SR-54 Temperature Controller

Specification and User Manual

Laird™

THERMAL SYSTEMS

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Revision History

REV	DATE	DESCRIPTION	PAGE
1.0	051515		
1.1	040622	Updated manual to LTS Format	

Revision History

1. Introduction to TC-XX-SR-54

The TC-XX-SR-54 temperature controller is a microcontroller-based device that can be incorporated into a thermoelectric assembly (TEA) to add integrated temperature control. TC-XX-SR-54 is a bi-polar temperature controller for cooling/heating of thermoelectric assemblies requiring precise temperature control accuracy. The TC-XX-SR-54 has thermoelectric cooler module outputs, three programmable fan outputs, alarm output relay, alarm condition LEDs, three temperature sensor inputs. The parameters will be programmed at the factory according to the customer requirements. Custom configurations are available, however MOQ applies.

2. Contents

Contents in package should contain the following:
- TC-XX-SR-54
- TC-NTC1 (NTC thermistor)

3. Features

- Operation in cooling and heating mode.
- Available Regulation mode are ON/OFF or PID or Power.
- Input power range can accommodate 16 to 60 VDC, nominally 16 to 48 VDC.
- Preprogrammed setpoint/s at the factory according to the customer requirements.
- Connectors are available for fans, thermoelectric cooler modules, NTC thermistor sensors, overheating thermostat switch, alarms. Some features sold on custom configurations only.
- USB communication interface

4. Benefits

- Standalone operation.
- Control temperature, from –20°C to +100°C (-4 to +212°F) with the standard NTC sensor.
- Temperature resolution of max 0.13°C (-10°C to +50°C)
- Control Stability of ±0.13°C (-10°C to +50°C)
- Use with NTC sensors
- Three temperature sensor inputs
- Alarm relay output, normally closed (will open on alarm), normally open, common: 1A at 125VAC/110VDC
- Pulse width modulation available for thermoelectric output: (Base Frequency of 8kHz)
- Adjustable Fan Speed (Base frequency of 1KHz)
- Tachometer sensor inputs provided to measure the speed of two internal fans as well as external fan.
- Overheating thermostat switch input available to sense an over temperature condition and will turn off power to thermoelectric outputs, fans and microcontroller. An external overheat thermostat is required for operation.
- Alarm LED outputs available to indicate type of failure.
- The controller's temperature set point/s, regulation parameters, alarm configuration can be programmed at factory according to the requirements, please consult with Laird Thermal Systems.

5. Markets

- Medical diagnostics
- Analytical instrumentation
- Photonics laser systems
- Electronic enclosure cooling
- Chillers (liquid cooling)

6. Connections

Fig 1 shows the pinout for TC-XX-SR-54

- Apply power between VIN and GND_IN, with positive applied to VIN with respect to GND_IN
- If overheat thermostat is needed, connect one which can handle 15V, min of 0.5A current. A jumper wire needs to be connected between +15V OUT to 15V, if no overheat thermostat is required.
- Thermoelectric cooler modules are connected between TEM OUT A and TEM OUT B.

    If temperature measured by thermistor at Therm1 is more than set point, TEM OUT A is positive with respect to TEM OUT B

    If temperature measured by thermistor at Therm 1 is less than set point, TEM OUT B is positive with respect to TEM OUT A

- Fan connectors:

    External/Internal Fan 1/Internal fan 2: 4 wire fans can be connected. PWM output signal from controller is 15V, 1KHz signal, whose duty cycle can be changed as per the requirement from 0% to 100%
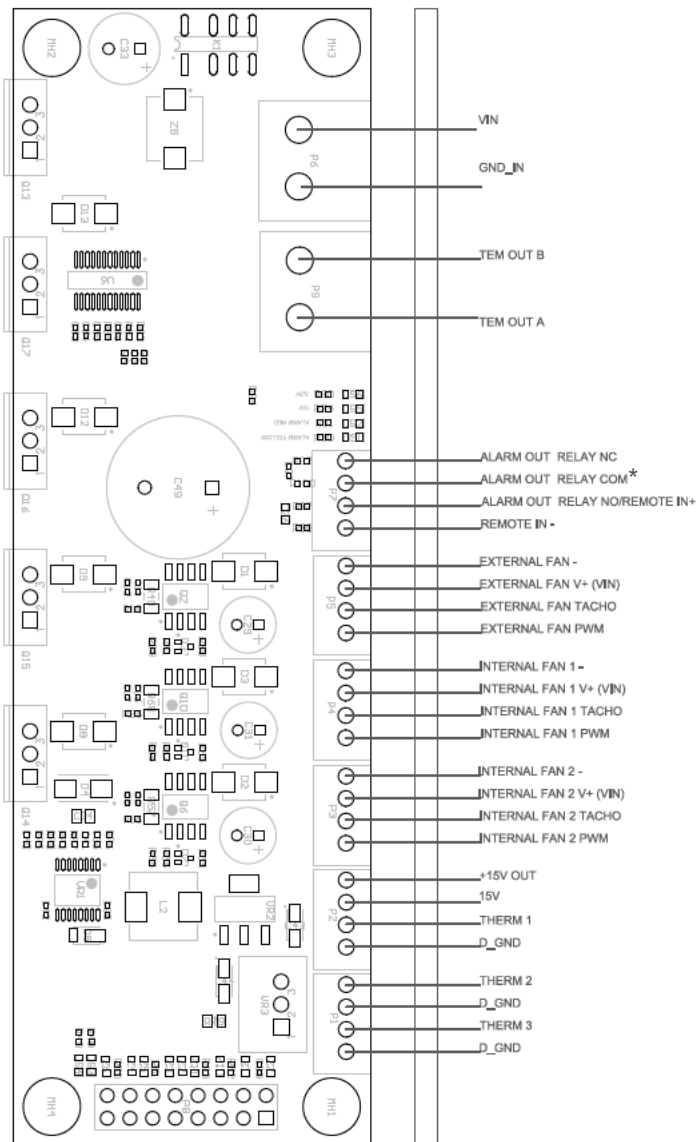
- Thermistors connections:

    For temperature sensor 1, thermistor is applied between THERM1 and D_GND
    For temperature sensor 2, thermistor is applied between THERM2 and D_GND
    For temperature sensor 3, thermistor is applied between THERM3 and D_GND

- Alarm Relay:

    NO, NC and COM pins for the relay are available

Note: If amperage exceeds 15 Amps it is recommended to incorporate external fan to circulate air over MOSFETs to keep them from overheating or connect an external heatsink.
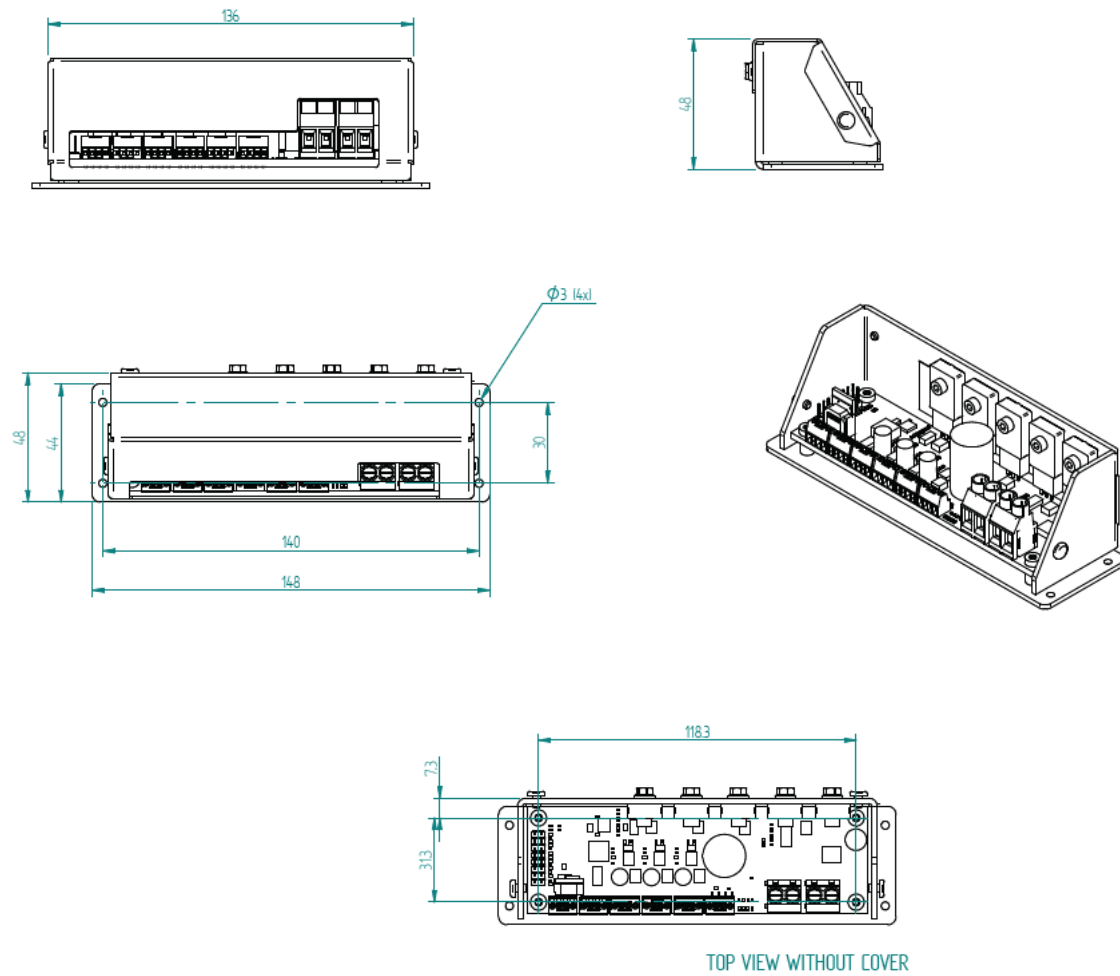
Fig 1. Pinout of TC-XX-SR-54

VIN
GND_IN
TEM OUT B
TEM OUT A
ALARM OUT RELAY NC
ALARM OUT RELAY COM*
ALARM OUT RELAY NO/REMOTE IN+
REMOTE IN -
EXTERNAL FAN -
EXTERNAL FAN V+ (VIN)
EXTERNAL FAN TACHO
EXTERNAL FAN PWM
INTERNAL FAN 1 -
INTERNAL FAN 1 V+ (VIN)
INTERNAL FAN 1 TACHO
INTERNAL FAN 1 PWM
INTERNAL FAN 2 -
INTERNAL FAN 2 V+ (VIN)
INTERNAL FAN 2 TACHO
INTERNAL FAN 2 PWM
+15V OUT
15V
THERM 1
D_GND
THERM 2
D_GND
THERM 3
D_GND

*Standard boards will come with 3 contacts Alarm out relay outputs and REMOTE IN feature is disabled.

7. Mounting

Controller comes with outer sheet metal casing with the cover to protect contents and dissipate heat generated from MOSFETS. The sheet metal casing has two 4.5 mm diameter through holes on the bottom. Mount onto system level wall with machine screws or standoffs.

Fig 2: Mounting for TC-XX-SR-54

TOP VIEW WITHOUT COVER

8. Specifications

TECHNICAL SPECIFICATIONS	
Power	
Voltage	16 to 60 VDC
Current	Max 20A Continuous at 50°C ambient at 28VDC
	Max 12A Continuous at 50°C ambient at 60VDC
Power	560W at 28VDC MAX, 720W at 60VDC Max
User Interface	
	Onboard Potentiometer
Sensors	
Temp Sensor	NTC Thermistor, 3 temperature sensor inputs available
Fan Internal Tachometer 1	Use with fans w/ an open collector tachometer
Fan Internal Tachometer 2	Use with fans w/ an open collector tachometer
Fan External Tachometer	Use with fans w/ an open collector tachometer
Outputs	
Thermoelectric Module	Max 15A Continuous @ 50°C ambient @ 28VDC Max 10A Continuous @ 50°C ambient @ 60VDC PWM output at 8KHz
Fan Internal 1	Max 1A Continuous @ 50°C ambient @ 28VDC Max 0.5A Continuous @ 50°C ambient @ 60VDC
Fan Internal 2	Max 1A Continuous @ 50°C ambient @ 28VDC Max 0.5A Continuous @ 50°C ambient @ 60VDC
PWM output for FANs	15V, 1KHz
Alarm Relay	**Default:** Relay with 3 contacts (NO,NC, COM) Contact max current is 1A at 125VAC/110VDC **Optional:** Optocouple isolated NO/NC: 2 contacts
Overheating Thermostat	External Overheating protection thermostat of 15V, 0.5A can be connected (optional)
LED	Status/Errors
Alarms	
Low Voltage	Alarms if the input voltage is lower than the programmed minimum level
High Voltage	Alarms if the input voltage is above the programmed maximum level
Battery Delimiter	Turns on the modules and fans only if battery voltage is above DELIM_H value and turns off everything if battery voltage drops below DELIM_L
Tachometer Int 1 & 2, Ext fan	If the RPM signal is lower/higher than the programmed minimum/maximum level, error is indicated and outputs can be turned off
Fan Failure/Missing	If fan rotor fails, fault is indicated
Fan Overcurrent	If fan draws over current, fault is indicated
Temperature Sensors 1,2/3 short/open/out of range	If the temperature sensors are short/open or out of range, fault is detected and outputs can be turned off
TEM Over Current/Missing	Fault is indicated and fans outputs can be turned of

Note: All programming of parameters is conducted by Laird Thermal Systems. For any or all of the above fault condition/s, controller can be programmed to trigger the alarm relay and TEM/ Fan outputs can be programmed to be turned off

| **Temperature Regulation**	
ON/OFF mode	Controller switches the TEM output between full power and zero power at the programmed set point and hysteresis
PID mode (single set point)	Controller can be selected to switch between P, PI, PD or PID modes
PID mode (dual set point)	Controller can be selected to switch between P, PI, PD or PID modes
Power mode	Depending on the value of external potentiometer the output can be controlled
Programmable Control Set Point/s	Can be programmed at any value between -40°C to +100°C
Temperature resolution	Max resolution of ± 0.13°C (set point range of -10°C to +50°C)
Accuracy	±0.5°C
Protection	
Over and under voltage	Yes
Reverse polarity	Yes
Self-start up test	For testing fans, modules and temperature sensor on startup (optional

9. Temperature Regulation

The regulator controls the main H-bridge output. The output is regulating the power and current direction through the Peltier modules connected. Below regulation modes are available and one of the below mode can be selected to get the best performance for your application:

9.1 OFF mode

Regulator will be off

9.2 ON/OFF mode

ON/OFF mode is used to simulate with two set points, dead band, and hysteresis around it. The output from the controller will be full power outside the setpoint range (temperature more than setpoint 2 and temperature below setpoint 1) and zero power within the range (between setpoint 1 and setpoint 2)
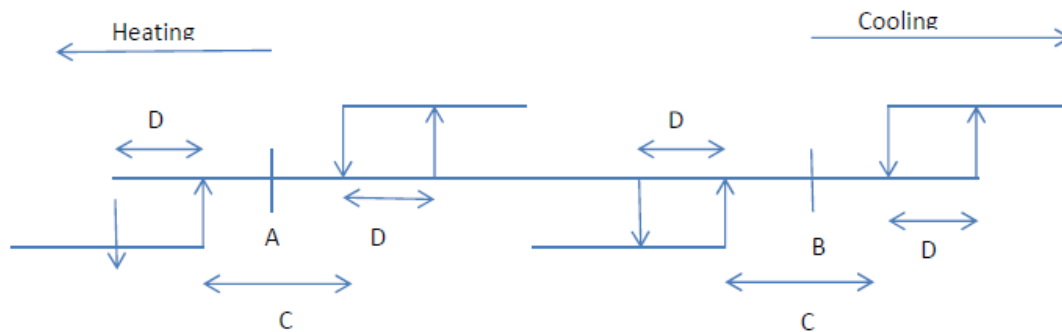
A= Setpoint 1 -40°C to 100°C

B= Setpoint 2 -40°C to 100°C

C= Deadband 0% to 50% of output

D= Hysteresis 0°C to 10°C

Fig 3: ON/OFF mode

9.2 PID mode (single set point)

This mode can be used for maintaining the temperature around a single setpoint, with following programmable parameters: setpoint, deadband around the setpoint, proportional constant, integral constant and derivative constant.

Refer to fig 4 for reference

Error (Te) = Setpoint- measured temperature

Sampling speed is 250Hz
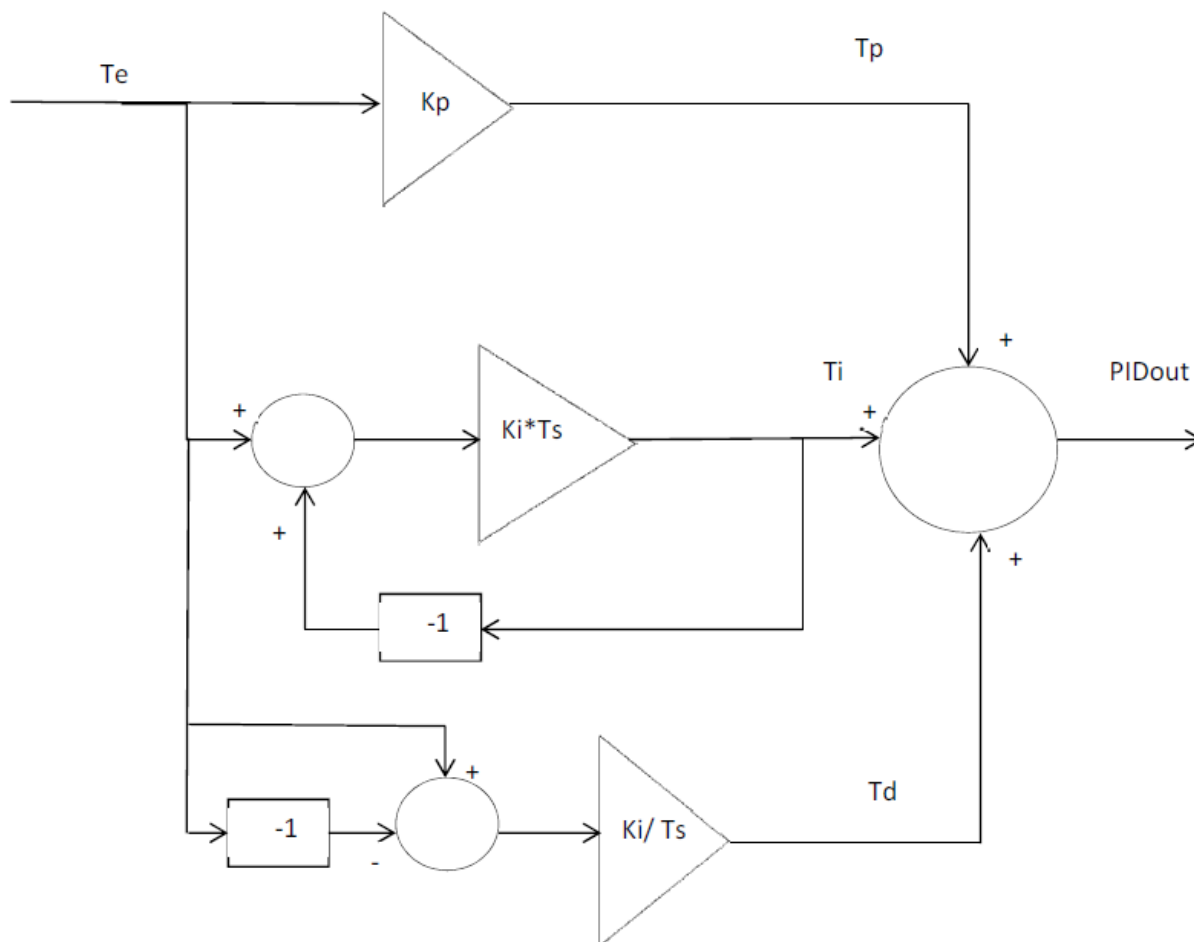
Ts = 0.004seconds

PID = Tp+Ti+Td

Fig 4: PID mode

9.3 Hysteric PID mode (dual set points)

This mode can be used for maintaining the temperature within a particular range, with following programmable parameters: setpoint1, setpoint 2, hystereis around the setpoints, proportional constant, integral constant and derivative constant.

Fig 4 loop is used to maintain the temperature within the specified range. The advantage of this mode with respect to the ON/OFF mode is the transition from off mode to ON mode is gradual and power consumption is less because of PWM signal.

9.4 Power mode

This mode is used to directly control the output power. This can be useful when determining the response of your system. You can connect an external power supply (0 to 3.3V) to V_POT signal (pin 10) with respect to D_GND (pin5) available on the 16 pin connector, where, 0V = -100%, 1.6V =0%and 3.2V=100%, with the output being linear between -100% to +100%(0 to 3.2V). The output is zero between -10% to +10% (deadband)

10. Fan Regulation modes

10.1 Always OFF

The fan is always off

10.2: Always ON

The fan is always ON

10.3 Cool Mode

Fan will be on at full speed when in cooling mode

10.4 Heat mode

Fan will be on at full speed in heating mode

10.5 PWM speed: Always ON

The fan will be always on running at programmed percentage of the full speed

10.6: PWM speed: Cool Mode (Only External Fan)

The external fan can be programmed to run at the specified percentage of full speed when in cooling mode

10.7: PWM speed: Heat Mode (Only External Fan)

The external fan can be programmed to run at the specified percentage of full speed when in heating mode

11. Alarms

11.1 Alarm Conditions

Controller can be programmed to turn TEM off or Fans off or all off under any alarm condition/s. Also the Alarm relay switches from normally open to normally close under Alarm condition

Low Voltage	Alarms if voltage is lower than programmed minimum level
High Voltage	Alarms if voltage is higher than programmed level
Battery Delimiter_HIGH*	Alarms if input voltage is above DELIM_H value at power on
Battery Delimiter_LOW*	Alarms if input voltage is below DELIM_L value at power on
Fan speed low (Int Fan 1 & 2, Ext Fan	Alarms if the fan speed is lower than the programmed level
Fan speed high (Int Fan 1 & 2, Ext Fan	Alarms if the fan speed is higher than the programmed level
Fan Failure/Missing (Int Fan 1 & 2, Ext Fan	Alarms if fan rotor fails/is locked
Fan Overcurrent (Int Fan 1 & 2, Ext Fan	Alarms if fan current is more than the programmed level
Temperature short (THERM 1/2/3	Alarms if the temperature sensor is short
Temperature open (THERM 1/2/3	Alarms if the temperature sensor is open
Under temperature/Over Temperature (THERM 1/2/3)	Alarms if the temperature sensor is out of programmed range, under temperature or over temperature

Thermoelectric module (TEM) Over Current	Alarms if TEM current is more than the programmed level
Thermoelectric module (TEM) Missing	Alarms if TEM is missing /open

Note: All programming of parameters is conducted by Laird Thermal Systems.

*Battery Demiliter is used in case when the controller/assembly is operated by battery.

Battery Delimiter High alarm is if the battery is over charged, but the battery voltage is still less than the programmed high at turn on

Battery Delimiter Low alarm is if the battery is under charged, but the battery voltage is more than the programmed low voltage at turn on

11.2 Alarm and Power LEDS

Fault condition and power to the board are indicated by LEDS on the TC-XX-SR-54. Starting from Left hand side below are the LEDs: Alarm Yellow LED, Alarm Red LED, 15V LED, 3.3V LED.

1. Normal condition:

    a. ALARM YELLOW LED: OFF
    b. ALARM RED LED: OFF
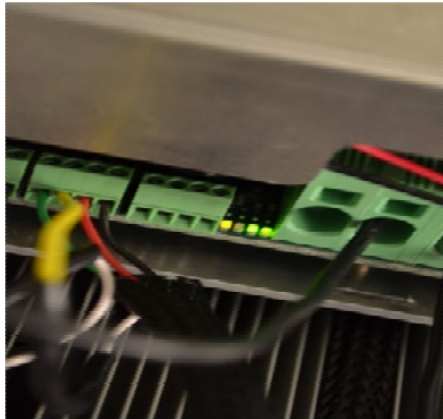   c. 15V LED: On/Green
    d. 3.3V LED: ON/Green

2. Fan fault condition (Internal Fan 1 or Internal Fan 2 or External Fan):

    a. ALARM YELLOW LED: OFF
    b. ALARM RED LED: ON/RED
    c. 15V LED: On/Green
    d. 3.3V LED: ON/Green
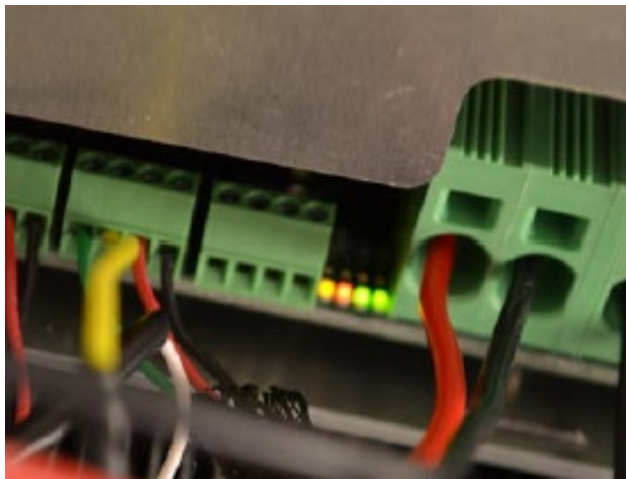
3. TEM fault condition:

    a. ALARM YELLOW LED: ON/YELLOW
    b. ALARM RED LED: OFF
    c. 15V LED: On/Green
    d. 3.3V LED: ON/Green

4. Temp sensor fault condition:

    a. ALARM YELLOW LED: ON/YELLOW
    b. ALARM RED LED: ON/RED
    c. 15V LED: On/Green
    d. 3.3V LED: ON/Green

12. External interface

USB signals are available on the 16-pin connector to connect to PC. When connected to PC a virtual COM port can be detected. The recommended baud rate is 115200, 8 bits, no parity, 1 stop bit, Enter Key Emulation: CR only
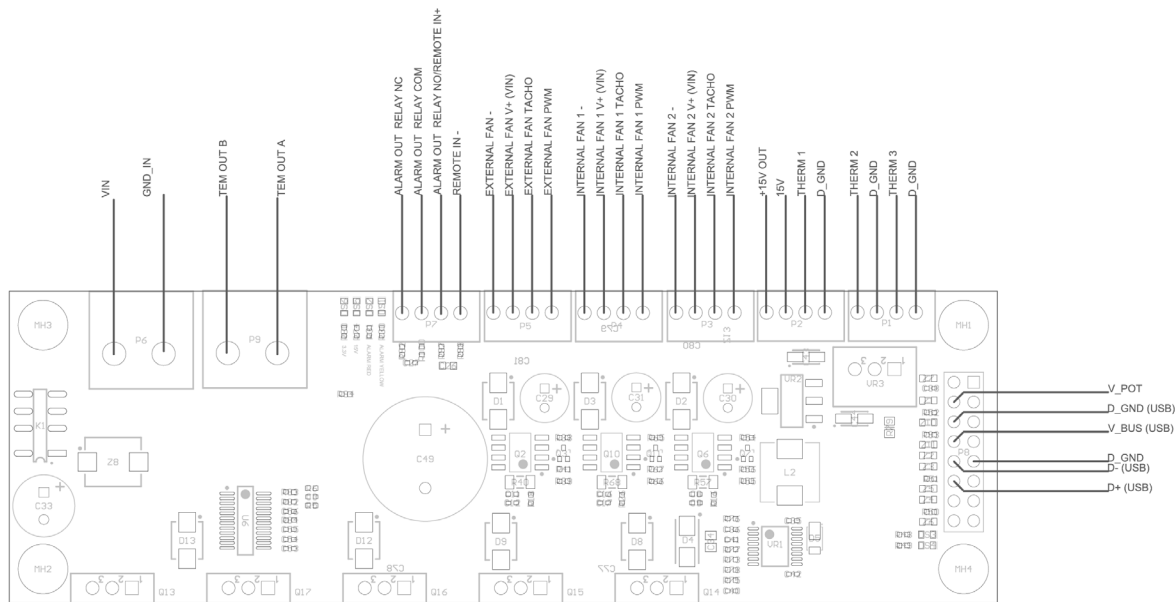

Fig 5: Pinout with USB signals and external potentiometer connections

About Laird Thermal Systems

Laird Thermal Systems develops thermal management solutions for demanding applications across global medical, industrial, transportation and telecommunications markets. We manufacture one of the most diverse product portfolios in the industry ranging from active thermoelectric coolers and assemblies to temperature controllers and liquid cooling systems. Our engineers use advanced thermal modeling and management techniques to solve complex heat and temperature control problems. By offering a broad range of design, prototyping and in-house testing capabilities, we partner closely with our customers across the entire product development lifecycle to reduce risk and accelerate their time-to-market. Our global manufacturing and support resources help customers maximize productivity, uptime, performance and product quality. Laird Thermal Systems is the optimum choice for standard or custom thermal solutions. Learn more by visiting www.lairdthermal.com.

Contact Laird Thermal Systems

Have a question or need more information about Laird Thermal Systems? Please contact us via the website www.lairdthermal.com.

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