Automotive Functional Safety for C2000™ Real-Time Microcontrollers

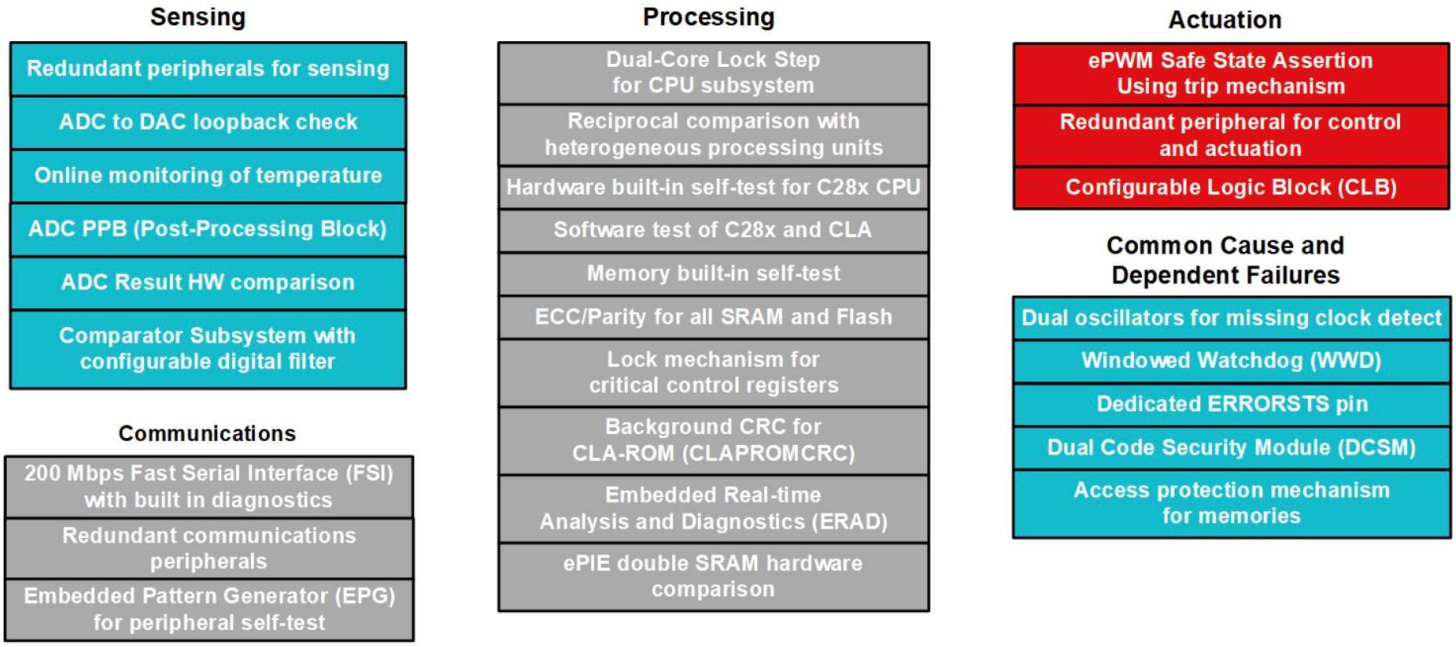
Texas Instruments

Streamline and speed up the ISO 26262 certification processes with our Functional Safety-Compliant products, documentation, software and support from our knowledgeable experts. Our C2000™ real-time MCUs are independently assessed and certified by TÜV SÜD to meet a systematic capability up to ASIL D and help you build automotive applications requiring functional safety. C2000 real-time MCUs also address **Industrial Functional Safety**.

Highlights of the C2000 functional safety offering are

- Device architecture tuned for functional safety
- Documentation to support to ease customer's safety assessment at system level
- Software library to implement the safety mechanisms

C2000 Key Safety Mechanisms



Safety mechanisms play a key role in the overall safety of a system by detecting potentially dangerous failures and consequently helping place the system in a safe state. With over 300 built-in safety mechanisms defined and independently assessed by TÜV SÜD for its effectiveness, C2000 MCUs provide the required diagnostic coverage to meet a random hardware capability of ASIL B at a component level. Functional safety manuals provide detailed information on the safety mechanisms, techniques for achieving non-interference between elements and avoiding dependent failures, to aid customers in the development of compliant systems up to ASIL D. The tunable FMEDA provides increased flexibility to customize and calculate HW metrics with features such as package FIT estimation, product function tailoring, safety mechanism tailoring and custom diagnostics allowing customers to **tune the FMEDA** to their own application specific needs.

Learn More about C2000 real-time MCU Key Safety Features

Key safety features		F2838x	F2837x F2807x	F28004x	F28003x	F28002x	F280015x	F28P65x	F28P55x
Hardware	ASIL D Compliant Development Process	✓	✓	✓	✓	✓	✓	✓	✓
	Random Hardware Capability	ASIL B	ASIL B	ASIL B	ASIL B	QM	ASIL B	ASIL B	ASIL B
	Systematic Capability	ASIL D	ASIL D	ASIL D	ASIL D	ASIL D	ASIL D	ASIL D	ASIL D
	Single Point Fault Coverage of CPU (SPFM)	Reciprocal comparison	Reciprocal comparison	Reciprocal comparison	Reciprocal comparison	N/A	Lockstep C28x	Reciprocal comparison (CPU1 + CLA) Lockstep C28x (CPU2)	Reciprocal comparison
	Memory parity	✓	✓	✓	X	X	✓	✓	✓
	Memory ECC	✓	✓	✓	✓	✓	✓	Flash Only	✓
	Memory BIST (MPOST)	✓	X	✓	✓	✓	✓	✓	✓
	Dual Core Security Module (DCSM) to achieve non-interference between software elements	✓	✓	✓	✓	✓	✓	✓	✓
	Windowed watch-dog timer with independent clock	✓	✓	✓	✓	✓	✓	✓	✓
	Hardware CRC acceleration	✓	✓	✓	✓	✓	✓	✓	✓
	Hardware BIST (HWBIST): Permanent fault coverage of 90%+ for C28x CPU	✓	✓	X	✓	✓	X	✓	X
	Redundant and independent ADC / PWM Modules	✓	✓	✓	✓	✓	✓	✓	✓
	Automatic comparison of ADC conversion results in HW	X	X	X	X	X	X	✓	✓
	Redundant Configurable Logic Block (CLB) option	✓	✓	✓	✓	✓	N/A	✓	✓
Software	STL (Software Test Library): Permanent fault coverage of 60%+ for C28x CPU	N/A	N/A	✓	N/A	N/A	✓	✓	Coming Soon
	STL (Software Test Library): Permanent fault coverage of 60% for CLA	✓	✓	✓	✓	N/A	N/A	✓	Coming Soon
	Functional Safety Quality (FSQ) Flash APIs	X	X	X	✓	N/A	✓	✓	✓
Doc	Safety Manual: detailed product overview, capabilities and constraints, TI development process, safety elements, and safety diagnostics.	SFFS022	SPRUI78	SPRUID8	SFFS277	SPRUIT5	SFFS222	SFFS700	Beta
	Device Certification	SSZQQM2	SWAQ009	SPRQ004	SFFS610	N/A	SFFS748	SFFS901	Coming Soon

Safety collateral	
Development Process Certificate Hardware | Software	TUV-SUD certificate for QRAS-AP00210. Functional safety development process for IEC 61508-2 and ISO 26262-5 Compliant Hardware Components
C2000 Safety package*	By request and NDA required. Package includes below elements: • **Technical Report on Random HW Capability** • **Technical Report on Systematic Capability** • **FMEDA**: A failure mode, effects and diagnostic analysis (FMEDA) is used in the development stage to provide a detailed analysis of different failure modes, the associated effects of failure modes, diagnostics and the impact of any implemented diagnostics/ safety mechanisms in terms of diagnostic coverage. 5 part FMEDA training video series. • **Device Concept Assessment** • **SAR (Safety Analysis Report)**: Contains results of safety analysis according to the targeted functional safety standards.
Software diagnostic library	A library of modules and examples demonstrating safety features and mechanisms. Examples include CPU, memory, clocks/ watchdogs, HWBIST, etc. F2837x/07x supported through this library. All other F28x series supported by libraries released in C2000Ware.
C28x CPU self-test library (C28x-STL)*	Library to perform start-up for C28x logic integrity

CLA co-processor self-test library*	Library to perform start-up and periodic tests for CLA logic integrity
Functional Safety flash APIs	Library is available in C2000Ware. Contact local TI representative for further compliance support package offerings.
Compiler qualification kit	Compare compiler coverage for customer use cases against coverage of TI compiler release validations
Safety certified RTOS (SafeRTOS)	Pre-certified safety Real Time Operating System (RTOS)
MathWorks simulation & code generation	IEC certification kit helps you qualify MathWorks code generation and verification tools to streamline certification of your embedded systems

*Not publicly available collateral. Contact your local TI representative to request.

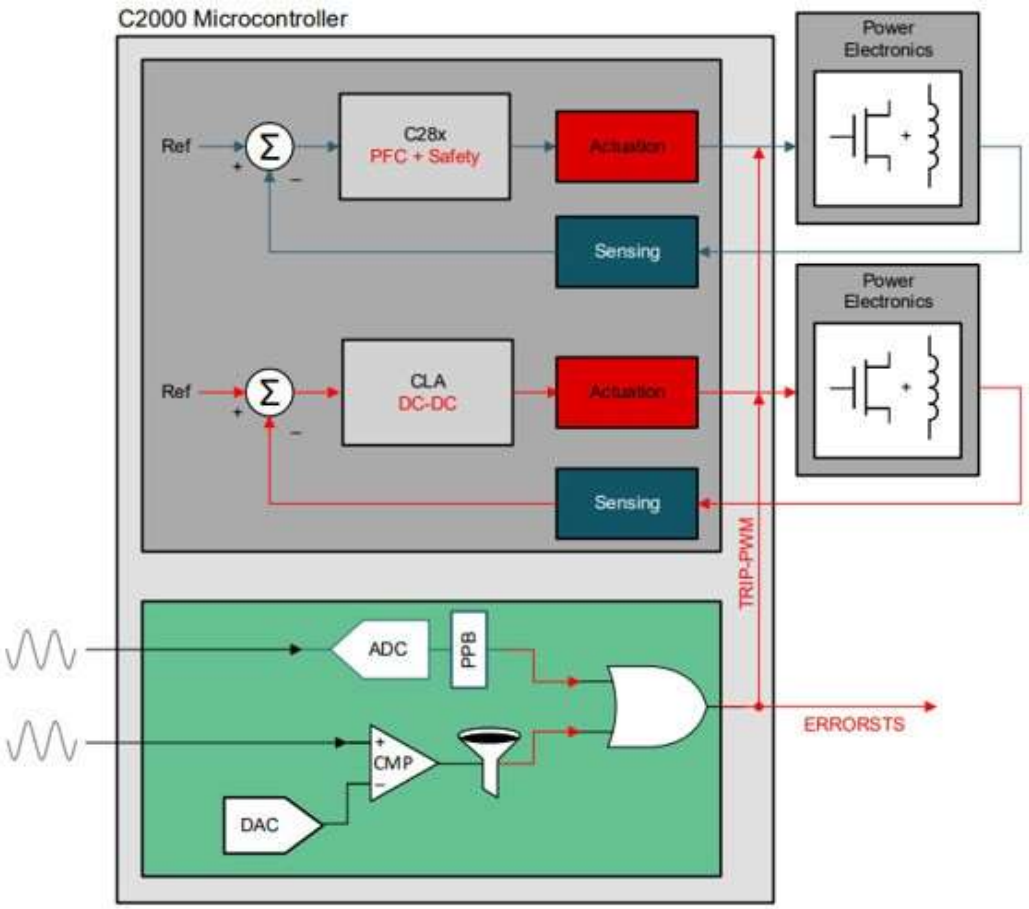


Figure 1. Automotive Functional Safety application example: on-board charger (OBC) with F28003x-Q1.

- Intended function: can be implemented on both C28x and CLA
- Safety mechanism: Implement on C28x or CLA, or using hardware modules such as ADC-PPB, CMPSS, SDFM secondary filter, CLB, and so forth
    - SPFM of the safety goal can be met by **Reciprocal Comparison by Software** or hardware redundancy between the modules used in implementing safety mechanism, **Periodic Software Read Back of Static Configuration Registers** and so forth
- Diagnostic function: Implement on the other processing unit or with hardware modules such as ADC-PPB, CMPSS, SDFM secondary filter, CLB, and so forth
    - LFM can be met by by **Software Test of CLA**, **Software Test of CPU** or S**oftware Test of Function Including Error Tests** and so forth

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