NI-9214 Specifications

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Contents

NI-9214 Specifications

Definitions

Warranted specifications describe the performance of a model under stated operating conditions and are covered by the model warranty.

Characteristics describe values that are relevant to the use of the model under stated operating conditions but are not covered by the model warranty.

- **Typical** specifications describe the performance met by a majority of models.
- **Nominal** specifications describe an attribute that is based on design, conformance testing, or supplemental testing.

Specifications are **Typical** unless otherwise noted.

Conditions

Specifications are valid for the range -40 °C to 70 °C unless otherwise noted.

Related information:

- Software Support for CompactRIO, CompactDAQ, Single-Board RIO, R Series, and EtherCAT

Input Characteristics

Number of channels	
NI-9214	16 thermocouple channels, 1 internal autozero channel
TB-9214	3 internal cold-junction compensation channels

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)

Timing Mode	Conversion Time (Per Channel)	Sample Rate[1] (All Channels[2])
High-resolution	52 ms	0.96 S/s
High-speed	735 µs	68 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

[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 compensation channels.

COM-to-earth ground	120 dB
Thermocouple signal input bandwidth	
High-resolution mode	14.4 Hz
High-speed mode	80 Hz
Open thermocouple settling time when switching OTD on/off	6 s
High-resolution noise rejection (at 50 Hz and 6 Hz)	65 dB
Overvoltage proection	±30 V between any two inputs
Differential input impedance	20 MΩ
Input noise	
High-resolution mode	
RMS	220 nVrms
Crest factor	6
High-speed mode	
RMS	2.8 µVrms
Crest factor	10
Gain error	
High-resolution mode	0.03% typical at 25 °C, 0.15% maximum at -40 °C to 70 °C

High-speed mode	0.04% typical at 25 °C, 0.16% maximum at -40 °C to 70 °C
Offset error	
High-resolution mode	2 µV typical, 8 µV maximum
High-speed mode	15 µV typical, 23 µV maximum
Offset error from source impedance with OTD enabled	Add 0.2 µV per Ω
Input current	
OTD enabled	200 nA
OTD disabled	400 pA
OTD bias current drift	200 pA/°C maximum
Cold-junction compensation accuracy[3]	
23 ±5 °C	0.25 °C typical
-20 °C to 70 °C	0.6 °C maximum
-40 °C to 70 °C	0.9 °C maximum

Temperature Measurement Accuracy

Measurement sensitivity[4]	
High-resolution mode	

[3] Cold-junction compensation accuracy assumes that the thermocouple wires are 0.25 mm (24 AWG) or smaller.

[4] Measurement sensitivity represents the smallest change in temperature that a sensor can detect. It is a function of noise. The values assume the median of the full measurement range of the standard thermocouple sensor according to NIST Monograph 175.

Types J, K, T, E, N	0.01 °C
Types R, S	0.03 °C
Type B	0.04 °C
High-speed mode	
Types J, K, T, E	0.10 °C
Type N	0.11 °C
Types R, S	0.36 °C
Type B	0.48 °C

The following thermocouple measurement tables and graphs show the module accuracy for each thermocouple type under the following conditions:

- Autozero is enabled.
- Open thermocouple detection is disabled.
- 0 V common-mode voltage.

The tables include all measurement errors of the module and terminal block including RMS noise. The tables do not include the accuracy of the thermocouple itself.

Table 1. Thermocouple Type J/N Measurement Accuracy (°C)

Temperature	High-Resolution			High-Speed		
	Typical	Maximum		Typical	Maximum	
	23 °C ± 5 °C	-20 °C to 70 °C	-40 °C to 70 °C	23 °C ± 5 °C	-20 °C to 70 °C	-40 °C to 70 °C
-100 °C	0.53	1.70	1.70	1.49	2.79	2.79
0 °C	0.40	1.24	1.26	1.17	2.12	2.12

Temperature	High-Resolution			High-Speed		
	Typical	Maximum		Typical	Maximum	
	23 °C ± 5 °C	-20 °C to 70 °C	-40 °C to 70 °C	23 °C ± 5 °C	-20 °C to 70 °C	-40 °C to 70 °C
100 °C	0.37	1.00	1.24	1.05	1.76	2.00
300 °C	0.39	1.16	1.41	0.96	1.78	1.98
500 °C	0.44	1.44	1.69	0.97	1.96	2.17
700 °C	0.45	1.58	1.80	1.03	2.24	2.42
900 °C	0.50	1.89	2.10	1.12	2.59	2.77
1100 °C	0.59	2.33	2.57	1.24	2.99	3.18

Table 2. Thermocouple Type K Measurement Accuracy (°C)

Temperature	High-Resolution			High-Speed		
	Typical	Maximum		Typical	Maximum	
	23 °C ± 5 °C	-20 °C to 70 °C	-40 °C to 70 °C	23 °C ± 5 °C	-20 °C to 70 °C	-40 °C to 70 °C
-100 °C	0.50	1.56	1.56	1.17	2.33	2.33
0 °C	0.36	1.06	1.10	0.86	1.64	1.66
100 °C	0.37	0.95	1.20	0.87	1.50	1.76
300 °C	0.42	1.23	1.49	0.95	1.81	2.08
700 °C	0.52	1.82	2.08	1.11	2.46	2.72
900 °C	0.60	2.21	2.48	1.25	2.91	3.19
1100 °C	0.69	2.64	2.93	1.41	3.42	3.71
1400 °C	0.85	3.40	3.71	1.70	4.32	4.64

Table 3. Thermocouple Type T/E Measurement Accuracy (°C)

Temperature	High-Resolution			High-Speed		
	Typical	Maximum		Typical	Maximum	
	23 °C ± 5 °C	-20 °C to 70 °C	-40 °C to 70 °C	23 °C ± 5 °C	-20 °C to 70 °C	-40 °C to 70 °C
-100 °C	0.54	1.76	1.76	1.25	2.59	2.59
0 °C	0.37	1.17	1.17	0.88	1.77	1.77
100 °C	0.33	0.89	1.04	0.77	1.38	1.53

Temperature	High-Resolution			High-Speed		
	Typical	Maximum		Typical	Maximum	
	23 °C ± 5 °C	-20 °C to 70 °C	-40 °C to 70 °C	23 °C ± 5 °C	-20 °C to 70 °C	-40 °C to 70 °C
300 °C	0.33	1.00	1.17	0.69	1.41	1.53
500 °C	0.37	1.25	1.42	0.69	1.60	1.77
700 °C	0.43	1.58	1.74	0.78	1.96	2.13
900 °C	0.49	1.94	2.11	0.90	2.37	2.55

Table 4. Thermocouple Type R/S Measurement Accuracy (°C)

Temperature	High-Resolution			High-Speed		
	Typical	Maximum		Typical	Maximum	
	23 °C ± 5 °C	-20 °C to 70 °C	-40 °C to 70 °C	23 °C ± 5 °C	-20 °C to 70 °C	-40 °C to 70 °C
0 °C	0.81	2.80	2.80	4.50	6.85	6.85
100 °C	0.61	1.94	1.94	3.30	4.91	4.91
300 °C	0.54	1.84	1.84	2.74	4.26	4.27
700 °C	0.57	2.15	2.15	2.54	4.32	4.32
900 °C	0.59	2.31	2.31	2.47	4.38	4.38
1100 °C	0.60	2.48	2.48	2.42	4.47	4.47
1400 °C	0.67	2.86	2.86	2.49	4.85	4.85

Table 5. Thermocouple Type B Measurement Accuracy (°C)

Temperature	High-Resolution			High-Speed		
	Typical	Maximum		Typical	Maximum	
	23 °C ± 5 °C	-20 °C to 70 °C	-40 °C to 70 °C	23 °C ± 5 °C	-20 °C to 70 °C	-40 °C to 70 °C
0 °C	—	—	—	—	—	—
100 °C	—	—	—	—	—	—
300 °C	0.94	3.40	3.45	7.36	10.40	10.45
700 °C	0.51	1.97	2.00	3.46	5.21	5.23
900 °C	0.46	1.86	1.88	2.88	4.52	4.54
1100 °C	0.43	1.89	1.89	2.55	4.19	4.21

Temperature	High-Resolution			High-Speed		
	Typical	Maximum		Typical	Maximum	
	23 °C ± 5 °C	-20 °C to 70 °C	-40 °C to 70 °C	23 °C ± 5 °C	-20 °C to 70 °C	-40 °C to 70 °C
1400 °C	0.45	2.04	2.05	2.33	4.10	4.11

Figure 1. Thermocouple Error, Typical (High-Resolution), 23 °C±5 °C

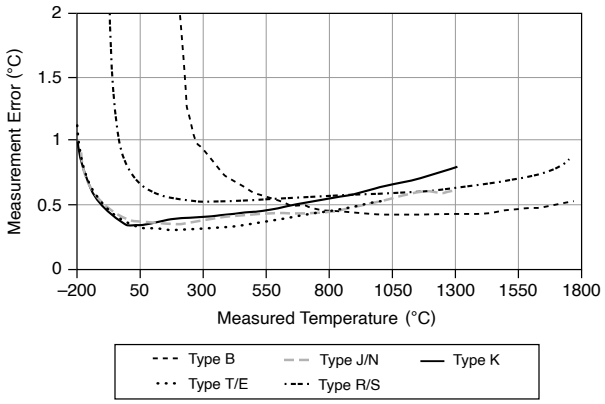
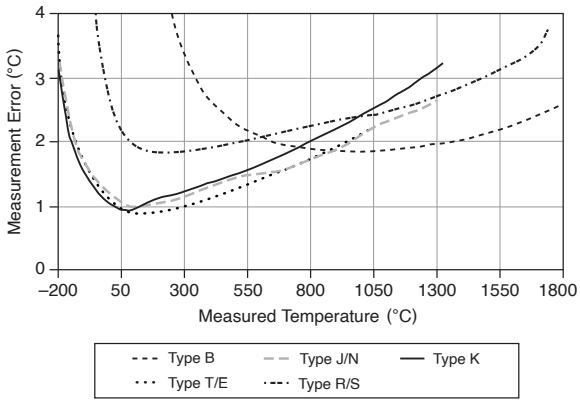


Figure 2. Thermocouple Error, Maximum (High-Resolution), -20 °C to 70 °C



Power Requirements

Power consumption from chassis	
Active mode	300 mW maximum
Sleep mode	30 µW maximum
Thermal dissipation (at 70 °C)	

Active mode	630 mW maximum
Sleep mode	450 mW maximum

Physical Characteristics

Screw-terminal wiring	
Gauge	0.05 mm to 0.5 mm (30 AWG to 20 AWG) copper conductor wire
Wire strip length	
Outer insulation	51 mm (2.0 in.) of insulation stripped from the end
Inner insulation	5.1 mm (0.2 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
TB-9214 securement	
Securement type	Jackscrews provided
Torque for jackscrews	0.4 N · m (3.6 lb · in.)
Weight	
NI-9214	141 g (5.0 oz)
TB-9214	102 g (3.6 oz)

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

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 60068-2-30)	10% RH to 90% RH, noncondensing
Storage humidity (IEC 60068-2-30)	5% RH to 95% RH, noncondensing
Pollution Degree	2
Maximum altitude	2,000 m

Indoor use only.

Calibration

You can obtain the calibration certificate and information about calibration services for the NI-9214 at ni.com/calibration.

Calibration interval	1 year