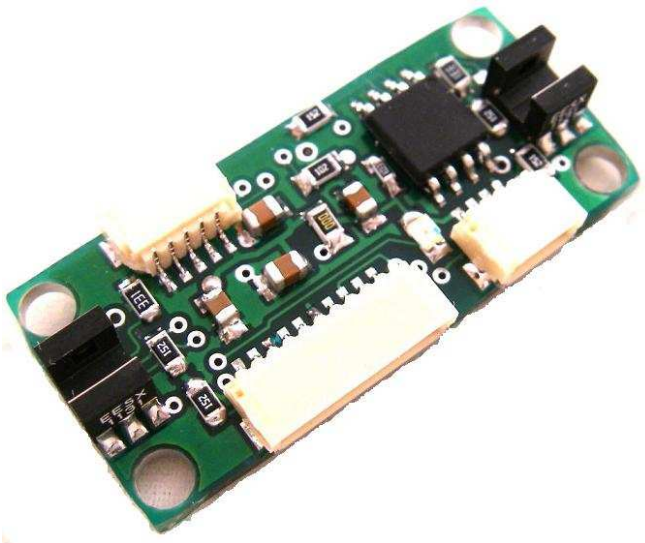
MS23SL Magnetic Linear Sensor With Smart Limit Switches

2 micron Quadrature Output
0.4 micron Serial Output
0.4 micron PWM Output

Technical Reference Guide

PCB Rev 1.0



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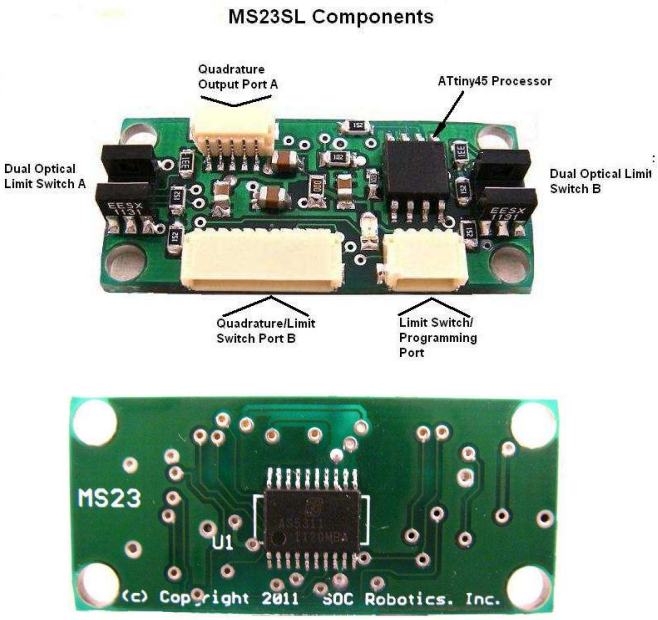
1.0 Introduction



Features

- 2 micron linear magnetic position sensor
- 0.4 micron PWM output
- 0.4 micron serial output
- 2 dual optical limit switches
- Limit switches mounted on top
- Linear Position Sensor mounted on bottom
- On board limit switch processor with smart bus suppor
- LED power indication
- 3.3V or 5V operation (component set)
- Dimensions: 1.37x0.61 inch

Overview

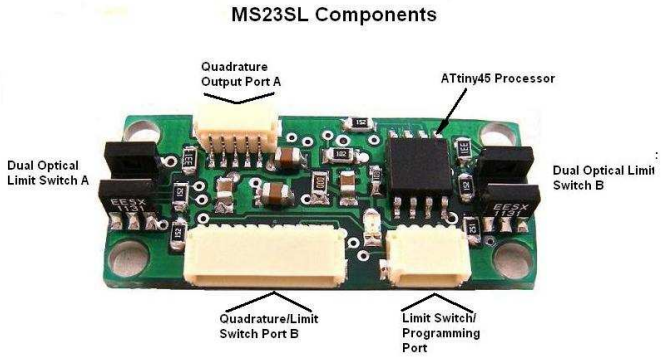
The MS23SL is a high performance sensor that combines a Magnetic Linear position measurement sensor with 2 micron Quadrature resolution (or 0.4 micron Serial or 0.4 micron PWM position output) with two dual optical interruptible limit switches monitored by an on board processor. The MS23 is a version of the MS23SL without limit switches. Integrating limit switches with the linear position sensor eliminates the need to wire separate limit switches.

Linear Position Sensor

All three output formats are available on connector J1. The 2 micron (0.000078740in) quadrature output tracks linear moves at speeds up to 0.65m/sec while the 0.4 micron (0.000015748in) PWM/Serial output can track at 2.3m/sec. The sensor typically lies 0.3-0.5mm (0.012-0.020in) above a magnetized 1mm dipole magnetic strip. The MS23SL uses the Austria Microsystems AS5311 magnetic linear position sensor.

Dual Limit Switch Sensors

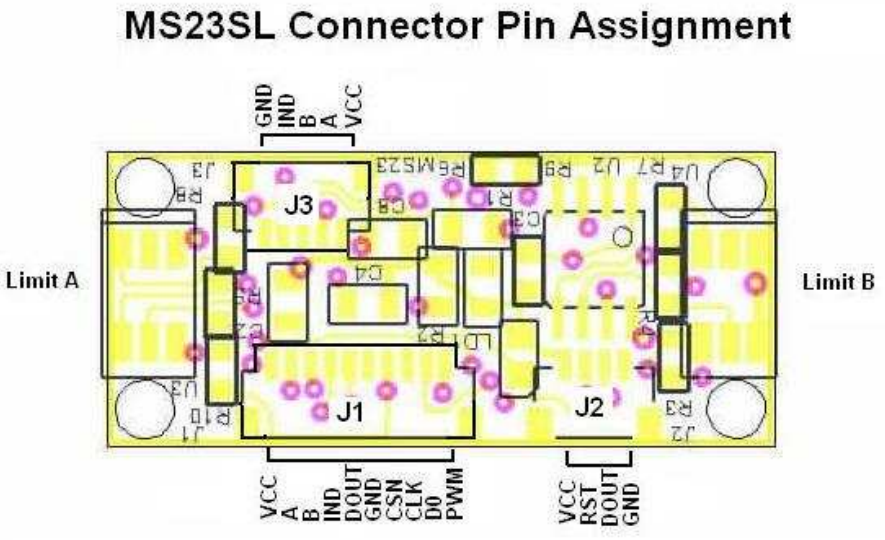
Two dual optical interruptible limit switches are monitored by an on board processor that signals when either sensor is interrupted. Each limit switch has two IR transmitter/receiver pairs allowing the sensor to know in which direction it is being interrupted. The processor supports several modes of operation including simple interrupt indication (active high or low) whenever any of the four optical paths are interrupted or a one-wire like communicates mode that allows a host control processor to interrogate the MS23SL to see which of the four sensors was interrupted. The processor supports a party line communication protocol allowing two or more MS23SLs to exist on a single wire harness.



2.0 MS23SL Detailed Description

2.1 Connector Pin Assignments

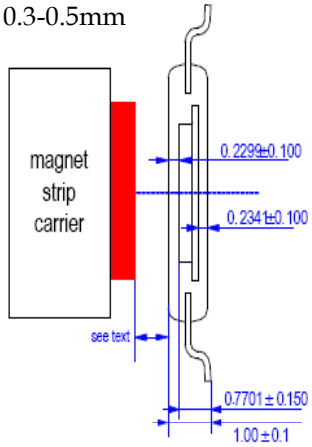
The MS23SL has three interface connectors – quadrature output (J3), limit switch output (J2) and a quadrature/limit switch output (J1). The combined output (J3) also supports the linear sensor's Serial/PWM output formats.

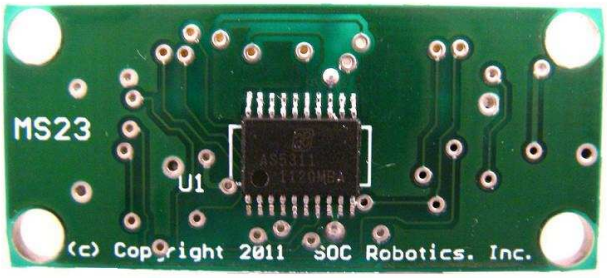


2.2 Linear Position Sensor

The linear magnetic sensor is mounted on the bottom of the PCB. This sensor must be located 0.3-0.5mm above a specially magnetized strip of 1mm dipoles. The sensor breaks the 1mm dipole into 4096 individual increments yielding a 0.4 micron resolution and outputs the absolute location within each dipole by this amount on the serial and PWM outputs. The quadrature output adds hysteresis reducing the effective resolution from 0.4 micron to 2 micron.

Fly height 0.3-0.5mm

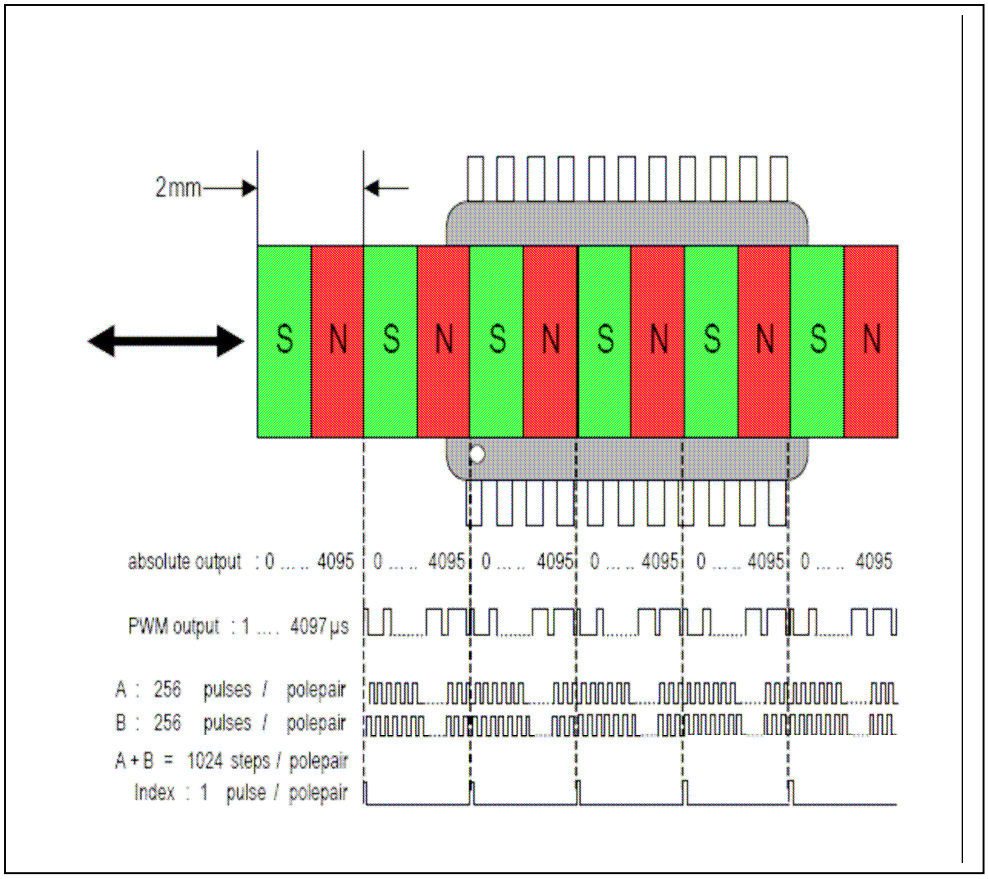




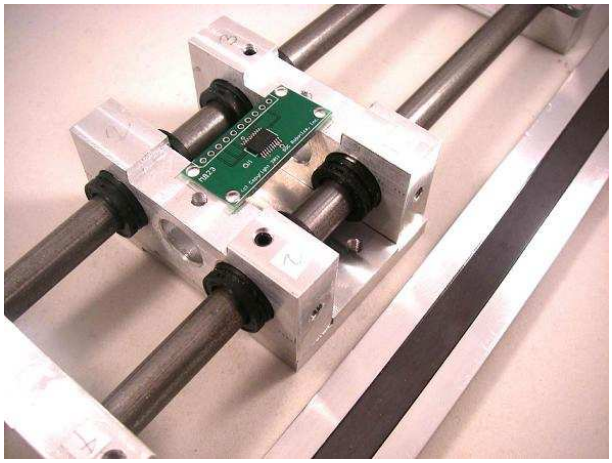
The maximum resolution of the sensor is output in Serial and PWM modes yielding a resolution of 0.4micron (0.000015748in). Both outputs are not output in real time. PWM output is updated at a 244Hz rate while the serial output can be updated at a 10.4KHz rate. The serial interface requires a host controller to provide CLK to the device. The quadrature output has a resolution of

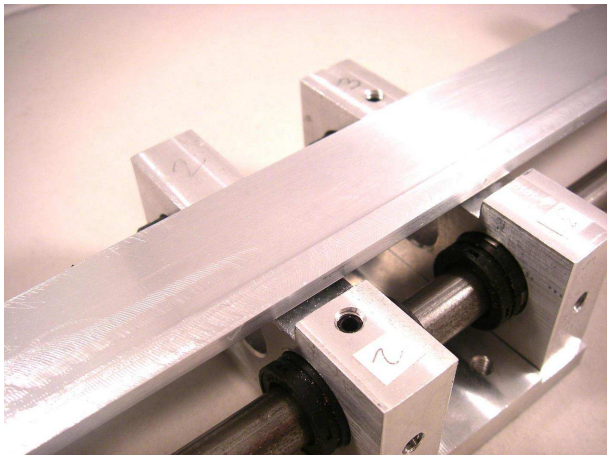
2micron (0.00007940) and is output in real time. For quadrature (incremental) output the CSN pin must be held low (pull down resistor is on the board so can be left unconnected).

Quadrature position information is available on outputs J1 and J3. Quadrature, serial and PWM outputs are available on J1 along with limit switch output.



Typical magnet strip mounted on linear actuator is shown below with the magnetic strip to the right.





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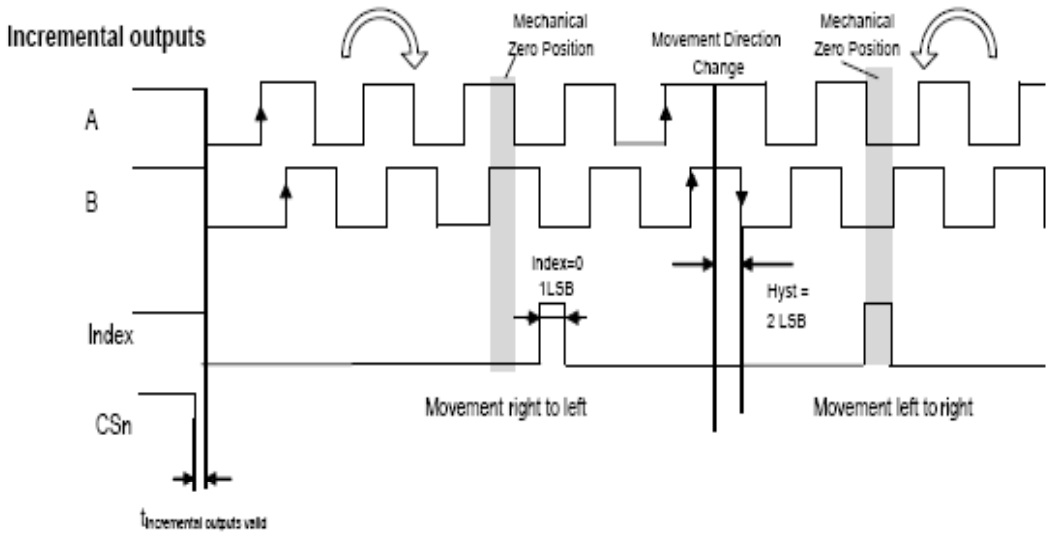
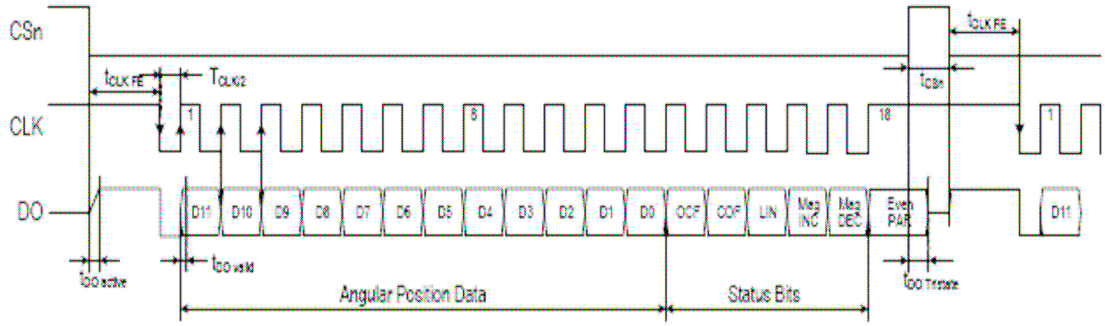
Quadrature Output Format

Typical quadrature output signal format is shown below



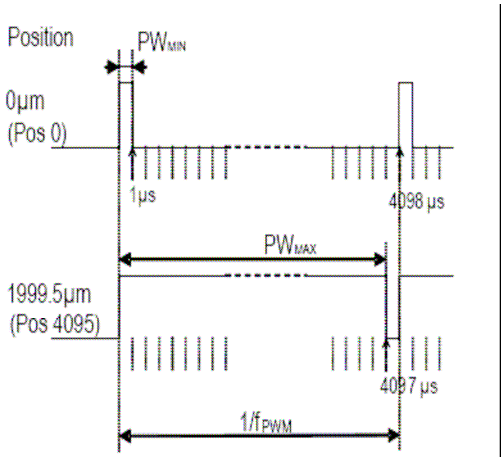
Serial Output Format

Typical serial output format is shown below (see datasheet for detailed technical description).



PWM Output

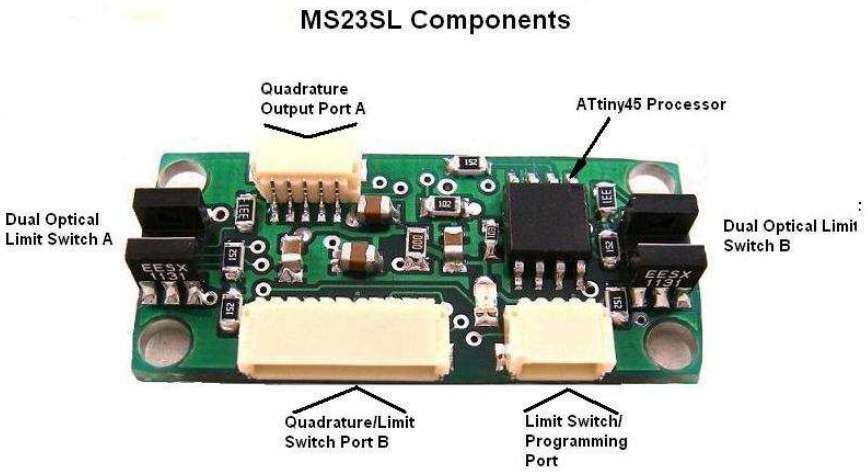
Typical PWM output format is shown on the right (see datasheet for detailed technical information).

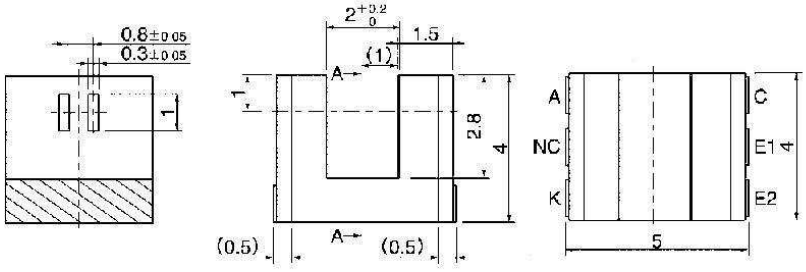


The AS5311 requires approximately 26ma at the rated voltage. Consult the AS5311 datasheet for detailed technical information on chip operation.

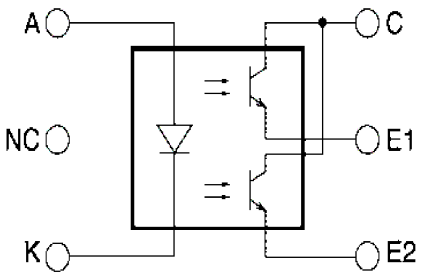
2.3 Smart Limit Switch Sensors

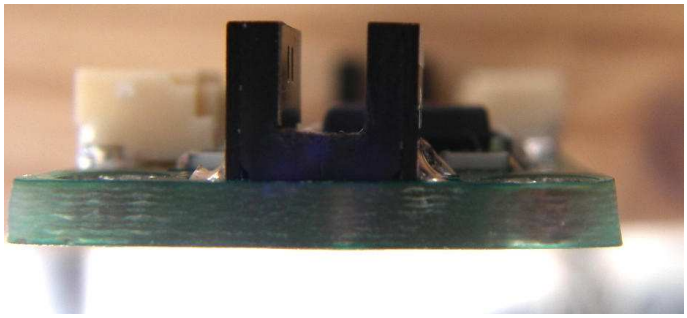
Two dual optical interruptible limit switches are monitored by an on board processor that signals when either sensor is interrupted. Each limit switch has two IR transmitter/receiver pairs separated by 0.8mm allowing the sensor to know in which direction it has been interrupted. Components mounted on the PCB are low enough to allow an interruption device to pass through the length of the MS23SL allowing intermediate home positions to be defined along the length of travel between each end of the actuator.





Dimensions in mm.





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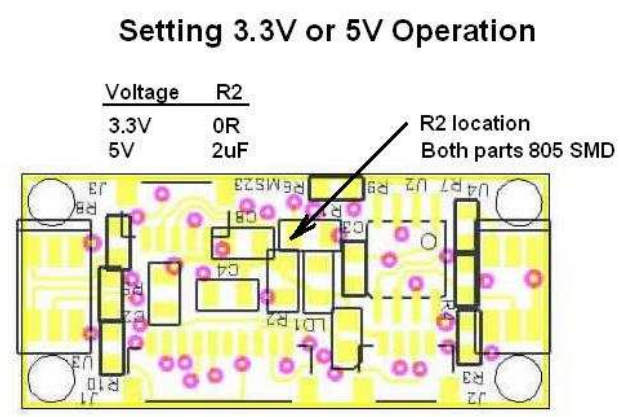
Processor Operation

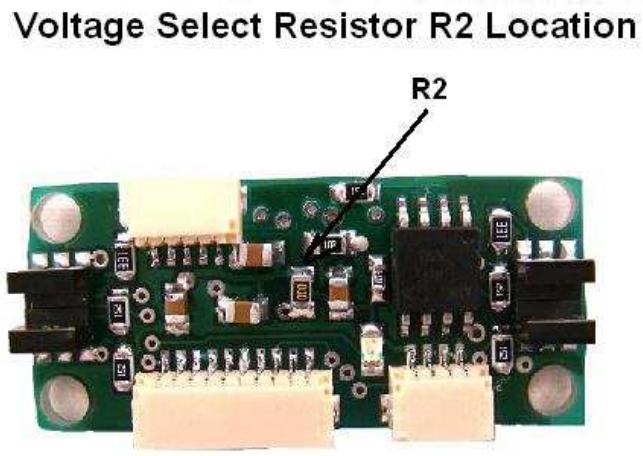
The MS23SL has an 8 bit Atmel ATtiny45 processor that monitors the state of the limit switches. The processor supports several modes of operation including simple interrupt monitoring whenever any of the four optical paths are interrupted (active high or low) or a one-wire like communications mode that allows a host control processor to interrogate the MS23SL to see which of the four sensors was interrupted. The processor supports a party line communication protocol allowing two or more MS23SL's to exist on a single wire harness.

Protocol TBD.

2.4 Selecting Device Operating Voltage

The AS5311 can be powered from a 3.3VDC or 5VDC source – the board must be configured for the correct voltage source. If powered by 5V component R2 must be replaced by a 2uF 805 surface mount capacitor mounted as shown in the picture below on the right. If powered at 3.3V a 0R surface mount resistor is installed at R2.



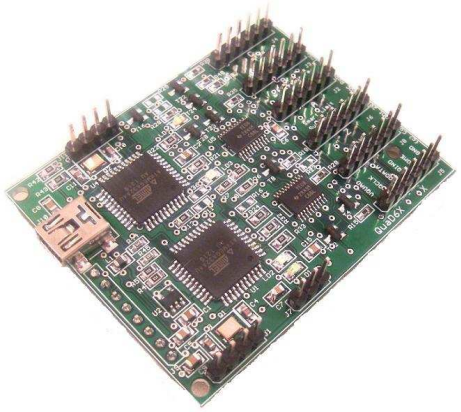


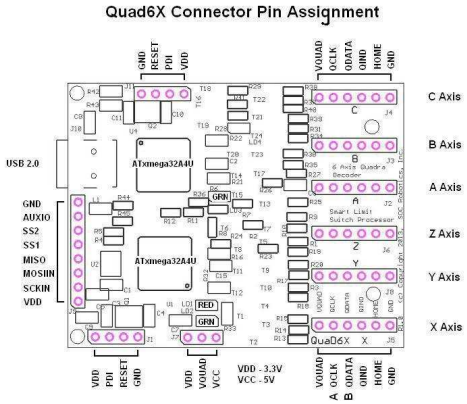
3.0 Software and Applications

3.1 Linear Position Sensor

The linear position sensor outputs position as a quadrature signal, serial position or PWM position. Quadrature information is incremental with an index pulse every 4096 transitions in one direction. The serial and PWM output is the absolute position within each 1mm dipole magnet (broken down into 4096 individual positions). Host software must convert the incremental and absolute position into English or Metric position by keeping track of the incremental changes or transitions across absolute positions and apply a conversion factor to yield inch or metric absolute position.

The Quad6X six channel quadrature decoder can convert the output from up to six MS23SL sensors into absolute position (English or metric). The Quad6X has a USB interface and communications with the desktop via a serial communication protocol. The Quad6X also supports the MS23SL's smart limit switch protocol.





3.2 Smart Limit Switch Protocol

The onboard processor supports a bi-directional communication protocol with a host control processor. The communication line is a 3.3V or 5V open collector part line bus using a single line. Data is encoded as one start bit, 8 data bits, 1 stop bit at a 38,400 baud rate. The host controller is considered the master with the MS25SL a slave. The protocol is similar to I2C in that up to 128 unique MS25SL's can exist on a single bus. An address of 0 is considered the broadcast address. The host controller sends and address byte followed by a read or write (similar to the I2C communication format).

A MS25SL has two optical interrupt detectors with two sensors per interrupter for a total of four optical sensors. The onboard processor is monitoring the state of these sensors based on settings sent to it by the master controller.

All commands start with printable ASCII characters.

3.3 Magnetic Strip Configuration Options

The MS23SL determines linear position by accurately measuring the position over a 1mm dipole magnetic strip to a resolution of 1 in 4096 yielding an inherent resolution of 0.4 micron. The magnet strip is 0.375″ wide by 0.068″ high (including sticky back tape). The magnetic strip is provided in various lengths.

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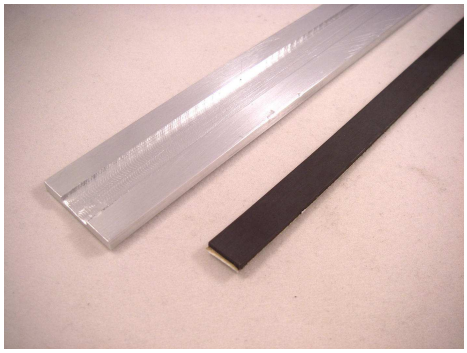
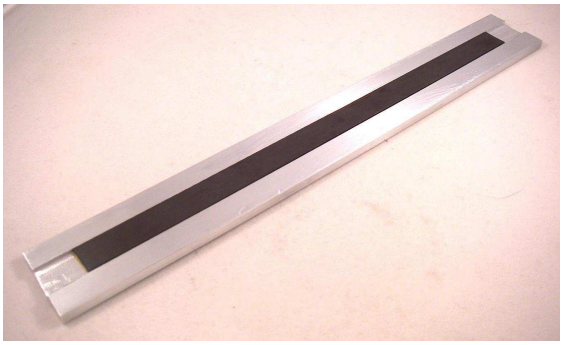
The magnetic strip is provided as a standalone strip with sticky backed tape or mounted on an aluminum strip. The aluminum strip is available in two thicknesses – 0.125″ and 0.200″ and is one inch wide with a 0.378″x0.068″ slot milled in the center of the strip so that the magnetic strip is flush with the top of the aluminum.





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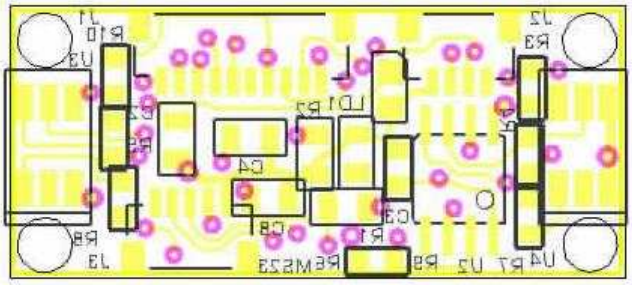
Electrical and Mechanical Description

Component Layout

Components are mounted on one side of the board.



Electrical Specifications

Electrical

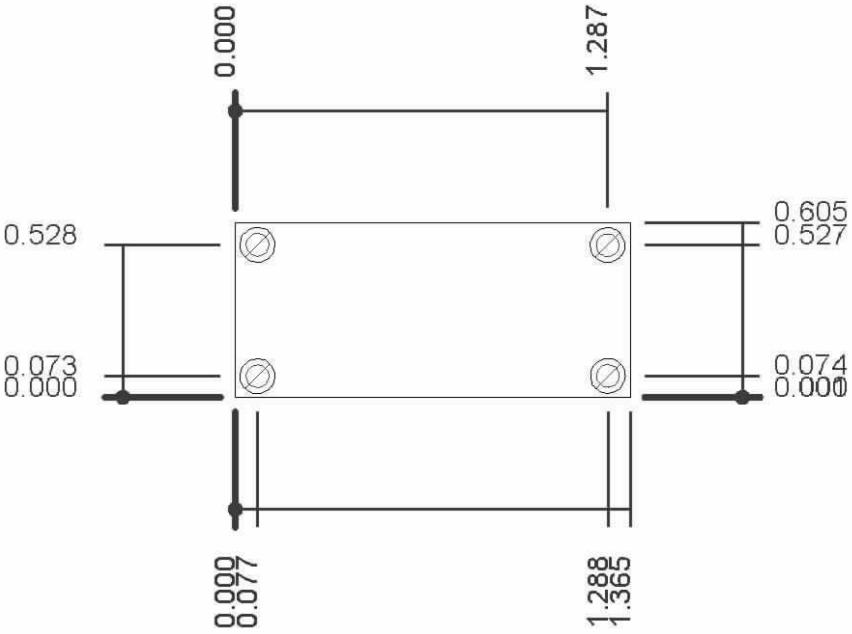
Logic Power: 3.3V or 5V DC

Mechanical

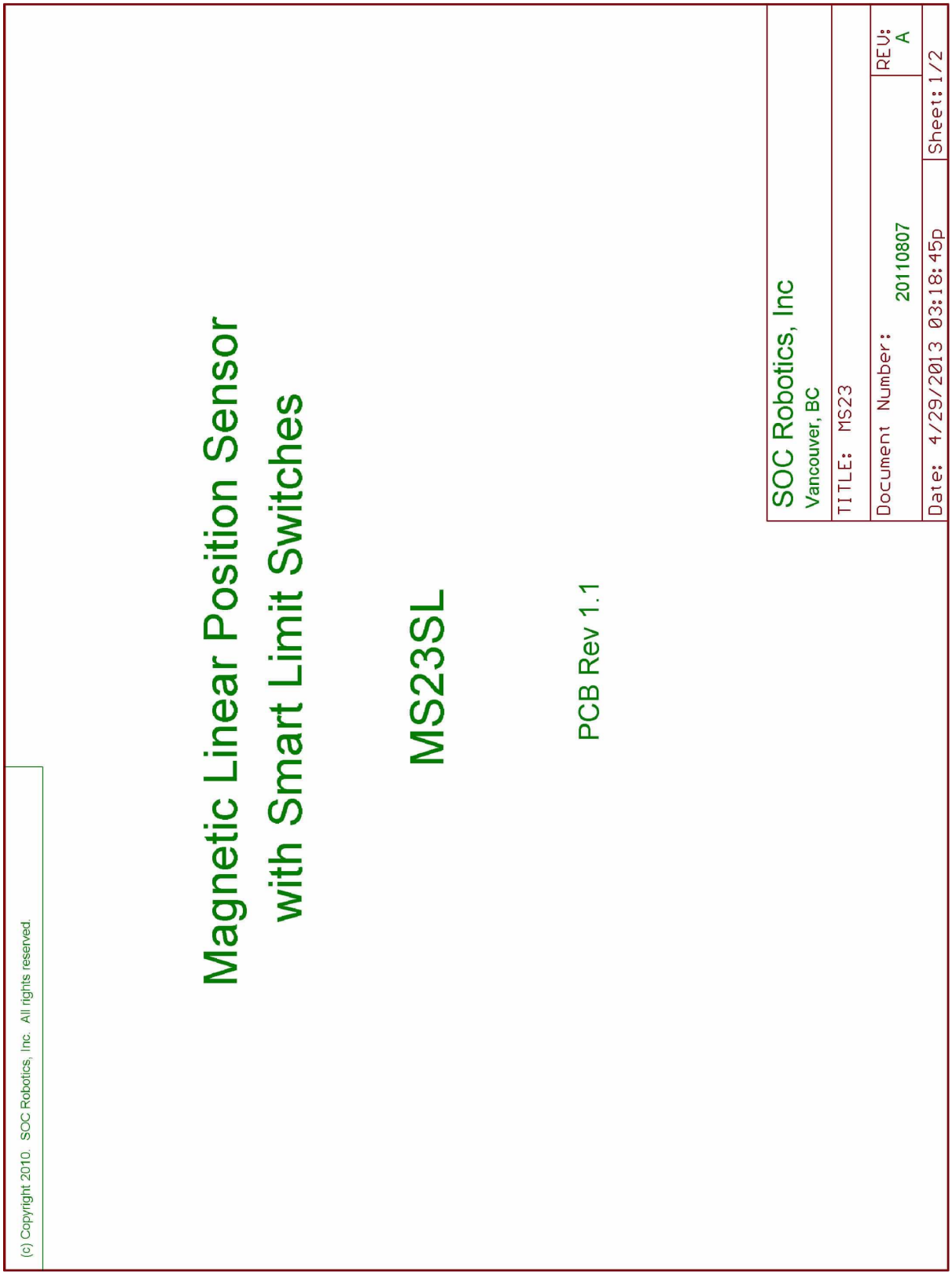
Dimensions: 1.70 x 0.61 in
Weight: 20 grams

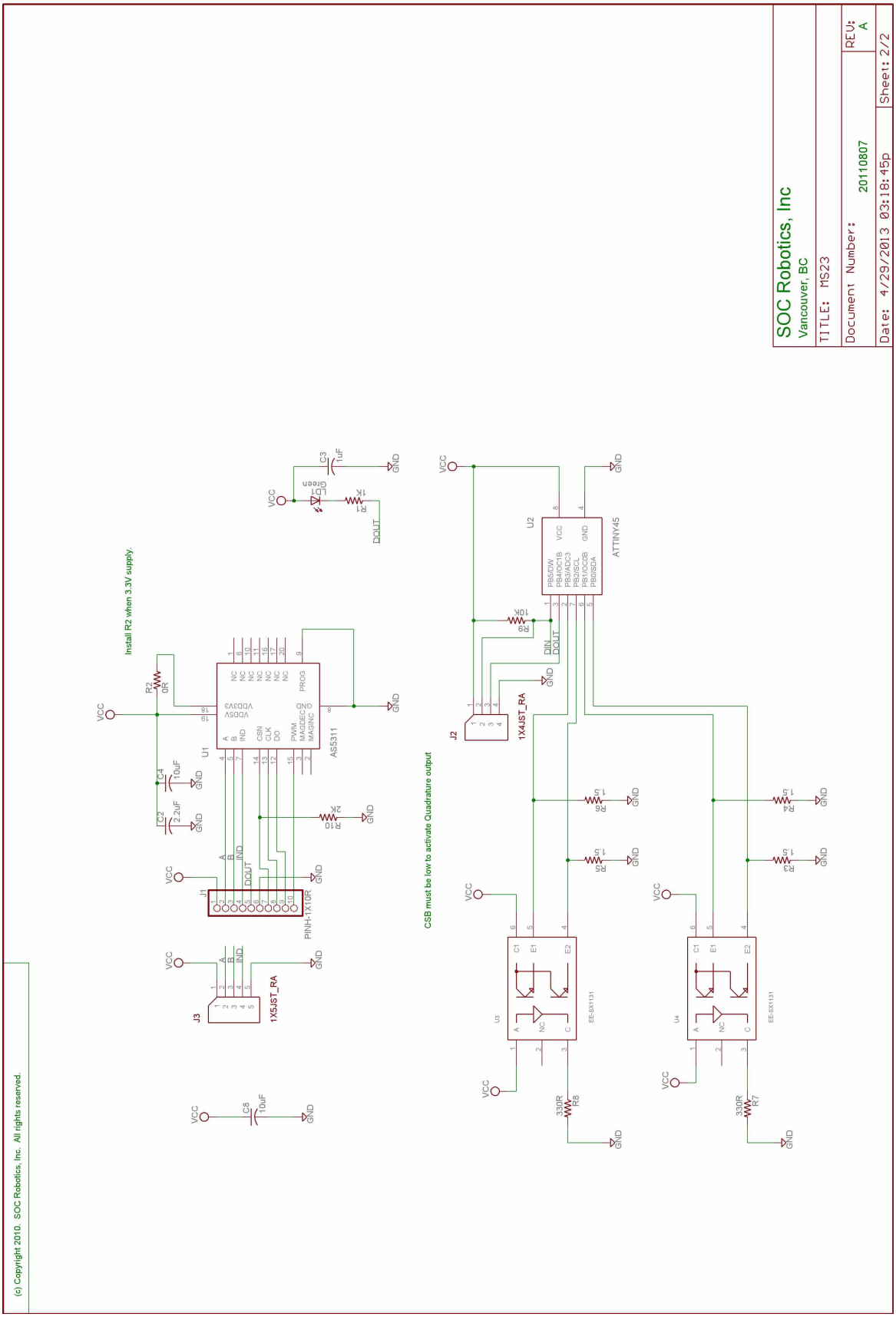
Mechanical Dimensions

Board dimensions are stated in inches.



MS23SL Circuit Schematic

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Vancouver, BC
TITLE: MS23
Document Number: 20110807
REV: A
Date: 4/29/2013 03:18:45p
Sheet: 2/2
Install R2 when 3.3V supply.
CSB must be low to activate Quadrature output
U1
AS5311
U2
ATTINY45
J1
PINH-1X10R
J2
1X4JST_RA
J3
1X5JST_RA
U3
U4
EE-SX1131
VCC
GND
DOUT
DIN
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Notes:

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