TechTalk # 2

Filters for Data Acquisition Systems – Part One

They're everywhere. Look inside most real world electronic systems and you will find a couple. Sound systems use them for pre-amplification, equalization, and tone control. Communication systems use them for tuning specific frequencies (and removing others). DSP systems use them to prevent the aliasing of out-of-band noise and interference.

What am I talking about? Gremlins? No, analog filters of course.

In this first part of a three part series, I would like to examine an analog versus digital filtering strategy. In part two, we will look at design parameters and some characteristics. In part three, I will examine some low pass designs in depth.

Why should we care about this?

Because you are trying to impress your coworkers with your technical daring-do. OK, maybe not

Have you ever tried to get rid of the extraneous noise in a data acquisition system? If so, you probably utilized analog low-pass filters, digital filters, or a combination of both. With a low-pass analog filter high frequency noise is removed from the signal path before the analog-to-digital (A/D) conversion. This is so the converter output codes do not contain any undesirable harmonic information (also called aliasing).

Analog versus digital filters

As I mentioned, when implementing an analog filter I put it before the A/D converter. If the design requires post processing I will place a digital filter after the A /D conversion. As a rule: analog before, digital after, simple right?

Analog filtering removes the extraneous noise peaks superimposed on the signal before reaching the important stuff. Digital filtering cannot eliminate these peaks. Consequently, even when the average value of the signal is within the stated limits, noise peaks riding on the signal near full scale have the potential to saturate the analog modulator of the A/D converter.

Additionally, analog filtering is more suitable for systems operating above 5 kHz. In these types of systems, an analog filter can reduce noise in the out-of-band frequency region. This, in turn, reduces those nasty fold back signals (aliasing).

A quiet A/D conversion makes for a high-resolution A/D conversion.

I am sometimes asked "If a digital filter using over-sampling and averaging techniques can reduce in-band and out-of-band noise, why not use it for both purposes?" A wonderful idea. Except, all that sampling and averaging of signals takes time. Time your design may not tolerate.

Another benefit to digital post filtering is removal of noise injected during the A/D conversion process. Analog filtering cannot do this. It is also easier to make a digital filter programmable. Depending on the digital filter design, this gives the user the ability to program the cutoff frequency and output data rates.

In summary, use an analog filter before the A/D converter, and a digital filter post conversion.