An Improved Flyback Inverter for Photovoltaic Applications

P.Dhandayuthabaani*, M.Hemalatha*, V.Gowtham*, M.Suresh#

Assistant Professor, Dept. of EEE, Kongu Engineering College, Perundurai, Tamilnadu, India#

UG Student, Dept. of EEE, Kongu Engineering College, Perundurai, Tamilnadu, India*

ABSTRACT: Electricity is widely demanded throughout the world .Due to the rapid depletion of non-renewable sources nowadays demand for renewable energy sources is growing tremendously. Amongthevarious renewable sources, Solar power is reliable and has high potential. Flyback inverter is used here to convert the DC into AC. The flyback inverter has the advantages of simple control loop, less cost, high efficiency, compact confirmation. It is operated in BCM mode for its added advantage of wider switching frequency. Thus the Improved flyback inverter operated in BCM mode is an ideal solution for the PV applications.

KEYWORDS:Renewable energy, Flyback inverter, BCM mode, photovoltaic applications, AC systems.

I.INTRODUCTION

Solar power is the best available renewable energy that has wide scope for harvesting huge amount of electricity. It can be said that An average home has more than enough area in the roof to produce sufficient amount of solar electricity to meet all its requirements. Using an Inverter, the DC power from the PV array can be conveniently converted to AC similar to connection with normal power grid. There are only two primary disadvantagesto using solar power: amount of sunlight and cost of equipment.The best way of lowering the cost of solar energyis to improve the cell's efficiency. In this project we have proposed an Improved flyback inverter which operates in BCM mode so as to increase the efficiency.

In this paper, the efficiency of inverter can be improved by using flyback topology.The topology of the flyback inverter, which consists of three MOSFETs, two diodes, and a flyback transformer.The two outputs from the transformer are connected to the grid, through a common filter circuit, which can switch reciprocally and synchronouslywith the polarity of the grid voltage.It is simple, has less component count hence reduced cost and has advantage of isolation through transformer.A Pulse Width Modulation (PWM) control circuit to control the duty ratio of the switch. In fly-back circuits, for closed loop output voltage regulation, one needs to feed output voltage magnitude to the PWM controller.Here the Boundary Conduction Mode is used for the purpose of choosing broader frequency range.The energy from sun is transformed into direct current electricity. Maximum power point is a unique operating point supplying maximum power to the load which is present in a PV array. Tracking the maximum power point of the PV array is done to improve the efficiency of the photovoltaic energy system MPPT is an electronic system that operates the Photovoltaic (PV) modules in a manner that allows the modules to produce all the power capable of PV module. MPPT is not amechanical tracking system that "physically moves"themodules to make them point more directly at the sun

II.TYPES OF INVERTERS

The basic function of the inverterin a photovoltaic solar power system array is to convert the DC electricity generated by the solar panels into standard AC power. Any photovoltaic system which supplies power to an load must use an inverter to cover the DC power generated into AC power . There are four basic types of inverters commonly used namely Standalone inverters, Grid Tie inverters ,bimodal inverters,AC module inverters. In this project we are using Grid Tie Inverters**.** Popularly known as utility-interactive inverters, these inverters are connected to and work concurrently with the localutility grid. Power from the PV array is first directed to the point of consumption based on the load demand. Any excess power from the solar array which is not consumed is fed back into the utility grid through the power company's electrical meter. These inverters are inbuilt with safety features like anti-islanding. Anti-islanding will shut down the transmission of power from the solar array to the utility in case of any fault or other serious fluctuation in voltage or frequency.

III.FLYBACK CONVERTERS

In this paper, we have analyzed about the working of flyback converter operating in BCM mode. Conventional converters used like Buck boost have certain disadvantages hence we go for the improved flyback topology in this paper. The **flyback converter** is used in both AC/DC and DC/DC conversion along with the galvanic isolation between the input and any outputs. The flyback converter is nothing but a buck boost converter with the inductor split to form a transformer, with an additional advantage of isolation. The flyback converters provide isolation between input and output.The main reason for isolation is for safety to prevent any kind of shock hazard when using a piece of equipment. In addition to providing safety, isolation is used to separate sections from one another.
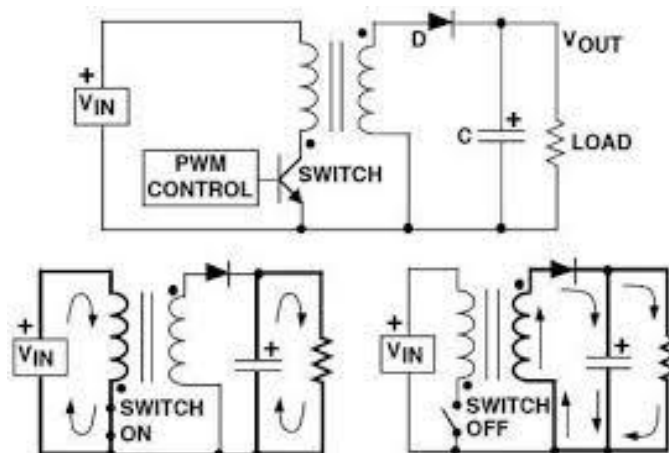

Fig1.Basic Flyback Inverter and its functioning

IV.MODES OF OPERATION

The flyback converter usually operates in three   modes namely CCM ,DCM and BCM. They can exclusively operate in one mode for their load and line range but can also switch between modes of operation. Forexample, aflyback converter can be designed to operate in CCM for high loads and then transition to DCM for light loads. In this paper we have realized the operation of flyback in BCM mode for high loads and enter DCM at light loads .In the BCM the flyback operates at a variable frequency that is varies with the output load for a given input voltage and output voltage. Entering DCM allows the flyback to handle with light loads eliminating the need to operate at higher frequencies. If the flyback remained in BCM, then the operational frequency might increase to infinity while operating at lighter loads. The name boundary conduction mode comes from the fact that the controller operates right on the boundary between CCM and DCM. During this mode, the switch turns on and stores just enough charge to replenish the load during the time the switch opens. Thus the switch will turn on again once all the energy stored is transferred to the output load. The point where the switch is turned on and the current begins to ramp in the primary occurs as soon as the current returns to zero in the secondary. since the switching occurs after all the energy is transferred, the operating frequency is dependent on line and load conditions.

V. COMPARISON BETWEEN BCM AND CCM

DCM operation is very similar to BCM operation   because the transformer is not required to store energy across cycles. Attributing to this factor, the two operational modes i.e. BCM and DCM share similar operating characteristics, merits and demerits. Due to this reason a comparison of CCM and BCM would provide more insight into the advantages and disadvantages of each operational strategy. Comparison is first made in terms of losses and then in terms of operational strategy.

A. **Loss mechanism**

There are four major losses which include   conduction losses, switching losses ,transformer losses and diode losses. Of the four losses diode loss accounts for about half of the accountable loss. When comparing CCM and BCM,certain losses are higher for one than the other. For example in terms of conduction loss, the BCM mode shows higher loss because of its higher relative RMS current levels. On the other hand in terms of switching loss ,the loss here is higher for CCM since the strategy operates at higher frequency resulting in a larger loss. It was not clear whether CCM or BCM resulted

in higher diode losses. Finally it is difficult to arrive at a conclusion as of which strategy is better in terms of comparison of just the losses.

B. Operational comparison

BCM differs from CCM fact that switching occurs only after all the energy stored in the primary of the transformer is transferred to the secondary. One key advantage gained from switching at a known condition on each cycle is that no oscillator is required. A second operational difference is how the two topologies deal with current limit or short circuit conditions. The BCM mode is inherently suited for short circuit operation because it only switches once the current reaches zero in the secondary .In addition, a similar advantage relates from the fact that the diode turns off at zero current in BCM. The soft switching of the output diode reduces EMI generated by the turn off of the output diode. For the reasons listed above, BCM provides some advantages over CCM operation in practical circuit applications.
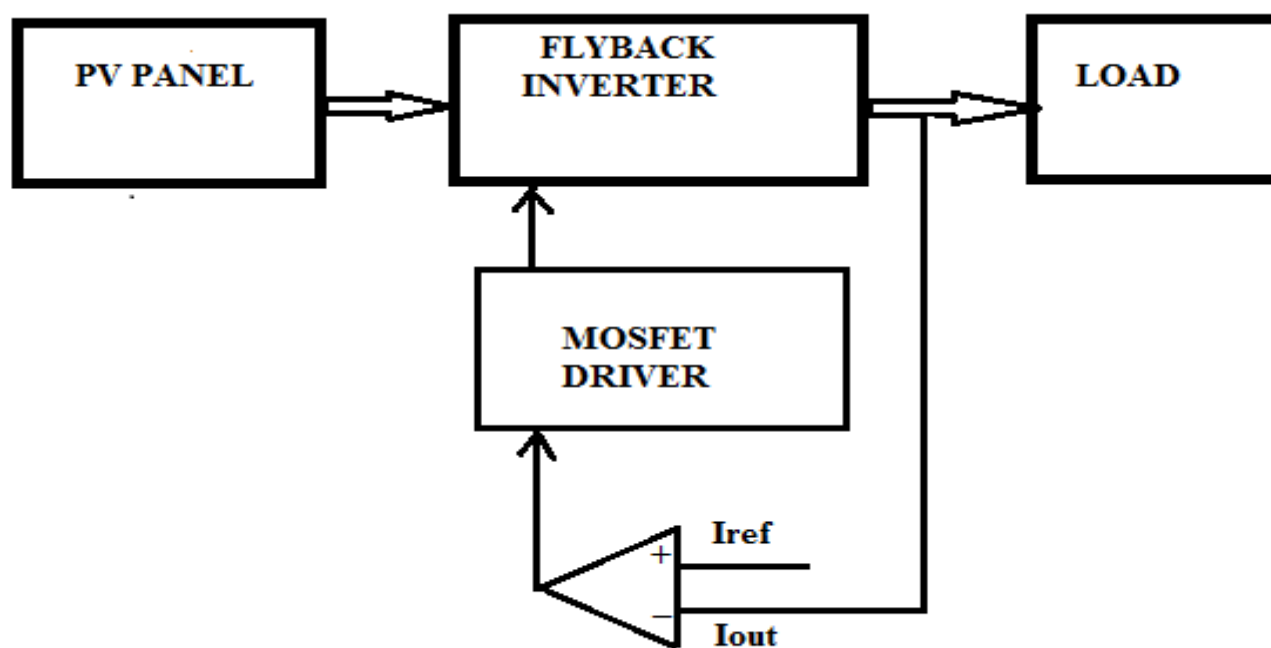
VI.PROPOSED BLOCK DIAGRAM

fig 2. Block diagram

VII.WORKING OF THE CIRCUIT

ThePV panel supplies DC power tothe Flyback inverter. The Flyback inverter is a combined block of Flyback converter and Grid tied inverter.The grid tie inverter works in tandem with the load. The grid tie inverter inverts the DC into AC and feeds the AC supply to the load. The operation of the converter in the inverter block is controlled using a MOSFET driver. The driver controls the duty cycle of the MOSFET in the converter circuit thereby controlling the operation of the inverter. The output load current is compared with the reference current in the comparatorThe comparator output is fed to the controller. . Based on the error signal the comparator drives the controller. The controller in turn drives the MOSFET driver. During heavyloads the inverter is made to operate in BCM mode when light loads, it operates in discontinuous conduction mode. Thereby the inverter operates at a wider switching frequency during heavy loads. The MOSFET being a faster switching device and hence the switching losses are reduced.

VIII.SIMULATION AND RESULTS

The circuit is simulated using MATLAB and the resulting graphs are obtained. From the result plot of voltage and current it can be seen that the efficiency is more than 94%.From the waveform obtained as a result of simulation, it can be seen that the percentage of distortion is also very less. Compared to the efficiency of other conventional converters, the Flyback inverter circuit is proved to have better results as inferred from the simulation and results.
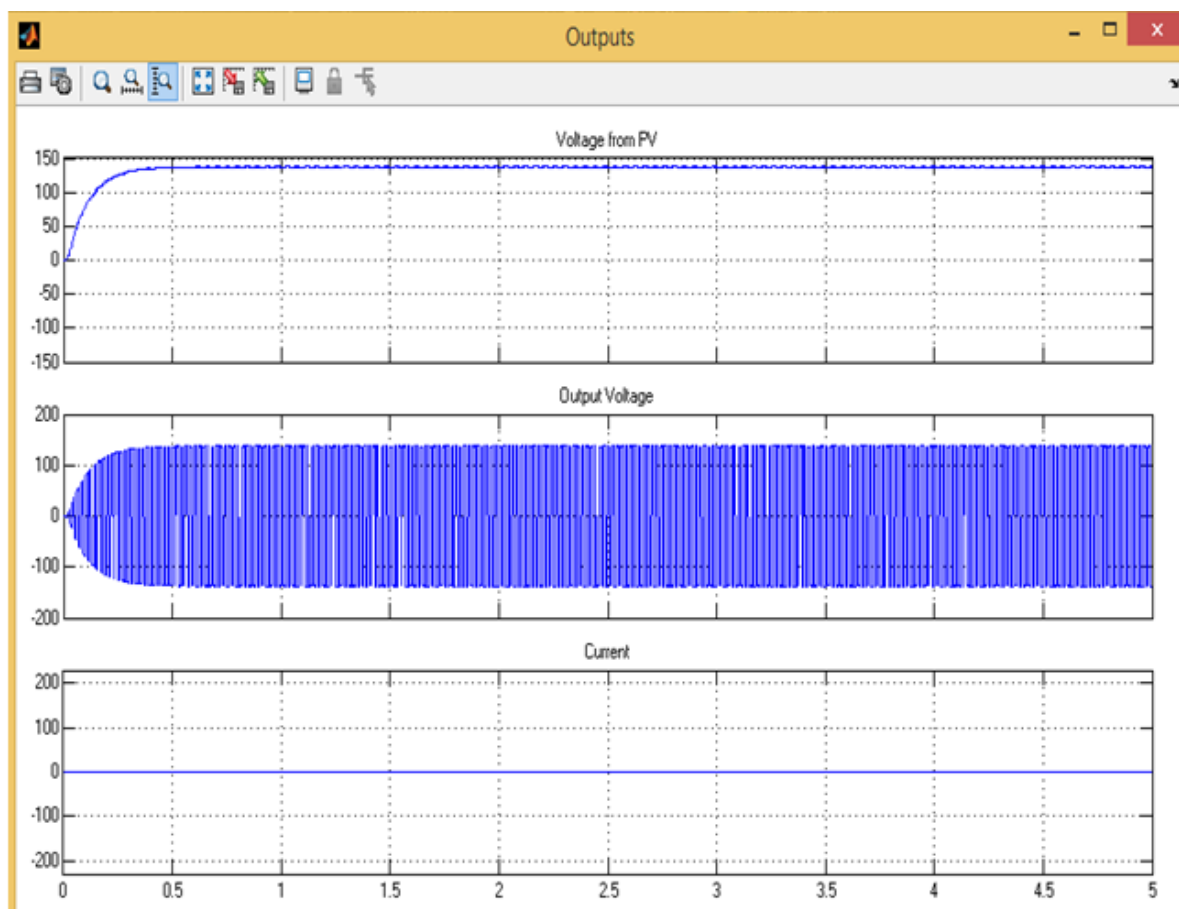

Fig3.simulation results

IX.CONCLUSION

Thus the improved flyback inverter has many advantages including simple control loop,wider switching frequency bandwidth, less cost and higher efficiency compared to other inverters used.Thus flyback inverter is an attractive solution for all the photovoltaic applications.Moreover using a grid tied inverter, it is able to supply voltage that is synchronous with the grid.Having an efficiency of more than 94% it is very advantageous when compared to conventional inverter circuits. The effectiveness of the proposed inverter is confirmed through simulation.

REFERENCES

[1] Young-Ho Kim; Jin-Woo Jang; Soo-Cheol Shin; Chung-yuen Won, "Weighted-Efficiency Enhancement Control for a Photovoltaic AC Module Interleaved Flyback Inverter Using a Synchronous Rectifier," *Power Electronics, IEEE Transactions on* , vol.29, no.12, pp.6481,6493, Dec. 2014

[2]Weidong Xiao; Ozog, N.; Dunford, W.G., "Topology Study of Photovoltaic Interface for Maximum Power Point Tracking," *Industrial Electronics, IEEE Transactions on* , vol.54, no.3, pp.1696,1704, June 2007.

[3]] Y. Li and R. Oruganti, "A flyback-CCM inverter scheme for photovoltaic AC module application," in *Proc. Power Eng. Conf. (AUPEC'08)*, , pp. 1–6. Dec.14–17, 2008

[4] A. Ch. Kyritsis, E. C. Tamaki's, and N. P. Papanikolaou, "Optimum design of the current-source flyback inverter for decentralized grid-connectedphotovoltaic systems," *IEEE Trans. Energy Convers.*, vol. 23, no. 1,pp. 281–293, Mar. 2008.

[5] A. C. Nanakos, E. C. Tatakis, and N. P. Papanikolaou, "A weighted efficiency-oriented design methodology of flyback inverter for AC photovoltaicmodules," *IEEE Trans. Power Electron.*, vol. 27, no. 7, pp. 3221– 3233, Jul. 2012.

[6] T. Shimizu, K. Wada, and N. Nakamura, "A flyback-type single phase utility interactive inverter with low-frequency ripple current reduction on the DC input for an AC photovoltaic module system," in *Proc. 2002 IEEE 33rd Annu. Power Electron. Spec. Conf. (PESC'02)*, , vol. 3,pp. 1483–1488.2002

[7] Y. Li and R. Oruganti, "A low cost flyback CCM inverter for AC moduleapplication," *IEEE Trans. Power Electron.*, vol. 27, no. 3, pp. 1295–1303,Mar. 2012.

[8]Kasa, N.; Iida, T.; Liang Chen, "Flyback Inverter Controlled by Sensorless Current MPPT for Photovoltaic Power System," *Industrial Electronics, IEEE Transactions on* , vol.52, no.4, pp.1145,1152, Aug. 2005

[9]Young-Ho Kim, Young-HyokJi, Jun-Gu Kim, Yong-Chae Jung, and Chung-Yuen Won, "A New ControlStrategy forImprovingWeighted Efficiency in Photovoltaic AC Module-Type Interleaved Flyback Inverters," in IEEE Transactions on power electronics, vol. 28, no. 6, 2013.

[10]Jong-Hyun Lee, Joung-Hu Park, Member, IEEE, and J. H.Jeon, "Series-Connected Forward–FlybackConverter for High Step-Up Power Conversion," in IEEE Transactions on power electronics, vol. 26, no. 12, 2011.