MSP-BSL Bootstrap Loader (BSL) Programmer for MSP430 and MSP432

User's Guide

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Texas Instruments
Post Office Box 655303
Dallas, TX 75265
http://www.ti.com/msp430

Revision Information

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1 Introduction

The MSP430® and MSP432® Bootstrap Loader (BSL) is an application built into the MSP430 and MSP432 microcontroller. It enables the user to communicate with the device and read and write its memory. Primarily this feature is used for programming the device, during prototyping phase, final production, and in service. Both, the programmable memory (Flash memory or FRAM) and the data memory (RAM) can be modified as required. Different BSLs offer different peripherals to communicate with, e.g. UART, I^2C, SPI, or USB.

The MSP-BSL (figure 1.1 and 1.2)—previously called MSP430-BSL—is a low-cost programmer in the shape of a rocket. Hence it is nicknamed 'BSL Rocket'. It is designed for easy communication between PC and the BSL of a MSP430/MSP432 via USB. The MSP-BSL is a collaboration project between Olimex LTD and Texas Instruments. PCB and firmware for the MSP-BSL are open source. At present the MSP-BSL supports UART, I^2C and SPI communication but can be extended for future requirements.

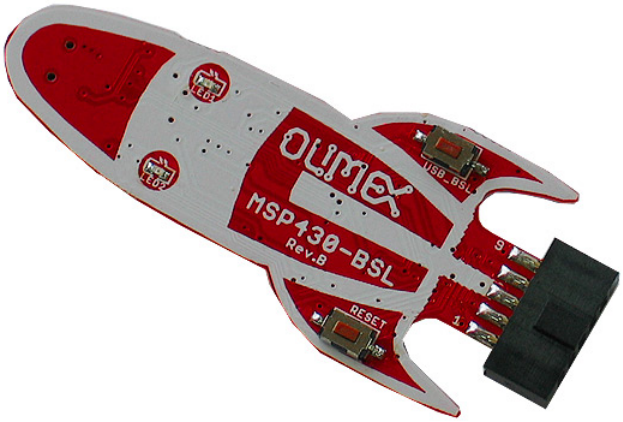

Figure 1.1: Top side of MSP-BSL

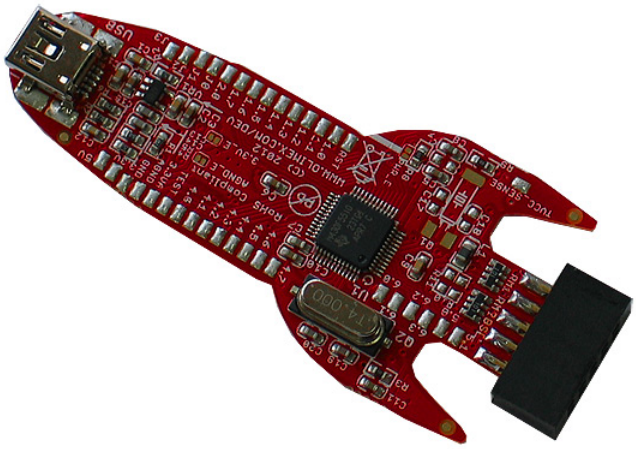

Figure 1.2: Bottom side of MSP-BSL

1.1 Supplementary Online Information

More information on the BSL can be found in the following documents:

MSP430 Programming Via the Bootstrap Loader (BSL) (SLAU319)

MSP430FR4xx and MSP430FR2xx Bootstrap Loader (BSL) (SLAU610)

MSP430FR58xx and MSP430FR59xx Bootstrap Loader (BSL) (SLAU550)

MSP432P401R Bootstrap Loader (BSL) User's Guide (SLAU622)

Creating a Custom Flash-Based Bootstrap Loader (BSL) (SLAA450)

The latest version of the firmware for the MSP-BSL is available on the MSP430/MSP432 BSL download website.

The source code can be obtained from Gitorious@TI. It is open for contributions.

2 Functionality and Supported Protocols

The MSP-BSL is a USB CDC (communications device class) device. On the host PC it enumerates as a virtual COM port. The data send to the MSP-BSL via this serial connection appears transparently at the output and data received by the MSP-BSL is forwarded transparently to the PC.

The serial communication to the MSP-BSL uses 8 data bits, no parity bit, and 1 stop bit (8N1). The baud rate selects the target communication protocol in use. Special functionality (for example applying a BSL entry sequence (see section 2.1)) can also be triggered by baud rate changes.

Table 2.1 gives an overview of all baud rates used by the MSP-BSL. Each function is described in the following subsections in detail.

Table 2.1: Supported baud rates of the MSP-BSL

Baud Rate	**Description**
1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400*, 460800*, 921600*	UART modes (* not supported by MSP430/MSP432 BSL)
4801	Invokes the USB BSL of the MSP-BSL
9601	Triggers BSL entry sequence
100000	I^2C Standard Mode (Sm) (100 kbit/s)
100001	Above I^2C mode with BSL entry sequence
400000	I^2C Fast Mode (Fm) (400 kbit/s)
400001	Above I^2C mode with BSL entry sequence
125000	SPI mode (125 kHz)
125001	Above SPI mode with BSL entry sequence
250000	SPI mode (250 kHz)
250001	Above SPI mode with BSL entry sequence
500000	SPI mode (500 kHz)
500001	Above SPI mode with BSL entry sequence
1000000	SPI mode (1 MHz)
1000001	Above SPI mode with BSL entry sequence

2.1 BSL Entry Sequence

For most MSP430 there are at least two ways to invoke the BSL. It can be called by the application software or by applying a hardware entry sequence.

The MSP-BSL can apply the entry sequence (see figure 2.1) to the target device. This entry sequence can be used for devices with shared and dedicated JTAG pins. The entry sequence can

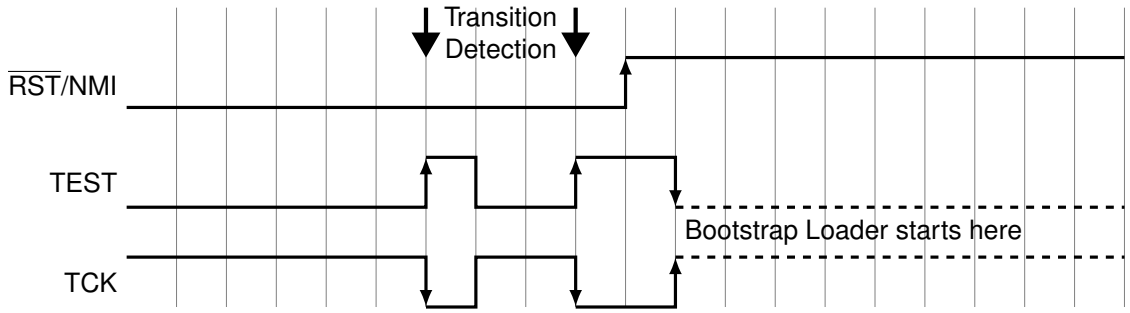

Figure 2.1: BSL Entry Sequence with Shared and Dedicated JTAG Pins

be triggered by setting the communication speed of the MSP-BSL to 9601 baud (for UART) or to the baud rate of any mode with BSL entry sequence, e.g. 100001 baud for I²C mode with BSL entry sequence (see table 2.1).

For further information on the BSL entry sequence see the BSL User's Guides referenced in section 1.1.

2.2 UART Communication

The MSP-BSL provides a mode to communicate with UART BSLs. In this mode all data sent to the virtual COM port will be output at the TX pin (RX on the target connector, see section 4.2). All data received on the RX pin (TX on the target connector) will be forwarded to the PC. The MSP-BSL acts as a transparent USB to UART bridge.

The UART mode can be selected by setting the connection speed to any of the standard UART baud rates listed below:

- 1200 baud
- 2400 baud
- 4800 baud
- 9600 baud
- 19200 baud
- 38400 baud
- 57600 baud
- 115200 baud
- 230400 baud*
- 460800 baud*
- 921600 baud*

* Not supported by MSP430/MSP432 BSL.

2.3 I²C Communication

Similar to the UART mode, the MSP-BSL supports the I²C protocol starting from firmware version 2.1. All data sent to the virtual COM port will be output via the SDA/SCL pins (see section 4.2).

Data received via I²C will be forwarded to the PC. The MSP-BSL acts as a transparent USB to I²C bridge, except that it will return an error code (055h) to the PC if the I²C communication fails. It has a state machine that emulates this transparent behavior.

The MSP-BSL operates as I²C master and uses 7-bit addressing mode. The slave address for the MSP430/MSP432 target is set to 048h.

I²C Standard Mode (Sm) with a maximum transfer rate of 100 kbit/s and I²C Fast Mode (Fm) with a maximum transfer rate of 400 kbit/s are supported by the MSP-BSL. Both of these modes are selected by changing the baud rate of the serial connection from PC to MSP-BSL.

Additionally a BSL entry sequence can be generated prior to the I²C communication:

- 100000 baud: I²C Standard Mode (Sm)
- 100001 baud: I²C Standard Mode (Sm) with the BSL entry sequence
- 400000 baud: I²C Fast Mode (Fm)
- 400001 baud: I²C Standard Mode (Sm) with the BSL entry sequence

I²C communication requires pull-up resistors on the SDA and SCL lines. Either pull-up resistors can be soldered on the MSP-BSL PCB (see section 4.4) or they can be included in the target application design, e.g. by jumpering the I²C pull-ups on the MSP430/MSP432 target socket board.

2.4 SPI Communication

Similar to the UART mode, the MSP-BSL supports the SPI protocol starting from firmware version 3.0. All data send to the virtual COM port will be output via the SOMI, SIMO, CLK and STE pins (see section 4.2). A state machine on the MSP-BSL makes the communication appear like transparent UART to the outside.

The MSP-BSL operates as 4-pin SPI master. Data is changed on first clock edge and captured on the following edge (CKPH = 0). Clock is high when inactive (CKPL = 1). Slave transmit enable (STE) is active low. 8-bit serial data character format (MSB first transmit/receive) is used.

SPI communication is clocked at 125 kHz, 250 kHz, 500 kHz, or 1 MHz depending on the selected mode. These mode are selected by the baud rate of the serial connection from PC to MSP-BSL. Additionally a BSL entry sequence can be generated prior to the SPI communication:

- 125000 baud: SPI mode at 125 kHz
- 125001 baud: SPI mode at 125 kHz with the BSL entry sequence
- 250000 baud: SPI mode at 250 kHz
- 250001 baud: SPI mode at 250 kHz with the BSL entry sequence
- 500000 baud: SPI mode at 500 kHz
- 500001 baud: SPI mode at 500 kHz with the BSL entry sequence
- 1000000 baud: SPI mode at 1 MHz
- 1000001 baud: SPI mode at 1 MHz with the BSL entry sequence

3 Firmware Update

To update the firmware of the MSP-BSL, the USB BSL onboard the MSP-BSL's MSP430F5510 can be used. The following steps describe how to update the firmware:

Step 1: Download the latest firmware for the MSP-BSL. It can be obtained from the BSL wiki page.

Step 2: Download and install the MSP430 USB Firmware Upgrade Example. It is part of the MSP430 USB Developers Package.

Step 3: Start the MSP430 USB Firmware Upgrade Example. It will show 'No device connected' at this time.

Step 4: Before starting the update, the USB BSL of the MSP-BSL must be invoked.

- Disconnect the MSP-BSL from the USB cable.
- Hold the USB_BSL button down while connecting the USB cable.
- Alternatively, switching to baud rate 4801 will also invoke the BSL on the MSP-BSL.

The BSL is now invoked and the Firmware Upgrade Example will show 'Found 1 device'. (See figure 3.1)

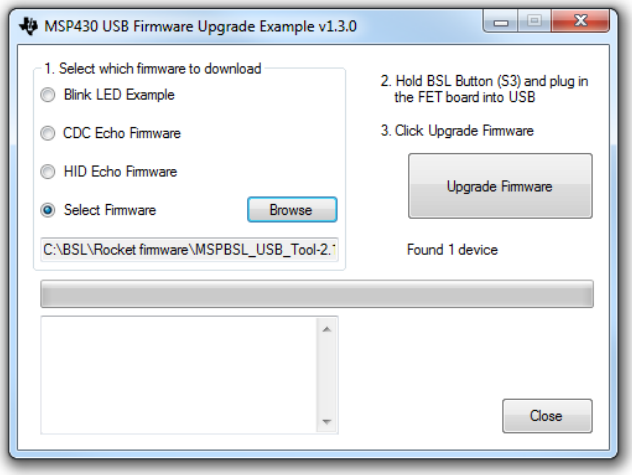

Figure 3.1: Firmware Upgrade Example with selected firmware and connected MSP-BSL (USB BSL invoked)

Step 5: Now the firmware can be updated.

- Click 'Select Firmware' and 'Browse' to select the TI-TXT firmware image for the MSP-BSL.
- Then click 'Upgrade Firmware'.

The image will be loaded and the MSP-BSL restarts automatically. The new firmware is now ready to use. (See figure 3.2)

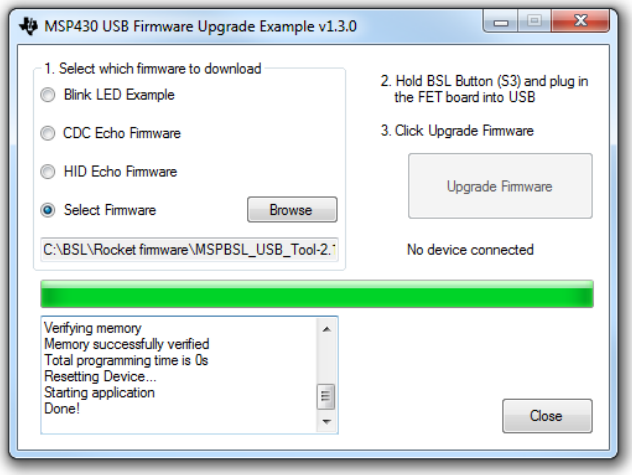

Figure 3.2: Firmware Upgrade Example showing successful firmware update

4 Hardware

The hardware of the MSP-BSL is open source. The design files are available on the Olimex website.

The MSP-BSL programmer is based on MSP430F5510. All I/Os that are not used by the standard BSL target connector (see section 4.2) are made available as pads on the bottom of the PCB. Furthermore, there are two status LEDs (green and yellow) and two push-buttons, a reset button and a button to invoke the USB BSL of the MSP430F5510.

The MSP-BSL features also an on-board 3.3 V voltage regulator that can supply up to 150 mA to the target. (See section 4.3)

4.1 Schematic

Figure 4.1 shows the schematic of the MSP-BSL.

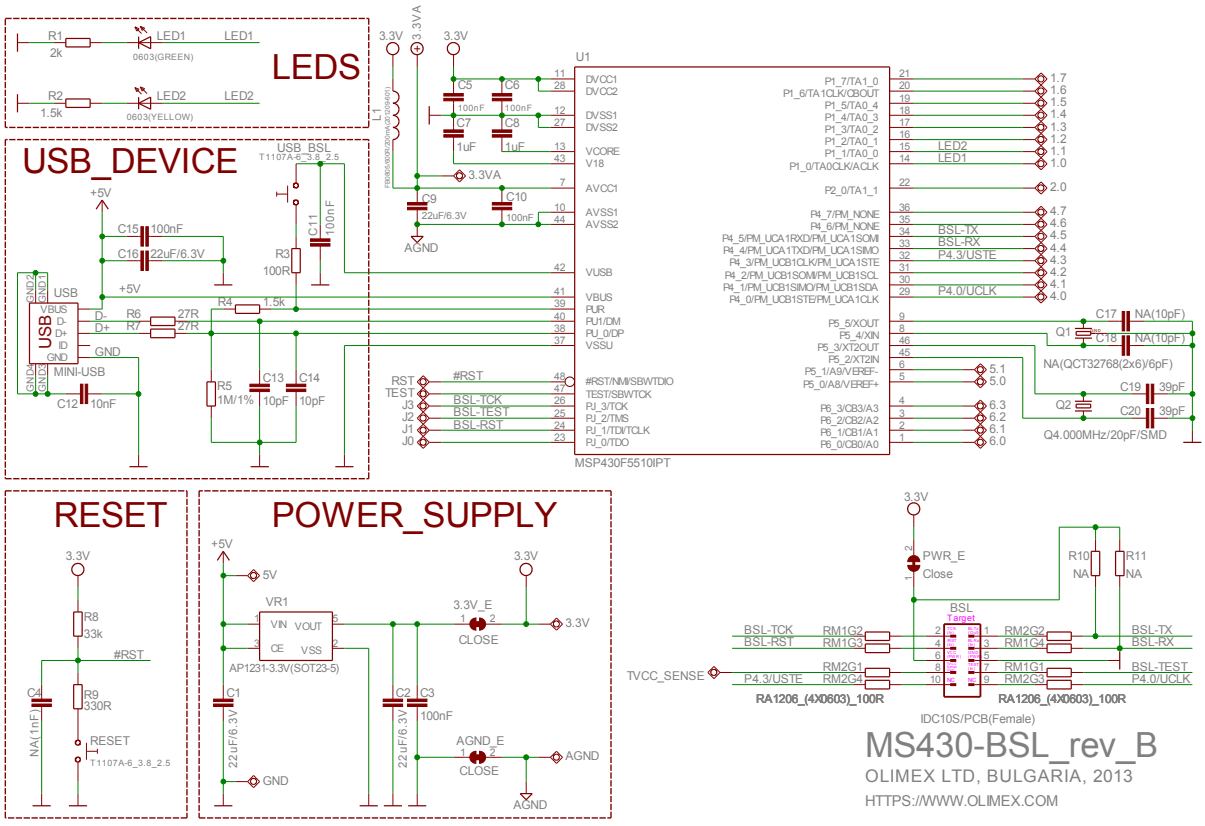

Figure 4.1: Schematic of the MSP-BSL

4.2 BSL Connector

The BSL Connector (as seen from target side) is depicted in figure 4.2. The pinout is as follows:

- UART communication is handled via pin 1 (TX) and pin 3 (RX).
- I^2C communication is handled via pin 1 (SDA) and pin 9 (SCL).
- SPI communication is handled via pin 1 (SOMI), pin 3 (SIMO), pin 9 (CLK) and pin 10 (STE).
- The entry sequence can be generated using pin 4 (RST) and pin 7 (TEST) for devices with shared JTAG pins, or via pin 2 (TCK) and pin 4 (RST) for devices with dedicated JTAG pins.
- Power is supplied via pin 6 (VCC), pin 5 (GND) provides electrical ground.

The connector uses 0.1” spacing and is a 10-pin male header on the target board.

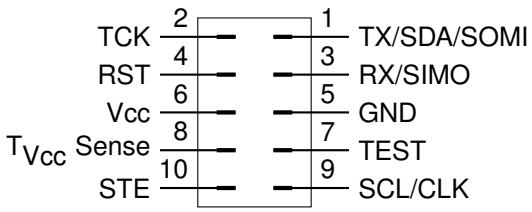

Figure 4.2: Pinout of the BSL connector (target side)

4.3 Target Power Supply

The MSP-BSL has a built-in 3.3 V power supply for the target board. It can supply up to 150 mA of current. The power is supplied via pin 6 of the BSL connector, but can be cut (by opening PWR_E, see figure 4.3) if not needed.

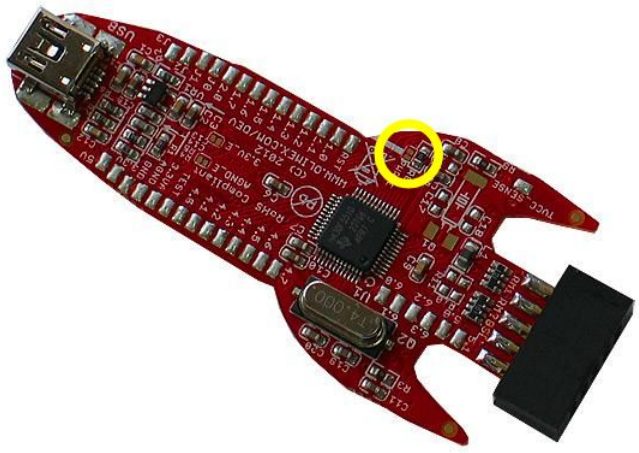

Figure 4.3: Cuttable power supply trace (PWR_E)

⚠Cutting the power supply at PWR_E will also prevent onboard pull-up resistors (R10, R11) from being pulled high.

4.4 Pull-Ups for I²C Operation

In order to operate the I²C communication pull-ups are required on the SDA and SCL lines. These pull-up resistors can be included in the target application design or on-board the MSP-BSL. Two unpopulated pads (R10 and R11) are prepared to place 0603 SMD resistors there as pull-ups. (See figure 4.4)

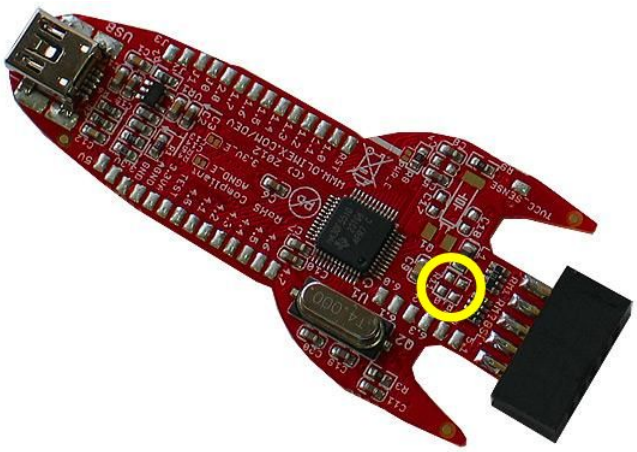

Figure 4.4: Pull-up resistor pads

5 Releases

Table 5.1: Firmware releases

Version	Changes
3.0	SPI support was added. USB stack was updated.
2.1	I^2C support was added.
1.0	Initial version.

6 Revision History

Version 1 2015-02-09

- Initial version.

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