PRECISION FILTERS, INC.

*On the **New Frontiers** of **Precision***

Precision 28612
for the 28000 Analog Signal Conditioner

Precision 28612

Dual-Channel 3 MHz Programmable Filter/Amplifier

The 28612 Programmable Filter/Amplifier is a member of the Precision 28000 family of signal conditioners. The 28612 provides two channels of low noise programmable amplification and programmable low-pass or high-pass filters with programmable cutoff frequencies from 5 kHz to 3.15 MHz. Up to sixteen 28612 cards may reside in the 28000 system to provide 32 channels per chassis. In addition, the 28612 may be mixed with other conditioners in the 28000 family to meet your unique signal conditioning requirements.

The 28612 provides sharp, selectable wide-bandwidth filters with programmable gain. As part of the Precision 28000 System, fully automated factory acceptance tests and Go/No-Go tests are available for the 28612. The tests allow for traceable in-place calibration and performance verification with full reports.

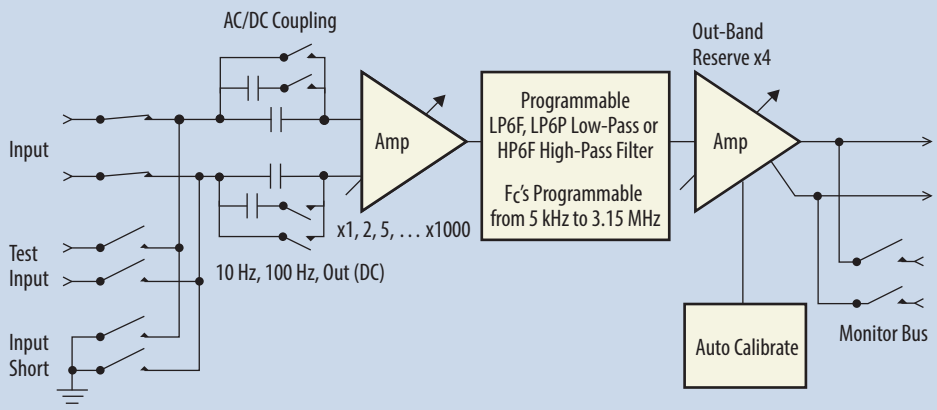
Precision 28612 Applications

- High Frequency Anti-Aliasing Filters
- General Purpose Voltage Amplifier/Filter for Dynamic Measurements
- Improve Signal-to-Noise Ratio for Resonant Transducers
- High Frequency Band-Pass Filters
- Low Drift DC Amplifier for Low-Level DC Signals

Precision 28612 Features

- Two channels per card, 32 channels per chassis
- Programmable single-ended/differential input
- Programmable AC/DC input coupling
- Programmable input termination (50 Ohms or Hi-Z)
- Programmable gain: x1, 2, 5, 10, 20, 50, 100, 200, 500, 1000
- Six-pole low-pass filters with programmable pulse/flat characteristics (model 28612-LP6FP)
- Six-pole high-pass filter with maximally flat elliptic characteristics (model 28612-HP6F)
- Cutoff frequencies programmable from 5 kHz to 3.15 MHz
- Precise digital calibration

28612 Channel Block Diagram



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

28612 Details and Specifications

28612 Input Characteristics

Type:
Balanced differential input or single-ended input with programmable AC/DC coupling

Maximum Level (AC + DC + Common Mode):
±5 Vpk for f ≤3.15 MHz
±5 Vpk (3.15 MHz/f); f >3.15 MHz

Slew Rate:
130 V/µs minimum

Input Protection:
25 V continuous power on; 15 V continuous power off; 100 Vpk transient for 1 mS, 10% duty cycle

CMRR (gain > x5):
90 dB, DC to 500 Hz
60 dB, 500 Hz to 100 kHz

Input Impedance:
1 MΩ minimum per side or 50 Ω (programmable)

Drift:
5 µV/°C, RTI + 200 µV/°C RTO

Noise:
1 Hz to 10 kHz:
2 µVrms RTI + 150 µVrms RTO
1 Hz to 100 kHz:
6 µVrms RTI + 300 µVrms RTO
1 Hz to 1 MHz:
10 µVrms RTI + 400 µVrms RTO
1 Hz to 10 MHz:
20 µVrms RTI + 550 µVrms RTO

AC Coupling Frequency:
LP6FP: Programmable 10 Hz or 100 Hz
HP6F: Fixed, 100 Hz

28612 Programmable Features

- Input Type: Single-ended or Balanced Differential
- Input Termination: 50 Ohms or Hi-Z
- AC/DC Input Coupling (LP6FP only)
- Test Modes: Amp Short, Test Bus
- Output Monitor
- Gain (x1, 2, 5, 10, 20, 50, 100, 200, 500, 1000)
- Filter Type: Pulse or Flat (LP6FP only)
- Cutoff frequency: 5 kHz to 315 kHz in 5 kHz steps; 350 kHz to 3.15 MHz in 50 kHz steps

28612 Amplifier Characteristics

Gain:
x1, 2, 5, 10, 20, 50, 100, 200, 500, 1000

Out-Band Reserve:
Gain is distributed around the filter to accommodate and remove out of band signals up to 4x larger than the in-band signal of interest without signal clipping.

DC Accuracy: (LP6FP only)
±0.2 % at any gain setting

Temperature Coefficient: (LP6FP only)
±0.001% /°C

DC Linearity: (LP6FP only)
0.1% re: Full-scale, relative to best straight line

28612 Test Modes

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.

28612 Filter Characteristics

Type:
LP6FP: 6-pole, 6-zero low-pass filter. Programmable for maximally flat pass-band (LP6F) or linear phase with optimized pulse response (LP6P).

HP6F: 6-pole, 6-zero high-pass filter with maximally flat pass-band

Cutoff Frequencies:
5 kHz to 315 kHz in 5 kHz steps
350 kHz to 3.15 MHz in 50 kHz steps

LP6FP Pass-Band Accuracy:
Fc ≤315 kHz:
±0.1 dB, DC to 0.8 Fc
±0.25 dB, 0.8 Fc to Fc
315 kHz < Fc ≤ 3.15 MHz:
±0.2 dB, DC to 0.5 Fc
±0.35 dB, 0.5 Fc to 0.8 Fc
±0.5 dB, 0.8 Fc to Fc

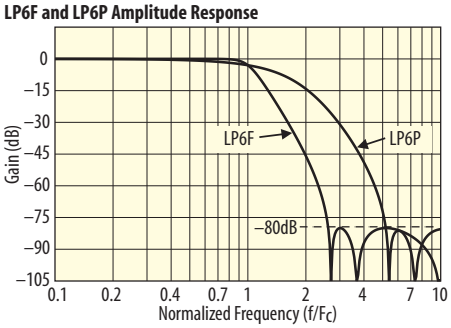
HP6F Pass-Band Accuracy:
Fc ≤200 kHz:
±0.2 dB, 1.2 Fc to 2 Fc
±1 dB, 2 Fc to 4 MHz
200 kHz < Fc ≤ 3.15 MHz:
±1 dB, 1.2 Fc to 4 MHz

Filter Specification	LP6F 6-Pole Maximally Flat Low-Pass Filter	LP6P 6-Pole Time Delay Low-Pass Filter	HP6F 6-Pole Maximally Flat High-Pass Filter
Cutoff Frequency Amplitude	–3.01 dB	–3.01 dB	-3.01 dB
DC Gain	0.00 dB	0.00 dB	–80 dB
Pass-Band Ripple	0.00 dB	0.00 dB	0.00 dB
Stop-Band Frequency	2.6113 F_c	5.1923 F_c	0.3830 Fc
Cutoff Frequency Phase	–270.0 deg	–140.3 deg	270.0 deg
Phase Distortion (DC to F_c)	<31.8 deg	<1.45 deg	n/a
Zero Frequency Group Delay	0.5834/F_c	0.3924/F_c	n/a
Percent Overshoot	15.8%	1.1%	n/a
1% Settling Time	2.80/F_c	0.84/F_c	2.98/Fc
0.1 % Settling Time	4.36/F_c	1.02/F_c	4.56/Fc
–0.1 dB Frequency	0.766 F_c	0.193 F_c	1.305 Fc
–1 dB Frequency	0.9080 F_c	0.5983 F_c	1.1013 Fc
–2 dB Frequency	0.9624 F_c	0.8293 F_c	1.0391 Fc
–3.01 dB Frequency	1.0000 F_c	1.0000 F_c	1.0000 Fc
–20 dB Frequency	1.3822 F_c	2.3616 F_c	0.7235 Fc
–40 dB Frequency	1.8546 F_c	3.5115 F_c	0.5392 Fc
–60 dB Frequency	2.3206 F_c	4.5462 F_c	0.4309 Fc
–80 dB Frequency	2.6113 F_c	5.1923 F_c	0.3830 Fc

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

The 28612 card has a flexible high performance 6-pole low-pass filter characteristic that can be optimized for time or frequency domain measurements.

LP6F and LP6P Amplitude Response



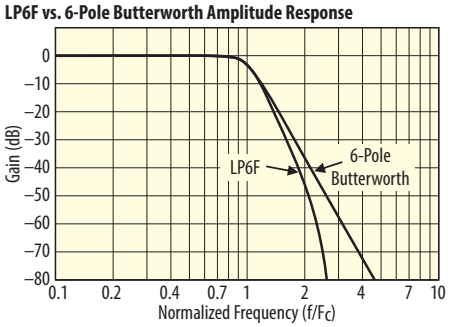
Flat/Pulse Low-Pass Filters

The LP6F and LP6P 6-pole low-pass filters have the versatility to address applications in either the time or frequency domain. Simply program the filter characteristic to match your measurement requirements.

Flat Mode Low-Pass Filters

The LP6F FLAT mode characteristic has a pass-band amplitude response nearly identical to the 6-pole Butterworth yet has much sharper roll-off characteristics. This makes the LP6F a good choice for spectral analysis or for anti-aliasing applications.

LP6F vs. 6-Pole Butterworth Amplitude Response

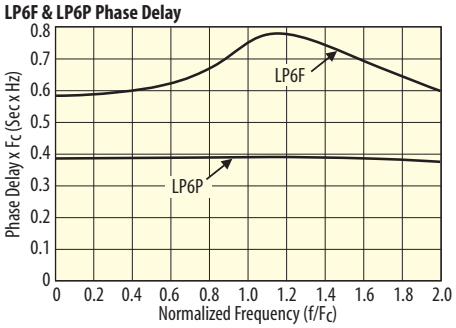


The input to output time delay of the LP6F and Butterworth are not constant versus frequency as a consequence of the non-linear phase property of these filters. Filters with linear phase, such as the Precision LP6P, have linear phase and thus constant delay for all frequencies in the pass-band.

Pulse Mode Low-Pass Filters

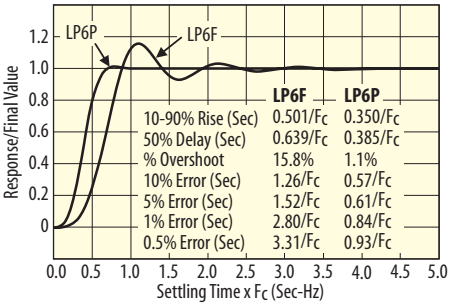
For the time domain, the LP6P PULSE mode low-pass filter has excellent transient response and phase linearity required for time domain applications such as transient (shock) measurements and time domain waveform analysis.

LP6F & LP6P Phase Delay

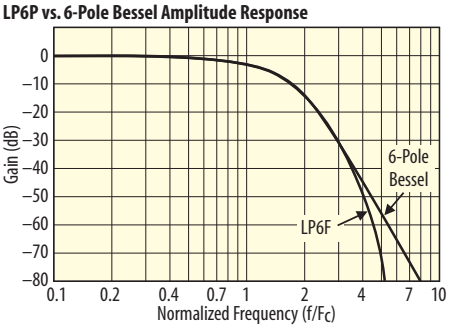


When compared to a 6-pole Bessel filter, the LP6P has similar pass-band characteristics yet has much sharper transition slope from pass-band to stop-band.

LP6F & LP6P Step Response



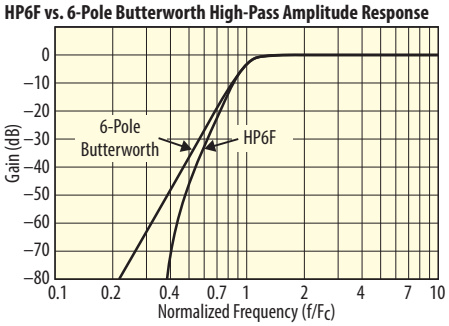
LP6P vs. 6-Pole Bessel Amplitude Response



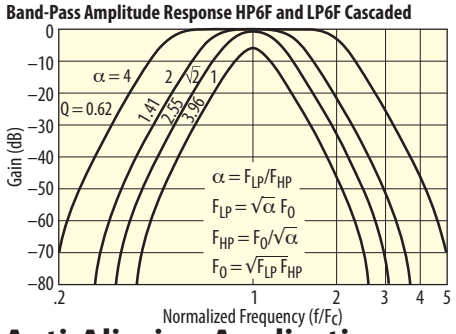
High-Pass and Band-Pass Filters

For high-pass filtering, we offer the HP6F 6-pole FLAT characteristic. Cascade an HP6F with an LP6F to make a symmetric band-pass filter with programmable bandwidth and center frequency. Q's as high as 3.96 are attainable with the two filters set to the same programmed cutoff frequency.

HP6F vs. 6-Pole Butterworth High-Pass Amplitude Response



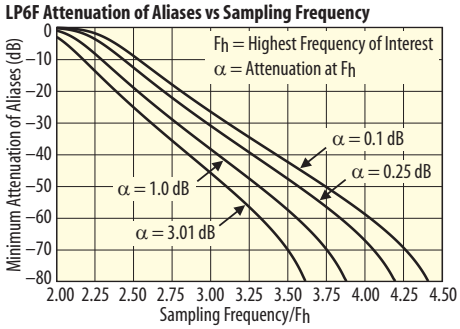
Band-Pass Amplitude Response HP6F and LP6F Cascaded



Anti-Aliasing Applications

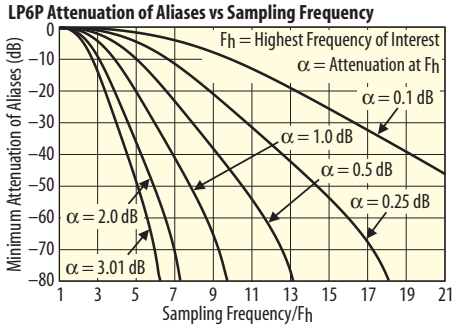
When used for anti-aliasing applications, the LP6F provides more useable bandwidth for a given sampling frequency.

LP6F Attenuation of Aliases vs Sampling Frequency



In exchange for linear phase and excellent transient response, the LP6P is less selective and thus requires a higher sampling frequency than the LP6F.

LP6P Attenuation of Aliases vs Sampling Frequency



The chart below provides a comparison of attenuation of aliases versus sampling frequency for the LP6P, 6-pole Bessel (BE6), LP6F and the 6-pole Butterworth (BU6). It is clear that much lower sampling frequencies are required for the Precision LP6P and LP6F when compared to traditional filter characteristics.

	Sampling Frequency for –3.01 dB Attenuation @ F_h			
Alias Attn.	**BE6**	**LP6P**	**BU6**	**LP6F**
20	$3.4F_C$	$3.4F_C$	$2.5F_C$	$2.4F_C$
40	$4.6F_C$	$4.5F_C$	$3.2F_C$	$2.9F_C$
60	$6.4F_C$	$5.5F_C$	$4.2F_C$	$3.3F_C$
80	$9.0F_C$	$6.2F_C$	$5.6F_C$	$3.6F_C$

28612 Specifications and Accessories

PRECISION FILTERS, INC.

28612 Output Characteristics

Type:
DC coupled, single-ended output

Impedance:
50 Ω

Max Output:
±5 Vpk, ±40 mA pk

Offset:
<5 mV after auto-adjust at any gain setting

Offset Drift (LP6FP):
5 µV/°C, RTI + 200 µV/°C RTO

Crosstalk:
–80 dB, DC to 100 kHz, –60 dB to 1 MHz

Output Monitor:
A switch at the output of each channel allows for multiplexed connection to the 28000 chassis output monitor bus BNC connector for viewing the channel output with an external device.

28612 General Characteristics

28612 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)

Connectors

The input and output connectors are integral to the 28612 cards. Two 2-pin LEMO input connectors, one for each 28612 input, are available on the front panel of the 28612 card. Cutouts on the 28000 frames allow the output connector to pass through the backplane and to directly mate with the output cables. One Combo-D connector with two coaxial inserts is utilized for the 2 outputs. Connectors have high quality machined gold plated pins/sockets.

Accessories

Mating Connectors

Precision Filters mating connectors are supplied with high quality metal backshells and gold plated screw machined contacts for high reliability connections and long service life.

CONN-IN-LEMO-FGG.1B.302: Precision Filters part number A11767G1 consisting of LEMO part number FGG.1B.302.CLAD? (where ? indicates collet size). A set of collets for cable overall diameter from 0.122 to 0.300 inches is provided. Solder pins accommodate up to 20 gage wire (AWG).

CONN-OUT-COMBO-D-RG178B/U: Two-Channel Mating Combo-D Output Connector. 50 Ohm Coaxial Inserts Accommodating RG-178 Coaxial Cable (A7953G1).

ADAPTER-I-2LEMO2P/2BNC1: BNC input adapter module. Provides two panel mounted BNC female input connectors with integral cables to adapt to the LEMO inputs. Module securely mounts to 28612 front panel via captive screws.

ADAPTER-I/O-2BNC1: BNC Output Connector Adapter, Combo-D to Two BNC. Adapter is fastened to rear panel of chassis, mating directly to the Combo D connector on the 28612 card. The card may be removed from the chassis without removal of the adapter or output cables.

Ordering Information

28612-LP6FP | HP6F

- Filter Specification: 6-pole low-pass (LP6FP) / 6-pole high-pass (HP6F)
- 28612 Dual-Channel Filter/Amplifier

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.

PRECISION FILTERS, INC
ISO 9001 CERTIFIED QUALITY

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