IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 5, Issue 1, January 2018

Photovoltaic Battery Powered DC Bus System for Common Portable Electronic Devices

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Abstract: Non-Conventional vitality sources, for example, Photovoltaic (PV) alongside battery based vitality stockpiling requires control molding to be interface with electrical matrix. This is done through dc-dc converter or dc-air conditioning inverter stages. At the point when the heap is dc there is no need of dc-air conditioning transformation, the point of this task is to display mixture PV-Battery fueled dc transport framework that will wipe out dc-air conditioning change organize. A cross breed support flyback converter is utilized.

Keywords: DC Bus, Dc-Dc Converter, Hybrid Boost-Fly Back Converter, Photovoltaic (PV) Power System

I. INTRODUCTION

The quick increment in the quantity of current electronic hardware and machines has changed the heap profile seen by the electrical framework, since these gadgets require dc control. Be that as it may, because of the current foundation of the air conditioner electrical lattice, an ac– dc vitality change arrange is expected to supply energy to these advanced electronic hardware consequently an exchanging air conditioning connector for each gadget is given. These gadgets incorporate the accompanying printers, note pad PCs, PC workstations, sound/video/computerized video plate (DVD) players, fax machines, MP3 players, advanced cameras, cell phones, and research facility instruments. To tap sustainable power hotspots for the air conditioner network the ordinary path is by dc– air conditioning change. In any case, when a sustainable power source, for example, sun oriented power is accessible and since it is fluctuating dc in nature, the dc– air conditioning reversal took after by ac– dc change can be dispensed with if the yield is dc. In the event that a dc– dc converter with greatest power point following (MPPT) capacity is embedded in the middle of the sustainable power source and the heap would spare the additional change misfortunes related with the superfluous transformation stages [1]. Yet, to fit in the sustainable power sources, it is exorbitant to make diverse dc– dc converters for various gear voltages when this hardware has as of now an exchanging air conditioning connector. The supplanted exchanging air conditioning connector will turn into a hurtful waste to the earth hence it is alluring to reuse these air conditioner connectors as the majority of them are comprised of exchanging dc– dc converters. By giving a typical dc transport the exchanging air conditioning connectors can take control from such a transport to control the different basic compact electronic gadgets. One of the real worries with sun based vitality is its irregular nature and along these lines it needs some sort of capacity which is commonly given by a battery to keep up yield voltage direction constantly. With the solid motivators of green and free vitality sources and progression of battery innovation, control age isn't simply exclusively depended on coal-let go or gas-let go control plants yet everybody can deliver their own power from these vitality sources to control their own heaps to certain power level. A large number of these sources and applications are of dc nature however the present power foundation is as yet in light of air conditioning. Along these lines there are superfluous power preparing stages to deal with the power age to the client (i.e. dc to air conditioning and back to dc once more). What's more, the savvy utilization of energy hardware converters can enable power clients to bring down the age cost and streamline the framework effectiveness.

II. LITERATURE REVIEW

The day to day increase in the use of modern electronic equipment's and appliances has changed the load profile seen by the ac electrical grid as they require dc power. Therefore a switching ac adaptor for every device is provided. To tap renewable energy sources for the ac grid the conventional way is by dc–ac conversion. There has been a great deal of research work reported in the technical literature on how to improve the inversion efficiency by utilizing different converter topologies and control strategies [1]–[7]. If a dc–dc converter with maximum power point tracking (MPPT) capability is inserted in between the renewable energy source and the load would save the extra conversion losses associated with the unnecessary conversion stages. For example, a dc–dc buck–boost powering an array of LEDs from the photovoltaic (PV) panels is introduced in [8]. The major concerns with the solar energy are its intermittent nature and therefore it needs some kind of alternate storage which is typically provided by battery to maintain the output voltage regulation. A common practice is to adopt a cascaded connection of a battery charger and a converter (or inverter) to provide dc (or ac) voltage for the load. A multiple-port or multiple-input configuration becomes more popular because this allows the intake of multiple energy sources [9]–[13] such as a Photovoltaic panel, wind turbine, fuel cell, and battery at the same time, and favours the hybrid power system development. The Photovoltaic-battery dc–dc converter for the proposed dc bus system has to achieve charging of the battery, Maximum power point tracking function, and provide tight output regulation, i.e., a dc–dc converter with high voltage gain and simple circuitry is required. An attempt was made in [14] to combine the battery charger and the inverter into a circuit for PV-battery-powered lighting system, but it was still a two-stage design (i.e., input power has been processed twice). A coupled inductor was employed in [15] to achieve high step-up voltage, but resonance was produced between the leakage inductance and the output rectifier.

III. IMPLEMENTATION OF PROPOSED METHODOLOGY

A. Boost Converter

Lift converter ventures up the info voltage size to a required yield voltage size without the utilization of a transformer. The fundamental segments of a lift converter are an inductor, a diode and a high recurrence switch. These in a co-ordinated way supply energy to the heap at a voltage more noteworthy than the info voltage size. The control methodology lies in the control of the obligation cycle of the switch which causes the voltage change.

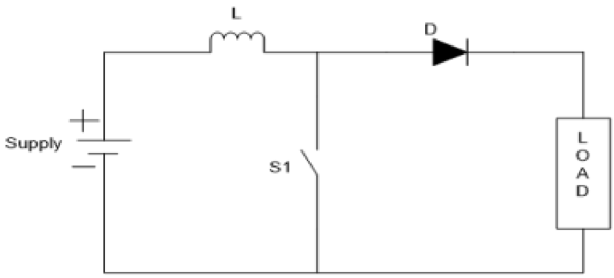

Figure 1 A Boost Converter

Modes of Operation

There are two methods of operation of a lift converter. Those depend on the end and opening of the switch. The main mode is the point at which the switch is shut; this is known as the charging method of operation. The second mode is the point at which the switch is open; this is known as the releasing method of operation.

1. Charging Mode

In this method of operation; the switch is shut and the inductor is charged by the source through the switch. The charging current is exponential in nature yet for straightforwardness is thought to be directly differing. The diode limits the stream of current from the source to the heap and the request of the heap is met by the releasing of the capacitor.

2. Discharging Mode

In this method of operation; the switch is open and the diode is forward one-sided. The inductor now releases and together with the source charges the capacitor and takes care of the heap requests. The heap current variety is little and as a rule is expected steady all through the operation.

B. Maximum Power Point Tracking

Most extreme power point following (MPPT) framework is an electronic control framework that can have the capacity to constrain the greatest power from a Photovoltaic framework. It doesn't include a solitary mechanical segment that outcomes in the development of the modules altering their course and influence them to confront straight towards the sun. Most extreme Power Point Tracking control framework is a totally electronic framework which can convey greatest passable power by fluctuating the working purpose of the modules electrically.

1. Necessity of Maximum Power Point Tracking

In the Power Vs Voltage normal for a PV module appeared in fig. 3.6, we can watch that there exist single maxima i.e. a greatest power point related with a particular voltage and current that are provided. The general productivity of a module is low around 12%. So it is important to work it at the peak control point with the goal that the most extreme power can be given to the heap regardless of consistently changing natural conditions. This expanded power improves it for the utilization of the sun powered PV module. A dc/dc converter which is put alongside the PV module separates greatest power by coordinating the impedance of the circuit to the impedance of the PV module and exchanges it to the heap. Impedance coordinating should be possible by changing the obligation cycle of the exchanging components.

2. MPPT algorithms
There are many algorithms which help in tracing the maximum power point of the PV module.

They are as following
a) Perturb and Observe method
b) Incremental Conductance method
c) Parasitic Capacitance method
d) Constant Voltage method
e) Constant Current method.

C. Flyback Converter

1. Introduction
Fly-back converter is the most normally utilized SMPS circuit for low yield control applications where the yield voltage should be disengaged from the information principle supply. The yield energy of fly-back compose SMPS circuits may shift from couple of watts to under 100 watts. The general circuit topology of this converter is impressively less difficult than different SMPS circuits. Contribution to the circuit is for the most part unregulated dc voltage acquired by redressing the utility air conditioning voltage took after by a basic capacitor channel. The circuit can offer single or various confined yield voltages and can work over extensive variety of info voltage variety. In regard of vitality productivity, fly-back power supplies are second rate compared to numerous different SMPS circuits yet its basic topology and minimal effort makes it mainstream in low yield control go [29]. The ordinarily utilized fly-back converter requires a solitary controllable switch like, MOSFET and the typical exchanging recurrence is in the scope of 100 kHz.

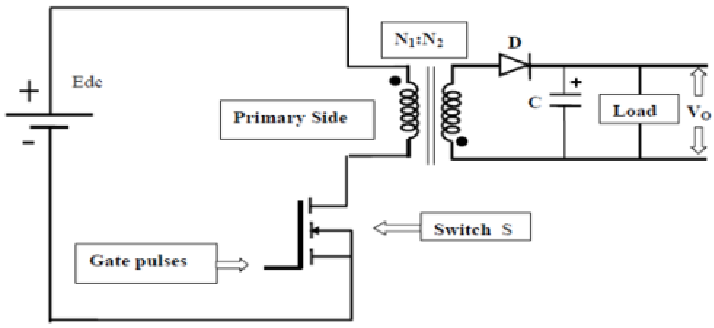

Figure 2 Flyback Converter

Fig.2 demonstrates the essential topology of a fly-back circuit. Contribution to the circuit might be unregulated dc voltage got from the utility air conditioning supply after correction and some sifting. The swell in dc voltage waveform is for the most part of low recurrence and the general swell voltage waveform rehashes at double the air conditioner mains recurrence. Since the SMPS circuit is worked at significantly higher recurrence (in the scope of 100 kHz) the information voltage, regardless of being unregulated, might be considered to have a consistent size amid any high recurrence cycle. A quick exchanging gadget ('S'), like a MOSFET, is utilized with quick powerful control over switch obligation (proportion of ON time to exchanging day and age) to keep up the coveted yield voltage. The essential and optional windings of the fly-back transformer don't convey current at the same time and in this sense fly-back transformer works uniquely in contrast to an ordinary transformer. Since essential and auxiliary windings of the fly-back transformer don't lead all the while they are more similar to two attractively coupled inductors and it might be more proper to get back to the fly transformer as inductor transformer.

2. Principle of Operation
During its operation fly-back converter assumes different circuit-configurations. Each of these circuit configurations have been referred here as modes of circuit operation.

Mode-1
When switch 'S' is on, the primary winding of the transformer gets connected to the input supply with its dotted end

connected to the positive side. At this time the diode 'D' connected in series with the secondary winding gets reverse biased due to the induced voltage in the secondary (dotted end potential being higher). Thus with the turning on of switch 'S', primary winding is able to carry current but current in the secondary winding is blocked due to the reverse biased diode. The flux established in the transformer core and linking the windings is entirely due to the primary winding current.

Mode-2

When switch 'S' is turned off after conducting for some time. The primary winding current path is broken and according to laws of magnetic induction, the voltage polarities across the windings reverse. Reversal of voltage polarities makes the diode in the secondary circuit forward biased.

D. Hybrid High Step up dc/dc Converter

1. Introduction

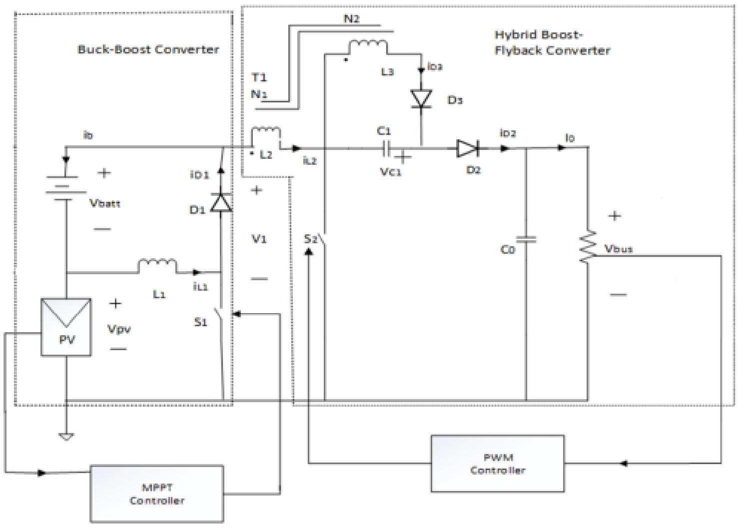

Figure. 3 Hybrid high step up dc/dc Converter

The cross breed high advance up dc– dc topology is appeared in Fig. 3 and is shaped by joining a buck– support converter with a half breed boost– flyback converter [1]. The buck– support converter shaped by L1, S1, and D1 works both as a battery charger for VBatt and a circuit for Maximum Power Point Tracking. The cross breed boost– flyback converter framed by a coupled inductor (L2 and L3), S2, D3, and C1 is utilized to control the transport voltage VBus. VPV and VBatt are associated in arrangement and fill in as the contribution of the cross breed boost– flyback converter. A customary voltage-mode beat width balance (PWM) controller is adequate to manage the yield voltage. The yield voltage is downsized and nourished back to the controller that has a blunder enhancer and a comparator for the modification of the obligation cycle of S2. A novel incorporated high-voltage pick up advance up dc– dc converter, consolidating a buck– help converter and another half and half boost– flyback converter, fit for accomplishing battery charging, Maximum Power Point Tracking capacity, and tight yield direction. The proposed arrangement beats all the beforehand specified issues with capacitor voltage irregularity, single sourced converters, and ringing/reverberation because of spillage inductances. In rundown, the new half and half boost– flyback converter consolidates the upsides of lift and flyback converters and has the accompanying highlights:

1) Higher advance up proportion than that of the lift converter or flyback converter;

2) Lower voltage weight on the power switch. For the lift converter, the voltage weight on the power switch breaks even with the yield voltage, yet for the proposed converter, the voltage push is not as much as the yield voltage. This suggests less switching loss of the switch.

2. Principle of Operation

Since the two converters are in course association and have free control, their operations are additionally autonomous to each other. For the buck– help converter, at time t0, S1 is turned ON, L1 is energized by VPV, and D1 is invert one-sided. The span of ON-time of S1 is dictated by the Maximum Power Point Tracking controller to keep up input voltage consistent for Maximum Power Point Tracking. At time t1, S1 is killed, vitality put away in L1 is coupled to the battery VBatt. L1 can work in both intermittent conduction mode (DCM) and persistent conduction mode (CCM). For high-control application, CCM operation of L1 is favored as it decreases the info current swell and separating prerequisite. The operation method of L1 does not influence VBatt as it is firmly controlled by the Maximum Power Point Tracking controller. At time t2, S1 is turned ON again to rehash the following exchanging cycle. For the cross breed boost– flyback converter, at time t3, S2 is turned ON, the current in L2 increments directly. A blocking voltage of VC1 + V1 (N2/N1) is connected on D3, which is switch one-sided. The term of ON-time of S2 is chosen by the PWM controller to keep up yield consistent. At time t4, S2 is killed, vitality put away in L2 releases in two courses: to yield through D2 and to C1 through L3 and D3. T1 works for the most part in CCM to decrease the present weight on L2 and S2. At time t5, iL2 tumbles to zero yet iD3 keeps on releasing the vitality put away in T1 to C1. Time t6 is started by S2 to start the following exchanging cycle.

As appeared in Fig.3, the PV board has two current ways: iL1 and iL2, i.e., the PV board needs to share the heap request with the battery (iL2) and charge the battery (iL1) all the while. To guarantee MPPT constantly, the Photovoltaic board evaluations must fulfill the imbalance: PV board control ⩾ yield control battery release control. The additional board control is for battery charging at MPPT condition, i.e., Maximum Power Point = battery charging power+ (yield control battery release control). Since the battery releases for each exchanging period, there is dependably space for Maximum Power Point Tracking aside from the state of no-heap operation and the battery is completely charged. It ought to be noticed that the arrangement association of the sun powered board and the battery upgrades the change effectiveness as a major aspect of the vitality created from the PV is exchanged specifically to the yield without being put away into the battery first and after that prepared at a later time. The less the power being prepared more than once, the less exchanging misfortune the framework. It has been demonstrated compelling tentatively in air conditioning/dc change.

The voltage second balance on *L*2 is expressed as

$$V_1 D = (V_{bus} - V_{c1} - V_1)(1 - D) \quad \textbf{(1)}$$

As the voltage across on *C*1 is given by

$$V_{c1} = V_1 \frac{D}{1-D} \frac{N_2}{N_1} \quad \textbf{(2)}$$

By substituting (2) into (1), the voltage conversion ratio of the hybrid boost–flyback converter is given by

$$\frac{V_{bus}}{V_1} = \frac{1 + D\left(\frac{N_2}{N_1}\right)}{1-D}$$

Which is higher than that of conventional boost converter by 1+D (N_2/N_1) by times.

IV. RESULT

A. Simulation Results of Boost Converter

The simulations are carried out in Simulink and the various voltages, currents and power plots are obtained.

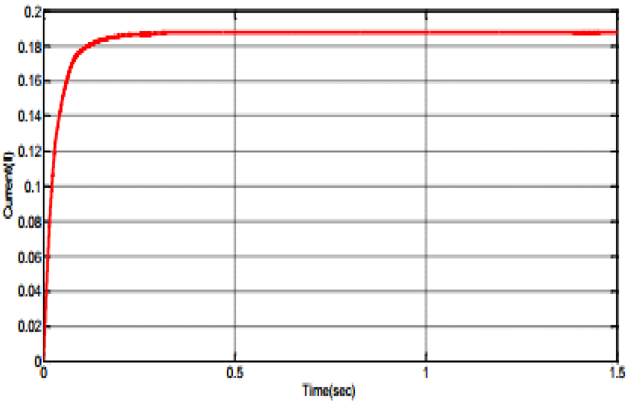

Figure 4 Output Current of boost converter

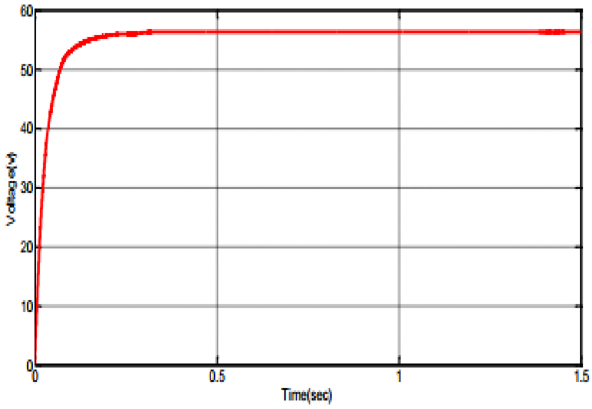

Figure 5 Output Voltage of boost converter

 DOI 10.17148/IARJSET.2018.512

IARJSET

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ISSN (Print) 2394-1588

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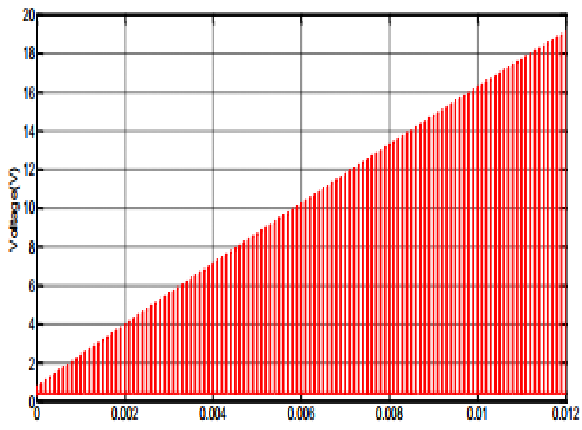


Figure 6 Voltage across Switch

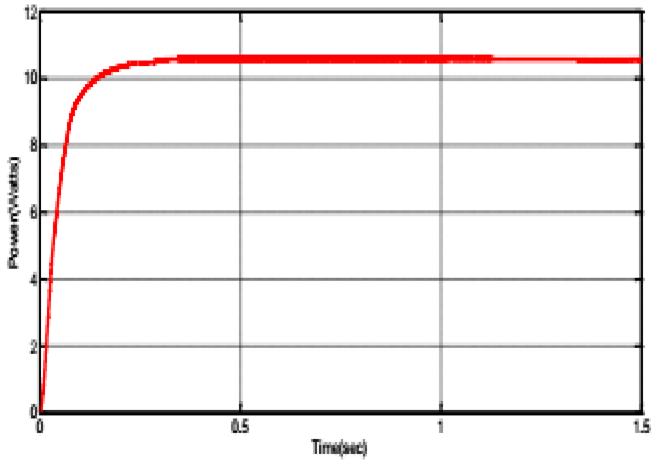


Figure 7 Output Power of boost converter

The above figures shows the output results of conventional boost converter for a constant load of 300Ω. The Output Voltage, Output Current, Output Power and voltage across the switch of converter is shown.

1. Effects of Change in Irradiance

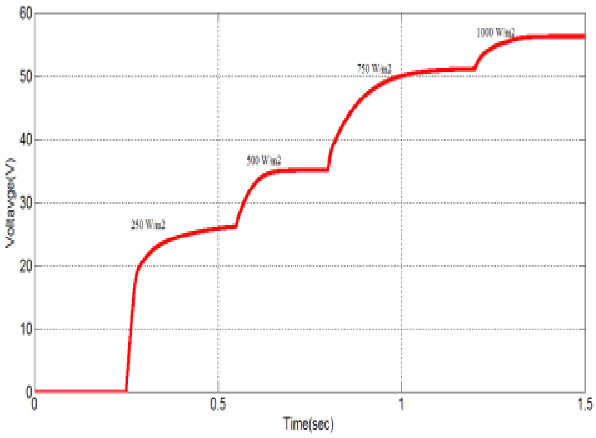


Figure 8 Output Voltage of boost converter

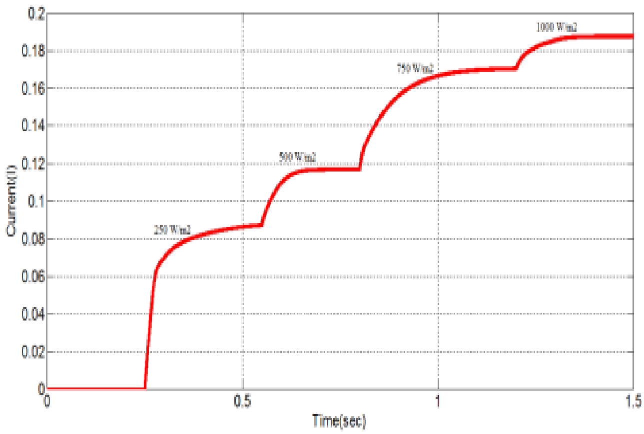


Figure 9 Output Current of boost converter

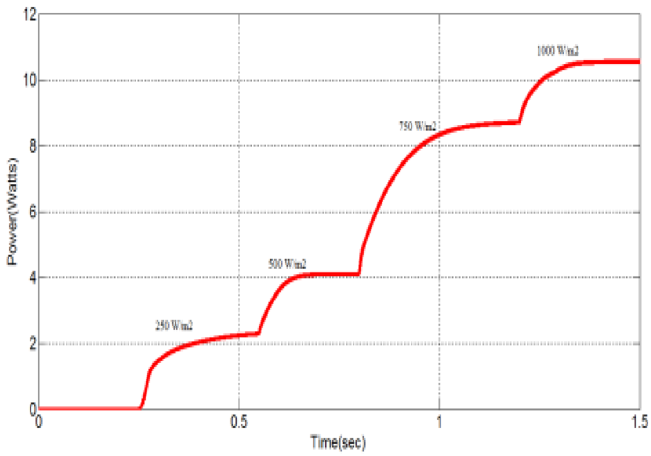


Figure 10 Output Power of boost converter

The above figures show the output results of boost converter with the change in the values of irradiations for constant load of 300Ω. As shown with the increase in the value of irradiation the Output Voltage, Output Power and Output Current is also increasing.

B. **Simulation Results of Flyback Converter**

The simulations are carried out in Simulink and the various voltages, currents and power plots are obtained.

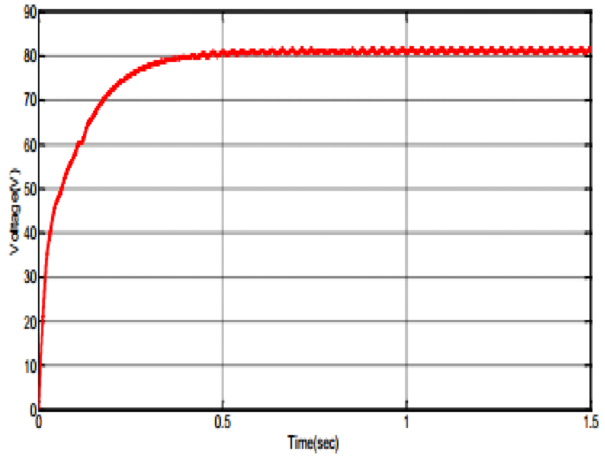


Figure 11 Output Voltage of Flyback converter

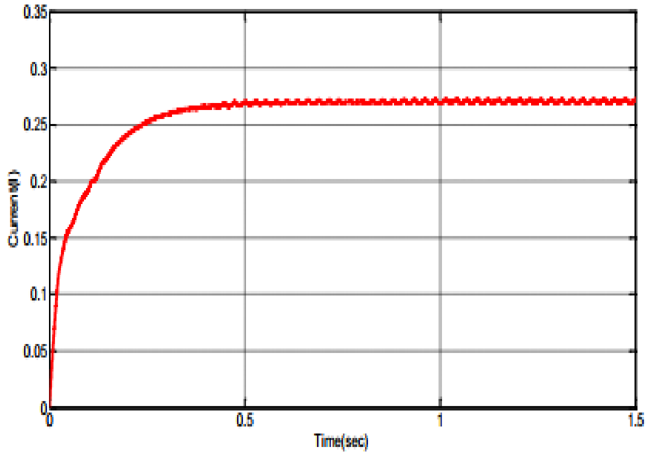


Figure 12 Output Current of Flyabck converter

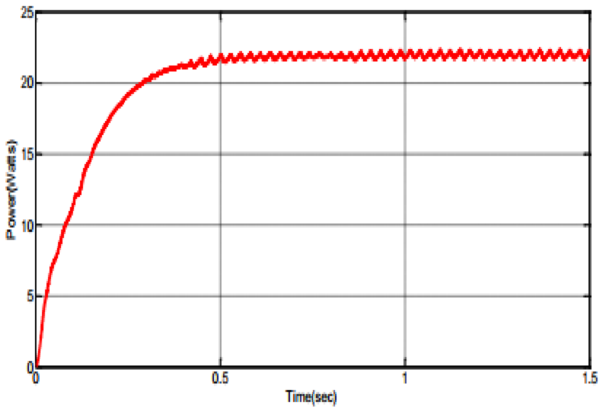


Figure 13 Output Power of Flyabck converter

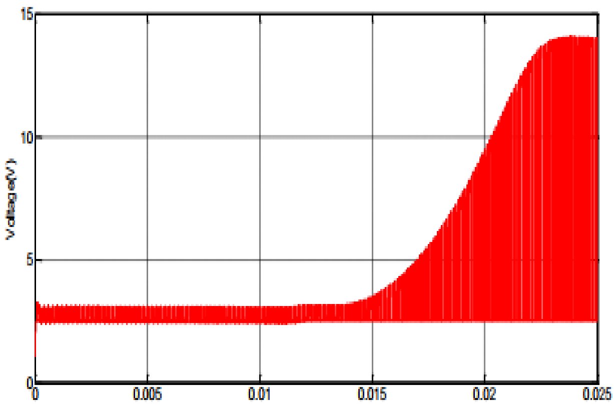


Figure 14 Voltage across switch

The above figures shows the output results of flyback converter for constant load of 300Ω. The Output Voltage, Output Current, Output Power and Voltage across switch of converter is shown.

1. Effects of Change in Irradiance

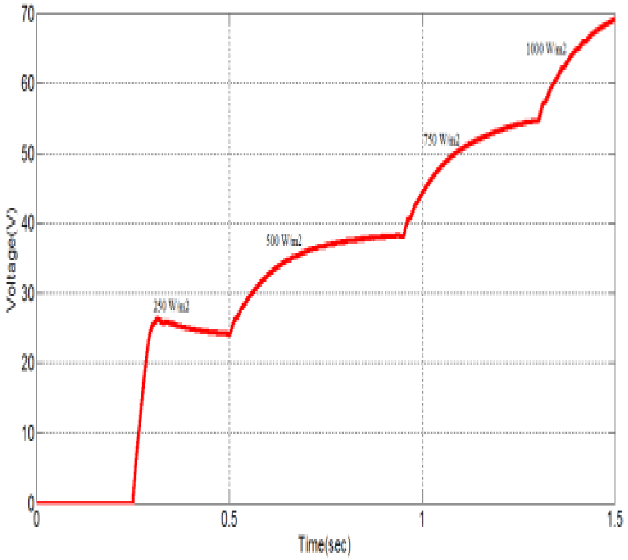


Figure 15 Output Voltage of Flyback converter

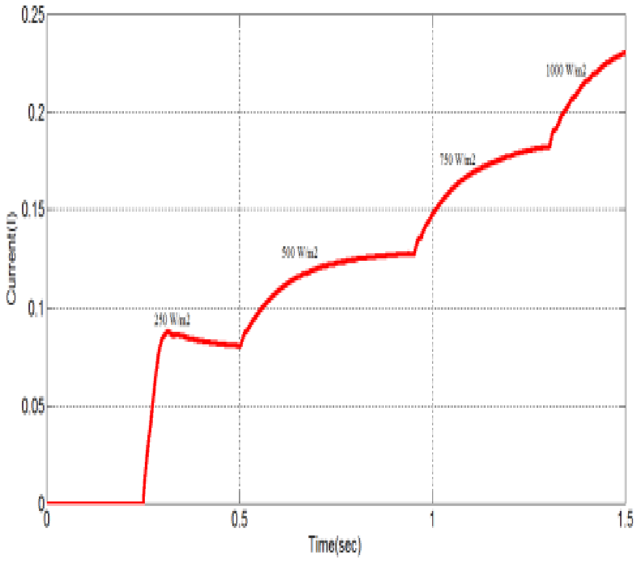


Figure 16 Output Current of Flyback converter

DOI 10.17148/IARJSET.2018.512

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 5, Issue 1, January 2018

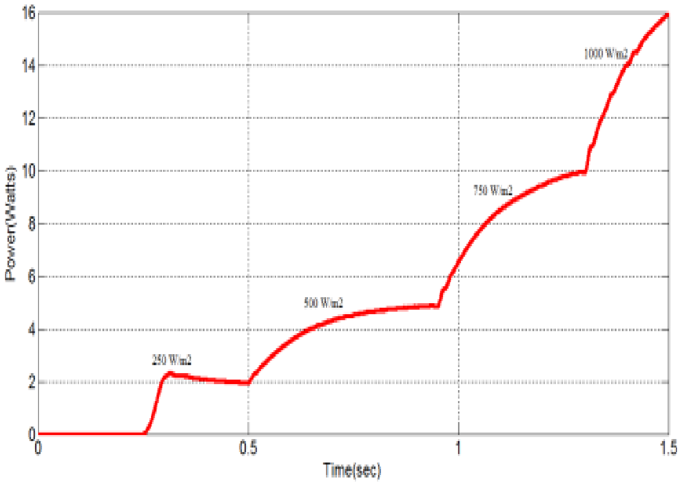


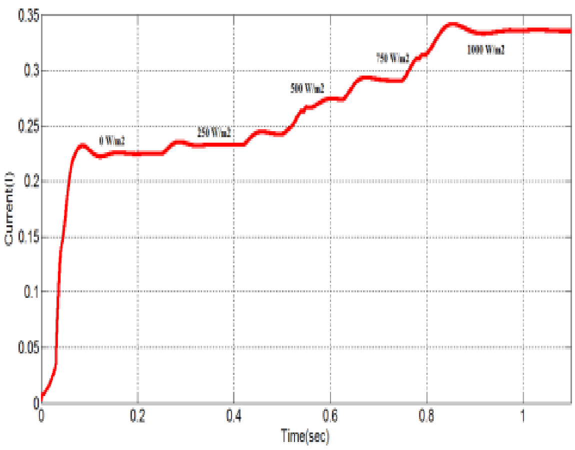
Figure 17 Output Power of Flyback converter

The above figures shows the output results of flyback converter with change in the values of irradiation for constant load of 300Ω. As shown with the increase in value of irradiation the Output Voltage, Output Current and Output Power is also increasing.

C. **Simulation Results of Hybrid High Step up dc/dc Converter**

The simulations are carried out in Simulink and the various voltages, currents and power plots are obtained.

1. For different Irradiances



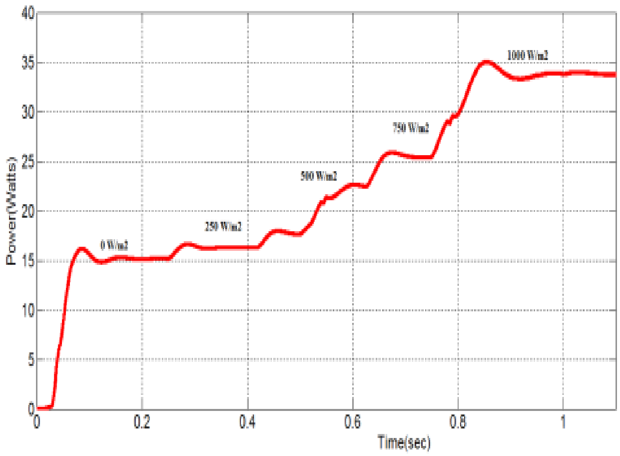


Fig. 18 Output Current of hybrid high step up dc/dc converter Fig. 19 Output Power of hybrid high step up dc/dc converter

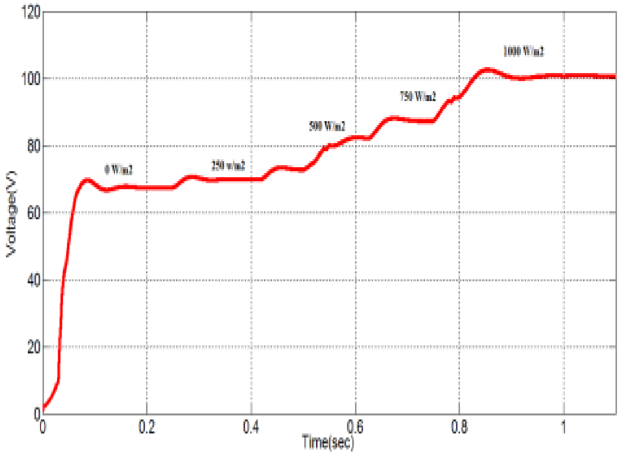


Figure.20 Output Voltage of hybrid high step up dc/dc converter

2. Effects of change in load

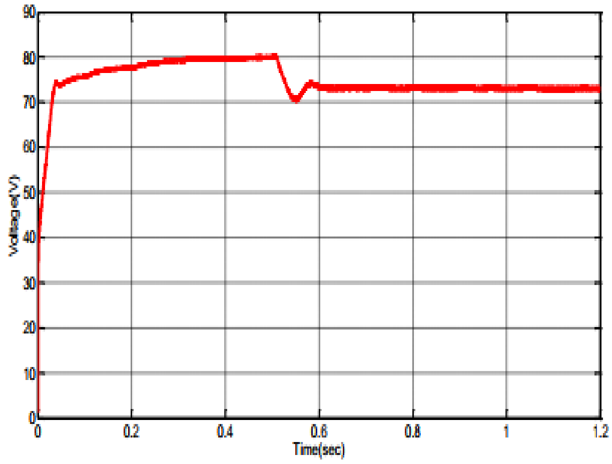


Figure 21 Output Voltage of hybrid high step up dc/dc converter

The above figure shows the output voltage of hybrid high step up dc/dc converter. As shown in figure as the load is changed from 300Ω to 200Ω at time 0.5sec therefore there is a decrease in the value of voltage.

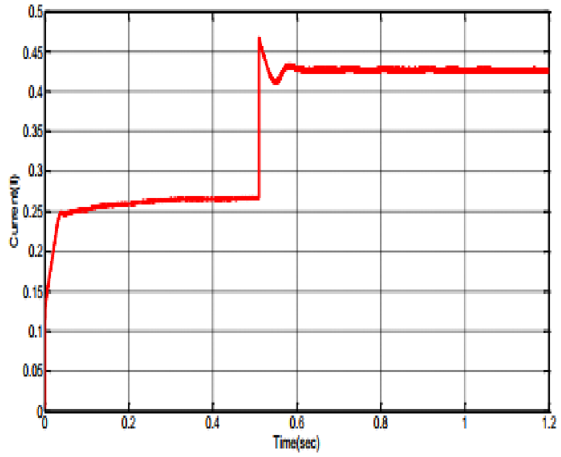


Figure 22 Output Current of high step up dc/dc converter

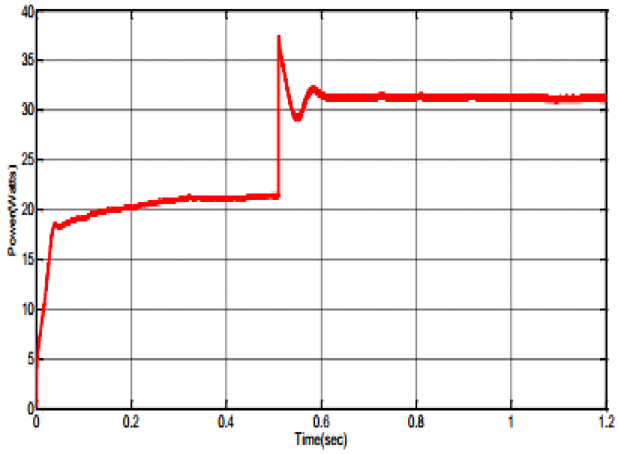


Figure 23 Output Power of hybrid high step up dc/dc converter

The above figures show the Output Power and Output Current of hybrid high step up dc/dc converter. As the load is changing at time 0.5 and for that a circuit breaker is used so the circuit will become open for some period therefore there is a spike in the values of Power and Current.

V. CONCLUSION

A high advance up half and half dc-dc converter is contemplated and mimicked which have higher advance up proportion than traditional lift converter. The mixture high advance dc/dc converter defeats the different issues like ringing and reverberation. This converter has higher voltage change proportion than regular lift converter and lower voltage weight on control switch of converter.
The crossover high advance up dc/dc converter can used to venture up the voltage for the dc transport with higher effectiveness and lower misfortunes. The dc transport framework can be exceptionally proficient to supply the regular compact electronic gadgets which require dc control. The dc/dc converter additionally has battery joined in arrangement with PV so when irradiance isn't accessible, the battery can supply to the heap. This makes the converter more dependable.

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