

WLS-TEMP

Wireless Sensor Measurement

User's Guide

Trademark and Copyright Information

Measurement Computing Corporation, InstaCal, Universal Library, and the Measurement Computing logo are either trademarks or registered trademarks of Measurement Computing Corporation. Refer to the Copyrights & Trademarks section on mccdaq.com/legal for more information about Measurement Computing trademarks. Other product and company names mentioned herein are trademarks or trade names of their respective companies.

© 2014 Measurement Computing Corporation. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form by any means, electronic, mechanical, by photocopying, recording, or otherwise without the prior written permission of Measurement Computing Corporation.

Notice

Measurement Computing Corporation does not authorize any Measurement Computing Corporation product for use in life support systems and/or devices without prior written consent from Measurement Computing Corporation. Life support devices/systems are devices or systems that, a) are intended for surgical implantation into the body, or b) support or sustain life and whose failure to perform can be reasonably expected to result in injury. Measurement Computing Corporation products are not designed with the components required, and are not subject to the testing required to ensure a level of reliability suitable for the treatment and diagnosis of people.

Table of Contents

Preface

About this User's Guide	5
What you will learn from this user's guide	5
Conventions in this user's guide	5
Where to find more information	5

Chapter 1

Introducing the WLS-TEMP.....	6
Overview: WLS-TEMP features	6
Remote wireless operation	6
WLS-TEMP block diagram	7

Chapter 2

Installing the WLS-TEMP.....	8
What comes with your shipment?.....	8
Hardware	8
Documentation.....	8
Unpacking.....	8
Installing the software	8
Installing the hardware	8
Configuring the hardware	9
Temperature sensors	9
Network parameters (remote operation)	10
Connecting the external power supply for remote operation	11
Calibrating the WLS-TEMP	11
Warm up time	11

Chapter 3

Sensor Connections	12
Screw terminal pinout.....	12
Sensor input	12
Current excitation output	13
Four-wire, two sensor common	13
Two sensor common.....	13
CJC sensors.....	13
Digital I/O.....	13
Power output.....	13
Ground.....	13
Thermocouple connections	13
Wiring configuration.....	14
RTD and thermistor connections	14
Two-wire configuration	15
Three-wire configuration	16
Four-wire configuration.....	16
Semiconductor sensor measurements	17
Wiring configuration.....	17
Digital I/O connections.....	17
Configuring the DIO channels to generate alarms	18

Chapter 4

Functional Details	19
Thermocouple measurements	19
Cold junction compensation (CJC)	19
Data linearization.....	19

Open-thermocouple detection (OTD)	19
RTD and thermistor measurements	20
Data linearization	20
AC power supply	20
External components	20
Screw terminals.....	21
USB connector.....	21
Status LEDs	21
LED Test button.....	22
Chapter 5	
Specifications	23
Analog input	23
Channel configurations	24
Compatible sensors	24
Accuracy	25
Thermocouple measurement accuracy	25
Semiconductor sensor measurement accuracy	25
RTD measurement accuracy	26
Thermistor measurement accuracy	26
Throughput rate to PC (USB or wireless)	27
Digital input/output.....	27
Temperature alarms	28
Memory	28
Microcontroller.....	28
Wireless communications	28
USB +5V voltage	29
Power	29
USB specifications	30
Current excitation outputs (Ix+)	30
Environmental	30
Mechanical	30
LED / button configuration.....	31
Screw terminal connector	32
Declaration of Conformity	33

About this User's Guide

What you will learn from this user's guide

This user's guide describes the Measurement Computing WLS-TEMP data acquisition device and lists device specifications.

Conventions in this user's guide

For more information

Text presented in a box signifies additional information related to the subject matter.

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

bold text **Bold** text is used for the names of objects on a screen, such as buttons, text boxes, and check boxes.

italic text *Italic* text is used for the names of manuals and help topic titles, and to emphasize a word or phrase.

Where to find more information

Additional information about WEB-TEMP hardware is available on our website at www.mccdaq.com. You can also contact Measurement Computing Corporation with specific questions.

- Knowledgebase: kb.mccdaq.com
- Phone: 508-946-5100 and follow the instructions for reaching Tech Support
- Fax: 508-946-9500 to the attention of Tech Support
- Email: techsupport@mccdaq.com

Introducing the WLS-TEMP

Overview: WLS-TEMP features

This user's guide contains all of the information you need to configure the WLS-TEMP for remote wireless operation, and to connect to the signals you want to measure.

The WLS-TEMP is a wireless-based USB 2.0 full-speed temperature measurement module that is supported under popular Microsoft® Windows® operating systems. The WLS-TEMP is fully compatible with both USB 1.1 and USB 2.0 ports.

The WLS-TEMP provides eight differential input channels that are software programmable for different sensor categories including thermocouple, RTD, thermistor and Semiconductor sensors. 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.

You can take measurements from four sensor categories:

- Thermocouple – types J, K, R, S, T, N, E, and B
- Resistance temperature detectors (RTDs) – two, three, or four-wire measurements of 100 Ω platinum RTDs
- Thermistors – two, three, or four -wire measurements
- Semiconductor temperature sensors – LM35, TMP35 or equivalent

The WLS-TEMP provides a 24-bit analog-to-digital (A/D) converter for each pair of differential analog input channels. Each pair of differential inputs constitutes a channel pair. You can connect a different category of sensor to each channel pair, but you can not mix categories among the channels that constitute a channel pair (although it is permissible to mix thermocouple types).

The WLS-TEMP provides two integrated cold junction compensation (CJC) sensors for thermocouple measurements, and built-in current excitation sources for resistive sensor measurements.

An open thermocouple detection feature lets you detect a broken thermocouple. An onboard microprocessor automatically linearizes the measurement data according to the sensor category.

The WLS-TEMP features eight independent temperature alarms. Each alarm controls an associated digital I/O channel as an alarm output. The input to each alarm is one of the temperature input channels. The output of each alarm is software-configurable as active high or low. You set up the temperature threshold conditions to activate each alarm. When an alarm is activated, the associated DIO channel is driven to the output state.

All configurable options are software programmable. The WLS-TEMP is fully software-calibrated.

You can operate the WLS-TEMP as a standalone plug-and-play device which draws power through the USB cable. You can also operate the WLS-TEMP as a remote device that communicates with the computer through the WLS-IFC USB-to-wireless interface device. An external power supply is shipped with the device to provide power during remote operations.

Remote wireless operation

When operating as a remote device, the WLS-TEMP communicates with the computer through the WLS-IFC device connected to the computer's USB port

Before you can operate the WLS-TEMP remotely, you must connect it to the computer's USB port and configure the network parameters required to establish a wireless link with the interface device. Only devices with the same parameter settings can communicate with each other. All configurable options are programmable with InstaCal.

LEDs on the WLS-TEMP indicate the status of communication over the wireless link. An LED bar graph shows the fade margin of signals received by the WLS-TEMP.

For more information on setting up network parameters, refer to "[Network parameters \(remote operation\)](#)" on page 10.

WLS-TEMP block diagram

WLS-TEMP functions are illustrated in the block diagram shown here.

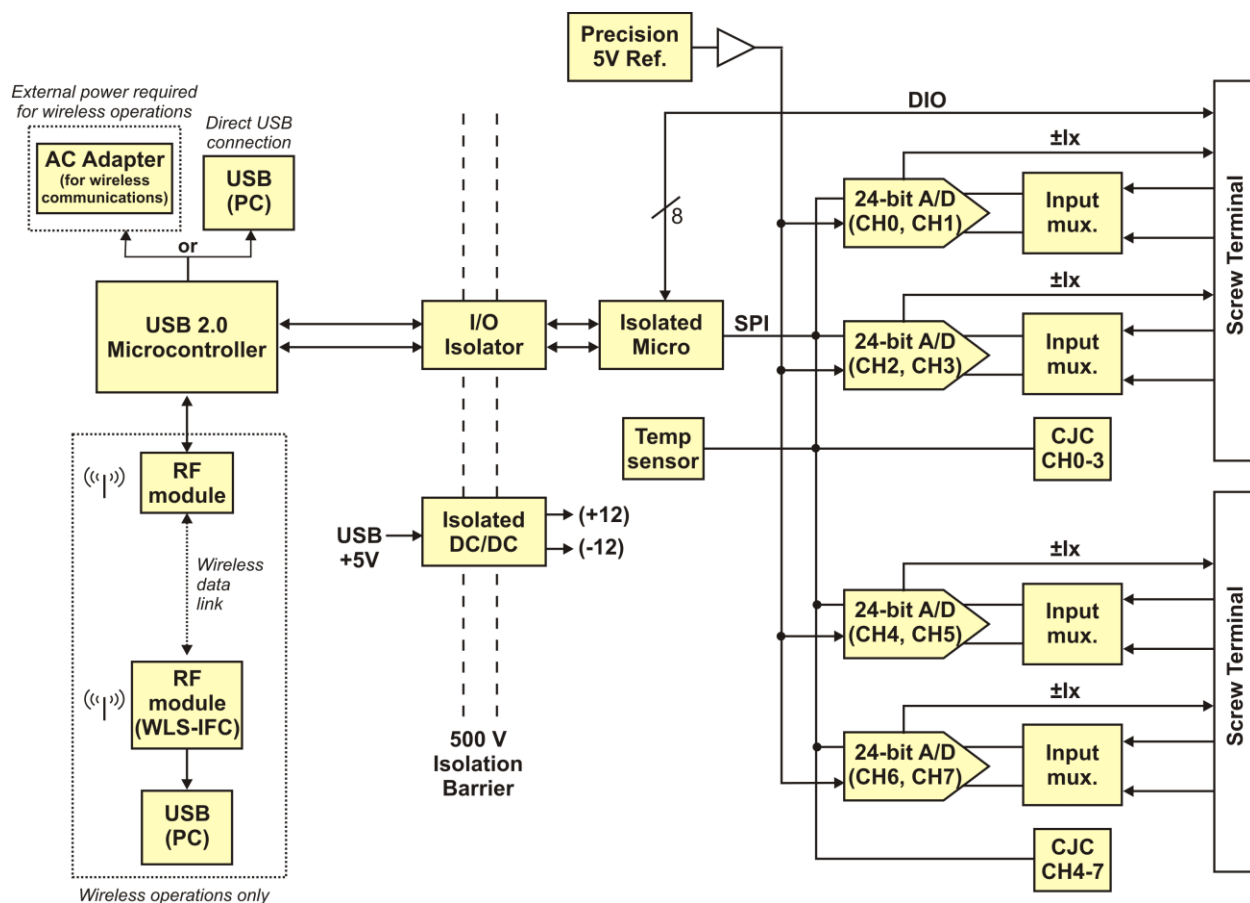


Figure 1. Functional block diagram

Installing the WLS-TEMP

What comes with your shipment?

The following items are shipped with the WLS-TEMP:

Hardware

- WLS-TEMP
- AC-to-USB power adapter (2.5 watt supply for wireless operations) and USB cable (2 meter length)

Software

- MCC DAQ Software CD

Documentation

- Quick Start Guide
This booklet provides an overview of the MCC DAQ software you received with the device, and includes information about installing the software. Please read this booklet completely before installing any software or hardware.
- Setup Options
An overview of installation options is provided in the *Wireless Setup* document that ships with the device.

Unpacking

As with any electronic device, you should take care while handling to avoid damage from static electricity. Before removing the WLS-TEMP 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 any components are missing or damaged, contact us immediately using one of the following methods:

- Knowledgebase: kb.mccdaq.com
- Phone: 508-946-5100 and follow the instructions for reaching Tech Support
- Fax: 508-946-9500 to the attention of Tech Support
- Email: techsupport@mccdaq.com

For international customers, contact your local distributor. Refer to the International Distributors section on our website at www.mccdaq.com/International.

Installing the software

Refer to the *Quick Start Guide* for instructions on installing the software on the MCC DAQ CD. This booklet is available in PDF at www.mccdaq.com/PDFmanuals/DAQ-Software-Quick-Start.pdf.

Installing the hardware

Before you operate the WLS-TEMP as a local or remote device, first install it onto your system and configure it with InstaCal.

Install the MCC DAQ software before you install the WLS-TEMP

The driver needed to run your board is installed with the MCC DAQ software. Therefore, you need to install the MCC DAQ software before you install your board. Refer to the *Quick Start Guide* for instructions on installing the software.

Complete the following steps to connect the WLS-TEMP to your system:

1. 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 WLS-TEMP.

Always connect an external hub to its power supply

If you are using a hybrid hub (one that can operate in either self-powered or bus-powered mode), always connect it to its external power supply.

If you use a hub of this type without connecting to external power, communication errors may occur that could result in corrupt configuration information on your wireless device. You can restore the factory default configuration settings with InstaCal.

When you connect the WLS-TEMP for the first time, a notification message opens as the WLS-TEMP is detected. After your system detects new hardware, the **Found New Hardware Wizard** opens and prompts you to respond to the question "*Can Windows connect to Windows Update to search for software?*"

2. Click on the **No, not this time** option, and then click on the **Next** button.

The next dialog prompts you for the location of the software required to run the new hardware.

3. Keep the default selection "*Install the software automatically*" and then click on the **Next** button.

The wizard locates and installs the software on your computer for the WLS-TEMP. A dialog appears when the wizard completes the installation.

4. Click on the **Finish** button to exit the **Found New Hardware Wizard**.

A dialog box opens when the hardware is installed and ready to use. The **Command** LED will blink and then remain on to indicate that communication is established between the WLS-TEMP and your computer. The **Wireless Power** LED turns on to indicate that the internal RF module is receiving power.

**If the Command LED turns off**

If the Command LED is on but then turns off, the computer has lost communication with the WLS-TEMP. If the WLS-TEMP is connected to the computer USB port, disconnect the USB cable from the computer and then reconnect it. This should restore communication, and the LED should turn back *on*.

If the Command LED turns off when you are operating the WLS-TEMP remotely through the wireless interface, disconnect the USB cable from the USB power adapter, and then reconnect it. This should restore communication, and the Command LED should turn back *on*.

Configuring the hardware

Before using the WLS-TEMP, configure the temperature sensors and network parameters for remote wireless communication. All hardware configuration options on the WLS-TEMP are programmable with InstaCal.

Configuration options are stored on the WLS-TEMP in non-volatile memory in EEPROM, and are loaded on power up.

Temperature sensors

Use InstaCal to set the sensor type for each channel pair. The configurable options dynamically update according to the selected sensor category. You can modify sensor settings when you operate the WLS-TEMP remotely.

You can configure sensor settings when the WLS-TEMP is connected locally to the computer through the USB port, or when the device is operated remotely through the wireless interface.

The factory-default sensor configuration is *Disabled*. The Disabled mode disconnects the analog inputs from the terminal blocks and internally grounds all of the A/D inputs. This mode also disables each of the current excitation sources.

Network parameters (remote operation)

The following network parameter options are programmable with InstaCal.

- **Identifier:** Text that identifies the device (optional).
- **PAN (hex):** The personal area network (PAN) ID assigned to the device.

The PAN value is a number used to identify the interface device with which you want to communicate. The WLS-TEMP can only communicate with a device whose PAN is set to the same value.

Most users do not need to change the default value assigned to the device. However, you may want to assign a different PAN ID in the following situations:

- You have multiple WLS Series devices, and do not want to allow communication between all of them. Set the PAN ID to the same value on each device that you want to communicate.
- If other WLS Series devices are operating in the vicinity, you can avoid accidental changes to your device settings by changing the default PAN value.

- **CH:** The radio frequency (RF) channel number assigned to the device.

The channel number is used to transmit and receive data over the wireless link. You may want to change the channel number in InstaCal when another WLS Series device is already transmitting on that channel, or when noise is present on the channel.

The table below lists each available channel and its corresponding transmission frequency:

RF Channel	Transmission Frequency (GHz)	RF Channel	Transmission Frequency (GHz)
12	2.410	18	2.440
13	2.415	19	2.445
14	2.420	20	2.450
15	2.425	21	2.455
16	2.430	22	2.460
17	2.435	23	2.465

- **AES Key:** Value used to encrypt data (optional).

AES encryption is disabled by default. Unless you suspect that there are other users of WLS Series devices in the area, there should be no need to enable encryption. However, if you suspect that there are other WLS Series devices in the area, and you need to secure the devices from being accessed by other users, enable AES encryption.

Enabling encryption does NOT secure the device from access through a local USB connection. A remote device configured for encryption can be connected locally through the USB port to access other remote WLS Series devices with the same settings; you may need to physically secure the remote devices to prevent tampering of the of device's network.

Set the PAN ID, RF channel, and AES key to the same value for each device that you want to communicate

Only devices with matching parameter settings for PAN, CH, and AES Key (if set) can communicate with each other.

For information on setting up the network parameters for your WLS-TEMP, refer to the "WLS Series" section of the "Temperature Input Boards" chapter in the *Universal Library User's Guide*.

After configuring the network parameters, disconnect the WLS-TEMP from the computer, and move the device to its remote location. The WLS-TEMP can be located up to 150 feet (50 meters) indoors, or up to ½ mile (750 m) outdoors from the interface device.

Restoring factory default settings

You can restore the factory default configuration settings with InstaCal.

Connecting the external power supply for remote operation

Connect the USB cable to the AC-to-USB power adapter when you are operating the WLS-TEMP remotely through the wireless interface. The **Command** and **Wireless Power** LEDs turn on approximately five seconds after you connect the AC power adapter.

Caution! To satisfy FCC RF exposure requirements for mobile transmitting devices, maintain a separation distance of 20 cm (0.66 feet) or more between the antenna of this device and personnel during device operation. To ensure compliance, operation at closer than this distance is not recommended. The antenna used for this transmitter must not be co-located in conjunction with any other antenna or transmitter.

Calibrating the WLS-TEMP

You can fully calibrate the WLS-TEMP using InstaCal. Allow a 30-minute warm up before calibrating. InstaCal prompts you to run its calibration utility if you change the sensor category. If you don't change the sensor category the normal calibration interval is once per year.

You can calibrate the WLS-TEMP when it is connected locally to the computer through the USB port, or when it is operated remotely through the wireless interface.

Warm up time

Allow the WLS-TEMP to warm up for 30 minutes before taking measurements. This warm up time minimizes thermal drift and achieves the specified rated accuracy of measurements.

For RTD or thermistor measurements, this warm-up time is also required to stabilize the internal current reference.

Sensor Connections

The WLS-TEMP supports the following temperature sensor types:

- Thermocouple – types J, K, R, S, T, N, E, and B
- Resistance temperature detectors (RTDs) – two-, three-, or four-wire measurement modes of 100 Ω platinum RTDs.
- Thermistors – two-, three-, or four-wire measurement modes.
- Semiconductor temperature sensors – LM35, TMP35 or equivalent

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

Screw terminal pinout

The WLS-TEMP has four banks of screw terminals. There are 26 connections on each side. Between each bank of screw terminals are two integrated CJC sensors used for thermocouple measurements. Signals are identified in Figure 2.

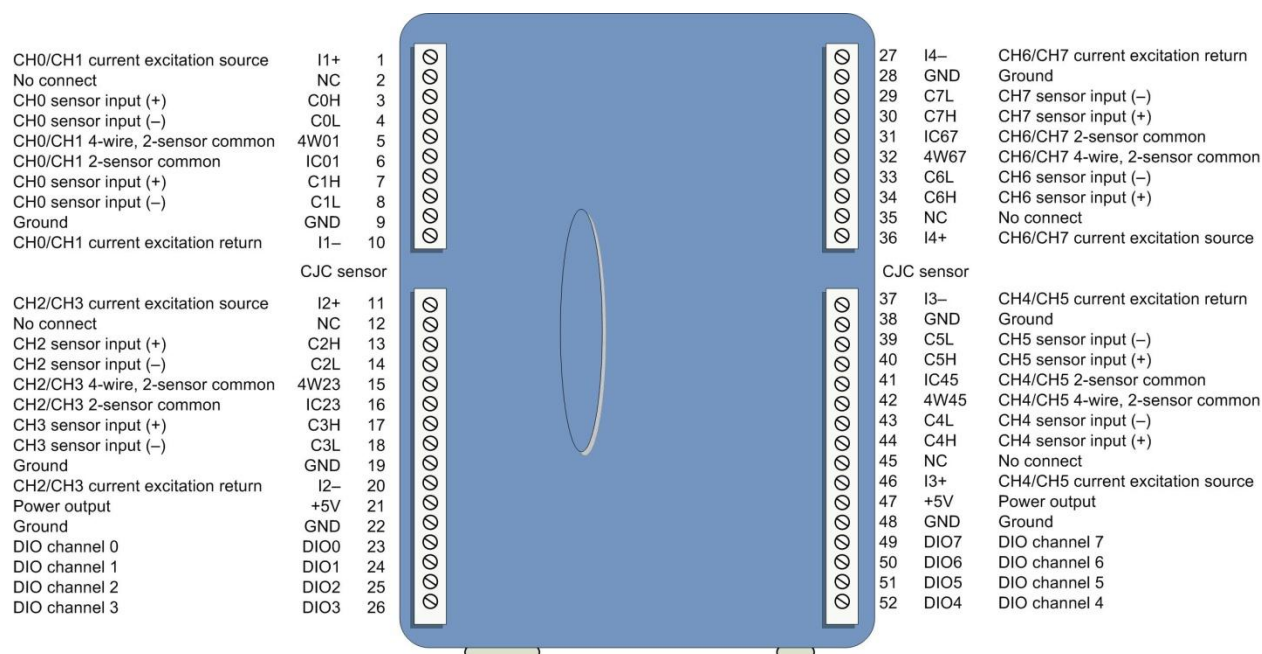


Figure 2. Screw terminal pinout

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.

Sensor input

You can connect up to eight temperature sensors to the differential sensor inputs (**C0H/C0L** to **C7H/C7L**). Supported sensor categories include thermocouples, RTDs, thermistors, or semiconductor sensors.

Do not mix sensor categories within channel pairs. You can mix thermocouple types (J, K, R, S, T, N, E, and B) within channel pairs, however.

Do not connect two different sensor categories to the same channel pair

The WLS-TEMP provides a 24-bit A/D converter for each channel pair. Each channel pair can monitor one sensor category. To monitor a sensor from a different category, connect the sensor to a different channel pair (input terminals).

Current excitation output

The WLS-TEMP has four dedicated pairs of current excitation output terminals ($\pm I1$ to $\pm I4$). These terminals have a built-in precision current source to provide excitation for the resistive sensors used for RTD and thermistor measurements.

Each current excitation terminal is dedicated to one pair of sensor input channels:

- I1+ is the current excitation source for channel 0 and channel 1
- I2+ is the current excitation source for channel 2 and channel 3
- I3+ is the current excitation source for channel 4 and channel 5
- I4+ is the current excitation source for channel 6 and channel 7

Four-wire, two sensor common

Terminals **4W01**, **4W23**, **4W45**, and **4W67** are used as the common connection for four-wire configurations with two RTD or thermistor sensors.

Two sensor common

Terminals **IC01**, **IC23**, **IC45**, and **IC67** are used as the common connection for two-wire configurations with two RTD or thermistor sensors.

CJC sensors

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

Digital I/O

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.

Power output

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

Caution! The +5V terminal is an output. Do not connect an external power supply to this terminal or you may damage the WLS-TEMP and possibly the computer.

Ground

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

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 WLS-TEMP 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 InstaCal 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 WLS-TEMP using a differential configuration, as shown in Figure 3.

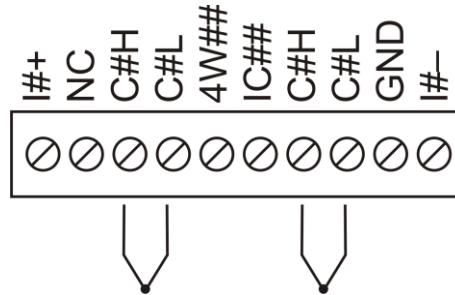


Figure 3. Typical thermocouple connection

Connect thermocouples to the WLS-TEMP so that they float with respect to ground. The **GND** pins are isolated from earth ground, so you can connect thermocouple sensors to voltages referenced to earth ground as long as you maintain the isolation between the GND pins and earth ground.

When you attach thermocouples 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 device is powered on, and ± 40 VDC when the device 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.

RTD and thermistor connections

A resistance temperature detector (RTD) measures temperature by correlating the resistance of the RTD element with temperature. A thermistor is a thermally-sensitive resistor that is similar to an RTD in that its resistance changes with temperature. Thermistors show a large change in resistance that is proportional to a small change in temperature. The main difference between RTD and thermistor measurements is the method used to linearize the sensor data.

RTDs and thermistors are resistive devices that need an excitation current to produce a voltage drop that can be measured differentially across the sensor. The WLS-TEMP features four built-in current excitation sources ($\pm I1$ to $\pm I4$) for measuring resistive type sensors. Each current excitation source is dedicated to one channel pair.

The WLS-TEMP makes two, three, and four-wire measurements of RTDs (100 Ω platinum type) and thermistors.

Use InstaCal to select the sensor type and the wiring configuration. Once the resistance value is calculated, the value is linearized in order to convert it to a temperature value. A 32-bit floating point value in either temperature or resistance is returned by software.

- In RTD mode, the WLS-TEMP cannot measure resistance values greater than 660 Ω . This 660 Ω resistance limit includes the total resistance across the current excitation ($\pm Ix$) pins, which is the sum of the RTD resistance and the lead resistances.
- In thermistor mode, the WLS-TEMP cannot measure resistance values greater than 180 k Ω . This 180 k Ω resistance limit includes the total resistance across the current excitation ($\pm Ix$) pins, which is the sum of the thermistor resistance and the lead resistance.

Two-wire configuration

The easiest way to connect an RTD sensor or thermistor to the WLS-TEMP is with a two-wire configuration, since it requires the fewest connections to the sensor. With this method, the two wires that provide the RTD sensor with its excitation current also measure the voltage across the sensor.

Since RTDs exhibit a low nominal resistance, the lead wire resistance can affect measurement accuracy. For example, connecting lead wires that have a resistance of $1\ \Omega$ ($0.5\ \Omega$ each lead) to a $100\ \Omega$ platinum RTD results in a 1% measurement error.

With a two-wire configuration, you can connect either one sensor per channel pair, or two sensors per channel pair.

Two-wire, single-sensor

A two-wire, single-sensor measurement configuration is shown in Figure 4.

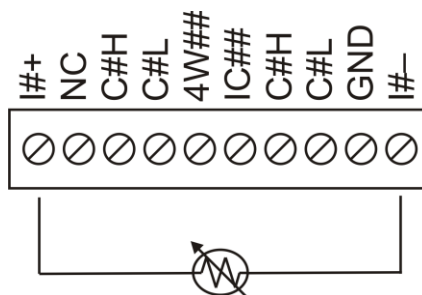


Figure 4. Two-wire, single RTD or thermistor sensor measurement configuration

When you select a two-wire, single-sensor configuration with InstaCal, connections to C#H and C#L are made internally.

Two-wire, two sensor

A two-wire, two-sensor measurement configuration is shown in Figure 5.

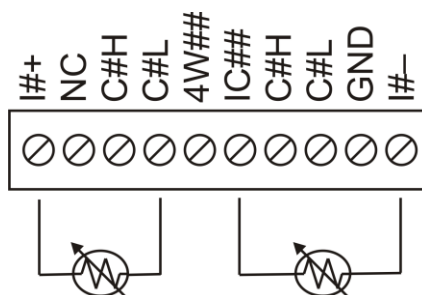


Figure 5. Two-wire, two RTD or thermistor sensors measurement configuration

When you select a two-wire, two-sensor configuration with InstaCal, connections to C#H (first sensor) and C#H/C#L (second sensor) are made internally.

When configured for two-wire mode, connect both sensors to obtain proper measurements.

Three-wire configuration

A three-wire configuration compensates for lead-wire resistance by using a single-voltage sense connection. With a three-wire configuration, you can connect only one sensor per channel pair. A three-wire measurement configuration is shown in Figure 6.

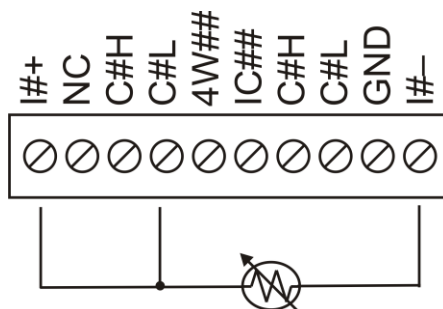


Figure 6. Three-wire RTD or thermistor sensor measurement configuration

When you select a three-wire sensor configuration with InstaCal, the WLS-TEMP measures the lead resistance on the first channel (C#H/C#L) and measures the sensor itself using the second channel (C#H/C#L). This configuration compensates for any lead-wire resistance and temperature change in lead-wire resistance. Connections to C#H for the first channel and C#H/C#L of the second channel are made internally.

For accurate three wire compensation, the individual lead resistances connected to the $\pm I\#$ pins must be of equal resistance value.

Four-wire configuration

With a four-wire configuration, connect two sets of sense/excitation wires at each end of the RTD or thermistor sensor. This configuration completely compensates for any lead-wire resistance and temperature change in lead-wire resistance.

Connect your sensor with a four-wire configuration when your application requires very high accuracy measurements.

You can configure the WLS-TEMP with either a single sensor per channel or two sensors per channel pair.

Four-wire, single-sensor

A four-wire measurement configuration is shown in Figure 7. The diagram on the left shows the sensor connected to the first channel in the channel pair. The diagram on the right shows the sensor connected to the second channel in the channel pair. The # indicates the channel number. Do not make connections to pin marked "NC".

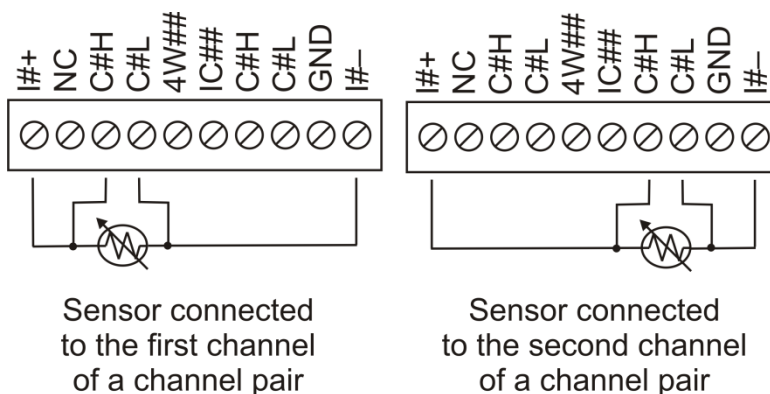


Figure 7. Four-wire, single RTD or thermistor sensor measurement configuration

Four-wire, two-sensor

A four-wire, two-sensor measurement configuration is shown in Figure 8.

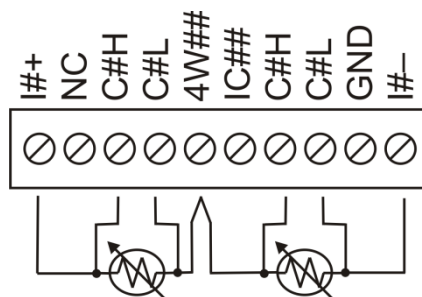


Figure 8. Four-wire, two RTD or thermistor sensors measurement configuration

When configured for four-wire, two sensor mode, both sensors must be connected to obtain proper measurements.

Semiconductor sensor measurements

Semiconductor sensors are suitable over a range of approximately -40°C to 125°C , where an accuracy of $\pm 2^{\circ}\text{C}$ is adequate. The temperature measurement range of a semiconductor sensor is small when compared to thermocouples and RTDs. However, semiconductor sensors are accurate, inexpensive, and easily interface with other electronics for display and control.

The WLS-TEMP makes high-resolution measurements of semiconductor sensors and returns a 32-bit floating point value in either a voltage or temperature.

Use InstaCal to select the sensor type (LM35, TMP35 or equivalent), and the sensor input channel that connects to the sensor.

Wiring configuration

You can connect a semiconductor sensor to the WLS-TEMP using a single-ended configuration, as shown in Figure 9. The WLS-TEMP also provides **+5V** and **GND** pins for powering the sensor.

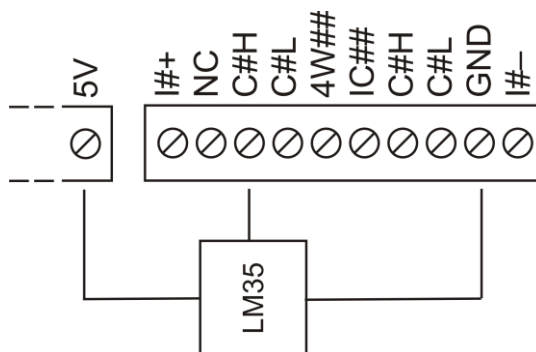


Figure 9. Semiconductor sensor measurement configuration

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 WLS-TEMP digital I/O terminals to detect the state of any TTL-level input. Refer to the schematic shown in Figure 10. If you set the switch to the +5V input, DIO0 reads *TRUE* (1). If you move the switch to GND, DIO0 reads *FALSE* (0).

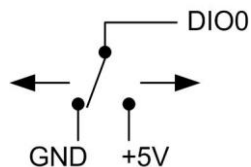


Figure 10. Schematic showing switch detection by digital channel DIO0

Caution! All ground pins on the WLS-TEMP (pins 9, 19, 28, 38) are common and 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 web site at www.mccdaq.com/signals/signals.pdf).

Configuring the DIO channels to generate alarms

The WLS-TEMP features eight independent temperature alarms. All alarm options are software configurable. Remote alarm configuration is supported.

When a digital bit is configured as an alarm, that bit is configured as an output on the next power cycle and assumes the state defined by the alarm configuration.

Each alarm controls an associated digital I/O channel as an alarm output. The input to each alarm is one of the temperature input channels. You set up the temperature conditions to activate an alarm, and also the output state of the channel (active high or low) when activated. When an alarm is activated, its associated DIO channel is driven to the output state specified.

The alarm configurations are stored in non-volatile memory and are loaded on power up. The temperature alarms function in wireless operations and while attached to the USB port on a computer.

You can configure alarm settings when you connect the WLS-TEMP locally to the computer through the USB port, or when operating it remotely through the wireless interface.

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 WLS-TEMP 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 WLS-TEMP 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 WLS-TEMP 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 WLS-TEMP subtracts the *cold junction* voltage from the thermocouple voltage.

The WLS-TEMP has two high-resolution temperature sensors that are integrated into the design of the WLS-TEMP. 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 onboard 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)

Open-thermocouple detection (OTD) is automatically enabled for each analog input channel when a channel pair is configured for thermocouple sensor. The maximum open detection time is 3 seconds.

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, a maximum of 105 nA 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:

$$\text{error voltage} = \text{resistance of the thermocouple} \times 105 \text{ nA}$$

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 OTD disabled, a maximum of 30 nA of input leakage current is injected into the thermocouple.

RTD and thermistor measurements

RTDs and thermistors are resistive devices that require an excitation current to produce a voltage drop that can be measured differentially across the sensor. The WLS-TEMP measures the sensor resistance by forcing a known excitation current through the sensor and then measuring (differentially) the voltage across the sensor to determine its resistance.

After the voltage measurement is made, the resistance of the RTD is calculated using Ohms law – the sensor resistance is calculated by dividing the measured voltage by the current excitation level ($\pm I_x$) source. The value of the $\pm I_x$ source is stored in local memory.

Once the resistance value is calculated, the value is linearized in order to convert it to a temperature value. The measurement is returned by software as a 32-bit floating point value in a voltage, resistance or temperature format.

Data linearization

An onboard microcontroller automatically performs linearization on RTD and thermistor measurements.

- RTD measurements are linearized using a Callendar-Van Dusen coefficients algorithm (you select DIN, SAMA, or ITS-90).
- Thermistor measurements are linearized using a Steinhart-Hart linearization algorithm (you supply the coefficients from the sensor manufacturer's data sheet).

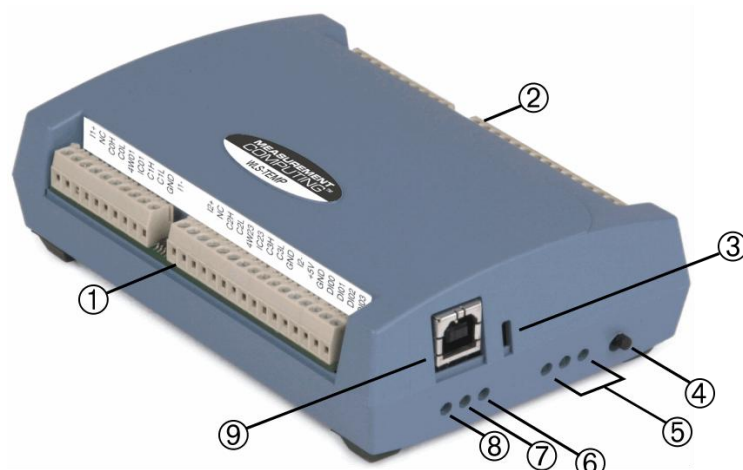
AC power supply

The external power supply is an AC-to-USB 2.5 W supply that is used to power the WLS-TEMP during remote wireless operations (MCC p/n *USB Power Adapter*.)

External components

The WLS-TEMP has the following external components, as shown in Figure 11.

- Screw terminals
- USB connector
- Status LEDs (Command, Wireless Power, Transmit, Receive, Received Signal Strength indicators)
- LED Test button



- | | | | |
|---|-------------------------------------|---|--------------------|
| 1 | Screw terminal pins 1 to 26 | 6 | Receive LED |
| 2 | Screw terminal pins 27 to 52 | 7 | Transmit LED |
| 3 | Command LED | 8 | Wireless Power LED |
| 4 | LED Test button | 9 | USB connector |
| 5 | Received Signal Strength (RSS) LEDs | | |

Figure 11. WLS-TEMP component locations

Screw terminals

The device's four banks of screw terminals are for connecting temperature sensors and digital I/O lines. These terminals also provide ground and power output connections. Refer to "[Screw terminal pinout](#)" on page 12 for screw terminal descriptions.

Caution! The two **+5V** terminals (pin 21 and pin 47) are isolated (500 VDC) from the USB +5V. Each +5V terminal is an output. Do not connect to an external power supply or you may damage the WLS-TEMP and possibly the computer.

USB connector

The USB connector provides +5V power and communication. External power is required to operate the WLS-TEMP remotely through the wireless interface.

For local operation, connect to the USB port or hub on your computer. For remote wireless operation, connect to the external AC adapter shipped with the device.

Status LEDs

The LEDs indicate the communication status of USB and wireless operations. In addition, three LEDs indicate the signal strength of data received over the wireless link. Refer to the table below for the function of each LED.

LED functions

LED	Function
Command	Steady green – the WLS-TEMP is connected to a computer or AC adapter
	Blinking green – the WLS-TEMP is receiving a command over the USB or wireless link.
Wireless Power (green)	The WLS-TEMP internal RF device is receiving power (USB or AC adapter).
Transmit (yellow)	Data is being transmitted over an active wireless link.
Receive (red)	Data is being received over an active wireless link.

LED	Function
Received Signal Strength (RSS) Indicator LEDs	<p>3 green LED bar graph. The LEDs will turn on when receiving a wireless message and stay on for approximately 1 second after the end of the message. They indicate the amount of fade margin present in an active wireless link. Fade margin is defined as the difference between the incoming signal strength and the device's receiver sensitivity.</p> <ul style="list-style-type: none">▪ Three LEDs on: Very strong signal (> 30 dB fade margin)▪ Two LEDs on: Strong signal (> 20 dB fade margin)▪ One LED on: Moderate signal (> 10 dB fade margin)▪ No LEDs on: Weak signal (< 10 dB fade margin)

LED Test button

The LED test button tests the functionality of the LEDs. When pressed, each LED lights in sequence (first the Command LED then left to right from the Wireless Power LED to the RSS indicator LEDs).

Specifications

All specifications are subject to change without notice.

Typical for 25 °C unless otherwise specified.

Specifications in *italic text* are guaranteed by design.

Analog input

Table 1. Generic analog input specifications

Parameter	Condition	Specification
A/D converters		Four dual 24-bit, Sigma-Delta type
Number of channels		8 differential
<i>Input isolation</i>		<i>500 VDC minimum between field wiring and USB interface</i>
Channel configuration		Software programmable to match sensor type
Differential input voltage range	Thermocouple	±0.080 V
	RTD	0 to 0.5 V
	Thermistor	0 to 2 V
	Semiconductor sensor	0 to 2.5 V
<i>Absolute maximum input voltage</i>	<i>±C0x through ±C7x relative to GND</i>	±25 V power on ±40 V power off
Input impedance		5 GΩ, min
Input leakage current	Open thermocouple detect disabled	30 nA max
	Open thermocouple detect enabled	105 nA max
<i>Normal mode rejection ratio</i>	<i>f_{IN} = 60 Hz</i>	<i>90 dB min</i>
<i>Common mode rejection ratio</i>	<i>f_{IN} = 50 Hz/60 Hz</i>	<i>100 dB min</i>
Resolution		24 bits
<i>No missing codes</i>		<i>24 bits</i>
Input coupling		DC
Warm-up time		30 minutes min
Open thermocouple detect		Automatically enabled when the channel pair is configured for thermocouple sensor. The maximum open detection time is 3 seconds.
<i>CJC sensor accuracy</i>	<i>15 °C to 35 °C</i>	<i>±0.25 °C typ, ±0.5 °C max</i>
	<i>0 °C to 70 °C</i>	<i>−1.0 °C to +0.5 °C max</i>

Channel configurations

Table 2. Channel configuration specifications

Sensor Category	Condition	Max number of sensors (all channels configured alike)
Disabled		
Thermocouple	J, K, S, R, B, E, T, or N	8 differential channels
Semiconductor sensor		8 differential channels
RTD and thermistor	2-wire input configuration with a single sensor per channel pair	4 differential channels
	2-wire input configuration with two sensors per channel pair	8 differential channels
	3-wire configuration with a single sensor per channel pair	4 differential channels
	4-wire input configuration with a single sensor per channel pair	4 differential channels
	4-wire input configuration with two sensors per channel pair	8 differential channels

Note 1: Internally, the device has four dual-channel, fully differential A/Ds providing a total of eight differential channels. The analog input channels are therefore configured in four channel pairs with CH0/CH1 sensor inputs, CH2/CH3 sensor inputs, CH4/CH5 sensor inputs, and CH6/CH7 sensor inputs paired together. This "channel-pairing" requires the analog input channel pairs be configured to monitor the same category of temperature sensor. Mixing different sensor types of the same category (such as a type J thermocouple on channel 0 and a type T thermocouple on channel 1) is valid.

Note 2: 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 or wireless from an external application, and the configuration is made non-volatile through the use of the EEPROM.

Note 3: The factory default configuration is *Disabled*. The Disabled mode will disconnect the analog inputs from the terminal blocks and internally ground all of the A/D inputs. This mode also disables each of the current excitation sources.

Compatible sensors

Table 3. Compatible sensor type specifications

Parameter	Condition
Thermocouple	J: -210 °C to 1200 °C
	K: -270 °C to 1372 °C
	R: -50 °C to 1768 °C
	S: -50 °C to 1768 °C
	T: -270 °C to 400 °C
	N: -270 °C to 1300 °C
	E: -270 °C to 1000 °C
	B: 0 °C to 1820 °C
RTD	100 Ω PT (DIN 43760: 0.00385 ohms/ohm/°C)
	100 ΩPT (SAMA: 0.003911 ohms/ohm/°C)
	100 Ω PT (ITS-90/IEC751:0.0038505 ohms/ohm/°C)
Thermistor	Standard 2,252 Ω through 30,000 Ω
Semiconductor / IC	LM35, TMP35 or equivalent

Accuracy

Thermocouple measurement accuracy

Table 4. Thermocouple accuracy specifications, including CJC measurement error

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

Note 4: Thermocouple measurement accuracy 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 device 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 5: Thermocouples must be connected to the device such that they are floating with respect to GND (pins 9, 19, 28, 38). The device 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 6: 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.

Semiconductor sensor measurement accuracy

Table 5. Semiconductor sensor accuracy specifications

Sensor Type	Temperature Range (°C)	Maximum Accuracy Error
LM35, TMP35 or equivalent	–40 to 150	±0.50

Note 7: Error shown does not include errors of the sensor itself. These specs are for one year while operation of the device is between 15 °C and 35 °C. Please contact your sensor supplier for details on the actual sensor error limitations.

RTD measurement accuracy

Table 6. RTD measurement accuracy specifications

RTD	Sensor Temperature (°C)	Maximum Accuracy Error (°C) $I_{x+} = 210 \mu A$	Typical Accuracy Error (°C) $I_{x+} = 210 \mu A$
PT100, DIN, US or ITS-90	-200 to -150	± 2.85	± 2.59
	-150 to -100	± 1.24	± 0.97
	-100 to 0	± 0.58	± 0.31
	0 to 100	± 0.38	± 0.11
	100 to 300	± 0.39	± 0.12
	300 to 600	± 0.40	± 0.12

Note 8: Error shown does not include errors of the sensor itself. The sensor linearization is performed using a Callendar-Van Dusen linearization algorithm. These specs are for one year while operation of the device is between 15 °C and 35 °C. The specification does not include lead resistance errors for 2-wire RTD connections. Please contact your sensor supplier for details on the actual sensor error limitations.

Note 9: Resistance values greater than 660 Ω cannot be measured by the device in the RTD mode. The 660 Ω resistance limit includes the total resistance across the current excitation ($\pm I_x$) pins, which is the sum of the RTD resistance and the lead resistances.

Note 10: For accurate three wire compensation, the individual lead resistances connected to the $\pm I_x$ pins must be of equal value.

Thermistor measurement accuracy

Table 7. Thermistor measurement accuracy specifications

Thermistor	Temperature range (°C)	Maximum accuracy error (°C) $I_{x+} = 10 \mu A$
2252 Ω	-40 to 120	± 0.05
3000 Ω	-40 to 120	± 0.05
5000 Ω	-35 to 120	± 0.05
10000 Ω	-25 to 120	± 0.05
30000 Ω	-10 to 120	± 0.05

Note 11: Error shown does not include errors of the sensor itself. The sensor linearization is performed using a Steinhart-Hart linearization algorithm. These specs are for one year while operation of the device is between 15 °C and 35 °C. The specification does not include lead resistance errors for 2-wire thermistor connections. Please contact your sensor supplier for details on the actual sensor error limitations. Total thermistor resistance on any given channel pair must not exceed 180 k Ω . Typical resistance values at various temperatures for supported thermistors are shown in Table 8.

Table 8. Typical thermistor resistance specifications

Temp (°C)	2252 Ω thermistor	3000 Ω thermistor	5 k Ω thermistor	10 k Ω thermistor	30 k Ω thermistor
-40	76 k Ω	101 k Ω	168 k Ω	240 k Ω (Note 12)	885 k Ω (Note 12)
-35	55 k Ω	73 k Ω	121 k Ω	179 k Ω	649 k Ω (Note 12)
-30	40 k Ω	53 k Ω	88 k Ω	135 k Ω	481 k Ω (Note 12)
-25	29 k Ω	39 k Ω	65 k Ω	103 k Ω	360 k Ω (Note 12)
-20	22 k Ω	29 k Ω	49 k Ω	79 k Ω	271 k Ω (Note 12)
-15	16 k Ω	22 k Ω	36 k Ω	61 k Ω	206 k Ω (Note 12)
-10	12 k Ω	17 k Ω	28 k Ω	48 k Ω	158 k Ω
-5	9.5 k Ω	13 k Ω	21 k Ω	37 k Ω	122 k Ω
0	7.4 k Ω	9.8 k Ω	16 k Ω	29 k Ω	95 k Ω

Note 12: Resistance values greater than 180 k Ω cannot be measured by the device in the thermistor mode. The 180 k Ω resistance limit includes the total resistance across the current excitation ($\pm I_x$) pins, which is the sum of the thermistor resistance and the lead resistances.

Note 13: For accurate three wire compensation, the individual lead resistances connected to the $\pm I_x$ pins must be of equal value.

Throughput rate to PC (USB or wireless)

Table 9. 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 14: 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 device is approximately 0.5 seconds

Digital input/output

Table 10. Digital input/output specifications

Parameter	Specification
Digital type	CMOS
Number of I/O	8 (DIO0 through DIO7)
Configuration	Independently configured for input or output. Power on reset is input mode unless bit is configured for alarm.
Pull up/pull-down configuration	All pins pulled up to +5 V via 47 k Ω resistors (default). Pull down to ground (GND) also available.
Digital I/O transfer rate (software paced)	<ul style="list-style-type: none"> ▪ Digital input: 50 port reads or single bit reads per second, typ ▪ 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 15: All ground pins are common and 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.

Temperature alarms

Table 11. Temperature alarm specifications

Parameter	Specification
Number of alarms	8 (one per digital I/O line)
Alarm functionality	Each alarm controls its associated digital I/O line as an alarm output. The input to each alarm may be any of the analog temperature input channels. When an alarm is enabled, its associated I/O line is set to output (after the device is reset) and driven to the appropriate state determined by the alarm options and input temperature. The alarm configurations are stored in non-volatile memory and are loaded at power on. Alarms will function both in wireless mode and while attached to USB.
Alarm input modes	<ul style="list-style-type: none"> Alarm when input temperature > T1 Alarm when input temperature > T1, reset alarm when input temperature goes below T2 Alarm when input temperature < T1 Alarm when input temperature < T1, reset alarm when input temperature goes above T2 Alarm when input temperature is < T1 or > T2 Note: T1 and T2 may be independently set for each alarm.
Alarm output modes	<ul style="list-style-type: none"> Disabled, digital I/O line may be used for normal operation Enabled, active high output (digital I/O line goes high when alarm conditions met) Enabled, active low output (digital I/O line goes low when alarm conditions met)
Alarm update rate	1 second

Memory

Table 12. Memory specifications

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

Microcontroller

Table 13. Microcontroller specifications

Parameter	Specification
Type	Three high performance 8-bit RISC microcontrollers

Wireless communications

Table 14. Wireless Communications specifications

Parameter	Specification
<i>Communication standard</i>	<i>IEEE 802.15.4, ISM 2.4GHz frequency band, non-beacon, point-to-point</i>
Range	Indoor/urban: Up to 150' (50 m) Outdoor RF line-of-sight: Up to 1/2 mile (750 m)
Transmit power output	10 mW (10 dBm)
<i>Receiver sensitivity</i>	<i>-100 dBm (1% packet error rate)</i>
<i>RF channels</i>	<i>12 direct sequence channels available, channels 12 – 23 (2.410 – 2.465 GHz) (software selectable)</i>
Addressing	16-bit PAN (personal area network) IDs per channel (software selectable) 64-bit device address
<i>Encryption</i>	<i>128-bit AES (software selectable)</i>

Note 16: Contains FCC ID: OUR-XBEEPRO. The enclosed device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (i.) this device may not cause harmful interference and (ii.) this device must accept any interference received, including interference that may cause undesired operation.

Note 17: Canada: Contains Model XBee Radio, IC: 4214A-XBEEPRO

Caution! To satisfy FCC RF exposure requirements for mobile transmitting devices, a separation distance of 20 cm or more should be maintained between the antenna of this device and persons during device operation. To ensure compliance, operations at closer than this distance is not recommended. The antenna used for this transmitter must not be co-located in conjunction with any other antenna or transmitter.

USB +5V voltage

Table 15. USB +5V voltage specifications

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

Power

Table 16. Power specifications

Parameter	Condition	Specification
Connected to USB		
Supply current		500 mA max
User +5V output voltage range (terminal block pin 21 and 47)	Connected to a self-powered hub. (Note 18)	4.75 V min to 5.25 V max
User +5V output current (terminal block pin 21 and pin 47)	Connected to a self-powered hub. (Note 18)	10 mA max
Isolation	Measurement system to PC	500 VDC min
Wireless Communications operation		
Supply current		500 mA max
AC Adapter Power Supply (used for remote wireless communications operation)		
Standalone power supply		USB power adapter 2.5 Watt USB adapter with interchangeable plugs (Includes plug for USA)
Output voltage		5 V $\pm 5\%$
Output wattage		2.5 W
Input voltage		100 VAC to 240 VAC 50 Hz to 60 Hz
Input current		0.2 A

Note 18: 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. This device may not be used with bus-powered hubs due to the power supply requirements.

Root Port Hubs reside in the PC USB Host Controller. The USB port(s) on your PC are root port hubs. All externally powered root port hubs (desktop PC) 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 17. USB specifications

Parameter	Specification
USB device type	USB 2.0 (full-speed)
Device compatibility	USB 1.1, USB 2.0
	<i>Bus powered, 500 mA consumption max</i>
USB cable type	<i>A-B cable, UL type AWM 2725 or equivalent. (min 24 AWG VBUS/GND, min 28 AWG D+/D-)</i>
USB cable length	3 m (9.84 ft) max

Current excitation outputs (I_x)

Table 18. Current excitation output specifications

Parameter	Specification
Configuration	4 dedicated pairs: ±I1: CH0/CH1 ±I2: CH2/CH3 ±I3: CH4/CH5 ±I4: CH6/CH7
Current excitation output ranges	Thermistor: 10 µA typ
	RTD: 210 µA typ
Tolerance	±5% typ
Drift	200 ppm/°C
Line regulation	2.1 ppm/V max
Load regulation	0.3 ppm/V typ
Output compliance voltage (relative to GND pins 9, 19, 28, 38)	3.90 V max −0.03 V min

Note 19: The device has four current excitation outputs, with ±I1 dedicated to the CH0/CH1 analog inputs, ±I2 dedicated to CH2/CH3, ±I3 dedicated to CH4/CH5, and ±I4 dedicated to CH6/CH7. The excitation output currents should always be used in this dedicated configuration.

Note 20: The current excitation outputs are automatically configured based on the sensor selected (thermistor or RTD).

Environmental

Table 19. Environmental specifications

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

Mechanical

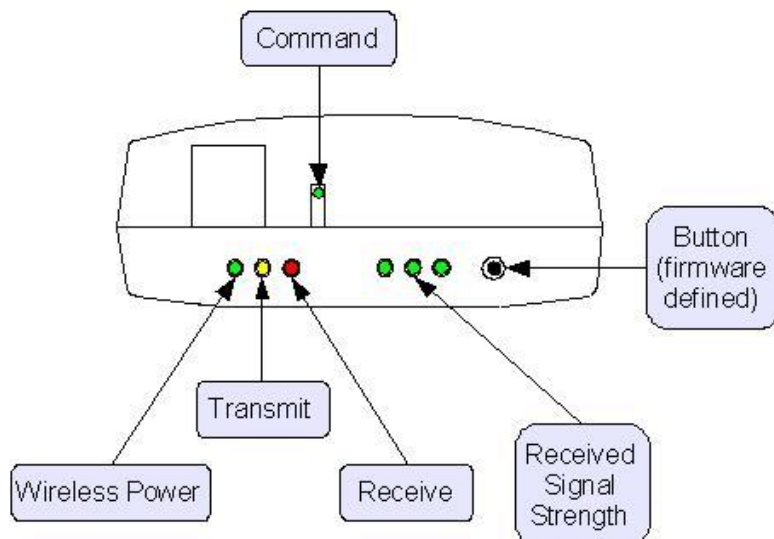
Table 20. Mechanical specifications

Parameter	Specification
Dimensions (L × W × H)	128.52 x 88.39 × 35.56 mm (5.06 × 3.48 × 1.43 ft)
User connection length	3 m (9.84 ft) max

LED / button configuration

Table 21. LED configuration

Parameter	Specification
Command LED	Green LED – indicates a command was received by the device (either USB or wireless)
Received Signal Strength Indicator (RSSI) LEDs	<p>Three green LED bar graph.</p> <p>LEDs turn on when receiving a wireless message and stay on for approximately 1 second after the end of the message. The LEDs indicate the amount of fade margin present in an active wireless link. Fade margin is defined as the difference between the incoming signal strength and the receiver sensitivity of the device.</p> <ul style="list-style-type: none"> 3 LEDs on: Very strong signal (>30 dB fade margin) 2 LEDs on: Strong signal (>20 dB fade margin) 1 LED on: Moderate signal (>10 dB fade margin) 0 LED on: Weak signal (<10 dB fade margin)
Wireless Power LED	Green LED: indicates that the internal RF module is powered.
Transmit LED	Yellow LED: indicates transmitting data over the wireless link.
Receive LED	Red LED: indicates receiving data over the wireless link.
Button	Firmware-defined; this revision executes an LED test.



Screw terminal connector

Table 22. Screw terminal connector specifications

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

Table 23. Screw terminal pinout

Pin	Signal Name	Pin Description	Pin	Signal Name	Pin Description
1	I1+	CH0/CH1 current excitation source	27	I4–	CH6/CH7 current excitation return
2	NC	No connection	28	GND	Ground
3	C0H	CH0 sensor input (+)	29	C7L	CH7 sensor input (–)
4	C0L	CH0 sensor input (–)	30	C7H	CH7 sensor input (+)
5	4W01	CH0/CH1 4-wire, 2 sensor common	31	IC67	CH6/CH7 2 sensor common
6	IC01	CH0/CH1 2-sensor common	32	4W67	CH6/CH7 4-wire, 2 sensor common
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	No connection
10	I1–	CH0/CH1 current excitation return	36	I4+	CH6/CH7 current excitation source
	CJC sensor			CJC sensor	
11	I2+	CH2/CH3 current excitation source	37	I3–	CH4/CH5 current excitation return
12	NC	No connection	38	GND	
13	C2H	CH2 sensor input (+)	39	C5L	CH5 sensor input (–)
14	C2L	CH2 sensor input (–)	40	C5H	CH5 sensor input (+)
15	4W23	CH2/CH3 4-wire, 2 sensor common	41	IC45	CH4/CH5 2 sensor common
16	IC23	CH2/CH3 2 sensor common	42	4W45	CH4/CH5 4-wire, 2 sensor common
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	No connection
20	I2–	CH2/CH3 current excitation return	46	I3+	CH4/CH5 current excitation source
21	+5V	+5V output	47	+5V	+5V output
22	GND	Ground	48	GND	Ground
23	DIO0	DIO channel 0	49	DIO7	DIO channel 7
24	DIO1	DIO channel 1	50	DIO6	DIO channel 6
25	DIO2	DIO channel 2	51	DIO5	DIO channel 5
26	DIO3	DIO channel 3	52	DIO4	DIO channel 4

CE Declaration of Conformity

Manufacturer: Measurement Computing Corporation
Address: 10 Commerce Way
Suite 1008
Norton, MA 02766
USA
Category: Electrical equipment for measurement, control and laboratory use.

Measurement Computing Corporation declares under sole responsibility that the product

WLS-TEMP

to which this declaration relates is in conformity with the relevant provisions of the following standards or other documents:

EU EMC Directive 89/336/EEC: Electromagnetic Compatibility, EN 61326 (1997) Amendment 1 (1998)

Emissions: Group 1, Class B

- EN 55011 (1990)/CISPR 11: Radiated and Conducted emissions.

Immunity: EN61326, Annex A

- IEC 61000-4-2 (1995): Electrostatic Discharge immunity, Criteria C.
- IEC 61000-4-3 (1995): Radiated Electromagnetic Field immunity Criteria A.
- IEC 61000-4-8 (1994): Power Frequency Magnetic Field immunity Criteria A.

ETSI EN301 489-1 (2004)

IEC 61000-3-2 (2001) Harmonic Current Emissions, IEC 61000-3-3 (2003) Voltage Fluctuations and Flicker

Emissions: Group 1, Class B

- CISPR 22 (2004): Radiated and Conducted Electromagnetic Emissions (USB cable with ferrite suppressor assembly required).
- IEC 61000-3-2 (2001): Harmonic Emissions Class A
- IEC 61000-3-3 (2003): Fluctuations and Flicker

Immunity:

- IEC 61000-4-2 (2001): Electrostatic Discharge immunity, Criteria C.
- IEC 61000-4-3 (2002): Radiated Electromagnetic Field immunity Criteria A.
- IEC 61000-4-4 (2004): Electric fast transient burst immunity Criteria B.
- IEC 61000-4-5: Fast surge immunity Criteria B
- IEC 61000-4-6 (2003): Radio Frequency Common Mode immunity Criteria B*.
- IEC 61000-4-11 (2004): Voltage dips and interrupt immunity Criteria B

* There may be a loss of performance in the presence of an RF electromagnetic disturbance on the input/output ports. Performance loss will be limited to measured temperatures outside of specified accuracy. The transmitter / receiver will continue to operate as specified. Stored data and operating state will be maintained during the disturbance. Operation will recover to within specified limits after the disturbance is removed.

Declaration of Conformity based on tests conducted by Chomerics Test Services, Woburn, MA 01801, USA in November, 2006. Test records are outlined in Chomerics Test Report #EMI4660.06.

We hereby declare that the equipment specified conforms to the above Directives and Standards.



Carl Haapaoja, Director of Quality Assurance

Measurement Computing Corporation
10 Commerce Way
Suite 1008
Norton, Massachusetts 02766
(508) 946-5100
Fax: (508) 946-9500
E-mail: info@mccdaq.com
www.mccdaq.com