Infineon AURIX™ Microcontrollers

Intelligent solutions for Commercial, Construction, Agricultural Vehicles (CAV)& Transportation

AURIX™: Infineon's TriCore Processor

MICROCONTROLLER

- √ Fast context switch & interrupt response
- √ Integrated Peripheral support
- √ Powerful bit manipulation unit & comparison Instructions

RISC processor

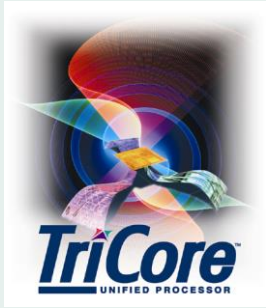
- √ 32-bit load/store Harvard architecture
- √ Super-scalar execution & uniform register set
- √ Memory Protection Unit (MPU) & C/C++ and RTOS support

DSP

- √ Sustainable single-cycle dual MAC
- √ DSP addressing modes & Zero overhead modes
- √ Saturation, Rounding & Q-Math (fraction format)

Three in **One**

TriCore™
AURIX™
MCU



AURIX™ TriCore unites the elements of a RISC processor core, a microcontroller and a DSP in one single MCU!

AURIX™ - the right **solution** for **CAV**

ENABLEMENT	› Excellent Know-How & Preferred Design House Support › Highest Quality Standards and Longterm Supply Availability
Scalability	› Fully scalable hardware with up to 3 Cores @ 300 MHz, 512kb to 8MB Flash, 48kb to 2.7MB SRAM, various packages (TQFP80-BGA516)
RIGHT FEATURES	› Special devices with extended SRAM up to 2.7MB SRAM › High Efficiency/low power architecture › Multiple ADCs & communication interfaces › Specrial devices with FFT engine for Radar applications
SAFETY	› Family Safety Concept based on ISO 26262 (up to ASIL D) › IEC61508 documentation (FMEDA / Safety Manual) › Comprehensive functional safety support
CONNECTIVITY & SECURITY	› Ethernet, CAN FD, › Hardware Security Support
EXTENSIVE ECOSYSTEM	› Free and comprehensive toolchain to get started

No other MCU family can offer this **combination** of functionality across multiple compatible products

Commercial, construction and agricultural vehicles (CAV)- Focus Applications

ADAS/Safety

- 24 GHz radar
- 77 GHz radar
- 24V Sensor Fusion
- EHPS
- Braking

Connectivity

- 24V Gateway BCM with SOTA Platooning
- Telematics, Smart Cockpit

Low voltage motor control

- Unidirectional motor control of DC motor
- 24V Brushed DC motor control
- 24V Brushless DC motor control
- 24V EMS

Hybrid electric solutions

- Auxiliary applications
- Powertrain inverter
- BMS, DCDC Converter, OBC, Charging

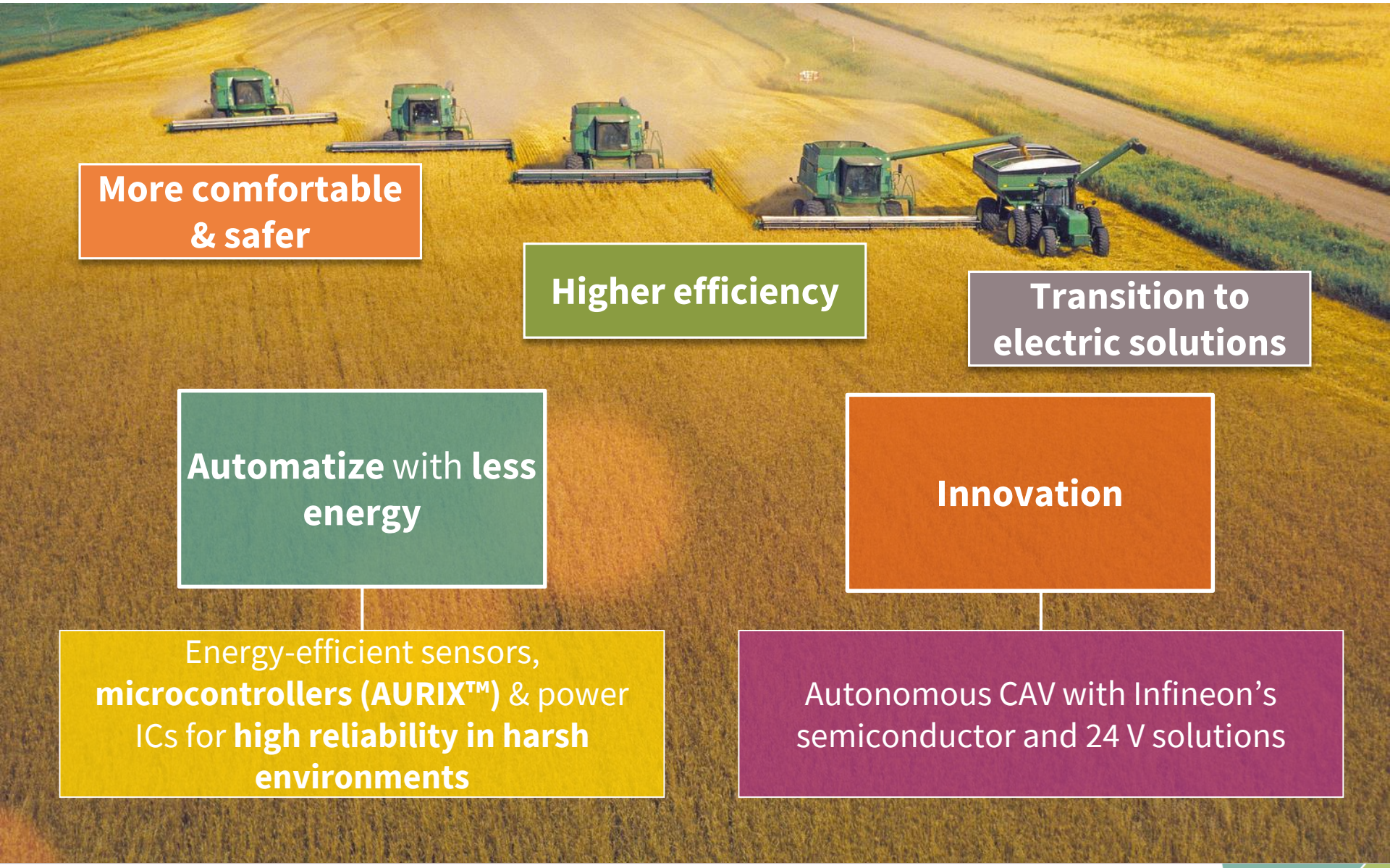
Body and I/O management

- 24V body ECU, BCM
- Hydraulic & Pneumatic management systems
- LED Lighting
- Seat management

Transportation

- Safety management systems for trains
- Safety Airborne systems (EASA)

AURIX™ advantages for Commercial, construction and agricultural vehicles (CAV)



More comfortable & safer

Higher efficiency

Transition to electric solutions

Automatize with **less energy**

Energy-efficient sensors, **microcontrollers (AURIX™)** & power ICs for **high reliability in harsh environments**

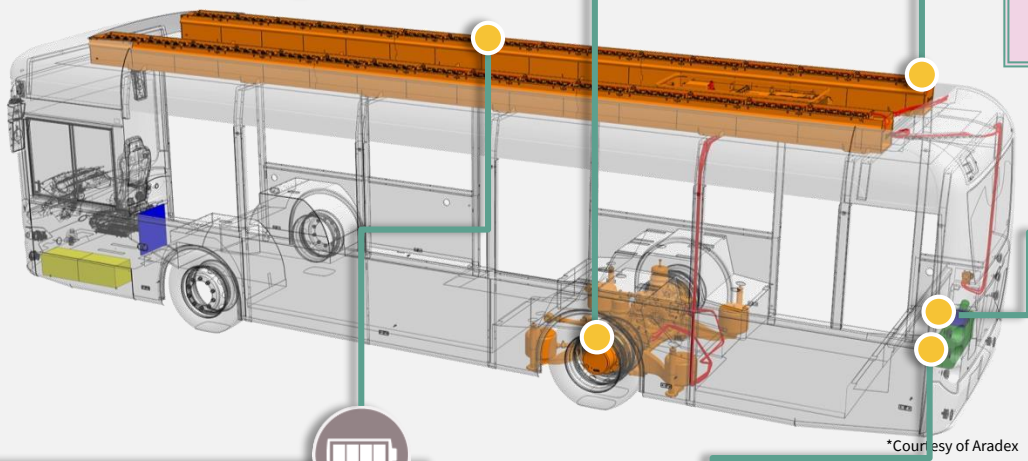
Innovation

Autonomous CAV with Infineon's semiconductor and 24 V solutions

AURIX™ advantages for eletrification of eBUS

Main inverter
Torque management & rotor positioning for efficient motor control

DC/DC converter
Handles communication to AUTOSAR stack & executes control loops for up to 8 phases



*Courtesy of Aradex

Auxiliaries
Drives water pump, cooling compressor or oil pump for best energy efficient use

Battery management
Monitors and reacts on State of Health, State of Charge and Depth of Discharge with the assistance of balancing ASICs

On-board charger
Ensures galvanic insulation between mains and HV-battery, secure charge-billing & various power classes for flexible charging times

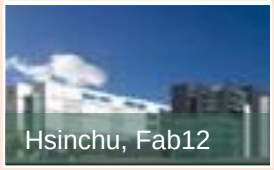
AURIX™: Quality & Business Continuity Leadership

AURIX™: Supply Security Leadership

THREATS

- FIRE
- ACCIDENT
- NATURAL DISASTERS
- OTHER PERILS

Infineon DELIVERS

Dual Fab Concept	3 Month Supply Chain Buffer	Preparedness
TSMC  Hsinchu, Fab12 TSMC  Tainan, Fab14	› ~3 months delivery possible from available WIP within supply chain	› **EDDIE: Early Detection System** of Natural Hazards & Critical Incidents › **Business Continuity Plan** - in Place

Continuity of supply is critical for our customers. AURIX™ delivers.

AURIX™: Long Term Technology Availability

32 Bit (TriCore™) Technology Horizon: AURIX™ 1G

Product	Technology	Wafer Fab	Location	2014	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
TC26x	65nm	TSMC	Taiwan																					
TC27x	65nm	TSMC	Taiwan																					
TC29x	65nm	TSMC	Taiwan																					
TC23x	65nm	TSMC	Taiwan																					
TC22x	65nm	TSMC	Taiwan																					
TC21x	65nm	TSMC	Taiwan																					

Qualification successfully completed/mass production

No new designs recommended

No prognosis from today`s perspective possible, depending on volume

The **Long term availability & Next Level of Zero Defect** program ensures **Quality & extended product supply life cycle** throughout the full AURIX™ MCU products

AURIX™: Scalable Family Concept

AURIX™: TC2xx Scalable Family
From low cost to high performance applications

Flash \ Package	TQFP 80	TQFP 100	T/LQFP 144	LQFP 176	LFBGA 292	BGA 416	LFBGA 516
TC29x 8 MB	🔒				TC297T 300MHz	TC298T 300MHz	TC299T 300MHz
TC27x 4 MB	🔒			TC275T 200 MHz	TC277T 200MHz		
TC26x 2.5 MB			TC264D 200 MHz	TC265D 200 MHz	TC267D 200 MHz		
TC23x 2 MB	🔒	TC233L 200 MHz	TC234L 200 MHz		TC237L 200 MHz		
TC22x 1 MB	TC222L/S 133 MHz	TC223L/S 133 MHz	TC224L/S 133 MHz				
TC21x 512 kB	TC212L/S 133 MHz	TC213L 133 MHz	TC214L/S 133 MHz				

🔒 Devices with HSM

↕ Upgrade/Downgrade path with pin compatible packages

Single Core (S) Single Lockstep Core (L), Dual Core (D) Triple Core (T)

PRO SIL™: Safety supporting features

MCU Scalability
- Performance & Flash
- Software compatibility
- Pin-compatibility
- Diverse timer architecture

Power Consumption
- On-chip DC/DC high-efficiency power supply

Safety Concept
- PRO-SIL™ ISO26262/ IEC61508 compliance
- HW redundancy options

Security Concept
- Selected devices with Hardware Security Module (HSM)

Availability
- All devices are in mass production

Tools & Boards
- Multiple options available

AURIX™: TC29x Series – Performance Device

The AURIX™ family addresses applications, where more performance, connectivity, safety and security are needed.

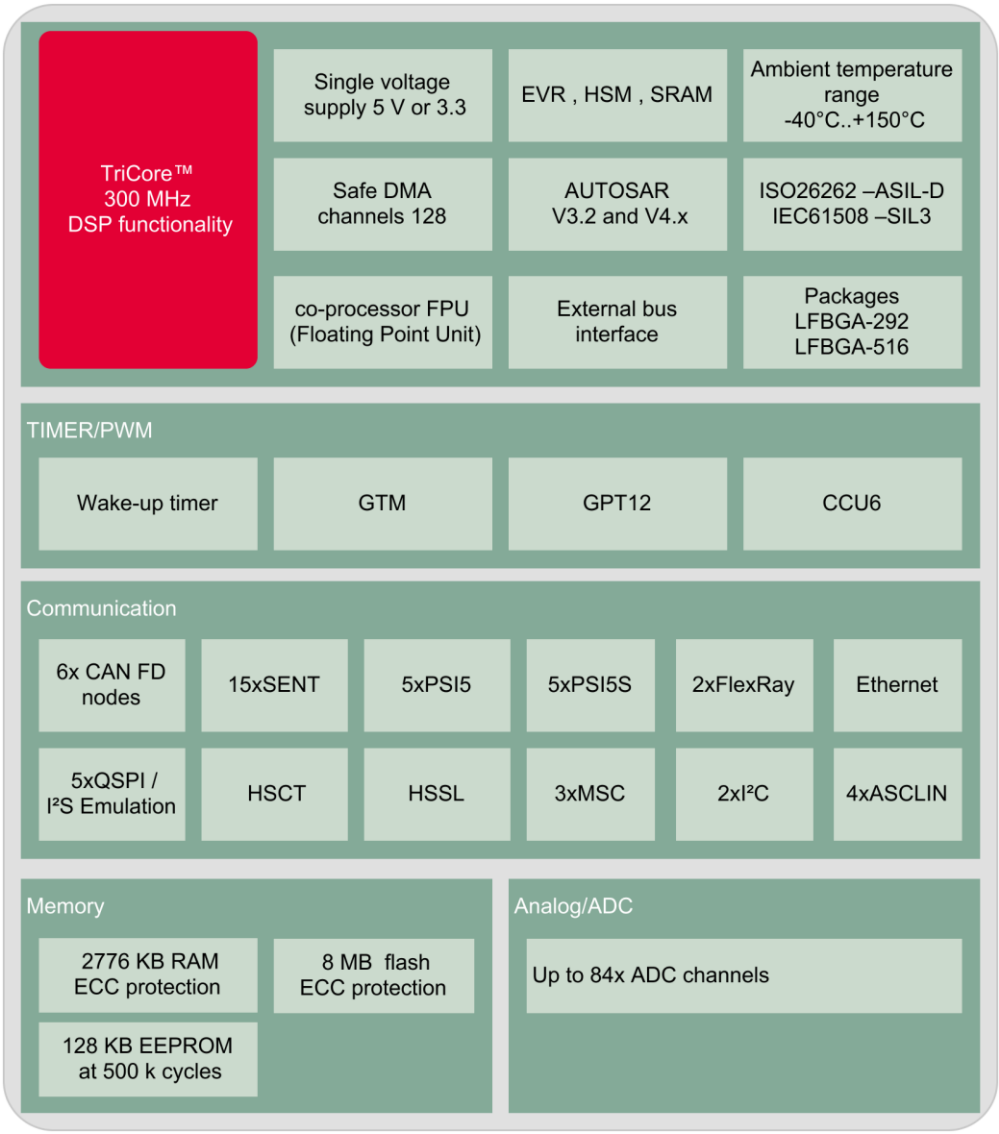
AURIX™ TC2xx microcontrollers serve the precise needs of the automotive and industrial market in terms of performance and safety

Most innovative safety:

- Diverse Lockstep Core with clock delay
- Redundant and diverse timer modules (GTM, CCU6, GPT12)
- Access permission system
- Safety management unit
- DMA
- I/O, clock, voltage monitor
- Developed and documented following ISO 26262 to support safety requirements up to ASIL-D
- AUTOSAR V3.2 and V4.x

System benefits :

- Diverse Lockstep architecture to reduce development effort for ASIL-D systems .
- High integration for reduced complexity and significant cost savings .
- Delta-sigma analog-to-digital converters for fast and accurate measurements .
- Innovative single supply concept for best-in-class power consumption and cost savings in external supply .
- Scalability in terms of performance, packages, memory and peripherals for flexibility across platform concepts .
- Available as single and lockstep core .
- Latest connectivity CAN FD (flexible data rate) .
- Scalable safety from QM to ASIL D for Industrial and Automotive Applications .
- Dedicated emulation device chip (ED) for multicore debugging, tracing and calibration .
- Hot package options for extended temperature range



AURIX™: TC21x Series – Value Efficient Device

The AURIX™ family addresses applications, where more performance, connectivity, safety and security are needed.

AURIX™ TC2xx microcontrollers serve the precise needs of the automotive and industrial market in terms of performance and safety

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- Diverse Lockstep Core with clock delay
- Redundant and diverse timer modules (GTM, CCU6, GPT12)
- Access permission system
- Safety management unit
- DMA
- I/O, clock, voltage monitor
- Developed and documented following ISO 26262 to support safety requirements up to ASIL-D
- AUTOSAR V3.2 and V4.x

System benefits :

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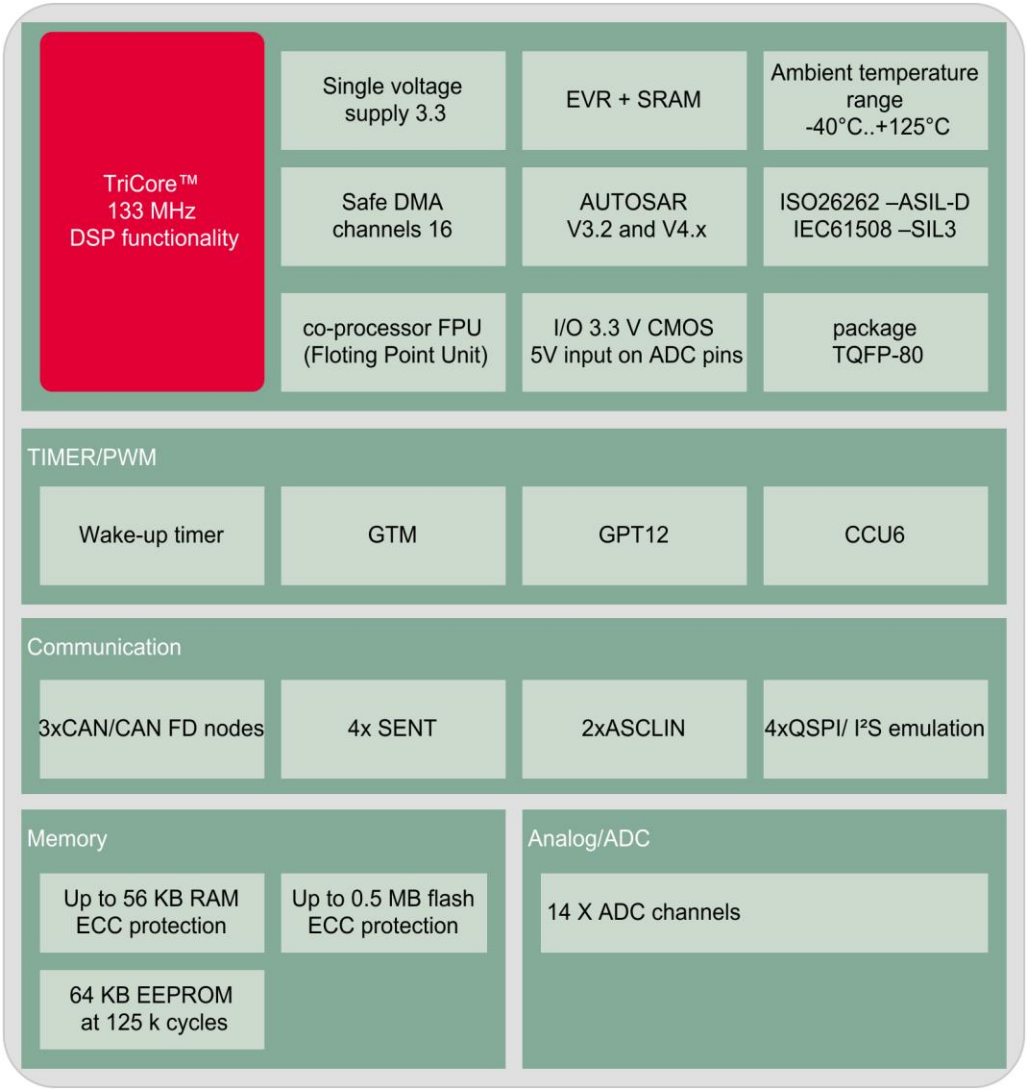


AURIX™ device list: Endless applications

Feature Set		9x Series	7x Series	6x Series	3x Series	2x Series	1x Series
TriCore	# Cores / Checker	3 / 1	2 / 1	1 / 1	- / -	- / -	- / -
1.6P	Frequency	2x300 / 1x200 MHz	200 MHz	200 MHz	-	-	-
TriCore	# Cores / Checker	- / -	1 / 1	1 / -	1 / 1	1 / 1 (1 / 0)	1 / 1 (1 / 0)
1.6E	Frequency	-	200 MHz	200 MHz	200 MHz	133 MHz	133 MHz
Flash	Program Flash	8 MB	4 MB	2.5 MB	2 MB	1 MB	512 KB
	EEProm @ w/e cycles	128 KB @ 500k	64 KB @ 500k	16 KB @ 500k	128k @ 125 k cycles	96k @ 125k cycles	64k @ 125k cycles
SRAM	Total (DMI , PMI, LMU)	728 KB	472 KB	240 KB	192 KB	96 KB	56 KB
DMA	Channels	128	64	48	16	16	16
ADC	Modules 12bit / DS	11 / 10	8 / 6	4 / 3	2 / -	2 / -	2 / -
	Channels 12bit / DS	84 / 10 diff	60 / 6 diff	50 / 3 diff	24 / -	/ -	24 / -
Timer	GTM Input / Output	48 / 152 channels	32 / 88 channels	24 / 64 channels	8 / 32	8 / 32	8 / 32
	CCU / GPT modules	2 / 1	2 / 1	2 / 1	2 / 1	2 / 1	2 / 1
Interfaces	FlexRay (#/ch.)	2 / 4	1 / 2	1 / 2	1 / 2	-	-
	CAN FD[3] (nodes/obj)	6 / 384	4 / 256	5 / 256	6 / 256	3 / 128	3 / 128
	QSPI / ASCLIN / I2C	6 / 4 / 2	4 / 4 / 1	4 / 4 / 1	4 / 2 / -	4 / 2 / -	4 / 2 / -
	SENT / PSI5 / PSI5S	15 / 5 / 1	10 / 3 / 1	6 / 2 / 1	4 / -	4 / -	4 / -
	HSCT / MSC / EBU	1 / 3 diff LVDS / 1	1 / 2 diff LVDS / -	1 / 2 diff LVDS / -	- / - / -	- / - / -	- / - / -
	Other	Ethernet	Ethernet	Ethernet	-	-	-
Safety	SIL Level	ASIL-D	ASIL-D	ASIL-D	ASIL-D	ASIL-D	ASIL-D
Security	HSM	Yes	Optional	No	Optional	No	No
Power	EVR	Yes	Yes	Yes	Yes	Yes	Yes

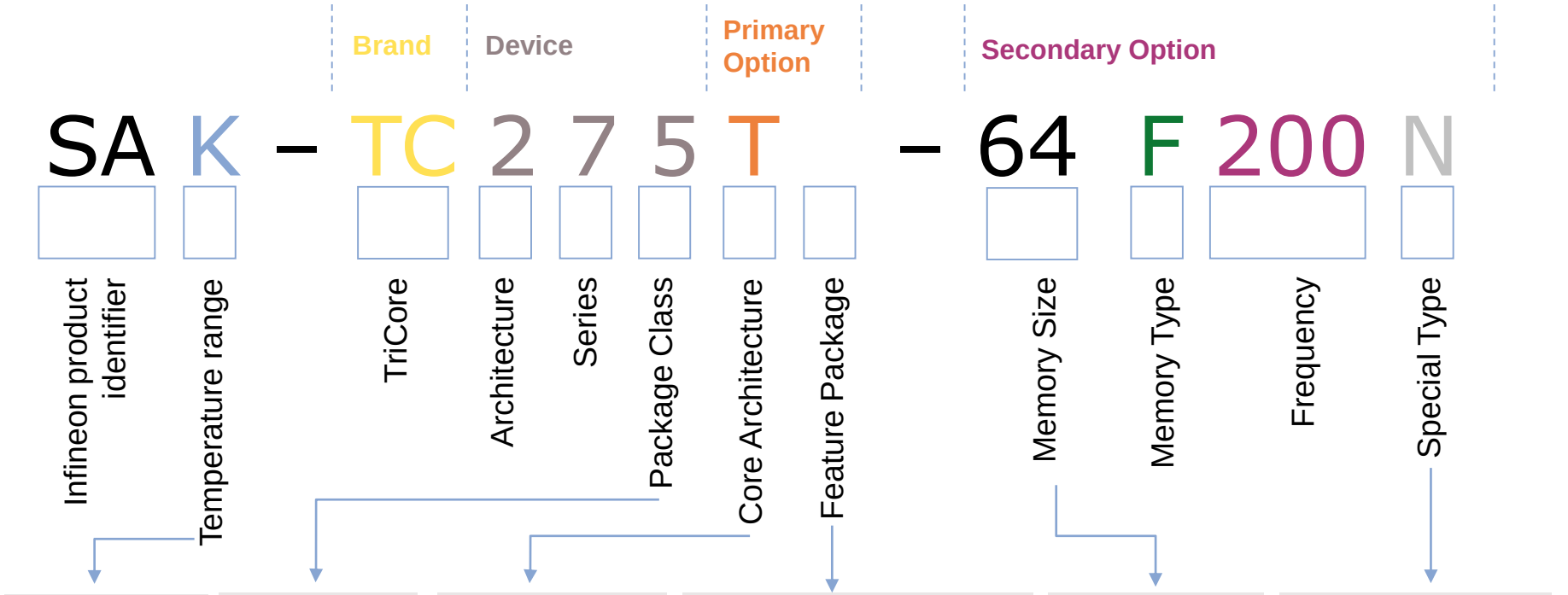
AURIX™ family concept offers both scalable feature-sets and pin-outs for optimal flexibility

AURIX™ device list: Endless applications

Feature Set Special Devices		29x Xtended	29x ADAS	26x ADAS	23x Xtended	23x ADAS
TriCore 1.6P	# Cores / Checker	3 / 1	3 / 1	- / -	- / -	- / -
	Frequency	2x300 / 1x200 MHz	2x300 / 1x200 MHz	-	-	-
TriCore 1.6E	# Cores / Checker	- / -	- / -	1 / -	1 / 1	1 / 1
	Frequency	-	-	200 MHz	200 MHz	200 MHz
Flash	Program Flash	8 MB	8 MB	2.5 MB	2 MB	2 MB
	EEProm @ w/e cycles	128 KB @ 500k	128 KB @ 500k	16 KB @ 500k	128k , 125 k cycles	128k , 125 k cycles
SRAM	Total (DMI , PMI, LMU)	728 KB + **2MB**	728 KB + 2MB	240 KB + 512 KB	192 KB **+ 512KB**	192 KB + 512KB
DMA	Channels	128	128	48 + ADAS DMA	16	16
ADC	Modules 12bit / DS	11 / 10	11 / 10	4 / 3	4/ -	4 / -
	Channels 12bit / DS	84 / 10 diff	84 / 10 diff	40 / 3 diff	24 / -	24 / -
Timer	GTM Input / Output	48 / 152 channels	48 / 152 channels	24 / 64 channels	8 / 32	8 / 32
	CCU / GPT modules	2 / 1	2 / 1	2 / 1	2 / 1	2 / 1
Interfaces	FlexRay (#/ch.)	2 / 4	2 / 4	1 / 2	1 / 2	1 / 2
	CAN FD[1)] (nodes/obj)	6 / 384	6 / 384	5 / 256	6 / 256	6 / 256
	QSPI / ASCLIN / I2C	6 / 4 / 2	6 / 4 / 2	4 / 4 / 1	4 / 2 / -	4 / 2 / -
	SENT / PSI5 / PSI5S	15 / 5 / 1	15 / 5 / 1	6 / 2 / 1	4 / -	4 / -
	HSCT / MSC / EBU	1 / 3 diff LVDS / 1	1 / 3 diff LVDS / 1	1 / 2 diff LVDS / -	- / - / -	- / - / -
	Other	Ethernet	Ethernet, **CIF, FFT accelerator**	Ethernet, **CIF, FFT accelerator**	Ethernet	Ethernet, **FFT accelerator**
Safety	SIL Level	ASIL-D	ASIL-D	ASIL-D	ASIL-D	ASIL-D
Security	HSM	Yes	Optional	No	Option	Option
Power	EVR	Yes	Yes	Yes	Yes	Yes

AURIX™ family concept offers both scalable feature-sets and pin-outs for optimal flexibility

AURIX™ Getting Started with A1G: Product Selector



Temp. Range
K -40°C - +125°C
L -40°C - +150°C

Package Class
9 LFBGA-516
8 BGA-416
7 LFBGA-292
5 LQFP-176
4 L/TQFP-144
3 TQFP-100
2 TQFP-80
0 Bare Die

Core Architecture
T Triple Core
D Dual Core
S Single Core
L Single Core with Lockstep

Feature packages
- Production Dev., No HSM
P Prod. Dev., HSM enabled
E Emulation Dev., no HSM
F Emulation Dev., HSM enabled
A ADAS enhanced, HSM enabled
X Feature ext., HSM enabled
C Customer specific

Flash size code

8	0.5MB
16	1 MB
24	1.5 MB
32	2 MB
40	2.5 MB
64	4 MB
96	6 MB
128	8 MB

Special Type Code
N CAN FD ISO frame
W LQFP 0.5mm pitch
F TQFP 0.4mm pitch
L BGA 1.0 mm pitch
S LFBGA 0.8mm pitch
Q Fusion Quad QFP 0.5 mm pitch

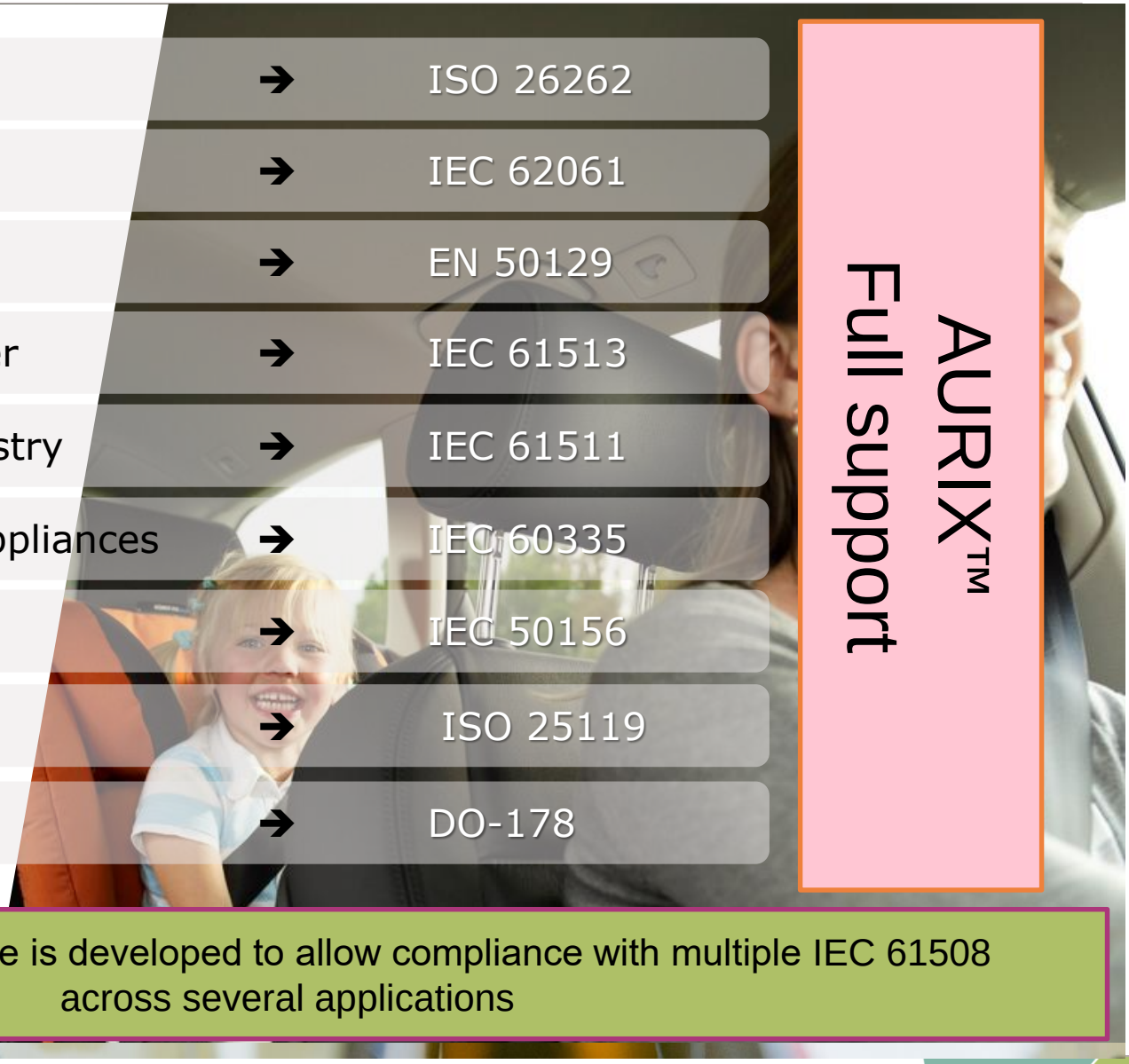
Consult the AURIX™ product selector to order samples today!

AURIX™: Functional Safety Leadership

AURIX™: Functional Safety Leadership

IEC 61508

Automotive	→	ISO 26262
Machinery	→	IEC 62061
Railway	→	EN 50129
Nuclear Power	→	IEC 61513
Process Industry	→	IEC 61511
Household Appliances	→	IEC 60335
Furnaces	→	IEC 50156
Agriculture	→	ISO 25119
Aviation	→	DO-178



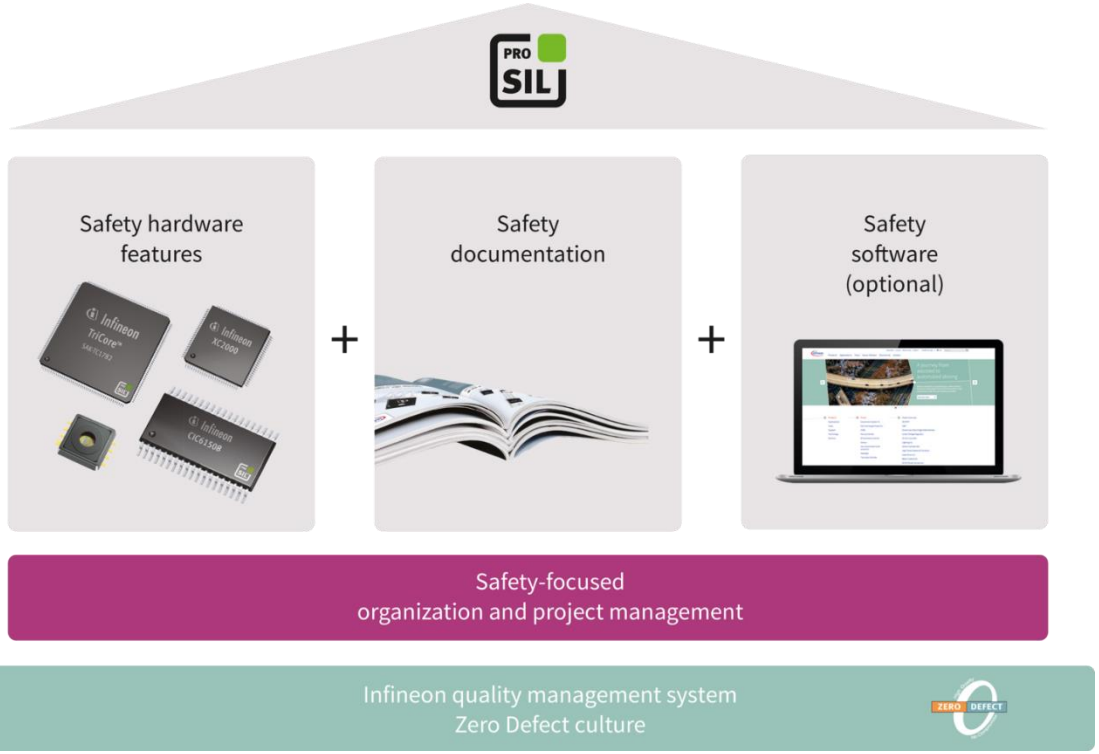
AURIX™ Full support

The AURIX™ architecture is developed to allow compliance with multiple IEC 61508 across several applications

AURIX™: Functional Safety Leadership as specified by PRO- SIL

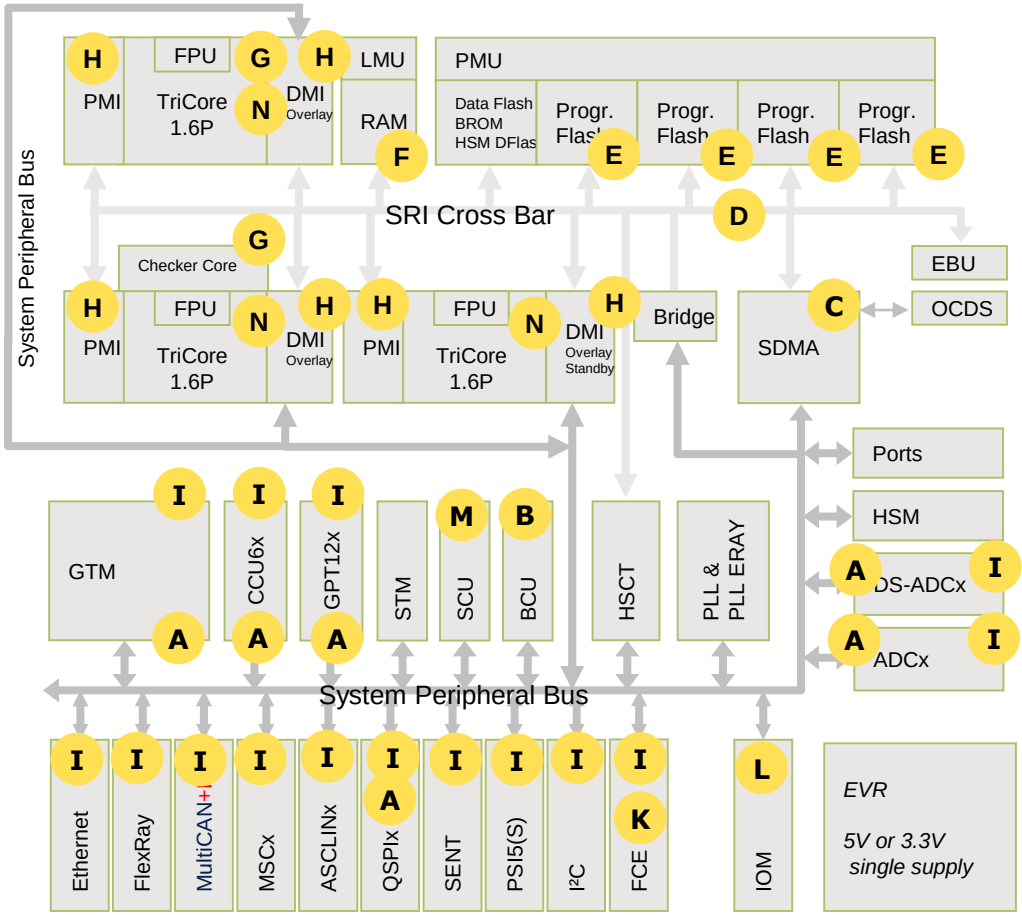
What is PRO-SIL™?

- PRO-SIL™ shows where an Infineon product has SIL (Safety Integrity Level) features
- Allows Infineon products to attain SIL (IEC 61508) and ASIL ISO 26262) level for safety systems



The AURIX™ is PRO-SIL™ compliant with safety hardware features throughout. Documentation may require an NDA. PRO-SIL™ SafeTlib Safety Software is available.

AURIX™: Hardware Functional Safety Leadership



- A Redundant, spatially separated peripherals
- B Bus Monitoring Unit
- C Safe DMA
- D Safe SRI
- E FLASH ECC (detects multi bit failures)
- F SRAM ECC (detects multi bit failures)
- G Lockstep core
- H Memory protection core
- I Memory protection peripherals
- J Safe Interrupt Processing
- K Flexible CRC Engine (FCE)
- L IO Monitor
- M Clock Monitoring
- N CPU self tests (90% Latent Fault Metric)

SAFETY is more than just a lockstep core. AURIX™ is designed with Pro-SIL™ (Safety Integrity Level) features throughout

AURIX™ Safety: IEC61508 Documentation

Safety documents:

FMEDA based on IEC61508

&

Safety Manual which contains IEC61508 data

+

Safety Case:

Infineon will not provide the IEC61508 Safety Case based only on ISO26262

Safety Case has to be done at the system level by the customer

+

Safety Support (optional):

Can be handled by PDH partner and can be booked from customer directly at PDH partner

Infineon partners are published on: www.infineon.com/pdh

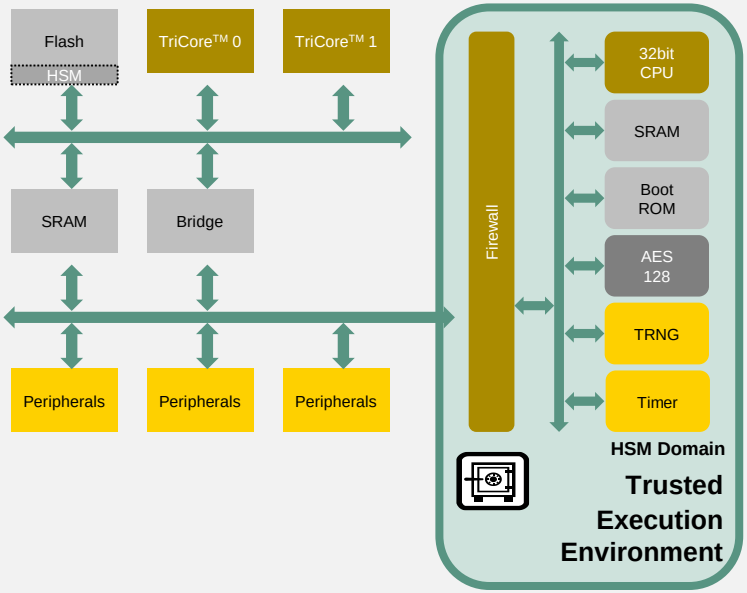
How to get access to the documentation? (might be subject to NDA)

- Register on MyInfineon on www.infineon.com
- After registration please send your email address to pdh-support@infineon.com and access to the documentation will be granted

AURIX™: Security Leadership

AURIX™ HSM: Automotive Security Leadership

What is the AURIX™ Hardware Security Module (HSM)?



- Trusted Execution Environment
- 32-bit ARM MCU separated by firewall
- Reserved access to shared NVM to host OEM application SW

AURIX™ HSM Use Cases

- Key Distribution and Generation
- Secure Boot
- Secure on board communication

AURIX™ HSM Crypto Accelerators

- **On-chip Symmetric:** HW AES-128
- **Asymmetric:** implemented in SHE + SW

AURIX™ HSM Security Level

- **EVITA Medium:** The standard for Secure on-board communications

AURIX™ provides security leadership by enabling secure on-board communications. HSM is available now on selected devices.

AURIX™:
Extreme Temperature Leadership

AURIX™: Extreme Temperature Leadership

Standard Automotive Temp (SAK)

- Standard Auto Temp range
  - -40 to + 125°C

Infineon HOT Package (SAL)

- Upgraded to
  - -40 to + 150°C

Potential Application

- Anywhere where extreme temperatures are required
- Examples include, transmissions, All wheel drive, starter generator….

No other scalable Automotive MCU family can offer HOT package, SAFETY and SECURITY across the entire product range

AURIX™: Extensive Ecosystem

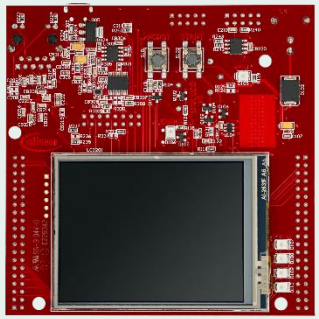
AURIX™ Getting Started: Kits

€99

Arduino Shield Buddy

- The Hitex TC275 ShieldBuddy follows the Arduino standard
- Compatible with 100's of Arduino application shields
- Evaluation licenses available
- Ideal for getting started on a high end real time embedded industrial or automotive application as well as students and hobbyists.
- KIT_AURIX_TC275_ARD_SB

€149



AURIX™ TFT

- Low cost board for early evaluation with limited access to signals
- Additional touchscreen display for convenient handling
- TFT board available for every silicon
- KIT_AURIX_TC2xx_TFT

€350+

AURIX™ TriBoard

- Full evaluation board for development to write and debug your 1st programs
- Includes Getting Started advice, free TriCore Entry Tool Chain , technical documentation, compiler and debugger.
- TriBoard available for every silicon
- KIT_AURIX_TC2xx_TRB

For more applications please check: www.Infineon.com/AURIX

AURIX™ Application Kits

To accelerate your Time to Market

Motor Control

- TC234 Application Kit with TFT Display incl. safety supply TLF35584
- Driving of a 3 Phase PMSM/BLCD (12Volt/max. 50Watt)
- BLDC Motor from Nanotec integrated
- Software available with flexible configuration
- **KIT_AURIX_TC234_MOTORCTR**

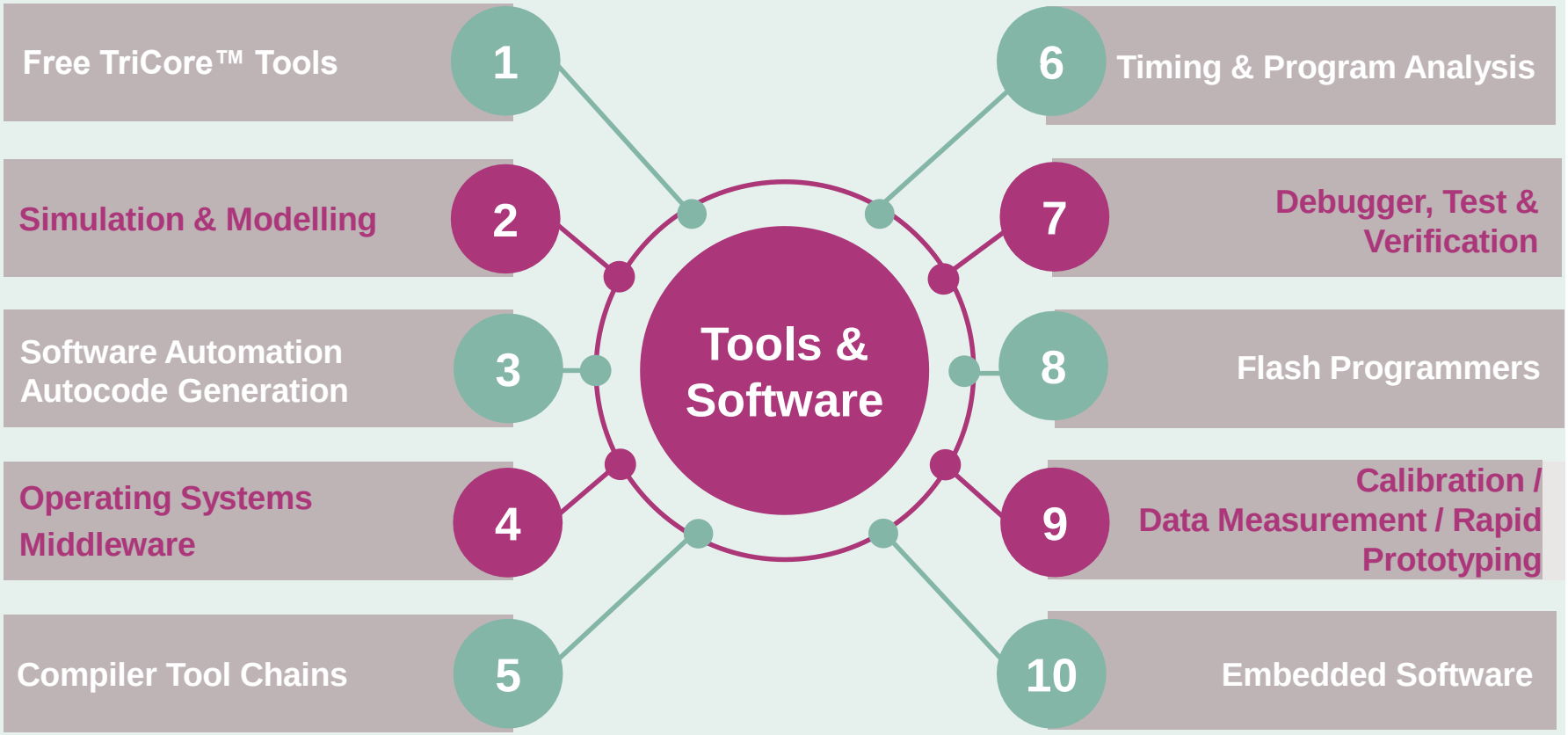
24GHz Radar

- Range-Doppler radar system with two Rx antennas and one Tx antenna based on AURIX™ TC264DA and BGT24ATR12
- allow implementation and testing of 24GHz radar applications as Doppler movement detectors, FSK or FMCW range/position measurement
- **KIT_ATV_24GHZ_RADAR**

Wireless Charging

- Supports all fast charge smartphones
- Unique power drive architecture minimizes EMI
- Improved accuracy Foreign Object Detection (FOD)
- **KIT_AURIX_TC21_SC**

AURIX™ Tools & Software Ecosystem

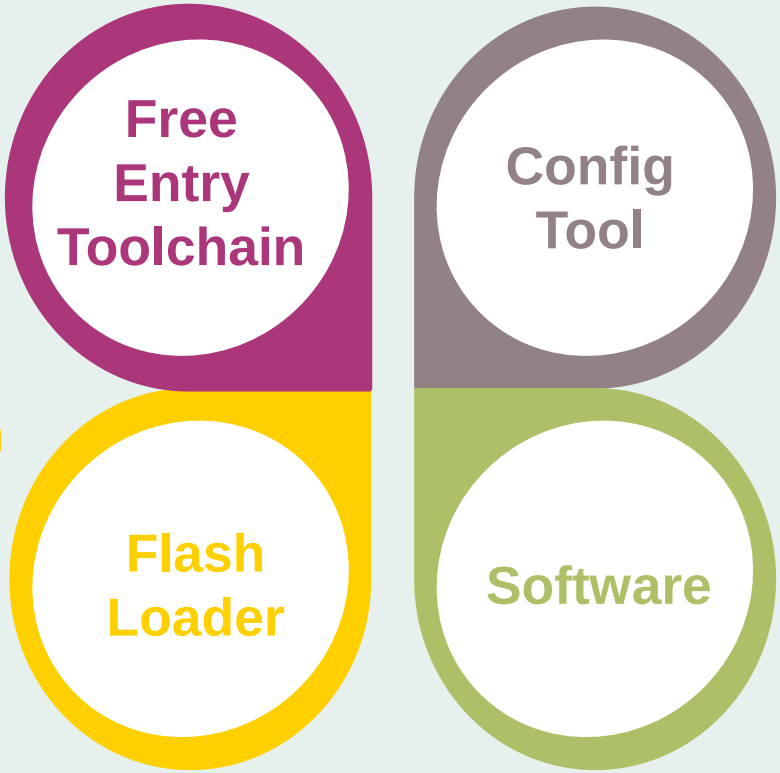


Infineon together with our partners has created an extensive AURIX™ Tools and software Ecosystem. Find the solution that works for you

AURIX™ Getting Started: Free Tools

AURIX™ Free Tool Chain

- **Provider:** HighTec
- Eclipse based IDE
- GNU C compiler
- On-chip flash programming



AURIX™ Configuration

- **Provider:** Altium
- AURIX™ pin mapping
- Drivers files + OS
- Compiler and debugger

AURIX™ Free Flash Loader

- **Provider:** Infineon
- Flash Loader SW
- Data Communication

Software

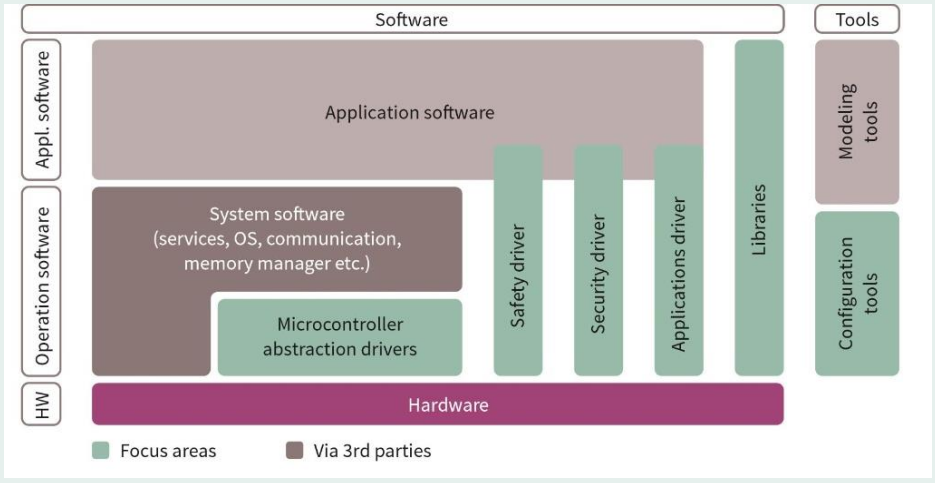
- **Provider:** Infineon
- Mem Tool – on chip flash programming
- DAS (Device Access Server) tool interface

It's easier than ever to get started with AURIX™ free Tools

AURIX™: Embedded Software Solution MC-ISAR

Why Infineon MC-ISAR Software?

1. Customer gets optimized software based on IFX hardware expertise.
2. Infineon saves the opportunity cost of SW developers
3. Leaves more time to differentiate with systems level software



MC-ISAR low-level drivers based on the AUTOSAR MCAL layer

- Set of standardized basic software drivers packages:
  - Basic
  - COM (Communications)
  - MEM (Memory)
  - CD (Complex Drivers)

To find our how to license MC-ISAR software, please contact tac@infineon.com

AURIX™: More Information

AURIX™ for CAV:
www.Infineon.com/CAV

Product home page AURIX™:
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