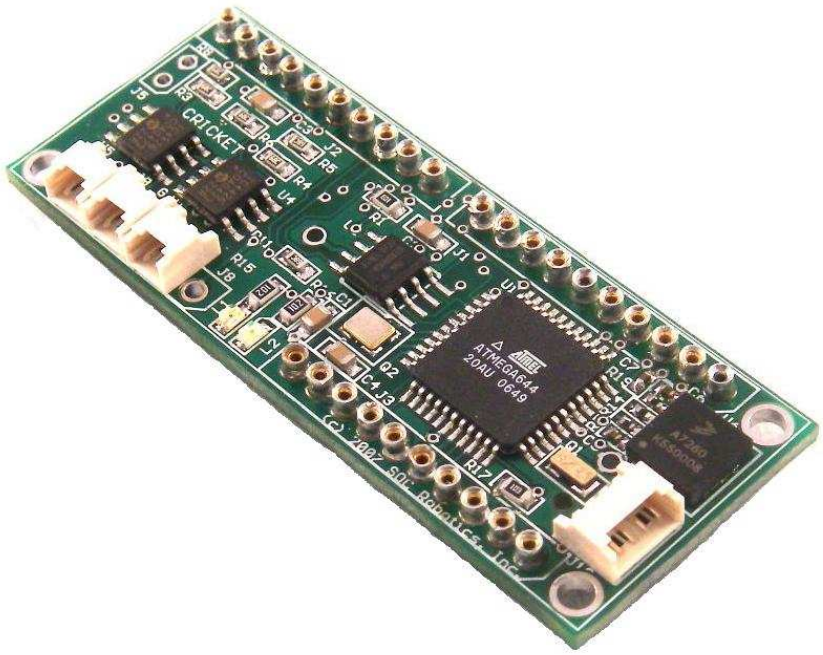
Cricket Embedded Processor

Dual H-Bridge/Bipolar Stepper Controller

Technical Reference Manual

PCB Rev 1.0



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December 2008

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1935A–08/00/5M

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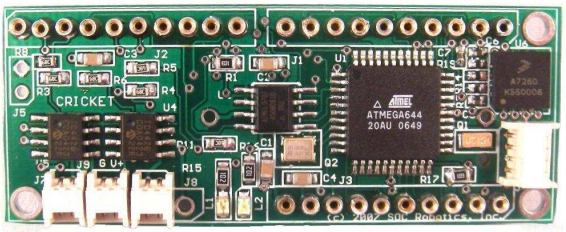
1.0 Introduction

Features:



- 8bit RISC AVR Processor (ATmega644)
- 10MHz External crystal oscillator
- 8ch 10 bit A/D
- 15 Digital IO
- SPI Port
- TWI I2C Port
- 64K Internal Program Flash
- 2K Internal EEPROM
- 4K Internal SRAM
- ISP Programming Port
- Machine pins on J1, J2, J3 to enable stacking
- 32.756KHz External Clock crystal
- GNU C Compiler, Third Party Commercial C Compiler
- Example application included for rapid application development
- Extremely Small form factor (2.3x0.9 in)
- 1.8-3.3VDC @ 12ma Power input
- Optional Components:
    - Temperature Sensor
    - 3-Axis Accelerometer
    - 512K/1M/2M/4M/8Mbyte External Serial Flash
    - 20MHz Crystal (no Serial Flash or Accelerometer)

Hardware

The **Cricket with 3-Axis Accelerometer** is an extremely compact embedded processor with Dual 1.5A H-Bridges for control of DC motors while monitoring acceleration in all 3-axis - the perfect combination for your next balancing robot application. The Cricket is powered by ATmega644 processor. The ATmega644 has the benefit of being able to generate an interrupt on any pin transition (low to high or high to low). The processor has internal Flash, SRAM, EEPROM, SPI, TWI (I2C), UART, 8 channel 10bit A/D and general purpose IO. The Cricket also has an internal 8MHz oscillator but is shipped with an external 10MHz crystal. An external 32.756KHz crystal is provided on the board enabling a real time clock for timed software execution.

The Cricket consumes about 12ma in active state and about 0.6ma in standby. By changing the internal clock and reducing power to certain peripherals it is possible for the Cricket to operate with very low power consumption. The Cricket is programming using an ISP Programming Adapter such as the ISP10.

The Rev 1.0 PCB has connectors J1, J2 and J3 on 0.1" pin spacing so prototype daughter cards can easily be attached to the top or bottom of the board making custom circuit design possible without the need for a custom PCB. Included on the CD is an Eagle CAD layout template of the connectors to facilitate the development of custom circuits.

Optional Serial Flash and a 3-axis accelerometer are available. Installation of these options is done at the factory and limit the processor to 10MHz and 3.3V.

Software

The **Cricket** is programmed in C using either a GNU C Compiler, AVR Studio V4.13 or higher with GNU C integrated with the IDE or a third party IDE such as ICCAVR from ImageCraft. The ATmega644 may not be programmable with ICCAVR so a special utility (ISProg.exe) is available to program the processor. Check the SOC Robotics web site www.soc-robotics.com for program examples and ICCAVR project files. ICCAVR project files are on the included CD. Example code is provided to read the accelerometer, communicate on the I2C port, run the H-Bridges and how to use the UART. The example Project files that come with the Cricket were written using the ImageCraft ICCAVR Windows IDE. With the release of AVR Studio V4.13 the open source AVR GNU C Tool chain is now integrated with the AVR Studio V4 Windows IDE and is recommended for cost sensitive development projects. The ImageCraft IDE is a low cost commercial C development environment and includes support for 64bit floating point operation in the PRO version.

Configurations

The **Cricket** is available in several configurations. The table below summarizes the different Cricket configurations. Note that in order to run at the maximum clock speed of 20MHz the board must be powered at 5V. Crickets with 3.3V peripherals must be powered at 3-3.3V and consequently can only run at 10MHz. The Cricket is shipped with a 10MHz crystal installed.

Configurations with Serial Flash have a choice of Flash size – see the table below.

Flash Size (bytes)	Chip Designation
512K	AT45DB041D
1M	AT45DB081D
2M	AT45DB161D
4M	AT45DB321D
8M	AT45DB642D

The optional 3-axis accelerometer must be installed at the factory.

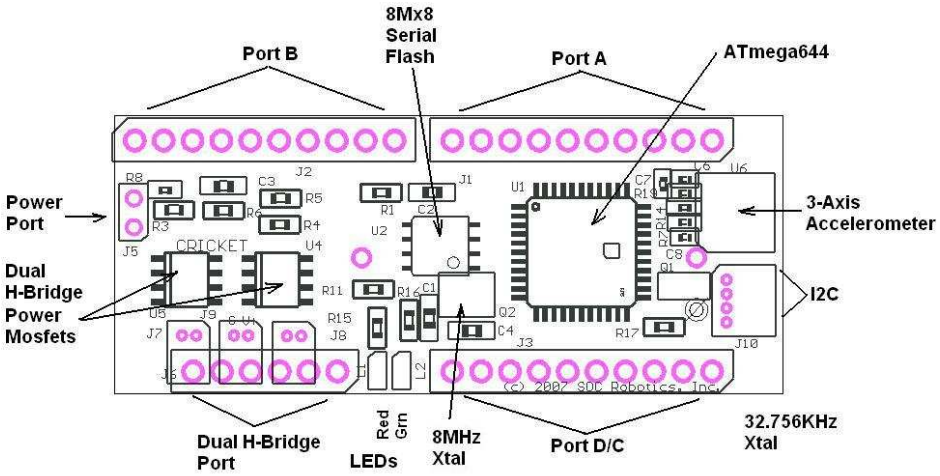
There is also an optional battery holders – 1/2AA (3V).

2.0 Cricket Detailed Description

2.1 Introduction

The Cricket is an extremely compact embedded processor for mobile data acquisition, control and monitoring applications. Programmed in C and powered by a standalone battery the Cricket is an excellent embedded processor platform for small mobile applications that require two dual H-Bridge control.

Cricket Key Features



2.2 Processor

The Cricket has an 8bit RISC AVR processor. The Cricket accepts either an ATmega16, ATmega32 or ATmega644 with 16K, 32K or 64Kbytes of internal Flash, 1K, 2K or 4Kbytes of internal SRAM or 512, 1K or 2Kbytes of internal EEPROM. Each processor has a UART, SPI port, TWI I2C, 8 Channel 10 bit A/D, digital IO ports, interrupts and timer/counter pins. A detailed device datasheet is available from the Atmel web site providing very detailed information on the internal peripherals. The Cricket is shipped with an Atmega644 installed.

The Cricket has a pad for an external crystal – the default crystal is 10MHz although an optional 20MHz crystal is available. Note that the ATmega644 requires 5VDC to run at 20MHz. Check the configuration of the Cricket before powering at 5VDC so no installed components are damaged.

Nominal power consumption of the board is 12ma. If internal peripherals are turned off and the processor placed in a sleep state power drops below 1ma.

2.3 Real Time Clock

A 32.756KHz clock crystal is connected to pins PC6/7 driving internal Timer 2. By setting up an interrupt routine on TIMER2 it is possible to create a time of day real time clock or to calibrate the internal 8MHz oscillator. The real time clock can be configured to wake the processor from a sleep state to reduce power consumption dramatically.

2.4 External Serial Flash

The Cricket has a pad for an optional Serial Flash. The AVR communicates with the Serial Flash using the SPI lines. The Cricket is compatible with the AT45DB041 (512Kx8), AT45DB081 (1Mx8), AT45DB161 (2Mx8), AT45DB321 (4Mx8) and AT45DB642 (8Mx8). The Serial Flash requires 3-3.3VDC so if this component is installed the Cricket should not be powered above 3.3V.

2.5 TWI Port

The Cricket has a TWI I2C port for communicating with smart peripherals or other I2C peripherals. The TWI port uses a 4 pin Molex picoBlade connector with power and ground so the Cricket can power other peripherals or be powered itself via this connector.

2.6 Expansion Ports

The Cricket has three expansion ports. PORTA, PORTB and PORTC/D - PORTA has analog inputs, digital IO, PORTB has SPI and PORTD has UART and TWI. The Cricket is supplied with small machine pins that allow mounting on both sides. These can be removed or be replaced with 0.1" pin headers.

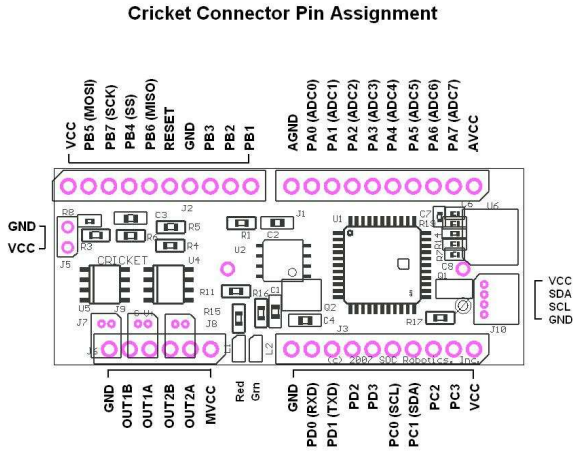


Figure 2-2. **Cricket Expansion port pin assignments.**

2.7 Battery Holder

The Cricket can be configured with an optional 1/2AA 3V battery holder. The battery holder mounts on the back of the Cricket. Ensure the 1/2AA battery holder is installed with the correct polarity – there is no reverse polarity protection power diodes on the Cricket board and incorrect installation will damage the board.

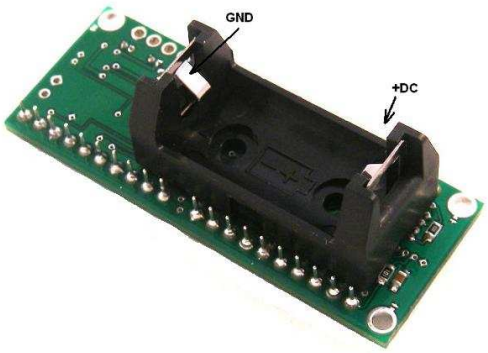


Figure 2-3. **1/2AA Battery Holder and polarity.**

2.8 ISP Programming

The Cricket is programmed using an ISP10 Parallel Port programming adapter or any 10pin Atmel ISP compatible programming adapter. The Cricket is supplied with a CISP adapter that converts the Cricket programming pins on J2 to an Atmel compatible 10pin adapter. The CISP attaches to connector J2 located on the top edge of the board – attach as shown in the picture below. The Cricket can also be programmed using a USB10 USB 2.0 peripheral.

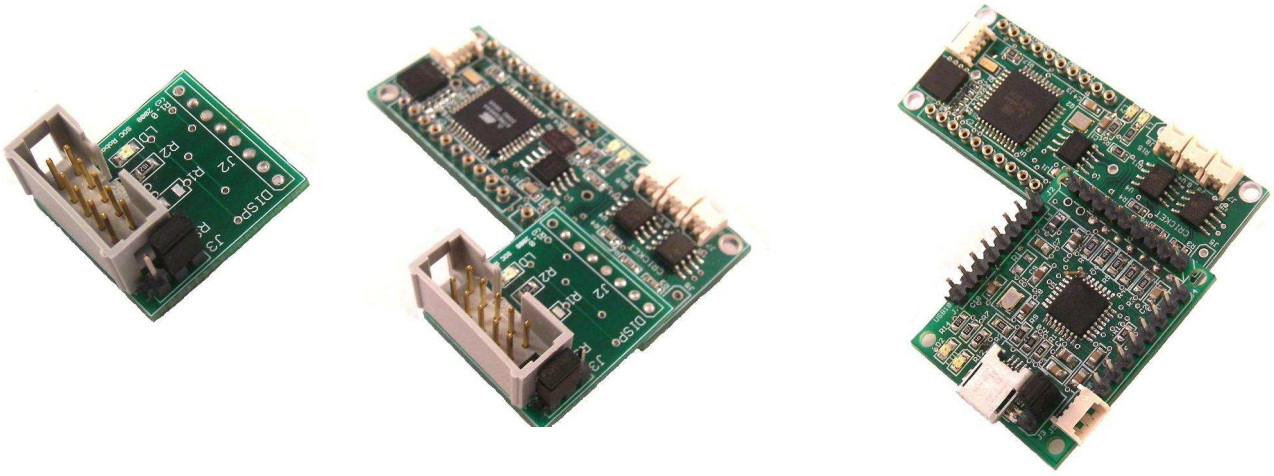


Figure 2-4. **CISP ISP and USB10 attached to the Cricket .**

2.9 Optional Components

The Cricket has pads for three optional components – Serial Flash, 3-axis accelerometer and temperature sensor. Temperature sensor R10 is located on the bottom of the board.

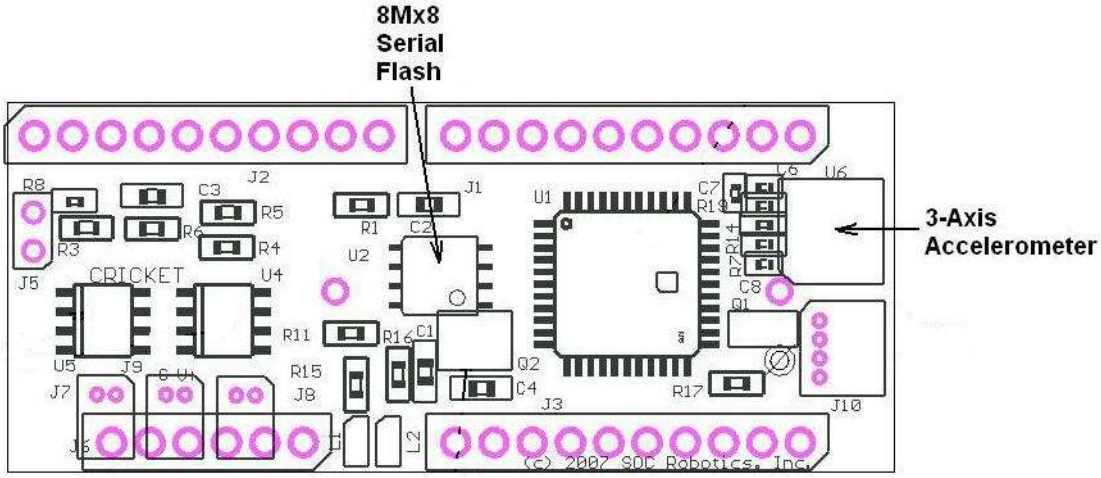


Figure 2-5. **Optional sensor locations and components installed on Cricket.**

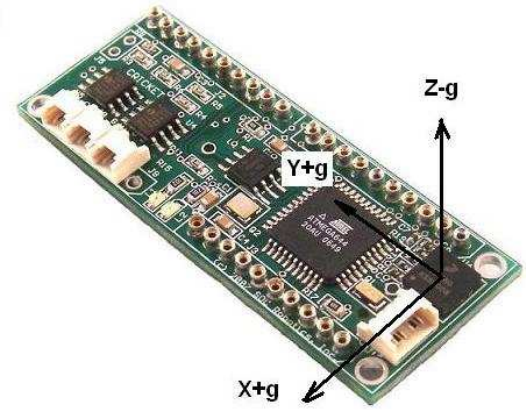
Serial Flash

The optional Serial Flash is available in several sizes: 512K8x, 1Mx8, 2Mx8, 4Mx8 and 8Mx8. The Serial Flash runs at 3.3V so the Cricket can not be powered at more than 3.3V if this option is installed.

3-Axis Accelerometer

The optional 3-Axis accelerometer is a Freescale Semiconductor MMA7260. The MMA7260 has four programmable acceleration ranges- 1.5G, 2G, 4G and 6G set by the ATmega644. The MMA7260 operates from 2.2 to 3.6Vdrawing 500uA so the Cricket should not be powered higher than 3.6V when the accelerometer is installed. The accelerometer has a sensitivity of 0.02g (1.5g setting), a bandwidth of 350Hz (XY) 150Hz (Z), non-linearity less than 1% and a cross-axis sensitivity less than 5%.
The accelerometer is oriented with the X+ on the long axis of the PCB toward Port A connector J1, Y+ on the short axis of the PCB toward Port B connector J2 and Z+ pointing up out of the board.

3-Axis Accelerometer Axis Orientation



Temperature Sensor

The optional temperature sensor is a 50K thermistor mounted on the bottom of the board in a series divider configuration. Voltage divider output is connected to ADC3.

2.10 Molex Connectors

The Cricket uses two small Molex picoBlade 4 pin and 5 pin male connectors with 1.25mm pin spacing (4 pin Molex Part No. 53048-0410 - Digikey Part No. WM1744-ND - 5 pin Molex Part No. 51021-0500 – Digikey part no. WM1745-ND). These connectors mate with female Molex 4 and 5 pin housing connectors (4 pin housing Molex Part No. 51021-0400 - Digikey Part No. WM1722-ND – 5 pin housing Molex Part No. 51021-0500 - Digikey Part No. WM1723-ND).

The housing connectors has two different crimp terminal types: 26-28AWG (Molex Part No. 50079-8000 - Digikey Part No. WM1722-ND – Crimp tool 63811-0300) and 28-32AWG (Molex Part No. 50058-8000 - Digikey Part No. WM1775-ND - Crimp tool 63811-0200).

2.11 H-Bridge/Bipolar Stepper Motor Port

The Cricket has two 1.5A 4.5-18VDC Dual H-Bridge drivers that can, using PWM, control the speed and direction of two DC motors or be configured in software to control a single bipolar stepper motor. Power

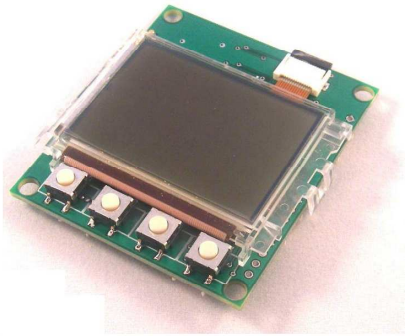
to both H-Bridge drivers is supplied to connector J7. J7 is not polarity protected so ensure power is correctly connected or the H-Bridge drivers could be damaged.

ATmega644 port pins PC5 and PC4 connect to Motor A H-Bridge pins INA and INB respectively. Port pins PD7 and PD6 connect to Motor B H-Bridge pins INA and INB respectively. In order to regulate speed Port pins PC5 and PC4 must be controlled by software to create a PWM sequence. Port pins PD7 and PD6 are internally connected to Timer 2 PWM output signals OC2A and OC2B respectively so once setup by software the PWM output runs without processor involvement.

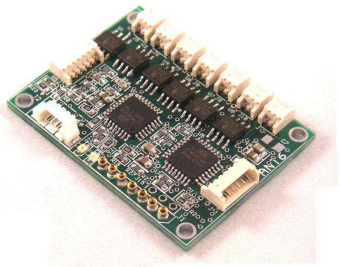
A high level on INA or INB drives the output low and vice versa. So no current flows if both inputs are high or low and current flows from OUTA if INA is high and INB is low.

2.12 Related Peripherals

The **Cricket** attaches to or can communicate with other SOC Robotics Embedded Processor devices such as the **SmartLCD**, **USB10**, **Ant6, LED8** and other peripherals.



. SmartLCD display that communicates via I2C.



Ant6 6 Channel H-Bridge Controller

2.11 Applications

The **Cricket** is a small, battery powered, low power, embedded processor with up to 8Mbytes of serial flash for storage of data measurement data, 8 10 bit analog input channels and up to 14 digital IO channels. The two H-Bridge drivers allow the Cricket to control two small DC motors or a single Bipolar Stepper Motor.

The USB10 provides a simple high speed communications interface with a PC for rapid transfer of data to the host PC. The USB10 also allows the PC to program the Cricket without the need for an ISP10 CISP combination.

Crickets can be stacked to increase processing horsepower and drive more H-Bridges. For example ten stacked Crickets operating at 5V would have a combined processing speed of 200MIPs, or a combined storage capacity of 80mbytes at 3.3V. The picture below shows two stacked Crickets. By stacking Crickets processing power can be increased in increments ensuring that a Cricket solution can address a wide range of embedded processing applications.

3.0 Cricket Hardware Expansion Port Summary

3.1 Introduction

The Cricket has three I/O expansion ports, power port, I2C and H-Bridge/stepper port as shown in the connector layout diagram below.

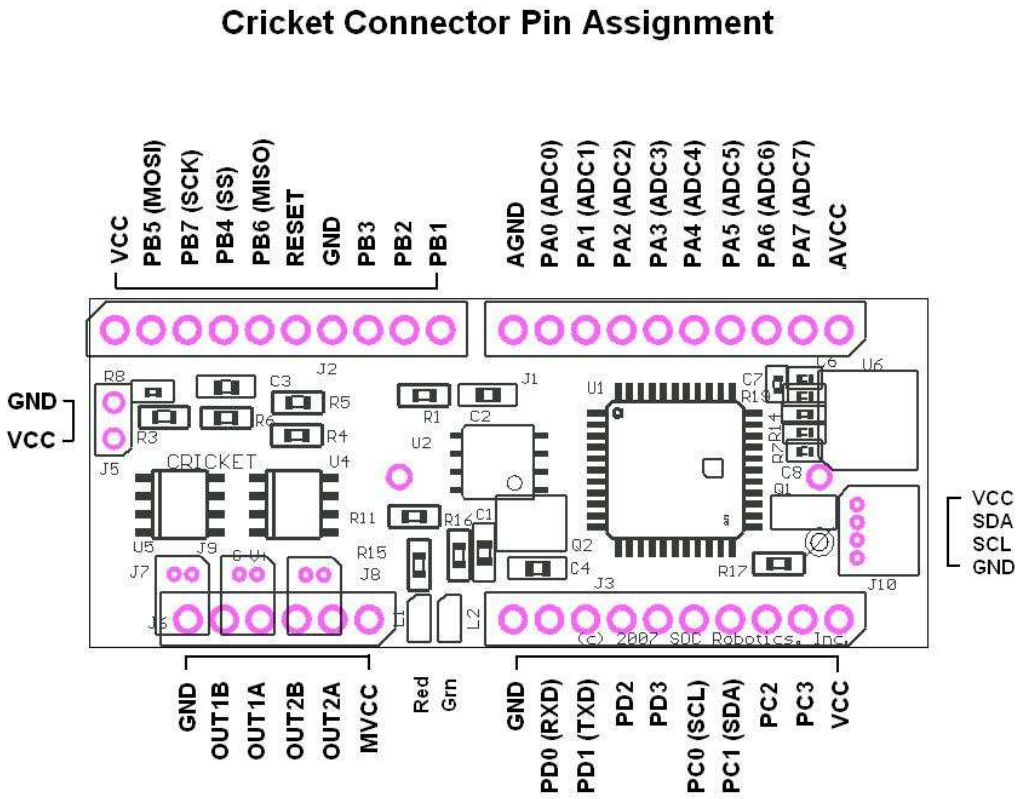


Figure 3-1. **Cricket port pin assignments.**

3.2 Expansion PORT A

AVR PORTA is routed to connector J1. Port A can be configured on an individual pin basis to be either an analog input or digital IO.

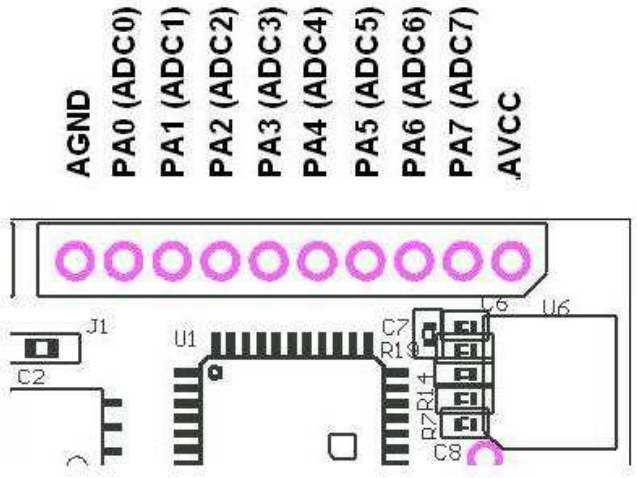


Figure 3-2. **PORTA Pin Assignment J1.**

3.3 Expansion PORT B

AVR PORTB is routed to connector J2. Port B can be configured in software to be an SPI port or general purpose digital IO on an individual pin basis.

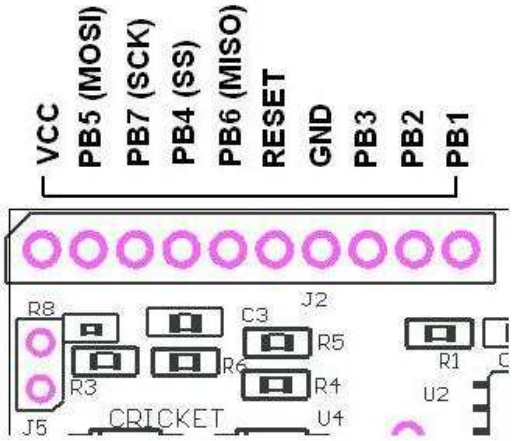


Figure 3-3. **PORTB Pin Assignment J2.**

3.4 Expansion PORT C/D

AVR PORTS C/D is routed to connector J3. Port C has an I2C port and general purpose digital IO. Port D has the full duplex UART and general purpose digital IO. Port operation is set by software.

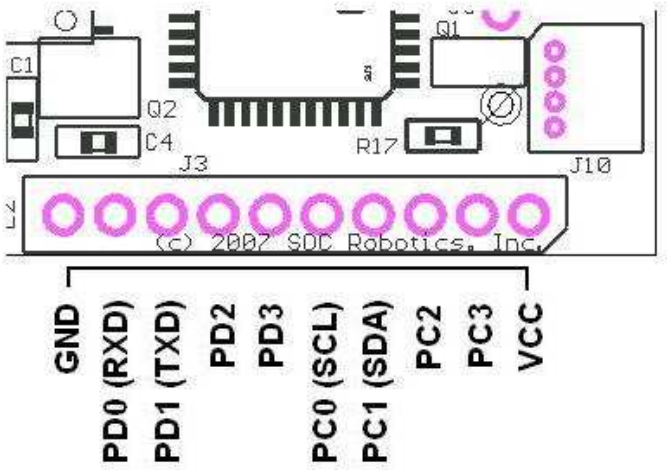


Figure 3-4. **PORTC/D Pin Assignment J3.**

3.5 TWI I2C Expansion Port

The TWI I2C lines are routed to a 4 pin Molex connector J10 (4 pin Molex picoBlade connector). J10 is compatible with the SOC Robotics Smart Peripheral family of motor controllers, LCD displays and data acquisition modules.

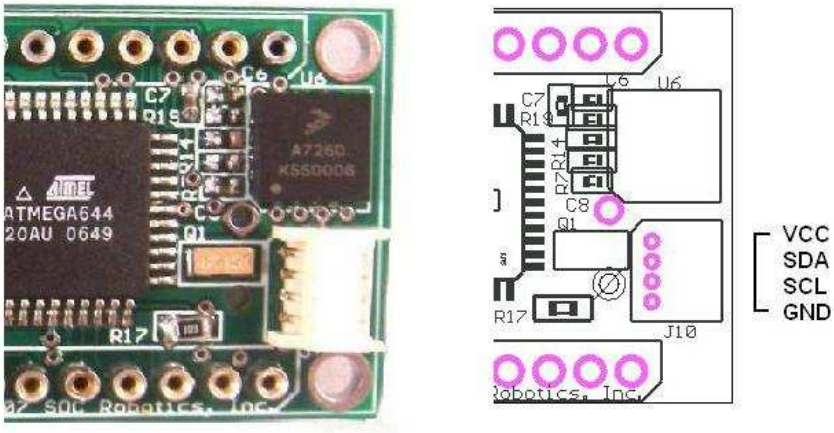


Figure 3-5. **TWI I2C Port with 4 Pin Molex picoBlade Connector.**

3.6 Board Power Connector and Battery Holder

Cricket power may range from 1.8 to 5VDC. Voltage level should not exceed 3.3V if the serial flash or accelerometer is installed. Power connect J5 is indicated in the picture below. A 1/2AA battery holder can also be mounted on the board providing complete mobility. Power may also be supplied to the Cricket through the I2C connector J10.

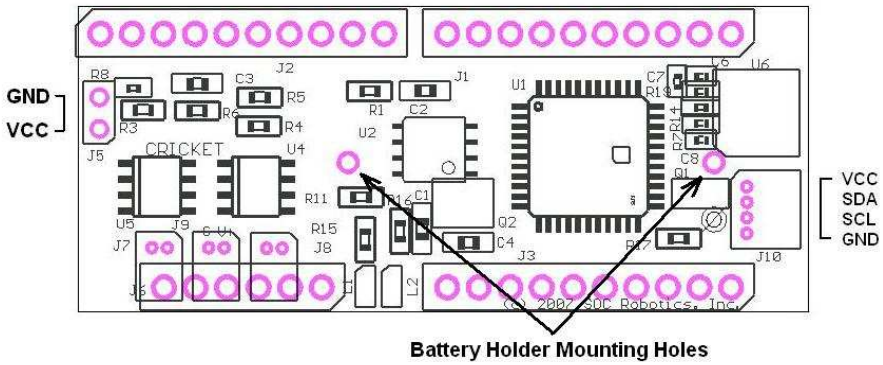


Figure 3-7. **Cricket Battery Mounting holes and Power Connector.**

3.7 ISP Programming Port

The ISP Programming port is on connector J2. See the Atmel ISP programming specification for detailed ATmega16/32/644 programming procedures. The CISP converts the 7 pin ISP signals to a standard 10 pin Atmel ISP header. The ISP10 parallel port ISP programmer (Figure 3-9) is used to program the Cricket using anyone of the following software utilities - ISProg.exe (SOC Robotics, Inc utility), AVRDude, ICCAVR IDE or PonyProg. The USB10 can also be used to program the Cricket.

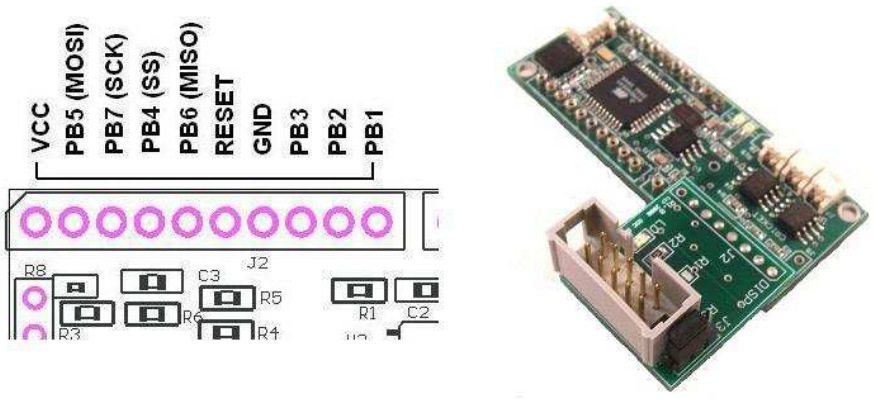


Figure 3-8. **ISP Programming Port and CISP Adapter Connection.**

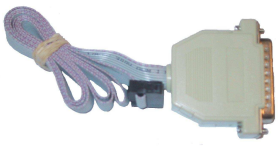


Figure 3-9. **ISP10 Programming Adapter.**

3.8 H-Bridge/Stepper Motor Port

The Cricket has two dual H-Bridge drive circuits that can be configured in software to be a single bipolar stepper motor driver or two dual H-Bridge circuits. Each H-Bridge (TC4426) is capable of 1.5A at 4.5-18VDC (with suitable forced air cooling). Two connector options are available – Molex picoBlade connectors or a standard 0.1″ pin header.

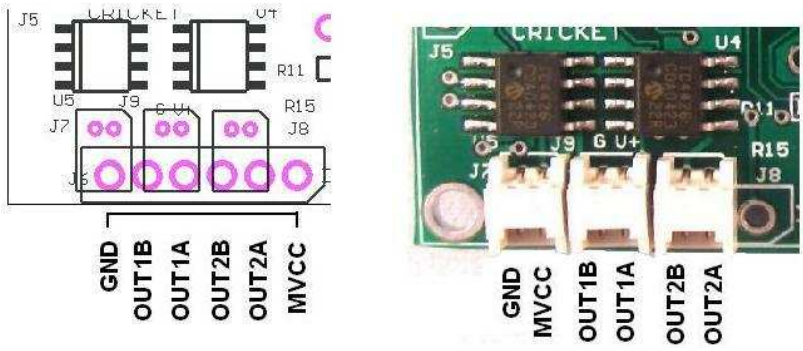
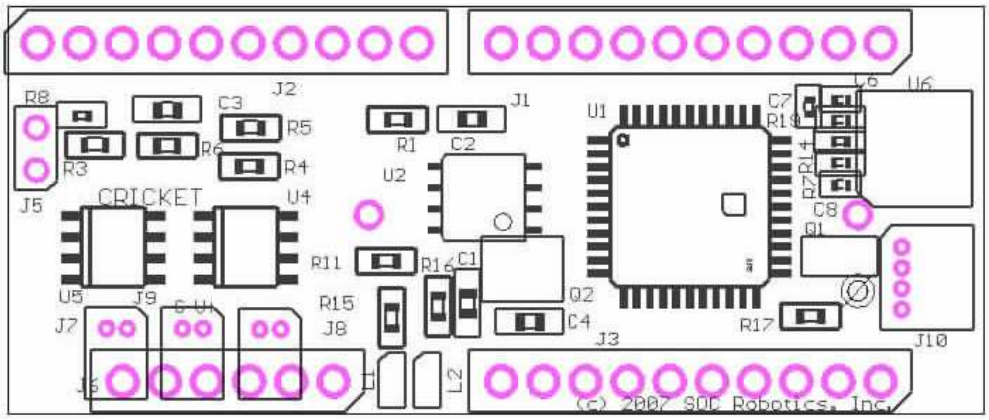


Figure 3-10. **Cricket H-Bridge/Bipolar Stepper Control Port.**

4.0 Electrical and Mechanical Description

4.1 Component Layout

Components are mounted on both sides of the board. Not all components may be mounted. See the section on optional components for more information.



4.2 Electrical Specifications

Electrical

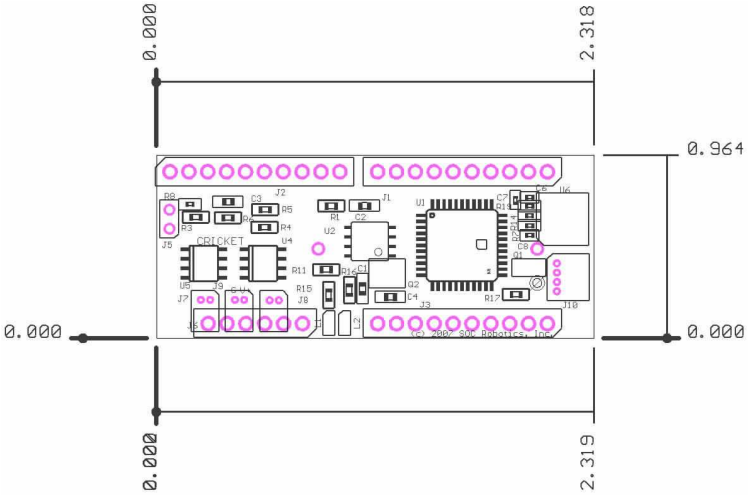
Input power: 1.8-5VDC @ 12ma
Voltage is limited to 3-3.3VDC when Serial Flash and Accelerometer installed

Mechanical

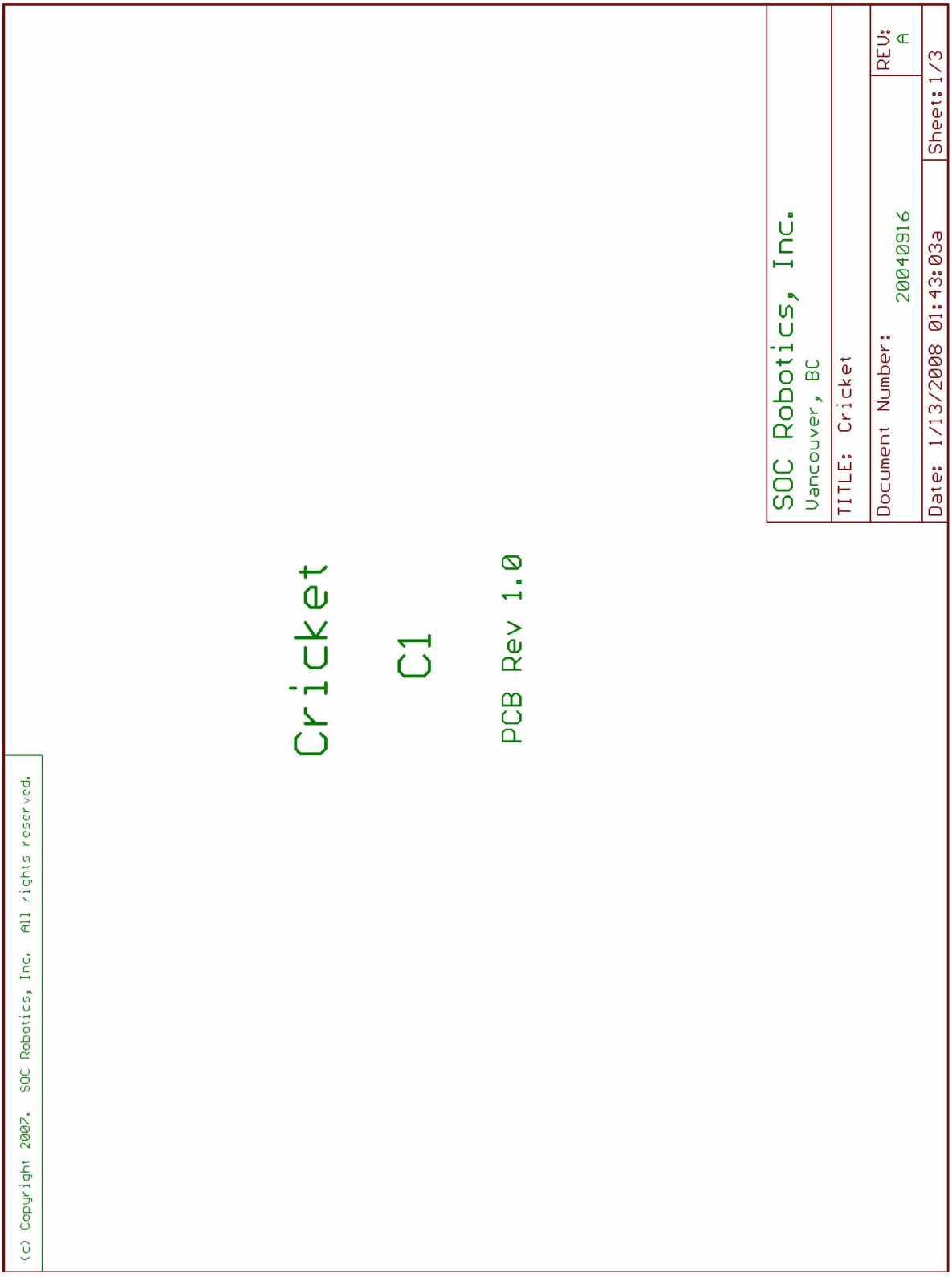
Dimensions: 1.47x1.15 in (one mounting hole)
Weight: 6 grams

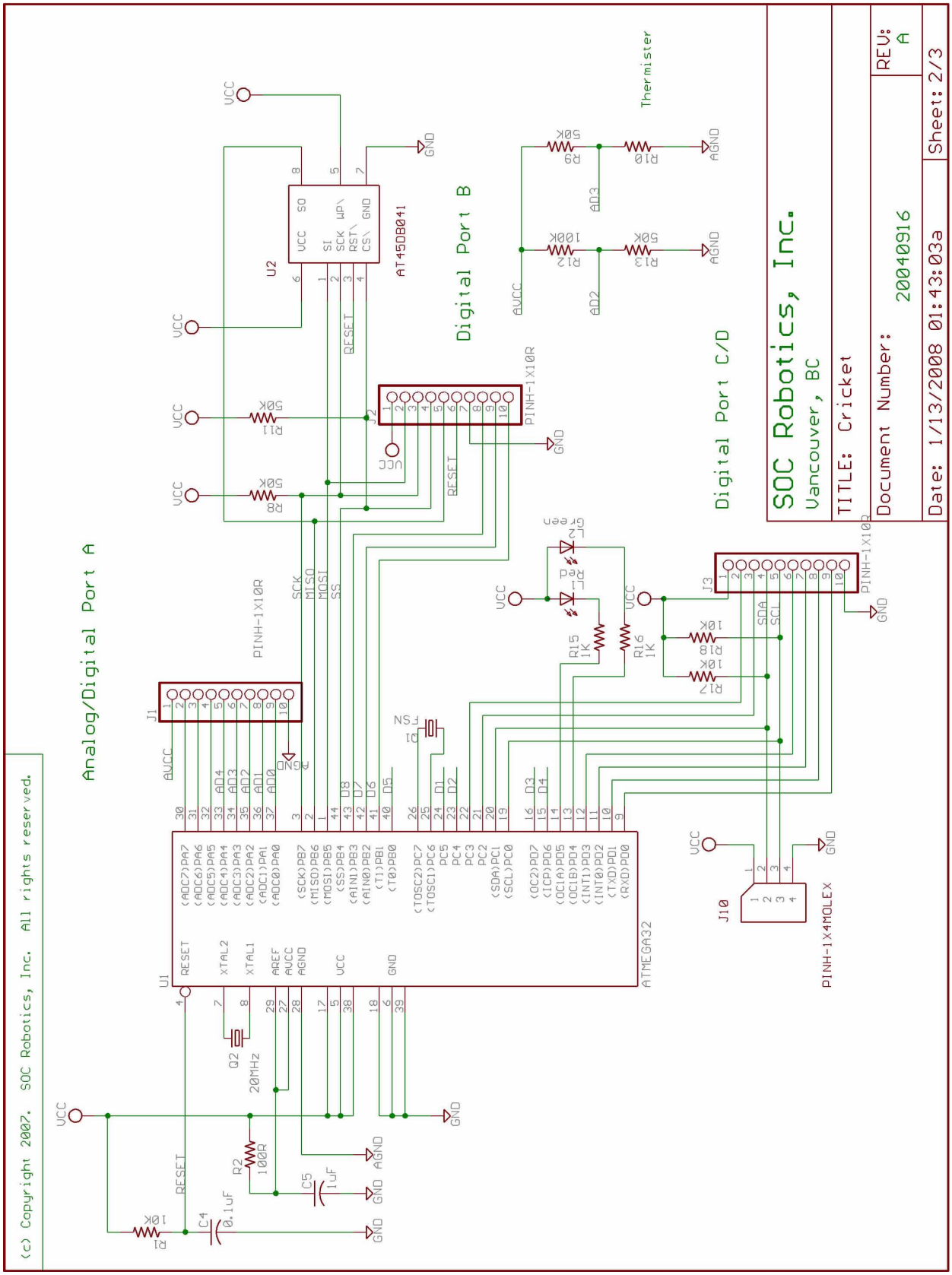
4.3 Mechanical Dimensions

Board dimensions are stated in inches. Connectors J1, J2 and J3 are positioned on 0.1" pin spacing so the Cricket is easily mounted directly on any standard 0.1" prototyping board. A sample schematic with connector library and board layout in Eagle CAD format is available at www.soc-machines.com/download/Cricketlayout.htm.



5.0 Cricket Rev 1.2 Schematics




Analog/Digital Port A
Digital Port B
Digital Port C/D
Thermister
SOC Robotics, Inc.
Vancouver, BC
TITLE: Cricket
Document Number: 20040916
REV: A
Date: 1/13/2008 01:43:03a
Sheet: 2/3
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ATMEGA32
AT45DB041
PINH-1X10R
PINH-1X4MOLEX
VCC
GND
AVCC
AGND
RESET
SCK
MISO
MOSI
SS
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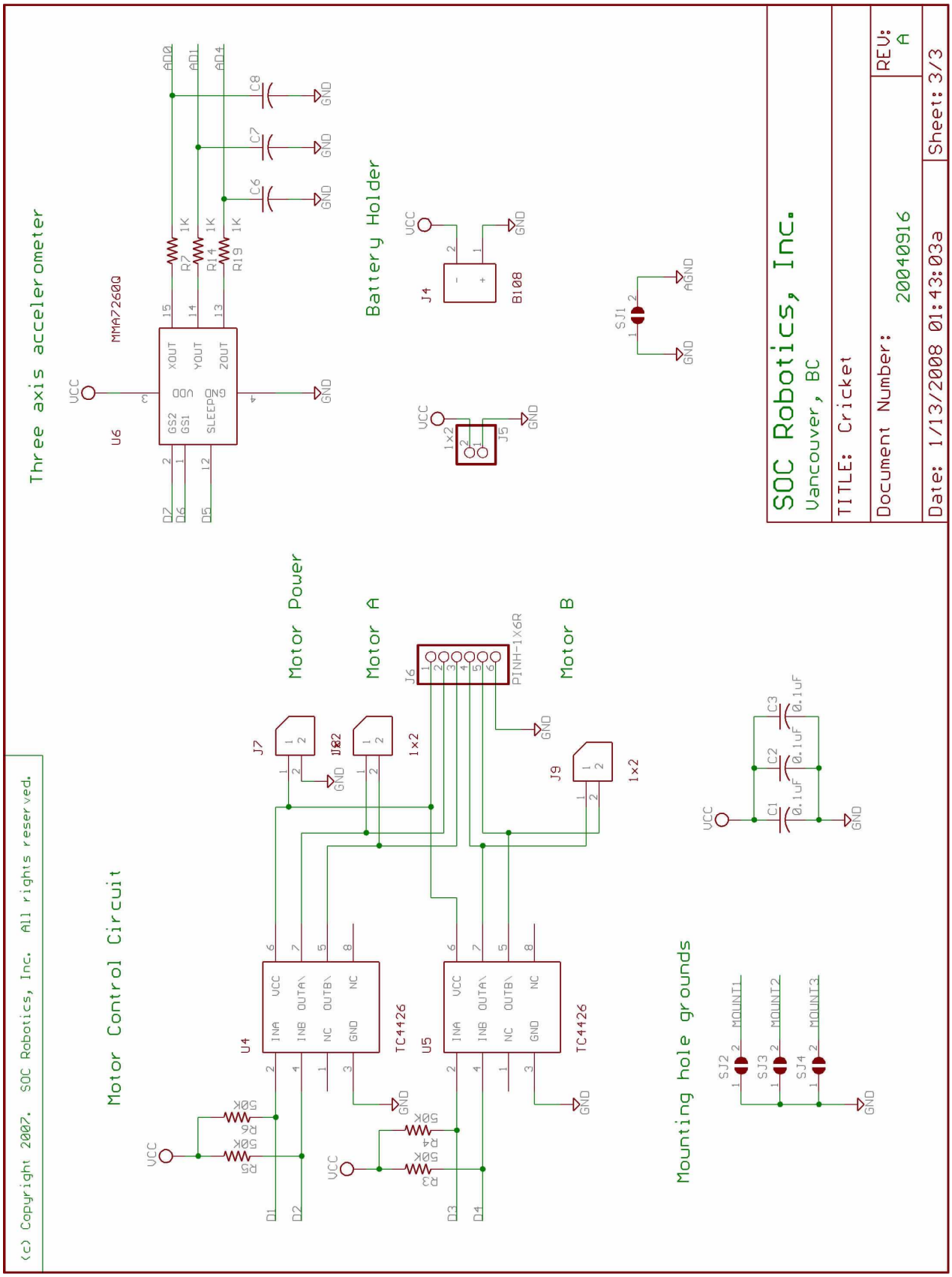
SCL
20MHz


Three axis accelerometer
MMA7260Q
U6
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YOUT
ZOUT
GS2
GS1
SLEEPN
AD0
AD1
AD4
R7 1K
R14 1K
R19 1K
C8
C7
C6
GND
VCC
Battery Holder
J4
B108
J5
1x2
SJ1
AGND
SOC Robotics, Inc.
Vancouver, BC
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Motor Control Circuit
Motor Power
Motor A
Motor B
J6
PINH-1X6R
J7
J8
J9
1x2
U4
U5
TC4426
INA
INB
VCC
OUTA\
OUTB\
NC
GND
R5 50K
R6 50K
R3 50K
R4 50K
D1
D2
D3
D4
C1 0.1uF
C2 0.1uF
C3 0.1uF
Mounting hole grounds
SJ2
SJ3
SJ4
MOUNT1
MOUNT2
MOUNT3
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Notes: