

# PF08D Series

## Miniature DIP Active Filter Modules



### INTRODUCTION

The PF08D Series of miniature active filter modules provide 8-pole filter characteristics with cutoff frequencies available from 1 Hz to 200 kHz. The package is a compact DIP footprint making it ideal for applications in which circuit board area is critical. The PF08D is a finished component and requires no external clocks, resistors or capacitors for operation.

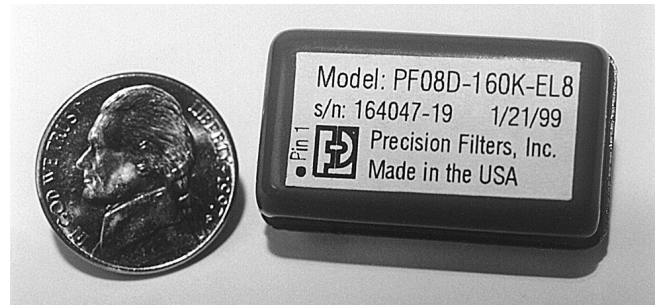
Performance is what you'd expect from Precision Filters — typically no more than 0.1 degrees of phase and 0.01 dB of amplitude mismatch between any two filters. The latest active devices (not switched capacitor devices) are used to build the filter meaning that it is extremely stable with temperature and that it has ultra-low noise and distortion. Six-sided RF shielding reduces susceptibility to unwanted noise and reduces cross-talk in multi-channel applications. The performance of these modules makes them an excellent choice as a front-end to a high-resolution A/D converter where high accuracy and performance are critical.

Five standard 8-pole filter characteristics are available for the PF08D Series: Elliptical low pass, Elliptical high pass, Butterworth low pass, Bessel low pass, and Constant Time Delay low pass.

Of all filters, the Elliptical filter provides the sharpest transition from pass-band to stop-band, making it the ideal choice for amplitude critical applications. Better than 0.1 dB flatness is maintained across the entire pass-band of the filter. The Elliptical filter provides a frequency response superior to all other low pass filter types including the Butterworth and Bessel.

The Time Delay Filter is a linear phase (constant time delay) low pass filter with amplitude response that is far superior to a Bessel. The TD8B Time Delay filter gives better amplitude response characteristics than the Bessel characteristic while still providing linear phase. The TD8B Time Delay filter has more overshoot than a Bessel does in response to a step input. The Time Delay filter is the best choice for transient filtering and for applications where preservation of time domain wave shapes is essential.

Design the PF08D Filter Module into your printed circuit board to put Precision Filters' expertise in active filter design to work for you. Today's data acquisition systems need a disciplined filter like the Precision PF08D series. It is not one of those loosely controlled filters with "2% Frequency Accuracy" that can have as much as 20° of phase mismatch between channels at the cutoff frequency. It is a tightly controlled filter with typically less than 0.1° of phase mismatch between channels to the cutoff frequency.



### APPLICATIONS

- Anti Aliasing Filters
- Automatic Test Equipment
- Data Acquisition
- Signal Conditioning
- Production Test Equipment
- Industrial Process Control
- Reconstruction Filters

### SALIENT FEATURES

Filter Technology:	Active
Filter Order:	8th
Power:	±5 V to ±18 V
Cutoff Frequencies:	1 Hz to 200 kHz, fixed
Phase Match:	0.1° typ., 1° max. DC to Fc, Fc < 25 kHz; DC to 0.8 Fc, Fc ≥ 25 kHz.
Amplitude Match:	0.01 dB typ., 0.1 dB max. DC to Fc, for Fc < 25 kHz; DC to 0.8 Fc, Fc ≥ 25 kHz.
Input Type:	Single ended
Output Type:	Buffered single ended
Physical:	Sealed, 6-side shielded case, all pins on 0.1-inch centers

### INPUT CHARACTERISTICS

(±15V supplies, 25°C unless otherwise noted)

Type:	DC coupled single ended
Z:	> 5 kΩ
Level:	±10 Vpk, ±Vs pk without damage
Level vs. Freq.:	±10 Vpk for f < 200 kHz ±10 Vpk x (200 kHz/f) for f ≥ 200 kHz

## PF08D FILTER CHARACTERISTICS

**EL8:** 8 Pole, 8 Zero Elliptic Low Pass Filter. The EL8 has 0.1 dB pass-band ripple, 0.1 dB of attenuation at the cutoff frequency, 90 dB attenuation at 1.77 Fc and 90 dB minimum stop-band attenuation. The EL8 has 19.8% overshoot in response to a step input. Phase distortion at Fc is 84.9°.

**EH8:** 8 Pole, 8 Zero Elliptic High Pass Filter with 0.1 dB pass-band ripple, 0.1 dB of attenuation at the cutoff frequency, 90 dB attenuation at 0.564 Fc and 90 dB minimum stop-band attenuation. The EH8 is formulated by performing a low pass to high pass transformation on the EL8 poles.

Cascading an **EH8** filter with an **EL8** filter results in a symmetrical band-pass filter on a log frequency scale.

**TD8B:** 8 Pole, 8 Zero Constant Time Delay (Linear Phase) Low Pass Filter. The TD8B gives greatly improved pass-band flatness and roll-off when compared to an 8 Pole Bessel while maintaining linear phase over the entire pass-band of the filter. The TD8B has 5% overshoot in response to a step input. Phase distortion is less than 0.23° at Fc. The TD8B amplitude response is 0.1 dB at 0.569 Fc, 3.01 dB at Fc and 80 dB at 3.335 Fc.

## FILTER CHARACTERISTICS (Continued)

**BU8:** 8 Pole Butterworth Low Pass Characteristic. The Butterworth is flat but monotonically increasing in attenuation. The filter is 0.1 dB at 0.79 Fc, 3.01 dB at Fc and 80 dB at 3.16 Fc. The BU8 overshoots 16.7% in response to a step input and has 66.2° of phase distortion at Fc.

**BE8:** 8 Pole Bessel Low Pass Characteristic. The Bessel provides a broadly rounded pass-band in exchange for a low overshoot and fast settling step response. Overshoot in response to a step input is 0.34%. The filter has less than 0.1° of phase distortion at Fc. The BE8 is -0.1 dB at 0.19 Fc, 3.01 dB at Fc and 80 dB at 6.07 Fc.

## FILTER SPECIFICATIONS

Cutoff Amplitude:	BU8, BE8, TD8B: 3.01 dB EL8, EH8: 0.1 dB
Amplitude Accuracy:	Filter Characteristic ±0.1 dB DC to Fc, Fc < 25 kHz ±0.1 dB DC to 0.8 Fc, Fc > 25 kHz ±0.25 dB at Fc, Fc > 25 kHz
Phase Match:	0.1° typ., 1° max. DC to Fc, Fc < 25 kHz; DC to 0.8 Fc, Fc ≥ 25 kHz.
Amplitude Match:	0.01 dB typ., 0.1 dB max. DC to Fc, Fc < 25 kHz; DC to 0.8 Fc, Fc ≥ 25 kHz.

8-Pole Filter Selection Guide

	EL8	EH8	TD8B	BU8	BE8
Filter Type	LP	HP	LP	LP	LP
Function	Cauer	Cauer	Time Delay	Butterworth	Bessel
Number of Poles, Zeros	8p, 8z	8p, 8z	8p, 8z	8p	8p
DC Gain (dB)	-0.1	-90.75	0	0	0
Pass-Band Ripple (dB p-p)	0.1	0.1	0.2	n/a	n/a
-0.1 dB Frequency	Fc	Fc	0.569 Fc	0.791 Fc	0.185 Fc
-3.01 dB Frequency	1.099 Fc	0.910 Fc	Fc	Fc	Fc
-20 dB Frequency	1.266 Fc	0.790 Fc	1.694 Fc	1.333 Fc	2.347 Fc
-40 dB Frequency	1.441 Fc	0.694 Fc	2.340 Fc	1.778 Fc	3.337 Fc
-60 dB Frequency	1.618 Fc	0.618 Fc	2.951 Fc	2.371 Fc	4.522 Fc
-80 dB Frequency	1.750 Fc	0.571 Fc	3.332 Fc	3.162 Fc	6.069 Fc
Stop-Band Frequency	1.788 Fc	0.559 Fc	3.332 Fc	n/a	n/a
Stop-Band Attenuation (dB)	90.75	90.75	80.28	n/a	n/a
Phase at Fc (°)	-359.20	359.20	-301.88	-360.00	-182.16
Phase Distortion at Fc (°)	84.9	n/a	0.23	66.2	0.00
Overshoot (%)	19.8	n/a	5.56	16.7	0.34
1% Settling Time (Sec)	5.15/Fc	6.03/Fc	1.54/Fc	3.45/Fc	0.79/Fc
0.1% Settling Time (Sec)	7.97/Fc	9.35/Fc	2.23/Fc	5.08/Fc	1.14/Fc

Note: B.S.L indicates Best Straight Line.

## PF08D OUTPUT CHARACTERISTICS

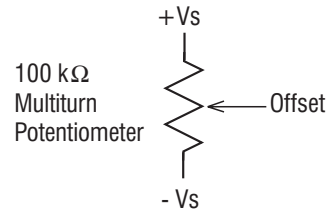
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Type:	Fully Buffered, DC coupled, single ended
Z:	10 $\Omega$ , typical
Max Out:	$\pm 10$ Vpk, $\pm 10$ mA pk with short circuit protection
Max Frequency:	$\pm 10$ Vpk for $f < 200$ kHz $\pm 10$ Vpk x (200 kHz/f) for $f \geq 200$ kHz
EH8 Upper 3 dB Small	
Signal Bandwidth:	1 MHz typical
Offset:	2 mV typical, 10 mV max (trimmable to 0)
DC Offset Stability:	120 $\mu$ V/ $^{\circ}$ C
DC Gain Stability:	5 ppm/ $^{\circ}$ C typical
THD + Noise:	No more than 0.003% re input w/FC=1 kHz and a 1 Vrms input at 100 Hz
Spectral Noise:	-133 dBV/ $\sqrt{\text{Hz}}$ at 0.5 Fc for Fc > 1 kHz
Broad Band Noise:	200 $\mu$ Vrms into 20 MHz for LP Filters 300 $\mu$ Vrms into 20 MHz for HP Filters

## OFFSET ADJUSTMENT

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A potentiometer may be used to externally trim offset. Connect the potentiometer as illustrated below.



## POWER SUPPLY ( $\pm V_s$ )

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Recommended:	$\pm 5$ VDC to $\pm 15$ VDC
Operating Range:	$\pm 5$ VDC to $\pm 18$ VDC
Max. Safe Voltage:	$\pm 18$ VDC
Quiescent Current:	20 mA Typical
Grounds:	Isolated analog and digital grounds. For applications using separate grounding systems, tie AGND to analog ground system and DGND to digital ground system for best noise performance. AGND and DGND may be tied together and connected to the system ground when only one ground is available.

## ABSOLUTE MAXIMUM RATINGS

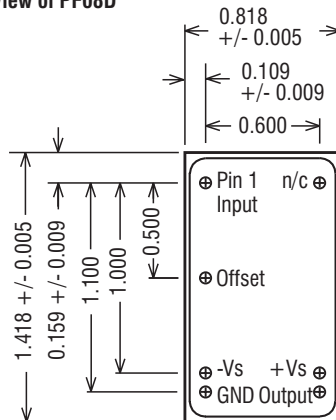
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Power Supply Voltage:	$\pm 18$ V
Analog Input Protection:	$\pm V_s$
Storage Temperature Range:	-25 $^{\circ}$ C to +85 $^{\circ}$ C
Operating Temperature Range:	0 $^{\circ}$ C to +70 $^{\circ}$ C
Lead Temp., Soldering (3 Sec):	300 $^{\circ}$ C
Output Short Circuit Duration:	Continuous

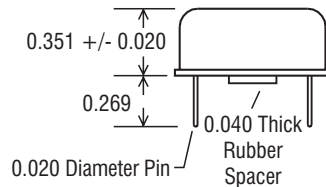
## PF08D PHYSICAL CHARACTERISTICS

Size (WxLxH): 0.818 x 1.4 x 0.391 inches for  $F_c > 1$  kHz  
 0.818 x 1.4 x 0.475 inches for  $F_c < 1$  kHz  
 Pin Grid: 0.1" centers  
 Operating Temp: 0 to 70°C  
 Storage Temp: -25 to 85°C

Top View of PF08D



End View of PF08D



PF08D Module Outline and Pin Identification

PF08D Pin Assignments	
Pin	Description
1	+INPUT
6	OFFSET
11	-Vs
12	AGND
13	OUTPUT
14	+Vs
24	No Connection

## MATING SOCKETS

Standard

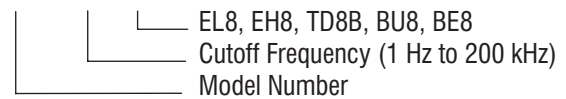
3M ZIF: 2-0024-03344-000-006-002 (Au)  
 2-0024-03344-000-006-005 (Ni)  
 ARIES ZIF: 24-516-10 (Sn)  
 24-516-11 (Au)  
 Digi-Key: ED58246-ND  
 Mill Max: 115-13-624-41-001 (Au/Au)  
 115-93-624-41-001 (Sn/Au)

Ultra-Low Profile (0.094)

Mill Max: 115-13-624-41-003 (Au/Au)  
 115-93-624-41-003 (Sn/Au)

## ORDERING INFORMATION

### PF08D-????-XXX



### Examples of valid model numbers:

PF08D-200K-EL8 (8-Pole Elliptic,  $F_c = 200$  kHz)

PF08D-1K32-TD8B (8-Pole Constant Delay,  $F_c = 1.32$  kHz)

PF08D-450-EH8 (8-Pole Elliptic High-Pass,  $F_c = 450$  Hz)

