Slide Mode Controlled Two-Stage Three-Level Grid-Connected Photovoltaic Inverter

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Abstract

This paper proposes a high-efficiency slide mode controlled two stage three-level grid-connected photovoltaic inverter. The proposed two-stage inverter comprises a three-level stepup converter and a three-level inverter. The three-level stepup converter not only improves the power-conversion efficiency by lowering the voltage stress but also guarantees the balancing of the dc-link capacitor voltages using a simple control algorithm; it also enables the proposed inverter to satisfy the VDE 0126-1-1 standard of leakage current. The three-level inverter minimizes the overall power losses with zero reverse-recovery loss. Furthermore, it reduces harmonic distortion, the voltage ratings of the semiconductor device, and the electromagnetic interference by using a three-level circuit configuration; it also enables the use of small and low cost filters. To control the grid current effectively, we have used a feed-forward nominal voltage compensator with a mode selector; this compensator improves the control environment by presetting the operating point. The proposed high-efficiency two-stage three-level grid-connected photovoltaic inverter overcomes the low efficiency problem of conventional two-stage inverters, and it provides high power quality with maximum efficiency

Introduction

I. DC - DC CONVERTERS

DC-DC converters are electronic devices used whenever we want to change DC electrical power efficiently from one voltage level to another. They are needed because unlike AC, DC cannot simply be stepped up or down using a transformer. In many ways, a DC-DC converter is the DC equivalent of a transformer.

Typical applications of DC-DC converters are where 24V DC from a truck battery must be stepped down to 12V DC to operate a car radio, CB transceiver or mobile phone; where 12V DC from a car battery must be stepped down to 3V DC, to run a personal CD player; where 5V DC on a personal computer motherboard must be stepped down to 3V, 2V or less for one of the latest CPU chips; where the 340V DC obtained by rectifying 240V AC power must be stepped down to 5V, 12V and other DC voltages as part of a PC power supply; where 1.5V from a single cell must be stepped up to 5V or more, to operate electronic circuitry; where 6V or 9V DC must be stepped up to 500V DC or more, to provide an insulation testing voltage; where 12V DC must be stepped up to +/-40V or so, to run a car hifi amplifier’s circuitry; or where 12V DC must be stepped up to 650V DC or so, as part of a DC-AC sine-wave inverter.

II. RELATED WORK

Sung-Saepresented a new step-down converter . It is composed of an auxiliary switch, a diode, and a coupled winding to the buck inductor in the conventional buck converter. By transferring the buck-inductor current to the coupled winding in a very short period, the negatively built-up leakage inductor current of the buck winding guarantees the zero-voltage switching (ZVS) operation of the buck switch in all load conditions

Laricopresenteda step-up/step-down isolated dc–dc converter referred to as a three-phase flyback push–pull dc–dc

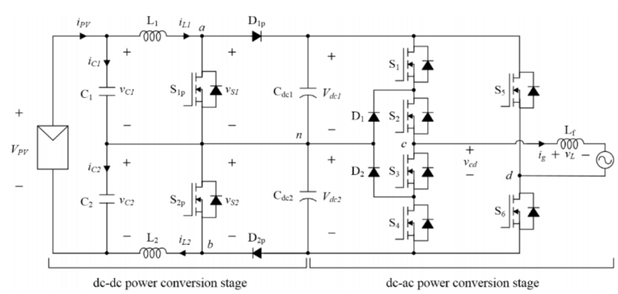

figure 1 proposed topology

converter is. The power circuit is constituted by a pair of coupled inductors, a three-phase transformer, a capacitor, three switching transistors and three power diodes. **Pahlevaninezhad et al p**resents a load adaptive control approach to optimally control the amount of reactive current required to guarantee zero-voltage switching (ZVS) of the converter switches.

C. S.Moo et al proposes a twin-buck converter with zero-voltage transition (ZVT). The converter comprises two identical buck conversion units employing power

MOSFETs as the active power switches with an interleaved inductor.

III. PROPOSED SYSTEM

This Project proposes a high-efficiency two-stage three-level grid-connected photovoltaic inverter. The proposed inverter solves two main problems of transformerless two-stage inverters; it not only limits the leakage current to less than 300mA but also provides high power-conversion efficiency by ensuring high efficiency of each stage. As shown in Fig. , the proposed two-stage inverter comprises a three-level step-up converter and a three-level inverter. The input capacitor of the three-level step-up converter is split into two halves, and the midpoint of the input capacitors and the midpoint of the dc- link capacitors are directly connected. This connection enables the proposed two-stage inverter to limit the leakage current to less than 300mA. Also, as dc-dc power conversion stage, the proposed three-level step-up converter not only improves the power-conversion efficiency with reduced voltage stress but also guarantees the balancing of the dc-link capacitor voltages by means of a simple control algorithm.

The proposed three-level step-up converter For the proposed three-level step-up converter, Fig. shows the equivalent circuits of each operating mode; and Figs. 4 and 5 indicate block diagram of control algorithm and theoretical waveforms. The proposed step-up converter shown in Fig. comprises two input capacitors C1 and C2, two input inductors L1 and L2, two primary switches S1p and S2p, two primary

diodes D1p and D2p, and two dc-link capacitors Cdc1 and Cdc2. To simply analyze the converter, the half of dc-link voltages Vdc1 and Vdc2 are given the same value, Vdc/2, with the steady-state condition. As shown in Fig. , S1p and S2p have the same step-up duty ratio D with a 180◦ phase difference. The voltage vS1 across S1p during one switching period is defined as follows:

$$v_{S1}(t) = \begin{cases} 0, & \text{for } \mathrm{S_{1p}} \text{ on-time} \\ \frac{V_{dc}}{2}, & \text{for } \mathrm{S_{1p}} \text{ off-time} \end{cases} \qquad (0 \le t < T_s)$$

whereTs is switching period.

IV. SLIDING MODE CONTROL

In control systems, **sliding mode control**, or **SMC**, is a nonlinear control method that alters the dynamics of a nonlinear system by application of a discontinuous control signal (or more rigorously, a set-valued control signal) that forces the system to "slide" along a cross-section of the system's normal behavior. The state-feedback control law is not a continuous function of time. Instead, it can switch from one continuous structure to another based on the current position in the state space. Hence, sliding mode control is avariable structure control method. The multiple control structures are designed so that trajectories always move toward an adjacent region with a different control structure, and so the ultimate trajectory will not exist entirely within one control structure. Instead, it will *slide* along the boundaries of the control structures. The motion of the system as it slides along these boundaries is called a *sliding mode*[1] and the geometrical locus consisting of the boundaries is called the *sliding (hyper)surface*. In the context of modern control theory, any variable structure system, like a system under SMC, may be viewed as a special case of a hybrid dynamical system as the system both flows through a continuous state space but also moves through different discrete control modes

IV. CONCLUSION

In this project a high-voltage-gain dc-dc converter is introduced . The proposed converter is based on slide mode controlled interleaved boost and the modified Dickson charge pump voltage multiplier circuit. It can draw power from a single source as well as from two independent sources while offering continuous input current in both cases. This makes the converter well suited for renewable applications like solar. The proposed converter is symmetric, i.e., the semiconductor components experience same voltage and current stresses which therefore reduces the effort and time spent in the component selection during the system design. The proposed converter has smaller voltage multiplier capacitors compared to a reference converter based on Dickson charge pump voltage multiplier cells; hence it is smaller in size. The converter finds its application in integration of individual solar panels onto the 400V distribution bus in datacenters, telecom centers, dc buildings and microgrids.

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