Precision PF-1U-FA
8 or 16-Channel Filter/Amplifier Systems

The **PF-1U-FA Multi-Channel Programmable Filter/Amplifier System** is 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 in standard or high-performance models. A choice of 4 and 8-pole filter characteristics is available in low-pass and band-pass configurations. Fully programmable gain is distributed around the filter to reduce the possibility of clipping on out-of-band signals.

**PF-1U-FA Description**

The PF-1UA-FA series is a multi-channel programmable filter/amplifier system in a compact rack mountable or bench top package. Fully programmable 8-channel and 16-channel configurations are available in high-performance or standard configurations with a selection of input connector configurations. For units with BNC input connectors, an optional programmable current source is provided on each channel to interface the PF-1U to IEPE transducers. For applications requiring balanced twisted/shielded cable inputs, an LEMO connector input option is available. Fully programmable input configuration (single-ended or differential) is supported for systems configured with LEMO input connectors.

For units with BNC input connectors, an option 3: Individual isolated LEMO front panel input connectors. Programmable single-ended or balanced differential input.

The standard PF-1U-FA configuration offers 4-pole low-pass filters with five programmable cutoffs and gain programmable to x1,024. The high performance PF-1U-FA offers a choice of 4 or 8-pole low-pass and band-pass filters with cutoffs programmable from 1 Hz to 204.6 kHz. The high performance PF-1U-FA has an upgraded wideband (500 kHz) low-noise amplifier with transducer DC suppress capability. Gain is programmable to x8,192.

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

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 passband 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 waveform analysis.

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.

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 Windows based Graphical User Interface (GUI) for local control.
You want your analog data to come clean before digital conversion.
The PF-1U-FA System has a variety of high performance filter characteristics available for 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 both the 8 and 16-channel systems.

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.

**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.

**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.

**Band-Pass Filters**

For band-pass filtering, choose the HP4F/LP4FP band-pass characteristic to provide programmable bandwidth and center frequency filters.
Operating the PF-1U-FA

System Control
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, allowing the unit to be pre-configured for an application in which a computer may not be available for 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.

Controls, Indicators and Connectors

Front Panel
Analog Input Connectors:
PF-1U-8FA – Eight coaxial BNC Input connectors provide input connection to channels 0 through 7.
PF-1U-16FA – Sixteen coaxial BNC Input connectors provide input connection to channels 0 through 15.
Input Overload Indicators:
Overload LEDs, one above each channel input connector, indicate an input overload condition.
Test Input Connector:
The coaxial BNC Test Input Connector provides a means to connect an external test signal from a programmable function generator to the channel inputs without disconnecting input signal cables.

Warning Indicator:
The Warning LED indicates a system fault such as over temperature or a power voltage out of factory specifications.

Power Switch and Indicator:
The On/Off Power Switch is located on the front panel and includes a Power On LED indicating when the system is powered up.

Ethernet Connector:
The RJ45 Ethernet connector provides the control link for a host computer and includes a Status LED indicating the host is communicating with the system.

Rear Panel
Analog Output Connectors:
PF-1U-8FA – Eight coaxial BNC Output connectors provide output connection to channels 0 through 7.
PF-1U-16FA – Sixteen coaxial BNC Output connectors provide output connection to channels 0 through 15.
Power In Connector:
The Power In Connector provides a connection for an external DC power supply.

Chassis Ground and Signal Ground Posts:
The Chassis Ground post and the Signal Ground post provide a means for coupling the chassis ground to the signal ground.

Monitor Output Connector:
The coaxial BNC Monitor Output connector provides a means for viewing the output of a selected channel using a scope or other measurement device without disconnecting output signal cables.
PF-1U-FA Details and Specifications

**Input Characteristics**

**Type:**
- Balanced Differential w/ programmable AC/DC input coupling

**Input Connector:**
- **Standard:** Individual isolated BNC’s at the front panel.
- **Option 3:** Individual isolated 3-pin (Signal High, Signal Low and Shield) LEMO connector at front panel with programmable single-ended (grounded Signal Low) or balanced differential input configuration. *Note: IEPE (Option I) is not supported with the LEMO option.*

**Input Impedance:**
- 10 MΩ // 100 pF 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:**
- High Performance PF-1U-FA: 25 V, ±5%
- Standard PF-1U-FA: 10 V, ±5%

**Noise:**
- High Performance PF-1U-FA: 7 nV per Hz at 1 kHz and pre-filter gain > 64, typical
- Standard PF-1U-FA: 14 nV per Hz at 1 kHz and pre-filter gain > 64, typical

**AC Coupling Frequency:**
- 0.25 Hz (–3.01 dB)

**CMRR (DC Coupled):**
- 86 dB, DC to 440 Hz and input gain > x16

**CMRR (AC Coupled):**
- 80 dB, 10 Hz to 440 Hz and input gain > x16

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

**Option I – IEPE Current Source:**
- Programmable (IN/OUT) Current Source for IEPE Transducers. When selected, the IEPE option provides an AC coupled, single-ended input with an 6 mA current source. When the IEPE current source is not selected, the PF-1U provides standard filter/amplifier functionality. *Note: Option I may not be ordered with the LEMO option.*

**Current:**
- 6 mA ±10%

**Current Source Compliance Voltage:**
- 26 V, ±5%

**AC Coupling Frequency w/ IEPE Selected:**
- 0.32 Hz ±5%

**IEPE Bias Monitor:**
- When selected, the IEPE transducer DC bias voltage is connected to the amplifier input via a 10x attenuator, allowing this voltage to be monitored at the channel output or at the system output monitor bus BNC connector.

**Zero Suppress (High Performance PF-1U-FA Only):**
- Precision programmable DC offset is injected at the channel input stage to suppress the DC operating voltage. Manual or automatic suppression modes are supported (Standard).

**0.64 V Suppress Ranges:**
- ±0.01 mV to ±10 mV in ±4.88 μV steps
- ±10.04 mV to ±80 mV in ±39 μV steps
- ±80.30 mV to ±0.64 V in ±312 μV steps

**10.24 V Suppress Ranges**
- (Gain limited to x 256):
  - ±0.08 mV to ±160 mV in ±78 μV steps
  - ±160.6 mV to ±1.28 V in ±625 μV steps
  - ±1.285 V to ±10.24 V in ±5 mV steps

**Accuracy:**
- ±0.25% of setting ±5 mV

**Amplifier Specifications (High Performance PF-1U-FA)**

**Pre-Filter Gain:**
- x1 to x512 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%

**Temperature Coefficient:**
- ±0.008%/°C

**DC Linearity:**
- ±0.01% re: Fullscale, relative to best straight line

**Frequency Response:**
- DC to 200 kHz; 0 dB ±0.1 dB; –3 dB typical at 500 kHz

**Amplifier Specifications (Standard PF-1U-FA)**

**Pre-Filter Gain:**
- x1 to x64 in x2 steps with overload detection (10.2 Vpk threshold)

**Post-Filter Gain:**
- x0.5 to x16 with 0.05% resolution

**DC Accuracy:**
- 0.2%

**Temperature Coefficient:**
- ±0.008%/°C

**DC Linearity:**
- ±0.01% re: Fullscale, relative to best straight line

**Frequency Response:**
- DC to 200 kHz; 0 dB ±0.1 dB; –3 dB typical at 190 kHz
**PF-1U-FA Details and Specifications**

**PF-1U-FA 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** *(High Performance PF-1U-FA Only):*
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** *(High Performance PF-1U-FA Only):*
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).

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<tr>
<th>Specification</th>
<th>LP4F</th>
<th>LP4P</th>
<th>LP8F</th>
<th>LP8P</th>
<th>HP4F</th>
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<td><strong>Cutoff Frequencies</strong> (High Performance PF-1U-FA):**</td>
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<tr>
<td>Flat Mode: LP4F, LP8F, HP4F</td>
<td>2 Hz to 2.046 kHz in 2 Hz steps</td>
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<td>Pulse Mode: LP4P, LP8P</td>
<td>2.2 kHz to 204.6 kHz in 200 Hz steps</td>
<td>1 Hz to 1.023 kHz in 1 Hz steps</td>
<td>1.1 kHz to 102.3 kHz in 100 Hz steps</td>
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<td><strong>Cutoff Frequencies (Standard PF-1U-FA):</strong></td>
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<td>LP4F, LP4P, LP8F, LP8P:</td>
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<tr>
<td>Amplitude Accuracy:</td>
<td>±0.1 dB max, DC to 0.8 Fc</td>
<td>±0.2 dB max, 0.8 Fc to Fc</td>
<td>±0.1 dB max, DC to 0.8 Fc</td>
<td>±0.2 dB max, 0.8 Fc to Fc</td>
<td>±0.1 dB max, 1.2 Fc to 204.6 kHz</td>
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<td>Phase Match:</td>
<td>±1° max, DC to 0.8 Fc</td>
<td>±2° max, 0.8 Fc to Fc</td>
<td>±1° max, DC to 0.8 Fc</td>
<td>±2° max, 0.8 Fc to Fc</td>
<td>±1° max, 1.2 Fc to 204.6 kHz</td>
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**Bypass Bandwidth:**
High Performance PF-1U-FA: 500 kHz, typical
Standard PF1U-FA: 190 kHz, typical
**PF-1U-FA Details and Specifications**

**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:**
- High Performance PF-1U-FA: $1 \, \mu \text{V/°C}$, RTI $+ 150 \, \mu \text{V/°C}$ RTO
- Standard PF-1U-FA: $10 \, \mu \text{V/°C}$, RTI $+ 150 \, \mu \text{V/°C}$ RTO

**Crosstalk:** $-90 \, \text{dB}$, DC to 100 kHz

**Noise:**
- High Performance PF-1U-FA: $2.8 \, \mu \text{V rms RTI} + 60 \, \mu \text{V rms RTO}$
- 3 Hz to 100 kHz
- Standard PF-1U-FA: $7 \, \mu \text{V rms RTI} + 100 \, \mu \text{V rms RTO}$
- 3 Hz 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 Requirements**
Power is supplied to the PF-1U-FA from either the external PF-1U-ACDC2-120W, included with each system, or a direct power source. The input power supply requirements are 12 VDC to 24 VDC, 75 W typical, and is applied at the rear panel POWER IN connector. Power supply mating connectors and pigtail mating connectors are available for custom applications. See Accessories on the last page for description and part numbers.

**PF-1U-ACDC2 External Power Supply**
The compact PF-1U-ACDC2-120W AC to DC external power supply features a thermostatically controlled cooling fan and carries the CE/UL listing marks. One PF-1U-ACDC2-120W is supplied with each PF-1U-FA system.

**Input Voltage, Frequency**
- 100-240 VAC, 47 to 63 Hz
- Current
  - 3.2 amp, 100-120 VAC,
  - 2.0 amp, 220-240 VAC

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PF-1U-FA General Characteristics

**PF-1U-FA 8-Channel Filter/Amplifier**
- Size: 19” x 19” x 1U (1.75”) WDH
- Weight: 10 lb. 2 oz. (with rack mount)

**PF-1U-16FA 16-Channel Filter/Amplifier**
- Size: 19” x 19” x 1U (1.75”) WDH
- Weight: 11 lb. 6 oz. (with rack mount)

Operating Temp: 0 to 40°C
Storage Temp: -25 to 85°C

**Power Supply**
- Input: 12 VDC provided by supplied external power supply or 12 to 24 VDC from user supplied DC voltage source
- Power Consumption: 75 W, typical

**PF-1U-FA External Supply**
- Model Number: PF-1U-ACDC2-120W CE/UL Mark
- Weight: 2 lb. 8 oz.
- Input Power: 110 to 240 VAC, 47-63 Hz

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### Accessories

**IN-LEMO3xx:**
- PF pn A10861 consisting of LEMO pn FG.G.1B.303.CYB.D?? (where ?? indicates ferrule size). A set of ferrules for cable O.D. 0.06 to 0.22 inches is provided. Crimp pins accommodate 20, 22 or 24 gage wire (AWG).

**1U-RM 19-inch Rack Mount Kit:**
- Rack Mount Kit provides standard 1U height RETMA rack installation (included with system)

**PF-1U Rubber Feet Kit:**
- The PF-1U Rubber Feet Kit provides non-skid feet for desk or table top installation (included with system)

**PF-1U-ACDC2-120W:**
- AC to DC external 120W power supply 110 to 240 VAC, 47-63 Hz with mating connector; CE/UL approved (included with system)

**Power Supply Mating Connector:**
- Three-pin Combo-D mating connector (Precision Filters P/N A11328G1)

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### 464kB High Density Programmable Switch Matrix

**Computer controlled analog signal switching replaces tedious manual patch panels.**

The 464kB is a reliable solid-state switch matrix system that provides computer-controlled connection between 256 inputs and 256 outputs, all in a single mainframe. 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.