Analysis and Modeling of Partial Shading in PV Panel using Fixed Configuration

Dr. Hari Krishnan P
Assistant Professor
Department of Electrical and Electronics Engineering
Anna University, Regional Campus- Coimbatore

Sumitha R
PG Scholar
Department of Electrical and Electronics Engineering
Anna University Regional Campus- Coimbatore

Abstract - The power reduction in PV array due to two factors the major factor among them is due to partial shading and Another factor is array module interconnection scheme. this project proposes to the method known as fixed interconnection scheme for PV arrays by which partial shading effect is considerably reduced. The proposed method facilitates distribution of shading over the entire array scheme, thereby reducing the mismatch losses caused by partial shading. The MATLAB/SIMULINK techniques are used and the results are analysed thereby proving that the proposed PV arrays under partial shading conditions has been considerably improved. Experimental results are provided to validate the proposed approach using a laboratory experimental setup. A comparison is study made for 3 x 3 array and 6 x 6 reconfiguration scheme and building a best result.

Keywords— Array configuration, interconnection partial shading photovoltaic, solar.

I. INTRODUCTION

As of later the utilization of sustainable strength supply has become an captivating choice to fossil fuels due to the fact of the developing problem on the environmental troubles. PV is emerging as a promising solution due to the fact of the enhancements in the semiconductor technology. Since PV structures are distinctly is the expensive, researchers in the field of PV are concentrating more on enhancing the conversion efficiency of solar power Power systems.

There are more than a few elements that together with to the discount of output energy from PV arrays. One of the essential factors is two partial shading. Partial shading is triggered by way of the passage of clouds, buildings, towers, and bushes. The losses prompted are through partial shading are normally due to the electrical configuration.The reduction in strength relies upon on the module interconnection scheme and additionally the shading pattern.Different interconnection schemes such as series–parallel (SP), whole go tied (TCT), and bridge linked (BL) have been proposed in the literature of the modules in the array because a shaded module in sequence with different unshaded modules limits the string present day thereby reducing the maximum strength generated by way of the array. During fractional concealing condition, the traits bends of PV module suggests more than one pinnacle electricity focuses called Local Maximum Power Point (LMPP) and Global Maximum Power Point (GMPP).In that cases, a regularly unpredictable Maximum Power Point Tracking (MPPT) calculation w ion topology of the PV modules is upgraded so that the modules working underneath equal conditions ought to be associated in a comparable string. In any case, the high present and low voltage in parallel association requires reputable molding to the best level utilizing a appropriate DC-DC converter. In this manner, it is necessary to pick out the inferred setups. Different interconnection topologies have been proposed in the literary works to lessen the impact of halfway concealing. Be that as it may, each contrasts from one any other in time period of cost, multifactors of nature, and simplicity of execution.which can be forget the close by the forces will be most required. The electrical overall performance of a PV module with SP, TCT, BL, SS (simple series), and HC (honey comb) interconnection configuration is analyzed. The five interconnection schemes are in contrast for their maximum energy and fill aspect and it is found that the TCT configuration suggests a optimal performance over the different four configurations.An electrical reconfiguration scheme is proposed in which the reconfiguration approach is based totally on a controllable matrix of switches configuring the PV modules in a single string of parallel related rows related to the load. Under partial shading conditions, the matrix manage algorithm reconfigures the PV modules to optimize the modern-day of the single string, i.e., the output electricity of the system.However, in this technique of entails higher complexity and cost, when you consider that it requires a large range of switches and sensors for implementation. The impact of change in interconnections amongst the modules within a shaded PV array on its maximum power point (MPP) and a clear relationship between the interconnections of the PV modules and their strength output used to be proposed.

This paper introduces a fixed association strategy for arranging the modules to enhance the PV strength age under halfway concealed conditions. This shape diminishes the tournament of concealing in the modules of a similar line in this manner maximizing the yield energy from the cluster. The framework execution is researched for a number of concealing prerequisites on a 3×3 PV showcase with normal its interconnection plans and the consequences uncover that the proposed structure indicates familiar execution below midway concealed conditions. A correlation is likewise made between the proposed graph and a range of setups in enlargement to the electrical showcase reconfiguration (EAR) configuration apportion utilising a 5×5 PV exhibit.

II. SYSTEM DESCRIPTION

A. Modeling of a PV cell

A PV cell is modeled as a current source shunted with a diode and represented by an equivalent circuit shown in Fig.

1. The characteristics of the module are obtained by connecting a number of such cells in series.
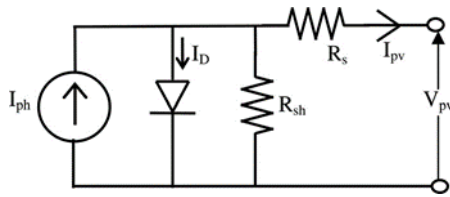

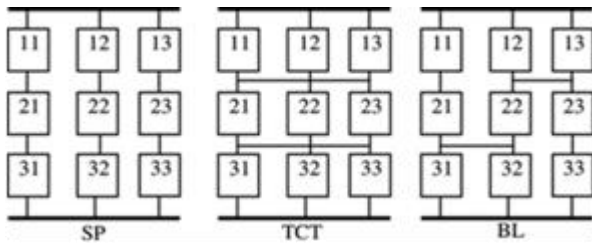Fig. 1. Equivalent circuit of a PV cell.

Fig. 2. Different interconnection schemes.

B. Conventional Interconnection Schemes

In a PV array, the interconnection scheme refers to the manner in which modules are interconnected in the array. The three widely used interconnection schemes mentioned in the literature are the SP, TCT, and BL configuration. The SP scheme consists of a series of panels in a string and a number of such strings are linked in parallel. The TCT configuration is ob- tained with the aid of connecting ties throughout each junction. The BL inter- connection scheme is derived from the connections in a bridge rectifier. Fig. 2 indicates the three interconnection schemes in a 3 X 3 PV array.

A study on the reachable module interconnections and their have an impact on on energy production are mentioned in the literature.Comparison of distinct interconnection schemes based on shading conditions and shading degrees displays the have an impact on of the interconnection schemes on generated PV power. The TCT scheme is considered to be the better scheme for reducing the losses underneath most of the shading conditions, although none of the schemes are located to be advantageous beneath vast shading condi- tions. In this study, a fixed interconnection scheme is proposed for lowering the losses for partial shading conditions. urbines are used in energy structures for the conversion of A PV cell is modeled as a today's grant shunted with a diode and represented through an equal circuit proven in Fig. 1. Connecting the modeling.

C. Methodology

The mismatch loss caused by way of partial shading is not propor- tional to the shading area but relies upon on the shading pattern. The fundamental goal of the proposed algorithm is to decrease the mismatch losses precipitated by way of partial shading by distributing its impact over the complete array using a constant configuration for all shading patterns.

First, consider the matrix of A with m n PV panels, which are electrically unconnected. The present algorithm proposes a method of renumbering the panels in such a way as to

disperse the partial shading effect. To disperse the effect, the electrical interconnections of the panels are made solely after renumbering the panels in such a way that currents getting into at unique nodes are equal. The modified (renumbered) matrix is denoted as B (m n). In both A and B matrices, m is the range of rows and n is the wide variety of columns.

1) Each subarray (irrespective of the location) must have the panels with distinct row indices where the subarray of an m x n PV array is chosen to be $(\sqrt{m})$ $(\sqrt{m})$).

2) Each row should have the panels with distinct row indices.

In order to incorporate the above considerations, the panels are divided into subarrays such that each subarray has panels with unique row indices. This ensures that the next column does not have any panel with matching row indices in the same row or group. The row indices of the panels in the third column are renumbered as $(i + 2f)$, and so on. This process is continued until the nth column for the case when m is not exactly divisible by f. When "m" is exactly divisible by "f", the aforementioned renumbering process is continued only until the stage when the row indices are not repeated for two panels in any row. This marks the completion of one cycle of renumbering (one cycle, for m/f columns). In total, "r" cycles occur, where r = floor [n/(m/f)]. In each cycle, an offset of x is added to the usual process (i.e., (j–1) f) for every additional cycle where "x" is incremented by 1. For instance, for the first cycle, "x" is zero, for the second cycle, "x" is one, and so on. This process is mathematically explained for an mn array.

In the PV array Amn , each panel is represented as Aij, where "i" is row index and "j" is the column index to which the mod- ule belongs. In this case, $i = 1, 2,.. .,m$ and $j = 1, 2,.. .,n$. The indices of the modules within the column in the array are renumbered using the proposed algorithm. The following steps are considered to create the modified PV array $Bm \times n$.

Step-I: Calculate f = (m), where floor function maps a real number to the largest previous integer.

Step-II: Calculate p = m mod f. (mod gives the remainder on division of m by f).

Step-III: In case p = 0, then k = i + (j–1) f, if k > m, then k = k mod m. To start with, the new array $Bkj = Aij$ for all i = 1 tom and j = 1 to n.

Step-IV: In case p = 0, then divide the n columns into r number of groups where r = [n/(m/f)]. The cell function maps a real number to the smallest following integer. If n mod (m/f) = 0, then (r–1) groups will have m/f columns in each and the remaining columns will be in rth group. Otherwise, every group will have (m/f) columns uniformly. The value of k = i + (j–1) f + (x–1), where x varies from 1 to r. If k > m, then k = k mod m. The new array $Bkj = Aij$ where i varies from 1 to m and j varies from 1 to n. Finally, the panels with the same row indices are connected in parallel and panels in the first column are connected in series in the new matrix (like TCT connection pattern of initial matrix). The renumbering of the modules using the proposed methodology is explained for   3 x 3, 5 x 5, and 6 x 6 PV array configurations. A flow chart describing the algorithm.

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1) 3 x 3 PV Array Illustration:

Consider an unconnected *3 x 3* PV array Here, *m = n = 3* and square root of "*m*" truncated to an integer (*f*) is equal to *1*. The value of "*p*" (*m mod f*) is equal to zero. Therefore, the row indices of the modules in the first three columns (*m/f = 3*) are renumbered uniformly. The modules in the first column remain the same as *k* is equal to *i*. The modules in the second column (*Ai₂*) are renumbered as *bk₂*, where *k =i+1*. Similarly, the modules in the third column (*Ai₃*) are renumbered as B*k3*, where *k = i + 2* for all *i = 1to m*. Finally, the panels with the same row indices (for example *11, 12*, and *13)* are connected in parallel and panels in the first column (namely *11, 21*, and *31)* are connected in series. The array terminals are taken out from both ends of the first column.

2) 5 x 5 PV Array Illustration:

Consider a *5x5* array in which the modules are arranged as shown in Fig. 5(a). Here, *m = n = 5* and square root of *m* truncated to an integer (*f)* is *2*. The value of *p* is *1*. Therefore, module *Aij* is renumbered as *Bkj* where *k = i + (j–1) f*. That is, the indices of the modules in the first column of *B* are the same as *A*. The module indices in the second column (*Ai₂*) are renumbered as *Bk₂* , where *k= i + 2*. Similarly, for the third, fourth, and fifth columns, the value of *k* is *i + 4, i + 6*, and *i + 8,* respectively, as shown in Fig. 5(b). It can be seen that any random subarray as well as any row of the array has the panels with distinct row indices. In addition, diagonals and subdiagonals in both orientations have also distinct row indices.

3) 6 x 6 PV Array Illustration:

Consider a *6 x 6* PV array . Here, *m = n = 6* and square root of *m* truncated to an integer (*f)* is *2*. The value of *p* is zero. Therefore, the array is reconfigured in accordance with *Step-IV* in the proposed algorithm. It is observed that any random subarray (consisting of *11, 52, 21, 62)* and row (consisting of *11, 52, 33, 64, 45, 26)* of the array have the panels with the distinct row indices respectively. the modules to be renumbered in each column for *6 × 6* PV array. To prove mathematically that the proposed configuration yields more power than can be obtained with the conventional TCT connection, a *5 x 5* array in which a shadow of size *2 x 2* is considered for both the TCT configuration and the proposed configuration.
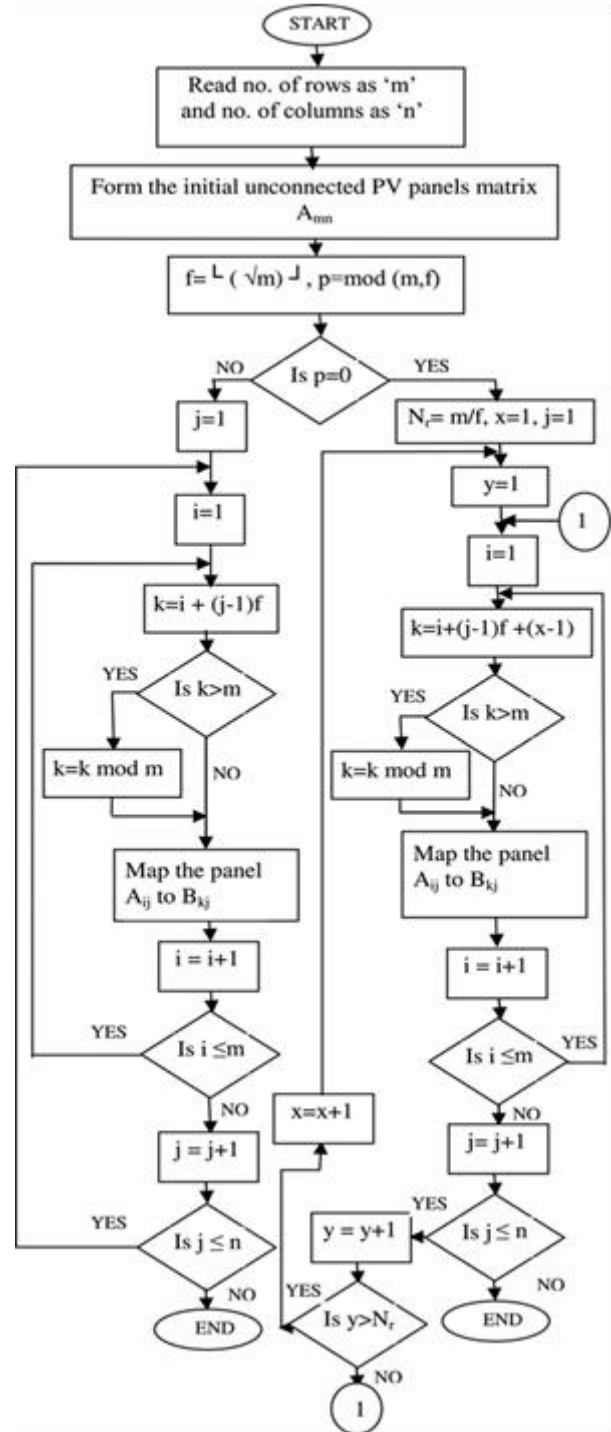

Fig. 3. Flow chart of algorithm for the renumbering of unconnected PV panels.

The fig 3 flow it will explained the step by step in previous section.the sections considering the matrix formation.

III. SIMULATIONS RESULTS

The simulations are carried out using MATLAB/Simulink environment. The specifications of the cell at standard test conditions are presented. All four configurations namely SP, TCT, BL, and the proposed configuration are compared for their losses under partial shading conditions. In order to validate the results obtained in simulation, a laboratory setup

was developed using nine PV cells of same rating. The insolation to these nine cells is provided by nine LED sources independently. The physical size and shape of the LED light is approximately similar to that of PV cell so that uniform insolation is provided. The LED light sources are powered by nine separate regulated power supplies to compensate minor dissimilarities in the PV cells. The insolation of light falling on the PV cell is controlled.
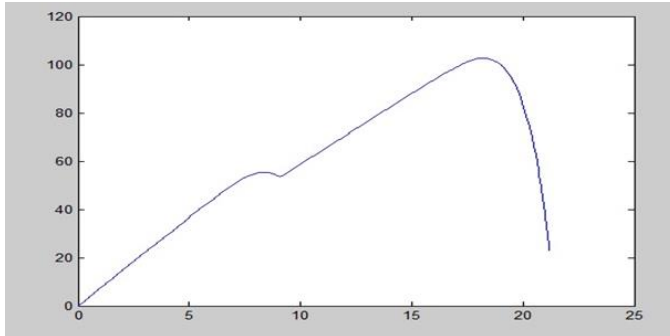

Fig 4.1 P-V characteristics of photovoltaic string under partial shading

This output was plotted between power and voltage, voltage and current. 8 cells receive irradiance of 1000 W/m2, the next 18 receive 800 W/m2, while the rest receive an irradiance of 500 W/m2.
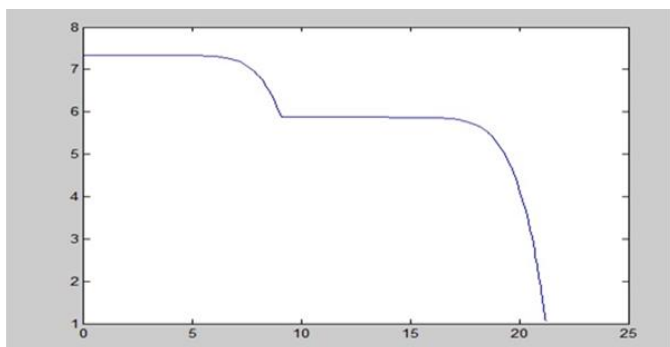

Fig 4.2 Effects of PV panel plotted between voltage vs current

It should be emphasized that the behavior of I–V and P–V characteristics, as well as the number of local maxima on the power curve, are dependent on the series-parallel configuration of the array. Output characteristics of the PV array at 800 W/m2 and 300 K under normal operation and 40% shading factor with different shaded modules I–V curves, P–V curves.
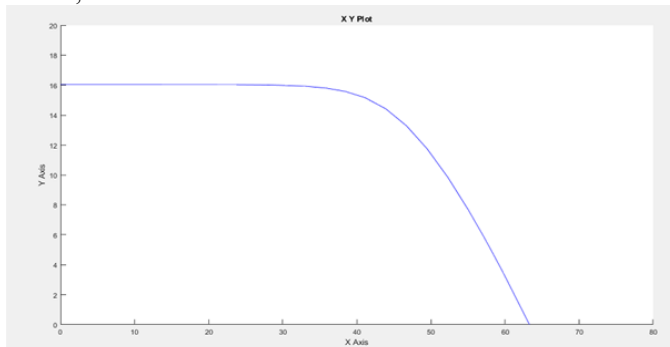

Figure 4.3 PV panel output plotted between current vs voltage plot

The shading factor is defined in the present paper as the ratio of the irradiation on shaded modules to that on unshaded modules. Figure 5.5 is assumed that all modules operate at the same temperature as partial shading is not likely to create substantial temperature difference between shaded and unshaded.
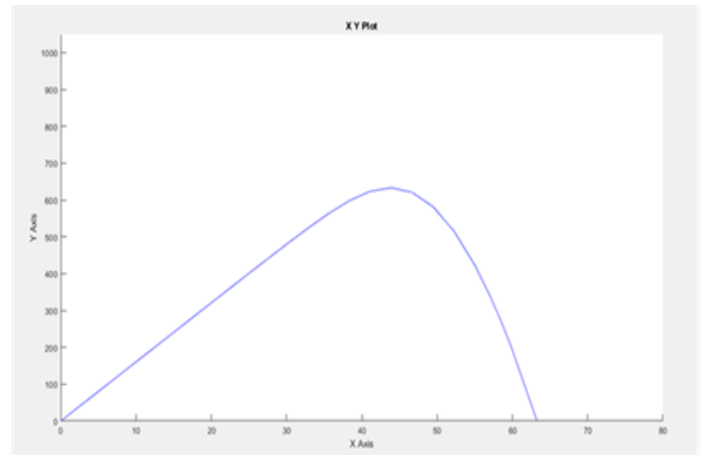

Figure 4.4 PV panel output plotted between power vs voltage.

The effect of PV panel plotted in figure 5.6. partial shading This hinders the power generation from the other modules in the array in all three conventional schemes.

IV CONCLUSION

A fixed interconnection scheme for large PV arrays, which enhances the PV power under different shading conditions is proposed in this project. The proposed structure facilitates distribution of the effect of partial shading over the entire array without any physical movement of the panels thereby reducing the mismatch losses because of partial shading. The performance of the system is investigated for different shading conditions. the simulation and experimental result show that the power extracted under partial shading conditions is greater with the proposed configuration compared with other configurations. It is also found that the EAR scheme and the proposed scheme yield the same power under different shading patterns. How-ever, implementation of the proposed scheme is significantly simpler and cheaper compared with the EAR scheme since it is onetime renumbering.

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