VTI Instruments

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EX1401

16 CHANNEL ISOLATED THERMOCOUPLE AND VOLTAGE MEASUREMENT INSTRUMENT

FEATURES

- 16-channel isolated universal thermocouple/voltage measurements
- 24-bit ADC per channel
- Channel-ground isolation 500 V peak
- Channel-channel isolation of 1000 V
- 20 kSa/Second/Channel sample rate
- Advanced CJC implementation
- Typical accuracies of 0.25 °C
- Power over Ethernet (POE+), or 10-50 V DC input
- Precise distributed measurement synchronization with IEEE-1588
- LXI Ethernet Interface
- 8-bit bank isolated digital I/O Compact 1U half-rack form factor

APPLICATIONS

- Battery and Fuel Cell Test
- Thermal Data Acquisition
- Gas Turbine Test
- HALT/HASS
- In-vehicle Automotive Test
- Electric Motor Test
- Wind Tunnel Evaluation
- Rocket Motor Reliability
- Health Monitoring

AMETEK® PROGRAMMABLE POWER

RELIABLE DATA FIRST TIME EVERY TIME

EX1401

Precision Accuracy, Isolated Measurements

The EX1401 adds high common mode measurement capability to the EX1000 series of instruments, an advanced, full-featured data acquisition family designed to acquire precision data from temperature and voltage sensors. The EX1401 delivers accurate and highly repeatable thermocouple (<0.25°C typical) and voltage measurements by implementing fully integrated signal conditioning, including advanced cold junction compensation (CJC). With maximum programmable sample rates at 20 kSa/s/channel, the EX1401 is well-suited for a wide range of applications requiring maximum accuracy and the recording of fast transient signals.

The EX1401 implements ergonomically friendly mini-TC connectors for input signal termination simplifying the installation and maintenance process. The mini-TC input jacks are Cu-Cu allowing direct connection of any thermocouple type. Thermocouple and voltage sensor signals are electrically isolated, with 500 V isolation from channel-to-ground and 1000 V isolation from channel-to-channel making the EX1401 ideal for measuring battery stacks made up of numerous discrete cells or in environments where the presence of potentially damaging voltage levels may be a concern.

Eight channels of digital input/output, isolated from system ground, are available at the rear panel. These channels can be scanned as part of the acquisition sequence or used to pass alarm or trigger signals for asynchronous communication between devices.

Scalable for High-Speed Synchronized Data Aquisition

In addition to the core set of features, the EX1401 integrates Extended Functions as defined in the LXI specifications to provide box-to-box synchronization to precisely correlate acquired data as well as time-stamping of data and LAN Event Messaging that facilitate intermodule communication and flexible triggering options over Ethernet, thereby eliminating overhead normally attributed to application software running on the host controller.

The EX1401 supports easy integration and synchronization of multiple devices through the IEEE-1588 v2 Precision Time Protocol standard for synchronization, providing an architecture that can be scaled from 10s to 1000s of channels.

Multiple boxes can be easily distributed extremely close to the measurement points of interest reducing the run length of analog cable and minimizing errors induced by noisy environments. Additionally, a Power Over Ethernet (PoE) enables a single cable to be used for both power and data capture. All measurement data is returned with IEEE-1588 timestamp codes with typical accuracies of <200nS ensuring that acquired data is tightly correlated across the test article.

Cold Junction Compensation (CJC)

The heart of any truly accurate thermocouple measurement system is the CJC implementation. The EX1401 is designed to measure the actual cold junction temperature at the point where the dissimilar metals meet. To further ensure the precision of the data, each channel has its own dedicated CJC sensor to reduce errors associated with temperature gradients across the box.

Self-Test

Manufacturing environments of today are dynamic, dictating minimal downtime of test systems in order to meet increasing product throughput demands. Ensuring that acquired data is reliable and instrument calibration can be turned around quickly are keys to the success of any production team. VTI embeds intelligence into the EX1401 to facilitate maximum system 'uptime' and increase manufacturing efficiency.

Built-in self-test can be invoked under software control prior to each critical test. A simple pass-fail result will be returned after completing system health diagnostics, including temperature and voltage level measurements of the on-board processor and can be used to prevent a test from running in the event of a failure.

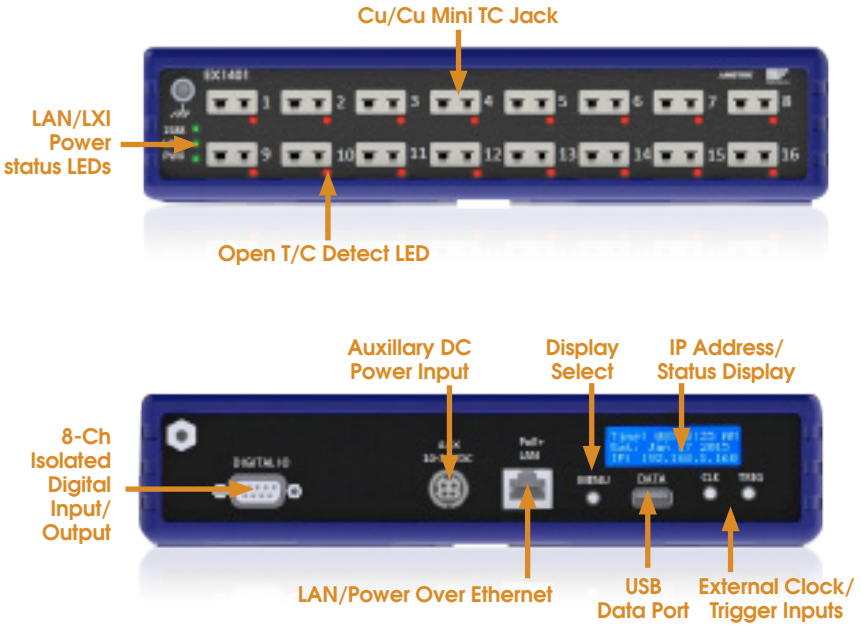
Open Thermocouple Detection (OTD) circuitry is incorporated and gives continuous visual indication via an LED whenever a broken transducer link is detected. OTD conditions can also be configured in the application through the supplied API and can be activated/deactivated on a per-channel basis.

LXI – The Industry Standard for Ethernet Instrumentation

Created in 2004 and adopted by the test and measurement industry in 2005, LXI (LAN Extensions for Instrumentation) defines a core set of capabilities that ensure compliant devices interact consistently in an instrumentation network. As an LXI-certified device, the EX1401 provides the convenience of LAN communications and control with features such as an embedded web page for monitor and control and a consistent means of identification on the network. Connect the device directly to your LAN network using industry standard cables with the assurance that it will be a trusted and proven 'network citizen'.

Isolated Measurements

Challenging measurement environments such as areas with a high level of electrical noise or where transient power surges can occur require unique protection capabilities in order to safeguard against common-mode noise or ground loop problems. The EX1401 provides exceptional input protection and isolation across a wide range of operating conditions, protecting the instrument from harmful voltages while ensuring measurement integrity. The Ethernet communications interface and input power are isolated from the analog front end inputs.



General Specifications

Channels	Analog	16 differential inputs, programmable type on per-channel basis, isolated
	Digital (Input/Output)	8 single-ended, 5 V TTL, bank isolated
Channel Types		Thermocouple inputs: J, K, T, E, S, R, B, N
		Voltage inputs: mV, V
Sampling Rate		Programmable, 20 kSa/sec/ch maximum down to 1 Sa/hour/ch (integer decimation)
Isolation, Analog	Channel-Ground	500 V
	Channel-Channel	1000 V
Isolation, Digital	Channel-Ground	250 V
	Channel-Channel	N/A (BANK ISOLATED)
Temperature Resolution		<0.001 ˚C
Temperature Accuracy		See Thermocouple Accuracy table
Voltage Resolution	±10.0 V	1.7 µV
	±1.0 V	150 nV
	±0.1 V	13.5 nV
	±0.01 V	1.7 nV
Voltage Accuracy	±10.0 V	±(0.025% + 500 µV)
	±1.0 V	±(0.025% + 50 µV)
	±0.1 V	±(0.025% + 10 µV)
	±0.01 V	±(0.05% + 10 µV)
Voltage Offset Stability	±10.0 V	±20 µV/°C typical
	±1.0 V	±10 µV/°C typical
	±0.1 V	±5 µV/°C typical
	±0.01 V	±2 µV/°C typical
Voltage Gain Stability	Voltage Input Channels (all ranges)	±25 ppm/°C, typical
Input Impedance (typical)		20 MΩ differential
INPUT BIAS CURRENT		5 nA typical
Common Mode Input Range		500 V peak with respect to earth ground

Common Mode Rejection Ratio (CMRR)

	Compliance Voltage	Frequency	Specification (Typical)
DC CMR	±500Vpk	—	-130 dB
AC CMR	±500Vpk	50 Hz	-130 dB
AC CMR	±425Vpk	60 Hz	-130 dB
AC CMR	±300Vpk	400 Hz	-120 dB

INPUT PROTECTION	100 V Normal mode protection
Host controller Connection	10/100 Base-T INPUT CONNECTOR, RJ45
Power Input	PoE+ or 10-50 V DC, 22 W MAX, 15 W TYPICAL
Dimensions (H x W x D)	44.45 mm x 203.2 mm x 254 mm; 1.75" x 8" x 10"
Weight	1.36 kg; 3 lbs.

Specifications subject to change without notice.

VTI Instruments
Corporate Headquarters
2031 Main St.
Irvine, CA 92614
+1 949-955-1894
sales@vtiinstruments.com
www.vtiinstruments.com

Synchronization Specifications

Specifications	Clock Oscillatory Accuracy	±50 PPM
	Synchronization Accuracy	Reports "Synchronized" When < ±200 nS of the 1588 Master Clock Timestamp
	Accuracy	As good as time synchronization down to 50 nS resolution, 25 nS
IEEE 1588-Based Trigger Timing	Alarm	**Trigger Time Accuracy:** As good as time synchronization Down to 50 µS Time to Trigger Delay 50 nS
	Receive LAN (0-7) Event	**Trigger Time Accuracy:** As good as time synchronization Down to 50 µS Time to Trigger Delay
	Future Timestamp	50 nS typical past/zero timestamp 1 mS maximum
Hardware Trigger Timing Dio	Bus	Time to trigger delay 75 nS Typical

Environmental Specifications

Temperature (Operating)		0°C TO +50°C
Humidity (Operating)		5% to 95% (non-condensing)
Altitude		Up to 4600 M
Shock and Vibration Conforms to MIL-PRF-28800F	Random Vibration	10 min per axis, MIL-PRF-28800F Class 3
	Sinusoidal	5 to 55HZ resonance search per MIL-PRF-28800F Class 3, each axis shock 30G/axis, 11MS half sine pulse per MIL-PRF-28800F Class 3

Temperature Accuracy Specifications (Thermocouples)

Type	Min (in °C)	Max (in °C)	-100 (in °C)	0 (in °C)	100 (in °C)	300 (in °C)	500 (in °C)	700 (in °C)	900 (in °C)	1100 (in °C)	1400 (in °C)
J	-200	1200	±0.25	±0.20	±0.20	±0.25	±0.30	±0.30	±0.35	±0.45	—
K	-200	1372	±0.25	±0.20	±0.20	±0.20	±0.35	±0.35	±0.45	±0.55	±0.50
T	-200	400	±0.25	±0.20	±0.20	±0.20	±0.25	—	—	—	—
E	-200	900	±0.25	±0.20	±0.20	±0.20	±0.25	±0.30	±0.35	—	—
S	-50	1768	—	±1.00	±0.75	±0.65	±0.65	±0.65	±0.70	±0.70	±0.75
R	-50	1768	±1.00	±0.75	±0.60	±0.60	±0.60	±0.60	±0.65	±0.70	—
B	-250	1820	—	—	—	±1.65	±1.10	±0.80	±0.70	±0.65	±0.65
N	-200	1300	±0.40	±0.25	±0.25	±0.25	±0.30	±0.35	±0.40	±0.40	—

Conditions

- 60-minute warm-up
- Guaranteed maximum limits are two times (2x) the typical values
- 20 °C to 30 °C, 1 year from full calibration
- Exclusive of thermocouple errors
- Exclusive of noise
- Common mode voltage = 0

Note for K type: 1400 accuracy is for 1372 °C
Note for T type: 500 accuracy is for 400 °C

Noise Levels (Typical)

Sample Rate	10V (uVpp)	1V (uVpp)	100mV (uVpp)	10mV (uVpp)	Temperature Type T, 40uV/C
10000	792	56.0	13.00	10.75	0.33 C pp
1250	204	12.5	3.01	2.93	0.075 C pp
156.25	67	5.2	1.14	0.89	0.029 C pp
19.53	26	1.8	0.60	0.41	0.015 C pp

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Corporate Headquarters
2031 Main St.
Irvine, CA 92614
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