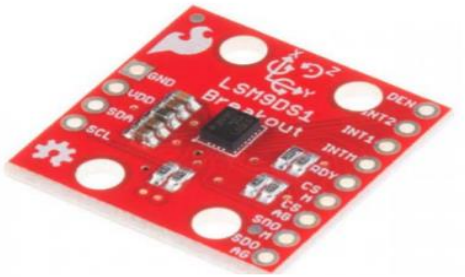
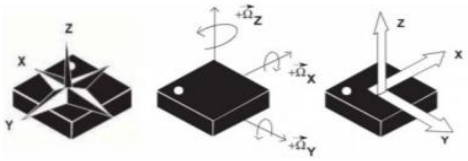
Exercise 4

Exercise 4.1 – 9DoF sensor (Gyro, Accelerometer and Magnetometer)

Perform measurements with a Gyro, accelerometer and magnetometer. The exercise should be approached by using the SPI interface.





LSM9DS1 board with a 6 DoF Gyro, accelerometer & magnetometer

Introduction to LSM9DS1:

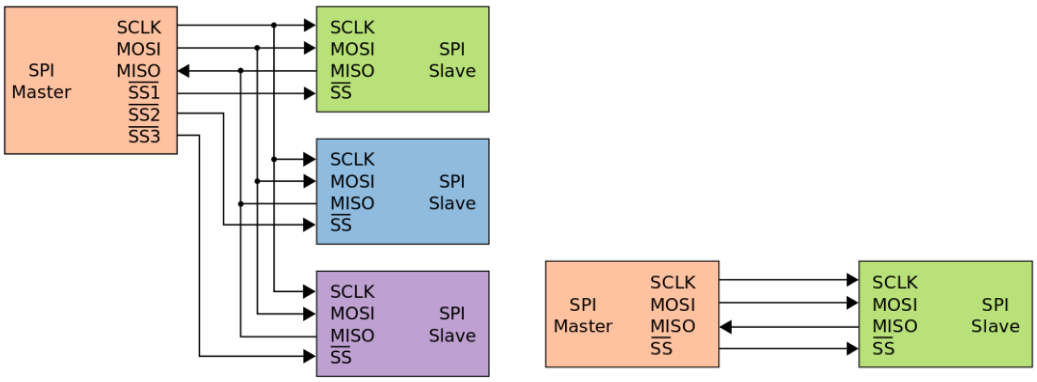
The LSM9DS1 is a versatile, motion-sensing system-in-a-chip. It houses a 3-axis accelerometer, 3-axis gyroscope, and 3-axis magnetometer - nine degrees of freedom (9DOF) in a single IC! Each sensor in the LSM9DS1 supports a wide range of...ranges: the accelerometer's scale can be set to ± 2, 4, 8, or 16 g, the gyroscope supports ± 245, 500, and 2000 °/s, and the magnetometer has full-scale ranges of ± 2, 4, 12, or 16 gauss. It includes a sensing element and an IC interface capable of providing the measured angular rate to the external world through a digital interface (I2C/SPI).

Pin connections and descriptions are given in the table below. For further descriptions see "LSM9DS1 Breakout Hookup guide" and datasheet (LSM9DS1-Datasheet.pdf).

LSM9DS1 Breakout board Interface	**LSM9DS1 chip**
VDD - Pin#22/23:	1.9-3.6V
SDA - Pin#4	SDA: I^2C serial data **SDI: SPI serial data input** **SDO: 3-wire interface serial data output**
SLC - Pin#2	SLC: I^2C serial clock **SPC SPI serial port clock**
GND - Pin#19/20	0V
DEN_A/G - Pin#13	Accelerometer and gyroscope data enable
INT2_A/G - Pin#12	Accelerometer and gyroscope interrupt 2
INT1_A/G - Pin#11	Accelerometer and gyroscope interrupt 1
INT_M - Pin#10	Magnetic sensor interrupt
RDY - Pin#9	Magnetic sensor data ready
CS M - Pin#8	SPI enable - I^2C/SPI mode selection for the magnetometer 1: SPI idle mode / I^2C communication enabled **0: SPI communication mode / I^2C disabled)**
CS AG - Pin#7	SPI enable - I^2C/SPI mode selection for the accelerometer and gyroscope 1: SPI idle mode / I^2C communication enabled **0: SPI communication mode / I^2C disabled**
SDO M - Pin#6	**SPI: serial data output (SDO) for the magnetometer** I^2C: least significant bit of the device address (SA0) for the magnetometer
SDO A/G - Pin#5	SPI: serial data output (SDO) for the accelerometer and gyroscope I^2C: least significant bit of the device address (SA0) for the accelerometer & gyroscope

Exercise 4.2 – Use SPI to program and read measurements from the sensors

In this exercise you will set up the SPI (Serial Peripheral Interface) in order to get data from the gyroscope, accelerometer and magnetometer



Gyro and Accelerometer:

It is recommended to follow the following steps:

Read the datasheet (LSM9DS1-Datasheet.pdf) to identify which registers the gyro and the accelerometer are using.

Set up an SPI interface by using as inspiration the library "30021_io.c"

Use the library "L3G4200D_Example" as inspiration to program/read from the gyro and the accelerometer

Perform measurement with the gyro and the accelerometer "by hand"

Use the motor from the previous Assignment to calibrate the gyro. Perform measurements in the gravity field for the accelerometer

Magnetometer:

It is recommended to follow the following steps:

Read the datasheet (LSM9DS1-Datasheet.pdf) to identify which registers the magnetometer is using.

Adapt the SPI interface to include the magnetometer

Perform measurement with the magnetometer "by hand" (using the Earth's magnetic field) and calibrate the magnetometer