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Grid-connected cross-ties configuration with integrated converters with MPP tracking under various climate conditions

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Abstract: Different PV module layouts make up the integrated photovoltaic cells' core inverter architecture. These PV module combinations experience power losses as a result of shade. A MPP controller is utilised in conjunction with the established architecture to lessen the effect of shade and to extract the most power possible. In this study, an MPPT controller is integrated with all of the string integrated converters, which are completely cross tied. MPPT methods such as perturb and observe, and incremental conduction are employed for maximum power extraction. Under various shading scenarios, each approaches' performance is contrasted and studied.

Keywords: Maximum power point (MPP), perturb and observe (P&O), shading conditions, incremental conduction (IC).

INTRODUCTION

Photo voltaic (PV) are the finest resource since the solar energy is limitless and free[1]. PV systems can accompany with other sources very easily as they do not have any mobile parts and can last longer than 20 years[2]. As the renewable sources are the environmentally friendly those are the most commonly used resources. Among the different sustainable power sources, the force produced by sunlight based (photovoltaic) PV frameworks have been raised 25% per year during the most recent 20 years.[3] PV deployment systems have power ratings in different ranges ranging from kilowatts to few megawatts [4].

To extract the PV arrays maximum energy a control strategy must developed for finding the operating, such control strategy is known as maximum power point tracking [5]. The most commonly used techniques are perturb and observe (P&O) technique and incremental conductance (IC)[6]. The position of the MPP depends on the variation of temperature and irradiances[7].

The integrated PV systems are generally associated with the central inverter design and this architecture[8] consists of different configurations of PV modules such as parallel, series, cross-tied, bridge-linked, honey-comb [9]. Due to the partial shading and mismatching the power output from the PV modules decreases[10]. Besides the power losses as the configurations of PV modules exhibits many

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connections it brings complicacy in the system [11]. The problems caused by inconsistent power losses were solved by attaching an anti-parallel bypass diode to each PV module [12].

In this proposed architecture 16 strings are used [13]. A single PV string generate 310.03 W of power at MPP voltage (43 V) and current (7.21A) at STC conditions. The P-V and I-V characteristics of a PV string at different isolation levels [14].

1. Proposed block diagram

The PV array is connected to the DC-DC converter through a DC link capacitor. The array (voltage), (current are fed to controller to generate a PWM signal and the signal is given to the DC-DC converter [15]. In this proposed block diagram, the MPPT is integrated with the DC-DC converter and then the output of the converter is given to the load [16]. The converter generates the voltage according to the pulse given by MPPT and final output is given to the load [17].

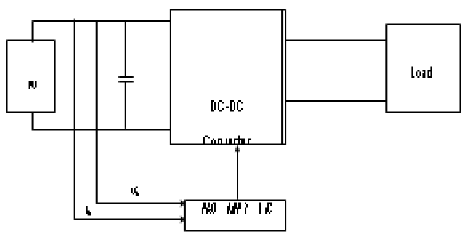

Fig 1. block diagram of proposed system

1.1 Proposed system

In this configuration all the 16 PV strings were cross tied and connected in series and parallel and distinguished as row and columns separately [18]. For this PV strings shading effect is created such as column shading, row shading, diagonal shading, row and column shading [19]. In the row shading the first row is shaded unevenly and in column shading the first column of strings are shaded unevenly and in diagonal shading the shading is done diagonally and in row and column shading the first two columns are shaded unevenly [20].

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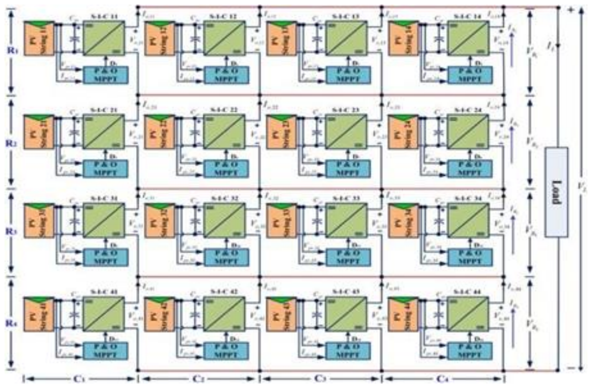

Fig 2. DC-DC converter with MPPT

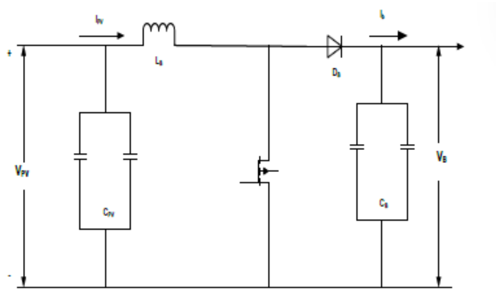

Fig 3. Boost converter

1.2 Implementation of MPPT:

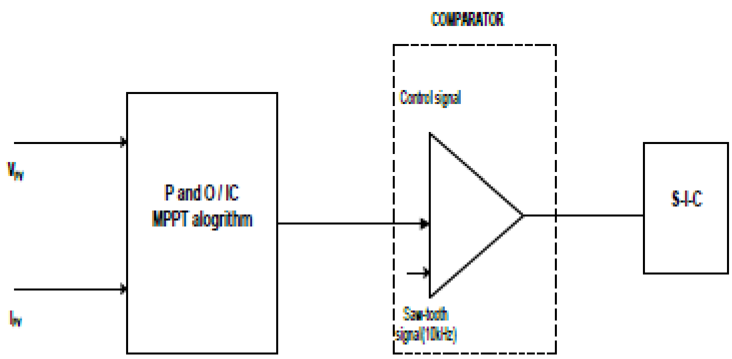

Fig 4: Implementation of MPPT controller

The PV voltage and current are provided are provided to the controller as input parameters to generate the output control signal [2]1. A PWM signal is generated by comparing the signal with the saw tooth signal of frequency of 10 KHZ. To obtain the maximum power the signal fed is applied to SIC [22].

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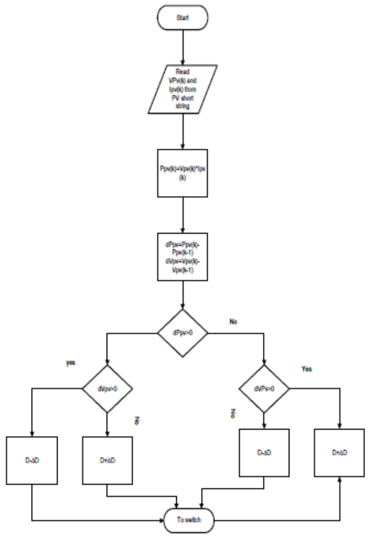

Fig 5. Algorithm of P&O MPPT

In this method, the voltage increased by the controller taken in small amount from the set and checks the output [23]. The power is calculated by taking the values of current and voltage. The change in power is calculated by subtracting the previous power value and present power value. If the change in power is greater than zero, the change in the values of voltage is taken by decreasing or increasing the duty ratios.

1.3 Algorithm of IC MPPT:

The controller tests incremental changes in PV array current and voltage within the incremental conductance system to predict the effect of a voltage shift. The incremental conductivity test measures the maximum power point. If these two are similar, then the MPP voltage is the output voltage. This voltage is regulated by controller until the irradiation switches and cycle is repeated. The incremental conductance.

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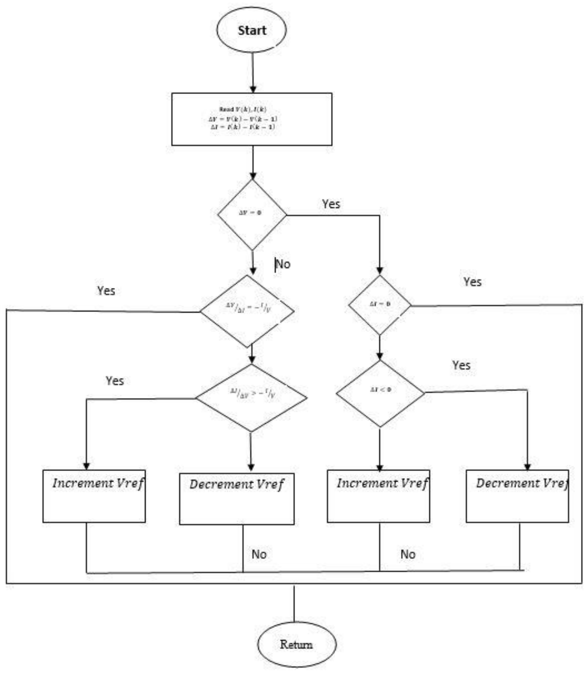

Fig 6. Algorithm of IC MPPT

2. Simulation results

The simulation results of the proposed configuration under various shading patterns using P&O and IC MPPT are described in this section.

Table 1 Specifications of PV module (sharp-nd-62RU2)

specification	Values
$P_{mp\ maximum\ power}$	62.006 W
V_{oc}	10.9 V
I_{oc}	7.82 A
V_{MPP}	8.6V
I_{MPP}	7.21 A
I_{ph}	7.8503 A
$I_{deality\ factor}$	0.89864
R_s	0.14767 Ω

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R_{sh}	38.1127 Ω
Ns, no. of cell	18
K_v	0.30849 V/K
K_I	0.052801 A/K

Based on the different irradiances the shading effect is created as row, column, diagonal, long and narrow shading unevenly. The shading pattern contains various insolation levels such as

300, 500, 800, 1000 .

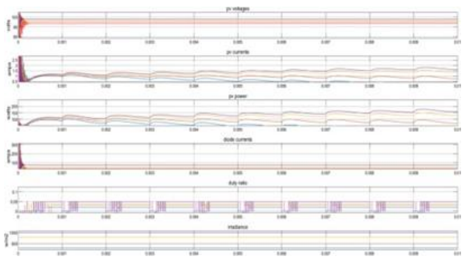

Fig7: uneven row shading using P&O

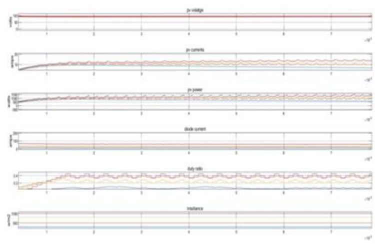

Fig8: uneven row shading using IC MPPT

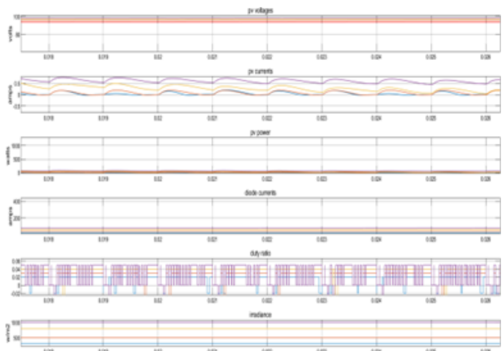

Fig9: uneven column shading using P&O

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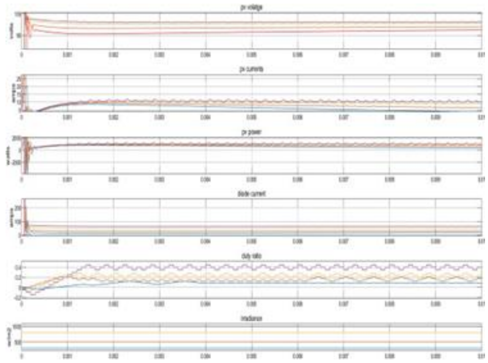

Fig10: uneven column shading using IC

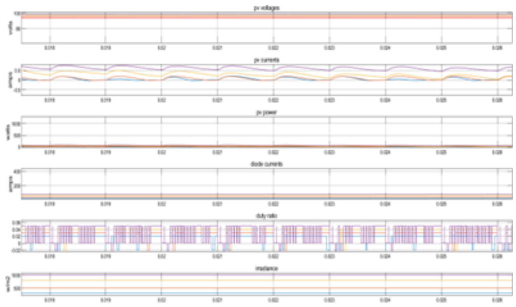

Fig11: uneven diagonal shading using P&O

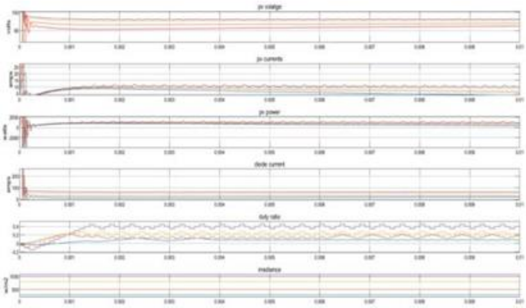

Fig12: uneven diagonal shading using IC

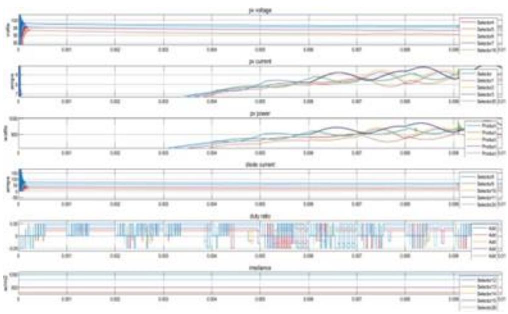

Fig13: Long and narrow shading using P&O

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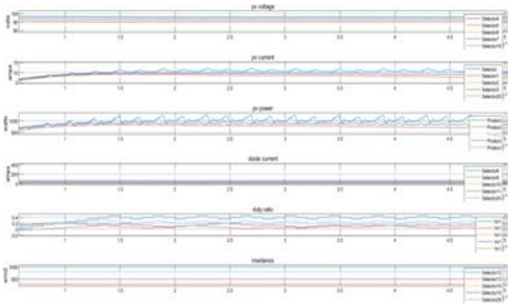

Fig14: Long and narrow shading IC

Table 2 Comparison of P&O and IC output power (KW) under different shading patterns

Shading patterns	Perturb and observe (KW)	Incremental (KW)
Uneven row	7.1	8.8
Uneven column	5.02	6.6
Diagonal	6.5	7.1
Long and narrow	6.7	7.5

CONCLUSION:

This article describes PV features, DC-DC converter design, and MPPT method application. The T-C-T arrangement of SICs is employed in this work to extract the most power. In this study, the outcomes of P&O and IC are compared to extract maximum power. The outcomes are contrasted while accounting for various shading impacts such as column shading, row shading, and unevenly lengthy and narrow shading under various irradiances. Compared to the P&O approach, the IC method tracks power more quickly.

REFERENCES

1. Suneel Raju pendem, Suresh Mikili, "PV Distributed- MPP Tracking: Total-Cross-tied Configuration of String-Integrated-Converter to Extract the Maximum Power Under Various PSCs", *IEEE SYSTEMS JOURNAL, May 25,2019.*

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 10, Iss 4, 2021

2. B. I. Rani, G. S. Ilango, and C. Nagamani, "Enhanced power generation from PV array under partial shading conditions by shade dispersion using Su Do Ku configuration," *IEEE Trans. Sustain. Energy*, vol. 4, no. 3, pp. 594–601, Jul. 2013.

3. J. M. Carrasco *et al.*, "Power-electronic systems for the grid integra- tion of renewable energy sources: A survey," *IEEE Trans. Ind. Electron.*, vol. 53, no. 4, pp. 1002–1016, Jun. 2006

4. J. D. Bastidas-Rodriguez, E. Franco, G. Petrone, C. A. Ramos-Paja, andG. Spagnuolo, "Maximum power point tracking architectures for photo- voltaic systems in mismatching conditions: A review," *IET Power Elec- tron.*, vol. 7, no. 6, pp. 1396–1413, Jan. 2014.

5. S.Sai Keerthi, J. Somlal, "Role of PI/Fuzzy Logic Controlled Transformerless Shunt Hybrid Power Filter using 6-Switch 2-Leg Inverter to Ease Harmonics in Distribution System", Indian Journal of Science and Technology, Vol.9,issue.23, pp.1-7, June-2016.

6. Y.-C. Kuo, T.-J. Liang, and J.-F. Chen, "Novel maximum-power- pointtracking controller for photovoltaic energy conversion system," *IEEE Trans. Ind. Electron.*, vol. 48, no. 3, pp. 594–601, Jun. 2001.

7. C. Lin, A. Amirahmadi, Q. Zhang, N. Kutkut, and I. Batarseh, "De- sign and implementation of three-phase two-stage grid-connected mod- ule integrated converter," *IEEE Trans. Power Electron.*, vol. 29, no. 8, pp. 3881–3892, Aug. 2014.

8. A. S. Yadav, R. K. Pachauri, Y. K. Chauhan, S. Choudhury, and A. R. Singh, "Performance enhancement of partially shaded PV array using novel shade dispersion effect on magic-square puzzle configuration," *Solar Energy*, vol. 144, pp. 780–797, Feb. 2017.

9. C. Manickam, G. P. Raman, G. R. Raman, G. Saravana Ilango, and C. Nagamani, "Fireworks enriched P&O algorithm for GMPPT and de tection of partial shading in PV systems," *IEEE Trans. Power Electron.*, vol. 32, no. 6, pp. 4432–4443, Jun. 2017.

10. J. Prasanth Ram and N. Rajasekar, "A novel flower pollination based global maximum power point method for solar maximum power point tracking," *IEEE Trans. Power Electron.*, vol. 32, no. 11, pp. 8486–8499, Nov. 2017.

11. Suresh Palla, Jarupula Somlal, Comprehensive Examination on Solar -Wind Energy Systems Grid Integration and Emerging Power Quality challenges, International Journal of Engineering and Advanced Technology (IJEAT), Vol.8, Issue 6S3, September 2019

12. Buchibabu P., Somlal J, An examination on advanced MPPT methods for PV systems under normal & partial shading conditions, International Journal of Engineering and Advanced Technology (IJEAT), Vol.8, Issue-6S3, September 2019.
13. T Vijay Muni, S V N L Lalitha, "Fast Acting MPPT Controller for Solar PV with Energy Management for DC Microgrid", International Journal of Engineering and Advanced Technology, Volume 8, Issue 5, pp-1539-1544.
14. Ravi Teja, S., Moulali, S., Nikhil, M., Ventaka Srinivas, B. "A dual wireless power transfer-based battery charging system for electric vehicles". International Journal of Engineering and Advanced Technology 8 (4) ,pp.1211, 2019.
15. D. Ravi Kishore, and T. Vijay Muni, "Efficient energy management control strategy by model predictive control for standalone dc micro grids", AIP Conference Proceedings 1992, 030012 (2018); doi: 10.1063/1.5047963
16. K Venkata Kishore, T Vijay Muni, P Bala Krishna, "Fuzzy Control Based iUPQ Controller to Improve the Network of a Grid Organization", Int. J. Modern Trends Sci. Technol. 2019, 5(11), 40-44.
17. T Vijay Muni; Kishore, K.V. Experimental Setup of Solar–Wind Hybrid Power System Interface to Grid System. Int. J. Modern Trends Sci. Technol. 2016, 2, 1–6.
18. Sudharshan Reddy, K., Sai Priyanka, A., Dusarlapudi, K., Vijay Muni, T., "Fuzzy logic based iUPQC for grid voltage regulation at critical load bus", International Journal of Innovative Technology and Exploring Engineering, 8(5), pp. 721-725
19. Swapna Sai, P., Rajasekhar, G.G., Vijay Muni, T., Sai Chand, M., "Power quality and custom power improvement using UPQC", International Journal of Engineering and Technology(UAE) 7(2), pp. 41-43.
20. T. Vijay Muni, S V N L Lalitha, B Rajasekhar Reddy, T Shiva Prasad, K Sai Mahesh, "Power Management System in PV Systems with Dual Battery", International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 1 (2017), pp.:523-529.
21. T. Vijay Muni, G Sai Sri Vidya, N Rini Susan, "Dynamic Modeling of Hybrid Power System with MPPT under Fast Varying of Solar Radiation", International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 1 (2017), pp.:530-537.

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 10, Iss 4, 2021

22. T Vijay Muni, A Satya Pranav, A Amara Srinivas, “IoT Based Smart Battery Station using Wireless Power Transfer Technology”, International Journal of Scientific and Technology Research, volume 9, issue 01, January 2020, pp:2876-2881.

23. Vo, Nam Xuan, Trung Quang Vo, Ha Thi Song Nguyen, and Thuy Van Ha. "The Economic Evaluation in Vaccines - A Systematic Review in Vietnam Situation." Systematic Reviews in Pharmacy 9.1 (2018), 1-5 Print. doi:10.5530/srp.2018.1.1