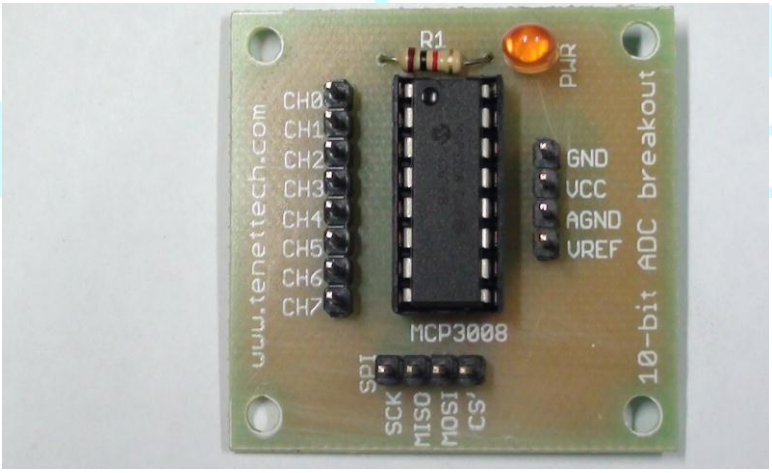
2015

TENET TECHNETRONICS

Interfacing MCP3008 with Raspberry pi



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Introduction:

Raspberry Pi is a credit card sized computer that plugs into a computer monitor or TV, and uses standard keyboard and mouse. It's capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games. Here we are going to do interface with LDR, LM35, potentiometer and accelerometer with Raspberry pi by using MCP3008 (ADC) IC.

Hardware Requirements:

1. Raspberry Pi board.
2. MCP3008 Breakout board
3. Tenet Power supply breakout board
4. Hookup wires
5. Tenet LDR breakout board
6. Tenet LM35 breakout board
7. Tenet potentiometer breakout board
8. Accelerometer

MCP3008 IC:

The MCP3008 10-bit Analog-to-Digital Converter (ADC) combines high performance and low power consumption in a small package, making it ideal for embedded control applications. The MCP3008 features a successive approximation register (SAR) architecture and an industry-standard SPI serial interface. The MCP3008 features 200k samples/second, 8 input channels, low power consumption (5nA typical standby, 425µA typical active), and is available in 16-pin PDIP and SOIC packages. Applications for the MCP3008 include data acquisition, instrumentation and measurement, multi-channel data loggers, industrial PCs, motor control, robotics, industrial automation, smart sensors, portable instrumentation and home medical appliances.

Pin diagram:

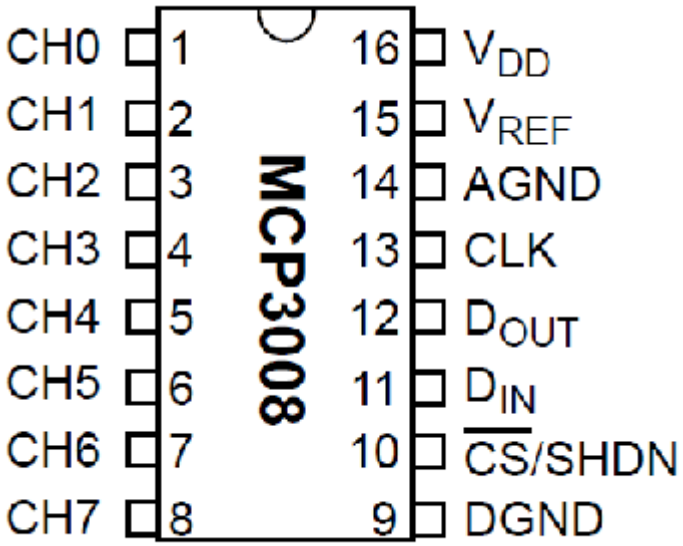


Figure 1

LDR:

A **Light Dependent Resistor** (LDR) or a photo resistor is a device whose resistivity is a function of the incident electromagnetic radiation. Hence, they are light sensitive devices. They are also called as photo conductors, photo conductive cells or simply photocells. They are made up of semiconductor materials having high resistance. There are many different symbols used to indicate a **LDR**, one of the most commonly used symbol is shown in the figure below. The arrow indicates light falling on it.

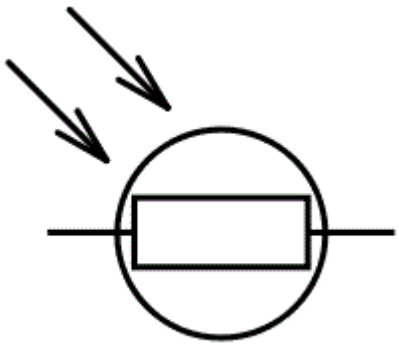


Figure 2

Working Principle of LDR:

A **light dependent** resistor works on the principle of photo conductivity. Photo conductivity is an optical phenomenon in which the materials conductivity (Hence resistivity) reduces when light is absorbed by the material.

When light falls i.e. when the photons fall on the device, the electrons in the valence band of the semiconductor material are excited to the conduction band. These photons in the incident light should have energy greater than the band gap of the semiconductor material to make the electrons jump from the valence band to the conduction band. Hence when light having enough energy is incident on the device more & more electrons are excited to the conduction band which results in large number of charge carriers. The result of this process is more and more current starts flowing and hence it is said that the resistance of the device has decreased.This is the most common working principle of LDR.

Tenet LDR breakout board:

Figure 3

Potentiometer Breakout:

A **potentiometer**, informally a pot, is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor

Accelerometer Sensor:

An accelerometer is an electromechanical device used to measure acceleration forces. Such forces may be static, like the continuous force of gravity or, as is the case with many mobile devices, dynamic to sense movement or vibrations.

An accelerator looks like a simple circuit for some larger electronic device. Despite its humble appearance, the accelerometer consists of many different parts and works in many ways, two of which are the piezoelectric effect and the capacitance sensor. The piezoelectric effect is the most common form of accelerometer and uses microscopic crystal structures that become stressed due to accelerative forces. These crystals create a voltage from the stress, and the accelerometer interprets the voltage to determine velocity and orientation.

The capacitance accelerometer senses changes in capacitance between microstructures located next to the device. If an accelerative force moves one of these structures, the capacitance will change and the accelerometer will translate that capacitance to voltage for interpretation.

Accelerometers are made up of many different components, and can be purchased as a separate device. Analog and digital displays are available, though for most technology devices, these components are integrated into the main technology and accessed using the governing software or operating system.

Typical accelerometers are made up of multiple axes, two to determine most two-dimensional movement with the option of a third for 3D positioning. Most smartphones typically make use of three-axis models, whereas cars simply use only a two-axis to determine the moment of impact. The sensitivity of these devices is quite high as they're intended to measure even very minute shifts in acceleration. The more sensitive the accelerometer, the more easily it can measure acceleration.

Accelerometers, while actively used in many electronics in today's world, are also available for use in custom projects. Whether you're an engineer or tech geek, the

accelerometer plays a very active role in a wide range of functionalities. In many cases you may not notice the presence of this simple sensor, but odds are you may already be using a device with it.

Temperature sensor:

The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly- proportional to the Centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling.

SPI Interface:

The Serial Peripheral Interface (SPI) bus was developed by Motorola to provide full-duplex synchronous serial communication between master and slave devices. The SPI bus is commonly used for communication with flash memory, sensors, real-time clocks (RTCs), analog-to-digital converters, and more.

As shown in Figure, standard SPI masters communicate with slaves using the serial clock (SCK), Master out Slave in (MOSI), Master in Slave out (MISO), and Slave Select (SS) lines. The SCK, MOSI, and MISO signals can be shared by slaves while each slave has a unique SS line.

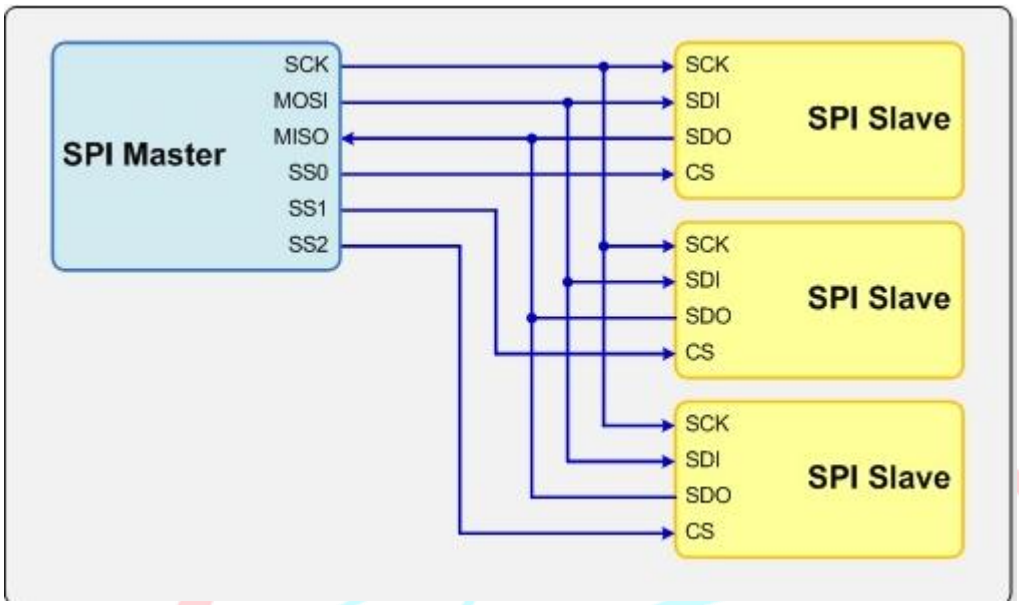


Figure 4

Polarity and Clock Phase

The SPI interface defines no protocol for data exchange, limiting overhead and allowing for high speed data streaming. Clock polarity (CPOL) and clock phase (CPHA) can be specified as '0' or '1' to form four unique modes to provide flexibility in communication between master and slave. If CPOL and CPHA are both '0' (defined as Mode 0) data is sampled at the leading rising edge of the clock. Mode 0 is by far the most common mode for SPI bus slave communication. If CPOL is '1' and CPHA is '0' (Mode 2), data is sampled at the leading falling edge of the clock. Likewise, CPOL = '0' and CPHA = '1' (Mode 1) results in data sampled at on the trailing falling edge and CPOL = '1' with CPHA = '1' (Mode 3) results in data sampled on the trailing rising edge. Table 1 below summarizes the available modes.

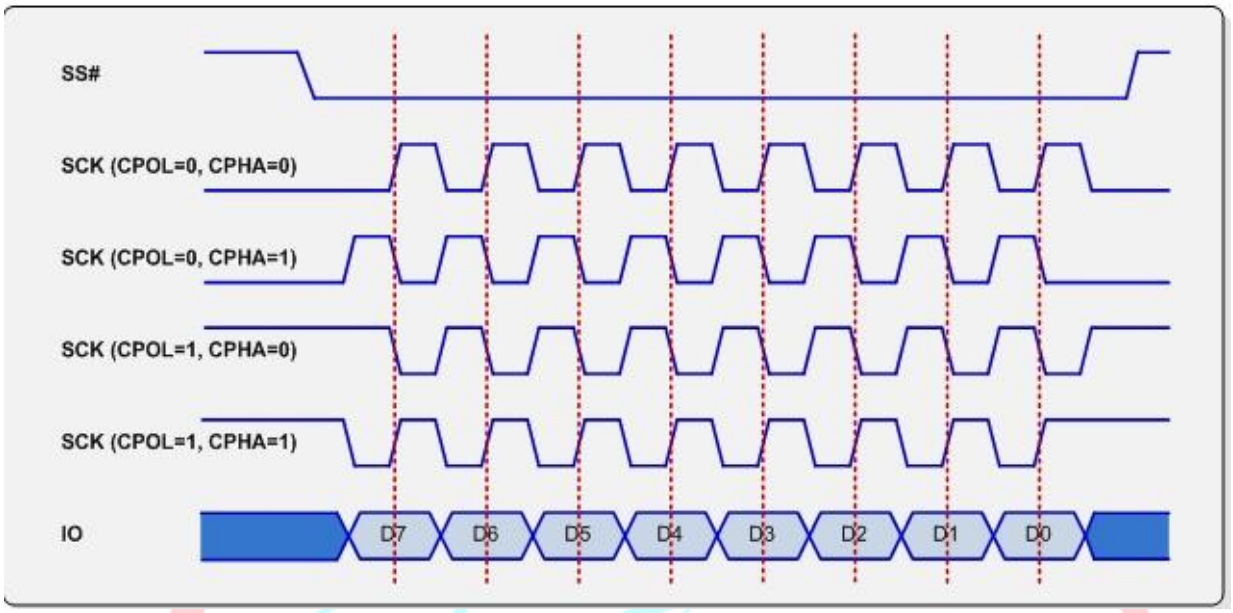


Figure 5

Enabling SPI on raspberry pi:

- **Start by running the following command :**

  Sudo raspi-config

- **This will launch the raspi-config utility. Select option 8 “Advanced Options”.**

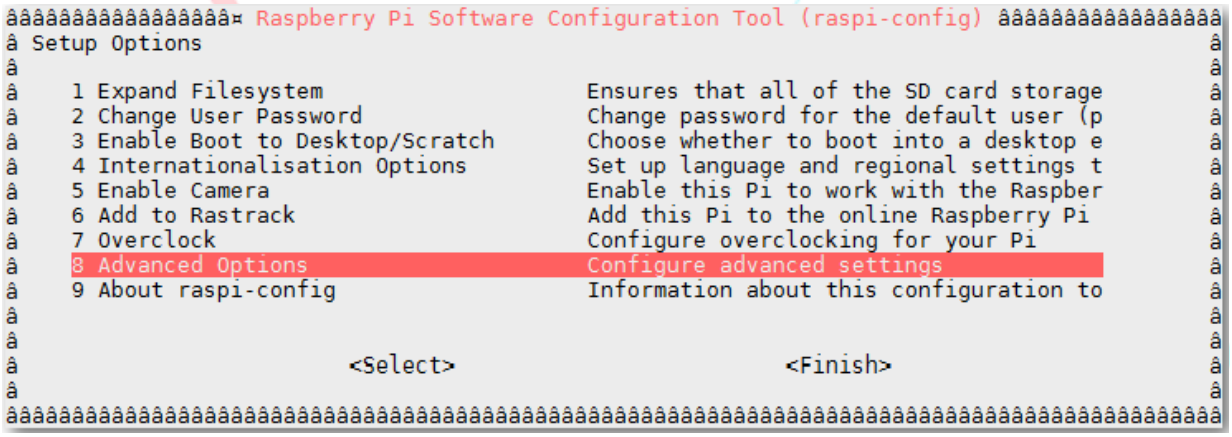


Figure 6

- **Select the “SPI” option.**

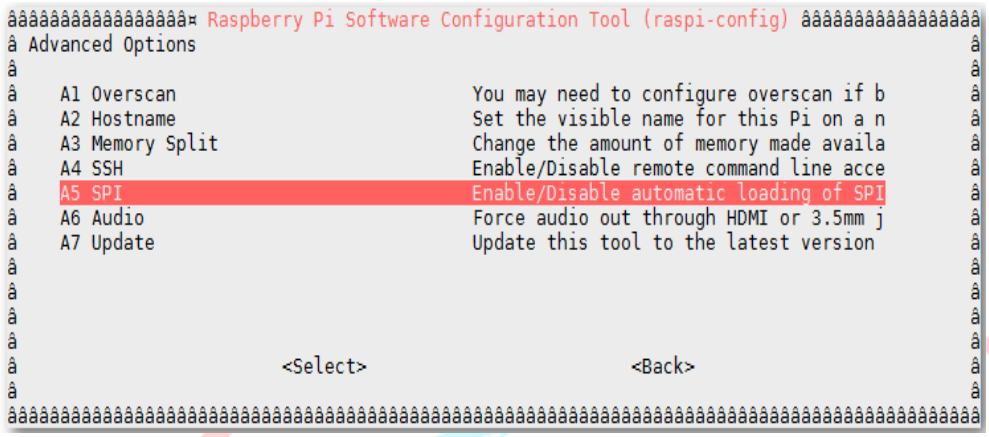


Figure 7

- **Set the option to “Yes”.**

Figure 8

- **Select “OK”.**

Figure 9

- **Select “Finish”**

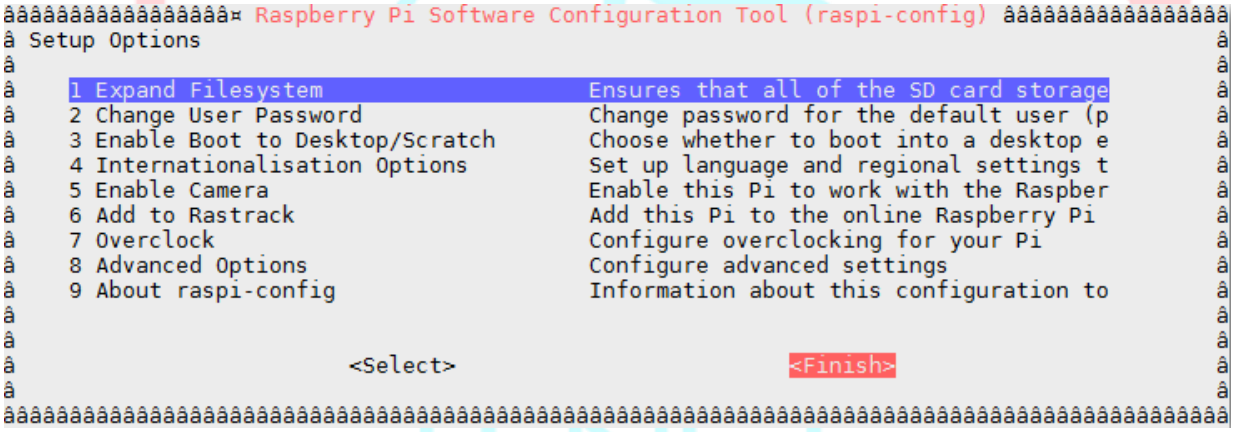


Figure 10

- **Reboot for the changes to take effect :**

  Sudo reboot

- **SPI is now enabled**.

- **In order to read data from the SPI bus in Python we can install a library called ‘py-spidev’. To install it we first need to install ‘python-dev’ :**

Sudo apt-get install python2.7-dev

- **Then to finish we can download 'py-spidev' and compile it ready for use :**

  wget https://github.com/Gadgetoid/py-spidev/archive/master.zip

  unzip master.zip

  rm master.zip

  cd py-spidev-master

  sudo python setup.py install

  cd ..

Coding:

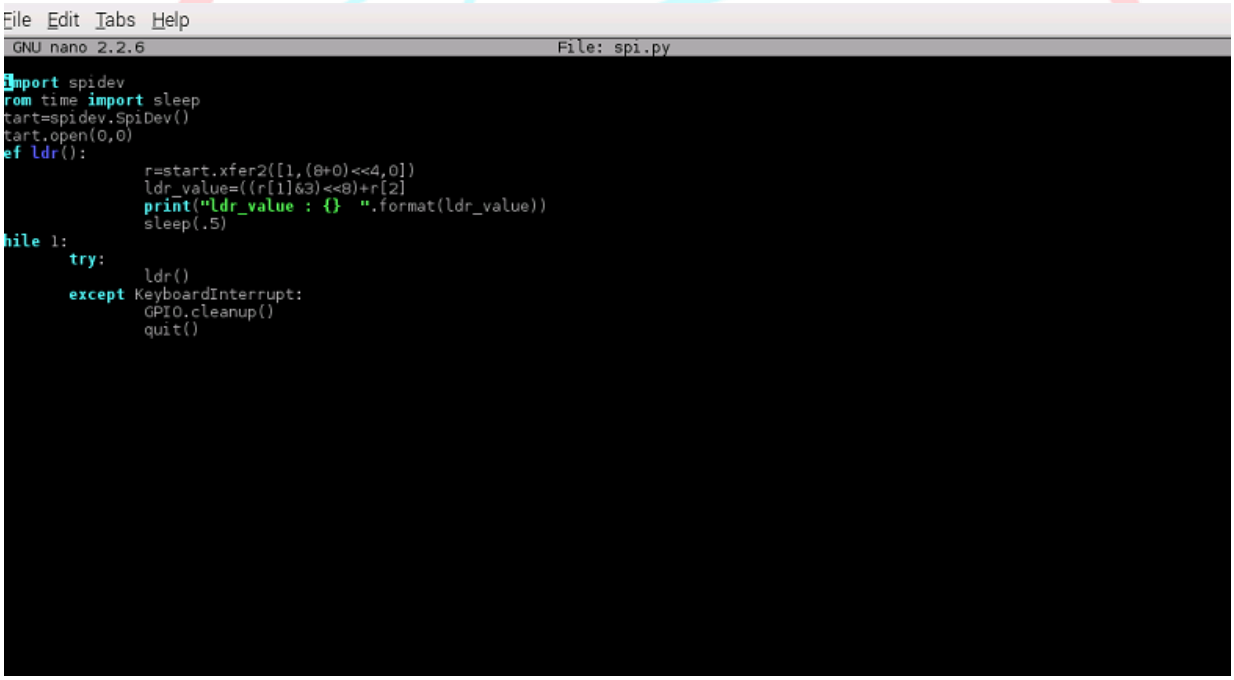


Figure 11

Circuit diagram:

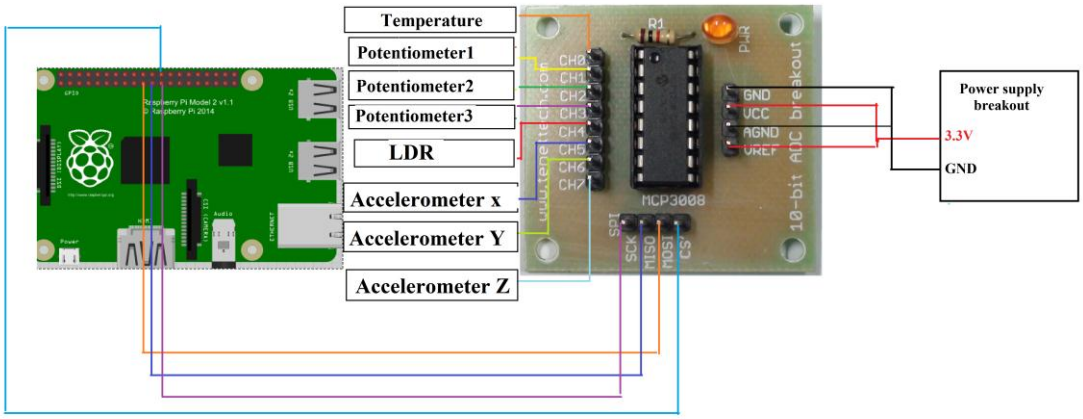


Figure 12

Output:

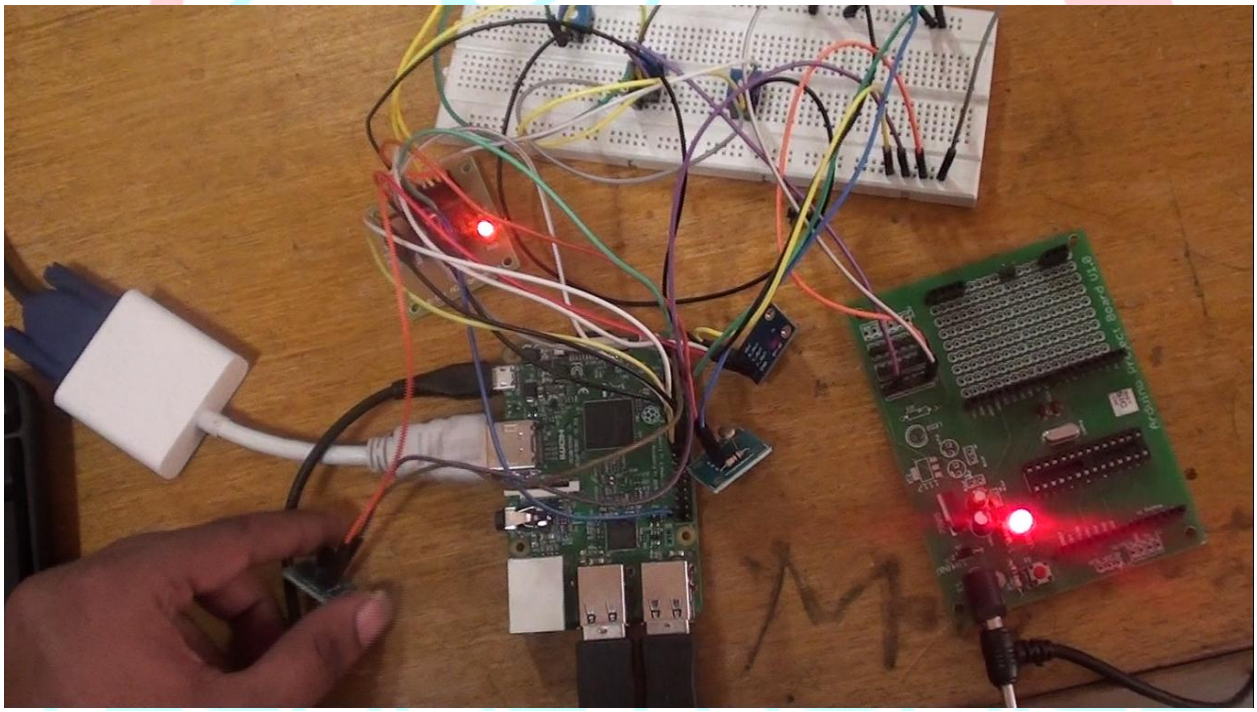
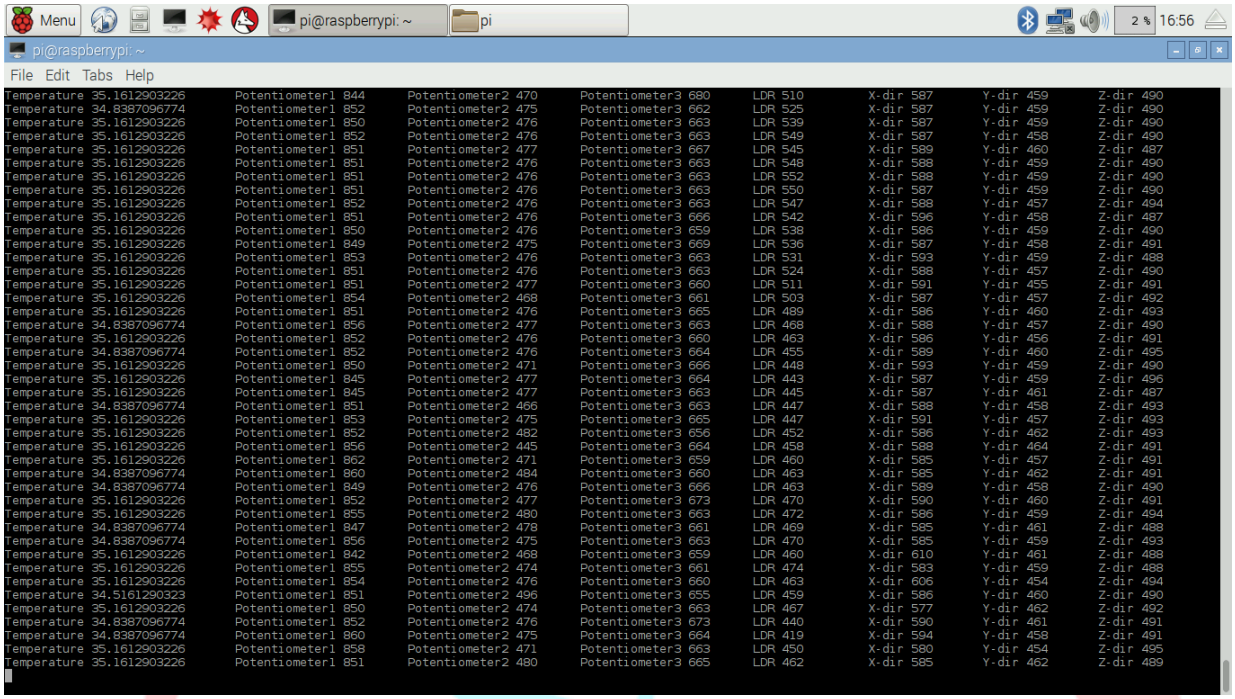
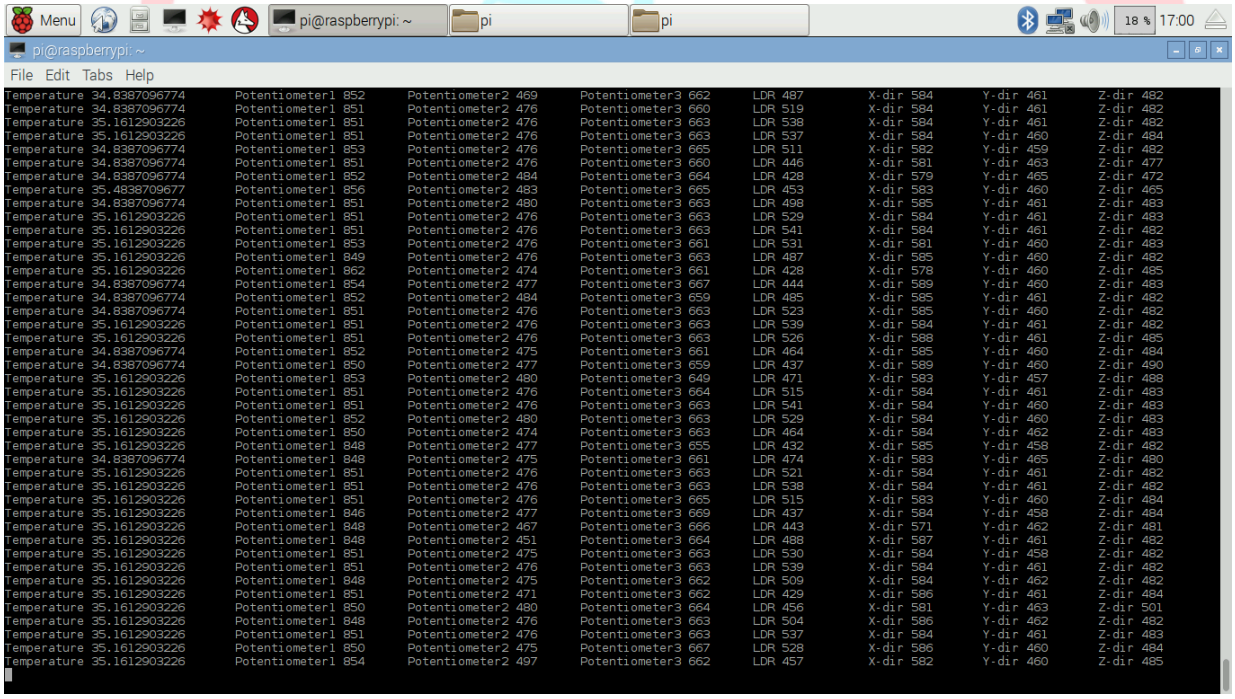


Figure 13





For more information please visit: www.tenettech.com

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