Application Brief

C2000™ F29H85x and F29P58x Real-Time Microcontrollers

Key Features and Benefits

- **Real-Time Processing**
  - Up to 3x 64-bit C29x CPU (VLIW architecture-based) running at 200MHz with the option of lockstep.
  - Delivers a total processing power equivalent to 480eMHz per Arm® Cortex™-M7* core.
  - Floating Point Unit up to 64 bits for more precision. Trigonometric Math Unit (TMU) to speed up algorithms key to real-time control systems.
- **Memory**
  - Up to 4MB Flash (ECC), 4x256KB banks.
  - Flexible architecture to distribute flash among CPUs.
  - Firmware Over the Air (FOTA) with A/B swap and Live Firmware Update (LFU).
  - 452kB RAM (ECC).
- **Sensing and Signal Generation**
  - 5x ADCs: 16 bit-1.19MSPS/ 12bit-3.92MSPS modes.
  - Up to 80 Channels, HW support for oversampling.
  - 21 Windowed Comparators with dual ramp generator and integrated 12-bit DAC for more synchronous signal protection.
  - 16x SDFM channels.
  - 6x SENT Interfaces.
- **Actuation**
  - Enhanced PWM to support multilevel topologies, safety with minimum dead-band, illegal combo logic and diode Emulation.
  - 36 HRPWMs with 75ps delay-line to support matrix converters, dual active bridge, resonant converters.
  - 6 CLB Tiles for encoder implementation, PWM protection, FPGA/CPLD removal.
- **Connectivity**
  - Highly connected with advanced communications such as EtherCAT ®, CAN-FD, UART, EMIF, FSI and more.
- **Safety**
  - Lockstep CPU/RTDMA/Interrupt controller (PIPE), MPOST, LPOST, Error Signaling Module, DCC
  - Functional Safety-Compliant targeted
  - Hardware and Systematic capability up to ASIL D and SIL 3 targeted.
- **Security**
  - EVITA-full Hardware Security Module (Cryptographic accelerators, Secure BOOT, Dedicated RAM/Flash).
  - Safety and Security Unit.
- **Packaging and Temperature**
  - 100 (14x14), 144 (18x18), 176 (22x22) HTQFP.
  - 256 (13x13) BGA.
  - Temperature: –40°C – 125°C

The F29H85x series is part of the high-performance line of C2000™ real-time microcontroller (MCU) family built for efficient control of power electronics. With the unmatched ultra-low latency, the device provides further real-time control innovation with enhanced control peripherals and advanced safety and security capabilities while optimizing cost with more integration, optimized BOM and at the device level.

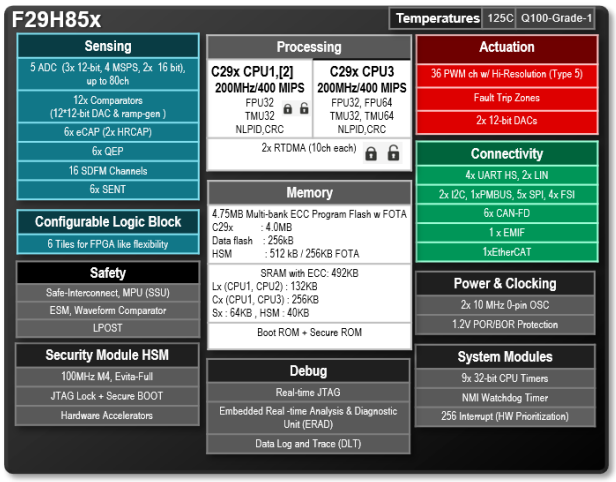


Figure 1. F29H85x Features Overview

Key Applications

- *Single-MCU architecture* for OBC+DCDC+Host utilizing the SSU to allow each function of a CPU to have its own code, data, stack, and peripheral access to achieve true freedom from interference (FFI).
- 36 PWMs with enhanced flexibility to enable new power topologies like multi-phase, multi-level power architecture, and matrix converters *for industrial power and automotive power train integration.*
- More ADC channels for more integration, HW ADC oversampling to save CPU bandwidth for *EV OBC / DC-DC, Automotive Safety Applications, Solar, and Energy Delivery.*
- Multicore with lock-step option for *enhanced safety* for *automotive* and *industrial*.
- Explore the wide range of applications enabled by F29H85x here.

Resources: Product and Software Pages

- F29H85x / F29H85x-Q1 Product Folder
- F29H85x LaunchPad™ Evaluation Module
- F29H85x controlSOM Evaluation Module
- F29H85x Software Development Kit
- F29H85x Motor Control SDK
- F29H85x Digital Power SDK
- Code Composer Studio Free IDE
- C29x Academy Training
- How MCUs Built With Innovative C29 Cores Increase Real-Time Performance in High-Voltage Systems Application Brief
- Achieving Faster Real-Time Signal Chain With C29 White Paper
- Implementing Real-Time Safety and Security with the SSU Application Note

New Generation 4 MCU Portfolio

The F29H85x real-time microcontrollers are the first of the Generation 4 C2000 MCU portfolio. This device is supported by the F29H85X-SDK, part of the F29x SDKs, and shares similarities in peripherals with many existing C2000 devices. Figure 2 illustrates this new *High-Performance* series tailored for security and safety focused applications.

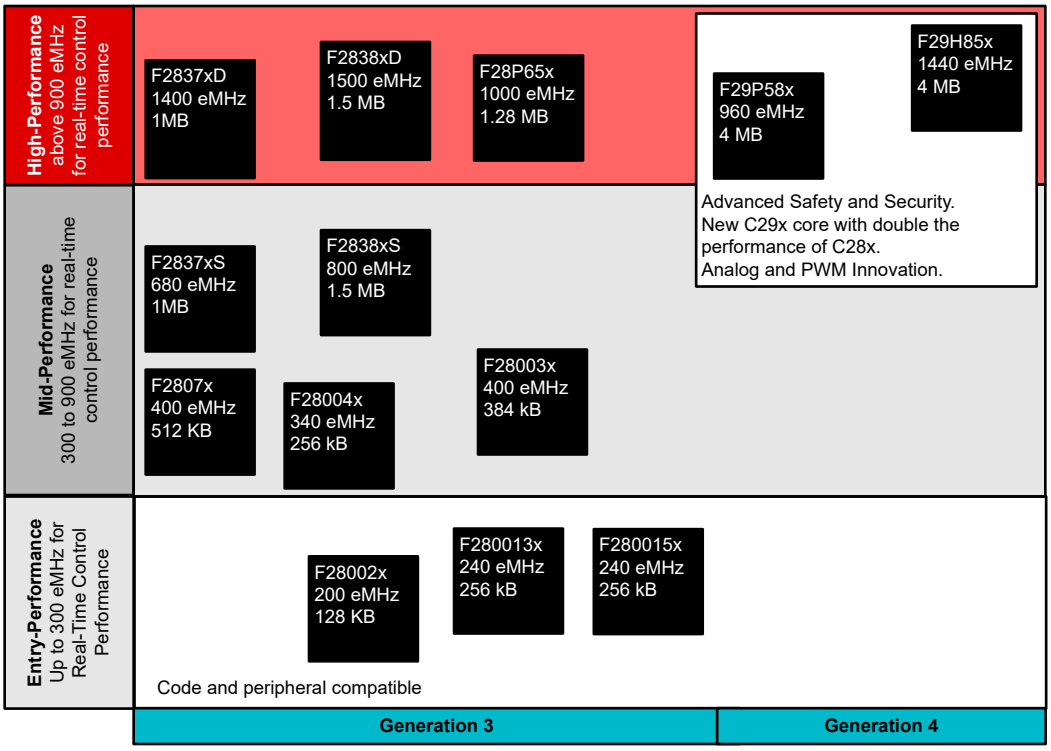


Figure 2. C2000 MCU Portfolio With New F29H85x and F29P58x High-Performance Line

Pin and Packaging Options

The F29H85x MCU series offers two memory and performance configurations and multiple package options with industrial (SIL-3) and automotive (ASIL-D/-Q1 parts) qualification support. Table 1 provides detailed information about packaging options and key differences.

Table 1. F29H85x and F29P58x Packaging Options and Key Variant Differences

Variant	Number of Cores (Running at 200MHz)	eMHz(1)	Flash	EtherCAT	Lock Step	100 QFP (16 × 16)	169 BGA (9 × 9)	176 QFP (26 × 26)	256 BGA (13 × 13)
F29H850TU9	3	1440	4 MB	✓	✓		✓	✓	✓
F29H859TU8	3	1440	4 MB		✓	✓	✓	✓	✓
F29H859TM8	3	1440	2 MB		✓	✓	✓	✓	✓
F29H850DU7	2	960	4 MB	✓			✓	✓	✓
F29H859DU6	2	960	4 MB			✓	✓	✓	✓
F29H850DM7	2	960	2 MB	✓			✓	✓	✓
F29H859DM6	2	960	2 MB			✓	✓	✓	✓
F29589DU5	2	960	4 MB		✓	✓	✓	✓	✓
F29580DM5	2	960	2 MB		✓	✓	✓	✓	✓
F29589DM5	2	960	2 MB		✓	✓	✓	✓	✓

(1) eMHz: equivalent MHz for a Cortex-M7 based device to achieve same real-time signal chain performance as device with C29x.

Comparison of Device Features

Compared to other high/mid-performance devices such as F2837x and F28P65x, the latest additions, F29H85x and F29P58x provides improved precision sensing, advanced actuation with new features, system flexibility and protection, real time connectivity, advanced safety and security features at an optimized price. Table 2 provides an overview of feature differences in this new device series.

Table 2. Comparison Between F29H85x and F29P58x Devices

Features	F29H85x	F29P58x
MIPS	Up to 1200 (C29x)	Up to 800 (C29x)
Number of Cores (running at 200MHz)	Up to 3x C29x CPU	Up to 2x C29x CPU
ARM M7 equivalent MHz (eMHz)	1440	960
TMU FPU	3 (TMU64 is built into CPU3 only) 3 (FPU64 is built into CPU3 only)	2 0
FLASH RAM	4 MB 452 KB	4 MB 260 KB
Type 5 - PWM | HR	36	24
ECAP | HR	6 | 2	6 | 0
# of ADC channels	80	80
EQEP	6	4
SDFM	16 channels	16 channels
CLB	6 tiles	4 tiles
SENT	6	6
FSI	4 TX / 4 RX	3 TX / 3 RX
CAN-FD	6	6
EtherCAT	1	0
#GPIO (including AGPIO)	190	190
Functional Safety compliant (hardware/systematic capability)	SIL-3 | ASIL-D	SIL-3 | ASIL-D
Security	HSM (AES, Secure boot, Key Provisioning), SSU	HSM (AES, Secure boot, Key Provisioning), SSU
Packages	100QFP, 144BQFP, 176QFP, 256BGA	100QFP, 144BQFP, 176QFP, 256BGA

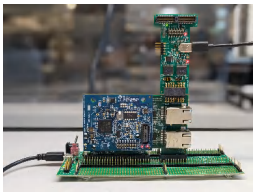
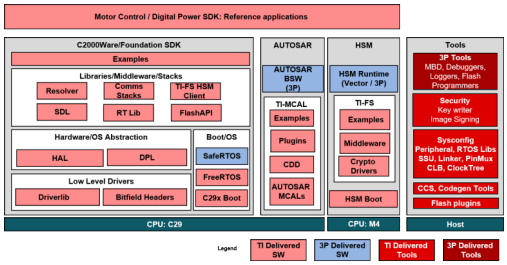
Migration From Previous Devices

Customers can successfully design boards using various software and hardware resources. If already using C2000 MCUs, the migration guides can help with the transition to F29x devices using the links provided below.

- F2837x → F29H85x Migration Guide
- F28P65x → F29H85x Migration Guide
- F28x → F29x Software Migration Guide
- C2000 IDE-Assist Migration Tool

Ecosystem

Table 3. F29H85x Hardware and Software Ecosystem

Safety and Security	Safety: • *ASIL-D/SIL-3 compliance* for systematic and hardware safety capabilities as per ISO26262. • *CPU safety features* include lockstep mode, hardware-automated thread isolation, and zero-overhead switching for the best real-time performance. • Memory Protection Unit-like *Safety and Security Unit (SSU)* enables run-time safety via isolation contexts (stacks) with no performance penalty and *freedom from interference (FFI).* • *Comprehensive memory protection* with ECC/Parity for buses, registers, and integrated memory to run full suite of diagnostic tests. • *Safety-certified tools* for software development, debugging, and system design including *AUTOSAR*, *MCAL*, and *third-party Basic Software (BSW)* support for seamless integration. • Refer to the *F29H85x Safety Secure Resources* for more access to safety software, collateral, resources.	Security: • *EVITA-Full and ISO21434-compliant Hardware Security Module (HSM)* supports secure boot, secure storage and keyring support, and secure debug authentication for enhanced system protection. – *Cryptographic accelerator engines* built into the hardware, support random number generators, symmetric/asymmetric encryption, hashing functions. • *Safety and Security Unit (SSU)* provides secure execution environments to protect the confidentiality and integrity of code and data assets during run time. • Refer to the *F29H85x Security Secure Resources* for more access to security software, collateral, resources.
C2000 Academy and Videos	All your training needs in one place including: getting started resources, interactive classes, and advanced workshops. • C29x Academy: Content and labs for all peripherals: ADC, EPWM, HSM, PIPE, SENT, MCAN and more. • Examples of training videos to accelerate learning and system development: – Software library training and Software tools training (CCS, F29H85X-SDK) – Reference design demos/showcases and end application and system design – SysConfig video series to learn about the important benefits of SysConfig and how to get started.	
Software and Hardware	• LaunchPad™ Development Kit for quick and easy development and controlSOM™ Development Kit for advanced testing. • Software examples, drivers, libraries, diagnostics, utilities, and Sysconfig, documentation in F29H85X-SDK and supported third-party (3P) tools. • Reference designs and EVM examples for motor control and digital power applications	**Table 3. F29H85x Hardware and Software Ecosystem**  **LaunchPad**  **controlSOM**  **Software Stack**

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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265