A Control Scheme of Interleaved Flyback Inverter for Photovoltaic Application for Maximum Efficiency

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Abstract : Electricity demand is progressively increasing everywhere in the world. The best solution of this problem is use of the renewable energy sources. Solar energy is one such type of energy which gives the more efficiency. This study represents the analysis and design of inverter for the photovoltaic application by using the interleaved flyback topology. The another main important aim of this study is to reduce the cost of system which will helpful for achieving the more efficiency. This cost reduction is achieved by using the converter topology making the use of small size of converter. With the help of this technology the reduction of the ripples is easily possible which plays the vital role in the design of the system. Maximum efficiency and near about unity power factor is possible by using this scheme**.**

IndexTerms **- Photovoltaic(pv), Discontinuous current mode(DCM)..**

I. INTRODUCTION

Solar energy is the one of the renewable energy source present on earth and which has greater potential to play major role in near about future in the energy market of the world[1]. Therefore many research are going on this field for its better use for the world[2]-[4]. But its high initial cost make its use restricted in the world. If we have to make commercialization in small electric power systems then low cost reduction is very important[5]. So this cost reduction is possible by using the flyback inverter topology which is mostly operate in which is mostly operated in discontinuous current mode.

Flyback topology is considered as lowest cost topologies amongst other because it uses the less number of component. It combines the energy storage inductor with the transformer. But as far as the other topologies are considered the these two elements are separate which effects on the performance of system and also effects on efficiency of system. The combination of these two components in a flyback topology eliminates the chances of bulky system and the costly the energy storage inductor and therefore reduces the overall cost. Here inductor is responsible for storage of energy while the transformer transfers the energy.The transformer bused in this case is called as the Flyback Transformer. The major advantage of this method is that each unit shares the power equally and does not need any controller for equal sharing. The ability to use smaller passive elements is very beneficial for reducing the cost and obtaining the small sized converter. Discontinuous mode of operation is preferred to make control system stable with fast dynamic response. DCM having one disadvantage that poor efficiency is possible by using this operation mode. The solution for this problem is interleaving which is helpful for increasing the efficiency.

II.SYSTEM DESCRIPTION AND OPERATING PRINCIPLE

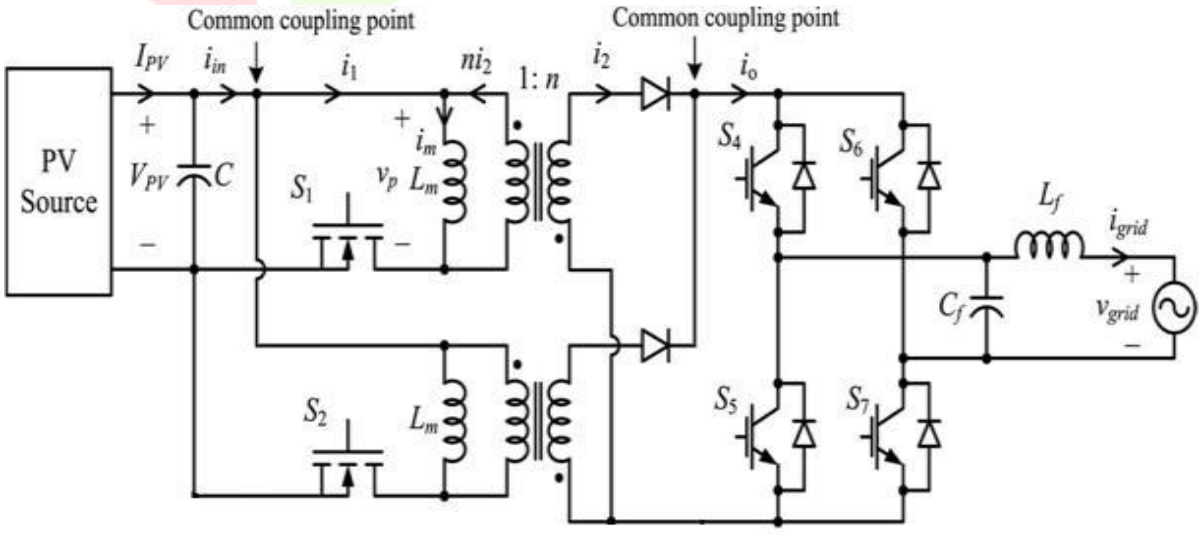

Fig.1.PV inverter system based on flyback inverter topology

According to the fig.1 the PV source is connected to the flyback converter with help of decoupling capacitor. The function of decoupling capacitor is to remove the harmonics of the primary side i.e from PV source .So the ripples from primary side is cleared for to improving the efficiency. Switch which is used in the circuit may be of any power electronic device. Here we are using the (MOSFET) which is nothing but Metal-oxide semiconductor-field effect transistor. Secondary circuit mainly consist of

the flyback transformer and diode. Full bridge inverter which is made up of switches on the secondary side. Current flows from PV source i.e from common coupling point to the inductance of flyback transformer. When Switch is ON position then, no current flows in the output due to the reverse position of diode. Energy is supplied by using the capacitor Cf and inductor Lf.During the last of switch on current reaches to its maximum value. When Switch is in the OFF position the energy stored in the inductance is transferred in the form of current.So we can say the flyback converter acts as a Voltage-controlled current source. At the last of Switch off,Current decreases from maximum value to the zero linearly. So, in this way, switching can be done in discontinuous conduction mode. So,the output current is DC. Hence, to convert dc current to the ac current,we can use bridge converter.Then After conversion of DC to AC, this current goes to the low pass filter which can filters out harmonics having high frequencies from required current.

III.CONVERTER ANALYSIS

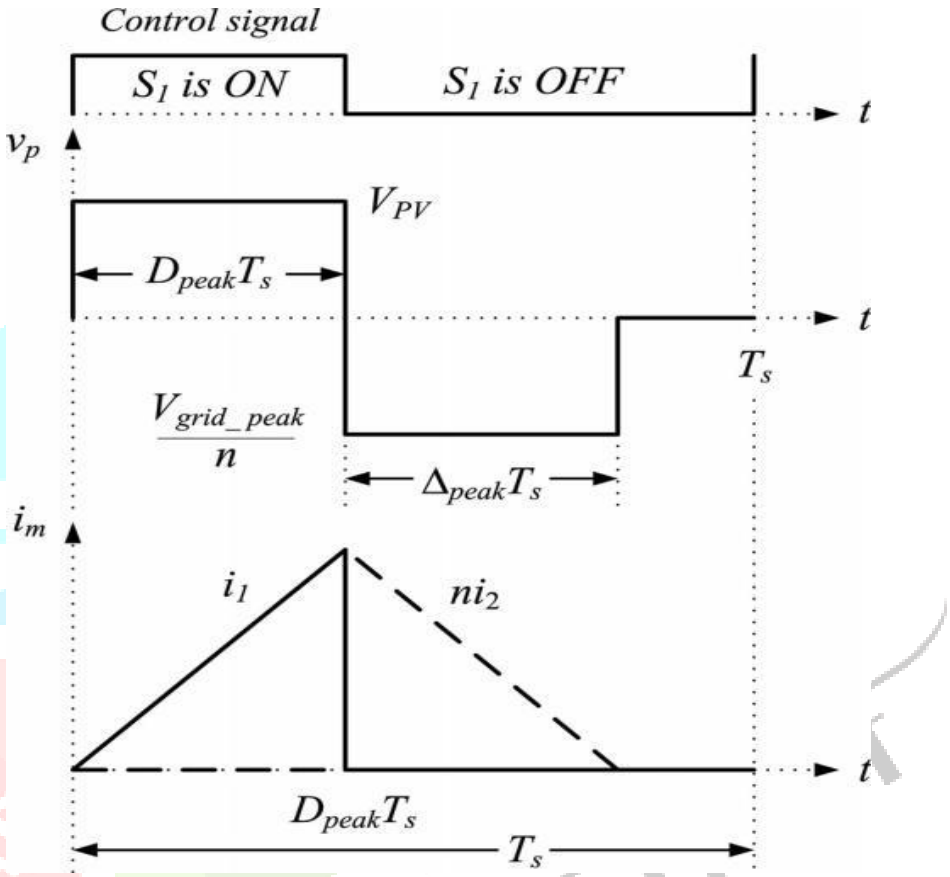

Fig.2.Control signal for flyback switch,magnetizing current(im) and flyback transformer primary voltage (vp)

Converter analysis is basically carried out by using two ways

A] When Switch is ON position.

When switch is in ON Position,input voltage is given to primary circuit and current flows through the primary side.Current starts increasing slowly and reaches to the maximum value with positive slope. So the relationship between flyback converter parameters and PV source output power can be written as follows:

$P_{PV}=V_{PV}I_{PV} = [nCell\ V^2pv\ D^2PV]/4L_mf_s$

B] Whwn Switch is in OFF position

The flyback transformer primary voltage becomes negative of the grid voltage and the average power drawn from PV panel equal to the active power transferred to the grid and it can be calculated as

$P_{PV}=V_{PV}I_{PV} = [nCell\ V^2pv\ D^2PV]/4L_mf_s$

Lm=Magnetizing inductance
,$nCell$=number of interleaved cell,
f_s=Switching frequency
D_{peak}=Duty peak ratio

IV.DESIGN OF SYSTEM

Design is mainly focus on small power domestic applications ,so the rating of power is selected as of 2Kw.The fvalue of switching frequency is of 40 kHz. The value of the peak converter input voltage is 108.5V for the given PV module. The main aim of interleaving is to reduce the passive filtering methods by using phase-shifted operation to reduceripple contents.The basically operation of whole system is based upon the flyback transformer who store some amount of energy and then transfer to the output. Therefore, during the design process, the main thing that can take into consideration is the most effective energy storage mechanism and proper & efficient energy transfer path. Here we are using 88 V for Vpv, Switching frequency fs is 40kHz ,Ppv is of 1950 W , and Dpeak of 0.3333.The control system can be designed to perform functions without using a feedback loop.When it is receiving the maximum power which is available from solar cells, it must provide that specified power to the utility having rich power quality. For that purpose, it must continuously regulate dc current Ipv and voltage Vpv when maximum energy is harvesting from the solar cells.

The decoupling capacitor is an important component of the power stage which controls the voltage ripple at the flyback converter input. As mentioned in the analysis section, smaller the voltage ripple, smaller the grid current THD. However, too small ripple means a very large value of capacitance; thus, some compromise must be made between ripple and size. The value of the decoupling capacitor is determined as 9400µf based on the simulation studies. Following table shows the design specification used while designing

Table.1. Design Specification

Design Parameter	Specification
PV model	BP365,65 W
Switching frequency	40 Hz
Open circuit voltage and short circuit current per panel	21.7 V,3.99 A
Total maximum DC power from panel group	1950 W

V.SIMULATION RESULT

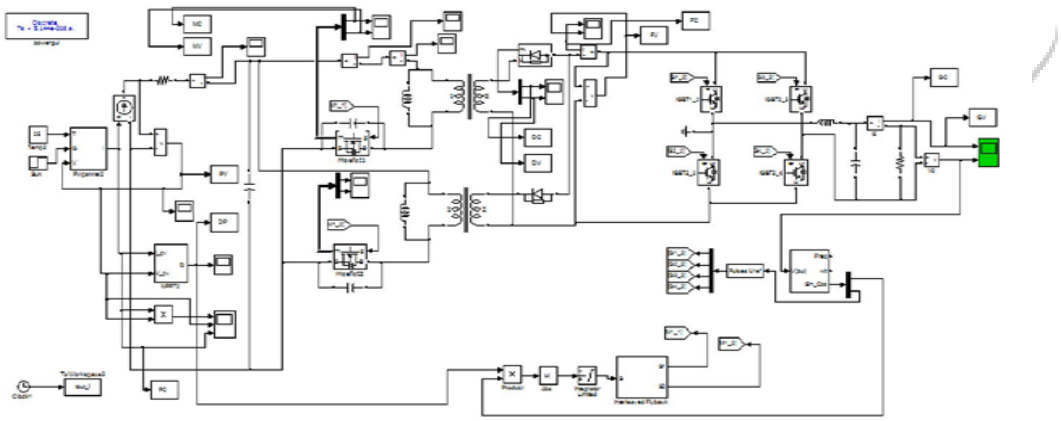

Fig.3.Simulation model of System

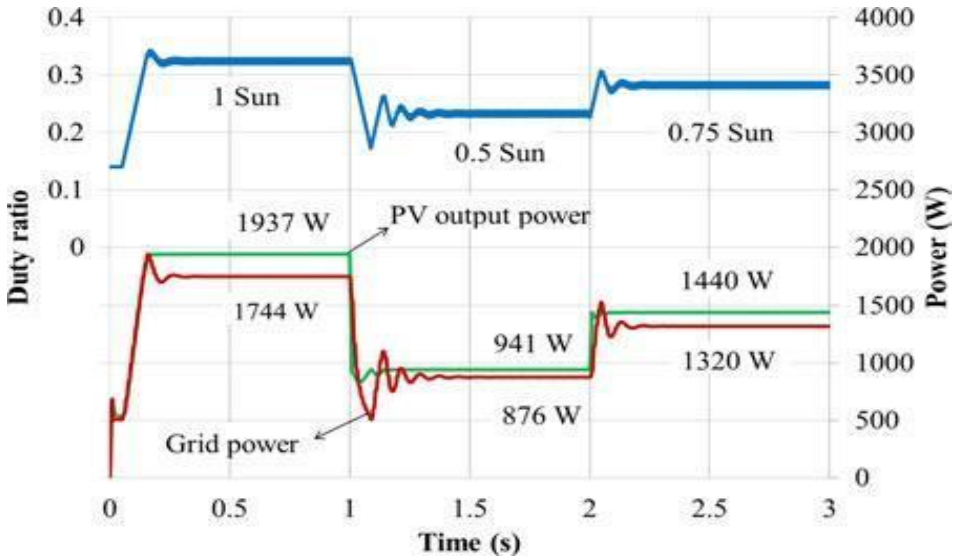

Fig.4.Peak Value of Duty ratio

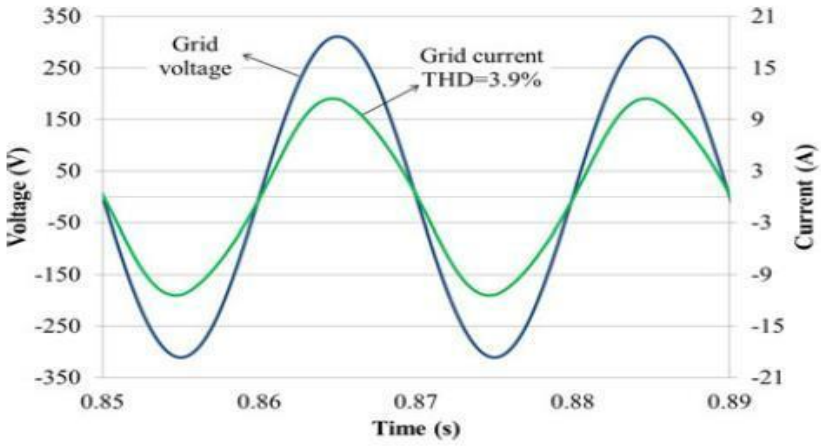

Fig.5.Grid voltage and current waveform

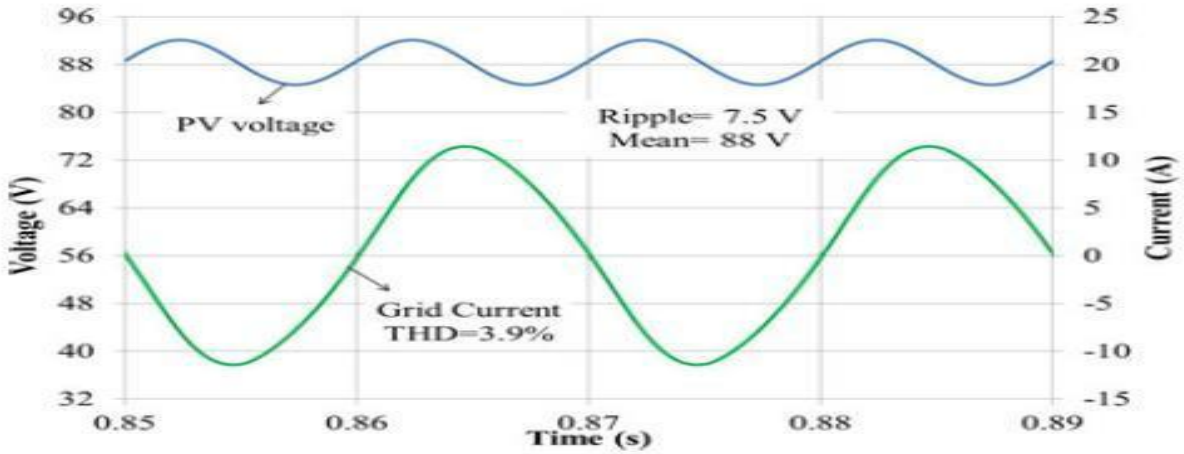

Fig.6.PV terminal voltage and current

VI.CONCLUSION

The main contribution of this system is that it helps for reducing the cost of overall system which is main factor while designing. It helps in the commercialization of solar technology in near future. The design whole system is very compact and less bulky as compared to the previous system. Building the inverter system based on the flyback converter topology offers the lowest cost since it requires the least number of components, operating in the discontinuous current mode enables very simple and always stable control system. The Efficiency near about 90% is possible by using this scheme of interleaved flyback inverter. Power factor near about .998 is very advantageous as compared to the other Inverters

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