**Introduction**

Precision Filters’ family of high-performance signal conditioning modules add unprecedented function and performance to measurement systems built on National Instruments™ C Series platform. Choose from five different modules to measure charge, bridge, dynamic strain, IEPE or voltage-based sensors. With no software to write, you can build a turnkey signal conditioning system front end using the low cost NI™ Ethernet RIO chassis controlled by PFI’s stand-alone Graphical User Interface. Or using the supplied LabView™ module driver VI, you can combine PFI’s signal conditioner modules with proven NI voltage input A/D modules to build a complete high-performance sensor measurement system in any CompactDAQ or CompactRIO chassis. Choose charge, voltage, bridge or dynamic strain modules. Count on PFI’s dependable signal conditioning technology for precise measurements.

All modules are fully programmable and are equipped with Precision Filters’ Test Input for inserting calibration signals at the module input, allowing for full end-to-end verification. Real time sensor parametric health is continuously measured and reported “on-the-fly”.

**Features**

- High performance programmable analog signal conditioning for NI CompactDAQ™ or CompactRIO™ System
- Conditioning for bridge type sensors, piezoelectric (charge mode) sensors, static or dynamic strain gages and others
- PFI Graphical User Interface software for stand-alone signal conditioning system control in low-cost 4 or 8-slot Ethernet RIO chassis
- 2 channels per module for 9102, 9302, 9452 and 9602
- 8 channels per module for 9608
- Up to 100 kHz bandwidth
- Programmable excitation, gain, and filtering
- Built-in hardware for system and sensor verification
- ~-40 to 70°C operating range

**Benefits**

- Integrate signal conditioning with NI A/D modules to build complete CDAQ™ or cRIO™ measurement systems.
- Stand-alone signal conditioning system operation controlled by PFI’s GUI. No software to write.
- Measure load, torque, dynamic or static strain, dynamic force, static or dynamic pressure, vibration and acoustics on NI C Series platform
- Fully programmable gain and excitation to optimize measurements
- Perform quick and easy verification of entire signal chain with Precision Filters’ built-in Test Bus and Sensor Health monitors
- Sharp, programmable low-pass filters provide alias protection for NI analog-to-digital converter modules
- Count on unsurpassed performance for high accuracy measurements

**Applications:**

- Transient shock
- Wind tunnel testing
- Aircraft engine test cells
- Gas turbines for power generation
- Flight tests
- Piezoelectric crash tests
- Automotive
- Underwater acoustics and sonar
- Modal analysis and vibration

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For other test measurement solutions visit our web site at www.pfinc.com or send e-mail to pfinfo@pfinc.com
## PFI-9102 Dual Channel Bridge Conditioner for Pressure/Strain/Vibration/Load Measurements

The PFI-9102 has a fully programmable bipolar excitation supply with remote sense to compensate for voltage drops in the leads to the bridge. Each channel supports measurements for full or half bridges. The module inputs are compatible NI 9944/45 for ¼-Bridge 120 or 350-ohm gage completion for single-arm bridge measurements. On the fly monitoring of sensor excitation and resistance is supported for real time sensor health indication.

A fully programmable gain amplifier is provided for out-of-band noise protection and a precision fixed frequency 100 kHz 3-pole low-pass filter is supplied for alias protection. Calibration signals may be injected at the module input to verify system performance without disconnecting any signal cables.

### Signal Types:
- AC/DC voltage, bridge, static or dynamic strain

### Supported Transducers:
- Static or dynamic strain gages, full bridge pressure, RTD, load cells, accelerometers or any bridge type sensor

### Recommended NI Analog Input A/D Modules:
- 9224/9239, 9228/9229, 9231/9234, 9250/9251

### Interface:
- 2- to 8-wire + shield via RJ50 input connector. Supports full, half, and quarter bridge connections.

### Excitation:
- Programmable constant voltage: 0 to 10 V, in 5 mV steps

### Gain: Programmable x10, 30, 100, 300

### Filter: 3-pole Butterworth low-pass, -3 dB at 100 kHz

### Test Modes:
- Test Input, Input Short, Excitation Monitor, Sensor Resistance Monitor, Shunt Cal, Sensor MUTE, EXC Off

## PFI-9302 Dual Channel Charge Conditioner for Piezoelectric Sensor Measurements

The PFI-9302 C Series module provides two channels of charge mode conditioning for piezoelectric sensors. The module outputs may be connected to any cDAQ or cRIO analog input A/D module for a high-performance vibration measurement system. The low noise, high sensitivity charge input stage combined with programmable gain allows the PFI-9302 to resolve charge signals as low as 0.15 pC while still allowing full scale input charge up to 10,000 pC. The Precision PFI-9302 is compatible with high temperature accelerometers even with accelerometer shunt resistance as low as 100 kOhm.

The PFI-9302 built in “T-Insertion” capability electronically stimulates the attached piezoelectric sensors to output a charge signal. Charge output during T-insertion is dependent on the impedance of the sensor and connecting cable and can be used as a sensor-based test signal for true end-to-end system verification. The PFI-9302 also has built-in shunt calibration; the measured NIST traceable value of the internal shunt calibration capacitor is readable from the PFI-9302 module allowing for in-situ calibration of the PFI-9302 and attached data acquisition system.

### Signal Types: Charge

### Supported Transducers:
- Piezoelectric accelerometers and pressure sensors, including high temperature sensors

### Recommended NI Analog Input A/D Modules:
- 9224/9239, 9228/9229, 9231/9234, 9250/9251

### Interface: BNC input

### Full-Scale Range:
- Programmable 333.3 pC, 1,000 pC, 3,333 pC, 10,000 pC

### Filter: 3-pole Butterworth low-pass, -3 dB at 100 kHz

### Test Modes: T-Insert, Shunt Cal

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### High-Performance Signal Conditioning Modules Selection Guide

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<th>Interface</th>
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<tr>
<td>PFI-9102</td>
<td>AC/DC Voltage, Bridge, Static</td>
<td>Static or dynamic strain, pressure, RTD, load, accel, AC/DC filter/amp, any bridge type sensor</td>
<td>2- to 8-wire + shield via RJ50 input</td>
<td>Programmable Constant Voltage: 0 to 10 V, in 5 mV steps. 10 mA source current</td>
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<td>PFI-9302</td>
<td>Charge</td>
<td>Grounded or floating piezoelectric accels and pressure sensors, including high temp sensors</td>
<td>BNC</td>
<td>N/A</td>
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<td>PFI-9452</td>
<td>Dynamic Strain</td>
<td>Dynamic strain gages</td>
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<td>PFI-9602</td>
<td>Programmable Filter</td>
<td>AC/DC voltage, IEPE accels and microphones</td>
<td>2-wire + shield via DE9 male</td>
<td>IEPE: 2.5 mA (Option I) Requires PFI-IEPE-9602 Adapter.</td>
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<td>PFI-9608</td>
<td>Programmable Filter</td>
<td>AC/DC voltage inputs</td>
<td>2-wire + shield via 37-pin D-sub male</td>
<td>N/A</td>
</tr>
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High-Performance Signal Conditioning Modules Selection Guide

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<td>3-pole Butterworth Low-Pass</td>
<td>100 kHz</td>
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<td>PFI-9302</td>
<td>100 kHz</td>
<td>333.3 pC, 1,000 pC, 3,333 pC, 10,000 pC</td>
<td>3-pole Butterworth Low-Pass</td>
<td>100 kHz</td>
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<tr>
<td>PFI-9452</td>
<td>100 kHz</td>
<td>x10, 30, 100, 300</td>
<td>3-pole Butterworth Low-Pass</td>
<td>100 kHz</td>
<td>Test Input, Input Short, Excitation Monitor, Sensor Resistance Monitor, Shunt Cal, Sensor MUTE, EXC Off</td>
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<td>PFI-9602</td>
<td>127 kHz</td>
<td>x1, 3, 10, 30, 100, 300, 1,000, 3,000</td>
<td>Programmable 6-pole Flat/ Pulse Low-Pass</td>
<td>10 Hz to 1.27 kHz in 10 Hz steps; 2 kHz to 127 kHz in 1 kHz steps</td>
<td>Test Input, Input Short, Sensor Resistance Monitor, Shunt Cal, Sensor MUTE</td>
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<tr>
<td>PFI-9608</td>
<td>Up to 30 kHz</td>
<td>Unity Gain</td>
<td>Programmable 4-pole Flat/ Pulse Low-Pass</td>
<td>FX06: 10, 30, 100, 300, 1,000 Hz FX02: 300 Hz, 1, 3, 10, 30 kHz</td>
<td>Test Input, Input Short</td>
</tr>
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</table>

PFI-9452 Dual Channel Dynamic Strain Conditioner with Balanced Constant Current™ (BCC™) Technology

The measurement of dynamic strain using a single active strain gage is commonly performed using a Wheatstone bridge. The Wheatstone bridge topology can be problematic for measurements using long cable runs since the cable resistance will cause potentially large measurement errors. The circuit is also highly susceptible to electrostatic noise pickup. In high temperature environments, cable resistance uncertainty precludes the use of the Wheatstone bridge circuit.

Precision Filters developed and perfected BCC for measuring dynamic strain. The technique is insensitive to cable resistance, provides a balanced connection to the strain gage for reduced electrostatic noise pickup and requires only two wires to connect to the strain gage. Balanced Constant Current is widely used for making dynamic strain measurements on rotating machinery. It is also used for shock and vibration measurements using shaker tables, wind tunnels, vehicle and aircraft survivability and many other applications that require the measurement of dynamic strain.

**Signal Types:** AC strain

**Supported Transducers:** Dynamic strain gages

** Recommended NI Analog Input A/D Modules:**
9224/9239, 9228/9229, 9231/9234, 9250/9251

**Interface:** 2-wire plus shield via 9-pin D-sub input connector

**Excitation:**
Programmable Balanced Constant Current: 0 to 10 mA in 100 µA steps

**Gain:** Programmable x10, 30, 100, 300

**Filter:** 3-pole Butterworth low-pass, -3 dB at 100 kHz

**Test Modes:**
Test Input, Input Short, Excitation Monitor, Sensor Resistance Monitor, AC Current, Sensor MUTE

PFI-9602 Dual Channel and PFI-9608 Octal Channel Programmable Filters

The PFI-9602 dual channel module is equipped with a fully programmable 6-pole, 6-zero low-pass filter and a distributed gain amplifier. The PFI-9608 is a high-density 8-channel unity gain programmable 4-pole, 4-zero low-pass filter module. Many sampling A/D converters are not equipped with low-pass filters to band limit the spectrum and are prone to aliasing. The sharp frequency responses of the 9602 or 9608 make them ideal for use as an anti-aliasing filter front end to sampling A/D converters that lack alias protection, such as the NI 9220. The low-pass filters may operate either in a “flat” mode for maximally flat passband amplitude response with sharp roll-off or in a “pulse” mode for low phase distortion and optimized transient response. Outstanding channel-to-channel phase and amplitude match makes these filters ideal for applications where time coherence between channels must be maintained.

The PFI-9602 amplifier adds precise, low-noise, wide bandwidth amplification of up to x3000 for low-level voltage input signals. The optional 9602 current source accessory allows for direct connection to IEPE microphones or accelerometers.

**Signal Types:** AC/DC voltage, IEPE (9602), externally excited bridge

**Supported Transducers:** AC/DC voltage (differential or single-ended), IEPE accelerometers and microphones (9602 only)

**Recommended NI Analog Input A/D Modules:**
9201, 9205, 9215, 9220, 9222/9223, 9228/9229, 9231/9234, 9250/9251

**Interface:** 2-wire plus shield

**Gain:**
9602: Programmable x1, 3, 10, 30, 100, 300, 1,000, 3,000
9608: Unity gain

**Filter:**
9602: 6-pole Flat/Pulse low-pass filter with over 200 programmable cutoffs from 10 Hz to 127 kHz
9608: 4-pole Flat/Pulse low-pass filter with 5 programmable cutoffs up to 30 kHz

**Test Modes:** Test Input, Input Short, Sensor MUTE
**Building C Series Measurement System**

1. Choose National Instruments CompactDAQ or CompactRIO Chassis

2. Choose Precision Filters Hot Swappable Signal Conditioning Modules

3. Connect PFI Module Outputs to NI Voltage Input Digitizer Modules

4. Control with National Instruments LabVIEW Software

**Building Stand-Alone Turn-Key Signal Conditioning System**

1. Choose National Instruments Ethernet RIO 9147 4-Slot or 9149 8-Slot Chassis

2. Mix and Match Precision Filters Hot Swappable Signal Conditioning Modules

3. Connect Inputs to Sensors Outputs to Preferred DAS

4. Control with Precision Filters GUI for Ethernet RIO – No Software to Write