Current Fed Switched Inverter Using Sliding Mode Controller (SMC) For Grid Application

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Abstract

For the grid applications, the current fed switched inverter (CFSI) is designed to distribute the energy using the Photo-Voltaic system is proposed in this paper. It has high gain generation ratio and using less passive components. The inverter circuit is powered by the PV model of two diodes and the uninterrupted supply to the inverter circuit is done by the Maximum Power Point Tracking (MPPT) of Incremental and conductance algorithm. In this system, the both switched boost characteristics and the source inverter characteristics are combined at the single stage power generation. The current in the utility grid is controlled and maintained by the sliding mode controller (SMC) controller. The SMC controls the harmonics in current, settling time of DC link voltage, and the high voltage gain achievement. The solar generates 24V and the dc link capacitor is 230V obtained by the CFSI and the system verified using MATLAB/Simulink.

Keywords: CFSI, PV, I&C, Grid, SMC.

1. Introduction

The main energy conversion system of large scale PV system is installed in wide range of the world. In this system the main area is the power conversion stage of AC to DC. For this purposes the multilevel converters are used in the PV power conversion system (1). Inverter dead time effect based on the input current of inverter is derived and the inclusion the expression of switching cycle input current of inverter average (2). The single CFSI is implemented without the DC constant voltage maintained capacitor. Here the intermediate DC bus that pulsated is introduced. For the high power applications, the proposed system with full three bridges is used (3).In (4) the inverter of self oscillating current fed is designed for the wireless power transmission.

In (5) the cost reduction inverter is proposed due to their reduction in the power switching devices. But the inverter fed motor also provides the high torque ripples when using in the non sinusoidal voltages. The motor is used in the water pumping system with the PV array and the proposed scheme is controlled by the sliding mode controller (7). The inverter for the permanent magnet synchronous motor is controlled by using the model predictive current control. The PMSM is explained with the consideration about the fluctuation in the capacitor voltage (6). In (8) quality of the power is improved micro grid system of single phase standalone is controlled by the adaptive sliding mode controller. The simulation of both PV system as well as grid model is simulated by using the Simulink. In this, the quality of the power is improved and two PV arrays are used (9). The Z- source inverter (ZSI) is used to both active and reactive power supply to load using the predictive power control. Utilization of this inverter leads to the major power generation from the solar system for grid (10). For the system of solar energy tied with grid, the phase locked loop is implemented at single stage. Here the losses can be reduced because there is no boost converter is used and the storage device done the power flow (11). The algorithm of adaptive sliding mode control (ASMC) is implemented to the solar energy based system. In this paper, when the occurrence of distortion of grid voltage, unbalanced loading and the duration of solar irradiance variation, the system would reduce the both reference and actual current of the inverter that given to the PV system which is connected with grid (12).

The power converter control with the two level grid connected of three phase is proposed. This paper explains the sliding mode which is used to regulates the voltage at the its outer loop and the power tracking at its inner loop (13). In the grid connected variable speed wind turbines are mostly sensible in grid faults. The control system design is in grid systems must be consider the faults that can occurred in grids. The SMC controller is best and suitable for the disturbances and the dynamic changes in the parameter variation. It offers the fast dynamic response to the system (14). In (15) the both balanced and unbalanced voltage conditions using the SMC with the control of direct power for extending the active power. Normally, the control method in the event of unbalanced voltage grid conditions would be complicated. The active power is provided to the grid system by the control of SMC.

2. Methods and Materials

In this method, the current fed switched inverter is used for the AC load applications. The source is generated from the solar two diode PV system and it is fed to the single power conversion stage of CFSI. At this stage, the given energy is achieved the high gain. The proposed system block diagram is shown in fig. 1. The both operation of conversion as well as inversion are done by the single stage power conversion using CFSI. The control of the system is achieved by sliding mode controller. It controls the harmonics, settling time, and the voltage gain that enhanced using the single stage CFSI. The SMC is used in the current fed switched inverter.

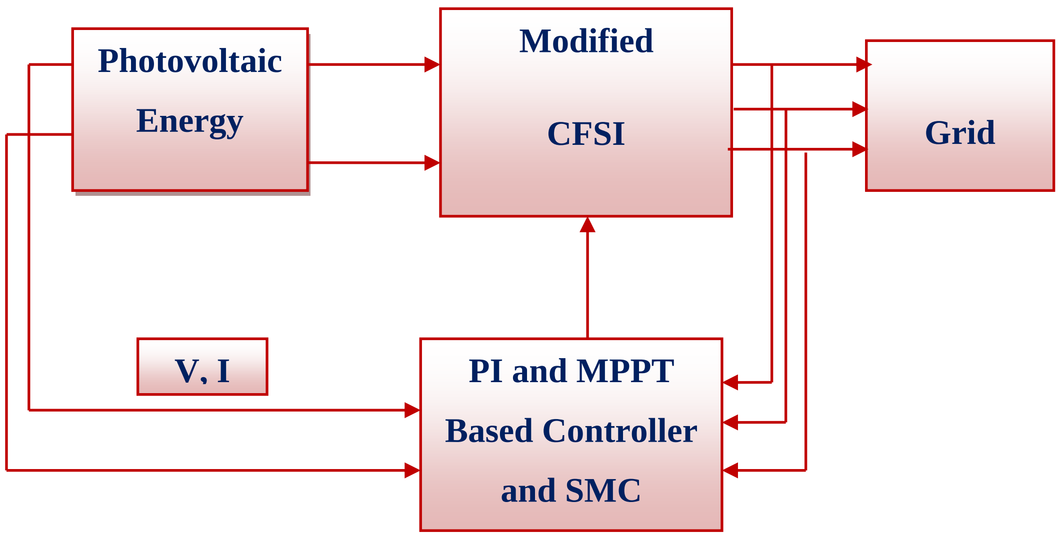

Figure. 1 Proposed System Block Diagram

3. PV System

The two diode structure shown in fig. 2 is slight difference to the single diode model. In two diodes model there is the addition of an extra diode to increase the accuracy by improving the fitness of the curve.

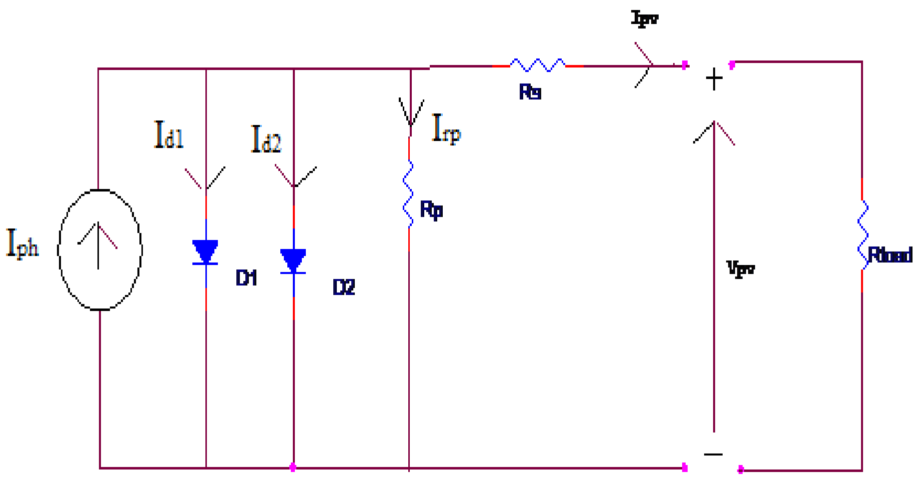

Figure. 2Two Diode PV Structure

The equations are given by

$$I = I_{Photo} - I_{Diode1} - I_{Diode2} - I_{shunt} \quad (1)$$

$$I_{D1} = I_{01}\left[e^{\left(\frac{V+IR_S}{\alpha_1 V_T}\right)} - 1\right] \quad (2)$$

$$I_{D2} = I_{02}\left[e^{\left(\frac{V+IR_S}{\alpha_2 V_T}\right)} - 1\right] \quad (3)$$

Where

V - PV voltage,

Rs, Rp - series resistance, parallel resistance.

I - PV current.

α - Diode ideality factor.

VT - Terminal voltage.

I01&I02 -output current to diode 1 and diode 2 respectively

4. I&C Algorithm

From the PV supply source, the power extraction technique that produces huge power or energy. The parameters are such as voltage, and current. I &C has high ability to generate more power from the source.

5. Current Fed Switched Inverter (CFSI)

The CFSI circuit is shown in fig. 3. The sliding mode controller is for providing control signals or variables to the three-phase inverter which utilizes for the conversion dc to alternating current. The PI-based I&C has used to provide continuous power to the system.. It has one switch, one capacitor and also a inductor; two diodes are associated with the inverter circuit and the supply.

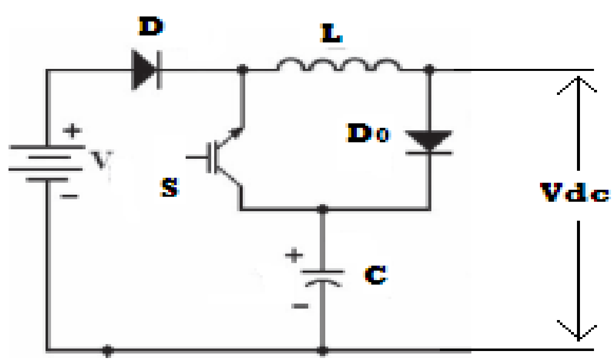

Figure. 3 CFSI inverter circuit diagram

6. Sliding Mode Controller (SMC)

The sliding mode controller is a popular control technique for the stability of the system and the system robustness regards the dynamic parameters, the input and output variation. SMC can be applied for the converters to control the single stage operation in the CFSI. Due to the less frequency in switching, the SMC cannot be applied ideally. In renewable energy applications, the output dc voltage from the converter can be varied or the source supplied to the inverter varies because of the applied load to the system. Fundamentally the SMC is chosen for the DC-DC converters in the power stage conversion to control the DC link voltage that provides energy to the inverter. Depends on the load variation, the changes in the input and output such application the SMC is well suitable one. The both conversion and the inverter operation are done by the sliding mode controller for the system stability and the voltage control.

7. Simulation Results

The CFSI is connected with the grid system is designed using PV system as a source. The energy is generated from the PV supply that fed to the inverter. The power conversion stage is done the voltage gain and maintain the DC link voltage. The three legs inverter performs the supply AC voltage to the grid and it is controlled by using sliding mode controller. The Simulink model of the system is illustrated in fig..4.

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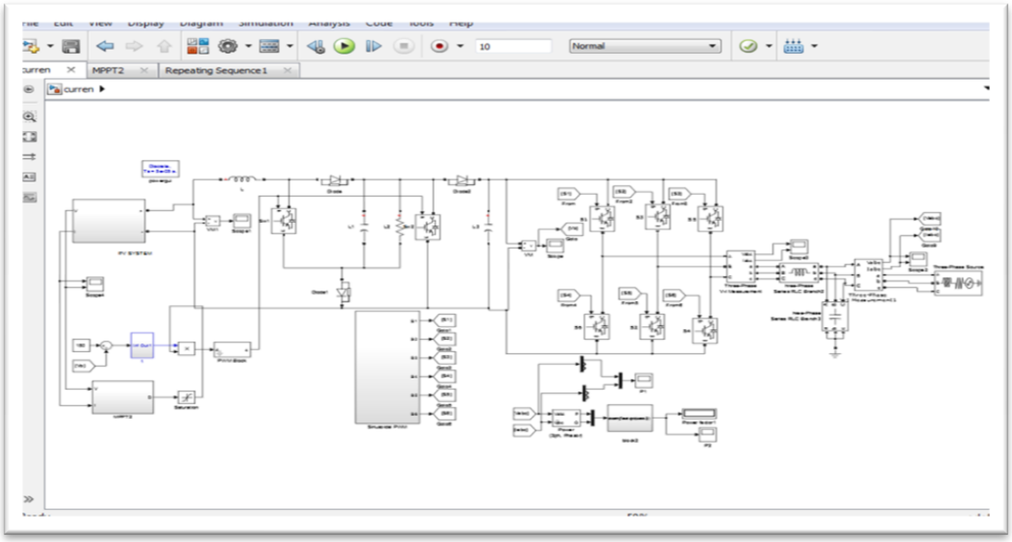

Figure. 4 The Simulink model of the system

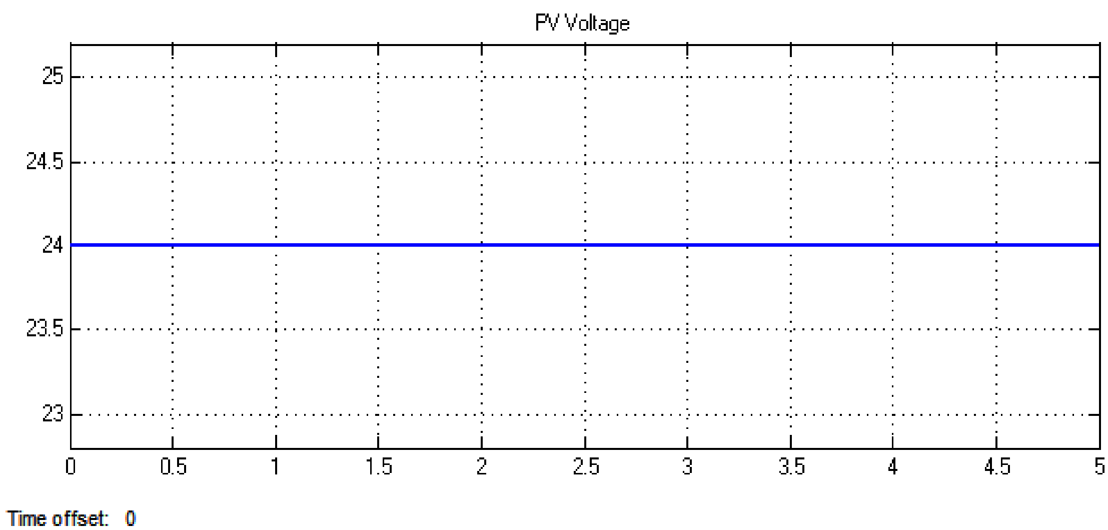

Figure. 5 PV input voltage

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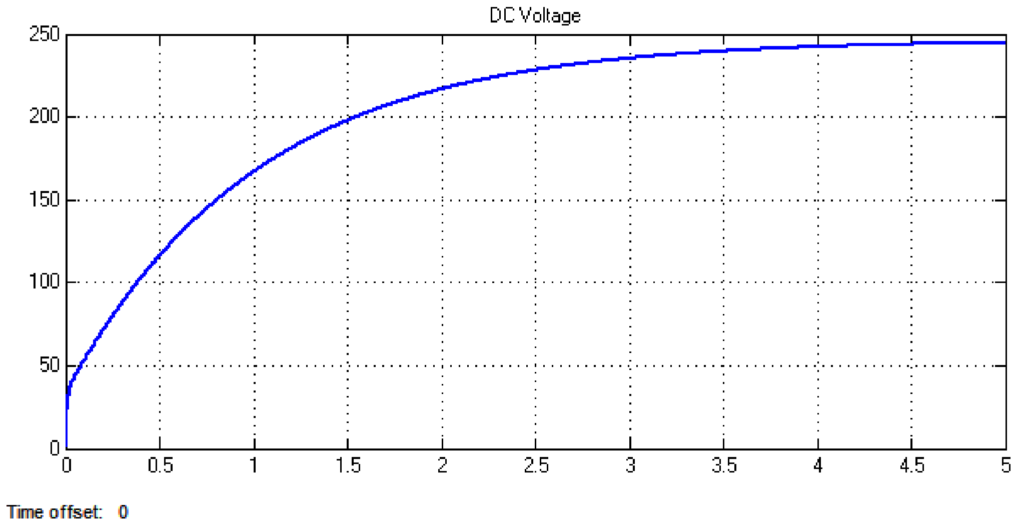

Figure. 6 DC link voltage using CFSI

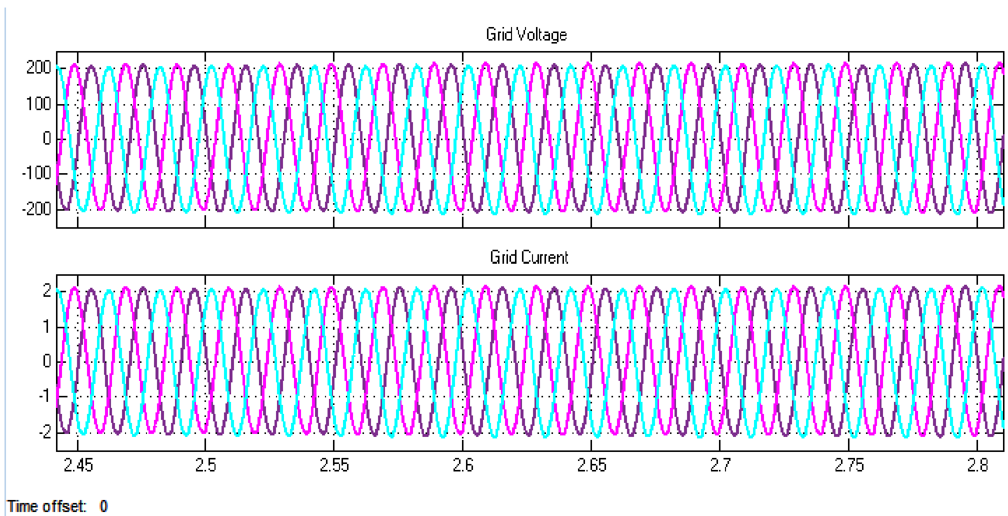

Figure. 7Grid voltage and current

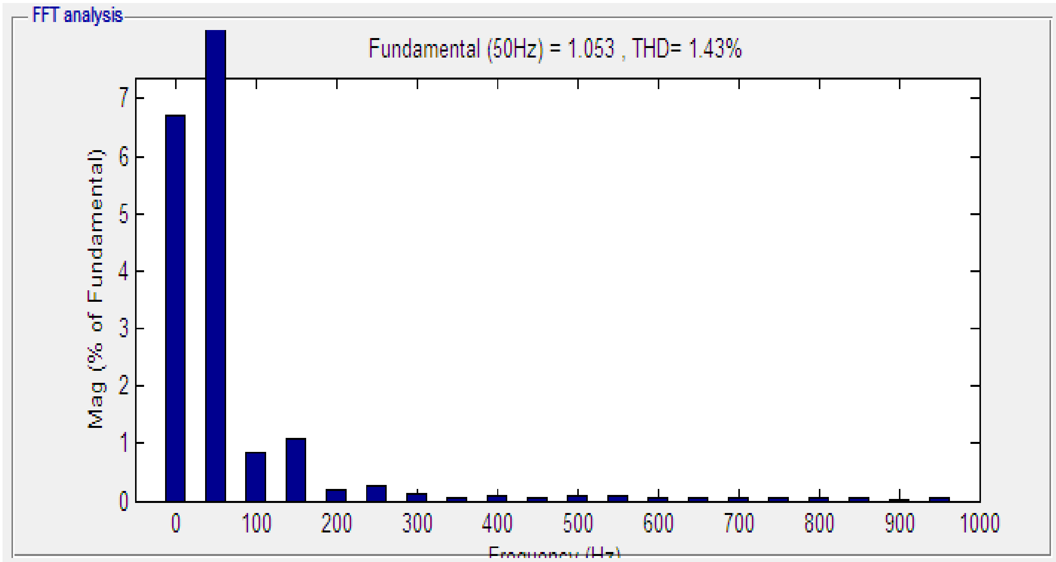

Figure. 8 Harmonic reduction in system current using CFSI

8. Conclusion

The PV system tied with the grid is implemented and designed using the CFSI that combines the Z-source inverter characteristics. This CFSI can done the operation of voltage enhancement and the capacitor voltage are maintained. The control signals for the system steady state are given by using the sliding mode controller. The inverter is supplying the current and voltage to the grid side using a filter. The source generation is highly obtained using I& C MPPT technique. The harmonics in the current can be reduced.

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