

# It's Time for a Change!



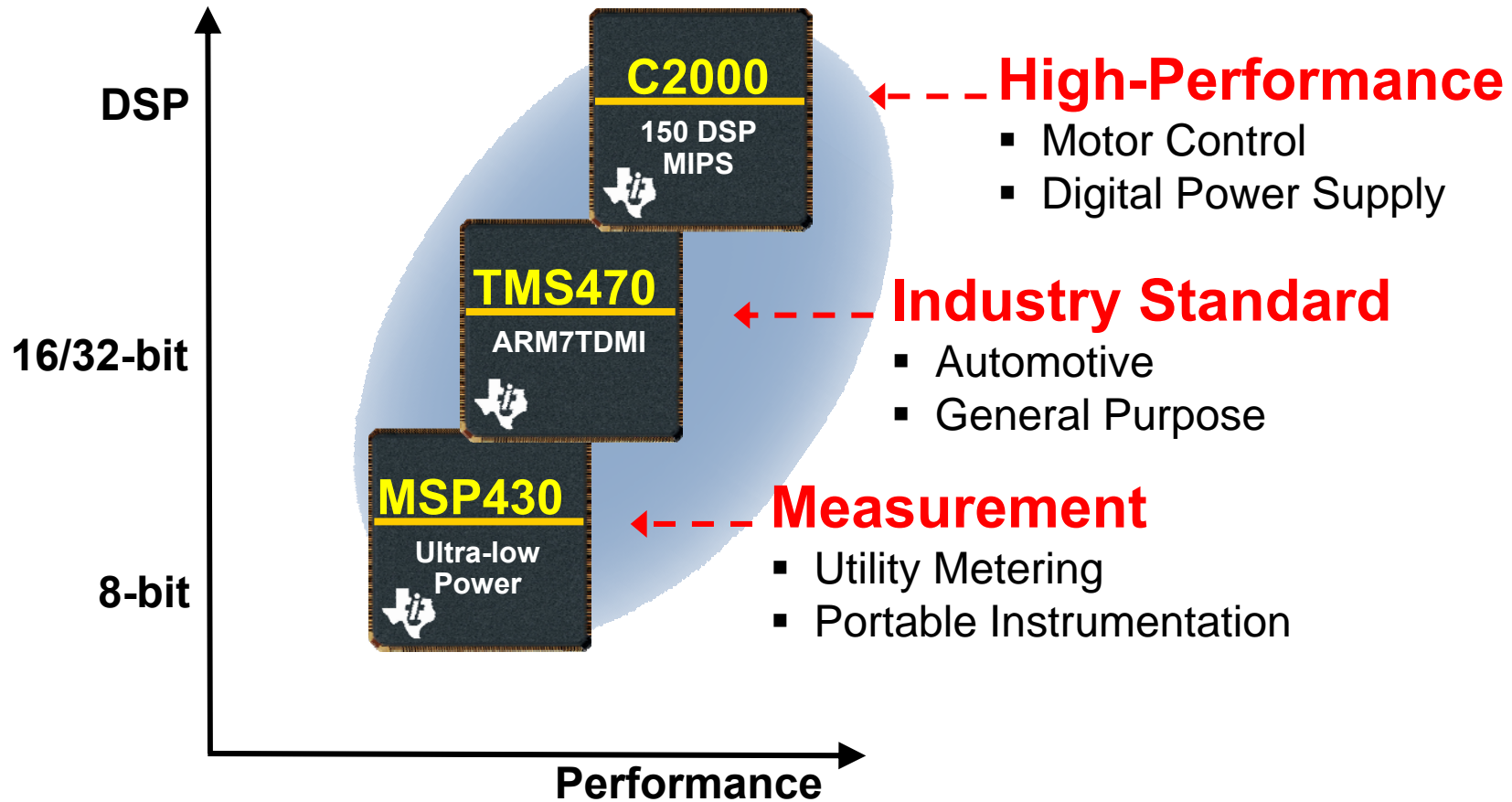
REAL WORLD SIGNAL PROCESSING™

 TEXAS INSTRUMENTS

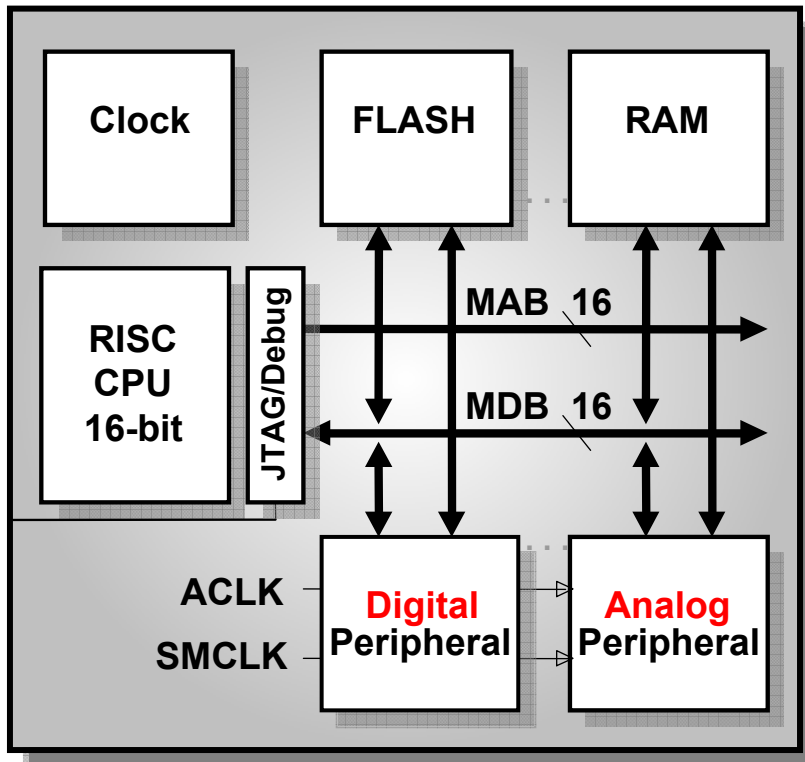
# MSP430 Agenda

- ❑ Core Architecture
- ❑ Integrated Peripherals
- ❑ Device Roadmap
- ❑ Ideal Applications
- ❑ Development Tools

# TI Microcontroller Portfolio



# MSP430 Features & Applications



## *Key Features*

- Ultra-low-power architecture extends battery life:
  - 0.1  $\mu\text{A}$  RAM retention
  - 0.8  $\mu\text{A}$  real-time clock mode
  - 250  $\mu\text{A}/\text{MIPS}$  active
- High-performance analog ideal for precise measurement
- Modern 16-bit RISC CPU enables new applications at a fraction of the code size
- In-system programmable Flash permits flexible code changes, field upgrades and data logging
- Complete integrated development environment starting at \$49
- Device pricing as low as \$0.49

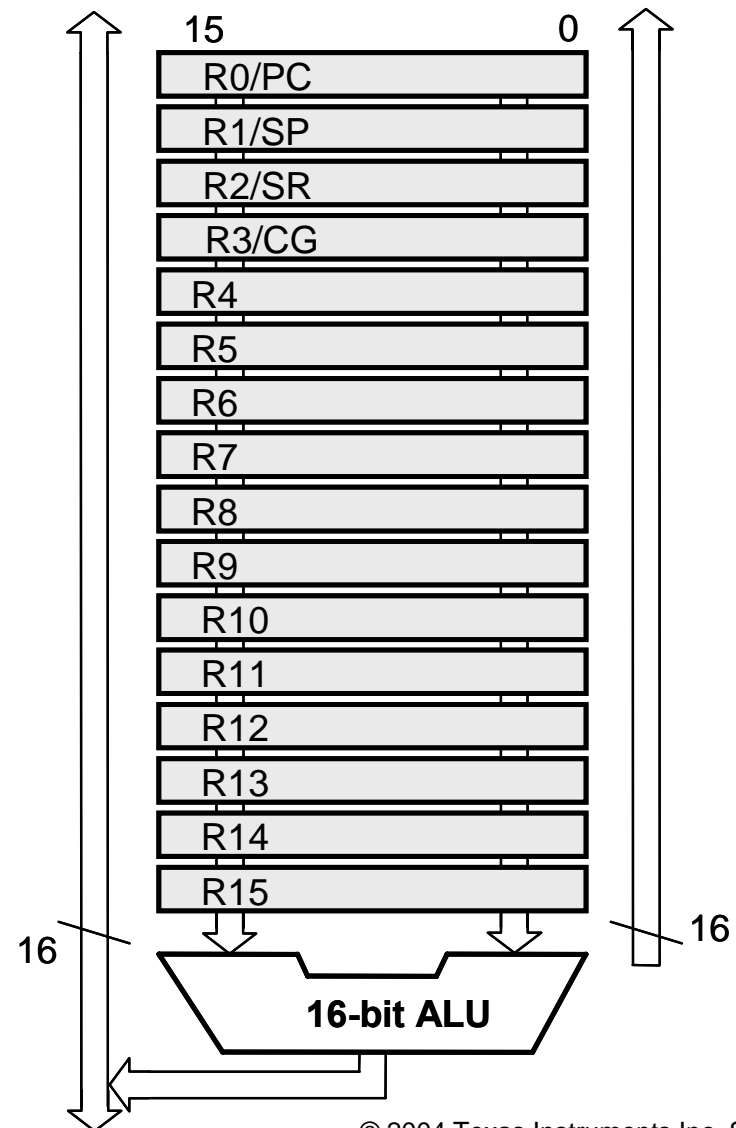
## *Key Applications*

- Utility metering
- Portable instrumentation
- Intelligent sensing

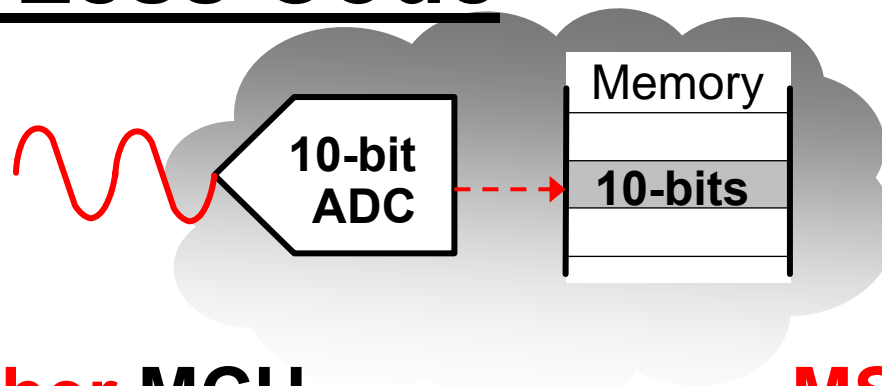
# Modern 16-bit RISC CPU

- No accumulator bottleneck
- Single-cycle operations
- Silicon area 30% smaller than '8051 lowers cost
- Industries most efficient C-code density

*Write Less Code, Use Fewer Cycles*



# Write Less Code



## Other MCU

```
movf    ADCRESH,W  
movwf   RAMH  
bsf     STATUS 0x20  
movf    ADCRESL,W  
bcf     STATUS 0x20  
movwf   RAML
```

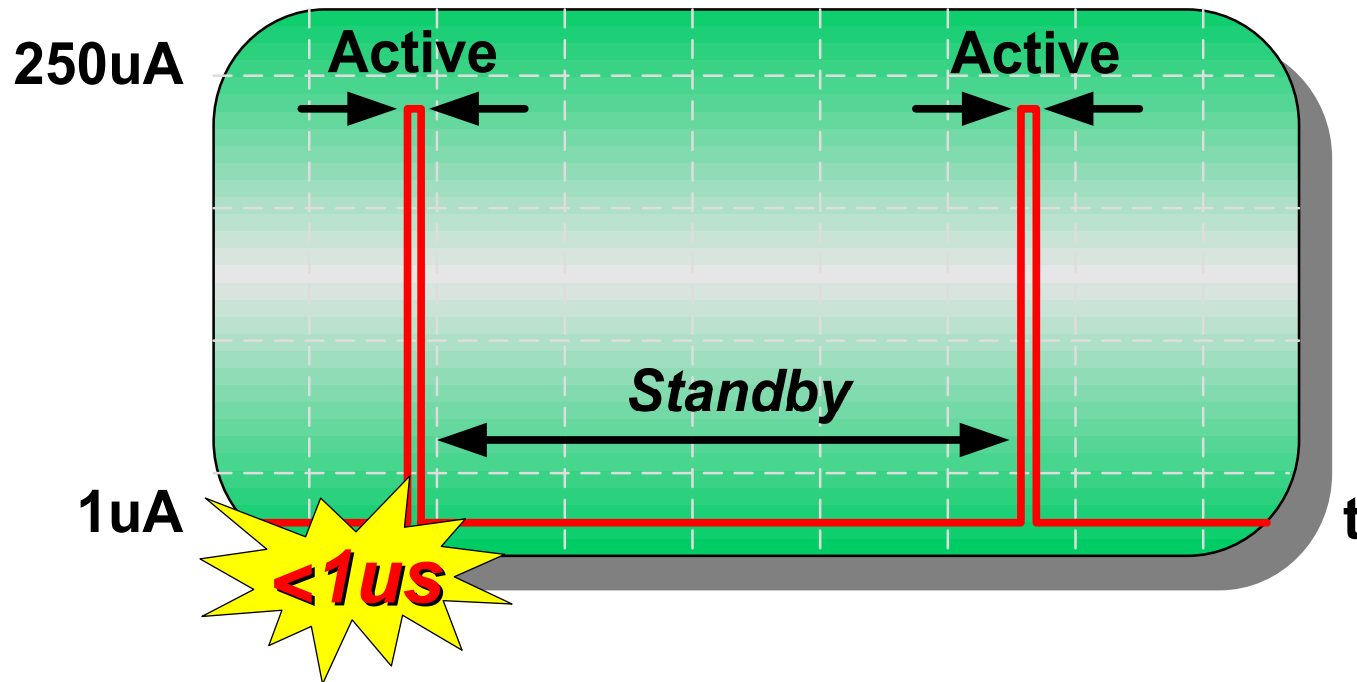
**84 bits / 24 cycles**

## MSP430

```
mov     ADC10MEM, RAM
```

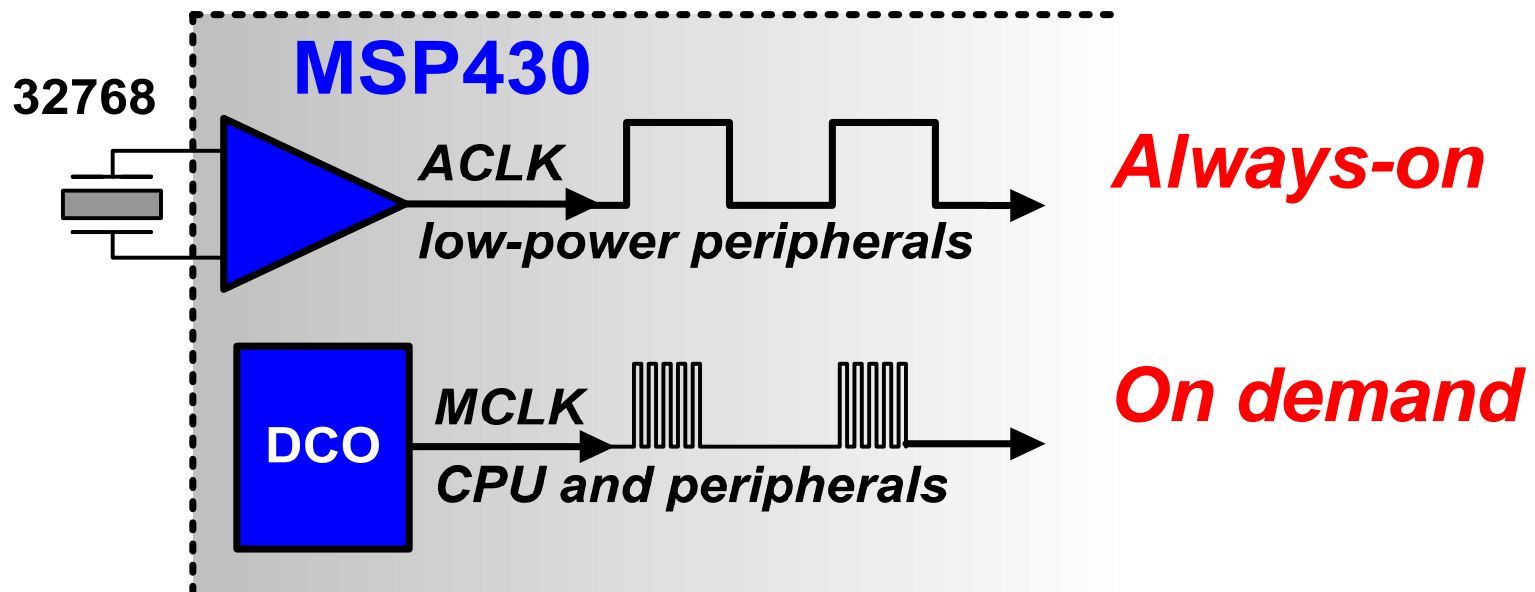
**48 bits / 6 cycles**

# Ultra-low Power Activity Profile



- *Operate in Standby as long as possible*
- *Fast Wake-Up from Interrupt-driven activity*

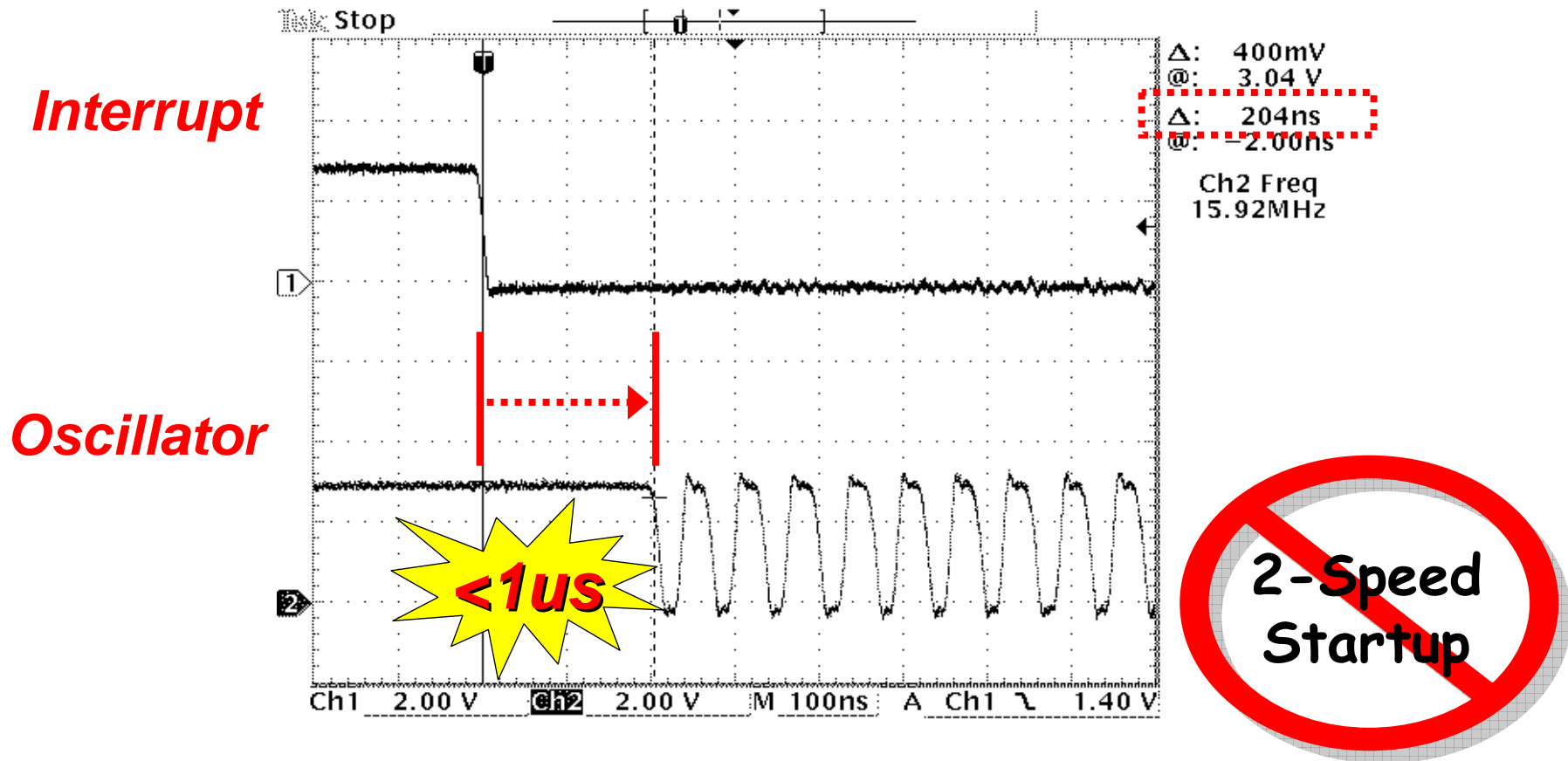
# Multiple Oscillator Clock System



- In **< 1us** the DCO is active and stable !

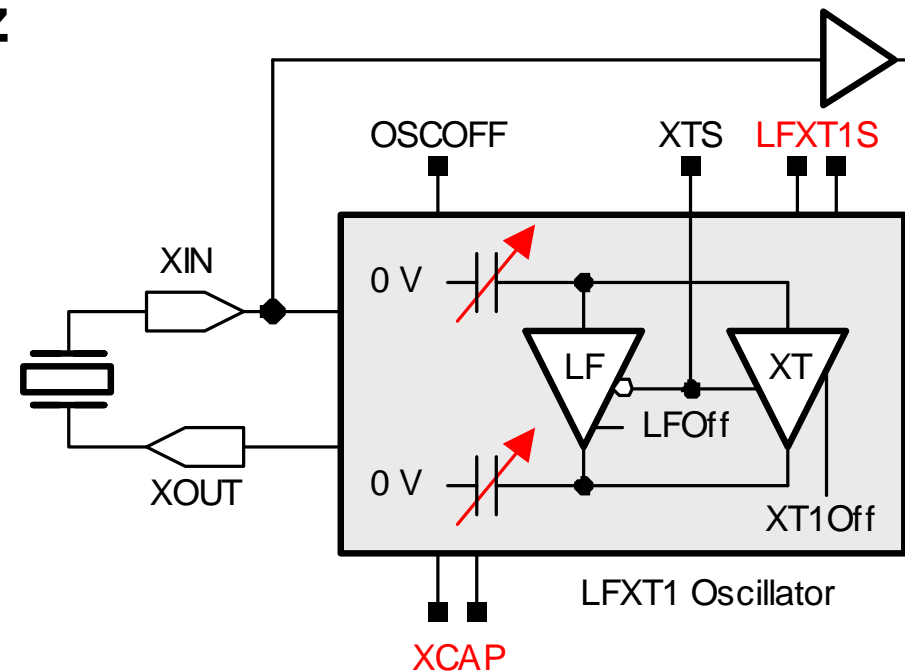


# DCO Allows Fast Reaction to Events

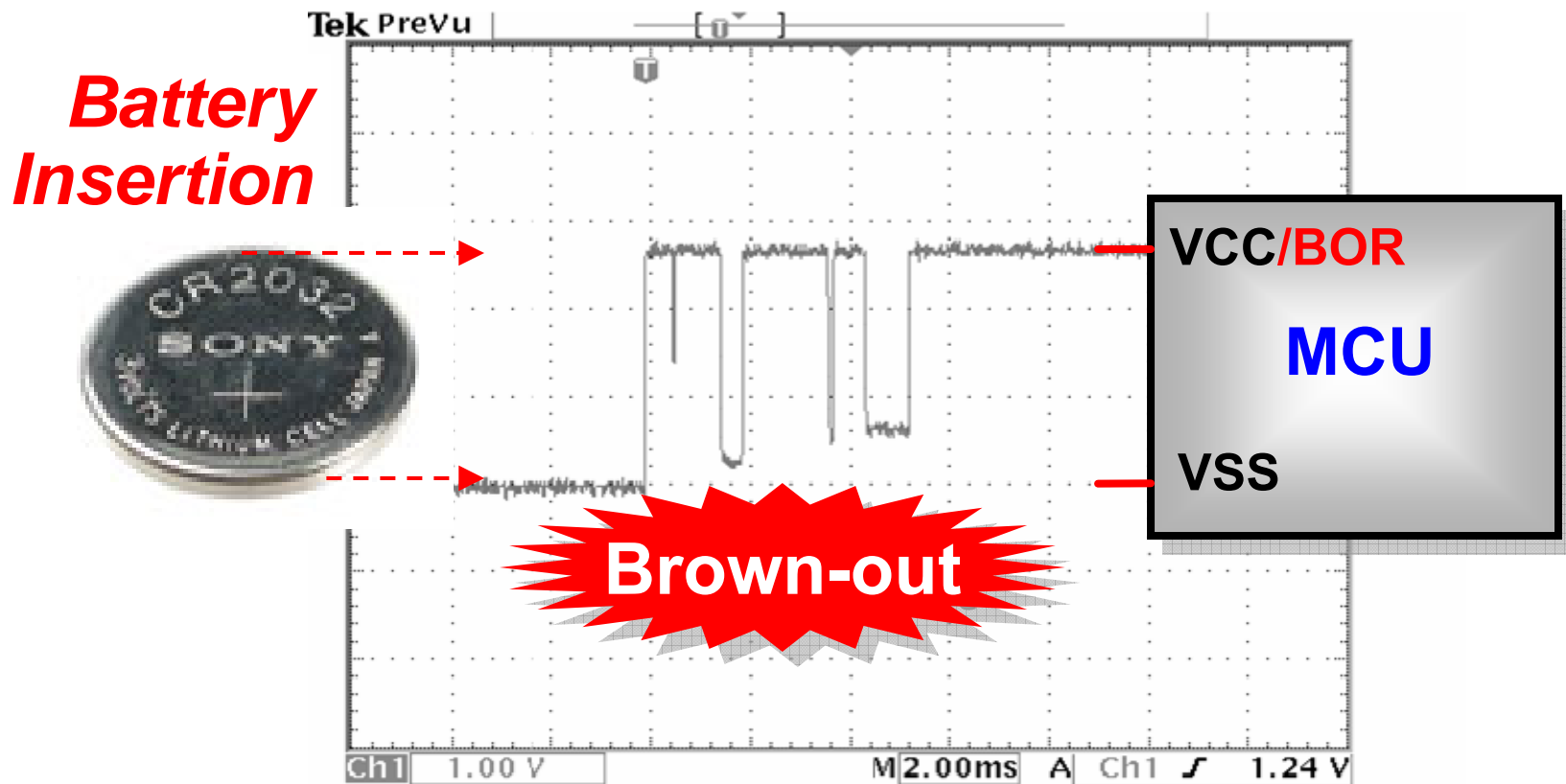


# Multiple Internal Crystal Oscillators

- LF – approximately 32kHz
- HF - 400k-16MHz
- Clock or Resonator Input
- *Integrated* & software-selectable load capacitors
- Automatic LF/HF OSC Fault Detection



# Brown Out Reset Protection

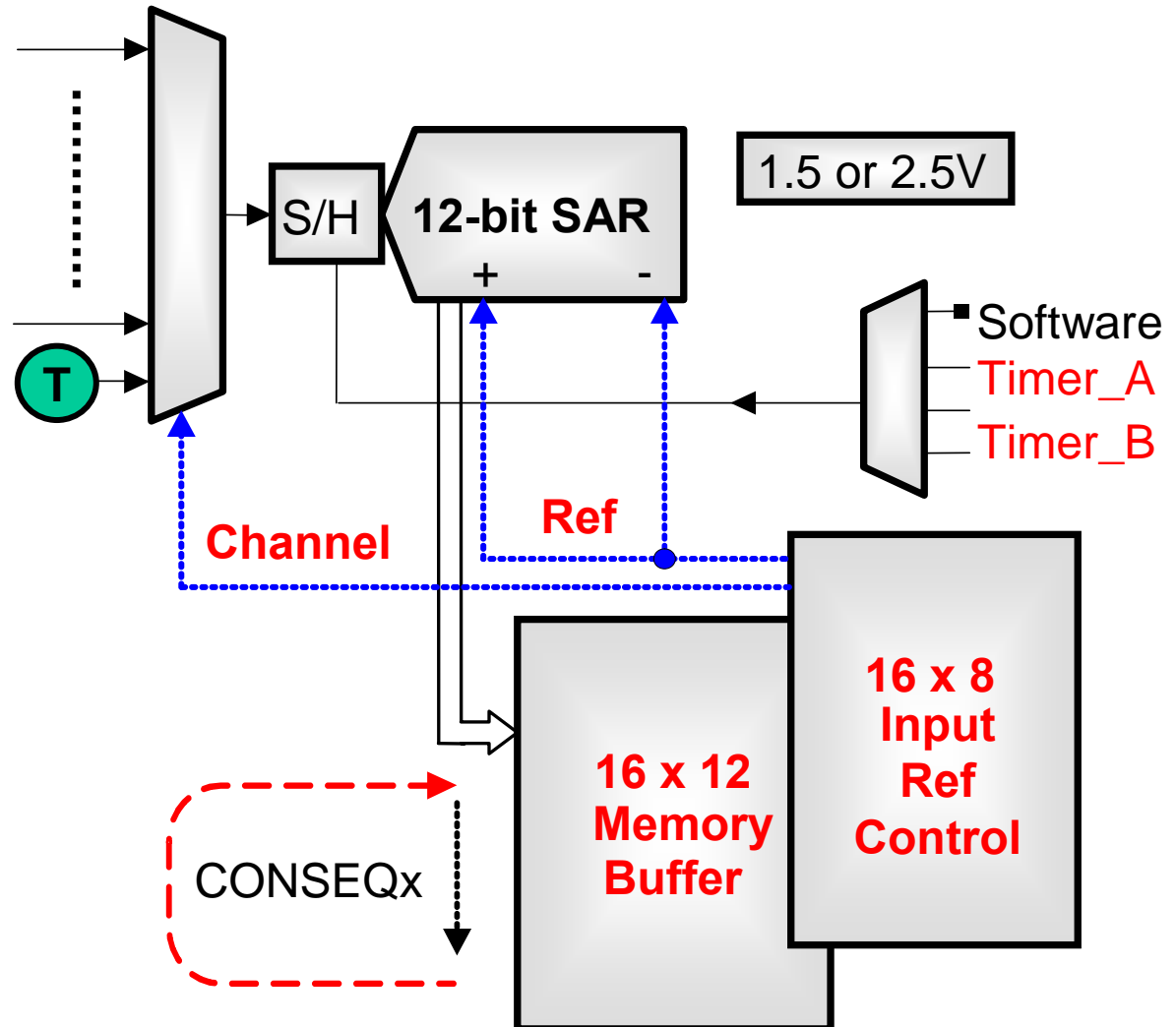


- **MSP430 BOR is always-on and zero-power**

# High Performance 12-bit ADC

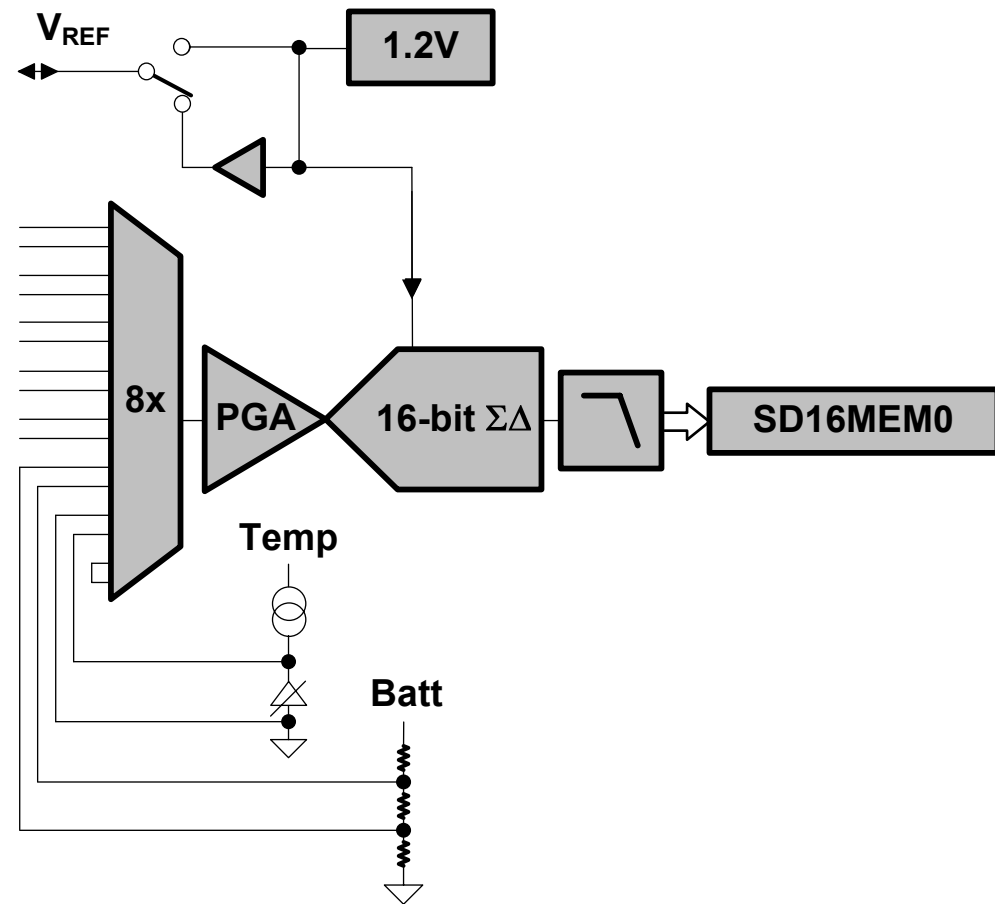
- 12-bit monotonic
- 200KSPS+
- Single sequence  
repeat-single  
repeat-sequence

**CPU-free  
data-handling**



# High-Precision 16-bit ADC

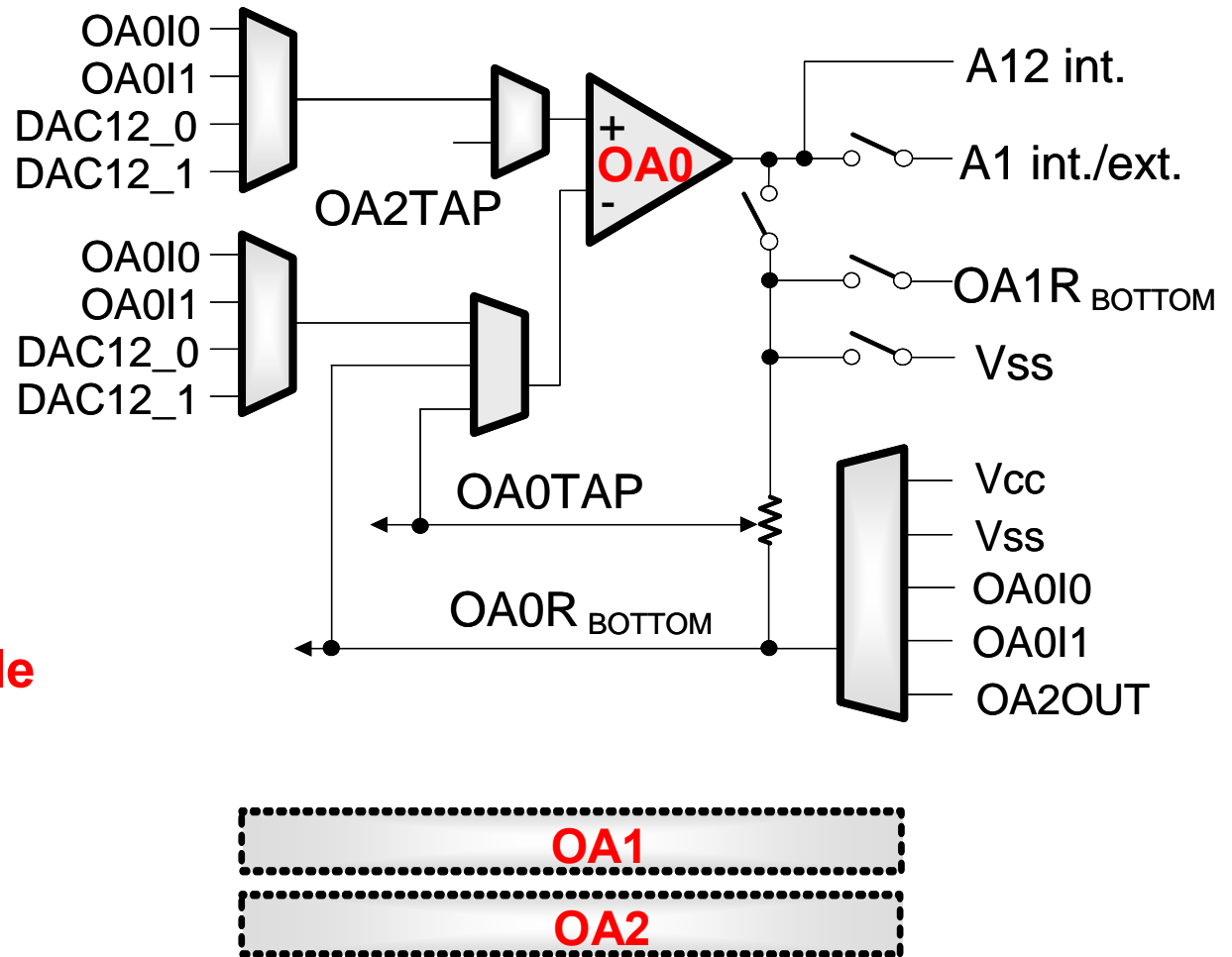
- ◆ 16-bit  $\Sigma\Delta$  ADC
- ◆ Differential inputs
- ◆ 4.096KSPS
- ◆ 85dB SINAD
- ◆ 32x PGA
- ◆ 18ppm 1.2V ref
- ◆ Temp sensor
- ◆ Battery input



# Precision Operational Amplifiers

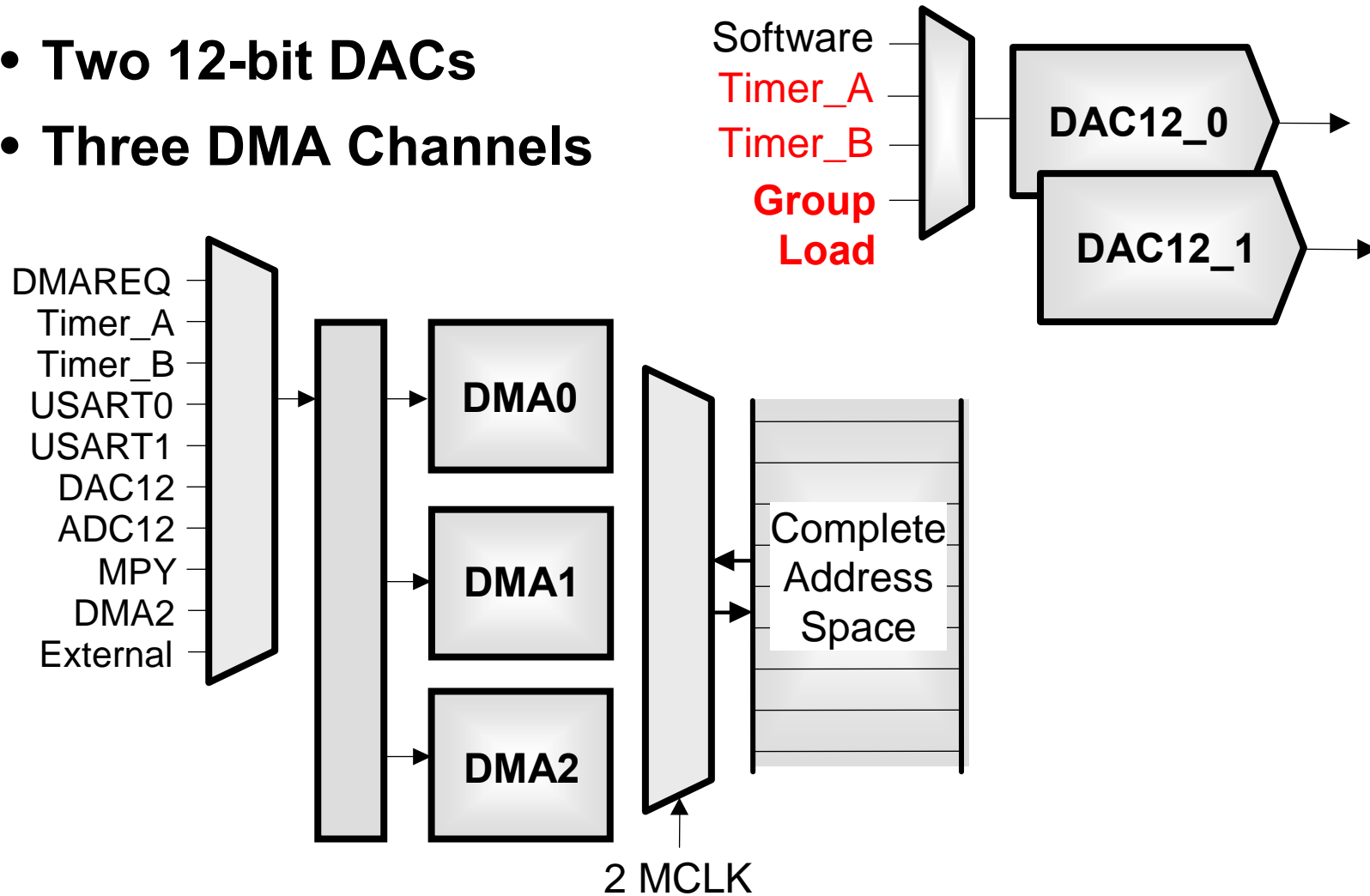
- Rail-to-rail input/output
- 0.5nA bias
- 10mV offset
- 10uV/C
- 70dB CMRR
- 70dB PSRR
- 2.5MHz UGB

**Three very flexible amplifier blocks**

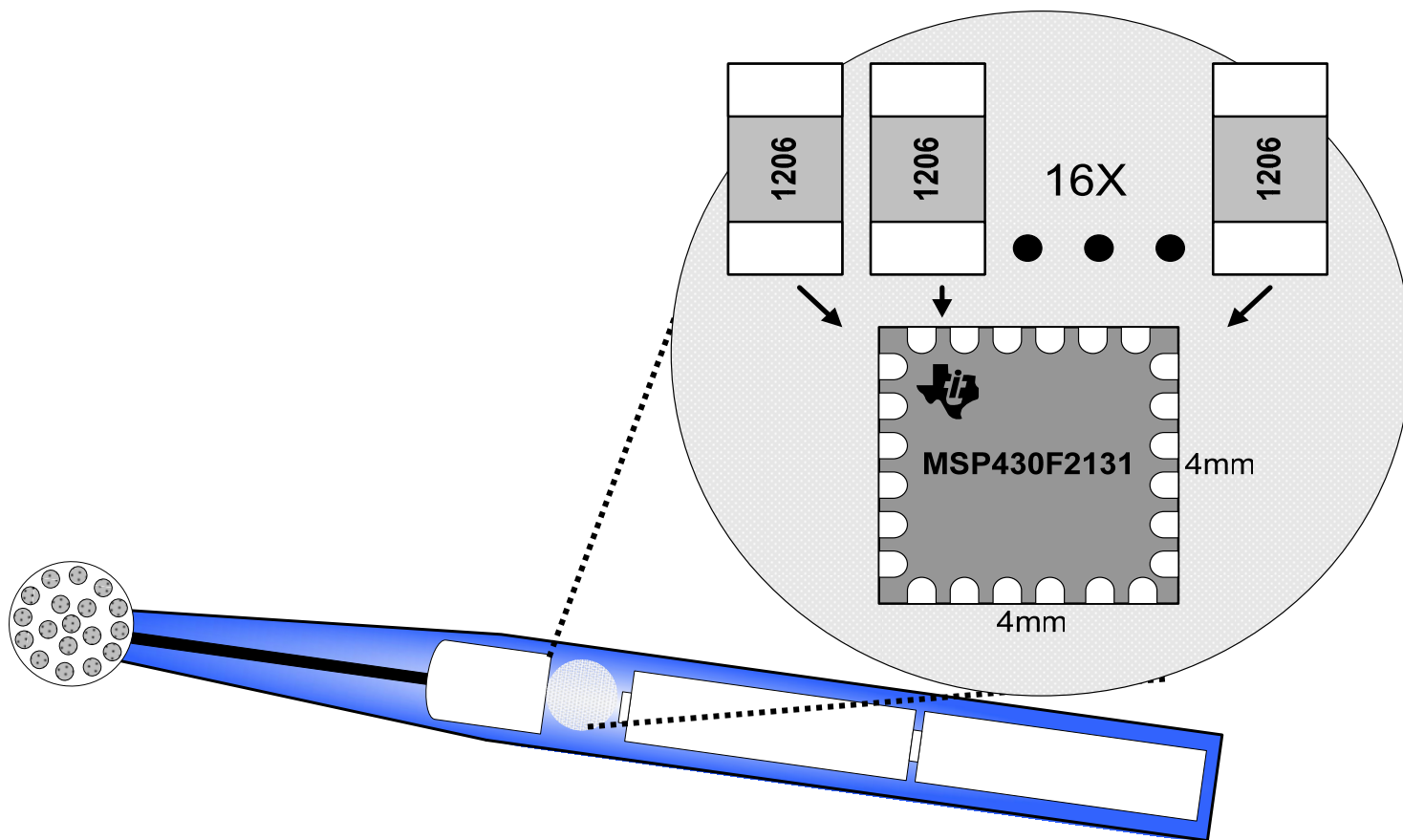


# DAC + DMA Completes **SCoC**

- Two 12-bit DACs
- Three DMA Channels

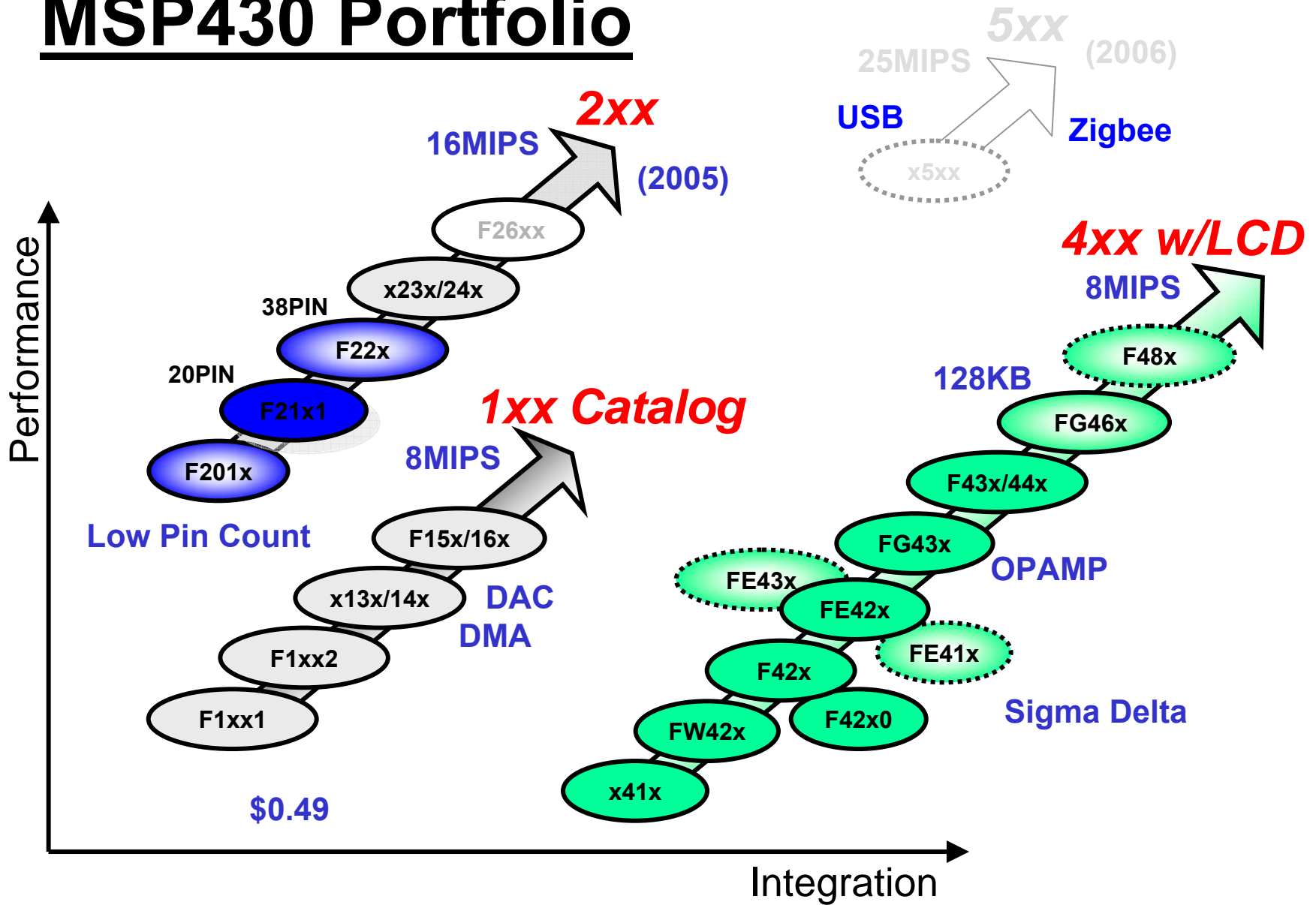


# Integrated Pull-Up/Down Resistors

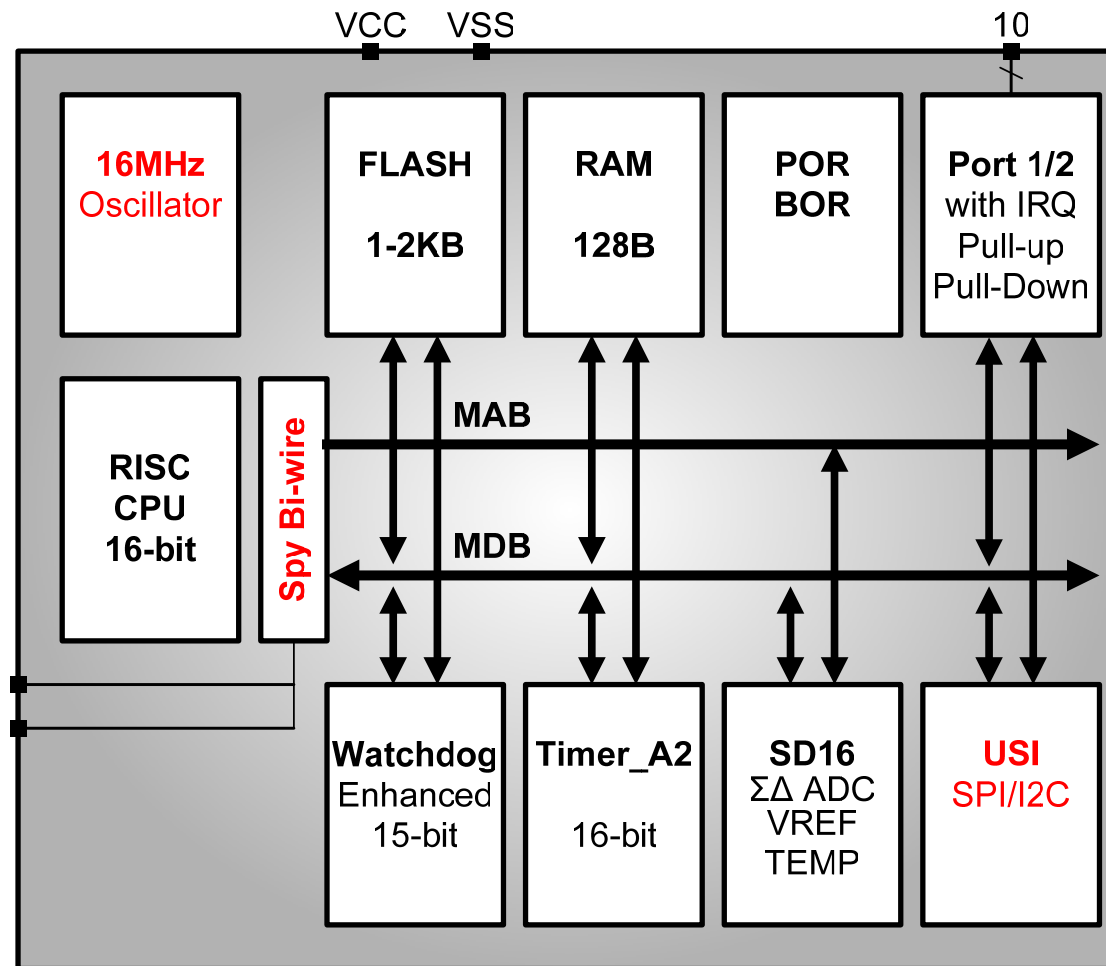




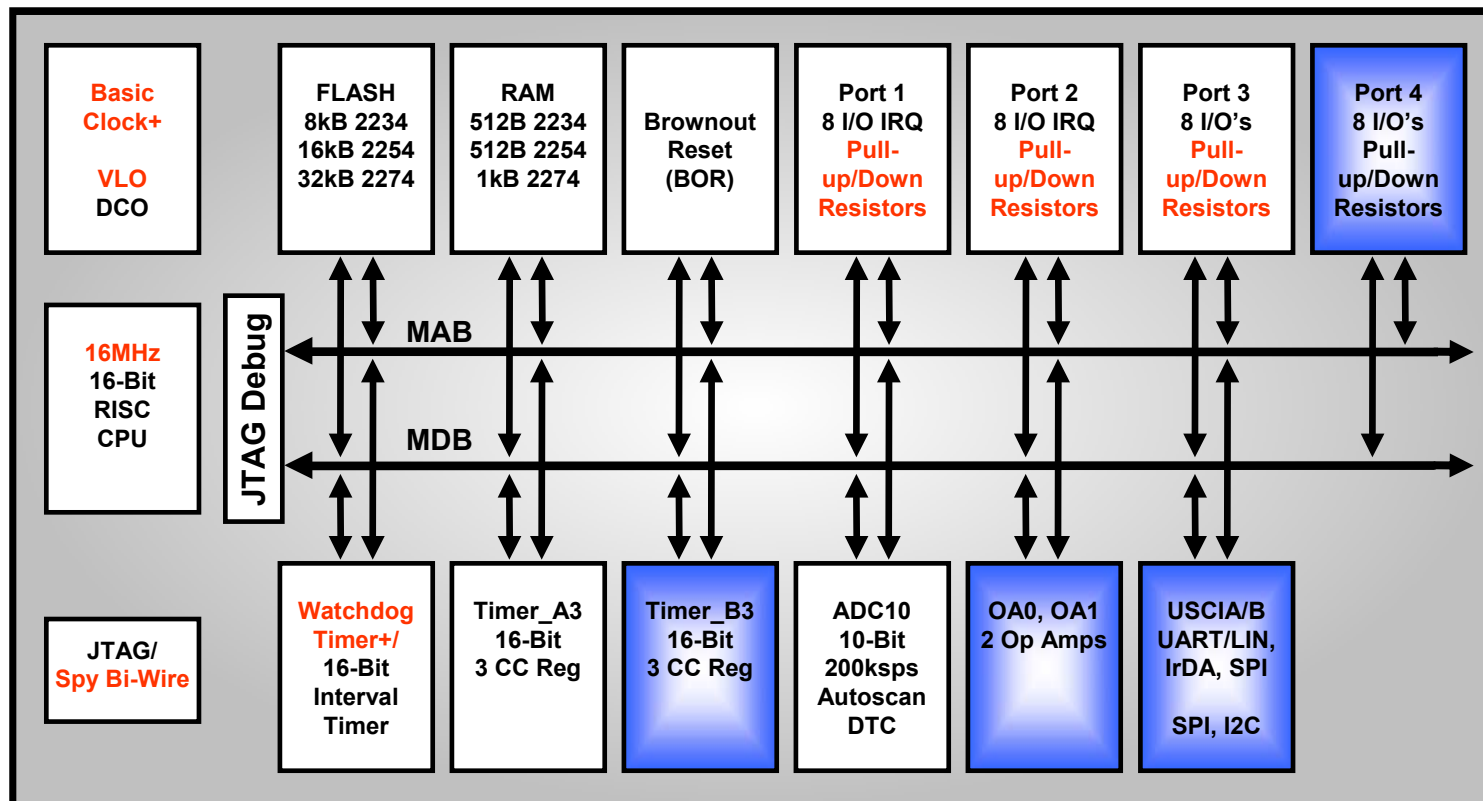
# MSP430 Portfolio



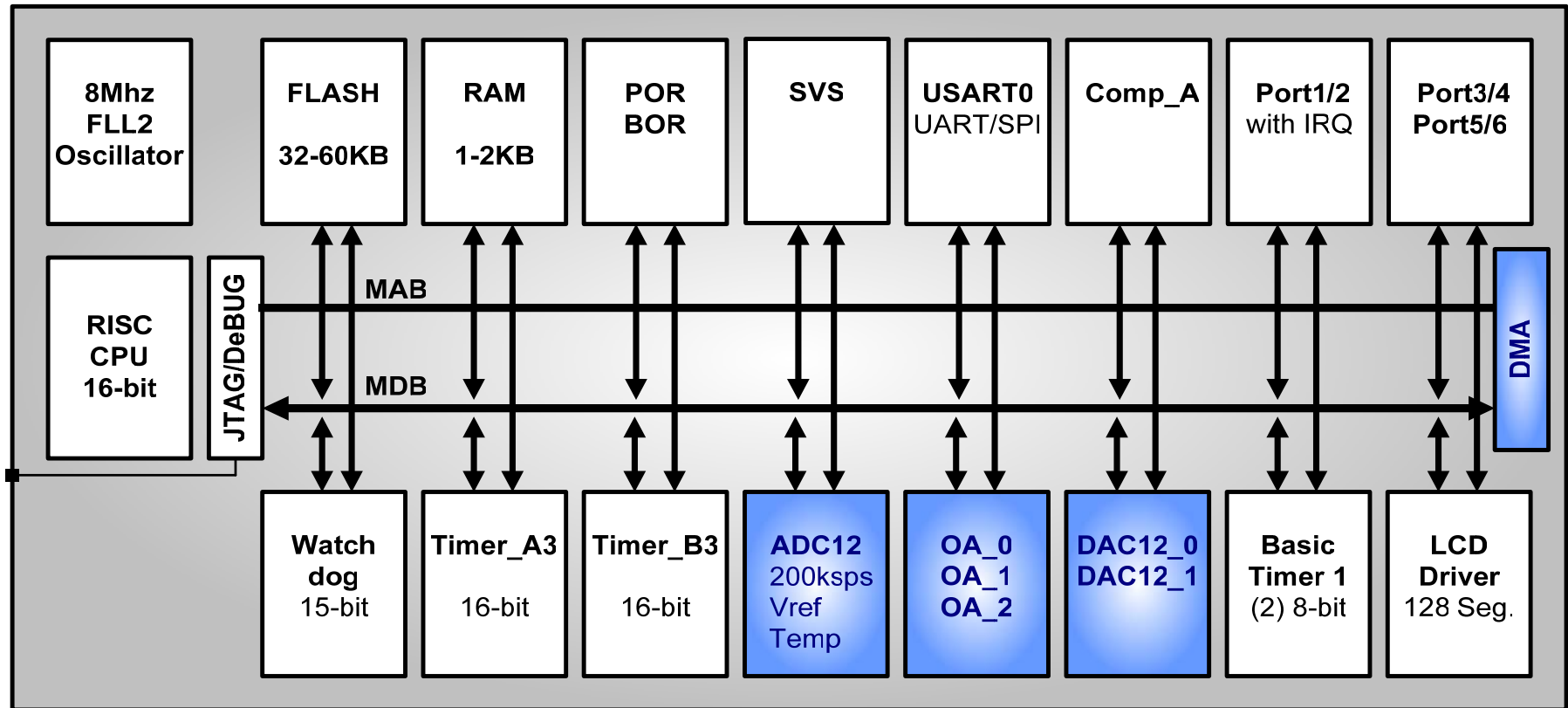
# Low-End MSP430 Devices



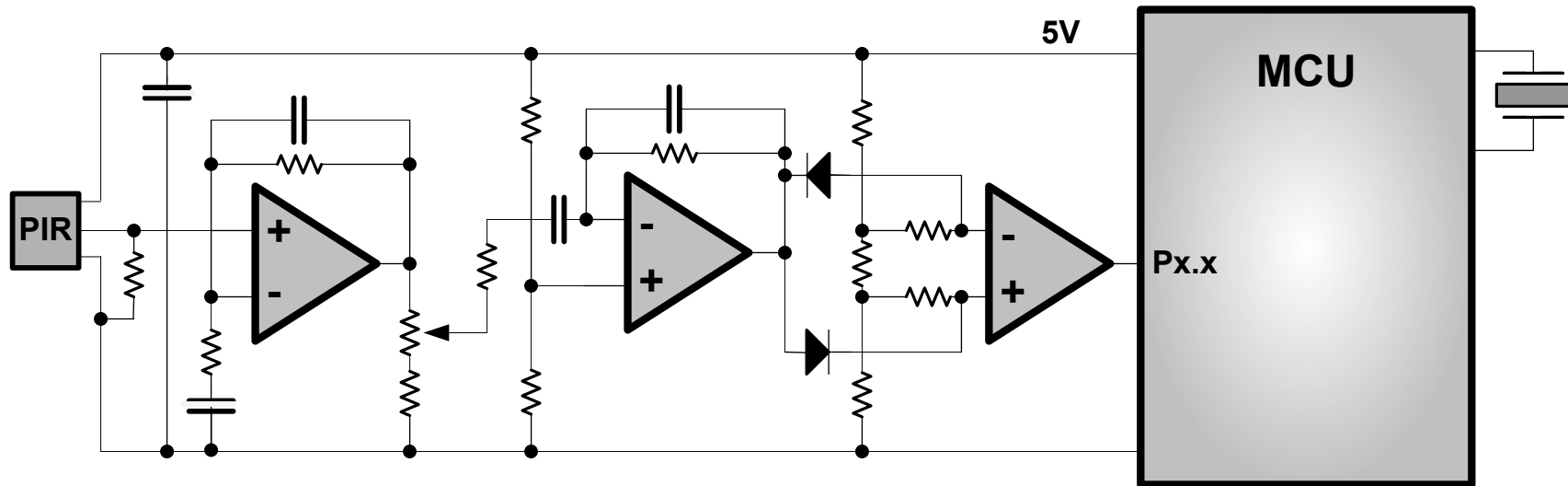
# Mid-Range MSP430 Devices



# High-End MSP430 Devices



# Ordinary Motion Detector

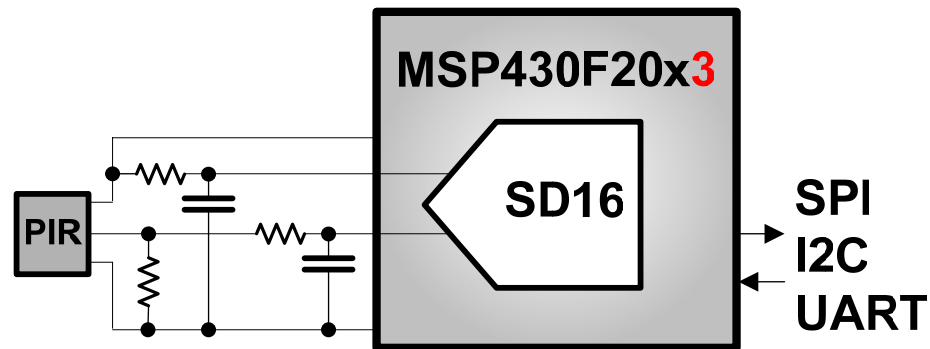


◆  $20\mu\text{A} - 2\text{mA}$

◆ Complicated

◆ Fixed function

# MSP430F20x3 Improved Motion Detector



## ◆ <math>10\mu\text{A}</math> total system power

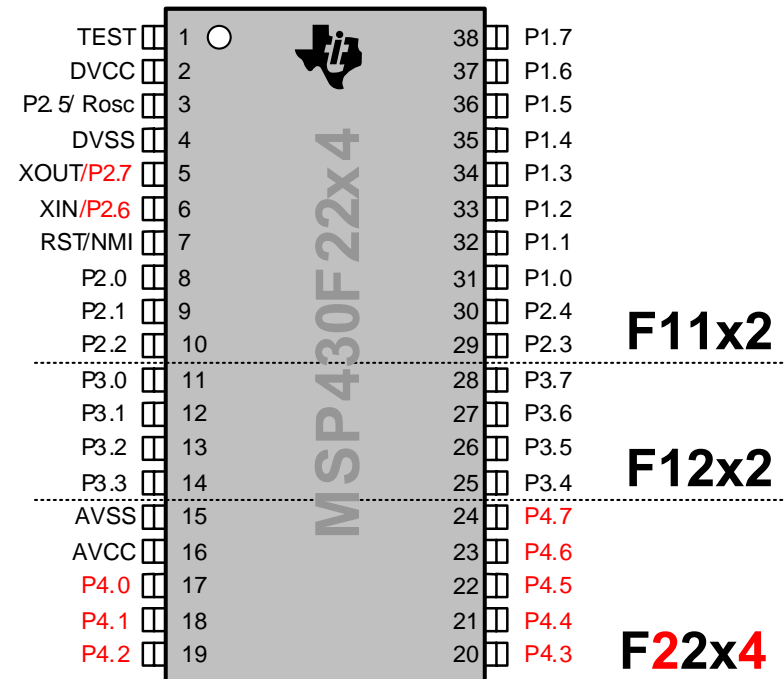
- ~6 $\mu\text{A}$  PIR
- ~3 $\mu\text{A}$  measurement
- ~0.5 $\mu\text{A}$  LPM3 using VLO

## ◆ No crystal needed – VLO

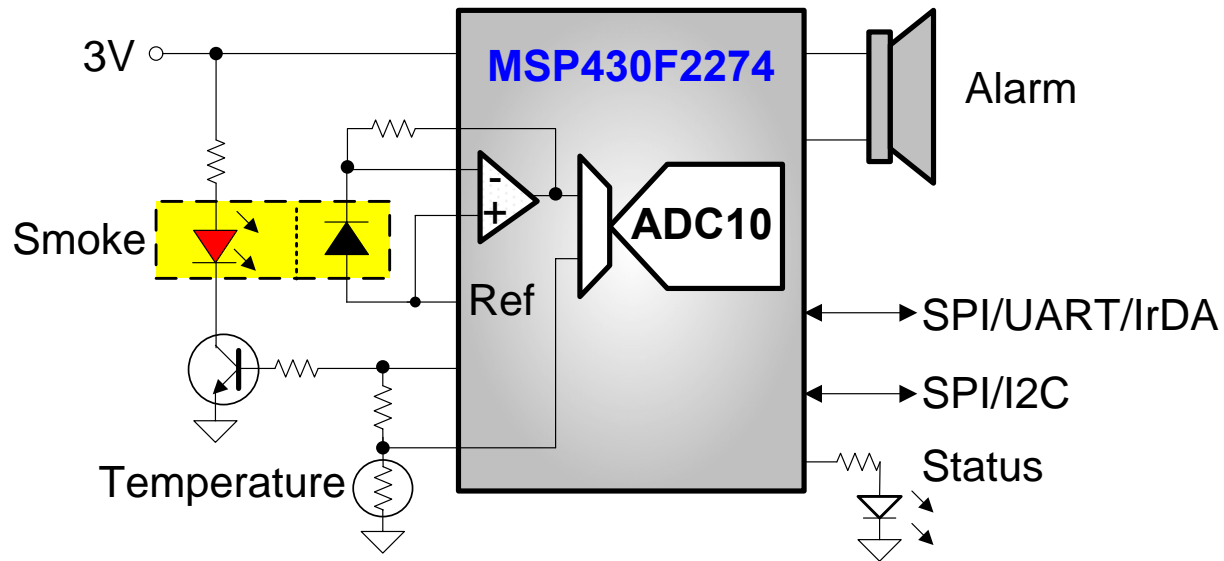
- ◆ Enhanced watchdog
- ◆ Fully programmable SoC
- ◆ Very low cost

# MSP430F22x4 For Sensor Applications

- ◆ **32KB Flash / 1KB RAM**
- ◆ **16 MIPS, <1μA LPM3**
- ◆ **10-bit 200ksps ADC**
- ◆ **2 Op Amps**
- ◆ **USCI**
- ◆ **Timer\_A3 / B3, WDT+**
- ◆ **32 GPIO**
- ◆ **38-pin F1xx2 upgrade ideal for sensor apps**



# MSP430F2274 Fire Detector

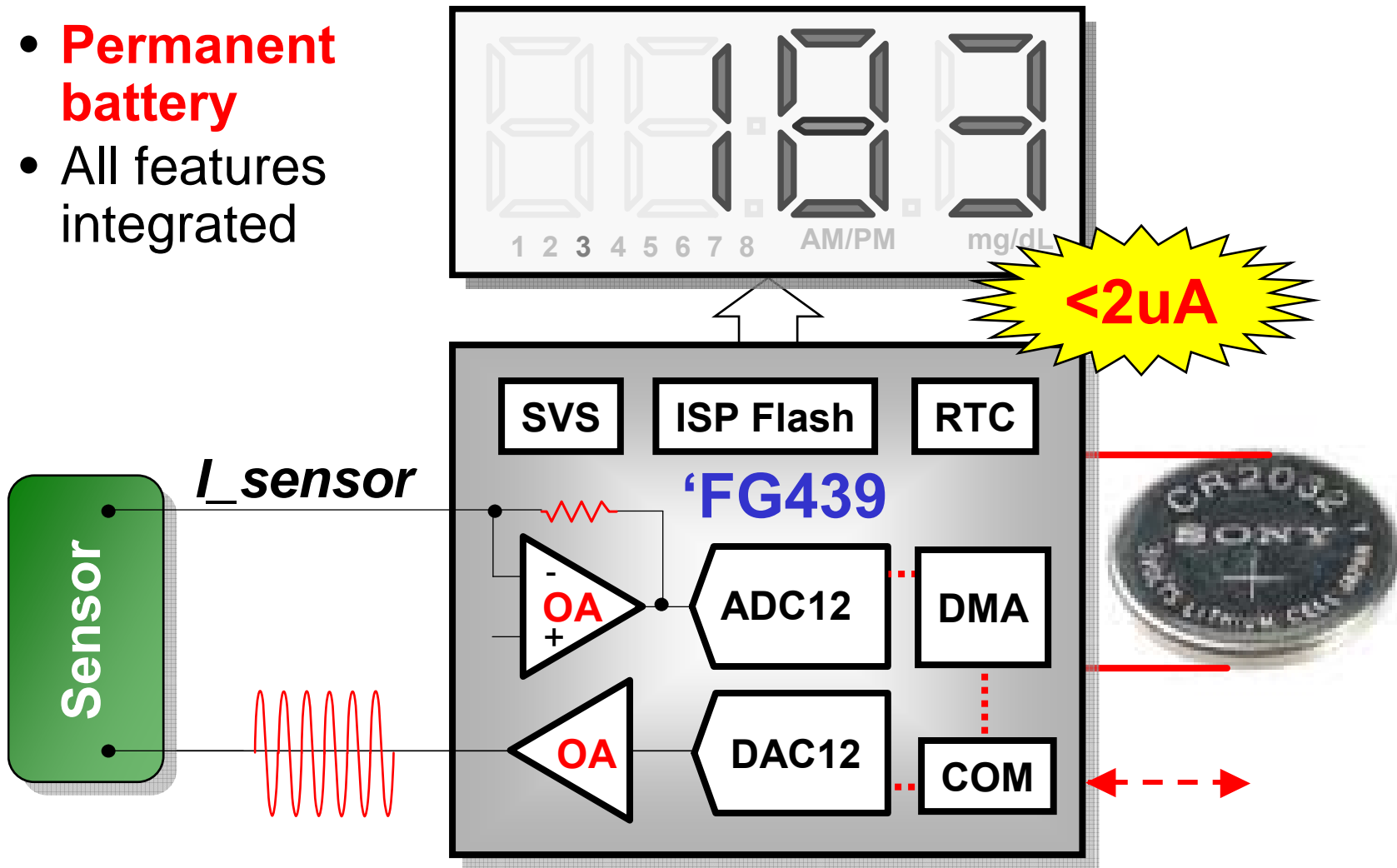


- ◆ Ultra-low Power
- ◆ Fully programmable SoC
- ◆ No crystal needed - VLO
- ◆ Enhanced watchdog
- ◆ Very low cost



# MSP430FG43x Portable **Medical** Device

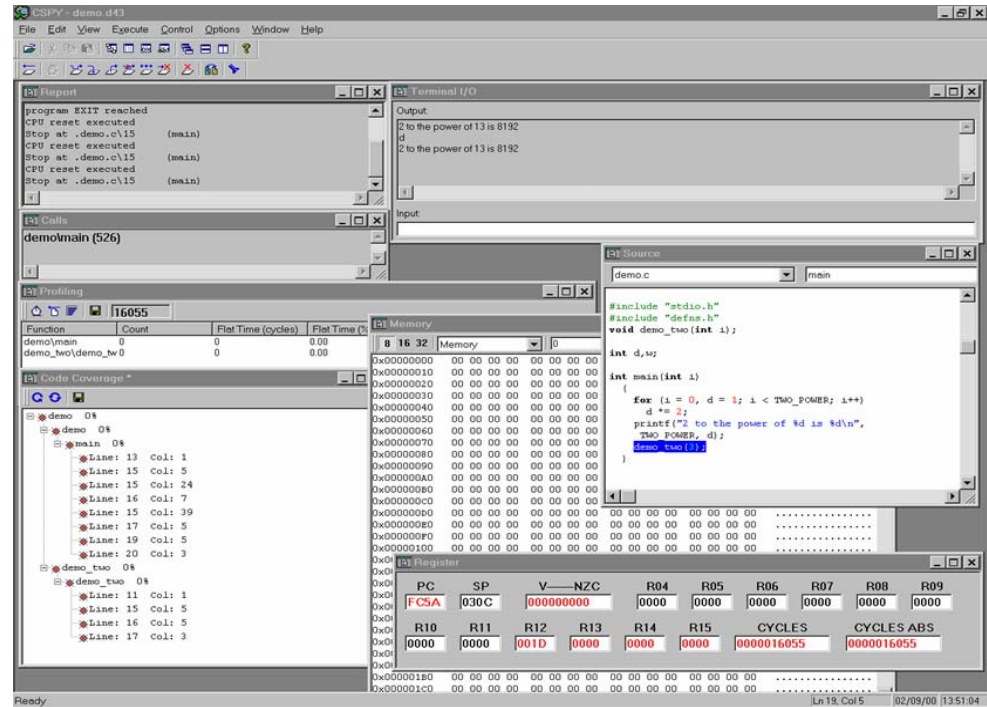
- **Permanent battery**
- All features integrated



# MSP430 Development Kit

**IAR Systems EW430 IDE**

**Same set of tools  
for all MSP430's**

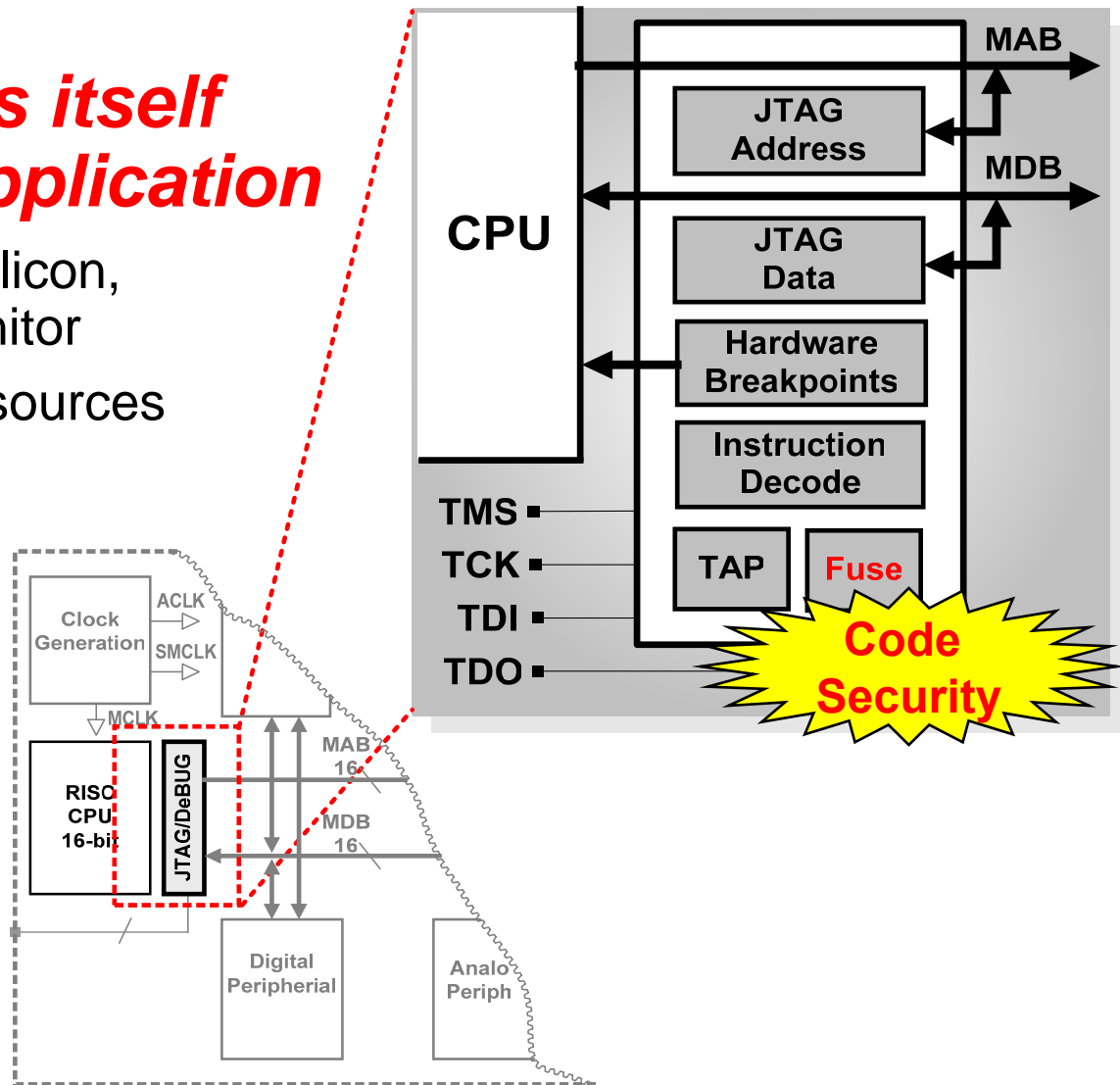


**Target Board**

# Embedded Emulation Module (EEM)

***MCU emulates itself  
real-time in application***

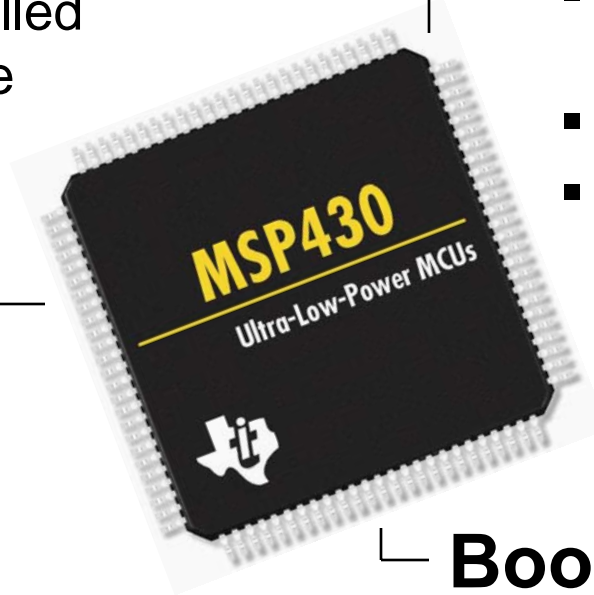
- Implemented in silicon, not by debug monitor
- No application resources used
- Full speed
- Breakpoint
- Single step
- Trace



# In System Programming Options

## Self Programming

- Any Flash location
- Use any interface
- Hardware controlled
- As fast 22us/byte



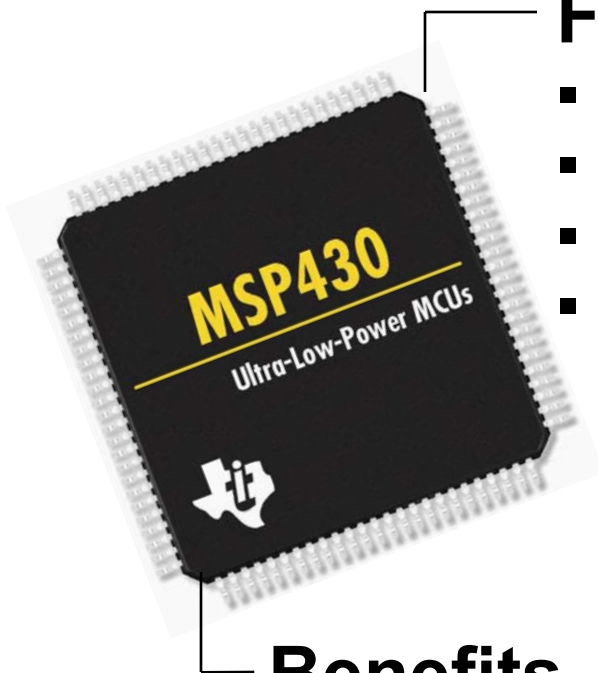
## JTAG

- IEEE 1149 interface
- Programming and emulation
- Permanent security fuse
- 60KB <3s

## Bootstrap Loader

- 9600/38400 BPS
- UART format
- 256 bit password protected

# MSP430 Security



## Features

- Lockable Flash Info Segments
- Permanent Security Fuse Option
- 256-bit Password Protection
- Hacker Detection & Prevention

## Benefits

- Permanently shut down access to internal memory by blowing security fuse
- Trying  $2^{256}$  random passwords would take billions of years
- Can automatically erase all internal memory if incorrect password is attempted 3 times in a row

# Sales & Support

- **User's Guides**

Architecture and peripheral info

- **Datasheets**

Electrical, packaging and pinning

- **Application reports**

Complete design examples

- **Code examples**

Downloadable code

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



MSP430x1xx Family

New!

## User's Guide

MSP430C11x1, MSP430F11x1A  
MIXED SIGNAL MICROCONTROLLER

SLAS229 P - SEPTEMBER 1999 - REVISED MARCH 2003

- Low Supply Voltage Range 1.8V - 3.6 V
- Ultralow-Power Consumption
  - Active Mode: 90µA at 1 MHz, 2.2 V
  - Standby Mode: 0.7 µA
  - Off Mode (RAM Retention): 0.1 µA
- Wake-Up From Standby Mode in 6 µs
- 4x16-bit Architecture, 192-nc
- Family Members Include:
  - MSP430C1101: 1KB ROM, 128B RAM
  - MSP430C1111: 3KB ROM, 128B RAM
  - MSP430C1121: 4KB ROM, 256B RAM
  - MSP430F1101A: 1KB + 128B Flash Memory, 128B RAM
  - MSP430F1111A: 2KB + 256B Flash Memory



Application Report  
C.L. Number - October 2002

### MSP430 Internet Connectivity

Andreas Dannenberg

MSP430

#### ABSTRACT

Computer communication systems and especially the Internet are playing a rapidly increasing role in many applications. This report describes a software toggle for the P1.0 pin of the MSP430F123 (2) microcontroller. The toggle is implemented in software and is controlled by the P1.0 pin of the microcontroller. The toggle is implemented in software and is controlled by the P1.0 pin of the microcontroller. The toggle is implemented in software and is controlled by the P1.0 pin of the microcontroller.

400+

```
#include <msp430x12x.h>

void main(void)
{
    WDCTL = WDTPW + WDTHOLD;           // Stop watchdog timer
    P1DIR |= 0x01;                      // Set P1.0 to output direction

    for (;;)
    {
        unsigned int i;

        P1OUT ^= 0x01;                 // Toggle P1.0 using exclusive-OR

        i = 50000;                      // Delay
        do {i--};
        while (i != 0);
    }
}
```

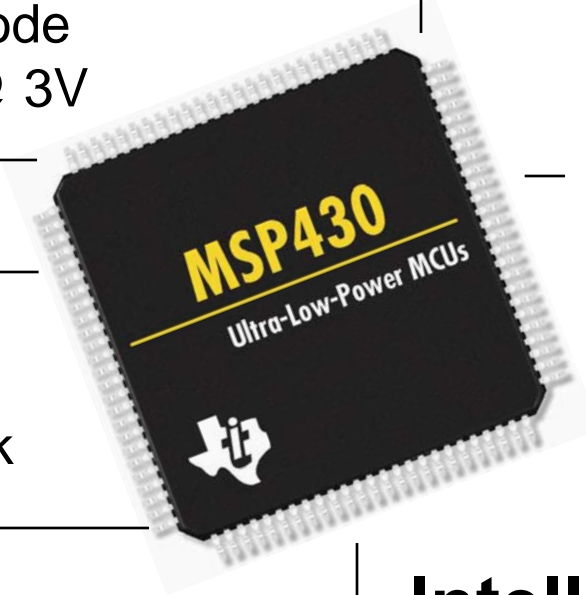
# Ultra-low Power MCU Checklist

## Multiple operating modes

- 0.1uA power down
- 0.8uA standby mode
- 250uA / 1MIPS @ 3V

**Zero-power BOR**

**50nA pin leakage**



## Modern CPU

Minimum cycles per task

**Intelligent peripherals**

**Instant-on *stable* high-speed clock**

# Time to Use the MSP430!

**Use Less Power**

**Write Less Code**

**Get to Market Faster**

**The Perfect Fit**