UNIVERSAL TRIGGERING CIRCUIT FOR POWER ELECTRONIC DEVICES

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ABSTRACT

Power electronic devices are most widely used in an industry for power conversion and for effective control of the various electric equipment. SPWM or sinusoidal pulse width modulation is used for the power electronic devices to control it and to reduce harmonic content present in the system. Nowadays SPWM signal can be generated with the help of microcontroller, microprocessors and FPGAs. But all of these methods require programming or coding which is very tedious and time consuming job. This paper represents how to generate SPWM signals with variable frequency, amplitude, and duty cycle using simple (OP-AMP) circuit and function generator IC's for triggering and control of various power electronic devices used in the industry. The given circuit is rugged, simple, consumes less power and space. In this circuit SPWM can be generated by comparing high frequency triangular carrier wave with sinusoidal reference wave of desired frequency. The width of each pulse can be in proportion to the amplitude of sine wave. The advantage of sinusoidal pulse width modulation is that it reduces harmonic content of the converter output when fed to the power electronic devices as compare to single pulse width modulation. So this circuit can be effectively implemented in inverters for triggering of power electronic devices to get smooth output. This circuit is also able to generate negative voltage pulse which can be used for turning off of the gate turn off thyristor (GTO). So this circuit can be effectively used for wide voltage and current ratings of various types of power electronic devices. [1], [2].

Keyword: - *SPWM, harmonics, duty cycle, OP-AMP, carrier wave, GTO.*

1. INTRODUCTION

As industrialization increased tremendously now a days, an increasingly significant portion of generated electrical energy is processed through power electronics devices for various application in residential, industrial, aerospace, commercial and military environment[3]. The technological development in the field of semiconductor devices, have led to development of power semiconductor devices with higher power rating and improved switching performances. Some of the popular power electronics devices available in the market are Metal Oxide Field Effect Transistor (Power MOSFET), Insulated Gate Bipolar Transistor (IGBT) and Gate Turn off Thyristor (GTO) [4].Due to this rapid advancement in power electronics devices large number of research is being devoted to area of static power converters. The input and output current and voltages of static power converters are generally associated with low order harmonics which can be diminished by using different switching techniques such as sinusoidal pulse width modulation (SPWM).

2. METHODOLOGY

For design of the universal triggering circuit of power electronics devices we have used a function generator IC to generate triangular and sinusoidal pulses of variable frequency as per requirement. The triangular wave acts as a high frequency carrier signal and sinusoidal wave as a reference signal which is given to the comparator to generate a sinusoidal pulse width modulation signal by comparing this two signals coming from the function generator IC. This output signal from the comparator is then given to the OP-AMP configured in amplifier mode to vary the amplitude of the output waveform.

2.1 Block Diagram

The block diagram of universal triggering circuit mainly consist of four blocks as shown in the following fig (1.1).

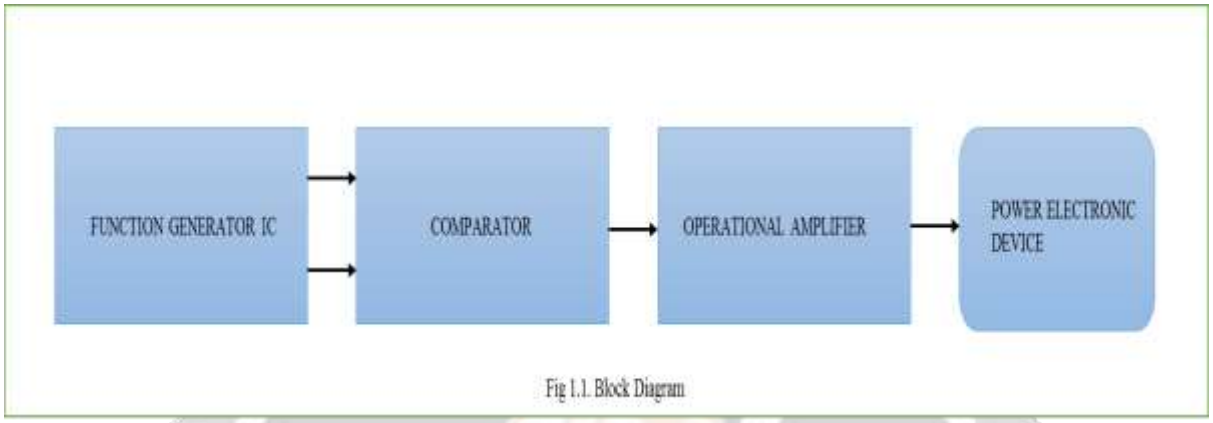

Fig 1.1. Block Diagram

2.3 Different circuit components

1. Function generator IC

In this circuit we have used a function generator IC (ICL8038) for generation of different waveforms with variable frequency. This IC can give pure sine, triangular and square waves simultaneously with very low distortion (about 1%). Frequency of this waves can be varied between (0.001 Hz to 30 KHz).

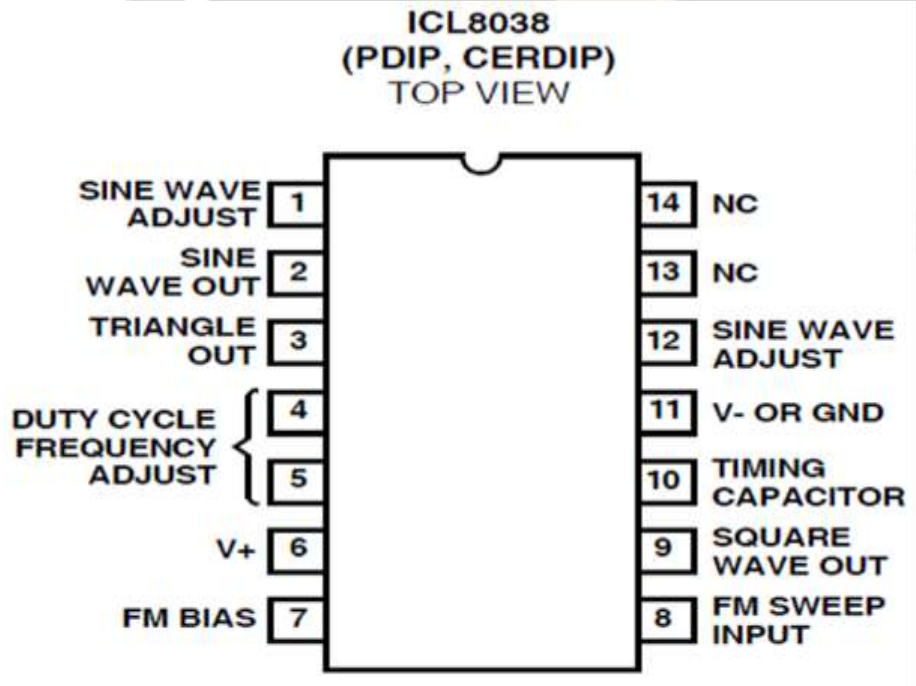

Fig 1.2 ICL8038 function generator IC

2. Comparator

A comparator is a device that compares two voltages or currents and outputs a digital signal indicating which is larger. Here the comparator compares triangular carrier wavy with sinusoidal reference wave to generate SPWM. We have used OP-AMP 741 as a comparator.

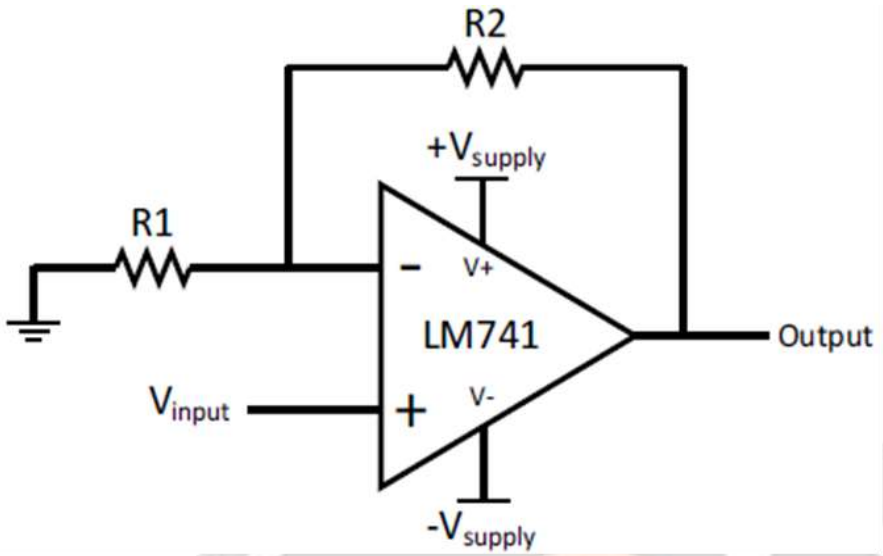

Fig 1.3 OP-AMP 741 as a comparator

3. Operational amplifier

Operational amplifier used is (OP-AMP548) which is configured in an amplifier mode to vary the amplitude of the SPWM output from the comparator. The voltage can be varied between (±4V to ±30V) and current output is (3A continuous and 5A peak) can be obtained.

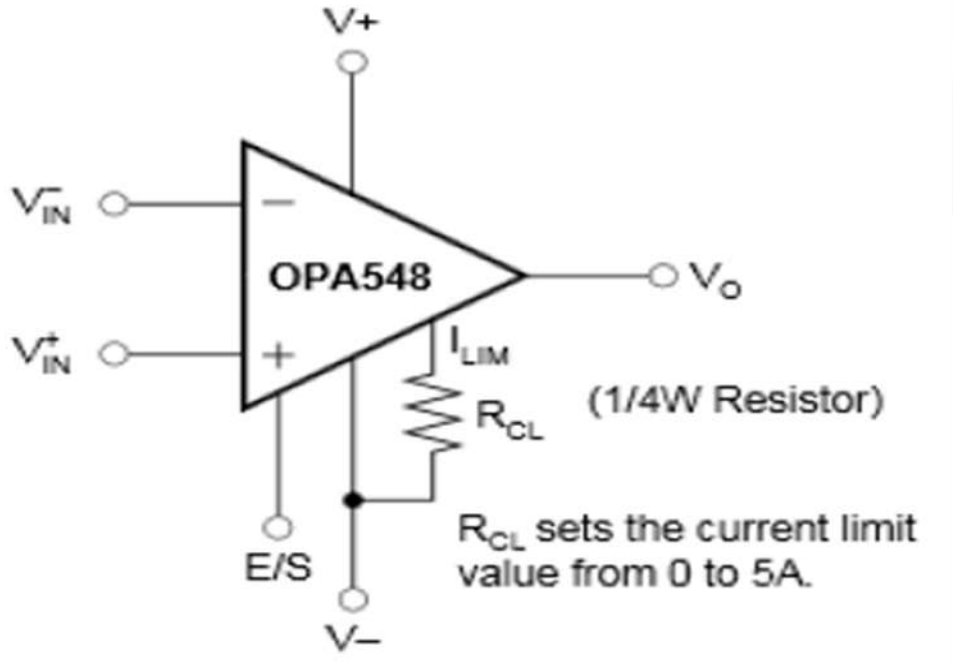

Fig 1.4 OP-AMP 458 as a amplifier

3. PULSE WIDTH MODULATION

The pulse width modulation (PWM) technique is defined as the technique where the pulses are generated by varying the pulse duration but maintaining the amplitude constant. Here normally the duty cycle of the pulses are varied. For this techniques conventionally reference and a carrier wave is generated which are further compared and an output is generated which is pwm wave. The reference signal can be sine wave, square wave, etc. According to desire and the carrier wave is triangular or ramp signal which frequency is normally very high then that of the modulating signals [5].

3.1. Sinusoidal pulse width modulation

In this modulation technique multiple number of output pulses are generated per half cycle with a different width. The width of pulses are varying in proportion to the amplitude of sine wave evaluated at the centre of the same pulse. The gating signals are generated by comparing sinusoidal reference with a high frequency triangular signal.

Advantages of SPWM
- Easy to implement and control
- Linearity
- Compatible with today's digital microprocessors
- Lower power dissipation
- Allows linear amplitude control of the output voltage/current from previously not present
- Lower switching losses
- Low harmonic contents in the output voltage and air currents, especially in the low-frequency region [6].

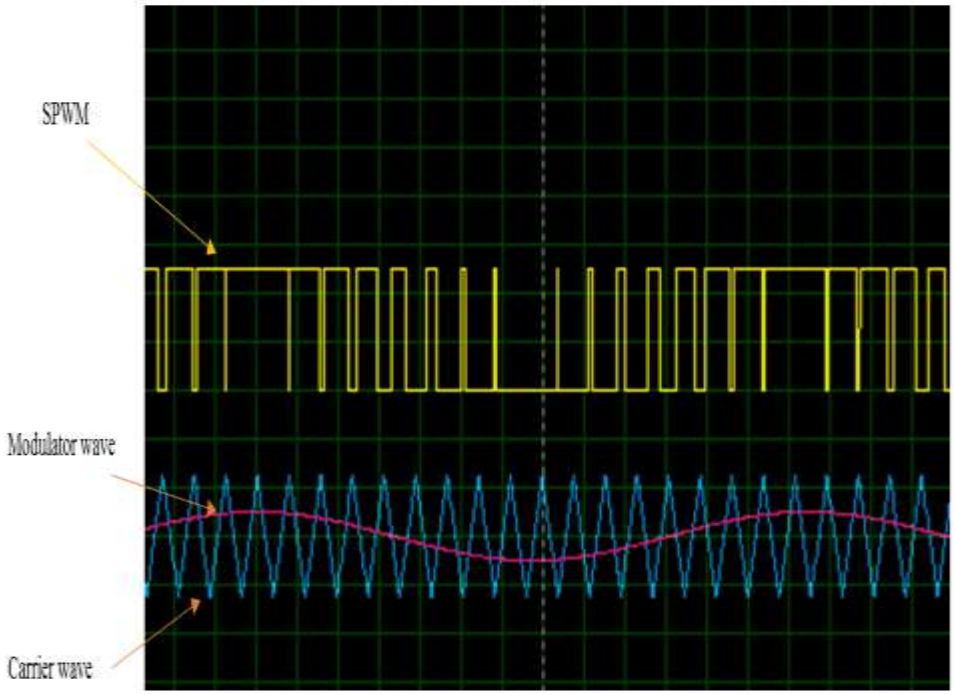

Fig 1.5 sinusoidal pulse width modulation

4. OUTPUT RESULTS

- Output voltage variation: (± 4V to ±30V)
- Output frequency variation: (0.001HZ to 30KHZ)
- Output current variation: (0A-3A)

5. CONCLUSIONS

In this paper it is explained that how to generate a triggering pulses for a power electronics devices with the minimal use of components and in low cost. Also the generated pulses can be varied as per the user requirement.

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