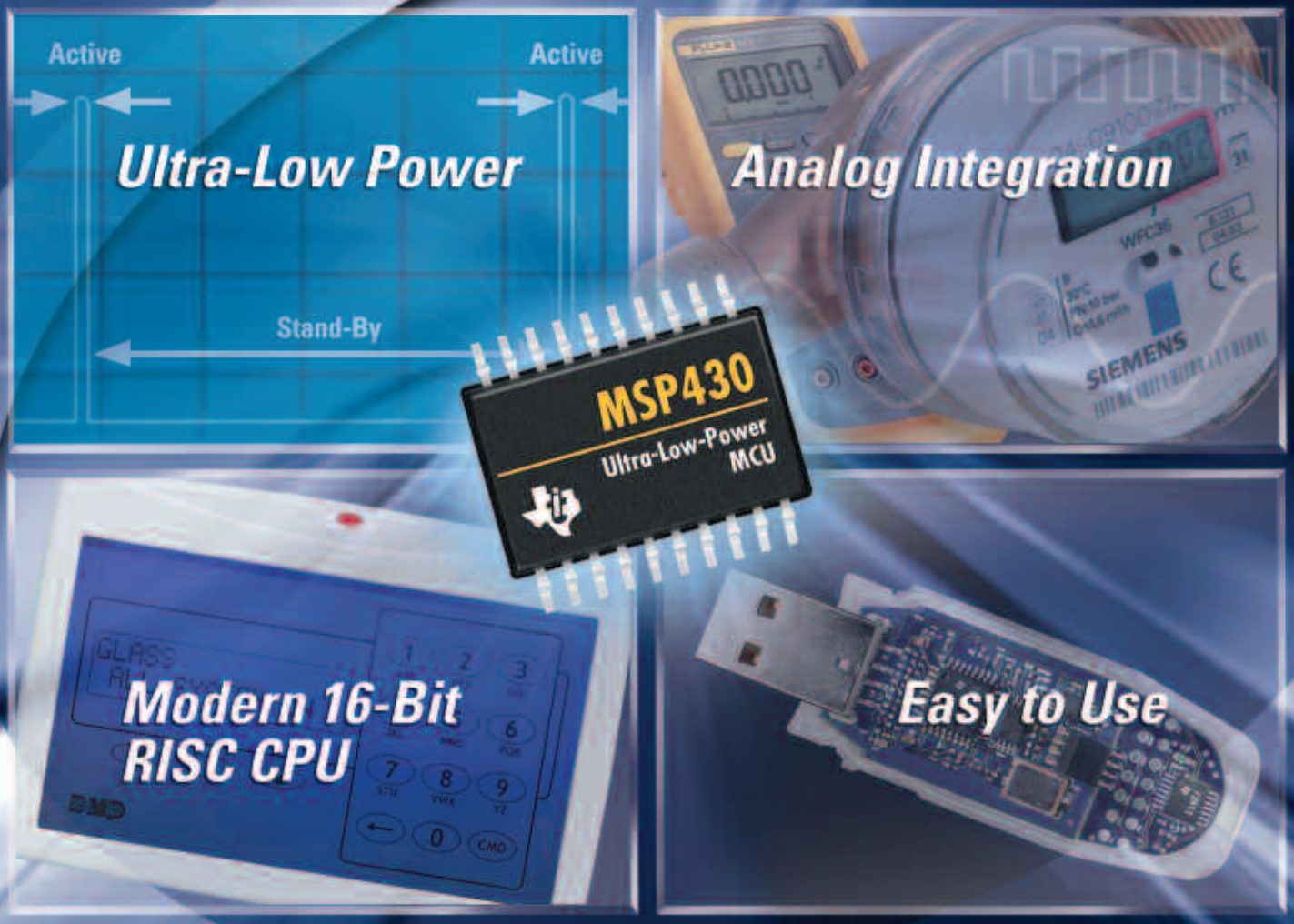
Texas Instruments

Technology for Innovators™

2007

MSP430 Ultra-Low-Power Microcontrollers



Embedded Controllers

Key Features

- **Modern 16-bit RISC CPU** enables new applications at a fraction of the code size
- **Ultra-low-power** architecture and flexible clock system extends battery life:
  - 0.1-µA RAM retention
  - 0.8-µA real-time clock mode
  - 250-µA/MIPS active
- **Integrated intelligent peripherals** including wide range of high-performance analog and digital peripherals offload the CPU
- **Easy to Get Started:** Complete development tools starting at only $20

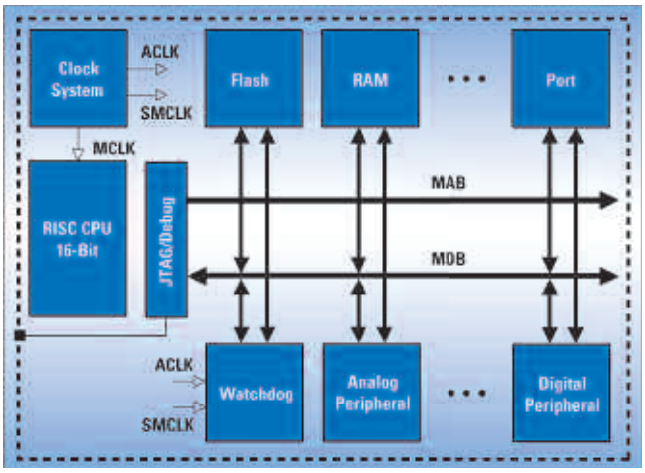
MSP430 Modular Architecture

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 a modern 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 120-KB ISP Flash
- RAM up to 10 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
- Watchdog timer
- UART/LIN
- I^2C
- SPI
- IrDA
- Hardware multiplier
- DMA controller
- Temperature sensor

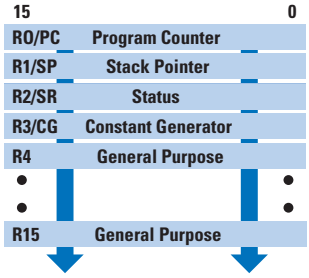


MSP430 von-Neumann architecture — all program, data memory and peripherals share a common bus structure. Consistent CPU instructions and addressing modes are used.

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 16 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. 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 single-cycle 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, even 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 and 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 power down
  - 0.8-µA standby
  - 250-µA / MIPS @3V
- 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
- Low-power peripheral options

Key Applications

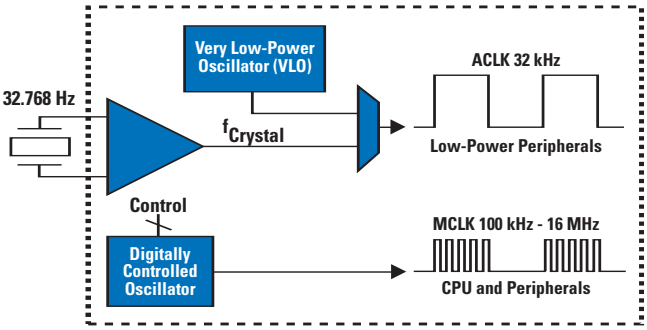
- Utility metering
- Portable medical and instrumentation
- Low-power wireless applications
- Intelligent sensing
- Consumer electronics
- Security systems

Flexible Clock System

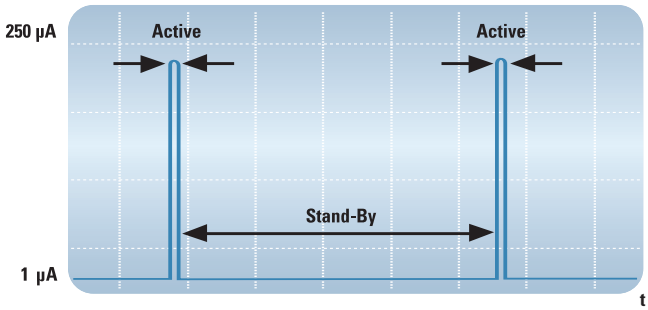
- Low-frequency auxiliary clock for ultra-low-power stand-by mode
- High-speed master clock for high-performance processing
- Stability over time and temperature

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). 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



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.

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 supervision, and monitoring of external analog signals for accurate voltage and resistor value measurement. The module features a selectable reference voltage generator and input multiplexer.

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 ten 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 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 devices features up to 32-x32-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.

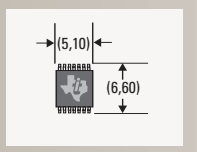
Flash/ROM-Based x1xx MCU Platform (V_{CC} 1.8-3.6V), Up to 8 MIPS

(C) ROM (F) Flash		Program (KB)	SRAM (B)	I/O	16-Bit Timers A	16-Bit Timers B	Watchdog	BOR	SVS	USART (UART/ SPI)	I²C	DMA	MPY	Comp_A	Temp Sensor	ADC Ch/Res	Additional Features	Package(s)	Price*
x11x1	MSP430F1101A	1	128	14	3	—	x	—	—	—	—	—	—	x	—	slope	—	20 DGV, DW, PW, 24 RGE	$0.99
	MSP430C1101	1	128	14	3	—	x	—	—	—	—	—	—	x	—	slope	—	20 DW, PW, 24 RGE	$0.60
	MSP430F1111A	2	128	14	3	—	x	—	—	—	—	—	—	x	—	slope	—	20 DGV, DW, PW, 24 RGE	$1.35
	MSP430C1111	2	128	14	3	—	x	—	—	—	—	—	—	x	—	slope	—	20 DW, PW, 24 RGE	$1.10
	MSP430F1121A	4	256	14	3	—	x	—	—	—	—	—	—	x	—	slope	—	20 DGV, DW, PW, 24 RGE	$1.70
	MSP430C1121	4	256	14	3	—	x	—	—	—	—	—	—	x	—	slope	—	20 DW, PW, 24 RGE	$1.35
F11x2	MSP430F1122	4	256	14	3	—	x	x	—	—	—	—	—	—	x	5ch, ADC10	—	20 DW, PW, 32 RHB	$2.00
	MSP430F1132	8	256	14	3	—	x	x	—	—	—	—	—	—	x	5ch, ADC10	—	20 DW, PW, 32 RHB	$2.25
F122	MSP430F122	4	256	22	3	—	x	—	—	1	—	—	—	x	—	slope	—	28 DW, PW, 32 RHB	$2.15
	MSP430F123	8	256	22	3	—	x	—	—	1	—	—	—	x	—	slope	—	28 DW, PW, 32 RHB	$2.30
F12x2	MSP430F1222	4	256	22	3	—	x	x	—	1	—	—	—	—	x	8ch, ADC10	—	28 DW, PW, 32 RHB	$2.40
	MSP430F1232	8	256	22	3	—	x	x	—	1	—	—	—	—	x	8ch, ADC10	—	28 DW, PW, 32 RHB	$2.50
F13x	MSP430F133	8	256	48	3	3	x	—	—	1	—	—	—	x	x	8ch, ADC12	—	64 PM, PAG, RTD	$3.00
	MSP430F135	16	512	48	3	3	x	—	—	1	—	—	—	x	x	8ch, ADC12	—	64 PM, PAG, RTD	$3.60
C13x1	MSP430C1331	8	256	48	3	3	x	—	—	1	—	—	—	x	—	slope	—	64 PM, RTD	$2.00
	MSP430C1351	16	512	48	3	3	x	—	—	1	—	—	—	x	—	slope	—	64 PM, RTD	$2.30
F14x	MSP430F147	32	1024	48	3	7	x	—	—	2	—	—	x	x	x	8ch, ADC12	—	64 PM, PAG, RTD	$5.05
	MSP430F148	48	2048	48	3	7	x	—	—	2	—	—	x	x	x	8ch, ADC12	—	64 PM, PAG, RTD	$5.75
	MSP430F149	60	2048	48	3	7	x	—	—	2	—	—	x	x	x	8ch, ADC12	—	64 PM, PAG, RTD	$6.05
F14x1	MSP430F1471	32	1024	48	3	7	x	—	—	2	—	—	x	x	—	slope	—	64 PM, RTD	$4.60
	MSP430F1481	48	2048	48	3	7	x	—	—	2	—	—	x	x	—	slope	—	64 PM, RTD	$5.30
	MSP430F1491	60	2048	48	3	7	x	—	—	2	—	—	x	x	—	slope	—	64 PM, RTD	$5.60
F15x	MSP430F155	16	512	48	3	3	x	x	x	1	x	x	—	x	x	8ch, ADC12	(2) DAC12	64 PM, RTD	$4.95
	MSP430F156	24	1024	48	3	3	x	x	x	1	x	x	—	x	x	8ch, ADC12	(2) DAC12	64 PM, RTD	$5.55
	MSP430F157	32	1024	48	3	3	x	x	x	1	x	x	—	x	x	8ch, ADC12	(2) DAC12	64 PM, RTD	$5.85
F16x	MSP430F167	32	1024	48	3	7	x	x	x	2	x	x	x	x	x	8ch, ADC12	(2) DAC12	64 PM, RTD	$6.75
	MSP430F168	48	2048	48	3	7	x	x	x	2	x	x	x	x	x	8ch, ADC12	(2) DAC12	64 PM, RTD	$7.45
	MSP430F169	60	2048	48	3	7	x	x	x	2	x	x	x	x	x	8ch, ADC12	(2) DAC12	64 PM, RTD	$7.95
	MSP430F1610	32	5120	48	3	7	x	x	x	2	x	x	x	x	x	8ch, ADC12	(2) DAC12	64 PM, RTD	$8.25
	MSP430F1611	48	10240	48	3	7	x	x	x	2	x	x	x	x	x	8ch, ADC12	(2) DAC12	64 PM, RTD	$8.65
	MSP430F1612	55	5120	48	3	7	x	x	x	2	x	x	x	x	x	8ch, ADC12	(2) DAC12	64 PM, RTD	$8.95

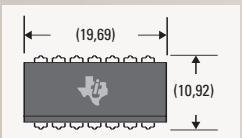
Suggested resale price in U.S. dollars in quantities of 1,000.

Selected Package Options for MSP430 Devices

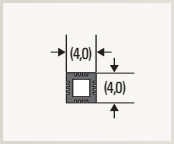
14-pin PW (TSSOP)



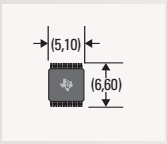
14-pin N (PDIP)



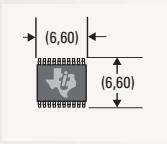
16-pin RSA (QFN)



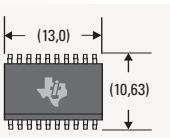
20-pin DGV (TVSOP)



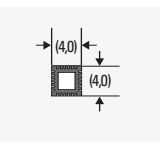
20-pin PW (TSSOP)



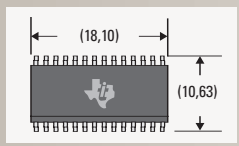
20-pin DW (SOIC)



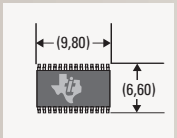
24-pin RGE (QFN)



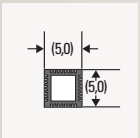
28-pin DW (SOIC)



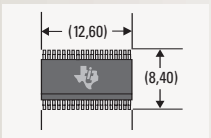
28-pin PW (TSSOP)



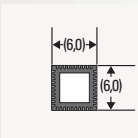
32-pin RHB (QFN)



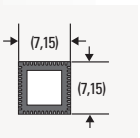
38-pin DA (TSSOP)



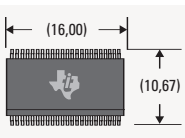
40-pin RHA (QFN)



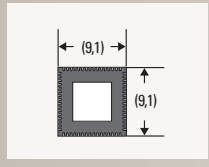
48-pin RGZ (QFN)



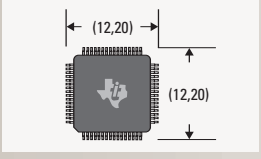
48-pin DL (SSOP)



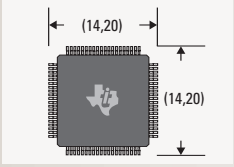
64-pin RGC, RTD (QFN)



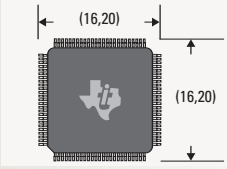
64-pin PM, PAG (LQFP/TQFP)



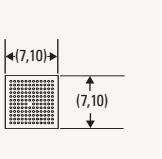
80-pin PN (LQFP)



100-pin PZ (LQFP)



113-pin ZQW (BGA)



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

Flash-Based F2xx MCU Platform (V_{CC} 1.8-3.6V), Up to 16 MIPS

	(F) Flash	Program (KB)	SRAM (B)	I/O	16-Bit Timers A	16-Bit Timers B	Watchdog	BOR Reset	SVS	USCI USI I²C/SPI	USCI Ch A: UART/LIN /IrDA/SPI	USCI Ch B: I²C/SPI	DMA	MPY	Comp_A+	Temp Sensor	ADC Ch/Res	Additional Features	Package(s)	Price*
F20xx	MSP430F2001	1	128	10	2	—	x	x	—	—	—	—	—	—	x	—	slope	—	14 PW, N, 16 RSA	$0.55
	MSP430F2011	2	128	10	2	—	x	x	—	—	—	—	—	—	x	—	slope	—	14 PW, N, 16 RSA	$0.70
	MSP430F2002	1	128	10	2	—	x	x	—	x	—	—	—	—	—	x	8ch, ADC10	—	14 PW, N, 16 RSA	$0.99
	MSP430F2012	2	128	10	2	—	x	x	—	x	—	—	—	—	—	x	8ch, ADC10	—	14 PW, N, 16 RSA	$1.15
	MSP430F2003	1	128	10	2	—	x	x	—	x	—	—	—	—	—	x	4ch, SD16	—	14 PW, N, 16 RSA	$1.50
	MSP430F2013	2	128	10	2	—	x	x	—	x	—	—	—	—	—	x	4ch, SD16	—	14 PW, N, 16 RSA	$1.65
F21x1	MSP430F2101	1	128	16	3	—	x	x	—	—	—	—	—	—	x	—	slope	—	20 DGV, DW, PW, 24 RGE	$0.90
	MSP430F2111	2	128	16	3	—	x	x	—	—	—	—	—	—	x	—	slope	—	20 DGV, DW, PW, 24 RGE	$0.99
	MSP430F2121	4	256	16	3	—	x	x	—	—	—	—	—	—	x	—	slope	—	20 DGV, DW, PW, 24 RGE	$1.35
	MSP430F2131	8	256	16	3	—	x	x	—	—	—	—	—	—	x	—	slope	—	20 DGV, DW, PW, 24 RGE	$1.70
F22x2	**MSP430F2232**	8	512	32	3	3	x	x	—	—	1	1	—	—	—	x	12ch, ADC10	—	38 DA, 40 RHA	$2.40
	MSP430F2252	16	512	32	3	3	x	x	—	—	1	1	—	—	—	x	12ch, ADC10	—	38 DA, 40 RHA	$2.70
	MSP430F2272	32	1024	32	3	3	x	x	—	—	1	1	—	—	—	x	12ch, ADC10	—	38 DA, 40 RHA	$3.10
F22x4	**MSP430F2234**	8	512	32	3	3	x	x	—	—	1	1	—	—	—	x	12ch, ADC10	(2) OPAMP	38 DA, 40 RHA	$2.65
	MSP430F2254	16	512	32	3	3	x	x	—	—	1	1	—	—	—	x	12ch, ADC10	(2) OPAMP	38 DA, 40 RHA	$2.95
	MSP430F2274	32	1024	32	3	3	x	x	—	—	1	1	—	—	—	x	12ch, ADC10	(2) OPAMP	38 DA, 40 RHA	$3.35
F23x0	**MSP430F2330**	8	1024	32	3	3	x	x	—	—	1	1	—	x	x	—	slope	—	40 RHA	$2.30
	MSP430F2350	16	2048	32	3	3	x	x	—	—	1	1	—	x	x	—	slope	—	40 RHA	$2.65
	MSP430F2370	32	2048	32	3	3	x	x	—	—	1	1	—	x	x	—	slope	—	40 RHA	$2.95
F23x	**MSP430F233**	8	1024	48	3	3	x	x	x	—	1	1	—	x	x	x	8ch, ADC12	—	64 PM, 64 RGC	$3.00
	MSP430F235	16	2048	48	3	3	x	x	x	—	1	1	—	x	x	x	8ch, ADC12	—	64 PM, 64 RGC	$3.60
F24x/2410	**MSP430F247**	32	4096	48	3	7	x	x	x	—	2	2	—	x	x	x	8ch, ADC12	—	64 PM, 64 RGC	$5.05
	MSP430F248	48	4096	48	3	7	x	x	x	—	2	2	—	x	x	x	8ch, ADC12	—	64 PM, 64 RGC	$5.75
	MSP430F249	60	2048	48	3	7	x	x	x	—	2	2	—	x	x	x	8ch, ADC12	—	64 PM, 64 RGC	$5.90
	MSP430F2410	56	4096	48	3	7	x	x	x	—	2	2	—	x	x	x	8ch, ADC12	—	64 PM, 64 RGC	$6.05
F24x1	**MSP430F2471**	32	4096	48	3	7	x	x	x	—	2	2	—	x	x	—	slope	—	64 PM, 64 RGC	$4.60
	MSP430F2481	48	4096	48	3	7	x	x	x	—	2	2	—	x	x	—	slope	—	64 PM, 64 RGC	$5.30
	MSP430F2491	60	2048	48	3	7	x	x	x	—	2	2	—	x	x	—	slope	—	64 PM, 64 RGC	$5.45
F241x	**MSP430F2416**	92	4096	48/64	3	7	x	x	x	—	2	2	—	x	x	x	8ch, ADC12	—	64 PM, 80 PN	$6.95
	MSP430F2417	92	8192	48/64	3	7	x	x	x	—	2	2	—	x	x	x	8ch, ADC12	—	64 PM, 80 PN	$7.60
	MSP430F2418	116	8192	48/64	3	7	x	x	x	—	2	2	—	x	x	x	8ch, ADC12	—	64 PM, 80 PN	$7.95
	MSP430F2419	120	4096	48/64	3	7	x	x	x	—	2	2	—	x	x	x	8ch, ADC12	—	64 PM, 80 PN	$7.60
F261x	**MSP430F2616**	92	4096	48/64	3	7	x	x	x	—	2	2	x	x	x	x	8ch, ADC12	(2) DAC12	64 PM, 80 PN	$8.85
	MSP430F2617	92	8192	48/64	3	7	x	x	x	—	2	2	x	x	x	x	8ch, ADC12	(2) DAC12	64 PM, 80 PN	$9.50
	MSP430F2618	116	8192	48/64	3	7	x	x	x	—	2	2	x	x	x	x	8ch, ADC12	(2) DAC12	64 PM, 80 PN	$9.80
	MSP430F2619	120	4096	48/64	3	7	x	x	x	—	2	2	x	x	x	x	8ch, ADC12	(2) DAC12	64 PM, 80 PN	$9.50

Suggested resale price in U.S. dollars in quantities of 1,000.

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

Flash/ROM-Based x4xx MCU Platform (V_{CC} 1.8-3.6V), Up to 8 MIPS (unless noted[1])

(C) ROM (F) Flash		Program (KB)	SRAM (B)	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	Comp_A	Temp Sensor	ADC Ch/Res	Additonal Features	Package(s)	Price*
x41x	MSP430F412	4	256	48	3	—	x	x	x	—	—	—	96	—	—	x	—	slope	—	64 PM, RTD	$2.60
	MSP430C412	4	256	48	3	—	x	x	x	—	—	—	96	—	—	x	—	slope	—	64 PM, RTD	$1.90
	MSP430F413	8	256	48	3	—	x	x	x	—	—	—	96	—	—	x	—	slope	—	64 PM, RTD	$2.95
	MSP430C413	8	256	48	3	—	x	x	x	—	—	—	96	—	—	x	—	slope	—	64 PM, RTD	$2.10
	MSP430F415	16	512	48	3,5	—	x	x	x	—	—	—	96	—	—	x	—	slope	—	64 PM, RTD	$3.40
	MSP430F417	32	1024	48	3,5	—	x	x	x	—	—	—	96	—	—	x	—	slope	—	64 PM, RTD	$3.90
F42x	MSP430F423	8	256	14	3	—	x	x	x	1	—	—	128	—	x	—	x	(3) SD16	—	64 PM	$4.50
	MSP430F425	16	512	14	3	—	x	x	x	1	—	—	128	—	x	—	x	(3) SD16	—	64 PM	$4.95
	MSP430F427	32	1024	14	3	—	x	x	x	1	—	—	128	—	x	—	x	(3) SD16	—	64 PM	$5.40
FW42x	MSP430FW423	8	256	48	3,5	—	x	x	x	—	—	—	96	—	—	x	—	slope	Flow-meter	64 PM	$3.75
	MSP430FW425	16	512	48	3,5	—	x	x	x	—	—	—	96	—	—	x	—	slope	Flow-meter	64 PM	$4.05
	MSP430FW427	32	1024	48	3,5	—	x	x	x	—	—	—	96	—	—	x	—	slope	Flow-meter	64 PM	$4.45
FE42x	MSP430FE423	8	256	14	3	—	x	x	x	1	—	—	128	—	x	—	x	(3) SD16	E-meter	64 PM	$4.85
	MSP430FE425	16	512	14	3	—	x	x	x	1	—	—	128	—	x	—	x	(3) SD16	E-meter	64 PM	$5.45
	MSP430FE427	32	1024	14	3	—	x	x	x	1	—	—	128	—	x	—	x	(3) SD16	E-meter	64 PM	$5.95
F42x0	MSP430F4250	16	256	32	3	—	x	x	—	—	—	—	56	—	—	—	x	5ch, SD16	DAC12	48 DL, RGZ	$3.10
	MSP430F4260	24	256	32	3	—	x	x	—	—	—	—	56	—	—	—	x	5ch, SD16	DAC12	48 DL, RGZ	$3.45
	MSP430F4270	32	256	32	3	—	x	x	—	—	—	—	56	—	—	—	x	5ch, SD16	DAC12	48 DL, RGZ	$3.80
FG42x0	**MSP430FG4250**	16	256	32	3	—	x	x	—	—	—	—	56	—	—	—	x	5ch, SD16	DAC12, (2) OPAMP	48 DL, RGZ	$3.35
	MSP430FG4260	24	256	32	3	—	x	x	—	—	—	—	56	—	—	—	x	5ch, SD16	DAC12, (2) OPAMP	48 DL, RGZ	$3.70
	MSP430FG4270	32	256	32	3	—	x	x	—	—	—	—	56	—	—	—	x	5ch, SD16	DAC12, (2) OPAMP	48 DL, RGZ	$4.05
F43x	MSP430F435	16	512	48	3	3	x	x	x	1	—	—	128/160	—	—	x	x	8ch, ADC12	—	80 PN, 100 PZ	$4.45
	MSP430F436	24	1024	48	3	3	x	x	x	1	—	—	128/160	—	—	x	x	8ch, ADC12	—	80 PN, 100 PZ	$4.70
	MSP430F437	32	1024	48	3	3	x	x	x	1	—	—	128/160	—	—	x	x	8ch, ADC12	—	80 PN, 100 PZ	$4.90
F43x1	**MSP430F4351**	16	512	48	3	3	x	x	x	1	—	—	128/160	—	—	x	x	slope	—	80 PN, 100 PZ	$4.05
	MSP430F4361	24	1024	48	3	3	x	x	x	1	—	—	128/160	—	—	x	x	slope	—	80 PN, 100 PZ	$4.30
	MSP430F4371	32	1024	48	3	3	x	x	x	1	—	—	128/160	—	—	x	x	slope	—	80 PN, 100 PZ	$4.50
FG43x	MSP430FG437	32	1024	48	3	3	x	x	x	1	—	—	128	x	—	x	x	12ch, ADC12	(2) DAC12, (3) OPAMP	80 PN	$6.50
	MSP430FG438	48	2048	48	3	3	x	x	x	1	—	—	128	x	—	x	x	12ch, ADC12	(2) DAC12, (3) OPAMP	80 PN	$7.35
	MSP430FG439	60	2048	48	3	3	x	x	x	1	—	—	128	x	—	x	x	12ch, ADC12	(2) DAC12, (3) OPAMP	80 PN	$7.95
F44x	MSP430F447	32	1024	48	3	7	x	x	x	2	—	—	160	—	x	x	x	8ch, ADC12	—	100 PZ	$5.75
	MSP430F448	48	2048	48	3	7	x	x	x	2	—	—	160	—	x	x	x	8ch, ADC12	—	100 PZ	$6.50
	MSP430F449	60	2048	48	3	7	x	x	x	2	—	—	160	—	x	x	x	8ch, ADC12	—	100 PZ	$7.05
xG461x	MSP430FG4616	92	4096	80	3	7	x	x	x	1	1	1	160	x	x	x	x	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ, **113 ZQW**	$9.45
	MSP430FG4617	92	8192	80	3	7	x	x	x	1	1	1	160	x	x	x	x	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ, **113 ZQW**	$9.95
	MSP430FG4618	116	8192	80	3	7	x	x	x	1	1	1	160	x	x	x	x	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ, **113 ZQW**	$10.35
	MSP430FG4619	120	4096	80	3	7	x	x	x	1	1	1	160	x	x	x	x	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ, **113 ZQW**	$9.95
	MSP430CG4616	92	4096	80	3	7	x	x	x	1	1	1	160	x	x	x	x	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ	$7.65
	MSP430CG4617	92	8192	80	3	7	x	x	x	1	1	1	160	x	x	x	x	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ	$8.05
	MSP430CG4618	116	8192	80	3	7	x	x	x	1	1	1	160	x	x	x	x	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ	$8.05
	MSP430CG4619	120	4096	80	3	7	x	x	x	1	1	1	160	x	x	x	x	12ch, ADC12	(2) DAC12, (3) OPAMP	100 PZ	$8.05
F47xx	**MSP430F4783**[1]	48	2480	72	3	3	WDT+	x	x	—	2	2	160	—	32x32	x	x	(3) SD16	—	100 PZ	$7.50
	MSP430F4793[1]	60	2560	72	3	3	WDT+	x	x	—	2	2	160	—	32x32	x	x	(3) SD16	—	100 PZ	$8.05
	MSP430F4784[1]	48	2048	72	3	3	WDT+	x	x	—	2	2	160	—	32x32	x	x	(4) SD16	—	100 PZ	$8.00
	MSP430F4794[1]	60	2560	72	3	3	WDT+	x	x	—	2	2	160	—	32x32	x	x	(4) SD16	—	100 PZ	$8.55

[1] *Up to 16 MIPS.*

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

**Suggested resale price in U.S. dollars in quantities of 1,000.*

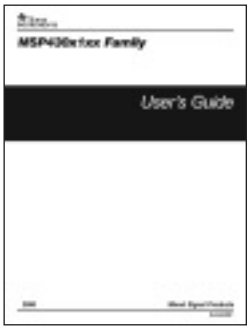
Get Started Now!

Getting started is easy with MSP430. MSP430 offers easy-to-use tools, free Kickstart 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.

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

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



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

Emulation Module Features

Device	MSP430F11x1, F12x, F12x2, F13x, F14x	MSP430F23x, F24x	MSP430F15x, F16x, F261x, F261x	MSP430F20xx, F21x1, F22xx, F23x0	MSP430F41x, F42x, FE42x, FW42x, FG43x	MSP430F43x, F44x, FG46x
EEM	Basic	Extended	Full	Extended	Extended	Full
Total Triggers/ Breakpoints	2 3 – F13x/14x	3	8	2	2	8
MAB/MDB	2 3 – F13x/14x	3	8	2	2	8
Reg/Write	—	1	2	—	—	2
Trace	—	—	X	—	—	X
Global Clock Control	—	X	X	X	X	X
Module Clock Control	—	X	—	FG43x only	X	X

See SLAA263b for complete EEM capability per device and description of features.

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, SLAA089B and SLAA096B.

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:

BP Microsystems www.bpmicro.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 either as stand alone or in-system using a JTAG connection.

Debugging and Programming Interfaces

Part Number	PC Port	Contents Include	Devices Supported	Price[1]
MSP-FET430UIF	USB	Interface only	All	$ 99
MSP-FET430PIF	Parallel	Interface only	All	$ 49
MSP-GANG430	Serial	Production programmer	All (8 devices at one time)	$ 199

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 IAR and CCE Kickstart software. All MSP-FET430Uxx Development Kits come with a MSP-FET430UIF USB Debugging and Programming Interface and an xx-pin target board.

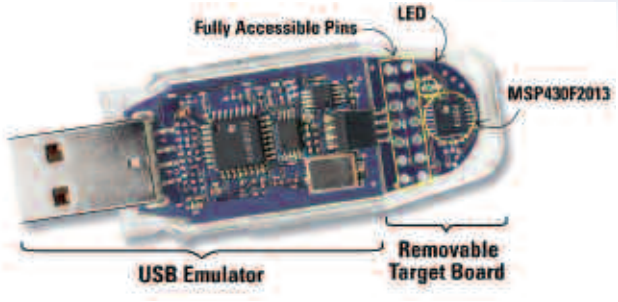
Development Kits

Part Number	PC Port	Contents Include	Devices Supported	Price[1]
eZ430-F2013	USB	Interface and target board	MSP430F20x1, 20x2, 20x3	$ 20
MSP-FET430U14	USB	Interface and target board	14-pin PW (TSSOP)	$ 149
MSP-FET430U28	USB	Interface and target board	20-/28-pin DW (SOIC)	$ 149
MSP-FET430U38	USB	Interface and target board	38-pin DA (TSSOP)	$ 149
MSP-FET430U23x0	USB	Interface and target board	MSP430F23x0 40-pin RHA (QFN)	$ 149
MSP-FET430U48	USB	Interface and target board	48-pin DL (SSOP)	$ 149
MSP-FET430U64	USB	Interface and target board	64-pin PM (LQFP)	$ 149
MSP-FET430U80	USB	Interface and target board	80-pin PN (LQFP)	$ 149
MSP-FET430U100	USB	Interface and target board	100-pin PZ (LQFP)	$ 149

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

eZ430 Development Tool

Designing with the world's lowest-power MCU just got even easier with the new eZ430-F2013 complete development tool for only $20. The platform provides all the required hardware and software in a portable USB stick enclosure. The eZ430-F2013 includes both the Code Composer™ Essentials (CCE) and IAR Kickstart IDEs providing full emulation with the option of designing a stand-alone system or detaching the removable MSP430F2013 MCU target board to integrate into an existing design.



Part Number	PC Port	Contents Include	Devices Supported	Price
eZ430-F2013	USB	Interface and target board	MSP430F20x1, 20x2, 20x3	$ 20
eZ430-T2012	__	3 eZ430 target boards	MSP430F2012	$10

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

Experimenter Boards *(with Wireless Capability)*

The MSP430FG4618/F2013 Experimenter Board from Texas Instruments feature selected MSP430 devices and additional hardware components for easy system evaluation and prototyping. This is an ideal platform for learning the MSP430 architecture, testing the capabilities of range of MSP430 peripherals and include an integrated header for plugging in Low-Power RF (CCxxxxEMK) radio modules.

MSP430 Experimenter Boards

Part Number	Contents Include	Devices Supported	Price
MSP-EXP430FG4618	Board Only–(MSP-FET430UIF sold separately)	MSP430FG4618 (on board), MSP430F2013 (on board), Chipcon Wireless Modules (sold separately)	$99

*New tools 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
Phyton www.phyton.com
IAR www.iar.com
Rowley www.rowley.co.uk
Imagecraft www.imagecraft.com

Software Development Tools

Part Number	Contents Include	Devices Supported	Price
IAR-KICKSTART	IAR Embedded Workbench	All	Free
MSP-CCE430	Code Composer Essentials	All	Free
MSP-CCE430PRO	Full Version IDE – Code Composer Essentials Professional	All	$499

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support.ti.com

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

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New Zealand	0800-446-934
Philippines	1-800-765-7404
Singapore	800-886-1028
Taiwan	0800-006800
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