

# MSP430 Day

Ultra-Low Power | High Integration | Easy-to-Use



## Embedded Series 2011



ARROW ELECTRONICS AND TEXAS INSTRUMENTS

# Embedded Series



MAKE THE SWITCH

# MSP430 MCUs



## Ultra-Low Power

### World's Lowest Power MCU

- Ultra-Low Power Active Mode
- 7 Low Power Modes
- Instant Wakeup
- All MSP430 devices are Ultra-Low Power

## Integration

### Intelligent Analog & Digital Peripherals

- Peripherals operate in low power modes
- Minimize physical footprint and Bill of Materials
- Featuring USB, RF, Capacitive Touch I/O, Metrology Engines, LCD, ADC, DAC, & MORE

## Extensive Portfolio, Low Cost Options

### Find the right MCU for you

- 300+ devices
- Up 256kB Flash, 18kB RAM, 24 package options
- Devices starting at \$0.25 with Value Line
- Various levels of performance & integration

## Easy to Get Started

### Low cost and simple point of entry

- Complete kits starting @ \$4.30
- One tool for all MSP430 devices
- GUI-based coding & debugging tools available
- Code, documentation & other resources online



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# MSP430-Enabled Applications

## Utility Metering

Electricity Meters  
Gas Meters  
Flow Meters  
Smart Meters



## Portable Medical

Blood Glucose Meters  
Thermometers  
Heart-Rate Monitors  
Implantable Devices



**Thousands of applications are enabled by MSP430 MCUs**

Differentiation is possible with MSP430 MCU's Ultra-Low Power performance, high analog & digital peripheral integration, and easy-to-use tool chain.

## Wireless Applications

Remote Sensors  
Communication  
Controllers  
RFID



## Sensors & Security

Smoke Detector  
Motion Detector  
Vibration Detector  
Smart Sensors



## Consumer Electronics

Portable Electronics  
Remote Controls  
Personal Care  
PC peripherals



## Energy Harvesting

Renewable Energy  
Battery-less devices  
Solar, thermal,  
vibration, etc



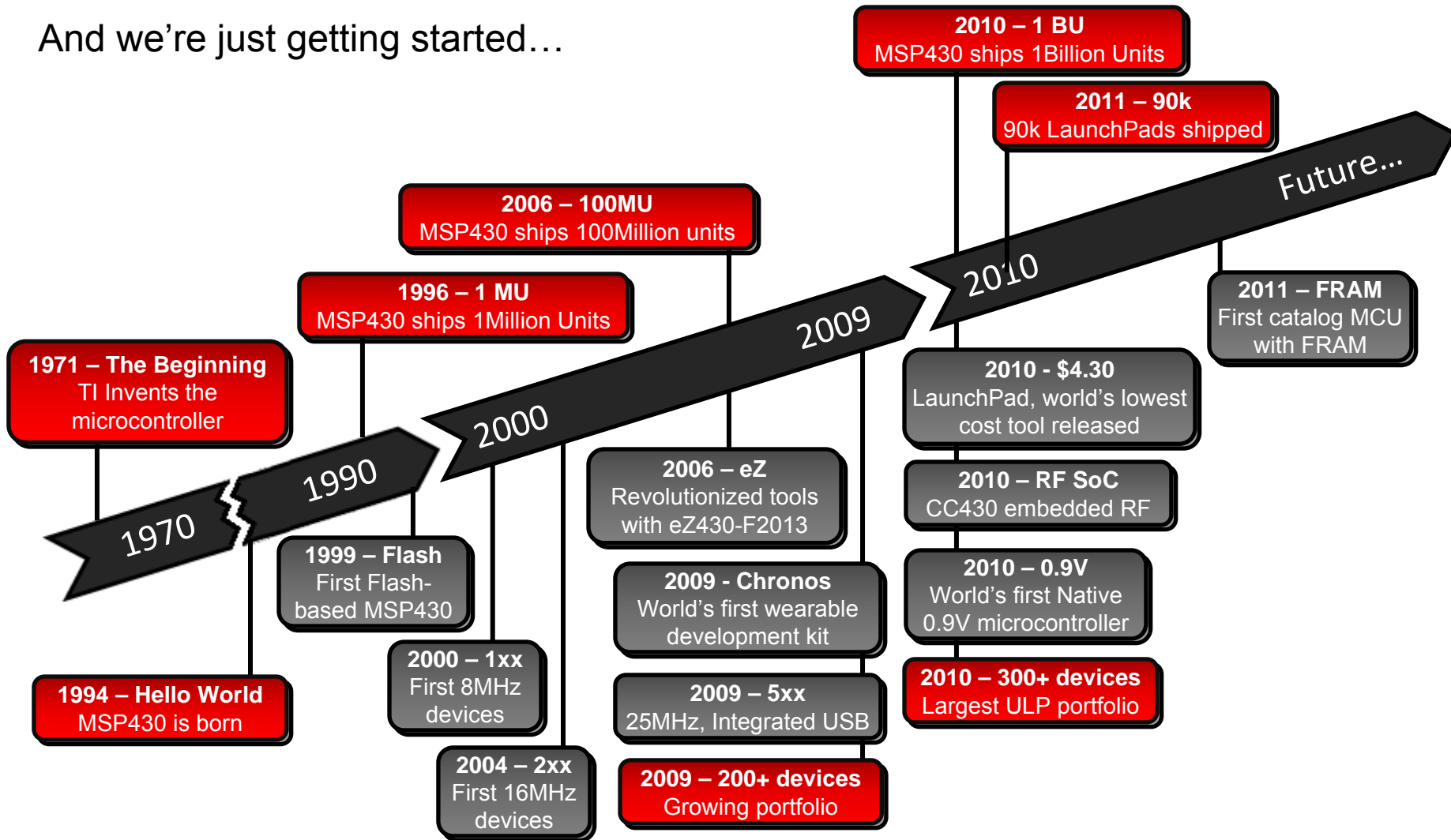
## Personal Health & Fitness

Sports Watches  
Pedometers  
Calorimeters  
Dive watches



# MSP430 – Always Innovating

And we're just getting started...



# MSP430 Accolades and Awards



Design News Golden Mousetrap  
Best New Products of 2011



ECN's 2010 Reader's Choice Winner  
Boards, Modules & Embedded Systems



EDN's Hot 100 Products of 2010  
Development Kits – MSP430 LaunchPad



Embedded Computing Design Award 2010  
Editor's Choice - MSP430 Value Line



EDN's 20<sup>th</sup> Annual Innovation Awards  
Software/Embedded Tools - 2010

MSP430 is paving the way for Ultra-Low Power and Easy-to-Use development.

**2007 Manufacturer of the Year**  
Global Design Chain Excellence

**2007 EDN Innovation**  
Development Kits

**2006 Embedded System Design**  
AdPower Award

**2005 Electronic Products**  
Product of the Year

**2005 EE Times**  
Ultimate Products

Continuing innovation...



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# MSP430 Key Values

**MSP430**  
Ultra-Low Power MCUs

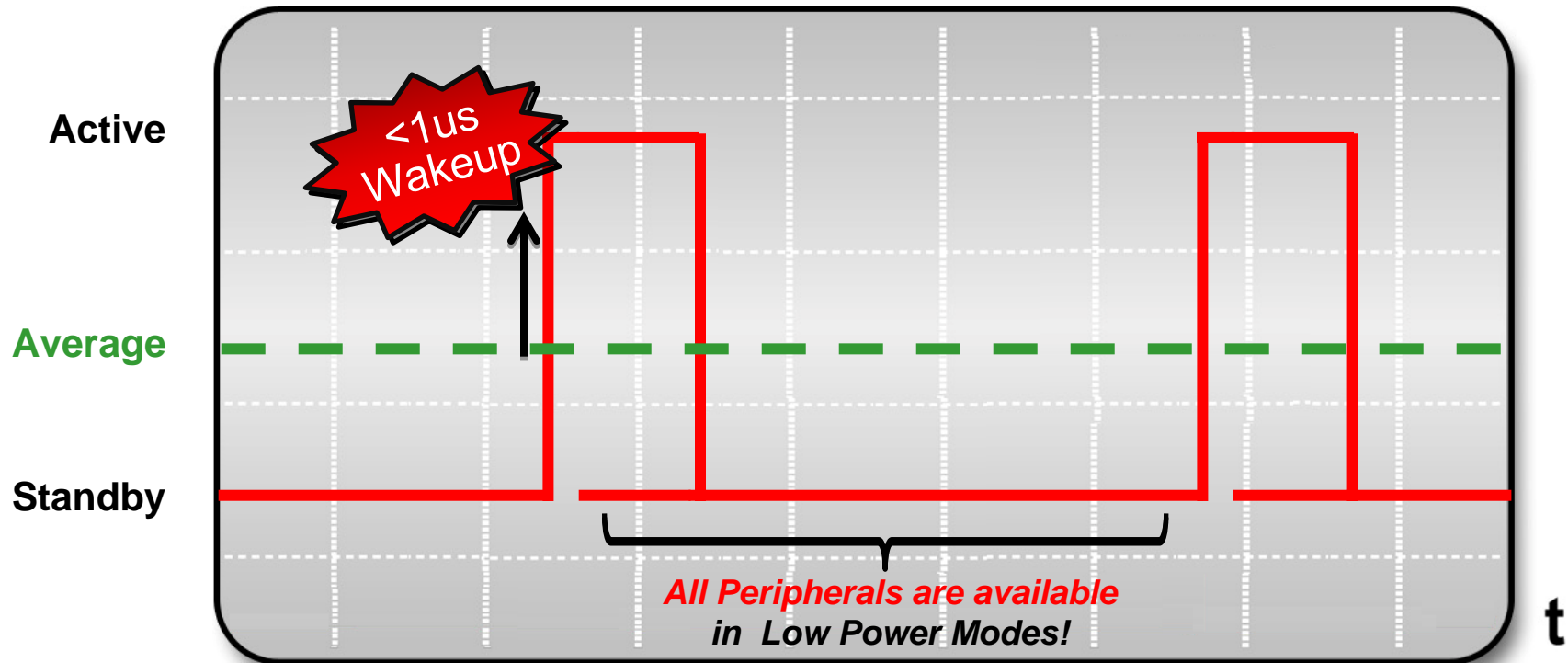


Ultra-Low Power

**Outlast your battery with MSP430 Microcontrollers**

- Ultra-Low Power Active Mode
- 7 Flexible Low Power Modes
- Instant Wakeup from Low Power Modes
- Intelligent and autonomous peripherals

# Ultra-Low Power Profile



- ✓ Low Power Active Mode
- ✓ 7 Flexible Low Power Modes
- ✓  $<1\mu\text{s}$  wakeup time
- ✓ Autonomous, integrated peripherals

MSP430 was designed from the ground up for ULP performance

# ✓ Ultra-Low Active Power

## Ultra-Low Power Active Mode

@2.2V, 1MHz, Flash operation

### F2xx (Gen purpose, max 16MHz)

- 220uA

### F4xx (w/LCD, max 16MHz)

- 200uA

### F5xx (Gen Purpose + USB, max 25MHz)

- 160uA

### MSP430 device with FRAM

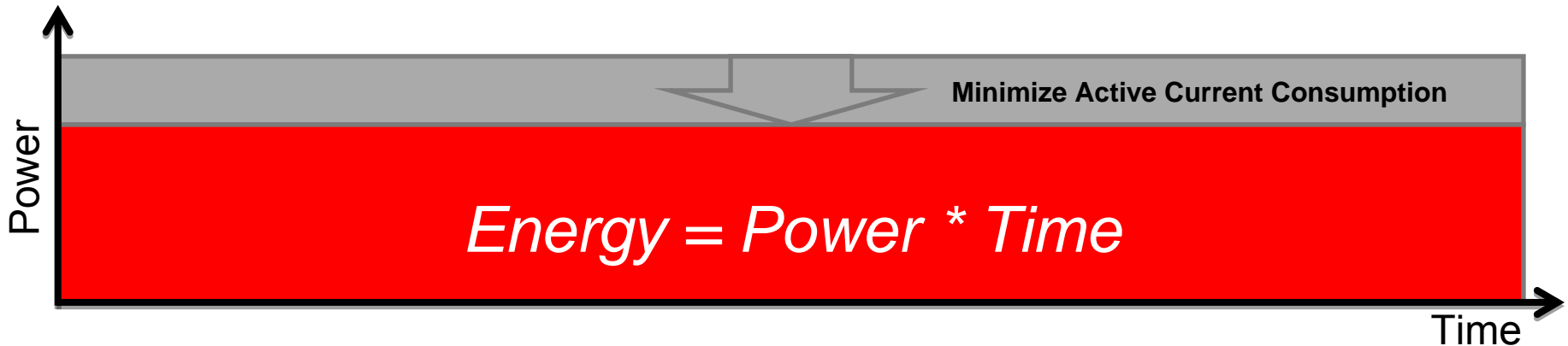
- <100uA

Nothing to hide! Baseline current includes:

- Zero-Power Brown Out Reset
- All peripherals are clocked and accessible
- All peripherals are available in Low Power Mode
- Ports are enabled
- Timers, WDT
- All interrupt sources

uA/MHz improves as CPU speed increases

## Active Mode Leader



# ✓ 7 Configurable Low Power Modes

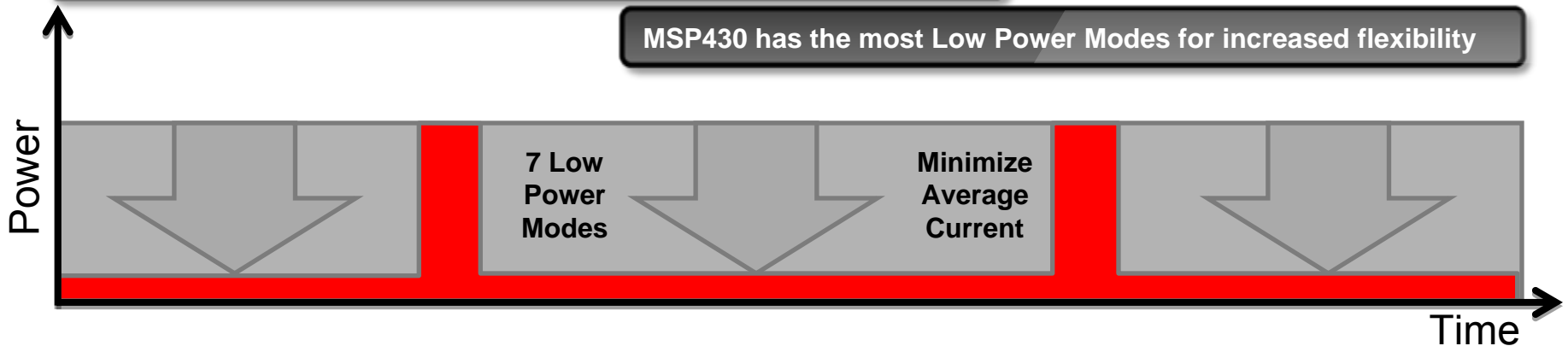
Optimize your power profile and minimize average current consumption

MSP430	Active	LPM0	LPM1	LPM2	LPM3	LPM3.5	LPM4	LPM4.5
CPU	ON	-	-	-	-	-	-	-
SMCLK (Hi-Freq peripheral clk)	Avail.	Avail.	Avail.	-	-	-	-	-
ACLK (Low Freq peripheral clk)	Avail.	Avail.	Avail.	Avail.	Avail.	-	-	-
Autonomous peripherals	Avail.	Avail.	Avail.	Avail.	Avail.	-	-	-
RAM Retention	YES	YES	YES	YES	YES	-	YES	-
Brown Out Reset	YES	YES	YES	YES	YES	YES	YES	YES

Zero-Power BOR

Most Applications spend 99 to 99.9% of the time in a Low Power Mode

MSP430 has the most Low Power Modes for increased flexibility



# ✓ Best-in-Class Wake Up Time

Quick wake up from any of MSP430's Low Power Modes

F2xx (Gen purpose, max 16MHz)

- <1us

F4xx (w/LCD, max 16MHz)

- <5us

F5xx (Gen Purpose + USB, max 25MHz)

- <6us



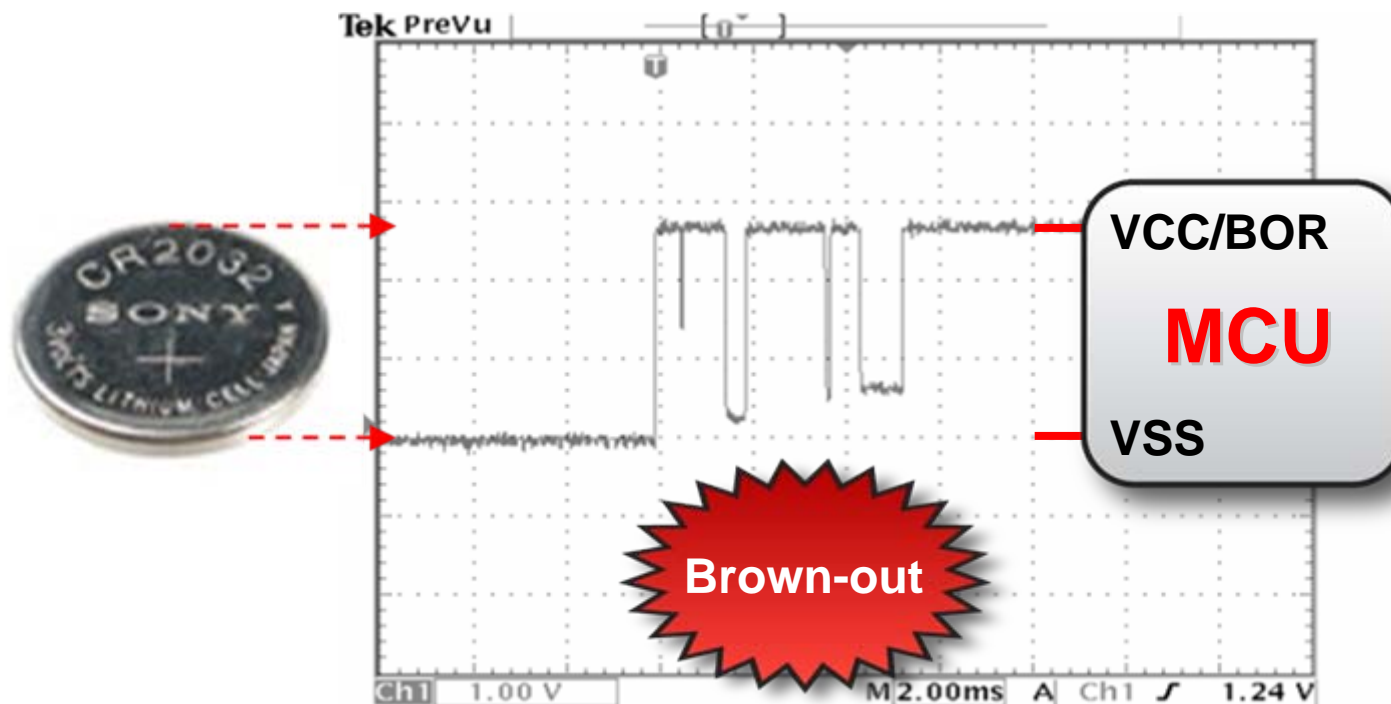
Get back to Low Power Modes faster with MSP430's instant wakeup!



# Always-on Brownout Reset

BOR is always-on and active in all operation modes for robust solutions.

- Brown-out reset (BOR) forces the MCU to reset both on power-up/down
  - When  $V_{CC}$  rises and when  $V_{CC}$  falls below normal operating range, a POR is triggered. This enables robust solutions, and ensures the device has stable power before executing code.
- Zero-power Brown Out Reset



# Demo Break | **The Grape Demo**

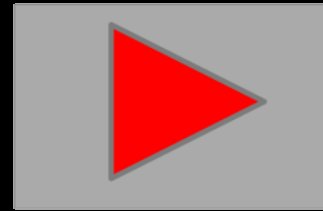
Can grapes power a microcontroller?

## **YES! With MSP430**

**MSP430 is the *world's lowest power MCU family*, designed for ULP from the ground up.**

- Ultra-Low Power Active Mode
- *7 Flexible Low Power Modes*
- *Instant wake up*
- *Integrated, intelligent peripherals*

***MSP430 can run a real-time clock and drive a 7-segment LCD off of a couple of grapes!***

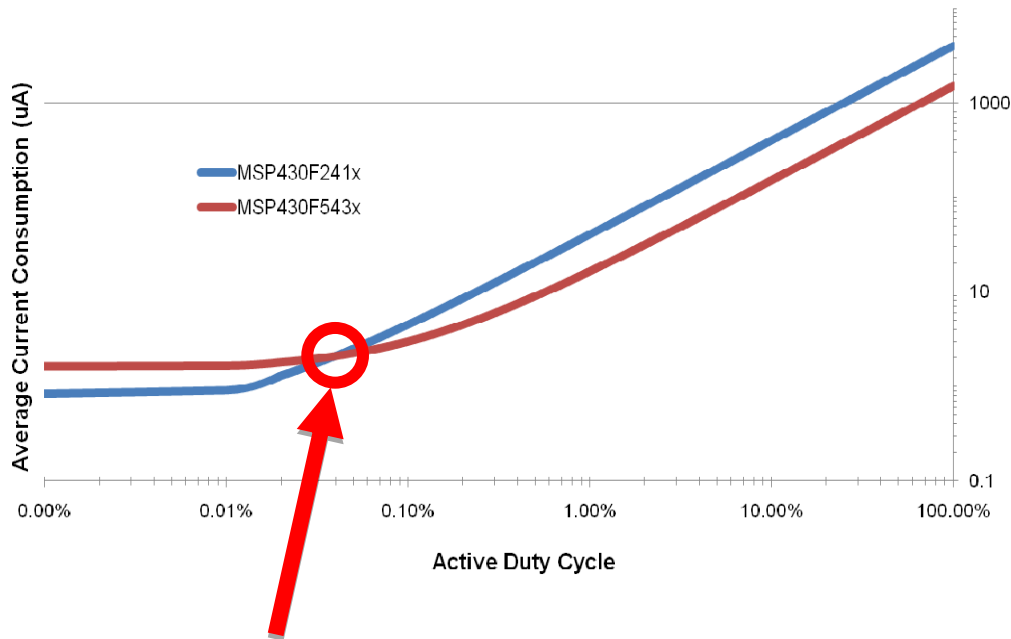


[Learn more @ www.ti.com/ulp](http://www.ti.com/ulp)



# What's more important – Standby vs Active

It depends on your application!



	F241x	F543x
Active @ 8MHz	4.25 mA	1.32 mA
LPM3	0.8 uA	1.1 uA

- MSP430x2xx has lower LPM3 consumption
- MSP430F5xx has lower active power consumption

The crossover is at ~0.04% Active

Or about 35 seconds/day

This means that if the CPU is Active >0.04% of the time (or >35 seconds per day), the lower Active Mode power of the F5xx outweighs the lower LPM3 current advantage of the F2xx device.

# ULP is Easy!

Enter Low Power Modes with just 1 line of code!

- Using our Low Power Modes are easy

```
void main(void)
{
    WDT_init(); // initialize Watchdog Timer
    while(1)
    {
        __bis_SR_register(LPM3_bits + GIE); // Enter LPM3, enable interrupts
        activeMode();                       // in active mode. Do stuff!
    }
}

#pragma vector=WDT_VECTOR
__interrupt void watchdog_timer (void)
{
    __bic_SR_register_on_exit(LPM3_bits); // Clear LPM3 bits from 0(SR), Leave LPM3, enter active mode
}
```



# MSP430 for Energy Harvesting

## “Self or Perpetual - Power” Apps

- **Energy harvesting** is the process by which energy is **captured** and **stored**
- Can substitute batteries that are costly to maintain and can extend system uptime
- Only possible with **ultra-low power components**
- Solar, kinetic, thermal, RF, salinity gradients, pH difference and other ambient sources available



Body worn monitoring devices powered by body heat, movement



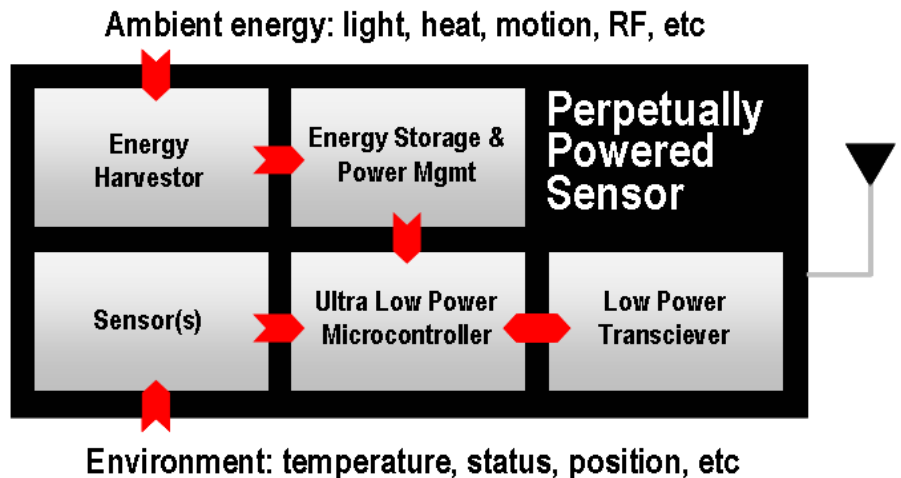
Monitor conditions on farm, winery, etc.



Mesh networking for environmental monitoring (e.g. forest fire detection)



Automotive monitoring (e.g. tire pressure gauges powered by vibration)



### Energy Harvesting Made Easy – MSP430 Solutions



# Battery Life when 1% Active

**MSP430 lasts 2 years longer than closest competitor!**

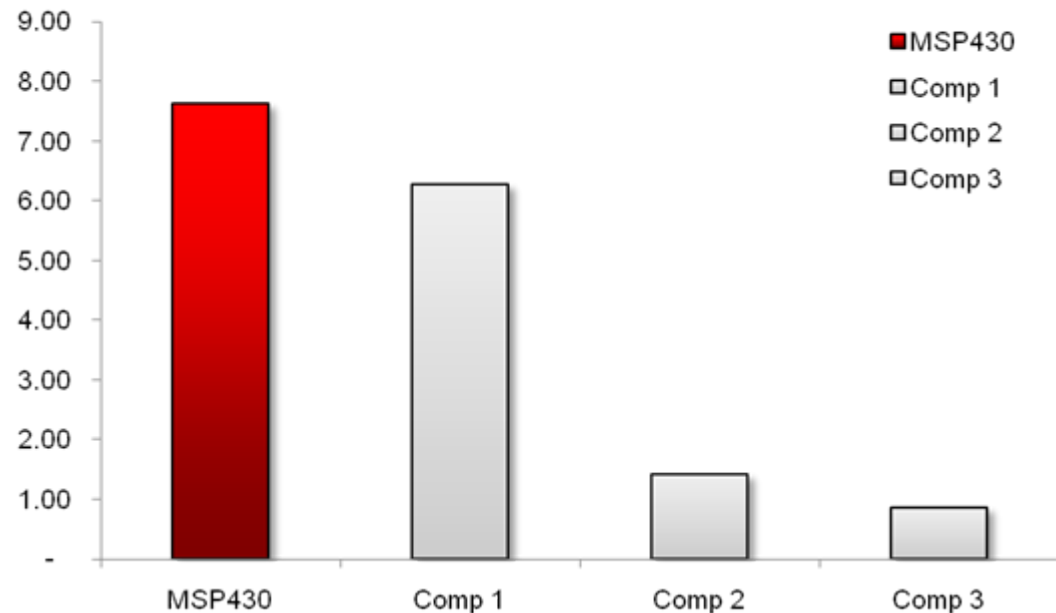
**MSP430's Ultra-Low Power Active Mode plays an important part in keeping average current consumption is at a minimum.**

- 1% Active ~ 14.4 minutes/day
- Application examples: Portable Medical, Blood Glucose Meters, thermometers, etc.

**MSP430's Ultra-Low Power Active Mode maximizes your customer's battery life!**



**Battery Life in Years**



# Battery Life when 0.1% Active

MSP430 lasts 33% longer than closest competitor!

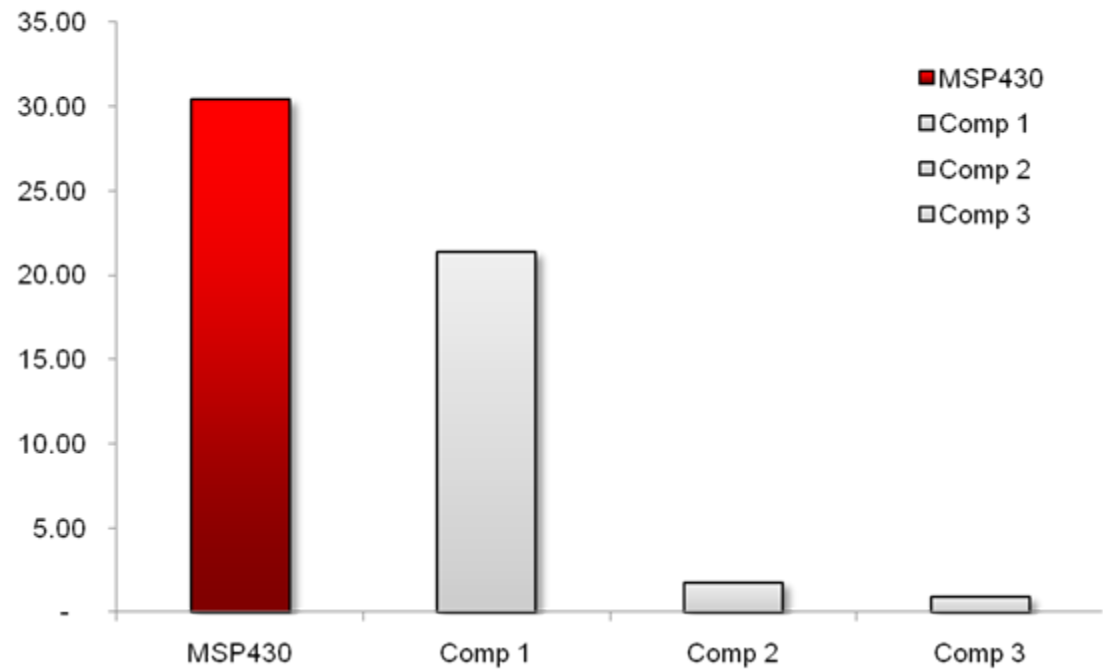
Low Power Modes play an important part in keeping average current down.

- 0.1% Active ~ 1.4 minutes/day
- Application examples: Wireless Sensor Networks, Smoke Detectors
- OUTLAST** Battery Leakage!

MSP430's Flexible Low Power Modes maximizes your customer's battery life!



## Battery Life in Years

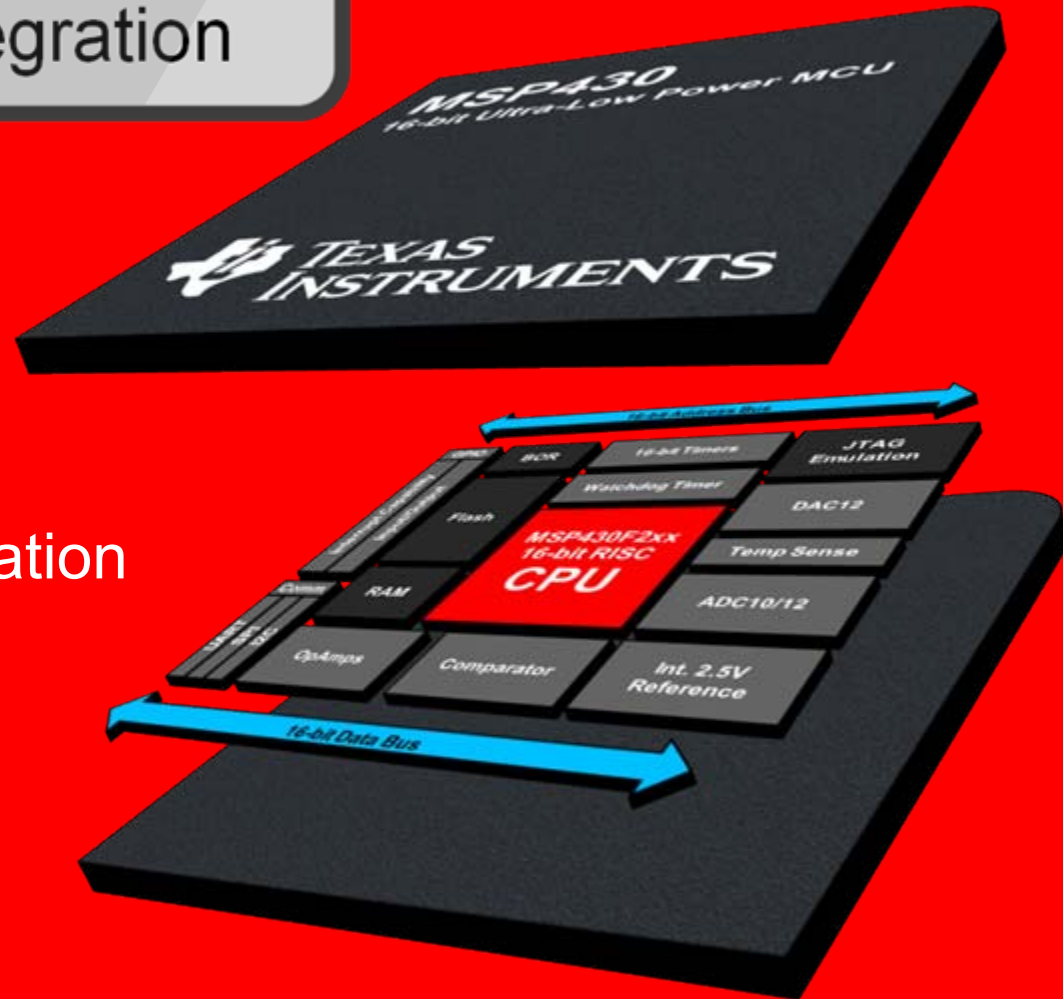


$$\int 430(x) dx$$

High Analog &  
Digital Integration

## Largest, most-scalable ULP portfolio

- 300+ Devices
- Various levels of integration
- Do more with less
- Devices starting @ \$0.25USD
- Mature portfolio



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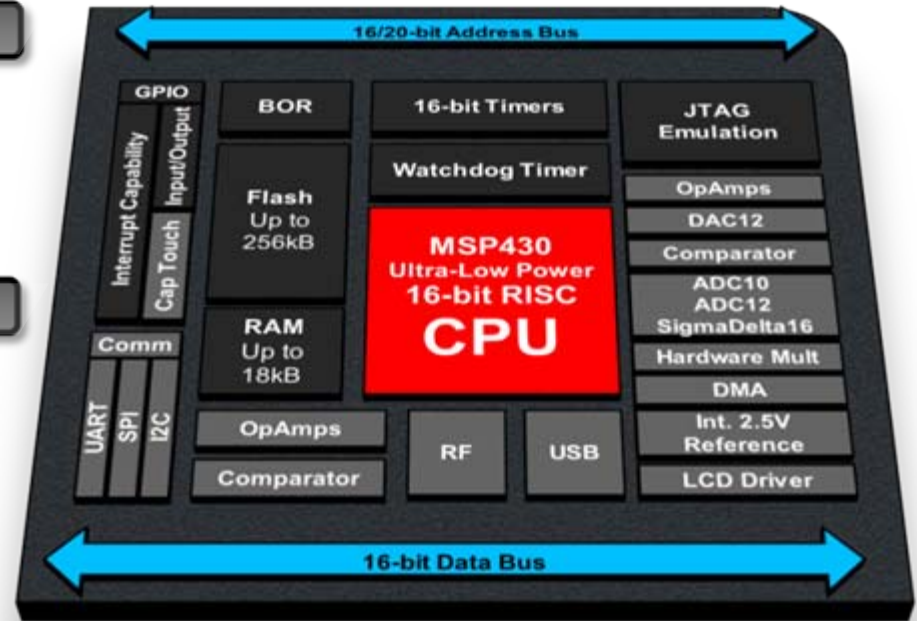
# High analog and digital integration

## 300+ Device Configurations

- **Flash:** Up to 256kB Flash, 512kB on the way
- **RAM:** Up to 18kB RAM
- **Package/Pin Count:** 24 packages, up to 113 pins
- **Cost effective:** MSP430 Value Line MCUs @ \$0.25

## Innovative Integration

- **FRAM** – the future of Embedded Memory
- **Capacitive touch I/O** – directly interface with pads
- **Hi-Resolution Timer** – 4ns resolution
- **A-POOL** – Configurable analog blocks
- **USB** – High Speed 2.0
- **RF** – Sub-1GHz (433, 868, 915MHz)
- **ESP430** – 2<sup>nd</sup> core for eMetering algorithms



## Full peripheral set

- **Devices integrated with:**
  - 10, 12-bit ADC
  - 16-bit Sigma Delta
  - 12-bit DAC
  - 16-bit Timers
  - I2C, SPI, UART
  - LCD Driver
  - USB
  - Integrated RF
  - Comparator
  - OpAmps
  - Direct Memory Access Module
  - Hardware Multipliers
    - AES128 Encrypt/Decrypt module
  - Watchdog Timer
  - Brown-Out Reset
  - Capacitive Touch I/O ports
  - Real-Time Clock
  - Power Management Module

MORE...



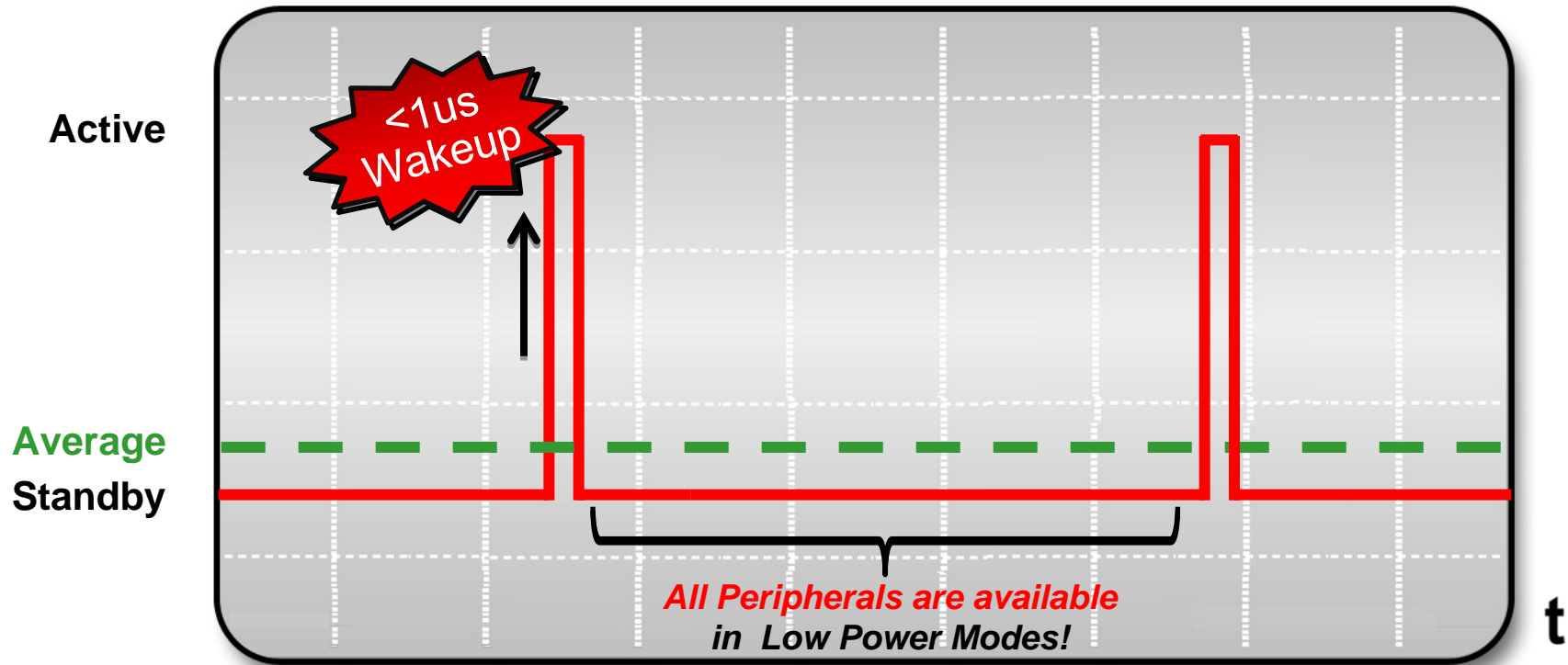
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MAKE THE SWITCH

# Do More in Low Power Modes



## Productive Low Power Modes allow:

- Take ADC Samples
- Transfer data throughout memory range
- Output PWM signal
- Update LCD
- Send & receive serial communication

**Intelligent, autonomous peripherals** allow developers to do all of this and more without the CPU.

Stay in Low Power Mode longer!



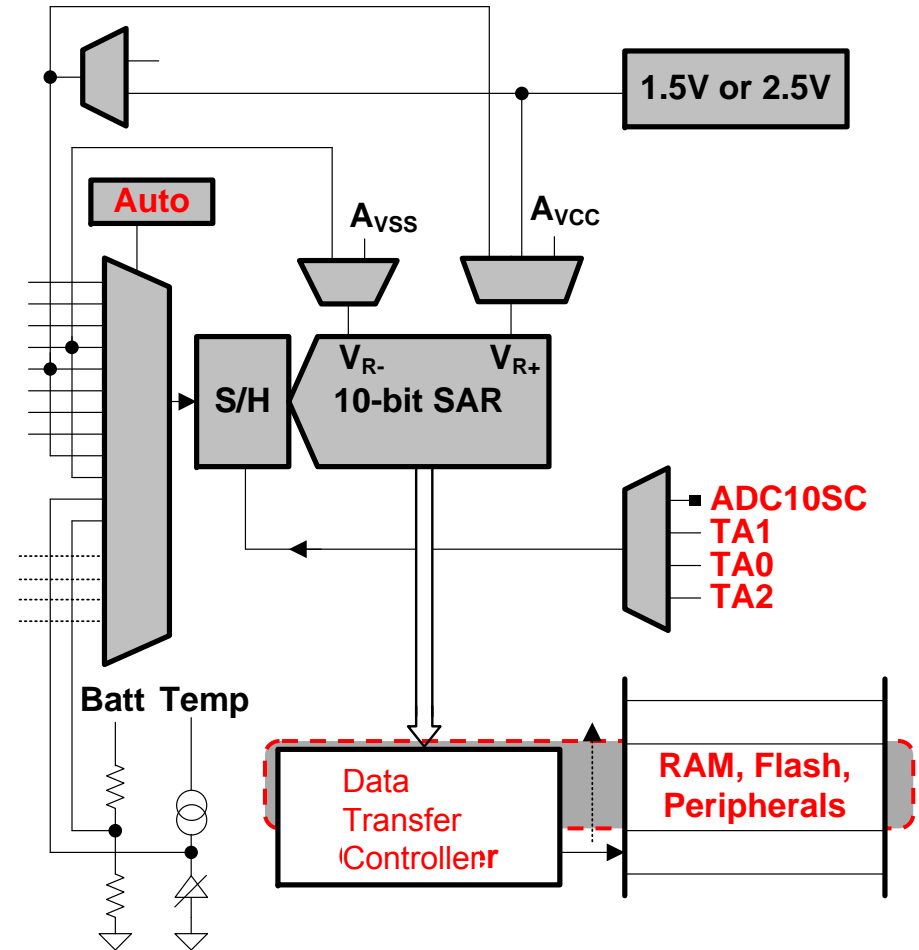
# Fast Flexible 10- and 12-bit ADCs

## Features

- 10-bit & 12-bit ADCs at the rate of 200ksps
- **Autoscan**
- Single, Sequence, Repeat-single, Repeat-sequence
- Timer triggers
- **Data Transfer Controller (DTC)**
- **DMA Enabled**

## Benefits

- Fast sample/conversions for greater accuracy
- Sample data autonomously in Low Power standby modes – without the CPU!
- Stay in Low Power Modes, minimizing current consumption
- Transfer samples to anywhere in memory using the DTC and DMA – all while in Low Power standby modes!



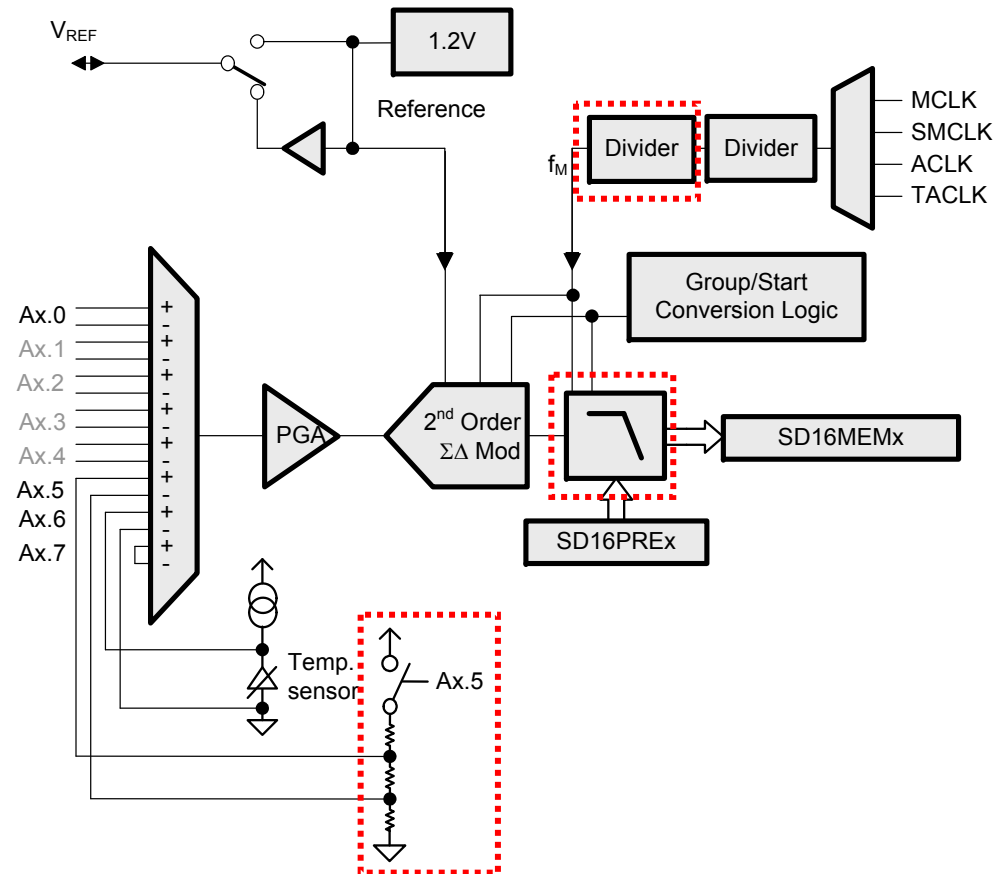
# 16-bit Sigma Delta

## Features

- 2nd order 16-bit sigma-delta architecture
- Multiple channels
- 30kHz to 1.1MHz modulation frequency
- Modulation frequency divider
- Up to 1024 OSR
- Temperature sensor
- AVCC measure
- Up to 4096 samples/sec
- Gain amplifier to support wide range of current measurements
- SW selectable internal/external reference

## Benefits

- High accuracy and resolution!
- Capable of implementing anti-tampering needs in applications such as utility metering.
- Same Low Power capabilities as ADC10 and ADC12



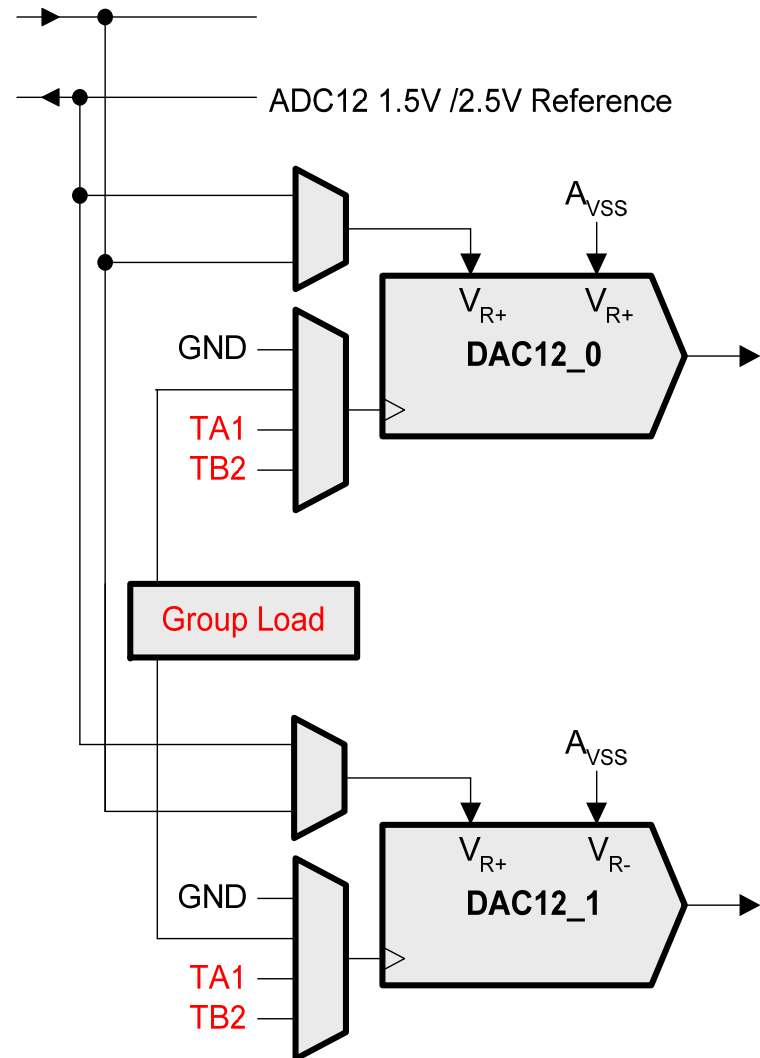
# DAC12

## Features

- 12-bit monotonic
- 8/12-bit voltage output
- Programmable settling time versus power
- Int/ext reference
- Binary or 2's compliment
- Self-calibration
- Group sync load
- DMA enabled

## Benefits

- Configurable balance between performance and power
- Allows synchronous update operations when multiple modules are available
- Output waves while in Low Power standby modes to minimize current consumption!



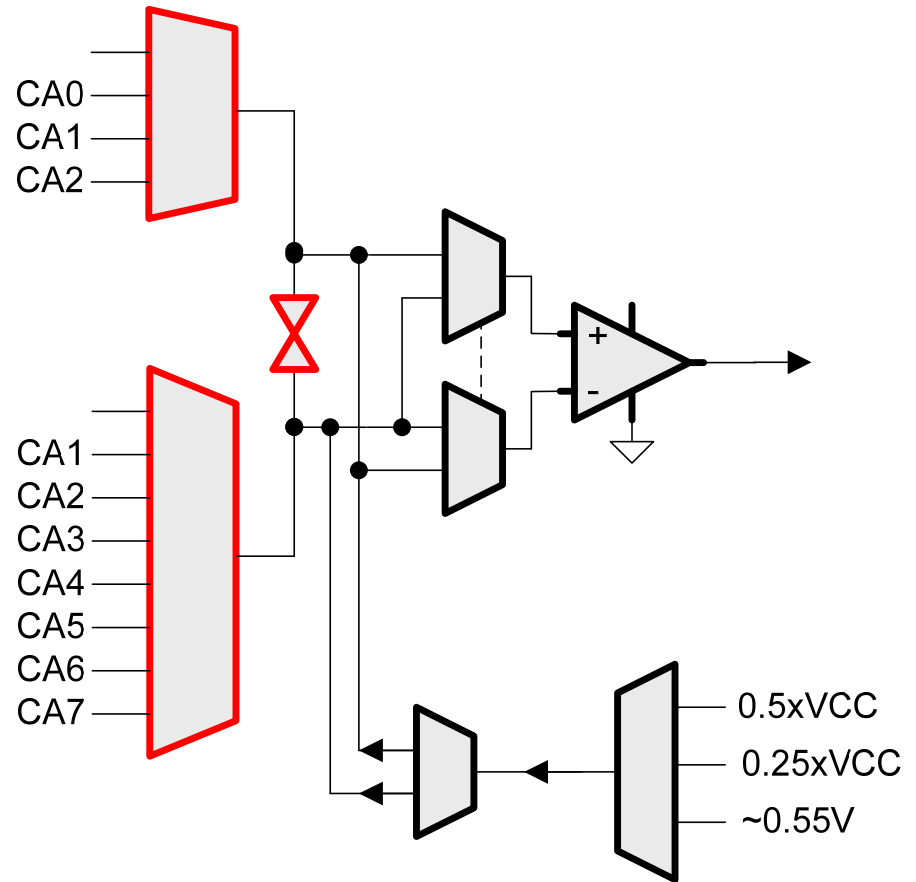
# Analog Comparators

## Features

- ~100nA operation (Comp\_B)
- Hysteresis generator (B)
- Input multiplexer
- Reference generator
- Low-pass filter
- Battery detect
- Interrupt source
- Timer\_A capture
- Multiplexer short for sample-and-hold

## Benefits

- Ultra-Low Power operation extends battery life
- Enables monitoring of external analog signals
- Supports precision slope Analog to Digital Conversions



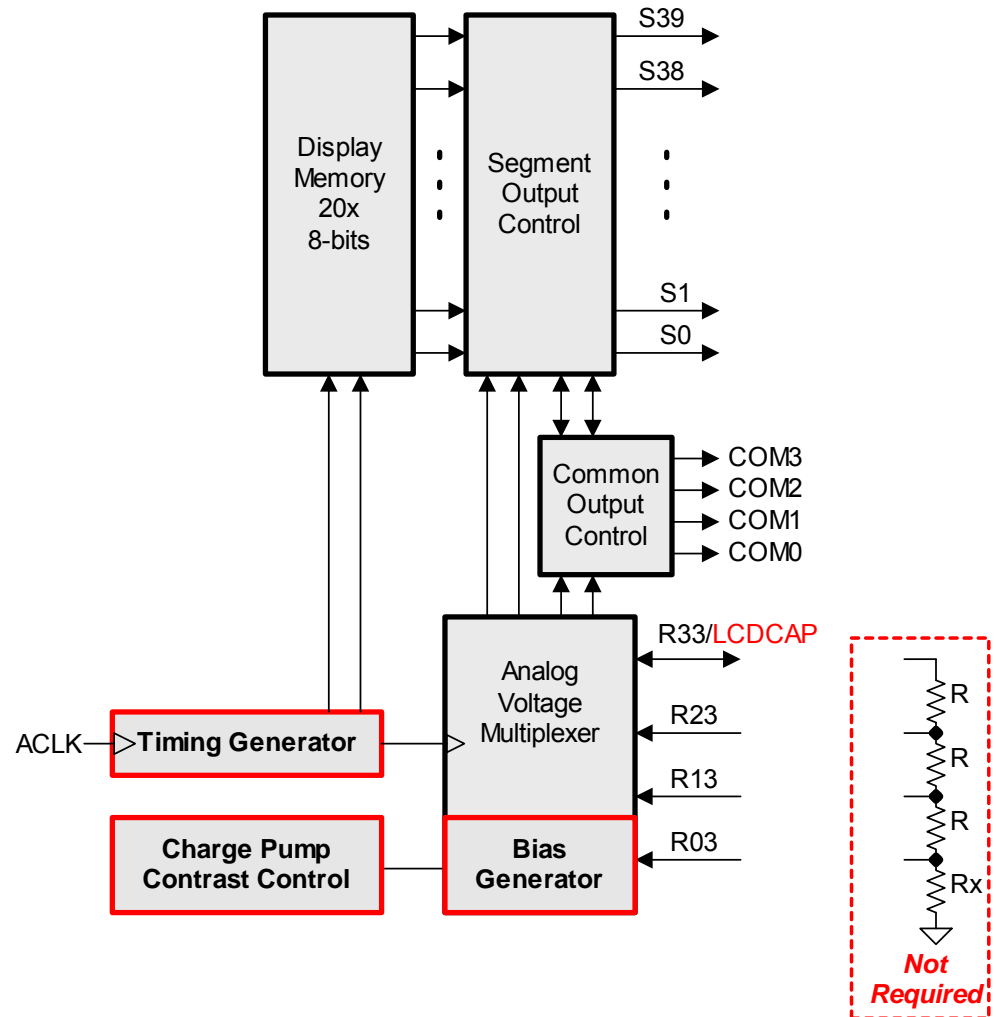
# LCD Controllers

## Features

- Fully automatic
- 4/3/2/1 mux
- Up to 160-bit display
- Internal regulated voltage generator
- Internal or external bias generation
- **Contrast control**
- 1/2 bias for 3 or 4 mux
- Internal clock generation
- **Auto segment blinking**

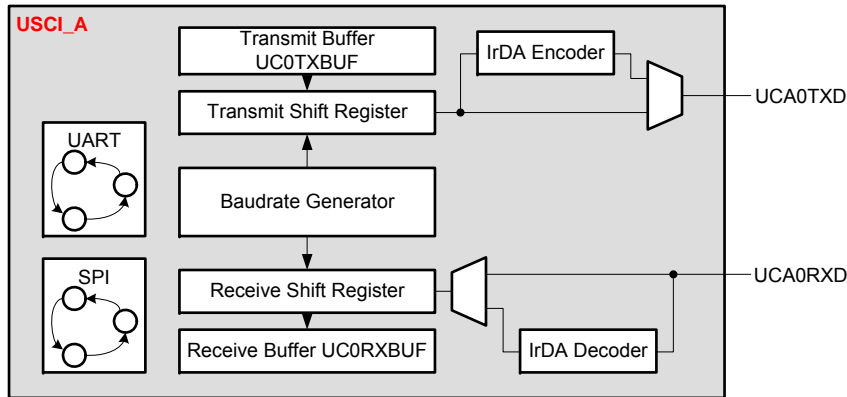
## Benefits

- Ultra-Low Power functionality
- Easy integration
- Flexible LCD support



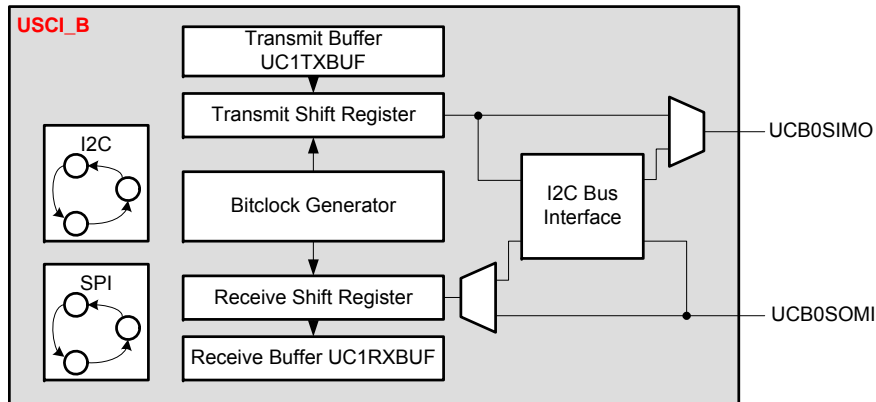
# USCI: Serial Communication I/F

## USCI\_A



- **UART** with **IrDA/LIN** support or **SPI**
- Baud-rate generator with auto-baud rate detect
- Double buffered TX/RX

## USCI\_B

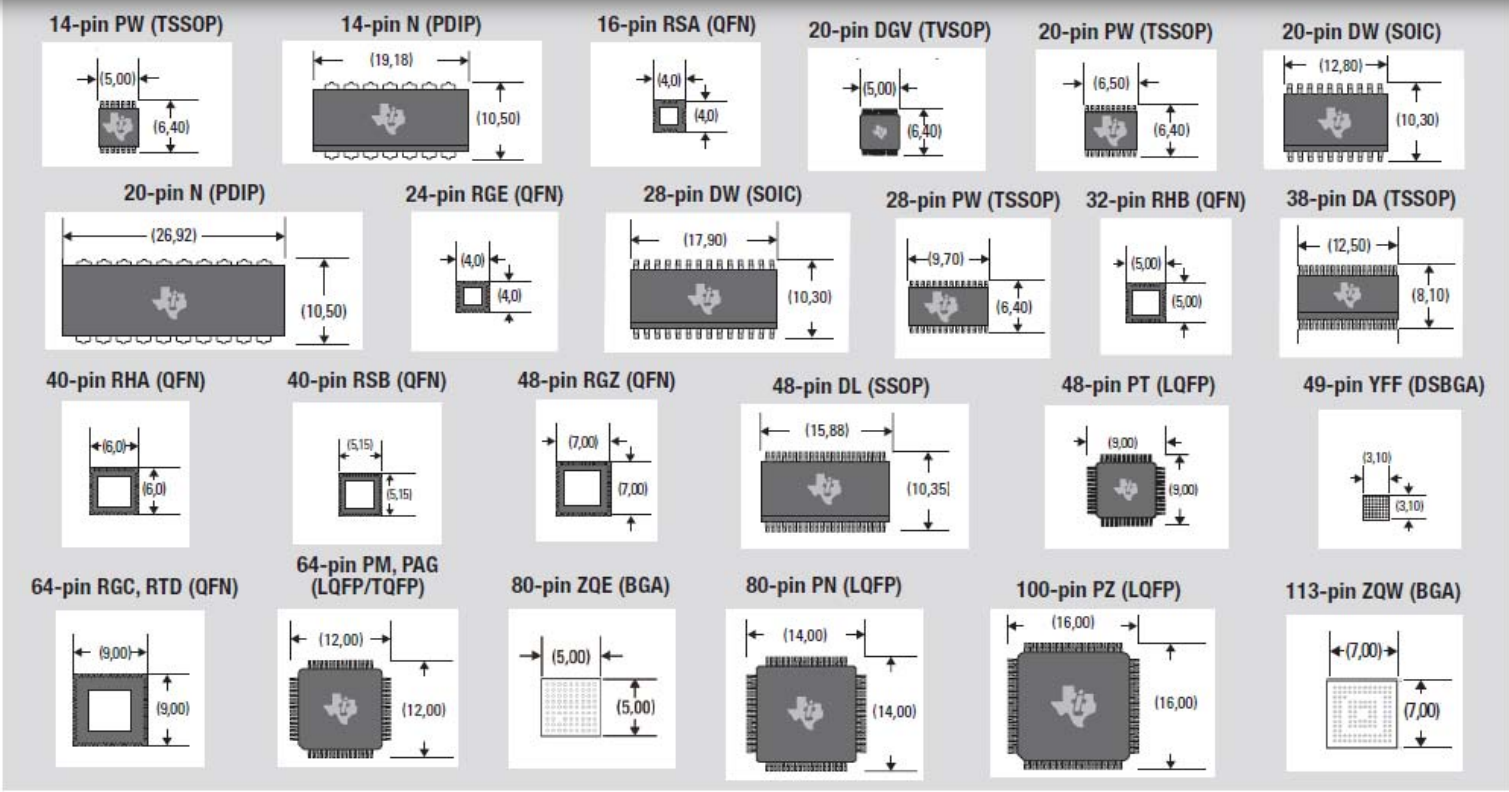
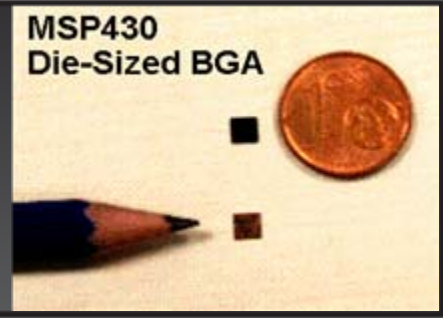


- **I2C** master/slave up to 400kHz or **SPI**
- Bit clock generator
- Double buffered TX/RXs

# MSP430 Package Options

- Ranging from 14 – 113 pins
- Die-sized BGA now available!
  - F2370: 3.232x3.232mm (49 pins)
  - F22xx: 3.33x3.49mm (49 pins)

**25+ packages!**



# MSP430 Portfolio at a glance

300+ Ultra-Low Power Devices Starting @ \$0.25USD

Featuring: Up to 256kB Flash, 18kB RAM, 24 Package Options, Up to 113 pins, High integration

← Ultra-Low Power Performance — Analog Integration — Easy-to-Use →

**MSP430**  
16-bit RISC CPU

All devices feature:

- 16-bit timers
- Watchdog Timer
- Internal Digitally Controlled Oscillator
- External 32-kHz crystal support
- <50 nA pin leakage
- <6 μs wakeup

**L092**  
0.9V-1.65V  
Speed 4Mhz  
ROM to 2kB  
RAM to 2kB  
GPIO 11

**F1xx**  
Speed 8Mhz  
Flash 1-60kB  
RAM to 10kB  
GPIO 14-48

- BOR
- DAC8
- Comp
- SVS
- BOR
- WDT
- A-POOL
- ADC8

- BOR
- ADC10,12
- Comp\_A
- DAC12
- DMA
- MPY
- SVS
- USART

**\$0.25**  
**G2xx**  
Speed 16Mhz  
Flash 0.5-8kB  
RAM to 256kB  
GPIO 10-16

**F2xx**  
Speed 16Mhz  
Flash 1-120kB  
RAM to 8kB  
GPIO 10-64

- BOR
- ADC10
- Comp\_A+
- Temp
- USI
- Cap Sense I/Os

- BOR
- ADC10,12
- SD16\_A
- Comp\_A+
- DAC12
- DMA
- MPY
- OpAmp
- SVS
- USCI
- USI

**F4xx**  
Speed 8/16Mhz  
Flash 4-120kB  
RAM to 8k  
GPIO 14-80

- BOR
- LCD
- ADC10,12
- SD16( \_A)
- Comp\_A
- DAC12
- DMA
- MPY
- OpAmp
- SVS
- USART
- USCI
- ESP430
- SCAN\_IF
- Basic Timer
- WDT+
- RTC\_C

**F5xx**  
Speed 25Mhz  
Flash 8-256kB  
512kB coming soon.  
RAM to 18kB  
GPIO 32-83

- PMIM
- BOR
- SVS
- SVM
- LDO
- MPY
- USCI
- DMA
- EDI
- USB
- ADC10,12 (A)
- Comp\_B
- RTC\_A/B
- WDT

**CC430**  
Speed 20Mhz  
Flash 8-32kB  
RAM to 4kB  
GPIO 40

- PMIM
- BOR
- SVS
- SVM
- LDO
- MPY
- USCI
- DMA
- Sub 1GHz RF
- AES
- ADC12 (A)
- Comp\_B
- RTC\_A/B
- LCD

All Devices Some Devices



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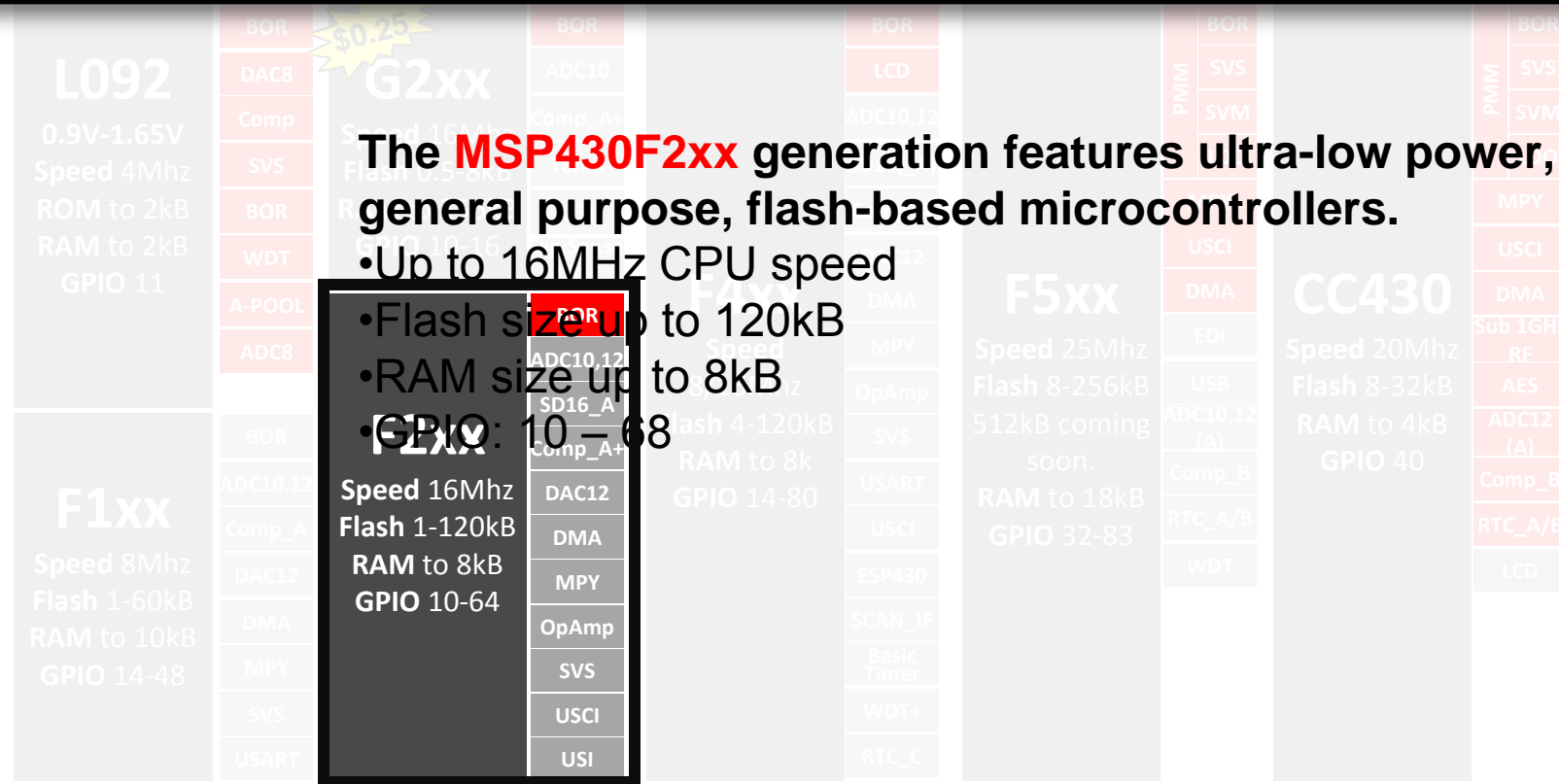
### All devices feature:

- 16-bit timers
- Watchdog Timer
- Internal Digitally Controlled Oscillator
- External 32-kHz crystal support
- <50 nA pin leakage
- <6 μs wakeup

The **MSP430F2xx** generation features ultra-low power, general purpose, flash-based microcontrollers.

- Up to 16MHz CPU speed
- Flash size up to 120kB
- RAM size up to 8kB
- GPIO: 10 – 68

Speed 16MHz  
Flash 1-120kB  
RAM to 8kB  
GPIO 10-64



All Devices Some Devices

# What's New in 2xx

## MSP430AFE2xx

### Metrology Analog Front End

#### Performance

- 16-bit RISC architecture, 62.5ns instruction cycle time
- Ultra-Low-Power, Integrated Analog, and Easy-to-Use

#### Features

- Low supply voltage range 1.8-3.6V
- Ultra-low power in active and sleep modes and ultrafast wake-up from standby mode in <1  $\mu$ s
- 3 independent  $\Sigma\Delta$  converters with 8ch each
- USART communication
- 24-pin TSSOP (PW)

#### Benefits

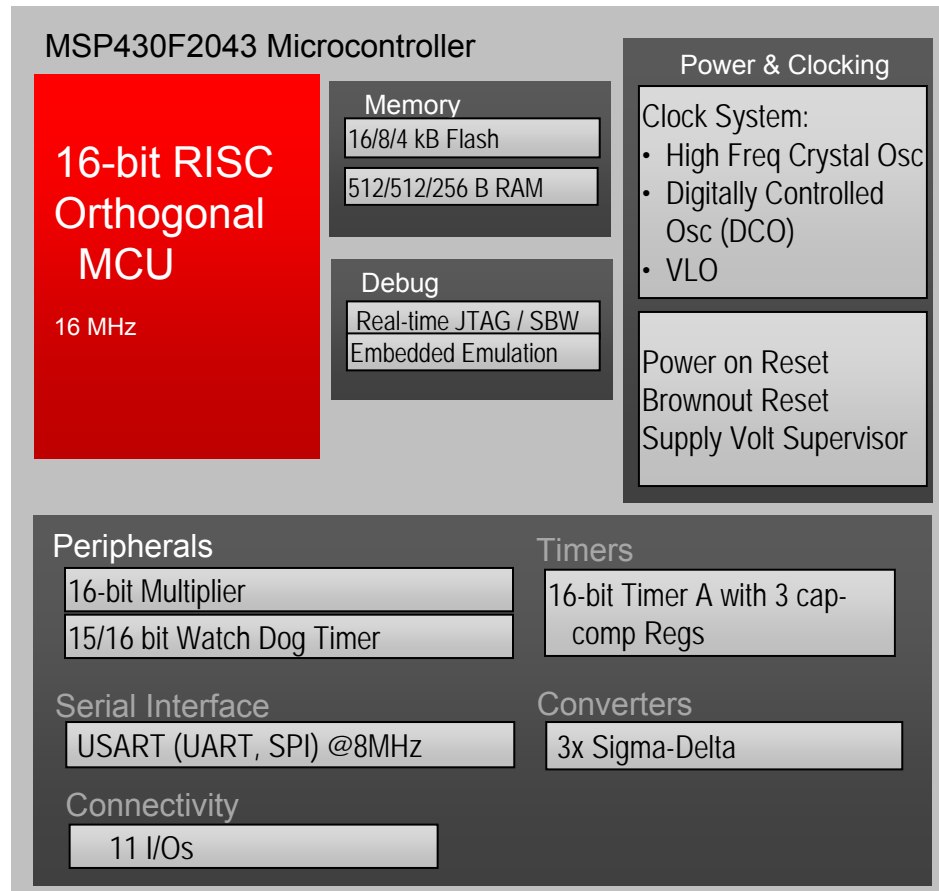
- **Cost optimized** for analog front end in metering, power monitors, high-precision measurements
- **<0.1% metering accuracy** for precise energy measurements with a 2400:1 dynamic range with  $\Sigma\Delta$  converters
- **Anti-tampering** capabilities with an additional  $\Sigma\Delta$  converter
- **Lower system power** due to world's lowest power MCU
- **Small Footprint** of 24-pin (35-50sqmm) enables solutions for in-system power monitoring and industrial sensing
- More robust performance and software development with simultaneous sampling

#### Tools

- Development/ Target Board MSP-TS430PW24
- 1-phase EVM in works – to be available 1Q2011
- Complete metering software available with EVM

#### Applications include:

- Single phase e-meter (with anti-tampering)
- Power Monitoring (Servers, Appliances, Branch Meters)
- High-precision measurements and Sensors



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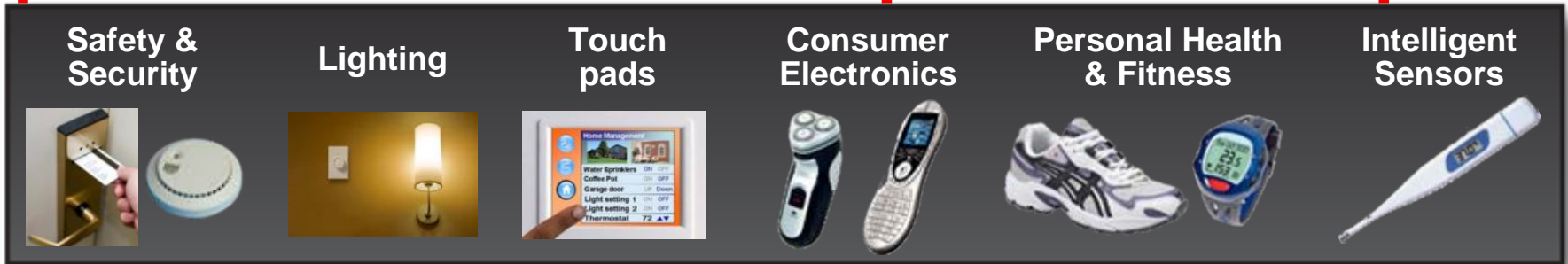
<p><b>L092</b></p> <p>0.9V-1.65V Speed 4Mhz ROM to 2kB RAM to 2kB GPIO 11</p>	<p>BOR</p> <p>DAC8</p> <p>Comp</p> <p>SVS</p> <p>BOR</p> <p>WDT</p> <p>A-POOL</p>	<p><b>\$0.25</b></p> <p><b>G2xx</b></p> <p>Speed 16Mhz Flash 0.5-8kB RAM to 256B GPIO 10-16</p>	<p>BOR</p> <p>ADC10</p> <p>Comp_A+</p> <p>Temp</p> <p>USI</p> <p>Cap Sense I/Os</p>	<p><b>F4xx</b></p> <p>Speed 10/16/12 Flash 0.5-8kB RAM to 8k GPIO 14-80</p>	<p>BOR</p> <p>LCD</p> <p>ADC10_12</p> <p>SD16(A)</p> <p>Comp_A</p> <p>DAC12</p> <p>DMA</p> <p>MPY</p> <p>OpAmp</p> <p>USART</p> <p>USCI</p> <p>ESP430</p> <p>SCAN_IF</p> <p>Basic Timer</p> <p>WDT+</p> <p>RTC_C</p>	<p><b>F5xx</b></p> <p>Speed 25Mhz Flash 0-256kB RAM to 18kB GPIO 32-83</p>	<p>BOR</p> <p>SVS</p> <p>SVM</p> <p>LDO</p> <p>MPY</p> <p>USCI</p> <p>DMA</p> <p>EDS</p> <p>Comp_B</p> <p>RTC_A/B</p> <p>WDT</p>	<p><b>CC430</b></p> <p>Speed 20Mhz Flash 0-52kB RAM to 4kB GPIO 40</p>	<p>BOR</p> <p>SVS</p> <p>SVM</p> <p>LDO</p> <p>MPY</p> <p>USCI</p> <p>DMA</p> <p>SUB 1GHZ</p> <p>RF</p> <p>AES</p> <p>I2C</p> <p>Comp_B</p> <p>RTC_A/B</p> <p>LCD</p>
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The **MSP430G2xx Value Line** generation features ultra-low power, general purpose, flash-based microcontrollers. **starting at just \$0.25!**

- Up to 16MHz CPU speed
- Flash size up to 8kB (16kB coming!)
- RAM size up to 256B (512B coming!)
- GPIO: 10 – 16
- Featuring **Capacitive Touch I/O ports**

All Devices Some Devices

# MSP430G2xx Value Line MCUs deliver 16-bit performance & ultra-low power at 8-bit price



	PIC10F202	MSP430G2001
Price	\$0.25	\$0.25
Flash	512B Ext 12V	512B In System
RAM	25B	128B
Timers	8-bit counter	16-bit multifunction
Emulation	0	2-pin In System
GPIO/ Interrupts	6 0	10 22
MIPS	1x 8-bit	16x 16-bit
Power Modes	2	5

Flexible

Agile

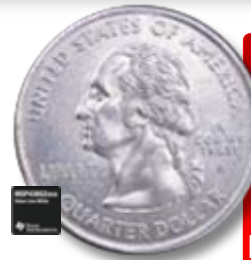
More Functionality

Faster Development

No Compromise

Hi-Performance

MSP430 is lower power in all modes of operation



**150+ new devices**

**Phase 1 – Now!**

27 devices, 2kB  
Flash, 10 GPIO, 128B RAM

**Phase 2 – Now!**

60+ devices, 8kB  
Flash, 16 GPIO, 512B  
RAM, CapTouch I/O

**Phase 3 – April '11**

60+ devices, 16kB  
Flash, 24 GPIO, 1kB RAM, Cap  
Touch I/O, UART



# MSP430 Capacitive Touch Sense

*World's lowest power Capacitive Touch solution*

## Benefits & Features

- Reduced System Size and Cost
  - Does not require external components to interface with capacitive touch pads
  - Oscillation circuitry is integrated into the MCU
- Easy to Get Started
  - Complete hardware and software reference design avail.
  - Supported by full software library with intuitive API calls
  - Provides instant differentiation! Replace any physical button with capacitive touch buttons, sliders, wheels, etc!



Capacitive Touch BoosterPack  
for LaunchPad

## Devices, Tools, SW available today!

MSP430G2xx2: Now!

MSP430G2xx3: April. 2011



[www.ti.com/capacitivetouch](http://www.ti.com/capacitivetouch)



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# Demo Break | **Capacitive Touch**

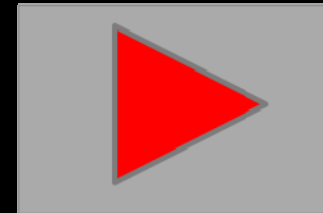
## Lowest Power Capacitive Touch Solutions

### **Complete HW & SW solutions**

The MSP430G2xx2/2xx3 devices are the first to include an integrated Capacitive Touch Sense I/O ports.

- Lowest power, lowest cost solution
- No external components needed
- Full support from Capacitive Touch Sense Library

***Add instant differentiation with Capacitive Touch for just \$4.30***



[Learn more @ www.ti.com/ulp](http://www.ti.com/ulp)



For more information on the  
MSP430G2xx Value Line family, visit  
[www.ti.com/430value](http://www.ti.com/430value)



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# MSP430 Portfolio at a glance

300+ Ultra-Low Power Devices Starting @ \$0.25USD

Featuring: Up to 256kB Flash, 18kB RAM, 24 Package Options, Up to 113 pins, High integration

← Ultra-Low Power Performance — Analog Integration — Easy-to-Use →

**MSP430**  
16-bit RISC CPU

All devices feature:

- 16-bit timers
- Watchdog Timer
- Internal Digitally Controlled Oscillator
- External 32-kHz crystal support
- <50 nA pin leakage
- <6 μs wakeup

The **MSP430F4xx** generation features ultra-low power, highly-integrated, flash-based microcontrollers

- Up to 16MHz CPU speed
- Flash size up to 120kB
- RAM size up to 8kB
- GPIO: 14 – 80
- Ideal for metering and medical-specific apps
- Featuring SD16, OpAmps, ESP430, LCD, and more

**F4xx**

Speed 8/16Mhz  
Flash 4-120kB  
RAM to 8k  
GPIO 14-80

BOR
LCD
ADC10,12
SD16( A)
Comp_A
DAC12
DMA
MPY
OpAmp
SVS
USART
USCI
ESP430
SCAN_IF
Basic Timer
WDT+
RTC_C

**F5xx**

Speed 25Mhz  
Flash 8-256kB  
512kB coming soon.  
RAM to 18kB  
GPIO 32-83

BOR
SVS
SVM
LDO
MPY
USCI
DMA
EDI
USB
ADC10,12 (A)
Comp_B
RTC_A/B
WDT

**CC430**

Speed 20Mhz  
Flash 8-32kB  
RAM to 4kB  
GPIO 40

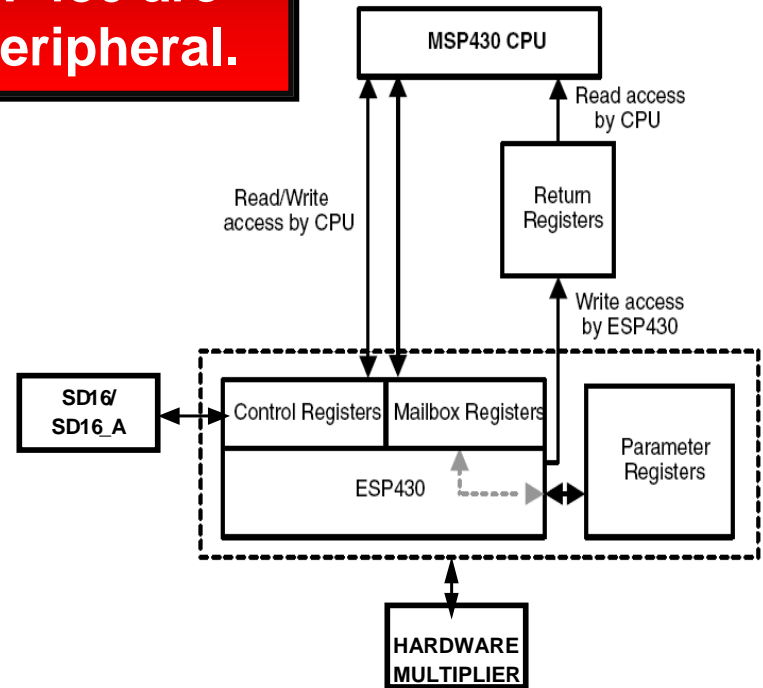
BOR
SVS
SVM
LDO
MPY
USCI
DMA
SUB 1GHZ RF
AES
ADC12 (A)
Comp_B
RTC_A/B
LCD

All Devices Some Devices

# ESP: Single-Chip E-Meter

eMetering-specific devices from MSP430 are integrated with the unique ESP430 peripheral.

- **Embedded Signal Processor (ESP)**
- **ESP430** - Energy metrology engine running parallel to MSP430 CPU activity
- Dedicated use of SD16s and Hardware multiplier
- Combines analog and digital signal processing
- Returns energy, power, voltage, current and power factor measurements
- Offload the MSP430 CPU by allowing the ESP430 to handle eMetering specific algorithms.
- Black box operation



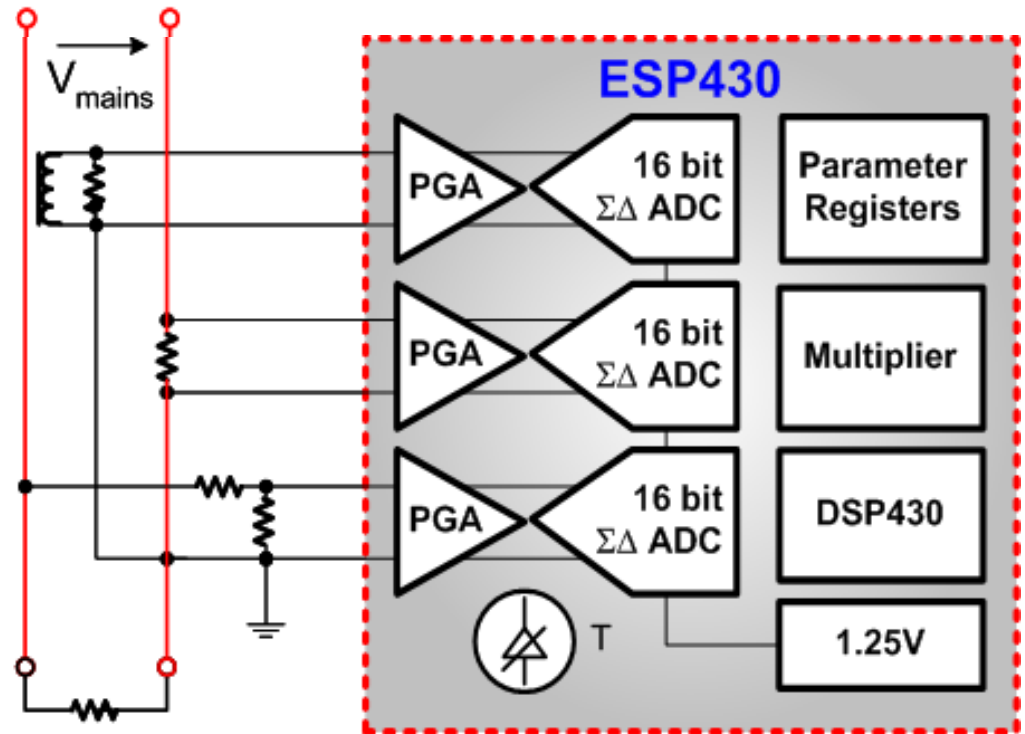
# ESP: Single-Chip E-Meter

## Features

- An embedded SoC dedicated to E-metering function
- Measures 2 or 3 wire, single phase energy and automatically calculates energy, power factor, etc

## Benefits

- Minimize system size with true SoC functionality
- Reduce total system chip count by 80%
- Maximize CPU offload with true encapsulated single phase e-meter module
- ESP430 offers black box operation, which simplifies eMetering application development.



# MSP430 Portfolio at a glance

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Featuring: Up to 256kB Flash, 18kB RAM, 24 Package Options, Up to 113 pins, High integration

← Ultra-Low Power Performance — Analog Integration — Easy-to-Use →

## MSP430

16-bit RISC CPU

All devices feature:

- 16-bit timers
- Watchdog Timer
- Internal Digitally Controlled Oscillator
- External 32-kHz crystal support
- <50 nA pin leakage
- <6 μs wakeup

The **MSP430F5xx** generation features ultra-low power, high-performance, flash-based microcontrollers

- Up to 25MHz CPU speed
- Flash size up to 256kB (512kB coming!)
- RAM size up to 18kB
- GPIO: 32 – 83
- Ideal for general purpose, consumer electronics, point of sales
- Featuring integrated USB, LCD, and more

## F5xx

Speed 25Mhz  
Flash 8-256kB  
512kB coming soon.  
RAM to 18kB  
GPIO 32-83

## CC430

Speed 20Mhz  
Flash 8-32kB  
RAM to 4kB  
GPIO 40

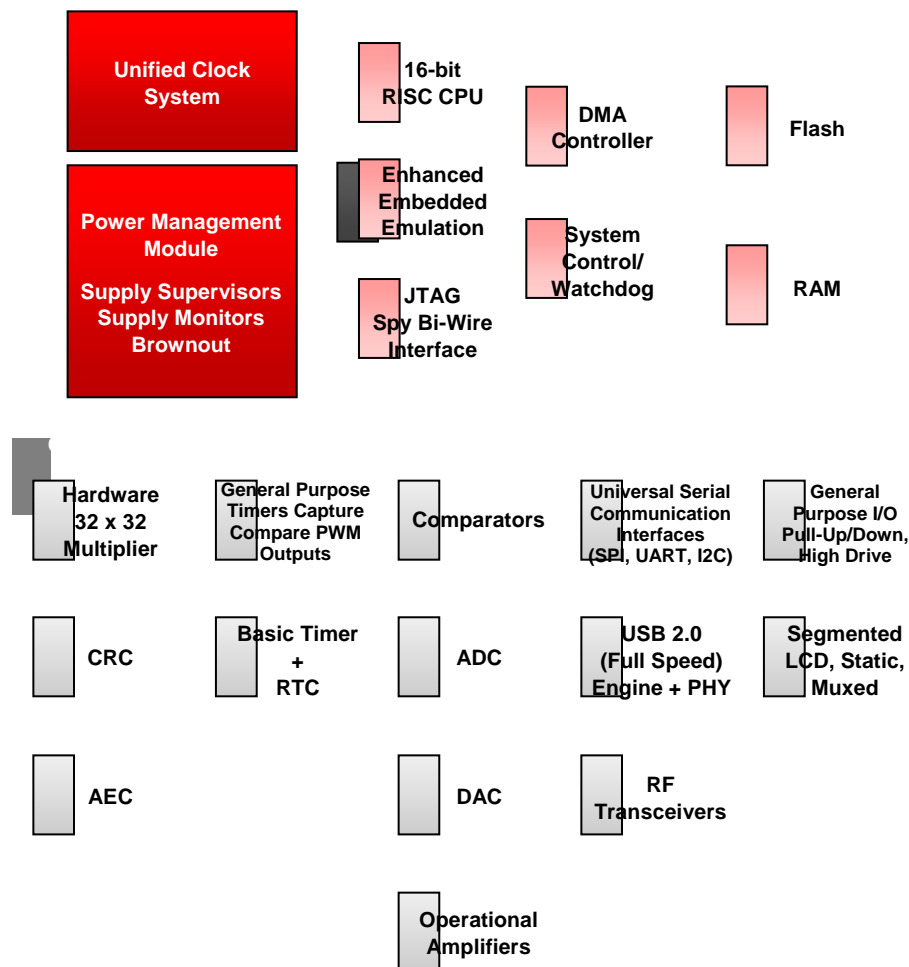
PMM	BOR
	SVS
	SVM
	LDO
MPY	
USCI	
DMA	
EDI	
USB	
ADC10,12 (A)	
Comp_B	
RTC_A/B	
WDT	

PMM	BOR
	SVS
	SVM
	LDO
MPY	
USCI	
DMA	
SUB 1GHZ	
RF	
AES	
ADC12 (A)	
Comp_B	
RTC_A/B	
LCD	

All Devices Some Devices

# 5xx Key Features

- Ultra-Low Power
  - <200  $\mu$ A/MIPS
  - 1.2  $\mu$ A standby mode
  - Integrated LDO, BOR, WDT+, RTC
  - 12 MHz @ 1.8V
  - Wake up from standby in <5  $\mu$ s
- Increased Performance
  - Up to 25 MHz
  - 1.8V ISP Flash erase and write
  - Fail-safe, flexible clocking system
  - User-defined Bootstrap Loader
  - Up to 1MB 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
  - Unique Power Management Module
  - USB Options



# What's New in 5xx?

## MSP430F51xx

HiResPWM, CompB, 5V I/O

### Performance

- 16-bit RISC architecture, 40ns instruction cycle time
- Ultra-Low-Power, Integrated Analog, and Easy-to-Use

### Features

- F5xx Architecture
- Ultra-low power in active and sleep modes
  - ultrafast wake-up from standby mode in <1  $\mu$ s
  - Low supply voltage range 1.8-3.6V
- Timer\_D supporting Hi-resolution PWM
- Comp\_B with 16 inputs
- 5V tolerant push and pull IOs
- 38-pin DA (TSSOP); 40-pin RHA (QFN) (6mm x 6mm)

### Benefits

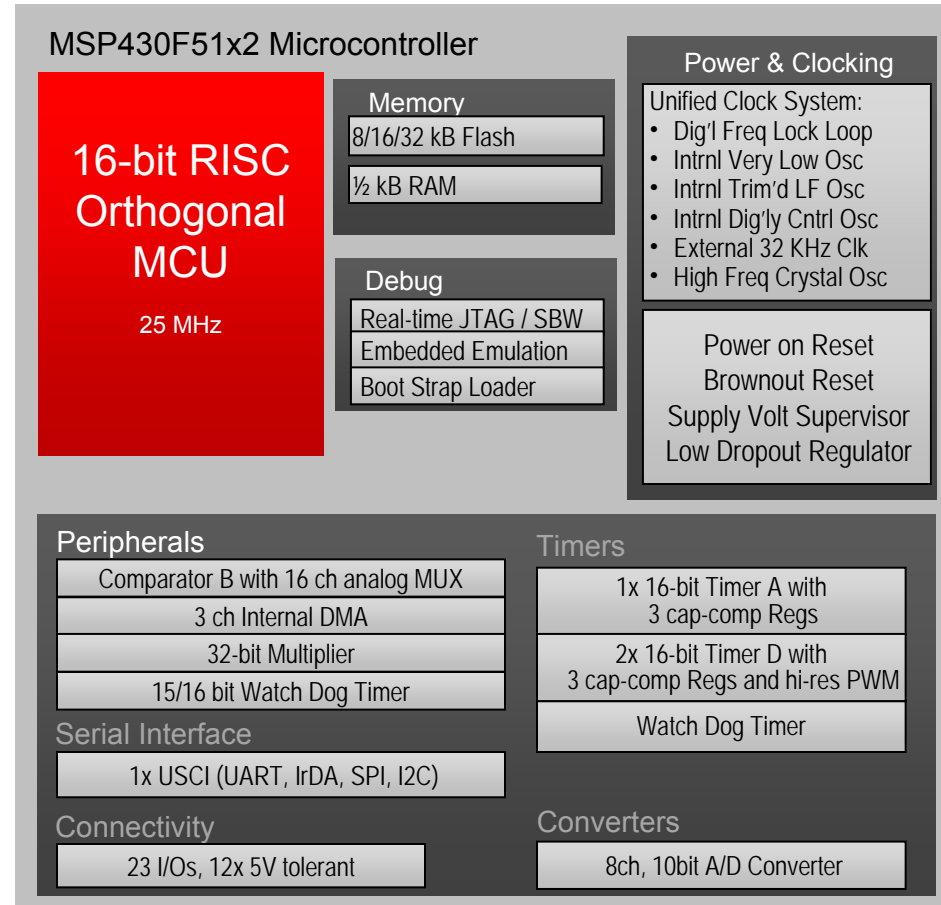
- **Precise control applications** such as LED lighting or motor control
  - due to 4ns Hi-res timer
- **Cap touch** applications such as cell phone keypad, legacy button replacements, PC mouse – enabled by 16 input comparator optimized for RO cap touch
- **Driving Bright LEDs** and ideal for battery operated devices due to world's lowest power MCU
- **Small Footprint** of QFN package

### Tools

- MSP-TS430RSB40 Target Board - with a mounted 40-pin ZIF socket to fit MSP430 F51x2 40pin WQFN package
- TBD - Lighting Demo Kit showing PFC Buck, DC/DC buck boost capabilities, wireless control, and DALI, DMX512 protocols

### Applications include:

- LED lighting Applications with AC inputs
- Portable LED Back Light solutions
- Battery powered LED spatial lighting
- High resolution Cap Touch



# Integrated Full-Speed USB

**40+ MSP430 devices with integrated USB – backed by Tools and Software**



## Ultra-low power MCUs + USB for smarter connectivity

- Embedded full-speed USB 2.0 (12 Mbps)
- High flexibility with configurable 2K data buffers that can be used as RAM
- Unused USB interface pins can function as high-current I/O pins (5 volt tolerant)

## Analog and peripheral integration reduces system cost

- Multiple analog options with 12-bit ADC, DAC, comparator
- Integrated 3.3V LDO for use with 5V USB bus power
- Uses low-cost crystal for USB clock, with flexible, integrated PLL

## Added features within MSPF663x / F563x devices

- Integrated 160 segmented LCD driver
- Higher flash memory options up to 256KB
- Battery back-up switch and Enhanced Data Integrity (EDI) feature for added reliability



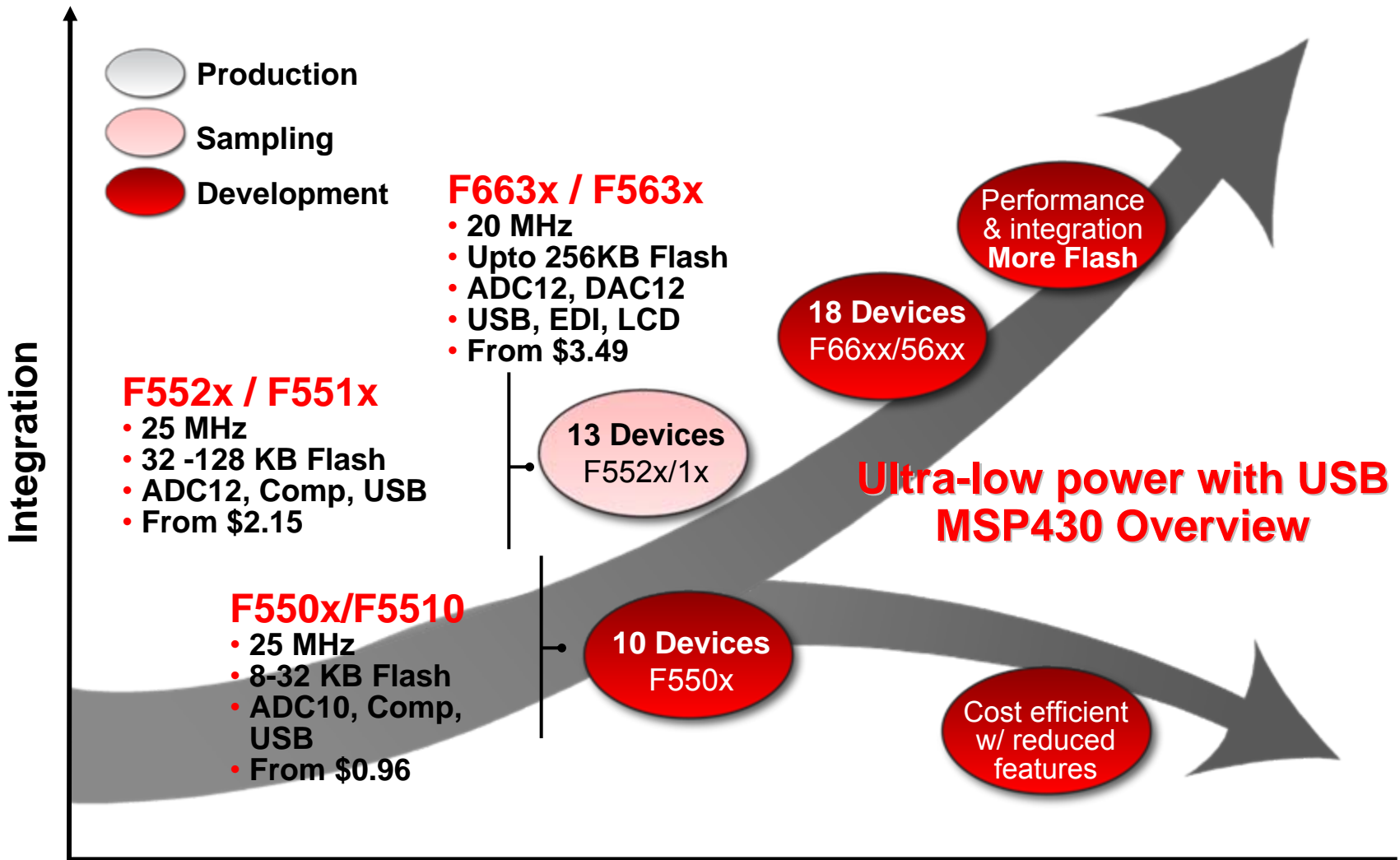
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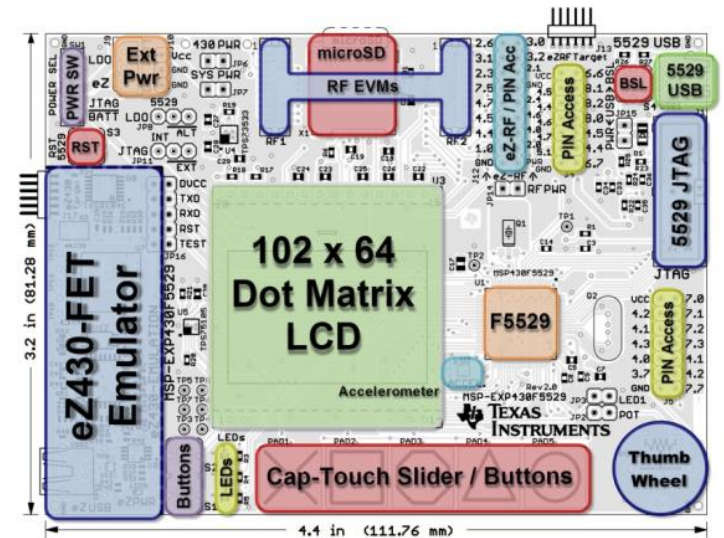
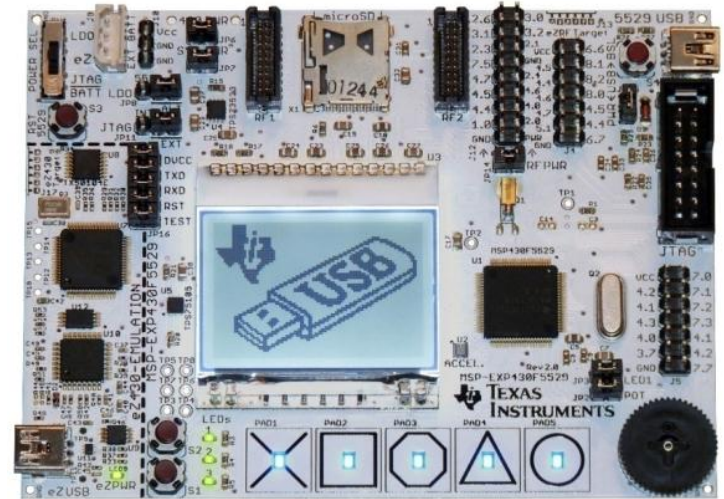
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# MSP430 w/USB Roadmap



# MSP-EXP430F5529 USB Experimenter Board

- Development platform for USB applications.
- 102x64 dot-matrix LCD
- microSD card slot
- 3-axis accelerometer
- 5 cap touch pads
- Built-in interface for Low Power Wireless RF modules (CCxxxxEMK)
- 9 LEDs
- analog thumb-wheel
- easy access to spare pins
- standard JTAG access
- integrated eZ-FET Spy Bi-Wire debug interface (USB FET not required for programming and debugging)



Available Now: ~~\$149~~ \$75

[www.ti.com/usbxp](http://www.ti.com/usbxp)



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# USB Software Tools

MSP430 Software Tools make USB development EASY

## USB Developer's Package

**Includes** SW Tools, Documentation & Examples

- **MSP430 API Code Stacks** All necessary APIs & examples to start USB development
- **USB Field Firmware Updater** Project template for building a GUI-based tool that upgrades MSP430 firmware in the field using MSP430's on-chip USB BSL.
- **Windows HID API** API enabling USB communication between PC and MSP430 MCU
- **USB Descriptor Tool** Code generation tool for configuring the USB API stack for various interfaces.

[Learn more @ www.ti.com/430usb](http://www.ti.com/430usb)



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For more information on F5xx and the  
USB Ecosystem, visit:  
[www.ti.com/5xx](http://www.ti.com/5xx)



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# MSP430 Portfolio at a glance

300+ Ultra-Low Power Devices Starting @ \$0.25USD

Featuring: Up to 256kB Flash, 18kB RAM, 24 Package Options, Up to 113 pins, High integration

← Ultra-Low Power Performance — Analog Integration — Easy-to-Use →

## MSP430

16-bit RISC CPU

All devices feature:

- 16-bit timers
- Watchdog Timer
- Internal Digitally Controlled Oscillator
- External 32-kHz crystal support
- <50 nA pin leakage
- <6  $\mu$ s wakeup

The **CC430** generation features ultra-low power, MCU+RF, flash-based system-on-chip microcontrollers

- Up to 20MHz CPU speed
- Flash size up to 32kB
- RAM size up to 4kB
- GPIO: 40
- Ideal for wireless, smart sensors, asset tracking
- Featuring monolithic, sub-1GHz integrated RF, LCD, AES128-bit encryption

## CC430

Speed 20Mhz  
Flash 8-32kB  
RAM to 4kB  
GPIO 40

All Devices

Some Devices



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# MSP430 – Your Low Power RF Protocol/Applications Microcontroller

	RF Systems-on-Chip	Application MCU RF Radio	Application MCU+ RF Protocol Processor
Application			MSP430
Wireless Protocols	RF SoC ( <b>CC430</b> , CC2430, CC2510, CC1110)	MSP430 (F54xx, F24xx, F26xx)	Protocol processor (CC2480, <b>CC430</b> )
Radio		Transceiver (CC1101, CC2500, CC2520)	

[http://focus.ti.com/apps/docs/appcategory.tsp?appId=171&DCMP=TIHeaderTracking&HQS=Other+OT+hdr\\_a\\_wireless](http://focus.ti.com/apps/docs/appcategory.tsp?appId=171&DCMP=TIHeaderTracking&HQS=Other+OT+hdr_a_wireless)



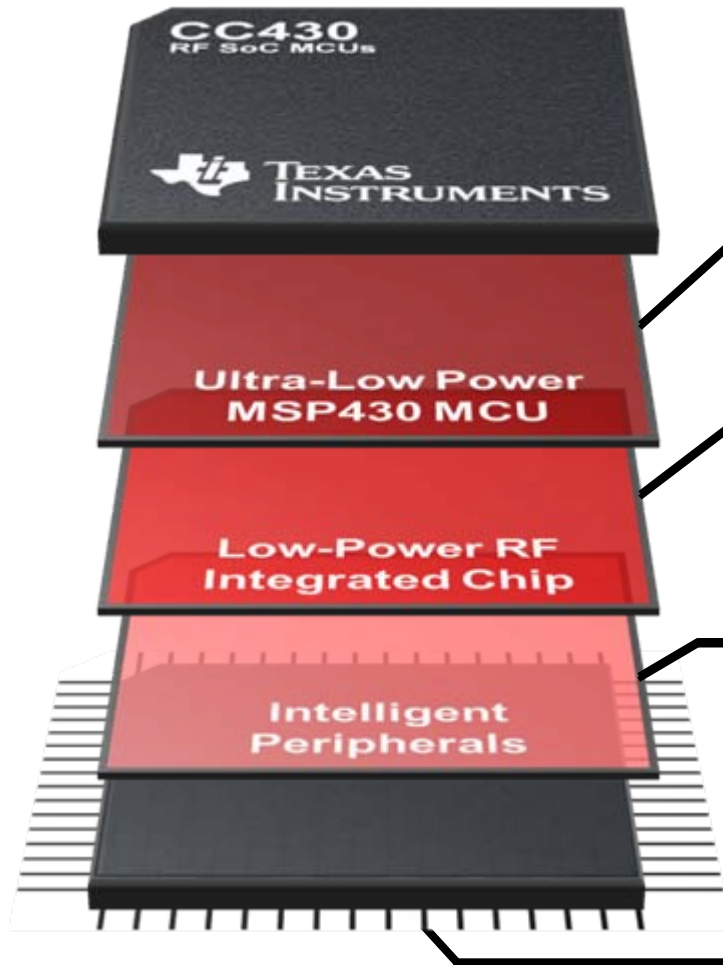
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# CC430 | MCU with integrated RF (SoC)



## **MSP430™ Microcontroller**

- Industry's lowest power MCU
- 16-bit RISC architecture
- 20 MHz processor
- High-performance analog
- Sensor interface

## **CC1101 RF Transceiver SoC**

- High sensitivity
- Low current consumption
- Excellent blocking performance
- Flexible data rate & modulation format

## **Intelligent Peripherals**

- 100 nA comparator
- 8ch 12-bit ADC offering 200-ksps
- 96 segment LCD controller
- 128-bit AES security encryption/decryption coprocessor

## **48/64-Pin QFN Package**

- 7x7 mm<sup>2</sup> / 9x9 mm<sup>2</sup> area



# CC430 derivatives

## With LCD module

- **CC430F6137**  
(LCD, ADC, Comparator B, 64-Pin)
  - 32KB+512B FLASH
  - 4KB RAM
- **CC430F6135**  
(LCD, ADC, Comparator B, 64-Pin)
  - 16KB+512B FLASH
  - 2KB RAM
- **CC430F6127**  
(LCD, Comparator B, 64-Pin)
  - 32KB+512B FLASH
  - 4KB RAM
- **CC430F6125**  
(LCD, Comparator B, 64-Pin)
  - 16KB+512B FLASH
  - 2KB RAM

## Without LCD module

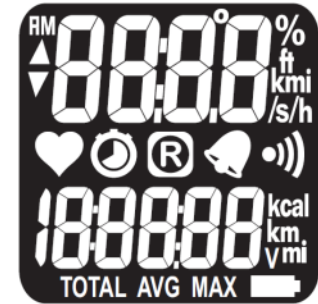
- **CC430F5137**  
(ADC, Comparator B, 48-Pin)
  - 32KB+512B FLASH
  - 4KB RAM
- **CC430F5135**  
(ADC, Comparator B, 48-Pin)
  - 16KB+512B FLASH
  - 2KB RAM
- **CC430F5133**  
(ADC, Comparator B, 48-Pin)
  - 8KB+512B FLASH
  - 2KB RAM



# CC430 Offers Unique Peripherals

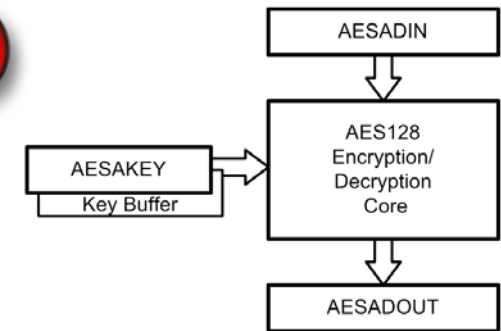
## LCD\_B

- Blinking of individual segments, Programmable frame frequency, Software-driven contrast control
- Regulated charge pump
- Integrated drivers



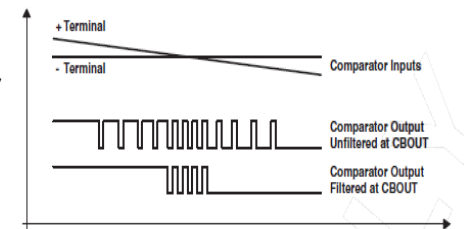
## AEC 128

- **Encryption** and **decryption** according to AES FIPS PUB 197 with 128-bit keys
- Key expansion for en- and decryption
- Off-line key generation for decryption



## Comparator\_B

- Flexible - Selectable ref. voltage & voltage hysteresis generator
- High-speed, normal, and **ultra-low power 100nA** modes
- Internal output to Timer A capture
- Selectable RC filter for comparator output



# Broad range of applications benefit from low power networking

## Consumer / personal networking



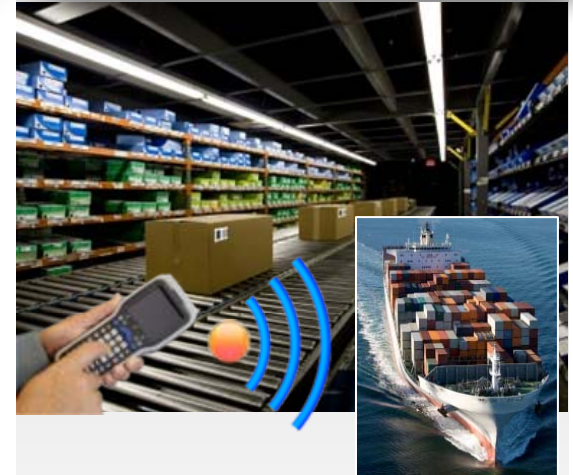
- Watch/shoe combination for monitoring of miles and calories
- Enough processing for wireless networking and batteries that 10+ years

## Industrial remote monitoring



- Low power sensor networks for innovative applications like remote monitoring for stress cracks
- Harvest energy from motion, vibration and heat

## Shipment monitoring



- Information transmitted wirelessly is protected via encryption for more secure systems
- Location, tamper detection and temperature monitoring

# Strong, Vibrant Ecosystem & Solutions



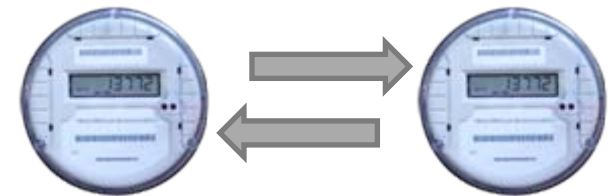
- IPv6 over low-power wireless area networks
- Highly efficient use of code and memory
- Direct end-to-end Internet integration
  - Multiple topology options



**Home automation & Lighting Control**



- Meter-to- meter communication
- Enables a simple star network topology that fits very well to the applications' requirements.
- Sub 1 GHz band (868 MHz)
  - Quality and low power consumption of the transmission critical



**Meter-to-Meter communication**



- Ultra-Low Power, Low Bandwidth space
  - Range is scalable, 10 - 2000 m (1.2 mi)
  - 433 MHz, 28 kbps
- Mandated by U.S. Department of Defense, allied militaries
- Asset Tracking, Tire pressure monitoring → sensors, security



**Asset Tracking & Tire Pressure Monitor**

# RF Software Tools

MSP430 Software Tools make USB development EASY

## SmartRF Studio



## SmartRF Studio 7

- Intuitive tool for evaluating TI's Low Power RF ICs and SoCs
- Generates device register values
- Tests RF performance and tune customer-specific hardware solutions.

## Packet Sniffer

- Analyze RF packets in real-time to greatly simplify RF debugging
- Display and store RF packets captured with a listening RF device
- Filters and decodes packets and displays them in a convenient way!

**Spectrum Analyzer (sub-1GHz) – coming soon**



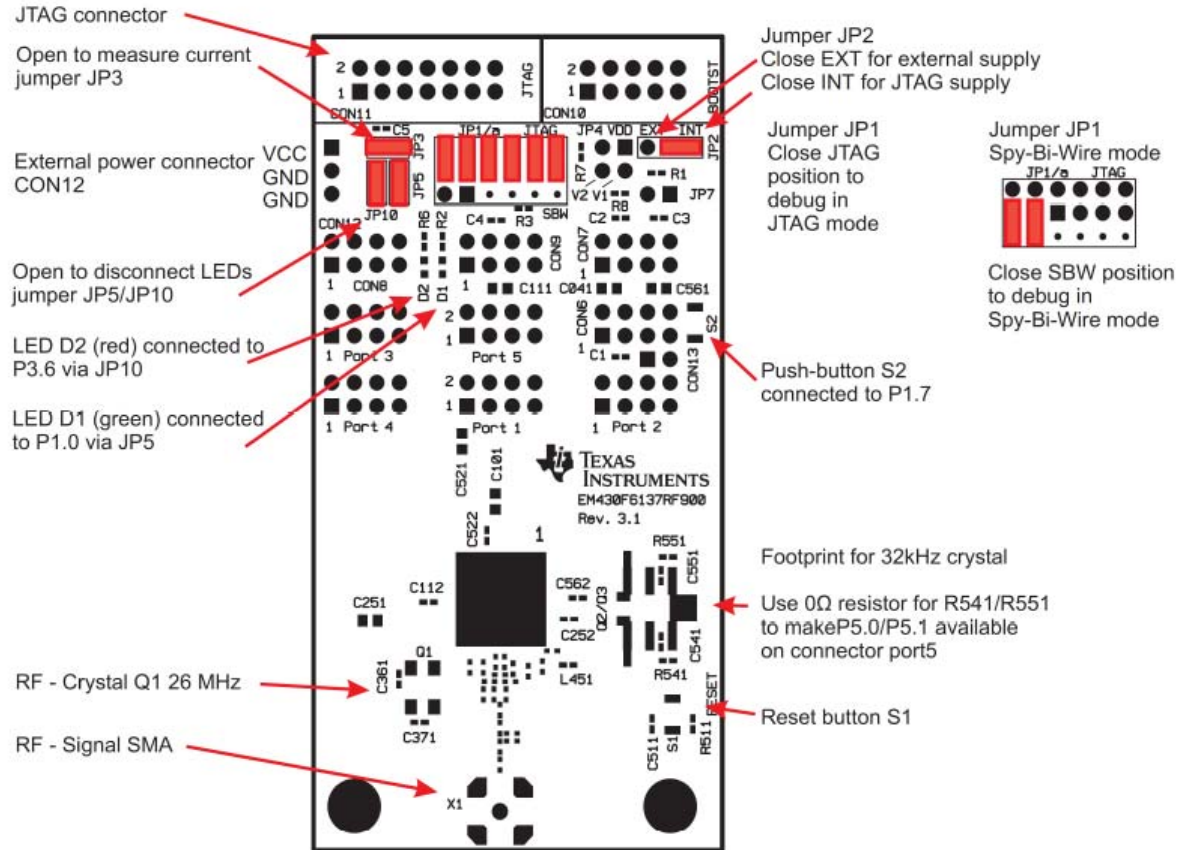
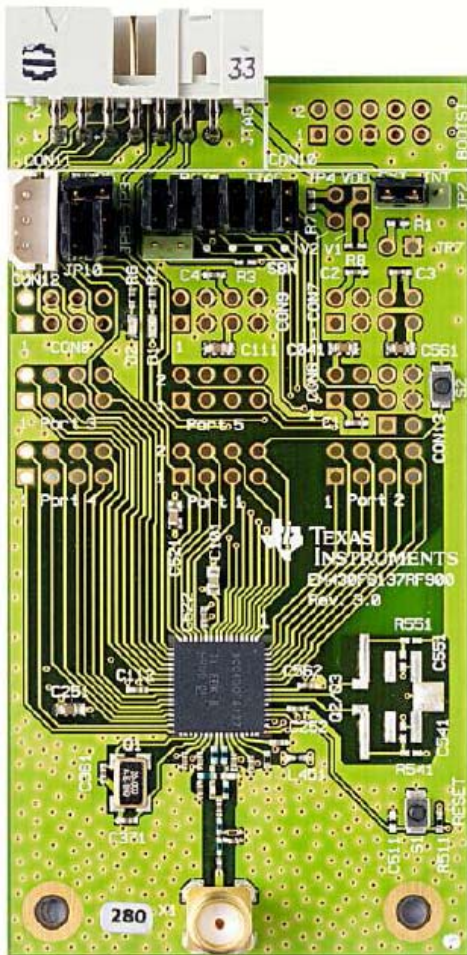
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# EM430F6137RF900 Sample Kit



# CC430 Experimenter's kit

## CC430F6137 base board:

- With custom LCD
- eZ430 emulator with backchannel
- All CC430 I/Os accessible
- 4 LEDs & 4 buttons, small soldering area
- Light Sensor + small F5137 base board

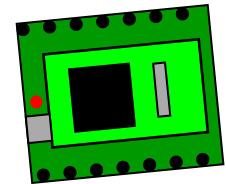
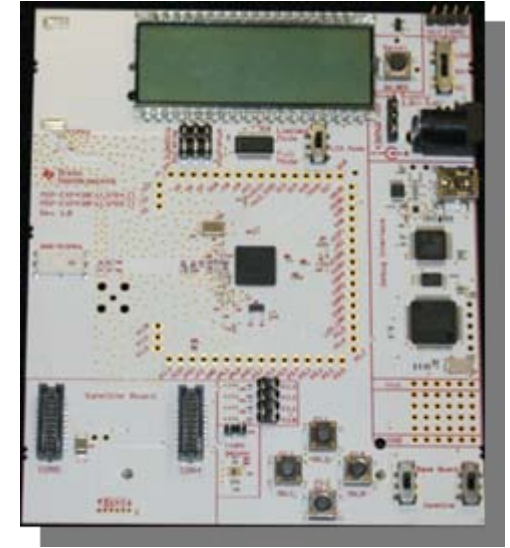
## CC430F5137 satellite board

- Small off-the-shelf amber wireless module on carrier PCB
- Can be debugged/programmed with base board
- Satellite board based on off-the-shelf module from Amber-Wireless

## In the box

- 1x Baseboard with batteries
- 1x satellite with batteries
- 1x USB cable
- wire antenna in addition to chip antenna + spare caps to select antenna (have to be soldered)

**Pricing:** US \$149 **Coming soon!**



# Chronos | World's first wearable development kit



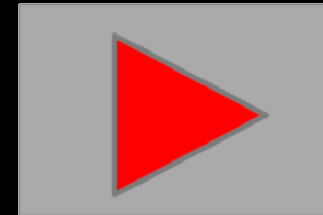
# Demo Break | Chronos

World's first wearable development tool

## Get started with RF development

Integrated with the CC430 MCU + RF SoC

- Sub 1GHz RF
- Integrated with LCD, 3 axis Accelerometer, pressure & temp sensor
- Comes with USB programmer and RF dongle



[Learn more @ www.ti.com/chronoswiki](http://www.ti.com/chronoswiki)

*Integrated, innovative, and unique development available for ~~\$49~~ **\$25***

TEXAS  
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For more information on CC430 & the  
RF Ecosystem, visit:  
[www.ti.com/cc430](http://www.ti.com/cc430)



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# MSP430 Portfolio at a glance

300+ Ultra-Low Power Devices Starting @ \$0.25USD

Featuring: Up to 256kB Flash, 18kB RAM, 24 Package Options, Up to 113 pins, High integration

← Ultra-Low Power Performance — Analog Integration — Easy-to-Use →

## MSP430 16-bit RISC CPU

### All devices feature:

- 16-bit timers
- Watchdog Timer
- Internal Digitally Controlled Oscillator
- External 32-kHz crystal support
- <50 nA pin leakage
- <6 μs wakeup

### L092

0.9V-1.65V  
Speed 4Mhz  
ROM to 2kB  
RAM to 2kB  
GPIO 11

BOR  
DAC8  
Comp  
SVS  
BOR  
WDT  
A-POOL  
ADC8

The **L092 device family** is the world's first **native 0.9V microcontroller**

- Up to 4MHz CPU speed
- ROM size up to 2kB
- RAM size up to 2kB
- GPIO: 11
- Features native **0.9V** operation, which enables all analog and digital logic to run at 0.9V without boosting components; Analog pool

[www.ti.com/lowvoltage/wiki](http://www.ti.com/lowvoltage/wiki)

All Devices Some Devices



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# Embedded Series



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# Analog Pool (A-POOL)

Maximum flexibility with Analog Pool

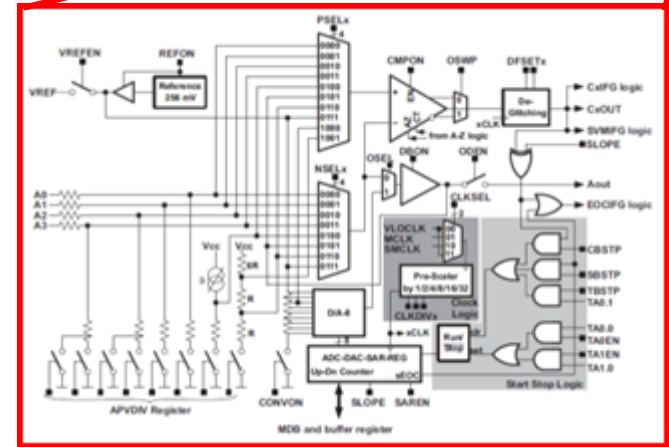
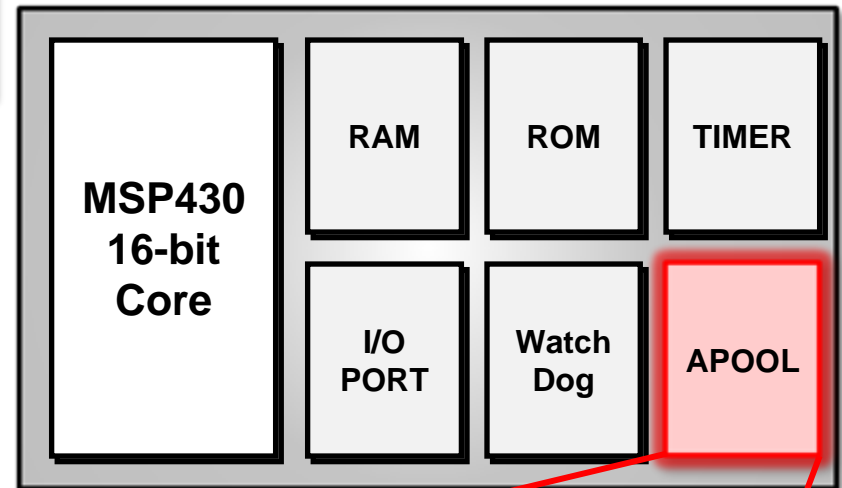
## Features

- A Software-configurable peripheral that can implement a complete signal chain
  - **Comparator**
  - 8-bit elementary **DAC**
  - 8-bit **ADC**
  - **Supply Voltage Monitor**
  - **Temperature Sensor**
  - **Ultra –low-voltage (256 mV) reference**

## Benefits

- Enable flexible and diverse designs
- Reduce board size
- Form a complete signal chain using one peripheral

## MSP430L092:



**For more information on the world's  
first Native 0.9V microcontroller, visit:  
[www.ti.com/lowvoltagewiki](http://www.ti.com/lowvoltagewiki)**



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**Embedded Series**

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# The Future of MSP430

Embedded FRAM

# FRAM | The Future of Embedded Memory



## FRAM provides maximum design flexibility

- **Universal memory:** Flexible use of work and data memory
- Maximizes value of PCB designs and customer product qualifications

## FRAM enables extreme ULP applications

- **High-speed (1000x), Low-voltage (10x) writes** for maximized battery lifetime
- **Lowest Active Power** in the Industry (<100uA/MHz) for autonomous nodes

## FRAM is reliable

- Endures in severe operating conditions, including radioactive environment
- FRAM is not effected by electromagnetic fields

## FRAM excels in Security applications

- Low-voltage High-speed writes minimize vulnerability to hacker attacks
- Drives new applications in Security by combining Security with Low-power

## FRAM is the best option for Data loggers

- **Maximized endurance of  $10^{14}$  write cycles** facilitates data logging
- Reduces BOM by avoiding EEPROM chip

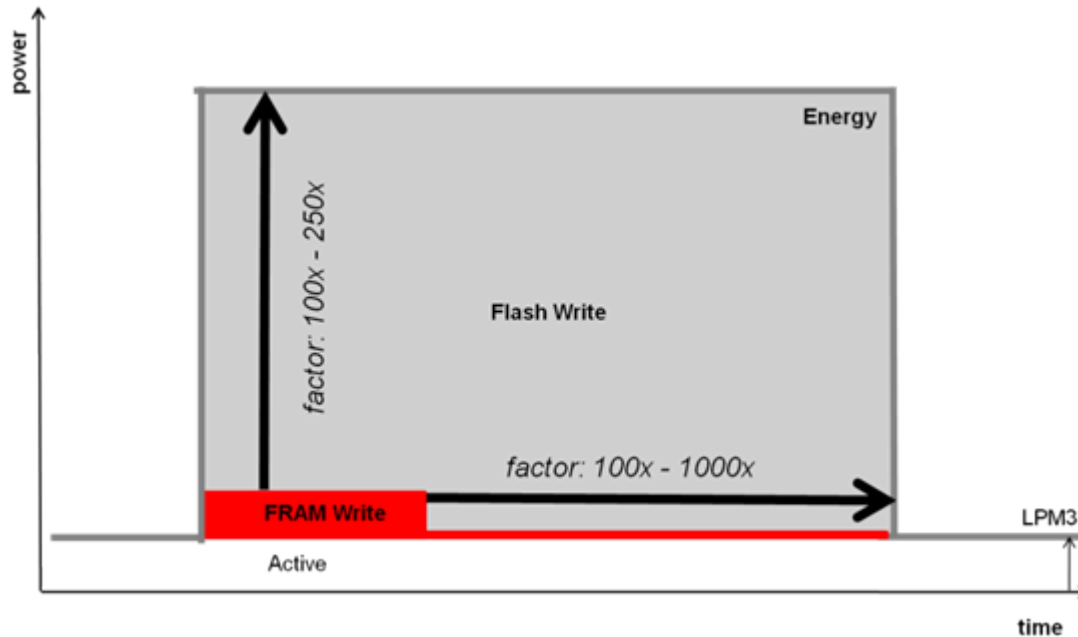
## TI is 10 years ahead with the tech of the future

- **Leveraging 10 years of RAMTRON experience**
- No scaling roadblocks on the horizon as in Flash memory

- Universal Memory
- 100 Trillion cycles
- 100x faster write
- 250x lower power



# FRAM is Faster and Lower Power



**Enable more effective & efficient applications**

- Up to 250x lower power
- Up to 1000x faster

# FRAM offers unseen write endurance



- Data Logging without compromise!
- Superior Realtime performance due to fast write!

# FRAM (Ferroelectric Random Access Memory)

Welcome to the future of embedded memory...

## Universal Memory

- Reconfigurable Memory block as cache (RAM), program or data memory
- Unparalleled Flexibility for developers
- Improved inventory efficiency

## 100 Trillion Read/Write cycle

- Best-in-class write endurance
- Datalogging without compromise
- 100 Billion times more cycles than Flash
- Best-in-class data reliability and radiation resistance

## New Realm of ULP

- Writes @ 250x lower power than Flash
- No charge pump! 1.5V low voltage writes
- Enables industry-best 82uA/MHz Active Mode current consumption
- ULP Standby Mode with Self wakeup: 0.5uA

## Ultra-Fast read/write speeds

- Up to 1000x faster writes than Flash
- Increased data throughput at much lower power
- Minimize risk window of data hacks

**Coming soon** @ Embedded Systems Conference San Jose  
• Broad Samples: May 2011  
• RTM: July 2011



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# Embedded Series



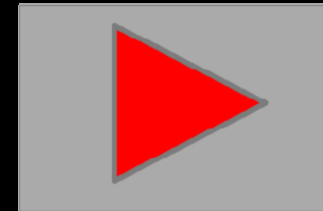
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# Demo Break | Meet FRAM

A new memory technology to meet the requirements of today and tomorrow...

Improve existing solutions and enable new applications with FRAM

- Enable lowest power active modes
- Up to 250x lower power
- Up to 1000x faster
- $10^{14}$  write cycles



[Learn more @ www.ti.com/fram](http://www.ti.com/fram)

*Welcome to the future of  
Embedded Memory*



# MSP430 Key Values

**MSP430**  
Ultra-Low Power MCUs



**MSP430 is Easy. Get started today.**

- Easy-to-use development tools
- Intuitive software tools
- Complete code library
- Get started at just \$4.30!



Easy and Affordable  
Tool Chain

# Easy and affordable tool chain

Get started at just \$4.30

MSP430 offers the **world's most affordable development kits!**

Start developing today with MSP430's \$4.30 LaunchPad development kit! Or start using our eZ430 evaluation modules (\$49 and under)!

These development kits include all of the hardware and software you need to get started today!



## \$4.30 LaunchPad

### MSP-EXP430G2

Easy development kit for MSP430G2xx MCUs. Includes all the HW/SW needed to start today!

#### • FEATURES:

- Integrated emulator for programming and debugging via USB
- 20-pin DIP target socket
- 2 switches / 2 LEDs
- Includes 2 MSP430G2xx devices, USB cable, PCB headers, quick start guide

• PRICE: **\$4.30**



## eZ430 Evaluation Kits

### eZ430-F2013

Based on MSP430F2013.  
Integrated emulator, 1 target  
Price: \$20

### eZ430-RF2500

Based on MSP430F2274  
Includes CC2500 2.5GHz RF  
Integrated emulator, 2 targets  
Price: \$49

### eZ430-Chronos

Based on CC430F6137  
Sub-1GHz SoC  
Integrated sensors, emulator  
Price: \$49



## Experimenter Boards

Experimenter boards are complete development kits that enable developers to explore the full features of an MSP430 device.

MSP430 has experimenter boards for Metering, USB, RF, and General Purpose applications.

MSP-EXP430FG4618  
MSP-EXP430F5529  
MSP-EXP430RF6137  
MSP-EXP430F5438A

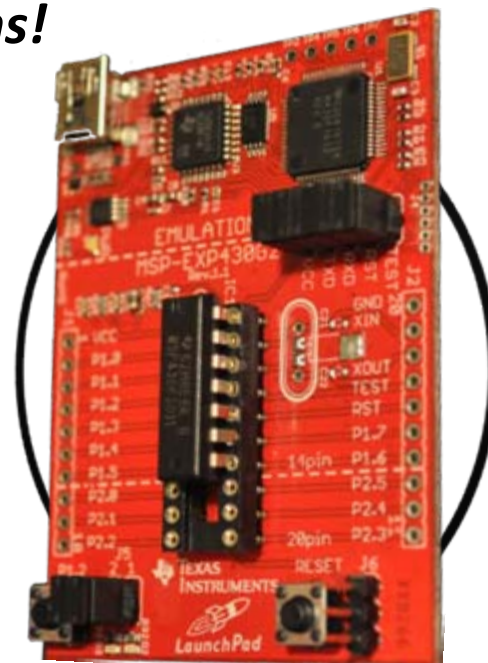
Price: \$149 each



# Meet the new *LaunchPad* (MSP-EXP430G2)

*Everything you need to Launch your applications!*

- + ***Embedded emulation***  
Includes mini USB Cable
- + ***14 and 20-pin DIP Socket***  
Supports all MSP430 Value Line devices
- + ***Includes 2x MSP430 Devices***  
MSP430G2231 & MSP430G2211
- + ***2 Pushbuttons***
- + ***2 LEDs***
- + ***FREE software Compiler/Debugger***  
Code Composer Studio Ver 4  
IAR Embedded Workbench



MSP430 **LaunchPad**

**\$4.30**

& for a limited time only  
**FREE SHIPPING!**



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**Embedded Series**



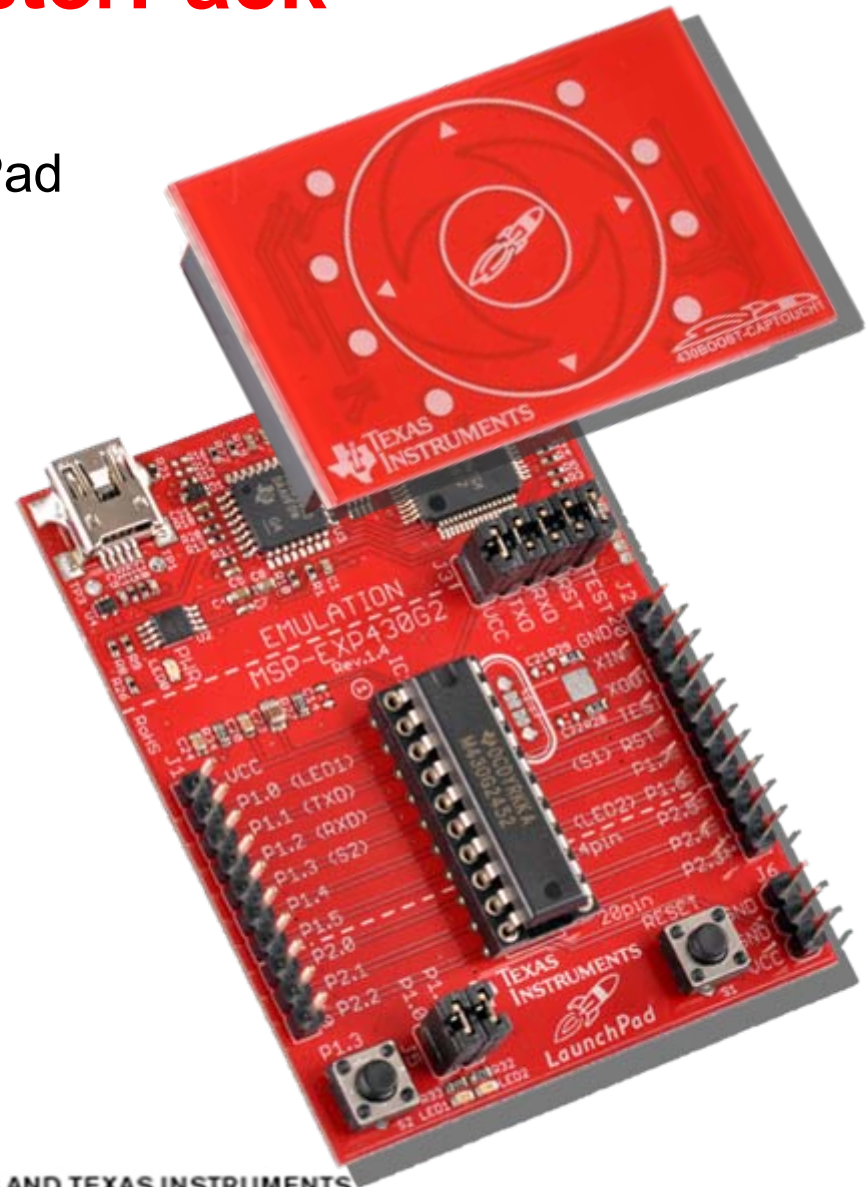
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# Capacitive Touch BoosterPack

Part Number: 430BOOST-SENSE1

- Capacitive Touch plug-in for LaunchPad
- Touch button, scroll wheel & proximity sensor
- Includes MSP430G2452 with Cap Touch I/O module
- Example design for scroll wheels & Proximity sensor
- Free Software Library
  - Free library for all MSP430 devices
  - Consumes as little as 1KB of Flash
  - Library supports various Touch Sensing algorithms
- [www.ti.com/capacitivetouch](http://www.ti.com/capacitivetouch)

**Only \$4.30** \*for a limited time



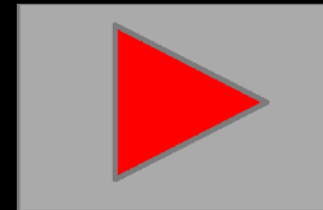
# Blast off with **LaunchPad (MSP-EXP430G2)**

Can I get started in 5 minutes, under \$5

## **ABSOLUTELY, but only with the LaunchPad Development Kit!**

Get started today, with the industry's lowest cost microcontroller development kit.

- Everything you need for \$4.30!
- Includes 2 MSP430G2xx devices
- Integrated Flash Emulation Tool for programming/debugging
- Supports 150+ MSP430G2xx Value Line microcontroller devices



[Learn more @ www.ti.com/launchpadwiki](http://www.ti.com/launchpadwiki)



# Scalable tool chain

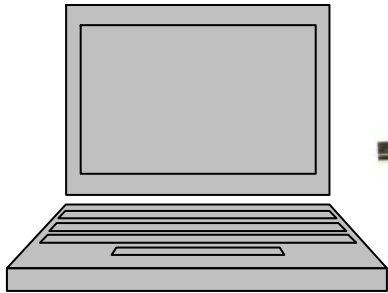
One Flash Emulation Tool for all 300+ MSP430 devices!

- **MSP430 Flash Emulation Tool (FET)** offers real-time debug and programming
- Supports **ALL** MSP430 devices when paired with appropriate Target Board
  - 4-wire JTAG or 2-wire Spy Bi-Wire

Support for all  
MSP430 IDEs

One Flash Emulation Tool (FET)  
to rule them all

A target board is available for all of  
MSP430's 24 package options

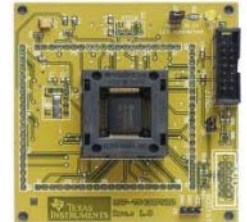
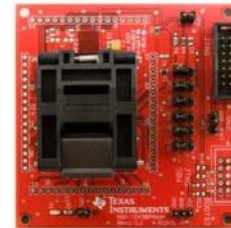


Interface via USB



MSP-FET430UIF

Price \$99



MSP-TS430xxxx

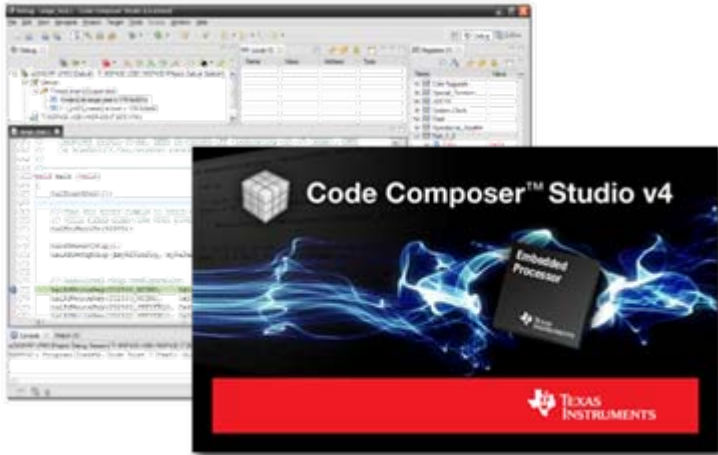
Price \$75

MSP-FET430Uxxxx  
(FET + Target bundle)

Price \$149 **\$75**

# Complete Software Suite

Free Integrated Development Environments (IDE) available



## Code Composer Studio version 4

- Eclipse-based IDE (Compiler, debugger, linker and more) for all TI embedded processors
- Unrestricted version available for \$445
- Free versions are available!
  - Free 16kB code-limited version available for download
  - Free, full-featured, 120-day trial version available

## IAR Embedded Workbench

- Strong third-party IDE offering with project management tools and editor. Includes config files for all MSP430 devices.
- Unrestricted version available for \$3200
- Free versions are available!
  - Free 4/8/16kB code-limited Kickstart version available for download
  - Free, full-featured, 30-day trial version available

 **IAR**  
SYSTEMS



**MSPGCC GNU IDE & other MSP430 IDE options are available! Learn more @ [www.ti.com/msp430tools](http://www.ti.com/msp430tools)**



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**Embedded Series**



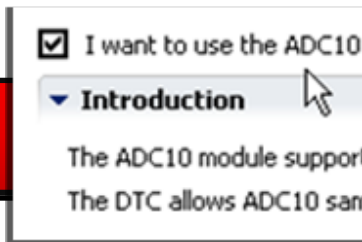
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# Meet Grace

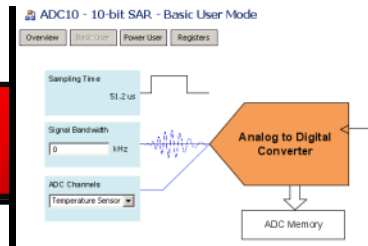
## Quicken time to market with Code generation tools

**Grace is a graphical user interface (GUI)** for enabling and configuring MSP430F2xx and G2xx peripherals. Navigate through buttons, drop down menus, and text fields to generate C code that properly enables and configures peripherals for your application.

- Spend less time enabling/configuring peripherals and spend more time in the application layer
- Various layers of abstraction – Basic View, Power User View, and Register View
- Helpful hints and hover overs guide developers through the configuration process
- Untap the full functionality of MSP430's integrated peripherals!
- Free plugin for Code Composer Studio.



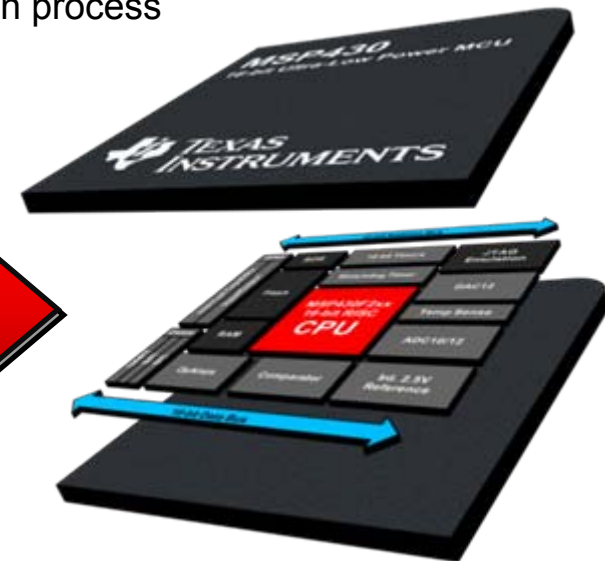
Enable peripherals with a single click



Interactive elements for peripheral configuration

```
5 void ADC10_init(void)
6 {
7     ADC10CTL0 &= ~ENC
8     /* Control Register
9     ADC10CTL0 = ADC10
10
11     /* Control Register
```

Generates fully-commented, easy-to-read C code



[www.ti.com/grace](http://www.ti.com/grace)



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Embedded Series



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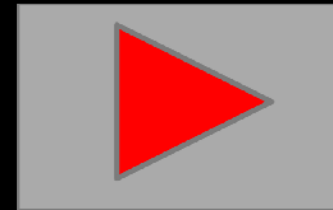
# GUI-based programming with **Grace**

Is there a GUI-based C code generation tool?

**Yes! The Grace graphical user interface generates fully commented C code.**

**Quicken time to market and promote more focus on the application layer!**

- Enable and configure MSP430F2xx and G2xx peripherals using an intuitive user interface
- Navigate buttons, drop-down menus & text fields to generate fully-commented C code
- Free plug-in for CCS



[Learn more @ www.ti.com/grace](http://www.ti.com/grace)



# Other Software Tools

MSP430 Software Tools make USB and RF development EASY

## RF Software Tools



### SmartRF Studio 7

- Intuitive tool for evaluating TI's Low Power RF ICs and SoCs
- Generates device register values
- Tests RF performance and tune customer-specific hardware solutions.

### Packet Sniffer

- Analyze RF packets in real-time to greatly simplify RF debugging
- Display and store RF packets captured with a listening RF device
- Filters and decodes packets and displays them in a convenient way!

## USB Tools

### USB Developer's Package (SW Tools, Documentation & Examples)

- **MSP430 API Code Stacks** All necessary APIs & examples to start USB development
- **USB Field Firmware Updater** Project template for building a GUI-based tool that upgrades MSP430 firmware in the field using MSP430's on-chip USB BSL.
- **Windows HID API** API enabling USB communication between PC and MSP430 MCU
- **USB Descriptor Tool** Code generation tool for configuring the USB API stack for various interfaces.

### Spectrum Analyzer (sub-1GHz) – coming soon



# Get Started Today



@ [www.ti.com/msp430](http://www.ti.com/msp430)



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# Extensive Community Support

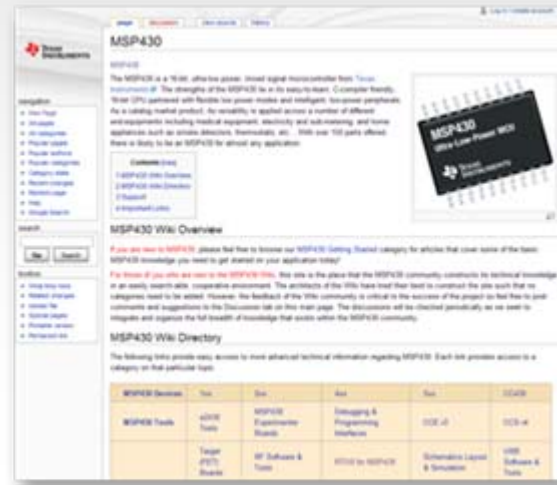
## E2E Community

- Videos, Blogs, Forums
- Extensive community support and idea exchange
- Global customer support
- <http://e2e.ti.com>




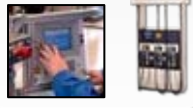










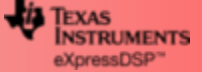
## Processor Wiki

- Growing collection of technical wiki articles
- Tips & tricks, common pitfalls, and design ideas
- <http://wiki.msp430.com>



# Beyond MSP430 TI's Processing Portfolio

TI Embedded Processors						
Microcontrollers (MCUs)		ARM®-Based Processors		Digital Signal Processors (DSPs)		
16-bit ultra-low power MCUs	32-bit real-time MCUs	32-bit ARM Cortex™-M3 MCUs	ARM Cortex-A8 MPUs	DSP DSP+ARM	Multi-core DSP	Ultra Low power DSP
<b>MSP430™</b>  Up to 25 MHz Flash 0.5 KB to 256 Analog I/O, ADC LCD, USB, RF Measurement, Sensing, General Purpose \$0.25 to \$9.00 	<b>C2000™ Delfino™ Piccolo™</b>  40MHz to 300 MHz Flash, RAM 16 KB to 512 PWM, ADC, CAN, SPI, I2C Motor Control, Digital Power, Lighting, Ren. Enrgy \$1.50 to \$20.00 	<b>Stellaris®</b> ARM® Cortex™-M3  Up to 100 MHz Flash 8 KB to 256 KB USB, ENET MAC+PHY CAN, ADC, PWM, SPI Connectivity, Security, Motion Control, HMI, Industrial Automation \$1.00 to \$8.00 	<b>Sitara™</b> ARM® Cortex™-A8 & ARM9  300MHz to >1GHz Cache, RAM, ROM USB, CAN, PCIe, EMAC Industrial computing, POS & portable data terminals \$5.00 to \$20.00 	<b>C6000™ DaVinci™ OMAP™</b> video processors 300MHz to >1Ghz +Accelerator Cache RAM, ROM USB, ENET, PCIe, SATA, SPI Floating/Fixed Point Video, Audio, Voice, Security, Conferencing \$5.00 to \$200.00 	<b>C6000™</b>  24.000 MMACS Cache RAM, ROM SRIO, EMAC DMA, PCIe Telecom test & meas., media gateways, base stations \$40 to \$200.00 	<b>C5000™</b>  Up to 300 MHz +Accelerator Up to 320KB RAM Up to 128KB ROM USB, ADC McBSP, SPI, I²C Audio, Voice Medical, Biometrics \$3.00 to \$10.00 




**Software & Dev. Tools**




MPUs – Microprocessors



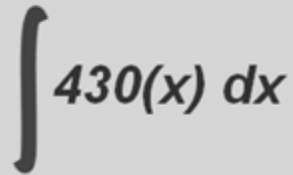
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**Embedded Series**  
 MAKE THE SWITCH

# THANK YOU!

**MSP430**  
Ultra-Low Power MCUs



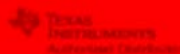
Ultra-Low Power



High Analog &  
Digital Integration



Easy and Affordable  
Tool Chain



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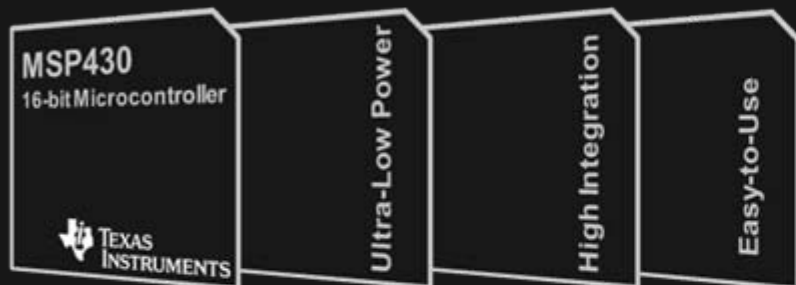
# MSP430\*

Ultra-Low Power Microcontrollers

<50nA Pin Leakage  
<1us Wake-up time  
0.1uA RAM Retention  
200uA Active Mode



9,133.2 Days  
1,304.7 Weeks  
300.2 Months  
25.2 Years



# 300+

Ultra-Low Power Microcontrollers

**150+** Value Line Microcontrollers

**6** MSP430 Generations

**Zero** Power Brown-Out Reset

**512** kB Flash Max

**SEVEN** Ultra-Low Power Modes

**16** Bit RISC Architecture

**>two-hundred** Application Notes

**113** Maximum pin count configuration

**24** Package options

**25** MIPS Max CPU Speed

**Thousands** of Code Examples

**\$4.30** Lowest Cost Development Tool

**250k** Tools Shipped

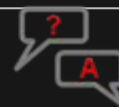
**>1 Billion** MSP430 Devices Shipped

**10k** LaunchPad kits shipped per month



**43 THOUSAND, 8 HUNDRED &**

**64** Active E2E Members World Wide



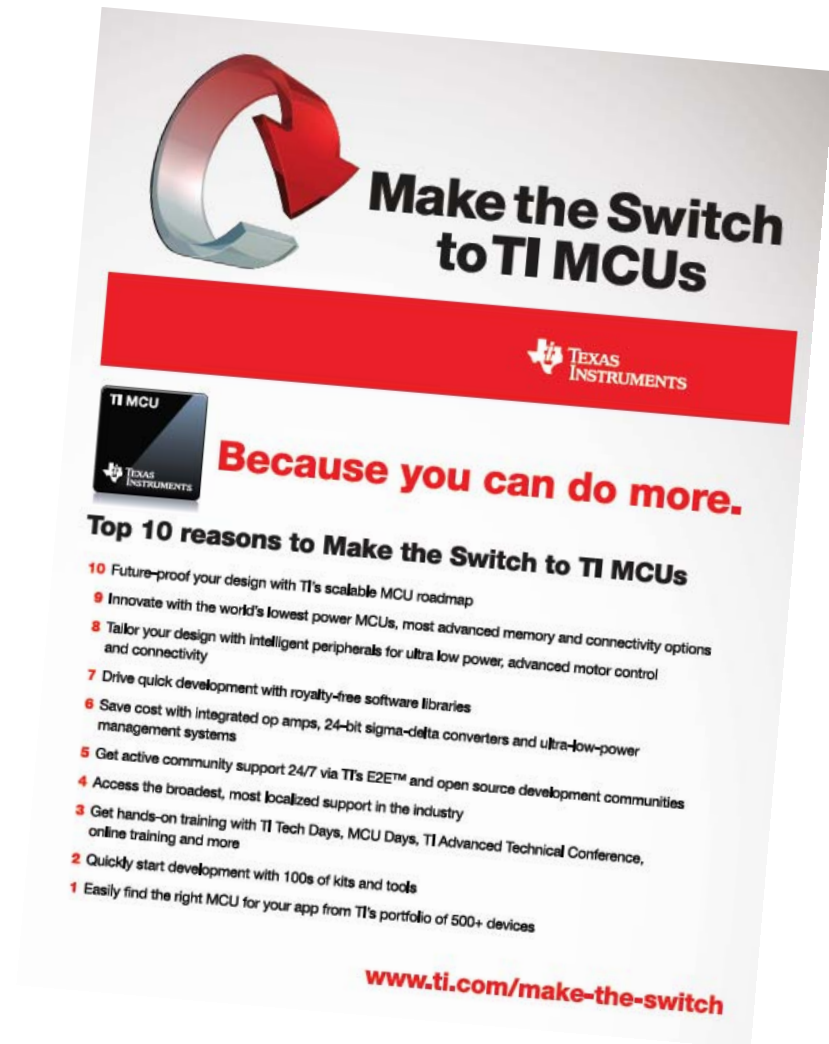
**19,352** E2E posts

# Make the Switch to TI Microcontrollers

Interested in designing with TI microcontrollers? Already using a TI MCUs but want to learn more? *It's easy!*

With a portfolio of 500+ MCUs, robust software options, 24/7 support, and more it's easy to switch to TI MCUs!

For more information, visit:  
[www.ti.com/make-the-switch](http://www.ti.com/make-the-switch)



**Make the Switch to TI MCUs**

TEXAS INSTRUMENTS

**Because you can do more.**

**Top 10 reasons to Make the Switch to TI MCUs**

- 10 Future-proof your design with TI's scalable MCU roadmap
- 9 Innovate with the world's lowest power MCUs, most advanced memory and connectivity options
- 8 Tailor your design with intelligent peripherals for ultra low power, advanced motor control and connectivity
- 7 Drive quick development with royalty-free software libraries
- 6 Save cost with integrated op amps, 24-bit sigma-delta converters and ultra-low-power management systems
- 5 Get active community support 24/7 via TI's E2E™ and open source development communities
- 4 Access the broadest, most localized support in the industry
- 3 Get hands-on training with TI Tech Days, MCU Days, TI Advanced Technical Conference, online training and more
- 2 Quickly start development with 100s of kits and tools
- 1 Easily find the right MCU for your app from TI's portfolio of 500+ devices

[www.ti.com/make-the-switch](http://www.ti.com/make-the-switch)



# EXCLUSIVE MSP430 and Stellaris Tool Discounts!

## MSP430 Day Attendee: Exclusive tool discounts!

Purchase via TI eStore to get 50% OFF  
for up to one of each tool:

- eZ430-Chronos Wireless Watch Development Tool –  
PN: ez430-chronos-915 (MSP430Day1)
- MSP430 Experimenter Board –  
PN MSP-EXP430F5529 (MSP430Day2)
- MSP430 Experimenter Board –  
PN: MSP-EXP430FG4618 (MSP430Day3)
- MSP430 Experimenter Board –  
PN: MSP-EXP430F5438 (MSP430Day4)
- All MSP-FET430Uxx kits (MSP430Day5)



Pick up a promo card and take  
advantage of these great deals!

Codes will be live for a month after the event and  
will expire May 31<sup>st</sup>

Presentations will be posted on  
[www.ti.com/embeddedseries](http://www.ti.com/embeddedseries)  
the day of the event

## Stellaris Day Attendee: Exclusive tool discounts!

Purchase via TI eStore to get up to one of each of  
the following kits for only \$49:

- Serial-to-Ethernet Reference Design Kit  
(RDK-S2E) (StellarisDay1)
- Ethernet Evaluation Kits (EK%-LM3S6965) (StellarisDay2)
- Ethernet+CAN Evaluation Kits (EK%-LM3S8962) (StellarisDay3)
- Ethernet+USB-OTG Evaluation Kits (EK%-LM3S9B90) (StellarisDay4)
- Ethernet+USB-OTG Evaluation Kits (EK%-LM3S9B92) (StellarisDay5)
- EVALBOT Evaluation Kits (EK%-EVALBOT) (StellarisDay6)\*\*



\*code valid thru 5-31-11

\*\*\$100 instead of regular \$149

[www.ti.com/estore](http://www.ti.com/estore)



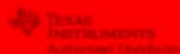
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# Embedded Series



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# BACKUP



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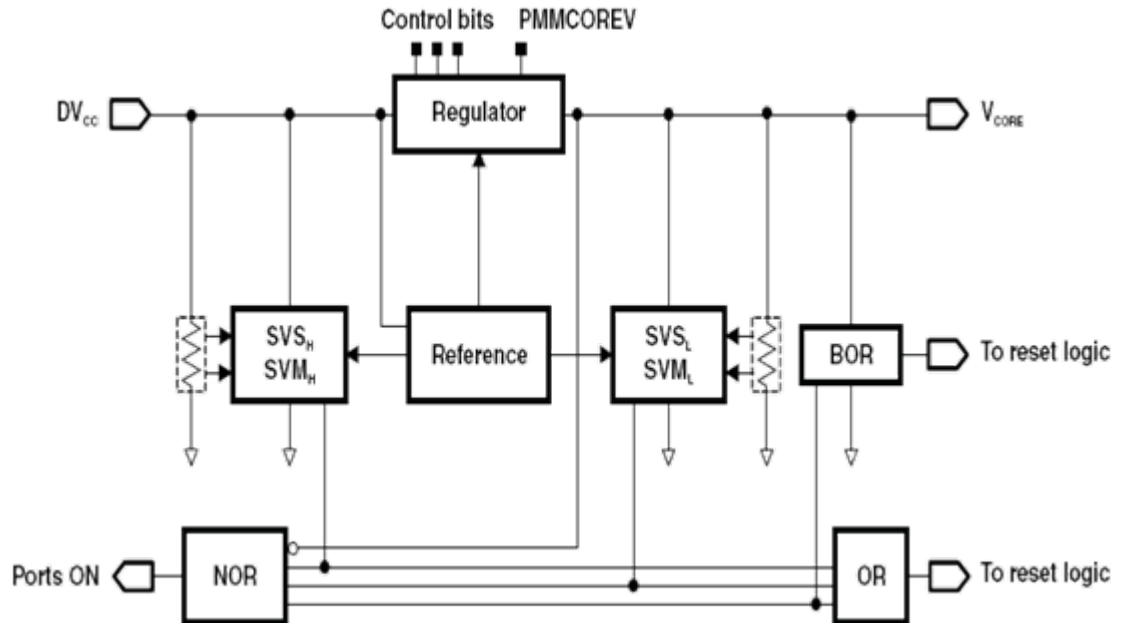
# Power Management Module (PMM)

## Features

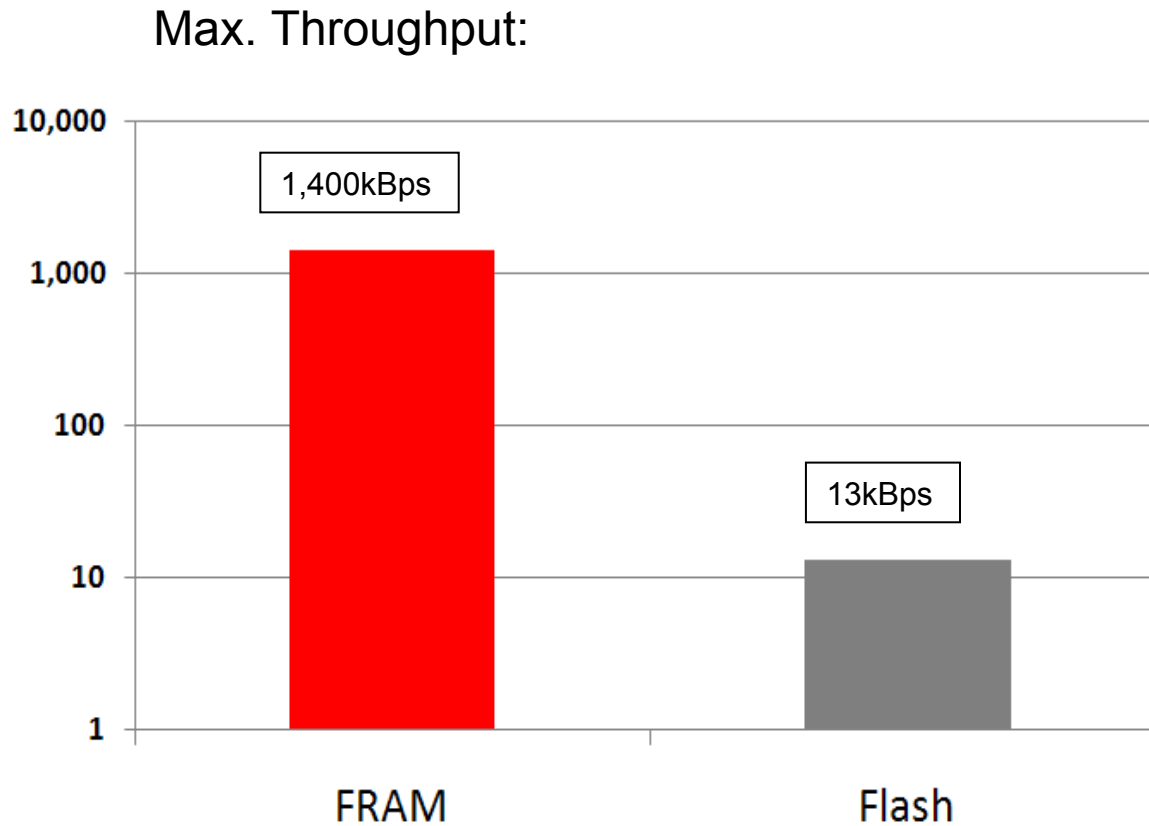
- Integrated LDO
- $V_{\text{CORE}}$  level programmable
- Flexibility in processing performance vs. power
- Integrated supervision & monitoring
- Zero-power BOR
- Five integrated supervisors
  - SVSH, SVSL, SVMH, SVML & BOR

## Benefits

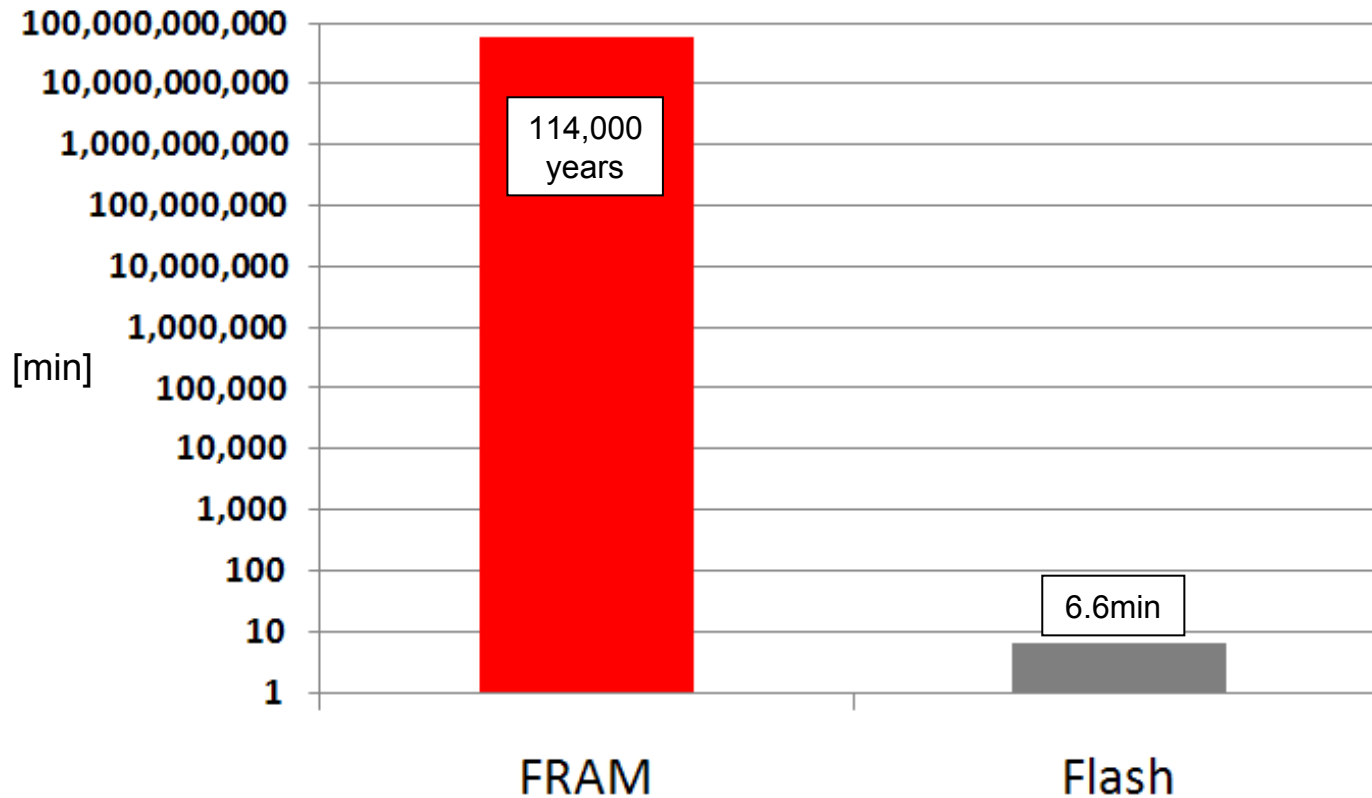
- Ultra-Low Power Functionality
- Ensure proper operation in power on and off sequences



# FRAM enables 100x faster writes!

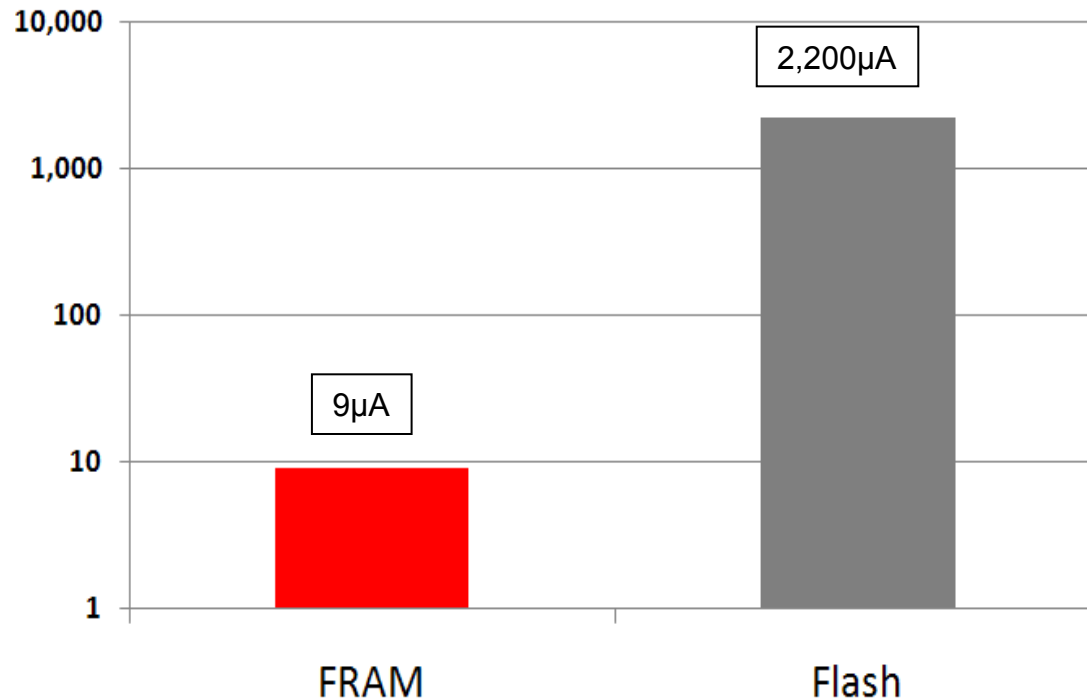


# FRAM – Endurance outperformance! Count the zeros!

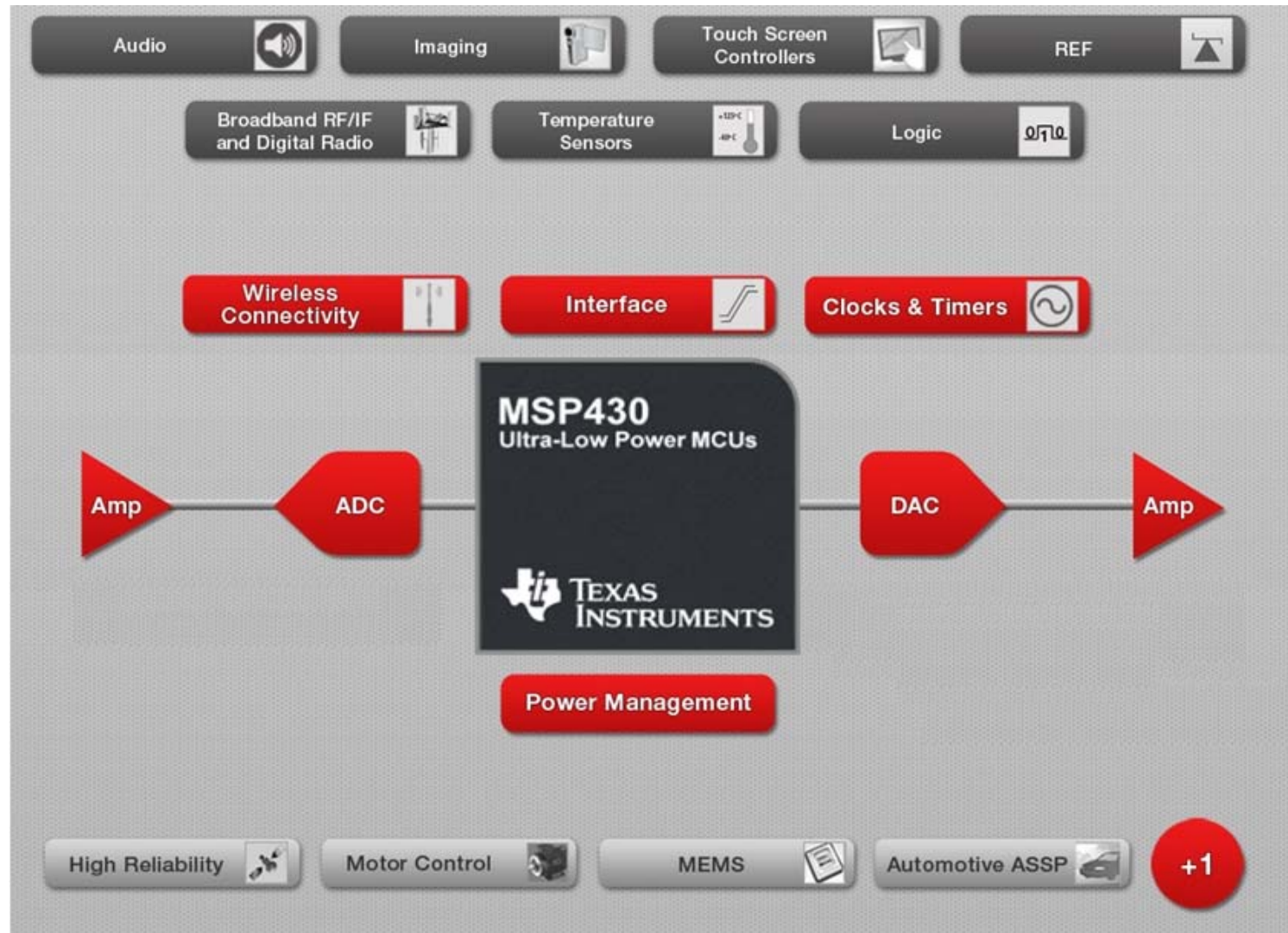


# FRAM consumes 250x less power than flash while writing!

Consumption @ 13kBps:



# MSP430: it's what's on the inside that counts. ...most of the time



# Need more \_\_\_\_\_ ?

- Functionality, Precision, Power Management, Interface....
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