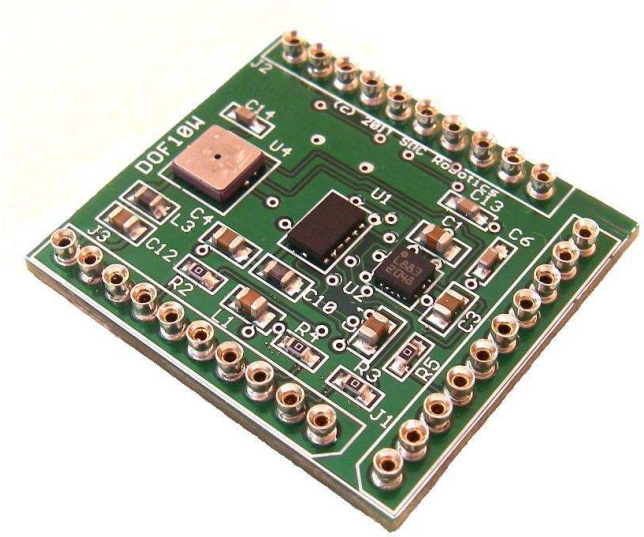
DOF10W 10 Degree of Freedom IMU Sensor
+-16G, +-2000 dps, +-8Gauss, 350-700hPa

Technical Reference Manual

PCB Rev 1.0



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1945A–08/00/5M

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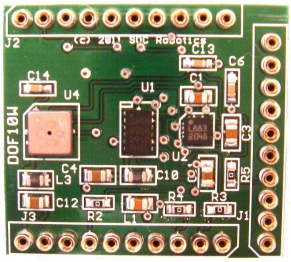
1.0 Description

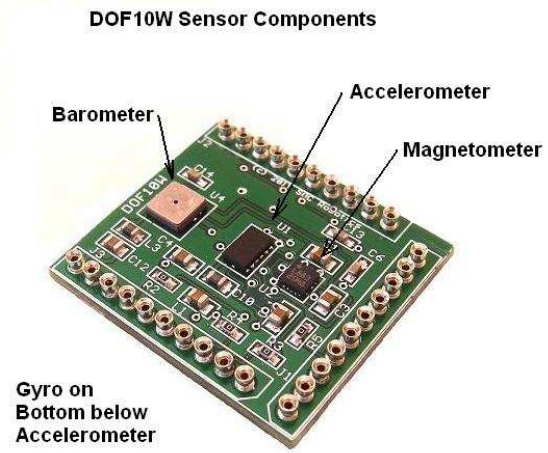
1.1 Features



- 4 Sensors integrated onto one PCB
- 3-Axis Accelerometer +-16G
- 3-Axis Rate Gyro 250/500/2000 deg/sec
- 3-Axis Magnetometer eight ranges from 0.88 – 8.1 gauss
- Barometer with 8m accuracy and 0.8m sensitivity
- All digital sensors – no analog interface required
- 3-3.3V DC operation
- Small form factor (1.15x1.28in)
- Compatible with Wasp/WaspARM/WaspX
- Mounts directly to a Wasp/WaspARM/WaspX processor
- Easy SPI and I2C interface to other processors
- 9 DOF version available
- Available with or without machine pins
- Sample programs included in Wasp Application Code
- Desktop Data Acquisition Device (DAD) for real time display

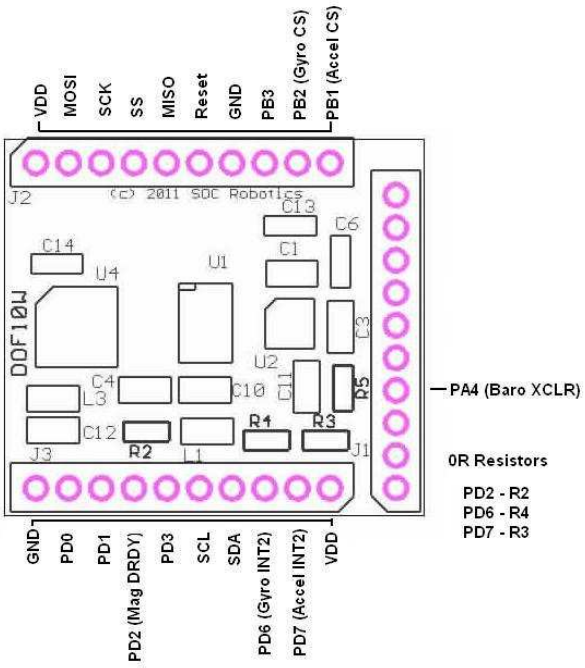
1.2 Introduction

The DOF10W is a 10 degree of freedom (DOF) all digital sensor thatbrings a new level of integration and sensing. The DOF10W has a 3-axis accelerometer, 3-axis rate gyro, 3-axis magnetometer and a barometric pressure sensor. The accelerometer is the Analog Devices ADXL345 sporting several acceleration range settings with a maximum of +-16G and a sensitivity of 4mG. The rate gyro is the STMicroelectronics L3G4200D with three range settings of 250, 500 and 2000 deg/sec. The magnetometer is a Honeywell HMC5883 with eight range settings from 0.88Gauss to 8.1Gauss. The barometer is a Bosch BMP085 with an absolute accuracy of 8M and a sensitivity of 80cm.



The picture below shows the DOF10W pin assignment. The accelerometer and rate gyro use an SPI interface while the magnetometer and barometer are I2C devices. The DOF10W attaches directly to either a Wasp (AVR Atmega644), WaspARM (ARM7 AT91SAM7S32) or WaspX (AVR ATxmega) embedded processors. Software to program and configure each of the four sensors is provided.

DOF10W Connector Pin Assignment



The DOF10W has three rows of machine pins for easy mounting to the Wasp, WaspARM or WaspX processors. The DOF10W is also available without machine pins.

1.3 Theory of Operation

Circuit Description

The DOF10W uses sensors with digital interfaces so no A/D conversion interface logic is required. See the individual sensor datasheet for detailed operational and programming information.

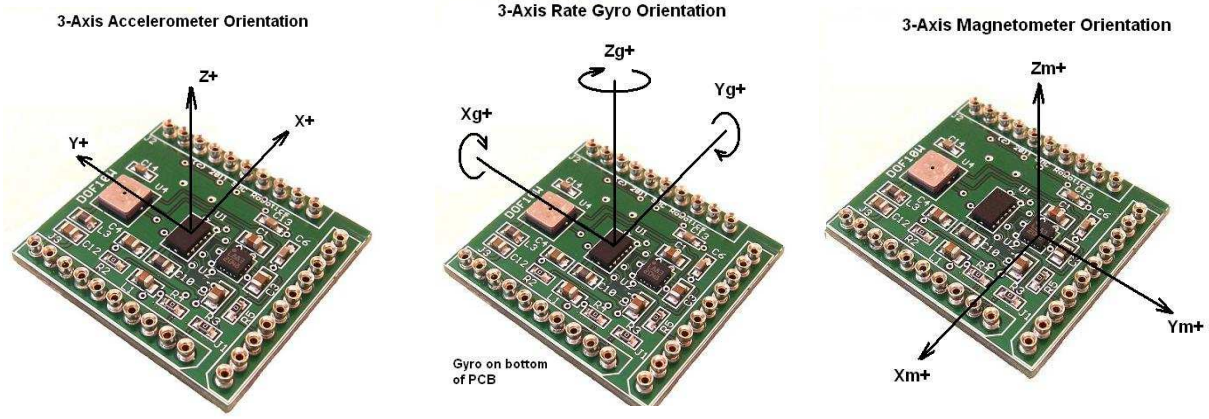
The Accelerometer and Rate Gyro have a high speed SPI interface. The Magnetometer and Barometric pressure sensor have an I2C interface. The 10DOFW is easily interfaced to other processors via the I2C and SPI interfaces.

The output from each sensor is in binary format and is easily converted to engineering units. The pressure sensor, however, requires a more sophisticated conversion formula and the source code for this conversion is provided in the sample application Wasp Datalogger V0.94 available for download from our web site.

Optional 0R resistors R2, R3 and R4 connect interrupt outputs from each sensor to connector pins. These resistors are not installed but can be added if requested. R2 connects the magnetometer DRDY output to J3. R3 connects the accelerometer INT2 output to connector J3. R4 connects gyro INT2 output to J3.

Polarity of Measurement

The DOF10W outputs 9 degree of freedom sensor data. The pictures below show the output orientation of each sensor. The barometric pressure sensor is not effected by orientation.



Calibration

Although each sensor has a digital interface sensor output may vary slightly due to sensor mounting skew – this should be taken into account before use.

1.4 Software Overview

A sample application Wasp DataLogger V0.94 (with full source code) configures each of the sensors on the 10DOFW sensor platform for a Wasp processor (ATmega644) and outputs the sensor data to the UART is available for download from our web site.

The Wasp DataLogger is a complete data logging application designed to simplify the setup and configuration of the sensors. The application was developed using ImageCraft's ICCAVR IDE. ICCAVR is available as a time limited free download. The application is being converted to GNU C with AVR Studio 4 support. Users can easily modify the source code to add additional functions such as AHRS or additional processing tasks.

A desktop GUI application called DAD is under development and should be released in June 2011. DAD is graphical real time display application that shows sensor data in graphical form on the desktop. The application relies on a small real time kernel executing on a Wasp processor connected to the desktop via a USB10 interface board to sample sensor data at a user defined data rate.

A Kalman Filter sensor fusion application is under development with a local university research team. More information about this application is available upon request.

1.5 Specifications

The DOF10W uses the STMicroelectronics L3G4200D digital 3-axis rate gyro, the Analog Devices ADXL345 3-axis accelerometer, Honeywell HMC5883 3-axis magnetometer and the Bosch BMP085 barometric pressure sensor. Several of the sensors also include an on chip temperature sensor.

Accelerometer Specifications

Parameter	Value
Power Source	3.0V-+0.3VDC
Temperature Range	-20 to +80 deg C
Resolution	4mG
Gain	2,4,8,16g
Rate Range	-+100 deg/sec
Interface	SPI
Frequency Response	200Hz (90 deg delay)
Power Consumption	140uA

Rate Gyro Specifications

Parameter	Value
Power Source	3.0V-+0.6VDC
Temperature Range	-20 to +80 deg C
Resolution	8.7/17/70mdps
Gain	3 settings
Rate Range	250/500/2000dps
Interface	SPI
Frequency Response	200Hz (90 deg delay)
Power Consumption	2.9ma

Magnetometer Specifications

Parameter	Value
Power Source	3.0V-+0.3VDC
Temperature Range	-20 to +80 deg C
Resolution	5mGauss
Gain	8 settings
Rate Range	0.88,1.3,8.1Gauss
Interface	I2C
Frequency Response	200Hz (90 deg delay)
Power Consumption	2.9ma

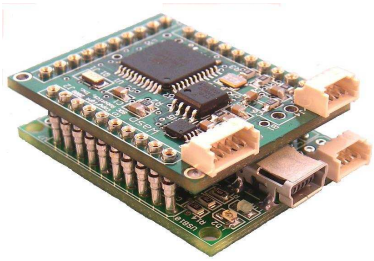
Barometer Specifications

Parameter	Value
Power Source	3.0V-+0.3VDC
Temperature Range	-20 to +80 deg C
Resolution	0.01hPa (0.00041psi)
Gain	8 settings
Rate Range	350-700hPa
Interface	I2C
Frequency Response	200Hz (90 deg delay)
Power Consumption	2.9ma

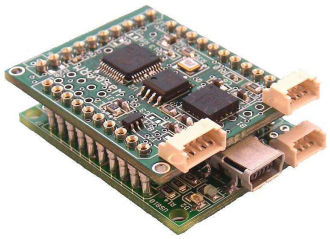
1.6 Related Products

The DOF10W is compatible with a number of related products. The DOF10W attaches to either a Wasp, WaspARM or WaspX embedded data acquisition processor. The Wasp processors attach to the USB10 for USB 2.0 communication.

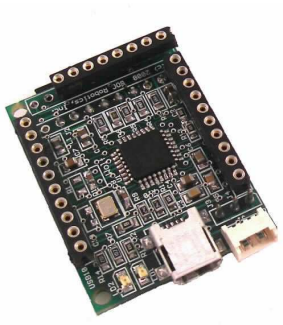
The Wasp family of products are small AVR and ARM7 based processors that can be programmed by the user to perform data acquisition tasks or using a sample data acquisition program can be turned into a real time data logger. By combining the Wasp with a USB10 a complete data acquisition system that communicates with the desktop via USB becomes possible.



Wasp on USB10



WaspARM on USB10

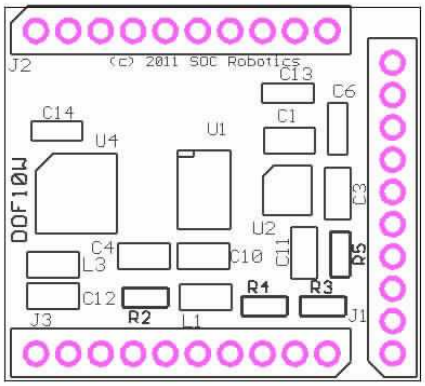


USB10

2.0 Electrical and Mechanical Description

2.1 Component Layout

Components are mounted on both sides of the board.



2.2 Electrical Specifications

Electrical

Input power: 3.3VDC @ 10ma

Mechanical

Dimensions: 1.28x1.16 in
Weight: 4 grams

2.3 Mechanical Dimensions

Board dimensions are stated in inches.

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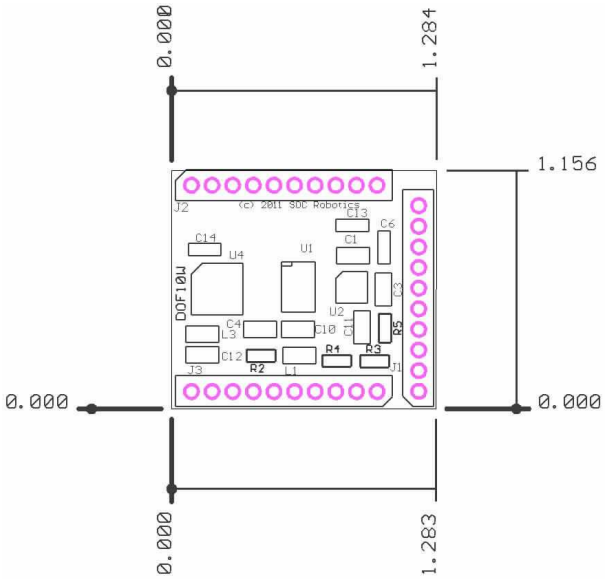
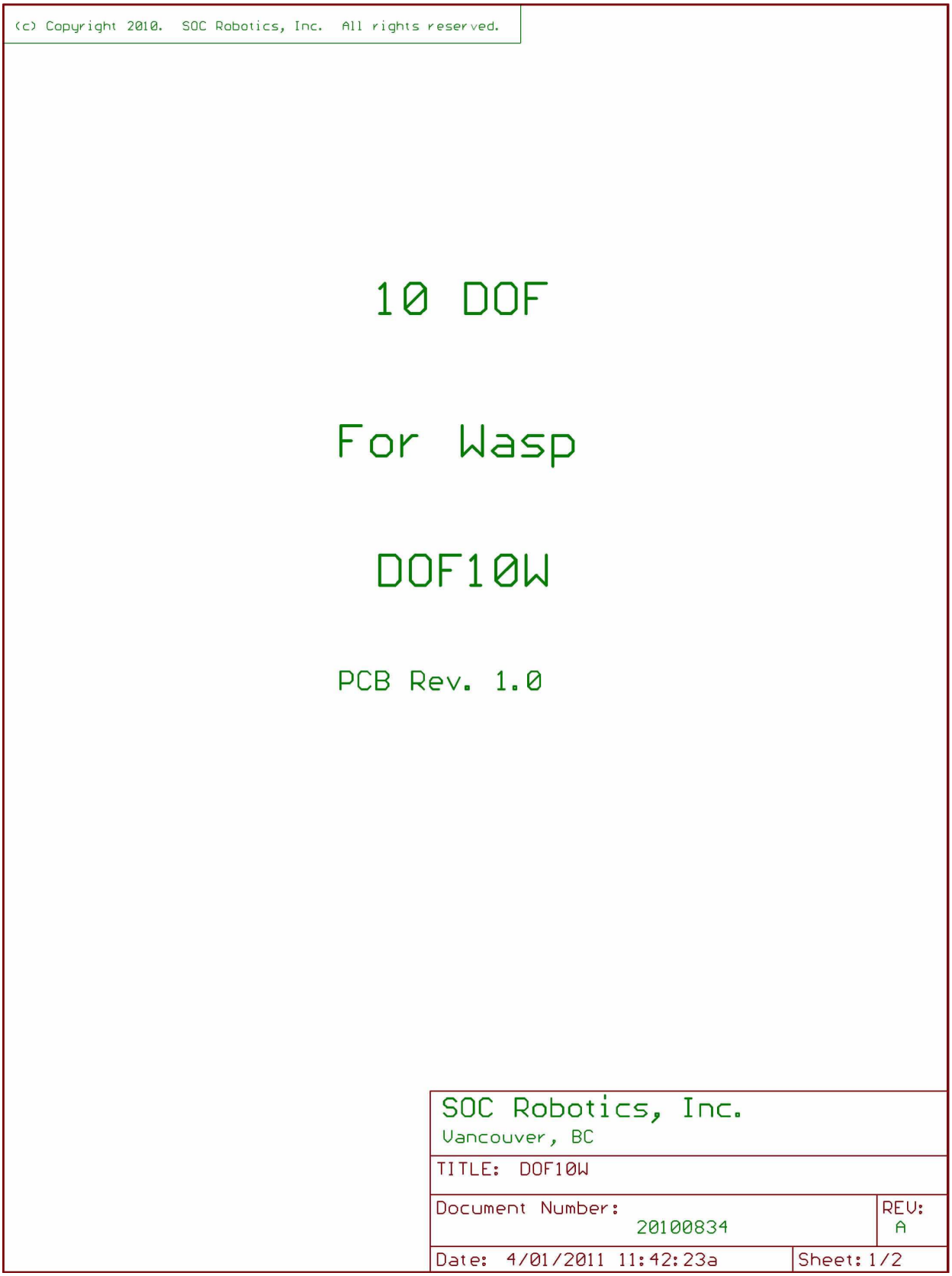
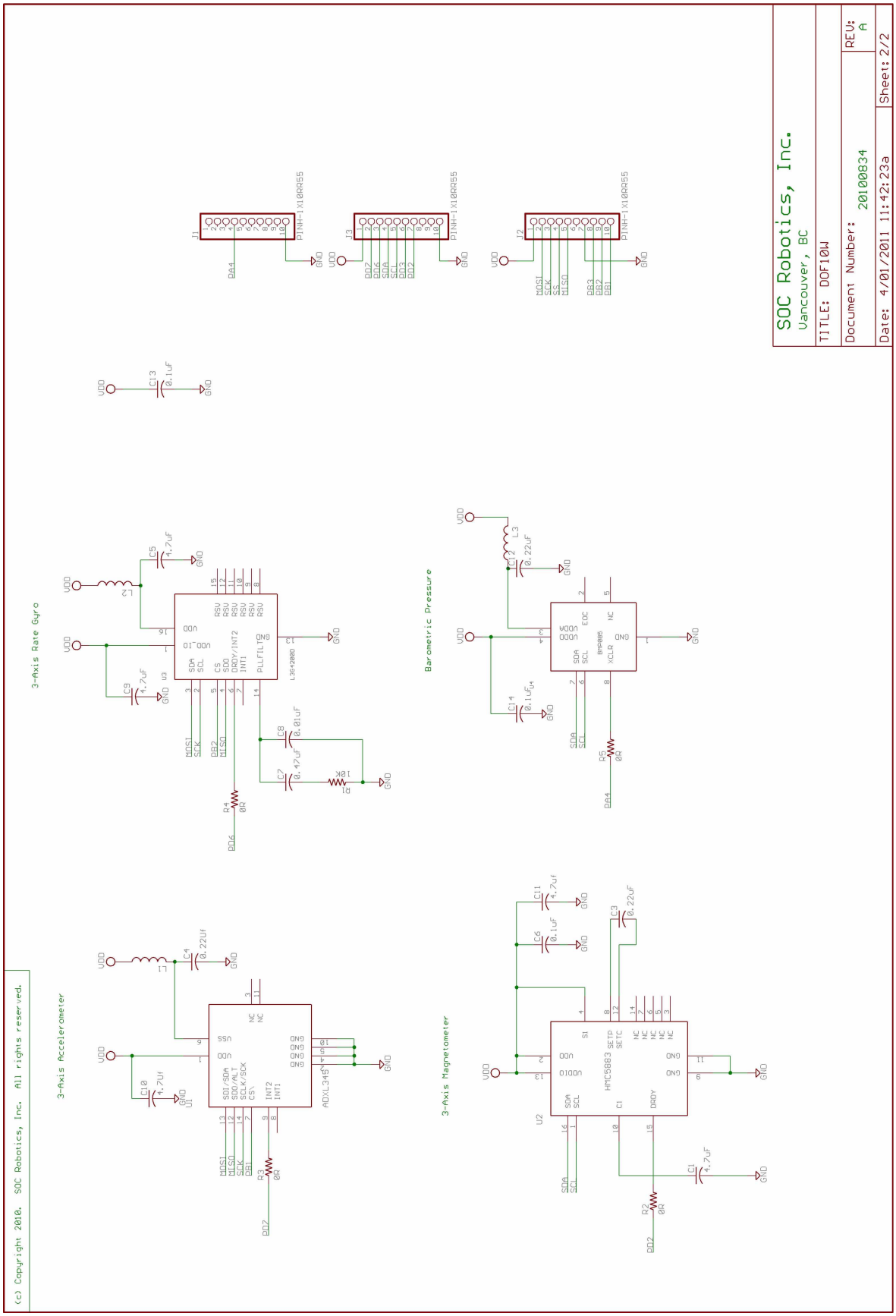


3.0 DOF10W Circuit Schematics




SOC Robotics, Inc.
Vancouver, BC
TITLE: DOF10W
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REV: A
Date: 4/01/2011 11:42:23a
Sheet: 2/2
3-Axis Rate Gyro
Barometric Pressure
3-Axis Accelerometer
3-Axis Magnetometer
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Notes: