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Incremental Conductance MPPT Technique with Boost Converter

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ABSTRACT: This paper involves an incremental conductance Maximum Power Point Tracking (MPPT) algorithm for solar panel output. MPPT, or Maximum Power Point Tracking, is a charge controller algorithm that is used to extract the maximum available power from a PV module under particular conditions. Maximum power point (or peak power voltage) refers to the voltage at which a PV module may output the most power. Maximum power is affected by solar radiation, ambient temperature, and the temperature of the solar cell. The output of the solar PV array is connected to DC-DC boost converter. To verify the effectiveness of the algorithm, the MATLAB/SIMULINK results are presented.

KEYWORDS: MPPT algorithm, solar energy, solar irradiance, boost converter

1. INTRODUCTION

The solar power plant system is turned into electrical energy utilizing solar panels in solar energy. However, there is a downside to using solar PV as a solar power plant. Because solar PV power is highly dependent on irradiance, it is unstable. Furthermore, the energy conversion efficiency is rather low (about 30%). As a result, solar PV requires the MPPT method to be used and forced to operate at the MPP point [1], [2]. Nowadays, research on the MPPT approach has been widely developed utilizing both conventional and artificial intelligence methodologies. P&O is a traditional method that is widely employed. The MPPT P&O condition forces solar PV to operate at the MPP point. When irradiance fluctuates, this scenario might lead to overvoltage. The MPPT is modified with a Constant Power Generation (CPG) to avoid this [3]. A photovoltaic array (composed of many solar cells) generates electricity by using photons of light to create voltage or electric current in a substance when exposed to light. Insolation is the amount of solar energy that strikes a specific location over a specific time period. Irradiance is defined as insolation per unit time. More power is created as the irradiance increases.

The current-voltage characteristics of a PV cell are non-linear. As more current is pulled from the PV array, the power delivered increases up to a certain point. highest Power Point Tracking (MPPT) is a technique used to ensure that a PV array produces the highest output power. V_{mpp} is the voltage of the PV array at which the maximum power is delivered. MPPT algorithms are numerous [4]. The Constant Voltage (CV) approach [5,6], beta method [7,8], Ripple Correlation method [9], Incremental conductance method, and Perturb and Observe method [10-12] are some of the more often utilised and effective MPPT techniques. CV has the simplest algorithm among the MPPTs, making it the easiest to implement. The power to the load is briefly cut, and the open-circuit voltage (Voc) is monitored.

In this paper, a 100 KW, 500 V solar plant is controlled using Incremental conductance algorithm and a boost converter is connected at the output of the panel to get the desired output voltage. In this paper, section 2, indicates modeling of PV panel, section 3 indicates the proposed model, section 4 simulation results and section 5 follows conclusion.

2. MODELING OF PV PANEL:

Fig.1 shows the single diode model of solar cell, where $I_L$is the source current from the panel I_D is the diode current and I_{sh} is the shunt resistance current. The number of solar PV cells forms as a solar panel which is modelled as shown in Fig.2

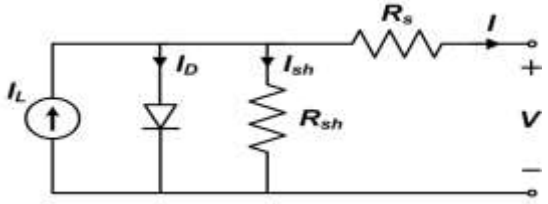

Fig.1 Single diode model of PV cell.

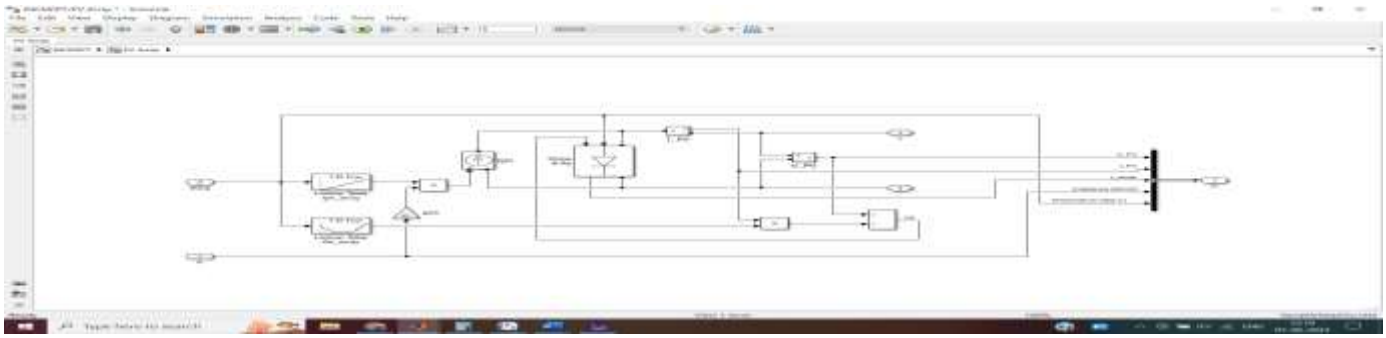

Fig.2 Model of PV panel

Generally, the inputs to the solar PV panel under simulation are solar irradiance and the ambient temperature, based on these two parameters, the solar panel will generate the energy. The diode equation is given as

$I_d=I_{sat}*[e^{(Vd/VT)} -1]$ ----------(1)

As shown in Fig.2, the two inputs to the panel are I_r (solar irradiance) and Temp (Ambient temperature).

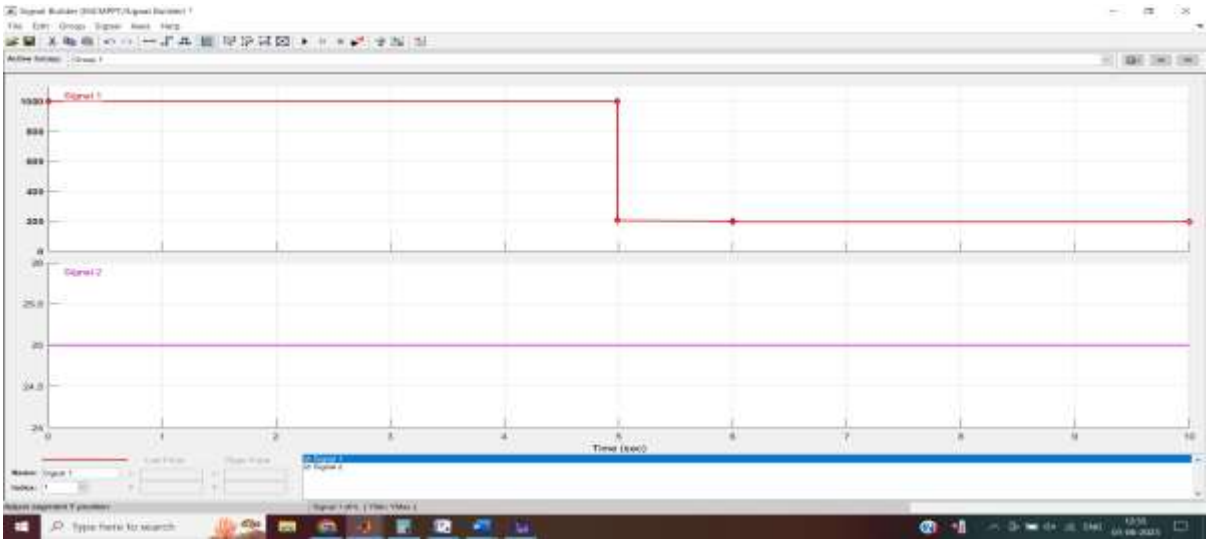

Fig.3 Irradiance and temperature signals

As shown in Fig.3, the irradiance is set to the value 1000 and the ambient temperature is set to 25^0 C.

MATLAB Code for Incremental Conductance Algorithm:

```
function y = MYMPP (u, i, uo, io, D)
m=0.4;
du=u-uo;
di=i-io;
d=0.00005;
if du==0
if di==0
m=D;
else
if di>0
m=D-d;
else
m=D+d;
end
end
else
if di/du== -(i/u)
m=D;
else
if di/du> -(i/u)
m=D-d;
else
m=D+d;
end
end
end
y = m;
end
```

3. PROPOSED CIRCUIT

The proposed circuit is shown in Fig.4 , the pv panel is modelled in MATLAB/SIMULINK and the MATLAB code for incremental conductance which is given in section 2 is developed in the SIMULINK environemnt to generate maximum power from the solar panel. This algorithm uses the instantaneous conductance I/V and the incremental conductance dI/dV for MPPT technique to track the power.

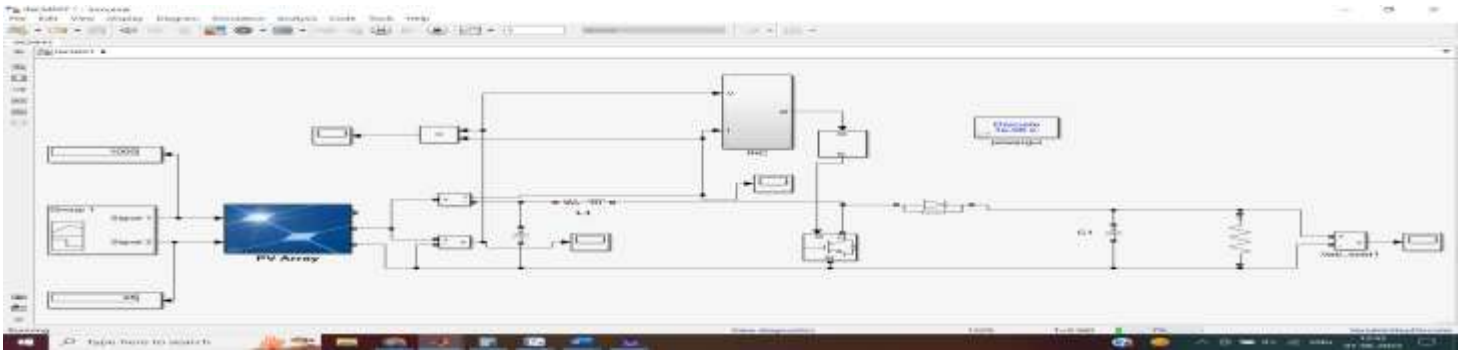

Fig.4. Proposed circuit

From the Fig.4, the output of the PV array is connected to the INC block which is the algorithm of incremental conductance. The algorithm of Incremental conductance provides the duty cycle of the switch in the boost converter. The duty cycle value is given to the pulse generator to generate the pulses for the IGBT switch in the boost converter. The boost converter is designed such that the ripples at the output are minimum with Inductance value = 0.0005 henry and capacitance value = 12000 micro farad. The output of the boost converter is connected to the series RLC load which 100 KW power.

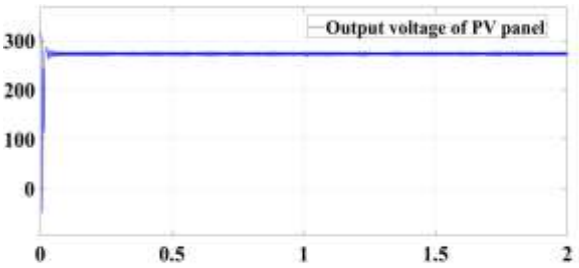

Fig.5. Output Voltage of PV panel for 1000 W/m^2 irradiance at 25^{0}c temperature

The solar module type of sun-power SPR 305HT is used for simulation in which 5 panels are connected in series and 66 in parallel to make a module. At our latitude, the value of solar irradiance at the surface is approximately 1000 W/m^2 on a clear day at solar noon in the summer months. Hence the value of irradiance assumed in the simulation is 1000 W/m^2. The output voltage of the PV panel after MPPT using incremental conductance algorithm is shown in Fig.5. The output voltage of the panel is approximately 275 Volts with ±5V as ripple content.

The grid voltage where the PV panel is to be installed is 500 V DC, hence the boost converter is used to level up the voltage of the PV panel. Hence the duty cycle of the switch in the boost converter is maintained at 0.64, such that 275V is boosted to 500V. The output of the boost converter is shown in Fig.6.

4. SIMULATION RESULTS

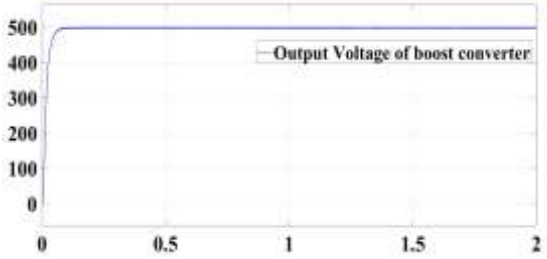

Fig.6. Output Voltage of boost converter for 1000 W/m^2 irradiance at 25^{0}c temperature

The PV panel and the setup is designed for 100 KW power generation, and the output power of the solar panel is shown in Fig. 7. The pulses which are provided to the IGBT is shown in Fig.8. which has duty cycle approximately as 0.64.

Fig.7. Output Power of panel for 1000 W/m^2 irradiance at 25^{0}c temperature

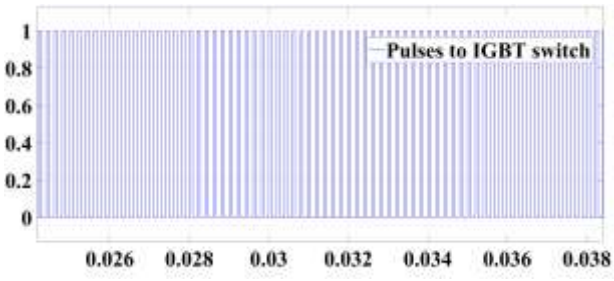

Fig.8. pulses for IGBT switch.

CONCLUSION

In this paper, an incremental conductance MPPT algorithm is designed for a PV system of 100 KW. The solar PV panel is modelled in MATLAB/SIMLINK with irradiance and temperature as inputs. The five panels are connected in series and 66 in parallel to form a module. The maximum power is obtained from the module using the incremental conductance algorithm and the output voltage is boosted using boost converter to get the desired voltage of the grid.

REFERENCES

1. R. A. Soumana, M. J. Saulo and C. M. Muriithi, "Comparison of MPPT Techniques on THD Current in a Grid-Connected Photovoltaic System," 2022 4th Global Power, Energy and Communication Conference (GPECOM), Nevsehir, Turkey, 2022, pp. 95-100, doi: 10.1109/GPECOM55404.2022.9815606.
2. J. Alrubaie, A. Al-Khaykan, R. Q. Malik, S. H. Talib, M. I. Mousa and A. M. Kadhim, "Review on MPPT Techniques in Solar System," 2022 8th International Engineering Conference on Sustainable Technology and Development (IEC), Erbil, Iraq, 2022, pp. 123-128, doi: 10.1109/IEC54822.2022.9807500.
3. R. I. Yuwanda, E. Prasetyono and R. P. Eviningsih, "Constant Power Generation Using Modified MPPT P&O to Overcome Overvoltage on Solar Power Plants," 2020 International Seminar on Intelligent Technology and Its Applications (ISITIA), Surabaya, Indonesia, 2020, pp. 392-397, doi: 10.1109/ISITIA49792.2020.9163685.
4. R. A. Soumana, M. J. Saulo and C. M. Muriithi, "Comparison of MPPT Techniques on THD Current in a Grid-Connected Photovoltaic System," 2022 4th Global Power, Energy and Communication Conference (GPECOM), Nevsehir, Turkey, 2022, pp. 95-100, doi: 10.1109/GPECOM55404.2022.9815606.
5. G. Luo, J. Liu, T. Yang, Y. Dou and N. Chen, "A Constant Current and Constant Voltage Charging Circuit through MPPT Method and Its Stability Analysis," 2022 3rd China International SAR Symposium (CISS), Shanghai, China, 2022, pp. 1-6, doi: 10.1109/CISS57580.2022.9971405.
6. R. Nansur, A. Syah Laili Hermawan and F. D. Murdianto, "Constant Voltage Control Using Fuzzy Logic Controller (FLC) to Overcome The Unstable Output Voltage of MPPT in DC Microgrid System," 2018 International Electronics Symposium on Engineering Technology and Applications (IES-ETA), Bali, Indonesia, 2018, pp. 19-24, doi: 10.1109/ELECSYM.2018.8615556.
7. S. Samantara, B. Roy, A. Rout and R. Sharma, "Modeling and simulation of CUK converter with beta (B) MPPT for standalone PV system," Michael Faraday IET International Summit 2015, Kolkata, 2015, pp. 641-645, doi: 10.1049/cp.2015.1708.
8. X. Li, H. Wen and C. Zhao, "Improved beta parameter based MPPT method in photovoltaic system," 2015 9th International Conference on Power Electronics and ECCE Asia (ICPE-ECCE Asia), Seoul, Korea (South), 2015, pp. 1405-1412, doi: 10.1109/ICPE.2015.7167963.
9. Ziouh, A. Abbou and S. Marhraoui, "Efficiency of Ripple Correlation Control Compared to Fuzzy Logic MPPT Algorithm in Space Climate Conditions for Nimbus 2 Satellite," 2017 International Renewable and Sustainable Energy Conference (IRSEC), Tangier, Morocco, 2017, pp. 1-5, doi: 10.1109/IRSEC.2017.8477389.
10. J. M. Riquelme-Dominguez and S. Martinez, "Comparison of Different Photovoltaic Perturb and Observe Algorithms for Drift Avoidance in Fluctuating Irradiance Conditions," 2020 IEEE International Conference on Environment and Electrical Engineering and 2020 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe), Madrid, Spain, 2020, pp. 1-5, doi: 10.1109/EEEIC/ICPSEurope49358.2020.9160791.
11. Nigam and A. Kumar Gupta, "Performance and simulation between conventional and improved perturb & observe MPPT algorithm for solar PVcell using MATLAB/Simulink," 2016 International Conference on Control, Computing, Communication and Materials (ICCCCM), Allahbad, India, 2016, pp. 1-4, doi: 10.1109/ICCCCM.2016.7918220.
12. J. E. Salazar-Duque, E. I. Ortiz-Rivera and J. González-Llorente, "Modified perturb and observe MPPT algorithm based on a narrow set of initial conditions," 2016 IEEE ANDESCON, Arequipa, Peru, 2016, pp. 1-4.