



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

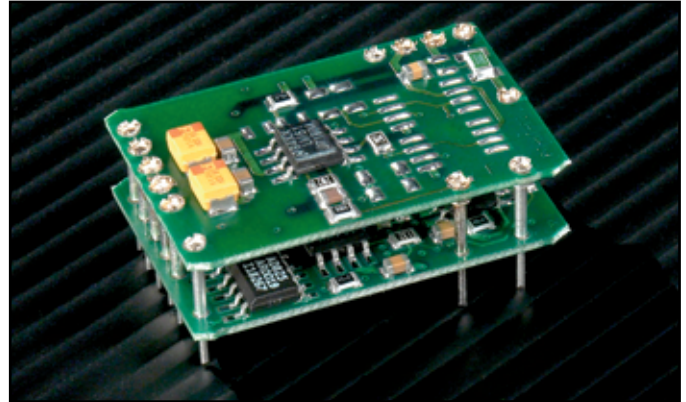
3-pole Bessel, 100 Hz to 100 kHz
-12 dB to +60 dB gain in 6 dB steps

VM32PAFF-PGAL5-300

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

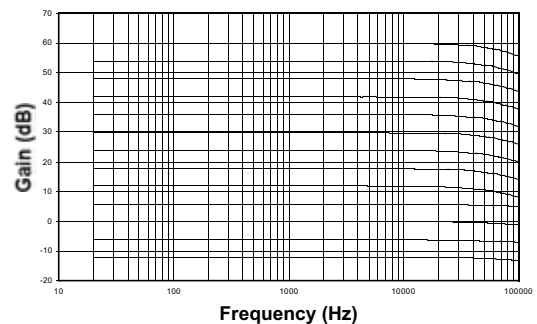
VM2.0PAFF-PGAL5-2.0

4-pole Bessel, >100 kHz to 2.0 MHz
-12 dB to +36 dB gain in 6 dB steps

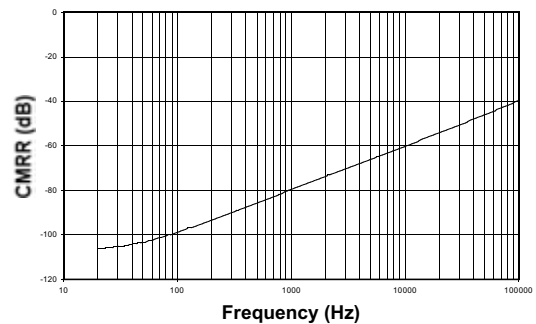


PGAB5-100 & PGAL5-100

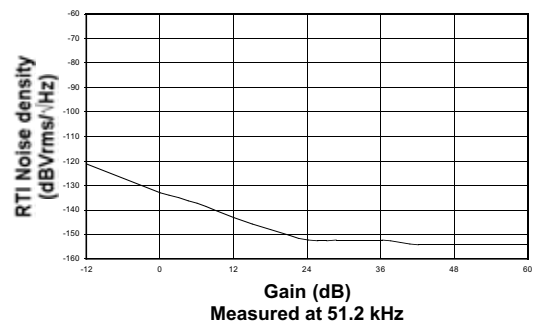
Frequency Response



Common Mode Rejection Ratio



Noise



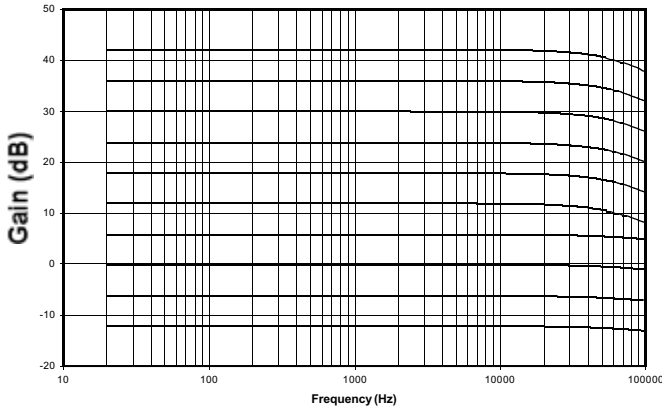


for FDI VME Boards

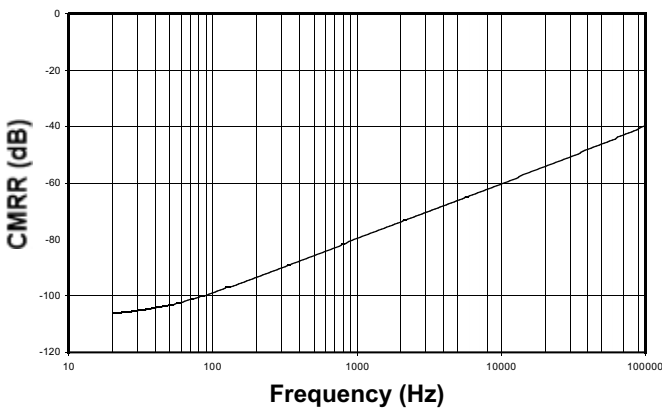
Fixed Frequency Filters with Programmable Amplifiers

PGAB5-300 & PGAL5-300

Frequency Response

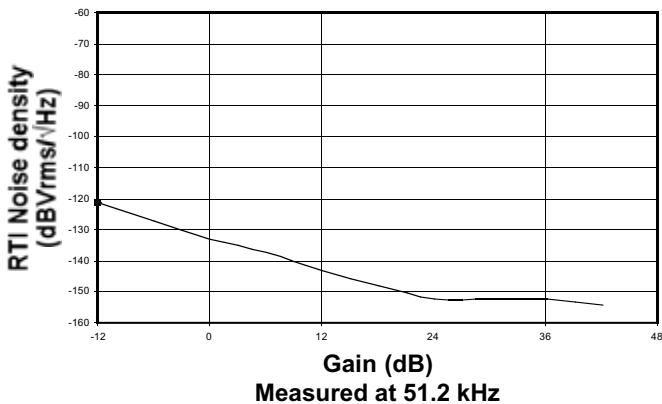


Common Mode Rejection Ratio



Frequency (Hz)

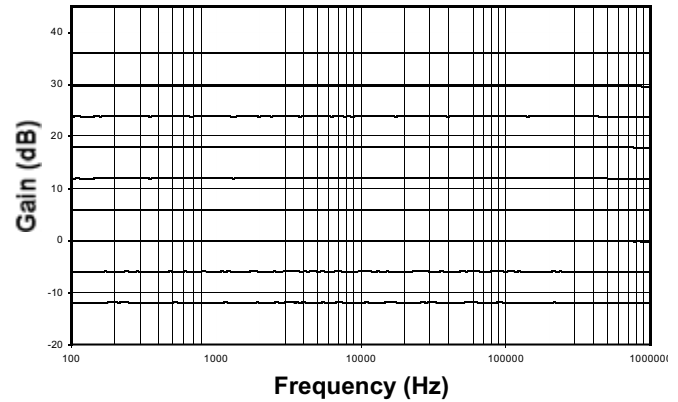
Noise



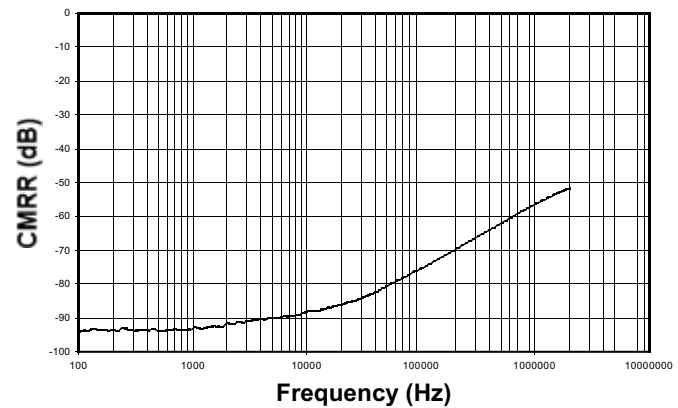
Gain (dB)
Measured at 51.2 kHz

PGAB5-2.0 & PGAL5-2.0

Frequency Response

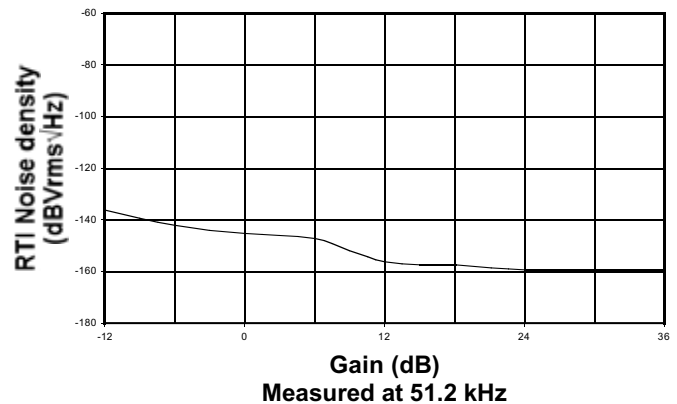


Common Mode Rejection Ratio



Frequency (Hz)

Noise



Gain (dB)
Measured at 51.2 kHz



Specification

(25°C and rated power input)

Butterworth Fixed Frequency Filters with Programmable Amplifiers

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

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



Specification

(25°C and rated power input)

Bessel Fixed Frequency Filters with Programmable Amplifiers

VME Board	VM32PAFF		VM2.0PAFF
	PGAL5-100	PGAL5-300	PGAL5-2.0
Analog Input Impedance Linear Input Range CMRR Maximum Input Range AC Couple (Optional Fixed Freq.)	1 M Ω /22pF \pm 8V pk 80 dB @ 1kHz typ. 60 dB min. \pm 15V 10Hz to 1.0 kHz	1 M Ω /22pF \pm 8V pk 80 dB @ 1kHz typ. 60 dB min. \pm 15V 10Hz to 1.0 kHz	1 M Ω /22pF \pm 8V pk \geq 50 dB, DC to 100 kHz \geq 40dB, 100kHz to 2MHz 20 V pk-pk, each leg 20 Hz to 1.0 kHz
Analog Output Impedance Linear Operating Range Chl. to Chl. Crosstalk Maximum Current Offset Voltage Offset Temp. Coeff.	1 Ω typ., 10 Ω max. \pm 5V, Output clamped to \pm 9V <-100dB @ 1 kHz, <-90dB @ 20 kHz 5 mA 2mV RTI, NTE 40 mV max. \pm (5+ 100/G) μ V/°C max.	1 Ω typ., 10 Ω max. \pm 5V, Output clamped to \pm 9V <-100dB @ 1 kHz, <-90dB @ 20 kHz 5 mA 2mV RTI, NTE 40 mV max. \pm (5+ 100/G) μ V/°C max.	1 Ω typ., 10 Ω max. \pm 4V into 500 Ω <-100dB @ 1 kHz, <-90dB @ 20 kHz 5 mA 25 mV typ. 50 mV max. \pm (5+ 100/G) μ V/°C max.
Filter Characteristics Filter type Cut-off Frequency f_c (-3 dB)	Bessel, 3-pole low-pass 100 Hz to 100 kHz	Bessel, 3-pole low-pass 100 Hz to 300 kHz	Bessel, 4-pole low-pass >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* Phase Match* Noise Voltage Density, RTI ($f_c = 100$ kHz) Distortion (2 V pk-pk) Distortion G=2X at 1VRMS Output, RL=2k Ω , BW=100 kHz Gain Programming (G) Gain Accuracy @ DC Differential Output	\pm 0.1dB @ DC, linear to \pm 0.25dB at f_c 0.2° typ., 1° max @ f_c 20nV/ $\sqrt{\text{Hz}}$ @1kHz,G=1,024 NA -83dB, 1 kHz single ended -86dB, 1 kHz differential 0.25X to 1024X in factors of 2 \pm 0.1 dB Optional	\pm 0.1dB @ DC, linear to \pm 0.25dB at f_c 0.5° typ., 2° max @ f_c 20nV/ $\sqrt{\text{Hz}}$ @1kHz,G=128 NA -83dB, 1 kHz single ended -86dB, 1 kHz single ended 0.25X to 128X in factors of 2 \pm 0.1 dB Optional	\pm 0.2dB @ DC 2.0° max @ f_c 16nV/ $\sqrt{\text{Hz}}$ @ 1 kHz, G=64 \leq -60db to 100 kHz \leq -50 dB, 100 kHz to 2 MHz NA NA 0.25X to 64X in factors of 2 \pm 0.1 dB max. NA

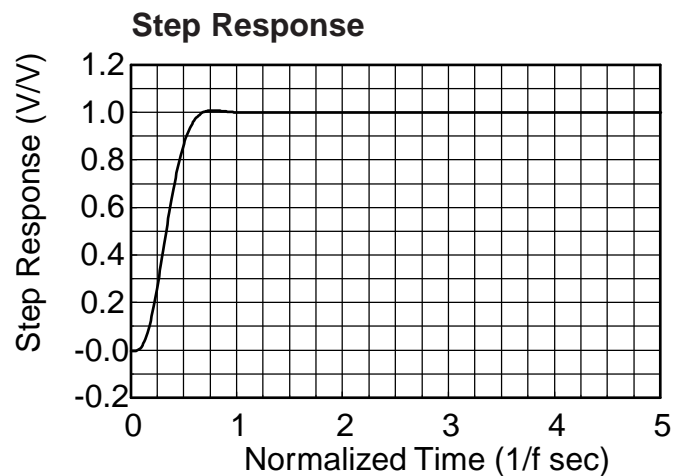
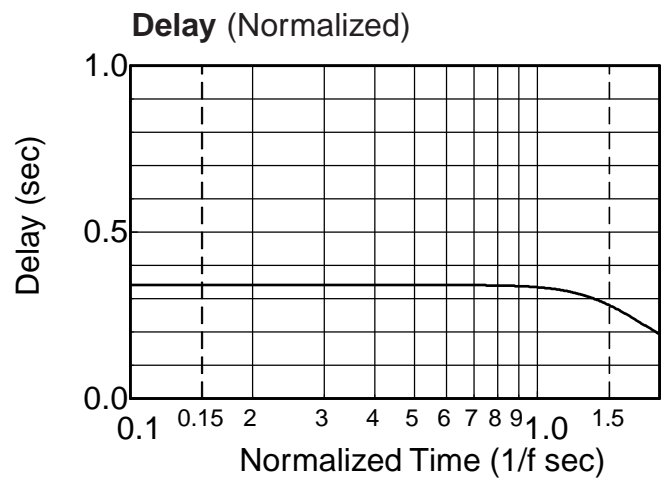
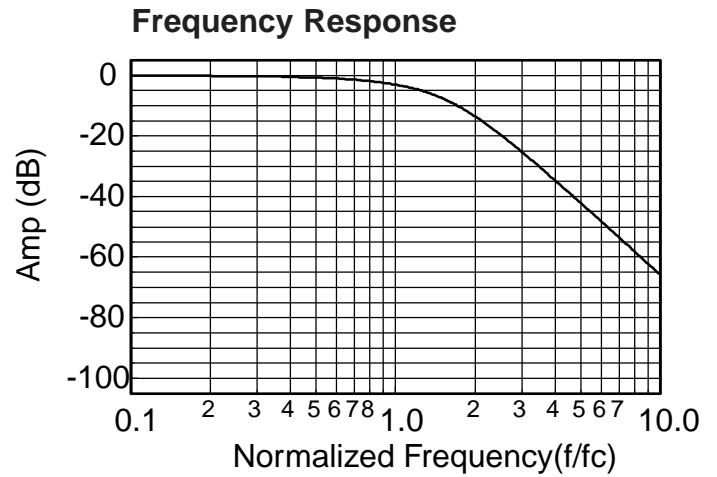
*Any two channels set to same gain and loading
 NA – Not Available



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).

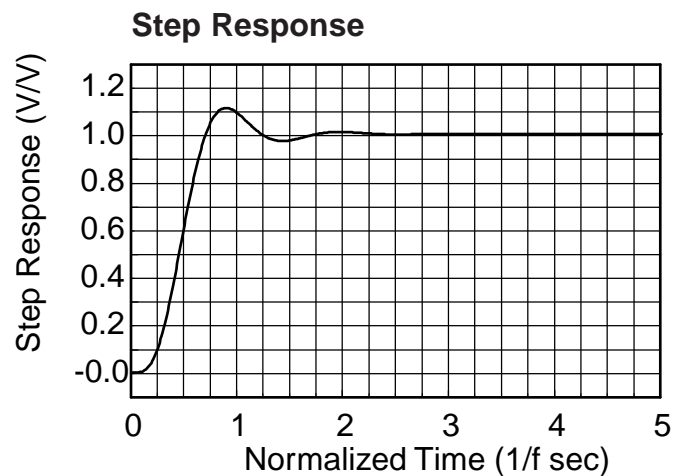
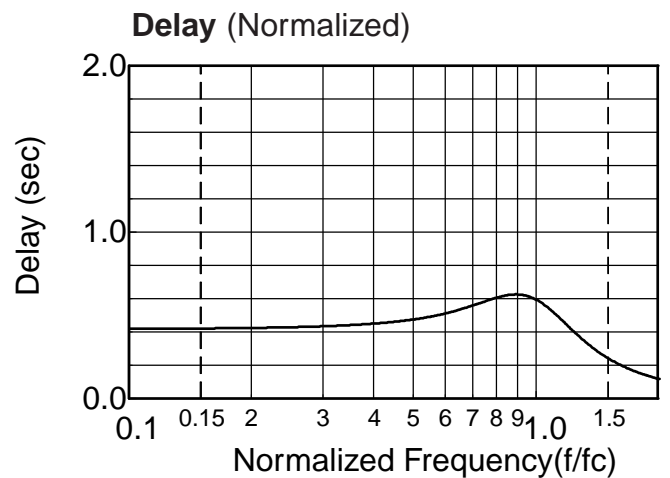
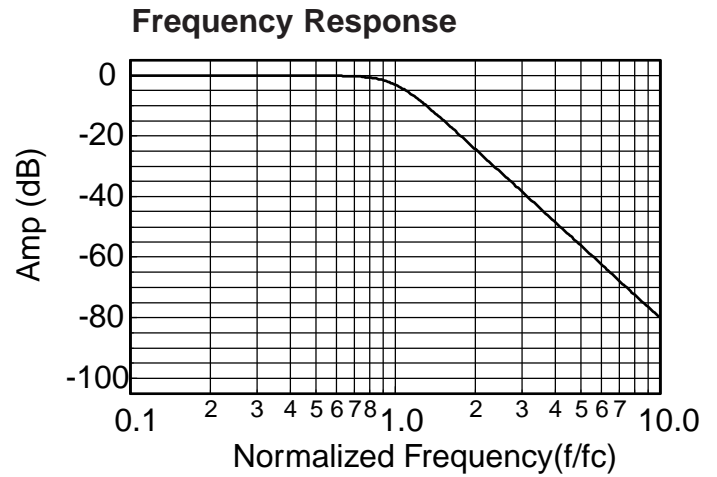
$$\text{Actual Delay} = \frac{\text{Normalized Delay}}{\text{Actual Corner Frequency (fc) in Hz}}$$



Appendix A

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).

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

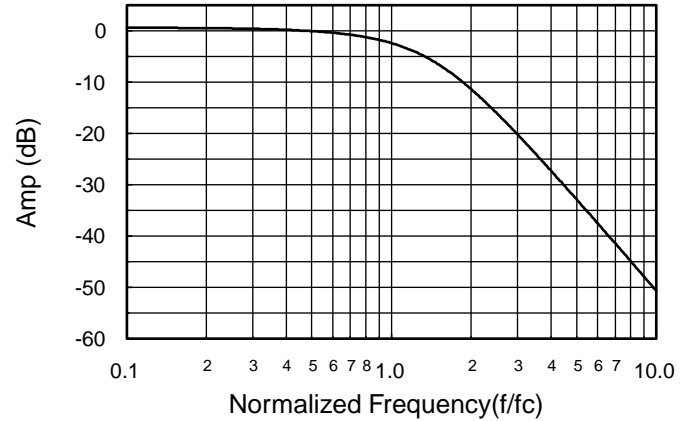


Appendix A

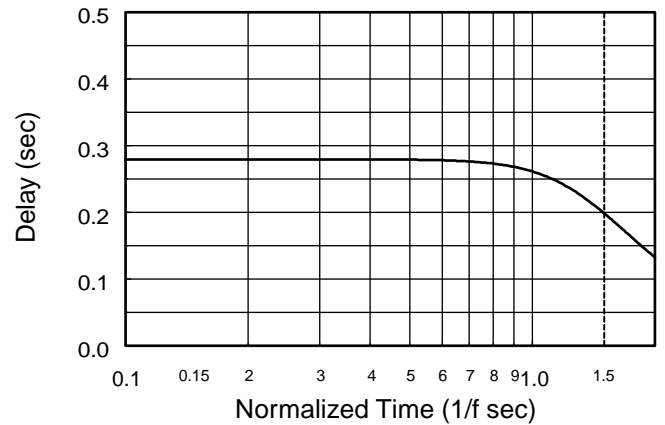
Theoretical Transfer Characteristics

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

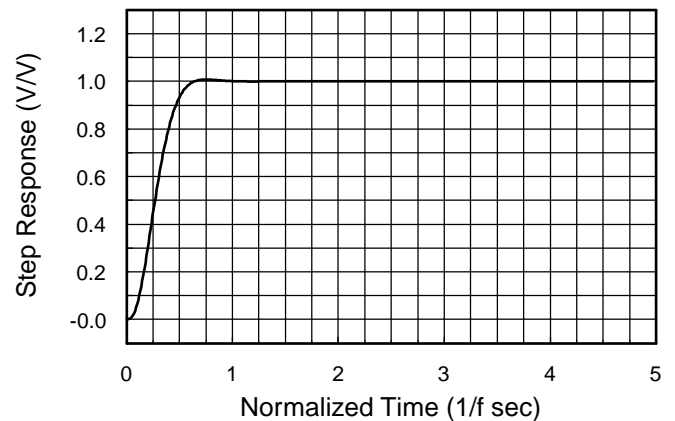
Frequency Response



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).

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

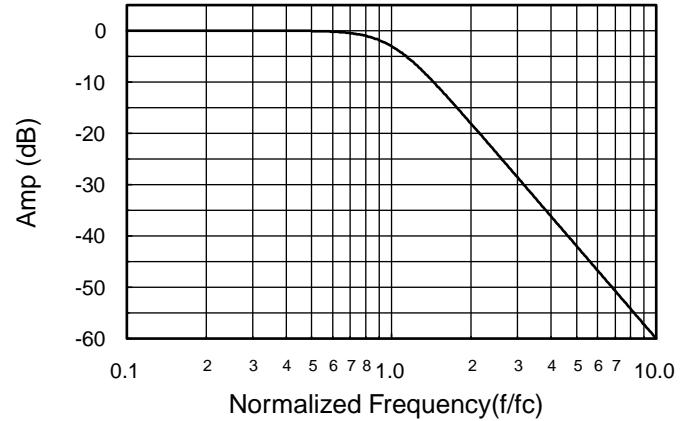


Appendix A

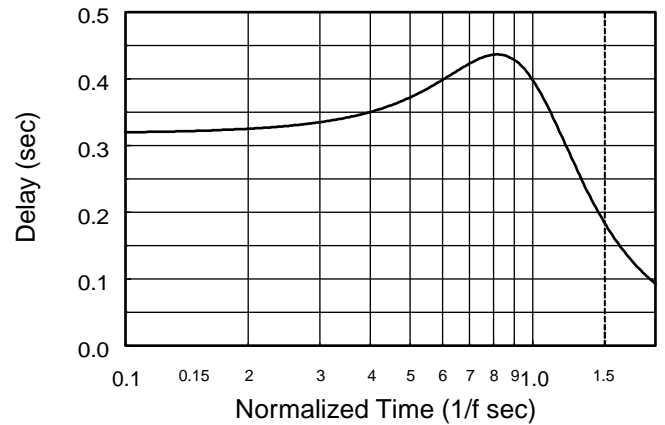
Theoretical Transfer Characteristics

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

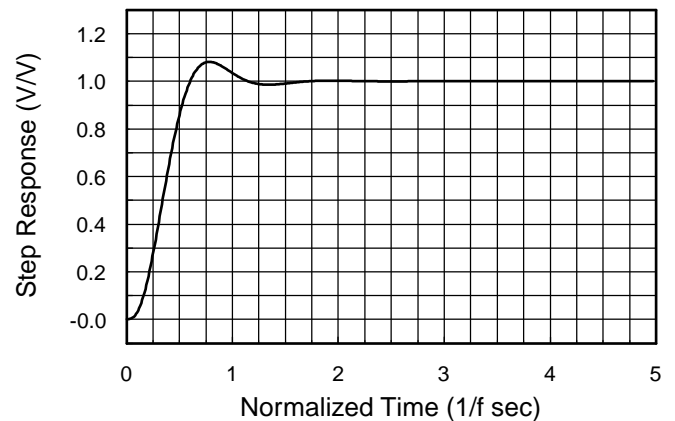
Frequency Response



Delay (Normalized)



Step Response



1. Normalized Group Delay:

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