FOR YOUR INFORMATION

FILTER TERMINOLOGY

ATTENUATION—Voltage loss in dB incurred by a signal in passing through a dissipative network or other medium.

BAND REJECT FILTER—A filter that rejects one band of frequencies and passes both higher and lower frequencies. Sometimes called a notch filter.

BANDWIDTH—The width of the passband of a band pass filter is the frequency difference between lower and upper 3dB points.

BAND PASS FILTERS—A filter that passes one band of frequencies and rejects both higher and lower frequencies.

BESSEL FUNCTION—A mathematical function used to yield maximally constant time delay in a filter with no consideration for amplitude response. This function is very close to a Gaussian function.

BUTTERWORTH FUNCTION—A mathematical function used to yield maximally constant amplitude response in a filter with no consideration for time delay, or phase response.

CENTER FREQUENCY (F_0)—In standard Band Pass Filters the center frequency is geometrically related to the 3dB points F_1 & F_2.

$$F_0 = \sqrt{F_1 \times F_2}$$

In Linear Phase (Constant Delay) Band Pass Filters the center frequency is arithmetically related to the 3dB points F_1 & F_2.

$$F_0 = 1/2\,(F_1 + F_2)$$

CHARACTERISTIC IMPEDANCE—The characteristic impedance of a filter is usually taken as equal to L/C where L is the total series inductance in henries and C is the total shunt capacity in farads. Characteristic impedance is measured in ohms.

CUT-OFF FREQUENCY (F_c)—The upper passband edge in low pass filters or the lower passband edge in high pass filters. The passband edge closest to the stop band, sometimes called the 3dB point.

DECIBEL (dB)—A unit of gain or attenuation for expressing the ratio of two voltages. It is used to describe voltage gain, voltage loss, performance figure or anything which can be considered as a ratio of two voltages. A decibel is defined as 20 Log (E_1/E_2) where E_1 and E_2 are two voltages such as input and output voltages, or peak voltage and average voltage, etc.

DISSIPATION—Energy losses in a filter due to resistive or core losses, etc.

DISTORTION—Generally speaking, the modification of signals which produce undesirable end effects. These modifications can relate to phase, amplitude, delay, etc. The distortion of a sine wave is usually defined as the percentage of signal power remaining after the fundamental sine wave component has been removed.

ELLIPTIC FUNCTION—A mathematical function used to yield the squarest possible amplitude filter response with a given number of circuit elements. The elliptic function has a Tchebycheff response in both the passband and the stop band. The elliptic function filter has a poorer phase response and transient response than any of the classical transfer functions.

ENVELOPE DELAY—The propagation time delay of the envelope of an amplitude modulated signal as it passes through a filter. Sometimes called time delay or group delay. Envelope delay is proportional to the slope of the phase shift response versus frequency curve. Envelope delay distortion occurs when the delay is not constant at all frequencies in the passband area.

FILTER Q—An important parameter of band pass and band reject filters:

$$\text{Band Pass \& Band Reject: } Q = \frac{F_0}{\text{3dB Bandwidth}}$$

GAUSSIAN FUNCTION—A mathematical function used to design a filter which passes a step function with zero overshoot with maximum rise time. Similar to a Bessel Function filter.

HIGH PASS FILTER—A filter which passes high frequencies and rejects low frequencies.

INSERTION LOSS—The loss of signal caused by a filter being inserted in a circuit. It has many different definitions and is usually measured in dB. In general, it is the ratio of voltage delivered to the load (at peak frequency response) with the filter in the circuit, to the voltage in the load if a perfect lossless matching transformer replaced the filter. When a filter is inserted between two circuits whose impedance differs widely, it is sometimes more practical to specify insertion loss some other way.

LINEAR PHASE FILTER—A filter that exhibits a constant change in degrees per unit of frequency. The resultant plot of frequency versus phase is a straight line. This type of filter ideally displays a constant delay in its passband.

LOAD IMPEDANCE—The impedance that normally must be connected to the output terminals of the filter in order to meet filter specifications; the filter will drive this load.

LOW PASS FILTER—A filter which passes low frequencies and rejects high frequencies.

OVERSHOOT—The amount in percent by which a signal exceeds its steady-state output on its initial rise.

PASSBAND—The frequency range in which a filter is intended to pass signals.

PASSBAND RIPPLE—Variations of attenuation with frequency within the passband of a filter.

PHASE SHIFT—The changing of phase of a signal as it passes through a filter. A delay in time of the signal is referred to as phase lag and in normal networks, phase lag increases with frequency, producing a positive envelope delay (see envelope delay).

RELATIVE ATTENUATION—Attenuation measured with the point of minimum attenuation taken as zero dB, or Relative Attenuation = Attenuation minus Insertion Loss.

RESPONSE—The term used to describe how a filter reacts to input signals. It is defined as the ratio of the input signal compared to the output signal (for amplitude response and phase response).

RIPPLE—Generally referring to the wavelike variations in the amplitude response of a filter. Tchebycheff and Elliptic Function filters ideally have equi-ripple characteristics, which means that the differences in peaks and valleys of the amplitude response in the passband are always the same. Butterworth, Gaussian, and Bessel functions have no ripple. Ripple is usually measured in dB.

RISE TIME—The length of time it takes a step-function at the output of a filter to move from 10% to 90% of its steady state value on the initial rise.

ROLL OFF—A term used to describe the stop band characteristics of a filter. For example, a filter may be specified to have a roll off of 42 dB per octave. This is a somewhat obsolete method of specifying a filter characteristic. It implies that the second octave would be down 84 dB and the third octave 126 dB and so on. In reality the ultimate attenuation levels off at somewhere around 80 dB and spurious "come-backs" are difficult to keep below 80 dB.

SHAPE FACTOR—An important parameter of all filters:

$$\text{Band Pass \& Band Reject: } S = \frac{\text{Attenuation Bandwidth}}{\text{3dB Bandwidth}}$$

$$\text{Low Pass \& High Pass : } S = \frac{\text{Attenuation Frequency}}{\text{3dB Cut-Off}}$$

STEP FUNCTION—A signal change in amplitude from one level to another which occurs in zero time. Usually refers to a rectangular front waveform used in testing transient response.

STOP BAND—The area of frequency where it is desirable to reject or attenuate all signals as much as practical. Also called reject band.

TCHEBYCHEFF FUNCTION—A mathematical function that produces a curve that ripples within certain bounds (see ripple). This produces a squarer amplitude response than the Butterworth Function but with less desirable phase, and time delay characteristics. There is a whole family of Tchebycheff functions (0.1 ripple, 0.5 ripple, etc.).

TIME DELAY—The amount of time it takes for certain signals to pass through a filter.