

USER GUIDE AND SPECIFICATIONS

NI USB-TC01

Single Channel Thermocouple Input Module

This user guide describes how to use the National Instruments USB-TC01 data acquisition (DAQ) device and lists the specifications.

Introduction

The NI USB-TC01 provides a Full-Speed USB interface for a single thermocouple channel.

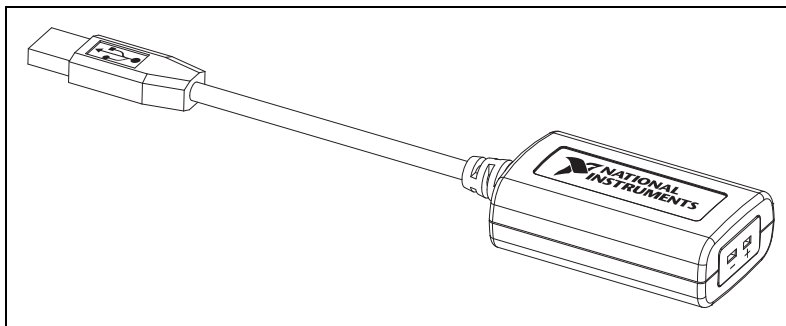


Figure 1. NI USB-TC01

Safety Guidelines



Caution Operate the NI USB-TC01 only as described in these operating instructions.

The following section contains important safety information that you must follow when installing and using the NI USB-TC01.



Caution Do not operate the NI USB-TC01 in a manner not specified in this user guide. Misuse of the device can result in a hazard. You can compromise the safety protection built into the device if the device is damaged in any way. If the device is damaged, contact National Instruments for repair.



Caution Do not substitute parts or modify the device except as described in this user guide. Use the device only with the accessories specified in the installation instructions.



Caution Do not operate the device in an explosive atmosphere or where there may be flammable gases or fumes. If you must operate the device in such an environment, it must be in a suitably rated enclosure.

If you need to clean the device, use a dry cloth. Make sure that the device is completely dry and free from contaminants before returning it to service.

Operate the device only at or below Pollution Degree 2. Pollution is foreign matter in a solid, liquid, or gaseous state that can reduce dielectric strength or surface resistivity. The following is a description of pollution degrees:

- Pollution Degree 1 means no pollution or only dry, nonconductive pollution occurs. The pollution has no influence.
- Pollution Degree 2 means that only nonconductive pollution occurs in most cases. Occasionally, however, a temporary conductivity caused by condensation must be expected.
- Pollution Degree 3 means that conductive pollution occurs, or dry, nonconductive pollution occurs that becomes conductive due to condensation.

You must insulate signal connections for the maximum voltage for which the device is rated. Do not exceed the maximum ratings for the device. Do not install wiring while the device is live with electrical signals.

Operate the device at or below the Measurement Category I¹. Measurement circuits are subjected to working voltages² and transient stresses (overvoltage) from the circuit to which they are connected during measurement or test. Measurement categories establish standard impulse withstand voltage levels that commonly occur in electrical distribution systems. The following is a description of measurement categories:

- Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as MAINS³ voltage. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.

¹ Measurement Category as defined in electrical safety standard IEC 61010-1. Measurement Category is also referred to as Installation Category.

² Working Voltage is the highest rms value of an AC or DC voltage that can occur across any particular insulation.

³ MAINS is defined as a hazardous live electrical supply system that powers equipment. Suitably rated measuring circuits may be connected to the MAINS for measuring purposes.

- Measurement Category II is for measurements performed on circuits directly connected to the electrical distribution system. This category refers to local-level electrical distribution, such as that provided by a standard wall outlet (for example, 115 V for U.S. or 230 V for Europe). Examples of Measurement Category II are measurements performed on household appliances, portable tools, and similar E Series devices.
- Measurement Category III is for measurements performed in the building installation at the distribution level. This category refers to measurements on hard-wired equipment such as equipment in fixed installations, distribution boards, and circuit breakers. Other examples are wiring, including cables, bus-bars, junction boxes, switches, socket-outlets in the fixed installation, and stationary motors with permanent connections to fixed installations.
- Measurement Category IV is for measurements performed at the primary electrical supply installation (<1,000 V). Examples include electricity meters and measurements on primary overcurrent protection devices and on ripple control units.

Information Resources

Technical Support on the Web

The NI USB-TC01 online support page contains links to the most recent product documentation, drivers and updates, KnowledgeBase documents, tutorials, and example code. The NI USB-TC01 support page is accessible from the NI USB-TC01 Launch Screen by selecting the **Device Support** link or from ni.com/info by entering infocode USBTC01.

Training Courses

If you need more help getting started developing an application with NI products, NI offers training courses. To enroll in a course or obtain a detailed course outline, refer to ni.com/training.

Installing the NI USB-TC01

The NI USB-TC01 software support for Windows 7/Vista/XP is provided by the device. No separate driver installation is required for operation.

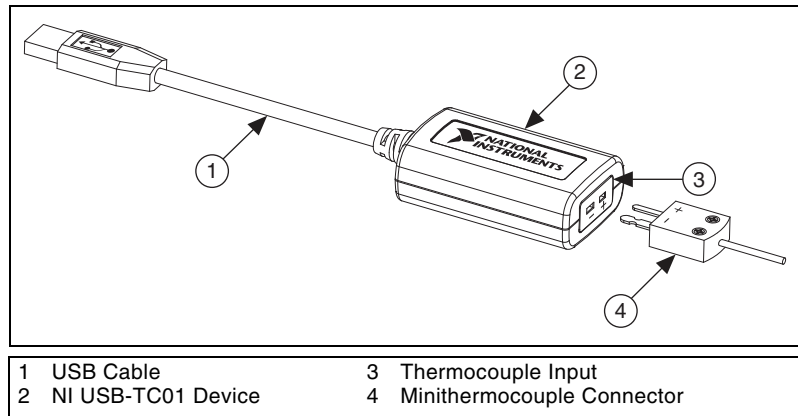


Figure 2. NI USB-TC01 Components

Complete the following steps to set up the NI USB-TC01:

1. Plug the thermocouple into the thermocouple input on the NI USB-TC01 device. Refer to the [Thermocouple Input](#) section for more information.
2. Connect the NI USB-TC01 USB cable into an available USB port on the computer. On first connection to the computer, it may take a few seconds for the operating system to detect and configure the NI USB-TC01 device.

Once the device has been successfully detected, the NI USB-TC01 Launch Screen will open (as shown in Figure 3), or a Windows Autoplay dialog will appear allowing you to select **TC01Launcher.exe** to run the software.



Note Your NI USB-TC01 needs to be connected to the computer for the NI USB-TC01 Launch Screen to open. If the NI USB-TC01 is connected to the computer and the NI USB-TC01 Launch Screen does not appear, refer to the NI USB-TC01 support page. The NI USB-TC01 support page is accessible from the NI USB-TC01 Launch Screen by selecting the **Device Support** link or from ni.com/info by entering infocode USBTC01.



Note If Autoplay does not start, locate the NI USB-TC01 under My Computer and double-click `TC01Launcher.exe` to manually run the software.

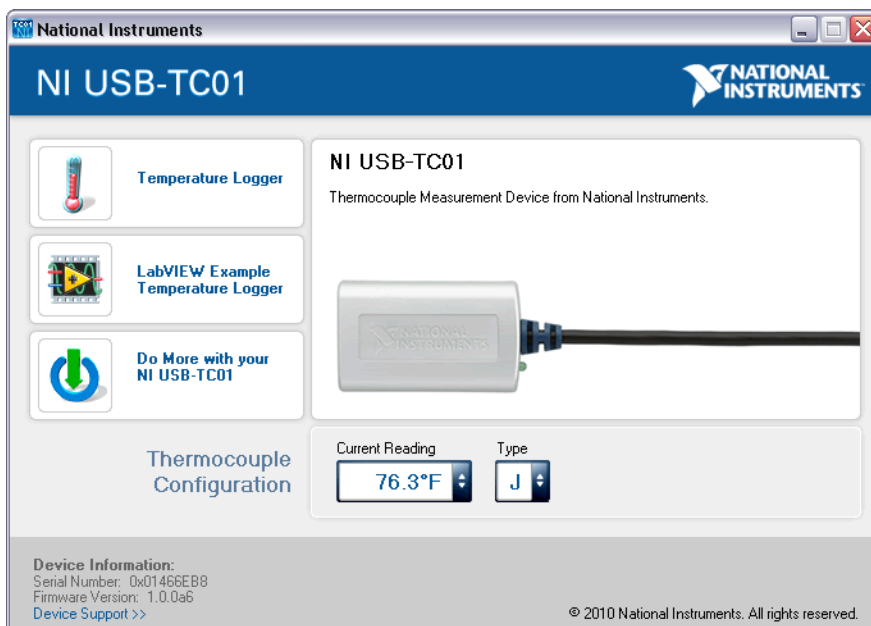


Figure 3. NI USB-TC01 Launch Screen

With the NI USB-TC01 Launch Screen, you can graph and log data with the Temperature Logger, customize the Temperature Logger source code in LabVIEW, and explore other ways to do more with your NI USB-TC01.



Note When the Temperature Logger or another application accesses the device, the **Current Reading** on the NI USB-TC01 Launch Screen is blocked and does not update.

LED Indicator

The NI USB-TC01 has a green LED next to the USB cable to indicate the device status. When the LED is illuminated, the device is powered and ready for operation. If the LED is not illuminated, the device is not powered or did not initialize.

Taking Measurements with Software

Logging Temperature

To log temperature data, complete the following:

1. From the NI USB-TC01 Launch Screen, click **Temperature Logger**.
2. In the NI USB-TC01 Temperature Logger window that opens, select the **Thermocouple Type** and **Temperature Units**.
3. If you want to capture, or log, the temperature readings, select **Log Data**.

4. Click **Start**. Your NI USB-TC01 acquires and graphs the temperature until you click **Stop**.
5. Click **View Log** to open the log file.

Downloading Additional Applications

Additional ready-to-run applications that provide added functionality for your NI USB-TC01 are available as free downloads. You can access these applications by selecting **Do More with your NI USB-TC01** from the NI USB-TC01 Launch Screen.

Creating Custom Software

In addition to taking measurements with the NI USB-TC01 Launch Screen, you can also build custom software for your NI USB-TC01 with LabVIEW and NI-DAQmx driver software. LabVIEW uses graphical icons and wires that resemble a flowchart, so you can graphically wire together function blocks to create your own applications for logging data, alarming, triggering, reporting, and performing real-time data analysis. To learn more, select **Do More with your NI USB-TC01** from the NI USB-TC01 Launch Screen.

Connecting Input Signals

The NI USB-TC01 provides connections for one thermocouple. Thermocouple types J, K, R, S, T, N, E, and B are supported.

The NI USB-TC01 has a two-prong uncompensated thermocouple input that accepts a standard two-prong male minithermocouple connector.

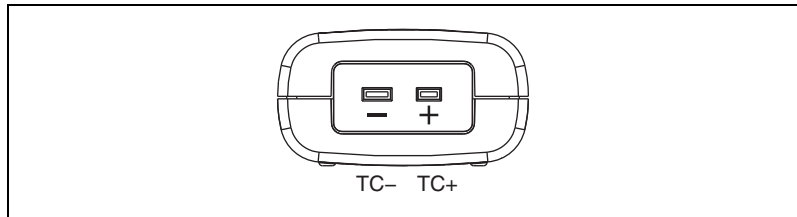


Figure 4. NI USB-TC01 Terminal Assignments

Connect the positive lead of the thermocouple connector to the TC+ terminal, and the negative lead of the thermocouple connector to the TC- terminal.

If you are unsure which of the thermocouple leads is positive and which is negative, check the thermocouple documentation or the thermocouple wire spool.

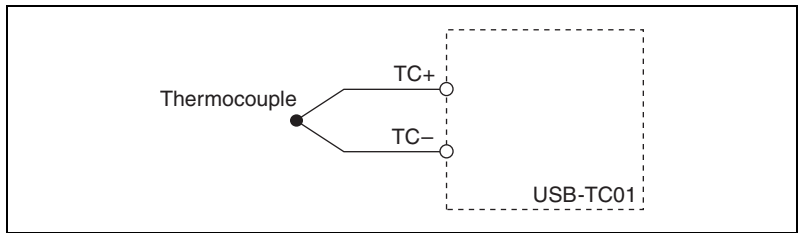


Figure 5. Connecting a Thermocouple Input Signal to the NI USB-TC01

For best results, NI recommends the use of insulated or ungrounded thermocouples when possible. 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.

Temperature measurement errors depend in part on the thermocouple type, the temperature being measured, the accuracy of the thermocouple, and the cold-junction temperature. Error graphs for each thermocouple type connected to the NI USB-TC01 are shown in the [Specifications](#) section.

NI USB-TC01 Circuitry

The NI USB-TC01 device's thermocouple channel passes through a differential filter and is sampled by a 20-bit analog-to-digital converter (ADC), as shown in Figure 6.

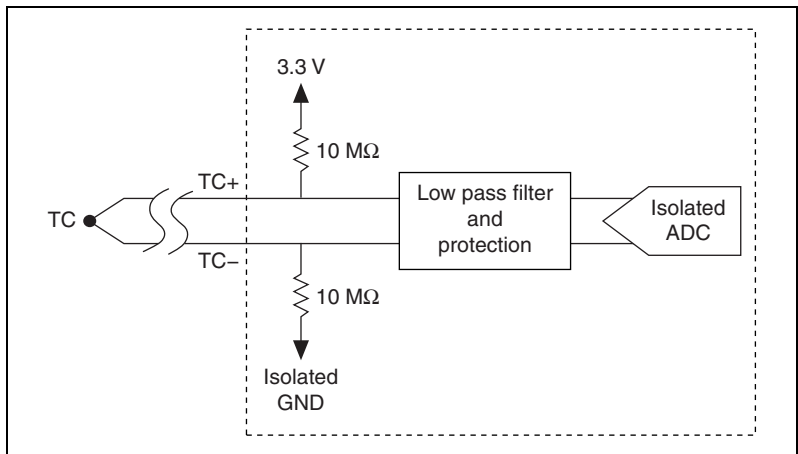


Figure 6. NI USB-TC01 Input Circuitry

Thermocouple Measurement Accuracy

Temperature measurement errors depend in part on the thermocouple type, the temperature being measured, the accuracy of the thermocouple, and the cold-junction temperature sensing accuracy.

Thermocouple Input

The NI USB-TC01 supports the J, K, S, T, N, E, R, and B thermocouple types. The thermocouple input supports the standard minithermocouple connector.

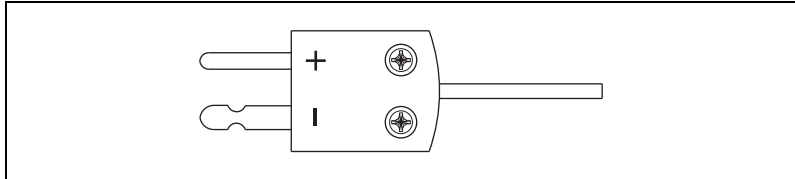


Figure 7. Minithermocouple Connector

If your thermocouple has bare wire leads, you can purchase a screw terminal minithermocouple connector to use with the NI USB-TC01. For the best accuracy, the minithermocouple connector type and thermocouple type should match.

Open-Thermocouple Detection (OTD)

The NI USB-TC01 is equipped with open-thermocouple detection. With OTD, any open-circuit condition at the thermocouple sensor is detected by the software. An open channel is detected by driving the input voltage to a positive value outside the range of the thermocouple output.

If an open thermocouple is detected, the NI USB-TC01 software displays a message and lists the internal CJC temperature, as shown in Figure 8.

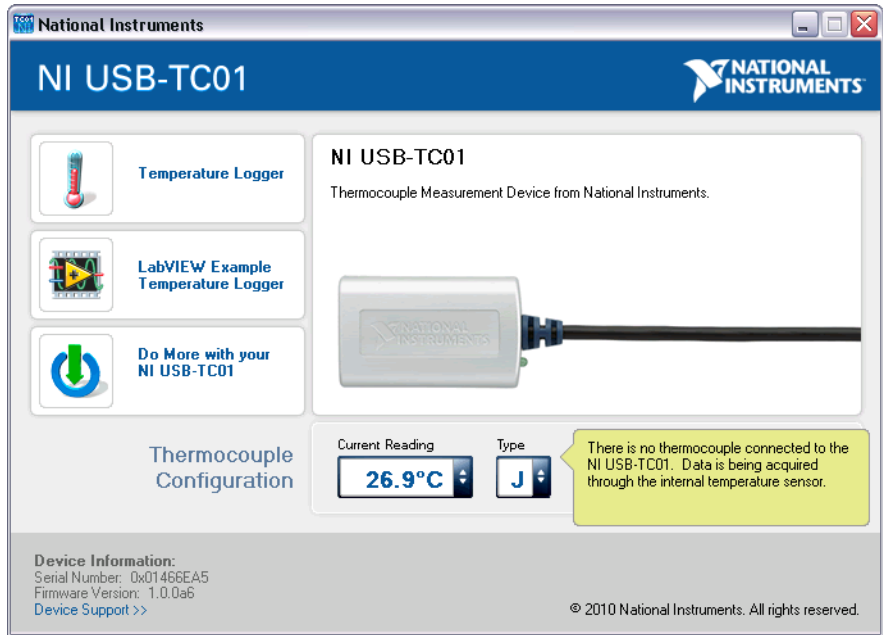


Figure 8. NI USB-TC01 Software Open Thermocouple Message



Note During an open thermocouple condition, some invalid values may be returned before the open thermocouple is reported.

Cold-Junction Temperature Measurement Accuracy

Heat from other nearby heat sources can cause errors in thermocouple measurements by heating up the terminals so that they are at a different temperature than the cold-junction compensation sensor used to measure the cold junction.

Minimizing Thermal Gradients

Thermocouple wire can be a significant source of thermal gradients if it conducts heat or cold directly to terminal junctions. To minimize these errors, use the following guidelines:

- Use small-gauge thermocouple wire. Smaller wire transfers less heat to or from the measuring junction.
- Avoid running thermocouple wires near hot or cold objects.
- If you connect any extension wires to thermocouple wires, use wires made of the same conductive material.

Specifications



Caution Electromagnetic interference can adversely affect the measurement accuracy of this product. The input terminals of this device are not protected for electromagnetic interference. As a result, this device may experience reduced measurement accuracy or other temporary performance degradation when connected cables are routed in an environment with radiated or conducted radio frequency electromagnetic interference. To limit radiated emissions and to ensure that this device functions within specifications in its operational electromagnetic environment, take precautions when designing, selecting, and installing measurement probes and cables.

The following specifications are typical at 25 °C, unless otherwise noted.

Recommended warm-up time.....15 minutes

Input Characteristics

Number of channels	1
ADC resolution	20 bits
Input range	±73.125 mV
Common-mode range	
Channel-to-USB Ground	±30 V
Common-mode rejection ratio (0 to 60 Hz)	
Common-to-USB ground	>145 dB
Noise rejection (50/60 Hz)	>80 dB
Temperature measurement ranges	Works over temperature ranges defined by NIST (J, K, R, S, T, N, E, and B thermocouple types. The E type has a maximum limit of 900 °C.)
Conversion time.....	250 ms
Sampling rate	4 samples per second max
Input bandwidth (–3 dB).....	1 Hz
Differential input impedance	20 MΩ between isolated 3.3 V and ground

Input noise.....	2 μ Vpp
Open thermocouple bias voltage.....	3.3 V
Cold-junction compensation sensor accuracy	
0 to 65 °C	1.25 °C max, 0.6 °C typical
Cold-junction compensation sensor resolution	0.0625 °C typical
Overvoltage protection.....	30 V max between TC+ and TC–

Temperature Measurement Accuracy

Figures 9 through 16 show the errors for each thermocouple type when connected to the NI USB-TC01. The figures display the maximum errors at 25 °C and over the full operating temperature range, and account for cold-junction compensation errors. The figures were generated using thermocouples connected to subminiature connectors of the same type.

The CJC sensor resolution is 0.0625 °C. This is the minimum value of the CJC step width. As such, the reading may result in a saw tooth curve rather than a square curve as the temperature inside the board changes. This is the expected behavior.

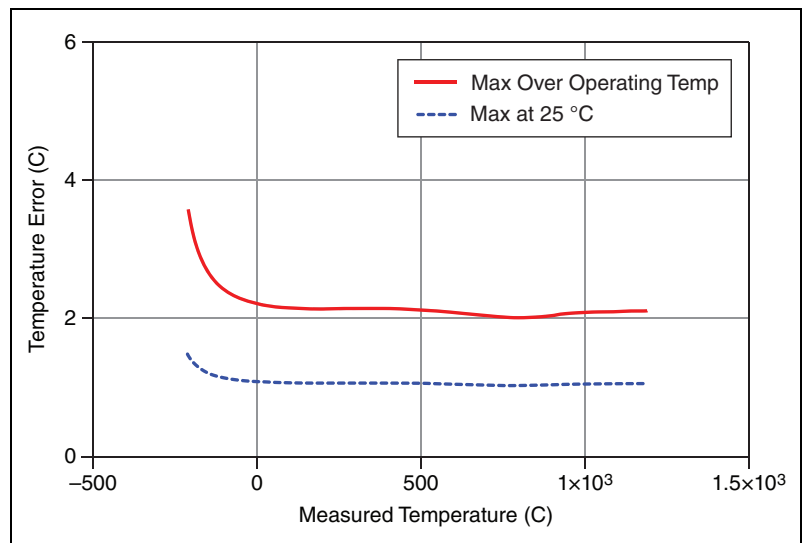


Figure 9. Temperature Error of Type J Thermocouple

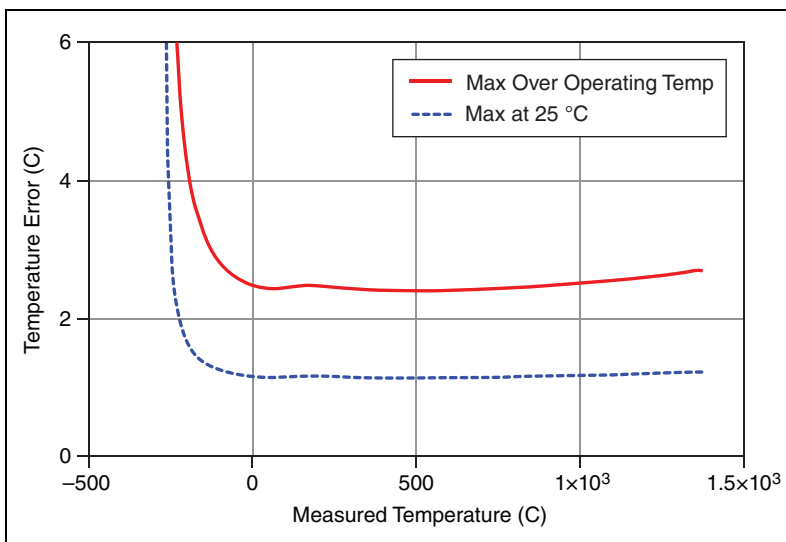


Figure 10. Temperature Error of Type K Thermocouple

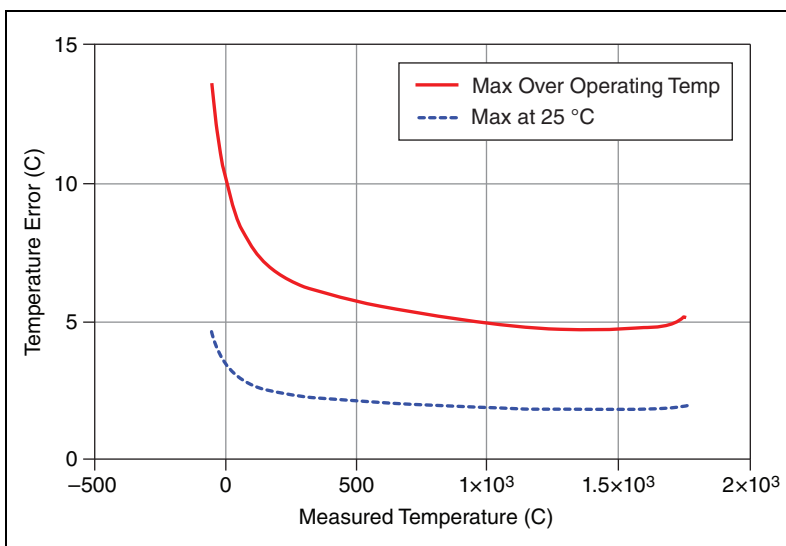


Figure 11. Temperature Error of Type R Thermocouple

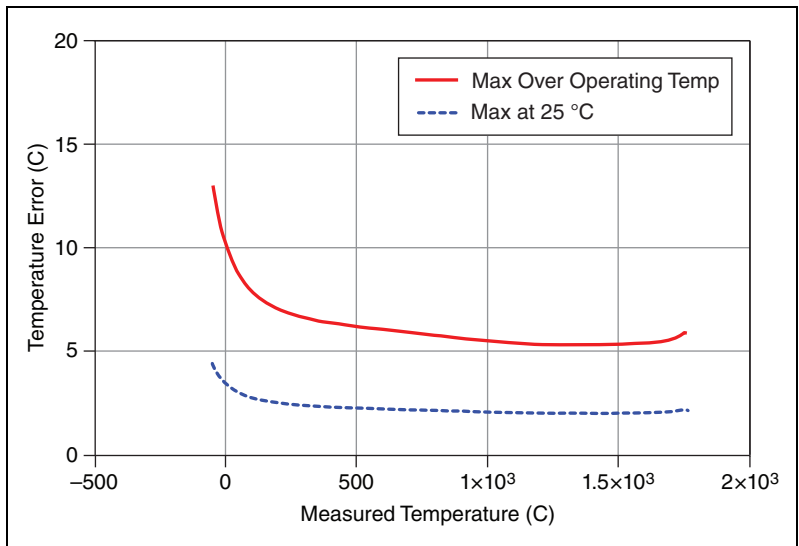


Figure 12. Temperature Error of Type S Thermocouple

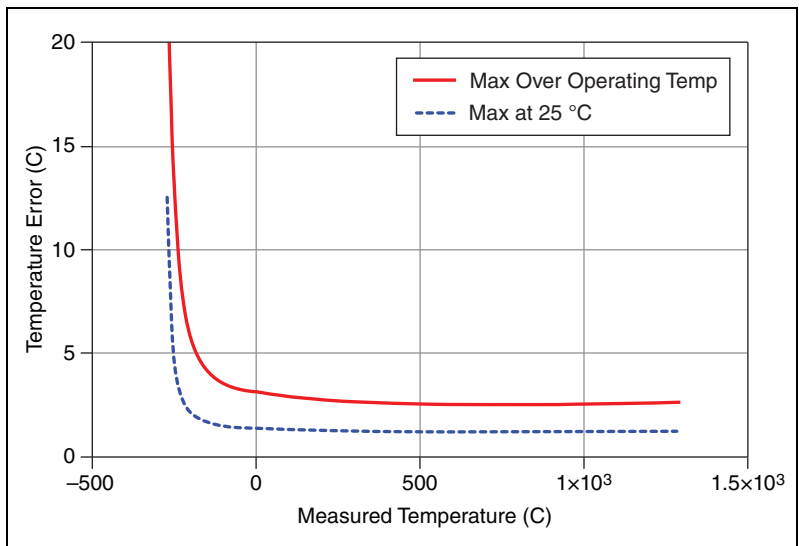


Figure 13. Temperature Error of Type N Thermocouple

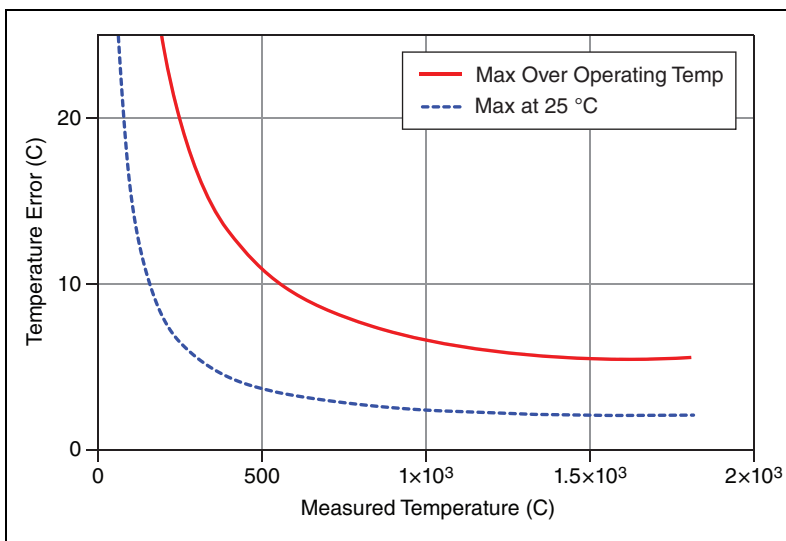


Figure 14. Temperature Error of Type B Thermocouple

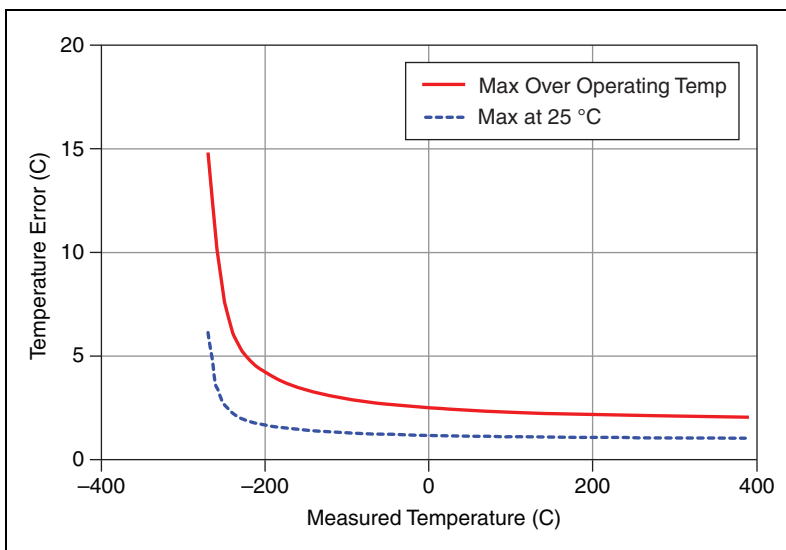


Figure 15. Temperature Error of Type T Thermocouple

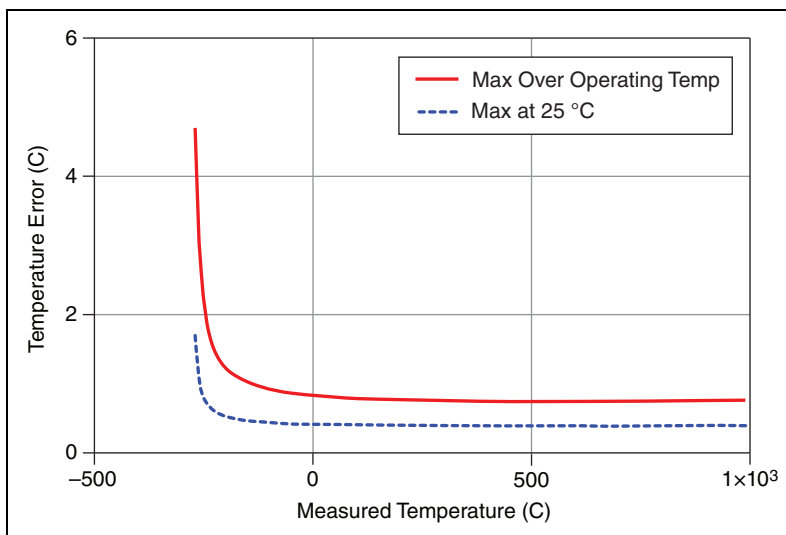


Figure 16. Temperature Error of Type E Thermocouple

Power Requirements

Current consumption from USB	150 mA max, 100 mA typical
Suspend mode	2.5 mA max

Bus Interface/Communication

USB specification USB 2.0 Full-Speed

Physical/Mechanical Characteristics

Dimensions..... $62.56 \times 38.10 \times 20.32$ mm
($2.463 \times 1.5 \times 0.8$ in.)
with a 2 m USB cable

Weight..... Approx. 116 g (4.1 oz)

USB cable length 2 m (6.5 ft)

Safety

This product meets the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN-61010-1
- UL 61010-1, CSA 61010-1



Note For UL and other safety certifications, refer to the product label or visit ni.com/certification, search by model number or product line, and click the appropriate link in the Certification column.

Safety Voltages

Connect only voltages that are within these limits.

Isolation

Channel-to-earth ground

Continuous±30 V max,
Measurement Category I

Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as *MAINS* voltage. MAINS is a hazardous live electrical supply system that powers equipment. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.

Hazardous Locations

The NI USB-TC01 is not certified for use in hazardous locations.

Electromagnetic Compatibility

This product meets the requirements of the following EMC standards for electrical equipment for measurement, control, and laboratory use:

- EN 61326 (IEC 61326): Class A emissions; Basic immunity
- EN 55011 (CISPR 11): Group 1, Class A emissions
- AS/NZS CISPR 11: Group 1, Class A emissions
- FCC 47 CFR Part 15B: Class A emissions
- ICES-001: Class A emissions



Note For the standards applied to assess the EMC of this product, refer to the *Online Product Certification* section.

CE Compliance

This product meets the essential requirements of applicable European Directives as follows:

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EC; Electromagnetic Compatibility Directive (EMC)

Online Product Certification

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for this product, visit ni.com/certification, search by model number or product line, and click the appropriate link in the Certification column.

Environmental

The NI USB-TC01 device is intended for indoor use only.

Operating temperature
(IEC 60068-2-1 and IEC 60068-2-2) 0 to 55 °C

Storage temperature
(IEC 60068-2-1 and IEC 60068-2-2) –40 to 85 °C

Operating humidity (IEC 60068-2-56).....10 to 90% RH, noncondensing

Storage humidity (IEC 60068-2-56) 5 to 95% RH, noncondensing

Maximum altitude 2,000 m (at 25 °C ambient temperature)

Pollution Degree (IEC 60664) 2

Environmental Management

National Instruments is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial not only to the environment but also to NI customers.

For additional environmental information, refer to the *NI and the Environment* Web page at ni.com/environment. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this user guide.

Waste Electrical and Electronic Equipment (WEEE)



EU Customers At the end of the product life cycle, all products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers, National Instruments WEEE initiatives, and compliance with WEEE Directive 2002/96/EC on Waste and Electronic Equipment, visit ni.com/environment/weee.

电子信息产品污染控制管理办法（中国 RoHS）



中国客户 National Instruments 符合中国电子信息产品中限制使用某些有害物质指令 (RoHS)。关于 National Instruments 中国 RoHS 合规性信息，请登录 ni.com/environment/rohs_china。(For information about China RoHS compliance, go to ni.com/environment/rohs_china.)

Where to Go for Support

The National Instruments Web site is your complete resource for technical support. At ni.com/support you have access to everything from troubleshooting and application development self-help resources to email and phone assistance from NI Application Engineers.

National Instruments corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. National Instruments also has offices located around the world to help address your support needs. For telephone support in the United States, create your service request at ni.com/support and follow the calling instructions or dial 512 795 8248. For telephone support outside the United States, contact your local branch office:

Australia 1800 300 800, Austria 43 662 457990-0,
Belgium 32 (0) 2 757 0020, Brazil 55 11 3262 3599,
Canada 800 433 3488, China 86 21 5050 9800,
Czech Republic 420 224 235 774, Denmark 45 45 76 26 00,
Finland 358 (0) 9 725 72511, France 01 57 66 24 24,
Germany 49 89 7413130, India 91 80 41190000, Israel 972 3 6393737,
Italy 39 02 41309277, Japan 0120-527196, Korea 82 02 3451 3400,
Lebanon 961 (0) 1 33 28 28, Malaysia 1800 887710,
Mexico 01 800 010 0793, Netherlands 31 (0) 348 433 466,
New Zealand 0800 553 322, Norway 47 (0) 66 90 76 60,
Poland 48 22 328 90 10, Portugal 351 210 311 210,
Russia 7 495 783 6851, Singapore 1800 226 5886,
Slovenia 386 3 425 42 00, South Africa 27 0 11 805 8197,
Spain 34 91 640 0085, Sweden 46 (0) 8 587 895 00,
Switzerland 41 56 2005151, Taiwan 886 02 2377 2222,
Thailand 662 278 6777, Turkey 90 212 279 3031,
United Kingdom 44 (0) 1635 523545

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