Anti-Aliasing Phenomenon (Krohn-Hite application note 1)

Alias Signals

Aliasing occurs when an input signal has frequency components at or higher than half the sampling frequency (or rate). If the signal is not correctly filtered (or band limited) to eliminate these frequencies, they will show up as aliases or spurious lower frequency components that cannot be detected from valid sampled data. These errors in data are actually at a higher frequency, but when sampled, appear as a lower frequency, and thus, false information.

Anti-Aliasing and Krohn-Hite Filters

One widely used application for Krohn-Hite filters is Anti-Aliasing. Aliasing becomes a problem in A/D conversion process when an input signal contains frequency components above half the A/D sampling rate. The higher frequencies "fold over" into the lower frequency spectrum and appear as false information that can not be distinguished from valid sampled data.

The best approach to eliminate these false or alias signals is to use a low-pass filter. A low-pass filter, such as the Krohn-Hite Model 3905B/3916B series, 3900 series, 3360 series or 3380, series can block these alias signals by limiting the input signal bandwidth to below half the sample rate. The filter, when applied to each input channel being sampled, eliminates unwanted high frequency noise and interference introduced prior to the sampling. It will reduce the system cost and time by allowing for a lower sampling rate. If the data is critical, then a low-pass filter is a vital part of the overall A/D system.

How to Avoid Aliasing in a Data Acquisition System

Avoiding Aliasing is quite simple – acquire a Krohn-Hite filter and follow the two steps below:
The input signal must be sampled at a rate of at least two times the highest frequency component of interest within the input signal. Any component above half the sampling rate must be filtered before sampling any data. Therefore, with a 100kHz sampling rate, signals above 50kHz are digitized as if they were [50kHz - (f -50kHz)] in frequency, that is, 80kHz would appear as 20kHz.

Elliptical Filter Applications

Elliptical filters find applications where frequency response is the primary concern and phase is secondary. These include A/D conversion (smoothing), audio spectral analysis, vibration analysis, transducer signal conditioning, medical and biological signal processing (including EKG and EEG), data recording and playback, electronic counter measures, sonar and seismic.

As a result of the improving economics of digitized analog signal processing, anti-aliasing filtering is a major application area. Signal digitizing usually involves sampling of the voltage at regular intervals. Aliasing is a phenomena in which the frequency spectrum becomes folded back on itself above one half the sampling frequency. Therefore, with a 100kHz sampling rate, signals above 50kHz are digitized as if they were [50kHz - (f -50kHz)] in frequency, that is, 80kHz would appear as 20kHz.

One definition of the task of any anti-aliasing filter is to attenuate signal components which are greater than the "fold frequency" (sample rate/2) sufficiently to prevent them from contaminating the data. For a 12 bit A/D, one significant bit represents -72dB relative to full scale; for 10 bits, -60dB; for 8 bits, -42dB. The width of the transition region (between fc, the cutoff frequency and fs/2, the fold frequency) reduces the usable bandwidth.

A second definition of the task of the anti-aliasing filter would apply if frequency components in the digitized data between the cutoff and the fold frequency will be ignored (as could be done in FFTs), then the required attenuation must occur at fs-fc which reduces the sample rate requirements.