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Research Article

DESIGN AND IMPLEMENTATION OF SOLAR INVERTER

Rishiraj Singh

Department of Electrical Engineering, Delhi Technological University, Delhi, India

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ABSTRACT

Most countries of the world are at crucial juncture relating to use of non-conventional energy to meet ever growing demand of energy. In India; free, unlimited, clean solar energy has amply proved its utility and potential in energy sector. This article highlights the design of a simple, clean, cheap to built yet powerful voltage driven inverter circuit using power MOSFETS as switching device which converts 12V DC signal to single phase 220V AC; charged by solar energy. The emergence of monocrystalline solar panels, the most efficient solar panels till date has ushered a revolutionary concept of solar farming in India. This design can be charged by solar energy and contribute significantly towards reducing carbon emission, helping energy starved rural region of India in domestic sector where electric supply is frequented by regular cuts or no supply.

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INTRODUCTION

Solar panels are simply solar cells lined up together in series and parallel so as to get sufficient voltage and are p-n junction semiconductor devices with pure silicon wafer doped with ‘n’ type phosphorous on the top and ‘p’ type boron on the base. If the PV(Photovoltaic) cell is placed in the sun, photons of light strike the electrons in the p-n junction and energize them, knocking them free of their atoms. These electrons are attracted to the positive charge in the n-type silicon and repelled by the negative charge in the p-type silicon. Connecting wires across the junction will have a current in them [1].

We need to understand solar panels so as to understand their applications. Today, we have mono crystalline, polycrystalline and amorphous thin film panels. Mono crystalline is so far the most efficient, given that they have the maximum silicon in a unit area so more current for the same number of photons. They are made out of a single silicon crystal as a continuous lattice .Solar panels are really useful in broad daylight but we need energy when the Sun isn’t shining above our rooftops. That’s why we need solar chargers which will store energy in rechargeable batteries.

A device that converts DC power into AC power at desired output voltage and frequency is called an Inverter. Phase controlled converters when operated in the inverter mode are called line commutated inverters. But line commutated inverters require at the output terminals an existing AC supply which is used for their commutation. This means that line commutated inverters can’t function as isolated AC voltage sources or as variable frequency generators with DC power at the input [2] .Therefore, voltage level, frequency and waveform on the AC side of the line commutated inverters can’t be changed. On the other hand, force commutated inverters provide an independent AC output voltage of adjustable voltage and adjustable frequency and have therefore much wider application.

Inverters can be broadly classified into two types based on their operation:

- Voltage Source Inverters (VSI)
- Current Source Inverters (CSI)

Voltage Source Inverters is one in which the DC source has small or negligible impedance. In other words VSI has stiff DC voltage source at its input terminals. A current source inverter is fed with adjustable current from a DC source of high impedance, i.e.; from a stiff DC current source. In a CSI fed with stiff current source, output current waves are not affected by the load [3].

This project aims to make a solar inverter based on the operation of the 555 timer, IRF540 (MOSFET) in it. 12VAC is step up to 220V AC by using a step up transformer.

Components Description

Solar Panel

A solar cell is a solid state electrical device that converts the energy of light directly into electricity by the photovoltaic effect. Assemblies of cells used to make solar modules which

*Corresponding author: Rishiraj Singh
Department of Electrical Engineering, Delhi Technological University, Delhi, India

are used to capture energy from sunlight, are known as solar panels. Solar Panel burn no fuel and have no moving parts hence, they are clean and silent and producing no atmospheric emissions of greenhouse gases [4].

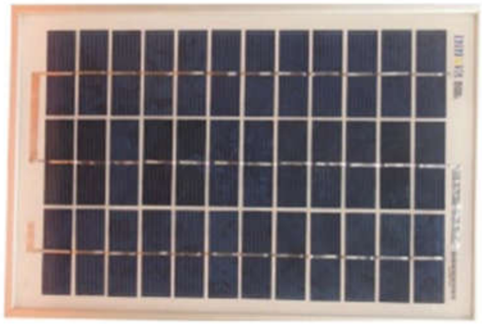

Figure 1-Solar Panel

Table 1 Solar Panel -Specification

Material Type	Polycrystalline
Voltage	Open Circuit: 21.0 V
Specifications	Number of cells: 36
Operating Voltage	16.8 V
Power In Watt	5
Item Weight in Kg	1
Dimension in mm	285 x 190 x 17
Operating Current	0.3 A
Current Rating	Short Circuit: 0.32 A

IC 555

The 555 timer IC was introduced in the year 1970 by Signetic Corporation. It is basically a monolithic timing circuit that produces accurate and highly stable time delays or oscillation. The 555IC is also equally reliable and is cheap in cost. Apart from its applications as a monostablemultivibrator and astablemultivibrator, it can also be used in dc-dc converters, digital logic probes, waveform generators, analog frequency meters and tachometers, temperature measurement and control devices, voltage regulators etc.

Figure 2 IC 555

Mosfet IRF540N

A metal-oxide semiconductor field-effect transistor is a special type of field-effect transistor that works by electronically varying the width of a channel along which charge carriers (electron or hole) flow. The wider the channel, the better the device conducts. The charge carriers enter the channel at the source, and exit via the drain [5]. The width of the channel is controlled by the voltage on an electrode called the gate, which is located physically between the source and the drain and is insulated from the channel by an extremely thin layer of metal oxide.

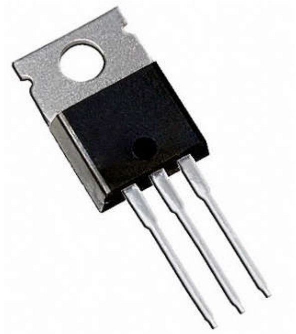

Figure 3 MOSFET IRF540N

Transistor BC549

A transistor is a semiconductor device used to amplify or switch electronic signals and electrical power with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals changes the current through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power, a transistor can amplify a signal.

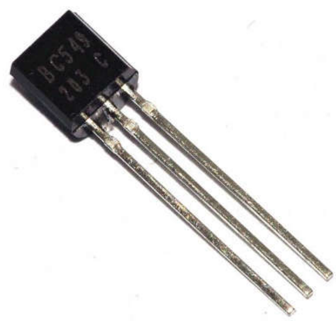

Figure 4 Transistor BC549

Transformer (12v to 220v, 5w)

A transformer is a static electrical machine which transforms electrical power from one circuit to another circuit, without changing the frequency. Transformer can increase or decrease the voltage with corresponding decrease or increase in current. When, primary winding is connected to a source of alternating voltage, alternating magnetic flux is produced around the winding. As the flux produced is alternating, EMF gets induced in the secondary winding according to Faraday's law of electromagnetic induction.

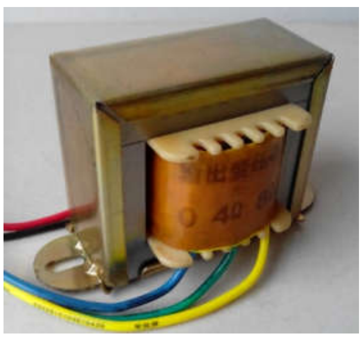

Figure 5 Transformer

A common topology for DC-AC power converter circuits uses a pair of transistors to switch DC current through the center-tapped winding of a step-up transformer, like this:

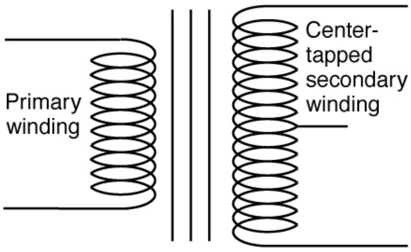

Figure 6 Centre Tapping

In electronics, a centre tap is a connection made to a point half way along a winding of a transformer or inductor, or along the element of a resistor or a potentiometer. Taps are sometimes used on inductors for the coupling of signals, and may not necessarily be at the half-way point, but rather, closer to one end.

Battery (Sealed lead acid)

This circuit is designed for three 4V, 1 Ah battery. This means a 1A current will charge the battery in 1hour. Lead acid batteries are not the best available options in rechargeable batteries (unlike portable and easy to use Li-ion batteries). But for small applications they are good enough. Secondary (rechargeable batteries) can be discharged and recharged multiple times i.e. the original composition of the electrodes can be restored by reverse current.

Figure 7 Lead Acid Battery

Simulation

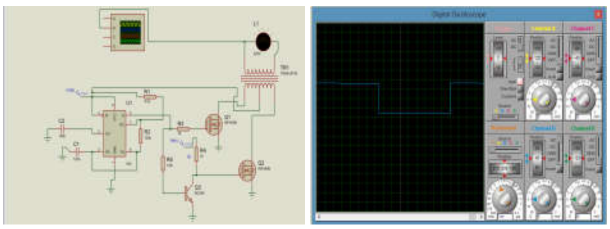

Figure 8 Simulation of Solar Inverter Circuit in Proteus Software

Experiment and Graphs

Observing Output Voltage Waveform on DSO

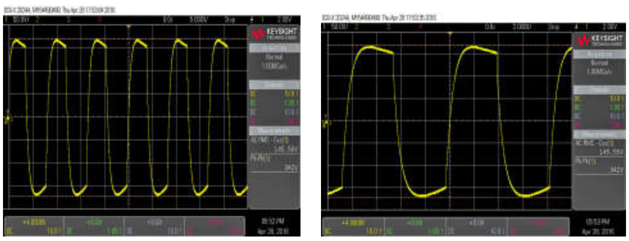

Figure 9 Output Voltage Waveform on DSO

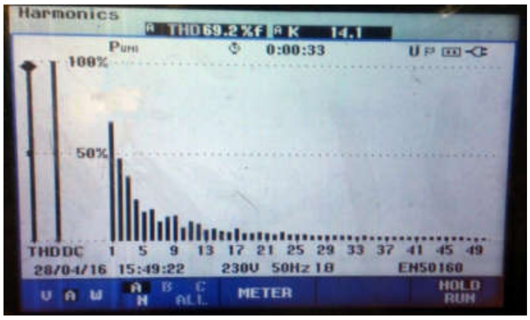

Figure 10 Output Voltage Waveform on PQ Analyzer

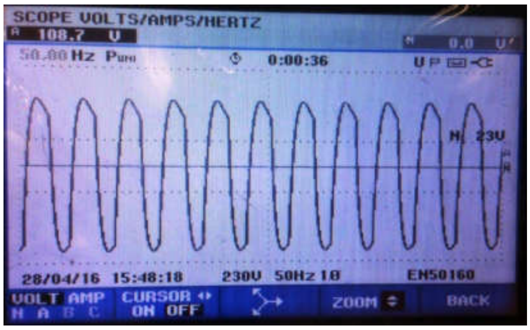

Figure 11 Output Current Harmonic Graph on PQ Analyzer

Observations

- No Load Output Voltage = 183.5 V

With 5W LED Bulb as Load:

- AC RMS Voltage = 145.56 V
- Pk-Pk Voltage = 342 V
- Total Harmonic Distortion(THD) = 69.2%

CONCLUSIONS

Here, a simple voltage driven inverter circuit using power MOSFETS as switching devices is build, which converts 12V DC signal to single phase 220V AC.

1. This circuit can be used in cars and other vehicles to charge small batteries.
2. This circuit can be used to drive low power AC motors
3. It can be used in solar power system.
4. This appliance can be very useful in rural areas where power supply is erratic and cost is a big concern.
5. It can be charged by solar energy and can significantly reduce carbon emission.

Cost Analysis

Table 2 Cost analysis of various components

S.No	COMPONENT	QTY	SPECIFICATIONS	PRICE PER UNIT(₹)
1	MOSFET	1	IRF540N	25
2	Capacitor	2	Ceramic	4
3	Transformer	1	12/220V, 1	125
4	Push Switch	1	Toggle Type	5
5	Resistor	1		2
6	Diode	1	IN4007	1
7	LED	1	Red	2
8	Solar Panel	1	5W	1000
9	Lead Acid Battery	3	4V, 1 Ah	450
10	IC	1	555 Timer	10

NET COST =Rs 2528

Future Scope

When considering possible performance enhancements for the aforementioned system, one improvement is to remove the transformer. Additionally, they are physically large and, in recent years, ever-growing in cost. However, their removal from the systems provides certain challenges. Firstly, their ratio-changing function is quite important. Optimally-loaded PV operational voltages on a 600VDC limited system run from typically 300 to500 VDC. Distribution systems in North America that are capable of accommodating these power levels are almost always 480 VAC. The respective DC voltages are far too low to allow direct inversion into 480VAC.The actual inversion voltage is usually 208VAC.A high- power, transformer less 208VAC three-phase inverter is only of use on a relevantly sized 208VAC distribution system. Such a system requires immense amounts of conductor. (It also requires all other appliances to be 208VAC-configured).As one would expect, such high-current, low-voltage distribution systems are rare and unlikely to be built purely for the convenience of a PV inverter.[6]

Aside from eliminating transformers, another likely improvement to commercial PV arrays is to go to higher PV voltages. This would, depending on how the arraysare wired, reduce DC-side conductor costs and losses. However, under traditional ground referencing of either the positive or negative rail, any increase in voltage would exceed the 600VDClimits on low-voltage equipment. Given the healthy step in cost to go to medium-voltage equipment, this apparently makes modest PV-voltage increases on traditionally referenced arrays not particularly useful with regard to cost reduction and operational performance.

The rise of three-phase string

Distributed architectures that utilize multiple three-phase string inverters throughout a solar array have been the typical architecture in Europe and are attractiontraction in the high-growth U.S. commercial market for distributed generation and energy –starved developing countries like India.. IHS predicts that low-power, three-phase inverter shipments will triple over the next four years in the U.S., with annual shipments of nearly 20 gigawatts globally in 2017. As one of the fastest-growing inverter applications worldwide, three-phase string inverters offer a compelling price-to-performance ratio, simplicity in design and ordering, ease of installation, improved uptime, and quick serviceability for commercial applications where flexibility and modularity are essential.

Figure 12 Full Setup

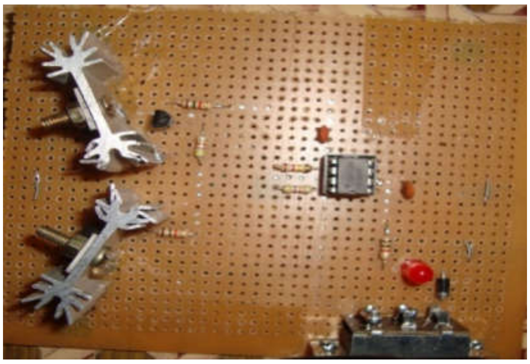

Figure 13 Close up of Inverter Circuit

References

1. D.S. Chauhan, S.K Srivastava, Non-Conventional Energy Sources, New Age International, 2010, 2nd edition
2. Solar Energy : Fundamentals, Design, Modelling and Application (Revised Edition) by Tiwari G N, Narosa Publishing House Pvt. Ltd. - New Delhi (2012)
3. Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers by Solanki C.S, Prentice Hall India Learning Private Limited (2013)
4. Physics of Solar Cells - A Text for Undergraduates, by *J Nelson, Imperial College Press*, 2003
5. Power Electronics: Circuits, Devices and Applications (English) 3rd Edition by Muhammad H. Rashid , Pearson 2003
6. "Analysis and Modeling of Transformer less Photovoltaic Inverter Systems," by Tamas Kerekes, Aalborg University Institute of Energy Technology Denmark, August 2009

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