A series on engineering better performance and lower costs in new designs, by Analog Devices.

A Whole New Value Equation for Industrial Designs

State-of-the-art analog and mixed signal ICs, particularly those manufactured on submicron CMOS, have brought significant size, cost, and power advantages to a wide variety of applications, with one notable exception — industrial. The high voltage requirements of sensors and actuators are forbiddingly high, but with today’s ICs. The continual decrease in smaller geometry CMOS power supplies and the shift to single supplies have caused industrial designers to add more discrete circuitry around new state-of-the-art ICs, adding board area and costs to each design. However, breakthrough technology has finally brought submicron innovation to the 10-V world.

A new process from Analog Devices called iCMOS, for industrial CMOS, changes all that. It combines the performance and cost advantages of low and high voltage CMOS, high voltage bipolar, and iCMOS processes in a submicron technology. This process allows users to put as much as 30 V across a chip. Analog Devices’ researchers concluded that there was a need to combine the cost benefits of submicron CMOS with a suite of high voltage, high performance analog devices on a single chip to achieve breakthroughs in accuracy, power, signal chain integration, and associated cost benefits that were previously unattainable using existing IC processes.

Process Engineering

The developers of iCMOS wanted to create a truly modular process that would produce both high and low voltage devices for a wide variety of applications, requiring that they develop specialized epitaxial and photolithographic masks that would work seamlessly together in many different configurations. This challenge was especially acute for the bipolar transistors, which have requirements that ordinarily influence the surrounding devices. But the designers of iCMOS were able to overcome this obstacle in such a way that the overall performance of the devices was not compromised.

Crisp to iCMOS was the development of a manufacturing process that would enable the growth of thicker gate oxide. This breathes new life into the world of CMOS. Today’s CMOS is a completely modular manufacturing process, meaning the performance and robustness of each of its designs are not simply the result of traditional trade-offs to achieve integration.

Here is what this new process brings to each of the devices that are the basis of industrial applications:

With regard to both converters and amplifier products, the process has been optimized for noise, matching, linearity, and stability. In addition, specific to amplifiers, it improves noise/power ratio and reduces offset and offset drift. It also reduces 1/f noise and output settling time. For references, they are now fully bipolar, which means higher accuracy and lower temperature coefficients.

As depicted in Figure 1, the real estate has dramatically improved on silicon. The AD71281 8-bit, 8-channel, 2.5-V to 5-V ADC reduces power consumption by 80%, as compared to competitive products. The AD7691 16-bit ADC offers simultaneous sampling on six channels and twice the accuracy of comparable devices. For Figure 3 for more ADCs.

The first 15 iCMOS products have been announced, and there are more on the way. They are emerging as breakthrough products in their own right, thanks to significant improvements over the competition in accuracy, power, footprint, and total cost.

Examples of Specific Products Toolled in this Technology:

- DAC: The AD5764 quad 16-bit DAC offers three times more accuracy while using 50% less board space. Some of the features included are an on-chip precision reference as well as reference buffers, a precision amplifier, temperature sensor, and an extended programmable output range. (See Figure 2.)

- ADCs: The AD5728 quad 16-bit ADC reduces power consumption by 80%, as compared to competitive products. The AD7691 16-bit ADC offers simultaneous sampling on six channels and twice the accuracy of comparable devices. For Figure 3 for more ADCs.

- Amplifier: The AD8681 precision rail-to-rail amplifier features the lowest offset voltage, noise, and input bias current in its class. Available in a 3 mm x 3 mm LFCSOP and a narrow SOIC-8, it is 70% smaller than the competition.

- Digital Potentiometer: The AD5290 delivers an unbeatable combination of features and performance in a compact MSOP-10 package and can be operated from a single-supply up to 30 V or dual-supply up to ±15 V.

- Switches and Multiplexers: These devices operate at ±15 V while delivering industry-leading performance in very small packaging. For example, the ADG408, 8:1 mux exhibits an on resistance that is 85% lower than its closest competitor.

Value Proposition

Individually and collectively, the analog and mixed-signal ICs made on the innovative iCMOS process enable new value metrics for high voltage, industrial ICs.

- Dramatic Power Reduction: The capability to employ multiple voltages on a single substrate enables direct sampling onto a high impedance capacitive array. Accompanied by the integration of off-chip, low noise amplifiers capable of driving high voltage outputs, these features combine to reduce component power consumption by as much as 85%.

- Smaller Footprint: iCMOS ICs are typically 30% to 75% smaller than other high voltage parts. In addition, the inclusion of auxiliary components, such as on-chip memory and on-chip signal conditioning, reduces board space even further while equaling the performance level of off-chip, standalone components.

- Less Complexity, in Much Less Time: The integration of high voltage components onto iCMOS enables more functionality and multiple voltages on a single substrate enables direct sampling onto a high impedance capacitive array. Accompanied by the integration of off-chip, low noise amplifiers capable of driving high voltage outputs, these features combine to reduce component power consumption by as much as 85%.

In summary, the submicron geometry, in concert with all the other attributes of iCMOS described above, enables the integration of more of the signal chain without compromising performance. Finally, state-of-the-art IC technology is available for applications such as factory automation, process control, and instrumentation. The newly available size, cost, and power advantages enables an entirely new value standard for the >10-V world.

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