



## Precision 28114 Quad-Channel Transducer Conditioner with Voltage and Current Excitation

**28114 Quad-Channel Transducer Conditioner with Voltage and Current Excitation** offers four channels of conditioning to support a wide variety of transducers including those that require constant voltage excitation or constant current excitation. Balanced constant voltage excitation in a bridge configuration supports applications such as strain gages and pressure transducers. Balanced current excitation accommodates single arm static or dynamic strain gages, RTDs or other resistive transducers that require constant current to excite them. Gain is programmable to x1024.



### Overview

## 28000 Analog Signal Conditioning System

*The new standard for the world's most discriminating test labs.*



The Precision 28000 signal conditioning system provides all the flexibility you need to manage your test measurements.

The Precision 28000 makes it easy to manage a test, with hundreds of channels and a mix of transducers. Choose charge, IEPE w/TEDS, voltage (filter amplifier), strain, thermocouple, RTD, potentiometer, current, frequency, or other transducers.

The built-in test hardware and software (optional) provide quick Go/No-Go tests, which can be run before each test, and rigorous Factory Acceptance Tests to assure you that the 28000 meets your most stringent requirements for critical applications. It won't be long before these tests earn a permanent place in your maintenance routine. And since they are traceable to NIST, they eliminate the need for off-site calibration.

In every phase of your tests—record keeping, installation, design, set-up, operation, maintenance, and upgrading—the Precision 28000 offers ways to help you save time and money over the life of the system.

### 28000 System Features

- Graphical user interface (GUI) and Ethernet network interface for system control
- Intelligent gain and system scaling algorithms
- Test input and output monitor busses
- Go/No-Go test with diagnostics to be used before tests
- Rigorous Factory Acceptance Test for maintenance
- Field-swappable AC power supplies
- Built-in temperature and power supply monitoring with alarms

### 28114 Applications

- Static, Dynamic or Transient Testing
- Turbine and Rocket Engine Test Stands
- Wind Tunnels
- Energetic Shock, Explosive, Ordnance Testing
- Structural Shock and Vibration Testing

### Sensor Applications

- Static or dynamic strain gage conditioner
- Full bridge conditioner
- Pressure transducer conditioner
- Piezoresistive accelerometer conditioner
- RTD conditioner
- Thermocouple
- Amplifier
- Load cell conditioner
- MEMS transducer conditioner
- Hot wire anemometry
- AC or DC filter/amplifier (<1 mV to 10 V inputs)

### Precision 28114 Features

- Four channels per card, 64 channels per 28016 chassis
- Balanced programmable constant voltage excitation with remote sense – up to 20 V delivered to the bridge
- Balanced differential constant current excitation (20 mA/20 V compliance) with AC current test mode for verifying transducer, cabling and frequency response
- On-the-fly report of measured transducer excitation and resistance
- Transducer open/short indication
- Transducer leakage to ground detection
- Automatic bridge balance/transducer suppress
- Up to 30 kHz “filtered” bandwidth or 190 kHz “wide-band” bandwidth
- 2 to 10-wire plus shield bridge input interface
- 2 or 4-wire input plus shield transducer interface with constant current excitation
- Programmable AC/DC input coupling
- Programmable gain: x1/16 to x1024 with 0.05% vernier
- 4-pole low-pass filters with programmable pulse/flat characteristics
- Overload detection
- Precise digital calibration
- Programmable 5000 step (BC6 completion module) or single step (BC7 completion module) bipolar shunt cal
- Programmable bridge configuration w/BC?: 1-arm, 2-arm or 4-arm bridges
- Programmable bridge resistance w/BC?: 120 Ω, 350 Ω or 1 kΩ
- Front panel connectors that accept output adapter modules for multiple buffered outputs per channel

# Precision 28114 Description

## Precision 28114 Description

The 28114 is a member of the Precision 28000 family of signal conditioners. The 28114 provides four channels of conditioning for transducers requiring constant current or constant voltage excitation. Up to sixteen 28114 cards may reside in the 28000 system to provide 64 channels per chassis. In addition, the 28114 may be mixed with other conditioners in the 28000 family to meet your unique signal conditioning requirements.

Large changes in sensor impedance or sensor excitation can indicate that data from this sensor is no longer meaningful. The unique transducer health monitor circuits of the 28114 provide an "on-the-fly" report of measured sensor excitation and resistance. Measured gage resistance is compared to user specified limits and flagged if out of tolerance. Also, the 28114 alerts the user to a transducer open or short condition. The input overload detector reports overloads by out-of-band signals which could cause in-band distortion.

Programmable bridge configuration and shunt calibration are supported on all four channels of the 28114 card via the optional BC plug-on module. The BC6 or BC7 modules support programmable bridge configuration for quarter, half or full bridges and programmable completion for 120  $\Omega$ , 350  $\Omega$  or 1 k $\Omega$  bridges. The BC6 provides over 5000 steps of bipolar shunt calibration while the BC7 has bipolar single-step precision resistor shunt cal. Dedicated shunt cal lines are provided that allow the user to perform the shunt cal on non-current carrying leads.

## Balanced Constant Voltage Excitation

The 28114 provides balanced constant voltage excitation of up to 20 volts and conditioning for 1-, 2-, and 4-arm resistive bridges. The 28114 features automatic calibration of gain and offset for the entire channel, including the amplifier, filter, and excitation supply. The 2- to 10-wire input connection provides 6 wires for the bridge, 3 wires for shunt calibration, 1 wire for the shield, and 1 wire for single-arm bridges. Automatic balance of the bridge is accomplished by inserting a voltage ratiometric with the excitation supply to the amplifier input stage. This balance method provides outstanding stability without loading the bridge. A wide range of unbalanced conditions may be accommodated.

Balanced constant voltage excitation offers a number of advantages over single-ended excitation. It enables a true balanced instrumentation amplifier input for outstanding rejection of high frequency common mode signals. Single-ended voltage excitation to balanced bridges produces a relatively large common mode voltage at half the excitation supply. The instrumentation amplifier must reject this signal. Balanced voltage excitation applied to balanced bridges results in lower common mode input voltages to the amplifier input stage.

The excitation supply has automatic amplitude and offset correction that may be run on the unit in place at any time. Dedicated remote sense lines allow the excitation supply regulator to deliver an accurate voltage to the bridge.

## Balanced Constant Current Excitation™

The 28114 is equipped with Precision Filters' proprietary balanced differential constant current excitation that is optimized for making dynamic strain measurements on single active strain gages. Balanced constant current excitation provides an accurate means of measuring dynamic strain with a single active strain gage using only a two-wire connection. Electrostatic pickup is reduced when compared to single-ended constant current excitation or a quarter bridge configuration with remote completion resistors or unbalanced current sources. The balanced current excitation circuit operates properly even under certain common gage fault conditions such as a direct short of the gage to the test model.

Balanced constant current excitation provides a true balanced input for rejection of common-mode signals. Programmable excitation provides 0 to  $\pm 20$  mA of constant current with an "excitation off" mode to detect input cable noise pickup. Gage open/short detection is also provided.

For dynamic strain conditioning applications, the 28114 can provide accurate measurements with only two wires by AC coupling the input. For best AC or DC measurements (required for RTD type transducers), the 28114 provides a 4-wire Kelvin connection for remote sense. Constant current excitation may be applied to full bridge applications with the advantage that excitation delivered to the bridge is unaffected by excitation supply lead wire resistance.

Suppression of the gage DC operating point is performed automatically using the zero suppress feature of the 28114. Zero suppress allows the use of more gain to emphasize small gage fluctuations. Zero suppress also provides the user with an accurate means to balance a full bridge.

The excitation current source output may be modulated to allow AC current injection in the loop. The frequency and amplitude of the AC current is user controlled. This allows the user to simulate changes in gage resistance in the loop and provides direct AC input stimulation to the signal conditioner for end-to-end system calibration.

## Input Stage

The 28114 balanced differential input stage may be either AC or DC coupled. AC coupling is useful for dynamic applications where the DC bias on the transducer, that can limit dynamic range, can be coupled out of the signal. The input stage may be shorted under program control to verify signal conditioner channel noise and DC offsets.

A switch at the input stage is provided to connect the amplifier to the 28000 system test bus. The test bus is used to inject signals for performance verification. In addition, both drive and sink current levels may be monitored separately making it possible to detect excitation current leakage conditions in the external current loop.

## Amplifier and Filter

Programmable pre- and post-filter amplifiers provide an overall gain of 1024. 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 Gain Wizard in the GUI allows the user to set a gain reserve and then apportions the gain between the input and output. This provides input gain for best noise performance yet conforms to the limitations of the user's worst case estimate of out-band or transient signals. Overload detectors alert the user to over-voltage conditions. A fully buffered output having over 20 mA of drive capability may be used to drive long output cable runs.

The 28114 is specified with a 4-pole low-pass filter with five programmable cutoffs. In addition, the filter may be programmed to "flat" or "pulse" mode. 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

## 28114 Programmable Features

- Constant voltage excitation level: 0 to 20.475 V in 5 mV steps
- Constant current excitation level: 0 to 20.475 mA in 5  $\mu$ A steps
- Expected transducer resistance and tolerance
- Voltage excitation sense: instrument or gage
- Current excitation input interface: 2-wire or 4-wire
- Bridge configuration: 1-arm (2-wire), 1-arm (3-wire), 2-arm or 4-arm
- Bridge resistance: 120  $\Omega$ , 350  $\Omega$  or 1 k $\Omega$
- Shunt cal: instrument or gage
- Shunt cal resistance and shunt arm: R1 or R2
- Automatic balance/suppress
- AC/DC input coupling
- Test modes: amp short, excitation off, test bus (voltage substitution), shunt calibration, AC current, excitation monitor
- Output monitor
- Gain: x1/16 to x1024 with 0.05% resolution
- Filter type: pulse or flat
- Cutoff frequency:  
FX02: 300 Hz, 1 kHz, 3 kHz, 10 kHz, 30 kHz
- Wide-band (190 kHz) or filtered operation

## 28114 Graphical User Interface Display

All programmable features in addition to:

- On-the-fly excitation monitor
- On-the-fly sensor resistance monitor with pass/fail status
- Sensor open or short indication
- Configuration read back
- Balance/Suppress status
- Input wiring
- Transducer sensitivity
- System scaling in engineering units
- Overload status
- Intelligent gain algorithm
- Group control

# 28114 Details and Specifications

## 28114 Conditioner Cards

The detailed description and specifications for the 28114 are organized as follows in the sections below:

- Card Model Number Structure
- Programmable Bridge Configuration Module
- Bridget Wiring
- Excitation Supply
- Input Characteristics
- Amplifier Characteristics
- Test Modes
- Filter Type Characteristics
- Output Characteristics
- General Characteristics
- Accessories
- Ordering Information

## Programmable Bridge Configuration Modules

### Constant Voltage Excitation Mode:

The optional BC plug-on bridge configuration modules provide support for programmable bridge configuration. In addition, the BC6 and BC7 modules support programmable shunt calibration for all four channels on the 28114 card when using constant voltage excitation. The BC8 module provides conditioning for modulated current output transducers, such as those with 4-20 mA outputs.

All completion modules may be programmed to support 1-arm, 2-arm or 4-arm (quarter, half or full) bridge configurations. Completion resistance is programmable for 120  $\Omega$ , 350  $\Omega$  or 1 k $\Omega$ . Completion resistors are metal foil technology and are very precise and very stable.

The BC6 shunt calibration utilizes voltage insertion at the bridge, providing over 5000 steps of single shunt calibration of bridge arms R1 or R2. The user may program the shunt to be applied at the gage (if additional cable wires are used) or at the instrument. Shunt sensitivity is set by a precision resistor on the BC6 card and is programmable from  $\pm 125 \mu\text{V}$  per V of programmed excitation to  $\pm 8 \text{ mV/V}$  in 0.2% resolution. The effective range of shunt resistor values is 30.75 to 2000 times the bridge programmed bridge resistance. The BC6 shunt calibration may only be used in conjunction with constant voltage excitation.

The BC7 provides traditional single-step bipolar shunt cal using a precision resistor. Single shunt of either R1 or R2 bridge arms may be selected. The standard BC7 shunt cal supplied with 120  $\Omega$ , 350  $\Omega$  and 1 k $\Omega$  cards produces 1 mV/V single shunt. Custom shunt resistor values may be specified.

The BC8 supports 2-wire or 4-wire connections to modulated current output devices that require a constant voltage power supply to excite them and provide a current output proportional to the measurement units. This includes sensors with 4-20 mA outputs. The BC8 switches a 250 ohm resistor across the amplifier input to measure the sensor current output.

The BC9 completion module supports programmable bridge completion only.

### Constant Current Excitation Mode:

When using constant current excitation, the bridge configuration modules provide programmable configuration of 2-wire or 4-wire input mode. 2-wire mode is useful for dynamic strain measurements where the input stage of the amplifier is AC coupled. The 4-wire mode may be used to make static measurements with a Kelvin connection to the gage. The 28114 zero suppress circuit can be used to zero the transducer bias when operating in the 4-wire configuration. The wide range of the zero-suppress circuit can accommodate large transducer bias voltages.

## Bridge Configuration Module Specifications:

### Completion Resistors:

120  $\Omega$ , 350  $\Omega$  and 1 k $\Omega$ , programmable

### Bridge Configuration:

1-arm, 1-arm w/ 3 wires, 2-arm or 4-arm, (programmable)

### Resistor Temperature Coefficient:

$\pm 0.2 \text{ ppm} / ^\circ\text{C}$

### Resistor Accuracy:

$\pm 0.02\%$

## BC6 Shunt Calibration (Constant Voltage Excitation Mode Only):

### Shunt Selection:

R1 or R2 bridge arms

### Equivalent Shunt Resistance Settings:

30.75R to 2000R w/ 0.2% minimum resolution where R = 120  $\Omega$ , 350  $\Omega$  or 1 k $\Omega$

### Shunt Sensitivity:

$\pm 0.125 \text{ mV/V}$  to  $\pm 0.5 \text{ mV/V}$   
in  $\pm 0.25 \mu\text{V/V}$  steps  
 $\pm 0.501 \text{ mV/V}$  to  $\pm 2.0 \text{ mV/V}$   
in  $\pm 1.00 \mu\text{V/V}$  steps  
 $\pm 2.004 \text{ mV/V}$  to  $\pm 8.0 \text{ mV/V}$   
in  $\pm 4.00 \mu\text{V/V}$  steps

### Shunt Accuracy:

$\pm 0.2\%$  for programmed excitation  $> 1 \text{ V}$

## BC7 Shunt Calibration:

### Shunt Selection:

R1 or R2 bridge arms

### Shunt Sensitivity:

$\pm 1 \text{ mV}$  per volt of programmed excitation

### Shunt Resistance:

29.940 k $\Omega$  for 120  $\Omega$  bridge  
87.325 k $\Omega$  for 350  $\Omega$  bridge  
249.5 k $\Omega$  for 1 k $\Omega$  bridge

### Resistor Accuracy:

$\pm 0.1\%$

## BC8 Current Sense:

### Modes:

2-wire sense or 4-wire sense

### Sense Resistor:

250 ohms  $\pm 0.1\%$

## Bridge Wiring

### Input Connector:

26-pin D-shell (2 ea.)

### Input Wires:

$\pm$ EXCITATION (2)  
 $\pm$ SENSE (2)  
 $\pm$ SIGNAL (2)  
SHUNT CAL (3)  
 $\frac{1}{4}$  Bridge RTN (1) Single Arm Bridge  
SHIELD (1)

# 28114 Details and Specifications

## 28114 Excitation Supply

### Programmable Constant Voltage Excitation

**Maximum Output:**  
20.475 V, 30 mA (balanced)

**Steps:**  
Programmable from 0 to 20.475 in 5 mV steps

**Excitation Sense:**  
Programmable (instrument or gage sense)

**Accuracy:**  
 $\pm 0.03\%$ ,  $\pm 500 \mu\text{V}$

**Noise:**  
100  $\mu\text{Vrms}$ , 3 Hz to 200 kHz

**Temperature Drift:**  
 $\pm 0.0025\%/^{\circ}\text{C}$  of setting or  $\pm 50 \mu\text{V}/^{\circ}\text{C}$ , whichever is greater

**Sense Leakage Current:**  
Less than 10  $\mu\text{A}$

**Calibration:**  
Automatically calibrated for gain and offset. Calibration initiated at the GUI panel.

**Excitation Off:**  
The excitation supply is programmed to 0 volts.

## 28114 Constant Current Excitation Supply

**Type:**  
Balanced differential constant current excitation

**Excitation:**  
0 to 20.475 mA in 5  $\mu\text{A}$  steps

**Total Gage Voltage (Volts):**  
22 –  $I \times 700$  minimum

**Input Impedance:**  
100 k $\Omega$  nominal per side

**CMRR (DC to 1 kHz):**  
80 dB for 120  $\Omega$  gage  
70 dB for 350  $\Omega$  gage  
60 dB for 1 k $\Omega$  gage

**Initial Accuracy:**  
0.05%, 5  $\mu\text{A}$

**Temperature Drift:**  
30 nA + 0.0024% of setting per  $^{\circ}\text{C}$

**Noise:**  
65 pA/ $\sqrt{\text{Hz}}$  at 1 kHz

**Bandwidth:**  
 $\pm 0.2$  dB to 200 kHz (RGAGE <1 k $\Omega$ )

## 28114 MUTE Mode

In harsh test environments, a sensor or input cable can become faulty or intermittent during a critical test. With high gain signal conditioning this can be troublesome if large signal swings on input or output cabling cross couple to other channels. The 28114 Mute control places the channel in the quietest operational state to minimize system noise in the event of a failed sensor. The Mute Mode is also useful to terminate unused channels in a safe and quiet state.

## 28114 Transducer Health Monitor

**Sensor Excitation Monitor:** Transducer excitation voltage or current is monitored and reported to the user on-the-fly. Measured excitation is compared to factory set tolerance and GUI indicators report if out of tolerance.

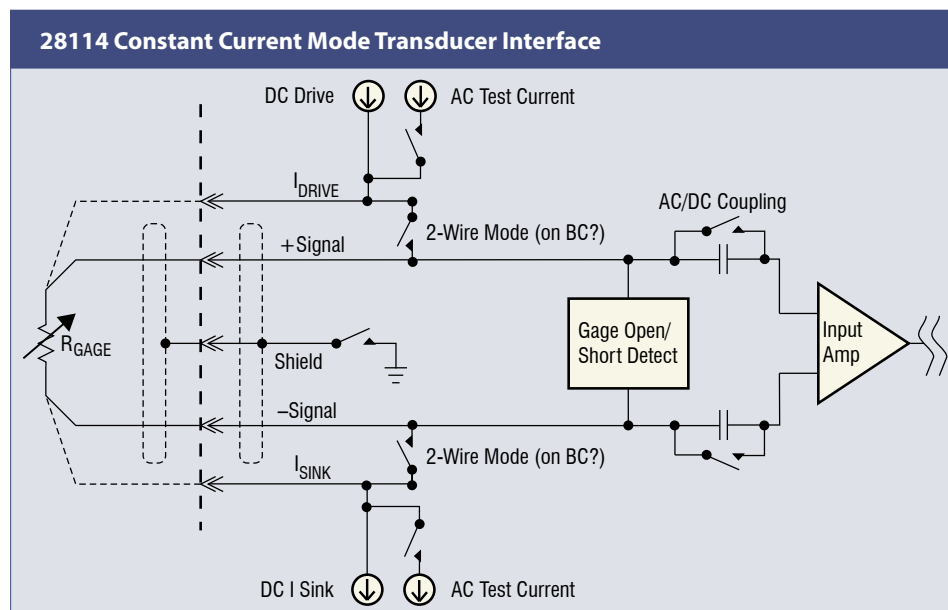
**Sensor Resistance Monitor:** Transducer resistance is monitored on-the-fly and compared to user defined limits. GUI indicators report if sensor resistance is out of user tolerance.

**Sensor Open/Short Monitor:** Transducer open or short condition is monitored and reported to the user via GUI indicators.

**Sensor Leakage Monitor:** Sensor leakage resistance to ground is measured and recorded.

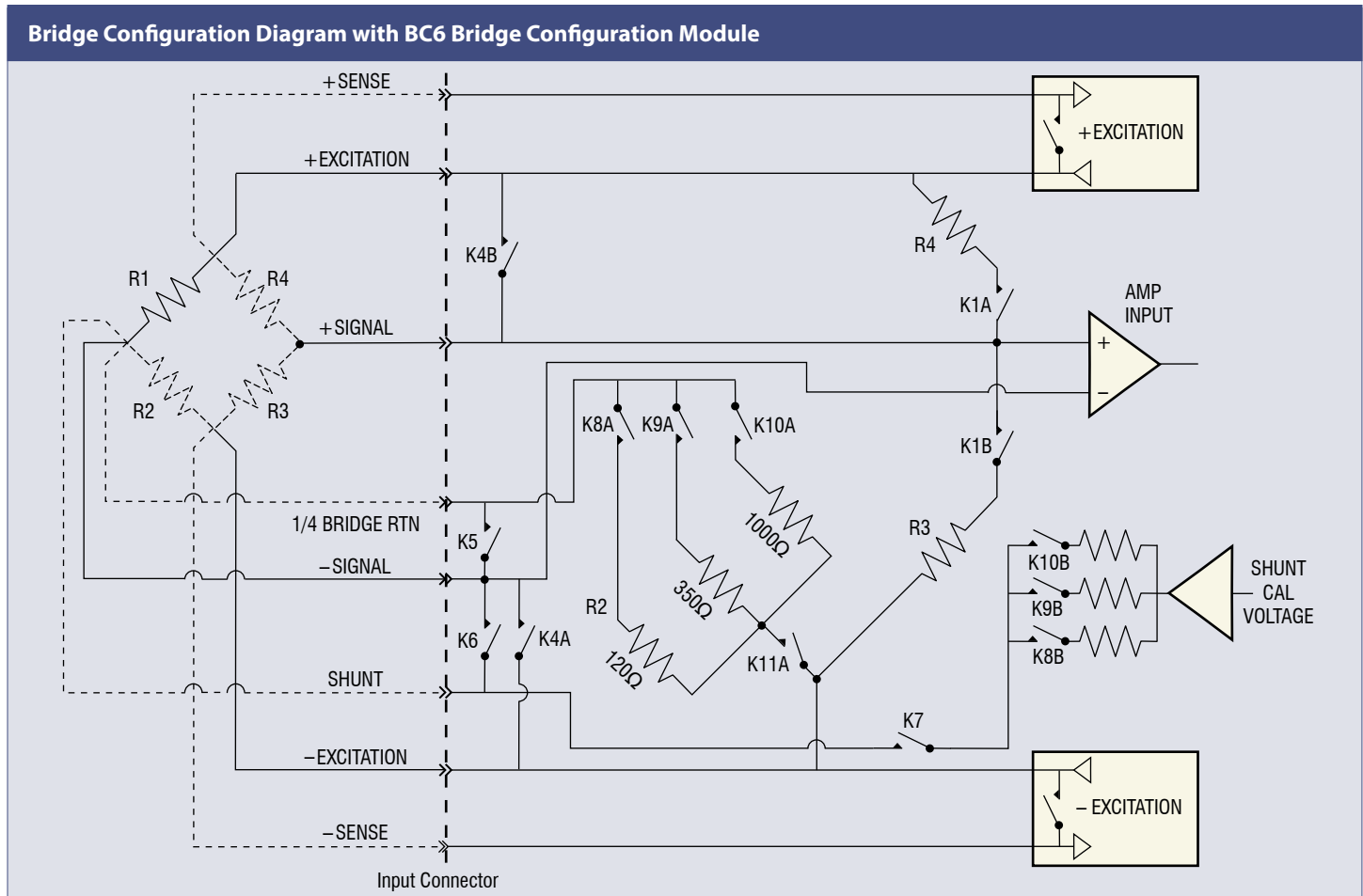
**Excitation Current Limit:** Current limit protection is provided by the 28114 excitation supply. Possible causes of current limit are an incorrect excitation setting or a shorted transducer. Current limit indicators are provided in the GUI.

**Excitation Thermal Shutdown:** The excitation supply regulator die temperature is continuously monitored and will shut down should the temperature reach a level where damage to the excitation supply may occur. Thermal shutdown indicators are provided in the GUI.





# 28114 Details and Specifications



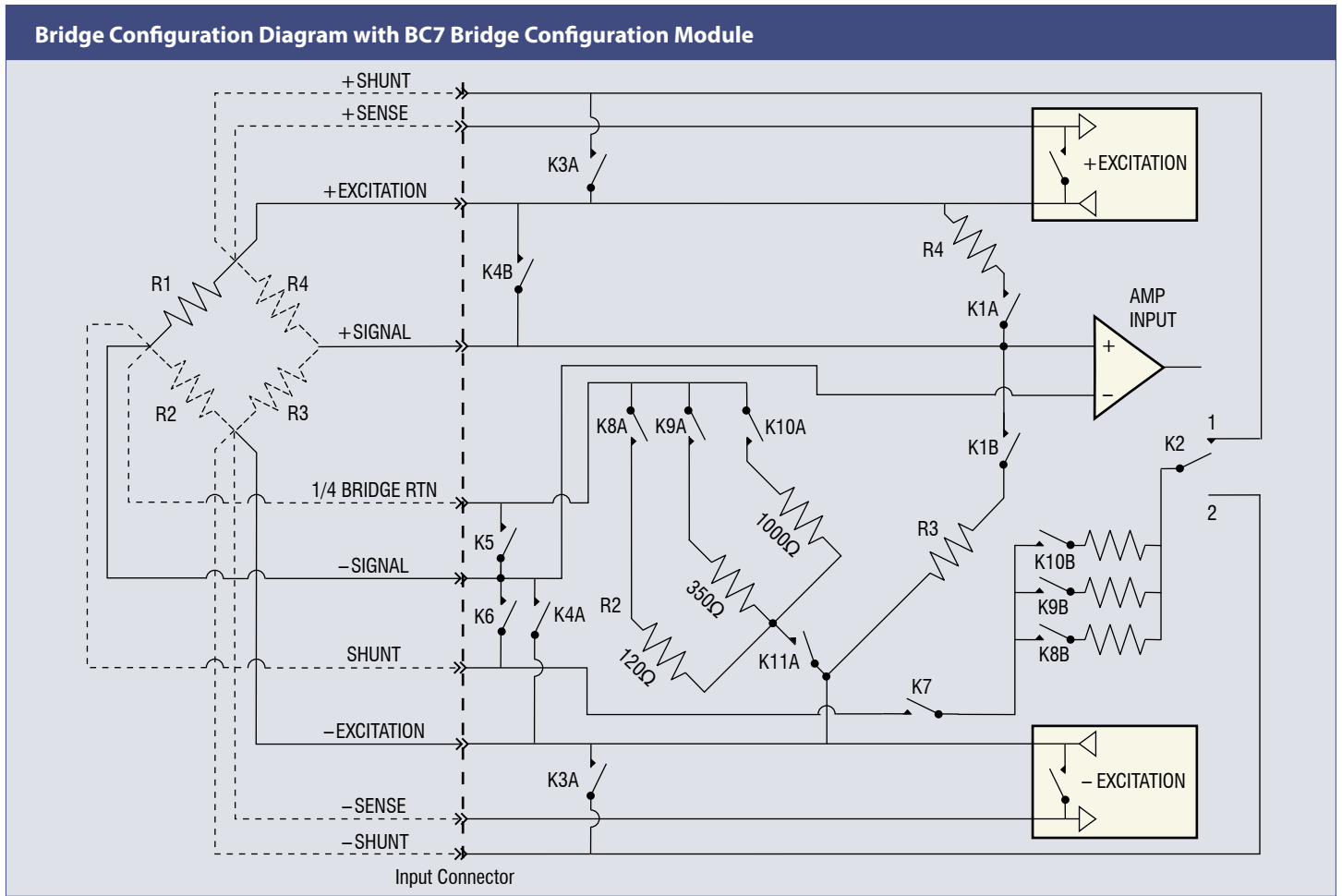
## Truth Table

Configuration	K1	K4	K5	K6	K7	K8	K9	K10	K11
¼ Bridge, 2-Wire	IN		IN			IN <sup>1</sup>	IN <sup>1</sup>	IN <sup>1</sup>	IN
¼ Bridge, 3-Wire	IN		OUT			IN <sup>1</sup>	IN <sup>1</sup>	IN <sup>1</sup>	IN
½ Bridge	IN					OUT	OUT	OUT	OUT
Full Bridge	OUT					OUT	OUT	OUT	OUT
120 Ohm Completion						IN	OUT	OUT	IN
350 Ohm Completion						OUT	IN	OUT	IN
1000 Ohm Completion						OUT	OUT	IN	IN
Shunt Cal Gage				OUT	IN				
Shunt Cal Instrument				IN	IN				
Constant Current 2-Wire		IN							
Constant Current 4-Wire		OUT							

<sup>1</sup> One switch selected at a time.

28114 with BC6 Bridge Configuration Module

# 28114 Details and Specifications



**Truth Table**

Configuration	K1	K2	K3, K6	K4	K5	K7	K8	K9	K10	K11
¼ Bridge, 2-Wire	IN				IN		IN <sup>1</sup>	IN <sup>1</sup>	IN <sup>1</sup>	IN
¼ Bridge, 3-Wire	IN				OUT		IN <sup>1</sup>	IN <sup>1</sup>	IN <sup>1</sup>	IN
½ Bridge	IN						OUT	OUT	OUT	OUT
Full Bridge	OUT						OUT	OUT	OUT	OUT
120 Ohm Completion							IN	OUT	OUT	IN
350 Ohm Completion							OUT	IN	OUT	IN
1000 Ohm Completion							OUT	OUT	IN	IN
Shunt Cal Gage			OUT			IN				
Shunt Cal Instrument			IN			IN				
Shunt R1		1				IN				
Shunt R2		2				IN				
Constant Current 2-Wire				IN						
Constant Current 4-Wire				OUT						

<sup>1</sup> One switch selected at a time.

# 28114 Filter Characteristics

You want your analog data to come clean before digital conversion.

## Flat/Pulse Low-Pass Filters

Our LP4FP 4-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 many 28000 card models.

## Flat Mode Low-Pass Filters

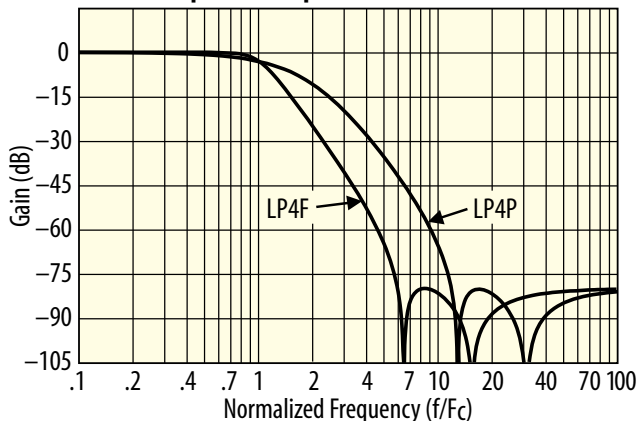
Precision LP4F "flat" mode characteristics are specified to have outstanding passband flatness equivalent to the Butterworth yet deliver very sharp roll-off characteristics.

The LP4F is a good choice as an anti-aliasing filter and for applications such as spectral analysis. The LP4F has zero passband ripple and roll-off superior to the Butterworth.

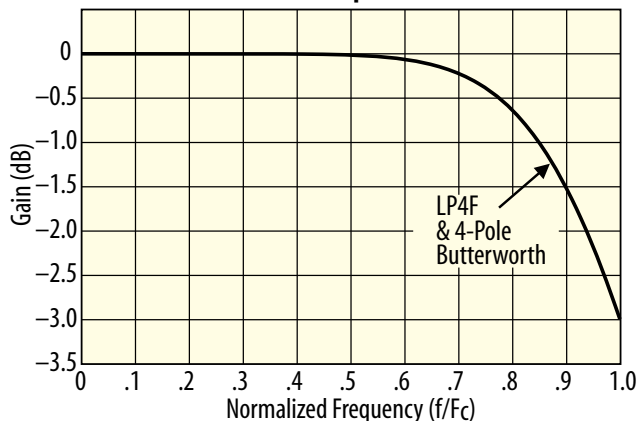
## Pulse Mode Low-Pass Filters

For the time domain, program the 28618 low-pass filter to "pulse" mode. 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.

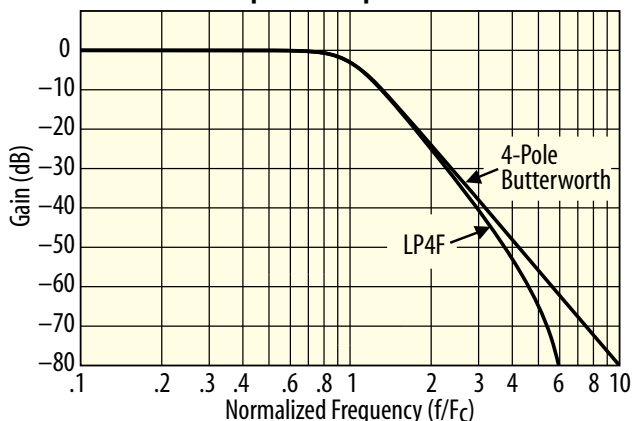
LP4F and LP4P Amplitude Response



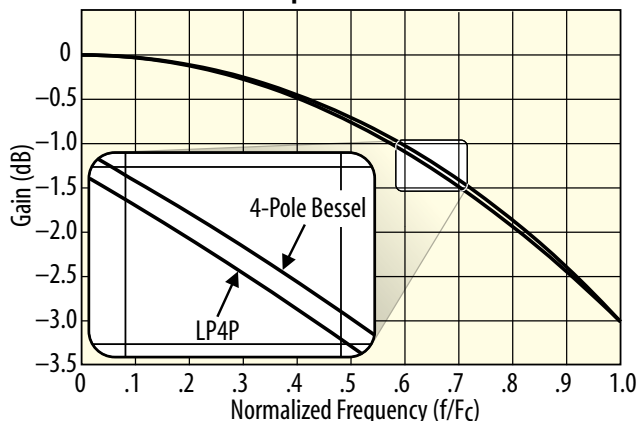
LP4F vs Butterworth Passband Response



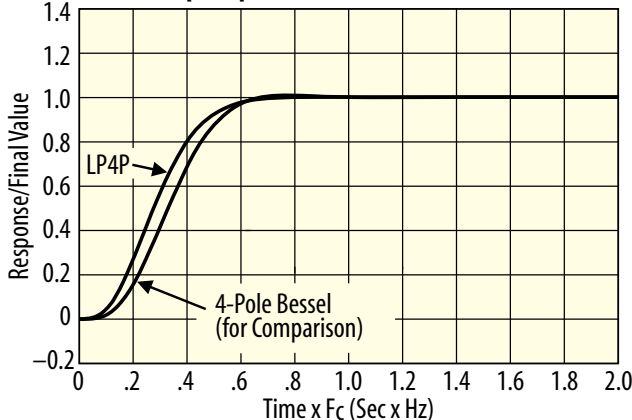
LP4F vs Butterworth Amplitude Response



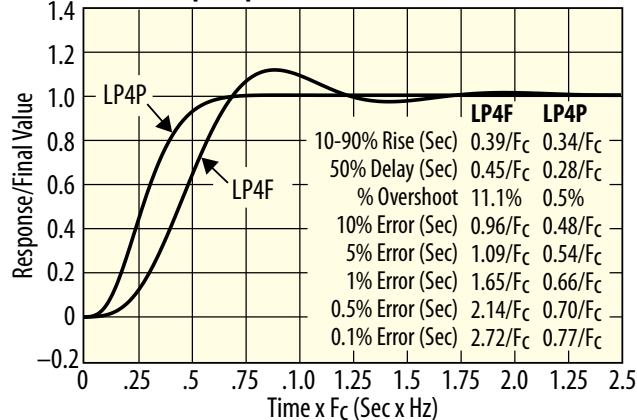
LP4P vs Bessel Passband Response



LP4P vs Bessel Step Response



LP4F and LP4P Step Response





# 28114 Details and Specifications

## 28114 Filter Type Characteristics

### Filter Type:

LP4FP: 4-pole, 4-zero low-pass filter.  
 Programmable for maximally flat pass-band (LP4F) or linear phase with optimized pulse response (LP4P).

### Cutoff Frequencies:

FX02: 300 Hz, 1 kHz, 3 kHz, 10 kHz, 30 kHz

### 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

### Filter Bypass:

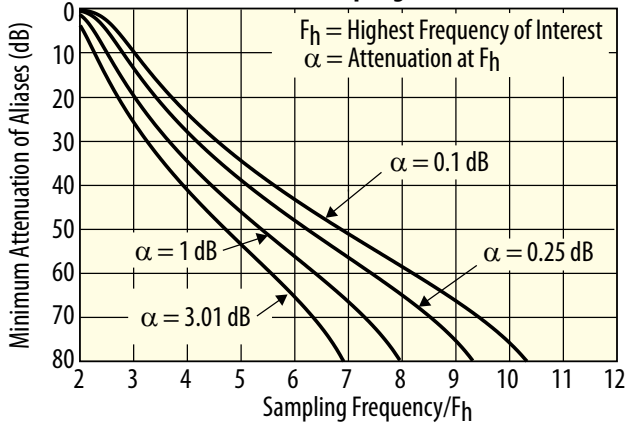
Bypasses filter but not amplifier stages.  
 Bypass Bandwidth: 190 kHz, typical

### Custom Filters:

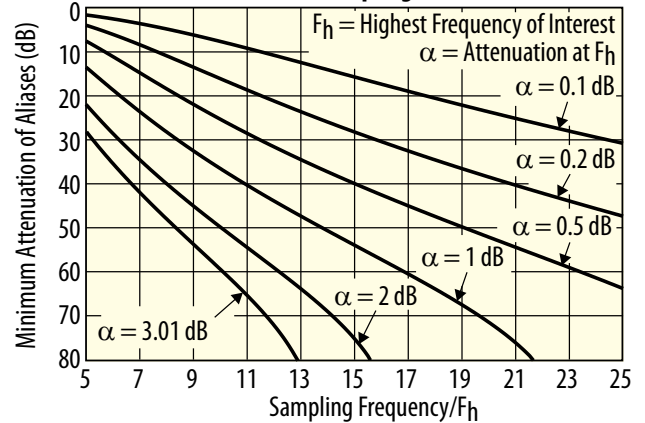
Other filter characteristics and cutoff frequencies are available. Please consult with factory for more information.

Specification	LP4F Maximally Flat Low-Pass Filter	LP4P 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	5.9465 Fc	11.863 Fc
Cutoff Frequency Phase	-180.0 deg	-101.5 deg
Phase Distortion (DC to Fc)	< 31.8 deg	< 3.7 deg
Zero Frequency Group Delay	0.4117/Fc	0.2920/Fc
Percent Overshoot	11.1%	0.5%
1% Settling Time	1.65/Fc	0.66/Fc
0.1% Settling Time	2.72/Fc	0.77/Fc
-0.1 dB Frequency	0.6348 Fc	0.1816 Fc
-1 dB Frequency	0.8487 Fc	0.5742 Fc
-2 dB Frequency	0.9370 Fc	0.8129 Fc
-3.01 dB Frequency	1.0000 Fc	1.0000 Fc
-20 dB Frequency	1.7412 Fc	3.0248 Fc
-40 dB Frequency	2.9555 Fc	5.6932 Fc
-60 dB Frequency	4.5986 Fc	9.0980 Fc
-80 dB Frequency	5.9465 Fc	11.8629 Fc

LP4F Attenuation of Aliases vs Sampling Rate



LP4P Attenuation of Aliases vs Sampling Rate



# 28114 Details and Specifications

## 28114 Input Characteristics

### Type:

Balanced differential w/ programmable AC/DC input coupling

### Input Impedance:

10 M $\Omega$  //100 pF per side

### Max Level:

(AC + DC + Common Mode):

$\pm 10$  Vpk for  $f < \text{or} = 200$  kHz

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

### Input Protection (Power On):

25 V continuous (power on)

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

### Offset Drift:

3.5  $\mu\text{V}/^\circ\text{C}$ , typical

### Noise:

4 nV per rt. 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 >x8

### CMRR (AC Coupled.):

80 dB, 10 Hz to 440 Hz and input gain >x8

### Auto Bridge Balance Mode:

The bridge is automatically balanced utilizing voltage insertion at the input amplifier when bridge balance mode is selected. The inserted voltage is derived from and thus tracks the excitation supply. A successive approximation A/D converter mechanization is used for rapid bridge balance.

### 64 mV/V Mode Auto-Balance Range:

0 mV/V to  $\pm 64$  mV/V in  $\pm 1.95$  mV/V steps

### 512 mV/V Mode Auto-Balance Range (Gain limited to x128):

0 mV/V to  $\pm 512$  mV/V in  $\pm 15.625$  mV/V steps

### Accuracy:

$\pm 0.1\%$  of setting  $\pm 0.1\%$  of F.S. range

### Stability:

$\pm 25$  ppm /  $^\circ\text{C}$  of setting

### Drift (RTI):

$\pm 1$   $\mu\text{V}$  /  $^\circ\text{C}$  for 64 mV/V range;

$\pm 8$   $\mu\text{V}$  /  $^\circ\text{C}$  for 512 mV/V range

### Auto Balance Time:

Less than 15 seconds per system of 64 channels.

### Auto Suppress Mode:

A programmable DC offset derived from a precision 10 V reference is injected at the channel input stage to suppress the gage DC operating voltage. Manual or automatic suppression modes are supported.

### 1.28 V Suppress Ranges:

0 mV to  $\pm 1.28$  V in  $\pm 39$   $\mu\text{V}$  steps

### 10.24 V Suppress Ranges

(Gain limited to x128):

0 V to  $\pm 10.24$  V in  $\pm 312.5$   $\mu\text{V}$  steps

### Accuracy:

$\pm 0.1\%$  of setting  $\pm 0.1\%$  of F.S. range

### Stability:

$\pm 25$  ppm /  $^\circ\text{C}$  of setting

### Drift (RTI):

$\pm 1$   $\mu\text{V}$  /  $^\circ\text{C}$  for 1.28 V range

$\pm 8$   $\mu\text{V}$  /  $^\circ\text{C}$  for 10.24 V range

### Auto Suppress Time:

Less than 15 seconds per system of 64 channels.

## 28114 Amplifier Characteristics

### Pre-Filter Gain:

x1 to x64 in x2 steps with overload detection (10.2 Vpk threshold)

### Post-Filter Gain:

x1/16 to x16 in binary steps with vernier adjustment

### Overall Gain:

x1/16 to x1024

### Gain Setability:

0.05% steps for POG  $\geq 1\text{X}$

0.05%/POG for POG  $< 1\text{X}$

### DC Gain Accuracy:

0.02% typical, 0.2% maximum for POG  $\geq 1\text{X}$

0.2%/POG maximum for POG  $< 1\text{X}$

### Frequency Response:

DC to 100 kHz, 0 dB  $\pm 0.1$  dB

-3 dB typical at 190 kHz

### Temperature Coefficient:

$\pm 0.005\%$  /  $^\circ\text{C}$  max

### DC Linearity:

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

## 28114 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:** Test input allows for injection of a test signal. An external test signal or the 28000-?-TEST Test Subsystem may be connected at the rear panel. Refer to the 28000-?-TEST Test Subsystem specification for more information.

**Shunt Cal:** Applies shunt to bridge.

**Excitation Monitor (Constant Voltage Mode Only):** The amplifier input is switched from the bridge to the excitation supply to monitor the excitation voltage at the amplifier output. Excitation monitor gain is x0.5.

**Excitation Off:** The excitation supply is programmed to zero volts or zero mA.

### AC Current (Constant Current Mode Only):

An AC current is injected into the current loop to evaluate end-to-end system frequency response. The AC current is generated from a voltage waveform on the test bus.

## 28114 Output Characteristics

### Type:

DC coupled, single-ended output with ground sense (Option Y)

### Output Ground Sense:

Used for driving grounded single-ended loads. Output is referred to ground at the load. Output sense also reduces ground loop interference by providing a high impedance connection between the ground at the load and the output stage ground.

### Impedance:

Hi Output: 10  $\Omega$  // 100 pF

Low Output (Sense Input):

100  $\Omega$  // 100 pF or ground via manual card switch.

### Max Output:

$\pm 10$  Vpk,  $\pm 20$  mA pk

### Offset:

<5 mV after auto-adjust at any gain setting

### Offset Drift:

3.5  $\mu$ V/ $^{\circ}$ C, RTI + 150  $\mu$ V /  $^{\circ}$ C RTO

### Noise:

6  $\mu$ V rms RTI + 100  $\mu$ V rms RTO,  
3 Hz to 100 kHz

### Crosstalk:

-90 dB, DC to 100 kHz

### Output Monitor:

A switch at the output of each channel allows for multiplexed connection to the 28000 chassis output monitor bus BNC connector for viewing the channel output with an external device.

## 28114 General Characteristics

### 28114 Card Size:

6.63 x 17.5 x 0.75 inches

### Card Weight:

1.4 lb. net

### Temperature:

0  $^{\circ}$ C to 40  $^{\circ}$ C (operating);

-20  $^{\circ}$ C to 70  $^{\circ}$ C (storage)

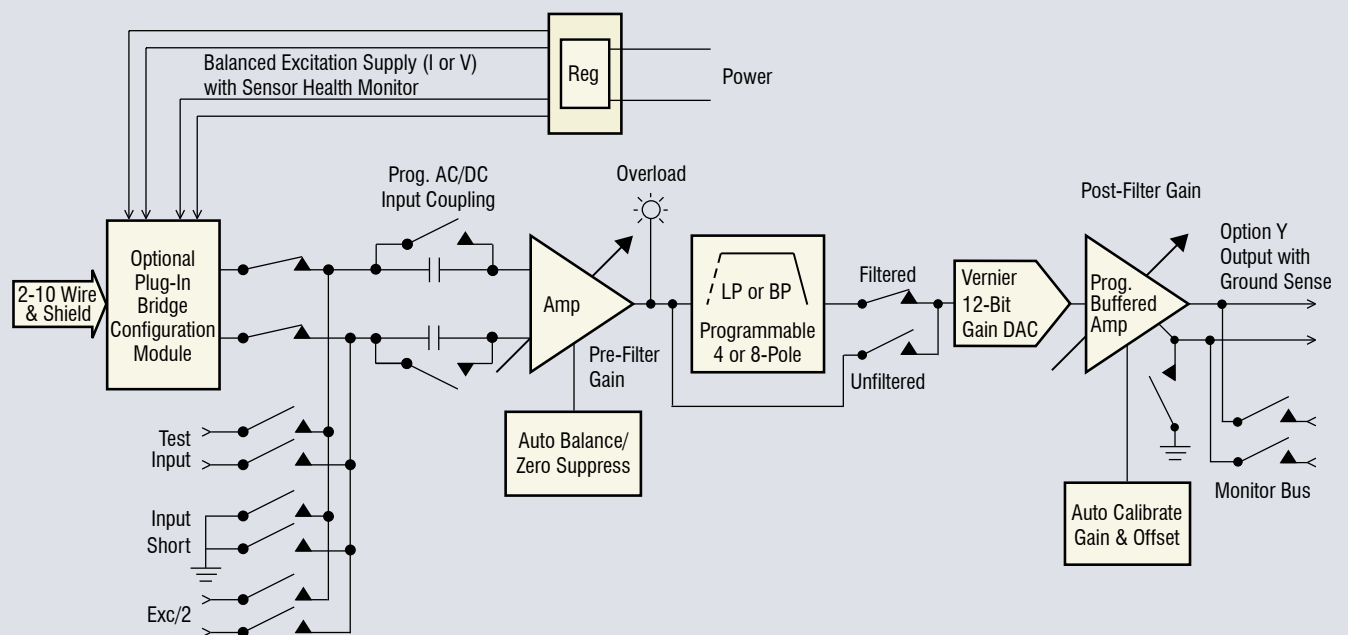
### Connectors:

The input connectors are integral to the 28114 card. Cutouts on the 28000 frames allow the input connector to pass through the backplane and to directly mate with the input cables.

Two 26-pin high-density D connectors are utilized for the 4 inputs (2 inputs per connector). Connectors have high quality machined gold plated pins/sockets.

28114 outputs are available on 50-pin D connectors that are integral to the 28000 System chassis. Three wires per output are provided to accommodate twisted/shielded cables.

28114 Channel Block Diagram



## Accessories

### Mating Connectors

Precision Filters mating connectors accommodate up to 22-AWG wire and are supplied with high quality metal backshells and gold plated screw machined contacts for high reliability connections and long service life.

**CONN-IN-26D:** High-Density 26-pin D-shell mating output connector with machined crimp pins and metal backshell with strain relief.

**CONN-IN-26D-SC:** High-Density 26-pin D-shell mating output connector with machined solder cup pins and metal backshell with strain relief.

**CONN-OUT-26D:** High-Density 26-pin D-shell mating output connector with machined crimp pins and metal backshell with strain relief.

**CONN-OUT-26D-SC:** High-Density 26-pin D-shell mating output connector with machined solder cup pins and metal backshell with strain relief.

### Output Adapters

Measurement systems often require multiple outputs per signal conditioning channel or special functions such as a DC output in proportion to the AC signal level. These outputs may be routed to control systems, tape backup systems, auxiliary data acquisition systems, scope bays and other destinations.

28114 cards are fitted with front panel connectors which accept Precision output adapter modules. Adapters plug on to the front of the signal conditioner card and are secured to the card by two screws. The adapters provide one or two additional fully buffered outputs per channel or RMS to DC functionality.

**28000-RMS/DC4:** Quad RMS-to-DC Converter Module

**BUFF-4BNC/15D:** Quad Output Buffer with single output per channel on four BNC Connectors or one 15-Pin D Connector

**BUFF-4CH/(2)15D:** Quad Output Buffer with dual outputs per channel on two 15-Pin D Connectors

### Precision PF-1U-FA Multi-Channel Programmable Filter/Amplifier System



#### Exceptional desktop performance.

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, both offering a choice of either 4 or 8-pole low-pass filters with programmable gain.

### High Density Programmable Switch Systems

Computer controlled analog signal switching replaces tedious manual patch panels.



#### Precision 4164 64x64 Switch Matrix System

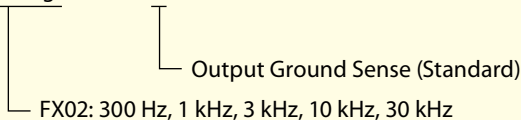


#### Precision 464kC Switch Matrix System

Precision switch systems are reliable solid-state switch matrix systems, providing computer-controlled connection between input and output signals. Configure the 464kC with up to 256 inputs and 256 outputs, all in a single mainframe, or choose the compact 4164 system with 64 inputs and 64 outputs. 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.

### Ordering Information

28114-<Filter Range>-LP4FP-Y



#### BC6, BC7, BC8, BC9 Programmable Bridge Configuration Module:

One module is required per 28114 card to support bridge completion or shunt cal options.