FREQUENCY DEVICES™, INC.

PGAB5 & PGAL5 Series

for FDI VME Boards

Fixed Frequency Filters with Programmable Amplifiers

Description

The PGAB5 and PGAL5 Series of fixed frequency filters with programmable gain amplifiers utilize digitally controlled gain modules that were designed for Frequency Devices' multi-channel VME board products to condition DC-coupled wide-band signals. Amplifiers are programmed by an 8-bit serial data stream for gain selection using clock, data and strobe inputs.

Other standard performance features include differential input, single ended output, 5V interface logic and low noise/distortion. Available options include AC coupled input (all models) and/or differential output (VM32PAFF only).

Features/Benefits:

- Offers a low cost, versatile and convenient way to provide up to 32 channels of precision filtering and amplification in a single width B-size (6U) VME form factor.
- Phase match down to 1.0° with gain accuracy of 0.1 dB provides precision performance solutions to design engineers, system integrators and OEM's.
- Butterworth or Bessel transfer functions with a broad range of corner frequencies are offered to meet a wide range of applications.

Filter/Amplifier Options:

VM32PAFF-PGAB5-100
3-pole Butterworth, 100 Hz to 100 kHz
-12 dB to +60 dB gain in 6 dB steps

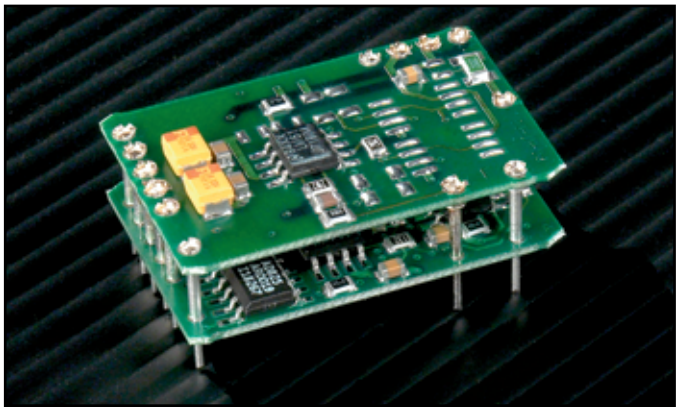
VM32PAFF-PGAB5-300
3-pole Butterworth, 100 Hz to 300 kHz
-12 dB to +42 dB gain in 6 dB steps

VM2.0PAFF-PGAB5-2.0
4-pole Butterworth, >100 kHz to 2.0 MHz
-12 dB to +36 dB gain in 6 dB steps

VM32PAFF-PGAL5-100
3-pole Bessel, 100 Hz to 100 kHz
-12 dB to +60 dB gain in 6 dB steps

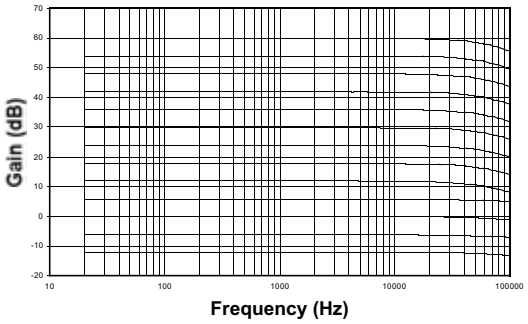
VM32PAFF-PGAL5-300
3-pole Bessel, 100 Hz to 300 kHz
-12 dB to +42 dB gain in 6 dB steps

VM2.0PAFF-PGAL5-2.0
4-pole Bessel, >100 kHz to 2.0 MHz
-12 dB to +36 dB gain in 6 dB steps

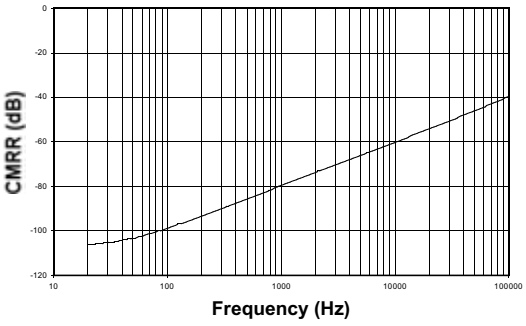


PGAB5-100 & PGAL5-100

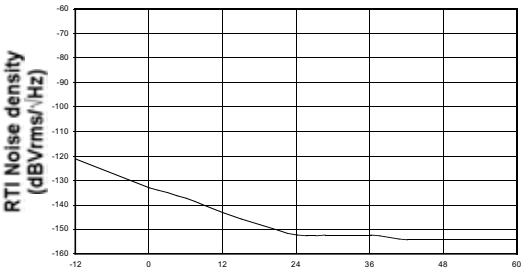
Frequency Response



Common Mode Rejection Ratio



Noise



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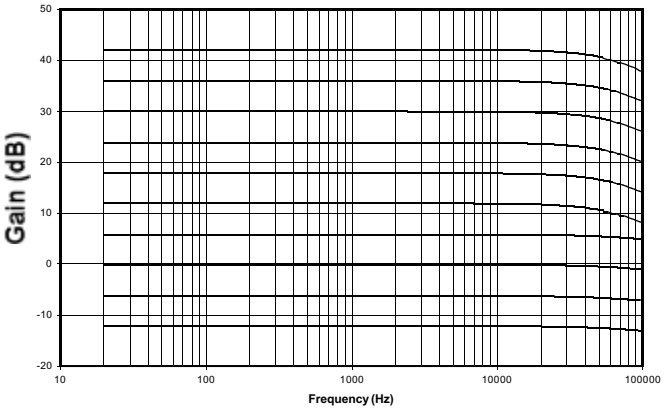
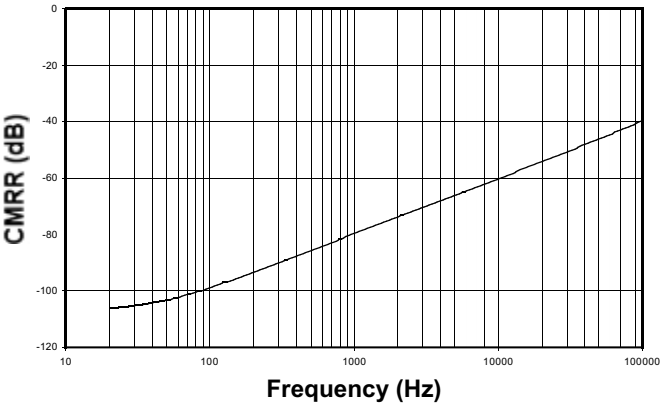
PGAB5-300 & PGAL5-300

Frequency Response



Common Mode Rejection Ratio



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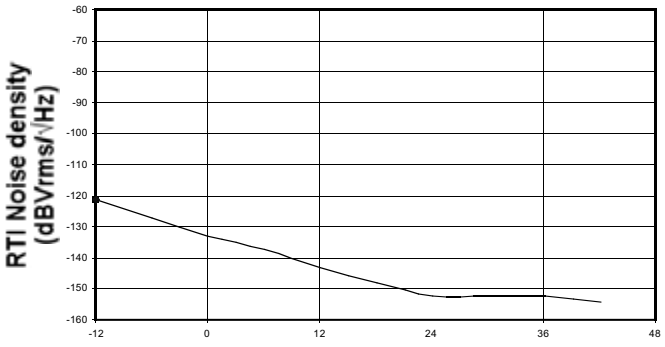
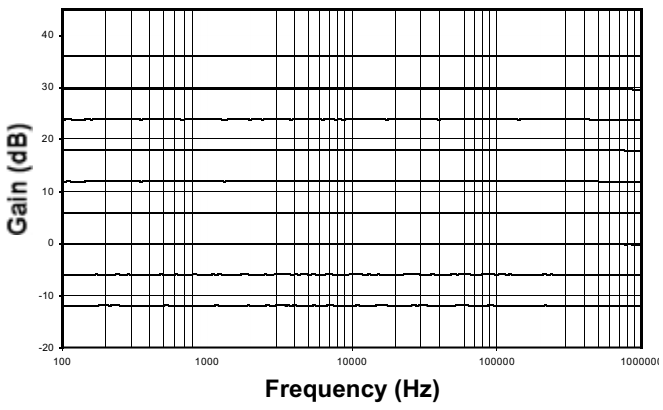
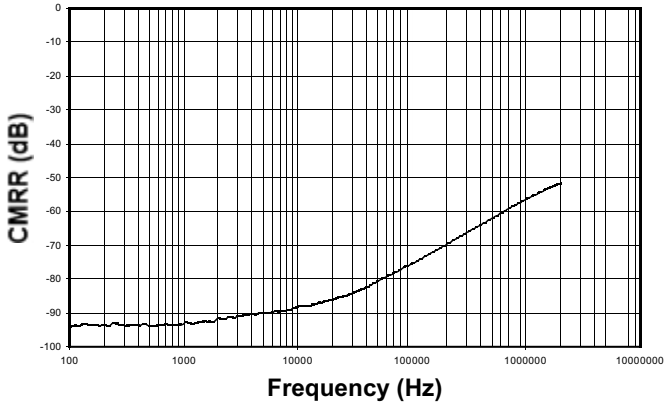


PGAB5-2.0 & PGAL5-2.0

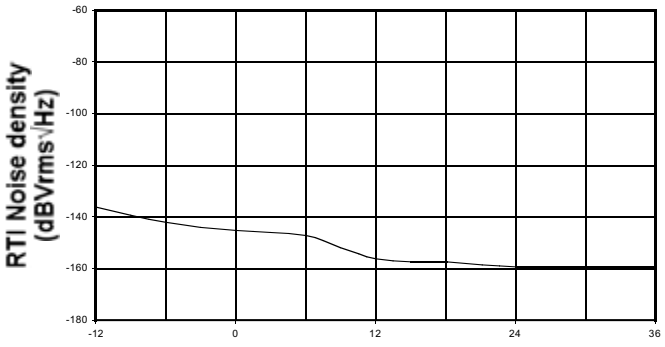
Frequency Response



Common Mode Rejection Ratio



Noise



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Specification

(25°C and rated power input)

Butterworth Fixed Frequency Filters with Programmable Amplifiers

VME Board	VM32PAFF PGAB5-100	VM32PAFF PGAB5-300	VM2.0PAFF PGAB5-2.0
Analog Input			
Impedance	1 MΩ/22pF	1 MΩ/22pF	1 MΩ/22pF
Linear Input Range	±8V pk	±8V pk	±8V pk
CMRR	80 dB @ 1kHz typ. 60 dB min.	80 dB @ 1kHz typ. 60 dB min.	≥ 50 dB, DC to 100 kHz ≥40dB,100kHz to 2MHz
Maximum Input Range	±15V	±15V	20 V pk-pk, each leg
AC Couple (Optional Fixed Freq.)	10Hz to 1.0 kHz	10Hz to 1.0 kHz	20 Hz to 1.0 kHz
Analog Output			
Impedance	1Ω typ., 10Ω max.	1Ω typ., 10Ω max.	1Ω typ., 10Ω max.
Linear Operating Range	±5V, Output clamped to ±9V	±5V, Output clamped to ±9V	±4V into 500Ω
Chl. to Chl. Crosstalk	<-100dB @ 1 kHz, <-90dB @ 20 kHz	<-100dB @ 1 kHz, <-90dB @ 20 kHz	<-100dB @ 1 kHz, <-90dB @ 20 kHz
Maximum Current	5 mA	5 mA	5 mA
Offset Voltage	2mV RTI, NTE 40 mV max.	2mV RTI, NTE 40 mV max.	25 mV typ. 50 mV max.
Offset Temp. Coeff.	±(5+ 100/G) µV/ºC max.	±(5+ 100/G) µV/ºC max.	±(5+ 100/G) µV/ºC max.
Filter Characteristics			
Filter type	Butterworth, 3-pole low-pass	Butterworth, 3-pole low-pass	Butterworth, 4-pole low-pass
Cut-off Frequency fc (-3 dB)	100 Hz to 100 kHz	100 Hz to 300 kHz	>100 kHz to 2 MHz
Theoretical Transfer Characteristics	See Appendix A Page 45	See Appendix A Page 45	See Appendix A Page 7
Amplitude Match*	±0.1dB @ DC, linear to ±0.25dB at fc	±0.1dB @ DC, linear to ±0.25dB at fc	±0.2dB @ DC
Phase Match*	0.2º typ., 1º max @ fc	0.5º typ., 2º max @ fc	2.0º max @ fc
Noise Voltage Density, RTI (Fc = 100 kHz)	20nV/√Hz @1kHz,G=1,024	20nV/√Hz @1kHz,G=128	16nV/√Hz @ 1 kHz, G=64
Distortion (2 V pk-pk)	NA	NA	≤-60db to 100 kHz ≤-50 dB, 100 kHz to 2 MHz
Distortion G=2X at 1VRMS	-83dB, 1 kHz single ended	-83dB, 1 kHz single ended	NA
Output, RL-2kΩ, BW=100 kHz	-86dB, 1 kHz differential	-86dB, 1 kHz single ended	NA
Gain Programming (G)	0.25X to 1024X in factors of 2	0.25X to 128X in factors of 2	0.25X to 64X in factors of 2
Gain Accuracy @ DC	±0.1 dB	±0.1 dB	±0.1 dB max.
Differential Output	Optional	Optional	NA

*Any two channels set to same gain and loading
NA – Not Available

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Specification

(25°C and rated power input)

Bessel Fixed Frequency Filters with Programmable Amplifiers

VME Board	VM32PAFF PGAL5-100	 PGAL5-300	VM2.0PAFF PGAL5-2.0
Analog Input			
Impedance	1 MΩ/22pF	1 MΩ/22pF	1 MΩ/22pF
Linear Input Range	±8V pk	±8V pk	±8V pk
CMRR	80 dB @ 1kHz typ. 60 dB min.	80 dB @ 1kHz typ. 60 dB min.	≥ 50 dB, DC to 100 kHz ≥40dB,100kHz to 2MHz
Maximum Input Range	±15V	±15V	20 V pk-pk, each leg
AC Couple (Optional Fixed Freq.)	10Hz to 1.0 kHz	10Hz to 1.0 kHz	20 Hz to 1.0 kHz
Analog Output			
Impedance	1Ω typ., 10Ω max.	1Ω typ., 10Ω max.	1Ω typ., 10Ω max.
Linear Operating Range	±5V, Output clamped to ±9V	±5V, Output clamped to ±9V	±4V into 500Ω
Chl. to Chl. Crosstalk	<-100dB @ 1 kHz, <-90dB @ 20 kHz	<-100dB @ 1 kHz, <-90dB @ 20 kHz	<-100dB @ 1 kHz, <-90dB @ 20 kHz
Maximum Current	5 mA	5 mA	5 mA
Offset Voltage	2mV RTI, NTE 40 mV max.	2mV RTI, NTE 40 mV max.	25 mV typ. 50 mV max.
Offset Temp. Coeff.	±(5+ 100/G) µV/ºC max.	±(5+ 100/G) µV/ºC max.	±(5+ 100/G) µV/ºC max.
Filter Characteristics			
Filter type	Bessel, 3-pole low-pass	Bessel, 3-pole low-pass	Bessel, 4-pole low-pass
Cut-off Frequency fc (-3 dB)	100 Hz to 100 kHz	100 Hz to 300 kHz	>100 kHz to 2 MHz
Theoretical Transfer Characteristics	See Appendix A Page 44	See Appendix A Page 44	See Appendix A Page 2
Amplitude Match*	±0.1dB @ DC, linear to ±0.25dB at fc	±0.1dB @ DC, linear to ±0.25dB at fc	±0.2dB @ DC
Phase Match*	0.2º typ., 1º max @ fc	0.5º typ., 2º max @ fc	2.0º max @ fc
Noise Voltage Density, RTI (Fc = 100 kHz)	20nV/√Hz @1kHz,G=1,024	20nV/√Hz @1kHz,G=128	16nV/√Hz @ 1 kHz, G=64
Distortion (2 V pk-pk)	NA	NA	≤-60db to 100 kHz ≤-50 dB, 100 kHz to 2 MHz
Distortion G=2X at 1VRMS	-83dB, 1 kHz single ended	-83dB, 1 kHz single ended	NA
Output, RL-2kΩ, BW=100 kHz	-86dB, 1 kHz differential	-86dB, 1 kHz single ended	NA
Gain Programming (G)	0.25X to 1024X in factors of 2	0.25X to 128X in factors of 2	0.25X to 64X in factors of 2
Gain Accuracy @ DC	±0.1 dB	±0.1 dB	±0.1 dB max.
Differential Output	Optional	Optional	NA

*Any two channels set to same gain and loading
NA – Not Available

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FREQUENCY DEVICES™, INC.

Low-Pass

4-Pole

Bessel

Appendix A

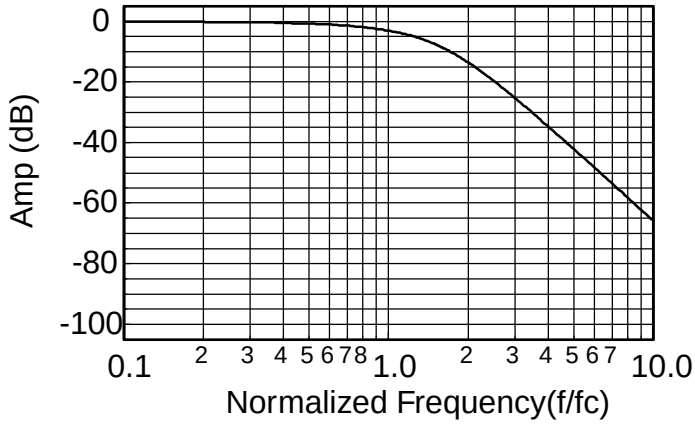
Theoretical Transfer Characteristics

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

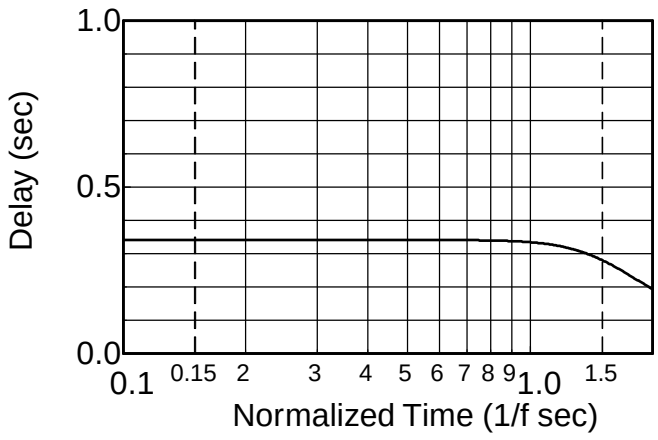
1.**Normalized Group Delay:**
The above delay data is normalized to a corner frequency of 1.0Hz.The actual delay is the normalized delay divided by the actual corner frequency (fc).

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

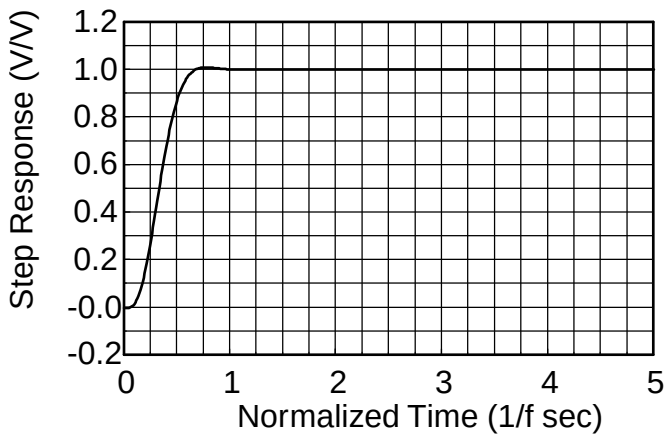
Frequency Response



Delay (Normalized)



Step Response



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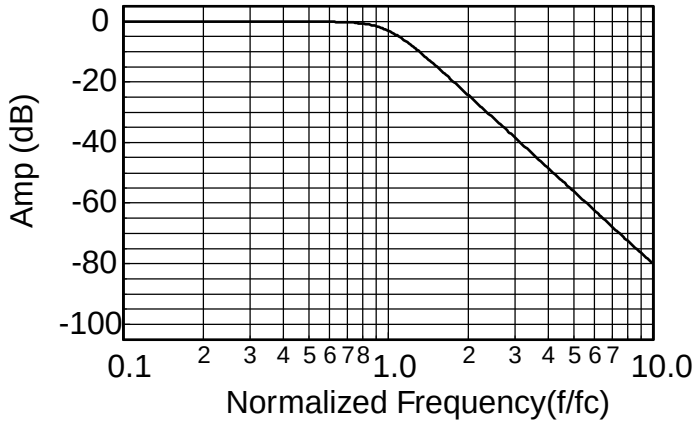
Theoretical Transfer Characteristics

f/fc (Hz)	Amp (dB)	Phase (deg)	Delay[1] (sec)
0.00	0.00	0.00	.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

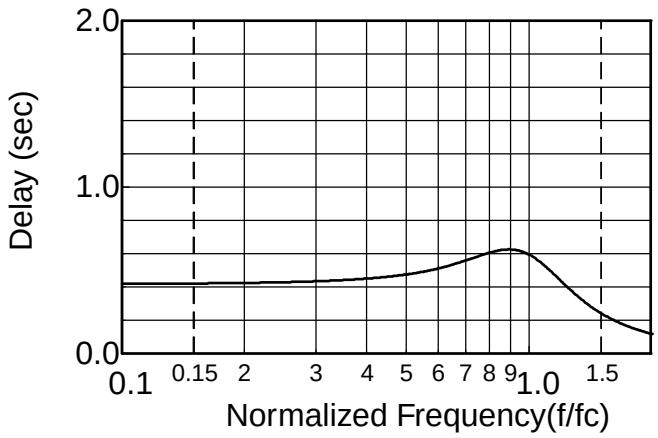
1. **Normalized Group Delay:**
The above delay data is normalized to a corner frequency of 1.0Hz.The actual delay is the normalized delay divided by the actual corner frequency (fc).

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

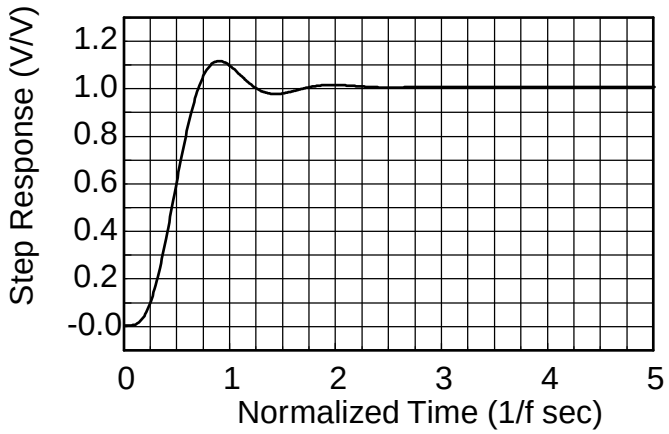
Frequency Response



Delay (Normalized)



Step Response



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FREQUENCY DEVICES™, INC.

Low-Pass

3-Pole Bessel

Appendix A

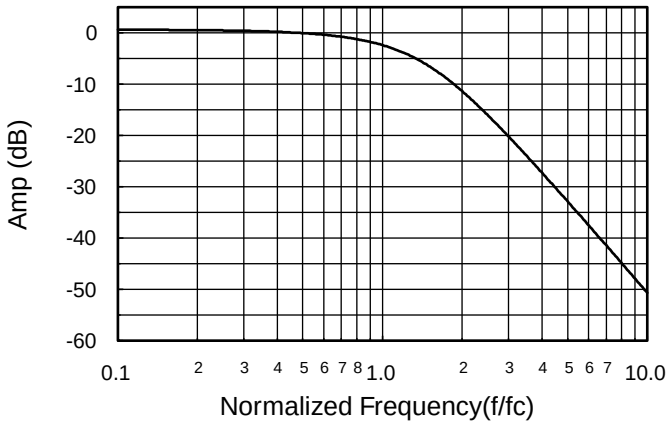
Theoretical Transfer Characteristics

f/fc (Hz)	Amp (dB)	Phase (deg)	Delay [1] (sec)
0.10	-0.027	-10.1	.279
0.20	-0.108	-20.1	.279
0.30	-0.243	-30.2	.279
0.40	-0.436	-40.2	.279
0.50	-0.689	-50.3	.279
0.60	-1.01	-60.3	.278
0.70	-1.39	-70.3	.276
0.80	-1.85	-80.2	.273
0.90	-2.39	-89.9	.268
1.00	-3.01	-99.5	.261
1.10	-3.71	-109	.252
1.20	-4.47	-118	.241
1.30	-5.31	-126	.228
1.40	-6.19	-134	.214
1.50	-7.12	-141	.199
1.60	-8.08	-148	.184
1.70	-9.05	-155	.170
1.80	-10.0	-161	.157
1.90	-11.0	-166	.144
2.00	-12.0	-171	.133
2.50	-16.7	-191	.089
3.00	-20.9	-204	.062
3.50	-24.6	-213	.046
4.00	-27.8	-221	.035
5.00	-33.4	-231	.022
6.00	-38.1	-237	.015
7.00	-42.0	-242	.011
8.00	-45.5	-245	.009
9.00	-48.5	-248	.007
10.0	-51.2	-250	.005

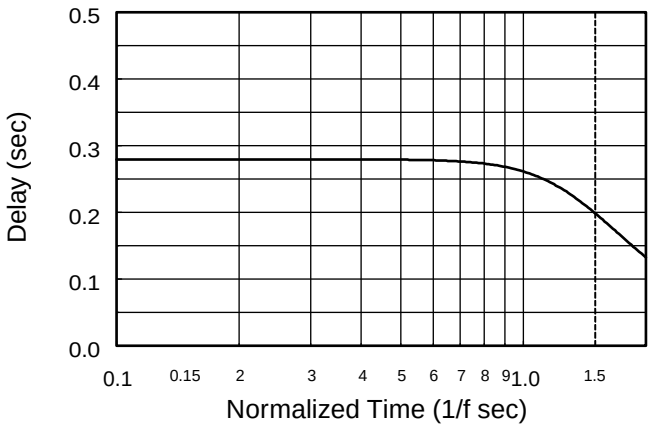
1.**Normalized Group Delay:**
The above delay data is normalized to a corner frequency of 1.0Hz.The actual delay is the normalized delay divided by the actual corner frequency (fc).

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

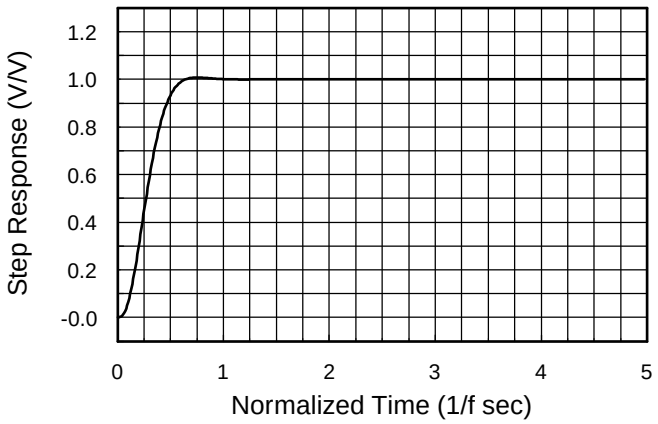
Frequency Response



Delay (Normalized)



Step Response



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FREQUENCY DEVICES™, INC.

Low-Pass

3-Pole Butterworth

Appendix A

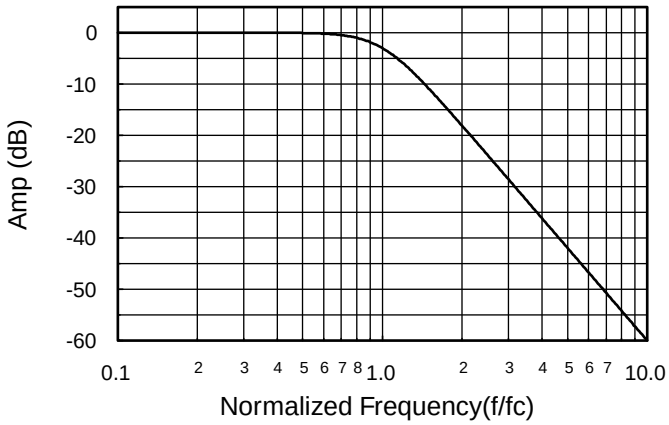
Theoretical Transfer Characteristics

f/fc (Hz)	Amp (dB)	Phase (deg)	Delay[1] (sec)
0.10	0.000	-11.5	.320
0.20	0.000	-23.1	.325
0.30	-0.003	-34.9	.335
0.40	-0.018	-47.3	.350
0.50	-0.067	-60.3	.372
0.60	-0.198	-74.1	.398
0.70	-0.483	-88.9	.423
0.80	-1.01	-104	.436
0.90	-1.85	-120	.428
1.00	-3.01	-135	.398
1.10	-4.43	-149	.352
1.20	-6.01	-160	.303
1.30	-7.65	-170	.257
1.40	-9.31	-179	.217
1.50	-10.9	-186	.185
1.60	-12.5	-192	.158
1.70	-14.0	-198	.137
1.80	-15.4	-202	.119
1.90	-16.8	-206	.105
2.00	-18.1	-210	.093
2.50	-23.9	-223	.056
3.00	-28.6	-231	.038
3.50	-32.6	-237	.027
4.00	-36.1	-241	.021
5.00	-41.9	-247	.013
6.00	-46.7	-251	.009
7.00	-50.7	-254	.007
8.00	-54.2	-256	.005
9.00	-57.3	-257	.004
10.0	-60.0	-259	.003

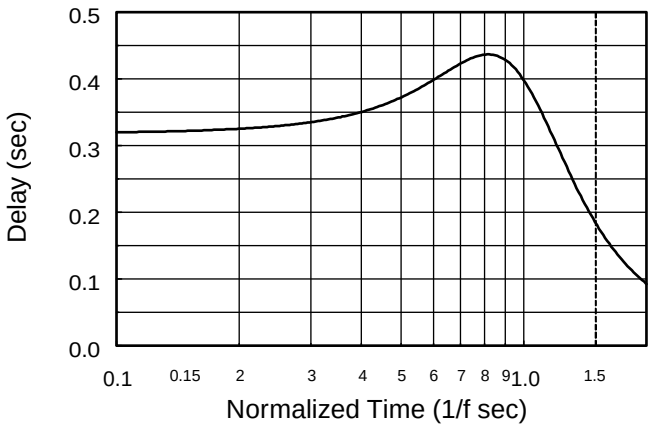
1.**Normalized Group Delay:**
The above delay data is normalized to a corner frequency of 1.0Hz.The actual delay is the normalized delay divided by the actual corner frequency (fc).

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

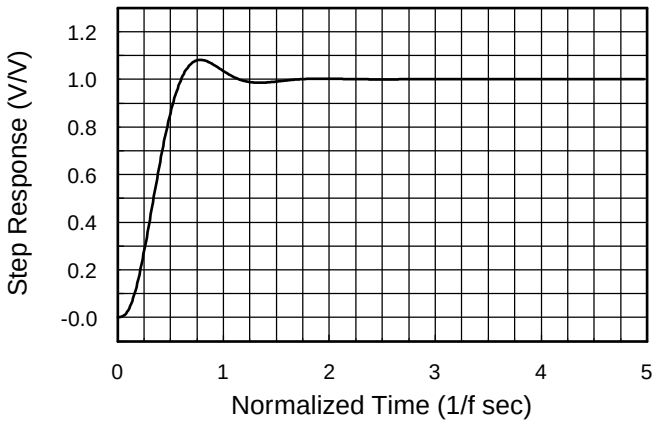
Frequency Response



Delay (Normalized)



Step Response



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