





## Materials Today: Proceedings

Volume 80, Part 3, 2023, Pages 3517-3522

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# Performance investigation on novel MPPT controller in solar photovoltaic system

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<https://doi.org/10.1016/j.matpr.2021.07.286> ↗

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### Highlights

- This novel idea proposes the detailed investigation on solar PV characteristics and MPPT operation using adaptive P&O algorithm.
- The fundamental characteristics of solar PV under varying environmental conditions have been experimentally analyzed and reported.
- The detailed operation of algorithm and mathematical approach behind the algorithm has been verified experimentally.

- Finally, the adaptive P&O algorithm operations are validated practically and the same has been validated with the theoretical approach respectively.

## Abstract

This paper investigates the performance of solar PV system by implementing MPPT algorithm. The IV and PV characteristics of solar photovoltaic system have been analyzed for various parameters of temperature and irradiation. From the characteristics, the peak power variations with respect to physical parameters have been identified using algorithmic approach. To validate the MPPT operation, the P&O algorithm has been implemented and verified the operation under varying environmental conditions. And also, the same has been compared with theoretical approach in this paper.

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## Introduction

Solar photovoltaic is area which gives us the way to exploit the tremendous amount of energy incoming to earth. The irradiation coming to earth is vast enough to fulfill our energy demands [1]. The solar energy is converted into electrical energy by the solar cells which are the basic unit of solar photovoltaic system. The solar cells are made up of semiconductor materials like silicon (Si), gallium arsenide (GaAs) etc. These materials are classified as: (i) Intrinsic semiconductor material (ii) Extrinsic semiconductor material. Pure semiconductor material which is not doped is called as intrinsic semiconductor such as Silicon, Germanium which belongs to Group IV of the periodic table [2]. These materials when doped using group III elements also called as acceptors, p-type or using group V elements also called as donors, n-type, they become extrinsic materials [3]. These doped materials help in the formation of solar cells. These cells convert the solar energy into electrical energy by the process called as photoelectric effect in which photoelectrons are emitted when the light falls onto it. The solar cells are connected in series and parallel to form solar panels [4]. These solar panels are connected in different combinations of series and parallel to form solar PV array. The generation of electrical energy from the solar PV array depends on several factors [5], [6], [7].

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## Section snippets

## Solar PV characteristics

Due to non-linearity behaviour of solar PV power generation, it is essential that the characteristics must be analyzed to extract maximum power.

## Novel MPPT algorithm

The solar energy generated by the SPV array needs to be extracted in such a manner that it always extracts the maximum power [8]. For a grid connected system the MPPT algorithm has been discussed in [9]. As shown in Fig. 5 the operating point should be at MPP for all the conditions. The solar PV generation is connected to SL-SC based high gain dc-dc converter to achieve higher DC voltage at DC bus. Fig. 5 shows the main block diagram of Solar PV fed SL-SC based high gain DC-DC Converter for

## Measured results and discussion

The simulation study was made using PSCAD software to test the analysis of solar PV characteristics and also to validate the P&O algorithm study for 5 kWp solar PV systems. The closed loop controller has been implemented to track the maximum power. Firstly, the solar PV instantaneous voltage and current being measured and supplied the information to P&O algorithm. The algorithm output produces the voltage at MPP point and given to the controller. The closed loop controller initially compares

## Conclusion

This proposed paper presents the detailed investigation on solar PV characteristics and MPPT operation using P&O algorithm. The fundamental characteristics of solar PV under varying environmental conditions have been reported in this paper. The detailed operation of algorithm and mathematical approach behind the algorithm has been reported in this paper. The simulation study was performed and measure results were observed and reported in this paper. Finally, the P&O algorithm operations are

## CRedit authorship contribution statement

**Ramu Bhukya:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Writing - original draft. **Shanmugasundaram N:** Project administration, Supervision, Validation, Visualization, Writing - review & editing.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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