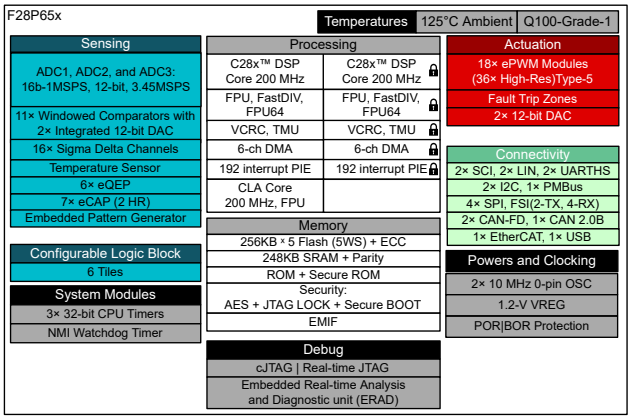
Product Overview

C2000™ F28P65x Real-Time Microcontrollers

Key Features and Benefits

- **Real-Time Processing**
  - Contains up to 3 CPUs: 2 × 32-bit C28x DSP CPU and 1 CLA CPU all running at 200 MHz delivering a total processing power equivalent to 1000-MHz Arm® Cortex®-M7*
  - Floating Point Unit up to 64 bits for more precision, accelerators like Trigonometric Math Unit (TMU), Fast Division (FINTDIV), and CRC engine and instructions (VCRC)
  - Option for LockStep CPU
- **Memory**
  - 1.28MB Flash (ECC), 5 × 256KB banks, 248KB RAM (Parity)
  - Flexible architecture to distribute flash among CPUs
  - Live Firmware Update (LFU) without a power cycle
- **Sensing and Signal Generation**
  - 3 × ADCs: 16 bit-1.1MSPS | 12-bit-3.5 MSPS modes
  - Up to 40 channels, hardware support for oversampling
  - 11 Windowed comparators with dual-ramp generator and integrated 12-bit DAC for more synchronous signal protection
  - 16 × SDFM channels
- **Actuation**
  - Enhanced PWM to support multilevel topologies, safety with minimum dead-band, illegal combo logic and diode emulation
  - 36 HRPWMs for future needs of matrix converters, dual active bridge and resonant converters
  - 6 CLB tiles for encoder implementation, PWM protection, FPGA | CPLD removal
- **Connectivity**
  - Highly connected with advanced communications such as EtherCAT®, CAN-FD, USB, EMIF, FSI, and more
- **Safety**
  - MPOST, Lockstep CPU|DMA|Interrupt controller (PIE), HWBIST, hardware ADC results checker
  - Functional Safety-Compliant targeted
  - Systematic capability up to ASIL D and SIL 3 targeted
- **Security**
  - AES accelerator (128, 192, and 256)
  - Secure BOOT and JTAG LOCK and Unique Identification number
  - Dual-zone security for third-party development (DCSM)
- **Packaging and Temperature**
  - 100 (16 × 16) or 176 (26 × 26) LQFP
  - 169 (9 × 9) or 256 (13 × 13) BGA
  - Temperature: –40°C – 125°C

The F28P65x series is part of the Mid-Performance line of C2000™ real-time microcontroller (MCU) family built for efficient control of power electronics. With an industry leading ultra-low latency, the F28P65x provides further real-time control innovation with more analog, new PWM capabilities while optimizing cost with more integration, and optimized BOM all at the device level.



Key Applications

- New ultra-small 9 × 9 mm, 169-BGA package with EtherCAT integration for **Servo drives and robotics**
- 36 PWMs with enhanced flexibility to enable new power topologies like multiphase, multilevel power architecture for **industrial power**, **automotive power train integration**, **EV charging**, and **energy storage systems**
- More ADC channels for more integration, hardware ADC oversampling to save CPU bandwidth for **Solar, Energy Delivery, EV OBC | DC-DC**
- Multicore with lock-step option for enhanced safety for **automotive and industrial**.

Resources: Software and Product Pages

TMS320F28P650DK Product Folder

TMS320F28P65x LaunchPad™ Evaluation Module

TMS320F28P65x controlCARD Evaluation Module

C2000WARE Software Development Kit

C2000WARE-MOTORCONTROL-SDK

C2000WARE-DIGITALPOWER-SDK

* Performance Benchmark Application Note

C2000 Academy Training Workshops

SysConfig Graphical Device Configuration

Code Composer Studio Free IDE

Addition to the Generation 3 MCU Portfolio

The F28P65x real-time microcontrollers are an extension of the Generation 3 C2000 MCU portfolio. All Generation 3 devices are compatible with C2000WARE software and pin-to-pin compatibility exists between many devices. Figure 1 illustrates the F28P65x series in the portfolio and includes a new focus on application tailored series in the *Mid-Performance* line.

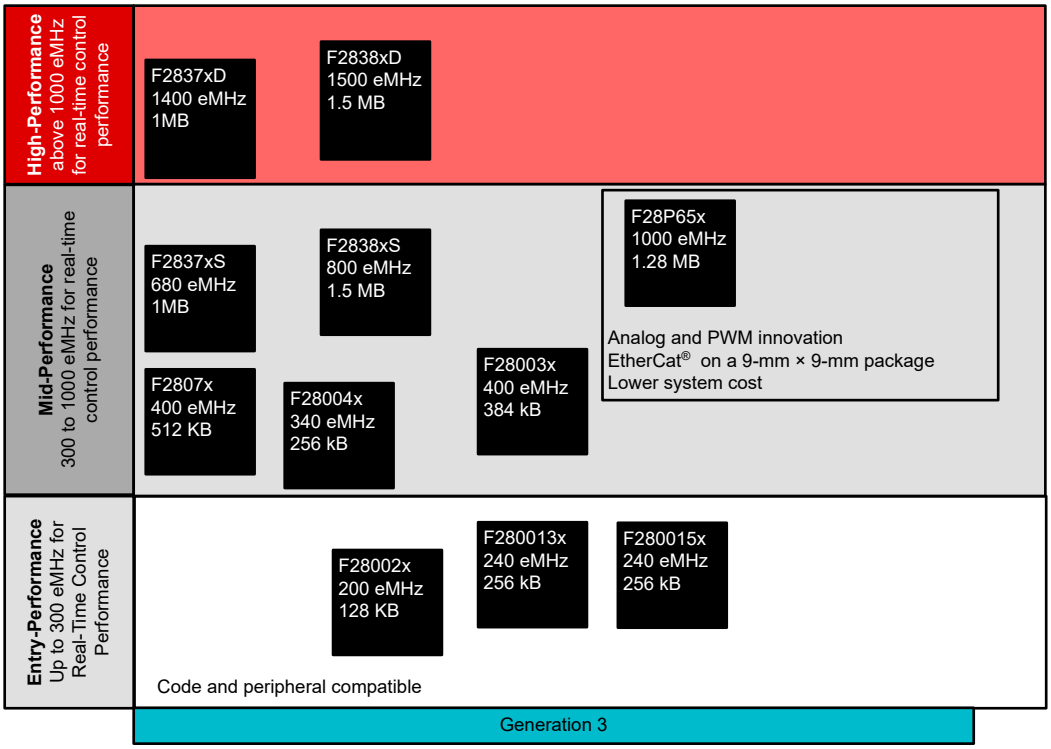


Figure 1. C2000 MCU Portfolio With New F28P65x Mid-Performance Line

Pin and Packaging Options

The F28P65x MCU series offers two memory and performance configurations and 4 package options with industrial and automotive (-Q1 parts) qualification support. Table 1 provides detailed information about packaging options and key differences.

Table 1. F28P65x Packaging Options and Key Variant Differences

Variant	Number of Cores (Running at 200 MHz)	eMHz(1)	Flash	EtherCAT	Lock Step	100 QFP (16 × 16)	169 BGA (9 × 9)	176 QFP (26 × 26)	256 BGA (13 × 13)
F28P650DK9	3	1000	1.28MB	✓	✓		✓	✓	✓
F28P650DK8	3	1000	1.28MB		✓		✓	✓	✓
F28P650DK7	3	1000	1.28MB	✓			✓	✓	✓
F28P650SK7	2	680	1.28MB	✓			✓	✓	✓
F28P650DK6	3	1000	1.28MB			✓	✓	✓	✓
F28P650SK6	2	680	1.28MB			✓	✓	✓	✓
F28P650SH7	2	680	768KB	✓			✓	✓	
F28P650DH6	3	1000	768KB			✓			
F28P650SH6	2	680	768KB			✓	✓	✓	
F28P659DK8-Q1	3	1000	1.28MB		✓	✓		✓	✓
F28P659DH8-Q1	3	1000	768KB		✓	✓			
F28P659SH6-Q1	2	680	768KB			✓		✓	

(1) eMHz: equivalent MHz for a Cortex-M7 based device to achieve same real-time signal chain performance as C28x device.

Comparison of Device Features

Compared to other high- and mid-performance devices such as the F2837x and F2838x, the latest addition, F28P65x 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 between the three.

Table 2. Comparison Between F2837x, F2838x, and F28P65x Series

Features	F2837x	F2838x	F28P65x
C28x MIPS	Up to 800	Up to 925	Up to 600
Number of Cores (running at 200 MHz)	Up to 4: 2 × C28x CPU + 2 × CLA	Up to 5: 2 × C28x CPU + 2 × CLA + 1 × Cortex M4F	Up to 3: 2 × C28x CPU + 1 × CLA
ARM M7 equivalent MHz (eMHz)	1380	1475	1000
CLA TMU FPU64	2 2 0	2 2 2	CPU1 – 1; CPU2- 0 2 2
FLASH RAM	1MB 204KB	1.5MB 324KB	1.28MB 248KB
PWM | HR	100 QFP:15ch | 9ch 176 QFP:24ch | 16ch 337 BGA:24ch | 16ch	176 QFP: 32ch | 16ch 337 BGA: 32ch | 16ch	100 QFP:36ch | 36ch 169 BGA:36ch | 36ch 176 QFP:36ch | 36ch 256 BGA:36ch | 36ch
PWM type	4	4	5
ECAP | HR	6 | 0	7 | 2	7 | 2
#ADC channels	100 QFP:14 176 QFP:20 337 BGA:24	176 QFP: 20 337 BGA: 24	100 QFP: 24 169 BGA: 34 176 QFP: 36 256 BGA: 40
EQEP	100 QFP:2 176 QFP:3 337 BGA:3	176 QFP | 337 BGA:3	100 QFP | 169 BGA | 176 QFP | 256 BGA: 6
SDFM	8 channel	8 channel	16 channel
CLB	4 tiles	8 tiles	6 tiles
FSI	0-0	2Tx-8Rx	2Tx-4Rx
CANFD	0	1	2
EtherCAT	0	1	1
#GPIO (including AGPIO)	100 QFP:41 176 QFP:97 337 BGA:169	176 QFP:97 337 BGA:169	100 QFP: 60 169 BGA: 119 176 QFP: 128 256 BGA: 185
Functional Safety compliant (systematic capability)	SIL-3 | ASIL-D	SIL-3 | ASIL-D	SIL-3 | ASIL-D (target)
Security	DCSM	DCSM, Secure boot, JTAG lock, AES	DCSM, Secure boot, JTAG lock, AES
Packages	100QFP,176QFP, 337BGA	176QFP, 337BGA	100QFP, 169BGA, 176QFP, 256BGA
Starting price 1KU	$7.31	$10.15	$5.85

Migration From Previous Devices

Customers can successfully design boards to achieve pin to pin compatibility with F2838x and F2837x with the help of the migration guides using the links provided below.

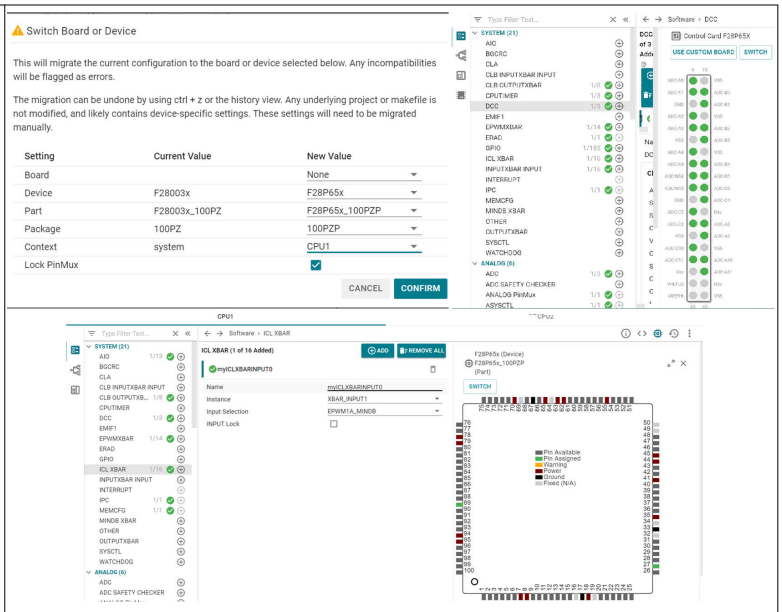
- Migration Guide: F2837x → F28P65x
- Migration Guide: F2838x → F28P65x

Ecosystem

SysConfig

C2000 SysConfig is a graphical interface tool which auto-generates content to help designers. The tool is a collection of information from device TRM, data sheet, errata, migration guides, application notes, and calculators to make user interface easier and faster.
The C2000 MCU SysConfig offers:

- Availability in cloud for evaluation
- Support for calculators and specific libraries
- Support for EVM and custom boards
- *NEW!* Support for one-click-in-place migration across device families
- *NEW!* Support for multi-core devices
- *NEW!* Enhanced Configurable Logic Block (CLB) simulation with added AOC block and more signals for debugging
- *NEW!* Improved error and warning checking



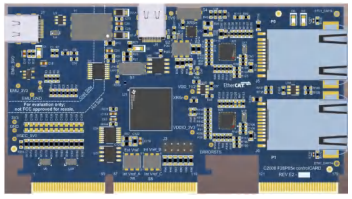
C2000 Academy and Videos

All available training is in one place including: getting started resources, interactive classes, and advanced workshops.

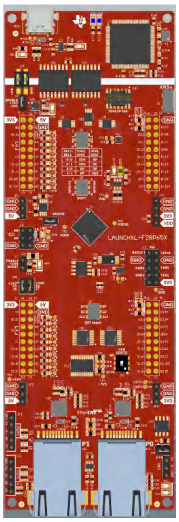
- C2000 academy: Content and labs for all peripherals: ADC, EPWM, CMPSS, ECAP, SCI, CLB, EQEP and more
- Examples of training videos to accelerate learning and system development:
  - Series for EPWM, ADC, and more!
  - Software library training (InstaSPIN Motor Control, and so forth) and Software tools training (CCS, C2000Ware)
  - Reference design demonstrations and showcases (Solar Inverters, EV Charging, and so forth) and end application and system design (EV, Motor Control, sensing, and so forth)
  - SysConfig video series to learn about the important benefits of SysConfig and how to get started!

Software and Hardware

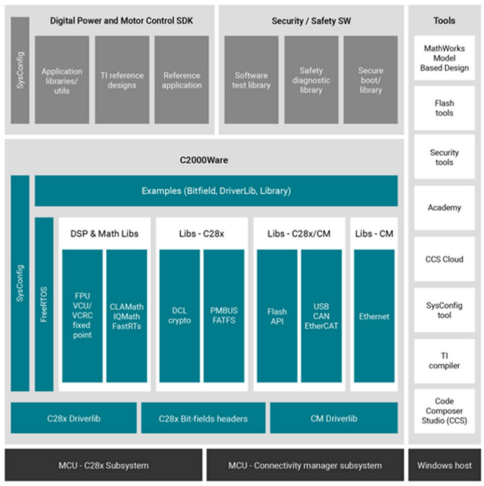
- Software examples, drivers, libraries, diagnostics, utilities, and documentation in C2000WARE Software Development Kit
- Reference designs and EVM examples for motor control and digital power applications.
- LaunchPad™ Development Kit for quick and easy development and controlCARD for advanced testing.



controlCARD



LaunchPad



Software Stack

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