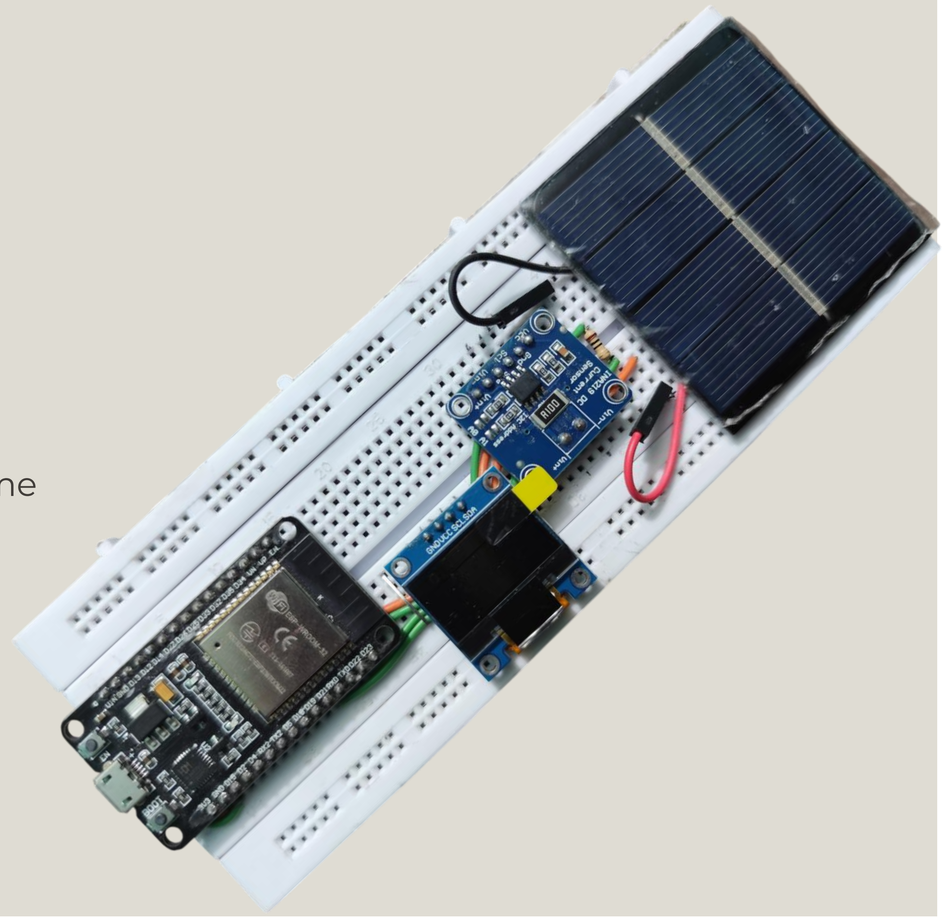
Affordable Light Irradiance Meter

A low-cost, Wi-Fi-enabled solar irradiance meter using ESP32 and INA219 for real-time light monitoring and analysis.



AUTHORS

Mohammad Abtahimul Khan(221-33-1563)
Talha Ibna Tamjid Kabbo(221-33-1595)
Department of Electrical and Electronic Engineering
Daffodil International University

AFFILIATIONS

Under the supervision of,
Dr.Tama Fouzder
Associate Professor ,
Department of Electrical and Electronic Engineering,
Daffodil International University.

INTRODUCTION

This project presents a low-cost, microcontroller-based light irradiance meter using a small solar cell and INA219 current sensor. The system calculates real-time irradiance and displays the results on both an OLED screen and a Wi-Fi-hosted web dashboard. Designed for affordability and accuracy, this meter has applications in renewable energy studies, solar power assessment, and educational tools.

OBJECTIVE

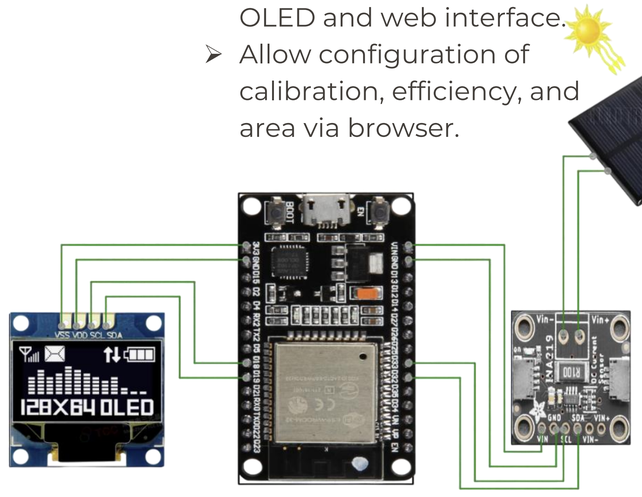
& Problem Statement

Problem:

- ❑ Accurate irradiance meters are expensive and inaccessible for small institutions and developing regions.

Objectives:

- ➢ Develop a portable, affordable irradiance meter.
- ➢ Use a solar cell and INA219 sensor for data collection
- ➢ .Display live data on an OLED and web interface.
- ➢ Allow configuration of calibration, efficiency, and area via browser.



Key Components:

- ESP32 microcontroller
- INA219 current sensor
- OLED display
- Solar cell
- Wi-Fi AP & Web Server
- EEPROM memory for configuration

METHODOLOGY

The ESP32 reads current and voltage from the solar cell using the INA219 sensor. These readings are filtered using exponential moving average (EMA) and used to calculate power and irradiance. The system also hosts a web server for real-time data monitoring and parameter adjustment. Key parameters are stored in EEPROM for persistence.

RESULTS

- ✓ Stable real-time data displayed on OLED
- ✓ Wireless access to live sensor data
- ✓ User-adjustable calibration, efficiency, and solar cell area
- ✓ Effective filtering using EMA

Real-World Applications

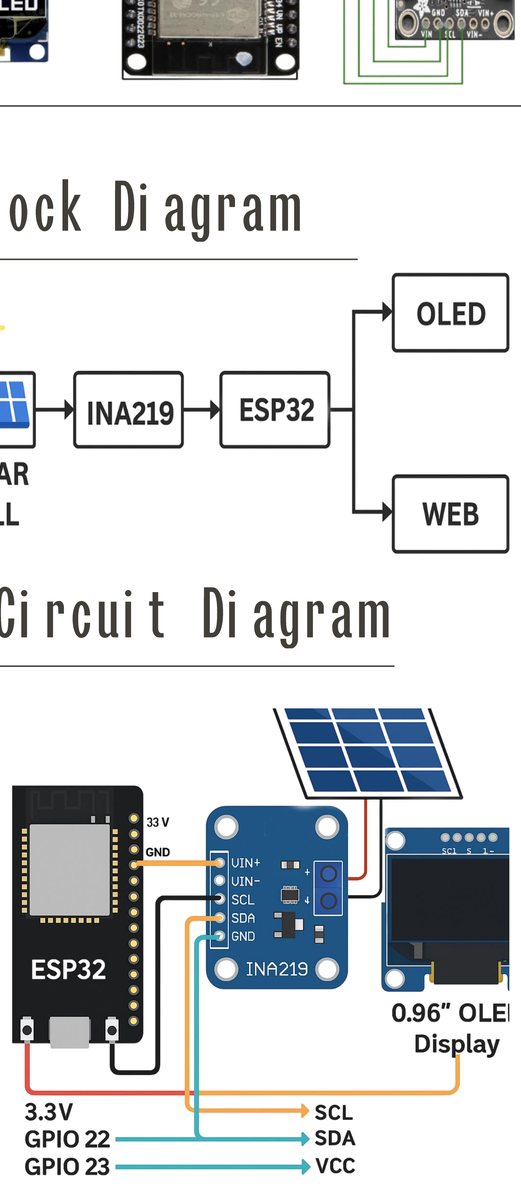
- Field testing of solar panels
- Science education (affordable classroom tool)Rural and remote weather stations
- DIY solar energy projects
- Calibration aid for photovoltaic research labs

ANALYSIS

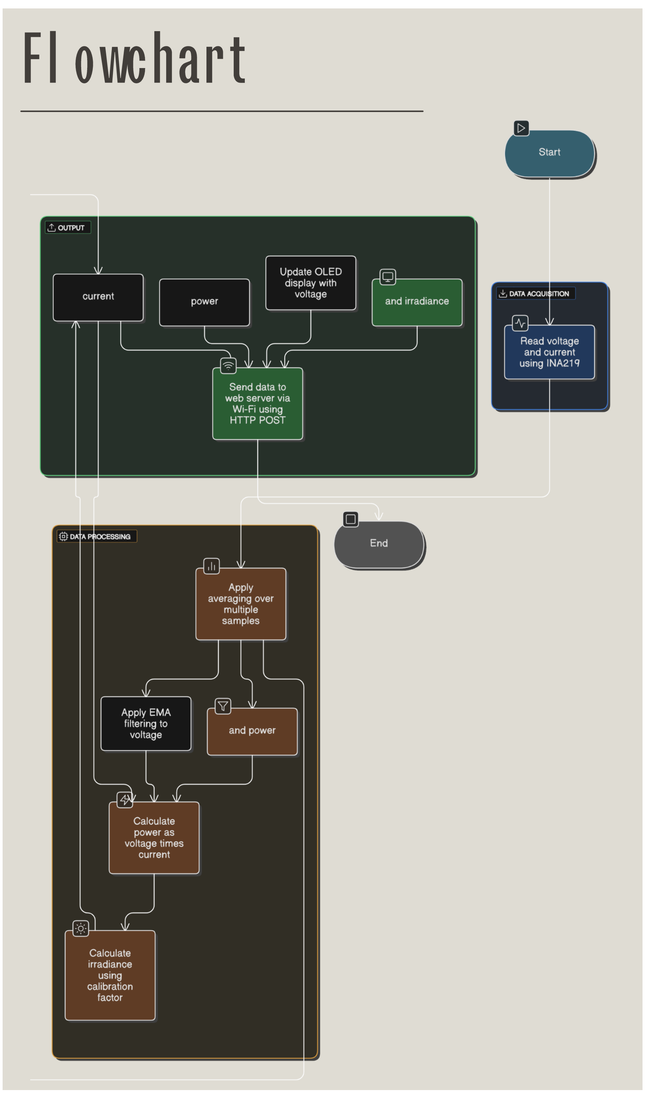
The device effectively converts voltage and current readings into accurate irradiance values using averaging and filtering. Its real-time OLED and web display ensure clear visualization, while EEPROM storage maintains settings across reboots. Testing shows reliable, stable performance in changing light conditions—demonstrating it as a viable low-cost alternative to commercial meters.

Block Diagram

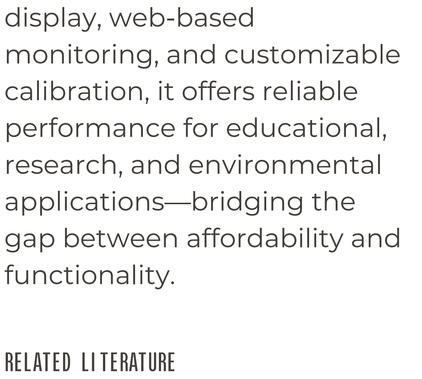
Circuit Diagram



Flowchart



Web Interface



Future Scope

- ✓ Add SD card logging
- ✓ WebSocket-based graph updates
- ✓ Integrate GPS for location-based irradiance mapping
- ✓ Enclosure design for outdoor deployment
- ✓ Auto-calibration from known irradiance sources

CONCLUSION

This project successfully demonstrates a cost-effective and portable solution for measuring solar irradiance using easily available components. With real-time display, web-based monitoring, and customizable calibration, it offers reliable performance for educational, research, and environmental applications—bridging the gap between affordability and functionality.

RELATED LITERATURE

- ❑ Adafruit INA219 Datasheet. [Online]. Available: https://adafruit.com/product/904
- ❑ Espressif Systems, "ESP32 Technical Reference Manual," 2023.
- ❑ Solar Irradiance Basics - NREL. [Online]. Available: https://www.nrel.gov/