AM243x Multi-Core Networking Arm MCUs

Supporting Industrial Networking, Real-time Control and Multi-Axis Motor Control on a Single Device

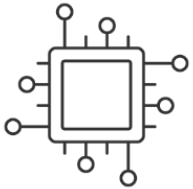
Sitara MPU
Aug 2024

Sitara MPU | Benefits of A Scalable Portfolio

- ✓ Comprehensive portfolio for your space-constrained, power-efficient, cost-optimized products!
- ✓ Strong ecosystem and easy migration path across entire portfolio accelerates the time to market!

Industry-leading Low Power

- 16nm tech node offering industrial IP with best in class performance and power.
- Designed for simple, low cost and efficient power architecture. (<1W active power/typical)
  - Reduces 30% power by lowing core voltage
- Supports non-heat sink design in harsh environments.
- Low Power Processor PMIC solutions



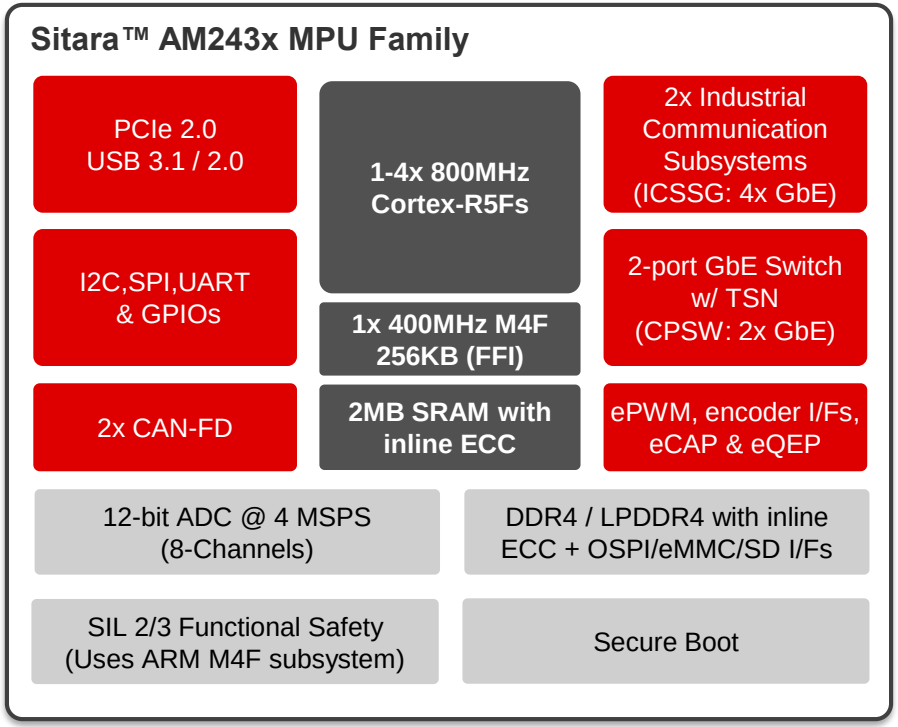
Scalable Solutions reliably designed

- Scalable platforms provide differentiated IPs with robust software for multiple apps.
  - General purpose, Networking, AI.
- Unified SW architecture with up-streamed Linux mainline Kernel provides an easy migration path across platform devices.
- 100K POH at 105C enhances reliable HW/SW designs

Supply Continuity / Sustainability

- Low cost solutions start from less than $5 at 1Ku.
- TI internal 45nm process fab builds sustainable capacity and cost.
- 16nm device flow utilizes comprehensive dual source strategy to ensure capacity and longevity.

AM243x: Multi-Core Industrial Networking MCU



Performance

- ❑ Up to four R5F real-time cores with up to 6.7k DMIPs
- ❑ Functional Safety & Secure boot

Gigabit Industrial Ethernet Support

- ❑ Up to 5x independent GbE ports
- ❑ Up to 2x 2-port GbE TSN, cut-through switches (2-ext, 1-int port)

2x Industrial Communication Subsystems (ICSSG)

- ❑ Programable real time peripheral connectivity
- ❑ Multi-protocol industrial networking support

PROFINET · EtherNet/IP · EtherCAT · IO-Link · TSN Time Sensitive Networking

Motor Control

- ❑ > 3 axis motor control (FOC)
- ❑ Up to 12x multi-protocol position encoders
- ❑ Up to 36x on-chip sigma delta filters for current measurement

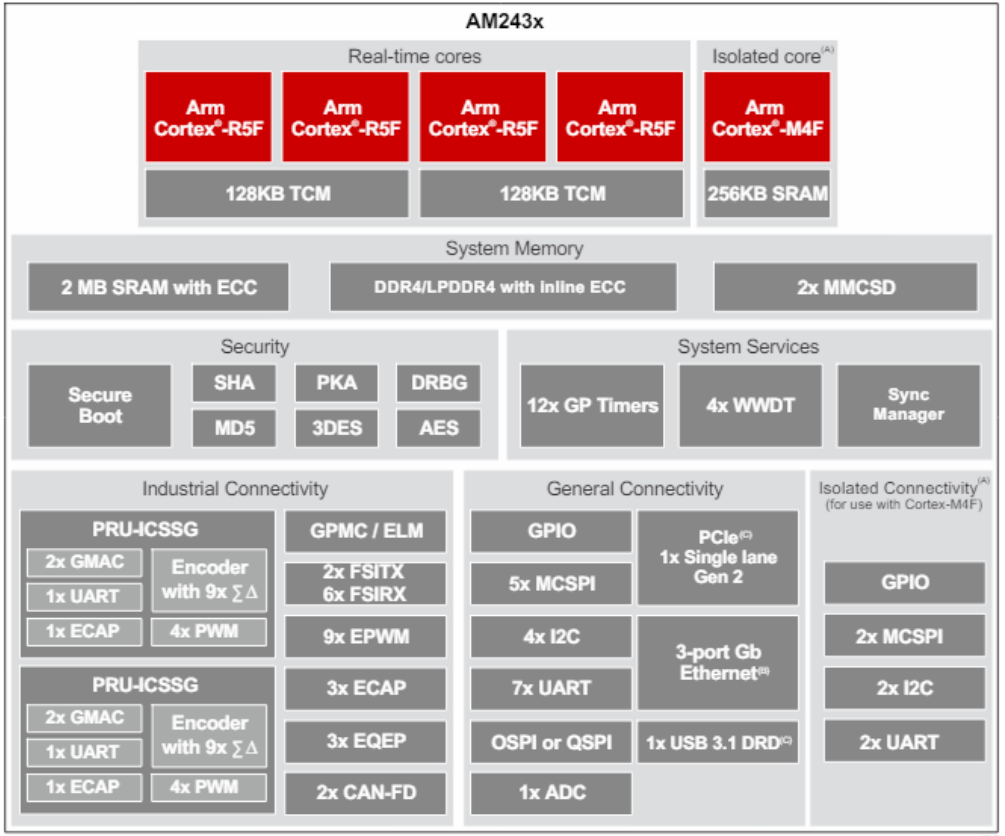
Processing Scalability

- ❑ P2P compatibility with AM64x MPU family (17mm package)

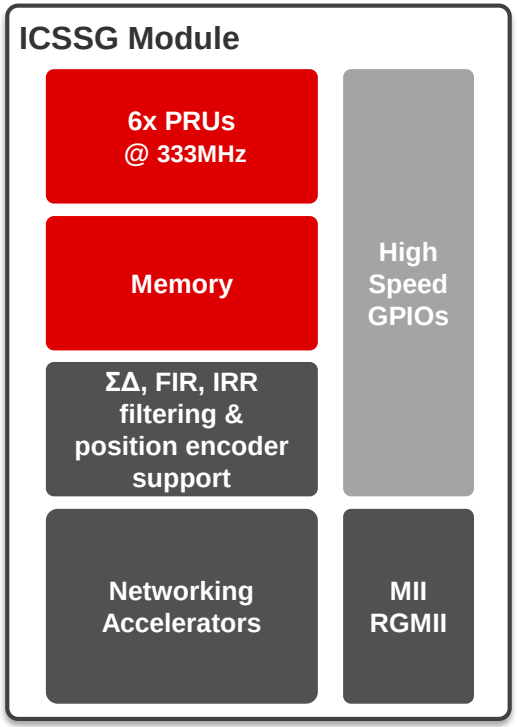
AM23x Cortex®-R5F based MCU

** *Released* **

- **Compute Processing Power**
  - 1-4x Cortex-R5 up to 800MHz (up to 6.7KDMIPS)
  - 2x PRU-ICSS-Gb
    - Enables up to 2x Gb industrial Ethernet protocols or 1x industrial Ethernet protocol + motor control current and position feedback
- **Integrated Analog**
  - 8-channel, 12-bit ADC with 4 MSPS
  - Simplified power solution, Integrated Voltage Monitors and SD card LDO
- **Memory IO**
  - 1x Octal-SPI w/ execution-in-place support, 2x MMC/SD, 1x GPMC (32-bit data)
- **Automotive IO**
  - 2x CAN-FD
- **High Speed IO**
  - 1x USB3.1 Gen 1/2.0 (5Gbps SS)
  - 2-port Gb Ethernet switch (AVB & TSN) (2 ext, 1 int port)
  - Up to 5x Gb Ethernet ports
  - 1x PCIe 1-Lane, Gen2 (Note: PCIe and USB 3.0 share the same SerDes)
- **Safety & Security**
  - SIL-2 device / SIL-3 System with the addition of a safety processor
  - 1x Cortex-M4F (400MHz) MCUSS with Freedom from interference (FFI), dedicated peripherals & 256KB SRAM
  - Diagnostic toolkit (entire SoC), voltage, temp, clock, ECC monitors & error signaling
  - Secure boot, on-chip Crypto accelerators
    - Dedicated Cortex-M3 running at 333MHz with 128KB of SRAM
- **Package**
  - 17.2mm x 17.2mm, 0.8mm ball pitch (Metal Lid today; Plastic samples in Jan 2025)
  - 11mm x 11mm, 0.5mm ball pitch
- **Operating Temp**
  - -40 to 105C and -40 to 125C Tj Options



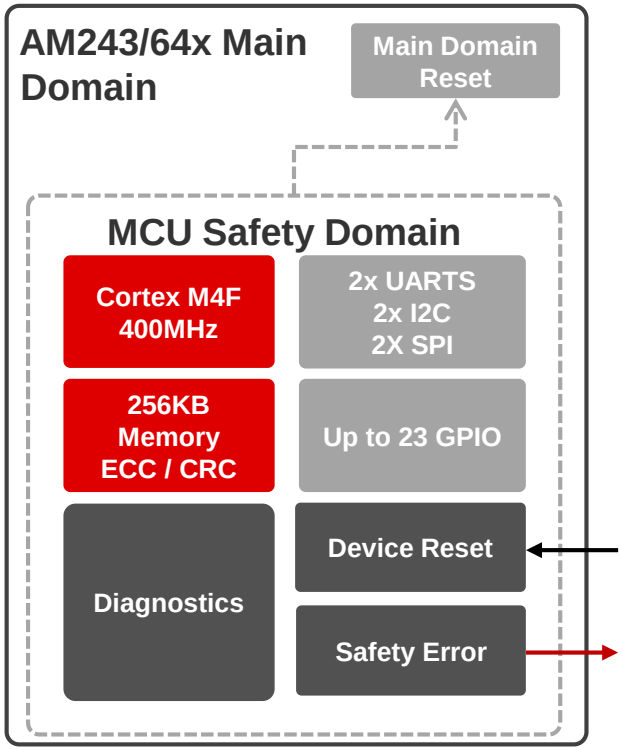
AM243/AM64x: Industrial Communication Subsystem



ICSSG Module Features:

- Up to 40 real-time, deterministic I/Os per ICSSG. Control output timing in **3ns increments** & support **6ns ISRs vs. ~ 1us ARM R5F** “real time” I/O performance.
- Multi-protocol **industrial Ethernet** and **motor control** support
  - Up to 2x 1GbE ports per ICSSG
  - Supports EtherCAT, Profinet, EtherNet/IP & other protocols
  - Multi-protocol position encoder support (up to 12x encoder I/Fs)
  - Up to 36 delta-sigma filters (sync1/2/3) with short circuit & overcurrent protection.
- Direct connect high-speed/precision ADCs to the AM64x (no FPGA required)
- Support standard or custom / legacy interface protocols
  - i.e. additional I2S, UART, CAN, OSPI, proprietary backplane, etc.
- Custom or non-TI supported protocols and interfaces can be supported using the ICSSG IDE with source level debugger, C & ASM language support tools

AM243/AM64x: Functional Safety



AM243/64x Safety Features:

- TÜV certified SIL-2 random faults / SIL-3 systematic element out of context
- Up to SIL-3 HFT=1 system support with external safety processor.
- Freedom from Interference (FFI) MCU Safety domain:
  - MCU domain isolated from Main domain with firewalls / time-out gaskets
  - Dedicated peripherals, memory, error & reset pins
  - MCU domain can reset main domain
- Main domain supports both safety and non-safety applications.
- Extensive diagnostics & BIST capabilities in both the Safety and Main domains
- Start FuSa work today! Safety Manual, Safety Analysis Report and FMEDA including FIT / FSS analysis is available under NDA.

AM234x: Low Power Consumption

AM2434 example application:

- 6 axis FOC motor control
  - Running on the Cortex R5Fs cores (1 per 2 axis)
  - Position Encoders / Delta Sigma filters on ICSSG1
- EtherCAT Industrial communications
  - Running on one Cortex R5F core & ICSSG0.
- Functional Safety
  - Cortex M4F supporting SIL 2/3

Worst Case Power Consumption
< 1.5 Watts @ 105C Junction

Power Calculation Details *Power Calc Link*

Operating Performance Point (OPP)		
	MPU A530/1 Frequency (MHz)	1000
	MCU R5F0/1 Frequency (MHz)	800
	MCU R5F2/3 Frequency (MHz)	800
	MCU M4F Frequency (MHz)	400
	ICSSG Frequency (MHz)	333

Processor Core Utilization (%)	
MPU-A530	0%
MPU-A531	0%
MCU-R5F0	80%
MCU-R5F1	80%
MCU-R5F2	80%
MCU-R5F3	61%
MCU-M4F	50%
PRU-ICSSG0	50%
PRU-ICSSG1	50%
Security Accelerator	0%

LVCMOS IO	Mode	IO Utilization (%)
MCU UART	112kbps	10%
MCU UART	112kbps	10%
MCU SPI	Slave, 12.5Mbd	5%
MCU SPI	Slave, 12.5Mbd	5%
ICSSG0	Dual Port RGMII 1Gbps	50%
ICSSG1	Dual Port MII 100Mbps	50%
Ethernet (CPSW) Port 0	RGMII 100Mbps	10%
OSPI	OSPI DDR 160Mbd	0%
GPMC	GPMC 16b 125 MHz	0%

Peripherals	Mode	Utilization (%)
DDR Type/Rate	LPDDR4 1066	0%
DDR WR %	0%	-
High Speed IO	Off	0%
USB2	1.8V on	0%
SD card	HS200	5%
eMMC	HS200	5%
ADC	on	-

Estimated Power			
	Power Supply	Voltage (V)	Power (W)
	VDD_CORE	0.85	1.107
	VDDAR_CORE	0.85	0.086
	VDDA_1V8	1.8	0.053
	VDD_DDR4 (without DIMM)	1.1	0.055
	SOC_DVDD1V8	1.8	0.050
	SoC_DVDD3V3	3.3	0.121
	Total		1.472

General	
Junction Temperature (°C)	105
Power Estimation Mode	Max

Power Estimate @ 105C Junction

Industrial Communication Software Engagement Models

Buy Direct from TI	Buy from Third-party
Fully bundled solution directly from TI	Stacks licensed from third parties
One license for all TI-offered stacks	Separate license per protocol
Licensing included with device	Licenses available as buyout, per project, and per family
Stack support directly from TI	Stack support from third party
Pre-certified solutions	Pre-certified solutions

TI provides the total solution for industrial protocols:
Easy engagement starting with Sitara AM243x and AM64x families

AM243/AM64x: Certified Stacks from TI

Protocol	Certified	Min. Cycle Time	Conformance Test /Certification	Key features supported
EtherCAT (Device/client)	Yes	31.25 us	2.5.0	CiA402, CAN over EtherCAT (CoE), Servo Drive Profile (SoE), Ethernet over EtherCAT (EoE), File Access over EtherCAT (FoE),Distributed Clocks
EtherNet/IP (Device/client)	Yes	1 ms	20.1	Address Conflict Detection (ACD), Quality of Service (QoS), Device Level Ring (DLR), Precision Time Protocol (PTP)
PROFINET (Device/client)	2H24 Certification	1 ms (RT) 250 us (IRT)	2.44.1	Conformance Class A, B (RT), and C (IRT), Precision Time Control Protocol (PTCP), Media Redundancy Protocol (MRP)
IO-Link (Controller/Host)	Yes	All communication classes supported	1.1.3	Up to 8 channel IO Link Master per ICSS, IO-Link standard-compliant with Standardized Master Interface (SMI)

Detailed feature set for each protocol available in the Industrial Communications Toolkit
Release datasheets EtherNet/IP EtherCAT PROFINET IO Link

Family Details

AM243x Family | Pin-to-Pin Compatible

Scalable:

- 1-4x R5F core options
- Maintain real-time performance even RTOS services running simultaneously.

Industrial:

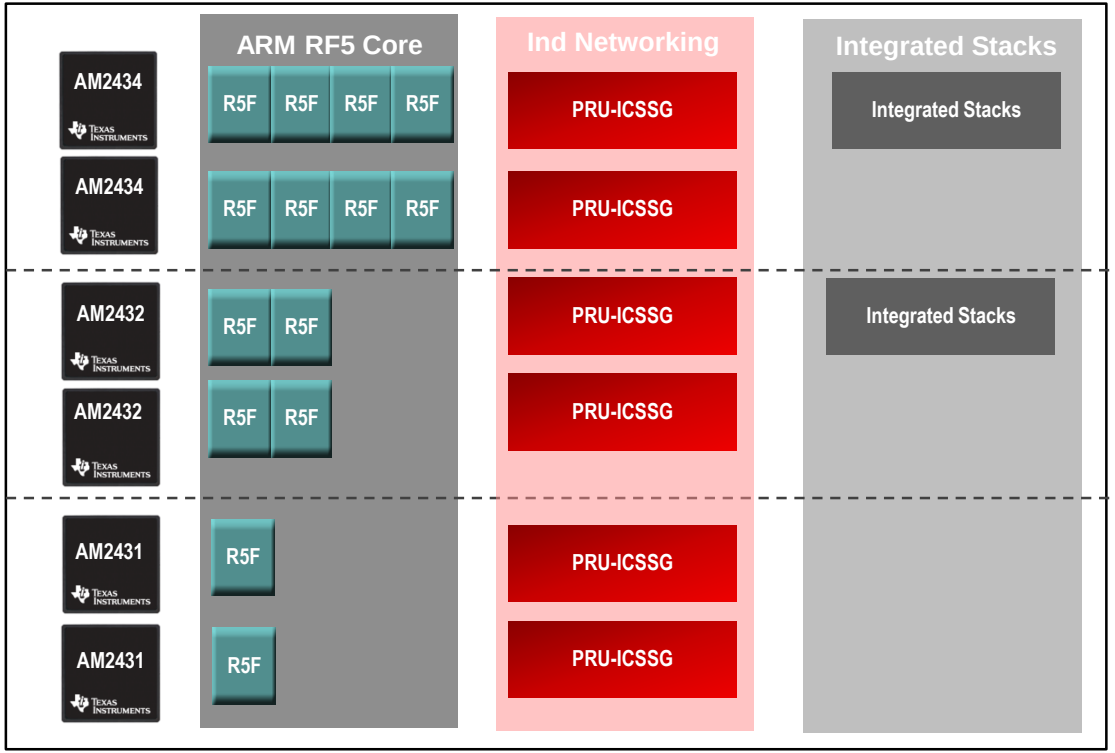
- Rated for -40 to 125C
- Industrial communications support (Profinet, EtherCAT, EtherNet/IP, and IO-Link)
- 100K Power-on-hours @ 105C
- Hardware integrity up to SIL 2; systematic capability up to SIL 3 with additional safety MCU

Package Options:

- 17x17mm package (Metal Lid)
- 11x11 mm package (Plastic)

Secure boot and runtime security

Low power consumption (1W)



Pin-to-pin and Software Compatible Family of AM2x MCUs

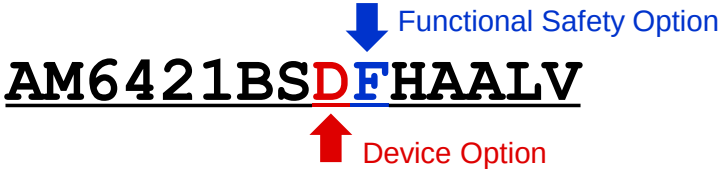
AM243x Family Device Options

Device Options	AM2434-ALV	AM2432-ALV	AM2431-ALV
R5F Cores @ 800MHz	Quad 4 x 64kB TCM	Dual 2 x 128kB TCM	Single 1x 128KB TCM
M4F Cores @ 400MHz (256KB)	MF4 with FFI	MF4 with FFI	M4F With FFI
Programmable Real-Time Unit Subsystem *(PRU Cores, eGPIO, UART, ECAP. EPWM)*	2x	2x	2x
ICSSG Industrial Communication Support *(4x 10/100/1000 Gigabit Ethernet MAC's with MII/RGMII, 36x ΣΔ decimation filters, & 12x multi-protocol encoder I/Fs)*	Yes	Yes	Yes (No EtherCAT Slave Support)
Industrial Communication Software Stacks *(Profinet, EtherCAT, EtherNet/IP, & I/O Link)*	Yes	Yes	No
Number of 1Gbps Ethernet Ports	Up to 5x	Up to 5X	Up to 5X
Dual CAN-FD	Yes	Yes	No
12-bit, 8-Channel, 4 MSPS ADC	Yes	Yes	Yes
Functional Safety *(SIL 2 device / SIL 3 system)*	Yes	Yes	Yes
1K Price (ALV and ALX package options)	$9 to $15	$7 to $13	$6.8 to $10

AM243x Family Device Options

Device Options	All AM64x Devices
On-Chip SRAM	2MB
DDR4 / LPDDR4 I/F	Up to 2GB with inline ECC (16-bit data, 1600MT/s)
Ethernet Switching	2-port 10/100/1Gb with MII/RMII/RGMII; IEEE 1588, TSN, and cut-through support (2 ext and 1 int port)
Ethernet Ports	2x IEEE 1588V2 ports (10/100/1000) on 6411/6412. Up to 5x IEEE ports on other device options.
PRU_ICSSG*	2x Gigabit Industrial Communication Subsystems (PRU_ICCSG). Industrial Networking, Sigma Delta decimation filtering, and motor encoder support only available on device options D, E, & F.
USB	USB 3.1 or USB 2.0
PCIe	PCIe 2.0 (Single Lane) (USB 3.1 and PCIe share the same SerDes)
Flash I/F	Octal / Quad SPI, Parallel NOR and NAND, & 2x eMMC/SDIO (4-bit & 8-bit)
Control Interfaces	9x EPWM, 3x ECAP, 3x EQEP
Other Peripherals	Main Domain: 7xUART, 4xI2C, 5xSPI, OctalSPI, 2x eMMC/SDIO, 6x FSI Rx/2x FSI Tx,up to 175 GPIOs Safety Domain: 2x UART, 2x I2C, 2x SPI, 23x GPIO
Security	Encrypt/decrypt/hash accelerators, TRNG/DRBG with true random number generator, secure Boot, memory firewall, effuse key storage, run-time security support, etc.
Operating Temp / Reliability	-40 to 105C Tj ; 100k power on hours (POH) @ 105C Tj. -40 to 125C Tj; 17.5k power on hours (POH) @ 125C TJ

AM243/64x Device Options



Device Option	Feature	Comment
C	Two Programmable Real-Time Unit Subsystems	Up to 80 real-time GPIOs with 3ns toggles and 6ns ISR. Direct connect high-speed / high-precision ADCs and other devices eliminating the need for small FPGAs. The ICSSG industrial communication features are not supported but the 2-port CPSW Ethernet switch/dual MAC is enabled and supports TSN
D	Option C + Industrial Communication Support	Device option D adds support for the ICSSG industrial communication features including up to 4x ICSSG 10/100/1000 Ethernet MACs (MII/RGMII), 36x sigma delta decimation filters, and 12x multi-protocol encoders I/Fs (HDSL, EnDat 2.2, Tamagawa etc. support). Supports HSR / PRP
E	Option D + EtherCAT and CAN-FD Support	Adds EtherCAT Device hardware accelerator and CAN-FD support. (CAN-FD and EtherCAT Device licenses are included). Option E or F is required to run the EtherCAT Device protocol.
F	Option E + Integrated Industrial Communication stacks	Includes EtherNet/IP, EtherCAT, Profinet RT/IRT, and IO-Link certified industrial networking software stacks (R5F binaries) powered by KUNBUS

Functional Safety	Feature	Comment
G	Non-Functional Safety Support	
F	Functional Safety Support	Device targeting SIL 2 / System Level SIL 3 with external safety processor

* *Standard CAN is supported on all device options*

AM243x Package Comparison

Feature	17mm x 17mm (ALV)	11mm x 11mm (ALX)
Package Info	441-pin BGA, 0.8mm pitch *Metal lidded package; improved thermal performance; P2P with ANI package option;2.512mm height*	293-pin BGA, 0.5mm pitch *Via Channel Array to allow low cost routing rules*
DDR Support	Optional, up to 1600MTs	Not Available
GPMC	Available	Not Available
PCI-Express	Available	Not Available
FSI	6 Rx, 2 Tx	4 Rx, 1 Tx
ADC	12bit, 70dB SNR, -75dB THD	10bit, 65dB SNR, -64dB THD
Octal-SPI	Octal-SPI with 4x Chip-Select	Quad-SPI with 2x Chip-Select
eMMC/SD	Two ports (8-bit and 4-bit)	One port (4-bit)
MCSPI	5x MCSPI interface	4x MCSPI interface
EPWM	9x EPWM	7x EPWM*
M4F Subsystem	2x UART, 2x I2C, 2x SPI, 21x GPIO	1x UART, 5x GPIO

*Only the A output signal is available for the EHRPWM5 instance of the ALX package type.