T. Y. B. Tech (Electrical and Computer Engineering)

Trimester: V **Subject: Microcontroller and Applications**
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Roll No: 52 **Batch: A3**

Experiment No: 07

Name of the Experiment: Generation of PWM using C8051F340 to control speed of DC motor
Performed on: 28/11/2023

Submitted on: 07/12/2023

Marks	Teacher's Signature with date

Aim: Write C program to generation PWM using C8051F340 to control speed of DC motor

Apparatus: EPBF340 board, DSO, DSO probes, DC motor

Theory:

DC Motors: A direct current (DC) motor is widely used device that translate electrical pulses into mechanical movement. In the DC motor we have only + and _ leads. Connecting them to a DC voltage source moves the motor in one direction . By reversing the polarity, the DC motor will move in the opposite direction.

Unidirectional control:

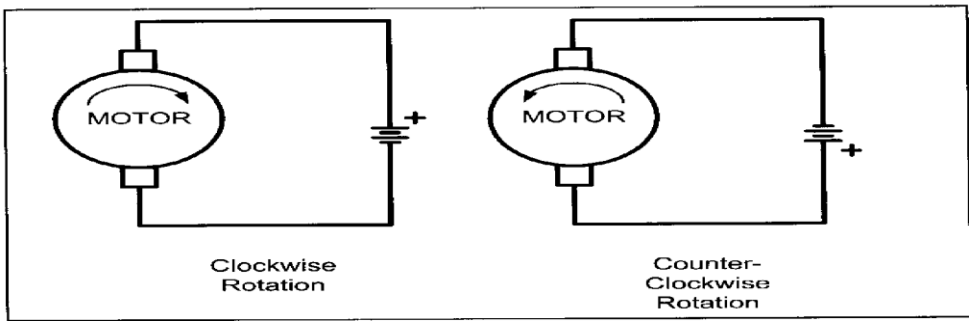

Figure 7.1: Unidirectional control of DC motor

Pulse Width Modulation (PWM):

The speed of motor depends on the three factors: i) load, ii) voltage, and iii) current. For a given fixed load we can maintain the steady speed by using a method called pulse width modulation (PWM). By changing (modulating) the width of the pulse applied to DC motor we can increase

or decrease the amount of power provided to the motor , thereby increasing or decreasing the motor speed. Notice that although the voltage has a fixed amplitude, it has a variable duty cycle.

PWM generation in C8051F340:

The Programmable Counter Array (PCA0) provides enhanced timer functionality. The PCA consists of a dedicated 16-bit counter/timer and five 16-bit capture/compare modules. Each module can be used independently to generate a pulse width modulated (PWM) output on its associated CEXn pin. The frequency of the output is dependent on the timebase for the PCA counter/timer. The duty cycle of the PWM output signal is varied using the module's PCA0CPLn capture/compare register.

Interfacing Diagram:

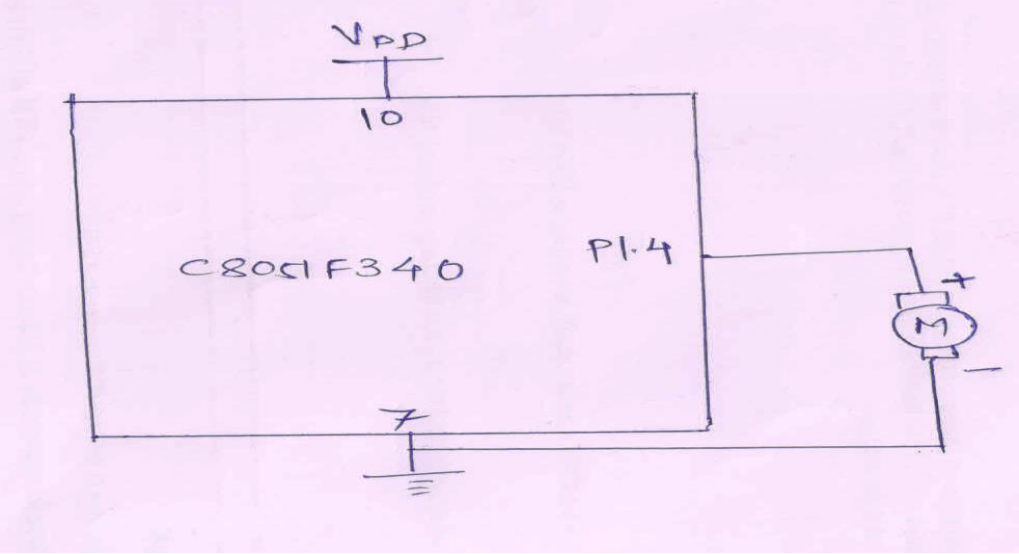

Figure 7.2 Interfacing Diagram of DC motor with C8051F340

Calculations of duty cycle: *DutyCycle = (*256-*PCA0CPHn)/256*

Hardware Connections: Output is available on Port pin P1.4. Observe waveform at pin no. 5 of PL3 connector of EPBF340 board with respect to ground on DSO/CRO. After this, connect DC motor between the same pin.

Program: Attach printout of the tested code.

Calculations:

Find the value to be loaded in PCA0L for generating the PWM waveform of following frequencies and duty cycle: Consider System clock = 12 MHz

Desired Frequency and Duty cycle	PCA0L	PCA0CPH0
60KHz - 50%		
100KHz - 25%		
140KHz - 75%		

Result:

The duty cycle of the PWM waveform should be observed on DSO/CRO.

OR

DC Motor should run with speed varying w.r.t the change in value of PWM.

Conclusion:

Study Question:

1. Define duty cycle.
2. Write the steps to program PCA to generate PWM
3. Write down the equations for the frequency and duty cycle of PWM in C8051F340

Code for PWM using C8051F340:

```
// Exp - 7 Generation of PWM using C8051F340 to control speed of DC motor
/*
Name: Shreerang Mhatre
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Class: TY

*/

#include "c8051f340.h"
#define SYSCLK 3000000
void main(){
    PCA0L=0x10;
    OSCICN=0x83;
    CLKSEL=0x00;
    XBR1=0x41;
    P2MDOUT=0x08;
    P0SKIP=0xff;
    P1SKIP=0xff;
    P2SKIP=0x07;
    while(1){
        PCA0MD=0x02;
        PCA0CPM0=0x42;
        PCA0CPH0=(256-(256*0.75));
        CR=1;
    }
}
```
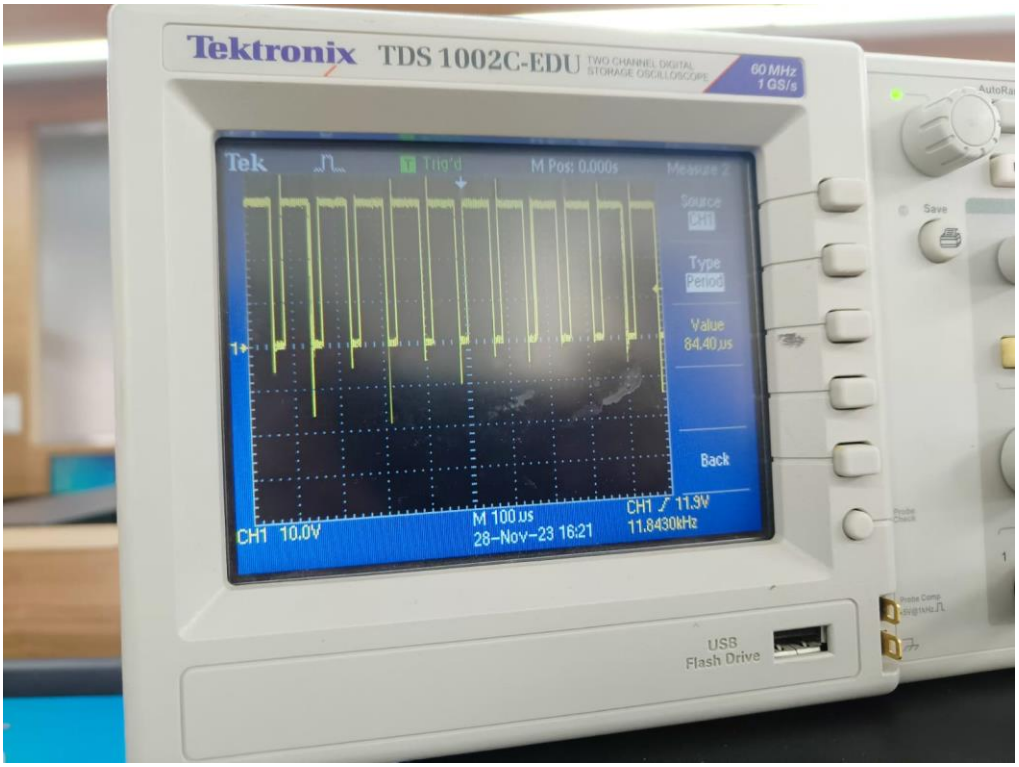

Output:


Tektronix TDS 1002C-EDU
60 MHz 1 GS/s
Tek
M Pos: 0.000s
Source CH1
Type Period
Value 84.40 µs
Back
CH1 10.0V
M 100 µs
28-Nov-23 16:21
CH1 11.9V
11.8430kHz
USB Flash Drive

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```
#include<C8051F340.h>
#define SYSCLK 3000000
void () {
    PCAOL= 0x10;
    OSCICN = 0x83;
    CLKSEL = 0x00;
    XBR1 = 0x41;
    P2MDOUT = 0x08;
    P0SKIP = 0xff;
    P1SKIP = 0xFF;
    P2SKIP = 0x07;
    while (1){
        PCA0MD = 0x02;
        PCA0CPM0 =0x42;
        PCA0CPH0 = (256 - (256 * 0.75));
        CR =1;
    }
}
```

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	Time Base	Duty Cycle (DC)	Time Period Measured on DSO	Time period calculated PCA0L=0x10	PCA0CPH0 = 256 − (256 * DC)
①	SysClk	25%	21.12μs	20 μSec	192
	PCA0MD	50%	21.10μs	20 μSec	128
	=0x08	75%	21.11μs	20 μSec	64
②	SYSCLK/12	25%	253.2μs	240 μSec	192
	PCA0MD	50%	253.2μs	240 μSec	128
	=0x00	75%	253.2μs	240 μSec	64
③	SYSCLK/4	25%	84.37μs	84.37μs	192
	PCA0MD	50%	84.40μs	84.32μs	128
	=0x02	75%	84.40μs	84.37μs	64

Time Period = (256 − PCA0L) * Time for clk cycle

(256 − PCA0L) × 1μSec

240 × 1 μSec

240 μSec

240 × 0.33 μSec

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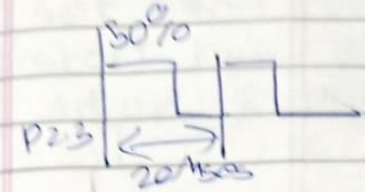
3) Write an embedded C program for generation of PWM wave form with a frequency of 20 ms & duty cycle of 50% on pin 2.3



Sys Clk = 12MHz

1Clk cyc = $\frac{1}{12MHz}$

= 83.3nsec

count = $\frac{70\,msec}{83.3\,nsec}$

= 240

value = 256 − 240

P(A0)L = 16 = $(10)_H$

① count = $\frac{60kHz}{83.3nHz} = \frac{0.016 \times 10^{-3}}{83.3 \times 10^{-9}}$

value = 256 − 192 = ~~64 d~~ $(57)_d = (39)_H$

= ~~220 0480~~

② Time period = $\frac{1}{100 \times 10^3} = 0.01\,ms$

count = $\frac{0.01\,ms}{83.3\,ns} = 120$

value = 256 − 120 = $(136)_d = (88)_H$

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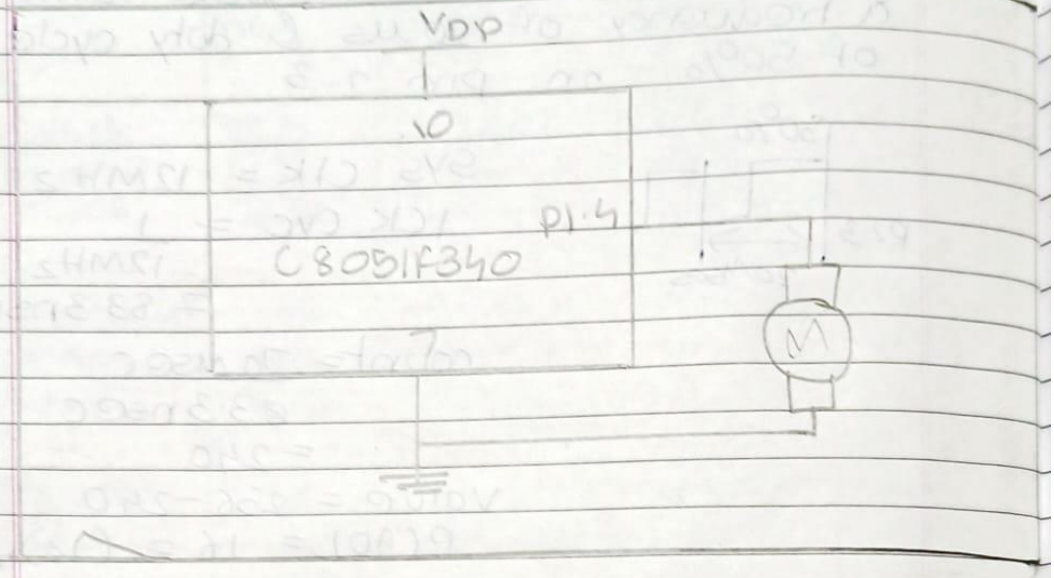
* Interfacing Diagram



* Post lab Questions

Q1) Define Duty cycle -

-> Duty cycle is a measure used in electronics and engineering to describe the ratio of time of a system, device or component is active (on) compared to the total time of its operation. It is often expressed as a percentage and represents the portion of the total time that a system spends in an active state.

->

Q2) write the steps to program PCA to generate PWM.

→ ① Initialize PCA module.
② Set PWM Period and Duty Cycle
③ Start the PCA Module.
④ Adjust PWM Parameters as Needed

Q3) write down the equations for the freqency and duty cycle of PWM in C8051f340.

→

Freqency:

$$F_{PWM} = \frac{SYSCLK}{PCA\ Counter \times (2^{16} - PCA\ Module\ 0\ High\ Byte \times 256 + PCA\ Module\ 0\ Low\ Byte)}$$

Duty Cycle:

$$Duty\_Cycle = \frac{PCA\ Module\ 0\ High\ Byte \times 256 + PCA\ Module\ 0\ Low\ Byte}{2^{16}}$$