / 240	•	•	•
d7	Compressor Drip Time (Reconnection)	Minutes	0 / 240	•	•	•
d8	Interval Time Between Defrost Cycles	h-m*	00.0 /18.0	•	•	•
d9	Fan Operation During Defrost Cycle	Range	no/yes			•
d10	Fan Drip Time (Time Until Reconnect)	Minutes	0 / 240			•
d11	Manual Defrost Synchronization	Range	no/yes	•	•	•
d12	Fan and Defrost Control Probe Selection	Range	sd1/sd2	•	•	•
A0	Fan and Alarm Differential	Degrees	0.1 / 20.0	•	•	•
A1	High Alarm Temperature	Degrees	0.1 / 99.9	•	•	•
A2	Low Alarm Temperature	Degrees	0.1 / 99.9	•	•	•
A3	Time After Continuous Cycle W/out Alarm	h-m*	0.0 /18.0	•	•	•
A4	Time After Defrost Cycle W/out Alarm W/out Alarm	h-m*	0.0 / 18.0	•	•	•
A5	Time After "Open Door" W/out Alarm	h-m*	0.0 / 18.0	•	•	•
A6	Time After Initial Connection W/out Alarm	h-m*	0.0 / 18.0	•	•	•
A7	Temperature Alarm Time Validation	h-m*	0.0 / 18.0	•	•	•
A8	External Alarm Validation Time	h-m*	0.0 / 18.0	•	•	•
F0	Fan Temperature Limit	Degrees	-99.9 / 302			•
F1	Fan Operation When "Door Opened"	Range	no/yes			•
c0	Minimum Compressor Stop Time	Minutes	0 / 240	•	•	•
c1	Continuous Cycle Time	h-m*	0 / 18.0	•	•	•
c2	% ON of Default Cycle	Number	0 / 100	•	•	•
c3	Total Default Cycle Time	Minutes	0 / 60	•	•	•
P0	Temperature Scale (Set from Factory)	Range	°C / °F	•	•	•
P1	Ambient Probe Calibration	Degrees	-20.0 / 20.0	•	•	•
P2	Decimal Point	Range	no/yes	•	•	•
P3	Probe to Display	Range	sd1 /sd2	•	•	•
P4	Number of Probes Used	Range	1/2	•	•	•
E0	Digital Configuration	Range	off//Al/In/def/ndf	•	•	•
H0	Record Parameter Configuration	Range	0 / 17	•	•	•
H1	Keyboard protection (only RS485 option)	Range	no/yes	•	•	•
H2	Operation with "Door Open"	Range	no/yes	•	•	•
H3	Minimum Connection Time	Minutes	0 / 240	•	•	•
H4	Address for Serial Communication	Number	0 / 999	•	•	•
H5	Password to Configure Parameters	Number	0 / 999	•	•	•
H6	Type of Probe (Set from Factory)	Range	ptc / pt1	•	•	•

(1) Refer to the setpoint

* h-m is in XX.Y format where XX is hours and Y represents tens of minutes (ex. 8.4 represents eight hours, 40 minutes).

** **Cooling / heating available on Series TSD only.**

2.8 Standard Configurations (*Parameter H0*)

Name	H0=0	H0=1	H0=2	H0=3	H0=4	H0=5	H0=6	H0=7	H0=8
SET	-20.0	2.0	-20.0	70.0	-4.0	36.0	-4.0	158	10.0
r0	1.0	1.0	1.0	5.0	1.0	1.0	1.0	10	5.0
r1	-30.0	-10.0	-30.0	0.0	-22.0	14.0	-22.0	32.0	-99.9
r2	10.0	15.0	10.0	100.0	50.0	59.0	50.0	212	302
r3	nor	nor	nor	----	nor	nor	nor	---	nor
r4	3.0	3.0	3.0	----	3.0	3.0	3.0	---	20.0
r5	3.0	3.0	3.0	----	3.0	3.0	3.0	---	20.0
r6	com	on	on	----	com	on	on	---	com
d0	in	re	re	in	in	re	re	in	re
d1	10.0	8.0	8.0	----	50.0	46.0	46.0	----	40.0
d2	15	30	30	----	15	30	30	----	10
d3	no	no	no	----	no	no	no	----	no
d4	0	0	0	----	0	0	0	----	0
d5	on	on	on	----	on	on	on	----	d
d6	15	15	15	----	15	15	15	----	0
d7	5	0	3	----	5	0	3	----	0
d8	4.0	6.0	6.0	----	4.0	6.0	6.0	----	0.1
d9	no	yes	yes	----	no	yes	yes	----	no
d10	5	0	0	----	5	0	0	----	0
d11	no	no	no	----	no	no	no	----	no
d12	sd2	sd2	sd2	----	sd2	sd2	sd2	----	sd2
A0	8.0	8.0	8.0	0.0	15.0	15.0	15.0	0.0	0.0
A1	9.0	9.0	9.0	9.0	16.0	16.0	16.0	16.0	20.0
A2	9.0	9.0	9.0	9.0	16.0	16.0	16.0	16.0	20.0
A3	0.1	0.1	0.1	----	0.1	0.1	0.1	----	0
A4	0.1	0.1	0.1	----	0.1	0.1	0.1	----	0
A5	0.1	0.1	0.1	----	0.1	0.1	0.1	----	0
A6	1.1	1.1	1.1	0.3	1.1	1.1	1.1	0.3	0
A7	1.1	1.1	1.1	0.1	1.1	1.1	1.1	0.1	0.1
A8	1.1	1.1	1.1	0.3	1.1	1.1	1.1	0.3	0
F0	10.0	8.0	8.0	----	50.0	46.0	46.0	----	50.0
F1	yes	yes	yes	----	yes	yes	yes	----	no
c0	1	1	1	----	1	1	1	----	0
c1	1.0	1.0	1.0	----	1.0	1.0	1.0	----	0.2
c2	70	50	70	50	70	50	70	50	50
c3	20	20	20	30	20	20	20	30	10
P0	°C	°C	°C	°C	°F	°F	°F	°F	°C
P1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P2	yes	yes	yes	yes	yes	yes	yes	yes	yes
P3	sd1	sd1	sd1	sd1	sd1	sd1	sd1	sd1	sd1
P4	2	2	2	1	2	2	2	1	2
E0	off	off	off	off	off	off	off	off	Al
H0	0	1	2	3	4	5	6	7	8
H1	no	no	no	no	no	no	no	no	no
H2	no	no	no	no	no	no	no	no	no
H3	0	0	0	0	0	0	0	0	0

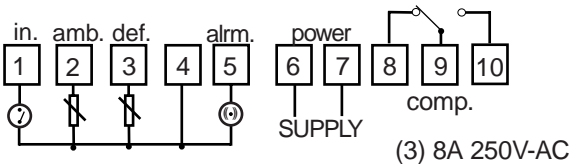
“-----“ Any choice of Parameter

3. TECHNICAL SPECIFICATIONS

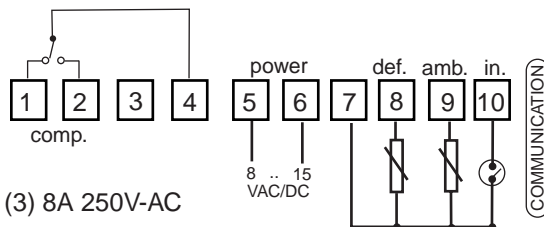
3.1 Series TSD (One Relay)

Power Supply	230VAC \pm 10%; 110VAC \pm 10% (models without communication) 12VAC/DC (models with RS485 communication)
Panel Mounting	Cutout: 71x29 mm
Ambient Temperature	32 to 158°F (0 to 70°C)
Storage Temperature	-4 to 176°F (-20 to 80°C)
Probe Range	-58 to 302°F (-50.0 to 150°C)
Accuracy	Better than 0.5 % of probe range
Resolution	\pm 0.1°C
Display	3-digit Red
Probes	Two 1.5" (4 cm)PTC thermistor with 5 ft (1.5 m) cable
Inputs	-Ambient probe -Defrost probe
Outputs	<ul style="list-style-type: none"> • 1 SPDT Relay [Imax=8A res. (3A ind); VAC max= 250V] • 1 Alarm Output of 5V [5mA max]
RS-485 Communication	Optional with Communication Card Model TS-4
Front Panel Protection	NEMA 4 (IP64)

TSD Wiring Diagram with Alarm



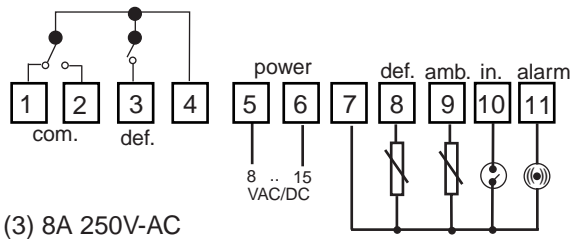
TSD Wiring Diagram with RS-485



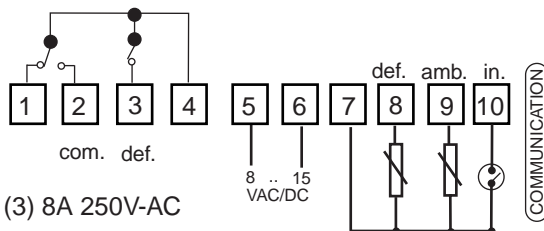
3.2 Series TSR (Two Relays)

Power supply	12VAC/DC
Panel mounting	Cutout: 71x29 mm
Ambient Temperature	32 to 158°F (0 to 70°C)
Storage Temperature	-4 to 176°F (-20 to 80°C)
Probe Range	-58 to 302°F (-50.0 to 150°C)
Accuracy	Better than 0.5 % of probe range
Resolution	±0.1 °C
Display	3-digits, Red
Probes	Two 1.5" (4 cm) PTC thermistor with 5 ft (1.5 m) cable
Inputs	-Ambient probe, -Defrost probe
Outputs	<ul style="list-style-type: none"> • 2 SPST Relays [$I_{max}=8A$ res. (3A ind); VAC max= 250V] • 1 Alarm Output of 5V [5mA max]
RS-485 Communication	Optional with RS-485 Communication Card TS-4
Front Panel Protection	NEMA 4 (IP64)

TSR Wiring Diagram with Alarm



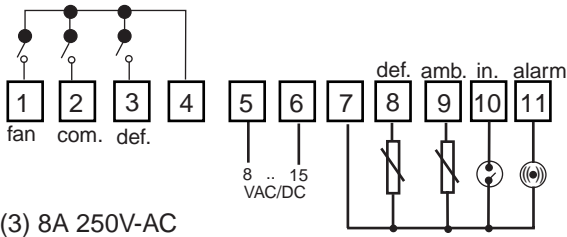
TSR Wiring Diagram with RS-485



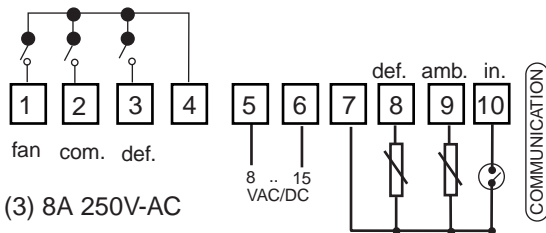
3.3 Series TST (Three Relays)

Power supply	12VAC/DC
Panel mounting	Cutout: 71x29 mm
Ambient Temperature	32 to 158°F (0 to 70°C)
Storage Temperature	-4 to 176°F (-20 to 80°C)
Probe Range	-58 to 302°F (-50.0 to 150°C)
Accuracy	Better than 0.5 % of probe range
Resolution	±0.1 °C
Display	3-digits, Red
Probes	Two 1.5" (4 cm)PTC thermistor with 5 ft (1.5 m) cable
Inputs	-Ambient probe, -Defrost probe
Outputs	<ul style="list-style-type: none"> • 3, SPST Relays [Imax=8A res. (3A ind); VAC max= 250V] • 1 Alarm Output of 5V [5mA max]
RS-485 Communication	Optional with RS-485 Communication Card TS-4
Front Panel Protection	NEMA 4 (IP64)

TST Wiring Diagram with Alarm



TST Wiring Diagram with RS-485



4. Maintenance / Repair

After final installation of the TSx Series Digital Temperature Switch, no routine maintenance is required. A periodic check of system calibration is recommended. The devices are not field-repairable and should be returned to the factory if service is required. After first obtaining a Returned Goods Authorization (RGA) number from a customer service representative, send the material, freight prepaid, to the following address. Please include a clear description of the problem plus any application information available.

Dwyer Instruments
Attn: Repair Department
102 Highway 212
Michigan City, IN 46360