BURR - BROWN®
APPLICATION BULLETIN
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TIPS FOR USING THE ADS78XX FAMILY OF A/D CONVERTERS

INHERENT OVERVOLTAGE PROTECTION

The input to each of the members of the ADS Family (ADS7804/05/06/07/08/09/10/19, so far) is a resistor divider network, converting the input signal to the range used internally. This resistor divider offers inherent overvoltage protection, which will often simplify analog circuitry.

In applications where the analog signal conditioning uses ±12V supplies (or higher), the ADS divider network eliminates potential problems if the op amp driving the ADS fails and drives the ADS input to the +12V rails. It also protects if the circuitry in front of the ADS is powered up before the ADS itself. Older ADCs on the market might fail under either of these conditions, requiring additional protection which can itself affect the accuracy and performance of the whole system.

In the “Absolute Maximum” section of the data sheets, we show that the input pins can go to ±25V. From our testing we know this is very conservative, but it is still much higher than the supplies commonly used for analog signal conditioning.

NOISE ON 16-BIT A/D CONVERTERS

Ground the input of a good 12-bit converter, convert a few thousand times, and you should see only 1-2 output codes (2 if the input is close to a transition). The same test on any 16-bit successive approximation (SAR) A/D will yield multiple codes due to noise. This is true for all 16-bit SAR A/Ds including ours.

Data sheets should indicate expected noise for DC inputs. We call it “Transition Noise”, and show a typical value in the specification table. The ADS7807 data sheet shows a typical rms transition noise of 0.8LSBs. As a rule, you can multiply rms noise figures by 6 to approximate expected peak-to-peak noise, so the ADS7807 typical transition noise should be about 5LSBs. This means that if you ground the input and run a thousand conversions, you should see about 5 different output codes, which is in fact what we see. The worst-case transition is at the major-carry (0V for a ±10V range); we recently ran 30,000 conversions with the input to an ADS7807 grounded and in fact saw only 7 output codes (one of which occurred 0.03% of the time).

NOISE EFFECTS ON DNL AND INL

The previous discussion on noise raises the question of how Integral Linearity Error (ILE), or Differential Linearity Error (DLE), can be measured and guaranteed to levels tighter than the noise of the part. What does a maximum of +1.5 LSB error mean when any signal conversion could output results +2 or +3 LSBs different from the ideal due to noise? The answer is fairly simple: to measure actual linearity of a specific 16-bit A/D, both we and our competition look below the noise floor of the parts.

The main tool for achieving this is averaging. For the ADS Family, when we are checking ILE, we put in a known voltage from a very stable reference D/A, perform 256 conversions, and average the results to determine the linearity of that point. Incidentally, when we say that ILE is ±3LSBs or ±1.5LSBs max, we actually use tighter limits in our test program. The guardband insures that we take into account the absolute accuracy of our reference D/A (which is itself regularly calibrated) plus repeatability constraints on any one test system and variations between test systems.

This also raises the question of how much averaging is needed to guarantee a certain confidence in the A/D converter. For every doubling in the number of averages, transition noise will decrease by a factor of 1 over the square root of two. Averaging 64 conversions from an ADS7807 would result in transition noise adding ±1/10 of an LSB of uncertainty (one σ) to the specified INL and DNL.

Printed in U.S.A. June, 1995