CPE 323
Intro to Embedded Computer Systems
System Architecture

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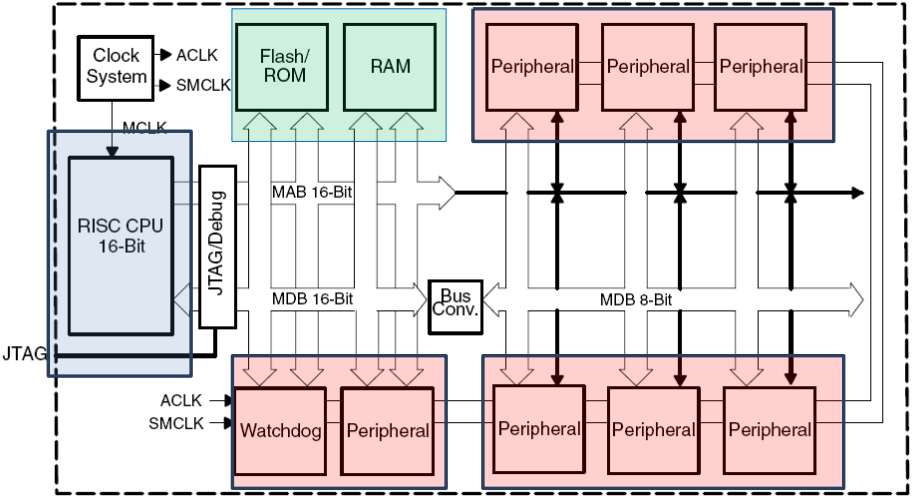
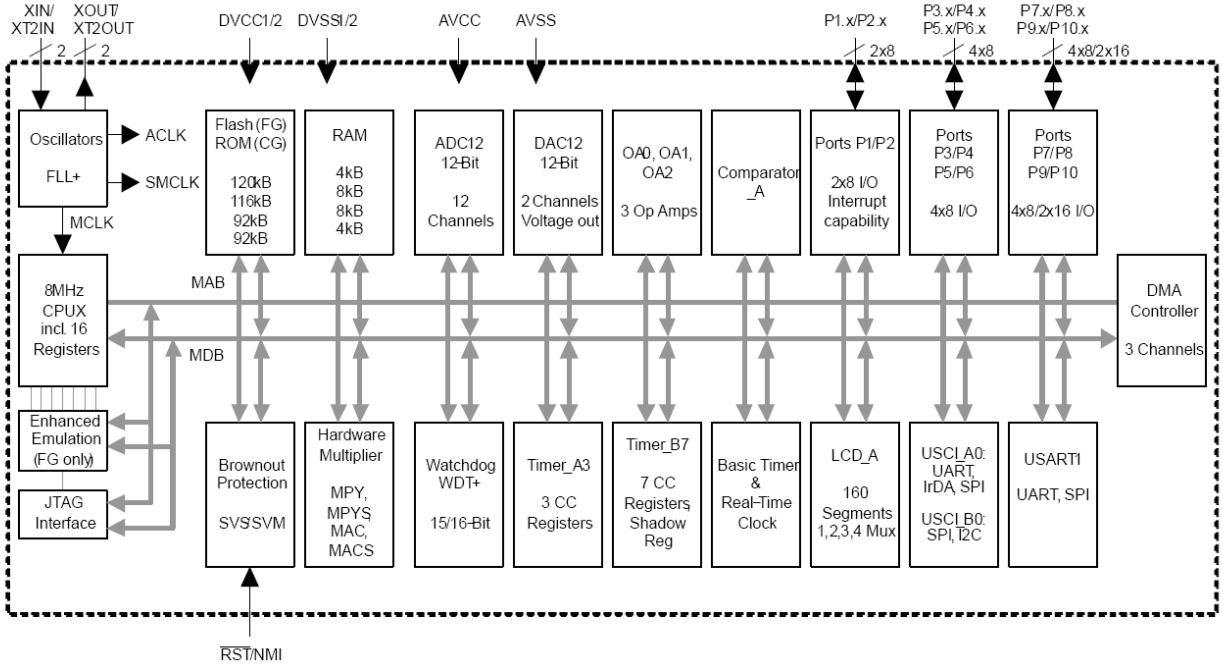
Admin

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



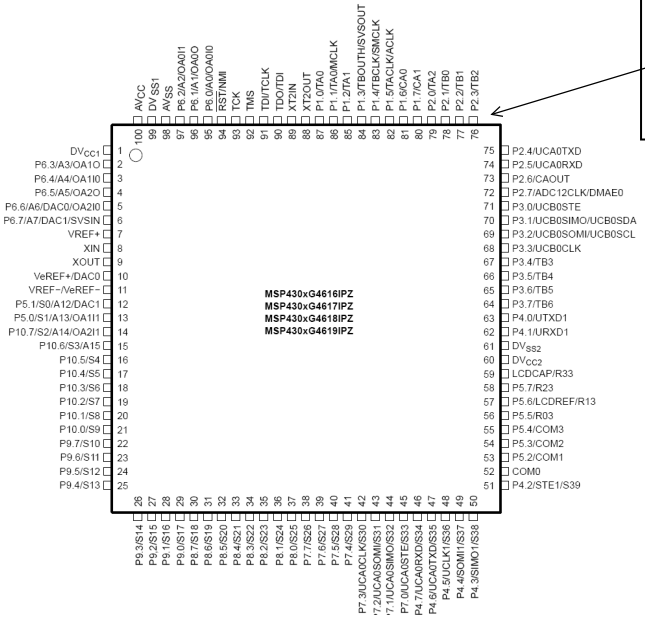
MSP430FG4618 Block Diagram

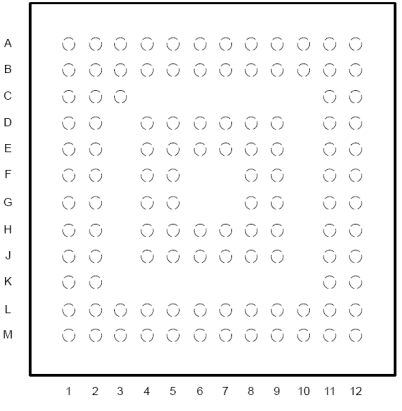


MSP430xG461x Microcontroller

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

- 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

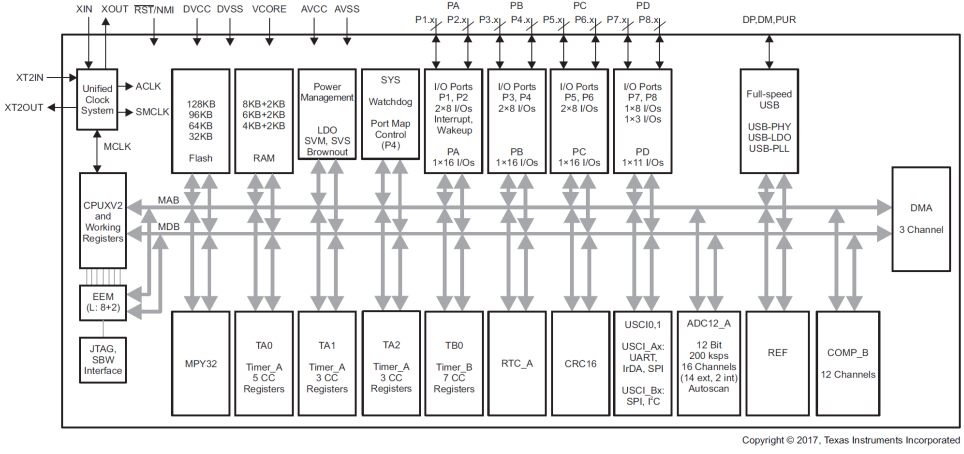
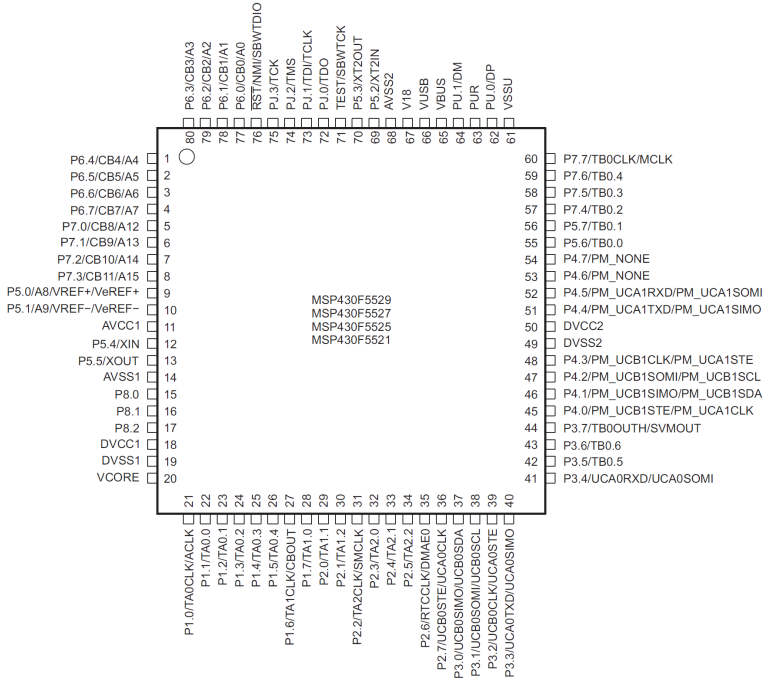


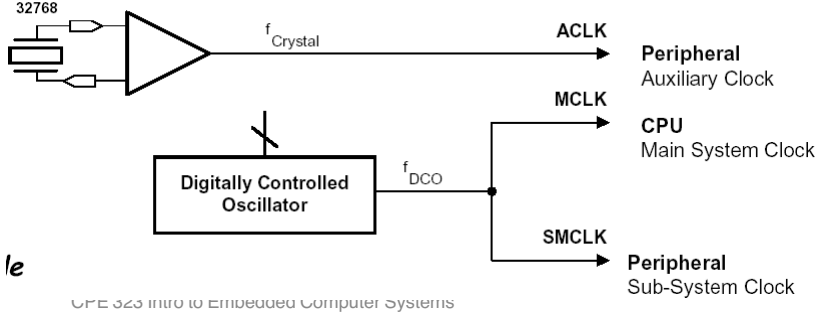
Figure 1-1. Functional Block Diagram – MSP430F5529IPN, MSP430F5527IPN, MSP430F5525IPN, MSP430F5521IPN

Pin Diagram for MSP430F5529



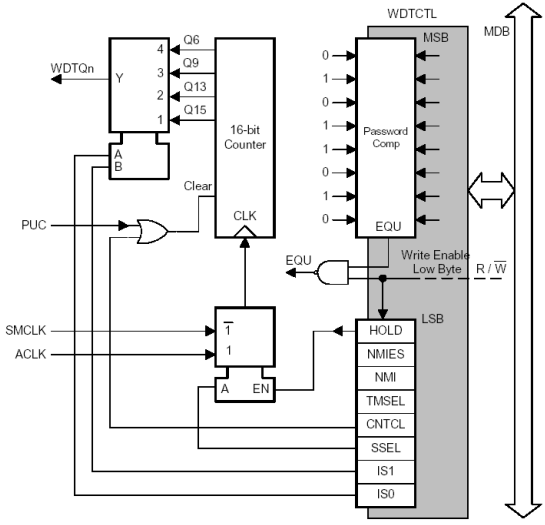
Clock Subsystem

- 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



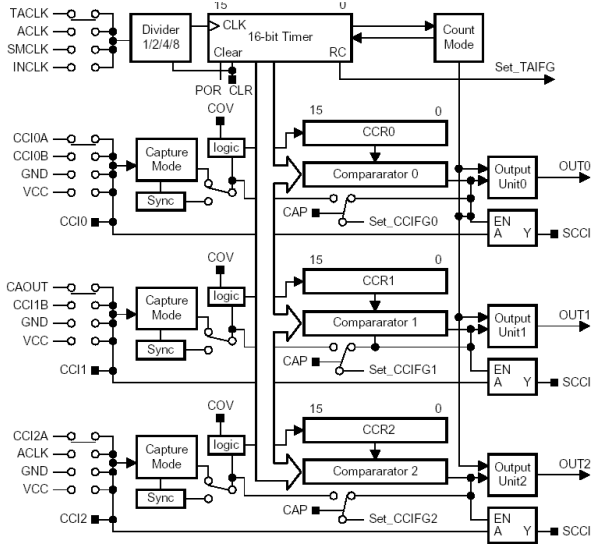
Watchdog Timer

- 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



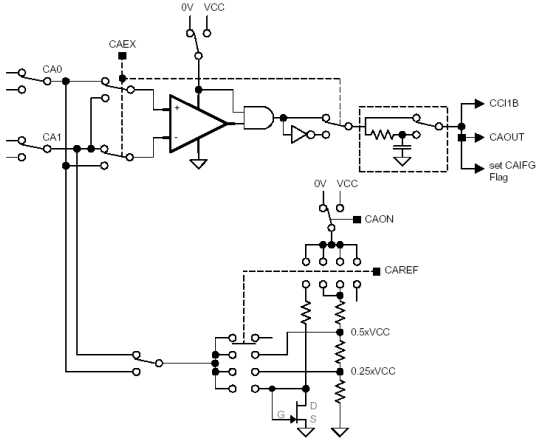
Timers (Timer_A, Timer_B)

- 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



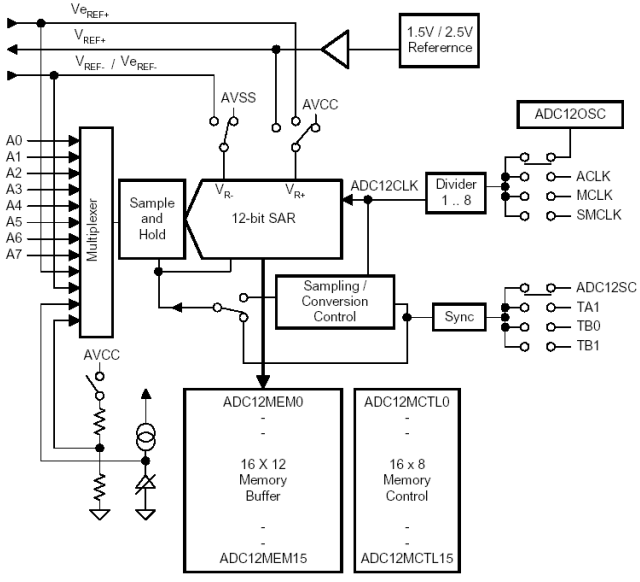
Comparator (Comparator_A)

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



Analog-to-Digital Converter (ADC12)

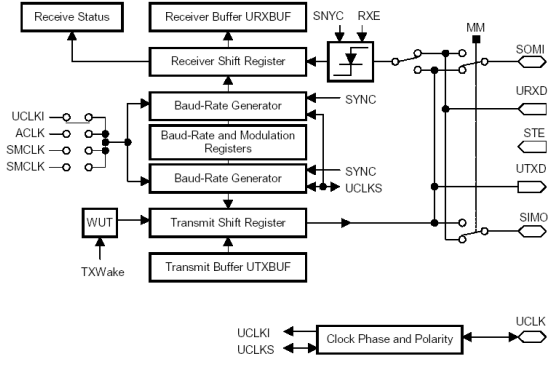
- Convert analog signals to binary counterparts
- ADC12:
  - 12-bit resolution
  - 200 Ksamples/s
  - 8 external inputs
  - Local memory
  - Programmable sample time
  - Selectable reference voltages



Serial Communication Interfaces

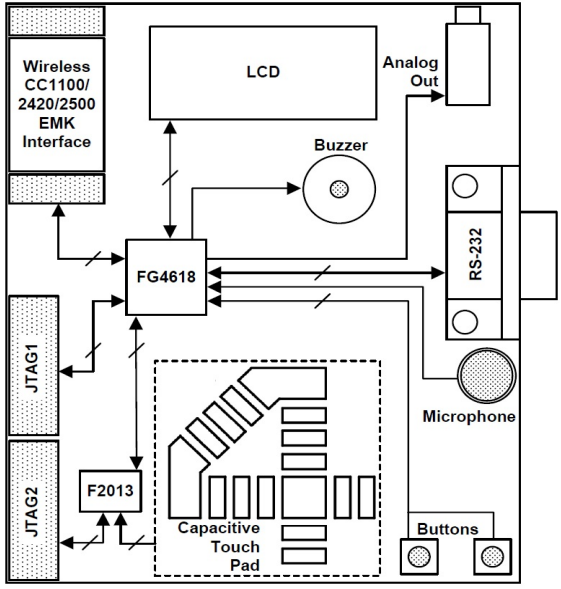
(USCI, USART, USI)

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



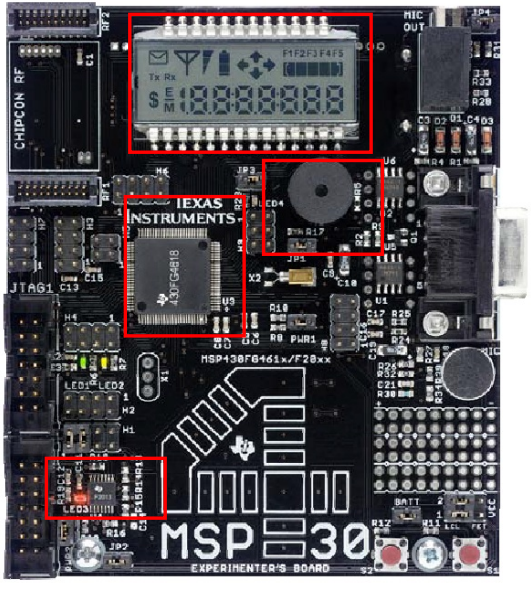
TI Experimenter's Board: Block Diagram

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



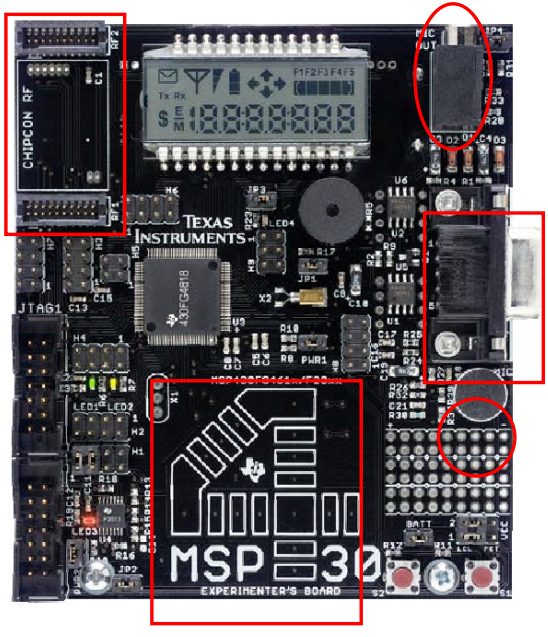
TI Experimenter's Board

- 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

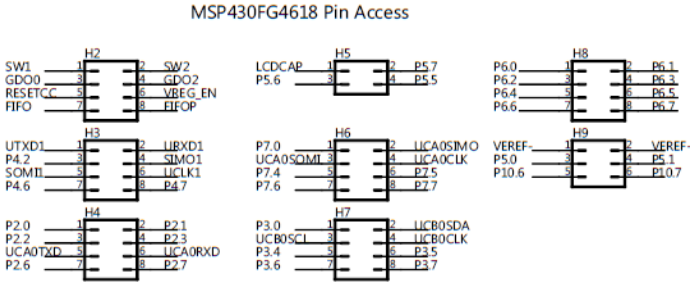


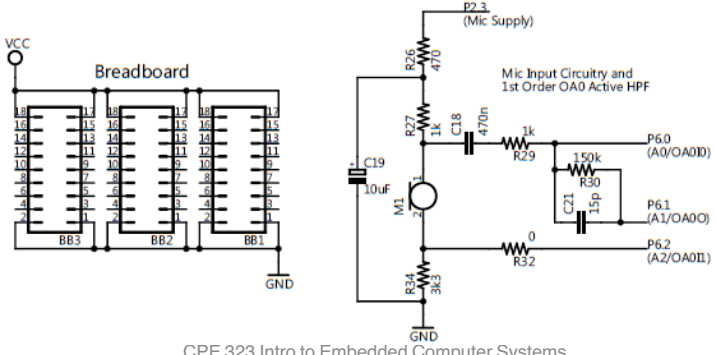
TI Experimenter's Board

- 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

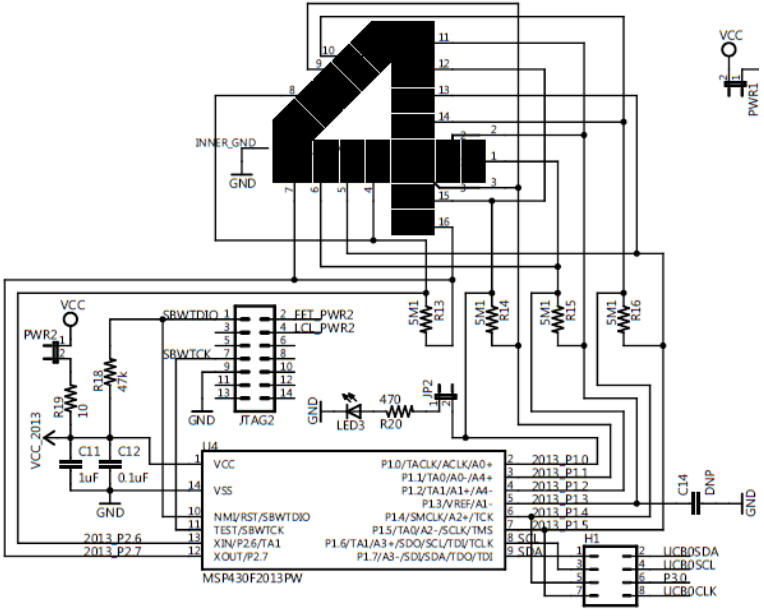


Headers

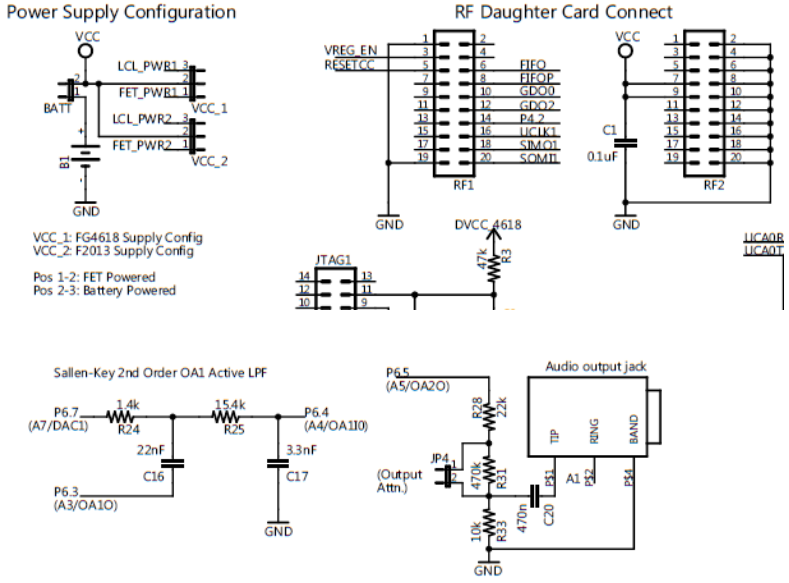

MSP430FG4618 Pin Access
H2
SW1
GDO0
RESETCC
FIFO
SW2
GDO2
VBEG_EN
FIFOP
H5
LCDCAP
P5.6
P5.7
P5.5
H8
P6.0
P6.2
P6.4
P6.6
P6.1
P6.3
P6.5
P6.7
H3
UTXD1
P4.2
SOMI1
P4.6
URXD1
SIMO1
UCLK1
P4.7
H6
P7.0
UCA0SOMI
P7.4
P7.6
UCA0SIMO
UCA0CLK
P7.5
P7.7
H9
VEREF-
P5.0
P10.6
VEREF-
P5.1
P10.7
H4
P2.0
P2.2
UCA0TXD
P2.6
P2.1
P2.3
UCA0RXD
P2.7
H7
P3.0
UCB0SCL
P3.4
P3.6
UCB0SDA
UCB0CLK
P3.5
P3.7


VCC
Breadboard
BB3
BB2
BB1
GND
P2.3
(Mic Supply)
R26
470
Mic Input Circuitry and
1st Order OA0 Active HPF
R27
1k
C18
470n
1k
R29
P6.0
(A0/OA0I0)
150k
R30
C21
15p
P6.1
(A1/OA0O)
C19
10uF
M1
0
R32
P6.2
(A2/OA0I1)
R34
3k3
GND

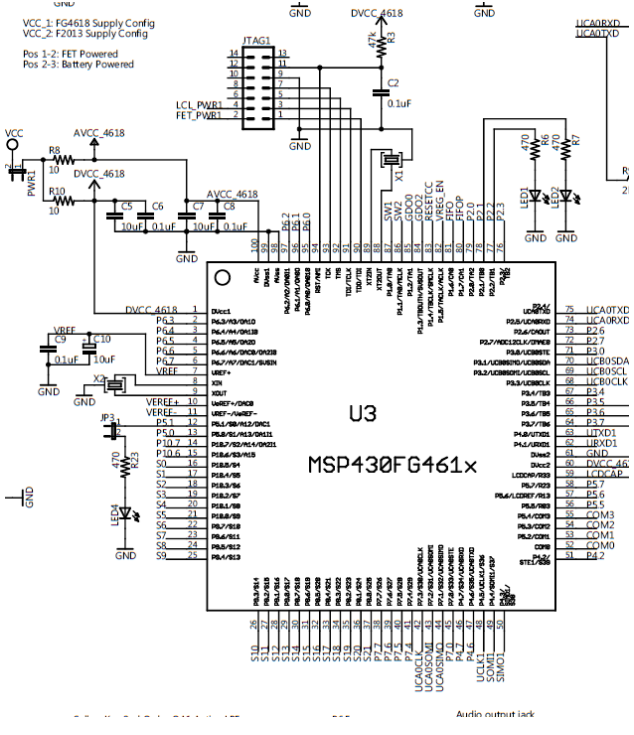
Capacitive Touch Pad



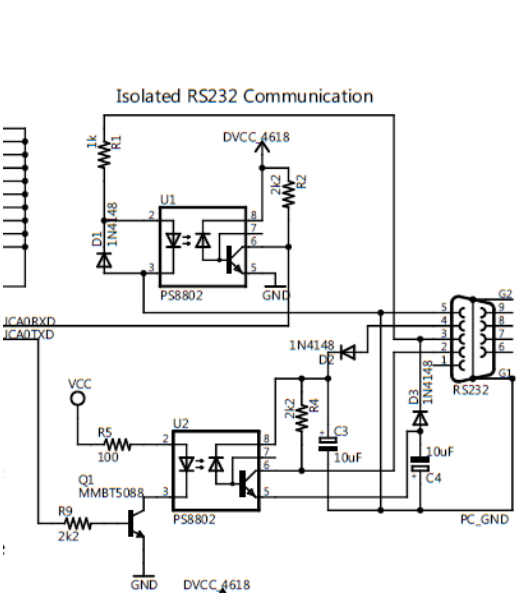
Power Supply Configuration, RF Daughter Card Connect, Audio Output

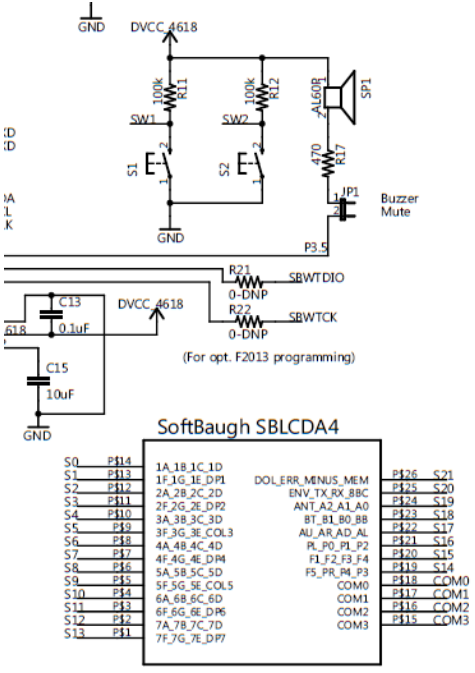


MSP430FG4618



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);
    }
}
```