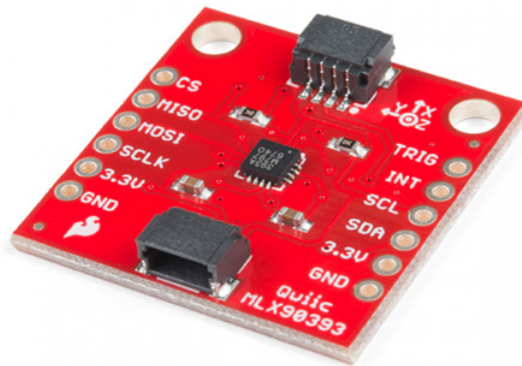


Qwiic Magnetometer (MLX90393) Hookup Guide

Introduction

The MLX90393 is a tri-axial magnetic sensor capable of sensing very small fields (like the Earth's magnetic field) while behaving as one would want and expect during saturation in larger fields (like a nearby magnet). It turns out the favorite HMC5883L and other such sensors that are intended for compass applications have a low dynamic range but also strange and undefined behavior in large fields. Ted Yapo did an incredibly extensive characterization of the sensor over on Hackaday. He published his controlled experiments testing a few sensors and found the MLX90393 to be superior.

The MLX90393 can be used as a compass sensor but also works well as a non-contact controller (joystick), flow meter (with magnetic impeller), or a linear actuator position sensor. The breakout board is also a part of SparkFun's Qwiic system, so you won't have to do any soldering to figure out what the magnetic fields look like.



SparkFun Triple Axis Magnetometer Breakout - MLX90393 (Qwiic)

© SEN-14571

Product Showcase: Qwiic MLX90393 Triple Axis Magnetometer



In this hookup guide, we'll get going by getting some basic readings from the sensor, then look at how to configure the sensor on different I²C addresses.

Required Materials

To get started, you'll need a microcontroller to control everything in your project.



SparkFun RedBoard - Programmed with Arduino

© DEV-13975



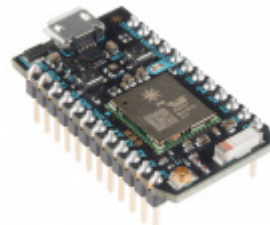
SparkFun ESP32 Thing

© DEV-13907



Raspberry Pi 3

© DEV-13825



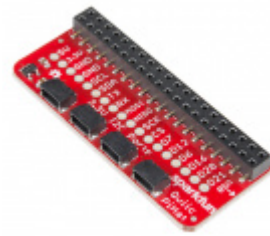
Particle Photon (Headers)

© WRL-13774

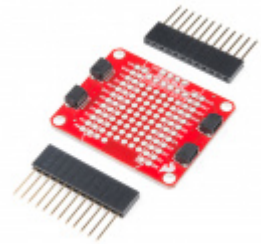
Now, to get your microcontroller into the Qwiic ecosystem, the key will be one of the following Qwiic shields to match your preference of microcontroller:



SparkFun Qwiic Shield for Arduino
● DEV-14352



SparkFun Qwiic HAT for Raspberry Pi
● DEV-14459



SparkFun Qwiic Shield for Photon
● DEV-14477

You will also need a Qwiic cable to connect the shield to your magnetometer, choose a length that suits your needs.



Qwiic Cable - 500mm
○ PRT-14429



Qwiic Cable - 200mm
● PRT-14428



Qwiic Cable - 100mm



Qwiic Cable - 50mm

Or, here's the wishlist to follow along exactly with this guide:

Qwiic Magnetometer Hookup Guide Wishlist SparkFun Wish List



SparkFun RedBoard - Programmed with Arduino

DEV-13975

At SparkFun we use many Arduinos and we're always looking for the simplest, most stable one. Each board is a bit...



SparkFun Qwiic Shield for Arduino

DEV-14352



Qwiic Cable - 100mm

PRT-14427



SparkFun Triple Axis Magnetometer Breakout - MLX90393 (Qwiic)

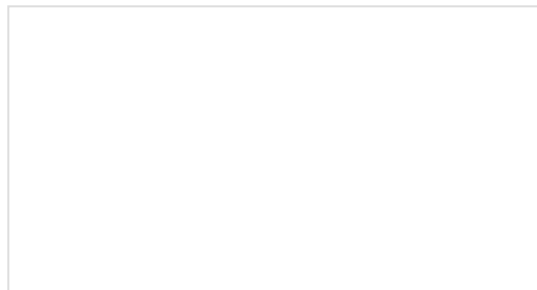
SEN-14571

Suggested Reading

If you aren't familiar with our new Qwiic system, we recommend checking out our overview:

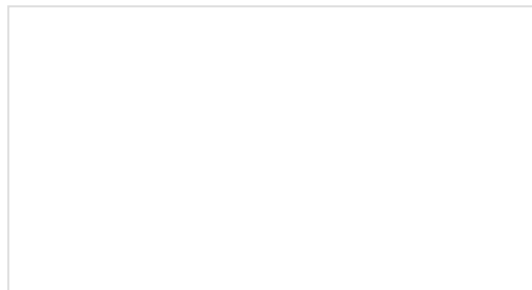
[WHAT IS QWIIC?](#)

We would also recommend taking a look at the hookup guide for the Qwiic Shield if you haven't already. Brushing up on your skills in I²C is also recommended, as all Qwiic sensors are I²C.



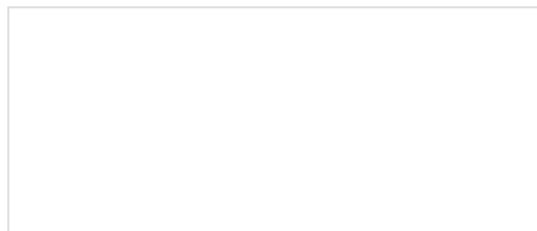
I2C

An introduction to I2C, one of the main embedded communications protocols in use today.



Serial Terminal Basics

This tutorial will show you how to communicate with your serial devices using a variety of terminal emulator applications.



Qwiic Shield for Arduino & Photon Hookup Guide

Get started with our Qwiic ecosystem with the Qwiic shield for Arduino or Photon.

Hardware Overview

Let's look over a few characteristics of the MLX90393 so we know a bit more about how it behaves.

Characteristic	Range
Operating Voltage	2.2V - 3.6V
Operating Temperature	-20°C - 85°C
Resolution	0.161 μ T
Current Consumption	100 μ A (Typ.)
I ² C Address	0xC0

Pins

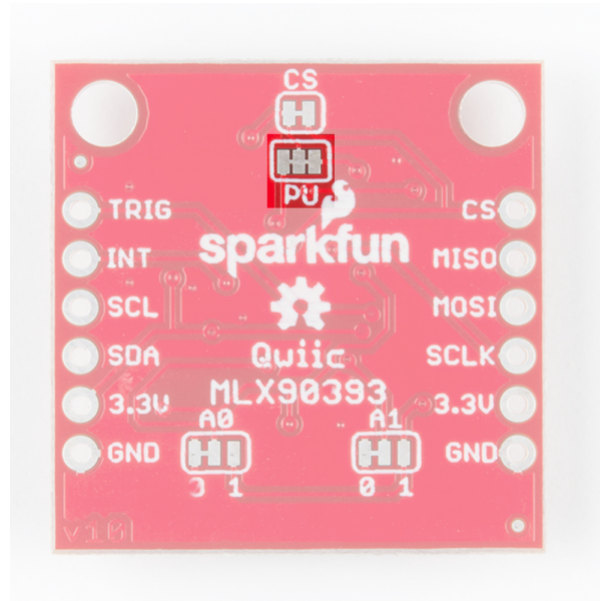
The characteristics of the available pins on the magnetometer are outlined in the table below.

Pin Label	Pin Function	Input/Output	Notes
3.3V	Power Supply	Input	Should be between 2.2V - 3.6V
GND	Ground	Input	0V/common voltage.
SDA	I ² C Data Signal	Bi-directional	Bi-directional data line. Voltage should not exceed power supply (e.g. 3.3V).
SCL/SCLK	I ² C Clock Signal	Input	Master-controlled clock signal. Voltage should not exceed power supply (e.g. 3.3V).
	I ² C Data Signal	Bi-directional	Bi-directional data line. Voltage should not exceed power supply (e.g. 3.3V).
CS	Chip Select	Input	Chip Select pin, digital input. Tied high for I ² C operation, cut trace jumper and tie low for SPI.
INT	Interrupt	Output	Interrupt pin, active high, digital output. Also configurable as a data ready pin

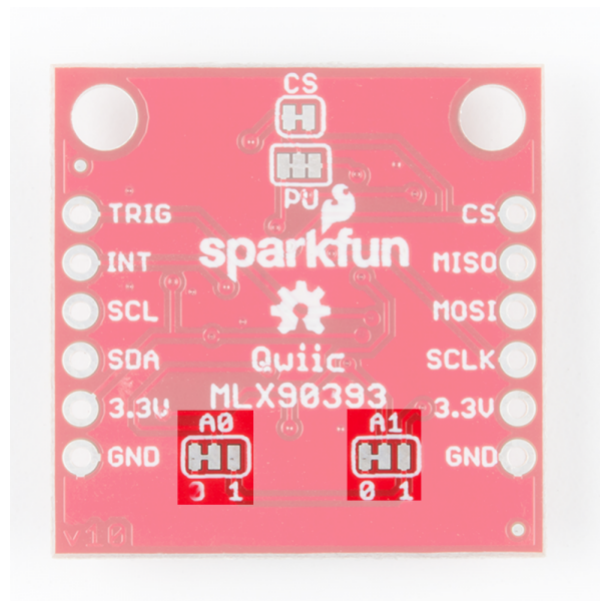
TRIG	Reset	Input/Output	Trigger pin, active high, digital output. Also configurable as interrupt pin.
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Optional Features

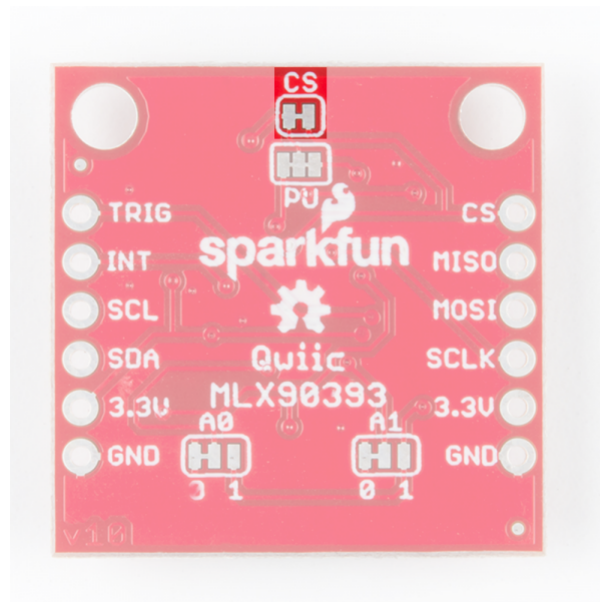
The Qwiic MLX90393 has onboard I²C pull up resistors, which can be removed by removing the solder from the jumper highlighted below. Only remove this solder if you are using your own pullups on the I²C lines.



The I²C of the Qwiic Magnetometer can be changed using the A0 and A1 jumpers on the back of the board. Simply cut the traces connecting each pad to ground (0) and solder the other side to connect it to 3.3V (1).



To operate the Qwiic Magnetometer in SPI mode, cut the chip select trace jumper (labeled below) and ensure that the CS pin is then connected to ground.

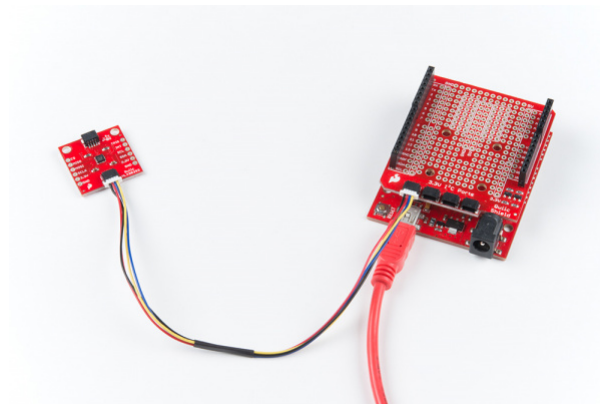


Hardware Assembly

If you haven't yet assembled your Qwiic Shield, now would be the time to head on over to that tutorial.

QWIIC SHIELD FOR ARDUINO PHOTON HOOKUP GUIDE

With the shield assembled, SparkFun's new Qwiic environment means that connecting the sensor could not be easier. Just plug one end of the Qwiic cable into the Magnetometer breakout, the other into the Qwiic Shield of your choice and you'll be ready to upload a sketch and figure out what the magnetic fields look like. It seems like it's too easy to use, but that's why we made it that way!



Example Code

Before we get into programming our Magnetometer, we'll need to download and install the magnetometer library. Ted Yapo has written a library to control the Qwiic Magnetometer. You can obtain the .zip for this library using the below button. Never installed a library before? That's ok! Checkout our tutorial on installing Arduino Libraries.

DOWNLOAD THE MLX90393 LIBRARY

Note: This example assumes you are using the latest version of the Arduino IDE on your desktop. If this is your first time using Arduino, please review our tutorial on installing the Arduino IDE. If you have not previously installed an Arduino library, please check out our installation guide.

Since this isn't a SparkFun library, the example sketches are not included, so you'll have to download those from the Github page by clicking the below button. The example sketches are located in `software`

DOWNLOAD THE MLX90393 GITHUB REPO

Go ahead and unzip these examples to a location of your choosing and open Example 1 - Basic Readings.

Example 1 - Basic Readings

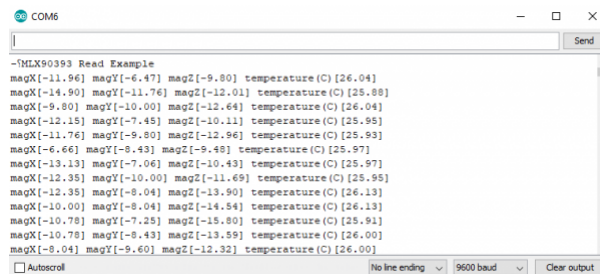
Once we have our first example opened up, let's look at how things are structured as we set up our sensor. First we create our sensor, and then an array of floats to contain our data.

```
MLX90393 mlx;  
MLX90393::xyz data; //Create a structure, called data, of four floats (t, x, y, and z)
```

Then in our setup loop, we must initialize our sensor, notice the delay afterwards, this gives the sensor time to initialize before we start attempting to talk to it.

```
mlx.begin(); //Assumes I2C jumpers are GND. No DRDY pin used.  
delay(1000); //Allow the sensor to initialize.
```

Once the sensor is initialized, our `void loop()` will read the data from our sensor into `data`, the array of floats we created earlier, and print it over serial to our serial monitor. Opening up your serial monitor to a baud rate of 9600 should display output similar to that shown below. The numbers are in units of μT . For scale, the magnetic field of the Earth ranges from 25 - 65 μT .



```
COM6  
-MLX90393 Read Example  
magX[-11.96] magY[-6.47] magZ[-9.80] temperature(C) [26.04]  
magX[-14.90] magY[-11.76] magZ[-12.01] temperature(C) [26.08]  
magX[-9.80] magY[-10.00] magZ[-12.64] temperature(C) [26.04]  
magX[-12.15] magY[-7.45] magZ[-10.11] temperature(C) [25.95]  
magX[-11.76] magY[-9.80] magZ[-12.96] temperature(C) [25.93]  
magX[-6.66] magY[-8.43] magZ[-9.48] temperature(C) [25.97]  
magX[-13.13] magY[-7.06] magZ[-10.43] temperature(C) [25.97]  
magX[-12.35] magY[-10.00] magZ[-11.69] temperature(C) [25.95]  
magX[-12.35] magY[-8.04] magZ[-13.90] temperature(C) [26.13]  
magX[-10.00] magY[-8.04] magZ[-14.54] temperature(C) [26.13]  
magX[-10.78] magY[-7.25] magZ[-15.80] temperature(C) [25.91]  
magX[-10.78] magY[-8.43] magZ[-13.59] temperature(C) [26.00]  
magX[-8.04] magY[-9.60] magZ[-12.32] temperature(C) [26.00]  
Autoscroll No line ending 9600 baud Clear output
```

Example 2 - Configure Sensor

Go ahead and open Example 2 from the location you saved it in. The only differences between this example and the previous one are in the `setup()` function. Notice how we now call the `begin()` function with 3 arguments, which are the value of the A0 jumper, the value of the A1 jumper, and the pin that we've connected to `INT`. The below code assumes that the A0 jumper has been cut from ground and soldered to 3.3V and that A3 is connected to the `INT` pin (sometimes referred to in the datasheet as the DRDY or data ready pin).

```
byte status = mlx.begin(1, 0, A3);
```

If we must change the address of our magnetometer due to overlapping addresses, ensure that the values we pass into `begin()` match up with the values of our address jumpers. The MLX90393 also has a ton of different ways to change the sensor behavior. You can set the gain, resolution of the x, y and z channels, oversampling rates, and even offsets of your x, y, and z channels. In this example however, we set the gain to 1 and the resolution of our x, y, and z channels to their finest setting, 0.


```

mlx.setGainSel(1);
mlx.setResolution(0, 0, 0);

```

A table showing the different possible resolutions of the sensor for the X and Y axes is shown below. These can be selected using the `setGainSel(uint8_t gain)` and `setResolution(uint8_t x, uint8_t y, uint8_t z)` functions. All resolutions are in units of $\mu\text{T}/\text{LSB}$.

XY Axis:

Gain	Res = 0	Res = 1	Res = 2	Res = 3
0	0.805	1.610	3.220	6.440
1	0.644	1.288	2.576	5.152
2	0.483	0.966	1.932	3.864
3	0.403	0.805	1.610	3.220
4	0.322	0.644	1.288	2.576
5	0.268	0.537	1.073	2.147
6	0.215	0.429	0.859	1.717
7	0.161	0.322	0.644	1.288

Shown below is the table containing the possible combinations for resolutions on the Z axis. Once again, units are in $\mu\text{T}/\text{LSB}$

Z Axis:

Gain	Res = 0	Res = 1	Res = 2	Res = 3
0	1.468	2.936	5.872	11.744
1	1.174	2.349	4.698	9.395
2	0.881	1.762	3.523	7.046
3	0.734	1.468	2.936	5.872
4	0.587	1.174	2.349	4.698
5	0.489	0.979	1.957	3.915
6	0.391	0.783	1.566	3.132
7	0.294	0.587	1.174	2.349

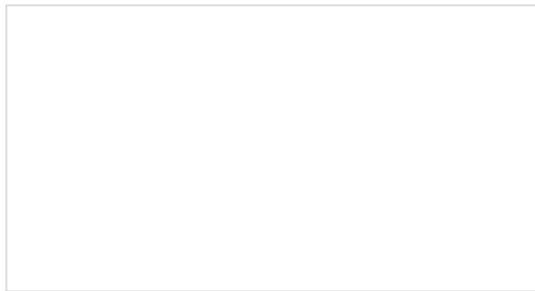
Since we are simply connecting our magnetometer on a different address, our output should be similar to the one in the first example.

Resources and Going Further

For more information, check out the resources below:

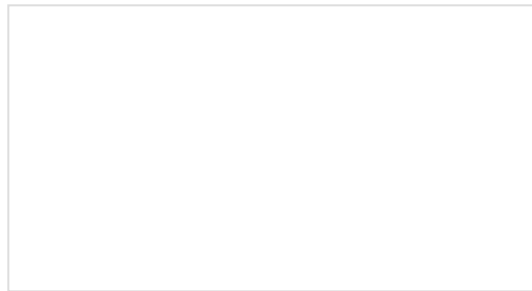
- [MLX90393 Schematic \(PDF\)](#) - Schematic for the MLX90393.
- [MLX90393 Eagle Files \(ZIP\)](#) - Board design files for the MLX90393.
- [MLX90393 Datasheet \(PDF\)](#) - Datasheet for MLX90393 Magnetometer.
- [Qwiic System Landing Page](#)
- [GitHub Repos](#)
 - [SparkFun MLX90393 GitHub Repository](#)
 - [MLX90393 Arduino Library](#)
- [SparkFun Showcase: Qwiic MLX90393 Triple Axis Magnetometer](#)
 - [Hackaday 3D Magnetic Field Scanner project](#)

Need some inspiration for your next project? Check out some of these related tutorials:



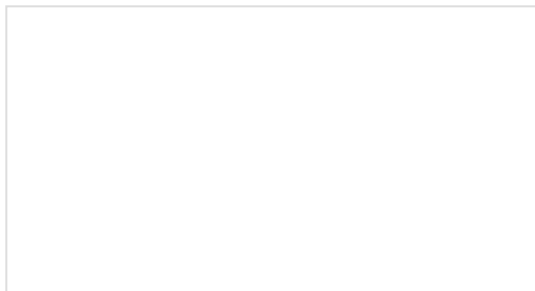
Qwiic Adapter Hookup Guide

Get started with your Qwiic adapter board. This adapter breaks out the I2C pins from the Qwiic connectors to pins that you can easily solder with your favorite I2C enabled device.



Qwiic Distance Sensor (RFD77402) Hookup Guide

The RFD77402 uses an infrared VCSEL (Vertical Cavity Surface Emitting Laser) TOF (Time of Flight) module capable of millimeter precision distance readings up to 2 meters. It's also part of SparkFun's Qwiic system, so you won't have to do any soldering to figure out how far away things are.



Qwiic Accelerometer (MMA8452Q) Hookup Guide

Freescale's MMA8452Q is a smart, low-power, three-axis, capacitive micro-machined accelerometer with 12-bits of resolution. It's perfect for any project that needs to sense orientation or motion. We've taken that

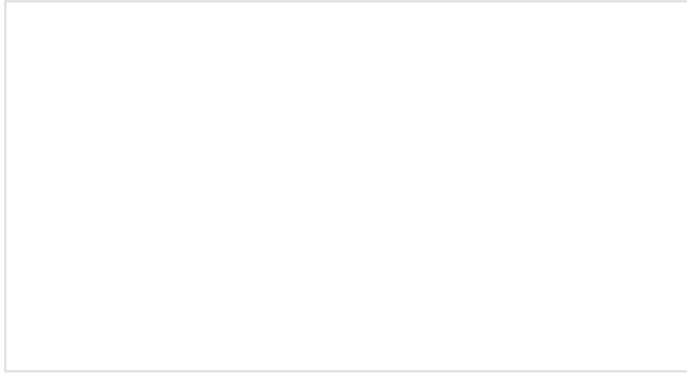


Qwiic VR IMU (BNO080) Hookup Guide

Figure out how things are oriented with the robust 9 degrees of freedom (DOF) BNO080 IMU. Maybe even make your own virtual reality (VR) applications if you're feeling savvy.

accelerometer and stuck it on a Qwiic-Enabled breakout board to make interfacing with the tiny, QFN package a bit easier.

Or check out this blog post about using a magnetometer as a compass:



Adventures in Science: Using a Magnetometer as a Compass
AUGUST 7, 2017