ELECTRONIC COMPASS MODULE (LSM303DLHC) – BM004

OPEN SOURCE HARDWARE MODULE

hardware made easy
Solutions Cubed

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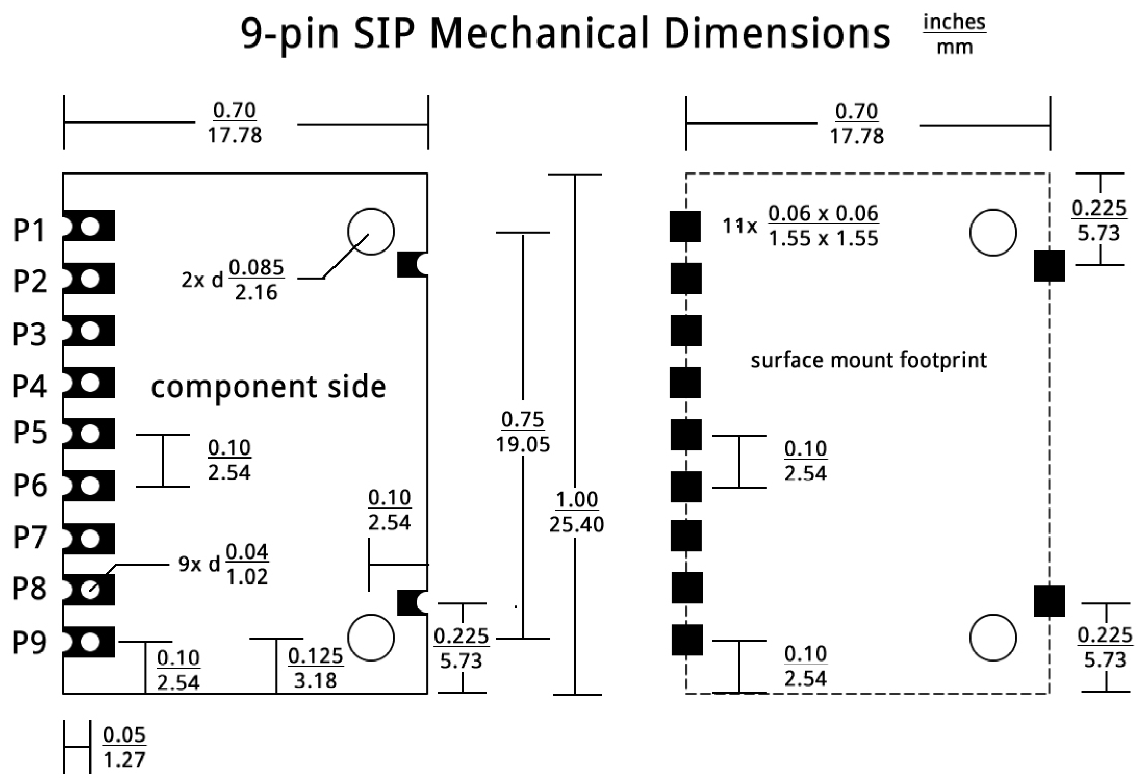
Product Description:

This breakout board carries a single ST Micro LSM303DLHC 3D accelerometer and 3D magnetometer. The module may be used to create an electronic compass.

- I^2C^{TM} serial interface
- Compatible with 3.3V or 5V inputs/outputs
- 3 magnetic field and 3 accelerometer channels, 16-bit data
- Embedded temperature sensor
- Forms core of compensated compass design
- Useful for motion activation, free-fall detection, pedometer, virtual reality

Dimensions:



Specifications:

Characteristic	Min	Typ	Max	Unit	Notes
VIN operating voltage	5		24	V	Onboard regulator provides 3.3V
Operating current		1.5		mA	Removing LED D1 can reduce this significantly.
Operating temperature	-40		85	°C	

Pin Functions and Notes

#	Name	Maximum Voltage	Notes
1	VIN	24V	Voltage supply. 5-24VDC supplies onboard 3.3V regulator
2	GND	0V	Ground return.
3	VDD	N/A	Voltage output. 3.3V should not draw more than 25mA from this connection.
4	VDD_IO	5V	Voltage input. Sets operating voltage for SCL, SDA, INT. This pin must be connected to a voltage, even if you have pull-up resistors external to the board.
5	SCL	VDD_IO	Logic input. Serial data clock line. This pin is pulled to VDD_IO by a 4.7KΩ resistor.
6	SDA	VDD_IO	Logic input output. Serial data input and output to the IC. This pin is pulled to VDD_IO by a 4.7KΩ resistor.
7	INT2	VDD	Logic output. Interrupt driven output pin.
8	INT1	VDD	Logic output. Interrupt driven output pin.
9	DRDY	N/A	Logic output. Data ready output pin.

User Notes/Tips

- Operation near magnetic fields or large conductors can cause measurement errors in the magnetometer. The device is most accurate if kept away from other electronics.
- The magnetometer axes registers are sequentially x,z,y not x,y,z. See LSM303DLHC datasheet for details.
- For accurate heading readings you should use a tilt compensated and calibrated method for calculating headings. See our Arduino code examples at www.solutions-cubed.com for methods to do this.
- VDD_IO must be connected to a voltage source, not left floating if you are using external pull-up resistors.
- For additional information on the accelerometer/magnetometer commands or timing of the I^2C^{TM} bus please review the ST Micro LSM303DLHC datasheet. The LSM303DLHC has a large command set detailed in the device datasheet.
- INT1 and INT2 functionality is highly configurable via the I^2C^{TM} communication protocol.
- Visit www.solutions-cubed.com for application notes related to this module.
- When operating at 5V you should provide 5V at the VIN and VDD_IO pins. This powers the on-board regulator and sets the voltage bus of the I^2C^{TM} pins. 3.3V will be present at the VDD pin. DRDY, INT1, and INT2 will be at 3.3V levels in this configuration.
- When operating at 3.3V you can provide 5V at VIN and use the on-board regulator output at VDD to power the VDD_IO pin. Alternatively you may tie VIN to ground and connect 3.3V to both VDD and VDD_IO if the on-board regulator is not needed to provide 3.3V.
- Keeping the module away from high currents and large metallic objects will reduce errors in measurement.

Calculating Heading, Pitch, and Roll:
For a more detailed discussion of using the LSM303DLHC as a compass see ST Micro's AN3192. A copy is maintained at the BM004 application note page at www.solutions-cubed.com.

We've provided example code for the Arduino in C. Using that code as a reference is the most efficient way to see how to implement heading readings.

Basic Heading:

Heading = $180° * atan(My_h/Mx_h)/\pi$ where My_h = My and Mx_h = Mx => the magnetometer register values.

However this equation is only valid with the tilt of the IC or module is equal to 0°. For tilt compensation you need the pitch and roll and other more detailed calculations.

Pitch and Roll:

You need the normalized acceleration values for the x and y axes, Ax and Ay, to calculate pitch and roll.

$Ax_n = Ax/sqrt(Ax^2 + Ay^2 + Az^2)$
$Ay_n = Ay/sqrt(Ax^2 + Ay^2 + Az^2)$

Pitch = $\arcsin(-Ax_n)$
Roll = $\arcsin(Ay_n/\cos(Pitch))$

Tilt Compensated Heading:

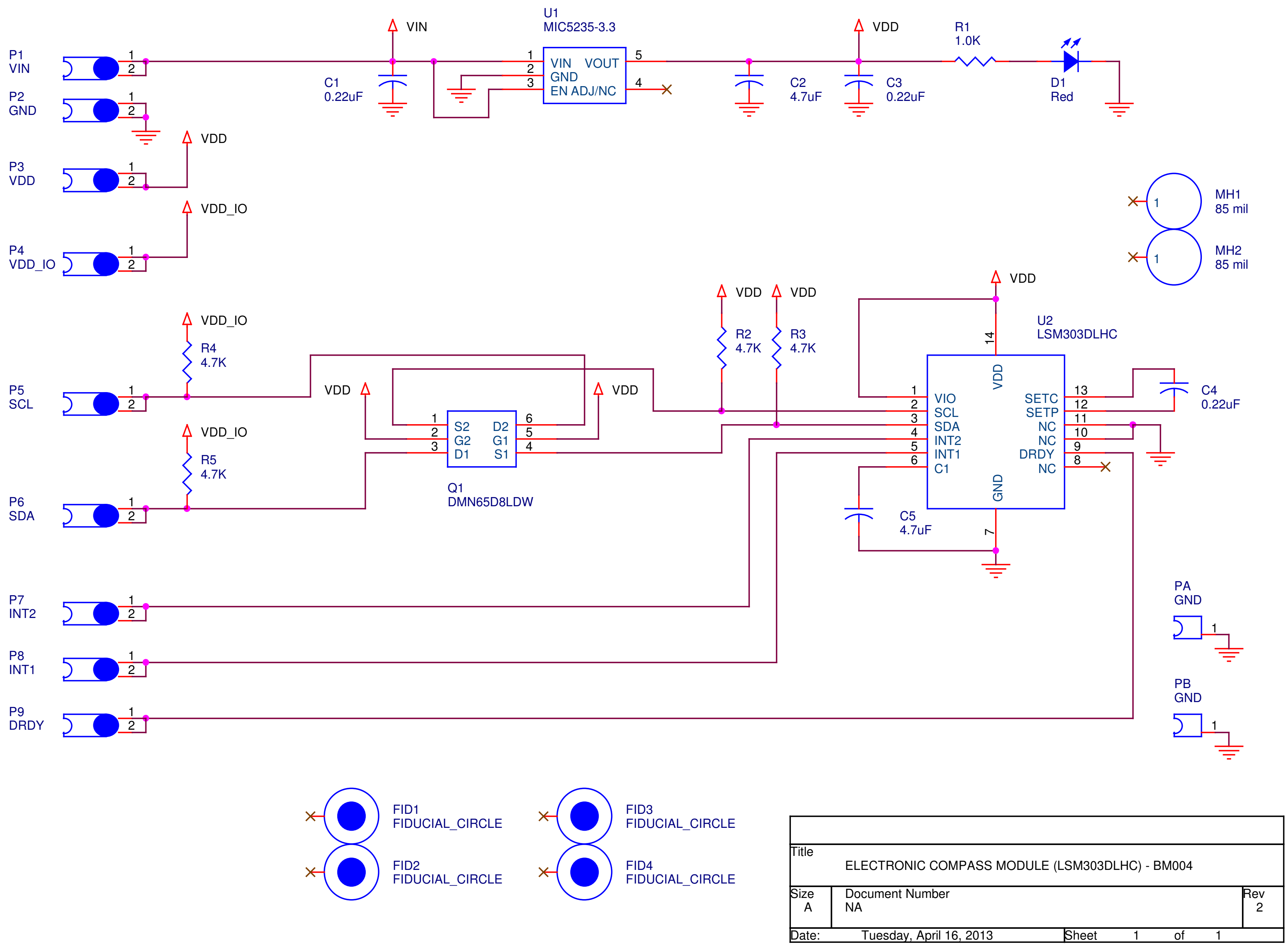
To provide accurate heading information you'll need to calibrate the magnetometer values for your specific sensor. One simple method to do this is to capture the min and max values for each axes Mx, My, and Mz. Rotate the sensor around all axes and write down the max and min values for each axis. Then adjust then offset and scale your magnetic field values as shown below.

Mx_c = (Mx-Mminx) / (Mmaxx-Mminx) *2 -1;
My_c = (My-Mminy) / (Mmaxy-Mminy) *2- 1;
Mz_c = (Mz-Mminz) / (Mmaxz-Mminz) * 2-1;

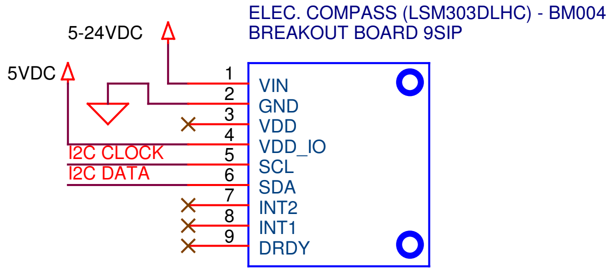
Then calculate Mx_h and My_h with these values.

$Mx_h = Mx_c*\cos(Pitch)+Mz_c*\sin(Pitch)$;
$My_h = Mx_c *\sin(Roll)*\sin(Pitch)+My_c*\cos(Roll)-Mz_c*\sin(Roll)*\cos(Pitch)$;

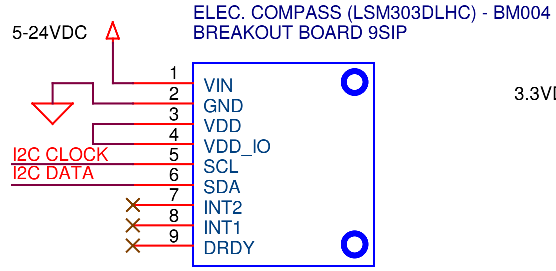
Heading = $180° * atan(My_h/Mx_h)/\pi$


P1
VIN
P2
GND
P3
VDD
P4
VDD_IO
P5
SCL
P6
SDA
P7
INT2
P8
INT1
P9
DRDY
VIN
VDD
VDD_IO
U1
MIC5235-3.3
VIN VOUT
GND
EN ADJ/NC
C1
0.22uF
C2
4.7uF
C3
0.22uF
R1
1.0K
D1
Red
MH1
85 mil
MH2
85 mil
R4
4.7K
R5
4.7K
R2
4.7K
R3
4.7K
S2 D2
G2 G1
D1 S1
Q1
DMN65D8LDW
U2
LSM303DLHC
VDD
VIO
SCL
SDA
INT2
INT1
C1
SETC
SETP
NC
NC
DRDY
NC
GND
C4
0.22uF
C5
4.7uF
PA
GND
PB
GND
FID1
FIDUCIAL_CIRCLE
FID2
FIDUCIAL_CIRCLE
FID3
FIDUCIAL_CIRCLE
FID4
FIDUCIAL_CIRCLE
Title
ELECTRONIC COMPASS MODULE (LSM303DLHC) - BM004
Size
A
Document Number
NA
Rev
2
Date: Tuesday, April 16, 2013
Sheet 1 of 1

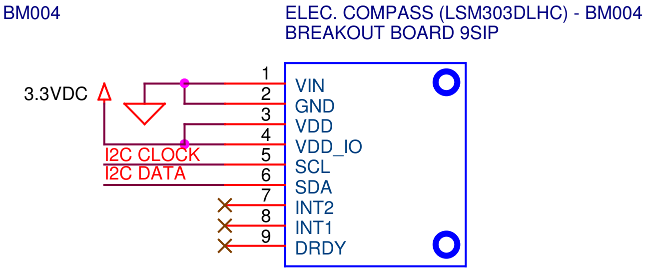
BASIC CONNECTIONS 5V SYSTEM



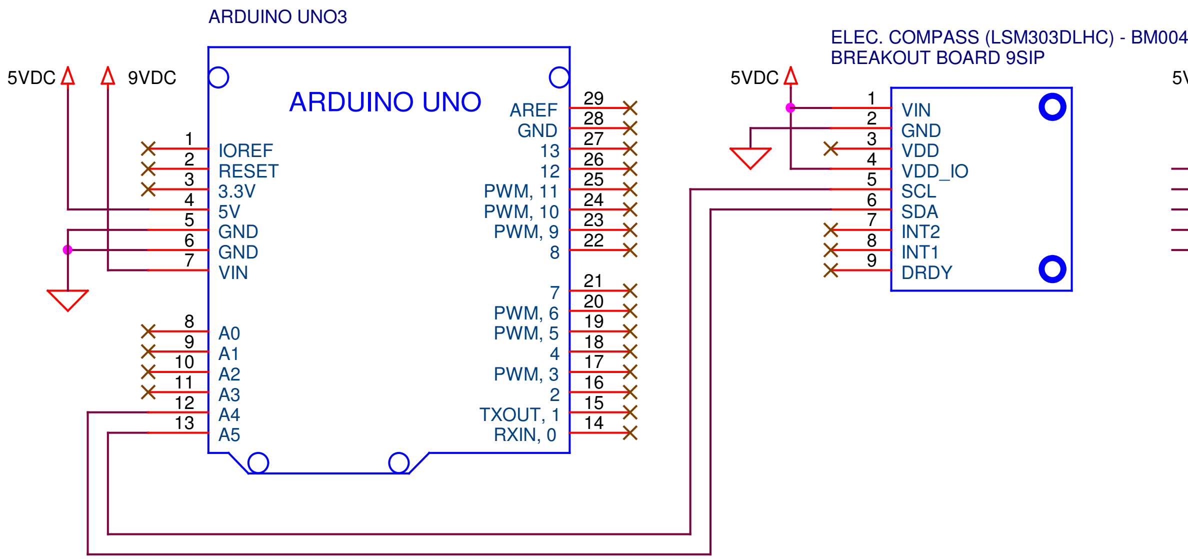
BASIC CONNECTIONS 3.3V SYSTEM



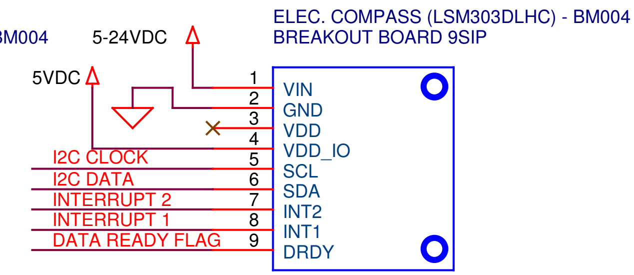
ALTERNATE CONNECTIONS 3.3V SYSTEM



ARDUINO CONNECTIONS



INTERRUPT AND DATA READY OUTPUTS



INTERRUPT AND DATA READY OUTPUTS WILL BE AT 3.3V LEVELS REGARDLESS OF THE VOLTAGE APPLIED TO VDD_IO

REVIEW THE LSM303DLHC COMMUNICATION PROTOCOL IN THE IC'S DATASHEET FOR MORE INFO ON INTERRUPTS