

Single-Phase Grid-Connected of PV Inverter Using PR Current Controller

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Abstract— This paper presents a Proportional Resonant (PR) current controller applied to single-phase grid-connected of PV inverter with LCL filter. The damping resistor is adopted in LCL filter for restraining the high resonant peak value. In order to track a reference value with fast, the system with high gain is produced by the PR current controller in the wide range of frequency. Then, low THD of the yield grid current is compared with PI current controller.

Keywords— PV inverter, LCL filter, PI controller, PR controller.

I. INTRODUCTION

Nowadays, due to the increasing demand for electricity, the engineer and researchers are focusing on alternative sources such as solar, wind, hydro and biomass for the production of electrical power. Solar photovoltaic (PV) is a source of natural energy or renewable energy (RE), which is in general environment-friendly and unlimited resources. Traditionally, the fossil fuels are prominent raw material to generate electrical power. However, these resources are becoming depressing. Hence, the REs become favorite for producing electrical power. Moreover, PV is convenient to develop in distribution area that could avoid a long transmission of electrical power that eventually the cost operation and dependability would be decreasing and improving [1][2].

Since the PV is generating DC source voltage, the conversion to AC voltage is essential for integrating the PV to electrical power grid network. The stage of conversion can be classified into two types, i.e., single and two stage of conversion. Typically, the two-stage conversion is more reliable and easy to implement that comprises two cascaded conversion phase of a DC-DC boost converter with maximum power point tracking (MPPT) and DC-AC conversion. Meanwhile, the boost voltage is designed in DC-AC conversion for single-stage PV inverter, which is more complicated in the controller point of view than two-stage conversion. Nevertheless, the single stage could significantly reduce the size and perhaps cost of the PV inverter [3]-[6]. Therefore, due to the simplicity of the control approach, the two-stage conversion for grid-connected is focused in this paper for further analysis.

In PV inverter, two controllers are satisfied to apply in current controlled, i.e., the Proportional Integral (PI) and Proportional Resonant (PR) controllers. A drawback of the PI controller is typical that it is not able to track a sinusoidal reference without steady-state error due to the dynamic of the integral term. Compared with the PR, it provides the system with high gain in the wide range of frequency for the fast-tracking of given reference and output grid current with low total harmonic distortion (THD) [5][6].

For grid-connected, the quality of the sinusoidal voltage from the inverter must be met the standard from the grid. Thus the passive filter is necessary. The most common and simple are using L as a filter. However, to decrease the current ripple, the large value of L should be applied, which is not so practical. Meanwhile, for LC filter, due to the uncertainty of the network impedance, it is still not convincing in the filtering result. The LCL filter is much more attractive than L and LC filter. Besides, when using the LCL filter, the cost and weight of the system are reduced. However, to stabilize the system, the active damping techniques are required for the grid-connected inverter due to the resonance of the LCL filter [6]- [7]. The additional of damping resistor in series with LCL would increase the power losses through a resistor, which is will degrade the system performance. Hence, the damping could just be applied to series with C that can minimize the power losses through the resistor.

Moreover, the grid is not always stable due to the environment of the weak network. Thus, the grid voltage has numerous disturbances such as sag, swell and frequency distortion. Therefore, the grid-connected quality system is required to investigate for robustness. The design of single-phase grid-connected of PV inverter using PR current controllers is presented in this paper. The LCL filter is adapted for this grid-connected inverter. The analyses are carried out through simulation study and shown the dependable performance during several disturbances factors.

II. SYSTEM DESIGN

In this section, PV inverter with LCL filter is described. The LCL filter parameters can be divided with inverter side inductor (L_i), capacitor filter (C_f) and grid side inductor