IJIREEICE

ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROL ENGINEERING
Vol. 4, Issue 4, April 2016

Multiple Renewable Energy Source with Single Energy Storage System Connected To Low Voltage DC-Grid

Nikhil R[1], T N Venkataraman[2]

PG Student, Department of Electrical Engineering, DSCE, Bangalore, Karnataka, India[1]

Asst Professor, Department of Electrical Engineering, DSCE, Bangalore, Karnataka, India[2]

Abstract: This paper presented the charge/discharge stage in the solar power system which is used by a multiple-winding bidirectional flyback converter. The maximum energy extraction from photovoltaic panels, battery charging and discharging dynamic control, and high voltage step-up to the inverter DC bus, also operating with soft-switching capability. In the normal operation of solar panels, the energy can be charged to the battery module. When one or more solar panels are out of order, the battery module supplies the energy to the load through the bidirectional flyback converter without affecting the operation of the load. Generally, one solar-energy maximum-power-point tracking circuit is with one battery module. So more tracking circuits need more battery modules. However, for the multiple-winding bidirectional flyback converter presented in this paper, it uses only one battery module and can be applied to the multiple solar energy maximum-power-point tracking circuits. Furthermore, about the charge way of battery, the interleaved energy charge method used to this bidirectional flyback converter is proposed in this paper. All the above mentioned functions are realized with digital signal processor to integrate the complete system. In order to capture the maximum energy from the PV module, solar inverters must guarantee that the PV module is operated at the MPP. This is accomplished by the maximum power point control loop known as the Maximum Power Point Tracker (MPPT).

Index term: Flyback converter, photovoltaic array, single Energy storage, Maximum Power Point Tracker.

I. INTRODUCTION

Due to global environmental concerns, photovoltaic (PV) systems (i.e., solar panels) are becoming more common as a renewable energy source. The main drawbacks of PV energy are the high cost of manufacturing silicon solar panels and the low conversion efficiency. However, with the latest techniques in manufacturing, PV systems are becoming more efficient, as well as cost effective. The conversion of the output voltage from a solar panel into usable DC or AC voltage must be done at its Maximum Power Point, or MPP. MPP is the PV output voltage at which the PV module delivers maximum energy to load. Solar energy is the most widely available source of renewable and sustainable energy that can play a leading role in the program of reducing greenhouse gas emissions. One of the established means to transfer this energy and transform it into electricity is Photovoltaic (PV) technology.

PV technology is becoming more popular for connecting to the grid both on large and small scales. PV solar farms are inactive during night and only partially utilized during daytime. Therefore, a huge investment remains unutilized in most of the time over a 24 hours period. In the solar power system, the battery module is usually applied in the system to provide the stable power quality to avoid the effect of the environment. To achieve the charge and discharge function of the battery, the converter used to the battery is usually a bidirectional converter. However, if one solar module has its own independent battery module, many solar modules need many battery modules. The cost and maintenance are inevitably increased. The number of the battery modules can be decreased if only one module is collocated with many solar systems, then the cost and maintenance of the system can also be reduced. Different bidirectional converter topologies applied to the solar renewable system are also proposed. However; these bidirectional converters are usually the one-output applications. Therefore, to reduce the number of the battery modules to one and the one battery module can be applied to many solar systems, the new multiple-winding bidirectional converter will be proposed in this paper.

II. LITERATURE SURVEY

R. Gules said that the analysis, design, and implementation of a parallel connected maximum power point tracking (MPPT) system for stand-alone photovoltaic power generation. The parallel connection of the MPPT system reduces the negative influence of power converter losses in the overall efficiency because only a part of the generated power is processed by the MPPT system. Furthermore, all control algorithms used in the classical series-connected MPPT can be applied to the parallel system. A simple bidirectional dc–dc power converter is proposed for the MPPT implementation and presents the functions of battery charger and step-up converter. The operation characteristics of the proposed circuit are analysed with the implementation of a prototype in a practical application.

F. Zhang, explains Bi-directional DC-DC converter is widely used in more and more areas. The paper proposed a novel type of bi-directional DC-DC converter topologies-

IJIREEICE
ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526
INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROL ENGINEERING
Vol. 4, Issue 4, April 2016

forward-flyback bi-directional DC-DC converters. The converter has the following merits: 1) The spike on the switches is much smaller than the current-fed type converter, the energy that cause the spike is much smaller than that in the current-fed converter; 2) The current of one side of the bi-directional DC-DC converter is continuous, the current ripple is small; 3) There is no the start-up problem in the forward-flyback bi-directional DC-DC converter; 4) It is easy to realize soft switching; and 5) The hybrid structure of forward and flyback converter makes it suit for high power situation. The paper analyzed the steady state operation principles in detail. The experimental results verify the analysis. Based on the principle of active clamp forward-flyback bi-directional DC-DC converter, a family of bi-directional DC-DC converter is proposed.

III. PROPOSED TOPOLOGY

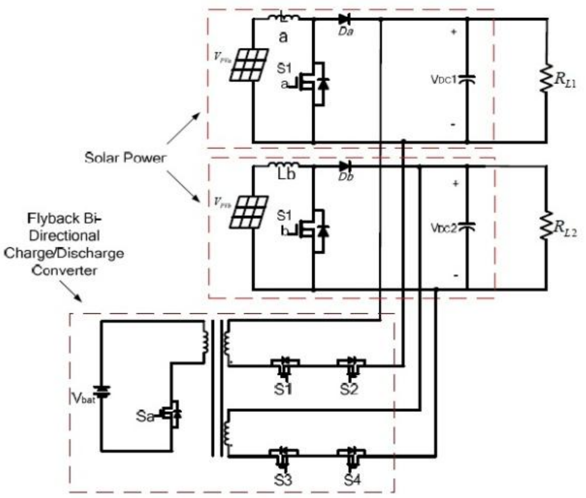

Fig.1 Architecture of the solar power system

The principle and analysis of the proposed multiple winding bidirectional converters will be discussed in this section. This system is a standalone solar power system. When the energy from the solar-power is greater than the load, the extra energy will be given to the battery through the bi-directional converter. The insufficient energy can come from the battery when the solar energy is not enough. The proposed system can provide the multiple independent sources to the independent loads. There are many situations existing in this system when one solar panel or many solar panels are out of order. So, the proposed system has many states need to be discussed and the following will give the related discussion.

Figure 1 shows the system architecture. It consists of the maximum-power-tracking circuit of the solar cells and bi-directional charge/discharge circuit. The detail analysis and discussion about the characteristic and topology of the bi-directional converter will be given in the following.

2.1 Multiple-winding Bi-directional Flyback Converter

A multiple-winding bi-directional flyback converter shown in Fig. 2 is proposed in this paper. It consists of the switches Sa, S1, S2, S3, and S4 and the multiple winding flyback transformers. The switches S2 and S4 are used to prevent the output energy of VDC1 and VDC2 at the same time.

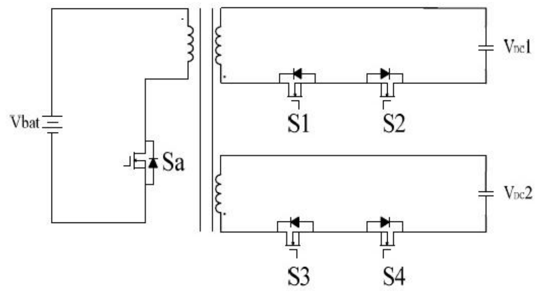

Fig. 2 Proposed multiple-winding bi-directional flyback converter

According to the switching actions of Sa, S1, S2, S3, and S4, the operation of the converter can be classified to the charge mode or discharge mode. When the switch Sa is in conduction, the transformer stores the battery energy. And when Sa is off, S1, S2 and (or) S3, S4 are in conduction, the stored energy is released to the VDC1 and (or) VDC2. By the modulation of duty cycle and turns ratio, the converter can be thought in a step-up discharge mode. On the other hand, when S1, S2 and (or) S3, S4 are in conduction, the energy from the VDC1 and (or) VDC2 can be stored in the transformer. And when S1, S2 and (or) S3, S4 are off, Sa can be on to release the energy to the battery. According to the change of the duty cycle and turns ratio, the converter can be thought in a step-down charge mode at this time.

State 1: Both solar panels are in normal operation and their energy is greater than the load requirement. Fig. 3 shows this situation. At this time, the driving signals of S1, S2 and S3, S4 are interleaved. When S1, S2 are on, the transformer stores the energy from VDC1. The energy of the transformer is released to the battery after the turn-off of S1, S2 and turn-on of Sa. The actions of S3, S4 is similar to the actions of S1, S2. But the on time of S3, S4 is after the on time of S1, S2. They are interlaced as shown in Fig. 3(b). It must be noticed that if the driving signals of S1, S2, S3, and S4 are in the synchronous operation, the converter cannot be operated normally because the energies coming from VDC1 and VDC2 are different due to the effect of the leakage inductances. To make the energies from VDC1 and VDC2 be sent normally, the interleaved battery charge method is proposed here. The driving signals of S1, S2 are interlaced with the driving signals of S3, S4.

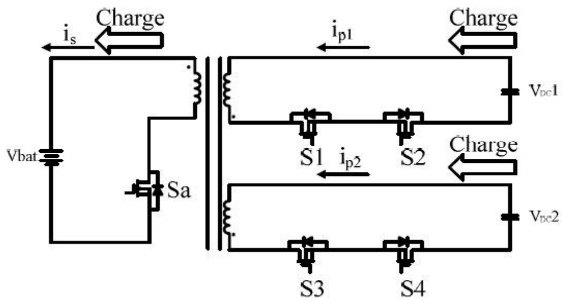

Fig. 3(a) Bi-directional converter in charge mode (Solar energy > load)

DOI 10.17148/IJIREEICE.2016.4403

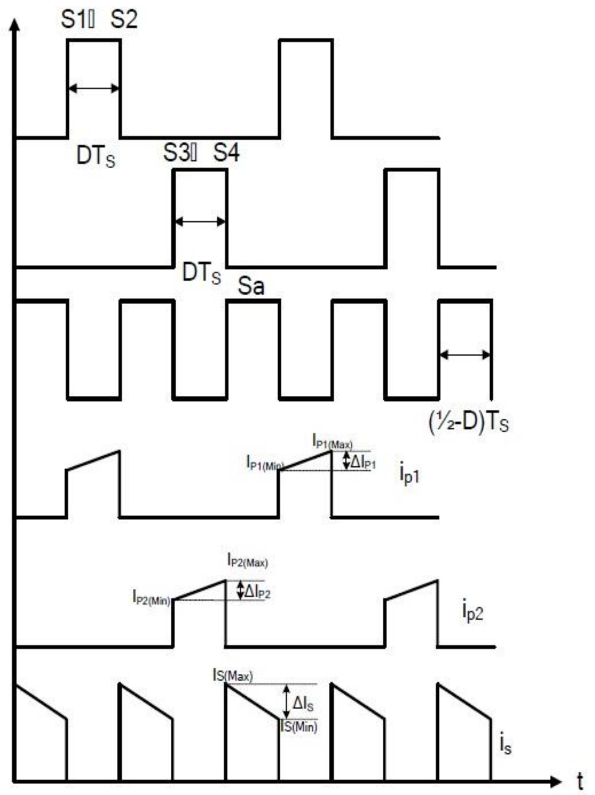

Fig. 3(b) Driving signals of S1, S2, S3, S4, and Sa and current waveforms

State 2: One of the solar module is out of order. At this time, the energy needed by the load is supplied by the battery through the one winding of the bi-directional converter. The other winding is not in action. Fig. 4(a) shows this state. The actions of S1, S2 and S3, S4 are shown in Fig. 4(b). S1, S2 are in action and S3, S4 are not in action.

State 3: Both solar modules are out of order. The energies needed by the loads are supplied by the battery as shown in Fig. 5(a). The switches Sa, S1, S2, S3, and S4 are all in action. The driving signals of Sa and S1, S2, S3, S4 are in the complement action. S1, S2, S3, S4 are in the synchronous operation because the battery needs to supply the energies to both loads when the solar modules are both out of order. Fig. 5(b) shows the waveforms.

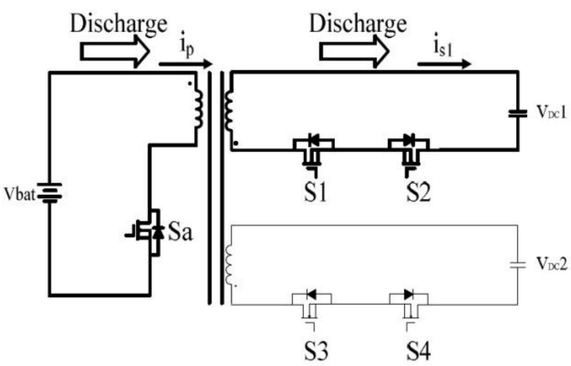

Fig. 4(a) Bi-directional converter operating in the discharge mode (One solar module is out of order)

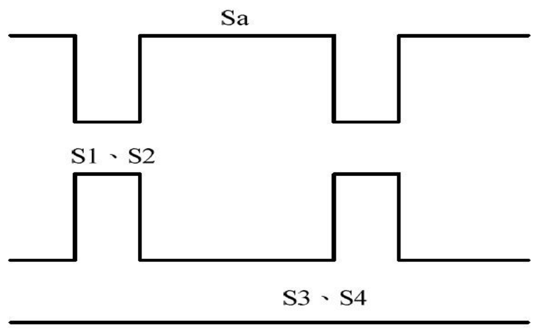

Fig. 4(b) Driving signals of S1, S2, S3, S4, and Sa

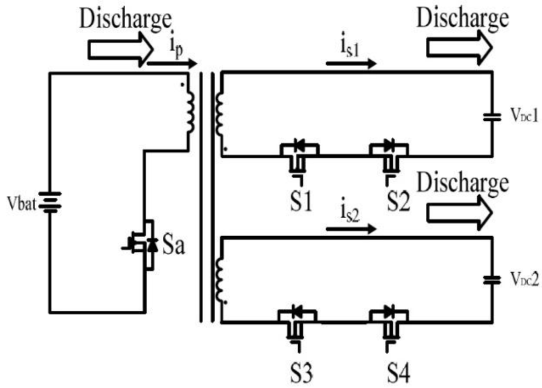

Fig. 5(a) Bi-directional converter operating in the discharge mode (Both modules are out of order)

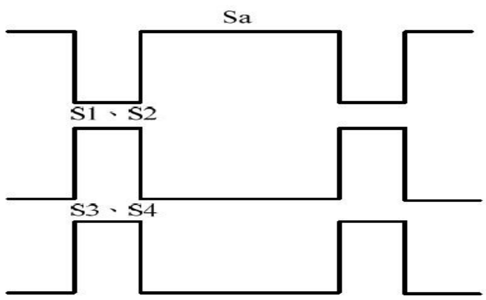

Fig. 5(b) Driving signals of S1, S2, S3, S4, and Sa

According to the above description, this charge/ discharge system has three states. The bi-directional flyback converter is operated according to the three states.

IV. SIMULATION RESULT

The overall system consists of the maximum power tracking circuit of the solar cells and the Multiple-winding bi-directional charge discharge circuit. The control signals of the overall system are realized by the DSP chip. After the implementation of the prototype circuit, the experimental results are used to confirm the function of the proposed circuit. In the experiments, two modules which consist of the maximum power tracking circuit of the solar cell are implemented. Then, the two modules are combined with the battery module to build the solar-powered system. Only one bi-directional charge/discharge circuit and one battery module are used. However, the bi-directional converter is with the multiple windings.

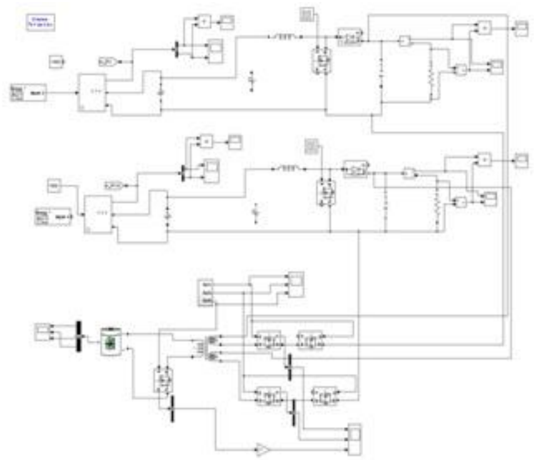

Fig 6(a) Simulation model of proposed method

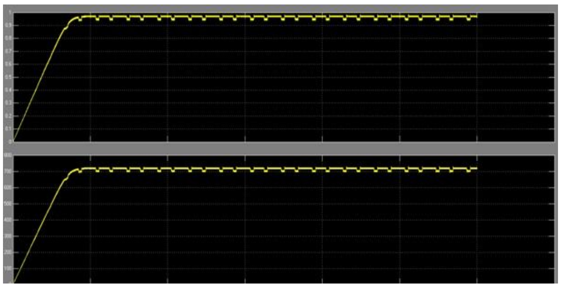

Fig 6(b) photovoltaic1 output waveform

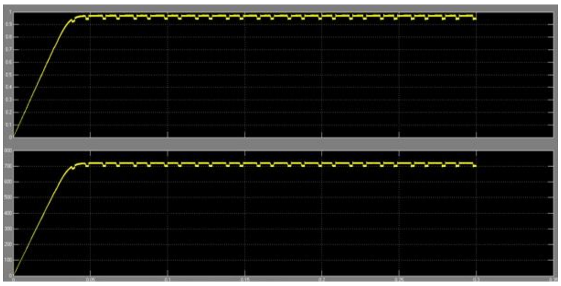

Fig 6(c) photovoltaic2 output waveform

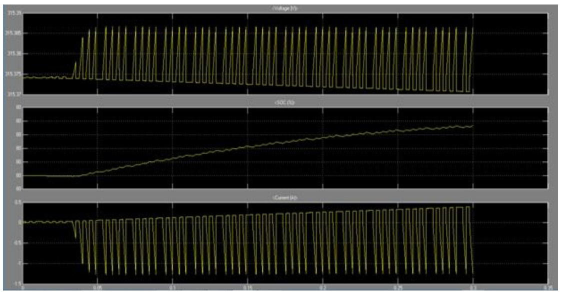

Fig 6(d) Battery Charging cycle

V. FUTURE SCOPE AND CONCLUSION

In existing system we are used a bidirectional fly back converter. In this method charging and the discharging takes place by switching action. Flyback converter takes some time to transfer the energy to storage device (battery) and vice versa. In order to reduce this problem as well as to reduce switching losses we are going to replace forward converter instead of flyback converter.

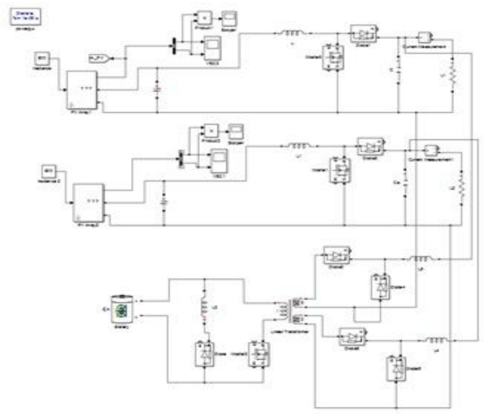

Fig 7 Flyback converter replaced by forward converter

This paper proposed a multiple-winding bi-directional flyback converter applying to the battery charge/discharge system. Contrary to the one-winding converter, the proposed converter can be applied to the multiple independent loads with only one battery module. The proposed converter has the advantage of lower cost compared with the system that consists of multiple solar modules with multiple battery modules. The loads of the proposed system can be independent. Therefore, it can be applied to the multi-level inverter as the independent sources. As for the control signals of the overall system, they are implemented with the DSP chip.

REFERENCES

[1] R. Rynkiewicz, “Discharge and charge modeling of lead acid batteries,’’ Proceeding of Fourteenth Annual Applied Power Electronics Conference and Exposition, vol. 2, pp. 707-710, Mar. 1999.

[2] T. Palanisamy, and P. O. Box, “Charging techniques for auniversal lead-acid battery charger,” Power Sources Symposium, pp. 72-76, Jun. 1990.

[3] L. Zhang, S. J. Yang, Y. Xing, “A novel bipolar bi-directional buck-boost converter,” International Conference on Electrical Machines and Systems, pp. 1980-1984, Oct. 2008.

[4] F. Zhang, L. Xiao, and Y. Yan, “Bi-directional forward-flyback dc-dc converter,” Power Electronics Specialists Conference IEEE 35th Annual, vol. 5, pp. 4058-4061, Jun. 2004.

[5] M. Jain, P. K. Jain, and M. Daniele, “A bi-directional dc-dc converter topology for low power application,” IEEE Transactions on Power Electronics, vol. 15, Issue 4, pp. 595-606, Jul. 2000.

[6] D. Liu, and L. Hui, “A zvs bi-directional dc-dc converter for multiple energy storage elements,” IEEE Transactions on Power Electronics, vol. 21, Issue 5, pp. 1513-1517, Sep. 2006.

[7] F. Z. Peng, L. Hui, S. Gui-Jia, and J. S. Lawler, “A new zvs bidirectional dc-dc converter for fuel cell and battery application,” IEEE Transactions on Power Electronics, vol. 19, Issue 1, pp. 54-65, Jan. 2004.