



## Precision 28208 Octal Wideband Thermocouple Conditioner

The 28208 Octal-Channel Thermocouple Conditioner provides eight channels of conditioning for all commonly used thermocouple types. The 28208 consists of a low-drift differential programmable pre-amplifier, a 3-pole programmable Bessel low-pass filter and a programmable post amplifier. The distributed gain topology allows the 28208 to provide protection against large out-of-band signals from clipping the amplifier. The bandwidth of the 28208 is suitable for both static and dynamic temperature measurements.

The 28208-1-ITB Isothermal Block provides reference junction compensation for a single 28208 card. Removable screw terminal connections are provided for convenient connection to the thermocouples. The block supports all thermocouple types and has better than 0.6 degrees overall reference junction compensation accuracy.



### Sensor Applications

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

### 28208 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 28208 Features:

- Eight channels per card, 128 channels per 28016 chassis
- Balanced differential input
- Low drift – 0.5  $\mu\text{V}/^\circ\text{C}$  max
- Open thermocouple detection
- Overload detection
- Front panel LEDs for open and overload indication
- Programmable gain: x1, 10, 100, 1000 with reserve settings of x1, 10 or 100
- Programmable 3-pole Bessel low-pass filter (1, 10, 100 Hz and wideband)
- Selectable input shield: driven, grounded or open
- Isothermal block with digital temperature sensor may be remotely located in isothermal environment
- Reference junction compensation for type B, E, J, K, N, R, S and T thermocouples
- Automatic offset calibration
- Input short test mode for verifying DC offset and noise
- Test bus for injection of external calibration signals
- 10 VDC calibration source
- Output Monitor bus
- Optional Differential Output (Option T)

### 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 28208 Description

## Precision 28208 Description

The 28208 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 28208 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 28208 channel consists of a low-drift programmable differential preamplifier, a 3-pole programmable filter, and a programmable post-amplifier. Overall gain may be programmed to  $\times 1$ ,  $\times 10$ ,  $\times 100$ , or  $\times 1000$ . A programmable reserve setting of  $\times 1$ ,  $\times 10$ , or  $\times 100$  is provided for protection against out-of-band-signals. For example, a reserve setting of 100 with a gain of 1000 will program the preamplifier to 10 and the postamplifier to 100, 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 28208 front-panel LEDs.

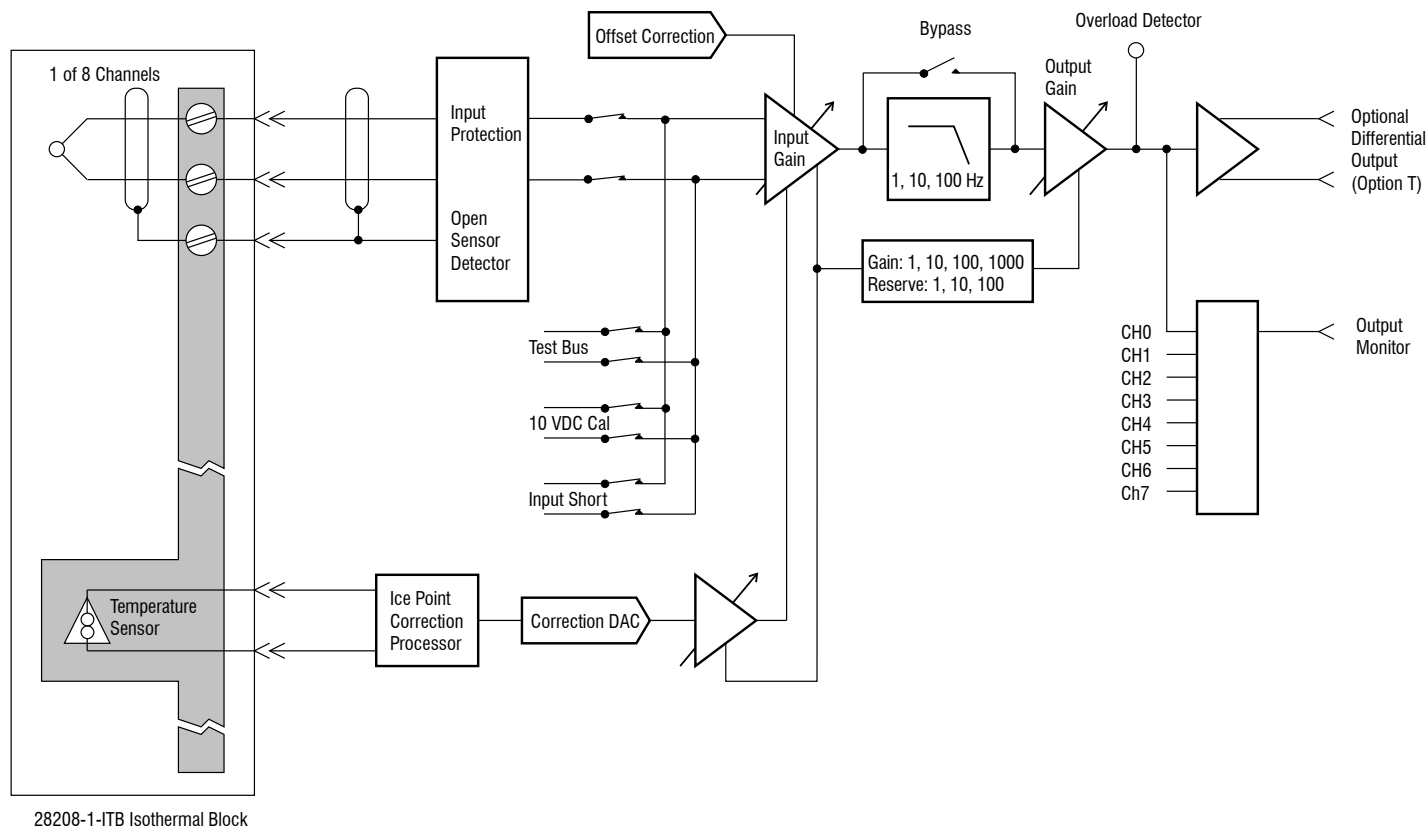
A 3-pole programmable Bessel filter is provided with cutoff frequency settings of 1, 10, and 100. The filter may be bypassed to provide wide-band operation.

## Isothermal Block

The 28208-1-ITB Isothermal Block provides a reference junction for a single 28208 card (8-channels). Removable 3-pole terminal connectors allow for easy wiring of the thermocouples. The 28208-1-ITB has a 4-foot cable which mates directly with the 28208 input connector. Extension cables are available to locate the block remotely from the 28000 System. A removable cover provides a more stable environment while protecting the block.

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 28208-1-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 28208 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 0.6 degrees.



28208 Card and Isothermal Block, 1 of 8 Channels Shown

# 28208 Details and Specifications

## Input Characteristics

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

**Offset Temperature Coefficient:**  
0.5  $\mu\text{V}/^\circ\text{C}$  max.

**Input Impedance:**  
1,000 M $\Omega$ /100 pF per side

**Protection:**  $\pm 40$  V

**Common Mode V:**  $\pm 10$  Vpk

**Common Mode Rejection:**  
106 dB for input gain  $> \times 100$  (DC – 100 Hz)

**Max Input:**  
 $\pm 10$  Vpk to 2.5 kHz  
 $\pm 10$  Vpk \* (2.5 kHz/f), f  $> 2.5$  kHz

**Noise:** (0.1 Hz to 100 Hz), See Table 1.

**Shield:**  
Switch selectable to open, grounded or driven. Switch setting displayed on GUI.

## 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 at the rear panel. The ITB block correction voltage is set to 0 V when the test input switch is activated.

Gain	Reserve	Noise RTI ( $\mu\text{V rms}$ )
1	1	35
10	1	3.5
100	1	0.5
1000	1	0.3
10	10	12
100	10	1.3
1000	10	0.3
100	100	8
1000	100	1

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

10 VDC Ref Output:  $10 \text{ V} \pm 0.2\%$   
10 VDC Ref Temperature Coefficient:  
20 ppm/ $^\circ\text{C}$

## 28208 Transfer Characteristics

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

**DC Linearity:**  
0.005% re fullscale, relative to best straight line

**Temperature Coefficient:**  
30 ppm/ $^\circ\text{C}$

**Frequency Response:**  
Typical small signal  $-3$  dB bandwidth  
650 Hz for Gain/Reserve of 1000/1;  
1 kHz for all other gain settings

## 28208 Filter Characteristics

**Type:**  
3-pole Bessel low pass (BE3)

**Cutoff Frequency (Fc):**  
F01 range: 1 Hz, 10 Hz, 100 Hz, and wideband (programmable)

**Cutoff Amplitude:**  
 $-3.01$  dB

**Amplitude Accuracy:**  
 $\pm 0.1$  dB, DC to Fc

**Wide Band Frequency Response:**  
See Transfer Characteristics section.

Gain	Reserve	Prefilter Gain	Postfilter Gain	Gain Total (%)
1	1	1	1	0.1
10	1	10	1	0.1
100	1	100	1	0.1
1000	1	1000	1	0.1
10	10	1	10	0.1
100	10	10	10	0.1
1000	10	100	10	0.1
100	100	1	100	0.25
1000	100	10	100	0.25

## 28208 Output Characteristics

**Type (Standard):** Single-ended

**Level:**  $\pm 10$  Vpk,  $\pm 5$  mA pk

**Output Impedance:** 10 ohms

**Option T:**  
Balanced differential output

**Level:**  $\pm 5$  Vpk,  $\pm 5$  mA pk per side

**Output Impedance:** 10 ohms, each side

**Drift:**  
 $(0.5 \mu\text{V}/^\circ\text{C}) * \text{Gain} + (15 \mu\text{V}/^\circ\text{C}) * \text{Reserve}$

**Offset:**  
 $< 3$  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  $11 \text{ V} \pm 1\%$ .

**Noise:**  
0.1 Hz to 100 kHz, Fc = 100 Hz, See Table 3

Gain	Reserve	Noise RTO ( $\mu\text{V rms}$ )
1	1	35
10	1	35
100	1	50
1000	1	250
10	10	115
100	10	130
1000	10	250
100	100	800
1000	100	1000

## 28208-1-ITB Isothermal Block

The 28208-1-ITB Isothermal Block provides a digital reference junction sensor and screw terminal connections for eight thermocouples (2 wires plus shield). Power to the temperature sensor is provided by the 28208 card.

The standard 28208-1-ITB has a 4-foot long cable that interfaces directly to the input connector of the 28208 card. For remote location (up to 150 feet) and to avoid long thermocouple extension leads, PFI provides an extension cable (CB-HD26S/HD26P-L).

Cold junction compensation may be disabled to allow the 28208 amplifier/filter to be used in applications other than thermocouple conditioning.

**Standard 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.

**Block Sensor Accuracy:**  
±0.5 deg C, -10 to 85°C

**Block Temperature Range:**  
-10 to 100°C

Gain	Reserve	Type E	Type J	Type K	Type T
100	1	0.6	0.6	0.6	0.6
1000	1	0.6	0.6	0.6	0.6
100	10	0.9	1.0	1.1	1.1
1000	10	0.6	0.6	0.6	0.6
100	100	3.7	4.4	5.5	5.3
1000	100	0.9	1.0	1.1	1.1

Table 4 lists the overall cold junction compensation accuracy (including sensor and hardware correction).

Type	Temp Range	Temp for Gain Setting (°C)	
		×1, ×10, ×100	×1000
B	0 to 1820	0 to 1820	0 to 1490
E	-270 to 1000	-270 to 1000	-270 to 152
J	-210 to 1200	-210 to 1200	-210 to 185
K	-270 to 1372	-270 to 1372	-270 to 246
N	-270 to 1300	-270 to 1300	-270 to 318
R	-50 to 1768	-50 to 1768	-50 to 961
S	-50 to 1768	-50 to 1768	-50 to 1035
T	-270 to 400	-270 to 400	-270 to 213

Table 5 describes how the temperature range for the thermocouple is affected by gain setting.

## 28208 General Characteristics

**28458 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)

**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.

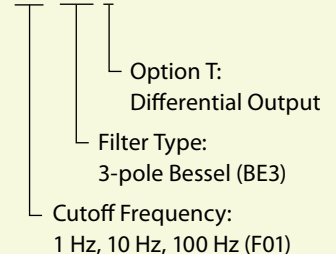
**CONN-IN-26D-SC** High-density 26-pin D-shell mating input connector with machined solder cup pins and metal backshell with strain relief.

**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

28208-F01-BE3-?



**CB-HC26S/HD26P-L**

Extension Cable for Isothermal Block  
L=Length in Feet,  
Maximum 150 Feet)