AURIX™ TC4x

A new benchmark to automotive microcontrollers

Infineon

Infineon is proud to introduce our new AURIX™ TC4x family, pushing the boundaries in e-Mobility, ADAS, automotive E/E architectures and artificial intelligence (AI) on-the-edge applications.

This future-proof microcontroller generation will help to overcome constraints in safe and secured processing performance and efficiency. Customers will appreciate a fast **time-to-market** and an overall **system cost reduction**.

What's new?

Relying on a scalable family concept, a leap in TC4x performance is brought by up to 6 Lockstep (LS) Tri-Core1.8 running at up to 500MHz. NVM ranges from low to high, targeting the various application require-ments, with zero downtime SOTA support.

Computation time of complex model-based algorithms is dramatically reduced by our Parallel Processing Unit (PPU; a vector DSP co-processor), enabling **AI-on-the-edge** up to ASIL-D. Newly added Convert-er-Digital-Signal-Processors (cDSP) filters allow for a flexible digital processing of ADC signals.

Real-time control functions profit from enhanced timers (eGTM), a high-resolution PWM and optimized ADCs – now all closely linked by a **low latency interconnect** (LLI).

The AURIX™ TC4x will be compliant to latest Cyber security and safety standards **ISO/SAE 21434** and **ISO 26262**. The cutting-edge security concept solves performance bottlenecks and supports post-quantum processing. This strengthens protection against quantum computer attacks, which pose a threat to cryp-tographic methods currently in use. Hypervisor and virtual machines allow for safe separation of different SW applications, ensuring freedom from interference (FFI).

Finally, automotive **E/E architectures** will profit from the broad and scalable connectivity features of TC4x, a Data Routing Engine (DRE) and high-speed communication interfaces, such as 5 Gbps Ethernet, PCIe, 10BASE-T1S Ethernet and CAN XL.

Range anxiety, charging speed and X-in-1 system cost –
How TC4x contributes to xEV market success

Battery Management Systems

The battery is the most valuable component in an EV. However, the battery's true capabilities are not yet fully exploited. Sophisticated battery models and algorithms are key to more accurately determining and predicting the battery's state (SoX), but insufficient on-edge computing performance is still a bottleneck today.

AURIX™ TC4x is now clearing this bottleneck by its new and powerful **PPU** that dramatically reduces computation time and enables the implementation of e.g. full-order electrochemical battery models, artificial neural networks and virtual sensors. A TC4x-powered BMS software will achieve the most accurate cell level estimation of battery charge, power and health. Customers profit from an **extended range**, **faster charging** and longer **battery lifetime**.

Traction Inverter

The traction inverter is the brain of electric vehicle drivetrains, as it controls the motor and determines driving behavior. It minimizes switching losses, maximizes thermal efficiency and enables regenerative braking to recharge the battery.

Best-in-class system efficiency and future-proof functional (**x-in-1**) integration concepts now become reachable through AURIXTM TC4x.

Its dependable ASIL-D performance and capable real-time peripherals are key to optimized control strategies. A combination of our innovative Converter-Digital-Processors (cDSP) and flexible SW filter-functions is offloading the main CPUs, improves robustness and accuracy and can replace external ASICs. The PPU enables real-time capable **virtual sensing concepts** which complement or even replace physical sensors, e.g. for rotor position or power module Tj estimation.

Power Conversion

Infineon wide bandgap (WBG) materials, such as silicon carbide (SiC) and gallium nitride (GaN) are key components for higher efficiency. They offer smaller footprints, improved dependability and thermal performance to on-board charger and DC-DC designs.

Exploiting the value of WBG solutions is facilitated by the integration of all fast real-time controls and protections into one single, safe & secured device. Thanks to its new eGTM timers, high-resolution PWM and optimized ADCs – all linked by **low-latency interconnects** – AURIX™ TC4x becomes the ideal automotive microcontroller for all power conversion applications.

AURIX™ TC4x boosts efficiency and system cost innovation to the next level.

TC4x ensures safe, secured and reliable driver assistance systems which lay the foundation for autonomous driving cars.

Radar

The automotive trend towards higher level of autonomy relies on an excellent separability of objects and is therefore dependent on an increase in radar channels, higher computational power and larger memory.

Latest AURIX™ TC4x radar devices offer dedicated Signal Processing Units (**SPU**) and DMA for fast data handling. Radar post-processing algorithms can now be offloaded to the PPU. Additional flexibility and scalability is supported by a **new PCIe** interface that allows to even cascade various TC4x.

E/E Architecture

Future E/E architectures will lead to a decentralization of power distribution and a centralization of data and signal processing within zone controllers. Here, AURIX™ TC4x sets new standards to interfaces and cyber security.

Exploiting the advantage of its variety of communication interfaces, Infineon's TC4x designers now also implemented novel hardware routing accelerators. Since almost all data flows through the zone controllers, cyber security also becomes pivotal. TC4x is therefore equipped with a dedicated cyber security core and a cyber security satellite and clears bottlenecks in extremely fast and secured communication. It is fitting our customers with a **future-proof security** architecture, getting you prepared for the emerging age of post-quantum cryptography.

ADAS/AD Domain Controller

Autonomous vehicles rely on an array of sensors such as LiDAR, radar, cameras and GPS information. In this context **Sensor Fusion** is paramount ensuring passenger safety through efficient and reliable ECU systems.

Beside the required computing performance, AURIX™ TC4x delivers rich connectivity features such as Gbit ethernet, PCIe, 10BASE-T1S Ethernet and CAN XL. These features enable fast data transmission, high bandwidth data preprocessing and **complex decision-making algorithms**.

As safety companion, AURIX™ TC4x ensures interoperable trajectories with vehicle dynamics and decomposes those into actuator commands. It also provides ASIL-D system monitoring and ensures a safety path in case of system failure.

Chassis & Safety

The implementation of advanced chassis applications such as steering, braking, suspension and airbag systems is pivotal for ensuring the safety and performance of modern vehicles. The critical nature of these functions demands a microcontroller solution that adheres to the **highest safety standards**. Our latest AURIX™ TC4x devices are designed to meet and exceed these standards, setting a new benchmark for reliability and safety in chassis applications. AURIX™ TC4x microcontrollers are equipped with high-performance security modules and secure crypto and hash engines, addressing the key requirement for future chassis applications. Furthermore, the comprehensive Ethernet and CAN connectivity, along with enhanced motor control capabilities, enable **safety-critical real-time communication** and pave the way for the seamless integration of a wide variety of future in-vehicle network (IVN) demands.

Embracing the forefront of automotive innovation, our microcontrollers are at the heart of the industry's transition towards **advanced X-by-wire systems**. The AURIX™ TC4x paves the way for **future-ready safety-critical applications**.

AURIX™ TC4x is the key enabler to numerous both conventional and emerging applications.

Beside a high compatibility to our leading AURIXTM TC3x generation, Infineon and its partners provide engineering support for seamless and easy upward **migration**.

The scalable AURIX™ family concept permits a common software architecture and thus a resource-saving development:
– Infineon MCAL drivers
– Seamless migration of existing **AURIX™ TC3x** algorithms & ecosystem possible
– Rapid prototyping support from Virtual Prototyping using Synopsys **Virtualizer Development Kit for AURIX™ TC4x** or **ASTC vLab works**
– Entry toolchain AURIXTM development studio (ADS)
– TC4x Evaluation kits and application-specific boards

Our **Hardware Support Package** now includes an automated toolchain for model-based design, AI and low-latency controls. Users can develop their complex functions on a high abstraction level and keep them independent from the actual accelerator hardware:
– Simplify PPU software development using the Synopsys **MetaWare Toolkit for AURIX™**
– Neural Network Software Development Kit, Machine Learning Toolchain
– Hardware Support Package (HSP) included in **MATLAB** Simulink with code generation, utilizing TriCore™ and PPU
– DSP and math libraries
– AUTOSAR Complex Device Driver

Infineon is the first choice when pioneering high-performant, safe & secured and yet cost-efficient applications.

If you are curious to learn more or seek advice for your specific use-case, we are happy to assist. Please reach out to Infineon.

Public

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