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Digital Signal Controllers Enhance Precision And Execution Of Real-Time Control

Microchip Technology's dsPIC33A core family of digital signal controllers (DSCs) is built around a 32-bit central processing unit (CPU) architecture with a 200-MHz operating speed. The dsPIC33A family's advanced core includes a double-precision floating-point unit (DP FPU) and DSP instructions for numerically intensive tasks in many closed-loop control algorithms.

The dsPIC33A architecture offers high-performance and precise real-time control coupled with a comprehensive development tool ecosystem to streamline and accelerate the design process. The ability for engineers to create sophisticated, computationally intensive embedded control algorithms is crucial for achieving superior operational efficiency in motor control, power supply, charging and sensing systems (Fig. 1).

"The dsPIC33A DSCs are a game-changer for developers because they are designed to offer the precision, efficiency and advanced features needed to push the boundaries of embedded system performance," said Joe Thomsen, vice president of Microchip's digital signal controller business unit. "With its ability to enable complex designs, address safety and security requirements, integrate advanced functionality and accelerate time-to-market, the dsPIC33A family positions our clients to secure a larger market share with innovative, competitive designs."

The dsPIC33A DSCs are enhanced with improved math and data processing, higher code efficiency, faster context switching and reduced latency. This lower latency allows for a faster response time to transient and safety-critical events. New and upgraded peripherals—such as high-resolution PWMs specifically engineered for motor control and digital power conversion—are designed to support progressive technology development in various markets including automotive, industrial, consumer, e-mobility, data center and sustainable solutions segments.

The dsPIC33A family features integrated analog peripherals, including 12-bit ADCs capable of conversion rates up to 40 MSPS, high-speed comparators and operational amplifiers. These analog peripherals, in conjunction with core independent peripherals (CIPs), allow for sophisticated sensing and high-performance control.

Thomsen notes that the dsPIC33A is the fifth generation of the dsPIC core. The chart in Fig. 2 outlines how the core has evolved through the various generations, while the illustration in Fig. 3 highlights the embedded system market trends that have driven development of the newest dsPIC core. Notice that Microchip went from a 16-bit architecture with 100-MHz operating speed in its 4th generation to the 32-bit architecture at 200 MHz in the latest generation.

With the 32-bit architecture, the company was able to address what Thomsen describes as the customer's biggest request—support for floating point operations. Traditionally, designers would model their algorithms using floating point units in programs such as Matlab and then do manual conversion to fixed point units for the DSC. The inclusion of double-precision floating-point unit (DP FPU) format will allow for more-precise calculations.

Another improvement, in the DSP engine, accumulators have been increased from 40 bits to 72 bits, also enabling more-accurate calculations and more specifically, greater resolution for interrupts. Thomsen observes that interrupts are "the bain of any control system, so anything we can do to reduce latency helps."

On the data acquisition side, as noted in Fig. 1, the 12-bit, 40 MSPS ADCs have oversampling built in. So for example, designers could implement a 16-bit ADC running at 500 kHz, says Thomsen, which he says provides "a huge cost advantage for our customers." Up to five ADCs are included per chip for simultaneous sampling.

In addition, the CIPs enable interaction among the peripherals without the need for CPU involvement, enhancing the efficiency of a single controller to manage multiple tasks. The result is more robust real-time control while reserving the CPU bandwidth for software stacks, functional safety diagnostics and security functions.

The dsPIC33A device families are outfitted with Flash security capabilities, including an Immutable Root of Trust, secure debugging and restricted memory access. The DSCs' instruction set architecture (ISA) enables the adoption of software code generated by model-based designs to simplify code generation. The combined features make dsPIC33A DSCs well suited for applications that require efficient motor control for fans, pumps

and compressors; they also manage digital power conversion for applications like AI servers and on-board chargers in electric vehicles and enable sensor interfacing for industrial and automotive applications.

The first family of dsPIC33AK128MC1xx DSCs includes 128 KB flash and an extensive peripheral set, offered in various packages, including SSOP, VQFN and TQFP options ranging from 28 to 64 pins, with package dimensions as small as at 4 × 4 mm (Fig. 4). Future dsPIC33A families with additional memory, peripherals and larger pin counts will complete the portfolio.

The dsPIC33A family is supported by the MPLAB XC-DSC Compiler, MPLAB Code Configurator (MCC) and the dsPIC33A Curiosity Development Board (EV74H48A). The dsPIC33A Curiosity Development Board supports feature expansion by providing mikroBUS and Xplained Pro interfaces that enable connection to Built-in Self Text Xplained Pro (BIST XPRO) extension kits, sensors and various Click boards. Separate dual in-line modules are available to support development for motor control, digital power conversion and general-purpose embedded applications.

The dsPIC33A devices start at less than $1 US each in high volumes. See the Digital Signal Controllers page to learn more about the company's full line of DSC devices. For a complete list of dsPIC33A development tools, visit the dsPIC33A DSC page. For additional information and to purchase, contact a Microchip sales representative, authorized worldwide distributor or visit Microchip's Purchasing and Client Services website.

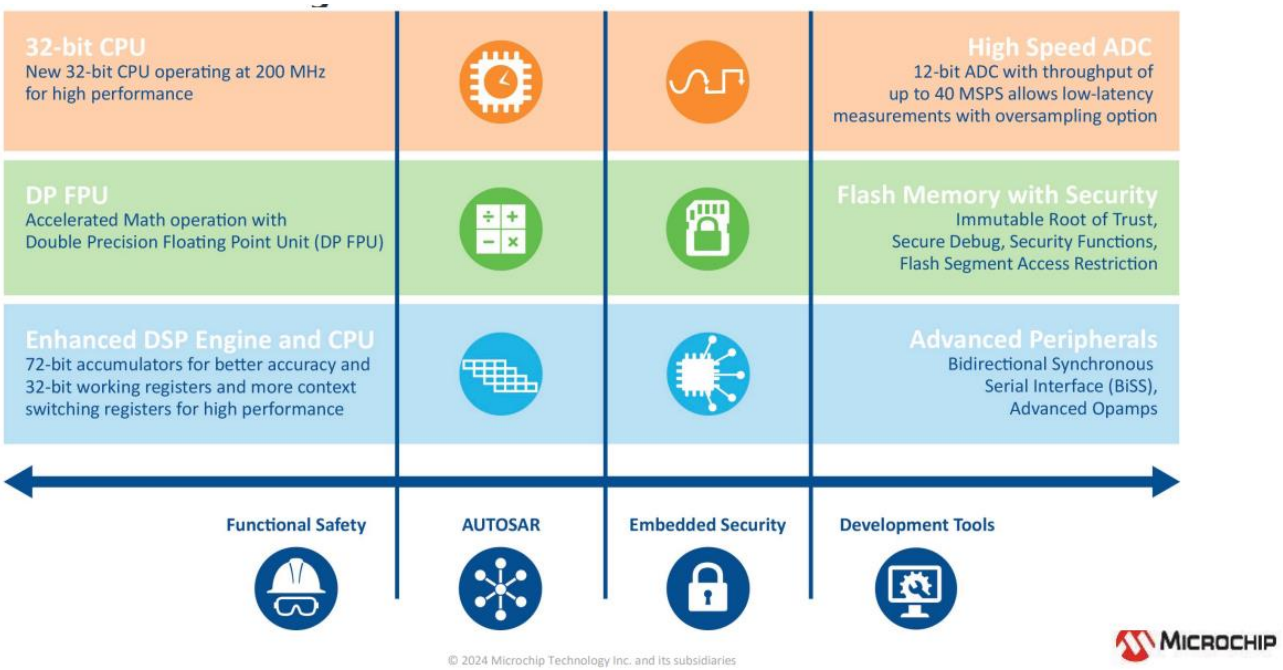

Fig. 1. dsPIC33A platform key features and enhancements. dsPIC33A DSCs feature a 32-bit architecture with a double-precision floating-point unit and DSP engine for faster computation in time-critical applications. The ability to create sophisticated, computationally intensive embedded control algorithms using these DSCs will be beneficial in motor control, power supply, charging and sensing systems. According to Microchip's Joe Thomsen, this will be especially true in power supply designs using fast switching, wide-bandgap power semiconductors operating in topologies like totem-pole PFC and LLC with complex control algorithms.

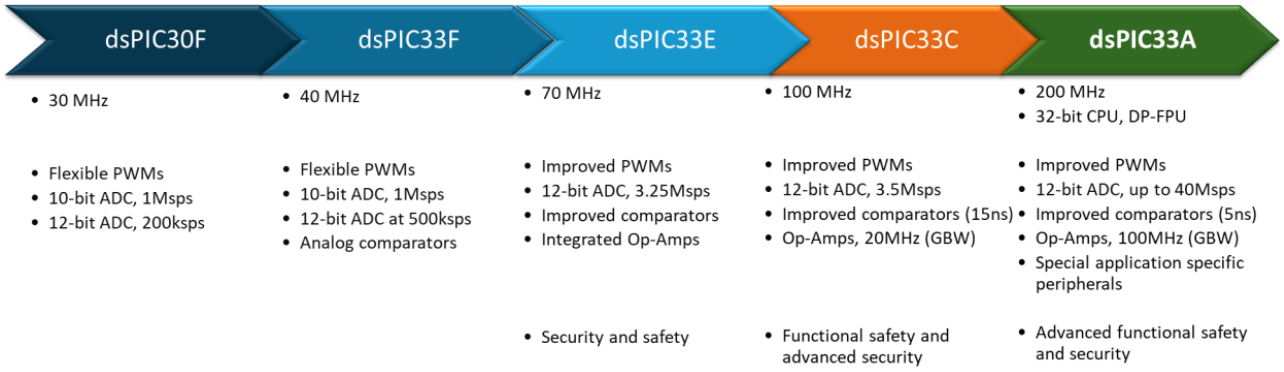

Fig. 2. dsPIC33 DSC core evolution. Now in its 5th generation with the dsPIC33A core, over the years the dsPIC core has increased performance and integration with each generation as depicted in this chart. As performance requirements increase, dsPIC33A DSCs provide a next step up in performance while preserving legacy code and ecosystem. The dsPIC33A DSCs offer common peripherals and a similar look and feel as the older dsPIC33 generations. So they provide an easy migration path forward, while still maintaining low latency real-time control.

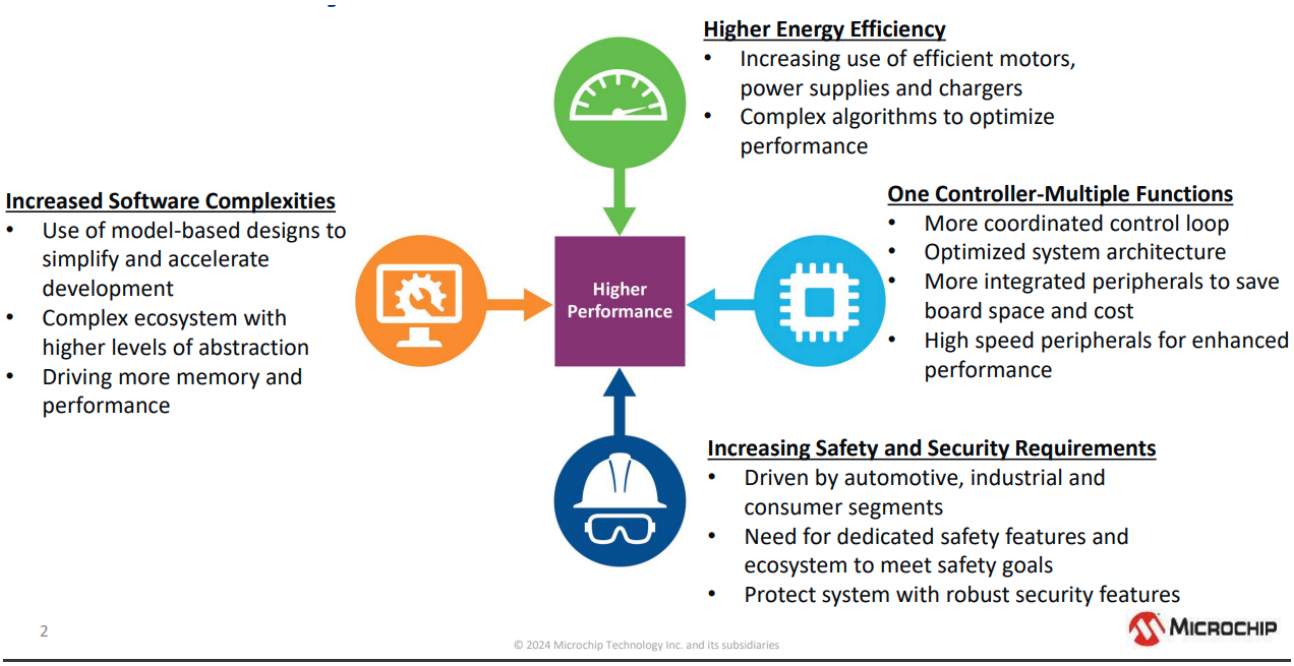

Fig. 3. Embedded systems market trends such as increased software complexity, application demands for higher energy efficiency, more complex control and increasing safety and security requirements drove the development of the dsPIC33A family.

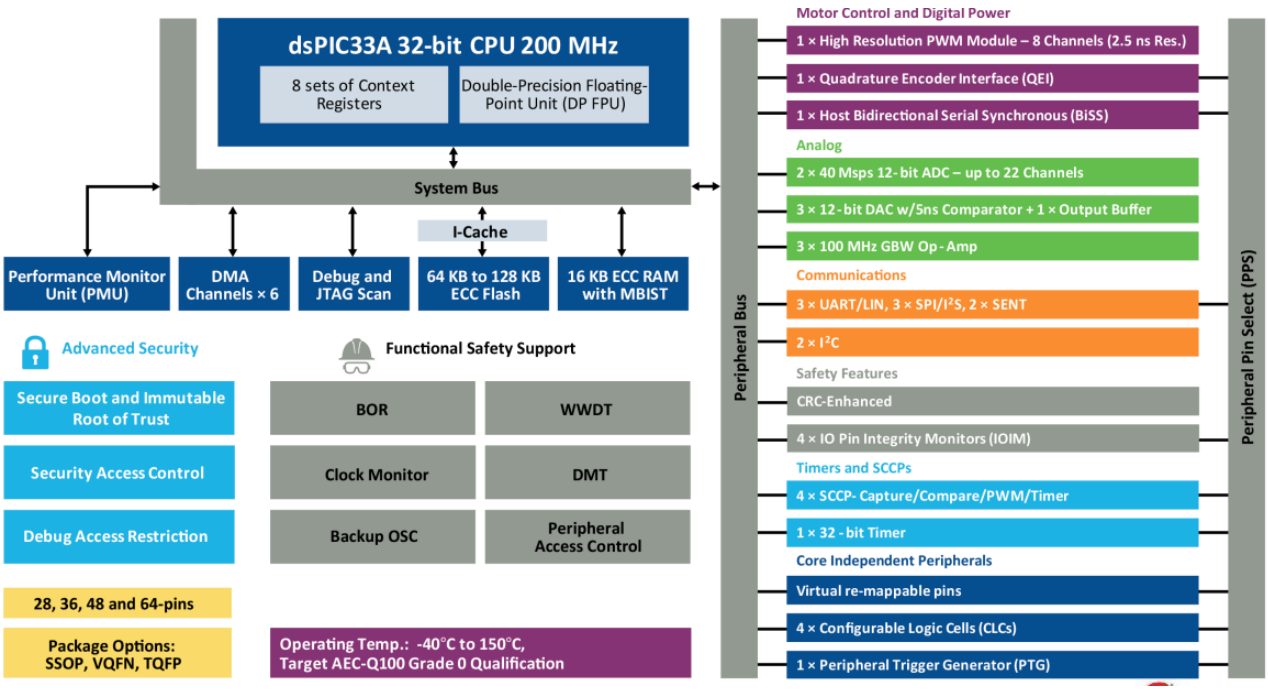

Fig. 4. The dsPIC33AK128MC106 DSC family includes 128 KB flash and an extensive peripheral set, offered in various packages.