



Precision 28208A Octal Thermocouple Conditioner with Enhanced Accuracy

The 28208A 8-Channel Thermocouple Conditioner with Enhanced Accuracy provides eight channels of conditioning for all commonly used thermocouple types. The 28208A consists of a low-drift programmable differential pre-amplifier, a 4-pole programmable filter and a programmable post-filter amplifier.

The 1U rack-mountable Isothermal block with integral digital temperature sensor includes mini-terminal connections for easy wiring of the thermocouples and better than 0.15 degree accuracy in reference junction compensation.



Sensor Applications

- Static or dynamic thermocouple conditioner
- AC or DC filter/amplifier (< 1 mV to 10 V inputs)

28208A Applications

- Static, Dynamic or Transient Temperature Testing
- Turbine and Rocket Engine Test Stands
- Wind Tunnels
- Energetic Shock, Explosive, Ordinance Testing
- Structural Shock and Vibration Testing

Precision 28208A Features:

- 8 channels per plug-in card
- 128 channels per 28016-M3 or 28016-M5 mainframe, 64 channels per 28008-M3/M5 mainframe, 32 channels per 28004-M3/M5 mainframe 16 channels per 28002-M5 mainframe
- Low temperature coefficient of offset and gain
- Open thermocouple detection
- Overload detection
- Programmable 4-pole Bessel low-pass filter (1, 10, 100 Hz and wideband)
- Precise cold junction compensation for type B, E, J, K, N, R, S and T thermocouples
- Automatic adjustment of DC offset and gain
- Programmable gain: x1, 10, 100, 1000 with out-band reserve settings of x1 or 10
- Remote isothermal block with high accuracy digital temperature sensor
- Programmable differential or single-ended input (Option 3)

Overview

28000 Analog Signal Conditioning System

The new standard for the world's most discriminating test labs.



The Precision 28000 signal conditioning system provides all the flexibility you need to manage your test measurements.

The Precision 28000 makes it easy to manage a test, with hundreds of channels and a mix of transducers. Choose charge, IEPE w/TEDS, voltage (filter amplifier), strain, thermocouple, RTD, potentiometer, current, frequency, or other transducers.

The built-in test hardware and software (optional) provide quick Go/No-Go tests, which can be run before each test, and rigorous Factory Acceptance Tests to assure you that the 28000 meets your most stringent requirements for critical applications. It won't be long before these tests earn a permanent place in your maintenance routine. And since they are traceable to NIST, they eliminate the need for off-site calibration.

In every phase of your tests—record keeping, installation, design, setup, operation, maintenance, and upgrading—the Precision 28000 offers ways to help you save time and money over the life of the system.

28000 System Features

- Graphical user interface (GUI) and Ethernet network interface for system control
- Intelligent gain and system scaling algorithms
- Test input and output monitor busses
- Go/No-Go test with diagnostics to be used before tests
- Rigorous Factory Acceptance Test for maintenance
- Field-swappable AC power supplies
- Built-in temperature and power supply monitoring with alarms

Precision 28208A Description

Precision 28208A Description

The 28208A octal thermocouple conditioner is a member of the Precision 28000 family of signal conditioners. It provides eight channels of conditioning for thermocouples or other DC and AC voltage inputs. The 28208A is ideal for applications such as static (DC) or dynamic (AC) temperature measurement and as a low-level DC or AC filter amplifier (<1 mV to 10 V inputs).

The 28208A channel consists of a low-drift programmable differential preamplifier, a 4-pole programmable filter, and a programmable postamplifier. Overall gain may be programmed to $\times 1$, $\times 10$, $\times 100$, or $\times 1000$. A programmable reserve setting of $\times 1$ or $\times 10$ is provided for protection against out-of-band signals. For example, a reserve setting of 10 with a gain of 100 will program the preamplifier to 10 and the post amplifier to 10, allowing the filter to reject out-of-band energy before all of the gain is applied.

An open thermocouple condition or a channel overload condition is automatically detected and reported to the graphical user interface (GUI) software. In addition, these fault conditions are indicated by 28208A front-panel LEDs.

A 4-pole programmable Bessel filter is provided with cutoff frequency settings of 1, 10, and 100. The filter may be bypassed to provide 10 kHz wideband operation.

Option 3 provides programmable single-ended or differential input. When grounded thermocouples are used, it is recommended to configure the input for differential mode for optimal SNR performance. For installations with floating thermocouples, potentially large noise pickup on floating leads can occur with input configured for differential mode. If input exceeds the common mode range of the amplifier, data will be invalid. It is therefore recommended to configure the input for single-ended mode to limit the noise pickup on the amplifier input and prevent saturation on the channel.

Isothermal Block



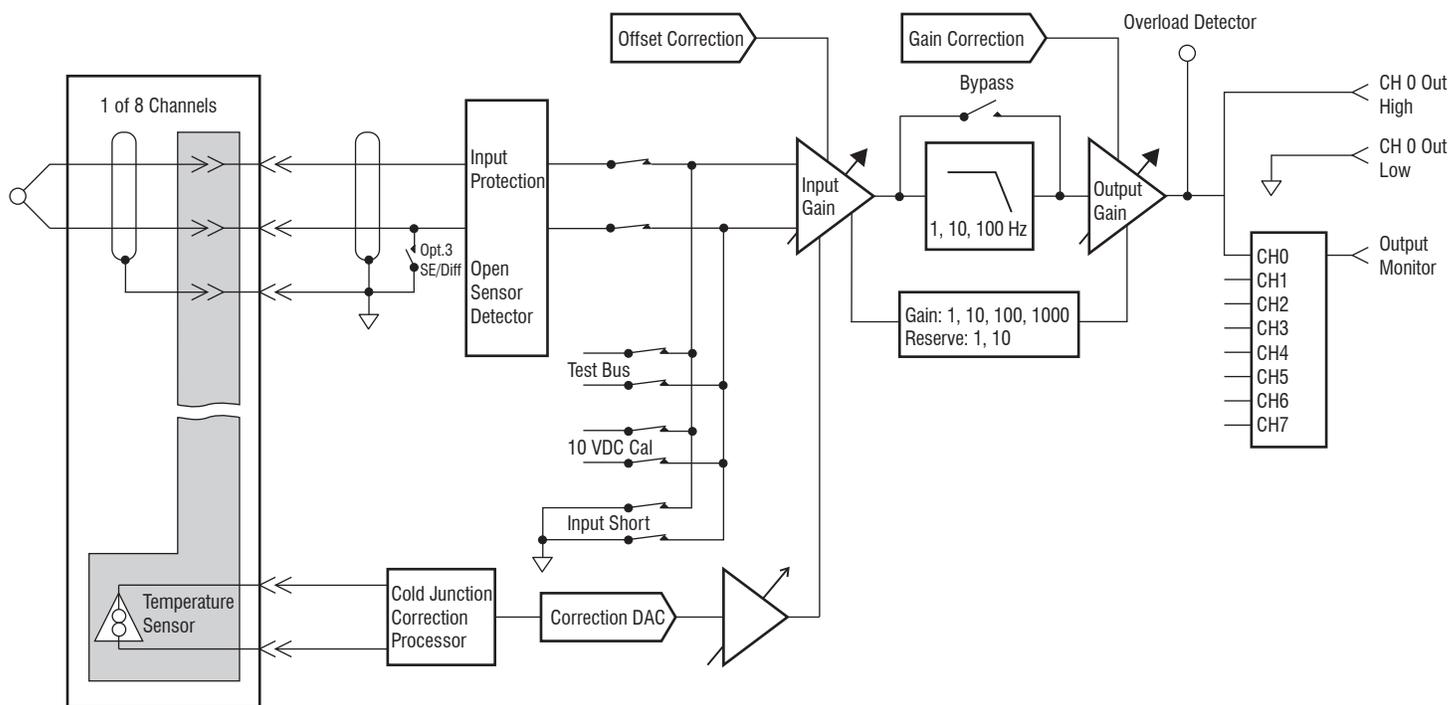
The 28208A-1-ITB 1U rack mountable Isothermal Block provides a reference junction for four 28208A cards (32-channels). Removable 2-pole flat type mini-terminal connectors allow for easy wiring of the thermocouples. Extension cables are available to locate the block remotely from the 28000 System.

For accurate cold junction compensation, the temperature of the isothermal block must be converted to the thermocouple thermoelectric voltage that would be generated if the junction were heated to the temperature that is measured. Thermocouple thermoelectric voltage has a non-linear relationship with temperature that is commonly referred to as "bowing". If a straight-line approximation to the thermoelectric voltage versus temperature were used, reference junction errors of over 1°C would result for a J-type thermocouple and over 2° for a T-type thermocouple.

A digital temperature sensor on the 28208A-1-ITB provides an accurate reading of the block temperature. The block temperature is interrogated once every 10 seconds. To remove errors caused by the bowing, a microcomputer in the 28208A sets a cold junction compensation DAC by calculating the correction voltage for the measured temperature based on NIST coefficients. Overall reference junction compensation accuracy is better than 0.15 degrees.



28208A-1-ITB Isothermal Block Rear View



28208A-1-ITB Isothermal Block (1 of 4 Sections)

28208A Card and Isothermal Block, 1 of 32 Channels Shown

28208A Details and Specifications

Input Characteristics

Type:

3-wire differential (high, low, shield)
DC coupled

Offset Temperature Coefficient:

Gain	Reserve	Offset Temp. Coef. ($\mu\text{V}/^\circ\text{C}$)
1	1	16.4
10	1	2.5
100	1	1.3
1000	10	1.2
10	10	11.2
100	10	2.0

Input Impedance:

1,000 M Ω /100 pF per side

Protection: ± 40 V

Common Mode V: ± 10 Vpk

Common Mode Rejection:

106 dB for input gain $\gg 100$ (DC – 100 Hz)

Max Input:

± 10 Vpk to 25 kHz
 ± 10 Vpk * (25 kHz/f), f > 25 kHz

Input Test Modes

Open Thermocouple Detection (Standard):

Open thermocouple condition is indicated on GUI and by front-panel LEDs

Input Short (Standard): A switch at the amplifier input is used to ground the input stage to measure amplifier noise and DC offset. The ITB block correction voltage is set to 0 V when the input short switch is activated.

Test Input (Standard): Test input allows for injection of a test signal. An external test signal or the 28000-?-TEST Test Subsystem may be connected to the front panel of the Backplane Interface (BIF) card. The ITB block correction voltage is set to 0 V when the test input switch is activated.

10 VDC Cal: A switch at the input connects a precision 10 VDC calibration reference to the input amplifier.

10 VDC Ref Output: 10 V \pm 0.2%

10 VDC Ref Temperature Coefficient:
20 ppm/ $^\circ\text{C}$

28208A Transfer Characteristics

The 28208A amplifier consists of prefilter gain and postfilter gain stages. The gain distribution is set by the programmed reserve. See Table 2 below:

DC Linearity:

0.005% re fullscale, relative to best straight line

Frequency Response:

Bandwidth (Filter Bypassed):
–3 dB ; 10 kHz

Gain Tolerance:

0.02%

Temperature Coef:

35 ppm/ $^\circ\text{C}$

28208A Filter Characteristics

Type:

4-pole Bessel low pass (BE4)

Cutoff Frequency (Fc):

F01 range: 1 Hz, 10 Hz, 100 Hz, and wideband (programmable)

Cutoff Amplitude:

–3.01 dB

Amplitude Accuracy:

± 0.1 dB, DC to Fc

28208A Output Characteristics

Type (Standard): Single-ended

Level: ± 10 Vpk, ± 5 mA pk

Output Impedance: 10 ohms

Offset:

<1 mV typical after auto adjust

Overload Detection:

Overload at channel output is indicated by front-panel LEDs and indicators in the GUI. Detection threshold is 11 V $\pm 1\%$.

Noise:

0.1 Hz to 100 kHz, Fc = 100 Hz, See Table 3

Gain	Reserve	Noise RTO ($\mu\text{V p-p}$)
1	1	7
10	1	20
100	1	200
1000	10	2000
10	10	50
100	10	200

Gain	Reserve	Prefilter Gain	Postfilter Gain
1	1	1	1
10	1	10	1
100	1	100	1
1000	10	100	10
10	10	1	10
100	10	10	10

28208A Details and Specifications

28208A-1-ITB Isothermal Block

Number of Channels: 32. Supports up to four 28208A cards.

Extension Cable: Cable extends 28208A card inputs to ITB. Standard cable length is 10' (max 100').

Thermocouple Types Supported:
B, E, J, K, N, R, S, T

Hardware Bow Correction:
Polynomial approximation to the thermoelectric voltage of a thermocouple versus temperature is utilized to reduce

thermocouple "bow" errors.
Note: Thermocouple non-linearity is not corrected.

Temperature Reading Sampling Period:
10 seconds

Reference Junction Monitor:
Command to support readout of reference junction by user.

Ambient Temperature Range:
-10° C to +100° C

Block Sensor Accuracy:
±0.1° C, maximum, -10° C to +50° C
±0.15° C, maximum, +50° C to +70° C
±0.2° C, maximum, +70° C to +100° C

Gain	Reserve	Type E	Type J	Type K	Type T
1	1	0.16	0.17	0.2	0.2
10	1	0.1	0.1	0.1	0.1
100	1	0.1	0.1	0.1	0.1
1000	10	0.1	0.1	0.1	0.1
10	10	0.17	0.17	0.2	0.2
100	10	0.1	0.1	0.1	1.1

Table 4 lists the overall cold junction compensation accuracy (including sensor and hardware correction).
Isothermal Block and 28000 chassis 23 ±5° C

	-100° C	0° C	100° C	300° C	500° C	700° C	900° C	1100° C
Type J	0.18	0.14	0.17	0.22	0.28	0.33	0.38	0.44
Type K	0.20	0.16	0.18	0.24	0.29	0.35	0.40	0.46
Type T	0.21	0.16	0.18	0.22	—	—	—	—
Type E	0.18	0.14	0.16	0.21	0.26	0.32	0.37	—
Type N	0.24	0.19	0.21	0.25	0.30	0.35	0.40	0.46

Table 5 describes the overall accuracy, including block correction, DC offset and gain drift.

Conditions:

- Guaranteed "Maximum" limits
- Isothermal Block = 23 ±5° C
- 28208A chassis system within ±2° C of auto gain and offset adjust temperature
- Does not include thermocouple errors
- Channel gain optimized for TC level (100x or 1,000x)

Note:
Overall accuracy of R, S & B type Thermocouples is highly dependent on the 28208A's analog reference point compensation. If the analog reference point compensation is used overall accuracy will depend on changes between ambient temperature during auto gain adjust (Tadj) and Temperature of use (Tuse) and is given by :

Type R and S: $0.02\% + 0.25^{\circ}\text{C} * (T(\text{use}) - T(\text{adj}))$
Type B: $0.02\% + 10^{\circ}\text{C} * (T(\text{use}) - T(\text{adj}))$

28208A General Characteristics

28208A Card Size:
6.63 x 17.5 x 0.75 inches

Card Weight: 1.4 lb. net

Temperature:
0° C to 40° C (operating);
-20° C to 70° C (storage)

28208A-1-ITB Isothermal Block Weight:
1.5 lb. net

Accessories

Mating Connectors

Precision Filters mating connectors accommodate up to 22-AWG wire and are supplied with high-quality metal backshells and gold plated screw machined contacts for high reliability connections and long service life.

CONN-IN-26D High-density 26-pin D-shell mating input connector with machined crimp pins and metal backshell with strain relief.

CONN-OUT-26D High-density 26-pin D-shell mating output connector with machined crimp pins and metal backshell with strain relief.

CONN-OUT-26D-SC High-density 26-pin D-shell mating output connector with machined solder cup pins and metal backshell with strain relief.

Ordering Information

28208A-F01-BE4-3

- Option 3: Programmable Single-ended or Differential Input
- Filter Type: 4-pole Bessel (BE4)
- Cutoff Frequency: 1 Hz, 10 Hz, 100 Hz (F01)

28208A-1-ITB

32-Channel Isothermal Block.
Supports up to four 28208A cards.

CB-28208A-ITB-10

Extension Cable for Isothermal Block.
One cable required per 28208A card.
Length=10 Feet
Consult factory for other lengths.