

Solar PV Powered Battery Management System

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Abstract- The growing demand for electricity and the depletion of fossil fuels have increased the need for clean, alternative energy sources. Solar photovoltaic (PV) energy is abundant and pollution-free, but its output varies with sunlight and cannot be used directly when the sun is not available. This paper presents the design of a solar PV powered battery management system in which a solar panel charges a rechargeable battery through a charge controller, while voltage and current sensors continuously monitor the battery. A DC-DC converter regulates the charging voltage, and an inverter converts the stored DC energy into AC for household loads. The proposed system aims to achieve efficient and safe battery charging, protect the battery from overcharge and deep discharge, and deliver clean, reliable and sustainable electricity.

Keywords- Battery, Inverter, Photovoltaic system, Solar energy, Solar panel

I. INTRODUCTION

Electricity demand is rising steadily with population growth, industrialisation and the wide use of electrical appliances. Most of this demand is still met by fossil-fuel based generation, which is limited in supply and releases greenhouse gases. Renewable energy sources, particularly solar energy, are therefore gaining importance as a clean and sustainable alternative.

A solar PV panel converts sunlight directly into DC electrical energy. Because sunlight is intermittent, a storage element is needed so that energy collected during the day can be used at night or in cloudy conditions. Rechargeable batteries serve this purpose, but they must be charged and discharged within safe limits. Overcharging, deep discharge and excess current shorten battery life and can be unsafe. A battery management system (BMS) is therefore required to monitor and control the battery.

This work presents a solar PV powered battery management system that charges a battery from solar energy with proper monitoring and management, and supplies the stored energy to the load through an inverter.

II. PROBLEM STATEMENT

The growing demand for electricity and the depletion of fossil fuels create the need for an alternative energy source. Solar energy is a suitable option, but a PV system needs a reliable method of storing energy and of charging the battery efficiently and safely. Without monitoring and control, battery performance and lifetime are reduced.

III. OBJECTIVES AND SCOPE

A. Objectives

- To convert solar energy into electrical energy and store it as chemical energy in a rechargeable battery.
- To generate clean, reliable and sustainable electricity.
- To charge the battery efficiently and safely using solar energy.
- To monitor battery voltage and current and manage charging through proper control.

B. Scope

The scope of the project includes the design, installation and operation of a renewable energy system consisting of a solar PV panel, charge controller, battery, sensors, DC-DC converter and inverter.

IV. SYSTEM DESCRIPTION

The system is made up of the following main blocks.

A. Solar PV panel

The panel converts incident solar radiation into DC power. Its output voltage and current change with irradiance and temperature, so the panel is connected to the battery only through a controlled stage.

B. Charge controller and DC-DC converter

The charge controller regulates the voltage and current delivered to the battery. The DC-DC converter steps the panel voltage to the level needed for charging. Together they prevent overcharging and limit the charging current.

C. Rechargeable battery

The battery stores the energy produced by the panel and supplies the load when solar power is not available.

D. Voltage and current sensors

Sensors measure the battery voltage and the charging or discharging current. These measurements are used to decide the charging stage, to detect abnormal conditions and to protect the battery.

E. Inverter

The inverter converts the DC power of the battery into AC power so that standard AC loads can be operated.

V. WORKING PRINCIPLE

Sunlight falling on the PV panel produces DC power, which is passed through the DC-DC converter and charge controller to the battery. The sensors continuously measure battery voltage and current. When the battery is deeply discharged, it is charged with the available current; as the voltage approaches its upper limit, the controller reduces the charging current and finally stops charging to avoid overcharge. When the battery voltage falls below its lower limit during discharge, the load is disconnected to prevent deep discharge. The stored energy is supplied to the load through the inverter.

VI. HARDWARE REQUIREMENTS

- Solar PV panel
- Rechargeable battery
- Charge controller
- Voltage and current sensors
- DC-DC converter
- Inverter and load

VII. EXPECTED RESULTS

The system is expected to charge the battery efficiently and safely using solar energy, with proper monitoring and management of battery voltage and current. Protection against overcharge and deep discharge is expected to improve battery life and make the supply to the load more reliable. Measured results from the prototype, such as battery voltage and current against time and charging efficiency, will be added after testing.

CONCLUSION

A solar PV powered battery management system provides a practical way to store solar energy and use it when needed. By monitoring battery voltage and current and controlling the charging process, the system supports safe and

efficient charging and promotes the use of clean and sustainable electricity. The system can be extended in future with maximum power point tracking, wireless monitoring and larger battery capacity.

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