

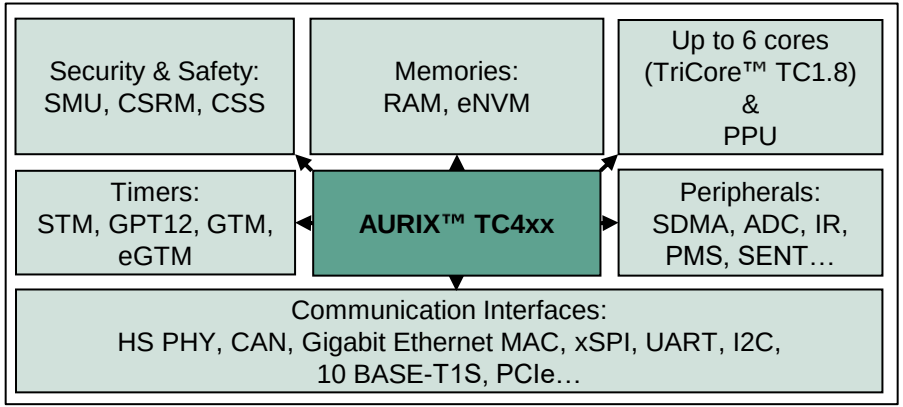
AURIX™
System architecture

AURIX™ TC4xx Microcontroller

V1.0.0 2024-09

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AURIX™
System architecture



Highlights

- Multicore Microcontroller with embedded Non-Volatile-Memory (eNVM); Flash or RRAM as target technology
- TriCore™ (MCU, RISC/DSP processor) up to @500 MHz
- Up to 25 MB eNVM and 10 MB RAM
- Extended virtualization support (Hypervisor mode)
- Parallel Processing Unit (PPU), Cyber Security Real-time Module (CSRM) and routing accelerators (CAN Routing Engine(CRE) and Data Routing Engine(DRE))

Key Features

Embedded NVM platform for real time applications

Up to 6 TriCore™ with RISC/DSP instructions, and 1 parallel processing unit as multi-issue vector DSP

Rich peripheral set and large RAMs

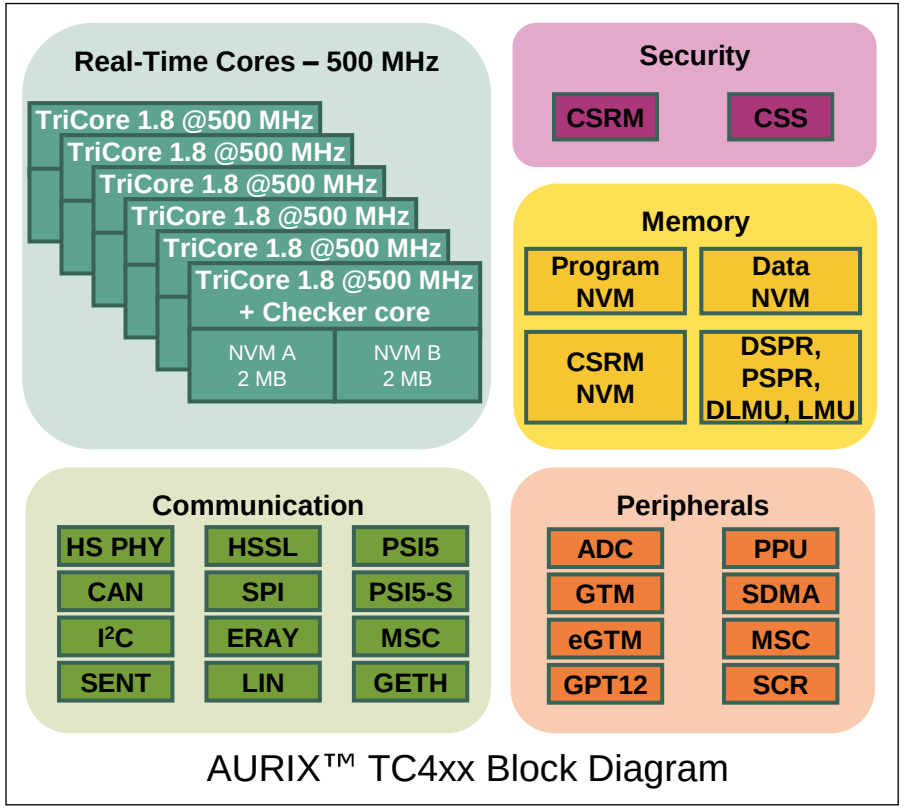
Customer Benefits

- Embedded NVM allows compact design and fast code execution
- Enables heavy processing tasks like radar and high performance vector/matrix signal processing
- Reduces the need for external components for cost competitive BOMs

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AURIX™
Up to 6 TriCore™ with DSP instructions

- The TriCore™ architecture combines three powerful concepts:
  - Microcontroller
  - RISC processor
  - DSP (Digital Signal Processor)
- **TC 1.8 (8-stage pipeline):**
  - 2 local Program NVM banks that increase the NVM access bandwidth
  - 16- and 32-bit instruction formats which reduce code space and lower the memory requirements and power consumption
  - Virtualization support with up to 7 guest virtual machines per core
  - Crypto instruction
- **32-bit Floating Point Unit in all CPUs:**
  - Single and double precision according to IEEE-754
  - 2 FLOPs per cycle (pipelined)



AURIX™ TC4xx Block Diagram

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AURIX™
Rich peripheral set and large RAMs

- **Peripherals:**
  - ADC: Analog-Digital Converter – more than 100 analog inputs can be connected
  - GTM, eGTM, GPT12: Signal Capture / Compare and PWM generation
  - PPU: Parallel Processing Unit (Vector DSP with Single Instruction Multiple Data (SIMD) support)
  - STM: Timer Module accompanying each core for application requiring both high precision and a long period
  - SDMA: System Direct Memory Access Module which enables data transfers through two move engines without the intervention of the CPU
  - OCDS and MCDS: Debug and Trace modules supporting developers in analyzing issues on software and system level
- **Communication Interfaces:**
  - QSPI and xSPI: Queued and extended Serial Peripheral Interfaces
  - CAN: Controller Area Network interface supporting both classical CAN, CAN-FD and Can-XL communication
  - ASCLIN: LIN, UART and SPI interface all in one module
  - Gigabit Ethernet: capable of supporting 10 M, 100 M, 1 G, 2.5 G and 5 G speed in full- duplex mode
  - Lite Ethernet supporting 10 M (including 10 BASE-T1S) and 100 M
  - I2C: Inter-Integrated Circuit Bus with up to 3.4 Mbit/s for the high-speed mode
  - HSPHY and HSSL: High Speed Physical Layer and Serial Link for high-speed communication
  - PCIe Interface with root complex and endpoint support (8 Gbps chip-to-chip communication)
  - Routing accelerators: supporting CAN to CAN and CAN to Ethernet routing
- **On-Chip Memories:**
  - Up to 10 MB integrated RAM including CPUs tightly coupled Scratch-Pad RAM
  - Up to 25 MB integrated Flash memory with EEPROM Emulation or RRAM technology (SOTA full A/B swap feature)

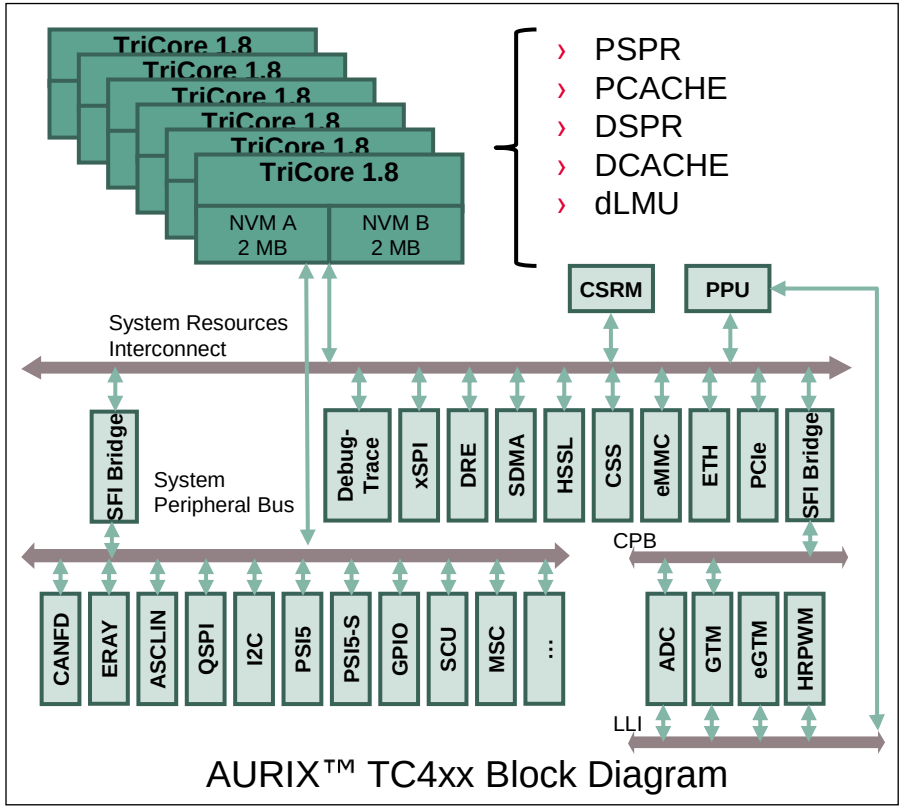
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AURIX™
Rich Peripheral set and large RAMs

AURIX™ Multi-CPU architecture contains:

- Distributed Scratch-Pad RAMs for data (DSPR) and program (PSPR)
  - Can be accessed by all CPUs
- Data and program cache memory
- Distributed LMU
- Virtualization support for peripherals

CPUs can execute code from the Program NVM modules or RAM memory.

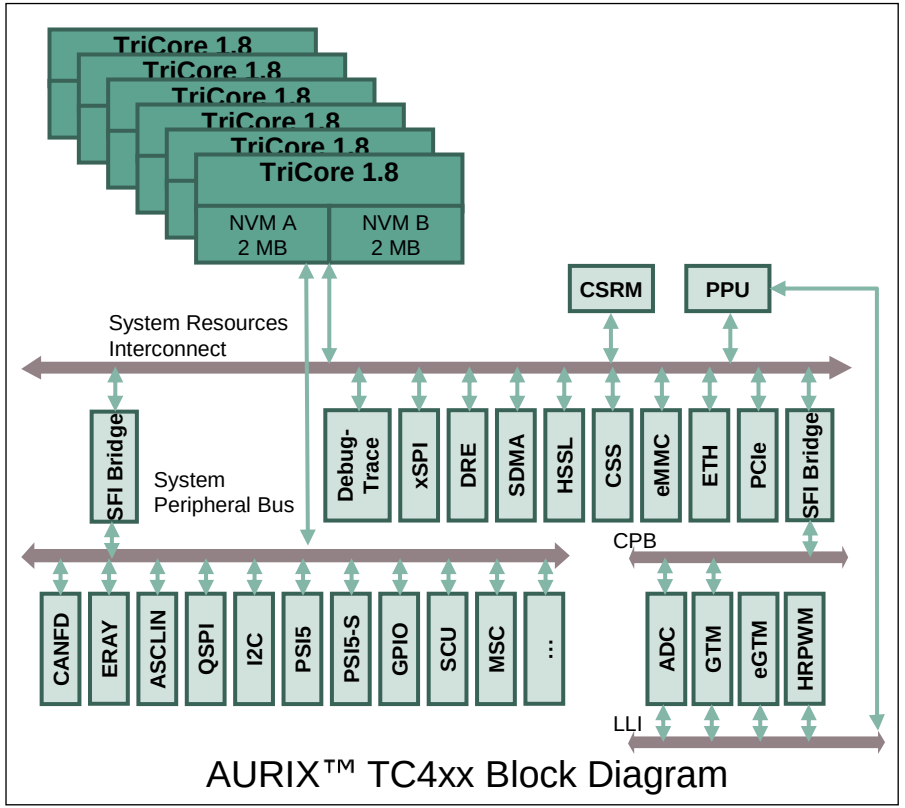


AURIX™ TC4xx Block Diagram

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AURIX™
System integration

- AURIX™ TC4xx combines three powerful technologies within one silicon die, improving power consumption, speed and reducing the costs for embedded applications:
  - Reduced Instruction Set Computing (RISC) processor architecture
  - Digital Signal Processing (DSP) operations and addressing modes
  - On-chip memories and peripherals
- AURIX™ TC4xx devices are designed to meet the needs of embedded control systems applications, where real-time responsiveness, computational power and data bandwidth are key design elements



AURIX™ TC4xx Block Diagram

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Application Example
Automotive Industry

Overview

Car systems like airbag and engine management need to operate in a safe and secure way:

- Safe: Airbag must not trigger under regular driving conditions
- Secure: Unauthorized persons must not be able to hack the car's systems

Advantages

- Beside AURIX™ TC4xx versatile set of on-chip peripherals connected to the TriCore™ CPUs, the AURIX™ family also offers safety and security modules to deal with critical embedded applications



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Document reference
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