design FAQs

Precision Analog Microcontrollers

FREQUENTLY ASKED QUESTIONS

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What is a precision analog microcontroller?

A precision analog microcontroller *(Fig. 1)* combines high-performance analog-to-digital converters (ADCs) and digital-to-analog converters (DACs) with a single-chip processor and peripherals that often are designed to augment the analog support. Precision analog microcontrollers are used extensively in applications such as industrial, instrumentation, automotive, and communications infrastructure. For example, particular applications like motor control require features such as multiple, synchronized pulse-width modulation (PWM) timer support. The class of processors ranges from 8-bit cores such as an 8051 to 32 bits such as the ARM7.

Does the inclusion of a DAC or ADC make a precision analog microcontroller?

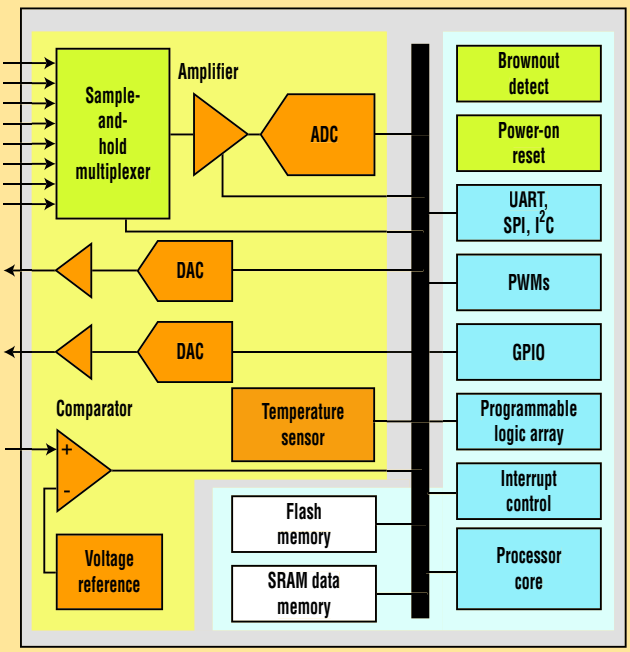
Not necessarily. The type and quality of the analog support can vary widely. Some applications don't need high resolution or fast throughput and can use basic analog support. Other applications require better accuracy. The analog peripherals frequently are merged with hardware such as shared memory or DMA to reduce host processor overhead while increasing throughput. This can enable the host to process more information or forward it to an external host more quickly.

What kinds of ADCs can be found in precision analog microcontrollers?

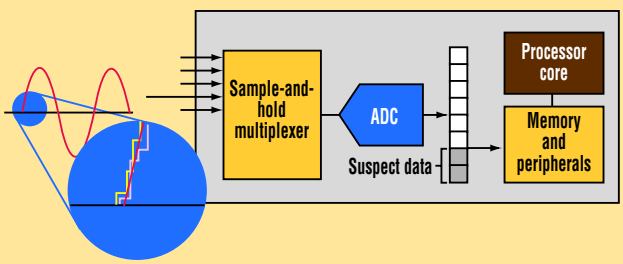
ADCs can be implemented using a range of techniques. The two common methods found on microcontrollers include sigma-delta and successive approximation register (SAR). ADC resolution on microcontrollers typically is 8, 12, 16, or 24 bits, though the quality of the results may vary depending upon the technology used.

What affects the ADCs' quality and precision?

A whole host of issues arises when discussing ADCs, so don't just examine the number of bits of resolution. Linearity, accuracy, sampling, and aliasing can affect the usefulness of the results *(Fig. 2)*. Also, quantization and nonlinearity error can affect how many bits of resolution are really useful. It all



1. Precision analog peripherals are what make this type of microcontroller. But an equal complement of digital peripherals is required as well. The amount of precision that the analog peripherals must deliver depends upon the application and can range from an 8-bit flash ADC to a 24-bit sigma-delta ADC. A whole host of details affects a designer's choice, from the conversion rate to the accuracy of voltage references.



2. ADCs provide a stepwise approximation of the analog input. But there can be errors in that result as well due to drift, nonlinearity of the conversion, and other factors that can lead to results with fewer significant digits than actually delivered.

goes back to the number of effective digits in a result.

Will the quality or precision of the analog performance suffer because of the proximity of the microcontroller?

Most precision analog microcontrollers are designed to minimize any interference problems between the analog and digital portions of the system in the same fashion that discrete ADCs or DACs isolate their analog and digital components. In fact, susceptibility to external radiation sources is reduced because of the close proximity of the on-chip analog and digital complements. It's usually more important to follow strict pc-board design and layout procedures, such as proper power and ground-plane management, and include suitable decoupling support. But be careful when examining spec sheets. Some manufacturers may not guarantee analog performance at all! Others may only guarantee performance under very specific microcontroller operating conditions.

What are the key features to look for when choosing a precision analog microcontroller?

The first analog specs such as ADC, DAC, on-chip precision references, and amplification requirements are the starting point. Look at the details like how well a peripheral operates over the specified temperature range. Likewise, will all analog peripherals found on a particular chip be required by the application? Second, are the processor and its memory complementary? Finally, don't overlook the capabilities of the digital components. Power-on reset, brownout detection, and low-power operation are as critical as other peripherals, RAM, and analog performance. Even on-chip features such as a programmable logic array can help reduce the bill of materials (BOM) in the same way the on-chip high precision analog devices often eliminate the need for off-chip analog support.

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