COMPARATIVE ANALYSIS OF I-V & P-V CHARACTERISTICS OF A SERIES AND PARALLEL CONNECTED SPV MODULES

Dr.G.Suresh Babu[1], B.Prem Charan[2], A.Radha Krishna[3]
[1]EEE Dept.,CBIT,Hyd, [2]EEE Dept., M.E Scholar, CBIT, Hyd,
[3]Dept.of EEE,GNTC, Hyd

Abstract

With a spurt in the use of non-conventional energy sources, photovoltaic installations are being deployed in several applications such as distributed power generation and standalone systems. Solar PhotoVoltaic (SPV) module is the basic component of the solar PV system. The efficiency of monocrystalline is 25% to 35% and polycrystalline is 25% to 30%. However a major challenge in using a PV system is to take its nonlinear output characteristics which vary with temperature and solar insolation.

The efficiency of PV array invariably depends upon temperature which in turn is dependent on radiation. This paper focuses mainly on comparison of the experimentation results and simulation results of I-V & P-V Characteristics on series and parallel combinations. An attempt is made to analyze the given SPV module by conducting couple of hardware tests and certain simulations. Photovoltaic Training and Research (PVTR) system, specially designed apparatus is adopted here to perform hardware tests.

Index Terms: SPV (solar photovoltaic), IV&PV, PVTR Pyranometer

1. INTRODUCTION

The global energy crunch has provided a renewed impulsion to the growth and development of Clean and Renewable Energy sources. Clean Development Mechanisms (CDMs) are being adopted by organizations all across the globe. Another advantage of utilizing renewable resources over conventional methods is the significant reduction in the level of pollution associated.

Any engineering process is incomplete without proper testing and analyzing. Hence, this standalone solar photovoltaic (SPV) system is tested by using solar PVTR system in order to record its behavior in various conditions. The standalone PV Systems [1] have been used for solar street lighting, home lighting system, water pumping system [3].

Series of experiments have been conducted on a solar PVTR system, where a solar module place an important role, so most importantly concentrated on solar which is a renewable energy.

2. SIMULATION

In order to carryout simulation studies on a SPV, initially a block diagram is prepared as shown in fig.1.Later simulink diagram has been generated using Matlab-Simulink software as shown in fig.5. Based on requirement the IV, PV curves were recorded on the scope provided.

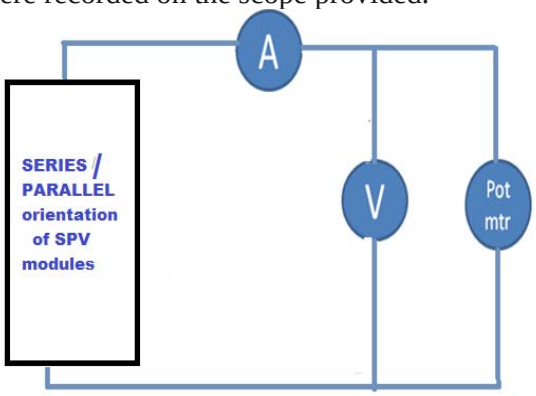

Fig.1 Block diagram

36 cells are drawn from Matlab simulink library to arrive the standard [4] SPV specification of 40

watt panel. The two PV modules were taken with the same capacity comprising of 40 watt peak each .parallel connection which is shown in the fig.3.The series connection of two modules is shown in the fig.2, where opposite terminals are connected to each other.

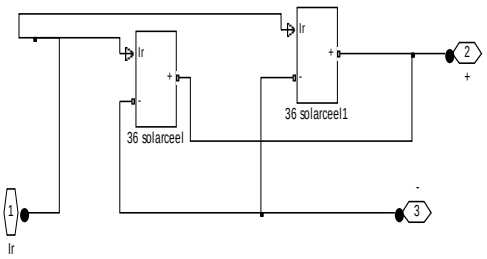

Fig.2 Simulink model of two modules connected in series

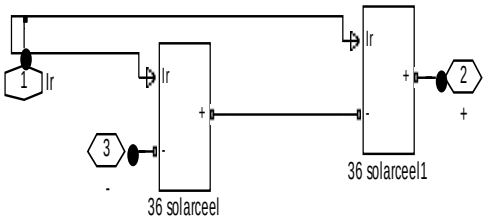

Fig.3 Simulink model of two modules connected in parallel

The irradiance is taken as an input with a constant block taken from the Simulink library, voltage and current sensors are taken to record the voltage and current while varying the load at particular radiation. Variable load is considered with a ramp for gradual slope change .XY graph is integrated to plot IV and PV curves. The difference in series and parallel simulations is in the internal connections of the two PV module terminals, excluding this every part and operation will be same, Which is shown in the fig. 4 and external structure in fig.5.

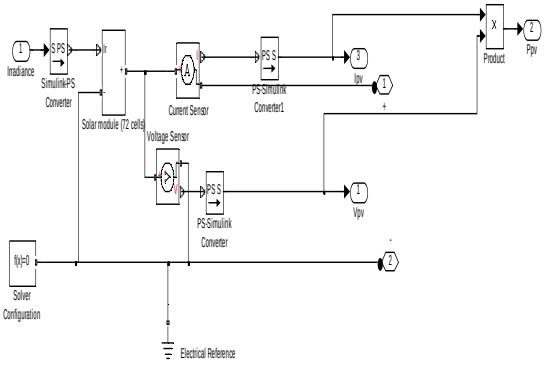

Fig.4 Simulink model of 2modules connected in series and parallel

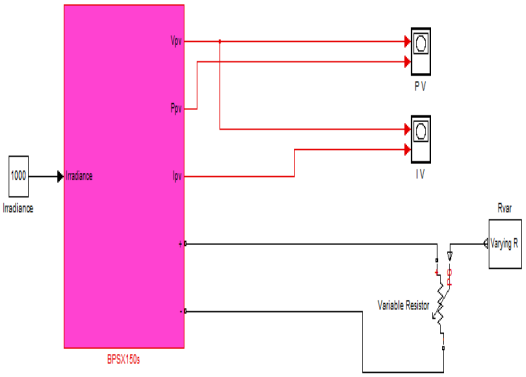

Fig.5 complete simulink model of series & parallel placed modules

The simulation results are shown in the below fig. (6,7,8 & 9) both for series connected modules as well as parallel connected modules, at a radiation of 150w/m^2.

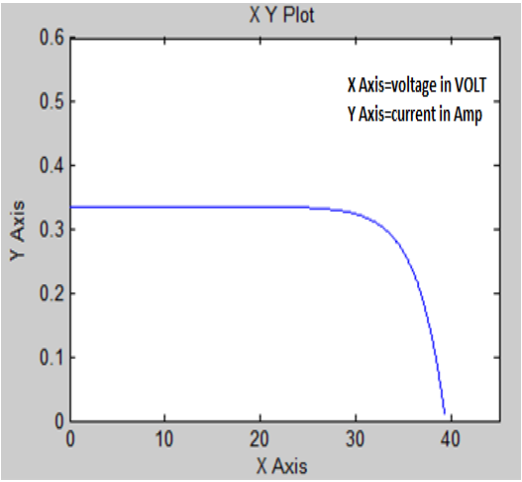

Fig.6 Simulation result of IV curve for series connected modules

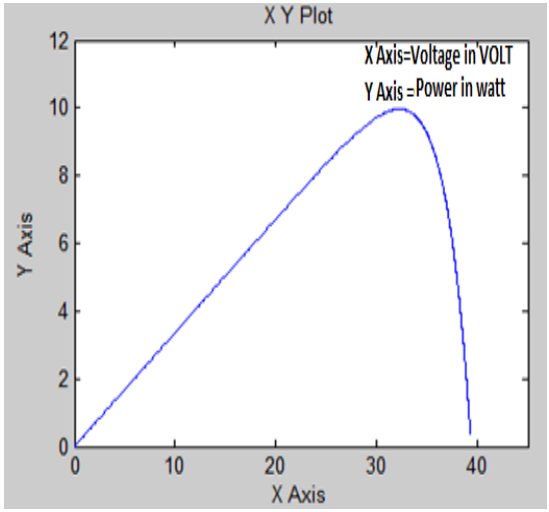

Fig.7 Simulation result of PV curve for series connected modules

The family of I-V & P-V simulation curves were generated in MATLAB/SIMULIMK environment for different [4] radiations such as 100w/m^2,200w/m^2,300w/m^2&400w/m^2.simulation curves are shown in below fig.10,11,12&13.

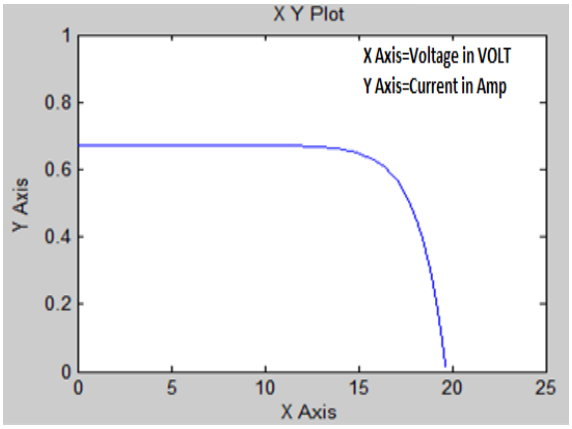

Fig.8 Simulation result of IV curve for parallel connected modules

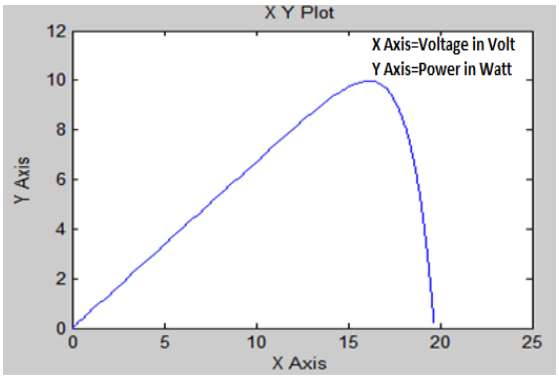

Fig.9 Simulation result of PV curve for parallel connected modules

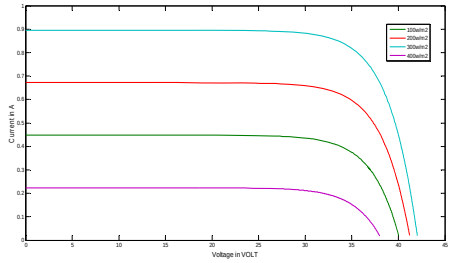

Fig.10 I-V curves for different radiations when PV modules are connected in series

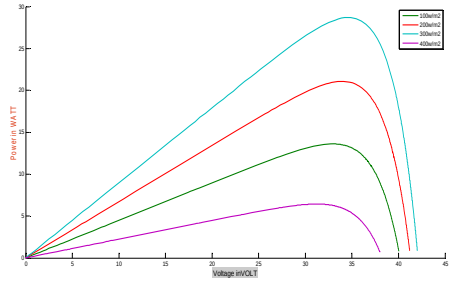

Fig.11 P-V curves for different radiations when PV modules are connected in series

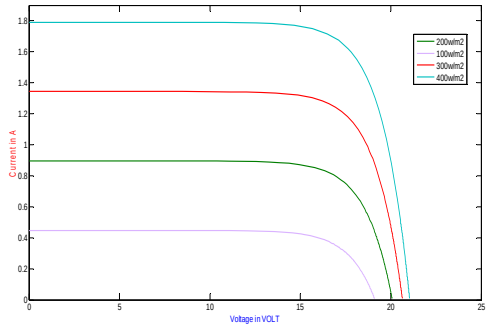

Fig.12 I-V curves for different radiations when PV modules are connected in parallel

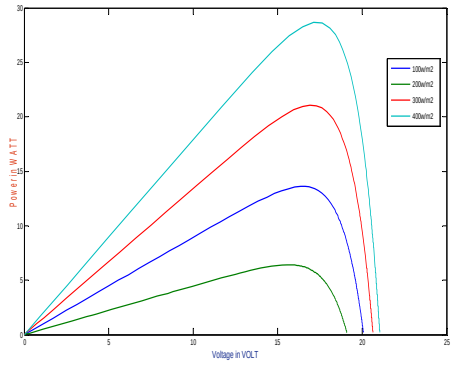

Fig.13 P-V curves for different radiations when PV modules are connected in parallel

3. CONCEPT VALIDATION

A. HARDWARE TESTING

In order to determine the IV and PV characteristics of the two modules when connected in series and parallel [2] with a capacity of each having 40 watt peak, these two modules are tested on a PVTR system. The schematic diagram to evaluate I-V and P-V characteristics of modules connected in series and parallel are shown in Fig.14(a)&15(a) respectively. The controller connections are shown in fig.14(b)&15(b). The voltage and current readings are recorded by varying the potentiometer (POT METER) at particular radiation, which acts as a load in the test.

The effect of load change on output voltage and current of the modules connected in [7] series or parallel can be observed by varying load resistance (pot meter). The radiation can be measured with the help of a pyranometer.

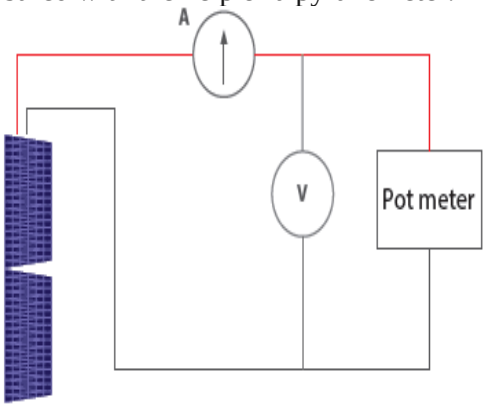

Fig.14(a)schematic diagram for evaluation of I-V and P-V characteristics of series connected modules

Fig.14(b) Controller connections for evaluation of I-V and P-V characteristics of series connected modules

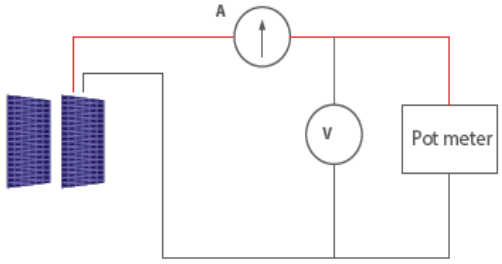

Fig.15(a) Schematic diagram for evaluation of I-V and P-V characteristics of parallel connected modules

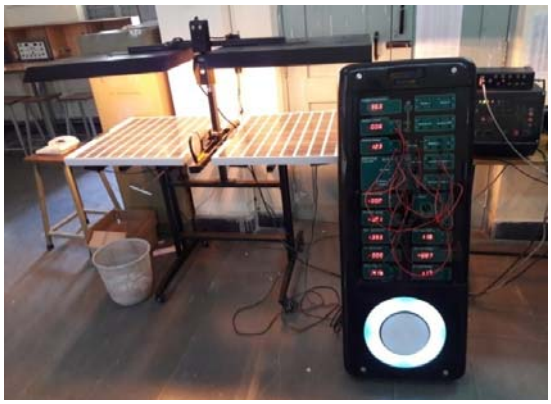

Fig.15(b) Controller connections for evaluation of I-V and P-V characteristics of parallel connected modules

B.EXPERIMENTATION RESULTS

After conducting experimentation with PVTR system both for series and parallel orientation of SPV [6] modules the readings obtained are tabulated as shown in Table 1 and 2 respectively and the corresponding graphs are drawn.

Table 1: voltage & current readings when modules are connected in series

S.NO	Voltage Volts	Current Amps	Power Watts
1	0	0.3	0
2	2.6	0.3	0.78
3	6.3	0.29	1.827
4	8.5	0.29	2.465
5	13	0.29	3.77
6	17.5	0.28	4.9
7	20.4	0.28	5.712
8	25.3	0.26	6.578
9	28.3	0.24	6.792
10	30.4	0.23	6.992
11	33.2	0.22	7.304
12	35.8	0.18	6.444
13	35.9	0.16	5.744
14	39.1	0	0

Table 2: voltage & current readings when modules are connected in parallel

S.NO	Voltage Volts	Current Amps	Power Watts
1	0	0.63	0
2	9.9	0.56	5.544
3	15.1	0.52	7.852
4	18.5	0.46	8.51
5	18.7	0.35	6.545
6	18.8	0.27	5.076
7	18.8	0.23	4.324
8	18.8	0.2	3.76
9	18.8	0.14	2.632
10	18.8	0.12	2.256
11	18.8	0.1	1.88
12	18.8	0.09	1.692
13	18.8	0.08	1.504
14	18.8	0.07	1.316
15	18.8	0	0

The I-V and P-V curves for series and parallel connection as shown in fig. 16 and 17 respectively.

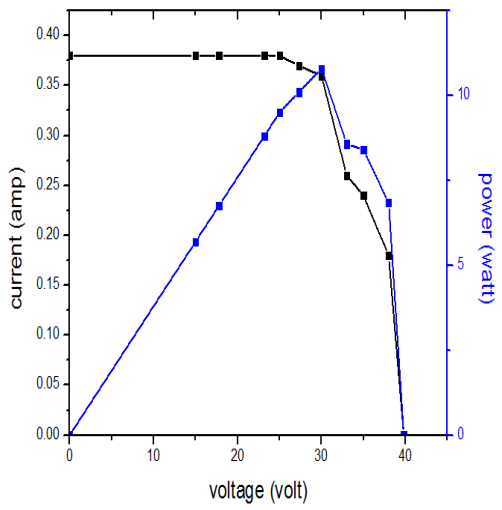

Fig.16 IV-PV curves when modules connected in series

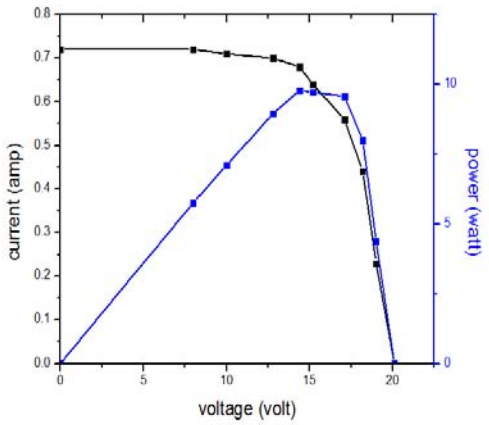

Fig.17 IV –PV curves when modules connected in parallel

INFERENCE: It is observed from the above fig.16 &17 that the net current of the system when the modules are connected in parallel is increased, and the net voltage of the system is increased when the modules are connected in series.

4. RESULTS AND ANALYSIS

After close observation of I-V & P-V graphs which are obtained by simulation and hardware experiment results, are found coherent.

The family of I-V curves shown in fig.10,12, obtained for series and parallel connection reveals that as the irradiance is increased in equal steps the short circuit current is found increasing in same proportion. The family of P-V curves shown in fig. 11&13 obtained for series and parallel connection reveals that as the radiance increases the maximum power [5] increases but the voltage at which the P_{max} occurs remains unchanged.

Though the I-V parameters tend to change, but the power output remains unchanged in either of the orientations.

5. CONCLUSION

Simulation studies and hardware Testing's are carried out on a pair of SPV modules which are connected in series and parallel orientations. The results obtained by simulations are validated by hardware experimentation performed on PVTR system. A family of curves (both I-V & P-V) is generated and their results are discussed.

Some more experiments such as shading effect,Tilt angle effect can be carried out to find out efficiency of SPV module and overall performance of standalone PV system.

6. REFERENCES

[1] Chokri Belhadj Ahmed, Mahmoud Kassas, Syed Essamuddin Ahmed "PV-standalone monitoring system performance using Lab VIEW" International Journal of Smart Grid and Clean Energy.

[2] Williams K. Francis, Prof. Shanifa Beevi, Prof. Johnson Mathew, **"**MATLAB/Simulink PV Module Model of P&O And DC Link CDC MPPT Algorithms with Lab view Real Time Monitoring And Control Over P&O Technique" International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering Vol. 3, Special Issue 5, December 2014.

[3] Izete Zanesco, Sérgio Boscato, Garcia Adriano Moehlecke, Sérgio Boscato Garcia, "Development of a PV System as a Way to Promote the Technology" JULY 2011 IEEE.

[4] Manish Khemariya and Arvind Mittal, "Modeling & Simulation of different components of a stand-alone Photovoltaic and PEM Fuel Cell Hybrid System" International Journal on Emerging Technologies.

[5] Eftichios Koutroulis and Frede Blaabjerg, "A New Technique for Tracking the Global Maximum Power Point of PV Arrays Operating Under Partial-Shading Conditions" IEEE journal of photovoltaic's, vol. 2, no. 2, April 2012.

[6] DIKE,DAMIAN OBIOMA, "Characterization of high penetration of photovoltaic system" International journal of engineering and applied sciences.

[7] parvathy suresh , jaimol Thomas, "performance analysis of standalone PV system using PV SYST".

.