

# Analog-to-Digital Converter Grounding Practices Affect System Performance

*High-Performance Analog*

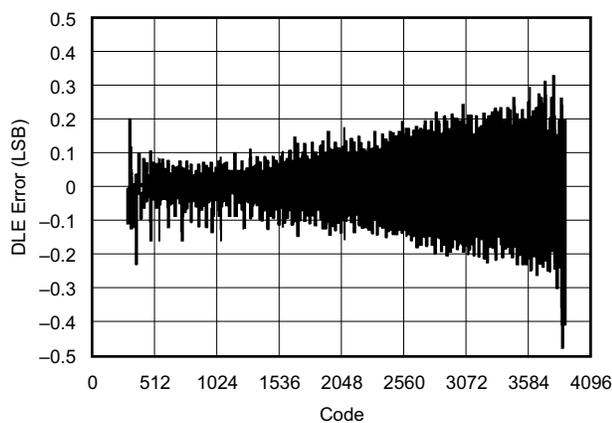
## ABSTRACT

Obtaining optimum performance from a high-resolution analog-to-digital converter (ADC) depends upon many factors. Power supply decoupling and good grounding practices are essential to maintaining accuracy in ADCs.

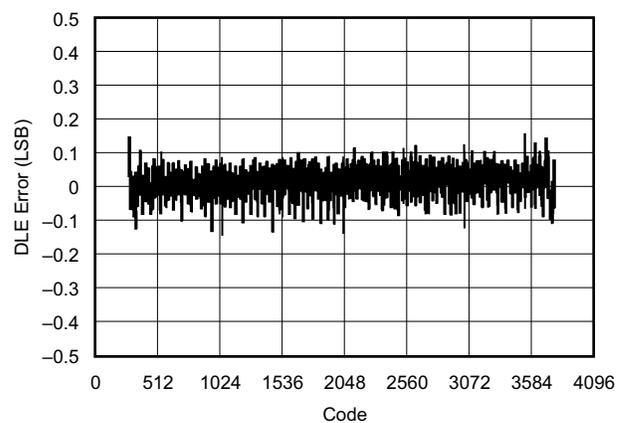
Poor grounding technique may manifest itself in many different ways such as excessive noise, or signal crosstalk in the system. A more difficult problem to track down is that of poor differential linearity error (DLE) in the converter. This is difficult because poor DLE may result from settling time problems inside the ADC, from the circuitry driving the ADC having too high an output impedance at the converter’s operating frequency, from poor grounding techniques or other sources.

Figure 1 is a DLE plot of a ADCTH (12-bit, 8 $\mu$ s conversion time ADC) in a specific printed circuit board. This histogram plots deviation from ideal differential linearity against specific codes output from the converter. The circuit shown in Figure 1 has a DLE of about  $\pm 0.4$ LSB. This meets the specification of the ADC774, but is less than optimum.

The cause of the DLE performance is the grounding scheme used in this application. The part was “grounded” using recommendations made in most of our ADC data sheets: connect the analog and digital grounds together at the ADC.



**Figure 1. ADC774 Board DLE with Poor Ground**



**Figure 2. ADC774 Board DLE with Improved Ground.**

What went wrong is that the analog and digital commons were connected together at the ADC, but that “ground” was then returned through a long trace on the PCB to the system ground. This means that the “ground” the ADC actually saw had a fair amount of resistance and inductance, as shown in Figure 3.

Returning the analog and digital common of the same ADC to a single ground plane underneath the converter (Figure 3) reduced this inductance and resistance considerably, and thus made the ADC “see” a much lower impedance; a more optimum ground. The results of this improved grounding technique are shown in Figure 2. The new board exhibits a DLE of only about  $\pm 0.1$ LSB, much closer to what the ADC774 typically does.

In general, using ground planes is the best way to set up grounding systems for high-resolution ADCs, so that the ADC ground return paths are as low an impedance as possible. Where the use of ground planes is not possible, using wide, short traces for ground returns is recommended to keep the ground impedance low. As this example shows, poor grounding can affect system performance in ways that don't readily indicate that a grounding problem may exist.

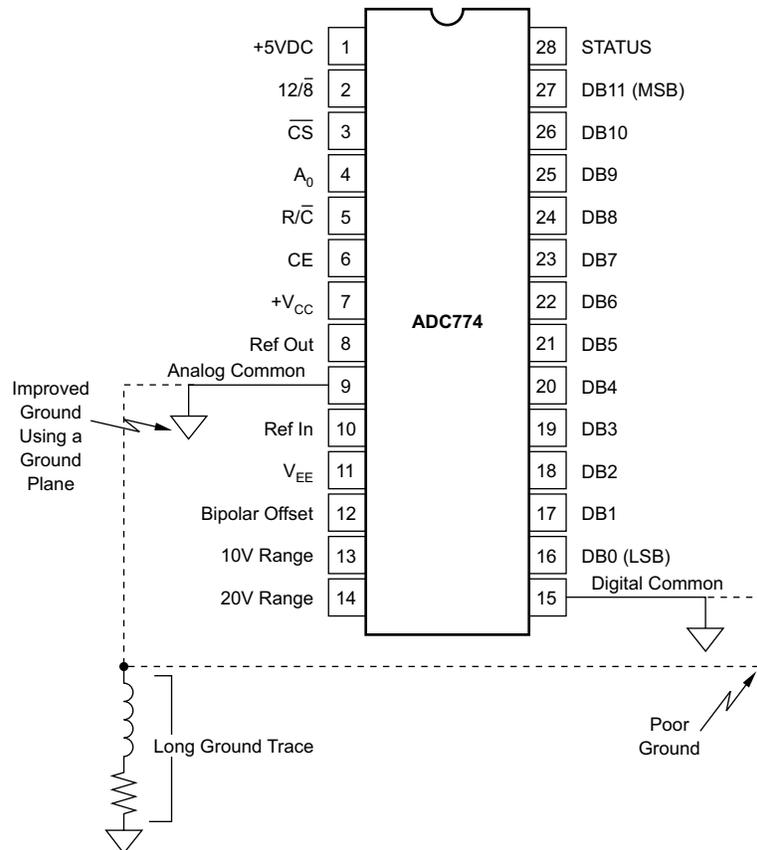


Figure 3. Ground Impedance is High Due to Long Circuit Trace. By Using Ground Plane, DLE is Improved

### Revision History

**Changes from Original (October 2000) to A Revision** **Page**

- Changed formatting to standard TI application note. .... 1

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

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