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Grid-Tied MOSFET Inverter Using PR Controller for Photovoltaic Application

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ABSTRACT

In the unipolar sinusoidal pulse width modulation (SPWM) in full-bridge transformer less photovoltaic (PV) inverter it can be attain high efficiency for using super-junction metal oxide semiconductor field effect transistor (MOSFET) together with diodes made up of silicon carbide (SiC).The MOSFETs are partial to use in transformer less PV inverter due to the low reverse recovery characteristics of the diode. In this paper, a personal of novel transformer less PV inverter topology for grid tied operation is future using super-junction MOSFETs and SiC diodes in reverse recovery issues main power switches for unity power operation. The added clamping branch clamps the freewheeling voltage at reduced for dc input voltage during freewheeling period. Excellently the common mode voltage kept continuous during grid period that reduces leakage current significantly. In addition, dead time is not important for main power switches at both high frequency commutation and grid zero crossing instant, results low current distortion at output. The simulation and the hardware results are presented here for the verification purpose. In the applications of inverters, the inverters with five level inversion topology can produce output not high step-up output voltage and more number of switches.

Keywords: Inverter, Grid, Voltage and Switches.

1. INTRODUCTION

Recently, transformer less inverter has been found as one of the excellent solution for grid- tied PV application because of its higher conversion efficiency, lower cost, lesser size, and light weight if compare with one's consist transformer. However, the main drawback of transformer less inverter is the leakage current issues that need to be addressed very carefully. Due to the loss of galvanic isolation between the PV module and the grid, a direct path is formed to flow leakage current which generally depends on the non-negligible parasitic capacitance between the PV module and the ground, and the amplitude of fluctuating CM voltage. The fluctuation of CM voltage depends on the topology structure and the control scheme. As a result of leakage current flowing through the system, the grid current harmonics and system losses are increases, strong conducted and radiated electromagnetic interference are created, and more significantly, gives rise to safety issues

This paper proposes a solution for reducing the ground leakage current in transformer less one-phase grid-connected photovoltaic converters. This is obtained with the introduction of an active common-mode filter able to compensate for variations of the output common-mode voltage of the power converter. The active common-mode filter is applied to a widespread and efficient full-bridge driven by a three-level pulse width modulation, allowing the power converter to operate with low ground leakage current and with an arbitrary power factor. After showing the desired voltage waveform for common-mode voltage compensation, this paper presents the design guidelines for the needed additional magnetic component together with the power loss considerations for all the devices added for the proposed solution. Experimental results show the performance of the proposed solution in terms of ground leakage current reduction, effectiveness of dead-time compensation, total harmonic distortion of the injected grid current, and power losses [8]. The main contribution of this paper is the derivation rules summarized from existing high-performance inverters with H6-type configuration, which makes novel topologies possible. In addition, a novel high-efficiency one-phase transformer less photovoltaic inverter with hybrid modulation method is also proposed and evaluated as an example. Without input split capacitors, common-mode voltage and leakage current issues in a non-isolated system with H6-type configuration are eliminated, and the feature of a three-level output voltage in the inverter bridge's middle point helps inductors and power quality optimization. The detailed operation principles with hybrid modulation strategy combined with unipolar and bipolar pulse width modulation schemes are presented. Experimental results of a 2200VA prototype verify the proposed topology with hybrid modulation method [7]. The unipolar sinusoidal pulse width modulation (SPWM) full-bridge transformer less photovoltaic inverter with ac bypass brings low conduction loss and low leakage current. In order to better eliminate the leakage current induced by the common-mode voltage, the clamping technology can be adopted to hold the common-mode voltage on a constant value in the freewheeling period [9].

2. DESCRIPTION

In order to reduce the leakage current, a lot of in-depth researches have been conducted in the literature, where a new freewheeling path has been introduced to decouple the PV module from the grid during freewheeling period. However, the switches junction capacitance that cannot be ignored in the practical application may have an impact on the leakage current. It is presented that to completely eliminate the leakage current, the CM voltage needs to be clamped to the mid-point of dc input voltage instead of only disconnecting the PV module from the grid. On the other hand, to improve the efficiency, transformer less inverter can be implemented using super-junction MOSFET and SiC diodes. The super-junction MOSFETs can avoid the fixed voltage drop and turn-off losses caused by tail current, thereby reducing the conduction and switching losses. However, due to poor reverse recovery of MOSFETs slow body-diode, it is limited to use in transformer less inverter. In the following, MOSFET based transformer less topologies for grid-tied PV application will be reviewed and discussed based on their circuit structure, efficiency and CM voltage clamping capability.

MODULES NAME

1. Maximum Power Point Tracking (Mppt)
2. Photo Voltaic System
3. Leakage Current

1. MAXIMUM POWER POINT TRACKING

MPPT stands for maximum power point tracker, which is an electronic system designed for optimizing the varying power output from a solar panel module such that the connected battery exploits the maximum available power from the solar panel. We know that the output from a solar panel is directly proportional to the degree of the incident sunlight, and also the ambient temperature. When the sun rays are perpendicular to the solar panel, it generates the maximum amount of voltage, and deteriorates as the angle shifts away from 90 degrees. The atmospheric temperature around the panel also affects the efficiency of the panel, which falls with increase in the temperature. Therefore we may conclude that when the sun rays are near to 90 degrees over the panel and when the temperature is around 30 degrees, the efficiency of the panel is toward maximum, the rate decreases as the above two parameters drift away from their rated values. The above voltage is generally used for charging a battery, a lead acid battery, which in turn is used for operating an inverter. However just as the solar panel has its own operating criteria, the battery too is no less and offers some strict conditions for getting optimally charged. The conditions are, the battery must be charged at relatively higher current initially which must be gradually decreased to almost zero when the battery attains a voltag15% higher than its normal rating.

2. PHOTOVOLTALIC SYSTEM

Cells require protection from the environment and are usually packaged tightly behind a glass sheet. When more power is required than a one cell can deliver, cells are electrically connected together to form photovoltaic modules, or solar panels. A one module is enough to power an emergency telephone, but for a house or a power plant the modules must be arranged in multiples as arrays

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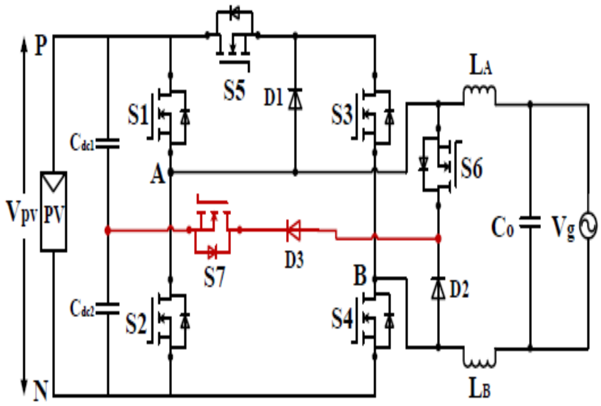
3. LEAKAGE CURRENT

There are two types of leakage current: ac leakage and dc leakage. Dc leakage current usually applies only to end-product equipment, not to power supplies. Ac leakage current is caused by a parallel combination of capacitance and dc resistance between a voltage source (ac line) and the grounded conductive parts of the equipment. The leakage caused by the dc resistance usually is insignificant compared to the ac impedance of various parallel capacitances. The capacitance may be intentional (such as in EMI filter capacitors) or unintentional. Some examples of unintentional capacitances are spacing on printed wiring boards, insulations between semiconductors and grounded heatsinks, and the primary-to-secondary capacitance of isolating transformers within the power supply.

Modules Description: Circuit Diagram



The traditional MOSFET based phase legs of transformer less inverter are shown. In order to ensure high efficiency, a modification is made by replacing IGBTs with MOSFETs and diodes which is shown. By combining these two phase legs, a family of new transformer less topologies is derived based on the ac decoupling and asymmetric phase legs. The followings are the derivation steps of the proposed new topologies:

1. First, IGBT switches of the HERIC and H5 methods are replaced with MOSFETs and diodes to boost the efficiency.
2. Next, combine these two phase legs to derive new topology. By changing the position of the freewheeling switches (S3 & D1), the family of the new topologies is derived.
3. Finally, to clamp the CM voltage at the half of the dc input voltage, a clamping branch consisting of a switch and a diode with a capacitor divider is introduced.

3. MODE OF OPERATION

Mode 1: is the active mode in the positive half cycle of the grid current. When S1 and S4 are turned-on, the inductor current i_L increases linearly through grid. In this mode, $V_{AN} = V_{PV}$ and $V_{BN} = 0$, thus $V_{AB} = V_{PV}$ and the inductor current.

Mode 2: is the freewheeling mode in the positive half cycle of the grid current, as indicated in Fig. 5(b). The inductor current i_L flows through S6 and D2, and reduces linearly under the effect of grid voltage. In this state, V_{AN} falls and V_{BN} rises until their values are equal. If the voltages ($V_{AN} \approx V_{BN}$) are higher than half of the dc-link voltage, freewheeling current flows through S7 and D3 to the midpoint of the dc link, results V_{AN} and V_{BN} are clamped at $V_{PV}/2$. Therefore,

Mode 3: is the active mode in the negative half cycle of grid current. Similar to mode 1, when S2, S3, and S5 are turned on, the inductor current increases in the opposite direction. In this mode, the voltage $V_{AN} = 0$ and $V_{BN} = V_{PV}$,

Mode 4: is the freewheeling mode in the negative half cycle of grid current. When S5 and S2 are turned-off, the inductor current flows through S3 and D1. Similar to mode 2, if the voltages ($V_{AN} \approx V_{BN}$) are higher than half of the dc-link

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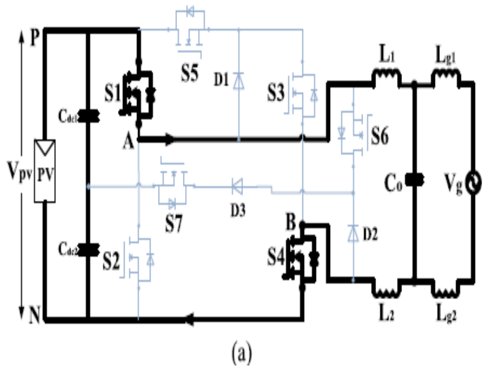
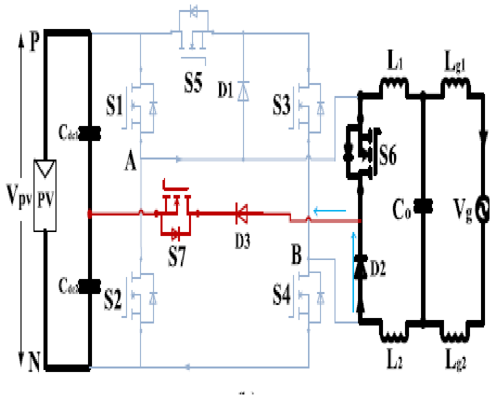
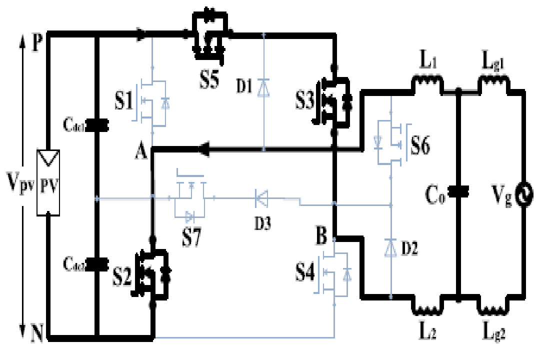
voltage, freewheeling current flows through S7 and D3 to the midpoint of the dc link, results the voltages *V*AN and *V*BN are clamped at *V*PV/2. Therefore, in this



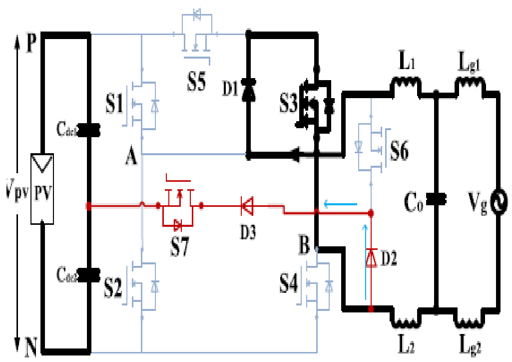
(a)



(b)



(c)



(d)

Introduction & Features

This Versatile programmer is a dedicated PIC Micro controller Programmer. All the PIC series of IC's except the 17 series can be programmed with this Hardware through RS232 Port of PC. This programmer also supports ICSP programming for on board programming of supported flash PIC devices. MPLAB IDE, PIC CCS C compiler Demo software with MPLAB Plug-in, and programming instructions are provided in CD-ROM. The programmer software is compatible to Windows 98, Windows 2000, and Windows XP platforms. A Soft copy of the user manual is also included in the CD, in addition to the hard copy provided with the Kit. This Dedicated programmer is for programming a wide range of PIC Micro controllers including EEPROMS, PIC12 series, PIC16 series & PIC18 series of IC's.

Specifications

- Auto detection of programmer by software
- Regulated Power supply 5,13.5V
- Auto Flash upgrades through serial port
- 16 MHz crystal Oscillator
- Built in RS232 connector
- ZIF socket for easy programming
- External ICSP Interface for on board programming
- Programmable configuration and ID

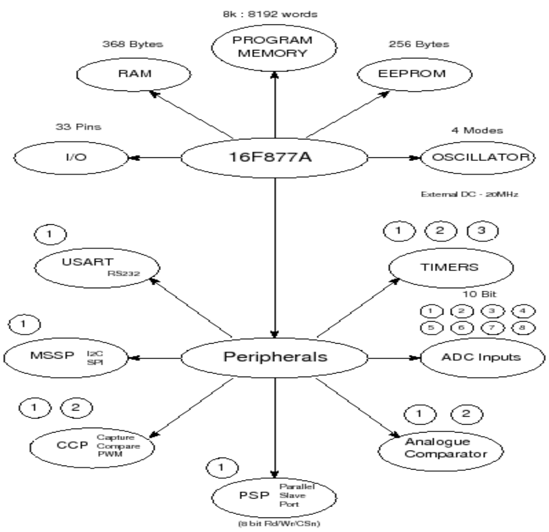


Fig.3.1. Micro-controller Peripherals

Peripheral Details

Timer0: 8-bit timer/counter with 8-bit presale, Timer1: 16-bit timer/counter with presale, can be incremented during Sleep via external crystal/clock, Timer2: 8-bit timer/counter with 8-bit period register, presale and postscaler, Two Capture, Compare, PWM modules, Capture is 16-bit max, resolution is 12.5 ns Compare is 16-bit max, resolution is 200 ns, PWM max, resolution is 10-bit Synchronous Serial Port (SSP) with SPI (Master mode) and I2C (Master/Slave), Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection, Parallel Slave Port (PSP) – 8 bits wide with external RD, WR and CS controls (40/44-pin only), Brown-out detection circuitry for Brown-out Reset (BOR).

Special Microcontroller Applications

100,000 erase/write cycle Enhanced Flash program memory typical, 1,000,000 erase/write cycle Data EEPROM memory typical, Data EEPROM Retention > 40 years, Self-reprogrammable under software control, In-Circuit Serial Programming via two pins, One-supply 5V In-Circuit Serial Programming Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation Programmable code protection, Power saving Sleep mode, Selectable oscillator options, In-Circuit Debug (ICD) via two pins.

MOSFET

A cross section through an n-MOSFET when the gate voltage V_{GS} is below the threshold for making a conductive channel; there is little or no conduction between the terminals source and drain; the switch is off. When the gate is more positive, it attracts electrons, inducing an n-type conductive channel in the substrate below the oxide, which allows electrons to flow between the n-doped terminals; the switch is on.

The metal–oxide–semiconductor field-effect transistor (MOSFET, MOS-FET, or MOS FET) is a transistor used for amplifying or switching electronic signals. The basic principle of this kind of transistor was first patented by Julius Edgar Lilienfeld in 1925. Twenty five years later, when Bell Telephone attempted to clear the junction transistor, they found Lilienfeld already holding a patent which was worded in a way that would include all types of transistors. Bell Labs was able to work out an agreement with Lilienfeld, who was still alive at that time. (It is not known if they paid him money or not.) It was at that time the Bell Labs version was given the name bipolar junction transistor, or simply junction transistor, and Lilienfeld's design took the name field effect transistor.

In electronics, a linear regulator is a component used to maintain a steady voltage. The resistance of the regulator varies in accordance with the load resulting in a constant output voltage. In contrast, the switching regulator is nothing more than just a simple switch. This switch goes on and off at a fixed rate usually between 50 kHz to 100 kHz as set by the circuit. The regulating device is made to act like a variable resistor, continuously adjusting a voltage divider network to maintain a constant output voltage. The primary advantage of a switching regulator over linear regulator is very high efficiency, a lot less heat and lesser size.

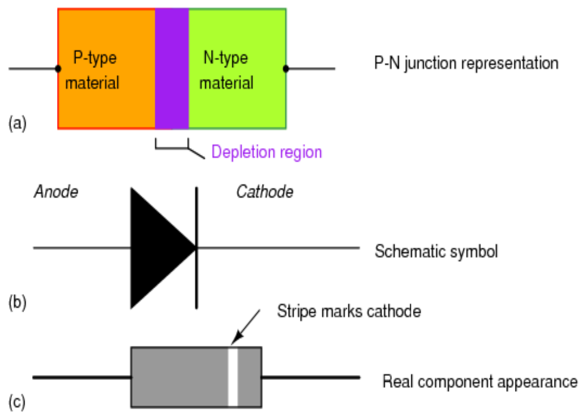
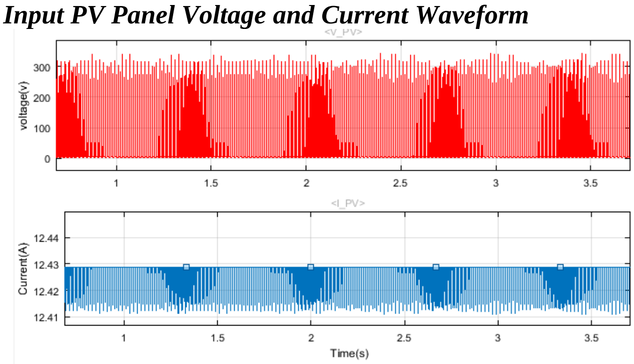


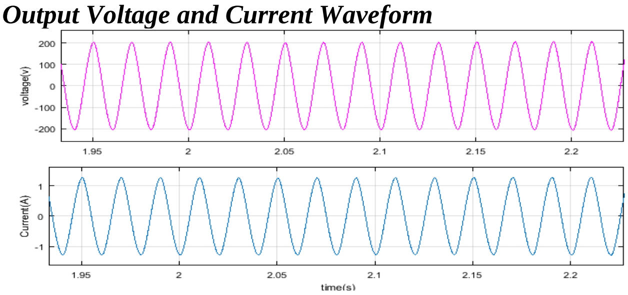
Fig. Diode

In electronics, a diode is a type of two-terminal electronic component with nonlinear resistance and conductance (i.e., a nonlinear current–voltage characteristic), distinguishing it from components such as two-terminal linear resistors which obey Ohm's law. A semiconductor diode, the most common type today, is a crystalline piece of semiconductor material connected to two electrical terminals. A vacuum tube diode (now rarely used except in some high-power technologies) is a vacuum tube with two electrodes: a plate and a cathode. The most common function of a diode is to allow an electric current to pass in one direction (called the diode's forward direction), while blocking current in the opposite direction (the reverse direction). Thus, the diode can be thought of as an electronic version of a check valve. This unidirectional behavior is called rectification, and is used to convert alternating current to direct current, and to extract modulation from radio signals in radio receivers—these diodes are forms of rectifiers.

Input PV Panel Voltage and Current Waveform



Output Voltage and Current Waveform



4. FUTURE SCOPE

All the electronics devices required dc supply to operate. The UPS is application of hardware computers so on .if the source having harmonics means, it may damage the equipments. In these system eliminating the losses by improving the power factor.

5. CONCLUSION

In this paper, a family of new efficient transformer less inverter for a grid-tied PV power generation system is presented using super junction MOSFETs as main power switches. The main advantages of the proposed topology are as follows: 1) High efficiency over a wide load range is achieved by using MOSFETs and Sic diodes, 2) CM voltage remains constant during all operation modes due to the added clamping branch, results low leakage current, 3) like as isolated FB inverter, excellent DM characteristics are achieved with unipolar SPWM, and 4) PWM dead time is not required for main power switches, results low distortion at output. Finally, the proposed topology has been validated by a prototype rated 240/50 Hz 1 kW

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