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Reduction of Harmonics in NE555 IC based Inverter Circuit by Using Passive Filters

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ABSTRACT

Solar energy consumption in the power system shows diverse impacts on power system. Voltage profile improvement, minimization of the losses, congestion management, reliability improvement are the positive aspects of its implementation whereas it also reflects some adverse impacts like harmonics insertion due to extensive use of power electronics devices such as rectifiers inverters, thyristors transistors. In this Work we visited the solar integrated substation. To study all these impacts on power system and prepared a prototype of the solar system with power conditioning unit using passive filters to mitigate harmonics.

Keywords: Power Quality, Inverter, NÉE 555 timer IC, Harmonics, Passive Filter.

I. INTRODUCTION

The rapid revolution of renewable generation stimulated the need for efficient, cheap and robust inverters that would interface them to the grid without compromising the quality of supply for the grid [1]. For fast work and quick response output we are selecting electronics equipment because of their switching property make them better. But there is a lack of power electronics equipment that they generate harmonics. These harmonics are amenable for input voltage and current distortion at the point of integration to the grid. Because of harmonics present in the system distorted power caused to damage the equipment, so harmonics can be considered as harmful gateways which harm the entire power system [2].

Improvement of semiconductor technology has elongated the power electronics field due the availability of power devices such as Field Effect Transistor (FET), Insulated Gate Bipolar Transistors (IGBT) and Gate Turn off Thyristors (GTO's) that have high power rating and good switching characteristics. These devices are mostly used in power converter circuit. The output current and voltage of converters are generally concerned with low order harmonics . Harmonics are inexpedient component in the sinusoidal waveform of the ac power supply. Harmonics occur as integral multiples of the fundamental frequency i.e. 3^{rd}, 5^{th}, 7^{th}, etc. It affects the power quality as well as efficiency.

This paper give an overall system of converting DC to AC solar inverter using 555 timer IC and passive power filter applications.

II. PROPOSED TOPOLOGY

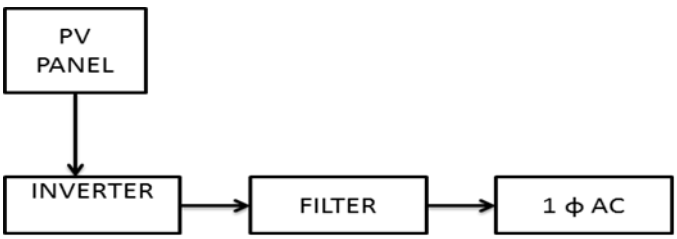

Figure 1. block diagram of the proposed Topology

III. PV PANELS

In this PV panel the photon will absorb the light illumination and cells stored in this will result the migration of conduction band to valance band, that is the holes in the layer will be absorbed by the n type electrons this result in the layer to store energy and the load is connected across it which is connected to the voltage regulator or inverter type load The main functions of the PV cell are:

- To convert the solar energy to direct current Electrical energy.
- Regulate the electrical energy output.
- Feed the electrical energy in to an external load circuit to perform and store the electrical energy in a battery subsystem for later use.

In our prototype we used polycrystalline 6W PV panal

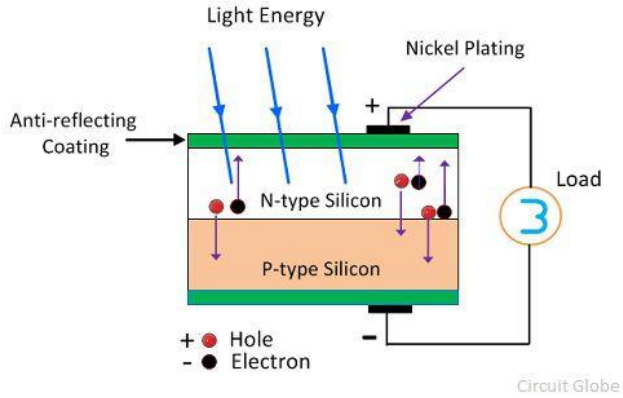

Figure 2. PV Cell

IV. 555 TIMER IC

The main objective of this paper is to produce sinusoidal waveform using multivibrator ICs. The application has been understood using NE555 timer IC which is fit for both mono-stable and astable applications. Similar others ICs the on-off time of this IC is also reliant on external capacitor. The capacitor takes finite period of time to charge and discharge through resistor which can be determined using R and C values using expressions. t=R*C

One of the most common operational modes of this IC is its use as astable multivibrator for fluctuating duty cycle generation. Astable multivibrator is arrangement of bistable multivibrator to switch conditions periodically. Bistable is connected with RC network in feedback loop to control the RC time constant in this mode, it simply acts as an oscillator generating a continuous waveform of rectangular on-off pulses alternating between two voltage levels.

4.1.ASTABLE MULTIVIBRATOR:-

Astable multivibrator has automatic built in triggering which switches if continuously between its two unstable states both set and reset. Astable multivibrator also known as free running multivibrator the astable circuit consist of two switching transistorsacross coupled feedback network time delay capacitors.

Astable oscillator produce a continuous square waveform its output. the basic circuit's astable multivibrator operates as common emitter amplifier with 100% positive feedback. Astable Multivibrator can produce two very slot of square wave output waveform.

NE 555 IC based inverter circuit with configuration of giving a 50HZ ,9V output. Voltage is 12V DC input voltage. Supply can be from any renewable energy generator, resistor R1,R2 and capacitor C1andC2. The resistor and capacitor will be designed as followings:

Frequency

$$F = \frac{1.44}{(R_1+2R_2)*C}$$

F=50 Hz;

$$\%\text{Duty Cycle} = \frac{(R1+R2)}{(R_1+2R_2)}$$

Let C=0.01μF;

Using Equations (1) and (2);

To find the values of R_1 and R_2.to design the 555 timer circuit.

T_c =charging

Time=0.693(R1+R2)*C,

Td =Discharging time 0.693R_2*C

Let consider as duty cycle is %

Frequency=50Hz, C=0.01μf

Equation (1):

(R1+2R2)*C=0.03..... (3)

Equation (2):

0.50=(R1+R2)/(R1+2R2);

R2=0.03

R_1..... (4)

Equation (4) in (3):

R_1=10 k Ω ..... (5)

Equation (5) in (4);

R_2=139 k Ω

The output from NPN and PNP transistor pair is in square wave which also contain harmonics and wave form will be distorted after simplification by the transistors, the proposed low pass filter configuration for 50HZ frequency .The harmonics are reduced and the output waveform is in the proper sinusoidal shape in the oscilloscope.

V. OVERVIEW OF HARMONICS

Harmonics are undesirable component in the sinusoidal waveform of the ac power supply. Harmonics occur as integral multiple of fundamental frequency. It is therefore necessary that harmonics in any power system be monitored.

The harmonics can arise in following ways:

1. Through the application of non-sinusoidal driving voltage to a circuit containing non-linear impedance.
2. Harmonics are created by electronics equipment. The short pulses cause distorted current waveform.

Harmonics can rectify by using suitable method such as filters. Using a mathematical technique known as Fast Fourier Transform, the distorted ac waveform can be resolved into its component waveform. The basic theory according to Fourier theorem, periodic non-sinusoidal or complex voltage or current waveforms can be represented by the sum of a series of multiple frequency terms of varying phases and magnitudes. Figure 1 and Figure 2 represents a pure sinusoidal wave before impact of harmonics and distorted wave after it affected by harmonic.

Types of Harmonics Sources

There are two types of harmonic sources:

1. Current-Source Type of Harmonic Sources
2. Voltage-Source Type of Harmonic Sources

1. Current-Source Type of Harmonic Sources:

Current harmonics are caused by nonlinear loads when a non-liner load, such as rectifier and inverter are connected to the system, it draw a current that is not necessarily sinusoidal. The current wave form can become quite complex, depending on type of load and its interaction with other component of the system. Current waveform becomes, as described through Fourier series analysis. This types of harmonics is generated in nonlinear loads. Examples of nonlinear loads include transistor and a non-ideal transformer. Nonlinear loads create disturbance in the fundamental harmonics which produces all type of harmonics.

2.Voltage-Source Type of Harmonic Sources:

Voltage harmonics are mostly causes by current harmonics. The voltage provided by the voltage source will be distorted by current harmonics due to source impedance. If the source impedance of the voltage source is small, current harmonics will causes only small voltage harmonics. It is typically the case that voltage harmonics are indeed small compare to current harmonics. The average real power contributed by current harmonics is equal to 0. However, if higher harmonics of voltage are consider

then current harmonics do make a contribution to the real power transferred to the load.

5.1 Behaviour of Harmonic

Harmonic behavior is defined by the Bullard laws of harmonics:

a. Harmonic amplitudes are proportional to the area of distortion.
b. The harmonic signature is the result of the angle where the sinusoid impact the distortion as predicted by the Bullard harmonic solution.
c. Even harmonics don't appear in the symmetrical distortion because they cancel each other out.
d. Square waves, triangle waves and all other kinds of waveforms obey these laws and their harmonic behavior can be predicted with simple mathematical formulas [8].

Harmonics are caused by steady state distortions to current and voltage waves and repeat every cycle. They are different from transient distortions such as spikes, dips and impulses .

5.2 Harmonic Detection Methods

There are different algorithms for harmonic detection which lead the accuracy, speed, the filter stability, easy and inexpensive implementation, etc.

Table 2. Harmonic Detection Methods

Harmonic Detection Method	
Frequency Domain	**Time Domain**
Discrete Fourier transform	Synchronous fundamental "dq-frame"
Fast Fourier transform	Synchronous individual harmonic "dq-frame"
Recursive discrete Fourier transform	Generalized integrators & variants

VI. PASSIVE FILTER

Passive filter are the oldest type of electronic filter, as they are quite simple, having resistor, capacitor and inductor and they do not depend on any type of external type of source.[2] The inductor will block high frequency signal but offer increasing impedance and conduct low frequency signals. The capacitors are going to do just the opposite. Passive filter are not restricted by the bandwidth limitations of op-amps.

Types of passive filter:-

There are several types of passive filter, here are some common passive filters.

1. Band pass filter
2. Power line filter
3. SAW filter
4. Signal filter

The passive filters are used in order to protect the power system by restricting the harmonic current to enter the power system by providing a low impedance path. Passive filter are the combination of series and shunt.

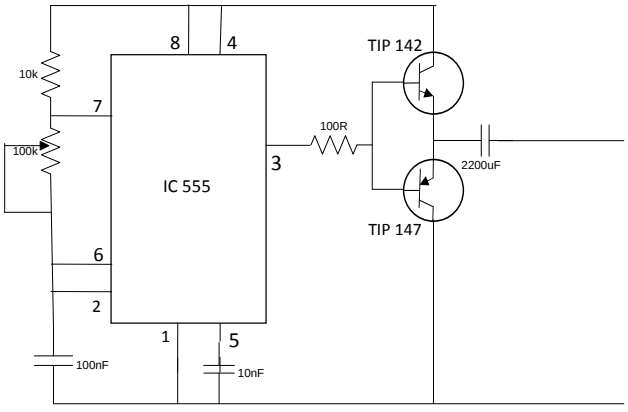

Figure 3. Inverter circuit diagram with 555 Timer

Here we used combination of resistor(R) and capacitor(C) Low pass filter for low power.

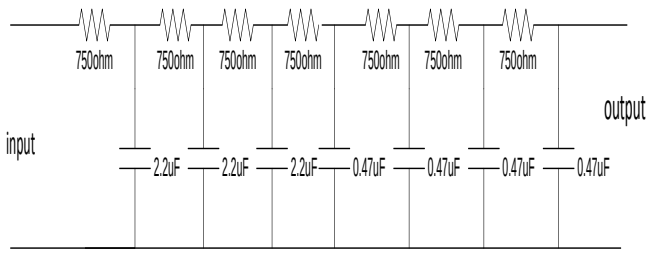

Figure 4. RC filter

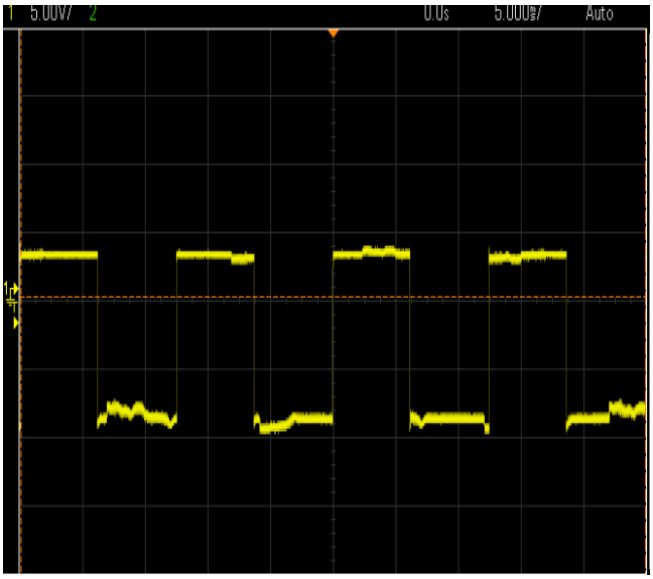

Figure 5.wave form of inverter circuit with

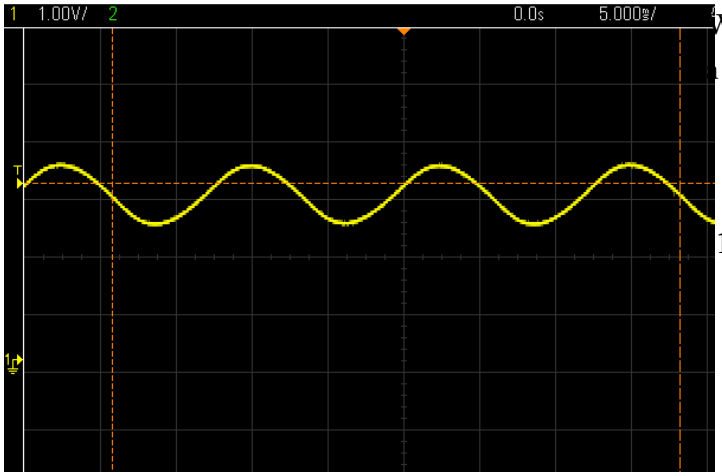

Figure 6.wave form of inverter circuit with RC filter

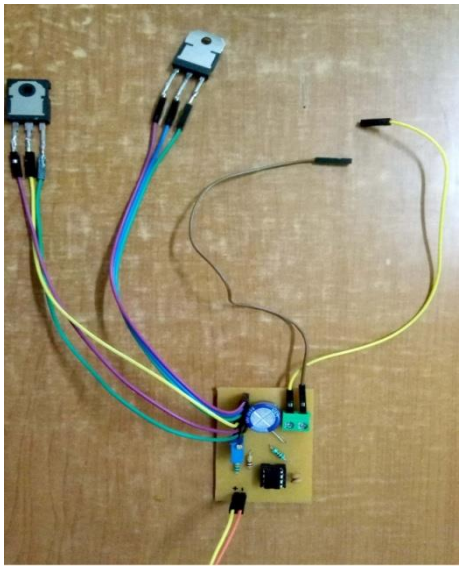

Figure 7. Prototype of inverter circuit without filter

VII. CONCLUSION

The result show has been done in the field of pure sine wave inverter but to obtain a waveform with reduced number of harmonics along with high efficiency which is easy to implement, cost proficient and reliable for low power application which is cheap to realize.

We plan extend this work in future work and present a better solution

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