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

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

Preliminary

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 provides pluggable screw terminal connection to the thermocouple wires with better than 0.15 degree accuracy in reference junction compensation.

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
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 ×1, ×10, ×100, or ×1000. A programmable reserve setting of ×1 or ×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.

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.
### Input Characteristics

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

**Offset Temperature Coefficient:**

<table>
<thead>
<tr>
<th>Gain</th>
<th>Reserve</th>
<th>Offset Temp. Coef. (μV/°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>16.4</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>2.5</td>
</tr>
<tr>
<td>100</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td>1000</td>
<td>10</td>
<td>1.2</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>11.2</td>
</tr>
<tr>
<td>100</td>
<td>10</td>
<td>2.0</td>
</tr>
</tbody>
</table>

**Input Impedance:**
1,000 MΩ/100 pF per side

**Protection:** ±40 V

**Common Mode V:** ±10 Vpk

**Common Mode Rejection:**
106 dB for input gain >x100 (DC – 100 Hz)

**Max Input:**
- ±10 Vpk to 100 kHz
- ±10 Vpk * (100 kHz/f), f >100 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 ± 0.2%
- 10 VDC Ref Temperature Coefficient: 20 ppm/°C

### 28208A Transfer Characteristics

The 28208A amplifier consists of prefilt er 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

**Frequency Response:**
Typical small signal BW (Filter Bypassed):
-3 dB ; 10 kHz

### 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, each side

**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 ±1%.

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

#### Table 1 Offset Temperature Coef. RTI

<table>
<thead>
<tr>
<th>Gain</th>
<th>Reserve</th>
<th>Offset Temp. Coef. (μV/°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>16.4</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>2.5</td>
</tr>
<tr>
<td>100</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td>1000</td>
<td>10</td>
<td>1.2</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>11.2</td>
</tr>
<tr>
<td>100</td>
<td>10</td>
<td>2.0</td>
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</table>

#### Table 2 DC Accuracy

<table>
<thead>
<tr>
<th>Gain</th>
<th>Reserve</th>
<th>Prefilter Gain</th>
<th>Postfilter Gain</th>
<th>Gain Tolerance (%)</th>
<th>Temp Coef. (ppm/°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.02</td>
<td>25</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>10</td>
<td>1</td>
<td>0.02</td>
<td>35</td>
</tr>
<tr>
<td>100</td>
<td>1</td>
<td>100</td>
<td>1</td>
<td>0.02</td>
<td>35</td>
</tr>
<tr>
<td>1000</td>
<td>10</td>
<td>1000</td>
<td>10</td>
<td>0.02</td>
<td>25</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>1</td>
<td>10</td>
<td>0.02</td>
<td>35</td>
</tr>
<tr>
<td>100</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>0.02</td>
<td>35</td>
</tr>
</tbody>
</table>

#### Table 3 Output Noise at Various Gain and Reserve Settings

<table>
<thead>
<tr>
<th>Gain</th>
<th>Reserve</th>
<th>Noise RTO (μV p-p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>20</td>
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<tr>
<td>100</td>
<td>1</td>
<td>200</td>
</tr>
<tr>
<td>1000</td>
<td>10</td>
<td>2000</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>100</td>
<td>10</td>
<td>200</td>
</tr>
</tbody>
</table>
28208A Details and Specifications

28208A-1-ITB Isothermal Block

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.

Table 4 Cold Junction Correction Accuracy (°C)

<table>
<thead>
<tr>
<th>Gain</th>
<th>Reserve</th>
<th>Type E</th>
<th>Type J</th>
<th>Type K</th>
<th>Type T</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0.16</td>
<td>0.17</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>100</td>
<td>1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>1000</td>
<td>10</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>0.17</td>
<td>0.1</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>100</td>
<td>10</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>1.1</td>
</tr>
</tbody>
</table>

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

Isothermal Block and 28000 chassis 23 ±5°C

Table 5 PFI 28208A Overall Accuracy (°C)

<table>
<thead>
<tr>
<th></th>
<th>–100°C</th>
<th>0°C</th>
<th>100°C</th>
<th>300°C</th>
<th>500°C</th>
<th>700°C</th>
<th>900°C</th>
<th>1100°C</th>
<th>1400°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type J</td>
<td>0.18</td>
<td>0.14</td>
<td>0.17</td>
<td>0.22</td>
<td>0.28</td>
<td>0.33</td>
<td>0.38</td>
<td>0.44</td>
<td>—</td>
</tr>
<tr>
<td>Type K</td>
<td>0.20</td>
<td>0.16</td>
<td>0.18</td>
<td>0.24</td>
<td>0.29</td>
<td>0.35</td>
<td>0.40</td>
<td>0.46</td>
<td>—</td>
</tr>
<tr>
<td>Type T</td>
<td>0.21</td>
<td>0.16</td>
<td>0.18</td>
<td>0.22</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Type E</td>
<td>0.18</td>
<td>0.14</td>
<td>0.16</td>
<td>0.21</td>
<td>0.26</td>
<td>0.32</td>
<td>0.37</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Type N</td>
<td>0.24</td>
<td>0.19</td>
<td>0.21</td>
<td>0.25</td>
<td>0.30</td>
<td>0.35</td>
<td>0.40</td>
<td>0.46</td>
<td>—</td>
</tr>
</tbody>
</table>

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

Conditions:
Guaranteed “Maximum” limits
Isothermal Block =23 ±5°C
28000 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 28000A’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°C * (T(use)–T(adj))
Type B: 0.02% +10°C * (T(use)–T(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
Filter Type: 4-pole Bessel (BE4)
Cutoff Frequency:
1 Hz, 10 Hz, 100 Hz (F01)

CB-28208A-ITB-10
Extension Cable for Isothermal Block
Length=10 Feet,
Consult factory for other lengths