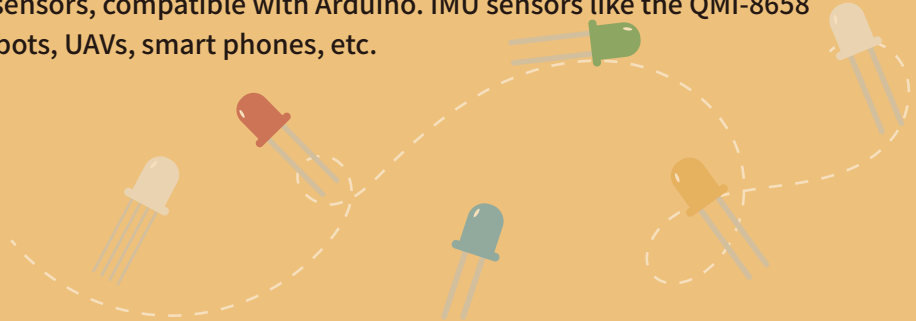# Lesson 15

Module QMI-8658

Overview

In this lesson, we will learn how to use QMI-8658 module which is one of the best IMU (Inertia Measurement Unit) sensors, compatible with Arduino. IMU sensors like the QMI-8658 are used in self balancing robots, UAVs, smart phones, etc.

■ **Component Required:**

(1) x Elegoo Uno R3

(1) x QMI-8658 module

(4) x F-M wires

Component Introduction

QMI-8658 SENSOR

■ **The** InvenSense QMI-8658 sensor contains a MEMS accelerometer and a MEMS gyro in a single chip. It is very accurate, as it contains 16-bits analog to digital conversion hardware for each channel. Therefore it captures the x, y, and z channel at the same time. The sensor uses the I2C-bus to interface with the Arduino.

■ **The** QMI-8658 is not expensive, especially given the fact that it combines both an accelerometer and a gyro.

■ **IMU** sensors are one of the most inevitable type of sensors used today in all kinds of electronic gadgets. They are seen in smart phones, wearables, game controllers, etc. IMU sensors help us in getting the attitude of an object, attached to the sensor in three dimensional space. These values usually in angles, thus help us to determine its attitude. Thus, they are used in smart phones to detect its orientation. And also in wearable gadgets like the nike fuel band or fit bit, which use IMU sensors to track movement.
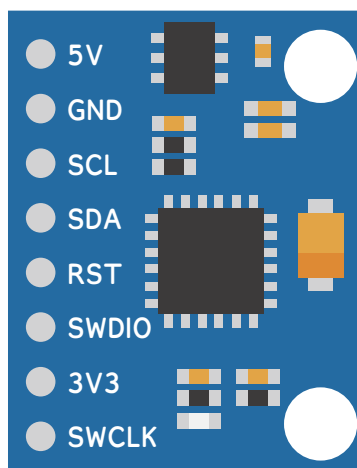
How does it work?

■ **IMU** sensors usually consists of two or more parts. Listing them by priority, they are : accelerometer, gyroscope, magnetometer and altimeter. The QMI-8658 is a 6 DOF (Degrees of Freedom) or a six axis IMU sensor, which means that it gives six values as output. Three values from the accelerometer and three from the gyroscope. The QMI-8658 is a sensor based on MEMS (Micro Electro Mechanical Systems) technology. Both the accelerometer and the gyroscope is embedded inside a single chip. This chip uses I2C (Inter Integrated Circuit) protocol for communication.

How does an accelerometer work?

■ **An** accelerometer works on the principle of piezo electric effect. Here, imagine a cuboidal box, having a small ball inside it, like in the picture above. The walls of this box are made with piezo electric crystals. Whenever you tilt the box, the ball is forced to move in the direction of the inclination, due to gravity. The wall with which the ball collides, creates tiny piezo electric currents. There are totally, three pairs of opposite walls in a cuboid. Each pair corresponds to an axis in 3D space: X, Y and Z axes. Depending on the current produced from the piezo electric walls, we can determine the direction of inclination and its magnitude. For more information check this.
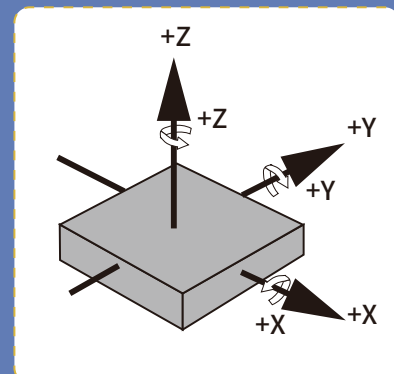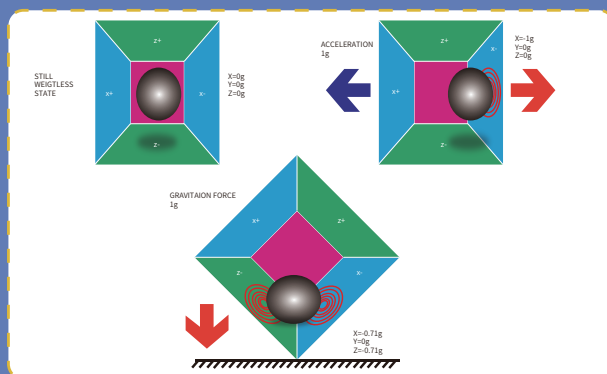

How does a gyroscope work?

■ **Gyroscopes** work on the principle of Coriolis acceleration. Imagine that there is a fork- like structure, which is in constant back- and- forth motion. It is held in place using piezo electric crystals. Whenever you try to tilt this arrangement, the crystals experience a force in the direction of inclination. This is caused as a result of the inertia of the moving fork. The crystals thus produce a current in consensus with the piezo electric effect, and this current is amplified. The values are then refined by the host microcontroller.

$$a \text{ (Coriolis)} = -2vr * \omega$$
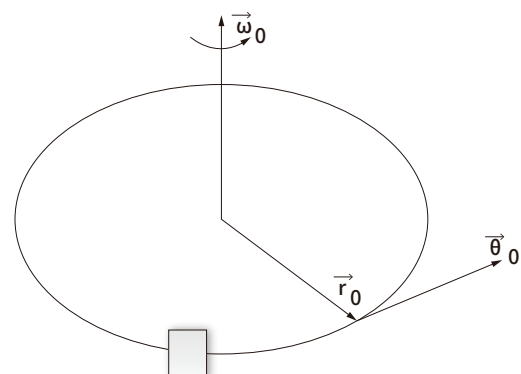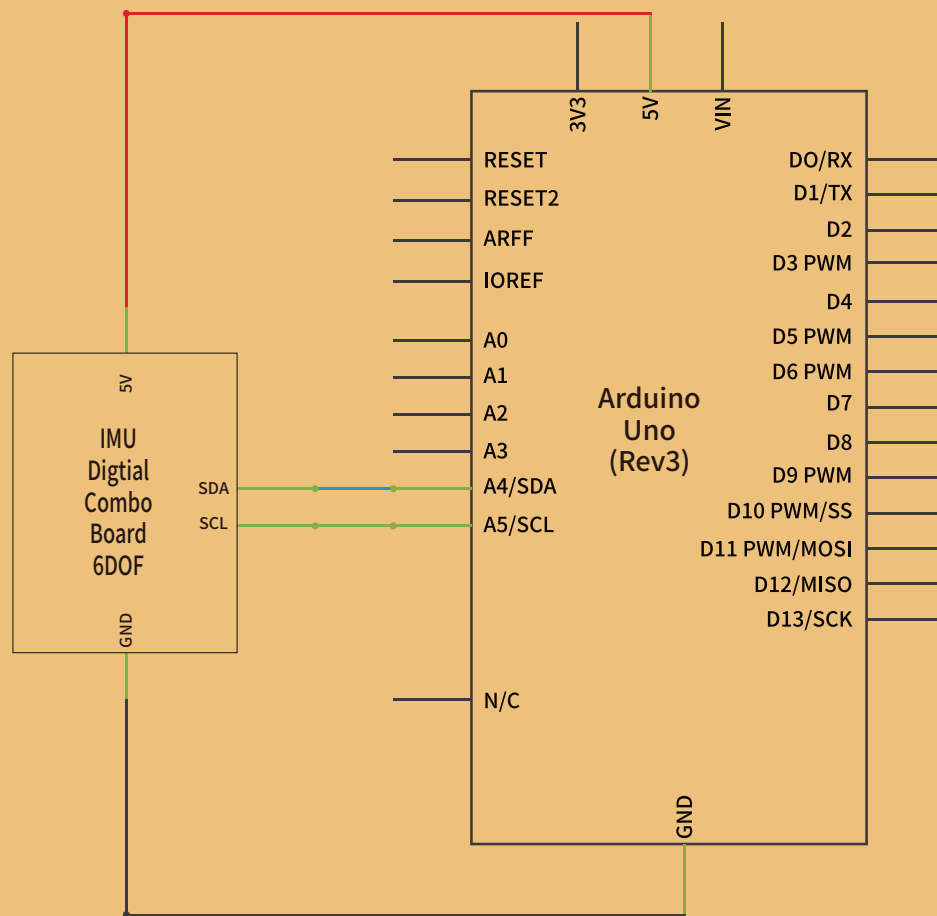
Connection Schematic
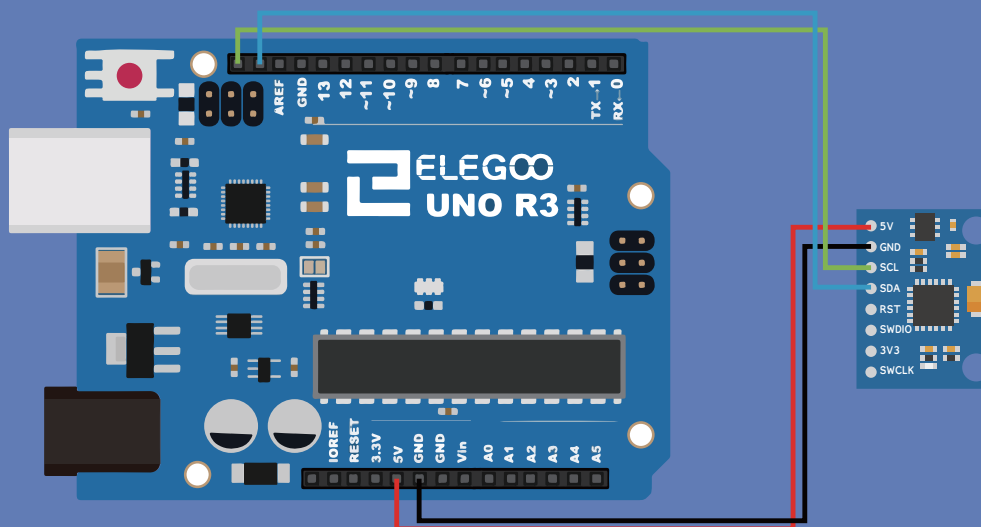
Next, we need to set up the I2C lines. For this connect the pin labelled as SDA on the QMI-8658 to the Arduino's analog pin 4 (SDA). And the pin labelled as SCL on the QMI-8658 to the Arduino's analog pin 5 (SCL). And that's it, you have finished wiring up the Arduino QMI-8658. (The A4 and A5 analog pins are duplicated on the other side of the board.)
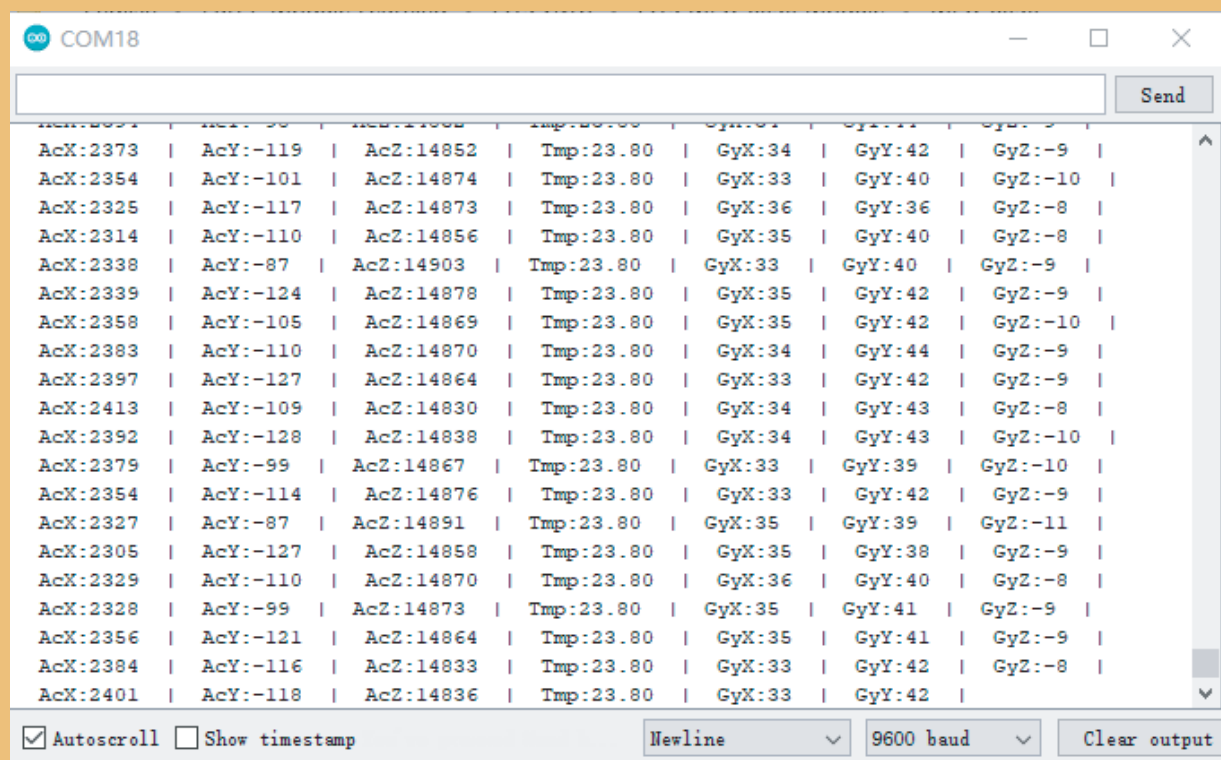
Wiring diagram

Libraries needed

- QMI-8658

The Code

- The short example sketch is a very short sketch and it shows all the raw values (accelerometer, gyro and temperature). It should work on Arduino Uno, Nano, Leonardo, and also Due.

- After wiring, please open the program in the code folder **QMI8658** and click UPLOAD to upload the program. See Lesson 5 in part 1 for details about program uploading if there are any errors.

- Before you can run this, make sure that you have installed the **< QMI8658>** library or re-install it, if necessary. Otherwise, your code won't work.

- For details about loading the library file, see Lesson 5 in part 1.

- Open the monitor then you can see the data as blow:
Click the Serial Monitor button to turn on the serial monitor. The basics about the serial monitor are introduced in details in part 2 Lesson 4.