FD-11613

8-Channel Temperature Input Device for FieldDAQ™

Definitions

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

The following characteristic specifications 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 at -40 °C to 85 °C unless otherwise noted.

Input Characteristics

Number of channels	8 isolated thermocouple channels, 2 CJC
ADC resolution	24 bits
Type of ADC	Delta-Sigma
Sample mode	Simultaneous
Sample rate	User configurable
Timebases[1]	80 MHz, 20 MHz, 100 kHz

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[1] Base clocks can be synchronized with other FieldDAQ devices using the network synchronization feature.

Voltage measurement range	±78.125 mV
Temperature measurement ranges	Works over temperature ranges defined by NIST (J, K, T, E, N, B, R, and S thermocouple types)

Table 1. Conversion Time

Timing Mode	Conversion Time (ms)	Sample Rate (Samples/s)
High resolution	550	1.8
Best 50 Hz rejection	140	7.1
Best 60 Hz rejection	120	8.3
High speed	11.7	85

Common-mode voltage range	
Channel-to-channel	Refer to *Safety Voltages* for more information
Channel-to-earth ground	Refer to *Safety Voltages* for more information
Common-mode rejection ratio, channel-to-earth ground voltages (DC to 60 Hz)	
High-resolution, best 50 Hz rejection, best 60 Hz rejection	165 dB
High-speed	125 dB
Thermocouple signal input bandwidth	
High-resolution	1.0 Hz
Best 50 Hz rejection	4.0 Hz
Best 60 Hz rejection	4.7 Hz
High-speed	31 Hz
Open thermocouple settling time	1.8 s
Noise rejection	
High-resolution (at 50/60 Hz)	78 dB
Best 50 Hz rejection	82 dB
Best 60 Hz rejection	89 dB
Differential input impedance	5.34 MΩ

Input noise

High-resolution	85 nV RMS
Best 50 Hz rejection, best 60 Hz rejection	150 nV RMS
High-speed	1 µV RMS

Table 2. Gain Error and Offset Error

Error	High-Resolution/Best 50 Hz Rejection/ Best 60 Hz Rejection			High-Speed		
	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)
Gain	0.020%	0.062%	0.104%	0.032%	0.066%	0.116%
Offset	2.4 µV	5.4 µV	12.3 µV	2.4 µV	5.4 µV	12.3 µV

Gain drift	±7 ppm/°C
Offset drift	±60 nV/°C
Offset error from source impedance	Add 95 nV per Ω
Input bias current	95 nA

Cold-junction compensation accuracy

5 °C to 40 °C	0.25 °C typical, 0.45 °C maximum
-40 °C to 85 °C	1.2 °C maximum

Temperature Measurement Accuracy

Measurement sensitivity[2]

High-resolution

Types J, K, T, E, N	0.01 °C
Types R, S	0.02 °C
Type B	0.03 °C

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

Best 50/60 Hz rejection

Types J, K, T, E, N	0.02 °C
Types R, S	0.04 °C
Type B	0.06 °C

High-speed

Types J, K, T, E	0.05 °C
Type N	0.07 °C
Types R, S	0.18 °C
Type B	0.26 °C

The following thermocouple measurement tables and graphs show the module accuracy for each thermocouple type at 0 V common mode voltage. The tables include all measurement errors of the device including RMS noise. The tables do not include the accuracy of the thermocouple itself.

Table 3. Thermocouple Type K Measurement Accuracy (°C)

Temperature	High-Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection			High-Speed		
	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)
-100 °C	0.43	0.83	1.73	0.47	1.02	2.78
0 °C	0.31	0.58	1.33	0.34	0.73	2.14
100 °C	0.32	0.6	1.39	0.36	0.77	2.18
300 °C	0.36	0.72	1.58	0.42	0.92	2.4
400 °C	0.37	0.77	1.65	0.44	0.97	2.47
700 °C	0.43	0.96	1.97	0.54	1.2	2.83
900 °C	0.49	1.13	2.28	0.63	1.41	3.2
1000 °C	0.53	1.22	2.44	0.68	1.52	3.4

Table 3. Thermocouple Type K Measurement Accuracy (°C) (Continued)

Temperature	High-Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection			High-Speed		
	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)
1100 °C	0.56	1.32	2.62	0.74	1.65	3.62
1300 °C	0.65	1.56	3.04	0.86	1.93	4.16

Error drift, thermocouple Type K (-100 °C to 1300 °C)

5 °C to 40 °C	0.1 °C/10 °C
-40 °C to 85 °C	0.16 °C/10 °C

Figure 1. Thermocouple Type K Errors (High-Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection)
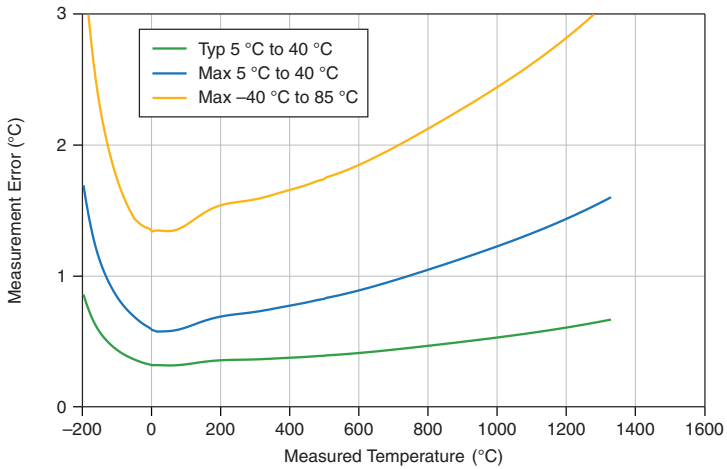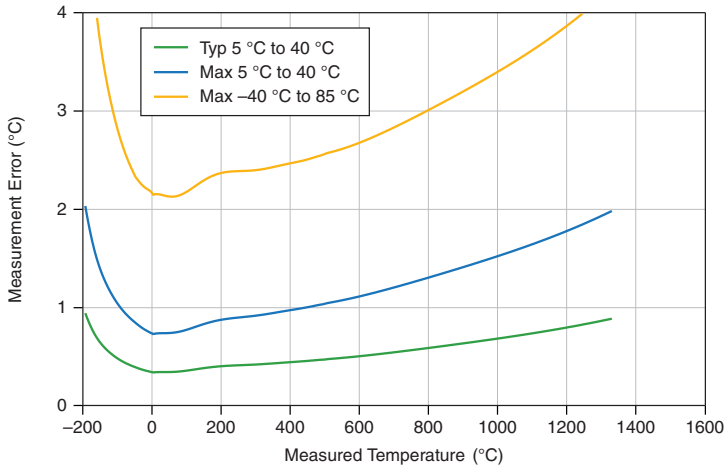
Figure 2. Thermocouple Type K Errors (High-Speed)

Table 4. Thermocouple Type J Measurement Accuracy (°C)

Temperature	High-Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection			High-Speed		
	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)
-100 °C	0.42	0.8	1.57	0.46	0.96	2.57
0 °C	0.32	0.59	1.29	0.34	0.73	2.1
100 °C	0.32	0.59	1.29	0.35	0.76	2.07
300 °C	0.35	0.71	1.48	0.41	0.9	2.26
400 °C	0.37	0.78	1.58	0.45	0.98	2.38
700 °C	0.39	0.87	1.68	0.49	1.09	2.43
900 °C	0.43	1.0	1.89	0.56	1.24	2.65

Table 4. Thermocouple Type J Measurement Accuracy (°C) (Continued)

Temperature	High-Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection			High-Speed		
	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)
1000 °C	0.48	1.12	2.09	0.62	1.39	2.91
1100 °C	0.51	1.22	2.25	0.67	1.5	3.1

Error drift, thermocouple Type J (-100 °C to 1100 °C)

5 °C to 40 °C	0.07 °C/10 °C
-40 °C to 85 °C	0.15 °C/10 °C

Figure 3. Thermocouple Type J Errors (High-Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection)
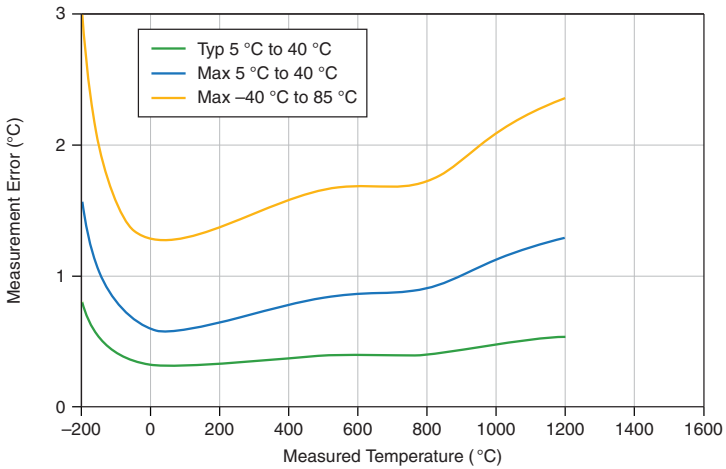
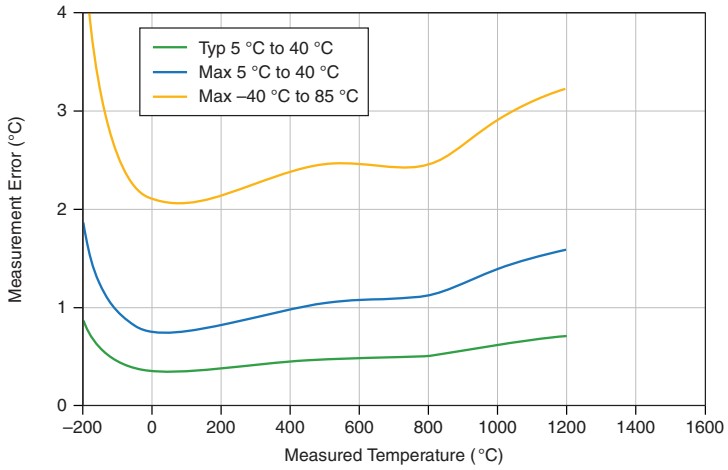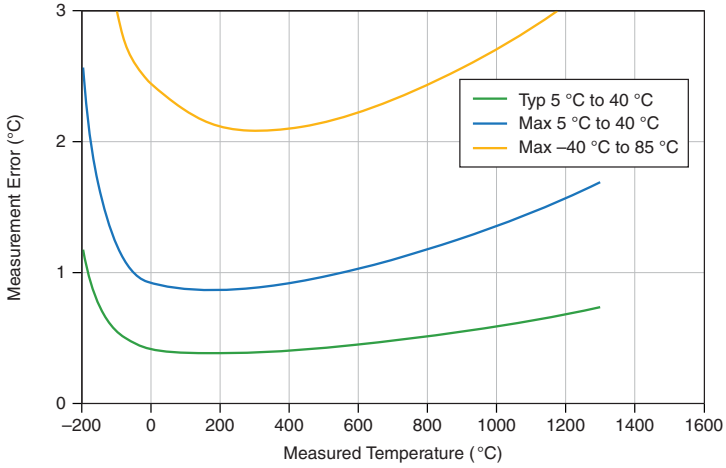**Figure 4.** Thermocouple Type J Errors (High-Speed)

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

Temperature	High-Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection			High-Speed		
	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)
-100 °C	0.5	1.01	1.92	0.55	1.22	2.99
0 °C	0.39	0.75	1.56	0.42	0.93	2.44
100 °C	0.35	0.69	1.46	0.39	0.88	2.24
300 °C	0.33	0.7	1.41	0.39	0.89	2.08
400 °C	0.34	0.73	1.44	0.41	0.92	2.1
700 °C	0.38	0.88	1.66	0.48	1.1	2.32
900 °C	0.43	1.02	1.88	0.55	1.26	2.57

Table 5. Thermocouple Type N Measurement Accuracy (°C) (Continued)

Temperature	High-Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection			High-Speed		
	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)
1000 °C	0.45	1.1	2.0	0.59	1.36	2.71
1100 °C	0.48	1.18	2.14	0.64	1.46	2.87

Error drift, thermocouple Type N (-100 °C to 1100 °C)

5 °C to 40 °C	0.08 °C/10 °C
-40 °C to 85 °C	0.17 °C/10 °C

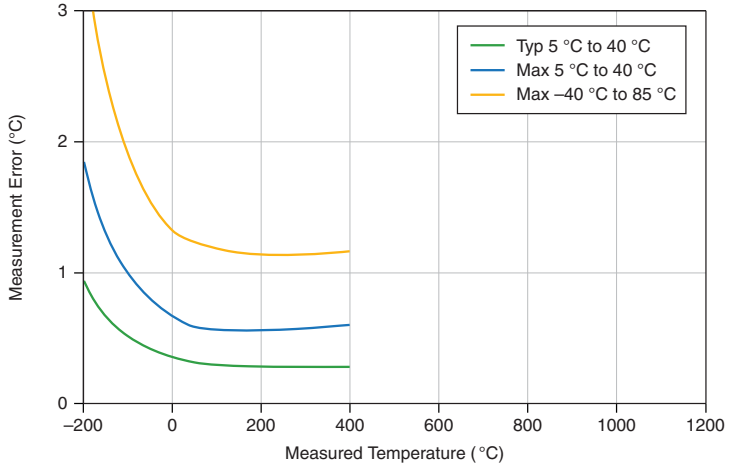**Figure 5.** Thermocouple Type N Errors (High-Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection)
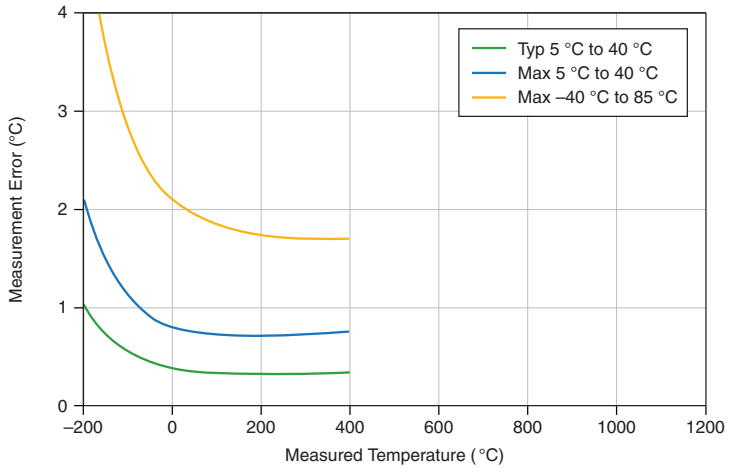
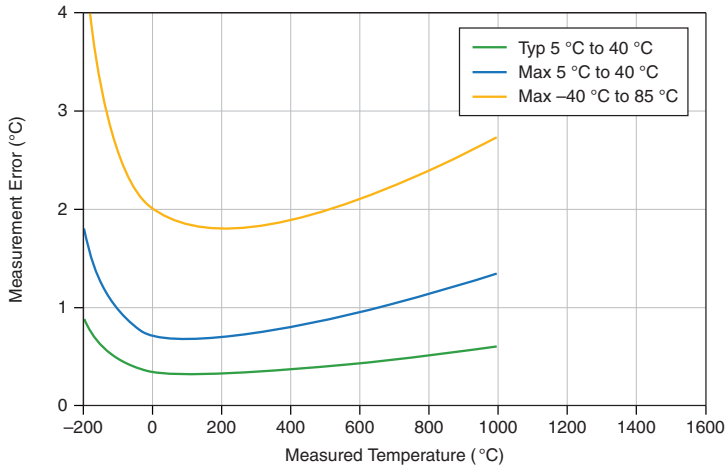**Figure 6.** Thermocouple Type N Errors (High-Speed)

Table 6. Thermocouple Type T Measurement Accuracy (°C)

Temperature	High-Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection			High-Speed		
	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)
-100 °C	0.51	0.99	1.91	0.56	1.14	2.85
0 °C	0.36	0.67	1.32	0.38	0.79	2.12
100 °C	0.3	0.56	1.18	0.33	0.72	1.85
300 °C	0.28	0.57	1.14	0.33	0.72	1.7
400 °C	0.28	0.6	1.16	0.34	0.75	1.7

Error drift, thermocouple Type T (-100 °C to 400 °C)

5 °C to 40 °C	0.09 °C/10 °C
-40 °C to 85 °C	0.19 °C/10 °C

Figure 7. Thermocouple Type T Errors (High-Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection)
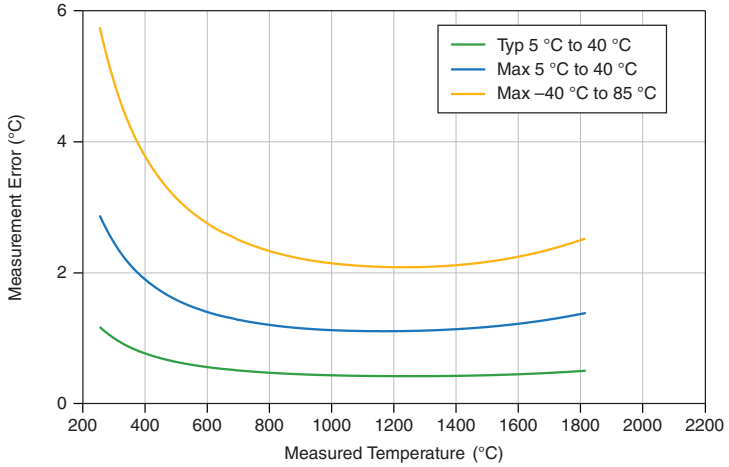

Figure 8. Thermocouple Type T Errors (High-Speed)

Table 7. Thermocouple Type E Measurement Accuracy (°C)

Temperature	High-Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection			High-Speed		
	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)
-100 °C	0.44	0.84	1.61	0.48	0.98	2.59
0 °C	0.32	0.59	1.22	0.34	0.7	2.01
100 °C	0.29	0.53	1.16	0.32	0.68	1.85
300 °C	0.29	0.59	1.19	0.34	0.74	1.82
400 °C	0.3	0.64	1.26	0.37	0.8	1.88
700 °C	0.37	0.84	1.58	0.47	1.04	2.24
900 °C	0.42	1.0	1.84	0.55	1.24	2.56
1000 °C	0.45	1.09	1.98	0.6	1.34	2.73

Error drift, thermocouple Type E (-100 °C to 1100 °C)

5 °C to 40 °C	0.07 °C/10 °C
-40 °C to 85 °C	0.17 °C/10 °C

Figure 9. Thermocouple Type E Errors (High-Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection)
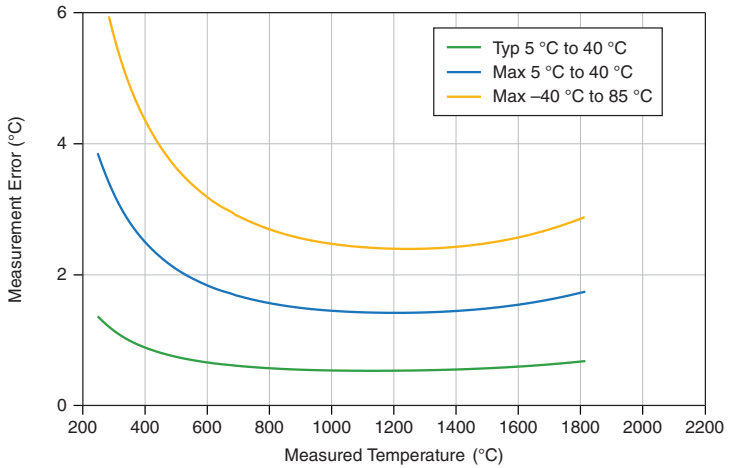
Figure 10. Thermocouple Type E Errors (High-Speed)

Table 8. Thermocouple Type B Measurement Accuracy (°C)

Temperature	High-Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection			High-Speed		
	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)
300 °C	0.98	2.43	4.86	1.16	3.27	5.71
500 °C	0.62	1.57	3.12	0.76	2.1	3.66
700 °C	0.52	1.3	2.51	0.64	1.71	2.93
900 °C	0.44	1.14	2.2	0.56	1.5	2.57
1100 °C	0.41	1.1	2.09	0.54	1.43	2.43
1400 °C	0.41	1.13	2.1	0.56	1.45	2.43
1700 °C	0.46	1.27	2.34	0.64	1.63	2.7

Error drift, thermocouple Type B (500 °C to 1800 °C)

5 °C to 40 °C	0.12 °C/10 °C
-40 °C to 85 °C	0.13 °C/10 °C

Figure 11. Thermocouple Type B Errors (High-Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection)

Figure 12. Thermocouple Type B Errors (High-Speed)

Table 9. Thermocouple Type R/S Measurement Accuracy (°C)

Temperature	High-Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection			High-Speed		
	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)	Typical (5 °C to 40 °C)	Maximum (5 °C to 40 °C)	Maximum (-40 °C to 85 °C)
0 °C	0.89	1.99	3.7	1.0	2.48	4.28
100 °C	0.64	1.43	2.58	0.72	1.81	3.27
300 °C	0.55	1.27	2.27	0.64	1.6	2.84
500 °C	0.55	1.28	2.27	0.64	1.6	2.82
700 °C	0.56	1.36	2.36	0.68	1.68	2.89
900 °C	0.57	1.41	2.41	0.71	1.73	2.93
1100 °C	0.58	1.46	2.49	0.74	1.79	3.0
1400 °C	0.63	1.63	2.74	0.82	1.99	3.27

Error drift, thermocouple Type R/S (100 °C to 1400 °C)

5 °C to 40 °C	0.11 °C/10 °C
-40 °C to 85 °C	0.17 °C/10 °C

Figure 13. Thermocouple Type R/S Errors (High-Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection)
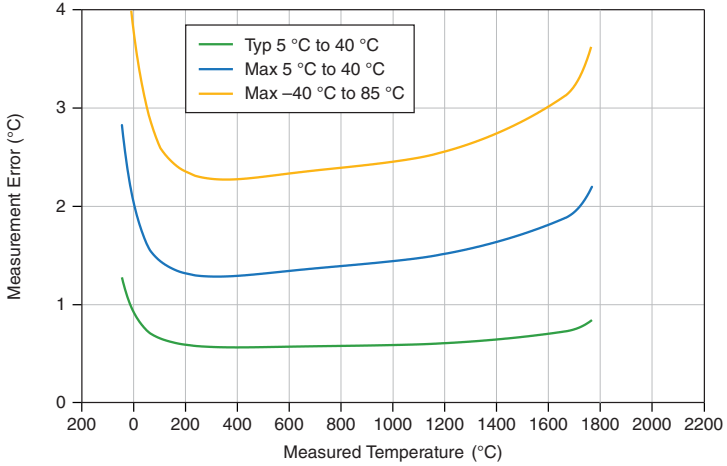
Figure 14. Thermocouple Type R/S Errors (High-Speed)
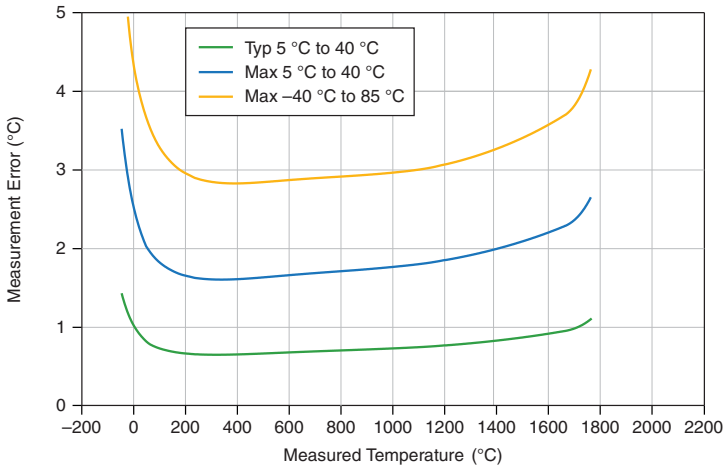
Time-Based Triggers

Type	Start Trigger

Timing and Synchronization

Protocol	IEEE 802.1AS for network synchronization over 1000 Base-TX, full-duplex
Network synchronization accuracy[3]	<1 µs
Network synchronization accuracy with optimized configuration[4]	<100 ns

Network Interface

Network protocols	TCP/IP, UDP
Network ports used	HTTP:80 (configuration only), TCP:3580; UDP:5353 (configuration only), TCP:5353 (configuration only); TCP:31415; UDP:7865 (configuration only), UDP:8473 (configuration only)
Network IP configuration	DHCP + Link-Local, DHCP, Static, Link-Local
Default MTU size	1500 bytes

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[3] I/O synchronization is system-dependent. Assumes the devices are connected in a line topology. For information about network synchronization accuracy, visit *ni.com/info* and enter Info Code syncacc.

[4] I/O synchronization is system-dependent. Assumes a system containing one hop. For information about achieving high accuracy synchronization, visit *ni.com/info* and enter Info Code fdsync.

Ethernet

Number of ports	2 8-pin X-coded M12 ports, internally switched[5]
Network interface	1000 Base-TX, full-duplex; 1000 Base-TX, half-duplex; 100 Base-TX, full-duplex; 100 Base-TX, half-duplex; 10 Base-T, full-duplex; 10 Base-T, half-duplex
Communication rates	10/100/1000 Mbps, auto-negotiated
Maximum cabling distance	100 m/segment
Maximum hops per line[6] without power boost	5

Power Requirements

> ⓘ **Notice** The protection provided by the FD-11613 can be impaired if it is used in a manner not described in the *FD-11613 User Guide*.

Voltage input range	
V_{in}	9 V DC to 30 V DC
V_{aux}	9 V DC to 30 V DC
Maximum device power consumption	4.9 W
Power input connector	5-pin L-coded male M12 connector
Power output connector	5-pin L-coded female M12 connector

Current Limits

> ⚠ **Caution** Exceeding the current limits may cause damage to the device. Stay below a maximum of 10 A shared between both Input and Aux terminals.

Power IN/OUT terminals	
V_{in}	10 A maximum
V_{aux}	10 A maximum total (combined with V_{in})

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[5] This allows for line topologies or network redundancy.
[6] With default software configuration. For information about creating reliable Ethernet-based systems, visit *ni.com/info* and enter Info Code fdenet.

Recommended external overcurrent protection	16 A, slow blow fuse

Physical Characteristics

Dimensions	198.5 mm × 77.4 mm × 47.1 mm (7.8 in. × 3.0 in. × 1.9 in.)
Weight	1.134 kg (40 oz)
Input connection	
Number	8
Type	Universal miniature thermocouple jack
Torque for M12 connectors (power, Ethernet)	0.6 N · m (5.31 lb · in.)

To clean the device, wipe it with a dry towel.

Calibration

Calibration interval	1 year

Environmental

Refer to the *FD-11613 User Guide* for more information about meeting these specifications.

Operating temperature (IEC 60068-2-1, IEC 60068-2-2)	-40 °C to 85 °C
Storage temperature (IEC 60068-2-1, IEC 60068-2-2)	-40 °C to 100 °C

Note Failure to follow the mounting instructions in the *FD-11613 User Guide* can cause temperature derating.

Ingress protection (IEC 60529)	IP65/IP67
Operating humidity	
IEC 60068-2-30 Test Db	80% to 100% RH, condensing
IEC 60068-2-78	10% RH to 90% RH, noncondensing
Pollution Degree	4
Maximum altitude	5,000 m

Note M12 connectors must be mated to cables or have caps installed on them to meet IP65/IP67 requirements. Cover the unused connectors with the included plastic caps whenever water, dust, or dirt are present.

Note Avoid long periods of exposure to sunlight.

Safety Voltages

Connect only voltages that are within the following limits:

Channel-to-channel isolation	
Continuous working voltage[7]	60 V DC (Dry Locations); 35 V DC (Wet Locations)
Transient overvoltage[8]	1,000 V RMS, verified by 5 s withstand[9]
Channel-to-earth ground isolation	
Continuous working voltage	60 V DC (Dry Locations); 35 VDC (Wet Locations)
Transient overvoltage	1,000 V RMS, verified by 5 s withstand
Overvoltage protection[10]	±30 V between TC+ and TC-

These test and measurement circuits are rated for measurements performed on circuits not directly connected to the electrical distribution system referred to as MAINS.

MAINS is a hazardous live electrical supply system to which equipment is designed to be connected to for the purpose of powering equipment. This product is rated 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.

Warning Do not connect the FD-11613 to signals or use for measurements within Measurement Categories II, III, or IV, or for measurements on MAINs circuits or on circuits derived from Overvoltage Category II, III, or IV which may have transient overvoltages above what the product can withstand. The product must not be connected to circuits that have a maximum voltage above the continuous working voltage, relative to earth or to other channels, or this could damage and defeat the insulation. The product can only withstand transients up to the transient overvoltage

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[7] Working voltage rating is the highest RMS value of the AC or DC voltage across the insulation that can continuously occur when the equipment is supplied at rated voltage.

[8] The short duration overvoltage of a few milliseconds or less, oscillatory or non-oscillatory, usually highly damped.

[9] Withstand rating is the highest RMS value of the AC or DC voltage the insulation can withstand without flashover or breakdown for a specified time.

[10] Temporary Overvoltage rating is the power frequency overvoltage of relatively long duration.

rating without breakdown or damage to the insulation. An analysis of the working voltages, loop impedances, temporary overvoltages, and transient overvoltages in the system must be conducted prior to making measurements.

Shock and Vibration

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

Operating vibration	
Random (IEC 60068-2-64)	10 g RMS, 5 Hz to 2,000 Hz
Sinusoidal (IEC 60068-2-6)	10 g, 5 Hz to 2,000 Hz
Operating shock (IEC 60068-2-27)	100 g, 11 ms half sine, 18 shocks at 6 orientations 40 g, 6 ms half sine, 4,000 shocks at 6 orientations, 24,000 total

Safety

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 C22.2 No. 61010-1

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 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
- 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 $\mathsf{C}\,\mathsf{E}$

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)

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 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.）