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Rectified Sinusoidal PWM Based Self–Lift Converter For Grid Connected Photovoltaic System

ABSTRACT

Solar based grid connected system has three major components namely solar system, power conditioning unit and the inverter. The voltage output of the solar system is very low. In order to improve this low generated voltage, power conditioning units are employed. The usage of power conditioning unit is to boost the generated voltage and make the solar output voltage get connected to the grid. This power conditioning unit consists of DC–DC converters and transformers. Based on the usage of transformer the power conditioning unit is classified as power conditioning unit with transformer and power conditioning unit without transformer. This research work concentrates on the DC–DC converters of power conditioning component without transformer.

The power conditioning unit without transformer uses a DC–DC converter with high gain. The high gain DC–DC converters are classified as (i) the low gain low power converters operated in the high gain converters region, (ii) low gain high power converters, (iii) high gain low power converters and (iv) high gain high power converters. The voltage lift converter considered in this work falls in the category of the high gain high power converters.

High gain is made possible in this type of converters by the use of voltage lifting capacitor and the leakage inductance energy of the coupled inductance. These provide the necessary additional voltage gain. The voltage–lift capacitor acts as a voltage lift circuit. If this circuit is added to conventional converter a new type of circuit is created called as self–lift converter. This research proposes self–lift converters for grid applications.

To this self–lift converter, a modified sinusoidal pulse width modulation named as Rectified Sinusoidal Pulse Width Modulation (RSPWM) is proposed in this research work. By applying this modulation technique the output voltage waveform of the converter is in the shape of ‘Negative–cycle–converted’ DC rectified output voltage.

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By using the proposed modulation technique the advantages achieved are (i) less number of high frequency switches in the complete circuit, (ii) the power loss of the entire circuit is reduced, (iii) the control circuit of the complete system is easier as less number of high frequency switches are used and (iv) the filter size in the output waveform is reduced.

The proposed RSPWM technique is tested with the SEPIC converter and it is tested with the widely used high gain high power DC–DC converters, viz., (i) self–lift Cuk converter, (ii) self–lift positive output Luo converter, (iii) self–lift negative output Luo converter and (iv) self–lift SEPIC converter. The output DC rectified output voltage waveform is inverted by using a pulse width modulation technique triggered inverter at normal frequency (50 Hz). These circuits were simulated using MATLAB Simulink in open loop and closed loop conditions. To demonstrate in practise the hardware models were developed. Before creating the hardware models, the circuit is simulated in the proteus software with PIC16F877A microcontroller and then the hardware was created. In addition to this, instead of using microcontroller for pulse generation, the pulses are generated by using the realtime interface model ‘dSPACE’. The proposed modulation triggered converter is tested by connecting it as a Distribution Generator (DG), to the 15–bus radial distribution network and the results are discussed.