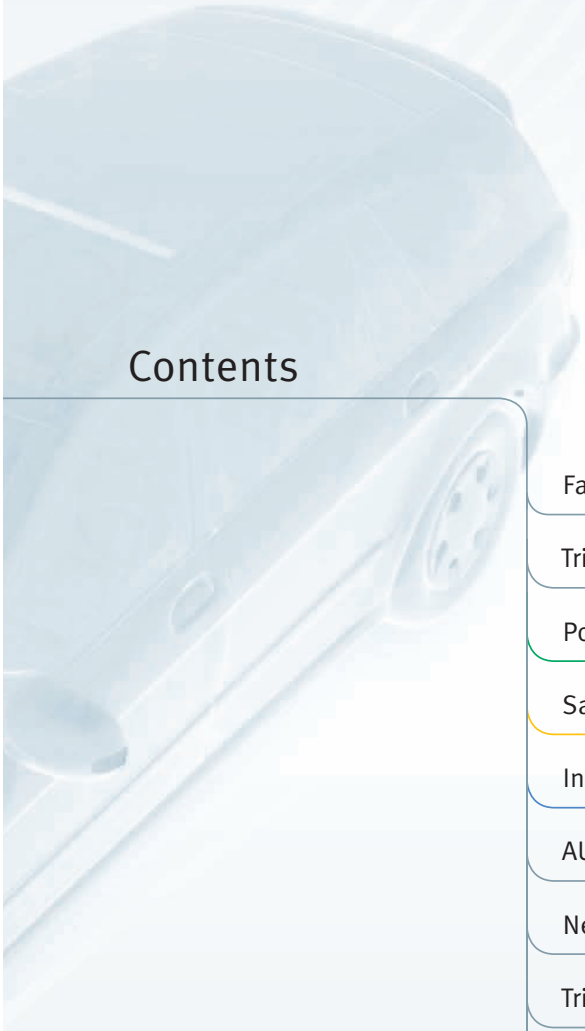
Highly Integrated and Performance Optimized

32-bit Microcontrollers for Automotive and Industrial Applications

[www.infineon.com/TriCore]



Contents

Evolution of TriCore™ Generations

In 1999, Infineon launched the first generation of AUDO (**AU**tomotive unifie**D** process**O**r). Based on a unified RISC/MCU/DSP processor core, this 32-bit TriCore™ microcontroller was a computational powerhorse. And the company has evolved and optimized the concept ever since – culminating in what is now the fourth TriCore™ generation. Based on the TriCore™ architecture, the new AUDO MAX family (version 1.6) sets new performance standards in the high-end segment.

AUDO → AUDO NG (Next Generation) → AUDO Future → **AUDO MAX**

Infineon's AUDO families are designed to handle highly complex algorithms. They are the perfect match for gasoline and diesel engine management systems – meeting rising market demands for lower emissions and higher efficiency levels. These trends are being accelerated by the Euro 5 and Euro 6 standards and increasingly stringent CO_2 regulations. In addition to engine management, the AUDO family is also ideal for applications in hybrid and electric vehicles as well as for transmission, active and passive safety and chassis applications. TriCore™-based products also deliver the versatility required for the industrial sector, excelling in optimized motor control applications and signal processing.

Our broad product portfolio allows engineers to choose from a wide range of memories, peripheral sets, frequencies, temperatures and packaging options. All of these features are fully compatible across generations. The new core is platform-compatible and can be used with software developed on existing controllers. Safety software is also available to help manufacturers meet SIL/ASIL safety standards. All members of the AUDO family are binary-compatible and share the same development tools. An AUTOSAR library that enables existing code to be easily integrated is also available.

Family Highlights

- Compatibility and scalability
- Lowest system cost
- Industry benchmark system performance
- Easy to use
- Broad portfolio
- Certified to automotive standards

Powertrain

Applications

- Leading innovative engine control from basic to high-end designs
- Competitive engines for car and motorcycle markets (compliance up to Euro 6)
- Advanced controller for modern transmission concepts such as CVT and DCT
- Support for latest hybrid and electric vehicle requirements

Safety

Applications

- Chassis domain control for highly integrated next generation car concepts
- Microcontrollers for suspension and damping systems
- Active power steering systems
- Compliance with safety standards for braking applications
- DSP functionality for advanced driver assistant systems

Industrial & Multimarket

Applications

- High-end servo drives
- Programmable logic controllers
- Mobile controller with rich feature set
- Support of multi-axis control for applications such as robotics
- Ready for harsh environments such as solar inverters and wind turbines

Contribution to a More Sustainable Mobility

Energy Efficiency & Environmental Protection

Electronic automotive components are key to raising fuel efficiency levels and cutting emissions. The latest environment protection agency standards – Euro 5 and Euro 6 for passenger cars and Euro 3 and Euro 4 for motorcycles – are driving developments in advanced engine management. TriCore™-based products can be found in improved combustion technologies such as Homogeneous Charge Compression Ignition (HCCI) as well as in direct injection, smart turbocharger and valve actuation applications. TriCore™-based products also have great potential in the emerging hybrid engine sector, enabling engine position control for start/stop features and regenerative braking.

TriCore™-based products are designed to reduce CO_2 emissions and mitigate the impact of global warming. They are ideal for a range of innovative transmission technologies such as Double Clutch Transmission (DCT) and modern Continuous Variable Transmission (CVT).

Safety

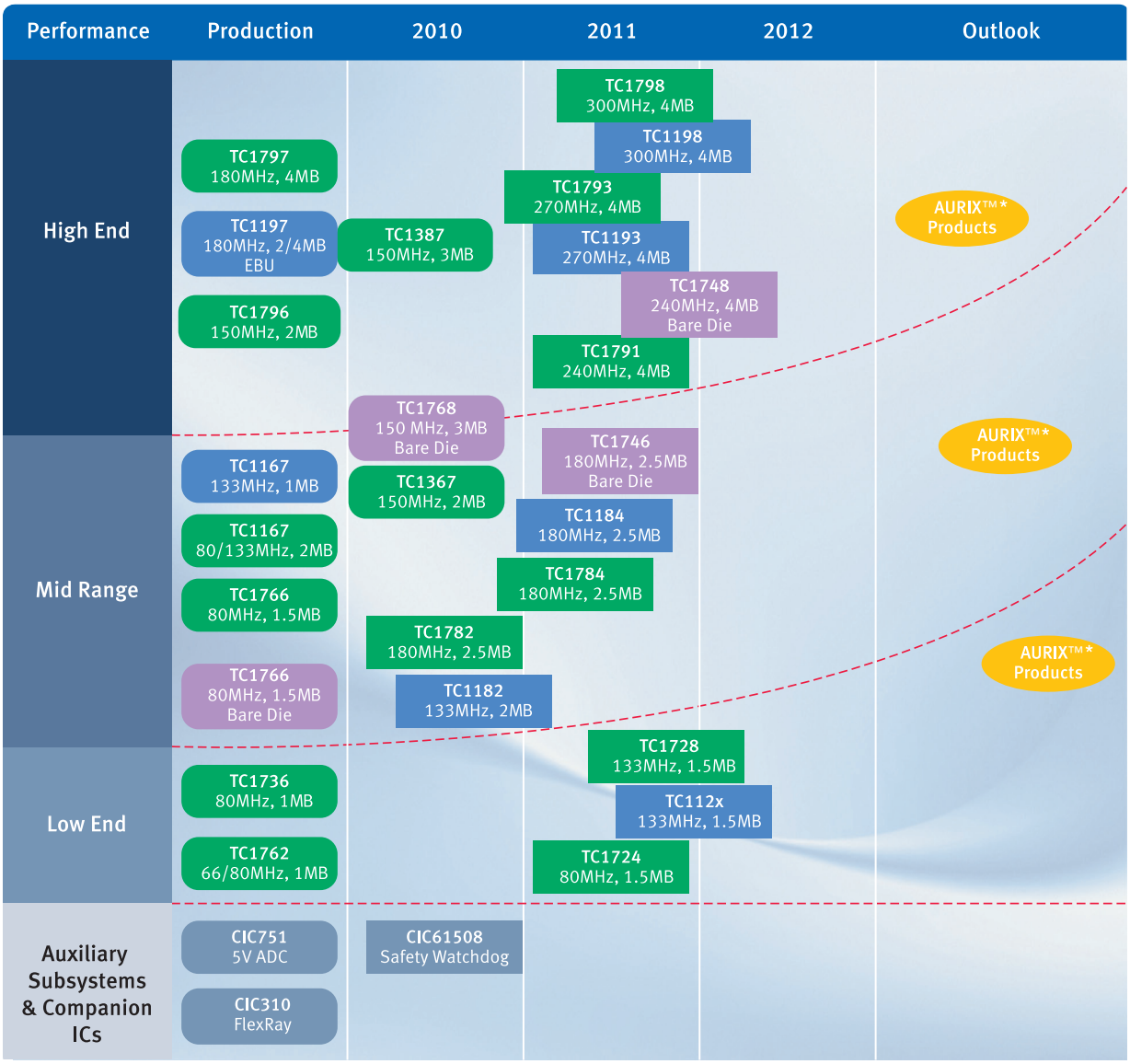
The new automotive safety standard ISO26262 will come into effect in 2011, flanking the industrial safety standard IEC61508. The new standard covers specific safety requirements for automotive functional safety and defines Automotive Safety Integrity Levels (ASILs) A to D. To support the new requirements, Infineon's portfolio includes microcontrollers with additional hardware features as well as SafeTcore safety software and a watchdog IC.

TriCore™-based AUDO families cover a broad spectrum of safety applications including active suspension and driver assistant systems as well as EPS and chassis domain control. The broad product portfolio delivers an extensive range of features such as memory protection, redundant peripherals, MemCheck units with integrated CRCs, ECC on memories, integrated test and debug functionality and FlexRay. TriCore™ is a heterogeneous, asymmetric dual core architecture with a peripheral control processor that enables user modes and core system protection.

Affordability

The low-price vehicle segment is expected to outpace other segments, driven by rising demand in emerging markets. Since mobility has a higher priority than status in those regions, more and more car manufacturers are turning to low-cost, highly functional solutions for passenger cars. TriCore™-based AUDO families enable low-cost, high-performance products tailored specifically to manufacturers' needs.

TriCore™-Based Product Roadmap



* Information available with NDA

Engine, Safety & Chassis

Transmission

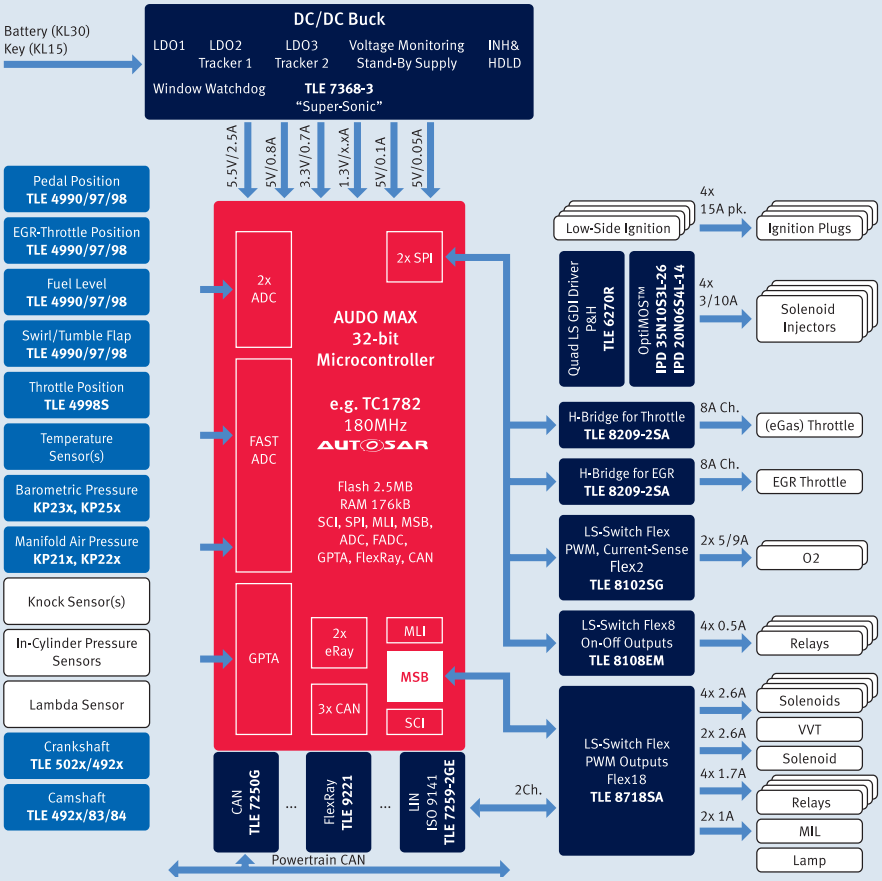
Industrial & Multimarket

Production

Development

Concept

Gasoline Direct Injection



Application Features

- Direct injection
- Scalable software-based knock detection
- Variable valve control
- Throttle and EGR control
- Turbo charging
- Catalyst after treatment
- Start/stop systems

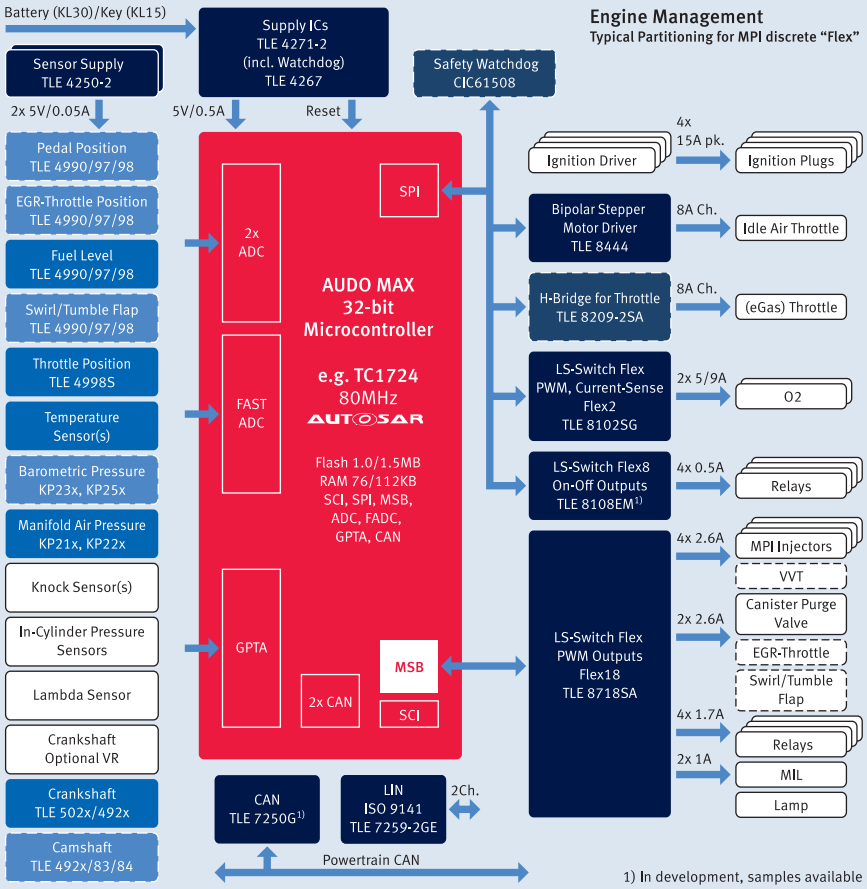
System Benefits

- Scalable platform – performance, memory size and I/Os
- Focus on reducing CO_2
- Easy migration from ultra low-end to mid-range applications
- Best tool/partner support for all development phases within V-cycle
- Delivers a more fun drive
- Microcontroller real-time performance benchmark
- Dedicated peripherals for powertrain

Suggested Products

- TC1767 – TriCore™ 32-bit microcontroller
- TC1782 – TriCore™ 32-bit microcontroller
- TC1784 – TriCore™ 32-bit microcontroller

Gasoline Multi-Port Injection



Application Features

- Gasoline port injection
- Scalable software-based knock detection
- Throttle and EGR control
- Catalyst after treatment
- Start/stop systems
- Cost optimized for entry segment

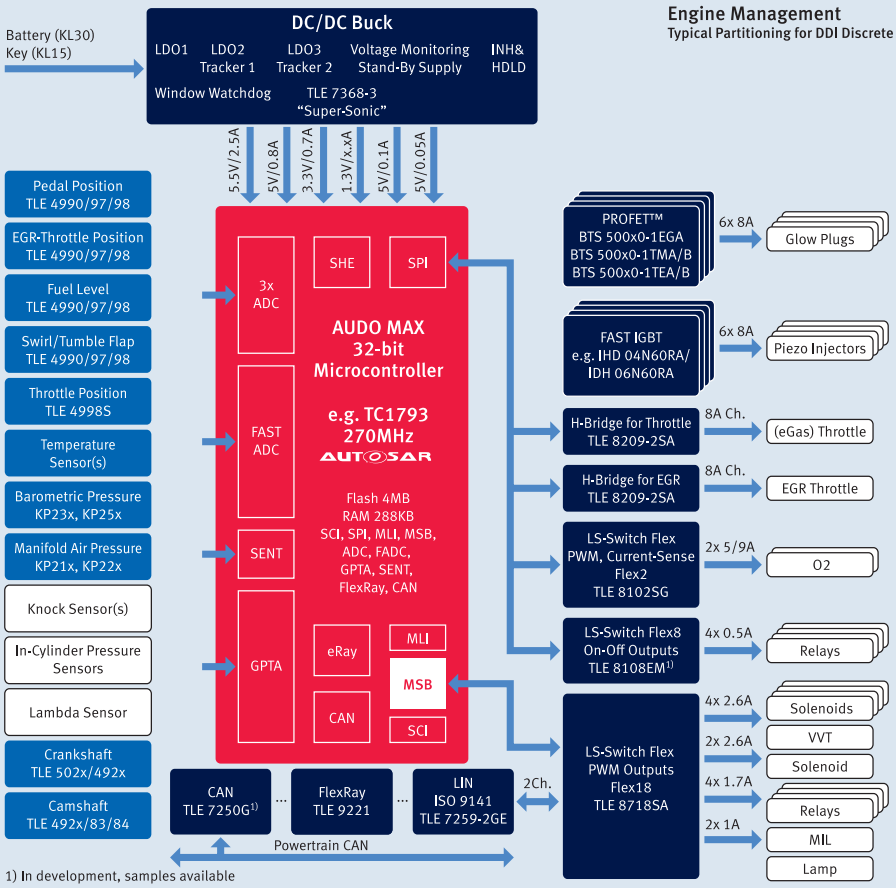
System Benefits

- Scalable platform – performance, memory size and I/Os
- Single voltage supply (EVR)
- Focus on reducing CO_2
- Easy migration from ultra low-end to mid-range applications
- Best tool/partner support for all development phases within V-Cycle

Suggested Products

- TC1724 – TriCore™ 32-bit microcontroller
- TC1728 – TriCore™ 32-bit microcontroller
- TC1736 – TriCore™ 32-bit microcontroller

Diesel Direct Injection



Application Features

- Direct injection (Piezo/Magnetic)
- In-cylinder pressure measurement
- Hardware-supported security enhancements
- Throttle and EGR control
- Turbo charging
- Diesel particulate filter
- 'Blue' after-treatment support (e.g. urea-based SCR)

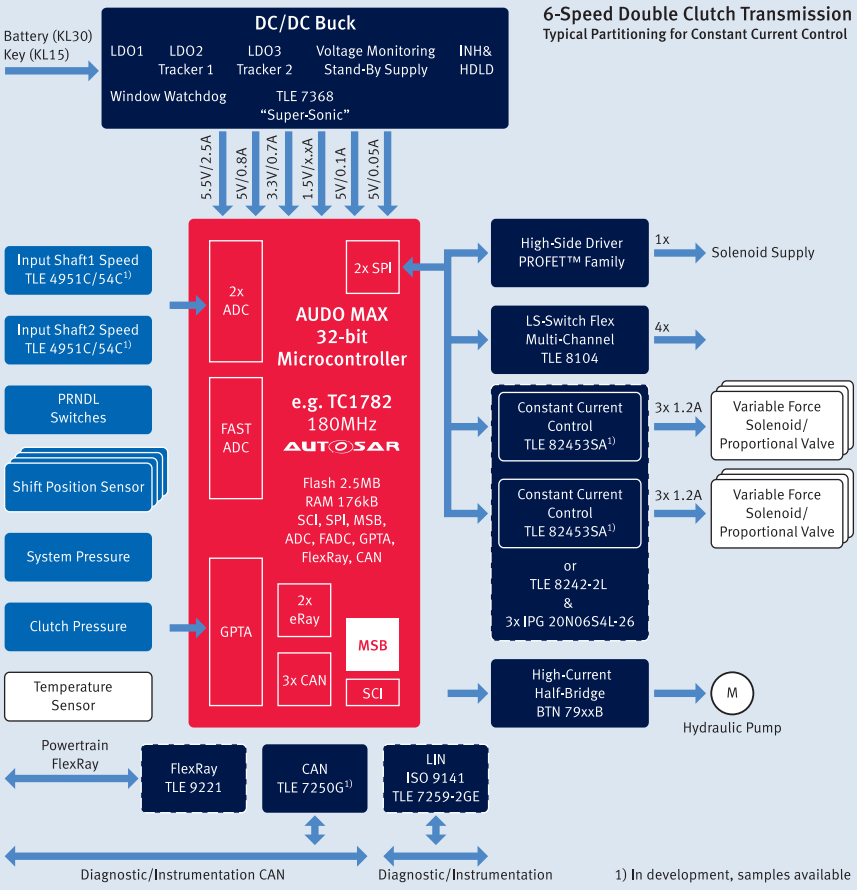
System Benefits

- Scalable platform – performance, memory size and I/Os
- Focus on reducing NOx and particulate matter in line with Euro 6 standard
- Hardware-supported IP/anti-theft protection and tuning protection
- Enhanced communication (FlexRay)
- Microcontroller real-time performance benchmark in high-end segment; dedicated peripherals for powertrain

Suggested Products

- TC1791 – TriCore™ 32-bit microcontroller
- TC1793 – TriCore™ 32-bit microcontroller
- TC1797 – TriCore™ 32-bit microcontroller
- TC1798 – TriCore™ 32-bit microcontroller

Dry Double Clutch Transmission – Hydraulic Control



Application Features

- Ultra fast gear switching
- Closely coupled with engine control via high-speed CAN/FlexRay link
- Support for four 3-phase DC-brushless E-drives (Dry-DCT)
- Microcontroller offered as bare die with junction temperature up to 170 °C

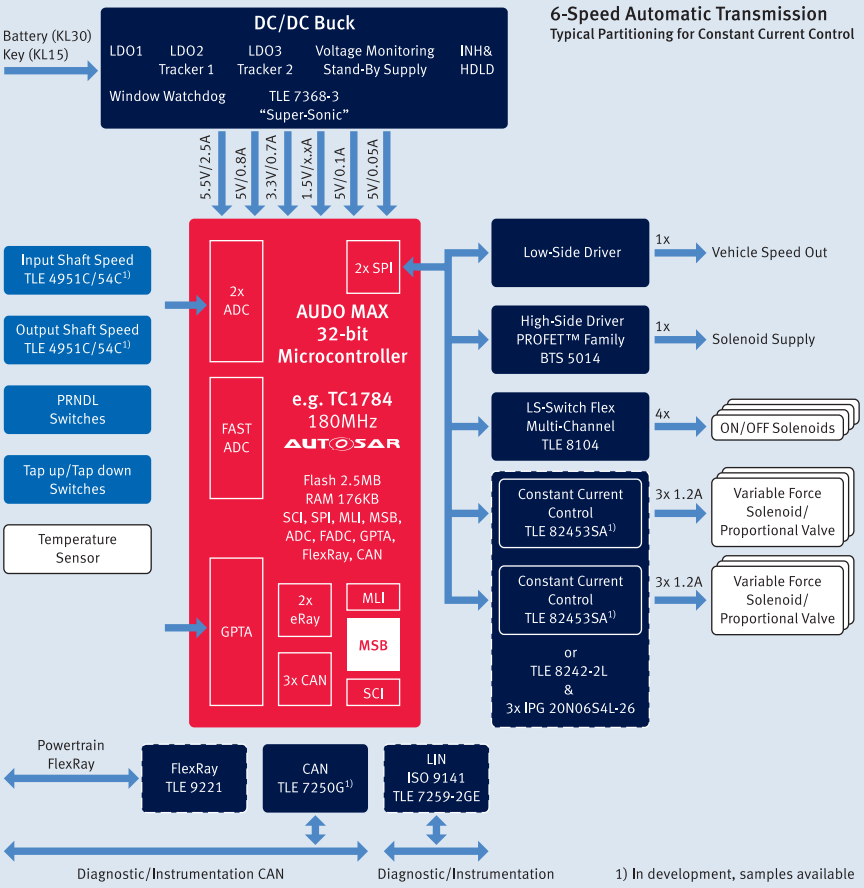
System Benefits

- Improved fast clutch control
- Feature set optimized for wet and dry DCT designs
- Continuous torque on wheels ensures a more fun driving experience
- Hot bare die capabilities enable micro-controllers to be placed directly where they are needed in the system
- Hot bare die supports modular temper-ature-optimized TCU design
- Digital Temperature Sensor (DTS) for increased accuracy

Suggested Products

- TC1746 – TriCore™ 32-bit microcontroller
- TC1782 – TriCore™ 32-bit microcontroller

Automatic Transmission – Hydraulic Control



Application Features

- Smooth gear shifting
- Closely coupled with engine control via high-speed CAN/FlexRay link
- Support for four 3-phase DC-brushless E-drives
- High microcontroller junction bare die temperature

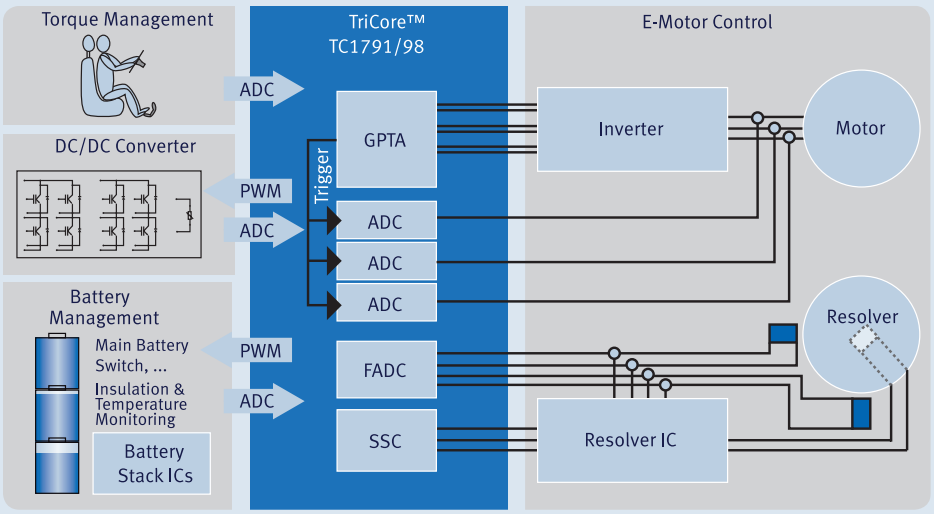
System Benefits

- Improved and fast clutch control
- Hot bare die supports modular temperature-optimized TCU design
- Hot bare die capabilities enable microcontrollers to be placed wherever they are needed in the system
- Digital Temperature Sensor (DTS) for increased accuracy
- Scalable product offering ensures perfect fit for individual application needs

Suggested Products

- TC1746 – Bare Die TriCore™ 32-bit microcontroller
- TC1748 – Bare Die TriCore™ 32-bit microcontroller
- TC1784 – TriCore™ 32-bit microcontroller

Hybrid Electric and Electric Vehicles



Application Features

- Advanced battery management for loading and balancing battery pack
- Vehicle power management
- Enables inverter functionality
- Enables efficient auxiliary aggregates
- Enables start/stop
- Support for mild/full hybrid variants

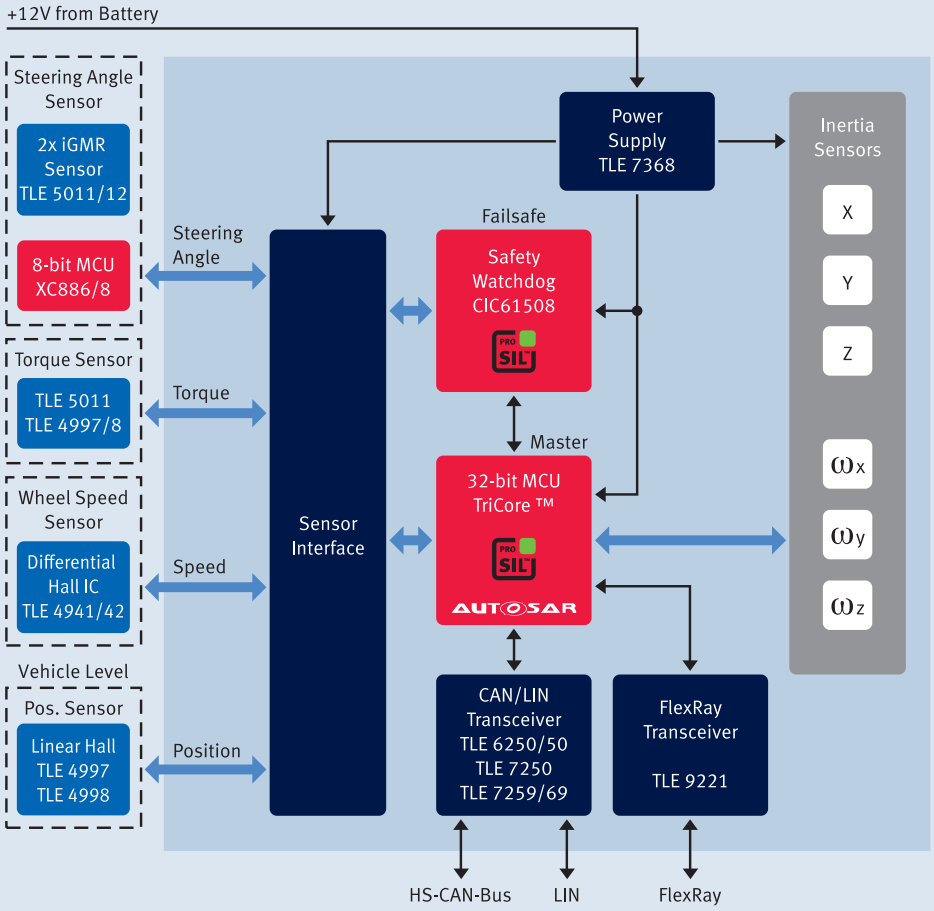
System Benefits

- Significantly lower CO_2 emissions
- Efficiency and fuel economy
- Delivers a more fun drive

Suggested Products

- TC1782 – TriCore™ 32-bit microcontroller
- TC1791 – TriCore™ 32-bit microcontroller
- TC1798 – TriCore™ 32-bit microcontroller

Chassis Domain Control



Application Features

- Multiple application ECU
  - Highest performance requirement
  - AUTOSAR support
- Software scalability to meet low- to high-end requirements
  - Intelligent sensor cluster with three dimension sensors
  - Domain control unit with six dimension sensors
- Compliance with IEC61508 and ISO26262

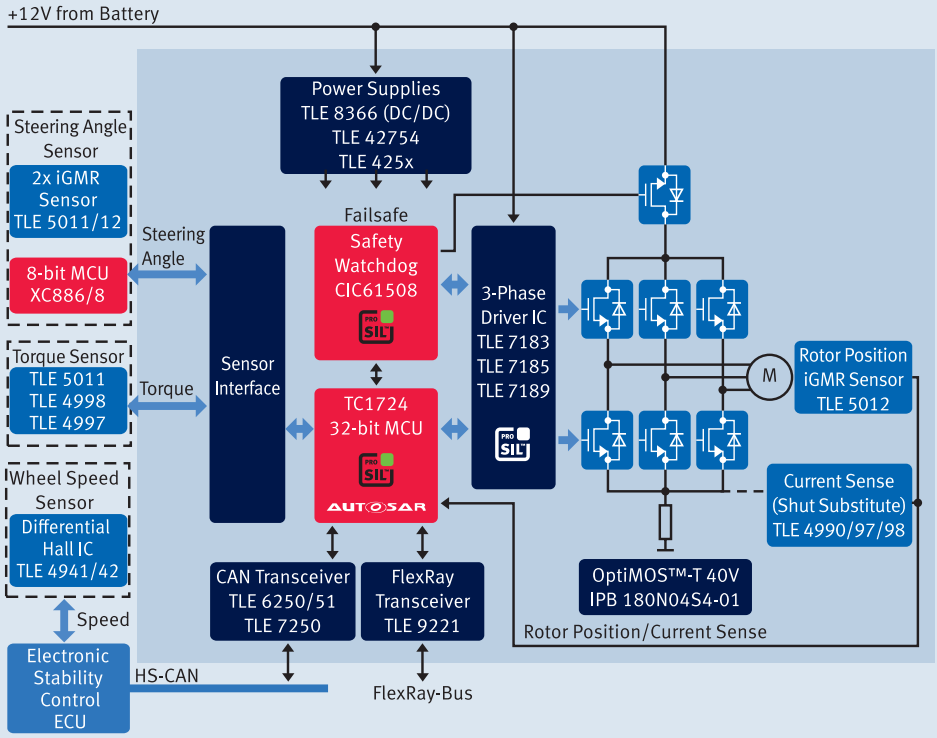
System Benefits

- Advanced communication with FlexRay
- Highest available performance with integrated FPU
- Flexible DMA unit
- Asymmetric dual core architecture (TriCore™/PCP)
- Scalability over Flash, RAM and peripherals
- Infineon PRO-SIL™ support

Suggested Product

- TC1791 – TriCore™ 32-bit microcontroller

Electric Power Steering (EPS)



Application Features

- Support for column and belt drive power steering systems
- Support for advanced BLDC drive control
- IEC61508 SIL3 compliant

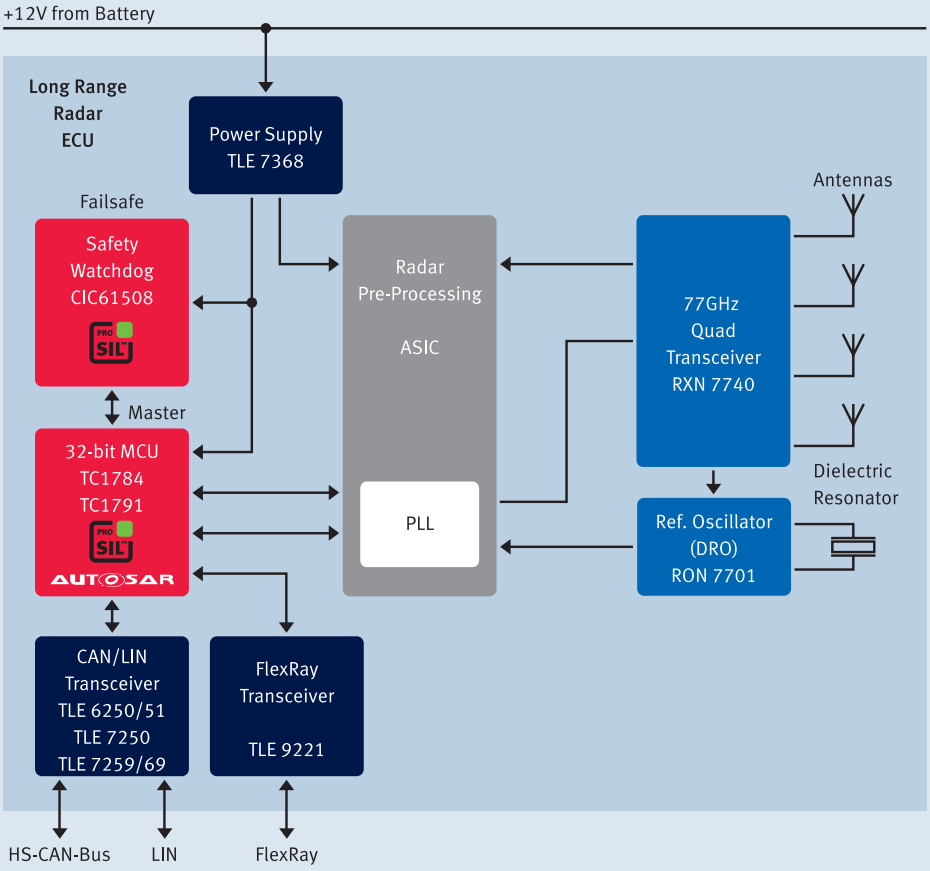
System Benefits

- Flexible GPTA timer unit
- Asymmetric dual core architecture (TriCore™/PCP)
- Redundant, flexible 5V ADCs
- Embedded voltage regulator
- Integrated FlexRay option

Suggested Product

- TC1724 – TriCore™ 32-bit microcontroller

Advanced Driver Assistant Systems (ADAS)



Application Features

- Long-/mid-/short-range radar
- Adaptive cruise control
- Blind spot detection
- Lane departure warning
- Collision warning
- Parking assistant
- Automatic high beam
- Ticket warning
- Night vision
- Car-to-car/car-to-infrastructure communication

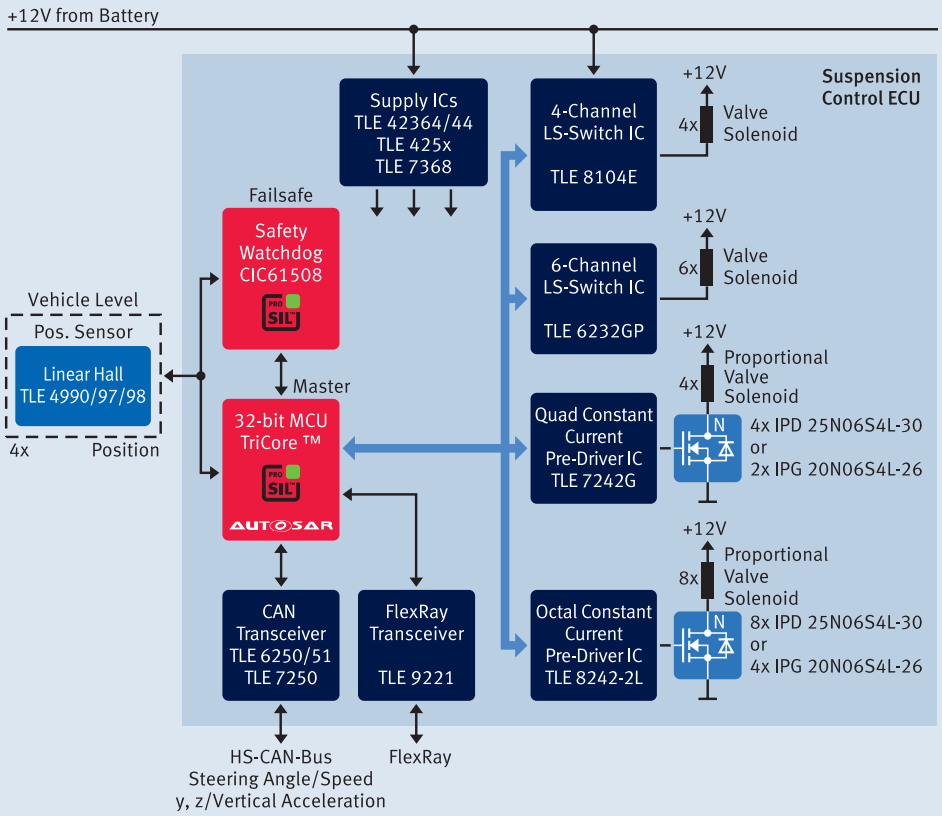
System Benefits

- TriCore™ DSP functionality
- Sophisticated GPTA timer module for capture compare and PWM generation
- High-speed MLI (Multi Link Interface) for serial communication
- External bus unit

Suggested Products

- TC1784 – TriCore™ 32-bit microcontroller
- TC1791 – TriCore™ 32-bit microcontroller

Active Suspension



Application Features

- Active air spring systems
- Active damping regulation systems
- Load leveling systems

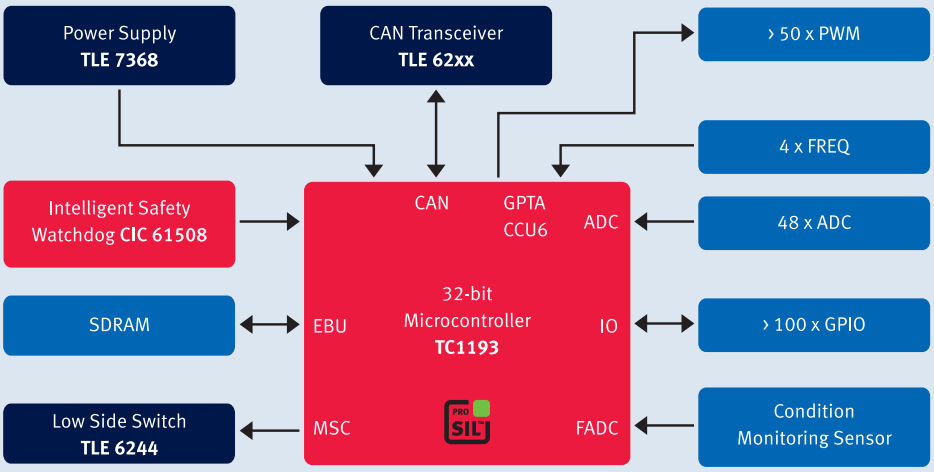
System Benefits

- Sophisticated GPTA timer module for capture/compare and PWM generation
- 5V ADC capability
- Comprehensive feature set and package options

Suggested Products

- TC1782 – TriCore™ 32-bit microcontroller
- TC1784 – TriCore™ 32-bit microcontroller

Mobile Controller



Application Features

- Closed-loop control of solenoid currents
- Multitasking to drive hydraulic and electric actuators
- IEC61131-3 support
- GNU toolchain
- Ready for harsh environments
- Compliance with IEC61508 for Safety Integrity Level (SIL) 1 to 3

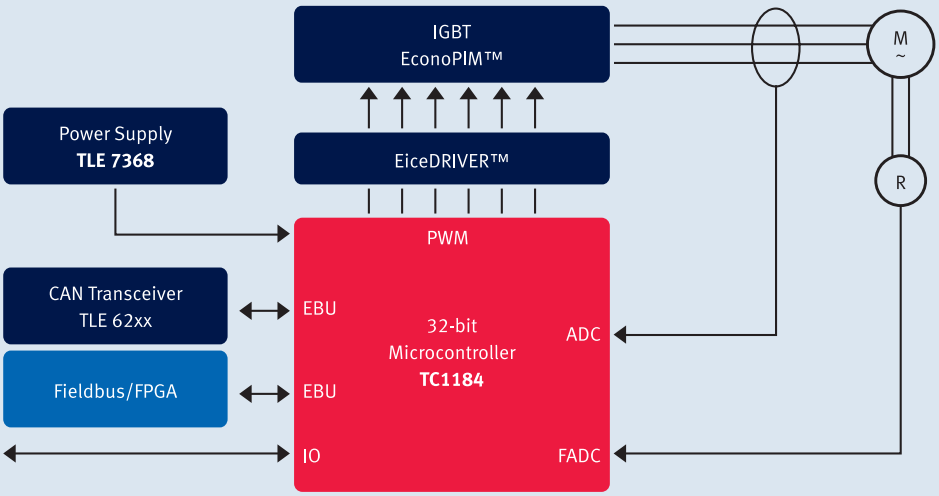
System Benefits

- High-speed 270MHz asymmetric dual core
- Up to 50 Pulse-Width-Modulated (PWM) outputs
- Three Analog to Digital Converters (ADC) 12-bit, up to 44 channels
- Four fast ADC inputs 10-bit (262.5ns @ f_{FADC} = 80MHz)
- Four frequency inputs
- Fast, 10-bit ADC
- Industrial and automotive temperature range
- SAE J1939 supported by four CAN nodes
- 32KB EEPROM for parameter
- Hitex PRO-SIL™ support

Suggested Products

- TC1193 – TriCore™ 32-bit microcontroller
- TC1198 – TriCore™ 32-bit microcontroller

Inverter



Application Features

- Multi-axis controller for two 3-phase complementary PWMs
- Multiple modulation strategies (SVPWM, DPWM, Soft-PWM, direct torque control) to support requirements for reduced noise emissions and increased efficiency
- Ready for four Q-inverters, matrix-inverters
- Field-oriented control with less than 10 % CPU load
- Multiprocessor support for reliability and safety

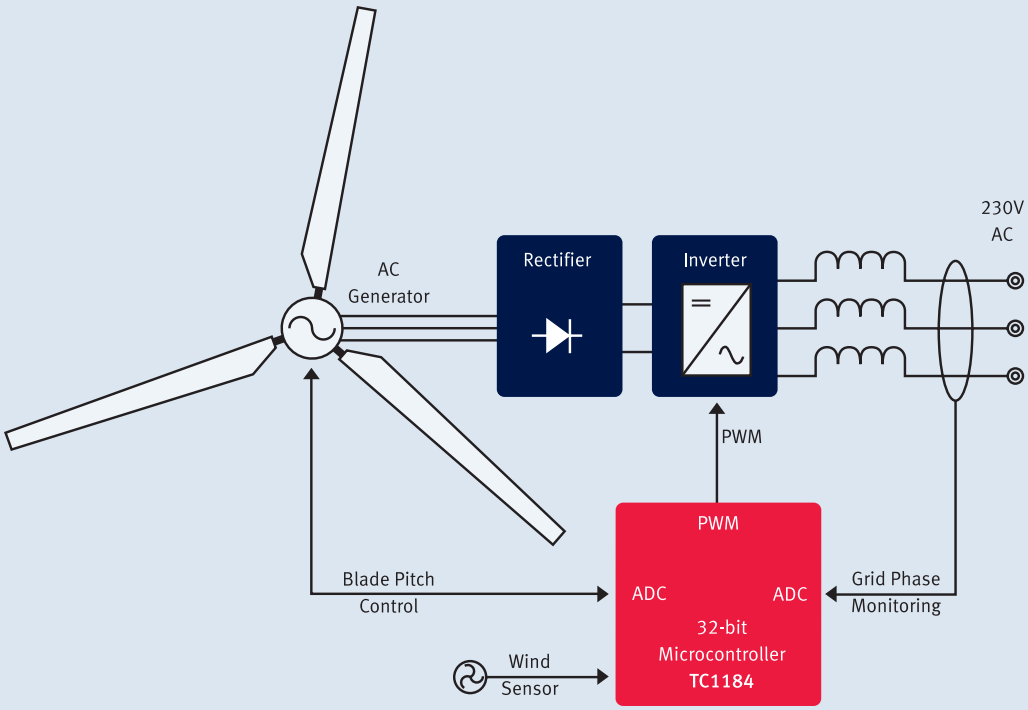
System Benefits

- Generic flexibility timer (GPTA)
- Two Analog to Digital Converters (ADC) 12-bit, up to 32 channels
- Fast, 10-bit ADC (262.5ns @ f_{FADC} = 80MHz)
- Resolver I/F
- Encoder I/F with digital noise filter
- Optimized motion control library
- Very fast control loop

Suggested Product

- TC1184 – TriCore™ 32-bit microcontroller

Wind Turbine Inverter



Application Features

- Reliable blade pitch control
- Increased wind turbine efficiency
- Multiple modulation strategies (SVPWM, DPWM, Soft-PWM, direct torque control) to support requirements for reduced noise emissions and increased efficiency
- Multiprocessor support for reliability and safety

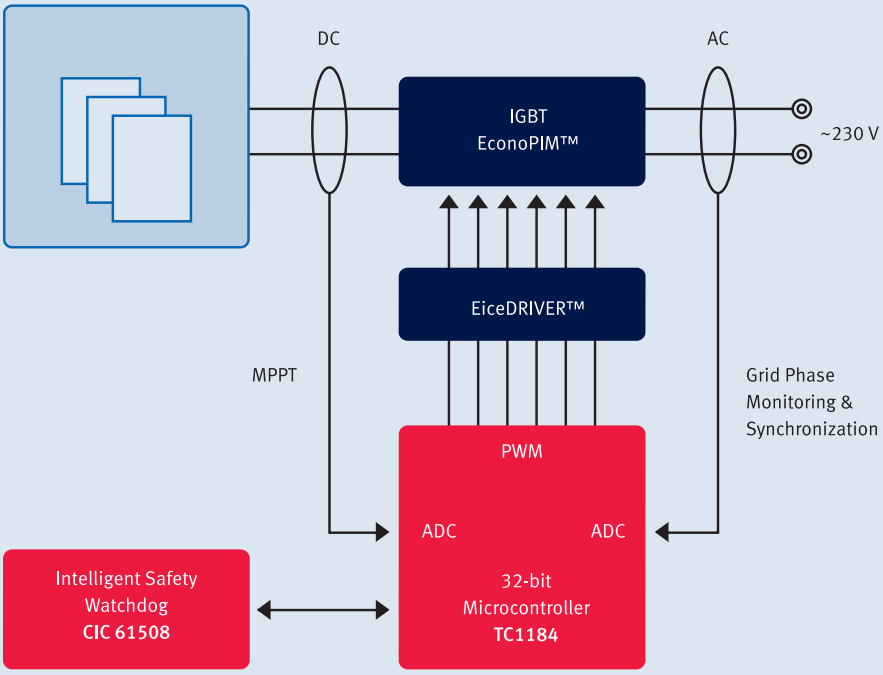
System Benefits

- Generic flexibility timer (GPTA)
- Two Analog to Digital Converters (ADC) 12-bit, up to 36 channels
- Fast, 10-bit ADC (262.5ns @ f_{FADC} = 80MHz)
- Resolver I/F
- Encoder I/F with digital noise filter
- Optimized motion control library

Suggested Products

- TC1182 – TriCore™ 32-bit microcontroller
- TC1184 – TriCore™ 32-bit microcontroller

Solar Panel



Application Features

- Multi-phase PWM controller for single or multiple strings
- Runs multiple modulation strategies (SVPWM, DPWM, Soft-PWM, direct torque control) to support requirements for reduced noise emissions and increased efficiency
- Maximum Power Point Tracking (MPPT) to extract maximum power from solar panels
- Grid phase monitoring and synchronization to ensure power factor unity
- Current control to avoid disharmonics and to determine the feed in refund
- Multiprocessor support for reliability and safety

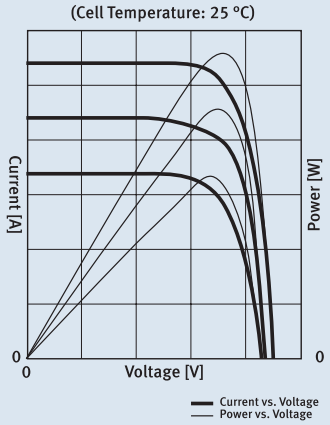
Suggested Products

- TC1184 – TriCore™ 32-bit microcontroller
- TC1193 – TriCore™ 32-bit microcontroller

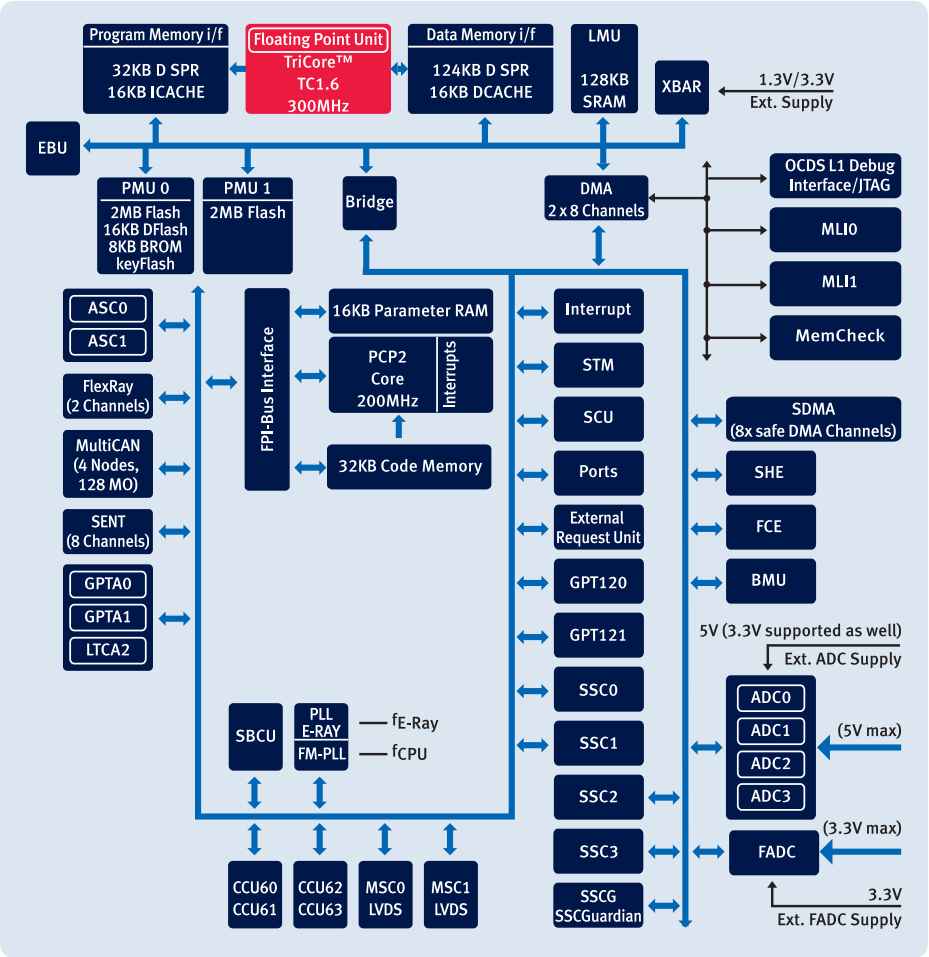
System Benefits

- Generic flexibility timer (GPTA)
- Two Analog to Digital Converters (ADC) 12-bit, up to 36 channels
- Fast, 10-bit ADC (262.5ns @ f_{FADC} = 80MHz)
- Optimized DSP library

Maximum Power Point Tracking (MPPT)



AUDO Family System Architecture



TriCore™ is the first unified, single-core, 32-bit-microcontroller DSP architecture optimized for real-time embedded systems. The TriCore™ Instruction Set Architecture (ISA) combines the real-time capability of a microcontroller, the computational power of a DSP plus the high-performance and price features of an RISC load/store architecture in a compact reprogrammable core.

The ISA supports a uniform, 32-bit address space with optional virtual addressing and memory-mapped I/O. It enables a wide range of implementations, from scalar to superscalar, and is capable of interacting with different system architectures, including multiprocessing environments. This flexibility at implementation and system level enables manufacturers to balance performance and cost requirements to meet individual needs.

The architecture supports both 16-bit and 32-bit instruction formats. 16-bit instructions are a subset of 32-bit instructions and were chosen due to their widespread popularity. They also significantly reduce code space and memory requirements as well as system and power consumption.

Real-time responsiveness is largely determined by interrupt latency and context switch time. The high-performance architecture minimizes interrupt latency by avoiding long multi-cycle instructions and providing a flexible hardware-supported interrupt scheme. The architecture also supports fast context switching.

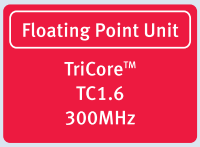
The Peripheral Control Processor (PCP2) is a programmable, single cycle, 32-bit processing unit with its own code and data memory unit (Harvard architecture). It is used as an interrupt service provider, delivering hardware interrupt priority arbitration with 255 priority levels. Instead of static implementation, the PCP provides programmable improved peripheral intelligence.

The General Purpose Timer Array (GPTA) delivers extremely flexible filtering and high resolution signal acquisition as well as a digital PLL to generate higher resolution input signals. It enables all types of enhanced counting, capture compare and PWM functionality thanks to its universal cell structure.

TriCore™ TC1.6

Features

- Up to 300MHz
- Six-stage pipeline
- Dedicated integer division unit in hardware
- Optimized Floating Point Unit (FPU)
- Enhanced branch prediction (branch history and target buffers)
- Optimized crossbar interconnect with 64-bit data width (shared resource interconnect)
- 16-bit and 32-bit instruction formats
- 32-bit load-store Harvard architecture
- Superscalar execution
- Sustained throughput by dual 16x32 MACs
- SIMD (Single Instruction Multiple Data) packed arithmetic
- Zero overhead loops (loop recognition buffer)
- DSP addressing modes and saturated math



Benefits

- Highest performance for complex engine management systems
- Integrated MCU-DSP instructions in one core
- Very fast context switching for interrupt driven system
- Fast and efficient processing of multiple tasks on one engine
- Low code size and inherent high level language support
- One development toolset for both MCU and DSP tasks
- Higher flexibility and lower cost
- Support and supply of complete system chipset

Peripheral Control Processor (PCP2)

Features

- Moves data between any two memory or I/O locations
- Up to 200MHz
- Read-modify-write capabilities
- Full computation capabilities including basic MUL/DIV
- Reads/moves data and adds it to previously read data
- Reads two data values and performs arithmetic or logical operations and stores results
- Bit handling capabilities (testing, setting, clearing)
- Flow control instructions (conditional/unconditional jumps, breakpoint)

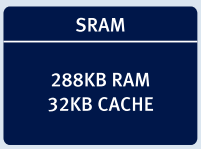
Benefits

- Data preconditioning
- First level of defense for frequently occurring peripheral interrupts
- Programmable implementation of state machines
- Intelligent DMA assistance

SRAM

Features

- Up to 288KB
- Overlay RAM
- Error Code Correction (ECC) with Single Error Correction (SEC) and Double Error Detection (DED)



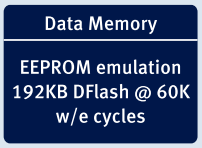
Benefits

- Fast memory access
- Safety

Data Flash

Features

- 60k cycles EEPROM emulation and data retention for a minimum of five years
- Read-while-write feature supported for EEPROM emulation



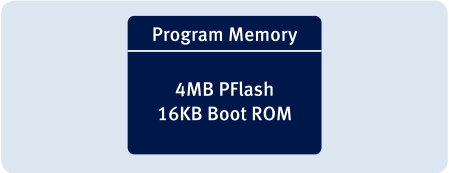
Benefits

- EEPROM emulations eliminate need for external EEPROM
- Alternative to stand-by RAM

Program Flash

Features

- Two banks offering concurrent read/ write/erase
- Dynamic error correction of single-bit errors and detection of double-bit errors (SEC-DED-ECC)
- Margin check control
- Flash read/write protection for each sector with three levels
- Flash read/write protection based on two-tier password
- One-Time Programmable (OTP)
- Tuning protection
- End-to-end protection of Flash data with ECC
- Detection of addressing errors



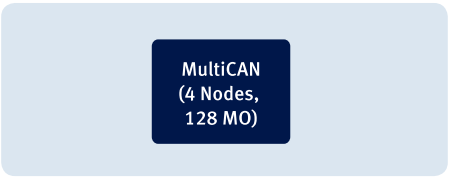
Benefits

- Fast end-of-line programming
- Faster access speeds
- Safety and security

MultiCAN

Features & Benefits

- Full CAN with CAN 2.0B active
- Up to four independent CAN nodes
- Up to 128 message objects
- Programmable acceptance filtering
- Data transfer rate of up to 1Mbit/s individually programmable for each node
- Powerful analysis capability
- FIFO data handling support
- Automatic gateway support
- Flexible interrupt handling



Direct Memory Access (DMA)

Features

- Up to 16 independent DMA channels
- Programmable priority of DMA subblocks on bus interfaces
- Buffer capability for move actions on buses (at least one move per bus is buffered)
- Individually programmable operation modes for each DMA channel
- Full 32-bit addressing capability of each DMA channel
- Programmable data width of DMA transfer/transaction: 8-bit, 16-bit or 32-bit
- Micro link bus interface support
- One register set for each DMA channel
- Flexible interrupt generation
- Memory check unit built in
- DMA controller operates as bus bridge between system peripheral bus and remote peripheral bus (AUDO NG) or to LMB bus (AUDO Future)

Benefits

- Flexible use for single event or continuous transfer operation
- Flexible interrupt generation
- Maximum flexibility to adapt to customer needs
- Maximum adaptation to application requirements

General Purpose Timer Array (GPTA)

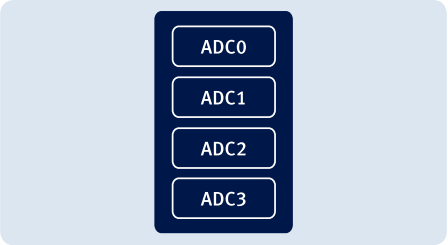
Features & Benefits

- Very flexible digital input filtering
- Tracking of all kinds of rotating shafts
- Scalable high resolution
- Independent access to time and angle domain
- All types of PWM generation supported thanks to Local Timer Cell (LTC) array
- Digital PLL for fine grain angle resolution
- PCP2 is the ideal coprocessor to handle critical short and real-time GPTA interrupt tasks from the GPTA
- Ideal for field test and repair work

Enhanced Analog-Digital Converter (ADC)

Features & Benefits

- 1-4 synchronizable A/D converters with up to 64 channels
- 8-/10-/12-bit resolution, +/- 2LSB @ 10-bit
- Conversion time down to 1.0µs
- Data reduction pre-processing
- Result accumulation and limit check
- External or internal trigger events and automatic conversion sequencing SSC0



Fast Analog to Digital Converter (FADC)

Features & Benefits

- Unique solution for knock detection without external ASICs or dedicated DSP
- Reduced software load for FIR filter thanks to integrated decimation comb filter (e.g. data reduction by a factor of six from 1200 to 200k samples)
- Quick adaptation of overall filter quality to meet application requirements by programming data rate used for the COMB filter
- Increased ADC accuracy thanks to data reduction filter and by moving averaging filter (e.g. from 10-bit to 11-bit by selected oversampling by a factor of four)

Asynchronous Serial Channel (ASC)

Features & Benefits

- Convenient off-board communication via LIN or K-line
- Full-duplex asynchronous communication up to 5.625Mbit/s
- Half-duplex synchronous communication up to 11.25Mbit/s

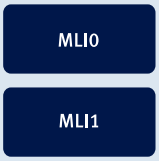
Micro Second Channel (MSC)

The MSC module sets a new open standard for serial high-speed communication when powering ASIC modules such as multi-switches (for ignition or injection drivers). It transfers command frames, data frames and asynchronous diagnosis feedback from the device. The MSC module helps designers reduce EMC for high bandrates (up to 45Mbit/s) by supporting low-voltage differential swing (LVDS) for high-speed downstream data and clock rates.

Multiprocessor Link Interface (MLI)

Features & Benefits

- Serial high-speed interface up to MLI/2 (e.g. 45MBaud for TC1797) used for inter-processor keyFlash communication between the AUDO family members, thus enabling scalable processing power within an application
- Fast interconnection to Infineon companion chips e.g. CIC310 FlexRay controller and CIC751 16-channel ADC



SENT – New Digital Sensor Interface

Features & Benefits

- SENT stands for Single (falling) Edge Nibble Transmission
- Eight SENT channels work independently in parallel
- Point-to-point digital protocol
- Less complex and lower cost alternative to CAN and LIN digital busses
- Good fit for environments with high noise level (e.g. powertrain) complies with SENT standard (unidirectional) as well as Short PWM Code (SPC) protocol extensions
- SPC enables use of enhanced protocol functionalities such as synchronous, range selection and ID selection
- Data rates of up to 65,8Kbit/s at 3µs tick length and six data nibbles on each channel

Secure Hardware Extension (SHE)

Features & Benefits

- Fulfills HIS consortium specifications (BMW, Audi, Daimler, Porsche, VW)
- Supports:
  - Encoding/decoding of data
  - Secure hash
  - Secure keys stored in secure Flash
  - Prevention of access by hardware or software
  - Key programming by OEM
  - True random number generator
  - Key exchange protocols
- Enables:
  - Manipulation protection
  - Authentication
  - Secure boot

General Purpose Timer 12 (GPT12)

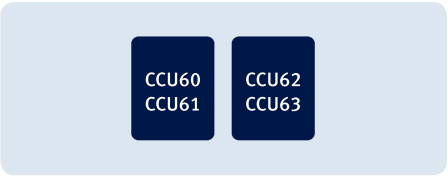
Features & Benefits

- Multifunctional timer structure:
  - Timing
  - Event counting
  - Pulse width measurement
  - Pulse generation
  - Frequency multiplication
- Modes:
  - Gated timer
  - Counter mode
  - Concatenation of different timers

Capture/Compare Unit 6 (CCU 6)

Features & Benefits:

- High resolution 16-bit capture and compare unit
- Mainly for AC drive control
- Also supports BLDC control, block commutation and multi-phase machines
- Center-aligned and edge-aligned PWM can be generated



FlexRay™ *

Features & Benefits

- Conformance with FlexRay protocol
- Specification V2.1
- Data rates of up to 10Mbit/s on each channel
- Up to 128 configurable message buffers
- 8KB of message RAM
- ERAY IP
- Supports demand for higher bandwidth (where CAN is bottleneck)
- Enables new vehicle partitioning concepts such as domain control
- Deterministic bus system (supports safety applications)

* FlexRay™ is a trademark of the FlexRay Consortium and used under license.

Synchronous Serial Channel (SSC)

Features & Benefits

- Supports rates up to 45Mbit/s
- Communication link for power devices, memories and sensors
- Full-duplex and half-duplex serial synchronous communication
- Hardware support for up to six slave select lines

Enhanced On-Chip Debug Support (OCDS)

TriCore™ V1.6 features enhanced On-Chip Debug Support (OCDS) with program flow and data access breakpoint capabilities. Debuggers can connect using JTAG or a high-speed Device Access Port (DAP) with only two pins. Flexible cross triggering with internal and external sources and targets helps analyze and debug hard real-time systems.

New Safety Modules

Flexible CRC Engine (FCE)

Features & Benefits

- Provides parallel implementation of CRC algorithms
- Uses IEEE802.3 ethernet CRC32 and Castagnoli CRC32C polynomials
- Hardware acceleration engine for software applications using CRC signatures
- Compatible with AUTOSAR CRC specification of CRC routines

Bus Monitoring Unit (BMU)

Features & Benefits

- Simplifies software monitoring requirements for safety applications
- Detects illegal access to safety-related configuration and status registers
- Supports brake-after-make safety concept (Lock-Step-Emulation)

Safe Direct Memory Access Controller (SDMA)

Features & Benefits

- Based on DMA peripheral
- With following additional features:
  - Upper and lower address boundary checking (source and destination address)
  - Generation of unique CRC checksums for source and destination addresses
  - Generation of in-line CRC checksum for read data

Synchronous Serial Interface Guardian (SSCG)

Features & Benefits

- Monitors communication of serial interfaces (SSCs)
- Dedicated guardian (SSCG) available for each SSC
- Additional compare logic for comparisons between ideal and actual transmit message
- Mismatch is traced and interrupt is raised

Memory Protection Unit (MPU)

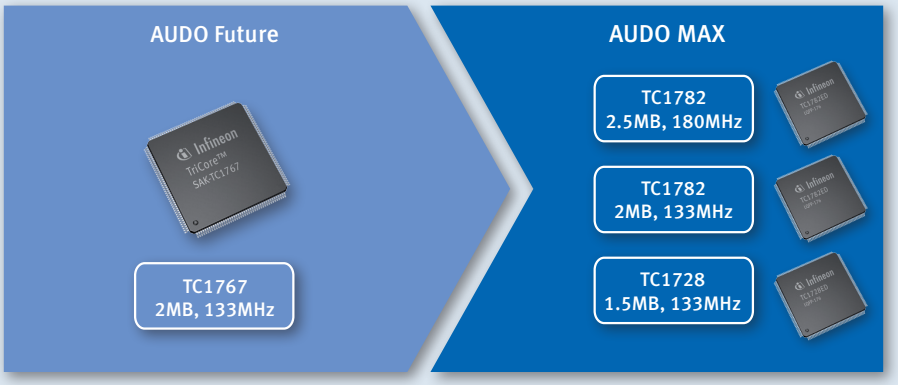
Features & Benefits

- Hardware mechanism that protects memory ranges from unauthorized data read/write and instruction fetch access
- Covers TriCore™ CPU, PCP and DMA memory operations
- Invalid access generates a trap
- Memory protection can be globally disabled
- 16 data ranges and eight code ranges shared between four protection sets

TriCore™ Upgrade Paths

Mid Range

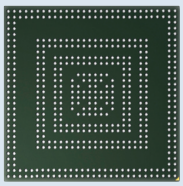
Advanced package technologies deliver the best price/performance ratio for mid-range applications.
Customers migrating from TC1767 can choose the lowest-cost option TC1728 or the richest feature set with TC1782.



Best cost/performance options in QFP-176 package

High End

LBGA516 (TC1798)

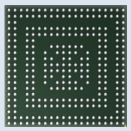


25 x 25 mm

- 72 analog inputs
  - 4 x 16 ADC
  - 4 x dedicated FADC
- Additional GPIOs

BGA Scalability

LFBGA292 (TC1791)



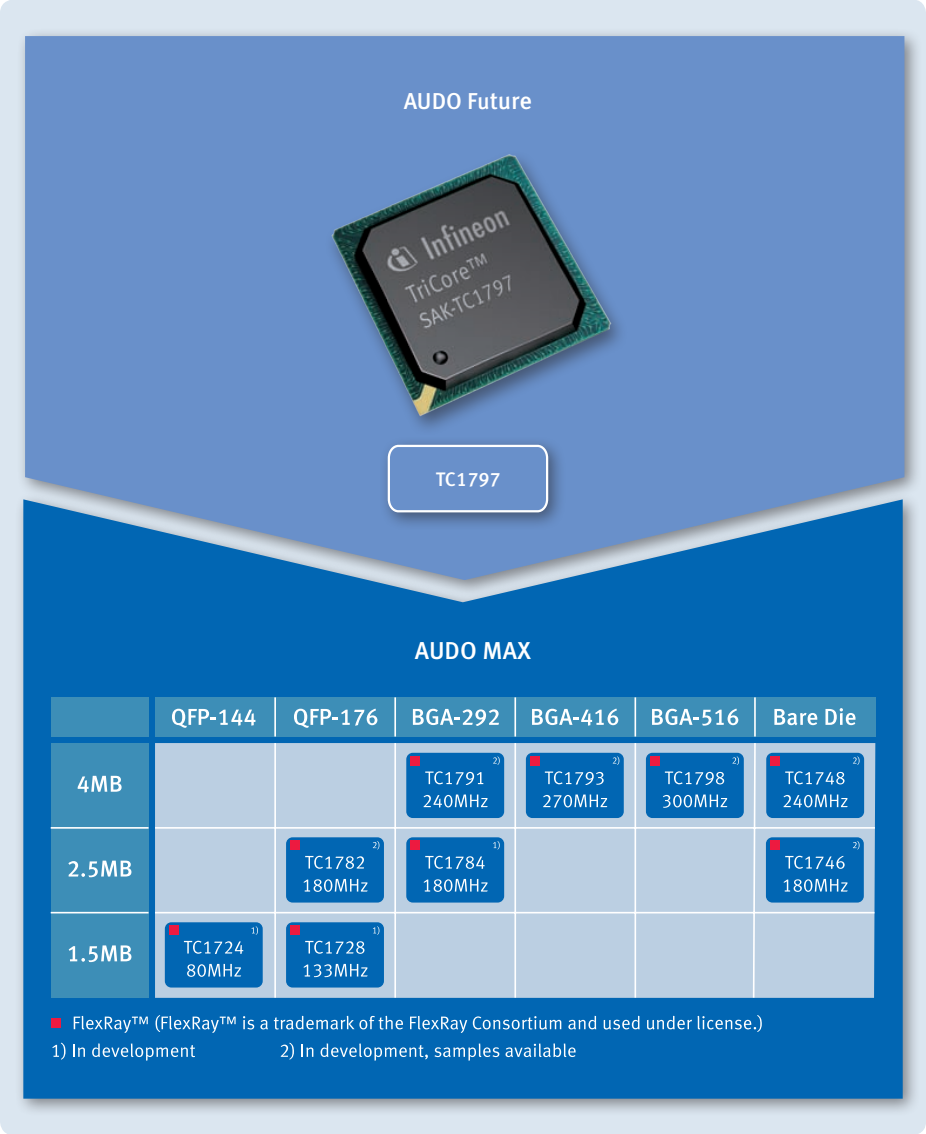
17 x 17 mm

- 48 analog inputs
  - 3 x 16 ADC
  - 4 FADC

optimized for

Function, scalability, size and cost

FlexRay™* Coverage



All products in the new 32-bit TriCore™ family AUDO MAX come with embedded FlexRay™. The family extends from low-end microcontrollers such as TC1724, a great solution for suspension applications, through mid-range products such as TC1782 and TC1746, which are popular in transmission and EV applications, to high-end segment products such as TC1798.

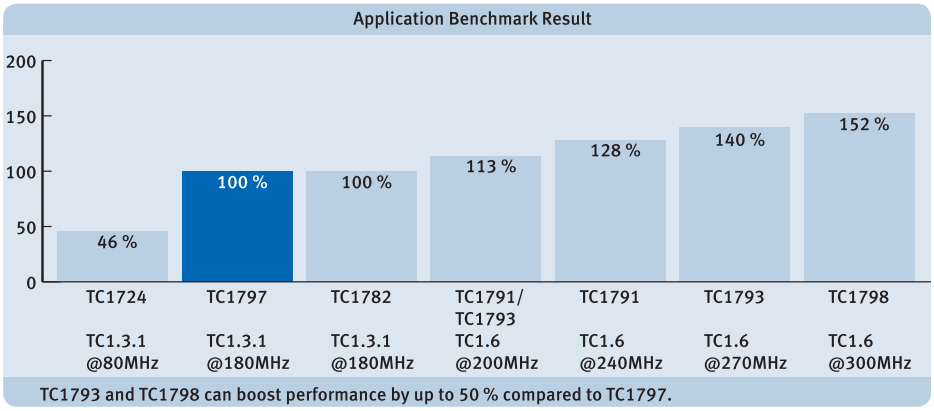
The TC1798 300MHz microcontroller is perfect for complex engine management systems such as six-cylinder gasoline direct injection. Every microcontroller features embedded FlexRay™ with protocol version 2.1/2.1 Rev. A. They also come with an official FlexRay™ protocol conformance certificate issued by the German testing organization TÜV Nord.

* FlexRay™ is a trademark of the FlexRay Consortium and used under license.

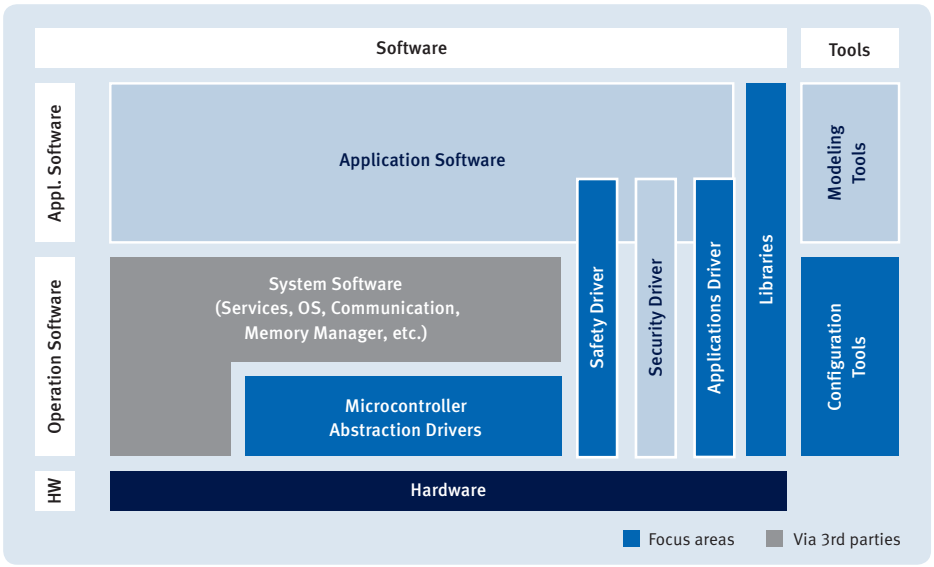
Embedded Software

TriCore™ Performance

Real-life application benchmark (software controlling a four cylinder diesel engine)



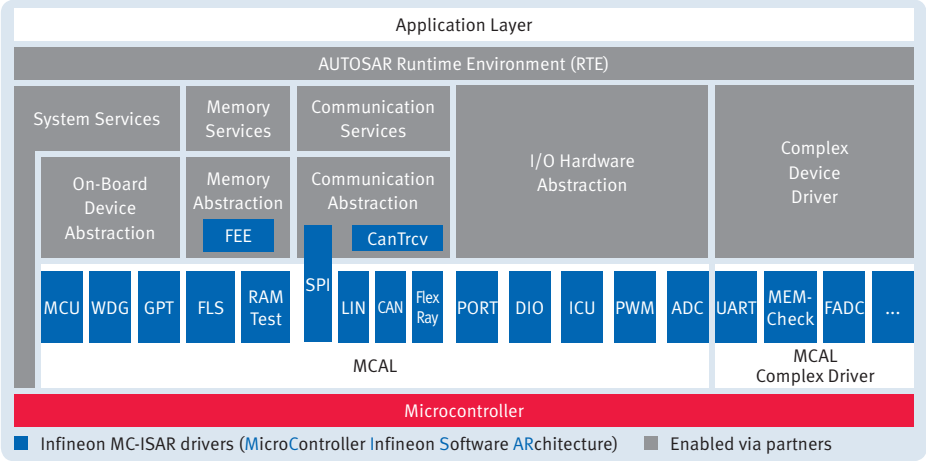
Infineon Software Product Overview



- Microcontroller abstraction drivers
  - AUTOSAR MCAL
  - DAVE™
- Safety driver
  - PRO-SIL™ SafeTcore
- Application drivers
  - DAVE™ Drive (IMM)
  - 3-phase eMotor driver
- System software
  - AUTOSAR suites from 3rd parties
- Configuration tool
  - DAVE™
- Libraries
  - TriLib
  - XC2000 DSP library
- Tools
  - MemTool, SDA TriCore™, stack depth analyzer, SAG TriCore™, signature anlalysis generator, etc.

Infineon AUTOSAR MCAL Drivers

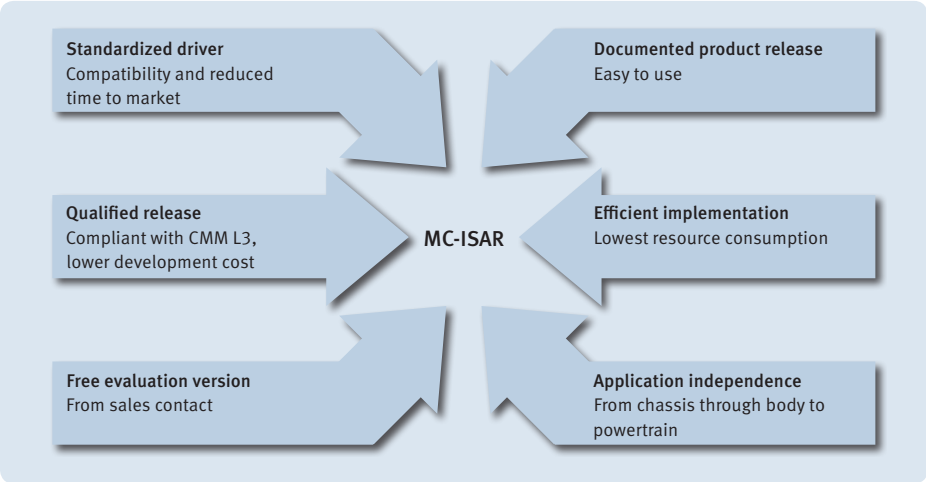
MC-ISAR Product Overview



MC-ISAR	MicroController – Infineon Software ARchitecture
MC-ISAR:	MCU, WDG, GPT, SPI, PORT, DIO, ICU, PWM, ADC
MC-ISAR COM:	CAN, CanTrcv, LIN, FlexRay
MC-ISAR MEM:	FLASH, FEE, RAM Test
MC-ISAR MCAL CD:	UART, MEMCheck, FADC, ect. for TriCore TM

- Supported AUTOSAR releases and devices:
  - V2.0: AUDO NG (TC1796, TC1766)
  - V2.1, V3.0: XC2000, AUDO Future (TC1797, TC1767), AUDO S
  - V3.0: AUDO MAX
- Complex driver for non-standardized modules (for TriCore™)
- CMM L3 process
- AUTOSAR BSW suite via partners: Electrobit, Greensoft KPIT, Vector Informatik
- Delivery packages include: source code, user manual, Tresos configuration tool

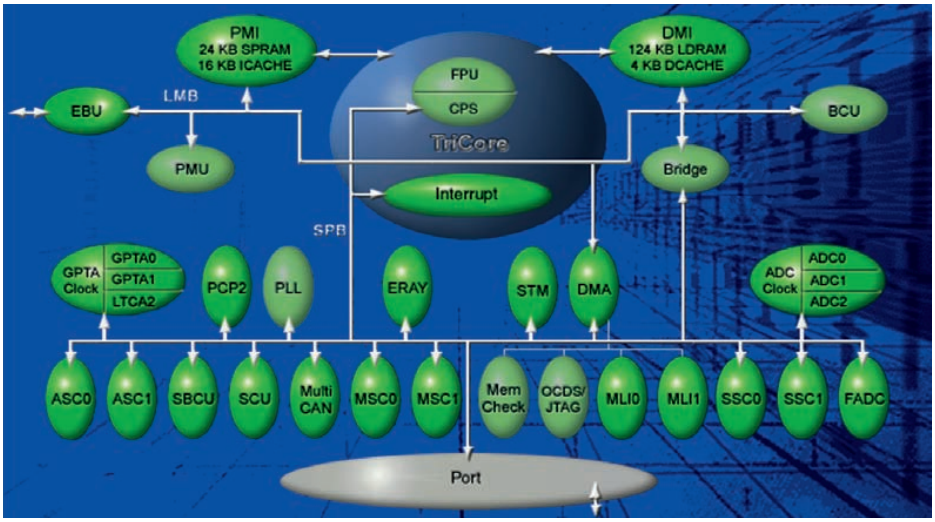
MC-ISAR AUTOSAR Driver Benefits



[www.infineon.com/autosar]

DAVE™ – Digital Application Virtual Engineer

DAVE™ is a tool that helps engineers program Infineon microcontrollers. It provides intelligent wizards that configure chips to specific requirements and automatically generate C-code with appropriate driver functions for all on-chip peripherals and interrupt controls.
DAVE™ interacts directly with the IDEs from leading tool suppliers and with Infineon's free toolchain DAVE™ Bench.
The DAVE™ mother system and DIP file for the microcontroller in question are needed to use DAVE™.



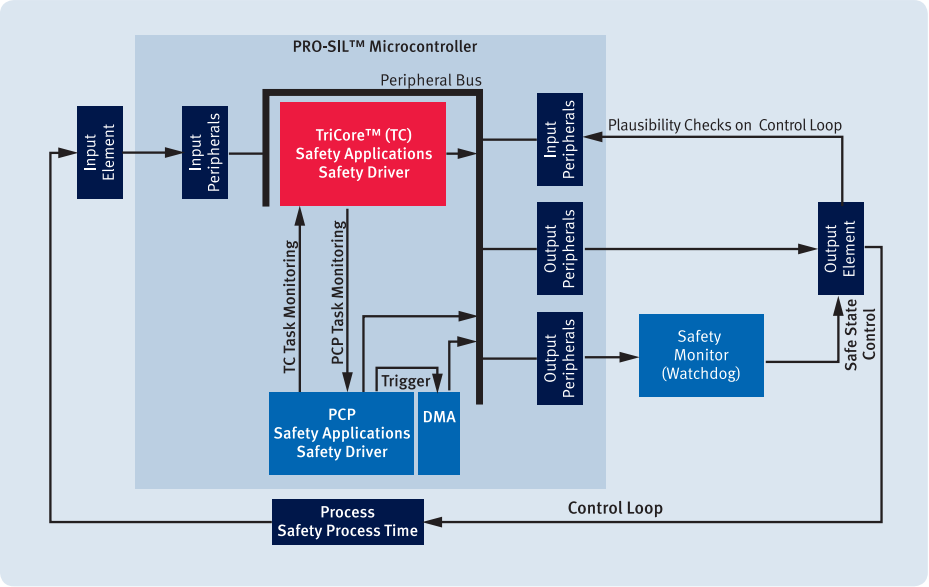
Key Features

- DAVE™ generates initialization code for Infineon microcontrollers
- DAVE™ displays all available peripherals in a block diagram at the start
- Click on a peripheral to define its functionality

[www.infineon.com/dave]

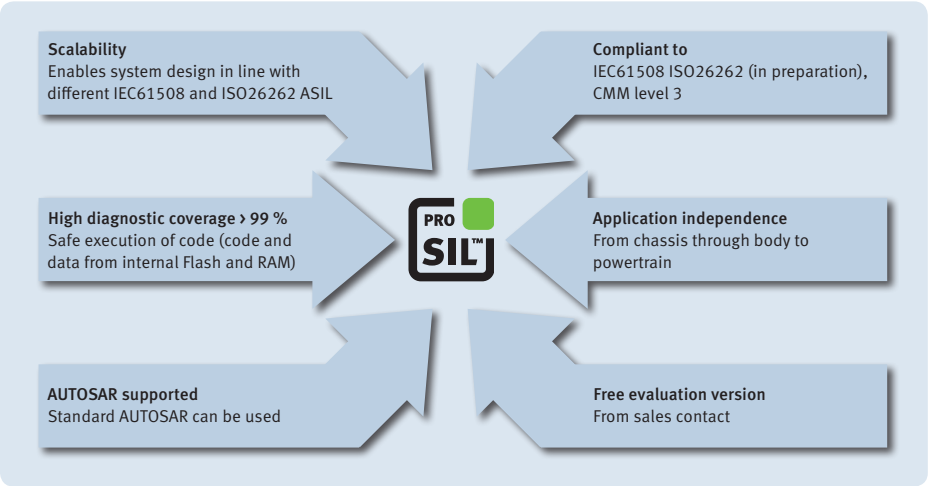
PRO-SIL™ Safety Core

Safety-Related System (SRS)



- Set of software tests to help system design reach the desired SIL (according to IEC61508) or ASIL (according to ISO26262)
- Supports
  - Core checks
  - Peripheral checks
  - External watchdog
- Target applications
  - ASIL applications
  - Chassis, hybrid, EV, powertrain/transmission

PRO-SIL™ Safety Core Driver Benefits



Development Support

Emulation Devices

- Emulation Devices (ED) have rich functionality
  - Complete emulator, fast prototyping and calibration
- Emulation logic is located next to the production chip on the same silicon
- High frequency capability due to short resistance
- Large number of interconnections
  - Several hundred traceable signals (at mask level)
- Production and emulation have the same behavior
  - Lower risk during development
- Easy link to standard PC via USB
  - Cost-effective, open platform and robust tools
- Compatible ED and PD
- Overlay mechanism for calibration
- Maximum 768KB memory for calibration and tracing

PD and ED in same package

Debugging and Calibration Concept

Today's vehicles are designed to meet rising market demands for engine performance, engine responsiveness, torque, drivability, fuel economy and emissions. Infineon's proven Multi-Core Debug Solution (MCDS) supports debugging, measurement and calibration – enabling manufacturers to design and optimize features to support these automotive trends.

Multi-Core Debug Solution (MCDS)

Key Features

- High bandwidth, low latency JTAG or DAP tool link
- Embedded on-chip trace memory up to 768KB
- Real-time, cycle-accurate tracing of processors and signals
- No additional pins needed on the chip

Starter Kits

Infineon AUDO family starter kits are powerful evaluation systems that enable evaluation and development well before the target hardware is available. They offer a solid platform for both hardware and software engineers to evaluate and prototype designs that are closely aligned with their final applications.

Infineon Starter Kits include

- Fully featured evaluation board
- USB cable
- Easy connectivity to all peripheral modules
- Extension board
- Development tools for evaluation such as compilers, debuggers and DAVE™
- Technical documentation – user manuals, architecture manuals, application notes, data sheets, board documentation

Type	Controller	Status
KIT_TC1797_SK	SAK-TC1797	available
KIT_TC1767_SK	SAK-TC1767	available
KIT_TC1736_SK	SAK-TC1736	available
KIT_TC1798_SK	SAK-TC1798	after January 2012
KIT_TC1793_SK	SAK-TC1793	after August 2011
KIT_TC1791_SK	SAK-TC1791	after November 2011
KIT_TC1784_SK	SAK-TC1784	after September 2011
KIT_TC1782_SK	SAK-TC1782	available
KIT_TC1728_SK	SAK-TC1728	after January 2012
KIT_TC1724_SK	SAK-TC1724	after November 2011
KIT_TC116x_SK	SAF-TC1164 or SAF-TC1166	available

Complete Tool Chain Support from Global Tool Partners

Modeling, simulation and cycle-accurate models

AbsInt Angewandte Informatik, ETAS, The MathWorks, VaST

Automatic code generation

dSPACE, ETAS, Infineon, The MathWorks

Embedded software and operating systems

AUTOSAR, ETAS, euros Embedded Systems GmbH, Infineon, vector, HIGHTEC

Integrated compiler/debugger tool chain

TASKING, HIGHTEC, Green Hills Software, Inc., WIND RIVER

Debugger tool chain

hitex Development Tools, pls Development Tools, LAUTERBACH Development Tools, iSYSTEM

Programmer & Flash tools

hitex Development Tools, pls Development Tools, Infineon, Data I/O

Test & validation

Development boards

Important Links/Contact

Local
Field application engineers via Infineon, distributors and sales representatives
www.infineon.com/sales
Regional Application engineering teams
Detroit, Munich, Shanghai, Singapore and Tokyo
Global Microcontroller R&D teams

Service center: **www.infineon.com/service**
Technical training: **www.infineon.com/mc-training**

Ask Infineon – Infineon Hotline-Service at your fingertips.
Where you need it. When you need it.

Infineon offers its toll-free 0800 service hotline as one central number, available 24 / 7 in English and German.

Our global connection service goes way beyond standard operating and switchboard services by offering qualified support on the phone. Call us!

- Germany 0800 951 951 951
- USA 1866 951 9519
- International 00 800 951 951 951
- Direct access ..... +49 89 234 - 0 (interconnection fee)

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Date: 02 / 2011

Feature Overview TriCore™ Family for Automotive Applications

	Core		Flash		SRAM	Communication		SENT	ADC		
	Core	Frequency	Program Flash	Data Flash		CAN	FlexRay	Channels	Channels	Package	Temp (Ta)
AUDO MAX											
TC1798	Version 1.6	300MHz	4MB	192KB	288KB	4	2	8	64	PG-LFBGA516	-40°C to +125°C
TC1793	Version 1.6	270MHz	4MB	192KB	288KB	4	2	8	44	PG-LBGA416	-40°C to +125°C
TC1791	Version 1.6	240MHz	4MB	192KB	288KB	4	2	8	48	PG-LFBGA292	-40°C to +125°C
TC1784	Version 1.3.1.	180MHz	2,5MB	128KB	176KB	3	2*	-	32	PG-LFBGA292	-40°C to +125°C
TC1782	Version 1.3.1.	180MHz	2,5MB	128KB	176KB	3	2*	-	32	PG-QFP176	-40°C to +125°C
TC1728	Version 1.3.1.	133MHz	1,5MB	64KB	152KB	3	2*	-	32	PG-QFP176	-40°C to +125°C
TC1724	Version 1.3.1.	133MHz	1,5MB	64KB	152KB	3	2*	-	24	PG-QFP144	-40°C to +125°C
AUDO FUTURE											
TC1797	Version 1.3.1.	180MHz	4MB	64KB	176KB	4	2	-	48	P/PG-BGA416	-40°C to +125°C
TC1767	Version 1.3.1.	133MHz	2MB	64KB	104KB	2	-	-	36	PG-QFP-176	-40°C to +125°C
TC1736	Version 1.3.1.	80Mhz	1MB	32KB	48KB	2	-	-	24	PG-QFP-144	-40°C to +125°C
AUDO NEXT GENERATION											
TC1796	Version 1.3	150Mhz	2MB	128KB	192KB	4	-	-	44	P/PG-BGA416	-40°C to +125°C
TC1766	Version 1.3	80Mhz	1,5MB	32KB	88KB	2	-	-	32	PG-QFP-176	-40°C to +125°C

[www.infineon.com/TriCore]

Feature Overview TriCore™ Family for Industrial Applications

	Core		Flash		SRAM	Communication		SENT	ADC		
	Core	Frequency	Program Flash	Data Flash		CAN	FlexRay	Channels	Channels	Package	Temp (Ta)
AUDO MAX											
TC1198	Version 1.6	300MHz	4MB	192KB	288KB	4	-	8	64	PG-LFBGA516	-40°C to +125°C
TC1193	Version 1.6	270MHz	4MB	192KB	288KB	4	-	8	44	PG-LBGA416	-40°C to +125°C
TC1184	Version 1.3.1.	180MHz	2,5MB	128KB	176KB	3	-	-	32	PG-LFBGA292	-40°C to +125°C
TC1182	Version 1.3.1.	180MHz	2,5MB	128KB	176KB	3	-	-	32	PG-QFP176	-40°C to +125°C
TC1128	Version 1.3.1.	133MHz	1,5MB	64KB	152KB	3	-	-	32	PG-QFP176	-40°C to +125°C
TC1124	Version 1.3.1.	80MHz	1,5MB	64KB	152KB	3	-	-	24	PG-QFP144	-40°C to +125°C
AUDO FUTURE											
TC1197	Version 1.3.1.	180MHz	4MB	64KB	224KB	4	-	-	48	P/PG-BGA416	-40°C to +125°C
TC1167	Version 1.3.1.	133MHz	1MB	64KB	128KB	3	-	-	32	PG-QFP-176	-40°C to +85°C
AUDO NEXT GENERATION											
TC1164	Version 1.3	80Mhz	1,0MB	16KB	56KB	2	-	-	32	PG-QFP-176	-40°C to +85°C
TC1166	Version 1.3	80Mhz	1,5MB	32KB	88KB	2	-	-	32	PG-QFP-176	-40°C to +85°C

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Date: 02 / 2011

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