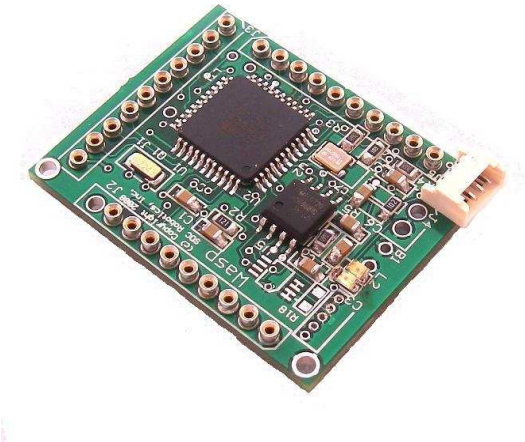
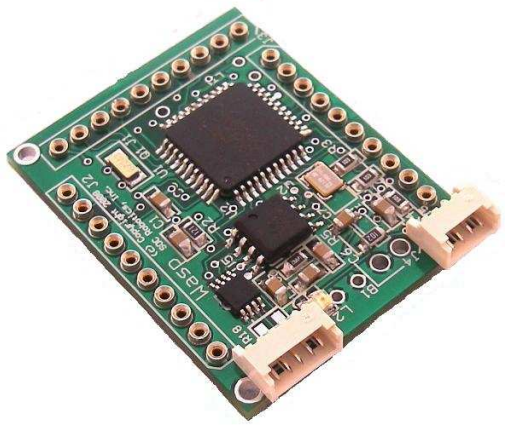
Wasp Embedded Processor

Hardware Reference Guide

PCB Rev 1.2



Wasp



Wasp Plus

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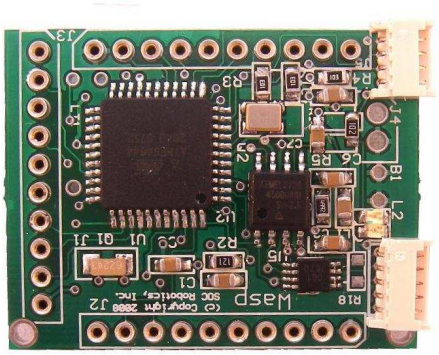
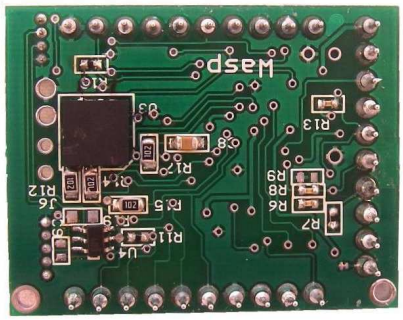
1.0 Introduction





Features:

- 8bit RISC AVR Processor (ATmega644)
- 8MHz 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
- 512K/1M/2M/4M/8Mbyte External Serial Flash
- 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 (1.47x1.15 in)
- 1.8-5VDC @ 12ma Power input
- Optional Components:
    - Light Sensor
    - Temperature Sensor
    - 3-Axis Accelerometer
    - 16 bit A/D
    - 16 bit D/A
    - 20MHz Crystal

Hardware

The Wasp is an extremely compact embedded processor for mobile data acquisition, control and remote monitoring applications. The Wasp by default is shipped with an ATmega644 processor although two other processors are available by special order: the ATmega16 and ATmega32. The ATmega644 has the added benefit of being able to generate an interrupt on any pin transition (low to high or high to low). All three processors are members of Atmel AVR processor family. Each processor has internal Flash, SRAM, EEPROM, SPI, TWI (I2C), UART, 8 channel 10bit A/D and general purpose IO. The Wasp has an internal 8MHz oscillator but is shipped with an external 8MHz crystal. An external 32.756KHz crystal is provided on the board to allow the creation of a real time clock for timed software execution.

The Wasp 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 Wasp to operate with very low power consumption. The Wasp is programming using an ISP Programming Adapter such as the ISP10.

The Rev 1.2 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.

Software

The Wasp 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, read the 16 bit A/D, write the 16 bit D/A and how to use the UART. The example Project files that come with the Wasp 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 numbers in the PRO version.

Configurations

The Wasp is available in several configurations. The table below summarizes the different Wasp configurations. Note that in order to run at the maximum clock speed of 20MHz the board must be powered at 5V. Wasps with 3.3V peripherals must be powered at 3-3.3V and consequently can only run at 8MHz.

Product Name	Crystal Speed	3-Axis Accelerometer 3.0-3.3V	16 Bit Analog	Serial Flash 3.0-3.3V	Light Sensor	Thermistor	Machine Pins
WaspL	20MHz	No	No	No	No	No	CISP Only
Wasp	8MHz	No	No	Yes	No	Yes	Yes
WaspG	8MHz	Yes	No	No	No	Yes	Yes
WaspA	20MHz	No	Yes	No	No	Yes	Yes
WaspP	8MHz	Yes	Yes	Yes	Yes	Yes	Yes

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

There is also a choice of two different battery holders – coin cell (3V) and 1/2AA (3V).

2.0 Wasp Detailed Description

2.1 Introduction

The Wasp is an extremely compact embedded processor for mobile data acquisition, control and monitoring applications. Programmed in C and powered by a coin cell the Wasp is an excellent embedded processor platform for small mobile applications.

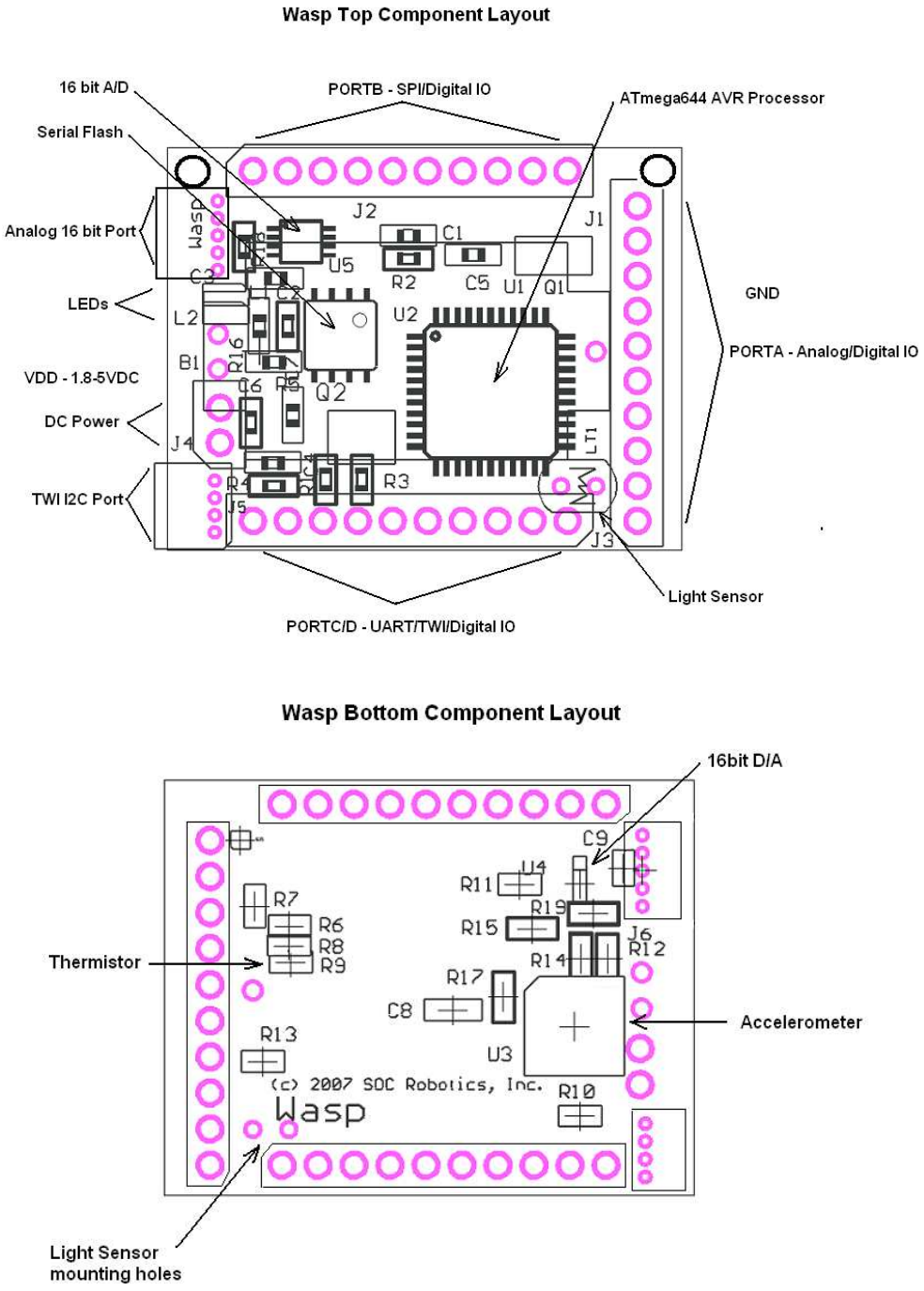


Figure 2-1. **Primary Components on top and bottom sides of PCB.**

2.2 Processor

The Wasp has an 8bit RISC AVR processor. The Wasp 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 Wasp has a pad for an external crystal – the default crystal is 8MHz although an optional 20MHz crystal is available. Note that the ATmega644 requires 5VDC to run at 20MHz. Check the configuration of the Wasp 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 Wasp has an ATDB45041 512Kbyte Serial Flash. The AVR communicates with the Serial Flash using the SPI lines. The Wasp is compatible with the AT45DB081 (1M), AT45DB161 (2M), AT45DB321 (4M) and AT45DB642 (8M) so higher capacity Flash can be mounted in place of the AT45DB041. The Serial Flash requires 3-3.3VDC so if this component is installed the Wasp should not be powered above 3.3V.

2.5 TWI Port

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

2.6 Expansion Ports

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

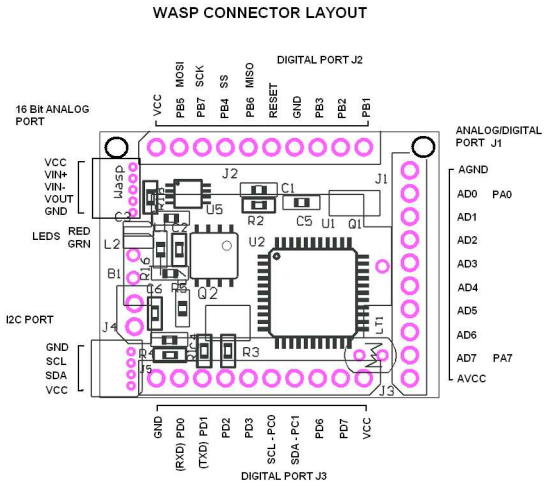


Figure 2-2. **Wasp Expansion port pin assignments.**

2.7 Battery Holders

The Wasp can be configured with two different battery holders: coin cell and 1/2AA. The battery holders mount on the back of the Wasp. Ensure the 1/2AA battery holder is installed with the correct polarity – there is no reverse polarity protection power diodes on the Wasp board. The Wasp is supplied with an unmounted coin cell holder.

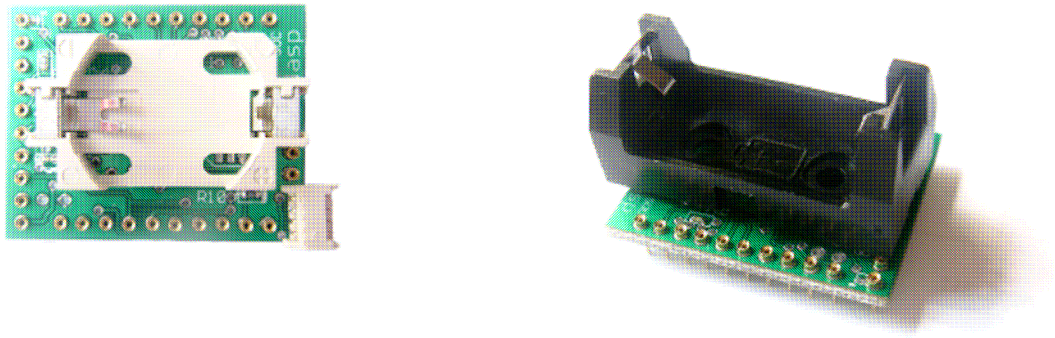


Figure 2-3. **Coin cell holder and Larger Battery holder.**

2.8 ISP Programming

The Wasp is programmed using an ISP10 Parallel Port programming adapter or any 10pin Atmel ISP compatible programming adapter. The Wasp is supplied with a CISP adapter that converts the Wasp 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 Wasp can also be programmed using a USB10 USB 2.0 peripheral.

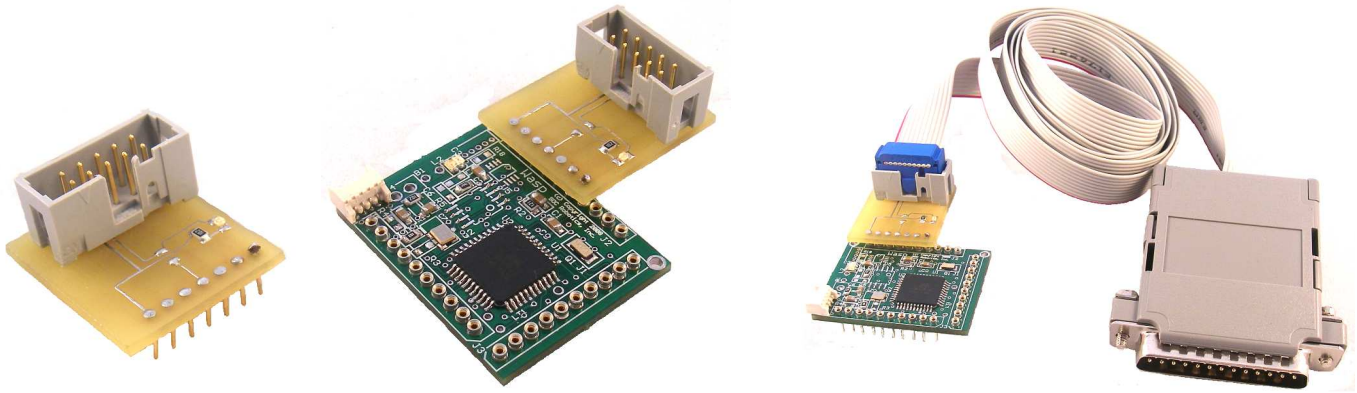


Figure 2-4. **CISP ISP Adapter and correct attachment to the Wasp .**

2.9 Optional Components

The Wasp has pads for five optional components – 16 bit A/D, 16 bit D/A, temperature sensor, light sensor and 3-axis accelerometer.

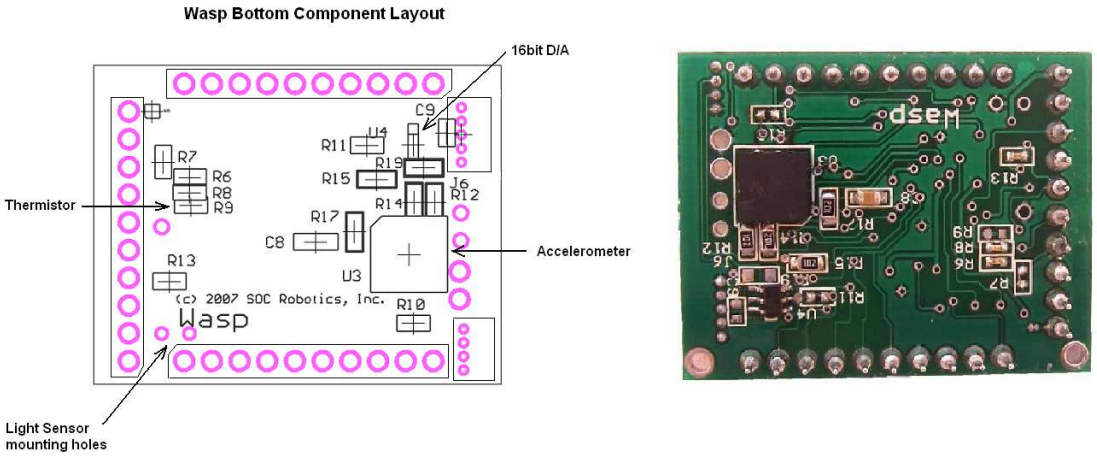


Figure 2-5. **Optional sensor locations and components installed on Wasp.**

16 Bit A/D

The optional 16 bit A/D is a Burr-Brown ADS1101. The A/D operates from 2.7 to 5VDC, performs up to 128 conversions per second, communication with the AVR is via an I2C interface (address 0x49), has four programmable gain levels of 1,2,4 and 8 and consumes 90uA. The A/D has a pull up or pull down resistor (not installed) on –VIN. The A/D inputs are connected to pin 2 (+VIN) and pin 3 (-VIN) of connector J6. J6 is a five pin Molex picoBlade connector.

16 Bit D/A

The optional 16 bit DAC is a Burr-Brown DAC8501. The DAC operates from 2.7 to 5VDC, settles in 10usec, has a multiplying-mode bandwidth of 350KHz, is written too via the SPI lines and consumes 250uA at 5V. DAC output is pin 4 of connector J6. J6 is a five pin Molex picoBlade connector.

Temperature Sensor

The optional thermistor R9 (0402) is mounted on the bottom of the board. The thermistor requires load resistor R8 (0402). Match the value of R8 to provide the best range for R9.

Light Sensor

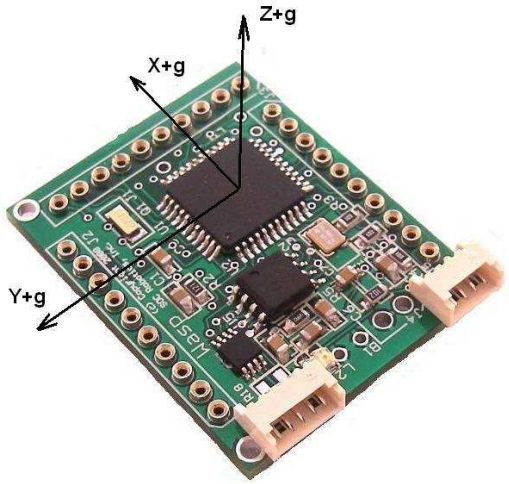
The optional light sensor LT1 can be mounted on the top or bottom of the board. The Light sensor requires load resistor R13 (0402). A light sensor such as PDV-P9 can be used.

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 Wasp 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



2.10 Molex Connectors

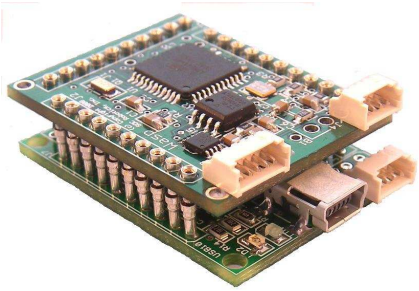
The Wasp uses two small Molex picoBlade 4 pin and 5 pin male connectors with 1.25mm pin spacing (4 pin Molex Part No. 53048-0410 - Digikey Part No. WM1744-ND - 5 pin Molex Part No. 51021-0500 – Digikey part no. WM1745-ND). These connectors mate with female Molex 4 and 5 pin housing connectors (4 pin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

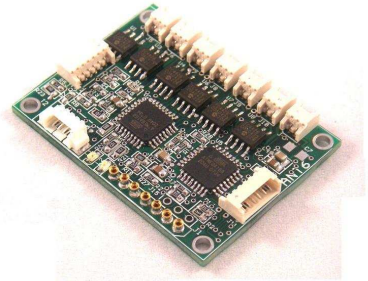
2.11 Related Peripherals

The Wasp attaches to or can communicate with other SOC Robotics Embedded Processor devices such as the SmartLCD, USB10, Ant6, Cricket and other peripherals. In addition a number of positioning and display devices attach directly to the Wasp such as a GPS receiver and small Color LCD.

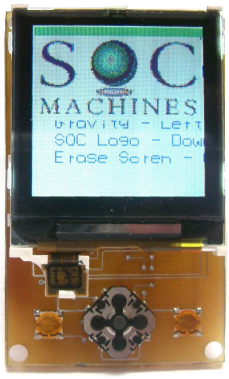
USB10 is a USB 2.0 device with an onboard AVR processor – the AT90USB162. The USB10 UART connects directly to the Wasp UART providing a serial communication path between the Wasp and a PC via USB. The Wasp and USB10 SPI lines are also connected providing an additional high speed communication link between the Wasp and PC.



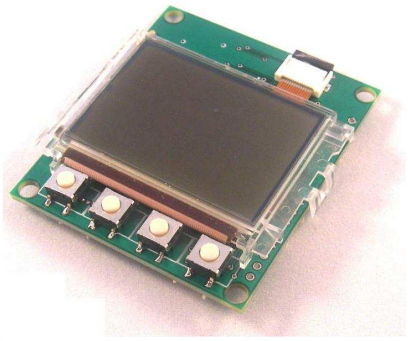
Wasp mounted on a USB10 communications board.



Ant6 6 Channel H-Bridge Controller



Color LCD display that attaches directly to Wasp.



SmartLCD display that communicates via I2C.

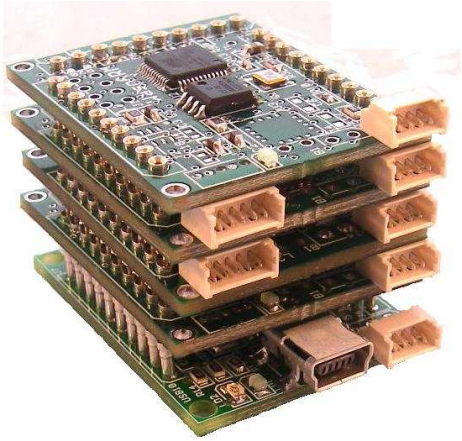
In development is a new a navigation sensor daughter card with one or two dual axis gyros and electronic compass.

2.11 Applications

The Wasp 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. When combined with the GPS option the device becomes a mobile position sensor for tracking applications. The 16 bit analog interface provides high precision analog data for special applications.

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 Wasp without the need for a ISP10 CISP combination.

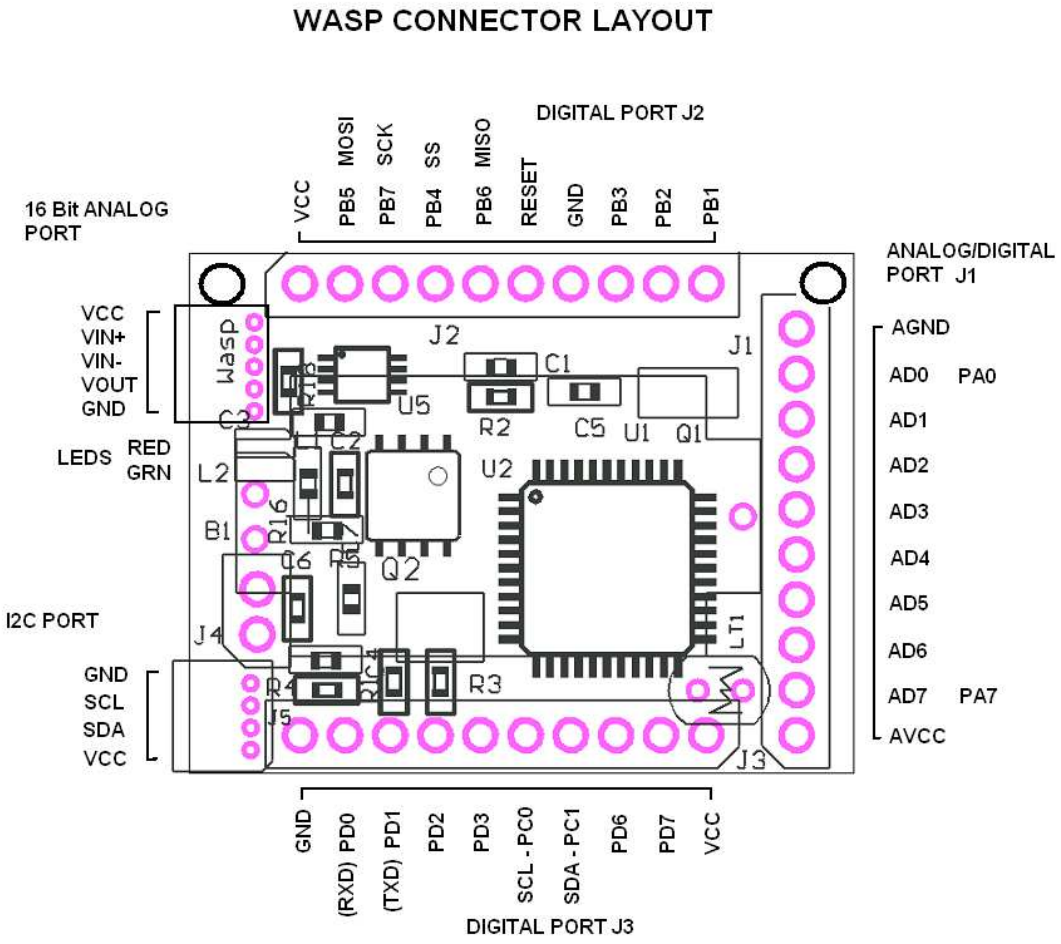
Wasps can be stacked to increase processing horsepower. For example ten stacked Wasps operating at 5V would have a combined processing speed of 200MIPs, or a combined storage capacity of 80mbytes at 3.3V. The picture below shows a Wasp stacked with a USB10 on the bottom and three WaspARM processors. The WaspARM has the same features as a Wasp but with the ATmega644 replaced with an AT91SAM7S32 ARM7 processor running at 55MHz. By stacking Wasps processing power can be increased in increments ensuring that a Wasp solution can address a wide range of embedded processing applications.



3.0 Wasp Hardware Expansion Port Summary

3.1 Introduction

The Wasp has three I/O expansion ports, power port, I2C port and 16 bit A/D-D/A port as shown in the connector layout diagram below.



3.2 Expansion PORT A

AVR PORTA is routed to connector J1.

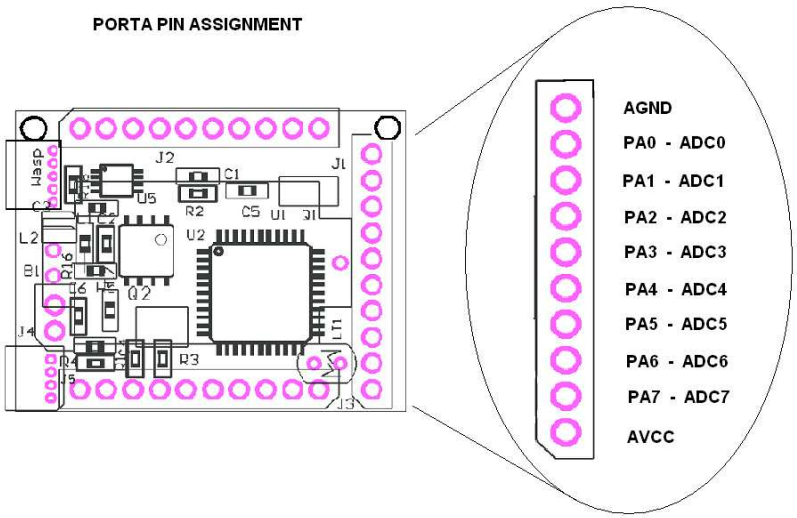


Figure 3-3. **PORTA Pin Assignment J1.**

3.3 Expansion PORT B

AVR PORTB is routed to connector J2.

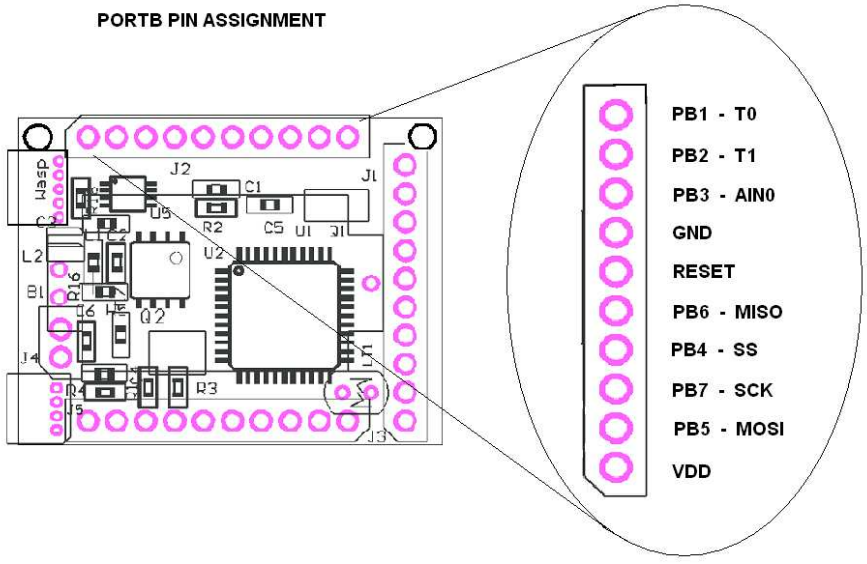


Figure 3-4. **PORTB Pin Assignment J2.**

3.4 Expansion PORT C/D

AVR PORTS C/D is routed to connector J3.

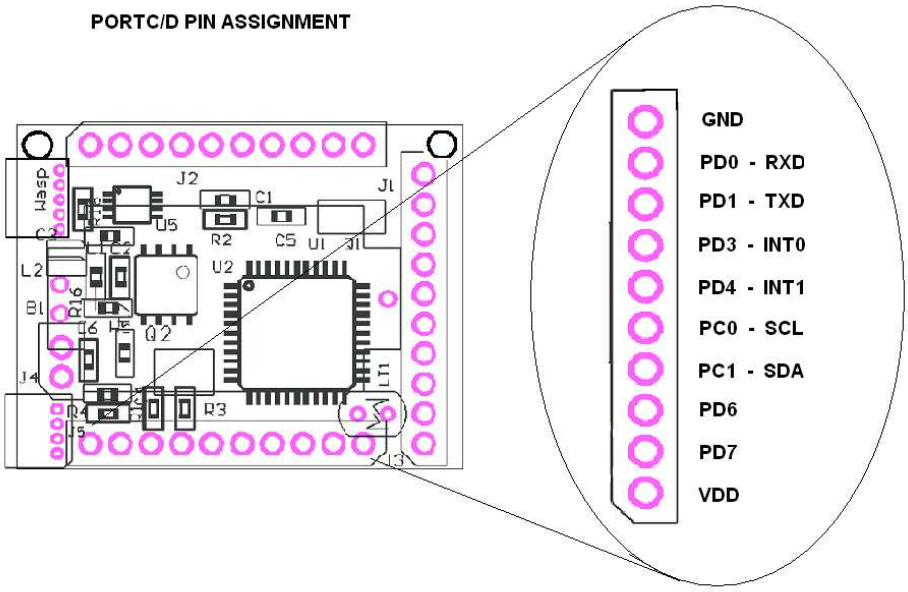


Figure 3-5. **PORTC/D Pin Assignment J3.**

3.5 TWI I2C Expansion Port

The TWI I2C lines are routed to connector J3 and a separate 4 pin Molex connector J5 (4 pin Molex picoBlade connector). J5 is compatible with the SOC Robotics Smart Peripheral family of motor controllers, LCD displays and data acquisition modules.

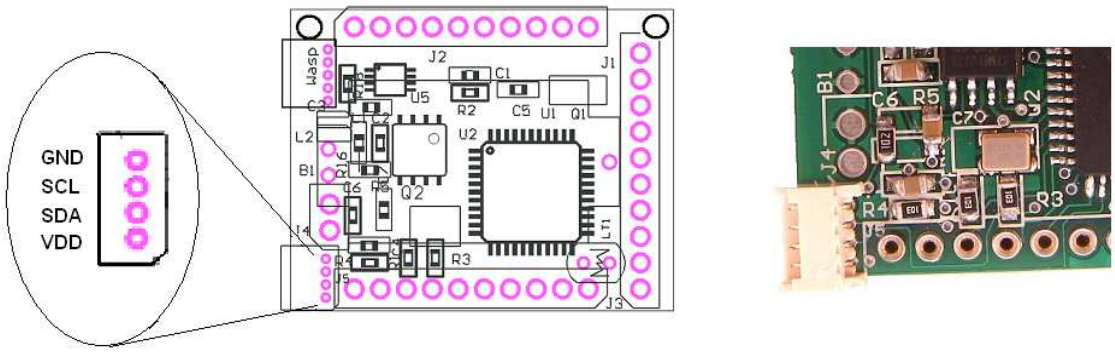


Figure 3-6. **TWI I2C Port with 4 Pin Molex picoBlade Connector.**

3.6 Board Power Connector and Battery Holder

Wasp power may range from 1.8 to 5VDC. Voltage level should not exceed 3.3V if the serial flash and accelerometer is installed. Power connect J4 is indicated in the picture below. A coin cell battery holder or 1/2AA battery holder can also be mounted on the board providing complete mobility.

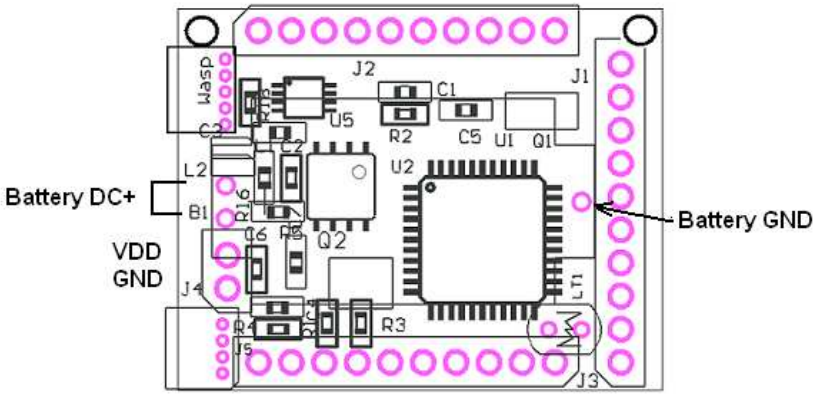


Figure 3-7. **Wasp Battery Mounting holes and Power Connector.**

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 Wasp 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 Wasp.

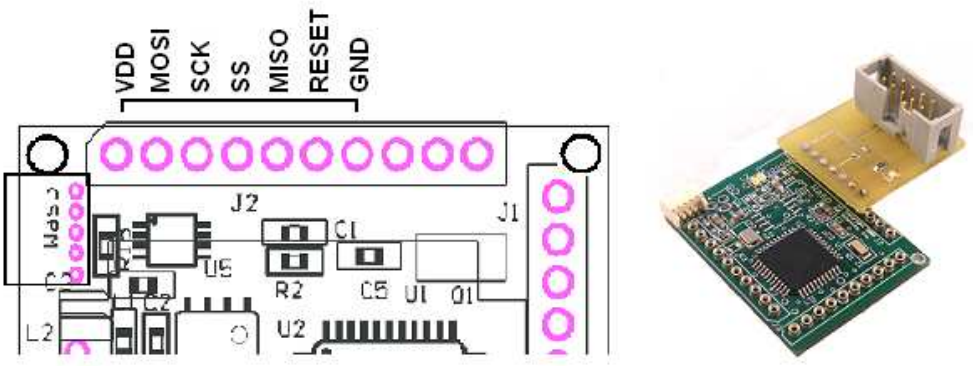


Figure 3-8. **ISP Programming Port and CISP Adapter Connection.**

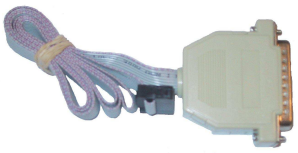
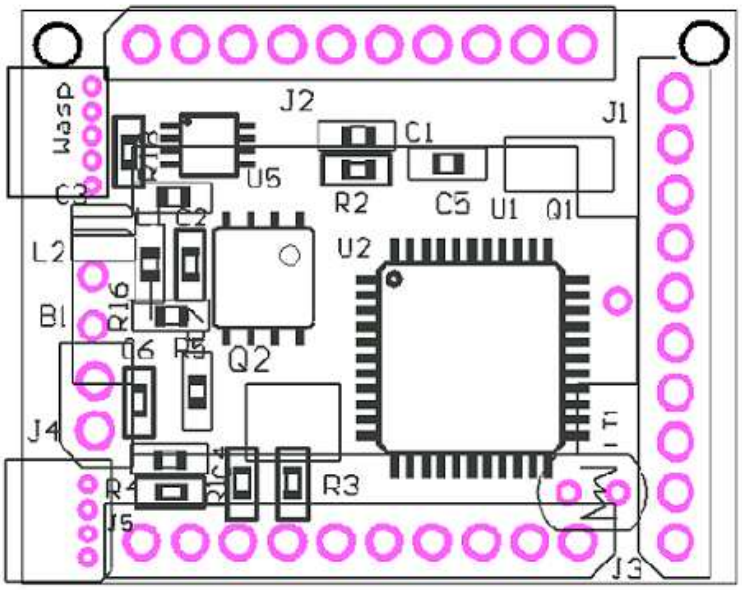


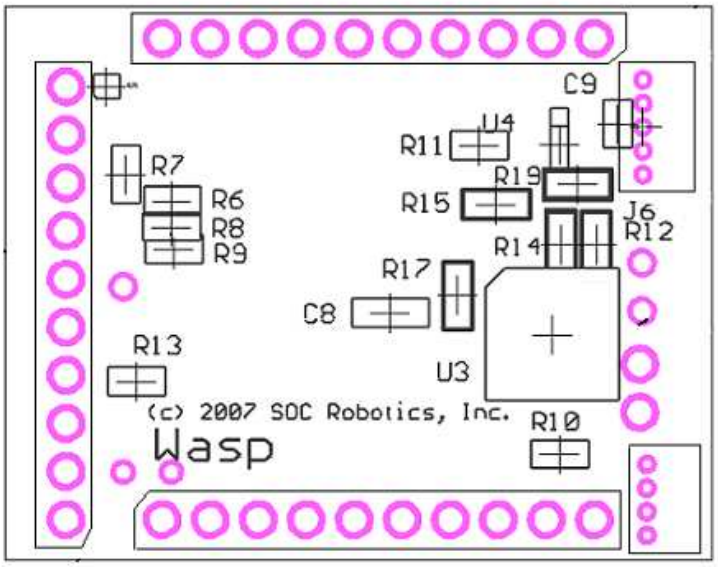
Figure 3-9. **ISP10 Parallel Port programming adapter.**

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
Sleep Mode: 0.7ma

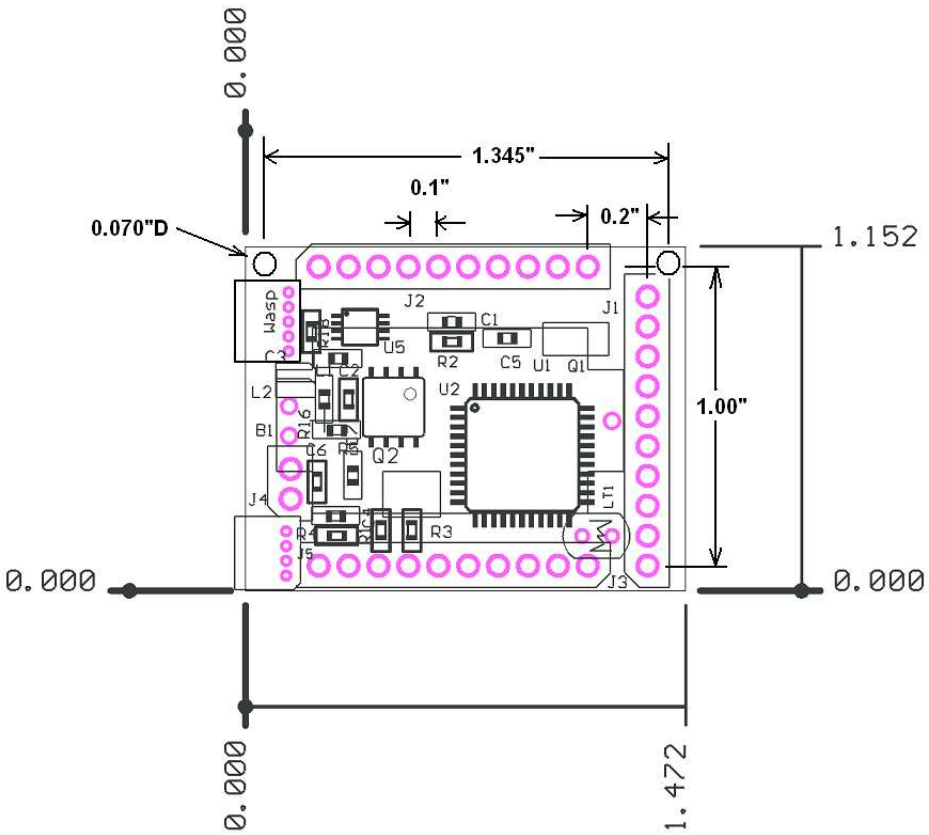
Mechanical

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

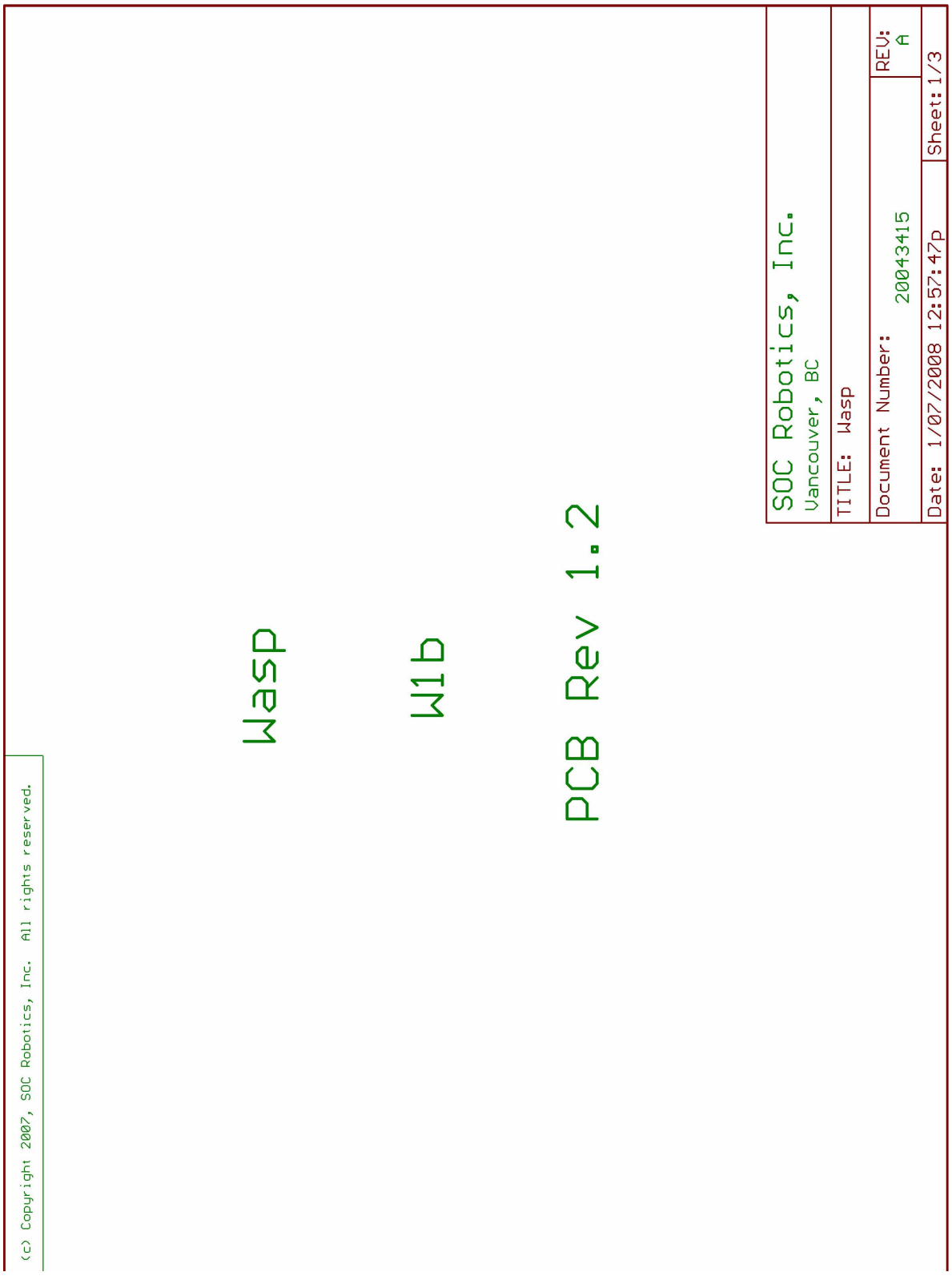
4.3 Mechanical Dimensions

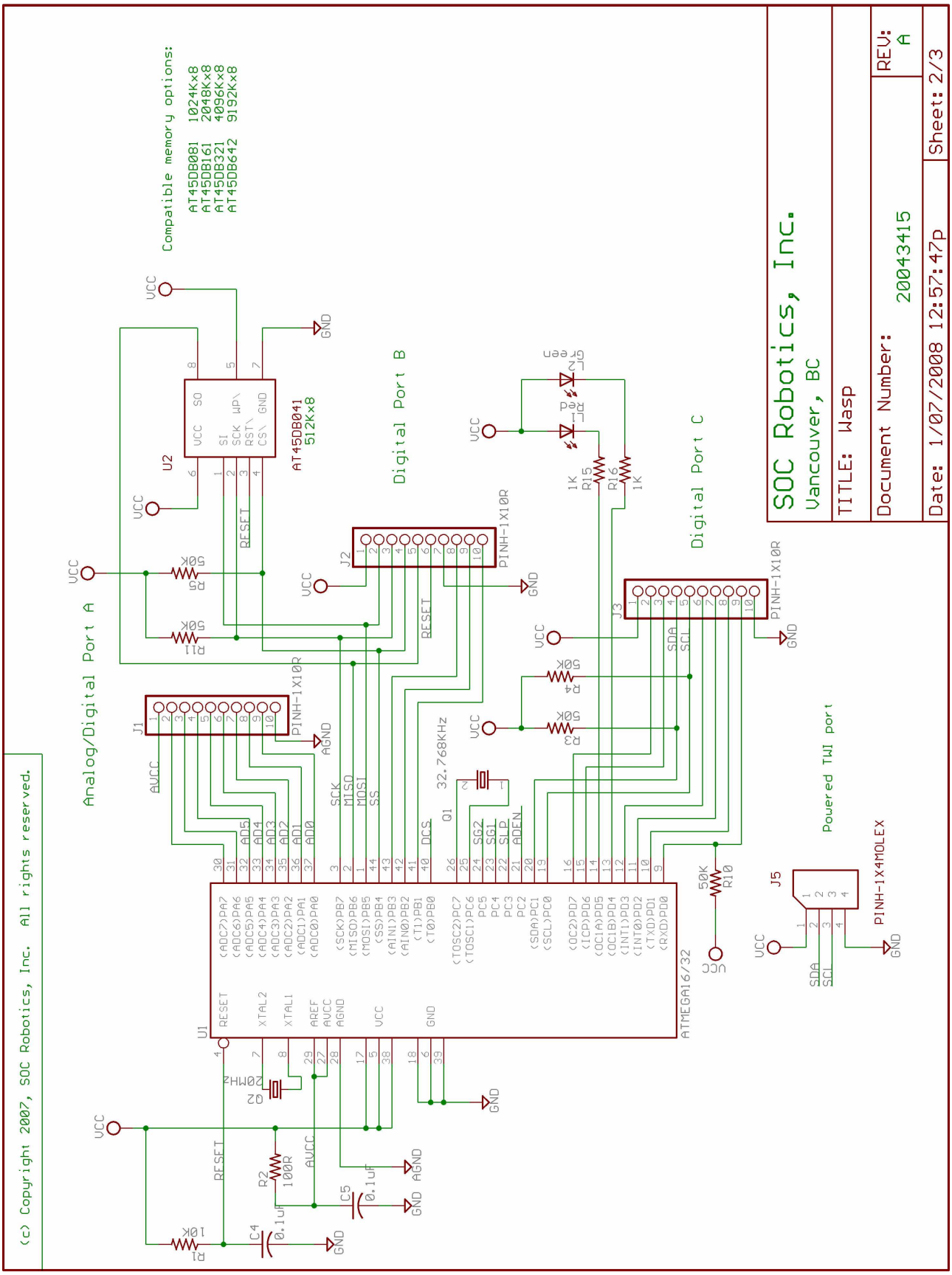
Board dimensions are stated in inches. Connectors J1, J2 and J3 are positioned on 0.1″ pin spacing so the Wasp is easily mounted directly on any standard 0.1″ prototyping board.

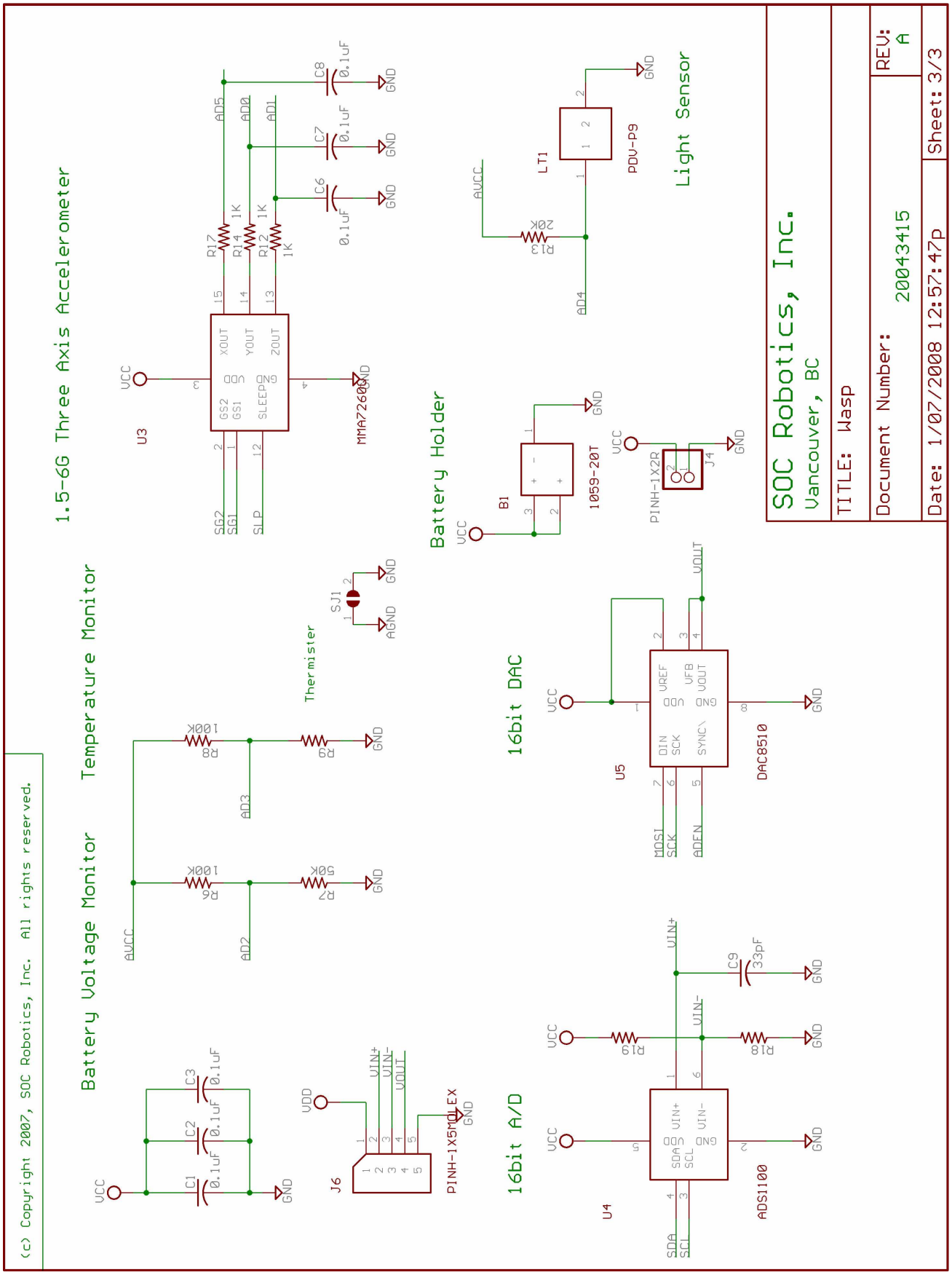
A sample schematic with connector library and board layout in Eagle CAD format is available at www.soc-machines.com/download/wasplayout.htm.



5.0 Wasp Rev 1.2 Schematics




Compatible memory options:
AT45DB081 1024Kx8
AT45DB161 2048Kx8
AT45DB321 4096Kx8
AT45DB642 8192Kx8
AT45DB041 512Kx8
Analog/Digital Port A
Digital Port B
Digital Port C
Powered TWI port
SOC Robotics, Inc.
Vancouver, BC
TITLE: Wasp
Document Number: 20043415
REV: A
Date: 1/07/2008 12:57:47p
Sheet: 2/3
(c) Copyright 2007, SOC Robotics, Inc. All rights reserved.
ATMEGA16/32
PINH-1X10R
PINH-1X4MOLEX
32.768KHz
16.0MHz


1.5-6G Three Axis Accelerometer
Battery Voltage Monitor
Temperature Monitor
Thermister
Battery Holder
Light Sensor
16bit DAC
16bit A/D
SOC Robotics, Inc.
Vancouver, BC
TITLE: Wasp
Document Number: 20043415
REV: A
Date: 1/07/2008 12:57:47p
Sheet: 3/3
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U3
MMA2260D
U4
ADS1100
U5
DAC8510
J6
PINH-1X5RA
J4
PINH-1X2R
B1
1059-20T
LT1
PDV-P9
SJ1
C1
C2
C3
C6
C7
C8
C9
R12
R14
R17
R18
R19
R20
R21
R22
R23
R24
R25
R26
R27
VCC
GND
AVCC
AGND
VDD
AD0
AD1
AD2
AD3
AD4
AD5
SCL
SDA
SCK
MOSI
SYNC\
ADEN
VOUT
VIN+
VIN-
SG1
SG2
SLP

Notes: