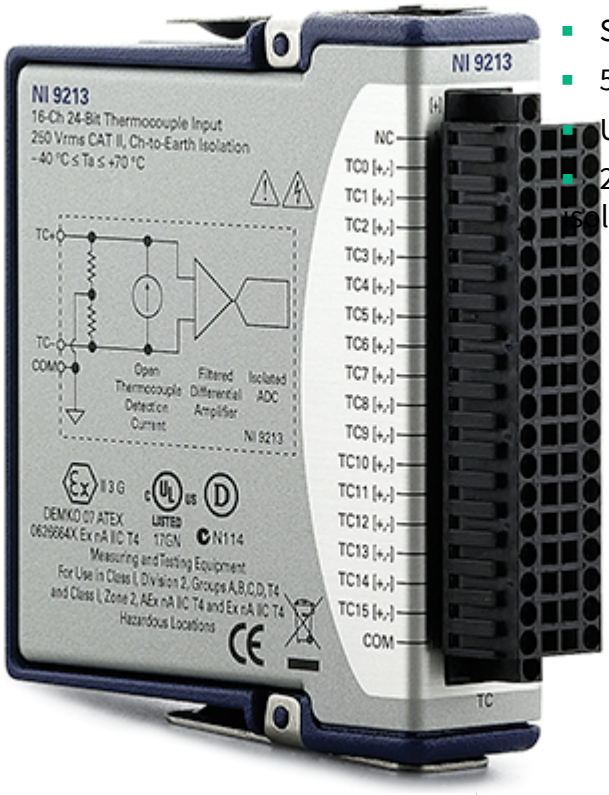
NI-9213 Specifications

2023-04-19

Contents

NI 9213 Datasheet



- Spring terminal connectivity
- 50 Hz/60 Hz noise rejection
- Up to 0.02 °C measurement sensitivity
- 250 V RMS, CAT II, channel-to-earth isolation

The NI-9213 is a high-density thermocouple module for CompactDAQ and CompactRIO chassis. Designed for higher-channel-count systems, the NI-9213 adds thermocouples to mixed-signal test systems without taking up too many slots.

Kit Contents	• NI 9213 • NI 9213 Getting Started Guide
Accessories	• NI 9940 Backshell Connector Kit

C Series Thermocouple Module Comparison

Product	Channels	Connectivity	Accuracy [1]	Max Sample Rate, Scanned [2]	Max Sample Rate, Simultaneous [3]	Max Sample Rate, All Filtered [4]	OTD [5]	Isolation [6]
NI 9210	4	Screw Terminal	0.8°C	14 S/s	–	2.3 Scans/s	Yes	Ch-Earth
		Mini-TC	0.84°C					
NI 9211	4	Screw Terminal	0.9°C	14 S/s	–	2.3 Scans/s	Yes	Ch-Earth
NI 9212	8	Screw Terminal	0.4°C	–	95 S/s/Ch	7.1 Scans/s	Yes	Ch-Ch
		Mini-TC	0.7°C					
NI 9213	16	Spring Terminal †	0.8°C	100 S/s	–	1.0 Scans/s	Yes	Ch-Earth
NI 9214	16	Screw Terminal	0.4°C	100 S/s	–	0.96 Scans/s	Select-able	Ch-Earth
NI 9219	4	Spring Terminal	1.6°C	–	50 S/s/Ch	7.1 Scans/s	No	Ch-Ch

[1] Typical at 23±5°C operating temperature, For J-type sensor measuring 100°C.
[2] This is the fastest rate of the module for a single channel. When scanning more than one channel, the sample rate is reduced, see data sheets for details.
[3] This is the fastest rate of the module; it can sample all channels simultaneously at this rate.
[4] This is the fastest rate of the module using all of its channels at the same time, with optimized rejection of standard power line frequencies. See data sheets for details about specific powerline frequencies.
[5] Open Thermocouple Detection.
[6] Ch-Ch isolation means that the channels are isolated from earth ground and from each other. Ch-Earth isolation means that the channels are isolated from earth ground but not from each other.
† These connectors feature tool-less wire entry, meaning that solid core wires (AWG 26 - AWG 16) can be inserted without using a tool.

NI C Series Overview

NI provides more than 100 C Series modules for measurement, control, and communication applications. C Series modules can connect to any sensor or bus and allow for high-accuracy measurements that meet the demands of advanced data acquisition and control applications.

- Measurement-specific signal conditioning that connects to an array of sensors and signals

- Isolation options such as bank-to-bank, channel-to-channel, and channel-to-earth ground
- -40 °C to 70 °C temperature range to meet a variety of application and environmental needs
- Hot-swappable

The majority of C Series modules are supported in both CompactRIO and CompactDAQ platforms and you can move modules from one platform to the other with no modification.

CompactRIO

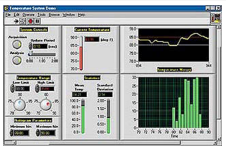
CompactRIO combines an open-embedded architecture with small size, extreme ruggedness, and C Series modules in a platform powered by the NI LabVIEW reconfigurable I/O (RIO) architecture. Each system contains an FPGA for custom timing, triggering, and processing with a wide array of available modular I/O to meet any embedded application requirement.

CompactDAQ

CompactDAQ is a portable, rugged data acquisition platform that integrates connectivity, data acquisition, and signal conditioning into modular I/O for directly interfacing to any sensor or signal. Using CompactDAQ with LabVIEW, you can easily customize how you acquire, analyze, visualize, and manage your measurement data.

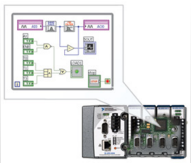
Software

LabVIEW Professional Development System for Windows



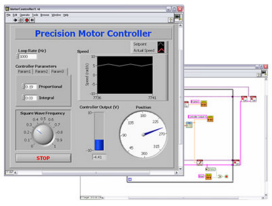
- Use advanced software tools for large project development
- Generate code automatically using DAQ Assistant and Instrument I/O Assistant
- Use advanced measurement analysis and digital signal processing
- Take advantage of open connectivity with DLLs, ActiveX, and .NET objects
- Build DLLs, executables, and MSI installers

NI LabVIEW FPGA Module



- Design FPGA applications for NI RIO hardware
- Program with the same graphical environment used for desktop and real-time applications
- Execute control algorithms with loop rates up to 300 MHz
- Implement custom timing and triggering logic, digital protocols, and DSP algorithms
- Incorporate existing HDL code and third-party IP including Xilinx IP generator functions
- Purchase as part of the LabVIEW Embedded Control and Monitoring Suite

NI LabVIEW Real-Time Module

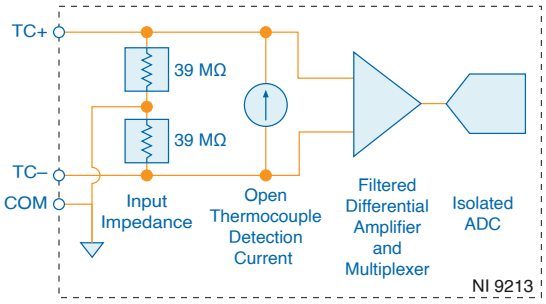


- Design deterministic real-time applications with LabVIEW graphical programming
- Download to dedicated NI or third-party hardware for reliable execution and a wide selection of I/O
- Take advantage of built-in PID control, signal processing, and analysis functions
- Automatically take advantage of multicore CPUs or set processor affinity manually
- Take advantage of real-time OS, development and debugging support, and board support
- Purchase individually or as part of a LabVIEW suite

NI-9213 Block Diagram

Each channel passes through a differential filter and then is multiplexed and sampled by a 24-bit analog-to-digital converter (ADC). The channels share a common ground, COM, that is isolated from other modules in the system.

Figure 1. Input Circuitry for One Channel of the NI-9213



Common-Mode Voltage

The NI-9213 common-mode range is the maximum voltage between any channel and COM. If COM is not connected, then the common-mode voltage range is the maximum voltage between any two channels. The NI-9213 measures the common-mode voltage level of each channel and returns a warning in the software if the signal is outside the common-mode voltage range.

Open Thermocouple Detection

Each channel has an open thermocouple detection (OTD) circuit, which consists of a current source between the TC+ and TC- terminals. If an open thermocouple is connected to the channel, the current source forces a full-scale voltage across the terminals.

Input Impedance

Each channel has a resistor that produces an input impedance between the TC and COM terminals. The gain and offset errors resulting from the source impedance of connected thermocouples are negligible for most applications. Thermocouples with a higher lead resistance can introduce more significant errors.

Thermocouple Measurement Accuracy

Thermocouple measurement errors depend partly on the following factors.

- Type of thermocouple
- Accuracy of the thermocouple
- Temperature that you are measuring
- Resistance of the thermocouple wires
- Cold-junction temperature

For the best accuracy performance, follow these guidelines:

- Set up the NI-9213 according to the getting started guide on ni.com/manuals to minimize thermal gradients across the NI-9213 terminals.
- Use the autozero channel to compensate for offset errors.

Cold-Junction Accuracy

Heat dissipated by adjacent C Series modules or nearby heat sources can cause errors in thermocouple measurements by heating the NI-9213 terminals to a different temperature than the cold-junction compensation sensor. Thermal gradient across the terminals can cause the terminals of different NI-9213 channels to be at different temperatures, which creates accuracy errors and affects the relative accuracy between channels.

The temperature measurement accuracy specifications include errors caused by the thermal gradient across the NI-9213 terminals for configurations with the NI-9213 terminals facing forward or upward.

Autozero Channel

The NI-9213 has an internal autozero channel, which can be subtracted from each thermocouple reading to compensate for offset errors. Use of the autozero channel is optional, however the NI-9213 specifications assume that autozero is applied to every sample. Refer to the documentation for the software that you are using with the NI-9213 for information about using the autozero channel.

Timing Modes

The NI-9213 supports high-resolution and high-speed timing modes. High-resolution timing mode optimizes accuracy and noise and rejects power line frequencies. High-speed timing mode optimizes sample rate and signal bandwidth.

NI-9213 Specifications

The following specifications are typical for the range -40 °C to 70 °C unless otherwise noted.

> **Caution** Do not operate the NI-9213 in a manner not specified in this document. Product misuse can result in a hazard. You can compromise the safety protection built into the product if the product is damaged in any way. If the product is damaged, return it to NI for repair.

Warm-up time	15 minutes

Input Characteristics

Number of channels	16 thermocouple channels, 1 internal autozero channel, 1 internal cold-junction compensation channel
ADC resolution	24 bits
Type of ADC	Delta-Sigma
Sampling mode	Scanned
Voltage measurement range	±78.125 mV
Temperature measurement ranges	Works over temperature ranges defined by NIST (J, K, T, E, N, B, R, S thermocouple types)

Table 1. Timing Modes

Timing Mode	Conversion Time (Per Channel)	Sample Rate[1] (All Channels[2])
High-resolution	55 ms	1 S/s/ch

Timing Mode	Conversion Time (Per Channel)	Sample Rate[1] (All Channels[2])
High-speed	740 µs	75 S/s/ch

Common-mode voltage range	
Channel-to-COM	±1.2 V minimum
COM-to-earth ground	±250 V
Common-mode rejection ratio	
High-resolution mode (at DC and 50 Hz to 60 Hz)	
Channel-to-COM	100 dB
COM-to-earth ground	>170 dB
High-speed mode (at 0 Hz to 60 Hz)	
Channel-to-COM	70 dB
COM-to-earth ground	>150 dB
Input bandwidth	
High-resolution mode	14.4 Hz
High-speed mode	78 Hz
High-resolution noise rejection (at 50 Hz and 60 Hz)	60 dB
Overvoltage protection	±30 V between any two inputs
Differential input impedance	78 MΩ
Input current	50 nA
Input noise	

High-resolution mode	200 nV RMS
High-speed mode	7 µV RMS
Gain error	
High-resolution mode	
at 25 °C	0.03% typical
at -40 °C to 70 °C	0.07% typical, 0.15% maximum
High-speed mode	
at 25 °C	0.04% typical
at -40 °C to 70 °C	0.08% typical, 0.16% maximum
Offset error	
High-resolution mode	4 µV typical, 6 µV maximum
High-speed mode	14 µV typical, 17 µV maximum
Offset error from source impedance	Add 0.05 µV per Ω, when source impedance >50 Ω
Cold-junction compensation accuracy	
0 °C to 70 °C	0.8 °C typical, 1.7 °C maximum
-40 °C to 70 °C	1.1 °C typical, 2.1 °C maximum
MTBF	852,407 hours at 25 °C; Bellcore Issue 2, Method 1, Case 3, Limited Part Stress Method

Temperature Measurement Accuracy

Measurement sensitivity[3]	
High-resolution mode	
Types J, K, T, E, N	<0.02 °C
Types B, R, S	<0.15 °C
High-speed mode	
Types J, K, T, E	<0.25 °C
Type N	<0.35 °C
Type B	<1.2 °C
Types R, S	<2.8 °C

The following figures show the errors for each thermocouple type when connected to the NI-9213 with the autozero channel on. The figures display the maximum errors over a full temperature range and typical errors at room temperature. The figures account for gain errors, offset errors, differential and integral nonlinearity, quantization errors, noise errors, 50 Ω lead wire resistance, and cold-junction compensation errors. The figures do not account for the accuracy of the thermocouple itself.

Figure 2. Thermocouple Types J and N Errors

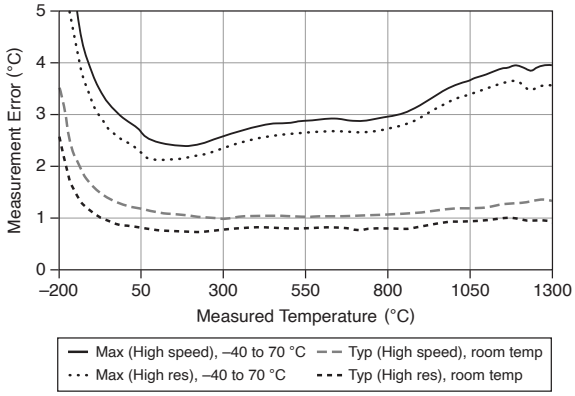


Figure 3. Thermocouple Type K Errors

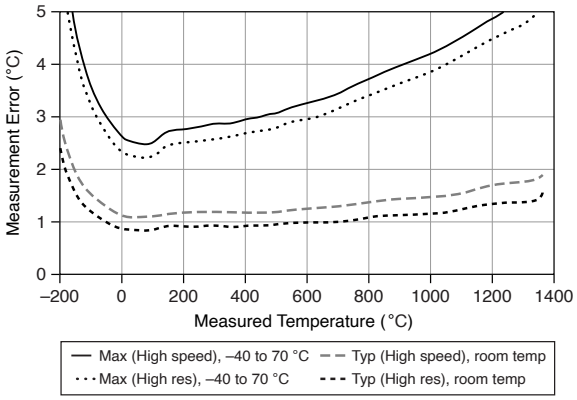


Figure 4. Thermocouple Types T and E Errors

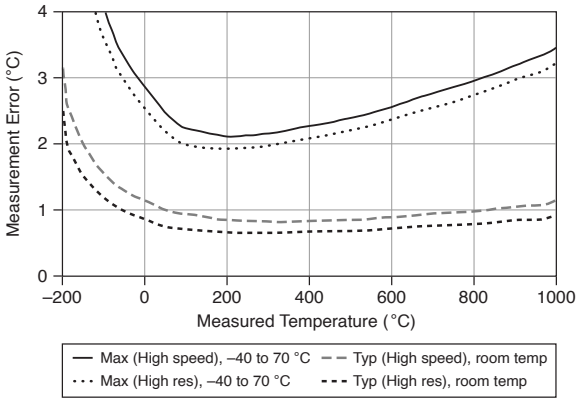


Figure 5. Thermocouple Type B Errors

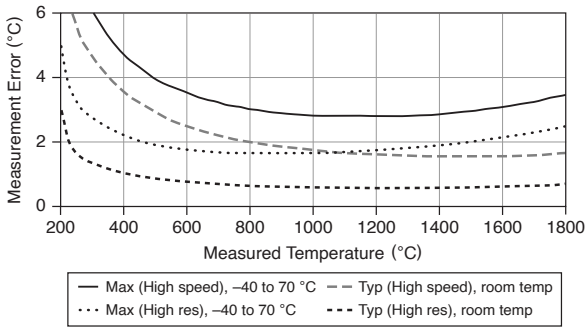
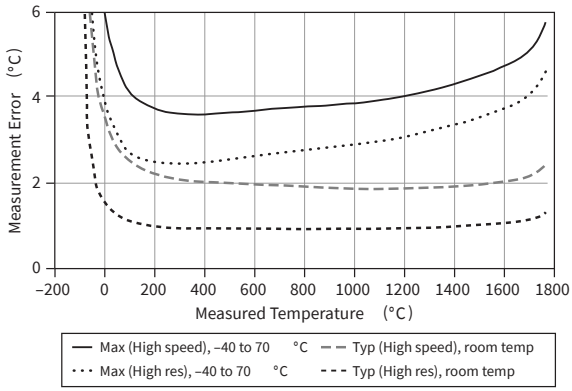


Figure 6. Thermocouple Types R and S Errors



Power Requirements

Power consumption from chassis	
Active mode	490 mW maximum
Sleep mode	25 µW maximum
Thermal dissipation (at 70 °C)	
Active mode	840 mW maximum
Sleep mode	710 mW maximum

Physical Characteristics

Note For two-dimensional drawings and three-dimensional models of the C Series module and connectors, visit ni.com/dimensions and search by module number.

Spring-terminal wiring	
Gauge	copper conductor wire
Wire strip length	of insulation stripped from the end
Temperature rating	
Wires per spring terminal	
Connector securement	
Securement type	Screw flanges provided
Torque for screw flanges	

NI-9213 (Black Connector) Safety Voltages

Connect only voltages that are within the following limits:

Between any two terminals	±30 V maximum
Isolation	
Channel-to-channel	None
Channel-to-earth ground	
Continuous	250 V RMS, Measurement Category II

Withstand	2,300 V RMS, verified by a 5 s dielectric withstand test

Hazardous Locations

U.S. (UL)	; ,
Canada (C-UL)	; ,
Europe (ATEX) and International (IECEx)	

Safety and Hazardous Locations Standards

This product is designed to meet the requirements of the following electrical equipment safety standards for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA 61010-1
- EN 60079-0:2012, EN 60079-15:2010
- IEC 60079-0: Ed 6, IEC 60079-15; Ed 4
- UL 60079-0; Ed 5, UL 60079-15; Ed 3
- CSA 60079-0:2011, CSA 60079-15:2012

Note For UL and other safety certifications, refer to the product label or the Online Product Certification section.

Electromagnetic Compatibility

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

- EN 61326 (IEC 61326): Class A emissions; Industrial 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.

Note For EMC compliance, operate this device with double-shielded cables.

CE Compliance CE

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

- 2014/35/EU; Low-Voltage Directive (safety)
- 2014/30/EU; Electromagnetic Compatibility Directive (EMC)
- 94/9/EC; Potentially Explosive Atmospheres (ATEX)

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.

Shock and Vibration

To meet these specifications, you must panel mount the system.

Operating vibration

Random (IEC 60068-2-64)	5 g_{rms}, 10 Hz to 500 Hz
Sinusoidal (IEC 60068-2-6)	5 g, 10 Hz to 500 Hz
Operating shock (IEC 60068-2-27)	30 g, 11 ms half sine; 50 g, 3 ms half sine; 18 shocks at 6 orientations

Environmental

Refer to the manual for the chassis you are using for more information about meeting these specifications.

Operating temperature (IEC 60068-2-1, IEC 60068-2-2)	-40 °C to 70 °C
Storage temperature (IEC 60068-2-1, IEC 60068-2-2)	-40 °C to 85 °C
Ingress protection	IP40
Operating humidity (IEC 60068-2-78)	10% RH to 90% RH, noncondensing
Storage humidity (IEC 60068-2-78)	5% RH to 95% RH, noncondensing
Pollution Degree	2
Maximum altitude	2,000 m

Indoor use only.

Environmental Management

NI is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial to the environment and to NI customers.

For additional environmental information, refer to the **Engineering a Healthy Planet** 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 document.

EU and UK Customers

- **Waste Electrical and Electronic Equipment (WEEE)**—At the end of the product life cycle, all NI products must be disposed of according to local laws and regulations. For more information about how to recycle NI products in your region, visit ni.com/environment/weee.

电子信息产品污染控制管理办法（中国 RoHS）

- **中国 RoHS**— NI 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 NI 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.)

Calibration

You can obtain the calibration certificate and information about calibration services for the NI-9213 at ni.com/calibration.

Calibration interval	1 year

[1] If you are using fewer than all channels, the sample rate might be faster. The maximum sample rate = 1/(Conversion Time x Number of Channels), or 100 S/s,

whichever is smaller. Sampling faster than the maximum sample rate may result in the degradation of accuracy.

[2] Including the autozero and cold-junction channels.

[3] Measurement sensitivity represents the smallest change in a temperature that a sensor can detect. It is a function of noise. The values assume the full measurement range of the standard thermocouple sensor according to ASTM E230-87.