Design and Implementation of PWM Signal Generator

Abstract—**This document gives information regarding implementation of PWM Signal Generator. The concept of the PWM Signal is nothing new. PWM Signal is a very commonly used signal in digital electronics for control circuitry. The design of PWM Signal Generator is based on using PIC16F877A on a breadboard. The PWM signal frequency is 5Khz and the duty cycle is from 0% to 100%**

Keywords— **PIC PIC16F877A: Resistor: Capacitor: Breadboard: Potentiometer: CCP1CON Register:**

I. INTRODUCTION

PWM is basically a modulation technique by which variable width pulses can be generated for representing the amplitude value of analog voltage signals. PWM signal can be used to control the power delivered to a specific load. Usually rheostat can control the power . It is connected in series but it has a disadvantage. The power loss is quite large. In order to control the power and avoid power loss PWM signal is used. It can control the power which will be delivered to the load. It can also be used in efficient voltage regulators. A desired level of output voltage can be generated using PWM Signals. PWM techniques can be used to soft blink some indicators. The light will be seen slowly transitioning from state to full intensity, and vice versa. Then it repeats the whole cycle [1].

The design of PWM Signal generator is based on microcontroller PIC16F877A IC on a breadboard. PWM Signal will be generated from compare capture module. This system will detect PWM signal which has many applications. The generated PWM Signal can be used as required. [2].

II. METHODOLOGY

The project was implemented using the microcontroller PIC16F877A IC and the full method will be discussed here. The capacitor used along the crystal oscillator will cause parallel resonance which will ensure maximum current at maximum frequency.

$$\text{Resonant Frequency} = \frac{1}{2\pi\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}} \quad (1)$$

Implementation Setup

The PWM Signal Generator in this project is based on PIC16F877A IC implemented on a breadboard. This system will generate PWM Signal from the compare capture module.The generated signal has a frequency of 5 Khz and a duty cycle which is variable. The range is from 0% to 100%. The variable duty cycle is created with the help of a potentiometer which provides analog voltage to the circuit. Basically an analog voltage of 0 to 5 V is provided in the circuit using potentiometer. The voltage is then converted from 0 to 1024 using the ADC module of the micro controller. This 0 to 1024 results in 0% duty cycle and 100% duty cycle. The generated frequency of the signal is 5Khz

Required components are:

- PIC16F877A IC
- BreadBoard
- 1K Potentiometer
- LED
- 20 Mhz Crystal Oscillator
- Resistors 1 x 10K
- Capacitors 1 x 10 uf , 2 x 22 pF
- Few Breadboard Connectors
- 9V Power Supply

Circuit Diagram

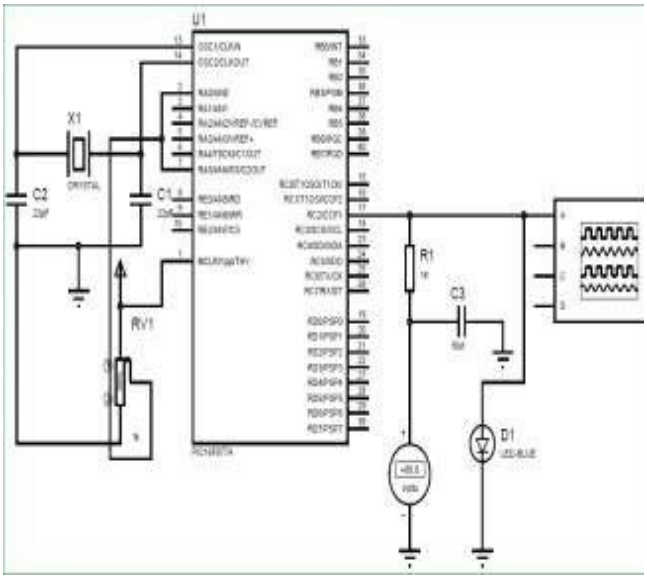

Figure 1: Circuit Diagram for PWM Signal generator

Described Steps:

1. PWM signals is generated in the microcontroller by the compare capture module. The 40 pin micro controller is used instead of the 28 pin because the 28 pin controller doesn't have the capture module. The PWM signal resolution is 10 bit. The duty cycle is 0 when value of bit is 0. The duty cycle is 100% for the value of 1024. In this setup the PWM signal is generated on the 17 number pin on the micro controller. But if it is required then two signals can also be generated.
2. Analog voltage ranging from 0V to 5V is produced from yhe potentiometer and it is sent to the ADC module. The ADC module then converts the analog voltage to bits. For 0V the analog voltage, the converted fata is 0. And for 5V analog voltage, the converted data is 1024. The converted data 0 provides 0% duty cycle and 1024 provides 100% duty cycle. Thus the duty cycle varies from 0% to 100%. Then the captire module is configured las described below.
3. The period of the PWM is inserted by writing the period to the PR2 register.
4. The duty cycle of the PWM is set by writing the CCPR1L register and CCP1CON<5:4> bits.
5. The CCP1 pin is selected as an output of the PWM signal. It was set by clearing TRISC<2> bit.
6. The prescale value of the TMR2 was set by writing the value to T2CON. The Timer2 was also enabled by writing the value to T2CON.
7. The CCP1 module had to be configured for our PWM operation

8. The Frequency of the PWM signal is 5 Khz. This value had to be written in the PR2 register in order to select this specific frequency for the PWM signal. The frequency was set using the formula given below:

PR2=(_XTAL_FREQ/(PWM_freq*4*TMR2PRESCALE))–1;

We wanted the frequency to be 5Khz. Thus we have assigned PWM_freq = 5000; The duty cycle of the PWM signal was determined by the function given below:

Duty=((float)duty/1023)*(_XTAL_FREQ/(PWM_freq*TMR2PRESCALE));

III. RESULT AND APPLICATIONS

The design of PWM Signal Generator is based on using PIC16F877A on a breadboard. This system is generating PWM Signal from the compare capture module found in the micro controller. The frequency of the PWM generated signal is 5 KHz and the duty cycle is from 0% to 100%.
The simulated circuit diagram to generate pwm signal is-

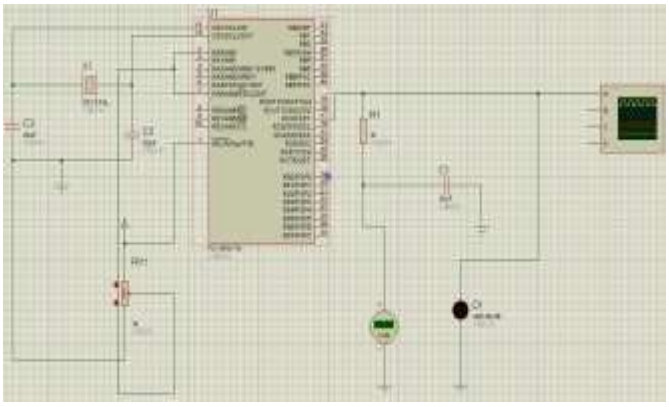

Figure 2: Simulated Circuit Diagram.

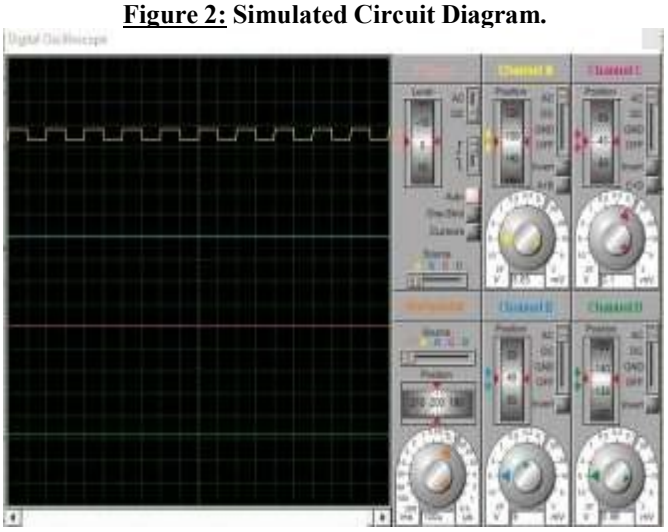

Figure 3: Simulated output of PWM signal.

The implemented circuit for 100% duty cycle is-

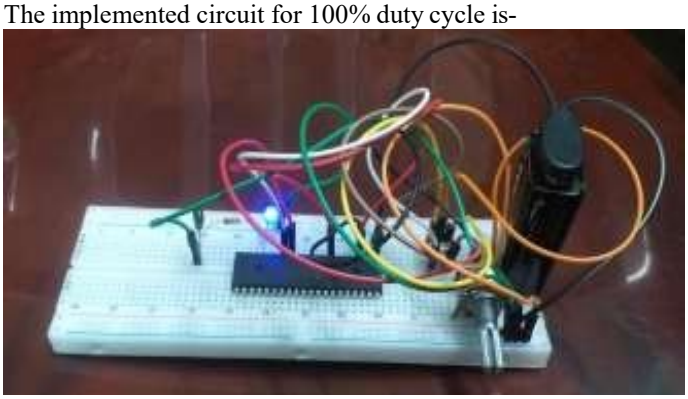

Figure 4: Output for 100% duty cycle.

The applications are:

- PWM signal in frequently used for the purpose of servomechanism control.
- PWM signal is used to control the voltage recieved by a load and amount of power delivered. The power can be delivered without losses
- PWM can also be used in efficient voltage regulators
- PWM techniques can be used to make some indicator blink softly
- Lossless power can be delivered with the help of PWM Signals
- PWM signal is often used instead of DC to control CPU and case fans of a computer as it can vary the fan speed

IV. Cost Analysis

TABLE I For Cost analysis of Smart Home project

Component name	Description	Quantity	Price
PIC16F877A	40 pin micro controller	01	300 BDT
Resistor	10 K ohm	01	30 BDT
Capacitor	22 pF	02	20 BDT
LED	Light emitting Diode	01	20 BDT
Breadboard	Connection board	01	120 BDT
Wires	Connection wires	08	60 BDT
Potentiometer	1k potentiometer	01	30 BDT
Crystal Oscillator	20 Mhz Crystal Oscillator	01	30 BDT
Battery	9V Battery	01	60 BDT
		Total	670 BDT

- *Competitive Study*: The project was implemented using a PIC micro controller. The signal can be generated in many more ways but the PIC Microcontroller provides a clean PWM signal with variable duty cycle. Nowadays this system and much more advance systems are being used in this sector

- *Future Scope:* The future scope of this project is huge. This can be used on many systems. In modern computers the case fan CPU fan has the option to use either PWM or dc signal. PWM allows the system to change the speed according to the temperature. Also, for control circuitry it is in huge demand. According to a recent study The PWM controllers market is likely to grow at 5.1% through 2032 [3]

V. Conclusions

The PWM Signal generator system was implemented using Microcontroller PIC16F877A. This was successfully implemented however many improvements can be done to the project. It can be connected to applications where PWM Signal is required. The duty cycle is changeable but it can be furthermore be extended to vary the range

Acknowledgment

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