Solar Street Light Charge Controller with Dusk-to-Dawn Control

A PWM three-stage solar charge controller with battery protection, dusk-to-dawn LED drive and midnight dimming, built as a bench prototype.

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1. Introduction / Background

A solar street light is panel, battery and lamp — but battery life is decided by the charge controller.

This project builds that controller: a PWM buck charging stage with three-stage logic, battery protection, dusk-to-dawn LED driving and a midnight dimming schedule, plus LCD status and charge logging.

2. Problem Statement

Students rarely encounter proper charge-stage theory or battery protection in builds. This project makes them the core: bulk/absorption/float staging with temperature compensation, overcharge and deep-discharge protection, and constant-current LED driving — honestly scoped as PWM (not MPPT).

3. Objectives

- Charge a 12 V battery from solar through three-stage PWM logic.
- Drive the LED lamp dusk-to-dawn with a configurable dimming schedule.
- Protect against overcharge, deep discharge, reverse polarity and short circuits.

4. Proposed Methodology

The controller senses panel/battery voltage and charge current, running bulk (max PWM), absorption (constant voltage) and float (trickle) stages with temperature-compensated setpoints. Panel-voltage + LDR dusk detection switches a constant-current LED driver on at dusk; a PWM schedule dims it through the midnight window. Protection logic handles overcharge cutoff and deep-discharge load disconnect with hysteresis.

5. System Architecture / Working

- Power: PWM buck stage (MOSFET + inductor + diode); constant-current LED driver.
- Control: ATmega-class MCU; three-stage algorithm; dusk sensing with flicker guard; dimming schedule.
- Protection/logging: overcharge/deep-discharge/reverse-polarity/short-circuit; daily Ah totals in EEPROM; 16x2 LCD.

6. Hardware / Software Requirements

- ATmega-class MCU board, buck power stage components, 12 V demo panel, 12 V demo battery, LDR, LED lamp string, constant-current driver, 16x2 LCD.

- Arduino IDE (C/C++); bench demo scale.

7. Expected Outcomes

- A working charge controller demonstrating staging, protection and dusk-to-dawn drive.
- Buyer-configured setpoints for their battery chemistry.
- A complete report, PPT and viva Q&A; on charge stages, buck conversion and battery protection.

8. Applications

- Solar lighting electronics teaching.
- Off-grid charge-controller design study.
- Campus solar demo installations.

9. Future Scope

- True MPPT tracking.
- Li-ion BMS integration.
- GSM charge-status reporting.

10. Conclusion

The project teaches the electronics that actually decide solar-light reliability, with PWM-vs-MPPT stated openly and every setpoint buyer-configured.