Precision 28124

Quad-Channel Transducer Conditioner with *Voltage and Current Excitation*

28124 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, and other resistive transducers. Each of three independent outputs can be programmed for filtered or wideband operation, allowing for simultaneous measurement of static and dynamic signals from one transducer.

28124 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 28124 Features

- Four channels per card, 64 channels per 28016 chassis
- Three wideband or filtered outputs per channel
- Balanced programmable constant voltage excitation with remote sense—up to 20 V delivered to the bridge with AC shunt calibration test mode for verifying transducer, cabling, and measurement system frequency response
- Balanced differential constant current excitation (0-20 mA/20 V compliance) with AC current cal test mode for verifying transducer, cabling, and frequency response
- Option HC10 – RTD/Bridge/Thermocouple Configuration. 4-Wire 0-1 mA RTD excitation. RTD substitution, Thermocouple substitution (1 mV – 100 mV) and resistive shunt cal.
- Option HC14 – Bridge/Strain/IEPE Configuration. Prog. Bridge Configuration (1, 2, 4-Arm) or 2-Wire/4-Wire Constant Current. Prog. Completion (120, 350 and 1kOhm). Programmable Precision 255 Step Bipolar Resistive Shunt Calibration of R1 or R2. IEPE input mode (8 mA constant current source).
- On-the-fly report of measured transducer excitation and resistance
- Transducer open/short indication
- Transducer leakage resistance measurement in constant current excitation mode
- Automatic bridge balance/transducer suppress
- Up to 100 kHz filtered bandwidth or 250 kHz wideband 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 x8192 with 0.01% resolution
- 4 -pole low-pass filters with programmable pulse/flat characteristics
- Prefilter overload detectors
- Precise digital calibration

Precision 28124 *for the 28000 Analog Signal Conditioner*

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

Precision 28124 Description

Precision 28124 Description

The 28124 is a member of the Precision 28000 family of signal conditioners. The 28124 provides four channels of conditioning for a wide variety of transducers requiring constant current or constant voltage excitation. Up to sixteen 28124 cards may reside in the 28000 system to provide 64 channels per chassis. In addition, the 28124 may be mixed with other conditioners in the 28000 family to meet your unique signal conditioning requirements.

Balanced Constant Voltage Excitation

The 28124 provides balanced constant voltage excitation of up to 20 volts and conditioning for 1-, 2-, and 4-arm resistive bridges. The 28124 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 DC 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.

The 28124 provides a unique AC shunt calibration capability that allows the operator to simulate dynamic gage fluctuations on the bridge. The test bus voltage is utilized as the reference for the AC shunt calibration signal meaning the waveform type and amplitude may be uniquely defined to match waveforms expected during the actual test.

In addition to verification of bridge impedance, the AC shunt calibration allows the user to examine the effects of the input cabling on the frequency response of the system.

Balanced Constant Current™ Excitation

The 28124 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. Standard programmable excitation provides 0 to ±20 mA of constant current with an "excitation off" mode to detect input cable noise pickup. Gage open/ short detection is also provided. Option HC10 provides 1 mA balanced excitation that is optimized for RTD measurements.

For dynamic strain conditioning applications, the 28124 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 28124 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 28124. 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.

28124 Sensor Configuration

The high degree of modularity of the 28124 allows the card to be easily configured to condition a particular sensor type. Two sensor configuration options are available to support a wide range of transducer conditioning applications.

Bridge/Strain/IEPE Configuration: The HC14 configuration option supports measurements of strain in a ¼, ½ or full bridge configuration or 2-wire/4-wire constant current measurements. Precise low drift (0.2 PPM) completion resistors are included for 120, 350 or 1000 ohm bridges. 255-step bipolar shunt calibration provides programmable shunt cal resistance values ranging from 7.5 kΩ to 1.92 MΩ. Shunt calibration can be applied internally to the 28124 card or remotely at the actual bridge using dedicated shunt calibration connections. Single shunt of R1 or R2 bridge arms is supported.

The HC14 also supplies an 8mA current source for measurements with IEPE transducers. An AC coupling capacitor removes the sensor bias and connects to the amplifier input stage. Sensor Bias and fault conditions are monitored in real time to alert the user to a fault condition.

Bridge/RTD/Thermocouple Configuration: The HC10 Bridge/RTD/Thermocouple Configuration Module supports full-bridge, RTD and thermocouple measurements. A 1mA precision constant current excitation is supplied to the RTD. Current drive and signal sense terminals are available on the input connector to allow a 4-wire Kelvin connection to the RTD. Precision RTD substitution resistors are supplied for calibration purposes.

For thermocouple measurements it is assumed that a third party UTR is used with isothermal block temperature read and processed by external means to compensate the 28124 output for a reference junction and to perform linearization. Precision thermocouple DC input voltage substitution is supported.

For full bridge measurements, programmable single-step bipolar shunt of R1 or R2 is supported. In addition, relay contacts are used to connect the sensor internal cal resistor (if equipped) to ±excitation.

Input Stage

The 28124 input stage provides 120 dB of common-mode rejection and 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. With the input DC coupled, low drift and ultra low noise is provided by the 28124 input stage. 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 8192. 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 input overload detector reports overloads by out-of-band signals which could cause in-band distortion. 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 25 mA of drive capability may be used to drive long output cable runs.

The 28124 is specified with a 4 -pole low-pass filter with cutoffs programmable from 1 Hz to 100 kHz and programmable "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.

Output Stage

The 28124 has three independently buffered outputs. A single-ended rear panel output is intended to drive the primary data acquisition hardware. Two sets of auxiliary outputs are available on the front panel of the card. All three outputs have ground sensing circuitry that breaks ground loops when connecting grounded loads. The sensing circuitry also corrects the output for any potential differences between the 28124 ground and the load ground. Each of the three outputs may be selected for filtered or wideband operation under program control. This allows the 28124 to measure both AC (dynamic) and DC (static) signals coming from one transducer.

28124 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 µA steps
- RTD Constant current excitation level (Option HC10): 0 to 1 mA in 0.25 uA steps
- IEPE current source (Option HC14): 0 or 8 mA
- Expected transducer resistance and tolerance
- Transducer leakage resistance thresholds
- 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 (HC14/BC6/BC7/BC8)
- Bridge resistance: 120 Ω, 350 Ω or 1 kΩ (HC14/BC6/BC7/BC8)
- DC shunt cal: instrument or gage (HC10/HC14/BC6/BC7/BC8)
- DC shunt cal resistance and shunt arm: R1 or R2 (HC10/HC14/BC6/BC7/BC8)
- Automatic balance/suppress
- AC/DC input coupling
- Test modes: amp short, 10 V DC CAL, excitation off, test bus (voltage substitution), DC shunt calibration, AC shunt calibration, AC current, excitation monitor
- RTD resistor substitution (HC10)
- Precision DC thermocouple voltage substitution (HC10)
- Sensor RCAL relay closure (HC10)
- Output monitor
- Gain: x1/16 to x8192 with 0.01% resolution
- Filter type: pulse or flat
- Cutoff frequency:
  - 2 Hz to 100 kHz, flat mode
  - 1 Hz to 100 kHz, pulse mode
- Wide-band (250 kHz) or filtered operation

28124 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

28124 Details and Specifications

Verification of Cables and Sensor Health:

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 28124 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 28124 alerts the user to a transducer open or short condition.

Strain Gage Loop Resistance Measurement: Strain measurements often require complicated wiring schemes. Long cable runs, multiple connection points, high-temperature high-impedance very small diameter wire and slip rings combine to cause uncertainty in the strain gage connection. Often a sudden increase in gage resistance is a predictor of gage failure. The Precision 28124 gives continual real time monitoring of the total "Loop Resistance" of the gage and cable circuit. This loop resistance reading can be compared to preset limits to alert the user of unexpected resistance shifts as well as gross gage short and gage open conditions.

Cable Roll-off: One often asked question of many measurements engineers is "How will my cable capacitance affect my high frequency strain measurement"? This question can be answered quickly and easily and all from the convenience of the control room. The AC dither current feature of the 28124, in balanced constant current excitation mode, modulates a small AC current on top of the DC excitation current to stimulate an AC signal across the actual strain gage sensing element. In balanced constant voltage excitation mode, the AC shunt calibration feature allows the operator to inject an AC current into a bridge corner to simulate actual gage fluctuations.

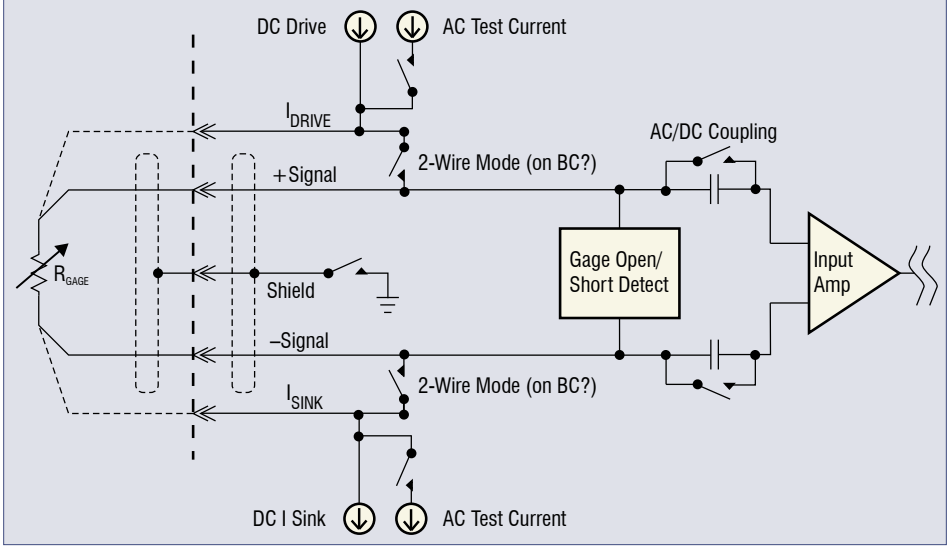
Since the stimulus signal is based at the sensor, it will exhibit the same roll-off characteristics as a signal resulting from actual dynamic strain. The test frequency of the AC signal can be increased as necessary to chart the cable roll-off characteristics and validate the cable circuit for use at the desired measurement frequencies.

Gage Leakage Measurements: In extremely hot sections of a test article, such as a gas turbine engine, it is impossible to use standard insulating materials in gage wiring. Often a rigid section of a stainless steel or Inconel sheath encloses high temperature inner conductor wires. The inner core of the sheath is filled with magnesium oxide (MGO) as a high temperature insulating material. The insulating properties of the MGO are affected by moisture absorption at damage points or improperly sealed cable terminations. In extreme conditions, insulation breakdown can cause a leakage path to ground and corrupt a gage reading. Other causes of cable leakage are fatigue or failure at extension wire tie-down points, or in the strain gage itself. The leakage detection feature of the 28124 continually monitors leakage and compares readings to preset threshold limits. Sensors which show higher than normal leakage can be quickly identified prior to or during the test run.

Muting Faulty Sensors:

Depending on the sensor type, various techniques must be used to quiet the channel's input and output circuits and ensure that no noise coupling occurs. For example, an intermittent gage will create a gage chatter condition whereby the connecting wires continually switch between the high voltage fault level and the proper low voltage operational level. This chatter condition creates a hostile noise source to any other gage extension wires in the vicinity of the hostile cable. Precision 28124 signal conditioning channels have a "MUTE" feature, which places the channel in its quietest quiescent state and minimizes the possibility of coupling noise to properly functioning channels.

28124 Constant Current Mode Transducer Interface



28124 Details and Specifications

28124 Conditioner Cards

The detailed description and specifications for the 28124 are organized as follows in the sections below:

- Programmable Sensor Configuration Options
- Bridge Wiring
- Excitation Supply
- Input Characteristics
- Amplifier Characteristics
- Test Modes
- Filter Type Characteristics
- Output Characteristics
- General Characteristics
- Accessories
- Ordering Information

Programmable Sensor Configuration Options

The 28124 optional sensor configuration modules provide versatility to condition a wide variety of transducers. The HC10 and HC14 options are factory configured and support bridge, strain, IEPE, RTD and thermocouple configurations and are recommended for new installations. BC6, BC7 and BC8 options can be installed in the field.

Configuration Module Specifications:

Bridge Configuration*:
1-arm, 1-arm w/ 3 wires, 2-arm or 4-arm, (programmable)

Completion Resistors*:
120 Ω, 350 Ω and 1 kΩ, programmable

Constant Current:
2-wire/4-wire (Kelvin) input, programmable

Resistor Temperature Coefficient:**
±0.2 ppm / °C

Resistor Accuracy:**
±0.02%

Notes:

* Not supported on HC10

** These specifications are guaranteed by design, but are not testable to these limits with the 28000 Factory Acceptance Test (FAT) system.

HC10 Full-Bridge/RTD/Thermocouple Configuration Module

RTD Substitution Cal

Values: 62.5, 125, 500, 1 k and 2 kΩ, programmable

Accuracy:**
±0.01%, 5ppm/°C

Thermocouple cal via prog. voltage substitution

Range: 1 mV - 100 mV w/ 0.1 mV min resolution of setting

Accuracy: +/-1-10mV: +/- 0.15%; ±10mV-100mV: +/- 0.07%

DC Shunt Calibration (Constant Voltage Excitation Mode Only):
3-Step Bipolar Shunt Cal

DC Shunt Selection:
R1 or R2 bridge arms

Shunt Sensitivity:
±1 mV per volt of programmed excitation

Shunt Resistance:
Selectable:
29.940 kΩ,
87.325 kΩ,
249.5 kΩ

Resistor Accuracy: ±0.2%

Sensor RCAL:
Connects sensor internal cal resistor to + or – excitation via relay contacts.

HC14 Bridge/Strain/IEPE Bridge/IEPE Configuration Module

DC Shunt Calibration:
255-Step Bipolar Shunt Cal

DC Shunt Selection:
R1 or R2 bridge arms

Shunt Resistance:
7.5 kΩ to 1.92 MΩ

Resistor Accuracy: ±0.1%

IEPE Input Mode:

Level: 8 mA, ±1%

Compliance Voltage:
26 V, Nominal

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

Fault Monitor:
Sensor open/short

IEPE Bias Monitor: Bias voltage continuously monitored and compared to user defined limits

BC6 DC Shunt Calibration

DC Shunt Selection:
R1 or R2 bridge arms

Equivalent Shunt Resistance Settings:
30.75R to 2000R w/ 0.2% minimum resolution where R = 120 Ω, 350 Ω, or 1 kΩ

Shunt Sensitivity:
±0.125 mV/V to ±0.5 mV/V
in ±0.25 µV/V steps
±0.501 mV/V to ±2.0 mV/V
in ±1.00 µV/V steps
±2.004 mV/V to ±8.0 mV/V
in ±4.00 µV/V steps

Shunt Accuracy:
±0.2% for programmed excitation >1 V

BC7 DC Shunt Calibration

DC Shunt Selection:
R1 or R2 bridge arms

Shunt Sensitivity:
±1 mV per volt of programmed excitation

Shunt Resistance:
29.940 kΩ for 120 Ω bridge
87.325 kΩ for 350 Ω bridge
249.5 kΩ for 1 kΩ bridge

Resistor Accuracy:
±0.1%

BC8 Current Sense:

Modes:
2-wire sense or 4-wire sense

Sense Resistor:
250 ohms ±0.1%

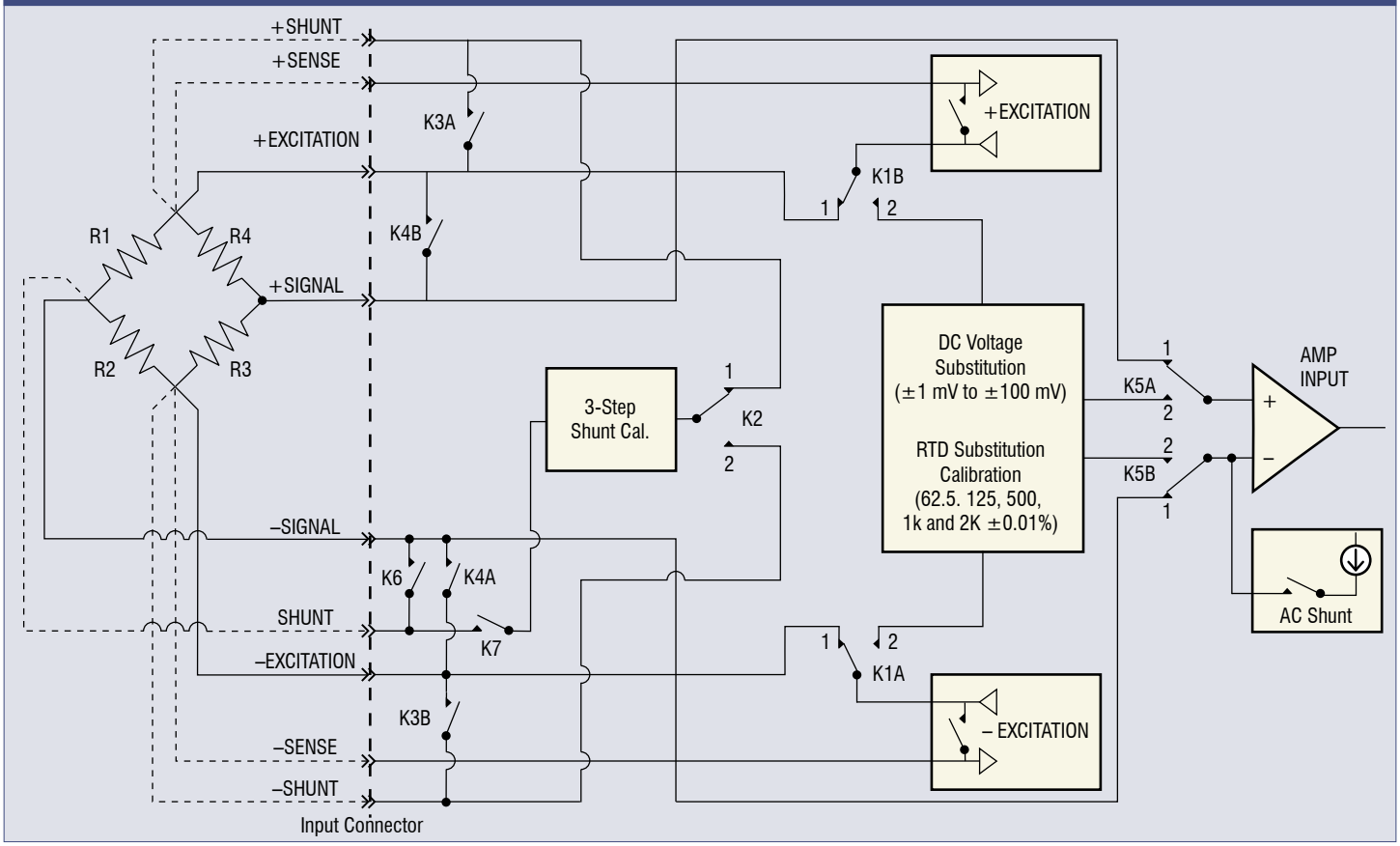
Bridge Wiring

Input Connector:
26-pin high-density D-shell (2 ea.)

Input Wires:
±EXCITATION (2)
±SENSE (2)
±SIGNAL (2)
SHUNT CAL (3)
¼ Bridge RTN (1) Single-Arm Bridge
SHIELD (1)

28124 Details and Specifications

Diagram with HC10 Bridge/RTD/Thermocouple Configuration Module

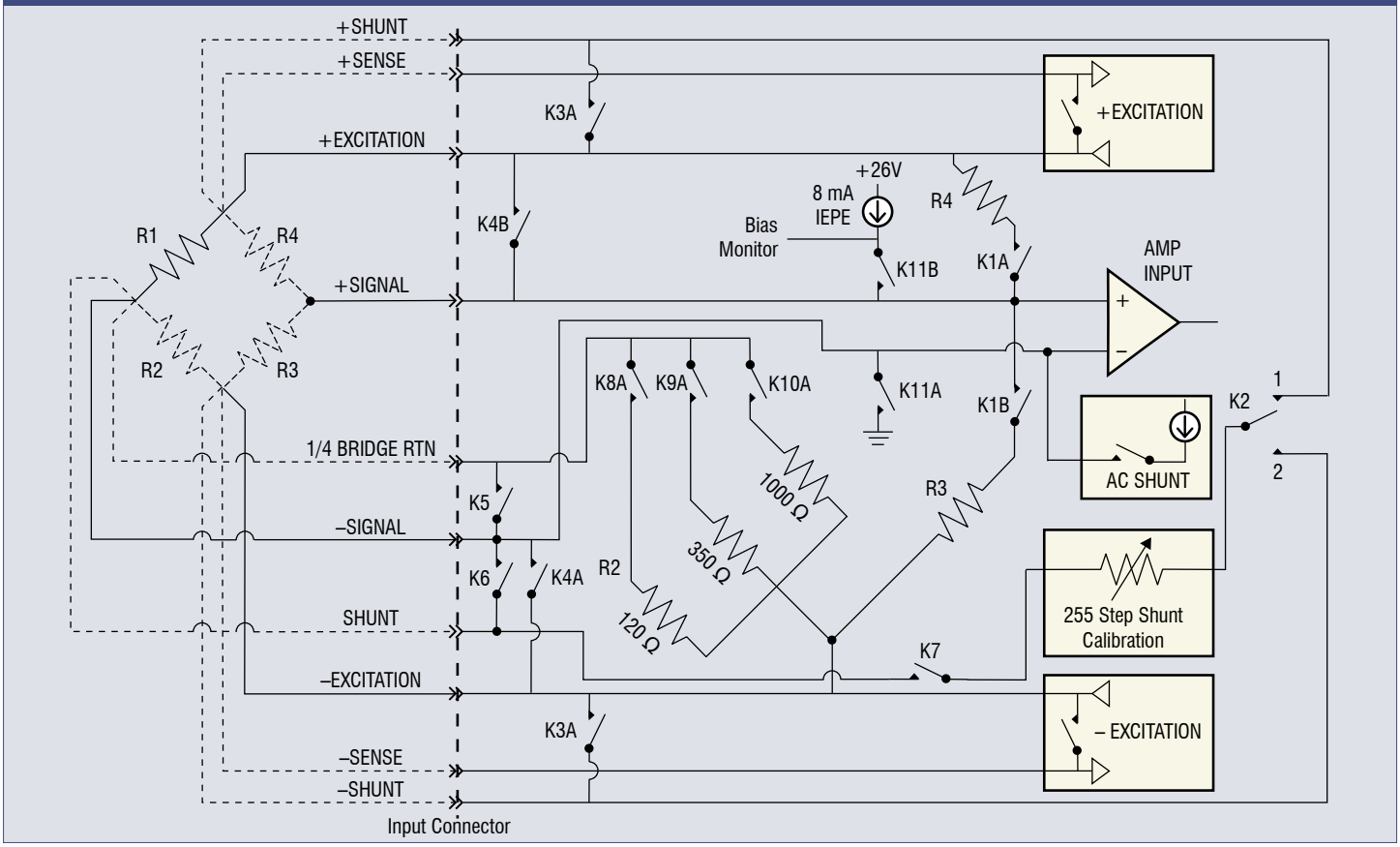


Truth Table

Configuration	K1	K2	K3, K6	K4	K5	K7
Shunt Cal Gage	1		OUT		1	IN
Shunt Cal Instrument	1		IN		1	IN
Shunt R1	1	1			1	IN
Shunt R2	1	2			1	IN
Sensor RCAL	1				1	IN
Constant Current 2-Wire	1			IN	1	
Constant Current 4-Wire	1			OUT	1	
DC Voltage Substitution	2				2	
RTD Substitution	2				2	

28124 with HC10 Bridge Configuration Module

Diagram with HC14 Bridge/Strain/IEPE Configuration Module



Truth Table

Configuration	K1	K2	K3, K6	K4	K5	K7	K8	K9	K10	K11
¼ Bridge, 2-Wire	IN				IN		IN[1]	IN[1]	IN[1]	IN
¼ Bridge, 3-Wire	IN				OUT		IN[1]	IN[1]	IN[1]	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						
8 mA IEPE Current Source	OUT		OUT	OUT	OUT	OUT				IN

[1] One switch selected at a time.

28124 with HC14 Bridge Configuration Module

28124 Details and Specifications

28124 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:
±0.03%, ±500 µV

Noise:
100 µVrms, 3 Hz to 200 kHz

Temperature Drift:
±0.0025%/°C of setting or ±50 µV/°C, whichever is greater

Sense Leakage Current:
Less than 10 µA

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

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

28124 Constant Current Excitation Supply

Type:
Balanced differential constant current excitation

Excitation:
0 to 20.475 mA in 5 µA steps

Total Gage Voltage (Volts):
22 – I x 700 minimum

Input Impedance:
100 kΩ nominal per side

CMRR (DC to 1 kHz):
80 dB for 120 Ω gage
70 dB for 350 Ω gage
60 dB for 1 kΩ gage

Initial Accuracy:
0.05%, 5 µA

Temperature Drift:
30 nA + 0.0024% of setting per °C

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

Bandwidth:
±0.2 dB to 200 kHz (RGAGE < 1 kΩ)

HC10 RTD Excitation

The HC10 option provides excitation levels optimized for RTD measurements.

Type:
Balanced differential constant current excitation

Level:
0 to 1.02375 mA in 0.25 µA steps

Total Gage Voltage:
22 – I x 14,000 minimum

Input Impedance:
2 MΩ nominal per side

Initial Accuracy:
0.05%, 250 nA

Drift:
1.5 nA + 0.0024% of setting per °C

Noise:
3.5 pA per rt Hz at 1 kHz

Bandwidth:
±0.2 dB to 200 kHz

28124 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 28124 Mute control places the channel in the quietest operational state to minimize system noise in the event of a failed sensor. Mute mode is also useful to terminate unused channels in a safe and quiet state.

28124 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.

Transducer Leakage Resistance Measurement: The 28124 monitors gage bias levels in order to detect constant current excitation leakage conditions in the external current loop. Transducer leakage status is monitored and reported via the GUI.

Excitation Current Limit: Current limit protection is provided by the 28124 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.

28124 Details and Specifications

28124 Input Characteristics

Type:
Balanced differential w/ programmable AC/DC input coupling

Input Impedance:
10 MΩ //100 pF per side

Max Level (AC + DC + Common Mode):
±10 Vpk for f ≤ 200 kHz
±10 Vpk x (200 kHz/f) for f > 200 kHz

Input Protection (Power On):
30 V continuous, 100 Vpk for 1mS, 10% duty cycle

Offset Drift:
1 µV/°C, typical

Noise:
9 nV/$\sqrt{Hz}$ at 1 kHz and prefilter gain > 64, typical

AC Coupling Frequency:
0.25 Hz (3.01 dB)

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

CMRR (AC Coupled.):
100 dB, 10 Hz to 440 Hz

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.

Range:
Bridge balance algorithm selects the most appropriate range to achieve balance with finest resolution.

32 mV/V Mode Auto-Balance Ranges:
±0.001 mV/V to ±32 mV/V in ±0.976 µV/V steps

512 mV/V Mode Auto-Balance Ranges (gain limited to x512):
±0.016 mV/V to ±512 mV/V in ±15.625 µV/V steps

Accuracy:
±0.1% of setting ±0.1% of F.S. range

Stability:
±25 ppm / °C of setting

Drift (RTI):
±0.3 µV / °C for 32 mV/V range;
±5 µV / °C for 512 mV/V range

Auto Balance Time:
Less than 60 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.

640 mV Suppress Ranges:
±0.001 mV to ±640 mV in ±19.53 µV steps

10.24 V Suppress Ranges (gain limited to x512):
±0.3125 mV to ±10.24 V in ±312.5 µV steps

Accuracy:
±0.1% of setting ±0.1% of F.S. range

Stability: ±25 ppm / °C of setting

Drift (RTI): ±0.3 µV / °C for 640 mV range;
±5 µV / °C for 10.24 V range

Auto Suppress Time:
Less than 60 seconds per system of 64 channels

28124 Amplifier Characteristics

Prefilter Gain:
x1 to x512 in binary steps with overload detection (10.5 Vpk threshold)

Postfilter Gain:
x1/16 to x16 in binary steps with vernier adjustment

Overall Gain: x1/16 to x8192

Gain Setability:
0.0125% steps for POG ≥ 0.5X
0.0125%/POG for POG < 0.5X

DC Gain Accuracy:
0.01% typical, 0.1% maximum for POG ≥ 0.5X
0.1%/POG maximum for POG < 0.5X

Gain Ratio of Wideband (Unfiltered) to the Filtered Outputs:
Each of the three 28124 outputs may be selected for wideband or filtered operation under program control. The ratio of the gain on the wideband output to the filtered output may be set from 0.1000 and 1.0000 with 0.1% resolution. All GUI Gain Wizard calculations are based on filtered output.

Stability: ±0.02% for 6 months

Temp Coef.: ±0.004%/°C

DC Linearity:
±0.005% re fullscale, relative to the best straight line

Frequency Response:
DC to 100 kHz, 0 dB ±0.1 dB
–3 dB typical @ 250 kHz

High Frequency Rolloff:
18 dB/octave

28124 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.

10 VDC CAL: A calibrated 10 VDC reference is connected to the amplifier input. The NIST traceable measured error (in percent) is stored in non-volatile memory on the card. Subsequent NIST traceable field measurement of the 10VDC reference requires the 28000-?-TEST test subsystem.

DC Shunt Cal: Applies resistive shunt across bridge arm.

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 Shunt Calibration (Constant Voltage Mode Only): An AC shunt calibration current is injected into the bridge to verify bridge impedance and to evaluate the end-to-end frequency response of the system. The AC shunt reference signal is derived from the voltage on the test bus.

AC Shunt Sensitivity:
10 µApk per Vpk of test bus voltage

AC Shunt Current Accuracy (350 Ohm Bridge):
±0.2% at 1 kHz
–5% typical at 50 kHz
–3 dB typical at 160 kHz

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.

AC Current Sensitivity:
100 µApk per Vpk of test bus voltage

AC Shunt Current Accuracy (350 Ohm Loop Resistance at Input):
±0.2% at 1 kHz ,
–5% typical at 50 kHz
–3 dB typical at 160 kHz

28124 Details and Specifications

28124 Filter Type Characteristics

Flat/Pulse Low-Pass Filters

Our LP4FP 4-pole flat/pulse low-pass filters provide you with the versatility to address applications in either the time or the frequency domain.

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, we offer the LP4P 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.

LP4FP Specifications

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

Note: Other filter types and cutoff ranges are available upon request. Please consult the factory.

Cutoff Frequencies

Flat Mode:
2 Hz to 2.046 kHz in 2 Hz steps
2.2 kHz to 100 kHz in 200 Hz steps

Pulse Mode:
1 Hz to 1.023 kHz in 1 Hz steps
1.1 kHz to 100 kHz in 100 Hz steps

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

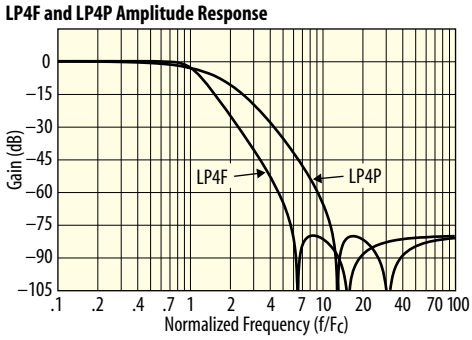
Phase Match:
±1° max, DC to 0.8 Fc
±2° max, 0.8 Fc to Fc

Bypass:
Bypasses filter but not amplifier stages

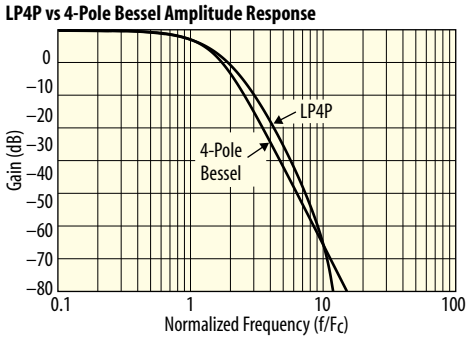
Bypass Bandwidth:
250 kHz, typical

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	4.586 Fc	9.0980 Fc
–80 dB Frequency	5.9465 Fc	11.8629 Fc

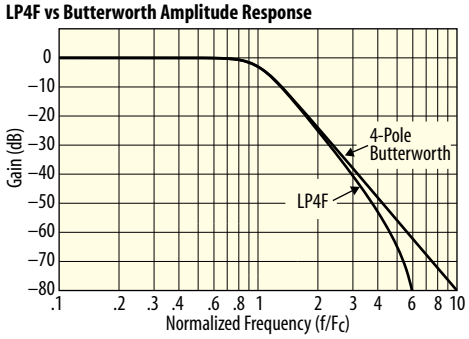
LP4F and LP4P Amplitude Response



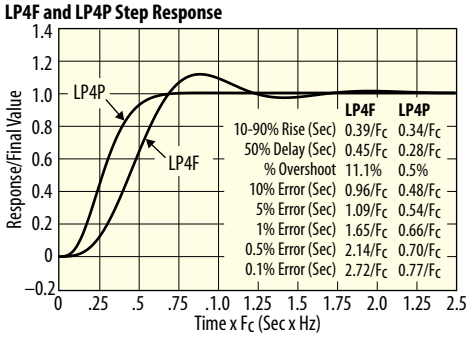
LP4P vs 4-Pole Bessel Amplitude Response



LP4F vs Butterworth Amplitude Response



LP4F and LP4P Step Response



Output Characteristics

Primary (Rear Panel) Output: Output available at rear panel of chassis via 50-pin D connector (M3 chassis) or 26-pin high-density D connector (M5 chassis). For M3 chassis, one 50-pin D accommodates up to 16 primary outputs for four 28124 cards. For chassis with the M5 option, one high-density 26-pin D is available per card slot.

Auxiliary Outputs: Two female 15-pin D connectors available on the front panel of the 28124 card.

Type:
DC coupled, single-ended output with selectable ground sense

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 breaking the connection between the load ground and the 28124 channel ground.

Impedance:
Hi Output: 10 Ω // 100 pF
Low Output (Sense Input):
100 Ω // 100 pF or ground via manual card switch

Output Shield:
Chassis ground

Max Output:
±10 Vpk, ±25 mA pk

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

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

Noise:
2.8 µV rms RTI + 60 µV 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.

28124 General Characteristics

28124 Card Size:
6.63 x 17.5 x 0.75 inches

Card Weight:
1.4 lb. net

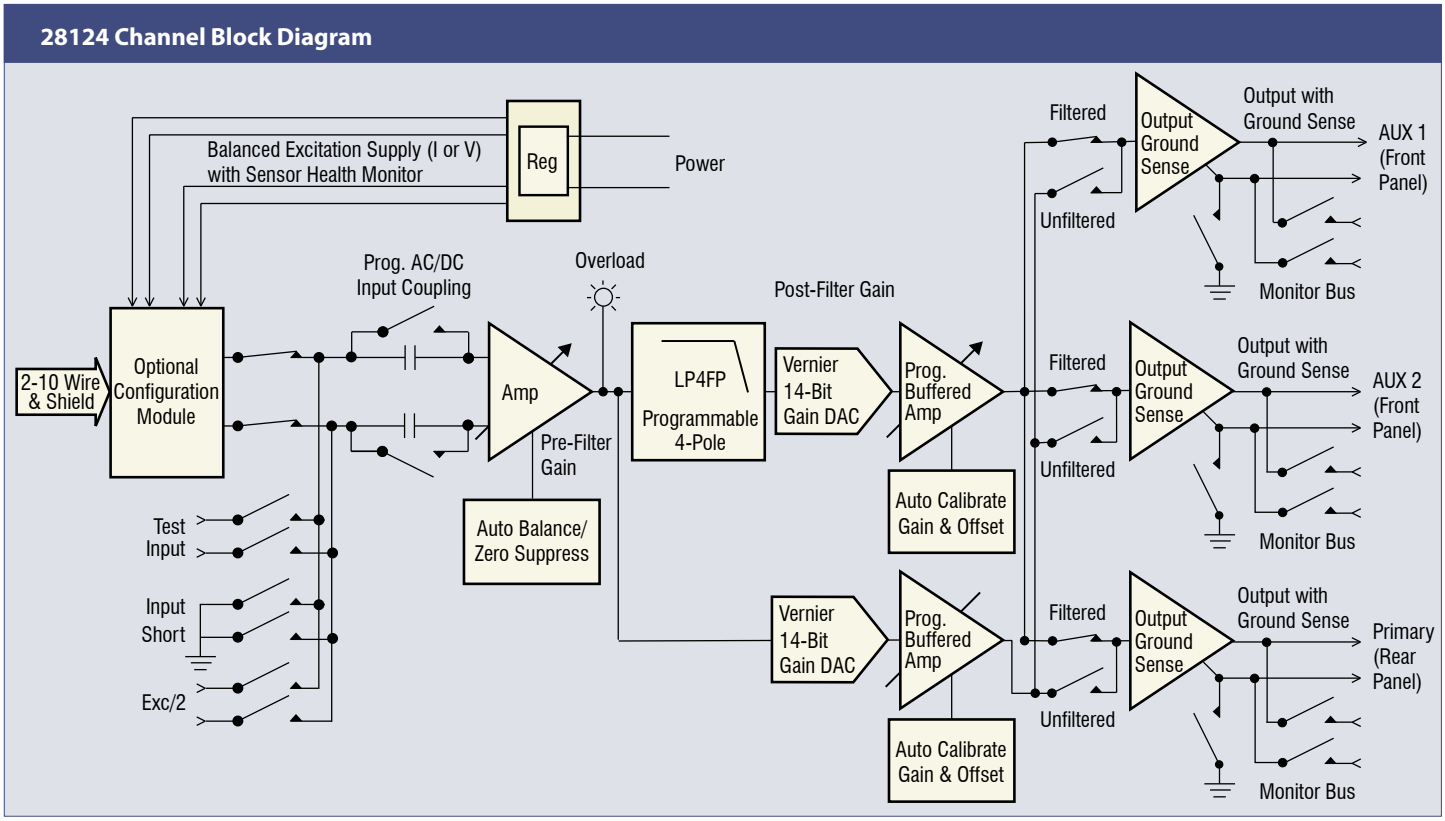
Temperature:
0°C to 40°C (operating);
–20°C to 70°C (storage)

Connectors:
The input connectors are integral to the 28124 card. Cutouts on the 28000 frames allow the input connector to pass through the backplane and to mate directly 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.

28124 output connectors are integral to the 28000 system chassis. Three wires per output are provided to accommodate twisted/shielded cables. Two additional auxiliary outputs with ground sense capability are available via 15-pin DB connectors the front panel.

28124 Channel Block Diagram



28124 Accessories and Ordering

PRECISION FILTERS, INC.

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 highly reliable connections and long service life.

CONN-IN-26D: High-density 26-pin D-shell mating input connector with machined crimp pins and metal backshell with strain relief

CONN-IN-26D-SC: High-density 26-pin D-shell mating input 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

CONN-OUT-15D: 15-pin D-shell mating output connector with machined crimp pins and metal backshell with strain relief

CONN-OUT-15D-SC: 15-pin D-shell mating output connector with machined solder cup pins and metal backshell with strain relief

CONN-OUT-50D-A: 50-pin D-shell mating output connector with crimp pins and backshell with strain relief

CONN-OUT-50D-SC-A: 50-pin D-shell mating connector with solder cup pins and backshell with strain relief.

Ordering Information

28124-<LP4FP>-<HC10\HC14>

- <HC10\HC14> — Optional Configuration Modules
- <LP4FP> — Filter Specification: 4-pole low-pass (LP4FP)

BC6, BC7, BC8, HC10, HC14 Optional Programmable Configuration Modules:

Only one BC or HC module may be supported per 28124 card.

BC6, BC7 and BC8 are separately ordered plug-on modules that are automatically identified and controlled by the system. One module supports all four channels on the card.

HC10 and HC14 are factory installed configuration modules and are specified as an option for the 28124 card.

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 464kB Switch Matrix System

Precision switch systems are reliable solid-state switch matrix systems, providing computer-controlled connection between input and output signals. Configure the 464*k*B 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.

PRECISION FILTERS, INC.
ISO 9001 CERTIFIED QUALITY

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P8465 Rev D