Precision 28304
Quad Charge/IEPE Conditioner with Long Distance TEDS™ and REZCOMP® Technology

The 28304 Quad Charge/IEPE Conditioner with Long Distance TEDS is a dual mode card providing four-channels of conditioning for either piezoelectric or IEPE sensors. It features versatile 4- or 8-pole filtering with programmable characteristics for either time or frequency domain applications and a filtered bandwidth up to 204.6 kHz or an unfiltered wide-band width of 450 kHz. The T-Insertion feature can be used as an “Electronic Tap-Test” to gather information on all accelerometer channels quickly and easily from the convenience of the control room.

The 28304 features patent pending REZCOMP® transducer compensation technology that extends the useable frequency response of resonant sensors. REZCOMP is effective at compensating the seismic mass resonant response of an accelerometer, the organ pipe resonant response of a recessed mounted pressure sensor and the resonant response associated with the protective screen of a microphone sensor. Based on a characterization of the sensor Q and resonance frequency, the compensation technique extends the usable sensor bandwidth by a factor of 3 or more.

The Precision Filters’ LDTEDS™ (Long-Distance Transducer Electronic Data Sheet) can communicate with TEDS capable sensors out to a distance of 1500 feet.

28304 Measurements
- Measurement of vibration, shock, pressure, acoustics
- High temperature PE sensor measurements
- Load, torque, force
- Extended frequency accelerometer, microphone and pressure measurements
- IEPE sensor measurements
- Low-level AC or DC voltage measurements
- Anti-aliasing filter/amplifier

28304 Applications
- Wind tunnels
- Gas turbines
- Acoustic test
- Transmission driveline test
- Steam turbines
- Ballistic shock
- Cylinder pressure

28304 Features
- Four channels per card, 64 channels per 28016 chassis system
- Dual mode: piezoelectric or IEPE
- REZCOMP® technology to extend frequency response of accelerometer, microphone and pressure sensor measurements
- Ground Sense Input Mode allows grounded sensors
- Up to 204.6 kHz “filtered” bandwidth or 450 kHz “wide-band” bandwidth
- Two charge conversion ranges for 10,000 or 100,000 pC FS inputs
- T-insertion for health test of inaccessible accelerometers
- Programmable IEPE current to 0, 4, 8, 12 mA
- TEDS compatible
- Programmable amplifier: x1/16 to x8192 with 0.05/vernier
- 4 or 8-pole low-pass filters with programmable flat/pulse characteristics with filter bypass (wide-band)
- Optional 8-pole band-pass filter (4-pole high-pass and 4-pole low-pass filter)
- 2° phase matching between any channels, 10 Hz to Fc
- Overload detection
- Precise automatic calibration
- Auxiliary front panel output connection to support the use of custom output modules

REZCOMP™ Overview
Precision Filters developed the patent pending REZCOMP technology to extend the frequency response of accelerometers, pressure sensors and microphones in real-time with no need for data post-processing. Accelerometers have the well-known under-damped seismic resonant response of the sensing mass. This response typically limits the use of the sensor to 20% of the resonance frequency. With REZCOMP, useable sensor bandwidth may be extended to as much as 80% of the resonance, resulting in a 4X improvement in overall measurement bandwidth.
**Precision 28304 Description**

The 28304 is a member of the Precision 28000 family of signal conditioners. The 28304 provides four channels of dual mode Charge/IEPE conditioning. Up to sixteen 28304 cards may reside in the 28000 System to provide 64 channels in a single 6U chassis.

In charge mode the 28304 provides two charge conversion ranges with full-scale inputs of 10,000 or 100,000 pC. Channel gains of up to 8192 provide charge sensitivity as high as 8.192 V/pC. A programmable input stage allows operation with either grounded or isolated accelerometers. Low noise, low-distortion and high accuracy circuits guarantee accurate high frequency measurements of even low-level signals.

Verification and documentation of actual charge gain can be performed using built-in shunt calibration with secondary standard shunt calibration capacitors. The calibrated value of shunt cal capacitors is stored on card EEPROM and can be recalled by host software for exact span verification or data post processing.

In IEPE mode the 28304 accommodates long cable runs with programmable IEPE current up to 12 mA. As with charge mode, accurate measurements of wide band, low-level signals are guaranteed by channel gains to 8192 filtered, frequency response to 204.6 kHz, low noise, and high accuracy circuits.

Input signal visibility is a crucial aspect of IEPE sensors as the sensors bias voltage is a useful indicator of sensor, cable and connector health. The 28304 card IEPE input stage continually monitors the DC bias voltage present on the channel input prior to the AC coupling stage. Not only is this voltage level displayed for each channel but it is also compared to user programmable upper and lower threshold limits to alert the user to a sudden shift of the bias level. A system bias level report can be requested at any time, creating a file useful for pre-test gage health documentation.

**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. Gain is apportioned between the input and output based on the reserve setting in the GUI. Gain is distributed for best noise performance while conforming to the user’s worst case estimate of out-band or transient signals. Overload detectors alert the user to over-voltage conditions.

The 28304 with either the 4-pole or 8-pole low-pass filter with cutoffs settings programmable from 1 Hz to 204.6 kHz and a selectable “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 pass-band response similar to the Bessel filter yet provides superior reject-band characteristics. The “pulse” mode is ideal for time domain applications including transient (shock) measurements and time domain waveform analysis.

**REZCOMP® Technology**

Precision Filters developed the patent pending REZCOMP® technology to extend the frequency response of accelerometers, pressure sensors and microphones in real-time with no need for data post-processing.

For recessed mounted pressure sensors, classic organ pipe resonances occur in the middle of the useable frequency response range of the sensor. REZCOMP flattens this resonant response and compensates for phase as well.

The introduction of a protective screen of a microphone produces a well-known Helmholtz resonant response that occurs in the useable bandwidth of the sensor. REZCOMP flattens the response to make use of the full available frequency response of the microphone.

REZCOMP compensation is based on user entry of sensor quality factor Q and resonance Fr. The complementary transfer function is programmed to flatten the sensor frequency response and linearize the sensor phase response. Vendors such as Kulite™ provide Q and Fr data specific to each sensor. For even more accurate results, the sensitivity of Q and Fr to temperature may be accounted for simply by entering the operating temperature of the sensor. As the block diagram on page 5 illustrates, programmable pre-filter gain is first applied to the input signal in order to preserve signal-to-noise ratios of the in-band sensor signal while allowing for headroom for out-of-band signals. Next the sensor frequency response correction is applied to compensate for the resonant response of the sensor. The programmable filter is then applied to the signal to eliminate out band energy and to prevent aliasing. The signal is then further amplified using post-filter gain to ensure the full use of the A/D dynamic range after compensation of the resonance characteristics.

It is possible to correct for undesired resonant frequencies by post-processing test data however post-processing data after digitization can result in poor signal-to-noise ratios since the A/D input must accommodate both the in-band signal of interest and the sensor resonance. Allocating amplifier headroom for the sensor resonance results in reduced amplification of the small in-band signal above the self-noise of the signal conditioner and A/D. This results in sub-optimal signal-to-noise ratios regardless of the resolution of the A/D. The REZCOMP correction approach provides superior real-time performance by maximizing signal-to-noise ratios.

**Long Distance TEDS**

The 28304 provides a mixed mode transducer interface in conformance with IEEE 1451.4 Smart Transducer Interface. The mixed mode interface supports IEPE (Integrated Electronic Piezo-Electric) sensors powered by current source and TEDS (Transducer Electronic Data Sheet) capable sensors. TEDS information such as manufacturer name, serial number, calibration data, etc. are readable by the system for use in system scaling, identification, bookkeeping, troubleshooting and other functions.

TEDS sensors may be effectively applied to test models; however, there is a restriction that the cable run between the signal conditioner and the sensor be limited to 400 feet in order to be able to properly read the TEDS. For applications such as weapons test or vibration test on large structures, safety, environment, test article size and other factors often require cable runs in excess of 1000 feet that have until now precluded the use of TEDS-equipped sensors.

To overcome the communications distance limitations of conventional TEDS, the 28304 is equipped with Precision Filters’ proprietary Long-Distance TEDS (LDTEDS) hardware. The proprietary LDTEDS circuitry uses an analog-to-digital converter to digitize the TEDS waveforms and utilizes a digital signal processor to process the TEDS data. LDTEDS can communicate with sensors at distances out to 1500 feet.
Precision 28304 Description

Accelerometer Conditioning
As the temperature of the test environment continues to increase, the vibration measurement task becomes more difficult. Accelerometer manufacturers have responded with high temperature accelerometers that perform at temperatures as high as 750°C; however, care must be taken when using these sensors. One common characteristic of accelerometers is a decreasing insulation resistance across the piezoelectric sensing element at high temperature. If a general-purpose charge amplifier is used, low frequency gain peaking could be as high as 20 to 30 dB. This will cause excessive low frequency noise, gain errors, and in severe cases total saturation of the charge amplifier. The Precision 28304 is compatible with high temperature accelerometers and exhibits less than 1 dB of peaking even with accelerometer shunt resistance as low as 100 kOhm.

Cables and Sensor Health

T Insertion
Acceleration measurements at high temperature (above 250°C) require the use of piezoelectric (charge mode) accelerometers. A very crude check of accelerometer functionality is known as the “tap test”. One by one each accelerometer case is physically tapped or stimulated with a hand held shaker. A second operator in the control room monitors the output display, verifies receipt of the signal and attempts to make some inference on functionality of the installed accelerometer. While this is a crude and time consuming technique, it is important in harsh environments to confirm basic sensor and cable health.

The Precision Filters 28304 accelerometer conditioner has built in “T-Insertion” capability to electronically stimulate the attached piezoelectric accelerometer to output a charge signal. Charge output of a stimulated accelerometer is dependent on the exact properties of the accelerometer and connecting cable. This output is extremely repeatable and can therefore be used to detect any change resulting from a faulty or damaged accelerometer. Additionally the stimulation frequency can be increased to interrogate the accelerometer in the vicinity of its mounted resonance frequency.

Since resonance characteristics are affected by accelerometer mounting, high frequency performance can identify mechanical damage that occurred during a test run. In summary, T-Insertion can be used as an “Electronic Tap-Test” to gather information on all accelerometer channels quickly and easily from the convenience of the control room. Pre- and post-T-Insert measurements can also be presented as a report that can greatly enhance QA documentation and add a new level of test validity documentation.

Muting Faulty Sensors
While most attention is paid to properly functioning sensors, a “real world” perspective forces us to consider sensors that are NOT functioning properly. Often a malfunctioning sensor can cause noise or fault currents that can corrupt other properly functioning channels. One common example of this is “cable chatter” caused by IEPE sensors with intermittent connections.

Due to cable, connector or sensor faults, it is not uncommon to develop an open circuit condition. When an open circuit occurs, the positive IEPE signal wire suddenly shifts to the compliance voltage level of the attached signal conditioner. A gross fault resulting in a permanent open condition does not cause a noise problem; however, an intermittent fault will create a chatter condition whereby the long connecting wires continually switch between the high voltage compliance level and the functional bias level of the IEPE sensor. This chatter condition creates a hostile noise source to any other gage extension wires near the hostile cable. Often a user may notice the noisy output signal and ignore the faulty channel. However, if the input is not properly muted by removing the IEPE current source, the unsuspecting user will still have difficulty understanding why other channels are showing increased noise.

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. Precision 28000 signal conditioning channels have a “MUTE” feature, which places the faulty channel in its quietest quiescent state and minimizes the possibility of coupling noise to properly functioning channels.

28304 Programmable Features

Charge Mode Features
• FS range (10,000 pC or 100,000 pC)
• Ground Sense Input Mode (breaks ground loops with grounded accelerometers)
• Shunt calibration (on or off)
• T-insertion (on or off)

IEPE Mode Features
• IEPE current (0, 4, 8, 12 mA)
• Bias monitor with programmable fault limits (upper limit and lower limit)
• Input mode (grounded or isolated)
• AC current dither

REZCOMP Features
• Quality Factor, Q, 1 to 50
• Resonance Compensation Frequency, Fr, 10 Hz to 255 kHz
• Sensor Operating Temperature

IEPE/Charge Common Features
• Gain (x1/16 to x8192)
• Programmable filter cutoffs setting from 1 Hz to 204.6 kHz
• Programmable Filter Characteristics: "Flat" mode for flat pass-band Butterworth type response. “Pulse” mode for linear phase Bessel type response.
• Test modes: Run (operate), Input short, Cal voltage substitution (Test Bus)

28304 Graphical User Interface Display
All programmable features in addition to:
• System scaling in engineering units
• Overload status
• Gain Wizard
• Filter Wizard
• Group Control


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28304 Details and Specifications

28304 Conditioner Cards
The detailed description and specifications for the 28304 are organized as follows in the sections below:

• Input Characteristics
• Filter/Amplifier Mode
• Test Modes
• Output Characteristics
• Filter Characteristics
• General Card Characteristics
• Accessories
• Ordering Information

28304 Input Characteristics
IEPE Inputs (IEPE Mode)
Type: Programmable, grounded (sensor floating) or isolated (sensor grounded)
Connector: Two isolated coaxial insert Combo-D (BNC or microdot using plug-on adapters)
IEPE Current: 0, 4, 8, 12 mA with disconnect
Current Accuracy: ±0.1 mA ±5% of setting
IEPE Compliance Voltage: 26 VDC – (IEPE x 400)
IEPE Current Noise: 130 pA/\sqrt{Hz}
Frequency Response: 0.25 Hz to 500 kHz
Noise: 10 nV/\sqrt{Hz}
RTI at 1 kHz and pre-gain >x8 typical
Maximum Distance to Sensor (with LDTEDS, Option T): 1500 feet (30 pf/ft cable)

Piezoelectric Inputs (Charge Mode)
Type: Programmable, grounded (sensor floating) or isolated (sensor grounded)
Connector: Two Combo-D pins (two channels per connector)
IEPE Current: 0, 4, 8, 12 mA with disconnect
Current Accuracy: ±0.1 mA ±5% of setting
IEPE Compliance Voltage: 26 VDC – (IEPE x 400)
IEPE Current Noise: 130 pA/\sqrt{Hz}
Frequency Response: 0.25 Hz to 500 kHz
Noise: 10 nV/\sqrt{Hz}
RTI at 1 kHz and pre-gain >x8 typical
Source Capacitance: Low frequency response is affected by accelerometer capacitance, see chart 2.
Source Resistance: Low frequency response exhibits less than 1 dB of peaking with R(in) as low as 100 kΩ, see chart 1.

Filter/Amplifier Mode
Note: Specs at 25°C unless otherwise noted.
Common Mode V: ±10 V operating
Input Protection: ±25 V continuous (power on)
CMRR: >-80 dB DC to 440 Hz (PRG >x8)
Input Impedance:
AC Coupled: 0.1 µF & 9 MΩ per side
DC Coupled: 9 MΩ/100pf per side
AC Coupling:
Frequency: 0.25 Hz (-3 dB)
Max Level: ±10 Vpk for F≤200 kHz;
±10 Vpk (200 kHz/F) for F>200 kHz
Noise: 10 nV/\sqrt{Hz} RTI at 1 kHz and pre-gain >x8 typical
Prefilter Gain (PRG): x1 to x 512 in binary steps
Postfilter Gain (POG): x1/16 to 16
Overall Gain: x1/16 to x8192
Gain Setability: 0.05% steps for gain >1X
0.05%/POG for gain <1X
Gain Accuracy: 0.02% typical, 0.2% maximum for gain >1X
0.2%/ gain maximum for gain <1X
Distortion: 0.1% re Fullscale
Frequency Response (Bypass Mode):
–3.01 dB @ 500 kHz
–0.1 dB @ 200 kHz
Bypass (Unfiltered) High Frequency Rolloff: 18 dB/octave

Chart 1: Low Frequency Charge Mode Sensitivity to R (in)
Chart 2: High Frequency Charge Mode Sensitivity to Accelerometer + Cable Capacitance
28304 Details and Specifications

28304 Test Modes

Shunt Cal:
(Charge Mode only) Test Bus signal is applied to charge amp input through a 1000 pF shunt cal capacitor.

T-insertion:
(Charge Mode only) Attached accelerometer low connection is driven with test signal to produce charge signal equal to \( Q = V \) (T-insert) \* C (sensor+cable). Charge Q is measured by charge amp as indication of sensor and cable health. T-Insert Voltage is derived from the system Test Bus according to:
\[ V (\text{T-insert}) = V (\text{Test Bus}) / 10 \]
T-insertion BW: (accel + cable <1000 pF ±0.5% to 10 kHz ±5% to 100 kHz

Amplifier Short:
A switch at the amplifier input is connected to ground for measurement of noise and DC offset.

Test Bus:
Test input allows for injection of voltage substitution test signal. An external test signal or the 28000 Test Subsystem may be connected at the BIF card front panel.

AC Current:
(IEPE Mode only) An AC dither current is summed with the IEPE current to create an AC voltage signal based on the transducer’s output impedance. AC current is derived from test bus voltage according to:
\[ AC \text{ Current} = V (\text{Test Bus}) / 10000 \]

28304 Output Characteristics

Type:
Two independently buffered single ended outputs (per channel) are available via rear panel high density 26-pin connector when using a M5 equipped chassis. The four primary outputs (Out A) are available via rear panel DB50 connector when using a M3 equipped chassis. Front panel outputs must be used if dual outputs are desired in a M3 equipped chassis.

Z:
10 Ω shunted by 100 pF

Max Output:
±10 Vpk, ±5 mA pk

Noise:
5 µVrms RTI + 60 µVrms RTO, typical 3 Hz to 100 kHz

Crosstalk:
–80 dB, DC to 30 kHz between channels with the same configuration and programmed settings

Output Monitor (Standard)
A switch located at the output of each channel allows for multiplexed connection to the mainframe output monitor bus. The output monitor bus is available at a connector located at the rear of the mainframe. The monitor function is used by the Test Subsystem or is available to the user for viewing channel output.

Front Panel Output Option 4
If a direct connection to the four outputs is desired via the front panel, Option 4 should be specified. Option 4 is useful if dual outputs are required in a M3 equipped chassis. Option 4 replaces the auxiliary output adapter connector with a industry standard HD26 connector.

28304 Channel Block Diagram

28304 Channel Simplified Block Diagram

2804 with Auxiliary Output Connector, left, and the 2804 with Option 4, right
You want your analog data to come clean before digital conversion.

The 28304 Card has a variety of high performance filter characteristics available for HP, LP or BP Precision filtering.

**Flat/Pulse Low-Pass Filters**

Our new choice of LP4FP 4-pole or LP8FP 8-pole flat/pulse low-pass filters provide the user with the versatility to address applications in either the time or frequency domain and are available on many 28000 card models. Frequencies can range as high as 204.6 kHz with fixed frequency choices for economy.

**Flat Mode Low-Pass Filters**

Precision LP4F and LP8F “flat” mode characteristics are specified to have outstanding passband flatness equivalent to the Butterworth yet deliver very sharp roll-off characteristics.

The LP4F and LP8F are a good choice as an anti-aliasing filter and for applications such as spectral analysis. The LP8F has zero passband ripple and over 100 dB/octave attenuation slope.

**Pulse Mode Low-Pass Filters**

For the time domain, there are the LP4P and LP8P “pulse” mode low-pass filters. These filters have excellent transient response and phase linearity making them ideal filters for time domain applications including transient (shock) measurements and time domain wave form analysis … all with roll-off characteristics superior to their Bessel filter counterparts.

**High-Pass and Band-Pass Filters**

For high-pass filtering, we offer the HP4F 4-pole characteristics. For band-pass filtering, choose the HP4F/LP4FP band-pass characteristic to provide programmable bandwidth and center frequency filters.

**REZCOMP Sensor Compension**

Patent pending REZCOMP® technology extends the frequency response of accelerometers, pressure sensors and microphones in real-time with no need for data post-processing. Based on user entry of sensor Q and resonant frequency, REZCOMP extends usable sensor bandwidth by a factor of two or more.

When applied to an accelerometer with Q of 10, REZCOMP extends usable 5% bandwidth by a factor of 5X as shown below.

**Traditional Filters**

Of course, we offer the traditional filter types such as Butterworth and Bessel characteristics … just ask!

In any case, we deliver to you a tightly controlled filter with phase match better than 1 degree and usually better than 0.5 degrees.
28304 Filter Type Characteristics

Option LP4FP:
- 4-pole, 4-zero low-pass filter.
  Programmable for maximally flat pass-band (LP4F) or linear phase with optimized pulse response (LP4P).
Option LP8FP:
- 8-pole, 8-zero low-pass filter.
  Programmable for maximally flat pass-band (LP8F) or linear phase with optimized pulse response (LP8P).
Option HP4F/LP4FP:
- 8-pole, 8-zero band-pass filter.
  Flat HP4F 4-pole, 4-zero high-pass filter cascaded with a 4-pole, 4-zero low-pass filter. Low-pass filter programmable for maximally flat pass-band (LP4F) or linear phase with optimized pulse response (LP4P).
Option REZC/LP4FP:
- REZCOMP® sensor compensation cascaded with LP4FP low-pass filter.

Cutoff Frequencies:
Flat Mode:
- 2 Hz to 2.046 kHz in 2 Hz steps
  2.2 kHz to 204.6 kHz in 200 Hz steps
Pulse Mode:
- 1 Hz to 1.023 kHz in 1 Hz steps
  1.1 kHz to 102.3 kHz in 100 Hz steps

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

<table>
<thead>
<tr>
<th>Specification</th>
<th>LP4F Maximally Flat Low-Pass Filter</th>
<th>LP4P Constant Time Delay Low-Pass Filter</th>
<th>LP8F Maximally Flat Low-Pass Filter</th>
<th>LP8P Constant Time Delay Low-Pass Filter</th>
<th>HP4F Maximally Flat High-Pass Filter</th>
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<td>-3.01 dB</td>
<td>-3.01 dB</td>
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<td>&lt; 3.7 deg</td>
<td>&lt; 102 deg</td>
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REZCOMP Q & Fr:
- Compensation Q: 1 to 20 in 0.1 steps; 20 to 50 in 0.5 steps

Compensation Frequency (Fr):
- Low-Range: 10 Hz to 2.55 kHz in 10 Hz steps
  Mid-Range: 2.6 kHz to 51 kHz in 200 Hz steps
  High-Range: 52 kHz to 255 kHz in 1 kHz steps

LP4F, LP4P, LP8F, LP8P:
- 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

REZCOMP (REZ):
- Amplitude Accuracy:
  Low-Range:
    ±0.1 dB DC to 0.8 Fr; 1.25 Fr ≤ f ≤ 10 kHz
    Q ≤ 10: ±0.2 dB; 0.8 Fr < f < 1.25 Fr
    Q > 10: ±0.02 dB * Q; 0.8 Fr < f < 1.25 Fr
  Mid-Range:
    ±0.15 dB DC to 0.8 Fr; 1.25 Fr ≤ f ≤ 100 kHz
    Q ≤ 10: ±0.25 dB; 0.8 Fr < f < 1.25 Fr
    Q > 10: ±0.025 dB * Q; 0.8 Fr < f < 1.25 Fr
  High-Range:
    ±0.2 dB; DC to 0.6 Fr; ±0.5 dB; 1.7 Fr ≤ f ≤ 255 kHz
    Q ≤ 10: ±1.25 dB; 0.6 Fr < f < 1.7 Fr
    or 255 kHz whichever is less
    Q > 10: ±0.125 dB * Q; 0.6 Fr < f < 1.7 Fr
    or 255 kHz whichever is less

- Phase Match:
  ±2°, DC to 0.8 Fr Low and Mid-Ranges;
  DC to 0.6 Fr High-Range

- Amplitude Match:
  ±0.2 dB, DC to 0.8 Fr Low and Mid-Ranges;
  DC to 0.6 Fr High-Range
28304 Specifications and Accessories

General Characteristics

28304 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)

Input and Output Connectors:
The input connectors are integral to the
28304 card. Cutouts on the 28000 frames
allow the connectors to pass through the
backplane and to directly mate with the
input cables.

Accessories

Mating Connectors
Precision Filters mating connectors accom-
modate up to 22-AWG wire and are supplied
with high quality metal backshells and gold
plated screw machined contacts for high reli-
ability connections and long service life.

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 out-
puts may be routed to control systems, tape
backup systems, auxiliary data acquisition
systems, scope bays and other destinations.

28304 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.

BUFF-4BNC/15D Output Buffer
The BUFF-4BNC/15D quad output buffer
module provides one buffered output per
channel on 4 BNC connectors and one 15-pin
multi-pin connector.

BUFF-4CH/(2)15D Dual Output Buffer
The BUFF-4CH/(2)15D dual output buffer
provides two buffered outputs per channel
on 15-position D-type female connectors.

28000-ACCEL/VEL4 Acceleration to
Velocity Integrator
The 28000-ACCEL/VEL4 converts the front-
panel acceleration outputs signals to analog
signals representative of velocity. Velocity
output for each channel is available via four
BNC connectors and one 15-pin D-shell
connection.

Factory Acceptance Test (FAT)
Adapters

28000-TEDS-ADAPTER-A
Supports FAT tests of the LDTEDS function
of the 28324 card. This dual channel adapter
incorporates TEDS memory and a load
capacitor that emulates the Long Distance
TEDS (LDTEDS) capability.

28304/28324-FAT-ADAPTER
Supports FAT tests of the charge circuit on
28304 cards. Consists of Combo-D input
adapter and NIST traceable calibration
capacitor.

Ordering Information
28304-<LP4FP|REZC/LP4FP|LP8FP|HP4F/LP4FP>-Option 4-Option T

Filter Specification:
4-pole low-pass (LP4FP)
REZCOMP w/4-pole low-pass (REZC/LP4FP)
8-pole low-pass (LP8F)
8-pole band-pass (HP4F/LP4FP)

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

Exceptional desktop performance.
Ideal for conditioning low-level volt-
age 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 464kB Switch Matrix System
Precision switch systems are reliable
solid-state switch matrix systems, provid-
ing computer-controlled connection
between input and output signals.
Configure the 464kB 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 configu-
rations from the host computer
over the network. Built-in self-test
with fault diagnostics.

Precision Filters, Inc.
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Web Site: www.pfinc.com