Electronic Design

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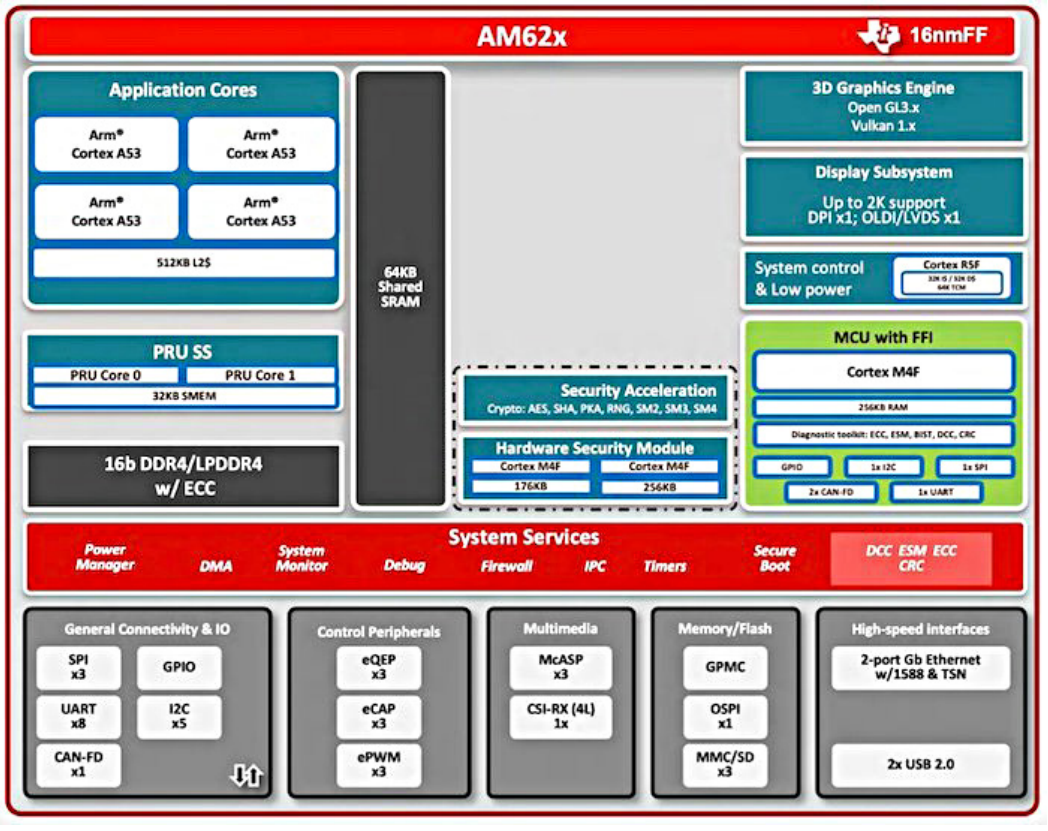
Power-Efficient Edge AI Processing Targets Next-Gen HMI

Sponsored by Texas Instruments: Featuring low-power modes and low active power consumption, the AM62x processor family brings AI-enabled human machine interface to industrial and IoT apps.

We've been steeped in the traditional methods of human machine interface (HMI) for so long that the addition of artificial intelligence (AI) and edge computing requires a tune-up of our knowledge base. In the past, an HMI consisted of a physical control panel with pushbuttons, switches, trackballs, and indicator lights that enabled users to communicate with a machine. But it's not sacrilege to suggest that these are rapidly exiting the scene.

In their place, edge computing brings compute power to where your data is collected. Edge AI is more nimble and agile than other forms of data processing, where data is sent



1. Shown is a high-level AM62x processor block diagram.

to remote data centers or the cloud for processing. It offers faster, localized processing with less latency than traditional forms of cloud computing.

With the proliferation of AI and machine learning (ML), the next generation of HMI is poised to bring entirely new ways of interacting with machines and devices. Coupling edge AI features such as machine vision, analytics, and predictive maintenance with HMI applications is changing the way we interact with machines. Examples include gesture and/or facial recognition in a noisy factory environment or allowing the control of machines via digital voice assistants (such as Alexa and Siri) and a wireless connection.

Bringing HMI to the Next Level

As HMI continues to evolve, the processor technology behind these applications must be ready to enable that evolution. Recently, Texas Instruments released new edge AI processors aimed at HMI applications. Designed for low power, the first devices in TI's Sitara AM62 processor family, the AM625 and AM623, bring power-efficient edge AI processing to dual-display and small-form applications. They include an AI accelerator that achieves high deep-learning AI inference performance. Inference involves the process of AI analyzing data collected from a sensor and then making decisions based on it in real-time or near-real-time.

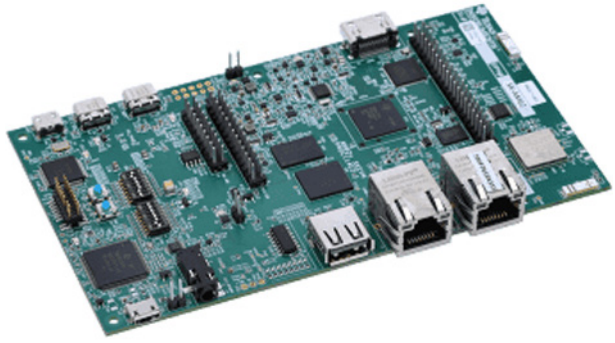
TI put a great deal of effort into developing the AM62x family *(Fig. 1)*. The processors consist of a quad-core 64-bit Arm Cortex-A53 microprocessor, single-core Cortex-R5F microcontroller (MCU), and a Cortex-M4F MCU. While the AM623 targets IoT and gateway SoCs with Arm Cortex-A53-based object and gesture recognition, the AM625 is aimed specifically at human-machine interactions with an Arm Cortex-A53-based edge AI, and a full-HD dual-display capability.

The best part may be the low power consumption of these devices. AM62x processors achieve less than 500-mW power consumption for a single A53 core running at 1 GHz. It's almost half of that achieved by similar low-power and low-cost processors in previous generations. AM62x processor power can be less than 1 W when quad A53 cores run a stressful application on all four cores at 1.4 GHz.

To bring analytics to edge devices at low power, including suspend states as low as 7 mW with no need to design for thermal considerations, TI's engineers employed a few clever techniques.

Low-Power Design

The low power consumption was made possible through a simplified power architecture—the device features only two dedicated power rails and five power modes. The modular architecture of this device delivers performance with support for several low-power modes without sacrificing critical system resources such as connectivity, power, security, safety, and cost.



2. The SK-AM62 evaluation kit can be used for display applications (e.g., HMI and control panel) with either an HDMI display or an external LVDS panel with up to 2K resolution.

Deep-sleep mode at <5 mW enables longer battery life, while an active power of <1.5 W is made possible by a core voltage of 0.75 V. As a result, AM62 processors can reduce power consumption in industrial applications by as much as 50% compared to competing devices, enabling an application powered by AA batteries to remain on for over 1,000 hours.

Achieving optimal power performance is further simplified with the new TPS65219, a companion power-management IC (PMIC) specifically designed to meet AM62x processor power-supply requirements. The device is characterized across an ambient temperature range of –40 to +105°C, making it suitable for various industrial applications. It includes three synchronous, stepdown dc-dc converters and four linear regulators.

Additional Features

The AM62x processors include on-chip resources such as a universal asynchronous receiver/transmitter, multichannel SPI and I^2C, and various connection options for popular industrial sensors or controllers. These processors also provide dual Ethernet support and EtherCAT master support with a third-party ecosystem.

The parts further support a wide variety of display interfaces, including the color format RGB888, where 8 bits are used for each of the color components red, green and, blue, and a low-voltage differential signaling interface that supports 2K and full high-definition displays. The processors support dual displays, which provide engineers with design flexibility as two screens effectively extend the visual real estate and help to make workflow smoother.

In addition, AM62x processors support multiple operating systems, including mainline Linux and Android operating systems.

The set of peripherals included in AM62x enables system-

level connectivity, such as USB, MMC/SD cards, camera interface, CAN-FD, and GPMC (general-purpose memory controller) for parallel host interface to an external ASIC/FPGA. The AM62x device also supports secure boot for IP protection with a built-in hardware security -odule (HSM) and advanced power-management support for portable and power-sensitive applications.

The AM625 and AM623 processors come in a 13- × 13-mm, 425-pin ALW package, with pricing starting at less than $5 in 1,000-unit quantities. The processors can meet the AEC-Q100 automotive standard in the 17.2- × 17.2-mm package (AMC). Industrial and automotive functional-safety requirements are met when using the integrated Cortex-M4F cores and dedicated peripherals, all of which can be isolated from the rest of the AM62x processor.

Getting Started

A rich hardware ecosystem, including a third-party evaluation module (EVM), helps designers get up and running quicker on application designs. The SK-AM62 starter kit for industrial HMI, IoT, and Arm-based edge AI is a low-cost ($149) standalone test and development platform *(Fig. 2)*. It offers power-efficient processing (featuring Cortex-A53, -R5F and -M4F cores), full-HD, dual-display support (HDMI and LVDO panels), and software that includes demos for edge AI, HMI, and more.

Conclusion

The AM62x's low-power modes and low active power consumption allow for a wide range of battery-operated uses, and its small form factor facilitates product design without heatsinks or fans. What's more, the 0.75-V core voltage operation and power-management features permit adjusting performance and power for each application, resulting in a simple and low-cost power solution.