UNBALANCED OPERATION OF DIODE-CLAMPED THREE-LEVEL INVERTER

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***Abstrct*— The intermittent nature of renewable energy sources can create serious system stability issues, especially at increased levels of penetration. A promising solution to this problem is the use of energy storage. Recently, batteries and super capacitors have emerged as leading energy storage devices. Furthermore, the combination of battery and supercapacitor provides an excellent match that can cover a wide range of power and energy requirements. As a result, power quality enhancement using batteries and super capacitors is actively pursued in the field of renewable energy as evident from literature. When it comes to the system integration, the simplest way of adding a battery (or a supercapacitor) bank is the direct connection to the dc-link of the grid side inverter. But it suffers from several drawbacks such as, large internal resistance, fixed current distribution governed by internal resistors and lack of control over the power flow. Effects of these issues can somewhat be reduced if an intermediate dc-dc. converter is placed between the battery (or the supercapacitor) bank and the dc-link. But the disadvantage of this topology is the increased number of components, cost and power losses.**

Keywords*— photovalatic board,grid- connected bridge inverterthree-phase electric power

Introduction

A power sharing and SOC balancing controllers for directly connected battery/supercapacitor energy storage for renewable power systems are presented. Proposed topologies eliminate the need for additional dc-dc converters by connecting two battery banks, two supercapacitor banks or a battery bank and a supercapacitor bank directly across dc-links of a diode clamped 3-level grid-connecting inverter. Unavoidable dc-link voltage imbalance is the major issue with these topologies. This problem is handled by a novel space vector modulation technique. It is proved in this paper that power sharing and SOC balancing between batteries and super capacitors can be achieved by altering the small vector composition..

MODULE EXPLANATION

The unbalance DC link voltage is caused due to capacitance. The splitting of the voltages in capacitance is not equal due to reactance of the capacitance so there will be voltage variations in positive and negative half cycle. The locations of small and medium vectors vary with dc-link voltages.

If the inverter is connected to a balanced three phase load, corresponding phase voltages can be derived from line to ground voltages using (1). Then these phase voltages are transformed into the dq reference frame by (2)

INVERTERS

The power in the battery is in DC mode and the motor that drives the wheels usually uses AC power, therefore there should be a conversion from DC to AC by a power converter. Inverters can do this conversion. The simplest topology that can be used for this conversion is the two-level inverter that consists of four switches. Each switch needs an anti-parallel diode, so there should be also four anti parallel diodes. There are also other topologies for inverters. A multilevel inverter is a power electronic system that synthesizes a sinusoidal voltage output from several DC sources. These DC sources can be fuel cells, solar cells, ultra capacitors, etc. The main idea of multilevel inverters is to have a better sinusoidal voltage and current in the output by using switches in series. Since many switches are put in series the switching angles are important in the multilevel inverters because all of the switches should be switched in such a way that the output voltage and current have low harmonic distortion.

The schematic diagram of the grid-connected photovoltaic power system is as Fig.1. Through the DC/DC converter the direct current of the solar panel is converted into 400V dc voltage. And then the 220V/50Hz ac is gained with the DC/AC inverter. The grid-connected system needs to guarantee the output current of the inverter in phase with the utility voltage and attain the unity power factor. This paper put emphasis on the grid interface control of the inverter's output current. Photovoltaic board

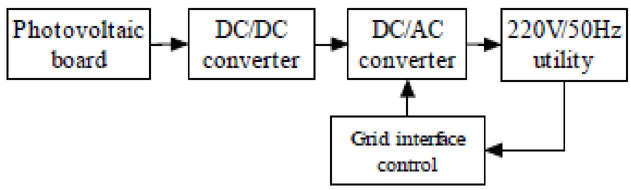

Fig. 1. Structure diagram of the grid-connected photovoltaic system

This work is supported by the National Natural Science Fund of China Currently most of the inverters in

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photovoltaic systems adopt the SPWM full bridge circuit[2], so the SPWM pulse generator and PLL loop is need, thus the control is complicated, the reliability is poor and the hardware cost is high. This paper puts forward a new digital grid interface control strategy. It chooses the grid voltage as the current reference signal that is traced by the output current of inverters. The unified constant frequency integration(UCI) control is realized by the error signal between the reference current and feedback inductor current. The proposed method has the characteristic of automatically tracing the utility voltage without the PLL loop. The system can automatically regulate the output power according to the dc input voltage and utility voltage, and it achieved fast response and islanding protection ability. The gridconnected inverter with high power factor is realized and the configuration of the system is rather simple

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GRID INTERFACE CONTROL BASE ON UNIFIED CONSTANT-FREQUECNCY INTEGRATION

A. Principles

A single-phase grid-connected inverter with a standard bridge is shown in Fig.2, where is the input dc voltage; voltage is the grid voltage; is the injected inductor current to the grid;

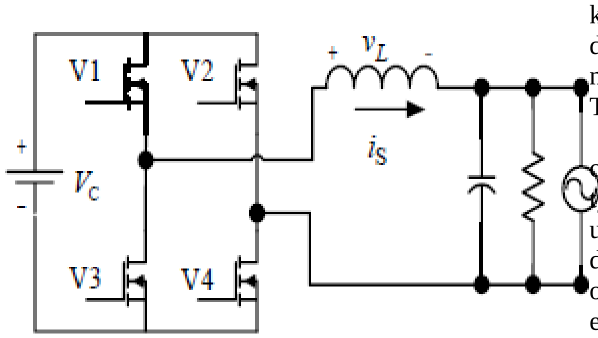


Fig. 2. Schematic diagram of grid-connected bridge inverter

L v is the voltage on the inductor.

The UCI is a control based on one cycle control. In order to simplify the analysis, here assume:

 The DC input voltage is constant;

 The switching frequency of the inverter is much higher than the utility frequency and output current frequency.

Supposing the switching frequency is , the switching period S f

TS = 1/ fS , the switching duty ratio is D, so there is:

During $0 < t < DT_S$, switch V1, V4 is on, swi

is off. The v_L can express as follows:

$$v_L = V_C - v_S .$$

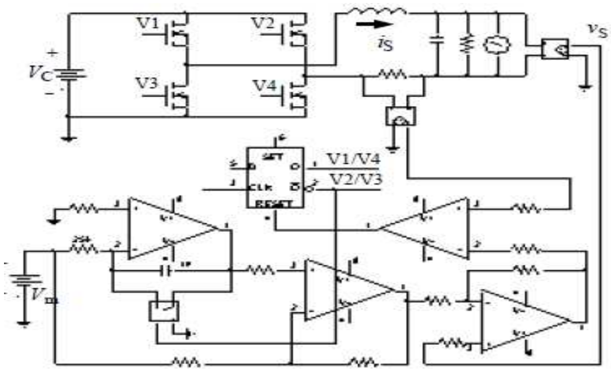


Fig. 3. Simulation circuit of grid-connected inverter system based on UCI control

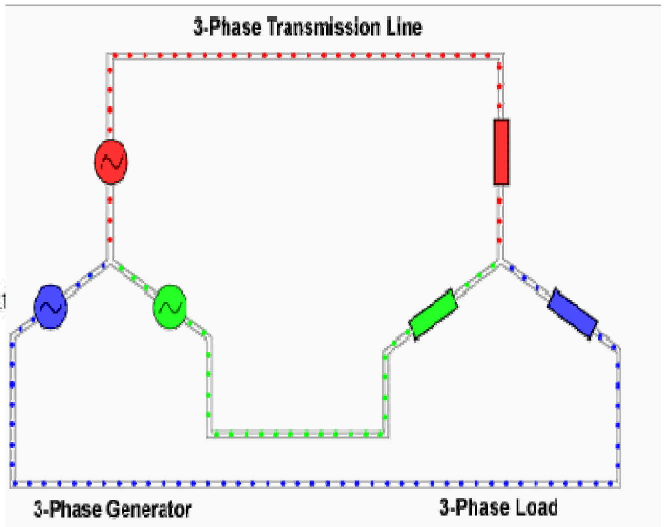
Fig 3. In the simulation experiment the rated dc input voltage is 200V, the rated grid voltage is 110V.

The simulation results of the clock signal, UCI control signal and switching drive signals is shown as Fig.4. The concrete realization is as follows: Make the period of the clock signal be equal to the switch period, the clock signal trigger the D trigger from zero to positive, the switch V1, V4 is on, the V2, V3 is off. At the same time the integrator starts to integrate for . When the utility voltage, the inductor current and the output of the integrator satisfy the control key equation, the D trigger will get a reset signal. Then the driving signals switch, the integrator resets and waits for the next clock signal, thus a switching cycle end.

THREE-PHASE ELECTRIC POWER

Three-phase electric power is a common method of alternating current electric power transmission. It is a type of poly-phase system and is the most common method used by electric power distribution grids worldwide to distribute power. It is also used to power large motors and other large loads. A three-phase system is generally more economical than others because it uses less conductor material to transmit electric power than equivalent single-phase or two-phase systems at the same voltage.

Generation and distribution



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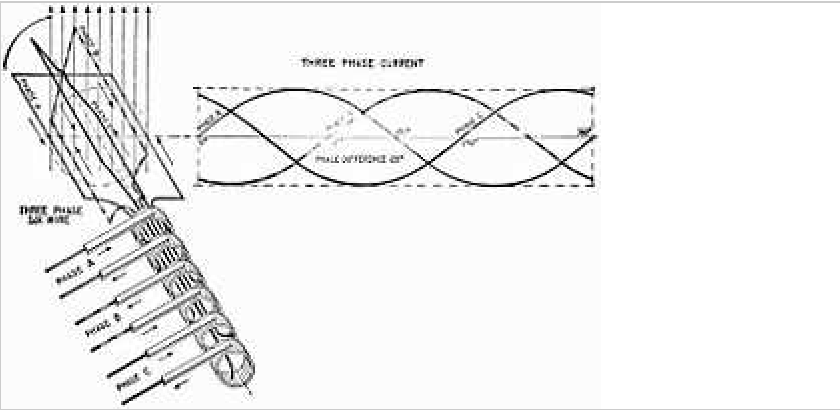

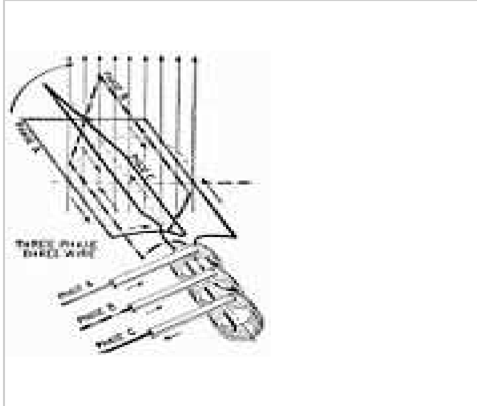

Animation of three-phase current flow

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Conclusions

This paper proposes a new transformer connection scheme to transform the three-phase grid power to a five-phase output supply. The connection scheme and the phasor diagram along with the turn ratios are illustrated. The successful implementation of the proposed connection scheme is elaborated by using simulation and experimentation. A five-phase induction motor under a loaded condition is used to prove the viability of the transformation system. It is expected that the proposed connection scheme can be used in drives applications and may also be further explored to be utilized in multiphase power transmission systems

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