Study of High Performing Standalone PV Generation System

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Abstract

This paper displays a specialized diagram of the immediate usage of solar radiation utilizing solar cell and examining about greatest extracting power from the solar system and changes over in to ac supplies with most extreme effectiveness and gives the steady and in addition unregulated sinusoidal inverter output changing climate conditions. The proposed system comprises of PV-system of 100KW, a DC to DC converter with MPPT control, bi-directional dc-dc converter, a battery, PWM inverter to supply the ac capacity to stack with Voltage and frequency control. Two types of control are proposed in this paper specifically the MPPT control for getting maximum and consistent power output from PV system and the second control is proposed in bi-directional dc-dc converter to guarantee the charging and discharging of thebattery.

Keywords: MPPT; Bi-directional dc-dc converter; P&O method; IC method; ANN; PWM inverter.

Introduction

Due to the weariness of petroleum derivative and environmental security causes, sustainable power source (e.g. wind energy, solar energy, tidal energy, geo-thermal energy and so many others.) has been comprehensively used from most recent twenty years [1]. Uncommonly, the Solar power has the absolutely free, no tainting, low help cost, appropriated through the earth, and no upheaval in light of not having any mechanical part. All in all, two sorts of solar ranch exist, which are characterized by their capacities and setup, specifically in particular independent power system and the power system related withsystem [2] to [5].The remain solitary solar homestead is possible for little power system while the matrix related solar homestead is attainable for high power application.

The power result from the PV system relies upon the Solar Irradiation and surrounding temperature and shifts accordingly with the variety of Solar Irradiation and encompassing temperature. MPPT is required to facilitate the PV output with the changing air conditions because the V-I characteristic of solar system is nonlinear in nature. Various techniques for control for MPPT have been produced[6].

This paper portrays about the independent PV system utilized as a part of independent applications. The three fundamental converters to be specific advance up dc-dc support converter, bi-directional dc-dc converter for charging/releasing of battery and dc-ac inverter must cooperate in a co-ordinate way to satisfy the nearby load, with high effectiveness output of the system. Capacities for the three converters are MPPT control, control of the dc connect voltage and ac voltage and its recurrence control independently. Speculative examination and reenactment results depict the colossal execution of the proposed control plans [12].

Proposed Solar System

The proposed standalone PV generation system is shown in figure-1. All components of this model and their simulation modeling are discussed one by one in this paper.

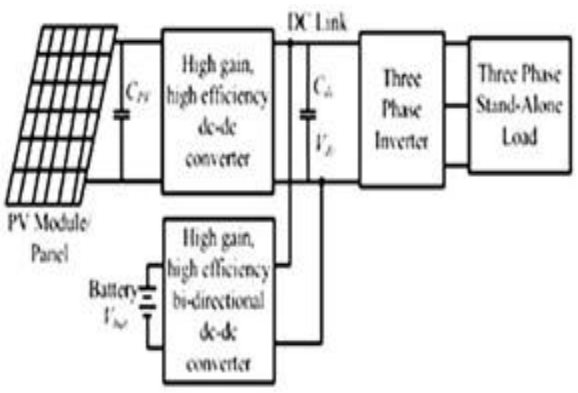

Figure -1

P-V ARRAY MODELING

The of single diode model characteristic equations are-

$$I = I_{lg} - I_{os} * \left[\exp\left\{q * \frac{V+I*R_s}{A*k*T}\right\} - 1\right] - \frac{V+I*R_s}{R_{sh}} [1]$$

$$I_{os} = I_{or} * \left(\frac{T}{T_r}\right)^3 * \left[\exp\left\{q * E_g * \frac{\frac{1}{T_r} - \frac{1}{T}}{A*k}\right\}\right] [2]$$

$$I_{lg} = \{I_{scr} + Ki\ (T - 25)\} * \lambda \quad [3]$$

The number of cell connected in series is called the string and the number of string connected in parallel is called module, and these number of series and parallel cell decides the characteristic equation of the PV array.

$$\mathrm{I} = \mathrm{Np} * \mathrm{Ilg} - \mathrm{NpIos}\left[\exp\left\{\mathrm{q}\frac{\frac{\mathrm{V}}{\mathrm{Ns}} + \mathrm{I}\frac{\mathrm{Rs}}{\mathrm{Np}}}{\mathrm{AkT}}\right\} - 1\right] - \frac{\mathrm{V}\left(\frac{\mathrm{Np}}{\mathrm{Ns}}\right) + \mathrm{IRs}}{\mathrm{Rsh}} [4]$$

Where

I_{lg}	Light – Generated Current
A	Ideality Factor
R_s	Series Resistance
R_{sh}	Shunt Resistance
γ	Solar Irradiance In W/M^2
K_i	S/C Current Temp Coefficient At I_{scr}
Q	Electron Charge .1.6*10^{-23} C
I_{scr}	Short Circuit Current At 25^0 Celsius
I	Cell Output Current
T	Cell Temperature In Celsius
E_g	Band Gap For Silicon
K	Botlzmann'sConstatnt, 1.38*10^{-19} J/K
T_r	Reference Temperature
I_{or}	Cell Saturation Current At Tr
I_{os}	Cell Reverse Saturation Current
V	Cell Output Voltage

MAXIMUM POWER POINT TRACKING (MPPT)

The Maximum Power Point Tracking (MPPT) is a method to extract the maximum power from PV array. The PV arrays behaves like a DC current source and generate the approximately constant current in a range of voltage but the value of voltage is suitable for output of PV array in which the multiplication of current and voltage is maximum and the value of voltage and current where this maximum power is gotten is taken as a output. The process to select only that point where maximum power is taken is called Maximum Power Point Tracking(MPPT).

Under this technique a DC to DC Boost converter is taken in series with PV array output. This converter is responsible to convert the uncontrolled DC generated by PV array to controlled DC. The various methods are used for MPPT. Perturbation & Observation (P&O) and Incremental Conduction (IC) Methods are very popular for MPPT. In this paper another method isused.

Artificial Neural Network (ANN) algorithm is used in these paper in which learning of neurons are done by 30000 samples of P&O methods and get a fast response and better output in compare to othertraditional methods like P&O.

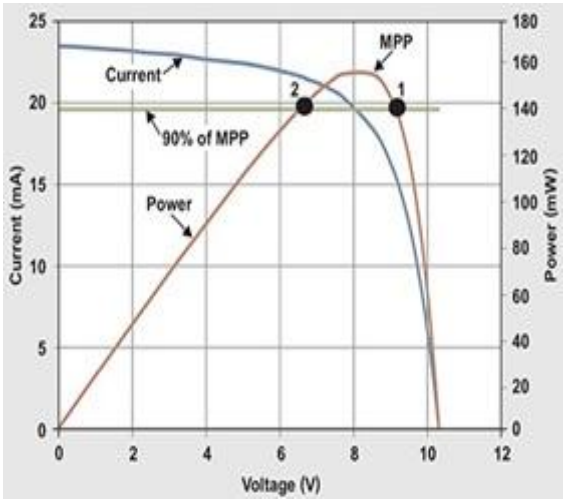

Figure -2

VARIOUS COMPONENTS OF MODEL

The first but main component is PV array which is capable to generate 100KW DC power by using solar irradiation.

The second component is DC to DC Boost converter. We have already discussed about this in previous. This is a converter which converts DC in usable form.

Inverter is another very important component of this model because this is a standalone model and both type of lode may be available and this inverter converts DC power into AC. A PWM inverter is used in this model.

Bi-Directional converter and a battery is also used in our model. Bi-directional converter is use for charging the battery during availability of solar energy and discharging the battery during non- availability of solarpower.

SIMULATION RESULT AND DISCUSSION

Figure shows the overall model of proposed system and the specified parameters are mentioned in the appendix. The simulation is carried out under variation of radiation and temperature in different time slot to analyze the proposed

system. The Simulink model of PV system and output wave forms are shown in following figures.

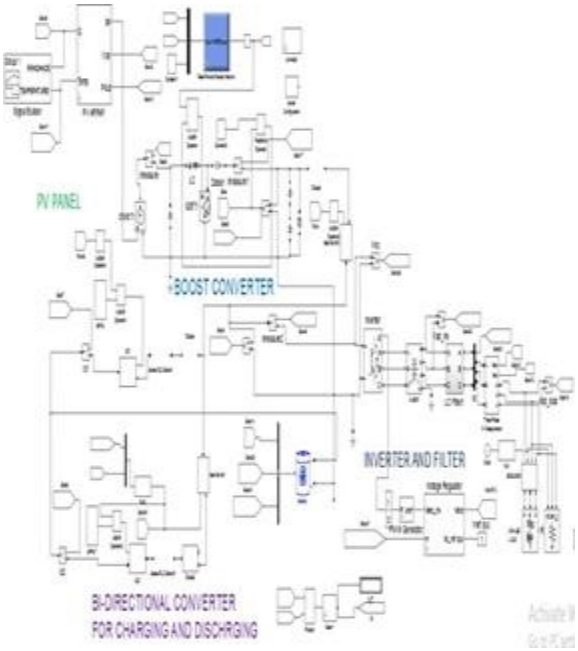

Figure -3

Case-1 Constant radiation and temperature

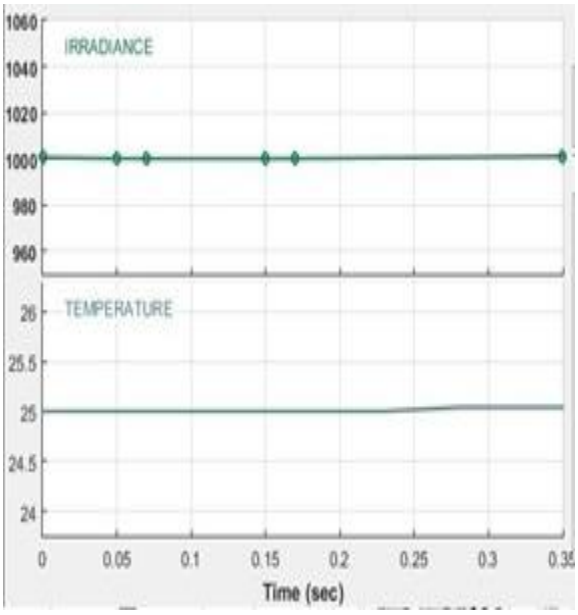

Figure -4 Output voltage, current and Powers

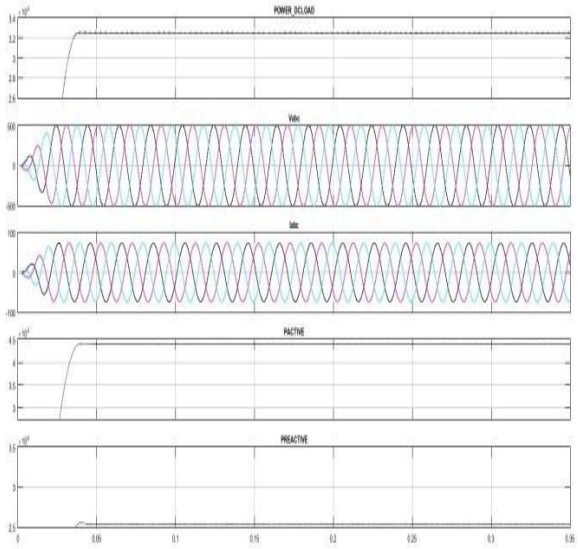

Figure -5

Presence of Harmonics in output

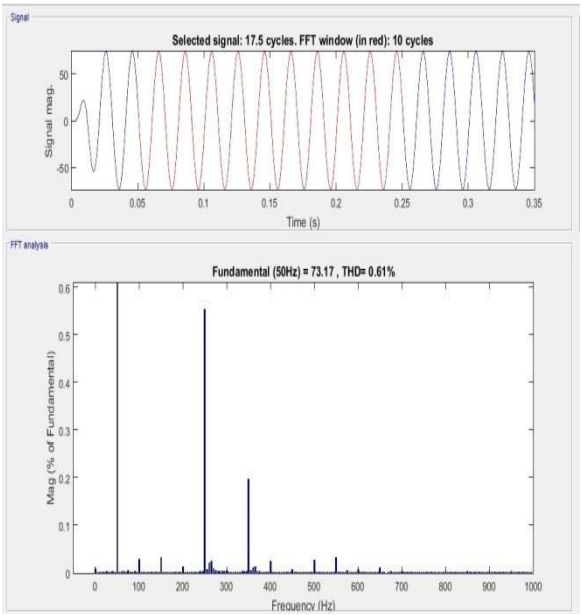

Figure -6

Case-2 Simulation start from t=0 and the value of radiation is 1000 W/m^2 and changes start from 0.05 sec to 0.17 sec. Variable radiation and temperature

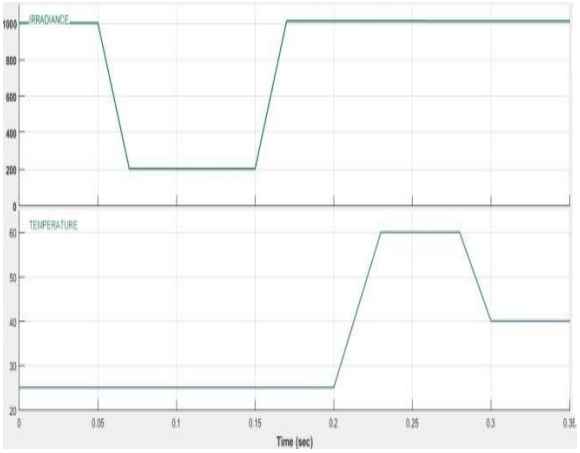

Figure -7

Output voltage, current and Powers

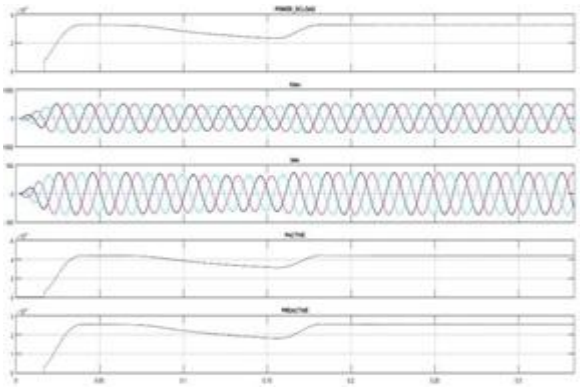

Figure -8

Presence of Harmonics in output during variable radiation

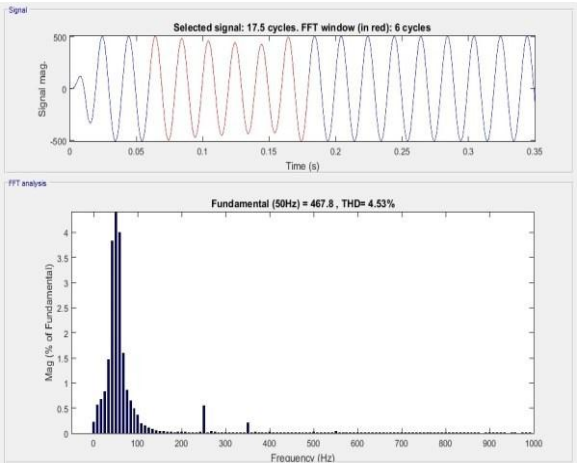

Figure -9

Presence of Harmonics in output during variable Temperature

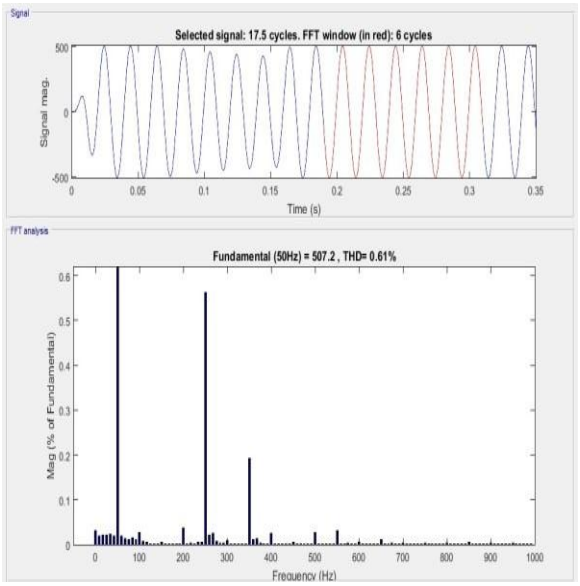

Figure -10

Conclusion

Due to be harmful for environment and its limited stock, the fusil fuel based electricity generation has to be limited and an alternative non-conventional power resource is needed. Solar power is a versatile power and available everywhere, but to extract the maximum power from solar energy and convert in to electrical power with maximum efficiency is still a challenge. In this paper, it is shown that a standalone power system is continuously powered with PV generation system by using a battery of sufficient capacity. Artificial neural network keeps the dc bus voltage constant and make it more efficient system during the sufficient availability of solar irradiant. The result shows that the output of the system is remain almost constant and the THD is under considerable value in allconditions.

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