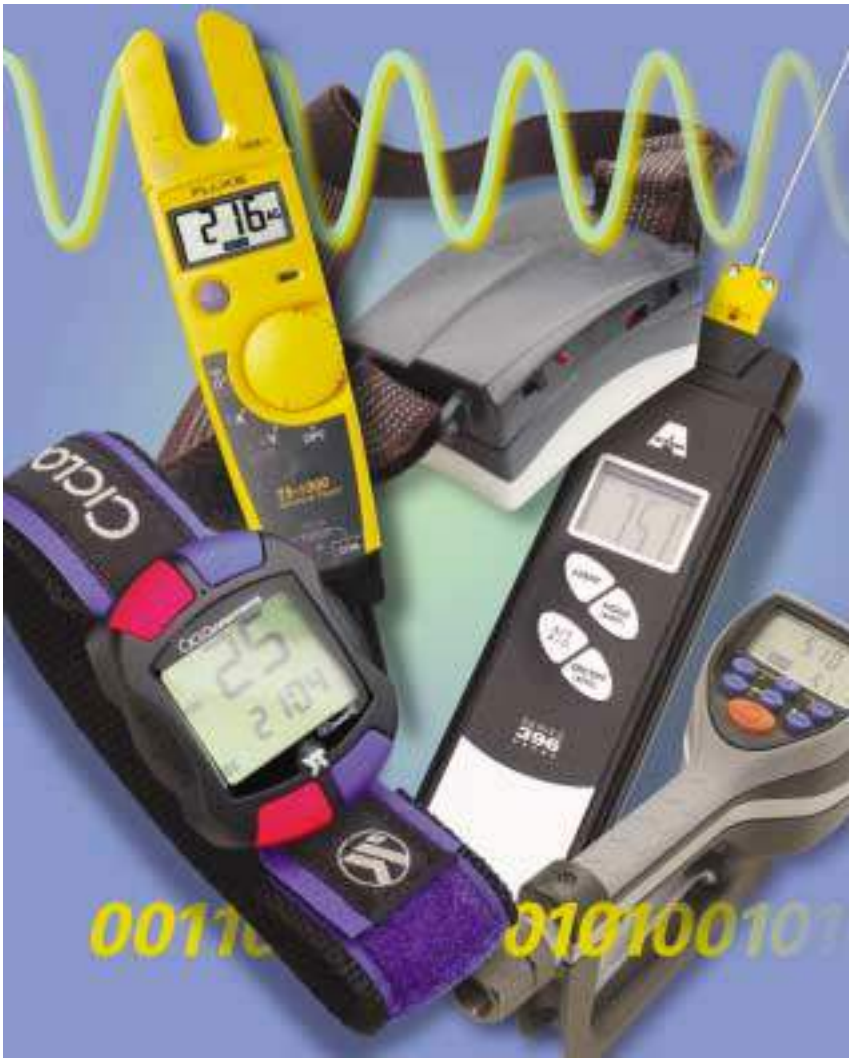
Product Bulletin Q4-2001

MSP430 Ultra-Low-Power Microcontrollers—The Solution for Battery-Powered Measurement

The MSP430 family of ultra-low-power 16-bit RISC mixed-signal processors from Texas Instruments (TI) provides the ultimate solution for battery-powered measurement applications. For low-power applications where both analog and digital signal processing are required, the MSP430 line provides a range of exceptional cost/performance options. Using its leadership in both mixed-signal and digital technologies, TI has created the MSP430 family which enables system designers to simultaneously interface to analog signals, sensors and digital components while maintaining unmatched low power.



Key Features

- Ultra-low-power architecture extends battery life
  - 0.1µA RAM retention
  - 0.8µA real-time clock mode
  - 250µA / MIPS active
- High-performance analog ideal for precise measurement
- Modern 16-bit RISC CPU enables new applications at a fraction of the code size
- In-system programmable Flash permits flexible code changes, field upgrades and data logging
- Complete integrated development environment starting at $49
- Device pricing starting at $0.99

Applications

When battery life, processing power and hardware flexibility are major design concerns, TI's MSP430 family offers an unbeatable combination of features.

The MSP430 family is suitable for applications such as:

- *Utility metering—gas, water, electric, heat allocators, thermostats*
- *Portable instrumentation—glucose meters, heart-rate monitors, thermometers, multi-meters, weight scales*
- *Intelligent sensing—security systems, smoke detectors, electronic tags*

The MSP430 line of ultra-low-power microcontrollers offers solutions that enable product ideas to become reality.

MSP430 Architecture

Using a von-Neumann common memory address bus (MAB) and memory data bus (MDB), a 16-bit RISC CPU, peripherals and flexible clock system are combined. Partnering a modern CPU with modular memory-mapped analog and digital peripherals, the MSP430 offers solutions for today's and tomorrow's mixed-signal applications.

Memory Options

- Flash, ROM, OTP versions (from 1 kB to 60 kB)
- RAM up to 2 kB

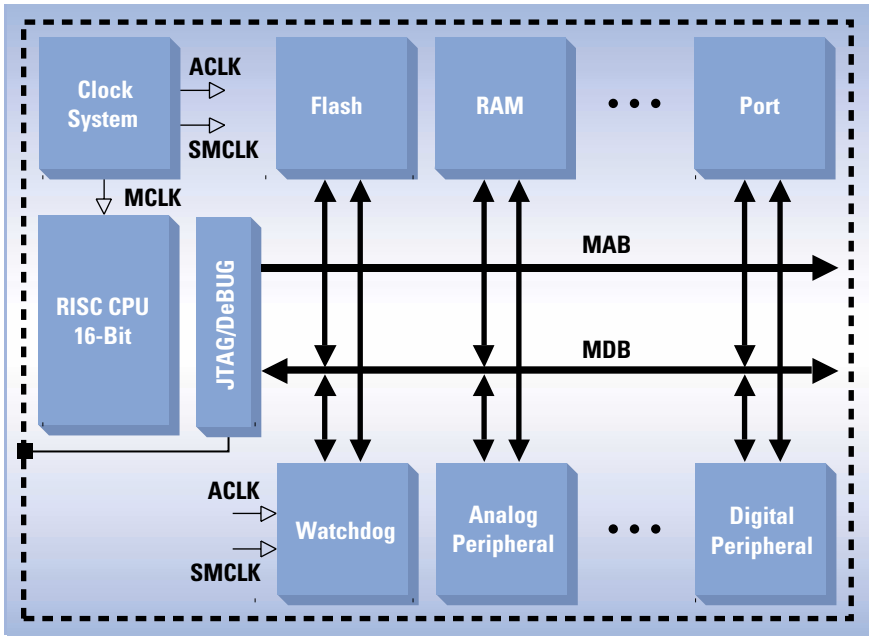
Analog Peripherals

- High-performance ADC
- Comparator
- LCD driver
- Supply Voltage Supervisor (SVS)

Digital Peripherals

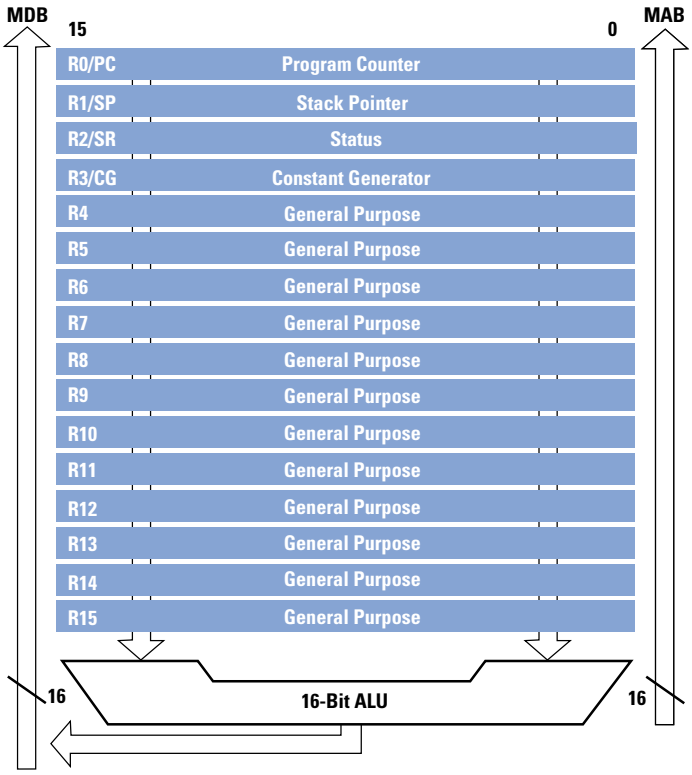
- USART
- Hardware multiplier
- 16-bit and 8-bit timers

In-Circuit Programmable MSP430 Flash



MSP430 von-Neumann architecture — all program, data memory and peripherals share a common bus structure. Consistent CPU instructions and addressing modes are used.

MSP430 Modern Orthogonal 16-Bit RISC CPU



The MSP430 CPU core with sixteen 16-bit registers, 27 single-cycle instructions and seven addressing modes results in higher processing efficiency and code density.

Modern 16-Bit RISC CPU

- Large register file eliminates accumulator bottleneck
- Optimized for C and assembler programming
- Compact core design reduces power and cost
- Up to 8 MIPS of performance available

The MSP430's orthogonal architecture provides the flexibility of 16 fully addressable single-cycle 16-bit CPU registers and the power of a RISC instruction set. The modern design of the CPU offers versatility through simplicity using only 27 easy-to-understand instructions and seven consistent-addressing modes. This results in a 16-bit CPU that is more processing effective, consumes little power, is smaller and more code efficient. New ultra-low-power high-performance applications are now possible—developed rapidly at a fraction of the code size.

Flexible Clock System

- Low frequency auxiliary clock —Ultra-low-power stand-by mode
- High-speed master clock —High-performance processing
- Stability over time and temperature

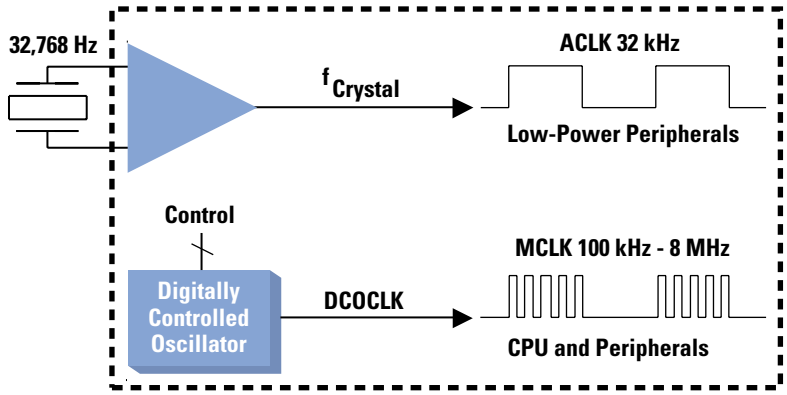
The MSP430 clock system is designed specifically for battery-powered applications. Multiple oscillators are utilized to support event driven burst activity. A low frequency Auxiliary Clock (ACLK) is driven directly from a common 32-kHz watch crystal—with no additional external components. The ACLK can be used for a background real-time clock self wake-up function. An integrated high-speed Digitally Controlled Oscillator (DCO) can source the master clock which is used by the CPU and high-speed peripherals. By design, the DCO is active and stable in less than 6 µs. MSP430 based solutions efficiently use 16-bit RISC high-performance in very short burst intervals. This results in very high-performance and ultra-low power consumption.

High-Performance Analog

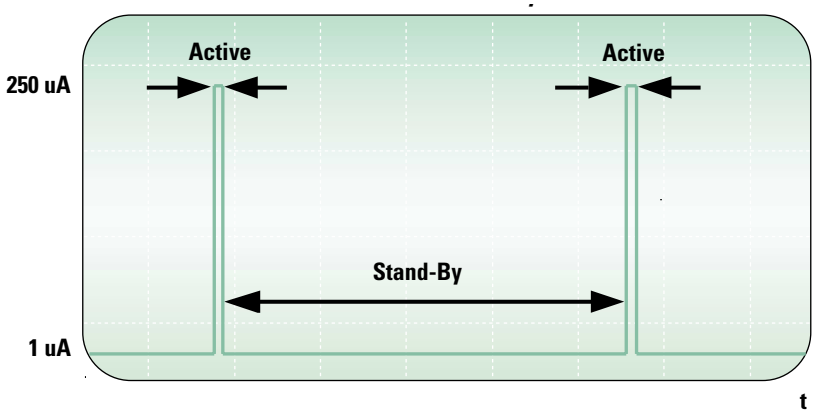
- 12-bit or 10-bit fast SAR ADC
- 14-bit hi-res SAR ADC
- 16-bit slope ADC

Several high-performance data converter solutions are available in the MSP430 family. Innovative comparator-gated timers are available on all devices for high-resolution slope type conversions. This is ideal for measuring resistive sensors such as thermistors when coupled with a capacitor. A fast 200-ksps+ 12-bit ADC with very high-integration is available on the MSP430F13x/14x/43x/44x and is ideal for demanding applications such as electricity meters and digital motor control. MSP430x32x derivatives offer a 14-bit ADC with a programmable current source.

Multiple Oscillator Clock System

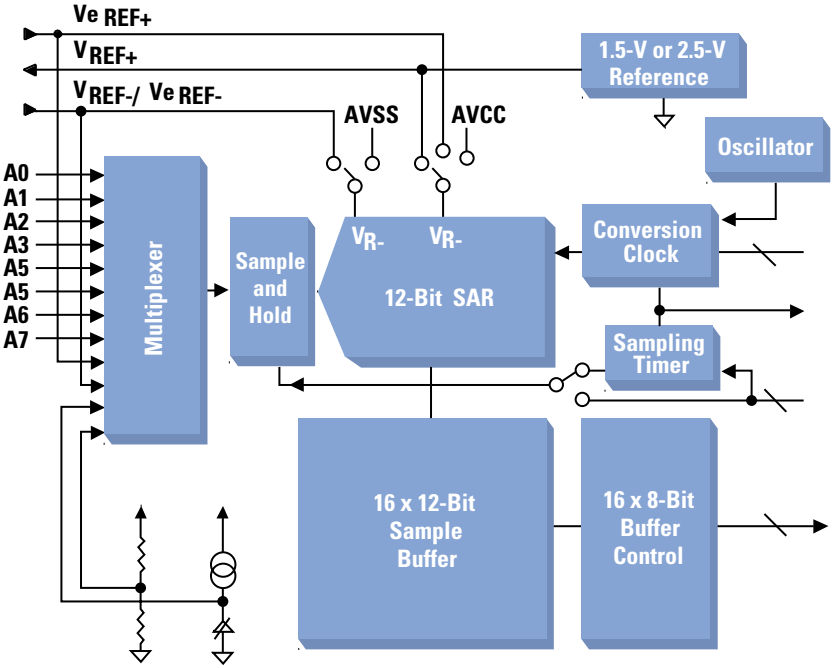


Ultra-Low-Power Activity Profile



Ultra-fast 6µs DCO start-up allows MSP430 systems to remain in low-power modes for the longest possible interval—extending battery life. The DCO is fully user programmable.

ADC12



ADC12 with 200 ksps+, auto-scan, V_{REF}, temperature sensor, and programmable sample and hold intervals.

MSP-FET430 Flash Emulation Tool

- JTAG based real-time in-system emulation
- Target board, interface box, cable and samples
- CD-Rom includes Kickstart IDE, assembler, linker, simulator and 2-kB C-compiler

The Flash Emulation Tool (FET) supports complete in-system development and is available for all MSP430F1xx and MSP430F4xx Flash devices. Programming, assembler/C-source level debug, single stepping, multiple hardware breakpoints, full-speed operation and peripheral access are all fully supported in-system using JTAG. The FET comes complete with everything required to complete an entire project.

MSP-EVKS330/320 Evaluation Kit

For MSP430x3xx devices, evaluation kits (EVK) are available for basic development and evaluation. EVKs include two UV erasable prototyping devices, a target board and a programmer—all software and documentation is included on a CD-ROM. For professional MSP430x3xx development, in-circuit emulators are available from Hitex.

MSP-PRGS430 Universal Programmer

The MSP-PRGS430 is a universal Flash, OTP or UV device programmer. Control of the programmer is provided through a PC serial port connection. Devices are programmed either stand-alone or in-system using a JTAG connection.

Visit our web site for documentation, downloadable code, software updates and complete information on TI and third party support.
www.ti.com/sc/msp430

TI IDE	Product Family	Price[1]
MSP-FET430X110	MSP430x11x	$ 49
MSP-FET430P120	MSP430x12x	$ 99
MSP-FET430P140	MSP430x13x/14x	$ 99
MSP-FET430P410	MSP430x41x	$ 99
MSP-FET430P440[2]	MSP430x43x/44x	$ 99
MSP-EVK430S320	MSP430x31x/32x	$399
MSP-EVK430S330	MSP430x33x	$399
MSP-PRGS430	All	$199

[1]Price per unit in U.S. dollars. [2]Planned release Q1 2002.

IAR SYSTEMS

IAR MSP430 C-Compiler

Baseline and full C-Compiler versions are available from IAR as enhancements to the 2-kB C-compiler included with TI's MSP430 tools.
www.iar.com

hitex DEVELOPMENT TOOLS

Hitex MSP430 ICE

With the Dprobe430, Hitex offers a modular emulation system, specifically designed to develop, test and optimize MSP430x3xx/ MSP430x1xx applications.
www.hitex.com

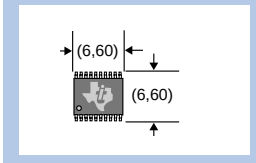
MSP430 Product Selection Guide

(C)ROM (E)UV (F) Flash (P)OTP	Temp Range[1]	Pins/ Pkg	Program	SRAM	I/O	Vcc	LCD Seg	Basic Timer (2) 8-Bit	Watchdog 16-Bit	Interval Timer 8-Bit	Timer/ Port (2) 8-Bit	Timer_A 16-Blt	Timer_B 16-Bit	USART	MPY	Comp_A	ADC	Price[2]
Flash Based F1xx Family																		
MSP430F1101	I	20 DW,PW	1 kB	128	14	1.8 - 3.6	–	–	X	–	–	X	–	–	–	X	slope	$0.99
MSP430F1111	I	20 DW,PW	2 kB	128	14	1.8 - 3.6	–	–	X	–	–	X	–	–	–	X	slope	$1.34
MSP430C1111	I	20 DW,PW	2 kB	128	14	1.8 - 3.6	–	–	X	–	–	X	–	–	–	X	slope	$1.23
MSP430F1121	I	20 DW,PW, DGV	4 kB	256	14	1.8 - 3.6	–	–	X	–	–	X	–	–	–	X	slope	$1.74
MSP430C1121	I	20 DW,PW, DGV	4 kB	256	14	1.8 - 3.6	–	–	X	–	–	X	–	–	–	X	slope	$1.47
MSP430P112	I	20 DW,PW	4 kB	256	14	2.7 - 5.5	–	–	X	–	–	X	–	–	–	–	slope	$2.33
PMS430E112	25C	20 CDIP	4 kB	256	14	2.7 - 5.5	–	–	X	–	–	X	–	–	–	–	slope	$49.00
MSP430F1122[4]	I	20 DW,PW	4 kB	256	14	1.8 - 3.6	–	–	X	–	–	X	–	–	–	–	ADC10	$2.24
MSP430F1132[4]	I	20 DW,PW	8 kB	256	14	1.8 - 3.6	–	–	X	–	–	X	–	–	–	–	ADC10	$2.48
MSP430F122	I	28 DW,PW	4 kB	256	22	1.8 - 3.6	–	–	X	–	–	X	–	1	–	X	slope	$2.39
MSP430F123	I	28 DW,PW	8 kB	256	22	1.8 - 3.6	–	–	X	–	–	X	–	1	–	X	slope	$2.51
MSP430F1222[4]	I	28 DW,PW	4 kB	256	22	1.8 - 3.6	–	–	X	–	–	X	–	1	–	–	ADC10	$2.62
MSP430F1232[4]	I	28 DW,PW	8 kB	256	22	1.8 - 3.6	–	–	X	–	–	X	–	1	–	–	ADC10	$2.79
MSP430F133	I	64 PM	8 kB	256	48	1.8 - 3.6	–	–	X	–	–	X	X	1	–	X	ADC12	$2.96
MSP430F135	I	64 PM	16 kB	512	48	1.8 - 3.6	–	–	X	–	–	X	X	1	–	X	ADC12	$3.55
MSP430C1331	I	64 PM	8 kB	256	48	1.8 - 3.6	–	–	X	–	–	X	X	1	–	X	slope	$1.95
MSP430C1351	I	64 PM	16 kB	512	48	1.8 - 3.6	–	–	X	–	–	X	X	1	–	X	slope	$2.25
MSP430F147	I	64 PM	32 kB	1024	48	1.8 - 3.6	–	–	X	–	–	X	X	2	X	X	ADC12	$4.95
MSP430F148	I	64 PM	48 kB	2048	48	1.8 - 3.6	–	–	X	–	–	X	X	2	X	X	ADC12	$5.65
MSP430F149	I	64 PM, PAG	60 kB	2048	48	1.8 - 3.6	–	–	X	–	–	X	X	2	X	X	ADC12	$5.95
Flash Based F4xx Family with LCD Driver																		
MSP430F412	I	64 PM	4 kB	256	48	1.8 - 3.6	96	X	X	–	–	X	–	–	–	X	slope	$2.55
MSP430C412[4]	I	64 PM	4 kB	256	48	1.8 - 3.6	96	X	X	–	–	X	–	–	–	X	slope	$1.90
MSP430F413	I	64 PM	8 kB	256	48	1.8 - 3.6	96	X	X	–	–	X	–	–	–	X	slope	$2.90
MSP430C413[4]	I	64 PM	8 kB	256	48	1.8 - 3.6	96	X	X	–	–	X	–	–	–	X	slope	$2.10
MSP430F435[3]	I	80 PN, 100 PZ	16 kB	512	48	1.8 - 3.6	160	X	X	–	–	X	X	1	–	X	ADC12	$4.40
MSP430F436[3]	I	80 PN, 100 PZ	24 kB	1024	48	1.8 - 3.6	160	X	X	–	–	X	X	1	–	X	ADC12	$4.65
MSP430F437[3]	I	80 PN, 100 PZ	32 kB	1024	48	1.8 - 3.6	160	X	X	–	–	X	X	1	–	X	ADC12	$4.85
MSP430F447[3]	I	100 PZ	32 kB	1024	48	1.8 - 3.6	160	X	X	–	–	X	X	2	X	X	ADC12	$5.65
MSP430F448[3]	I	100 PZ	48 kB	2048	48	1.8 - 3.6	160	X	X	–	–	X	X	2	X	X	ADC12	$6.40
MSP430F449[3]	I	100 PZ	60 kB	2048	48	1.8 - 3.6	160	X	X	–	–	X	X	2	X	X	ADC12	$6.95
ROM/OTP Based X3xx Family with LCD Driver																		
MSP430C311S	I	48DL	2 kB	128	11	2.5 - 5.5	64	X	X	X	X	–	–	–	–	–	slope	$1.99
MSP430P315S	I	48DL	16 kB	512	11	2.7 - 5.5	64	X	X	X	X	–	–	–	–	–	slope	$5.16
MSP430C312	I	56 DL	4 kB	256	14	2.5 - 5.5	92	X	X	X	X	–	–	–	–	–	slope	$2.40
MSP430C313	I	56 DL	8 kB	256	14	2.5 - 5.5	92	X	X	X	X	–	–	–	–	–	slope	$2.61
MSP430C314	I	56 DL	12 kB	512	14	2.5 - 5.5	92	X	X	X	X	–	–	–	–	–	slope	$2.82
MSP430C315	I	56 DL	16 kB	512	14	2.5 - 5.5	92	X	X	X	X	–	–	–	–	–	slope	$3.04
MSP430P315	I	56 DL	16 kB	512	14	2.7 - 5.5	92	X	X	X	X	–	–	–	–	–	slope	$5.16
PMS430E315	25C	68 FZ	16 kB	512	14	2.7 - 5.5	92	X	X	X	X	–	–	–	–	–	slope	$99.00
MSP430C323	I	64 PM, FN, PG	8 kB	256	14	2.5 - 5.5	84	X	X	X	X	–	–	–	–	–	ADC14	$5.23
MSP430C325	I	64 PM, FN, PG	16 kB	512	14	2.5 - 5.5	84	X	X	X	X	–	–	–	–	–	ADC14	$5.53
MSP430P325A	I	64 PM, FN, PG	16 kB	512	14	2.5 - 5.5	84	X	X	X	X	–	–	–	–	–	ADC14	$6.87
PMS430E325A	25C	68 FZ	16 kB	512	14	2.5 - 5.5	84	X	X	X	X	–	–	–	–	–	ADC14	$99.00
MSP430C336	I	100 PJM	24 kB	1024	40	2.5 - 5.5	120	X	X	X	X	X	–	1	X	–	slope	$6.10
MSP430C337	I	100 PJM	32 kB	1024	40	2.5 - 5.5	120	X	X	X	X	X	–	1	X	–	slope	$6.38
MSP430P337A	I	100 PJM	32 kB	1024	40	2.5 - 5.5	120	X	X	X	X	X	–	1	X	–	slope	$7.53
PMS430E337A	25C	100 PZ	32 kB	1024	40	2.5 - 5.5	120	X	X	X	X	X	–	1	X	–	slope	$99.00

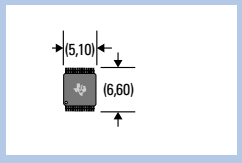
[1] I = Industrial. [2] Suggested 10,000 unit resale price in U.S. dollars. [3] Planned release Q1 2002. [4] Planned release Q2 2002.

Selected Package Options for MSP430 Devices

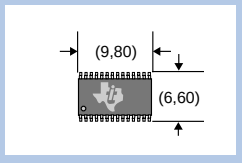
20-pin PW (TSSOP)



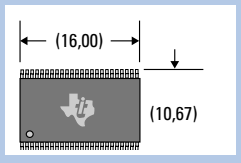
20-pin DGV (TVSOP)



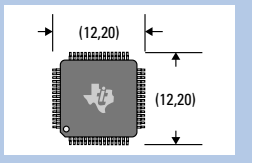
28-pin PW (TSSOP)



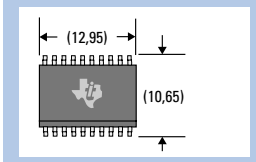
48-pin DL (SSOP)



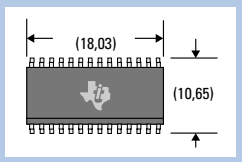
64-pin PM (QFP)



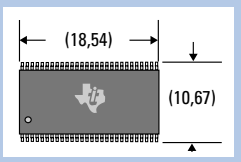
20-pin DW (SOP)



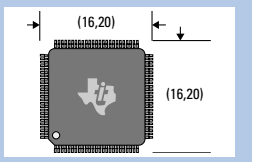
28-pin DW (SOP)



56-pin DL (SSOP)



100-pin PZ (LQFP)



All dimensions in millimeters.

TI Worldwide Technical Support

Internet

TI Semiconductor Product Information Center Home Page
www.ti.com/sc/support

TI Semiconductor KnowledgeBase Home Page
www.ti.com/sc/knowledgebase

Product Information Centers

Americas

Phone	+1(972) 644-5580
Fax	+1(214) 480-7800
Internet	www.ti.com/sc/ampic

Europe, Middle East, and Africa

Phone	
Belgium (English)	+32 (0) 27 45 55 32
France	+33 (0) 1 30 70 11 64
Germany	+49 (0) 8161 80 33 11
Israel (English)	1800 949 0107
Italy	800 79 11 37
Netherlands (English)	+31 (0) 546 87 95 45
Spain	+34 902 35 40 28
Sweden (English)	+46 (0) 8587 555 22
United Kingdom	+44 (0) 1604 66 33 99
Fax	+(49) (0) 8161 80 2045
Email	epic@ti.com
Internet	www.ti.com/sc/epic

Japan

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

Asia

Phone		
International	+886-2-23786800	
Domestic	Local Access Code	TI Number
Australia	1-800-881-011	-800-800-1450
China	108-00-886-0015	–
Hong Kong	800-96-1111	-800-800-1450
India	000-117	-800-800-1450
Indonesia	001-801-10	-800-800-1450
Korea	080-551-2804	–
Malaysia	1-800-800-011	-800-800-1450
New Zealand	000-911	-800-800-1450
Philippines	105-11	-800-800-1450
Singapore	800-0111-111	-800-800-1450
Taiwan	0800-006800	–
Thailand	0019-991-1111	-800-800-1450
Fax	886-2-2378-6808	
Email	tiasia@ti.com	
Internet	www.ti.com/sc/apic	

B092401

TEXAS INSTRUMENTS

Printed in the U.S.A. by Corporate Press Inc.
Printed on recycled paper.

SLAB034C