



Precision 28108 Octal Bridge Conditioner with Constant Voltage Excitation; 100 KHz Bandwidth

28108 Octal-Channel Bridge Conditioner with Constant Voltage Excitation offers eight channels of conditioning to support a wide variety of transducers, including those that require constant voltage excitation. Balanced constant voltage excitation in a bridge configuration supports applications such as strain gages and pressure transducers. The 28108 is easily configured to operate as a precise voltage filter/amplifier for low-level voltage inputs.



28108 Applications

- Wind Tunnel Test
- Underwater Acoustics
- Pyroshock Measurements
- Ballistics
- Vehicle Vulnerability/Survivability
- Rotating Machinery Test
- Automatic Test Equipment
- Industrial Process Control

28108 Uses

- Strain gage conditioner
- Static/dynamic pressure transducer conditioner
- Piezoresistive accelerometer conditioner
- RTD conditioner
- MEMS transducer conditioner
- Load cell conditioner
- Anti-alias filter/amp
- General purpose filter/amplifier (< 1 mV to 10 V inputs)
- Full bridge conditioner

Precision 28108 Features

- Eight channels per card, 128 channels per 28016 chassis.
- Balanced differential inputs with 2- to 6-wire plus shield transducer input interface.
- Balanced (zero common-mode) programmable constant voltage excitation. Up to 20 V delivered to the bridge.
- Automatic bridge balance/zero suppress via a programmable DC voltage inserted at the channel input.
- Distributed programmable gain of x1/16 to x8192 with 0.05% resolution.
- Input MUTE mode to terminate unused channels in a safe, quiet state.
- Prefilter overload detection.
- 4-pole low-pass filters with programmable pulse/flat characteristics for optimized time domain or frequency domain performance. Programmable low-pass filter cutoff frequencies:
 - Pulse mode: Programmable from 50 Hz to 12.75 kHz.
 - Flat mode: Programmable from 100 Hz to 25.5 kHz.
- Wideband (100 kHz) or filtered operation.
- Precise digital calibration.
- Single-ended outputs with ground sense or optional differential output.
- Programmable test modes for cal signal injection, excitation monitor, excitation off, and input short, allowing for automated measurement system validation.
- Output monitor bus.
- Auxiliary front-panel output connection supports the use of Precision Filters' output buffer modules for adding up to two buffered outputs per channel (for units without option 4).

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 28108 Description

Precision 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. The 28108 differential input stage may be either AC or DC coupled. AC coupling is useful for dynamic applications where the DC bias on the transducer, which can limit dynamic range, can be coupled out of the signal. The input stage may be shorted under program control to verify signal conditioner channel noise and DC offsets. 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 postfilter 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 GUI's Gain Wizard 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 overvoltage conditions.

The postfilter 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 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 from 50 Hz to 12.75 kHz in 50 Hz steps in pulse mode. 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. Pulse mode has time domain response similar to the Bessel filter yet provides superior amplitude response characteristics. This mode is ideal for time domain applications, including transient (shock) measurements and time domain waveform analysis.

Muting Faulty Sensors

Depending on the sensor type, various techniques must be used to quiet the channel's input and output circuits and ensure that no noise coupling occurs. For example, an intermittent gage will create a gage chatter condition whereby the connecting wires continually switch between the high-voltage fault level and the proper low-voltage operational level. This chatter condition creates a hostile noise source to any other gage extension wires in the vicinity of the hostile cable. Precision 28108 signal conditioning channels have a Mute feature, which places the channel in its quietest quiescent state and minimizes the possibility of coupling noise to properly functioning channels.

Multiple Buffered Outputs

When the optional BUFF-8CH/(2)26HD output adapter is attached to the front panel of the 28108 card, the 28108 can accommodate two additional independently buffered outputs for a total of three outputs per channel. Now each channel is able to drive the primary data acquisition hardware plus two additional devices, such as a control system or backup system, without introducing the ground loops that plague T output connections. Each output can be configured as single-ended or ground sensing, allowing the 28108 to drive either floating or grounded loads that are correctly ground referenced and free from ground loop noise.

28108 Details and Specifications

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:

±0.1% or 5 mV, whichever is greater

Current Limit:

40 mA, typical

Noise:

100 µVrms, 3 Hz to 50 kHz

Temperature Drift:

±0.0025%/ °C of setting or ±50 µV/ °C, whichever is greater

Sense Leakage Current:

Less than 10 µA

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 Programmable Features

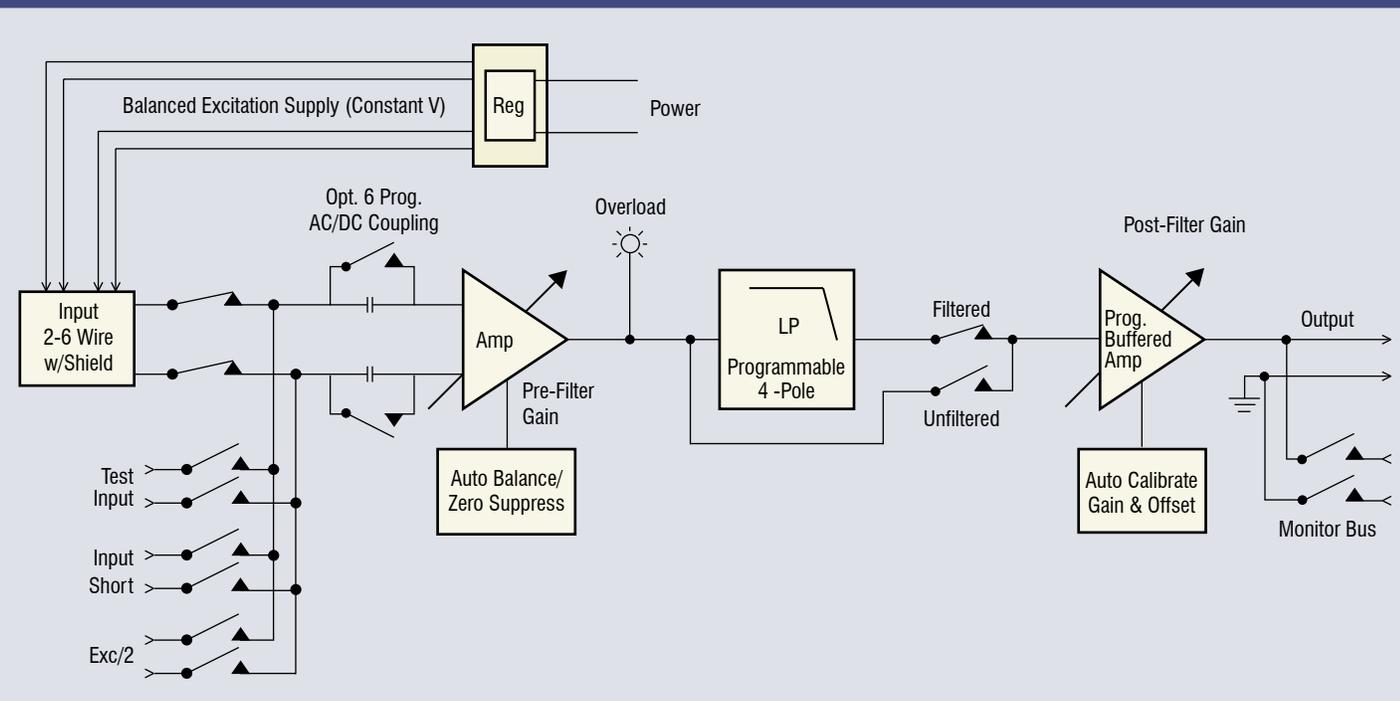
- Excitation level (0 to 20.475 V in 5 mV steps)
- Excitation sense (local or remote)
- Automatic balance (zero suppress)
- Mute: ON/OFF
- Test modes: Amp Short, Excitation Off, Test Bus, Excitation Monitor
- AC/DC Coupling (Option 6)
- Gain (x1/16 to x8192 with 0.05% resolution)
- Cutoff frequency:
 - Pulse mode: 50 Hz to 12.75 kHz in 50 Hz steps
 - Flat mode: 100 Hz to 25.5 kHz in 100 Hz steps
- Output Monitor
- Wideband (100 kHz) or filtered operation

28108 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 Channel Block Diagram



28108 Details and Specifications

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

Option 6: Programmable AC/DC Coupling:

Coupling Frequency:

0.25Hz (3.01 dB)

CMRR (AC Coupled):

80 dB, 10 Hz to 500 Hz, input gain > x16

Input Protection:

±45 V continuous
±100 Vpk transient, 1 ms pulse,
10% duty cycle

Input Impedance:

10 MΩ //100 pF per side
20 MΩ //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/ °C, maximum

Noise:

7 nV/ $\sqrt{\text{Hz}}$ RTI at 1 kHz and gain > x64

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

When bridge balance mode is selected, the bridge is automatically balanced utilizing voltage insertion at the input amplifier. 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.

Range:

32 mV/V Mode Autobalance Range:

±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 Autobalance Range

(Gain limited to x512):
±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

Accuracy:

±0.1% of setting ±0.1 of F.S. range

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.

Range:

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 x512):

±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:

±0.12% of setting +5 mV

Auto Balance or Suppress Time:

Less than 30 seconds per system to balance 128 channels

28108 Mute Mode

In harsh test environments, a sensor or input cable can become faulty or intermittent during a critical test. With high-gain signal conditioning, this can be troublesome if large signal swings on input or output cabling cross-couple to other channels. The 28108 Mute control places the channel in the quietest operational state to minimize system noise in the event of a failed sensor. Mute mode is also useful to terminate unused channels in a safe and quiet state.

28108 Details and Specifications

28108 Amplifier Specifications

Prefilter Gain:

x1 to x512 in x2 steps with overload detection (10.2 Vpk threshold)

Postfilter Gain:

x1/16 to x16 in binary steps with vernier adjustment of 0.05% of setting

Postgain Resolution:

Let G = Postgain setting
 Resolution (min) = 0.05% for $G \geq x0.5$
 0.1% for $x0.5 > G \geq x0.25$
 0.2% for $x0.25 > G \geq x0.125$
 0.4% for $x0.125 > G \geq x0.0625$

DC Accuracy:

0.02% typical, 0.1% max, gain > x0.5

Stability:

$\pm 0.02\%$ for 6 months

Temperature Coefficient

$\pm 0.004\%$ / °C max

DC Linearity:

$\pm 0.005\%$ re: Fullscale, relative to the best straight line

Frequency Response:

DC to 50 kHz, 0 dB ± 0.1 dB

-3.01 dB BW:

100 kHz, typical

High-Frequency Roll-off:

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:

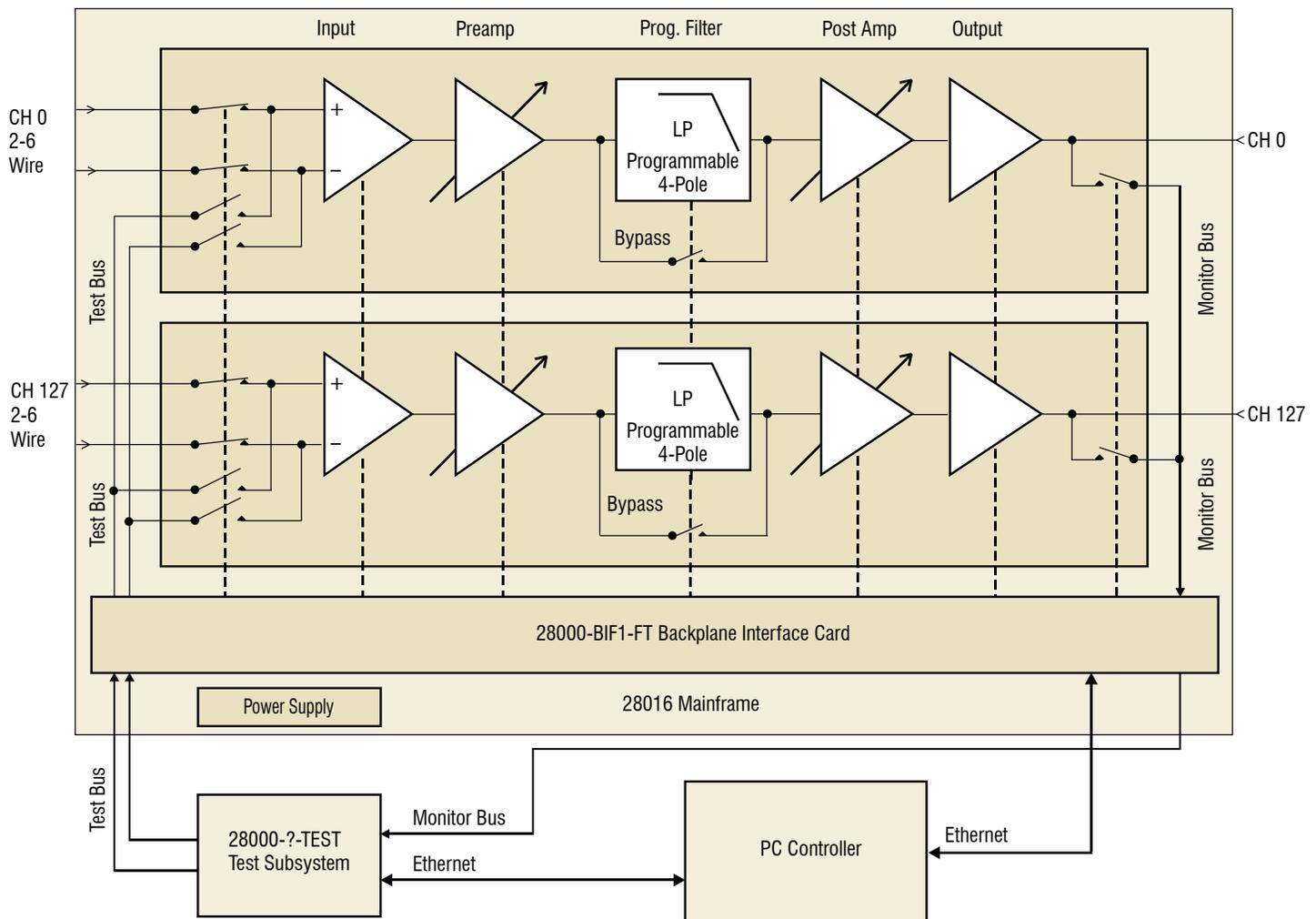
The excitation supply is programmed to zero volts.

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

28108 Filter Type Characteristics

Filter Type

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 the 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:

±1° max, DC to 0.8 Fc

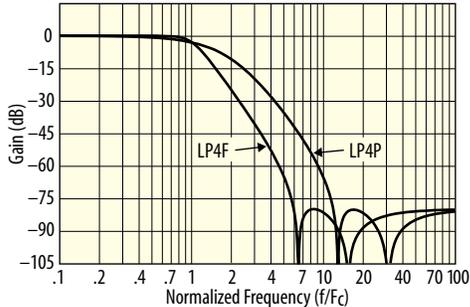
±2° max, 0.8 Fc to Fc

Flat/Pulse Low-Pass Filters

Our LP4FP 4-pole flat/pulse low-pass filters provide the user with the versatility to address applications in either the time or the frequency domain and are available on many 28000 card models.

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	0.6348 Fc	0.1816 Fc
-1 dB Frequency	0.8487 Fc	0.5742 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

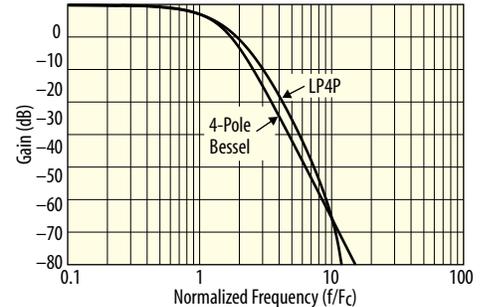
LP4F and LP4P Amplitude Response



Pulse Mode Low-Pass Filters

For the time domain, we offer the LP4P pulse mode low-pass filters. These filters have excellent transient response and phase linearity, making them ideal filters for time domain applications, including transient (shock) measurements and time domain waveform analysis ... all with roll-off characteristics superior to their Bessel filter counterparts.

LP4P vs 4-Pole Bessel Amplitude Response

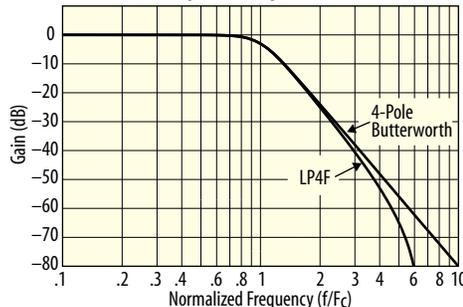


Flat Mode Low-Pass Filters

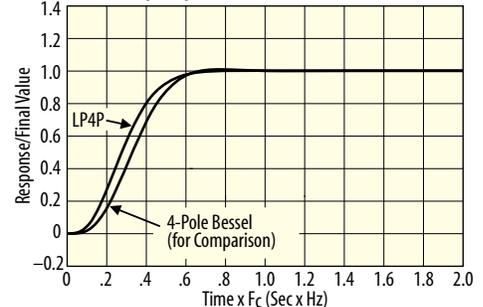
Precision LP4F "flat" mode characteristics are specified to have outstanding passband flatness equivalent to the Butterworth yet deliver very sharp roll-off characteristics.

The LP4F is a good choice as an anti-aliasing filter and for applications such as spectral analysis. The LP4F has zero passband ripple and roll-off superior to the Butterworth.

LP4F vs Butterworth Amplitude Response



LP4P vs Bessel Step Response



28108 Details and Specifications

28108 Output Characteristics

Type:

DC-coupled, single-ended output.

Z:

10 Ω shunted by 100 pF per side

Max Output:

± 10 Vpk, ± 5 mApk

Offset Drift:

1 μ V/ $^{\circ}$ C, RTI + 150 μ V/ $^{\circ}$ C, RTO, typical

Noise:

3 μ Vrms RTI + 300 μ Vrms RTO, typical
0.1 Hz to 50 kHz

Crosstalk:

-80 dB, DC to 25 kHz between adjacent channels with the same configuration and programmed settings

Front Panel Outputs (Option 4):

DC-coupled single-ended output available at the front panel of the 28108 card, allowing the 28108 card to be used in the 28016-M3 or the 28008-M3 chassis.

Note: For applications where multiple independent buffered outputs are required, Option 4 should not be used. In this case, a chassis with the M5 output option is required, along with use of the BUFF-8CH/(2)26DHD output adapter.

Connector:

High-density 26-pin D-shell sockets at the front panel of the 28108 card

Differential Output (Option T):

Balanced differential output

Max Output:

± 5 V pk per side (5 mA pk)

± 10 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 nonvolatile memory on the card for every gain setting. Changes in gain result in minimal disruption of the channel.

Output Monitor (Standard)

Output Monitor:

A programmable 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 on the controller card at the rear of the mainframe. The monitor function is used by the 28000-?-TEST Test System and is available for viewing channel outputs by the user.

Input Connectors

The input connectors are integral to the 28108 card. Cutouts on the 28000 frames allow the input connector to pass through the backplane and mate directly with the input cables.

Two 26-pin high-density D connectors are utilized for the eight inputs (4 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 or 28004-M3/M5: Output connectors are integral to the 28016-M5 chassis and the 28004-M3/M5 chassis rear panels. 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 adapter modules may not be used with a card that is equipped with Option 4.

Output Adapters

Measurement systems often require multiple outputs per signal conditioning channel or special functions such as a DC output in proportion to the AC signal level. These outputs may be routed to control systems, tape backup systems, auxiliary data acquisition systems, scope bays, or other destinations.

28108 cards (without Option 4) are fitted with front-panel connectors that accept Precision output adapter modules. Adapters plug on to the front of the signal conditioner card and are secured to the card by two screws.

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

General Characteristics

28108 Card Size:

6.63 x 17.5 x 0.75 inches

Card Weight:

1.4 lb. net

Temperature:

0 $^{\circ}$ C to 40 $^{\circ}$ C (operating);

-20 $^{\circ}$ C to 70 $^{\circ}$ C (storage)



28108 with Auxiliary Output Connector (L), and 28108 with Option 4 (R)

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.

Test Adapter

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

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Precision Product Solutions

For over 40 years, Precision Filters has been a global provider of instrumentation for test measurements. You can rely on a single source for signal conditioning and switching—a complete range of instrumentation—products optimized to work together to provide high performance at reasonable cost.

Precision Products

Precision PF-1U-FA Multi-Channel Programmable Filter/Amplifier System



Exceptional desktop performance at low cost.

Ideal for conditioning low-level voltage inputs in front of high-resolution digital data acquisition systems. Fully programmable 8-channel and 16-channel configurations are available, both offering a choice of either 4- or 8-pole low-pass filters with programmable gain.

464kC High-Density Programmable Switch Matrix



Computer-controlled analog signal switching replaces tedious manual patch panels.

The 464kC is a reliable solid-state switch matrix system that provides computer-controlled connection between 256 inputs and 256 outputs, all in a single mainframe. Save time and reduce errors on test system setup. Download switch configurations from the host computer over the network. Built-in self-test with fault diagnostics.

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-F01-Filter Type-Options

