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Design and Simulation of High Step-up DC-DC Converter based on the comparison between conventional and proposed converter for Enhanced Performance.

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ABSTRACT –There are various types of electrical applications requiring a large dc input voltage. Therefore we need a we need low –high voltage using dc-dc converter by using photovoltaic system. For that a coupled inductor with capacitor charge in parallel and release in series is used to for the high voltage transfer. This large step-up voltage and large duty ratio are this two advantages get by using this dc-dc converter. When the conduction losses are decreases and efficiency is increases then voltage imbalance is decreases.For that we need to making this simulation design a input is between 10v-20v from the panel and power of 345 watt and output voltage of upto 350v across the load. In this project this design done by coupled inductor and switching capacitor technique.

Keywords— Switched capacitor, Coupled inductor,Photovoltaic system.

I. INTRODUCTION

The energy demand is increasing day by day due to decrease in availability of fossil fuel. So alternative power source for that is renewable energy which is used for electrical energy generation. So the demand of solar electric energy is increasing consistently as its price getting reduced. So the rating of solar panel is decided on there dc output power under the standard conditions and ranges from 100watts to 220watts. But Some Sources like photovoltaic sources & fuel sources as they need to get boosted from low i/p voltage to high o/p voltage. This High step-up dc-dc converter is used because its high efficiency & high conversion ratio along with small size but main advantage is it converts low i/p voltage to high o/p voltage.

But the high Step-up dc-dc converter can be achieved by using high voltage in with high duty ratio. But some problems are comimg by performing such a converter such as system failure, small conversion ratio which are due to high duty ratio & .electromagnetic interference.

The many techniques like capacitor cascade switched capacitor techniques and voltage lift techniques are used to achieve high voltage gain. By connecting two step-up converter we get the more conversion ratio but it creates some drawbacks like large conduction losses and high transient current are due to voltage lift technique. Also it requires more switches & its low efficiency. We have a capacitor & coupled inductor which is parallely charged and release in series & due to this coupled inductor we obtain the large voltage transfer gain.so this converter gives large duty ratio with increasing the large step up voltage from low to high.which coupled inductor to increase the voltage We can improving the efficiency & decreases the conduction losses by reducing the voltage imbalance on main power switch.

There are several control technique have been presented to obtaining the fast transient response . Also, we can reduce voltage stress on main power switch with improved the efficiency and minimize the conduction losses.[4]

There are various types of control techniques have been presented to improving the fast transient response as well as stability.Here we used the coupling inductor with switching capacitor technique with open loop system and closed loop system using PID Controller.

We studied all converters, most widely used DC-DC converter is the High Step-Up DC-DC converter which provides a large voltage at the load side.V0 is output voltage which is Compared with source voltage Vs. in the open loop mood operation of this step-up DC-DC converter create some voltage regulation and undesirable dynamic response. Therefore, Closed loop mode of operation is fast respons as well as stability. offered for proper voltage regulation and excellent performance.

To improving the performance of the converter,in this paper voltage regulation is obtained by applying a PID Controller, tuned using trial and error method to find the approximate values for the proportional, integral, derivative gains.

II. THEORETICAL CONCEPT

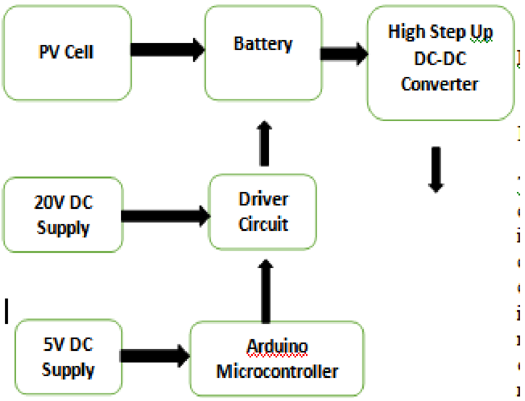

Figure 1. Block diagram of high voltage DC-DC converter by suing PV system.

- For this converter input is taken from the renewable energy sources is the dc input voltage. As there are various renewable energy sources like solar, wind, geothermal, biomass etc.
- We have selected as source for this project which is photovoltaic system. Solar PV modules generated a power and it released and stored by using battery. When battery get fully charged it will give constant output of voltage and current.
- We can use to turning on and off the switch in step-up dc-dc converter ardiuno microcontroller. Which is used as a control unit to produce the pulses to power the switches of converter.
- In this converter the output is connected to resistive load the for transfering the low voltage to high voltge a step up dc-dc converter is used.

A. High step-up DC-DC converter

As we see in fig.2 coupled inductor with step up converter. The energy is stored in coupled inductor which is used to charged the capacitor & produce the high voltage transfer gain. We use the low resistance which is give minimum imbalance of voltage on power switch and decreases the conduction losses.. This High Step up dc-dc converter can give large voltage gain with increasing efficiency.

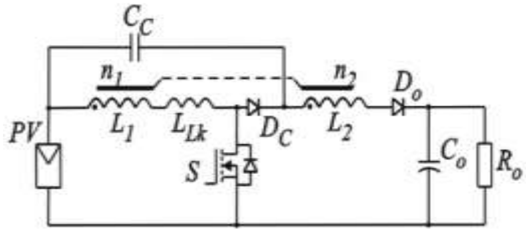

Figure 2. Coupled inductor step-up converter

III. METHODOLOGY

The fig 3. Shown the design of High step up dc-dc converter with switched capacitor and coupled inductor technique. This converter is consist of 4 capacitor, 4 diodes, D1 & C1 are shows clamp circuit, two switching capacitor, & A coupling inductor. A continued capacitor C3 is the voltage multiplier cell. By Combining Capacitor c1 and diode D2elements circuits get the voltage multiplier. In the voltage of clamping capacitor C1 with a magnetizing inductor CLM, leakage inductor CLK, and turn ratio of ideal transformer is same as of Ns(Np/Ns) the coupling inductor. Almost all same type of elements which has been used in this circuit. As the size of the capacitors V0, Vc1, Vc2, Vc3 are all constants with switch off period. The leakage inductor of the coupling inductor is correct when all factor given in the converter are ideal.

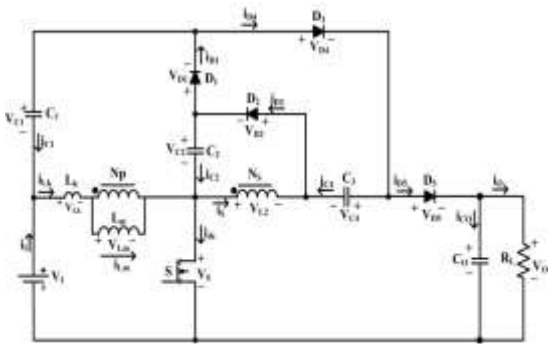

Figure 3. circuit diagram high step up DC DC convertor with coupled inductor and switched capacitor.

It consist of switching period one with five stages conduction. Following components can be observed by 5stage, so that five stages are as below.

Stage -1 [t0<t<t1]: During initial stage switch s is made active. After that two diodes are active which is Diode D2 and D4. After that two diodes are inactive which is diode D2, D4 . The another side of the coupling inductor CLM is parallelly connecting with the capacitor C2 and diode D2. So inductor is magnetizes by DC (v1)

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through Switch s. as the current of leakage inductor CLK commulate the second side of the coupling inductor then current reduces. The output of capacitor C0 is supply the energy of load (RL). This stage gets finished at second side of the coupling inductor as current compass zero at t=t0 At this stage circuit is shown in fig. 3(a)

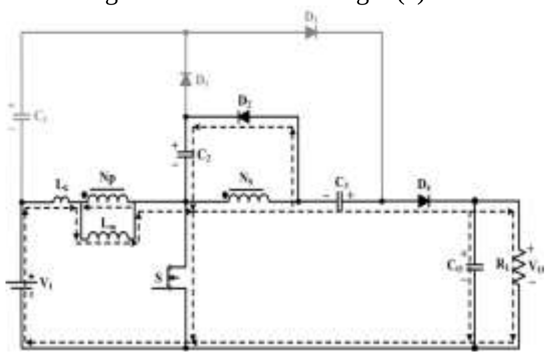

Figure 3(a). Circuit Topology at Stage 1

Stage -2 [t2<t<t3]: In the second initial stage, Diode D4 is active and the diode the diode D3 is made active by making Diode D1 & Diode D4 & D2 are inactive. The leakage inductor CLK gets add to linearly as the Dc supply V1 magnetizing CLM through switch s as a main switch. The DC source V1, exlamped capacitor & the second side of coupling inductor are recycled to charge the capacitor C5. The expected energy of load RL is existed in output capacitor of C0. This stage is finished when switch s is made inactive at t=t2. At this stage Circuit is shown in below Fig 3(b) .

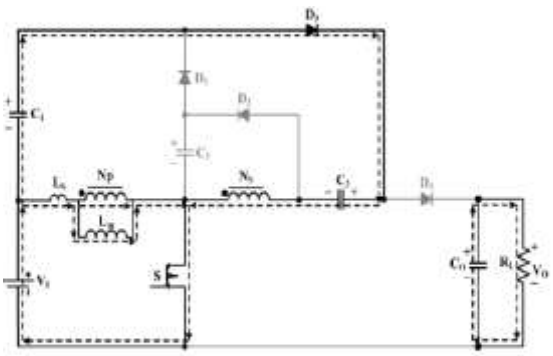

Figure 3(b): Circuit Topology at Stage 2.

Stage -3 [t2<t<t3]: In this third stage initially in circuit Switch S is made active. This make Diodes on which are diode D3 & diode D1.And also make diodes off which are diodes D2 & D4. The capacitor charge the clamp capacitor when energy is stored in the leakage inductor CLK . In this stage the magnetizing inductor Lm and capacitor are work as a energy expoit. The Current coupling inductor and current of the leakage inductor are increases and decreases independantly. For Charging Diode D3 & capacitor C3 are used for charging purpose. For charging capacitor C0 supplies the energy to load. when magnetizing inductor current are both are equal then this stage is completes. At this stage circuit is shown in below fig. 3(c)

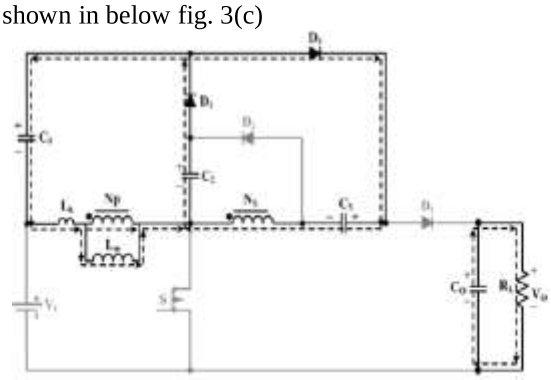

Figure 3(c). Circuit Topology at Stage 3.

Stage -4 [t3<t<t4]: In this stage 4, initially switch S is made off. And also Diode D1 & D4 are made off. Diode D2 and D3 are which is on. Energy is stored in magnetizing inductor CLm, leakage inductor CLK, capacitor to charge the clamped capacitor the enrgy is exploits. The current of the leakage inductor CLK and magnetizing inductor CLM increases or decreases individually when the energy stored in the capacitor CLm is transfer to another side of coupling inductor. When the dc supply is on the output capacitor is charged. Capacitor C3 and both side of coupling inductor get charged when output capacitor transfer the energy to the R1. when Diode D4 is on, And this stage is completes at t=t4 as shown in below fig 3 (d).

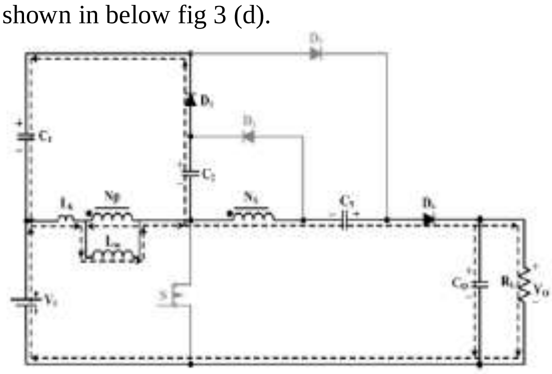

Figure 3(d). Circuit Topology at Stage 4.

Stage -5 [t4<t<t5]: In this fifth stage, initially switch s is on. Which made Diodes D1 & D3 are off. This make diode D2 & D4 are on. The CLK and CLM this both gets decreases. to charge the capacitor C2 an energy is stored in inductor LM

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is transfer to the next side of the coupling inductor in system. And this is done complete throgh D2 diode. DC input voltage V1 and energy stored in capacitor C0 are by uses the inductor on two sides of coupling inductor in this system. At this stage switch S is made active. This stage is completes when at t=t5.

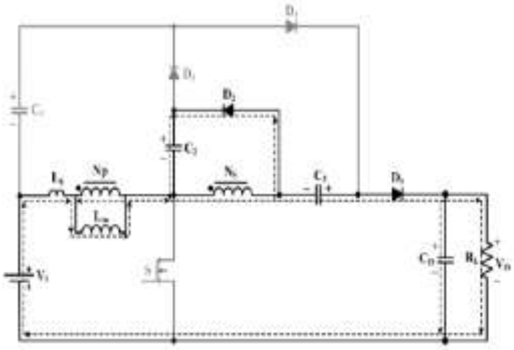

Figure 3 (e). Circuit Topology at Stage 5.

Calculation –

Assume worst case efficiency 80%

Po= 10W.

We know,

Efficiency = Po/Pin

Pin=10/0.8

Pin=12.5W

Secondary current (Irms)= Output power/Output Voltage

= 10/230

= 43.47 mA.

Primary current (Im)= Pin/Vin

= 12.5/12

= 1.041 A.

Primary current (Irms) = Im/$\sqrt{2}$

= 0.912

Transformer Turns ratio = Np/Ns=Vp/Vs

Np = 86/1630

= 1/19.53

Np (Approx). = 1/19

Vp/Vs= 1/19

Vs= 12*19

= 228V

Drain Current of MOSFET

From the inverter, Total Power is low

Po = 10W

Transformer Efficiency = Po/Pin

Pin=10/0.8

Pin=12.5W

The Battery Vtg is= 12 V

Drain Current ID= P/V

=12.5/12

=1.041amp

Simulation Model:

Simulation -

i) Open loop DC-DC converter -

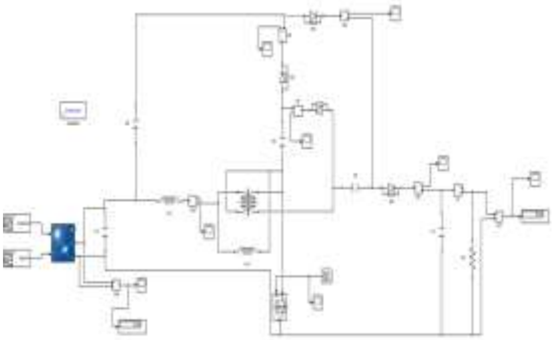

Figure 4. simulation diagram of open loop system using step-up dc-dc Converter

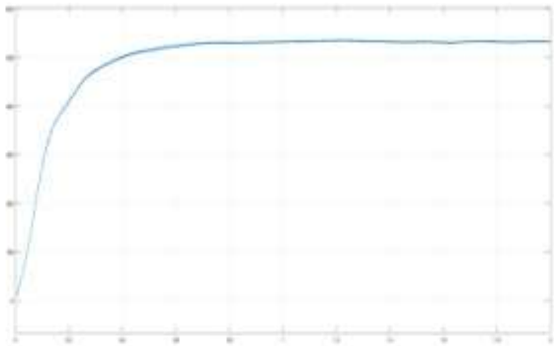

Figure 5.simulation design of Output Waveform of open loop system for 20v using step up DC-DC Converter

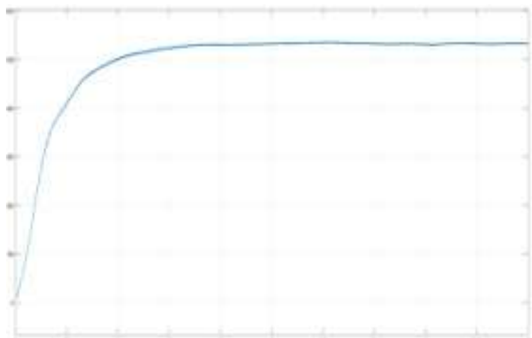

Figure 6.Simulation design of output waveform of open loop system For 25 V.

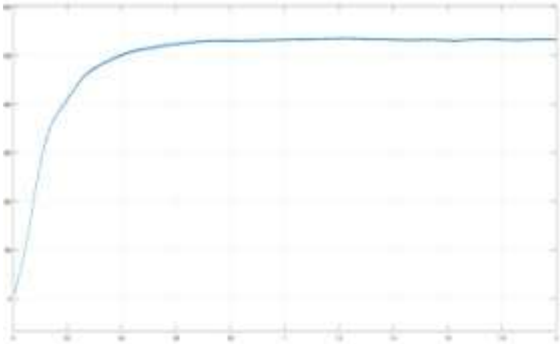

Figure 7 Simulation design of output Waveform of open loop system for 30 V

Closed loop DC-DC converter

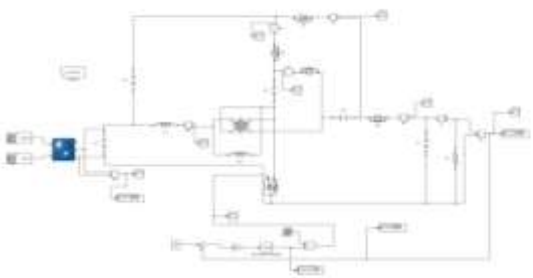

Figure 8.Simulation diagram of Closed loop system with PID

Controller using step up DC-DC Converter

I)

Figure 9 Simulation design of output waveform of closed loop system for 20 V using step up DC-DC Converter.

ii)

Figure 10.Simulation design of output Waveform of closed loop For 25 v using step up dC-dC Converter.

iii)

Figure 11. Simulation design of output waveform of closed loops ystem with PID Controller for 30 v using step up dc-dc Converter.

The proposed converter is approveed by simulation model. The advanced converter model has been verified in MATLAB Software.

Mode	Open loop	PID
Voltage i/p	12	20
Voltage reference	24	24
Voltage o/p	530	310
Deviation (V)	0.21	0.57
Deviation (%)	0.256	0.857

Table1. Deviation of voltage result from open loop & closed loop PID controller.

Parameter	Value
Kp	0.078
Ki	6.43
Kd	0.0027
Rated Power	800W
Duty Cycle	0.5
Boost Inductor	400H
Filter Capacitor	100
Resistive load	50
Input Voltage	20V-310V
Output Voltage	310V

Table 2. Simulation Parameter

Effect of PID on closed loop system.

	Settling time	Steady state error	Rise Time	Overshoot
Proportional	Small Change	Decrease	Decrease	Increase
Integral	Increase	eliminate	Decrease	Increase
Derivative	Decrease	Small Change	Small Error	Decrease

By using closed loop system with PID Controller using with step-up converter increases the dynamic response and decreases the steady state error. The integral controller (KI) & the transient response will decreases the steady state error of the system. Our closed loop system maintains when the input is in range of 20v-30v an output of the 310v. Because of this we use it in different industrial purposes.

For this proposed converter as shown. in fig 9 output wave shapes was operated on 50% duty cycle observed for variations of input voltage for 20v, 25v and 30v. resp. The output voltage waveform shows fluctuation with change in input voltage.

	Conventional		Proposed	
Input Voltage Vi (V)	Output Voltage, Vo (V)	Percentage Overshoot (%)	Output Voltage, Vo (V)	Percentage Overshoot (%)
20	260.8	22.44	310.4	2.88
25	280.5	21.99	310.6	2.19
30	350.0	23.50	310.8	2.20

V. CONCLUSION

Before the design a step up dc-dc converter with photovoltaic system by using switched capacitor and coupled inductor technique which is useful to understand advantages and disadvantages of converter. The energy in the leakage inductance of the coupled inductor is processed or collecting by operating switched capacitor. To increasing efficiency, voltage imbalance on main power switch is decreases. The PWM control schemes are used to generated the gate pulses. We design the simulation model of High step up dc-dc converter. The 20v i/p voltage into 310v o/p voltage. The converter is described by considering low conduction losses, low input current ripple voltage , voltage stress on main power switch is decreased. This converter find out useful things in PV systems, Fuel cell system, E-vehicles, and High intensity discharge lamps applications. The results states that this presented converter is more feasible, useful and advantageous.

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