

# PRECISION PF-1U-FA

## High Performance 8 or 16-Channel Filter/Amp Systems



### DESCRIPTION

The PF-1U-FA series is a multi-channel programmable filter/amplifier system in a compact rack mountable or bench top package. The PF-1U-16FA is a 16-channel 4 or 8-pole filter/amplifier while the PF-1U-8FA provides 8 channels. Either system is ideal for conditioning low-level voltage inputs in front of high-resolution digital data acquisition systems.

A choice of 4 or 8-pole low-pass filters and 8-pole band-pass filters is available. Cutoff settings from 1 Hz to 204.6 kHz are supported. The low-pass filters may operate in either a “flat” mode for maximally flat pass-band amplitude response with sharp roll-off or in a “pulse” mode for low phase distortion and optimized transient response.

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.

Programmable pre- and post-filter amplifiers provide an overall gain of 2048. 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 post-filter gain has resolution of better than 0.05% to enable system scaling of the outputs to match the full-scale input of the external recording device. Overload detectors alert the user to over-voltage conditions. Precise, automated digital calibration of gain and DC offset are provided.

Other features of the PF-1U-FA include a test input for injection of calibration signals into the channel input and a monitor output that allows for convenient monitoring of any channel output via a single BNC.

The system includes an Ethernet remote interface and is supplied with a Graphical User Interface (GUI) for local control.

### APPLICATIONS

- Anti-Aliasing Filters with Programmable Amplifiers
- Automatic Test Equipment
- Data Acquisition
- Signal Conditioning
- Production Test Equipment
- Industrial Process Control
- Reconstruction Filters
- Programmable Band-Pass Filters

### SALIENT FEATURES

- Number of Channels: 16 (PF-1U-16FA)  
8 (PF-1U-8FA)
- Input Connectors: Individual isolated BNC's at front panel
- Output Connectors: Individual BNC's at rear panel
- Inputs: Balanced differential with programmable AC/DC coupling
- Zero Suppress: Programmable DC voltage is inserted at channel input.
- Pre-Filter Gain: x1 to x128 in x2 steps with input overload detection
- Post-Filter Gain: x0.25 to x16 with 0.05% resolution
- Filters: Choice of 4- or 8-pole low-pass filters or 8-pole band-pass filters.
- Cutoff Frequency: Pulse Mode Programmable from 1 Hz to 102.3 kHz;  
Flat Mode programmable from 2 Hz to 204.6 kHz;  
and wideband (500 kHz)
- Outputs: DC coupled, single-ended
- Test Support: Test input and monitor output busses
- Physical: 1U high, standard 19-inch RETMA width, 19-inch depth
- Input Power: 12 to 24 VDC. External AC-to-DC power supply provided with unit.
- Control: Ethernet remote control. Local control via supplied GUI. Settings held in non-volatile RAM.



PF-1U-16FA Front Panel

## INPUT CHARACTERISTICS

Type: Balanced Differential w/ programmable AC/DC input coupling  
 Input Connector: Individual BNC's at front panel  
 Input Impedance: 10 M $\Omega$  //100pF per side  
 Max Level: (AC + DC + Common Mode)  
 $\pm 10$  Vpk for  $f \leq 200$  kHz  
 $\pm 10$  Vpk x (200 kHz/f) for  $f > 200$  kHz  
 Input Protection: 35 V  
 Offset Drift: 1  $\mu$ V/ $^{\circ}$ C, typical  
 Noise: 7 nV/ $\sqrt{\text{Hz}}$  at 1 kHz and pre-filter gain > 64, typical  
 AC Coupling Freq: 0.25 Hz (-3.01 dB)  
 CMRR (DC Cpld.): 86 dB, DC to 440 Hz and input gain > x8  
 CMRR (AC Cpld.): 80 dB, 10 Hz to 440 Hz

**Input Short:** All 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 external test signal via an external front panel BNC connector.

**Zero Suppress:** (Standard) Precision programmable DC offset is injected at the channel input stage to suppress the DC operating voltage. Manual or automatic suppression modes are supported.

1.28 V Suppress Ranges:

$\pm 0.01$  mV to  $\pm 20$  mV in  
 $\pm 9.77$   $\mu$ V steps  
 $\pm 20.08$  mV to  $\pm 160$  mV in  
 $\pm 78$   $\mu$ V steps  
 $\pm 160.6$  mV to  $\pm 1.28$  V in  
 $\pm 625$   $\mu$ V steps

10.24 V Suppress Ranges (Gain limited to x 256):

$\pm 0.08$  mV to  $\pm 160$  mV in  
 $\pm 78$   $\mu$ V steps  
 $\pm 160.6$  mV to  $\pm 1.28$  V in  
 $\pm 625$   $\mu$ V steps  
 $\pm 1.285$  V to  $\pm 10.24$  V in  $\pm 5$  mV steps

Accuracy:  $\pm 0.25\%$  of setting  $\pm 5$  mV

## AMPLIFIER SPECIFICATIONS

Pre-Filter Gain: x1 to x128 in x2 steps with overload detection (10.2 Vpk threshold)

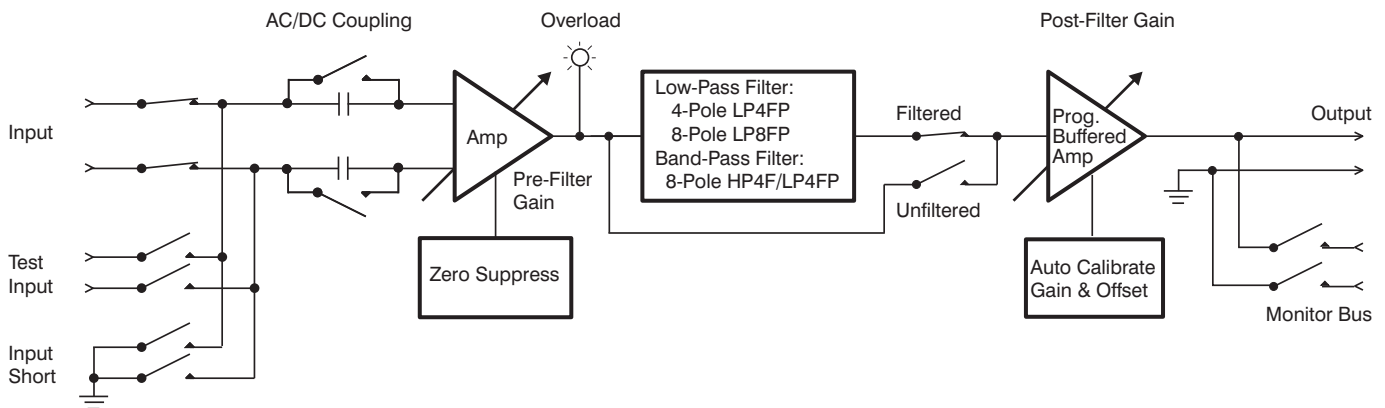
Post-Filter Gain: x0.25 to x16 with 0.05% resolution

DC Accuracy: 0.2% after auto-adjust at any gain setting

Temp. Coef:  $\pm 0.008\%$  / $^{\circ}$ C

DC Linearity:  $\pm 0.01\%$  re: Fullscale, relative to best straight line

Freq. Response: DC to 200 kHz; 0 dB  $\pm 1\%$   
 -3 dB typical at 500 kHz



PF-1U-FA Channel Block Diagram

## FILTER 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).

**Option HP4F/LP4FP:** 8-pole, 8-zero band-pass filter. Flat HP4F 4-pole, 4-zero high-pass filter cascaded with a 4-pole, 4-zero low-pass filter. Low pass filter programmable for maximally flat pass-band (LP4F) or linear phase with optimized pulse response (LP4P).

## FILTER CHARACTERISTICS (Continued)

### 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:  $\pm 0.1$  dB max, DC to 0.8 Fc  
 $\pm 0.2$  dB max, 0.8 Fc to Fc  
Amplitude Match:  $\pm 0.1$  dB max, DC to 0.8 Fc  
 $\pm 0.2$  dB max, 0.8 Fc to Fc  
Phase Match:  $\pm 1^\circ$  max, DC to 0.8 Fc  
 $\pm 2^\circ$  max, 0.8 Fc to Fc

### HP4F:

Amplitude Accuracy:  $\pm 0.1$  dB max, 1.2 Fc to 204.6 kHz  
 $\pm 0.2$  dB max, Fc to 1.2 Fc  
Amplitude Match:  $\pm 0.1$  dB max, 1.2 Fc to 204.6 kHz  
 $\pm 0.2$  dB max, Fc to 1.2 Fc  
Phase Match:  $\pm 1^\circ$  max, 1.2 Fc to 204.6 kHz  
 $\pm 2^\circ$  max, Fc to 1.2 Fc

Bypass: Bypasses filter but not amplifier stages. Each filter may be independently bypassed for the HP4F/LP4FP band-pass filter.

Bypass BW: 500 kHz, typical

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	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	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	1.65/Fc	0.66/Fc	4.03/Fc	1.25/Fc
0.1% Settling Time	2.72/Fc	0.77/Fc	7.02/Fc	2.25/Fc
-0.1 dB Frequency	0.635 Fc	0.182 Fc	0.8538 Fc	0.180 Fc
-1 dB Frequency	0.8487 Fc	0.5741 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

## OUTPUT CHARACTERISTICS

Type: DC coupled, single ended output  
 Output Connector: Individual BNC's at rear panel  
 Impedance:  $10 \Omega // 100 \text{ pF}$   
 Max Output:  $\pm 10 \text{ Vpk}$ ,  $\pm 10 \text{ mA pk}$   
 Offset:  $< 5 \text{ mV}$  after auto-adjust at any gain setting  
 Offset Drift:  $1 \mu\text{V}/^\circ\text{C}$ , RTI +  $150 \mu\text{V}/^\circ\text{C}$  RTO  
 Noise:  $2.8 \mu\text{V rms RTI} + 60 \mu\text{V rms RTO}$   
 3 Hz to 100 kHz  
 Crosstalk:  $-90 \text{ dB}$ , DC to 100 kHz

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

## POWER SUPPLY

PF-1U-FA Input: 12 to 24 VDC provided by supplied external 120 W AC/DC power supply  
 Power Consumption: 75 W, typical  
 External Supply  
 Model Number: PF-1U-ACDC-120W  
 CE/UL Mark  
 Input Power: 110 to 240 VAC, 47-63 Hz

## CONTROL

The PF-1U-FA system may be controlled remotely via an interactive command line interpreter that allows the PF-1U-FA to function as a server on the network.

For local control the PF-1U-FA system is controlled via an Ethernet interface using the supplied spreadsheet-style GUI application running on a Windows PC. The GUI supports control of all channel and system features and allows for group control of channels. Up to eight PF-1U-FA systems can be controlled by one GUI. System settings are restored on power-up or after a power fault. The settings are retained when the computer is disconnected even after a power-down and up. This allows the unit to be pre-configured for an application in which a computer may not be available for control.

## PF-1U SYSTEM PHYSICAL CHARACTERISTICS

Size : 19" x 19" x 1U (1.75") WDH  
 Weight: 11 lb. 6 oz. for PF-1U-16FA system  
 2 lb. 8 oz. for external power supply  
 Ethernet: RJ45 connector at front panel  
 Analog Inputs: Individual BNC's at front panel  
 Analog Outputs: Individual BNC's at rear panel  
 Test Input: BNC at front panel  
 Monitor Output: BNC at rear panel  
 Power Entry: 3-position locking connector  
 Operating Temp: 0 to 40°C  
 Storage Temp:  $-25$  to 85°C

## ACCESSORIES

**1U-RM** 19-inch Rack Mount Kit  
**PF-1U-ACDC-120W** AC to DC external 120 W power supply  
 110 to 240 VAC, 47-63 Hz; CE/UL

## ORDERING INFORMATION

PF-1U-??FA-<LP4FP|LP8FP|HP4F/LP4FP>-<Z>

Zero Suppress (Standard)

Filter Specification  
 4-pole low-pass (LP4FP)  
 8-pole low-pass (LP8FP)  
 8-pole band-pass (HP4F/LP4FP)

8FA 8-Channel Filter Amp  
 16FA 16-Channel Filter Amp



PF-1U-16FA Rear Panel

