Improved Z-Source Inverter Controller for Enhancement of Grid-Tied PV systems

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ABSTRACT

This paper presents a photovoltaic (PV) system using a three-phase impedance source inverter (ZSI) by optimizing PWM signals to reduce harmonics. One of the advantages of this inverter compared to traditional inverters is to have buck-boost capability. ZSI can increase the output voltage according to its structure. ZSI has the unique feature of shoot-through (ST) operation, which allows short-circuiting the switches of one leg of the inverter, thereby eliminating switching dead time to improve output performance. According to the characteristics of the ZSI, in this paper, by optimizing the PWM signals, the total harmonic distortion (THD) value is reduced and ultimately improves the power quality in the output waveform of the system. The simulation results are obtained using MATLAB/Simulink software.

Keywords: ZSI, THD, PWM

1 Introduction

Connecting PV panels to the electrical grid is related to the conditions of the power converter system in which the output DC power of the panels must be converted into AC power with the desired frequency and amplitude depending on the distribution network level. Converting DC power to AC using high-frequency inverters is a better method, because low-frequency inverters cause a reduction in the power factor and harmonics injection into the grid, and the power quality is reduced at the output of the system [1]. Power quality is a term that is typically used to express the quality of current and voltage, power supply, and increasing reliability in the grid [2]. Disturbance factors of power quality in PV systems include current and voltage harmonics, frequency distortion, power fluctuations in solar sources under irradiation and shadow changes [3]. Based on the parameters of power quality and their effects, the main focus of this study is the reduction of harmonics in solar power plants. In traditional inverters, in order to reach the output voltage of the solar panels to the optimal level, a boost converter is used to increase the voltage, on the other hand, due to the presence of power electronic elements in the switching operation and because of the dead time presence, it causes harmonic distortion in the output waveform, and cannot create an ideal ac current. Finally, the harmonic distortion phenomenon generally appears, and the harmonic problem in PV systems can be defined as a special disturbance [4]. The use of ZSI with boost features increases the voltage of the inverter and its application areas. In addition by modifying the PWM signals and eliminating the switching dead time using the ST feature, the THD value of the output waveform was reduced.

A comprehensive investigation of the harmonics in an integrated PV grid was presented in [5]. The effects of harmonic distortion on electrical grid depend on the location and number of PV systems.

Considering ZSI which has unique features and presented in the previous section, in this section the proposed PWM control structure (M.PWM) is shown in Fig. 1, in order to improve the ZSI capabilities in a PV system.

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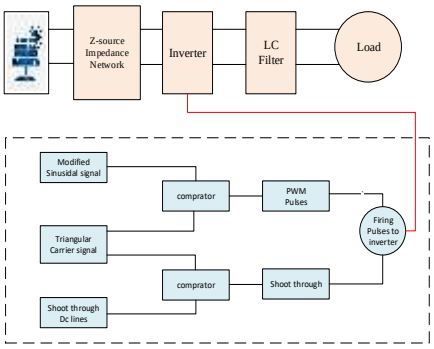

Figure 1: *Structure of the proposed controller*

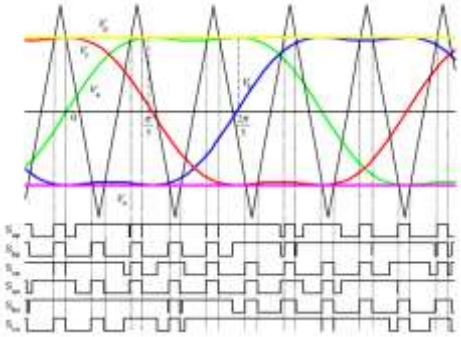

Figure 2: *Output pulses of the proposed control strategy*

In the proposed strategy, as shown in Fig. 2, a third harmonic is injected into the main three-phase sinusoidal signal with amplitude of 16%. As mentioned above, the obtained signal produces inverter PWM signals, with the difference that the peak sinusoidal waveform value decreases. Consequently, the modulation index is reduced, and the output voltage is higher than that of the traditionally controlled ZSI.

2 Outcomes and Discussion

The obtained results of voltage, THD and power for all states are presented in table 1:

Table 1: *The simulation results of three states*

Type	THD(%)	Input voltage	Output voltage	Output power
Conventional inverter	8.94	36 v	34 v	25 w
ZSI inverter	5.88	36 v	55 v	60 w
ZSI-proposed controller	3.81	36 v	56 v	62 w

3 Conclusion

According to the obtained results, the use of the proposed system (ZSI with modified PWM) improved the switching performance. It can be seen that the proposed system has a higher output voltage and lower THD than the ZSI. The simulation results in MATLAB/Simulink software proved the capability of the ZSI with the proposed PWM to improve the power quality.

How to Cite

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