Qwiic Distance Sensor (VL53L1X) Hookup Guide

Introduction

The VL53L1X is the latest Time Of Flight (ToF) sensor to be released. It uses a VCSEL (vertical cavity surface emitting laser) to emit a class 1 IR laser (940 nm) and time the reflection to the target. (You can't see the laser but cell phones can) What does all this mean? You can measure the distance to an object up to 4 meters away with millimeter resolution! That's pretty incredible.

SparkFun Distance Sensor Breakout - 4 Meter, VL53L1X (Qwiic)
SEN-14722

We've found the precision of the sensor to be 1mm but the accuracy is around +/-5mm. The minimum read distance of this sensor is 4cm. In this hookup guide we'll go over how to read distance, change ranging modes, and check the status of our range measurement along with the sample rate. We'll also check out how to display distance and speed over an LCD display.

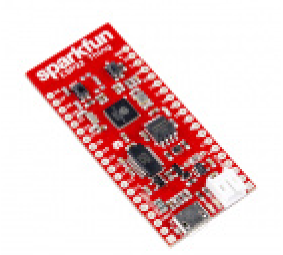
Product Showcase: VL53L1X Qwiic Distance Sensor

Required Materials

To get started, you’ll need a microcontroller to, well, control everything.

SparkFun RedBoard - Programmed with Arduino

◉ DEV-13975

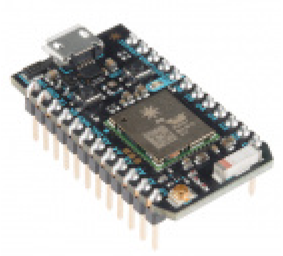


SparkFun ESP32 Thing

◉ DEV-13907

Raspberry Pi 3

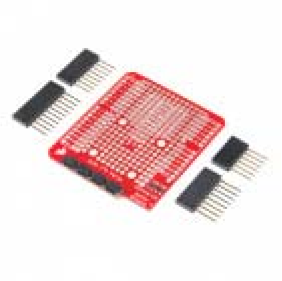
◉ DEV-13825



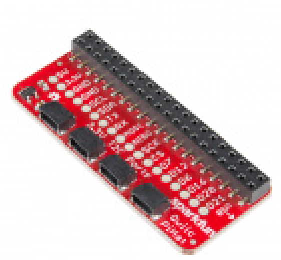
Particle Photon (Headers)

◉ WRL-13774

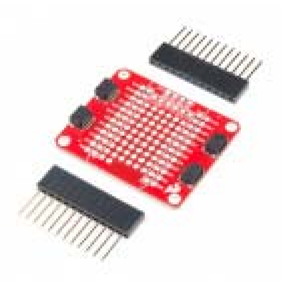
Now to get into the Qwiic ecosystem, the key will be one of the following Qwiic shields to match your preference of microcontroller:



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 distance sensor, choose a length that suits your needs.

Qwiic Cable - 200mm
◉ PRT-14428

Qwiic Cable - 100mm
⊖ PRT-14427

Qwiic Cable - 500mm

◉ PRT-14429

Qwiic Cable - 50mm

◉ PRT-14426

Suggested Reading

If you aren’t familiar with our new Qwiic system, we recommend starting here for an overview.

QWIIC SYSTEM OVERVIEW

We would also recommend taking a look at the following tutorials if you aren’t familiar with them.

Serial Communication

Asynchronous serial communication concepts: packets, signal levels, baud rates, UARTs and more!

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

First let’s check out some of the characteristics of the VL53L1X sensor we’re dealing with, so we know what to expect out of the board.

Characteristic	**Range**
Operating Voltage	**2.6V-3.5V**
Power Consumption	20 mW @10Hz
Measurement Range	~40mm to 4,000mm
Resolution	+/-1mm
Light Source	Class 1 940nm VCSEL
I^{2}C Address	0x52
Field of View	15° - 27°
Max Read Rate	50Hz

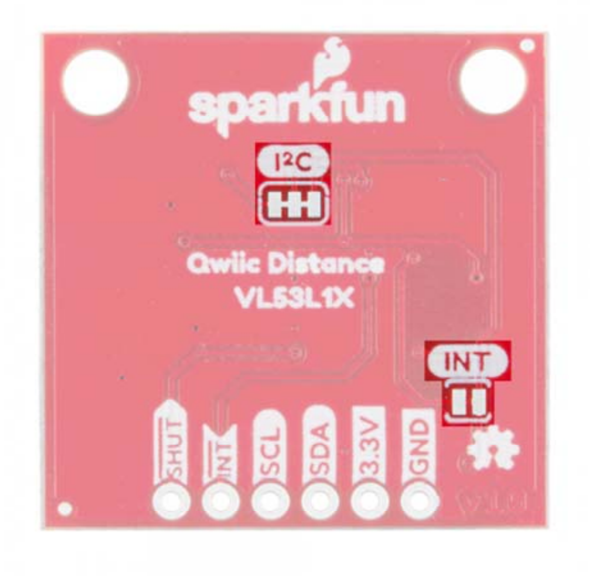
Pins

The following table lists all of the VL53L1X’s pins and their functionality.

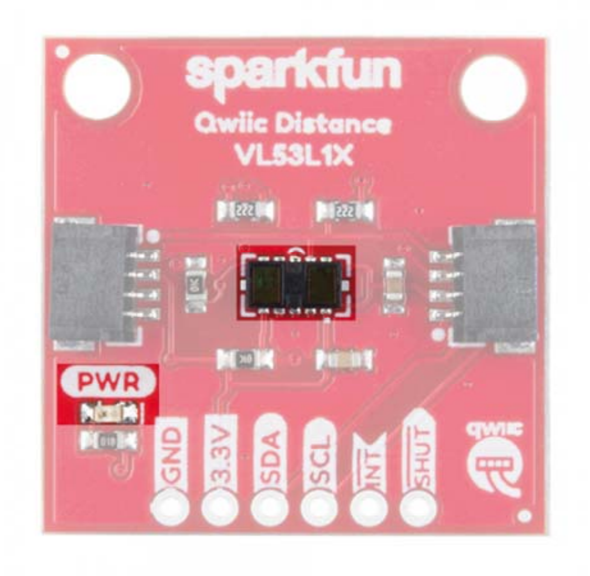
Pin	**Description**	**Direction**
GND	Ground	In
3.3V	Power	In
SDA	Data	In
SCL	Clock	In
$\overline{\text{INT}}$	Interrupt, goes low when data is ready.	Out
$\overline{\text{SHUT}}$	Shutdown, can be pulled low to put the IC in shutdown mode.	In

Optional Features

The VL53L1X breakout has pull up resistors attached to the I^{2}C bus as well as the interrupt pin; both can be removed by cutting the traces on the corresponding jumpers on the back of the board, highlighted below.



The onboard LED (highlighted below) will light up when the board is powered, and the sensor (also highlighted below) should be left uncovered in your application.

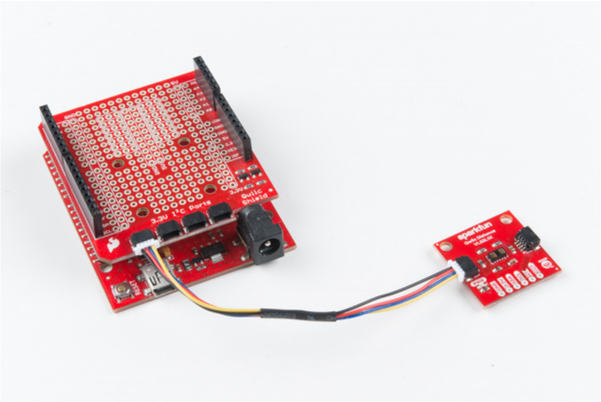


Hardware Assembly

If you haven’t yet assembled your Qwiic Shield, now would be the time to head on over to that tutorial. Depending on the microcontroller and shield you’ve chosen, your assembly may be different, but here’s a handy link to the Qwiic Shield for Arduino and Photon Hookup Guide to get you started!

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 VL53L1X breakout, the other into the Qwiic Shield and you’ll be ready to upload a sketch and figure out how far away you are from that thing over there. It seems like it’s too easy too use, but that’s why we made it that way!



SparkFun RedBoard and Qwiic Shield with the Qwiic Distance Sensor Attached

Library Overview

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.

First, you'll need the **Sparkfun VL53L1X** Arduino library. You can obtain these libraries through the Arduino Library Manager. Search for **Sparkfun VL53L1X Arduino Library** to install the latest version. If you prefer downloading the libraries from the GitHub repository and manually installing it, you can grab them here:

DOWNLOAD THE SPARKFUN VL53L1X ARDUINO LIBRARY (ZIP)

Before we get started developing a sketch, let's look at the available functions of the library.

- `boolean begin(uint8_t deviceAddress = defaultAddress_VL53L1X, TwoWire &wirePort = Wire);` — By default use the default I2C address, and use Wire port
- `void softReset();` — Reset the sensor via software
- `void startMeasurement(uint8_t offset = 0);` — Write a block of bytes to the sensor to configure it to take a measurement
- `boolean newDataReady();` — Checks if a measurement is ready.
- `uint16_t getDistance();` — Returns the results from the last measurement, distance in mm
- `uint16_t getSignalRate();` — Returns the results from the last measurement, signal rate
- `void setDistanceMode(uint8_t mode = 2);` — Sets distance mode (0 = short, 1 = medium, 2 = long)
- `uint8_t getDistanceMode();` — Returns the distance mode
- `uint8_t getRangeStatus();` — Returns the results from the last measurement, 0 = valid

Example Code

Now that we have our library installed and we understand the basic functions, let's run some examples for our distance sensor to see how it behaves.

Example 1 - Read Distance

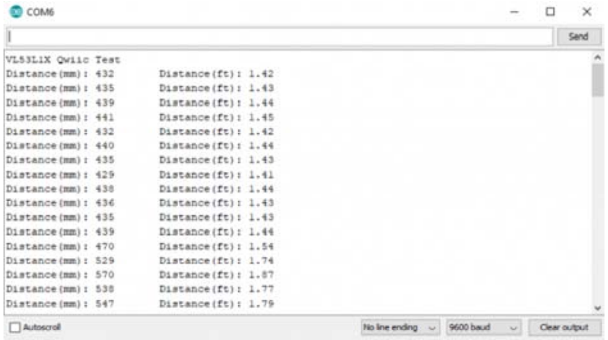
To get started with the first example, open up **File** > **Examples** > **SparkFun VL53L1x 4M Laser Distance Sensor** > **Example1_ReadDistance**. In this example, we begin by creating a **`VL53L1X`** object called `distanceSensor` and then initializing our sensor object in the `setup()` loop. The code to do this is shown below and is repeated in some form in all of the examples.

```
VL53L1X distanceSensor;

void setup(void)
{
  Wire.begin();

  Serial.begin(9600);
  Serial.println("VL53L1X Qwiic Test");

  if (distanceSensor.begin() == false)
    Serial.println("Sensor offline!");

}
```

Once we’ve initialized our sensor, we can start grabbing measurements from it. To do this, we send some configuration bytes to our sensor using `distanceSensor.startMeasurement()` to initiate the measurement. We then wait for data to become available and when it does, we read it in, convert it from millimeters to feet, and print it out over serial. The `void loop()` function that does this is shown below.

```
void loop(void)
{
  distanceSensor.startMeasurement(); //Write configuration bytes to initiate measureme
nt

  //Poll for completion of measurement. Takes 40-50ms.
  while (distanceSensor.newDataReady() == false)
    delay(5);

  int distance = distanceSensor.getDistance(); //Get the result of the measurement fro
m the sensor

  Serial.print("Distance(mm): ");
  Serial.print(distance);

  float distanceInches = distance * 0.0393701;
  float distanceFeet = distanceInches / 12.0;

  Serial.print("\tDistance(ft): ");
  Serial.print(distanceFeet, 2);

  Serial.println();
}
```

Opening your serial monitor to a baud rate of **9600** should show the distance between the sensor and the object it’s pointed at in both millimeters and feet. The output should look something like the below image.



```
VL53L1X Qwiic Test
Distance(mm): 432       Distance(ft): 1.42
Distance(mm): 435       Distance(ft): 1.43
Distance(mm): 439       Distance(ft): 1.44
Distance(mm): 441       Distance(ft): 1.45
Distance(mm): 432       Distance(ft): 1.42
Distance(mm): 440       Distance(ft): 1.44
Distance(mm): 435       Distance(ft): 1.43
Distance(mm): 429       Distance(ft): 1.41
Distance(mm): 438       Distance(ft): 1.44
Distance(mm): 436       Distance(ft): 1.43
Distance(mm): 435       Distance(ft): 1.43
Distance(mm): 439       Distance(ft): 1.44
Distance(mm): 470       Distance(ft): 1.54
Distance(mm): 529       Distance(ft): 1.74
Distance(mm): 570       Distance(ft): 1.87
Distance(mm): 538       Distance(ft): 1.77
Distance(mm): 547       Distance(ft): 1.79
```

☐ Autoscroll   No line ending   9600 baud

Distance readings in mm and ft

Example 2 - Set Distance Mode

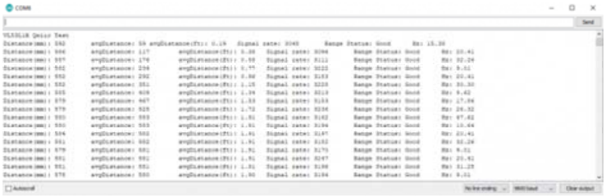
In this example, we’ll change the distance mode of the VL53L1X. The default long range mode is the most robust as far as sample rate and range are concerned, but for a slightly higher sample rate, you can bring the range down to medium (~3M) or short (~2M). To get started with the second example, open up **File** > **Examples** > **SparkFun VL53L1x 4M Laser Distance Sensor** > **Example2_SetDistanceMode**. The main difference between this example and the previous example is that after we initialize our sensor in the `setup()` loop, we first declare ints `shortRange - 0` , `midRange = 1` and `longRange = 2` to assign the proper values to our ranges. We then call `distanceSensor.setDistanceMode(shortRange)` to change the range of our sensor to short range. Although this feature is available, we'd recommend sticking with long range as it is the most robust.

Example 3 - Status and Rate

In the third example, we'll read and average our distance as well as read the sample rate and status of each measurement. To get started with the third example, open up **File** > **Examples** > **SparkFun VL53L1x 4M Laser Distance Sensor** > **ExampleStatusandRate**. The status of a measurement can be any of 8 values. Our `void loop()` interprets the value returned by `distanceSensor.getRangeStatus()` and prints that value over serial. The below table shows the possible values of `rangeStatus` and their corresponding errors.

Range Status	**Error**
0	Valid measurement
1	Raised if sigma estimator (uncertainty in measurement) check is above the internal defined threshold
2	Raised if signal value is below the internal defined threshold
4	Raised when phase is out of bounds
5	Raised in case of HW or VCSEL failure
7	Wrapped target, not matching phases
8	Internal algorithm underflow or overflow
14	The reported range is invalid

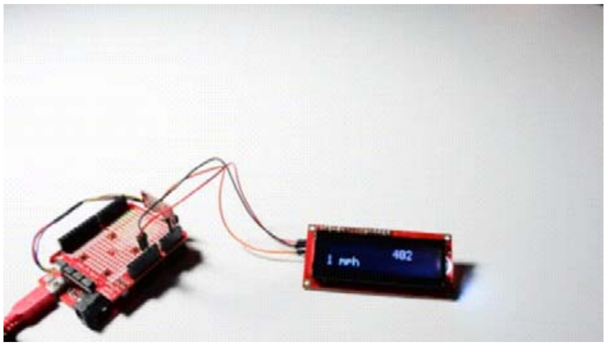
In the example code, notice how the sketch stores our previous values in the array `history` so that the average distance can also be calculated. Uploading this sketch to your microcontroller and opening the serial monitor to a baud rate of 9600 should give you an output similar to the image shown below.



Click the image for a closer look.

Example 4 - LCD Demo

The fourth example requires a serial enabled LCD screen for us to write our distance values to. If you haven't played around with a Serial enabled LCD before, checkout our hookup guide on the matter. To get started with the fourth example, open up **File** > **Examples** > **SparkFun VL53L1x 4M Laser Distance Sensor** > **Example4_LCDDemo**. We'll first need to connect the RX pin of our Serial LCD to pin **A3** on our Arduino. Connect 5V and ground on the LCD and the backlight should light up. Notice how we also include the `SoftwareSerial` library. Uploading the sketch to our Arduino then takes in our sample rate and distances. By using these values, it calculates a velocity. Like the sketch before, distances are stored in an array. The sketch uses these values in the array to calculate velocity and the velocity is then displayed along with the current distance on the LCD. The output on the LCD should look something like the below GIF.



Resources and Going Further

Now that you've successfully got your Qwiic Distance Sensor up and running, it's time to incorporate it into your own project!

For more information, check out the resources below:

- Schematic (PDF)
- Eagle Files (ZIP)
- VL53L1X Datasheet
- VL53L1X User Manual
- Qwiic Landing Page
- GitHub Repos
    - Product
    - Arduino Library
- SparkFun Product Showcase: VL53L1X Qwiic Distance Sensor

Want a great use case for your ToF sensor? How about integrating one into your AVC submission? Have a look here:

AVC Sensor Test

JUNE 20, 2016

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

Qwiic Shield for Arduino & Photon Hookup Guide

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

CCS811/BME280 (Qwiic) Environmental Combo Breakout Hookup Guide

Sense various environmental conditions such as temperature, humidity, barometric pressure, eCO2 and tVOCs with the CCS811 and BME280 combo breakout board.

Qwiic Micro OLED Hookup Guide

Get started displaying things with the Qwiic Micro OLED.

New!

Qwiic Real Time Clock Module (RV-1805) Hookup Guide

Find out what time it is, even after the power's been out on your project for a while with the Qwiic Real Time Clock (RTC) module.