

ABSTRAK

RANCANG BANGUN SISTEM PLTS BERBEBAN DINAMIS DENGAN MONITORING DAN PROTEKSI BERBASIS ESP32

**(2026: XV + 120 Halaman + 58 Gambar + 17 Tabel + Daftar Pustaka +
Lampiran)**

MUHAMMAD RAFA RAMADHAN

062330320654

JURUSAN TEKNIK ELEKTRO

PROGRAM STUDI TEKNIK ELEKTRONIKA

POLITEKNIK NEGERI SRIWIJAYA

Pembangkit Listrik Tenaga Surya (PLTS) off-grid merupakan sistem pembangkit mandiri dengan baterai sebagai penyimpan energi. Penelitian ini merancang dan merealisasikan sistem PLTS off-grid skala mikro dengan beban dinamis, monitoring energi, proteksi baterai, dan estimasi *State of Charge* (SOC) berbasis energi menggunakan ESP32. Tegangan, arus, dan daya diukur dengan sensor INA226, lalu diproses untuk menghitung energi (Wh) dan SOC selama pengisian dan pengosongan. Sistem juga dilengkapi XH-M604, proteksi *Low Voltage Disconnect* (LVD), dan pencatatan data real-time. Hasil pengujian menunjukkan rata-rata kesalahan INA226 sebesar 0,30% dan 0,72% pada sisi panel surya, serta 0,28% dan 0,27% pada sisi baterai. Selama tiga hari pengujian, energi maksimum baterai mencapai 54,00 Wh atau 100,00% SOC pada setiap siklus pengisian. Energi pengosongan berturut-turut sebesar 29,20 Wh, 38,80 Wh, dan 34,70 Wh. XH-M604 menghentikan pengisian pada 14,40 V, sedangkan LVD bekerja pada 10,40 V. Hasil penelitian menunjukkan bahwa estimasi energi berbasis Watt-hour mampu merepresentasikan perubahan kapasitas baterai dan menghasilkan estimasi SOC yang konsisten.

Kata Kunci: PLTS off-grid, estimasi energi, State of Charge (SOC), INA226, ESP32, LVD Low Voltage Disconnect.

ABSTRACT

DESIGN AND CONSTRUCTION OF PLTS SYSTEM DYNAMIC LOAD WITH ESP32-BASED MONITORING AND PROTECTION

(2026 : XV + 120 Pages + 58 Figures + 17 Tables + References + Appendices)

MUHAMMAD RAFA RAMADHAN

062330320654

ELECTRICAL ENGINEERING

STUDY PROGRAM OF ELECTRONICS ENGINEERING

STATE POLYTECHNIC OF SRIWIJAYA

An off-grid photovoltaic (PV) system is a stand-alone power system with batteries as the energy storage medium. This study designs and implements a micro-scale off-grid PV system with dynamic load, energy monitoring, battery protection, and energy-based State of Charge (SOC) estimation using an ESP32. Voltage, current, and power are measured using an INA226 sensor and processed to calculate energy (Wh) and SOC during charging and discharging. The system also includes an XH-M604 controller, Low Voltage Disconnect (LVD) protection, and real-time data logging. Experimental results show average INA226 errors of 0.30% and 0.72% on the PV side, and 0.28% and 0.27% on the battery side. Over three days of testing, the battery reached a maximum stored energy of 54.00 Wh or 100.00% SOC in each charging cycle. The discharged energy values were 29.20 Wh, 38.80 Wh, and 34.70 Wh. The XH-M604 terminated charging at 14.40 V, while the LVD operated at 10.40 V. The results show that Watt-hour-based energy estimation can represent battery capacity changes and provide consistent SOC estimation.

Keywords: *off-grid photovoltaic system, energy estimation, State of Charge (SOC), INA226, ESP32, Low Voltage Disconnect.*