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ORIGINAL PAPER

Performance improvement of grid-integrated PV system using novel robust least mean logarithmic square control algorithm

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Abstract

The growing integration of distribution grid with solar energy (PV) has resulted in severe power quality (PQ) concerns, particularly in the case of a weak distribution grid. In order to improve the PQ, the effective development of a control algorithm for the solar energy (PV) conversion system, interfaced to the grid, is very vital. In this article, an adaptive robust least mean logarithmic square (RLMLS) filter-based control has been proposed to provide grid integration capabilities of a PV system, for optimal operation. Moreover, it supplies active power to the linear/nonlinear load and grid, along with power factor correction, load balancing, and harmonics mitigation. MATLAB/Simulink (2018a) is used for modelling and evaluation of the proposed system, under various loading scenarios, including nonlinear, unbalance, and load increment. It is also tested under severe grid voltage conditions, such as unbalanced and distorted grid voltage. The system's performance has been verified as per IEEE-519 standard, showing that it is capable of grid integration and efficient in maintaining the PQ under non-ideal grid conditions characterized by a wide variety of load fluctuations, distortion, and unbalance with added benefits of faster convergence speed, reduced complexity, less sampling time, better accuracy, low dynamic oscillations/ripples in the estimation of active component, ease of implementation, and adaptability. Furthermore, a hardware prototype is developed for validation, and test results show that the system can operate efficiently under a wide variety of load fluctuations, distortion, and unbalance conditions.

Keywords Robust least mean logarithmic square (RLMLS) · Power quality (PQ) · Total harmonic distortion (THD) · Least mean square (LMS)

List of Symbols

RLMLS	Robust least mean logarithmic square
PQ	Power quality
THD	Total harmonic distortion
LMS	Least mean square
PV	Solar energy
RES	Renewable energy resources
PCC	Point of interconnection
MPPT	Maximum power point tracking
$\mathcal{U}_{pa}, \mathcal{U}_{pb}, \mathcal{U}_{pc}$	In-phase unit templates of voltages
$\mathcal{U}_{qa}, \mathcal{U}_{qb}, \mathcal{U}_{qc}$	Quadrature unit templates of voltages
e_{pa}, e_{pb}, e_{pc}	Estimation error of a, b, c phases
w_{pa}, w_{pb}, w_{pc}	Fundamental active weights' component of load of a, b, c phases
w_{lp}	Averaging of the fundamental active component of load of a, b, c phases
w_{qa}, w_{qb}, w_{qc}	Fundamental reactive weights' component of load of a, b, c phases
w_{lq}	Averaging of the fundamental reactive weight component of load of a, b, c phases
$\mathcal{V}_{sa}, \mathcal{V}_{sb}, \mathcal{V}_{sc}$	Phase voltages of a, b, c phases
V_{dc}	DC-link voltage
V_{dc}^{*}	Reference DC-link Voltage
K_{pd}, K_{id}	Gains of PI controller of DC link
K_{pa}, K_{ia}	PI controller's gain AC side
w_{dc}	DC loss weight
w_{ac}	AC loss weight
$G_c(S)$	Transfer function of the proposed control

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