

MAVRIC-IIB

Mega AVR Integrated Controller II
Revision B
Technical Manual

BDMICRO

<http://www.bdmicro.com/>

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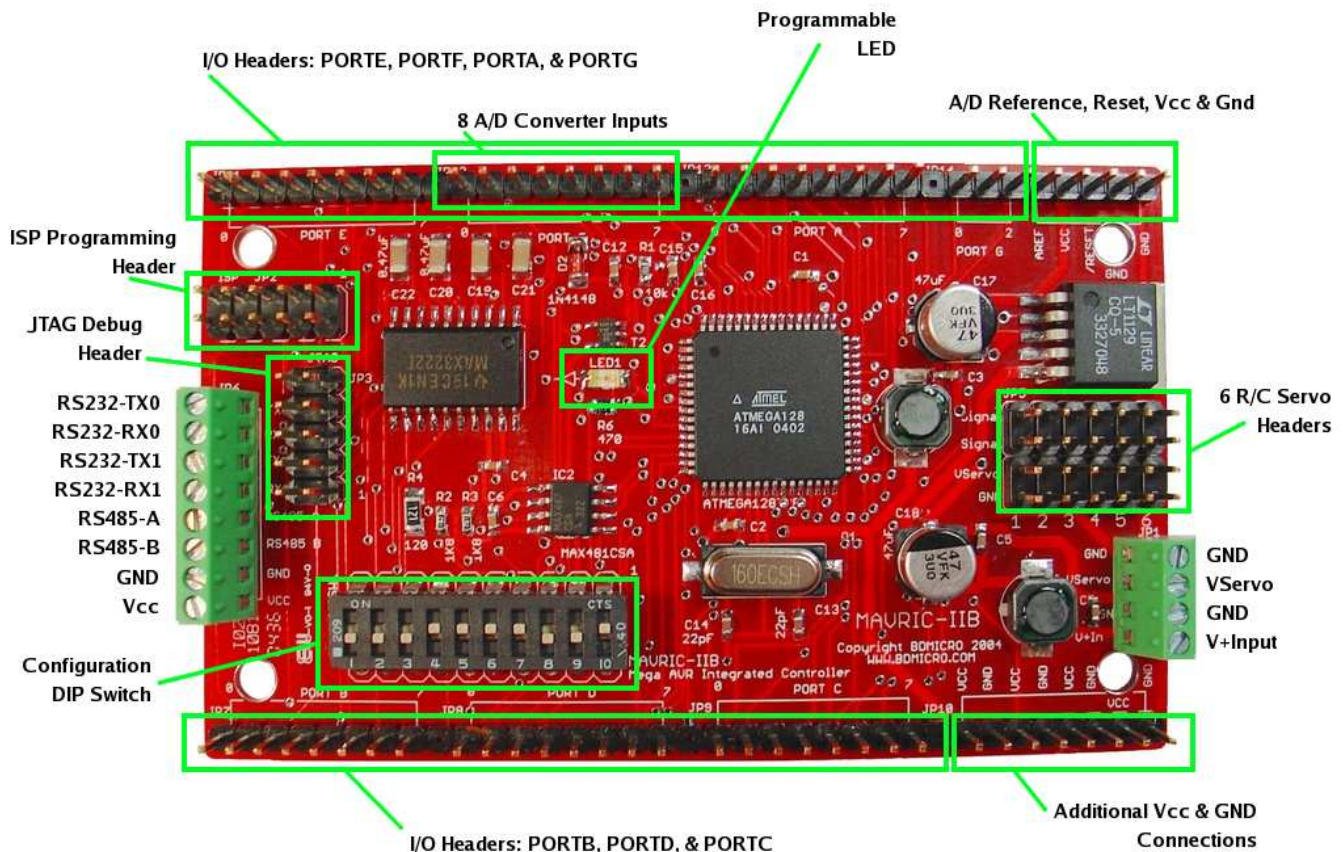
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Contents

1	MAVRIC-IIB Layout	4
2	Power Supply Connections	6
3	In-System Programming and JTAG Debug Headers	7
4	Port Header Connections	8
4.1	<i>I</i> ² <i>C</i> Connections	9
4.2	A/D Inputs and AREF Connection	9
4.3	PORTG3 and PORTG4 Connections	10
5	Serial Communications Connections	10
5.1	UART0 Startup Delay	11
6	DIP Switch Settings	12
7	Servo Headers	13
8	Fuse Bit Settings	14
9	Memory Expansion	14
10	Schematic Diagram	15
11	Mechanical Drawing	16
12	Soldering the MAVRIC-IIB Board	17

1 MAVRIC-IIB Layout

The BDMICRO MAVRIC-IIB is a powerful microcontroller board based on the ATmega128 MCU. It is fully programmable using familiar languages such as C and BASIC. The GNU GCC C compiler is very popular as it comprises the core of the de-facto standard tool chain of the open source community. Additionally, MCS Electronic's BASCOM-AVR BASIC compiler is also very popular, economical, and highly regarded by AVR enthusiasts.



The MAVRIC-IIB is the perfect microcontroller for many applications such as robotics where a fusion of many sensors and digital I/O are needed. Its copious program and data space allow you to implement sophisticated algorithms and logic without having to compromise features. MAVRIC-IIB's 8 channel, 10-bit A/D converter makes short work of reading analog sensors like the SHARP GP2D12 IR distance sensor. It has 2 on-board UARTs both of which are level-shifted to provide true RS232 levels, or they may be used using the unshifted TTL levels if that is more convenient. One of the UARTs can optionally be run as an RS485 interface which incorporates on-board termination and independent transmitter/receiver control. MAVRIC-IIB is I2C ready with on-board pull-ups so you can hook up your existing I2C devices such as your SRF08 Ultrasonic Ranger and your CMPS01 compass module, plus many other I2C peripherals. In addition to all that, 6 high resolution PWM outputs are available for driving

servos and PWM motors with high precision. And with up to 51 digital I/O pins, it can handle even the most complex and demanding control tasks.

The MAVRIC-IIB also includes 6 R/C servo headers for controlling servos directly. An auxiliary power input is provided to power the servos separately from the microcontroller electronics which protects the on-board electronics from the high current drain and associated brown-outs that can result from powering motors and electronics from the same power supply.

The on-board standard programming headers make development easy — 10-pin serial ISP header for connecting to your AVRISP or STK500, and also the standard 10-pin JTAG header for using your JTAGICE for programming and single-step, source level debugging.

The MAVRIC-IIB incorporates an advanced, on-board, low-dropout voltage regulator and can be powered with as little as 5.5 Volts. Four mounting holes are provided for securely mounting your board, and with its small size of 2.2 x 3.6 inches, you can mount it just about anywhere.

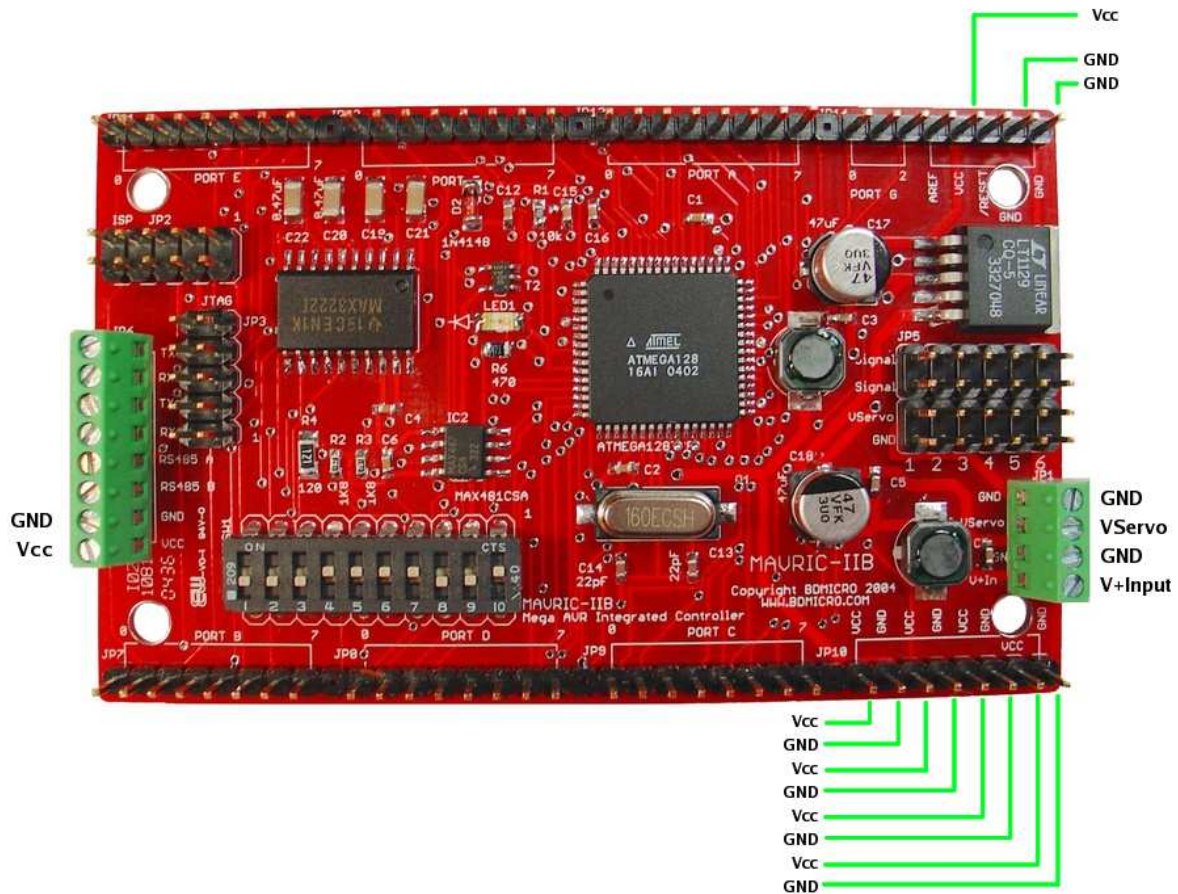
The capabilities of the ATmega128 MCU are numerous. Here are some of the highlights of the chip:

- 128K Flash memory (program space)
- 4K internal static RAM
- 4K EEPROM
- optional 64K external static RAM
- 8 channel analog to digital converter
- dual UARTs
- I^2C interface
- up to 53 digital I/O pins
- JTAG interface for programming and debugging
- 2 8-bit timers, 1 16-bit timer
- 6 PWM channels
- Watchdog timer

For a more detailed look at the ATmega128, the best reference is the datasheet provided by the chip manufacturer, Atmel. The datasheet is available from Atmel in the form of a PDF file here:

http://www.atmel.com/dyn/resources/prod_documents/doc2467.pdf

2 Power Supply Connections



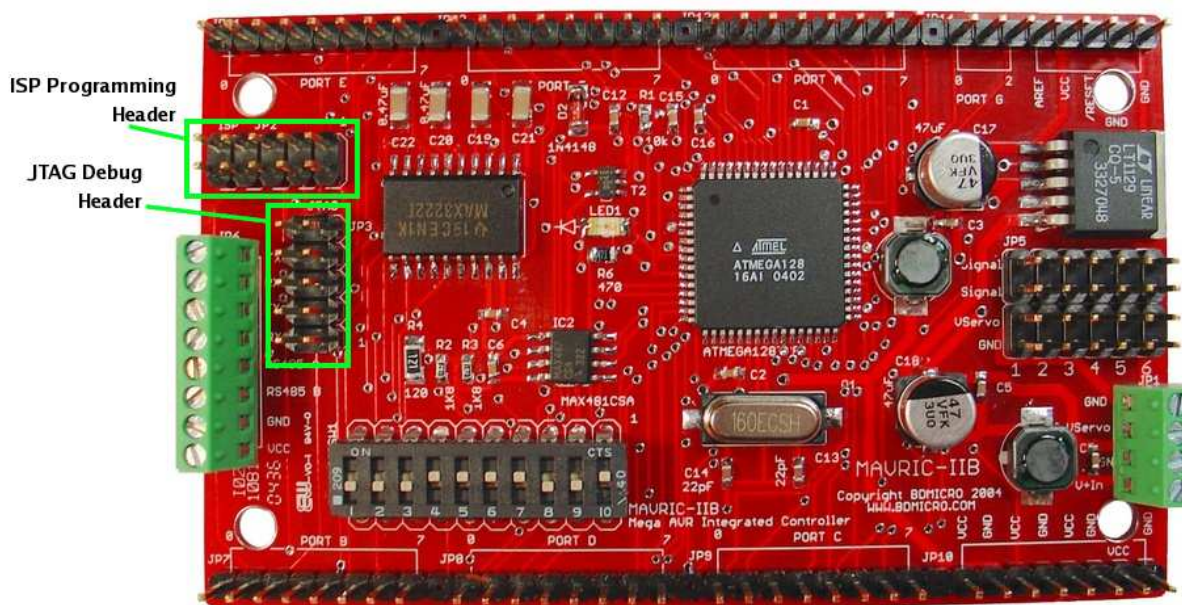
Note that all **VCC** connections are regulated 5.0 Volts, input or output. Connections labeled **V+** are unregulated 5.5 - 24V input and feed into the on-board regulator where it is regulated down to 5 Volts for the board electronics. The **V_{servo}** connection point powers only the 6 servo headers and should be limited to the range of 4.8V - 6V. Some servos can handle a higher voltage, but double check your servo specs before applying a higher voltage.

While the servo headers could potentially be powered from the **V_{cc}** output, one should generally NOT do that because the high instantaneous **V_{servo}** current draw can reset the microprocessor.

One can either supply **V_{cc}** directly from an off-board 5V regulated power supply in which case power into the board should connect directly to one of the **V_{cc}** connection points. Or one can supply the MAVRIC-IIB board with unregulated power input, in which case, it should be applied to the **V+Input** power input terminal. In this case, a small amount of regulated 5V is available for LEDs or low-current sensors from the **V_{cc}** connection points. One should never supply power to both the **V_{cc}** power connection and the **V+** power connection at the same time.

3 In-System Programming and JTAG Debug Headers

The standard 10-pin ISP programming header and the JTAG programming / debug headers are shown below.

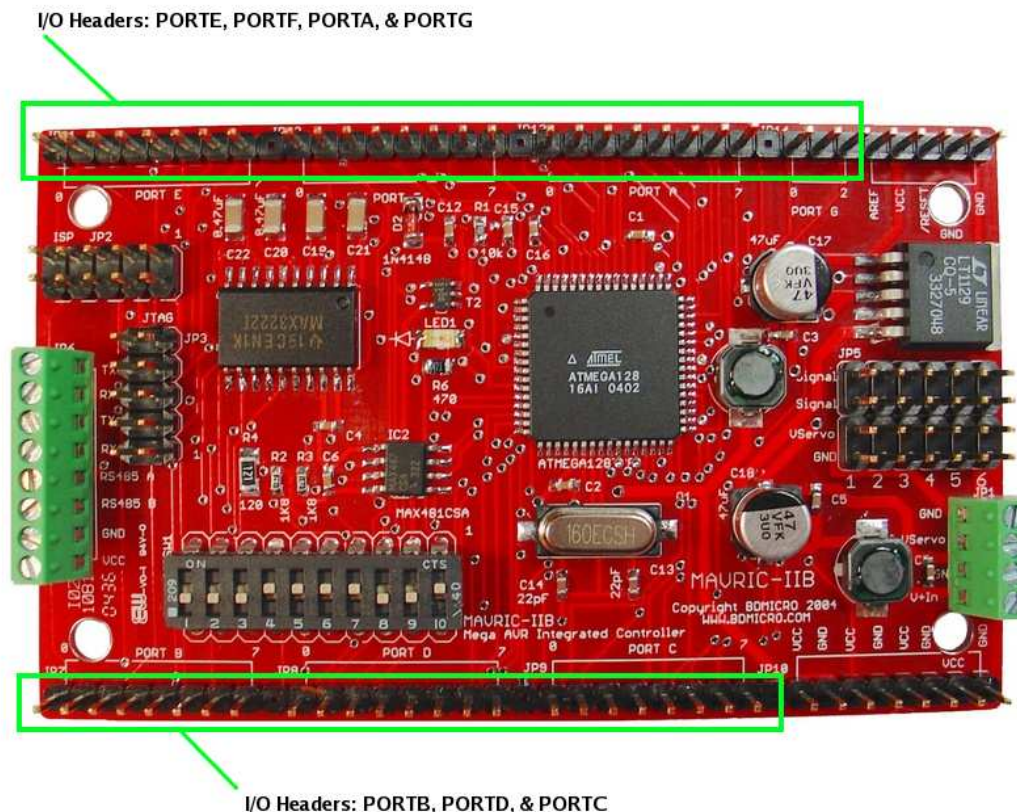


Both headers can be used to download the firmware to the MAVRIC-IIB board. The JTAG header, in addition, can be used to provide source level single-step debugging of your program as it runs natively on the chip itself. The JTAGICE or equivalent programmer is required to utilize the JTAG header.

Many programmers are available for utilizing the ISP programming header. Most are very economical and range from do-it-yourself versions that can be built with just a few resistors and utilize the parallel port of a standard PC, to advanced development boards like Atmel's STK500. One of the best and most economical ISP programmers is the Atmel AVRISP available from several sources including Digikey for around \$30.

4 Port Header Connections

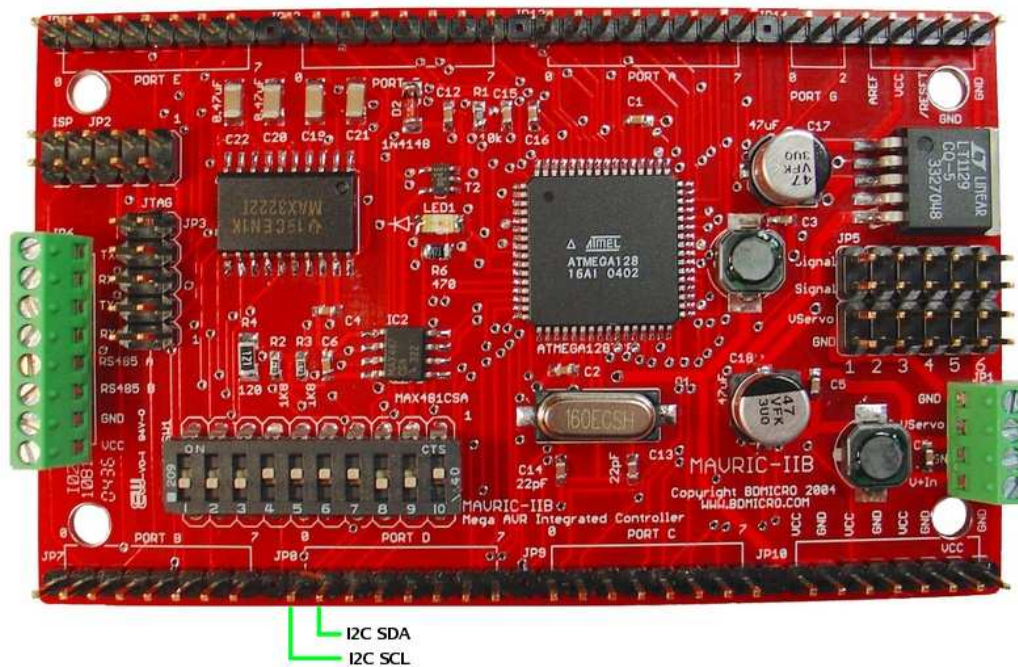
Nearly all ATmega128 port pins are brought out to headers around the perimeter of the MAVRIC-IIB board. The exceptions are PORTG3 and PORTG4, the crystal connections, and the PEN pin. All other pins are brought out. All headers are labeled along the perimeter of the board, and connect directly to the MCU pin of the same name, see the diagram below.



Note that while most pins connect only to the MCU pin, some pins also connect to other chips on the board. These include PORTE0, PORTE1, PORTD2, and PORTD3 which connect to the MAX3222 RS232 level shifter, PORTD0 and PORTD1 which connect to the I^2C bus pull-ups, PORTB1, PORTE0, PORTE1, and /RESET which connect to the ISP programming header, and ports PORTF4-7 which connect to the JTAG programming header. See the schematic diagram for additional information.

4.1 I^2C Connections

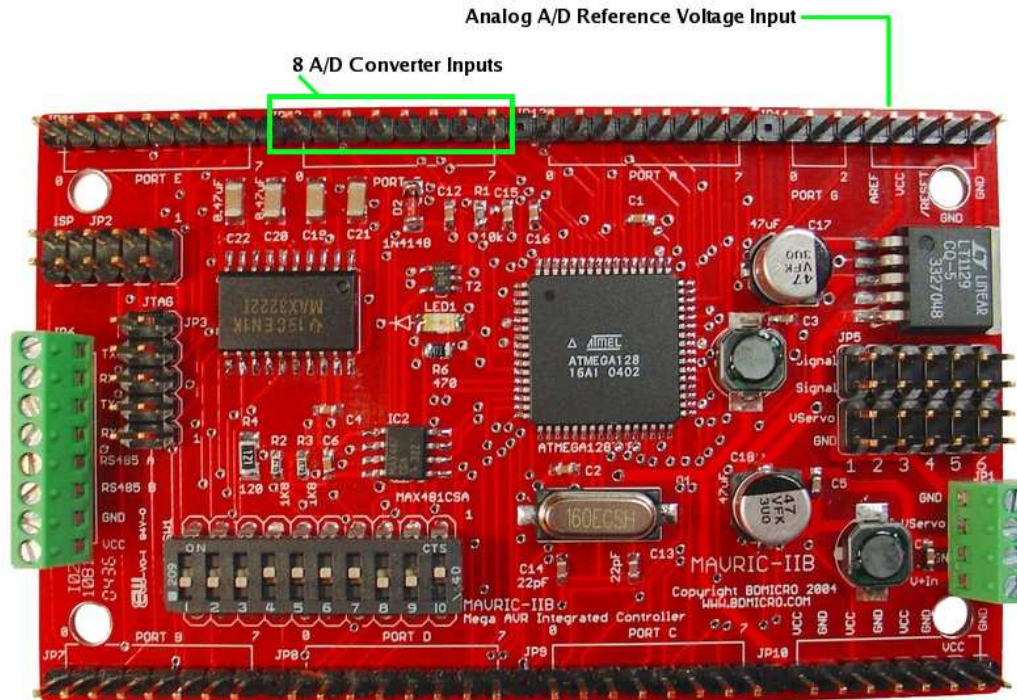
The I^2C bus SCL and SDA connection points are shared with PORTD0 and PORTD1 are shown in the diagram below.



Note that in order to utilize these pins for I^2C , the I^2C pull-ups must be enabled (DIP switch positions 8 & 9 ON), and the I^2C interface must be enabled by your firmware program.

4.2 A/D Inputs and AREF Connection

The A/D Converter inputs are shared with the 8 pins of PORTF as shown below. The AREF reference connection is brought out to JP14 where it is available to connect to a high precision voltage reference for A/D conversions if the on-chip reference provides sufficient precision.



The on-board voltage reference of the ATmega128 remains available and can be configured to match either V_{cc} (5.0V) or set to 2.56V by setting the appropriate bits of the ATmega128's ADMUX register. Note that while the external A/D reference pin is provided, the on-board reference is sufficient for many applications.

4.3 PORTG3 and PORTG4 Connections

PORTG3 and PORTG4 are hard-wired to the RS485 transceiver's /RE (NOT receiver enable) and DE (driver enable) lines respectively. These pins are thus dedicated to controlling the state of the RS485 transceiver's state. The special function of these pins as an alternate clock source for TIMER0 is not available.

5 Serial Communications Connections

The level shifted RS232 and RS485 connection points use convenient screw terminals. These are found on JP6 on the left hand side of the board. Also included on that screw terminal are a V_{cc} and G_{nd} connection point for convenience. See the digram below.



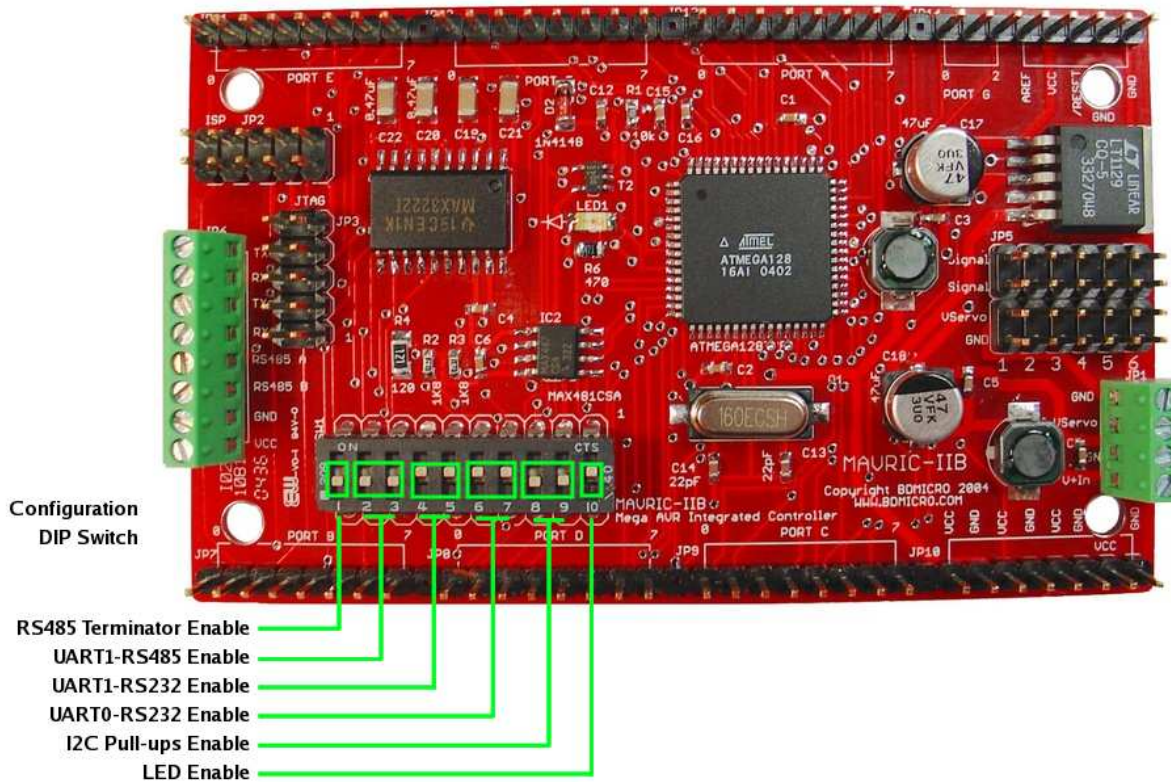
5.1 UART0 Startup Delay

Note that the RS232 level shifter is in a shutdown state when the MCU's /RESET line is active. The purpose is so that the RS232 level shifter does not interfere with ISP programming since they both use the PORTE0 and PORTE1 pins. When the level shifter is in shutdown, its I/O lines are in a high impedance state, and thus does not interfere with ISP programming.

Because the level shifter's charge pump takes a small amount of time to charge, one should not immediately begin sending RS232 communications from the MAVRIC-IIB after program reset. Ensure that at least a few milliseconds elapse after program reset either through normal initialization or through a hard coded delay before initiating any RS232 communications from the MAVRIC-IIB to give the level shifter's charge pump time to reach capacity.

6 DIP Switch Settings

MAVRIC-IIB configuration options are selected using the on-board DIP switch. The DIP switch is used to enable the on-board LED, *I*²*C* pull-up resistors, level shifted RS232 ports, RS485 transceiver, and the RS485 terminating resistor. Refer to the diagram below for the location of the DIP switches.



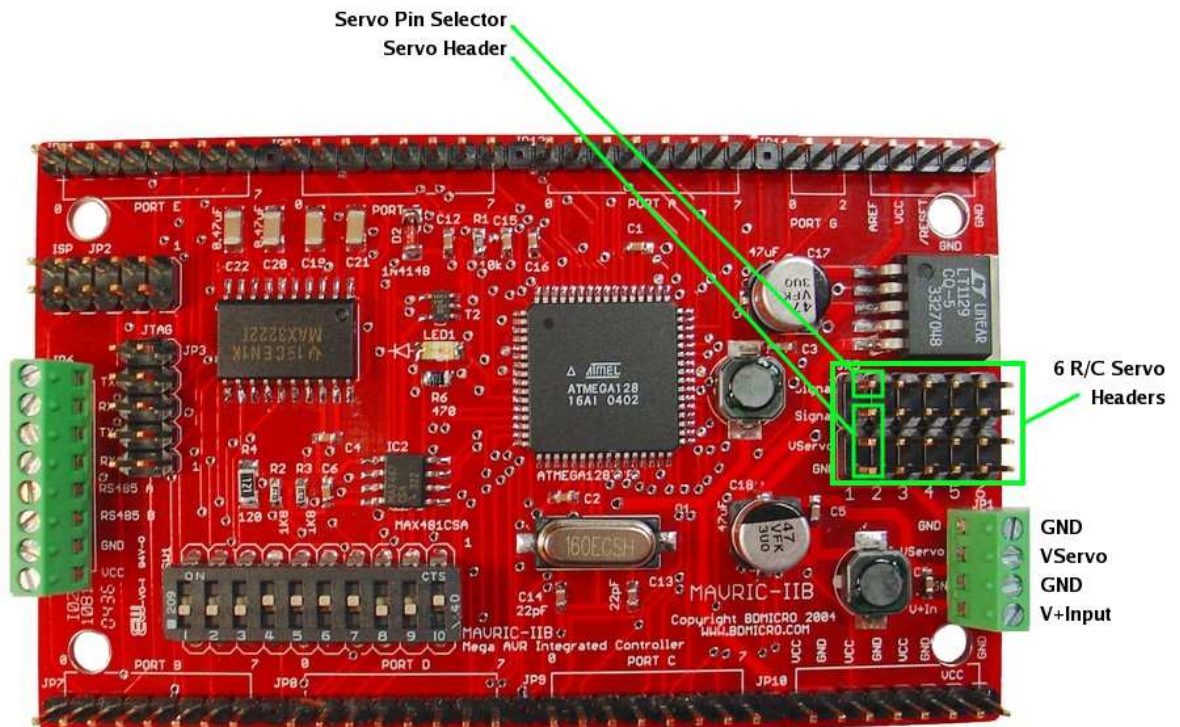
Note that the UART1 RS485 and RS232 selection DIP switches must not be in the “ON” position at the same time. When change the configuration of the UART1 selection, always turn off UART1-RS485 and UART1-RS232 first, then turn on either UART1-RS485 to enable the RS485 interface, or turn on positions UART1-RS232 to enable the RS232 interface. Never turn on both UART1-RS485 and UART1-RS232 simultaneously. See the following table for the settings.

DIP Switch Position	Off	On
RS485 Terminator Enable	RS485 terminator off	RS485 terminator on
UART1-RS485 Enable	UART1 RS485 interface disabled	UART1 RS485 interface enabled

UART1-RS232 Enable	UART1 RS232 level shifter disabled	UART1 RS232 level shifter enabled
UART0-RS232 Enable	UART0 RS232 level shifter disabled	UART0 RS232 level shifter enabled
I ² C Pull-Ups Enable	I ² C bus pull-ups disabled for PORTD0 and PORTD1	I ² C bus pull-ups enabled for PORTD0 and PORTD1
LED Enable	LED not connected to PORTB0	LED connected to PORTB0

7 Servo Headers

The MAVRIC-IIB incorporates 6 servo headers on-board which makes interfacing to R/C servos very easy and convenient. Refer to the diagram below:



Each of the 6 servo connectors is composed of 4 pins as shown. The bottom three pins are labeled *Signal*, *V_{Servo}*, and *GND* and is where the servo connector is connected. The 4th pin located above the servo connector and labeled *Signal* on the MAVRIC-IIB silkscreen and *Servo Pin Selector* in the diagram above is used to select which ATmega128 pin is used to drive that servo. This layout was chosen because most of the ATmega128's available I/O pins are shared with at least one of the chip's special peripheral features. This layout allows you to choose which of the ATmega128 pin(s) are used for driving servos, as opposed to hard-wiring the servo signal to certain pins, which would otherwise make the special peripheral feature of that pin unavailable to your application. Thus, you should wire the *Servo Pin Selector* pin for each servo connector to the ATmega128 pin of your choosing for driving that servo. In this way, you have greater flexibility to allocate the ATmega128's on-chip resources to precisely match your application's needs.

8 Fuse Bit Settings

Atmel AVR processors incorporate *fuse bits* which control various functions of the chip and persist even across a chip erase. By default, Atmel ships the ATmega128 with several fuse bits already programmed by default. Notably, the M103C fuse bit (ATmega103 compatibility mode) is enabled, as well as JTAGEN which enables the JTAG debugging lines of PORT F. Also, by default, the internal clock source is selected to run the processor at 1 MHz.

If you ordered a Kit, your ATmega128 processor's fuse bits are all at their default values and will need to be changed to run on the MAVRIC-IIB board at 16 MHz. For 16 MHz operation, you will need to program the CKOPT fuse bit (set to '0'). The clock selection lines will need to be modified as well: unprogram CKSEL3, CKSEL2, CKSEL1, and CKSEL0 (set to '1'). Also recommended when using the external crystal is to set SUT1 and SUT0 to '1' (unprogrammed). This setting is for slow rising power which may be necessary depending on your power supply. Additionally, you will need to unprogram the M103C fuse bit (set to '1') if you are compiling your code to run on an ATmega128 (as opposed to an ATmega103).

If you ordered an assembled and tested board, these fuse bits are already set appropriately to run at 16 MHz, and the M103C fuse bit has been unprogrammed.

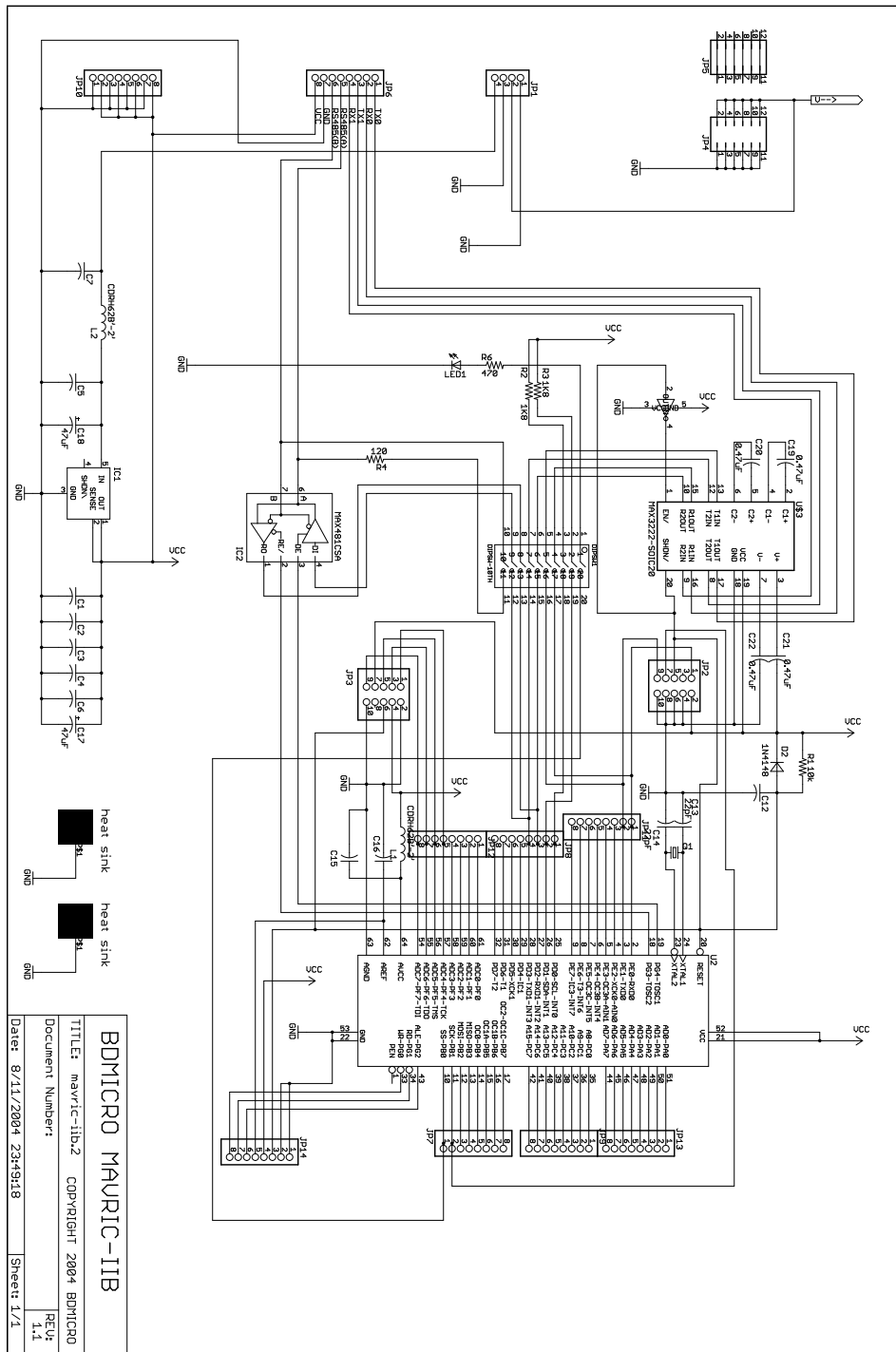
One other note with regard to fuse bits — the JTAG interface uses the upper nibble of PORT F, and the JTAGEN fuse bit is programmed by default. Since the JTAG interface supersedes all other functions of the PORT F lines, their other functions are not available while the JTAGEN fuse bit is programmed. Thus, if you are not using a JTAG programmer/debugger, you may wish to unprogram the JTAGEN fuse bit. We leave the JTAGEN fuse bit in its default programmed state since the recipient of the board may only have a JTAG programmer/debugger. If JTAGEN was unprogrammed, those with JTAG programmers would have to find another type of programmer (serial or parallel) in order to change the state of the JTAGEN bit, just so they could begin working on the board.

For a description of all the fuse bits, see pages 286 and 287 of the ATmega128 data sheet available from Atmel's web site (<http://www.atmel.com/>).

9 Memory Expansion

The MAVRIC-IIB board has 4K of internal static RAM via the ATmega128 processor. While 4K of SRAM is considered large for a microcontroller, some applications are memory intensive and require more. For this purpose, BDMICRO offers the **MAVRIC-II-RE** product, a RAM Expansion card that can be plugged in over the right half of your MAVRIC-IIB board. The MAVRIC-II-RE expands the memory capacity to 128K of RAM. In order to use the MAVRIC-II-RE, pin headers must be installed in JP9, JP10, JP13, and JP14. The MAVRIC-II-RE is available on-line from BDMICRO at <http://www.bdmicro.com/>.

10 Schematic Diagram



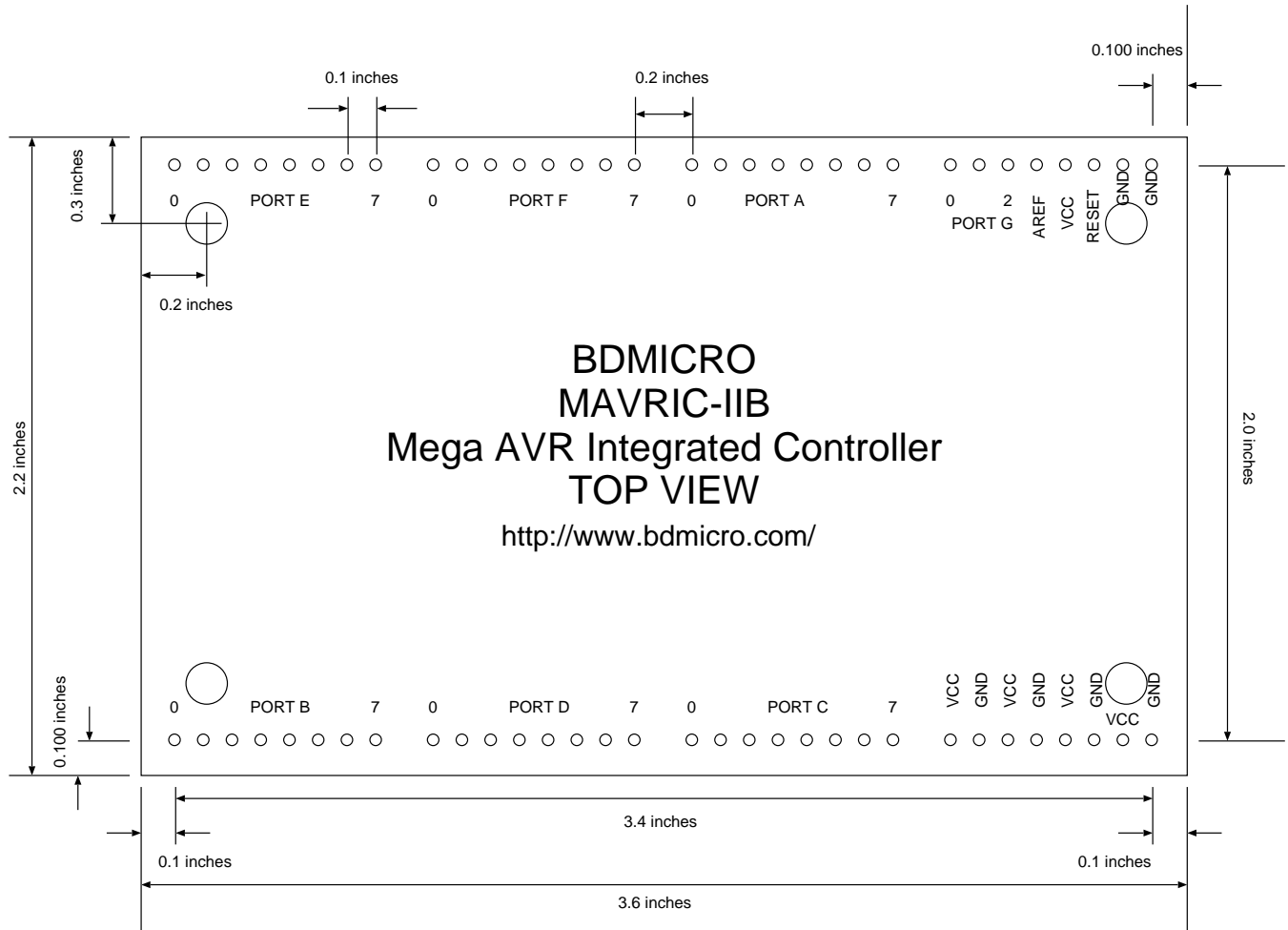
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11 Mechanical Drawing



12 Soldering the MAVRIC-IIB Board

If you purchased a bare board or a kit with a bare board, you will be soldering the components on the board. A small diameter solder such as 0.015 inches works well for the small surface mount parts. A temperature controlled iron also makes the job easier. If your vision is not the best (like mine), I've found that a magnifying visor helps a great deal. A short tutorial with some photos is available on the web site at <http://www.bdmicro.com/smt/>. The main points to remember are:

- Use your solder sparingly, it takes only a tiny amount to make a good connection.
- Don't use your soldering iron directly to melt the solder. Doing so causes the solder to bead up due to surface tension on the iron and then release in a big drop across the pins. This results in too much solder and causes bridging, shorting adjacent pins together.

Instead, use your iron to heat the pin, which then melts the pad underneath the pin. At this point, touch your 0.015 inch solder to the base of the pin. It should melt very quickly, consuming only one or two millimeters of solder, and flow onto the pin and around the pad. Remove the solder quickly.

- Make sure your iron is hot — about 630 degrees F seems to be about right. It needs to be hot enough to melt the solder indirectly, but not so hot that it damages the part.
- While not absolutely required, a good temperature-controlled soldering iron can make the process go much easier than with the standard soldering pencil type irons. If you plan to do much soldering, especially the smaller parts, it would be well worth your investment to acquire one. In fact, good deals can usually be found on on-line auction sites such as E-Bay.

The order in which you solder the parts can make the soldering easier. In general, I solder the parts based on size with the smaller parts first followed by successively larger parts. Thus, I install the surface mount capacitors, resistors, and diodes first, followed by the ICs, the larger surface mount caps and inductor, crystals, and finally the pin headers.

A good technique that I've found for soldering on even the tiniest of surface mount parts is this simple procedure, especially for tiny resistors and capacitors:

- First, prepare one pad by heating it with the tip of your soldering iron and flowing a bit of solder onto the pad. This will make a raised solder surface. Only do one pad at this point, not both.
- Use a pair of fine tweezers to move the part into position.
- Use the tip of your fingernail to hold the part in place, then re-apply heat to the raised solder area. The solder will liquify and the part will sink into position and be held firmly in place by the solder.
- Now move to the unsoldered side and apply a bit of solder to complete the connection.
- Finally, if necessary, return to the first side of the part, and re-apply a tiny bit of solder to ensure a good connection there.

This technique is described on the web site with photos for clarification. See <http://www.bdmicro.com/smt/>.

You can save time by first preparing one pad of each part by applying solder, then attach one side of all the parts, then solder the other side of all the parts, etc, instead of performing all the steps for a part before moving to the next one.