Lesson 14 Driving 7-Segment Display by 74HC595

Introduction

Since we've got some knowledge of the 74HC595 in the previous lesson, now let's try to use it and drive a 7-segment display to show a figure from 0 to 9 and A to F.

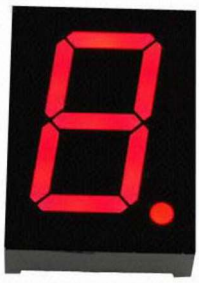
Components

- 1 * Raspberry Pi
- 1 * Breadboard
- 1 * 74HC595
- 1 * 7-segment display
- 1 * Resistor (220Ω)
- Jumper wires
- 1 * T-Extension Board
- 1 * 40-Pin GPIO Cable

Principle

7-Segment Display

A 7-segment display is an 8-shaped component which packages 7 LEDs. Each LED is called a segment – when energized, one segment forms part of a numeral (both decimal and hexadecimal) to be displayed. An additional 8th LED is sometimes used within the same package thus allowing the indication of a decimal point (DP) when two or more 7-segment displays are connected together to display numbers greater than ten.

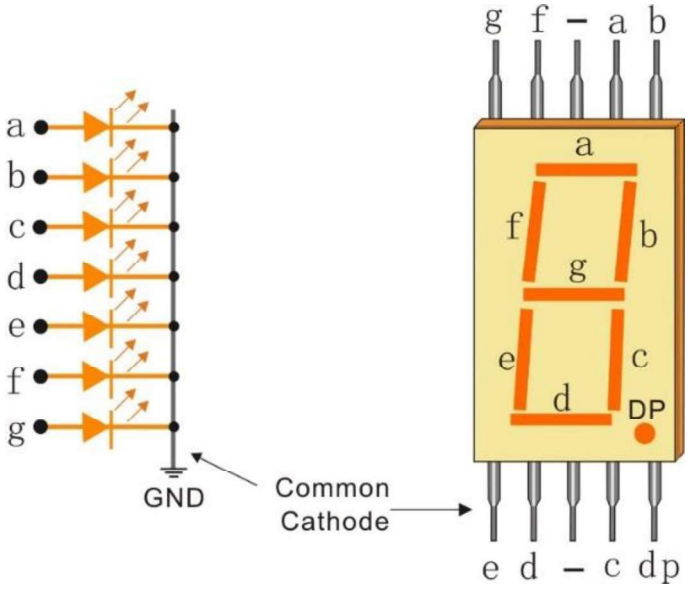


Each of the LEDs in the display is given a positional segment with one of its connection pins led out from the rectangular plastic package. These LED pins are labeled from "a" through to "g" representing each individual LED. The other LED pins are connected together forming a common pin. So by forward biasing the appropriate pins of the LED segments in a particular order, some segments will brighten and others stay dim, thus showing the corresponding character on the display.

The common pin of the display generally tells its type. There are two types of pin connection: a pin of connected cathodes and one of connected anodes, indicating Common Cathode

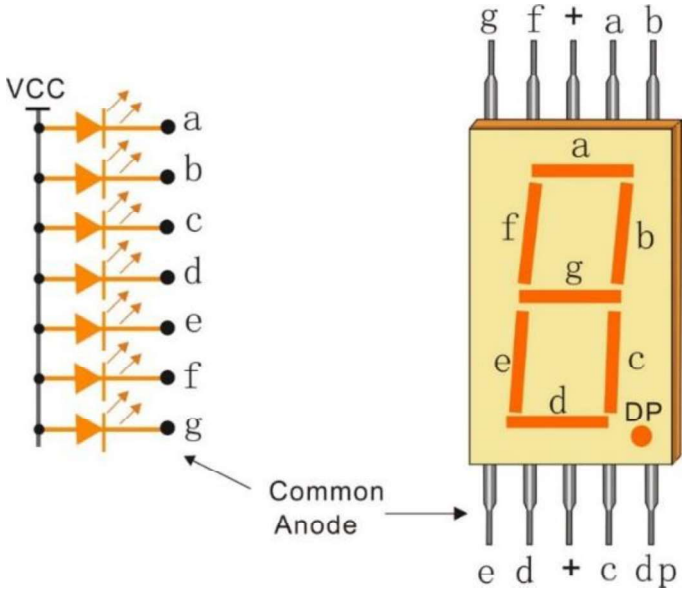
(CC) and Common Anode (CA). As the name suggests, a CC display has all the cathodes of the 7 LEDs connected when a CA display has all the anodes of the 7 segments connected.

Common Cathode 7-Segment Display



In a common cathode display, the cathodes of all the LED segments are connected to the logic "0" or ground. Then an individual segment (a-g) is energized by a "HIGH", or logic "1" signal via a current limiting resistor to forward bias the anode of the segment.

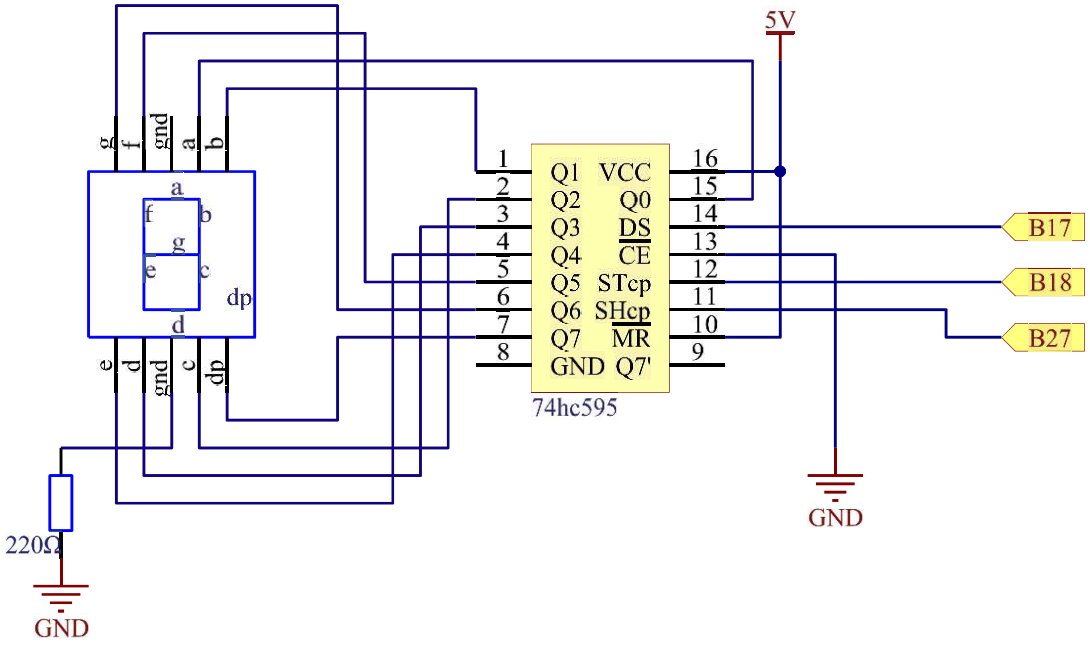
Common Anode 7-Segment Display



In a common anode display, the anodes of all the LED segments are connected to the logic "1". Then an individual segment (a-g) is energized by a ground, logic "0" or "LOW" signal via a current limiting resistor to the cathode of the segment.

In this experiment, a common cathode 7-segment display is use. It should be connected to ground. When the anode of an LED in a certain segment is at high level, the corresponding segment will light up; when it is at low, the segment will stay dim.

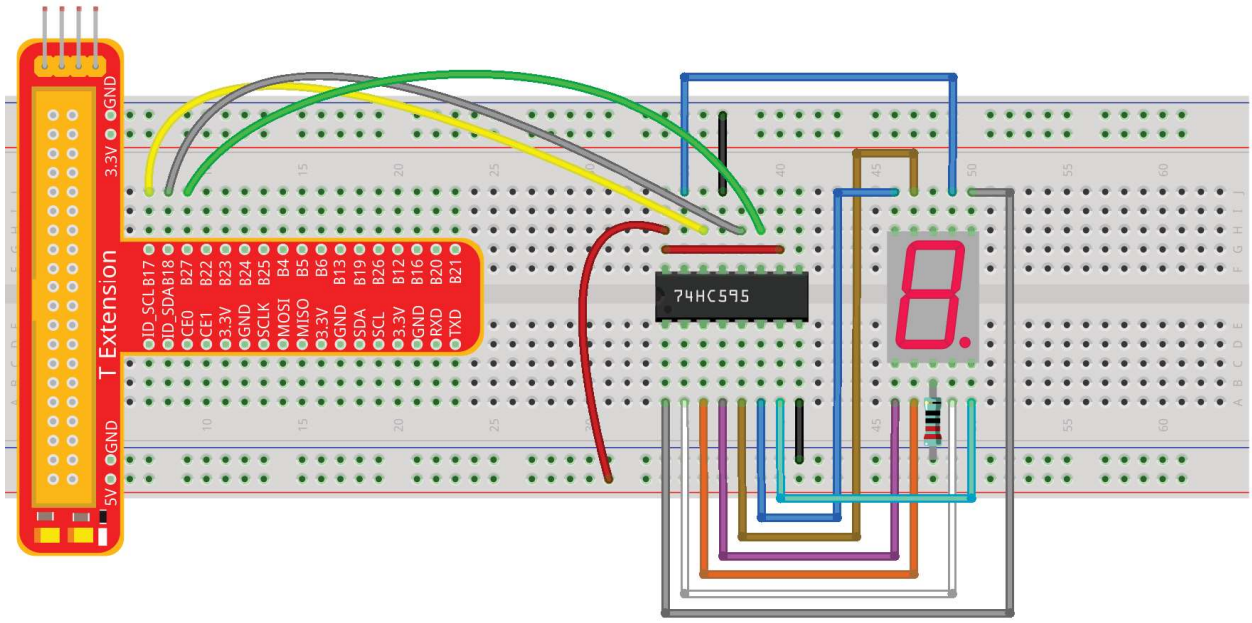
The schematic diagram is shown as below:



Principle: Connect pin ST_CP of 74HC595 to Raspberry Pi B18, SH_CP to B27, DS to B17, parallel output ports to 8 segments of the LED segment display. Input data in DS pin to shift register when SH_CP (the clock input of the shift register) is at the rising edge, and to the memory register when ST_CP (the clock input of the memory) is at the rising edge. Then you can control the states of SH_CP and ST_CP via the Raspberry Pi GPIOs to transform serial data input into parallel data output so as to save Raspberry Pi GPIOs and drive the display.

Experimental Procedures

Step 1: Build the circuit



For C language users:

Step 2: Get into the folder of the code.

```
cd /home/pi/SunFounder_Super_Kit_V3.0_for_Raspberry_Pi/C
```

Step 3: Compile

```
make 14_segment
```

Step 4: Run the executable file above.

```
sudo ./14_segment
```

Code Explanation

```
unsigned char SegCode[17] =
{0x3f,0x06,0x5b,0x4f,0x66,0x6d,0x7d,0x07,0x7f,0x6f,0x77,0x7c,0x39,0x5e,0x79,0x71,0x80};
// display array from 0 to F.
void init(void){}  // Initialize the function, set ds, st_cp, sh_cp three pins to low
level, and the initial state as 0.
void hc595_shift(unsigned char dat){
    int i;
    for(i=0;i<8;i++){
        digitalWrite(SDI, 0x80 & (dat << i));  // Assign the dat data to SDI(DS) by
bits. Here we assume dat=0x3f(0011 1111, when i=0, 0x3f will shift right(<<) 0 bits,
0x3f & 0x80 = 1000 0000,
        digitalWrite(SRCLK, 1);  // SH_CP will convert from low to high, and generate a
rising edge pulse, then shift the DS date to shift register.
        delay(1);
        digitalWrite(SRCLK, 0);
    }  // to assign 8 bit value to 74HC595's shift register
    digitalWrite(RCLK, 1); // ST_CP converts from low to high and generate a rising
edge, then shift data from shift register to storage register.
    delay(1);
    digitalWrite(RCLK, 0);
}// Transfer data in shift register to data register to update the displayed data.
```

For Python users:

Step 2: Get into the folder of the code.

```
cd /home/pi/SunFounder_Super_Kit_V3.0_for_Raspberry_Pi/Python
```

Step 3: Run

```
sudo python 14_segment.py
```

Code Explanation

```
# Define a segment code from 0 to F in Hexadecimal
# Commen cathode
```

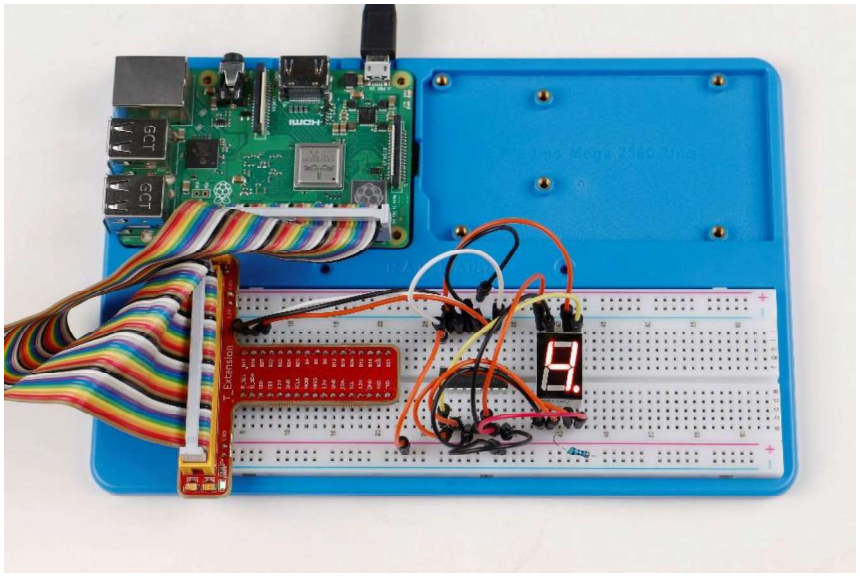
```
segCode =
[0x3f,0x06,0x5b,0x4f,0x66,0x6d,0x7d,0x07,0x7f,0x6f,0x77,0x7c,0x39,0x5e,0x79,0x71]
# Commen anode
# segCode =
[0xc0,0xf9,0xa4,0xb0,0x99,0x92,0x82,0xf8,0x80,0x90,0x88,0x83,0xc6,0xa1,0x86,0x8e]
# Shift the data to 74HC595
def hc595_shift(dat):
    for bit in range(0, 8):
        GPIO.output(SDI, 0x80 & (dat << bit))
        GPIO.output(SRCLK, GPIO.HIGH)
        time.sleep(0.001)
        GPIO.output(SRCLK, GPIO.LOW)
    GPIO.output(RCLK, GPIO.HIGH)
    time.sleep(0.001)
    GPIO.output(RCLK, GPIO.LOW)
for code in segCode:  # Input item in segCode list to hc595_shift()function, to display
the character.
    hc595_shift(code)
```

If you want to display a number, use the **hc595_shift()** function, **segCode** list and decimal value x in the sketch:

```
hc595_shift(segCode[x]) # x is a number needs to be displayed ranging from 0~15, and it
will be coverted and displayed by 0~F in hexadecimal.
```

Note: The hexadecimal format of number 0~15 are (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F)

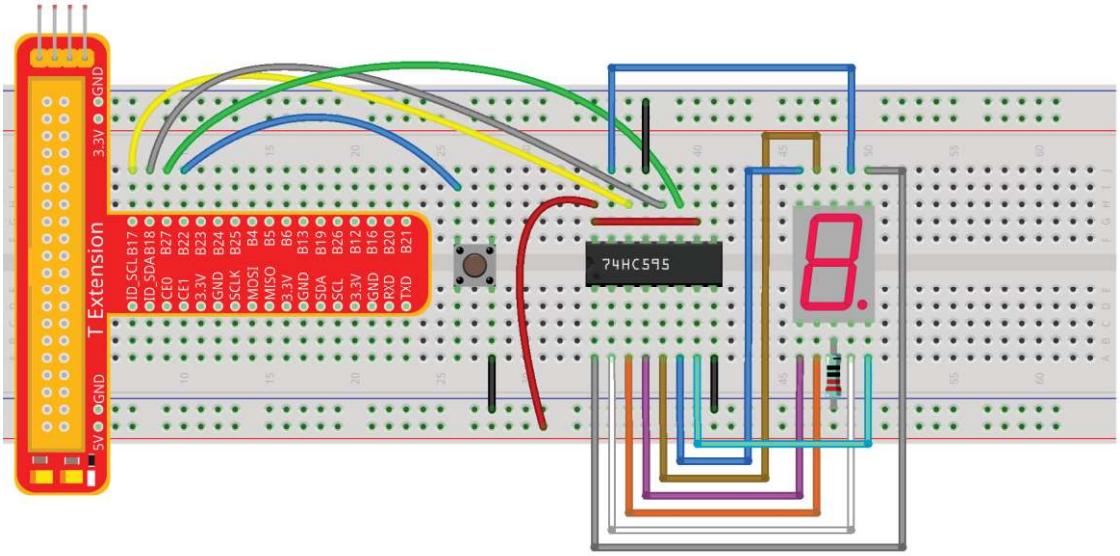
You should see the 7-segment display from 0 to 9 and A to F.



Further Exploration

You can slightly modify the hardware and software based on this experiment to make a dice. For hardware, add a button to the original board.

Build the circuit:



Get into the folder of the code.

```
cd /home/pi/SunFounder_Super_Kit_V3.0_for_Raspberry_Pi/C
```

Next, Compile the Code

```
make 14_dice
```

Run

```
sudo ./14_dice
```

Code Explanation

```
void randomISR(void){  // An interrupt function, run when the interrupt happens
    flag = 1;  // flag represents the state of the button
}
if(wiringPiISR(TouchPin, INT_EDGE_FALLING, &randomISR)){  //Set an interrupt here as the falling edge for TouchPin. When the interrupt happens, execute the function randomISR().
    printf("Unable to setup ISR : %s\n", strerror(errno));
    return 1;
}
srand(time(NULL));
num = rand() % 6;
// Two functions here: One is the srand function, which is used before calling function rand() and used as seed for the random number generator; while the other is rand(), which is a function to generate the random number. Usually, these two functions are used
```

```
together to generate the random number. Thus a random number of 0-6 will be displayed on
the 7-segment display.
```

For Python users:

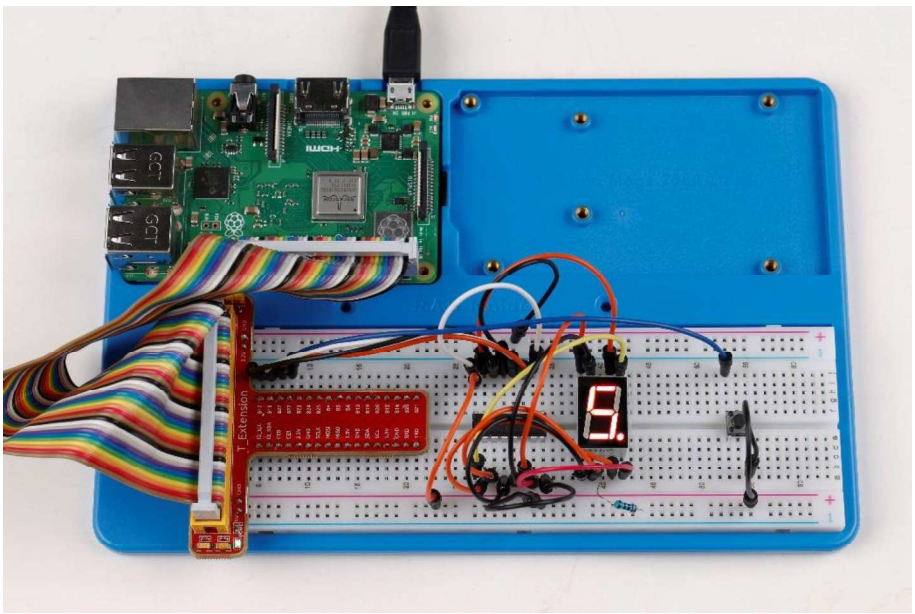
Step 2: Get into the folder of the code.

```
cd /home/pi/SunFounder_Super_Kit_V3.0_for_Raspberry_Pi/Python
```

Step 3: Run

```
sudo python 14_dice.py
```

Code Explanation

```
    import random  # use this function to generate the random number
    SegCode = [0x06, 0x5b, 0x4f, 0x66, 0x6d, 0x7d] # Define a segment code from 1 to 6
in Hexadecimal
GPIO.add_event_detect(TouchPin, GPIO.RISING, callback = randomISR, bouncetime = 20) #
Set an interrupt, and the rising edge for TouchPin. When the interrupt happens, execute
the function randomISR(). Set bouncetime for button to 20ms.
    def randomISR(channel):  # Interrupt calling  the function
        global flag
        flag = 1
        num = random.randint(1,6)
      #   Generate a random number from 1~6.
    hc595_shift(SegCode[num-1])    # Output the hexadecimal values in list by 74HC595.
```

Now you should see a number flashing between 0 and 6 quickly on the segment display. Press the button on the breadboard, and the display will statically display a random number between 0 and 6 for 2 seconds and then circularly flash randomly between 0 and 6 again.