Research on Structure Design of New Energy Photovoltaic Inverter

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Abstract. With the increase of energy demand, primary energy is drying up. In order to achieve sustainable development, renewable energy and new energy research is imperative. The research and development of solar photovoltaic inverter can supplement and improve the existing energy structure, which has long-term practical significance. In this paper, the structure design of solar photovoltaic inverter power supply is studied. The power supply adopts lead-acid battery energy storage and full bridge inverter structure. At the same time, the paper studies the design of power supply protection circuit to realize battery reverse connection protection and MOSFET overvoltage protection.

Keywords: solar photovoltaic power generation; full bridge inverter circuit; protection circuit.

1. Introduction
At present, the energy structure is still dominated by coal, oil, natural gas and other primary energy. However, with the increase of energy demand, these primary energy reserves are drying up. Therefore, to solve the problem of energy demand and achieve sustainable development, large-scale development and utilization of renewable energy and new energy are needed.

Small high efficiency solar inverter can convert solar energy into electric energy, and provide AC power to load through energy storage, conversion, control and other links. The power supply can supply power to the load on the spot, and also can reverse transmit to the public power grid through boosting, filtering, grid connection and other links, which has become an important supplement to the power supply of the distribution network. The new energy photovoltaic power generation is clean, pollution-free and renewable, which has far-reaching significance for building a green and energy-saving society.

2. Solar panels
As the core part of the solar inverter, solar panels convert light energy into electric energy through photoelectric effect or photochemical effect, and then store it in the battery [1]. The structure of the solar panel is shown in Figure 1.
Figure 1. Solar panel structure

In the picture 1, the function of solar cells is to generate electricity, mainly including crystalline silicon solar cells and thin film solar cells. Crystalline silicon solar cells have high photoelectric conversion efficiency and relatively low equipment cost, but the consumption and cell cost are very high, so it is suitable to generate electricity in outdoor sunlight. The photoelectric conversion efficiency of thin-film solar cells is more than half that of crystalline silicon cells, and the equipment cost is relatively high, but the consumption and battery cost are very low, and the weak light effect is very good. It can also generate electricity under ordinary light, which is suitable for weak light environment, such as solar cells on calculators. This design uses crystalline silicon solar panels.

Toughened glass is used for solar cells, EVA is used to fix toughened glass and solar cells, TPT is used for sealing, insulation and waterproof, and aluminum alloy frame is used to protect the whole structure.

3. Energy storage battery

In the new energy power generation technology, the main forms of energy storage can be divided into mechanical energy storage, electromagnetic energy storage, electrochemical energy storage and phase change energy storage[2]. This design uses the valve regulated lead-acid battery pack (VRLA battery) of electrochemical energy storage technology, its electrode is mainly made of lead and its oxide, and the electrolyte is sulfuric acid solution. In the discharge state, the main component of positive electrode is lead dioxide, and the main component of negative electrode is lead; in the charge state, the main component of positive and negative electrode is lead sulfate. The structure of VRLA battery is shown in Figure 2.

Figure 2. Lead-acid battery structure

The structure of VRLA battery is sealed as a whole, which has the advantages of safe and reliable use, long service life, simple installation and less investment. In addition, the VRLA battery does not pollute the equipment and the environment, and can be used together with electronic equipment. It does not need to be used in the room for battery placement and maintenance, and the maintenance workload is greatly reduced.
4. Inverter circuit design
Inverter is one of the most important devices in solar photovoltaic power generation system. Its main circuit topology mainly includes full bridge, half bridge, push-pull and so on [3]. The inverter designed in this paper adopts full bridge structure, and the circuit structure is shown in Figure 3.

![Figure 3. Inverter circuit structure](image)

The structure of inverter is composed of full bridge inverter circuit, step-up transformer and LC filter circuit. In Figure 3, each arm of the full bridge inverter circuit is composed of a controllable MOSFET and anti-parallel diodes. VT1 and VT4 are a pair, VT2 and VT3 are a pair. The diagonal arms control conduction in turn, and the diodes realize freewheeling and overvoltage protection. To prevent the upper and lower power transistors from conducting at the same time and causing short circuit, all four power transistors are closed in a short dead time. The step-up transformer can raise the voltage to the voltage level required by the system, and has the functions of electrical isolation, step-up and energy storage. The filter circuit is composed of inductance $L_f$ and capacitor $C_f$, which filters out the high-order harmonic components in the output voltage and realizes sine wave output.

5. Protection circuit design
In order to ensure the normal operation of the circuit, in addition to the main circuit, also need to design the necessary protection circuit.

(1) Battery reverse connection protection
The reverse connection protection of storage battery is shown in Figure 4, with $D_0$ as anti reverse diode and $FU$ as fuse. Diode $D_0$ and fuse $FU$ constitute the reverse connection protection circuit of the battery [4]. When the battery is connected reversely, diode $D_0$ and fuse $FU$ constitute a short circuit circuit. Excessive short circuit current causes fuse $FU$ to fuse quickly, thus protecting other components in the battery charging circuit.

![Figure 4. Reverse connection protection diagram of storage battery](image)

(2) MOSFET overvoltage protection
In order to suppress the overvoltage and reduce the turn off loss of MOSFET, a turn off buffer absorption circuit is needed. This design adopts RCD charge discharge type turn off buffer absorption circuit, and the circuit structure is shown in Figure 5.
The RCD absorption circuit is connected in parallel with the drain and source of MOSFET. When it is turned off, the voltage of absorption capacitor C rises from zero, which has a good effect of overvoltage absorption.

6. Summary
With the development of new energy technology represented by solar photovoltaic power generation, the progress of power electronic devices and the gradual maturity of various innovative topologies, solar household inverter power supply system will have a broader development prospect. The structural parameters of the solar inverter system designed in this paper are further improved in order to achieve higher efficiency.

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References
[1] Xiao Xiao, Xu Defu, et al. Basic concept of optical management of solar cells, Journal of Sichuan University (NATURAL SCIENCE EDITION), 2015,52(3), pp.611-618.
[2] Sun Rongle, Luo Wenjie. Status and application of energy storage technology in modern power system, Science and technology innovation guide, 2018, 15 (30), PP.43 + 45.
[3] Chen Jian, Kang Yong, power electronics power electronics conversion and control technology (Third Edition), Higher Education Press, Beijing, 2002.1.
[4] Ma Guofu. A battery reverse connection protection circuit, CN 201252397 Y