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Design and Simulation of Solar PV module in Mat lab Simulink

Smruti Ranjan Nayak, Sr Lecturer Dept. ECE/RE, CUTM, Bhubaneswar, India

smrutiranjan@cutm.ac.in

Abstract **It's a worth saying that after a few years we must put ourselves deeply into the crises of artificial energy. So to overcome we should go for an innovation towards natural energy sources from nature which is at our doorstep. Nothing to say only the renewable energy can fulfill our demand one of which solar energy is almost all known to everyone. A physical design of a solar PV module may be a hard task but not impossible. Still before going to do such a job it can be designed and tested in different conditions like temperature, irradiance tilt angle, latitude etc. by Mat Lab R2016a in Simulink as well as script file .This paper just only have a fundamental idea how to design a PV module with the cells parallel and series connection to help physical design easy.**

Keywords: -Sustainable Energy, Solar Photovoltaic System, Subsystem.

I. INTRODUCTION

Since from the beginning of generation, people have acquainted with the sun. Ancient people used to worship Sun as their God. Throughout history of mythology, farming and agriculture efforts, cure from disease have relied upon the sun's rays. Only recently however, have we developed the ability to harness the sun's awesome power. The resulting technologies have promising implications for the future of renewable energy and sustainability. Renewable energy sources have lately acquired a prominent place in energy policy decisions of countries all over the world, prompted by the hike of petroleum product.

II. HISTORY OF SOLAR CELLS

The development of solar cells started 140 years ago .In 1839 Becqerel observed some voltage developed when light fell on an electrode in an electrolyte[1].Around 1880 Adams and Day discovered a similar effect in selenium . By the end 1958 the efficiency of solar cells reached the 14% .In the year 1954 cadmium sulfide and cupper sulfide with hetro junction that gone for efficiency another 6 % hike [4].

III. AN OVERVIEW OF SOLAR PHOTOVOLATIC TECHNOLOGY

The connection of SPV is either series or parallel according to the desired requirement .Solar cells are the basic units of SPV arrays and diode generating electricity when illuminated by light .The output of solar cells, in terms of current, voltage and power varies according to radiation, temperature, tilt angle etc. The first generation of solar cell is Crystalline silicon solar cells .It has the efficiency. Amorphous is the second generation known as thin film technology efficiency range from 5-10%.[1]

IV. TYPES OF SOLAR CELLS ACCORDING TO DOPPING

Basically they are four types.

A: Homojunctions-Here the materials are same for both n and p dopped types that made for junction eg. N-type and P-type silicon.

B-Heterojunctions-The n-type and p- type materials that formed the junction are different in this case .Cadmium sulfide and cupper sulfide are two materials that can be cited for this purpose.

C-Heteroface structure-This type is little bit different. When a p-n junction consists of a semiconductor of band gap E_{g1}similar to homojunction at that time the window layer has another material of larger band gap E_{g2} .This helps to reduce loss of charges.[2]

D-Scottely Barrier cell.-This has a metal semiconductor junction where the depletion region is entirely inside the latter.

V.TYPES OF PHOTOVOLTIC MODULE

Figure-1

Figure-1: Examples of Different types of Solar cells

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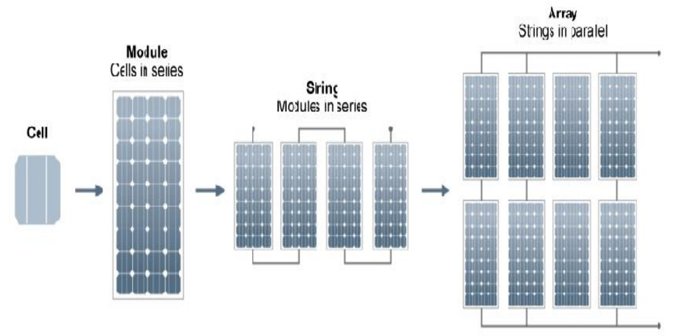

Figure-2

Figure-2: Concept of Cell, Module, String, Array with series and Parallel Connections.

VI-PV MODULE SPECIFICATION

A-Electrical Data at 1000 w/m^2 at 25^{0}C

1.	Rated power at STC	125 w_p to 150 w_p
2.	Module efficiency at STC	13.3%-11.3%
3.	Open circuit voltage –V_{oc}	43.24V to 43.42V
4.	Short circuit current -I_{sc}	3.73A-4.78A
5.	Rated Voltage V_{mpp}	35.64V-35.82V
6.	Rated Current I_{mpp}	3.55A-4.26A

B-Electrical Data at 800 w/m^2 at 25^{0}C

1.	Rated power at STC	101.3 w_p to 121.5 w_p
2.	Module efficiency at STC	13.3%-11.3%
3.	Open circuit voltage –V_{oc}	42.79V to 43.01V
4.	Short circuit current -I_{sc}	3.00A-3.60A
5.	Rated Voltage V_{mpp}	35.77V-35.95V
6.	Rated Current I_{mpp}	2.86A-3.44A

C-Operating Condition

1.	Temperature range	-40^{0}c-85^{0}c
2.	Maximum Voltage	600Vdc
3.	Maximum reverse current	10A
4.	Maximum surface load capacity	550kg/m^2

D-Mechanical structure

1.	No of cells	72
2.	Cell type	Polycrystalline
3.	Dimension of module	988*952 mm to1340*991mm
4.	Mounting Dimension	956*635 mm to 949*491 mm

VII.SOLAR ENERGY TERMINOLOGY

1. Intensity of solar Radiation-W/m^2
2. Solar Energy received by earth surface-kWh/m^2/year
3. Standard sun shine hours-(kWh/m^2)/day or (kWh/m^2)/year

VIII.SOLAR ARRAY PARAMETERS

VOC = open-circuit voltage: – This is the maximum voltage that the array provides when the terminals are not connected to any load (an open circuit condition). This value is much higher than Vmp which relates to the operation of the PV array which is fixed by the load. This value depends upon the number of PV panels connected together in series.

ISC = short-circuit current – The maximum current provided by the PV array when the output connectors are shorted together (a short circuit condition). This value is much higher than Imp which relates to the normal operating circuit current.

MPP = maximum power point – This relates to the point where the power supplied by the array that is connected to the load (batteries, inverters) is at its maximum value, where MPP = Imp x Vmp. The maximum power point of a photovoltaic array is measured in Watts (W) or peak Watts (Wp).

FF = fill factor – The fill factor is the relationship between the maximum power that the array can actually provide under normal operating conditions and the product of the open-circuit voltage times the short-circuit current, (Voc x Isc) This fill factor value gives an idea of the quality of the array and the closer the fill factor is to 1 (unity), the more power the array can provide. Typical values are between 0.7 and 0.8.

%eff = percent efficiency – The efficiency of a photovoltaic array is the ratio between the maximum electrical power that the array can produce compared to the amount of solar irradiance hitting the array. The efficiency of a typical solar array is normally low at around 10-12%, depending on the type of cells (monocrystalline, polycrystalline, amorphous or thin film) being used.

IX.SOLAR CELL I-V CHARACTERISTIC

Solar Cell I-V Characteristic Curves show the current and voltage (I-V) characteristics of a particular photovoltaic (PV) cell, module or array giving a detailed description of its solar energy conversion ability and efficiency

Photovoltaic solar cells convert the suns radiant light directly into electricity. With increasing demand for a clean energy source and the sun's potential as a free energy source, has made solar energy conversion as part of a mixture of renewable energy sources increasingly important. As a result, the demand for efficient solar cells, which convert sunlight directly into electricity, is growing faster than ever before.

Photovoltaic (PV) cells are made almost entirely from silicon that has been processed into an extremely pure crystalline form that absorbs the photons from sunlight and then releases them as electrons, electric current to flow when the photoconductive cell is connected to an external load.

The main electrical characteristics of a PV cell or module are summarized in the relationship between the current and voltage produced on a typical solar cell I-V characteristics

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curve. The intensity of the solar radiation (insolation) that hits the cell controls the current (I), while the increase in the temperature of the solar cell reduces its voltage (V).

Solar cells produce direct current (DC) electricity and current time's voltage equals power, so we can create solar cell I-V curves representing the current versus the voltage for a photovoltaic device.

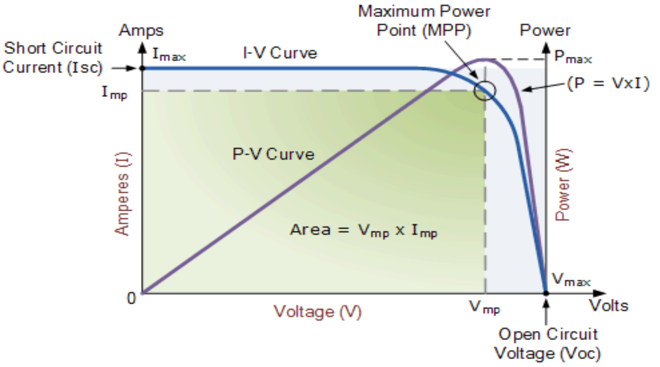


Figure-3:Maximum Power Tracking by I_{mp} & V_{mp}

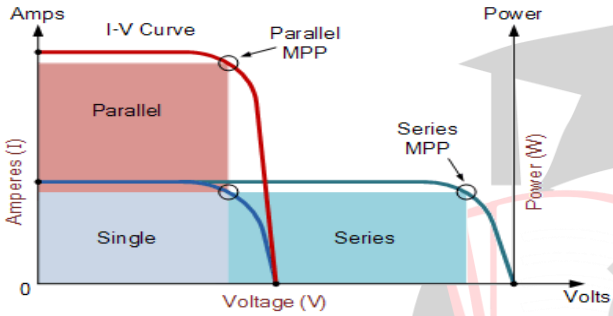


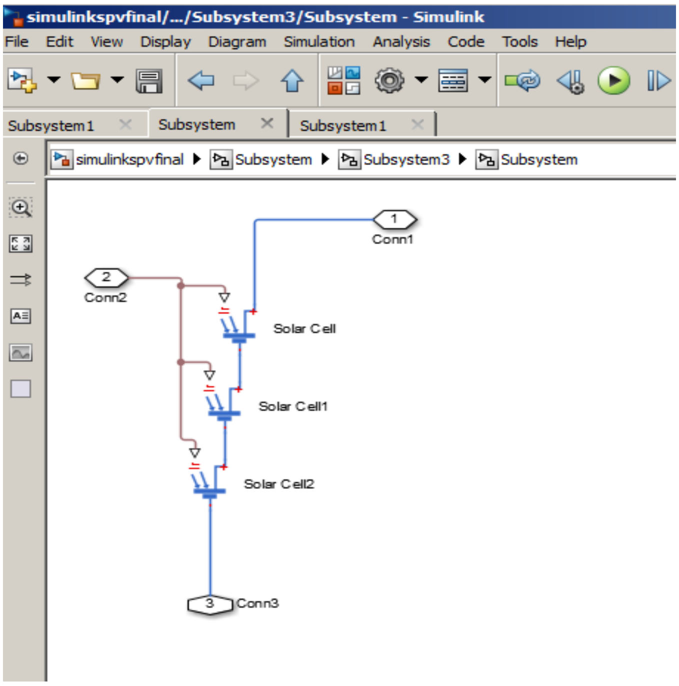
Figure-4

Figure-4:The above figure shows MPP between Voltage and Current in different parameters viz.Parallel Connection,Series Connection of cells and of a Single cell .

Parameter	Value
Short-circuit current [A]	Isc = 7.34
Open-circuit current [V]	Voc = 0.6
Quality factor	N = 1.5
Series resistance [Ω]	Rs = 0
First order temperature coefficient for Iph [1/K]	$T_{IPH1} = 0$
Temperature exponent for Is	$TRXI_{S1} = 3$
Temperature exponent for Rs	$TRXR_{S1} = 0$
Parameter extraction temperature [°C]	Tmenas = 25
Fixed circuit temperature [°C]	T_{FIXED}=25

Table-1: Cell parameters used in Simulink /script

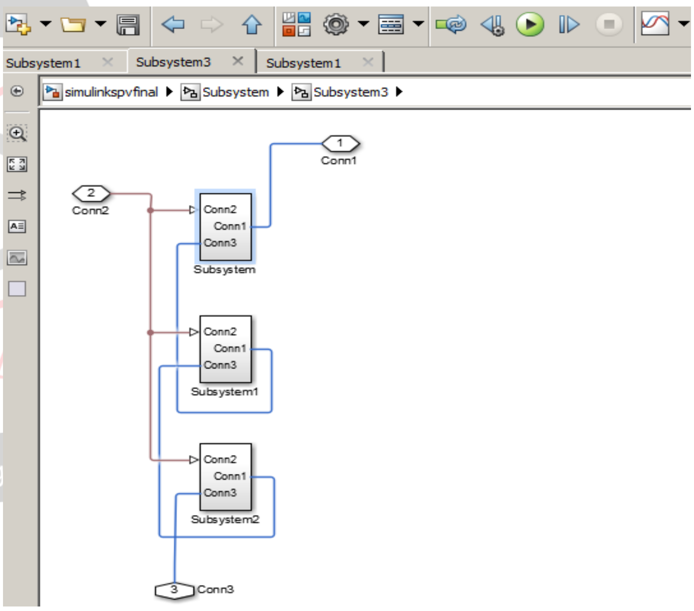
X. MATHMETICAL MODELING USING SIMULINK.



Subsystem-1

Figure-5

Figure-5: Design of Solar cells in Simulink Subsystem-1



Subsystem-2

Figure-6

Figure-6 :Connection of Solar Panels to make an Array from Subsystem ,1 and 2 .

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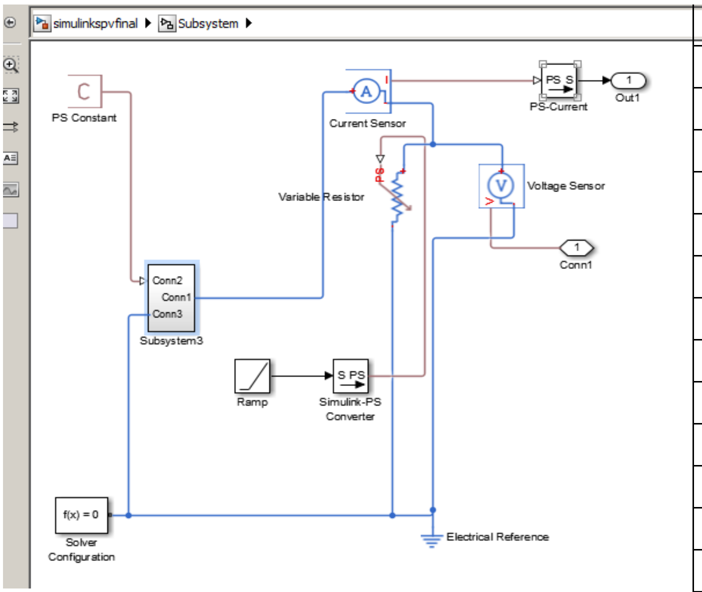

Figure-7

Figure-7:Conection of Current Sensor ,Voltage Sensor To mesure Voltage and Current.

Subsystem-3

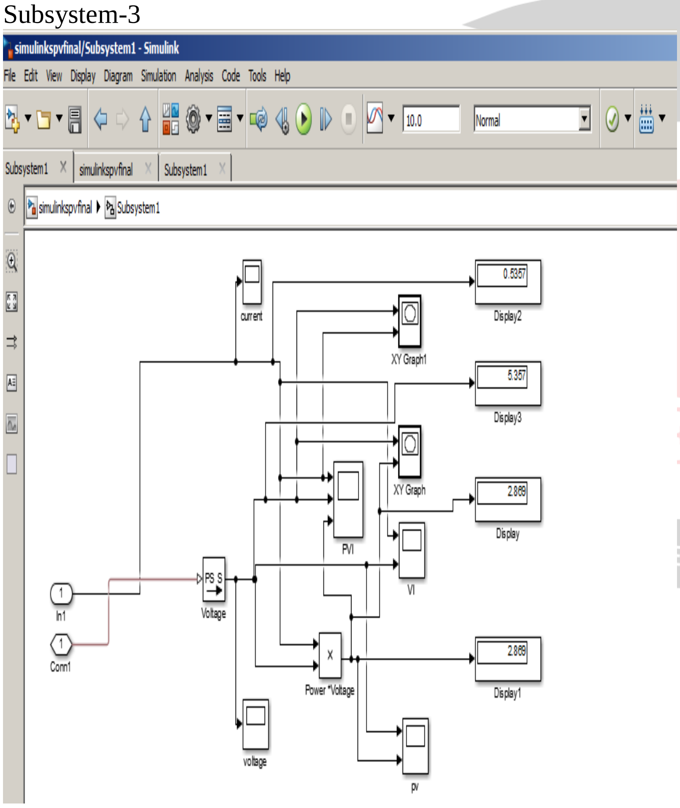

Figure-8

Figure-8:Connection of Oscilocope to view output Graph .

Practical output			
Irradiance w/sqr meter	current in amp	voltage	Power
100	0.7	0.734	0.538
200	1.4	1.46	2.155
300	2.2	2.3	4.899
400	2.93	2.9	8.67
500	3.6	3.6	13.4
600	4.297	4.9	18.46
700	4.707	4.9	22.15
800	4.955	4.9	24.55
900	5.122	5.2	26.24
1000	5.246	5.3	27.52
1100	5.34	5.4	28.54
1200	5.4	5.55	29.39
1300	5.4	5.56	30.75
1400	5.4	5.56	31.13
1500	5.5	5.7	31.81
1600	5.5	5.7	32.27
1700	5.6	5.7	32.69
1800	5.7	5.7	33.08
1900	5.7	5.7	33.5
2000	5.7	5.7	33.6

Table-2: Radiation in w/m^2 to measure Current, Voltage and Power

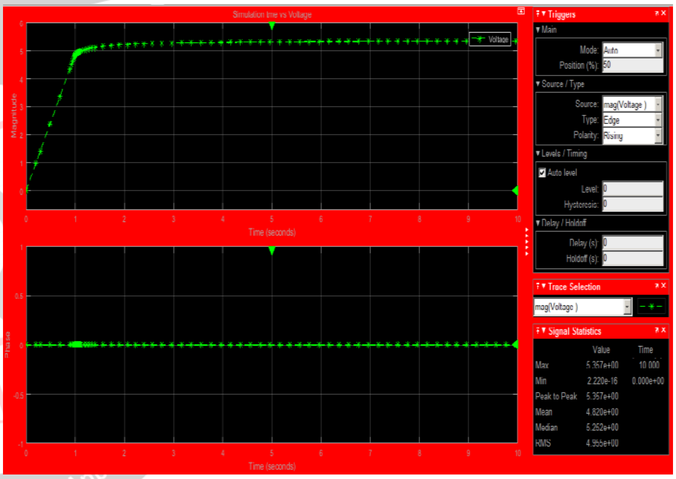

Figure-9

Figure-9:Time Vs. Current output Graph of Subsystem .

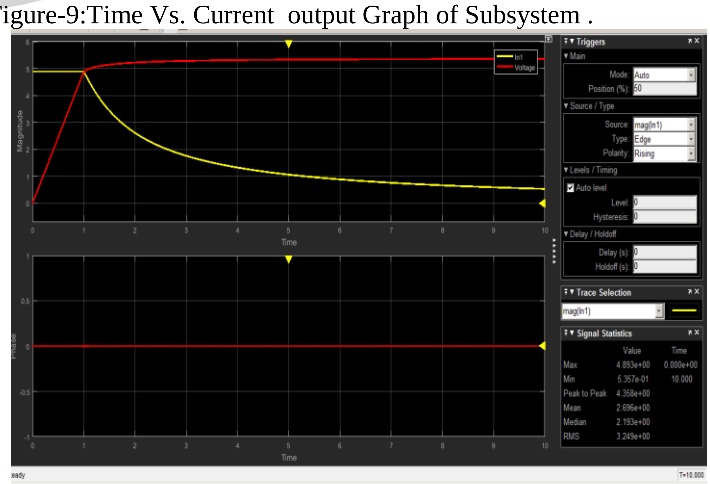

Figure-10

Figure-10:Time Vs. Current output Graph for subsystem-1

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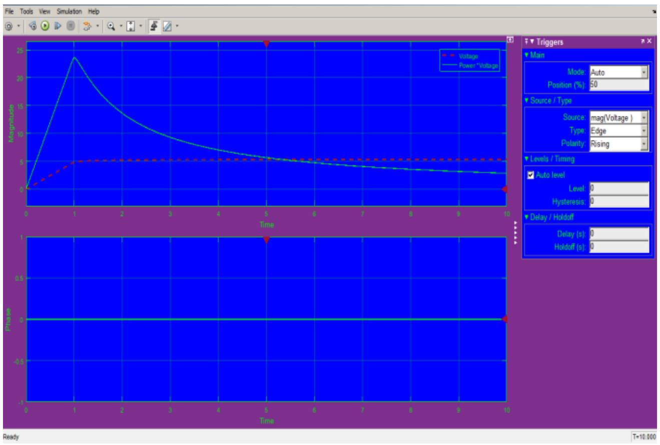

Figure-11

Figure-11:Time Vs. Current output Graph for subsystem-2

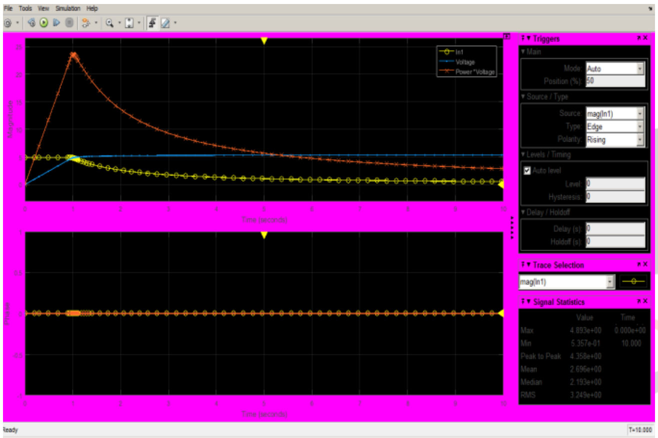

Figure-12

Figure-12:Magnitude and Phase Vs Time output Graph for Total System

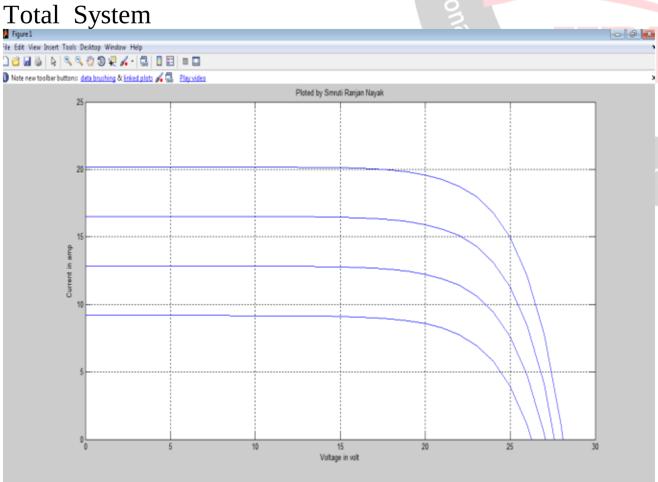

Figure-13

Figure-11:IV Charectristic of Cell

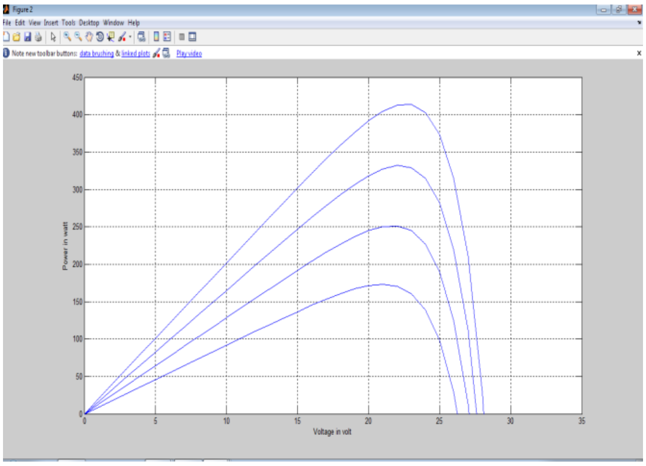

Figure-14

Figure-12:Maximum Power Point Tracking at Peak Time Which Proves that at radiation 1000 w/m^2 .

XI.CONCLUSION

Its conclude from this analysis that design and implementation of solar PV module in Mat Lab-2016 Simulink and script with different parameters successfully carried out .The different figures in figure window shows different values in different irradiance observed clearly with neat graphs .

ACKNOWLEDGMENT

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