Interface DC motor using motor driver IC to the Raspberry Pi

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Contents

1 Objective

In this tutorial we shall learn to control the velocity of DC motors interfaced with Raspberry Pi using a motor driver IC.

2 Prerequisites

- Python programming skills
- An R-Pi (with I2C; I will be using version 2)
- An idea about working of a dc motor
- Interfacing an MCP23017 IC with an R-Pi should be known

3 Hardware Requirement

1. Raspberry Pi (I will be using Version 2 Model B+)
2. MCP23017
3. Power adapter
4. DC motor
5. L293D
6. Capacitors (0.1 uF)
7. External power supply (for 12V)
8. Connecting wires
9. Bread board

4 Software Requirement

1. PyScripter (version 2.7 or above)
2. Mobaxterm (for windows user)

5 Theory and Description

A DC motor is any of a class of electrical machines that converts direct current electrical power into mechanical power. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor. Most types produce rotary motion; a linear motor directly produces force and motion in a straight line.

Motor Driver

Normal DC gear-head motors require current greater than 250mA. Most of the ICs like 555 timer,74 series ICs cannot supply this amount of current.Instead if we directly connect motors to the output of any of the above IC's, they might get damaged. There is a need of a circuitry that can act as a bridge between the above mentioned ICs and the motors. This is where a motor driver plays a crucial role. It regulates the current flowing through the circuit hence preventing any damage to the device. Different motor driver circuits can be classified as ones:

- Using Transistor
- Using L293D/L298
- Using relays

For controlling motor in both directions H bridge circuit is used. Its working is very simple and is described below.

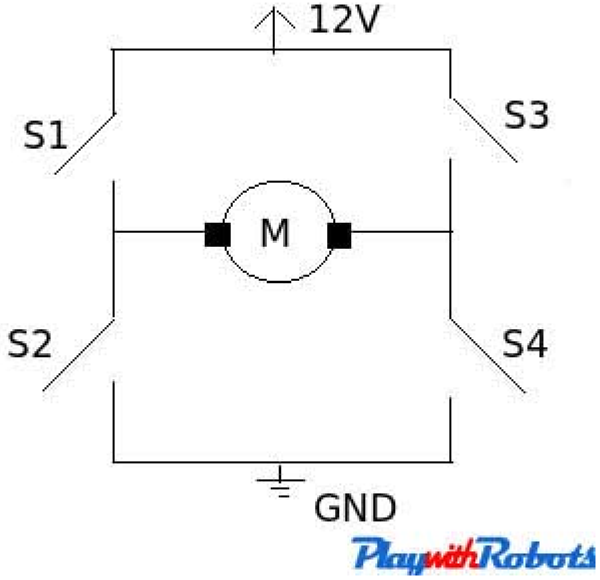


Figure 1: [2]

Closed Switches	Open Switches	Voltage across motor	Motion
Nil	S1,S2,S3,S4	0	No motion
S1,S4	S2,S3	12V	Clockwise
S2,S3	S1,S4	-12V	Anti-clockwise
S1,S3	S2,S4	0V	Brake

Ref: [2]

L293D Motor Driver

L293D is dual H-bridge motor driver ICs. Using these we can control the rotation of two motors in both clockwise and anti-clockwise direction.

Pin configuration

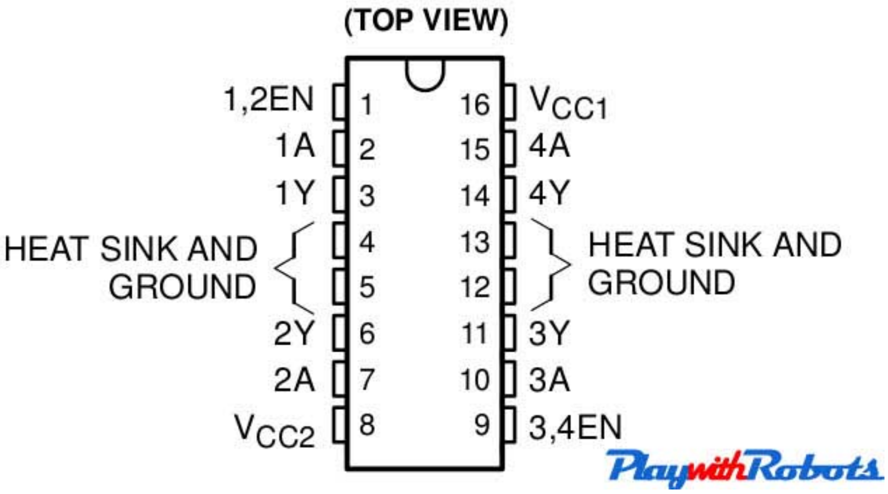


Figure 2: [2]

The description of each pin is as follows:

- Enable pins: These are pin no. 1 and pin no. 9. Pin no. 1 is used to enable Half-H driver 1 and 2.(H bridge on Left side). Pin no. 9 is used to enable H-bridge driver 3and 4.(H bridge on right side). The concept is simple, if you want to use a particular H bridge you have to give a high logic to corresponding enable pins along with the power supply to the IC. This pin can also be used to control speed of the motor using PWM technique.
- VCC1 (Pin 16): Power supply pin. Connect it to 5V supply.
- VCC2 (Pin 8): Power supply for motor. Apply +ve voltage to it as per motor rating. If you want to drive your motor at 12V, apply 12V on this pin. It is also possible to drive motor directly on a battery, other than the one used for supplying power to the circuit, Just connect +ve terminal of that battery to VCC2 pin and make GND of both the batteries common. (MAX voltage at this pin is 36V as per its datasheet).
- GND (Pins 4,5,12,13): Connect them to common GND of circuit.
- Inputs (Pins 2,7,10,15): These are input pins through which control signals are given by microcontrollers or other circuits/ICs. For

example, if on pin 2 (Input of 1st half H driver) we give Logic 1 (5V), we will get a voltage equal to VCC2 on corresponding output pin of 1st half H driver i.e pin no. 3. Similarly for Logic 0 (0V) on Pin 2, 0V on Pin 3 appears.

- Outputs (Pin 3,6,11,14): Outputs pins. According to input signal output signal comes. [2]

Circuit Diagram

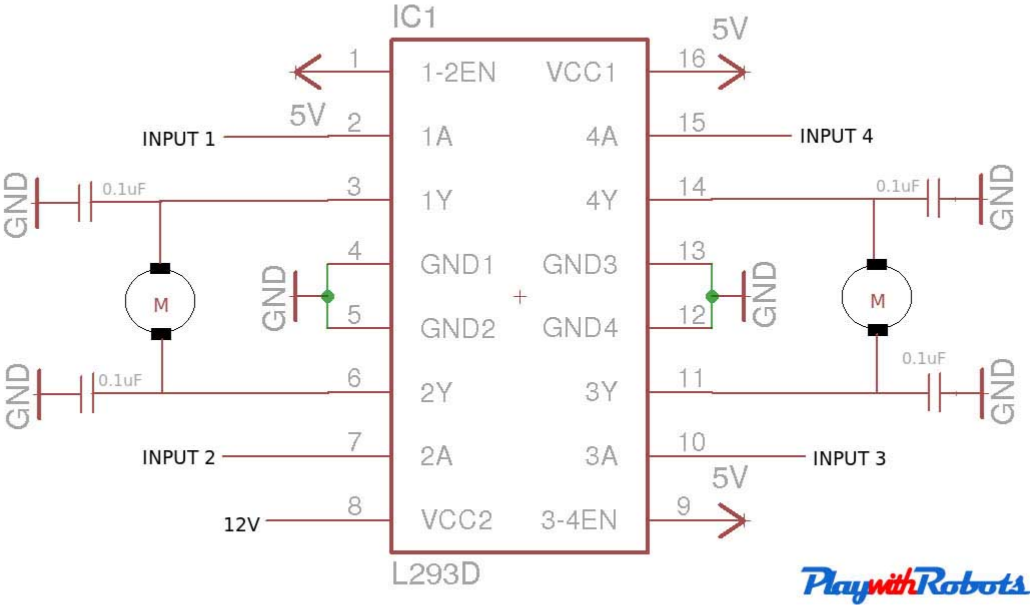


Figure 3: [2]

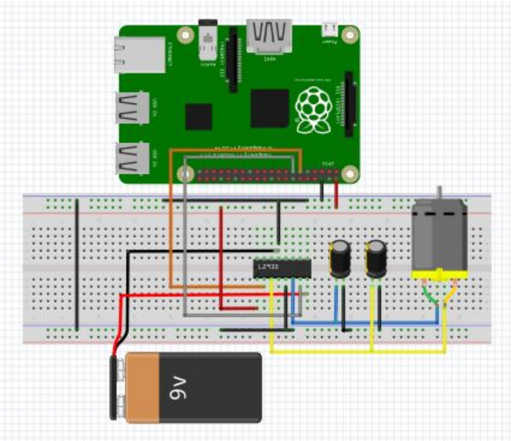
1A	2A	1Y	2Y	Motor 1
Logic 0	Logic 0	0	0	Stop
Logic 1	Logic 0	12V	0	Clockwise
Logic 0	Logic 1	0	12V	Anti-clockwise
Logic 1	Logic 1	12V	12V	Brake

Ref: [2]

6 Experiment

6.1 DC motor interfacing with Raspberry Pi through L293D using GPIO pins

In this experiment we will be rotating the DC motor both ways using L293D(Motor Driver IC) and GPIO pins of RPi.



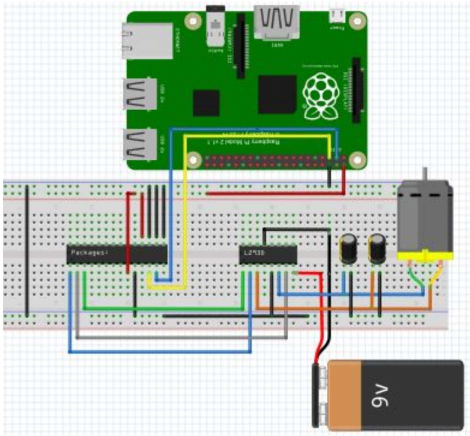
- Pin 1 (1-2EN)of L293D is Connected to 5V supply.
- 1A and 2A are connected to board pins 11 and 13 of Raspberry Pi respectively.
- Ground of L293D and 9V battery is connected to ground of Raspberry Pi.
- Pin 8 of L293D is connected to +ve of 9V battery.
- 1Y and 2Y are connected to the motor terminals which drives the motor.

Code

```
import RPi.GPIO as GPIO
import time
GPIO.setmode(GPIO.BOARD) #set the RPi mode as Board mode
GPIO.setup(11,GPIO.OUT)  #set pin 11 as output
GPIO.setup(13,GPIO.OUT)  #set pin 13 as output
GPIO.setwarnings(False)
p= GPIO.PWM(11,50) #set pin 11 as software PWM
q= GPIO.PWM(13,50) #set pin 13 as software PWM

p.start(0)
q.start(0)

try:
    while True:
        for i in range (100):
            p.ChangeDutyCycle(i) # speed of motor goes on increasing
                                 #in clockwise direction
            time.sleep(0.02)
        for i in range(100):
            p.ChangeDutyCycle(100-i) # speed of motor goes on decreasing
            time.sleep(0.02)

        p.ChangeDutyCycle(0)

        for i in range (100):
            q.ChangeDutyCycle(i) # speed of motor goes on increasing
                                 #in anticlockwise direction.
            time.sleep(0.02)
        for i in range(100):
            q.ChangeDutyCycle(100-i) # speed of motor goes on decreasing
            time.sleep(0.02)

        q.ChangeDutyCycle(0)

except KeyboardInterrupt:
    pass
GPIO.cleanup()
p.stop()
q.stop()
```

6.2 DC motor interfaced with Raspberry Pi through L293D and MCP23017 IC

In this experiment we will be rotating the DC motor both ways by using MCP23017(Port Expander IC) and L293D(Motor Driver IC).



As shown in the figure:

- Pin 9 (VDD) is connected to 5V (Red)
- Pin 10 (VSS) is connected to Ground (Black)
- Pin 12 (SCL) is connected to Pin 5 on the Pi GPIO (Blue)
- Pin 13 (SDA) is connected to Pin 3 on the Pi GPIO (Blue)
- Pin 18 (Reset) should be set high for normal operation so we connect this to 5V (Red)
- Pins 15, 16 & 17 (A0-A2) determine the number assigned to this device. We are only using one device so we will give it a binary zero by setting all three of these pins to 0 (ground) (Black)
- Input 1 and Input 2 of L293D is connected to GPB0 and GPB1 of MCP23017 (Orange)
- Pin 1 (enable pin) of L293D is connected to GPB2.
- Out 1 and Out 2 are connected to a DC motor

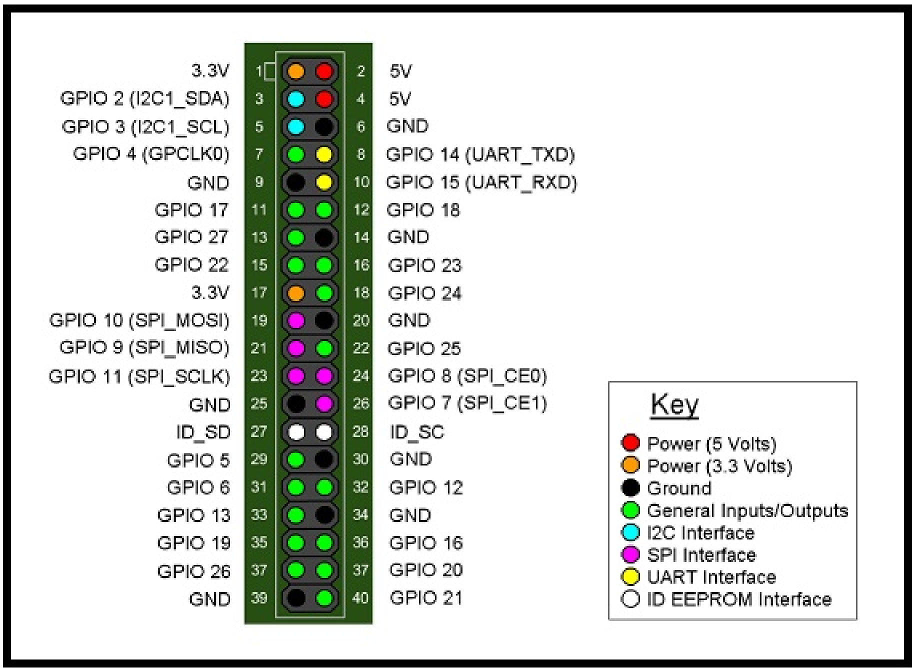
Code

```
import smbus  # module to access i2c based interfaces
import time

bus = smbus.SMBus(1) # Rev 2 Pi uses 1

DEVICE = 0x20 # Device address (A0-A2)
IODIRB = 0x01 # Pin direction register
OLATB  = 0x15 # Register for outputs

# all bits of IODIRB register are set to 0 meaning GPA pins are outputs
bus.write_byte_data(DEVICE,IODIRB,0x00)

# Set all the pins of Port B of MCP23017 to 0 except pin 3
# pin 3 is set to logic 1 which is given to enable pin of L293D
bus.write_byte_data(DEVICE,OLATB,0x04)

# Function name :forward
# Input : None
# Output : Motor moves in clockwise direction i.e. forward
# Example call: forward()
def forward():
    bus.write_byte_data(DEVICE,OLATB,0b00000101) # one input
                            #to the motor is set to logic high and the
     # other input is set to logic low resulting in clockwise motion
    time.sleep(1)


# Function name :backward
# Input : None
# Output : Motor moves in anticlockwise direction i.e. backward
# Example call: backward()
def backward():
    bus.write_byte_data(DEVICE,OLATB,0b00000110)# one input to the
                                  #motor is set to logic low and the
    # other input is set to logic high resulting in anticlockwise motion
    time.sleep(1)


try:
   while 1:
       forward()     # motor moves in clockwise direction
       time.sleep(2)
```

```
        bus.write_byte_data(DEVICE,OLATB,0b00000100)
                                # halt the motor for 1 second
        time.sleep(1)

        backward()      # motor moves in anticlockwise direction
        time.sleep(2)
        bus.write_byte_data(DEVICE,OLATB,0b00000100)
                                   # halt the motor for 1 second
        time.sleep(1)

except KeyboardInterrupt:
    pass
    bus.write_byte_data(DEVICE,OLATB,0b00000000)
    # Stop the motor by setting all pins to logic 0
```

7 Appendix

7.1 Raspberry Pi 2 Pin-out Diagram



3.3V	1	2	5V
GPIO 2 (I2C1_SDA)	3	4	5V
GPIO 3 (I2C1_SCL)	5	6	GND
GPIO 4 (GPCLK0)	7	8	GPIO 14 (UART_TXD)
GND	9	10	GPIO 15 (UART_RXD)
GPIO 17	11	12	GPIO 18
GPIO 27	13	14	GND
GPIO 22	15	16	GPIO 23
3.3V	17	18	GPIO 24
GPIO 10 (SPI_MOSI)	19	20	GND
GPIO 9 (SPI_MISO)	21	22	GPIO 25
GPIO 11 (SPI_SCLK)	23	24	GPIO 8 (SPI_CE0)
GND	25	26	GPIO 7 (SPI_CE1)
ID_SD	27	28	ID_SC
GPIO 5	29	30	GND
GPIO 6	31	32	GPIO 12
GPIO 13	33	34	GND
GPIO 19	35	36	GPIO 16
GPIO 26	37	37	GPIO 20
GND	39	40	GPIO 21

Figure 4: [4]

7.2 MCP23017 datasheet

http://ww1.microchip.com/downloads/en/DeviceDoc/21952b.pdf

8 References

1. https://en.wikipedia.org/wiki/DC_motor
2. http://playwithrobots.com/dc-motor-driver-circuits/
3. http://www.electronics-tutorials.ws/blog/pulse-width-modulation.html
4. http://data.designspark.info/uploads/images/53bc258dc6c0425cb44870b50ab30621