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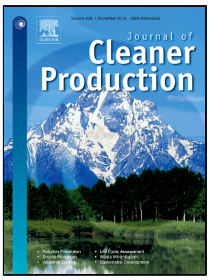

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Development of a Low-cost PV System using an improved INC algorithm and a PV panel Proteus model

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Abstract

This paper proposes a photovoltaic (PV) model for the design of PV systems with a simple MPPT to achieve high efficiency, faster response and low cost. First, a PV panel model is developed using SPICE code in Proteus tool. The verification and the validation are performed via an experimental test bench. Afterwards, a new modified Incremental Conductance (INC) algorithm is introduced. The proposed algorithm avoids the high number of the mathematical divisions used in the conventional INC. Both methods are implemented in the low-cost Arduino Uno board using the simulated PV panel model. The results show that the modified method presents good performances regarding response time (0.1 s), steady-state oscillation, and efficiency (98.5 %). To validate the proposed system, a hardware testbench is implemented using the low-cost ATMega328 microcontroller in the Arduino Uno board. Substantial cost reduction has been attained proving the financial competitiveness of the proposed controller.

Keywords- Arduino Uno; Low-cost; Mathematical division calculations; Modified incremental conductance; PV panel; Proteus.

NOMENCLATURES

- a: diode's ideality factor
- F: switching frequency [Hz]
- I: panel output current [A]
- I_s: diode saturation current [A]
- I_{ph}: photocurrent of the panel [A]
- G: solar irradiation [W/m²]
- k: Boltzmann constant [J.K^{-1}]
- q: electron charge [C]
- R_{ds}(on): Static Drain-to-Source On-Resistance of the switch transistor [Ω]
- R_s: series resistance [Ω]
- R_{sh}: shunt resistance [Ω]
- T: junction temperature [K]
- V: photovoltaic voltage [V]
- V_d: output of voltage divider circuit [V]
- V_o: output voltage of the Boost converter [V]
- I_o: output current of the Boost converter [A]
- ΔV: input voltage ripple of step-up converter [V]
- ΔV_o: output voltage ripple of step-up converter [V]
- ΔI_L: inductor current ripple [A]

GREEK LETTERS

- α: duty cycle

ABBREVIATIONS

- FLC: Fuzzy Logic Control
- INC: Incremental Conductance
- LCD: Liquid Crystal Display
- MPP: Maximum Power Point
- MPPT: MPP Tracking
- P & O: Perturb and Observe
- PV: Photovoltaic
- STC: Standard Test Condition