International Journal of Electrical and Electronics Engineers
Vol. No. 10, Issue No. 01, Jan-June 2018
ISSN (O) 2321-2055
ISSN (P) 2321-2047

VOLTAGE STABILITY USING SOLAR HYBRID INVERTER WITH OPTICAL SENSING TECHNOLOGY

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ABSTRACT

This project highlights the concept of reactive power compensation using a non-conventional source of energy i.e solar energy. This reactive power compensation technique improves the performance of electric power system by controlling the reactive power efficiently. Exploiting the inherent reactive power capability of the PV inverters to offset the voltage rise in distribution network systems is the basic approach on which this project is based on. This is a loss minimization technique which enhances the efficiency of the system by increasing the amount of active power transmission.

Keywords: PV inverters, Reactive power compensation, Renewable energy source

I. INTRODUCTION

The ability of a power system to maintain steady acceptable voltages at all buses in the system under normal operating conditions or after being subjected to a disturbance such as reactive power imbalance is called voltage stability. Hence, reactive power management plays an important role in how voltage levels are controlled in the electric power system. The use of Solar Photovoltaic (PV) energy is accelerating at a rapid pace throughout the world considering the availability of solar resources. Generally, PV systems use inverters to convert DC power from PV arrays to 60 Hz (or 50 Hz) AC power grid standard. In this project, PV inverters are operated as local VAr compensators (LVArC), providing the required reactive power to the system. VAr compensation using PV inverters reduce transmission losses, help support the supply voltage, maximize power transmission capability and hence enhances stability.

Higher percentage of voltage drop occurs at the distribution end of the power system. Hence, a system is needed which can compensate the losses by regulating the voltage using reactive power compensation. This project has been designed to be connected in parallel to the distribution line. It focusses on designing and developing a solar hybrid inverter using semiconductor power devices such as bipolar transistors, thyristors for voltage amplification, particularly MOSFET as the power switches, which makes the inverter a better additional supply. When voltage instability occurs in a line, AC voltage gets developed in the current transformer. After

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rectification, this voltage is given to the control circuit (comparator circuit). When this voltage is outside the pre-determined window area of the comparator, the relay is turned on and hence the inverter circuit gets energized. The inverter circuit then uses the energy from the battery which has been charged by the PV panel mounted on a solar tracker arrangement.

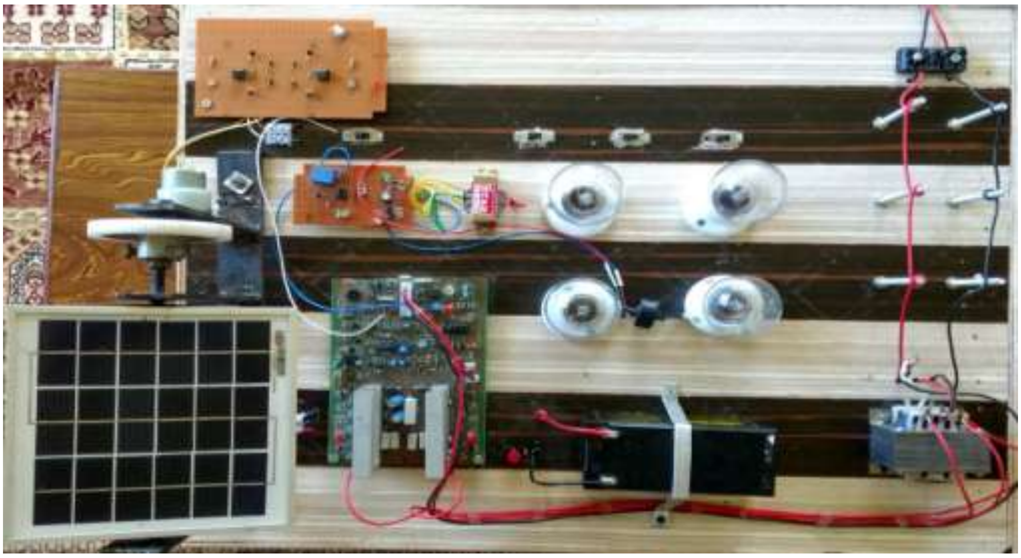

Fig 1. Project circuit view

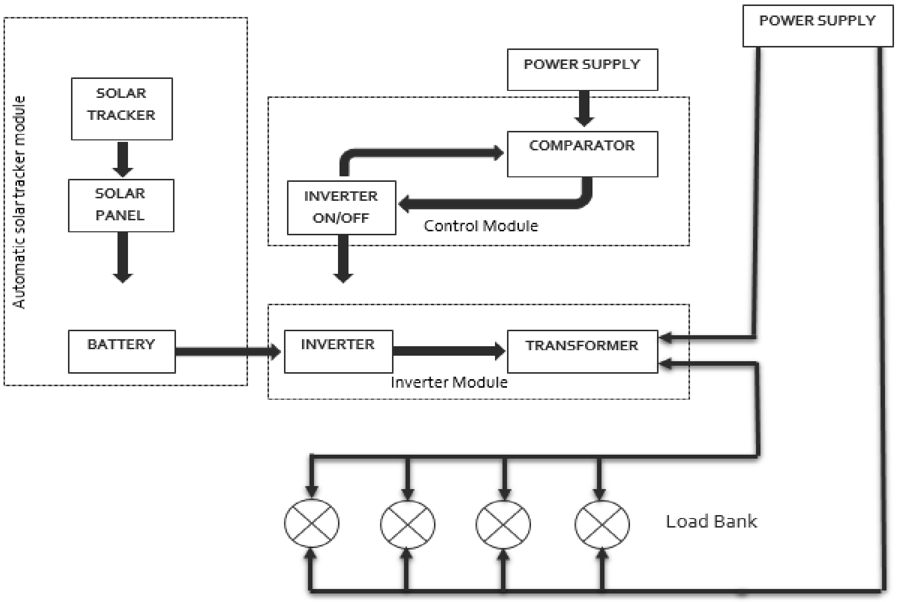

Fig 2. Block Diagram

II. SYSTEM DESCRIPTION

This project comprises of the following modules:

- Inverter module

I. Voltage control

II. Frequency control

III. Pulse width modulation

IV. Overload protection

V. Low battery protection

- Control module
- Automatic solar tracker module

2.1 INVERTER MODULE

An inverter is used to provide uninterrupted 220V AC supply to the load connected to it at its output. Constant AC supply is provided by the inverter, even when the AC mains supply is unavailable. This module is basically a combination of inverter circuit, charger circuit and a battery which consists of an inverter control and amplifier circuit SG3524A that is essentially the heart of PWM control circuit. The circuit incorporates considerable number of features which are required while keeping the cost as low as possible. The inverter output is 50 Hz pulse width modulated square wave with an EMI filter at the output. When the mains voltage is outside a pre-determined window area, inverter operation starts automatically. A single transformer is used to carry the inverter output. An automatic shutoff of the inverter occurs when the mains supply is within the desired limits. LED indicators indicate whether the load is completely on mains or the inverter is operating. The inverter module is responsible for frequency control, voltage control, pulse width modulation, overload protection and low battery protection.

2.2 CONTROL MODULE

This module consists of an operational amplifier with two NPN transistors added to the output of each amplifier which constitutes the integrated circuit "Voltage Comparator". The supply to the comparator circuit is given from the current transformer through a rectifying circuit, the output of which is fed to LM358.The comparator compares voltage levels at its output. If the output of the comparator is high, it is given to the transistor wired as a switch, which conducts and hence current passes through the relay coils. Consequently the relay switches its contacts and the inverter operates

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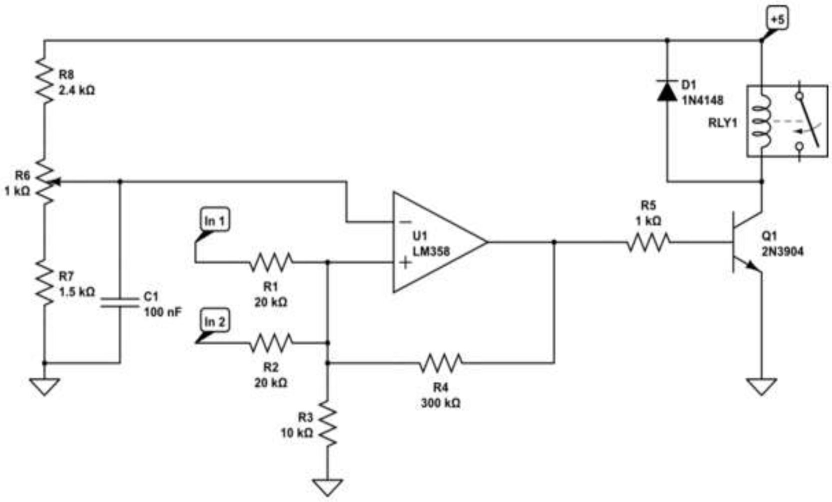

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Fig 3. Control Circuit

2.3 AUTOMATIC SOLAR TRACKER MODULE

The module consists of a simple solar tracker circuit and a solar panel whose direction is governed by a stepper motor. The solar panel is automatically moved in the direction of sun by the solar tracker circuit. This module is responsible for the battery charging and hence this solar energy as reactive power is fed to the system using the hybrid inverter.

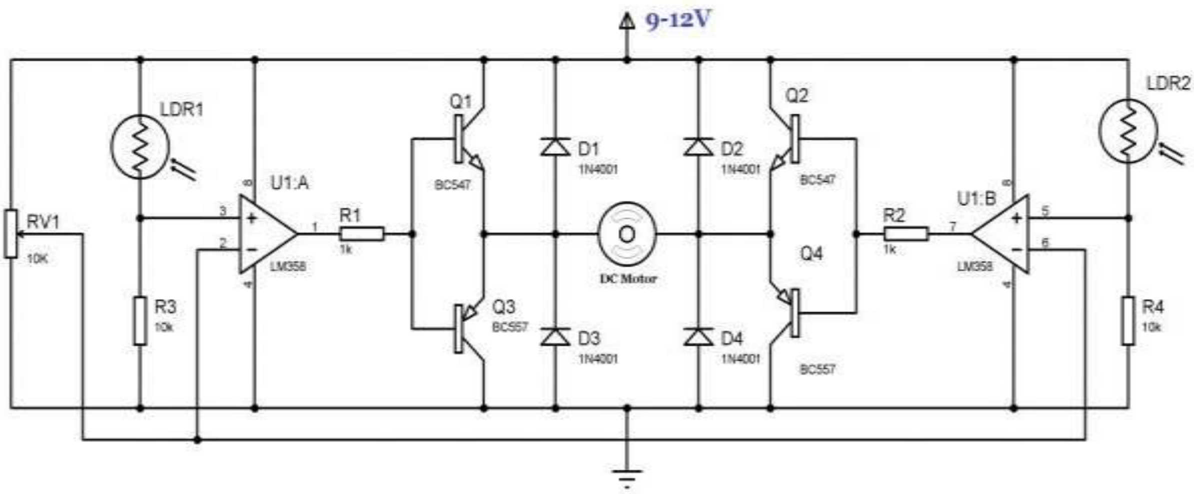

Fig 4. Automatic Solar Tracker Circuit

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III. DESIGN SPECIFICATIONS

- **Integrated Circuit(IC) SG 3524 PWM**

The SG3524 integrated circuit chips is a fixed frequency pulse width modulation (PWM) voltage regulator control circuit, with indifferent outputs for single ended or push pull applications. It performs all the necessary functions for the production of a regulating power supply, switching regulator or electrical inverter on a single chip.

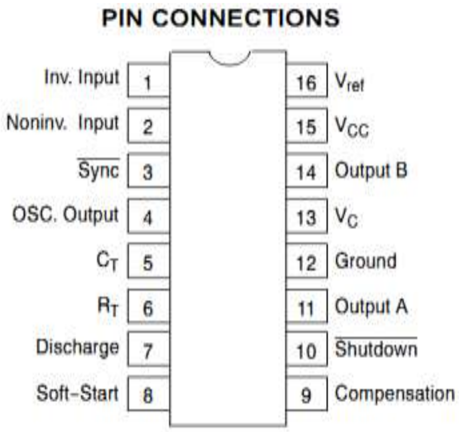

Fig 5. Pin Diagram of IC SG 3524

- **IC LM 339 Comparator**

It is a comparator IC with four inbuilt comparators and is used to compare two input voltage levels and gives digital output to indicate the larger one. The two input pins are named as inverting (V-) and non-inverting (V+). One of the pins is provided with a reference voltage and the other one receives analog input from a sensor or any external device.

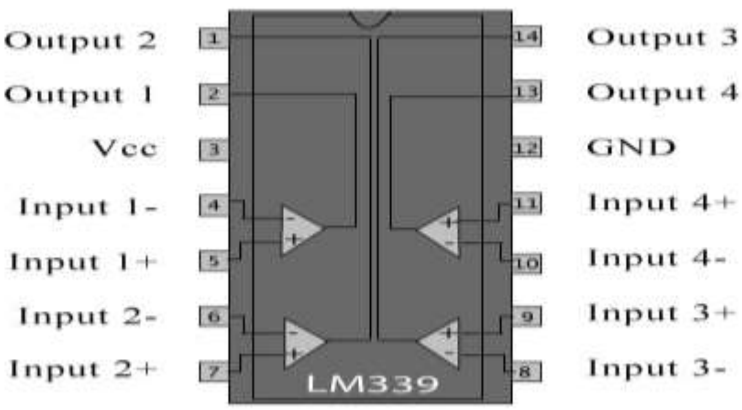

Fig 6. IC LM 339

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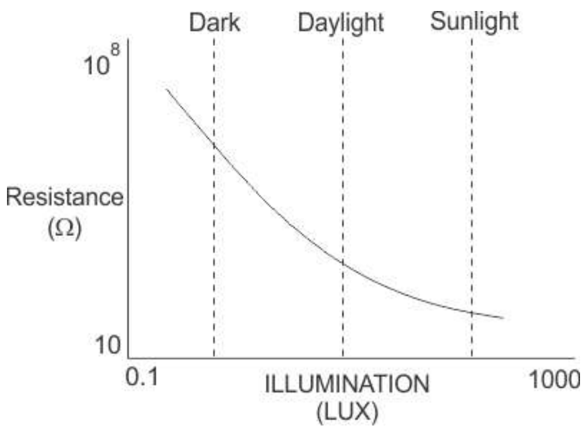
- **LDR (Light Dependent Resistor)**

A Light Dependent Resistor (LDR) or a photo resistor is a light sensitive device whose resistivity is a function of the incident electromagnetic radiation. On keeping a LDR in dark, its resistance increase and can be as high as $10^{12}\Omega$ and on absorbing light, its resistance decreases consequently.



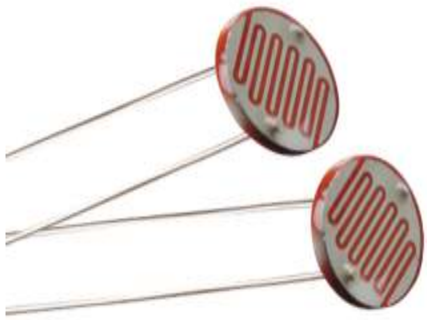


Fig 7. LDR characteristics **Fig 8. Light Dependent Resistor**

IV. FUTURE SCOPE

The common disadvantage of renewable sources is that, these generate unreliable power and hence, to overcome this problem a new technique can be implemented. We can use more than one source like both solar and wind energy in this system. The quality of power that is supplied to the consumers or other utilities should strictly adhere to the norms for the power quality. This can be achieved by ensuring that the same quality power at all levels of consumer usage, the dedicated low cost integrated chips for these kinds of applications could be developed and manufactured in large scale. This could make technology easily accessible to common man.

V. CONCLUSION

This project is a reliable circuit which takes over the task of regulating the voltage in the distribution line using a hybrid inverter. The capability of PV inverter to compensate reactive power, represents a significant opportunity to improve the operation, and efficiency of the electric power distribution system. This project came into existence considering today's reactive power interconnection requirements and seeing it as responsibility and not as a service for which one could expect compensation.

VI. ACKNOWLEDGEMENT

I would like to express our sincere gratitude for the assistance and support of a number of people especially my parents who made this project initiative a success. I wish to acknowledge Mr. Ishtiyaq Shafi Rafiqui and Ms.Adfar Majid for their throughout support and guidance in every step from conceptualisation to implementation of system aiding in successful completion of this paper.

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