CPE 323 Introduction to Embedded Computer Systems: MSP430 System Architecture – An Overview

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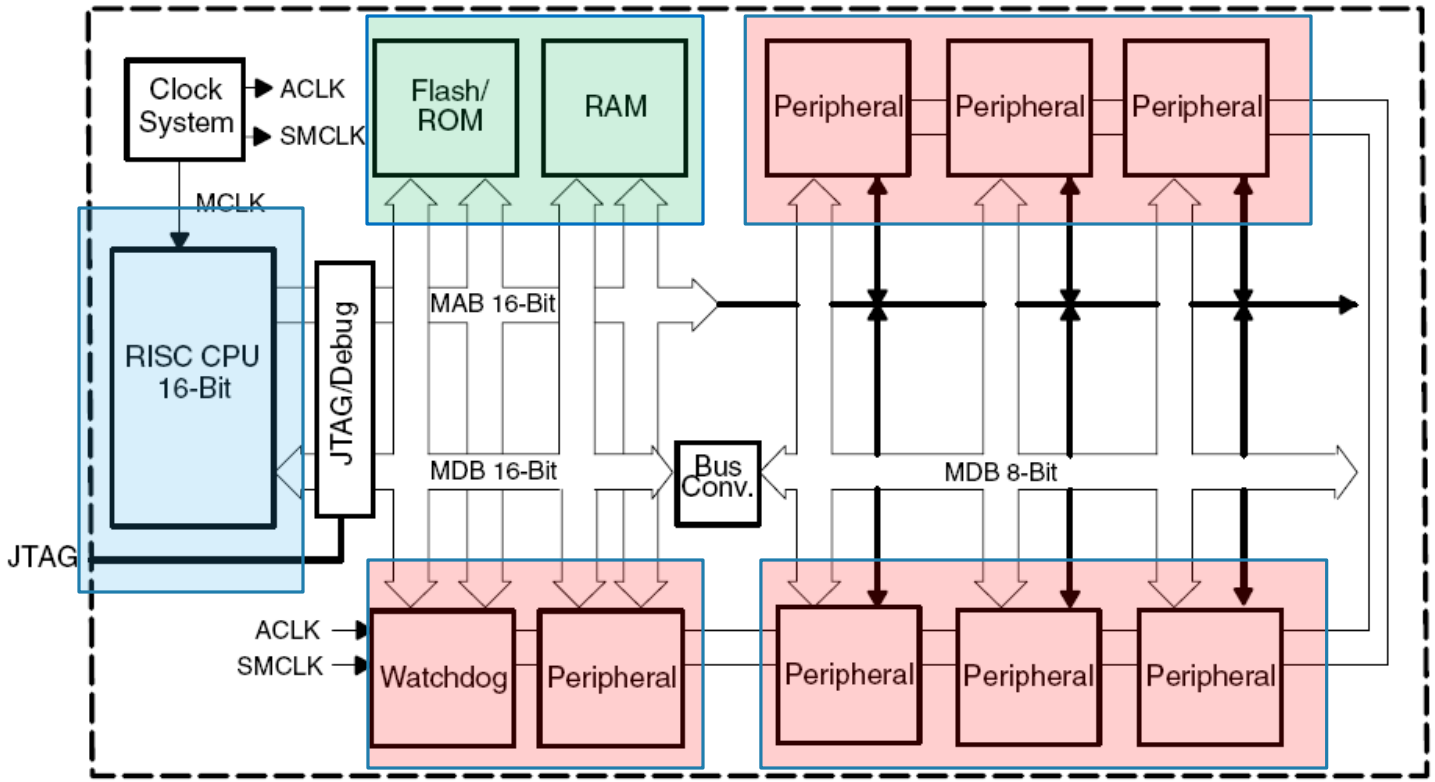
CPU, Memory, Peripherals, Bus (MAB, MDB)



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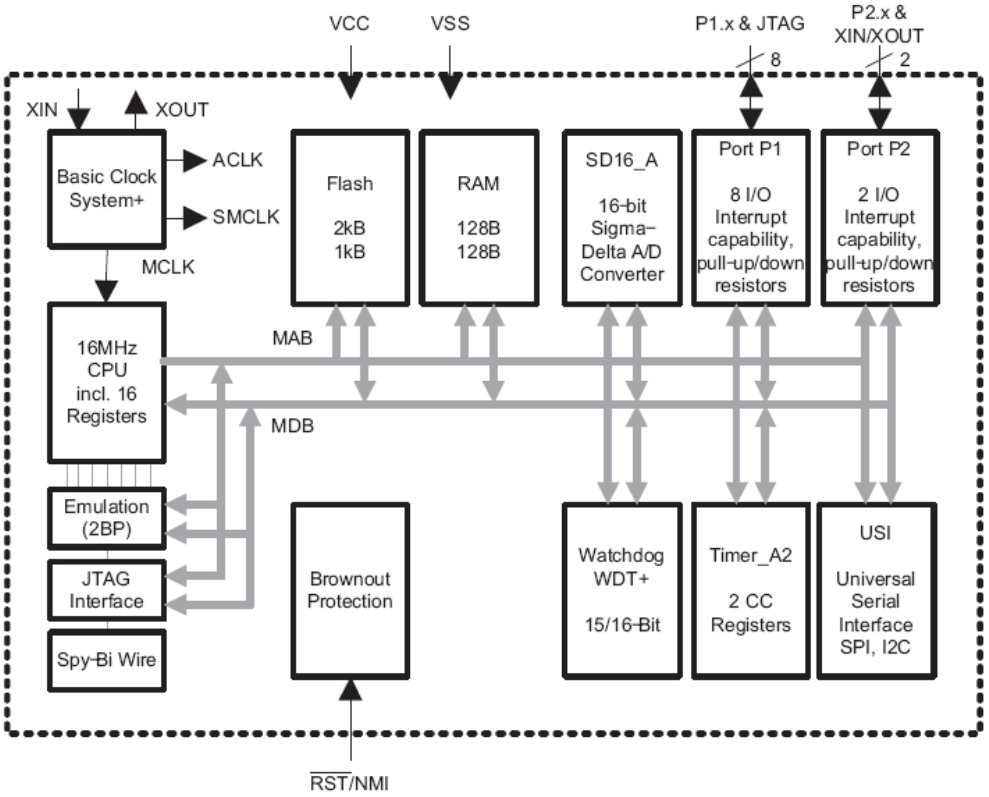
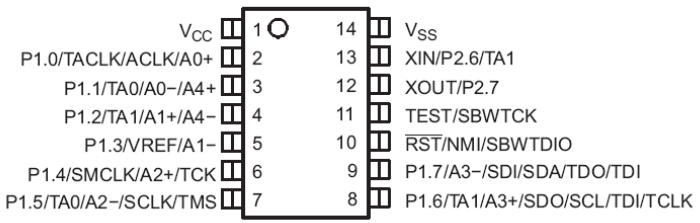
MSPx430F2013 Microcontroller

Functional Block Diagram, MSP430F20x3



PW or N PACKAGE
(TOP VIEW)



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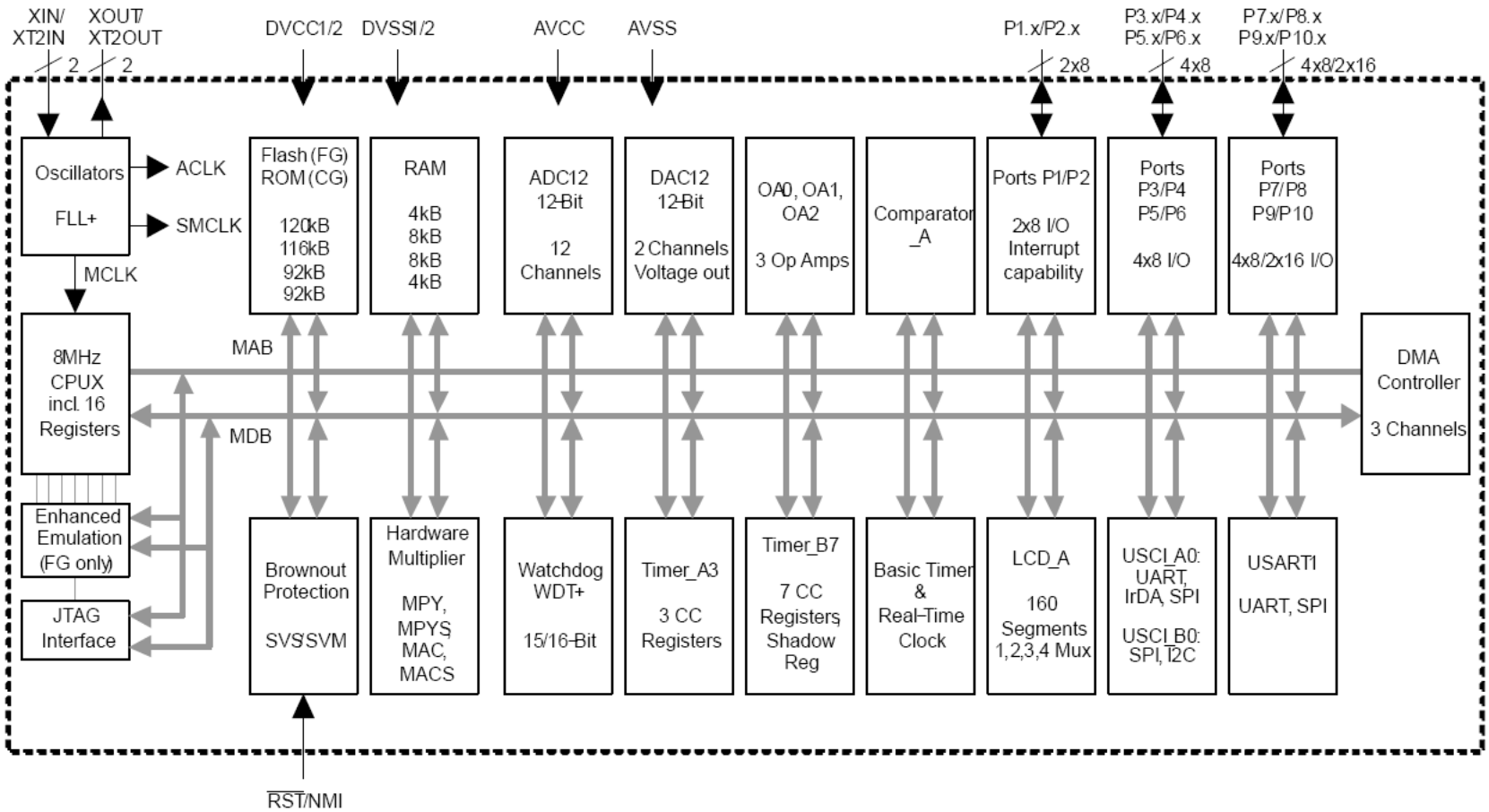
MSP430xG461x Microcontroller



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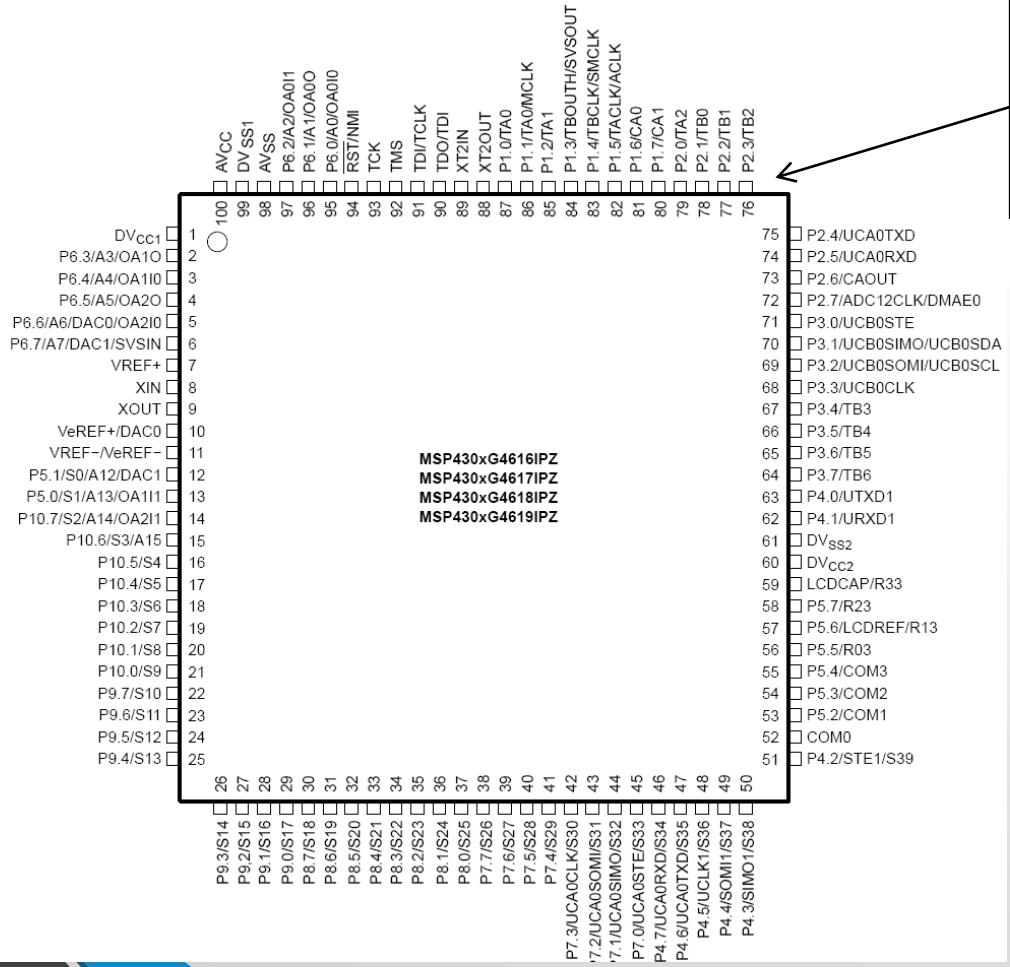
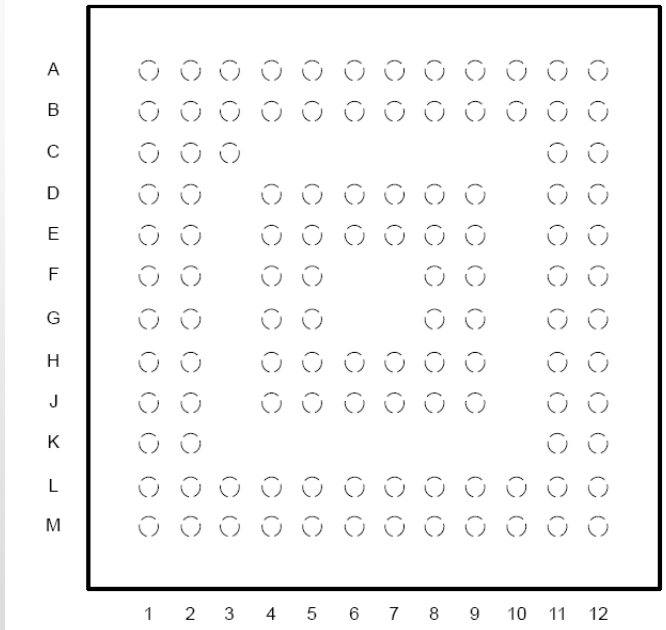
MSP430xG461x Microcontroller

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





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MSP430F5529

- 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

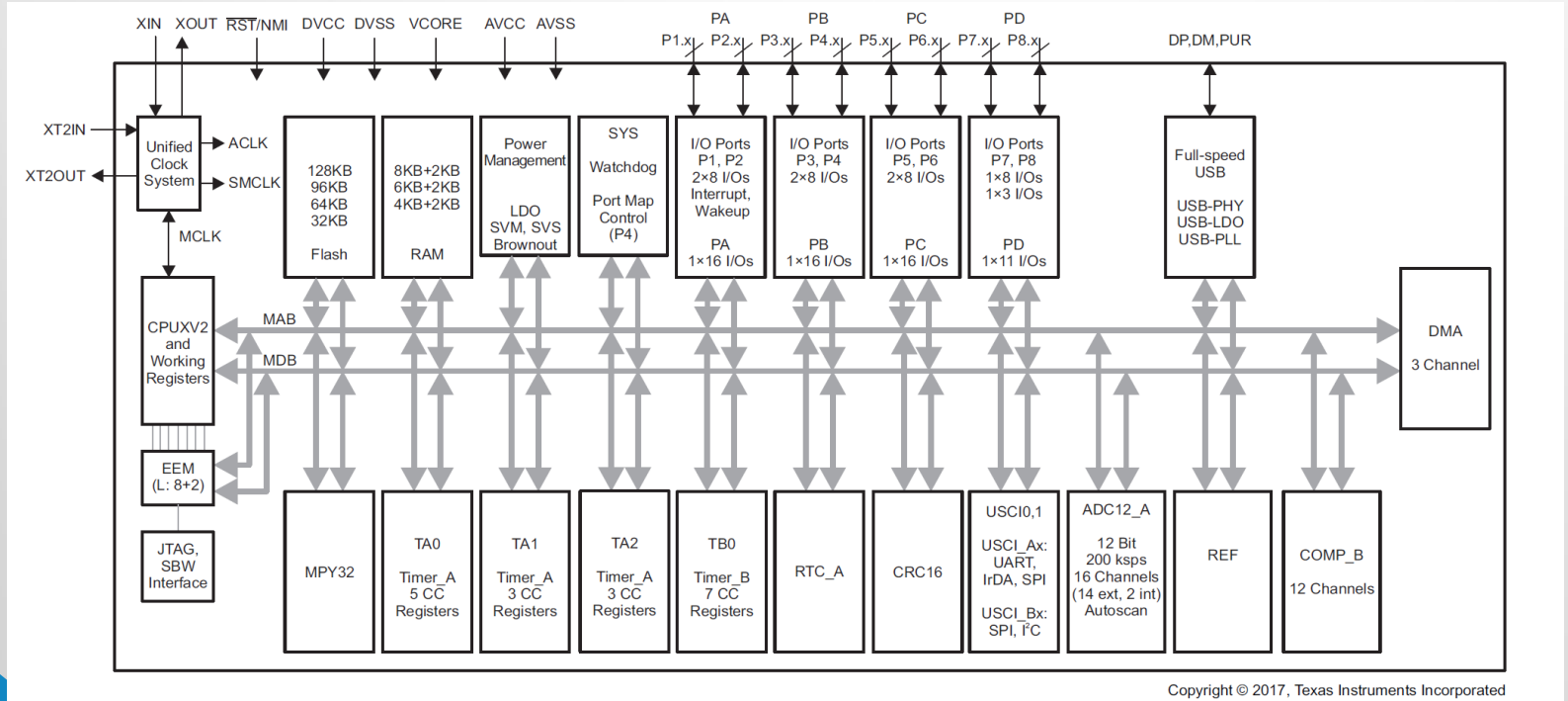

Figure 1-1. Functional Block Diagram – MSP430F5529IPN, MSP430F5527IPN, MSP430F5525IPN, MSP430F5521IPN

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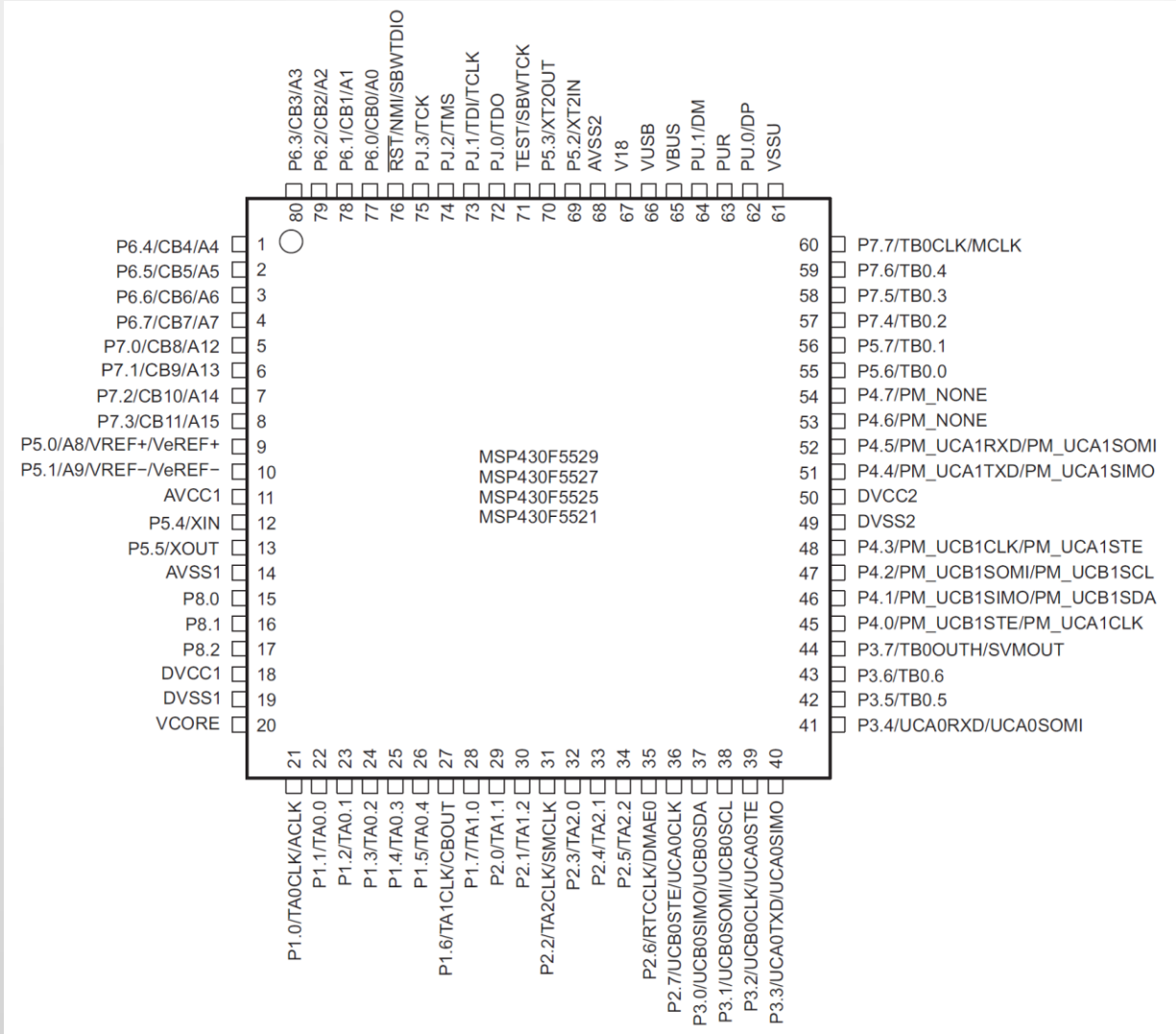
Pin Diagram for MSP430F5529



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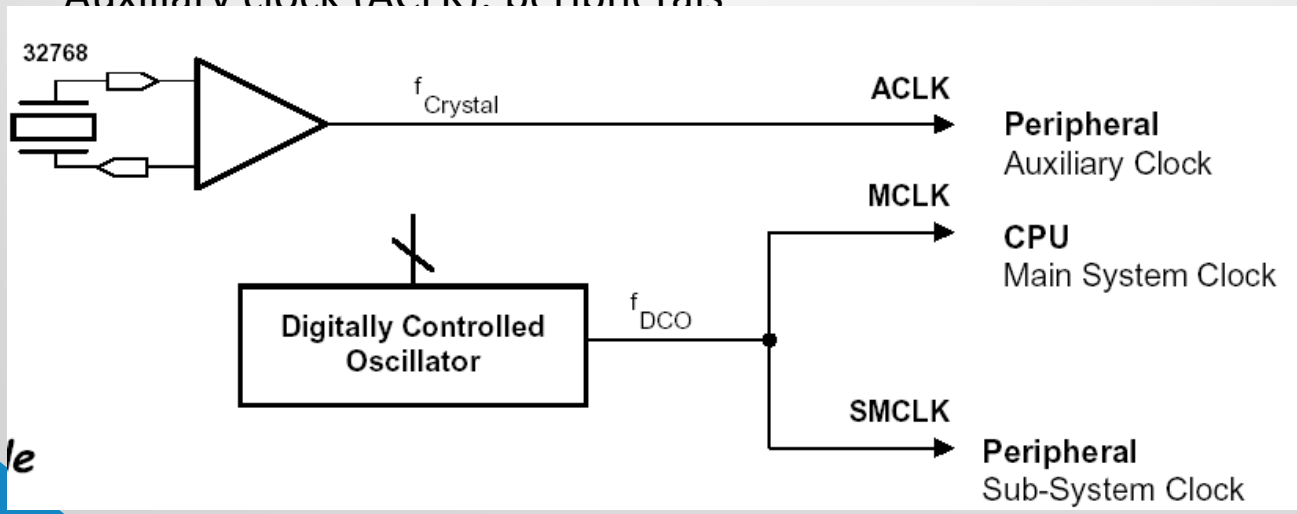
Clock Subsystem

- 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



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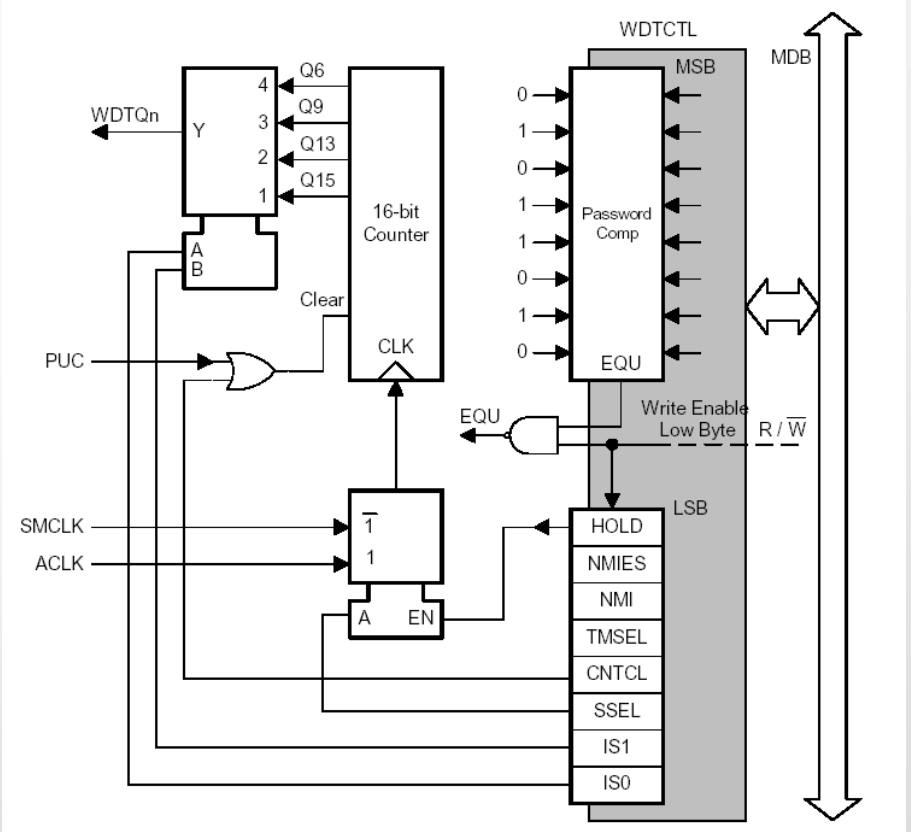
Watchdog Timer

- 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



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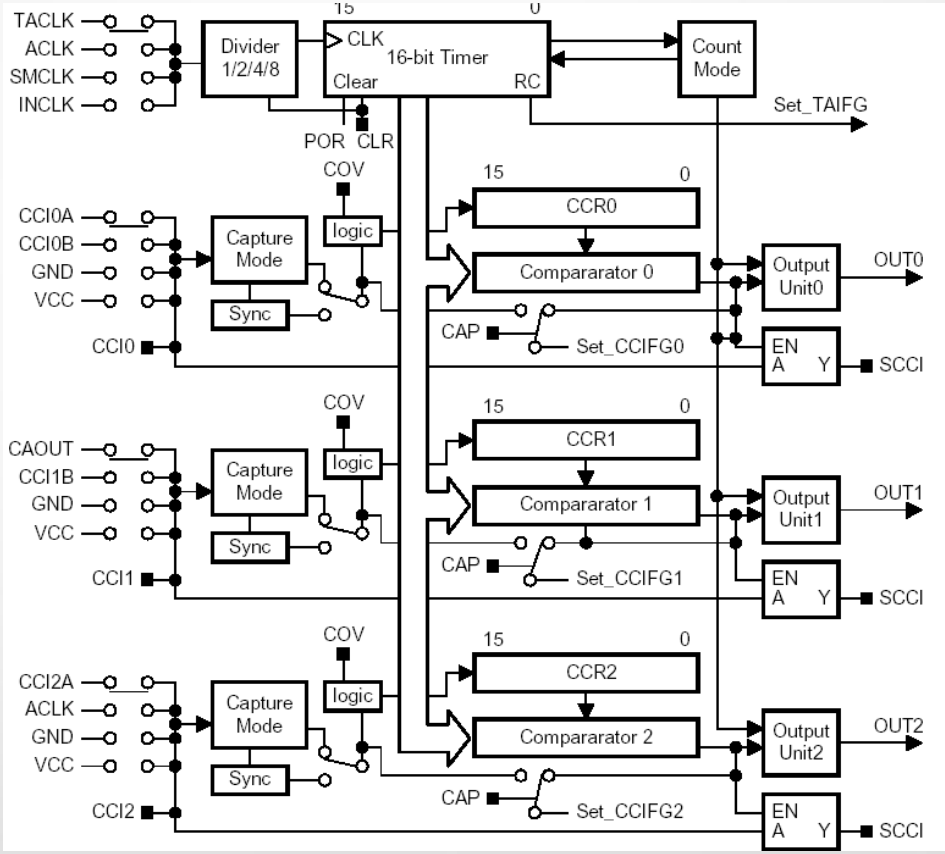
Timers (Timer_A, Timer_B)

- 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



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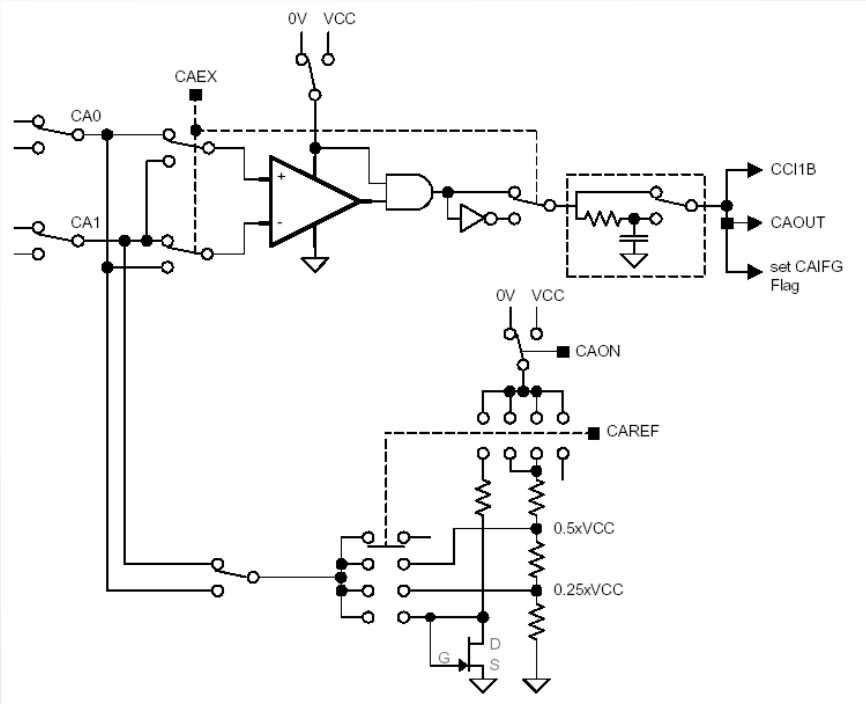
Comparator (Comparator_A)

- Compare an analog signal to a reference voltage and produces a binary output (1 if Vin≥Vref, 0 otherwise)
- Supports precision slope analog-to-digital conversions
- Supply voltage supervision
- Monitoring of external analog signals



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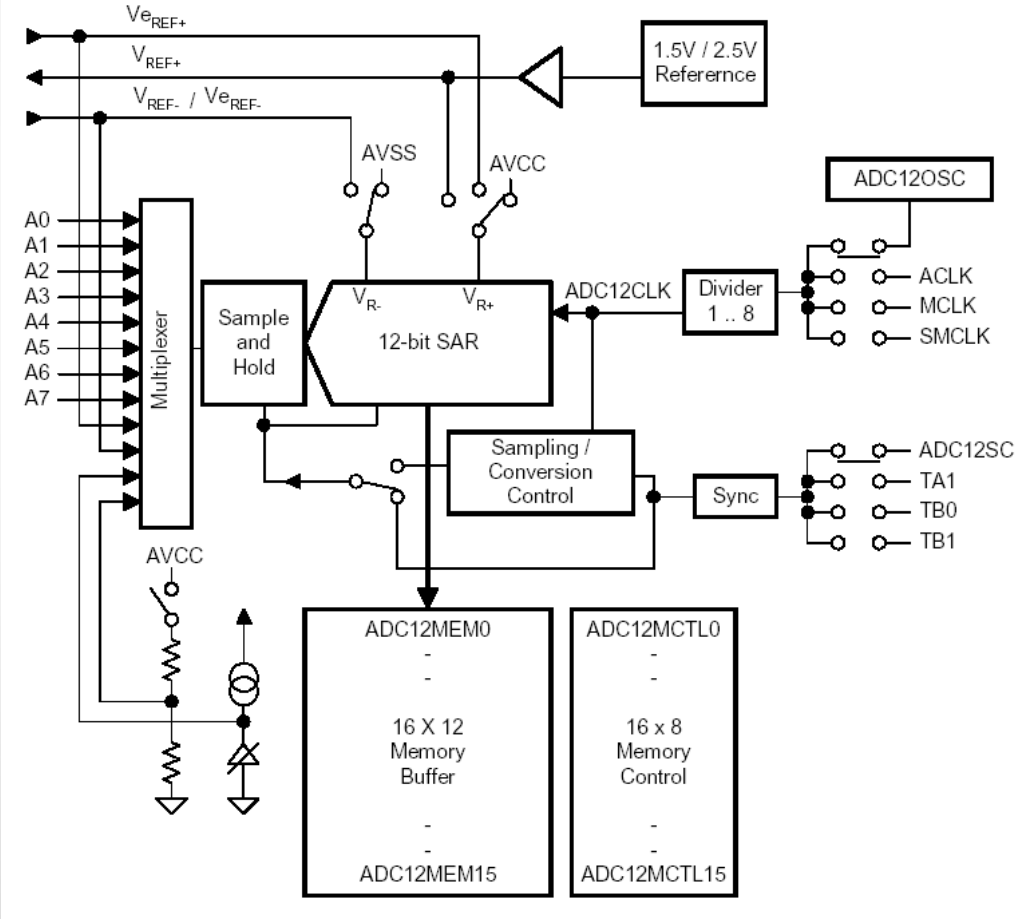
Analog-to-Digital Converter (ADC12)

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



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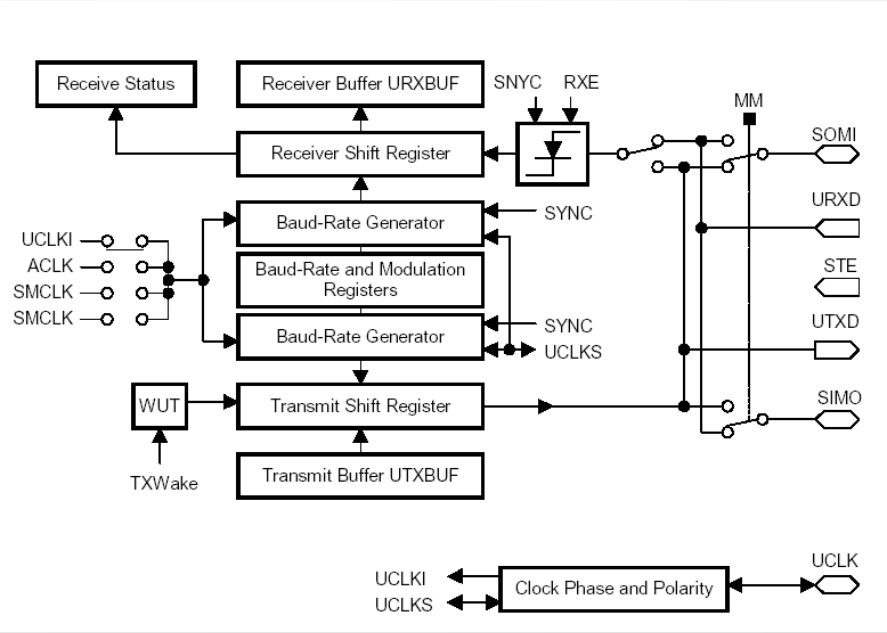
Serial Communication Interfaces (USCI, USART, USI)

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



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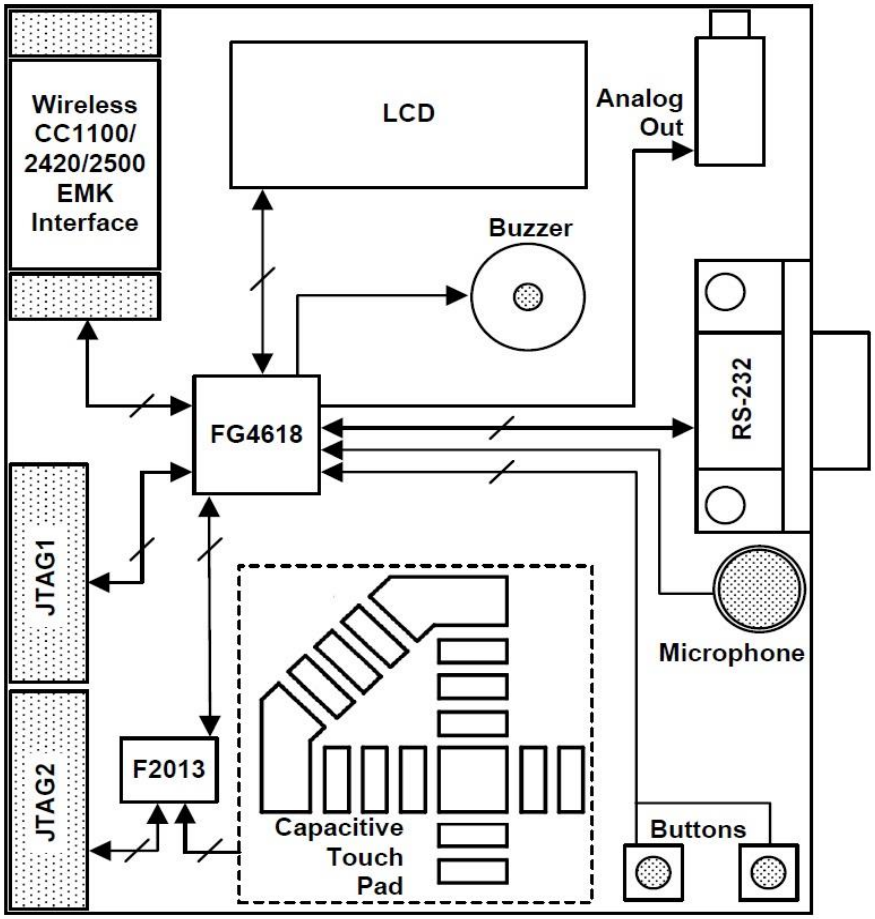
TI Experimenter's Board: Block Diagram

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



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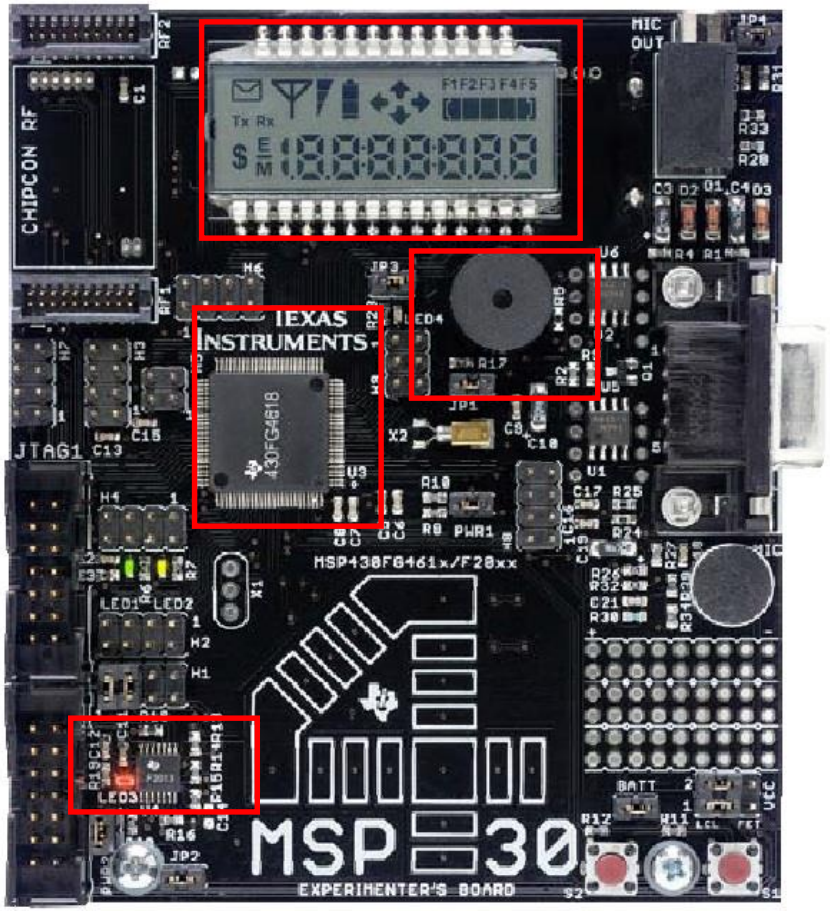
TI Experimenter's Board

- 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



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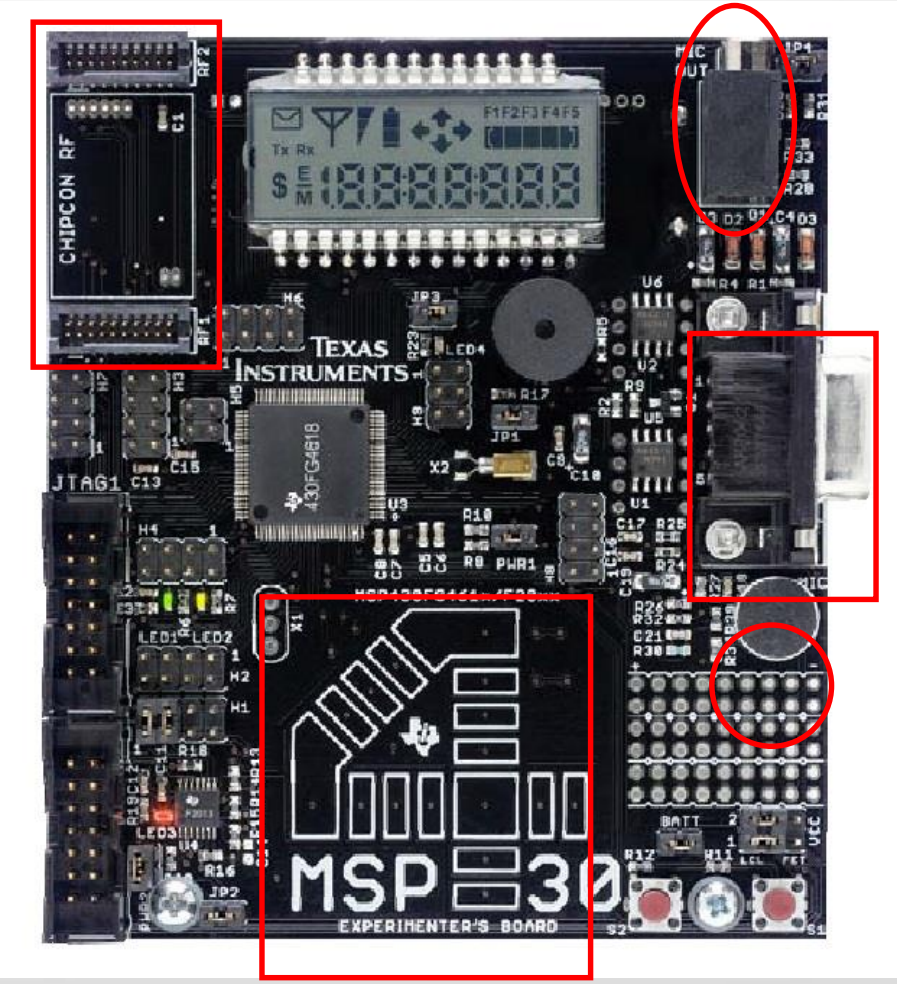
TI Experimenter's Board

- 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



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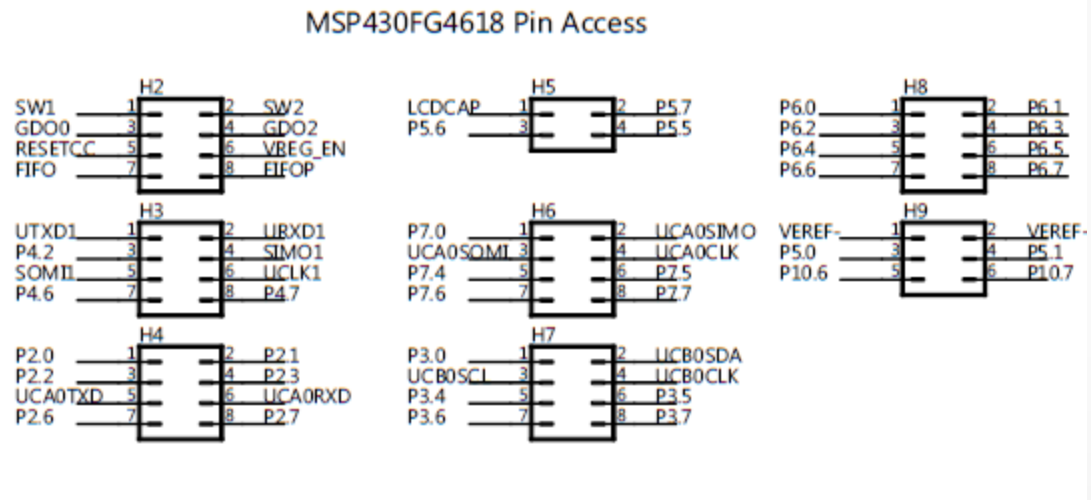
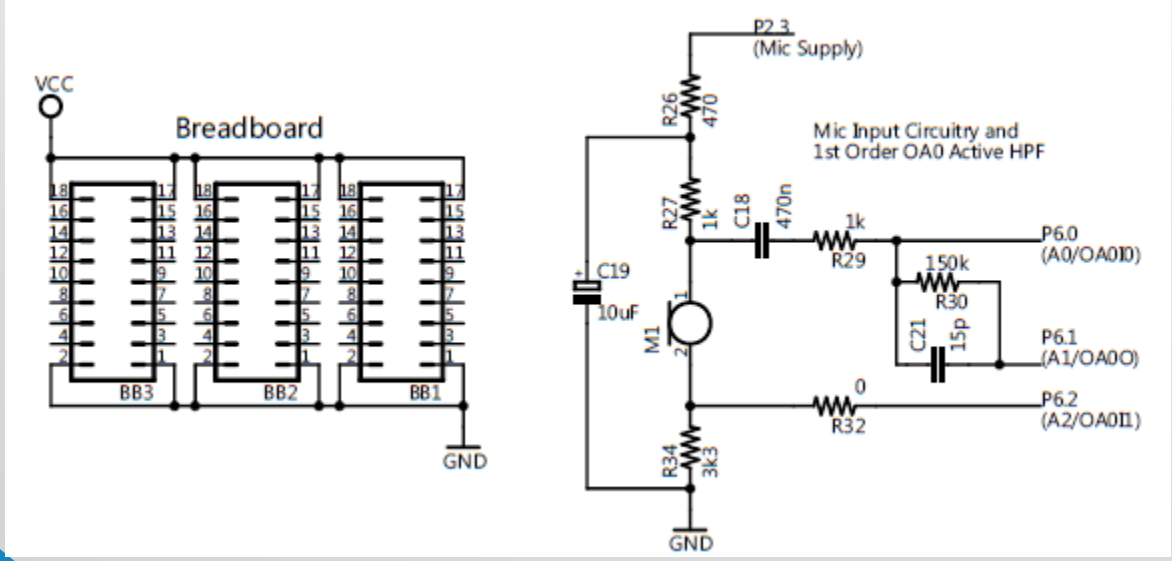
Headers





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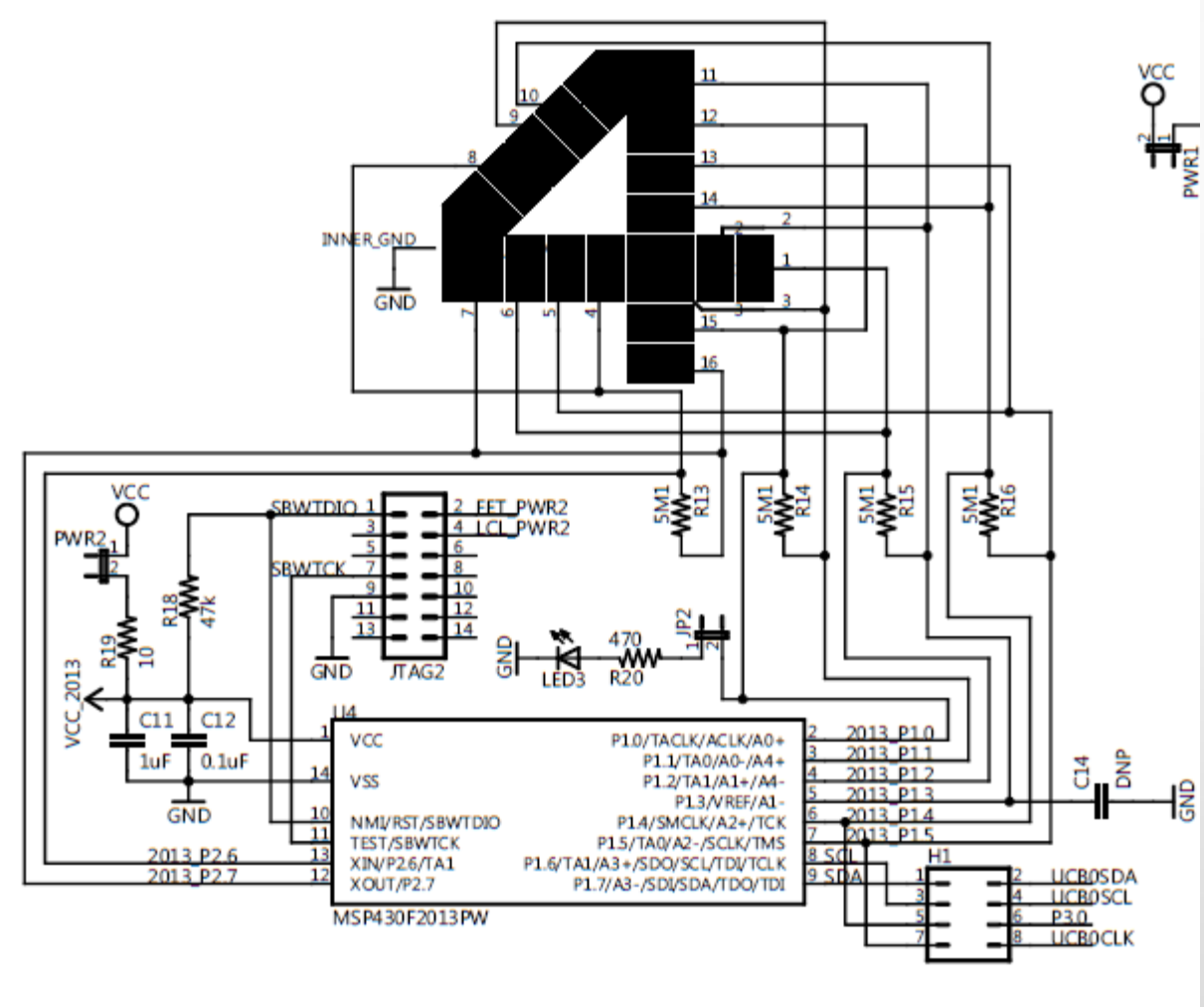
Capacitive Touch Pad



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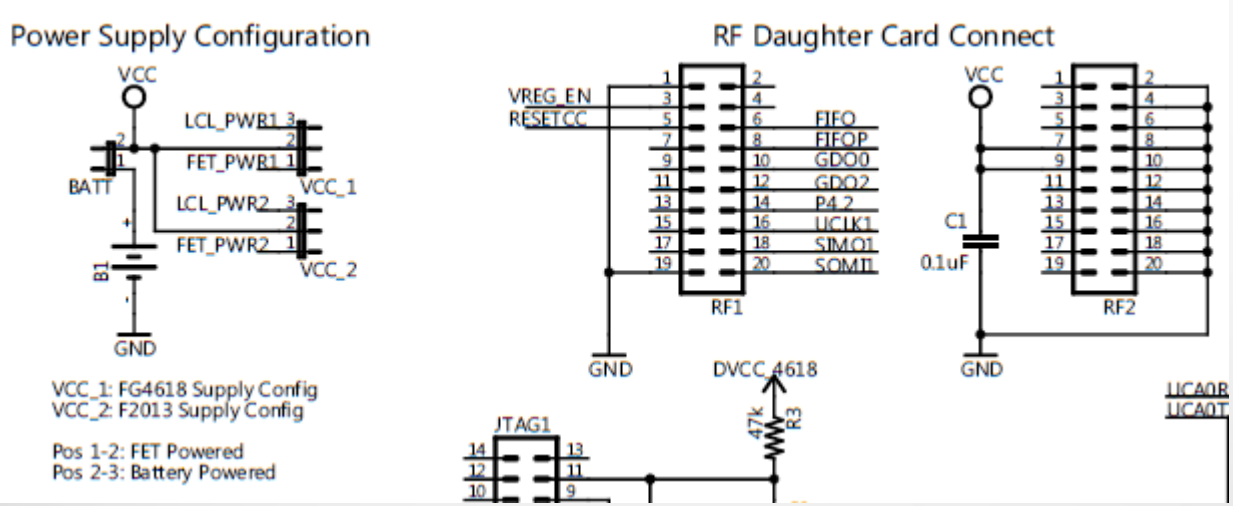
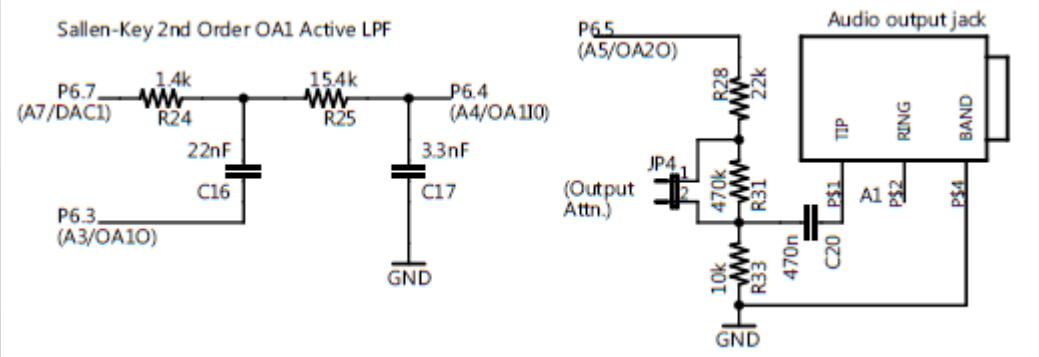
Power Supply Configuration, RF Daughter Card Connect, Audio Output





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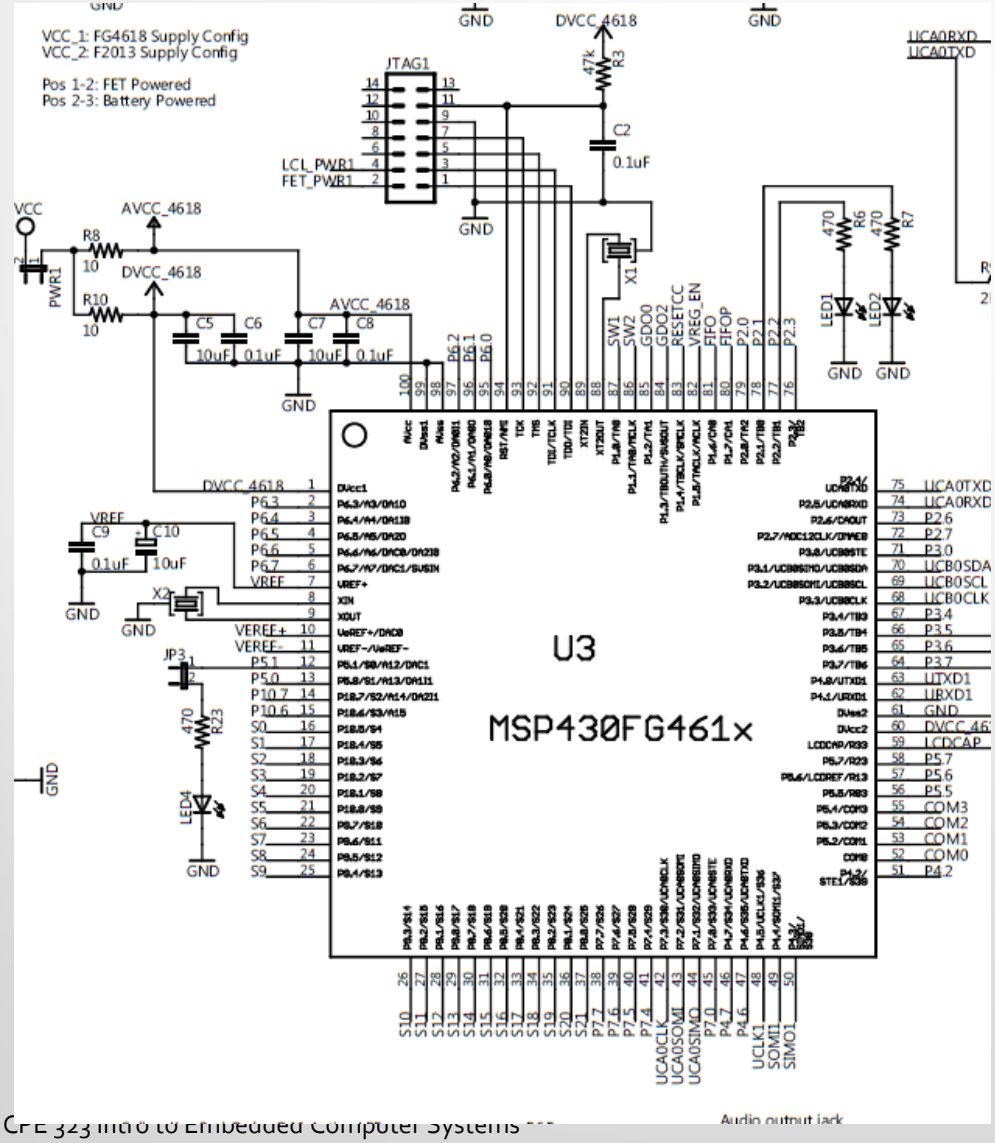
MSP430FG4618



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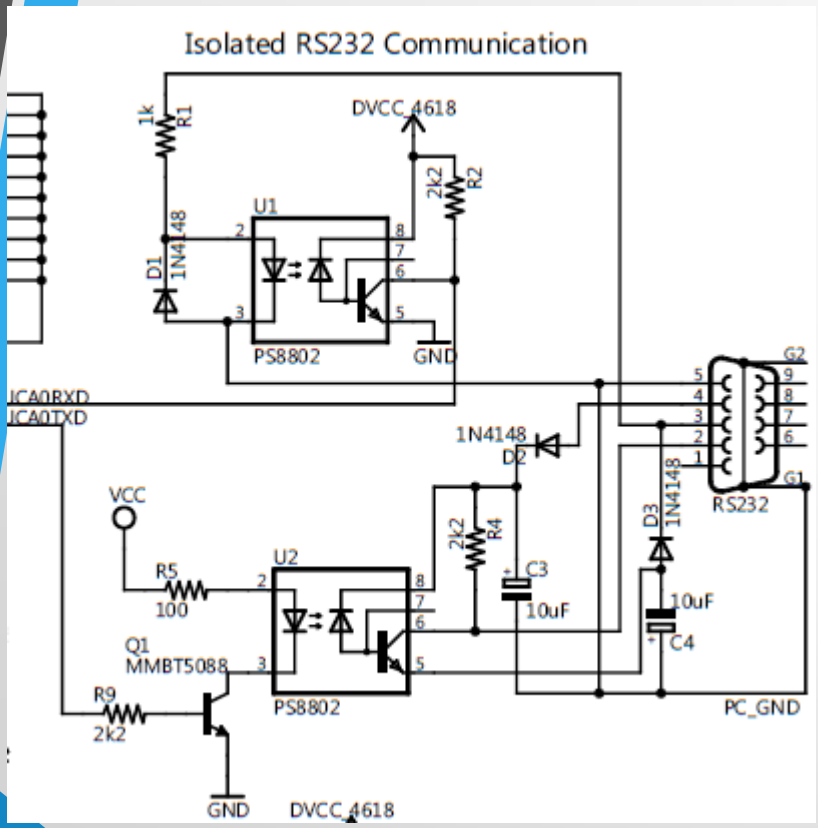
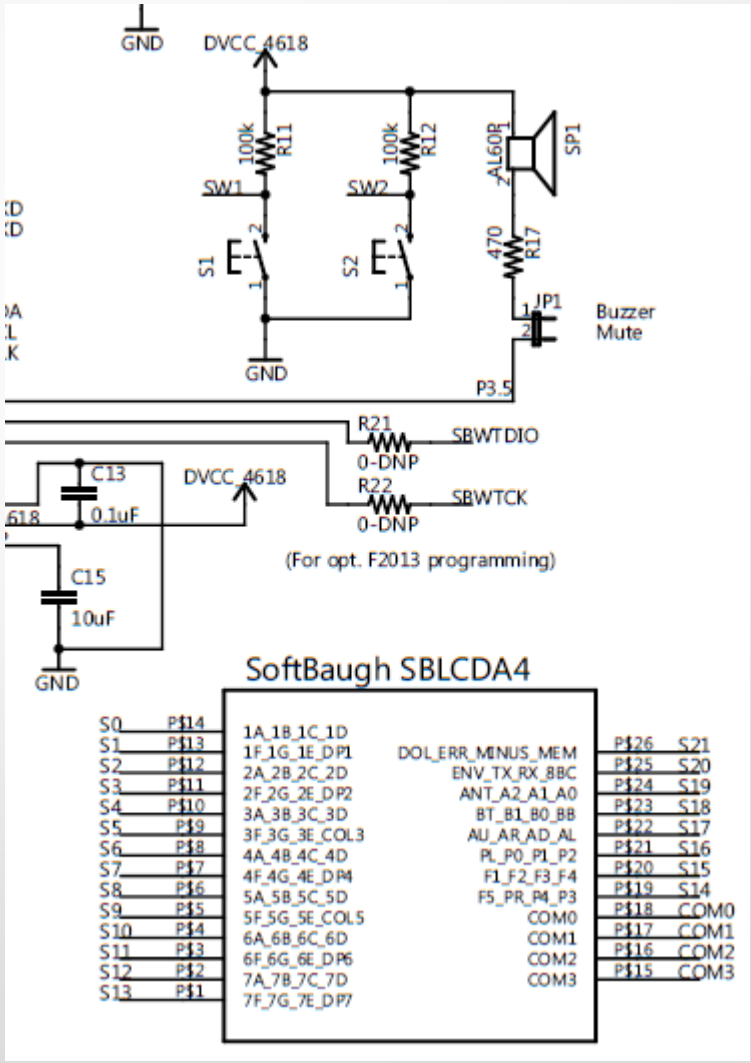
RS232 Connector, LCD Display





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Toggle LEDs 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)
;
;   A. Milenkovic, milenka@uah.edu
*****************************************************************************/
#include  <msp430xG46x.h>
void main(void) {
   WDTCTL = WDTPW + WDTHOLD;// Stop watchdog timer
   P2DIR |= 0x06;              // Set P2.1 and P2.2 to output direction (0000_0110)
   P2OUT = 0x02;                  // Set P2OUT to 0000_0010b (LED2 is ON, LED1 is OFF)
     for (;;) {
     unsigned int i;
     P2OUT ^= 0x06;        // Toggle P2.1 and P2.2 using exclusive-OR
     i = 50000;                // Delay
     do (i--);
     while (i != 0);
   }
}
```


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