Power flow Controller of PV System

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Abstract - *Photovoltaic cell generation is the technique which uses photovoltaic cell to convert solar energy into electrical energy. Now a day, the photovoltaic generation is developing increasingly fast as a renewable energy source. The functioning of a photovoltaic cell as the power generator is equivalent to an electric circuit containing a current generator, diode, series and shunt resistance. This paper presents a modeling and simulation of a photovoltaic system constitutes of a generator photovoltaic (PVG), DC-DC converter (boost chopper) to transfer the maximum power to a base transmitter station. The temperature and irradiance effects on the PVG will be studied, particularly on the variables such as the short circuit current Icc, the open circuit voltage Voc. Depending on the load (BTS, I=60A, V=48V) profile and climatic factors influencing, we can find a highly gap between the maximum power supplied by the PVG and that actually transferred to the BTS. A maximum power point tracker (MPPT) based on a boost converter commanded by a Pulse Width Modulation (PWM) is used for extracting the maximum power from the PVG. Thus, a real time tracking of the optimal point of functioning is necessary to optimize the efficiency on the system. The modeling and simulation of the system (PVG, boost converter, PWM and MPPT algorithm of Perturbation and Observation P&O) is then made with Matlab/Simulink software.*

Key Words: Photovoltaic Generator, Boost Converter, PWM,

1. Introduction

For two centuries, the world has used its energy almost exclusively from the combustion of coal, oil and gas represent today 80% of global energy consumption marketed. But coal, oil and gas are fossil energy that are not renewed. This energy is the principal cause of global warming, is now a major environmental and economic problem affecting the perspectives of sustainable development. The use of solar energy to produce electricity by a photovoltaic panel requires no fuel. So there is no issue or producing toxic gases from the combustion of coal which has the effect of increasing the temperature of the earth by greenhouse gases. Solar energy is a clean and inexhaustible excellent alternative. In addition, there is no waste from this technique of energy production and not reject polluting and toxic substances in the soil. In this study, we model and optimize a system comprising a photovoltaic generator connected to a boost converter for a best transfer the power drawn from the sun and converted into electricity, without burning coal.

2. Modeling of a Photovoltaic Cell

In the ideally a photovoltaic cell (PV) can be summarized by an ideal current source produces a current proportional to the Iph incident light power, in parallel with a diode[1]-[3]. If we connect a resistive load to the terminals of the GPV, latter is delivers a portion of current I and the rest Id, current in the diode. For an ideal GPV, the voltage at the terminals of the resistance is equal to that at the terminals of the led: V=Vd and the nonlinear diode I-V characteristic is given by the relation.

$$I_d = I_0 \left[\exp\left(\frac{q(V + R_s I)}{akT} \right) - 1 \right]$$

(1)

$$I = I_d - I_0 \left[\exp\left(\frac{q(V + R_s I)}{akT} \right) - 1 \right] - \frac{V + R_s I}{R_p}$$

(2)

In the real case in models loss of voltage and leakage by two resistance in parallel R_p and R_s series. The model of the cell is shown in (Fig. 1):
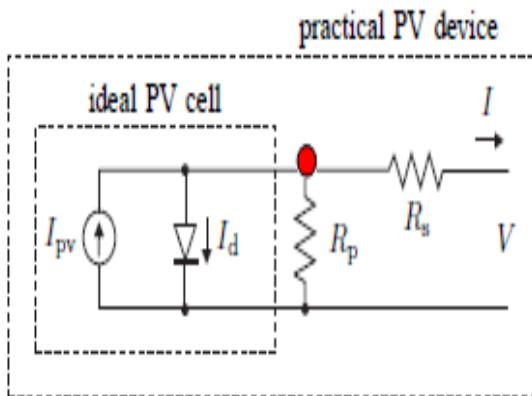
Fig -1: Model of PV cell with inclusion of voltage loss and leakage current.

According the law of Kirchhofff, we have:

$$I_{PV} = I_d + I_{Rp} + I \qquad (3)$$

$$I_{Rp} = \frac{V + IR_s}{R_p} \qquad (4)$$

In the ideal, R_s tends towards 0 and R_p to infinity. And

in the real, these resistors provide an assessment of the imperfections of the diode; considering that the resistance Rs has a low value. Using a numerical method (the method of Newton-Raphson for example) and under illumination, the slopes of the I-V characteristics are calculated at $I = 0$ open circuit and short circuit $V = 0$ and respectively give the inverse of series and shunt resistance values[4]-[7].

3- INFLUENCE OF LIGHT AND TEMPERATURE ON THE CHARACTERISTIC I(V)

The response of a PV cell at different light energy figure (1). Shows that irradiation has a significant effect on the current open-circuit. That is the curve of the I-V characteristic and relatively horizontal, while the effect on the voltage in open circuit, i.e. the slope of the I-V curve and relatively vertical, which is quite low[8]-[15]. With regard to the maximum power of a photovoltaic cell, when the illumination is highest, the cell generates more power. The temperature has a very important effect on the open circuit voltage and a no remarkable effect on the short circuit of cell (Fig. 2).

4- MODELING OF BOOST CHOPPER

A DC/DC converter is a chopper transistor type parallel voltage booster used to increase the output voltage from the source, the schematic diagram is shown in (fig. 2).
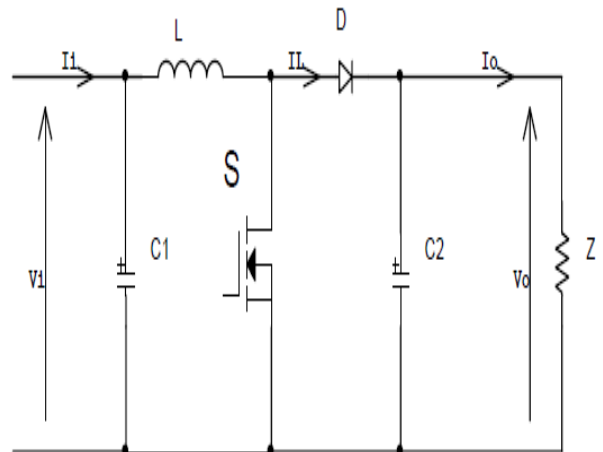

Fig -2: Model of a DC/DC chopper

It is sized for a 3 kW power that corresponds to the values nominal I=170, V=17.64 V, on the side of the generator, and Vs=50V, Is=60 A, load side. His transformation ratio is the duty cycle (ratio of time during which the transistor is closed, the period hash as α << 1

The chopper forces the GPV to operate at maximum power, whatever the illumination and transfer to the load for a duty cycle defined. This chopper has four components: An inductance L, a diode, a capacitor C and a switch that takes two states, S=1 and S=0. When the switch S is closed, the diode D is polarized in opposite the load is therefore isolated[15]-[24]. The source provided energy to the inductance. If the switch S is open, the output stage receives energy from the source and inductor where an increase in the output voltage. Ideally, all components are ideal; the boost chopper can be modeled using the following ordinary differential equations:

$$I_{c1} = C_1 \frac{dV_i}{dt} = I_i - I_L$$

$$(5)$$

$$I_{c2} = C_2 \frac{dV_0}{dt} = -I_0$$

$$(6)$$

$$V_L = L \frac{dI_L}{dt} = V_i$$

$$(7)$$

$$I_{c1} = C_1 \frac{dV_i}{dt} = I_i - I_L$$

$$(8)$$

$$I_{c2} = C_2 \frac{dV_0}{dt} = I_L - I_0$$

$$(9)$$

$$V_L = L \frac{dI_L}{dt} = V_i - V_0$$

$$(10)$$

We added to the previous model a resistance RL internal inductance and resistance Rc internal capacity, so the (9) and (10) become:
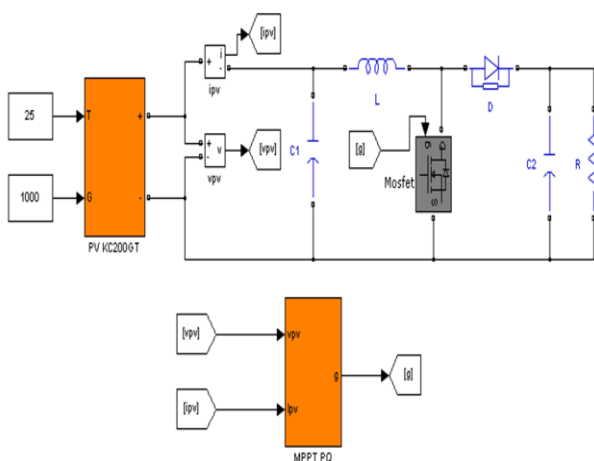
MODELING OF THE COMMANDS

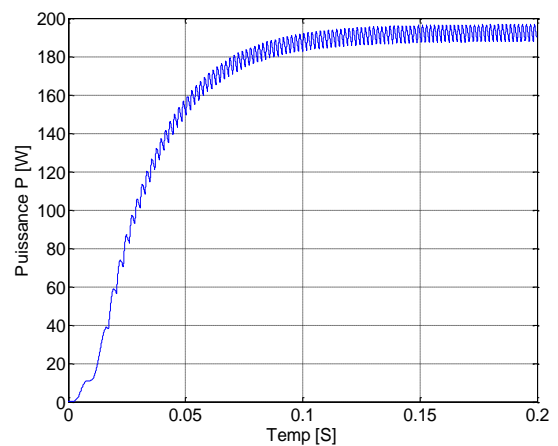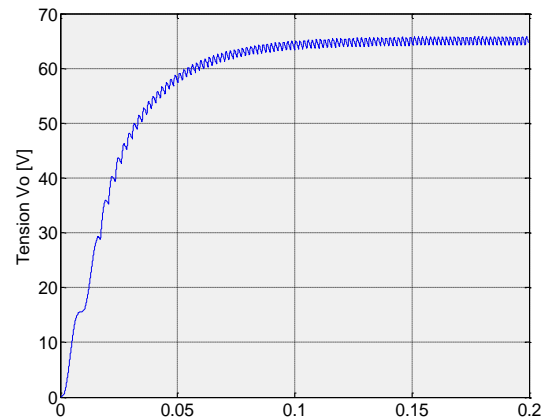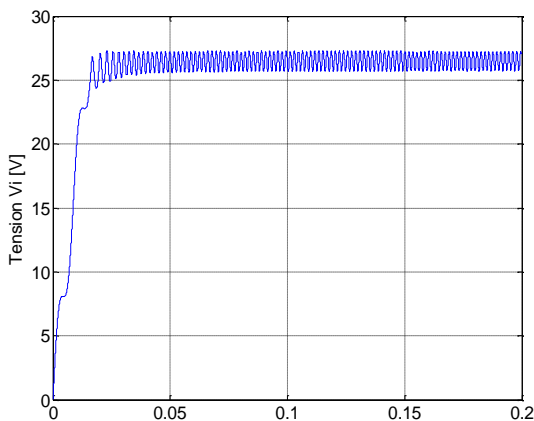**Fig -3:** Schema of Simulation GPV and boost chopper with MPPT.

Fig -4: Details of the waveforms of the input voltage, output voltage and the output power for a sampling frequency of 20KHz.

5- Control by Pulse Width Modulation (PWM)

The PWM control is to cut the output voltage generated by the converter into a series of elementary patterns with low period, and variable duty cycle in time. The temporal change of the duty cycle of each switch is then determined by a modulating signal which is selected generally sinusoidal. The control commands of each cell are generated by the intersection between a triangular carrier and the modulating signal. According to the strategy, it can be sampled synchronously with the triangular carrier, or directly compared. Each switch is switched at a rate imposed by the carrier[23]-[28].

The following figure illustrates the modeling of the PWM command in Matlab/Simulink.

6- CONCLUSION

The consumption of fossil energy is a major source of environmental degradation. The Photovoltaic can be used in various applications. This type of application can be installed on the roof of private homes (an average of 3 kW). There are also systems of larger size, up to several megawatts. And to obtain the best power transfer between the PV generator GPV and the load, we modeled the entire conversion chain in Matlab and the search algorithm of maximum power point tracking (MPPT) has been designed and simulated. It forces the GPV to work at its Maximum Power Point (MPP), leading to an overall improvement of performance of electrical conversion system. Although satisfactory for direct GPV-BTS connection, improved P & O algorithm may be necessary in the case of sudden changes of temperature and insolation.

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