D70 Series

100 Hz to 50 kHz Fixed Frequency

DIP Filters 8-, 6-, 4-Pole Filters

Description

The D70 Series of small, fixed-frequency, linear active DIP filters provide high performance linear, multi-pole filtering in a compact package, with a broad range of pole configurations. These Butterworth and Bessel low-pass and Butterworth high-pass filters combine the excellent performance of linear multi-pole filter design with the space saving of the dual in-line package (DIP). Each model comes factory tuned to a user-specified corner frequency between 100Hz and 50kHz. These fully self-contained units require no external components or adjustments. They operate with dynamic input voltage range from non-critical ±5V to ±18V power supplies.

Features/Benefits:

- Compact DIP design minimizes board space requirements
- Plug-in ready-to-use, reducing engineering design and manufacturing time
- Factory tuned, no external clocks or adjustments needed
- Low harmonic distortion and wide signal-to-noise ratio to 14 bit resolution
- Broad range of pole configurations and corner frequencies to meet a wide range of applications

Applications

- Anti-alias filtering
- Data acquisition systems
- Communication systems and electronics
- Medical electronics equipment and research
- Aerospace, navigation and sonar applications
- Sound and vibration testing
- Real and compressed time data analysis
- Noise elimination
- Signal reconstruction

Fixed Frequency

8-, 6-, 4-Pole Low-Pass Filters

Model	D70L8B	D70L6B	D70L4B	
Product Specifications				
Transfer Function	8-Pole, Butterworth	6-Pole, Butterworth	4-Pole, Butterworth,	
Size	0.84″ x 0.65″ x 0.31″	0.84″ x 0.65″ x 0.31″	0.65″ x 0.51″ x 0.31″	
Range fc	100 Hz to 50 kHz	100 Hz to 50 kHz	100 Hz to 50 kHz	
Theoretical Transfer Characteristics	Appendix A Page 9	Appendix A Page 8	Appendix A Page 7	
Passband Ripple (theoretical)	0.0 dB	0.0 dB	0.0 dB	
DC Voltage Gain (non-inverting)	0 ± 0.02 dB typ.	0 ± 0.02 dB typ.	0 ± 0.02 dB typ.	
Stopband Attenuation Rate	48 dB/octave	36 dB/octave	24 dB/octave	
Cutoff Frequency **Stability** **Amplitude** **Phase**	fc ± 2% max. ± 0.02% /°C -3 dB -360°	fc ± 2% max. ± 0.02% /°C -3 dB -270°	fc ± 2% max. ± 0.02% /°C -3 dB -180°	
Filter Attenuation (theoretical)	0.12 dB 0.80 fc 3.01 dB 1.00 fc 60.0 dB 2.37 fc 80.0 dB 3.16 fc	0.29 dB 0.80 fc 3.01 dB 1.00 fc 60.0 dB 3.16 fc 80.0 dB 4.64 fc	0.67 dB 0.80 fc 3.01 dB 1.00 fc 60.0 dB 5.62 fc 80.0 dB 10.0 fc	
Phase Match[1]				
Amplitude Accuracy[1] (theoretical)				
Total Harmonic Distortion @ 1 kHz	< -90 dB	< -90 dB	< -90 dB	
Wide Band Noise (20 Hz - 4 MHz)	200 µVrms typ.	200 µVrms typ.	200 µVrms typ.	
Narrow Band Noise (5 Hz - 50 kHz)	50 µVrms typ.	50 µVrms typ.	50 µVrms typ.	
Filter Mounting Assembly	FMA-01A	FMA-01A	FMA-01A	

1. Phase Match and Amplitude Accuracy are within ±2% max., ±1% typ. of the theoretical transfer characteristics.

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8-, 6-, 4-Pole Low-Pass Filters

Fixed Frequency

Model	D70L8L	D70L6L	D70L4L	
Product Specifications				
Transfer Function **Size** **Range f_c**	8-Pole, Bessel 0.84″ x 0.65″ x 0.31″ 100 Hz to 50 kHz	6-Pole, Bessel 0.84″ x 0.65″ x 0.31″ 100 Hz to 50 kHz	4-Pole, Bessel 0.65″ x 0.51″ x 0.31″ 100 Hz to 50 kHz	
Theoretical Transfer Characteristics	Appendix A Page 4	Appendix A Page 3	Appendix A Page 2	
Passband Ripple (theoretical)	0.0 dB	0.0 dB	0.0 dB	
DC Voltage Gain (non-inverting)	0 ± 0.02 dB typ.	0 ± 0.02 dB typ.	0 ± 0.02 dB typ.	
Stopband Attenuation Rate	48 dB/octave	36 dB/octave	24 dB/octave	
Cutoff Frequency **Stability** **Amplitude** **Phase**	f_c ± 2% max. ± 0.02% /°C -3 dB -182°	f_c ± 2% max. ± 0.02% /°C -3 dB -155°	f_c ± 2% max. ± 0.02% /°C -3 dB -121°	
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	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	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	
Phase Match[1]				
Amplitude Accuracy[1] (theoretical)				
Total Harmonic Distortion @ 1 kHz	< -90 dB	< -90 dB	< -90 dB	
Wide Band Noise	200 µVrms typ.	200 µVrms typ.	200 µVrms typ.	
Narrow Band Noise	50 µVrms typ.	50 µVrms typ.	50 µVrms typ.	
Filter Mounting Assembly	FMA-01A	FMA-01A	FMA-01A	

1. Phase Match and Amplitude Accuracy are within ±2% max., ±1% typ. of the theoretical transfer characteristics.

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Fixed Frequency

8-, 6-, 4-Pole High-Pass Filters

Model	D70H8B	D70H6B	D70H4B	
Product Specifications				
Transfer Function	8-Pole, Butterworth	6-Pole, Butterworth	4-Pole, Butterworth	
Size	0.84″ x 0.65″ x 0.31″	0.84″ x 0.65″ x 0.31″	0.65″ x 0.51″ x 0.31″	
Range fc	100 Hz to 50 kHz	100 Hz to 50 kHz	100 Hz to 50 kHz	
Theoretical Transfer Characteristics	Appendix A Page 29	Appendix A Page 28	Appendix A Page 27	
Passband Ripple (theoretical)	0.0 dB	0.0 dB	0.0 dB	
Voltage Gain (non-inverting)	0 ± 0.02 dB typ.	0 ± 0.02 dB typ.	0 ± 0.02 dB typ.	
Power Bandwidth	120 kHz	120 kHz	120 kHz	
Small Signal Bandwidth	(-6dB) 1 MHz	(-6dB) 1 MHz	(-6dB) 1 MHz	
Stopband Attenuation Rate	48 dB/octave	36 dB/octave	24 dB/octave	
Cutoff Frequency	fc ± 2% max.	fc ± 2% max.	fc ± 2% max.	
Stability	± 0.02% /°C	± 0.02% /°C	± 0.02% /°C	
Amplitude	-3 dB	-3 dB	-3 dB	
Phase	-360°	-270°	-180°	
Filter Attenuation (theoretical)	80 dB 0.31 fc 60 dB 0.42 fc 3.01 dB 1.00 fc 00.0 dB 2.00 fc	80 dB 0.21 fc 60 dB 0.32 fc 3.01 dB 1.00 fc 00.0 dB 2.50 fc	80 dB 0.10 fc 60 dB 0.18 fc 3.01 dB 1.00 fc 00.0 dB 4.0 fc	
Phase Match[1]				
Amplitude Accuracy[1] (theoretical)				
Total Harmonic Distortion @ 1 kHz	< -80 dB	< -80 dB	< -80 dB	
Wide Band Noise (20 Hz - 4 MHz)	400 µVrms typ.	400 µVrms typ.	400 µVrms typ.	
Narrow Band Noise (20 Hz - 100 kHz)	100 µVrms typ.	100 µVrms typ.	100 µVrms typ.	
Filter Mounting Assembly	FMA-01A	FMA-01A	FMA-01A	

1. Phase Match and Amplitude Accuracy are within ±2% max., ±1% typ. of the theoretical transfer characteristics.

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Specification

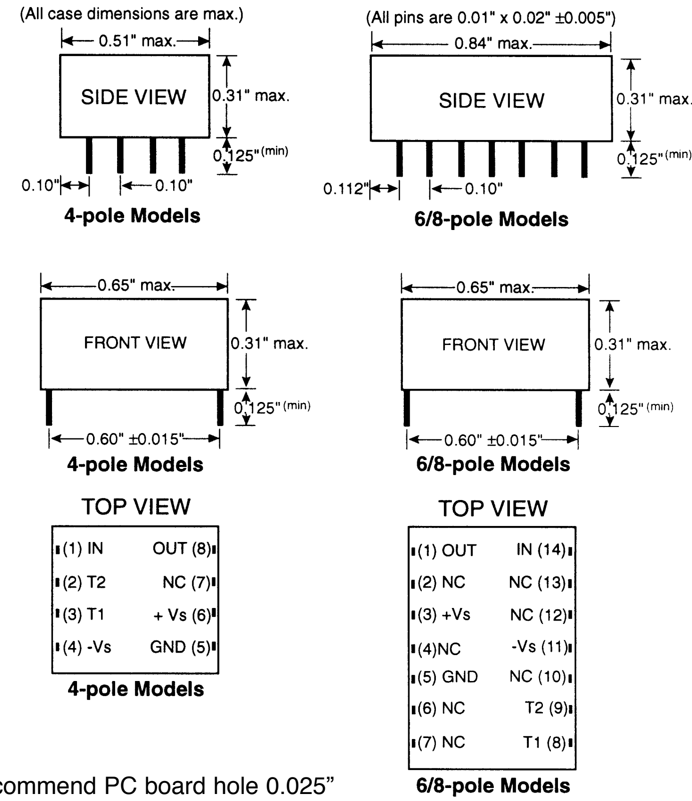
(25°C and Vs ± 15 Vdc)

Pin-Out and Package Data
Ordering Information

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
Offset Temp. Coeff.	50 µV /°C
Power Supply (±Vs)	
Rated Voltage	± 15 Vdc
Operating Range	± 5 to ± 18 Vdc
Maximum Safe Voltage	± 18 Vdc
Quiescent Current (max.)	
8 Pole	± 18 mA
6 Pole	± 15 mA
4 Pole	± 10 mA
Temperature	
Operating	0 to + 70°C
Storage	- 25 to + 85°C

Notes:

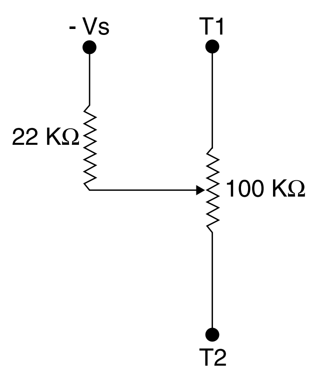
1. Input and output signal voltage referenced to supply common.
2. Output is short circuit protected to common. DO NOT CONNECT TO ±VS.
3. Adjustable to zero.



Recommend PC board hole 0.025”

Filter Mounting Assembly-See FMA-01A

Optional Offset Adjustment



Ordering Information

Filter Type
L - Low Pass
H - High Pass

Transfer Function
B - Butterworth
L - Bessel

D70L8B-849 Hz

No. of Poles
8
6
4

-3 dB Corner Frequency[4]
e.g., 849 Hz
2.50 kHz
33.3 kHz

4. 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 100 Hz to 50.0 kHz.

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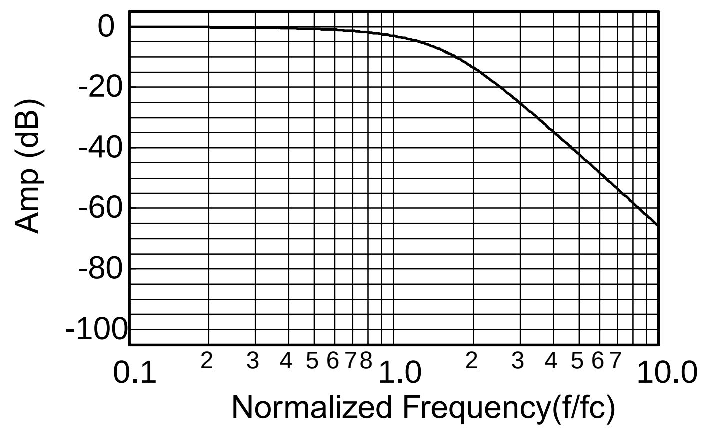
Theoretical Transfer Characteristics

f/fc (Hz)	Amp (dB)	Phase (deg)	Delay[1] (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

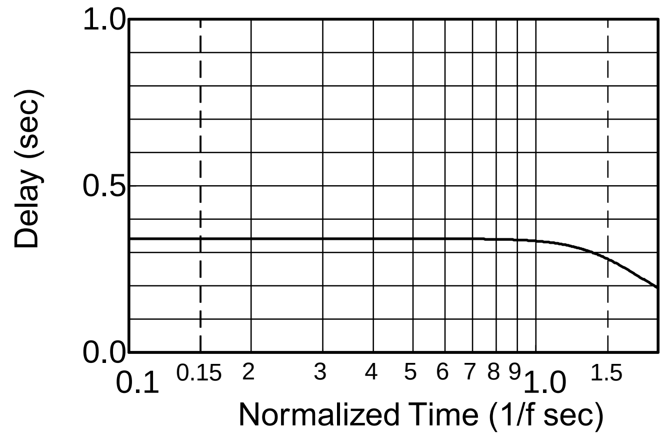
1.**Normalized Group Delay:**
The above delay data is normalized to a corner frequency of 1.0Hz.The actual delay is the normalized delay divided by the actual corner frequency (fc).

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

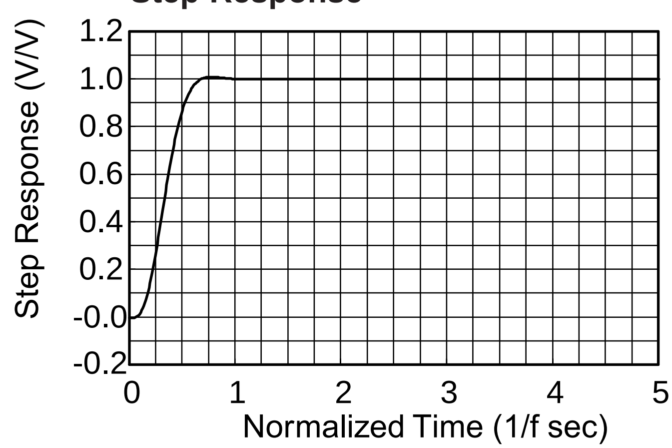
Frequency Response



Delay (Normalized)



Step Response



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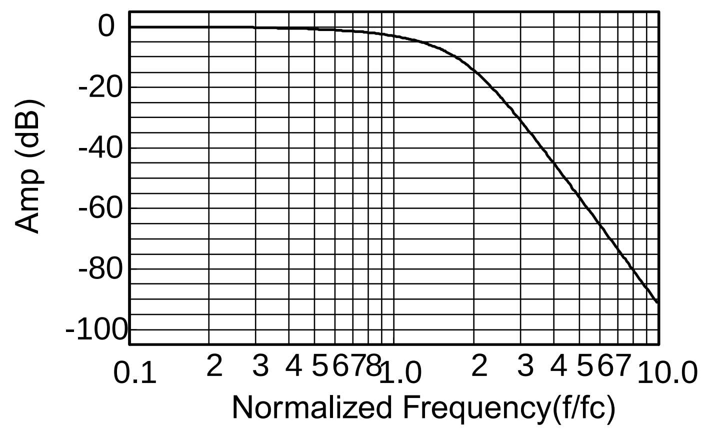
Theoretical Transfer Characteristics

f/fc (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

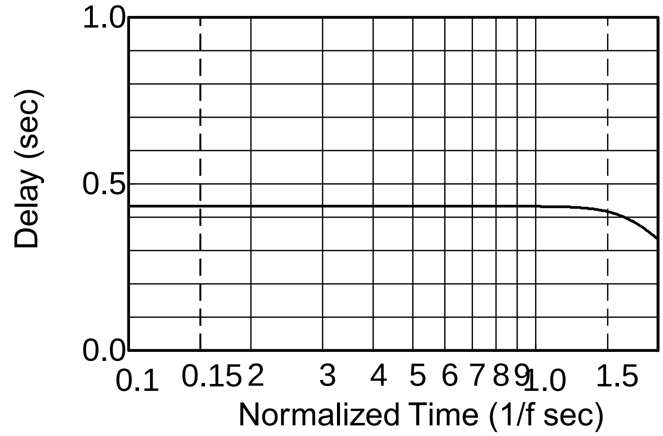
1.**Normalized Group Delay:**
The above delay data is normalized to a corner frequency of 1.0Hz.The actual delay is the normalized delay divided by the actual corner frequency (fc).

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

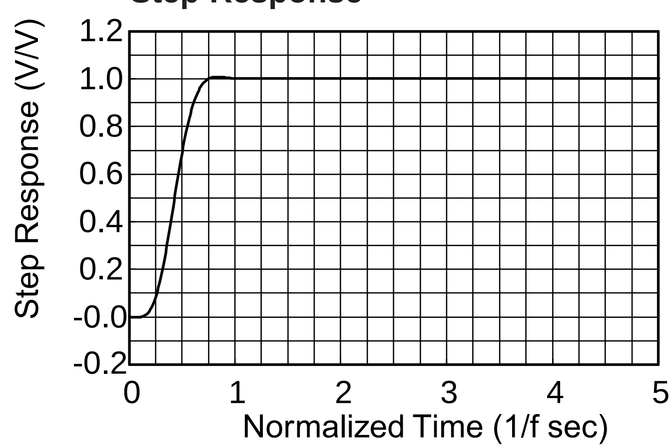
Frequency Response



Delay (Normalized)



Step Response



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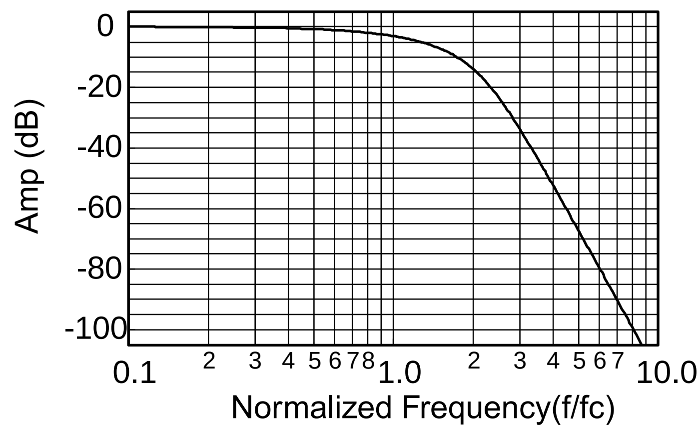
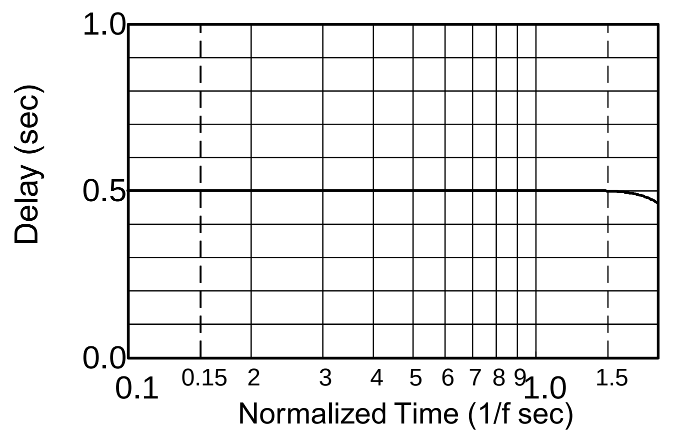
Theoretical Transfer Characteristics

f/fc (Hz)	Amp (dB)	Phase (deg)	Delay[1] (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

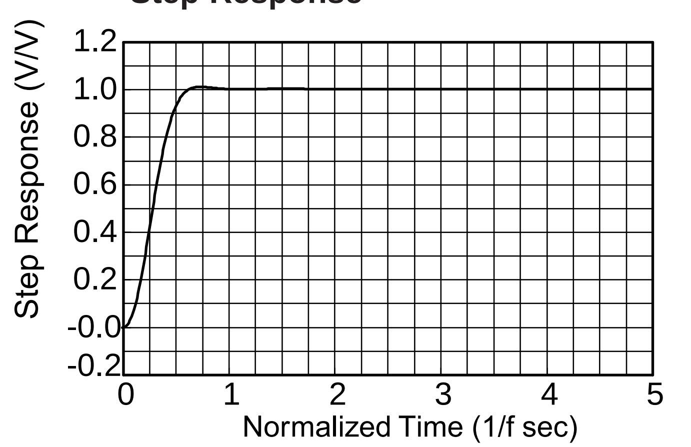
Frequency Response



Delay (Normalized)



Step Response



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

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

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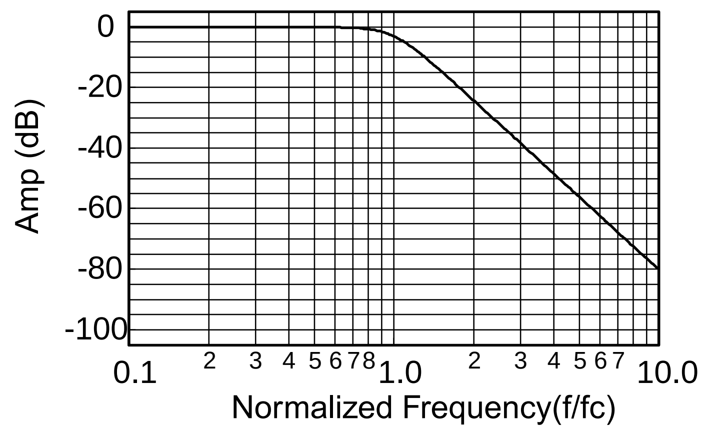
Theoretical Transfer Characteristics

f/fc (Hz)	Amp (dB)	Phase (deg)	Delay[1] (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

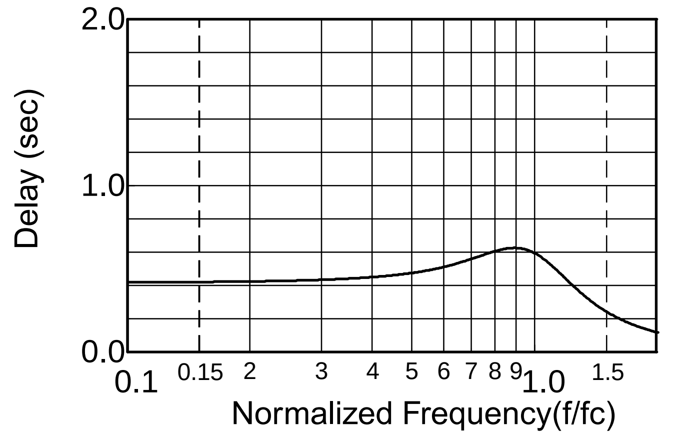
1.**Normalized Group Delay:**
The above delay data is normalized to a corner frequency of 1.0Hz.The actual delay is the normalized delay divided by the actual corner frequency (fc).

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

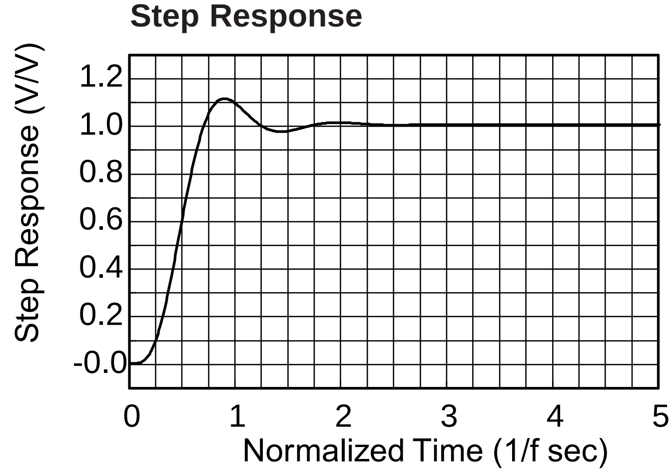
Frequency Response



Delay (Normalized)



Step Response



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FREQUENCY DEVICES™, INC.

Low-Pass

6-Pole

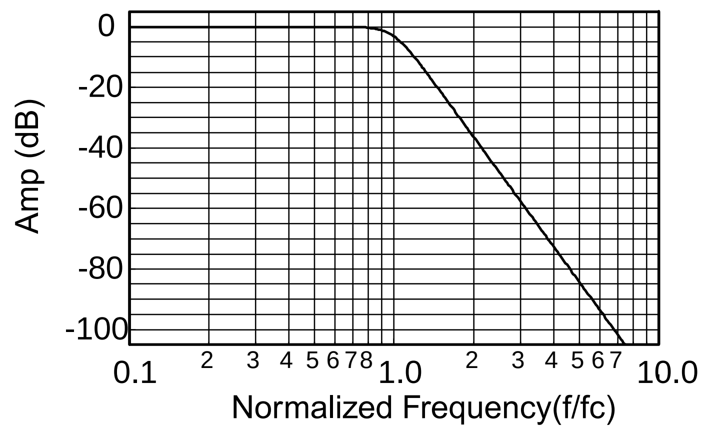
Butterworth

Appendix A

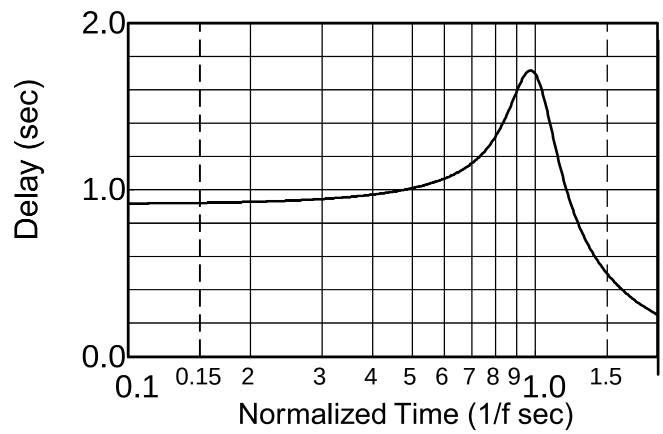
Theoretical Transfer Characteristics

f/fc (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

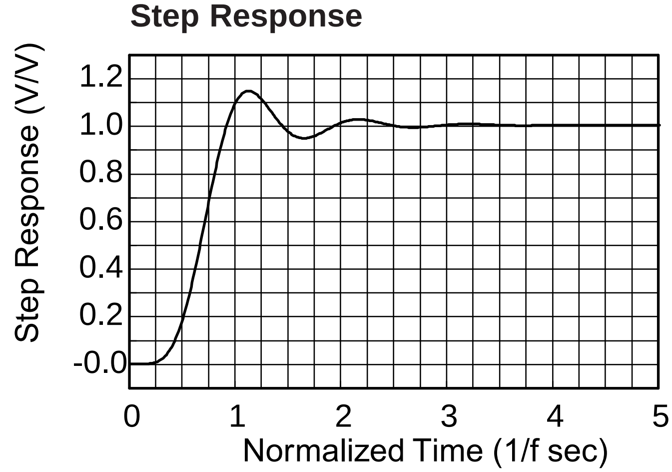
Frequency Response



Delay (Normalized)



Step Response



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

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

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Low-Pass

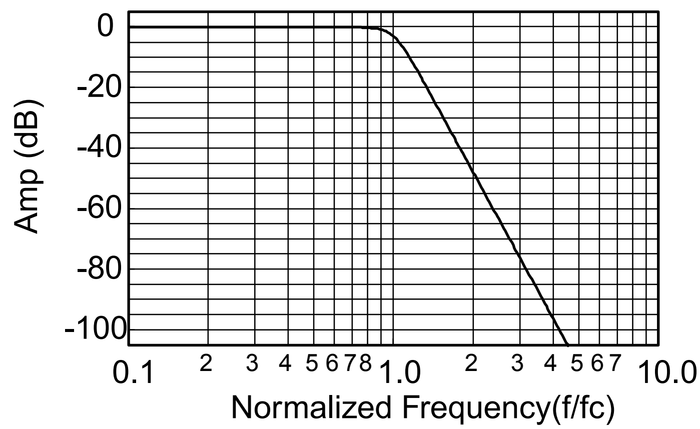
8-Pole

Butterworth

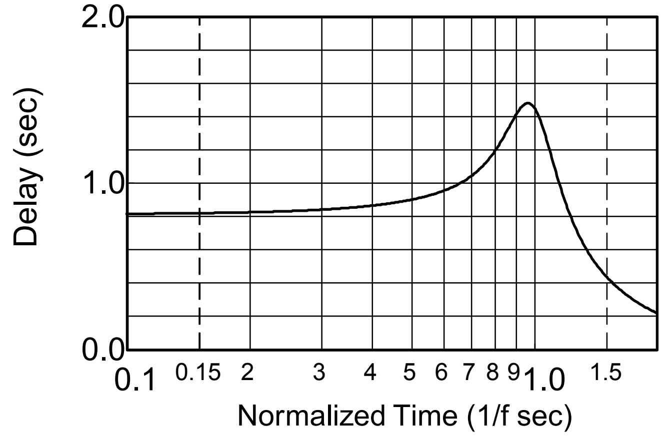
Theoretical Transfer Characteristics

f/fc (Hz)	Amp (dB)	Phase (deg)	Delay[1] (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

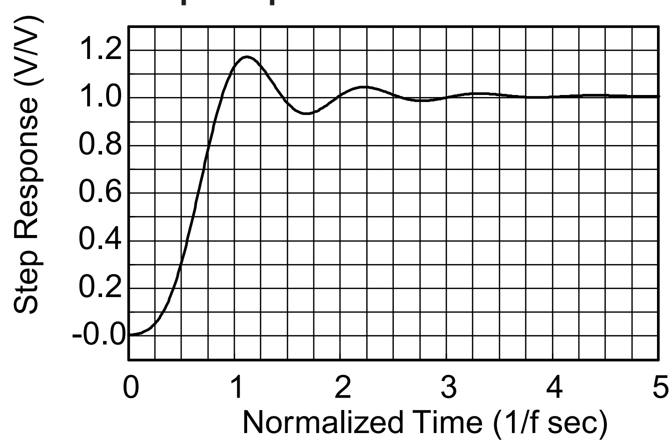
Frequency Response



Delay (Normalized)



Step Response



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

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

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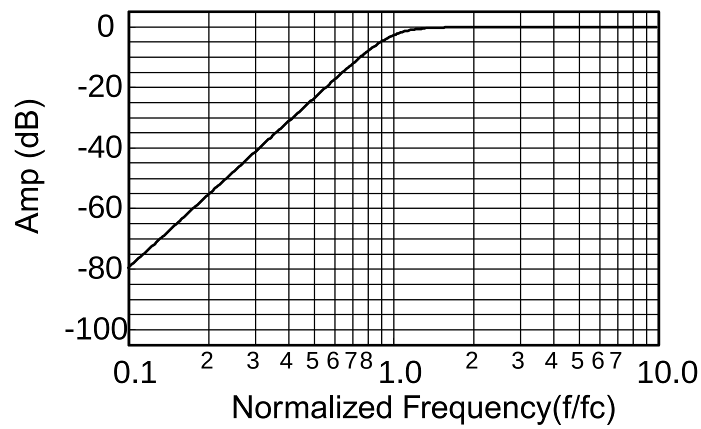
Theoretical Transfer Characteristics

f/fc (Hz)	Amp (dB)	Phase (deg)	Delay[1] (sec)
0.10	-80.0	345	.418
0.20	-55.9	330	.423
0.30	-41.8	314	.433
0.40	-31.8	299	.449
0.50	-24.1	282	.474
0.60	-17.8	264	.511
0.70	-12.6	245	.558
0.80	-8.43	224	.604
0.85	-6.69	213	.619
0.90	-5.22	202	.622
0.95	-3.99	191	.612
1.00	-3.01	180	.588
1.20	-0.908	143	.427
1.40	-0.285	118	.289
1.60	-0.100	100	.204
1.80	-0.039	87.6	.152
2.00	-0.017	78.0	.119
2.50	-0.003	61.4	.072
3.00	-0.001	50.7	.049
4.00	0.00	37.8	.027
5.00	0.00	30.1	.017
6.00	0.00	25.1	.012
7.00	0.00	21.4	.009
8.00	0.00	18.8	.007
9.00	0.00	16.7	.005
10.0	0.00	15.0	.004

Frequency Response



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

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

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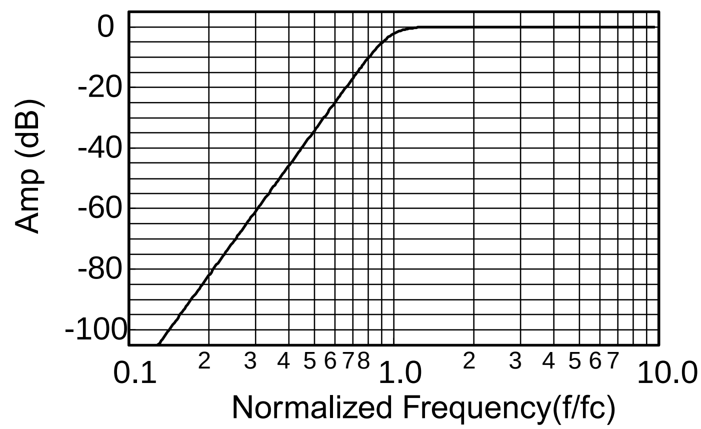
Theoretical Transfer Characteristics

f/fc (Hz)	Amp (dB)	Phase (deg)	Delay[1] (sec)
0.10	-120	518	0.617
0.20	-83.9	496	0.624
0.30	-62.7	473	0.637
0.40	-47.8	450	0.656
0.50	-36.1	425	0.685
0.60	-26.6	400	0.731
0.70	-18.6	373	0.803
0.80	-11.9	342	0.911
0.85	-9.05	325	0.970
0.90	-6.57	307	1.017
0.95	-4.55	288	1.033
1.00	-3.01	270	1.005
1.20	-0.46	209	0.660
1.40	-0.08	172	0.417
1.60	-0.02	147	0.291
1.80	-0.00	128	0.219
2.00	-0.00	115	0.171
2.50	-0.00	90.4	0.105
3.00	-0.00	74.8	0.071
4.00	0.00	55.8	0.039
5.00	0.00	44.5	0.025
6.00	0.00	37.0	0.017
7.00	0.00	31.7	0.013
8.00	0.00	27.7	0.010
9.00	0.00	24.6	0.008
10.0	0.00	22.2	0.006

Frequency Response



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

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

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High-Pass

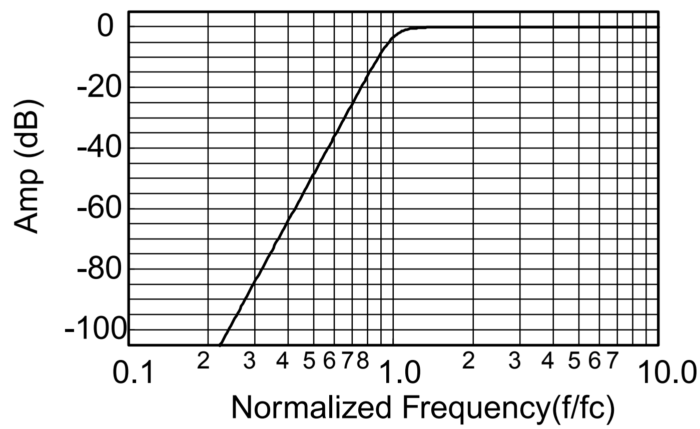
8-Pole

Butterworth

Theoretical Transfer Characteristics

f/fc (Hz)	Amp (dB)	Phase (deg)	Delay[1] (sec)
0.10	-160	691	0.819
0.20	-112	661	0.828
0.30	-83.7	631	0.843
0.40	-63.7	600	0.867
0.50	-48.2	568	0.903
0.60	-35.5	535	.956
0.70	-24.8	499	1.04
0.80	-15.6	459	1.19
0.85	-11.6	437	1.29
0.90	-8.06	413	1.40
0.95	-5.15	386	1.48
1.00	-3.01	360	1.46
1.20	-0.229	275	0.873
1.40	-0.020	226	0.540
1.60	-0.002	194	0.380
1.80	0.00	170	0.287
2.00	0.00	152	0.226
2.50	0.00	120	0.139
3.00	0.00	99.2	0.094
4.00	0.00	74.0	0.052
5.00	0.00	59.0	0.033
6.00	0.00	49.0	0.023
7.00	0.00	42.1	0.017
8.00	0.00	36.8	0.013
9.00	0.00	32.7	0.010
10.0	0.00	29.4	0.008

Frequency Response



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

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

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