International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 12
April 2018

High-Performance Constant Power Generation In Grid-Connected Pv Systems

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ABSTRACT

With a still increase of grid-connected Photovoltaic (PV) systems, challenges have been imposed on the grid due to the continuous injection of a large amount of fluctuating PV power, ike overloading the grid infrastructure (e.g., transformers) during peak power production periods. Hence, advanced active power control methods are required. As a cost-effective solution to avoid overloading, a Constant Power Generation (CPG) control scheme by limiting the feed-in power has been introduced into the currently active grid regulations.

However, the operational mode changes (e.g., from the maximum power point tracking to a CPG operation) will affect the entire system performance. Thus, a benchmarking of the presented CPG strategies is also conducted on a 3-kW single-phase grid-connected PV system. Comparisons reveal that either the P-CPG or I-CPG strategies can achieve fast dynamics and satisfactory steady-state performance. In contrast, the P&O-CPG algorithm is the most suitable solution in terms of high robustness, but it presents poor dynamic performance.

INTRODUCTION

Energy Storage Systems (ESS) are urgently needed by the traditional electrical generation industry, which have almost no such storage capability. Traditional electricity transmission and distribution systems transport the electrical energy from large power plants to consumers in a unidirectional way. Due to this, electricity must be consumed by matching precisely the generation with demand, but the electricity demand fluctuates heavily and consequently power plants must be overdesigned which implies an inefficient and expensive electrical system. Energy production could be made independent from the demand by means of ESS. With large-scale electricity storage capacity available, the generating capacity could be designed in electrical average terms rather than electrical peak terms. Subsequently, ESS could provide

e-ISSN: 2348-6848
p-ISSN: 2348-795X
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several advantages such as peaking power, standby reserve and load following.

In addition, the harmful emissions of the thermal power sources could be reduced with the improved grid efficiency thanks to the fact ESS provide spinning reserves and dispatchable loads. Furthermore, ESS is a needed technology for Distributed Energy Resource (DER) systems. A DER is meant to be as a sustainable and environmentally friendly alternative to the traditional energy system. which implies the energy system is becoming a mix of centralized and distributed subsystems. As DER provides smaller capacity but a bettered suited to respond to drastic load fluctuations, ESS is the key in order to increase power flexibility and back up Uninterruptible Power Supplies (UPSs).

EXISTING SYSTEM:

High-Performance Constant Power Generation in Grid-Connected PV Systems is discussed in this paper, which can ensure a fast and smooth transition between maximum power point tracking and Constant Power Generation (CPG). A two-stage grid-connected PV is employed to extend the operating area of the P&O-CPG algorithm.

By regulating the PV output power at the left side of the MPP (CPP-L). A stable CPG operation is always achieved, since the operating point will never "fall off the hill" during a fast decrease in the irradiance.

Thus, the P&O-CPG algorithm can be applied to any two-stage single-phase PV system : the operational principle of the P&O-CPG algorithm is discussed in, where the dynamics of the P&O-CPG algorithm are analyzed.

A high-performance CPG algorithm is proposed. Both the conventional and the proposed P&O-CPG algorithms are verified.

PROPOSED SYSTEM

Three CPG strategies based on 1) a power control method (P-CPG), 2) a current limit method (I-CPG) and 3) the Perturb and Observe algorithm (P&O-CPG). However, the operational mode changes (e.g., from the maximum power point tracking to a CPG operation) will affect the entire system performance. Thus, a benchmarking of the presented CPG strategies is also conducted on a 3-kW single-phase grid connected PV system.

The topology selected for the photovoltaic inverter with battery-super capacitor HESS consists of four converters that share the DC link. It is composed by a boost stage for the PV source for solving MPPT, two bidirectional DC/DC converters for both ESS, the battery and the super capacitor, for maintaining a DC link voltage, and a traditional 3-phase inverter for injecting a reference power into the grid. A transformer or DC current injection detection must be added for avoiding DC current injection into the grid. Figure 2 shows the scheme of the topology, which contains all the electrical variables used in subsequent sections.

The proposed grid-connected PV HESS converter concept has been implemented experimentally to validate its operation. Each arrow in the diagram is a voltage or a current magnitude measured in the prototype by Hall Effect transducers, LV 25-P (LEM, Geneva, and LA 55P/SP1 (LEM, Geneva, Switzerland) respectively. The STM32F407 microcontroller-based control board acquires the measurements at a sample rate of 10 kHz, while the generated 5 kHz PWM signals to control the electronic switches are updated at the same rate, that is two times each period. The power semiconductor are two IGBT-IPM 6MBP50RA120 modules (Fuji Electric, Tokyo, Japan), where each of them includes three legs to implement the topology.

MP 176065 Li-ion batteries (Saft, Bagnolet, France) and BMOD0165 P048 B01 super capacitor (Maxwell Technologies, San Diego, CA, United States) are connected to the power stage by means of its filters. The PV array is emulated by the HP E4351B solar array simulator (Agilent Technologies, Santa Clara, California, United States) and the grid is emulated by the HP 6834B Power Source/Analyzer (Agilent Technologies, Santa Clara, CA, United States), both of them connected to the topology by the appropriate filter. Voltage and current magnitudes are measured by Hall Effect transducers which provides galvanic isolation and both DC and AC components.

CONCLUSION

A benchmarking of the three CPG control methods has also been conducted in terms of dynamic and steady-state performances, tracking error, stability, and complexity. Comparisons have revealed that the CPG strategy based on a current limit method (I-CPG) has the simplest control structure.

A grid-connected photovoltaic inverter with battery-super capacitor HESS for providing manageable power injection has been presented. An adapted combination of converter topologies has been selected. The system components were designed in order to match the required behavior, taking into account different irradiance conditions based on a typical daily profile. The control logic was implemented with the objectives of: (1) extracting the maximum power from the PV panels (MPPT control), (2) suitable task sharing between battery and SC and (3) injecting power into the grid based on the direct-quadrature theory.

The main benefit of the proposed system is the possibility to transform a PV plant in a manageable power plant. This is due to the constant power injection to the grid during 15-min intervals, which is a value often considered by several standards. In addition, a fraction of the battery current is diverted to the SC along with the high frequency components. Because of this, there is a significant reduction in charge/discharge current rates, which leads to a longer lifetime and permits a reduction in size of the battery.

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