PFI-9602 C Series Module
2-Channel Programmable 6-Pole Filter/Amplifier for Voltage Input

- High-performance analog input/output modules for use in any National Instruments™ CompactDAQ™ or CompactRIO™ chassis
- Provides protection against aliasing in front of NI™ C Series analog to digital converters
- 2 channels per module
- Balanced differential input
- Programmable AC/DC coupling
- Programmable gain, x1 to x3000
- Programmable FLAT/PULSE 6-pole low-pass filter; 10 to 100 kHz programmable bandwidth
- Test bus for system calibration signal injection
- Support for IEPE microphones or accelerometers via optional current source accessory
- –40 to 70°C operating range

Description

Precision Filters, Inc. model PFI-9602 C Series™ module provides two channels of high-performance programmable low-pass filter amplifiers. The module outputs may be connected to a suitable National Instruments™ C Series analog input A/D module to form a complete signal measurement system.

The PFI-9602 amplifier provides precise low-noise and wide bandwidth amplification to low-level voltage signals. The sharp, selective response of the filters allows for lower sampling rates for required alias protection. Outstanding channel-to-channel phase and amplitude match makes the PFI-9602 ideal for applications where time coherence between channels must be maintained.

The PFI-9602 is equipped with a fully programmable 6-pole, 6-zero low-pass filter and a distributed gain amplifier. The low-pass filters may operate either in 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 provides optimal response for applications such as spectral analysis. The “pulse” mode has transient response similar to the Bessel filter yet provides superior amplitude characteristics. The “pulse” mode is ideal for time domain applications including transient (shock) measurements and waveform analysis.

The filter cutoff frequency may be programmed from 10 Hz to 100 kHz in over 200 steps. Gain is programmable from 1 to 3000 and is distributed around the filter to provide protection against large out-of-band energy or transients present in resonant sensors that could cause clipping before the filter, distorting the data. The optional current source accessory allows for direct connection to IEPE microphones or accelerometers.

Applications

- Transient (shock) measurements
- Underwater acoustics and sonar
- Modal analysis and vibration
- Acoustics
- IEPE sensor conditioner
- Anti-aliasing filter
- Reconstruction filter

**Analog Filter:**

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

**Programmable Cutoff Frequencies:**
10 Hz to 1.27 kHz in 10 Hz steps
2 kHz to 127 kHz in 1 kHz steps

**Pass-Band Accuracy:**
±0.1 dB, DC to 0.8 Fc

**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:**
A switch at the channel input allows for automated injection of an external calibration signal via front panel SMB connectors. A second SMB connector allows the test bus signal to be daisy chained across multiple modules.

**Output:**

**Type:**
Single-ended

**Impedance:**
10 Ω || 10 pF

**Max Output:**
±5 Vpk, ±2 mApk

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

**Offset Drift:**
2 μV/°C, RTI + 150 μV/°C RTO

**Crosstalk:**
–80 dB DC to 40 kHz

**Noise:**
4 µVrms RTI + 120 µVrms RTO

**Programming:**

There are two methods of controlling the settings of the PFI-9602.

A) PFI supplied LabView™ Driver VI to control the module from a LabView project.

B) Alternately, stand-alone turnkey signal conditioning systems supplied by Precision Filters can be controlled using PFI executable GUI requiring no software programming. Stand-alone system require use of NI 9146 4-slot or 9149 8-slot chassis.

**Power:**
950 mW maximum

**Isolation:**
60 V DC or AC continuous Bank isolation, channel to earth ground
The PFI-9602 has a flexible high performance 6-pole low-pass filter characteristic that can be optimized for time or frequency domain measurements.

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.

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.

Anti-Aliasing Applications

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

The LP6F may be used to effectively reduce resonant peaking of transducers while maximizing the useable bandwidth.

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.

The LP6F FLAT mode characteristic is less selective and thus requires a higher sampling frequency than the LP6F. 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 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.
### Certifications

- CE, EX European Union Hazardous Locations, ROHS
- Safety Standards: EN 61010-1
- EMC Standards: EN 61326-1
- Hazardous Location Standards: EN 60079-0 & EN 60079-15

### Physical:

- NI C Series Compatible
- Input Connector: 9-pin D sub
- Output Connector: 2 ea. SMB jack
- Test Bus Connector: 2 ea. SMB jack
- Weight: 6 oz.

### Accessories

- **PFI-IEPE-9602 Input Adapter:**
  - 2 ea. Microdot Input Connectors supply 2.5 mA IEPE current source to connected sensor
- **CONN-IN-9D Mating Input Connector** with metal backshell and crimp contacts
- **CONN-IN-9D-SC Mating Input Connector** with metal backshell and solder cup contacts
- **CONN-IN-9D-SCT Mating Input Connector** with metal backshell and screw terminal connections
- **CB-SMB/BNCM-L:** SMB plug to BNC male cable; L = 0.5, 1, 3, 10 feet
- **CB-SMB/PIGTAIL-L:** SMB plug to prepped/tinned leads for NI screw terminal connections; L = 0.5, 1, 3, 10 feet
- **CB-16XSMB/DC37S-L:** 16 SMB plug to DC37 sockets for connection to NI 9220; L = 1, 3 feet
- **CB-SMB/SMB-L:** SMB plug to SMB plug cable for bussing test input; L = 0.5, 1 feet

### Ordering Information

**PFI-9602-<I>**

- Option I: IEPE Current Source (Requires PFI-IEPE-9602 Adapter)
- 2-Channel Filter/Amplifier Module

### PFI-9602 Channel Block Diagram

- Optional PFI-IEPE-9602 Adapter
- Microdot 10-32 Connector
- Input
- IEPE RTN
- Test Input
- Input Short
- 22 V Option I
- AC/DC Coupling 0.25 Hz, Out (DC)
- Programmable LP6F or LP6P Low-Pass Filter
- Overall Gain: x1, 3, 10, 30, 100, 300, 1000, 3000
- Programmable \( f_c \)'s = 10 Hz to 1.27 kHz in 10 Hz steps
  - 2 kHz to 127 kHz in 1000 Hz steps
- Auto Calibrate