Design And Implementation Of Cost Effective Inverter

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Abstract: This paper deals with the design and construct of a 100 Watt, 220 Volt and 50 Hz Inverter. The system is designed without any microcontroller and it has a cost-effective design architecture. The elementary purpose of this device is to transmute 12 V DC to 220 V AC. Snubber technology is used to diminish the reverse potential, transients and excessive heat of transformer winding and transistor switches. Switching pulse generated by NE 555 timer circuit and comparator circuit was used to take signal strength input from its rear as well as from both sides for triggering the MOSFET switches. Another switch is used to invert pulse between two switching circuitries. A 5 volts regulator (IC: 7805) was used to supply fixed 5V for biasing the switching and amplifying circuitry.

Index Terms: DC Source, Switching Circuit, Snubber Circuit, Timer Circuit, Comparator Circuit, Cost Effectiveness, Proteus Simulation, Hardware Implementation.

1 INTRODUCTION

ENERGY crisis is an alarming issue all over the world. The demand of the energy resources minutely electricity is facing a rapid increase. Such hasty increase in electricity demand, using conventional electricity generation techniques, such as burning fossil fuel is no longer solution to this crux. Moreover burning the fossil fuel will result environmental problems. The emission of carbon dioxide, methane and other greenhouse gasses will result in global warming. Most of the researchers have focused their concentration on renewable energy and actively looking for cost effective solution of this crux. Solar energy is the one of the potential sources which is preferred over other renewable sources due to availability, ingenuousness, lower maintenance and reliability. Photovoltaic (PV) arrays drastically reduce energy expenditure and dependability on other non-renewable energy sources. It can provide a worthy, cost effective solution for consumers requiring large amount of power. Bangladeshi government took a splendid initiative as eradicate darkness from rural areas [1]. Inverter is an inevitable component of PV module. There is lots of inverter available in market. Though those are reliable but cost of these inverter are bit high because of microcontroller based SPWM generator [2], [3], [5]. In most of the rural areas, people are unable to effort the cost of this inverter. Again many of the peoples are using inverter less PV module with DC LED light. The brightness of LED is not enough for eradicate darkness. Most of the senior citizens are suffering various eye diseases for lacking of sufficient light.

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Though firing angle is bit complex for inverter, the state - variable formation applied to the analysis of two widely used dive system conjoining square-wave inverters [4].Transformer based push-pull inverter is very convenient for converting DC to AC [7], [10]. A great deal of research has been done to improve the efficiency of inverters. As the market is now flooded with varieties of the inverter but they are very costly and some of those are very complicated to use and less efficient. In our project, the primary goal was to develop an efficient cost effective inverter that can convert solar DC power to AC, which will especially optimize the rural areas of Bangladesh. In our research, we have used only the essential switching and amplifying components to minimize the cost and losses. We had done simulation and hardware implementation and added snubber components for minimizing oddity of voltage and transformer heating. At the last we attained splendid AC output which used for using different type of AC lighting load and it is capable of supplying sufficient light for removing darkness of rural areas. People of rural areas poor peoples are also able to bear the cost of this inverter.

2 DESIGN CONSIDERATION

To develop a cost effective efficient inverter, firstly we choose 12 volt DC source (100W and 8.3A). Regulated voltage source (IC: 7805) was used for supplying fixed 5 volt for biasing all ICs. We had chosen 220V/12V transformer for designing a push pull inverter. Two MOSFET were used for switching purpose. The third MOSFET is used to invert the input pulse. NE 555 Timer was used for generating switching Pulse and IC: 741 comparator was used to provide proper logic level pulse for triggering two switches distinctly. 9watt, 25watt, 40watt, 60watt and 100-watt incandescent lamps are used as lighting loads for testing purpose.

2.1 Block Diagram

The seven major components were used in our proposed project which mentioned here

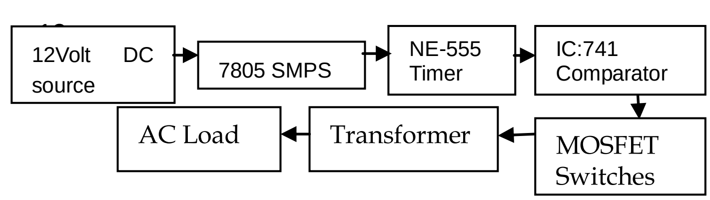

Fig. 1. *Block Diagram of the proposed model*

2.2 Circuit Diagram

This is the circuit diagram of the proposed inverter and snubber circuit are added with transformer and MOSFET switches.

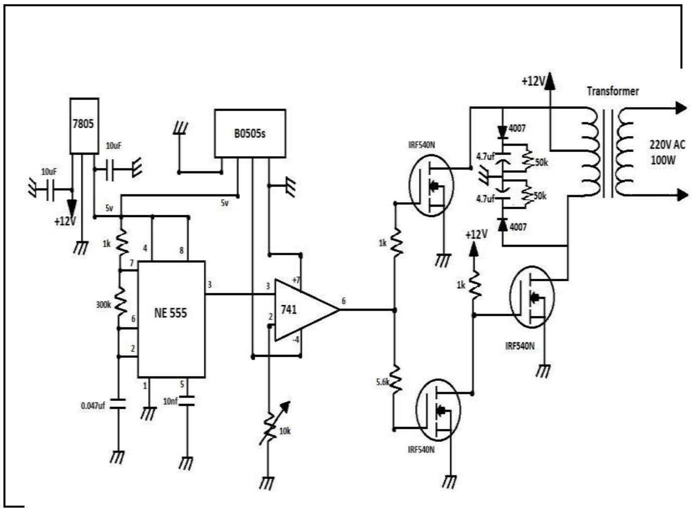

Fig. 2. *Circuit Diagram of proposed inverter*

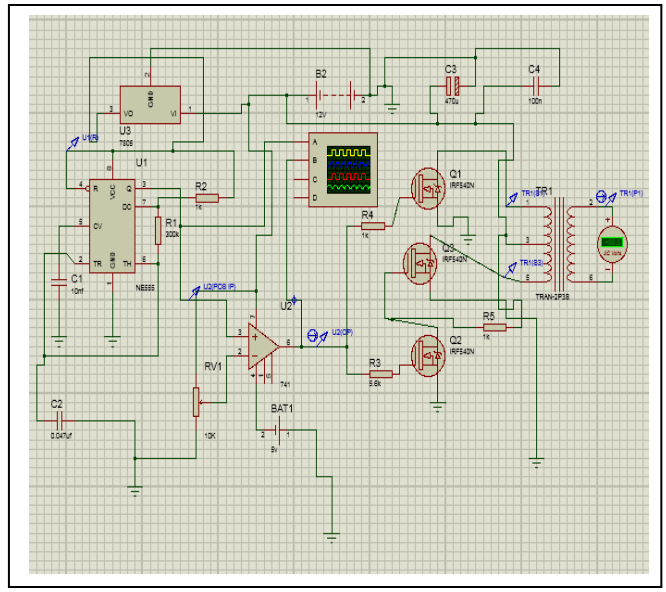

Fig. 3. *Software simulation design of proposed inverter circuit*

3 System Specification

Inverter and switching devices specification are illustrated below

3.1 Inverter Specification

The Characteristics of the proposed inverter system is showed in table 1[10].

TABLE 1: *Inverter Specification*

Input Voltage	12 Volt (DC)
Input Current	8.3 A(DC)
Maximum Output Power	100 Watt
Output Voltage	220 Volt (AC)
Output Current	0.46 A(AC)
Input Frequency	Nil
Output Frequency	50 Hz

3.2 Switching Specification

MOSFET Switches were used and it's specified according to expected output of inverter [11]. It's showed in table 2.

TABLE 2: *Switching Specification*

Frequency(f)	50 Hz
Time Period (T)	0.02 Sec
Gate Current (I_g)	0.0183A
Drain Current(Id)	8.34 A

4 Design Process

We had done both software Simulation and hardware implementation of this inverter. Both are illustrated below

4.1 Software Simulation Design

We used Proteus design suit for Simulation of total circuit

4.2 Hardware Design

The hardware for this project can be divided into seven main phases

I. 12 volt DC battery (For testing purpose we were using DC battery instead of PV panel)
II. Unregulated Switching Mode Power Supply (SMPS) IC: 7805 for drive the circuit
III. 220Volt/12Volt Centre-tapped transformer for implementing Push-Pull Inverter
IV. MOSFET for switching of Push-Pull inverter
V. Snubber Circuit for controlling oddity of transformer and MOSFET
VI. NE-555 timer circuit for generating switching pulse
VII. Comparator IC-741 for confute the PULSE for triggering the two switches.

Figure 4 is the hardware design of our proposed inverter. Here 100 watt AC bulbs provide full bright light.

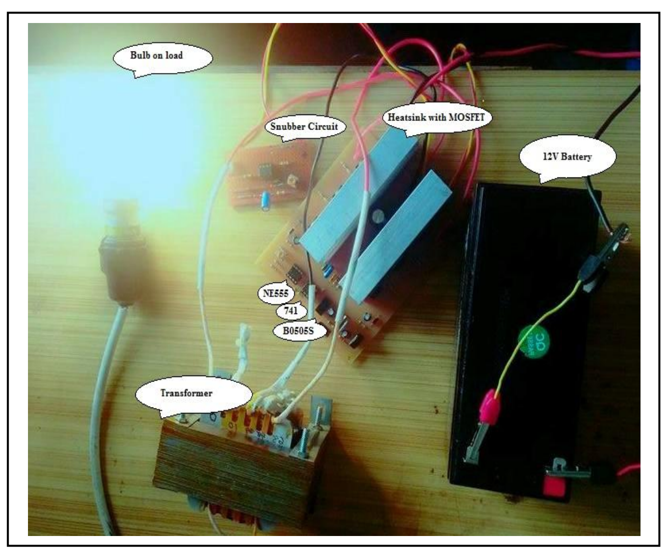

Fig. 4. *Hardware design of proposed inverter circuit*

5 SYSTEM OUTPUT

We have attained three parameters output

I. NE 555 Timer output
II. Comparator output
III. Push-Pull inverter output

Here NE 555 Timer generated pulse signal for triggering MOSFET switches (Figure 5 and Figure 6). Comparator circuit was used to make this pulse more strong for switching the MOSFET switches accurately (Figure 7 and Figure 8) [13].

5.1 NE-555 Timer

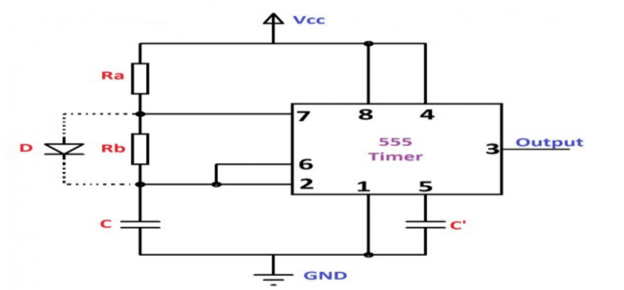

Fig.5. *Circuit diagram for NE-555 Timer*

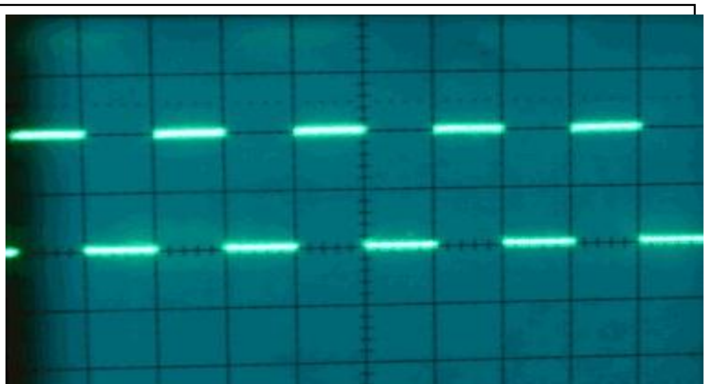

Fig.6. Output waveform of NE-555 Timer

5.2 741-Comparator

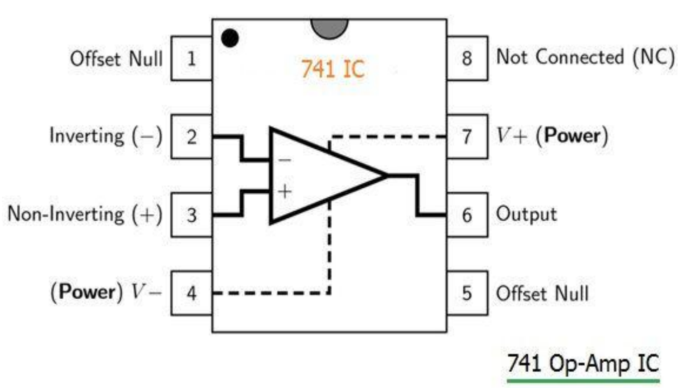

Fig.7. Circuit diagram for 741-Comparator

5.3 Inverter Pure AC Signal

For Oscilloscope X axis= Time period and Y axis=Voltage
Here in X-axis,
Time period =24 unit
Tiny 1 Unit=0.83 ms
Time period =24*0.83ms=19.2ms
Frequency, $f = 1/T$=1/19.2ms≈50 HZ

Here in Y-axis,
Peak Voltage, V=2.25 Unit
Large 1 Unit=100 Volt
Peak Voltage, V=100*2.25≈220 Volt

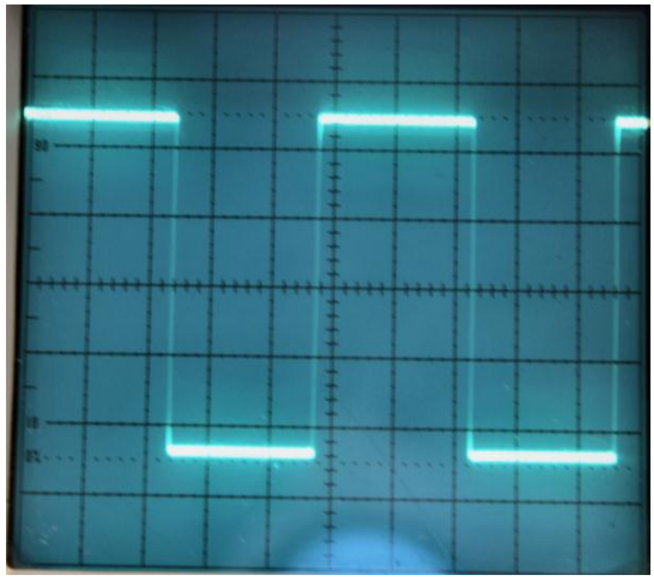

Fig.9. Final output for inverter pure AC signal

6 EFFICIENCY

The efficiency of the system was calculated from the input and output power of the inverter for various AC lighting load. For testing purpose we were using 12 V DC Battery as an input source. Table 3 shows the efficiency of system for different inputs.

TABLE 3: *SYSTEM EFFICIENCY*

Lighting Load	Output(w)	Input(w)	Efficiency
9W	8.4	20.24	41.52%
25W	32.16	38.678	83.15%
40W	45.078	49.885	90.37%
60W	66.15	66.0192	100.20%
100W	99.45	104.22	95.43%

It is reveals that the inverter works best from 40 W to 100W as the efficiency was more than 90% for this range.

7 COST EFFECTIVENESS

One of the key characteristics of this project is cost effectiveness. Usually the price of available microcontroller based inverter is almost 3000 to 3500 BDT or 38to 44 USD. It is very difficult to bear this high cost of Bangladeshi rural areas poor peoples. Table 4 shows the total equipment's price of this inverter.

TABLE 4: *PRICE LIST*

Equipment list	Quantity	Total Amount(BDT)
Transformer	1	650/-
MOSFET	3	60/-
NE555	1	10/-
LM7805	1	10/-
741	1	10/-
Variable Resistor	1	2/-
Resistor	7	7/-
Capacitor	6	6/-
PCB board	1	100/-
Diode	2	2/-
Total		857/-

This inverter is very low price which price is almost 857 BDT or 11 USD.

8 LIMITATION

To get maximum power from solar or photovoltaic inverters, a Maximum Power Point Tracking (MPPT) System is needed. Without microcontroller it's impossible to do sampling and make it pure sine wave. A closed loop control system to implement MPPT will greatly improve. MPPT circuit may be added to find the maximum power [12]. Also, more experimental data is needed to assess the product for commercial usage. Circuit insulation is needed for the safety of users.

9 CONCLUSION

This paper discusses the design and implementation of the cost effective efficient DC to AC inverter. The main objective of this project was to find an efficient power conversion system to use photovoltaic energy to meet the increasing power demands. It is optimal solution for converting solar power to AC. Specially it is fabricated for rural areas people whose are unable to buy a costly inverter. It may be also used for DC load. The efficiency of the inverter is relatively low for lower input power. As the input power increases, the efficiency increases as well. The inverter works perfectly and its cost is almost one third of conventional inverter. It has met every goal set at the commencement of this venture, though more experimental data is needed to be gathered and a closed loop MPPT system is required to be installed before applying it at any operation.

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