A NEW TOPOLOGY OF PHOTO VOLTAIC BASED THREE-PHASE POWER CONVERSION SYSTEM

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ABSTRACT

A topology for a DC power to three-phase power conversion is proposed which converts the power from a PV cell to three phase power for a three-phase load applications. The proposed power conversion interface comprises a bridge-type switch set, a set of three-phase inductors, a transformer set and a set of three-phase capacitors. Consequently, both the power circuit and control circuit are simplified. The transformer set is used to decouple the NZS currents and the ZS currents. The NZS currents are used to generate a high-quality three-phase voltage that supplies power to a three-phase load. This paper focuses on a PSIM model of a phase conversion topology interface with induction motor.

Key words: NZS,ZS,PSIM

INTRODUCTION

The proposed power conversion converts the dc power from pv cell to three phase power to the induction motor. Single-phase distribution power systems are generally used for residential applications. However, several types of loads require three phase power. For example, compared with a single-phase motor, a three-phase motor has the advantages of constant torque, constant power and a more compact. three-phase inverter which further converts this DC power to three-phase AC power to supply the three-phase load.[1] A DC capacitor acts as an energy buffer, to decouple the power between the dc power and the three phase load. Several topologies are proposed for reducing the amount of power semiconductor devices in a power conversion interface. A capacitor leg can replace a power electronic arm in the singlephase rectifier or the three-phase inverter. However, this still requires independent controllers for the single-phase rectifier and the three-phase inverter, respectively. Three-phase load, and the control objects are the three-phase voltages which will be supplied to a three-phase load. Only a bridge type switch set is used in the proposed power conversion interface where the bridge-type switch set is controlled to output a set of nonzero-sequence (NZS) currents and a set of zero sequence (ZS) currents. The NZS and the ZS currents are decoupled, using a transformer set, and these perform different functions in the single-phase distribution power system and the three phase load. In the single-phase distribution power system, the power conversion interface performs the function of unity power factor. The power conversion interface outputs high quality three-phase voltages with an adjustable amplitude and frequency that supply power to the three-phase load. A prototype is developed and tested under different loads, in order to verify the performance of the proposed power conversion interface.

POWER CIRCUIT CONFIGURATION :

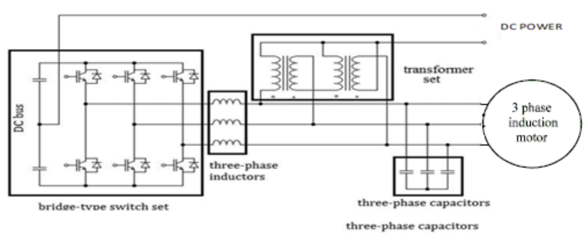


Figure1: Block Diagram representation

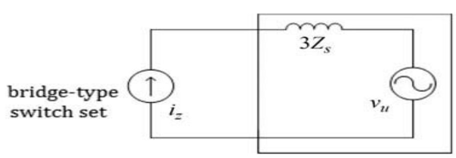
Figure 1 shows the power circuit configuration for the proposed power conversion interface. The proposed conversion technique is given to the input supply is dc source from PV cell[10] .The proposed power conversion interface comprises a bridge-type switch set, a set of three-phase inductors, a transformer set and a set of three-phase capacitors. The bridge-type switch set is a bridge configuration that consists of three electronic switch legs and a capacitor leg. The three electronic-switch legs are connected to the three phase load through the three-phase inductors. The three-phase inductors filter out the high-frequency current ripple that is caused by switching of the three electronic-switch legs. The three-phase capacitors are connected in parallel to the three-phase load, to filter out the ripple voltage. A current-mode control is used to control the switching of bridge-type switch set to generate three output currents, which integrates a set of NZS currents and a set of ZS currents. The transformer set is connected between the three-phase load and the single-phase utility. The transformer set comprises two single-phase transformers with the unity turn ratio. Since the primary and secondary windings have the same turn number, the currents in both the primary winding and the secondary winding are the same. the three currents, injected into the transformer set, must be equal, which produces a ZS current loop. Since the three-phase load can be regarded as a node, the sum of the three-phase currents for the three-phase load must be zero. Therefore, only NZS currents pass to the three-phase load which can be regarded as an NZS current loop. Accordingly, the circuit connected to the bridge type switch set contains an NZS current loop and a ZS current loop which is decoupled by the transformer set. The NZS and the ZS currents of the output currents for the bridge-type switch set will pass through the NZS current loop and the ZS current loop, respectively. If the transformer becomes damaged, the bridge-type switch set will turn off all the power electronic switches[2]. When the two transformers are short circuit, all the three terminals of the load will be connected to the utility and thus the three-phase load voltages are zero. In addition, the utility current is zero. When the two transformers are open circuit, the three-phase load voltages will be zero and the utility current is zero. The failure of transformer will not result in dangerous voltages or currents in the three-phase load and the utility.

PRINCIPLE OF OPERATION :

The proposed conversion technique takes place the three output currents of the bridge-type switch set can be divided into two components: ZS currents and NZS currents. According to the superposition theory, discussions of NZS and the ZS currents are, respectively, stated as follows. First the zero sequence currents are analyzed.

Fig 2 shows the ZS equivalent circuit for the power conversion interface, where ZS is the system impedance of the bridge-type switch set with current-mode control is regarded as a current source, ie, which is the ZS current. Since no ZS currents will flow through the NZS current loop, the three-phase load does not appear in the ZS equivalent circuit three times the magnitude of the ZS currents outputted from the bridge-type switch set, because the transformer set combines three ZS currents. The Dc power from the PV cell utility voltage can be represented as

$$v_u(t)=v_u \sin(\omega t) \quad \text{(i)}$$



The dc power utility current is represented as

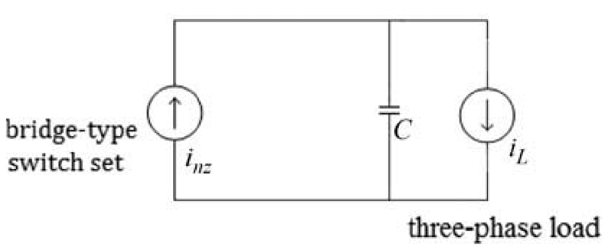


Figure 2 : PV cell utility voltage and current representation

$$i_u(t)=i_u \sin(\omega t) \quad \text{(ii)}$$

the waveform of the utility current is the same as the utility voltage, and only the amplitude of the utility current should be determined. Since the input power factor of the power conversion interface is unity, the real power supplied from utility can be represented as

$$P_u=1/2 v_u i_u \quad \text{(iii)}$$

The capacitor leg will adjust the real power imbalance between the DC power utility and the three-phase load under the transient state and induce a drift of the DC bus voltage. Accordingly, the amplitude of the single-phase utility current can be determined by the DC bus voltage regulation. Therefore, the desired current is obtained. Consequently, the desired ZS currents are the following

$$i_z(t)=i_{zR}(t)=i_{zS}(t)=i_{zT}(t)=1/3\ l_u \sin(\omega t) \quad \text{(iv)}$$

later the nonzero sequence currents are disscused. The NZS currents are controlled to generate high-quality three-phase voltages to supply power to the three-phase load.where C is the capacitance of the three-phase capacitors. Since the NZS currents cannot flow through the transformer set, the transformer set is an open circuit for the NZS equivalent circuit.

The three phase load voltages are desired to be sinusoidal and balanced and can be represented as

$$V^*_{LR}(t)=V_L \sin(\omega_p t+\theta_p) \quad \text{(v)}$$

$$V^*_{LS}(t)=V_L \sin(\omega_p t-120^\circ+\theta_p) \quad \text{(vi)}$$

$$V^*_{LT}(t)=V_L \sin(\omega_p t-240^\circ+\theta_p) \quad \text{(vii)}$$

where V_L, ω_p and θ_p are the amplitude, frequency and phase of the three-phase load voltage. The frequency, ω_p, of three-phase load voltage can be equal to, or higher or lower than that of the input voltage. Then non zero sequence currents is represented as

$$i_{nzR}(t)=i_{cR}(t) + i_{LR}(t) \quad \text{(viii)}$$

$$i_{nzS}(t)=i_{cS}(t) + i_{LS}(t) \quad \text{(ix)}$$

$$i_{nzT}(t)=i_{cT}(t) + i_{LT}(t) \quad \text{(x)}$$

where $i_{cR}(t)$, $i_{cS}(t)$ and $i_{cT}(t)$ are the currents of the three-phase capacitors and $i_{LR}(t)$, $i_{LS}(t)$ and $i_{LT}(t)$ are the three-phase load currents. The desired currents of three-phase capacitors can be derived by dividing the desired three-phase load voltages by the impedance of the three-phase capacitors, which contain only positive-sequence components**.** **L**oad currents are directly measured by current detectors. Since the three-phase load may be unbalanced, the current source for the three-phase load may include positive-sequence components and negative sequence components. Hence, the NZS currents include not only positive-sequence components but also negative–sequence components. [1]The desired NZS currents of the bridge-type switch set are obtained by summing the detected three-phase load currents and the derived three-phase currents in the three-phase capacitors Theoretically, the three-phase load voltages will be the same as (v)–(vii) if the bridge-type switch set can generate NZS currents shown as (viii)–(x). However,
the error in the current-mode control will induce the distortion of three-phase load voltages practically[3]. Consequently, the feedback control of the three-phase load voltages should be integrated into the control of the NZS currents, and the NZS currents are rewritten as

$$i_{nzR}(t)=i_{cR}(t) + i_{LR}(t) + i_{fR}(t) \quad \text{(xi)}$$

$$i_{nzS}(t)=i_{cS}(t) + i_{LS}(t) + i_{fR}(t) \quad \text{(xii)}$$

$$i_{nzT}(t)=i_{cT}(t) + i_{LT}(t) + i_{fR}(t) \quad \text{(xiii)}$$

where $i_{fR}(t)$, $i_{fS}(t)$ and $i_{fT}(t)$ are the compensation signals for the feedback control of the three-phase load voltages. The bridge-type switch set will generate the three-phase currents composed of NZS and ZS currents by the current-mode control. The NZS and the ZS currents will be decoupled and pass through the NZS current loop and the ZS current loop, respectively. The bridge-type switch set controls the ZS currents injecting a power from the single-phase utility to establish the DC bus voltage and then controls the NZS currents supplying the three-phase load and the three-phase capacitors to establish the three-phase load voltage. The capacitor leg of bridge-type switch set plays a role of energy buffer between the single-phase utility and the three-phase load.

RESULTS :

Figure 3: Input pulses for the switches S_1 to S_6

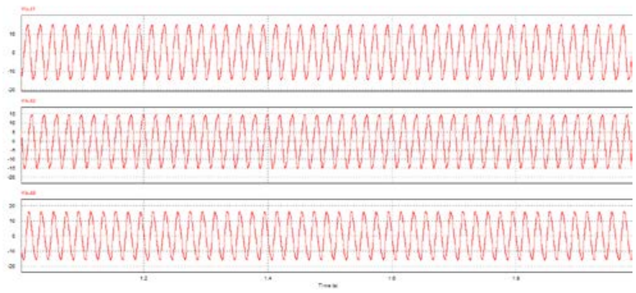


Figure 4: Output waveforms of three phase load

CONCLUSION:

This paper proposes a power conversion interface that supplies high-quality power to a three phase load in a single-phase distribution power system. The proposed power conversion interface comprises only a bridge-type switch set and a transformer set. Therefore, both the power circuit and control circuit are simplified. The experimental results verify that the proposed power conversion interface effectively converts the power from a PV cell to the power demanded by a three-phase load. From the view of the power conversion interface gives low harmonic distortion and a unity power factor, regardless of whether the three-phase load is linear, non-linear or an induction motor and whether the frequency of the three-phase load voltage is equal to, or higher or lower than that of the single-phase utility voltage. The proposed power conversion interface also supplies high-quality three-phase voltages to a three-phase load, regardless of the conditions in the three-phase load, and the frequency of the three-phase load voltage can be equal to, or higher or lower than that of the single-phase utility voltage.

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