RedLab TC

USB-based 8-channel Thermocouple Input Module

User's Guide

MEILHAUS ELECTRONIC

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USB-based 8-Channel Thermocouple Input Module

User's Guide

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About this User's Guide

What you will learn from this user's guide

This user's guide explains how to install, configure, and use the RedLab TC so that you get the most out of its USB-based temperature measurement features.

This user's guide also refers you to related documents available on our web site, and to technical support resources.

Conventions in this user's guide

> **For more information on …**
> Text presented in a box signifies additional information and helpful hints related to the subject matter you are reading.

Caution! Shaded caution statements present information to help you avoid injuring yourself and others, damaging your hardware, or losing your data.

<#:#>   Angle brackets that enclose numbers separated by a colon signify a range of numbers, such as those assigned to registers, bit settings, etc.

bold text   **Bold** text is used for the names of objects on the screen, such as buttons, text boxes, and check boxes. For example:
1. Insert the disk or CD and click the **OK** button.

italic text   *Italic* text is used for the names of manuals and help topic titles, and to emphasize a word or phrase. For example:
The *Insta*Cal installation procedure is explained in the *Quick Start Guide*.
Never touch the exposed pins or circuit connections on the board.

Where to find more information

The following electronic documents provide helpful information relevant to the operation of the RedLab TC.

- The *Quick Start Guide* is available on our RedLab CD in the root directory.
- The *Guide to Signal Connections* is available on our RedLab CD under „ICalUL\Documents".
- The *Universal Library User's Guide* is available on our RedLab CD under „ICalUL\Documents".
- The *Universal Library Function Reference* is available on our RedLab CD under „ICalUL\Documents".
- The *Universal Library for LabVIEW™ User's Guide* is available on our RedLab CD under „ICalUL\Documents".

Introducing the RedLab TC

Overview: RedLab TC features

This user's guide contains all of the information you need to connect the RedLab TC to your computer and to the signals you want to measure.

The RedLab TC is a USB 2.0 full-speed, thermocouple input module that is supported under popular Microsoft® Windows® operating systems. The RedLab TC is fully compatible with both USB 1.1 and USB 2.0 ports.

The RedLab TC provides eight differential thermocouple input channels. Eight independent, TTL-compatible digital I/O channels are provided to monitor TTL-level inputs, communicate with external devices, and to generate alarms. The digital I/O channels are software programmable for input or output.

With the RedLab TC, you can take measurements from type J, K, R, S, T, N, E, and B thermocouples.

The RedLab TC provides two integrated cold junction compensation (CJC) sensors for thermocouple measurements.

An open thermocouple detection feature lets you detect a broken thermocouple. An on-board microprocessor automatically linearizes the measurement data.

The RedLab TC is a standalone plug-and-play module which draws power from the USB cable. No external power supply is required. All configurable options are software programmable.

The RedLab TC is fully software calibrated.

RedLab TC block diagram

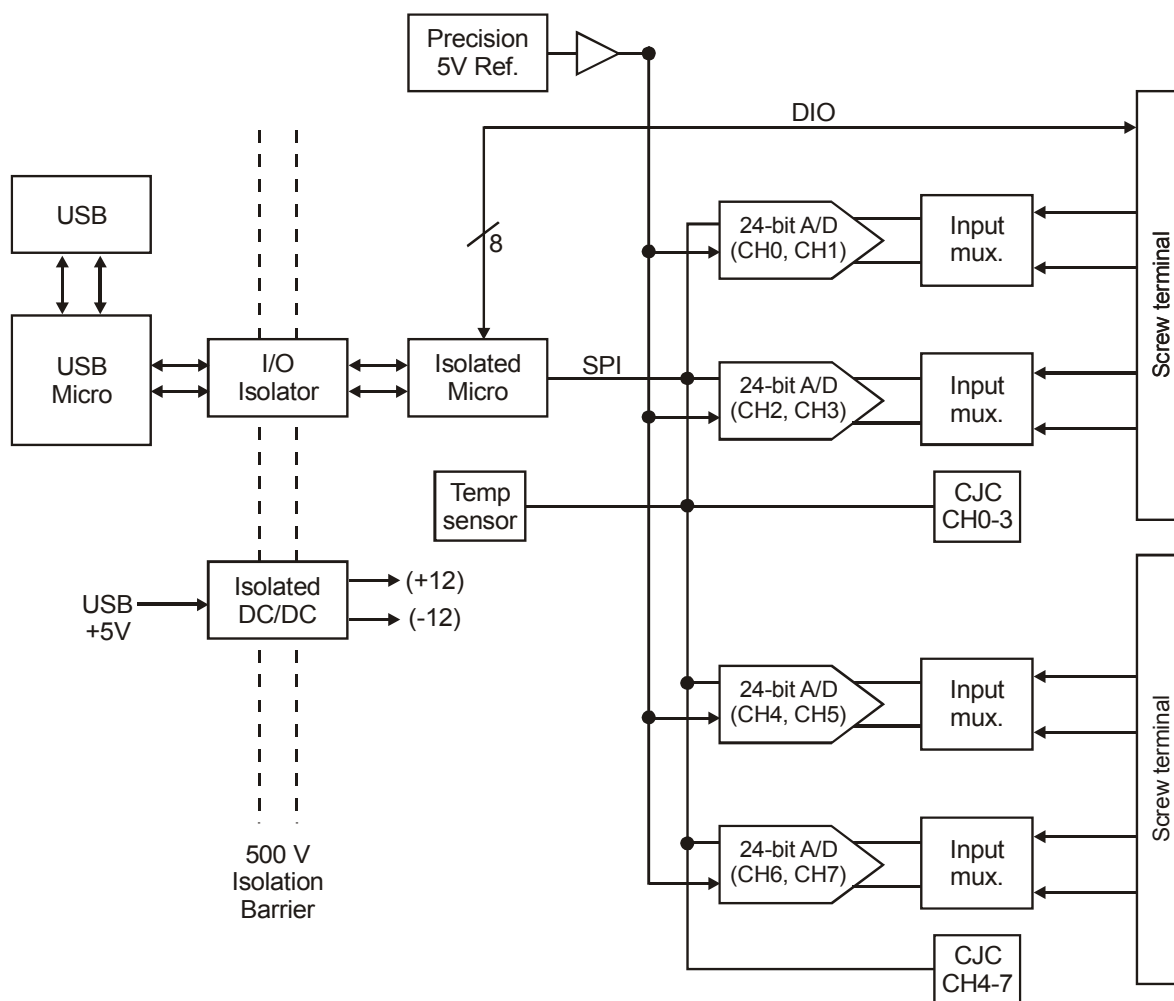RedLab TC functions are illustrated in the block diagram shown here.

Figure 1. RedLab TC functional block diagram

Software features

For information on the features of *Insta*Cal and the other software included with your RedLab TC, refer to the *Quick Start Guide* that shipped with your device. The *Quick Start Guide* is also available in PDF on our RedLab CD (root directory).

Connecting a RedLab TC to your computer is easy

Installing a data acquisition device has never been easier.

- The RedLab TC relies upon the Microsoft Human Interface Device (HID) class drivers. The HID class drivers ship with every copy of Windows that is designed to work with USB ports. We use the Microsoft HID because it is a standard, and its performance delivers full control and maximizes data transfer rates for your RedLab TC. No third-party device driver is required.

- The RedLab TC is plug-and-play. There are no jumpers to position, DIP switches to set, or interrupts to configure.

- You can connect the RedLab TC before or after you install the software, and without powering down your computer first. When you connect an HID to your system, your computer automatically detects it and configures the necessary software. You can connect and power multiple HID peripherals to your system using a USB hub.

- You can connect your system to various devices using a standard four-wire cable. The USB connector replaces the serial and parallel port connectors with one standardized plug and port combination.

- You do not need a separate power supply module. The USB automatically delivers the electrical power required by each peripheral connected to your system.

- Data can flow two ways between a computer and peripheral over USB connections.

Installing the RedLab TC

What comes with your RedLab TC shipment?

The following items are shipped with the RedLab TC.

Hardware

- RedLab TC

- USB cable (2 meter length)

Additional documentation

In addition to this hardware user's guide, you should also receive the *Quick Start Guide* (available on our RedLab CD (root directory)). This booklet supplies a brief description of the software you received with your RedLab TC and information regarding installation of that software. Please read this booklet completely before installing any software or hardware.

Unpacking the RedLab TC

As with any electronic device, you should take care while handling to avoid damage from static electricity. Before removing the RedLab TC from its packaging, ground yourself using a wrist strap or by simply touching the computer chassis or other grounded object to eliminate any stored static charge.

If your RedLab TC is damaged, notify Meilhaus Electronic immediately by phone, fax, or e-mail. For international customers, contact your local distributor where you purchased the RedLab TC.

- Phone: +49 (0) 8141/5271-188
- Fax: +49 (0) 8141/5271-169
- E-Mail: support@meilhaus.com

Installing the software

Refer to the *Quick Start Guide* for instructions on installing the software *Guide* (available on our RedLab CD (root directory)).

Installing the RedLab TC

To connect the RedLab TC to your system, turn your computer on, and connect the USB cable to a USB port on your computer or to an external USB hub that is connected to your computer. The USB cable provides power and communication to the RedLab TC.

When you connect the RedLab TC (follow illustrations: USB-TC) for the first time, a **Found New Hardware** popup balloon (Windows XP) or dialog (other Windows versions) opens as the RedLab TC is detected.
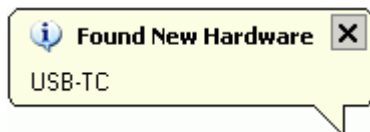
When this balloon or dialog closes, the installation is complete. The **USB LED** should flash and then remain lit. This indicates that communication is established between the RedLab TC and your computer.

Caution!   Do not disconnect **any** device from the USB bus while the computer is communicating with the RedLab TC, or you may lose data and/or your ability to communicate with the RedLab TC.

If the LED turns off

If the LED is lit but then turns off, the computer has lost communication with the RedLab TC. To restore communication, disconnect the USB cable from the computer, and then reconnect it. This should restore communication, and the LED should turn back *on*.

Configuring the RedLab TC

All hardware configuration options on the RedLab TC are programmable with software. Use *Insta*Cal to set the thermocouple type for each channel pair. Configuration options are stored on the RedLab TC 's isolated microcontroller in EEPROM, which is non-volatile memory on the RedLab TC module. Configuration options are loaded on power up. The factory default configuration is *Type J* thermocouple.

Allow the RedLab TC to warm up for 30 minutes after powering up before taking measurements. This warm up time minimizes thermal drift and achieves the specified rated accuracy of measurements.

Calibrating the RedLab TC

The RedLab TC is fully calibrated via *Insta*Cal. Allow a 30 minute warm up before calibrating.

Sensor Connections

The RedLab TC supports type J, K, R, S, T, N, E, and B thermocouples.

Thermocouple selection

The thermocouple type you select will depend on your application needs. Review the temperature ranges and accuracies of each type to determine which is best suited for your application.

Screw terminal pin out

The RedLab TC has four rows of screw terminals — two rows on the top edge of the housing, and two rows on the bottom edge. Each row has 26 connections. Between each bank of screw terminals are two integrated CJC sensors used for thermocouple measurements. Signals are identified in Figure 2.
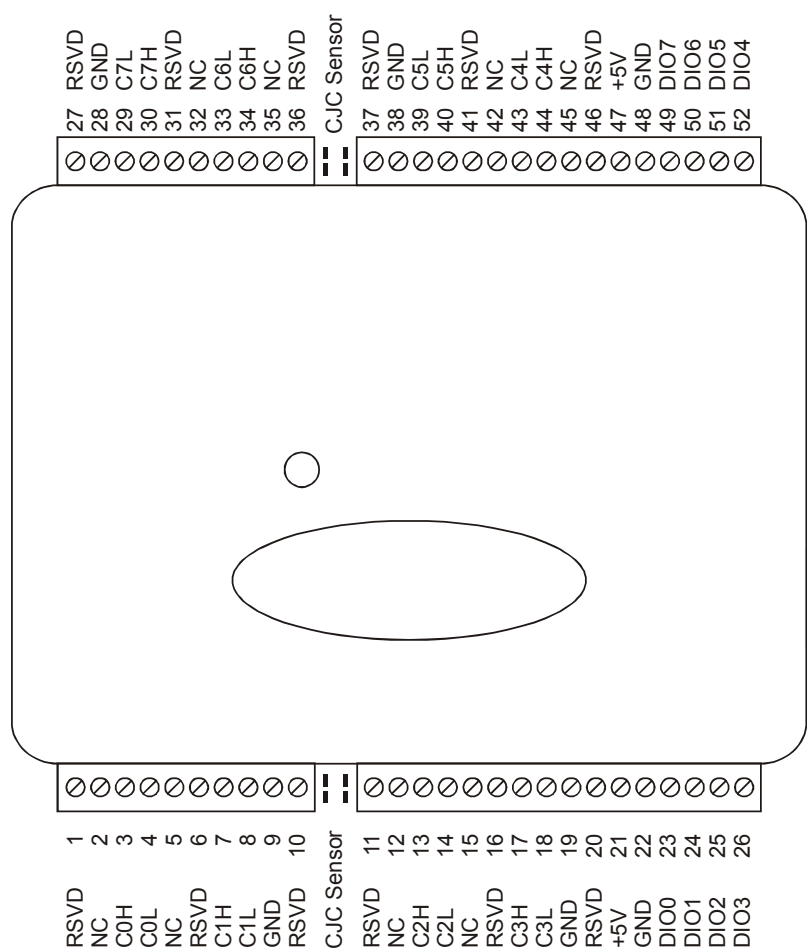
Figure 2. RedLab TC screw terminal pin numbers

Table 3-1. RedLab TC screw terminal descriptions

Pin	Signal Name	Pin Description	Pin	Signal Name	Pin Description
1	RSVD	Reserved, Do Not Use	27	RSVD	Reserved, Do Not Use
2	NC	Not connected	28	GND	Ground
3	C0H	CH0 sensor input (+)	29	C7L	CH7 sensor input (−)
4	C0L	CH0 sensor input (−)	30	C7H	CH7 sensor input (+)
5	NC	Not connected	31	RSVD	Reserved, Do Not Use
6	RSVD	Reserved, Do Not Use	32	NC	Not connected
7	C1H	CH1 sensor input (+)	33	C6L	CH6 sensor input (−)
8	C1L	CH1 sensor input (−)	34	C6H	CH6 sensor input (+)
9	GND	Ground	35	NC	Not connected
10	RSVD	Reserved, Do Not Use	36	RSVD	Reserved, Do Not Use
	CJC sensor			CJC sensor	
11	RSVD	Reserved, Do Not Use	37	RSVD	Reserved, Do Not Use
12	NC	Not connected	38	GND	Ground
13	C2H	CH2 sensor input (+)	39	C5L	CH5 sensor input (−)
14	C2L	CH2 sensor input (−)	40	C5H	CH5 sensor input (+)
15	NC	Not connected	41	RSVD	Reserved, Do Not Use
16	RSVD	Reserved, Do Not Use	42	NC	Not connected
17	C3H	CH3 sensor input (+)	43	C4L	CH4 sensor input (−)
18	C3L	CH3 sensor input (−)	44	C4H	CH4 sensor input (+)
19	GND	Ground	45	NC	Not connected
20	RSVD	Reserved, Do Not Use	46	RSVD	Reserved, Do Not Use
21	+5V	+5V output	47	+5V	+5V output
22	GND	Ground	48	GND	Ground
23	DIO0	Digital Input/Output	49	DIO7	Digital Input/Output
24	DIO1	Digital Input/Output	50	DIO6	Digital Input/Output
25	DIO2	Digital Input/Output	51	DIO5	Digital Input/Output
26	DIO3	Digital Input/Output	52	DIO4	Digital Input/Output

Use 16 AWG to 30 AWG wire for your signal connections.

Tighten screw terminal connections

When making connections to the screw terminals, be sure to tighten the screw until tight. Simply touching the top of the screw terminal is not sufficient to make a proper connection.

Thermocouple input terminals (C0H/C0L to C7H/C7L)

You can connect up to eight thermocouples to the differential sensor inputs (C0H/C0L to C7H/C7L). The RedLab TC supports type J, K, R, S, T, N, E, and B thermocouples.

Ground terminals (GND)

The six analog ground terminals (**GND**) provide a common ground for the input channels and DIO bits and are isolated (500 VDC) from the USB GND.

Power terminals (+5V)

The two **+5V** terminals are isolated (500 VDC) from the USB +5V.

Digital terminals (DIO0 to DIO7)

You can connect up to eight digital I/O lines to the screw terminals labeled **DIO0** to **DIO7**. Each terminal is software configurable for input or output.

CJC sensors

The RedLab TC has two built in high-resolution temperature sensors. One sensor is located on the right side of the package, and one sensor is located at the left side.

Thermocouple connections

A thermocouple consists of two dissimilar metals that are joined together at one end. When the junction of the metals is heated or cooled, a voltage is produced that correlates to temperature.

The RedLab TC makes fully differential thermocouple measurements without the need of ground-referencing resistors. A 32-bit floating point value in either a voltage or temperature format is returned by software. An open thermocouple detection feature is available for each analog input which automatically detects an open or broken thermocouple.

Use *Insta*Cal to select the thermocouple type (J, K, R, S, T, N, E, and B) and one or more sensor input channels to connect the thermocouple.

Wiring configuration

Connect the thermocouple to the RedLab TC using a differential configuration, as shown in Figure 3.
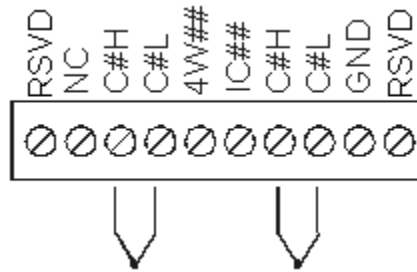

Figure 3. Typical thermocouple connection

Connect thermocouples to the RedLab TC such that they are floating with respect to GND (pins 9, 19, 28, 38). The RedLab TC **GND** pins are isolated from earth ground, so connecting thermocouple sensors to voltages referenced to earth ground is permissible as long as the isolation between the GND pins (9, 19, 28, 38) and earth ground is maintained.

When thermocouples are attached to conductive surfaces, the voltage differential between multiple thermocouples must remain within ±1.4 V. For best results, we recommend the use of insulated or ungrounded thermocouples when possible.

Maximum input voltage between analog input and ground

The absolute maximum input voltage between an analog input and the isolated GND pins is ±25 VDC when the RedLab TC is powered on, and ±40 VDC when the RedLab TC is powered off.

If you need to increase the length of your thermocouple, use the same type of thermocouple wires to minimize the error introduced by thermal EMFs.

Digital I/O connections

You can connect up to eight digital I/O lines to the screw terminals labeled **DIO0** to **DIO7**. You can configure each digital bit for either input or output. All digital I/O lines are pulled up to +5V with a 47 K ohm resistor (default). You can request the factory to configure the resistor for pull-down to ground if desired.

When you configure the digital bits for input, you can use the RedLab TC digital I/O terminals to detect the state of any TTL-level input. Refer to the schematic shown in Figure 4. If you set the switch to the +5V input, DIO0 reads *TRUE* (1). If you move the switch to GND, DIO0 reads *FALSE* (0).
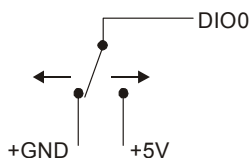
Figure 4. Schematic showing switch detection by digital channel DIO0

Caution!   All ground pins on the RedLab TC (pins 9, 19, 28, 38) are isolated from earth ground. If a connection is made to earth ground when using digital I/O and conductive thermocouples, the thermocouples are no longer isolated. In this case, thermocouples must not be connected to any conductive surfaces that may be referenced to earth ground

For general information regarding digital signal connections and digital I/O techniques, refer to the *Guide to Signal Connections* (available on our RedLab CD under „ICalUL\Documents").

Functional Details

Thermocouple measurements

A thermocouple consists of two dissimilar metals that are joined together at one end. When the junction of the metals is heated or cooled, a voltage is produced that correlates to temperature.

The RedLab TC hardware level-shifts the thermocouple's output voltage into the A/D's common mode input range by applying +2.5 V to the thermocouple's low side at the C#L input. Always connect thermocouple sensors to the RedLab TC in a floating fashion. Do not attempt to connect the thermocouple low side C#L to GND or to a ground referencing resistor.

Cold junction compensation (CJC)

When you connect the thermocouple sensor leads to the sensor input channel, the dissimilar metals at the RedLab TC terminal blocks produce an additional thermocouple junction. This junction creates a small voltage error term which must be removed from the overall sensor measurement using a cold junction compensation technique. The measured voltage includes both the thermocouple voltage and the cold junction voltage. To compensate for the additional cold junction voltage, the RedLab TC subtracts the *cold junction* voltage from the thermocouple voltage.

The RedLab TC has two high-resolution temperature sensors that are integrated into the design of the RedLab TC. One sensor is located on the right side of the package, and one sensor is located at the left side. The CJC sensors measure the average temperature at the terminal blocks so that the cold junction voltage can be calculated. A software algorithm automatically corrects for the additional thermocouples created at the terminal blocks by subtracting the calculated cold junction voltage from the analog input's thermocouple voltage measurement.

Increasing the thermocouple length

If you need to increase the length of your thermocouple, use the same type of thermocouple wires to minimize the error introduced by thermal EMFs.

Data linearization

After the CJC correction is performed on the measurement data, an on-board microcontroller automatically linearizes the thermocouple measurement data using National Institute of Standards and Technology (NIST) linearization coefficients for the selected thermocouple type.

The measurement data is then output as a 32-bit floating point value in the configured format (voltage or temperature).

Open-thermocouple detection (OTD)

The RedLab TC is equipped with an open-thermocouple detection for each analog input channel. With OTD, any open-circuit or short-circuit condition at the thermocouple sensor is detected by the software. An open channel is detected by driving the input voltage to a negative value outside the range of any thermocouple output. The software recognizes this as an invalid reading and flags the appropriate channel. The software continues to sample all channels when OTD is detected.

Input leakage current

With open-thermocouple detection enabled, 105 nA (max.) of input leakage current is injected into the thermocouple. This current can cause an error voltage to develop across the lead resistance of the thermocouple that is indistinguishable from the thermocouple voltage you are measuring. You can estimate this error voltage with the following formula:

error voltage = resistance of the thermocouple x 105 nA

To reduce the error, reduce the length of the thermocouple to lower its resistance, or lower the AWG of the wire by using a wire with a larger diameter. With open-thermocouple detection disabled, 30 nA (max.) of input leakage current is injected into the thermocouple.

USB connector

The USB connector provides +5V power and communication. No external power supply is required.

LED

The LED indicates the communication status of the RedLab TC. It uses up to 5 mA of current. The table below defines the function of the RedLab TC LED.

LED Illumination

LED Illumination	Indication
Steady green	The RedLab TC is connected to a computer or external USB hub.
Pulsing green	Data is being transferred. Upon connection, the LED should flash three times and then remain lit (indicates a successful installation).

Power

The two **+5V** terminals are isolated (500 VDC) from the USB +5V.

Caution!   Each +5V terminal is an output. Do not connect to an external power supply or you may damage the RedLab TC and possibly the computer.

Specifications

Typical for 25 °C unless otherwise specified.
Specifications in *italic* text are guaranteed by design.

Analog input

Table 1. Generic analog input specifications

Parameter	Conditions	Specification
A/D converters		Four dual 24-bit, Sigma-Delta type
Number of channels		8 differential
Input isolation		*500 VDC minimum between field wiring and USB interface*
Channel configuration		Thermocouple sensor type
Differential input voltage range	Thermocouple	±0.080 V
Absolute maximum input voltage	*±C0x through ±C7x relative to GND (pins 9, 19, 28, 38)*	±25 V power on, ±40 V power off.
Input impedance		5 Gigohm, min.
Input leakage current	Open thermocouple detect enabled	105 nA max.
Normal mode rejection ratio	*f_{IN} = 60 Hz*	*90 dB min.*
Common mode rejection ratio	*f_{IN} = 50 Hz/60 Hz*	*100 dB min.*
Resolution		24 bits
No missing codes		*24 bits*
Input coupling		DC
Warm-up time		30 minutes min.
Open thermocouple detect		Automatically enabled when the channel pair is configured for thermocouple sensors. The maximum open detection time is 3 seconds.
CJC sensor accuracy	*15 °C to 35 °C*	*±0.25 °C typ., ±0.5 °C max.*
	0 °C to 70 °C	*-1.0 to +0.5 °C max*

Channel configurations

Table 2. Channel configuration specifications

Sensor Category	Conditions	Specification
Thermocouple	J, K, S, R, B, E, T, or N	8 differential channels

Note 1: Channel configuration information is stored in the EEPROM of the isolated microcontroller by the firmware whenever any item is modified. Modification is performed by commands issued over USB from an external application, and the configuration is made non-volatile through the use of the EEPROM.

Note 2: The factory default configuration is *Type J.*

Accuracy

Thermocouple measurement accuracy

Table 3. Thermocouple accuracy specifications, including CJC measurement error

Sensor Type	Maximum error	Typical error	Temperature range
J	±1.499 °C	±0.507 °C	-210 to 0 °C
	±0.643 °C	±0.312 °C	0 to 1200 °C
K	±1.761 °C	±0.538 °C	-210 to 0 °C
	±0.691 °C	±0.345 °C	0 to 1372 °C
S	±2.491°C	±0.648 °C	-50 to 250 °C
	±1.841 °C	±0.399 °C	250 to 1768.1 °C
R	±2.653 °C	±0.650 °C	-50 to 250 °C
	±1.070 °C	±0.358 °C	250 to 1768.1 °C
B	±1.779 °C	±0.581 °C	250 to 700 °C
	±0.912 °C	±0.369 °C	700 to 1820 °C
E	±1.471 °C	±0.462 °C	-200 to 0 °C
	±0.639 °C	±0.245 °C	0 to 1000 °C
T	±1.717 °C	±0.514 °C	-200 to 0 °C
	±0.713 °C	±0.256 °C	0 to 600 °C
N	±1.969 °C	±0.502 °C	-200 to 0 °C
	±0.769 °C	±0.272 °C	0 to 1300 °C

Note 3: Thermocouple specifications include linearization, cold-junction compensation and system noise. These specs are for one year, or 3000 operating hours, whichever comes first and for operation of the RedLab TC between 15 °C and 35 °C. For measurements outside this range, add ±0.5 degree to the maximum error shown. There are CJC sensors on each side of the module. The accuracy listed above assumes the screw terminals are at the same temperature as the CJC sensor. Errors shown do not include inherent thermocouple error. Please contact your thermocouple supplier for details on the actual thermocouple error.

Note 4: Thermocouples must be connected to the RedLab TC such that they are floating with respect to GND (pins 9, 19, 28, 38). The RedLab TC GND pins are isolated from earth ground, so connecting thermocouple sensors to voltages referenced to earth ground is permissible as long as the isolation between the GND pins and earth ground is maintained.

Note 5: When thermocouples are attached to conductive surfaces, the voltage differential between multiple thermocouples must remain within ±1.4V. For best results we recommend the use of ungrounded or insulated thermocouples when possible.

Throughput rate

Table 4. Throughput rate specifications

Number of input channels	Maximum throughput
1	2 Samples/second
2	2 S/s on each channel, 4 S/s total
3	2 S/s on each channel, 6 S/s total
4	2 S/s on each channel, 8 S/s total
5	2 S/s on each channel, 10 S/s total
6	2 S/s on each channel, 12 S/s total
7	2 S/s on each channel, 14 S/s total
8	2 S/s on each channel, 16 S/s total

Note 6: The analog inputs are configured to run continuously. Each channel is sampled twice per second. The maximum latency between when a sample is acquired and the temperature data is provided by the USB unit is approximately 0.5 seconds.

Digital input/output

Table 5. Digital input/output specifications

Digital type	CMOS
Number of I/O	8 (DIO0 through DIO7)
Configuration	Independently configured for input or output. Power on reset is input mode.
Pull-up/pull-down configuration	All pins pulled up to +5 V via 47 K resistors (default). Pull-down to ground (GND) also available.
Digital I/O transfer rate (software paced)	**1.** Digital input – 50 port reads or single bit reads per second typ. **2.** Digital output – 100 port writes or single bit writes per second typ.
Input high voltage	2.0 V min., 5.5 V absolute max.
Input low voltage	0.8 V max., –0.5 V absolute min.
Output low voltage (IOL = 2.5 mA)	0.7 V max
Output high voltage (IOH = -2.5 mA)	3.8 V min.

Note 7: All ground pins on the RedLab TC (pins 9, 19, 28, 38) are isolated from earth ground. If a connection is made to earth ground when using digital I/O and conductive thermocouples, the thermocouples are no longer isolated. In this case, thermocouples must not be connected to any conductive surfaces that may be referenced to earth ground.

Memory

Table 6. Memory specifications

EEPROM	1,024 bytes isolated micro reserved for sensor configuration 256 bytes USB micro for external application use

Microcontroller

Table 7. Microcontroller specifications

Type	Two high performance 8-bit RISC microcontrollers

USB +5V voltage

Table 8. USB +5V voltage specifications

Parameter	**Conditions**	**Specification**
USB +5V (VBUS) input voltage range		4.75 V min. to 5.25 V max.

Power

Table 9. Power specifications

Parameter	Conditions	Specification
Supply current	USB enumeration	<100 mA
Supply current (Note 8)	Continuous mode	140 mA typ.
User +5V output voltage range (terminal block pin 21 and 47)	Connected to self-powered hub. (Note 9)	4.75 V min. to 5.25 V max.
User +5V output current (terminal block pin 21 and pin 47)	Bus-powered and connected to a self-powered hub. (Note 9)	10 mA max.
Isolation	Measurement system to PC	500 VDC min.

Note 8: This is the total current requirement for the RedLab TC which includes up to 10 mA for the status LED.

Note 9: Self-Powered Hub refers to a USB hub with an external power supply. Self-powered hubs allow a connected USB device to draw up to 500 mA.

Root Port Hubs reside in the PC's USB Host Controller. The USB port(s) on your PC are root port hubs. All externally powered root port hubs (desktop PC's) provide up to 500 mA of current for a USB device. Battery-powered root port hubs provide 100 mA or 500 mA, depending upon the manufacturer. A laptop PC that is not connected to an external power adapter is an example of a battery-powered root port hub.

USB specifications

Table 10. USB specifications

USB device type	USB 2.0 (full-speed)
Device compatibility	USB 1.1, USB 2.0
	Self-powered, 100 mA consumption max
USB cable type	*A-B cable, UL type AWM 2527 or equivalent. (min 24 AWG VBUS/GND, min 28 AWG D+/D–)*
USB cable length	3 meters max.

Environmental

Table 11. Environmental specifications

Operating temperature range	0 to 70 ° C
Storage temperature range	-40 to 85 ° C
Humidity	0 to 90% non-condensing

Mechanical

Table 12. Mechanical specifications

Dimensions	127 mm (L) x 88.9 mm (W) x 35.56 (H)
User connection length	3 meters max.

Screw terminal connector type and pin out

Table 13. Screw terminal connector specifications

Connector type	Screw terminal
Wire gauge range	16 AWG to 30 AWG

Screw terminal pin out

Table 14. Screw terminal pin out

Pin	Signal Name	Pin Description	Pin	Signal Name	Pin Description
1	RSVD	Reserved, Do Not Use	27	RSVD	Reserved, Do Not Use
2	NC		28	GND	
3	C0H	CH0 sensor input (+)	29	C7L	CH7 sensor input (-)
4	C0L	CH0 sensor input (-)	30	C7H	CH7 sensor input (+)
5	NC		31	RSVD	Reserved, Do Not Use
6	RSVD	Reserved, Do Not Use	32	NC	
7	C1H	CH1 sensor input (+)	33	C6L	CH6 sensor input (-)
8	C1L	CH1 sensor input (-)	34	C6H	CH6 sensor input (+)
9	GND		35	NC	
10	RSVD	Reserved, Do Not Use	36	RSVD	Reserved, Do Not Use
	CJC sensor			CJC sensor	
11	RSVD	Reserved, Do Not Use	37	RSVD	Reserved, Do Not Use
12	NC		38	GND	
13	C2H	CH2 sensor input (+)	39	C5L	CH5 sensor input (-)
14	C2L	CH2 sensor input (-)	40	C5H	CH5 sensor input (+)
15	NC		41	RSVD	Reserved, Do Not Use
16	RSVD	Reserved, Do Not Use	42	NC	
17	C3H	CH3 sensor input (+)	43	C4L	CH4 sensor input (-)
18	C3L	CH3 sensor input (-)	44	C4H	CH4 sensor input (+)
19	GND		45	NC	
20	RSVD	Reserved, Do Not Use	46	RSVD	Reserved, Do Not Use
21	+5V	+5V output	47	+5V	+5V output
22	GND		48	GND	
23	DIO0	Digital Input/Output	49	DIO7	Digital Input/Output
24	DIO1	Digital Input/Output	50	DIO6	Digital Input/Output
25	DIO2	Digital Input/Output	51	DIO5	Digital Input/Output
26	DIO3	Digital Input/Output	52	DIO4	Digital Input/Output