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# An Improved Interleaved High Power Flyback Inverter for PV Application

**Chetan.D.Patil[1], Kshitija.S.Desai[2], Ankita.A.Kumbhoje[3] , Rutuja.C.Chavan[4], Bhagyshri.S.Khot[5], Sonali.S.Gavali[6]**

Assistant professor, Dept. of EE, Sharad Institute of Technology College of Engineering, Yadrav, Maharashtra, India[1]

UG Student , Dept. of EE, Sharad Institute of Technology College of Engineering, Yadrav, Maharashtra, India[2,3,4,5,6]

**ABSTRACT**: In this paper, a High Power Flyback Inverter with Improved Interleaved Technique is proposed. This paper presents analysis of an load-connected inverter for photovoltaic application based on interleaved flyback converter topology which is operate in discontinuous current mode. The main advantage of interleaving is that the frequency of ripple component is increased in proportion to number of cells which allows easy filtering. Therefore it is a best solution to increase the power level which minimizes the current ripple can reduce the passive component size. The flyback converter is having low cost and requires less no of elements, this is due to inductor along with the transformer so that voltage ratio multiplied with an advantage of isolation.

**KEYWORDS:** Flyback Converter, Interleaved Transformers, Photovoltaic (PV), Discontinuous Current Mode (DCM).

## I.INTRODUCTION

The electricity demand is increasing all over the world and the world searches the greenery way to generate the electricity. The solar energy is one of the greenery source to generate the electricity, also it is available freely in nature. In this paper design of an high Power Flyback Inverter with Improved Interleaved Technique using a solar energy as an input or as an fuel. Generally in power transformer there is a external inductor is provided in which energy storage and power transfer are separately done which make circuit complicated. But, in this paper flyback topology is introduced in which inductor is internally provided in transformer so the power transfer and energy storage internally carried out. The combination of these two components in flyback topology eliminates the bulky and costly energy storage inductor and therefore leads to a reduction in a cost and size of converter. The two isolated transformers are interleaved.

The factor for system is selection of mode of operation. There are two modes of operation Continuous Current Mode (CCM) and Discontinuous Current Mode (DCM). In this paper Discontinuous Current Mode of operation is used which has several advantages as mentioned below:

- Less switching losses.
- Efficiency is more.
- Easy to control.

The drawback of discontinuous current mode (DCM) is higher from form factor as compared to continuous current mode (CCM) due to this large amount of power loss is occurred. The solution for this is, interleaving the transformers.

There are two types of charge controllers they are MPPT charge controller and PWM charge controller. Here MPPT charge controller is used to track maximum power from solar panel. The most recent and best type of solar charge controller is called Maximum Power Point Tracking or MPPT. MPPT controllers are basically able to convert excess voltage into amperage. With PWM charge controller used with 12v batteries, the voltage from the solar panel to the charge controller typically has to be 18v.

The flyback topology is known to be the lowest cost converter among the isolated topologies since it uses the least number of components. This fact comes from the ability of the flyback topology to combine the energy storage inductor (the inductor in the buck-boost converter) with the transformer. In other type of isolated topologies, the inductor and the transformer are separate. While the inductor is responsible for energy storage, the transformer on the other hand is responsible for energy transfer while providing galvanic isolation. The combination of these two components in a flyback topology eliminates the bulky and the costly the energy storage inductor and therefore reduces the overall cost. Now the transformer is required to storage energy, which is not a typical characteristic of a power transformer. In order to distinguish this transformer from the conventional power transformers, it is called "flyback transformer."

In order for the flyback transformer to store energy, the magnetizing inductance must be reduced and typically, a large air gap must be inserted. Having to have a relatively large air gap results in large amount of leakage flux and so reduced coupling, and poor energy transfer efficiency. Because of this reasons, the flyback converters are generally not designed for high power. The recommended use of flyback topology is limited below 200W. Nevertheless, if advanced design techniques are employed, the flyback converter can be used in high power applications as well. One of those methods to push the power limit to higher levels is to employ interleaving technique. In this technique, more than one unit are connected in parallel, but they are equally phase shifted with respect each other. The major advantage of this method is that each unit shares the power equally and does not need any controller for equal sharing. Another major benefit is that the switching frequency ripple elements at voltage and current waveforms are multiplied depending on the number of interleaved units. The last feature allows easy filtering of the ripple components or using smaller sized filtering elements. The ability to use smaller passive elements is very beneficial for reducing the cost and/or obtaining the small sized converter. As mentioned before, the discontinuous mode of operation is preferred and used to simplify the control system, and to obtain always a stable system with fast dynamic response. Contrary to these advantages, the DCM operation is generally a cause for poor efficiency because of the high peak to rms ratio of the waveforms. The discontinuous currents in the DCM operation yield higher rms values compared to the currents in continuous current mode (CCM) case, and therefore more power losses are generated. The interleaving technique can also be a solution to this problem. The discontinuity in the waveforms before and after the common node is reduced and continuity is regained because of the phase-shifted operation of the parallel cells.

## II.SYSTEM MODEL AND ASSUMPTIONS

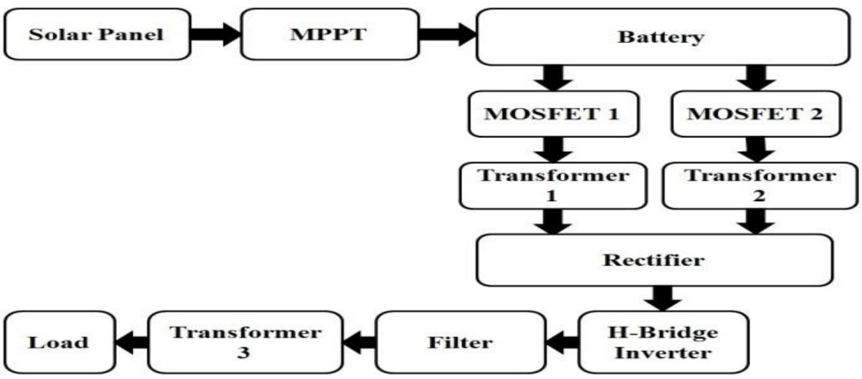


Fig1. Block diagram of the proposed system

This system consist of solar panel, switch, MPPT, battery, MOSFET, transformers, filter, H-bridge inverter, load,etc. A 20W solar panel output is given to MPPT circuit where maximum power is tracked. This power is fed to battery of 12v, 12Ah. The out of 12v battery is given to MOSFET. By using zero switching MOSFET ac power is fed to transformer. After transformer filter is used to remove the harmonic. Rectifier circuit is used to convert ac power to dc power. This dc is given to the H-bridge inverter which operates is discontinuous mode by using PWM technique. The output of inverter is fed to load.

a) ATMega-328p

**ATMEGA328P** is high performance, low power controller from Microchip. ATMEGA328P is an 8-bit microcontroller based on AVR RISC architecture. It is the most popular of all AVR controllers as it is used in

ARDUINO boards. P&O method is used for tracking the MPP. In this technique, a minor perturbation is introduced to; cause the power variation of the PV module. The PV output power is periodically measured and compared with the previous power. If the output power increases, the same process is continued otherwise perturbation is reversed. In this algorithm perturbation is provided to the PV module or the array voltage. The PV module voltage is increased or decreased to check whether the power is increased or decreased. When an increase in voltage leads to an increase in power, this means the operating point of the PV module is on left of the MPP.

b) MPPT

A typical solar panel converts only 30 to 40 percent of the incident solar irradiation into electrical energy. Maximum power point tracking technique is used to improve the efficiency of the solar panel. According to Maximum Power Transfer technique, the output power of a circuit is maximum when the source impedance matches with the load impedance, for this pot is used to vary the resistance. In the source side a buck converter is connected to a solar panel in order to enhance the output voltage. There are various MPPT techniques are proposed. In this project the perturb and observe (P&O) technique is used.

In this proposed system perturb and observe MPPT algorithm is used. In this method the controller adjusts the voltage by a small amount from the array and measures power, if the power increases, further adjustments in the direction are tried until power no longer increases. This is called P&O method. Due to ease of implementation and cost effectiveness, it is the most commonly used MPPT method.

The voltage to a cell is increased initially, if the output power increase, the voltage is continually increased until the output power starts decreasing. Once the output power starts decreasing, the voltage to the cell decreased until maximum power is reached. This process is continued until the MPPT is obtained.

c) Transformer

In this three transformers are used,in which two are interleved transformers.They are of 3A, 12-0-12V. The input of transformer is pulsating DC from MOSFET.

Another transfomer is step up transformer which is 12V/230V.This transformer output is given to the load.

d) H-bridge

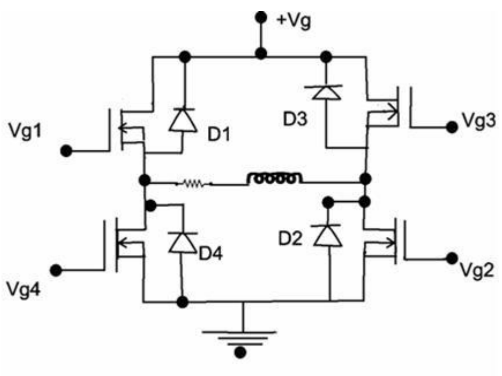


Fig 2. H-Bridge

An H-Bridge or full bridge converter is a switching configuration composed of four switches in this case MOSFETs in an arrangement that resembles an H. By controlling which switches are closed at any given moment, the voltage across the load can be either positive, negative, or zeroWhen switch S1 and S2 are closed and switches S3 and S4 are open a positive voltage will be applied across the load. By closing S3 and S4 switches and opening S1 and S2 switches a reverse voltage will be applied to the load. Using nomenclature above switches S1 and S4 should never be closed at the same time as this will cause a shot circuit on between the power supply and ground, potentially damaging the devices or draining the power supply. The same applies to switches S2 and S3. This condition is known as shoot-through. The table below outlines the positions. Note that shoot-through switch positions are omitted. The switches used to implement an H-Bridge can be mechanical or built from solid state transistors. Selection of the proper switches varies greatly.

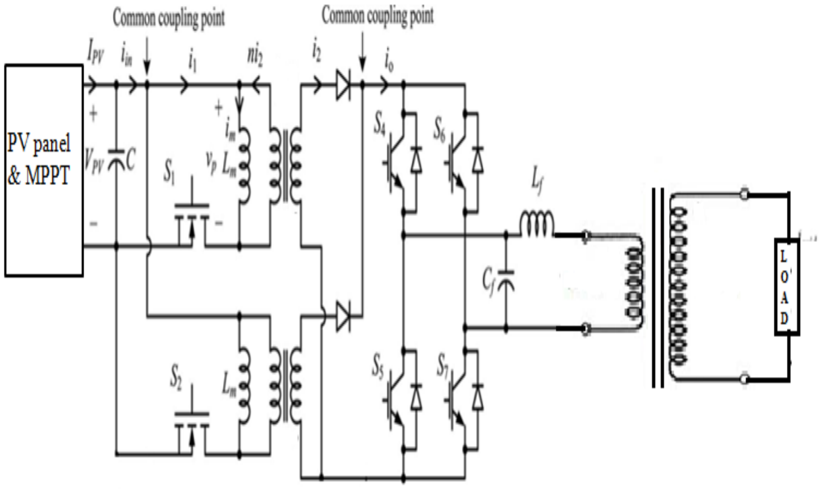


Fig 3. Circuit diagram of proposed system

In the existing system three interleaved transformers were implemented which makes circuit more complicated and size of circuit is increased. Existing PV Inverter System Based On Three-Cell Interleaved Flyback Converter Topology. In the proposed circuit size of the circuit is reduced by removing switch and transformer so that complexity of circuit is reduced. The capability of the old system can be compensated in proposed system by increasing transformers turns .It consist of primary and secondary circuit. In primary circuit current flows from pv source to the switches through a decoupling capacitor which is used to reduce ripples produced in the input or primary circuit i.e. from PV source. So practically the ripples from the PV source must be small for good performance of the converter and it can be gained by decoupling capacitor. A metal oxide semiconductor field-effect transistor (MOSFET) can be used at the primary side for the switching purpose in Flyback converter. The secondary circuit consists of a flyback transformer and a diode. The system also employs full-bridge inverter as well as low-pass filter to interface with the system in systematic manner.

The full bridge inverter is made up of switches and diodes. Now switching can be done as the fly back switches (S1 & S2) are turned ON. So current flows from the PV source i.e. from common point into the magnetizing inductance of the fly back transformers and energy is stored in the inductance. When the switch is ON position then no current flows to the output due to the reverse position of the diodes present at the secondary side therefore energy supplied to load. By the capacitor Cf and inductor Lf . At the last of switch on time current goes to maximum value. When switch is OFF position the energy stored in the magnetizing inductances is transferred into the load in the form of current. Hence Flyback inverter acts as voltage controlled current source. At the last of switch off time of switches the magnetizing current decreases from maximum value to zero value linearly. The similar process gets repeated in switch S2.

## III. ANALYSIS

| Sr.No. | Stages | Voltage across stages(Volt) |
|---|---|---|
| 1 | Battery | 12.2 |
| 2 | MOSFET | 8 |
| 3 | Transformer output | 12.2 |
| 4 | Rectifier | 9.39 |
| 5 | Inverter | 11.2 |
| 6 | Step up transformer output<br>I. With load<br>II. Without load | <br>149<br>223.5 |

Table1. Result

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## IV. CONCLUSION

A central-type PV inverter for small electric power system applications rated at 20W is implemented based on the interleaved flyback converter topology. The flyback topology is selected because of its simple structure and easy power flow control with high power quality outputs at the grid interface. Interleaved flyback inverter is best solution for all photovoltaic application.

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