# 2015



# Reading analog value from LM35 temperature sensor on Raspberry Pi using MCP3008



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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 read analog value from LM35 temperature sensor by using MCP3008.

### **Hardware Requirements:**

- 1. Raspberry Pi board.
- 2. Tenet Power supply breakout board
- 3.Jumper wires.
- 4. MCP3008 IC (ADC).
- 5. Tenet LM35 breakout board.

### MCP 3008 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:

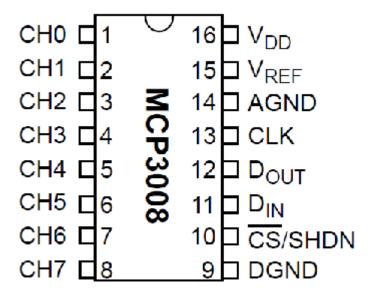


Figure 1

### Tenet LM35 breakout board:

The LM35 datasheet specifies that this ICs are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature.

The LM35 thus has an advantage over linear temperature sensors calibrated in  $^\circ$  Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of  $\pm 1/4$   $^\circ$ C at room temperature and  $\pm 3/4$   $^\circ$ Cover a full -55 to +150  $^\circ$ C temperature range.



Figure 2

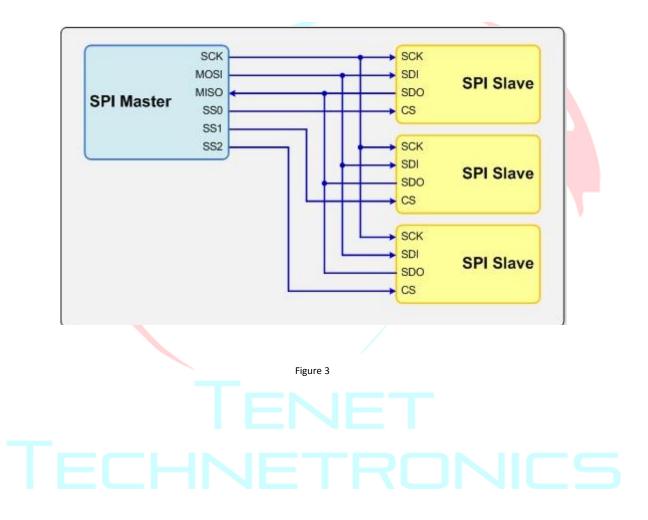
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### SPI Interface:

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.

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.



### **Enabling SPI on raspberry pi:**

Step 1: Start by running the following command:

### Sudo raspi-config

**Step 2:** This will launch the raspi-config utility. Select option 8 "Advanced Options".

```
ââââââââââââââa Raspberry Pi Software Configuration Tool (raspi-config) âââââââââââââââââ
â Setup Options
    1 Expand Filesystem
                                        Ensures that all of the SD card storage
â
â
    2 Change User Password
                                        Change password for the default user (p
    3 Enable Boot to Desktop/Scratch
4 Internationalisation Options
                                        Choose whether to boot into a desktop e
â
                                        Set up language and regional settings t
â
                                        Enable this Pi to work with the Raspber
â
    5 Enable Camera
    6 Add to Rastrack
                                        Add this Pi to the online Raspberry Pi
â
â
    7 Overclock
                                        Configure overclocking for your Pi
â
    9 About raspi-config
                                        Information about this configuration to
â
â
                        <Select>
                                                      <Finish>
```

Figure 4

### Step 3: Select the "SPI" option.

```
âââââââââââââ⤠Raspberry Pi Software Configuration Tool (raspi-config) ââââââââââââââââââ
â Advanced Options
â
                                      You may need to configure overscan if b
    Al Overscan
                                       Set the visible name for this Pi on a n
                                                                                @ @ @ @ @ @ @ @ @
â
    A2 Hostname
â
    A3 Memory Split
                                      Change the amount of memory made availa
â
    A4 SSH
                                      Enable/Disable remote command line acce
â
                                       Enable/Disable automatic loading of SPI
â
    A6 Audio
                                       Force audio out through HDMI or 3.5mm j
â
    A7 Update
                                      Update this tool to the latest version
â
â
â
â
â
                       <Select>
                                                    <Back>
```

Figure 5

```
â
â Would you like the SPI kernel module to be loaded by
                                       â
default? Current setting: no
                                       â
                                       â
â
â
â
                                       0 0 0 0 0 0 0 0 0 0 0 0
â
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â
â
â
â
â
â
                                       â
          <Yes>
â
                         <No>
                                       â
```

Figure 6

Step 5: Select "OK".

```
â
SPI kernel module will now be loaded by default
                               â
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â
              <0k>
```

Figure 7

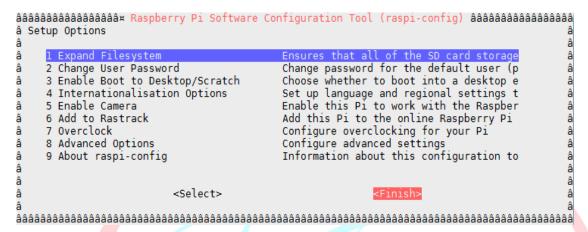


Figure 8

Step 7: Reboot for the changes to take effect.

### Sudo reboot

SPI is now enabled.

**Step 8:** 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

Step 9: 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 or rm —r master.zip

cd py-spidev-master

sudo python setup.py install

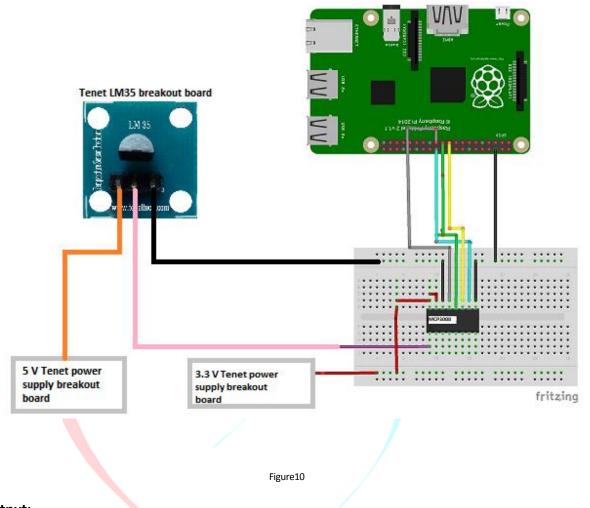
cd ..

### Coding:

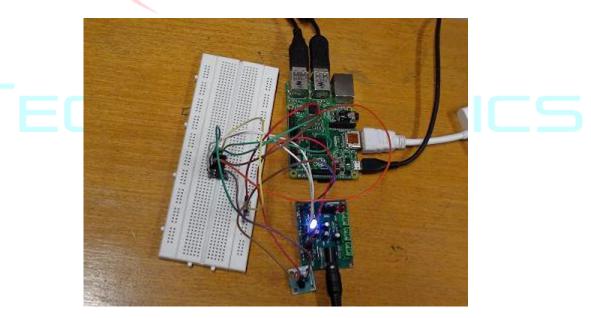
```
Figure 9
                                             //Importing spidev to access SPI
Import spidev
                                             //import sleep for giving delay
From time import sleep
Start=spidev.SpiDev()
                                             //creating object with name start
Start.open(0,0)
                                             //(BUS,channel) since one channel and Bus
While 1:
       try:
                                             //creating function
               r=start.xfer2([1,(8+0)<<4,0]) //enabling SPI and 3 bytes of data stored in r
              value=((r[1]&3)<<8)+r[2]
                                          //Retrieving last 10 bit
              volt=((3.3*value)/1023)
                                             //Converting to Voltage
              Temperature=volt/.01//converting to celcius
               print("Temperature:{}celcius".format(Temperature) //printing values
       excepy KeyboardInterrupt:
                                                    //when CTRL+C is pressed terminate it
              GPIO.cleanup()
              quit()
```

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# Circuit diagram:



# Output:



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### Output on the screen:

```
pi@raspberrypi ~ $ sudo python temp.py
emerature: 25.4838709677 celcius
emerature: 25.4838709677 celcius
emerature: 25.4838709677 celcius
Temerature: 25.4838709677 celcius
emerature: 25.4838709677 celcius
Temerature: 25.4838709677 celcius
Temerature: 25.1612903226 celcius
Temerature: 25.4838709677 celcius
Temerature: 25.4838709677 celcius
Temerature: 25.4838709677 celcius
Temerature: 25.4838709677 celcius
Gemerature: 25.4838709677 celcius
emerature: 25.4838709677 celcius
Gemerature: 25.4838709677 celcius
Temerature: 25.4838709677 celcius
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emerature: 25.4838709677 celcius
emerature: 25.4838709677 celcius
emerature: 25.4838709677 celcius
emerature: 25.4838709677 celcius
```

Figure 12

### For product link:

- 1. http://tenettech.com/product/7021/raspberry-pi-2-model-b-basic-kit-tt-sp-19022015
- 2. http://www.tenettech.com/product/6068/power-supply-breakout-board.
- **3.**<a href="http://www.tenettech.com/product/2985/mcp3008-8-channel-10-bit-adc-with-spi-interface">http://www.tenettech.com/product/2985/mcp3008-8-channel-10-bit-adc-with-spi-interface</a>
- 4. http://www.tenettech.com/product/3009/lm35-temperature-sensor.

For more information please visit: www.tenettech.com

For technical query please send an e-mail: info@tenettech.com