

MPU-9250

From The Relativity Wiki

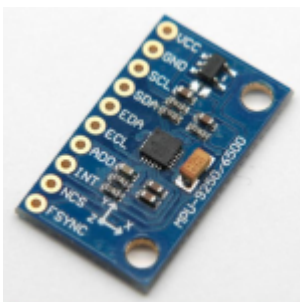
An Arduino and an MPU-9250 as a 9DoF tracker

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At the moment, the tracker seems a bit *jumpy*. The orientation seems slightly sketchy too. Currently, the code appears to work on most Arduino boards, including the ESP32. If you have an MPU-9250 laying around, please try it & see what you think.

My own personal feeling is that the libraries & code are overly complex, and given that this chip has now been obsoleted by TDK, I don't know if it's worth putting in the effort to stabilise it...

The library that we will be using was created from Kris Winer's code (see the introduction page) by Hideaki Tai in Japan - however, as is normal in this field, there is a hardware gotcha that you have to be aware of.



The breakout boards that are widely available are supposed to be based on a specific sensor chip: The InvenSense MPU 9250 Nine-Axis (Gyro + Accelerometer + Compass) MEMS MotionTracking™ Device. Or, as you or I would call it, a 9250 chip. However, most of the boards that are now in circulation on eBay and AliExpress are actually based on a 9255 chip instead! It's still made by InvenSense and, as far as we're concerned, it's pretty much identical to the 9250 in every respect bar one. The chips have information storage slots inside them called registers, one of which is called **Who_am_I**. This register lives up to its name, and just returns a simple hexadecimal code that identifies the chip - and thus the sensor. The 9250 chip **Who_am_I** register returns **0x71** whereas the 9255 chip **Who_am_I** register returns **0x73**. It's a small, but rather significant difference, as it causes all the sanity checks inside the library to fail. If the chip doesn't identify itself as **0x71** (i.e. a 9250), nothing runs and everything errors.

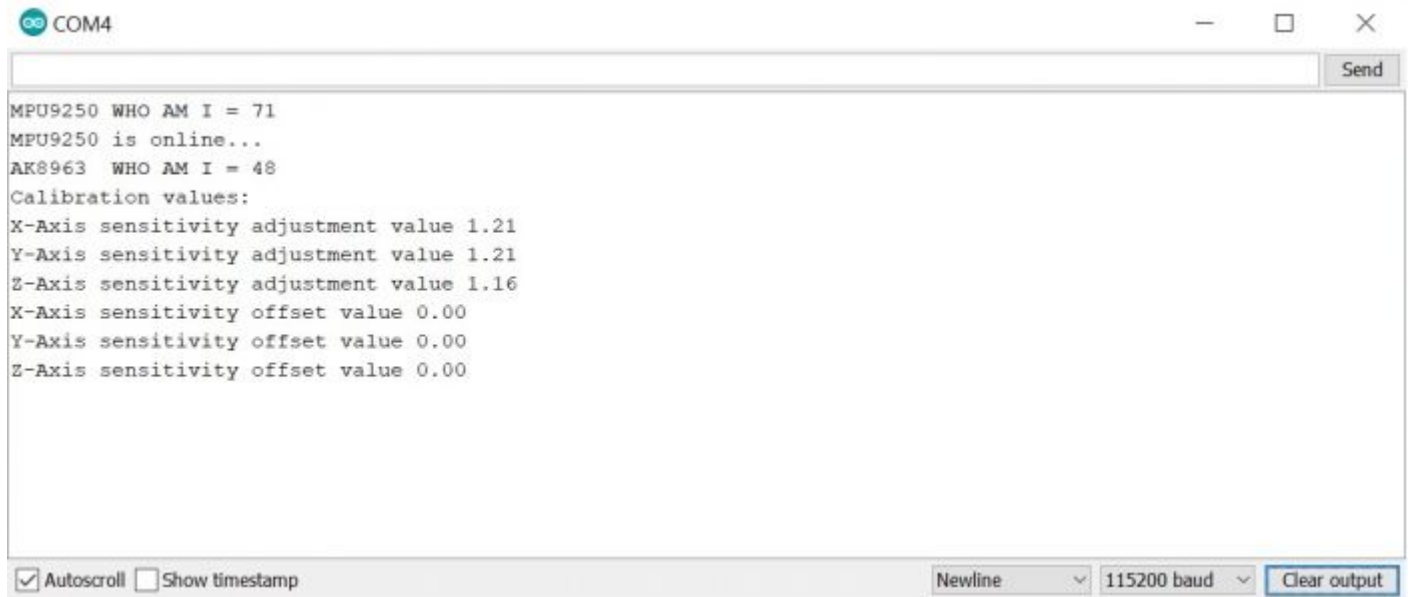
You need to connect your sensor to your Arduino. I am working on the assumption that you have your board all prepared and ready to rock'n'roll (e.g. if you are using an STM32, you have your bootloader). I am also assuming that you have Dupont jumper wires or some way of wiring in your sensor passably. You need 4 wires. If your board is like mine, we will be using the first 4 pins. **VCC** goes to **3v3** on your Arduino, and **GND** goes to **GND**. Connect the **SDA** and **SCL** up as follows:

Sensor	SCL/SCLK	SDA/SDI
STM32	B6	B7
Nano	A5	A4
Uno	A5	A4
Due	21	20

As I mentioned earlier, the 9DoF sensor uses the earth's magnetic field to compensate and correct for drift. There are two important considerations when it comes to dealing with the earth's magnetic field however. The first is that it varies depending on where you physically are on the surface of the earth. The second is that it varies over time as well. This isn't quite as much of a problem as it seems though. The magic number that we need is called Magnetic Declination, and we need to work out a new value about once a year or so. That means that you should update your library & reflash your tracker sketch every now and then, to keep you accurately aligned. Thankfully, there are web pages linked to Google Maps that do the whole thing for you, and 5 seconds with a calculator gives you the number that you need to type in. **The entire procedure is documented in the [Magnetic_Declination.txt](http://web.archive.org/web/20200909122955/https://github.com/JustinS-B/9DoF/blob/master/Magnetic_Declination.txt) (http://web.archive.org/web/20200909122955/https://github.com/JustinS-B/9DoF/blob/master/Magnetic_Declination.txt) file, which you definitely need to read. Once you see what to do, it only takes a few seconds to get it all organised.** You'll need this number shortly, to update your library.

Before that though, you will need to add the library to your Arduino IDE. Go to the **Sketch** menu -> **Include Library** -> **Manage Libraries**. This will give you your Library Manager. In the search field enter **9250** and scroll down the list of results until you get to **MPU9250 by hideakitai Version 0.1.1** and install it.

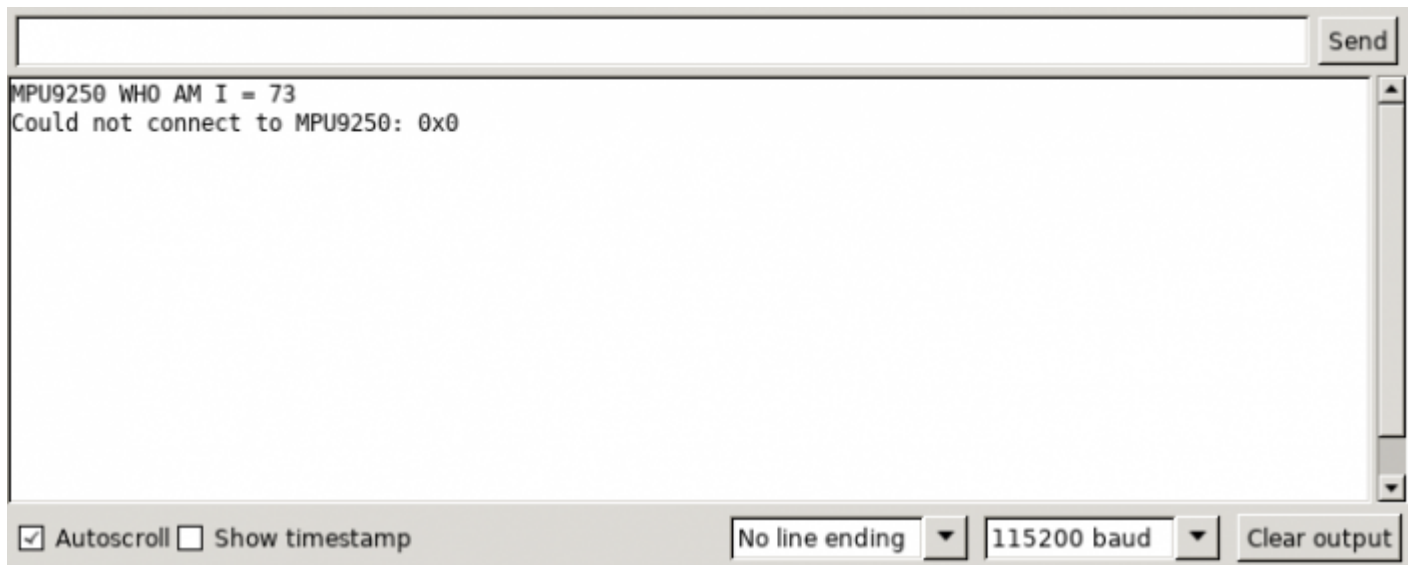
Next, we need to find out if you have a 9250 or a 9255 chip. Download the sketch called **Chip_Test** from **here** (<http://web.archive.org/web/20200909122955/https://github.com/JustinS-B/9DoF>). Select your Arduino Board and Port (if required) from the menus in the IDE & flash the sketch as normal. Once it has completed, open the serial monitor. You will see something resembling either one of these two images.



```
COM4
MPU9250 WHO AM I = 71
MPU9250 is online...
AK8963 WHO AM I = 48
Calibration values:
X-Axis sensitivity adjustment value 1.21
Y-Axis sensitivity adjustment value 1.21
Z-Axis sensitivity adjustment value 1.16
X-Axis sensitivity offset value 0.00
Y-Axis sensitivity offset value 0.00
Z-Axis sensitivity offset value 0.00
```

☒ Autoscroll ☐ Show timestamp Newline 115200 baud Clear output

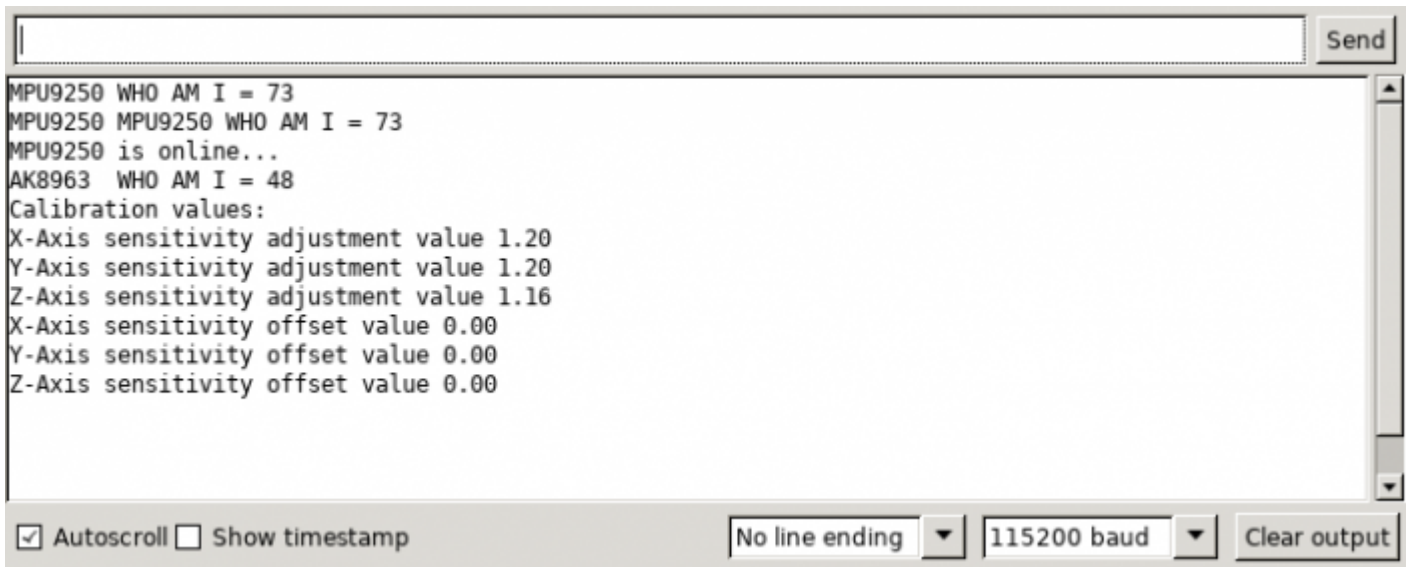
Default Library settings & a genuine 9250 chip: Looking for 0x71 and found 0x71



```
MPU9250 WHO AM I = 73
Could not connect to MPU9250: 0x0
```

☒ Autoscroll ☐ Show timestamp No line ending 115200 baud Clear output

Default Library settings & a 9255 chip: Looking for 0x71 but found 0x73



Updated Library settings & a 9255 chip: Looking for 0x73 and found 0x73

Basically, in the first image, I am using a completely default library, with nothing changed - along with a genuine 9250 chip. It all works, with no modifications. In the second image I have a 9255 chip plugged into the Arduino. It's looking for 0x71 but getting 0x73 - and it's not happy about it. Go to your Arduino libraries folder, look for **MPU9250** and open **MPU9250.h** in a text editor. Scroll down to line 26 and look for this text:

```
const uint8_t MPU9250_WHOAMI_DEFAULT_VALUE {0x71};
```

Change 0x71 to 0x73

```
const uint8_t MPU9250_WHOAMI_DEFAULT_VALUE {0x73};
```

Whilst you are editing this file, you also need to update your **Magnetic Declination**, so scroll down to line 55 and look for this text:

```
float magnetic_declination = -7.51; // Japan, 24th June
```

Change it to the value for your location that you calculated earlier. It really helps if you put a date and location in the comment field next to it, so you know when & where you last updated it.

```
float magnetic_declination = -0.25; // London, 25th April, 2019
```

Save your library file, & reflash your sketch. You should now see something like the second image as it's now looking for 0x73 and getting 0x73, so it knows that it has the right chip (even if it's an updated version). If, however, you get something that looks like the second image straight away (but with 71 instead of 73), then you actually have a 9250 chip. **This means that you only need to update your Magnetic Declination, so don't touch the WHOAMI_DEFAULT_VALUE.**

If you have a board with a 9250 chip, please take a screen grab of the Serial Monitor screen, so that I can update the Wiki as I don't have one

The next step is to calibrate your sensor. If you don't, your readings will be all over the place. Trust me, you really cannot skip this step! All you have to do is to open the **File** menu in your Arduino IDE, select **Examples**, select

MPU9250 and load the **calibrate** sketch. Once you have uploaded it, check that your Serial Monitor is set to **115200** and just follow the instructions. To begin with, the sensor needs to be stationary, but once it has done its first calibration it will ask you to move it in a figure of 8 for 30 seconds or so. It appears to store its calibration settings inside the sensor registers, so the calibration is preserved between sketch flashes.

Once you have calibrated your sensor, flash the **9DoF_Tracker** sketch from my GitHub repo. Open the Serial Monitor & check that it appears to be working. **It is important to note what Com Port it is using whilst you have the Arduino IDE open, as it is probably different from your old sensor.** All you should need to do it to update the Com Port your OSVR **osvr_server_config.json** file and you should be good to go.

Please feed back your findings, experiences or problems to **help-hardware**.

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