

# Abstract

A reliable **solar battery monitoring system** is essential for maintaining battery health and ensuring efficient energy management in solar power installations. This project presents the design and implementation of a **solar battery voltage monitor using the NodeMCU ESP8266, a 16x2 LCD display with an I2C interface, and a 0–25V voltage sensor module**. The system continuously measures the voltage of a 12V battery connected to a solar charging circuit and displays the real-time voltage and battery status on the LCD screen.

In this system, the solar panel output is first regulated using a voltage regulator circuit and protected with reverse polarity protection to prevent damage from incorrect wiring. An automatic over-voltage cutoff circuit ensures that the battery is not overcharged by disconnecting the charging source when the voltage exceeds a predefined threshold. The battery voltage is then monitored using the voltage sensor module, which safely scales down the battery voltage to a level suitable for the NodeMCU analog input.

The NodeMCU processes the analog voltage data and calculates the actual battery voltage. The processed information is displayed on the LCD screen along with battery level indicators and charging status. The system also includes a charging detection mechanism using a digital input pin that identifies whether the battery is currently charging or discharging. Visual battery icons and status messages provide an intuitive representation of battery health.

Additionally, the NodeMCU is powered through a regulated 5V supply using the **7805 voltage regulator**, which steps down the 12V battery voltage to a safe operating level for the microcontroller and display. The use of an I2C LCD interface reduces wiring complexity and improves system reliability.

This solar battery voltage monitoring system provides a low-cost and efficient solution for real-time battery monitoring in small solar power systems. It helps users prevent battery overcharging and deep discharge while improving the overall performance and safety of solar energy setups. The system can also be expanded in the future with wireless monitoring, IoT dashboards, and remote battery health tracking, making it suitable for modern smart solar power applications.