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A Performance Analysis Of Microgrid Solar Photovoltaic System

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Abstract

Photovoltaics system need always new technology that improve the power quality of the system. Here in this paper use the new technology i.e. improve the control strategy for the photovoltaics system and connected with the grid. Because in transmission line connected with grid is difficult and complex task. Solar PV system connected with solar radiation whose nonlinear quantity. MPPT techniques one of the best techniques to control the photovoltaics system. Solar PV system implementing MPPT techniques to improve the quality of the system. Here, main part of the MPPT present and incremental conductance is one of the best techniques and new technique whose implement in the system. Consider system in proposed paper MPPT, boost converter, voltage source inverter, three phase filter, distribution system, load, grid and control system etc. Here to purpose to simulate the system is obtained the V-P curve and V-I curve characteristic under different irradiations and temperature and to analysis the dynamic behavior of the system. To improve the power quality of the system and total harmonic of the system in transmission line of the PV system who is connected with the micro grid.
Keywords: *Photovoltaic, MPPT, Incremental Conductance, VSI, DC-DC Boost Converter.*

1. INTRODUCTION

Energy is a very important role to fulfill the requirement of the person or population. Electricity energy generated from Fossil fuel. Non-renewable energy generates from fossil fuel and i.e. limited so that save the fossil fuel. Non-renewable energy generates pollution and noise. But renewable energy is clean and pollution free. Main renewable energy generated from biomass, geothermal, hydro, photo voltaic, wind, and etc. So that, in this paper represented solar PV system i.e. a renewable energy and it's provided clean and pollution free energy and last three decay, Solar PV system is more implement it in the world.

Solar energy generate the electrical energy and it is generated from irradiation. As know, solar photovoltaic energy has low maintenance so that it’s economically usable. Solar energy is noisy and pollution free. Solar PV panel are used to improve the power efficiency with power converter. For controlling the power controller use various type of controller in which maximum power point tracking technique one of the best techniques and to maximize the efficiency of the system MPPT techniques takes important role. Grid connected PV system take lot of advantage to the standalone PV system because standalone PV system does not connect to another system so that we need backup system here we need installed a battery for when solar system not working then cost of the system high. And other hand grid connected PV system does not required any type of backup because when solar system is not working then system can receive the supply from the grid system. That is an important role to implement with grid system. So that in this paper we consider without battery backup and it generate more efficiency. This grid connected PV system has been prepared in mat lab/Simulink software. The solar PV system has prepared of solar PV array, maximum power point tracking, incremental conductance, DC boost converter, voltage source inverter, LC filter to improvement of the power quality, harmonic present in the transmission line and load and grid

2. METHODOLOGY

(A). PV Array

The smallest part of the Photovoltaic system is solar cell. Only one cell cannot generate lots of power so that make a system that connected with series and parallel whose increase the power of the system. And combination of the solar cell is call PV modules (Photovoltaic Modules) or PV modules. These modules are connected in series and PV modules in parallel form Arrays. PV cell modelling [1] has been done by looking at single diode of PV cell. The basic diagrams and equations used for solar cell modelling have been considered. Based on the number of these equations have been modified total numbers of solar cells. Solar cell as shown in mathematical equation below.

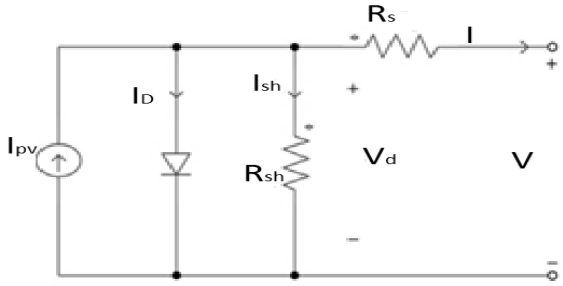

Fig 1. Schematic diagram of the Solar cell

Following fig 1 current equation can be drive as

$$I=I_{pv}-I_D-I_{sh} \tag{1}$$

Where, Total current generated from the solar cell and it's denoted by "I", photon current denoted as I rsub {pv}, diode current denoted as I_D and current flow denoted as "Ish" through shunt resistor R rsub {sh}.

For solar cell [1]:

$$I_D=I_0\left[\exp^{\left(\frac{V+IR_s}{aV_{th}}\right)}-1\right] \tag{2}$$

$$I_{sh}=\frac{V+IR_s}{R_{sh}} \tag{3}$$

Equation (1) can be written now,

$$I=I_{pv}-I_0\left[\exp^{\left(\frac{V+IR_s}{aV_{th}}\right)}-1\right]-\frac{V+IR_s}{R_{sh}} \tag{4}$$

Where, $\{I\}$ rsub $\{0\}$ isthe reverse saturation current, R rsub $\{s\}$ is the series of a PV cell and $\{R\}$ rsub {sh} is shunt resistance of a PV cell, diode ideally factor denoted as "a", and the thermal voltage denoted as V rsub {th}. It is given here.

$$V_{th}=\frac{KT}{q} \tag{5}$$

Where, Boltzmann constant denoted as "K" and its value 1.23 x 10^{-23} J/K, cell temperature denoted as "T", and the charge of an electron denoted as "q" and its value 1.6 x$10^{-19}C$.

Know the total number of solar-linked series N which is by solar module and numbers Series denoted as "Ns" and number of parallel denoted as "Np" connected solar panels, current equation for PV array is shown in mathematically:

$$I=N_pI_{pv}-N_pI_0\left[\exp\left(\frac{V+IR_s}{\frac{N_s}{aNV_{th}}}\right)-1\right]-\frac{V+IR_s}{R_{sh}} \tag{6}$$

(B). Maximum Power Point Tracking (MPPT)

There is a non-linear behavior of the irradiation in the solar PV array and at the dynamic condition of the weather, its production often changes. MPPT Technique helps PV modules provide maximum power over its output and improve the system efficiency. This insulated-gate bipolar transistor (IGBT) regulate the duty cycle as required of the switching which is used to enhance the power of the boost converter. This technique with internal regulator has been used to model MPPT. At maximum power point:

$$\frac{dP}{dV} = 0 \tag{7}$$

Now,

$$\frac{d(VxI)}{dV} = \frac{dV}{dV}xI + \frac{dI}{dV}xV = I + \frac{dI}{dV} = 0 \tag{8}$$

Hence,

$$\frac{dI}{dV} + \frac{I}{V} = 0 \tag{9}$$

MPPT technique shows that if $\frac{dI}{dV}$and $\frac{I}{V}$is zero. It means no change in duty cycle and If the sum of $\frac{dI}{dV}$and $\frac{I}{V}$is not zero, PI controller increase or decrease of the pulse as error and minimizes this error. The PI controller change the output pulse as get initially input signal. It is added to the initial value of duty cycle (D) as shown in Figure 3.

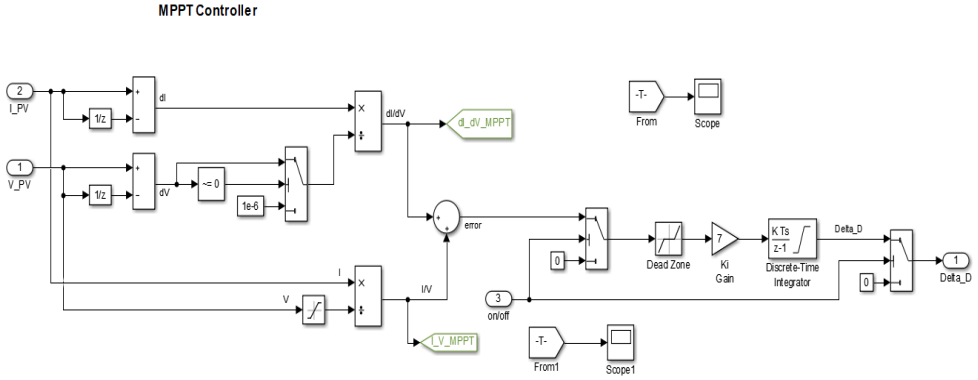

Fig 2. Maximum Power Point Tracking using Incremental Conduction

(C). Boost Converter: Used to promote and regulate a boost converter to enhance the power of the overall system and provide good efficiency. This model is draw with circuit diagram and mathematically shown in the Fig. 4. The DC to DC Boost Converter calculate below:

$$V_0 = \frac{V}{1 - D} \tag{10}$$

In the circuit was selected using the inductor and capacitor the following equation

$$L > \frac{VxD}{fx\Delta t} \tag{11}$$

$$C_1 = C_2 = \frac{V_{out}D}{2f\Delta V_{out}R_{load}} \tag{12}$$

Where, the output voltage denoted asV_0, the input voltage denoted as V, the duty cycle value denoted as D, the converter frequency denoted as f, current wave denoted as ΔI, capacitor capacitance

denoted as C_1 and C_2 output voltage ripple denoted as , ΔV_{out} and the load resistance denoted as R_{load} given V_{out}/I_{out} .

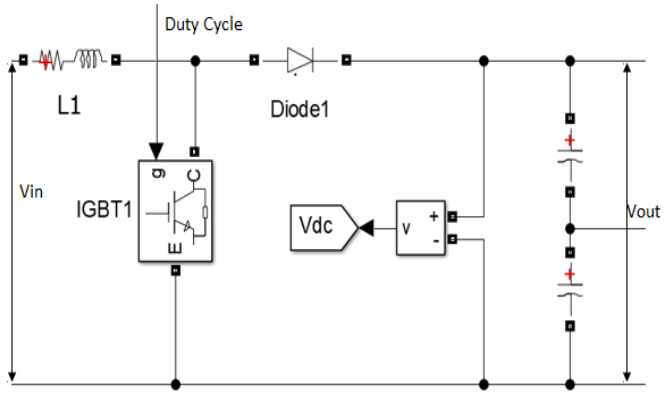

Fig 3. DC to DC Boost Converter Modelling

(D). DC to AC Converter:

DC has converted into AC. This type of converter can able to convert dc supply into three phase ac supply. So that, three phased three level VSI Used as shown in fig 4. Here, neutral is a common point need who's provided by the capacitors. The gate pulse of the inverter control by VSI controller.

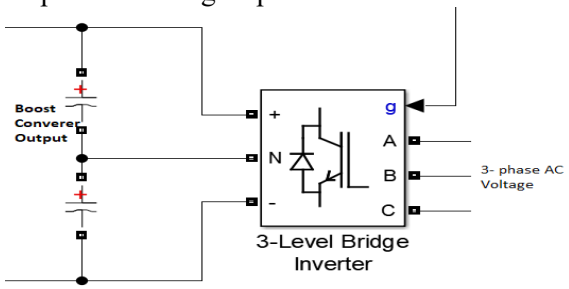

Fig 4. Simulink model Three Phase VSI Bridge Block

3. Simulation Results

This proposed system simulated on Mat lab/Simulink as shown in fig. 5. Here, Photovoltaic array has generated the maximum power and apply the maximum power generation use incremental technique (MPPT) technique. The proposed system categories into several part as Solar PV system, DC-DC boost converter, (incremental Conductance) maximum power point controller, voltage source inverter, transmission line, and grid have been designed. This PV system simulated at 33kV grid. This propose system has designed, the total power of the system is 100kW at 1000 W/m2 solar irradiance and maximum voltage generated about 310V.

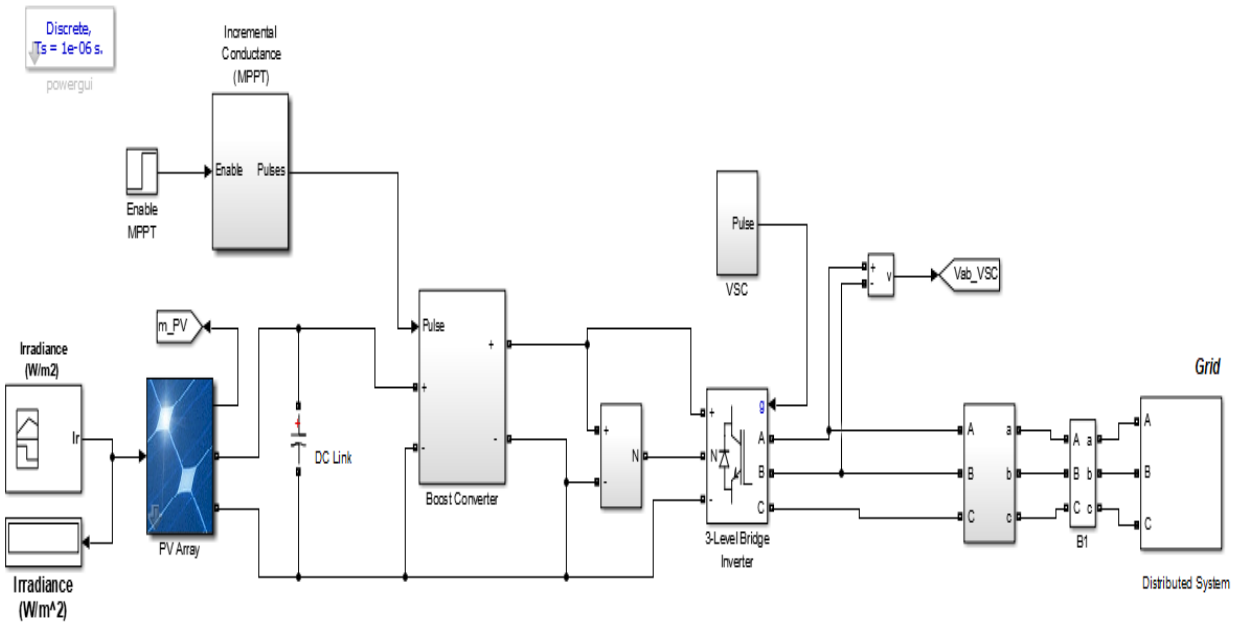

Fig 5. Grid connected Solar PV System

In this fig.6, current and voltage curve and also be find Power and voltage. Both curve has denoted as maximum output get at the solar PV panel. And as shown, in simple PV module, 6 amp current and 65 volts can draw on the 1kW/m^2 irradiance. And same as 305W power can draw in a single module

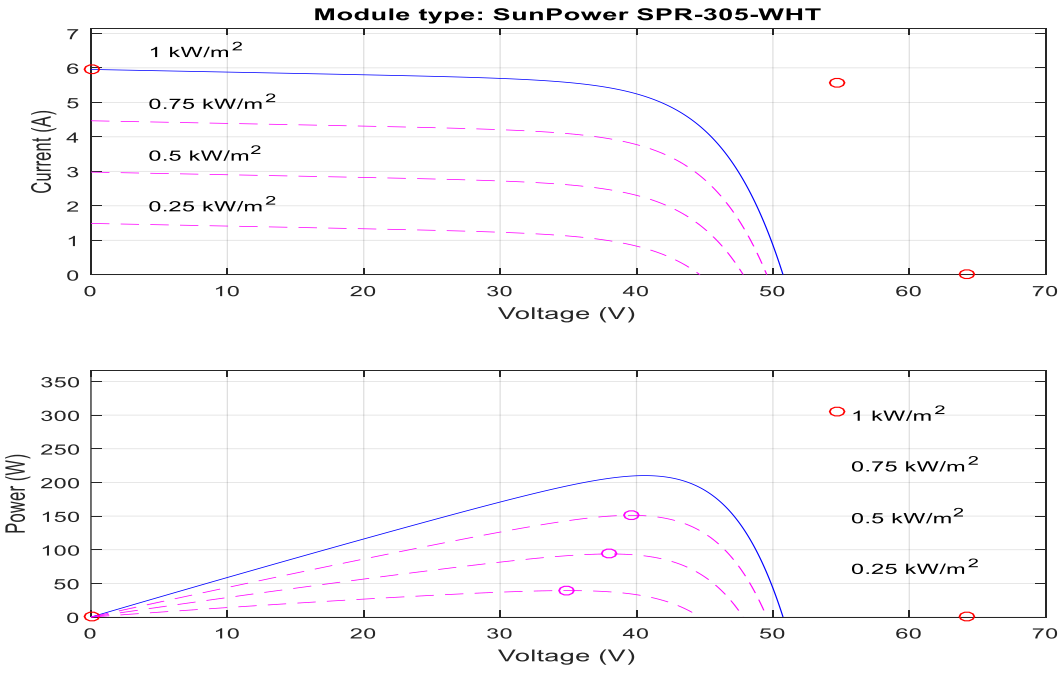

Fig.6. single module of I-V curve and P-V curve

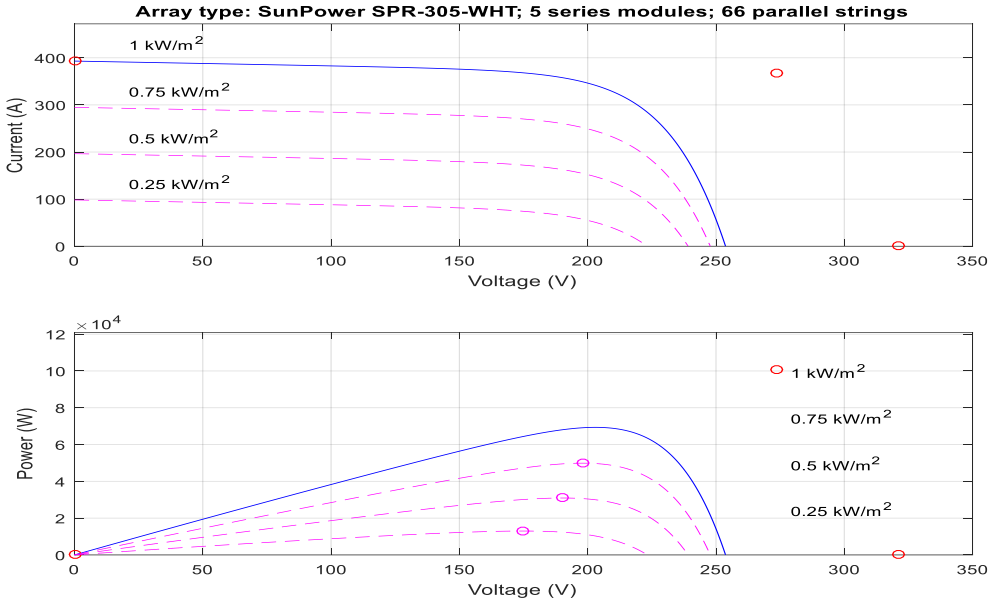

Fig. 7. Single module of I-V curve and PV curve

And in fig. 7, panel connected in series so that only increase voltage as shown figure. And as shown, in Array PV module, 4000 amp current and 280 volts can draw on the 1kW/m^2 irradiance. And same as 100kW power can draw in a single module but power should be increase as increase voltage.

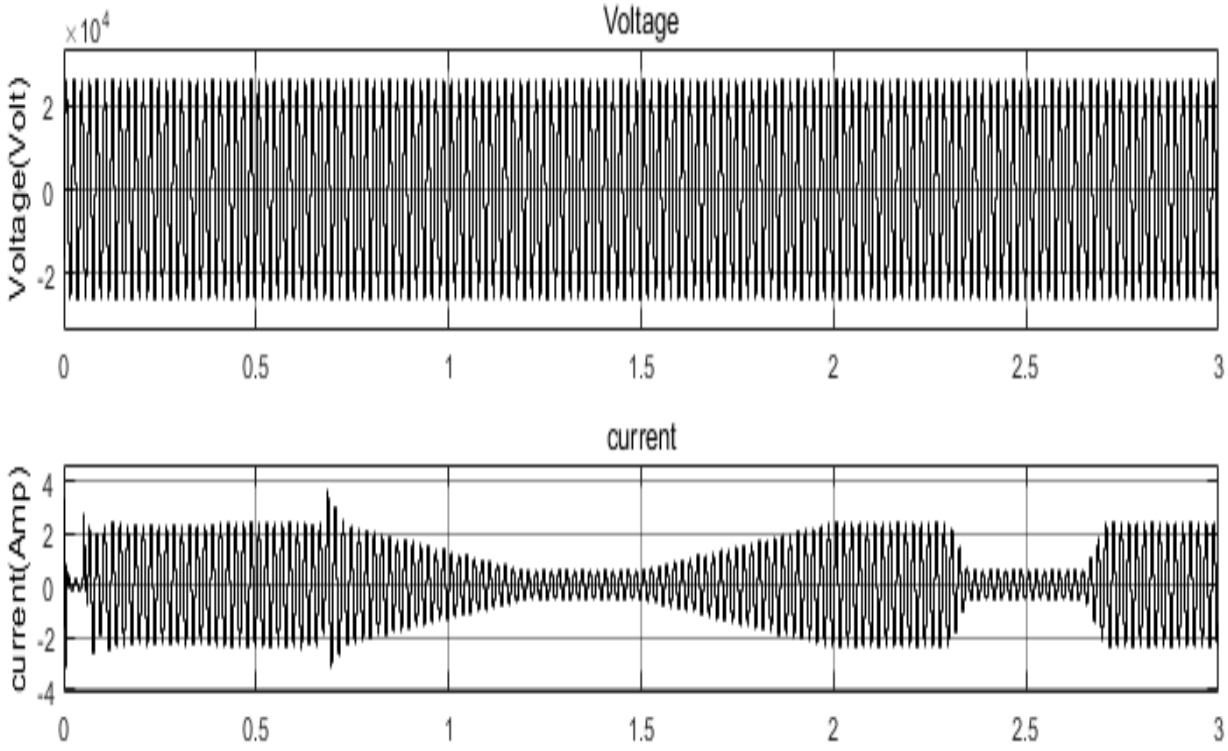

Fig. 8. Output of the Voltage and current of the system

As shown in fig 8. Voltage and current graph shown in which voltage stable but current vary at different condition because irradiance of the system should be varying at different point so that its value also vary. Fig.9 shows that three phase ac supply provide continuous signal at the grid. In first figure, single line shows without fluctuation voltage and second, single phase current shows due to change in radiation. Current is high at 0.7 S and 0.7 S to 1.2 S reduced the current and constant between 1.2 to 1.5 S, 1.5 to 2 S increase the current, 2 to 2.3 the value of system should be maximum. And instantly drop between 2.3 to 2.35 and go to the minimum voltage, 2.35 to 2.65 should be minimum power provide, and so on working shows and 2.7 to 3 S should be maximum as shows in fig 8.

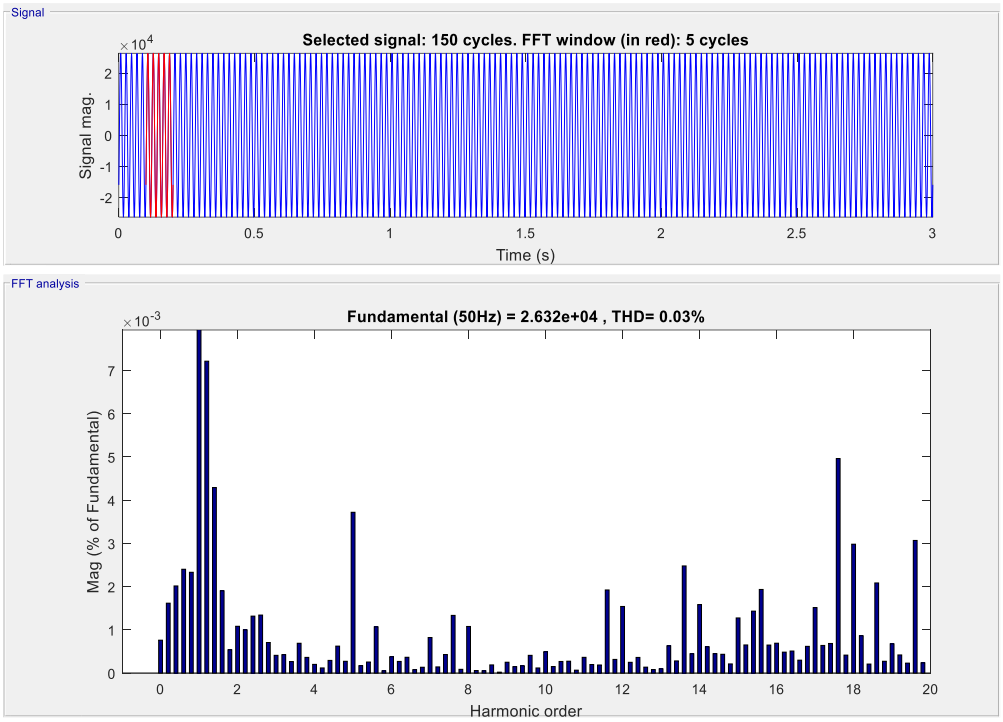

Fig.9. Total Hormonic Distortion window on Matlab Software

Shown in Fig 9. Total Hormonic Distortion is very low as shown. THD check the availability of the hormonic in the signal as consider five cycle in the signal and check the hormonic distortion of the system i.e. good and value rise 0.03%.

Conclusion

Solar Photovoltaic system connected with grid to need implement the suitable strategy to control the MPPT technique. In this paper, this proposed system simulated on Mat lab/Simulink. Here, PV array has generated the maximum power as shown in V-P and V-I graph and apply the maximum power generation use incremental technique (MPPT) technique. The proposed system categories into several part as Solar PV system, DC-DC boost converter, (incremental Conductance) maximum power point controller, voltage source inverter, transmission line, and grid have been designed. In the solar PV system discuss as the power quality and total harmonic system (THD) as shown in fig 9. In which THD value is 0.03%. And stability of the system is also good as shown in fig 8.

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