

# DCMOTOR\_PWM -- Overview

## DC Motor Speed Control Using PWM



## OBJECTIVES

After performing this lab exercise, learner will be able to:

- Program Arduino board to generate the PWM signals using Arduino UNO Board
- Interface DC motors using H-bridge circuit
- Control the speed of a 12V DC motor using PWM duty cycle

## EQUIPMENT

To carry out this experiment, you will need:

- 12 V 500rpm DC Motor
- H - Bridge
- ARDUINO Uno board
- Micro IR Sensor
- Resistor
- TBS1KB - Digital Oscilloscope from Tektronix
- Voltage probe (provided with oscilloscope) / BNC cables
- Breadboard and connecting wires

## THEORY

- PWM control is a very commonly used method for controlling the power across loads. This method is very easy to implement and has high efficiency.
- PWM signal is essentially a high frequency square wave (typically greater than 1KHz). The duty cycle of this square wave is varied in order to vary the power supplied to the load.
- Duty cycle is usually stated in percentage and it can be expressed using the equation :

$$\% \text{ Duty cycle} = 100 \times T_{\text{ON}} / (T_{\text{ON}} + T_{\text{OFF}})$$

Where  $T_{\text{ON}}$  is the time for which the square wave is high and  $T_{\text{OFF}}$  is the time for which the square wave is low

- When duty cycle is increased the power delivered to the load increases and when duty cycle is reduced, power across the load decreases.
- Control signal is what we give to the PWM controller as the

input. It might be an analog or digital signal according to the design of the PWM controller. The control signal contains information on how much power has to be applied to the load. The PWM controller accepts the control signal and adjusts the duty cycle of the PWM signal according to the requirements.

- The digital pins of the Arduino can provide the current of only up to 40 mA and hence cannot drive the motor directly. For fixing this problem, the L293D motor driver H-Bridge circuit is used to drive the motor according to the PWM signal available at digital pins.

## Measurement of motor speed using Magnetic Read Switch

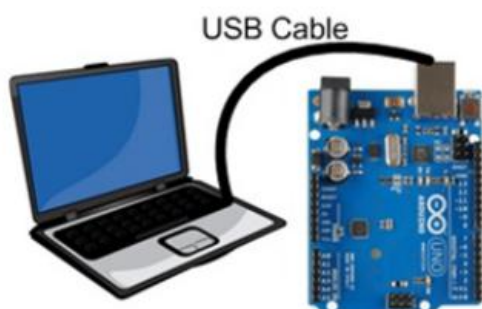
- The reed switch is an electrical operated switch by an applied external magnetic field.
- There are two contacts and it is kept open initially. If we apply external magnetic field nearby the contacts, then it gets closed. By using this principle, we have measured the speed of motor.
- Initially we have attached the robotic wheel in the shaft of motor and we have attached one small neodymium magnet in the outer surface of wheel. So, whenever the magnet comes near to the read switch, it gets closed and the signal has passed to the analog input of Arduino. We have measured the speed according to the time taken by one complete rotation of the wheel.

## DCMOTOR\_PWM -- Procedures

### Step 1

### DUT / CIRCUIT SETUP

- Ensure you have Arduino IDE (software to program the Arduino board) installed on your computer.
- Connect the Arduino board to PC using USB cable

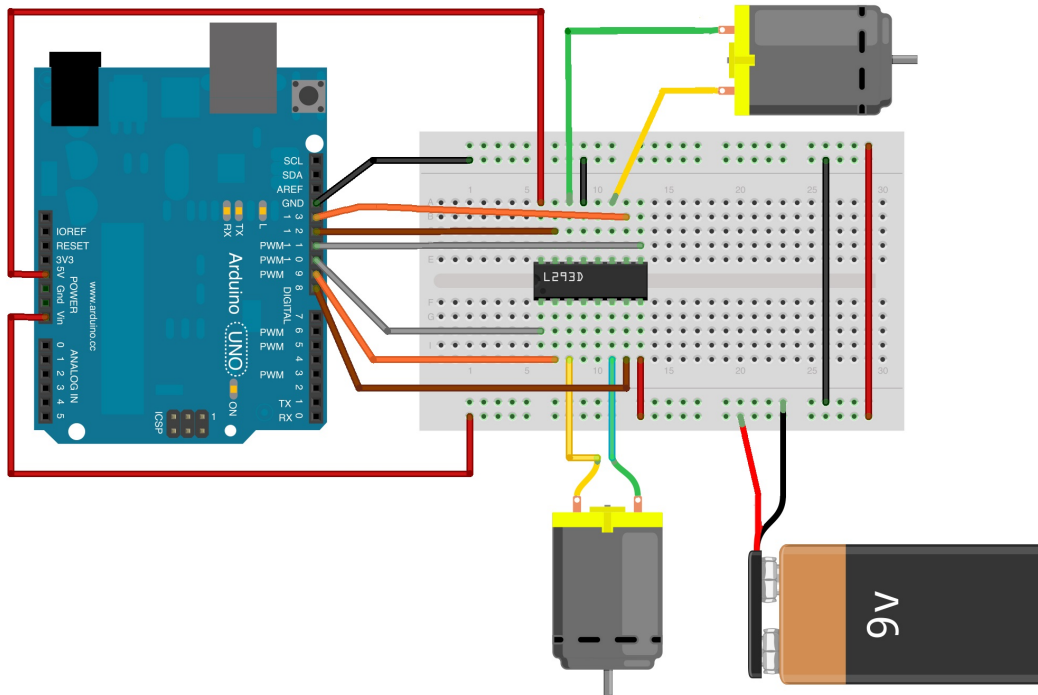


- Program the Arduino board with code

### Step 2

## DUT / CIRCUIT SETUP

- Build the circuit connection as given below:



### Step 3

- Power ON the oscilloscope
- Connect the Channel 1 probe and Channel 2 probe of the oscilloscope at the PWM output pin and ground pin of ARDUINO respectively.

### Step 4

- Do the Autoset on the scope to efficiently capture and view the signal
- If AUTOSSET feature is not enabled, then manually set the horizontal and vertical scale, and trigger condition to view waveform without any clipping

### Step 5

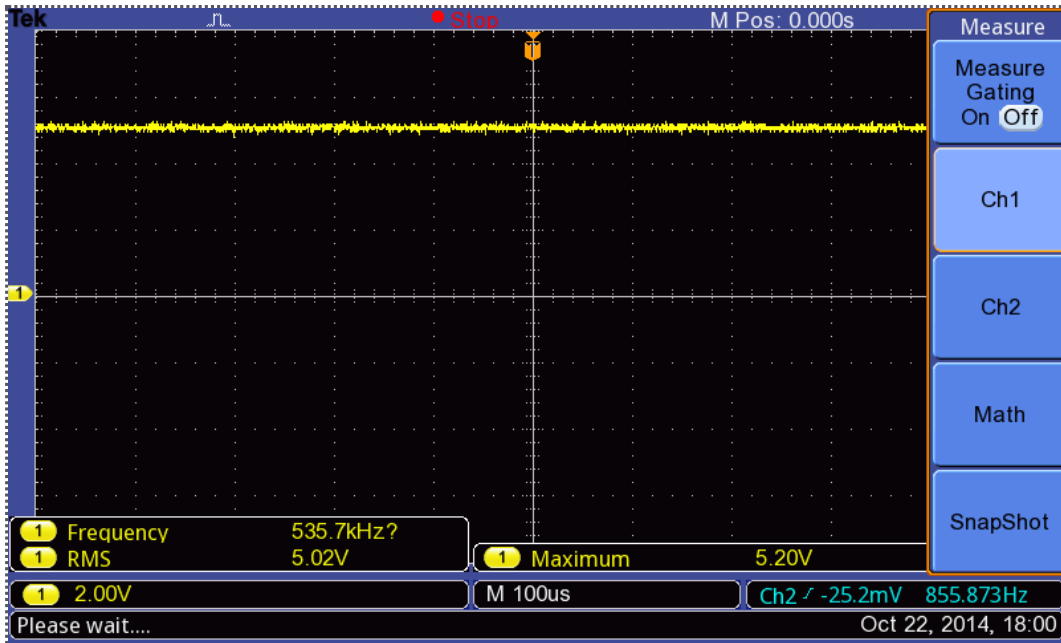
- Acquire the signal(s) from circuit on oscilloscope for different PWM pulses (say 25%, 50%, 75% & 100% duty cycle)

### Step 6

## OUTPUT WAVEFORM

The output waveform would look like,

100 % PWM duty cycle:



## Step 7

### RESULT

- Thus the design, construction and testing of the speed control of DC motor controlled by ARDUINO is completed successfully. The waveforms of the output voltage at different time delays were taken from the DSO.
- Relation between the PWM input and the speed of the motor is given in table below.

PWM Duty cycle	Motor speed (rpm)
100%	500
75%	375
50%	250
25%	125