7 Segment Display Interfacing with Raspberry Pi

Raspberry Pi is an ARM architecture processor based board designed for electronic engineers and hobbyists. The PI is one of most trusted project development platforms out there now. With higher processor speed and 1 GB RAM, the PI can be used for many high profile projects like Image processing and IoT.

In this tutorial, we are going to do Raspberry Pi 7 segment display interfacing. Seven Segment displays are the cheapest for a display unit. A couple of these segments stacked together could be used to display temperature, counter value etc. We will connect the 7 segment display unit to GPIO of PI and control them to display digits accordingly. After that we will write a program in PYTHON for seven segment display to counts from 0-9 and resets itself to zero.

Seven Segment Display:

There are different types and sizes of 7 Segment Displays. We have covered Seven Segment working in detail here. Basically there are two types of 7 Segment, Common Anode type (Common Positive or Common VCC) and Common Cathode type (Common Negative or Common Ground)

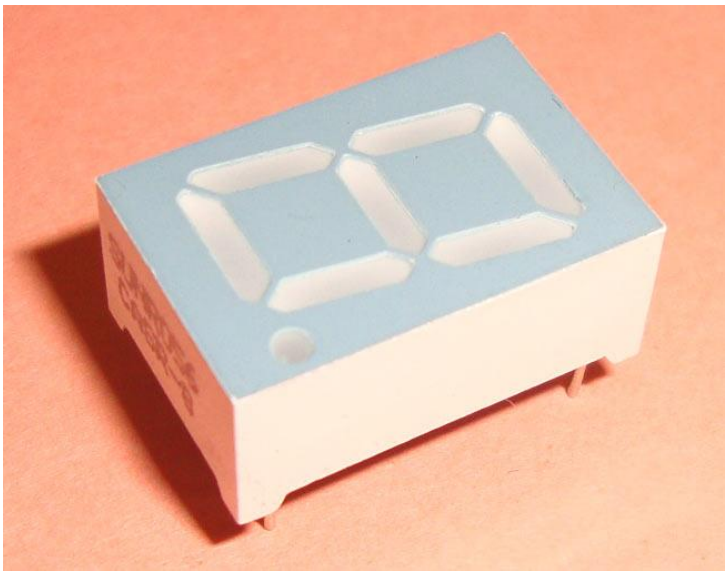


FIGURE 1 SEVEN SEGMENT DISPLAY

A seven-segment display (SSD) is a widely used electronic display device for displaying decimal numbers from 0 to 9. They are most commonly used in electronic devices like digital clocks, timers and calculators to display numeric information. As its name indicates, it is made of seven different illuminating segments which are arranged in such a way that it can form the numbers from 0-9 by displaying different combinations of segments. It is also able to form some alphabets like A, B, C, H, F, E, etc.

7 segment displays are among the simplest display units to display the numbers and characters. As shown in the above image of a 7-segment display, it consists of 8 LEDs, each LED used to illuminate one segment of unit and the 8thLED used to illuminate DOT in 7 segment display. We can refer each segment as a LINE, as we can see there are 7 lines in the unit, which are used to display a number/character. We can refer each segment "a,b,c,d,e,f,g" and for dot character we will use "h". There are 10 pins, in which 8 pins are used to refer a,b,c,d,e,f,g and h/dp, the two middle pins are common anode/cathode of all he LEDs. These common anode/cathode are internally shorted so we need to connect only one COM pin.

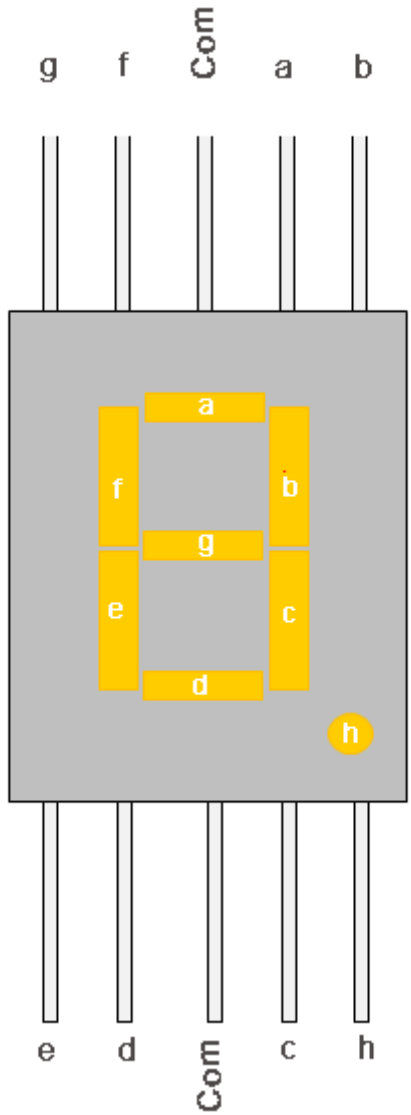
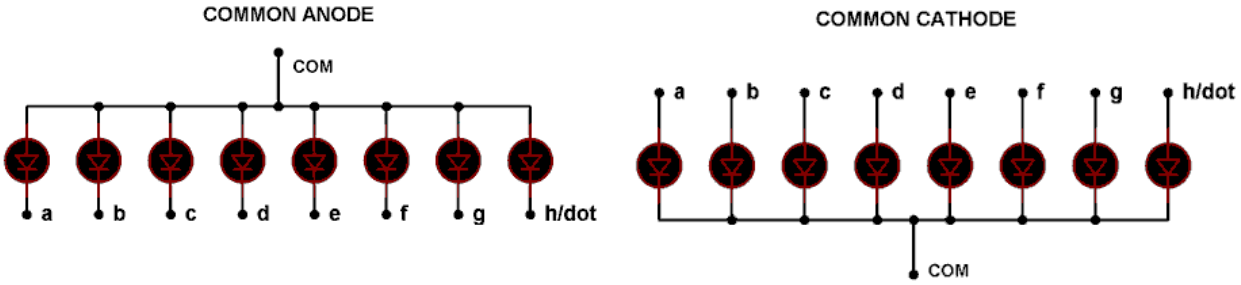


FIGURE 2 SEVEN SEGMENT DISPLAY PINOUT

There are two types of 7 segment displays: Common Anode and Common Cathode:

Common Cathode: In this all the Negative terminals (cathode) of all the 8 LEDs are connected together (see diagram below), named as COM. And all the positive terminals are left alone.

Common Anode: In this all the positive terminals (Anodes) of all the 8 LEDs are connected together, named as COM. And all the negative thermals are left alone.



Internal connections of 7 Segment Display

How to Display Numbers on 7 Segment Display?

If we want to display the number "0", then we need to glow all the LEDs except LED which belongs to line "g" (see 7 segment pin diagram above, so we need a bit pattern 11000000. Similarly to display "1"we need to glow LEDs associated with b and c, so the bit pattern for this would be 11111001. A table has been given below for all the numbers while using

Common Anode type 7 segment display unit.

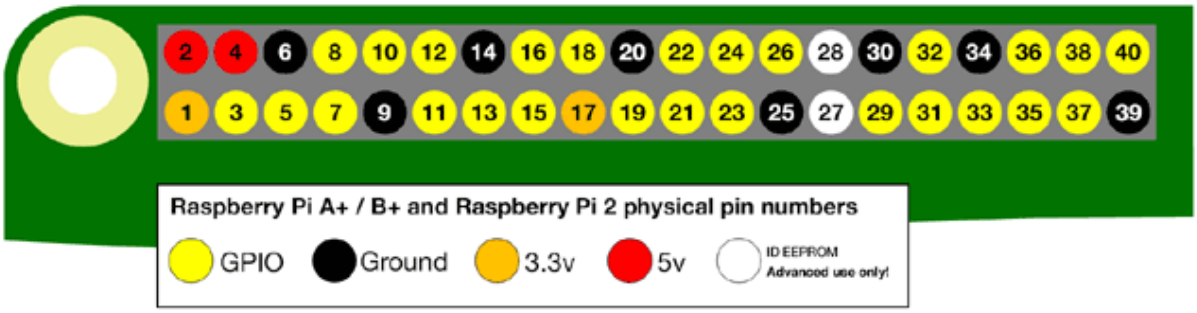
Digit to Display	h g f e d c b a	Hex code
0	11000000	C0
1	11111001	F9
2	10100100	A4
3	10110000	B0
4	10011001	99
5	10010010	92
6	10000010	82
7	11111000	F8
8	10000000	80
9	10010000	90

Common Cathode type 7 segment display unit.

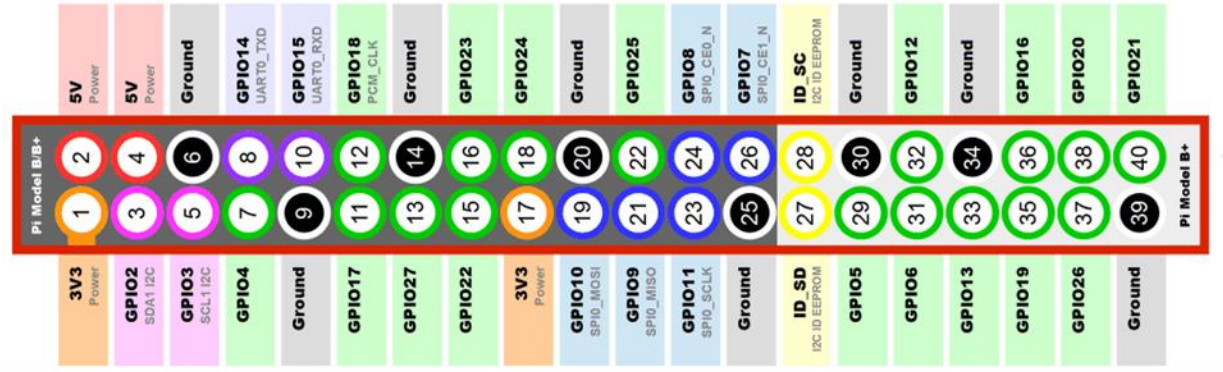
Digit to Display	h g f e d c b a	Hex code
0	00111111	3F
1	00000110	06
2	01011011	5B
3	01001111	4F
4	01100110	66
5	01101101	6D
6	01111101	7D
7	00000111	07
8	01111111	7F
9	01100111	67

We will discuss a bit about Raspberry Pi GPIO before going any further,

There are 40 GPIO output pins in Raspberry Pi 2. But out of 40, only 26 GPIO pins (GPIO2 to GPIO27) can be programmed, see the figure below. Some of these pins perform some special functions. With special GPIO put aside, we have 17 GPIO remaining.



The GPIO's (pin 1 or 17) +3.3V signal is enough to drive the 7 Segment Display. To provide current limit, we will use 1KΩ resistor for each segment as shown in the Circuit Diagram

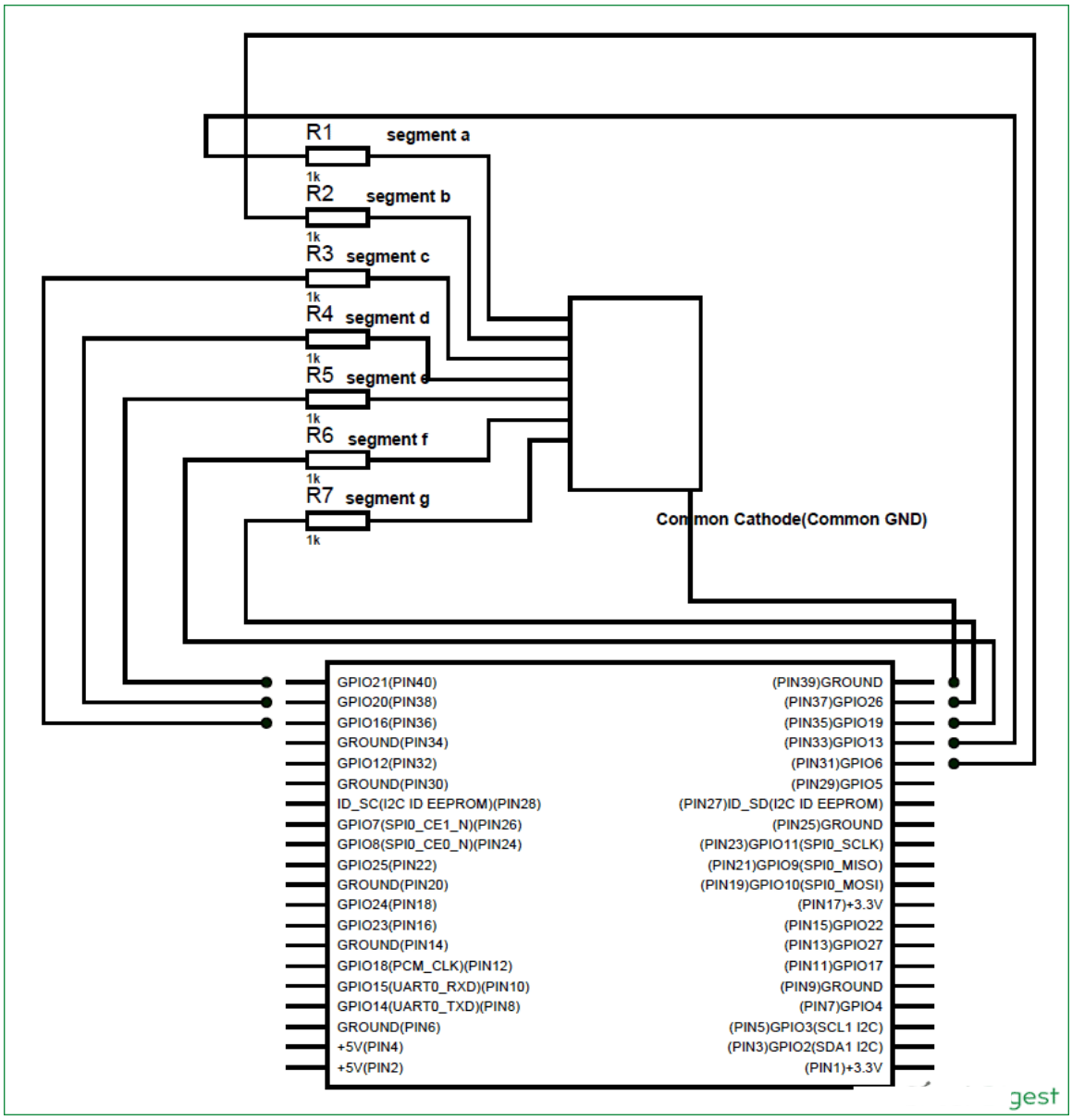


Components Required:

Here we are using Raspberry Pi 3 Model B with Raspbian Jessie OS. All the basic Hardware and Software requirements are previously discussed, you can look it up in the Raspberry Pi Introduction, other than that we need:

- Connecting pins
- Common Cathode 7 segment display (LT543)
- 1KΩresistor (8 pieces)
- Breadboard

Circuit and Working Explanation:

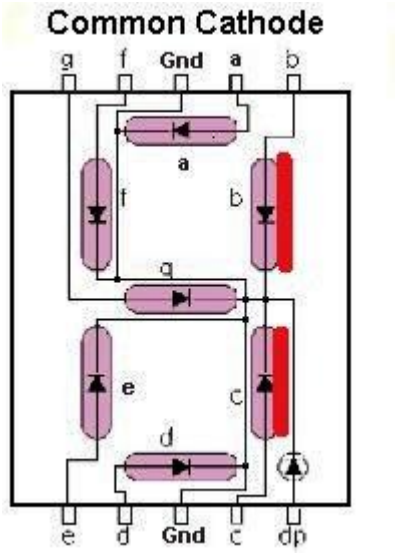


The connections, which are done for Interfacing 7 segment display to Raspberry Pi, are given below. We have used Common Cathode 7 Segment here:

- PIN1 or e ---------- GPIO21
- PIN2 or d ---------- GPIO20
- PIN4 or c ---------- GPIO16
- PIN5 or h or DP ---------- GPIO 12 //not compulsory as we are not using decimal point
- PIN6 or b ----------GPIO6
- PIN7 or a ----------GPIO13
- PIN9 or f ---------- GPIO19
- PIN10 or g ---------- GPIO26
- PIN3 or PIN8 ----------connected to Ground

So we will be using 8 GPIO pins of PI as an 8bit PORT. In here GPIO13 is being LSB (Least Significant Bit) and GPIO 12 being MSB (Most Significant Bit).

Now, if we want to display Number “1”, we need to power segments B and C. To power segment B and C, we need to power GPIO6 and GPIO16. So the byte for ‘PORT’ function will be 0b00000110 and the hex value of ‘PORT’ will be 0x06. With both the pins high we get “1” on display.



We have written the values for each digit to be displayed and stored those values in a String of Characters named ‘DISPLAY’ (Check the Code section below). Then we have called those values one by one to show the corresponding digit on the display, using the Function ‘PORT’.

Programming Explanation:

Once everything is connected as per the circuit diagram, we can turn ON the PI to write the program in PYHTON.

We will talk about few commands which we are going to use in PYHTON program,

We are going to import GPIO file from library, below function enables us to program GPIO pins of PI. We are also renaming “GPIO” to “IO”, so in the program whenever we want to refer to GPIO pins we will use the word ‘IO’.

import RPi.GPIO as IO

Sometimes, when the GPIO pins, which we are trying to use, might be doing some other functions. In that case, we will receive warnings while executing the program. Below command tells the PI to ignore the warnings and proceed with the program.

IO.setwarnings(False)

We can refer the GPIO pins of PI, either by pin number on board or by their function number. Like ‘PIN 29’ on the board is ‘GPIO5’. So we tell here either we are going to represent the pin here by ‘29’ or ‘5’.

IO.setmode (IO.BCM)

We are setting 8 GPIO pins as output pins, for Data and Control pins of LCD.

IO.setup(13,IO.OUT)

IO.setup(6,IO.OUT)

IO.setup(16,IO.OUT)

IO.setup(20,IO.OUT)

IO.setup(21,IO.OUT)

IO.setup(19,IO.OUT)

IO.setup(26,IO.OUT)

IO.setup(12,IO.OUT)

In case the condition in the braces is true, the statements inside the loop will be executed once. So if the bit0 of 8bit 'pin' is true, PIN13 will be HIGH, otherwise PIN13 will be LOW. We have eight ‘if else’ conditions for bit0 to bit7, so that appropriate LED, inside the 7 segment display, can be made High or Low, to display the corresponding Number.

```
if(pin&0x01 == 0x01):
  IO.output(13,1)
else:
  IO.output(13,0)
```

This command executes the loop 10 times, x being incremented from 0 to 9.

for x in range(10):

Below command is used as forever loop, with this command the statements inside this loop will be executed continuously.

While 1:

All the other functions and commands have been explained in below 'Code' section with the help of 'Comments'.

After writing the program and executing it, the Raspberry Pi triggers the corresponding GPIOs to show the digit on 7 Segment Display. The program is written for the display to count from 0-9 continuously.

Code

```
import RPi.GPIO as IO    # calling for header file which helps us use
GPIO's of PI
import time              # calling for time to provide delays in program

DISPLAY = [0x3F,0x06,0x5B,0x4F,0x66,0x6D,0x7D,0x07,0x7F,0x67]# string of
characters storing PORT values for each digit.

IO.setwarnings(False)     # do not show any warnings
IO.setmode (IO.BCM)      # programming the GPIO by BCM pin numbers. (like
PIN29 as'GPIO5')

IO.setup(13,IO.OUT)  # initialize GPIO Pins as outputs
IO.setup(6,IO.OUT)
IO.setup(16,IO.OUT)
IO.setup(20,IO.OUT)
IO.setup(21,IO.OUT)
IO.setup(19,IO.OUT)
IO.setup(26,IO.OUT)
IO.setup(12,IO.OUT)

def PORT(pin):               # assigning GPIO logic by taking 'pin' value
    if(pin&0x01 == 0x01):
        IO.output(13,1)      # if  bit0 of 8bit 'pin' is true, pull PIN13
high
    else:
        IO.output(13,0)      # if  bit0 of 8bit 'pin' is false, pull PIN13
low
    if(pin&0x02 == 0x02):
        IO.output(6,1)       # if  bit1 of 8bit 'pin' is true, pull PIN6
high
    else:
        IO.output(6,0)       #if  bit1 of 8bit 'pin' is false, pull PIN6
low
    if(pin&0x04 == 0x04):
        IO.output(16,1)
    else:
```

```
        IO.output(16,0)
    if(pin&0x08 == 0x08):
        IO.output(20,1)
    else:
        IO.output(20,0)
    if(pin&0x10 == 0x10):
        IO.output(21,1)
    else:
        IO.output(21,0)
    if(pin&0x20 == 0x20):
        IO.output(19,1)
    else:
        IO.output(19,0)
    if(pin&0x40 == 0x40):
        IO.output(26,1)
    else:
        IO.output(26,0)
    if(pin&0x80 == 0x80):
        IO.output(12,1)         # if  bit7 of 8bit 'pin' is true, pull
PIN12 high
    else:
        IO.output(12,0)         # if  bit7 of 8bit 'pin' is false, pull
PIN12 low

while 1:
    for x in range(10):          # execute the loop ten times incrementing
x value from zero to nine
        pin = DISPLAY[x]        # assigning value to 'pin' for each digit
        PORT(pin);              # showing each digit on display
        time.sleep(1)
```