27608A OCTAL PROGRAMMABLE FILTER AMPLIFIERS

For the 28000 Signal Conditioning System

PRECISION FILTERS, INC.

28000 SIGNAL CONDITIONING SYSTEM

- 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
- Rigorous factory acceptance test for maintenance
- Field swappable AC or DC power supplies
- Built-in temperature and power supply monitoring with alarms
- Backward compatible with 27000 signal conditioning modules such as the 27608A card

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 system is backward compatible with 27000 signal conditioning modules such as the 27608A card.

The built-in test hardware and software (optional) provide quick go/no-go performance checks 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.

27608A FEATURES

- Broad selection of filter characteristics; 4 or 6 poles
- Wide range of cutoff frequency selections (1 Hz to 32 kHz) with filter bypass
- Distributed gain: x1 to x1024 in x2 steps or x1 to x1000 in x1, x2, x5, x10 ... x1000 sequence
- Hi-Z, Hi-CMRR differential input
- Selectable AC/DC input coupling
- Can be installed in the Precision 28000 system frames

27608A INTRODUCTION

The 27608A octal programmable filter/amplifier card allows for up to 128 channels of programmable precision filtering in one 28016-M3 or 27000 chassis. High-pass and low-pass filter/amplifiers are available. Other system configurations include 64 channels of programmable bandpass filter/amplifiers. Systems beyond 128 channels may be accommodated by multiple mainframes controlled from a single controller.

Filters are offered with superior specifications to insure the highest performance which is needed by today's high resolution A/D converters. Data integrity is maintained by individually regulating the power for each filter channel. This results in low channel-to-channel crosstalk. Eleven standard filter characteristics are available for the Precision 27608A: elliptical low-pass, elliptical high-pass, Butterworth low-pass, Bessel low-pass, and the TD Series of constant time-delay low-pass filters. Filters are available in 4-pole and 6-pole configurations.

Standard models offer single ranges that are programmable over a 255:1 range and two range models which cover a 2550:1 range. Available cutoffs span from 1 Hz to as high as 32 kHz.

27608A INPUT CHARACTERISTICS

Type: Balanced differential input
Impedance: 1.58 MΩ // 100 pF per side
Level: ±10 Vpk linear; ±50 Vpk w/o damage
Level vs. Freq.: ±10 Vpk for f < 100 kHz
±10 Vpk (100 kHz/ f) for f ≥ 100 kHz
CMRR: 90 dB min, DC to 440 Hz
at pre-filter gain > 16
Bias Current: <1 nA typical
Noise: 7 nV/√Hz at 1 kHz RTI, typ
Offset Drift: ±1 μV/^{0}C, RTI at max gain, typ

Option 6: Programmable AC/DC coupling
Impedance: 1.58 MΩ //0.1 μF per side
–3 dB Freq: 1.56 Hz
CMRR: –80 dB, 60 Hz to 440 Hz
with pre-filter gain ≥16

AMPLIFIER CHARACTERISTICS

Test Input (Std): A switch at the input of each channel allows for injection of a test signal.
Option A2: Pre-Filter Binary Gain
Gain: x1, 2, 4, ... 128
Accuracy: ±0.1% re 0 dB at 1 kHz

Option A5: Pre-Filter 1, 2, 5, 10 Gain Sequence
Gain: x1, 2, 5, 10, 20, 50, 100
Accuracy: ±0.1% re 0 dB at 1 kHz

Option G2: Post-Filter Binary Gain
Gain: x1, 2, 4, 8
Accuracy: ±0.1% re 0 dB at 1 kHz

Option G5: Post Filter 1, 2, 5, 10 Gain
Gain: x1, 2, 5, 10
Accuracy: ±0.1% re 0 dB at 1 kHz

AMPLIFIER CHARACTERISTICS (Continued)

Other Overall Amplifier Specifications
DC Gain Stability: n x (2.5 PPM/^{0}C) + (15 PPM/^{0}C)
where n = number of filter poles
DC Linearity: ±0.01% of F_S relative to best straight line at any setting
Freq. Response: ±0.1 dB DC to 32 kHz

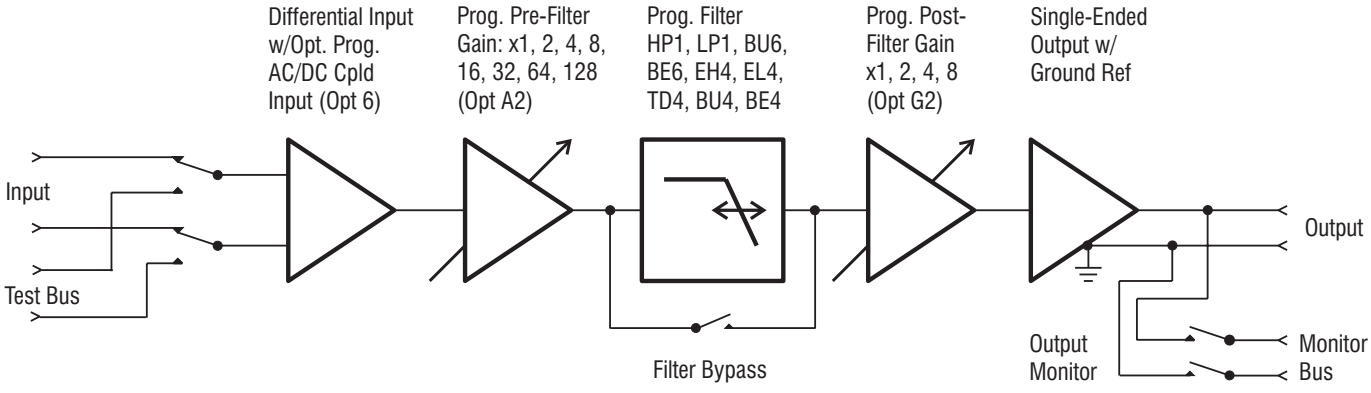
Gain Control Modes
Two gain control modes are supported by the Graphical User Interface for the 27608A.

Standard Mode: Enter the pre-gain and post-gain. Gain may be entered either in linear steps or in logarithmic steps.

Standard Mode w/ Out-band Reserve: Enter the overall gain desired and the required protection against overload caused by out-of-band signals (out-band reserve) that are larger than the signal of interest. The proper gain distribution is automatically computed and set. Gain and out-band reserve may be entered either in linear steps or logarithmic steps.

27608A OUTPUT CHARACTERISTICS

Type: DC-coupled, single-ended output
Z: 50 Ω // 100 pF
Max Output: ±10 Vpk, ±2 mApk
Drift: ±(Input Drift)∗(A ∗ G)±(20 μV/^{0}C) ∗ G ∗ n
± 15 μV/^{0}C, where
A = pre-gain setting,
G = post-gain setting and
n = number of filter poles
Noise, LP Filters: 100 μVrms in 1 MHz BW at a gain of x1
Noise, HP Filters: 200 μVrms in 1 MHz BW at a gain of x1
Total Harmonic Distortion: Better than –80 dB re: fullscale with 1 Vrms input at 0.5 Fc for low-pass filter
Crosstalk: –80 dB



27608A Channel Block Diagram

27608A OUTPUT CHARACTERISTICS (Cont.)

Auto-Offset (Std): Auto-offset automatically zeroes offset at the channel output to less than 5 mV typical at any gain setting.

Output Mon (Std): A switch at the output of each channel allows for connection to the output monitor bus. The output monitor bus is available via a connector at the main-frame rear panel. The monitor function is used by the auto-offset circuitry and the Test Subsystem.

FILTER SPECIFICATIONS

Cutoff Amplitude: –3.01 dB for HP1, LP1, TD6B, BU6, BE6, EL4, EH4, TD4, BU4, BE4
–9.61 dB for TD6A

For BU4, BE4, EL4, EH4, TD4, BU6, BE6, TD6:

Ampl. Accuracy (DC to $F_{-3.01\ dB}$; $F_{-3.01\ dB}$ to 32 kHz for EH4):
filter char. ±0.1 dB

Amplitude Match (DC to $F_{-3.01\ dB}$; $F_{-3.01\ dB}$ to 32 kHz for EH4):
0.1 dB max, 0.025 dB typ

Phase Match (DC to $F_{-3.01\ dB}$; $F_{-3.01\ dB}$ to 32 kHz for EH4):
1^{0} max, 0.25^{0} typ

4-Pole Filter Selection Guide

	EL4	EH4	TD4	BU4	BE4
Filter Type	LP	HP	LP	LP	LP
Function	Cauer	Cauer	Bessel w/Z	Butterworth	Bessel
Number of Poles, Zeros	4p, 4z	4p, 4z	4p, 4z	4p	4p
Pass-Band Ripple (dB p-p)	0.1	0.1	n/a	n/a	n/a
–0.1 dB Frequency	0.827 Fc	1.209 Fc	0.189 Fc	0.625 Fc	0.189 Fc
–3.01 dB Frequency	Fc	Fc	Fc	Fc	Fc
–20 dB Frequency	1.492 Fc	0.670 Fc	2.524 Fc	1.776 Fc	2.542 Fc
–40 dB Frequency	2.398 Fc	0.417 Fc	4.483 Fc	3.162 Fc	4.724 Fc
–60 dB Frequency	3.666 Fc	0.273 Fc	7.049 Fc	5.623 Fc	8.482 Fc
–80 dB Frequency	4.719 Fc	0.212 Fc	9.144 Fc	10.00 Fc	15.13 Fc
Stop-Band Frequency	4.719 Fc	0.212 Fc	9.144 Fc	n/a	n/a
Stop-Band Attenuation (dB)	80	80	80	n/a	n/a
Phase at Fc (^{0})	–220.35	220.35	–107.16	–180.00	–120.82
Phase Distortion at Fc (^{0})	53.26	n/a	0.25	30.49	0.28
Overshoot (%)	13.8	n/a	0.80	11.4	1.03
1% Settling Time (Sec)	2.73/Fc	2.59/Fc	0.63/Fc	1.66/Fc	0.64/Fc
0.1% Settling Time (Sec)	4.36/Fc	4.07/Fc	1.15/Fc	2.73/Fc	1.00/Fc

6-Pole Filter Selection Guide

	LP1	HP1	TD6A	TD6B	BU6	BE6
Filter Type	LP	HP	LP	LP	LP	LP
Function	Cauer	Cauer	Bessel w/Z	Bessel w/Z	Butterworth	Bessel
Number of Poles, Zeros	6p, 6z	6p, 6z	6p, 4z	6p, 6z	6p	6p
Pass-Band Ripple (dB p-p)	0.1	0.1	n/a	0.2	n/a	n/a
–0.1 dB Frequency	0.925 Fc	1.081 Fc	0.109 Fc	0.582 Fc	0.731 Fc	0.186 Fc
–3.01 dB Frequency	Fc	Fc	0.589 Fc	Fc	Fc	Fc
–20 dB Frequency	1.190 Fc	0.840 Fc	1.388 Fc	1.882 Fc	1.467 Fc	2.350 Fc
–40 dB Frequency	1.474 Fc	0.678 Fc	2.113 Fc	3.093 Fc	2.154 Fc	3.640 Fc
–60 dB Frequency	1.776 Fc	0.563 Fc	3.017 Fc	4.428 Fc	3.162 Fc	5.416 Fc
–80 dB Frequency	1.970 Fc	0.508 Fc	4.064 Fc	n/a	4.642 Fc	7.990 Fc
Stop-Band Frequency	1.970 Fc	0.508 Fc	n/a	4.893 Fc	n/a	n/a
Stop-Band Attenuation (dB)	80	80	n/a	70	n/a	n/a
Phase at Fc (^{0})	–358.50	358.50	–255.32	–255.32	–270.00	–154.37
Phase Distortion at Fc (^{0})	111.3	n/a	2.11	2.11	48.6	0.00
Overshoot (%)	19.2	n/a	0.60	5.04	14.4	0.64
1% Settling Time (Sec)	4.64/Fc	5.21/Fc	1.21/Fc	1.47/Fc	2.36/Fc	0.74/Fc
0.1% Settling Time (Sec)	8.45/Fc	9.14/Fc	1.94/Fc	2.21/Fc	3.89/Fc	1.16/Fc

FILTER SPECIFICATIONS (Continued)

For LP1, HP1:

Ampl. Accuracy (DC to $F_{-0.1\ dB}$; $F_{-0.1\ dB}$ to 32 kHz for HP1):
filter char. ±0.1 dB

Amplitude Match (DC to $F_{-0.1\ dB}$; $F_{-0.1\ dB}$ to 32 kHz for HP1):
0.1 dB max, 0.05 dB typ

Phase Match (DC to $F_{-0.1\ dB}$; $F_{-0.1\ dB}$ to 32 kHz for HP1):
1^0 max, 0.25^0 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 BW:	100 kHz, typ
High Freq. Rolloff:	18 dB/octave
Freq. Response:	±0.1 dB to 32 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 $f \leq 100$ kHz, minimum stop-band attenuation ±2 dB
for 100 kHz < f < 1 MHz, ±5 dB

High-Pass Filter Small Signal Bandwidth: 100 kHz

27608A FILTER CHARACTERISTICS

4-Pole Filters

EL4: 4-pole, 4-zero Elliptic low-pass filter
EH4: 4-pole, 4 zero Elliptic high-pass filter
TD4: 4-pole, 4-zero constant time delay (linear phase) low-pass filter
BU4: 4-pole Butterworth low-pass filter
BE4: 4-pole Bessel low-pass filter

Note: Cascading an EH4 with an EL4 results in a symmetrical band-pass filter on a log frequency scale.

6-Pole Filters

LP1: 6-pole, 6 zero Elliptic low-pass filter
HP1: 6-pole, 6 zero Elliptic high-pass filter
TD6: 6-pole, 4/6-zero constant time delay (linear phase) low-pass filter. Both the TD6A and TD6B characteristics are provided. Selection of TD6A or TD6B is set with an on-card selector switch.
BU6: 6-pole Butterworth low-pass filter
BE6: 6-pole Bessel low-pass filter

Note: Cascading an HP1 with an LP1 results in a symmetrical band-pass filter on a log frequency scale.

CUTOFF FREQUENCY SETTINGS

Standard Two Range Filters

C Range:	1 Hz to 255 Hz in 1 Hz steps 300 Hz to 25.5 kHz in 100 Hz steps
D Range:	10 Hz to 2550 Hz in 10 Hz steps 2600 Hz to 25.5 kHz in 100 Hz steps
E Range:	1 Hz to 255 Hz in 1 Hz steps 260 Hz to 2.55 kHz in 10 Hz steps

Standard F8??? Single 255:1 Ranges (No Setup Required)

F8??? Range:	??? Hz to 255 * ??? Hz in ??? Hz steps where ??? is an integer between 1 and 100
F8001 Range:	1 Hz 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

Custom Cutoff Frequency Models

FX?? Range: Five custom frequencies between 1 Hz and 32 kHz with a maximum span of 1000:1. ?? = a factory assigned identification number given to each set of unique frequencies.

Fixed Frequency Models

??? Range: ??? denotes a fixed cutoff frequency in the range between 1 Hz to 32 kHz

27608A GENERAL CHARACTERISTICS

27608A Card Size:	5.68 x 13.15 x 0.75 inches 14.43 x 33.40 x 1.91 cm
Card Weight:	1.87 lbs net, 3.3 lbs shipping (0.85 kg net, 1.5 kg shipping)
Temperature:	0^0C to 40^0C (operating) -20^0C to 70^0C (storage)

ORDERING INFORMATION

27608A-?-XXX-?

Options:	6, A?, G?
Filter Types:	EL4, EH4, TD4, BU4, BE4 LP1, HP1, TD6A, TD6B, BU6, BE6
Frequency:	See Cutoff Frequency Settings

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