27304 QUAD CHARGE/VOLTAGE CONDITIONER IEPE CURRENT SOURCE

For the 28000 Universal Signal Conditioning System

PRECISION FILTERS, INC.

SYSTEM 28000 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 or DC power supplies
- Built-in temperature and power supply monitoring with alarms

28000 SIGNAL CONDITIONING SYSTEM

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.

PRECISION 27304 FEATURES

Charge Mode

- Fullscale charge: 2.5 to 160,000 pC
- Fullscale MU: 2.5 to 160,000 pC/Transducer Sensitivity (pC/MU)
- Transducer Sensitivity: 0.001 pC/MU to 9999 pC/MU

Voltage Mode (IEPE)

- Fullscale voltage: 2.5 to 10.24 V
- Fullscale MU: 2.5 mV to 10.24 V/Transducer Sensitivity (mV/MU)
- Transducer Sensitivity: 0.001 mV/MU to 9999 mV/MU

Additional Features

- Fullscale output: ±1.0000 to 10.000 V
- Programmable anti-alias filters: 4-, 6-, or 8-pole
- Pre-filter and output overload detectors
- HP filter: –3.01 dB at 0.5 Hz (2-pole)
- Pseudo-Isolated or grounded inputs

27304 DESCRIPTION

The 27304 is a member of the 28000 family of signal conditioners. It provides conditioning for two types of transducers to provide flexibility for use in a wide range of applications. For piezoelectric sensors it utilizes a charge converter which covers the range of fullscale charge from 2.5 pC to 160,000 pC. For integrated circuit piezoelectric sensors (IEPE) and remote charge preamps, a voltage input with current excitation is provided to cover a fullscale voltage range from 2.5 mV to 10.24 V. And it provides 4-digit sensor sensitivity settings from 0.001 to 9999 (mV/MU or pC/MU).

The 27304 has a broad range of anti-alias filter characteristics (4, 6, and 8 poles) and a wide selection of cutoff frequency settings (available from 1 Hz to 127.5 kHz) with filter bypass. Using these real anti-alias filters the 27304 is data acquisition ready. A 2-pole high-pass filter with a –3.01 dB at 0.5 Hz attenuates low frequency noise.

The 27304 has a unique pseudo-differential input that provides rejection to external ground noise by more than 60 dB. Ground loop interference caused by externally grounded transducers is significantly reduced.

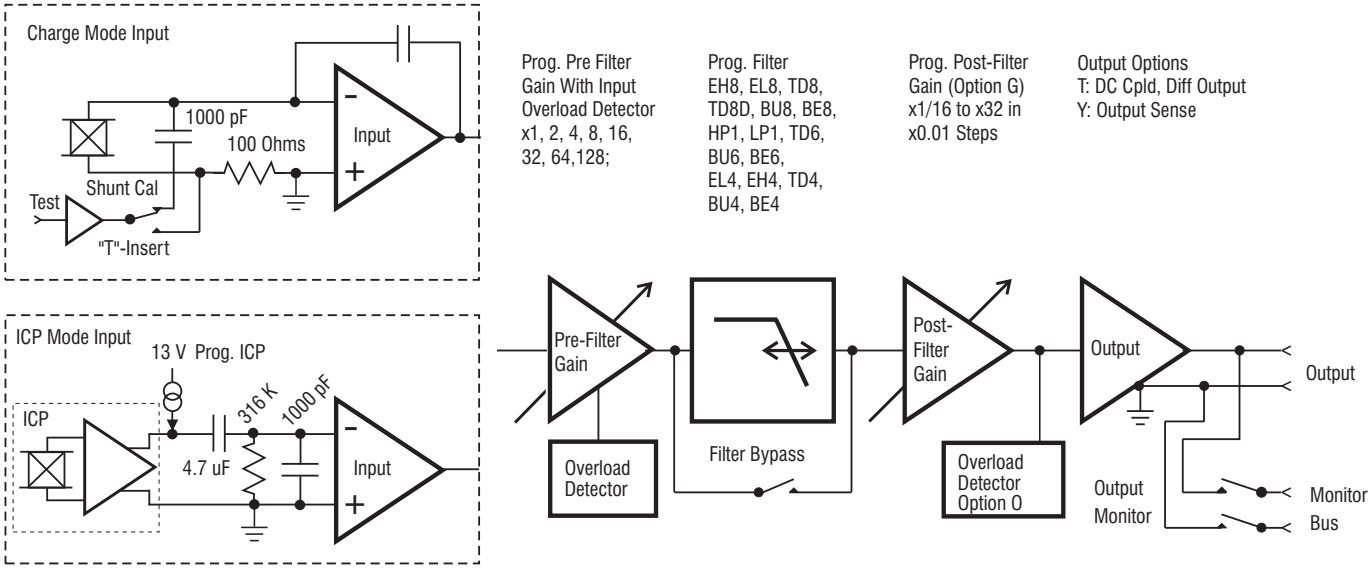
Test inputs in both charge mode and voltage mode, along with the system test bus and output monitor bus, make the card ready to work with the 28000 test subsystem hardware and software to support go/no-go and acceptance tests.

27304 CHARGE MODE CHARACTERISTICS

Full Scale Range (MU):	2.5 to 160,000 pC/transducer sensitivity	
Transducer Sensitivity Settings:	0.001 pC/MU to 9999 pC/MU	
	1000 pF Cap	16,000 pF Cap
Charge Conv. Gain:	1 mV/pC	0.0625 mV/pC
Max Charge Input:	10,000 pC	160,000 pC
Noise, RTI, Max Gain:	3 fC +1.6 fC/nF	50 fC +1.6 fC/nF
Gain Range:	1 to 4096 mV/pC	0.0625 to 256 mV/pC
Freq. Response:	–3 dB at 0.5 Hz (12 dB/octave)	
Max. Charge Input:	160,000 pC Range: 160,000 pC for input frequency, f ≤ 25 kHz; 160,000 pC*(25 kHz/f) for 25 kHz < f < 200 kHz.	
10,000 pC Range:	10,000 pC for input frequency, f ≤ 100 kHz; 10,000 pC*(100 kHz/f) for 100 kHz < f < 200 kHz.	
Gain Accuracy:	±0.1% typical, ±0.5% maximum	
Gain Tempco:	50 ppm/°C + 5 ppm/°C/filter pole	
CMRR, Isolated:	60 dB, 50 Hz to 200 Hz	
Common Mode Lvl:	±3.2 Vpk	
Common Mode Z:	100 Ω	

VOLTAGE MODE CHARACTERISTICS CURRENT-SOURCE, IEPE (OPTION I)

Full Scale Range (MU):	0.0025 to 10.24 V/transducer sensitivity (24 V compliance) 0.0025 to 5 V/transducer sensitivity (13 V compliance)
Transducer Sensitivity:	0.001 mV/MU to 9999 mV/MU
Gain Range:	0.0625 to 4096 in binary steps or continuous with 4-digit resolution
Gain Accuracy:	±0.1% typical, ±0.5% maximum
Gain Tempco:	±80 ppm/°C ±5 ppm/°C/filter pole
Current Source Range:	1 to 12.75 mA
Setting Resolution:	50 μA
Current Drift:	40 ppm/°C
Current Noise:	0.1 μA rms (1 Hz to 100 kHz)
Voltage Compliance:	26 V with 28000 frame
Voltage Noise RTI:	7 μVrms (w/o current source) (10 Hz to 100 kHz)



27304 Channel Block Diagram

27304 TRANSFER CHARACTERISTICS

Frequency Response
- Filter Bypass On: –3 dB at 0.5 Hz & 200 kHz
- Filter Bypass Off: Bypass response + Filter response
- Channel Match: ±0.1 dB & ±1°, 10 Hz to Fc
- Harmonic Distortion: Distortion product –70 dB re fullscale
- Channel Crosstalk: –80 dB re fullscale signal in another channel
- Full Power BW: 100 kHz in Bypass
- Overload Recovery: Negligible for charge inputs less than fullscale input X reserve setting
- Overload Detectors: Detect both in-band and out-band overloads. Input overload detection is standard.

Option O: Post-filter overload detector
- Overload Threshold: Programmable ±1 V to ±10 V in 5 mV steps
- Accuracy: ±50 mV ±1%

OUTPUT CHARACTERISTICS

- Type: Single-ended
- Level: ±10 Vpk, ±5 mA
- Impedance: 50 Ω//100 pF

Option T: DC coupled differential output
- Impedance: 50 Ω // 100 pF
- Maximum Output: ±10 Vpk, ±5 mA pk
- Noise: 250 μVrms into 1 MHz BW at a gain of x1

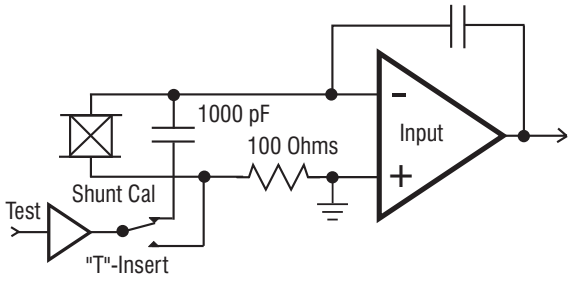
Option Y: Output Sense. Used for driving grounded single ended loads. Senses ground at the load on the output stage and refers the output to this ground. Output sense also reduces ground loop interference by providing a high impedance connection between the ground at the load and the output stage ground.
- Impedance: 50 Ω // 100 pF, Hi Output
  1 kΩ // 0.1 μF, Sense Input (Lo Output)
  Jumper selectable to 10 Ω // 0.1 μF
- Ground Error Rejection: 40 dB, DC to 120 Hz

TEST BUS—MONITOR BUS—AUTO-OFFSET AND SOFTWARE

- Test Input (Std.): A switch at the input of each channel allows the injection of a test signal.
- Shunt Cal (Std.): Test bus signal is applied to charge converter through precision (±0.1%) 1000 pF capacitor

Option C1: T-Insertion. Test signal is applied across a 100 Ω resistor inserted in series with ground return. T-insertion tests the transducer, cable, connectors, and signal conditioner channel.

T-insertion cannot be performed with transducer low connected to ground.



Test Inputs for Charge Mode

- Output Monitor (Std.): A switch at the output of each channel provides connection to the monitor bus. The monitor is accessed by auto-offset circuits, the test subsystem and external instruments for measuring or viewing channel outputs.
- Auto-Offset (Std.): When invoked, the auto-offset zeros each output offset to less than 5 mV at any gain setting.

27304 FILTER CHARACTERISTICS

8-Pole Filters

EL8	8-pole, 8-zero Elliptic low-pass filter.
TD8	8-pole, 6/8-zero constant time delay (linear phase) low-pass filter. Both the TD8A and TD8B characteristics are provided. Selecting between the TD8A and the TD8B is accomplished via front panel or computer control.
TD8D	8-pole, 8-zero constant time delay (linear phase) low-pass filter.
BU8	8-pole Butterworth low-pass characteristic.
BE8	8-pole Bessel low-pass characteristic.

6-Pole Filters

LP1	6-pole, 6-zero Elliptic low-pass filter.
TD6	6-pole, 4/6-zero constant time delay (linear phase) low-pass filter. Both the TD6A and TD6B characteristics are provided. Selecting between the TD6A and the TD6B is accomplished via front panel or computer control.
BU6	6-pole Butterworth low-pass characteristic.
BE6	6-pole Bessel low-pass characteristic.

4-Pole Filters

EL4	4-pole, 4-zero Elliptic low-pass filter.
TD4	4-pole, 4-zero constant time delay (linear phase) low-pass filter.
BU4	4-pole Butterworth low-pass characteristic.
BE4	4-pole Bessel low-pass characteristic.

CUTOFF FREQUENCY SETTINGS

Standard 2-Range Models

A Range	5 Hz to 1.275 kHz in 5 Hz steps	(Low)
	1.5 kHz to 127.5 kHz in 500 Hz steps	(High)
C Range	1 Hz to 255 Hz in 1 Hz steps	(Low)
	300 Hz to 25.5 kHz in 100 Hz steps	(High)
E Range	1 Hz to 255 Hz in 1 Hz steps	(Low)
	260 Hz to 2.55 kHz in 10 Hz steps	(High)

Standard F8??? Single 255:1 Ranges (no setup required)

F8001 Range	1Hz to 255 Hz in 1 Hz steps
F8010 Range	10 Hz to 2.55 kHz in 10 Hz steps
F8100 Range	100 Hz to 25.5 kHz in 100 Hz steps
F8500 Range	500 Hz to 127.5 kHz in 500 Hz steps

Fixed Frequency Models

???	??? denotes a fixed cutoff frequency in the range between 1 Hz and 127.5 kHz.

8-Pole Filter Selection Guide

	EL8	TD8A	TD8B	TD8D	BU8	BE8
Filter Type	LP	LP	LP	LP	LP	LP
Function	Cauer	Bessel w/Z	Bessel w/Z	Time Delay	Butterworth	Bessel
Number of Poles, Zeroes	8p, 8z	8p, 6z	8p, 8z	8p, 8z	8p	8p
Pass-band Ripple (dB p-p)	0.1	n/a	0.2	0.005	n/a	n/a
–0.1 dB Frequency	F_c	0.104 F_c	0.569 F_c	1.0932 Fc	0.791 F_c	0.185 F_c
–3.01 dB Frequency	1.099 F_c	0.565 F_c	F_c	1.2743 Fc	F_c	F_c
–20 dB Frequency	1.266 F_c	1.345 F_c	1.694 F_c	1.6294 Fc	1.333 F_c	2.347 F_c
–40 dB Frequency	1.441 F_c	1.867 F_c	2.340 F_c	2.1120 Fc	1.778 F_c	3.337 F_c
–60 dB Frequency	1.618 F_c	2.396 F_c	2.951 F_c	2.6240 Fc	2.371 F_c	4.522 F_c
–80 dB Frequency	1.750 F_c	2.915 F_c	3.332 F_c	2.9745 Fc	3.162 F_c	6.069 F_c
Stop-band Frequency	1.788 F_c	n/a	3.332 F_c	3.000 Fc	n/a	n/a
Stop-band Attenuation (dB)	90.75	n/a	80.28	82.57	n/a	n/a
Phase at F_c (^{0})	–359.20	–301.88	–301.88	n/a	–360.00	–182.16
Phase Distortion at F_c (^{0})	84.9	0.23	0.23	±0.5 B.S.L.	66.2	0.00
Overshoot (%)	19.8	0.19	5.56	10.2	16.7	0.34
1% Settling Time (sec)	5.15/F_c	1.34/Fc	1.54/F_c	3.15/Fc	3.45/F_c	0.79/F_c
0.1% Settling Time (sec)	7.97/F_c	1.86/Fc	2.23/F_c	3.76/Fc	5.08/F_c	1.14/F_c

BE8: 8-pole Bessel low pass
BU6: 8-pole Butterworth low-pass
EL8: 8-pole, 8-zero elliptic low-pass

TD8A: 8-pole, 6-zero constant time delay (linear phase) low-pass filter with 6 zeros in the stop-band
TD8B: 8-pole, 6-zero constant time delay (linear phase) low-pass Bessel with zeros
TD8D: 8 pole, 8-zero constant time delay (linear phase) low-pass

27304 FILTER SPECIFICATIONS

Cutoff Amplitude: –0.1 dB for EL8
–3.01 dB for TD8B, BU8, BE8,
LP1, TD6B, BU6, BE6,
EL4, TD4, BU4, BE4
–10.06 dB for TD8A
– 9.61 dB for TD6A

BU4, BE4, EL4, TD4, BU6, BE6, TD6, BU8, BE8, TD8, TD8D:

Amplitude Accuracy (DC to $F_{-3.01\ dB}$): ±0.1 dB
Amplitude Match (DC to $F_{-3.01\ dB}$):
$F_c \leq 20$ kHz: 0.05 dB max, 0.005 dB typ
20 kHz < $F_c \leq$ 127.5 kHz: 0.1 dB max, 0.01 dB typ
Phase Match (DC to $F_{-3.01\ dB}$):
$F_c \leq 20$ kHz: 0.5^o max, 0.05^o typ
20 kHz < $F_c \leq 127.5$ kHz: 1^o max, 0.1^o typ

LP1, EL8:

Amplitude Accuracy (DC to $F_{-0.1\ dB}$):
$F_c \leq 20$ kHz: filter char. ±0.1 dB
20 kHz <Fc ≤127.5 kHz:
filter char. ±0.15 dB
Amplitude Match (DC to $F_{-0.1\ dB}$):
$F_c \leq 20$ kHz: 0.05 dB max, 0.005 dB typ
20 kHz < $F_c \leq 127.5$ kHz: 0.1 dB max, 0.01 dB typ

FILTER SPECIFICATIONS (Continued)

LP1, EL8 Continued:

Phase Match (DC to $F_{-0.1\ dB}$):
$F_c \leq 20$ kHz: 0.5^o max, 0.05^o typ
20 kHz < $F_c \leq 127.5$ kHz: 1^o max, 0.1^o typ
–3.01 dB Frequency Amplitude Accuracy:
±0.25 dB
Filter Bypass (Std): Bypasses the filter but not the amplifier stages. Specifications when the filter is bypassed:
–3.01 dB Bandwidth: 200 kHz, typ
High Freq. Rolloff: 18 dB/octave
Freq. Response: ±0.1 dB, DC to 127.5 kHz

Other Specifications

Stop-Band Amplitude Response
Conformance: f = frequency in the stop-band or where there is greater than 80 dB attenuation for monotonic filters.
for f ≤ 100 kHz, minimum stop-band attenuation ±3 dB
for 100 kHz < f < 1 MHz, ±5 dB

6-Pole Filter Selection Guide

	LP1	TD6A	TD6B	BU6	BE6
Filter Type	LP	LP	LP	LP	LP
Function	Cauer	Bessel w/Z	Bessel w/Z	Butterworth	Bessel
Number of Poles, Zeroes	6p, 6z	6p, 4z	6p, 6z	6p	6p
Pass-band Ripple (dB p-p)	0.1	n/a	0.2	n/a	n/a
–0.1 dB Frequency	0.925 F_c	0.109 F_c	0.582 F_c	0.731 F_c	0.186 F_c
–3.01 dB Frequency	F_c	0.589 F_c	F_c	F_c	F_c
–20 dB Frequency	1.190 F_c	1.388 F_c	1.882 F_c	1.467 F_c	2.350 F_c
–40 dB Frequency	1.474 F_c	2.113 F_c	3.093 F_c	2.154 F_c	3.640 F_c
–60 dB Frequency	1.776 F_c	3.017 F_c	4.428 F_c	3.162 F_c	5.416 F_c
–80 dB Frequency	1.970 F_c	4.064 F_c	n/a	4.642 F_c	7.990 F_c
Stop-band Frequency	1.970 F_c	n/a	4.893 F_c	n/a	n/a
Stop-band Attenuation (dB)	80	n/a	70	n/a	n/a
Phase at F_c (^{o})	–358.50	–255.32	–255.32	–270.00	–154.37
Phase Distortion at F_c (^{o})	111.3	2.11	2.11	48.6	0.00
Overshoot (%)	19.2	0.60	5.04	14.4	0.64
1% Settling Time (sec)	4.64/F_c	1.21/Fc	1.46/F_c	2.36/F_c	0.74/F_c
0.1% Settling Time (sec)	8.45/F_c	1.94/Fc	2.21/F_c	3.89/F_c	1.16/F_c

BE6: 6-pole Bessel low-pass
BU6: 6-pole Butterworth low-pass
LP1: 6-pole, 6-zero elliptic low-pass
TD6A: 6-pole, 4-zero constant time delay (linear phase) low-pass
TD6B: 6-pole, 6-zero constant time delay (linear phase) low-pass Bessel w/zeros in the stop band

27304 GENERAL CHARACTERISTICS

27304 Card Size:	5.68 x 13.15 x 0.75 inches 14.43 x 33.40 x 1.91 cm
Card Weight:	1.87 lb. net, 3.3 lb. shipping (0.85 kg net, 1.5 kg shipping)
Temperature:	0^{o}C to 40^{o}C (operating) -20^{o}C to 70^{o}C (storage)

ORDERING INFORMATION

27304-?-XXX-?

Options:	C1, I, O, T
Filter Type:	EL8, TD8, BU8, BE8, TD8D LP1, TD6, BU6, BE6 EL4, TD4, BU4, BE4
Frequency:	A, C, E, ... etc. See Cutoff Frequency Settings section.

4-Pole Filter Selection Guide

	EL4	TD4	BU4	BE4
Filter Type	LP	LP	LP	LP
Function	Cauer	Bessel w/Z	Butterworth	Bessel
Number of Poles, Zeroes	4p, 4z	4p, 4z	4p	4p
Pass-band Ripple (dB p-p)	0.1	n/a	n/a	n/a
–0.1 dB Frequency	0.827 F_c	0.189 F_c	0.625 F_c	0.189 F_c
–3.01 dB Frequency	F_c	F_c	F_c	F_c
–20 dB Frequency	1.492 F_c	2.524 F_c	1.776 F_c	2.542 F_c
–40 dB Frequency	2.398 F_c	4.483 F_c	3.162 F_c	4.724 F_c
–60 dB Frequency	3.666 F_c	7.049 F_c	5.623 F_c	8.482 F_c
–80 dB Frequency	4.719 F_c	9.144 F_c	10.00 F_c	15.13 F_c
Stop-band Frequency	4.719 F_c	9.144 F_c	n/a	n/a
Stop-band Attenuation (dB)	80	80	n/a	n/a
Phase at F_c (^{o})	–220.35	–107.16	–180.00	–120.82
Phase Distortion at F_c (^{o})	53.26	0.25	30.49	0.28
Overshoot (%)	13.8	0.80	11.4	1.03
1% Settling Time (sec)	2.73/F_c	0.63/Fc	1.66/F_c	0.64/F_c
0.1% Settling Time (sec)	4.36/F_c	1.15/Fc	2.73/F_c	1.00/F_c

BE4: 4-pole Bessel low-pass

BU4: 4-pole Butterworth low-pass

EL4: 6-pole, 6-zero elliptic low-pass

TD4: 4-pole, 4-zero constant time delay (linear phase) low-pass Bessel with zeros in the stop band

PRECISION FILTERS, INC.
240 Cherry Street, Ithaca, New York 14850
607-277-3550 Fax: 607-277-4466 www.pfinc.com