Sitara MCU Overview
Powerful MCUs for Industrial Ethernet Protocols and Motor Drives

2022 Sep

TEXAS INSTRUMENTS

TI Processors **Business Unit**

Arm®-based MCUs & Processors

Products

Sitara™ MCU
TEXAS INSTRUMENTS

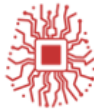Sitara™ MPU
TEXAS INSTRUMENTS

Jacinto™
TEXAS INSTRUMENTS
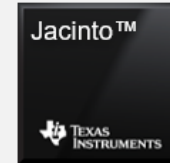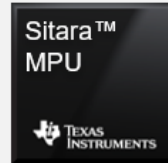
Investment vectors

Integrated precision sensing & control: Lower system costs with the industry's best-integrated analog

Edge AI & edge computing: Enable decision making & machine learning at the edge

Energy efficiency: Maximize energy efficiency with advanced processing & control capabilities

Functional safety & security: Design robust products with integrated features for functional safety & security

011100
100010
001111

Networking: Real-time networking with high-speed communication switches and network packet accelerators

SDK

Unified software development kit: Develop with ease, flexibility and scalability

AM2x: TI's new portfolio of high-performance MCU devices

Brings the best of both MCU & MPU world

AM2x combines

- MPU **performance** with single-core 400MHz up to multi-core 1GHz MCUs
- MCU **ease-of-use** with large & fast integrated RAM with dedicated flash interfaces
- **System-level integration**

AM2x scalability

- Unified platform with industrial and automotive grade qualification and **price** from $2 to $8
- Broad range of application supported **with optimized derivatives** per market
- **SW-compatible** scalability to TI industrial and automotive processor MPUs

MCU+	MCU+ Networking	MCU+ Real-time control	MCU+ Signal processing accelerators
AM22x	AM24x	AM26x	AM27x
❑ Low-cost general purpose & HMI	❑ Pre-integrated industrial protocols, Ethernet switch, CAN-FD, LIN, PCIe	❑ Premium analog integration	❑ DSP and radar accelerators
❑ **Target applications:** Building Automation, Appliances, Test & Measurement	❑ **Target applications:** Remote IO Modules, Telematics, Building Security Gateways, Communication modules	❑ **Target applications:** Motor drives, HEV/EV, Solar inverters, Industrial robots	❑ **Target applications:** Audio, Radar

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AM2x | Industrial and Automotive Portfolio

45nm **16FF**

AM27x
MCU+
Signal processing

AM2732 45nm **2x R5F**
- 2x R5F (LS) @ 400MHz
- 1x C66x DSP @ 450MHz
- Up to 5MB RAM, HWA 2.0
- CSI-2, HSM, 10/100 ENET
- SIL2/ASIL-B FS-Compliant
- BGA: 13x13mm -Q100

RTM'd

AM26x
MCU+
Real-time control

AM263x 45nm **4x R5F**
- 1-4x R5F (LS) @ 400MHz
- Up to 2MB RAM
- HRPWMs, ADCs, DAC, Comparators
- GbE switch, PRU-ICSS
- BGA: 15x15mm – Q100

Sampling now!

AM24x
MCU+
Networking

AM243x 16FF **4x R5F**
- 1-4x R5F @ up to 800MHz
- 2MB RAM w/ ECC
- GbE switch, 2x PRU-ICSS-Gb
- PCIe, USB2
- Safety Monitoring
- BGA: 17x17mm, 11x11mm

RTM'd(17x17)

AM22x
MCU+

Sampling now   Sampling 2023+

Reliable
100,000 POH @ 105C

Integrated Security
Secure Boot, Run-time security, HSM with full EVITA/SHE1.1

Functional Safety-Compliant
Up to SIL3/ASIL D FS-Compliant

Power conscious
Best-in-class active power to performance ratio with low-power modes on the way
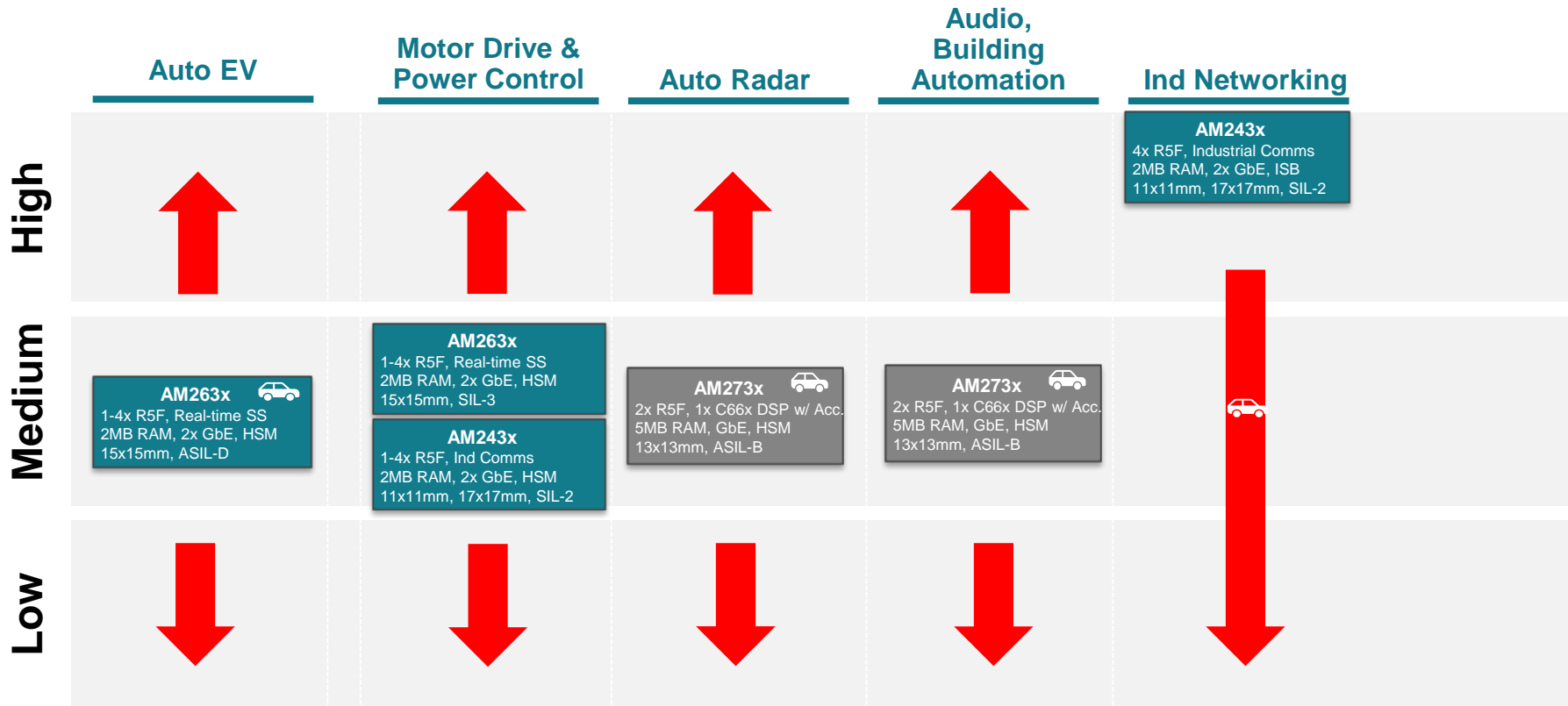
Easy to Use
Pre-integrated communication stacks, Application examples, FreeRTOS and Baremetal support

Legend
TSN Gb TSN enabled

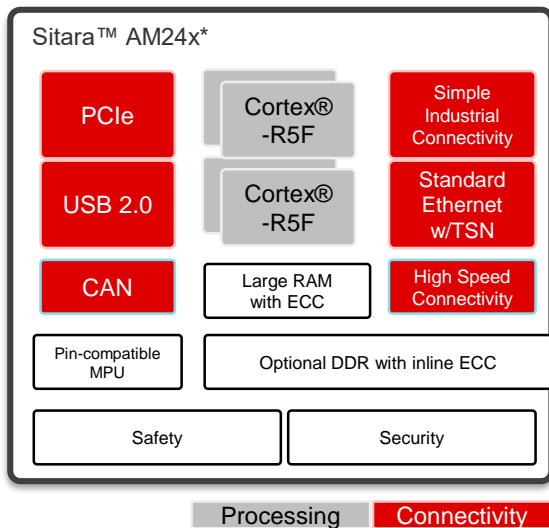Pre-integrated industrial Ethernet stacks

Pin-compatible MPU available

In Definition
Development
Sampling
Production

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AM2x| Portfolio & Example Applications

Production
Sampling

	Auto EV	Motor Drive & Power Control	Auto Radar	Audio, Building Automation	Ind Networking
High					**AM243x** 4x R5F, Industrial Comms 2MB RAM, 2x GbE, ISB 11x11mm, 17x17mm, SIL-2
Medium	**AM263x** 1-4x R5F, Real-time SS 2MB RAM, 2x GbE, HSM 15x15mm, ASIL-D	**AM263x** 1-4x R5F, Real-time SS 2MB RAM, 2x GbE, HSM 15x15mm, SIL-3 **AM243x** 1-4x R5F, Ind Comms 2MB RAM, 2x GbE, HSM 11x11mm, 17x17mm, SIL-2	**AM273x** 2x R5F, 1x C66x DSP w/ Acc. 5MB RAM, GbE, HSM 13x13mm, ASIL-B	**AM273x** 2x R5F, 1x C66x DSP w/ Acc. 5MB RAM, GbE, HSM 13x13mm, ASIL-B	
Low					

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AM24x Networking

Sitara™ AM24x*

PCIe	Cortex®-R5F	Simple Industrial Connectivity
USB 2.0	Cortex®-R5F	Standard Ethernet w/TSN
CAN	Large RAM with ECC	High Speed Connectivity
Pin-compatible MPU	Optional DDR with inline ECC	
Safety	Security	

Processing   Connectivity

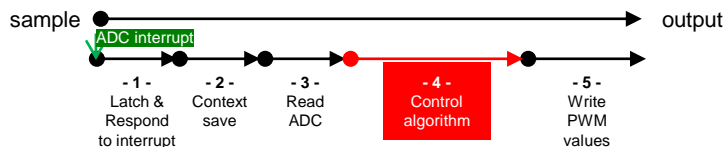| Application-enhancing IP	Details
PRU-ICSS-Gb	• Enables PROFINET@TSN and Pre-integrated EtherCAT, PROFINET, EtherNet/IP, and IO-Link Master connectivity • Can bridge two different real-time networks with one MCU
CPSW	• Gb Ethernet switch with cut-through capabilities and TSN support
Pin-compatibility to select MPUs	• AM243x 17x17mm package is pin-compatible with AM64x
PCIe & USB 2.0	• High-speed connectivity with widely accepted standards
CAN	• Support for CAN & CAN-FD

*Exact configuration of devices varies per part number. Some peripherals not available in certain part numbers

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AM26x Real-time Control

Sitara™ AM26x*

- ADC(s)
- Cortex®-R5F — Lockstep — Cortex®-R5F
- PWM(s)
- QEP(s)
- PRU-ICSS
- Large RAM with ECC
- DAC
- Capture
- Safety
- Security
- Automotive Connectivity

Sensing | Processing | Actuation
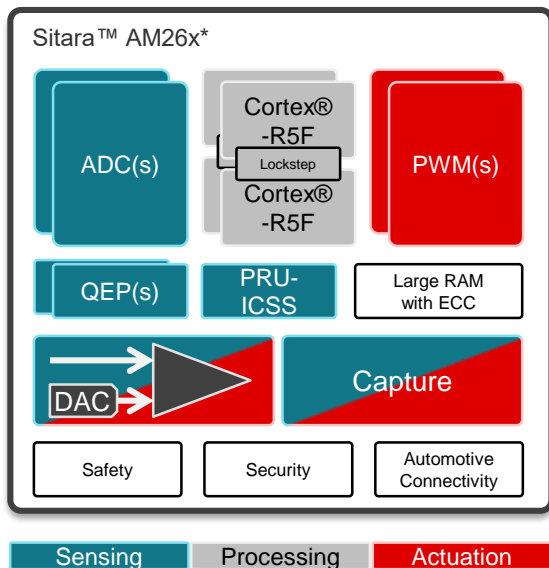
Whole signal chain optimized, not only control algorithm

sample → output

ADC interrupt

- 1 - Latch & Respond to interrupt
- 2 - Context save
- 3 - Read ADC
- 4 - Control algorithm
- 5 - Write PWM values

Application-enhancing IP	Details
Integrated ADC	• 3.3V input ADC; 5x with 30-input channels 4MSPS **for voltage and current sampling**
Integrated Analog comparators	• 40x analog comparators with internal DAC reference. Integrated **for peak current mode control, voltage trip monitoring**
Integrated DAC	• 3.3V buffered DAC **for power applications**
eHRPWM	• Type-5 PWM's with High resolution capabilities (150ps). Up to x32 modules with 64 channels. **Enables complex control topologies and higher channel count**
PRU-ICSS	• Connect various **absolute encoder** types including EnDat 2.2, HIPERFACE DSL, Tamagawa
Sigma Delta Filters	• Integrated sigma-delta digital filter modules with 8 integrated channels **for monitoring current or resolver position with over/under current and zero crossing detection**
eQEP	• Integrated 3x channels **for linear or rotary position**
eCAP	• Integrated 10x modules **for capturing time measurements** (e.g. period and duty cycle, elapsed time measurements etc.)
Topology	• Low latency interconnect enabling high performance control loops, flexible input, output cross bar with extensive sync and trip cross triggering **for precise control across peripherals**

*Exact configuration of devices varies per part number. Some peripherals not available in certain part numbers

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Block Diagram

TEXAS INSTRUMENTS
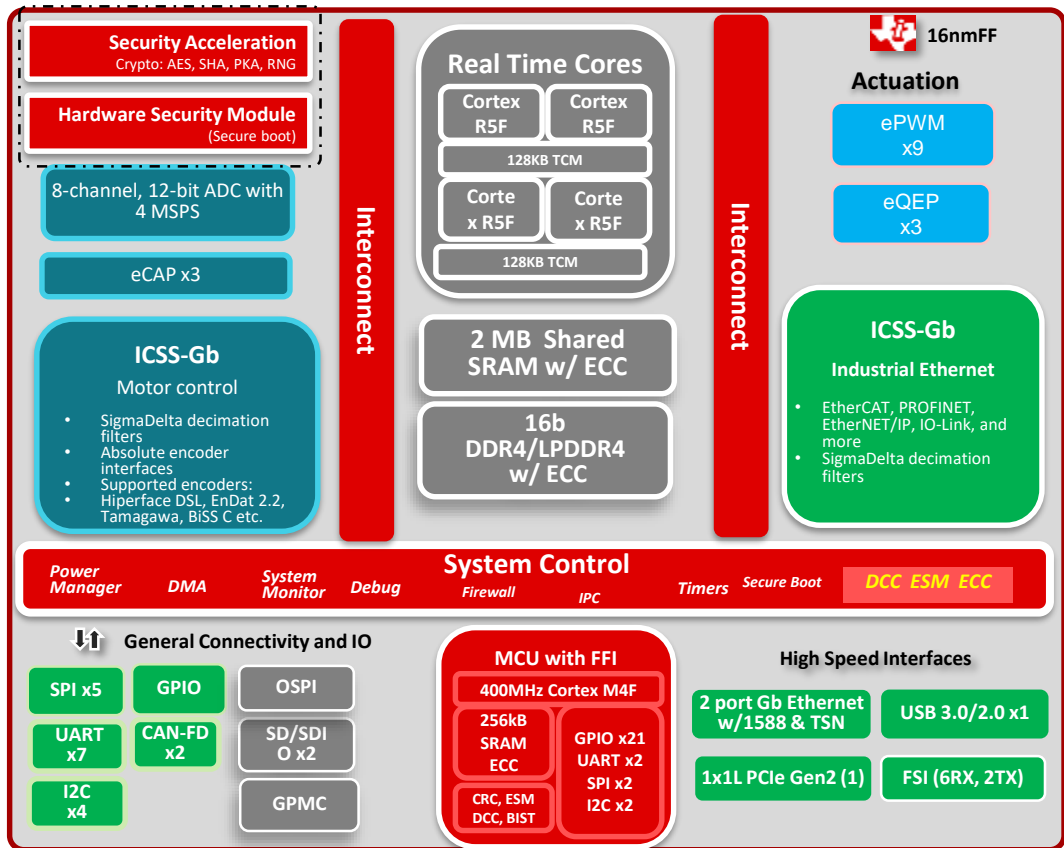
AM243x | Cortex®-R5F MCU

Features
- **Compute subsystem**
  - 1-4x Cortex-R5F up to 800MHz, (6.4K DMIPS)
- **Real Time Control**
  - Each ICSS-Gb can enable either enable industrial communication protocols or motor control interfaces.
  - 8-channel, 12-bit ADC with 4 MSPS.
- **Peripheral / IO Highlight**
  - Octal-SPI with XIP support and 4x chip select @ 166 MHz.
  - GPMC (16b parallel bus) for connection to an external host
  - 8-bit eMMC/SD interface and 4-bit SD/SDIO interface
  - RS485 support on UART, baud rates up to 10Mbps
- **Functional Safety-Compliant MCU**
  - Safety island w/ 400 MHz Cortex-M4F and Dedicated UART & GPIO for safety monitoring.
  - Diagnostic tool kit for entire SoC with voltage, temperature, clock, ECC monitors and Error Signaling Module.
- **Power**
  - Simple power solution, integrated voltage supervisors
  - <1W for typical applications. Support for full 100K POH @ Tj=105C (Ta=85 or higher)

Tools & Resources
- **MCU+ Academy:** Click here to explore MCU+ Academy online now!
- **MCU+ SDK** is available **NOW on ti.com**.

Package
- **ALX**: 441-pin, 11mm x 11mm 0.5mm VCA™ (low cost PCB routing rules)
- **ALV:** 293-pin, 17mm x 17mm, 0.8mm ball pitch

TI Information – Selective Disclosure

16nmFF

Security Acceleration Crypto: AES, SHA, PKA, RNG

Hardware Security Module (Secure boot)

8-channel, 12-bit ADC with 4 MSPS

eCAP x3

ICSS-Gb Motor control
- SigmaDelta decimation filters
- Absolute encoder interfaces
- Supported encoders:
- Hiperface DSL, EnDat 2.2, Tamagawa, BiSS C etc.

Interconnect

Real Time Cores
Cortex R5F | Cortex R5F
128KB TCM
Cortex R5F | Cortex R5F
128KB TCM

2 MB Shared SRAM w/ ECC

16b DDR4/LPDDR4 w/ ECC

Interconnect

Actuation
ePWM x9
eQEP x3

ICSS-Gb Industrial Ethernet
- EtherCAT, PROFINET, EtherNET/IP, IO-Link, and more
- SigmaDelta decimation filters

System Control
Power Manager | DMA | System Monitor | Debug | Firewall | IPC | Timers | Secure Boot | *DCC ESM ECC*

General Connectivity and IO
SPI x5 | GPIO | OSPI
UART x7 | CAN-FD x2 | SD/SDIO x2
I2C x4 | GPMC

MCU with FFI
400MHz Cortex M4F
256kB SRAM ECC | GPIO x21 UART x2 SPI x2 I2C x2
CRC, ESM DCC, BIST

High Speed Interfaces
2 port Gb Ethernet w/1588 & TSN | USB 3.0/2.0 x1
1x1L PCIe Gen2 (1) | FSI (6RX, 2TX)

Sensing | Processing | Actuation | Safety/Sec | Communication

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How do I get started?

Learn more about AM243x

https://www.ti.com/product/AM2434

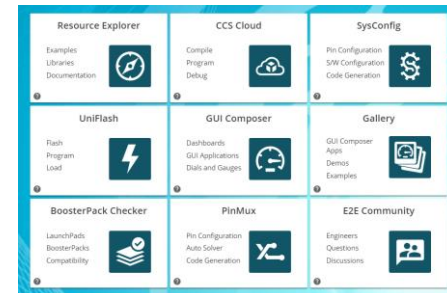## Get started now with TMDS243GPEVM & LP-AM243

Buy the AM243x Evaluation Module & Launch Pad

Get started with Project Zero

AM263x | Cortex®-R5F MCU

- **Compute Processing Power**
  - 2-4x Cortex-R5F up to 400MHz with LS option (3.2K DIMPS), total of 256KB TCM
  - 2MB on-chip SRAM and ECC on all critical memories
- **Real Time Control**
  - PWM: 32x (64-ch), all with high resolution (150ps) capability
  - 6-channel 12-bit ADC with 4 MSPS, 12-bit DAC, 12x comparators
  - industry leading real-time control sub-system that originated in C2000 products.
  - Capture modules for time measurements, quadrature encoders, and sigma-delta filter modules
  - ICSS-M can enable either industrial communication protocols at 100 Mbps such as EtherCAT, PROFINET, etc. or motor control interfaces
- **Robust Safety & Security**
  - ASIL-D / SIL-3 functional safety
  - ECC memory, Redundancy, Lockstep cores, HW BIST, Watchdog
- **Memory IO**
  - Parallel NAND flash or NOR support
  - 1x QSPI (Image download) , 1x MMC/SD
- **Peripheral / IO Highlight**
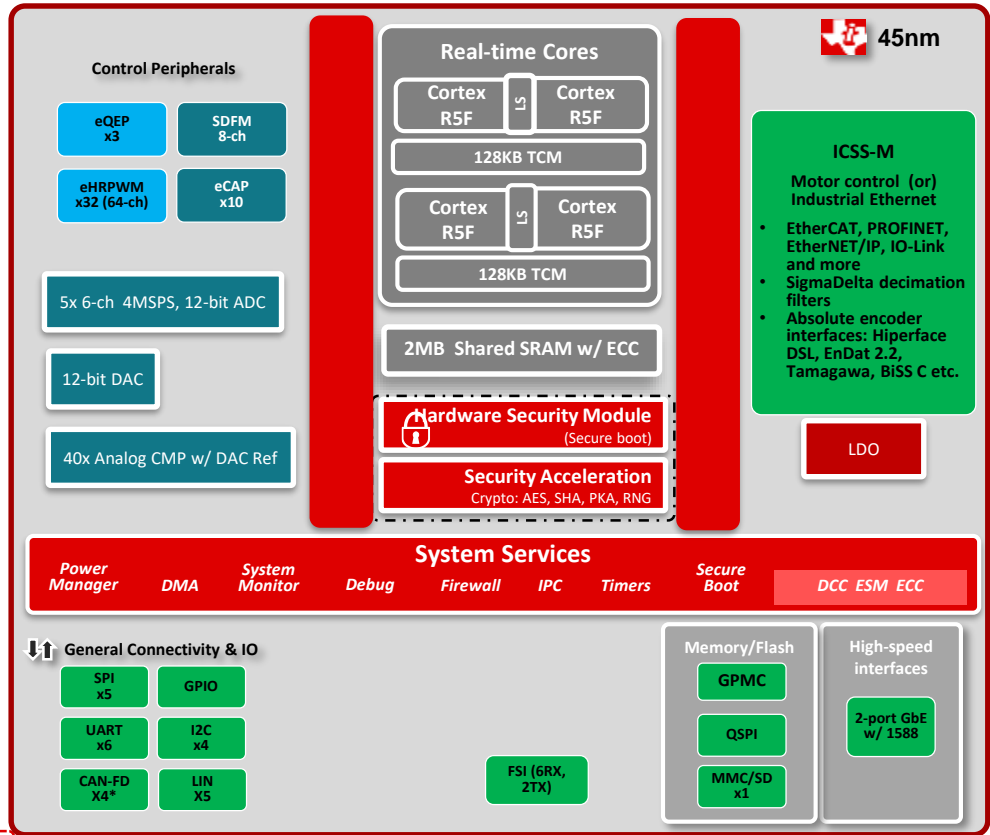 - RS485 support on UART with baud rates up to 10Mbps
- **Safety & Security**
  - Dual Cortex®-R5F with optional lockstep operation
  - ASIL-D / SIL-3 FS-Compliant
  - HSM supporting Secure Boot, Run-time security (encryption/decryption), IP protection & validation, FOTA support
- **Power:** <1.5W typical @125dC Tj (use case dependent)
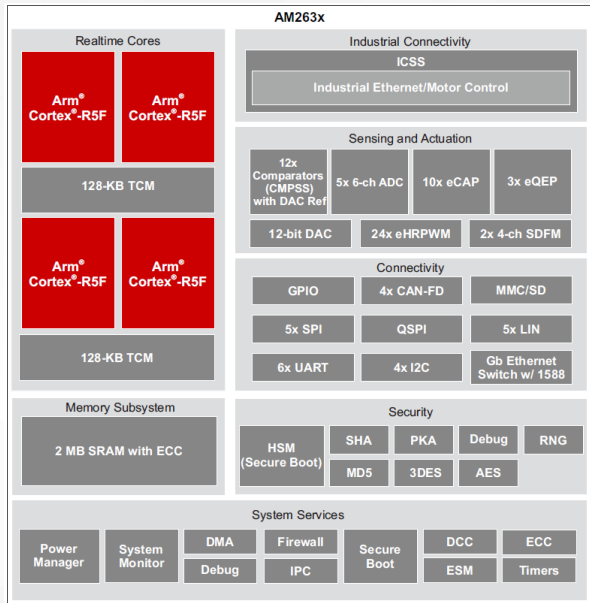- **Package:** 15x15mm, 0.8mm ball pitch
  - Support for Tj=150C

TI Information – Selective Disclosure

45nm

Control Peripherals

eQEP x3 | SDFM 8-ch

eHRPWM x32 (64-ch) | eCAP x10

5x 6-ch 4MSPS, 12-bit ADC

12-bit DAC

40x Analog CMP w/ DAC Ref

Real-time Cores

Cortex R5F | LS | Cortex R5F

128KB TCM

Cortex R5F | LS | Cortex R5F

128KB TCM

2MB Shared SRAM w/ ECC

Hardware Security Module (Secure boot)

Security Acceleration
Crypto: AES, SHA, PKA, RNG

ICSS-M
Motor control (or) Industrial Ethernet
- **EtherCAT, PROFINET, EtherNET/IP, IO-Link and more**
- **SigmaDelta decimation filters**
- **Absolute encoder interfaces: Hiperface DSL, EnDat 2.2, Tamagawa, BiSS C etc.**

LDO

System Services

| Power Manager | DMA | System Monitor | Debug | Firewall | IPC | Timers | Secure Boot | DCC ESM ECC |

General Connectivity & IO

SPI x5 | GPIO

UART x6 | I2C x4

CAN-FD X4* | LIN X5

FSI (6RX, 2TX)

Memory/Flash
GPMC
QSPI
MMC/SD x1

High-speed interfaces
2-port GbE w/ 1588

optional

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| Sensing | Processing | Actuation | Safety/Sec | Communication |

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How do I get started?

Learn more about AM263x

AM263x

Realtime Cores
Arm® Cortex®-R5F	Arm® Cortex®-R5F
128-KB TCM	
Arm® Cortex®-R5F	Arm® Cortex®-R5F
128-KB TCM	

Industrial Connectivity
ICSS
Industrial Ethernet/Motor Control

Sensing and Actuation
12x Comparators (CMPSS) with DAC Ref	5x 6-ch ADC	10x eCAP	3x eQEP
12-bit DAC	24x eHRPWM		2x 4-ch SDFM

Connectivity
GPIO	4x CAN-FD	MMC/SD
5x SPI	QSPI	5x LIN
6x UART	4x I2C	Gb Ethernet Switch w/ 1588

Memory Subsystem
2 MB SRAM with ECC

Security
HSM (Secure Boot)	SHA	PKA	Debug	RNG
	MD5	3DES	AES	

System Services
Power Manager	System Monitor	DMA	Firewall	Secure Boot	DCC	ECC
		Debug	IPC		ESM	Timers

https://www.ti.com/product/AM2634

Get started now with AM263x

TMDSCNCD263
Control Card

Development-focused experience with direct interface to leverage existing C2000 application specific platforms

- Includes 2 industrial/standard Ethernet jacks

Simplified out of box experience with standard headers for easy expandability & open ecosystem

LP-AM263
LaunchPad

- Includes 2 industrial/standard Ethernet jacks
- Power and data through single USB-C option
- Compatible with the following booster packs: BOOSTXL-DRV301, BOOSTXL-DRV305, BOOSTXL-BUCKCONV

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AM2732 – Two Chip Cascade Radar Processor

RTM'd

Processing Cores & Accelerators
- 1x C66x @ 450 MHz 32K L1P, 32K L1D, 384K L2
- 1x ARM Cortex R5F lock-step upto 400 MHz, 16K I-Cache, 16K D-Cache, 64K TCM, 960KB L2
- 1x HWA 2.0 @ 400 MHz, 128KB Local Buffer

Radar / Vision Interface
- 2x CSI-2 (4 lane) Camera or MMIC Interface

Memory & Flash
- 3.5625 MB L3 memory w/ECC
- 1x QSPI (166 MHz SDR / 80MHz DDR)

High-Speed & Debug IO
- Aurora LVDS

Peripherals
- 2x CAN-FD, 1x RGMII
- 4x SPI, 3x I2C, 4x UART, 3x ePWM

Safety/Security
- Supports ASIL B on MCU Island
- HSM, Secure Boot

Package
- 13x13 mm BGA, 0.65mm ball pitch
- 15x15 mm BGA, 0.8mm ball pitch

Power
- 2W Target

Temperature
- Tj: -40 to 140C Automotive
- Tj: -40 to 105C Industrial

45 nm

C66x DSP

R5F LS

3.5625 MB L3 RAM w/ECC

Radar ACC
1x HWA 2.0

HSM & Crypto

FFI Isolation

MCU Island
- ARM R5F
- 1056KB RAM
- ESM
- RTI
- DCC
- BIST
- 1x ADC 12b
- 1x SPI
- 1x UART
- 1xI2C
- 1x CAN FD
- GPIOs
- 1x QSPI
- Timers

SYSTEM SERVICES
- DMA
- Mailboxes
- WDT
- Spinlock
- Timers

MMIC I/F
- 2x CSI2 4L RX 600 Mbps

Vehicle connectivity
- Aurora
- 1x CAN FD
- 1x RGMII

Serial & IO
- 3xSPI
- 2xI2C
- 3xPWM
- 3xUART
- GPIOs

ASIL B

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Protocol

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Industrial protocol stacks by TI

Integrated real-time protocols

- TI-supported protocol firmware and stacks

- Dedicated R5F for real-time stack to offload performance from application cores

- EtherCAT, PROFINET, EtherNet/IP and IO-Link master for AM64x/AM243x available now

Scalable and reusable SW support

Sitara (AM6x / AM2x)

Cortex A53 (Linux or Linux RT)

Cortex R5 Application Cores (RTOS)

Comms Subsystem

Stack (R5F)

Firmware (PRU) switch
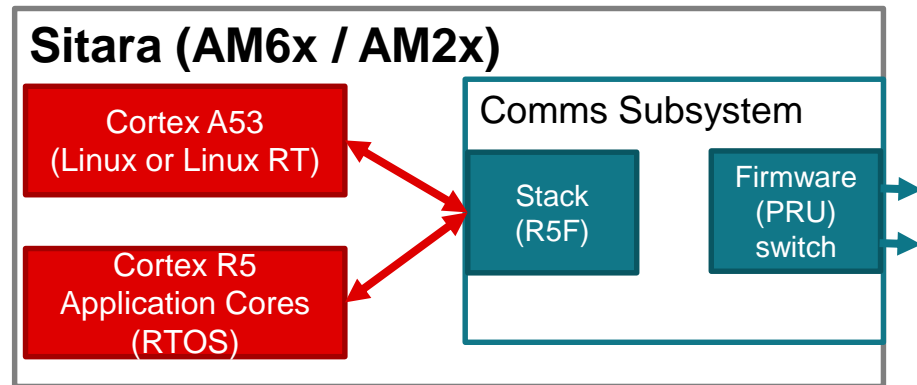
TI Supported Protocols Firmware and Stacks

EtherCAT®

IO-Link

PROFINET INDUSTRIAL ETHERNET

EtherNet/IP

TI Supported Interfaces (motor encoder)

EnDat 2.2

BiSS INTERFACE

HIPERFACE DSL

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Industrial Communication Engagement Models

Direct from TI

> **Fully bundled solution <u>directly from TI</u>**

> **<u>One license for all</u> TI-offered stacks**

> **Licensing included with device**

> **Stack <u>support directly</u> from TI**

> **Pre-certified solutions**

Third-party Based

> **Stacks licensed from third parties**

> **Separate license per protocol**

> **Licenses available as buyout - per project, and per family**

> **Stack support from third party**

> **Pre-certified solutions**

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

Learn more about industrial protocols supported by TI <u>here</u>

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Certified Industrial Protocol Stack from TI

Protocol	Min. Cycle Time	Conformance Test / Certification	Key features supported
EtherCAT (Certification Complete!)	31.25 us	ETG.7000.2	CiA402, CAN over EtherCAT (CoE), Servo Drive Profile (SoE), Ethernet over EtherCAT (EoE), File Access over EtherCAT (FoE), Distributed Clocks
EtherNet/IP (Certification Complete!)	1 ms	CT18.1	Address Conflict Detection (ACD), Quality of Service (QoS), Device Level Ring (DLR), Precision Time Protocol (PTP)
PROFI NET (INDUSTRIAL ETHERNET)	250 us (IRT) 1 ms (RT)	2.4.2	Conformance Class A, B (RT), and C (IRT), Precision Time Control Protocol (PTCP), Media Redundancy Protocol (MRP)
IO-Link (Certification Complete!)	All communication classes supported	1.1.2	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
SDK August 2021 Release Candidate datasheets EtherNet/IP EtherCAT PROFINET IO Link

Safety & Security

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# TI Engineering Expertise for Functional Safety

- Decades of safety engineering expertise

- Industry leadership as a participant in IEC 61508 and ISO 26262 standards organizations

- R&D processes enabling up to ASIL-D and SIL-3 systems

- Tools and expertise to simplify part selection

- Functional safety-compliant products leverage our TÜV SÜD-certified hardware and software development processes.

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WHAT DOES TI PROVIDE?

Reference SW and Examples to demonstrate usage of HW Safety Features and usage of TI Provided Safety SW.

Software for Supporting HW Safety Diagnostics. **Provided with CSP** to Support Customer Qualification Effort
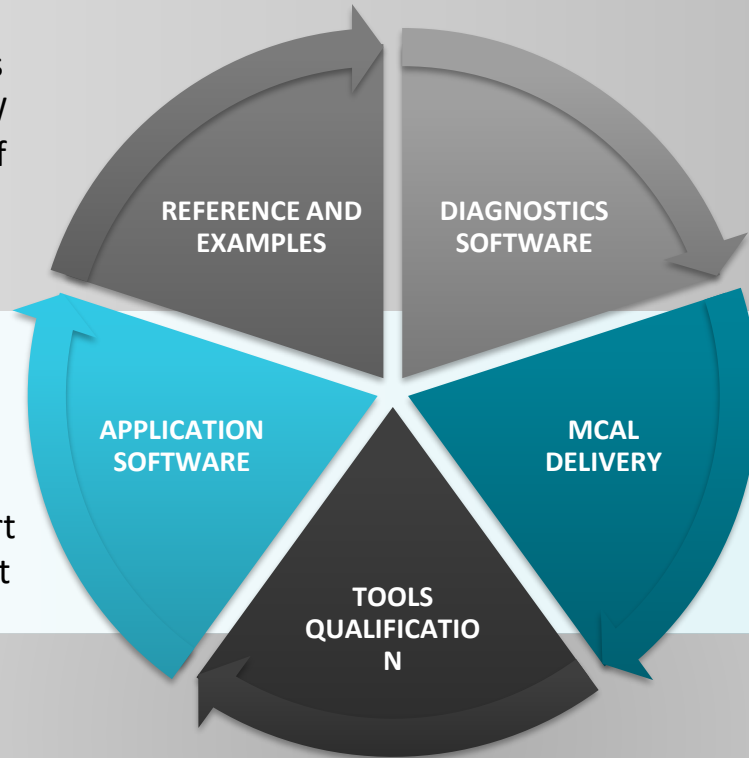
Deep learning, Analytics libraries and Software. **Provided with CSP** to Support Customer Qualification Effort

MCAL for Autosar integration. **Provided with CSP** to Support Customer Qualification Effort

REFERENCE AND EXAMPLES

DIAGNOSTICS SOFTWARE

APPLICATION SOFTWARE

MCAL DELIVERY

TOOLS QUALIFICATION

Tool Qualification Support for TI Provided Tools Used For Safety SW

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Our Functional Safety Commitment

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		Functional Safety-Capable	Functional Safety Quality-Managed	Functional Safety-Compliant
		Low-complexity products that can be evaluated for use in a functionally safe system	Previously-released, complex products that have had additional documentation developed to enable their use in functional safety applications.	Products specifically developed to be compliant to functional safety standards that can be used in functional safety applications
Development process	TI quality-managed process	✓	✓	✓
	TI functional safety process			✓
Analysis report	Functional safety FIT rate calculation	✓	✓	✓
	Failure mode distribution (FMD) and/or pin FMA*	✓	Included in FMEDA	Included in FMEDA
	FMEDA		✓	✓
	Fault-tree analysis (FTA)*			✓
Diagnostics description	Functional safety manual		✓	✓
Certification	Functional safety product certificate**			✓

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May only be available for analog power and signal chain products.   **Available for select products.*

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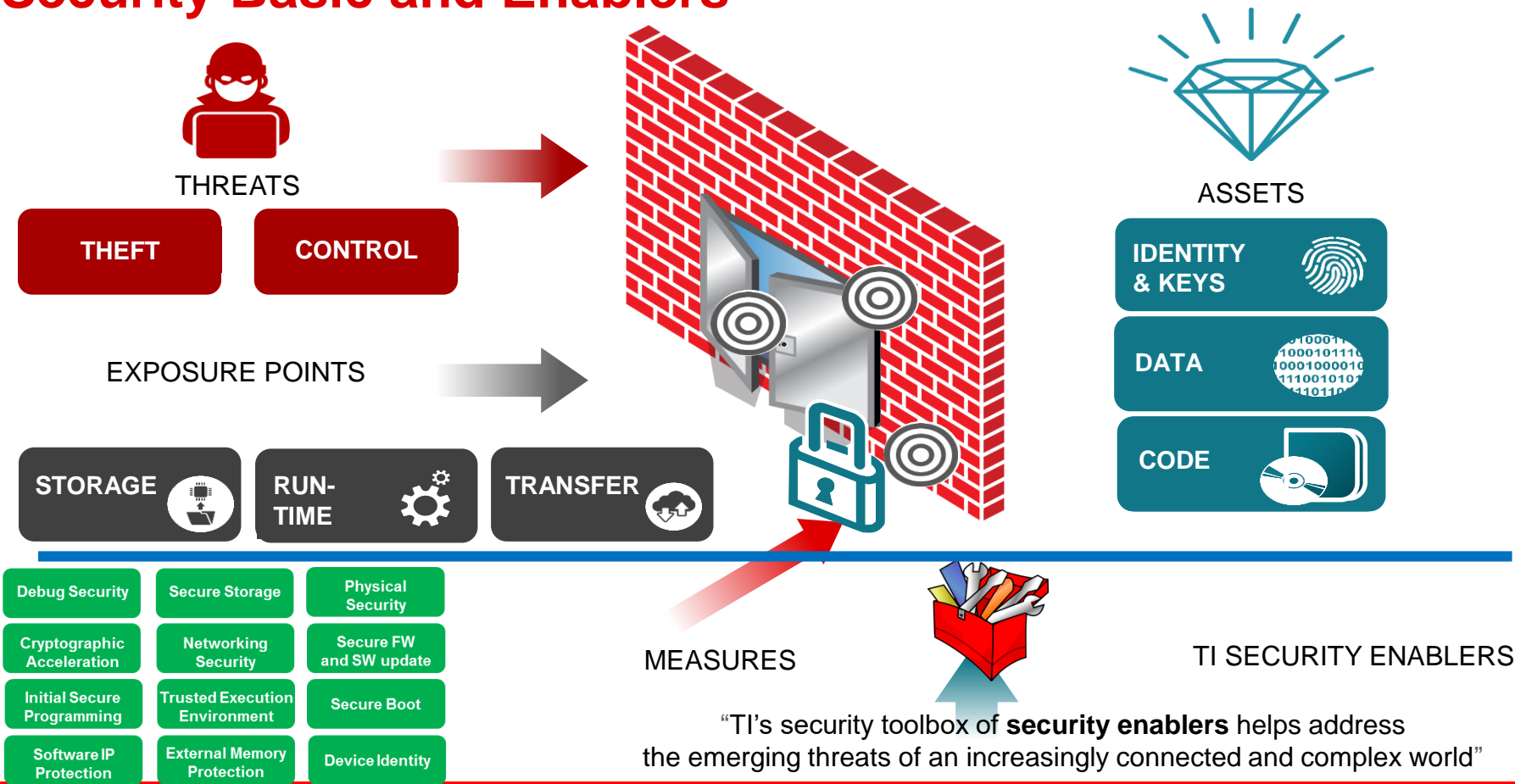# Functional Safety
Supporting Safety Documentation Deliverables

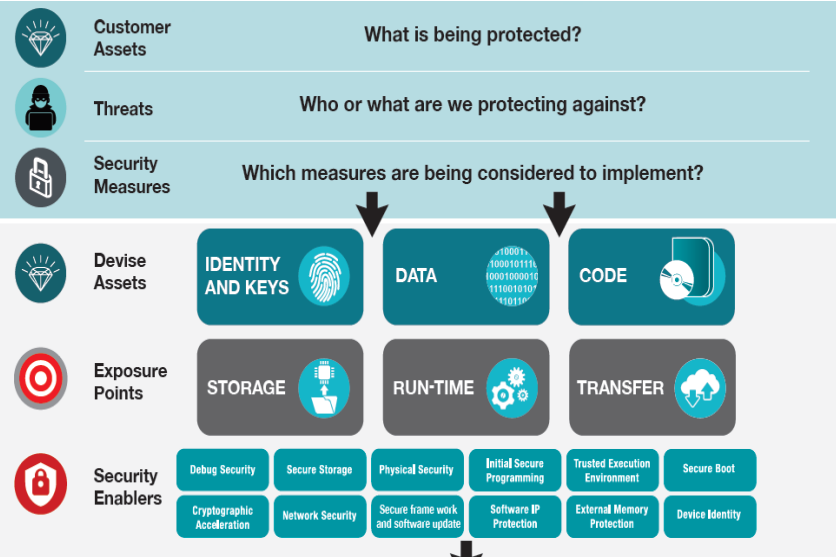Documents provided by TI to assist in the system safety analysis:

☐ **Device Safety Manual (SM)**
  Details product safety architecture and recommended usage
  Used during the system design process

☐ **Safety Analysis Report Summary (FMEDA)**
  Summary of FIT rates and diagnostic coverage at the device level
  according to IEC 61508 and/or ISO 26262. Contains the FMEDA.
  Used during the end of the system design process

☐ **Assessment Certificate (**TuV SUD Assessment Report)
  Summary of compliance to IEC 61508 and/or ISO 26262
  Used as a part of system safety case

Security Basic and Enablers

THREATS

THEFT   **CONTROL**

EXPOSURE POINTS

STORAGE   **RUN-TIME**   **TRANSFER**

ASSETS

IDENTITY & KEYS

DATA

CODE

|		
Debug Security	Secure Storage	Physical Security
Cryptographic Acceleration	Networking Security	Secure FW and SW update
Initial Secure Programming	Trusted Execution Environment	Secure Boot
Software IP Protection	External Memory Protection	Device Identity

MEASURES

TI SECURITY ENABLERS

"TI's security toolbox of **security enablers** helps address
the emerging threats of an increasingly connected and complex world"

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Security: Discovery process

TI device portfolio options: microcontrollers and microprocessors

www.ti.com/security

Security deployment:

- Good understanding of target application

- Risk assessment to identify security threats

- Identify TI processor/device/system with appropriate measures

- Engage measures

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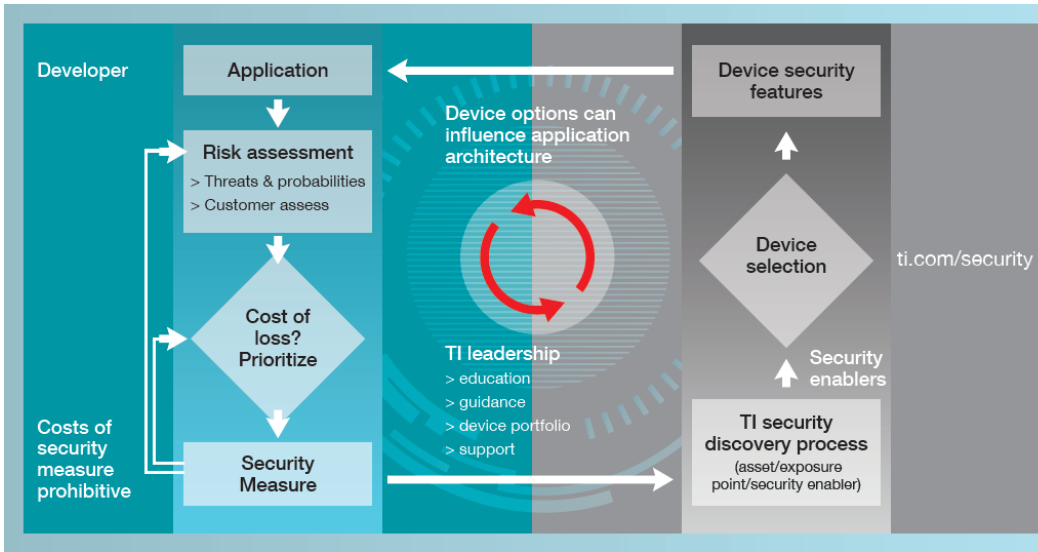
Security enablers in embedded systems

Design Resource

TEXAS INSTRUMENTS
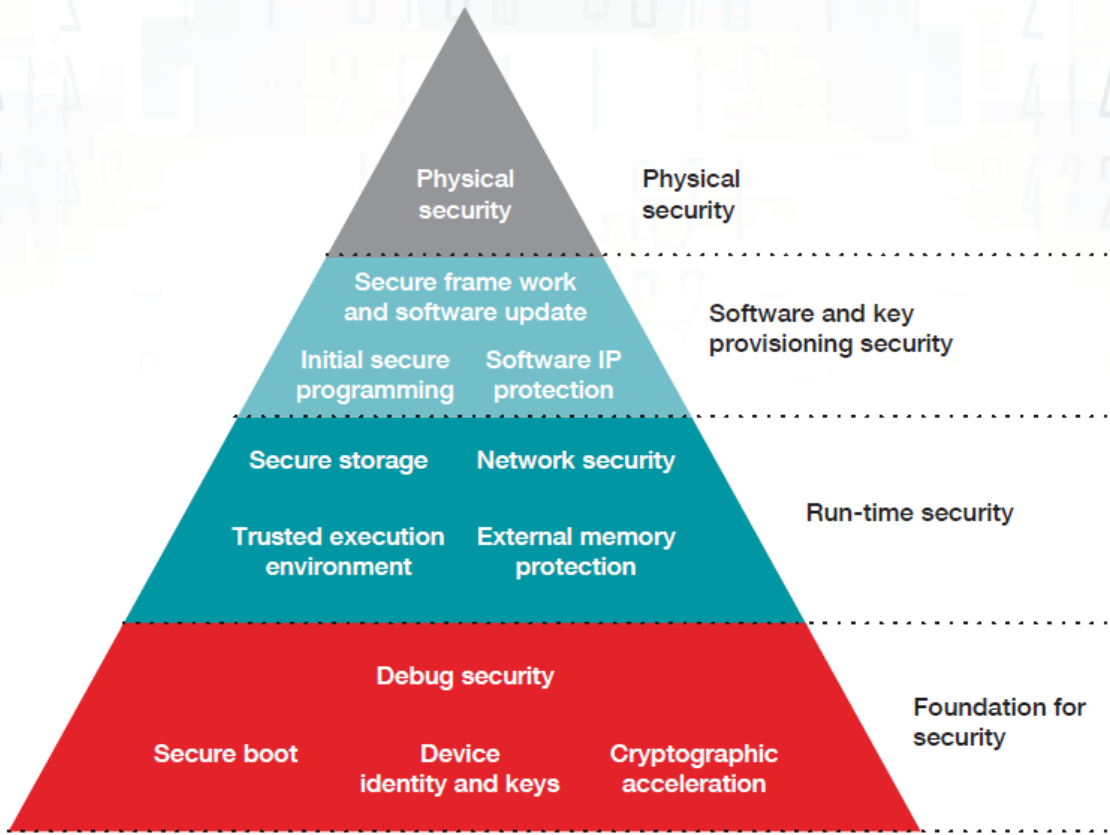
Get to market faster with AM2x Ecosystem…

TI Reference Platforms
LP-AM243 Launchpad
TMDS243GPEVM Evaluation Module
LP-AM263 LaunchPad

TI LaunchPad™

Networking
CAN-FD,
Protocols:
- TI enabled
- 3P enabled
Encoders: EnDat 2.2, HDSL, and Tamagawa
Time Sensitive Networking (TSN)

PROFINET®
EtherCAT®
CC-Link IE TSN
EtherNet/IP™

Software / Framework

Software Development Kit (SDK)
- MCU+ SDK
- FreeRTOS / SafeRTOS
- Baremetal
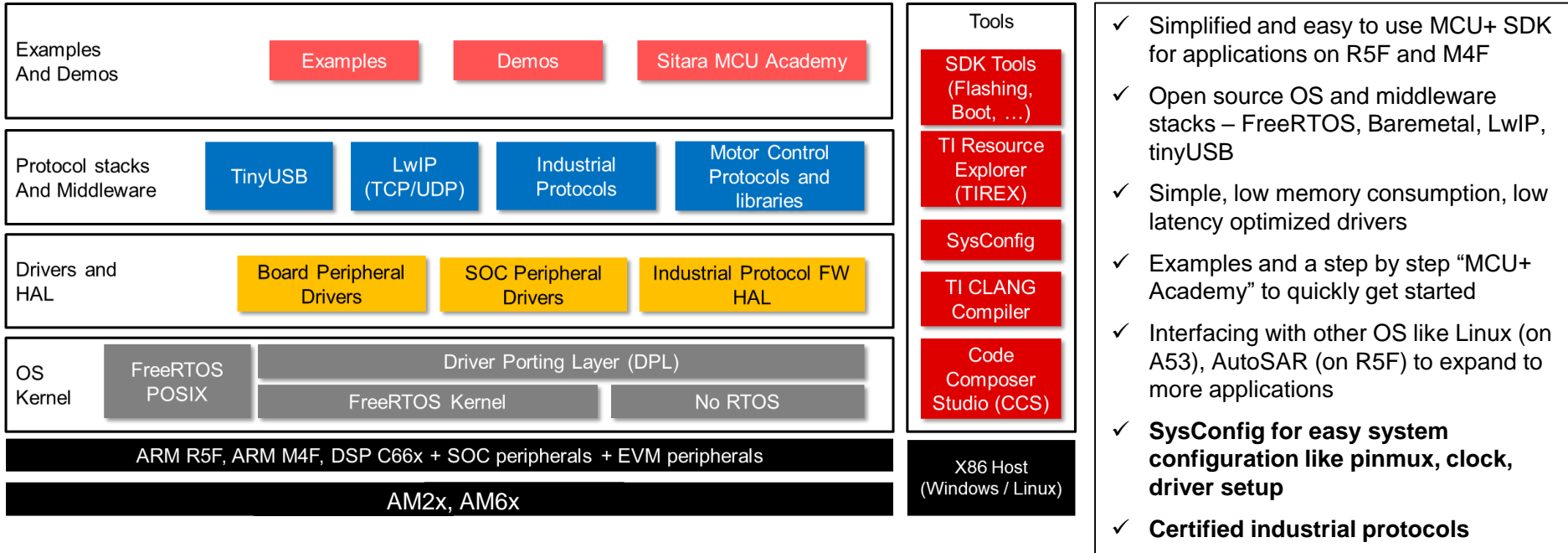
Libraries: TinyUSB, LwIP, TSN

SDK

Application Kits & Hardware Platform
Training/Collateral & Support
Sitara™ MCU
Texas Instruments
Software & Tools

Support
CouthIT
PHYTEC
port
3P support
Modules
Application & Design Expertise
Call an expert

MCU+ Academy for AM243x
"Intro to the Industrial Communications Toolkit"
"Get Started with EtherCAT" module
"Get Started with EtherNet/IP" module
"Get Started with PROFINET RT" module
Embedded Multi-Protocol Demo

Tools & Application Code
SysConfig Tool
TI Resource Explorer
TI Arm CLANG compiler
Examples for PROFINET, EtherNet/IP, & EtherCAT

TEXAS INSTRUMENTS

MCU+ Software Development Kit

Examples And Demos	Examples	Demos	Sitara MCU Academy	
Protocol stacks And Middleware	TinyUSB	LwIP (TCP/UDP)	Industrial Protocols	Motor Control Protocols and libraries
Drivers and HAL	Board Peripheral Drivers	SOC Peripheral Drivers	Industrial Protocol FW HAL	

OS Kernel

FreeRTOS POSIX	Driver Porting Layer (DPL)	
	FreeRTOS Kernel	No RTOS

ARM R5F, ARM M4F, DSP C66x + SOC peripherals + EVM peripherals

AM2x, AM6x

Tools

- SDK Tools (Flashing, Boot, …)
- TI Resource Explorer (TIREX)
- SysConfig
- TI CLANG Compiler
- Code Composer Studio (CCS)

X86 Host (Windows / Linux)

- ✓ Simplified and easy to use MCU+ SDK for applications on R5F and M4F
- ✓ Open source OS and middleware stacks – FreeRTOS, Baremetal, LwIP, tinyUSB
- ✓ Simple, low memory consumption, low latency optimized drivers
- ✓ Examples and a step by step "MCU+ Academy" to quickly get started
- ✓ Interfacing with other OS like Linux (on A53), AutoSAR (on R5F) to expand to more applications
- ✓ **SysConfig for easy system configuration like pinmux, clock, driver setup**
- ✓ **Certified industrial protocols**

Enable protocols simply use the SDK and configure protocol on the device pins using SysConfig

TI

MCU+ SDK at a glance

Complete SW kit developed and delivered by TI, available <u>here</u> at ti.com!
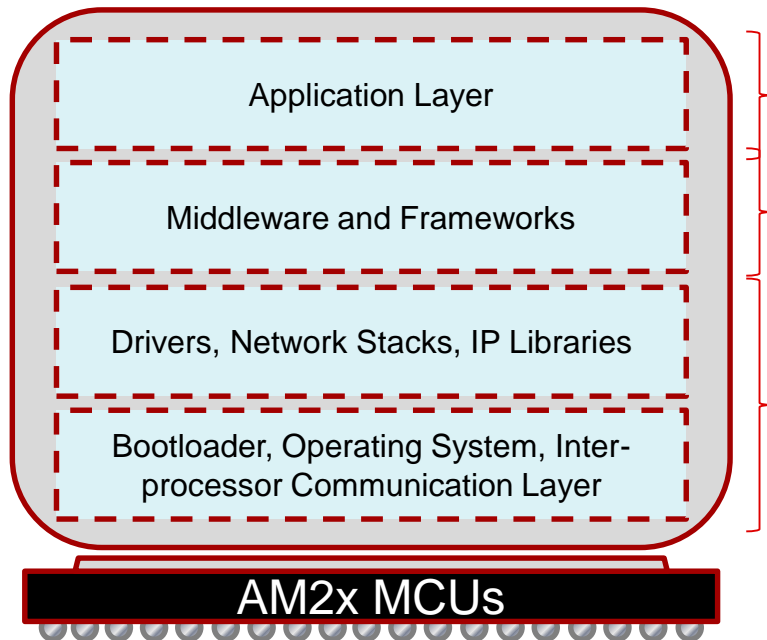
Demos and examples that show how kit is used
> TI developers as beta users of the kit
> Build system expertise, deliver continuous improvement

Infrastructure to make the platform easier to use
> Industrial protocol stacks, motor control libraries

Core foundational components
- Hardware abstraction for SoC capabilities
- Deliver performance entitlement
  > FreeRTOS operating system

TEXAS INSTRUMENTS

MCU+ SDK

MCU+ SDK Free**RTOS**

Application Layer

Applications

Middleware and Stacks

Industrial Protocols, USB, PCI, CAN, Ethernet

Drivers and Libraries

Motor Control (PRU)

Ethernet Firmware

IPC (optional)

Device Drivers

Free RTOS, Safe RTOS

Bootloader

MCU (R5F) 1-4

AM2x Silicon
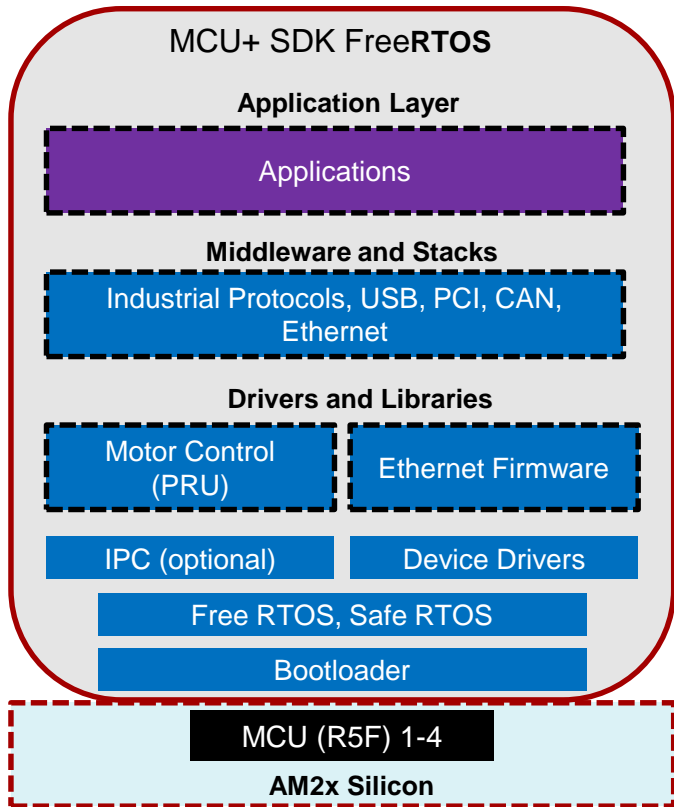
Software for full SoC – MCUs and compute cores
Developed for Industrial and Automotive – Static analysis, certified libraries

Scalable across products – re-use code across full AM2x product family. Replace components with internally developed or from TI developer network.

Use TI provided or 3rd Party

TI provided in SDK

Application Layer:
+ TI Provided Demos in SDK

TEXAS INSTRUMENTS

TI MCU+ Platform

We're building a cohesive developer ecosystem around our **Arm®-based MCU+** revolving around a single SDK & powerful tool suite enabled by TI & partners.

Scalable High-performance Portfolio of Arm-based MCUs

Simplified connectivity Pre-integrated industrial protocol stacks & certified solutions available
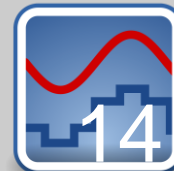
High precision analog integration Best-in-class control peripherals including High-resolution PWMs and ADCs

Comprehensive Tool Suite TI & 3rd party IDEs, utilities & code generation tools

ONE SDK Enabling 100% code re-use & portability, even when scaling to MPUs with MCUs

LaunchPad™ Kits Low cost, modular hardware dev kits.

Everything you need is one click away with TI Resource Explorer All of your development resources in one place.

MCU+ Academy

A comprehensive and interactive learning tool for the **Sitara MCU** portfolio

MCU+ Academy training modules:

- Detailed background information by topic along with interactive quizzes and coding exercises.
- Self-paced and hands-on training approach to give users a holistic view of the MCU+ SDK.
- Covers many topics within the Sitara MCU platform including TI's FreeRTOS, driver APIs, and toolkits.
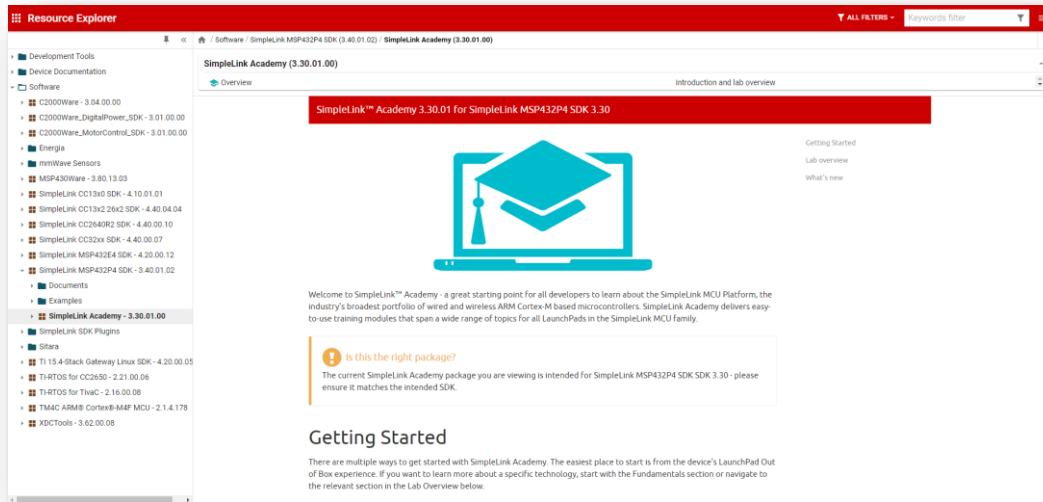
MCU+ Academy to replicate the look & feel of existing Simplelink Academy

Click here to explore MCU+ Academy online now!

- AM243x EVM **OOB user experience** built around MCU+ Academy

- Modules start at **Project Zero** (LED blinking) to more advanced topics for all engineering levels

- Tool housed in **TI Resource Explorer;** **u**pdated/added to based on user feedback

- **Hands-on exercises** also applicable to MPU customers (non-Linux)

View in slideshow mode for live demo →

Adding a Driver to an MCU+ SDK Application

The SDK includes drivers for a number of peripherals. These drivers are provided in the `<SDK_INSTALL_DIR>/source/drivers` directory. The driver examples show how to use these drivers.

See the MCU+ SDK Documentation for the complete list of drivers along with full information about the APIs and configuration structures.

In this tutorial we are going to modify the empty example to toggle an LED using a GPIO pin.

Step 1: Add a GPIO Instance
To use the GPIO driver, we need to add an instance.

a. Double-click `example.syscfg` to open the SysConfig GUI
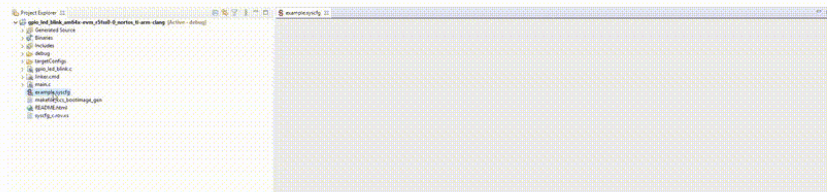
b. Click on **GPIO** and click **ADD** to add a GPIO instance

MCU+ Academy, beta version

Sitara MCU | Debug and trace tools

- Code composer studio from TI (**free download**)
  - Eclipse based IDE
  - C6x, R5F, M4F – debug and trace via JTAG
    - single step, breakpoint, watch point, disassembly
  - FreeRTOS aware (Real-time Object View - ROV)
  - Powerful scripting via Debug Server Scripting (DSS)
  - Access to system memory and peripheral registers through Debug Access Port
  - Multicore debugging
  - Multiprocessor debugging

- TRACE32 from Lauterbach
  - Support C6x, ARMv7 (R5F, M4F)
  - OS aware debugging – FreeRTOS, AutoSAR
  - Powerful script language
  - Easy high-level and assembler debugging
  - Support for CoreSight components like Debug Access Port, Trace Funnel, Trace Port Interface Unit, Embedded Trace Buffer, Cross Trigger Interface, Cross Trigger Matrix, System Trace Port, Trace Memory Controller
  - Real-time access to system memory and peripheral registers through Debug Access Port without halting the core
  - Multicore debugging
  - Multiprocessor debugging
  - Safety tool kit and certifications making them useable for ISO 26262 and DO-178C

http://www.ti.com/tool/download/CCSTUDIO

LAUTERBACH
DEVELOPMENT TOOLS

www.lauterbach.com/
Search for CHIP = TI
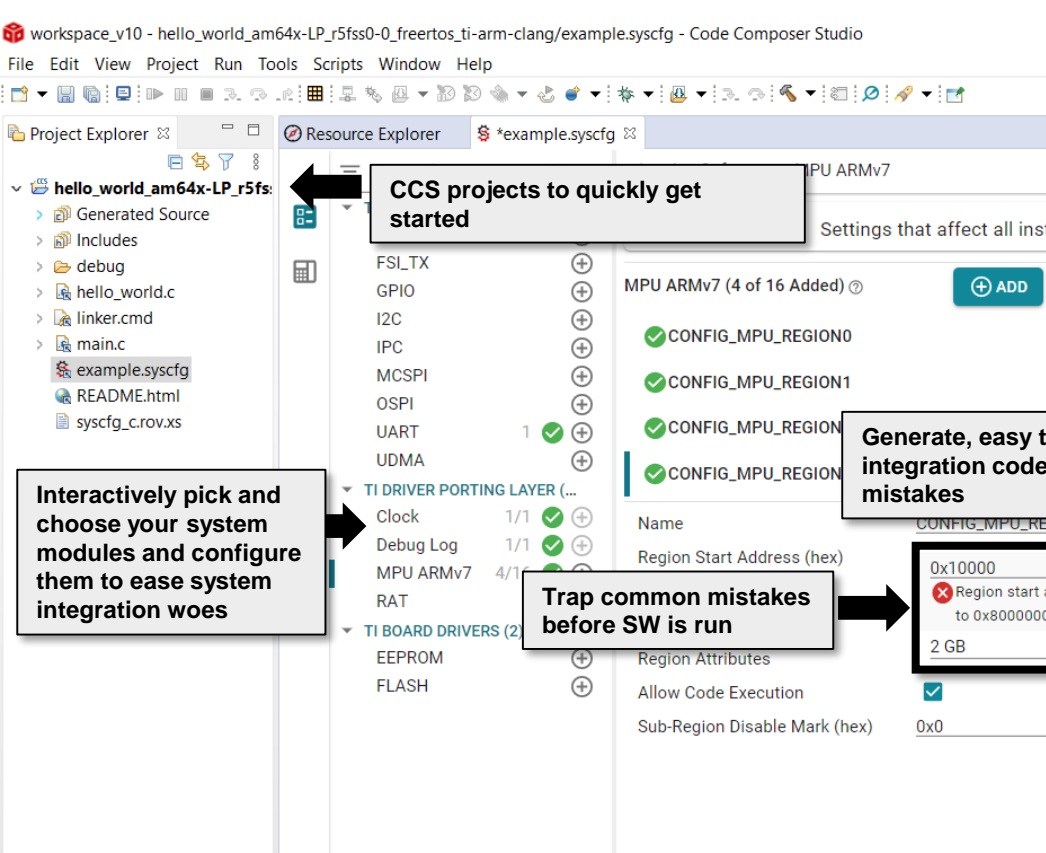
Tools | SysConfig

CCS projects to quickly get started

Interactively pick and choose your system modules and configure them to ease system integration woes

Generate, easy to read, system integration code and reduce mistakes

Trap common mistakes before SW is run

Reduce design time through simplified SoC and SW view in SysConfig to ease system integration issues

Available in unified offering in CCS Desktop on Linux/Windows and in the cloud on TI.com

Resource Explorer

https://dev.ti.com

Search: AM64x

- Software
  - MCU+ SDK
    - MCU+ SDK for AM64X - 00.0
      - Documents
        - User Guide
      - Examples
        - Development Tools
          - AM64x General Purpose EVM (TMDS64GPEVM)
            - freertos
              - drivers
              - kernel
                - dpl
                  - hello_world
                    - m4fss0-0
                    - r5fss0-0

Manage Versions

Download

Reduce eval time by allowing browsing and running examples and via browser without having to download and install anything

05.00.02) / Documents / **User Guide**

MCU+ SDK 00.05.00

Introduction

This is a early evaluation release and some SW below are still in developement and you wont s

so all documentation pages are not yet comp

future, this package will be included within th
ake a single SDK installer that enables both L
evelopment.

e to **MCU+ SDK for AM64X**. This SDK conta
RTOS and non-RTOS based applications for
RM R5F, ARM M4F app

AM64x MCU+ SDK

OS Kernel

Driver Porting Layer (DPL)

Download SDK and get started in CCS

Browse SDK Example and Documentation before installation

hello_world

EXAMPLE   Import to CCS Cloud IDE

example.syscfg

C hello_world.c

Import to CCS Cloud and get started without installing anything

36

DEMO

TEXAS INSTRUMENTS

AM243x multi-protocol and motor drive demo

https://training.ti.com/connect-and-control-factory-floor

TEXAS INSTRUMENTS

Directly Connect an ADC to microprocessor with Sitara MPU and MCU

https://training.ti.com/directly-connect-adc-microprocessor-sitara-mpu-and-mcu

TEXAS INSTRUMENTS

Summary

- Sitara MCU
  - High-performance ARM core MCU

  - AM243x for network
    - https://www.ti.com/product/am2434
    - Multi-protocols
      - EtherCAT, PROFINET, Ethernet/IP, IO-Link Master stack provided by TI.

  - AM263x for motor drive
    - https://www.ti.com/product/AM2634
    - 고정밀 analog – ADC, DAC, PWM, comparator

TEXAS INSTRUMENTS