FREQUENCY DEVICES™

D70 Series

T-64-05

Linear Active DIP Filters

Anti-Alias Filters

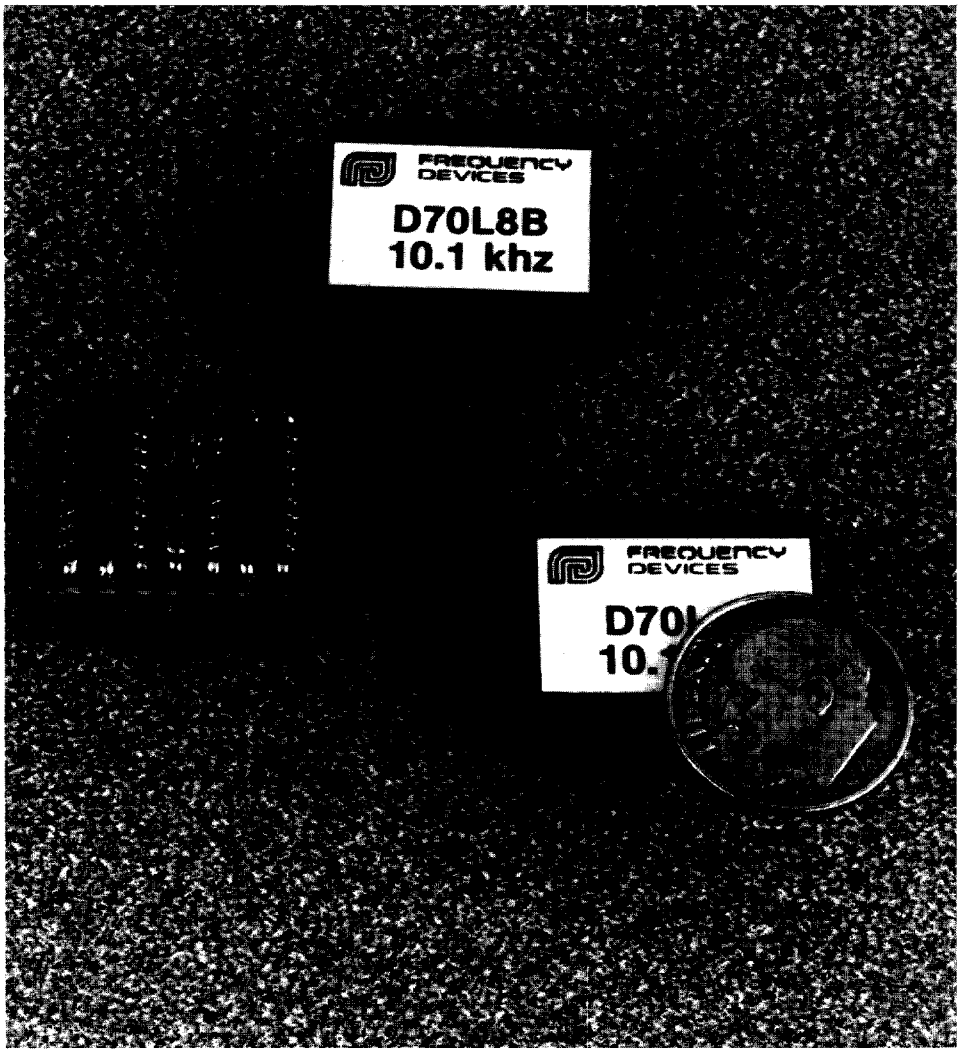
Applications

- Data Acquisition
- Signal Reconstruction
- Noise Elimination

Description

The D70 Series of fixed-frequency linear active DIP filters offer a unique combination of small size and high performance. These Butterworth and Bessel low-pass filters combine the excellent performance of linear multi-pole filter design with the space saving of the dual in-line package (DIP).

The D70 family of fully finished filters require no external clocks, components or adjustments.



Features

- Compact Dual In-line Packaging
- -100dB Signal-to-Noise Ratio
- -90dB Distortion Characteristics
- User Specified Corner Frequency between 500 Hz and 50 kHz
- Plug-In, Ready-to-Use

Available Low-Pass Models:

D70L8B 8-pole Butterworth

D70L6B 6-pole Butterworth

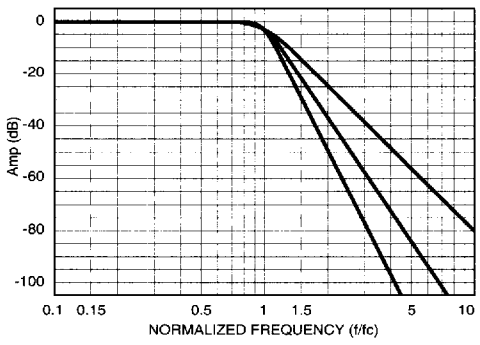
D70L4B 4-pole Butterworth

D70L8L 8-pole Bessel

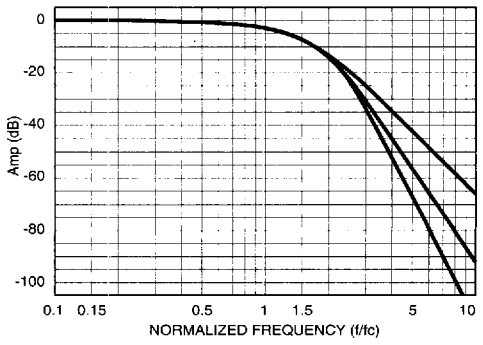
D70L6L 6-pole Bessel

D70L4L 4-pole Bessel

Butterworth Frequency Response



Bessel Frequency Response



25 Locust Street • Haverhill, Massachusetts 01830 • (508) 374-0761 • FAX (508) 521-1839

FREQUENCY DEVICES™

D70L8B

Linear Active DIP Filters

8-Pole Butterworth Low-Pass Filter

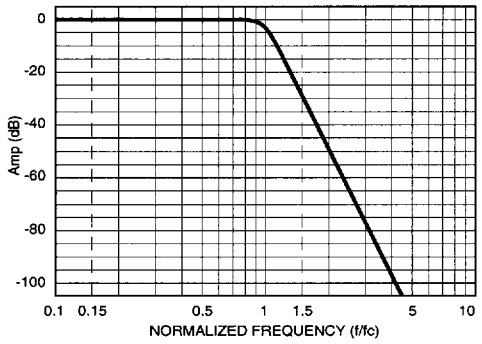
Description

The 8-pole low-pass Butterworth transfer function is maximally flat (first fifteen derivatives equal to zero) and has no ripple in the passband and has a monotonic roll-off at the rate of 48 dB/octave in the stop band.

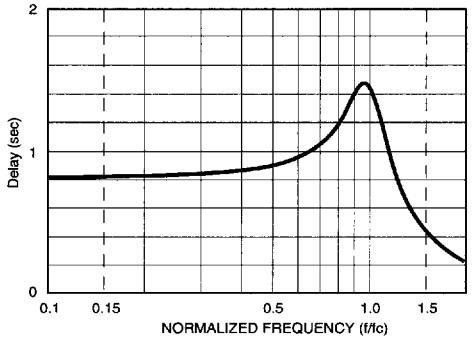
Specifications

Transfer Function	8-pole Butterworth Low-Pass
Passband Ripple (theoretical)	0.0 dB
Passband Gain (non-inverting)	0 ± 0.2 dB
Stopband Attenuation Rate	48 dB/octave
Cutoff Frequency f_c	± 2%
Amplitude	– 3.01 dB
Phase	– 360°
Maximum	50 kHz
Minimum	500 Hz
Filter Attenuation (theoretical)	
0.12 dB	0.80 f_c
3.01 dB	1.00 f_c
60.0 dB	2.37 f_c
80.0 dB	3.16 f_c
Total Harmonic Distortion @ 1 kHz	< – 90 dB
Signal-to-Noise Ratio (5 Hz - 50 kHz)	> 100 dB

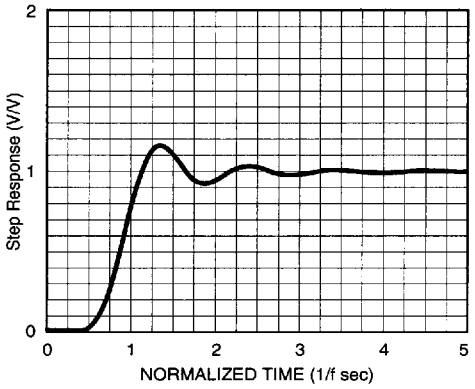
Frequency Response



Delay (Normalized)



Step Response



f/fr (Hz)	Amp (dB)	Phase (deg)	Delay * (sec)
0.00	0.00	0.00	.816
0.10	0.00	-29.4	.819
0.20	0.00	-59.0	.828
0.30	0.00	-89.1	.843
0.40	0.00	-120	.867
0.50	0.00	-152	.903
0.60	-0.001	-185	.956
0.70	-0.014	-221	1.04
0.80	-0.121	-261	1.19
0.85	-0.311	-283	1.29
0.90	-0.738	-307	1.40
0.95	-1.58	-333	1.48
1.00	-3.01	-360	1.46
1.10	-7.48	-408	1.17
1.20	-12.9	-445	.873
1.30	-18.2	-472	.672
1.40	-23.4	-494	.540
1.50	-28.2	-511	.448
1.60	-32.7	-526	.380
1.70	-36.9	-539	.328
1.80	-40.8	-550	.287
1.90	-44.6	-560	.253
2.00	-48.2	-568	.226
2.25	-56.3	-586	.174
2.50	-63.7	-600	.139
2.75	-70.3	-611	.113
3.00	-76.3	-621	.094
3.25	-81.9	-629	.080
3.50	-87.1	-635	.069
4.00	-96.3	-646	.052
5.00	-112	-661	.033
6.00	-125	-671	.023
7.00	-135	-678	.017
8.00	-144	-683	.013
9.00	-153	-687	.010
10.0	-160	-691	.008

* Normalized 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 (fc).

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

FREQUENCY DEVICES™

D70L6B

Linear Active DIP Filters

6-Pole Butterworth Low-Pass Filter

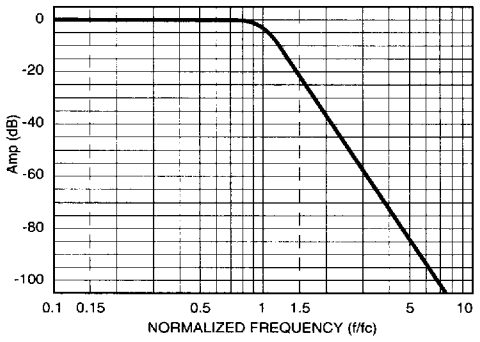
Description

The 6-pole low-pass Butterworth transfer function is maximally flat (first eleven derivatives equal to zero) and has no ripple in the passband and has a monotonic roll-off at the rate of 36 dB/octave in the stop band.

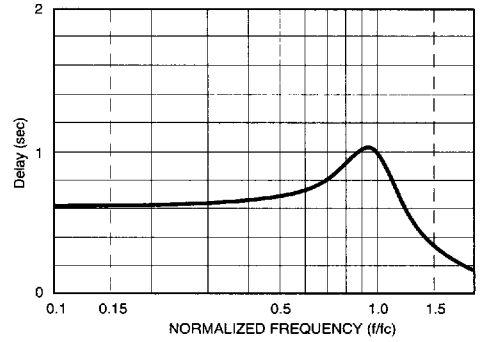
Specifications

Transfer Function	6-pole Butterworth Low-Pass
Passband Ripple (theoretical)	0.0 dB
Passband Gain (non-inverting)	0 ± 0.2 dB
Stopband Attenuation Rate	36 dB/octave
Cutoff Frequency f_c	± 2%
Amplitude	– 3.01 dB
Phase	–270°
Maximum	50 kHz
Minimum	500 Hz
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
Total Harmonic Distortion @ 1 kHz	< – 90 dB
Signal-to-Noise Ratio (5 Hz - 50 kHz)	> 100 dB

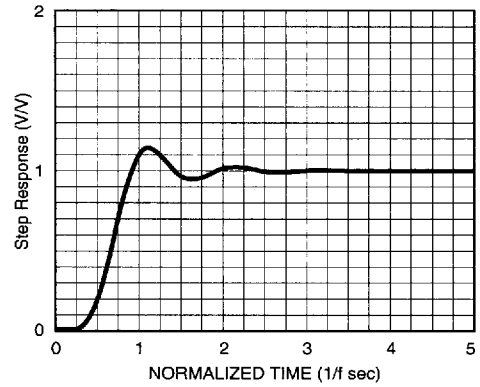
Frequency Response



Delay (Normalized)



Step Response



f/fr (Hz)	Amp (dB)	Phase (deg)	Delay * (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

* Normalized 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 (fc).

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

FREQUENCY DEVICES™

D70L4B

Linear Active DIP Filters

4-Pole Butterworth Low-Pass Filter

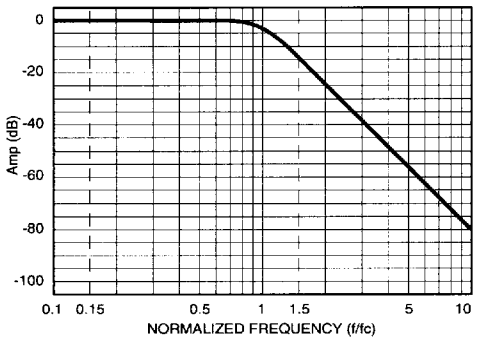
Description

The 4-pole low-pass Butterworth transfer function is maximally flat (first seven derivatives equal to zero) and has no ripple in the passband and has a monotonic roll-off at the rate of 24 dB/octave in the stop band.

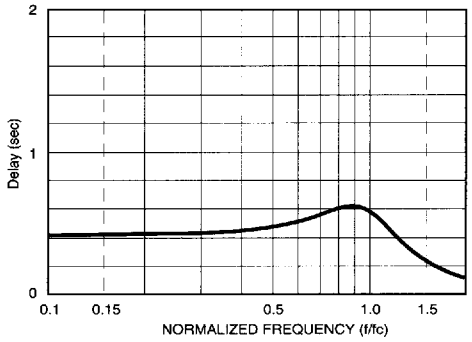
Specifications

Transfer Function	4-pole Butterworth Low-Pass
Passband Ripple (theoretical)	0.0 dB
Passband Gain (non-inverting)	0 ± 0.2 dB
Stopband Attenuation Rate	24 dB/octave
Cutoff Frequency f_c	± 2%
Amplitude	– 3.01 dB
Phase	– 180°
Maximum	50 kHz
Minimum	500 Hz
Filter Attenuation (theoretical)	
-0.67 dB	0.80 f_c
3.01 dB	1.00 f_c
60.0 dB	5.62 f_c
80.0 dB	10.0 f_c
Total Harmonic Distortion @ 1 kHz	< – 90 dB
Signal-to-Noise Ratio (5 Hz - 50 kHz)	> 100 dB

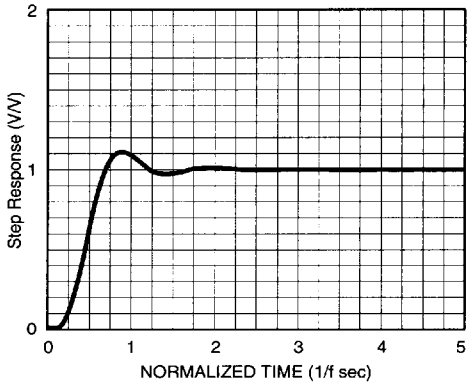
Frequency Response



Delay (Normalized)



Step Response



f/fr (Hz)	Amp (dB)	Phase (deg)	Delay * (sec)
0.00	0.00	0.00	.416
0.10	0.00	-15.0	.418
0.20	0.00	-30.1	.423
0.30	-0.00	-45.5	.433
0.40	-0.003	-61.4	.449
0.50	-0.017	-78.0	.474
0.60	-0.072	-95.7	.511
0.70	-0.243	-115	.558
0.80	-0.674	-136	.604
0.85	-1.047	-147	.619
0.90	-1.555	-158	.622
0.95	-2.21	-169	.612
1.00	-3.01	-180	.588
1.10	-4.97	-200	.513
1.20	-7.24	-217	.427
1.30	-9.62	-231	.350
1.40	-12.0	-242	.289
1.50	-14.3	-252	.241
1.60	-16.4	-260	.204
1.70	-18.5	-266	.175
1.80	-20.5	-272	.152
1.90	-22.3	-277	.134
2.00	-24.1	-282	.119
2.25	-28.2	-291	.091
2.50	-31.8	-299	.072
2.75	-35.1	-304	.059
3.00	-38.2	-309	.049
3.25	-41.0	-313	.041
3.50	-43.5	-317	.035
4.00	-48.2	-322	.027
5.00	-55.9	-330	.017
6.00	-62.3	-335	.012
7.00	-67.6	-339	.009
8.00	-72.2	-341	.007
9.00	-76.3	-343	.005
10.0	-80.0	-345	.004

* Normalized 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 (fc).

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

FREQUENCY DEVICES™

D70L8L

Linear Active DIP Filters

8-Pole Bessel Low-Pass Filter

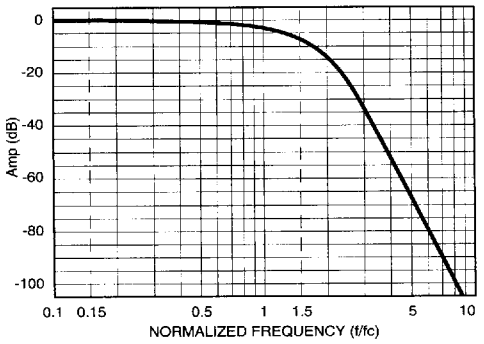
Description

The 8-pole low-pass Bessel transfer function has a monotonic roll-off in the passband and the stopband and its final rolloff rate is 48 dB/octave in the stopband. It exhibts a constant delay in the passband and has an overshoot free step response.

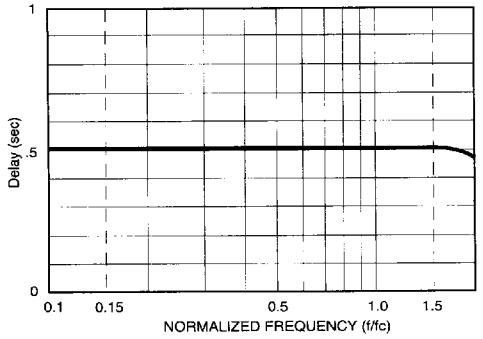
Specifications

Transfer Function	8-pole Bessel Low-Pass
Passband Ripple (theoretical)	0.0 dB
Passband Gain (non-inverting)	0 ± 0.2 dB
Stopband Attenuation Rate	48 dB/octave
Cutoff Frequency f_c	±2%
Amplitude	– 3.01 dB
Phase	– 182°
Maximum	50 kHz
Minimum	500 Hz
Filter Attenuation (theoretical)	
-1.91 dB	0.80 f_c
3.01 dB	1.00 f_c
60.0 dB	4.52 f_c
80.0 dB	6.07 f_c
Total Harmonic Distortion @ 1 kHz	< – 90 dB
Signal-to-Noise Ratio (5 Hz - 50 kHz)	> 100 dB

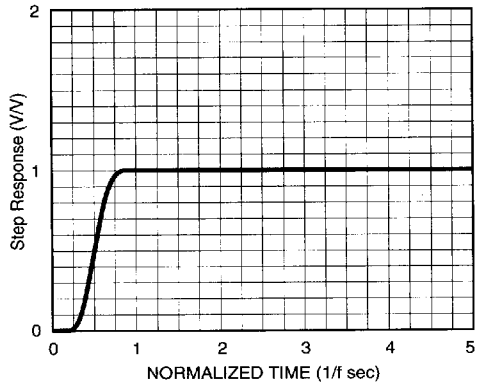
Frequency Response



Delay (Normalized)



Step Response



f/fr (Hz)	Amp (dB)	Phase (deg)	Delay * (sec)
0.00	0.00	0.00	.506
0.10	-0.029	-18.2	.506
0.20	-0.117	-36.4	.506
0.30	-0.264	-54.7	.506
0.40	-0.470	-72.9	.506
0.50	-0.737	-91.1	.506
0.60	-1.06	-109	.506
0.70	-1.45	-128	.506
0.80	-1.91	-146	.506
0.85	-2.16	-155	.506
0.90	-2.42	-164	.506
0.95	-2.71	-173	.506
1.00	-3.01	-182	.506
1.10	-3.67	-200	.506
1.20	-4.40	-219	.506
1.30	-5.20	-237	.506
1.40	-6.10	-255	.505
1.50	-7.08	-273	.504
1.60	-8.16	-291	.502
1.70	-9.36	-309	.498
1.80	-10.7	-327	.492
1.90	-12.1	-345	.482
2.00	-13.7	-362	.468
2.25	-18.1	-402	.417
2.50	-23.1	-436	.352
2.75	-28.3	-465	.291
3.00	-33.4	-489	.241
3.25	-38.3	-509	.201
3.50	-43.1	-526	.170
4.00	-51.8	-552	.126
5.00	-66.8	-587	.077
6.00	-79.2	-610	.052
7.00	-89.8	-626	.038
8.00	-99.0	-638	.029
9.00	-107	-647	.023
10.0	-114	-655	.018

* Normalized 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 (fc).

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

FREQUENCY DEVICES™

D70L6L

Linear Active DIP Filters

6-Pole Bessel Low-Pass Filter

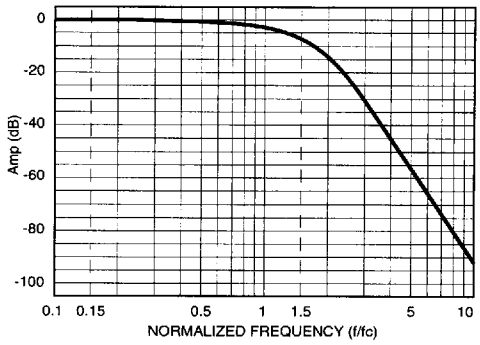
Description

The 6-pole low-pass Bessel transfer function has a monotonic roll-off in the passband and the stopband and its final rolloff rate is 36 dB/octave in the stopband. It exhibts a constant delay in the passband and has an overshoot free step response.

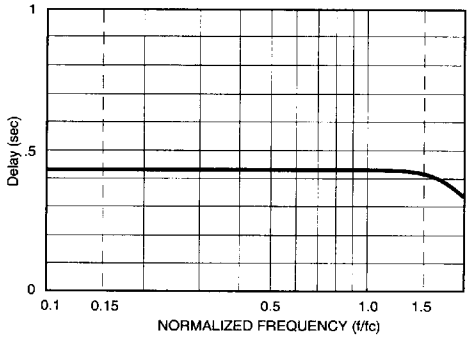
Specifications

Transfer Function	6-pole Bessel Low-Pass
Passband Ripple (theoretical)	0.0 dB
Passband Gain (non-inverting)	0 ± 0.2 dB
Stopband Attenuation Rate	36 dB/octave
Cutoff Frequency f_c	±2%
Amplitude	– 3.01 dB
Phase	– 154.9°
Maximum	50 kHz
Minimum	500 Hz
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
Total Harmonic Distortion @ 1 kHz	< – 90 dB
Signal-to-Noise Ratio (5 Hz - 50 kHz)	> 100 dB

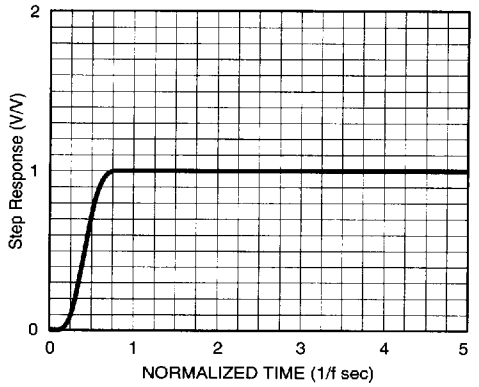
Frequency Response



Delay (Normalized)



Step Response



f/fr (Hz)	Amp (dB)	Phase (deg)	Delay * (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

* Normalized 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 (fc).

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

FREQUENCY DEVICES™

D70L4L

Linear Active DIP Filters

4-Pole Bessel Low-Pass Filter

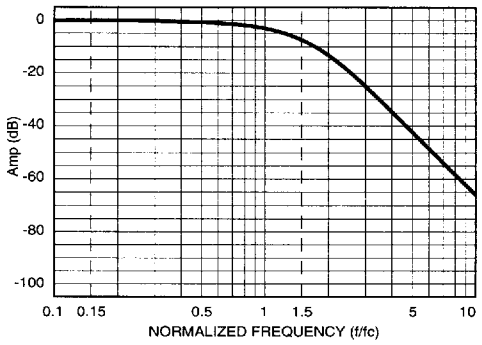
Description

The 4-pole low-pass Bessel transfer function has a monotonic roll-off in the passband and the stopband and its final rolloff rate is 24 dB/octave in the stopband. It exhibts a constant delay in the passband and has an overshoot free step response.

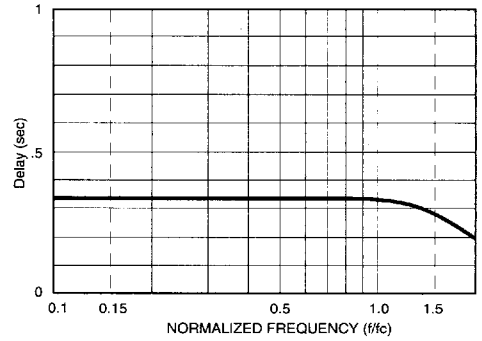
Specifications

Transfer Function	4-pole Bessel Low-Pass
Passband Ripple (theoretical)	0.0 dB
Passband Gain (non-inverting)	0 ± 0.2 dB
Stopband Attenuation Rate	24 dB/octave
Cutoff Frequency f_c	±2%
Amplitude	– 3.01 dB
Phase	– 121°
Maximum	50 kHz
Minimum	500 Hz
Filter Attenuation (theoretical)	
-1.86 dB	0.80 f_c
3.01 dB	1.00 f_c
60.0 dB	8.48 f_c
80.0 dB	15.12 f_c
Total Harmonic Distortion @ 1 kHz	< – 90 dB
Signal-to-Noise Ratio (5 Hz - 50 kHz)	> 100 dB

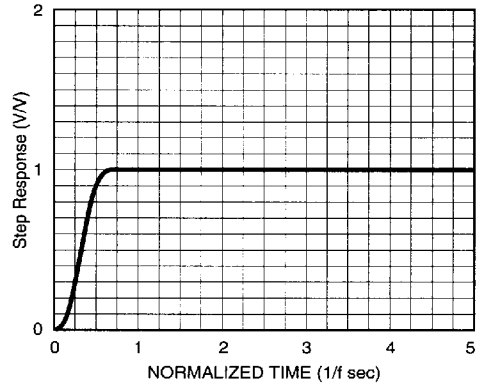
Frequency Response



Delay (Normalized)



Step Response



f/fr (Hz)	Amp (dB)	Phase (deg)	Delay * (sec)
0.00	0.00	0.00	.336
0.10	-0.028	-12.1	.336
0.20	-0.111	-24.2	.336
0.30	-0.251	-36.3	.336
0.40	-0.448	-48.4	.336
0.50	-0.705	-60.6	.336
0.60	-1.02	-72.7	.336
0.70	-1.41	-84.8	.336
0.80	-1.86	-96.8	.335
0.85	-2.11	-103	.334
0.90	-2.40	-109	.333
0.95	-2.69	-115	.332
1.00	-3.01	-121	.330
1.10	-3.71	-133	.325
1.20	-4.51	-144	.318
1.30	-5.39	-156	.308
1.40	-6.37	-166	.295
1.50	-7.42	-177	.280
1.60	-8.54	-187	.263
1.70	-9.71	-195	.246
1.80	-10.9	-204	.228
1.90	-12.2	-212	.211
2.00	-13.4	-219	.194
2.25	-16.5	-235	.158
2.50	-19.5	-248	.129
2.75	-22.4	-259	.107
3.00	-25.1	-267	.089
3.25	-27.6	-275	.076
3.50	-30.0	-281	.065
4.00	-34.4	-291	.049
5.00	-41.9	-305	.031
6.00	-48.1	-315	.021
7.00	-53.4	-321	.016
8.00	-58.0	-326	.012
9.00	-62.0	-330	.009
10.0	-65.7	-333	.008

* Normalized 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 (fc).

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

FREQUENCY DEVICES™

D70 Series

Pin-Out and Package Data Ordering Information

Specification

Analog Input Characteristics[1]

Impedance	10 kΩ min.
Voltage Range	± 10 Vpeak
Max. Safe Voltage	± Vs

Analog Output Characteristics

Impedance	1 Ω
Linear Operating Range	± 10 V
Maximum Current[2]	± 10 mA
Offset Voltage[3]	± 10 mV

Power Supply (±Vs)

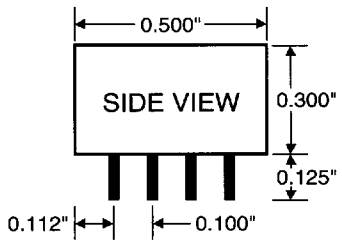
Rated Voltage	± 15 Vdc
Operating Range	± 5 to ± 20 Vdc
Maximum Safe Voltage	± 20 Vdc
Quiescent Current	
8 Pole	± 18 mA
6 Pole	± 15 mA
4 Pole	± 10 mA

Temperature

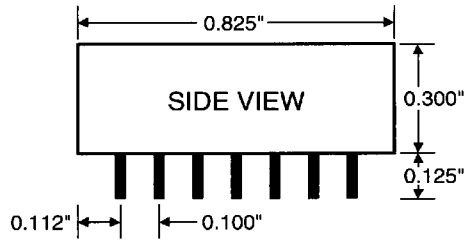
Operating	0 to + 70 °C
Storage	- 25 to + 85 °C

Notes:

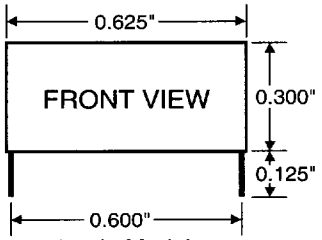
1. Input and output signal voltage referenced to supply common.
2. Output is short circuit protected to common. DO NOT CONNECT TO ±Vs.
3. Adjustable to zero.



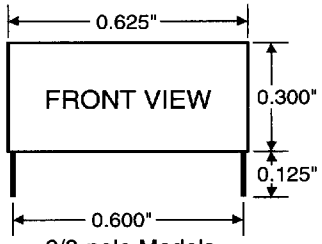
4-pole Models



6/8-pole Models

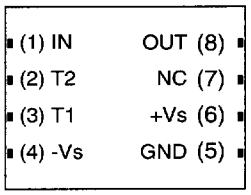


4-pole Models



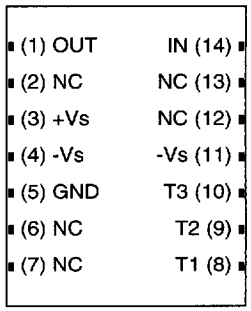
6/8-pole Models

TOP VIEW



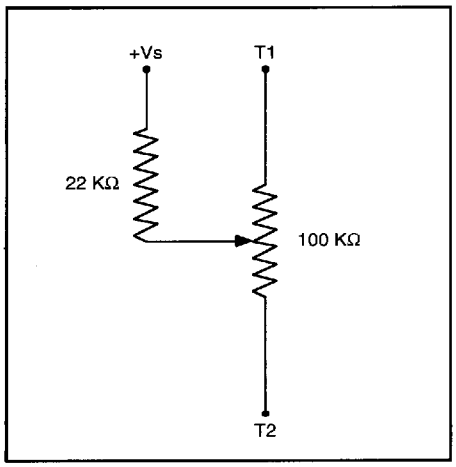
4-pole Models

TOP VIEW



6/8-pole Models

Optional Offset Adjustment



Ordering Information

How to Specify Corner Frequencies

Corner frequencies are specified by attaching a three digit frequency designator to the basic model number. Corner frequencies can range from 500 Hz to 50 kHz. The letter "k" may be substituted for the thousands comma. Please refer to the following examples:

Model Number	Transfer Function	3 dB Corner Frequency
D70L8B-849	8-pole Butterworth	849 Hz
D70L6B-2k50	6-pole Butterworth	2.50 kHz
D70L4B-5k49	4-pole Butterworth	5.49 kHz
D70L8L-10k3	8-pole Bessel	10.3 kHz
D70L6L-20k0	6-pole Bessel	20.0 kHz
D70L4L-33k3	4-pole Bessel	33.3 kHz

25 Locust Street • Haverhill, Massachusetts 01830 • (508) 374-0761 • FAX (508) 521-1839

2-92-2500