MSP-EXP430G2 LaunchPad Experimenter Board

User's Guide

Literature Number: SLAU318
July 2010

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Read This First

If You Need Assistance

If you have any feedback or questions, support for the MSP430 devices and the MSP-EXP430G2 is provided by the Texas Instruments Product Information Center (PIC) and the TI E2E Forum (https://community.ti.com/forums/12.aspx). Contact information for the PIC can be found on the TI web site at support.ti.com. Additional device-specific information can be found on the MSP430 web site at www.ti.com/msp430.

Related Documentation from Texas Instruments

The primary sources of MSP430 information are the device-specific data sheets and user's guides. The most up-to-date versions of the user's guide documents available at the time of production have been provided on the CD-ROM included with this tool. However, the most current information is found at www.ti.com/msp430.

Information specific to the MSP-EXP430G2 LaunchPad Experimenter Board can be found at http://focus.ti.com/docs/toolsw/folders/print/msp-exp430g2.html.

MSP430 device user's guides and the FET user's guide (SLAU157) may be accessed on the included CD-ROM under the user's guides section. The FET user's guide includes detailed information on setting up a project for the MSP430 using Code Composer Essentials.

FCC Warning

This equipment is intended for use in a laboratory test environment only. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to subpart J of part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case, the user will be required to take whatever measures may be required to correct this interference his own expense.

MSP-EXP430G2 LaunchPad Experimenter Board

1 MSP-EXP430G2 LaunchPad Overview

1.1 Overview

The MSP-EXP430G2 low-cost experimenter board called LaunchPad is a complete development solution for the new Texas Instruments MSP430G2xx series. Its integrated USB-based emulator offers all the hardware and software necessary to develop applications for all MSP430G2xx series devices. The LaunchPad has an integrated DIP target socket that supports up to 20 pins, allowing MSP430 Value Line devices to be dropped into the LaunchPad board. It also offers an on-board flash emulation tool allowing direct interface to a PC for easy programming, debugging, and evaluation. The LaunchPad experimenter board is also capable of programming the eZ430-RF2500T target boards, the eZ430-Chronos watch module or the eZ430-F2012T/F2013T target boards. It also provides a 9600-Baud UART serial connection from the MSP430G2xx device to the host PC or a connected target board.

The MSP-EXP430G2 uses the IAR Embedded Workbench Integrated Development Environment (IDE) or Code Composer Studio (CCS) to write, download, and debug an application. The debugger is unobtrusive, allowing the user to run an application at full speed with hardware breakpoints and single stepping available while consuming no extra hardware resources.

MSP-EXP430G2 LaunchPad features:

- USB debugging and programming interface featuring a driverless installation and application UART serial communication with up to 9600 Baud
- Supports all MSP430G2xx and MSP430F20xx devices in PDIP14 or PDIP20 packages
- Two general-purpose digital I/O pins connected to green and red LEDs for visual feedback
- Two push button for user feedback and device reset
- Easily accessible device pins for debugging purposes or as socket for adding customized extension boards
- High-quality 20-pin DIP socket for an easy plug-in or removal of the target device

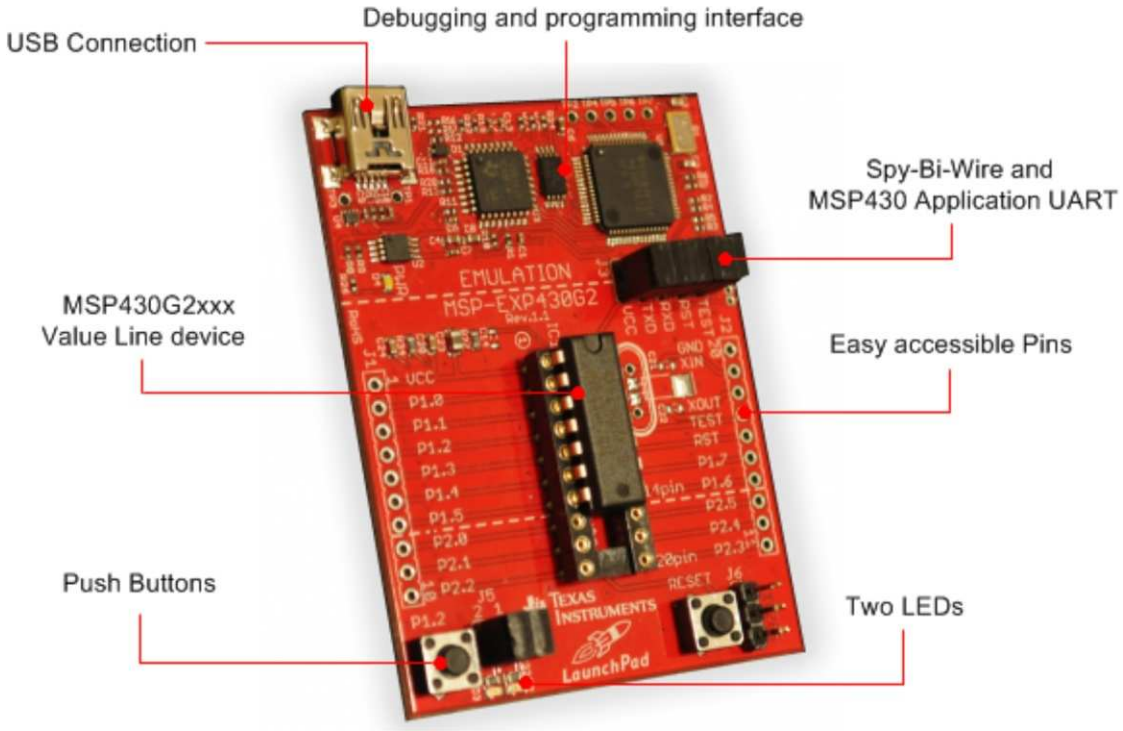

Figure 1. MSP-EXP430G2 LaunchPad Overview

For latest information on the MSP-EXP430G2 LaunchPad and all the necessary files, visit the MSP430 LaunchPad Wiki page http://processors.wiki.ti.com/index.php/MSP430_LaunchPad_(MSP-EXP430G2). There you can find software examples, more details on the supported software, and where to order the MSP-EXP430G2 LaunchPad.

1.2 Kit Contents

The EXP430G2 experimenter kit includes the following hardware:

- LaunchPad emulator socket board (MSP-EXP430G2)
- Mini USB-B cable, 0.5 m
- Two MSP430 flash devices
  - MSP430G2231: Low-power 16-bit MSP430 microcontroller with an 8-channel 10-bit ADC, 2kB flash memory, and 128 bytes of RAM (preloaded with a sample program)
  - MSP430G2211: Low-power 16-bit MSP430 microcontroller with a comparator, 2kB flash memory, and 128 bytes of SRAM
- 10-pin PCB connectors (two male and two female)
- 32.768-kHz clock crystal from Microcrystal (www.microcrystal.com)
- Quick start guide
- Two LaunchPad stickers

2 Installation

The MSP-EXP430G2 LaunchPad installation consists of three easy steps:

1. Download the required software
2. Install the selected IDE
3. Connect the LaunchPad to the PC

Then the LaunchPad is ready to develop applications or play with the pre-programmed demo application.

2.1 Download the Required Software

There are different development software tools available for the MSP-EXP430G2 LaunchPad development board. IAR Embedded Workbench KickStart and Code Composer Studio (CCS) are both available in a free limited version. IAR Embedded Workbench allows 4kB of C-code compilation. CCS is limited to a code size of 16kB. The software is available at www.ti.com/msp430 or the LaunchPad Wiki page http://processors.wiki.ti.com/index.php/MSP430_LaunchPad_(MSP-EXP430G2). There are many other compilers and integrated development environments (IDEs) for MSP430 including Rowley Crossworks and MSPGCC available to use with the MSP-EXP430 LaunchPad. However, example projects have been created using IAR Embedded Workbench KickStart and Code Composer Studio (CCS). For more information on the supported software and the latest code examples visit the LaunchPad Wiki page.

2.2 Install the Software

Download one of the integrated development environments (IDEs). IAR KickStart and CCS offer the required driver support to work with the MSP-EXP430 LaunchPad onboard emulation. Once installed, the IDE should find the MSP-EXP430G2 LaunchPad as USB:HID debugging interface. Now all is set for developing MSP430G2xx based application on the LaunchPad.

2.3 Install the Hardware

Connect the EXP430G2 LaunchPad socket board with the enclosed USB cable to a PC. The driver installation starts automatically. If prompted for software, allow Windows to install the software automatically. This is possible only if either IAR KickStart or Code Composer Studio is already installed (see Section 2.2).

3 Getting Started With MSP-EXP430G2 LaunchPad

3.1 Getting Started

The first time the MSP-EXP430G2 LaunchPad Experimenter Board is used, a demo application automatically starts as soon as the board is powered from the USB host. To start the demo, connect the MSP-EXP430G2 LaunchPad with the included mini USB cable to a free USB port. The demo application starts with an LED toggle to show the device is alive. More information about the Demo Application can be found in Section 3.2.

3.2 Demo Application, Internal Temperature Measurement

The LaunchPad experimenter board includes a pre-programmed MSP430G2231 device already located in the target socket. When LaunchPad is connected via USB, the demo starts with an LED toggle sequence. The onboard emulation generates the supply voltage and all the signals necessary to start.

Pressing button P1.3 switches the application to a temperature measurement mode. A reference temperature is taken at the beginning of this mode and the LEDs of the LaunchPad signal a rise or fall in temperature by varying the brightness of the on-board red or green LED, respectively. The reference temperature can also be re-calibrated with another button press on P1.3. The collected temperature data is also communicated via back-channel UART through the USB emulation circuitry back to the PC. The transmitted values representing the temperature measured with the MSP430G2231 internal temperature sensor in Fahrenheit and can be displayed with any terminal application or the Temperature Sensor GUI available on the MSP430 LaunchPad wiki page http://processors.wiki.ti.com/index.php/MSP430_LaunchPad_(MSP-EXP430G2). The serial communication port on the PC must configured with 2400bps, one stop bit, and no flow control to display the values correctly.

The demo application uses the on-chip peripherals of the MSP430G2231 device such as the 10-bit ADC, which samples the internal temperature sensor, and 16-bit timers, which drive the PWM to vary brightness of the LEDs and enable software UART for communication with the PC. The source code for this pre-loaded demo application is available for download in the Projects section of the MSP430 LaunchPad wiki page. Further information on the Temperature Sensor application and other examples and applications can be found on the MSP430 LaunchPad wiki page as well.

The provided applications can be a great starting point for various custom applications and give a good overview of the manifold possibilities of the MSP430G2xx Value Line devices. Also available are the executable and source files for a GUI, which displays the data that is being communicated back to the PC from the LaunchPad

4 Develop your Application with the MSP-EXP430G2 LaunchPad

4.1 Developing an Application

The integrated development environments (IDEs) shown in Section 2 offer support for the whole MSP430G2xx Value Line. The MSP-EXP430G2 LaunchPad needs only a connection to the USB of the Host PC—there is no external hardware required. The power supply and the Spy-Bi-Wire JTAG signals TEST and RST must be connected with jumper J3 to allow the onboard emulation connection to the device, as shown in Section 5. Now the favored device can be plugged into the DIP target socket of the LaunchPad experimenter board (see Figure 2). Both PDIP14 and PDIP20 devices of the MSP430G2xx Value Line and the MSP430F20xx family can be inserted into the DIP socket aligned to pin 1. A complete list of supported devices can be found in Section 4.7.

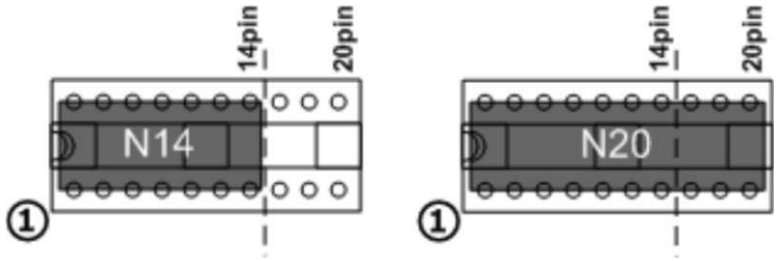

Figure 2. Insert Device Into Target Socket

The following example for Code Composer Studio v4 shows how to download and debug the demo application described in Section 3.2.

4.2 Program and Debug the Temperature Measurement Demo Application

The source code of the demo application can be downloaded from the MSP430 LaunchPad wiki page. Download the project folder and unpack it to a location of your choice. For this demo, Code Composer Studio v4 or newer must be installed.

The demo application can be loaded to the CCS workspaces by clicking File→Import. Select the location of the extracted project files and import Existing projects into Workspace. Now the MSP-EXP430G2-Launchpad project appears inside the CCS workspace. The project must be marked as the active project to start programming and debugging the device.

Connect the LaunchPad with an inserted MSP430G2231 device to the host PC and click the Debug button on the CCS Toolbar. The MSP-EXP430G2 LaunchPad is initialized and the download of the compiled demo application starts. The CCS view switches to a debugging interface once the download is completed and the application is ready to start. Figure 3 shows Code Composer Studio v4 with the MSP-EXP430G2 LaunchPad demo application in debug view.

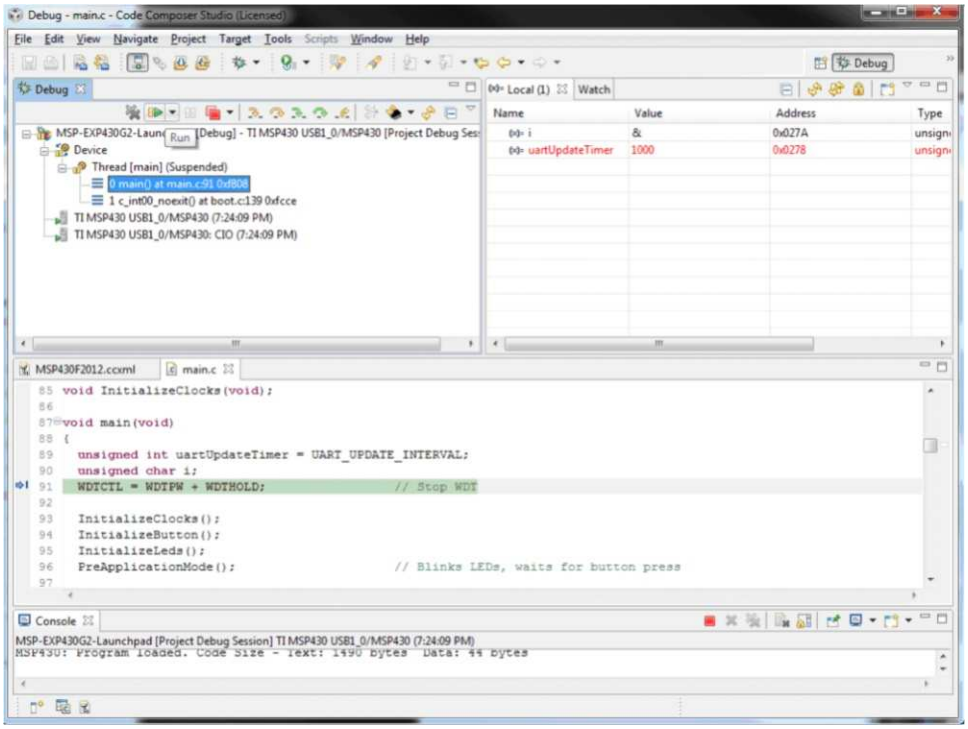

Figure 3. Code Composer Studio v4 in Debugging Mode

4.3 Disconnect Emulator From Target With Jumper J3

The connection between the MSP-EXP430G2 emulator and the attached target device can be opened with the jumper array J3. This can be useful to access an attached eZ430 target board by disconnecting the Spi-Bi-Wire JTAG lines $\overline{\text{RST}}$ and TEST or if the JTAG lines are used for other application purposes. The jumper array can also be used to measure the power consumption of the LaunchPad application. For this intention, all connections except VCC must be opened, and a multi meter can used on VCC to measure the power consumption of the MSP-EXP430G2 target device and its peripherals. The jumper 5 VCC also must be opened if the LaunchPad board is powered with an external power supply over J6. Table 1 shows the jumpers in between the MSP-EXP430G2 emulator and the target device.

Table 1. Jumper Connection J3 Between Emulator and Target

Jumper	Signal	Description
1	TEST	Test mode for JTAG pins / Spy-Bi-Wire test clock input during programming and test
2	RST	Reset / Spy-Bi-Wire test data input/output during programming and test
3	RXD	UART receive data input
4	TXD	UART transmit data output
5	VCC	Target socket power supply voltage (power consumption test jumper)

4.4 Program Connected eZ430 Target Boards

The MSP-EXP430G2 LaunchPad can program the eZ430-RF2500T target boards, the eZ430-Chronos watch module, or the eZ430-F2012T/F2013T. To connect one of the ez430 targets, connector J4 must be populated with a 0.050-in (1.27-mm) pitch male header, as shown in Figure 4, to connect the target boards.

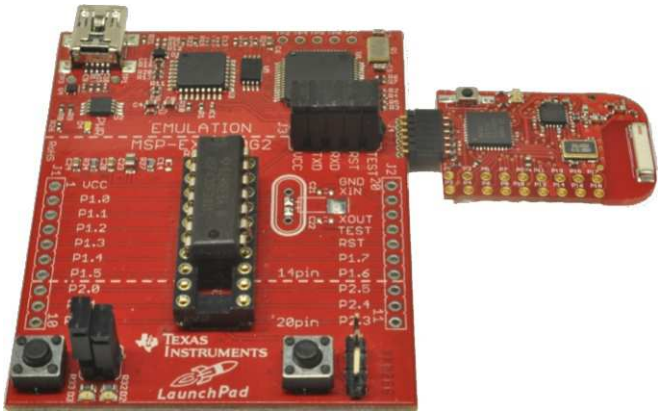

Figure 4. MSP-EXP430G2 LaunchPad With Attached eZ430-RF2500 Target Board

To program the attached target without interfering with the LaunchPad socket board, jumper connections TEST and RST of J3 must be open. The interface to the eZ430 target board is always connected to the MSP-EXP430G2 emulator, so the programming and debugging of a connected LaunchPad target device is possible only if the eZ430 target is not connected on the same time. The application UART, on the other hand, is connected directly to the LaunchPad target device, and jumper J3 can be closed to monitor the transmission from the LaunchPad target to the attached eZ430. This way both possible connections, from the device to the PC and from the device to the eZ430, can be established without changing the direction of the UART pins.

Table 2 shows the pin out of the debugging interface J4.

Table 2. eZ430 Debugging Interface

Pin	Signal	Description
1	TXD	UART transmit data output (UART communication from PC/MSP430G2xx to eZ430 target board)
2	GND	Power supply ground
3	$\overline{\text{RST}}$ / SBWTDIO	Reset / Spy-Bi-Wire test data input/output during programming and test
4	TEST / SBWTCK	Test mode for JTAG pins / Spy-Bi-Wire test clock input during programming and test
5	VCC	Power supply voltage
6	RXD	UART receive data input (UART communication from eZ430 target board to PC/MSP430G2xx)

4.5 Connecting a Crystal Oscillator

The MSP-EXP430G2 LaunchPad offers a footprint for a variety of crystal oscillators. The XIN and XOUT signals of the LFXT1 oscillator can support low-frequency oscillators like a watch crystals of 32768 Hz or a standard crystal with a range defined in the associated datasheet. The signal lines XIN and XOUT can also be used as multipurpose I/Os or as a digital frequency input. More information on the possibilities of the low-frequency oscillator and the possible crystal selection can be found in the *MSP430x2xx Family User's Guide* (SLAU144) or the device-specific data sheet.

The oscillator signals are connected to connecter J2 to use the signals on an attached application board. In case of signal distortion of the oscillator signals that leads to a fault indication at the basic clock module, resistors R29 and R28 can be used to disconnect the pin header J2 from the oscillating lines.

4.6 Connecting a Satellite Board

The LaunchPad is the perfect experimenter board to start hardware development with the MSP430G2xx Value Line. Connectors J1/J2 and the power supply at J6 are aligned in a 0.1-in (2.54-mm) grid to allow an easy and cheap development of a breadboard extension module. These satellite boards can access all the signals of the LaunchPad target device. So the satellites can hold their own device and use the LaunchPad as a pure programming interface or work with the device plugged into the LaunchPad socket. The alignment of the connectors and the pin out can be found in Section 5. The MSP-EXP430G2 LaunchPad kit includes four 10-pin PCB connectors (two male and two female) to get started with the first extension board right away.

4.7 Supported Devices

Texas Instruments offers several MSP430 devices in a PDIP package that is compatible with LaunchPad. Table 3 shows the supported devices.

Table 3. Supported Devices

Part Number	Family	Description
MSP430F2001	F2xx	16-bit Ultra-Low-Power Microcontroller, 1kB Flash, 128B RAM, Comparator
MSP430F2002	F2xx	16-bit Ultra-Low-Power Microcontroller, 1kB Flash, 128B RAM, 10-Bit SAR A/D, USI for SPI/I2C
MSP430F2003	F2xx	16-bit Ultra-Low-Power Microcontroller, 1kB Flash, 128B RAM, 16-Bit Sigma-Delta A/D, USI for SPI/I2C
MSP430F2011	F2xx	16-bit Ultra-Low-Power Microcontroller, 2kB Flash, 128B RAM, Comparator
MSP430F2012	F2xx	16-bit Ultra-Low-Power Microcontroller, 2kB Flash, 128B RAM, 10-Bit SAR A/D, USI for SPI/I2C
MSP430F2013	F2xx	16-bit Ultra-Low-Power Microcontroller, 2kB Flash, 128B RAM, 16-Bit Sigma-Delta A/D, USI for SPI/I2C
MSP430G2001	G2xx	16-bit Ultra-Low-Power Microcontroller, 512B Flash, 128B RAM
MSP430G2101	G2xx	16-bit Ultra-Low-Power Microcontroller, 1kB Flash, 128B RAM
MSP430G2111	G2xx	16-bit Ultra-Low-Power Microcontroller, 1kB Flash, 128B RAM, Comparator
MSP430G2121	G2xx	16-bit Ultra-Low-Power Microcontroller, 1kB Flash, 128B RAM, USI for SPI/I2C
MSP430G2131	G2xx	16-bit Ultra-Low-Power Microcontroller, 1kB Flash, 128B RAM, 10-Bit SAR A/D, USI for SPI/I2C
MSP430G2201	G2xx	16-bit Ultra-Low-Power Microcontroller, 2kB Flash, 128B RAM
MSP430G2211	G2xx	16-bit Ultra-Low-Power Microcontroller, 2kB Flash, 128B RAM, Comparator
MSP430G2221	G2xx	16-bit Ultra-Low-Power Microcontroller, 2kB Flash, 128B RAM, USI for SPI/I2C
MSP430G2231	G2xx	16-bit Ultra-Low-Power Microcontroller, 2kB Flash, 128B RAM, 10-Bit SAR A/D, USI for SPI/I2C

5 MSP-EXP430G2 Hardware

5.1 Device Pinout

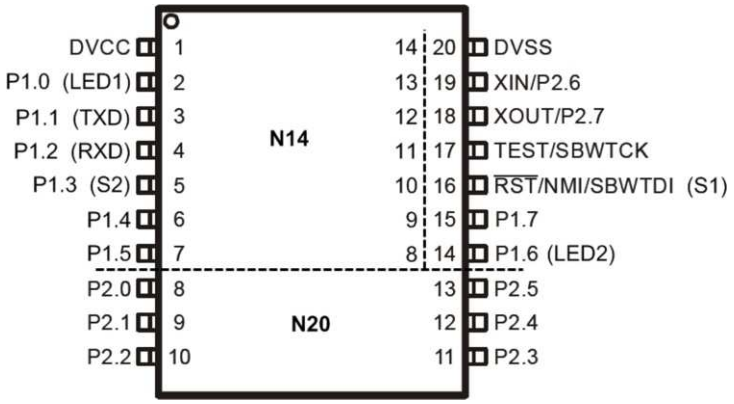

Figure 5. Device Pinout

5.2 Schematics

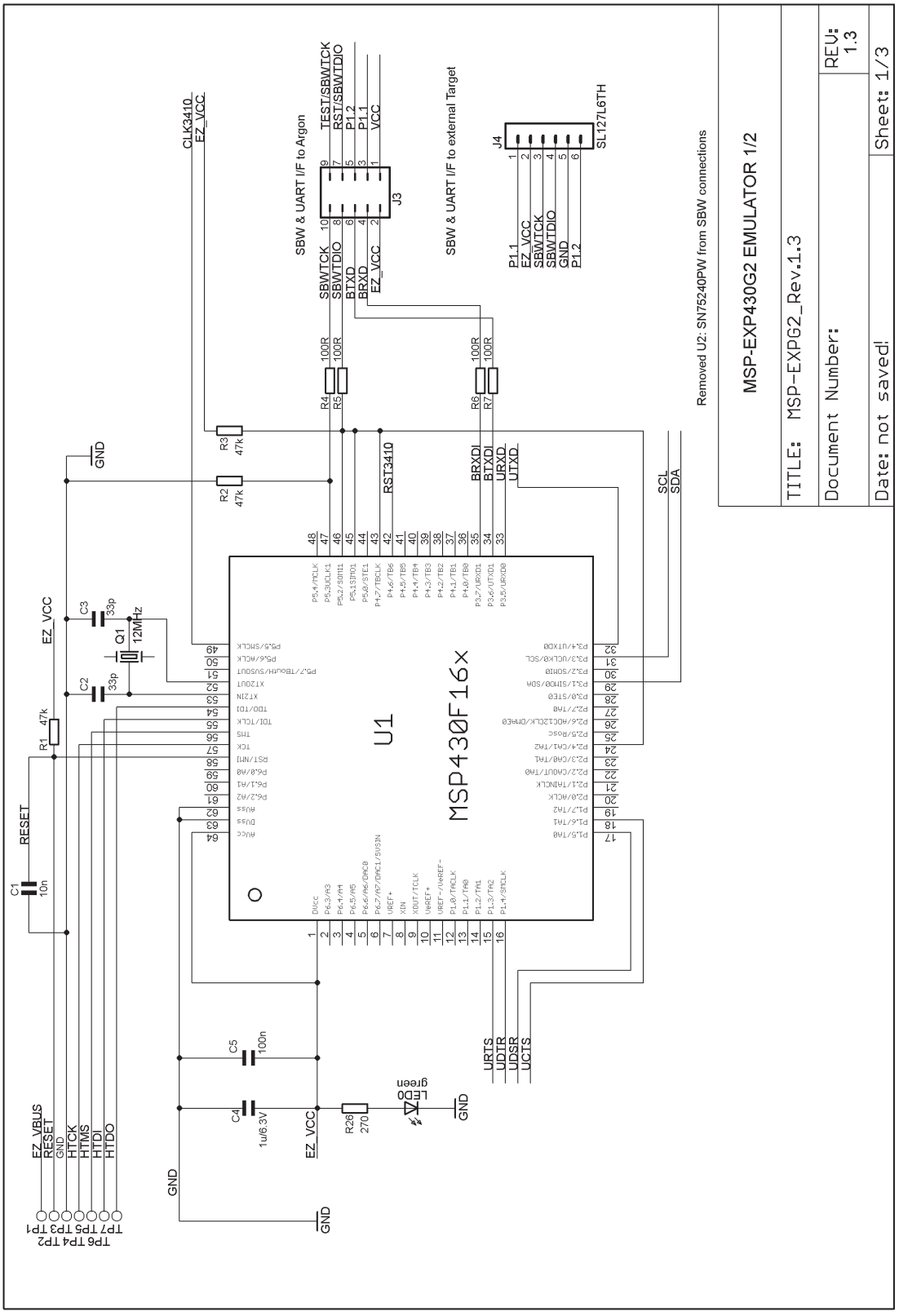

Figure 6. Schematics (1 of 3)

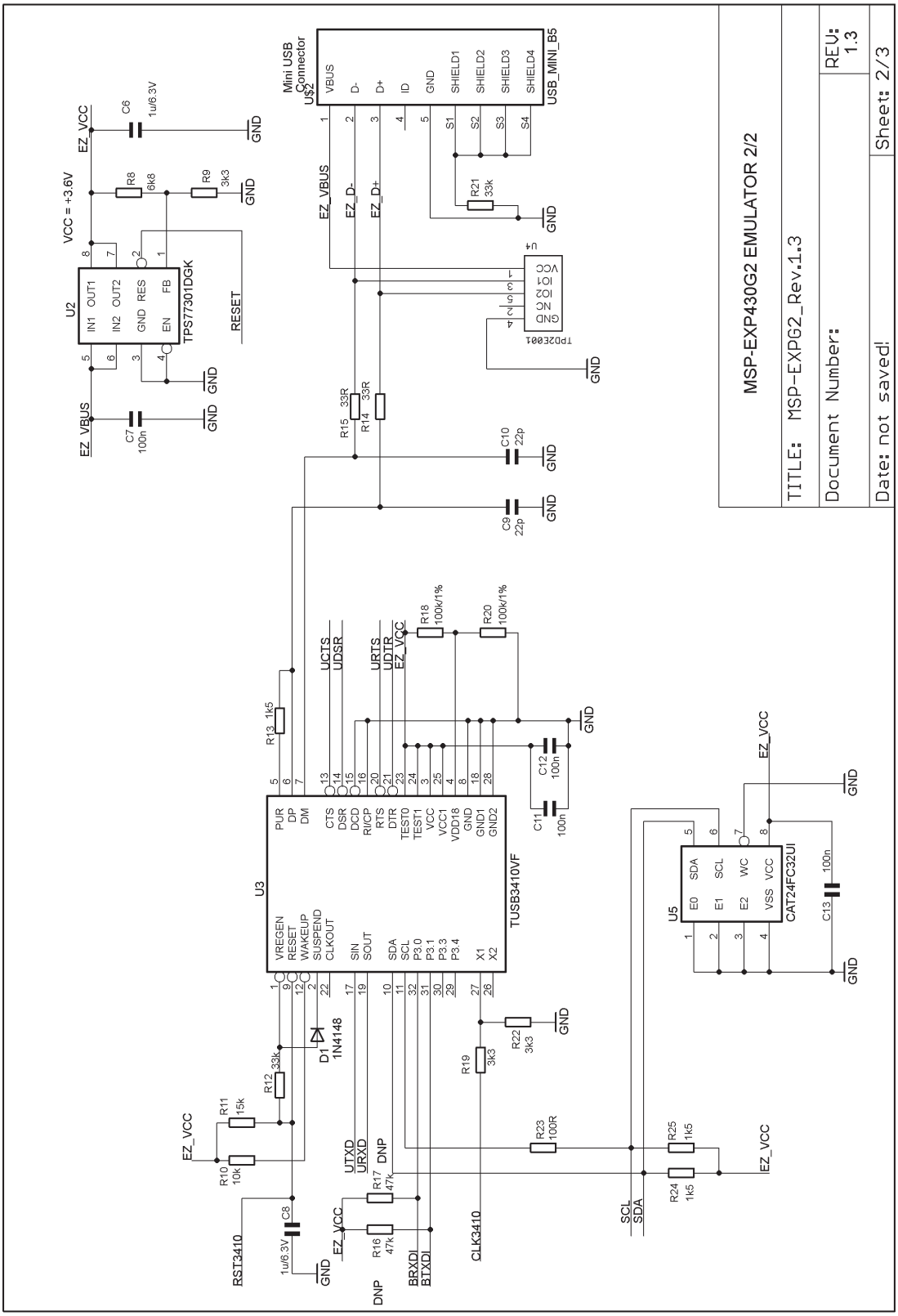

Figure 7. Schematics (2 of 3)

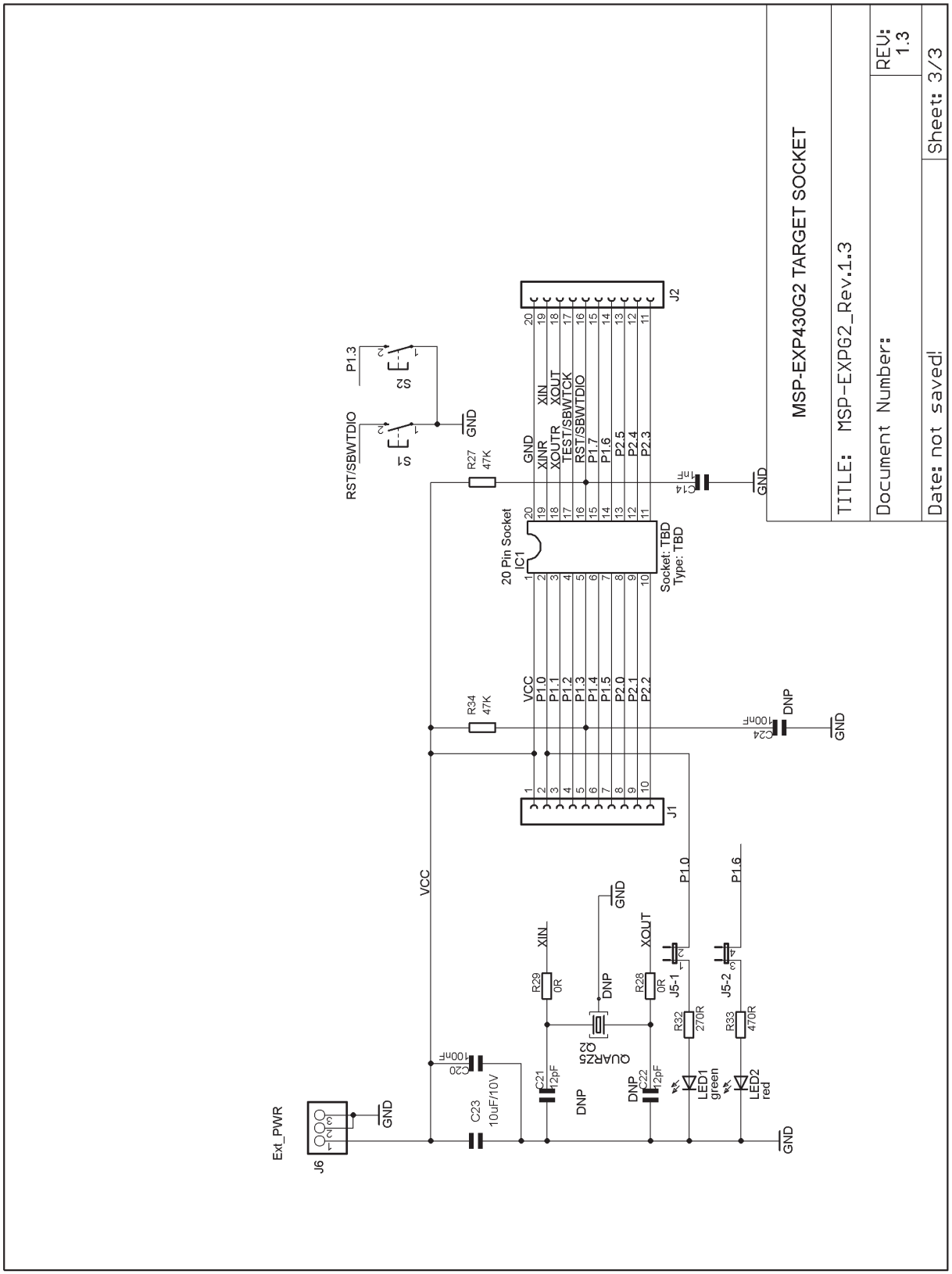

Figure 8. Schematics (3 of 3)

5.3 PCB Layout

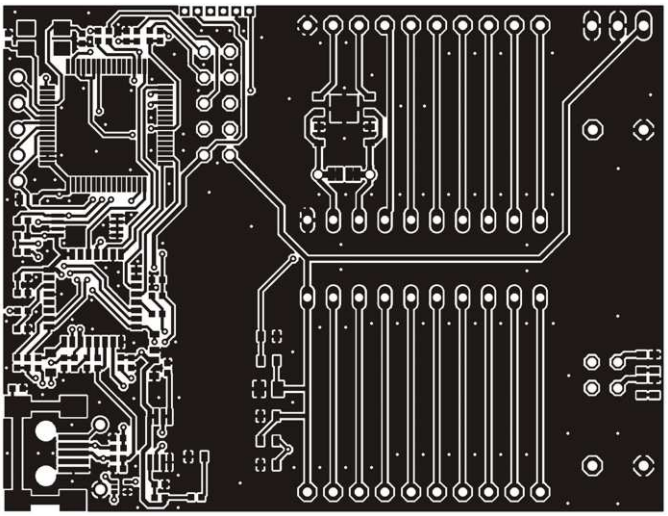

Figure 9. Layout LaunchPad Top Layer

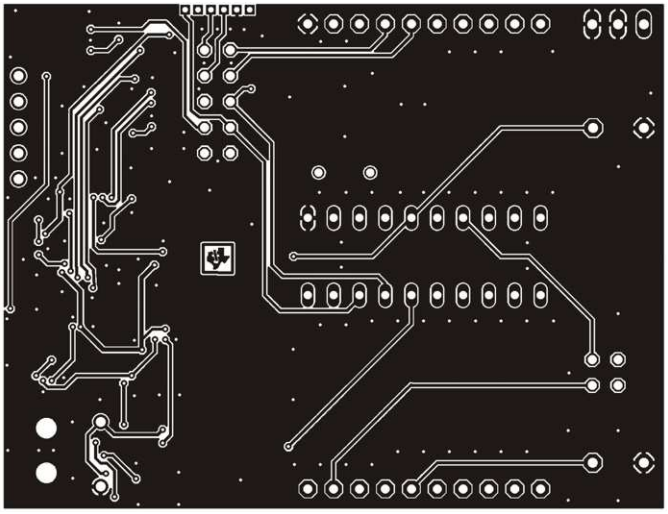

Figure 10. Layout LaunchPad Bottom Layer

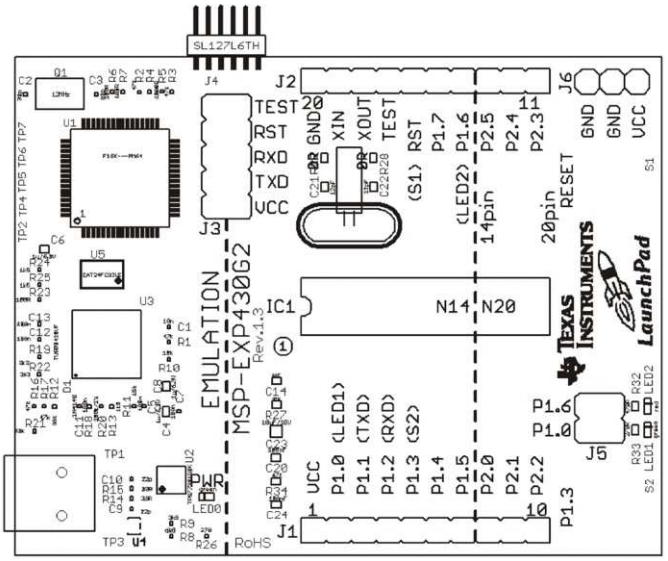

Figure 11. Layout LaunchPad Silkscreen

5.4 Bill of Materials (BOM)

Table 4. Bill of Materials

Pos.	Ref Name	Number per Board	Description
1	C2, C3	2	33pF 0402 (16pF from Rev1.4)
2	C9, C10	2	22pF 0402
3	C1	1	10nF 0402
4	C5, C7, C11, C12, C13	5	100nF 0402
5	C4, C6, C8	3	1uF/6.3V 0604
6	D1	1	1N4148 Micromelf
7	EZ_USB	1	Mini USB connector
8	Q1	1	SMD Oscillator 12MHz
9	R1, R2, R3, R16, R17	3	47k 0402
10	R8	1	6k8 0402 (61.5k from Rev1.4)
11	R19, R22	2	3k3 0402
12	R9	1	3k3 0402 (30k from Rev1.4)
13	R12 R21	2	33k 0402
14	R4, R5, R6, R7, R23	5	100R 0402
15	R14, R15	2	33R 0402
16	R18, R20	2	100k 0402
17	R13, R24, R25	3	1k5 0402
18	R10	1	10k 0402
19	R11	1	15k 0402
20	U1	1	MSP430F1612IPMR
21	U4	1	TPD2E001DRLR
22	U3	1	TUSB3410VF
23	U2	1	TPS77301DGKR
24	U5	1	I2C EEPROM 128k
25	TP1, TP2, TP3, TP4, TP5, TP6, TP7		

Table 4. Bill of Materials (continued)

Pos.	Ref Name	Number per Board	Description
26	C14	1	1nF, SMD0603
27	C21, C22	2	12.5pF, SMD0603
28	C23	1	10uF/10V, SMD 0805
29	C20, C24	2	100nF, SMD0603
30	LED0, LED1	2	green DIODE0603
31	LED2	1	red DIODE0603
32	R34, R27	2	47k SMD0603
33	R32, R26	2	270R SMD0603
34	R33	1	470R SMD0603
35	R28, R29	2	0R SMD0603
36	IC1	1	DIP20 Socket
37	Q2	1 NP	Clock Crystal 32kHz
38	J1, J2,	2/2 NP	10-pin header, TH, 2.54 mm Male/Female,
39	J3	1	2X05 Pin Header Male
40	J4	1 NP	6 Pin Header Male 1.28 mm
41	J5	1	2X02 Pin Header Male
42	J6	2	3-pin header, male, TH
43	S1, S2	2	Push Button

6 Suggested Reading

The primary sources of MSP430 information are the device-specific data sheets and user's guides. The most up-to-date versions of those documents can be found at the Texas Instruments MSP430 page or the MSP430 LaunchPad wiki.

www.ti.com/msp430, http://processors.wiki.ti.com/index.php/MSP430_LaunchPad_(MSP-EXP430G2)

To get an inside view of the supporting IDEs like CCS and IAR, download the latest version from the web pages above and read the included user's guides and documentation inside the installation folder. Documents describing the IAR tools (Workbench/C-SPY, the assembler, the C compiler, the linker, and the library) are located in common\doc and 430\doc. All necessary CCS documents can be found inside the msp430\doc inside the CCS installation path. The FET user's guide also includes detailed information on how to set up a project for the MSP430 using IAR or CCS, and it is included in most of the IDE releases and on the TI MSP430 side.

7 Requently Asked Questions (FAQ)

1. Does the MSP-EXP430G2 support fuse blow?

   The MSP-EXP430G2 LaunchPad experimenter board onboard debugging interface lacks the JTAG security fuse-blow capability. To ensure firmware security on devices going to production, the USB Flash Emulation Tool or the Gang Production Programmer, which support the fuse-blow feature, are recommended.

2. Can other programming tools like the MSP-FET430UIF interface the MSP-EXP430G2 LaunchPad socket device?

   The LaunchPad experimenter board works with any programming tool supporting the 2-wire Spy-Bi-Wire interface. Both the MSP430 USB FET (MSP-FET430UIF) and the Gang Programmer (MSP-GANG430) support these devices, but the connection must be made directly to the dedicated Spy-Bi-Wire ports. 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. Don't try to connect the standard JTAG connector to the MSP-EXP430G2 pinheads, as this could result in damage to the attached hardware.

3. What versions of IAR Embedded Workbench and Code Composer Studio are supported?

   The MSP-EXP430 LaunchPad hardware is supported by IAR Embedded Workbench KickStart Version 6.00 and Code Composer Studio v4 or higher. To download the software and for more information on the supported software visit the LaunchPad Wiki page.
   http://processors.wiki.ti.com/index.php/MSP430_LaunchPad_(MSP-EXP430G2)

4. What are the part numbers for the connectors between the LaunchPad emulator board and the other eZ430 target boards?

   Header: Mill-Max 850-10-006-20-001000

   Socket: Mill-Max 851-93-006-20-001000

5. I am not able to select the MSP430 Application UART and cannot receive data.

   Ensure that the Application UART driver is correctly installed. This is done by installing either IAR Embedded Workbench or Code Composer Studio v4.

   To determine if the driver is correctly installed:

   a. Plug in the MSP-EXP430G2 LaunchPad with the included Mini USB cable.
   b. Right click My Computer and select Properties.
   c. Select the Hardware tab and click on Device Manager.
   d. Under Ports (COM & LPT) should be an entry for "MSP430 Application UART (COM xx)".

   If the entry is there, but no characters are received, reconnect the LaunchPad to the PC and restart the application to reload the drivers. If the Application UART is not listed, install the driver by following the instructions in Section 2.2.

6. The device is not answering to any communication, JTAG or UART.

   If you are experiencing difficulties in communicating to the attached MSP430 target device, even though all the communication drivers for the MSP-EXP430G2 are loaded correctly, the emulator is probably set to a wrong communication state. This can be fixed by reconnecting the LaunchPad Experimenter Board and restarting the communicating application.

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