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Practical Implementation of a Proposed MPPT Control Strategy to Mitigate Inaccurate Responses for Photovoltaic Systems

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Abstract: In recent years, the solar energy has been considered as one of principal renewable energy sources for electric power generation. However, the maximization of extracted power from PV system is a matter of concern as its conversion efficiency is low. Therefore, a maximum power point tracking (MPPT) controller is necessary in a PV system for maximum power extraction. This paper presents a new Maximum Power Point Tracking (MPPT) algorithm for Photovoltaic (PV) systems. The new method combines a novel strategy to identify the global maximum power point. In the proposed PV-MPPT system, a new control strategy creates two operating areas. In these two areas, the step-size changes adaptively from small step to large step. Thanks to this strategy all the drawbacks of the conventional technique have been eliminated. A SEPIC DC–DC converter was applied and controlled with MPPT techniques. The modified Incremental Conductance (IncCond) method is validated by simulation under real scenario of solar irradiation. Compared with conventional method, simulation results demonstrate the highest MPPT efficiency and the shortest convergence time of the proposed MPPT method even under fast changing of solar radiation.

Keywords: Conventional Incremental Conductance (IncCond) algorithm; Maximum Power Point Tracking (MPPT); Photovoltaic (PV) System; DC-DC Converter;

Nomenclature:
$\mathbf{R_s}$ and $\mathbf{R_p}$: Series and parallel resistances, respectively ;
$\mathbf{I}$, $\mathbf{I_{pv}}$ **and** $\mathbf{I_s}$: Cell output current, cell photocurrent and cell reverse saturation current respectively;
$\mathbf{N_p}$ **and** $\mathbf{N_s}$: Number of cell connected in parallel and in series respectively;
k: Boltzmann constant;
T: Temperature in degrees Kelvin;
V: Cell output voltage;
q: Electron charge.
$\mathbf{k_i}$: Short-circuit current temperature coefficient;
$\mathbf{T_r}$: Cell reference temperature;
S: Solar irradiation W/m².
$\mathbf{I_{so}}$: Reverse saturation at $\mathbf{T_{ref}}$;
$\mathbf{E_g}$: Band-gap energy of cell's semiconductor;
A: Dimensionless junction material factor;
V_{oc}: Open circuit voltage;
I_{sc}: short-circuit current;
$\mathbf{V_m}$: Maximum PV voltage;
I_m : Maximum PV current ;
P_m: Maximum PV power;

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