

SPECIFICATIONS

FD-11614

16-Channel Temperature Input Device for FieldDAQ™

Conditions

Specifications are typical and valid at -40 °C to 85 °C unless otherwise noted.

Input Characteristics

Number of channels	16 isolated thermocouple channels, 4 CJC
Isolation	Galvanic isolation between channels and to chassis
ADC resolution	24 bits
Type of ADC	Delta-Sigma
Sample mode	Simultaneous
Sample rate	User configurable
Timebases ¹	80 MHz, 20 MHz, 100 kHz
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

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

Table 1. Conversion Time (Continued)

Timing Mode	Conversion Time (ms)	Sample Rate (Samples/s)
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
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Channel-to-earth ground	Refer to Safety Voltages for more information
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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
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High speed	125 dB
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Thermocouple signal input bandwidth

High resolution	1.0 Hz
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Best 50 Hz rejection	4.0 Hz
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Best 60 Hz rejection	4.7 Hz
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High speed	31 Hz
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Open thermocouple settling time	1.8 s
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Noise rejection

High resolution (at 50/60 Hz)	78 dB
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Best 50 Hz rejection	82 dB
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Best 60 Hz rejection	89 dB
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Differential input impedance	5.34 M Ω
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Input noise

High resolution	85 nV RMS
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Best 50 Hz rejection, best 60 Hz rejection	150 nV RMS
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High speed	1 μ V RMS
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Table 2. Gain Error and Offset Error

Timing Mode	Temperature	Gain Error (% of Reading)	Offset Error (μV)
High resolution, Best 50 Hz rejection, Best 60 Hz rejection	5 °C to 40 °C, typical	0.020%	2.4 μV
	5 °C to 40 °C, maximum	0.062%	5.4 μV
	-40 °C to 85 °C, maximum	0.104%	12.3 μV
High speed	5 °C to 40 °C, typical	0.032%	2.4 μV
	5 °C to 40 °C, maximum	0.066%	5.4 μV
	-40 °C to 85 °C, maximum	0.116%	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, typical 0.25 °C

5 °C to 40 °C, maximum 0.45 °C

-40 °C to 85 °C, maximum 1.2 °C

Temperature Measurement Accuracy

Measurement sensitivity²

High resolution

Types J, K, T, E, N 0.01 °C

Types R, S 0.02 °C

Type B 0.03 °C

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 Hz rejection, best 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		
	5 °C to 40 °C, Typical	5 °C to 40 °C, Maximum	-40 °C to 85 °C, Maximum	5 °C to 40 °C, Typical	5 °C to 40 °C, Maximum	-40 °C to 85 °C, Maximum
-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		
	5 °C to 40 °C, Typical	5 °C to 40 °C, Maximum	-40 °C to 85 °C, Maximum	5 °C to 40 °C, Typical	5 °C to 40 °C, Maximum	-40 °C to 85 °C, Maximum
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)

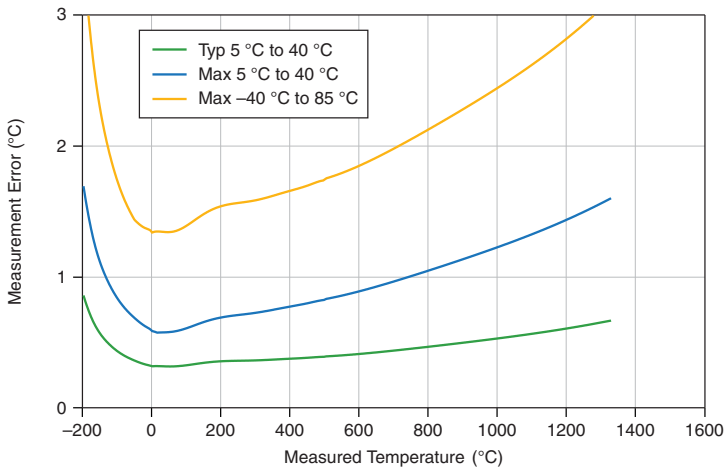


Figure 2. Thermocouple Type K Errors (High Speed)

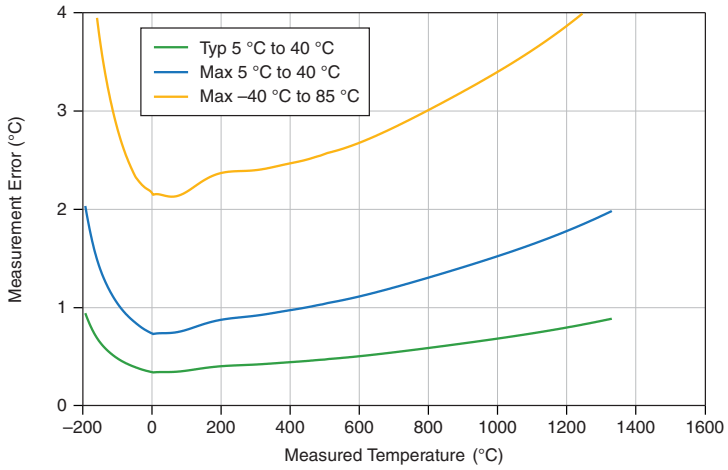


Table 4. Thermocouple Type J Measurement Accuracy (°C)

Temperature	High Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection			High Speed		
	5 °C to 40 °C, Typical	5 °C to 40 °C, Maximum	-40 °C to 85 °C, Maximum	5 °C to 40 °C, Typical	5 °C to 40 °C, Maximum	-40 °C to 85 °C, Maximum
-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		
	5 °C to 40 °C, Typical	5 °C to 40 °C, Maximum	-40 °C to 85 °C, Maximum	5 °C to 40 °C, Typical	5 °C to 40 °C, Maximum	-40 °C to 85 °C, Maximum
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)

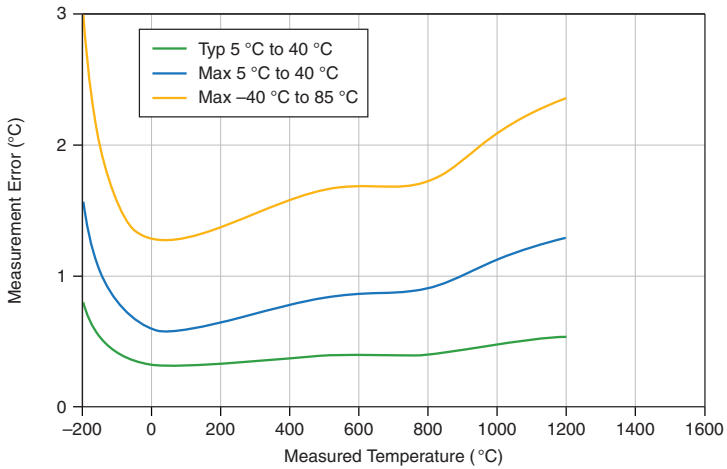


Figure 4. Thermocouple Type J Errors (High Speed)

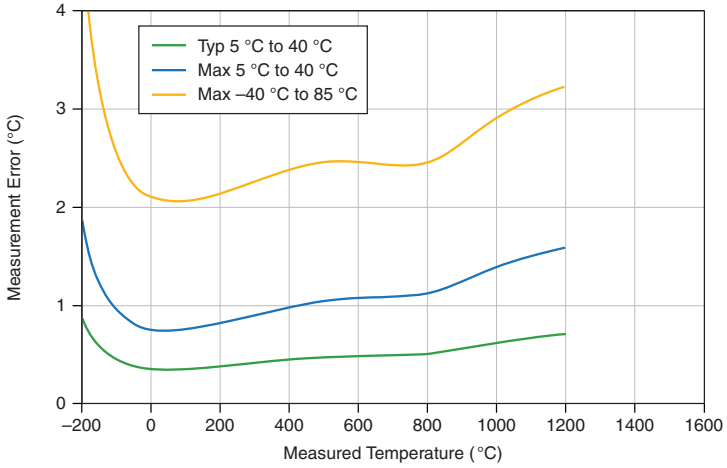


Table 5. Thermocouple Type N Measurement Accuracy (°C)

Temperature	High Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection			High Speed		
	5 °C to 40 °C, Typical	5 °C to 40 °C, Maximum	-40 °C to 85 °C, Maximum	5 °C to 40 °C, Typical	5 °C to 40 °C, Maximum	-40 °C to 85 °C, Maximum
-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		
	5 °C to 40 °C, Typical	5 °C to 40 °C, Maximum	-40 °C to 85 °C, Maximum	5 °C to 40 °C, Typical	5 °C to 40 °C, Maximum	-40 °C to 85 °C, Maximum
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)

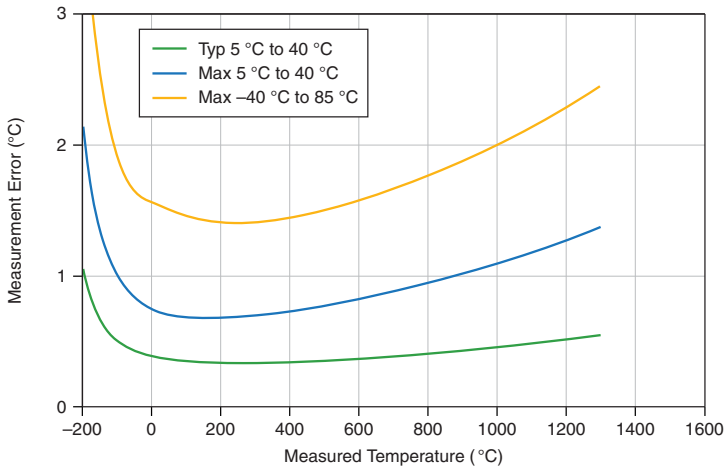


Figure 6. Thermocouple Type N Errors (High Speed)

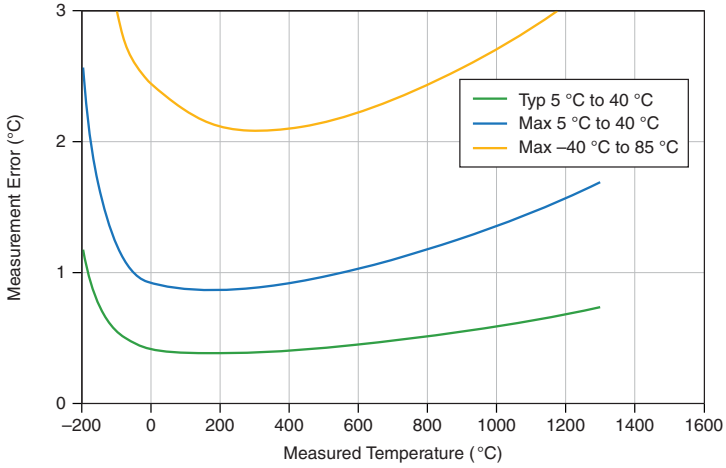


Table 6. Thermocouple Type T Measurement Accuracy (°C)

Temperature	High Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection			High Speed		
	5 °C to 40 °C, Typical	5 °C to 40 °C, Maximum	-40 °C to 85 °C, Maximum	5 °C to 40 °C, Typical	5 °C to 40 °C, Maximum	-40 °C to 85 °C, Maximum
-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)

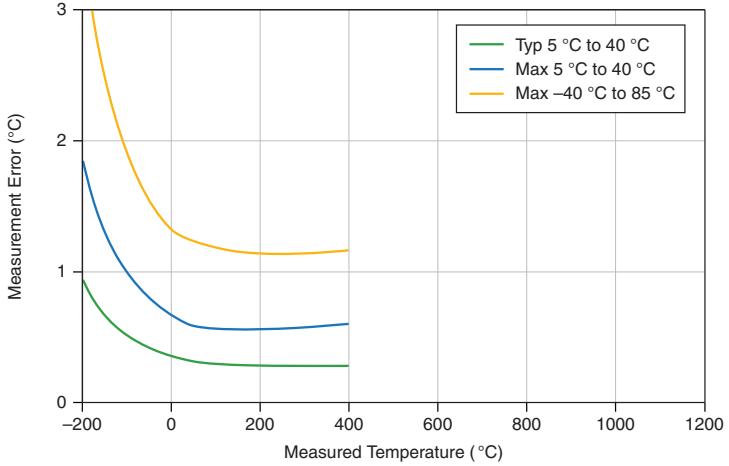


Figure 8. Thermocouple Type T Errors (High Speed)

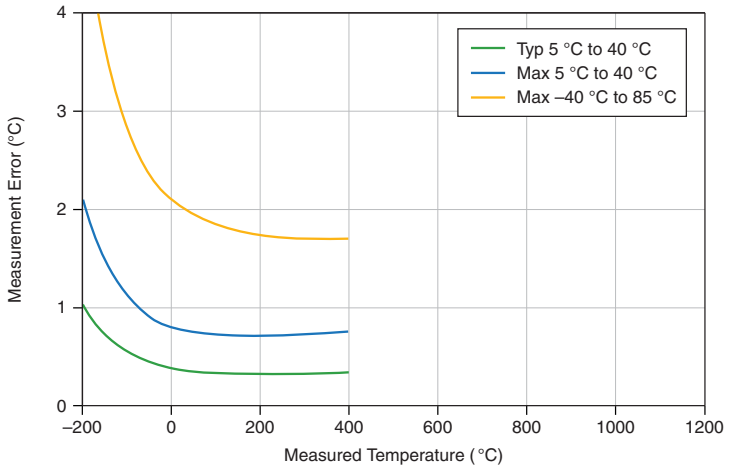


Table 7. Thermocouple Type E Measurement Accuracy (°C)

Temperature	High Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection			High Speed		
	5 °C to 40 °C, Typical	5 °C to 40 °C, Maximum	-40 °C to 85 °C, Maximum	5 °C to 40 °C, Typical	5 °C to 40 °C, Maximum	-40 °C to 85 °C, Maximum
-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)

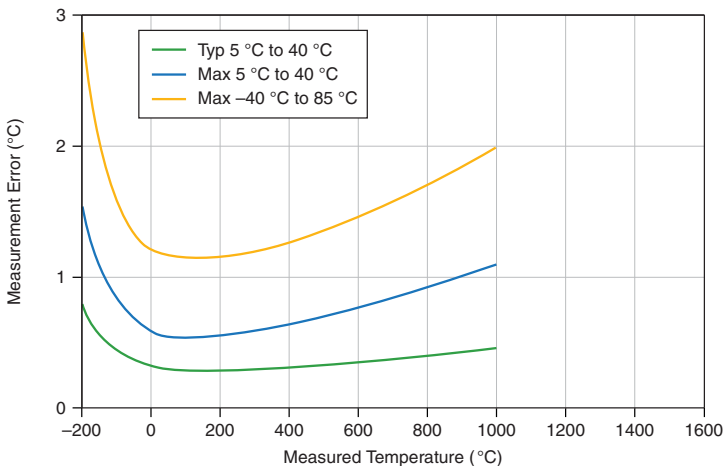


Figure 10. Thermocouple Type E Errors (High Speed)

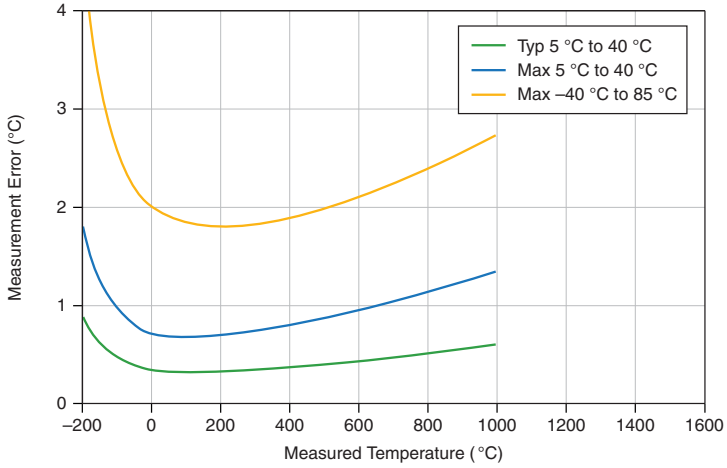


Table 8. Thermocouple Type B Measurement Accuracy (°C)

Temperature	High Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection			High Speed		
	5 °C to 40 °C, Typical	5 °C to 40 °C, Maximum	-40 °C to 85 °C, Maximum	5 °C to 40 °C, Typical	5 °C to 40 °C, Maximum	-40 °C to 85 °C, Maximum
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)

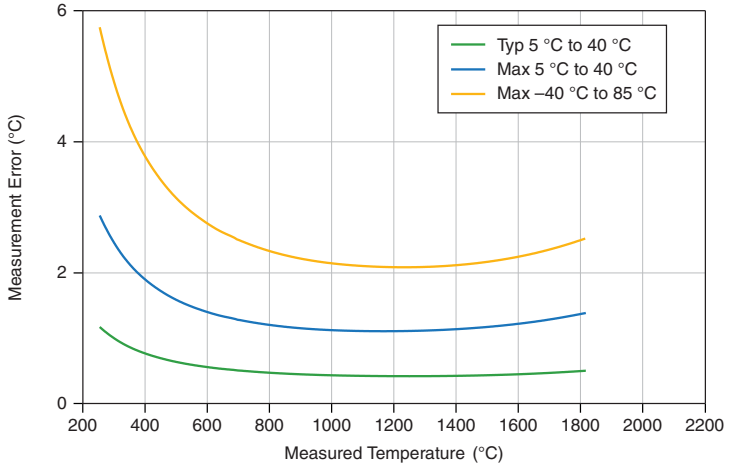


Figure 12. Thermocouple Type B Errors (High Speed)

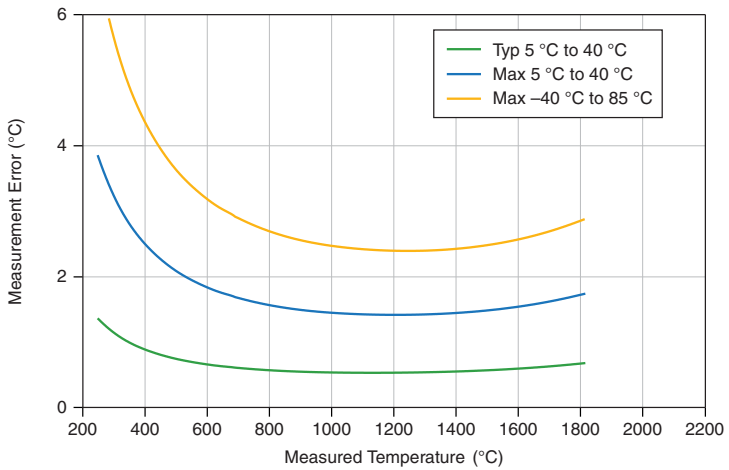


Table 9. Thermocouple Type R/S Measurement Accuracy (°C)

Temperature	High Resolution/Best 50 Hz Rejection/Best 60 Hz Rejection			High Speed		
	5 °C to 40 °C, Typical	5 °C to 40 °C, Maximum	-40 °C to 85 °C, Maximum	5 °C to 40 °C, Typical	5 °C to 40 °C, Maximum	-40 °C to 85 °C, Maximum
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)

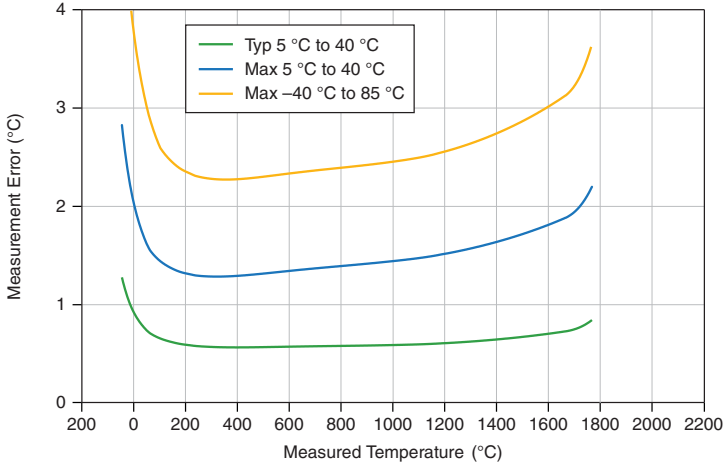
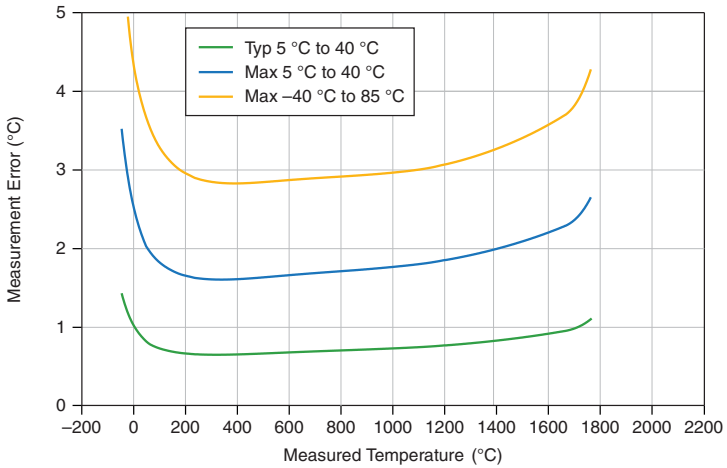


Figure 14. Thermocouple Type R/S Errors (High Speed)



Time-Based Triggers

Type	Start Trigger
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Timing and Synchronization

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



Note When configured to use IEEE 1588, performance of synchronization may vary from these specifications.

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

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

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 `synccacc`.

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 `edsync`.

⁵ This allows for line topologies or network redundancy.

Maximum cabling distance	100 m/segment
Maximum hops per line ⁶	15

Power Requirements



Notice The protection provided by the FD-11614 can be impaired if it is used in a manner not described in the *FD-11614 User Guide*.

Voltage input range

V_{in}	9 V DC to 30 V DC
V_{aux}	Up to 30 V DC

Maximum device power consumption⁷ 5.7 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})

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 1.18 kg (2 lb 9 oz)

⁶ With default software configuration. For information about creating reliable Ethernet-based systems, visit ni.com/info and enter Info Code `fdenet`.

⁷ The total amount of power drawn by the device from the power input connector, including power delivered to external sensors.

Input connection

Number	16
Type	Universal miniature thermocouple jack
Torque for M12 connectors (power, Ethernet)	0.6 N · m (5.31 lb · in.)

Calibration

Calibration interval	1 year
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Environmental Characteristics

Refer to the *FD-11614 User Guide* for more information about meeting these specifications.

Temperature and Humidity

Temperature

Operating	-40 °C to 85 °C
Storage	-40 °C to 100 °C

Humidity

Operating	Up to 100% relative humidity, condensing or noncondensing
Storage	Up to 100% relative humidity, condensing or noncondensing

Ingress protection	IP65/IP67
Pollution Degree	4
Maximum altitude	5,000 m



Note Failure to follow the mounting instructions in the *FD-11614 User Guide* can cause temperature derating.



Notice If your application is subject to high vibration or shock, NI recommends 0.5 mm² (20 AWG) or larger thermocouple wire. Strain relieve all cables as close to the device as possible.



Notice To protect against ESD, water, and dirt, install unconnected mini-TC plugs into all unused terminals, and install FD-11940, Mini-TC Connector Protection Boot (Qty 16) (NI part number 786395-01) on all mini-TC plugs.



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.

Shock and Vibration

Operating vibration

Random	10 g RMS, 5 Hz to 2,000 Hz
Sinusoidal	10 g, 5 Hz to 2,000 Hz
Operating shock	100 g, 11 ms half sine, 3 shocks at 6 orientations, 18 total 40 g, 6 ms half sine, 4,000 shocks at 6 orientations, 24,000 total

Environmental Standards

This product meets the requirements of the following environmental standards for electrical equipment.

- IEC 60068-2-1 Cold
- IEC 60068-2-2 Dry heat
- IEC 60068-2-6 Sinusoidal operating vibration
- IEC 60068-2-27 Operating shock
- IEC 60068-2-30 Damp heat cyclic (12 + 12h cycle)
- IEC 60068-2-64 Random operating vibration



Note To verify marine approval certification for a product, refer to the product label or visit ni.com/certification and search for the certificate.

Safety Voltages

Connect only voltages that are within the following limits:

Channel-to-channel isolation

Continuous working voltage ⁸	60 V DC (Dry Locations); 35 V DC (Wet Locations)
Transient overvoltage ⁹	1,000 V RMS, verified by 5 s withstand

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 protection¹⁰ ±30 V between TC+ and TC-

These test and measurement circuits are *not* rated for measurements performed on circuits 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-11614 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 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.

⁸ 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.

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 overvoltage of relatively long duration.

Safety Compliance 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 C22.2 No. 61010-1



Note For UL and other safety certifications, refer to the product label or the [Product Certifications and Declarations](#) section.

Electromagnetic Compatibility Standards

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; Basic 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
- EN 61326-1 (IEC 61326-1): Class A emissions; Industrial immunity



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 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.



Notice For EMC declarations and certifications, and additional information, refer to the [Product Certifications and Declarations](#) section.



Notice To ensure the specified EMC performance, operate this product only with shielded Ethernet cables.

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)
- 2011/65/EU; Restriction of Hazardous Substances (RoHS)

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/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.)

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