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MPPT Hybrid Solar Inverter Project – Dual Solar and AC Charging System

A Detailed Project Synopsis  
  
This synopsis presents a comprehensive study, design overview, and working explanation of the MPPT Hybrid Solar Inverter Project with Dual Solar and AC Charging System. The project focuses on efficient utilization of renewable solar energy combined with conventional AC power for reliable battery charging and AC power generation.

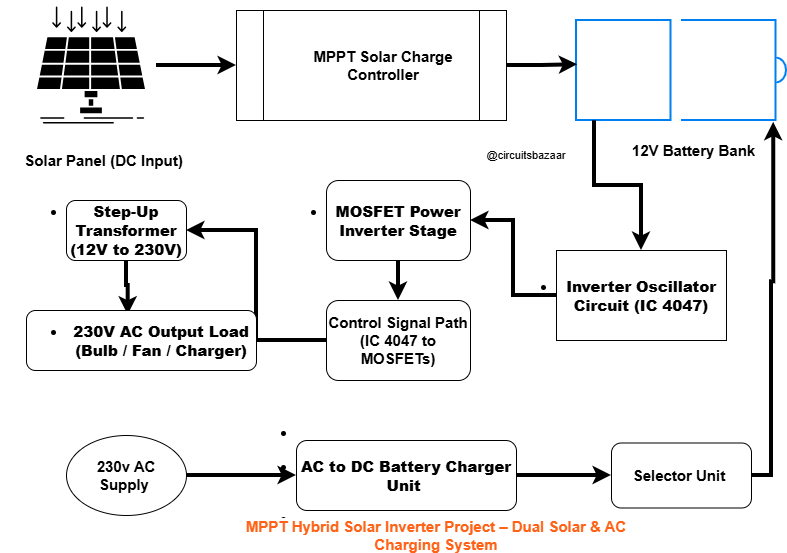
# 1. Introduction

The growing demand for electrical energy, coupled with rising energy costs and environmental concerns, has increased the importance of renewable energy sources such as solar power. Solar energy is clean, abundant, and sustainable, making it an ideal alternative to conventional fossil-fuel-based electricity generation. However, solar power availability is intermittent due to variations in sunlight, which makes energy storage and hybrid power systems essential.  
  
This project, titled 'MPPT Hybrid Solar Inverter Project – Dual Solar and AC Charging System', is designed to address these challenges by integrating solar power, Maximum Power Point Tracking (MPPT) based charging, AC mains charging, battery storage, and inverter technology into a single functional system. The system ensures efficient battery charging from solar energy when sunlight is available and automatically utilizes AC mains charging when solar power is insufficient.

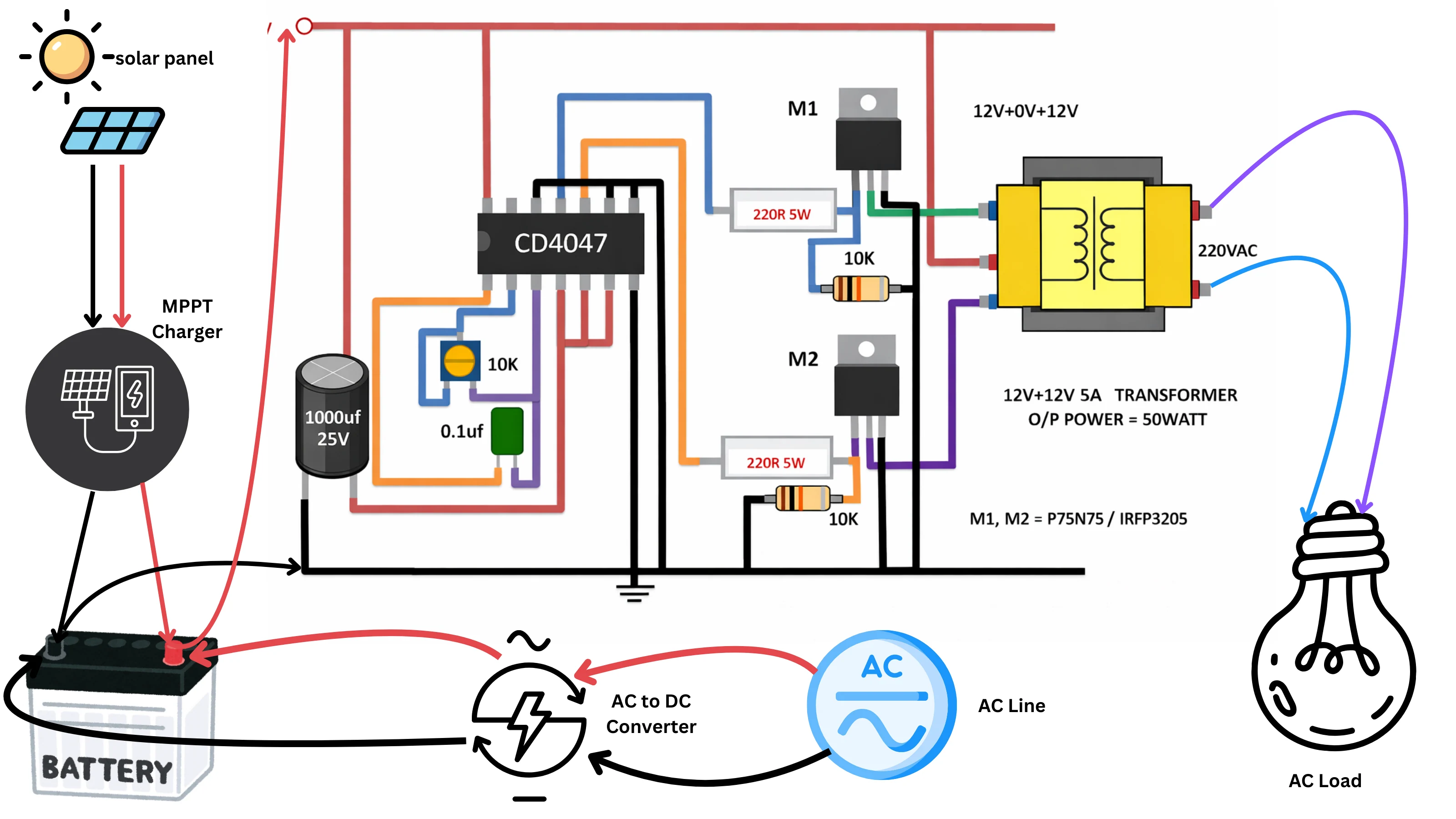
# 2. Objectives of the Project

The primary objectives of this project are:  
  
• To design and develop a hybrid power system capable of charging a battery using both solar energy and AC mains supply.  
• To implement MPPT technology for maximum extraction of power from the solar panel.  
• To convert stored DC energy into usable AC power using an inverter circuit.  
• To provide a reliable, efficient, and educational renewable energy project suitable for academic demonstrations and evaluations.  
• To enhance practical understanding of power electronics, renewable energy systems, and hybrid charging concepts.

# Block Diagram :-



# Circuit Diagram



# 3. System Overview

The MPPT Hybrid Solar Inverter system consists of multiple functional blocks including a solar panel, MPPT charge controller, battery bank, AC mains charger, inverter circuit, and output load. The system operates by prioritizing solar energy for battery charging. When sufficient solar power is available, the MPPT controller regulates the charging process efficiently. In the absence of adequate sunlight, the system allows battery charging through an AC mains powered charger.  
  
The inverter section converts the stored 12V DC battery power into high-voltage AC output suitable for operating common electrical appliances.

# 4. Components Used

This project uses a combination of power electronics components, control circuits, and energy storage devices. Each component plays a critical role in ensuring proper system operation.

## 4.1 Solar Panel

The solar panel is the primary renewable energy source in this project. It converts sunlight into direct current (DC) electricity using the photovoltaic effect. The panel used in this system provides a nominal 12V DC output suitable for battery charging applications.

## 4.2 MPPT Solar Charge Controller

The MPPT (Maximum Power Point Tracking) charge controller is responsible for extracting maximum possible power from the solar panel. Unlike conventional charge controllers, MPPT dynamically adjusts voltage and current levels to operate the solar panel at its optimal power point, thereby improving charging efficiency and reducing power losses.

## 4.3 Battery Bank

The battery serves as an energy storage unit in the system. It stores electrical energy generated from solar power or AC mains charging and supplies DC power to the inverter when required. A 12V rechargeable battery is typically used in this project.

## 4.4 AC Mains Charger

The AC mains charger converts 230V AC supply into regulated DC power suitable for battery charging. This ensures continuous battery availability during periods of low or no solar energy.

## 4.5 Inverter Circuit

The inverter circuit is responsible for converting 12V DC battery power into 230V AC output. This project uses an IC 4047 based oscillator circuit to generate switching pulses, which drive power MOSFETs connected to a step-up transformer.

## 4.6 IC 4047 Oscillator

IC 4047 is used as an astable multivibrator to generate a stable square wave signal. This signal determines the frequency of the AC output, typically set to 50Hz for standard power applications.

## 4.7 MOSFET Power Stage

Power MOSFETs act as electronic switches that amplify the oscillator signal and drive the transformer. They enable efficient switching of high currents required for inverter operation.

## 4.8 Step-Up Transformer

The transformer increases the low-voltage AC signal from the inverter stage to high-voltage AC output suitable for household appliances.

# 5. Working Principle

The working of the MPPT Hybrid Solar Inverter system can be divided into three major stages: solar charging, AC charging, and inverter operation.

## 5.1 Solar Charging Mode

In this mode, solar energy is used to charge the battery. The MPPT controller ensures maximum power extraction from the solar panel and regulates charging parameters to protect the battery.

## 5.2 AC Charging Mode

When solar power is unavailable, the AC mains charger supplies DC power to charge the battery. This ensures uninterrupted energy storage and system reliability.

## 5.3 Inverter Mode

The inverter draws DC power from the battery and converts it into AC output. The IC 4047 generates switching pulses that control MOSFET operation, and the transformer steps up the voltage to usable AC levels.

# 6. Advantages

• Utilizes renewable solar energy effectively.  
• Dual charging capability ensures continuous operation.  
• MPPT improves overall system efficiency.  
• Reduces dependency on grid power.  
• Suitable for educational and practical applications.

# 7. Disadvantages

• Initial setup cost may be higher than basic inverter systems.  
• Requires proper battery maintenance.  
• Output power limited by inverter and battery capacity.

# 8. Applications

• Educational demonstrations and laboratory experiments.  
• Final-year engineering projects.  
• Backup power systems for homes and offices.  
• Rural and off-grid electrification solutions.

# 9. Future Scope

This project can be further enhanced by integrating advanced battery technologies, IoT-based monitoring systems, and higher-capacity inverter designs. Smart energy management features can also be added for improved performance.

# 10. Conclusion

The MPPT Hybrid Solar Inverter Project demonstrates a practical and efficient approach to renewable energy utilization. By combining solar power, AC charging, battery storage, and inverter technology, the system provides a reliable and educational platform for understanding modern hybrid power systems.

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