
NI-9211

Specifications

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NI 9211



The NI 9211 thermocouple input module for use with CompactDAQ and NI CompactRIO chassis includes a 24-bit delta-sigma analog-to-digital converter, anti-aliasing filters, open-thermocouple detection, and cold-junction compensation for high-accuracy thermocouple measurements. The NI 9211 features NIST-traceable calibration and a channel-to-earth ground double isolation barrier for safety, noise immunity, and high common-mode voltage range.

	Kit Contents	<ul style="list-style-type: none"> • NI 9211 • NI 9211 Getting Started Guide
	Accessories	<ul style="list-style-type: none"> • NI 9932 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	Selectable	Ch-Earth
NI 9219	4	Spring Terminal	1.6°C	—	50 S/s/Ch	7.1 Scans/s	No	Ch-Ch

¹Typical at 23±5°C operating temperature, For J-type sensor measuring 100°C.
²This 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.
³This is the fastest rate of the module; it can sample all channels simultaneously at this rate.
⁴This 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.
⁵Open Thermocouple Detection.
⁶Ch-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.



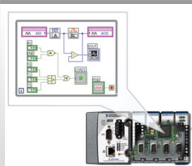
Software

LabVIEW Professional Development System for Windows



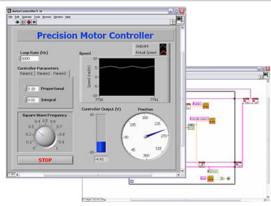
- Use advanced software tools for large project development
- Generate code automatically using DAQ Assistant and Instrument I/O Assistant
- Use advanced measurement analysis and digital signal processing
- Take advantage of open connectivity with DLLs, ActiveX, and .NET objects
- Build DLLs, executables,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

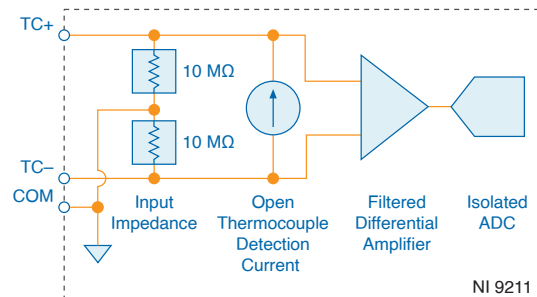


- Design deterministic real-time applications with LabVIEW graphical programming
- Download to dedicated NI or third-party hardware for reliable execution and a wide selection of I/O
- Take advantage of built-in PID control, signal processing, and analysis functions
- Automatically take advantage of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

Input Circuitry

The NI-9211 channels share a common ground isolated from other modules in the system. Each channel passes through a filter and then a 24-bit analog-to-digital converter (ADC) samples the channel.

Figure 1. Input Circuitry for One Channel of the NI-9211



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

Cold-Junction Accuracy

Heat dissipated by adjacent C Series modules or nearby heat sources can cause errors in thermocouple measurements by heating the NI-9211 terminals to a different temperature than the cold-junction compensation sensor. Thermal gradient across the terminals can cause the terminals of different NI-9211 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-9211 terminals for configurations with the NI-9211 terminals facing forward or upward.

Autozero Channel

The NI-9211 has an internal autozero channel, which can be subtracted from each thermocouple reading to compensate for offset errors. Use the autozero channel if the ambient temperature is less than 15 °C or more than 35 °C. Refer to the

documentation for the software that you are using for information about using the NI-9211 autozero channel.

NI-9211 Specifications

The following specifications are typical for the range -40 °C to 70 °C unless otherwise noted. Accuracy within typical use can vary based on chassis, mounting parameters, other modules present in the system, and installed accessories.



Caution 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.

Input Characteristics

Number of channels	4 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	±80 mV
Temperature measurement ranges	Works over temperature ranges defined by NIST (J, K, T, E, N, B, R, S thermocouple types)

Conversion time	70 ms per channel; 420 ms total for all channels including the autozero and cold-junction channels
Common-mode voltage range	
Channel-to-COM	± 1.5 V
COM-to-earth ground	± 250 V
Common-mode rejection ratio (0 Hz to 60 Hz)	
Channel-to-COM	95 dB
COM-to-earth ground	>170 dB
Input bandwidth (-3 dB)	15 Hz
Noise rejection (at 50 Hz and 60 Hz)	85 dB minimum
Overvoltage protection	± 30 V between any input and COM
Differential input impedance	20 M Ω
Input current	50 nA
Input noise	1 μ V _{rms}
Gain error (at -40 °C to 70 °C)	0.06% typical, 0.1% maximum
Offset error (with autozero channel on)	± 15 μ V typical, ± 20 μ V maximum
Gain error from source impedance	Add 0.05 ppm per Ω when source impedance >50 Ω

Offset error from source impedance	Add $\pm 0.05 \mu\text{V}$ typical, $\pm 0.07 \mu\text{V}$ maximum per Ω when source impedance $> 50 \Omega$
Cold-junction compensation sensor accuracy	
0 °C to 70 °C $\pm 0.6 \text{ °C}$ typical, $\pm 1.3 \text{ °C}$ maximum	
-40 °C to 70 °C $\pm 1.7 \text{ °C}$ maximum	
MTBF	633,012 hours at 25 °C; Bellcore Issue 2, Method 1, Case 3, Limited Part Stress Method

Temperature Measurement Accuracy

Measurement sensitivity^[1]		
With autozero channel on		
Types J, K, T, E, N		$< 0.07 \text{ °C}$
Type B		$< 0.25 \text{ °C}$
Types R, S		$< 0.60 \text{ °C}$
With autozero channel off		
Types J, K, T, E, N		$< 0.05 \text{ °C}$
Type B		$< 0.20 \text{ °C}$
Types R, S		$< 0.45 \text{ °C}$

The following figures show the typical and maximum errors for each thermocouple type when used with the NI-9211 over the full temperature range and autozero on. The figures account for gain errors, offset errors, differential and integral

nonlinearity, quantization errors, noise errors, and isothermal errors. The figures do not account for the accuracy of the thermocouple itself.

Figure 2. Thermocouple Type J and N Errors

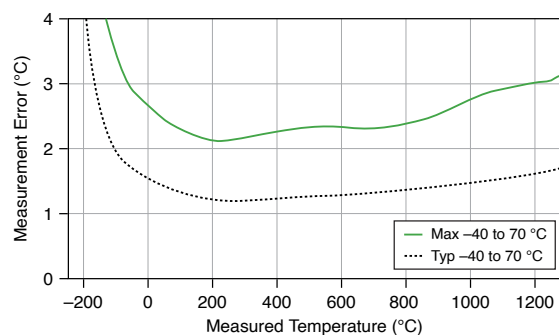


Figure 3. Thermocouple Type K Errors

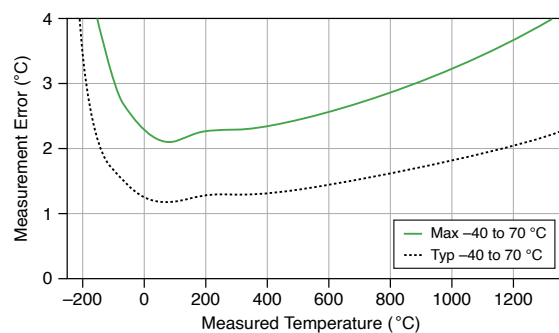


Figure 4. Thermocouple Type T and E Errors

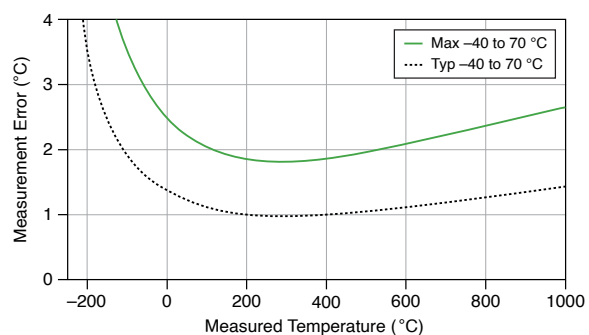


Figure 5. Thermocouple Type B Errors

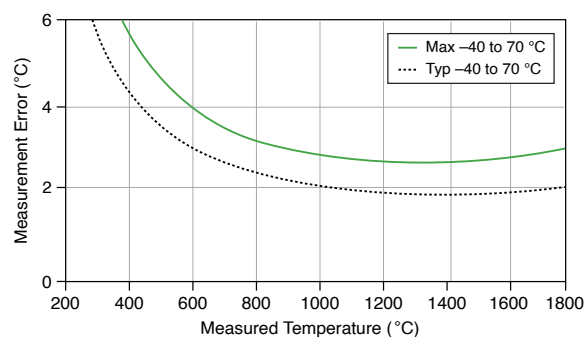
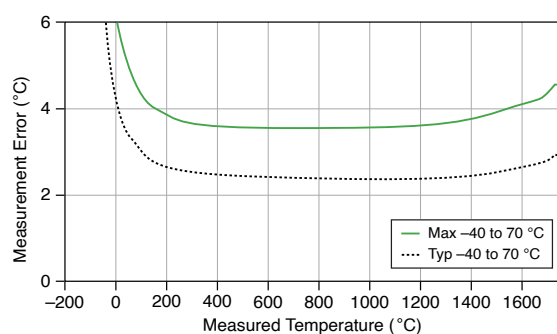


Figure 6. Thermocouple Type R and S Errors



Power Requirements

Power consumption from chassis

Active mode 170 mW maximum

Sleep mode 4 mW maximum

Thermal dissipation (at 70 °C)

Active mode 170 mW maximum

Sleep mode 4 mW maximum

Physical Characteristics

Screw-terminal wiring

Gauge	0.25 mm ² to 2.5 mm ² (24 AWG to 12 AWG) copper conductor wire
Wire strip length	7 mm (0.28 in.) of insulation stripped from the end
Temperature rating	90 °C, minimum
Torque for screw terminals	0.3 N · m (2.66 lb · in.)
Wires per screw terminal	One wire per screw terminal
Connector securement	
Securement type	Screw flanges provided
Torque for screw flanges	0.2 N · m (1.80 lb · in.)

Safety Voltages

Connect only voltages that are within the following limits.

Channel-to-COM	±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
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Hazardous Locations

U.S. (UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, AEx nA IIC T4 Gc
Canada (C-UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, Ex nA IIC T4 Gc
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 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 61326-2-1 (IEC 61326-2-1): 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 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.

CE Compliance

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)

Product Certifications and Declarations

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for NI products, visit ni.com/product-certifications, search by model number, and click the appropriate link.

Shock and Vibration

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

Operating vibration	
Random	5 g RMS, 10 Hz to 500 Hz
Sinusoidal	5 g, 10 Hz to 500 Hz
Operating shock	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-9211 at ni.com/calibration.

Calibration interval	1 year
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¹ Measurement sensitivity represents the smallest change in 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.