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SIMULATION RESULT ON VOLTAGE REGULATION OF SMALL POWER STAND ALONE SOLAR PHOTOVOLTAIC ENERGY SYSTEM

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[I] ABSTRACT: *This paper represents the analysis on, '**SIMULATION RESULT ON VOLTAGE REGULATION OF SMALL POWER STAND ALONE SOLAR PHOTOVOLTAIC ENERGY SYSTEM**'. Various results of standalone solar PV energy system are displayed. Outputs are at DC, Inverter & at AC ends. It is observed that at single phase it is 220Vac, 50 Hz (aprox).*

[II] KEYWORDS:
DC SOURCE (Battery), MPPT, PV, Filter Unit, Load.

[III]INTRODUCTION: Introduction of Simulation of the photovoltaic module result is realized with Simulink model. The simulation allows having the curve I-V and P-V characteristics.

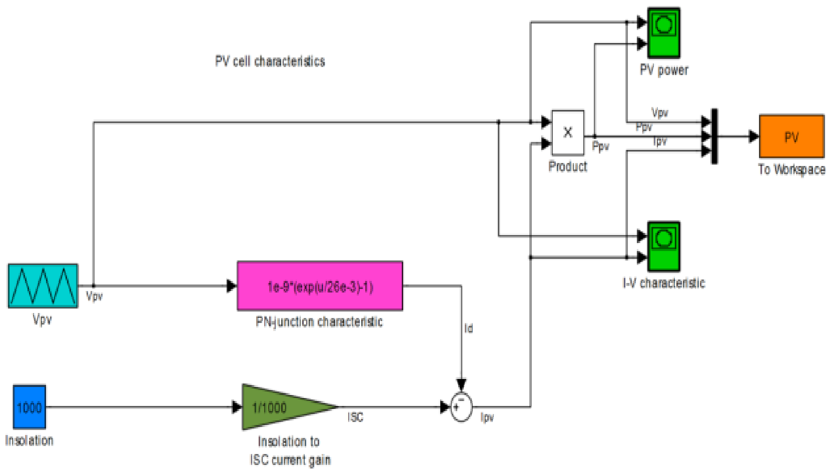


Fig. 1 Simulation of the PV module

Certain variables are modified for the application with maximum power point tracking. The input parameters required for the model are: The PV characteristics from data sheet are used to generate the file necessary for R_s, R_p and other parameters for the maximum power point. The initial setup is used to obtain the I-V curve characteristics of the PV array and show the maximum power point of the PV. The model of the PV is used with the boost converter to determine the performance of the maximum power point tracker.

The proposed system will consist of PV arrays, a step-up dc–dc converter, a grid-tie inverter (GTI) and an automatic AC transfer switch. PV arrays convert solar energy into electric energy. Step-up dc–dc converter boosts the array voltage to a higher level; the GTI inverts the DC power produced by the PV array into AC power aligned with the voltage and power quality requirements of the utility grid and the transfer switch changes supply source and also selects serving loads according to availability.

In normal condition, the system power up on-site electrical loads and serve energy to the grid if the system output is greater than the on-site demand. Net metering would allow the homeowner to sell energy back to government. But when the utility grid power is not available or when the utility voltage level or frequency goes beyond accepted limits, the system automatically disconnects the grid through an anti-islanding scheme. In this condition, existing battery less grid-tied PV systems do not serve the residential loads also. But in our proposed design it will supply residential loads during the grid failure or blackout for load shedding by an automatic AC transfer switch. This feature is indispensible considering the grid load shedding condition in state

Configuration of a typical grid-tied PV system is depicted below in figure

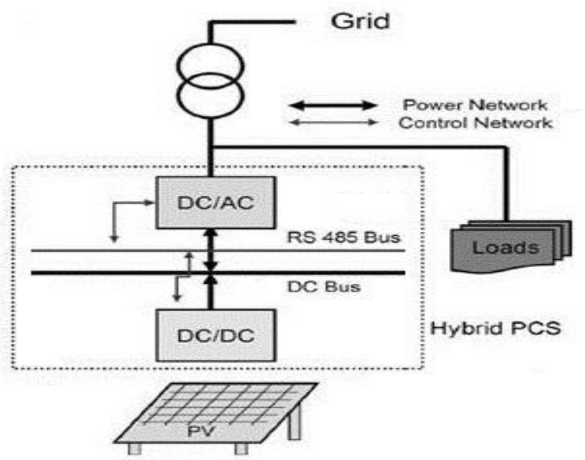


Fig. 2 Grid connected system

[IV] SIMULINK MODEL OF BOOST CONVERTER

Fig. 3 shows the Simulation of the boost converter. The input of the boost converter is the photovoltaic output voltage. The inductance and the capacitor need to be specified.

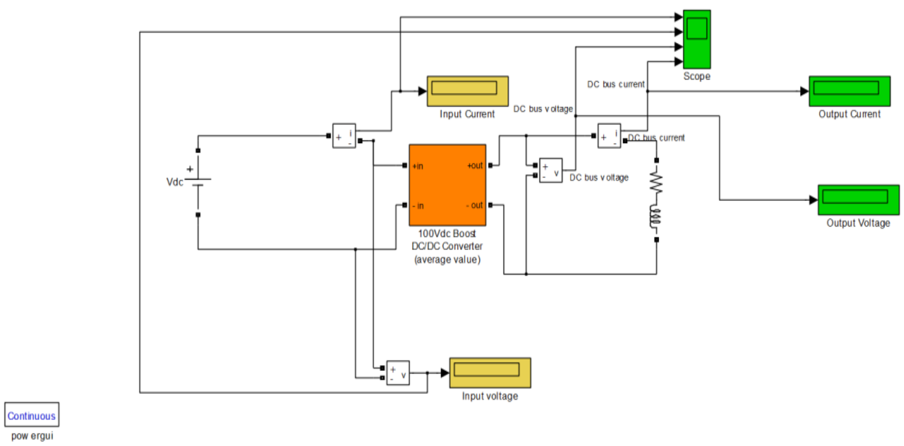


Fig. 3 Simulation of the DC-DC converter

The voltage and the current of the photovoltaic array are the input, and the duty cycle is the output. The duty cycle is compared to a triangle wave signal to generate the PWM. The frequency of the triangle wave is the pulsation frequency of the boost converter.

[V] SIMULINK MODEL OF THE PHOTOVOLTAIC SYSTEM WITH AC-DC-AC PWM CONVERTER

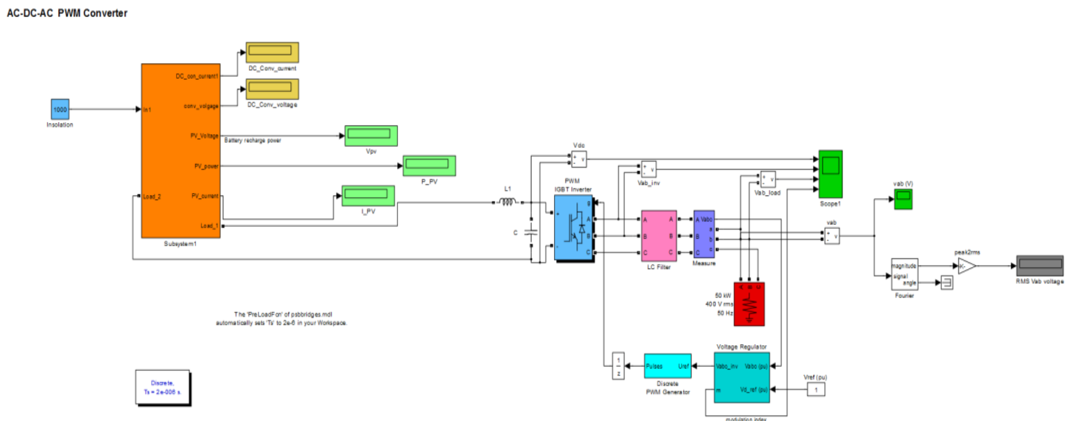


Fig. 4 Simulation of the PV system with boost and three-phase inverter

The PV system with three-phase inverter shown in Fig. 4 is used. The three-phase inverter has three-phase inductance filter and resistance load. An inverter block from Simulink is the three-phase inverter. The PV and boost, remain the same. The pulse generator produces the gating signal for the inverter block. The output voltage from the boost converter is the DC voltage for the three-phase inverter.

[VI] SIMULINK MODEL OF THE PHOTOVOLTAIC SYSTEM WITH MPP

The maximum power point controller block is shown in Fig. 5. The voltage and the current of the photovoltaic array are the input, and the duty cycle is the output.

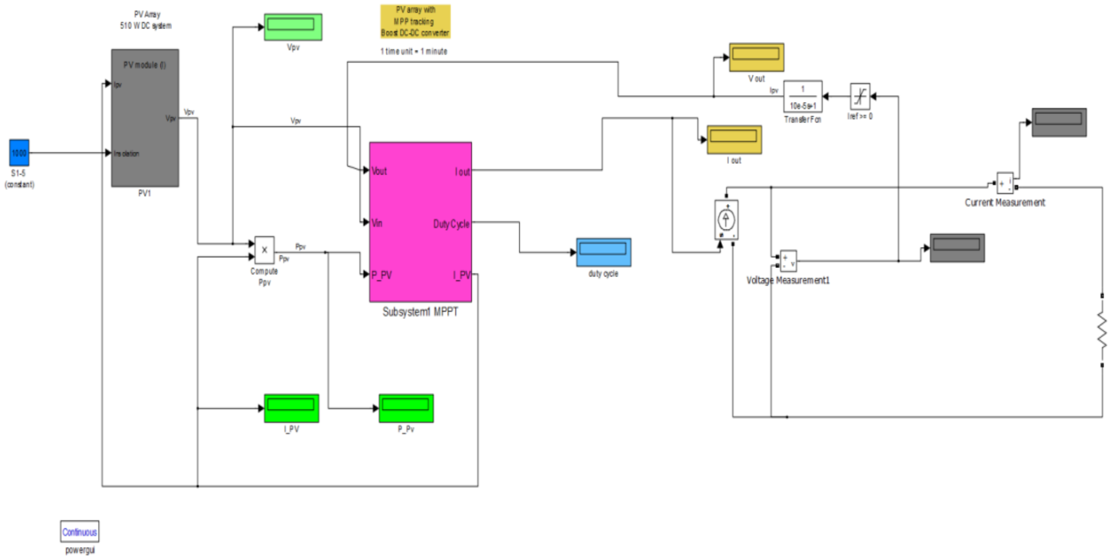


Fig. 5 Simulation of the PV system with MPPT

The duty cycle is compared to a triangle wave signal to generate the PWM. The frequency of the triangle wave is the pulsation frequency of the boost converter.

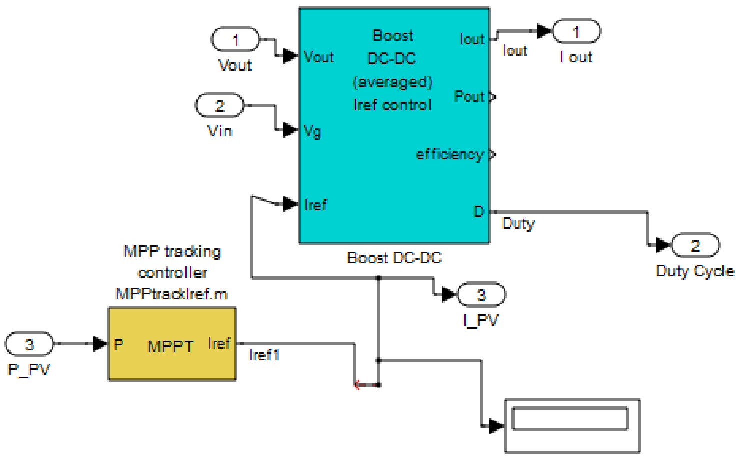


Fig. 6 Simulation of the DC to dc converter with MPPT

The perturb and observe algorithm is implemented and shown in Fig. 6. The duty cycle is increased or decreased until the maximum power point of the photovoltaic is reached. The step of the duty cycle is constant, and it determines the efficiency and accuracy of the MPPT controller.

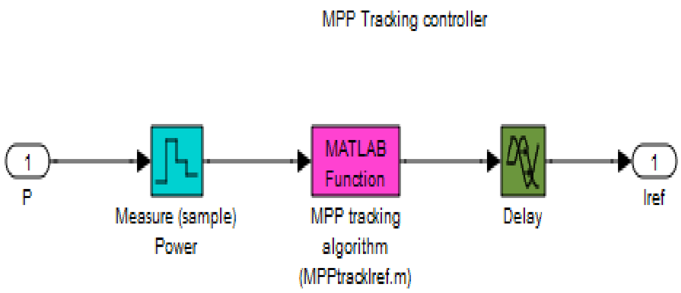


Fig. 7 Simulation of the perturb and observe algorithm

[VII] SIMULINK MODEL OF THE PHOTOVOLTAIC SYSTEM WITH MPPT AND BATTERY

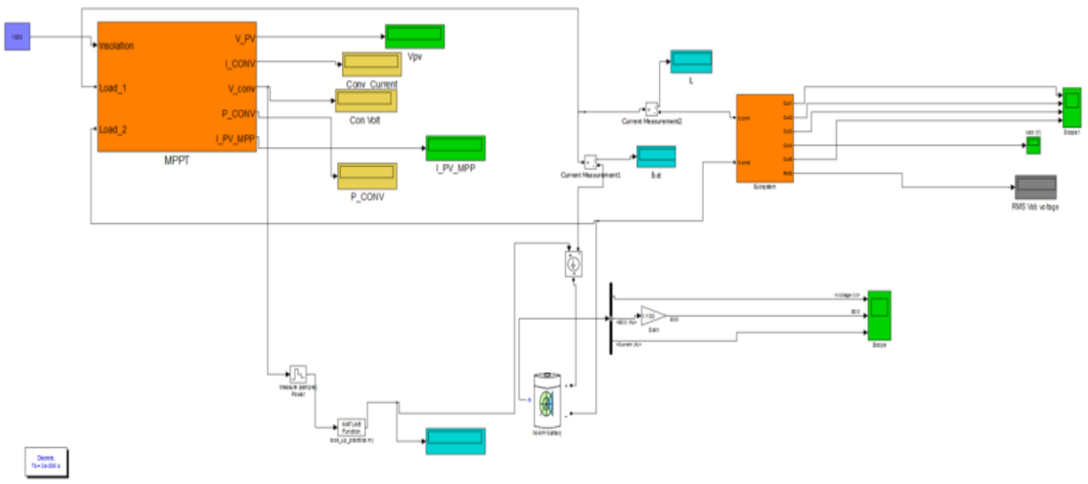


Fig. 8 Simulation of the PV system with MPPT and battery

The simulation of PV with MPPT and Battery is shown in Fig. 8 which is connected with the 50 KW load.

[VIII] SIMULINK MODEL OF GRID CONNECTED PHOTOVOLTAIC SYSTEM

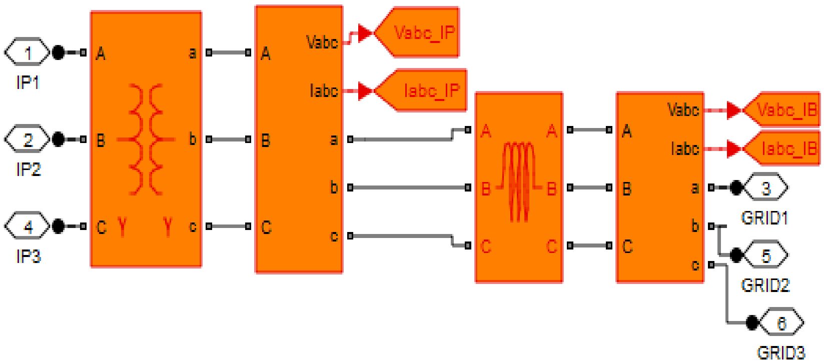


Fig. 9 interconnection between grid and inverter

Figure shows the interconnection between grid and inverter. Here transformer used for the

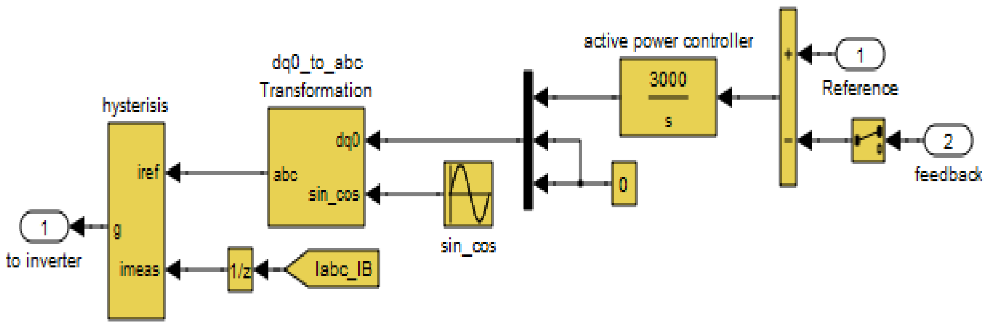


Fig. 10 Grid synchronizing

The simulation model of Grid connected Photovoltaic system is shown in Figure The three-phase inverter has three-phase inductance filter and resistance load. An inverter block from Simulink is the three-phase inverter. The PV, boost and MPPT, remain the same. The pulse generator produces the gating signal for the inverter block. The output voltage from the boost converter is the DC voltage for the three-phase inverter.

[IX] SIMULATION RESULT OF THE PHOTOVOLTAIC SYSTEM USING MATLAB / SIMULINK

Simulation result of photovoltaic system

The model of the photovoltaic system in the previous chapter is used to determine the performance of the MPPT controller with boost converter. This simulation presents an analysis of the photovoltaic array with boost converter and resistive load. The temperature, irradiance and load, are varied to determine the performance of the MPPT and track the maximum power of the PV. The major component of Grid-tied PV system is the GTI which along with regulating the voltage and current received from solar panels ensures that the power supply is in phase with the grid power. On AC side, it keeps the sinusoidal output synchronized to the grid frequency (nominally 50Hz). The voltage of the inverter output needs to be variable and a touch higher than the grid voltage to enable current to supply the loads in the house or even supplies excess power to the utility.

Photovoltaic array characteristics

The I-V and P-V characteristics of single cell

Fig shows the I-V and P-V characteristics and table shows the maximum power point of the single cell at the different insolation.

1000W/m^2

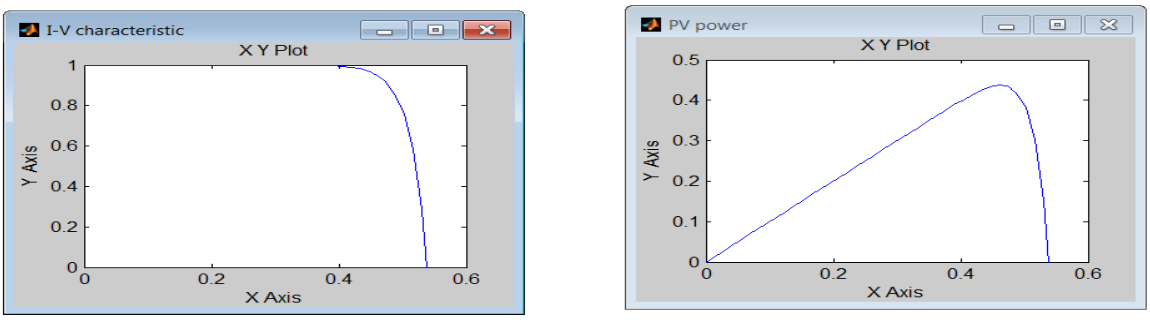


Fig. 11 I-V curve and P-V curve of the BP MSX 120 module

800W/m^2

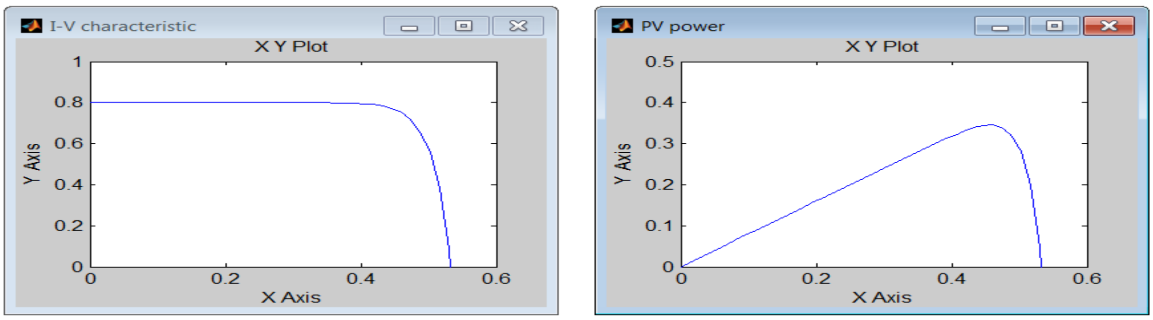


Fig. 12 I-V curve and P-V curve of the BP MSX 120 module

600W/m^2

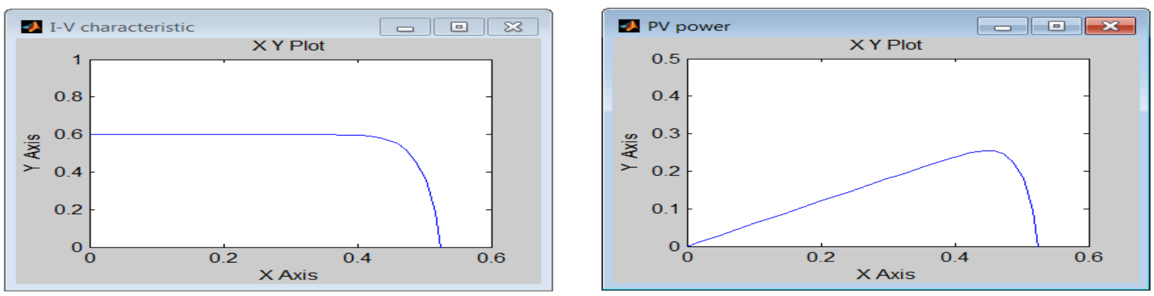


Fig. 13 I-V curve and P-V curve of the BP MSX 120 module

TABLE 1
PHOTOVOLTAIC MODULE MAXIMUM POWER POINT VALUES
AT 1000, 800 & 600W/M^2

Ratting	MPP power	MPP Voltage	MPP Current
1000W/m^2	0.4378	0.46	0.9517
800W/m^2	0.3458	0.46	0.7517
600W/m^2	0.255	0.446	0.5718

The photovoltaic model used is the NE-80EJEA. It has a maximum power output 80 W. The table 1gives the characteristic of the module NE-80EJEA at STC 25C.

Photovoltaic connected to a three-phase inverter

In this simulation, the output of the boost converter is connected to the three-phase inverter and the three-phase resistive load. The simulation model in Fig. 12 is used to simulate the three-phase photovoltaic system with 10 Ω resistive loads on each phase. The carrier frequency is set at 2 kHz and the sampling time is 2 e-6 s [23]. The three-phase inverter delivers a three-phase current to the load. Fig. 13 shows a sinusoidal load voltage for phase a. The DC voltage produced by the photovoltaic system is converted into AC current to the load for Vab & Vdc.

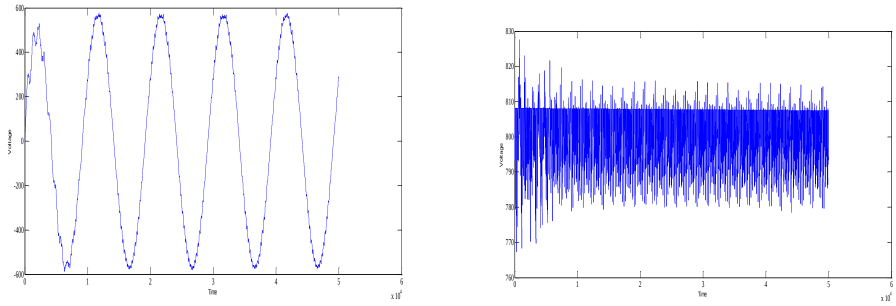


Fig. 14 sinusoidal load voltage (Vab & Vdc)

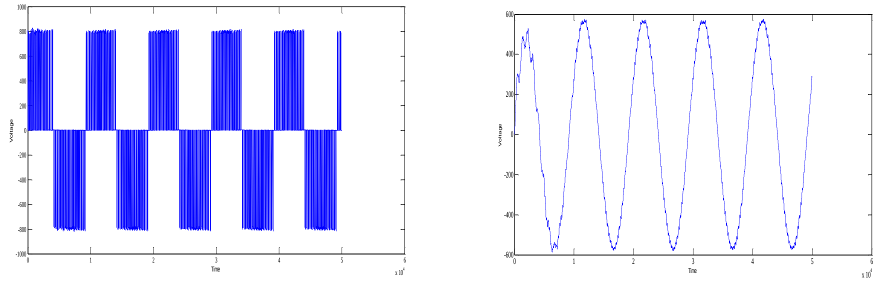


Fig. 15 (a) Vab Inverter (b)_Vab load

Fig. 14 shows a V_{dc}, V_{ab}, sinusoidal load voltage for V_{ab} and modulation index. The DC voltage produced by the photovoltaic system is converted into AC current to the load.

Fig. 15 is the photovoltaic voltage, inverter voltage, load voltage, modulation index. Without the current control and the voltage control, the DC link voltage is not constant. The voltage of the DC link is dependent of the load. Table 2 shows the result of the photovoltaic system connected to the load

TABLE 2

PARAMETERS OF 26 KW PHOTOVOLTAIC SYSTEMS

DATA	VALUE	DATA	VALUE
Insolation	1000	I_{sc}	43.6
Dc connected current	63.86	V_{oc}	888
Dc connected voltage	773.30	I_{pm}	39.6
V_{pv}	753.7	V_{pm}	704
I_{pv}	64.49	L	200*e-6 H
P_{pv}	26.83kw	C	5000*e-6 F

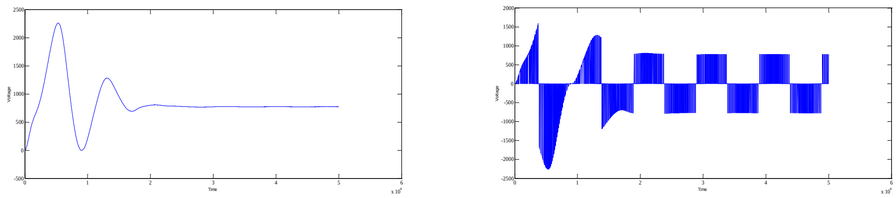


Fig. 16 Vdc Vab Inverter

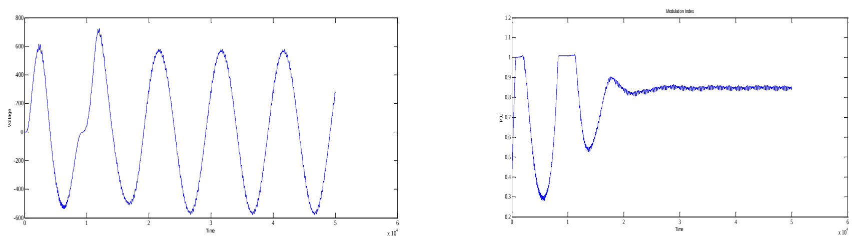


Fig. 17 Vab Load Modulation Index

PV system connected with load including MPPT

In fig 16 shows the simulation model of maximum power point controller with PV system. The result of simulation is shown below.

TABLE 3
READING OF V, I, P, &D

INSOLATION	RESISTANT	V_{PV}	I_{PV}	P_{PV}	DUTY CYCLE	V_{OUT}	I_{OUT}
1000	25	105.1	4.85	509.5	0.07679	111.2	4.448
	50	105.1	4.85	509.5	0.3158	150	3.288
	75	105.1	4.85	509.5	0.3158	150	3.288
	100	105.1	4.85	509.5	0.3158	150	3.288
800	25	106.5	3.85	409.9	0.012	95.48	3.82
	50	106.5	3.85	409.5	0.2591	141.1	2.822
	75	106.5	3.85	409.5	0.3029	150	2.654
	100	106.5	3.85	409.5	0.3031	150	2.653
500	25	37.53	2.65	99.45	0.2764	50.03	1.888
	50	37.53	2.65	99.45	0.4717	68.53	1.37
	75	37.53	2.65	99.45	0.5675	83.71	1.116
	100	37.53	2.65	99.45	0.6247	96.46	0.9645

From above table we show that, when we change the value of resistance, there is no effect on voltage, current and power.

Grid connected PV system

The simulation model of grid connected PV system. The result of simulation is shown below.12

TABLE 4
READING OF GRID CONNECTED SYSTEM AT DIFFERENT INSOLATION

INSOLATION	V_{PV}	CONVERTER CURRENT	CONVERTER VOLT	CONVERTER POWER	I_{PV} MPP	V_{dc}
1000	856.4	66.72	955.3	6.68*10000	78	955.3
800	849.4	58.48	881	5.351*10000	63	881
500	846.8	38.57	618.1	3.269*10000	38.6	618.3

Now the waveform shows the voltage, current, active and reactive power, terminal voltage and V_{abc} at input side and infinity bus, I_{abc} at infinite bus.

Insolation at 1000 W/m^2

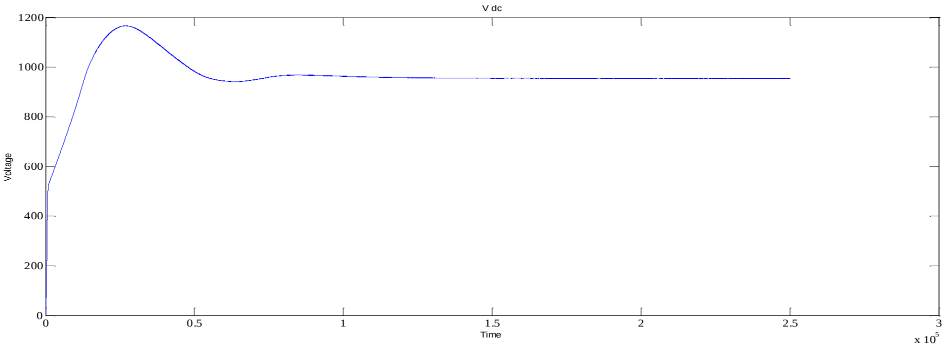


Fig. 18 Vdc

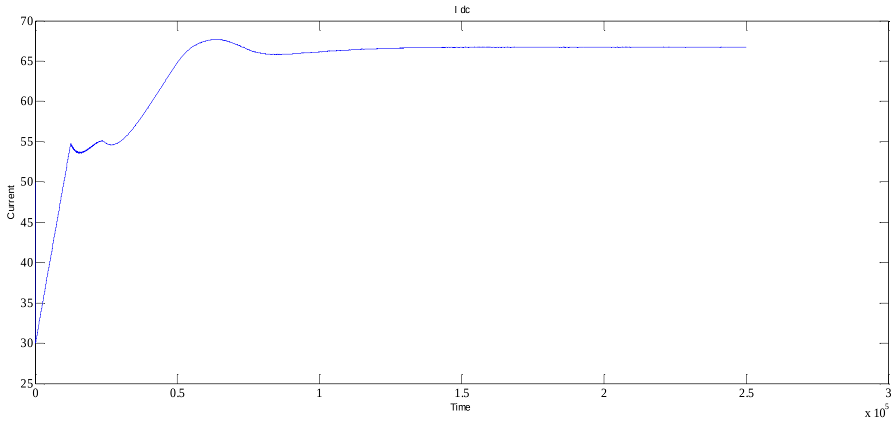
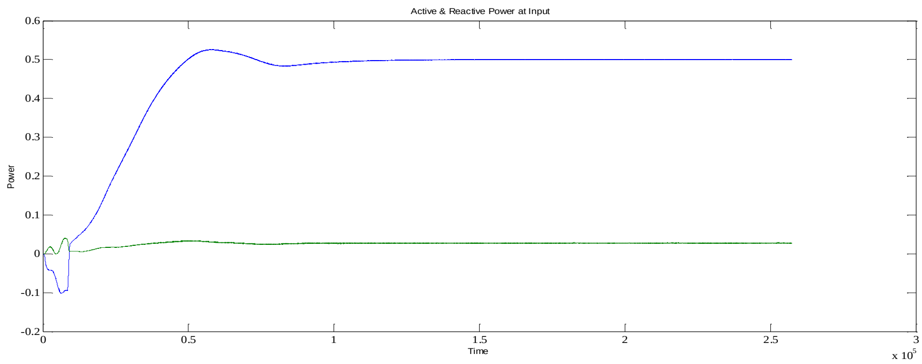


Fig. 19 waveform of DC bus I dc

Active & Reactive power (I/P)



Active & Reactive power (I/B)

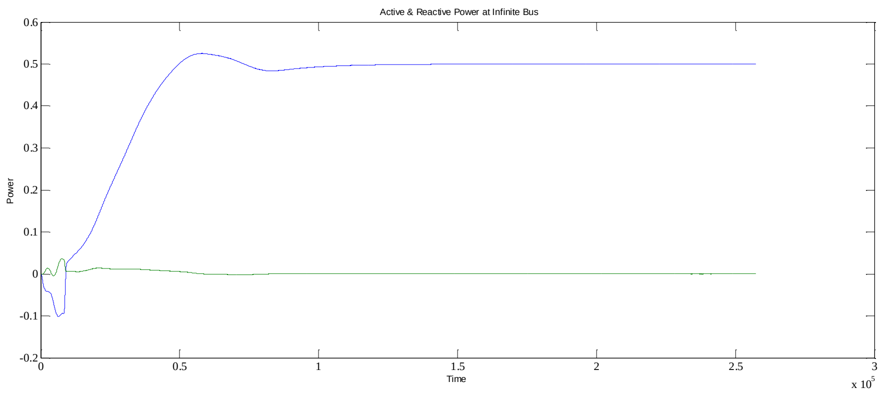
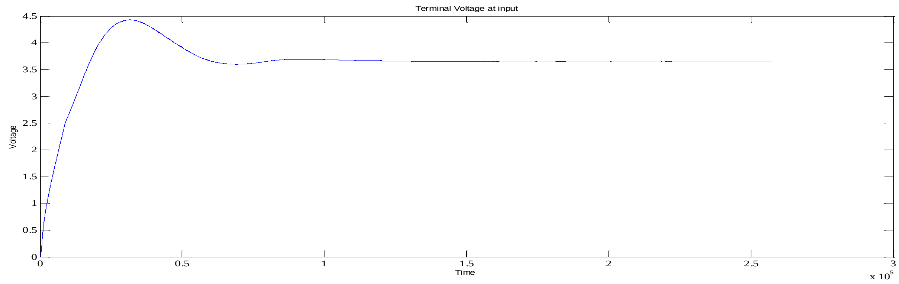


Fig. 20: waveform of active and reactive power

Terminal Voltage (I/P)



Terminal Voltage (I/B)

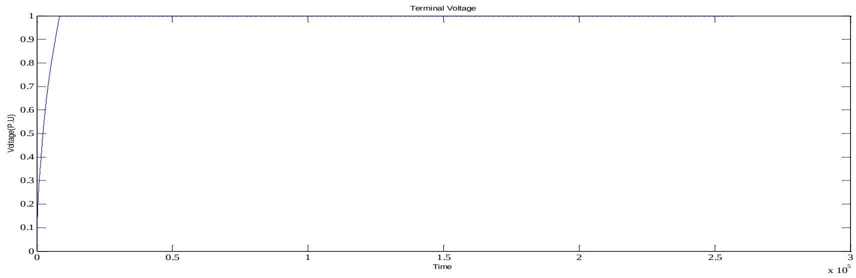
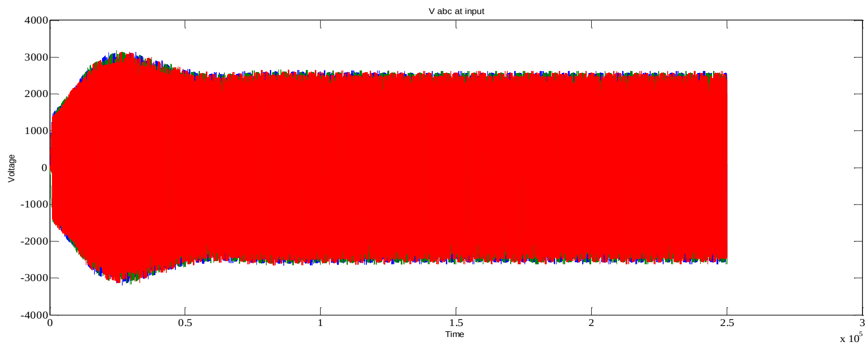
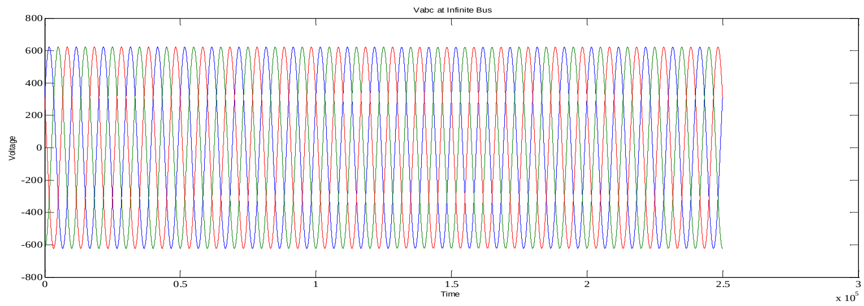


Fig. 21: waveform of terminal voltage

Vabc (I/P)



Vabc (I/B)



Iabc (I/B)

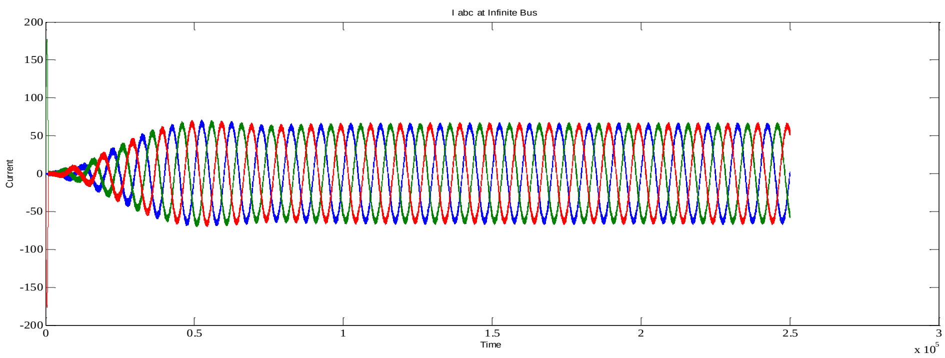


Fig. 22: waveform of V_{abc} and I_{abc}

Similarly for Insolation at 800 W/m^2 & 600 W/m^2

[X] CONCLUSION

In this paper, the study of the photovoltaic system with maximum power point controller has been developed. From the theory of the photovoltaic, a mathematic model of the PV has been presented. Then, the photovoltaic system with DC-DC boost converter; maximum power point controller and resistive load have been designed. Finally, the system has been simulated with Simulink /MATLAB. Results are very close to practical one.

[XI]FUTURE RESEARCH

The proposed topology may be further implemented with Hybrid system. A fully digitized implementation of the proposed system can be carried out through the development of programmable Hybrid system. We can develop a master grid to excess of energy, connected with the different sources.

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