

28108 OCTAL WIDEBAND BRIDGE CONDITIONER

Constant Voltage Excitation; 100 kHz Bandwidth

**PRECISION
FILTERS, INC.**



SYSTEM 28000 FEATURES

- Graphical User Interface (GUI) 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

28000 SIGNAL CONDITIONING SYSTEM

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, set-up, operation, maintenance and upgrading—the Precision 28000 offers ways to help you save time and money over the life of the system.

PRECISION 28108 APPLICATIONS

- Strain gage conditioner
- Load cell conditioner
- Pressure transducer conditioner
- Piezoresistive transducer conditioner
- General purpose bridge conditioner
- Potentiometer conditioner
- Low level AC or DC amplifier (<1 mV to 10 V inputs)
- Anti-aliasing filter/amplifier

PRECISION 28108 FEATURES

- 8 channels per card, 128 channels per chassis
- Balanced programmable constant voltage source with remote sense
- Up to 20 V excitation delivered to the bridge
- ± 10 V_{cm} operation
- Up to 25.5 kHz “filtered” bandwidth or 100 kHz “wide-band” bandwidth
- 2- to 6-wire plus shield transducer input interface
- Automatic bridge balance/transducer suppress
- Programmable amplifier: x1/4 to x8192 with 0.05% vernier
- 4-pole low-pass filters with filter programmable pulse/flat characteristics
- 2° phase matching between any channels
- Overload detection
- Precise automatic calibration
- Auxiliary front panel output connection to support the use of custom output modules (for unit without option 4)



28108 Front Panel with Auxiliary Output Connector

28108 DESCRIPTION

The 28108 is a member of the Precision 28000 family of signal conditioners. The 28108 provides eight channels of conditioning to support a wide variety of transducers including those that require constant voltage excitation in a bridge configuration such as strain gages and pressure transducers. The 28108 may be easily configured to operate as a precise voltage filter/amplifier on low-level voltage inputs. Up to sixteen 28108 cards may reside in the 28000 system to provide up to 128 channels per chassis. In addition, the 28108 may be mixed with other conditioners in the 28000 family to meet your unique signal conditioning requirements.

The 28108 provides constant voltage excitation and conditioning for 4-arm resistive bridges. The 28108 features automatic calibration of gain and offset for the entire channel, including the amplifier and filter.

Automatic balance of the bridge is accomplished by inserting a voltage ratiometric with the excitation supply to the amplifier input stage. This balance method provides outstanding stability without loading the bridge. A wide range of unbalanced conditions may be accommodated.

Balanced Voltage Excitation

The 28108 features a programmable constant voltage excitation supply that can source up to 20 volts to the bridge. Dedicated remote sense lines allow the excitation supply regulator to deliver an accurate voltage to the bridge.

Balanced constant voltage excitation offers a number of advantages over single-ended excitation. It enables a true balanced instrumentation amplifier input for outstanding rejection of high frequency common-mode signals. Single-ended voltage excitation to balanced bridges produces a relatively large common-mode voltage at half the excitation supply. The instrumentation amplifier must reject this signal. Balanced voltage excitation applied to balanced bridges results in lower common-mode input voltages to the amplifier input stage.

Input Stage

The 28108 input stage has 100 dB of common-mode rejection, low DC drift and low noise. A programmable switch at the input stage is provided to connect the amplifier to the 28000 system test bus. The test bus is used to inject signals for performance verification. In addition, the excitation supply may be connected to the input stage for direct verification of the excitation supply level.

Amplifier and Filter

Programmable pre- and post-filter amplifiers provide an overall gain of 8,192. Gain is distributed both before and after the filter to provide protection from large out-of-band energy or transients that could cause clipping before the filter, distorting the data. The Gain Wizard in the GUI allows the user to set a gain reserve and then apportions the gain between the input and output. This provides input gain for best noise performance yet conforms to the limitations of the user's worst case estimate of out-band or transient signals. Overload detectors alert the user to over-voltage conditions.

The post-filter gain has resolution of better than 0.05% to enable precise system scaling of the 28108 outputs to match the full-scale input of the external recording device, given the transducer sensitivity and fullscale input in measurement units. A fully buffered output having over 5 mA of drive capability may be used to drive long output cable runs.

The 28108 contains a 4-pole low-pass filter with cutoffs programmable from 100 Hz to 25.5 kHz in "flat" mode or 50 Hz to 12.75 kHz in 50 Hz steps in "pulse" mode. The "flat" mode provides pass-band characteristics nearly identical to a Butterworth filter while providing a much sharper roll-off. This mode is a good choice for applications such as spectral analysis. The "pulse" mode has time domain response similar to the Bessel filter yet provides superior amplitude response characteristics. The "pulse" mode is ideal for time domain applications including transient (shock) measurements and time domain waveform analysis.

28108 PROGRAMMABLE FEATURES

- Excitation level (0 to 20.475 V in 5 mV steps)
- Excitation sense (local or remote)
- Automatic balance (zero)
- Test Modes: Amp Short, Excitation Off, Voltage Substitution, Excitation Monitor, Output Monitor
- Gain (x1/4 to x8192 with 0.05% resolution)
- Cutoff frequency:
 - Pulse Mode: 50 Hz to 12.75 kHz in 50 Hz steps
 - Flat Mode: 100 Hz to 25.5 kHz in 100 Hz steps
- Wideband (100 kHz) or filtered operation

GRAPHICAL USER INTERFACE DISPLAY

All programmable features in addition to:

- Balance (zero) status
- Input wiring
- Gage sensitivity
- System scaling in engineering units
- Overload status
- Gain Wizard
- Filter Wizard
- Group Control

28108 CONDITIONER CARDS

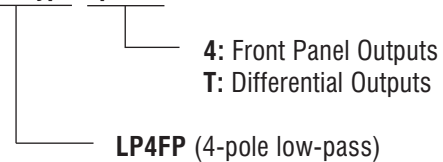
The detailed description and specifications for the 28108 card are organized as follows in the sections below.

- Card Model Number Structure
- Bridge Wiring
- Excitation Supply
- Input Characteristics and Options
- Amplifier Characteristics
- Test Modes
- Filter Type Characteristics
- Output Characteristics
- General Card Characteristics
- Accessories and Ordering Information

28108 CARD MODEL NUMBER

The 28108 card model number describes the configuration of the four channels on the card. The model number identifies the filter characteristic, or filter type, of the low-pass filters.

28108-Filter Type-Options



BRIDGE WIRING

Input Connector: 26-pin D-shell (2 ea.)
Input Wires: EXCITATION (2)
SENSE (2)
SIGNAL (2)
SHIELD (1) two common shield pins shared across four channels in each input connector

28108 EXCITATION SUPPLY

Programmable Constant Voltage Excitation

Maximum Output: 20.475 V, 30 mA (balanced)
Steps: Programmable from 0 to 20.475 V in 5 mV steps
Excitation Sense: Programmable (local or remote sense)
Accuracy: $\pm 0.1\%$ or 5 mV, whichever is greater
Current Limit: 40 mA, typical
Noise: $100 \mu\text{Vrms}$, 3 Hz to 50 kHz
Temp. Drift: $\pm 0.0025\%/^{\circ}\text{C}$ of setting or $\pm 50 \mu\text{V}/^{\circ}\text{C}$, whichever is greater
Sense Current: Less than $10 \mu\text{A}$
Excitation Off: The excitation supply is programmed to 0 volts.

Excitation Monitor (Standard)

Excitation Monitor: Under GUI control, the amplifier input is switched from the bridge to the excitation supply to monitor the excitation voltage. Excitation monitor gain is x0.5.

28108 INPUT CHARACTERISTICS

Type:	Balanced differential
Common-Mode Voltage:	± 10 V operating
CMRR:	100 dB maximum, DC to 500 Hz, with a full bridge input and input gain of x16 or greater
Input Protection:	± 45 V continuous ± 100 Vpk transient, 1 ms pulse 10% duty cycle
Input Impedance:	10 M Ω //100 pF per side 20 M Ω //50 pF differential
Max Level:	± 10 Vpk for $f \leq 50$ kHz; ± 10 Vpk (50 kHz/f) for $f > 50$ kHz
Offset Drift:	1 μ V/ $^{\circ}$ C, maximum
Noise:	7 nV/ $\sqrt{\text{Hz}}$ RTI at 1 kHz and gain $> \times 64$

Input Short (Standard)

Input Short: A switch at the amplifier input is used to ground the input stage to measure amplifier noise and DC offset.

Test Input (Standard)

Test Input: Test input allows for injection of a test signal. An external test signal or the 28000-?-TEST Test System may be connected at the rear panel. Refer to the 28000-?-TEST Test System specification for more information.

Auto Bridge Balance Mode: The Bridge is automatically balanced utilizing voltage insertion at the input amplifier when bridge balance mode is selected. The inserted voltage is derived from and thus tracks the excitation supply. A successive approximation A/D converter mechanization is used for rapid bridge balance. Bridge balance algorithm selects the most appropriate range to achieve balance with finest resolution.

Ranges are:

32 mV/V Mode Auto-Balance Ranges:

± 0.0002 mV/V to ± 0.5 mV/V in ± 0.244 μ V/V steps
 ± 0.502 mV/V to ± 4.0 mV/V in ± 1.95 μ V/V steps
 ± 4.016 mV/V to ± 32.0 mV/V in ± 15.625 μ V/V steps

512 mV/V Mode Auto-Balance Ranges

(Gain limited to $\times 512$):

± 0.004 mV/V to ± 8.0 mV/V in ± 3.9 μ V/V steps
 ± 8.03 mV/V to ± 64.0 mV/V in ± 31.25 μ V/V steps
 ± 64.25 mV/V to ± 512.0 mV/V in ± 250 μ V/V steps

Resolution: $\pm 0.05\%$ of span

Stability: 50 ppm/C of setting

Auto Suppress Mode: A programmable DC offset derived from a precision 10 V reference is injected at the channel input stage to suppress the gage DC operating voltage. Manual or automatic suppression modes are supported.

Ranges are:

640 mV Suppress Ranges:

± 0.005 mV to ± 10 mV in ± 4.9 μ V steps
 ± 10.04 mV to ± 80 mV in ± 39 μ V steps
 ± 80.31 mV to ± 640 mV in ± 312 μ V steps

10.24 V Suppress Ranges (Gain limited to $\times 512$):

± 0.08 mV to ± 160 mV in ± 78 μ V steps
 ± 160.6 mV to ± 1.28 V in ± 625 μ V steps
 ± 1.285 V to ± 10.24 V in ± 5 mV steps

Accuracy: 0.25% of setting + 5 mV

Auto Balance

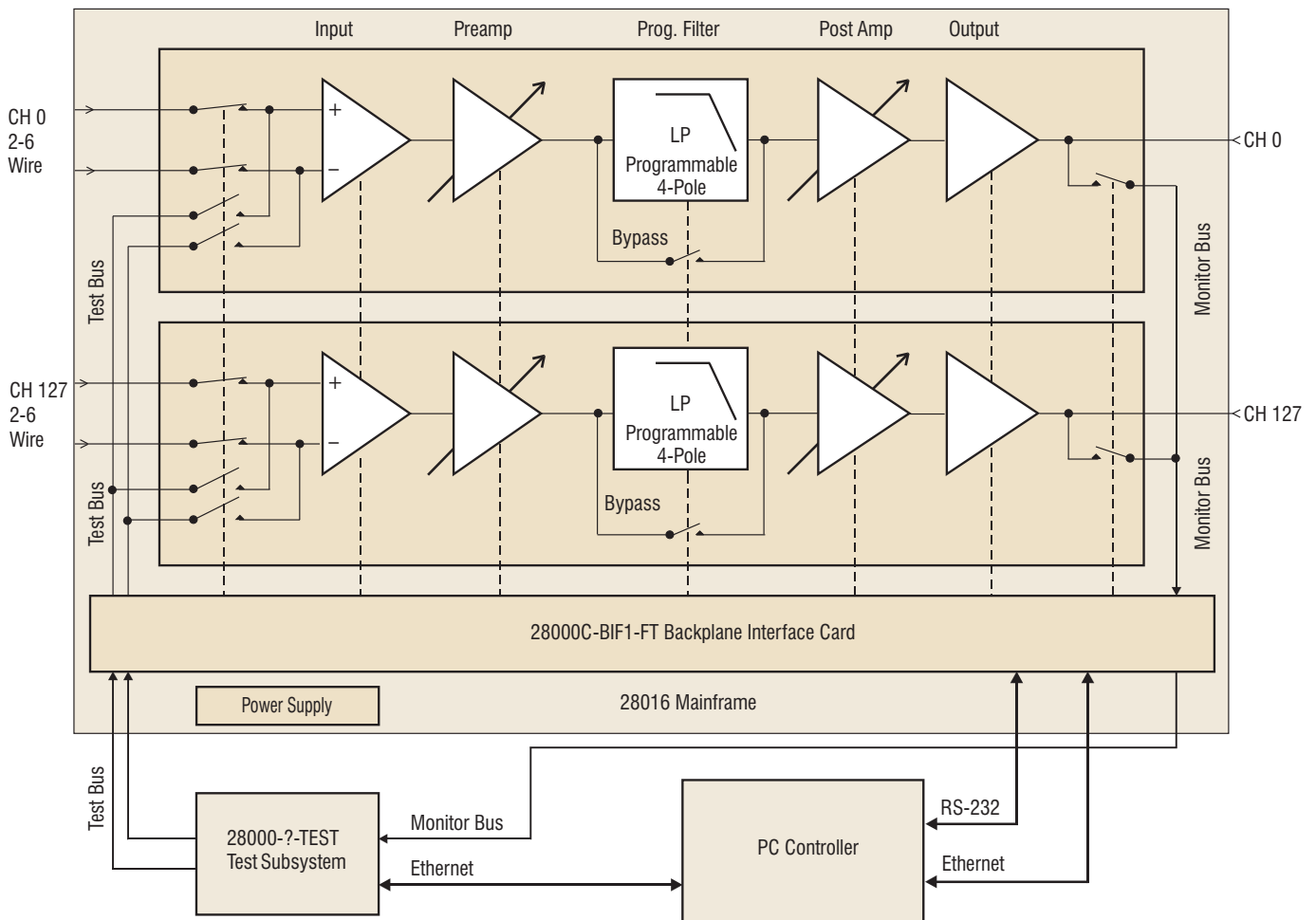
or Suppress Time: Less than 30 seconds per system to balance 128 channels

28108 AMPLIFIER CHARACTERISTICS

- Pre-filter Gain: x1 to x512 in binary steps with over-load detection (10.2 Vpk threshold)
- Post-filter Gain: x1/4 to x16 in binary steps with vernier adjustment of 0.05% of setting
- DC Accuracy: 0.1% after auto cal at any gain setting
 - Stability: $\pm 0.02\%$ for 6 months
 - Temp Coef.: $\pm 0.004\%/^{\circ}\text{C}$
- DC Linearity: $\pm 0.005\%$ re Fullscale, relative to the best straight line
- Freq. Response: DC to 50 kHz, 0 dB ± 0.1 dB
 - 3.01 dB BW: 100 kHz, typical
- High Freq. Rolloff: 18 dB/octave

28108 TEST MODES

- Excitation Monitor:** The amplifier input is switched from the bridge to the excitation supply to monitor the excitation voltage. Excitation monitor gain is x0.5.
- Excitation Off:** The excitation supply is programmed to zero volts.
- Amplifier Short:** A switch at the amplifier input is utilized to ground the input stage for measurement of noise and DC offset.
- Test Bus:** Test input allows for injection of a test signal. An external test signal or the 28000-?-TEST Test System may be connected at the rear panel. Refer to the 28000-?-TEST Test System specification for more information.



System Block Diagram

28108 FILTER CHARACTERISTICS

Option LP4FP:

4-pole, 4-zero low-pass filter. Programmable for maximally flat pass-band (LP4F) or linear phase with optimized pulse response (LP4P).

Custom Filters:

Other filter characteristics and cutoff frequencies are available. Please consult with factory for more information.

Cutoff Frequencies:

Pulse Mode: 50 Hz to 12.75 kHz in 50 Hz steps

Flat Mode: 100 Hz to 25.5 kHz in 100 Hz steps

Amplitude Accuracy: ± 0.1 dB max, DC to 0.8 Fc
 ± 0.2 dB max, 0.8 Fc to Fc

Amplitude Match: ± 0.1 dB max, DC to 0.8 Fc
 ± 0.2 dB max, 0.8 Fc to Fc

Phase Match: $\pm 1^\circ$ max, DC to 0.8 Fc
 $\pm 2^\circ$ max, 0.8 Fc to Fc

Specification	LP4F Maximally Flat Low-Pass Filter	LP4P Constant Time Delay Low-Pass Filter
Cutoff Frequency Amplitude	-3.01 dB	-3.01 dB
DC Gain	0.00 dB	0.00 dB
Pass-Band Ripple	0.00 dB	0.00 dB
Stop-Band Frequency	5.9465 Fc	11.863 Fc
Cutoff Frequency Phase	-180.0 deg	-101.5 deg
Phase Distortion (DC to Fc)	< 31.8 deg	< 3.7 deg
Zero Frequency Group Delay	0.4117/Fc	0.2920/Fc
Percent Overshoot	11.1%	0.5%
1% Settling Time	1.65/Fc	0.66/Fc
0.1% Settling Time	2.72/Fc	0.77/Fc
-0.1 dB Frequency	0.635 Fc	0.182 Fc
-1 dB Frequency	0.8487 Fc	0.5741 Fc
-2 dB Frequency	0.9370 Fc	0.8129 Fc
-3.01 dB Frequency	1.0000 Fc	1.0000 Fc
-20 dB Frequency	1.7412 Fc	3.0248 Fc
-40 dB Frequency	2.9555 Fc	5.6932 Fc
-60 dB Frequency	4.5986 Fc	9.0980 Fc
-80 dB Frequency	5.9465 Fc	11.8629 Fc

28108 OUTPUT CHARACTERISTICS

- Type: DC-coupled, single-ended output.
Programmable wideband (100 kHz) or filtered.
- Z: $10\ \Omega$ shunted by 100 pF per side
- Max Output: $\pm 10\ \text{Vpk}$, $\pm 5\ \text{mApk}$
- Offset Drift: $1\ \mu\text{V}/^\circ\text{C}$, RTI + $150\ \mu\text{V}/^\circ\text{C}$, RTO, typ
- Noise: $3\ \mu\text{Vrms}$ RTI + $300\ \mu\text{Vrms}$ RTO, typ
0.1 Hz to 50 kHz
- Crosstalk: $-80\ \text{dB}$, DC to 25 kHz between adjacent channels with the same configuration and programmed settings.
- Option T: Balanced differential output
- Max Output: $\pm 5\ \text{V}$ pk per side (5 mA pk)
 $\pm 10\ \text{V}$ pk differential

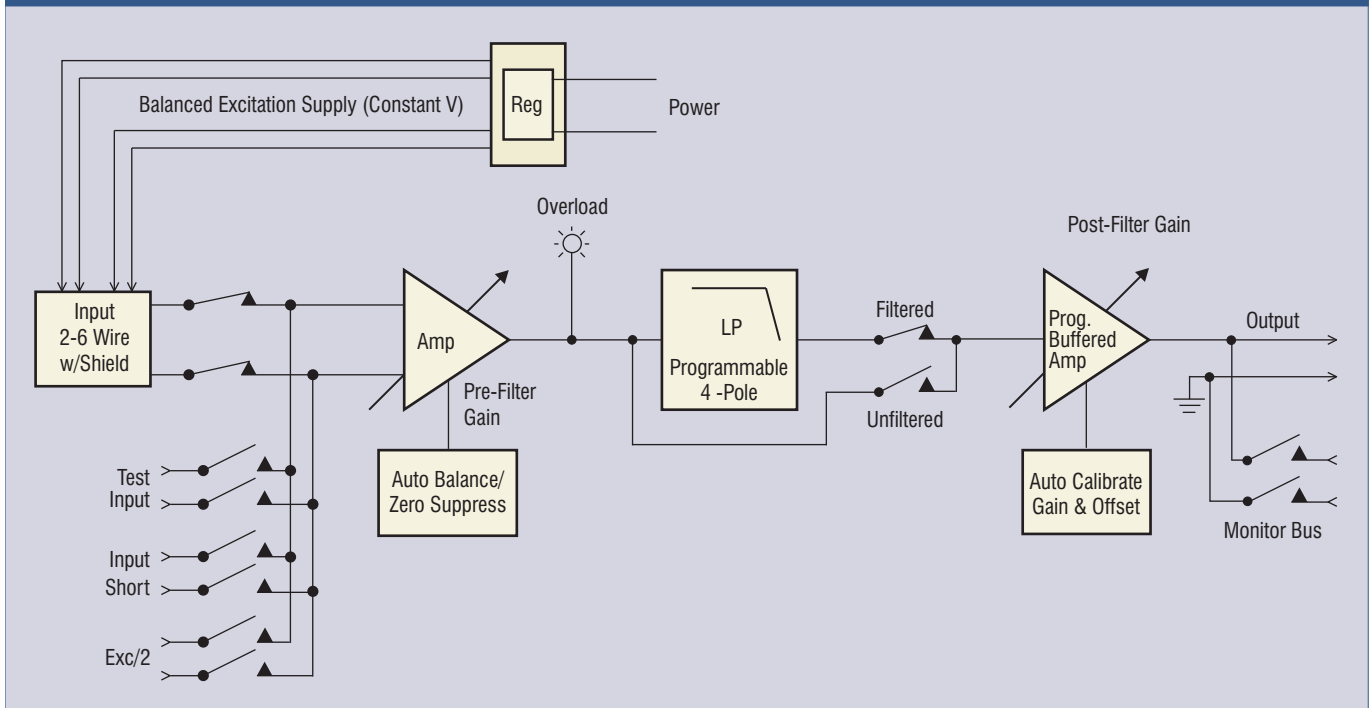
Auto-Offset Adjust (Standard)

Auto-Offset: Auto-offset automatically zeroes offset at the channel output to less than 5 mV at any gain setting. The auto-offset cycle is initiated in the GUI. The offset DAC settings are stored in non-volatile memory on the card for every gain setting. Changes in gain result in minimal disruption of the channel.

Output Monitor (Standard)

Output Monitor: A switch located at the output of each channel allows for multiplexed connection to the mainframe output monitor bus. The output monitor bus is available at a connector located in the 17th slot at the rear of the mainframe. The monitor function is used by the 28000-?-TEST Test System or is available to the user for viewing channel outputs.

28108 Channel Block Diagram

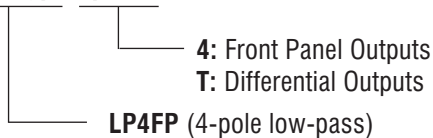


28108 CARD GENERAL CHARACTERISTICS

28108 Card Size: 6.63 x 17.5 x 0.75 inches
Card Weight: 1.4 lb. net
Temperature: 0° to 40° C (operating)
-20° to 70° C (storage)

ORDERING INFORMATION

28108-Filter Type-Options



ACCESSORIES

Input Mating Connectors

The input connectors are integral to the 28108 cards. Cutouts on the 28000 frames allow the input connector to pass through the backplane and to directly mate with the input cables. Two 26-pin high-density D connectors are utilized for the eight inputs (four inputs per connector). Connectors have high quality machined gold plated pins/sockets.

Output Mating Connectors

A summary of 28108 card compatibility with Precision Filters chassis model numbers is provided below:

28016-M5: Output connectors are integral to the 28016-M5 chassis rear panel. One high-density 26-pin connector is provided per slot to accommodate the eight 28108 outputs.

28016-M3 or 28008-M3: *The 28108 card must be configured with option 4* when used in the 28016-M3 or 28008-M3 chassis. The eight 28108 outputs are available on 26-pin D connectors that are integral to the 28108 card front panel (option 4). Note: Output buffer modules may not be used with a card that is equipped with option 4.

ACCESSORIES (Continued)

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-MTL: High-Density 26-pin D-shell mating input connector with machined crimp pins and metal backshell with strain relief.

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

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

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

Test Adapter

28108-TEST-ADAPTER supports FAT test of the excitation supply and is used to test excitation accuracy under full load, linearity, sense, current limit and offset.

Output Buffer Modules

The 28108 front panel auxiliary output connector is standard on cards not equipped with option 4. Precision Filters output adapter modules provide multiple buffered outputs per channel. Refer to the 28000 Output Buffer Module specification sheet for more information.

BUFF-8CH/(2)HD26D DUAL OUTPUT BUFFER: The BUFF-8CH/(2)26HD dual output buffer for 8-channel cards provides two buffered outputs per channel on 26-pin high density D-type connectors.



28016-M5 Mainframe Front Panel

