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Simulink Modeling of DC-DC Converter with Solar Cell for Distributed Generating System

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***Abstract*— This paper presents the modeling of high efficiency DC-DC converter for distributed generating system with the input voltage of 15V taken from PV cell. To maintain the power generation closer to the consumer, distributed generation is installed and in that distributed PV is one type. Here, that system is modeled and the DC-DC converter is plotted. Using the MATLAB/SIMULINK the modeling is done.**

***Index Terms*— Photo Voltaic Cell, IGBT, Filter, DC-DC converter, distributed generation (DG).**

I. INTRODUCTION

In general increasing utilization of electronic devices in homes is a growing concern for utility companies due to harmonic distortions. The harmonic problem could be further complicated by the harmonic resonance introduced by other system components, such as the power factor correction (pfc) capacitors. Besides the degrading power quality, the harmonic current flow may interfere with the adjacent telephone lines. The harmonics in a residential system is difficult because of the dispersed nature of the residential loads.

So, in this project the power quality was increasing in the load harmonics improves the residential distribution system. Due to installation of capacitor banks in the distribution network the harmonics resonance was worsen. So in that improve the harmonics distortion, active or passive filter are used.

They are so many DG systems such as photovoltaic (PV), wind and fuel cells, have DG-grid interfacing converters. The increasing implementation of distributed generation (DG) in residential areas, to improve the power quality it increases interest in this type of systems. The potential for using photovoltaic (PV) interfacing inverters to compensate the residential system harmonics is explored. .

The proposed circuit is as shown in the Fig.1. In this circuit the charging of the capacitors is done in parallel, and discharging is done in series with the help of the coupled inductor. By maintaining the duty cycle, high step up gain is achieved. Due to this voltage stresses are reduced, low resistance for the main switch is adopted and thus it improves the efficiency.

At this context, if we need to analyze the DG system with PV modelling of the individual elements needs to be done. By this analysis, efficiency also gets increased.

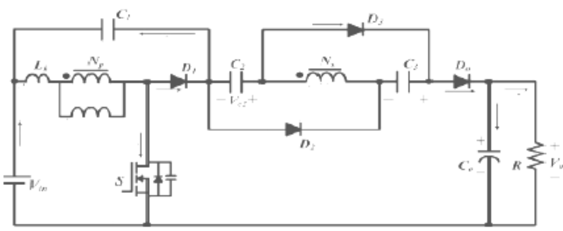

Fig.1. Basic Diagram of the DC-DC converter

PV distributed system is as shown in Fig.2

PV sources are used to power the DG systems. The solar source used here is a low input source(15-17V). To obtain the large conversion ratio and high efficiency, the DC-DC converters are used at front ends.

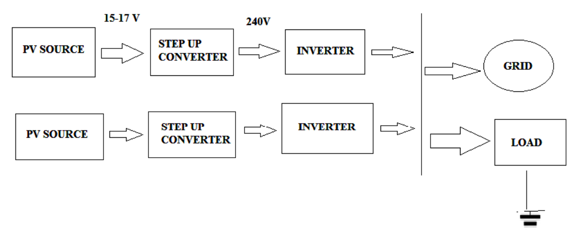

Fig. 2 PV distributed System

Now here in this paper to obtain the high efficiency, distributed generating system with PV is modelled and converter is also modelled by using the MATLAB/SIMULINK..

II. DC-DC CONVERTER (STEP UP CONVERTER)

The operation of the step up converter is done in 2 ways

- Continuous Conduction Mode.
- Discontinuous Conduction Mode.

Fig. 1 shows the circuit topology of the proposed converter. This converter consists:

- dc input voltage V_{in} , power switch S
- coupled inductors N_p and N_s,
- one clamp diode D_1 & clamp capacitor C_1 ,
- two blocking capacitors C_2 and C_3 &
- Two blocking diodes D2 and D3 ,

- output diode Do, and output capacitor C_0.

The coupled inductor is modeled as the magnetizing inductor L_m and leakage inductor L_k.

To simplify the circuit analysis, the following conditions are assumed.

1. Capacitors C_2, C_3, and C_0 are large enough that V_{c2}, V_{c3}, and V_0 are considered to be constant in one switching period.
2. The power MOSFET and diodes are treated as ideal, but the parasitic capacitor of the power switch is considered.
3. The coupling coefficient of coupled inductor k is equal to $L_m/(L_m+L_k)$ and the turns ratio of coupled inductor n is equal to N_s/N_p.

A .Continuous Conduction Mode:

We get six modes of operation of converter here

- Mode I [t_0, t_1]: During this time interval, S is turned on. Diodes D_1, D_2, and D_3 are turned off, and D_0 is turned on
- Mode II [t_1, t_2]: During this time interval, S is still turned on. Diodes D_1 and D_0 are turned off, and D_2 and D_3 are turned on
- Mode III [t_2, t_3]: During this time interval, S is turned off. Diodes D_1 and D_0 are turned off, and D_2 and D_3 are turned on
- Mode IV [t_3, t_4]: During this time interval, S is turned off. Diodes D_1, D_2, and D_3 are turned on and D_0 is turned off
- Mode V [t_4, t_5]: During this time interval, S is turned off. Diodes D_1 and D_0 are turned on, and D_2 and D_3 are turned off
- Mode VI [t_5, t_6]: During this time interval, S is still turned off. Diodes D_1 and D_0 are turned on, and D_2 and D_3 are turned off.
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B. Discontinuous Conduction Mode:

During this discontinuous conduction operation we get 3 mode of operation

- Mode I [t0, t1]: During this time interval, S is turned on.
- Mode II [*t*1, *t*2]: During this time interval, *S* is turned off.
- Mode III [*t*2, *t*3]: During this time interval, *S* remains turned off

At modes IV and V, the energy of the leakage inductor L_k is released to the clamped capacitor C_1.

The duty cycle of the released energy can be expressed as

$$D_{C1} = \frac{t_{C1}}{T_S} = \frac{2(1-D)}{n+1} \tag{1}$$

Where T_s is the switching period, D_{c1} is the duty ratio of the switch, and t_{c1} is the time of modes IV and V

$$V_{C1} = \frac{D}{1-D} V_{in} \frac{(1+K)+(1-K)n}{2} \tag{2}$$

III. MODELING OF THE DISTRIBUTED SYSTEM

The block diagram of a DC-DC converter with PV Module is as shown:

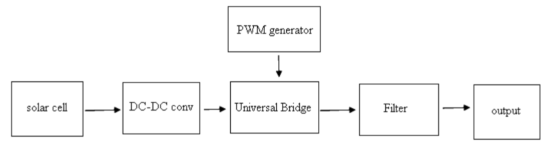

Fig .3. Block Diagram with Filter

Individual modeling is done and all blocks are connected together and the output is plotted. Pulses for the diode are generated by PWM generator.

A. Solar cell modeling

Modeling of solar cell is given below:

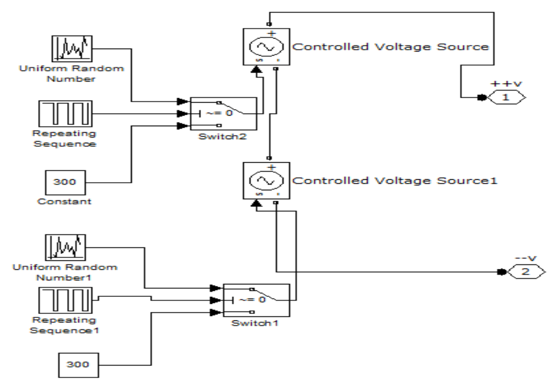

Fig.4 . Modeling of Solar Cell

Simulink modeling of a solar cell is represented in Fig.4. It is modeled by interconnecting the arrays which are controlled voltage sources. Inputs for switch are considered as:

Repeating sequence, the time values and output value is considered as follows:

Time values: [0 4 4 6 6]

Output values: [15 15 0 0 15]

B. DC-DC converter modeling

DC-DC converter is modeled by considering the Fig.1 represents the basic circuit of step up converter; it consists of capacitor, diodes and coupled inductors. Capacitors are charged in parallel and discharged in series by the coupled inductor

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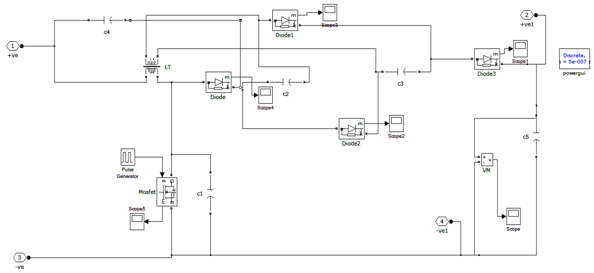

Fig. 5 Simulink Block Diagram of DC-DC converter

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The modeling is done for the block diagram shown in Fig.1. Simulink modeling of Fig.1 is as shown in Fig.5. The input for the step up converter is 15V and is provided by the photovoltaic module. Step up converter shown in the Fig.1 gives the output of 240V. It consist of IGBT's, because of the fastness of the IGBT in almost all the power electronic appliances now-a-days uses them.

IV. Results

Here physical modelling is done and the plots are plotted for that circuit.

PV Cell $\rightarrow$ 15-17V.

Converter output voltage $\rightarrow$ 240.

The output of the DC-DC converter is shown below

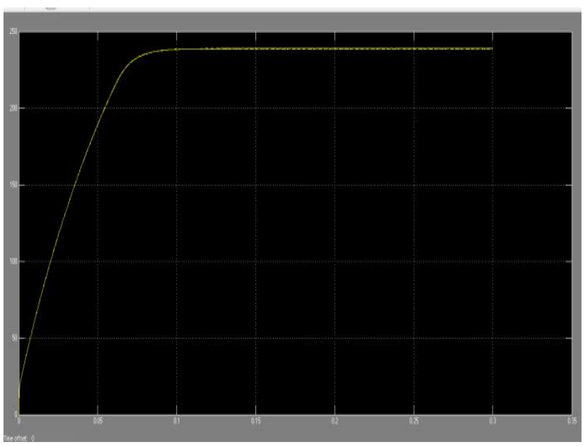

Fig.6. Output of DC-DC converter

For the input of 15V-17V the converter generates the output voltage of 240V. Output obtained is taken by considering the first order filter.

Output is plotted between the output voltage of the step up converter and the time.

The output for the same system with filter and without filter can also plotted

V. Conclusion

Distributed generation is an approach that employs small-scale technologies to produce electricity close to the end users of power. DG technologies often consist of modular (and sometimes renewable-energy) generators, and they offer a number of potential benefits. In many cases, distributed generators can provide lower-cost electricity and higher power reliability and security with fewer environmental consequences than can traditional power generators.

In this paper photovoltaic cell distributed generation is used as that modular. Modeling is done in this paper for that type of system and the output voltage of the converter is plotted.

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