IoT UPS Health Monitor with Backup-Time Dashboard

An ESP32 monitor that tracks UPS/inverter battery voltage, load current and outage events, estimating remaining backup time on a live dashboard.

Title

IoT UPS Health Monitor with Backup-Time Dashboard — battery and outage telemetry for inverters.

Introduction / Background

A UPS fails exactly when it is needed most — usually because its battery degraded silently over months. Owners discover this during the outage, not before. Meanwhile nobody knows the answer to the simplest question during a power cut: how many minutes of backup are left? This project instruments a 12 V UPS/inverter battery with an ESP32 node that continuously measures battery voltage and load current, detects mains failures, logs every outage, and serves a dashboard with live gauges, a backup-time estimate and a 30-day battery health trend.

It is a practical study in battery telemetry: voltage-based state-of-charge estimation, load-aware runtime prediction, and event logging — all visible on a phone.

Problem Statement

UPS batteries age invisibly: capacity fades, internal resistance rises, and the printed '30 minutes backup' becomes fiction. A useful monitor must track voltage and current continuously, convert them into state-of-charge and remaining-runtime estimates, record every mains failure with duration, and surface a health trend that warns before the battery becomes useless — without modifying the UPS itself.

Objectives

- Measure 12 V battery voltage (divider) and load current (ACS712) continuously.
- Estimate state of charge from voltage under load and predict remaining backup time at the current load.
- Detect mains failure/restore via an optocoupler and log every outage with timestamps.
- Serve a Blynk dashboard: live gauges, 60-minute V/I chart, backup-time readout, event log, 30-day health trend.
- Show key values locally on an OLED.

Proposed Methodology

A resistor divider scales battery voltage to the ESP32 ADC; an ACS712 Hall sensor measures load current in series with the battery. Firmware samples both, applies a moving average, and estimates SoC from the loaded terminal voltage against a 12 V lead-acid discharge curve stored in firmware. Remaining backup time is computed as usable capacity divided by present load current, updated every few seconds. An optocoupler on the mains side flags failures and restores; each event is timestamped and pushed to Blynk. Long-term, the minimum voltage recorded under a reference load is trended over 30 days as a health indicator — a steady decline signals a weakening battery.

System Architecture / Working

Node: ESP32 + divider + ACS712 + optocoupler mains sense + OLED, wired across the UPS battery (non-invasive to the UPS). Cloud: Blynk dashboard with gauges (voltage, current, SoC, backup minutes), time-series chart, outage event log and health-trend chart. Local: OLED shows V, I, SoC and backup estimate. No UPS modification is required.

Hardware / Software Requirements

- Hardware: ESP32 dev board, ACS712 current sensor module (5 A), divider resistors, optocoupler mains-presence module, 0.96" OLED display, 12 V lead-acid battery or UPS for demo.
- Software: Arduino IDE, Blynk IoT app/account.

Expected Outcomes

A working monitor with live battery voltage/current/SoC, a backup-time estimate at design-target ±15% under constant load, a timestamped outage log, and a 30-day health trend chart on the dashboard. Runtime figures are design targets derived from the discharge curve, documented in firmware — the buyer verifies them against their own battery during testing.

Applications

- Home inverter/UPS monitoring with phone alerts.
- Small-office UPS supervision.
- Solar battery watch for rooftop systems.
- Lab demonstration of battery telemetry and SoC estimation.

Future Scope

- Coulomb counting with a dedicated fuel-gauge IC.
- Predictive battery-replacement alerts from the health trend.
- Multi-UPS fleet view for facilities.
- Mains quality logging (sags, swells, frequency).