



PFA-2 Precision Dual-Channel Compact Filter/ Amplifier System



Description

The PFA-2 is a compact, rugged, and versatile dual-channel precision filter/amplifier. The low-noise, high common-mode rejection balanced differential input with programmable AC/DC input coupling is ideal for conditioning static or dynamic signal inputs.

Sharp, programmable 6-pole low-pass precision filters support two response characteristics which are optimized for making time-domain or frequency-domain measurements. Gain is distributed as pre- and postfilter gain, allowing for elimination of out-of-band energy such as transducer resonant peaking, which can cause nonlinearities due to clipping of the amplifier. Overload detectors alert the user to pre- and postfilter overload conditions that could otherwise

be masked by the filter. The optional 2-pole high-pass filter provides programmable low-frequency roll off to attenuate sources of low-frequency noise.

A high-level command interface is available to control the PFA-2 via a USB 2.0 interface. A spreadsheet-style graphical user interface is supplied to control up to 8 PFA-2 units as a single system. Configurations may be saved to and recalled from the host computer. Settings may be saved to nonvolatile memory for deployment without a host computer. Front panel LED indicators alert the user to overloads.

The PFA-2 is powered by 10 to 30 VDC and is supplied with an external AC-to-DC universal supply.

PFA-2 Features

- Two channels per system
- Balanced differential input
- Programmable AC/DC input coupling
- Prefilter gain: x1 to x128 in binary steps
- Postfilter gain: x1/16 to x16 with 0.025% minimum resolution
- 6.3 nV/ $\sqrt{\text{Hz}}$ maximum input noise
- 6-pole low-pass filters with programmable flat/pulse characteristics
- Optional 2-pole high-pass filter for band-pass operation
- Cutoff frequencies programmable from 5 Hz to 127.75 kHz
- Input and output overload detection with programmable threshold
- Precise digital calibration of DC offset
- 0.05% overall DC accuracy
- Test input for voltage substitution calibration
- USB 2.0 remote control with field upgradable firmware
- Front panel overload LED indicators
- Spreadsheet-style GUI interface for control of up to 8 PFA-2 units
- Compact stackable chassis design with link kit to lock units together
- Side-by-side rack-mount option

Applications

- Low-pass, band-pass, high-pass filter/amplifier
- IEPE sensor conditioner
- Anti-aliasing filters
- Transient (shock) measurements
- Reconstruction filters

PFA-2 Control

Remote Interface:

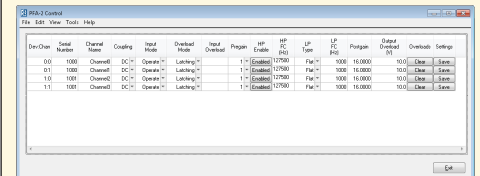
USB 2.0 Type B using high-level command set protocol

Nonvolatile Memory:

PFA-2 programmed state may be saved to nonvolatile memory for retention of settings through the power cycle or for field deployment without an attached control computer.

Graphical User Interface:

Spreadsheet-style software executable on Windows OS provided with each unit. Up to eight PFA-2 units may be controlled as a system via the GUI. Provisions for save/recall of configurations are supported.



Front Panel Controls and Indicators:

LEDs are provided for each channel to indicate input or output overload. Momentary switches are provided to clear overload detectors in latching mode. The front panel switches may be locked out via remote commands or via a control panel in the GUI.



PFA-2 Filter/Amplifier Front View

PFA-2 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 Input:

Switch disconnects signal from input connector and injects signal on Test Input BNC at the amplifier input.

Operate:

Normal operating mode



PFA-2 Filter/Amplifier Rear View

PFA-2 Details and Specifications

Input Characteristics

Type:

Balanced differential with programmable AC/DC coupling

Input Connectors

Standard: Individual Isolated BNC's at front panel

Option 1: Individual Isolated 2-pin twinaxial BNC at front panel

Input Impedance:

10 M Ω // 50 pF per side

Maximum Level:

(AC + DC + Common Mode)

± 10 Vpk for $f \leq 200$ kHz

± 10 Vpk x (200 kHz/f) for $f > 200$ kHz

Input Protection:

24 V continuous (power on)

60 Vpk transient (1 ms pulse, 50% duty cycle)

Offset Drift:

1 μ V/ $^{\circ}$ C, RTI

Noise:

8 nV/ rt. Hz RTI at 10 Hz

6.3 nV/ rt. Hz RTI, $f \geq 100$ Hz

AC Coupling Frequency:

0.25 Hz (-3.01 dB)

CMRR (DC Coupled):

110 dB, DC to 1 kHz, input gain > x16

CMRR (AC Coupled):

80 dB, 47 Hz to 1 kHz, input gain > x16

Amplifier Short: Amplifier inputs may be programmed to ground to measure amplifier noise and DC offset.

Test Input: A switch at the channel input allows for injection of an external test signal applied to a front panel BNC connector.

Amplifier Characteristics

Pre-filter Gain:

x1 to x128 in x2 steps with overload detection (10 Vpk threshold)

Postfilter Gain:

x1/16 to x16

Postfilter Gain Resolution:

0.025% min for POG ≥ 1

0.025%/POG for POG < 1

Overall DC Accuracy:

$\pm 0.05\%$ at any gain setting. Includes filter.

Temperature Coefficient:

$\pm 0.004\%$ / C

DC Linearity:

0.005% re: full scale output, best-fit straight line

Frequency Response (Filter Out):

DC to 200 kHz: 0 dB ± 0.1 dB;

-3 dB typical at 500 kHz

Output Characteristics

Type:

DC coupled, single-ended output, short circuit protected

Impedance:

10 Ω

Max Output:

± 10 Vpk, ± 25 mA pk

Offset:

< 5 mV after auto adjust at any gain setting

Offset Drift:

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

Noise:

2.8 μ V rms RTI + 60 μ V rms RTO, 3 Hz to

100 kHz

Crosstalk:

-80 dB, DC to 100 kHz

Output Overload Detector:

Level programmable from 0.1 to 10.2 V

in 0.1 V steps

Power Requirements

Power is supplied to the PFA-2 from either the external PFA-2-ACPS, included with each system, or a direct power source. The input power supply requirements are 10 VDC to 30 VDC, 25 W maximum. Power is applied at the rear panel Mini DIN connector.

PFA-2-ACPS External Power Supply

The compact PFA-2-ACPS AC to DC external power supply carries the CE/UL listing marks. One PFA-2-ACPS is supplied with each PFA-2 system.

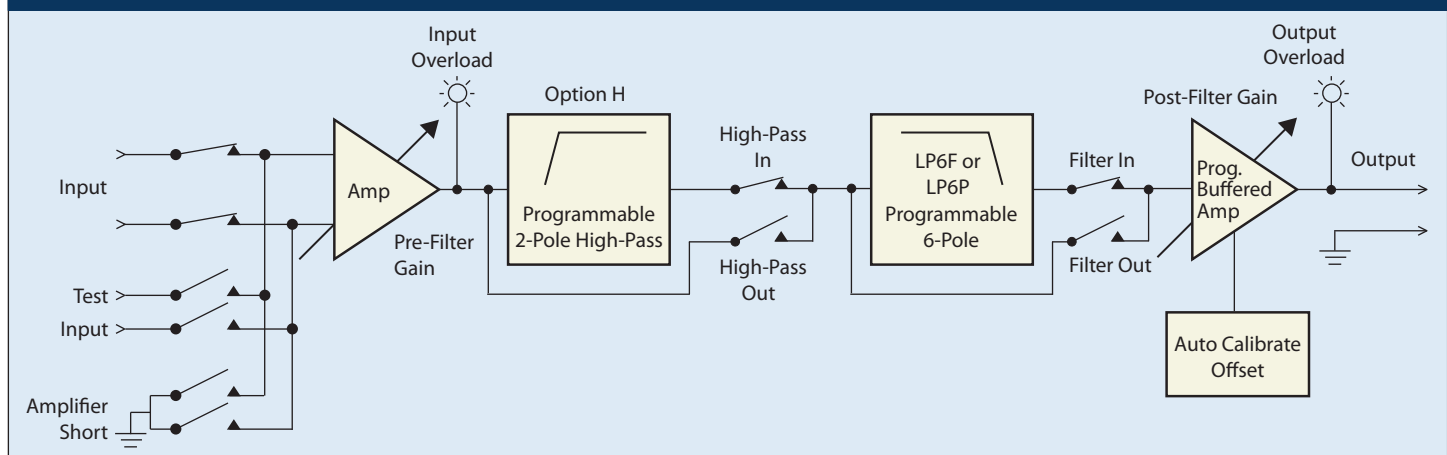
Input Voltage, Frequency

100-240 VAC, 47-63 Hz

Output

12 VDC, 25W

PFA-2 Channel Block Diagram



PFA-2 Details and Specifications

PFA-2 Filter Characteristics

Programmable Flat/Pulse Filter

Type:

Programmable flat/pulse low-pass 6-pole, 6-zero low-pass filter. Programmable for maximally flat pass-band (LP6F) or linear phase (LP6P).

Cutoff Frequencies:

5 Hz to 2.555 kHz in 5 Hz steps
2.75 kHz to 127.75 kHz in 250 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

Wideband Mode:

Filter may be removed from the signal path, resulting in 3-pole Butterworth wideband amplifier frequency response with nominal -3 dB frequency at 500 kHz.

Parameter	LP6F 6-Pole Maximally Flat Low-Pass Filter	LP6P 6-Pole 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	2.6113 Fc	5.1923 Fc
Cutoff Frequency Phase	-270.0	-140.3 deg
Phase Distortion (DC to Fc)	<60 deg	<1.45 deg
Zero Frequency Group Delay	0.5834/Fc	0.3924/Fc
Percent Overshoot	15.8%	1.1%
1% Settling Time	2.80/Fc	0.84/Fc
0.1 % Settling Time	4.36/Fc	1.02/Fc
-0.1 dB Frequency	0.766 Fc	0.193 Fc
-1 dB Frequency	0.9080 Fc	0.5983 Fc
-2 dB Frequency	0.9624 Fc	0.8293 Fc
-3.01 dB Frequency	1.0000 Fc	1.0000 Fc
-20 dB Frequency	1.3822 Fc	2.3616 Fc
-40 dB Frequency	1.8546 Fc	3.5115 Fc
-60 dB Frequency	2.3206 Fc	4.5462 Fc
-80 dB Frequency	2.6113 Fc	5.1923 Fc

Programmable High-Pass Filter (Option H)

Type:

2-pole Butterworth high-pass filter

Cutoff Frequencies:

1 Hz to 255 Hz in 1 Hz steps
300 Hz to 12.75 kHz in 50 Hz steps
13 kHz to 127.5 kHz in 500 Hz steps

Amplitude Accuracy:

±0.1 dB max, 1.2 Fc to 127.5 kHz
±0.2 dB max, Fc to 1.2 Fc

Amplitude Match:

±0.1 dB max, 1.2 Fc to 127.5 kHz
±0.2 dB max, Fc to 1.2 Fc

Phase Match:

±1° max, 1.2 Fc to 127.5 kHz
±2° max, Fc to 1.2 Fc

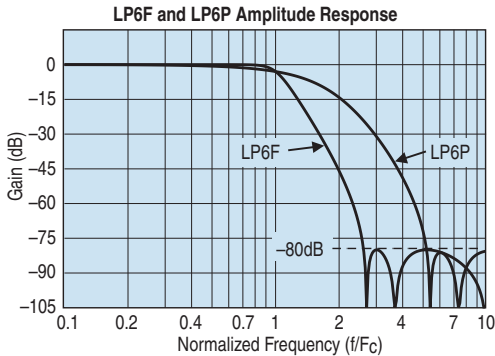
Bypass Mode:

High-pass filter is removed from the signal path.

Parameter	2-Pole Butterworth High-Pass Filter
Cutoff Amplitude	-3.01 dB
High Frequency Gain	0.00 dB
Pass-Band Ripple	0.00 dB
Low Frequency Roll off	-40 dB/Decade
Cutoff Frequency Phase	90 deg
-0.1 dB Frequency	2.559 Fc
-0.25 dB Frequency	2.026 Fc
-1 dB Frequency	1.402 Fc
-2 dB Frequency	1.143 Fc
-3.01 dB Frequency	1.000 Fc
-20 dB Frequency	0.316 Fc
-40 dB Frequency	0.100 Fc
-60 dB Frequency	0.0316 Fc
-80 dB Frequency	0.0100 Fc

Flat/Pulse Low-Pass Filters

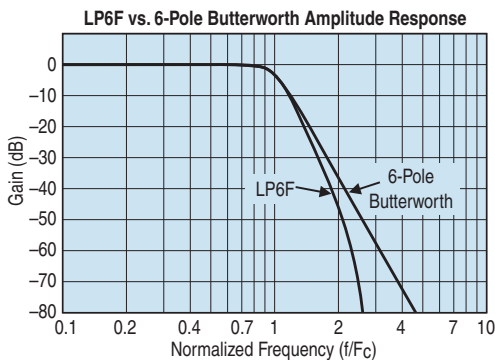
The PFA-2 has a flexible high-performance 6-pole low-pass filter characteristic that can be optimized for time- or frequency-domain measurements.



The LP6F and LP6P 6-pole low-pass filters have the versatility to address applications in either the time domain or the 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 with much sharper roll-off characteristics. This makes the LP6F a good choice for spectral analysis or for anti-aliasing applications.



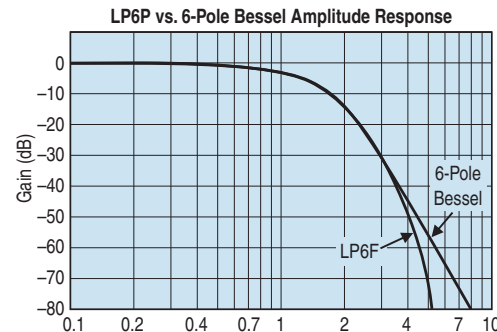
Like the Butterworth low-pass filter, the LP6F has a nonlinear phase response with 60 degrees of phase distortion at the cutoff frequency.

The nonlinear phase characteristics of the LP6F result in an input-to-output time delay that is not constant versus frequency. Filters with linear phase, such as the LP6P, have 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.

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



Anti-Aliasing Applications

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

The chart below provides a comparison of attenuation of aliases versus sampling frequency for the LP6P, 6-pole Bessel (BE6), LP6F, and 6-pole Butterworth (BU6). It is clear that much lower sampling frequencies are required for the PFA-2 LP6P and LP6F than for traditional filter characteristics.

Alias Attn.	Sampling Frequency for -3.01 dB Attenuation @ Fh			
	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

PFA-2 General Characteristics

Size: 12.5 x 8.6 x 1.75 inches (LxWxH)

Weight: 3.5 lb. net

Temperature:

0°C to 55°C (operating)

-20°C to 85°C (storage)

Humidity:

10% to 90% noncondensing

ISO/IEC Conformance:

PFA-2 conforms to IEC directives for emissions, immunity, and safety

Input Connectors:

2 ea. BNC (Standard) or
Twinaxial (Option 1)

Output Connectors:

2 ea. isolated BNC on rear panel

Test Input Connector:

Isolated BNC on front panel

Ground:

Signal ground post at rear panel. Slider switch connects chassis ground to signal ground or isolates signal ground to accommodate external ground reference. Chassis ground is referenced to ground pin on power input connector.

Power Entry Connector: Mini DIN

Accessories

PFA-2-LINK Link Kit for Joining Two PFA-2 Units

PFA-2-RM Rack Mount Ear Kit

PFA-2-ACPS

Spare External AC/DC Power Supply (one included with PFA-2 unit)

USB-A/B-6

Locking USB Cable Accessory (72"). Standard (nonlocking) Type A USB connector for host computer to locking Type B USB connector for PFA-2.

Ordering Information

PFA-2-<1>-<H>

Option H: 2-Pole High-Pass Filter

Option 1: Twinaxial Input Connectors

PFA-2 Dual-Channel Filter/Amplifier