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Design and Simulation of Low Cost Pure Sin Wave Inverter Through Multivibrator Technique by Using Multisim

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Abstract— Pure sine wave transformers are very important nowadays when it comes to using ds power sources for both low and high-power applications. These inverters not only increase the efficiency of the power system but also prevent electrical components from damaging. Much work has been done in the field of pure sine wave inverter but for a waveform with low number of harmonics along with high efficiency is still an open challenge. There are techniques available to do this, but the need to adapt to a solution that is easy to implement as well as specifically for low energy applications. In this paper, a multi-vibration technique is used to generate a square wave which is then split into two square waves of the same frequency by the 4017-decade counter to hold the H-bridge inverter. The output of the H-bridge inverter contains harmonics that are filtered using a low pass filter. Thus, we get a pure sin wave in the output.

Keywords— PWM, Inverter, 555 timer, 4017 Decade counter, Harmonics, Filter.

I. Introduction

There are two kinds of sources of power generation. One is conventional and the second is non-conventional. Today to generate most conventional power sources such as coal and gas, nuclear power generators are used. Some traditional sources of power are causing environmental pollution and are not much better because of their harmful radiation impact on humanity. Ten years later, traditional sources will not be sufficient enough to meet the demands of mankind. Therefore, some electrical energy must be generated from non-conventional energy sources such as solar and wind [1].

Renewable energy sources such as wind and solar energy are the main sources of energy used in this regard. This solar energy can be converted to electricity with the help of solar panels consisting of silicon photovoltaic cells. With a good design application, solar energy can save large amounts of energy at low cost. Power Inverter is an essential part of photovoltaic power generation. The inverter is required to convert DC into AC used in standalone mode or network application. Inverter options are often available in expensive production and poor quality production. The quality of the inverter output waveform features current harmonic content [2].

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The main function of the inverter is to convert DC input voltage to a AC output voltage of the desired magnitude. The output voltage waveforms of the ideal inverters should be sinusoidal, however the waveform of the practical inverters are non-sinusoidal and contains different harmonics. Square wave or quasi-square-wave voltages are acceptable only for low and medium power applications, but for high power applications low distorted sinusoidal waveforms are required. By using high speed power semi-conductor devices and by using different switching techniques we can reduce the harmonic content in output voltage. These inverters usually use pulse width modulation control signals to provide an AC output signal [5].

The paper [6] is an approach to the DC to AC power inverter, which aims to efficiently convert the power source DC, similar to the power that will be available in the power outlet. The way in which the low voltage DC voltage is inverted is completed in two steps. The first is to convert the source of the high voltage dc to the AC waveforms using the pulse width modulation. Another way to complete the desired result would be to first convert the low voltage DC power to the AC and then use the transformer to get the desired output. Focusing on the first method is specifically described as conversion of high voltage source DC to AC [6]. Paper [3] represents a duty cycle-based configuration of LM555 timer to generate an AC output of 50Hz. Two BJT transistors (NPN and PNP) are used to convert the 12V DC into 12V AC cycle. Also, a low pass filter design is tested to convert a distorted square wave to a pure sine wave with minimal ripples on any load condition. The results shown are simulated based, indicating the correct form of output with 220V AS with very less harmonics storms and noise effects.

Research has been carried out on the production of pure, cost effective and effective sine wave inverter recently and this paper offers a very useful design for low energy based applications. The paper concentrates on the use of renewable solar energy by incorporating a multi-vibrator IC (NE-555), in this case operating in a stable mode, the PWM generating technique used to drive a pure sine wave inverter. It appears that the design is easy to implement and proves to be cost-effective for low power applications [8].

II. Srtructure of Prpoposed Work

The block diagram of the proposed circuit is shown in Figure 1. It is clear from the block diagram that the circuit is divided into five main stages. Each of these stages and their function is discussed in details below. Pure Sine inverter may be a series of modular design and must be able to work together with competitive efficiency, cost, ease of implementation and use.

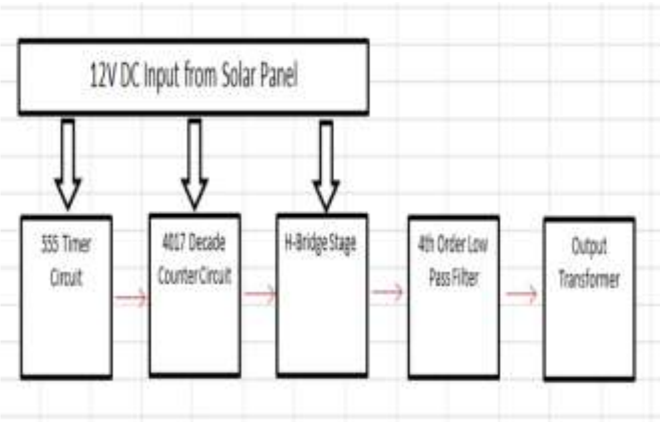

Figure 1. Block diagram of proposed circuit

A. 555-Timer Stage

The 555-timer stage is responsible for generating the required clock pulse needed for the entire circuit. The clock pulse frequency should be higher than the frequency of outputs required because we will also use 4017-decade counter in the next stage. The pulse frequency of the clock is controlled through the resistor and capacitor values that will be connected with the timer. In order to produce a square wave of desired frequency the timer 555 is used in astable mode in this circuit. The 555-timer section of the circuit is shown in Figure 2.

The frequency of the output square wave can be found by using the formula given below

$$f = 1.44/(R2+2R1)\,C2$$

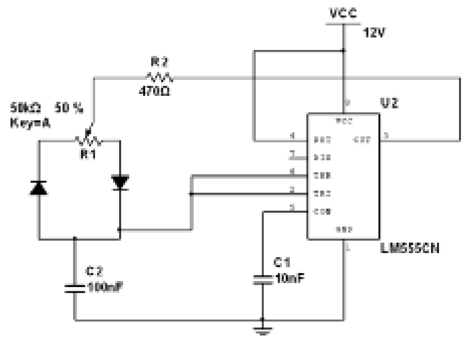

Figure 2. 555-timer connected in Astabe mode

B. 4017-Decade Counter Stage

4017-decade counter is a decimal counter that can count from 0 to 9. It has ten output pins that goes high one after another. It also has a clock input which determines the frequency of count pulses. The purpose of using 4017-decade counter in this paper is to get two separate clock pulses with a delay between them from a single clock pulse coming from 555 timer. The 4017-decade counter connected with 555 timer is shown in Figure 3. Pins 3 and 7 were chosen to act as triggering outputs, while pin 5 was chosen to act as a reset signal and connected to the reset input itself. This 3-5-7 combination introduces a delay in between the trigger signals, which will be very useful in achieving a pure sine wave output later on in the circuit.

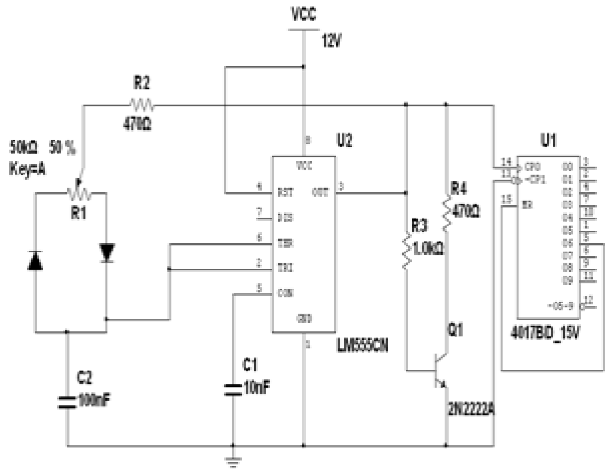

Figure 3. Decade counter connected with 555 timer

C. H-bridge Inverter Stage

It is the main part of our circuit that would convert DC into AC. An H-bridge inverter consists of four switching devices (BJT in this case) connected in the form of an H bridge. The two clock pulses from 4017-decade counter will control the switching of BJTs connected in the H-bridge. The circuit of H-bridge is shown in Figure 4.

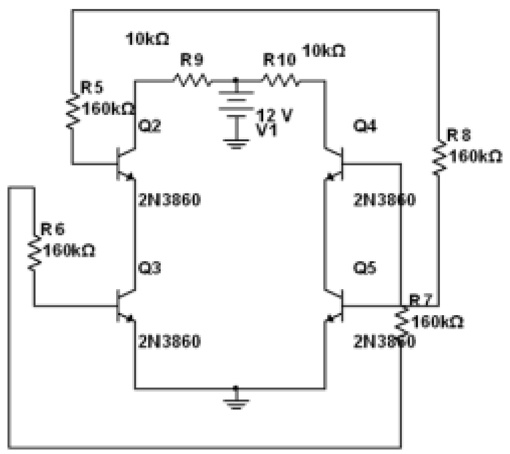

Figure 4. H-bridge circuit

The clock pulse coming from pin3 of 4017-decade counter is given to the common point of Q2 and Q5. The clock pulse coming from pin7 is given to the common point of Q3 and Q4. As there is delay between the two clock pulses hence the two pairs of transistors are switched on one after another for equal half interval of time. This creates an AC signal with an average value of zero that resembles a square wave, which makes the signal much easier to filter and turn into a pure sine wave signal.

D. Filter Stage

The square wave coming from H-bridge contains a large amount of harmonics that needs to be filtered out. For this purpose, we use filter connected in series with the H-bridge inverter. The filter stage was chosen to be a passive filter because an active filter would involve the use of op-amps, consuming more power and lowering efficiency. Since the H-bridge circuit has a two-ended output, the 4th order low pass filter consisted of 8 resistors and 4 capacitors. The transfer function of this complicated of a circuit is very difficult to calculate, so the values of the components were found through trial and error by seeing which combination produced the best output signal. The circuit of filter stage is shown in Figure 5.

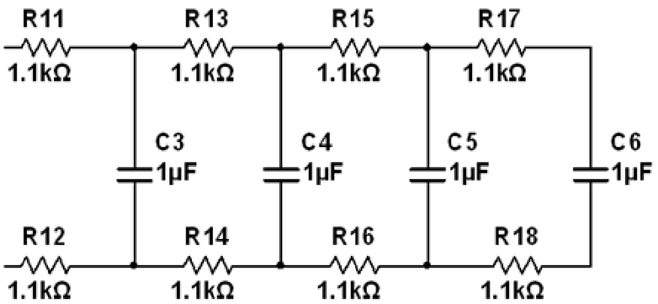

Figure 5. Filter circuit

E. Transformer Stage

The last stage of our circuit is the transformer stage. The peak value of the voltage at the at the filter output is very low. In order to step up it to the required value we need to connect a step-up transformer. Hence the output coming from the filter is given to a step-up transformer.

Complete Circuit Diagram

The final circuit diagram of proposed circuit is shown in Figure 6. All the above discussed stages are connected together to get the final circuit diagram.

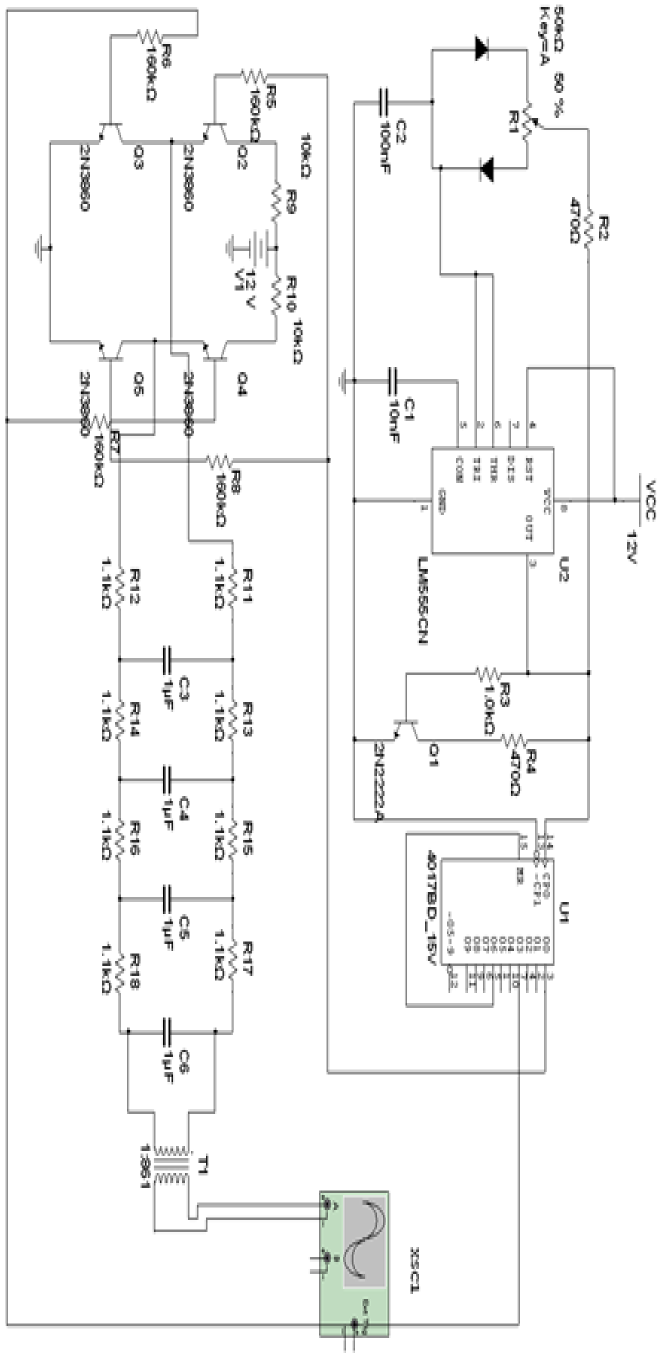

Figure 6. Complete circuit diagram

III. SIMULATION RESULTS

The simulation results of different stages are given below. Figure 7 shows a clock pulse of frequency 250Hz. Figure 8 shows two similar waveforms each of frequency 25Hz. Figure 9 shows a square waveform of frequency 50Hz containing harmonics. Finally, in Figure 10 a pure sin wave of frequency 50Hz is shown after filtration and voltage rise through transformer of ratio 1:861 to produce a voltage of 220V RMS.

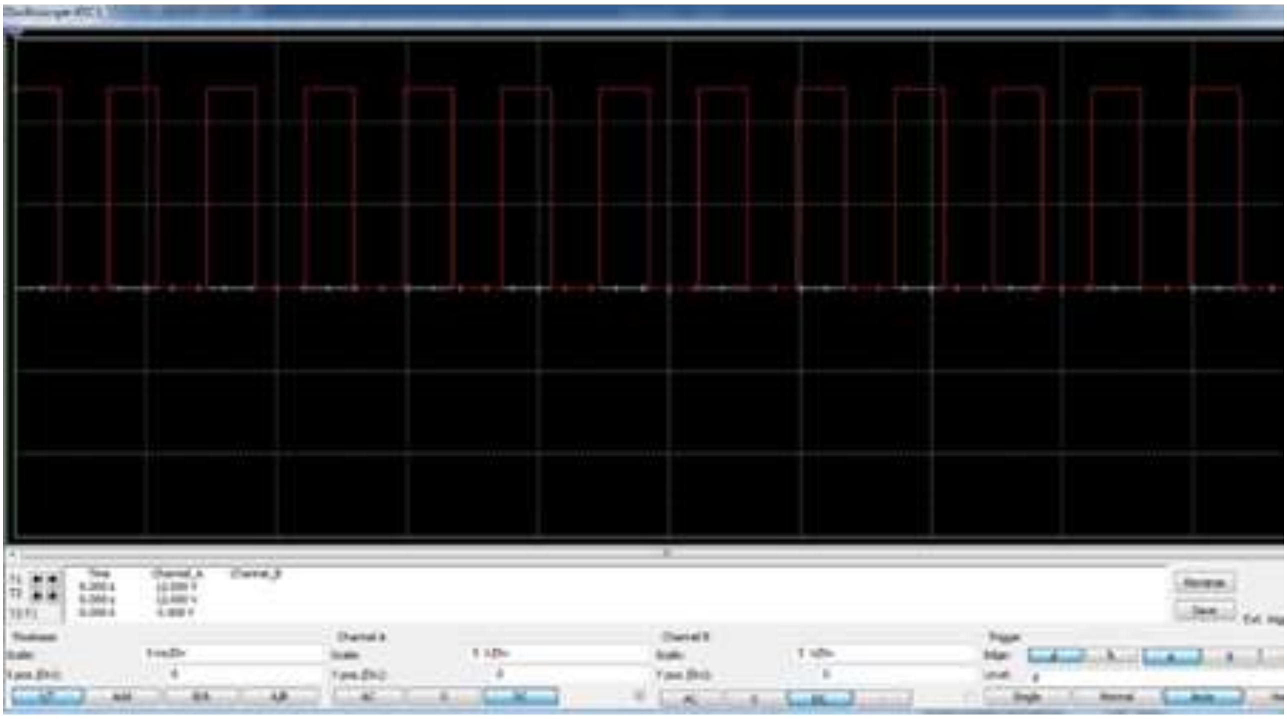

Figure 7. Simulation result of 555 timer stage

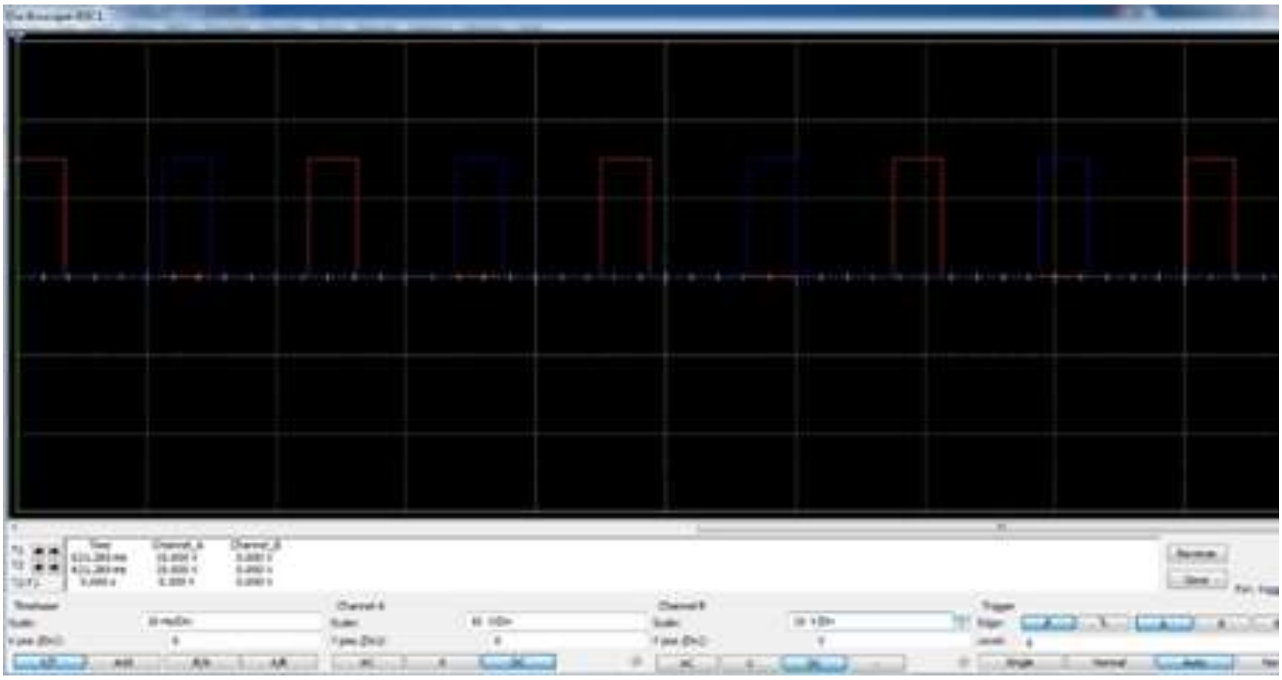

Figure 8. Simulation result of Decade counter

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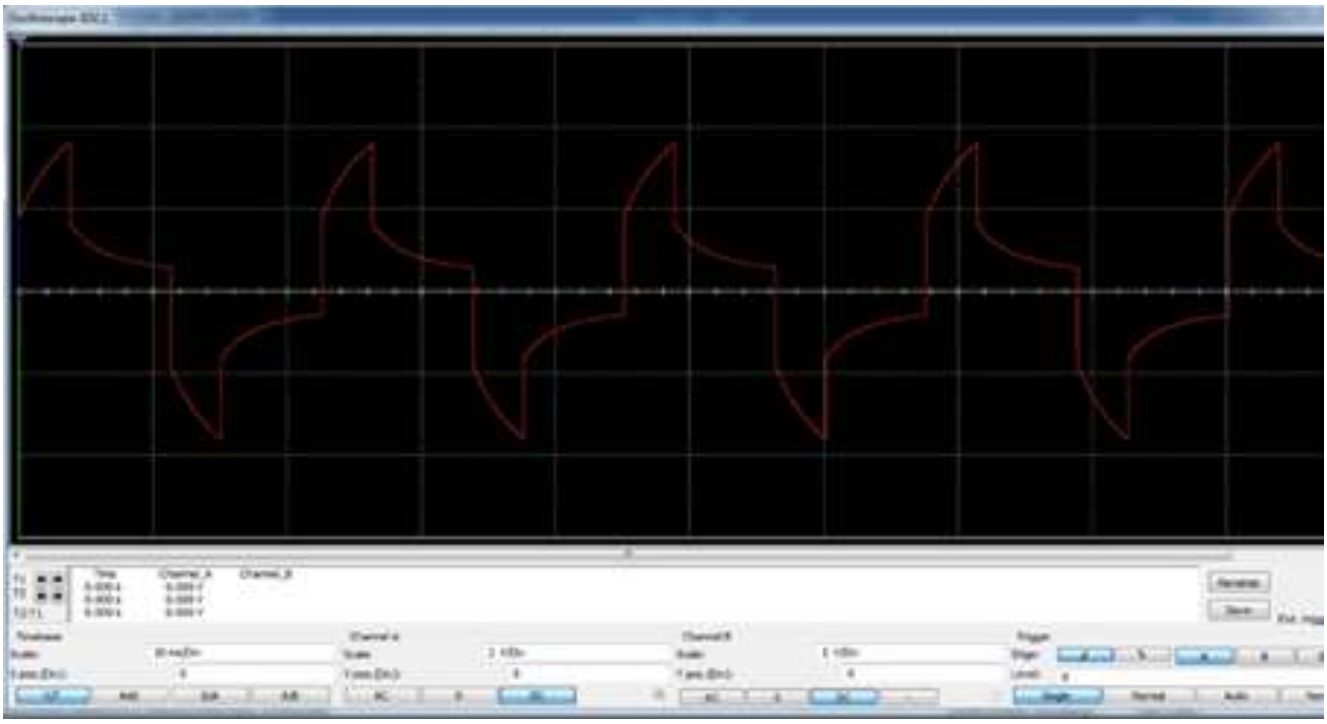

Figure 9. Simulation result of H-bridge cicuit

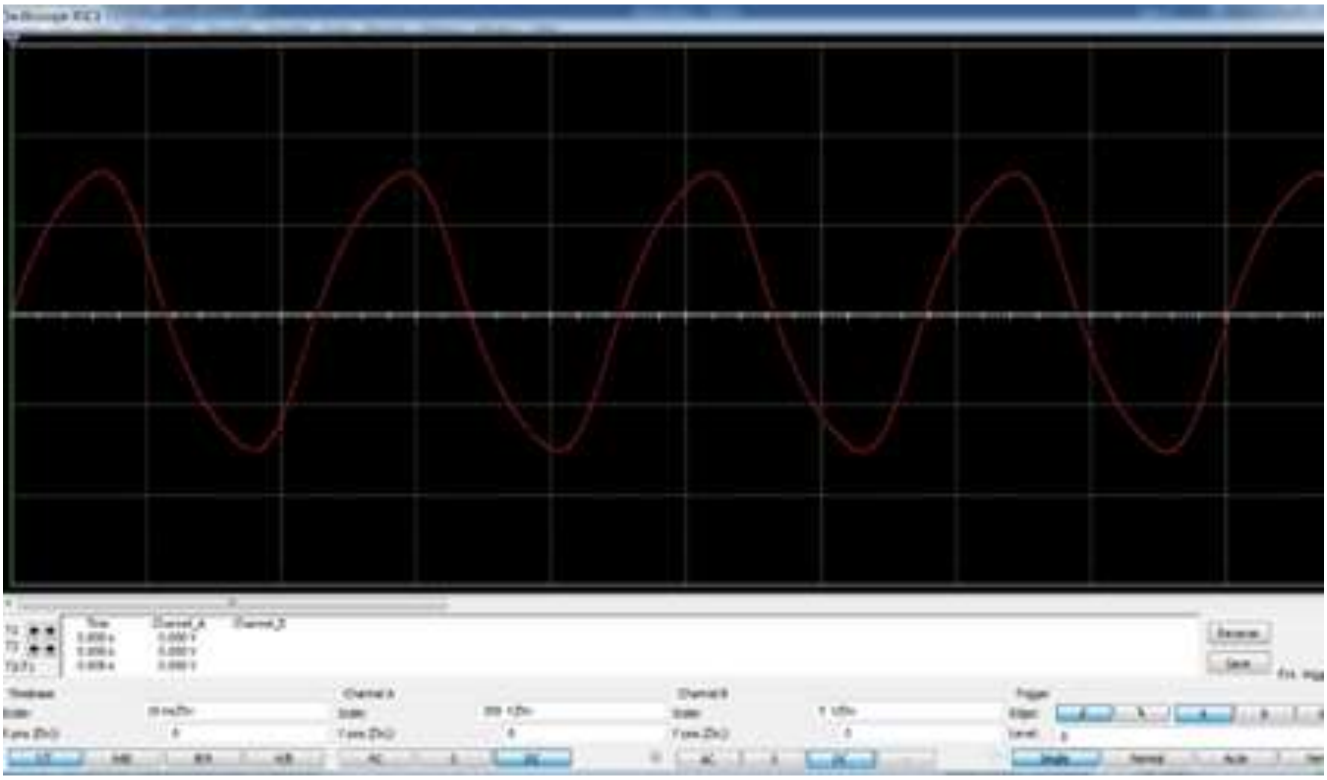

Figure 10. Final waveform

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CONCLUSION

This paper focuses on the design of low-cost pure sin wave inverter. The paper discussed available techniques and tried to come up with a solution for low energy applications that are easy to implement, cost-effective and reliable from the point of view of consumers. We have tried to come up with a design for low power applications that are cheap to achieve. The proposed solution has used multivibrator technique for the generation of square wave to control the switching of H-bridge. The harmonics are removed using low pass filter. The circuit is then simulated in Multisim software.

FUTURE WORK

The paper was a general success and all requirements were met. However, the design still uses a lot of optimization. If efficiency improves, the design will be a much better alternative to existing circuits in the market. This added efficiency can even allow the circuit to use active filtration, which would give the circuit the best pure sine wave output signal. The circuit is tested on an open loop. However, it can also be tested in the future on a close loop. In order to step up the voltage boost converter can also be used instead of transformer.

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REFERENCES

[1] Nishit Kapadia, Amit Patel, Dinesh Kapadia, "simulation and design of low cost single phase solar invertor", International Journal of Emerging Technology and Advanced Engineering Vol 2 (2012), pp. 158-163.

[2] Sridhar Dandin, Dr. Ashwini Kumari, "Highly Efficient Pure Sine-Wave Inverter for Photovoltaic Applications with MPPT Technique", International Journal of Engineering Research & Technology (IJERT), Vol.02 (2014), pp. 255-260.

[3] Zeeshan Shahid, Sheroz Khan, AHM Zahirul Alam and Musse Muhamod Ahmed, "LM555 Timer-Based Inverter Low Power Pure Sinusoidal AC Output", World Applied Sciences Journal 30 (Innovation Challenges in Multidisciplinary Research & Practice), (2014), pp. 141-143.

[4] Sheu Akeem Lawal, Alade Olusope Michael, "Design, construction and performance evaluation of 1kVA pure sin wave inverter", International Journal of Scientific & Engineering Research, Vol 6 (2015), pp. 1288-1303.

[5] Prof R. Kameswara Rao, P. Srinivas, M.V. Suresh Kumar, "Design and analysis of various inverters using different PWM techniques", The International Journal of Engineering and Science (IJES), (2014), pp. 41-51.

[6] Aye Myat Thu, Kyaw Soe Lwin, "Design and Implementation of Solar inverter for Pure Sine Wave Inverter", The international journal of scientific engineering and technology research, Vol.03 (2014), pp. 1293-1297.

[7] A. A. Mamun, M. F. Elahi, M. Quamruzzaman, M. U. Tomal, "Design and implementation of single phase inverter", International Journal of Science and Research (IJSR), Vol 2 (2013), pp. 163-67.

[8] Meraj Hasan, Junaid Maqsood, Mirza Qutab Baig, Syed Murtaza Ali Shah Bukhari, Salman Ahmed, "Design & Implementation of Single Phase Pure Sine Wave Inverter Using Multivibrator IC", 17th International Conference on Modelling and Simulation, (2015), pp. 451-455.

[9] Sudarshan P J, K.M. Chandrasekhar Swamy, Nagaraja P, "A Novel Transformer Less SPWM Inverter using DC-DC Boost Converter with Coupled Inductor for Standalone Applications", Computation of Power, Energy Information and Communication (ICCPEIC), 2016 International Conference.

[10] Himani Goyal, "Understanding of IC555 Timer and IC 555 Timer Tester", International Journal of Inventive Engineering and Sciences (IJIES), Vol3 (2015), pp. 4-6.

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