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Solar Photovoltaic System through Cuk Converter Using MATLAB

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Abstract: This paper present solar energy is most useful for sustainable development. The most important application field of this research is renewable energy resources. Solar energy is being popular ones owing to abundant, ease of availability and convertibility to the electric energy. A general model of Photovoltaic system with proposed Cuk converter is implemented on Matlab such that it gives constant and stepped up dc voltage to the load. A Cuk Converter is used for examine the performance of solar PV system.

***IndexTerms*—Photovoltaic System, Cuk converter, Battery, Inverter, etc.**

I Introduction

Solar energy demand is increasing day by day due to increase in population, urbanization, and industrialization, renewable energy resources are alternatives to our traditional energy sources which are limited and will expire. The photovoltaic energy effect can be considered an essential sustainable resource because of solar radiant energy abundance and the sustainability thus grid connected photovoltaic system is widely used, although solar energy is available abundantly and free of cost, the cost of the photovoltaic cells is very high. Hence the initial investment on solar energy will be very high.

Solar powered electrical generation relies on photovoltaic system and heat engines. The solar energy's uses are limited only by human creativity. To harvest the solar energy, the most common way is to use photo voltaic panels which will receive photon energy from sun and convert to electrical energy source. Solar technologies are broadly classified as either passive solar or active solar depending on the way they detain, convert and distribute solar energy. Solar energy is abundantly available that has made it possible to harvest it and utilize it properly. A solar energy can be a standalone generating unit or can be a grid connected generating unit depending on the availability of a grid nearby. The power conversion mechanisms have been greatly reduced in size in the past few years. The development in power electronics and material science has helped engineers to come up very small but powerful systems to withstand the high power demand. They can hardly compete in the competitive markets as a prime power generation source. The PV module represents the fundamental power conversion unit of PV generator system.

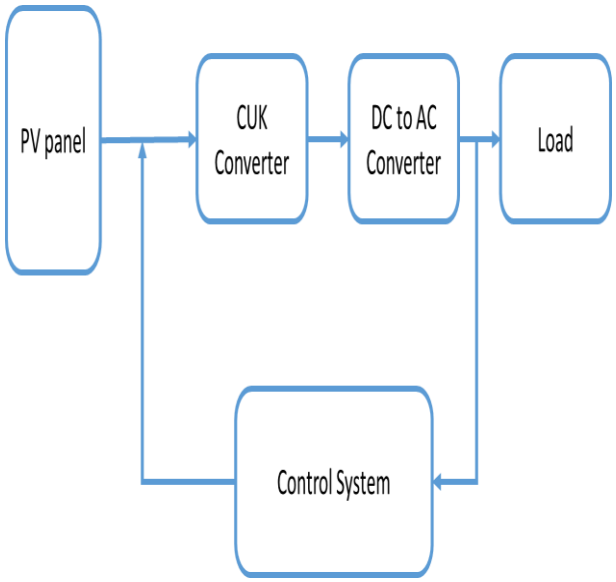

Fig. 1. Solar energy Distribution process

The proposed topology consists of control strategy of interconnection between photovoltaic array with control system and Cuk converter to load as shown in below figure 1.

II. Photovoltaic Cell

Photovoltaic (PV) system directly converts solar energy into electrical energy source. The basic device of a PV system is the PV cell. In the cells may be grouped to form arrays. In the voltage and current available at the terminals of a PV device may directly feed small loads such as lighting systems and DC motors by using proper energy

conversion. This photovoltaic system consists of main parts such as PV module, battery, charger, inverter and load.

A solar cell is the building block of a solar panel. A photovoltaic module is formed by connecting many solar cells in series and parallel. Considering only a single solar cell; it can be modeled by utilizing a current source, a diode and two resistors. This model is known as a single diode model of solar cell. Two diode models are also available but only single diode model is considered here in fig. 2.

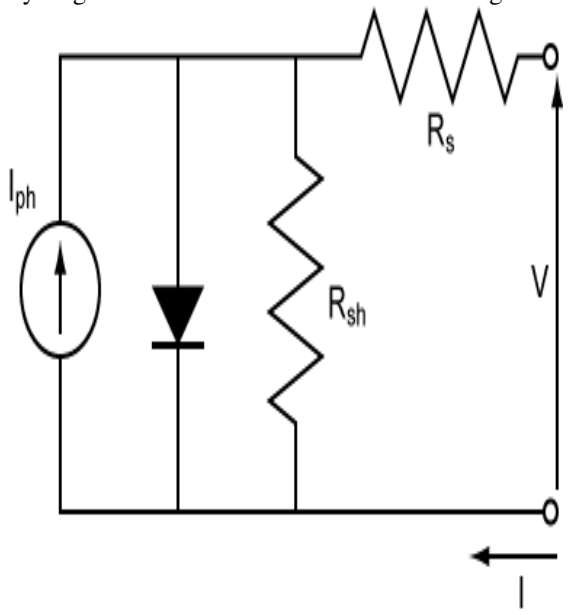

Fig. 2.Single PV Cell module

III Mathematically expressed

The current source Iph represents the cell photocurrent. In usually the value of Rsh is very large and that of Rs is very small signal, hence they may be neglected to simplify the analysis. The photovoltaic (PV) cells are grouped in larger units called PV modules which are further interconnected in a parallel-series configuration to form PV arrays.

Modeling photo-current

$$I_{ph} = [I_{SCr} + K_i i(T - 298)] * \lambda/1000 \quad (1)$$

Module reverse saturation current – Irs

$$I_{rs} = I_{SCr}/[\exp\left(\frac{qV_{oc}}{N_s kAT}\right) - 1] \quad (2)$$

The module saturation current I_0 varies with the cell which is given by

$$I_0 = I_{rs}\left[\frac{T}{T_r}\right]^3 \exp\left[\frac{q*E_{g0}}{Bk}\left\{\frac{1}{T_r} - \frac{1}{T}\right\}\right] \quad (3)$$

$$I_{pv} = N_p * I_{ph} - N_p * I_0\left[\exp\left\{\frac{q*(V_{PV}+I_{PV}R_s)}{N_s kAT}\right\}\right] - 1 \quad (4)$$

IV Cuk Converter Modeling

There are variations on the basic Cuk converter. For example, the coils may share single magnetic core, which drops the output ripple, and adds efficiency. Because the power transfer flows continuously via the capacitor, this type of switcher has minimized EMI radiation. The Cuk converter enables the energy flow bidirectionally, by adding a diode and a switch. The basic circuit of a Cuk converter is shown in Fig.3 and as you can see it has an additional inductor and capacitor. The circuit configuration is in some ways like a combination of the buck and boost converters, although like the buck-boost circuit. It delivers an inverted output. Note that virtually all of the output current must pass through C1, and as ripple current. So C1 is usually a large electrolytic with a high ripple current rating and low ESR (equivalent series resistance), to minimize losses. When switch is turned on, current flows from the input source through L1 and MOSFET, storing energy in L1. Magnetic field. Then when MOSFET is turned off, the voltage across L1 reverses to maintain current flow.

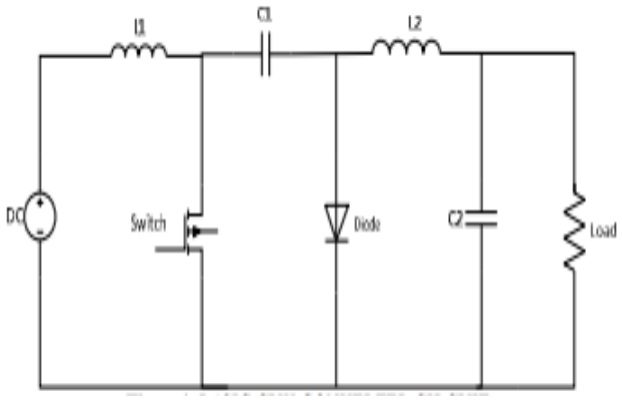

Fig. 3. ***CUK converter***

As in the boost converter current then flows from the input source, through L1 and diode, charging up C1 to a voltage somewhat higher than Vin and transferring to it some of the energy that was stored in L1. Then when MOSFET is turned on again, C1 discharges through via L2 into the load, with L2 and C2 acting as a smoothing filter.

$$\frac{\text{Vout}}{\text{Vin}} = -\frac{\text{D}}{(\text{D}-1)} \quad (5)$$

V Simulink Model of PV system With CUK

In this paper, the simulation model is developed with MATLAB/SIMULINK. The proposed needs independent dc source which is supplied from photovoltaic cell (PV cell). The inputs are fed by voltage and current of the photovoltaic terminals, while the output provides duty cycle for the CUK converter. The simulation model of the proposed method is shown in Fig.4.

For PV module function is simulink with the help of programming and another part such as converter, voltage regulator and filter with simulink. Solar energy is essential for generating voltage at minimum maintenance cost because it's a natural source of energy. CUK converter is also simulink for uplifting the voltage level as per requirement of load.

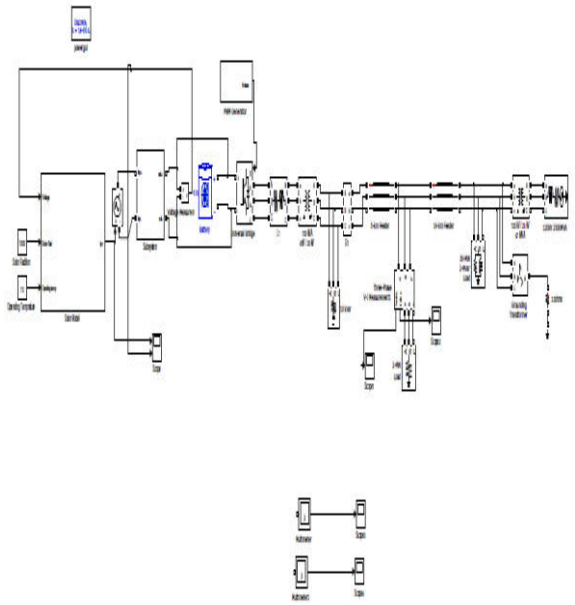

Fig.4Simulink model

In this paper the modeling and simulation of PV model and CUK converter technique is done using MATLAB/SIMULINK.

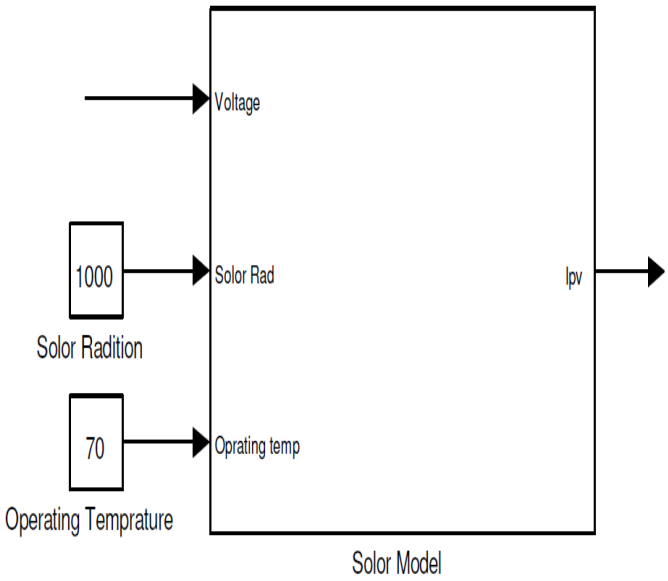

Fig. 5Solar model Simulink block

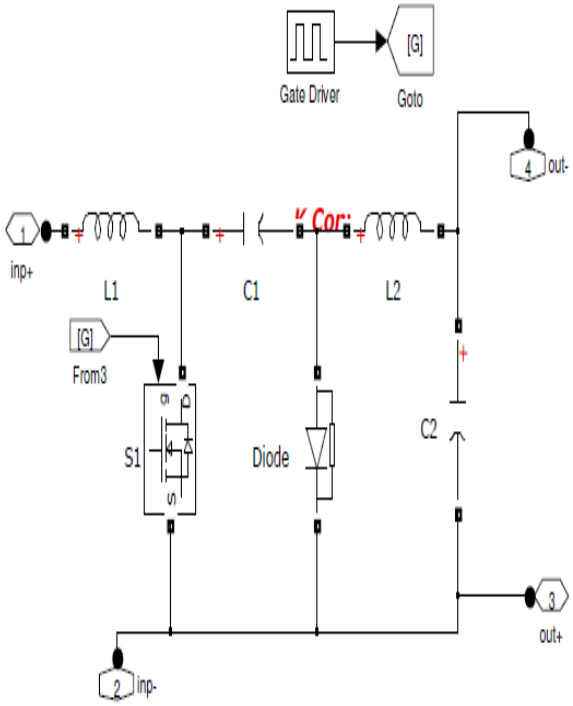

Fig. 6 This symmetric of Cuk converter

VI RESULTS AND DISCUSSION

The performance of result analyses of cuk converter simulation is done using MATLAB. The duty cycle is deviated and compatible voltage and current is analyzed in the Cuk converter. According to this analysis, the output power of Cuk converter is maximum. From the relative examination, it is unveiled that the proposed Cuk converter is better when analyzed to other converter. The proposed converter efficiency is varied more.

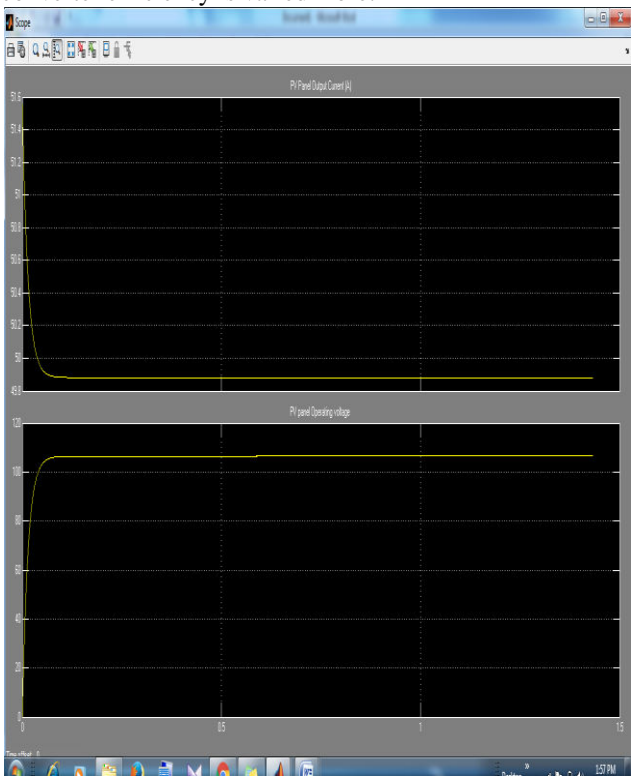

Fig.7 The simulation waveform of battery connected Inverter output

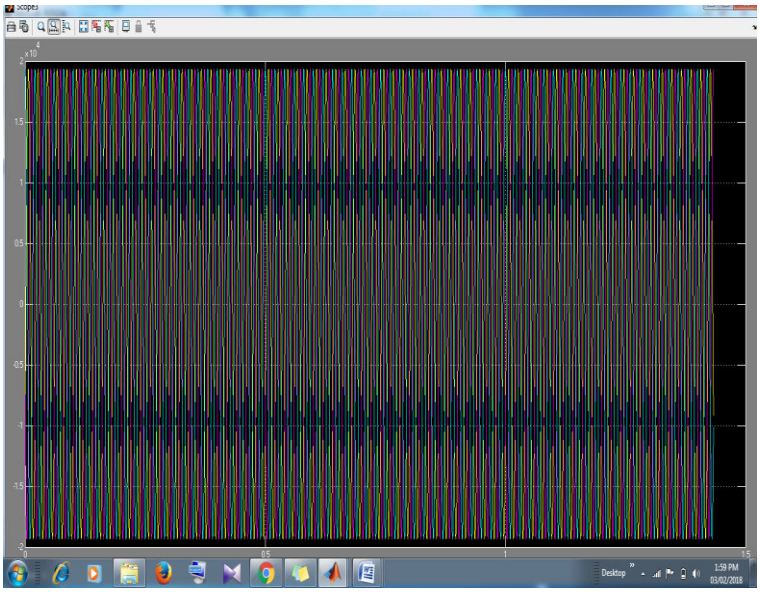

Fig.8 Performance of battery discharge characteristics

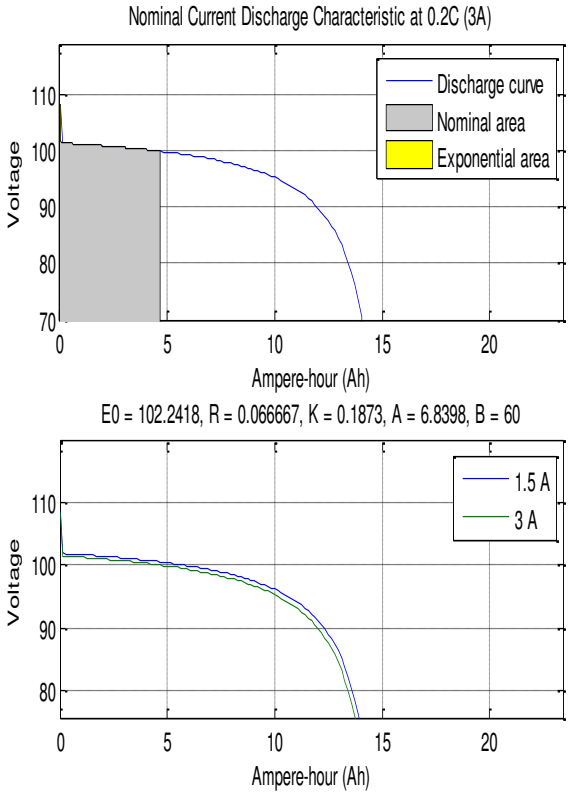

Fig. 9 This waveform of charging and discharging current

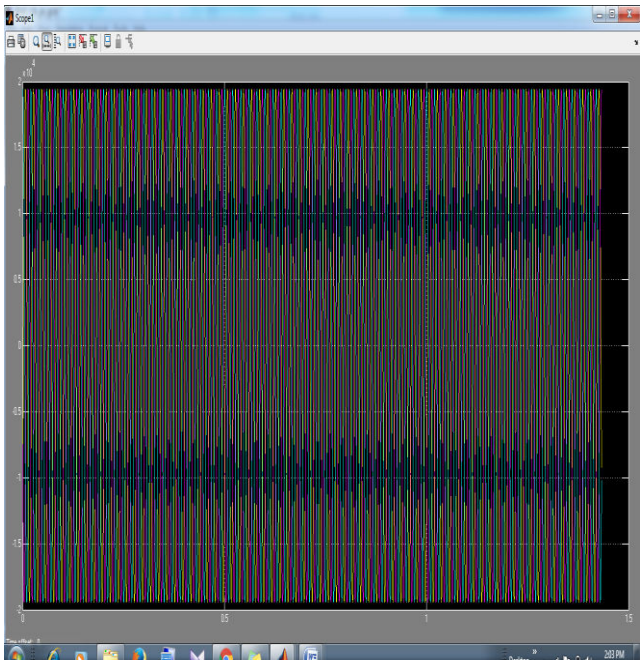

Fig. 10 The Graph Performance of voltage at load

VII CONCLUSION

This paper analysis nonlinear, switched, and state-space models for CUK converters. The simulation environment MATLAB/SIMULINK is quite suitable to design the modelling circuit, and to learn the dynamic behaviour of different converter structures in open loop. CUK converter, the duty cycle is varied and corresponding voltage and current is observed. It is used different duty cycle, the performance of convertor is better results.

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