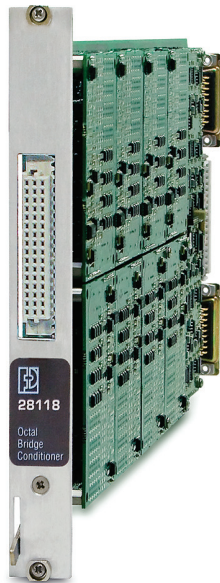




Precision 28118

Octal-Channel Bridge Conditioner with Constant Voltage Excitation

28118 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 28118 is easily configured to operate as a precise voltage filter/amplifier for low-level voltage inputs.



28118

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

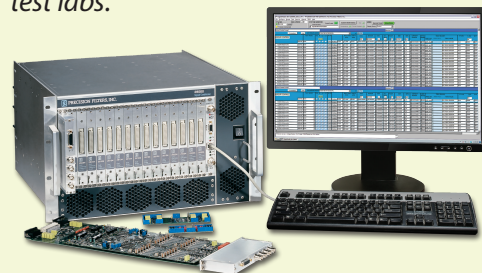
Precision 28118 Features

- Eight channels per card, 128 channels per 28016 chassis
- Balanced programmable constant voltage excitation with remote sense
- Up to 20 V delivered to the bridge
- ± 10 Vcm operation
- Up to 100 kHz filtered bandwidth or 190 kHz "wide-band" bandwidth
- 2- to 6-wire plus shield transducer input interface
- Automatic bridge balance/transducer suppress
- Programmable amplifier: x1/16 to x1024 with 0.05% vernier
- Distributed gain to provide reserve against out-of-band signal such as transducer resonances
- 4-pole low-pass filters with programmable pulse/flat characteristics
- 2° phase matching between any channels
- Overload detection
- Auxiliary front panel output connection to support the use of custom output modules (for unit 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 28118 Description

Precision 28118 Description

The 28118 is a member of the Precision 28000 family of signal conditioners. The 28118 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 28118 may be easily configured to operate as a precise voltage filter/amplifier on low-level voltage inputs. Up to sixteen 28118 cards may reside in the 28000 system to provide up to 128 channels per chassis. In addition, the 28118 may be mixed with other conditioners in the 28000 family to meet unique signal conditioning requirements.

Balanced Constant Voltage Excitation

The 28118 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.

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.

Input Stage

The 28118 differential input stage may be either AC or DC coupled. AC coupling is useful for dynamic applications where the DC bias on the transducer, that 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 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 sense leads may be connected to the amplifier input so that the excitation voltage appears at the amplifier output. This feature allows the user to measure the excitation voltage with the data acquisition system.

Amplifier

Programmable pre- and post-filter amplifiers provide an overall gain of 1024. 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. Examples of out-of-band signals that could cause clipping include shock (impulse) events that excite the transducer resonance or gear mesh noise on rotating machinery.

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 28118 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 28118 features automatic calibration of gain and offset for the entire channel, including the amplifier and filter.

Filter

The 28118 is specified with a 4-pole low-pass filter with five programmable cutoffs. In addition, the filter may be programmed to "flat" or "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.

28118 Programmable Features

- Excitation level (0 to 20.475 V in 5 mV steps)
- Excitation sense (local or remote)
- Automatic balance (zero)
- Input Coupling (AC or DC)
- Test Modes: Amp Short, Excitation Off, Voltage Substitution, Excitation Monitor
- Output monitor
- Gain: x1/16 to x1024 with 0.05% resolution
- Filter type: pulse or flat
- Cutoff frequency:
FX02: 300 Hz, 1 kHz, 3 kHz, 10 kHz, 30 kHz
FX03: 10 kHz, 20 kHz, 40 kHz, 80 kHz, 100 kHz
- Wide-band (190 kHz) or filtered operation

28118 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

28118 Details and Specifications

28118 Conditioner Cards

The detailed description and specifications for the 28118 are organized in the following sections:

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

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

28118 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.

28118 Input Characteristics

Type:
Balanced differential w/ Programmable AC/DC input coupling

Input Impedance:
10 MΩ // 100pF per side

Max Level:
(AC + DC + Common Mode)
±10 Vpk for f < or = 200 kHz
±10 Vpk x (200 kHz/f) for f > 200 kHz

Input Protection:
25 V continuous (power on)
60 Vpk transient
(1 ms pulse, 50% duty cycle)

Offset Drift:
3.5 µV/°C, typical

AC Coupling Frequency:
0.25 Hz (-3.01 dB)

CMRR (DC Coupled):
86 dB, DC to 440 Hz and input gain >x8

CMRR (AC Coupled):
80 dB, 10 Hz to 440 Hz and input gain >x8

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.

Range:
Bridge balance algorithm selects the most appropriate range to achieve balance with finest resolution.

64 mV/V Mode Auto-Balance Range:
0 mV/V to ±64 mV/V in ±1.95 µV/V steps

512 mV/V Mode Auto-Balance Range (Gain limited to x128):
0 mV/V to ±512 mV/V in ±15.625 µV/V steps

Accuracy:
±0.1% of setting ±0.1% of F.S. range

Stability:
±0.0025% / °C of setting

Drift (RTI):
±1 µV / °C for 64 mV/V range;
±8 µV / °C for 512 mV/V range

Auto Balance Time:
Less than 15 seconds per system of 128 channels

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.

1.28 V Suppress Ranges:
0 mV to ±1.28 V in ±39 µV steps

10.24 V Suppress Ranges (Gain limited to x128):
0 V to ±10.24 V in ±312.5 µV steps

Accuracy:
±0.1% of setting ±0.1% of F.S. range

Stability:
±0.0025% / °C of setting

Drift(RTI):
±1 µV / °C for 1.28 V range;
±8 µV / °C for 10.24 V range

Auto Suppress Time:
Less than 15 seconds per system of 128 channels

28118 Details and Specifications

28118 Amplifier Specifications

Pre-Filter Gain:

x1 to x64 in x2 steps with overload detection (10.2 Vpk threshold)

Post-Filter Gain:

x1/16 to x16 in binary steps with vernier adjustment

Overall Gain:

x1/16 to x1024

Gain Setability:

0.05% steps for POG ≥1X
0.05%/POG for POG <1X

DC Gain Accuracy:

0.02% typical, 0.2% maximum for POG ≥1X
0.2%/POG maximum for POG <1X

Frequency Response:

DC to 100 kHz; 0 dB ±0.1 dB; -3 dB typical at 190 kHz

Temperature Coefficient

±0.005% /°C max

DC Linearity:

±0.01% re: Fullscale, relative to best straight line

28118 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 28118 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.

28118 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:

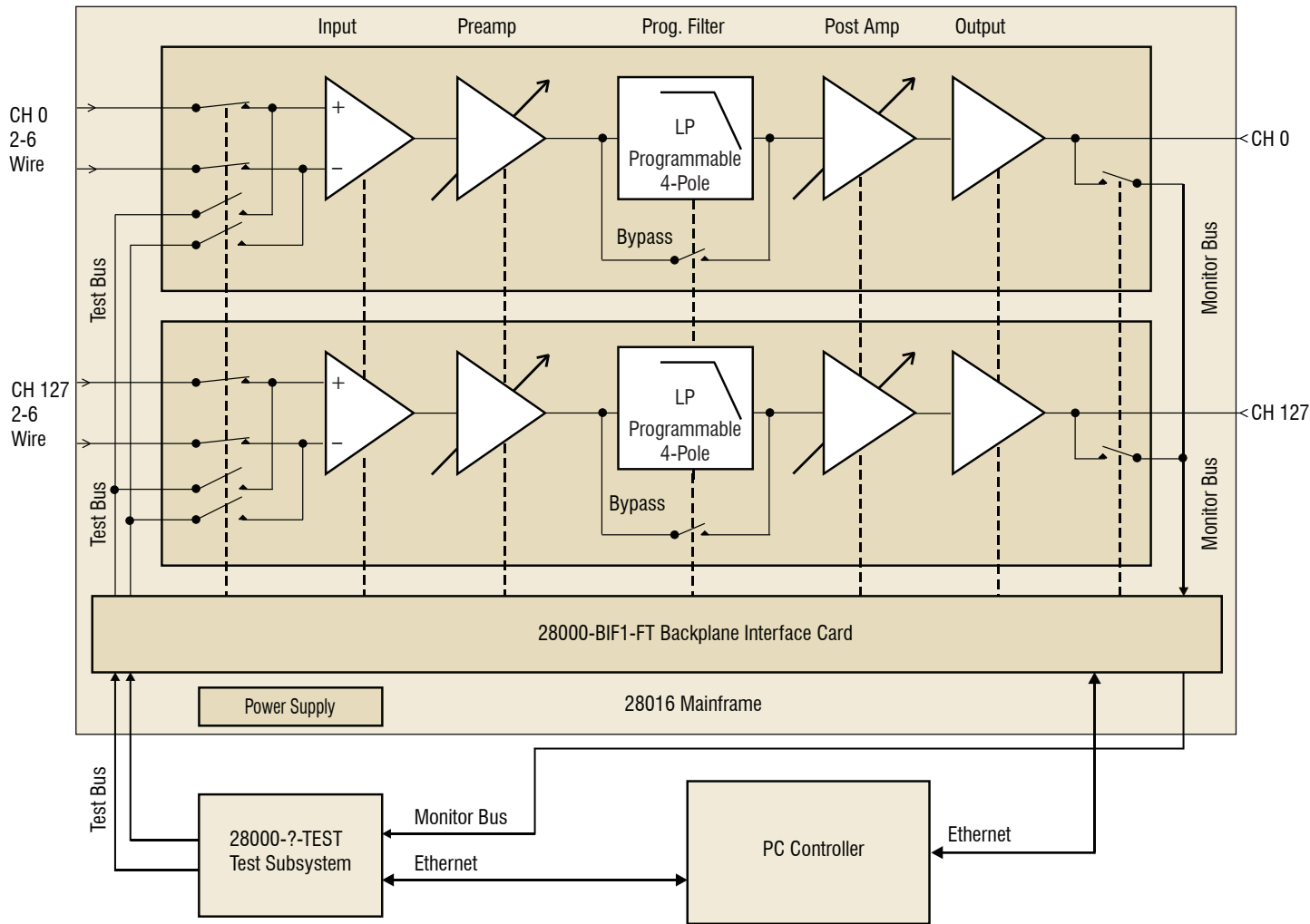
The excitation supply is programmed to zero volts.

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

28118 Filter Characteristics

You want your analog data to come clean before digital conversion.

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 frequency domain and are available on many 28000 card models.

Flat Mode Low-Pass Filters

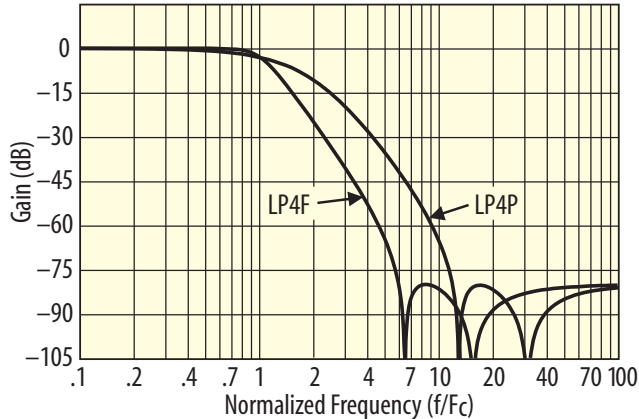
Precision LP4F "flat" mode characteristics are specified to have outstanding passband flatness equivalent to the Butterworth yet deliver very sharp roll-off characteristics.

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.

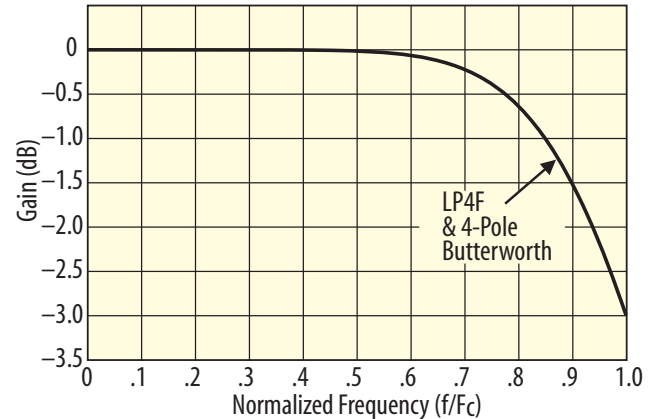
Pulse Mode Low-Pass Filters

For the time domain, program the 28618 low-pass filter to "pulse" mode. 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.

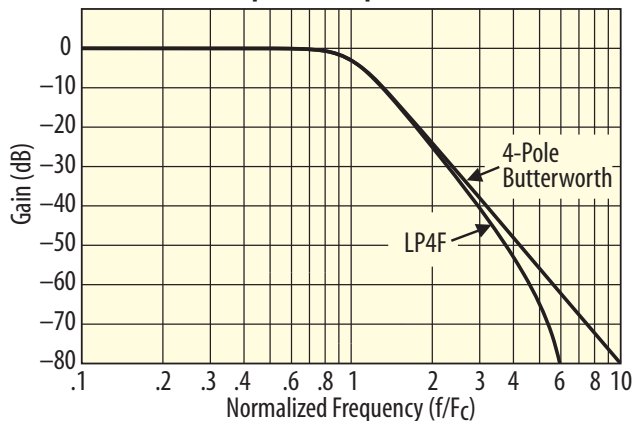
LP4F and LP4P Amplitude Response



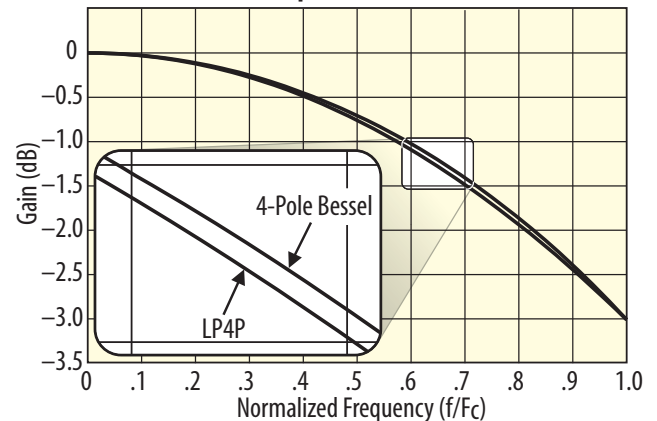
LP4F vs Butterworth Passband Response



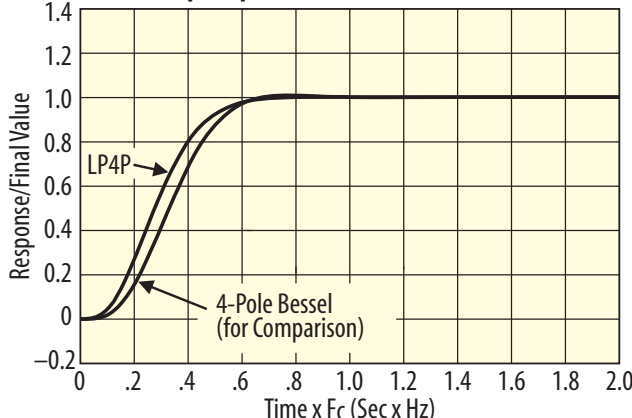
LP4F vs Butterworth Amplitude Response



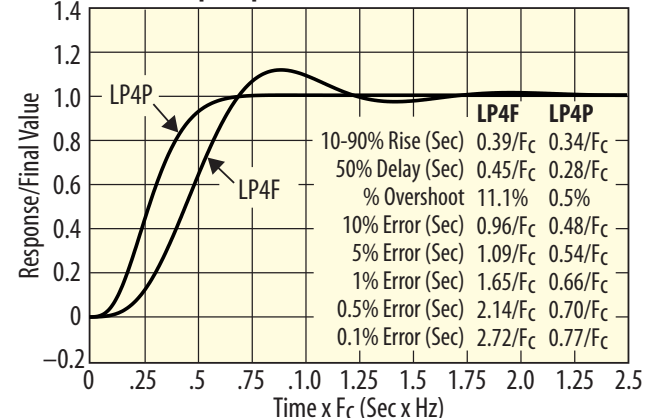
LP4P vs Bessel Passband Response



LP4P vs Bessel Step Response



LP4F and LP4P Step Response



28118 Filter Characteristics

28118 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).

Cutoff Frequencies:

FX02: 300 Hz, 1 kHz, 3 kHz, 10 kHz, 30 kHz
FX03: 10 kHz, 20 kHz, 40 kHz, 80 kHz, 100 kHz

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

Filter Bypass:

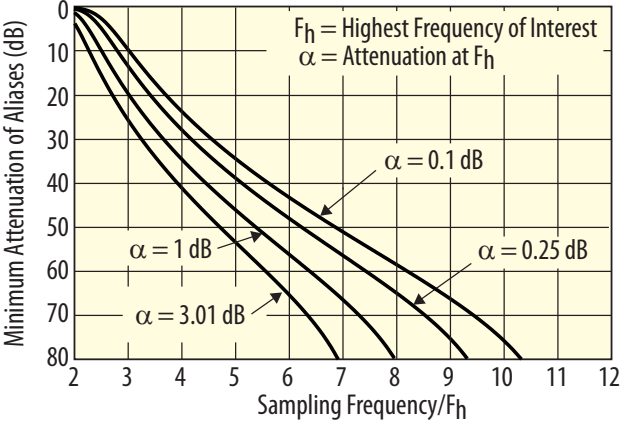
Bypasses filter but not amplifier stages.
Bypass Bandwidth: 190 kHz, typical

Custom Filters:

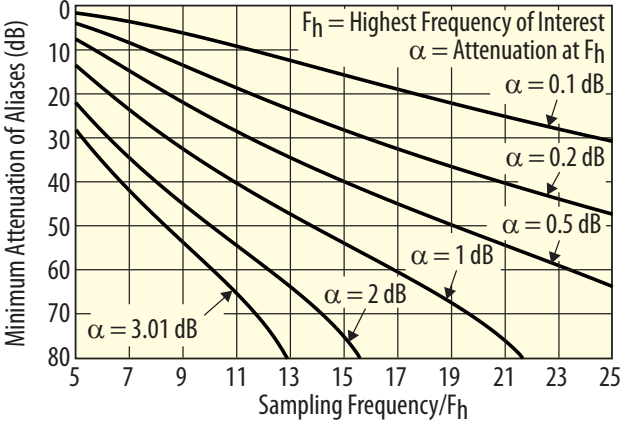
Other filter characteristics and cutoff frequencies are available. Please consult with factory for more information.

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 Attenuation of Aliases vs Sampling Rate



LP4P Attenuation of Aliases vs Sampling Rate



28118 Details and Specifications

28118 Output Characteristics

Type:

DC-coupled, single-ended output.
Programmable wideband (190 kHz)
or filtered

Z:

10 Ω shunted by 100 pF per side

Max Output:

± 10 Vpk, ± 5 mApk

Offset:

<5 mV after auto-adjust at any gain
setting

Offset Drift:

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

Noise:

6 μ Vrms RTI + 100 μ Vrms RTO, typical
3 Hz to 100 kHz

Crosstalk:

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

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 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 programmable switch located at the
output of each channel allows for mul-
tiplexed 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.

General Characteristics

28118 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)

Input Connectors:

The input connectors are integral to the
28118 card. 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 (4 inputs per
connector). Connectors have high quality
machined gold plated pins/sockets.

Output Mating Connectors

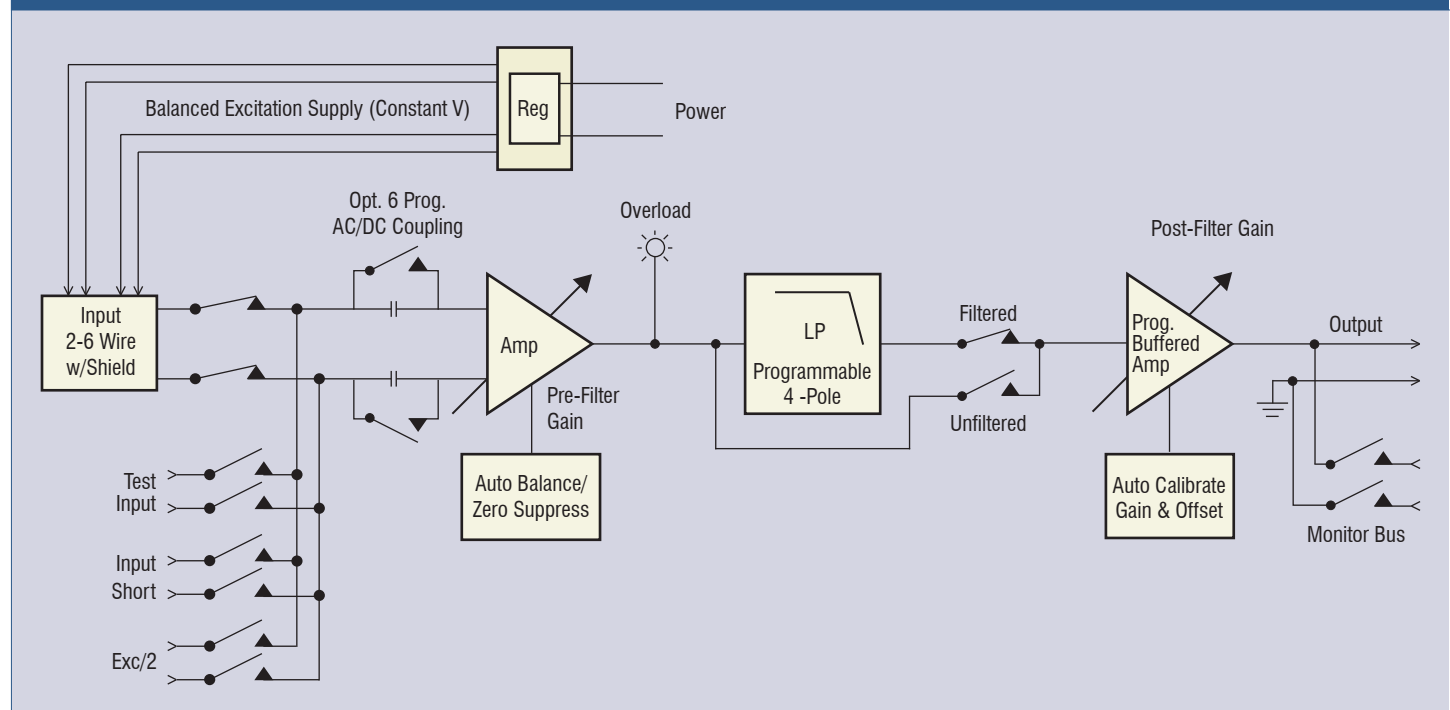
A summary of 28118 card compatibility with
Precision Filters chassis model numbers is
provided below:

**28016-M5, 28008-M3/M5, 28004-M3/M5
or 28002-M5:** Output connectors are integral
to the 28016-M5, 28008-M3/M5, 28004-M3/
M5 and 28002-M5 chassis rear panels. One
high-density 26-pin connector is provided
per slot to accommodate the eight
28118 outputs.

28016-M3 or 28008-M3: The 28118 card
must be configured with Option 4 when used
in the 28016-M3 or 28008-M3 chassis. The
eight 28118 outputs are available on 26-pin D
connectors that are integral to the 28118 card
front panel (Option 4).

Note: Output buffer modules may not be
used with a card that is equipped with
Option 4.

28118 Channel Block Diagram



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.

Bridge Completion Adapters

281X8-SCT-?: Plug-on bridge completion adapters that allow for ¼ and ½ bridge measurements on octal bridge conditioner cards. Available with 120 Ω, 350 Ω, or 1 kΩ completion resistors. Adapters plug onto the HD26 input connectors and provide bridge completion for 4 channels. Two adapters are required for 8 channels of bridge completion.

Test Adapter

28118-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.

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.

28118 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.

28000-RMS/DC8: Output adapter for octal conditioner cards provides eight channels of RMS to DC conversion. Outputs are fully buffered and provided on a 26-pin high density D-type connector.

28118 Card Model Number

The 28118 card model number describes the configuration of the four channels on the card. The model number identifies the filter range, and output options.

28118-<Filter Range>-LP4FP-Options

4: Front-panel output via HD26 connect
T: Differential outputs
FX02: 300 Hz, 1 kHz, 3 kHz, 10 kHz, 30 kHz



28118 with Auxiliary Output Connector (L), and 28118 with Option 4 (R)

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



Exceptional desktop performance.

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.

High Density Programmable Switch Systems

Computer controlled analog signal switching replaces tedious manual patch panels.



Precision 4164 64x64 Switch Matrix System



Precision 464kC Switch Matrix System

Precision switch systems are reliable solid-state switch matrix systems, providing computer-controlled connection between input and output signals. Configure the 464kC with up to 256 inputs and 256 outputs, all in a single mainframe, or choose the compact 4164 system with 64 inputs and 64 outputs. 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.