# LAB 1

Raspbian & Eclipse

# RASPBIAN I2C

- Raspbian does not install with I2C enabled
- Follow these steps to enable: http://ozzmaker.com/i2c/
- Use i2cdetect  to read all the slave addresses
  - 0x6A for the gyroscope and accelerometer
  - 0x1C for the magnetometer
  - 0x77 for the pressure sensor

```
pi@raspberrypi2:~ $ sudo i2cdetect -y 1
     0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f
00:          -- -- -- -- -- -- -- -- -- -- -- -- --
10: -- -- -- -- -- -- -- -- -- -- -- -- 1c -- -- --
20: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
30: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
40: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
50: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
60: -- -- -- -- -- -- -- -- -- -- 6a -- -- -- -- --
70: -- -- -- -- -- -- -- 77
```

# BAROMETRIC SENSOR


- Bosch BMP280 digital pressure sensor, https://ae-bst.resource.bosch.com/media/_tech/media/datasheets/BST-BMP280-DS001-19.pdf
- BerryIMU breakout board, http://ozzmaker.com/berryimu-quick-start-guide/
- I²C slave device on address 0x77
- ID register 0xD0 contains the chip identification number chip_id[7:0], 0x58

- Pressure range 300 to 1100 hPa (equiv. to +9000…-500 m above/below sea level)
  - One hectopascal = 0.02953 inches of mercury
- Package 8-pin LGA metal-lid Footprint : 2.0 × 2.5 mm, height: 0.95 mm
- Temperature coefficient offset 1.5 Pa/K, equiv. to 12.6 cm/K (25 … 40°C @900hPa)
- Digital interfaces I²C (up to 3.4 MHz) SPI (3 and 4 wire, up to 10 MHz)

# PYTHON INITIALIZE I2C BUS

- Create a file .py
- Open the I2C bus
  - System Management Bus (smbus) is derivative of $I^2C$ for PC power
  - https://pypi.org/project/smbus2/
- Read from  bus for the slave address 0x77
  - The product id register, 0xD0
  - It should be0x58 (88 decimal)

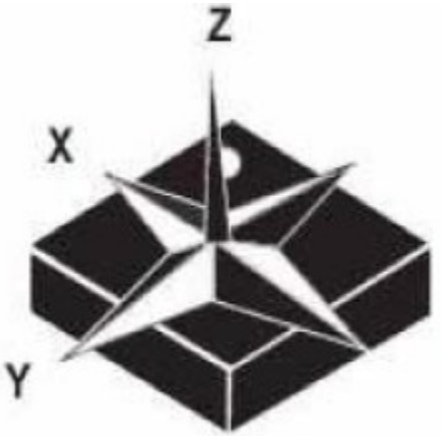
```
import smbus
# Get I2C bus
bus = smbus.SMBus(1)
# BMP280 address, 0x77
#    Read data back from 0xD0,
#    One byte
b1 = bus.read_i2c_block_data(0x77, 0xD0, 1)
print(b1)
```

# READ PRESSURE

- Add to .py file
- Set Configuration and Control Measurement registers
- Read 19-bits of pressure data
- Convert to inches or mercury
  - **Why is the value off by a little?**
    - Trim and Temperature

```
#Select Configuration register, 0xF5(245)
# 0 - I2C, # 2,3,4 -  IIR filter, # 5,6,7 -  tstandby, Stand_by time = 0.5 ms
bus.write_byte_data(0x77, 0xF5, 0x08)

#Select Control measurement register, 0xF4(244)
# 0,1 - Power Mode, Forced mode, # 2,3,4 - Oversample pressure x8
# 5,6,7 - Oversample temp x1
bus.write_byte_data(0x77, 0xF4, 0x32)
time.sleep(0.5)

# Read data back from 0xF7(247), 8 bytes
# Pressure MSB, Pressure LSB, Pressure xLSB
data = bus.read_i2c_block_data(0x77, 0xF7, 3)
print(data);
```

# MAGNETOMETER




- Same STμ LSM9DS1, 3D digital linear acceleration sensor, a 3D digital angular rate sensor, and a 3D digital magnetic sensor
- Same BerryIMU breakout board, http://ozzmaker.com/berryimu/
- $I^2C$ slave device on address 0x1C
- WHO_AM_I_M register 0x0F contains 0x3D

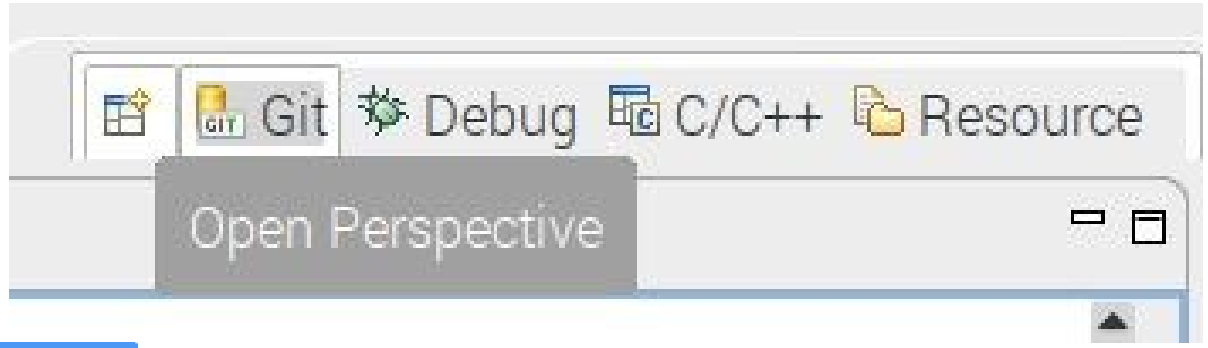
- I2C bus
  - 400 KHz, fast mode operation
- Magnetic field full scale of ±4/±8/±12/±16 gauss
- Magnetic sensitivity, FS = ±4 gauss 0.14 mgauss/ LSB

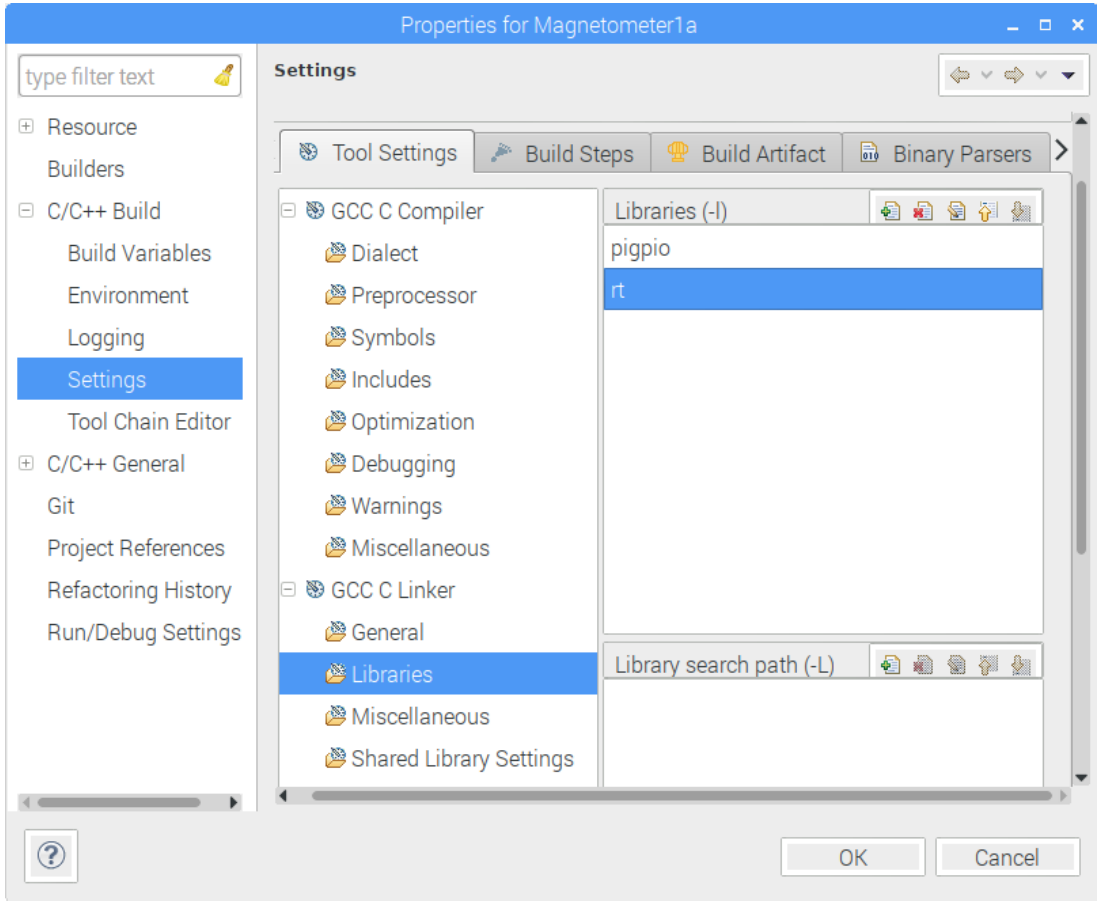
# C++ INITIALIZE I2C BUS

- Create a file .c
  - Include i2c-dev.h header file
- Open the I2C bus
  - As a file from devices
  - Use bus number from i2cdetect
  - Select slave device with I/O control
- Read from  bus for the slave address 0x1C
  - The who am I register, 0x0F
  - It should be 0x3D
- Compile
  - gcc -o magnetometer magnetometer.c

```
#include "linux/i2c-dev.h"

const int MAG_ADDRESS = 0x1C;
const int ProductId = 0x0F;
const int WhoAmIResponse = 0x3D;

//the I2C bus file handle for I/O
int file;

//open the bus device driver
char filename[20];
sprintf(filename, "/dev/i2c-%d", 1);
file = open(filename, O_RDWR);

// I/O control to set the slave address on the bus file
// in effect until file is closed or selection changed.
ioctl(file, I2C_SLAVE, MAG_ADDRESS);

//Detect if LSM9DS1is connected
int response = i2c_smbus_read_byte_data(file, ProductId);
if (response == WhoAmIResponse) printf("LSM9DS1 detected");
```

# ECLIPSE

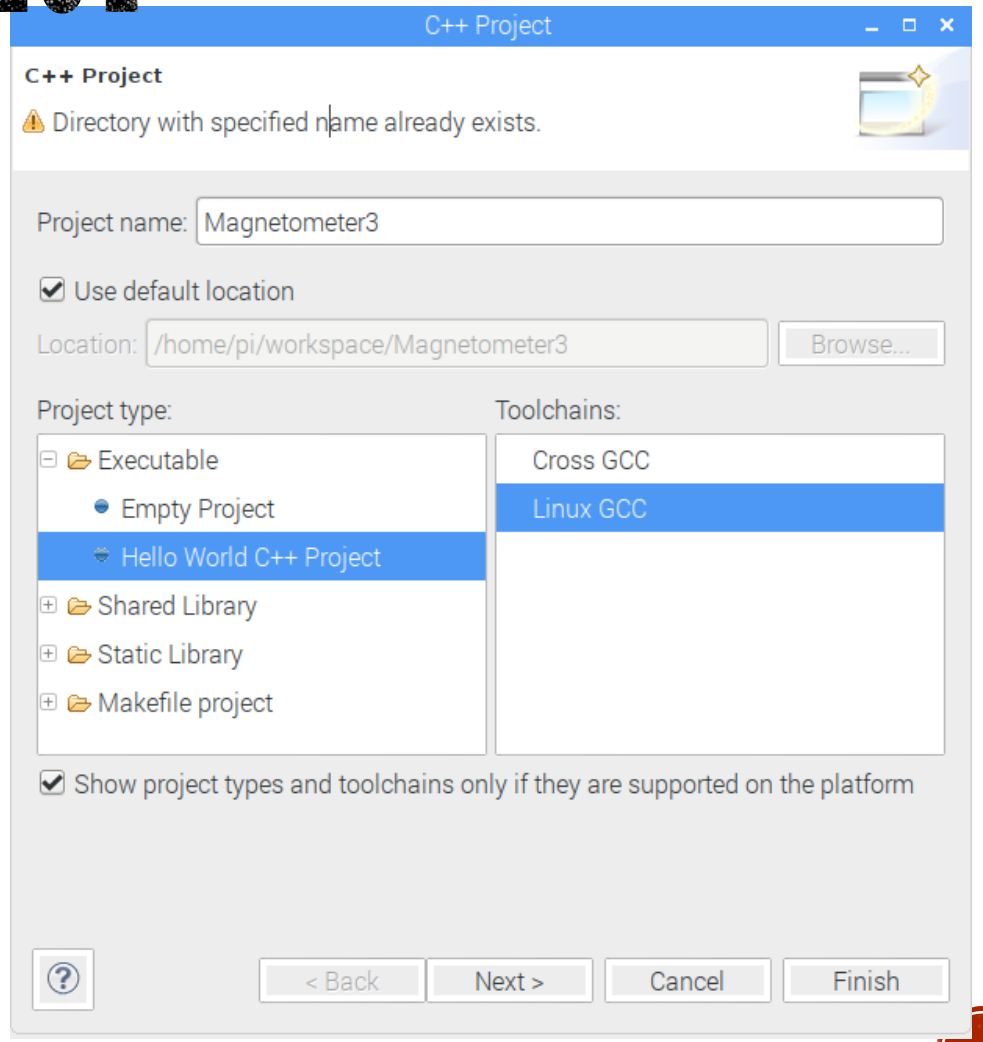



- Open Perspectives
  - Debug and C/C++

# CREATE NEW C++ PROJECT

- File -> New -> C++ Project
- Name it Magnetometer1c
- Choose "Hello World" project type and Linux GCC toolchain
- Finish
- Delete the file in the src folder
- Download all the files from https://1drv.ms/f/s!Ar3pO7_GhJY9hOttE8IlFGsVOuS5VA
- Place the files in the src folder and refresh the project



Starting LSM9DS1

Detected Magnetometer.

Magnetometer Initialized...

x: -31749 y: -1007 z: -1028

x: -28165 y: -1007 z: -1028

x: -30725 y: -1008 z: -1028

# CHALLENGE #1

Slow down the output to one reading per second.

Move the magnet and determine the orientation of x, y and z axis