Driving Miss ADC

Q: I've been told that ADC inputs can be "unfriendly." What should I be worried about?

A: Don't panic. ADC inputs may indeed be unfriendly, but they can be tamed. You'll need a good driver, though.

ADC drivers are required for three main reasons. First, many signal sources are single ended, while many high-speed ADCs have differential inputs, so the driver must perform single-ended to differential conversion. Second, many ADCs have switched-capacitor inputs that are prone to incoming and outgoing charge spikes, so the driver must buffer the signal source from the ADC inputs. Third, small signals must often be amplified and level shifted to match the full-scale input range of the ADC. The driver handles this task as well.

Differential signaling can reduce system noise and distortion. Differential systems do not have a shared ground, so no ground coupling occurs. They reject common-mode noise, and tend to cancel out even-order distortion products, which appear as common-mode signals. Balanced signaling (equal and opposite phase and magnitude) also reduces radiated emissions that could affect other parts of the system. In addition, differential systems achieve twice the signal swing on a given power supply, doubling the dynamic range and improving the signal-to-noise ratio.

The goal of the ADC driver is to transfer the signal from the source to the ADC, conditioning it as necessary to optimize performance, while minimizing added distortion, noise, and settling time errors.

You'll want to match the amplifier's performance to the ADC's performance within the constraints of your system. Some of the many considerations for choosing an ADC driver are noise, distortion, and settling time.

In broadband, dc-coupled applications, for example, try to keep the peak-to-peak noise from the driver and any included filters less than or equal to one LSB at the effective number of bits of the ADC.

In frequency-domain based applications, such as communications systems, harmonic distortion is critical. For best results keep it less than or equal to one LSB at the effective number of bits of the ADC.

In video systems, other time-domain based applications, and multiplexed systems, settling time is of interest. Settling errors can also be expressed in LSBs, with a common requirement being that the driver settles to within one LSB in a specified time. Settling time can be difficult to characterize in high-resolution systems.

Every application is different, so it's best to check the ADC datasheet for the recommended driver.