MSP430-T5510
development board for breadboarding

USER'S MANUAL

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Designed by OLIMEX Ltd, 2012

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THERE IS NO WARRANTY FOR THE DESIGN MATERIALS AND THE COMPONENTS USED TO CREATE MSP430-T5510. THEY ARE CONSIDERED SUITABLE ONLY MSP430-T5510.

Table of Contents

CHAPTER 1: OVERVIEW

1. Introduction to the chapter

Thank you for choosing the MSP430-T5510 development board from Olimex! This document provides a user's guide for the Olimex MSP430-T5510 board. As an overview, this chapter gives the scope of this document and lists the board's features. The document's organization is then detailed.

The MSP430-T5510 development board enables code development of applications running on the microcontroller MSP430F5510, manufactured by Texas Instruments.

1.1 Features

- MCU: MSP430F5510 with 32K Bytes Program Flash, 4K Bytes RAM, 25Mhz
- MSP430F5510 microcontroller
- mini USB connector
- User button
- RESET and BOOT buttons
- JTAG connector
- UEXT connector for UEXT modules
- T-shape for easy breadboarding
- Dimensions: 2.5"x2.1" (6.35cm x 5.33cm)

1.2 Target market and purpose of the board

MSP430-T5510 is intended to work with Energia - an Arduino-like IDE for MSP430. The community is working on adding full support for Energia. At the time of writing this manual such support isn't fully added but it is on the way. When such support is implemented there will be software examples below in Energia format.

MSP430-T5510 was specially designed for the EasyMSP project which is created by Matthew Burmeister (a.k.a. MattTheGeek from 43oh.com). Matt did amazing work by creating Arduino-like language and commands to compile with MSP430 hardware just adding these in header files, so they compile with MSPGCC. However, personal problems restrained Matthew to finish the project he started. That is why Energia is the now default and recommended development environment.

The target market are the MSP430 fans and people with electronic basics – the shape of the board makes it perfect for mounting on a breadboard and using solderless connections to access the GPIO pins. People with better understanding of software than hardware would find this tiny board quite capable once the Energia Arduino-like IDE support is implemented.

1.3 Organization

Each section in this document covers a separate topic, organized as follow:
- Chapter 1 is an overview of the board usage and features
- Chapter 2 provides a guide for quickly setting up the board and software notes
- Chapter 3 contains the general board diagram and layout
- Chapter 4 describes the component that is the heart of the board: the MSP430-T5510 microcontroller
- Chapter 5 is an explanation of the control circuitry associated with the microcontroller to reset. Also shows the clocks on the board
- Chapter 6 covers the connector pinout, peripherals and jumper description
- Chapter 7 shows the memory map
- Chapter 8 provides the schematics
- Chapter 9 contains the revision history, useful links and support information

CHAPTER 2: SETTING UP THE MSP430-T5510 BOARD

2. Introduction to the chapter

This section helps you set up the MSP430-T5510 development board for the first time. Please consider first the electrostatic warning to avoid damaging the board, then discover the hardware and software required to operate the board.

The procedure to power up the board is given, and a description of the default board behavior is detailed.

2.1 Electrostatic warning

MSP430-T5510 is shipped in a protective anti-static package. The board must not be exposed to high electrostatic potentials. A grounding strap or similar protective device should be worn when handling the board. Avoid touching the component pins or any other metallic element.

2.3 Hardware requirements

In order to set up the MSP430-T5510 optimally, the following items are required:

1) mini USB cable for using Energia IDE or EasyMSP

You can buy such a cable from us. Proper connectivity is tested at our testing facilities.

2) Solderless breadboarding area

BREADBOARD - 82x52x10 mm solderless breadboard for experimenting - https://www.olimex.com/dev/bb-1.html
BREADBOARD-MINI - 45x35x8.5 mm solderless breadboard for experimenting - https://www.olimex.com/dev/bb-mini.html

3) JTAG SBW (Spy-Bi-Wire) MSP430 compatible programmer - for custom programming

We offer three low-cost products capable of programming the board (of course any SBW-compatible programmer you might already own would do the job):

MSP430-JTAG-ISO-V2 – our best MSP430 programmer, featuring LCD display, SD card and stand-alone mode of programming: https://www.olimex.com/dev/msp-jtag-iso-v2.html

MSP430-JTAG-ISO – standalone programmer: https://www.olimex.com/dev/msp-jtag-iso.html

MSP430-JTAG-TINY – tiny is size but powerful JTAG programmer
https://www.olimex.com/dev/msp-jtag-tiny.html

Notice our MSP programmers work with a free flash software we distribute and are compatible with all IDEs based on the original Texas Instruments MSP430.dll.

Additional components and extension boards (not required for basic operation!):

- UEXT expansion boards

All OLIMEX boards which names start with MOD, are compatible with the UEXT interface. There are over 20 different functionalities you can add via the UEXT. Notice that there is multiplexing between the Arduino platform connector (for the shields) and the UEXT. You can't use two devices with SPI communication at the same time.

2.5 Powering the board and operating modes

The board is powered either via the mini USB or via JTAG/SBW connector, the board can also be powered by Vin and +5V pins of the GPIO connectors.

The board can be programmed in three ways:

1) as a general purpose board via the JTAG.
2) by the BSL (BootStrap Loader) bootloader by MSP430

When powered the red power LED should turn on. By default the green LED near the battery connector should start blinking if used in debugger/general mode.

To enter BSL mode hold BOOT button and power the board. Or while the board is powered hold BOOT down then press RESET and then release BOOT button. If the board is started in boot mode the green LED should remain off.

2.6 Prebuilt software and bootloader

The prebuilt software is a bootloader and a simple LEDs and buttons test. When you power the board initially red power LED will be ON and the green GPIO LED will start blinking. To enter

bootloader mode hold BOOT button and press RESET button, then release BOOT.

2.7 EasyMSP and Energia

MSP430-T5510 is intended to work with Energia - an Arduino-like IDE for MSP430. The community is working on adding full support for Energia. At the time of writing this manual such support isn't fully added but it is on the way. When such support is implemented there will be software examples below in Energia format.

The Energia web site and repository may be found at the following web addresses:

http://energia.github.com/Energia/ and https://github.com/energia/Energia/

MSP430-T5510 was initially specially designed for the EasyMSP project which is created by Matthew Burmeister (a.k.a. MattTheGeek from 43oh.com). Matt did amazing work by creating Arduino-like language and commands to compile with MSP430 hardware just adding these in header files, so they compile with MSPGCC. However, personal problems restrained Matthew to finish the project he started. That is why Energia is the now default and recommended development environment.

EasyMSP community is at 43oh.com forum http://www.43oh.com/forum/viewforum.php?f=34.

The project is hosted at http://code.google.com/p/easymsp/.

When we learned about EasyMSP the first idea was to create custom open hardware board which to work with EasyMSP. So we contacted Matt and asked him if he wants custom board build for his project. This is how MSP430-T5510 was born.

So if you want to develop some hand-held or battery powered devices with USB connection to PC MSP430-T5510 is the low cost solution for you.

The software for the boards is released under General Purpose License.

# CHAPTER 3: MSP430-T5510 BOARD DESCRIPTION

3. Introduction to the chapter

Here you get acquainted with the main parts of the board. Note the names used on the board might differ from the names used below to describe them. For the actual names check the MSP430-T5510 board itself.

3.1 Layout (top view)
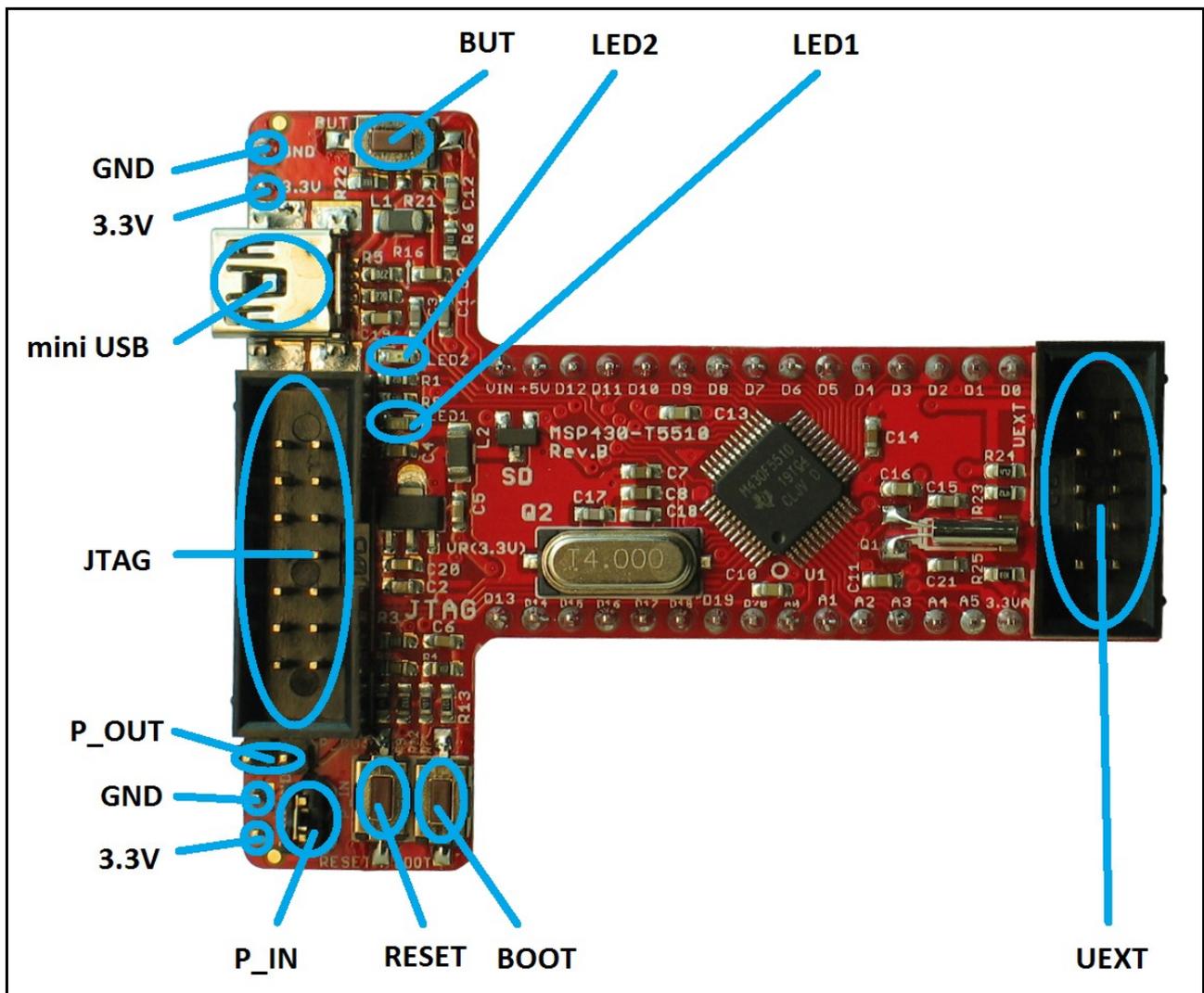
3.2 Layout (bottom view)
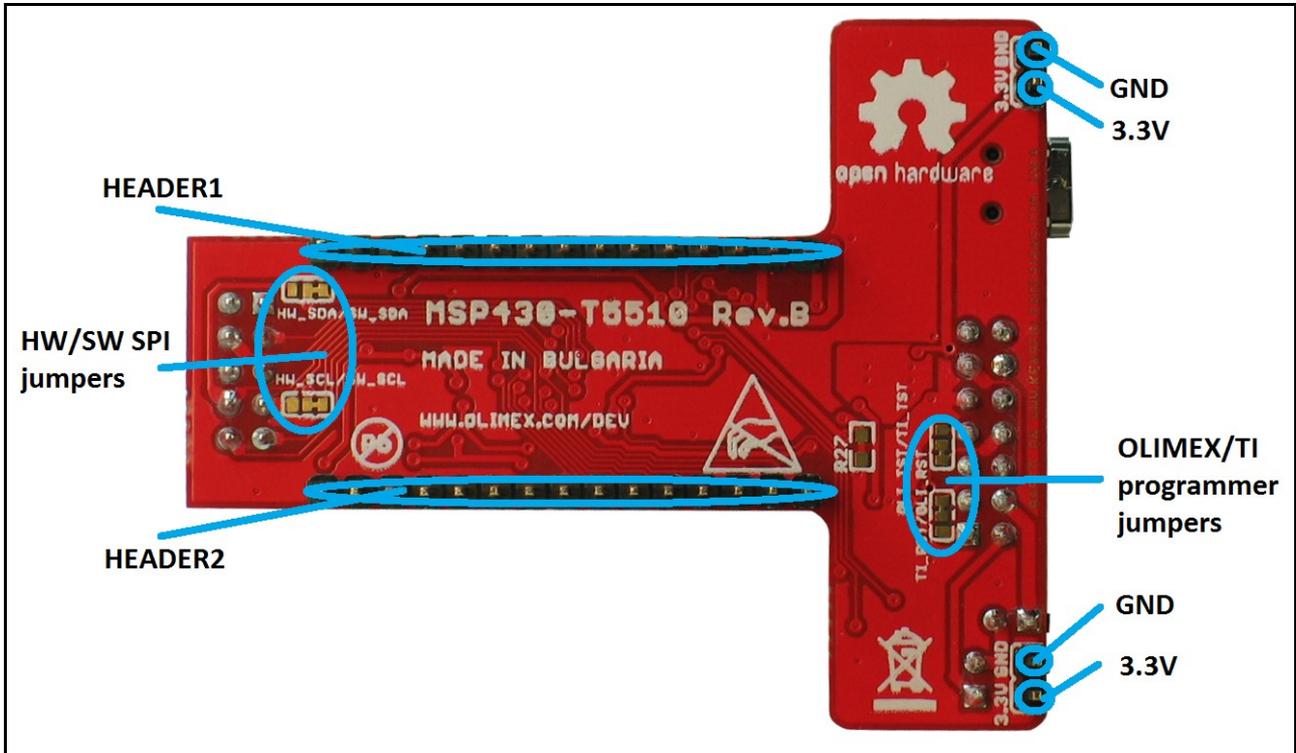
CHAPTER 4: THE MSP430F5510 MICROCONTROLLER

4. Introduction to the chapter

In this chapter is located the information about the heart of MSP430-T5510 – its microcontroller MSP430F5510. The information is a modified version of the datasheet provided by its manufacturers.

4.1 The microcontroller

■ Ultra-Low Power Consumption

   - Active Mode (AM)
   - All System Clocks Active

   - 195 µA/MHz at 8 MHz, 3 V, Flash Program Execution (Typical)

   - 115 µA/MHz at 8 MHz, 3 V, RAM Program Execution (Typical)

- Standby Mode (LPM3)

   - Real Time Clock With Crystal, Watchdog, and Supply Supervisor Operational, Full RAM Retention, Fast Wake-Up: 1.9 µA at 2.2 V, 2.1 µA at 3 V (Typical)

   -Low-Power Oscillator (VLO), General-Purpose Counter, Watchdog, and Supply Supervisor Operational, Full RAM Retention, Fast Wake-Up: 1.4 µA at 3 V (Typical)

- Off Mode (LPM4)

   - Full RAM Retention, Supply Supervisor Operational, Fast Wake-Up: 1.1 µA at 3 V (Typical)

   - Shutdown Mode (LPM4.5) 0.18 µA at 3 V (Typical)

■ Wake-Up From Standby in Less Than 5 µs

■ 16-Bit RISC Architecture, Extended Memory, Up to 25-MHz System Clock

■ Flexible Power Management System

- Fully Integrated LDO With Programmable Regulated Core Supply Voltage

- Supply Voltage Supervision, Monitoring, and Brownout

■ Unified Clock System

- FLL Control Loop for Frequency Stabilization

- Low-Power Low-Frequency Internal Clock Source (VLO)

- Low-Frequency Trimmed Internal Reference Source (REFO)

- 32-kHz Watch Crystals (XT1)

- High-Frequency Crystals up to 32 MHz (XT2)

■ 16-Bit Timer TA0, Timer_A With Five Capture/Compare Registers

■ 16-Bit Timer TA1, Timer_A With Three Capture/Compare Registers

■ 16-Bit Timer TA2, Timer_A With Three Capture/Compare Registers

■ 16-Bit Timer TB0, Timer_B With Seven Capture/Compare Shadow Registers

■ Two Universal Serial Communication Interfaces

- USCI_A0 and USCI_A1 Each Supporting:

      - Enhanced UART Supporting Auto-Baudrate Detection

      - IrDA Encoder and Decoder

      - Synchronous SPI

- USCI_B0 and USCI_B1 Each Supporting:

      - I2CTM

      - Synchronous SPI

■ Full-Speed Universal Serial Bus (USB)

■ Integrated USB-PHY

■ Integrated 3.3-V/1.8-V USB Power System

■ Integrated USB-PLL

■ Eight Input, Eight Output Endpoints

■ 10-Bit Analog-to-Digital (A/D) Converter With Window Comparator

■ Comparator

■ Hardware Multiplier Supporting 32-Bit Operations

■ Serial Onboard Programming, No External Programming Voltage Needed

■ Three Channel Internal DMA

■ Basic Timer With Real Time Clock Feature

For comprehensive information on the microcontroller visit the Texas Instruments' web page for a datasheet.

At the moment of writing the microcontroller datasheet can be found at the following link:
http://www.ti.com/lit/ds/symlink/msp430f5510.pdf

CHAPTER 5: CONTROL CIRCUITY

5. Introduction to the chapter

Here you can find information about reset circuit and quartz crystals locations, the power supply circuit is discussed.

5.1 Reset

MSP430-T5510's reset circuit includes R7 (33Ω), R8 (330Ω), and a RESET button.

5.2 Clocks

Q1 – 32 768 MHz quartz crystal on pins 8 and 9 of the F5510 allowing RTC(Real-Time Clock).

Q2 - 4 MHz quartz crystal is connected to pins 45 and 46 of the MSP430F5510 processor.

5.3 Power supply circuit

The power supply circuit of MSP430-T5510 allows powering via different sources – from the miniUSB (the device will draw it's required current automatically, however ensure the USB port is standard compatible and can provide at least 1A of current), from the JTAG or via the "Vin" and "+5V" pins.

CHAPTER 6: CONNECTORS AND PINOUT

6. Introduction to the chapter

In this chapter are presented the connectors that can be found on the board all together with their pinout and notes about them. Jumpers functions are described. Notes and info on specific peripherals are presented. Notes regarding the interfaces are given.

6.1 JTAG/SBW (Spy-Bi-Wire) debug connector

The SBW interface is used to program and debug the board. "NC" stands for "Not Connected".

JTAG/SBW interface			
Pin #	**Signal Name**	**Pin #**	**Signal Name**
1	NC/TI_RST*	8	OLI_TST/NC*
2	NC/P_IN**	9	GND
3	NC	10	NC
4	P_OUT/NC*	11	OLI_RST/NC*
5	Not connected	12	NC
6	Not connected	13	NC
7	NC/TI_TST*	14	NC
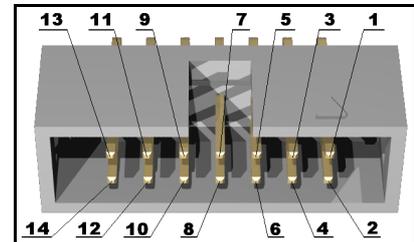
*The information lines can be switched via the SMD jumpers TI_RST/OLI_RST and TI_TST/OLI_TST. This might be required for different programmers. If you use Texas Instruments programmer switch them to TI_RST and TI_STS. If using Olimex programmer switch to OLI_RST and OLI_TST. By default they are in Olimex position.

**The Pin/Pout jumper declares if the board is internally powered or has to be powered externally (via SBW programmer).

6.2 UEXT connector

MSP430-T5510 board has a UEXT connector and can interface Olimex's UEXT expansion modules.

For more information on UEXT please visit:

http://www.olimex.com/dev/OTHER/UEXT.pdf

| UEXT connector	
Pin #	Signal Name
1	3.3V
2	GND
3	D1(TXD)
4	D0(RXD)
5	SW_SCL/NC*
6	SW_SDA/NC*
7	NC/D12(MISO1)*
8	NC/D11(MOSI1)*
9	D13(SCK)
10	#UEXT_CS
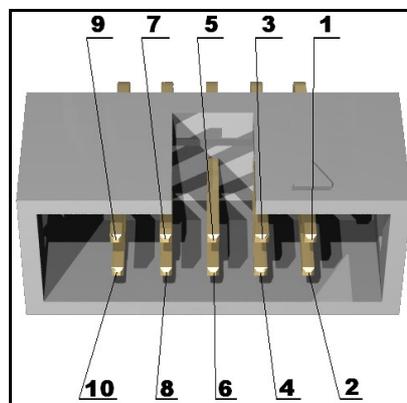
*Those pin signals depend on the jumpers HW_SCL/SW_SCL and HW_SDA/SW_SDA. By default the board is set in software SPI mode (SW_SCL/SW_SDA).

Notice the orientation of the cut on the connector in the picture above.

6.4 MINI USB

Note that this is not USB OTG (On-The-Go).

Pin #	Signal Name
1	+5V
2	D-
3	D+
4	Not connected
5	GND
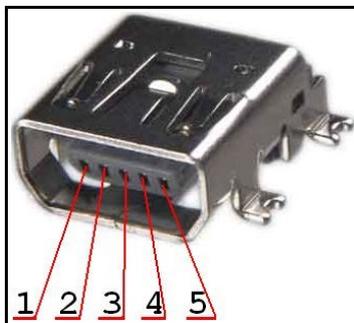
6.5 Jumper description

Please note that the jumpers on the board are ONLY SMD type. For setting the SMD jumpers please consider that if you feel insecure of your soldering/cutting technique it is better not to try to adjust those jumpers.

6.6.1 P_OUT/P_IN

When in position P_OUT, the board gets powered by SBW debugger.
When is position P_IN, the board gets powered by other sources.

The default position is P_OUT.

6.6.2 3.3V_E

When open 3.3V_E the processor doesn't receive power. Processor pins 11 and 28 are disconnected from the power circuit.

The default position is closed.

6.6.3 AGND_E

When open AGND_E disables the analog ground signal.

The default position is closed.

6.6.4 CHG_D

When closed disables the battery charging circuit.

The default position is jumper open.

6.6.5 AREF_E

When open disables the AREF on the Arduino CON4.

The default position is open.

6.6.6 TI_TST/OLI_TST and TI_RST/OLI_RST

Note these jumpers must be moved together!

They control the TST and RST signals on the SBW interface. The TST and RST differ when using different programmers. If you are not sure how your programmer is configured and the board doesn't get programmed via SBW try the TI_TST + TI_RST option.

The default position is OLI_TST closed + OLI_RST closed.

6.6.7 HW_SCL/SW_SCL and HW_SDA/SW_SDA

Note these jumpers must be moved together!

They configure either hardware or software SPI on the UEXT.

The default position is set for software SPI – SW_SCL closed + SW_SDA closed.

6.7 Additional hardware components

The components below are mounted on MSP430-T5510 but are not discussed above. They are listed here for completeness:

Reset button - used for hardware reset of the board

BUT – general purpose button

BOOT button – used for starting the MSP430 bootstrap loader

LED1 (Green) + Power LED2 (Red)

CHAPTER 7: BLOCK DIAGRAM AND MEMORY

7. Introduction to the chapter

On the next page you can find a memory map for this family of processors. It is strongly recommended to refer to the original datasheet released by NXP for one of higher quality.

7.2 Processor block diagram

The block diagram is taken from the original datasheet of MSP430F5510.
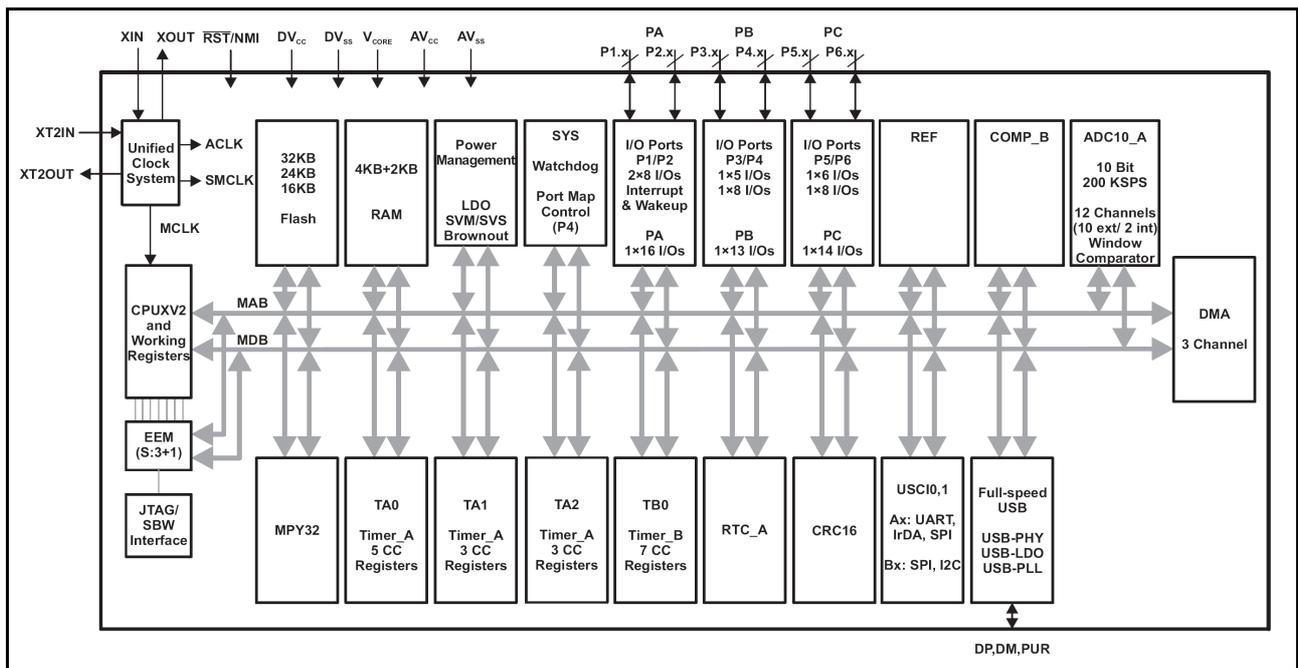
7.3 Physical memory map

This is the memory map diagram from the original datasheet of MSP430F5510.

|		MSP430F5510 MSP430F5507 MSP430F5503
Memory (flash) Main: interrupt vector Main: code memory	Total Size	32 KB 00FFFFh–00FF80h 00FFFFh-008000h
RAM	Sector 1	2 KB 0033FFh–002C00h
	Sector 0	2 KB 002BFFh–002400h
USB RAM[2]		2 KB 0023FFh–001C00h
Information memory (flash)	Info A	128 B 0019FFh–001980h
	Info B	128 B 00197Fh–001900h
	Info C	128 B 0018FFh–001880h
	Info D	128 B 00187Fh–001800h
Bootstrap loader (BSL) memory (flash)	BSL 3	512 B 0017FFh–001600h
	BSL 2	512 B 0015FFh–001400h
	BSL 1	512 B 0013FFh–001200h
	BSL 0	512 B 0011FFh–001000h
Peripherals	Size	4 KB 000FFFh–0h

CHAPTER 8: SCHEMATICS

8. Introduction to the chapter

In this chapter are located the schematics describing logically and physically MSP430-T5510. The MSP430-T5510 schematics are released under Creative Commons Attribution-Share Alike 3.0 United States License.

8.1 Eagle schematic

MSP430-T5510 schematic is visible for reference here. You can also find them on the web page for MSP430-T5510 at our site: https://www.olimex.com/dev/msp430-t5510.html. They are located in HARDWARE section.

The EAGLE schematic is situated on the next page for quicker reference.
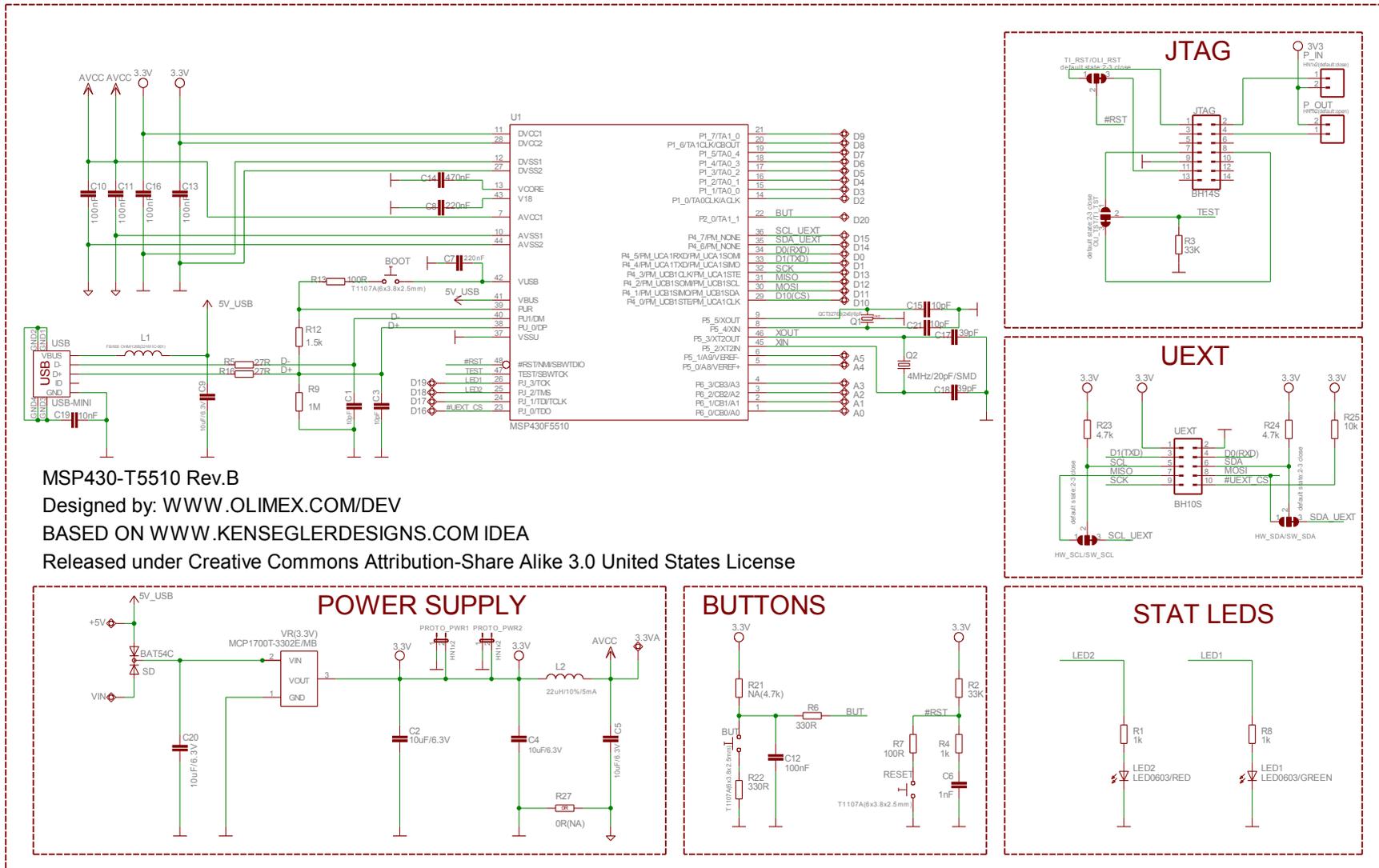
MSP430-T5510 Rev.B
Designed by: WWW.OLIMEX.COM/DEV
BASED ON WWW.KENSEGLERDESIGNS.COM IDEA
Released under Creative Commons Attribution-Share Alike 3.0 United States License

JTAG

UEXT

POWER SUPPLY

BUTTONS

STAT LEDS
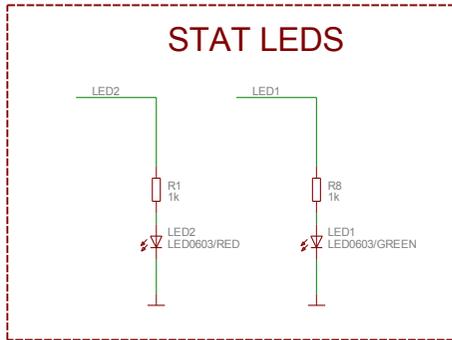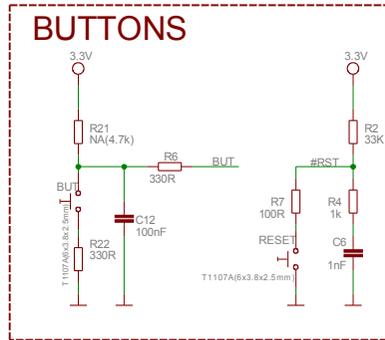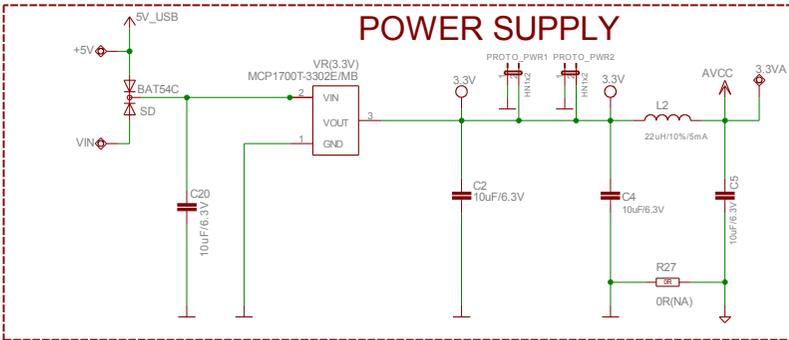
8.2 Physical dimensions

Note that all dimensions are in mils.
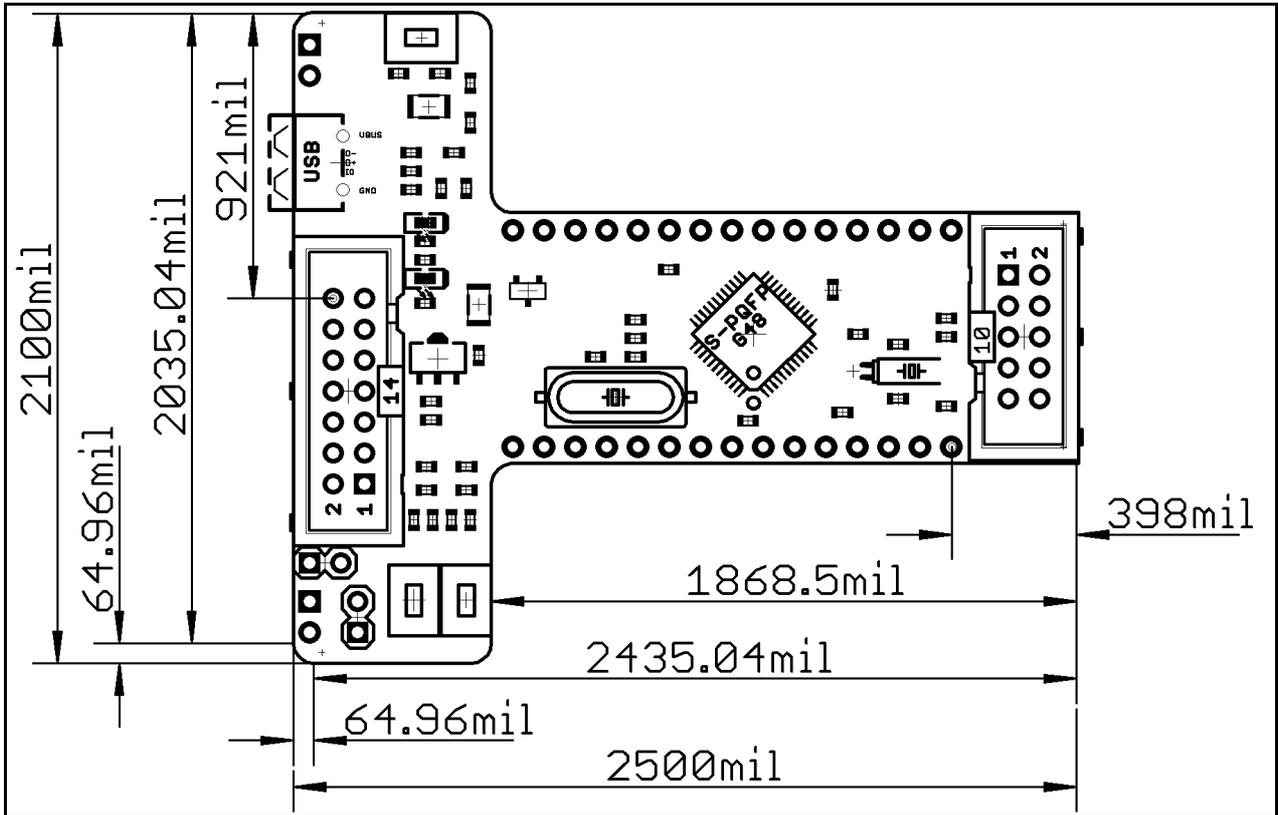
The highest elements on the board are the two connectors – UEXT and JTAG – 320mil each (without the PCB).

CHAPTER 9: REVISION HISTORY AND SUPPORT

9. Introduction to the chapter

In this chapter you will find the current and the previous version of the document you are reading. Also the web-page for your device is listed. Be sure to check it after a purchase for the latest available updates and examples.

9.1 Document revision

Revision	Changes	Modified Page#
A, 2.08.12	Initial Creation	All

9.2 Board revision

Revision	Notable Changes
B	Initial release of the board

9.3 Useful web links and purchase codes

The web page you can visit for more info on your device is https://www.olimex.com/dev/msp430-t5510.html.

ORDER CODES:

MSP430-T5510 – MSP430-T5510 featuring MSP430F5510 processor

MSP430-JTAG-ISO-V2 – our best MSP430 programmer, featuring LCD display, SD card and stand-alone mode of programming: https://www.olimex.com/dev/msp-jtag-iso-v2.html

MSP430-JTAG-ISO – standalone programmer: https://www.olimex.com/dev/msp-jtag-iso.html

MSP430-JTAG-TINY – tiny in size but powerful JTAG programmer
https://www.olimex.com/dev/msp-jtag-tiny.html

USB-MINI-CABLE – USB mini to USB-A cable

The latest price list can be found at http://olimex.com/dev/pricelist.html.

How to order?

You can order to us directly or by any of our distributors.

Check http://www.olimex.com/ and http://olimex.com/dev/order.html for more info.

9.3 Product support

For product support, hardware information and error reports mail to: support@olimex.com. Note that we are primarily a hardware company and our software support is limited.

Please consider reading the paragraph below about the warranty of Olimex products.

```
Warranty and returns:

Our boards have lifetime warranty against manufacturing defects and
components.

During development work it is not unlikely that you can burn your programmer
or development board. This is normal, we also do development work and we have
damaged A LOT of programmers and boards during our daily job so we know how it
works. If our board/programmer has worked fine then stopped, please check if
you didn't apply over voltage by mistake, or shorted something in your target
board where the programmer was connected etc. Sometimes boards might get
damaged by ESD shock voltage or if you spill coffee on them during your work
when they are powered.

Please note that warrany do not cover problems caused by unproper use, shorts,
over-voltages, ESD shock etc.

If the board has warranty label it should be not broken. Broken labels void
the warranty, same applies for boards modified by the customer, for instance
soldering additional components or removing components - such boards will be
not be a subject of our warranty.

If you are positive that the problem is due to manufacturing defect or
component you can return the board back to us for inspection.

When we receive the board we will check and if the problem is caused due to
our fault and we will repair/replace the faulty hardware free of charge,
otherwise we can quote price of the repair.

Note that all shippings back and forth have to be covered by the customer.
Before you ship anything back you need to ask for RMA. When you ship back
please attach to it your shipping address, phone, e-mail, RMA# and brief
description of the problem. All boards should be sent back in antistatic
package and well packed to prevent damages during the transport.
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