LP4F & LP4P

4-POLE, 4-ZERO FLAT/PULSE LOW-PASS FILTER

PRECISION FILTERS, INC.

DESCRIPTION

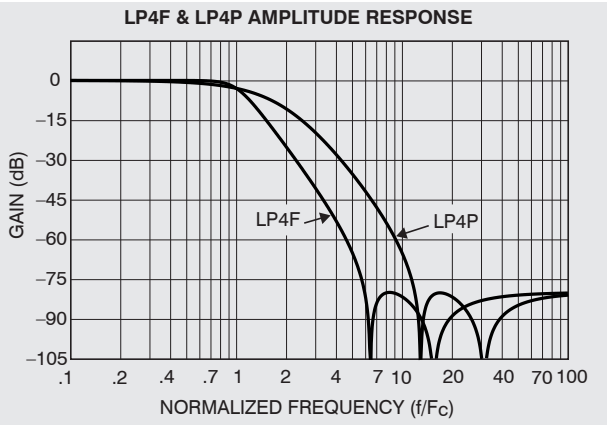
The LP4F and LP4P 4-pole, 4-zero Low-Pass filters together provide the user with the versatility to address applications in either the time or frequency domain. The choice of LP4F or LP4P is programmable in most Precision Filters products that offer this filter characteristic.

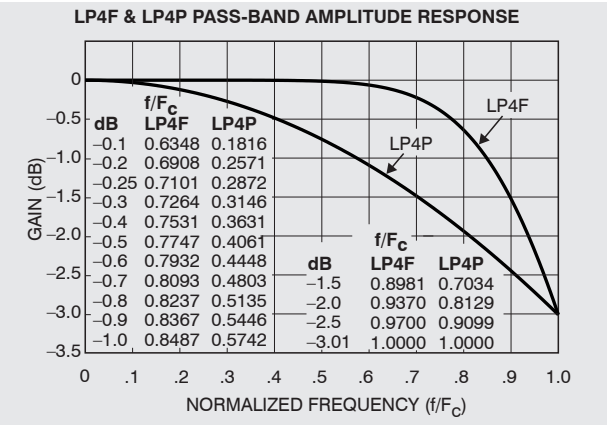
The LP4F is specified to have excellent pass-band flatness and sharp roll-off characteristics. The pass-band characteristic is nearly identical to a 4-pole Butterworth yet the LP4F has a much sharper roll-off. The LP4F is a good choice for applications such as spectral analysis and for less stringent anti-aliasing applications where a moderately high sampling ratio is available. The LP4P has excellent transient response and phase linearity making it a good filter for time domain applications including transient (shock) measurements and time domain waveform analysis. The LP4P has frequency and time domain characteristics superior to the 4-pole Bessel filter. Like the Bessel, the LP4P has a broadly rounded amplitude response that is a consequence of the LP4P's linear phase property.

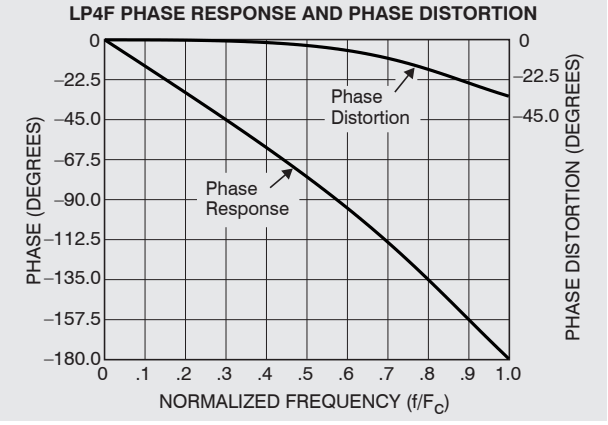
Cascade an HP4F with an LP4F to form a band-pass filter. If the filters are set with the –0.1 dB frequencies overlapping, the resulting band-pass filter will have 0.2 dB of insertion loss and will provide more than 80 dB of attenuation below 0.107 F_C and above 9.364 F_C.

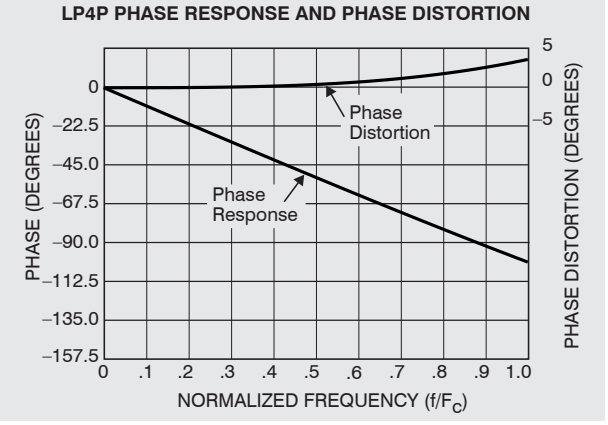
SPECIFICATIONS

	LP4F Maximally Flat Low-Pass Filter	LP4P Constant Time Delay Low-Pass Filter
Cutoff Frequency Amplitude	**–3.01 dB**	**–3.01 dB**
DC Gain	**0.00 dB**	**0.00 dB**
Pass-Band Ripple	**0.00 dB**	**0.00 dB**
Stop-Band Frequency:	**5.9465 F_C**	**11.863 F_C**
Cutoff Frequency Phase	**–180.0°**	**–101.5°**
Phase Distortion (DC to F_C)	**<31.8°**	**<3.7°**
Zero Frequency Group Delay	**0.4117/F_C**	**0.2920/F_C**
Percent Overshoot	**11.1%**	**0.5%**
1% Settling Time	**1.65/F_C**	**0.66/F_C**
0.1 % Settling Time	**2.72/F_C**	**0.77/F_C**
–0.1 dB Frequency	**0.6348 F_C**	**0.1816 F_C**
–1 dB Frequency	**0.8487 F_C**	**0.5742 F_C**
–2 dB Frequency	**0.9370 F_C**	**0.8129 F_C**
–3.01 dB Frequency	**1.0000 F_C**	**1.0000 F_C**
–20 dB Frequency	**1.7412 F_C**	**3.0248 F_C**
–40 dB Frequency	**2.9555 F_C**	**5.6932 F_C**
–60 dB Frequency	**4.5986 F_C**	**9.0980 F_C**
–80 dB Frequency	**5.9465 F_C**	**11.8629 F_C**

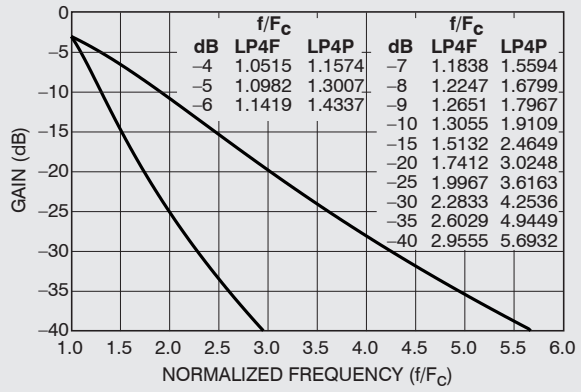






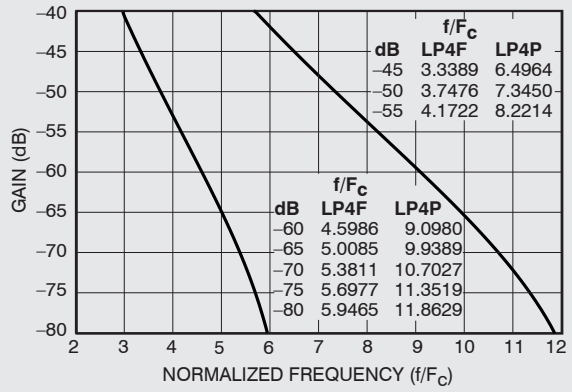


LP4F & LP4P TRANSITION REGION AMPLITUDE RESPONSE



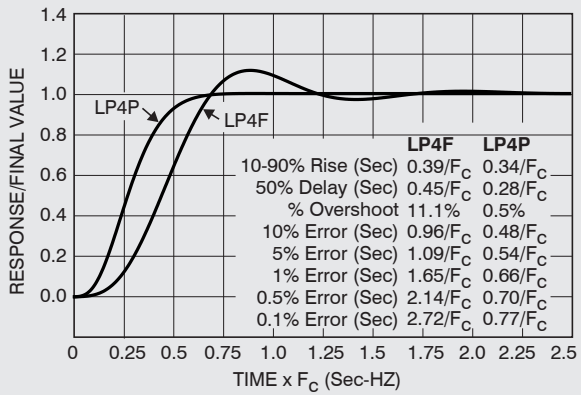
dB	f/Fc LP4F	f/Fc LP4P	dB	f/Fc LP4F	f/Fc LP4P
–4	1.0515	1.1574	–7	1.1838	1.5594
–5	1.0982	1.3007	–8	1.2247	1.6799
–6	1.1419	1.4337	–9	1.2651	1.7967
			–10	1.3055	1.9109
			–15	1.5132	2.4649
			–20	1.7412	3.0248
			–25	1.9967	3.6163
			–30	2.2833	4.2536
			–35	2.6029	4.9449
			–40	2.9555	5.6932

LP4F & LP4P TRANSITION REGION AMPLITUDE RESPONSE



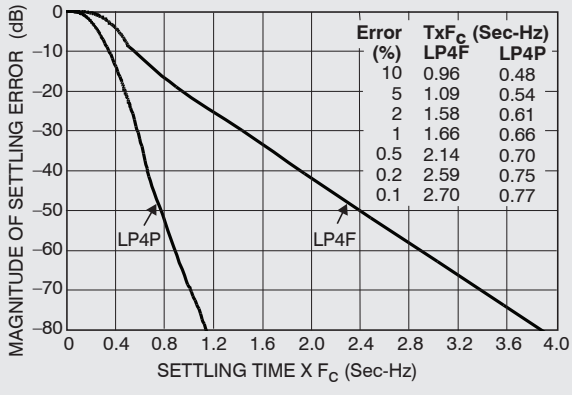
dB	f/Fc LP4F	f/Fc LP4P
–45	3.3389	6.4964
–50	3.7476	7.3450
–55	4.1722	8.2214
–60	4.5986	9.0980
–65	5.0085	9.9389
–70	5.3811	10.7027
–75	5.6977	11.3519
–80	5.9465	11.8629

LP4F & LP4P STEP RESPONSE



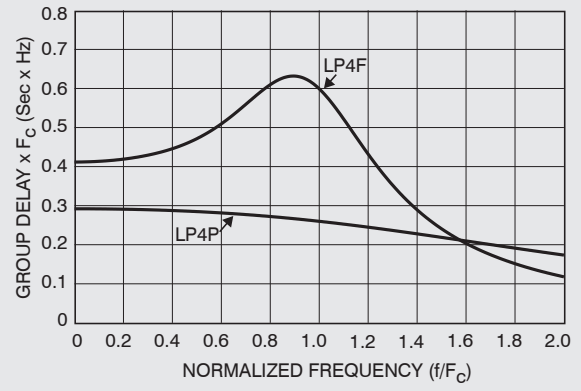
	LP4F	LP4P
10-90% Rise (Sec)	0.39/Fc	0.34/Fc
50% Delay (Sec)	0.45/Fc	0.28/Fc
% Overshoot	11.1%	0.5%
10% Error (Sec)	0.96/Fc	0.48/Fc
5% Error (Sec)	1.09/Fc	0.54/Fc
1% Error (Sec)	1.65/Fc	0.66/Fc
0.5% Error (Sec)	2.14/Fc	0.70/Fc
0.1% Error (Sec)	2.72/Fc	0.77/Fc

LP4F & LP4P SETTLING TIME

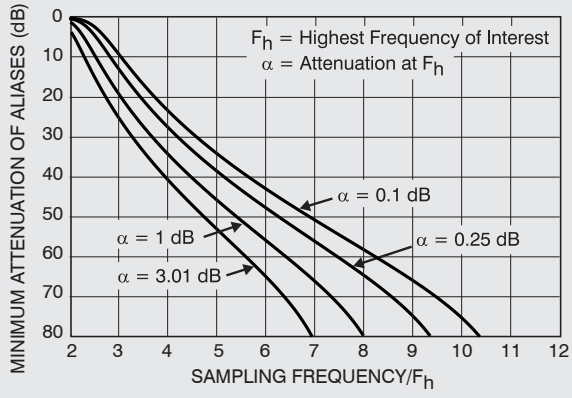


Error (%)	TxFc (Sec-Hz) LP4F	LP4P
10	0.96	0.48
5	1.09	0.54
2	1.58	0.61
1	1.66	0.66
0.5	2.14	0.70
0.2	2.59	0.75
0.1	2.70	0.77

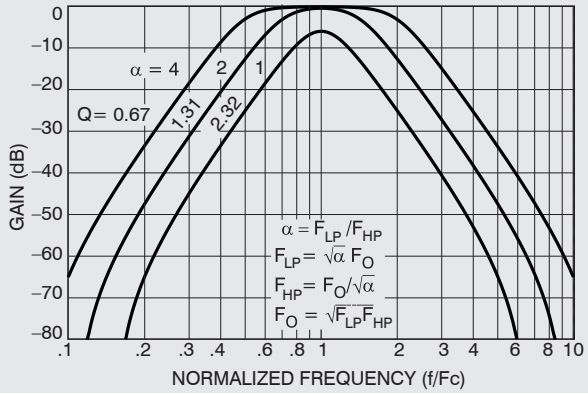
LP4F & LP4P GROUP DELAY



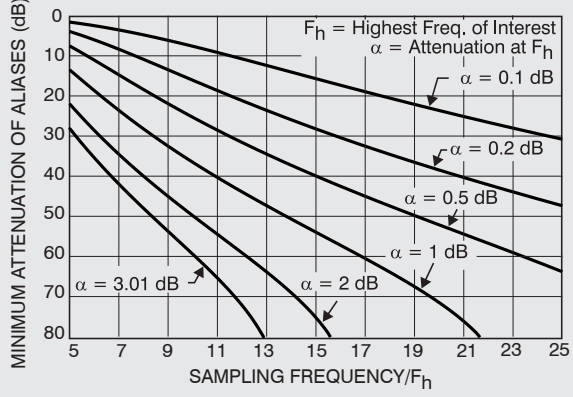
LP4F ATTENUATION OF ALIASES VS SAMPLING RATE



BANDPASS AMPLITUDE RESPONSE HP4F & LP4F CASCADED



LP4P ATTENUATION OF ALIASES VS SAMPLING RATE



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