MINI-MAX/MSP430-C

Single Board Computer
Technical Manual

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WARRANTY:

BiPOM Electronics warrants MINI-MAX/MSP430-C for a period of 1 year. If the board becomes defective during this period, BiPOM will at its option, replace or repair the board. This warranty is voided if the product is subjected to physical abuse or operated outside stated electrical limits. BiPOM Electronics will not be responsible for damage to any external devices connected to MINI-MAX/MSP430-C. BiPOM Electronics disclaims all warranties express or implied warranties of merchantability and fitness for a particular purpose. In no event shall BiPOM Electronics be liable for any indirect, special, incidental or consequential damages in connection with or arising from the use of this product. BiPOM Electronics' liability is limited to the purchase price of this product.

1. Overview

MINI-MAX/MSP430-C is a general purpose, low-cost, highly-reliable and highly-expandable micro-controller system, based on the Texas Instruments MSP430F5437IPNR Ultra Low Power Microcontroller.

CPU features:

- Current consumption in Active Mode: 165 μA/MHz, Standby Mode: 2.60 μA
- 16 KB of on-chip static RAM and 256 KB of on-chip Flash for programs.
- 16-bit RISC architecture
- In-System/In-Application Programming (ISP/IAP) via on-chip boot-loader software.
- Embedded Emulation Module (EEM) supports real-time in-system debugging
- 16 channel, 12-bit Analog to Digital Converter with internal precision reference, 200K Samples/sec.
- Three 16-bit timers/external event counters (with capture and compare channels), PWM unit (six outputs) and watchdog.
- Low power Real-time clock with independent power and dedicated 32 kHz clock input.
- Dual serial port can be configured as UART, I2C, SPI or IrDA
- Vectored interrupt controller with priorities and vector addresses.
- 68 general purpose I/O pins in a tiny 80-pin TQFP package (58 available on the board)
- Hardware Multiplier Supporting 32-Bit Operations
- One active mode and six software selectable low-power modes of operation
- Real-Time Clock/Calendar
- DMA Controller
- Single power supply chip with Power-On Reset and Brown-Out Reset circuits
- CPU operating voltage range of 2.2 V to 3.6 V

MINI-MAX/MSP430-C board complements these features, providing:

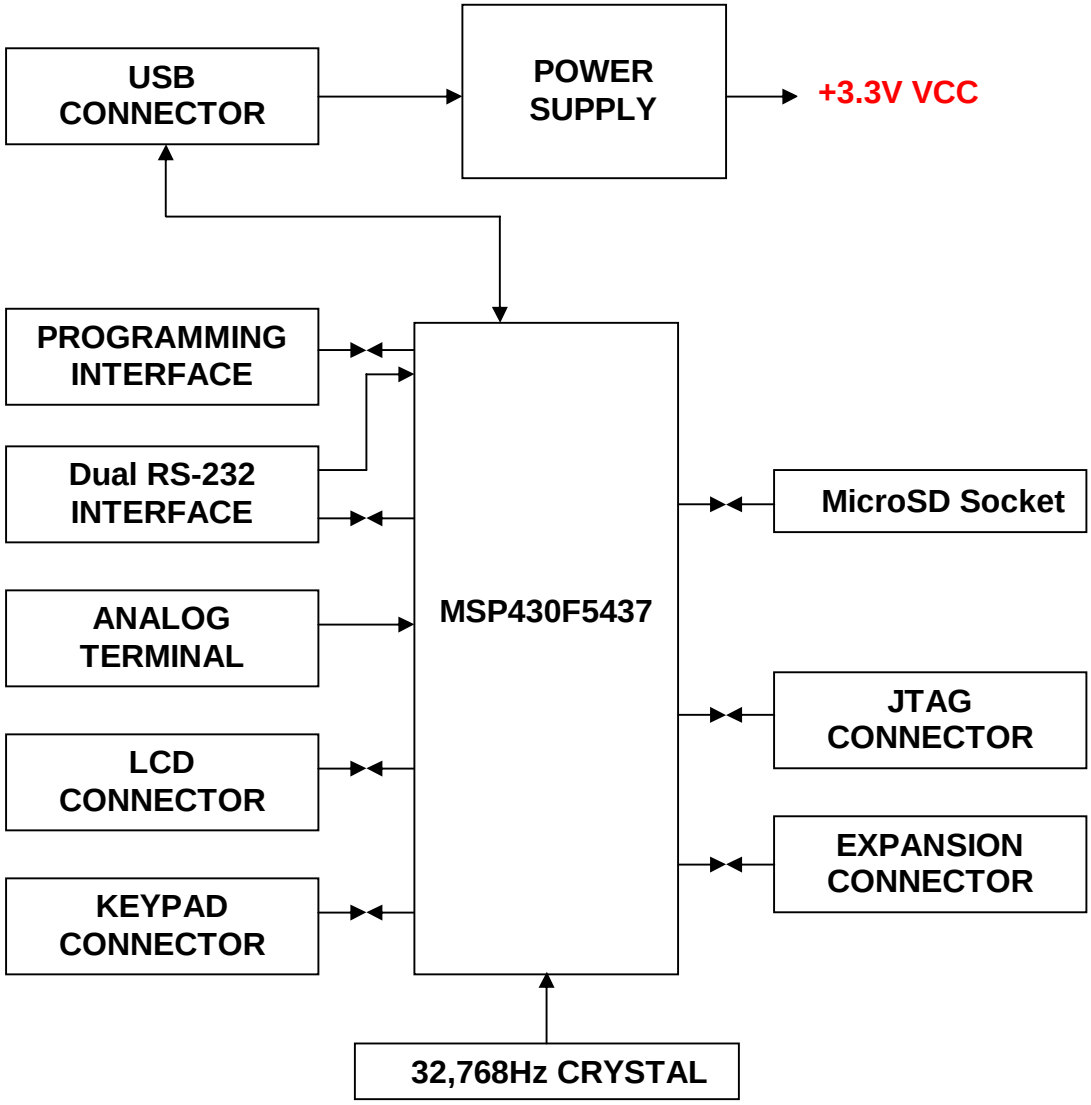
- 32.768 KHz crystal, with up to 18 MHz internal operation (default is 1 MHz)
- Ultra Low Power, USB or Battery operation possible, peripheral shutdown capability
- Socket for MicroSD cards
- Two RS232 Serial Ports with RTS/CTS handshake lines
- USB Device port based on FTDI chipset
- JTAG programming interface
- Keypad connector
- LCD connector (programmable contrast adjustment for the LCD)
- Screw terminal block for analog circuits.
- Expansion bus interface to low-cost peripheral boards
- 3.3 Volt on-board regulator

2. Specifications

Dimensions are 2.35 X 2.40 inches (5.97 X 6.10 centimeters).
Mounting holes of 0.125 inches (3 millimeters) on four corners.
0° - 70°C operating, -40° - +85° C storage temperature range.

3. Functional Blocks

Figure1. Block diagram of the MINI-MAX/MSP430-C system.



Micro-controller

The Texas Instruments MSP430 family of ultra low-power microcontrollers consists of several devices featuring different sets of peripherals targeted for various applications. The architecture, combined with five low-power modes is optimized to achieve extended battery life in portable measurement applications. The device features a powerful 16-bit RISC CPU, 16-bit registers, and constant generators that contribute to maximum code efficiency. The digitally controlled oscillator (DCO) allows wake-up from low-power modes to active mode in less than 5 μs. Typical applications for this device include analog and digital sensor systems, digital motor control, remote controls, thermostats, digital timers, hand-held meters, etc. and medical systems. For detailed information please refer here:

http://focus.ti.com/docs/prod/folders/print/msp430f5437.html

MicroSD Connector

MicroSD is a format for removable flash memory cards. SD is an acronym for Secure Digital. It is the smallest memory card available commercially; at 15 mm×11 mm×1 mm (about the size of a fingernail), it is about a quarter the size of an SD card. MicroSD cards are now available in sizes of many Gigabytes. MINI-MAX/MSP430-C has a push-push type ejector connector (H1) for accepting standard MicroSD cards. This allows creating low-power data loggers with huge storage capacities.

In-System Programming & Debugging

MINI-MAX/MSP430-C can be re-programmed using either the USB or JTAG interface. MSP430F5437IPNR comes with a built-in boot loader. The in-circuit programming feature simplifies program development on the board since downloading programs from a host PC takes only few seconds. User programs can also be downloaded and debugged through the JTAG port (X11).

MSP Development System based on Micro-IDE Integrated Development Environment from BiPOM Electronics fully supports In-System Programming on the MINI-MAX/MSP430-C using the serial port.

USB Connector

X14 is a 5-pin Mini USB connector (extra pins on the schematics indicate chassis of the connector). The USB port on MINI-MAX/MSP430-C is a Device port that is used for both powering the board and for communications with a USB Host such as a PC or BiPOM's ARM9 series boards with host USB, such as GadgetPC. USB port is mapped to IC4 (FT232RL) from FTDI. This chip serves as a USB to RS232 converter. This means that the MINI-MAX/MSP430-C appears like a COM port to a host PC.

JTAG Connector

X11 JTAG connector is a dual row, 14-pin header that matches the pinout of popular JTAG debuggers such as MSP-FET430UIF from Texas Instruments. There are two jumpers associated with JTAG operation. X12 (TARGET) and X13 (TOOL) jumpers configure how the outputs of JTAG debugger is powered. To power the outputs of JTAG adapter from MINI-MAX/MSP430-C, install both jumpers. Otherwise, remove both jumpers. Both configurations will work.

The board can also be powered from JTAG debugger. To do this, install X12 and X13 and remove X16 (USB/JTAG) jumper.

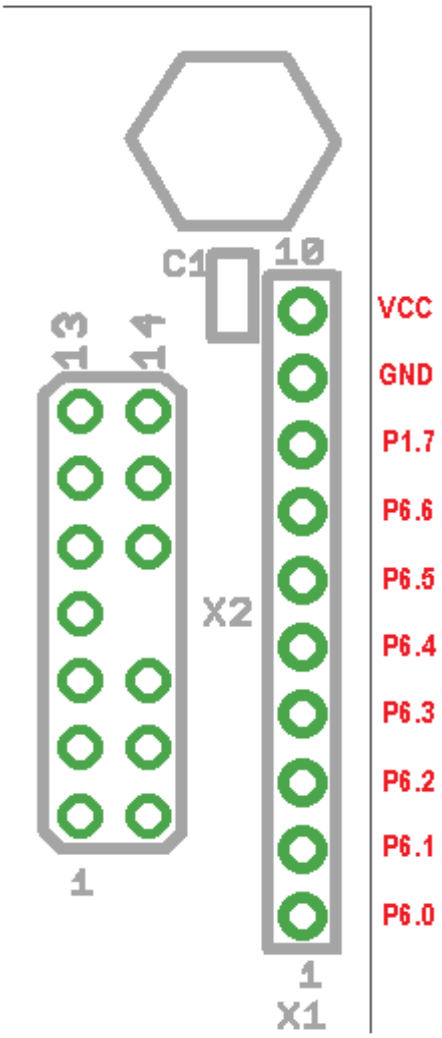
Keypad connector

Keypad connector can be used to scan various types of keypads, such as 3 by 5 or 4 by 4. Keypad connector contains 5 Volt power and ground lines and the 8 port lines of the micro-controller. The lines can also be used as general-purpose inputs/outputs.

Keypad Connector (X2)

Signal	Pin
P6.0 (KEY0)	1
P6.1 (KEY1)	2
P6.2 (KEY2)	3
P6.3 (KEY3)	4
P6.4 (KEY4)	5
P6.5 (KEY5)	6
P6.6 (KEY6)	7
P1.7 (KEY7)	8
Ground (GND)	9
VCC (+5V)	10

Table 1



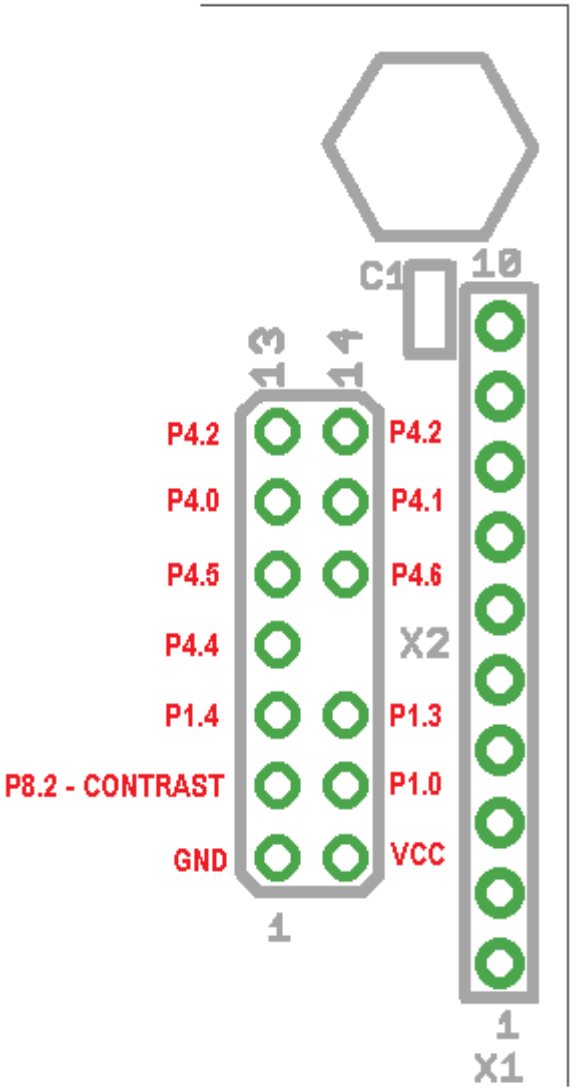
LCD Connector

LCD connector serves various types of character and graphic LCD modules. Alternatively LCD port can be used as a 10-bit general purpose I/O. Contrast is a 16-bit analog PWM output to adjust the contrast of the LCD display under software control. Alternatively it can be used as a general purpose analog output.

LCD Connector (X2)

Signal	Pin	Pin	Signal
Ground (GND)	1	2	VCC (+5V)
P8.2 Contrast (VEE)	3	4	P1.0 (CTRL)
P1.4 (READ)	5	6	P1.3 (STROBE)
P4.4 (LD4)	7	8	Not Connected
P4.5 (LD6)	9	10	P4.6 (LD7)
P4.0 (LD0)	11	12	P4.1(LD1)
P4.2 (LD2)	13	14	P4.3 (LD3)

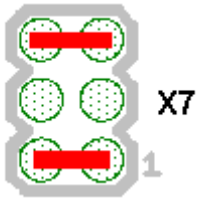
Table 2



RS232 Serial Ports

Two RS232 serial ports are available on the MINI-MAX/MSP430-C. IC2 converts micro-controller's RXD and TXD pins to/from RS232 levels. IC2 has an internal circuit that generates +/-6 Volts for RS232 logic levels. First RS232 port is wired to a 10-pin header (X6). Second RS232 port is wired to a 6-pin header (X7).

The default configuration is to have two RS232 ports with RX/TX lines only. This configuration does not have any handshake lines. If a single RS232 port with handshake lines (RTS/CTS) is needed, the two RS232 ports can be combined into one on X6. For this purpose, 2 jumpers must be set between pins 5, 6 and 1, 2 of X7 as shown below:

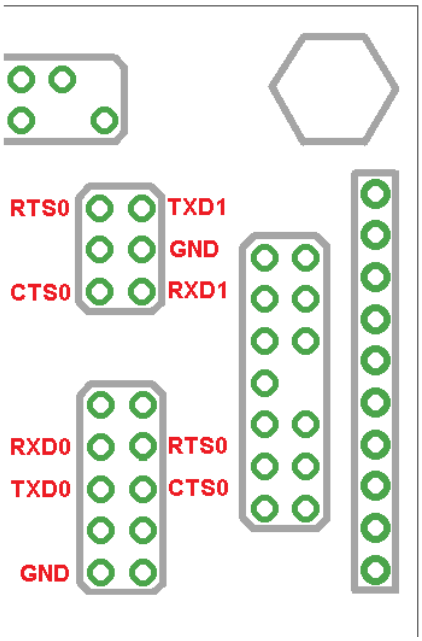


First RS232 Serial Port (X6)

Signal	Pin	Pin	Signal
NC (Not Connected)	1	2	NC (Not Connected)
RXD_0 (RX0 input)	3	4	RTS_0* (RTS0 output)
TXD_0 (TX0 output)	5	6	CTS_0* (CTS0 input)
NC (Not Connected)	7	8	NC (Not Connected)
Ground (GND)	9	10	NC (Not Connected)

Second RS232 Serial Port (X7)

Signal	Pin	Pin	Signal
RXD_1 (RX input)	1	2	CTS_0* (CTS0 input)
Ground (GND)	3	4	NC (Not Connected)
TXD_1 (TX output)	5	6	RTS_0* (RTS0 output)



MSP430-C has two hardware UART's. Additionally, a third UART option can be implemented in software (Soft UART). I/O pins P1.1 and P1.2 have been assigned for this purpose. This allows MINI-MAX/MSP430-C to have up to three serial ports (two RS232 and one USB-based using FTDI chip, IC4). Soft UART port is also used for downloading programs to MINI-MAX/MSP430-C through the USB port. Table 3 below shows various configuration options:

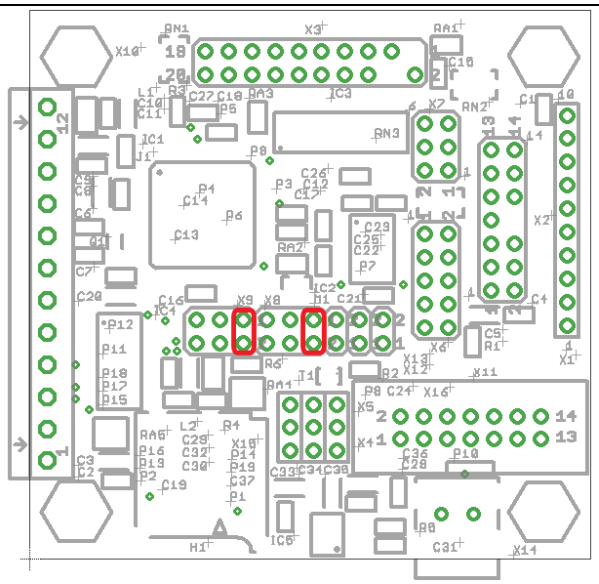
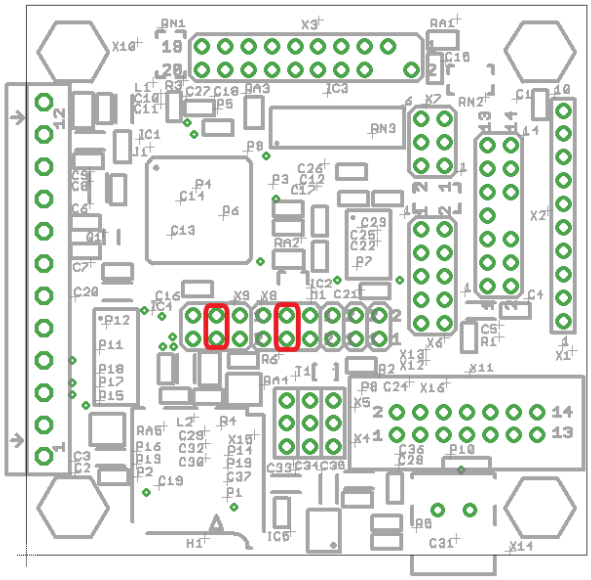
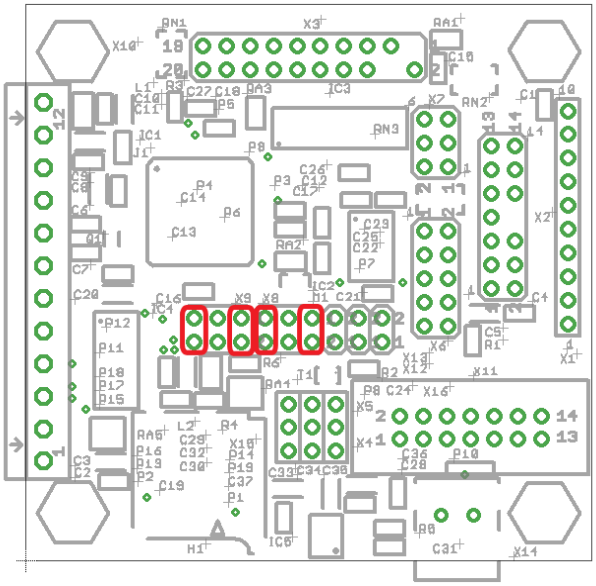
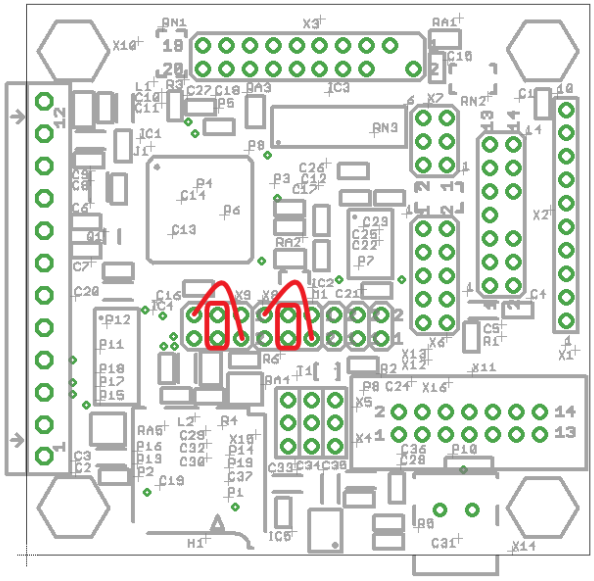
Configuration #1: UART1 of MSP430 is connected to RS232 PORT1. USB Serial Port is not used.	**Configuration #2:** UART1 of MSP430 is connected to USB Serial Port. RS232 PORT1 is not used.
	
	
Configuration #3: UART1 of MSP430 is connected to RS232 PORT1. Soft UART of MSP430 is connected to USB Serial Port.	**Configuration #4**: Soft UART of MSP430 is connected to RS232 PORT1. UART1 of MSP430 is connected to USB Serial Port.

Table 3

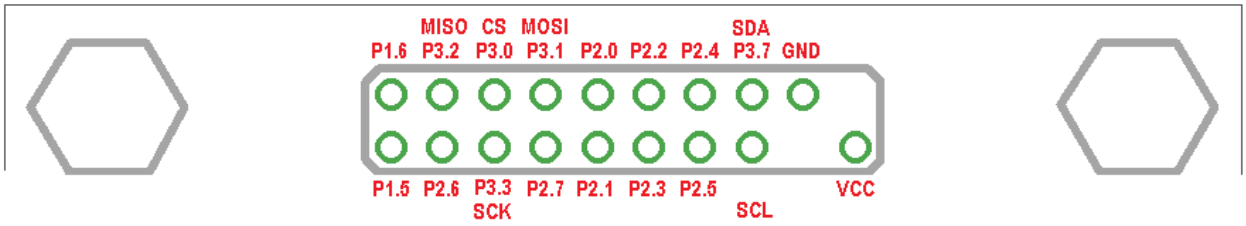
Expansion connector

Expansion connector can be used for interfacing to external circuitry, prototyping boards and peripheral boards. Expansion connector has 16 lines, which can be used as general purpose I/O. Some of these lines have special functions. MINI-MAX/MSP430-C peripheral boards can be connected either as a piggy-back daughter-board on MINI-MAX/MSP430-C using standoffs or can be placed up away from MINI-MAX/MSP430-C using a 20-wire ribbon cable. Peripherals section lists the available expansion boards. Table 4 shows the pin assignments for the MINI-MAX/MSP430-C Expansion connector.

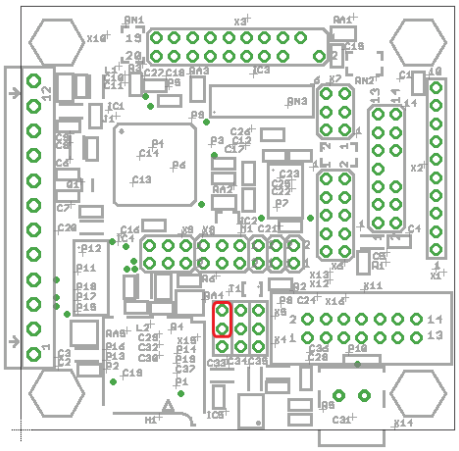
Expansion connector (X3)

Signal	Pin	Pin	Signal
Ground (GND)	1	2	VCC (+5V)
Ground (GND	3	4	VCC (+5V)
P3.7 (SDA)	5	6	P5.4 (SCL)
P2.4 (IO4)	7	8	P2.5 (IO5)
P2.2 (IO2)	9	10	P2.3 (IO3)
P2.0 (IO0)	11	12	P2.1 (IO1)
P3.1 (MOSI)	13	14	P2.7 (IO7)
P3.0 (CS)	15	16	P3.3 (SCK)
P3.2 (MISO)	17	18	P2.6 (IO6)
P1.6 (IO9)	19	20	P1.5 (IO8)

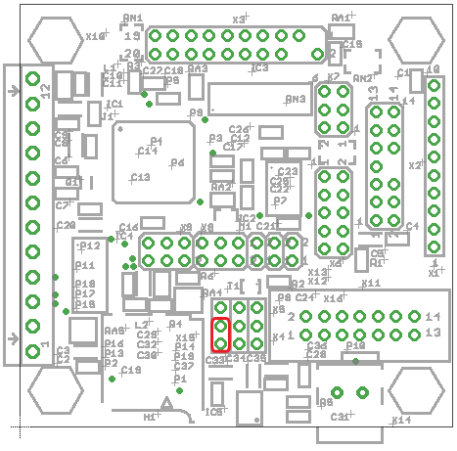
Table 4



The voltage VCC on the expansion connector can be either 3.3V or 5 Volts. This can be selected using jumper X15. Also, the power to peripheral boards can be shut down using SHDN signal that is tied to port P8.3 of the microcontroller. Shutting power to idle peripheral boards reduces power consumption of the overall system. VCC is enabled on the expansion connector when P8.3 is logic high.



X15 configured for 3.3V VCC on Expansion Connector



X15 configured for 5V VCC on Expansion Connector

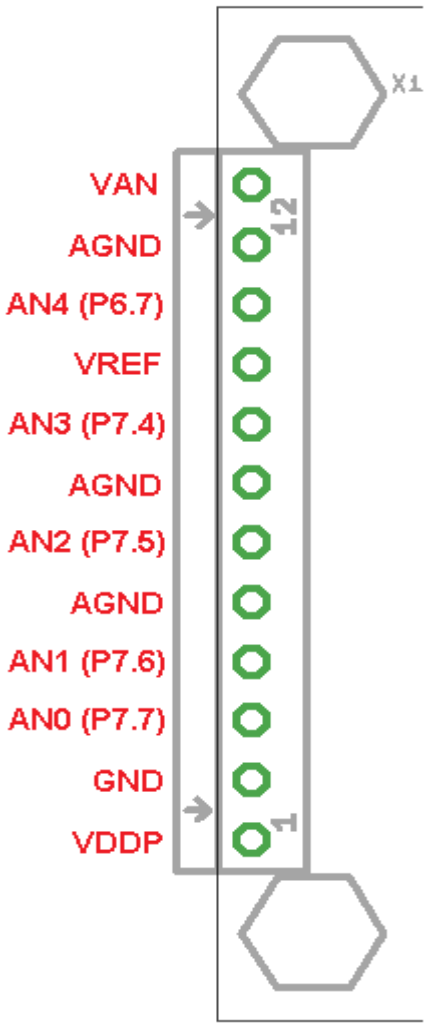
Analog interface

Analog terminal X10 serves for interfacing to various types of analog periphery, such as strain gages, pressure sensors, thermocouples etc. Five ADC inputs, analog reference VREF, analog power supply VAN and analog ground are wired to X10. Reference is programmable as either 1.5 Volts or 2.5 Volts.

Analog terminals (X10)

Signal	Pin
VDDP	1
GND	2
P7.7 (AN0)	3
P7.6 (AN1)	4
Analog Ground (AGND)	5
P7.5 (AN2)	6
Analog Ground (AGND)	7
P7.4 (AN3)	8
Reference Voltage (VREF, output)	9
P6.7 (AN4)	10
Analog Ground (AGND)	11
3.3V Analog Power (VAN, output)	12

Table 5



Real Time Clock

The Real Time Clock module inside the microcontroller can be used as a general-purpose 32-bit counter (counter mode) or as an integrated real-time clock (RTC) (calendar mode). In counter mode, the Real Time Clock also includes two independent 8-bit timers that can be cascaded to form a 16-bit timer/counter. Both timers can be read and written by software. Calendar mode integrates an internal calendar which compensates for months with less than 31 days and includes leap year correction. Real Time Clock also supports flexible alarm functions and offset-calibration hardware.

Power Supply Unit

MINI-MAX/MSP430-C board comes with a Mini USB cable to power the board from a computer or from a 5 Volt regulated power supply.

MINI-MAX/MSP430-C has an on-board voltage regulator. IC5 provides +5V digital supply, IC6 is +3.3V for digital circuits and IC7 is +3.3V for analog circuits.

Battery Operation

MINI-MAX/MSP430-C can be powered from a battery instead of a USB power source. When using a battery, the positive of the battery is applied to VDDP pin (pin 1) of Analog Terminal block (X10) and the negative of the battery is connected to GND pin (pin 2) of Analog Terminal block (X10). The battery voltage must be between 2.2 Volts and 3.6 Volts for proper operation of MINI-MAX/MSP430-C. When operating from a battery, jumper X16 should be removed to prevent the leakage of battery current into the 3.3V Regulator (IC5).

When operating from battery, most of the peripheral boards will not work because they require 5 Volts for proper operation.

4. Peripherals

A peripheral board can either be stacked on top of MINI-MAX/MSP430-C using stand-offs or connected in a chain configuration using flat ribbon cable. Figure 8 shows how any peripheral board can be connected to a micro-computer board in a stacked fashion. Figure 9 shows the chain connection.

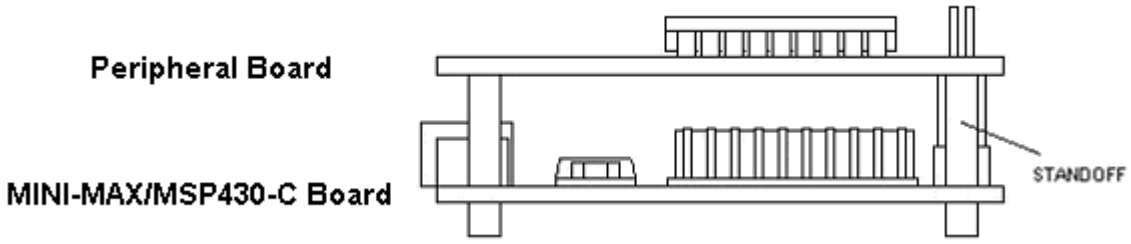


Figure 8

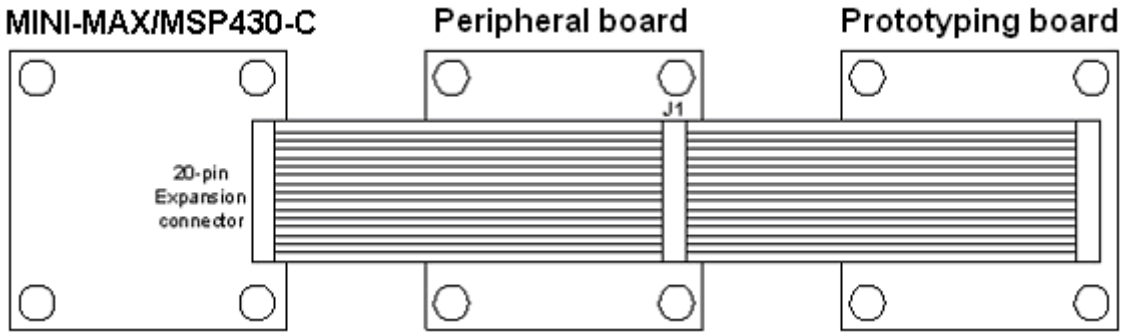


Figure 9

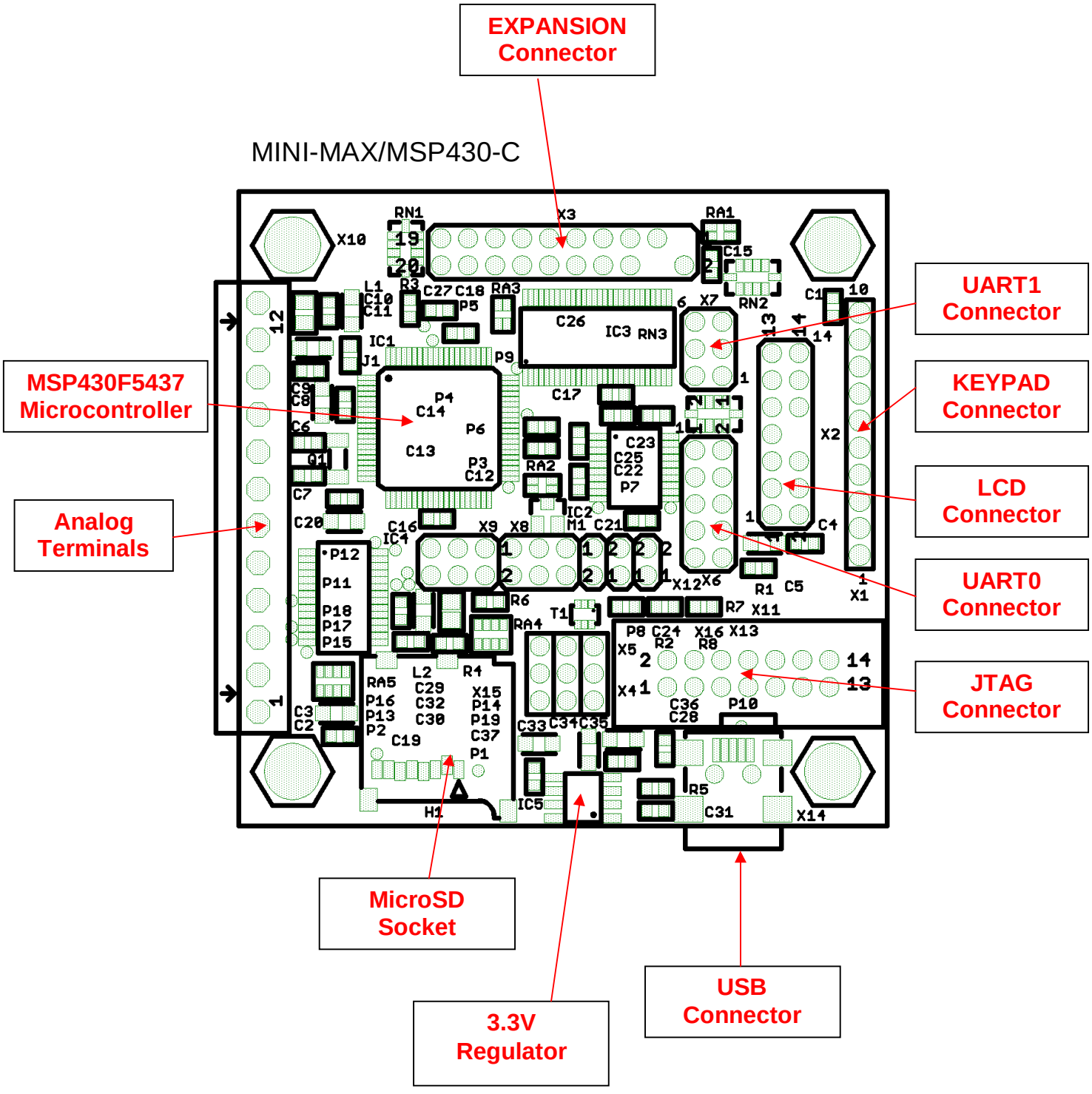
More details regarding BiPOM Peripheral boards are available from the link below:
www.bipom.com/periph_boards.php

5. Software

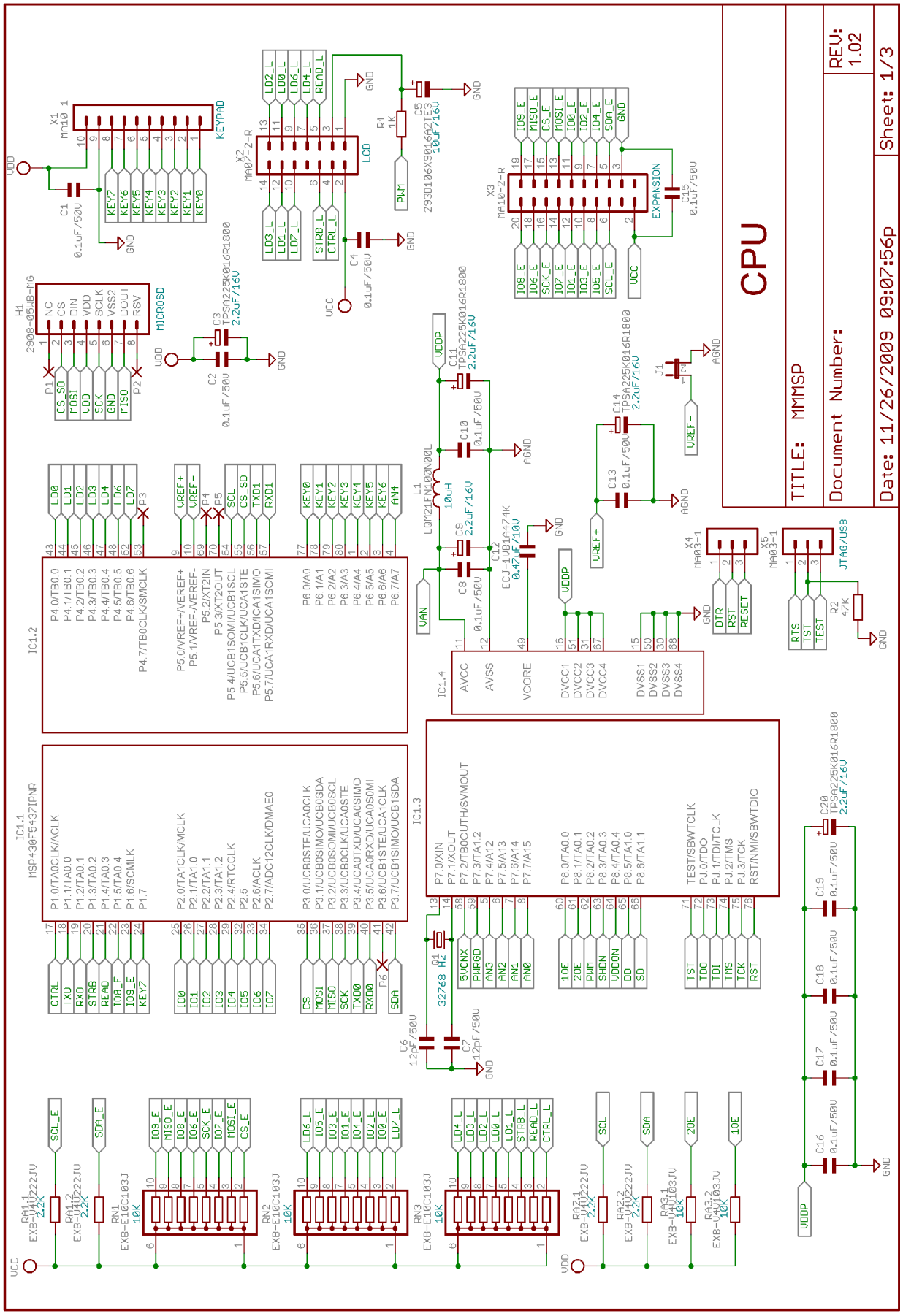
Please visit www.bipom.com/products/us/3164630.html and read FAQ's.

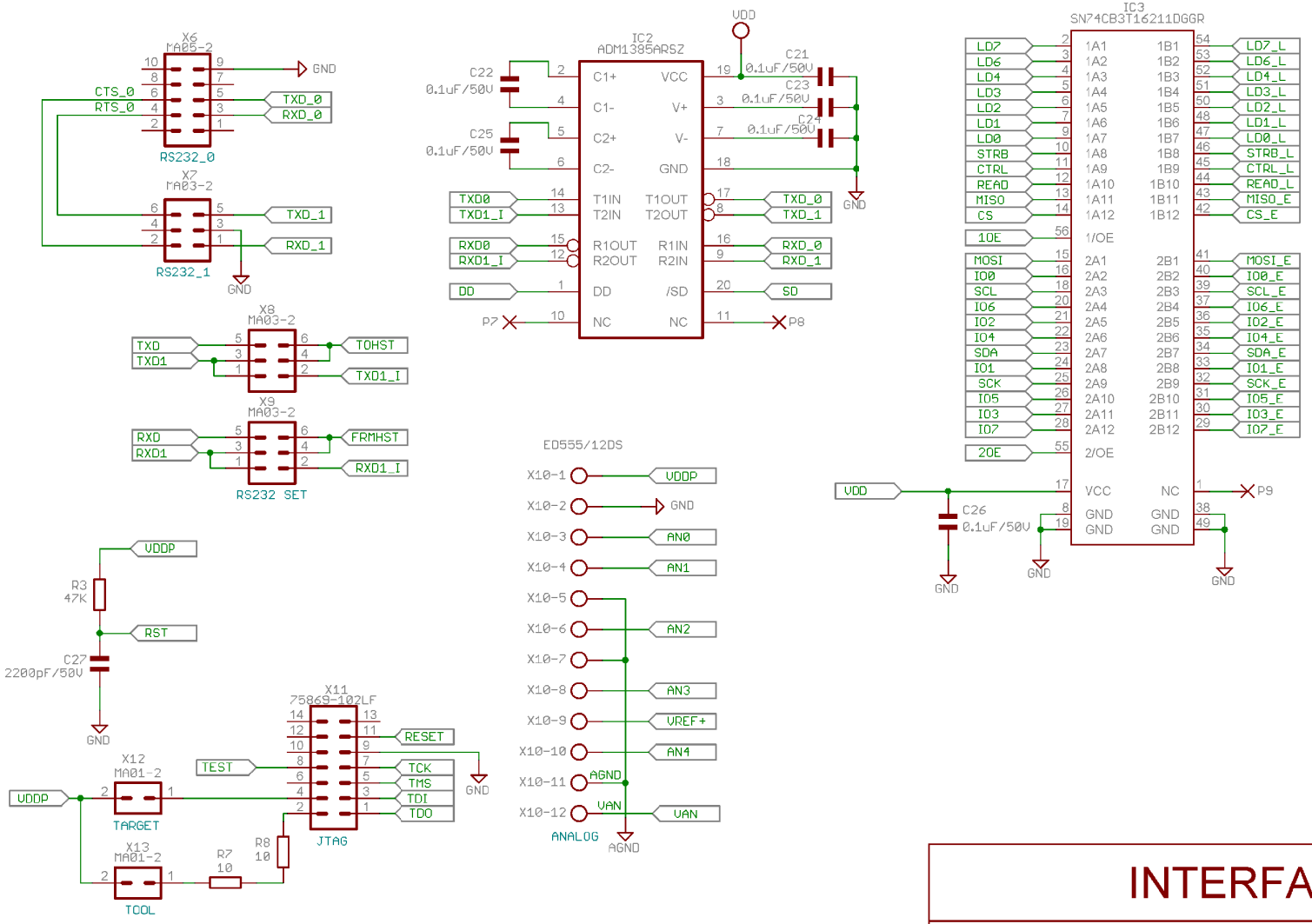
Please visit www.bipom.com/products/us/3180265.html and download the MSP Development System.

6. Board Layout



7. Schematics





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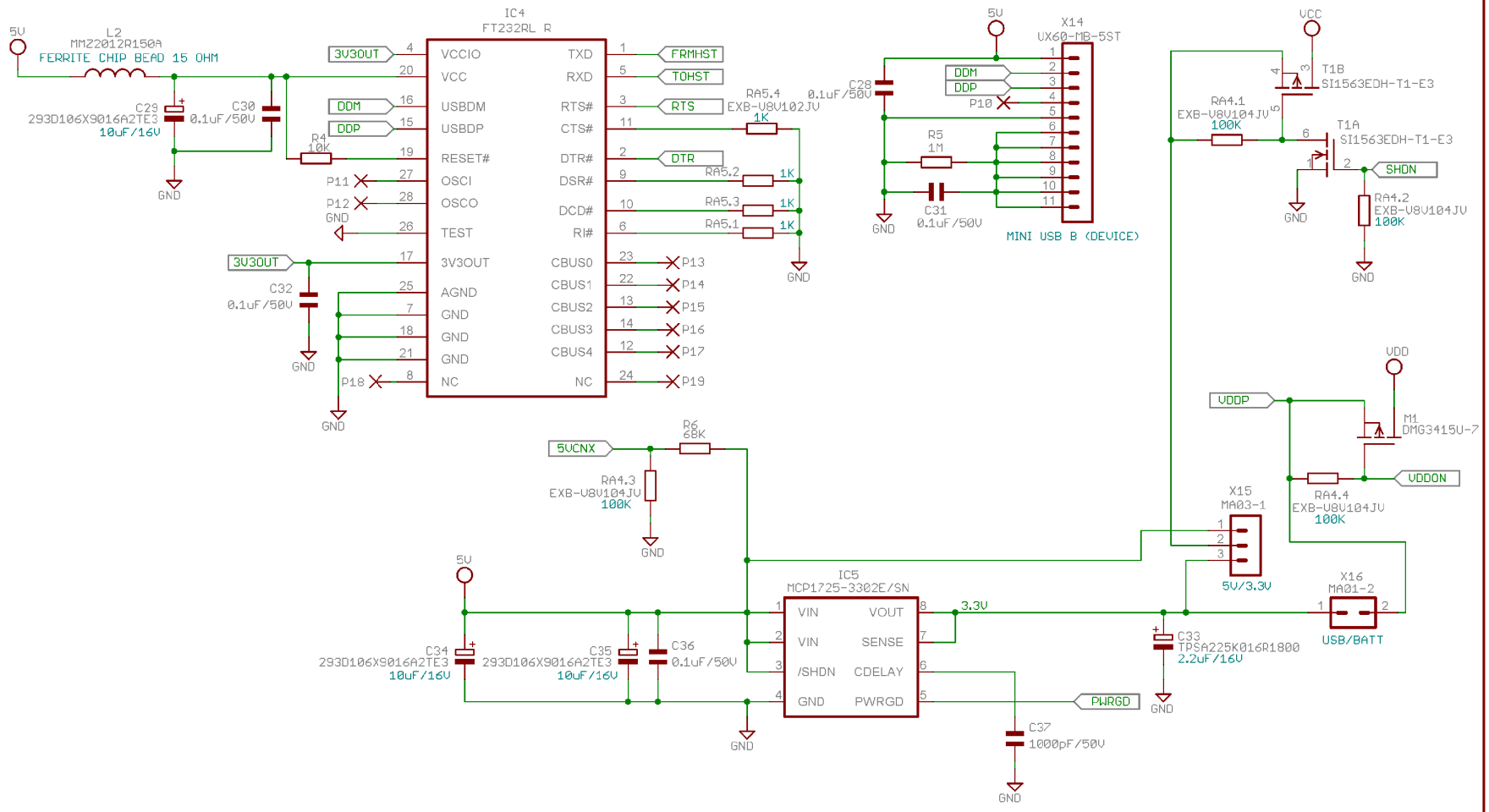

POWER SUPPLY

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