

CPE 323

Intro to Embedded Computer Systems

System Architecture

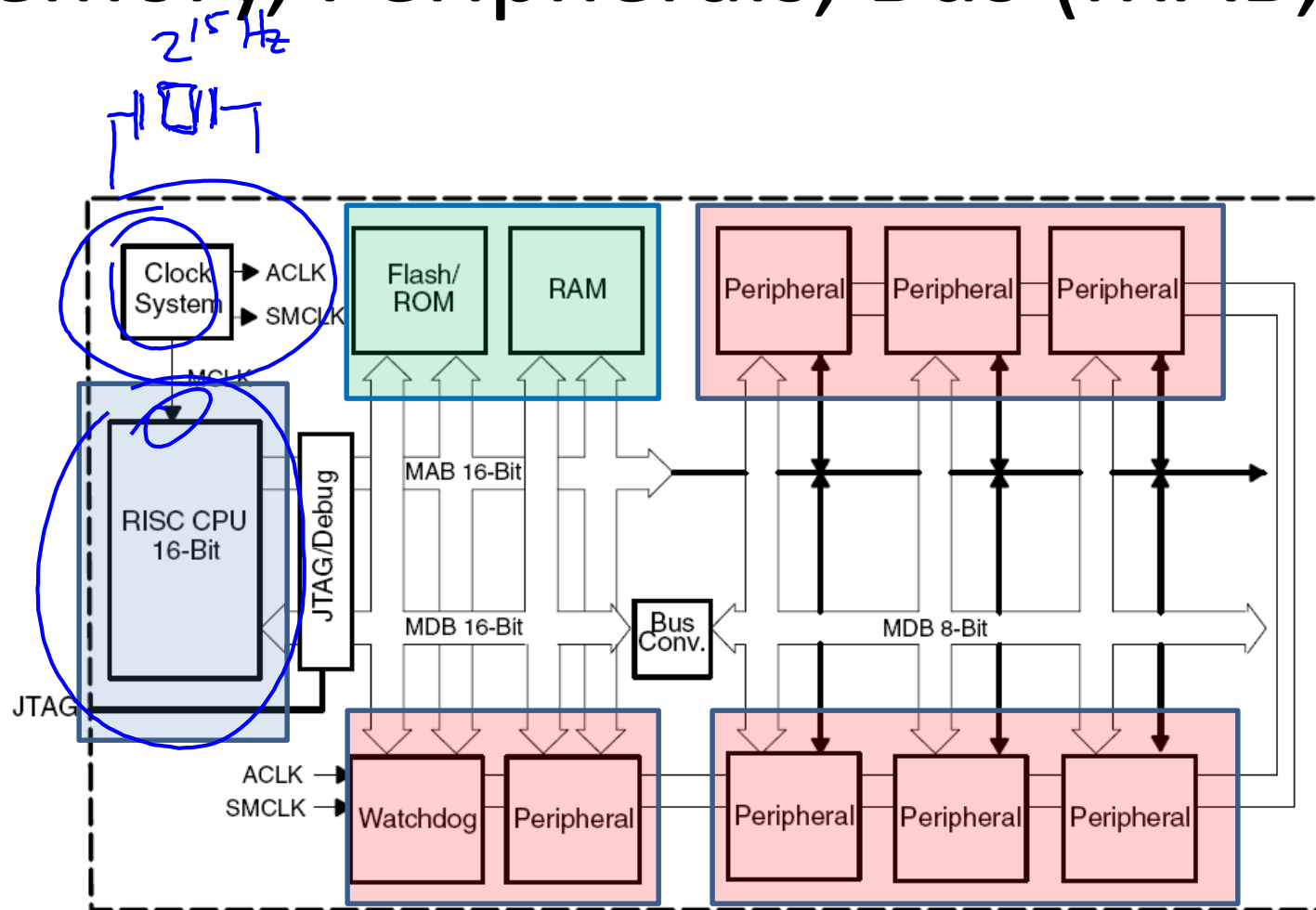
Aleksandar Milenkovic

milenka@uah.edu

Admin

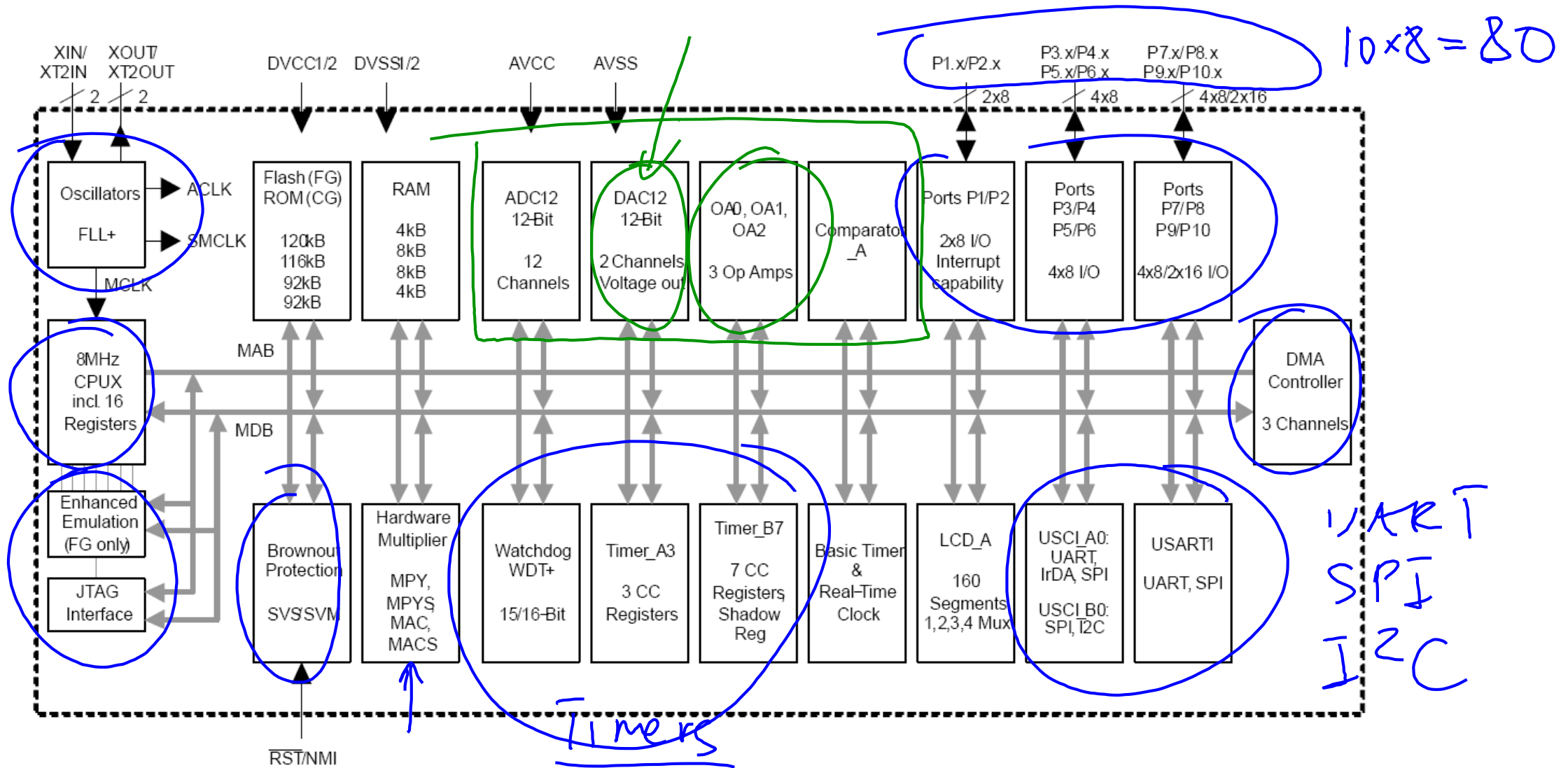
CPU, Memory, Peripherals, Bus (MAB, MDB)

2^{20} Hz
 MCLK - Main Clock
 2^{20} Hz
 SMCLK - Submain Clock
 2^{15} Hz
 ACLK - Auxiliary Clock

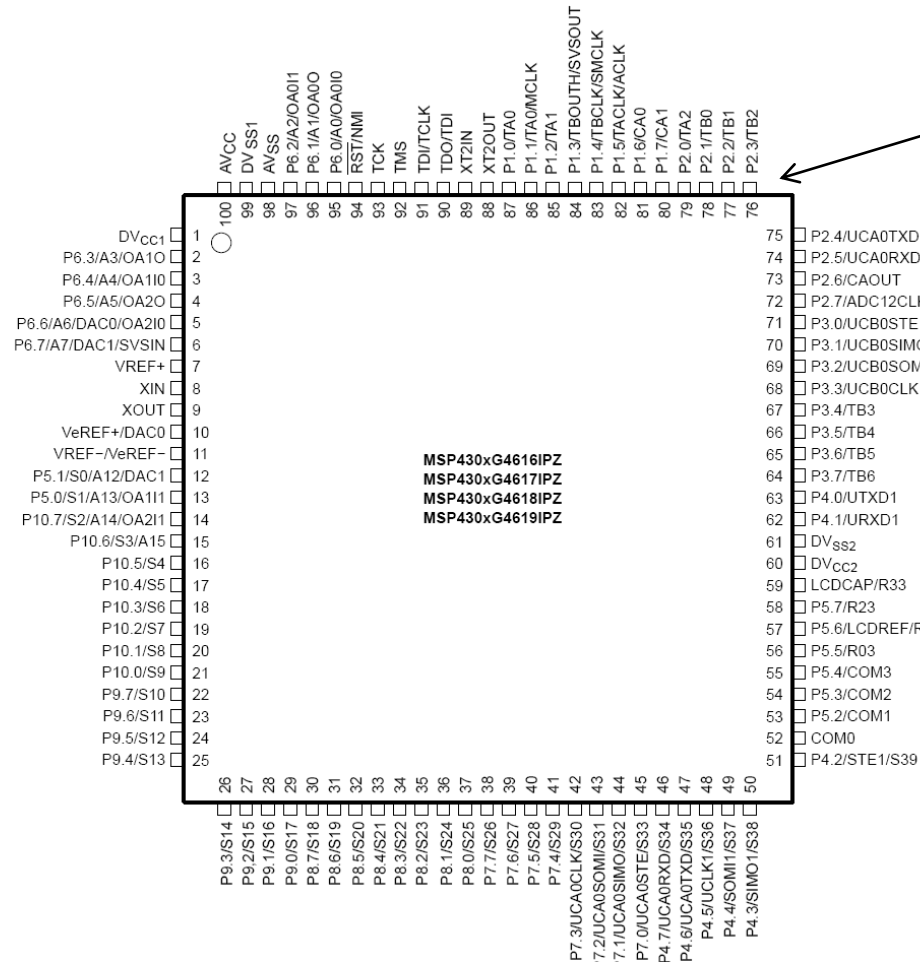


Active
 LPM0
 LPM1
 LPM2
 LPM3
 LPM4

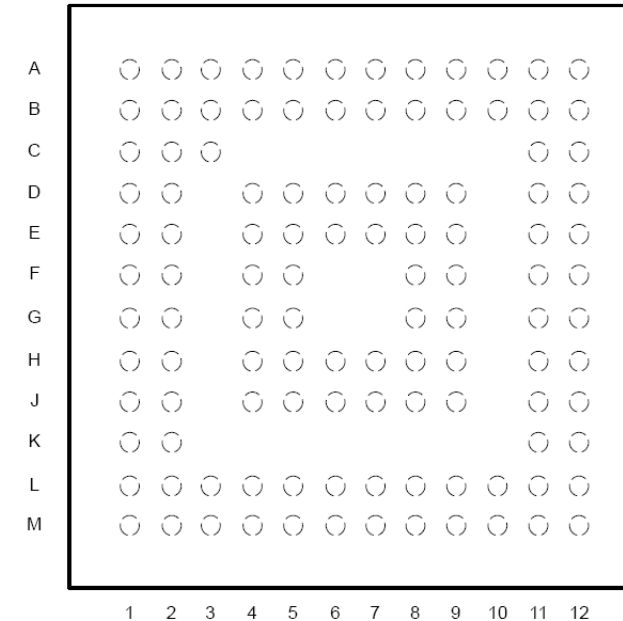
MSP430FG4618 Block Diagram



MSP430xG461x Microcontroller



AVAILABLE OPTIONS		
T _A	PACKAGED DEVICES	
	PLASTIC 100-PIN TQFP (PZ)	PLASTIC 113-BALL BGA (ZQW)
-40°C to 85°C	MSP430FG4616IPZ	MSP430FG4616IZQW
	MSP430FG4617IPZ	MSP430FG4617IZQW
	MSP430FG4618IPZ	MSP430FG4618IZQW
	MSP430FG4619IPZ	MSP430FG4619IZQW
	MSP430CG4616IPZ	MSP430CG4616IZQW
	MSP430CG4617IPZ	MSP430CG4617IZQW
	MSP430CG4618IPZ	MSP430CG4618IZQW
	MSP430CG4619IPZ	MSP430CG4619IZQW



MSP430F5529 (PN)

- A quad flat package (QFP) – surface mounted IC package, leads extend on all 4 sides: LQFP (low profile QFP), TQFP (thin QFP)
- PN – Texas Instruments name of the package

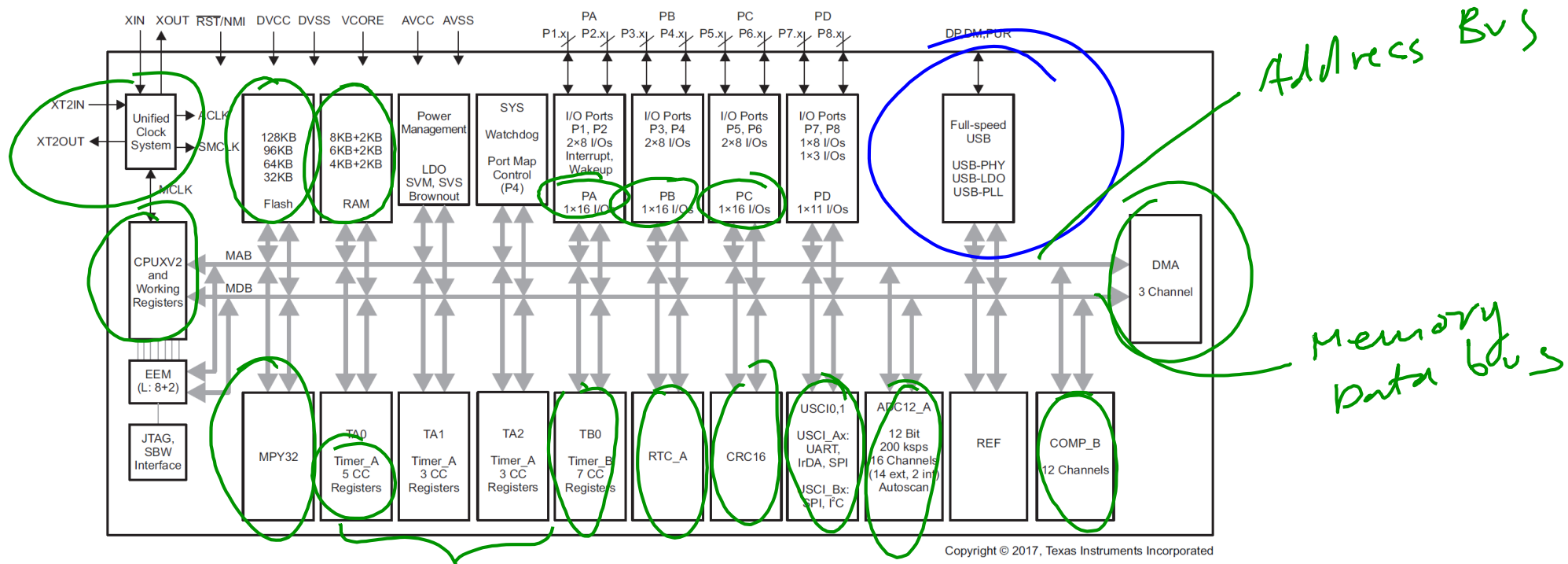
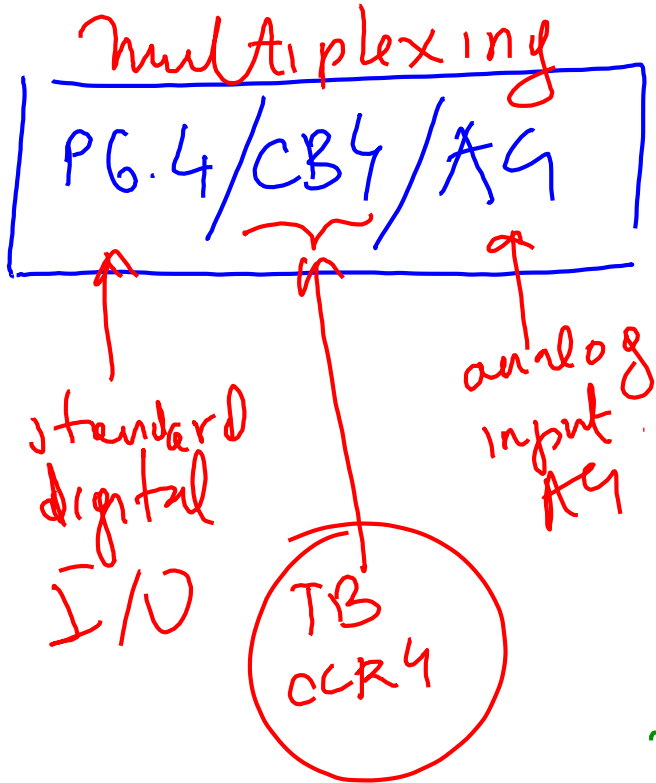


Figure 1-1. Functional Block Diagram – MSP430F5529IPN, MSP430F5527IPN, MSP430F5525IPN, MSP430F5521IPN

Pin Diagram for MSP430F5529

80 physical pins



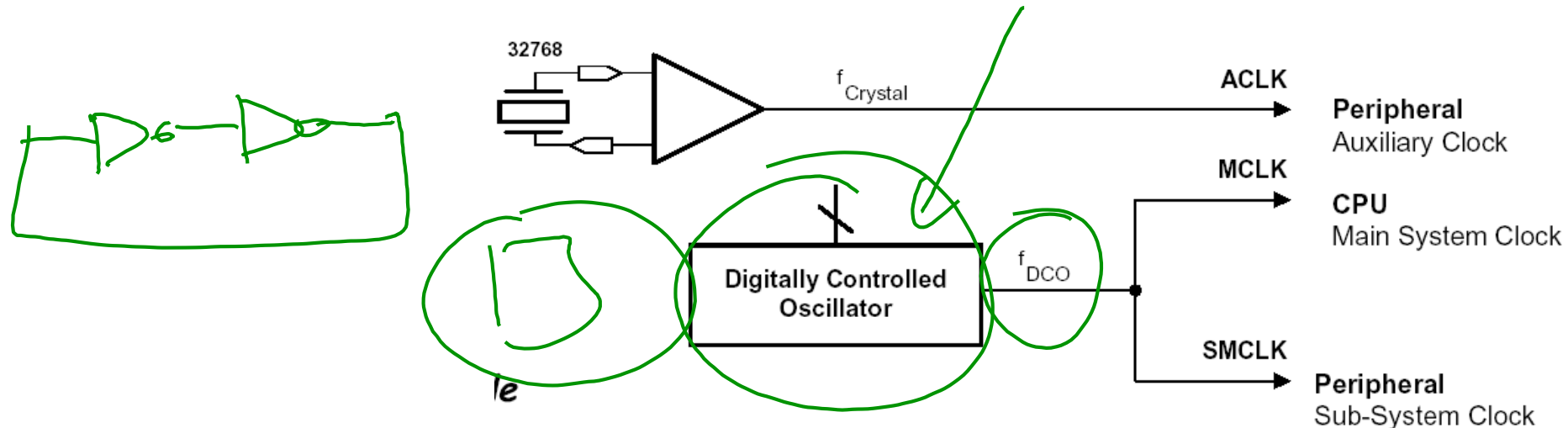
PxDIR
PxIN
PxOUT
PxSEL

Multiplexing



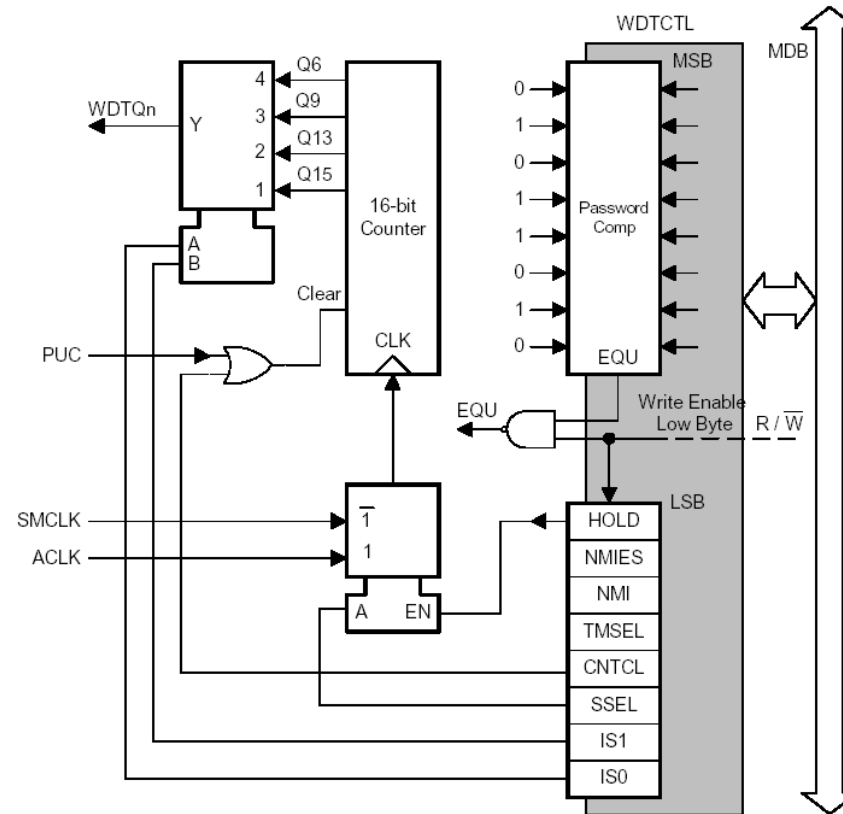
Clock Subsystem

- Generate clocks used by components on the chip
 - Configured and tuned by software, enable/disable clocks for Low-Power Modes
- Multiple types (FLL+, Basic Clock Module)
- Three clocks are available:
 - Main clock (MCLK): CPU, DMA, selected peripherals
 - Sub-system clock (SMCLK): peripherals
 - Auxiliary clock (ACLK): peripherals



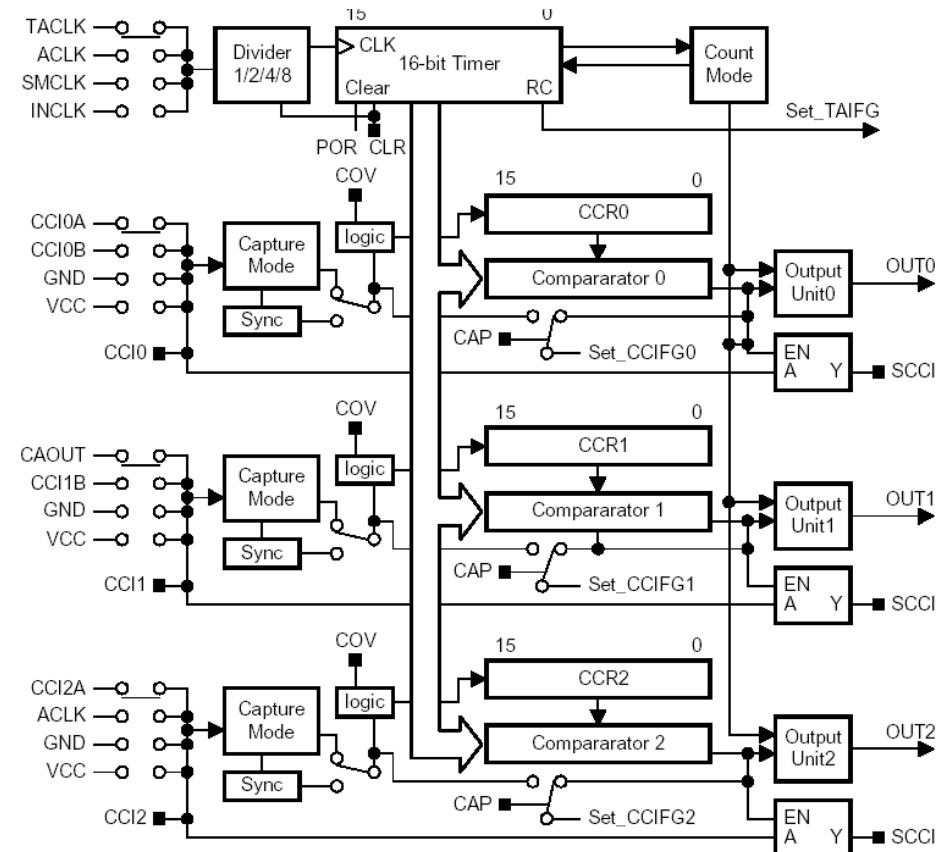
Watchdog Timer

- Monitors system operation
- Two modes of operation
 - Watchdog
 - Interval timer
- Watchdog: performs controlled system reset if a software error occurs
- Interval timer: generates an regular periodic interrupt
- Active on power-up



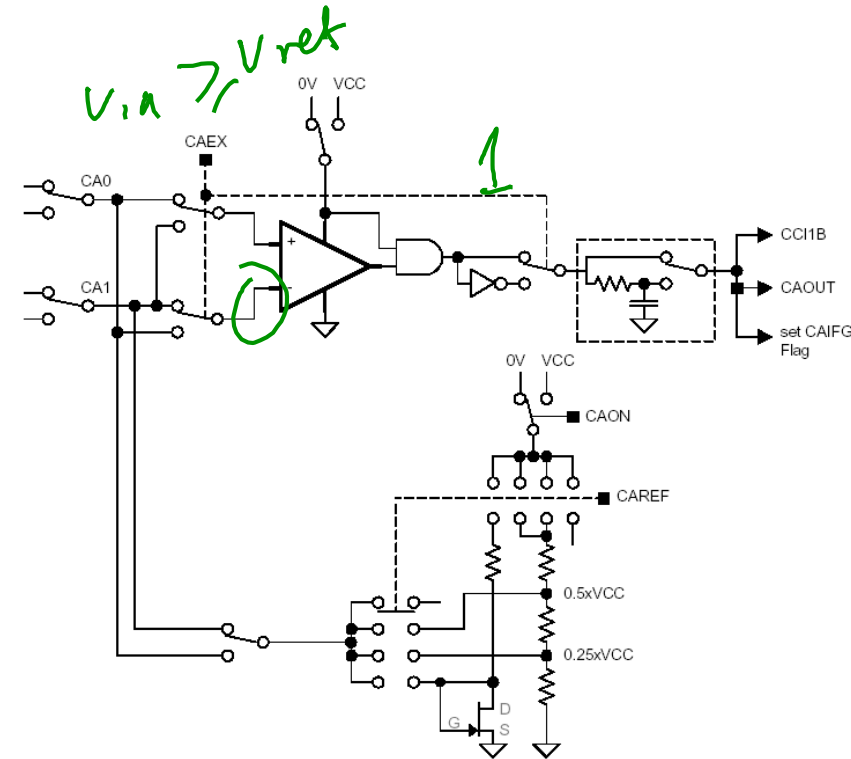
Timers (Timer_A, Timer_B)

- Time keeping
 - Timer block: counter
 - Capture&Compare block: logic where action occurs
- Two main functions
 - Capture
 - Compare
- Capture: monitor external events (signal transitions) and timestamp them when a change is detected
- Compare: produce PWM signals, compare running counter to predefined values in CCRx and trigger a change in a signal



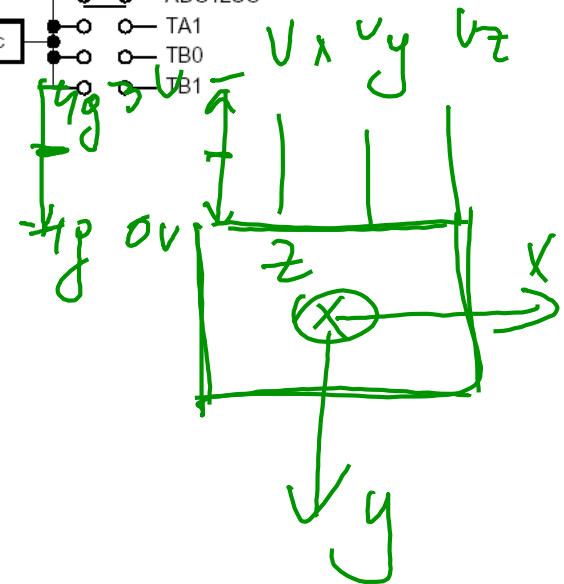
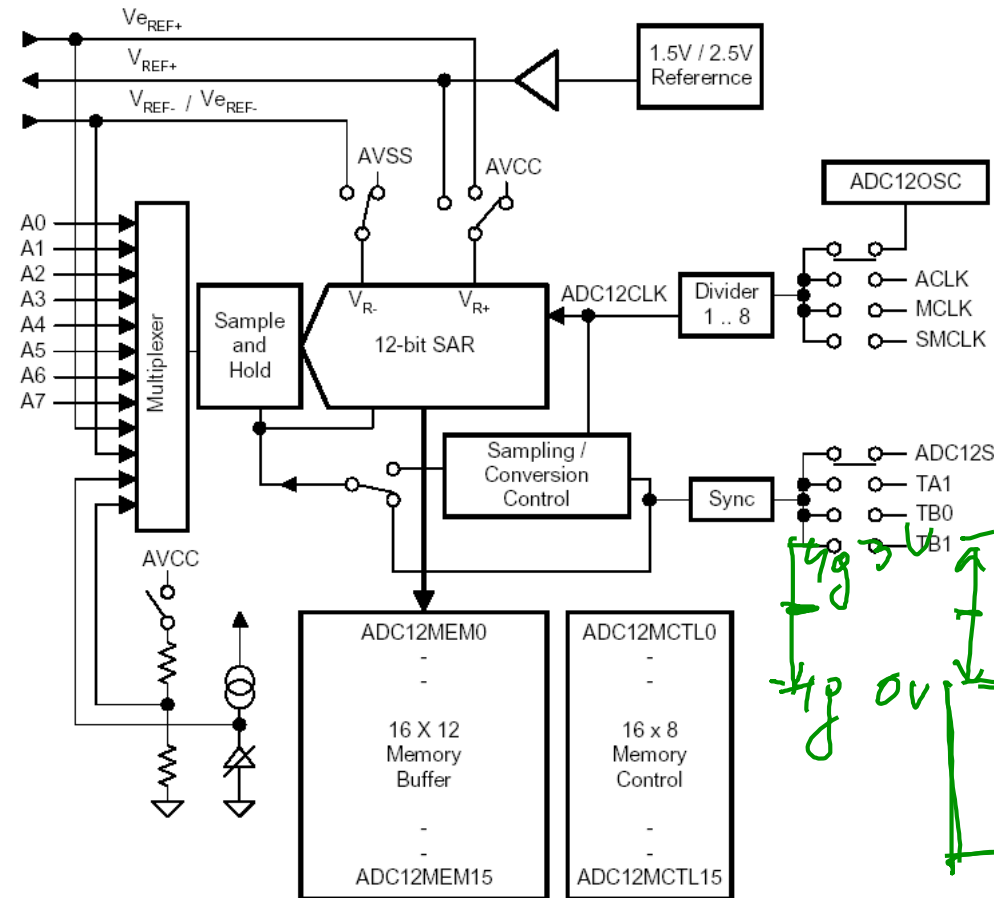
Comparator (Comparator_A)

- Compare an analog signal to a reference voltage and produces a binary output (1 if $V_{in} \geq V_{ref}$, 0 otherwise)
- Supports precision slope analog-to-digital conversions
- Supply voltage supervision
- Monitoring of external analog signals



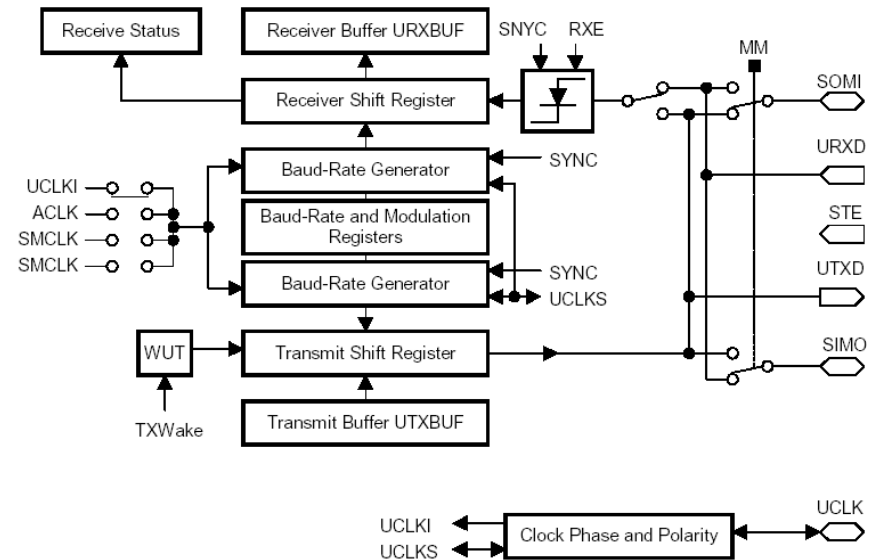
Analog-to-Digital Converter (ADC12)

- Convert analog signals to binary counterparts
- ADC12:
 - 12-bit resolution
 - 200 Ksamples/s
 - 8 external inputs
 - Local memory
 - Programmable sample time
 - Selectable reference voltages



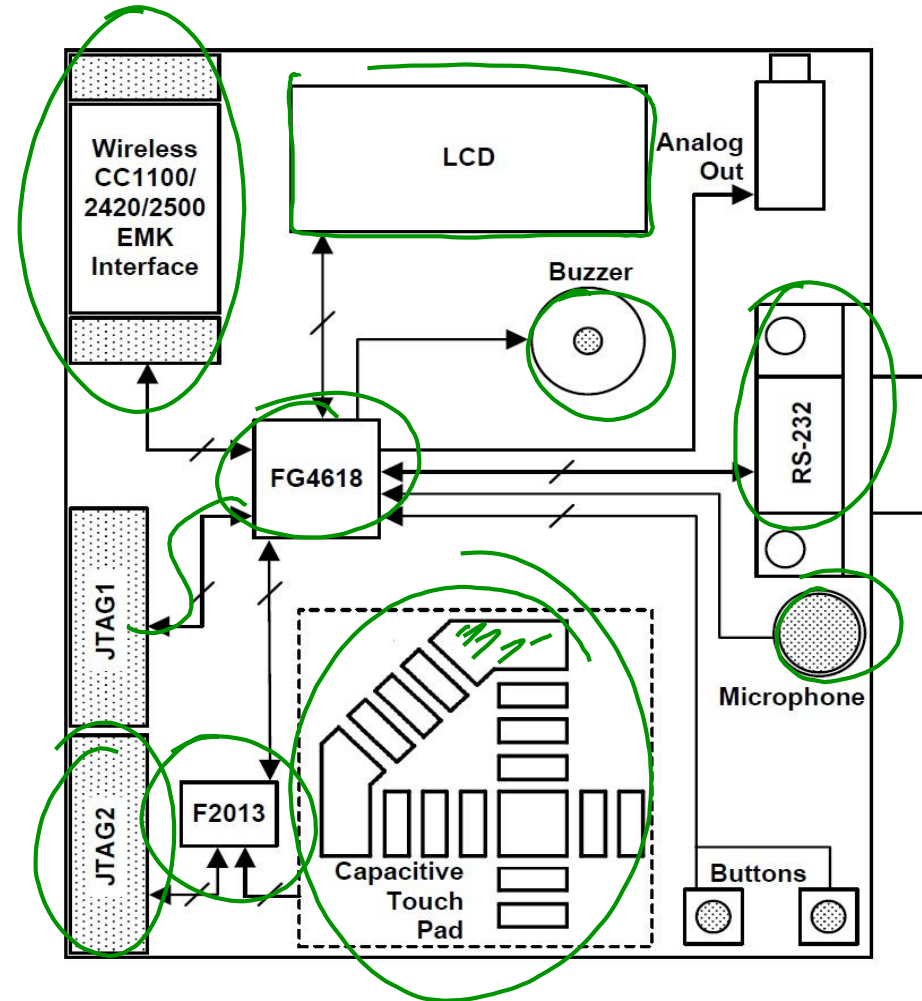
Serial Communication Interfaces (USCI, USART, USI)

- Support for synchronous and asynchronous serial communication
- UART
- SPI
- I2C
- Infrared



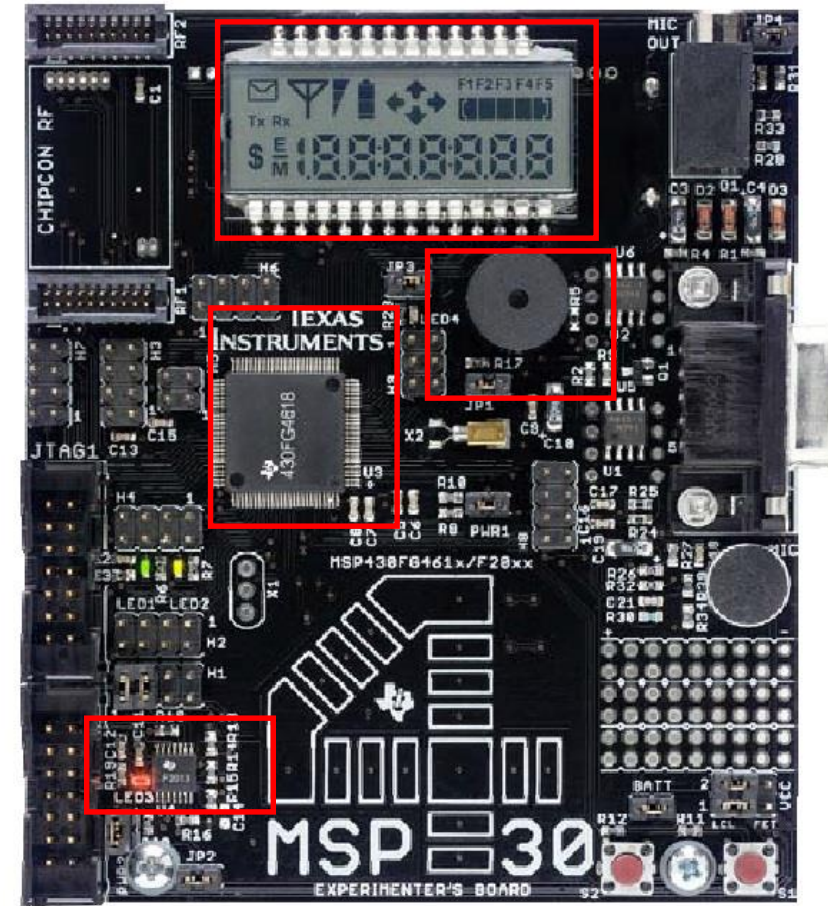
TI Experimenter's Board: Block Diagram

- Microcontroller's (F4618, F2013)
- JTAGs
- Buttons/Switches
- Capacitive Touch Pad
- Microphone
- Buzzer
- LCD
- Wireless Interface
- RS232



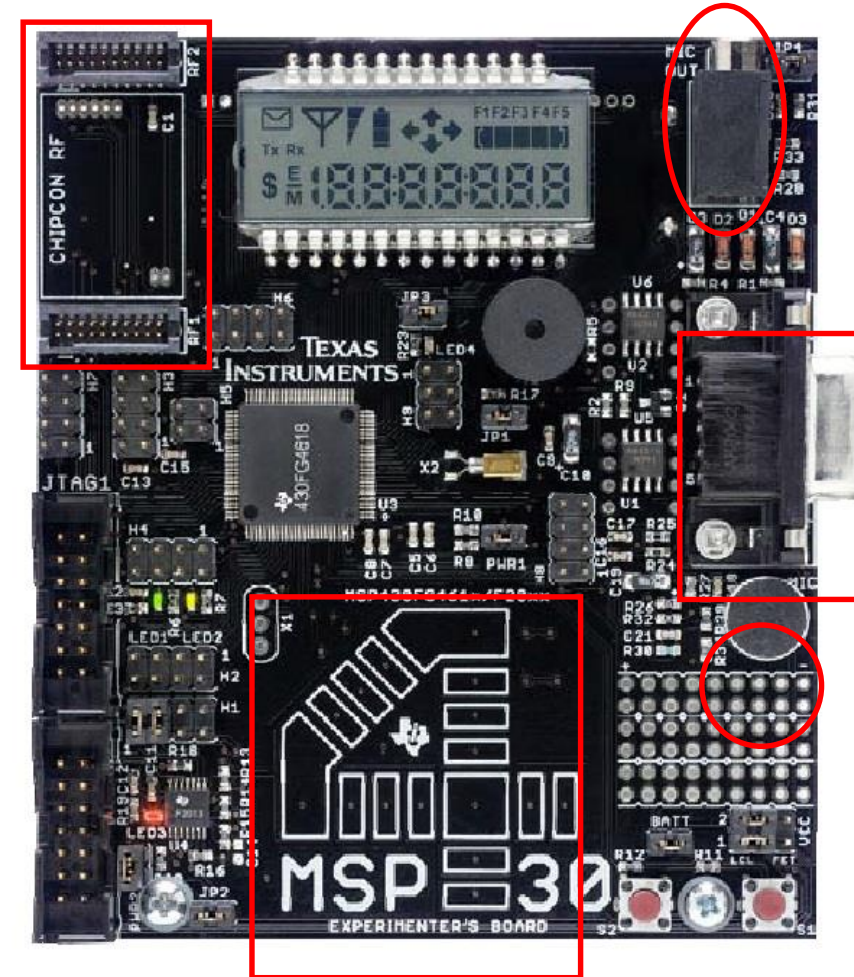
TI Experimenter's Board

- Two on-board CPUs
 - MSP430FG4618
 - MSP430F2013
- The Softbaugh SBLCDA4 LCD display
 - 4-MUX operation and is interfaced to the MSP430FG4618 LCD driver peripheral
- Momentary Push-ON Buttons
 - S1 and S2 are connected to pins on Port 1 (P1) of the MSP430FG4618
- Light Emitting Diodes (LEDs)
 - Four LEDs, three of which are connected to the MSP430FG4618, and one connected to the F2013.
- Buzzer
 - Connected to one of the MSP430FG4618 port pins and can be disabled using jumper JP1



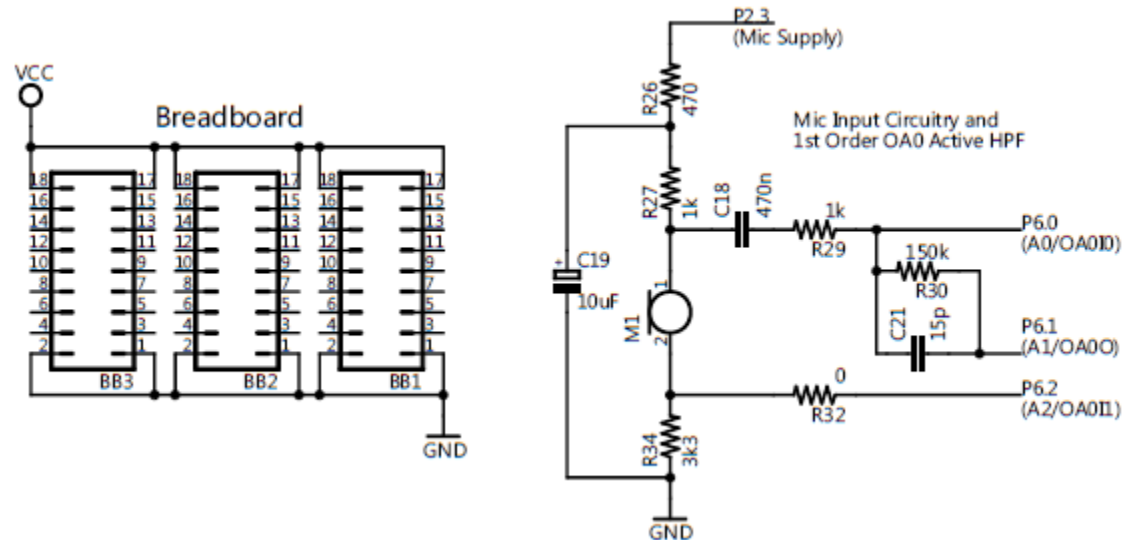
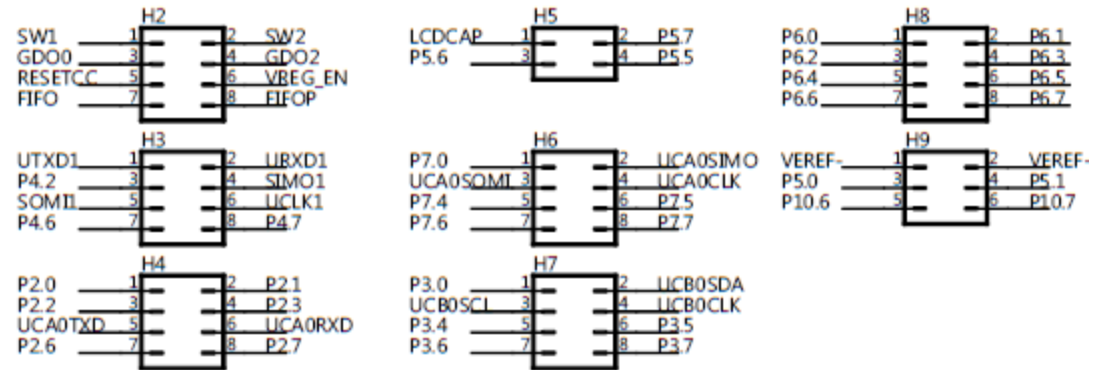
TI Experimenter's Board

- Single-Touch Capacitive Sensing Interface
 - A 16-segment touch pad in the shape of a “4” is connected to the data pins of the MSP430F2013, which then relays the data to the MSP430FG4618 using the inter-processor communications peripherals on each CPU
- RS232 Serial Communication Port
 - A standard 9-pin serial communications port is connected to the MSP430FG4618 USCI peripheral and can be used when the USCI is configured in UART mode
- Microphone & Analog Out
 - A microphone is connected to a port pin of the MSP430FG4618, and the input to the 3.5mm analog out can be connected to the output from the MSP430FG4618's 12-bit digital to and analog (DAC12) convertor
- Radio
 - Wireless Communication Module Interface

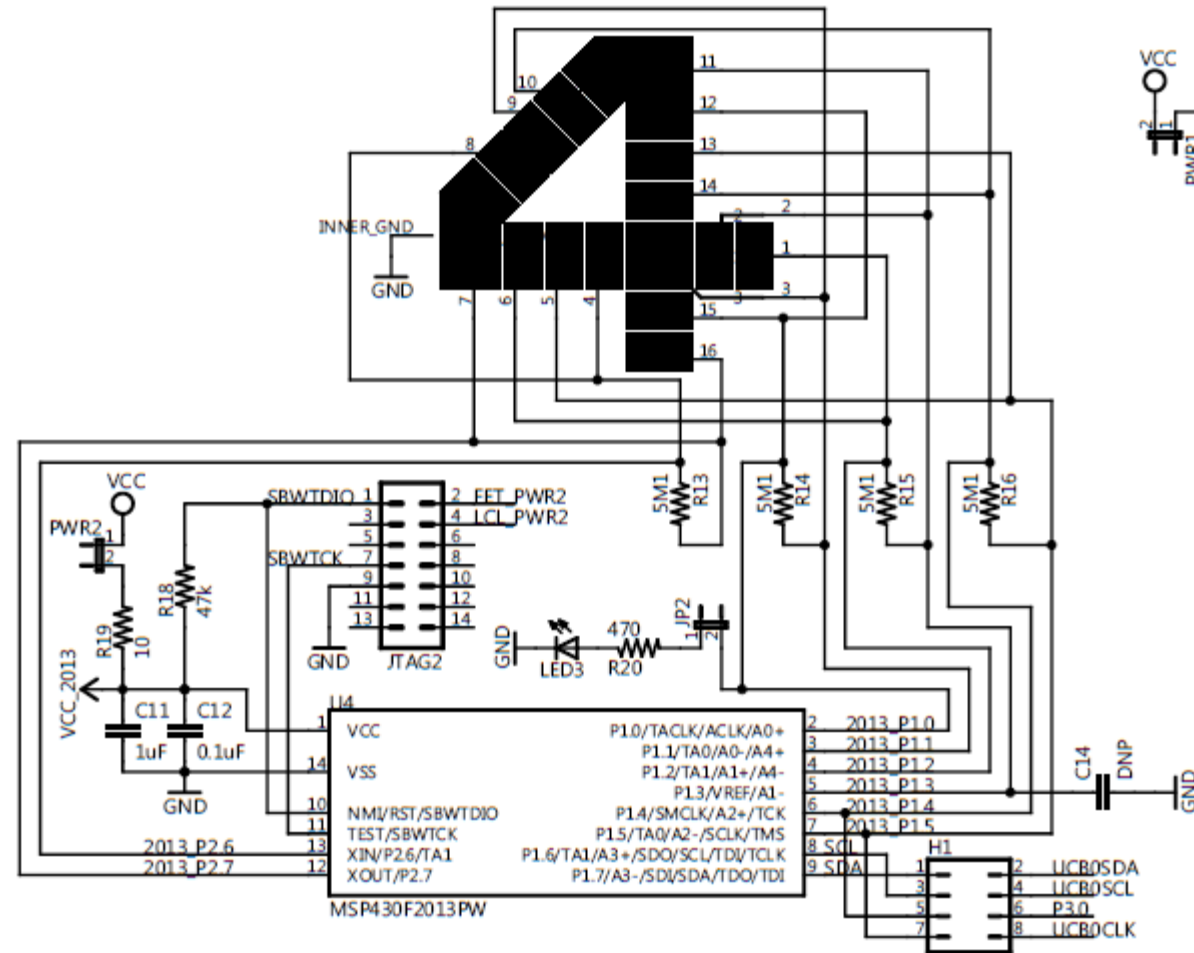


Headers

MSP430FG4618 Pin Access

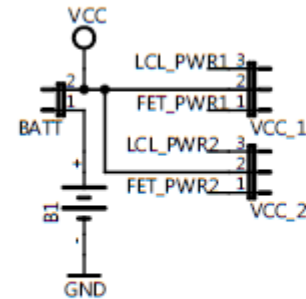


Capacitive Touch Pad



Power Supply Configuration, RF Daughter Card Connect, Audio Output

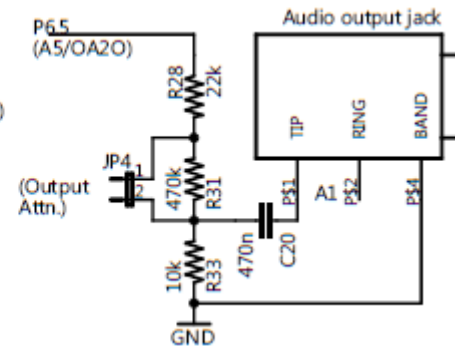
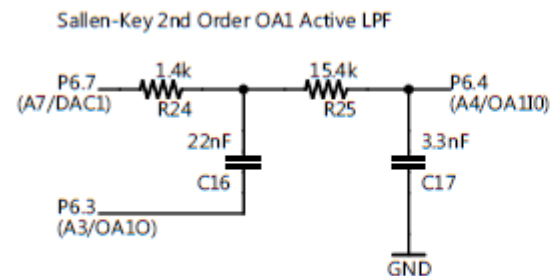
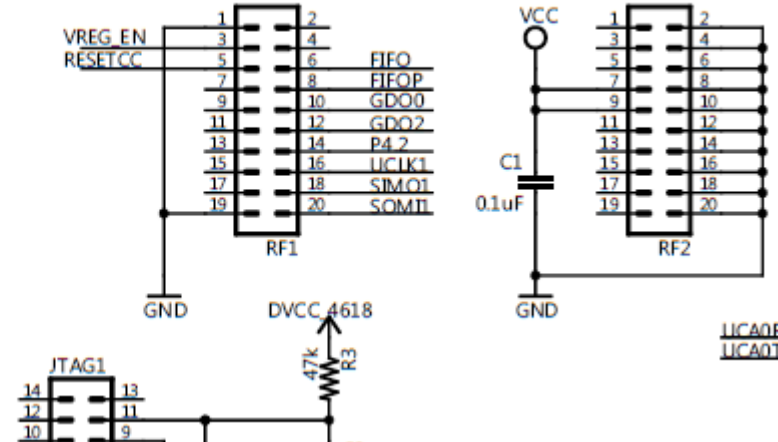
Power Supply Configuration



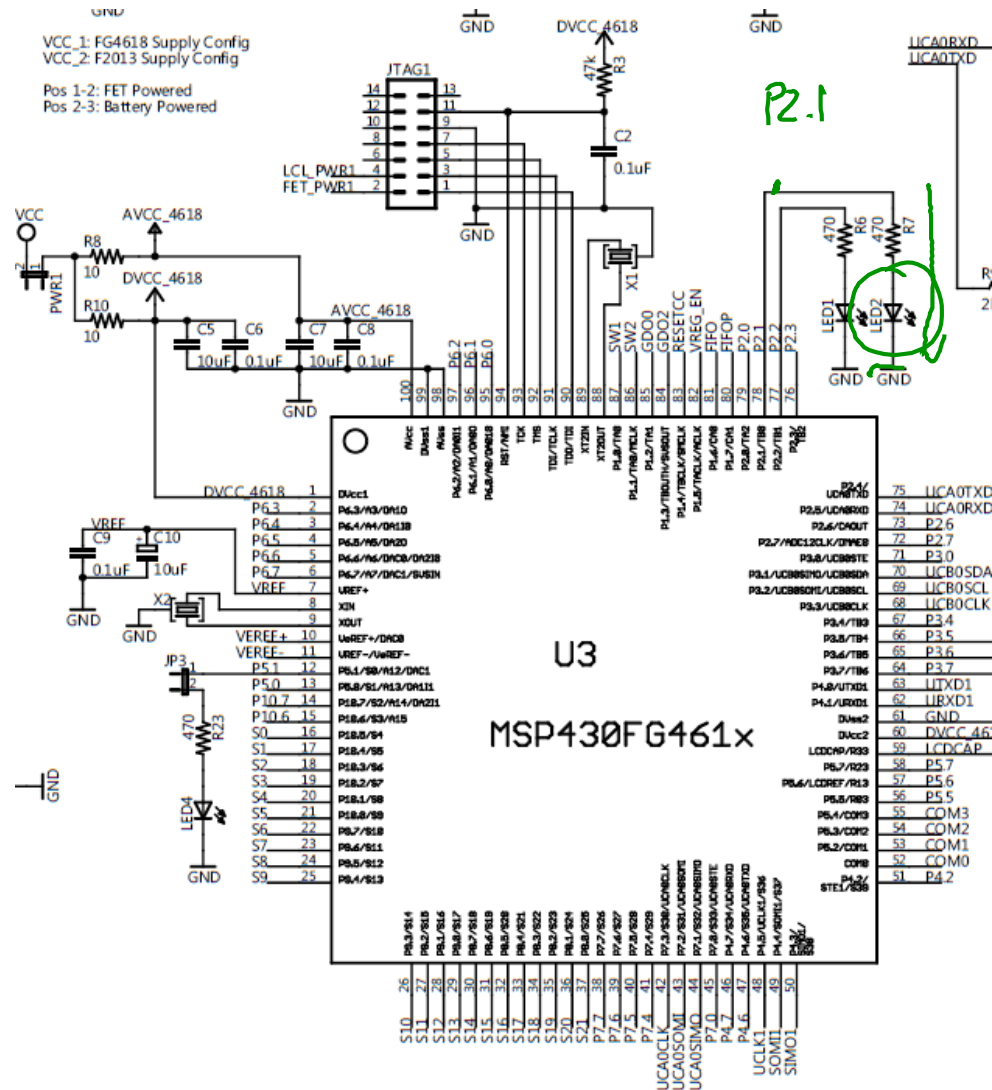
VCC_1: FG4618 Supply Config
VCC_2: F2013 Supply Config

Pos 1-2: FET Powered
Pos 2-3: Battery Powered

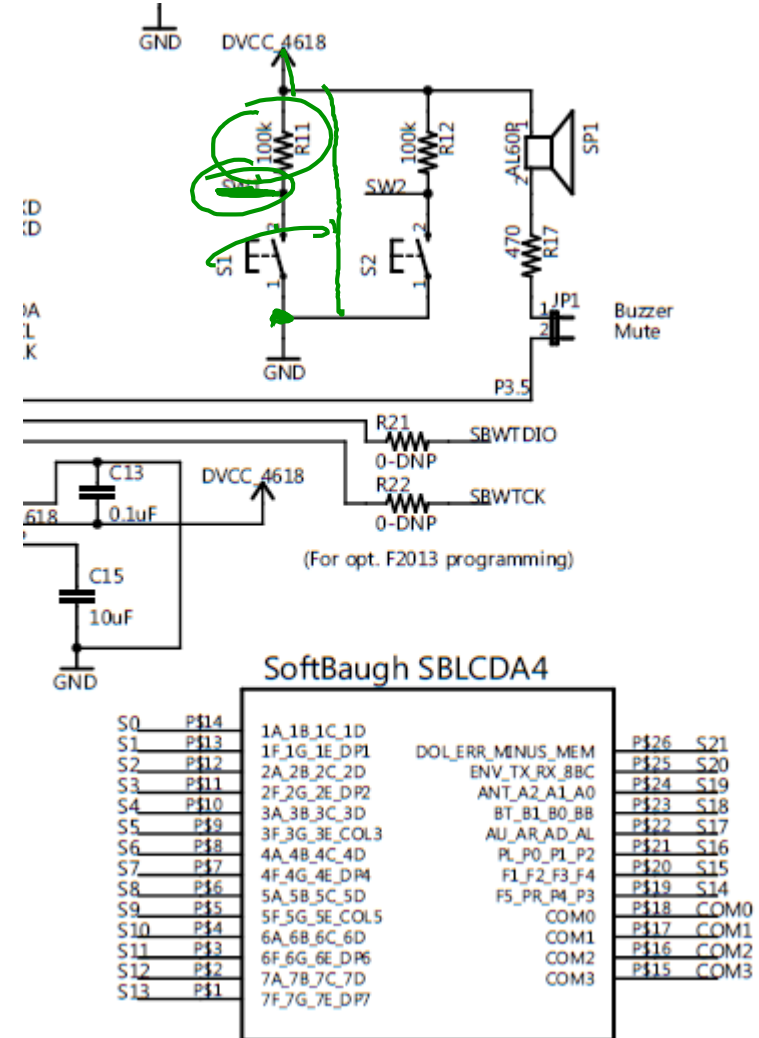
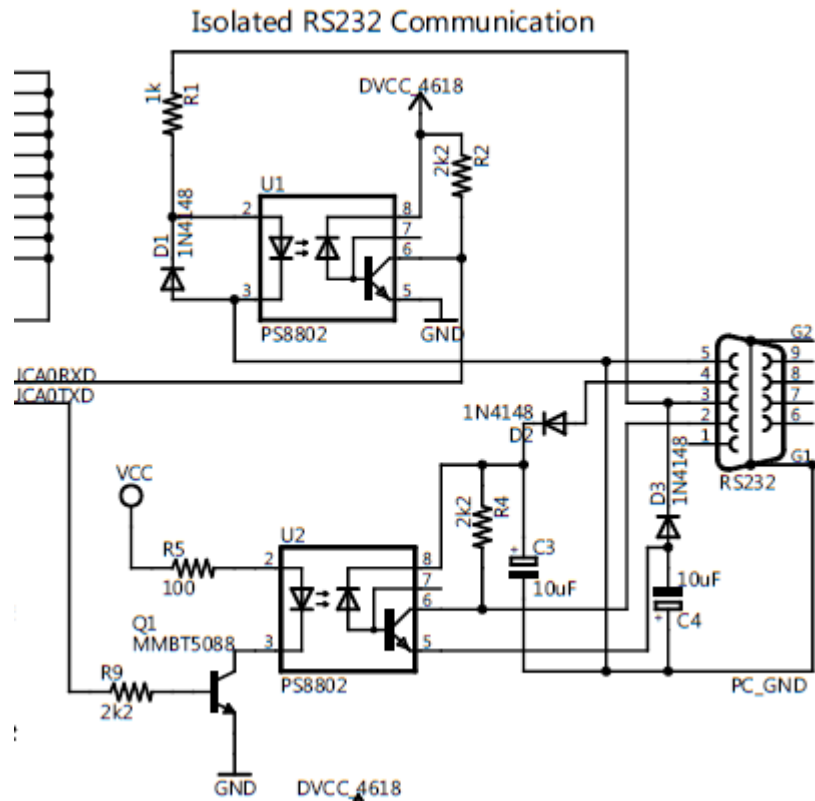
RF Daughter Card Connect



MSP430FG4618



RS232 Connector, LCD Display



Blink a LED Program

```

/*****
; TI Experimenter board demo, blinking leds LED1 and LED2 (msp430FG4618)
; Description: Toggle P2.1 and P2.2 by xoring P2.1 and P2.2 inside a loop.
;             The LEDs are connected to P2.1 and P2.2 and are on when
;             P2.1=1 and P2.2=1;
;             The LEDs are initialized P2.1 to be off, and P2.2 to be on;
;             ACLK = 32.768kHz, MCLK = SMCLK = default DCO
;             MSP430xG461x
;
;             -----
;             /\|
;             | |
;             --|RST
;             |
;             P2.2|-->LED1 (GREEN)
;             |
;             P2.1|-->LED2 (YELLOW)
; Alex Milenkovich, milenkovic@computer.org
;*****/
#include "msp430xG46x.h"

void main(void)
{
    WDTCTL = WDTPW + WDTHOLD; // Stop watchdog timer
    P2DIR |= 0x06;             // Set P2.1&P2.2 to output direction (0000_0110)
    P2OUT = 0x02;              // Set P2OUT to 0x0000_0010 (LED2 is on, LED1 is off)
    for (;;) {
        unsigned int i;
        P2OUT ^= 0x06;         // Toggle P2.1 using exclusive-OR
        i = 50000;              // Delay
        do (i--);
        while (i != 0);
    }
}

```