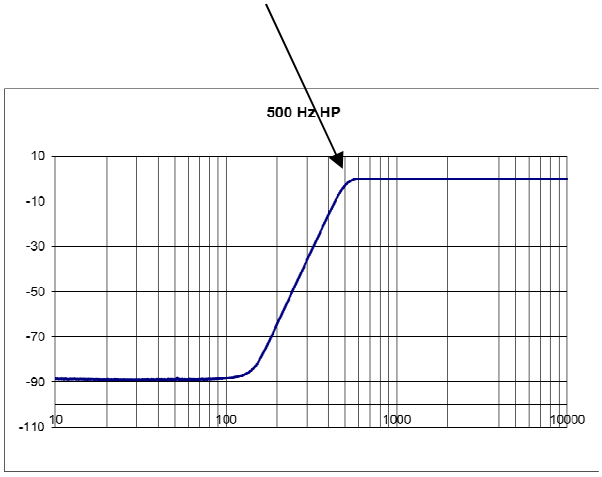
Technical note series:
An introduction to Filters – Article 3

Specifying a filter?

Previously in this series of articles we have reviewed the basics of an electronic filter design and looked at the different types of filter. In this article we will look at the key elements that are required to specify a few of the most popular filter response types.

Cut off frequency: The cut off frequency is the point at which the filter starts to take effect on the frequency content of a signal. Whether you are using a low pass or high pass filter, a cut off frequency must be specified. Often abbreviated to $\mathbf{f_c}$



Filter response: The shape of a filter viewed in the frequency domain, in particular the slope of the filter is referred to as the filter response type. There are a number of common filter responses that are used for different purposes, each has a specific criteria.

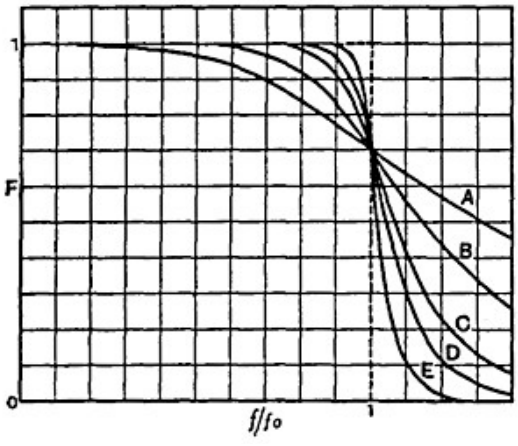
- **Butterworth filter** is a type of filter designed to have a frequency response that is as flat as possible in the passband. It was first described in 1930 by the British engineer and physicist Stephen Butterworth in his paper entitled "On the Theory of Filter Amplifiers"

  His plot of the frequency response of 2-, 4-, 6-, 8-, and 10-pole filters is shown as A, B, C, D, and E in his original graph.

  Higher number of poles creates a sharper roll off

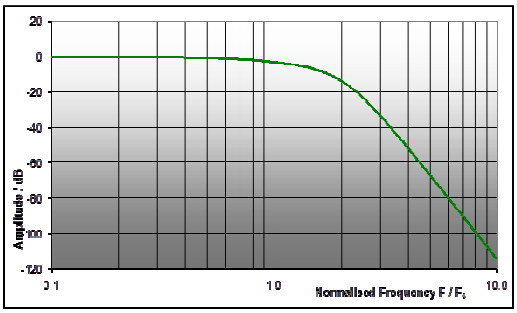
  4 pole – 24dB/octave

  8 pole – 48dB/octave

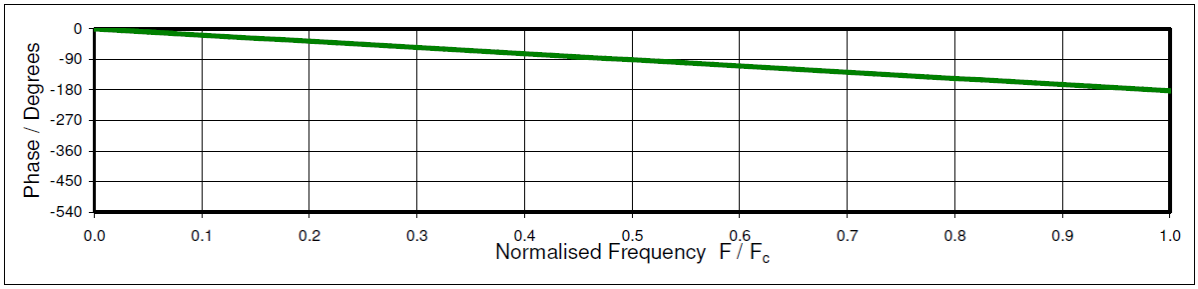


Actual plot taken from Butterworth's 1930 paper showing different versions of his filter design

- **Bessel filter**: is named after the German mathematician Friedrich Bessel (1784–1846), who developed the mathematical theory on which the filter is based. It is designed to achieve a maximally flat group delay (i.e., maximally linear phase response), this is important as it preserves the wave shape of filtered signals in the passband.



Kemo response 07 - 8 pole Bessel 38dB/octave

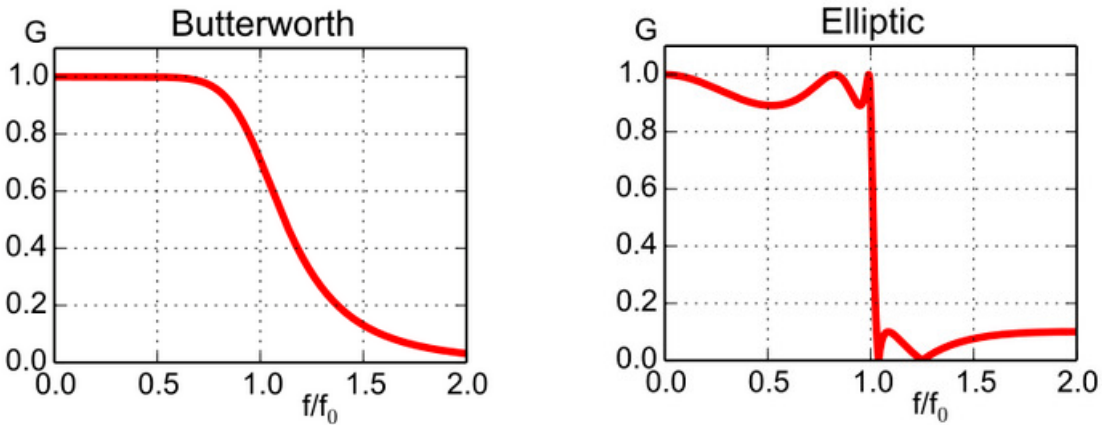


Passband Phase Response

The curve above shows the passband phase response of the Kemo response07 filter.

- **Anti-Aliasing**: is generally an elliptic filter (also known as a Cauer filter, named after Wilhelm Cauer, or as a Zolotarev filter, after Yegor Zolotarev) which among other key features has a sharp cut-off. This makes it perfect for use as an anti aliasing filter.

  Aliasing is the phenomenon whereby reconstructed signals which have been digitally sampled present incorrect frequency content caused by insufficient sampling rates



Example comparison of Butterworth and Elliptic (anti-aliasing) filters

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