# Specifying High Performance Data Converters

## Art Versus Science

### Editorial

Not so many years ago, high precision data converter performance was determined by an almost equal combination of design and process technology. The IC processes necessary for 12-bit to 16-bit data converter performance tended to be complex BiCMOS processes that were never run in high volume and consequently required a lot of expertise to produce highly repeatable results. After fabrication, precision thin-film laser trimming technology typically had to be utilized to reduce the variation inherent in the process, and even then, automated testing was usually employed to divide the resulting distribution into performance grades. Product performance was obtained via a complex combination of art and science, driving costs and prices higher. This limited analog system designers' choices, forced them to add large design margins, and in many cases (particularly in high volume applications) prevented them from achieving their systems' full potential.

The last five years have produced enormous advances in analog IC design expertise on submicron CMOS. This has taken the expensive and less repeatable BiCMOS process out of the equation and provided a stable and low cost platform for a new generation of high performance data converters. The intrinsic limitations of CMOS have steadily fallen under a critical mass of creative IC designers worldwide who refused to accept previous performance limits and figured out how to gain maximum advantage from CMOS' advantages of extremely small and well matched transistors. This has produced tremendous benefits for system designers. With a vast choice of high performance data converters emerging, they can now bring high performance analog to the masses for the first time. An interesting example is the 16-bit ADC (analog-to-digital converter) market, previously synonymous with high performance and high cost. Over the last five years, speeds for these devices have improved by an order of magnitude, with significant improvements in accuracy and power.

**TIMELINE**

| | AD677 | AD977 | AD7677 | AD7674 | AD7621 |
|---|---|---|---|---|---|
| **Year of Release** | 1993 | 1997 | 2002 | 2003 | 2003 |
| **Resolution** | 16 Bits | 16 Bits | 16 Bits | 18 Bits | 16 Bits |
| **Accuracy (INL)** | ±1.5 LSB (24 ppm) | ±2 LSB (30 ppm) | ±1 LSB (15 ppm) | ±2.5 LSB (10 ppm) | ±1 LSB (15 ppm) |
| **Speed** | 100 kSPS | 200 kSPS | 1 MSPS | 800 kSPS | 3 MSPS |

These repeated design innovation successes have greatly increased the demand for high performance, affordable data converters, and have predictably drawn in many more competitors. This increased competitive noise has resulted in some companies compensating for performance shortfalls by choosing aggressive, and sometimes misleading, marketing tactics. For example, redefining what is meant by a 16-bit converter to be one that certainly has 16 data pins, but which may only yield barely 12-bit performance is becoming an increasingly common practice. One could shrug and say that this is a transparent tactic that analog designers will immediately recognize, but it is making product selection increasingly difficult. Resolution, INL, DNL, THD, and SNR all have to be carefully examined, to say nothing of the secondary impact of PSRR, CMRR, tempco, etc. It is also progressively more difficult for the electronic trade press to make these distinctions for their readers. The result is an increasing incidence of overhyped but under-specified products on the market.

Analog Devices does not subscribe to this philosophy. We believe that products marketed as high performance converters need to be comprehensively specified that way. Product specifications need to be balanced along all critical dimensions with key performance parameters easily achievable in a real-world system. Performance variation needs to be standardized to allow minimal system design margins. ADI goes to extreme lengths to simulate long-term process variation and specify extremely capable data sheet limits to ensure that our products' specified performance is achievable by our customers. We strongly believe that high performance analog products need to be specified comprehensively and transparently. Our overarching goal is to make design challenges easier and to allow designers to produce system performance that exceeds their expectations and delights their end-customers.