A New Robust Controller Design for Three-Phase Grid-Connected PV Systems

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***Abstract*—**Development of distributed generations' (DGs) technologies and their continuous increasing penetration has recently lead to a great tendency toward these resources, among which photovoltaic (PV) generations in power distribution systems are of great importance. Being cost-effective, PV resources which are directly connected to utility grids are studied in this paper where a new control approach based on Lyapunov strategy to deal with their nonlinear characteristic is applied. The proposed scheme can be utilized in a diverse scope of PV technologies. Simulation results indicate that the suggested strategy improves the efficiency of the system by reducing the total harmonic distortion of the injected current to the grid; and, in addition to having the output current in phase with the voltage of the utility grid, it increases the robustness of the system against uncertainties while rendering the closed-loop system globally stable.

Keywords- three-phase single-stage grid-connected photovoltaic; adaptive controller; lyapunove-based control

I. INTRODUCTION

Climate changes and sustainable electrical power supplies cause renewable energy sources to become more popular than before, and among them, the photovoltaic (PV) system attracts the most attention due to environment-friendly performance [1]. As a result of the feed-in-tariff and the reduction of battery cost, the grid-connected PV system has gained popularity. However, changes in atmospheric conditions affect the intermittent PV generation [2]. Reducing cost-per-watt of PV systems generally is reached by the following [3]:

1) Ameliorating the efficiency of PV cells/modules;
2) Decreasing manufacturing costs of PV cells/modules;
3) Improving the overall PV system efficiency by focusing on the power conditioning elements.

Based on efforts devoted to new PV cell material and manufacturing technologies, high-efficient and cheaper PV panels has been yielded recently. Increasing the efficiency of the overall system using proper power conditioning stage can be an alternative to reduce the cost-per-watt of existing PV systems. Since it is the responsibility of the power conditioning stage to transfer energy properly from the energy source to the load, this stage is an essential part of the PV system. Improving the quality of the power conditioning stage is one of the key issues of future PV applications [4]. Generally, a two-step procedure, namely: 1) selecting the circuit topology and the elements of the power converter properly, and 2) designing control strategy for the chosen power conditioning stage sufficiently should be followed to conceive a PV power conditioning system. In order to have a stable non-oscillatory dynamical behavior of the PV system, the latter task is of high importance. Obviously, there is a long tradition of using linear design techniques found suitable in cases where the power converter operates about/around a fixed operating point and the disturbances are small. "P Resonant" controllers