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DATA SHEET

U2802A 31-Channel Thermocouple Input Device

Introduction

The Keysight U2802A is a 31-channel thermocouple signal conditioning module with a built-in thermistor for cold junction compensation. The U2802A is designed to convert low input voltage signals (less than ±100 mV) from a thermocouple into an output voltage range suitable for data acquisition devices (±10 V). The U2802A device is to be used in conjunction with the Keysight U2355A or U2356A model DAQ device to enable temperature measurements using thermocouples. It works as a standalone device attached to a single DAQ device via two SCSI-II 68 conductor cables. The U2802A is compatible with eight standard thermocouple types and is suitable for a wide range of applications in various industrial environments.

Features

- Up to 31 thermocouple inputs
- Supports thermocouple type J, K, R, S, T, N, E, and B
- Up to 10 V voltage input range
- Open thermocouple detection
- Built-in isothermal terminal construction
- Built-in thermistor
- Built-in zeroing function
- Sampling rate of 500 kSa/s for overall module
- Sampling rate of 10 kSa/s total for all channels in thermocouple mode
- Configurable for voltage input or thermocouple input mode independently on each channel

Features to Meet Your Demands

- 31 input channels that can be independently configured to either differential thermocouple input mode, single-ended voltage input mode, or differential voltage input mode using two input channels set to voltage input mode
- Supports the standard thermocouple types defined in the NIST ITS-90 Thermocouple Database
- Error detection for open thermocouple channels
- Built-in isothermal construction on the terminal block for improved measurement accuracy
- Built-in zeroing function to compensate for overall system offset errors due to temperature drift and long-term drift
- Up to ±10 V input voltage range for higher voltage inputs
- Quick and easy USB setup
- Robust, cost-effective, and user friendly

Applications

The U2802A thermocouple input device is designed for robust and demanding industrial applications. This product is suitable and ideal for thermocouple measurement applications such as,

- product thermal analysis and characterization,
- environmental chamber profiling,
- process monitoring in consumer electronics markets,
- material properties testing in education environments,
- study of electronic temperature properties and appliances testing

Thermocouple input mode

In thermocouple input mode, the U2802A can acquire up to ±100 mV input signals. Each channel includes an instrumentation amplifier and a 4 Hz low-pass filter. The low-pass filter removes unwanted noise from the thermocouple wires to obtain accurate measurement data.

Voltage input mode

Alternatively, you can select separate voltage input modes for each channel. The channel will be set to bypass the amplifier and filter, allowing up to ±10 V input signals to be directly routed to the DAQ device analog input. The bandwidth in this mode is more than 500 kHz.

Zero mode

In zero mode, the positive and negative inputs of the instrumentation amplifier are shorted together. The voltage measured in this mode corresponds to the offset voltage of the channel. You can subtract this offset voltage from subsequent thermocouple mode measurements to increase measurement accuracy. This mode is only applicable in thermocouple mode.

Thermocouple compatibility

The U2802A is compatible with a wide range of standard thermocouple types defined in the NIST ITS-90 Thermocouple Database. This includes types J, K, R, S, T, N, E, and B.

Open thermocouple detection

The U2802A includes open thermocouple detection circuitry to indicate the presence of an open thermocouple.

Calibration EEPROM

The U2802A gain and offset calibration factors for each channel are stored in the EEPROM during factory calibration and can be retrieved prior to taking measurements. This onboard EEPROM also stores the module ID, serial number, and calibration date for your reference. A section of the EEPROM is also allocated for you to save your calibration data.

Restoring factory calibration

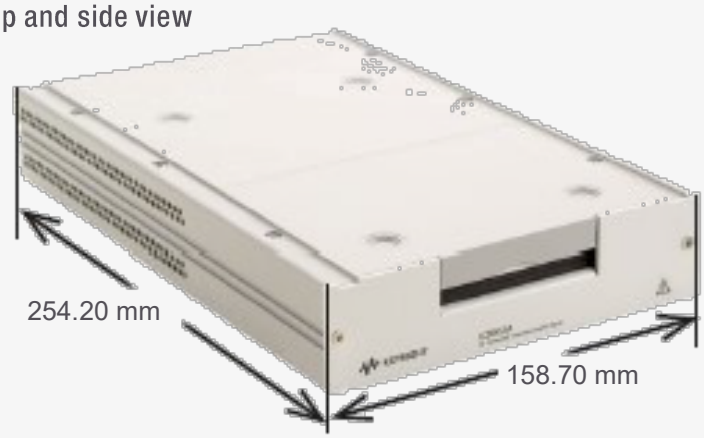
Using the KMM software, you can easily restore the U2802A calibration data from your settings to the original factory settings.

Product Outlook and Dimensions

Front view

Rear view

Top and side view



Product Characteristics and General Specifications

Specifications	
Power Consumption	+12 VDC, 480 mA maximum
Operating Environment	• Operating temperature from 0 °C to +55 °C • Relative humidity at 50% to 85% RH (non-condensing) • Altitude up to 2000 meters
Storage Compliance	Storage temperature from –40 °C to 70 °C
Safety and EMC Compliance	Refer to Declaration of Conformity for the latest revisions of regulatory compliance
Shock and Vibration	Tested to IEC/EN 60068-2
IO Connector	• 2 × 68-pin female SCSI connector • 2 × 34 pin screw terminal block • 1 × 24 pin screw terminal block
Dimension (W × D × H)	Module dimension: • 158.70 mm × 254.20 mm × 40.50 mm
Weight	1.036 kg

Product Specifications

Specifications	
General characteristics	
Number of channels	31 differential and 1 CJC
Input voltage range for voltage mode	±10 V (signal + common mode)
Input voltage (thermocouple mode)	±100 mV
Sampling rate for thermocouple mode	10 kSa/s total for all channels
Sampling rate for overall module	500 kSa/s
Thermocouple types	J, K, R, S, T, N, E, and B
Input specifications	
Accuracy (thermocouple mode) • Overall gain error • Overall offset error • Nonlinearity	 • 0.06% (23 °C ± 5 °C) • 15 µV (without zeroing) (23 °C ± 5 °C) 6 µV (with zeroing) • < 0.005% of full-scale range
System noise (rms) • Gain (× 1) • Gain (× 100)	 • 100 µVrms • 5 µVrms
Common Mode Rejection Ratio (CMRR) • Voltage mode • Thermocouple mode	 • > 60 dB • > 80 dB
Cold junction accuracy	• ±1.0 °C typical (23 °C ± 5 °C) • ±1.5 °C typical (0 °C to 18 °C, 28 °C to 55 °C)
Input characteristics	
Bandwidth (voltage mode)	> 500 kHz
Bandwidth (thermocouple mode)	4.0 Hz
Overvoltage protection [1]	**TC Mode** [2] • Common mode: ±17 V (TC+ and TC– with respect to GND)

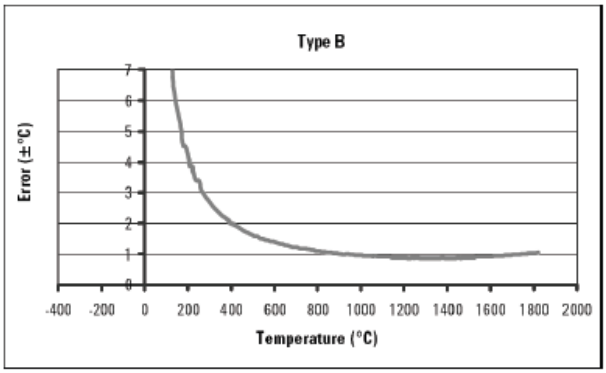
	• Differential mode: ±7 V (Differential voltage between TC+ and TC–) **Bypass mode** • ±20 V (TC+ input with respect to GND) **Power-off Mode** • ±11 V (TC+, TC– input with respect to GND)
Input impedance	> 1 GΩ
Input bias current	±2.5 nA max
Input offset current	±1.5 nA max
Gain drift	60 ppm/°C max
Offset drift	1 µV/°C max
Filter cut-off frequency (–3 dB) (thermocouple mode)	4.0 Hz
Filter type (thermocouple mode)	Low Pass RC Filter
Other features	
Recommended warm uptime	30 minutes

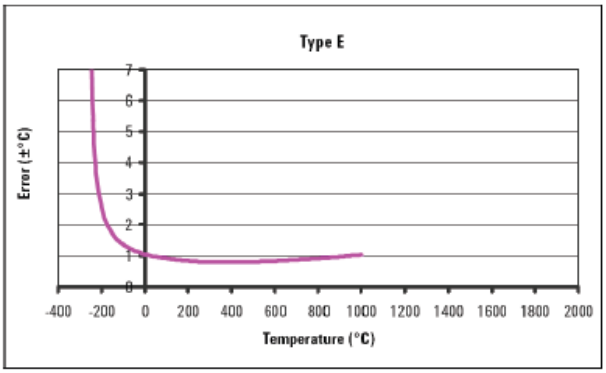
Notes:

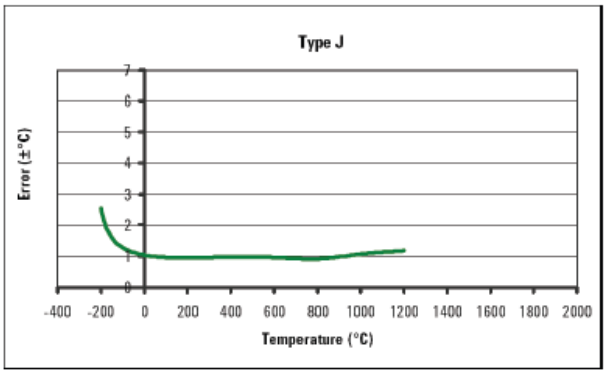
1. The overvoltage protection levels specified above indicate the maximum voltage each input pin can tolerate without resulting in any damages. However, prolonged exposure to these levels may affect device safety and reliability. Hence, it should be avoided where possible.
2. On the channels configured for thermocouple mode, the TC+ and TC– pins can tolerate up to ±17 V of differential voltage for a few minutes. However, exceeding a voltage range of ±100 mV on these channels can cause additional current to be drawn from the device's power supply regulators, which may damage the device if multiple channels are overdriven for prolonged periods. This is the case when a voltage source is tied across the TCn+ and TCn– pin. Voltage sources greater than ±100 mV should be tied to TCn+, and GND (floating source), or TCn+ and TCn+1+ (grounded source), and have the channels set for bypass mode.

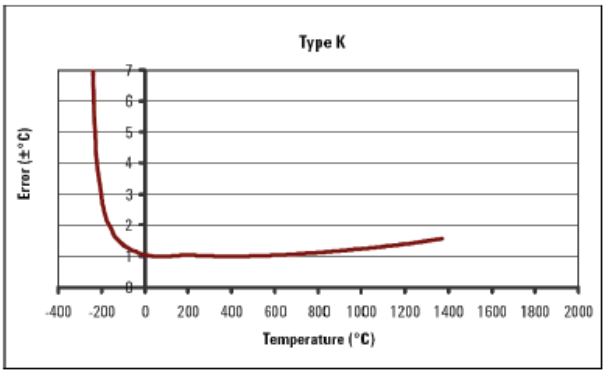
Thermocouples typical measurement accuracy

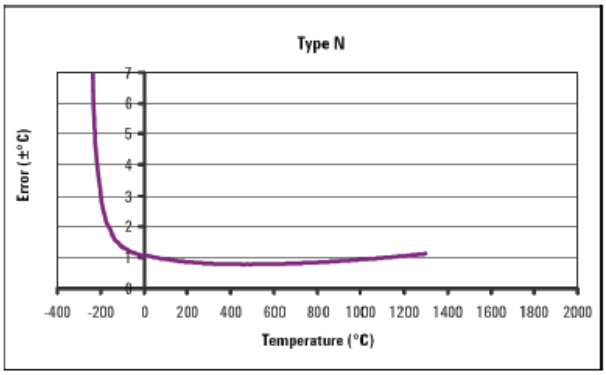
The U2802A measurement error with U2355A or U2356A at 23 °C ± 5 °C is shown below:

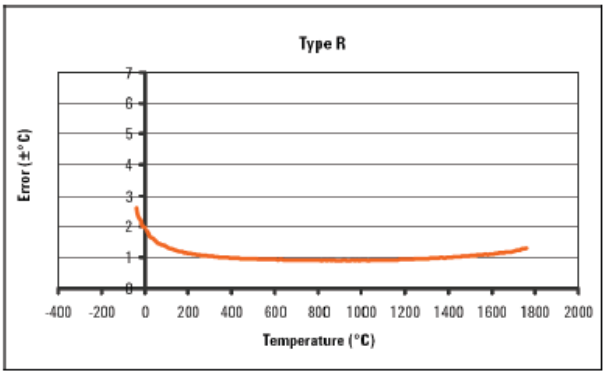


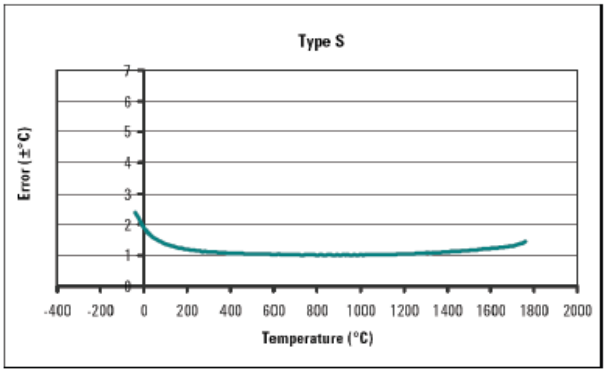


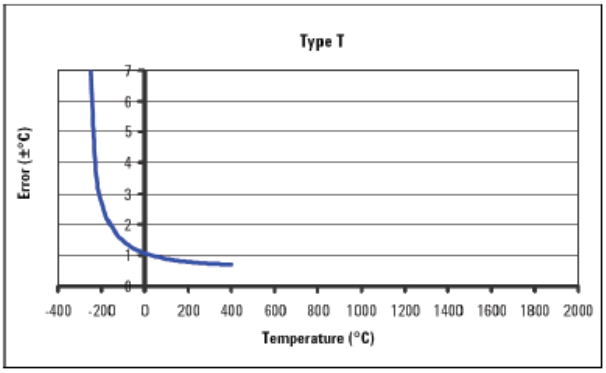












System accuracy specifications

The U2802A system accuracy specifications are shown in Table 1, Table 2, and Table 3. These measurements are derived from the U2802A and DAQ input accuracy specifications without including the thermocouple error. Refer to the “Calculating System Accuracy” section in the Keysight U2802A 31-Channel Thermocouple Input Device User’s Guide for the calculation methodology

Table 1. Measurement accuracy of the U2355A and U2356A at 23 °C ± 5 °C

Thermocouple measurement accuracy (U2355A, U2356A @ 23 °C ± 5 °C)							
T/C type	ITS-90 Temperature range (°C)		Optimum measurement range (°C)		Without averaging (± °C)	50 points averaging (± °C)	500 points averaging (± °C)
	Low	High	Low	High			
B	0	1820	1100	1820	1.9	1.2	1.0
			400	1100	4.4	2.5	2.0
E	–270	1000	–150	1000	1.7	1.6	1.6
			–200	–150	2.4	2.3	2.3
J	–210	1200	–150	1200	1.6	1.5	1.5
			–210	–150	2.7	2.6	2.5
K	–270	1372	–100	1200	1.5	1.4	1.4
			–200	–100	2.7	2.6	2.6
N	–270	1300	–100	1300	1.5	1.3	1.3
			–200	–100	3.0	2.7	2.6
R	–50	1768	300	1760	2.0	1.4	1.3
			–50	300	5.0	3.1	2.6
S	–50	1768	400	1760	2.1	1.6	1.4
			–50	400	4.5	2.8	2.4
T	–270	400	–100	400	1.5	1.4	1.4
			–200	–100	2.7	2.5	2.5

Table 2. Measurement accuracy of the U2355A at 0 to 18 °C and 28 to 45 °C

Thermocouple measurement accuracy (U2355A @ 0 to 18 °C and 28 to 45 °C)							
T/C type	ITS-90 Temperature range (°C)		Optimum measurement range (°C)		Without averaging (± °C)	50 points averaging (± °C)	500 points averaging (± °C)
	Low	High	Low	High			
B	0	1820	1100	1820	3.4	2.4	2.2
			400	1100	7.5	3.6	2.2
E	–270	1000	–150	1000	2.7	2.6	2.5
			–200	–150	3.8	3.6	3.6
J	–210	1200	–150	1200	2.5	2.4	2.4
			–210	–150	4.2	4.0	3.9
K	–270	1372	–100	1200	2.9	2.8	2.8
			–200	–100	4.3	4.0	3.9
N	–270	1300	–100	1300	2.6	2.5	2.5
			–200	–100	4.9	4.2	4.0
R	–50	1768	300	1760	3.8	3.1	3.0
			–50	300	8.5	4.6	3.3
S	–50	1768	400	1760	4.2	3.4	3.2
			–50	400	7.7	4.2	3.1
T	–270	400	–100	400	2.4	2.2	2.2
			–200	–100	4.3	4.3	3.9

Table 3. Measurement accuracy of the U2356A at 0 to 18 °C and 28 to 45 °C

Thermocouple measurement accuracy (U2355A @ 0 to 18 °C and 28 to 45 °C)							
T/C type	ITS-90 Temperature range (°C)		Optimum measurement range (°C)		Without averaging (± °C)	50 points averaging (± °C)	500 points averaging (± °C)
	Low	High	Low	High			
B	0	1820	1100	1820	6.1	3.1	2.4
			400	1100	14.4	6.3	2.7
E	–270	1000	–150	1000	3.0	2.6	2.6
			–200	–150	4.2	3.7	3.6
J	–210	1200	–150	1200	2.9	2.5	2.5
			–210	–150	4.9	4.1	4.0
K	–270	1372	–100	1200	3.3	2.9	2.9
			–200	–100	5.3	4.2	4.0
N	–270	1300	–100	1300	3.4	2.7	2.6
			–200	–100	6.8	4.6	4.1
R	–50	1768	300	1760	6.2	3.7	3.2
			–50	300	15.7	7.2	3.8
S	–50	1768	400	1760	6.4	4.0	3.4
			–50	400	14.2	6.6	3
T	–270	400	–100	400	3.0	2.4	2.2
			–200	–100	5.3	4.2	3.9