



Differential Low-Pass Filters

6-Pole & 9-Pole

Description

The 5BAF Series are differential-input 6 - or 9 - Pole Butterworth or Bessel low-pass anti-alias filters that are pin-out and package compatible with industry-standard 5B Series signal conditioning modules. Each filter comes factory tuned to a user-specified corner frequency from 1 Hz to 50 kHz for 6-pole models and 1 kHz to 50 kHz for 9-pole models. These filters are ideally suited to sharply limit A/D converter bandwidth to eliminate aliasing higher frequency input signals and noise.

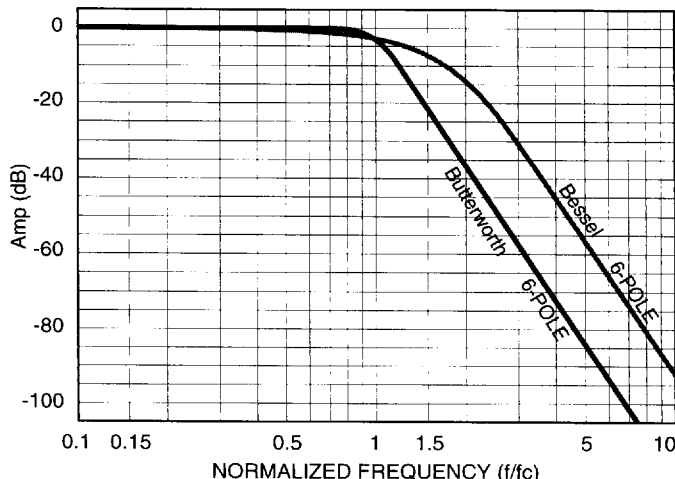
To serve real-world applications, all 5BAF Series filters are configured with a differential input having a common mode rejection ratio of 74 dB (min.) at 1 kHz. A self contained dc-to-dc converter enables the 5BAF filters to operate from a non-critical $+5 \pm 10\%$ volt power source key in many systems since +5V logic power is readily available.

Features/Benefits

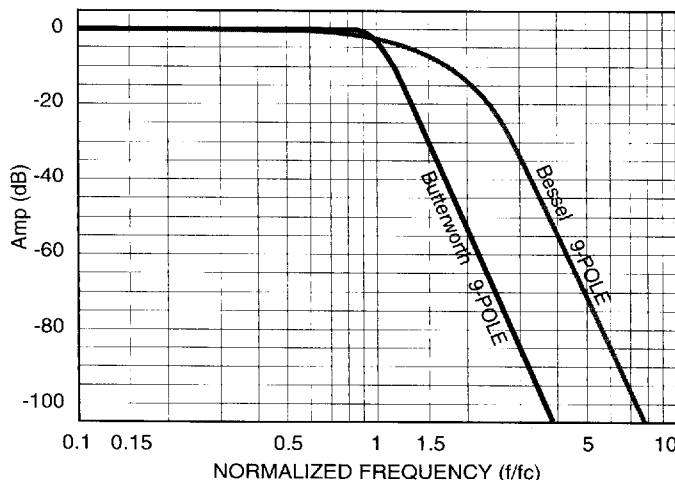
- The 10 volt input range with an overall gain of 1 provides an excellent match to both the transducer output and the data acquisition board input
- 5BAF modules allow for partitioning between system segments providing a means to minimize ground loops
- Factory tuned, no external clocks or adjustments needed
- 5B plug-in compatible provides quick and easy installation
- Broad range of corner frequencies to meet a wide range of applications

Applications

- Anti-alias filtering
- Vibration analysis
- Industrial and process control
- Noise reduction
- Signal reconstruction
- Test systems



**6-Pole Low-Pass Butterworth & Bessel
Frequency Response**



**9-Pole Low-Pass Butterworth & Bessel
Frequency Response**

Available Low-Pass Models:

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Signal Conditioning Module

6-Pole Bessel Low-Pass Filter

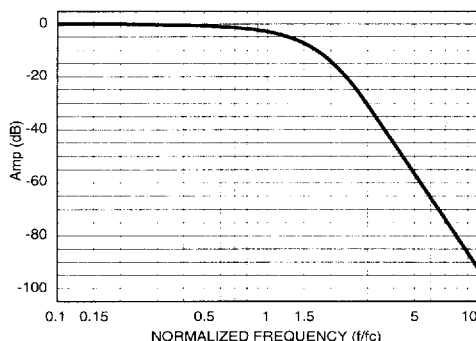
Description

The 5BAF-LPBE6 is a 6-pole, low-pass Bessel transfer function that has a differential input and is pin-out and package compatible with industry standard 5B signal conditioning modules, has a monotonic roll-off in the passband and the stopband, and its final roll-off rate is 36 dB/octave in the stopband. It exhibits a constant delay in the passband and has an overshoot free step response.

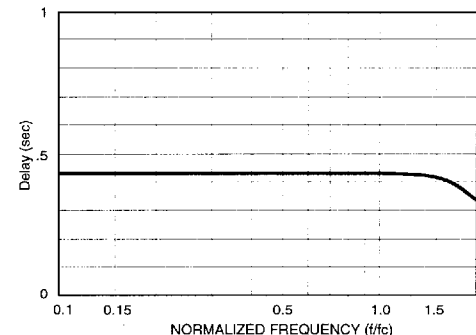
Specifications

Transfer Function	6-Pole Bessel Low-Pass
Size	Std. 5B
Range f_c	1 Hz to 50 kHz
Accuracy	$\pm 2\%$ max.
Analogue Input Characteristics ²	
Impedance ³	1.0 M Ω min.
Differential Gain	$1 \pm 0.03\%$
Com. Mode Voltage Range	± 20 V
Com. Mode Rejection	74 dB min. @ 1 kHz
Voltage Range	± 10 V peak
Maximum Safe Voltage	± 40 V
(Power ON or OFF)	
Stopband	
Attenuation Rate	36 dB/octave
Filter Attenuation	(theoretical)
1.89 dB	0.80 f_c
3.01 dB	1.00 f_c
60.0 dB	5.41 f_c
80.0 dB	7.99 f_c
Narrow Band Noise	75 μ V _{RMS}
(DC - 50 kHz)	

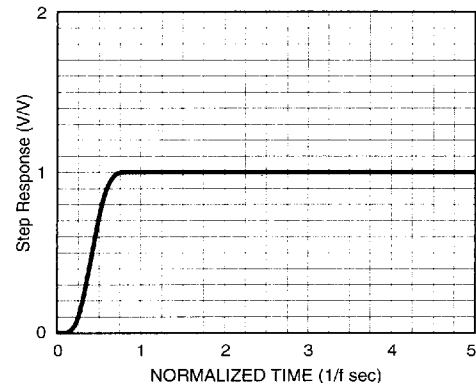
Frequency Response



Delay (Normalized)



Step Response



Theoretical Transfer Characteristics

f/f_c (Hz)	Amp (dB)	Phase (deg)	Delay ¹ (sec)
0.00	0.00	0.00	.430
0.10	-0.029	-15.5	.430
0.20	-0.116	-31.0	.430
0.30	-0.261	-46.5	.430
0.40	-0.465	-62.0	.430
0.50	-0.728	-77.4	.430
0.60	-1.05	-92.9	.430
0.70	-1.44	-108	.430
0.80	-1.89	-124	.430
0.85	-2.15	-132	.430
0.90	-2.42	-139	.430
0.95	-2.70	-147	.430
1.00	-3.01	-155	.430
1.10	-3.68	-170	.429
1.20	-4.44	-186	.428
1.30	-5.29	-201	.426
1.40	-6.23	-216	.422
1.50	-7.29	-232	.416
1.60	-8.46	-246	.401
1.70	-9.74	-261	.393
1.80	-11.1	-275	.376
1.90	-12.6	-287	.357
2.00	-14.2	-300	.335
2.25	-18.3	-328	.279
2.50	-22.6	-351	.228
2.75	-26.7	-369	.187
3.00	-30.7	-385	.156
3.25	-34.5	-398	.131
3.50	-38.1	-408	.111
4.00	-44.7	-426	.083
5.00	-55.9	-449	.052
6.00	-65.2	-465	.036
7.00	-73.2	-476	.026
8.00	-80.1	-484	.020
9.00	-86.2	-490	.015
10.0	-91.6	-495	.013

Notes:

- Input and output signal voltage referenced to I/O COM.
- Must be DC coupled for bias.

1. Normalized Group Delay: The above delay data is normalized to a corner frequency of 1.0 Hz. The actual delay is the normalized delay divided by the actual corner frequency (f_c).

$$\text{Actual Delay} = \frac{\text{Normalized Delay}}{\text{Actual Corner Frequency } (f_c) \text{ in Hz}}$$

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Signal Conditioning Module

6-Pole Butterworth Low-Pass Filter

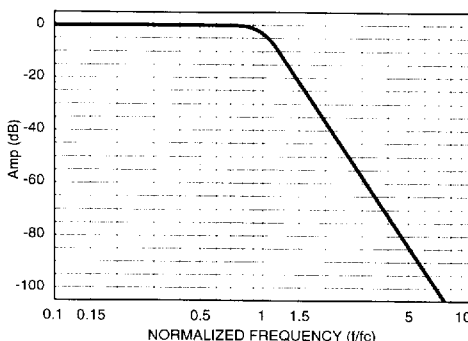
Description

The 5BAF-LPBU6 is a 6-pole, low-pass Butterworth transfer function that has a differential input and is pin-out and package compatible with industry standard 5B signal conditioning modules, is maximally flat, has no ripple in the passband, and has a monotonic roll-off at the rate of 36 dB/octave in the stopband.

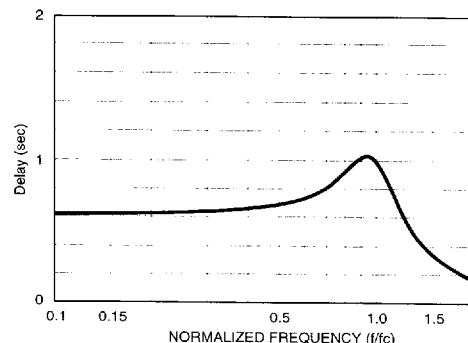
Specifications

Transfer Function	6-pole Butterworth Low-Pass
Size	Std. 5B
Range f_c	1 Hz to 50 kHz
Accuracy	$\pm 2\%$ max.
Analog Input Characteristics ²	
Impedance ³	1.0 M Ω min.
Differential Gain	$1 \pm 0.03\%$
Com. Mode Voltage Range	± 20 V
Com. Mode Rejection	74 dB min. @ 1 kHz
Voltage Range	± 10 V peak
Maximum Safe Voltage	± 40 V (Power ON or OFF)
Stopband	
Attenuation Rate	36 dB/octave
Filter Attenuation	(theoretical)
0.29 dB	0.80 f_c
3.01 dB	1.00 f_c
60.0 dB	3.16 f_c
80.0 dB	4.64 f_c
Narrow Band Noise	75 μ V _{RMS} (DC - 50 kHz)

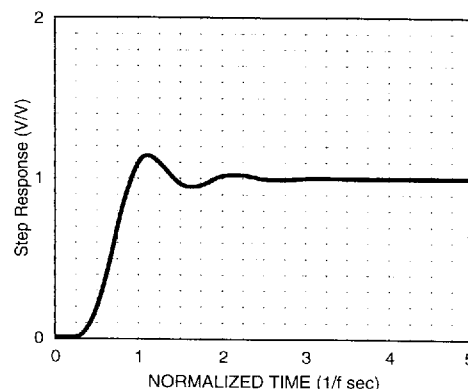
Frequency Response



Delay (Normalized)



Step Response



Theoretical Transfer Characteristics

f/f_c (Hz)	Amp (dB)	Phase (deg)	Delay ¹ (sec)
0.00	0.00	0.00	.615
0.10	0.00	-22.2	.617
0.20	0.00	-44.5	.624
0.30	0.00	-67.2	.637
0.40	0.00	-90.4	.656
0.50	-0.001	-115	.685
0.60	-0.009	-140	.731
0.70	-0.060	-167	.803
0.80	-0.289	-198	.911
0.85	-0.578	-215	.970
0.90	-1.080	-233	1.02
0.95	-1.88	-252	1.03
1.00	-3.01	-270	1.00
1.10	-6.17	-304	.845
1.20	-9.96	-331	.660
1.30	-13.9	-352	.518
1.40	-17.6	-368	.417
1.50	-21.2	-382	.345
1.60	-24.5	-393	.291
1.70	-27.7	-403	.251
1.80	-30.6	-412	.219
1.90	-33.5	-419	.193
2.00	-36.1	-425	.171
2.25	-42.3	-439	.132
2.50	-47.8	-450	.105
2.75	-52.7	-458	.086
3.00	-57.3	-465	.071
3.25	-61.4	-471	.060
3.50	-65.3	-476	.052
4.00	-72.2	-484	.039
5.00	-83.9	-496	.025
6.00	-93.4	-503	.017
7.00	-101	-508	.012
8.00	-108	-512	.0097
9.00	-115	-515	.0076
10.0	-120	-518	.0062

Notes:

- Input and output signal voltage referenced to I/O COM.
- Must be DC coupled for bias.

1. Normalized Group Delay: The above delay data is normalized to a corner frequency of 1.0 Hz. The actual delay is the normalized delay divided by the actual corner frequency (f_c).

$$\text{Actual Delay} = \frac{\text{Normalized Delay}}{\text{Actual Corner Frequency } (f_c) \text{ in Hz}}$$

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Signal Conditioning Module

9-Pole Bessel Low-Pass Filter

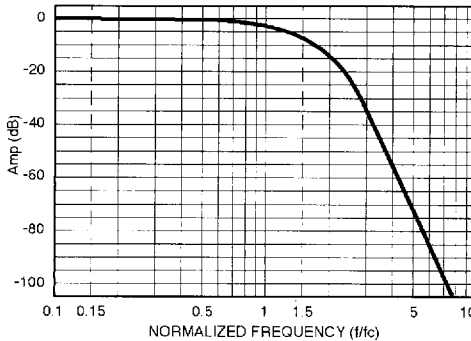
Description

The 5BAF-LPBE9 is a 9-pole, low-pass Bessel transfer function that has a differential input and is pin-out and package compatible with industry standard 5B signal conditioning modules, has a monotonic roll-off in the passband and the stopband, and its final roll-off rate is 54 dB/octave in the stopband. It exhibits a constant delay in the passband and has an overshoot free step response.

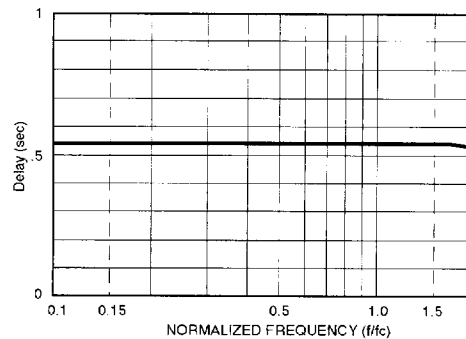
Specifications

Transfer Function	9-Pole Bessel Low-Pass
Size	Std. 5B
Range f_c	1 kHz to 50 kHz
Accuracy	$\pm 2\%$ max.
Analogue Input Characteristics ²	
Impedance	20 k Ω min.
Differential Gain	$1 \pm 0.03\%$
Com. Mode Voltage Range	± 20 V
Com. Mode Rejection	74 dB min. @ 1 kHz
Voltage Range	± 10 V peak
Maximum Safe Voltage	± 40 V
(Power ON or OFF)	
Stopband	
Attenuation Rate	54 dB/octave
Filter Attenuation	(theoretical)
1.90 dB	0.80 f_c
3.01 dB	1.00 f_c
60.0 dB	4.30 f_c
80.0 dB	5.60 f_c
Narrow Band Noise	75 μ V _{RMS}
(DC - 50 kHz)	

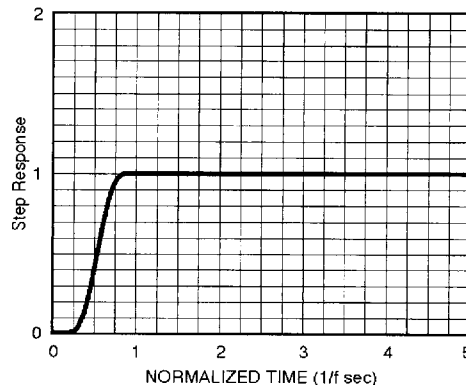
Frequency Response



Delay (Normalized)



Step Response



Theoretical Transfer Characteristics

f/f_c (Hz)	Amp (dB)	Phase (deg)	Delay ¹ (sec)
0.00	0.00	0.00	.540
0.10	-0.029	-19.4	.540
0.20	-0.118	-38.9	.540
0.30	-0.265	-58.3	.540
0.40	-0.472	-77.7	.540
0.50	-0.739	-97.2	.540
0.60	-1.07	-117	.540
0.70	-1.46	-136	.540
0.80	-1.91	-155	.540
0.85	-2.16	-165	.540
0.90	-2.43	-175	.540
0.95	-2.71	-185	.540
1.00	-3.01	-194	.540
1.10	-3.66	-214	.540
1.20	-4.39	-233	.540
1.30	-5.18	-253	.540
1.40	-6.06	-272	.540
1.50	-7.02	-291	.539
1.60	-8.07	-311	.539
1.70	-9.23	-330	.537
1.80	-10.5	-350	.534
1.90	-11.9	-369	.529
2.00	-13.4	-388	.521
2.25	-17.7	-433	.481
2.50	-22.8	-473	.419
2.75	-28.4	-508	.350
3.00	-34.0	-537	.290
3.25	-39.4	-561	.241
3.50	-44.7	-581	.203
4.00	-54.5	-612	.150
5.00	-71.3	-654	.091
6.00	-85.3	-681	.062
7.00	-97.2	-700	.045
8.00	-108	-714	.034
9.00	-117	-725	.027
10.0	-125	-734	.022

Notes:

2. Input and output signal voltage referenced to I/O COM.

1. Normalized Group Delay: The above delay data is normalized to a corner frequency of 1.0 Hz. The actual delay is the normalized delay divided by the actual corner frequency (f_c).

$$\text{Actual Delay} = \frac{\text{Normalized Delay}}{\text{Actual Corner Frequency (fc) in Hz}}$$

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Signal Conditioning Module

9-Pole Butterworth Low-Pass Filter

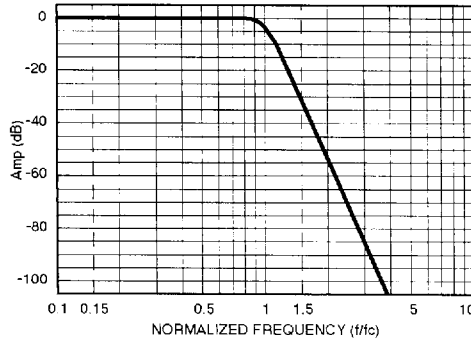
Description

The 5BAF-LPBU9 is a 9-pole, low-pass Butterworth transfer function that has a differential input and is pin-out and package compatible with industry standard 5B signal conditioning modules, is maximally flat, has no ripple in the passband, and has a monotonic roll-off at the rate of 54 dB/octave in the stopband.

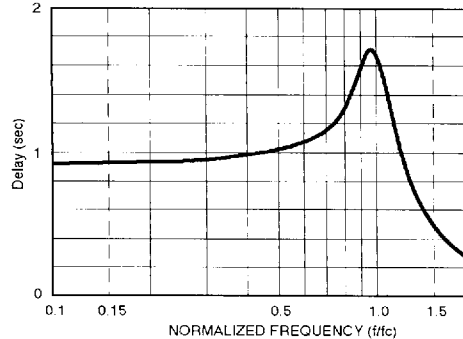
Specifications

Transfer Function	9-pole Butterworth Low-Pass
Size	Std. 5B
Range f_c	1 kHz to 50 kHz
Accuracy	$\pm 2\%$ max.
Analog Input Characteristics ²	
Impedance	20 k Ω min.
Differential Gain	$1 \pm 0.03\%$
Com. Mode Voltage Range	± 20 V
Com. Mode Rejection	74 dB min. @ 1 kHz
Voltage Range	± 10 V peak
Maximum Safe Voltage (Power ON or OFF)	± 40 V
Stopband	
Attenuation Rate	54 dB/octave
Filter Attenuation	(theoretical)
0.10 dB	0.80 f_c
3.01 dB	1.00 f_c
60.0 dB	2.15 f_c
80.0 dB	2.78 f_c
Narrow Band Noise (DC - 50 kHz)	75 μ V _{RMS}

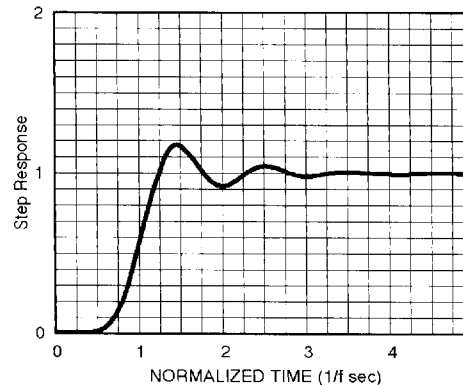
Frequency Response



Delay (Normalized)



Step Response



Theoretical Transfer Characteristics

f/f_c (Hz)	Amp (dB)	Phase (deg)	Delay ¹ (sec)
0.00	0.00	0.00	.917
0.10	0.00	-33.0	.920
0.20	0.00	-66.3	.930
0.30	0.00	-100	.947
0.40	0.00	-135	.974
0.50	0.00	-170	1.01
0.60	0.000	-208	1.07
0.70	-0.007	-248	1.16
0.80	-0.078	-292	1.32
0.85	-0.227	-317	1.45
0.90	-0.607	-345	1.59
0.95	-1.45	-374	1.70
1.00	-3.01	-405	1.69
1.10	-8.17	-460	1.34
1.20	-14.4	-501	.975
1.30	-20.5	-532	.748
1.40	-26.3	-556	.602
1.50	-31.7	-576	.501
1.60	-36.7	-593	.426
1.70	-41.5	-607	.368
1.80	-45.9	-619	.322
1.90	-50.2	-630	.284
2.00	-54.2	-640	.253
2.25	-63.4	-660	.195
2.50	-71.6	-675	.156
2.75	-79.1	-688	.127
3.00	-85.9	-699	.106
3.25	-92.1	-707	.090
3.50	-97.9	-715	.077
4.00	-108	-727	.059
5.00	-126	-744	.037
6.00	-140	-755	.026
7.00	-152	-763	.019
8.00	-163	-769	.014
9.00	-172	-773	.011
10.0	-180	-777	.009

1. Normalized Group Delay: The above delay data is normalized to a corner frequency of 1.0 Hz. The actual delay is the normalized delay divided by the actual corner frequency (f_c).

$$\text{Actual Delay} = \frac{\text{Normalized Delay}}{\text{Actual Corner Frequency (fc) in Hz}}$$

Notes:

2. Input and output signal voltage referenced to I/O COM.

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**FREQUENCY
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Specification

5BAF Series

Pin-Out and Package Data Ordering Information

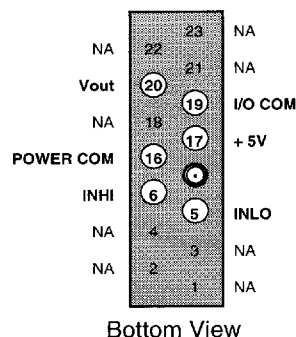
Analog Input Characteristics¹

See transfer function specifications.

Analog Output Characteristics^{1,2}

Impedance (Closed Loop)	< 1 Ω typ. 10 Ω max.
Linear Operating Range	± 10 V
Maximum Current	± 2 mA
Offset Voltage	± 3 mV typ.
Offset Temp. Coeff.	± 100 μ V / $^{\circ}$ C
Gain Drift	± 30 ppm / $^{\circ}$ C
Output Load	See note 3

Pin Designations



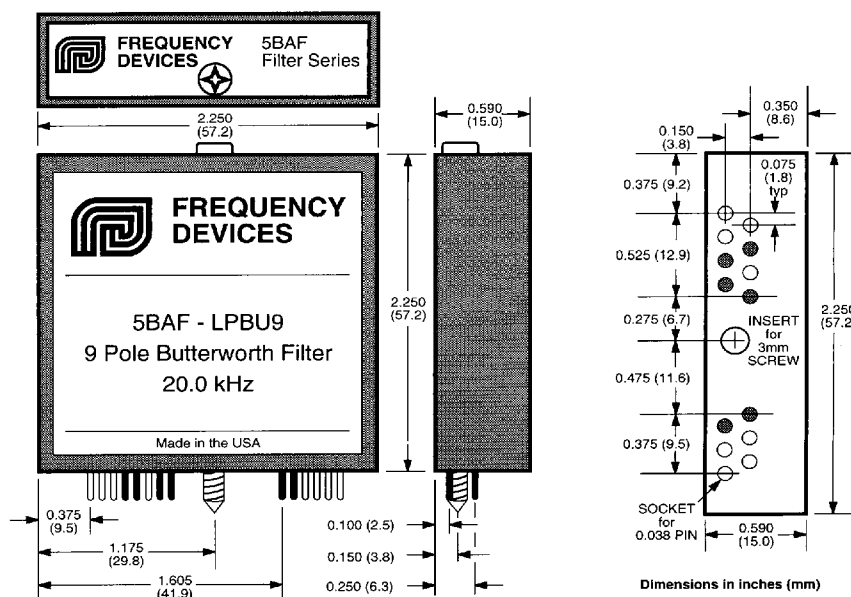
Package Data

Power Supply ($\pm$ Vs)

Rated Voltage	+ 5 V $\pm$ 0.5 Vdc
Quiescent Current (1 kHz to 20 kHz)	100 mA typ. 125 mA max.
Quiescent Current (20 kHz to 50 kHz)	120 mA typ. 135 mA max.

Temperature

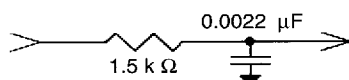
Operating	- 25 to + 85 $^{\circ}$ C
Storage	- 40 to + 85 $^{\circ}$ C



Ordering Information

Notes:

- Input and output signal voltage referenced to I/O COM.
- Output is short circuit protected to common. DO NOT CONNECT TO +5V or POWER COM.
- Output can drive a series 1.5 kW resistor and 0.0022 mF capacitor without slew rate limiting with a ± 10 V square wave input.



No. of Poles

- 6 - 6-Pole (1 Hz to 50 kHz)
- 9 - 9-Pole (1 kHz to 50 kHz)

5BAF-LPBE9-10.7 kHz

Transfer Function

BU - Butterworth
BE - Bessel

- 3 dB Corner Frequency

e.g., 10.7 kHz
1.00 Hz
50.0 kHz

88040

We hope the information given here will be helpful. The information is based on data and our best knowledge, and we considered the information to be true and accurate. Please read all statements, recommendations or suggestions herein in conjunction with our conditions of sale which apply to all goods supplied by us. We assume no responsibility for the use of these statements, recommendations or suggestions, nor do we intend them as a recommendation for any use which would infringe any patent or copyright.

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