Anti-Aliasing Filter Order for a Required Attenuation

Butterworth filter order needed to attenuate signals that would alias into the band of interest by a required amount, from the sampling rate and pass band.

Method: Butterworth magnitude response

Input parameters

Unit system: SI

Parameter	Value	Unit
Sampling rate	10.000	kHz
Highest frequency of interest (filter corner)	1.0000	kHz
Attenuation wanted where aliases would fall on f_p (dB)	60.000	

Calculated results

Parameter	Value	Unit
Lowest frequency that aliases onto f_p	9.0000	kHz
Filter order needed (exact)	3.1439	
Filter order to use	4.0000	
Attenuation at f_a with that order (dB)	76.339	

Notes for this case

• A signal at f_s − f_p folds back onto the edge of the band of interest, so the filter must attenuate it by A. A Butterworth filter of order n with its corner at f_p attenuates by 10 log₁₀[1 + (f/f_p)^(2n)], about 6n dB per octave, so n = log₁₀(10^(A/10) − 1)/[2 log₁₀(f_a/f_p)]. Sampling faster moves f_a away and cuts the order needed; that is why oversampling converters need only simple filters.

Formula and method

$$A(f) = 10\log_{10}\left[1 + \left(\frac{f}{f_p}\right)^{2n}\right], \quad f_a = f_s - f_p, \quad n = \frac{\log_{10}(10^{A/10} - 1)}{2\log_{10}(f_a/f_p)}$$

Variables

f_s	Sampling rate	1/s
f_p	Highest frequency of interest (filter corner)	1/s
A	Attenuation wanted where aliases would fall on f_p (dB)	-
f_a	Lowest frequency that aliases onto f_p	1/s
n	Filter order needed (exact)	-
n_{sel}	Filter order to use	-
A_{sel}	Attenuation at f_a with that order (dB)	-

Method and standards

Anti-aliasing filter.

Assumptions and limits

- Butterworth response with the corner at f_p.

References

Butterworth magnitude response

Report details

Report reference	FCC-Y7DW-EPC1 (the same inputs always give the same reference)
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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/instrumentation/signals-calibration/anti-aliasing-filter-order

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.