



Precision 28314 Quad Dynamic Charge/IEPE Conditioner with Long Distance TEDS™

The 28314 Quad Charge/IEPE Conditioner with Long Distance TEDS is a dual-mode amplifier that provides four channels of conditioning for either piezoelectric or IEPE sensors. The high bandwidth of the 28314 (500 kHz wideband, 200 kHz filtered) makes the card suitable for dynamic sensor measurements while the long time constant enables measurement of short duration static (quasi-static) events without droop. A multi-range charge converter and a wide range of gain settings allow the amplifier to accommodate a wide range of sensor sensitivities and full scale measurands.

The 28314 features a choice of 4 or 8-pole filters with programmable filter characteristics optimized for transient/time domain or frequency domain measurements. The filter cutoff frequency can be programmed under user control and the filters may be bypassed for wide bandwidth measurements. LDTEDS™ (Long-Distance Transducer Electronic Data Sheet) can communicate with TEDS capable sensors to a distance of 1500 feet.



Sensor Applications

- Pressure
- Force
- Acceleration
- Load
- IEPE or Charge type sensors
- AC or DC filter/amplifier (< 1 mV to 10 V inputs)

28314 Applications

- Ballistics shock testing
- Environmental chambers
- Gas turbines
- Rocket engine test
- Wind Tunnels
- Energetic Shock, Explosive, Ordnance Testing
- Structural Shock and Vibration Testing

Precision 28314 Features

- 4 channels per card, 64 channels per chassis
- Dual mode: piezoelectric or IEPE
- Floating or grounded input
- Up to 200 kHz “filtered” bandwidth or 500 kHz “wide-band” bandwidth
- Two charge conversion ranges for 50,000 or 500,000 pC FS inputs
- Extremely large time constant for quasi-static charge measurements
- Programmable IEPE current to 25 mA
- TEDS compatible
- Programmable amplifier: x1 to x8192 with 0.05/vernier
- 4- or 8-pole low-pass filters with filter bypass (wide-band)
- 2° phase matching between any channels, DC to Fc
- Overload detection
- Precise automatic calibration
- Auxiliary front panel output connector to support use of custom output modules

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, set-up, 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 28314 Description

Precision 28314 Description

The 28314 is a member of the Precision 28000 family of signal conditioners. The 28314 provides four channels of dual mode Charge/IEPE conditioning. Up to sixteen 28314 cards may reside in the 28000 System to provide 64 channels in a single 6U chassis.

In charge mode the 28314 provides two charge conversion ranges with full-scale inputs of 50,000 or 500,000 pC. Channel gains of up to 8192 provides charge sensitivity as high as 1.6 V/pC. A programmable input stage allows operation with either grounded or isolated accelerometers. Extremely large time constants allow measurement of quasi-static charge phenomena. Low noise, low-distortion and high accuracy circuits guarantee accurate high frequency measurements of even low-level signals.

Overall measurement accuracy is assured with built in charge gain adjustment circuits, which can be used in situ to adjust gain under run time conditions. Verification and documentation of actual charge gain can be performed using built-in shunt calibration with secondary standard shunt calibration capacitors. The calibrated value of shunt cal capacitors is stored on card EEPROM and can be recalled by host software for exact span verification or data post processing.

In IEPE mode the 28314 accommodates long cable runs with programmable IEPE current up to 25 mA. As with charge mode, accurate measurements of wide band, low-level signals guaranteed by channel gains to 8192, frequency response to 204.6 kHz, low noise, and high accuracy circuits.

Input signal visibility is a crucial aspect of IEPE sensors as the sensors bias voltage is a useful indicator of sensor, cable and connector health. The 28314 card IEPE input stage continually monitors the DC bias voltage present on the channel input prior to the AC coupling stage. Not only is this voltage level displayed for each channel but it is also compared to user programmable upper and lower threshold limits to alert the user to a sudden shift of the bias level. A system bias level report can be requested at any time, creating a file useful for pre-test gage health documentation.

Long Distance TEDS

The 28314 provides a mixed mode transducer interface in conformance with IEEE 1451.4 Smart Transducer Interface. The mixed mode interface supports IEPE (Integrated Electronic Piezo-Electric) sensors powered by current source and TEDS (Transducer Electronic Data Sheet) capable sensors. TEDS information such as manufacturer name, serial number, calibration data, etc. are readable by the system for use in system scaling, identification, bookkeeping, troubleshooting and other functions.

TEDS sensors may be effectively applied to test models; however, there is a restriction that the cable run between the signal conditioner and the sensor be limited to 400 feet in order to be able to properly read the TEDS. For applications such as weapons test or vibration test on large structures, safety, environment, test article size and other factors often require cable runs in excess of 1000 feet that have until now precluded the use of TEDS-equipped sensors.

To overcome the communications distance limitations of conventional TEDS, the 28314 is equipped with Precision Filters' proprietary Long-Distance TEDS (LDTEDS) hardware. The proprietary LDTEDS circuitry uses an analog-to-digital converter to digitize the TEDS waveforms and utilizes a digital signal processor to process the TEDS data. LDTEDS can communicate with sensors at distances out to 1500 feet.

Input Stage

The 28314 input stage connects to either the charge or the IEPE front end. The input stage has low distortion, low DC drift and ultra-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.

Amplifier and Filter

Programmable pre- and post-filter amplifiers provide an overall gain of 8192. 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. A fully buffered output having over 20 mA of drive capability may be used to drive long output cable runs.

The 28314 contains a 4- or 8-pole low-pass filter with cutoffs programmable from 1 Hz to 204.6 kHz and programmable "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.

28314 Details and Specifications

28314 Conditioner Cards

The detailed description and specifications for the 28314 are organized as follows in the sections below:

- Input Characteristics
- Programmable Features
- Filter/Amplifier Characteristics
- Filter Characteristics
- Test Modes
- Output Characteristics
- Filter Characteristics
- General Card Characteristics
- Accessories
- Ordering Information

Input Characteristics

IEPE Inputs (IEPE Mode)

Type:

Single-ended (Low connected to conditioner ground)

Connector:

Two Combo-D pins (two channels per connector)

IEPE Current:

0 to 25 mA in 1 mA steps with disconnect

Current Accuracy:

±1%

Maximum Input:

22 V (DC bias + AC signal)

IEPE sensitivity:

1 mV/mV to 12,000 mV/mV

IEPE Current Noise:

130 pA/√Hz

Freq. Response:

1 Hz to 200 kHz

Noise:

7 nV/√Hz RTI at 1 kHz and pre-gain >x100

Piezoelectric Inputs (Charge Mode)

Type:

Programmable single-ended (sensor floating) or isolated (sensor grounded)

Connector:

Two isolated coaxial insert Combo-D (two channels per connector)

Maximum Input:

Low range, 50,000 pC ($F \leq 200$ kHz)

50,000 * 200 kHz/F ($F \geq 200$ kHz)

High Range, 500,000 pC ($F \leq 20$ kHz)

500,000 pC * 20 kHz/F ($F \geq 20$ kHz)

Charge Sensitivity:

Low range, 0.2 mV/pC to 1.64 V/pC

High range, 0.02 mV/pC to 0.164 V/pC

Charge Conversion Accuracy:

0.2% (V_{out}/Q_{in} after auto gain adjustment at 55 Hz, Gain = 1X)

Shunt Calibration Capacitor:

5,000 pF ±0.1% (Calibrated value stored in card EEPROM)

Shunt Cal Frequency Response:

-0.05 dB at 100 kHz,

-0.2 dB at 200 kHz

Time Constant:

Low Range: 10 or 5,000 seconds

High Range: 100 or 50,000 seconds

Noise (100 kHz BW):

Low Range: 0.08 pC + 0.0033 pC/nF

High Range: 0.8 pC + 0.0033 pC/nF

Drift:

2pC/Sec

Ground Signal Rejection:

-60 dB DC to 1 kHz (Isolated Mode)

Source Capacitance:

<0.03 μF meets all specifications

Source Resistance:

>10 MΩ meets all specifications

Reset:

1 KΩ shunt resets conversion capacitor

28314 Programmable Features

Charge Mode Features

- FS range (50,000 pC or 500,000 pC)
- Input Type (isolated or grounded)
- Time constant (long or short)
- Charge converter reset (reset or enable)
- Shunt calibration (on or off)

IEPE Mode Features

- IEPE current (0 to 25 mA, 1 mA steps)
- Bias monitor with programmable fault limits (upper limit and lower limit)
- Input mode (IEPE conditioner or differential input filter/amp)
- AC current dither

IEPE/Charge Common Features

- Gain (1/16X to 8192X)
- Cutoff frequency:
(1 Hz to 102.3 kHz, pulse mode)
(2 Hz to 204.6 kHz, flat mode)
- Wideband (500 kHz) or filtered operation
- Test modes:
Run (operate), Input Short, Cal Voltage Substitution (Test Bus)

28314 Graphical User Interface Display

All programmable features in addition to:

- System scaling in engineering units
- Overload status
- Gain Wizard
- Filter Wizard
- Group control



Front Panel Charge/IEPE Mode Switch



28314 Card Input Connectors

28314 Details and Specifications

Filter/Amplifier Mode Characteristics

Note: Specs at 25°C unless otherwise noted.

Common Mode V:

±10 V operating

CMRR:

-80 dB DC to 10 kHz

Input Protection:

±35 V

Input Impedance (DC Coupled):

10 MΩ//100 pF per side
20 MΩ//50 pF differential
100 MΩ//24 pF common mode

Input Impedance (AC Coupled):

(0.1 μF & 10 MΩ)//100 pF per side
(0.159 Hz)
0.2 μF & 20 MΩ common mode

Max Level:

±10 Vpk for f≤200 kHz;
±10 Vpk (200 kHz/f) for f>200 kHz

Offset Drift:

2.5 mV/°C, max

Noise:

7 nV/√Hz RTI at 1 kHz and pre-gain >x100

28314 Amplifier Characteristics

Pre-filter Gain:

x1 to x512 in binary steps,
with overload detection
(10.5 Vpk threshold)

Post-filter Gain:

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

DC Accuracy:

0.12% after auto cal at any gain setting

Stability:

±0.02% for 6 months

Temp Coefficient:

±0.004%/°C

DC Linearity:

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

Frequency Response:

DC to 200 kHz, -0.15 dB ±0.15 dB

-3.01 dB BW:

500 kHz, typical

28314 Test Modes

Shunt Cal: (Charge Mode only) Test Bus signal is applied to charge amp input through a 5000 pF shunt cal capacitor.

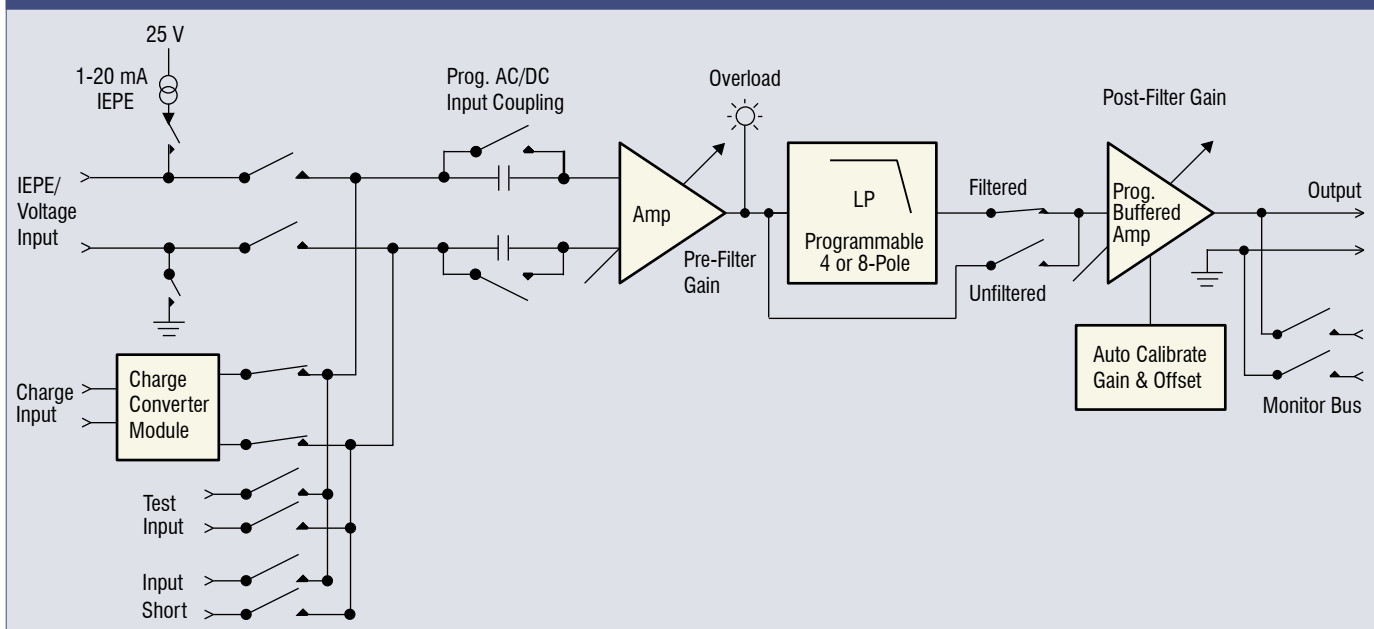
Amplifier Short: A switch at the amplifier input is utilized to ground the input stage for measurement of noise and DC offset.

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

AC Current: (IEPE Mode only) An AC dither current is summed with the IEPE current to create an AC voltage signal based on the transducer's output impedance. AC current is derived from test bus voltage according to:

$$\text{AC Current} = V (\text{Test Bus})/10000$$

28314 Channel Block Diagram



28314 Simplified Channel Block Diagram

28314 Details and Specifications

28314 Output Characteristics

The 28314 card output connections are made at the rear panel 50-pin D-shell connectors. The 28016-M3 mainframe provides four 50-pin connectors, which provide four outputs per card slot in the mainframe. The 28008-M3 frame provides two 50-pin connectors.

In addition, an auxiliary front panel output connector is provided to support the use of custom output modules.

- Type:**
DC-coupled, single-ended output with ground reference.
- Z:**
10 Ω shunted by 100 pF
- Max Output:**
 ± 10 Vpk, ± 20 mApk
- Offset Drift:**
2.5 μ V/ $^{\circ}$ C, RTI + 150 μ V/ $^{\circ}$ C, RTO
- Noise:**
5 μ Vrms RTI + 300 μ Vrms RTO
0.1 Hz to 200 kHz
- Crosstalk:**
-80 dB, DC to 100 kHz between adjacent channels with the same configuration and programmed settings.

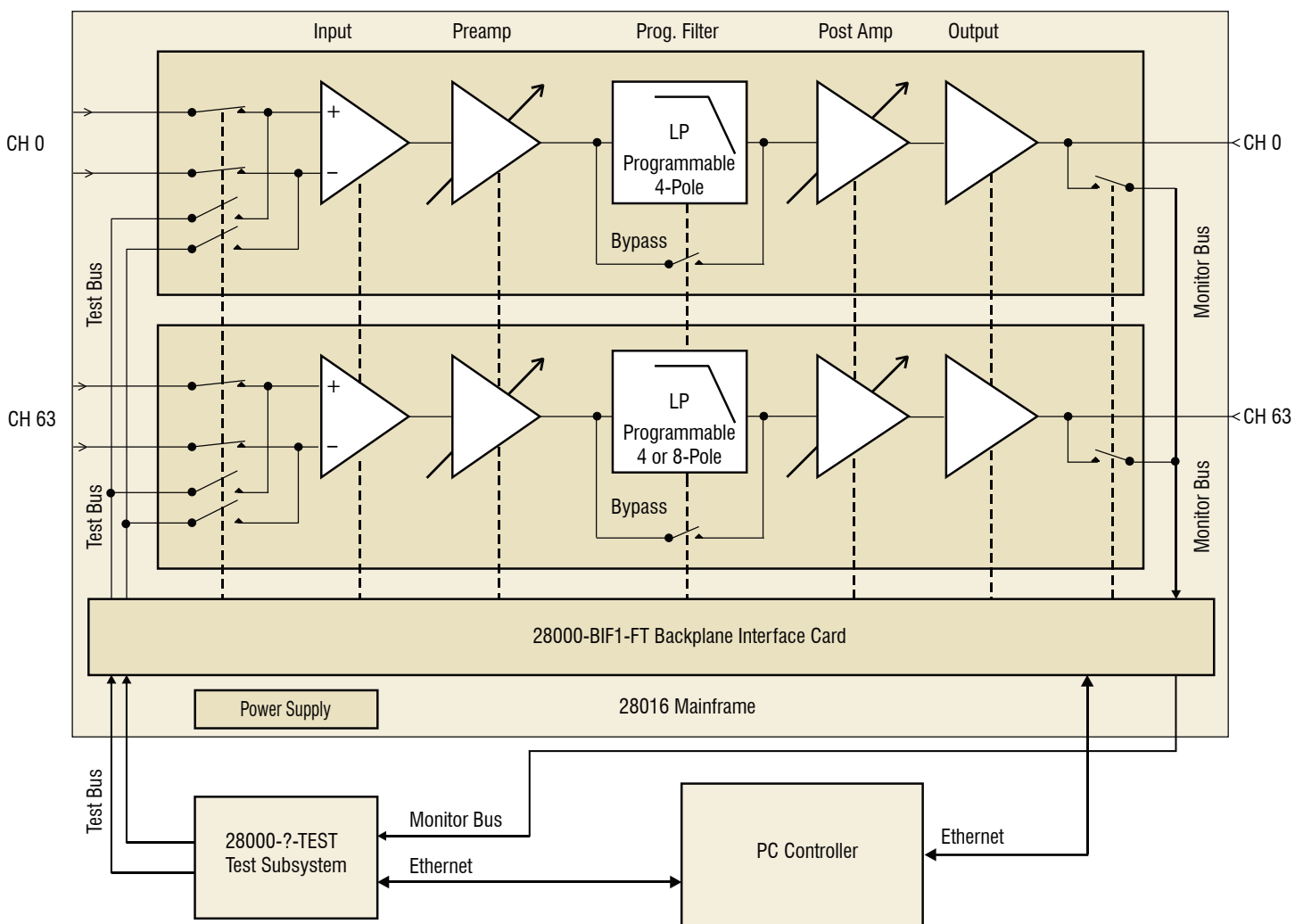
Auto-Offset Adjust (Standard)

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 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 Test Subsystem or is available to the user for viewing channel outputs.



28000 System with 64 Channels of 28314 Charge/IEPE Block Diagram

28314 Filter Characteristics

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

The 28314 card has a variety of high performance filter characteristics available for HP, LP or BP Precision filtering.

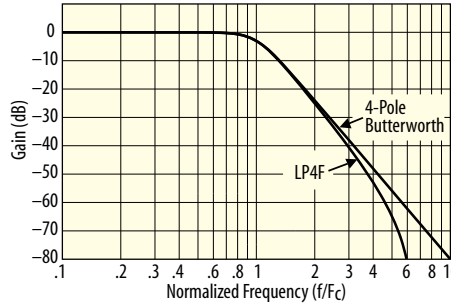
Flat/Pulse Low-Pass Filters

Our new choice of LP4FP 4-pole or LP8FP 8-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. Frequencies can range as high as 204.6 kHz with fixed frequency choices for economy.

Flat Mode Low-Pass Filters

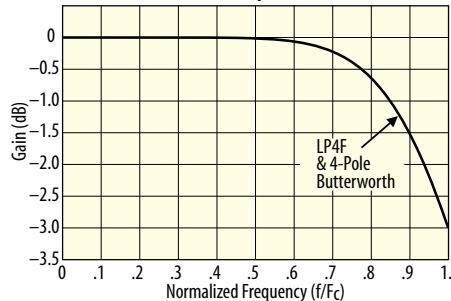
Precision LP4F and LP8F "flat" mode characteristics are specified to have outstanding passband flatness equivalent to the Butterworth yet deliver very sharp roll-off characteristics.

LP4F vs Butterworth Amplitude Response

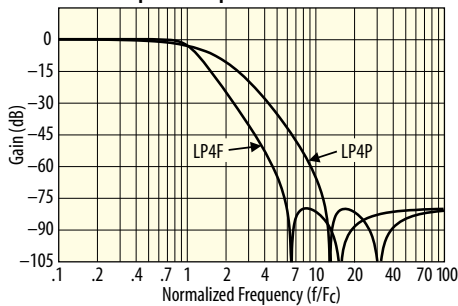


The LP4F and LP8F are a good choice as an anti-aliasing filter and for applications such as spectral analysis. The LP8F has zero passband ripple and over 100 dB/octave attenuation slope.

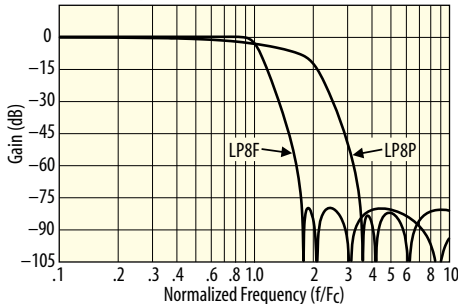
LP4F vs Butterworth Passband Response



LP4F and LP4P Amplitude Response



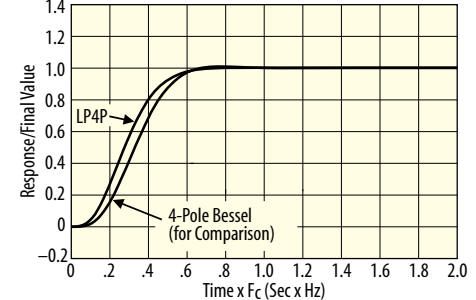
LP8F and LP8P Amplitude Response



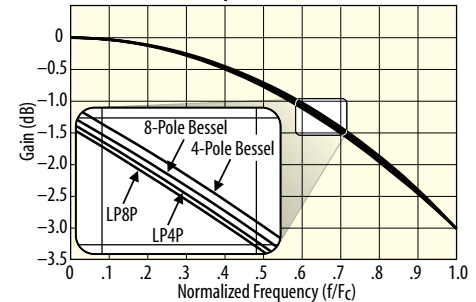
Pulse Mode Low-Pass Filters

For the time domain, there are the LP4P and LP8P "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.

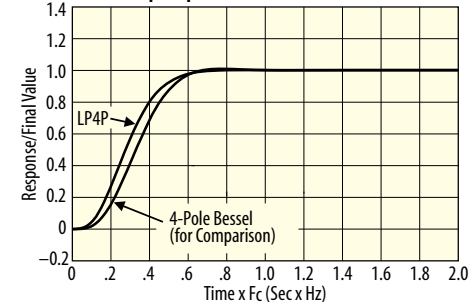
LP4P vs Bessel Step Response



LP8P and LP4P Passband Response



LP4P vs Bessel Step Response



Traditional Filters

Of course, we offer the traditional filter types such as Butterworth and Bessel characteristics ... just ask!

In any case, we deliver to you a tightly controlled filter with phase match better than 1 degree and usually better than 0.5 degrees.

28314 Filter Type 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).

Option LP8FP:

8-pole, 8-zero low-pass filter.
Programmable for maximally flat pass-band (LP8F) or linear phase with optimized pulse response (LP8P).

Cutoff Frequencies:

Flat Mode:

2 Hz to 2.046 kHz in 2 Hz steps
2.2 kHz to 204.6 kHz in 200 Hz steps

Pulse Mode:

1 Hz to 1.023 kHz in 1 Hz steps
1.1 kHz to 102.3 kHz in 100 Hz steps

LP4F, LP4P, LP8F, LP8P:

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

Bypass:

Bypasses filter but not amplifier stages.

Bypass Bandwidth:

500 kHz, typical

Custom Filters:

Other filter types and cutoff frequencies are available. Please consult with Precision Filters for more information.

Specification	LP4F Maximally Flat Low-Pass Filter	LP4P Constant Time Delay Low-Pass Filter	LP8F Maximally Flat Low-Pass Filter	LP8P Constant Time Delay Low-Pass Filter
Cutoff Frequency Amplitude	-3.01 dB	-3.01 dB	-3.01 dB	-3.01 dB
DC Gain	0.00 dB	0.00 dB	0.00 dB	0.00 dB
Pass-Band Ripple	0.00 dB	0.00 dB	0.00 dB	0.00 dB
Stop-Band Frequency (-80 dB)	5.9465 Fc	11.863 Fc	1.7479 Fc	3.4688 Fc
Cutoff Frequency Phase	-180.0 deg	-101.5 deg	-360 deg	-161.9 deg
Phase Distortion (DC to Fc)	< 31.8 deg	<3.7 deg	<102 deg	<0.05 deg
Zero Frequency Group Delay (SEC)	0.4117/Fc	0.2920/Fc	0.7197/Fc	0.4496/Fc
Percent Overshoot	11.1%	0.5%	18.9%	1.1%
1% Settling Time (SEC)	1.65/Fc	0.66/Fc	4.03/Fc	1.25/Fc
0.1% Settling Time (SEC)	2.72/Fc	0.77/Fc	7.02/Fc	2.25/Fc
-0.1 dB Frequency	0.6348 Fc	0.1816 Fc	0.8538 Fc	0.180 Fc
-1 dB Frequency	0.8487 Fc	0.5742 Fc	0.9437 Fc	0.5685 Fc
-2 dB Frequency	0.9370 Fc	0.8129 Fc	0.9772 Fc	0.8087 Fc
-3.01 dB Frequency	1.0000 Fc	1.0000 Fc	1.0000 Fc	1.0000 Fc
-20 dB Frequency	1.7412 Fc	3.0248 Fc	1.2149 Fc	2.2342 Fc
-40 dB Frequency	2.9555 Fc	5.6932 Fc	1.4443 Fc	2.7556 Fc
-60 dB Frequency	4.5986 Fc	9.0980 Fc	1.6391 Fc	3.2016 Fc
-80 dB Frequency	5.9465 Fc	11.8629 Fc	1.7479 Fc	3.4688 Fc

General Characteristics

28314 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)

Input and Output Connectors:

The input connectors are integral to the 28314 card. Cutouts on the 28000 frames allow the connectors to pass through the backplane and to directly mate with the input cables.

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-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.

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 and other destinations.

28314 cards are fitted with front panel connectors which 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-4BNC/15D Output Buffer

The BUFF-4BNC/15D quad output buffer module provides one buffered output per channel on 4 BNC connectors and one 15-pin multipin connector.

BUFF-4CH/(2)15D Dual Output Buffer

The BUFF-4CH/(2)15D dual output buffer provides two buffered outputs per channel on 15-position D-type female connectors.

Factory Acceptance Test (FAT) Adapters

28000-TEDS-ADAPTER-A

Supports FAT tests of the LDTEDS function of the 28314 card. This dual channel adapter incorporates TEDS memory and a load capacitor that emulates the Long Distance TEDS (LDTEDS) capability.

28304/28314-FAT-ADAPTER

Supports FAT tests of the charge circuit on 28314 cards. Consists of Combo-D input adapter and NIST traceable calibration capacitor.

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.

28314 Card Model Number

28314-<Filter Type>

Filter Specification

LP4FP (4-pole low-pass)

LP8FP (8-pole low-pass)