MODELLING AND IMPLEMENTATION OF DC TO DC BOOST CONVERTER FOR PV SYSTEM USING MODIFIED ARRAY DESIGN

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Abstract-* *Renewable energy is evolved from natural sources Photovoltaic (PV) and fuel cells are commonly used Renewable energy sources (RES) A derived DC-DC converter is suggested for efficient renewable energy sources, & for efficient Boost converter (BC) topology is discussed in this dissertation for renewable energy sources The merits of this topology are reduced EME (Electromagnetic emission), fast transient response and low input current ripple. Cheap fast & efficient switching use in the high-tech world Causes of varying needs & specifications engineers are expected to design reliable & unique solutions. Safety cost & size of each design is also a priority in today's industrialist economy & Boost converter with PV module for renewable energy sources is introduced here. Comparative study low EME and fast transient response finding with this model, also getting low ripple in input current. This converter has many advantages and is suitable for renewable energy sources. Converter is controlled by varying the switching frequency of carrier waves. The simulation results shows that the auxiliary inductor can suppress the switching losses of power switch and diode without increasing the current and voltage stress. This topology has two identical inductors and an auxiliary inductor are used to reduce the switching loss and switching stress of BC connected with PV system. The performance of BC along with PV system is analysed by Maltab /Simulink software.

Keywords: RES, DC-DC Boost Converter, PV System, Modified Array Design, EME.

I INTRODUCTION

Modern electronic systems need top quality little light weight reliable & amp efficient power provides. Linear Power regulators whose principle of operation relies on a voltage or current divider are in economical.

Therefore, High-frequency electronic power processors are employed in DC-DC power conversion functions of dc-dc converters are:

- Convert a dc input voltage V in to a dc output Vo.
- Regulate the dc output voltage against load and line Variations.
- Reduce the ac voltage ripple on the dc output voltage below the desired level.
- Provide isolation between the input supply & the Load (isolation is required).
- Protect the equipped system and therefore the input supply from electromagnetic interference (EMI).
- Satisfy numerous international and national safety standards.

A major area of analysis is to develop higher frequency rectifiers that may rectify into THz and light frequencies. Devices are employed in optical heterodyne detection that has myriad applications in glass fiber communication and atomic clocks. Some another prospective application for such devices is to directly rectify lightweight waves picked up by small antenna referred to as n-antennas to provide DC wattage and it's thought that arrays of n-antennas can be an additional economical means that of producing solar energy than solar cells .

A connected area of analysis is to develop smaller rectifiers as a result of a smaller device encompasses a higher cutoff frequency. Analysis comes are trying to develop a uni-molecular rectifier one organic molecule that will operate as a rectifier.

II BOOST CONVERTER DEVICES

There are two classes of DC to DC converters: Isolated & Non-Isolated DC to DC converters. Isolated DC to DC converters because the name implies electrically isolate the output from the input employing a high frequency electrical device. There are transformer's turn's quantitative relation dictates the link between the input &output voltage. By having multiple secondary windings isolated converters are able to give multiple levels of output voltages. The scale of the electrical device typically dictates the scale of isolated device. Thence they often are giant in size. On the opposite Non-Isolated topologies will vary the dc output voltage & provide completely different level of output voltages while not the employment of electrical device &require fewer parts to implement. Boost device is additionally called the increase device. It's one in every of the well-known topology within the field of power electronics & like the other DC to DC converters it aims to attain high potency conversion. There's existence of boost device depends on the invention of semiconductor switches. These switches are much quicker & reliable than alternative switches like vacuum tubes & mechanical device relays. The semiconductor switches are able to operate at high frequency from concerning 200 kilohertz to as high as 2 megahertz there is frequency of Boost converters has associate inverse relationship with the scale of the magnetic parts. Thus having a high switch frequency is useful to decrease the scale of the device.

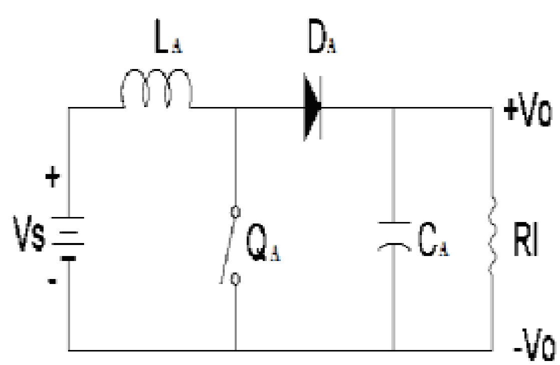

Figure 1 Boost converter

The projected Boost device is a way to produce an additional economical intensify device whereas at identical time decreasing the strain seen on a basic boost device. Contemplate them rather like the other topologies of DC – DC converters Two-Phase Boost device analyzes semiconductor switches as the foundation of its operation. Semiconductor switches have quick activate and off times and low on resistances that facilitate to decrease losses throughout shift and conduction. Two-Phase Boost device is largely two boost devices placed in parallel sharing identical input and output as shown in Figure there essence it will identical issue as a boost converter that is stepping up the fastened dc voltage input. But not like paralleled boosts the two sections within the projected two-phase boost can ne'er draw input current at identical time rather the path alternates between the primary and second phase. So every path solely carries half of the output power and hence half the strain compared to a single.

Both Boost and Two-Phase Boost configuration share identical main elements. As represented in Figures 1 they each use inductor switch and diode. The electrical device is being utilized because the main storage component that depends on its non-instantaneous linear current modification following its Volt-Second Balance. The put on the opposite in depends on the converter's duty cycle. For potency purpose & in general if the is most popular.

Switch is conducting over its idleness time a MOSFET with low Rds on otherwise a MOSFET with low gate capacitance to reduce shift loss is that the most popular decisions, and so as for the diode once fast turns off responses are required as in DC – DC converters Schottky diode is often used. To extend the device's potency any a method referred to as synchronous rectification will be applied to the converter. With this system the diode is replaced with another switch. betting on the duty cycle this method would replace the diode with either low Rds or low shift loss on MOSFET for an additional economical method Quite the contrary the point in time topologies together with the projected two-phase device have solely been recently studied here and most of the point in time topologies are focused on applications that need a really low step down with output voltage at comparatively high current like those found in microprocessors. But the potential of using point in time topology in alternative topologies has not been extensively explored. One application that has recently gained associate raised interest is that the renewable energy.

Many of the renewable energy sources give dc output that must be stepped up so as to match the voltage level thereto of the grid. Naturally this is often wherever boost device plays a crucial role. Hence this thesis is aimed to check the advantages of implementing a two-phase boost device that will be utilized in conjunction with any renewable energy sources. That need intensify perform. The planning simulation of the projected device are performed as explained in later chapters. What is more to exhibit the potential of the projected device a hardware epitome is made and test.

When Boost device are primarily an increase power device that soak up an occasional voltage input and provide associate output at a far higher voltage and input and output voltage relationship is controlled by the switch. Duty cycle D in step with the equation below

$$V_{out} = \left(\frac{1}{1-D}\right) V_{IN}$$

The overall boost converter consists of three specific modules the triangle wave generator. The open loop boost converter finally the compensation network.

III RELATED WORK

To build this boost converter that meets the teams' specifications the team wants the facility stage which will offer the higher V output from a lower input. This circuit are the daughterboard of style or design the planning to line the required frequency for this converter the groups must design a pulse width modulation (PWM) circuit up to 20MHz to drive the boost converter.

A third circuit is required to catch up on any variation within the output is termed the error electronic equipment or management loop and monitors the output for a constant V. These stages conjure the look for a high frequency DC/DC boost converter with a control loop. Figure shows a diagram for the boost converter.

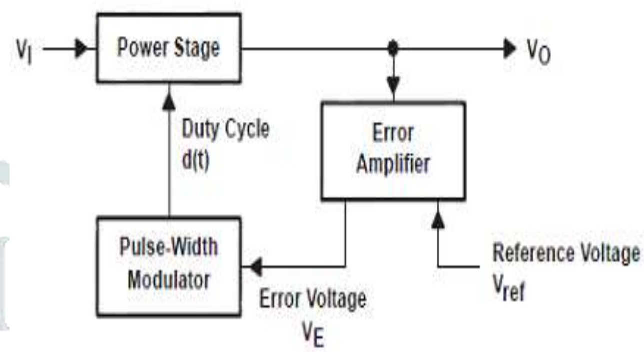

Figure 2 Building Blocks of a Boost Converter System

The power stage has two inputs;

- The input voltage V
- The duty cycle d(t)

The switching is controlled by the duty cycle. It a logic signal input controls the ability stage and as are going to be mentioned in more detail within the following section the output voltage. The sole nonlinear elements within the power stage are the switching devices. and so remainder of the elements are linear parts, thus, Over the switching cycle a linear model of simply the non-linear elements are often obtained if the voltages its of such elements are to be averaged. Intrinsically a model for the switching devices are often derived & There model is understood as the Pulse-Width Modulator switch model.

Pulse width Modulation for MOSFETs

The fundamental principle concerned in creating a boost converter is making a square pulse to manage the switching of the MOSFET. This square pulse is termed the duty cycle and this duty cycle (D) controls the output voltage. The transfer perform comes by the subsequent set of equations. Figure 3 is that the ideal gate voltage to be ready to switch the MOSFET and create a boosted output voltage coordinate axis shows V & the coordinate axis shows the amount of the GS signal.

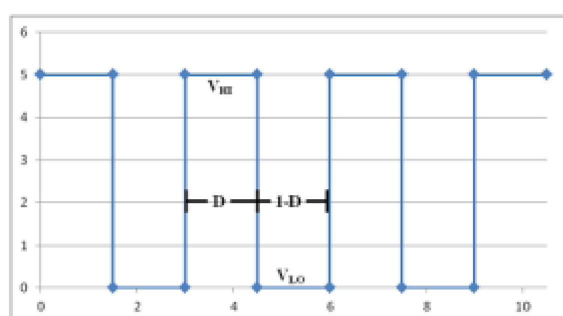

Figure 3 Gate Voltage on MOSFET

As the MOSFET gate switches to 0 V current is not any longer sourced on to ground therefore forcing current to the output. Conversely once the gate is switched to 5 V the present within the inductance flows directly from the drain to the supply that is connected to ground making completely different voltages across the inductance. The voltage across the inductance and the voltage changes with the duty cycle.

Step-Down (Buck) converter

The step-down dc–dc converter unremarkably referred to as a buck converter is shown in figure, It consists of dc input voltage supply VS controlled switch S diode D filter inductance L filter capacitor C and load resistance R Typical wave forms within the converter are shown in underneath assumption that the inductance current is usually positive, These state of the converter within which the inductance current is ever zero for any amount of time is termed the continual conduction mode (CCM), and It is seen from the circuit that once the switches commanded to the on state the diode D is reverse biased, When the switch S is off the diode conducts to support associate uninterrupted current within the inductance, and the connection among the input voltage output voltage and also the switch duty quantitative relation D is derived as an example from the inductance voltage VL wave form, and the in step with Faraday's law the inductance volt–second product over an amount of steady-state operation is zero.

$$(V_s - V_o)DT = -V_o(1-D)T$$

$$M_v \equiv \frac{V_o}{V_s} = D$$

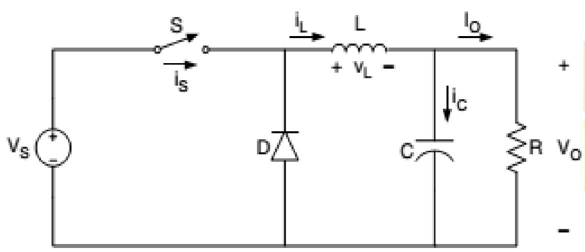

Figure 4 Buck Converter

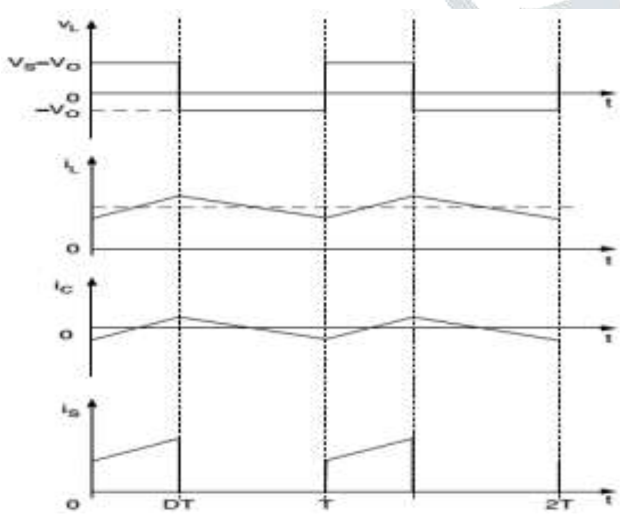

Figure 5 Buck Converter characteristics

Step-up (Boost) Converter [5]

Figure 6 depict a step-up or a PWM boost device. it's comprised of dc input voltage supply V boost inductance L controlled switch S, diode D filter, electrical condenser C & load resistance R, The device wave forms within the CCM are conferred in Figure 2.6, once the switch S is within the on state this within the boost inductance will increase linearly, The diode D is off at the time, once the switch S is turned off the energy hold on within the inductance is released through the diode to the input RC circuit. Using the Faradays law for the boost inductor,

$$L_b = \frac{(1-D)^2 DR}{2f}$$

As shown in Figure 6 the present provided to the output RC circuit is discontinuous that a bigger filter condenser is needed compared to it within the buck-derive dc converters. To limit the output voltage ripple .This condenser filter should offer the output dc current to the load when the diode D,

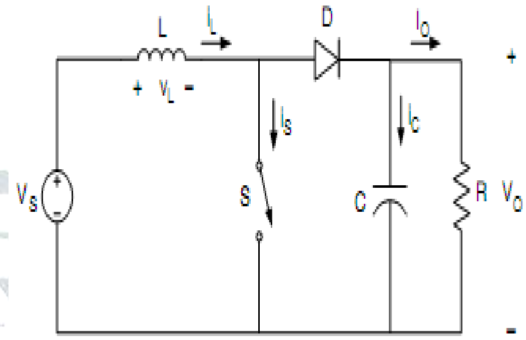

Figure 6 Step-up Converter

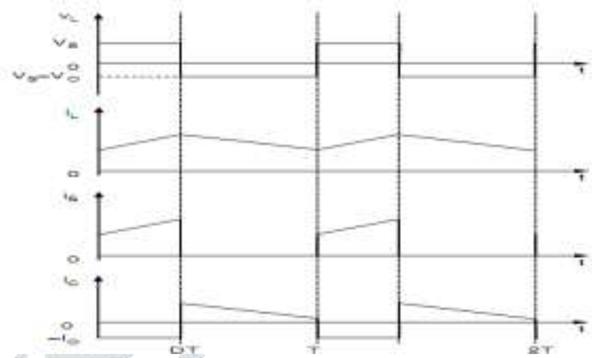

Figure 7 Boost waveforms

Then, intensify Boost device are basically a step-up power converter that take in an occasional voltage input and provide associate output at a way higher voltage A diagram of a perfect dc/dc boost device is shown within the figure below in 8.

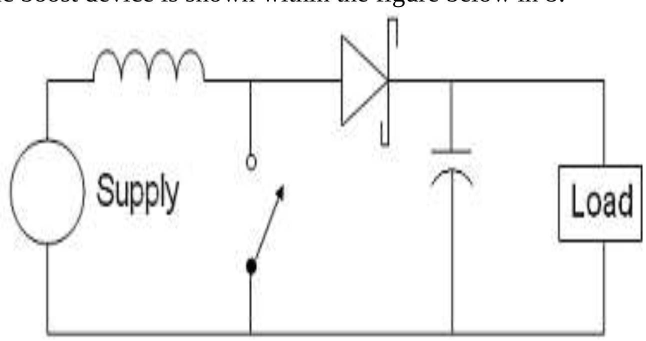

Figure 8 step up boost converter

The input &output voltage relationship is controlled by the switch duty cycle D according to the equation below;

$$V_{out} = \left(\frac{1}{1-D}\right) V_{IN}$$

There is a perfect boost converter is lossless in terms of energy therefore the input and output power are equal, In observe there'll be losses within the switch & passive parts however efficiencies higher than 90th are still attainable through careful choice of system parts & operational parameters like the switch frequency, the interior operations of a boost converter will be thought of as a charge storage and transfer mechanism, There are two states on and off.

Boost converter terminology

This boost converter in a position for producing a dc output voltage larger in magnitude than input dc voltage, this circuit for a boost converter is as shown in figure 9.

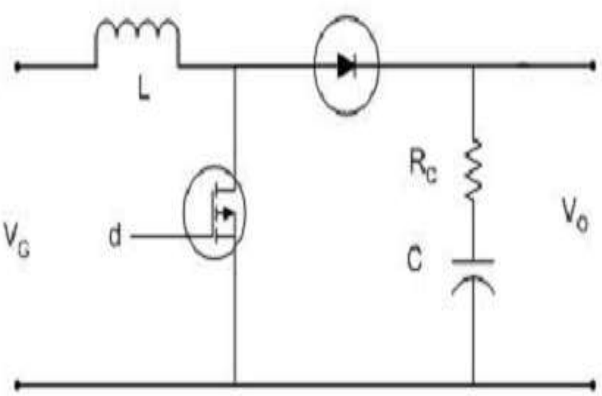

Figure 9 Boost converter terminology

When transistor Q1 is “on” the current in inductor L rise linearly & at this time capacitor C supplies the load current & it is partially discharged, in second interval when transistor Q1 is “off” diode D1“on”& the inductor L supply;

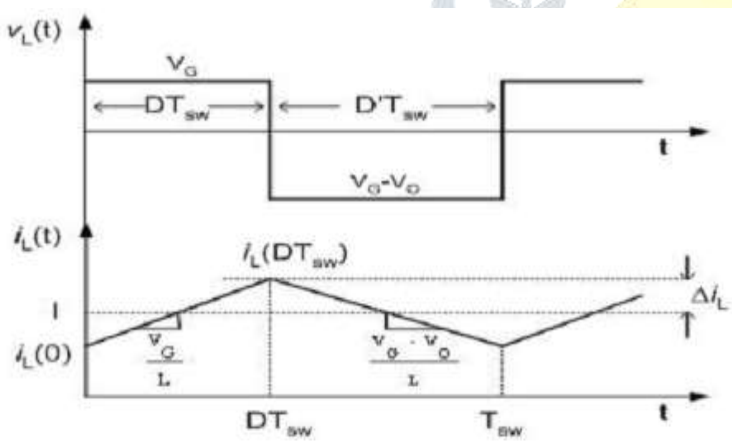

Figure 10 Terminology waveforms

The steady state output voltage equation get by the inductor voltage balance principle.

$$V_G.T_{ON} + (V_G - V_O).T_{OFF} = 0$$
$$\frac{V_O}{V_G} = \frac{T_{SW}}{T_{OFF}} = \frac{1}{1-D}$$

Than converter o/p voltage is bigger than input voltage input Current that is additionally the inductance current is larger than output current and in observe inductance current flowing through semiconductors Q1 and D1; inductance winding resistance becomes terribly large and with result being that part non-idealities might cause large power loss,

As the duty cycle approaches one & inductance current becomes terribly massive and these part non idealities cause massive power losses, consequently & potency of the boost device decreases speedily at high duty cycles.

Buck-Boost converter [5]

There is buck-boost converter is capable of producing a dc output voltage that is either larger or smaller in magnitude than the dc input voltage. This arrangement for the buck-boost device is as shown,

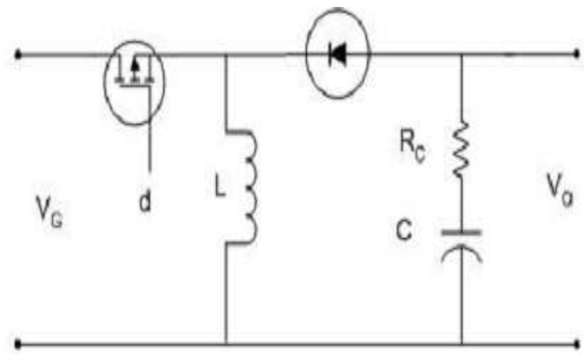

Figure 11 Buck Boost phenomenon

When the junction transistor Q1 is on then input voltage is applied across the inductor & the present in inductor L rises linearly, At this point the condenser C and provides the load current and it's part discharged throughout the second interval once the transistor is off and the voltage across the inductor reverses in polarity and the diode throughout this interval the energy hold on within the inductor provides the in addition and load recharges the condenser. The steady state inductor current and voltage wave form is shown in figure 12.

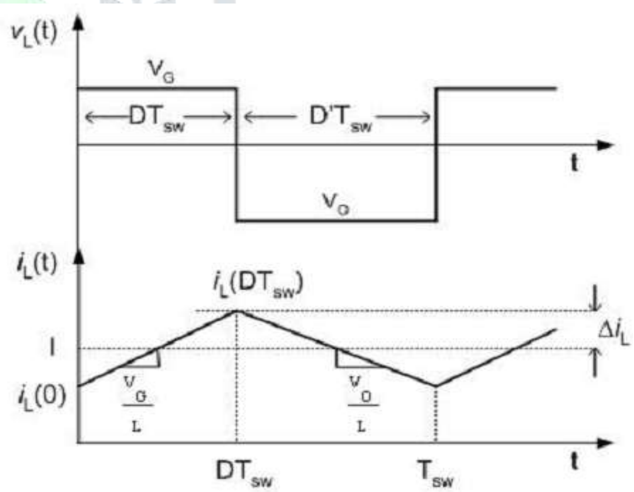

Figure 12 Buck Boost phenomenon waveforms

Voltage balance principle, finding the steady state output voltage equation yields,

$$V_G.T_{ON} + (V_O).T_{OFF} = 0$$

$$\frac{V_O}{V_G} = \frac{T_{SW}}{T_{OFF}} = -\frac{1}{1-D}$$

The d varies between 0 and 1 thus output voltage may be lower or higher than the input voltage in magnitude but opposite in polarity.

IV PROPOSED METHODOLOGY

Photovoltaic Cell

Equation Used for PV cell

The net current I is composed of the light generated current Ipv and diode current I_d figure 13 shows the Simulink model of the PV cell.

$$I = I_{PV} - I_d$$

Where

$I_d = I_0 \exp(qV/aKT)$

I_0 = Leakage Current of the Diode

Q = Electron Charge

K = Bolzman Constant

T = Temperature of PN junction

A = Diode indent constant

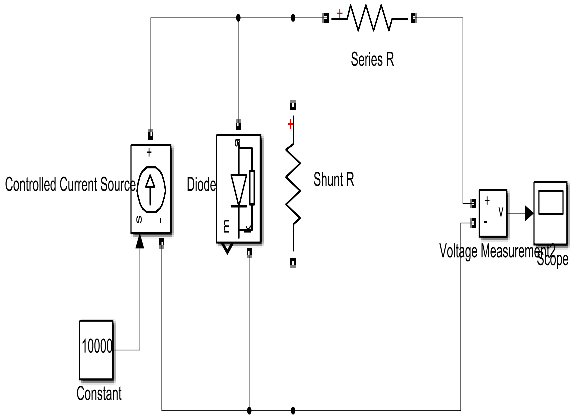

Figure 13 Simulink model of Photovoltaic Cell

Practically composed of several connected PV cells and the observation of the characteristics at the terminals of the PV array requires the inclusion of additional parameters to the basic equation.

$$I = I_{PV} - \left[\exp\left(V + \frac{R_S I}{V_t a}\right) - 1\right] - \frac{V + R_S I}{R_P}$$

Where $V_t = N_S KT/qs$ is the thermal voltage of the array with N$s$cells connected in series.

Simulink Model

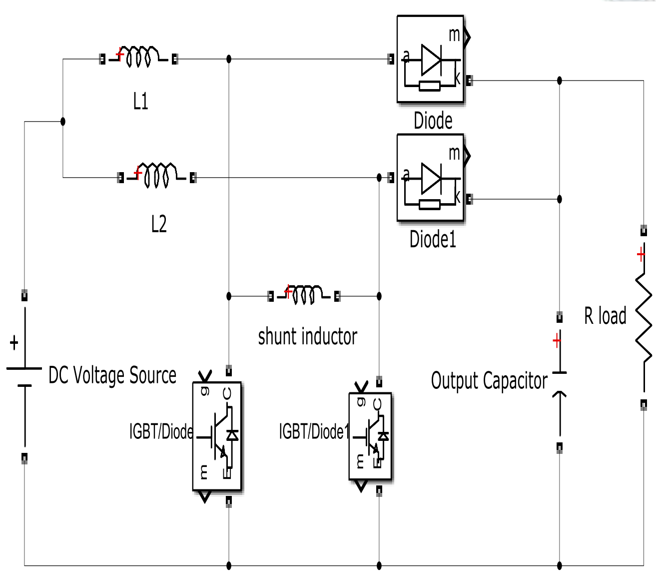

Figure 14 Simulink model of Boost Rectifier

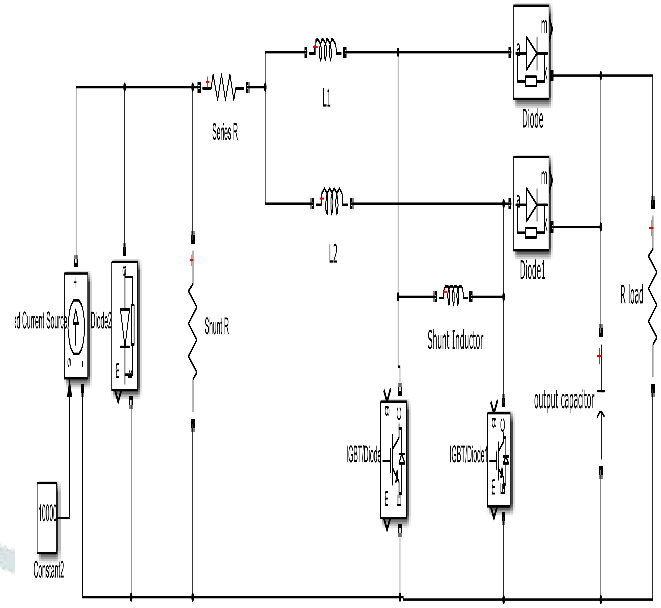

Figure 15 Simulink model of Boost rectifier with PV cell

PWM Technique

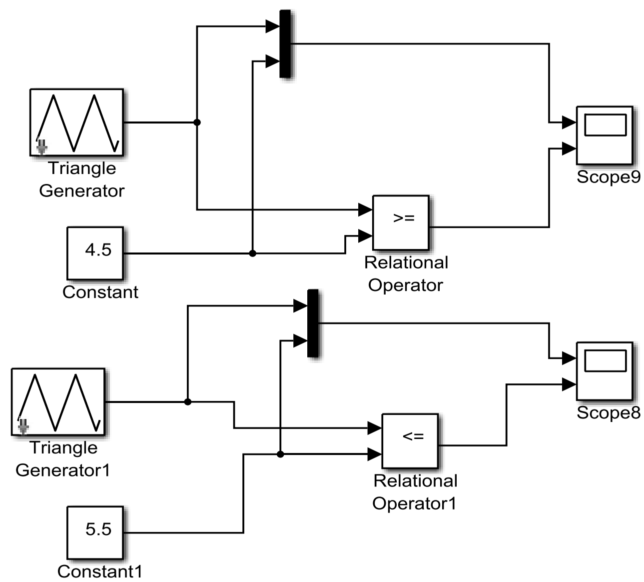

Figure 16 Switching of MOSFETs with PWM technique

Duty Cycle

A duty cycle is the percentage of one period in which a signal is active a period is the time it takes for a signal to complete an on-and-off cycle.

- As a formula a duty cycle may be,
  D = (T_{ON}/T_{total})*100%
  Where
  D is Duty cycle T_{ON} is time of ON period and
  T_{Total} is total time period of signal.

V SIMULATION RESULTS

Parameter Used

Shunt Resistance (R)	**10 k ohm**
Series Resistance (Rs)	**0.001ohm**
Output Voltage of PV cell	**18.77 Volt**
Inductor L1 & L2	**300 micro H**
Shunt Inductor (Ls)	**270 micro H**
Output Capacitor (Co)	**330 micro F**
Output Voltage (Vo)	**40.9 Volt**
Output Current (Io)	**4.09 Amp**
Output Power (Po)	**83.6 Watt**
Carrier frequency	**20 K-Hz**

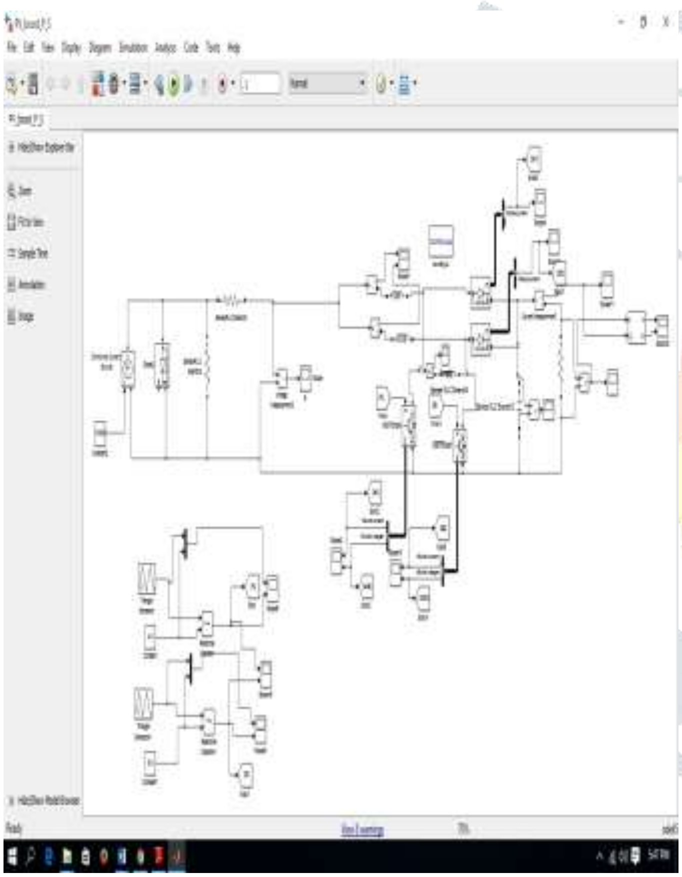

Figure 17 model representation of project

Various Outputs

Shunt Inductor (Ls)

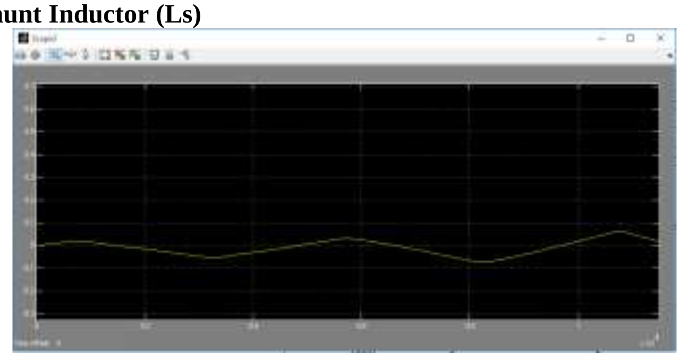

Figure 18 Simulation Result of Shunt Inductor (L_S)

Inductor Current (L_1& L_2)

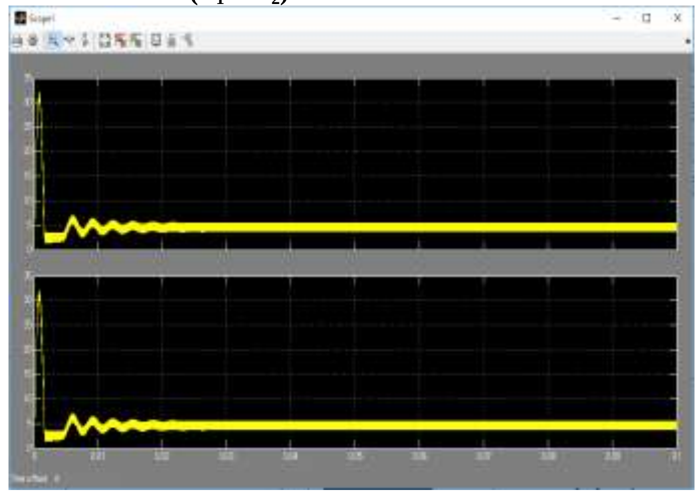

Figure 19 Simulation Result of Inductor (L_1 and L_2) Current

Diode Current

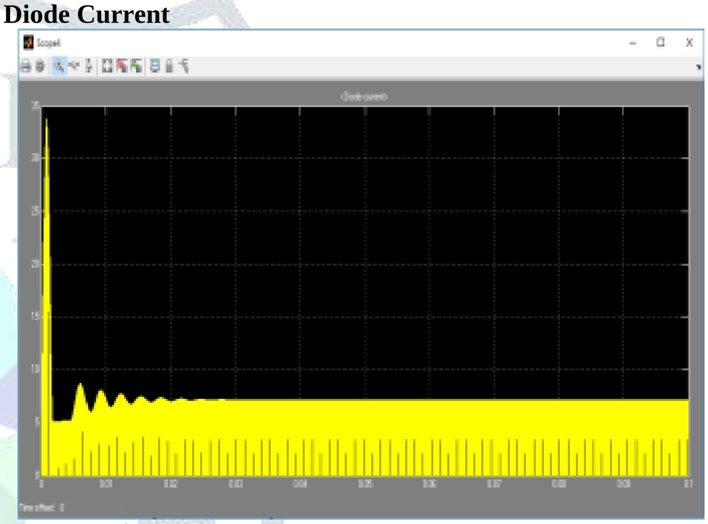

Figure 20 Simulation Result of Diode (Id_1) Current

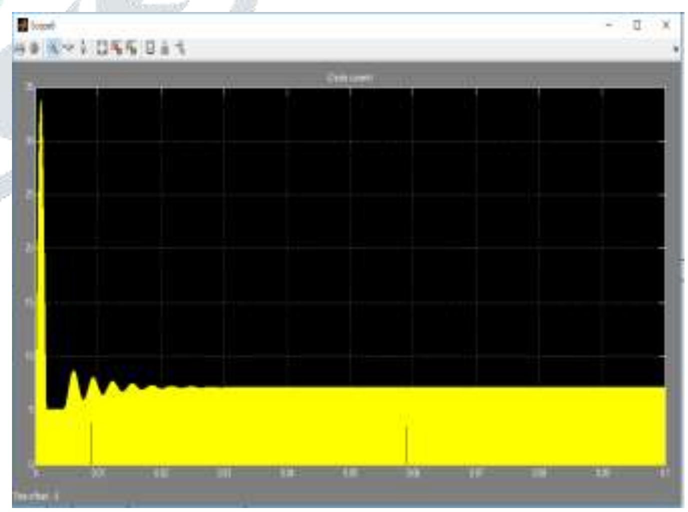

Figure 21 Simulation Result of Diode (Id_2) Current

Output across the load

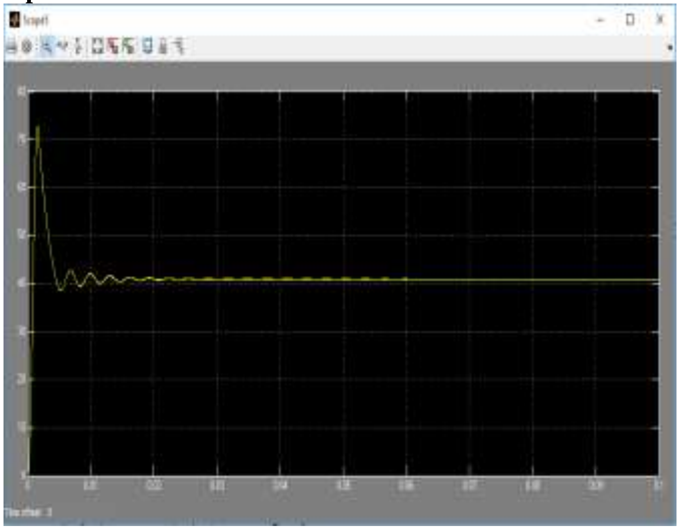

Figure 22 Output Voltage (40.9 Volt.)

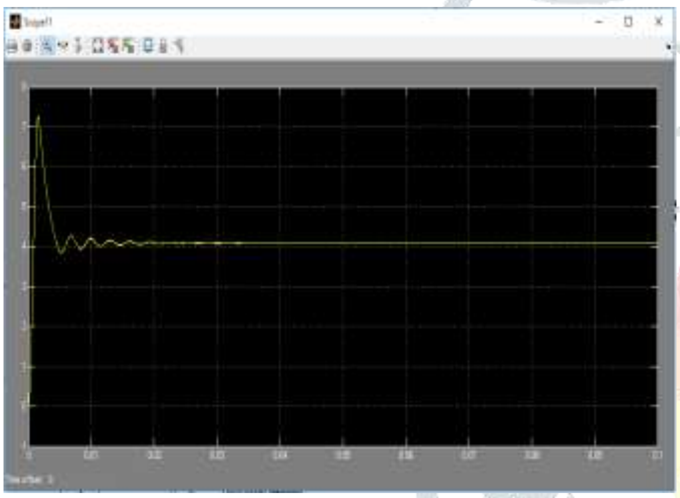

Figure 23 Output Current (4.09 Amp.)

Total Output Power (83.6 Watt)

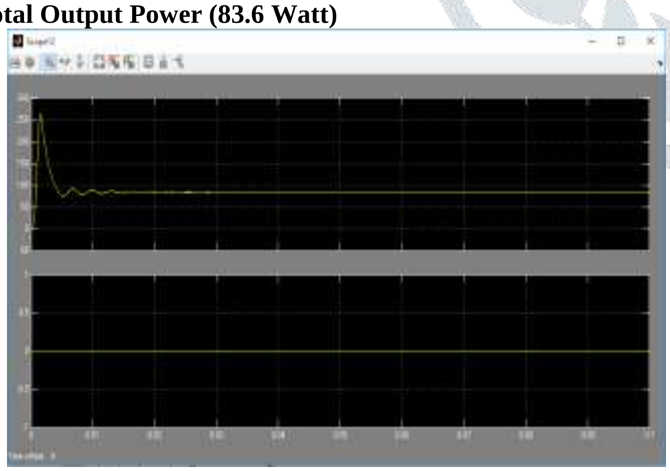

Figure 24 Simulink result of total output power

Photovoltaic Output

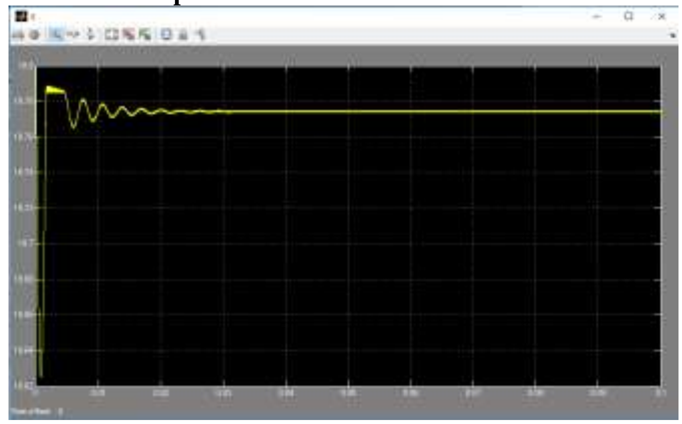

Figure 25 Photovoltaic cell output

Current & Voltage across Power Switches

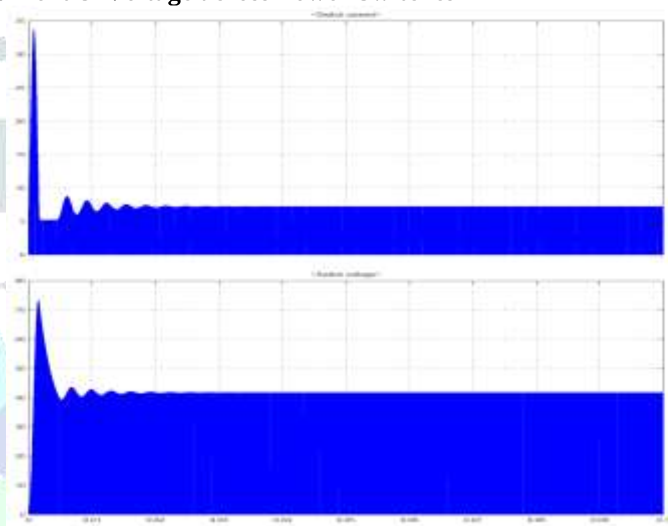

Figure 26 Current across the switch

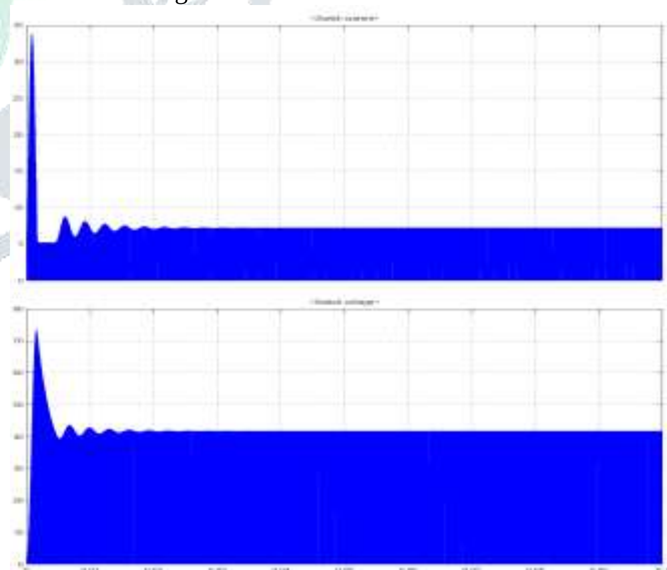

Figure 27 Voltage across the switch

From figure 18 to 27 shows the various output of our project model. Simulation result of shunt inductor shown in the figure 18, from this figure 18 we can see the output in term of waveform shows variation with time. Simulation result of inductors (L_1 & L_2) current shown in the figure 19, basically these connected series reduce the ripple factor of current as show in the figure 19 at starting ripple has continuously high but after the behavior of inductor ripple controlled after some time. Simulation results of IGBT diode current (I_{d1} & I_{d2}) shown in the figure 20 and 21. In figure 22 and 23 depicted the simulation output across the load, these figure shows the output voltage i.e. 40.9 volt and output current i.e. 4.09 ampere. The total output power i.e. 83.6 watt shown in the figure 24, which is also the boost dc output of project model as an input 40 volt through photovoltaic cell shown in the figure 25. Switch voltage and current waveform shown in the figures 26 and 27.

VI CONCLUSION

Cheap fast & efficient switching use in the high-tech world Causes of varying needs & specifications engineers are expected to design reliable &unique solutions. Safety cost &size of each design is also a priority in today's industrialist economy & Boost converter with PV module for renewable energy sources is introduced here. Comparative study low EME and fast transient response finding with this model, also getting low ripple in input current. This converter has many advantages and is suitable for renewable energy sources. Converter is controlled by varying the switching frequency of carrier waves. The simulation results shows that the auxiliary inductor can suppress the switching losses of power switch and diode without increasing the current and voltage stress.

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