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Performance Enhancement of Isolated Soft Switching Interleaved Boost converter using different MPPT algorithm

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Abstract

This proposed work introduces a isolated soft switching interleaved boost converter using different MPPT(Maximum Power Point Tracking) algorithm. The proposed converter can be applied as grid connected system to operate as a high gain boost stage with inverter in PV (Photo Voltaic) energy system. The output of PV panel is affected by temperature and insulation, which makes reduction in conversion efficiency. The efficiency of PV is improved by using MPPT. The performance of proposed isolated soft switching interleaved boost converter is improved by using Hill climbing and incremental conductance algorithm. In this proposed boost converter high step up transformer and voltage multiplier are used. The voltage multiplier help to improve the voltage gain and reduce the voltage stress on the MOSFET switches. In the proposed converter soft switching method is implemented to reduce the switching loss in the switch. The performance parameters like output power, efficiency, voltage stress, conduction loss, ripple factor are compared with both MPPT methods.

Keywords— maximum power point tracking(MPPT), isolated soft switching interleaved boost converter(ISSIBC).

Introduction

Solar energy is the most readily available renewable resource. Solar power is non-pollution and maintenance free PV panels are used to convert the solar energy into electrical energy. Solar energy supplied by the sun in one hour is equal to the energy required by the human population in one year. Power generated by PV module depends upon the solar irradiation, cell temperature. PV system installation has been increased nowadays, lowered system costs, governmental initiatives, rising electricity bills. Isolated DC-DC converters are widely used in application like power factor correction circuits, battery charger, electric vehicles, and renewable sources. Normally isolated DC-DC converter is categorizing as Buck, Boost, and Buck Boost converts. [1]-[8]. These converter big challenges are to bring the higher Efficiency, high voltage gain. If we increase the voltage output in Boost converter will get decrease efficiency [1]-[10]. The isolated fly back converter selected for to stress on switch and hard switching efficiency low. Like For isolated zeta, sepic, cuk converters are derived from non-isolated one. But thus converters are also suffering from same problem as like fly back converter. [11]. The two switch buck isolated boost converter is more attractive due its flexible control and high efficiency [12]-[16]. It have buck cell and boost cell, inductor. The another method is to improve the efficiency is applying ZVS(Zero Voltage Switching) to higher efficiency [2]-[6] obviously the input stage of IBB(Isolated Buck Boost) is buck cell and output stage is boost cell both are linked by high frequency inductor and transformer. It is same as that of two switch buck-boost converter. The PV generation system has two major problems, low efficiency on energy, particularly under low irradiance conditions, electric power generated by solar array changes continuously with weather conditions and temperature variations. Therefore necessary to design a methodology that can be modeled in such a way that it obtains maximum power from the sun at all times. Thus, a variety of Maximum Power Point Tracking algorithms has been proposed which aim to extract and utilize the maximum portion of the incoming radiation. There are two ways to get maximum output from PV panel one is mechanical tracking another one is electrical tracking. The Mechanical tracking is obtained the direction of PV panel oriented in such a way that to get maximum power from the sun. The electrical tracking is obtained by manipulating the load to get maximum output under changing condition of irradiation and temperature. The selection of the algorithm depends on the time duration, cheaper and simpler.Many methods have been proposed to determine the maximum power point of PV panel. [14][15].The proposed MPPT algorithm includes;

- Perturb and Observe
- Incremental Conductance
- Hill climbing
- Beta method

Among them Hill climbing and ICT algorithm can track maximum power point, good dynamic response and also it incorporate change in temperature and irradiation. In this paper incremental conduction and hill climbing are used to extract maximum power from PV panel.

Analysis of Full Bridge Isolated Boost Converter

The isolated soft switching interleaved boost converter is proposed in this paper. This proposed converter could be operated in boost mode. Each mode could be operated in continuous conduction mode. The secondary side phase shift is φ i.e. the difference between S_6 and S_4 gate signal.

$$D_s = Ø/\pi \quad (1)$$

Primary side phase shift is α is defined for s_1 and s_3. In the boost mode ZVS turns on the secondary side switch it is because of the operation of the secondary side switch is same as the synchronous rectifier.

$$D_P = \alpha/\pi \quad (2)$$

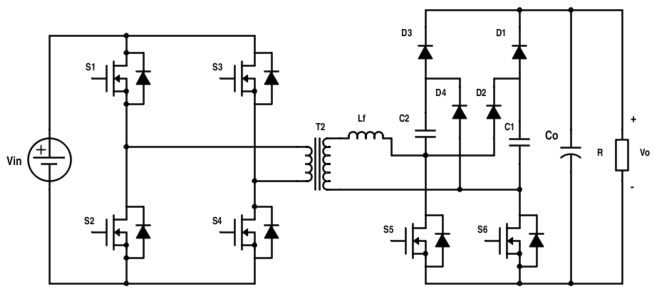

Fig.1 Proposed Converter

A) Mode 1

In mode 1 operation the S2 and S3 turn OFF. Body diodes of S1 and S4 begin to conduct due to the energy stored in Lf, which results in ZVS of S1 and S4.Due to the negative voltage across Lf the current iL_f decreases rapidly.

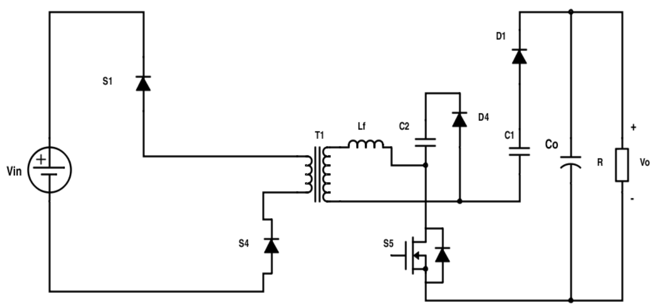

Fig.2 Mode 1

B) Mode 2

In mode 2 operation the switches S1 and S4 are turned ON with ZVS. This stage ends when iL_f returns to zero, and D2 is OFF naturally without reverse-recovery.

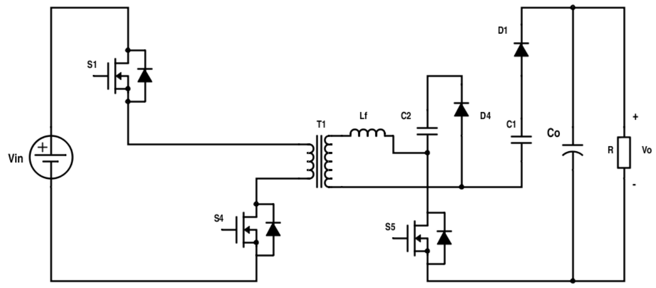

Fig.3 Mode 2

C) Mode 3

In mode 3 operation body diode of S6 begins to conduct and Lf is charged by the input voltage.

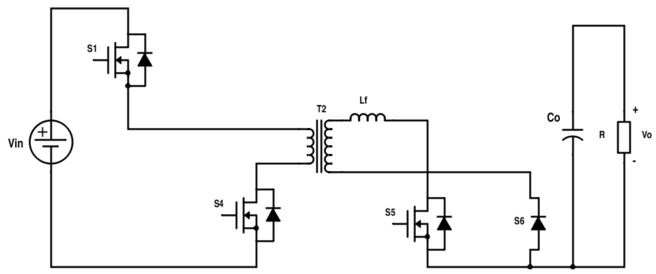

Fig.4 Mode 3

D) Mode 4

S5 turns OFF, and S6 turns ON with ZVS. D2 and D3 are on and the power is transferred to the load during this stage.

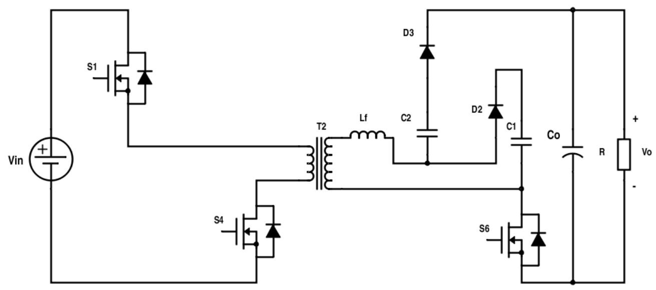

Fig.5 Mode 4

E)Simulation Specification

Parameters	Specification
DC input voltage, Vdc	12 Volt
Switching frequency, fs	20 KHz
Input current ripple	0.012 Amp
Output Power	7.5 Watt
Output Voltage	74 Volt
Self Inductance, Lf	1 Micro henry
Output capacitor, Cr2	220 Micro henry

F) Key Wave Forms

The gate pulses to the switches in the ISSIBC is as shown in the below fig.6. The gate pulses are generated with the frequency of 20 KHz.

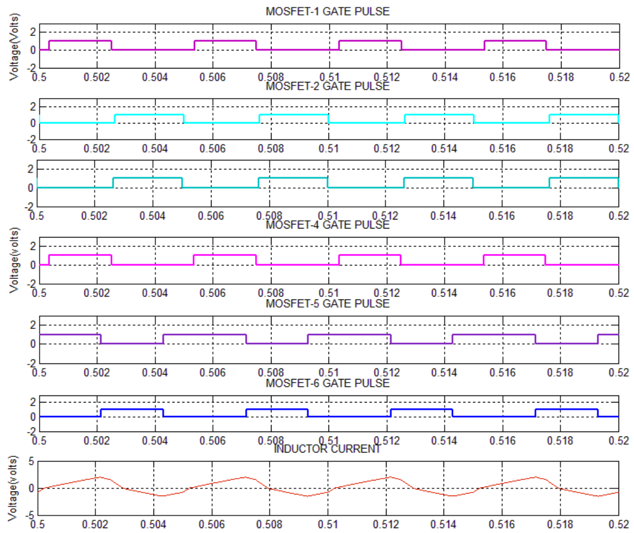

Fig.6 Key waveforms of proposed converter

Modelling of Photovoltaic Cell

The PV panel is to way, one is used of electric equivalent circuit and writing MATLAB program. The equivalent circuits of PV panel consist of ideal current source in parallel with ideal diode

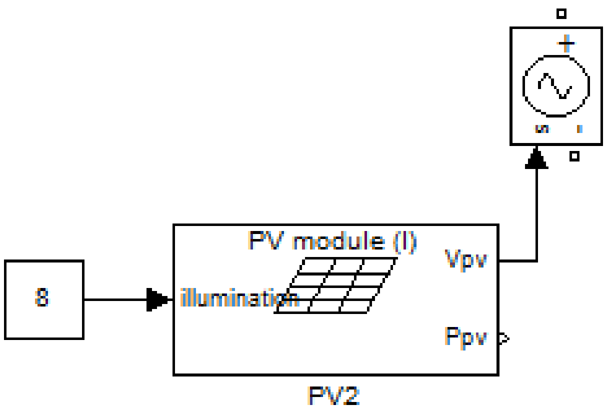

Fig.7 Model of PV

The current represent the current generated by photon under constant temperature and constant irradiation. If high is incident on the PV panel, the free charge carriers are produced. The positive and negative charge carrier isolated by space charge region. Hence voltage generated from output terminal of PV.

Modelling of Mppt

The Maximum power point tracking is the most widely used method to produce maximum power from the solar panel. There are many methods in MPPT e.g. P&O, incremental conductance, hill climbing algorithm etc. In this paper two method of MPPT algorithm is implemented and compared.

Incremental Conductance

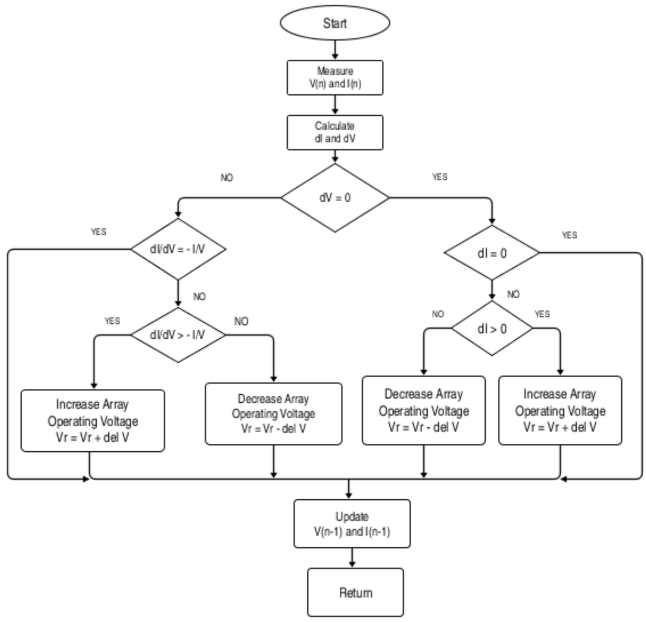

Fig.8 Incremental conductance algorithm

The fig.8 shows that flow chart for incremental conductance algorithm. The voltage, current of n^{th} and n-1th instant is sensed from that change in output conductance and output conductances were calculated. If both are equal the maximum power point was occur.

A). *Hill climbing*

The hill climbing method is same as that of P&O algorithm. The fig.9 indicates hill climbing algorithm. The voltage, current of nth and n-1th instant is sensed from that power of nth n-1th power calculated. The duty cycle of the algorithm increase and decrease based power which was calculated from the nth and n-1th instant.

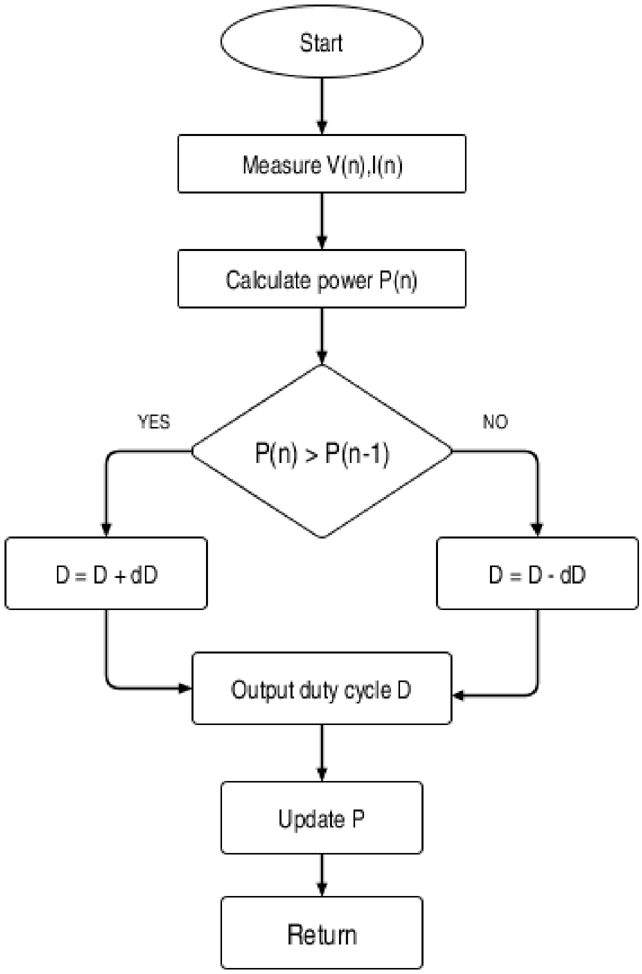

Fig.9 Hill climbing algorithm

Simulation Result

The simulation result for the proposed method is analyzed with the MATLAB software. Simulation is analyzed for existing method and proposed method. Proposed converter is compared with two MPPT techniques and the results are analyzed. The result of both the MPPT methods is compared for find efficient method.

A) Proposed isolated boost converter without MPPT

The input voltage to the existing converter is as shown in the fig.10 the input voltage is about 12V.

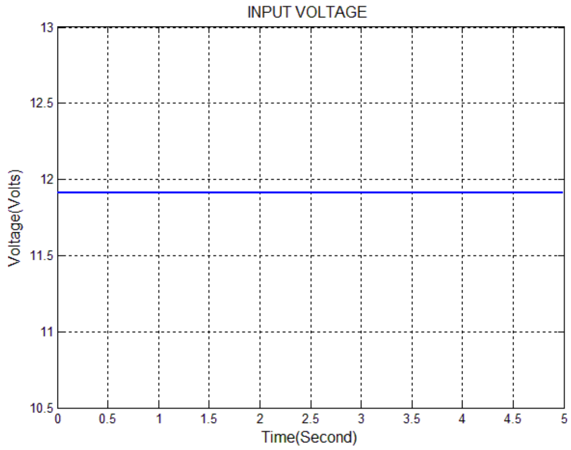

Fig.10 PV output voltage

The input current to the existing method is as shown in the fig.11. The input current is about 0.8Amp.

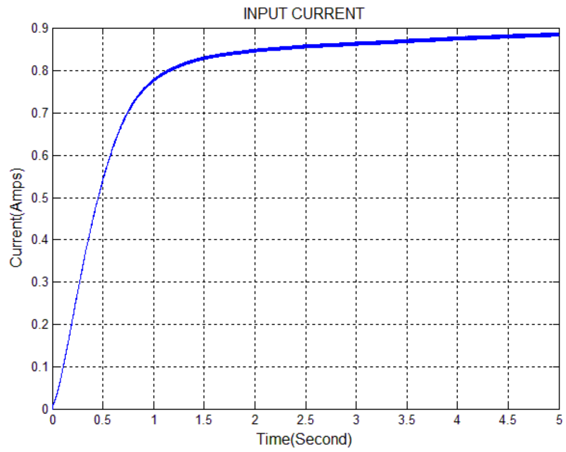

Fig.11 PV output current

Input power in the existing method is 15Watt. The output power waveform is as shown in the below fig. 12.

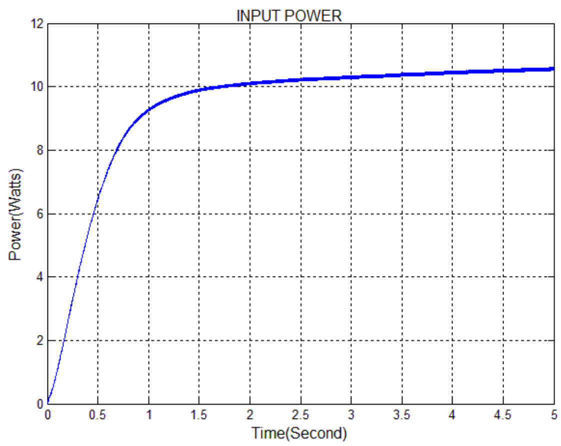

Fig.12 PV output power

In the below fig.13 output voltage of the existing method is produced. The output voltage is about 72V.

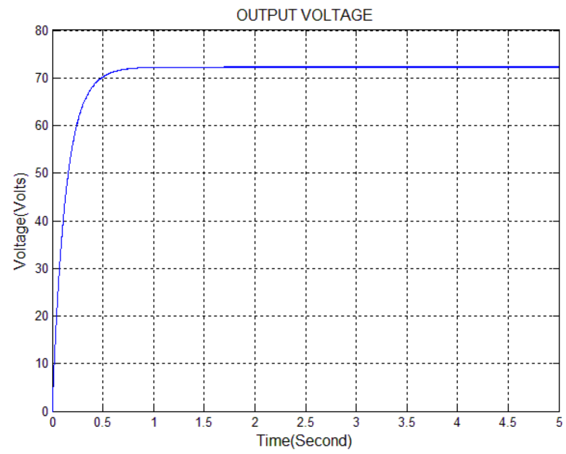

Fig.13 Proposed Converter Output voltage

In the below fig.14 the output current waveform is analysed. The output current is about 0.11Amp.

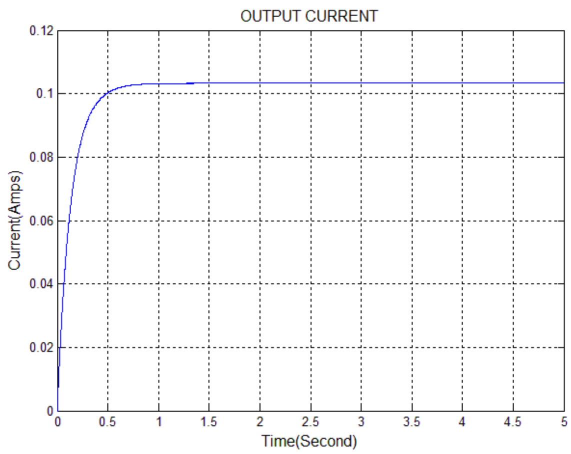

Fig.14 Proposed converter Output current

The output power of the existing method is as shown in the following fig.15.

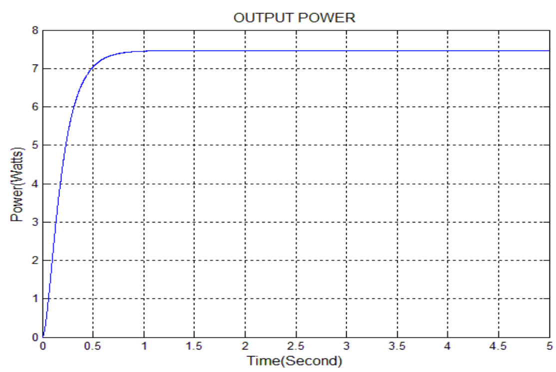

Fig.15 Proposed Converter Output power

The output power is compared to find the existing system efficiency. The efficiency waveform is as shown below fig.16.

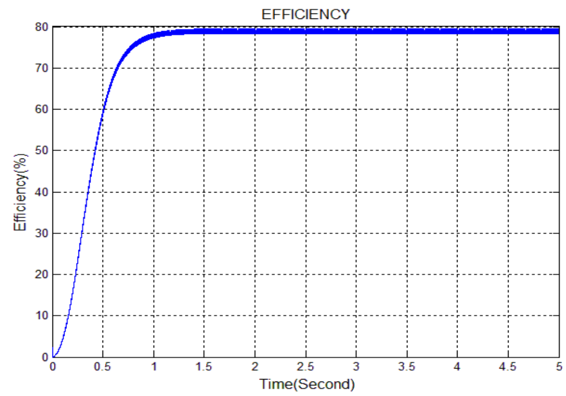

Fig.16 Proposed Converter Efficiency

B) Soft-Switching Performance

According to the modes of operation of proposed converter the ZVS of the main switches will be described. The simulated result of ZVS turn-on on the secondary-side switches S5 and S6 are given in fig.17 and 18.

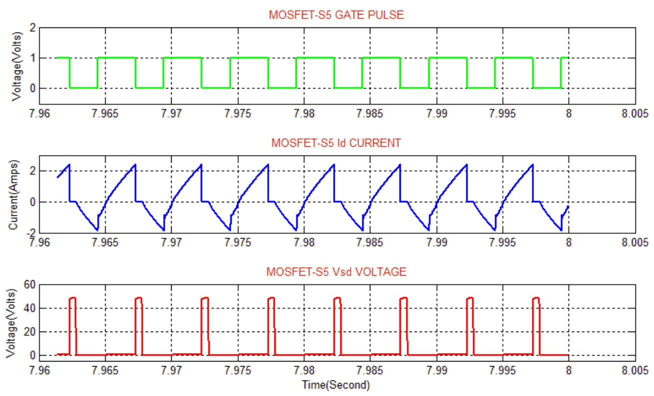

Fig.17 ZVS turn-on of switch S5

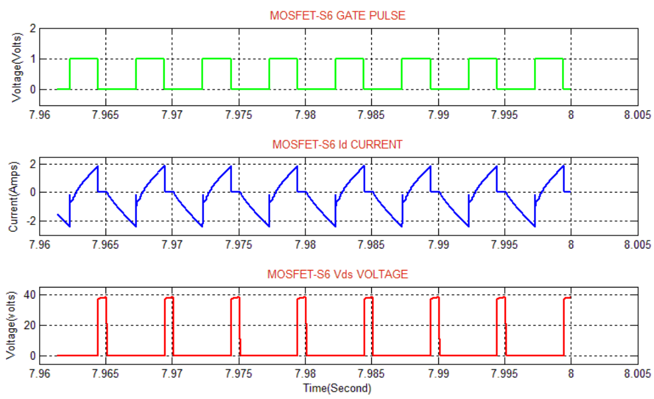

Fig.18 ZVS turn-on of switch S6

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The ZVS switching of main switches are reduce switching loss in turn to increase the efficiency of proposed converter.

C) Proposed method simulation with incremental conduction Algorithm

Input voltage to the proposed converter in IC is about 12V. The MATLAB simulation waveform is as shown below in fig.19.

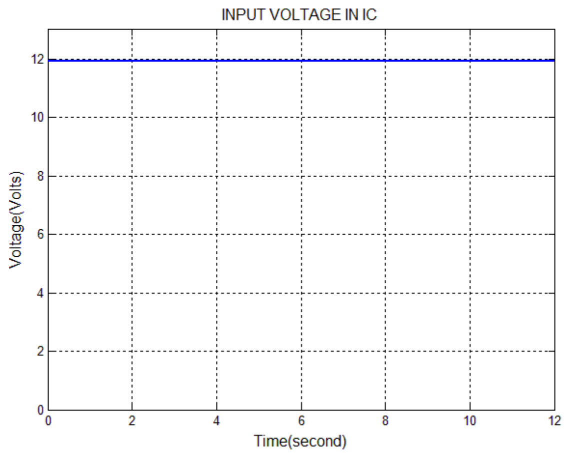

Fig.19 Proposed converter with ICT PV output voltage

In the proposed simulation case1 i.e., with ICT input current is 0.9Amp. The waveform for the input current is as shown in the following fig.20.

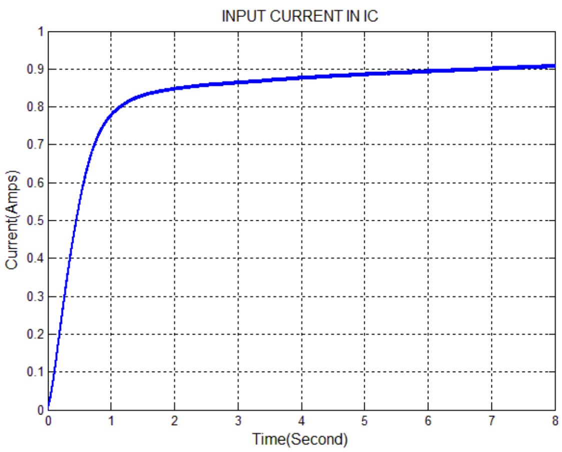

Fig.20 Proposed converter with ICT PV output current

The input power to the proposed system is as shown in the following fig.21 the input power to the proposed converter is 10W.

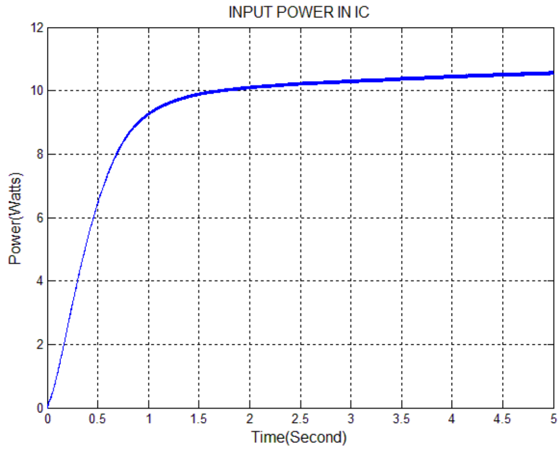

Fig.21 Proposed converter with ICT PV output power

The output voltage from the proposed converter is as shown in the below fig.22 the output voltage is 80V.

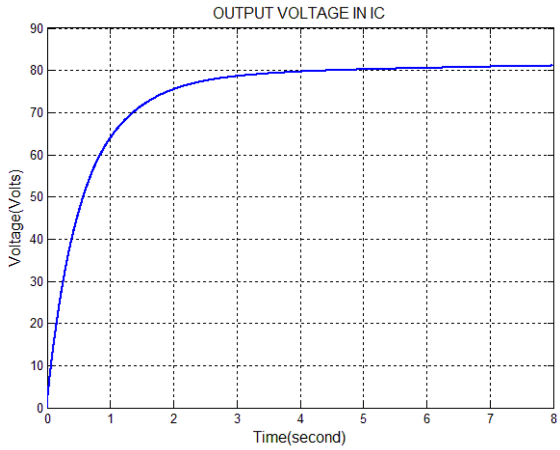

Fig.22 Proposed converter with ICT Output voltage

The output current for the proposed method to the load is as shown in the following fig. 23.

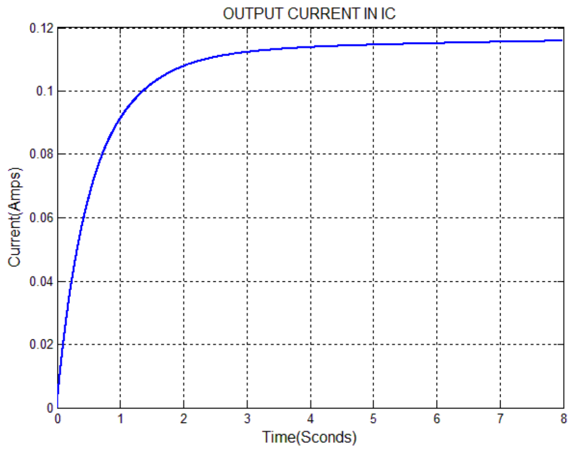

Fig.23 Proposed converter with ICT Output current

The belowfig.24 represents the output power of about 9W from the proposed converter with incremental algorithm.

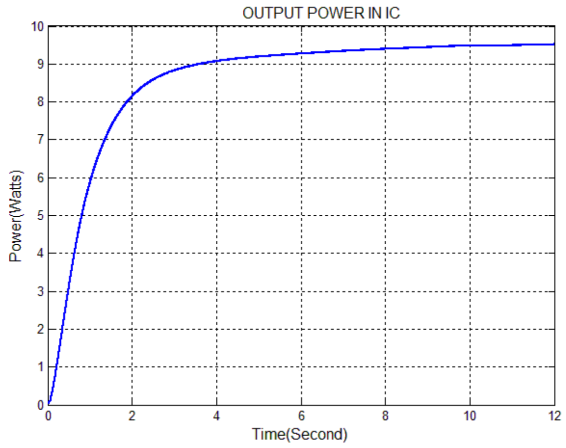

Fig.24 Proposed converter with ICT Output power

The efficiency of the proposed converter with incremental conductance is found with the output and input power as 87.5%. The waveform of the power efficiency is shown below fig.25.

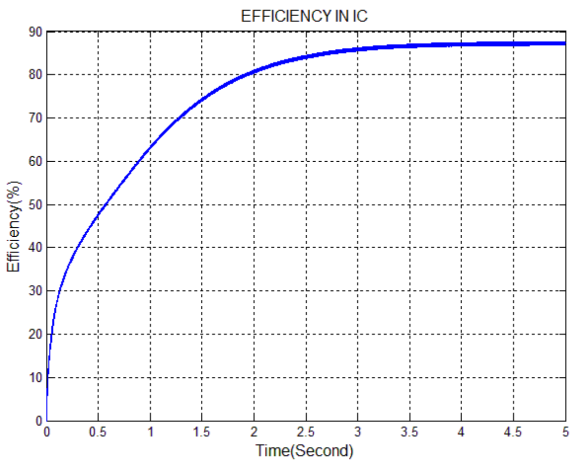

Fig.25 Proposed converter with ICT Efficiency

D) Proposed method simulation with Hill Climbing Algorithm

The input voltage from the solar panel is 12 V the waveform is as shown in the following fig.26.

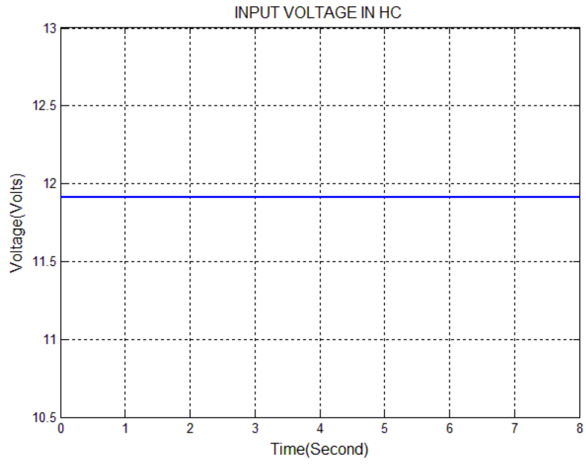

Fig.26 Proposed converter with HC PV output voltage

The input current from the solar panel is 0.9A generated and the waveform is as shown in the following fig.27.

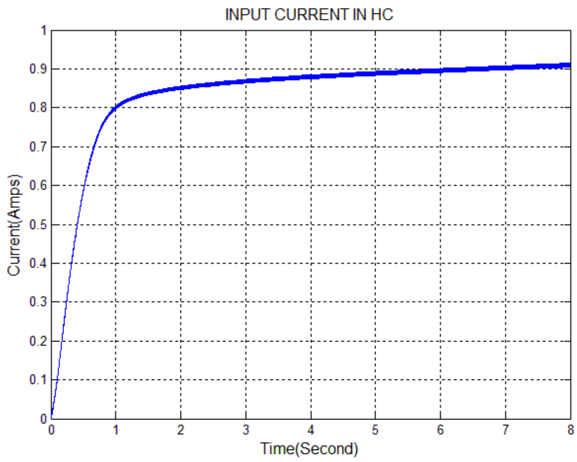

Fig.27 Proposed converter with HC PV output current

The output voltage is analysed in the proposed circuit as shown in the fig.28.

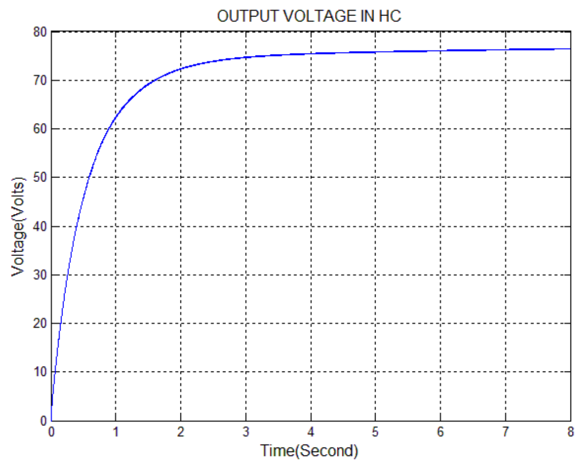

Fig.28 Proposed converter with HC Output voltage

The output current to the load is a0.9A and this converter is output current waveform is as shown in the below fig.29.

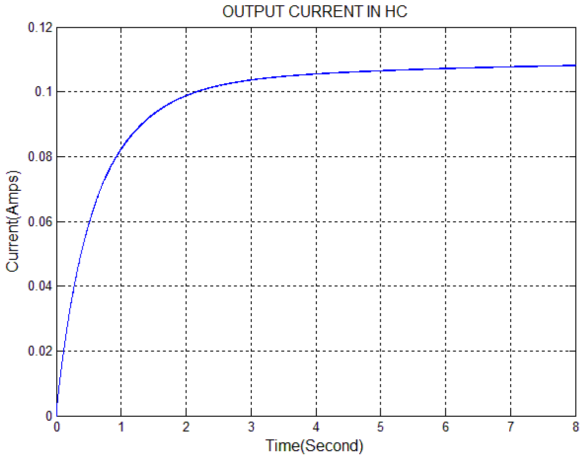

Fig.29 Proposed converter with HC Input current

The output power to the load is measured and plotted in graph as shown in the following fig.30.

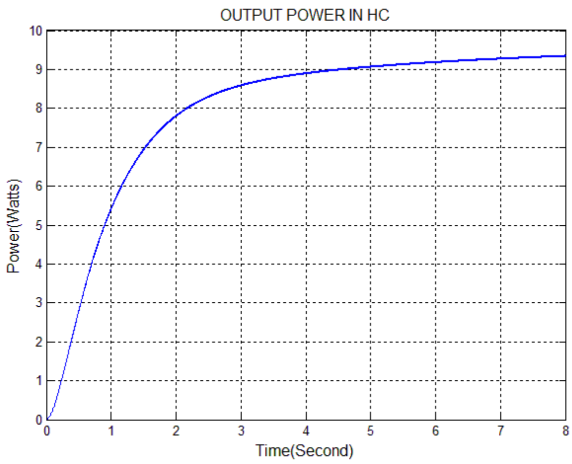

Fig.30 Proposed converter with HC Output Power

The overall efficiency of the proposed converter with the power output and input is 86.5% and the graph plotted is as shown in the following fig.31.

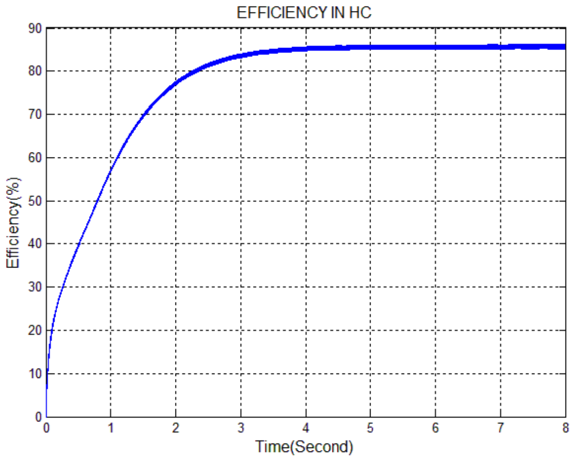

Fig.31 Proposed converter with HC Efficiency

E) Performance Parameter

The proposed converter with solar panel is compared with two algorithms and the results of the two MPPT algorithm is presented in the following table1.

TABLE.1. Comparison Of Series Resonant Inverter With Different Topology

Parameters	Without MPPT	Hill Climbing	Incremental conductance
O/P Voltage(Volt)	74.0V	78V	80.5V
O/P current(Amps)	0.102A	0.108A	0.116A
O/P Power(Watts)	7.5W	9.2W	9.5W
Efficiency (%)	79.0%	86.0%	88.0%
Input current ripple(Amps)	0.012A	0.011A	0.0061A
Conduction Loss Total Switch's(Watts)	0.792W	0.788W	0.715W
Voltage Stress(Volts)	39V	30V	27V

Table 1 Comparison of MPPT Results

From the comparison table the incremental conductance algorithm provides better output power, reduced ripple, better efficiency and less conduction loss.

Conclusion

This paper has presented comparative study of Isolated soft switching boost converter with MPPT and without MPPT. The performance parameters such as input current ripple, ripple, voltage stress for the switch, output power and conduction loss are compared. From that result it is concluded that proposed boost converter with incremental conductance MPPT method performance enhanced successfully. In the future process this work is continued with MPPT fuzzy algorithm and compared for the better results and fastest response MPPT algorithm to improve the usage of solar power.

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