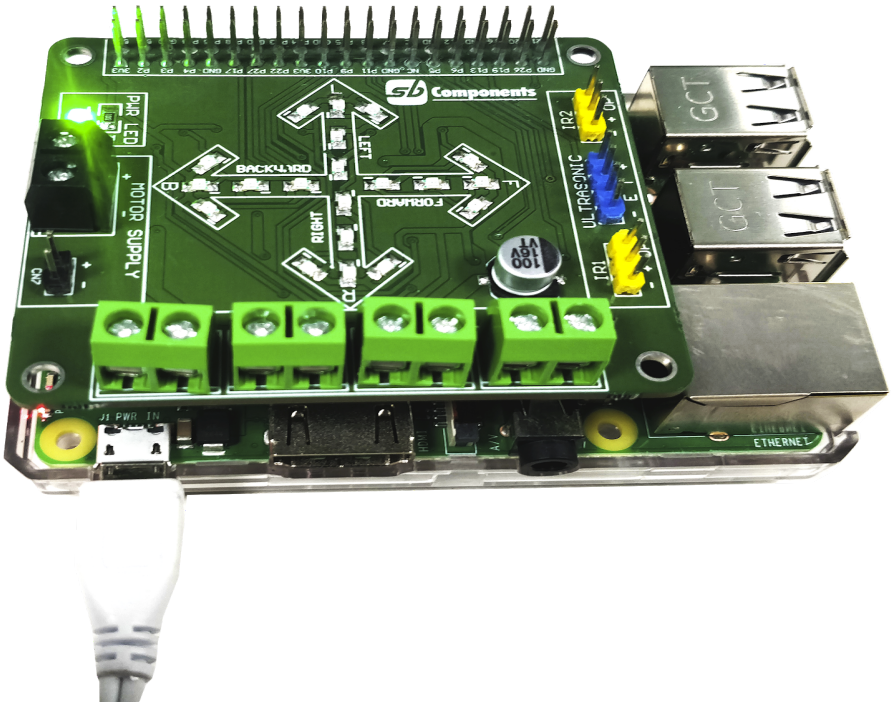
MOTORSHIELD: Motor Driver Shield for Raspberry Pi

User Manual



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GENERAL DESCRIPTION

Before starting any projects on robots or motors you will eventually need to learn about controlling a variety of motors like DC motors, Stepper motors or servo motors. A DC motor requires a current of more than 250mA. One of the most useful ways to control the motor is to interface L293D Motor Driver Shield with Raspberry Pi, it is the easiest way of controlling motors.

The motor shield is an expansion board designed for Raspberry Pi Models to control 4 independent DC Motors or 2 Stepper Motor, 2 IR Sensor and 1 Ultrasonic Sensor. On the shield, you can see a number of LEDs. There is a green power LED and other onboard RGB LEDs are for the direction purpose.

The motor shield is a driver module that allows your Raspberry Pi to control the speed and the direction of the motors. Based on the Dual full-Bridge Drive Chip L293DD, it is able to drive four DC motors or two stepper/servo motors.

1.1 Features and Benefits

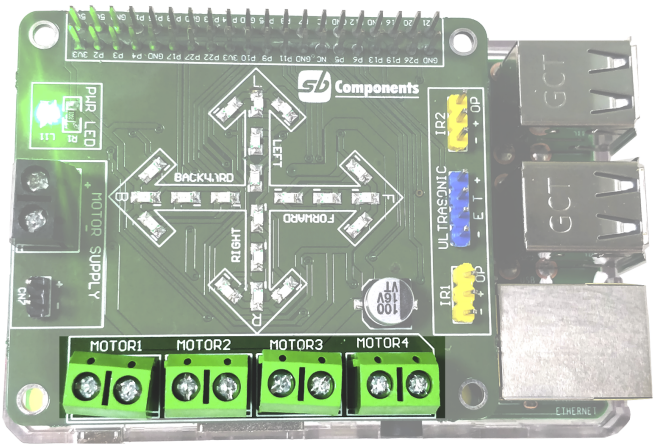
1. Dual H-Bridge IC L293DD.Motor Input Supply Range: 6V – 24V.
2. Single Motor Output Current: 600mA or 1A peak per channel.
3. Onboard Arrow Indicator for motor direction Indication.
4. 2 x IR sensor connectors with 3.3V level output protection.
5. 1 Ultrasonic sensor connector with 3.3V level output protection.

1.2 Functional Description

The Motor Shield has 5 major sections:

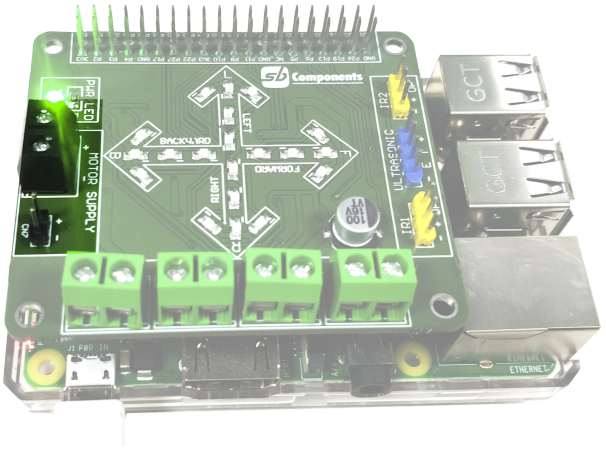
1. Motor Terminals
2. Sensor Interface Terminal
3. Power Pins
4. GPIOs
5. Onboard LEDs

MOTOR TERMINALS



There are four screw terminals to connect 4 DC Motors or 2 Stepper Motors. You can connect each motor independently with the same voltage all the terminals.

POWER PINS

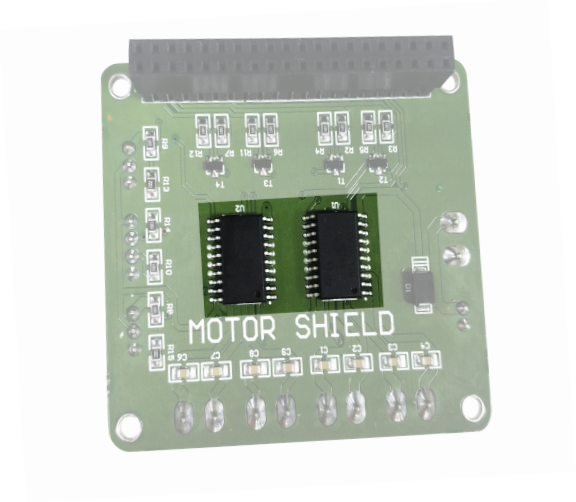


The motor shield can be powered by an external 6V~24V power supply via terminal input. The Pi provides the supply of 5V to the shield, but each motor needs (6~12 V) itself individually so the supply is provided to each motor separately via 4 pairs of screw terminals on the motor shield. To power-up, you can either use the screw terminal or the male power headers. The shield is polarity protected but still, you can check the polarity of wires before the connection also the terminal polarity is mentioned on the shield.

NOTE: The shield doesn't provide power to your Pi so use a separate supply for the Pi.

Also, 0.1 uF capacitors are fitted all over the motor outputs and a 100 uF capacitor on the 6-24 V motor shield.

L293DD



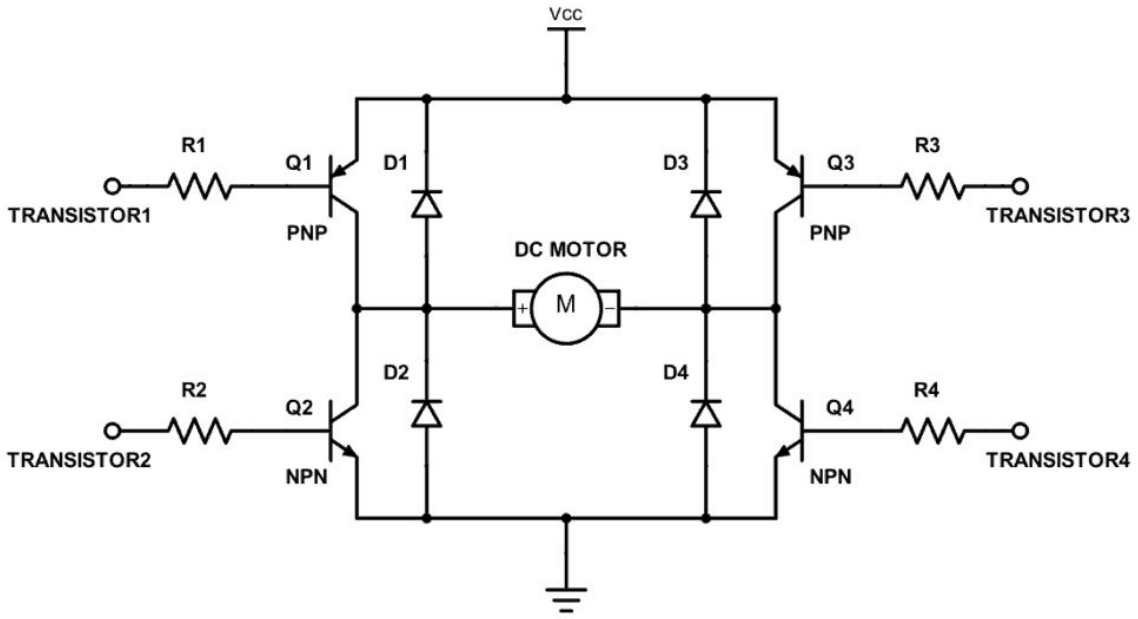
The L293DD is a dual-channel H-Bridge motor driver capable of driving a pair of DC motors or single stepper motor. Let's have a look at the difference between L293D and L293DD. L293D is assembled in a 16 lead plastic package which has 4 centre pins connected together and used for heatsinking. The L293DD is assembled in a 20 lead surface mount which has 8 centre pins connected together and used for heatsinking.

Why we require a motor driver or shield to drive motors?

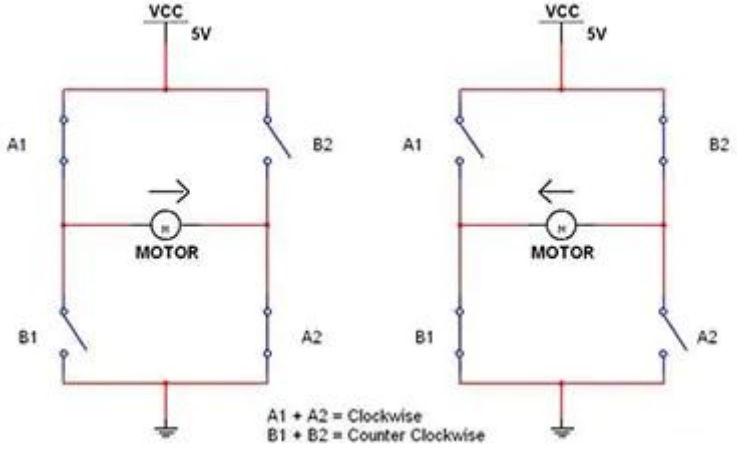
Let's figure out its answer.

The digital output of your controller or Raspberry Pi is not enough to drive the motors. So, we need some external voltage source and also we need a switch in between the motor and the external voltage. But when the switch is closed there will be a huge voltage difference which can lead to sparks in the circuit and to prevent this a flyback diode (SS34 Diode) is used. SS34 is a surface mount High Power Schottky Rectifier with a Low voltage drop of 0.5V and a high forward current of 3A. This diode has high efficiency and high surge current capability of 100A. It is commonly used in freewheeling, DC/DC converter and reverse polarity protection applications. Flyback diode enforces voltage across it once the switch is open.

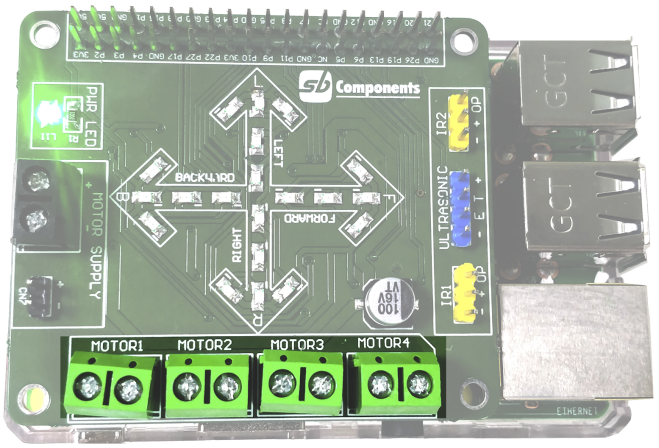
The shield comes with two L293DD motor driver chipset which you can find on the backside of the shield, that means it can individually drive up to four DC motors making it ideal for building four-wheel robot platforms.



The shield offers a total of 4 H-Bridges and each H-bridge can deliver up to 0.6A to the motor. An H bridge is an electronic circuit that allows a voltage to be applied across a load in any direction. H-bridge circuits are frequently used in robotics and many other applications to allow DC motors to run forward & backwards. These motor control circuits are mostly used in different converters like DC-DC, DC-AC, AC-AC converters and many other types of power electronic converters. In specific, a bipolar stepper motor is always driven by a motor controller having two H-bridges.

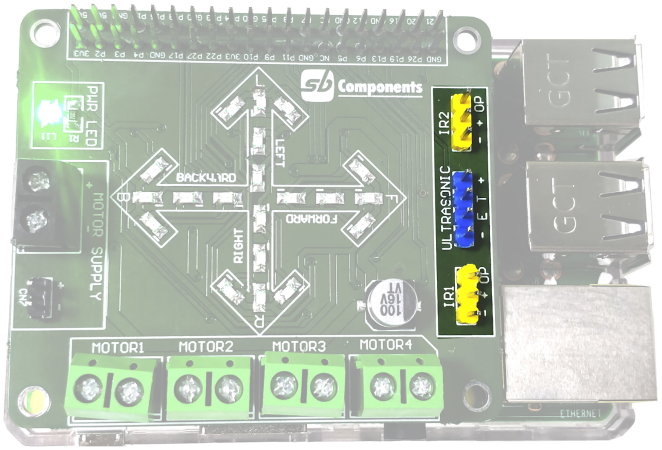


MOTOR TERMINALS



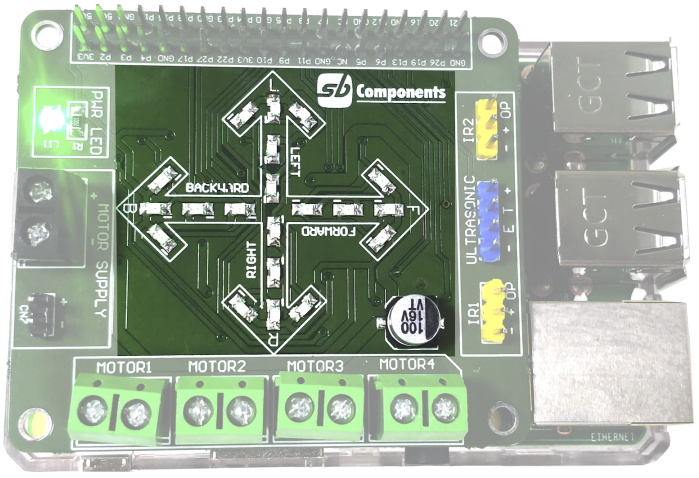
There are four screw terminals to connect 4 DC Motors or 2 Stepper Motors. You can connect each motor independently with the same voltage all the terminals.

SENSOR INTERFACE HEADERS



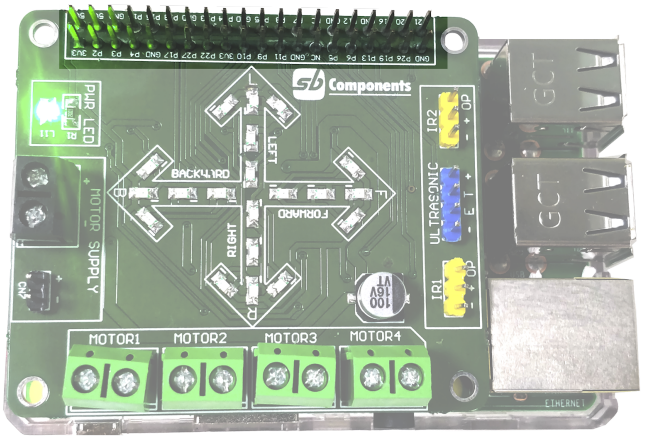
Also, the shield comes with two 3-pin connection IR sensors with pins 5V, GND and input. In addition, there is an input for an Ultrasonic distance measuring sensor, comprising a 4 pin connection, ie 5V, GND, Trigger, and Echo. These sensors have 3.3V level output protection. The shield has resistive dividers to reduce the 5V signal from each of the sensors to 3.3V and thereby no need of any external potential divider is required while using sensors.

ONBOARD LEDs



To indicate which motor is in action there are 4 directions arrows mounted on the shield. Each arrow consists of 5 LEDs driven by a BC817 transistor. These can be very useful while testing codes and projects. There is also a green power LED at the left side of the power headers which indicates that the Pi is powered up.

GPIOs

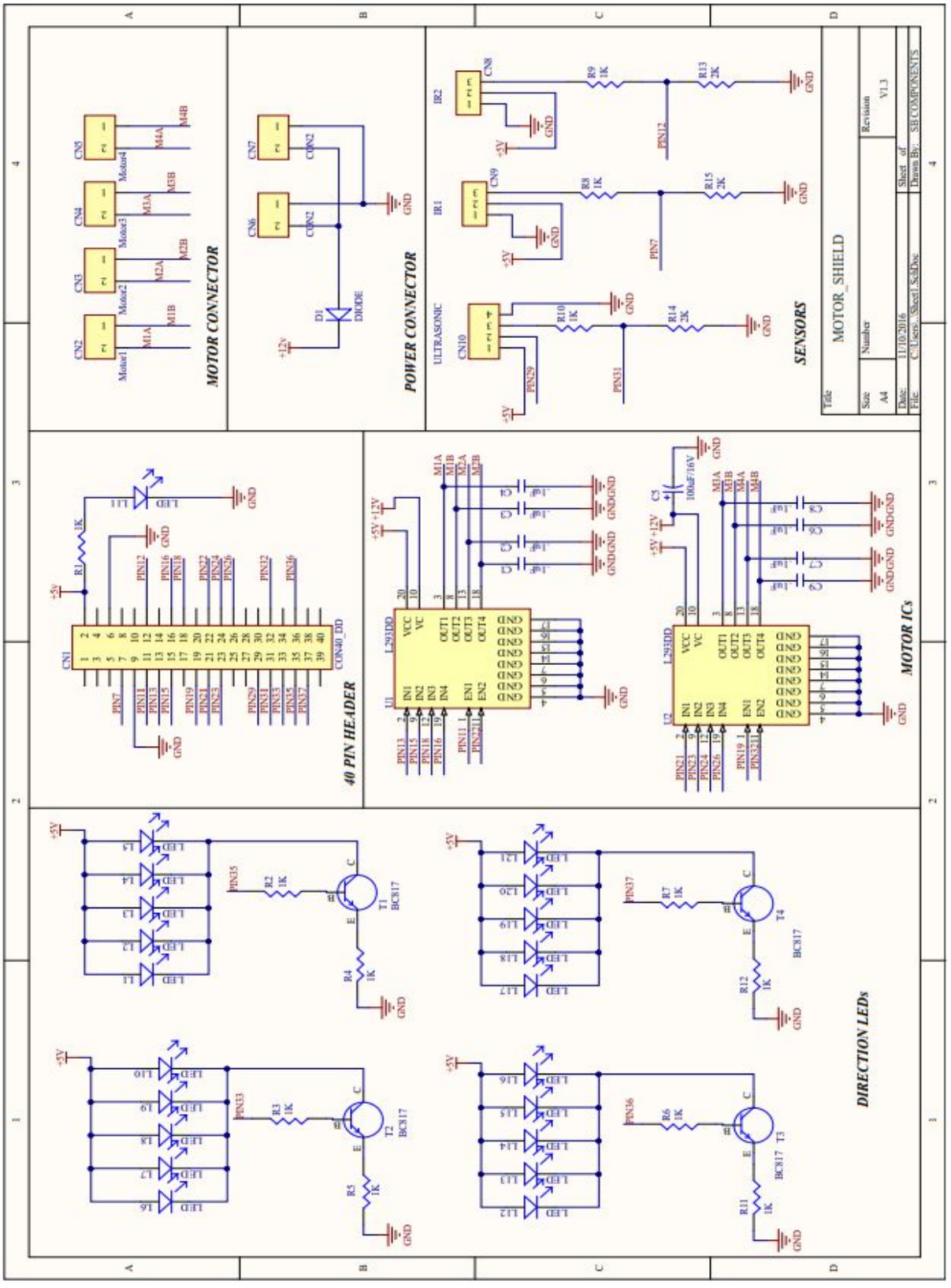


The GPIOs pins are also provided on the shield so that you also connect devices using these pins. Also in case your any ports or terminal doesn't work you can cross-check through these or use pins only. The ports are connected with GPIO pins. You can check the pin description for further information.

Pin Description

S. No.	MOTORS/ SENSOR	PINS
1.	DC Motor 1	Enable - 11 Control - 13, 15
2.	DC Motor 2	Enable - 22 Control - 16, 18
3.	DC Motor 3	Enable - 19 Control - 21, 23
4.	DC Motor 4	Enable - 32 Control - 13, 15
5.	Stepper Motor 1	Enable - 11, 22 Control - 13, 15, 18, 16
6.	Stepper Motor 2	Enable - 19, 32 Control - 21, 23, 24, 26
7.	IR 1	Echo=7
8.	IR 2	Echo=12
9.	Ultrasonic Sensor	Trigger=29, Echo=31

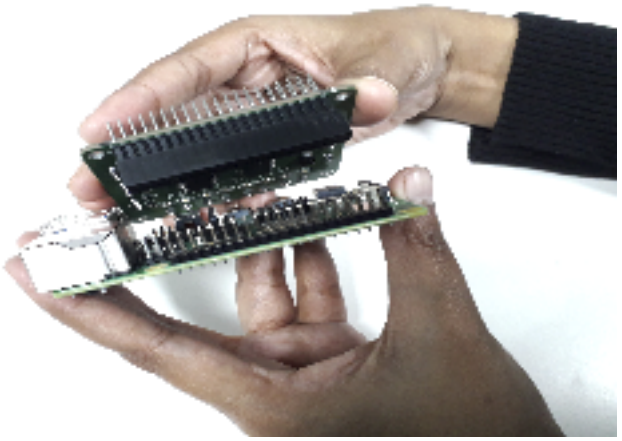
Motorshield Schematic



How to use Motorshield

CONNECTION

1. **Mounting the Motor-shield**



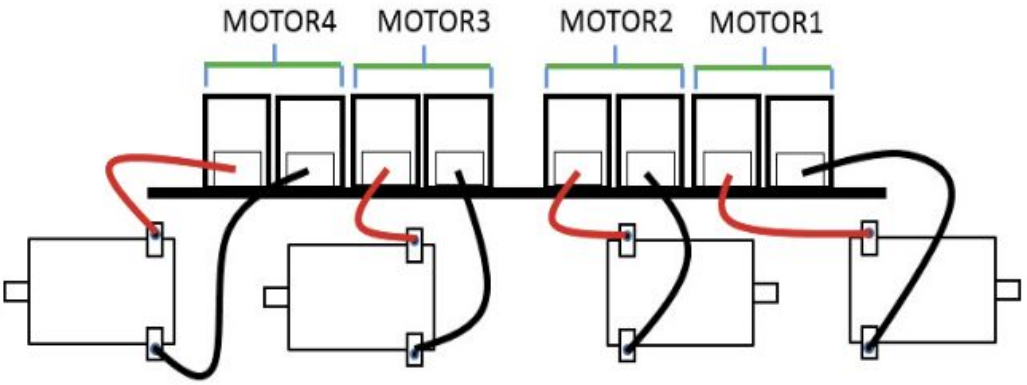
To attach the Motorshield to the Raspberry Pi simply push the GPIO pin connectors on the underside of the Motor-shield onto the GPIO pins of the Raspberry Pi.
Be careful to ensure that all of the pins are correctly seated and the Motor shield over-lays the Raspberry Pi.

2. **Powering your Motor-shield**

The motorshield can draw power from the Raspberry Pi but not enough to power motors when loaded with the chassis of your robot. For testing your robot program however the Pi can provide enough to power the LEDs.
To provide power for 4 motors you will need a supply of 6V to 24V with at least 1500mAH. For 2 motors power requirements are obviously less and you can use 4 x AA batteries, although these will drain quickly. Give power either by the screw terminal or through the power header. After the complete connection only, turn ON the power supply.

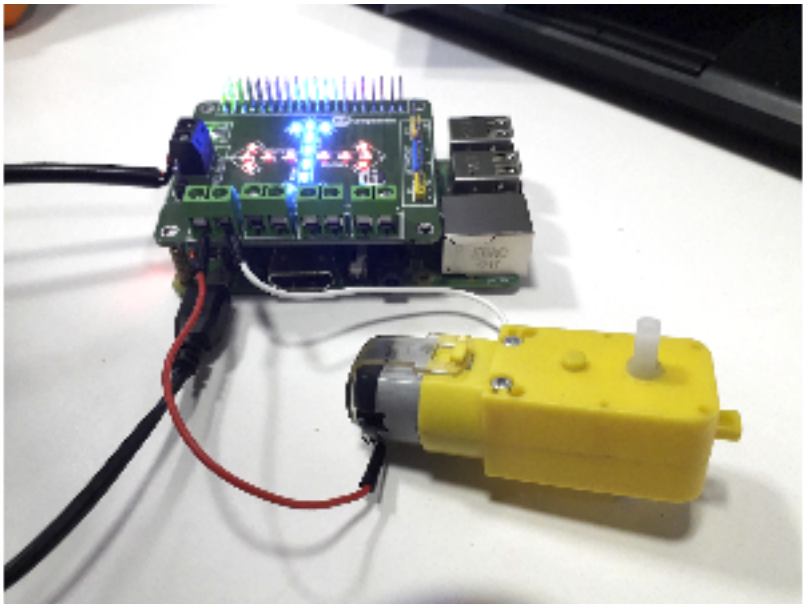
3. **Connecting motors to the shield**

Connect each motor to a single pair of labelled motor terminals on the Motorshield (one terminal of the motor to one terminal on the Motorshield) via screw motor terminal.



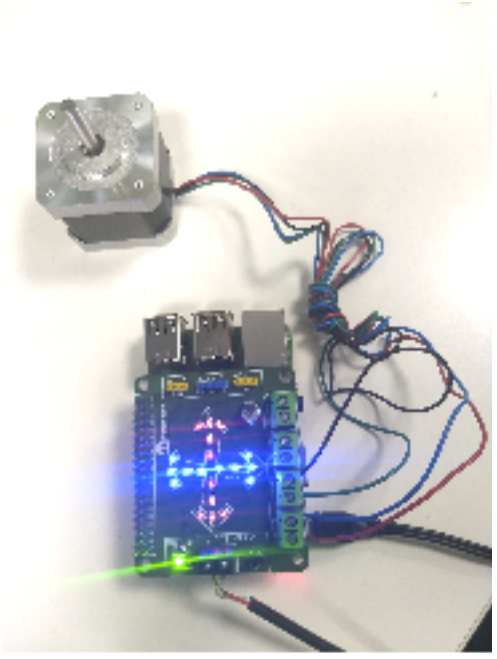
Connecting DC Motor to the Shield

We can connect 4 independent DC Motor on the motor shield of range voltage 7V-12V. The DC motor only has two wires for a connection unlike Stepper Motor so all we have to do is connect the wires into the screw terminals. As each motor wired up to a chassis tends to be reversed in the direction it points it can be very confusing to get the wires connected in the correct order to make both go “forward”. Therefore proper connection and configuration are very much needed. Before connecting the wires check the polarity with the multimeter once or you can also check the polarity by running our example codes of forward and reverse movements.



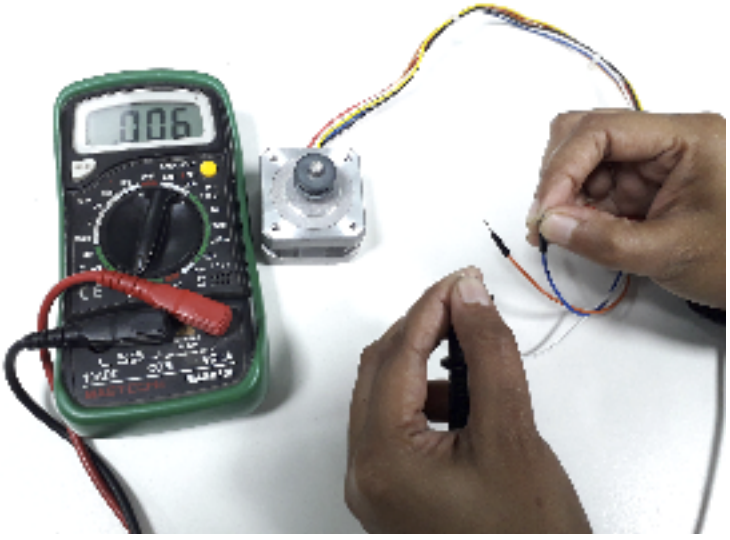
Connecting Stepper Motor to the Motorshield

We'll find out in this section how to make the connection between the motor and Raspberry Pi using the Motor shield. First, we have to find the common wire which can be done by using a multimeter. Let's see how to find it out.



6 Wire Motor

The 6 wire stepper motor can be used as a unipolar motor or as a bipolar motor and has four coil end wires with two centre trap wires. The motor has two coils with three wires each and out of the three wires, one is a common centre trap wire. The centre trap wires have less or half resistance than other coil end wires. The way that we can determine which wire is this, is by measuring the resistance and the resistance from one of the centre wires to one of the other wires on the same coil will be much less as compared to the other pairs. If two wires are not on the same coil, you will measure an open circuit.



This following table is the resistance measurement of 6 wire motor:

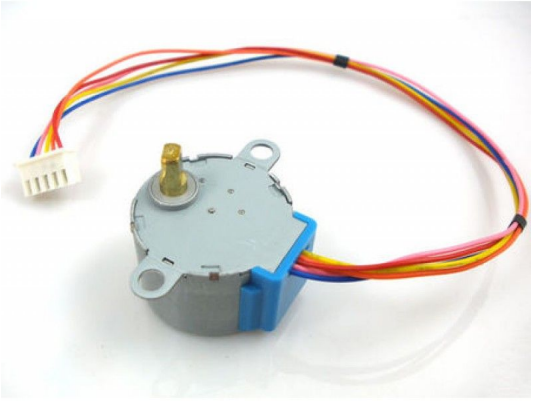
Wires	YELLOW	BLACK	RED
YELLOW	-	0.006	0.012
BLACK	0.006	-	0.006
RED	-	0.006	0.012

Wires	ORANGE	WHITE	BLUE
ORANGE	-	0.006	0.012
WHITE	0.006	-	0.006
BLUE	0.012	-	0.006

From the above tables, you can easily figure out that the black and white wires are of less resistance or half the resistance as compared with the other wires. It concludes that the black and white wires are the central trap wires. For unipolar driver, we have to use all 6 wires and for a bipolar driver, use one coil end wire and one centre tap of each windings.

5 Wire Motor

The 5 wire stepper motor is a unipolar motor has four coil end wires and one centre trap wire. It is same as 6 wire stepper motor but the center trap wires are connected together internally. This makes it impossible to work as a bipolar motor. To find the centre trap wire we need to measure the resistance of the wires like we did for 6 wire the procedure will be the same. The resistance of the coil end wires will be equal in resistance while the centre trap wire is half of the resistance of coil end wires. In the end, arrange the wires in the correct sequence because the wrong sequence can cause step back and forth.



4 Wire Motor

The 4 wire stepper motor can be driven in bipolar mode and each phase has only one winding. Each winding has two wires. To check the wires sequence we need to measure the resistance of all the wires. There are two coils with two wires each. Measure the resistance and if there's a reading on the Multimeter then the wires are part of the same coil and if there is no reading this means the wires are of the different coil. Arrange the wires in the correct sequence now because the wrong sequence can cause step back and forth.

DOWNLOADING AND INSTALLING

After the connection of motors with the shield, here comes the software part. To control the motors, we must use the library of MOTORSHIELD. From our GitHub you can get the library and the required codes to run your motors, also full documentation is provided there. We also have provided some example codes to test the motors and the basic forward, reverse and stop movements. To get those code files and other documents copy the following command in your raspberry Pi terminal :

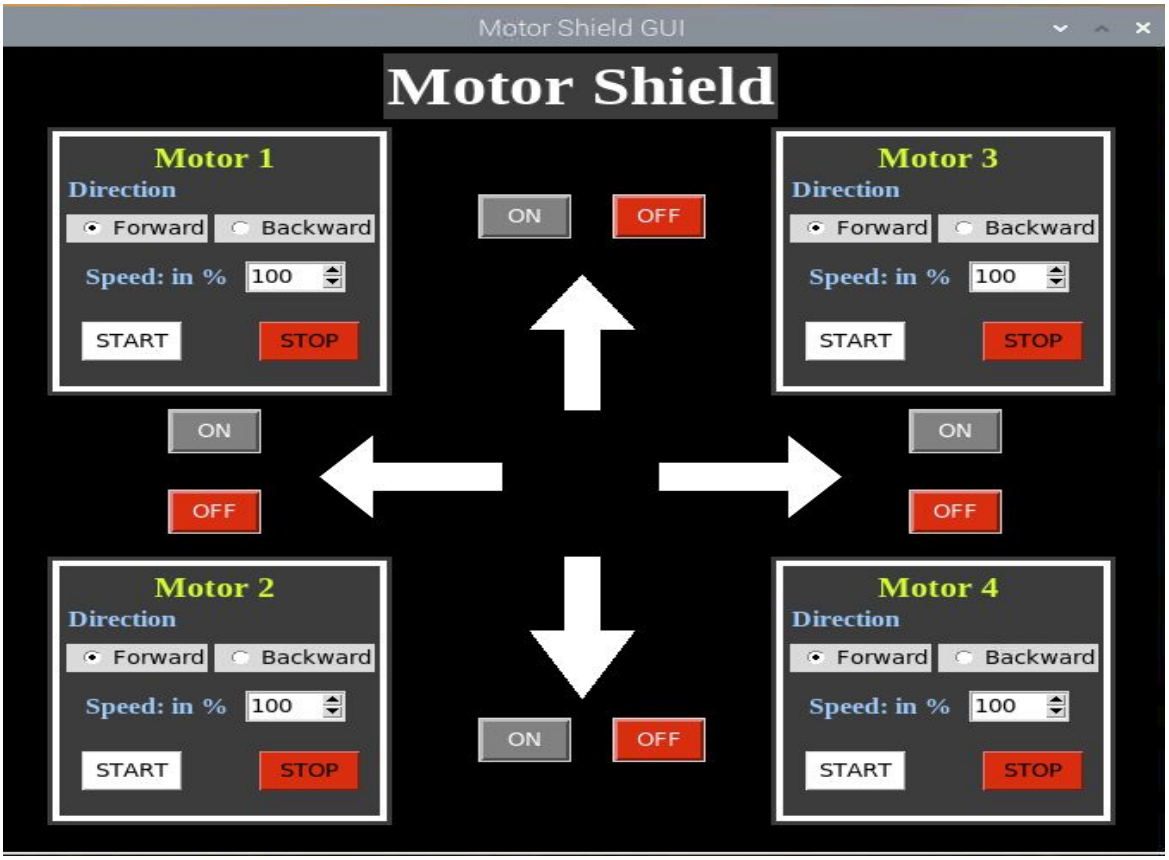
git clone https://github.com/sbcshop/MotorShield.git

This command will clone the motorshield directory in your Raspberry Pi. The files will be downloaded in the '/home/pi' directory. You can confirm the cloning by using 'ls' command in your terminal. As soon as the download is completed you can access the example codes and the PiMotor

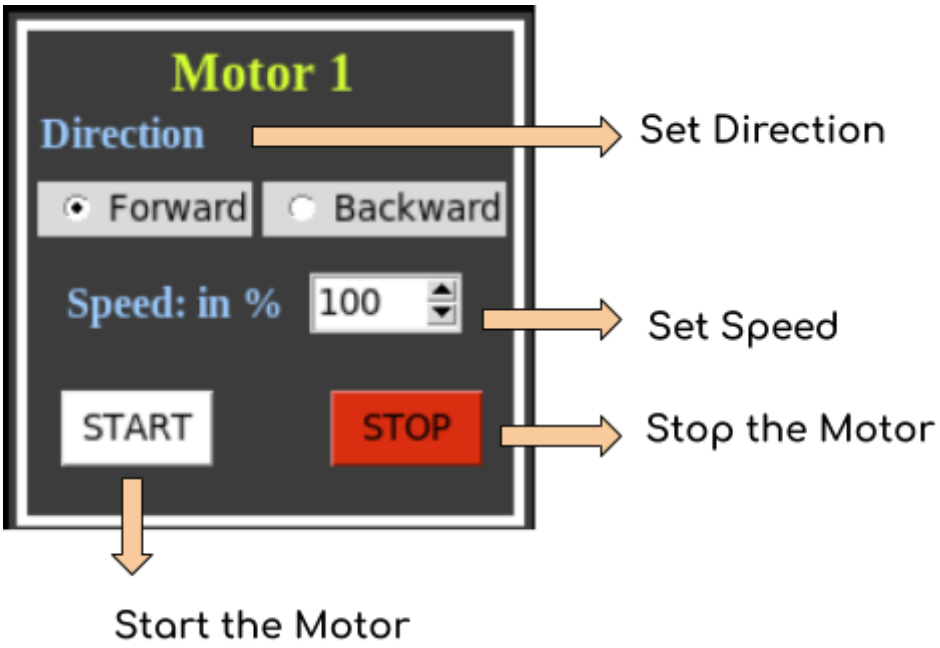
In the Motorshield directory, you will find the test code of the motors. The test code of DC motor is Test_Motor.py file, run it into IDLE3 or in MU editor or any other python editor.

For stepper motor the test code Stepper_Test.py is there. Run the code in any python editor you want.

Controlling through GUI



- GUI for Controlling Motors using Motorshield
- Control 4 DC motors with Direction controlling
- User can also control the Speed of each Motor
  1. Set the direction (i.e. Forward or Backward) and speed of Motor. Adjust the Speed in percentage i.e. 10 – 100%.
  2. Click the START button to start the Motor.



- You can ON/OFF the direction LED also as per the direction of Motor or Robot.
- You can set all 4 motors at a different speed and direction.