C2000™ Real-Time Microcontrollers

Texas Instruments

2011

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C2000™ Microcontrollers

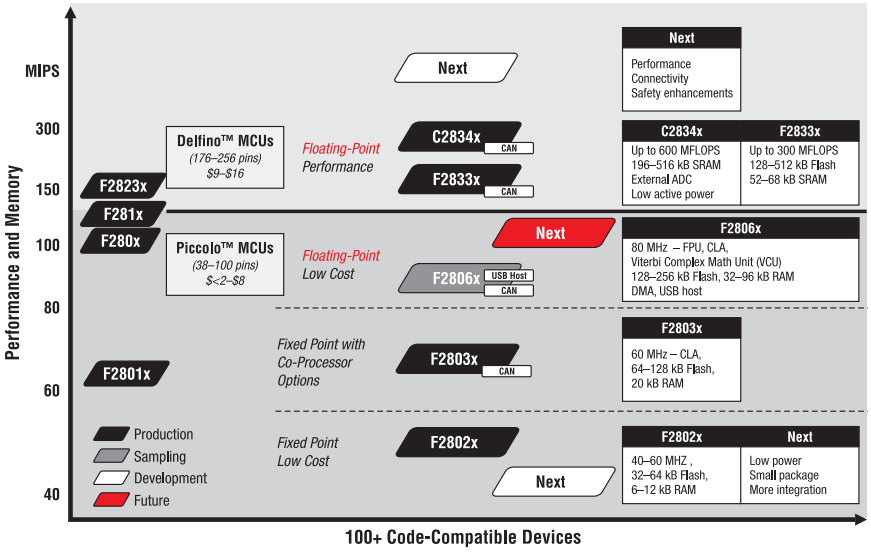
The TMS320C2000™ MCU Advantage

The world is changing. Devices are getting smarter, modern technology is spreading throughout the globe, and advances are allowing us to reach new heights like never before – all with an increased focus on green energy and efficiency. But, that doesn't have to mean increased costs or longer development cycles.

With a 32-bit architecture, advanced peripherals, analog integration, and package sizes from 32 to 256 pins, the C2000™ MCU family enables uncompromising performance and real-time control in a variety of applications. Unique, feature-filled peripherals include an unparalleled on-chip 12.5 MSPS ADC, high-resolution PWMs, enhanced capture units, and much more. The TMS320C28x™ 32-bit core features a single-cycle 32×32-bit hardware multiplier and single-cycle atomic instruction execution. The controlCARD-based development tools and comprehensive controlSUITE™ software package help to dramatically shorten development time. Explore our wide range of products and configurations to find the perfect solution for your designs.

Piccolo™ 32-Bit Microcontrollers: Small Package, Big Performance

The TMS320F2802x/2803x/2806x Piccolo family of C2000 MCUs provides a low-cost, highly integrated processor solution, enabling processor-intensive real-time control in cost-sensitive applications. Piccolo processors support speeds of up to 80 MHz and up to 256kB of integrated flash memory, dedicated high-resolution PWMs, powerful ADCs, analog comparators and communications interfaces in a cost-sensitive mixed-signal device. Integrated floating-point support in select Piccolo devices brings the ease of floating-point development to cost-sensitive applications. An optional floating-point co-processor called the Control Law Accelerator (CLA) – with independent access to feedback and feedforward peripherals – provides a parallel control loop path to unload the main CPU. The addition of a Verterbi Complex Math Unit (VCU) enables PLC applications and further speeds complex math processing. F2806x MCUs also include floating point for further performance and ease of use. Available in multiple package and peripheral options, the Piccolo family is the ultimate combination of performance, integration, size and low cost. **www.ti.com/piccolo**



All pricing is to be considered budgetary and subject to change. Pricing is 1KU SRP –40 to 105°C.

Delfino™ Microcontrollers: High-Performance, Floating-Point Microcontrollers

The Delfino F2833x and C2834x series of TI C2000 32-bit microcontrollers bring leading floating-point performance and integration to high-performance, real-time control applications. Delfino MCUs support speeds of up to 300 MHz, up to 512KB of integrated flash or 516KB internal RAM, high-resolution PWMs, integrated 12.5 MSPS ADC or external ADC interface, and a wide variety of communications interfaces. Higher performance enables greater intelligence and efficiency in high-end real-time control applications.

With a high-performance core, control-optimized peripherals, and scalable development platform, the Delfino line of microcontrollers can reduce system cost, increase system reliability, and boost performance for applications such as industrial power electronics, power delivery, renewable energy, and smart sensing. **www.ti.com/delfino**

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.

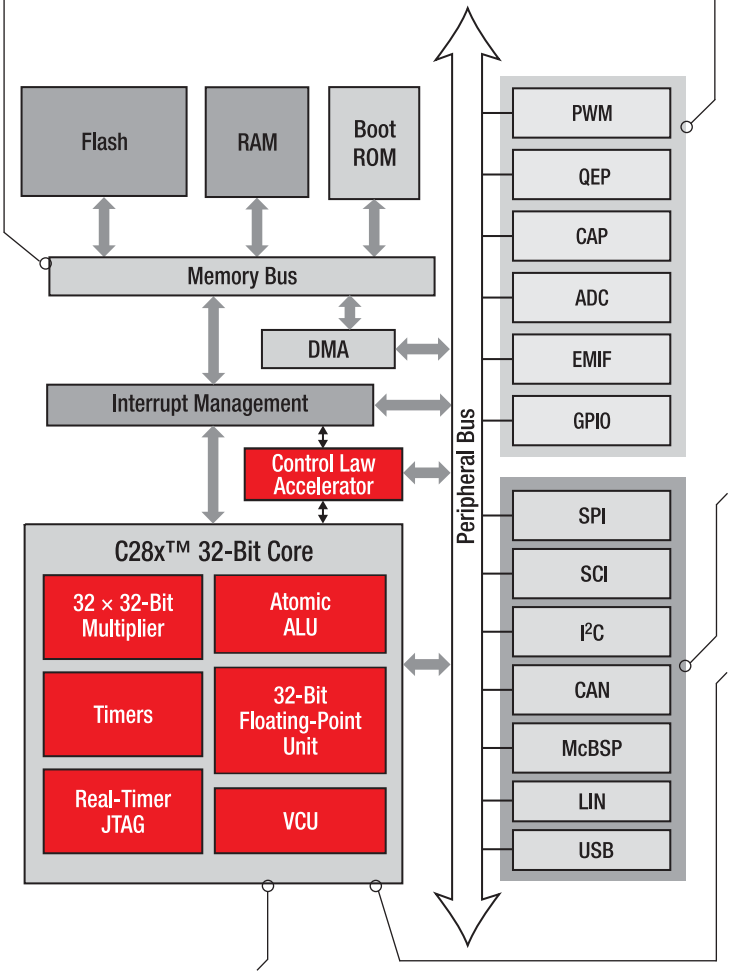
Blogs – Read blog posts about everything from new discoveries to rising cases of "net lag." Find blogs with the musings of some of the brightest minds at TI.

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.

Memory Bus and Fast Interrupts

With 96 interrupt vectors, C2000 MCUs offer the utmost flexibility in your projects. Designed for real-time control, the C28x™ microcontroller core has fast interrupts that allow context switches in as fast as 10 cycles.

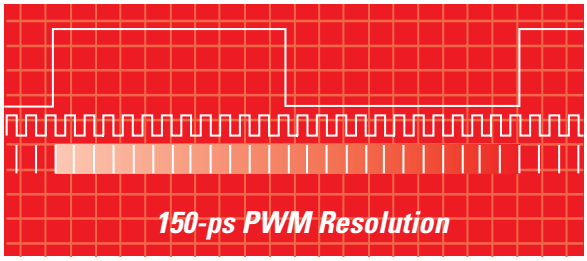
Using a modified Harvard architecture, the 32-bit data and peripheral buses ensure that the core, memory, and peripherals interface efficiently. Secure flash, RAM, and ROM protect your intellectual property from unwelcome eyes. A six-channel DMA is available on select devices.



Unique Peripherals

The C2000 MCU device platform leads in offering unique peripheral interfaces that improve system performance and flexibility.

- The C2000 microcontroller platform offers as many as 16 analog input channels with dual sample and hold and 12-bit ADC sampling up to 12.5 MSPS – the industry's leading embedded ADC.
- Enhanced capture units based on 32-bit timers allow high-accuracy sensing and more flexibility.
- High-resolution PWM generators provide unprecedented precision for controlling power electronics by offering 150-ps resolution and down to 65 ps for 300 MHz Delfino devices. Additionally, fully programmable trip-zone detection and dead-time generators offer complete system protection from faults and surges.



Communication Interfaces

C2000 microcontrollers include a mix of communication interfaces to talk to system components.

C2000 MCU 32-Bit Architecture

The C28x microcontroller generation is optimized to deliver the highest-performance control solution with the best time to market.

- Floating-point and fixed-point microcontrollers
- Up to 300 MIPS or 600 MFLOPS
- A mix of 16- and 32-bit instructions
- Best-in-class compiler efficiency
- Single-cycle 32×32-bit multiply accumulate
- Software compatibility across entire C2000 MCU platform

The Floating-Point Advantage

The new Piccolo™ TMS320F2806x and Delfino™ MCU TMS320F283xx series feature an integrated hardware floating-point unit, offering native single-precision floating-point processing, ease of use and better integration with additional simulation and development tools. The Control Law Accelerator co-processor (CLA) in select Piccolo 32-bit microcontrollers brings floating point to an even wider range of applications.

Compatible with all C2000 devices, the IQMath library eliminates the scaling and saturation burden of fixed-point math, giving you adjustable global or local range and resolution, which speeds development and provides easier tuning and re-use of systems. IQMath is fully supported by the C28x MCU compiler and includes dozens of arithmetic, trigonometric, and numerical conversion functions. **www.ti.com/iqmath**

C2000 Key Applications

- *Digital power*
- *Digital motor control*
- *Renewable energy*
- *Power line communications*
- *Lighting*
- *Automotive*
- *Precision sensing and control*

C2000™ Microcontrollers

TMS320C2000™ Microcontrollers

Device (TMS320x)	Processor: Speed (MHz)	Processor: VCU	Processor: DMA	Processor: CLA	Memory: RAM (KB)	Memory: Flash (KB)	Memory: ROM (KB)	Control Interfaces: PWM Ch	Control Interfaces: HiRes PWM	Control Interfaces: Quadrature Encoder	Control Interfaces: Event Captures	Control Interfaces: Timers*	Control Interfaces: 12-Bit ADC Channels/ Conversion Time (ns)	Control Interfaces: Comparators	Communication Ports: USB (Host)	Communication Ports: McBSP	Communication Ports: I²C	Communication Ports: UART/ SCI	Communication Ports: SPI	Communication Ports: Lin	Communication Ports: CAN	Communication Ports: External Memory Bus	Core Supply (Volts)	GPIO Pins	On-Chip OSC/ Regulator	Pin/ Package	1 KU Pricing†
F2802x Piccolo™ MCUs																											
F28027	60	–	–	–	12	64	Boot	9	4	0	1	9	7-13 / 217	1-2	–	–	1	1	1	–	–	–	3.3	20-22	Yes / Yes	38TSSOP, 48LQFP	2.85-3.47
F28026	60	–	–	–	12	32	Boot	9	4	0	1	9	7-13 / 217	1-2	–	–	1	1	1	–	–	–	3.3	20-22	Yes / Yes	38TSSOP, 48LQFP	2.65-3.24
F28023	50	–	–	–	12	64	Boot	9	4	0	1	9	7-13 / 260	1-2	–	–	1	1	1	–	–	–	3.3	20-22	Yes / Yes	38TSSOP, 48LQFP	2.45-3.00
F28022	50	–	–	–	12	32	Boot	9	4	0	1	9	7-13 / 260	1-2	–	–	1	1	1	–	–	–	3.3	20-22	Yes / Yes	38TSSOP, 48LQFP	2.25-2.76
F28021	40	–	–	–	10	64	Boot	9	–	0	1	9	7-13 / 500	1-2	–	–	1	1	1	–	–	–	3.3	20-22	Yes / Yes	38TSSOP, 48LQFP	2.20-2.45
F28020	40	–	–	–	6	32	Boot	9	–	0	1	9	7-13 / 500	1-2	–	–	1	1	1	–	–	–	3.3	20-22	Yes / Yes	38TSSOP, 48LQFP	1.99-2.23
F280200	40	–	–	–	6	16	Boot	8	–	0	0	8	7-13 / 500	1-2	–	–	1	1	1	–	–	–	3.3	20-22	Yes / Yes	38TSSOP, 48LQFP	1.85-2.01
F2803x Piccolo MCUs																											
F28035	60	–	–	Yes	20	128	Boot	13-15	6-7	1	1	11-12	14-16 / 217	3	–	–	1	1	1-2	1	1	–	3.3	26-44	Yes / Yes	56QFN, 64TQFP, 80LQFP	4.41-5.62
F28034	60	–	–	—	20	128	Boot	13-15	6-7	1	1	11-12	14-16 / 217	3	–	–	1	1	1-2	1	1	–	3.3	26-44	Yes / Yes	56QFN, 64TQFP, 80LQFP	3.75-4.77
F28033	60	–	–	Yes	20	64	Boot	13-15	6-7	1	1	11-12	14-16 / 217	3	–	–	1	1	1-2	1	1	–	3.3	26-44	Yes / Yes	56QFN, 64TQFP, 80LQFP	4.11-5.22
F28032	60	–	–	–	20	64	Boot	13-15	6-7	1	1	11-12	14-16 / 217	3	–	–	1	1	1-2	1	1	–	3.3	26-44	Yes / Yes	56QFN, 64TQFP, 80LQFP	3.49-4.44
F28031	60	–	–	–	16	64	Boot	13-15	–	1	1	11-12	14-16 / 500	3	–	–	1	1	1-2	1	1	–	3.3	26-44	Yes / Yes	56QFN, 64TQFP, 80LQFP	2.97-3.91
F28030	60	–	–	–	12	32	Boot	13-15	–	1	1	11-12	14-16 / 500	3	–	–	1	1	1-2	1	1	–	3.3	26-44	Yes / Yes	56QFN, 64TQFP, 80LQFP	2.79-3.67
F2806x Piccolo MCUs with Floating-Point Capabilities																											
F28069	80	Yes	Yes	Yes	100	256	Boot	15	6	1	3	12	12/325	3	0–1	1	1	1	2	–	1	–	3.3	40	Yes/Yes	80LQFP, 80HTQFP	7.90
	80	Yes	Yes	Yes	100	256	Boot	19	8	2	7	16	16/325	3	0–1	1	1	2	2	–	1	–	3.3	54	Yes/Yes	100LQFP, 100HTQFP	8.45
F28068	80	Yes	Yes	–	100	256	Boot	15	6	1	3	12	12/325	3	0–1	1	1	1	2	–	1	–	3.3	40	Yes/Yes	80LQFP, 80HTQFP	7.00
	80	Yes	Yes	–	100	256	Boot	19	8	2	7	16	16/325	3	0–1	1	1	2	2	–	1	–	3.3	54	Yes/Yes	100LQFP, 100HTQFP	7.55
F28067	80	–	Yes	–	100	256	Boot	15	6	1	3	12	12/325	3	0–1	1	1	1	2	–	1	–	3.3	40	Yes/Yes	80LQFP, 80HTQFP	6.60
	80	–	Yes	–	100	256	Boot	19	8	2	7	16	16/325	3	0–1	1	1	2	2	–	1	–	3.3	54	Yes/Yes	100LQFP, 100HTQFP	7.15
F28066	80	–	Yes	–	68	256	Boot	15	6	1	3	12	12/325	3	0–1	1	1	1	2	–	1	–	3.3	40	Yes/Yes	80LQFP, 80HTQFP	6.20
	80	–	Yes	–	68	256	Boot	19	8	2	7	16	16/325	3	0–1	1	1	2	2	–	1	–	3.3	54	Yes/Yes	100LQFP, 100HTQFP	6.75
F28065	80	Yes	Yes	Yes	100	128	Boot	15	6	1	3	12	12/325	3	0–1	1	1	1	2	–	1	–	3.3	40	Yes/Yes	80LQFP, 80HTQFP	7.10
	80	Yes	Yes	Yes	100	128	Boot	19	8	2	7	16	16/325	3	0–1	1	1	2	2	–	1	–	3.3	54	Yes/Yes	100LQFP, 100HTQFP	7.65
F28064	80	Yes	Yes	–	100	128	Boot	15	6	1	3	12	12/325	3	0–1	1	1	1	2	–	1	–	3.3	40	Yes/Yes	80LQFP, 80HTQFP	6.20
	80	Yes	Yes	–	100	128	Boot	19	8	2	7	16	16/325	3	0–1	1	1	2	2	–	1	–	3.3	54	Yes/Yes	100LQFP, 100HTQFP	6.75
F28063	80	–	Yes	–	68	128	Boot	15	6	1	3	12	12/325	3	0–1	1	1	1	2	–	1	–	3.3	40	Yes/Yes	80LQFP, 80HTQFP	5.40
	80	–	Yes	–	68	128	Boot	19	8	2	7	16	16/325	3	0–1	1	1	2	2	–	1	–	3.3	54	Yes/Yes	100LQFP, 100HTQFP	5.95
F28062	80	–	Yes	–	52	128	Boot	15	6	1	3	12	12/325	3	0–1	1	1	1	2	–	1	–	3.3	40	Yes/Yes	80LQFP, 80HTQFP	4.95
	80	–	Yes	–	52	128	Boot	19	8	2	7	16	16/325	3	0–1	1	1	2	2	–	1	–	3.3	54	Yes/Yes	100LQFP, 100HTQFP	5.50
283x Delfino™ Floating-Point MCUs																											
C28346	300	–	Yes	–	516	–	Boot	24	9	3	6	19	–	–	–	2	1	3	2	–	2	16 or 32-bit	1.2	88	–	256BGA	16.39
C28345	200	–	Yes	–	516	–	Boot	24	9	3	6	19	–	–	–	2	1	3	2	–	2	16 or 32-bit	1.1	88	–	256BGA, 179BGA	14.42
C28344	300	–	Yes	–	260	–	Boot	24	9	3	6	19	–	–	–	2	1	3	2	–	2	16 or 32-bit	1.2	88	–	256BGA	12.78
C28343	200	–	Yes	–	260	–	Boot	24	9	3	6	19	–	–	–	2	1	3	2	–	2	16 or 32-bit	1.1	88	–	256BGA, 179BGA	11.25
C28342	300	–	Yes	–	196	–	Boot	16	6	2	4	14	–	–	–	1	1	3	2	–	2	16 or 32-bit	1.2	88	–	256BGA	10.17
C28341	200	–	Yes	–	196	–	Boot	16	6	2	4	14	–	–	–	1	1	3	2	–	2	16 or 32-bit	1.1	88	–	256BGA, 179BBGA	8.95
F28335	150	–	Yes	–	68	512	Boot	18	6	2	6	16	16/80	–	–	2	1	3	1	–	2	16 or 32-bit	1.9	88	–	179BGA, 176LQFP	15.65
F28334	150	–	Yes	–	68	256	Boot	16	6	2	4	14	16/80	–	–	2	1	3	1	–	2	16 or 32-bit	1.9	88	–	179BGA, 176LQFP	14.75
F28332	100	–	Yes	–	52	128	Boot	16	4	2	4	14	16/80	–	–	1	1	2	1	–	2	16 or 32-bit	1.9	88	–	179BGA, 176LQFP	13.85
28x Fixed-Point MCUs																											
F28235	150	–	Yes	–	68	512	Boot	18	6	2	6	16	16 / 80	–	–	2	1	3	1	–	2	16 or 32-bit	1.9	88	–	179BGA, 176LQFP	14.55
F28234	150	–	Yes	–	68	256	Boot	16	6	2	4	14	16 / 80	–	–	2	1	3	1	–	2	16 or 32-bit	1.9	88	–	179BGA, 176LQFP	13.72
F28232	100	–	Yes	–	52	128	Boot	16	4	2	4	14	16 / 80	–	–	1	1	2	1	–	2	16 or 32-bit	1.9	88	–	179BGA, 176LQFP	12.88
F2812	150	–	–	–	36	256	Boot	16	–	2	6	8	16 / 80	–	–	1	–	2	1	–	1	16-bit	1.9	56	–	179BGA, 176LQFP	15.75
F2811	150	–	–	–	36	256	Boot	16	–	2	6	8	16 / 80	–	–	1	–	2	1	–	1	–	1.9	56	–	128LQFP	14.75
F2810	150	–	–	–	36	128	Boot	16	–	2	6	8	16 / 80	–	–	1	–	2	1	–	1	–	1.9	56	–	128LQFP	13.85
F2809	100	–	–	–	36	256	Boot	16	6	2	4	14	16 / 80	–	–	–	1	2	4	–	2	–	1.8	35	–	100BGA, 100LQFP	12.95
F2808	100	–	–	–	36	128	Boot	16	4	2	4	14	16 / 160	–	–	–	1	2	4	–	2	–	1.8	35	–	100BGA, 100LQFP	11.60
F2806	100	–	–	–	20	64	Boot	16	4	2	4	14	16 / 160	–	–	–	1	2	4	–	1	–	1.8	35	–	100BGA, 100LQFP	8.70
F28044	100	–	–	–	20	128	Boot	16	16	–	–	24	16 / 80	–	–	–	1	1	1	–	–	–	1.8	35	–	100LQFP	9.95
F2802	100	–	–	–	12	64	Boot	8	3	1	2	9	16 / 160	–	–	–	1	1	2	–	1	–	1.8	35	–	100BGA, 100LQFP	7.10
F2801	100	–	–	–	12	32	Boot	8	3	1	2	9	16 / 160	–	–	–	1	1	2	–	1	–	1.8	35	–	100BGA, 100LQFP	5.80
F2802-60	60	–	–	–	12	64	Boot	8	3	1	2	9	16 / 267	–	–	–	1	1	2	–	1	–	1.8	35	–	100LQFP	4.75
F2801-60	60	–	–	–	12	32	Boot	8	3	1	2	9	16 / 267	–	–	–	1	1	2	–	1	–	1.8	35	–	100LQFP	3.95
F28016	60	–	–	–	12	32	Boot	10	4	0	2	10	16 / 267	–	–	–	1	1	1	–	1	–	1.8	35	–	100LQFP	3.50
F28015	60	–	–	–	12	32	Boot	10	4	0	2	10	16 / 267	–	–	–	1	1	1	–	–	–	1.8	35	–	100BGA, 100LQFP	3.25

All devices available with AEC-Q100 (125°C) maximum temperature range.

New products are listed in bold red.

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

All devices available in Pb-Free/Green packaging.

†Prices are quoted in U.S. dollars and represent 2011 suggested resale pricing for baseline packages. All prices are subject to change.

ROM devices are available. Please contact TI sales for more information.

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. **www.ti.com/controlsuite**

Why go for digital power?

Reduces costs

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

Higher reliability

- Built-in supervision
- Intelligent diagnostics, failure prediction, reporting capability

Higher quality

- Adaptive efficiency across load range
- Flexibility through programmability
- Calibration at final functional test
- Less sensitive to drift and better noise immunity
- Parameter monitoring for continual quality improvement
- Proven concept in mature digital motor control market

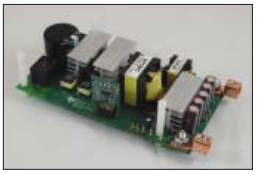
Key Applications

- *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!

Power Factor Correction Kit – $249
- 2-phase interleaved PFC
- 300W, up to 400V DC output
- Isolated JTAG for real-time debug
- Comes with Piccolo™ F28027 controller card



Phase Shifted Full Bridge – $249
- Up to 400VDC input
- 360W 12VDC output
- Multiple control methods
- Comes with Piccolo F28027 controller card

Bridgeless PFC Kit – $249
- 2-phase interleaved PFC
- 300W, up to 400V DC output
- Isolated JTAG for real-time debug
- Comes with Piccolo F28027 controller card

Resonant LLC Kit – $249
- Up to 400VDC input
- 360W 12VDC output
- Experiment with OCP, OVP and UVP
- Comes with Piccolo F28027 controller card

Digital Motor Control

C2000 microcontrollers reduce the overall cost of motor control systems by providing the integration and performance necessary to implement advanced control techniques such as sensorless vector control of three-phase motors. Using the more processor-intensive vector control, for example, allows developers to reduce the size and cost of the motors and power electronics. With C2000 microcontrollers, developers can now capitalize on the latest advancements in motor designs and control techniques. **www.ti.com/c2000dmc**

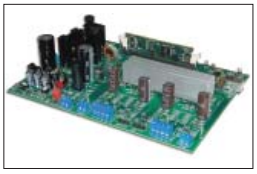
Key Applications

- *Variable-speed drives*
- *Servo drives*
- *Appliance motors*
- *HVAC compressors and blowers*
- *Industrial pumps*
- *Electric power steering*
- *Soft starters*
- *White goods*

Motor Control Libraries

- *AC induction motors*
- *PMSM motors*
- *Brushless DC motors*
- *Solutions for both sensored and sensorless systems*

Dual Motor Control and PFC Developer's Kit – $399



- Power factor correction plus dual- or single-axis motor control with a single Piccolo™ device
- Sensorless field oriented control
- Isolated onboard USB JTAG emulation
- Single-motor version also available for $369

C2000 Digital Motor Control Gives You MORE

C2000-based motor-control systems enable energy and cost savings throughout products.

- 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

Software and hardware demonstrating all listed advantages can be found at **www.ti.com/c2000dmc**

High-Voltage PFC and MC Developer's Kit – $599

- 1.5KW, 350V three-phase motor driver stage
- 750W 110–220 Vac PFC stage
- CAN control ACI, PMSM and BLDC
- Motors of each type available directly from TI (sold separately)
- Isolated CAN and UART interfaces

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 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

Key Applications

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

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*

Renewable Energy

Environmental concerns and rising energy prices are fuelling a rapid growth in renewable energy sources. TMS320C2000™ microcontrollers can play a pivotal role in enabling the development of such systems. Powerful C2000 processors can provide maximum efficiency by quickly executing real-time control-loop algorithms at high frequency and running multiple maximum power point tracking algorithms in parallel. C2000 MCUs can also manage intelligent switching between the main grid and auxiliary batteries to allow seamless integration of alternative energy sources. **www.ti.com/solar**

Key Applications

- *Solar inverters*
- *Wind turbine inverters*
- *Deep-cycle battery management*
- *Hydropower*
- *DC/AC converters*
- *Large-scale power grids*
- *Stand-alone power systems*

Tools and Software

- *Renewable Energy Developer's Kit*
- *Digital power kits*
- *Signal processing libraries*

Benefits

Single C2000 MCU has performance and peripherals to control entire system

A C2000 MCU can run intelligent battery charging algorithms along with sophisticated grid management

Real-time control of DC/DC and DC/AC power conversion stages

Maximize power output across varying load and shade conditions

Increased efficiency reducing cost per kilowatt

Multiple PWM time bases allow the control of different turbine types

Easy system networking with I²C, CAN, SPI, and UART peripherals

Renewable Energy Developer's Kit – $349

- Digitally controlled DC/AC inverter with a maximum power output of 45 watts
- Capable of syncing to an external AC line and managing a back-up battery
- Provides the necessary current and voltage measurements to implement advanced algorithms, such as maximum power point tracking
- Comes with an F2808 controlCARD

Lighting

C2000 microcontrollers are the ideal solution for a wide range of lighting applications, from LED backlighting to commercial lighting. For displays, a microcontroller unlocks higher contrast ratios, faster turn-on, improved brightness, wider color gamut, and eliminates the need for mercury. To improve reliability and safety in commercial lighting, a microcontroller allows temperature monitoring to prevent thermal runaway along with operating state and fault detection. The addition of adaptive dimming based on usage and environmental conditions contributes to less energy consumption and light pollution. **www.ti.com/led**

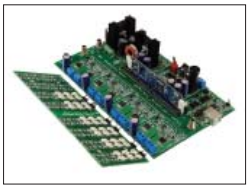
Why it's worth the switch to LED lighting:

- LEDs are more efficient than traditional lighting, such as incandescent and HID, resulting in less heat dissipation
- Longer bulb life, less maintenance
- Capable of variable dimming
- Improvements in semiconductor technology will continue to improve LEDs

Key Applications

- *LED/HID streetlights*
- *LCD TV backlight*
- *LED display*
- *Outdoor and indoor lighting*
- *Automobile lights (headlamp, brake)*
- *LED array backlighting*

DC/DC LED Lighting Developer's Kit – $379



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

Benefits

One MCU controls power stage and LED lighting

Precise LED intensity and color mixing through independent high-resolution PWMs and multi-channel high-speed ADC

Easy system networking through power line communication or I²C, SPI, and UART peripherals

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. TI has developed a freely available PLC software library and hardware reference design for data throughput speeds of up to 5 kbps without crossing an isolation transformer. **www.ti.com/metering**

Use C2000 microcontrollers to combine PLC with:

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

Tools and Software

- *PLC Software Library*
- *Hardware reference designs*
- *C2000 development kits*

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: I^2C, 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

- *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 150 ps • 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

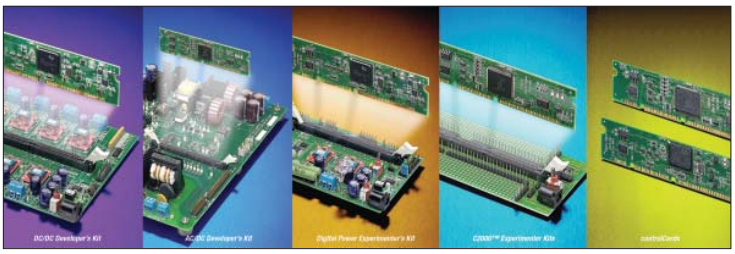
Easy Development with C2000's controlCARD system

Unique Development Tools

We understand picking the right processor can be tough, and purchasing specific EVM boards can add costs quickly. That's why we've created the controlCARD system.

The C2000 controlCARDs are the latest tools for TMS320C2000™ MCUs. By detaching the C2000 processor and all necessary support devices and putting them on "controlCARDs", a designer can test multiple processors on one board. Separating the MCU from the base also decreases replacement costs should accidents happen. These controlCARDs require only one 5V supply and plug into a standard DIM socket that gives access to every pin on the device.

With over 20 experimenter and development kits available, C2000 MCUs make it easy to start developing today. All kits are complete with Code Composer Studio™ IDE v4.0 C28x™ Free 32KByte version and the necessary power supply. Each kit also includes documented software, example code, and full hardware documentation. Visit **www.ti.com/c2000tools** for more information.



controlCARD	Part Number	Description	Price
F28044	TMDSCNCD28044	F28044 controlCARD	$59.00
F2808	TMDSCNCD2808	F2808 controlCARD	$59.00
Piccolo™ MCUs			
F28027	TMDXCNCD28027	F28027 controlCARD	$49.00
F28035	TMDXCNCD28035	F28035 controlCARD	$59.00
F28069	TMDXCNCD28069	F28069 controlCARD	$59.00
Delfino™ MCUs			
F28335	TMDSCNCD28335	F28335 controlCARD	$69.00
C28343	TMDXCNDC28343	C28343 controlCARD	$109.00
C28346	TMDXCNCD28346-168	C283436 controlCARD	$125.00

Piccolo 32-Bit Microcontroller Tools

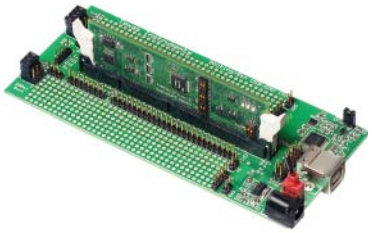
With the Piccolo series of TMS320F2802x/F2803x/F2806x MCUs comes low-cost USB-based tools that provide instant access to peripherals and pins. Start developing for just $39.

Piccolo 32-Bit Microcontroller controlSTICK – $39

- Everything you need to work with the Piccolo F28027 or F28069 microcontrollers
- Access to all Piccolo control peripherals through header pins
- On-board USB JTAG emulation (no external emulator required)
- Numerous sample labs to get you started immediately

Experimenter's Kit – Starting at $79

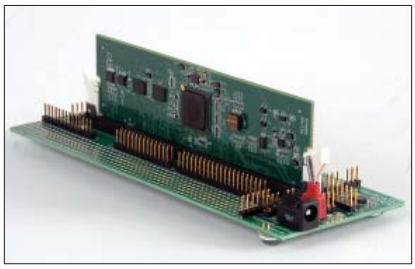
- Launch Piccolo MCU-based designs quickly and easily
- Access to all Piccolo functional device pins
- Prototyping area to get started developing quickly and easily
- On-board USB JTAG emulation (no external emulator required)
- Compatible with controlSTICK example projects



Delfino Microcontroller Tools

Delfino brings C2000 MCUs to a whole new level. Unleash the speed with two versions of the Experimenter's Kit. Unlike other experimenter's kits, these kits require an external JTAG emulator.

Key Features	DIM168	DIM100
C28x™ device	300-MHz C28346	200-MHz C283425
ADC channels accessible	16 channels	12 channels
On-board ADC	No	2×12-bit, 12-channel (2 MSPS)
External memory I/F accessible	Yes	No
External memory	2×128 kB SRAM; 64 kB EEPROM	64 kB EEPROM
Accessible IO pins	All	Control peripherals
Power supply	Single 5V	Single 5V
Pricing	$189	$159



Delfino Experimenter's Kit

Third-Party JTAG Emulators

Name	Device	Website	Description	Price
JTAG Emulators				
Blackhawk USB2000	All C2000	www.blackhawk-dsp.com	Blackhawk USB2000 USB JTAG Emulator	$299.00
XDS510LC	All C2000	www.spectrumdigital.com	Spectrum Digital XDS510LC USB JTAG Emulator	$249.00
XDS510USB	All C2000	www.spectrumdigital.com	XDS510™ USB Emulator, works with multiple TI families	$1,299.00
JTAGjet-C2000	All C2000	www.signum.com	XDS510 class USB emulator. C2000 only.	$595.00
JTAGjet-C2000-ISO	All C2000	www.signum.com	XDS510 class USB 2.0 emulator with optically isolated JTAG. C2000 only.	$795.00

Training

TI provides a multitude of training opportunities for C2000 microcontrollers. Between hands-on multi-day and single-day workshops, webcasts, and online training, it's easy to gain a working understanding of how to optimally use the C28x™ microcontroller and accelerate product development. For a full list of training opportunities, visit **www.ti.com/c2000training**

Tech Days

Join Texas Instruments for a day packed with technical design sessions and technology exhibits. These rotating seminars are aimed at providing a learning forum where practical high-performance design solutions, tools, techniques, topologies, and examples will be presented. The exhibits will demonstrate the latest TI technology so don't miss this opportunity to meet with a number of Texas Instruments' experts and gain valuable ideas for solving your technical challenges. Check the schedule at **www.ti.com/techdays**

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*

eZdsp™ Development Kits

TI also offers traditional eZdsp development kits from Spectrum Digital. They feature on-board JTAG emulation headers for various communication peripherals. Kits start at $395.

F2808 eZdsp kit.

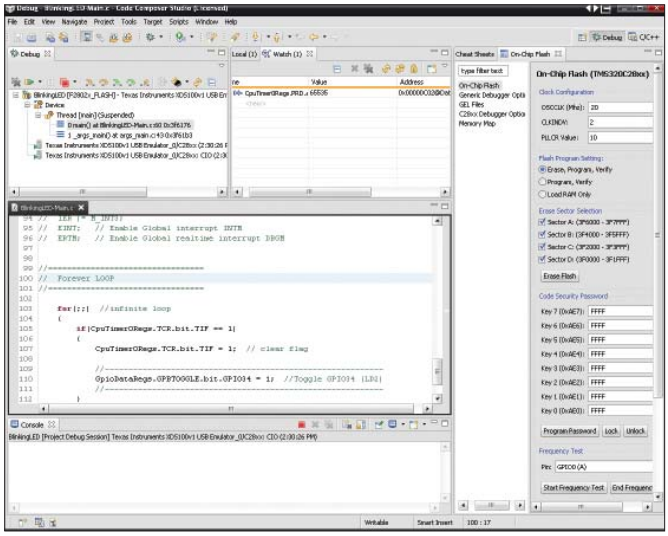
Third Party	Website	Service
C2000 Microcontroller Third Parties		
D3 Engineering	www.d3engineering.com	Design Services; Consulting; Algorithms
Drivetech	www.drivetechinc.com	Design Services; Consulting; DMC Expertise
The MathWorks	www.mathworks.com	Embedded Target; Auto Code Generation
Visual Solutions	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

Industry-Leading Development Environment

The Code Composer Studio™ integrated development environment (IDE) delivers all of the host tools and runtime software support for your C2000 microcontroller-based real-time embedded applications. The Code Composer Studio (CCStudio) IDE allows developers of all experience levels to move quickly through each phase of the application development process including designing, coding and building, debugging, analyzing, and tuning. Powerful tools and interfaces allow users to get started faster and become productive immediately. All development tools come with a size-limited version of CCStudio IDE. Free versions of CCStudio v4 include code-limited MCU edition and XDS100-limited edition. Full MCU edition available from $445.

Key Benefits

- *DSP/BIOS™ kernel scheduler*
- *Real-time analysis capabilities*
- *Visual project manager*
- *Debugger and optimization tools*
- *Flash programming plug-in*
- *C/C++ compiler, assembler, linker*
- *Real-time watch windows and graphs*
- *Register name auto completion*



Code Composer Studio IDE

- Project manager
- File associations
- Source, libraries, and files included
- C2000 supports both CCStudio v3.3 and CCStudio v4

Full C/C++ and Assembly Debugging

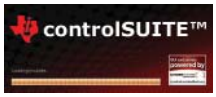
- C and ASM source
- Mixed mode
- Set break and probe points

C2000 MCU Real-Time Debugging

- Graph and modify variables/registers in real time while running code
- Allows you to halt in 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

Software and Support

Markets are demanding. They want product ideas in their hands tomorrow. TI understands, and that's why TI created controlSUITE™ software to help speed development time. For more details, visit **www.ti.com/controlsuite**



controlSUITE Benefits

One stop for all C2000 software

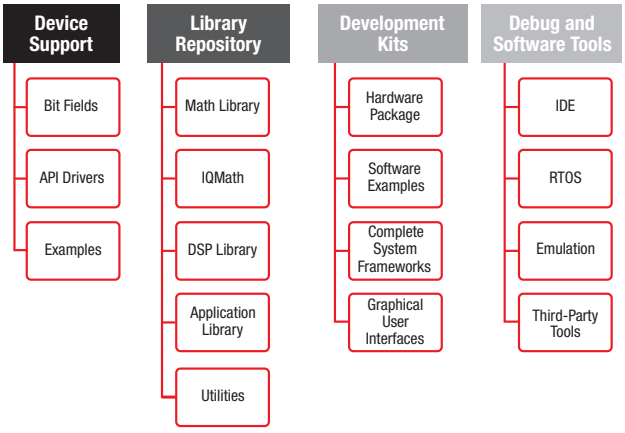
- Single, centralized location
- Intelligent installer eliminates the search for dependencies
- Notifications for software updates
- controlSUITE Desktop helps to navigate **all** C2000 resources

Open, real-world systems

- Compilation of 15 years of systems and applications expertise
- Unique, optimized libraries for math, filtering, DSP and specific applications with complete system examples utilizing incremental builds
- Allows developers to focus on differentiation, not basics

Program the MCU your way

- Significantly reduces development time with hardware abstraction and extensive libraries
- Four inter-usable levels of hardware abstraction



Programming in a Flash

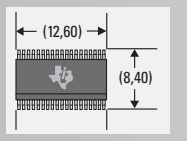
Are you looking to integrate flash programming into your project? The C2000 MCUs flash APIs contain complete example projects and documentation to get you on your way. Embedded flash programming offers several opportunities to the system designer, which allows functionality customizations of the device in your system. This can enable field re-programming for firmware updates or calibration data storage.

TI's E2E™ Community

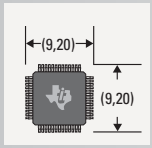
For help on projects, news, and everything TI, visit our online community for videos, blogs, and forums. **community.ti.com**

Selected Package Options for TMS320C2000™ Devices

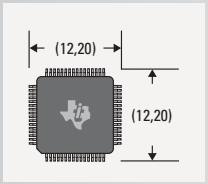
38-pin DA (TSSOP)



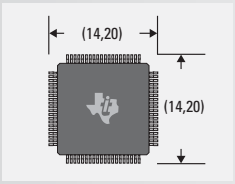
48-pin PT



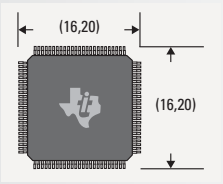
64-pin TQFP



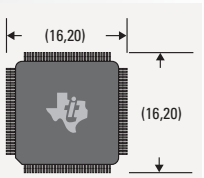
80-pin PN (LQFP)



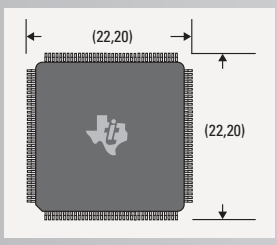
100-pin PQFP



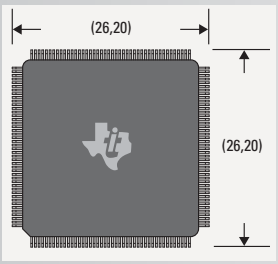
128-pin PQFP



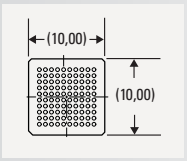
144-pin PQFP



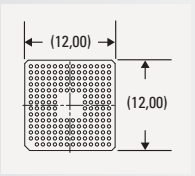
176-pin LQFP



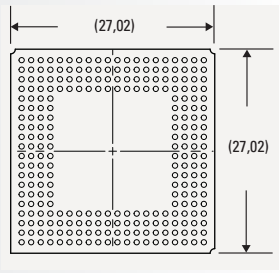
100-pin BGA



179-pin BGA



256-pin BGA



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(972) 644-5580
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	support.ti.com/sc/pic/euro.htm

Japan

Phone	Domestic	0120-92-3326
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

International	+91-80-41381665
Domestic	Toll-Free Number
Australia	1-800-999-084
China	800-820-8682
Hong Kong	800-96-5941
India	1-800-425-7888
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

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Email	tiasia@ti.com
	ti-china@ti.com
Internet	support.ti.com/sc/pic/asia.htm

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