AHSANULLAH UNIVERSITY OF SCIENCE & TECHNOLOGY

PROJECT REPORT

Project Title: Hybrid Inverter with Solar and AC Main Battery Charger

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Section: D2

Dept. of EEE, AUST

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Hybrid Inverter with Solar and AC Main Battery Charger

Objective: An intelligent hybrid inverter or smart grid inverter is an advanced generation of dedicated U.P.S. The aim of this project is the development of a hybrid inverter system that will consist of solar energy and AC mains, providing to consumers uninterrupted power in case of disturbance of the mains. The system first makes use of the solar energy in charging the batteries and when there is no or little solar support, switches over to the AC mains without any hassle ensuring uninterrupted electricity with very low maintenance and encouraging the use of green energy sources. Surplus generated electricity by solar panels can only be available in the daylight hours with most productive generation in the middle of the day. This electricity is volatile hence out of line with when the household uses its electricity supply. Therefore, in order to meet this deficit, that is the energy demand during nighttime when there is no solar electricity production, there is a need to utilize energy storage facilities in a smart manner.

Equipment List:

- 18 Volt, 20-Watt Solar Panel
- 12 Volt, 4.5Ah Rechargeable Battery
- IC uA741 Operational Amplifier
- IC SG3525A
- 12 Volt Single Changeover Relay
- 1N4007 Diodes
- Zener Diode (10V)
- Light Emitting Diode
- Bipolar Junction Transistors (BC547)
- MOSFET (IRFZ44N)
- Transformer (220V to 12V, 3A, 50Hz)
- LED Bulb & Holder
- Others (Resistors, Capacitors, Jumper Wires, MOSFET Sink, Switch)

Block Diagram:

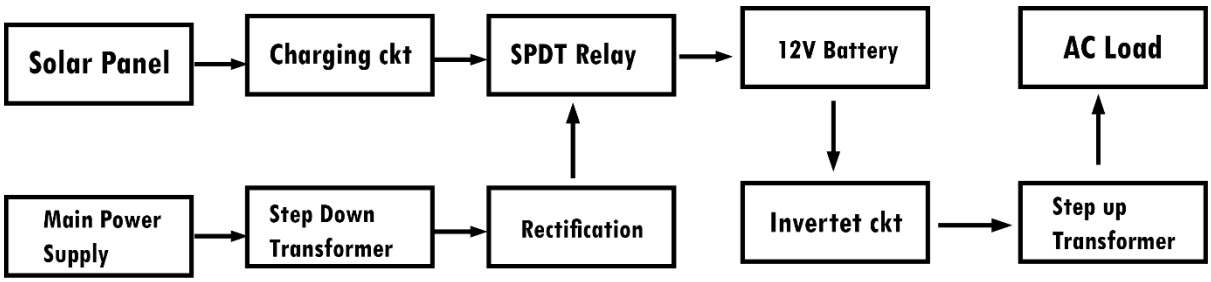


Figure: Block Diagram of the Project.

Circuit Diagram:

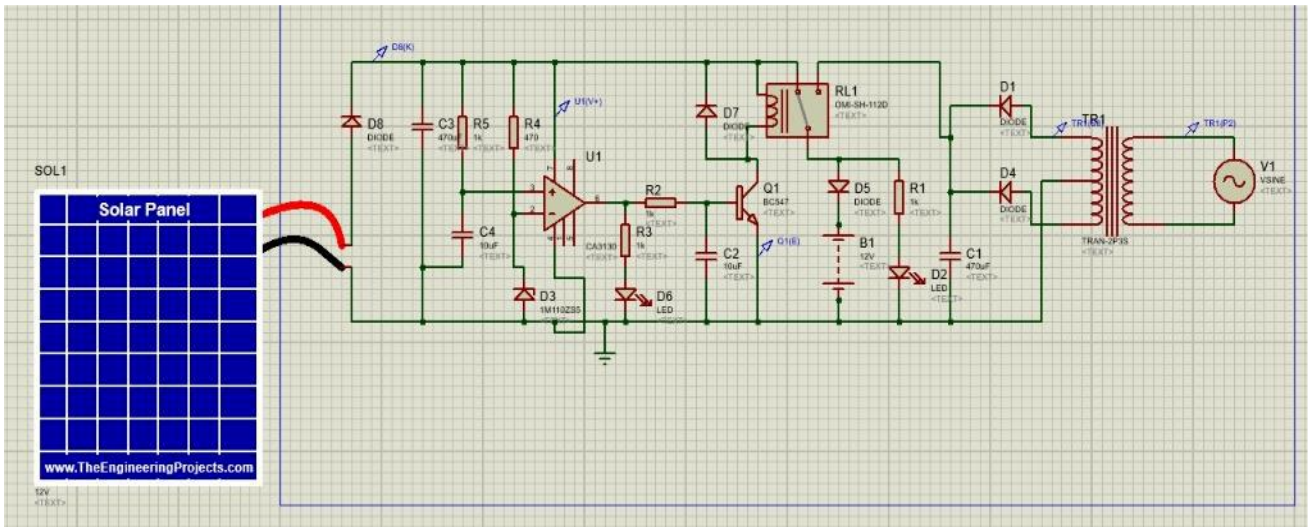


Figure 1: Charging Circuit.

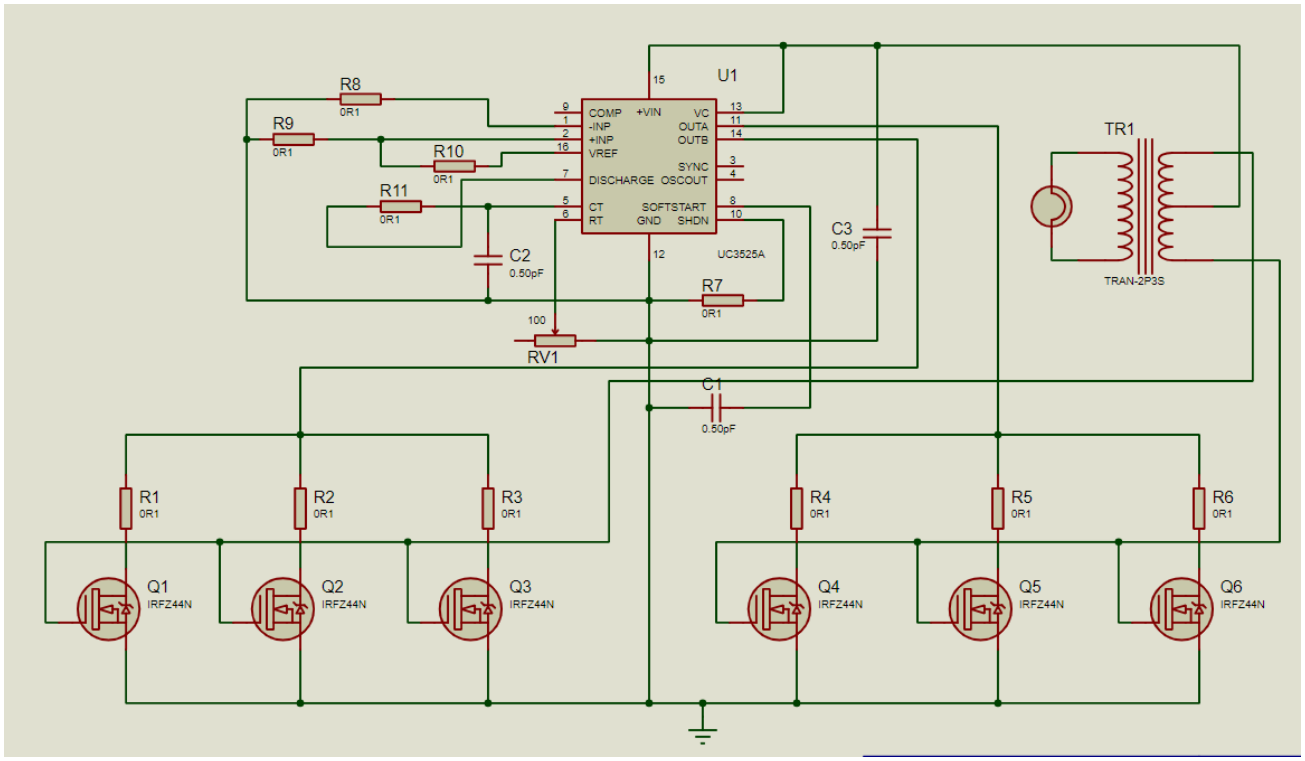


Figure 2: Inverter Circuit.

Working Principle:

"Hybrid Inverter with Solar Battery Charger" is combination of two circuits.

- Charging circuit.
- Inverter circuit.

Working Principle of Charging Circuit:

In the charging circuit, when the output of the solar panel is 12 Volts, the battery charges using the solar power. But when the output of the solar panel drops below 12 Volts, the battery charges through the AC mains power supply. This changeover is done through the 12 Volts SPDT (Single Pole Double Throw) relay. In bright sunlight solar panel gives a steady output of 18 Volts. Then the Zener diode goes in breakdown region and provides 11 volts to the inverting terminal of the comparator. Since its non-inverting input gets a higher voltage at this time, the output of the comparator turns high and the same is indicated by glowing green. Then the transistor conducts and the relay energizes. Thus, the battery gets charging current from the solar panel through the normally-open (N/O) and common contacts of the relay. A glowing green LED indicates charging of the battery from the solar panel. A capacitor is provided for clean switching of transistor. There is a diode to protect the transistor from back EMF and another diode prevents the discharge of battery current into the circuit. When output from the solar panel drops below 12Volts, then the output of the comparator turns low and the relay de-energizes. Now the battery gets charging current from the transformer-based power supply through the normally closed (N/C) and common contacts of the relay. This power supply comprises step-down transformer, two rectifying diodes, and smoothing capacitor.

Working Principle of Inverter Circuit:

In the inverter circuit we have used IC SG3525A for the switching purpose. Basically, the SG3525A IC generates PWM signals. By using the PWM signal of the output Pins [Output A(Pin11) & Output B(Pin14)] we are triggering the MOSFET's for the switching purpose. Here from the output A Signal we are controlling the 1st three MOSFET's & from the output B Signal we are controlling the other three MOSFET's. Thus, in this way we are converting the DC signal to the Modulated Sine Wave Signal.

Special Features:

- Automatically battery charging by two ways (Solar Power Supply/Main Power Supply). When solar power supply is not available then battery charging is done by main power supply (AC mains). Otherwise, battery charging occurs through solar power supply.
- Optimal utilization of solar energy.
- Uninterrupted power supply. In case of power outage from either or both the power sources (Solar power and AC mains) the battery provides backup and continues to supply the load.
- Low maintenance cost. This inverter does not require frequent servicing.

Real Circuit Picture:

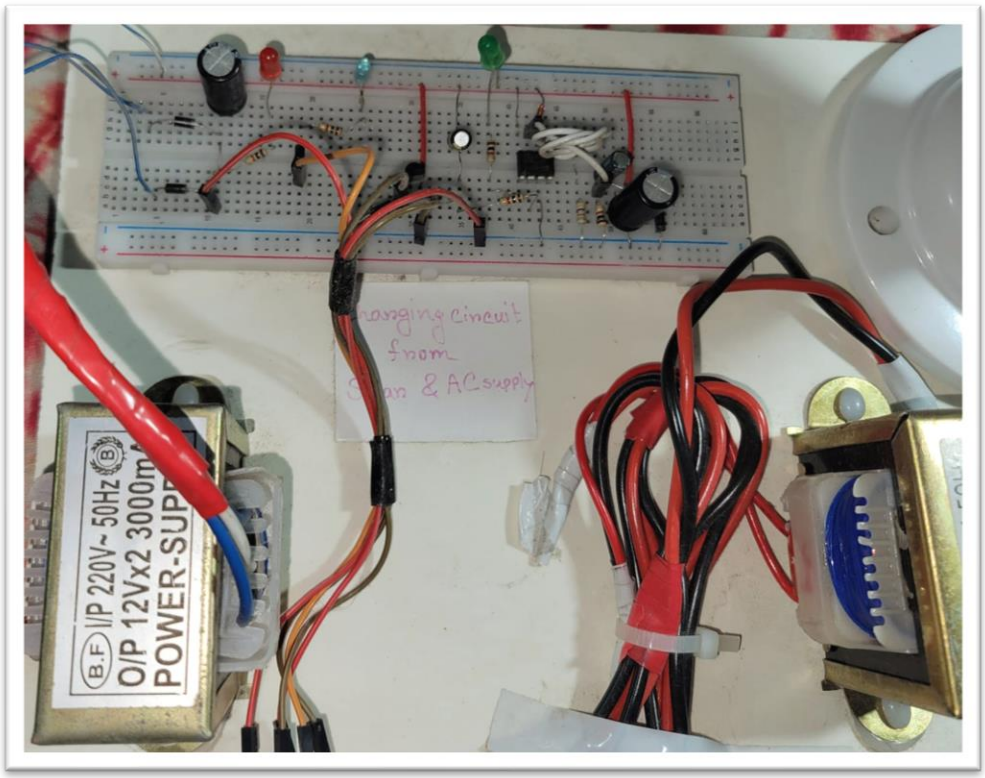


Figure 4: Charging Circuit.

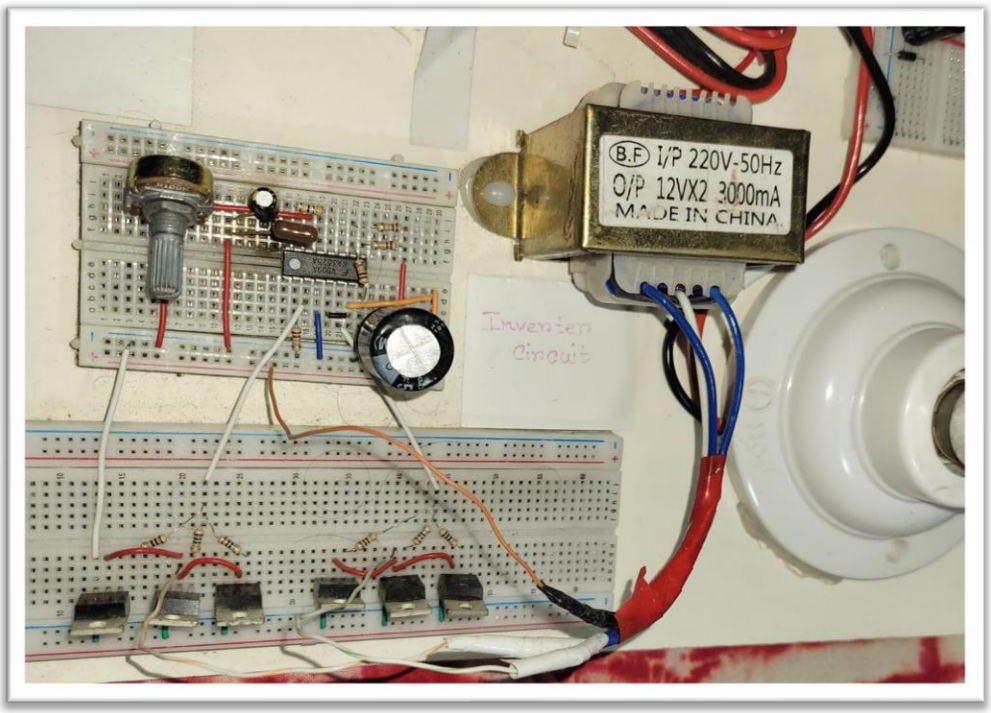
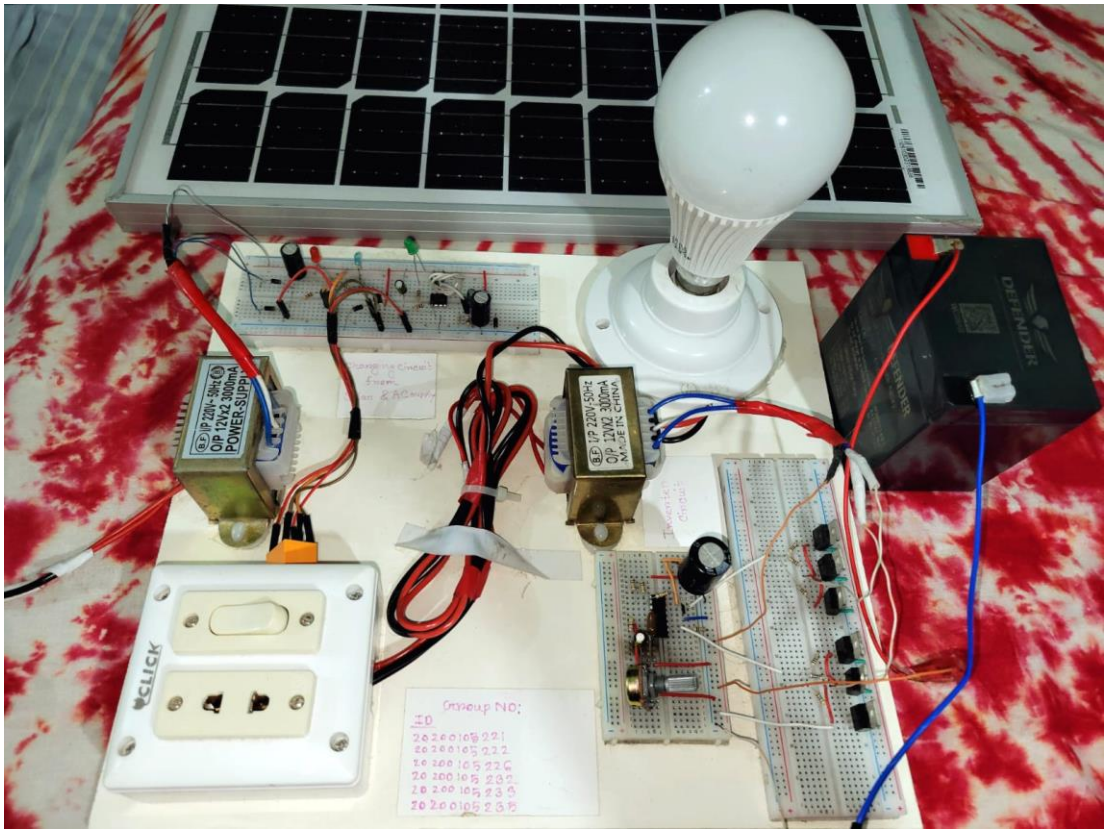


Figure 5: Inverter Circuit.



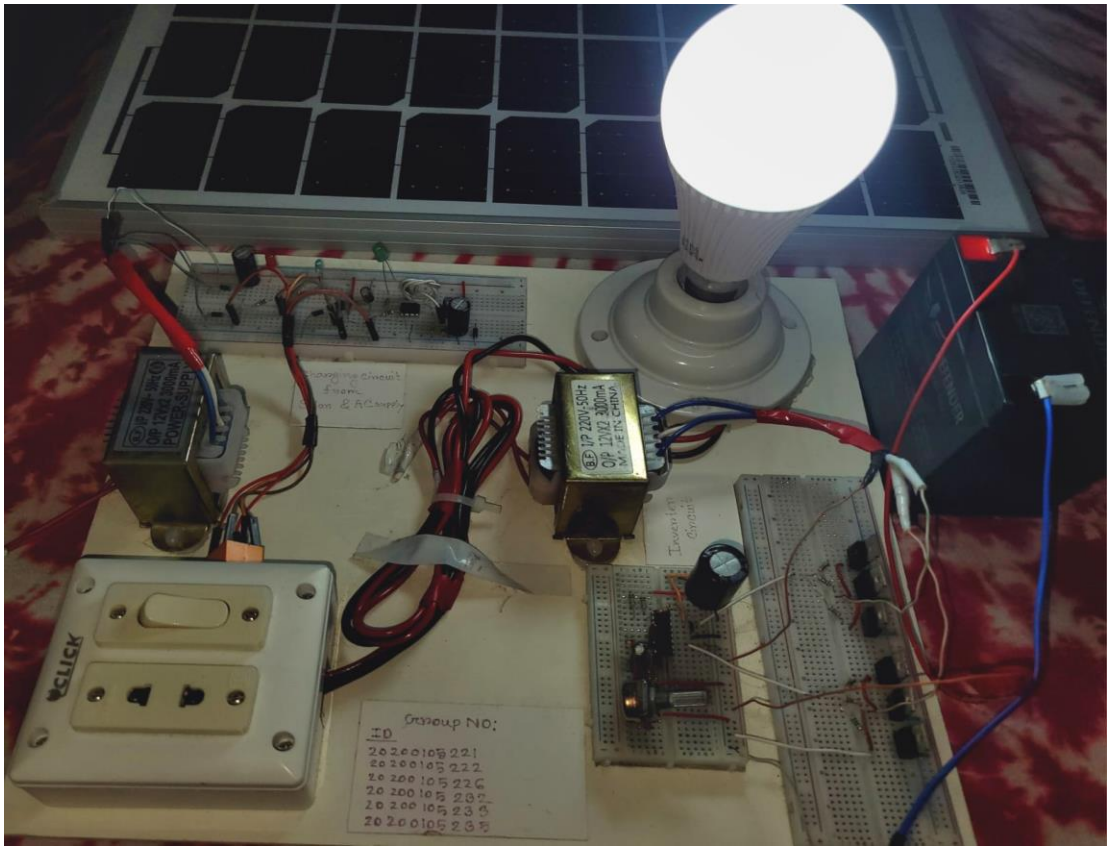


Figure 6: Full Circuit.

Figure 6: Output Waveshape.

Measured Output Voltage	
No Load	185 V
With Load (5W)	146 V
With Load (15W)	122 V
With Load (18W)	116 V

Scope for Future Work:

- From this paper It is observed that the hybrid inverter with solar battery charging provides an uninterrupted power supply during the power cuts. It is also economical as we are using solar power, which is free of cost. The solar power is also pollution free and eco-friendly in nature. A solar hybrid system stores the excess solar energy and can also provide back-up power during a blackout. As the inverter provides uninterrupted power supply, this project is applicable in the areas like hospitals, educational institutions etc. All the circuit topologies proposed in the present work is related to a single-phase inverter system. Thus, these topologies can be easily extended for the three-phase system. The inverter used in this project is combined with both ac and solar power. This can be extended by combining solar with wind energy and other renewable sources.

- The hybrid solar inverter made by us is just a prototype for making future projects which incorporates advanced technologies like micro controlled solar tracking, charge control, etc. this is to show that solar inverters are very cheap and easy to install so that the energy

demands are shifted on using renewable sources of energy. There are more advancements pending in this field which will revolutionize the energy stream and solar energy will be playing the most important role.

Drawbacks:

Inefficient Charging in Cloudy Weather: One major drawback of the system is its inefficiency in charging the battery during cloudy weather conditions. The system heavily relies on solar energy, which becomes less effective under such circumstances.

High Initial Cost: The installation cost of the hybrid inverter system, including the solar panels and battery, is relatively high. This makes it less accessible for some users despite its long-term benefits.

Large Space Requirement: The system requires a significant amount of space for installation, particularly for the solar panels. This might be impractical for users with limited space.

Dependence on Battery Health: The entire system depends on the health of the battery. If the battery dies or malfunctions, the entire system becomes non-functional, and regular monitoring is required to ensure its longevity.

Maintenance of Battery: The lead-acid battery used in the system requires regular servicing and must be replaced after a period of 2-3 years, which adds to the operational costs and maintenance.

Discussion:

The "Hybrid Inverter with Solar Battery Charger" offers a sustainable and eco-friendly solution for uninterrupted power supply by efficiently utilizing both solar energy and AC mains power. The system is designed to automatically switch between solar and mains power based on availability, thus optimizing energy usage. However, while the hybrid inverter system provides several advantages, such as stable daily output and a reduction in dependence on conventional fuel sources, it is not without challenges. The inefficiency of solar-based charging during cloudy conditions and the system's high initial costs are significant barriers to widespread adoption. Furthermore, the reliance on battery health poses challenges in terms of regular monitoring and maintenance, which can be a drawback for users seeking low-maintenance solutions. Despite these drawbacks, the system holds promise for areas with high solar availability and frequent power outages, such as hospitals and educational institutions. The project's future scope includes integrating other renewable energy sources, such as wind power, and utilizing advanced technologies like micro-controlled solar tracking. With these enhancements, the hybrid inverter system has the potential to play a vital role in the transition to renewable energy sources.

Reference: S. Shome, S. Chakravorty, and S. Pal, "Hybrid Inverter with Solar Battery Charger," B.Tech. Project Report, Dept. of Electrical Eng., RCC Institute of Information Technology, Maulana Abul Kalam Azad University of Technology, Kolkata, India, 2022.

Link: https://www.rcciit.org/students_projects/projects/ee/2022/GR1.pdf