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Find the *National Instruments NI 9213* at our website: ***Click HERE***

DATASHEET

NI 9213

16 TC, ±78 mV, 24 Bit, 75 S/s Aggregate



- Spring-terminal connectivity
- 50 Hz/60 Hz noise rejection
- Up to 0.02 °C measurement sensitivity
- 250 Vrms, 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

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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.



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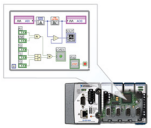
Software

LabVIEW Professional Development System for Windows



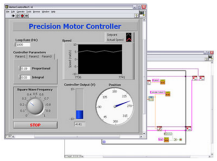
- Use advanced software tools for large project development
- Generate code automatically using DAQ Assistant and Instrument I/O Assistant
- Use advanced measurement analysis and digital signal processing
- Take advantage of open connectivity with DLLs, ActiveX, and .NET objects
- Build DLLs, executables,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



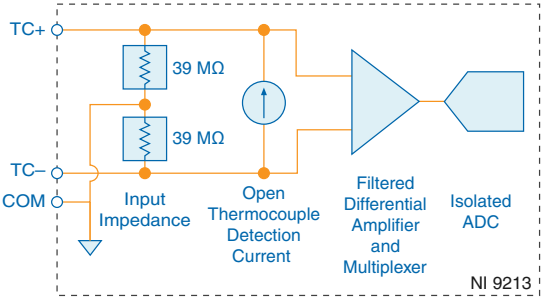
- Design deterministic real-time applications with LabVIEW graphical programming
- Download to dedicated NI or third-party hardware for reliable execution and a wide selection of I/O
- Take advantage of built-in PID control, signal processing, and analysis functions
- Automatically take advantage of 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 Circuitry

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.

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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.

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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

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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
High-speed	740 µs	75 S/s

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 nVrms
High-speed mode	7 µVrms

[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.

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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,

[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.

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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

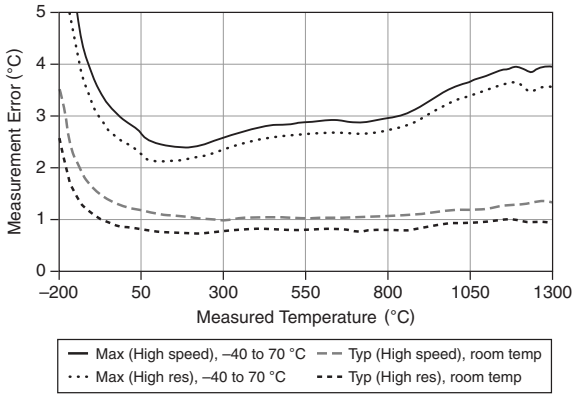
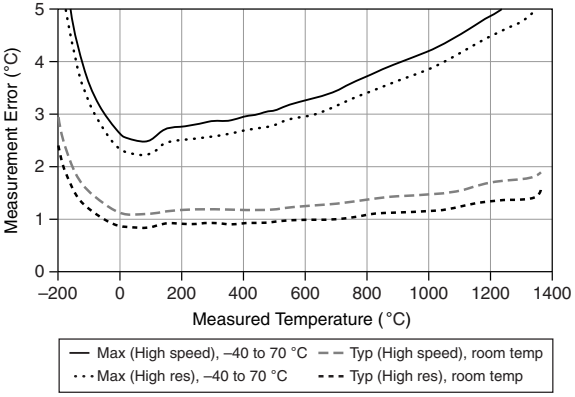


Figure 3. Thermocouple Type K Errors



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Figure 4. Thermocouple Types T and E Errors

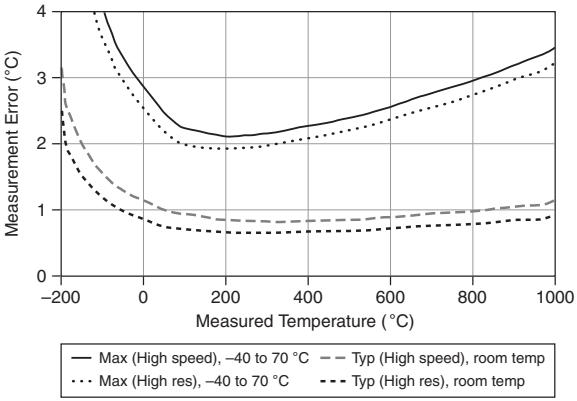


Figure 5. Thermocouple Type B Errors

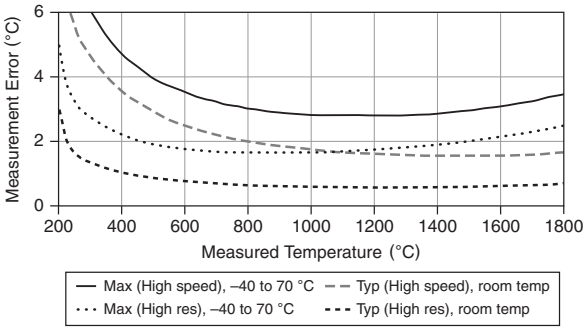
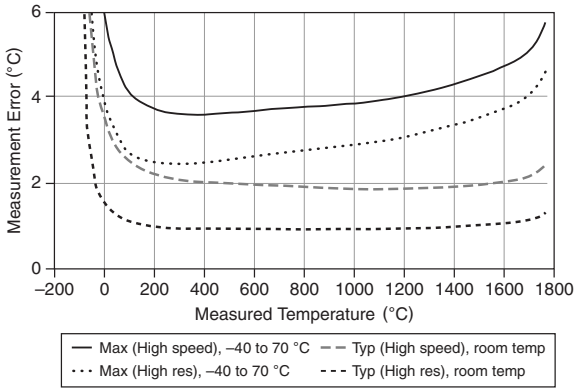


Figure 6. Thermocouple Types R and S Errors



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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

If you need to clean the module, wipe it with a dry towel.



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

Push-in spring-terminal wiring	
Gauge	0.14 mm^2 to 1.5 mm^2 (26 AWG to 16 AWG) copper conductor wire
Wire strip length	10 mm (0.394 in.) of insulation stripped from the end
Temperature rating	90 °C minimum
Wires per spring terminal	One wire per spring terminal; two wires per spring terminal using a 2-wire ferrule
Ferrules	0.14 mm^2 to 1.5 mm^2
Connector securement	
Securement type	Screw flanges provided
Torque for screw flanges	0.2 N · m (1.80 lb · in.)
Weight	164 g (5.8 oz)

Safety Voltages

Connect only voltages that are within the following limits:

Channel-to-channel	None
Channel-to-earth ground	
Continuous	250 Vrms, Measurement Category II
Withstand up to 4,000 m	3,000 Vrms, verified by a 5 s dielectric withstand test

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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.

Caution Do not connect the NI 9213 to signals or use for measurements within Measurement Categories III or IV.

Hazardous Locations

U.S. (UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, AEx nA IIC T4
Canada (C-UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, Ex nA IIC T4
Europe (ATEX) and International (IECEx)	Ex nA IIC T4 Gc

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 6, UL 60079-15; Ed 4
- 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.

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)
- 2014/34/EU; Potentially Explosive Atmospheres (ATEX)

Electromagnetic Compatibility

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

- EN 61326-1 (IEC 61326-1): Class A emissions; Industrial immunity
- EN 55011 (CISPR 11): Group 1, Class A emissions
- EN 55022 (CISPR 22): Class A emissions
- EN 55024 (CISPR 24): Immunity

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- AS/NZS CISPR 11: Group 1, Class A emissions
- AS/NZS CISPR 22: Class A emissions
- FCC 47 CFR Part 15B: Class A emissions
- ICES-001: Class A emissions

Note In the United States (per FCC 47 CFR), Class A equipment is intended for use in commercial, light-industrial, and heavy-industrial locations. In Europe, Canada, Australia and New Zealand (per CISPR 11) Class A equipment is intended for use only in heavy-industrial locations.

Note Group 1 equipment (per CISPR 11) is any industrial, scientific, or medical equipment that does not intentionally generate radio frequency energy for the treatment of material or inspection/analysis purposes.

Note For EMC declarations and certifications, and additional information, refer to the *Online Product Certification* section.

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

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Storage humidity (IEC 60068-2-78)	5% RH to 95% RH, noncondensing
Pollution Degree	2
Maximum altitude	4,000 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 *Minimize Our Environmental Impact* 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.

Waste Electrical and Electronic Equipment (WEEE)



EU Customers 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`.)

Calibration

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

Calibration interval	1 year

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