MSP430 Ultra-Low-Power Microcontrollers

Texas Instruments

2008

MSP430 Microcontrollers

Key Features

- **Ultra-low-power** architecture and flexible clock system extends battery life:
  - 0.1-µA RAM retention
  - <1-µA RTC mode
  - <250 µA/MIPS
- **Integrated intelligent peripherals** including wide range of high-performance analog and digital peripherals offload the CPU
- **16-bit RISC CPU architecture** enables new applications with industry leading code density
- **Easy to Get Started:** Complete development tools starting at only $20

MSP430 Modular Architecture

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

Device Configuration

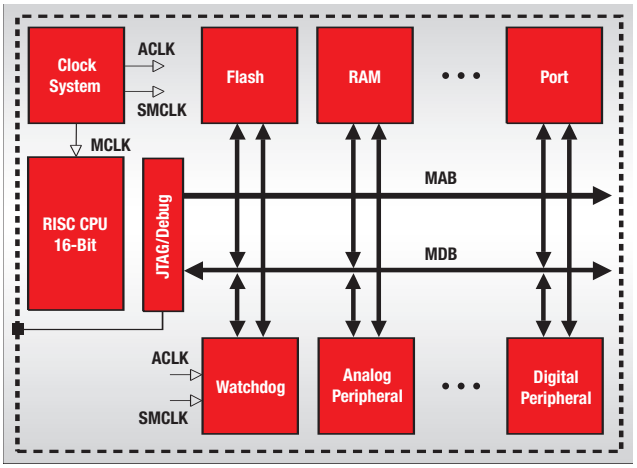
- 1-kB to 256-kB ISP Flash
- RAM up to 16 kB
- 14- to 100-pin options

Ultra-Low Power

- Zero-power Brown Out Reset (BOR)
- <1-µs clock startup
- <50-nA pin leakage

Integrated Peripherals

- 10-/12-bit SAR ADC
- 16-bit Sigma Delta ADC
- 12-bit DAC
- Comparator
- LCD driver
- Supply Voltage Supervisor (SVS)
- Operational amplifiers
- 16-bit and 8-bit timers
- LDO
- Watchdog timer
- UART/LIN
- I^2C
- SPI
- IrDA
- Hardware multiplier
- DMA controller
- Temperature sensor

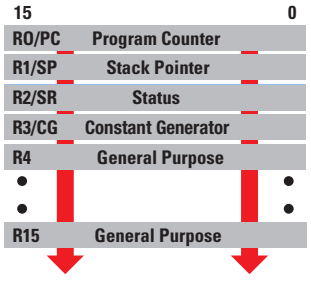


MSP430 von-Neumann architecture — all program, data memory and peripherals share a common bus structure. Consistent CPU instructions and addressing modes are used.

16-Bit RISC CPU

- Optimized for C and assembler programming
- 16 general-purpose registers
- Compact core design reduces power and cost
- Up to 25 MIPS of performance available

The MSP430 MCU's orthogonal architecture provides the flexibility of 16 fully addressable, single-cycle 16-bit CPU registers and the power of a RISC. The modern design of the CPU offers versatility using only 27 easy-to-understand instructions and seven consistent-addressing modes. This results in a 16-bit low-power CPU that has more effective processing, is smaller-sized, and more code-efficient than other 8-/16-bit microcontrollers. This will allow you to develop new ultra-low-power, high-performance applications at a fraction of the code size.



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

Ultra-Low-Power Performance

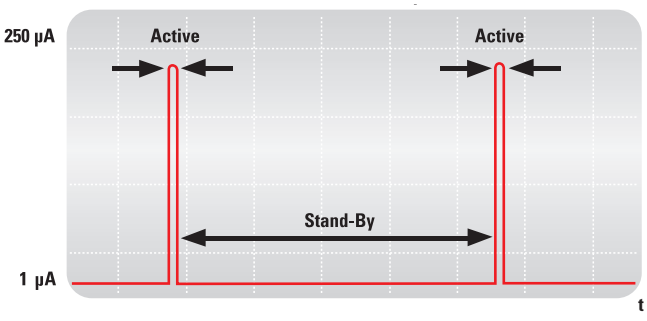
The MSP430 is designed specifically for ultra-low-power applications. A flexible clocking system, multiple operating modes and zero-power always on brown-out reset (BOR) are implemented to reduce power consumption and dramatically extend battery life. The MSP430 BOR function is always active in all low-power modes to ensure the most reliable performance possible.

The MSP430 CPU architecture with 16 registers and 16-bit data and address buses minimize power consuming fetches to memory and a fast vectored-interrupt structure reduces the need for wasteful CPU software flag polling. Intelligent hardware peripheral features were also designed to allow tasks to be completed more efficiently independent of the CPU. Many MSP430 customers have developed battery-based products that will last for over 10-years from the original battery!

Ultra-Low Power Checklist:

- Multiple operating modes
  - 0.1-µA RAM retention
  - <1-µA RTC mode
  - <250 µA/MIPS
- Instant-on stable high-speed clock
- 1.8-V to 3.6-V operation
- Zero-power BOR
- <50-nA pin leakage
- CPU that minimizes CPU cycles per task
- Intelligent, low-power peripheral options

Ultra-Low-Power Activity Profile



Ultra-fast 1-µs DCO start-up allows MSP430-based systems to remain in low-power modes for the longest possible interval – extending battery life. The DCO is fully user programmable.

Key Applications

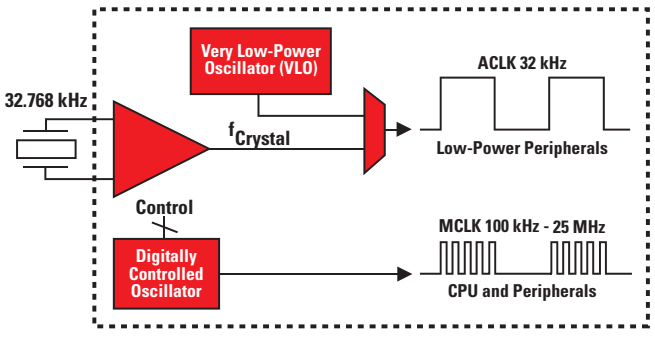
- Utility metering
- Portable medical and instrumentation
- Low-power wireless applications
- Intelligent sensing
- Consumer electronics
- Security systems

Flexible Clock System

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

The MSP430 MCU 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 or the internal very low-power oscillator (VLO) – 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 (MCLK) used by the CPU and sub-main clock (SMCLK) used by the high-speed peripherals. By design, the DCO is active and stable in 1 µs (F2xx) or <6 µs (x1xx, x4xx, F5xx). MSP430 device-based solutions efficiently use 16-bit RISC CPU high performance in very short burst intervals. This results in very high performance and ultra-low power consumption.

Multiple Oscillator Clock System



MSP430 Microcontrollers

The Next Generation: MSP430F5xx

The MSP430F5xx is the next generation technology platform for the MSP430 family and continues to expand on MSP430's industry leadership in the ultra-low-power 16-bit MCU space. The 5xx family offers improved ultra-low-power performance with innovative new power conserving features such as adjustable core voltage and an integrated low-power LDO. Cutting edge power efficiency is available through an innovative power management system as well as record breaking performance at 160 µA/MIP with 256-kB flash and 16-kB RAM. The 5xx also offers increased peripheral performance, significantly higher levels of integration and many new features designed for customer ease of use, all while remaining completely compatible with existing MSP430 families.

Ultra-Low Power

- 160 µA/MIPS
- 2.5-µA standby mode
- Integrated LDO, BOR, WDT+, RTC
- 12 MHz @1.8 V
- Wake up from standby in <5 µs

Increased Performance

- Up to 25 MHz
- 1.8-V ISP Flash erase and write
- Fail-safe, flexible clocking system
- User-defined Bootstrap Loader
- Up to 1-MB linear memory addressing

Innovative Features

- Multi-channel DMA supports data movement in standby mode
- Industry leading code density
- More design options including USB, RF, encryption, LCD interface

Flash-Based x5xx MCU Platform (V_{CC} 1.8-3.6V), Up to 25 MIPS *(See **www.ti.com/msp430** for additional information)*

(F) Flash	Program (kB)	SRAM (kB)	I/O	16-Bit Timers A	16-Bit Timers B	Watchdog and RTC	PMM, (BOR SVS, SVM LDO)	USCI Ch A: UART/LIN/ IrDA/SPI	USCI Ch B: I²C/SPI	DMA	MPY (32 x 32)	Comp_A	Temp Sensor	ADC Ch/Res	Additional Features	Packages	100-U Price[1]
MSP430F5418	128	16	64	5, 3	7	✔	✔	2	2	✔	✔	—	✔	16ch ADC12 A	—	80 PN	4.15
MSP430F5419	128	16	83	5, 3	7	✔	✔	4	4	✔	✔	—	✔	16ch ADC12 A	—	100 PZ	4.55
MSP430F5435	192	16	64	5, 3	7	✔	✔	2	2	✔	✔	—	✔	16ch ADC12 A	—	80 PN	4.85
MSP430F5436	192	16	83	5, 3	7	✔	✔	4	4	✔	✔	—	✔	16ch ADC12 A	—	100 PZ	5.35
MSP430F5437	256	16	64	5, 3	7	✔	✔	2	2	✔	✔	—	✔	16ch ADC12 A	—	80 PN	5.50
MSP430F5438	256	16	83	5, 3	7	✔	✔	4	4	✔	✔	—	✔	16ch ADC12 A	—	100 PZ	6.10

[1] *Prices are quoted in U.S.dollars and represent year 2008 suggested resale pricing. All prices are subject to change. Customers are advised to obtain the most current and complete pricing information from TI prior to placing orders. TI may verify final pricing prior to accepting any order.*

*New products are listed in **bold red**. Preview products are listed in **bold blue**.*

Get Started Now!

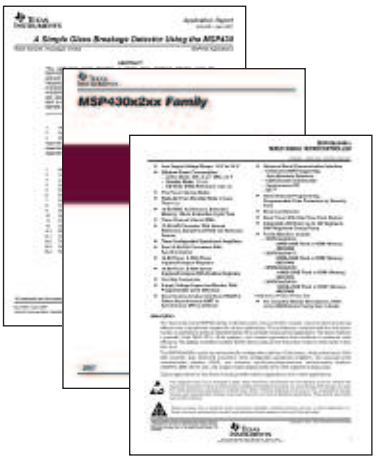
Getting started is easy with MSP430. MSP430 offers easy-to-use tools, free development software and hundreds of application notes and code examples to help get your design started.

Two main collateral pieces are needed for device documentation.

- Data Sheets for each specific device provide pin functions, internal signal connections and operational parameters. Datasheets can be obtained by going to the specific device web page.
- User Guides provide in-depth detailed technical information on the device peripherals. These are written for each family of the MSP430, including x1xx, x2xx and x4xx and the new F5xx.

Visit **www.ti.com/msp430** for all the documentation and resources.

- User's Guides
- Datasheets
- Application Reports
- Code Examples
- Code Function Libraries
- Latest Development Tool Software
- Footprints/Symbols for CAD Tools
- 3rd Party Listing
- Silicon Errata



Flash-Based F2xx MCU Platform (V_{CC} 1.8-3.6V), Up to 16 MIPS *(See **www.ti.com/msp430** for additional information)*

	(F) Flash	Program (kB)	SRAM (kB)	I/O	16-Bit Timers A	16-Bit Timers B	Watchdog	BOR	SVS	USI: I²C/SPI	USCI Ch A: UART/LIN /IrDA/SPI	USCI Ch B: I²C/SPI	DMA	MPY (16 x 16)	Comp_A+	Temp Sensor	ADC Ch/Res	Additional Features	Packages	100-U Price[1]
F20xx	MSP430F2001	1	128	10	2	—	✔	✔	—	—	—	—	—	—	✔	—	slope	—	14 PW, N, 16 RSA	0.70
	MSP430F2011	2	128	10	2	—	✔	✔	—	—	—	—	—	—	✔	—	slope	—	14 PW, N, 16 RSA	0.80
	MSP430F2002	1	128	10	2	—	✔	✔	—	✔	—	—	—	—	—	✔	8ch, ADC10	—	14 PW, N, 16 RSA	1.05
	MSP430F2012	2	128	10	2	—	✔	✔	—	✔	—	—	—	—	—	✔	8ch, ADC10	—	14 PW, N, 16 RSA	1.15
	MSP430F2003	1	128	10	2	—	✔	✔	—	✔	—	—	—	—	—	✔	4ch, SD16	—	14 PW, N, 16 RSA	1.50
	MSP430F2013	2	128	10	2	—	✔	✔	—	✔	—	—	—	—	—	✔	4ch, SD16	—	14 PW, N, 16 RSA	1.65
F21xx	MSP430F2101	1	128	16	3, 2	—	✔	✔	—	—	—	—	—	—	✔	—	slope	—	20 DGV, DW, PW, 24 RGE	0.90
	MSP430F2111	2	128	16	3, 2	—	✔	✔	—	—	—	—	—	—	✔	—	slope	—	20 DGV, DW, PW, 24 RGE	1.00
	MSP430F2121	4	256	16	3, 2	—	✔	✔	—	—	—	—	—	—	✔	—	slope	—	20 DGV, DW, PW, 24 RGE	1.35
	MSP430F2131	8	256	16	3, 2	—	✔	✔	—	—	—	—	—	—	✔	—	slope	—	20 DGV, DW, PW, 24 RGE	1.70
	MSP430F2112	2	256	22	3, 2	—	✔	✔	—	—	1	1	—	—	✔	✔	8ch, ADC10	—	28 PW, 32 RHB	1.95
	MSP430F2122	4	512	22	3, 2	—	✔	✔	—	—	1	1	—	—	✔	✔	8ch, ADC10	—	28 PW, 32 RHB	2.10
	MSP430F2132	8	512	22	3, 2	—	✔	✔	—	—	1	1	—	—	✔	✔	8ch, ADC10	—	28 PW, 32 RHB	2.20
F22x2	MSP430F2232	8	512	32	3	3	✔	✔	—	—	1	1	—	—	—	✔	12ch, ADC10	—	38 DA, 40 RHA	2.40
	MSP430F2252	16	512	32	3	3	✔	✔	—	—	1	1	—	—	—	✔	12ch, ADC10	—	38 DA, 40 RHA	2.70
	MSP430F2272	32	1024	32	3	3	✔	✔	—	—	1	1	—	—	—	✔	12ch, ADC10	—	38 DA, 40 RHA	3.10
F22x4	MSP430F2234	8	512	32	3	3	✔	✔	—	—	1	1	—	—	—	✔	12ch, ADC10	(2) OPAMP	38 DA, 40 RHA	2.65
	MSP430F2254	16	512	32	3	3	✔	✔	—	—	1	1	—	—	—	✔	12ch, ADC10	(2) OPAMP	38 DA, 40 RHA	2.95
	MSP430F2274	32	1024	32	3	3	✔	✔	—	—	1	1	—	—	—	✔	12ch, ADC10	(2) OPAMP	38 DA, 40 RHA	3.35
F23x0	MSP430F2330	8	1024	32	3	3	✔	✔	—	—	1	1	—	✔	✔	—	slope	—	40 RHA	2.30
	MSP430F2350	16	2048	32	3	3	✔	✔	—	—	1	1	—	✔	✔	—	slope	—	40 RHA	2.65
	MSP430F2370	32	2048	32	3	3	✔	✔	—	—	1	1	—	✔	✔	—	slope	—	40 RHA	2.95
F23x	**MSP430F233**	8	1024	48	3	3	✔	✔	✔	—	1	1	—	✔	✔	✔	8ch, ADC12	—	64 PM, 64 RGC	3.00
	MSP430F235	16	2048	48	3	3	✔	✔	✔	—	1	1	—	✔	✔	✔	8ch, ADC12	—	64 PM, 64 RGC	3.60
F24x/2410	**MSP430F247**	32	4096	48	3	7	✔	✔	✔	—	2	2	—	✔	✔	✔	8ch, ADC12	—	64 PM, 64 RGC	5.05
	MSP430F248	48	4096	48	3	7	✔	✔	✔	—	2	2	—	✔	✔	✔	8ch, ADC12	—	64 PM, 64 RGC	5.75
	MSP430F249	60	2048	48	3	7	✔	✔	✔	—	2	2	—	✔	✔	✔	8ch, ADC12	—	64 PM, 64 RGC	5.90
	MSP430F2410	56	4096	48	3	7	✔	✔	✔	—	2	2	—	✔	✔	✔	8ch, ADC12	—	64 PM, 64 RGC	6.05
F24x1	**MSP430F2471**	32	4096	48	3	7	✔	✔	✔	—	2	2	—	✔	✔	—	slope	—	64 PM, 64 RGC	4.60
	MSP430F2481	48	4096	48	3	7	✔	✔	✔	—	2	2	—	✔	✔	—	slope	—	64 PM, 64 RGC	5.30
	MSP430F2491	60	2048	48	3	7	✔	✔	✔	—	2	2	—	✔	✔	—	slope	—	64 PM, 64 RGC	5.45
F241x	**MSP430F2416**	92	4096	48/64	3	7	✔	✔	✔	—	2	2	—	✔	✔	✔	8ch, ADC12	—	64 PM, 80 PN, **113 ZQW**	6.95
	MSP430F2417	92	8192	48/64	3	7	✔	✔	✔	—	2	2	—	✔	✔	✔	8ch, ADC12	—	64 PM, 80 PN, **113 ZQW**	7.60
	MSP430F2418	116	8192	48/64	3	7	✔	✔	✔	—	2	2	—	✔	✔	✔	8ch, ADC12	—	64 PM, 80 PN, **113 ZQW**	7.95
	MSP430F2419	120	4096	48/64	3	7	✔	✔	✔	—	2	2	—	✔	✔	✔	8ch, ADC12	—	64 PM, 80 PN, **113 ZQW**	7.60
F261x	**MSP430F2616**	92	4096	48/64	3	7	✔	✔	✔	—	2	2	✔	✔	✔	✔	8ch, ADC12	(2) DAC12	64 PM, 80 PN, **113 ZQW**	8.85
	MSP430F2617	92	8192	48/64	3	7	✔	✔	✔	—	2	2	✔	✔	✔	✔	8ch, ADC12	(2) DAC12	64 PM, 80 PN, **113 ZQW**	9.50
	MSP430F2618	116	8192	48/64	3	7	✔	✔	✔	—	2	2	✔	✔	✔	✔	8ch, ADC12	(2) DAC12	64 PM, 80 PN, **113 ZQW**	9.85
	MSP430F2619	120	4096	48/64	3	7	✔	✔	✔	—	2	2	✔	✔	✔	✔	8ch, ADC12	(2) DAC12	64 PM, 80 PN, **113 ZQW**	9.50

Flash/ROM-Based x4xx MCU Platform (V_{CC} 1.8-3.6V), Up to 8 MIPS (unless noted[2]) *(See **www.ti.com/msp430** for additional information)*

	(C) ROM (F) Flash	Program (kB)	SRAM (kB)	I/O	16-Bit Timers A	16-Bit Timers B	Watchdog and Basic Timer	BOR	SVS	USART (UART/SPI)	USCI Ch A: UART/LIN /IrDA/SPI	USCI Ch B: I²C/SPI	LCD Segments	DMA	MPY (16 x 16)	Comp_A	Temp Sensor	ADC Ch/Res	Additonal Features	Packages	100-U Price[1]
x41x	MSP430F412	4	256	48	3	—	✔	✔	✔	—	—	—	96	—	—	✔	—	slope	—	64 PM, RTD	3.25
	MSP430C412	4	256	48	3	—	✔	✔	✔	—	—	—	96	—	—	✔	—	slope	—	64 PM, RTD	2.40
	MSP430F413	8	256	48	3	—	✔	✔	✔	—	—	—	96	—	—	✔	—	slope	—	64 PM, RTD	3.70
	MSP430C413	8	256	48	3	—	✔	✔	✔	—	—	—	96	—	—	✔	—	slope	—	64 PM, RTD	2.65
	MSP430F415	16	512	48	3, 5	—	✔	✔	✔	—	—	—	96	—	—	✔	—	slope	—	64 PM, RTD	4.25
	MSP430F417	32	1024	48	3, 5	—	✔	✔	✔	—	—	—	96	—	—	✔	—	slope	—	64 PM, RTD	4.90
F42x	MSP430F423	8	256	14	3	—	✔	✔	✔	1	—	—	128	—	✔	—	✔	(3) SD16	—	64 PM	5.65
	MSP430F425	16	512	14	3	—	✔	✔	✔	1	—	—	128	—	✔	—	✔	(3) SD16	—	64 PM	6.20
	MSP430F427	32	1024	14	3	—	✔	✔	✔	1	—	—	128	—	✔	—	✔	(3) SD16	—	64 PM	6.75

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[2] Up to 16 MIPS

*New products are listed in **bold red**.*

MSP430 Microcontrollers

Flash/ROM-Based x4xx MCU Platform (V_{CC} 1.8-3.6V), Up to 8 MIPS (unless noted[2]) *(See **www.ti.com/msp430** for additional information)*

	(C) ROM (F) Flash	Program (kB)	SRAM (kB)	I/O	16-Bit Timers A	16-Bit Timers B	Watchdog and Basic Timer	BOR	SVS	USART (UART/SPI)	USCI Ch A: UART/LIN /IrDA/SPI	USCI Ch B: I²C/SPI	LCD Segments	DMA	MPY (16 x 16)	Comp_A	Temp Sensor	ADC Ch/Res	Additional Features	Packages	100-U Price[1]
FW42x	MSP430FW423	8	256	48	3,5	—	✔	✔	✔	—	—	—	96	—	—	✔	—	slope	Flow-meter	64 PM	4.70
	MSP430FW425	16	512	48	3,5	—	✔	✔	✔	—	—	—	96	—	—	✔	—	slope	Flow-meter	64 PM	6.20
	MSP430FW427	32	1024	48	3,5	—	✔	✔	✔	—	—	—	96	—	—	✔	—	slope	Flow-meter	64 PM	5.60
FE42xx	MSP430FE423	8	256	14	3	—	✔	✔	✔	1	—	—	128	—	✔	—	✔	(3) SD16	E-meter	64 PM	4.85
	MSP430FE425	16	512	14	3	—	✔	✔	✔	1	—	—	128	—	✔	—	✔	(3) SD16	E-meter	64 PM	5.45
	MSP430FE427	32	1024	14	3	—	✔	✔	✔	1	—	—	128	—	✔	—	✔	(3) SD16	E-meter	64 PM	5.95
	MSP430FE4232	8	256	14	3	—	✔	✔	✔	1	—	—	128	—	✔	—	✔	(2) SD16	E-meter	64 PM	3.70
	MSP430FE4242	12	512	14	3	—	✔	✔	✔	1	—	—	128	—	✔	—	✔	(2) SD16	E-meter	64 PM	3.95
F42x0	MSP430F4250	16	256	32	3	—	✔	✔	—	—	—	—	56	—	—	—	✔	5ch, SD16	DAC12	48 DL, RGZ	3.90
	MSP430F4260	24	256	32	3	—	✔	✔	—	—	—	—	56	—	—	—	✔	5ch, SD16	DAC12	48 DL, RGZ	4.35
	MSP430F4270	32	256	32	3	—	✔	✔	—	—	—	—	56	—	—	—	✔	5ch, SD16	DAC12	48 DL, RGZ	4.75
FG42x0	**MSP430FG4250**	16	256	32	3	—	✔	✔	—	—	—	—	56	—	—	—	✔	5ch, SD16	DAC12, (2) OPAMP	48 DL, RGZ	4.20
	MSP430FG4260	24	256	32	3	—	✔	✔	—	—	—	—	56	—	—	—	✔	5ch, SD16	DAC12, (2) OPAMP	48 DL, RGZ	4.65
	MSP430FG4270	32	256	32	3	—	✔	✔	—	—	—	—	56	—	—	—	✔	5ch, SD16	DAC12, (2) OPAMP	48 DL, RGZ	5.10
F43x	MSP430F435	16	512	48	3	3	✔	✔	✔	1	—	—	128/160	—	—	✔	✔	8ch, ADC12	—	80 PN, 100 PZ	5.60
	MSP430F436	24	1024	48	3	3	✔	✔	✔	1	—	—	128/160	—	—	✔	✔	8ch, ADC12	—	80 PN, 100 PZ	5.90
	MSP430F437	32	1024	48	3	3	✔	✔	✔	1	—	—	128/160	—	—	✔	✔	8ch, ADC12	—	80 PN, 100 PZ	6.15
F43x1	**MSP430F4351**	16	512	48	3	3	✔	✔	✔	1	—	—	128/160	—	—	✔	✔	slope	—	80 PN, 100 PZ	5.10
	MSP430F4361	24	1024	48	3	3	✔	✔	✔	1	—	—	128/160	—	—	✔	✔	slope	—	80 PN, 100 PZ	5.40
	MSP430F4371	32	1024	48	3	3	✔	✔	✔	1	—	—	128/160	—	—	✔	✔	slope	—	80 PN, 100 PZ	5.65
FG43x	MSP430FG437	32	1024	48	3	3	✔	✔	✔	1	—	—	128	✔	—	✔	✔	12ch, ADC12	(2) DAC12, (3) OPAMP	80 PN	8.15
	MSP430FG438	48	2048	48	3	3	✔	✔	✔	1	—	—	128	✔	—	✔	✔	12ch, ADC12	(2) DAC12, (3) OPAMP	80 PN	9.20
	MSP430FG439	60	2048	48	3	3	✔	✔	✔	1	—	—	128	✔	—	✔	✔	12ch, ADC12	(2) DAC12, (3) OPAMP	80 PN	9.95
F44x	MSP430F447	32	1024	48	3	7	✔	✔	✔	2	—	—	160	—	✔	✔	✔	8ch, ADC12	—	100 PZ	7.15
	MSP430F448	48	2048	48	3	7	✔	✔	✔	2	—	—	160	—	✔	✔	✔	8ch, ADC12	—	100 PZ	8.10
	MSP430F449	60	2048	48	3	7	✔	✔	✔	2	—	—	160	—	✔	✔	✔	8ch, ADC12	—	100 PZ	8.80
xG461x	MSP430FG4616	92	4096	80	3	7	✔	✔	✔	1	1	1	160	✔	✔	✔	✔	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ, **113 ZQW**	11.85
	MSP430FG4617	92	8192	80	3	7	✔	✔	✔	1	1	1	160	✔	✔	✔	✔	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ, **113 ZQW**	12.45
	MSP430FG4618	116	8192	80	3	7	✔	✔	✔	1	1	1	160	✔	✔	✔	✔	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ, **113 ZQW**	12.95
	MSP430FG4619	120	4096	80	3	7	✔	✔	✔	1	1	1	160	✔	✔	✔	✔	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ, **113 ZQW**	12.45
	MSP430CG4616	92	4096	80	3	7	✔	✔	✔	1	1	1	160	✔	✔	✔	✔	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ	9.60
	MSP430CG4617	92	8192	80	3	7	✔	✔	✔	1	1	1	160	✔	✔	✔	✔	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ	10.10
	MSP430CG4618	116	8192	80	3	7	✔	✔	✔	1	1	1	160	✔	✔	✔	✔	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ	10.50
	MSP430CG4619	120	4096	80	3	7	✔	✔	✔	1	1	1	160	✔	✔	✔	✔	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ	10.10
	MSP430F4783[1]	48	2480	72	3	3	WDT+	✔	✔	—	2	2	160	—	32x32	✔	✔	(3) SD16	—	100 PZ	9.40
	MSP430F4793[1]	60	2560	72	3	3	WDT+	✔	✔	—	2	2	160	—	32x32	✔	✔	(3) SD16	—	100 PZ	10.00
	MSP430F4784[1]	48	2048	72	3	3	WDT+	✔	✔	—	2	2	160	—	32x32	✔	✔	(4) SD16	—	100 PZ	10.10
	MSP430F4794[1]	60	2560	72	3	3	WDT+	✔	✔	—	2	2	160	—	32x32	✔	✔	(4) SD16	—	100 PZ	10.70
F471xx	**MSP430F47166**[1]	92	4096	72	3	3	✔	✔	✔	—	2	2	160	✔	✔	✔	—	(6) SD16	RTC	100 PZ	TBD
	MSP430F47176[1]	92	8192	72	3	3	✔	✔	✔	—	2	2	160	✔	✔	✔	—	(6) SD16	RTC	100 PZ	TBD
	MSP430F47186[1]	116	8192	72	3	3	✔	✔	✔	—	2	2	160	✔	✔	✔	—	(6) SD16	RTC	100 PZ	TBD
	MSP430F47196[1]	120	4096	72	3	3	✔	✔	✔	—	2	2	160	✔	✔	✔	—	(6) SD16	RTC	100 PZ	TBD
	MSP430F47167[1]	92	4096	72	3	3	✔	✔	✔	—	2	2	160	✔	✔	✔	—	(7) SD16	RTC	100 PZ	TBD
	MSP430F47177[1]	92	8192	72	3	3	✔	✔	✔	—	2	2	160	✔	✔	✔	—	(7) SD16	RTC	100 PZ	TBD
	MSP430F47187[1]	116	8192	72	3	3	✔	✔	✔	—	2	2	160	✔	✔	✔	—	(7) SD16	RTC	100 PZ	TBD
	MSP430F47197[1]	120	4096	72	3	3	✔	✔	✔	—	2	2	160	✔	✔	✔	—	(7) SD16	RTC	100 PZ	TBD

[1] *Prices are quoted in U.S.dollars and represent year 2008 suggested resale pricing. All prices are subject to change. Customers are advised to obtain the most current and complete pricing information from TI prior to placing orders. TI may verify final pricing prior to accepting any order.*

[2] *Up to 16 MIPS*

*New products are listed in **bold red**. Preview products are listed in **bold blue**.*

Flash/ROM-Based x1xx MCU Platform (V_{CC} 1.8-3.6V), Up to 8 MIPS *(See **www.ti.com/msp430** for additional information)*

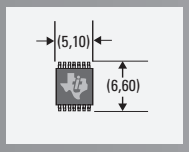
(C) ROM / (F) Flash		Program (kB)	SRAM (kB)	I/O	16-Bit Timers A	16-Bit Timers B	Watchdog	BOR	SVS	(UART/ SPI)	DMA	MPY (16 x 16)	Comp_A	Temp Sensor	ADC Ch/Res	Additional Features	Packages	100-U Price[1]
x11x1	MSP430F1101A	1	128	14	3	—	✔	—	—	—	—	—	✔	—	slope	—	20 DGV, DW, PW, 24 RGE	1.25
	MSP430C1101	1	128	14	3	—	✔	—	—	—	—	—	✔	—	slope	—	20 DW, PW, 24 RGE	0.75
	MSP430F1111A	2	128	14	3	—	✔	—	—	—	—	—	✔	—	slope	—	20 DGV, DW, PW, 24 RGE	1.70
	MSP430C1111	2	128	14	3	—	✔	—	—	—	—	—	✔	—	slope	—	20 DW, PW, 24 RGE	1.40
	MSP430F1121A	4	256	14	3	—	✔	—	—	—	—	—	✔	—	slope	—	20 DGV, DW, PW, 24 RGE	2.10
	MSP430C1121	4	256	14	3	—	✔	—	—	—	—	—	✔	—	slope	—	20 DW, PW, 24 RGE	1.90
F11x2	MSP430F1122	4	256	14	3	—	✔	✔	—	—	—	—	—	✔	5ch, ADC10	—	20 DW, PW, 32 RHB	2.50
	MSP430F1132	8	256	14	3	—	✔	✔	—	—	—	—	—	✔	5ch, ADC10	—	20 DW, PW, 32 RHB	2.80
F122	MSP430F122	4	256	22	3	—	✔	—	—	1	—	—	✔	—	slope	—	28 DW, PW, 32 RHB	2.65
	MSP430F123	8	256	22	3	—	✔	—	—	1	—	—	✔	—	slope	—	28 DW, PW, 32 RHB	2.85
F12x2	MSP430F1222	4	256	22	3	—	✔	✔	—	1	—	—	—	✔	8ch, ADC10	—	28 DW, PW, 32 RHB	2.95
	MSP430F1232	8	256	22	3	—	✔	✔	—	1	—	—	—	✔	8ch, ADC10	—	28 DW, PW, 32 RHB	3.15
F13x	MSP430F133	8	256	48	3	3	✔	—	—	1	—	—	✔	✔	8ch, ADC12	—	64 PM, PAG, RTD	3.75
	MSP430F135	16	512	48	3	3	✔	—	—	1	—	—	✔	✔	8ch, ADC12	—	64 PM, PAG, RTD	4.50
C13x1	MSP430C1331	8	256	48	3	3	✔	—	—	1	—	—	✔	—	slope	—	64 PM, RTD	2.50
	MSP430C1351	16	512	48	3	3	✔	—	—	1	—	—	✔	—	slope	—	64 PM, RTD	2.85
F14x	MSP430F147	32	1024	48	3	7	✔	—	—	2	—	✔	✔	✔	8ch, ADC12	—	64 PM, PAG, RTD	6.30
	MSP430F148	48	2048	48	3	7	✔	—	—	2	—	✔	✔	✔	8ch, ADC12	—	64 PM, PAG, RTD	7.15
	MSP430F149	60	2048	48	3	7	✔	—	—	2	—	✔	✔	✔	8ch, ADC12	—	64 PM, PAG, RTD	7.55
F14x1	MSP430F1471	32	1024	48	3	7	✔	—	—	2	—	✔	✔	—	slope	—	64 PM, RTD	5.75
	MSP430F1481	48	2048	48	3	7	✔	—	—	2	—	✔	✔	—	slope	—	64 PM, RTD	6.65
	MSP430F1491	60	2048	48	3	7	✔	—	—	2	—	✔	✔	—	slope	—	64 PM, RTD	7.00
F15x	MSP430F155	16	512	48	3	3	✔	✔	✔	1 with I^2C	✔	—	✔	✔	8ch, ADC12	(2) DAC12	64 PM, RTD	6.20
	MSP430F156	24	1024	48	3	3	✔	✔	✔	1 with I^2C	✔	—	✔	✔	8ch, ADC12	(2) DAC12	64 PM, RTD	6.95
	MSP430F157	32	1024	48	3	3	✔	✔	✔	1 with I^2C	✔	—	✔	✔	8ch, ADC12	(2) DAC12	64 PM, RTD	7.35
F16x	MSP430F167	32	1024	48	3	7	✔	✔	✔	2 with I^2C	✔	✔	✔	✔	8ch, ADC12	(2) DAC12	64 PM, RTD	8.45
	MSP430F168	48	2048	48	3	7	✔	✔	✔	2 with I^2C	✔	✔	✔	✔	8ch, ADC12	(2) DAC12	64 PM, RTD	9.35
	MSP430F169	60	2048	48	3	7	✔	✔	✔	2 with I^2C	✔	✔	✔	✔	8ch, ADC12	(2) DAC12	64 PM, RTD	9.95
	MSP430F1610	32	5120	48	3	7	✔	✔	✔	2 with I^2C	✔	✔	✔	✔	8ch, ADC12	(2) DAC12	64 PM, RTD	10.35
	MSP430F1611	48	10240	48	3	7	✔	✔	✔	2 with I^2C	✔	✔	✔	✔	8ch, ADC12	(2) DAC12	64 PM, RTD	10.85
	MSP430F1612	55	5120	48	3	7	✔	✔	✔	2 with I^2C	✔	✔	✔	✔	8ch, ADC12	(2) DAC12	64 PM, RTD	11.20

[1] *Prices are quoted in U.S.dollars and represent year 2008 suggested resale pricing. All prices are subject to change. Customers are advised to obtain the most current and complete pricing information from TI prior to placing orders. TI may verify final pricing prior to accepting any order.*

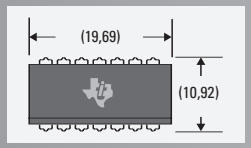
*New products are listed in **bold red**. Preview products are listed in **bold blue**.*

Selected Package Options for MSP430 Devices

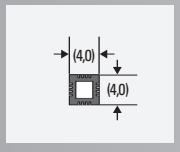
14-pin PW (TSSOP)



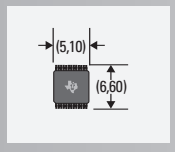
14-pin N (PDIP)



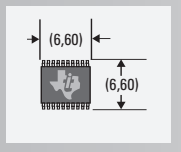
16-pin RSA (QFN)



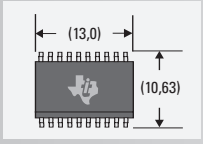
20-pin DGV (TVSOP)



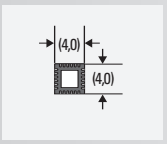
20-pin PW (TSSOP)



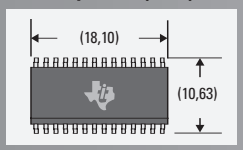
20-pin DW (SOIC)



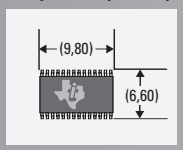
24-pin RGE (QFN)



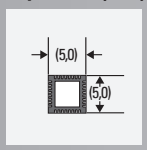
28-pin DW (SOIC)



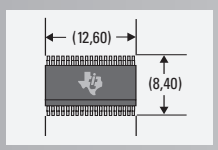
28-pin PW (TSSOP)



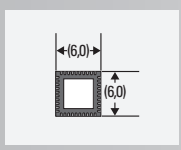
32-pin RHB (QFN)



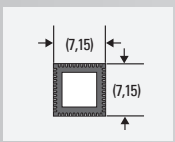
38-pin DA (TSSOP)



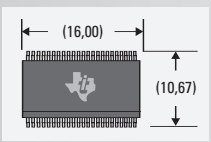
40-pin RHA (QFN)



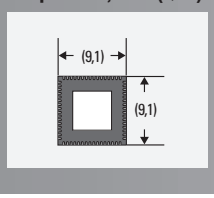
48-pin RGZ (QFN)



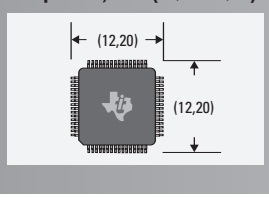
48-pin DL (SSOP)



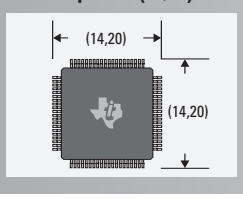
64-pin RGC, RTD (QFN)



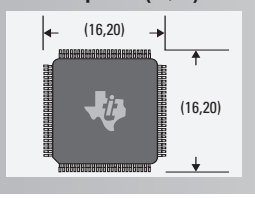
64-pin PM, PAG (LQFP/TQFP)



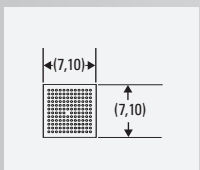
80-pin PN (LQFP)



100-pin PZ (LQFP)



113-pin ZQW (BGA)



*New products are listed in **bold red**.*

Intelligent Peripherals

With purely software-driven functions, the CPU is 100% active and consuming power. Effectively utilizing peripherals allows the CPU to be turned off to save power or work on other activities to achieve the highest performance. MSP430 device peripherals are designed to require the least amount of software service. Additional hardware features allow CPU resources to focus more on differentiated application-specific features and less on basic data handling. Lower-cost systems can be implemented using less software and lower power.

Peripheral Overview

ADC10/ADC12—The ADC10/12 module supports fast, >200ksps, 10- or 12-bit analog-to-digital conversions. The module features a 10 or 12-bit SAR core with 5, 8 or 12 input channels, sample select control, 1.5/2.5V reference generator and internal temperature sensor. ADC10 features a data transfer controller (DTC) and ADC12 features a 16 word conversion-and-control buffer. These added features allow samples to be converted and stored without CPU intervention.

BOR—The brown-out reset (BOR) circuit detects low supply voltages and reset circuit resets the device by triggering a POR signal when power is applied or removed. MSP430's zero-power BOR circuit is continuously turned on, including in all low power modes.

Comparator_A/Comparator_A+ — The Comparator_A/A+ module supports precision slope analog-to-digital conversions, supply voltage super vision, and monitoring of external analog signals for accurate voltage and resistor value measurement. The module features a selectable reference voltage generator and input multiplexer. (Comp A+)

DAC12—The DAC12 module is a 12-bit, voltage output DAC featuring internal or external reference selection, programmable settling time for optimal power consumption and can be configured in 8-or 12-bit mode. When multiple DAC12 modules are present, they may be grouped together for synchronous update operation.

DMA—The direct memory access (DMA) controller transfers data from one address to another, without CPU intervention, across the entire address range. The DMA increases the throughput of peripheral modules and reduces system power consumption. The module features up to three independent transfer channels.

ESP430 (integrated in FE42x devices)—The ESP430CE1 module incorporates the SD16, hardware multiplier and ESP430 embedded processor engine for single-phase energy metering applications. The module performs metering calculations independent of the CPU.

FLASH—The MSP430 flash memory is bit-, byte-, and word-addressable and programmable. The main memory segment size is 512 bytes. Each MSP430 also has up to 256 bytes of Flash Information Memory for EEPROM emulation. Flash can be read, erased and written (100,000 cycles) through the JTAG debugging interface, the Bootstrap Loader, and in-system.

I/O—MSP430 devices have up to 12 digital I/O ports implemented, P1-P10. Each port has eight I/O pins. Every I/O pin is configurable for input or output direction, and can be individually read or written to. Ports P1 and P2 have interrupt capability. MSP430F2xx, 5xx and some 4xx devices feature built-in individually configurable pull-up or pull-down resistors.

LCD/LCD_A—The LCD/LCD_A controller directly drives LCD displays with automatic signal generation for up to 160 segments. The MSP430 LCD controller can support static, 2-mux, 3-mux, and 4-mux LCDs. The LCD_A module includes an integrated charge pump for contrast control.

MPY—The hardware multiplier module supports 8-/16-bit x 8-/16-bit signed and unsigned multiply with optional 'multiply and accumulate' functionality. It is a peripheral which does not interfere with CPU activities and can be accessed by the DMA. The MPY on new F47xx and F5xx devices features up to 32x32 bit operation.

OA—The MSP430 integrated operational amplifiers feature single supply, low current operation with rail-to-rail outputs and programmable settling times. Internal, programmable feedback resistors and connections between multiple op amps allow for a variety of software selectable configuration options including: unity gain mode, comparator mode, inverting PGA, non-inverting PGA, differential and instrumentation amplifier.

SCAN IF—The Scan IF module is a programmable state machine with analog front end used to automatically measure linear or rotational motion with the lowest possible power consumption. The module features support for different types of LC and resistive sensors and for quadrature encoding.

SD16/SD16_A—The SD16/SD16_A module features up to three 16-bit sigma-delta A/D converters with an internal 1.2V reference. Each has up to 8 fully differential multiplexed inputs including a built-in temperature sensor. The converters are second-order oversampling sigma-delta modulators with selectable oversampling ratios of up to 1024 (SD16_A) or 256 (SD16).

SVS—The supply voltage supervisor (SVS) is a configurable module used to monitor the AVCC supply voltage or an external voltage. The SVS can be configured to set a flag or generate a POR reset when the supply voltage or external voltage drops below a user-selected threshold.

Timer A/Timer B—Timer_A and Timer_B are asynchronous 16-bit timer/counters with up to seven capture/compare registers and four operating modes. The timers support multiple capture/compares, PWM outputs, and interval timing and also have extensive interrupt capabilities.

USART—The universal synchronous/asynchronous receive/transmit (USART) peripheral interface supports asynchronous RS232 and synchronous SPI communication with one hardware module. The MSP430F15x and MSP430F16x USART module also supports I^2C. The module supports programmable baud rate and independent interrupt capability for receive and transmit.

USCI—The universal serial communication interface (USCI) module features two independent channels which can be used simultaneously. The asynchronous channel (USCI_A) supports UART mode, SPI mode, pulse shaping for IrDA, and automatic baud rate detection for LIN communications. The synchronous channel (USCI_B) supports I^2C and SPI modes.

USI—The universal serial interface (USI) module is a synchronous serial communication interface with a data length of up to 16-bit and can support SPI and I^2C communication with minimal software.

Embedded Emulation with MSP430 MCUs

- In-system development
- Subject your design to the exact same characteristics of the final application
- Non-obtrusive development and debug
- Common user software and physical interface
- Maintains signal integrity of microvolt analog signals

Today's applications operating at lower voltages, with tighter packaging and higher-precision analog, benefit greatly from the MSP430 MCU's in-system emulation approach. The MSP430 MCU's dedicated embedded emulation logic resides on the actual device itself and is accessed via JTAG (4-wire) or Spy-Bi-Wire (2-wire) using no additional system resources. Maintaining signal integrity is virtually impossible with cumbersome in-circuit emulators that are sensitive to cabling crosstalk. And, unlike abstract background debuggers, no time-sharing of system serial communication resources is required with embedded emulation on the MSP430 device. From the first day of development, firmware engineers can now unobtrusively develop and debug their embedded code with full-speed execution, breakpoints, and single steps in an application.

Advanced Debugging Using the Enhanced Emulation Module (EEM)

Every MSP430 includes advanced on-chip debug logic. The Enhanced Emulation Module (EEM) features support for both precision analog and full-speed digital debug. Depending on the device being used, the EEM provides different levels of debug features. Due to the common architecture and peripherals of the family of MSP430 devices, it's possible to use a device with the full version of the EEM for development and then easily migrate to a smaller device for final production, optimized for the application.

- 2-8 hardware breakpoints
- Complex breakpoints
- Embedded trace capability
- Break if read/write at specified address
- Protection of read/write areas within memory
- All timers and counters can be stopped (device dependent)
- Intelligent clock control keeps PWM generation, on-going ADC conversion or communication running, even if emulation is on hold
- Single step/step into and over/run in real-time
- Full support of all low-power modes
- Support for DCO dependencies such as temperature and voltage

Production Programming:

In-System Production Programming

JTAG: Programming through JTAG is supported with all MSP430 devices. A security fuse can be blown to sever JTAG access and prevent reverse engineering.
Spy-Bi-Wire: 2-wire debug/programming interface similar to JTAG for the new low-pin-count MSP430F2xx devices.
Bootstrap Loader: On all MSP430 devices (except MSP430F20xx), the bootstrap loader (BSL), is part of factory-masked ROM and can be implemented via a UART. Single devices are programmed either stand-alone or in-system. Program, verify, read out and segment erase are password protected.

For further information on JTAG and bootstrap loader, go to www.ti.com/msp430appnotes and download Application Notes SLAA149, SLAA089 and SLAA096.

ROM and Flash

For high-volume customers, masked ROM and factory programmed Flash devices can be ordered. The ROM process takes approximately 8-12 weeks from the receipt of a customer's verified code to the production of the first silicon. Flash devices take approximately 6-8 weeks. A customer-specific coded part number will be released.

Production Programming

MSP430 devices may also be programmed by TI's MSP-GANG430 or manual and automated production programming systems from third party vendors such as:
BPM Microsystems www.bpmmicro.com
Data I/O www.dataio.com
Elprotronic www.elprotronic.com
SoftBaugh www.softbaugh.com

Hardware Development Tools

Debugging & Programming Interfaces

TI offers USB and Parallel Port Flash Emulation Tools (FET) supporting complete in-system development for JTAG (4 wire) and Spy-Bi-Wire (2 wire – USB only). Programming, assembler /C-source level debug, single stepping, multiple hardware breakpoints, full speed operation and peripheral access are all fully supported in-system. This interface can be used with any development board with a JTAG header.

The MSP-GANG430 is a Flash device programmer which can program eight targets simultaneously using a JTAG connection either as a stand-alone programmer or in a development environment.

Debugging and Programming Interfaces

Part Number	PC Port	Contents Include	Devices Supported	Price[1]
MSP-FET430UIF	USB	Interface only	All	$ 99
MSP-GANG430	Serial	Production programmer	All (8 devices at one time)	$ 199

[1]Price per unit in U.S. dollars.

Development Kits

MSP430 Development Kits come with everything required to complete an entire project including a socketed target board, a Flash Emulation Tool (FET) debugger and programming interface, cables and free code limited Code Composer Essentials (16 kB) and IAR (4 kB) software. All MSP-FET430Uxx Development Kits come with a MSP-FET430UIF USB Debugging and Programming Interface and an xx-pin target board unless otherwise noted.

Development Kits

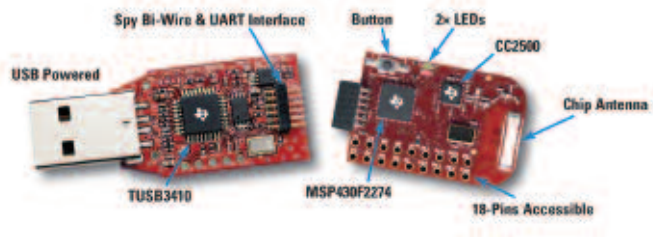
Part Number	Contents Include	Devices Supported	Price[1]
MSP-FET430U14	Interface and target board	14-pin PW (TSSOP)	$ 149
MSP-FET430U28	Interface and target board	20-/28-pin PW (TSSOP)	$ 149
MSP-FET430U38	Interface and target board	38-pin DA (TSSOP)	$ 149
MSP-FET430U23x0	Interface and target board	MSP430F23x0 40-pin RHA (QFN)	$ 149
MSP-FET430U48	Interface and target board	48-pin DL (SSOP)	$ 149
MSP-FET430U64	Interface and target board	64-pin PM (LQFP)	$ 149
MSP-FET430U80	Interface and target board	80-pin PN (LQFP)	$ 149
MSP-FET430U100	Interface and target board	100-pin PZ (LQFP)	$ 149
MSP-FET430U5x100	Interface and target board	100-pin PZ (TQFP)	$ 149
MSP-TS430PZ5x100	Target board only	100-pin PZ (TQFP)	$ 49

[1]Price per unit in U.S. dollars.

*New products are listed in **bold red**.*

eZ430: MCUs Made Easy

Designing with the world's lowest-power MCU just got even easier with the eZ430 family of low-cost development tools starting at only $20! These platforms contain all the required hardware and software in a portable USB stick enclosure and include a free 16-kB code-limited version of Code Composer™ Essentials (CCE) which provides full emulation with the option of designing a stand-alone system or detaching the removable target board to integrate into an existing design.



Experimenter Boards

This innovative kit feature the largest MSP430 devices with additional hardware components to take advantage of the high level of analog integration available for easy system evaluation and prototyping. These are ideal for learning the MSP430 architecture, testing the capabilities and range available peripherals and include integrated headers for plugging in low-power RF modules (CCxxxxEMK).

eZ430 Tools and Experimenter Boards

Part Number	Contents Include	Devices Included	Price[1]
eZ430-F2013	Interface and target board	MSP430F2013	$ 20
eZ430-F2012	3 target boards	MSP430F2012	$ 10
eZ430-RF2500	Interface, (2) target boards, battery board	MSP430F2274, CC2500	$ 49
eZ430-RF2500T	Target board, battery board	MSP430F2274, CC2500	$ 20
eZ430-RF2480	Interface, (3) target boards, 2 battery boards	MSP430F2274, CC2480	$ 99
MSP-EXP430FG4618	Board only (FET sold separately)	MSP430FG4618, MSP430F2013	$ 99

[1]*Price per unit in U.S. dollars.*

*New products are listed in **bold red**.*

Software Development Tools

Texas Instruments and third party developers offer Integrated Development Environments (IDE) to program all MSP430 devices. Full C-compilers are available enabling customers to develop and debug code in seconds. Free, code-limited versions of IAR Embedded Workbench Kickstart and TI Code Composer™ Essentials are also available for download.

Third Party IDEs include:

GCC mspgcc.sourceforge.net
HT Soft www.htsoft.com
IAR www.iar.com
Imagecraft www.imagecraft.com
Phyton www.phyton.com
Quadravox www.quadrovox.com
Rowley www.rowley.co.uk

Software Development Tools

Part Number	Contents Include	Devices Supported	Price[1]
IAR-KICKSTART	IAR Embedded Workbench Kickstart Edition (4 kB limit)	All	Free
MSP-CCE430	Code Composer Essentials Core Edition (16 kB limit)	All	Free
MSP-CCE430PRO	Code Composer Essentials Professional (unrestricted)	All	$ 499

[1]*Price per unit in U.S. dollars.*

TI Worldwide Technical Support

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support.ti.com

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

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Internet/Email	support.ti.com/sc/pic/americas.htm

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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.

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New Zealand	0800-446-934
Philippines	1-800-765-7404
Singapore	800-886-1028
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