User's Guide

SLAU213B–March 2007–Revised August 2018

# MSP430FG4618/F2013 Experimenter Board (MSP-EXP430FG4618)

The MSP430FG4618/F2013 Experimenter Board is a comprehensive development target board that can be used for a number of applications. The MSP-EXP430FG4618 kit comes with one MSP430FG4618/F2013 experimenter board (see Figure 1) and two AAA 1.5-V batteries.

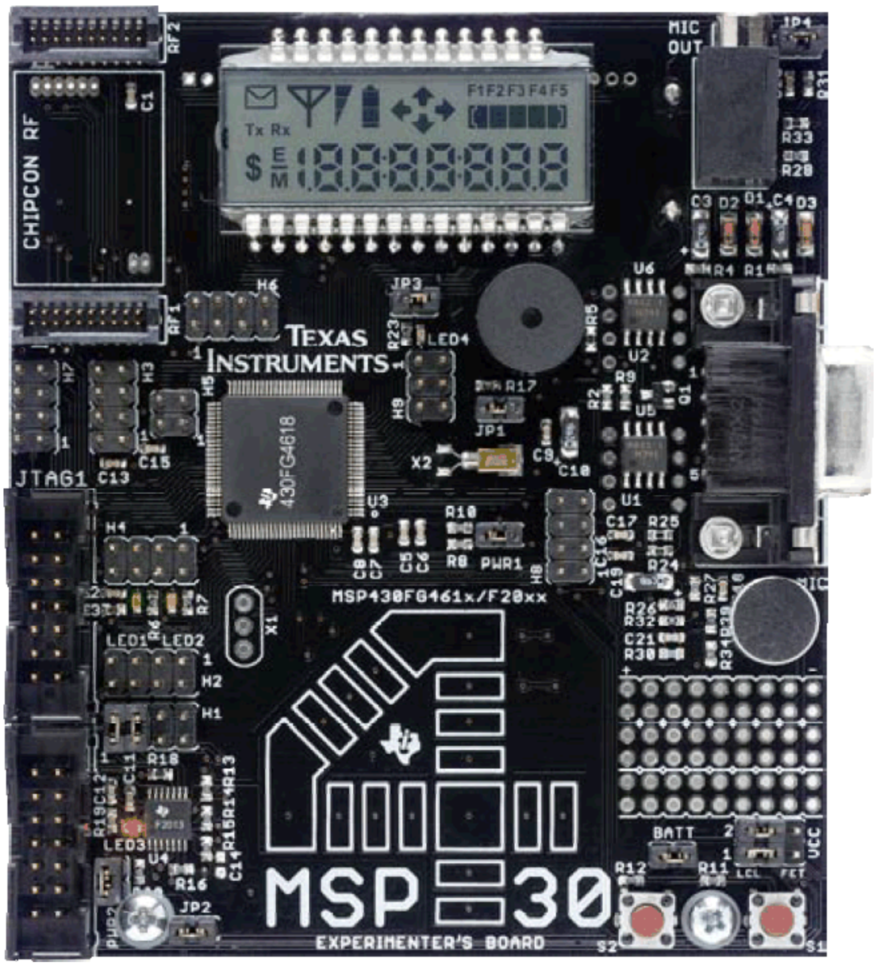

**Figure 1. MSP430FG4618/F2013 Experimenter Board**



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## 1 Devices Supported

The MSP430FG4618/F2013 experimenter board is based on the Texas Instruments ultra-low power MSP430™ microcontrollers. This board includes the MSP430FG4618 and the MSP430F2013 microcontrollers.

## 2 If You Need Assistance

If you need additional assistance with this experimenter board, visit the TI E2E™ Community forums.

## 3 Required Tools

A flash emulation tool for MSP430 MCUs (MSP-FET) is required to download code and debug the MSP430FG4618 and MSP430F2013. Two separate JTAG headers are available, supporting independent debug environments. The MSP430FG4618 uses the standard 4-wire JTAG connection while the MSP430F2013 uses the Spy-Bi-wire (2-wire) JTAG interface allowing all port pins to be used during debug. For more details on the flash emulation tool, see the MSP Debuggers User's Guide.

## 4 Functional Overview

The MSP430FG4618/F2013 experimenter board supports various applications through the use of the on-chip peripherals connecting to a number of onboard components and interfaces (see Figure 2).

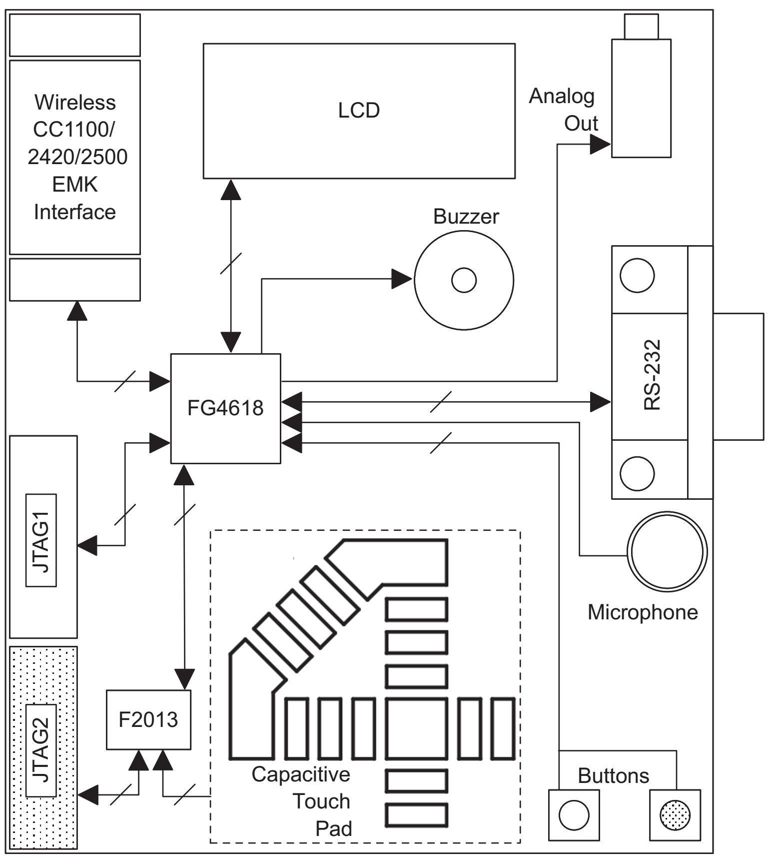


**Figure 2. MSP-EXP430FG4618 Block Diagram**

Wireless communication is possible through the expansion header, which is compatible with all Wireless Evaluation Modules from Texas Instruments. Interface to a 4-mux LCD, UART connection, microphone, audio output jack, buzzer, and single touch capacitive touch pad enable the development of a variety of applications. Communication between the two onboard microcontrollers is also possible. In addition, all pins of the MSP430FG4618 are made available either through headers or interfaces for easy debugging. MSP430Ware™ for MSP Microcontrollers includes sample code for this board.


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## 5 Hardware Installation

Power may be provided locally from two onboard AAA batteries, externally from a FET, or from an external supply. The power source is selected by configuring jumpers VCC_1, VCC_2, and BATT. PWR1 and PWR2 independently control the power supply to each MSP430 MCU. See Section 6.5.1 the location of these jumpers. Figure 3 shows the jumper hierarchy and configuration options.

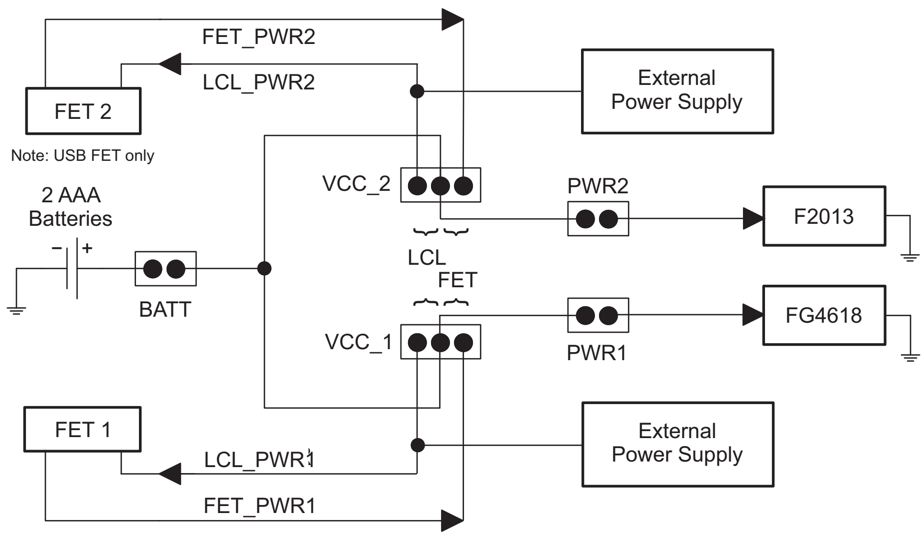


**Figure 3. Jumper Settings for Power Selection**

The battery jumper BATT is used to select the onboard batteries to power the system, independent of the FET connections. The user must ensure that this voltage meets the requirement for proper functionality of the MSP430 MCU.

The power selection jumpers VCC_1 and VCC_2 select the power connections between the board and each FET interface. These jumpers are two rows of 3-pin headers, one for each MSP430 onboard. VCC_1, the bottom row, is for the MSP430FG4618 and, VCC_2 on the top row, is for the MSP430F2013. A jumper placed on the right 2 pins (FET) selects the JTAG FET as the power source. A jumper placed on the left 2 pins (LCL) enables local power (either from the batteries or an external supply) to be applied to each FET for proper logic threshold level matching during program and debug.

Headers PWR1 and PWR2 have been provided to enable power to the individual MSP430s. A jumper placed on PWR1 provides power to the MSP430FG4618 and a jumper placed on PWR2 provides power to the MSP430F2013. Individual device current consumption can be measured through each of these jumpers. Do not make interconnections to the MSP430 MCU that could influence such a measurement.

When the required power selections have been made, the experimenter board is ready to be used. Both the MSP430FG4618 and MSP430F2013 are factory programmed. After power up, the MSP430FG4618 executes an ultra-low-power real-time clock displayed on the LCD. The MSP430F2013 pulses LED3 from LPM3 using the VLO for periodic wakeup.



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# 6 Hardware Overview

This section contains information about the various onboard interfaces and their functionality and about the various peripherals enabling these interfaces. Wireless applications are facilitated using the capabilities of the MSP430 MCUs to interface with the wireless evaluation modules (CCxxxxEMK) from TI. The onboard LEDs and LCD display give visual feedback. Audio applications that leverage the full analog signal chain of the MSP430FG4618 can be implemented using the microphone and the audio output jack. In addition, communication across components on and off the board has been integrated.

## *6.1 Interfaces*

Some of these interfaces have the option of being inactive when not in use to conserve power. This is made possible by port pin configurations on the MSP430 MCUs or hardware jumpers on the experimenter board. For details of the jumper configurations and positions, see Section 6.5.1.

### 6.1.1 4-Mux LCD Display

The integrated SoftBaugh SBLCDA4 LCD display supports 4-MUX operation and interfaces to the LCD driver peripheral of the MSP430FG4618. More information on the LCD can be obtained from the SoftBaugh website.

### 6.1.2 Momentary-On Push Buttons

Two external push buttons (S1 and S2) connect to port P1, an interrupt-capable digital I/O port on the MSP430FG4618.

### 6.1.3 Light Emitting Diodes (LEDs)

The experimenter board has four LEDs. Three connect to the MSP430FG4618, and one connects to the MSP430F2013. The LEDs are primarily used for display purposes. Two of the LEDs can be disconnected using jumpers to reduce the overall power consumption of the board.

### 6.1.4 Buzzer

A buzzer connects to and is driven by a digital I/O port of the MSP430FG4618. The buzzer can be disconnected by jumper JP1.

### 6.1.5 Single-Touch Sensing Interface

A capacitive touch sensing interface in the shape of a "4" is provided. This touchpad is connected to the digital I/O ports of the MSP430F2013. A total of 16 individual segments form the touchpad, and the MSP430F2013 monitors activity on the touchpad. The resulting data is communicated to the MSP430FG4618 through the onboard MCU intercommunication connections.

## *6.2 Communication Peripherals*

The experimenter board supports numerous communication interfaces for onboard and offboard connections.

### 6.2.1 Wireless Evaluation Module Interface

Interface to the wireless world is accomplished through the wireless evaluation module header supporting the CCxxxxEMK boards. The transceiver modules are connected to the USART of the MSP430FG4618 configured in SPI mode. For libraries that interface the MSP430 MCUs, visit the CC2500 product page. The CC2420EMK (obsolete) supports the IEEE 802.15.4 and Zigbee standards. The CC1100EMK (obsolete) supports an RF carrier frequency up to 868 MHz, and the CC2500EMK and CC2420EMK support an RF carrier frequency of 2.4 GHz.


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### 6.2.2 RS-232

For a serial interface to a PC, the MSP430FG4618 supports the standard RS-232 9-pin interface through its USCI peripheral configured in UART mode. Software can configure standard baud rates for transmission and reception.

### 6.2.3 I²C and SPI

The MSP430FG4618 and the MSP430F2013 support I²C and SPI protocols through the USCI and the USI peripherals for inter-processor communication. The links can be disconnected in hardware to use these peripherals for other communication purposes.

## 6.3 Analog Signal Chain

The experimenter board can form a complete analog signal chain using the MSP430FG4618. This board can be used for numerous audio applications. The board can record and play audio signals without the use of additional external components.

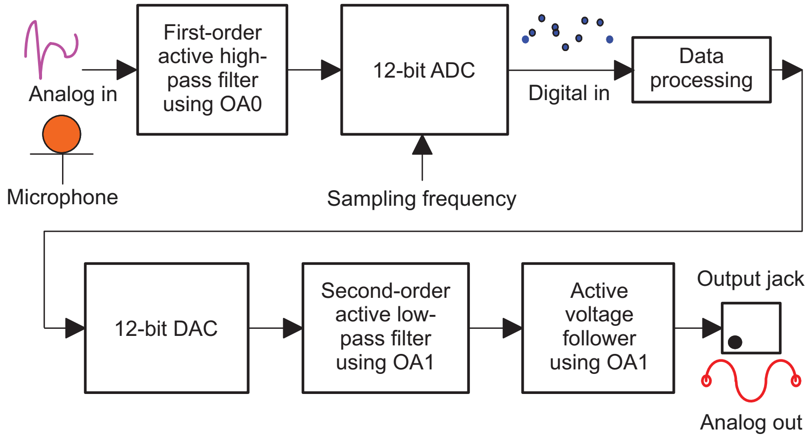


**Figure 4. Analog Signal Chain of MSP430 MCU**

### 6.3.1 Microphone

The microphone is connected to the MSP430FG4618 and may be used for various applications. The microphone is enabled or disabled through a port pin connected to the MSP430FG4618.

### 6.3.2 Analog Filters

An active first-order high-pass filter (HPF) with a cut-off frequency of approximately 340 Hz follows the microphone to eliminate extremely low input frequencies. An optional second-order Sallen-Key active low-pass filter (LPF) with a cut-off frequency of approximately 4 kHz removes the high-frequency noise on the analog output of the 12-bit DAC. Figure 5 shows the filter setup. These filters use the integrated op-amps of the MSP430 MCU. The op-amps OA0 and OA1 facilitate the filtering processes. The gray blocks in Figure 5 are elements that are internal to the MSP430FG4618.


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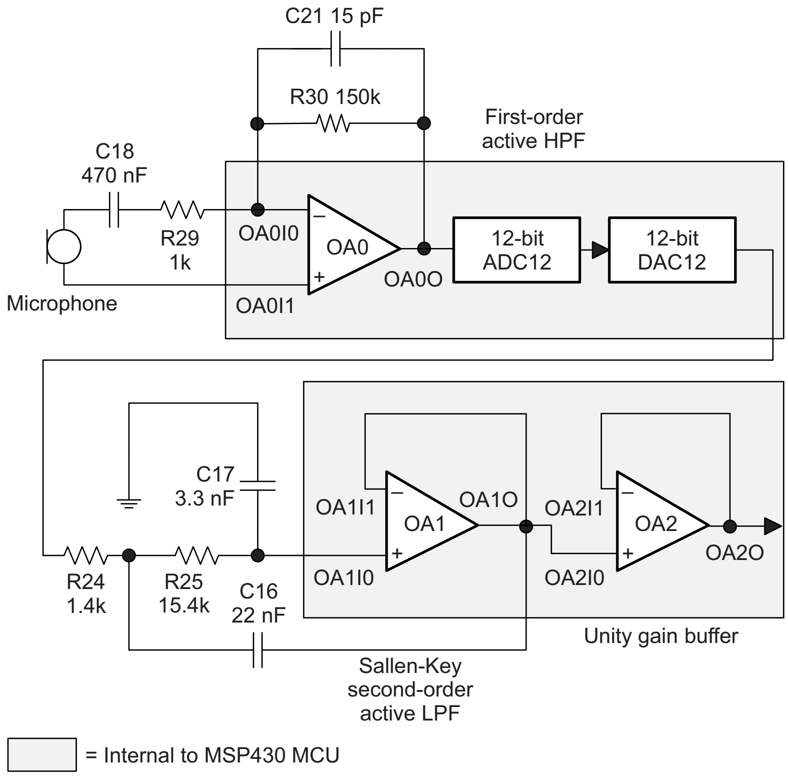


**Figure 5. Active Analog Filter**

### 6.3.3 Analog Output

Analog output can be brought out of the board through a mono 3.5-mm jack connected to the integrated op-amp OA2. The input to this amplifier can be internally connected to the DAC12 output of the MSP430FG4618. Several attenuation options are provided internally and in hardware using jumper JP4.

## 6.4 System Clocks

The experimenter board has various system clock options that support low and high frequencies. Each MSP430 MCU has integrated clock sources and support for external connections.

### 6.4.1 MSP430F2013 Clock Sources

The MSP430F2013 uses the internal VLO operating at approximately 12 kHz for an ultra-low-power standby wake-up time base. The integrated DCO is internally programmable at frequencies up to 16 MHz for high-speed CPU and system clocking.

### 6.4.2 MSP430FG4618 Clock Sources

A standard 32.768-kHz watch crystal is populated at footprint X2 and sources source ACLK of the MSP430FG4618 for low-frequency ultra-low-power standby operation and RTC functionality. The integrated FLL+ clock module provides a programmable internal high-frequency clock source for the CPU and other on-chip peripherals. In addition to the FLL+, an external high-frequency crystal or resonator up to 8 MHz can be added to footprint X1.


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## *6.5 Jumper Configurations*

The board can enable various peripherals and components when they are required and disabled them when not in use to reduce overall power consumption. This is achieved either by software or directly in hardware. Some of the jumpers are mandatory for the board to function correctly. Section 6.5.1 describes the jumpers and their locations.

### 6.5.1 Jumper Locations and Settings

Figure 6 shows the location and name of each jumper on the experimenter board. Table 1 lists the function of each jumper.

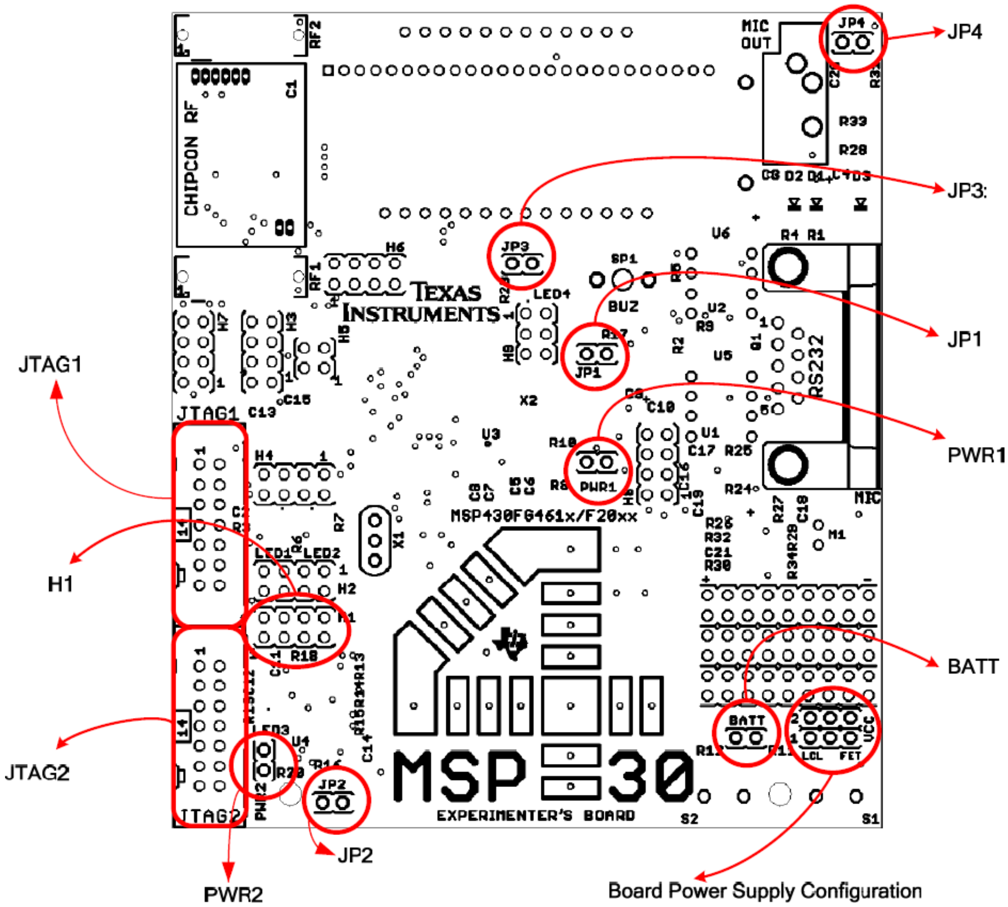


**Figure 6. Jumper Locations**



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**Table 1. Jumper Settings and Functionality**

| Header | Functionality When Jumper Present | Functionality When Jumper Absent | Requirement |
|---|---|---|---|
| PWR1 | Provides power to MSP430FG4618. Also used to measure current consumption of the MSP430FG4618. | MSP430FG4618 is not powered | Required to use MSP430FG4618 |
| PWR2 | Provides power to MSP430F2013. Also used to measure current consumption of the MSP430F2013. | MSP430F2013 is not powered | Required to use MSP430F2013 |
| BATT | Onboard batteries provide power. Also used to measure current consumption. | Batteries do not provide power to either MSP430 MCU | Required to use AAA batteries |
| JP1 | Buzzer enabled and connected to P3.5 of the MSP430FG4618. | Buzzer muted | Optional |
| JP2 | LED3 enabled and connected to P1.0 of the MSP430F2013. | LED3 connection disabled | Required to use LED3 |
| JP3 | LED4 enabled and connected to P5.1 of MSP430FG4618. | LED4 connection disabled | Required to use LED4 |
| JP4 | Attenuation set to approximately 69% of the DAC12 audio output. | 98% attenuation of the DAC12 audio output | Optional |
| Header H1 (Pins 1-2, 3-4) | **I$^2$C Configuration**<br>1-2: SDA – UCB0SDA<br>3-4: SCL – UCB0SCL | No communication possible through I$^2$C | Required to use I$^2$C |
| Header H1 (Pins 1-2, 3-4, 5-6, 7-8) | **SPI Configuration**<br>1-2: SDI – UCB0SIMO<br>3-4: SDO – UCB0SOMI<br>5-6: P1.4 – P3.0 (CS)<br>7-8: SCLK – UCB0CLK | No communication possible through SPI | Required to use SPI |

## 7 Frequently Asked Questions

1. **What devices can be programmed with the experimenter board?**

   The experimenter board is designed to develop applications using the MSP430FG4618 and MSP430F2013. These devices can be replaced by MSP430FG461x and MSP430F20xx device derivatives, respectively.

2. **How is power supplied to the experimenter board?**

   Three supply options exist: 2xAAA battery power, JTAG and external power supplies are supported.

3. **Can I use the Parallel FET (MSP-FET430PIF) to program and debug the MSP430 MCUs?**

   The MSP4304618 supports the USB FET (MSP-FET430UIF) and parallel port FET ( MSP-FET430PIF). The MSP430F2013 is supported by the USB FET (MSP-FET430UIF) only. The parallel port FET does not support the Spy Bi-Wire program and debug mode used.

   **NOTE:** The MSP MCU Programmer and Debugger (MSP-FET) supersedes both the MSP-FET430UIF and MSP-FET430PIF.

4. **I have erased and reprogrammed the MSP430 MCU. Can I restore the factory-programmed firmware on the device?**

   The software source files are available in MSP430Ware for MSP Microcontrollers.


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5. **The MSP430FG4618 is no longer accessible through JTAG, is something wrong with the device?**
   - Verify that the target device is powered properly
   - If the target is powered locally, verify Vcc is applied to pin 4 of the JTAG header
   - If communication and power are correctly applied to the target and the issue persists, it may be due to the MSP430FG4618 accidentally being programmed with MSP430F2xx source code. In some conditions 'F2xx source code loaded onto the FG4618 can configure the SVS module to monitor SVSIN (P6.7) and reset the device in case of a low voltage condition externally applied. Temporarily connecting P6.7 of the FG4618 to Vcc and reprogramming the target device with the valid source code will eliminate this issue.
6. **Does the experimenter board protect against blowing the JTAG fuse of the target devices?**

   No. Fuse blow capability is inherent to all Flash-based MSP430 devices in order to protect user's intellectual property. Care must be taken to avoid the enabling of the fuse blow option during programming that would prevent further access to the MSP430 device(s) through JTAG.
7. **I am measuring system current in the range of 30mA, is this normal?**

   Current consumption of the system is dependent on the functions and operation of the hardware being performed. The RF connectivity and isolated UART communication support, when used, can reach these current consumption levels. Take care that these elements are not accidentally enabled, specifically the isolated UART, if such system currents are not expected.
8. **Can I use two FETs to perform simultaneous access of the FG4618 and F2013 during program/debug?**

   Yes, independent flash emulation tools (either USB or Parallel for FG4618 and USB only for F2013) can be simultaneously used to program the MSP430 target devices. When supplying power from the FET, it is recommended to use only one FET to source power. The second FET can sense this voltage level instead of supplying power, to avoid any voltage conflicts in-system. See Section 5 for details regarding supported power supply configurations.
9. **I cannot properly open the workspace and projects provided in the .zip file with IAR, how can I open the sample code?**

   The IAR workspace/projects included for the sample code provided has been created using IAR Embedded Workbench Version 3.42A. These projects are not backward compatible with older IAR releases and will not open using prior versions. New workspace/projects can be created and the sample code source files can be added manually in order to build these samples with older versions. Instruction for setting up a project in IAR are described in the IAR Embedded Workbench IDE Version 7+ for MSP430 MCUs.
10. **I have loaded the FG4618 and F2013 sample code for the capacitive touch sensing application. It doesn't seem to be working. What is wrong?**

    Verify that the correct jumper settings are used for H1 enabling the $I^2C$ communication link between MSP430s. Make sure jumper JP2 is removed, disconnecting LED3 from the touchpad circuitry. When connected, the LED causes the measurement of the capacitive touch element on P1.0 to fail.



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# 8 Schematic

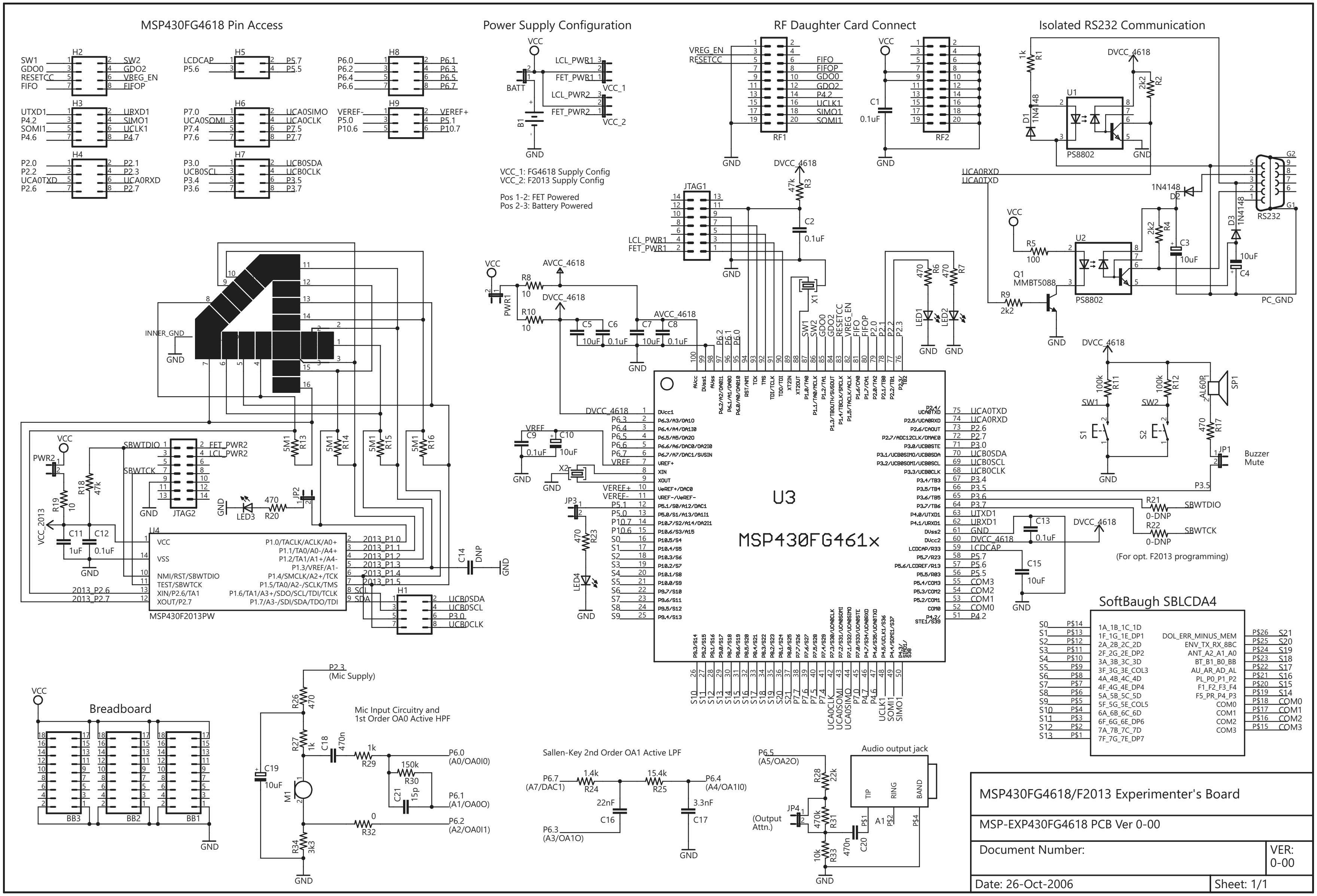


**Figure 7. MSP-EXP430FG4618 Schematic**



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## 9 References


1. MSP430x4xx Family User's Guide
2. MSP430x2xx Family User's Guide
3. MSP430FG461x, MSP430CG461x Mixed-Signal Microcontrollers
4. MSP430F20x1, MSP430F20x2, MSP430F20x3 Mixed-Signal Microcontrollers
5. IAR Embedded Workbench IDE Version 7+ for MSP430 MCUs
6. MSP430 Interface to CC1100/2500 Code Library




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# Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

**Changes from October 3, 2007 to August 27, 2018** **Page**




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   3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

   **CAUTION**

   This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

   Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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   *NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.*

**FCC Interference Statement for Class B EVM devices**

*NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:*

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

**Concerning EVMs Including Radio Transmitters:**

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

**Concernant les EVMs avec appareils radio:**

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

**Concerning EVMs Including Detachable Antennas:**

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

**Concernant les EVMs avec antennes détachables**

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

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1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page
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3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

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4 *EVM Use Restrictions and Warnings:*

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4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

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