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. This system will generate PWM Signal from the PIC MCU which has a special module called Compare Capture module (CCP) which can be used to generate PWM signals. The generated PWM signal is of 5 kHz with a variable duty cycle from 0% to 100%.**

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

I. Introduction

Some machines only require partial or variable power. Full power is not required. Previously, controlling was done by the use of a rheostat which was connected in series with the motor in order to adjust amount of current flowing through the motor. It was quite inefficient because power was wasted as heat in the resistor element of the rheostat. It was tolerable though because the total power was low. The rheostat was one of methods of controlling power but a low cost and efficient power adjustment method was needed. This mechanism also required to drive motors for fans, pumps and robotic servos, and needed to be compact enough to interface with lamp dimmers. PWM emerged as a solution for this complicated problem.

PWM is often used for controlling servomechanism. In the field of telecommunications, PWM is a form of signal modulation. Here the widths of the pulses correspond to specific data values encoded and decoded at the both ends. PWM can be used to control the amount of power delivered to a load without losses which would have resulted via linear power delivered by resistive means. The power drawn by the load and energy delivered to the load is discontinuous. High frequency PWM power control systems can be produced with semiconductor switches. PWM can also be used in efficient voltage regulators. By switching voltage to the load with proper duty cycle, the output will approximate a voltage at the desired level. PWM techniques can be used to make some indicator blink softly. The light will slowly transition from dark 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 the PIC MCU which has a special module called Compare Capture module (CCP). 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 PIC MCU which has a special module called Compare Capture module (CCP) which can be used to generate PWM signals. The generated PWM signal is of 5 kHz with a variable duty cycle from 0% to 100%. The duty cycle is varied by using a potentiometer which will feed the circuit with variable analog voltage. In our program we will read an Analog voltage of 0-5v from a potentiometer and map it to 0-1024 using ADC module. Then a PWM signal will be generated with frequency 5000Hz and vary its duty cycle based on the input Analog voltage. That is 0-1024 will be converted to 0%-100% Duty cycle

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

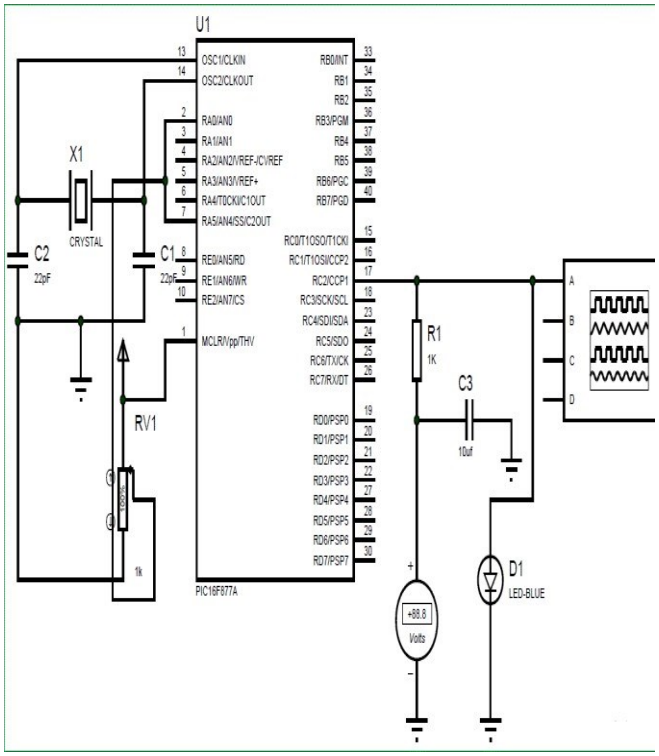

Figure 1 Circuit Diagram for PWM Signal generator

Described Steps:

1. PWM signals is generated in PIC Microcontroller by using the CCP (Compare Capture PWM) 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 resolution of our PWM signal is 10-bit, for a value of 0, there will be a duty cycle of 0% and for 1024 (2^10) duty cycle is of 100%. Due to having two CCP modules in PIC MCU (CCP1 And CCP2), two PWM signals can be generated with two different pins (pin 17 and 16) simultaneously. The PWM signal is generated on pin 17.
2. In the program an Analog voltage of 0-5v will be read from a potentiometer and map it to 0-1024 using ADC module. Then a PWM signal with frequency 5000Hz was generated and its duty cycle was varied based on the input Analog voltage. That is 0-1024 will be converted to 0%-100% Duty cycle. The CCP module was configured as instructed below for PWM operation:
3. Set the PWM period by writing to the PR2 register.
4. Set the PWM duty cycle by writing to the CCPR1L register and CCP1CON<5:4> bits.
5. Made the CCP1 pin an output by clearing the TRISC<2> bit.
6. Set the TMR2 prescale value and enable Timer2 by writing to T2CON.
7. Configured the CCP1 module for PWM operation.
7. We have set the Frequency of the PWM signal. The value of the frequency must be written in the PR2 register. The desired frequency is set by using the below formulae

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

8. We have assigned PWM_freq = 5000; so that we can get a 5 KHz operating frequency for our PWM signal. We have set the duty cycle of the PWM by using the below function:

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 PIC MCU which has a special module called Compare Capture module (CCP) which can be used to generate PWM signals. The generated PWM signal is of 5 kHz with a variable duty cycle from 0% to 100%.

The applications are:

- PWM is often used for controlling servomechanism
- PWM can be used to control the amount of power delivered to a load without losses
- PWM can also be used in efficient voltage regulators
- PWM techniques can be used to make some indicator blink softly
- High frequency PWM power control systems can be produced with semiconductor switches

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

References

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