Modtronix Engineering

Modular Electronic Solutions

SBC44UC

Single Board Computer with PIC18F4550 and USB port

Table of Contents

1 Introduction

The following documentation is for the SBC44UC Revision 1, which is marked on the PCB as SBC44UC Rev1!

The SBC44UC is an embedded (PIC based) Single Board Computer (SBC) with a full speed USB interface. It is assembled with the PIC18F4550 PIC chip from Microchip. It is programmed with the Microchip Bootloader, meaning no programmer is required to program it! It has been designed to work with the free Microchip USB Software. This includes software for developing:

Human Interface Device (HID) class firmware

Communication Device Class (CDC) firmware

Mass Storage Class Firmware

Microchip Bootloader

Microchip Custom Driver

The SBC44UC can be powered by the USB bus, or an external power supply. A unique relay circuit is used to select between USB or external power. This ensures that the full USB voltage is available to the SBC board and possible user applications. Seeing that the voltage supplied by the USB bus is specified between 4.75V to 5.25V, it is very important

that the full voltage is obtained, seeing that many electronic components require a minimum of 4.75V. Most USB applications that support external supplies use a diode/transistor based switching mechanism, which will drop the USB voltage by about 0.6 to 1V. Using this method would mean that the user could not use standard, 4.75V electronic components for custom expansion circuits.

The SBC44EC has sockets for inserting a MCP23008 I/O expander and external EEPROM. There is space on the PCB for an external FRAM chip, like the 32k byte FM25256 for example.

The Bootloader Source code, Example Projects, Drivers, Documentation, PC Bootloader application and more can be downloaded from the SBC44UC Product Page. These example projects can be uploaded to the SBC44UC via the bootloader PC program that is also contained in the download.

Figure 1

2 Features

- 33 general purpose user programmable I/O ports
- 13 user programmable, 10 bit Analog to Digital converters
- 2 user programmable, 10-bit CCP units that can be used for PWM or Capture/Compare functions.
- 1 USART
- 1 I2C/SPI serial interface
- 2 Comparitors
- 1 8-bit and 3 16-bit timers
- 32k Bytes of user programmable FLASH memory
- 2048 Bytes of RAM memory
- 256 Bytes of non-volotile internal EEPROM memory. Has socket for addition external EEPROM chip.
- Has space for a 8 pin Ramtron SPI FRAM chip (32Kbyte FM25256 chip for example) to be assembled.
- Micro Match socket with Power, I^2C and SPI signals. The Micro Match connector can be used to daisy chain multiple I2C devices together, like our LCD2S Serial LCD displays with keyboard decoder. For details on the Micro Match connector, click here.
- Red user LED on PIC port RB6.
- Is part of our MicroX product range, and has a Frontend and Compact Daughter board connector for expansion. For details see www.modtronix.com/microx.
- Compact size of 58mm x 54mm.
- Can be powered via USB bus, or external 9V to 12V power supply (via diode protected 2.1mm power connector).
- High quality machine assembly, with brand name, quality components:
  - All electrolytic capacitors used are extra long life Panasonic brand, which is 5 times more than standard!
  - PCB is Gold plated for best contact and no corrosion
  - All pin headers are gold plated for best possible contact
- Has an ICSP (In Circuit Serial Programming) connector (ICPC1 type) - CPU can be programmed in circuit. For details see Programming Modtronix PIC based boards.

3 Daughter Board Connectors

The SBC44UC's Daughter Board connectors can be used as an expansion port to add additional functionality. It contains all free CPU port pins, power, I2C, SPI, RS232 signal,..... For the location of the Daughter Board connectors, see the *Dimensions* chapter of this document. The Daughter Board connectors port pins are mapped to the following signals:

CON2 Daughter Board Connector		*CON1 Daughter Board Connector*	
Daughter Board Port Pin	***Signal***	***Daughter Board Port Pin***	***Signal***
T0	Port 0 of the MCP23008 I/O expander (if assembled)	T4	Port 4 of the MCP23008 I/O expander (if assembled)
T1	Port 1 of the MCP23008 I/O expander (if assembled)	T5	Port 5 of the MCP23008 I/O expander (if assembled)
T2	Port 2 of the MCP23008 I/O expander (if assembled)	T6	Port 6 of the MCP23008 I/O expander (if assembled)
T3	Port 3 of the MCP23008 I/O expander (if assembled)	T7	Port 7 of the MCP23008 I/O expander (if assembled)
SIG0	No Connection	GND	Ground
SIG1	No Connection	+5V	Regulated 0.5A 5V supply
B0	PIC pin RB2 – has 5K pull-up resistor.	VIN	Unregulated input voltage
B1	PIC pin RB3	CLR#	PIC pin /MCLR
B2	PIC pin RB0	A0	PIC pin RA0
B3	PIC pin RB1	A1	PIC pin RA1
B4	PIC pin RB4	A2	PIC pin RA2
B5	PIC pin RB5	A3	PIC pin RA3
B6	PIC pin RB6 – also used for ICP (1)	A4	PIC pin RA4
B7	PIC pin RB7 – also used for ICP (1)	A5	PIC pin RA5
C4	PIC pin RB0 – port pin assigned for I2C (2)	C0	PIC pin RC0
C5	PIC pin RC7	C1	PIC pin RC1
C6	PIC pin RC6 – can be used for RS232/RS485 TX	C2	PIC pin RC2
C7	PIC pin RC7 – can be used for RS232/RS485 RX	C3	PIC pin RB1 – port pin assigned for I2C (2)
D2	PIC pin RD2 (4)	D0	PIC pin RD0
D3	PIC pin RD3 (4)	D1	PIC pin RD1
D4	PIC pin RD4 (3)	E0	PIC pin RE0
D5	PIC pin RD5 (3)	E1	PIC pin RE1
D6	PIC pin RD6 (3)	E2	PIC pin RE2
D7	PIC pin RD7 (3)	GND	Ground

(1) Port Pins B6 and B7 are also used for in circuit programming, and to enter bootloader mode! If they are used, and the board should still be in circuit programmable, make sure their impedance is greater then a 1000 ohms!

(2) Port Pins C3 and C4 are connected to PIC port pins RB0 and RB1, that can be used for the I2C bus. When no I2C devices are used (external EEPROM or MCP23008 I/O expander for example), these ports can be used as general purpose I/O pins.

(3) If a serial FRAM chip is assembled, these pins will be used to communicate with it. By default, there is no FRAM chip assembled, and these pins can be used for general purpose I/O pins. Pin D4 has a 5K pull-up resistor connected to it!

(4) PIC port pins RD2 and RD3 are also used for “USB Self Power Sense” and “USB Bus Sense” inputs. If this functionality is not required, they can be used as general purpose I/O pins. They both have a 47k resistor that will pull it high or low, depending on how the board is currently powered.

3.1 As a Daughter Board

The SBC44UC can be used to add USB capabilities to any board by using it as a daughter board. All connectors and PCB standoffs required to do this can be purchased from our web site. The board that is to take the SBC44UC as a daughter board needs to provide two 2x12 pin, 2.54mm pin headers for the SBC44UC to plug into. The 2x12 pin header connectors available from Modtronix are specially made so that when mated with the connectors on the SBC44UC, the main board and SBC44UC will be 15.9mm apart.

3.2 Expansion boards

The SBC44UC can be used as a full functional Single Board Computer. It's Daughter Board connector can be used as an expansion port to add additional functionality. It contains all free CPU port pins, power, I2C, SPI, RS232 signal,..... For a list of available daughter boards from our site see www.modtronix.com/products/sbc44ucec/#expansion.
The Picture to the right shows the SBC44UC with a PT01TC prototype daughter board plugged onto it.

Additionally, users can download PCB templates for creating their own Daughter Board from our Download page – see www.modtronix.com/downloads. The ***daughter_compact.brd*** PCB fits onto the SBC44UC.

4 Frontend Connectors

The SBC44UC's Frontend connectors can be used as an expansion port to add additional functionality. It contains all free CPU port pins, power, I2C, SPI, RS232 signal,..... Most important pins have been placed on BRD1 connector, so a single IDC connector can be connected to it, and it's signals will be available via a ribbon cable. For the location of the Frontend connectors, see the *Dimensions* chapter of this document. The Frontend connectors port pins are mapped to the following signals:

BRD2 Frontend Connector		***BRD1 Frontend Connector***	
Frontend Port Pin	***Signal***	***Frontend Port Pin***	***Signal***
T0	Port 0 of the MCP23008 I/O expander (if assembled)	T4	Port 4 of the MCP23008 I/O expander (if assembled)
T1	Port 1 of the MCP23008 I/O expander (if assembled)	T5	Port 5 of the MCP23008 I/O expander (if assembled)
T2	Port 2 of the MCP23008 I/O expander (if assembled)	T6	Port 6 of the MCP23008 I/O expander (if assembled)
T3	Port 3 of the MCP23008 I/O expander (if assembled)	T7	Port 7 of the MCP23008 I/O expander (if assembled)
SIG0	No Connection	GND	Ground
SIG1	No Connection	+5V	Regulated 0.5A 5V supply
B0	PIC pin RB2 – has 5K pull-up resistor.	VIN	Unregulated input voltage
B1	PIC pin RB3	CLR#	PIC pin /MCLR
B2	PIC pin RB0	A0	PIC pin RA0
B3	PIC pin RB1	A1	PIC pin RA1
B4	PIC pin RB4	A2	PIC pin RA2
B5	PIC pin RB5	A3	PIC pin RA3
B6	PIC pin RB6 – also used for ICP (1)	C2	PIC pin RC2
B7	PIC pin RB7 – also used for ICP (1)	C3	PIC pin RB1 – port pin assigned for I2C (2)

BRD2 Frontend Connector		BRD1 Frontend Connector	
A4	PIC pin RA4	C4	PIC pin RB0 – port pin assigned for I²C (2)
A5	PIC pin RA5	C5	No Connection

(1) Port Pins B6 and B7 are also used for in circuit programming, and to enter bootloader mode! If they are used, and the board should still be in circuit programmable, make sure their impedance is greater then a 1000 ohms!

(2) Port Pins C3 and C4 are connected to PIC port pins RB0 and RB1, that can be used for the I²C bus. When no I²C devices are used (external EEPROM or MCP23008 I/O expander for example), these ports can be used as general purpose I/O pins.

Figure 2 shows the location of the Frontend Connectors on the board.

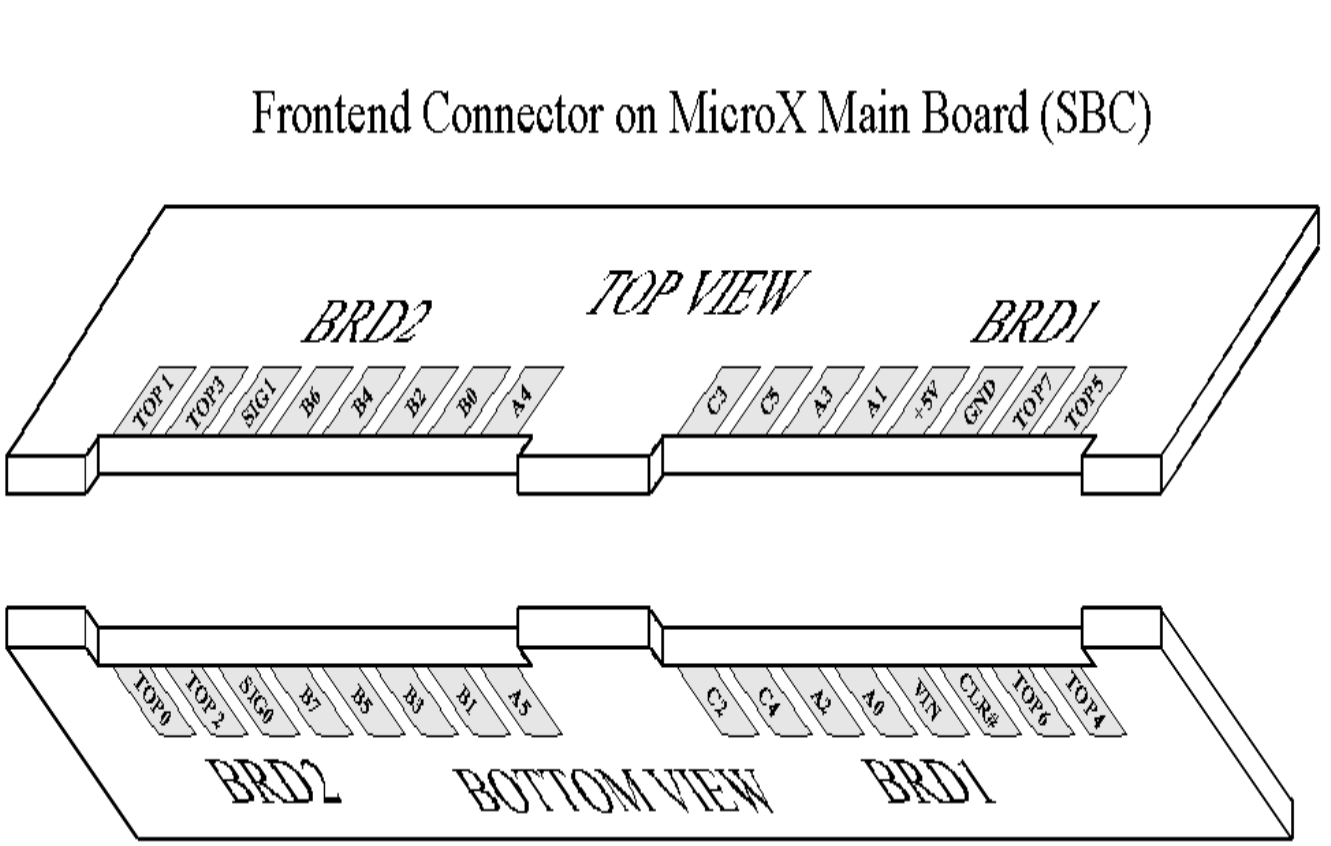
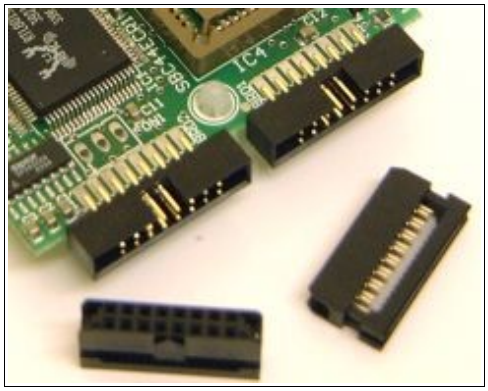


Figure 2

4.1 Connecting IDC connectors to the Frontend Connector

For an easy way of accessing the BRD1 and BRD2 Frontend Connectors signals, 2mm IDC connectors can be soldered onto one or both of the frontend connectors. By doing this, the frontend signals will be available via a standard 2mm ribbon cable. Note that the IDC connectors shown in the image are not soldered onto the Frontend Connector!



4.2 Expansion boards

The SBC44UC's Frontend connectors can be used as an expansion port to add additional functionality. It contains all free CPU port pins, power, I2C, SPI, RS232 signal,..... The image to the right shows the SBC28PC with a Sub-D 9 pin expansion board. For a list of Frontend Boards currently available from Modtronix Engineering, see SBC44UC Product Page.

Additionally, users can download PCB templates for creating their own Frontend expansion boards from

our Downloads page – see www.modtronix.com/downloads.

5 Interfaces

5.1 USB

The SBC44UC has a USB interface via a standard type-B connector.

USB Connector	Description
1	Vbus = +5V
2	D-
3	D+
4	Gnd = 0V

5.2 Micro Match connector with I2C and SPI signals

The SBC44UC has a 6 pin female Micro Match type connector with I^2C signals, SPI signals, Vcc and Ground. The PIC can be configured for either I^2C **or** SPI mode, both can not be used at the same time. The Micro Match connector is manufactured by AMP, and is a very small, polarized and a cheap connector! This connector is also supported by other manufactures of I^2C equipment, which allows devices from different manufactures to be interchanged.

Male Micro Match connectors that fits into this connector are available from various distributors and also from the Modtronix online store. Particularly useful is the "male-on-wire" type connector, seeing that they can be crimped onto a standard 1.27mm ribbon cable. Multiple of these connectors can be daisy chained together to allow several I^2C on a single bus. Pre-made cables are also available from the Modtronix online store.

When using this connector for I^2C signals, pin 6 of the connector can be used for Interrupts. To enable this feature, solder jumper J1 has to be made. This will connect pin 6 to PIC port pin RB2, which is an external interrupt input of the PIC chip (can also be used an an output of course). This port pin is also connected to a 5K pull-up resistor. By default, this solder jumper is **not** made!

When using this connector for SPI signals, the CS signal will only be available after making solder jumper J1. It is located on the bottom of the board, right under the Micro Match connector. This port pin is also connected to a 5K pull-up resistor. See the circuit diagram for details. By default, this solder jumper is **not** made!

The pinouts of the Micro Match I^2C connector is:

Micro Match Connector Pin	I^2C Signal	SPI Signal
1	SDA - I^2C data I/O (PIC port pin RB0)	SDI - SPI data in (PIC port pin RB0)
2	+5V	+5V
3	Ground	Ground
4	SCL - I^2C clock (PIC port pin RB1)	SCK - SPI clock (PIC port pin RB1)
5	RC5 - Can be used as general purpose pin	SDO - SPI data out (PIC port pin RC7)
6	INT – Interrupt pin (PIC port pin RB2)	CS – SPI Chip Select (PIC port pin RB2)

For further info on the pinouts have a look at the picture in the *Dimensions* section later on in this document.

For more info on the Micro Match I^2C connector see www.modtronix.com/info/i2c/micromatch

6 Updating Firmware

The SBC44UC board is programmed with a modified version of the Microchip Bootloader. To enter bootloader mode, the jumper on the CON3 pin header must be moved from it's default position (over pins 7 and 8) to pins 1 and 2. See pictures on the right. When the jumper is in this position, and the board is powered, it will enter bootloader mode. The LED on the board will blink at a rate of about 10 pulses per second to indicate the board is in bootloader mode. The Microchip bootloader PC program (PDFSUSB.EXE) can now be used to update the firmware on the board. The bootloader source code, PC program, example programs, documentation and more can be downloaded in a single zip file from here. The bootloader PC program is located in the "boot1/pc/Pdfsusb" folder. This download also contains example programs that can be uploaded to the SBC44UC via the bootloader.

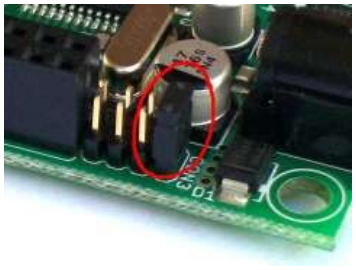


Figure 3 - Bootloader Mode

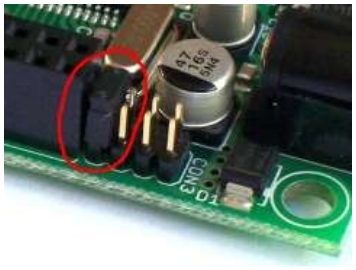


Figure 4 - Normal Mode

Bootloader mode is entered by connecting PIC port pins RB6 and RB7 (pins 1 and 2 of CON3 pin header). To simplify the process of entering bootloader mode, two switches could be place on a daughter board that plugs into the SBC44UC, like the PT01TC-ASM prototype daughter board for example. This can be very useful if developing software for example, and the bootloader mode will be used frequently. The one switch can be used to short RB6 and RB7, and the other to reset the board (short MCLR to GND). To enter bootloader, both switches have to be pressed and released (reset must be released first). This will put the board in bootloader mode, and allow it to be programmed and reset via the bootloader PC program.

7 External Memory

The SBC44UC board has a 8 pin IC socket for mounting an I^2C bus serial EEPROM, like the 24LC256 (32Kbytes) or 24LC512 (64 Kbytes) chips. This is very useful for applications that need to store non volatile memory, like data loggers for example.

8 8 Bit I/O Expander

The SBC44UC board has a 18 pin IC socket for mounting an MCP23008 I2C bus I/O expander chip. The MCP23008 provides 8 additional I/O ports rated at 25mA each. It has internal power-on reset circuitry to assure defined pin values on power up. The MCP23008 has an interrupt output pin that can be connected to PIC port pin RB2 via solder jumper J2. See Configuration section for details.

9 Configuration

The SBC44UC board can be configured via jumper J1, J2 and J3. They are all solder jumpers, and are located on the bottom of the board. By default, none of them are made, and they are all open circuit. Refer to the PCB layout later on in this document for the location of these jumpers and headers.

Solder jumper J1 can be made to connect PIC port pin RB2 to the CS signal of the Micro Match connector. This should be done if the Micro Match connector is used to connect to a device via the SPI interface.

Solder jumper J2 is used to connect PIC port pin RB2 to the interrupt pin of the MCP23008 I/O port expander. This jumper should be made if a MCP23008 I/O expander chip is inserted into IC socket U6, and the interrupt pin of the MCP23008 is required by the software. The interrupt pin of the MCP23008 will indicate if the inputs of the MCP23008 have changed. This port pin is also connected to a 5K pull-up resistor. By default, this solder jumper is **not** made!

Solder jumper J4 will connect a 5k pull-up resistor to the RA3 input of the PIC chip. This is required if the D3 reference voltage is assembled. Many different SOT-23 voltage reference chips can be used for D3, like the LM4040 for example. When assembling D3, the PIC chip will have a precision reference voltage for it's ADC converters. When using a 4.096V reference, each bit of the ADC (when used in 10-bit mode) will represent 4mV. This will greatly simplify ADC calculations in software!

10 Specifications

10.1 Absolute Maximum Ratings

Item	Symbol	Min	Typ	Max	Unit
Operating Temperature:	Top	-40		85	°C

10.2 Electrical Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit
DC Supply Voltage:	Vdd	-	9		16	V
Typical Operating Current when powered via USB	Idd	Vdd = 5V		45		mA
Typical Operating Current with external power	Idd	Vdd = 9V		53		mA

10.3 D.C. Characteristics of user I/O pins on Daughter Board connector.

The following values are for common PIC chips like the PIC16F876A or the PIC18F252.

Item	Symbol	Condition	Min	Typ	Max	Unit
Input Low Voltage - configured as TTL input:	V_{IL}		0		0.75	V
Input Low Voltage - configured as Schmitt Trigger input:	V_{IL}		0		1	V
Input High Voltage - configured as TTL input:	V_{IH}		2.05		5	V
Input High Voltage - configured as Schmitt Trigger input:	V_{IH}		4		5	V
Output Low Voltage:	V_{OL}	I_{OL} = 8.5mA			0.6	V
Output High Voltage:	V_{OH}	I_{OH} = 3mA	4.3			V
Capacitive loading:	C_{IO}			50		pF

Many inputs on the PIC are Schmitt Trigger inputs, consult the data sheet for details.

11 Dimensions

The SBC44UC conforms to the MicroX Compact Main Board Dimensions, as shown in Figure 5.

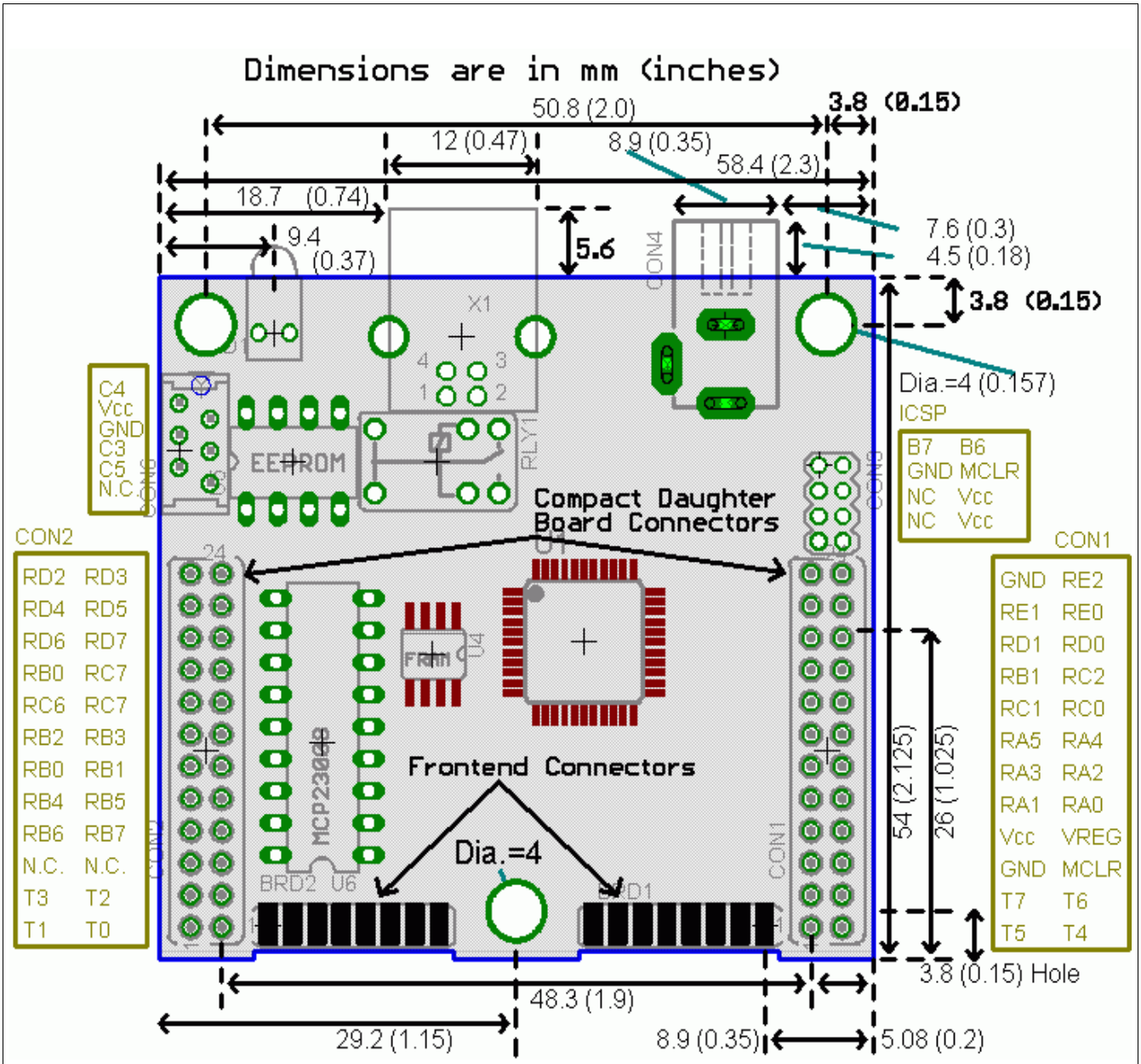
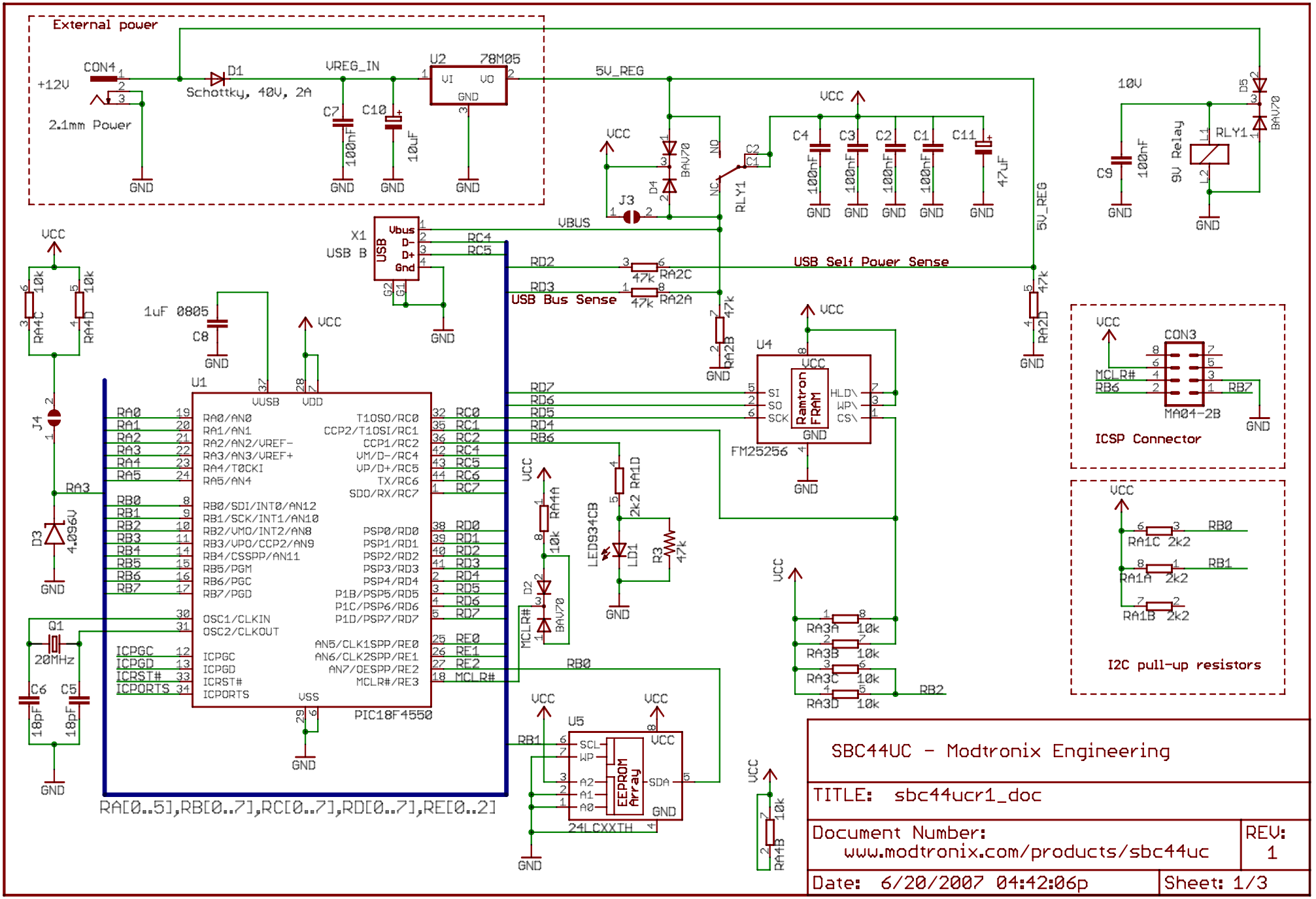


Figure 5

12 Schematics


External power
+12V
CON4
2.1mm Power
GND
D1
Schottky, 40V, 2A
VREG_IN
C7
100nF
C10
10uF
U2
78M05
VI
VO
GND
5V_REG
VCC
J3
D4
BAV70
NO
NC
C2
C1
RLY1
C4
C3
C2
C1
C11
100nF
47uF
10V
D5
BAV70
C9
100nF
9V Relay
L1
L2
RLY1
X1
USB B
USB
Vbus
D-
D+
Gnd
VBUS
RC4
RC5
RD2
RD3
USB Self Power Sense
USB Bus Sense
RA2C
RA2A
RA2B
RA2D
47k
10k
RA4C
RA4D
1uF 0805
C8
U1
VUSB
VDD
VSS
PIC18F4550
RA0/AN0
RA1/AN1
RA2/AN2/VREF-
RA3/AN3/VREF+
RA4/T0CKI
RA5/AN4
RB0/SDI/INT0/AN12
RB1/SCK/INT1/AN10
RB2/VMO/INT2/AN8
RB3/VPO/CCP2/AN9
RB4/CSSPP/AN11
RB5/PGM
RB6/PGC
RB7/PGD
OSC1/CLKIN
OSC2/CLKOUT
ICPGC
ICPGD
ICRST#
ICPORTS
T1OSO/RC0
CCP2/T1OSI/RC1
CCP1/RC2
VM/D-/RC4
VP/D+/RC5
TX/RC6
SDO/RX/RC7
PSP0/RD0
PSP1/RD1
PSP2/RD2
PSP3/RD3
PSP4/RD4
P1B/PSP5/RD5
P1C/PSP6/RD6
P1D/PSP7/RD7
AN5/CLK1SPP/RE0
AN6/CLK2SPP/RE1
AN7/OESPP/RE2
MCLR#/RE3
RA[0..5],RB[0..7],RC[0..7],RD[0..7],RE[0..2]
J4
D3
4.096V
Q1
20MHz
C6
18pF
C5
18pF
U4
Ramtron FRAM
SI
SO
SCK
HLD\
WP\
CS\
FM25256
LED934CB
LD1
2k2 RA1D
R3
47k
RA4A
10k
D2
BAV70
MCLR#
U5
EEPROM Array
SCL
WP
A2
A1
A0
SDA
24LCXXTH
RA3A
RA3B
RA3C
RA3D
RB2
RA4B
CON3
MA04-2B
ICSP Connector
RA1C 2k2
RA1A 2k2
RA1B 2k2
I2C pull-up resistors
SBC44UC - Modtronix Engineering
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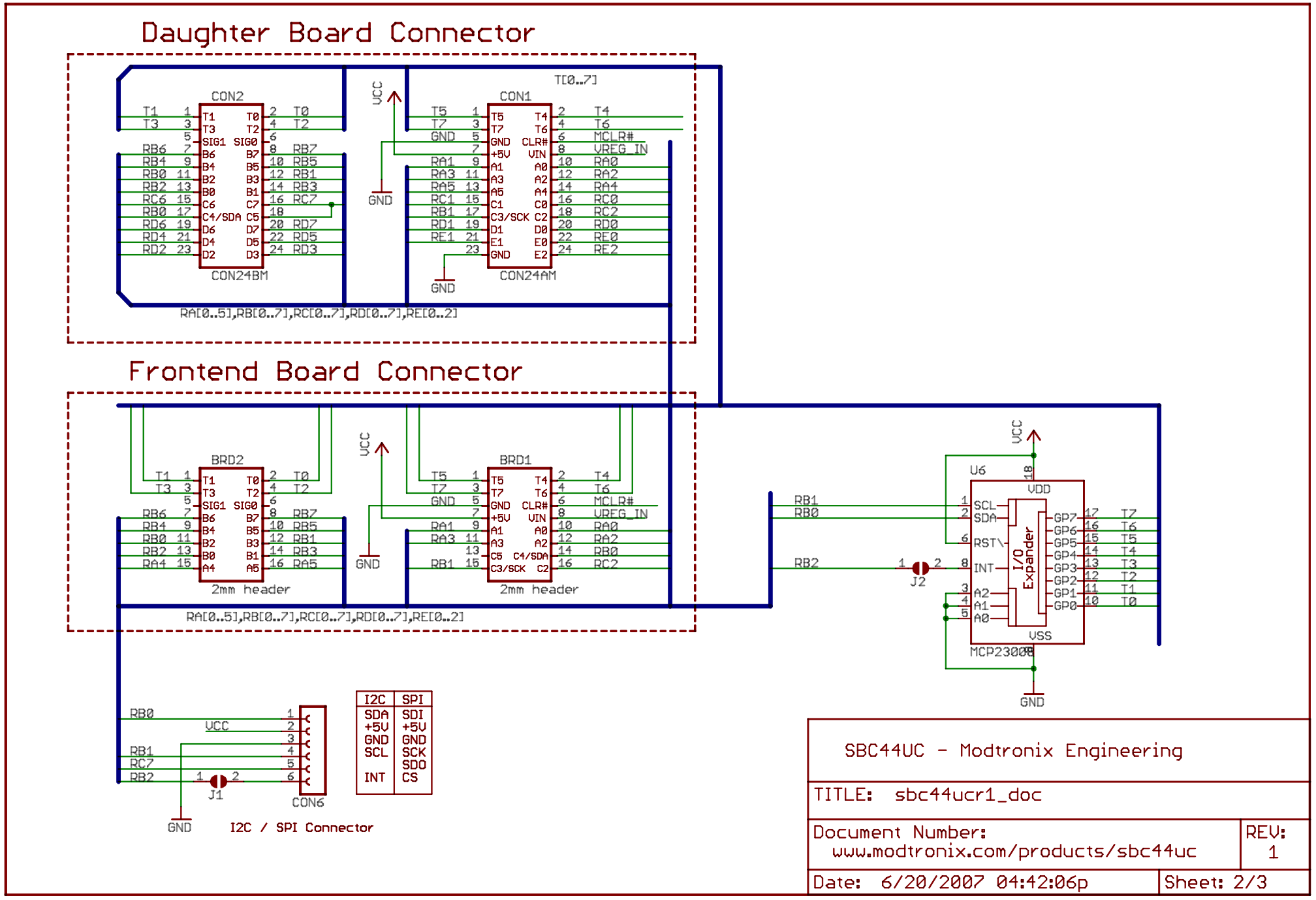
Daughter Board Connector
CON2
CON1
CON24BM
CON24AM
T[0..7]
VCC
GND
RA[0..5],RB[0..7],RC[0..7],RD[0..7],RE[0..2]
Frontend Board Connector
BRD2
BRD1
2mm header
U6
VDD
VSS
I/O Expander
MCP23008
SCL
SDA
RST\
INT
A2
A1
A0
GP7
GP6
GP5
GP4
GP3
GP2
GP1
GP0
J2
J1
CON6
I2C
SPI
SDA
SDI
+5V
GND
SCL
SCK
INT
SDO
CS
I2C / SPI Connector
SBC44UC - Modtronix Engineering
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