

Hardware Development Tools

The aim of this chapter is to describe the MSP430 hardware development tools. During the chapters that follow, the laboratories will be supported by either one of two platforms. Depending on the specific peripheral that will be studied, it will use the eZ430-F2013/eZ430-RF2500 MSP430 USB Stick Development Tool and/or the MSP430FG4618/F2013 Experimenter's board. Some information is also provided covering the new hardware development tool that includes a MSP430x5xx device. The main features and integrated peripherals for each platform are described.

Additionally, hardware development tools provided by third parties are also listed.

Topic	Page
3.1 Starter kit description - eZ430-F2013/eZ430-RF2500 MSP430 USB Stick Development Tool.....	3-3
3.1.1 eZ430-F2013	3-3
3.1.2 eZ430-RF2500	3-3
3.1.3 Device features and integrated peripherals.....	3-4
3.1.4 Board features.....	3-5
3.2 Starter kit description - MSP430FG4618/F2013 Experimenter's board.....	3-6
3.2.1 Device features and integrated peripherals.....	3-7
3.2.2 Board features.....	3-8
3.3 Starter kit description—MSP-EXP430F5438 demo board	3-10
3.3.1 Device features and integrated peripherals.....	3-11
3.3.2 Board features.....	3-12
3.4 MSP-FET430 Flash Emulation Tool (FET)	3-14
3.4.1 Device features	3-14
3.4.2 Hardware Installation	3-15
3.5 Wireless expansion (Chipcon's RF transceiver chip)	3-16
3.6 Third party hardware development tools	3-18

3.7	Quiz	3-22
3.8	FAQs	3-23
	Annex A – eZ430-F2013 schematics	3-27
	Annex B – eZ430-RF2500 schematics	3-28
	Annex C- MSP430FG4618/F2013 Experimenter's board schematics.....	3-31
	Annex D – MSP- EXP430F5438 Experimenter board schematics	3-32
	Annex E – MSP-FET430 schematics.....	3-34

3.1 Starter kit description - eZ430-F2013/eZ430-RF2500 MSP430 USB Stick Development Tool

3.1.1 eZ430-F2013

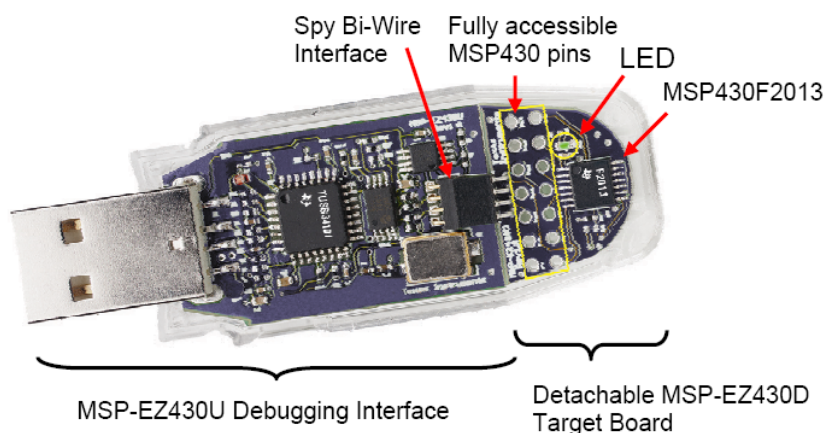
The eZ430-F2013 is a MSP430 development tool used to evaluate the 'F2013 and develop projects on hardware that is contained on a USB stick (*Figure 3-1*).

For software, the eZ430-F2013 uses the IAR Embedded Workbench Integrated Development Environment (IDE) to provide full emulation. The Integrated IAR Kickstart user interface provides an assembler, linker, simulator, source-level debugger and limited C-compiler. The design can be implemented as a stand-alone system or the removable target board detached to integrate into the user's own hardware.

The USB port provides enough power to operate the MSP430 without requiring an external power supply.

All 14-pins on the MSP430F2013 are accessible on the MSP-EZ430D target board for easy debugging and interfacing to peripherals. One of these digital I/O ports is connected to an LED for visual feedback. Annex A gives the schematics for the eZ430-F2013.

Figure 3-1. eZ430-F2013 development tool.



3.1.2 eZ430-RF2500

The eZ430-RF2500 is a USB-based MSP430 wireless development tool used to evaluate the MSP430F2274 microcontroller and CC2500 2.4-GHz wireless transceiver (*Figure 3-2*).

The eZ430-RF2500 uses the IAR Embedded Workbench Integrated Development Environment (IDE) or Code Composer Essentials (CCE) to develop an application.

The eZ430-RF2500T target board is an out-of-the box wireless system that may be used with the USB debugging interface, as a stand-alone system, with or without external sensors, or may be incorporated into an existing user design.

The new USB debugging interface allows the eZ430-RF2500 to remotely send and receive data from a PC using the MSP430 Application UART.

Annex B contains the schematics of the eZ430-RF2500 development tool.

Figure 3-2. eZ430-RF2500 development tool.

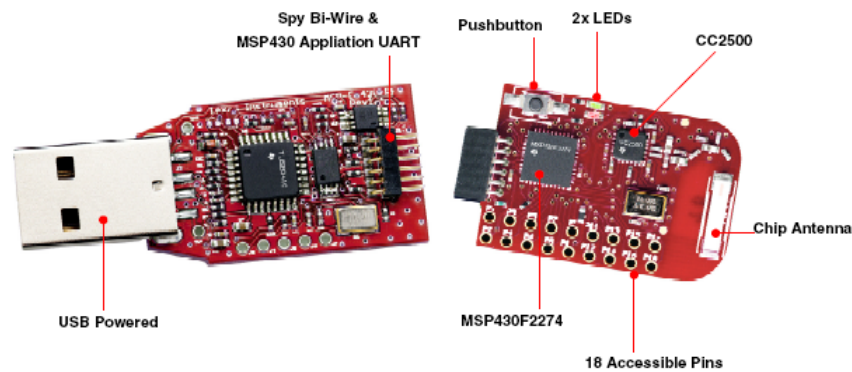
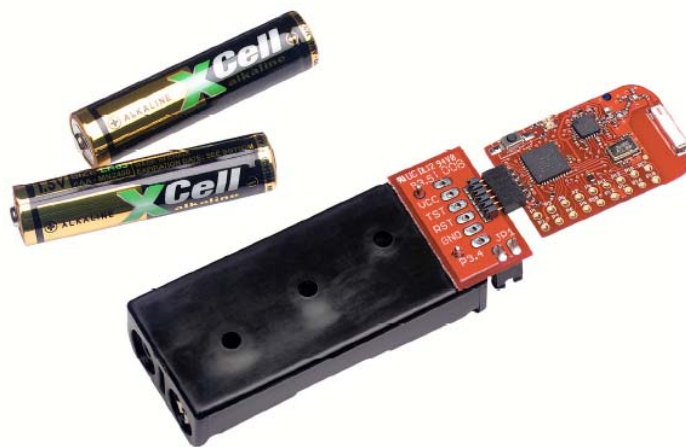


Figure 3-3. eZ430-RF2500 battery board.



3.1.3 Device features and integrated peripherals

- ❑ eZ430-F2013(MSP430F2013):
 - 16 MIPS performance;
 - 16-bit Sigma Delta Analogue-to-Digital converter;
 - 16-bit timer;
 - Watchdog timer;
 - Brownout detector;

- USI module supporting SPI and I2C;
- Five low power modes drawing as little as 0.5 μ A standby.
- eZ430(MSP430F2274)-RF2500:
 - 16-MIPS performance;
 - 200-ksps 10-bit SAR ADC;
 - Two built-in operational amplifiers;
 - Watchdog timer, 16-bit Timer_A3 and Timer_B3;
 - USCI module supporting UART/LIN, (2) SPI, I2C, or IrDA;
 - Five low-power modes drawing as little as 700 nA in standby;
 - 2.4-GHz radio-frequency (RF) transceiver;
 - Programmable data rate up to 500 kbps;
 - Low current consumption.

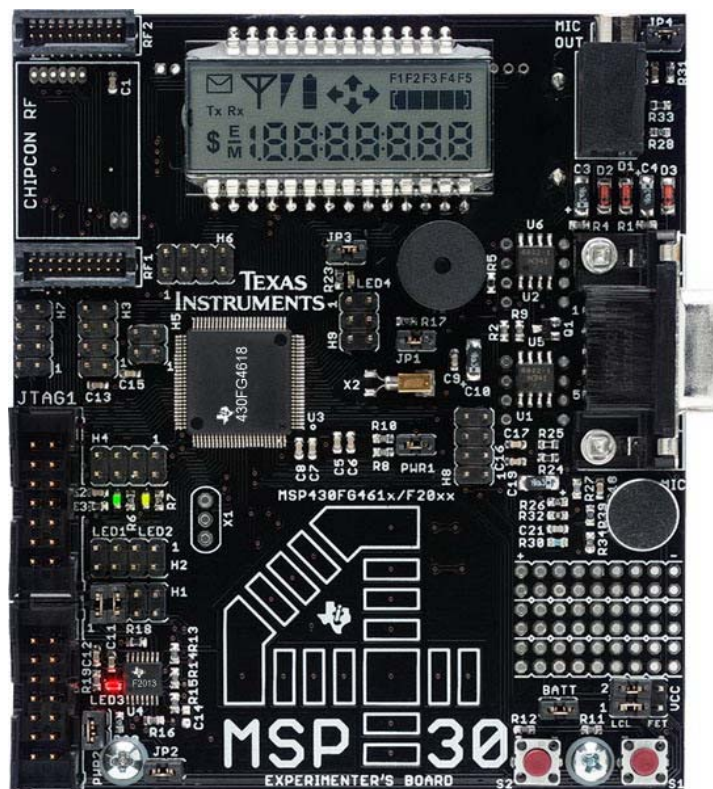
3.1.4 Board features

- eZ430-F2013:
 - Development tool including a USB debugging interface and detachable MSP430F2013 target board;
 - LED indicator;
 - Removable USB stick enclosure;
 - Debugging interface supports development with all MSP430F20xx devices.
- eZ430-RF2500 features:
 - USB debugging and programming interface featuring a driverless installation and application backchannel;
 - 18 available development pins;
 - Highly integrated, ultra-low-power MSP430 MCU with 16-MHz performance;
 - Two general-purpose digital I/O pins connected to green and red LEDs for visual feedback;
 - Interruptible push button for user feedback.

3.2 Starter kit description - MSP430FG4618/F2013 Experimenter's board

The MSP430 experimenter's board (shown in *Figure 3-4*) features a MSP430F2013 and a MSP430FG4618, and is compatible with TI's wireless evaluation modules. The combination of these two MCUs provides nearly every peripheral available in the MSP430 family. The integrated TI wireless evaluation module header and the large amounts of RAM on the MSP430FG4618 makes it an ideal platform for wireless applications.

Figure 3-4. MSP430FG4618/F2013 experimenter's board.



Two JTAG headers are accessible to program and debug each MSP430 individually. Communication is possible with external devices or between the two MSP430s. 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. Two independent debug environments are supported: IAR Embedded Workbench and TI Code Composer Essentials (CCE).

The wide range of integrated peripherals and hardware connectivity allows extensive development possibilities and makes it an ideal platform for learning the MSP430 MCU architecture.

A TI USB Flash Emulation Tool (FET), like the MSP-FET430UIF, is required to program and debug the MSP430 devices on the experimenter board. Power may be supplied over the USB FET or from two AAA 1.5 V batteries.

Annex C gives the schematics of the Experimenter's board.

3.2.1 Device features and integrated peripherals

Key Features:

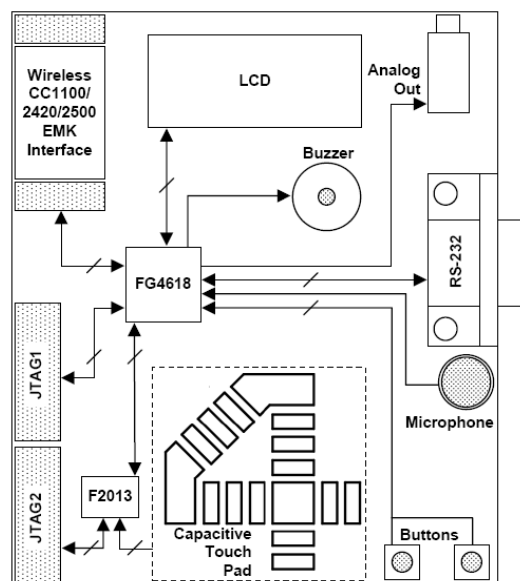
- ❑ MSP430 Devices:
 - MSP430FG4618;
 - MSP430F2013.
- ❑ Integrated peripherals:
 - 12-bit SAR Analogue-to-Digital Converter;
 - 16-bit Sigma Delta Analogue-to-Digital Converter;
 - Operational Amplifiers;
 - Direct Memory Access (DMA);
 - Multiplier;
 - LCD Controller;
 - Communication Interfaces: SPI, UART, I2C, IrDA.

The MSP430FG4618 and the MSP430F2013 contain support for I2C and SPI protocols using the USCI and the USI peripherals. These peripherals are used for inter-processor communication. The link can be disconnected in hardware to allow the peripherals to be used for other communication purposes.

- ❑ Programming and Debugging: Can be programmed using any MSP430 Flash Emulation Tool (MSP-FET430UIF)
- ❑ Wireless expansion: Compatible with TI Wireless CCxxx0EMK Evaluation Modules, such as the CC2500EMK

The MSP430FG4618/F2013 experimenter's board supports a range of applications through the use of the on-chip peripherals, connecting it to a number of on-board components and interfaces as shown in *Figure 3-5*.

Figure 3-5. MSP430FG4618/F2013 experimenter's board block diagram.



The experimenter's board has several system clock options that support low and high frequencies. Each MSP430 has integrated clock sources, as well as support for external connections.

❑ **MSP430F2013 Clock Sources:**

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

❑ **MSP430FG4618 Clock Sources:**

- A standard 32.768 kHz watch crystal is populated at component X2 and sources the 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 peripherals on-chip. In addition to the FLL+, an external high frequency crystal or resonator up to 8 MHz can be added via component X1.

3.2.2 Board features

The Experimenter's board features are:

- ❑ **Microphone:** This is connected to the MSP430FG4618 and may be used for various applications where a sound input is required. The microphone is enabled/disabled via a port pin connected to the MSP430FG4618.
- ❑ **Buzzer:** It is connected to a digital I/O port of the MSP430FG4618. It is driven via a port pin of the MSP430. The buzzer can be completely disconnected at jumper JP1.
- ❑ **LCD:** 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 manufacturer's datasheet.
- ❑ **Capacitive touch sensing interface:** with the "4" shape on the circuit board. This touchpad is connected to the digital I/O ports of the MSP430F2013. A total of 16 individual segments form the touchpad, and is activity monitored by the MSP430F2013. The resulting data values are communicated to the MSP430FG4618 via the MSP430 inter-communication connections provided on the board.
- ❑ **2x push buttons, S1 and S2:** Connected to the interrupt capable MSP430FG4618 digital I/O port, P1.
- ❑ **Light Emitting Diodes (LEDs):** The board has a total of four LEDs, three connected to the MSP430FG4618 and one connected 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.
- ❑ **Prototyping space:** Allows the user to add their own external components.

- ❑ RS232 communication interface: For a serial interface to a PC, the MSP430FG4618 supports the standard RS-232 9-pin interface via its USCI peripheral, configured in UART mode.
- ❑ 2x JTAG programming interfaces;
- ❑ 3.5 mm headphone jack: This analogue output can be brought out of the board via 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.

The board supports various peripherals and components to be enabled when required and disabled 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. Refer to *Figure 3-6* and *Table 3-1* for detailed information regarding the exact locations of these jumpers and their functionality.

Figure 3-6. MSP430FG4618/F2013 experimenter's board jumper locations.

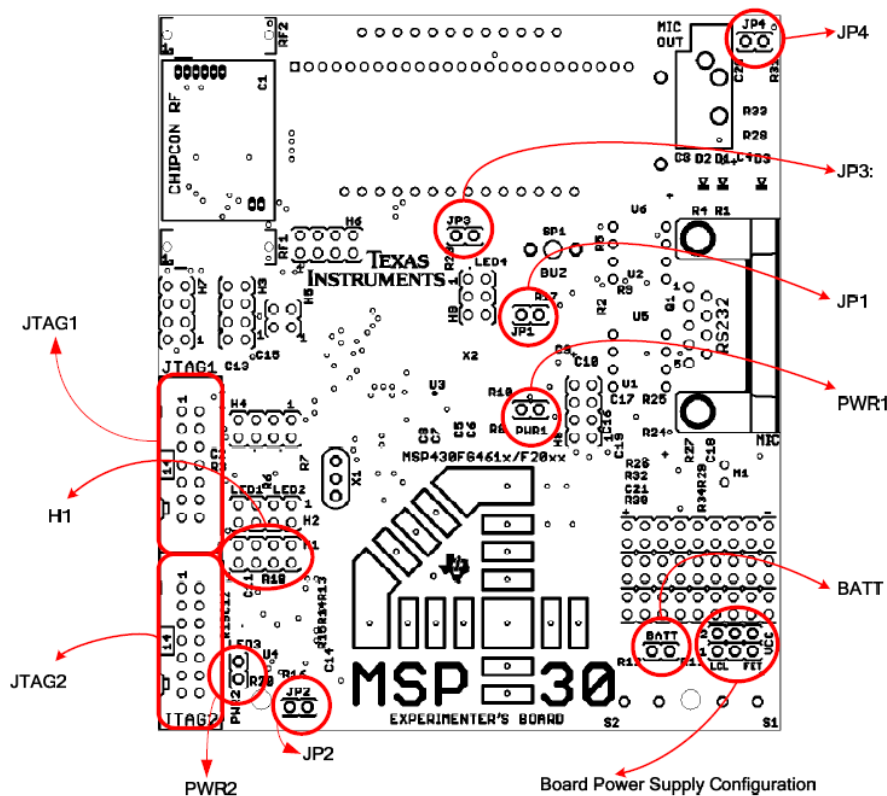


Table 3-1. Jumper settings and functionality.

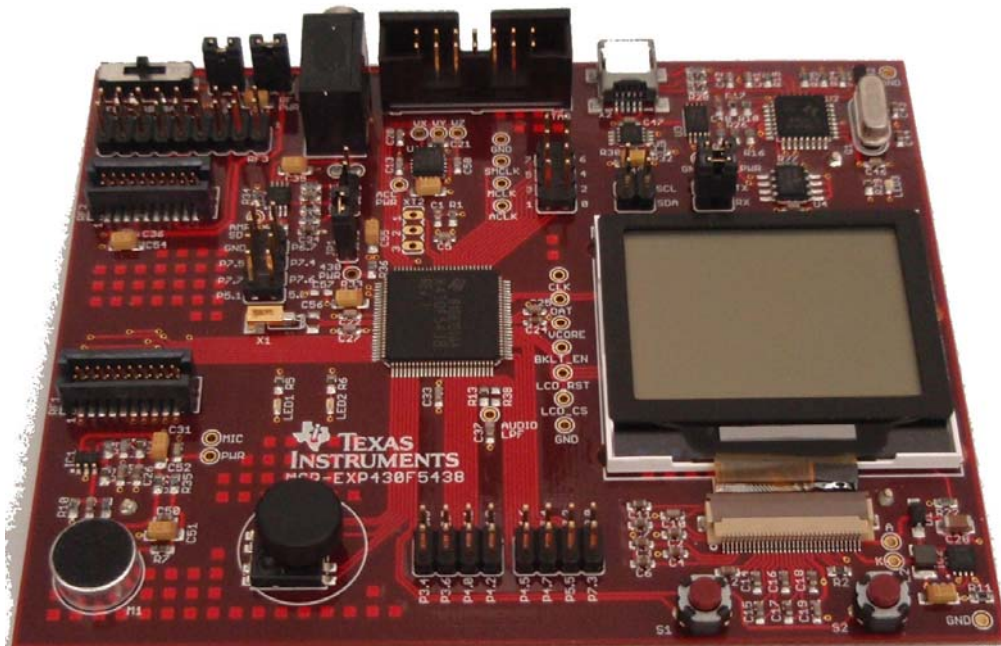
Header	Functionality (when jumper present)	Functionality (when jumper absent)	Requirements
JTAG1	FET tool connector to program / debug the FG4618.	FG4618 is not emulated	
JTAG2	FET tool connector to program / debug the F2013.	F2013 is not emulated	
PWR1	Place to power FG4618. Use also to measure current consumption.	FG4618 is not powered.	Required for FG4618 use
PWR2	Place to power F2013. Use also to measure current consumption.	F2013 is not powered.	Required for F2013 use
BATT	Place to locally power board from 2xAAA batteries. Use also to measure the total board current consumption.	Batteries will not provide power to either MSP430	Required for use with AAA batteries
JP1	Place to enable buzzer (FG4618 – P3.5)	Buzzer muted	Optional
JP2	Place to allow LED3 operation (F2013 – P1.0)	LED3 connection disabled	Optional / Required for LED3 use
JP3	Place to allow LED4 operation (FG4618 – P5.1)	LED4 connection disabled	Optional / Required for LED4 use
JP4	Attenuate audio output voltage level (69%).	98% attenuation of the DAC12 audio output.	Optional
H1 (1-2, 3-4)	I2C Configuration 1-2: SDA – UCB0SDA 3-4: SCL – UCB0SCL	No communication possible via I2C	Required for inter-processor communication
H1 (1-2, 3-4, 5-6, 7-8)	SPI Configuration 1-2: SDI – UCB0SIMO 3-4: SDO – UCB0SOMI 5-6: P1.4 – P3.0 (CS) 7-8: SCLK – UCB0CLK	No communication possible via SPI	Required for inter-processor communication
VCC	VCC_1 : Lower 3 pins. Used for FG4618/JTAG1. VCC_2 : Upper 3 pins. Used for F2013/JTAG2. LCL : Provide local VCC to FET interface. FET : Power board from the FET interface. (BATT should not be set)	Power source from JTAG	Required for use without batteries

3.3 Starter kit description – MSP-EXP430F5438 demo board

The MSP-EXP430F5438 Demo Board (shown in *Figure 3-7*) features the brand new MSP430 family, the 5xx. The MSP430 included in this board is the F5438.

Due to the new features as Power Management Module (PMM), Unified Clock System (UCS) and system (SYS) modules, expanded memory/peripheral mapping, peripheral module enhancements and enhanced performance such as 20 bit address capability and the 32 bit Hardware Multiplier, included in this family, this board provides the wide range of F5438 peripherals.

Figure 3-7. MSP-EXP430F5438 demo board.



One JTAG header is accessible to program and debug the MSP430F5438 and allows for communication to external devices. The MSP430F5438 uses the standard 4-wire JTAG interface allowing all port pins to be used during debug. Two independent debug environments are supported: IAR Embedded Workbench and TI Code Composer Essentials (CCE).

The wide range of integrated peripherals and hardware connectivity allows extensive development possibilities and makes it the ideal learning platform the new MSP430x5xx MCU architecture.

A TI USB Flash Emulation Tool (FET), like the MSP-FET430UIF, is required to program and debug the MSP430 device on the MSP-EXP430F5438 demo board. Power may be supplied over the USB FET interface, USB interface or from the included two AA 1.5 V batteries.

In Annex D are exposed the schematics of the MSP-EXP430F5438 demo board.

3.3.1 Device features and integrated peripherals

Key Features:

- ❑ Device Featured:
 - MSP430F5438 (256 KB+512 B flash memory; 16 KB RAM).
- ❑ Integrated peripherals:
 - Three 16-bit timers;
 - 12-bit SAR Analogue-to-Digital Converter;
 - Direct Memory Access (DMA);

- Hardware multiplier (supporting 32-Bit operations);
- Universal Serial Communication Interfaces (USCI): Enhanced UART Supporting Auto-Baudrate; IrDA Encoder and Decoder; Synchronous SPI; I²C™;
- Real time clock module with alarm capabilities;
- Temperature sensor;
- Up to 87 I/O pins.

The MSP430F5438 supports I²C and SPI protocols.

- Programming and Debugging: Can be programmed using any MSP430 Flash Emulation Tool (MSP-FET430UIF);
- Wireless expansion:
 - Compatible with TI Wireless CCxxxXEMK Evaluation Modules, such as the CC2500EMK;
 - Compatible with TI eZ430-RF2500.

The demo board has various system clock options that support low and high frequencies. The MSP430F5438 has integrated an Unified Clock System that provides different clock sources:

- Three low-frequency sources:
 - LFXT1;
 - Internal Very Low Power/Low Frequency Oscillator (VLO);
 - Internal Reference Oscillator (REFO).
- Internal Digitally Controlled Oscillator (DCO) / Frequency Locked Loop (FLL) for highspeed operation:
 - FLL reference selectable from LFXT1, REFO, or XT2.
- ACLK/SMCLK/MCLK can all be driven from any source;
- Dedicated MODOSC (internal) used for modules like Flash controller, ADC, among others.

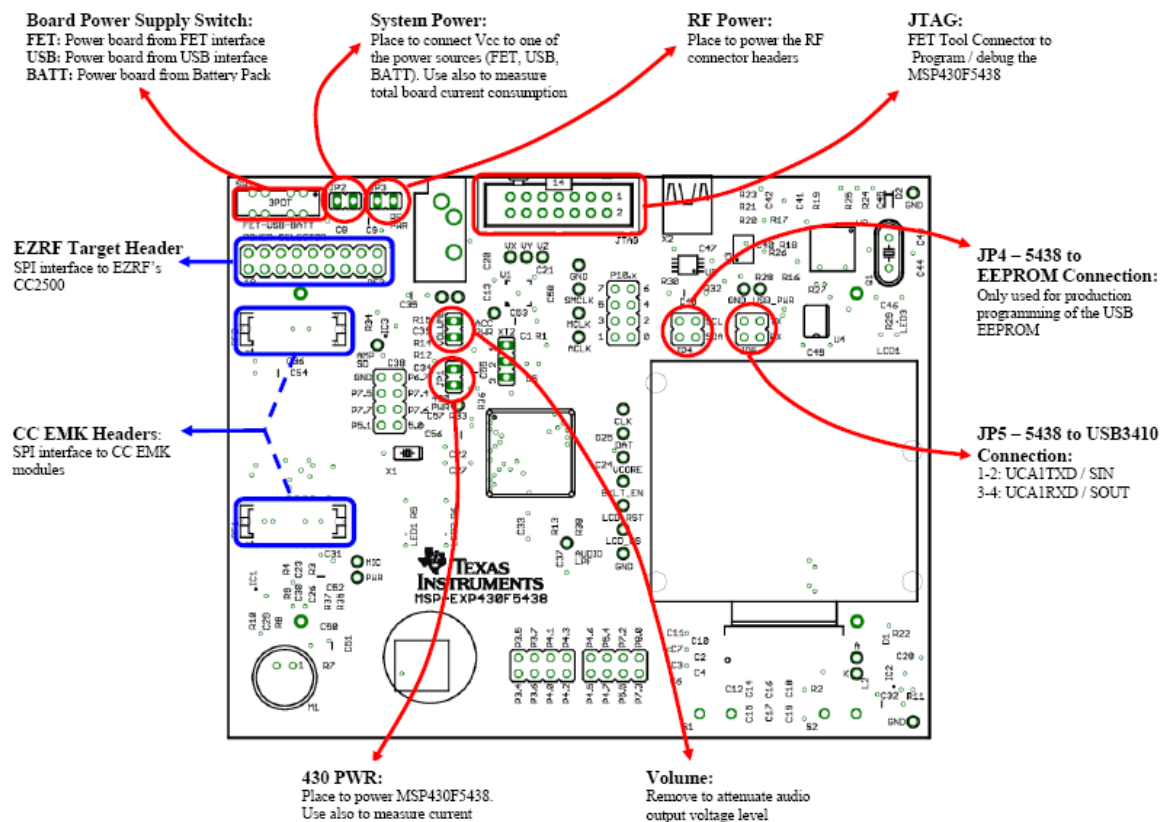
3.3.2 Board features

- 32,768 Hz crystal oscillator;
- Digital I/O ports connectors populated;
- Microphone: The microphone is enabled/disabled via a port pin connected to the MSP430F5438;
- LCD: The integrated Hitachi HD66753 (168 x 132-dot Graphics LCD Controller/Driver with Bit-operation Functions). More information on the LCD can be obtained from the manufacturer's datasheet;
- Joystick;
- 2x push buttons, S1 and S2: Connected to the interrupt capable MSP430F5438 digital I/O port, P2;

- ❑ Two Light Emitting Diodes (LEDs) primarily used for display purposes. Connected to the interrupt capable MSP430F5438 digital I/O port, P1;
- ❑ JTAG Programming Interface;
- ❑ 2 or 3-axis accelerometer (Analog Devices ADXL322/330). The 3-axis accelerometer is not populated. More information on the accelerometer can be obtained from the manufacturer's datasheet;
- ❑ 3.5 mm headphone jack;
- ❑ Mini USB connector;
- ❑ Three Radio Frequency (RF) connectors (SPI interface). RF1 and RF2 provide connection to the TI's wireless evaluation modules header: CCxxxXEMK boards. RF3 provides connection to the eZ430-RF2500.

The board supports various peripherals and components to be enabled when required and disabled 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. Refer to *Figure 3-8* for detailed information regarding the exact locations of these jumpers and their functionality.

Figure 3-8. MSP-EXP430F5438 demo board jumper and connectors locations.



3.4 MSP-FET430 Flash Emulation Tool (FET)

The flash emulation tool allows the application development on the MSP430 MCU. Two debugging interfaces are available, USB and parallel port, respectively named MSP-FET430UIF (*Figure 3-9*) and MSP-FET430PIF. These two debugging interfaces are used to program and debug the MSP430 in-system through the JTAG interface or the pin saving Spy Bi-Wire (2-wire JTAG) protocol.

These debugging tool interface the previously presented MSP430 hardware development tools to the included integrated software environment (CCE or IAR) and includes code to start an application. Both MSP-FET430 supports development with all MSP430 flash devices.

Figure 3-9. MSP-FET430UIF flash emulation tool.



3.4.1 Device features

MSP430 debugging interface to connect a MSP430-Flash-device to a USB port (MSP-FET430UIF) or a Parallel port (MSP-FET430PIF) on a PC with the following features shown in *Table 3-2*.

Table 3-2. MSP-FET430 flash emulation tool features.

Feature	MSP-FET430UIF	MSP-FET430PIF
Supports all MSP430 flash-based devices (F1xx, F2xx, F4xx, F5xx)	X	X
Allows JTAG security fuse blow to protect code	X	
Adjustable target supply voltage 1.8 and 3.6 volts at 100mA	X	
Fixed 2.8-V target supply voltage		X
4-wire JTAG debug protocol	X	X
2-wire JTAG (Spy-Bi-Wire) debug protocol	X	
Supported by CCE	X	X
Supported by IAR	X	X

The following characteristics of the MSP-FET430 Flash Emulation Tool (FET) here presented are for use with Code Composer Essentials for MSP430 Version 3).

Additional information can be found in the MSP-FET430 Flash Emulation Tool User's Guide included in MSP430 Teaching ROM Annex D:

- ❑ MSP-FET430 Flash Emulation Tool (FET) (for use with Code Composer Essentials for MSP430 Version 3) User's Guide <slau157g.pdf>;
- ❑ MSP-FET430 Flash Emulation Tool (FET) (for use with IAR Embedded Workbench Version 3+) User's Guide <slau138.k.pdf>.

3.4.2 Hardware Installation

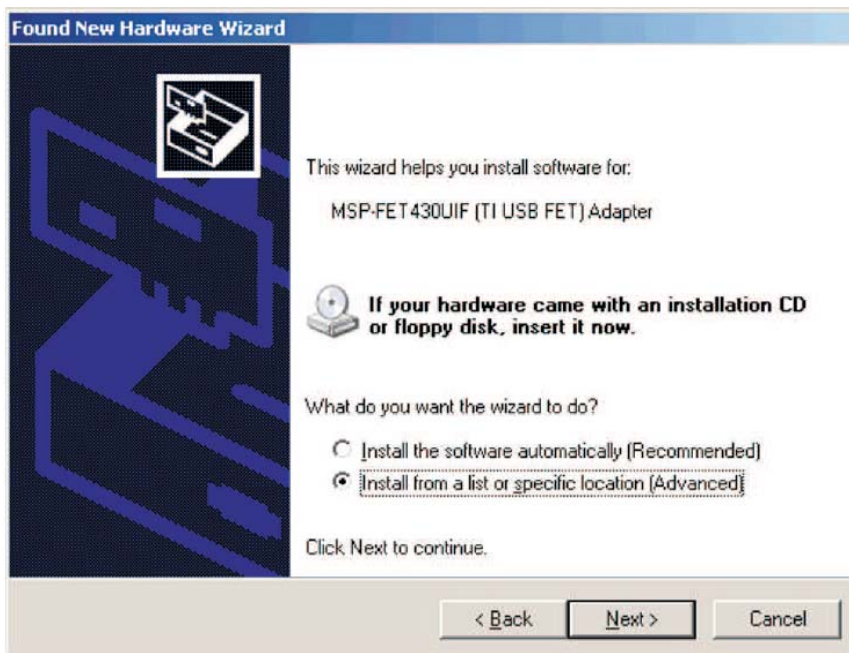
Use the USB cable (MSP-FET430UIF) or the 25-conductor cable (MSP-FET430PIF) to connect the FET interface module to a USB port or to the parallel port of the PC. The necessary driver for accessing the ports (USB or parallel) is installed automatically during CCE installation.

If the install wizard starts automatically for the MSP-FET430UIF, it will open the "Found New Hardware Wizard" window.

Figure 3-10. MSP-FET430UIF WinXP hardware recognition.



Figure 3-11. MSP-FET430UIF WinXP hardware wizard.

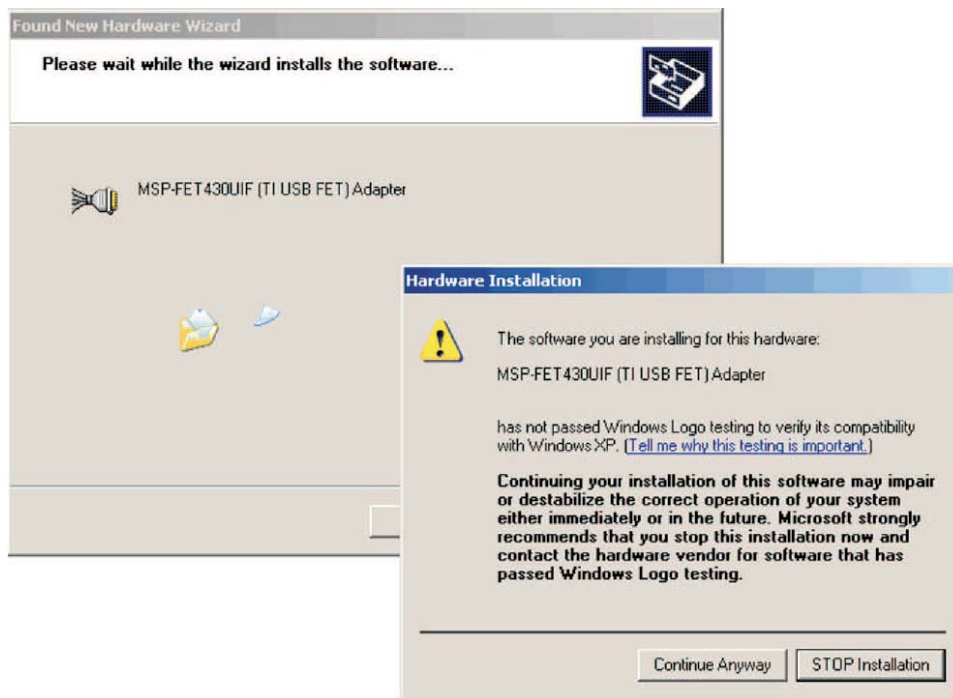


Click "Next". The Hardware Wizards try to find the driver in the system. If does not find it, select "Install from a list or specific location" and follow the prompts and point the wizard to the driver files normally located in C:\Program Files\Texas Instruments\

MSP430_USB_DRIVERS_v3\ (this is the default location unless another installation directory was specified during CCE installation).

During installation, Windows may show a warning that the driver is not certified by Microsoft. Ignore this warning and click "Continue Anyway".

Figure 3-12. WinXP MSP-FET430UIF Driver Installation.



The wizard installs the driver files and it will show a message when has finished the installation of the software for "MSP-FET430UIF (TI USB FET) Adapter" (or "MSP430 Application UART").

After closing the hardware wizard, Windows automatically recognizes another new hardware device called "MSP-FET430UIF - Serial Port". Follow the same steps.

In Annex E are exposed the schematics of the MSP-FET430UIF and MSP-FET430PIF.

3.5 Wireless expansion (Chipcon's RF transceiver chip)

Experimenter's boards support the TI's wireless evaluation modules header: CCxxxxEMK boards. The transceiver modules are connected to the USART of the MSP430FG4618 and of the MSP430F5438 configured in SPI mode.

- ❑ The CC2420EMK supports the 802.15.4/Zigbee standard;
- ❑ The CC1100EMK may be configured to work at an RF carrier frequency of up to 868 MHz;

- ❑ The CC2500EMK/CC2420EMK at an RF carrier frequency of 2.4 GHz.

CC1100EMK Evaluation Module 868 MHz

The evaluation kit in combination with a CC1100 development kit.

This evaluation kit includes CC1100EM 868 MHz modules and antenna. The CC1100EMs are add-on daughter boards that require a CC1100-1150DK development kit for evaluation and development.

It allows performing RF measurements. Using SmartRF® Studio, the radio ICs can be configured with parameters that suit the intended application and easily measure sensitivity, output power and other RF parameters.

The smartRF®04DK includes a Silicon Labs 8051 core MCU with 16 kB of program memory and 1 kB of data memory. By programming this MCU and utilizing the various peripherals included on the Evaluation Board, the prototype of the intended application can be developed. All signals are brought out on 0.1" pin-row connectors so easy connection of other required circuitry is possible. These connectors are also compatible with Agilent logic analyser probes for easy debugging. It is also possible to disconnect the Silicon Labs MCU from the EVM board, and connect a MCU selected by the user to the I/O connectors.

CC2420EMK Evaluation Module IEEE 802.15.4/Zigbee

The CC2420 is a true single-chip 2.4 GHz 802.15.4 compliant RF transceiver designed for low-power and low-voltage wireless applications. The CC2420EMK evaluation kit in combination with a CC2420 development kit is a powerful and flexible tool specifically designed to evaluate the RF performance of the CC2420 and to minimize the time spent on evaluation.

This evaluation kit includes two CC2420EM modules and antennas. The CC2420EM are add-on daughter boards that require a CC2420DK or CC2420DBK development kit for evaluation and development.

CC2500EMK Evaluation Module 2.4 GHz

The CC2500EM evaluation modules are provided with antennas. These evaluation modules are add-on daughter boards that require a CC2500 development kit for evaluation and development.

It allows to do range testing (PER testing) and transfer data from one PC to another using the SmartRF®04DK, in order to evaluate how well the SmartRF®04 products fit the intended application.

It allows performing RF measurements. Using SmartRF® Studio, the radio ICs can be configured with parameters that suit the intended application and easily measure sensitivity, output power and other RF parameters.

3.6 Third party hardware development tools

Texas Instrument's Third-Party Network of several independent companies provides hardware development tools for TI's line of MSP430 Ultra-Low Power Microcontroller products. The hardware tools provided by such companies concern Development Boards/Evaluation modules (EVMs), Production Programming Tools, Hardware Reference Design, Designer's kits, and Adapters/Support Components.

There are several third party MSP430 hardware development tools. Their usage depends on the specific needs of the user, because different manufacturers provide different starter kits, benefiting the use of some peripherals at the detriment of others.

In a first approach, Softbaugh and Olimex provide a large quantity of the most general starter kits, providing feedback user interface, like LCD, LED, buttons and others. Additionally, Softbaugh provides RF boards (packet radio module for point-to-point and star networks, Zigbee stacks, among others).

In the following tables, it can be found the main features included in the boards of the hardware development tools provided by third party, divided into Communication, Human interface and Additional features, each one with specific characteristics. Consult the [TI MSP430 Ultra-Low-Power Microcontrollers \(MCU\)](#) internet page, on the [Third-Party Network](#) to check for changes or updates to the information posted concerning the [Third-Party Hardware Tools](#) (Development Boards/EVMs, Production Programming Tools, Hardware Reference Design, Designer's kits, and Adapters/Support Components).

Table 3-3. Communication interfaces included at Third-party hardware development tools.

Third party	Board ref.	MCU	Ethernet	USB	SPI Port	RS232	RS485	Wireless	IrDA	BSL
Elprotronic Inc.	MSP430F169 Evaluation Board	F169	X	X		X	X			
Gill Instruments	Trainer KIT ET-MSP430					X (MODBUS)	X (MODBUS)	X (ISM band)		
	TCX-MSP430		CS8900A 10Base			X				
Microtrend Systems Inc.	MS-3002					X				
	MS-3003					X				
	MS-3004	F449				X				
	MS-3005	F437	56K modem			X				
	MS-3006	F449				X				
Olimex, Ltd	MSP430-169LCD	F169								
	MSP430-4619LCD	FG4619							X	
	MSP430-1121STK2	F1121A				X				
	MSP430-169STK	F169			X	X				
	MSP430-413STK2	F413				X				
	MSP430-417STK2	F417				X				
	MSP430-449STK2	F449				X				
	MSP430-EasyWeb2	F149	CS8900 LAN controller+LAN transformer+RJ45 LAN connector			X				
PassWorld Y.K.	MSP430-EasyWeb3	F149	CS8900 LAN controller+LAN transformer+RJ45 LAN connector			MAX3232				
	PW-SB169	F169								
	PW-SB1611	F1611								
SoftBaugh	ES449	F449				X				
	ESG439	FG439								
	ES437	F437								
	ESW427	FW427				X				
	ES427	F427				X				
	ES417	F417				X				
	ES169	F169				X				
	ES1611	F1611				X				
	ES1232	F1232				X				
	DG439V	FG439								X
	D437V	F437								X
	DE427	FE427								X
Tecnotron	DIr169	F169				(MAX3221)				
	CM2131	F2131								
	CM1611	F1611				2 (MAX3232)				
	CM1232	F1232				MAX3232				
	CM427	F427				MAX3232				
	CM417	F417								
	CM169	F169				2 (MAX3232)				
	CM149	F149				2 (MAX3232)				

Table 3-4. Human interfaces included at Third-party hardware development tools.

Third party	Board ref.	MCU	Dallas	LCD	buttons	buzzer	Joystick	LED	Switch	Microphone	Headphone	Pin Access
Elprotronic Inc.	MSP430F169 Evaluation Board	F169								2	2	all
Gill Instruments	Trainer KIT ET-MSP430			16x2				4	3	1		
	TCX-MSP430			16x2	4			4				
Microtrend Systems Inc.	MS-3002			X								
	MS-3003			X								
	MS-3004	F449		VI-322	2							all
	MS-3005	F437										
	MS-3006	F449		VI-322								all
Olimex, Ltd	MSP430-169LCD	F169		NOKIA 3310 LCD 84x48			X	2	1 (reset)			all
	MSP430-4619LCD	FG4619		NOKIA 6610 LCD 128x128	2		X					all
	MSP430-1121STK2	F1121A	X		2+1(reset)	X		2				all
	MSP430-169STK	F169	X	LCD 16x2	3			2		1	1	all
	MSP430-413STK2	F413	X	5 digits, 5 decimal counters, special signs	2	X		1				all
	MSP430-417STK2	F417	X	5 digits, 5 decimal counters, special signs	2	X		1				all
	MSP430-449STK2	F449	X	X	4	X		1				all
	MSP430-EasyWeb2	F149	iButton	16x2		X		4	4			
PassWorld Y.K.	MSP430-EasyWeb3	F149						3				all
	PW-SB169	F169		101x64					X			all
SoftBaugh	PW-SB1611	F1611		101x64					X			all
	ES449	F449		7 digit 3v 4-mux SBLCD A2	2			4				all
	ESG439	FG439		SBLCD A4 LCD	2			4				all
	ES437	F437		SBLCD A4 LCD	2			4				all
	ESW427	FW427		SBLCD A4 LCD	2			4				all
	ES427	F427		SBLCD A4 LCD	2			4				all
	ES417	F417		SBLCD A4 LCD	2							all
	ES169	F169			2							all
	ES1611	F1611			2							all
	ES1232	F1232			2							all
	DG439V	FG439		3-1/2 digit LCD				1	3			all
	D437V	F437		3-1/2 digit LCD				1	3			all
	DE427	FE427		SBLCD A4 LCD				2	2			
Tecnotron	DIr169	F169						2	2	X	X	all
	CM2131	F2131						4				
	CM1611	F1611						4				
	CM1232	F1232						4				
	CM427	F427						4				
	CM417	F417						4				
	CM169	F169						4				
	CM149	F149						4				

Table 3-5. Additional features included at Third-party hardware development tools.

Third party	Board ref.	MCU	Flash	SD/MMC	Oscillator	battery holder	ADC	DAC	Analog I/O	RTC	DC/DC	Other
Elprotronic Inc.	MSP430F169 EVM	F169	1MB						2/2			
Gill Instruments	Trainer KIT ET-MSP430						12bits	12bits				1 Acoustic interface; 1 potentiometer; 4 DIP switches
	TCX-MSP430								4			1 Potentiometer; 4 DIP switches
Microtrend Systems Inc.	MS-3002									X	X	Optocouple
	MS-3003							12bits				Sallen-Key LPF; Class EF amplifier
	MS-3005	F437						12bits		X		Sallen-Key LPF; Accelerometer output
	MS-3006	F449										Analog Devices ADXL2xxE accelerometer
Olimex, Ltd	MSP430-169LCD	F169		X	32kHz;8MHz							MMA7620 3 axis accelerometer
	MSP430-4619LCD	FG4619		X	32kHz;8MHz							Frequency input; TEST Pin pull-down; RST/NMI pin pull-up
	MSP430-1121STK2	F1121A			32kHz	2xAA 1,5 V; 3.6V li-ion						2 potentiometers; TEST Pin pull-down; RST/NMI pin pull-up
	MSP430-169STK	F169	8MBx8 ext. NAND		32kHz;8MHz	Jack for 7.5-9VDC			1/1			TEST Pin pull-down; RST/NMI pin pull-up
	MSP430-413STK2	F413			32kHz	CR2032 li-battery 3V						TEST Pin pull-down; RST/NMI pin pull-up
	MSP430-417STK2	F417			32kHz	CR2032 li-battery 3V						Frequency input; TEST pin pull-down; RST/NMI pin pull-up
	MSP430-449STK2	F449			32kHz;8MHz	2xAA 1,5 V battery						4 optocoupled inputs; frequency input;
PassWorld Y.K.	MSP430-EasyWeb2	F149	64K eeprom		8MHz	X	X					
	MSP430-EasyWeb3	F149			8MHz							
PassWorld Y.K.	PW-SB169	F169		X						X		
	PW-SB1611	F1611		X						X		
SoftBaugh	ES449	F449	2Mbit SST serial		32kHz	One-cell (TXS60310); CR2032; 3,3V capacitive charge pump (CCP)		12bit				TXS7201 LDO; Prototyping area
	ESG439	FG439	2Mbit SST serial		32kHz	One-cell (TXS60310); CR2032; 3,3V CCP		12bit				TXS7201 LDO; Prototyping area
	ES437	F437	2Mbit SST serial		32kHz	One-cell (TXS60310); CR2032; 3,3V CCP		12bit				TXS7201 LDO; Prototyping area
	ESW427	FW427	2Mbit SST serial		32kHz	1x AAA 3,3V (TXS60310); CR2032 (TXS60212)						TXS7201 LDO; Prototyping area; Comparator A experiment block
	ES427	F427	2Mbit SST serial		32kHz	1x AAA 3,3V (TXS60310); CR2032 (TXS60212)						TXS7201 LDO; Prototyping area
	ES417	F417	2Mbit SST serial		32kHz	One-cell (TXS60310); CR2032; 3,3V CCP		12bit				TXS7201 LDO; Prototyping area
	ES169	F169	2Mbit SST serial		32kHz	One-cell (TXS60310); CR2032; 3,3V CCP		12bit				TXS7201 LDO; Prototyping area
	ES1611	F1611	2Mbit SST serial		32kHz	One-cell (TXS60310); CR2032; 3,3V CCP		12bit				TXS7201 LDO; Prototyping area
	ES1232	F1232	2Mbit SST serial		32kHz	One-cell (TXS60310); CR2032; 3,3V CCP		12bit				TXS7201 LDO; Prototyping area
	DG439V	FG439			32 kHz	CR2032 coin cell supply						50k Potentiometer
	D437V	F437			32 kHz	CR2032 coin cell supply						50k Potentiometer; Prot. area
	D1r169	F169			32kHz	Dual alkaline power supply						Optional ceramic XT2; Prototyping area
Tecnotron	CM2131	F2131			32Hz;16MHz							TEST Pin pull-down; RST/NMI pin pull-up
	CM1611	F1611			32kHz;8MHz							RST/NMI pin pull-up
	CM1232	F1232			32kHz;8MHz							TEST Pin pull-down; RST/NMI pin pull-up
	CM427	F427			32kHz;8MHz							RST/NMI pin pull-up
	CM417	F417			32kHz;8MHz							RST/NMI pin pull-up
	CM169	F169			32kHz;8MHz							RST/NMI pin pull-up
	CM149	F149			32kHz;8MHz							RST/NMI pin pull-up

3.7 Quiz

1. The eZ430-F2013 USB stick has an ADC:
 - (a) 10-bit SAR;
 - (b) 16-bit Sigma/Delta;
 - (c) 12-bit SAR;
 - (d) Slope.

2. The eZ430-RF2500 comparing with the eZ430-F2013 USB stick supports additionally the following communication protocols:
 - (a) UART/LIN, SPI;
 - (b) I2C, IrDA;
 - (c) UART/LIN, IrDA;
 - (d) SPI, I2C.

3. The eZ430-RF2500 comparing with the eZ430-F2013 USB stick has the additional user interfaces:
 - (a) 2 LED, 1 touch button and 14 development pins;
 - (b) 1 LED, 2 touch buttons, and 21 development pins;
 - (c) 2 LEDs, 2 touch buttons, and 10 development pins;
 - (d) 1 LED, 1 touch button and 7 development pins.

4. The MSP430 devices populated in the Experimenter's board are:
 - (a) MSP430FG4618 and MSP430F2013;
 - (b) MSP430FG4619 and MSP430F2013;
 - (c) MSP430FG4618 and MSP430F2274;
 - (d) MSP430FG4618 and MSP430F2003.

5. Some of the FG4618/F2013 Experimenter's board user interfaces are:
 - (a) Microphone, Buzzer, LCD, Capacitive touch sensing...
 - (b) LCD, Potentiometers, Capacitive touch sensing, 2 push buttons
 - (c) Joystick, 4 LEDs, Prototyping space, headphone jack
 - (d) Accelerometer, 2 push buttons, 4 LEDs, Prototyping space

6. The MSP-EXP430F5438 demo board has:
 - (a) 3 timers and 2 SAR ADC;
 - (b) 2 timers and 2 SAR ADCs;
 - (c) 3 timers and 1 SAR ADC;
 - (d) 2 timers and 1 SAR ADC and 1 SD ADC.

Solution: 1. (b); 2. (c); 3. (d); 4. (a); 5. (a); 6. (c)

3.8 FAQs

1. What devices can be programmed with the MSP-eZ430U debugging interface?

The MSP-eZ430U debugging interface was designed to communicate with devices over a Spy Bi-Wire interface. All members of the MSP430F20xx family of microcontrollers have been tested and are supported.

2. Does the eZ USB sticks support fuse blow?

Both MSP-eZ430U and eZ430-RF USB debugging interfaces lack the JTAG security fuse blow capability. To ensure firmware security on devices going to production, the USB Flash Emulation Tool or the Gang Programmer, which include the fuse blow feature are recommended.

3. What is the voltage supplied to the eZ target boards from the debugging interface?

Either the MSP-EZ430U or the eZ430-RF USB debugging interfaces supply a regulated 3.6 V to the MSP-eZ430D and to the eZ430-RF2500T target boards respectively.

4. Can other programming tools interface to the eZ target boards?

Both the MSP-EZ430D and the eZ430-RF2500T target boards will work with any programming tool supporting the 2-wire Spy Bi-Wire interface. Both the MSP430 USB FET (MSP-FET430UIF) and the Gang Programmer support these devices. See MSP-FET430 Flash Emulation Tool User's Guide (SLAU138) for details on using MSP430 USB FET and the Gang Programmer for a 2-wire Spy-Bi-Wire interface.

5. What versions of IAR Embedded Workbench are supported by the eZ USB sticks?

Both the eZ430-F2013 and the eZ430-RF2500 hardware are supported by IAR Embedded Workbench KickStart Release 4.64 (IAR 3.42F) and Code Composer Essentials v2.03 (SP3) or higher. At the time of print, CCE is currently not supported by the SimpliciTI protocol or the Sensor Monitor Demo. Please check the TI web site for updates.

6. What are the part numbers for the connectors between the USB stick emulators and the target boards?

For the MSPeZ430U emulator and the MSP-eZ430D target board:

- Header: Mill-Max 850-10-004-20-001000
- Socket: Mill-Max 851-93-004-20-001000

For the eZ430-RF USB debugger and the eZ430-RF2500T target board:

- Header: Mill-Max 850-10-006-20-001000
- Socket: Mill-Max 851-93-006-20-001000

Mill-Max: <http://www.mill-max.com>

7. Concerning the eZ430-RF2500 hardware tool, where to find more information about the 2.4-GHz chip antenna?

Part Number: 7488910245

Würth Elektronik Group: www.we-online.com

8. Why can't I get the debugger started?

(a) Check in the Device Manager for the COM Port assigned to the eZ430. If is detected a conflict with port already in use, the conflicting port may be disable or assign a new COM port to the device.

(b) Check all devices that use a serial port; even devices that do not show up in the Device Manager.

(c) Check if capacitors C6 or C9 are populated on the MSPeZ430U debugging interface, since they may have been unknowingly removed while opening the enclosure.

9. For the eZ430-RF2500 hardware tool, the MSP430 Application UART can't be selected, the data isn't received, or the demo application doesn't appear to change.

(a) Ensure that the Application UART driver is correctly installed (run the installer for the Sensor Monitor Visualizer or newest version of the IAR KickStart or the CCE). Follows the instructions present in the hardware tool user guide < slau227c.pdf>.

To determine if the driver is correctly installed:

i) Plug in the eZ430-RF2500 USB debugging interface

ii) Right click My Computer and select Properties

iii) Select the Hardware tab and click on Device Manager

iv) Under Ports (COM & LPT) should be an entry for "MSP430 Application UART (COM xx)".

If the entry is there, but no characters are received, restart the PC. If the Application UART is not listed, please re-install the driver following the instructions presented in the hardware tool user guide < slau227c.pdf>.

10. What is the RF range of the eZ430- RF2500?

Indoor line-of-sight range measured of more than 50 meters (practical range testing with one node connected to a PC and the other node connected to the battery board). This range can be significantly affected by the orientation of the boards and the environment. Please visit the TI website for additional reference designs and antenna options.

11. Why is my battery board different than in the documentation?

Since introduction, the eZ430RF-2500 battery board was slightly modified in order to reduce the wireless communications perturbation due to the relative position of the antenna to the batteries. The connections and function remain the same.

12. What devices can be programmed with the FG4618/F2013 experimenter's board?

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

13. How is power supplied to the FG4618/F2013 experimenter's board?

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

14. Can I use the Parallel FET (MSP-FET430PIF) to program/debug the MSP430?

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

15. I have erased and reprogrammed the MSP430; can I restore the factory programmed-firmware on the device(s)?

The software source files are available at the MSP-EXP430FG4618 documentation page at www.ti.com/msp430.

16. Why the MSP430FG4618 device is no longer accessible via JTAG after operation?

- a) Verify that the target device is powered properly
- b) If the target is powered locally, verify Vcc is applied to pin 4 of the JTAG header
- c) 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.

17. Does the FG4618/F2013 experimenter's 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) via JTAG.

18. I am measuring system current in the range of 30 mA, 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.

19. 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 via 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. Additional details in the hardware tool user guide <slau213a.pdf>.

20. I have loaded the MSP430FG4618 and MSP430F2013 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 I2C 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.

[illegible]

Annex B – eZ430-RF2500 schematics

Figure 3-14. eZ430-RF2500, USB Debugging Interface schematic.

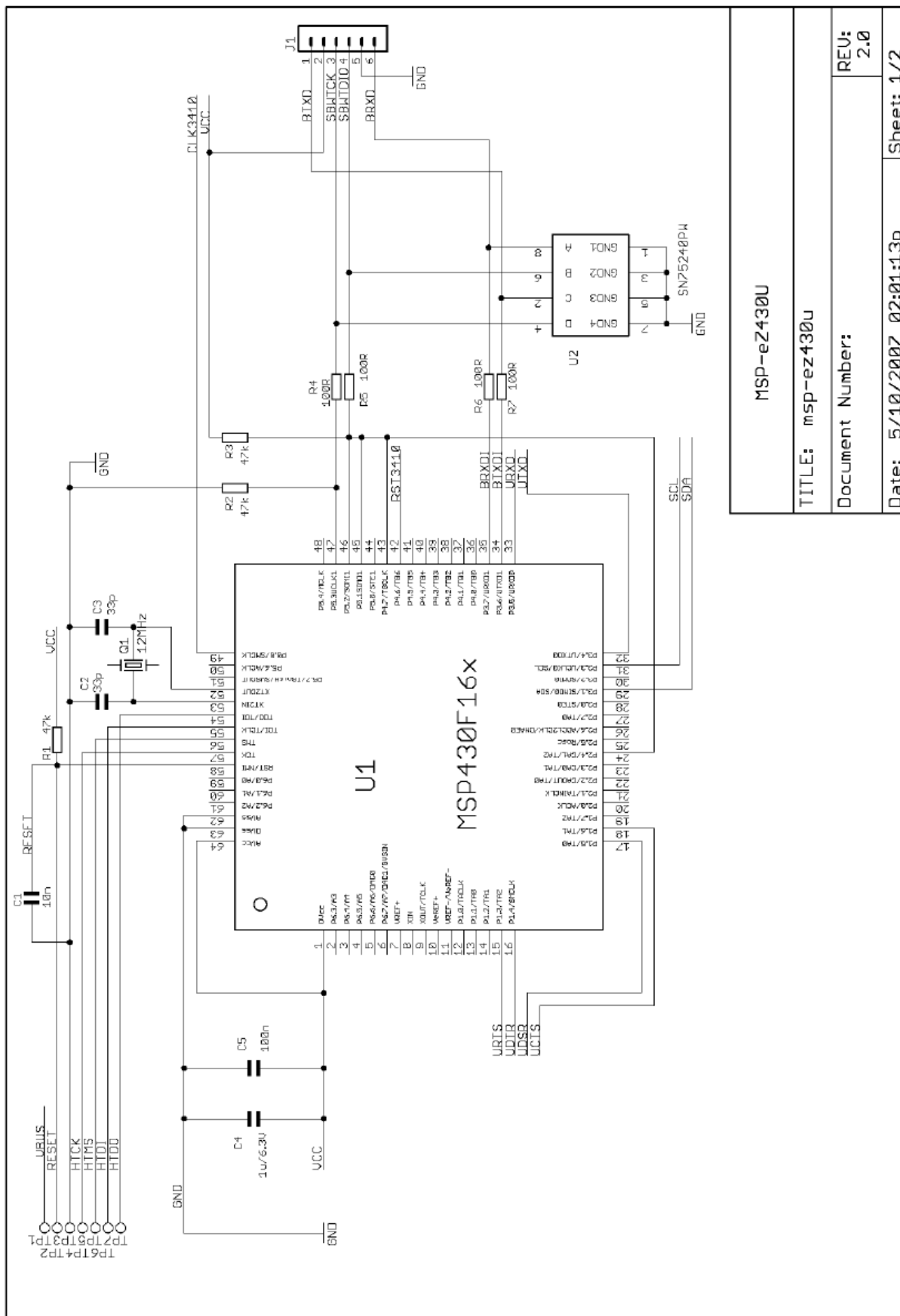


Figure 3-15. eZ430-RF2500, USB Debugging Interface schematic.

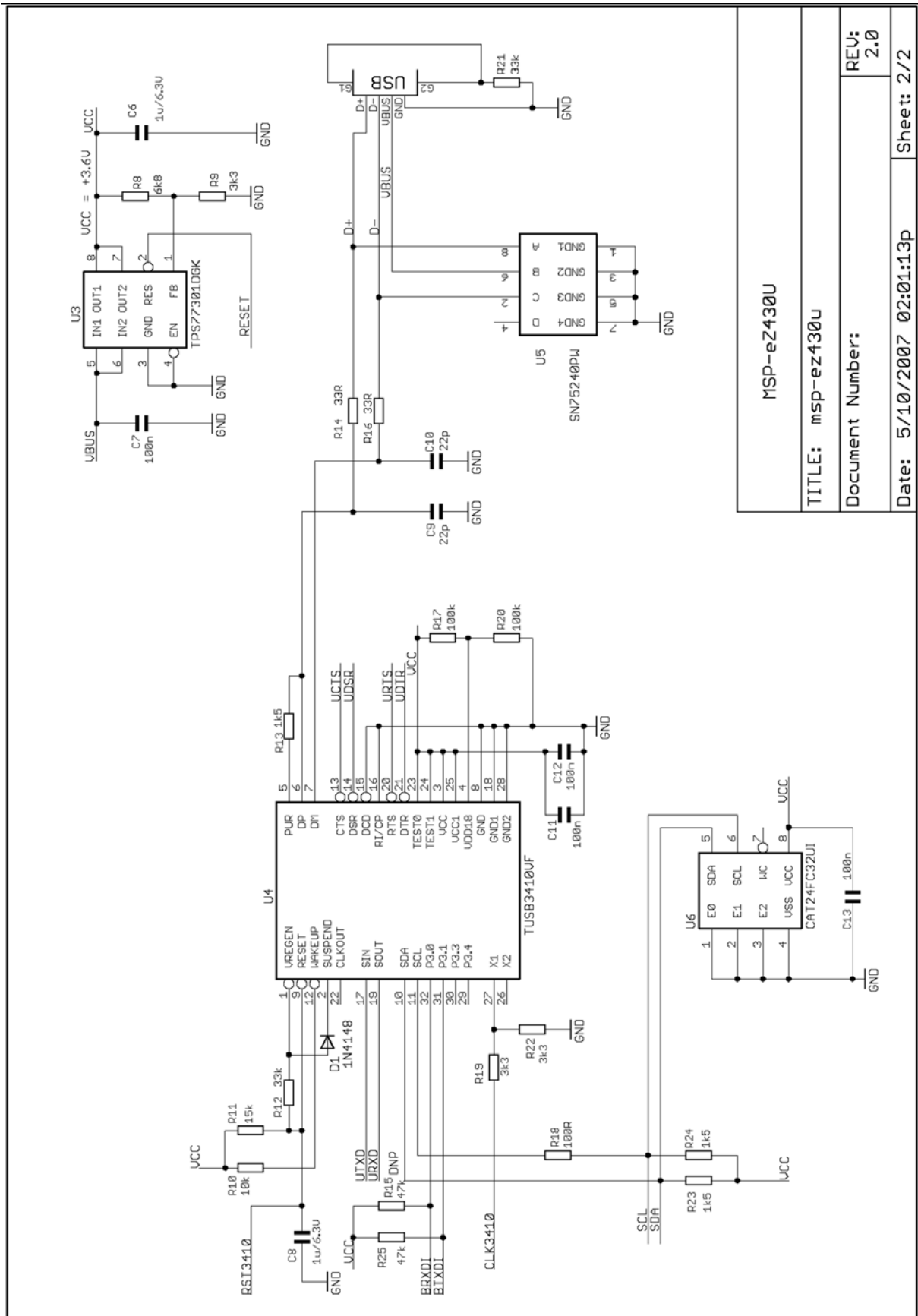
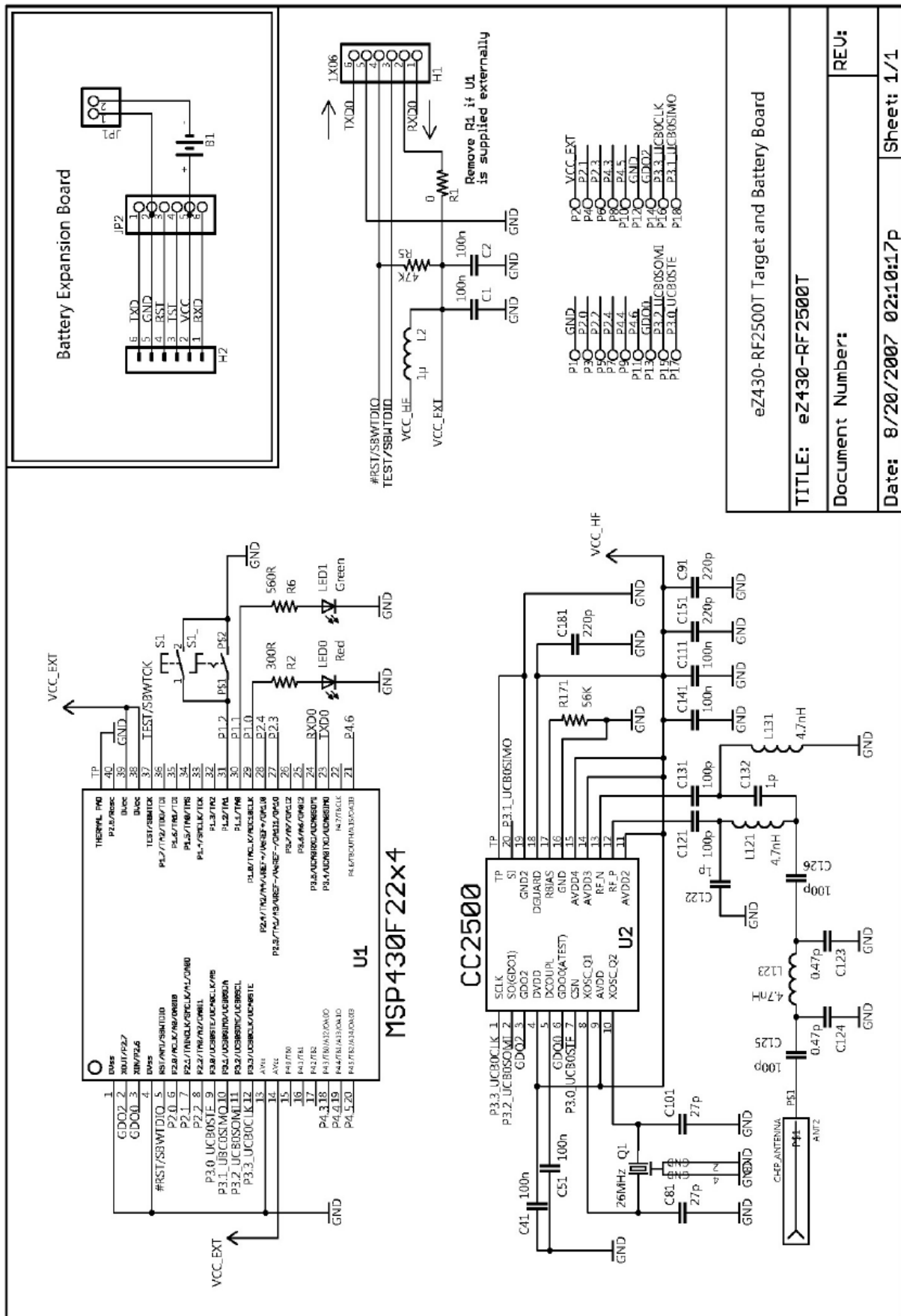
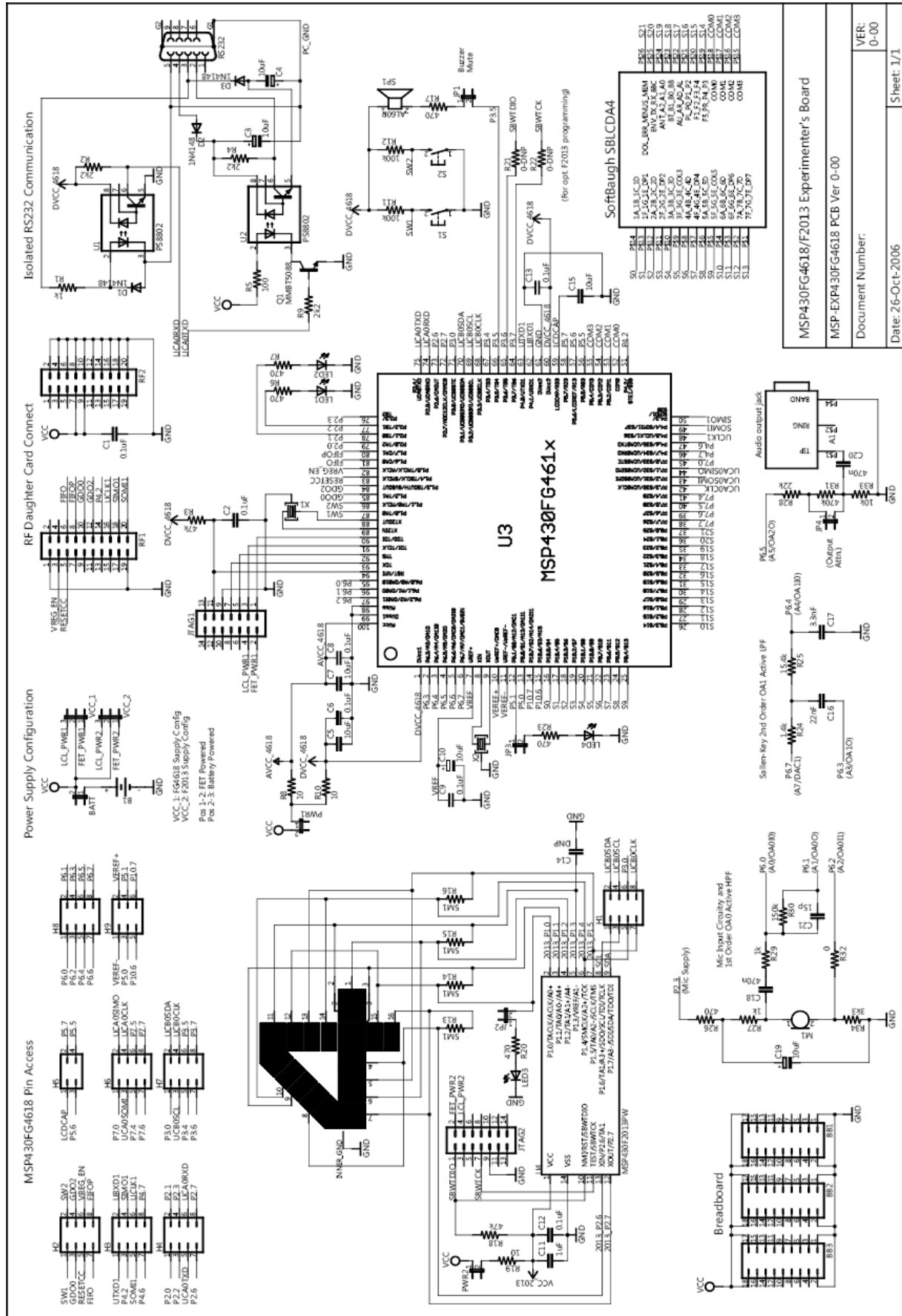


Figure 3-16. eZ430-RF2500, Target board and battery board schematic.



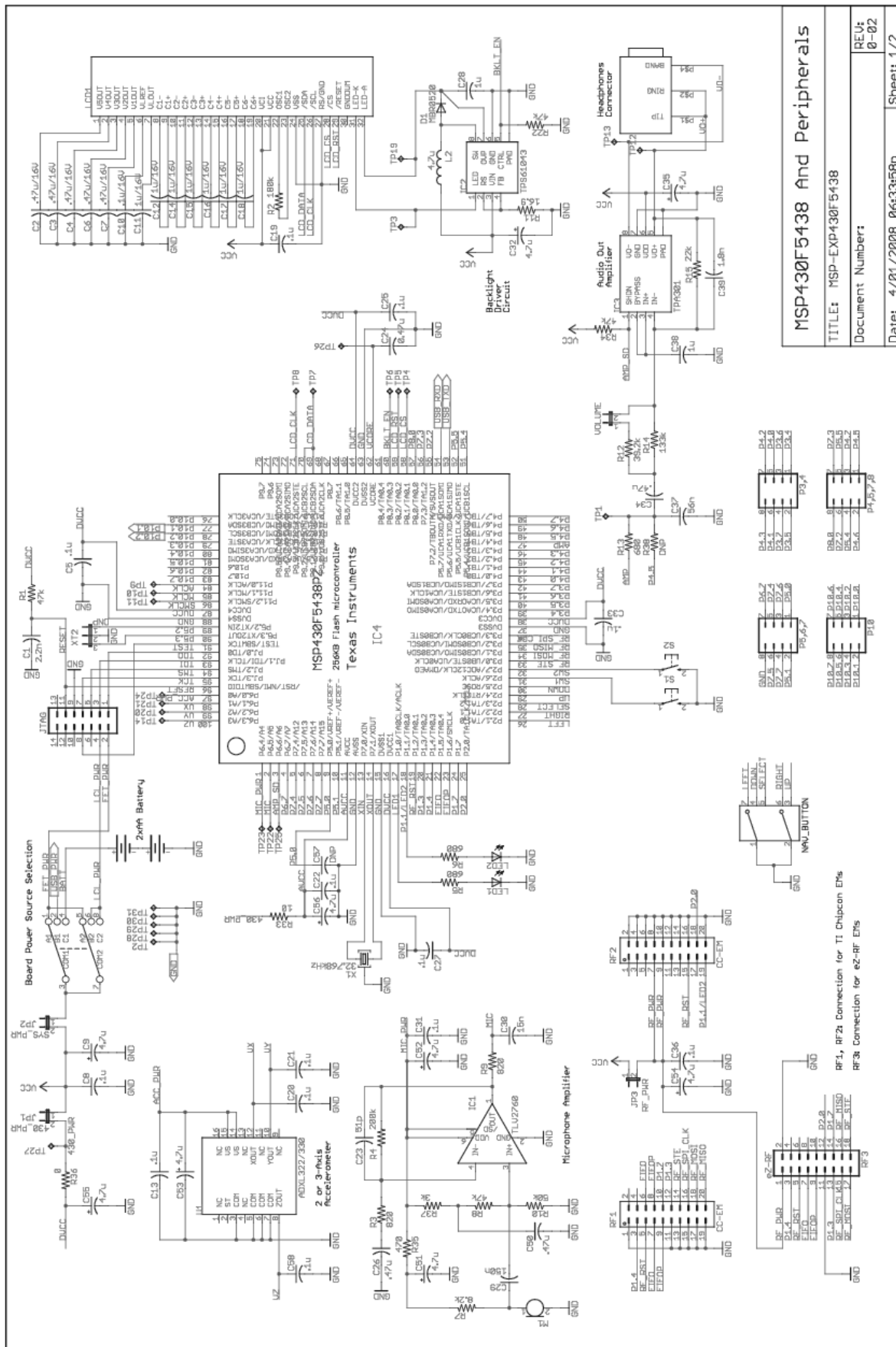
Annex C- MSP430FG4618/F2013 Experimenter's board schematics

Figure 3-17. MSP430FG4618/F2013 Experimenter board schematic.



Annex D – MSP- EXP430F5438 Experimenter board schematics

Figure 3-18. MSP-EXP430F5438 demo board schematic.



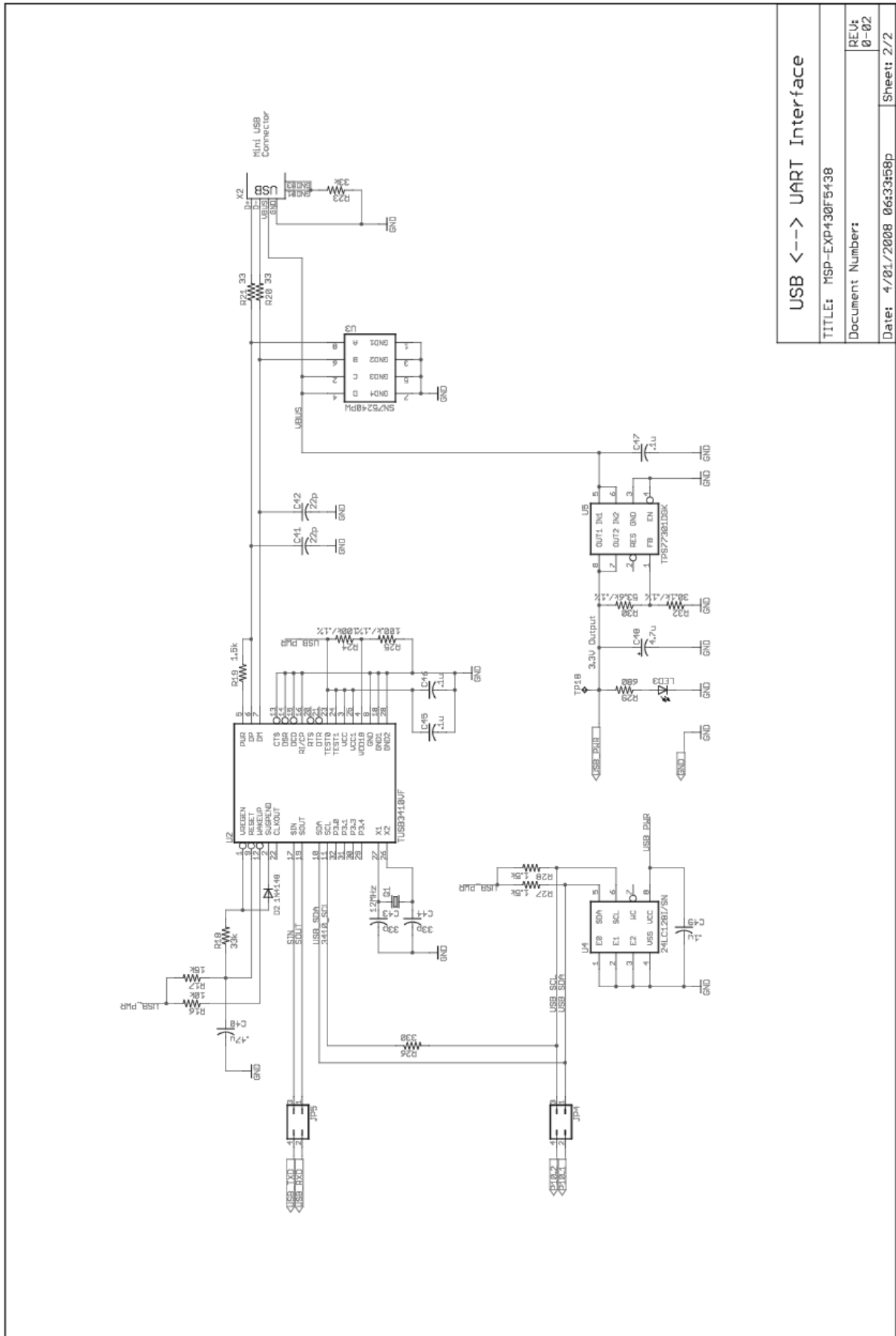
MSP430F5438 And Peripherals

TITLE: MSP-EXP430F5438

Document Number:

Date: 4/01/2008 06:33:58p Sheet: 1/2

Figure 3-19. MSP-EXP430F5438 demo board USB <-> UART interface schematic.



Project: MSP-FETP430IF Flash-Emulation-Kit-Interface
Block:
Size:
Name:
Date: 26.07.2001 10:03:24
Rev: 1.3
Sheet: 1/1

Figure 3-21. MSP-FET430UIF FET interface module, schematic (1/4).

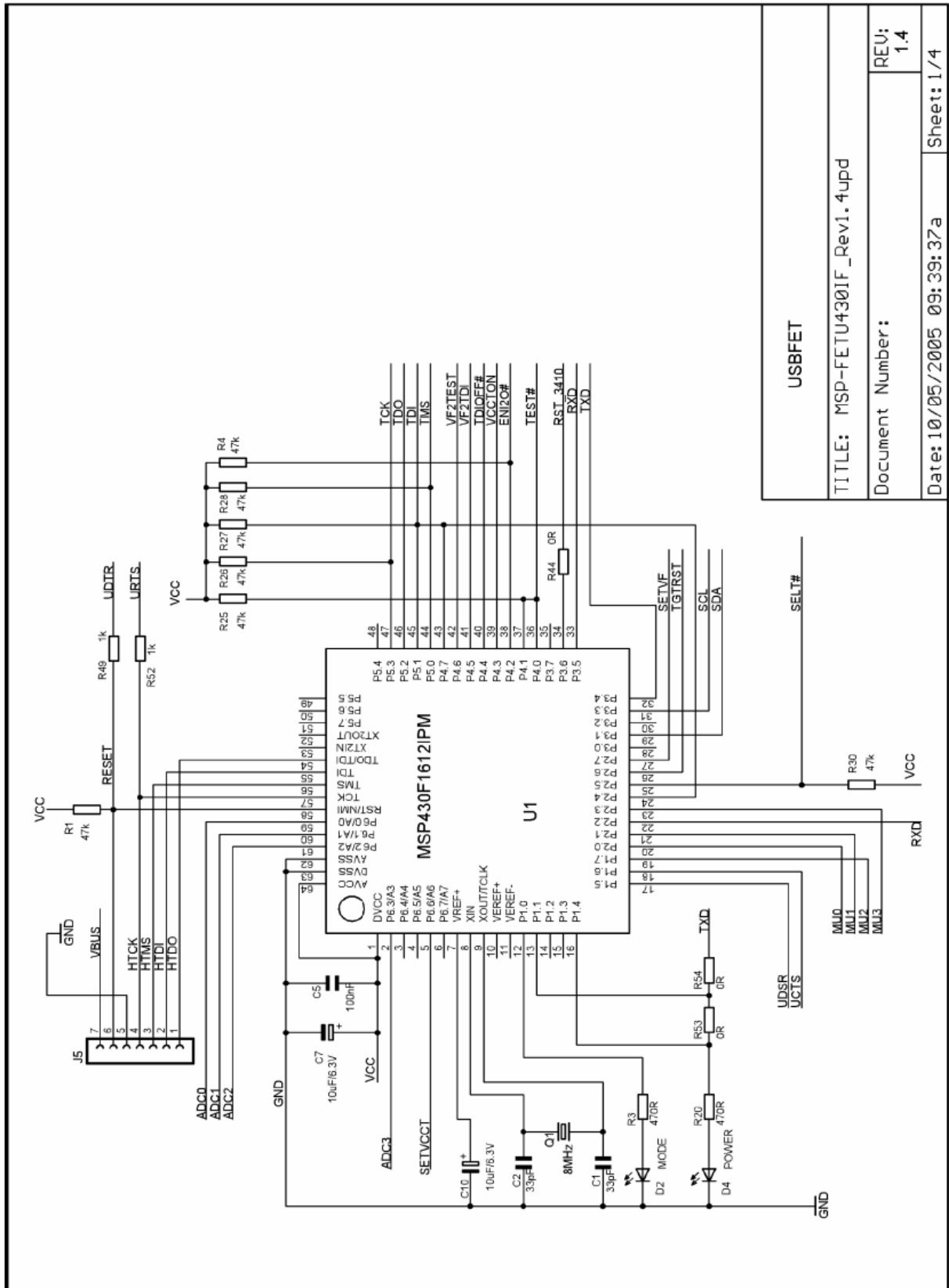


Figure 3-22. MSP-FET430UIF FET interface module, schematic (2/4).

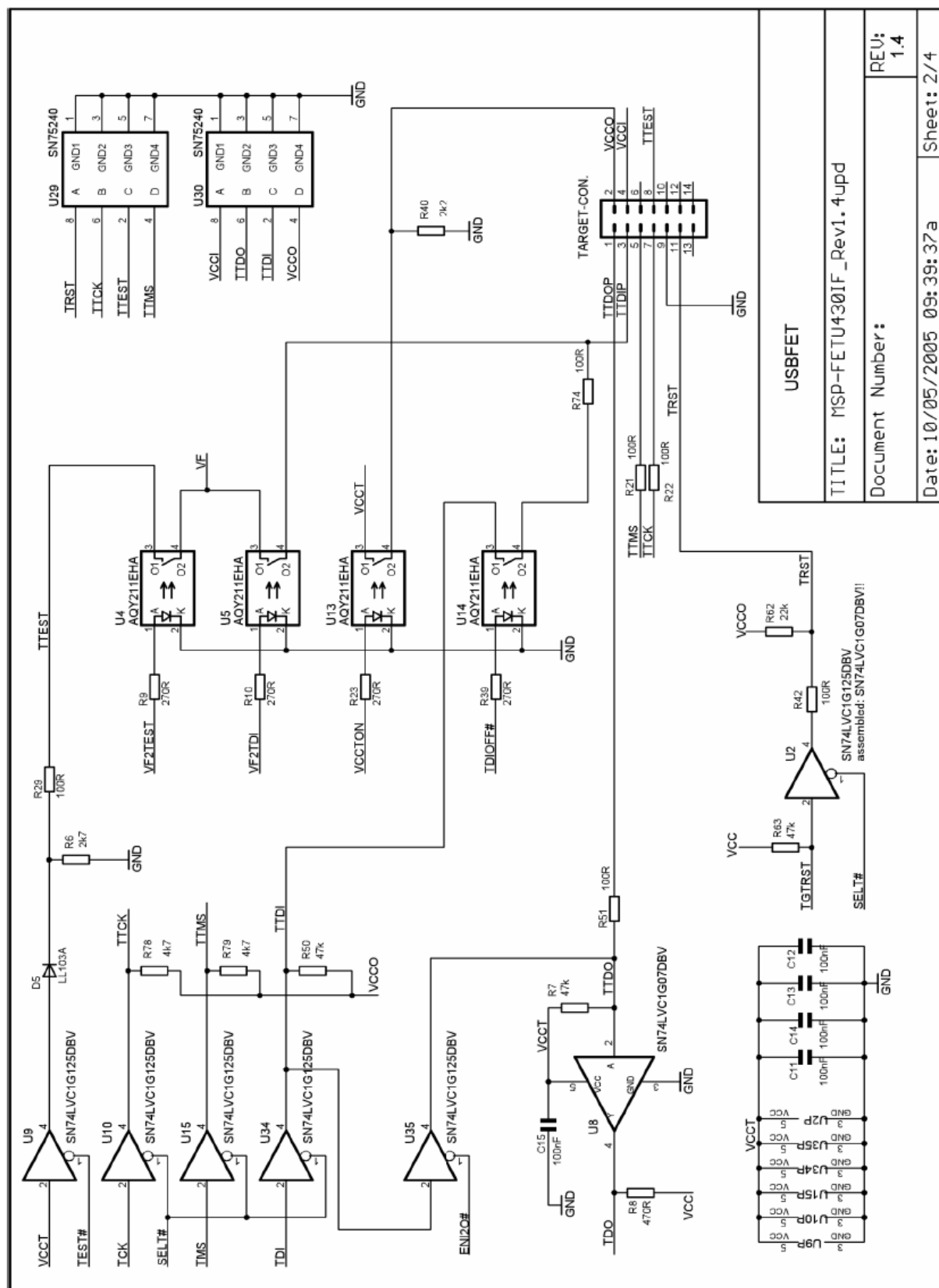


Figure 3-23. MSP-FET430UIF FET interface module, schematic (3/4).

