C2000™ Real-Time Microcontrollers

Texas Instruments

www.ti.com/c2000

2016

C2000™ Microcontrollers

Microcontrollers designed for power electronics and precision-sensing applications

The C2000 MCU Advantage

With a 32-bit architecture, DSP processing and advanced control peripherals, the C2000 MCU family enables uncompromising performance for a variety of real-time control applications such as motor control, digital power supplies, solar and renewable energy, LED lighting, smart grid, radar and more.

At the core, C2000 MCUs are based around the TMS320C28x 32-bit DSP core, featuring single-cycle 32×32-bit hardware multiplies and single-cycle atomic instruction execution. The C28x core also includes hardware accelerators such as the Viterbi complex math unit for power line communication algorithms and the trigonometric math unit to accelerate trigonometric functions common in many motor control algorithms. The real-time coprocessor, also know as the CLA, provides an independent CPU capable of handling tasks independently of the main C28x core. Increase the bandwidth of the C28x core by offloading math-intensive tasks to the CLA. Unique, feature-filled peripherals complement the core performance with industry-leading PWM generation, unparalleled ADC conversion, enhanced capture units, and more. Plus, unique architectural designs are incorporated for faster, safer and more effective control systems.

At the heart of C2000 microcontrollers is an application-focused design. Many unique features are included to improve performance of power electronics applications. This application focus is further extended with development kits for C2000 MCUs, where extensive kit selections are offered for motor control, digital power, solar energy, LED lighting and power line communications to accelerate development.

Further easing and speeding development, C2000 MCUs include a vast collection of software libraries, both device-specific and application-specific, to make it easy to begin developing optimized software and hardware solutions.

C2000 MCUs are *the* control solution. Check out one of our Piccolo™, Delfino™, or F28M3x families to find the right MCU for *your* control application.

C2000 MCU Families:

Piccolo™ Microcontrollers

Real control. Real time. For real systems.

Highly-integrated microcontrollers for real-time control of cost-sensitive power electronics applications. With control-optimized performance, specialized peripherals, and a control-focused architecture, Piccolo MCUs bring innovative solutions to demanding control challenges.

Starting at **U.S. $1.89**

Packages from 38 to 176 pins

Delfino™ Microcontrollers

High performance. For high-end control.

The leading microcontroller family for high-performance control needs. Featuring single-core devices with speeds up to 300 MHz and a dual-core device with a combined CPU performance of 400 MHz. This family also includes industry-leading PWM control resolution, and high-precision ADCs with ultra-fast response times. Delfino MCUs tackle the toughest control challenges.

Starting at **U.S. $8.95**

Packages from 100 to 337 pins

F28M3x Microcontrollers

Connectivity. Control. No compromise.

Differentiated microcontroller family combining the ARM® Cortex®-M3 core with C2000's C28x core in a single MCU package. The F28M3x MCUs bring together leading host communications and leading real-time control without compromise of control performance or communications.

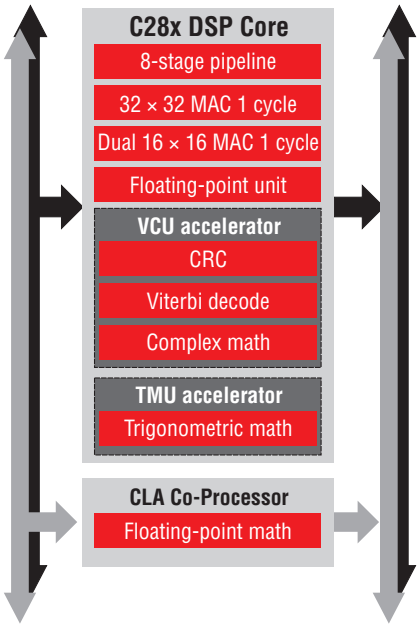
Starting at **U.S. $9.40**

Packages from 144 to 289 pins

DSP performance, MCU ease

DSP core with control focused co-processor and accelerator options to provide unparalleled performance and flexibility for a variety of applications

- 32-bit C28x DSP architecture
- Modified Harvard architecture including six separate data/address buses for data and program memory
- Eight-stage pipeline with single-cycle operation across pipeline
- Native DSP math processing with single-cycle 32 × 32-bit multiply accumulate (MAC) operations and dual 16 × 16 MACs
- 192 interrupt vectors with low-latency service routines down to nine cycles
- Floating-point unit options across portfolio and revolutionary IQMath™ floating-point software for fixed-point devices
- Real-time control accelerator (CLA) doubles system performance enabling parallel processing of control loops
- Trigonometric Math Unit accelerator for fast execution of trig-based functions
- VCU accelerator for unparalleled execution of power line communication algorithms
- Best-in-class compiler efficiency
- Software compatibility across the portfolio



C2000 MCU Processing Engine
Dual C28x, dual CLA co-processor, TMU accelerator and VCU accelerator

Take control with C2000 MCU peripherals

Most flexible, configurable, and highest performing in their class

PWM generation:

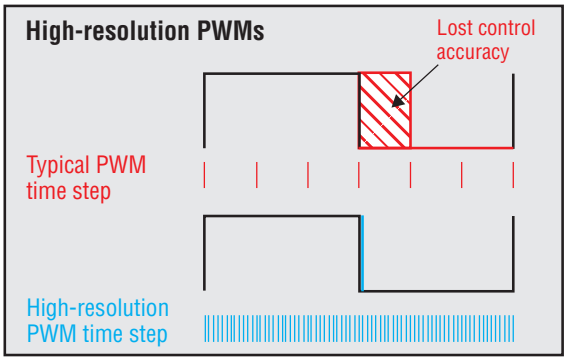
- Achieve unprecedented precision with unparalleled high-resolution duty-cycle control down to 55ps time steps
- Reduce power-switching loses with high-resolution and configurable deadband support
- Protect your system and add safety features with direct PWM tripping from comparator or trip zone pin inputs
- Flexible PWM outputs configurations, including dual-edge asymmetric and symmetric PWM generation
- Programmable or hardware-locked PWM time and phase synchronization

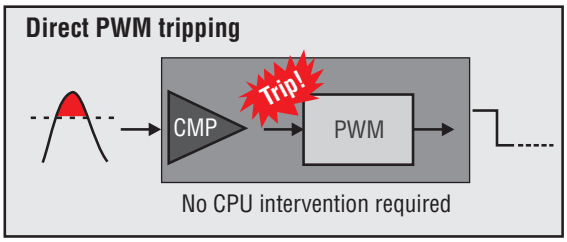
ADC feedback:

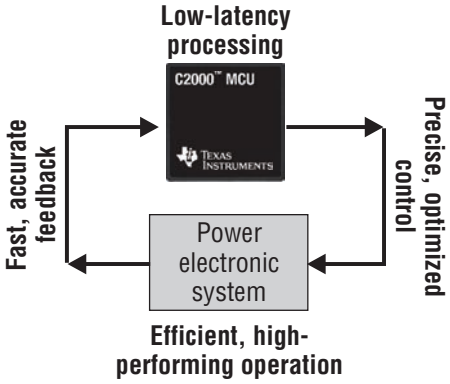
- 16-bit and 12-bit resolution for high accuracy
- Up to 4 ADCs
- Ultra-fast ADC sample and conversion rates up to 12.5 mega samples per second (MSPS)

Capture and quadrature encoder interfaces:

- Highly accurate capture interfaces based on 32-bit timers with additional capabilities for high-resolution measurements
- 32-bit quadrature encoder pulse module for interfacing with incremental encoders used in motor control systems







C2000 MCUs complete the loop

Piccolo™ Microcontrollers

Low-cost microcontrollers for real-time control applications such as white goods appliances, industrial drives, pumps, HVAC systems, solar inverters, digital power supplies, LED lighting, battery charging and power line communications.

See why Piccolo microcontrollers' combination of performance, control-oriented architecture, and low cost make them the ideal control solution for power electronics.

Powerful performance

C28x core, CLA co-processor, TMU and VCU accelerators come together to solve your toughest control challenges

- Up to 240 MIPS of total performance with the 32-bit C28x DSP core combined with the CLA co-processor
- Trigonometric math unit (TMU) accelerator executes common trig math operations in 1 to 2 cycles
- Accelerate advanced communications-based algorithms by up to 7× with the VCU accelerator

CLA co-processor solutions

Double system throughput with an independent 32-bit co-processor

- Intelligently partition system burdensome tasks such as high-frequency control loops to the CLA and increase bandwidth of the main C28x CPU
- CLA has access to control and analog peripherals to execute tasks without intervention from the C28x CPU
- Run applications such as multiple motors, motor plus power factor correction, LED lighting plus power line communications and more
- Implement safety standards with dual-core redundancy, cross-checking of computational results, and verification of peripheral functioning

Control-focused peripherals

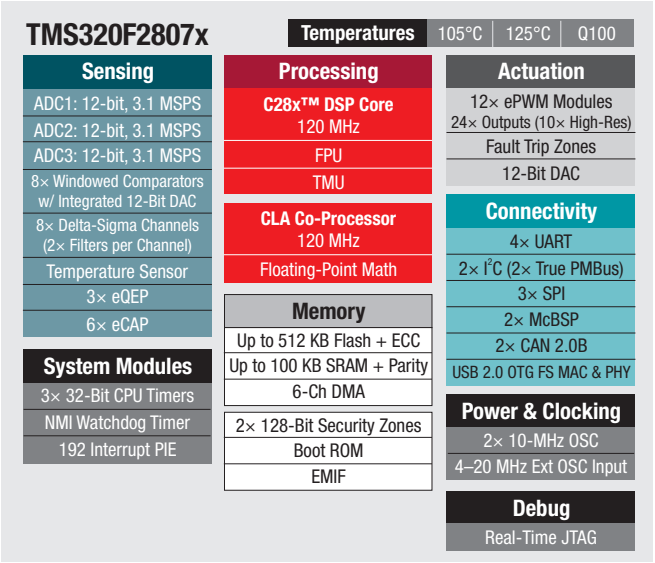
Streamlined control to make your applications more responsive

- Sophisticated PWM shadowing, synchronization, asynchronous edge positioning, trip logic, etc., supports multi-level, matrix and other demanding switching topologies
- High-resolution PWMs (150 ps) for system efficiency and fast system response
- Create quick systems with ultra-fast PWM tripping, allowing PWM shutdown or drive high/low conditions in 20 ns

Reducing system complexity with intelligent analog peripherals

Full integration of all analog peripherals needed for real-time control design

- Simultaneously sample multiple motor phases or concurrent voltage and current values with up to three independent 12-bit ADCs
- Power stage protection with integrated analog windowed comparators with direct PWM trip in over/under current conditions
- Integrated Sigma-Delta filters enable direct interface to "hot side" isolated converters providing high-side current sense, with close coupling to trip logic for fast-acting protection



- Integrated 12-bit buffered DACs provide needed excitation for position resolver applications, reference and bias settings for external analog/op-amp interfaces, or simply for waveform reconstruction during debug sessions.

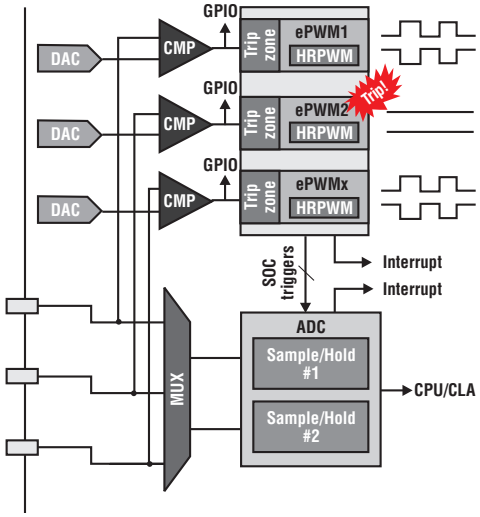
InstaSPIN™ enabled

Unique motor control expertise on-chip

- Select Piccolo devices include motor control software on-chip
- FAST premium software sensor (observer) to replace mechanical sensors and software estimators
- InstaSPIN-FOC identifies motor parameters and tunes a sensorless field-oriented torque-control system
- InstaSPIN-MOTION adds premium position and speed control with full motion control suite
- See page 18 for details

Control-tuned architecture

The integration you need with the features to differentiate your application from the competition.



TMS320C2000™ Microcontrollers

	Processor						Memory			Control Interfaces										Communication Ports											
Device	Speed (MHz)	FPU	CLA co-processor	TMU accelerator	VCU accelerator	DMA	Flash (KB)	RAM (KB)	ROM (KB)	PWM ch.	High-resolution PWM ch.	Quadrature encoder	Event captures	HRCAP	Timers*	12-bit ADC ch.	ADC conversion time (ns)	Comparators	OpAmp/PGA	USB	McBSP	I²C	UART/SCI	SPI	CAN	LIN	External memory interface	Core supply (V)	GPIO pins	On-chip oscillator	Voltage regulator	Package pin counts
Piccolo™ MCU generation																															
TMS320F2802x MCUs																															Starting from $2.00 (1 ku)
TMS320F280200	40	–	–	–	–	–	16	6	Boot	9	–	–	–	–	8	13	500	2	–	–	–	1	1	1	–	–	–	3.3	22	2	Yes	38, 48
TMS320F28020	40	–	–	–	–	–	32	6	Boot	9	–	–	1	–	9	13	500	2	–	–	–	1	1	1	–	–	–	3.3	22	2	Yes	38, 48
TMS320F28021	40	–	–	–	–	–	64	10	Boot	9	–	–	1	–	9	13	500	2	–	–	–	1	1	1	–	–	–	3.3	22	2	Yes	38, 48
TMS320F28022	50	–	–	–	–	–	32	12	Boot	9	–	–	1	–	9	13	260	2	–	–	–	1	1	1	–	–	–	3.3	22	2	Yes	38, 48
TMS320F28023	50	–	–	–	–	–	64	12	Boot	9	4	–	1	–	9	13	260	2	–	–	–	1	1	1	–	–	–	3.3	22	2	Yes	38, 48
TMS320F28026	60	–	–	–	–	–	32	12	Boot	9	4	–	1	–	9	13	217	2	–	–	–	1	1	1	–	–	–	3.3	22	2	Yes	38, 48
TMS320F28026F‡	60	–	–	–	–	–	32	12	Boot	9	4	–	1	–	9	13	217	2	–	–	–	1	1	1	–	–	–	3.3	22	2	Yes	48
TMS320F28027	60	–	–	–	–	–	64	12	Boot	9	4	–	1	–	9	13	217	2	–	–	–	1	1	1	–	–	–	3.3	22	2	Yes	38, 48
TMS320F28027F‡	60	–	–	–	–	–	64	12	Boot	9	4	–	1	–	9	13	217	2	–	–	–	1	1	1	–	–	–	3.3	22	2	Yes	48
TMS320F2803x MCUs																															Starting from $3.05 (1 ku)
TMS320F28030	60	–	–	–	–	–	32	12	Boot	15	–	1	1	1	12	16	500	3	–	–	–	1	1	2	1	1	–	3.3	44	2	Yes	56, 64, 80
TMS320F28031	60	–	–	–	–	–	64	16	Boot	15	–	1	1	1	12	16	500	3	–	–	–	1	1	2	1	1	–	3.3	44	2	Yes	56, 64, 80
TMS320F28032	60	–	–	–	–	–	64	20	Boot	15	7	1	1	1	12	16	217	3	–	–	–	1	1	2	1	1	–	3.3	44	2	Yes	56, 64, 80
TMS320F28033	60	–	Yes	–	–	–	64	20	Boot	15	7	1	1	1	12	16	217	3	–	–	–	1	1	2	1	1	–	3.3	44	2	Yes	56, 64, 80
TMS320F28034	60	–	–	–	–	–	128	20	Boot	15	7	1	1	1	12	16	217	3	–	–	–	1	1	2	1	1	–	3.3	44	2	Yes	56, 64, 80
TMS320F28035	60	–	Yes	–	–	–	128	20	Boot	15	7	1	1	1	12	16	217	3	–	–	–	1	1	2	1	1	–	3.3	44	2	Yes	56, 64, 80
TMS320F2805x MCUs																															Starting from $3.25 (1 ku)
TMS320F28050	60	–	–	–	–	–	32	12	Boot	15	–	1	1	–	12	16	500	6	3	–	–	1	3	1	1	–	–	3.3	42	2	Yes	80
TMS320F28051	60	–	–	–	–	–	64	16	Boot	15	–	1	1	–	12	16	500	7	4	–	–	1	3	1	1	–	–	3.3	42	2	Yes	80
TMS320F28052	60	–	–	–	–	–	64	20	Boot	15	–	1	1	–	12	16	267	7	4	–	–	1	3	1	1	–	–	3.3	42	2	Yes	80
TMS320F28052F‡	60	–	–	–	–	–	64	20	Boot	15	–	1	1	–	12	16	267	7	6	–	–	1	3	1	1	–	–	3.3	42	2	Yes	80
TMS320F28052M§	60	–	–	–	–	–	64	20	Boot	15	–	1	1	–	12	16	267	7	4	–	–	1	3	1	1	–	–	3.3	42	2	Yes	80
TMS320F28053	60	–	Yes	–	–	–	64	20	Boot	15	–	1	1	–	12	16	267	7	4	–	–	1	3	1	1	–	–	3.3	42	2	Yes	80
TMS320F28054	60	–	–	–	–	–	128	20	Boot	15	–	1	1	–	12	16	267	7	4	–	–	1	3	1	1	–	–	3.3	42	2	Yes	80
TMS320F28054F‡	60	–	–	–	–	–	128	20	Boot	15	–	1	1	–	12	16	267	7	4	–	–	1	3	1	1	–	–	3.3	42	2	Yes	80
TMS320F28054M§	60	–	–	–	–	–	128	20	Boot	15	–	1	1	–	12	16	267	7	4	–	–	1	3	1	1	–	–	3.3	42	2	Yes	80
TMS320F28055	60	–	Yes	–	–	–	128	20	Boot	15	–	1	1	–	12	16	267	7	4	–	–	1	3	1	1	–	–	3.3	42	2	Yes	80
TMS320F2806x MCUs																															Starting from $4.95 (1 ku)
TMS320F28062	90	Yes	–	–	–	Yes	128	52	Boot	19	8	2	7	4	17	16	325	3	–	1	1	1	2	2	1	–	–	3.3	54	2	Yes	80, 100
TMS320F28062F‡	90	Yes	–	–	–	Yes	128	52	Boot	19	8	2	7	4	17	16	325	3	–	1	1	1	2	2	1	–	–	3.3	54	2	Yes	80, 100
TMS320F28065	90	Yes	Yes	–	Yes	Yes	128	100	Boot	19	8	2	7	4	17	16	325	3	–	1	1	1	2	2	1	–	–	3.3	54	2	Yes	80, 100
TMS320F28066	90	Yes	–	–	–	Yes	256	68	Boot	19	8	2	7	4	17	16	325	3	–	1	1	1	2	2	1	–	–	3.3	54	2	Yes	80, 100
TMS320F28067	90	Yes	–	–	–	Yes	256	100	Boot	19	8	2	7	4	17	16	325	3	–	1	1	1	2	2	1	–	–	3.3	54	2	Yes	80, 100
TMS320F28068F‡	90	Yes	–	–	Yes	Yes	256	96	Boot	19	8	2	7	4	17	16	325	3	–	1	1	1	2	2	1	–	–	3.3	54	2	Yes	80, 100
TMS320F28068M§	90	Yes	–	–	Yes	Yes	256	96	Boot	19	8	2	7	4	17	16	325	3	–	1	1	1	2	2	1	–	–	3.3	54	2	Yes	80, 100
TMS320F28069	90	Yes	Yes	–	Yes	Yes	256	100	Boot	19	8	2	7	4	17	16	325	3	–	1	1	1	2	2	1	–	–	3.3	54	2	Yes	80, 100
TMS320F28069F‡	90	Yes	Yes	–	Yes	Yes	256	96	Boot	19	8	2	7	4	17	16	325	3	–	1	1	1	2	2	1	–	–	3.3	54	2	Yes	80, 100
TMS320F28069M§	90	Yes	Yes	–	Yes	Yes	256	96	Boot	19	8	2	7	4	17	16	325	3	–	1	1	1	2	2	1	–	–	3.3	54	2	Yes	80, 100
TMS320F2807x MCU																															Starting from $9.26 (1 ku)
TMS320F28075	120	Yes	Yes	Yes	–	Yes	512	100	Boot	24	16	3	6	–	24	17	325	8	–	Yes	2	2	4	3	2	–	16/32	3.3	97	2	Yes	100, 176

**Timers include CPU timers, PWM timers, eCAP timers and Watchdog timers*

†Prices are quoted in U.S. dollars and represent 2016 suggested retail pricing for baseline packages and device configurations. All prices are subject to change.

‡InstaSPIN-FOC capable devices

§InstaSPIN-MOTION (and InstaSPIN-FOC) capable devices

C2000™ Microcontrollers

Delfino™ Microcontrollers

High-performance microcontrollers with high-integrity analog and unparalleled control peripherals to provide a real-time engine targeted at applications requiring heavy signal processing such as servo drives, mid-/high-end AC inverters, solar inverters, industrial UPS systems, power line communications, radar and much more.

Uncompromising performance

Up to 800 MIPS of total system performance with the 32-bit C28x DSP core combined with the performance of the CLA co-processor

- Get DSP performance in an MCU-class device with the C28x core and enjoy single-cycle 32×32 MAC or 16×16 dual-MAC operations
- Flash-based devices feature dual or single 32-bit floating-point C28x core options running at up to 200MHz each
- RAM-based device boasts 32-bit floating-point C28x CPUs at up to 300MHz
- Native floating-point support eliminates the hassle of fixed-point development – likewise, porting code between fixed- and floating-point native devices is a snap with the IQMath™ virtual floating-point engine
- Eliminate the need for a second processor with a single or dual core that is efficient at both the DSP math tasks and microcontroller system control tasks

Reducing system latency with new hardware accelerators

Boosting C28x execution speeds with the new Trigonometric Math Unit (TMU) and Viterbi Complex Unit (VCU II) accelerators

- TMU accelerator expedites trigonometric-based algorithms common in many control-loop calculations such as torque loops
- VCU II provides CPU acceleration for narrowband PLC standards widely used in smart grid advanced meter infrastructure networks such as PRIME, G3 and IEEE P1901.2
- Alternatively, VCU II can also be used for vibrational analysis (FFT) on motors to predict failures

Expanding CPU bandwidth with CLA co-processors

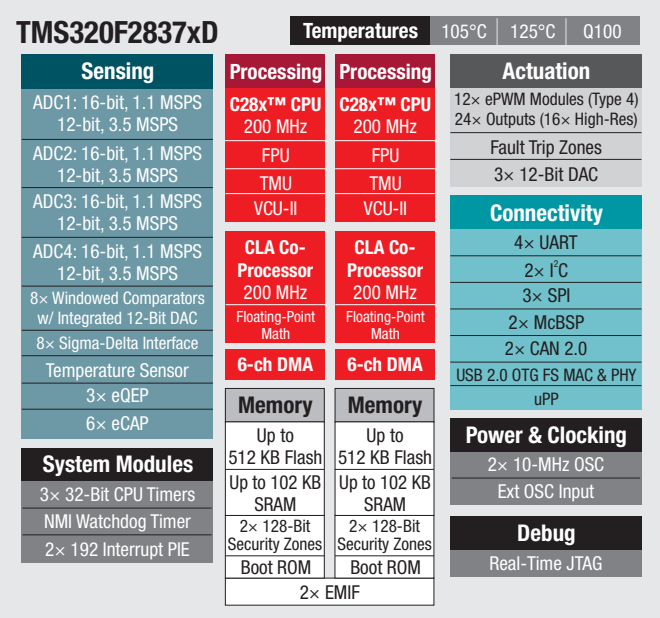
Doubling performance with a new approach to system partitioning

- Independent 32-bit floating point CLA co-processor with additional 400MIPS of system performance to alleviate signal processing burdens from C28x of complex tasks such as managing independent control loops, signal pre-processing, DSP filtering, etc.
- Cross-checking of computational results with C28x and CLA redundancy

Differentiating with high-performance analog

Powerful System on Chip (SoC) architected for speed and precision control systems

- Simultaneously sample multiple motor phases or concurrent voltage and current values with four integrated ADCs
- Develop precision feedback loops with 16-bit ADCs, 1MSPS
- Run fast control loops with a 12.5 MSPS, 12-bit ADC



- Power stage protection with integrated analog windowed comparators with direct PWM trip in over/under current conditions
- Integrated Sigma-Delta demodulators enable direct interface to "hot side" isolated converters providing high-side current sense, with close coupling to trip logic for fast-acting protection
- Integrated 12-bit buffered DACs provide needed excitation for position resolver applications, reference and bias settings for external analog/op-amp interfaces, or simply for waveform reconstruction during tricky debug sessions.

Unprecedented control peripherals

Streamlined control to make your applications more responsive

- Enhanced PWM functions can precisely control complex switch timing for all drive inverters, solar inverters and every type of power-conversion application
- Sophisticated PWM shadowing, synchronization, asynchronous edge positioning, trip logic, etc., supports multi-level, matrix, and other demanding switching topologies
- High-resolution PWM duty cycle edge placement down to 55ps time unit increments for system efficiency and fast system response
- Create safer and quick systems with ultra-fast PWM tripping, allowing PWM shutdown or drive high/low conditions in 20ns
- Get more accuracy for speed and other time-sensitive sensing with responsive event capture units (5ns)

Expanding system communications

Providing on-/off-board communication

- A host of serial communications such as dual CAN, SPI, SCI for localized communication
- Dual EMIF with 32/1-bit-wide bus for extended memory additions
- USB interface for quick field updates
- Universal parallel port (uPP) provides high-speed 16-bit parallel data bus to other processors such as FPGAs or processors with the same interface

TMS320C2000™ Microcontrollers																																				
	Processor						Memory			Control Interfaces															Communication Ports												
Device	Speed (MHz)	FPU	CLA co-processor	TMU accelerator	VCU accelerator	DMA	Flash (KB)	RAM (KB)	ROM (KB)	PWM ch.	High-resolution PWM ch.	Quadrature encoder	Position manager	Event captures	Timers*	12-bit ADC ch.	12-bit ADC conversion time (ns)	16-bit ADC or 12-bit ADC (No.)	16-bit ADC/ 12-bit ADC ch.	16-bit/12-bit conversion time (ns)	Delta-sigma filter (ch.)	Comparators	USB	McBSP	I²C	UART/SCI	SPI	CAN	Universal parallel Port (uPP)	External memory interface (No.)	EMIF (bit)	Core supply (V)	GPIO pins	On-chip oscillator	Voltage regulator	Package pin counts
Delfino™ MCU generation																																				
TMS320F2833x MCUs																																			Starting from $13.20 (1 ku)	
TMS320F28335	150	Yes	–	–	–	Yes	512	68	Boot	18	6	2	–	6	16	16	80	–	–	–	–	–	–	2	1	3	1	2	–	1	16/32	1.9	88	1	–	176, 179
TMS320F28334	150	Yes	–	–	–	Yes	256	68	Boot	16	6	2	–	4	14	16	80	–	–	–	–	–	–	2	1	3	1	2	–	1	16/32	1.9	88	1	–	176, 179
TMS320F28332	100	Yes	–	–	–	Yes	128	52	Boot	16	4	2	–	4	14	16	80	–	–	–	–	–	–	1	1	2	1	2	–	1	16/32	1.9	88	1	–	176, 179
TMS320C2834x MCUs																																			Starting from $8.95 (1 ku)	
TMS320C28346	300	Yes	–	–	–	Yes	–	516	Boot	24	9	3	–	6	19	–	–	–	–	–	–	–	–	2	1	3	2	2	–	1	16/32	1.2	88	1	–	256
TMS320C28345	200	Yes	–	–	–	Yes	–	516	Boot	24	9	3	–	6	19	–	–	–	–	–	–	–	–	2	1	3	2	2	–	1	16/32	1.2	88	1	–	179, 256
TMS320C28344	300	Yes	–	–	–	Yes	–	260	Boot	24	9	3	–	6	19	–	–	–	–	–	–	–	–	2	1	3	2	2	–	1	16/32	1.2	88	1	–	256
TMS320C28342	300	Yes	–	–	–	Yes	–	196	Boot	16	6	2	–	4	14	–	–	–	–	–	–	–	–	1	1	3	2	2	–	1	16/32	1.2	88	1	–	256
TMS320F2837x MCUs																																			Starting from $11.32 (1 ku)	
TMS320F28374D	200 (×2)	Yes	2	2	2	Yes	512	164	Boot	24	16	3	–	6	24	–	–	4	–/24	–/286	8	8	Yes	2	2	4	3	2	1	2	16/32, 16	1.2	169	1	Yes	176, 337
TMS320F28374S	200	Yes	1	1	1	Yes	512	132	Boot	24	16	3	–	6	24	–	–	4	–/24	–/286	8	8	Yes	2	2	4	3	2	1	2	16/32, 19	1.2	169	1	Yes	100, 176, 337
TMS320F28375D	200 (×2)	Yes	2	2	2	Yes	1024	204	Boot	24	16	3	–	6	24	–	–	4	–/24	–/286	8	8	Yes	2	2	4	3	2	1	2	16/32, 16	1.2	169	1	Yes	176, 337
TMS320F28375S	200	Yes	1	1	1	Yes	1024	164	Boot	24	16	3	–	6	24	–	–	4	–/24	–/286	8	8	Yes	2	2	4	3	2	1	2	16/32, 18	1.2	169	1	Yes	100, 176, 337
TMS320F28376D	200 (×2)	Yes	2	2	2	Yes	512	164	Boot	24	16	3	–	6	24	–	–	4	12/24	910/ 286	8	8	Yes	2	2	4	3	2	1	2	16/32, 16	1.2	169	1	Yes	176, 337
TMS320F28376S	200	Yes	1	1	1	Yes	512	132	Boot	24	16	3	–	6	24	–	–	4	12/24	910/ 286	8	8	Yes	2	2	4	3	2	1	2	16/32, 17	1.2	169	1	Yes	100, 176, 337
TMS320F28377D	200 (×2)	Yes	2	2	2	Yes	1024	204	Boot	24	16	3	–	6	24	–	–	4	12/24	910/ 286	8	8	Yes	2	2	4	3	2	1	2	16/32, 16	1.2	169	1	Yes	176, 337
TMS320F28377S	200	Yes	1	1	1	Yes	1024	164	Boot	24	16	3	–	6	24	–	–	4	12/24	910/ 286	8	8	Yes	2	2	4	3	2	1	2	16/32, 16	1.2	169	1	Yes	100, 176, 337
TMS320F28379D	200 (×2)	Yes	2	2	2	Yes	1024	204	Boot	24	16	3	Yes	6	24	–	–	4	12/24	910/ 286	8	8	Yes	2	2	4	3	2	1	2	16/32, 16	1.2	169	1	Yes	176, 337
TMS320F28379S	200	Yes	1	1	1	Yes	1024	164	Boot	24	16	3	Yes	6	24	–	–	4	12/24	910/ 286	8	8	Yes	2	2	4	3	2	1	2	16/32, 16	1.2	169	1	Yes	100, 176, 337

**Timers include CPU timers, PWM timers, eCAP timers and Watchdog timers*

Fixed-point microcontrollers

C2000 also has an extensive line of fixed-point microcontrollers with various performance and feature set offerings to meet requirements for a variety of real-time control applications.

TMS320C2000™ Microcontrollers																																				
	Processor					Memory			Control Interfaces													Communication Ports																
Device	Speed (MHz)	FPU	CLA co-processor	VCU accelerator	DMA	Flash (KB)	RAM (KB)	ROM (KB)	PWM ch.	High-resolution PWM ch.	Quadrature encoder	Event captures	HRCAP	Timers*	12-bit ADC ch.	ADC conversion time (ns)	Comparators	OpAmp/PGA	USB	McBSP	I²C	UART/SCI	SPI	CAN	LIN	External memory interface (bit)	Core supply (V)	GPIO pins	On-chip oscillator	Voltage regulator	Package pin counts
Fixed-Point MCU generation																																				
TMS320F2823x MCUs																																			Starting from $12.25 (1 ku)	
TMS320F28235	150	–	–	–	Yes	512	68	Boot	18	6	2	6	–	16	16	80	–	–	–	2	1	3	1	2	–	16/32	1.9	88	1	–	176, 179
TMS320F28234	150	–	–	–	Yes	256	68	Boot	16	6	2	4	–	14	16	80	–	–	–	2	1	3	1	2	–	16/32	1.9	88	1	–	176, 179
TMS320F28232	100	–	–	–	Yes	128	52	Boot	16	4	2	4	–	14	16	80	–	–	–	1	1	2	1	2	–	16/32	1.9	88	1	–	176, 179
TMS320F281x MCUs																																			Starting from $13.20 (1 ku)	
TMS320F2812	150	–	–	–	–	256	36	Boot	16	–	2	6	–	8	16	80	–	–	–	1	–	2	1		–	16	1.9	56	1	–	176, 179
TMS320F2811	150	–	–	–	–	256	36	Boot	16	–	2	6	–	8	16	80	–	–	–	1	–	2	1		–	–	1.9	56	1	–	128
TMS320F2810	150	–	–	–	–	128	36	Boot	16	–	2	6	–	8	16	80	–	–	–	1	–	2	1		–	–	1.9	56	1	–	128
TMS320F280x MCUs																																			Starting from $4.26 (1 ku)	
TMS320F2809	100	–	–	–	–	256	36	Boot	16	6	2	4	–	14	16	80	–	–	–	–	1	2	4	2	–	–	1.8	35	1	–	100
TMS320F28044	100	–	–	–	–	128	20	Boot	16	16	–	4	–	24	16	80	–	–	–	–	1	1	1	–	–	–	1.8	35	1	–	100
TMS320F2808	100	–	–	–	–	128	36	Boot	16	4	2	4	–	14	16	160	–	–	–	–	1	2	4	2	–	–	1.8	35	1	–	100
TMS320F2806	100	–	–	–	–	64	20	Boot	16	4	2	4	–	14	16	160	–	–	–	–	1	2	4	1	–	–	1.8	35	1	–	100
TMS320F2802	100	–	–	–	–	64	12	Boot	8	3	1	2	–	9	16	160	–	–	–	–	1	1	2	1	–	–	1.8	35	1	–	100
TMS320F2802-60	60	–	–	–	–	64	12	Boot	8	3	1	2	–	9	16	267	–	–	–	–	1	1	2	1	–	–	1.8	35	1	–	100
TMS320F2801-60	60	–	–	–	–	32	12	Boot	8	3	1	2	–	9	16	267	–	–	–	–	1	1	2	1	–	–	1.8	35	1	–	100
TMS320F28016	60	–	–	–	–	32	12	Boot	10	4	–	2	–	10	16	267	–	–	–	–	1	1	1	1	–	–	1.8	35	1	–	100
TMS320F28015	60	–	–	–	–	32	12	Boot	10	4	–	2	–	10	16	267	–	–	–	–	1	1	1	–	–	–	1.8	35	1	–	100

**Timers include CPU timers, PWM timers, eCAP timers and Watchdog timers*

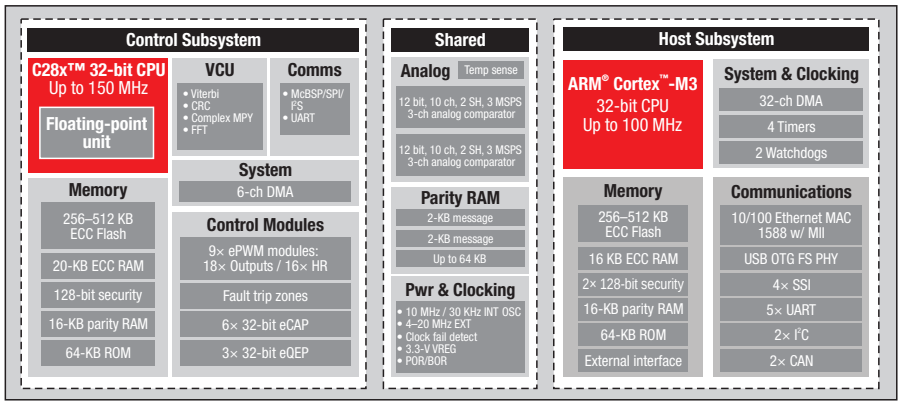
†Prices are quoted in U.S. dollars and represent 2016 suggested retail pricing for baseline packages and device configurations. All prices are subject to change.

C2000™ Microcontrollers

F28M3x Microcontrollers

The F28M3x MCUs bring together connectivity and control by combining an ARM® Cortex®-M3 core with C2000's C28x core and control peripherals in a single device. With F28M3x MCUs, applications such as solar inverters and industrial control can retain the benefits of separate communications and control sub-systems while enjoying the benefits of a single-chip solution.

See why F28M3x MCUs have changed the game for intelligent power electronics applications.



*Starting at **U.S. $9.40***
***Q100** qualified and **125°C** temperature support*

Control *OR* Communications: Why compromise? Get the best of both!

C2000 focused real-time control and ARM Cortex-M3 focused connectivity

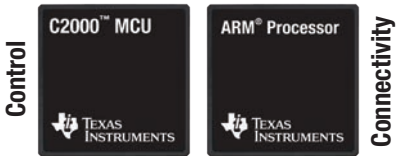
Single MCU challenge

- Compromise between ideal host and control capability
- Complex tasking / prioritization
- Still appropriate for deeply embedded systems

Dedicated MCUs challenge

- Additional complexity
- Dual developments plus interface challenges / latency
- Necessary solution depending on isolation boundary trade-offs

F28M3x solution



- Independent, optimized, subsystems on a single device
- Tightly coupled interface
- Single platform for development
- No compromises

C2000 + ARM® Cortex-M3

Using two strengths to your advantage

C2000 MCUs:

Precision control

- Industry-leading computational performance
- VCU communications accelerator hardware
- C2000 high-resolution PWMs
- Lowest latency control loops
- Robust control software support
- High-speed precision analog
- Fine-tuned control architecture

ARM:

Ecosystem of developers

- Operating systems
- Middleware
- Software infrastructure

Robust communication

- Ethernet
- USB
- CAN
- Serial
- Wireless
- Fieldbus support

Thinking safety?

Certification made easy with F28M3x MCU safety-enabling features

Error detection and correction

- Memory with error correction (ECC)
- Cyclic redundancy checking (CRC)
- Comparators for over-voltage and over-current protection
- Parity on CAN and interrupt registers

Security

- Lock protection on GPIO and registers
- Memory protection for IP safeguarding
- Permanent JTAG disable for anti-theft

Redundancy

- Two cores for cross checking computations and peripheral results
- Two ADCs for reliable measurements
- Two clocks for backup
- Multiple system watchdogs

TMS320C2000™ Microcontrollers

	Processor					Memory			Control Interfaces											Communication Ports								External memory interface	Core supply (V)	GPIO pins	On-chip oscillator	Voltage regulator	Package pin counts
Device	Speed (MHz) C28x/M3	FPU	CLA co-processor	VCU accelerator	DMA	Flash (KB)	RAM (KB)	ROM (KB)	PWM ch.	High-resolution PWM ch.	Quadrature encoder	Event captures	HRCAP	Timers*	# of ADCs	12-bit ADC ch.	ADC conversion time (ns)	Comparators	OpAmp/PGA	USB	Ethernet	McBSP	I²C	UART/SCI	SPI	CAN	LIN						
F28M3x MCU generation																																Starting from $9.40 (1 ku)
F28M35E20B	60/60	Yes	–	Yes	Yes	512	72	Boot	24	16	3	6	–	25	2	20	433/433	6	–	–	–	1	1	6	5	2	–	Yes	3.3	64	2	Yes	144
F28M35M20B	75/75	Yes	–	Yes	Yes	512	72	Boot	24	16	3	6	–	25	2	20	347/347	6	–	–	–	1	1	6	5	2	–	Yes	3.3	64	2	Yes	144
F28M35M22C	75/75	Yes	–	Yes	Yes	512	136	Boot	24	16	3	6	–	25	2	20	347/347	6	–	1	Yes	1	1	6	5	2	–	Yes	3.3	64	2	Yes	144
F28M35M52C	75/75	Yes	–	Yes	Yes	1024	136	Boot	24	16	3	6	–	25	2	20	347/347	6	–	1	Yes	1	1	6	5	2	–	Yes	3.3	64	2	Yes	144
F28M35H22C	150/75 or 100/100	Yes	–	Yes	Yes	512	136	Boot	24	16	3	6	–	25	2	20	347/520	6	–	1	Yes	1	1	6	5	2	–	Yes	3.3	64	2	Yes	144
F28M35H52C	150/75 or 100/100	Yes	–	Yes	Yes	1024	136	Boot	24	16	3	6	–	25	2	20	347/520	6	–	1	Yes	1	1	6	5	2	–	Yes	3.3	64	2	Yes	144
F28M36H33B	150/75 or100/100	Yes	–	Yes	Yes	768	296	Boot	30	16	3	6	–	25	2	24	347/520	6	–	–	–	1	1	6	5	2	–	Yes	3.3	64	2	Yes	144
F28M36H33C	150/75 or 100/100	Yes	–	Yes	Yes	768	296	Boot	30	16	3	6	–	25	2	24	347/520	6	–	1	Yes	1	1	6	5	2	–	Yes	3.3	64	2	Yes	144
F28M36H53B	150/75 or 100/100	Yes	–	Yes	Yes	1024	296	Boot	30	16	3	6	–	25	2	24	347/520	6	–	-	-	1	1	6	5	2	–	Yes	3.3	64	2	Yes	144
F28M36H53C	150/75 or 100/100	Yes	–	Yes	Yes	1024	296	Boot	30	16	3	6	–	25	2	24	347/520	6	–	1	Yes	1	1	6	5	2	–	Yes	3.3	64	2	Yes	144
F28M36P53C	150/75 or 125/125	Yes	–	Yes	Yes	1024	296	Boot	30	16	3	6	–	25	2	24	347/416	6	–	1	Yes	1	1	6	5	2	–	Yes	3.3	64	2	Yes	289
F28M36P63C	150/75 or 125/125	Yes	–	Yes	Yes	1536	296	Boot	30	16	3	6	–	25	2	24	347/416	6	–	1	Yes	1	1	6	5	2	–	Yes	3.3	64	2	Yes	289

**Timers include CPU timers, PWM timers, eCAP timers and Watchdog timers*

†Prices are quoted in U.S. dollars and represent 2016 suggested retail pricing for baseline packages and device configurations. All prices are subject to change.

C2000 Software Solutions

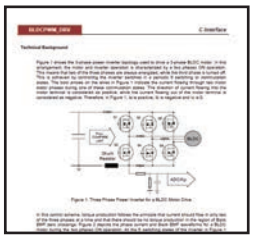
controlSUITE™ Software Suite

controlSUITE software is a completely free suite of device software, development kit resources, software libraries, documentation, and design support. controlSUITE software comes with a graphical user interface (GUI) for easy visual navigation of all C2000 design resources. Users can learn through device-level example projects, begin application development with development kits, understand control methods through detailed application guides, and explore everything C2000 MCUs have to offer. With controlSUITE software, it is easy to access all the resources you need to for development. No more scouring the web searching for device headers, libraries, or documentation, controlSUITE software is a centralized resource for all C2000 microcontroller software, hardware and technical resource needs.

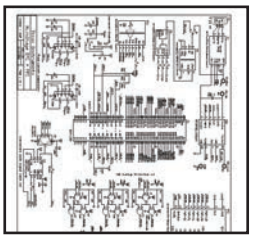
*Learn more and download today at **www.ti.com/controlSUITE***

All of your design resources in one place!


Example projects


Device and application libraries

Kit software and GUIs


Hardware design files

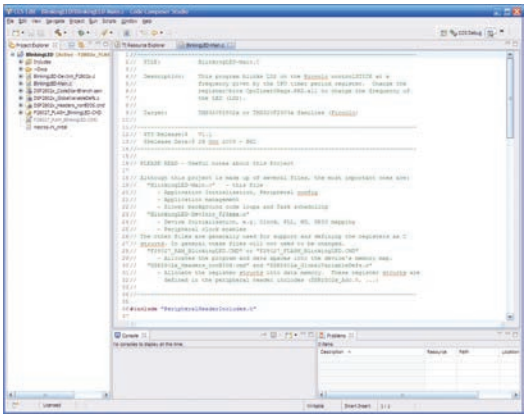

Datasheets, users guides, and more

Code Composer Studio™ IDE

Code Composer Studio (CCStudio) integrated development environment (IDE) comprises a single-user interface to a suite of tools used to develop and debug TI embedded applications.

Code Composer Studio IDE features

- C2000-optimized compilers
- Source code editor
- Project build environment
- Debugger (Full C/C++ and Assembly debugging)
- Profiler
- Simulators
- Real-time operating system
- Intuitive Eclipse-based interface



*Learn more and download today at **www.ti.com/ccs***

C2000 MCUs real-time debugging

- Graph and modify variables/registers in real-time while running code
- Allows you to halt non-critical code for debugging while time-critical interrupts continue to be serviced
- Access memory and registers without stopping the processor
- Implemented in silicon, not by a debugging monitor: easy to use, no application resources required

controlSUITE™ Device Libraries

We have reinvented the wheel so you do not have to!

IQMath™ Library – A Virtual Floating-Point Engine

Texas Instruments IQMath Library is a virtual floating-point engine. This library is a collection of highly optimized mathematical functions enabling C/C++ programmers to develop with floating-point math on devices without native floating-point hardware support. IQMath enables code to be seamlessly ported between floating- and fixed-point devices for ultimate code scalability. The IQMath functions facilitate execution speeds considerably faster than equivalent code written in ANSI C on fixed-point MCUs, while eliminating the burden of dealing with fixed-point scaling. Just write C floating-point code and let the compiler take care of the rest.

DSP Fixed- and Floating-Point Libraries

Offers support for common DSP operations such as complex FFTs, real FFTs, inverse FFTs, FIR filters, IIR filters, vector and matrix routines, common math routines and utility functions.

DSP Signal Generation Library

Makes signal waveform generation easy with SIN generation, ramp generation and trapezoidal generation modules.

VCU DSP Library – Accelerated FFTs, Viterbi Decoding and CRC Memory Checking

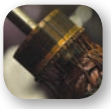
VCU hardware accelerator library containing library functions for real, complex and inverse FFTs, Viterbi Add-Compare-Select and traceback operation, and CRC memory checking up to 32 bits. With the combination of the VCU hardware accelerator and library support, developers can achieve 2-cycle Viterbi butterfly operation, 3-cycle Viterbi traceback operation, 5-cycle 16-bit FFT butterfly operation, and overall, accelerate communications algorithms by up to 8× over the main C28x core of C2000™ devices.

Math Libraries

Common trigonometric and math function support. Includes libraries for fixed-point devices, floating-point devices and the CLA co-processor.

controlSUITE Software Application Libraries

Modular, application-tuned libraries essential for real-time control systems



Motor Control Library

Consists of C macros covering nearly all target-independent mathematical functions and target-specific peripheral configuration functions essential for motor control. This includes transformation and observer modules, signal generators and control modules, peripheral drivers and real-time debugging modules.

Digital Power Library

Consists of modules that enable digital control of various power topologies. This includes peripheral drivers, control modules, mathematical functions and utility functions.

Solar Power Library

Provides a framework of common solar algorithms to ease implementation of solar systems. This includes Maximum Power Point Tracking (MPPT) algorithms, Phase Locked Loop (PLL) modules, control modules and math modules.

Power Line Communications Libraries

Texas Instruments is a leader in Power Line Communications (PLC) technology, providing software for various modulations and standards. Included software libraries ease development of PLC applications for SFSK IEC61334, PRIME and G3 standards. FlexOFDM libraries are also available for custom OFDM implementations, enabling scalability for the emerging standards.

powerSUITE Software Tools

powerSUITE is a collection of software graphical user interface tools which make it easy to develop and modify digital power designs. powerSUITE has an intuitive interface which seamlessly integrates developed code into TI's Code Composer Studio™ integrated development environment (IDE) and is comprised of three tools which are the Solution Adapter, the Compensation Designer, and the Software Frequency Response Analyzer (SFRA).

The Solution Adapter

Allows designers to easily modify existing code examples for custom hardware using a simple GUI instead of directly modifying development code.

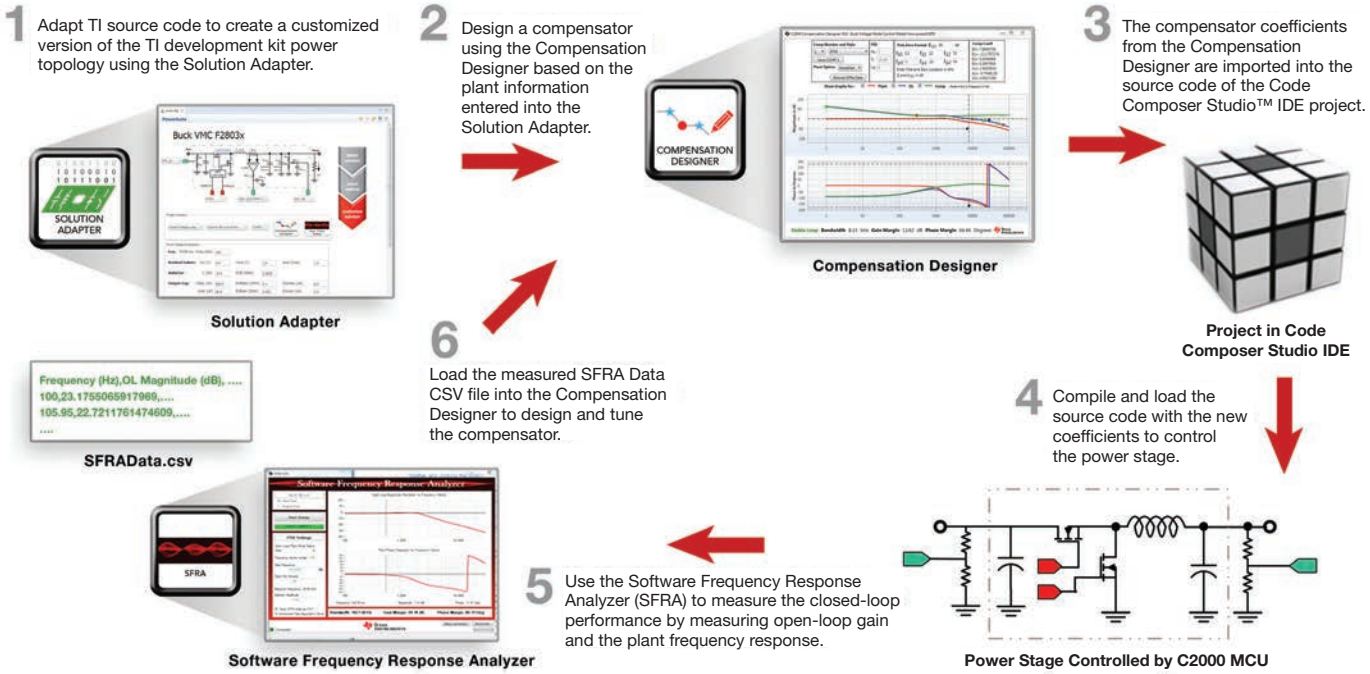
The Compensation Designer

Enables developers to create compensators of different styles, providing a method to effortlessly tune control loops.

The Software Frequency Response Analyzer

Provides developers with an in-circuit method for measuring the frequency response of digital power converter control loops.

Designing a power system using powerSUITE software tools

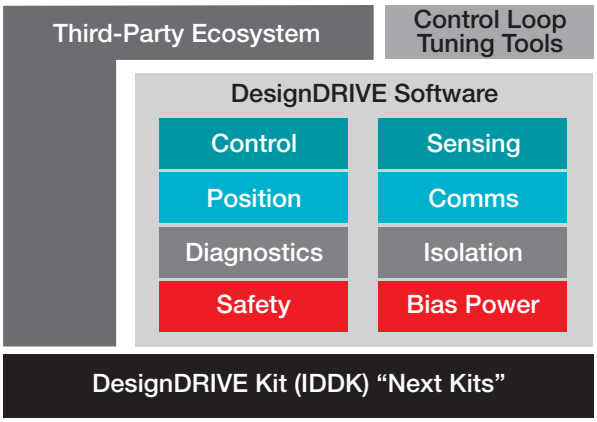


DesignDRIVE Technology – The ONE Place to Create MANY Designs for Industrial Drives

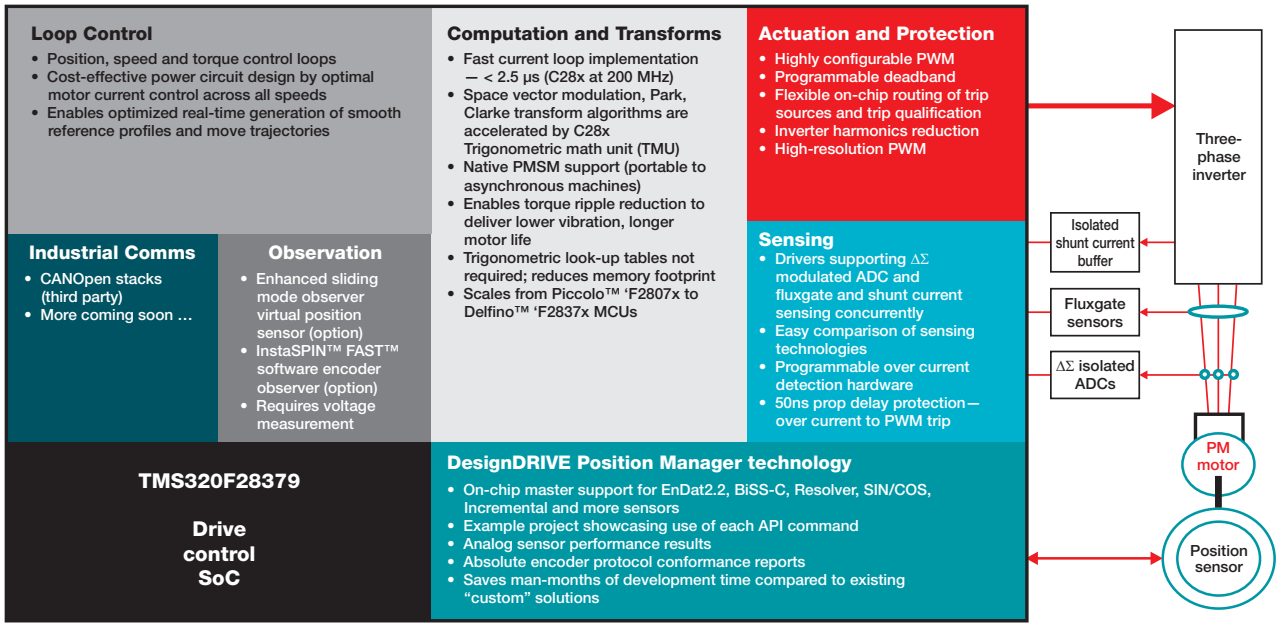
C2000™ DesignDRIVE technology helps designers develop industrial drives and motor control solutions spanning different motor types and multiple drive topologies.

Key Applications

- AC inverter and variable frequency drives
- Manufacturing robotics
- Servo drives
- CNC machinery
- Elevators



DesignDRIVE software

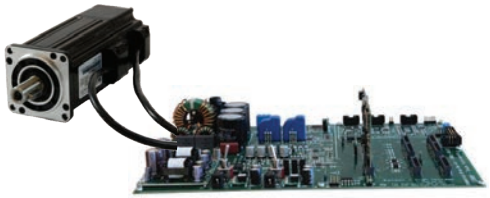


Industrial drives hardware development kits

The **DesignDRIVE IDDK development kit** and software solutions offer an easy path for customers to explore current sensing technologies and interface to various position sensors and motor types. The on-board expansion slots make the board ready for real-time Ethernet and functional protection additions as well. DesignDRIVE software is also available in the C2000 MCU **controlSUITE™** libraries package and includes specific examples of vector-based control incorporating current, speed and position loops utilizing current and position-sensing routines.

DesignDRIVE & motor bundle – U.S. $1,199
(TMDXIDDK377D-MTR-BNDL)

- DesignDRIVE kit
- High-voltage PMSM motor with built-in encoder



DesignDRIVE kit-IDDK – U.S. $999
(TMDXIDDK377D)

- Integrated three-phase power module
- Feedback sensing via shunt, fluxgate / Hall, delta-sigma
- Position feedback*
  - Analog resolver and SIN/COS
  - Digital incremental
  - Digital absolute (BiSS, EnDAT)
- Isolation links
  - SPI/McBSP
- System expansion and upgrades
  - Industrial connectivity expansion slot
  - Functional safety expansion slot

*Full encoder feedback functionality requires additional purchase of TMXCNCD28379D controlCARD

Digital Power

C2000 microcontrollers bring a new range of possibilities in digital power management and power control. A digitally controlled system based on a C2000 MCU overcomes many of the analog power supply challenges and provides significant benefits to most power supplies, such as improved efficiency, added functions and features, and increased reliability. For example, C2000 microcontroller-driven power supplies are reaching unprecedented efficiency levels, especially at light loads. TI provides digital power algorithms and user-friendly software libraries that can be adapted to different topologies and voltage power levels, allowing for faster time to market. **www.ti.com/digitalpower**

controlSUITE™ software includes multiple control methods and multiple topologies through modular software for C2000 microcontrollers at no cost. powerSUITE is also included as part of the controlSUITE download and includes a collection of graphical users tools to simplify digital power supply design. **www.ti.com/controlsuite**

Why use digital power controllers in a power supply design?

Reduced development costs
- Tunable platforms lead to new products quicker
- Calibration, better noise and temperature immunity
- Reduced board area and parts count

Higher system efficiency
- Adaptive efficiency across load range
- Support for faster switching frequencies and sophisticated zero-voltage crossing techniques

Power topology flexibility
- Precise waveform control supported by high-resolutions phase, frequency, and duty cycle control
- Tightly coupled ADCs and PWMs peripherals for low-latency on-chip control methodologies
- On-chip comparators and slope compensation for phase-shifted full bridge and custom power topologies

Higher quality
- Flexibility through programmability
- Calibration at final functional test
- Less sensitive to drift and better noise immunity
- Parameter monitoring for continual quality improvement

System-level monitoring and reliability
- On-chip communication interfaces for integration with other system components
- Built-in diagnostics for over-voltage, over-current, and other system-level protection
- Intelligent diagnostics, failure prediction, reporting capability

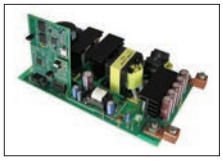
Key Applications

- *Switch-mode power supplies*
- *Uninterruptible power supplies*
- *AC/DC rectifiers*
- *Hybrid vehicles*
- *Digital TVs*
- *DC-DC modules or POLs:*
  - *Buck or boost*
  - *Half-bridge*
  - *Full-bridge*
  - *Multiphase interleaved*
- *Communication systems in:*
  - *Server farms*
  - *Base stations*
  - *Telecom/Consumer equipments*

Tools and software for digital power applications

High voltage development kits and digital power software libraries to jump start designs

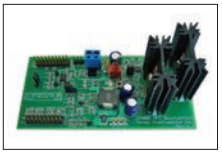
Bridgeless PFC Kit – $450
TMDSHVBLPFCKIT
- 2-phase interleaved PFC
- 300W, up to 400V DC output
- Isolated JTAG for real-time debug
- Comes with Piccolo F28035 controlCARD



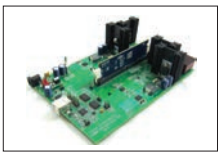
Phase Shifted Full Bridge – $550
TMDSHVPSFBKIT
- Up to 400VDC input
- 600W 12VDC output
- Peak current mode with slope compensation
- Comes with Piccolo F28027 controlCARD

Resonant LLC Kit – $400
TMDXHVRESLLCKIT
- Up to 400VDC input
- 360W 12VDC output
- Experiment with OCP, OVP and UVP
- Comes with Piccolo F28027 controlCARD

2-Phase Interleaved PFC – $299
TMDSILPFCKIT
- 2-phase interleaved PFC
- 300W, up to 400V DC output
- Comes with Piccolo F28027 controlCARD



Digital Power BoosterPack – $59
BOOSTXL-BUCKCONV
- Single-stage buck converter
- External 9V, 2A source
- Supports C2000 Piccolo TMS320F28069
- Purchase LAUNCHXL-F28069M separately



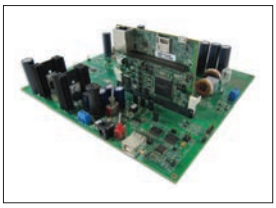
Digital Power Training Kit – $399
TMDSC2KWRKSHPKIT
- Digital control of multiple power conversion stages
- Parallel operation of 2 buck converters
- Peak current mode control
- Vin of 9VDC

Solar Energy

Solar energy is a booming technology for energy harvesting. With C2000 microcontrollers, solar systems can extract more energy from the sun through advanced power conversion and maximum power point tracking (MPPT) performance. Whether the system feeds power back to the grid, charges a battery, or both, C2000 MCUs provide the power conversion control to most efficiently extract and deliver energy.

Solar Explorer Development Kit – $349

- 20VDC / 50W non-isolated design
- Single-switch DC/DC boost for MPPT
- DC/DC sepic for MPPT and battery charging
- Output inverter stage 24VAC maximum
- Piccolo™ MCU

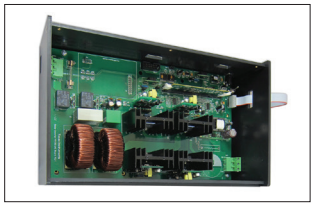


High-Voltage Solar DC/DC MPPT Kit – $349

- 200–300VDC input up to 500W
- 400VDC output
- 2-phase DC/DC boost for MPPT
- 1:1 resonant LLC for isolation
- Piccolo MCU

High Voltage Solar 1-Phase Inverter Kit – $349

- >96% efficient
- Grid-tie with enable/disable
- Ethernet remote control and monitoring
- 110/220VAC selectable output
- Piccolo or F28M3x MCU control



Key Applications

- *Central and string inverters*
- *Micro inverters*
- *On- and off-grid solar applications*
- *Battery charging applications*
- *Solar arc detection*

Lighting

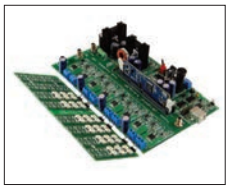
LED lighting is increasingly becoming the dominant lighting technology due to its inherent efficiency, safety, configurability, and asthetic benefits. Likewise, C2000 microcontrollers are an ideal solution for many LED lighting applications. With an optimized DSP core and powerful peripherals, C2000 microcontrollers provide the processing capability and integration to drive low-cost, dynamic, and energy-efficient lighting systems. With just a single, low-cost Piccolo™ MCU, high efficiency digital power conversion, dynamic multi-string LED lighting control, and advanced communications can be implemented in a lighting system. **www.ti.com/led**

Key Applications

- *Industrial & commercial lighting*
- *Building lighting*
- *Street lighting*
- *Stage lighting*
- *Automotive lighting*
- *Large infrastructure lighting*
- *Intelligent lighting*

DC/DC LED Lighting Developer's Kit – $399

- Eight independent 10-watt LED driver stages
- Buck or boost DC/DC power stage
- Digital control of DC/DC power stage and LED driver stages with a single Piccolo MCU
- Includes Piccolo F28035 controlCARD



Multi-DC/DC Color LED Kit – $499

- Eight independent DC/DC boost/sepic power stages
- Implements color mixing
- Digital control of eight DC/DC power stages and eight LED driver stages with a single Piccolo MCU
- Includes Piccolo F28027 controlCARD

Benefits

Increase operating efficiency across lighting conditions

Single design for multiple lighting fixture implementations

Add intelligence with advanced communications protocols such as Power-Line Communications (PLC), DALI, DMX, KNX, etc.

Precise LED intensity, dimming, and color mixing through on-chip high-resolution PWM and ADC peripherals

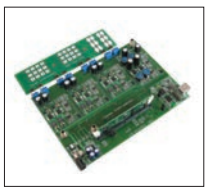
Reduce cost through integration of all major control systems into a single MCU

Easy field upgrades and dynamic on-the-fly adjustments

Easy implementation of advanced features such as temperature sensing and correction, dimming scheduler, aging compensation, etc.

Isolated AC LED Lighting & Communications Kit – $699

- AC/DC LED lighting power supply
- 6 LED strings with dimming
- DALI, DMX512, & Power Line Communications (PLC)



Automotive

The automotive industry is constantly looking for new ways to make their cars safer, more reliable, and more efficient. The powerful PWM modules and analog ADC integrated in C2000 microcontroller devices can be used in applications such as collision avoidance, power steering, radar applications, heads-up display and electronically-controlled interfaces.

The industry is also looking at a shift toward hybrid and fully electric vehicles, and C2000 MCUs provide a low-cost solution to many aspects of HEV/EV operation. With a powerful DSP-based core, a variety of communication protocols including LIN and CAN, and automotive AEC-Q100 qualification (–40° to 125°C), C2000 microcontrollers work to complete your automotive designs. **www.ti.com/hev**

HEV benefits

- **Reconfigurable constant voltage/current/power charging mode**
- **Optimized battery charging to extend battery life and performance**
- **Communication via PLC for smart charging**
- **Improved SOC/SOH estimation for optimal battery usage**

Tools and Software

- *Hardware reference designs*
  - *– Start/Stop system – 4-phase interleaved boost*
  - *– Motor control board for small-task-oriented vehicles (STOV)*
  - *– Automotive headlamp*
- *controlSUITE™ software*

Key Applications

- *Automotive radar and collision avoidance*
- *Electric power steering*
- *Drive-by-wire*
- *Power conversion*
- *Heads-up displays*
- *Hybrid Electric Vehicle/Electric Vehicle (HEV/EV)*
  - *– Online battery charger*
  - *– DC/DC power conversion*
  - *– Battery management system*
  - *– Electric motor inverter*

Digital Motor Control

Texas Instruments understands the challenges facing motor-control developers, and provides software and tools that significantly accelerate development of motor-control systems. Thorough documentation, rich suites of digital motor control and math libraries, modular software strategies, and open-source motor-control development kits lead developers through the process of creating a complete motor-control system. Combining this complete motor ecosystem with motor-tuned microcontroller architectures, C2000 MCUs reduce the overall cost of motor-control systems and enable control techniques to create efficient, cutting-edge solutions. **www.ti.com/c2000dmc** and **www.ti.com/instaspin**

Key Applications

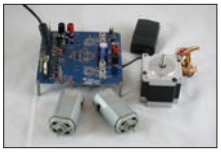
- *Variable-speed drives*
- *Servo drives*
- *Appliance motors*
- *HVAC compressors and blowers*
- *Pumps and fans*
- *Electric power steering*
- *Soft starters*
- *Tools*

C2000 motor control gives you MORE

• Variable speed control	→	MORE efficient motors
• Field-oriented control	→	MORE efficient control
• Space vector PWM	→	MORE efficient power stage
• Sensor-less control	→	MORE cost effective
• Multi-axis control	→	MORE motors per controller
• Integrated digital PFC	→	MORE system functions
• Meeting IEC standards	→	MORE reliable and robust
• Broadest MCU portfolio	→	MORE products, one platform

Motor Solution Kits

Brushed & Stepper Motor Kit with DRV8412 & Piccolo MCU – $199



- 52V, 3.5A 3-phase motor driver stage
- Quadrature encoder interface
- Piccolo F28035 micro-controller control
- Includes two brushed DC and one stepper motor

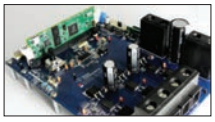
LaunchPad + Booster Kit – $66

- 6–24V, 10A continuous 14A peak inverter
- Self-protecting DRV8301 pre-driver with integrated buck and opamps
- Power dense NexFET™ power MOSFETs

High-Voltage PFC and MC Developer's Kit – $699

- 1.5KW, 350V 3-phase motor driver stage
- 750W 110–220 VAC PFC stage
- Projects for ACI, BLDC, and PMSM motors sold by TI
- Spin your own motor instantly with InstaSPIN versions
- Isolated CAN and UART interfaces

Three-Phase BLDC & PMSM Motor Kit with DRV8301/DRV8302 and Piccolo MCU – $299



- 60V, 60A 3-phase motor driver stage
- NO motor included
- Spin your own motor instantly with InstaSPIN™ versions
- Hall & quadrature encoder interfaces
- Isolated SPI and CAN interfaces

Three Phase BLDC & PMSM Motor Kit with DRV8312 & Piccolo MCU – $299

- 50V, 3.5A 3-phase motor driver stage
- NEMA17 BLDC/PMSM 55W motor
- Spin your own motor instantly with InstaSPIN versions
- Hall & quadrature encoder interfaces
- Isolated SPI and CAN interfaces

Kit Part Number	Controller Included	Voltage (V)	Current (Continuous, A)	Software	Control Techniques	Supported Motor Types			Rotor Sensor		
						Step/ Brush	ACI	BLDC/PM	Hall	Encoder	SW Sensor
DRV8412-C2-KIT	TMDSCNCD28035ISO	12–50	3.5	controlSUITE™	Micro-stepping, Brushed torque	•					
DRV8312-C2-KIT	TMDSCNCD28035ISO	15–50	3.5	controlSUITE	BLDC, InstaSPIN-BLDC, SMO FOC			•	•		•
DRV8312-69M-KIT	TMDSCNCD28069MISO	15–50	3.5	MotorWare	InstaSPIN-FOC, InstaSPIN-MOTION		•	•		•	•
BOOSTXL-DRV8301	LAUNCHXL-F28027F* and LAUNCHXL-F28069M	6–24	10	MotorWare	InstaSPIN-FOC, InstaSPIN-Motion		•	•		•	•
BOOSTXL-DRV8305EVM	LAUNCHXL-F28027F* and LAUNCHXL-F28069M	4.4–45	15	MotorWare	InstaSPIN-FOC, InstaSPIN-Motion		•	•		•	•
DRV8302-HC-C2-Kit	TMDSCNCD28035ISO	18–60	60	controlSUITE	InstaSPIN-BLDC, SMO FOC			•			•
DRV8301-HC-C2-KIT	TMDSCNCD28035ISO	18–60	60	controlSUITE	InstaSPIN-BLDC, SMO FOC			•			•
DRV8301-69M-KIT	TMDSCNCD28069MISO	18–60	40	MotorWare	InstaSPIN-FOC, InstaSPIN-MOTION		•	•		•	•
TMDSHVMTRPFCKIT	TMDSCNCD28035 and TMDSCNCD28335	50–350	10	controlSUITE	V/Hz, BLDC, SMO/FE FOC		•	•	•	•	•
TMDXHVMTRKIT5X	TMDXCNCD28055ISO	50–350	10	controlSUITE	SMO/FE FOC		•	•			•
TMDSHVMTRINSPIN	TMDSCNCD28069MISO and TMDSCNCD28027F	50–350	10	MotorWare	InstaSPIN-FOC, InstaSPIN-MOTION		•	•		•	•

**If purchased as a bundle.*

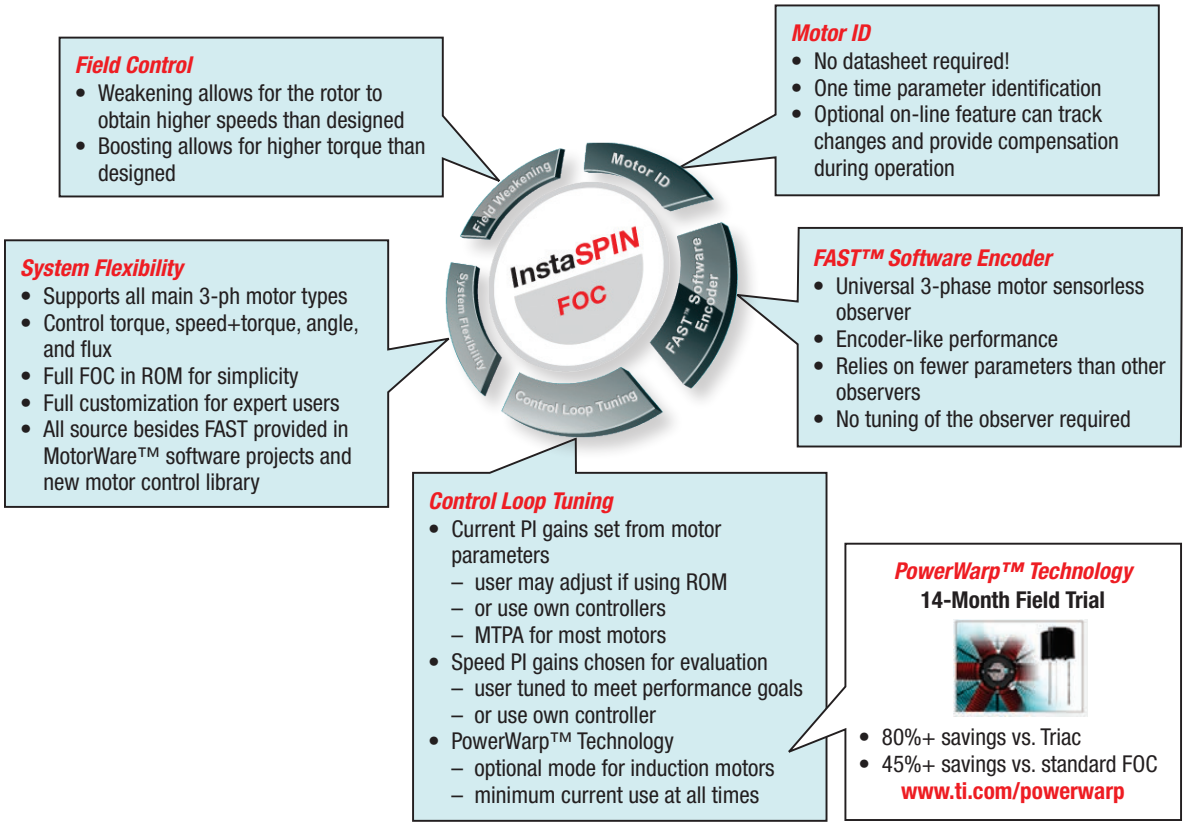
InstaSPIN™ motor and motion control technology

Making motor development easier, faster and more affordable

- Embedded in the read-only-memory (ROM) on select Piccolo devices
- Save months of design time with motor parameter identification, automatic software observer and torque control tuning, rapid speed-control tuning and a full suite of trajectory generation and state-based motion planning.
- Near encoder performance with embedded on-chip FAST™ observer algorithm, which through only analysis of currents and voltages, calculates a reliable and robust estimation of rotor flux, angle, speed and torque across use conditions. Accurate, sensorless estimator performance eliminates the need for a physical sensor in nearly all torque and velocity applications.
- Accommodate all three-phase motors, synchronous (BLDC, SPM and IPM) and asynchronous (ACI) with the same solution.
- Identify and tune with off-line motor commissioning that identifies the required parameters of the motor, tunes the FAST algorithm, and initializes the current controllers for stable operation. An optional online resistance re-estimation mode tracks changes for robust observer performance under the most demanding low speed loads.
- Eliminate start-up challenges of other sensorless techniques with built-in start-up modes and observer angle lock in less than one electrical cycle.
- Slow speed performance with angle integrity preserved at steady state below 1 Hz (typical) with full torque, zero speed stability, reversals through zero speed and smooth stall recovery.
- Gain system architecture flexibility with the ability to implement a single function call FOC torque controller or a completely custom control system with FAST as the software motor sensor.

InstaSPIN-FOC

TI's InstaSPIN-FOC software solution takes advantage of the FAST™ premium software sensor for rotor flux measurement and provides motor identification, automatic current control tuning and sensorless feedback in a field-oriented control (FOC) torque controller and speeds deployment of efficient, sensorless, variable-load three-phase motor solutions.



F

Rotor Flux
- High integrity signal for stable field control

A

Rotor Angle
- Locks within one electrical cycle of rotation
- Stable through zero
- Robust under dynamics
- Recovery after stall events

S

Rotor Speed
- Mechanical and electrical speed estimations
- Near zero phase lag

T

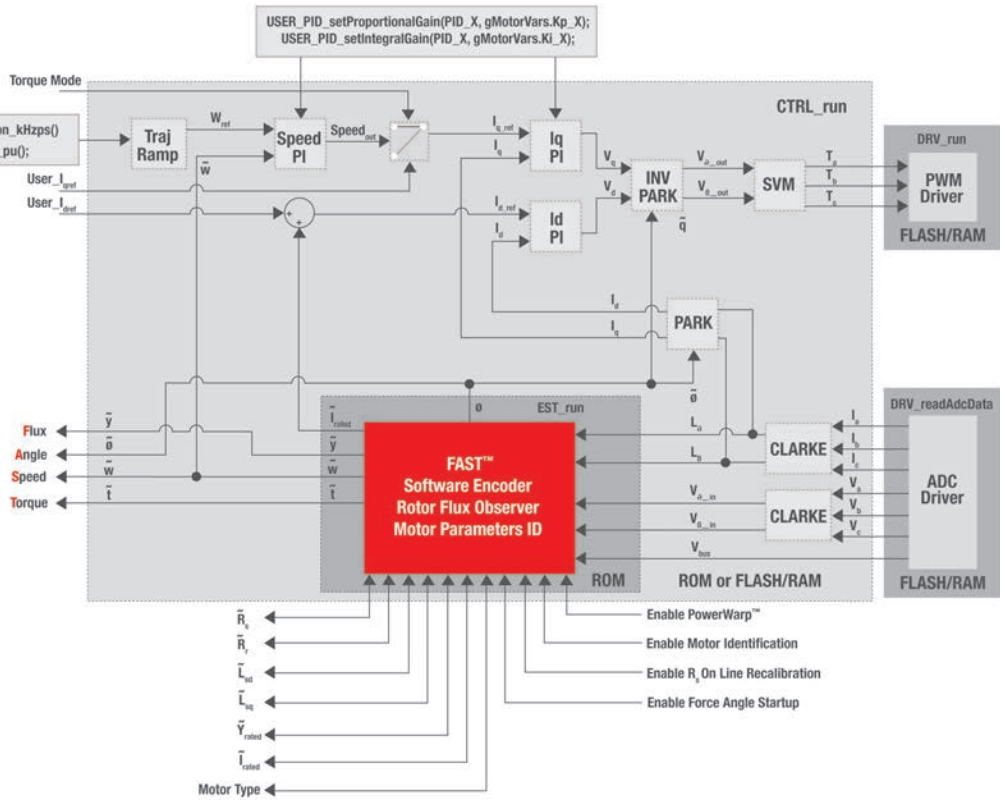
Rotor Torque
- Accurate for load monitoring, flow rate, unbalanced load, motor diagnostics

FAST™ Software Encoder (Sensorless Observer)

- Universal 3-phase motor software encoder supports
  - Synchronous (BLDC, SPM, IPM)
  - Asynchronous (ACI) motors
  - Unique, high-quality feedback signals for use in control systems
- Performance
  - Tracks below 1 Hz
  - Tracks through zero on speed reversals
  - Stable feedback to control system when rotor is at zero speed
- Motor parameters
  - Relies on fewer parameters than other observers
  - Off-line commissioning learns the needed electrical motor parameters
  - Optional online observer tracks parameter changes to ensure estimation accuracy over time and temperature
- Tuning
  - No tuning of the observer required

Included in ROM on select Piccolo™ MCUs, with software API

InstaSPIN FOC



- FAST is always called from ROM
- Full InstaSPIN-FOC system (torque or speed+torque) may be called from ROM
- Source also provided for FOC to call from user memory
- Any custom system may be developed using feedback from FAST

InstaSPIN™-MOTION

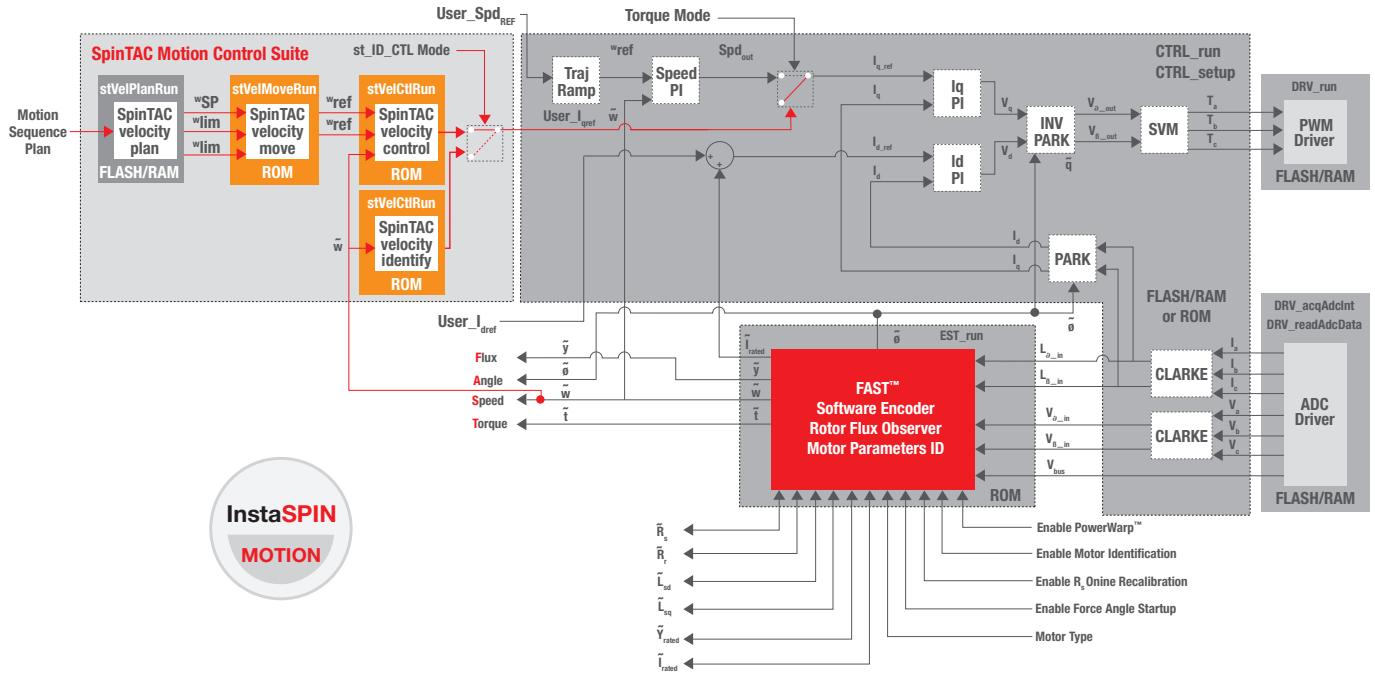
Built upon TI's InstaSPIN-FOC technology, InstaSPIN-MOTION software powered by SpinTAC™ technology provides accurate speed and position control with minimal disturbances.

IDENTIFY – Ensure optimum tracking and disturbance rejection, working with the real inertia of the system.

CONTROL – Minimize effort and reduce complexity with single coefficient tuning. Rapidly test and tune velocity control from soft to stiff response, defining a controller gain that typically works across the entire variable speed and load range of an application. Actively estimate and cancel system disturbances in real time, providing maximum performance.

MOVE – Produce an automatically optimized motion profile based on start velocity, target velocity and system limitations for acceleration, jerk and motion trajectory type.

PLAN – Quickly build various states of motion (speed A to speed B) and tie them together with state-based logic.



InstaSPIN-FOC and -MOTION capable devices

	Processor					Memory			Control Interfaces									Communication Ports													
Device	Speed (MHz)	FPU	CLA co-processor	VCU accelerator	DMA	Flash (KB)	RAM (KB)	ROM (KB)	PWM ch.	High-resolution PWM ch.	Quadrature encoder	Event captures	HRCAP	Timers*	12-bit ADC ch.	ADC conversion time (ns)	Comparators	OpAmp/PGA	USB	McBSP	I²C	UART/SCI	SPI	CAN	LIN	External memory interface	Core supply (V)	GPIO pins	On-chip oscillator	Voltage regulator	Package pin counts	1 kU pricing (U.S. $)
TMS320F28026F‡	60	–	–	–	–	32	12	Boot	9	4	–	1	–	9	13	217	2	–	–	–	1	1	1	–	–	–	3.3	22	2	Yes	48	4.45
TMS320F28027F‡	60	–	–	–	–	64	12	Boot	9	4	–	1	–	9	13	217	2	–	–	–	1	1	1	–	–	–	3.3	22	2	Yes	48	4.66
TMS320F28052F‡	60	–	–	–	–	64	20	Boot	15	–	1	1	–	12	16	267	7	6	–	–	1	3	1	1	–	–	3.3	42	2	Yes	80	5.69
TMS320F28052M§	60	–	–	–	–	64	20	Boot	15	–	1	1	–	12	16	267	7	4	–	–	1	3	1	1	–	–	3.3	42	2	Yes	80	7.32
TMS320F28054F‡	60	–	–	–	–	128	20	Boot	15	–	1	1	–	12	16	267	7	4	–	–	1	3	1	1	–	–	3.3	42	2	Yes	80	6.25
TMS320F28054M§	60	–	–	–	–	128	20	Boot	15	–	1	1	–	12	16	267	7	4	–	–	1	3	1	1	–	–	3.3	42	2	Yes	80	8.00
TMS320F28062F‡	90	Yes	–	–	Yes	128	52	Boot	19	8	2	7	4	17	16	325	3	–	1	1	1	2	2	1	–	–	3.3	54	2	Yes	80, 100	6.70
TMS320F28068F‡	90	Yes	–	Yes	Yes	256	96	Boot	19	8	2	7	4	17	16	325	3	–	1	1	1	2	2	1	–	–	3.3	54	2	Yes	80, 100	11.33
TMS320F28068M§	90	Yes	–	Yes	Yes	256	96	Boot	19	8	2	7	4	17	16	325	3	–	1	1	1	2	2	1	–	–	3.3	54	2	Yes	80, 100	7.00
TMS320F28069F‡	90	Yes	Yes	Yes	Yes	256	96	Boot	19	8	2	7	4	17	16	325	3	–	1	1	1	2	2	1	–	–	3.3	54	2	Yes	80, 100	10.03
TMS320F28069M§	90	Yes	Yes	Yes	Yes	256	96	Boot	19	8	2	7	4	17	16	325	3	–	1	1	1	2	2	1	–	–	3.3	54	2	Yes	80, 100	12.56

†Prices are quoted in U.S. dollars and represent 2016 suggested retail pricing for baseline packages and device configurations. All prices are subject to change.

**Timers include CPU timers, PWM timers, eCAP timers and Watchdog timers*

‡InstaSPIN-FOC capable devices

§InstaSPIN-MOTION (and InstaSPIN-FOC) capable devices

Power-Line Communications

Power-line communications (PLC) transmit data over an existing high-voltage power line instead of requiring dedicated cabling. Although the technology has been used for decades, recent concepts and ideas have opened the door to new innovations driven by power line communication. C2000 microcontrollers are an ideal platform for power-line networked applications because the performance, large on-chip memory, and integrated peripheral interfaces provide a single-chip solution for control and PLC functions. Additionally, with unique on-chip IP such as the Verterbi Complex Math Unit (VCU), C2000 MCUs are tuned for power-line communications, offering unparalleled performance in a cost-sensitive package. TI has developed freely available PLC software libraries and hardware reference designs which provide a flexible platform to quickly develop and test robust PLC implementations. With a flexible PLC development platform and PLC-optimized C2000 MCUs, TI provides industry-leading solutions for PLC development. **www.ti.com/plc**

Key Applications

- *Lighting*
- *Solar*
- *Metering*
- *Industrial controls*
- *Ballast*
- *Security gates/cameras*
- *Motor control*

C2000 Power-Line Modem Developer's Kit – $599

- Two PLC modems
- PLC software supporting OFDM (PRIME, G3, FlexOFDM) and SFSK communication
- Two F28069 controlCARDs included

Benefits
Single C2000 MCU has the performance and peripherals to control the entire system
PLC systems controlled with software allow multiple standard support and easy protocol updating
Software-based system allows modulation scheme to be changed in software
Integrated system communication interfaces: I²C, CAN, SPI, UART, LIN

Precision Sensing and Control

The growing requirements to add active intelligence and functionality to sensing and measurement applications make microcontrollers that enable a high-precision response very desirable. The benefits of a DSP-based core (filtering and high-performance calculations) combined with the best features of an MCU (easy development and low-cost integration) allow for innovative implementations and advancements of common systems. The C2000 platform is composed of components that can improve almost any application that requires precision sensing and control.

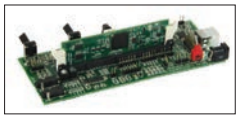
Key Applications

- *RFID readers*
- *Musical effects*
- *Alarm systems*
- *Robots*
- *Motor systems*
- *Medical*
- *Bar-code scanners*
- *Pressure/torque/inertial sensors*
- *Capacitive/piezoresistive sensors*
- *Thermal and laser control for optical networks*
- *Radar sensing*

Tools and Software

- *C2000 LaunchPad*
- *Experimenter's Kit*
- *Peripheral Explorer Kit*
- *Software libraries*

Peripheral Explorer Kit – $179



- Easily learn how to use all of the advanced peripherals on a C2000 MCU
- Ready-to-run software and hardware
- Comes with an F28335 controlCARD
- Includes on-board USB JTAG emulation
- Includes C2000 teaching CD-ROM

Benefits	Enabling features
Accurate measurements	• Fastest on-chip ADC on the market – up to 12.5 MSPS with dual sample-and-hold to allow concurrent measurements
Precise outputs and control	• Multiple high-resolution PWM modules provide step resolution at 55ps • Fully configurable PWM outputs allow the creation of almost any output waveform with any synchronization scheme • 32-bit enhanced captures with four event time stamps
Minimize cost and improve reliability	• Dual integrated high-speed oscillators and analog comparators • Power-on reset, brown-out protection, and programmable trip conditions

C2000 LaunchPads and BoosterPacks – Low-cost platforms to get started with C2000 MCUs

C2000 LaunchPads are low-cost, powerful evaluation platforms which are used to develop real-time control systems based on C2000 MCUs. From Piccolo™ to Delfino™, InstaSPIN™-FOC to InstaSPIN-MOTION, developers can find a LaunchPad with the right performance and feature mix for any application.

C2000 BoosterPacks take the power of the LaunchPads one step further with application-specific kits which plug into the LaunchPads. These kits enable developers to design full solutions using a LaunchPad + BoosterPack combination.

Get started in minutes

- Integrated USB-powered (cable included isolated JTAG emulation tool protects host PC)
- No additional hardware or soldering needed

Rapid prototyping

- Allows interface to external components or custom daughter boards
- Access to all C2000 pins with pin mappings*
- One programmable push button, one push button for CPU reset and four LEDs

**Except JTAG*

See the **LaunchPad website** for a full list of all TI LaunchPads and BoosterPacks

C2000 LaunchPads and BoosterPacks

Piccolo LaunchPads

LAUNCHXL-F28027	LAUNCHXL-F28027F	LAUNCHXL-F28069M
		
MCU supported: TMS320F28027 $17.05	MCU supported: TMS320F28027F InstaSPIN-FOC ready $17.00	MCU supported: TMS320F28069M InstaSPIN-Motion ready $24.99

Delfino LaunchPads

LAUNCHXL-F28377S	LAUNCHXL-F28379D
	
MCU supported: TMS320F28377S $29.99	MCU supported: TMS320F28379D $33.79

Compatible BoosterPacks

BOOSTXL-C2KLED	BOOSTXL-DRV8301	BOOSTXL-DRV8305EVM
		
LED BoosterPack $30.00	Motor Drive BoosterPack $49.00	3-Phase Motor Drive BoosterPack $49.00
Energia Ready	Energia Ready	

Compatible BoosterPacks

BOOSTXL-DRV8301	BOOSTXL-DRV8305EVM	BOOSTXL-BUCKCONV
		
Motor Drive BoosterPack $49.00	3-Phase Motor Drive BoosterPack $49.00	Digital Power Buck BoosterPack $59.00

controlCARD ecosystem

We understand picking the right processor can be tough, and purchasing device-specific EVM boards can become costly. That's why we created the controlCARD development platform.

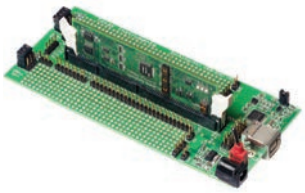
C2000 controlCARDs detach the C2000 processor and all necessary support circuitry from development boards, and instead, assemble these onto modular adapter cards, called "controlCARDs". With the C2000 controlCARD platform, a designer can evaluate multiple C2000 MCUs using the same development board. Simply unplug the old controlCARD and plug-in a new controlCARD. By separating the MCU and support circuitry from the development board, controlCARDs simplify hardware prototyping and reduce replacement costs.

With over 20 device and end-equipment development kits available, C2000 MCUs make it easy to start developing today. All kits are complete with the Code Composer Studio™ IDE and on-board USB JTAG support. Provided through C2000 MCUs' controlSUITE™ Software Suite, each kit also includes fully documented software, example code and hardware development packages. Visit **www.ti.com/c2000tools** for a complete listing of C2000 development tools, and visit **www.ti.com/controlSUITE** to download controlSUITE software for C2000 development kits.

controlCARDs				
Part number	**MCU**	**Socket**	**Incl. USB JTAG**	**Price (Each, U.S. $)**
TMDSCNCD28044	TMS320F28044	DIMM100	–	59
TMDSCNCD2808	TMS320F2808	DIMM100	–	59
Piccolo™ MCUs				
TMDSCNCD28027	TMS320F28027	DIMM100	–	49
TMDSCNCD28027F	TMS320F28027F	InstaSPIN™ DIMM100	–	69
TMDSCNCD28035	TMS320F28035	DIMM100	–	59
TMDSCNCD28035ISO	TMS320F28035	DIMM100	Yes	69
TMDSCNCD28069	TMS320F28069	DIMM100	–	59
TMDSCNCD28069ISO	TMS320F28069	DIMM100	Yes	85
TMDSCNCD28069MISO	TMS320F28069M	InstaSPIN DIMM100	Yes	99
TMDXCNCD28075	TMX320F28075	HSEC180	Yes	129
TMDSCNCD28055ISO	TMS320F28055	DIMM100 and InstaSPIN DIMM100	Yes	69
TMDSCNCD28054MISO	TMS320F28054	DIMM100 and InstaSPIN DIMM100	Yes	69
Delfino™ MCUs				
TMDSCNCD28335	TMS320F28335	DIMM100	–	69
TMDSCNCD28346-168	TMS320C28346	DIMM168	–	125
TMDSCNCD28379D	TMS320F28379D	HSEC180	Yes	159
F28M3x MCUs				
TMDSCNCDH52C1	F28M35H52C1	DIMM100	Yes	130
TMDSCNCD28M36	F28M36P63	HSEC180	Yes	145

Experimenter's Kit

C2000 Experimenter's Kits are great tools for device exploration and initial prototyping. Each Experimenter's Kit includes a docking station and controlCARD with a C2000 MCU. The docking station provides access to all controlCARD signals and includes an on-board USB JTAG emulator. For prototyping, there are two breadboard areas and header pins, allowing for creation of custom solutions.

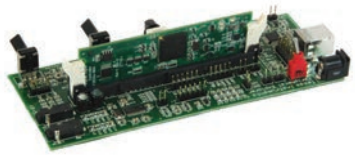


Experimenter's Kits				
Part number	**MCU**	**Socket**	**Incl. USB JTAG**	**Price (Each, U.S. $)**
TMDSDOCK2808	TMS320F2808	DIMM100	Yes	89
Piccolo MCUs				
TMDSDOCK28027	TMS320F28027	DIMM100	Yes	79
TMDSDOCK28035	TMS320F28035	DIMM100	Yes	130
TMDSDOCK28069	TMS320F28069	DIMM100	Yes	99
TMDXDOCK28075	TMX320F28075	HSEC180	Yes	189
Delfino MCUs				
TMDSDOCK28335	TMS320F28335	DIMM100	Yes	99
TMDSDOCK28346-168	TMS320C28346	DIMM168	Yes	125
TMDSDOCK28379D	TMS320F28379D	HSEC180	Yes	219
F28M3x MCUs				
TMDSDOCKH52C1	F28M35H52C1	DIMM100	Yes	185
TMDSDOCK28M36	F28M36P63	HSEC180	Yes	195

C2000™ Microcontrollers

Peripheral Explorer Kit

The C2000 Peripheral Explorer Kit is a great learning tool for new C2000 developers and university students. The kit includes a peripheral explorer board and a controlCARD with the TMS320F28335 MCU. The board includes many hardware-based peripheral components for interacting with the various peripherals common to C2000 MCUs, such as the ADC, PWMs, eCAP, I²C, CAN, SPI and McBSP. Likewise, a teaching ROM is provided containing presentation slides, a learning textbook with over 750 pages, and over 15 laboratory exercises with solutions.



Peripheral Explorer Kit				
Part number	**MCU**	**Socket**	**Incl. USB JTAG**	**Price (Each, U.S. $)**
Delfino™ MCUs				
TMDSPREX28335	TMS320F28335	DIMM100	Yes	179

JTAG Emulators

Most C2000 development kits include on-board XDS100 emulation. However, for other JTAG needs, there are a wealth of third-party JTAG emulators available for C2000 MCUs:

JTAG emulators				
Third party	**Emulator**	**Website**	**Part number**	**Price (Each, U.S. $)**
Spectrum Digital	XDS100	www.spectrumdigital.com	TMDSEMU100U-14T	79
Blackhawk	USB2000	www.blackhawk-dsp.com	TMDSEMU2000U	299
Spectrum Digital	XDS510C	www.spectrumdigital.com	See third-party website	249
Spectrum Digital	XDS510USB	www.spectrumdigital.com	See third-party website	1,299
Signum Systems	JTAGjet-C2000	www.signum.com	See third-party website	595
Signum Systems	JTAGjet-C2000-ISO	www.signum.com	JTAGjet-C2000-ISO	795
Signum Systems	JTAGjet-C2000F-ISO	www.signum.com	JTAGjet-C2000F-ISO	995

Development Kit Software

All software and hardware packages for development kits are included in the controlSUITE software suite. Visit **www.ti.com/controlSUITE** to download today.

Training

To help assist design engineers in taking full advantage of the C2000 microcontroller features and performance, TI has developed a variety of training resources. Utilizing the online training materials and downloadable hands-on workshops provides an easy means for gaining a complete working knowledge of the C2000 microcontroller family. These training resources have been designed to decrease the learning curve, while reducing development time, and accelerating product time to market. For more information on the various training resources, visit **www.ti.com/c2000training**

Third-Party Tools and Software

The MathWorks® Embedded

Target for C2000 Microcontrollers

Embedded Target integrates MATLAB® and Simulink® with TI's Code Composer Studio™ IDE and C2000 microcontrollers. Together, these products let you perform automatic code generation, prototyping, and embedded system deployment. With Embedded Target, you can develop and validate control designs and DSP algorithms from concept through code. **www.mathworks.com/products/tic2000**

Key Features

- *Generates documented, readable, and editable C code in Code Composer Studio IDE project format*
- *Automates the testing and execution of Simulink models*
- *Enables the real-time evaluation of system designs on eZdsp™ boards*
- *Provides block-level access to on-chip peripherals*
- *Provides block-level access to the TI IQMath library for simulation and code generation*

VisSim/Embedded Controls Developer™

VisSim/Embedded Controls Developer is a visual development environment for the rapid prototyping and development of motion-control systems. VisSim is unique in its ability to generate small memory footprint target files and can drastically reduce development time and lower prototyping costs. **www.vissim.com/c2000**

Key Features

- *VisSim/Motion per vissim.com block set that includes pre-built motor, amplifier, sensor, encoder, dynamic load, and PID models*
- *C2000 MCU DMC block set includes all of the TI DMC library in block form*
- *Peripheral blocks generate code for C2000 MCU on-chip devices*
- *Automatic C code generation of production-quality fixed-point code*
- *Real-time visualization while code executes on DSPs*
- *Code Composer Studio IDE plug-in for automatic project creation*

Third Party	Website	Service
C2000 Microcontroller Third Parties		
D3 Engineering	www.d3engineering.com	Design Services; Consulting; Algorithms
Drivetech	www.drivetechinc.com	Design Services; Consulting; DMC Expertise
The MathWorks	www.mathworks.com	Embedded Target; Auto Code Generation
Visual Solutions	www.vissim.com	Rapid Prototyper: Visual Application Development
Signum Systems	www.signum.com	Tools: Flash Programming; Emulation
Windmill	www.windmill-systems.com	TCP/IP
Pentad Design	www.pentaddesign.com	Design Services, DPS and CLA Expertise
Codeskin	www.codeskin.com	Flash Programming Tools and C2000 Code Development
Simma Software	www.simmasoftware.com	CAN and LIN Development
Wittenstein	www.safertos.com	Safety-Certified Operating Systems for F28M3x MCUs

Visit the TI E2E™ Community

Join fellow engineers at the TI E2E Community web site, where you can find training videos, blogs, and an active forum to find the answers to your questions. With a rapidly growing user base, the E2E community will serve as a nexus for all things TI. **www.ti.com/c2000community**

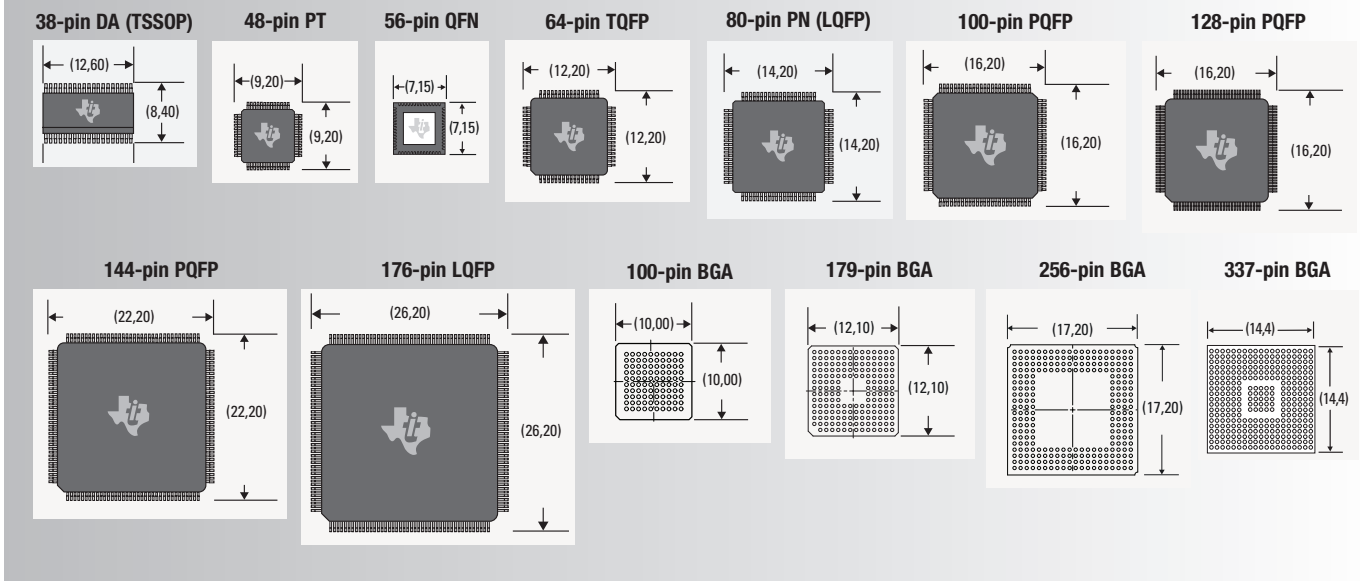
Videos – Watch videos on training, engineering topics, and TI events. Visit the E2E Videos section to learn not only about TI products but also new technologies and trends.

Blogs – Read blog posts about everything from new discoveries to rising cases of "net lag." Find blogs with the musings of some of the brightest minds at TI.

Forums – Get help at the TI E2E forums. Perused by engineers both inside and outside TI, there's someone out there who understands your problems. And if you're feeling smart, don't hesitate to return the favor.

For all C2000™ device configurations, please visit www.ti.com/c2000

Selected Package Options for TMS320C2000™ Devices



TI Worldwide Technical Support

Internet

TI Semiconductor Product Information Center Home Page
support.ti.com

TI E2E™ Community Home Page
e2e.ti.com

Product Information Centers

Americas	Phone	+1(512) 434-1560
Brazil	Phone	0800-891-2616
Mexico	Phone	0800-670-7544
	Fax	+1(972) 927-6377
	Internet/Email	support.ti.com/sc/pic/americas.htm

Europe, Middle East, and Africa

Phone

European Free Call	00800-ASK-TEXAS (00800 275 83927)
International	+49 (0) 8161 80 2121
Russian Support	+7 (4) 95 98 10 701

Note: The European Free Call (Toll Free) number is not active in all countries. If you have technical difficulty calling the free call number, please use the international number above.

Fax	+(49) (0) 8161 80 2045
Internet	www.ti.com/asktexas
Direct Email	asktexas@ti.com

Japan

Fax	International	+81-3-3344-5317
	Domestic	0120-81-0036
Internet/Email	International	support.ti.com/sc/pic/japan.htm
	Domestic	www.tij.co.jp/pic

Asia

Phone — Toll-Free Number

Note: Toll-free numbers may not support mobile and IP phones.

Australia	1-800-999-084
China	800-820-8682
Hong Kong	800-96-5941
India	000-800-100-8888
Indonesia	001-803-8861-1006
Korea	080-551-2804
Malaysia	1-800-80-3973
New Zealand	0800-446-934
Philippines	1-800-765-7404
Singapore	800-886-1028
Taiwan	0800-006800
Thailand	001-800-886-0010

International	+86-21-23073444
Fax	+86-21-23073686
Email	tiasia@ti.com or ti-china@ti.com
Internet	support.ti.com/sc/pic/asia.htm

B021014

Printed in U.S.A. by (Printer, City, State)

TEXAS INSTRUMENTS

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers’ products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers’ products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		

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