

Thermal Runaway Detector/Preventer Rev 3.

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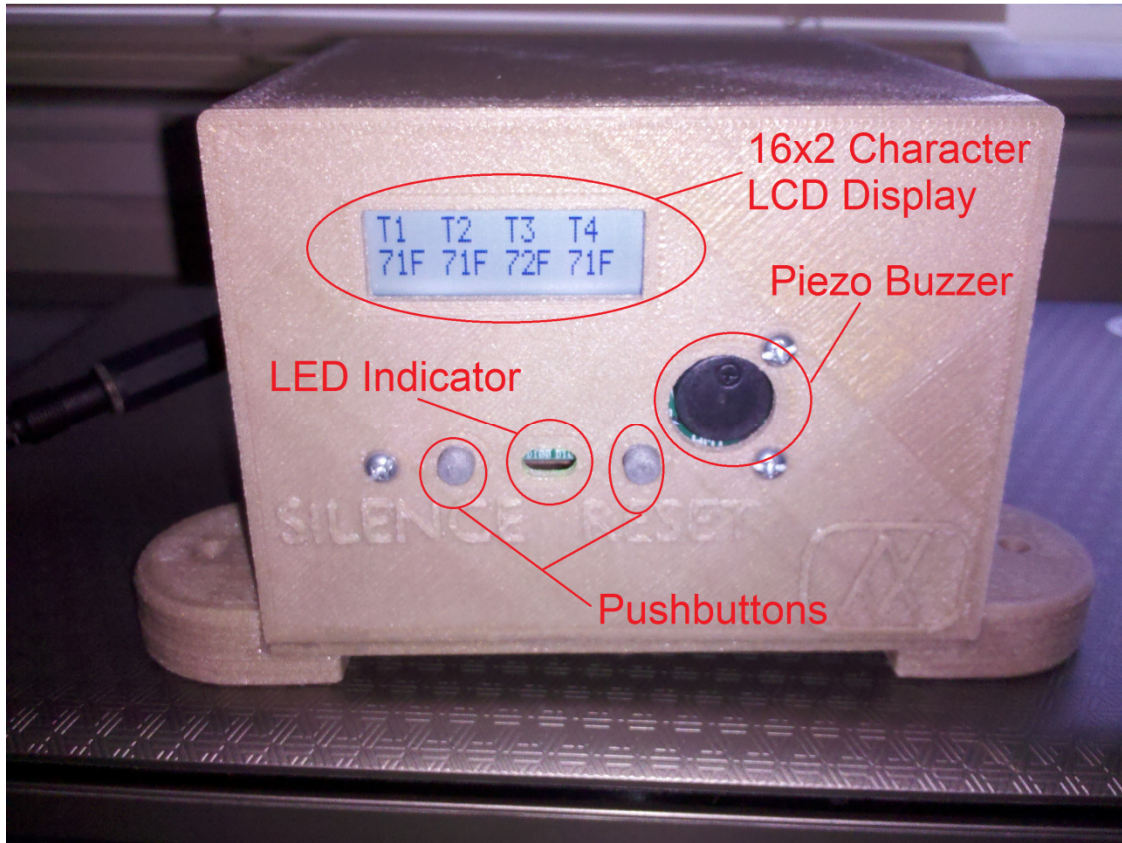
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Overview

The thermal runaway detector/preventer is a device that can monitor up to four temperature sensors and control the trip of up to four UVR battery breakers. The UVR circuits of the battery breakers are placed in series with the thermal runaway detector and the user can configure set points for controlling the alarm levels and trip points for the system. The system is designed so any one temperature sensor can control any number and combination of trip circuits. The thermal runaway detector can display either Celsius or Fahrenheit values for each of the active temperature sensors on the 16x2 character LCD display built into the unit. Two status LEDs and a piezo buzzer are used as visual and audio indicators for the status of the device. Two normally open dry contacts are also available to indicate whether a major alarm is or a trip situation is present on the device. A silence button and reset button are also provided for local control of the status relays and buzzer. The device set points, active channels, calibrations and units of measure are all configurable through a USB based serial port. All set points are stored in EEPROM memory to ensure the values will be retained during periods where power is not applied to the device. The serial port may be accessed through any terminal program such as HyperTerminal. Temperatures and alarm conditions are also available through the serial port. The entire device is controlled by a single ATmega328 Atmel microcontroller.

Product Pictures

The following is a picture of the front of the thermal runaway detector/interrupter:

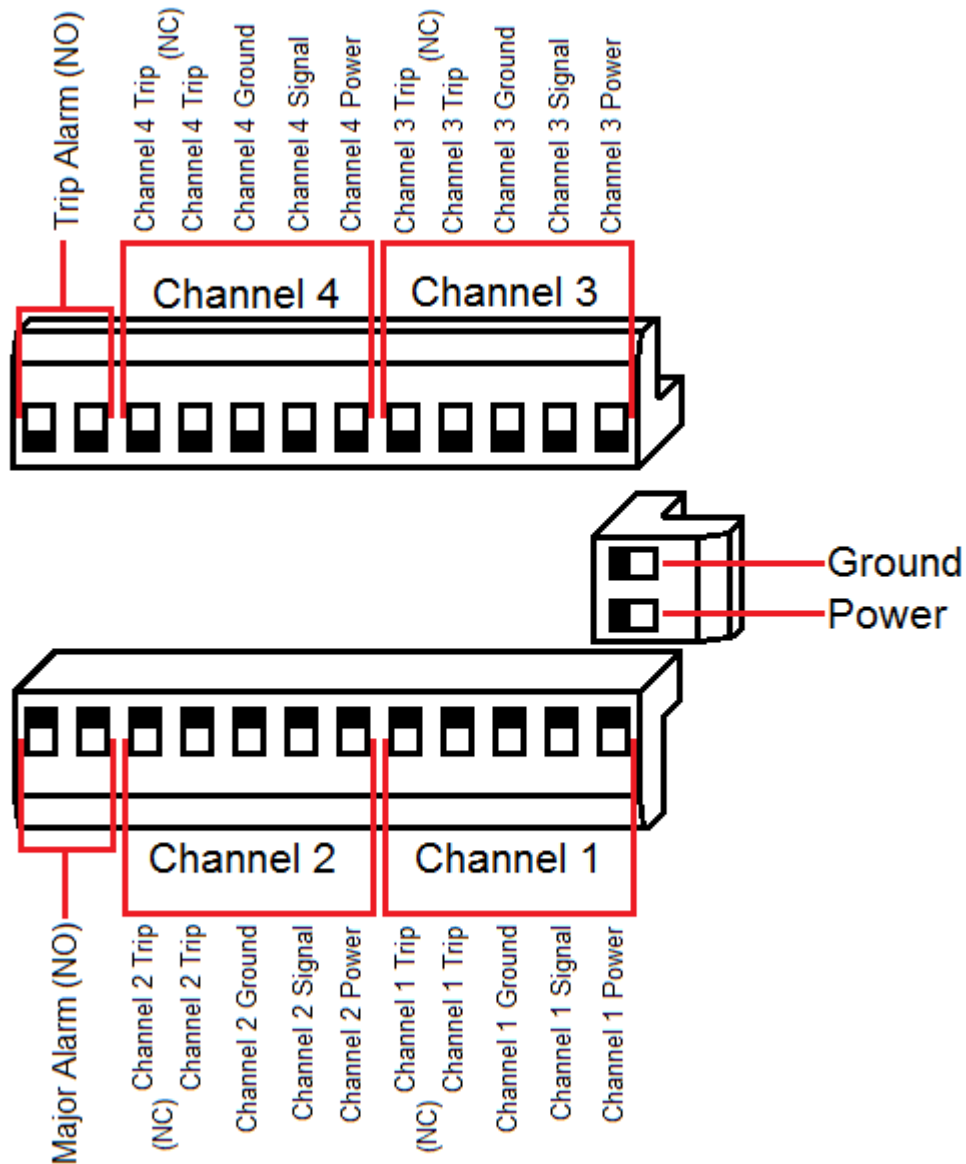


The following picture is of one of the temperature sensors in its carrier:



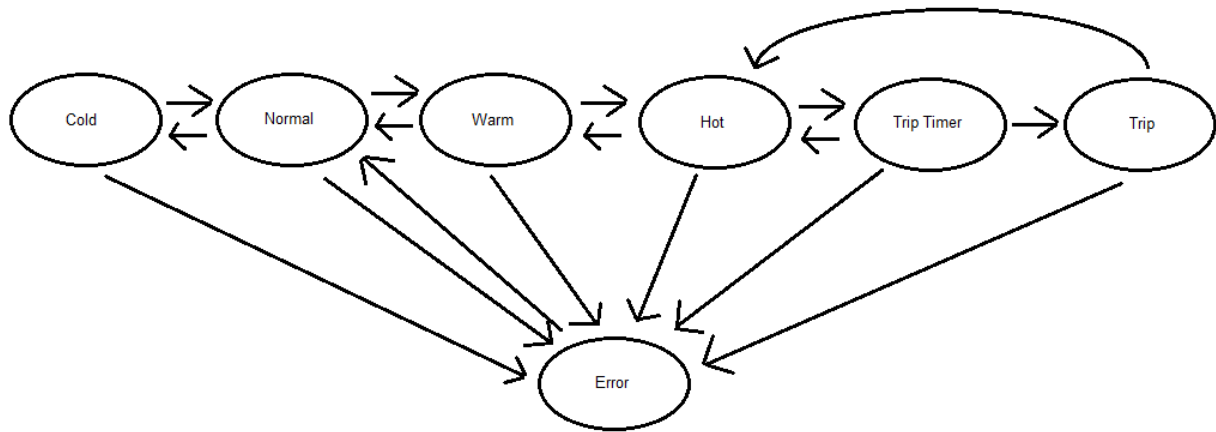
Terminal block connections

The following diagram shows the connections on the back of the device:



State Machine

The following is a simplified diagram of the state machine used in the device to control the alarms.



The “major alarm” dry contact will close when the device enters the “Hot” state. When the hot state is not active, the major alarm relay is open. The major alarm relay is non-latching.

The “Trip alarm” dry contact will close when the device enters the “Trip timer” state. The trip alarm will remain active until the “Reset” button is pressed on the front of the device. The trip alarm dry contact is latching and will stay active even after the device leaves the trip timer and trip states.

The “Error” state can be reached by any other state and is caused by a delta t calculation that is out of range. The delta t calculation is described in the terminal functions section of this document.

Each channel in the device has its own independent state machine as described above.

Terminal Functions

The thermal runaway detector/interrupter has a built in USB based serial port. The settings for the serial port are 9600, 8, N, 1, None. The terminal menu is brought up by pressing enter on a blank line. The terminal menu has the following format:

1. Channel 1 (E or D): Enabled
2. Channel 2 (E or D): Enabled
3. Channel 3 (E or D): Enabled
4. Channel 4 (E or D): Enabled
5. Channel 1 Calibration (+/-) (0 to 99): + 5
6. Channel 2 Calibration (+/-) (0 to 99): + 0
7. Channel 3 Calibration (+/-) (0 to 99): - 4
8. Channel 4 Calibration (+/-) (0 to 99): + 1
9. Trip Mask Channel 1 (0x00 to 0x0F): 01
10. Trip Mask Channel 2 (0x00 to 0x0F): 02
11. Trip Mask Channel 3 (0x00 to 0x0F): 04
12. Trip Mask Channel 4 (0x00 to 0x0F): 08
13. Units of Measure (C or F): Fahrenheit
14. Temperature Setpoint LOW (36 to 194): 50F
15. Temperature Setpoint COLD (36 to 194): 64F
16. Temperature Setpoint WARM (36 to 194): 86F
17. Temperature Setpoint HOT (36 to 194): 100F
18. Temperature Setpoint TRIP (36 to 194): 113F
19. Temperature Setpoint HIGH (36 to 194): 158F
20. Temperature Setpoint ERROR (1 to 999): 10
21. Reset to Factory Defaults

T1:74.2F T2:74.2F T3:74.2F T4:74.3F
Alarm1: NONE Alarm2: NONE
Alarm3: NONE Alarm4: NONE
Firmware Revision: 0.1

The follow is a description of the functions in the terminal menu. All letters typed into the terminal are case insensitive.

Selections 1 through 4 turn the individual channels on and off. Examples follow.

To enable channel 1, type into the terminal:

1(space)e(enter)

To disable channel 4, type:

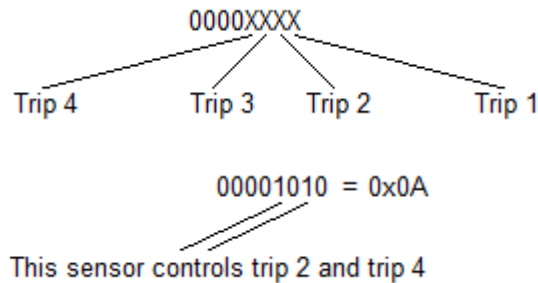
4(space)d(enter)

Selections 5 through 8 are used to calibrate the four channels. The values are ADC counts. For example, setting channel 2 to + 5 will increase the measured ADC value by 5 before a temperature is calculated. Setting channel 4 to - 15 will decrease the measured ADC value by 15 before a temperature is calculated. Examples follow. Notice a space is required between the +/- sign and the number.

6(space)+(space)2(enter)

7(space)-(space)13(enter)

Selections 9 through 12 determine which temperature sensors controls which relays. The trip mask is a hexadecimal representation of a binary bit mask. The bits should be set to 1 for all relays to be controlled by the given sensor. Below is a diagram showing which bits correspond to which sensors and the hexadecimal representation:



Example for temperature sensor 1 controlling trip 1, 2 and 4:

9(space)b(enter)

Example for temperature sensor 4 controlling trip 3 and 4:

12(space)0C(enter)

Notice a 0 may precede the hexadecimal value but is not required.

Selection 13 controls whether the units of measure are Celsius or Fahrenheit. The following example makes the units of measure Fahrenheit:

13(space)f(enter)

Selections 14 through 19 determine what the set points are for the state machine. The high and low values are the values that are out of range and generate an error if those temperatures are reached. If a sensor measures the values outside the low and high ranges, a minor error is reported. A trip will not be generated from a high reading.

This example sets the trip set point to 120F:

18(space)120(enter)

Selection 20 sets the delta t value between sensor readings that cause an error. The value is measured in ADC counts. The default is 10 ADC counts. This means that if the current reading is 10 counts greater or less than the previous reading, an error will be generated.

The following example sets the error value to 20 ADC counts:

20(space)20(enter)

Selection 21 resets all values to the default values. The only valid input for selection 21 is the following:

21(enter)

The temperature readings are displayed after the set points. The temperatures are displayed to $1/10^{\text{th}}$ of a degree to allow accurate calibration of the temperature sensors. Any alarms existing on the channels are displayed next. Finally, the firmware revision is displayed.

The terminal will provide feedback as to the status of the last request. "ERR" will be echoed back if the last request was incorrect and "OK" will be echoed back if the last request was successfully processed.