



Comparative Analysis of Various Configuration Techniques to Improve Performance of Solar PV Array

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Abstract: In this paper the study of PV array configuration is determine whether the configuration of a photovoltaic array minimize the effect of partial shading conditions. To study the effect of solar PV module on partial shading a module of size 5×5 of series (S), parallel (P) series-parallel (SP), Bridge-linked (BL) Total-cross-tied (TCT), and Honeycomb (HC) have been assembled. The results of proposed solar PV module configuration have been compared in terms open-circuit voltage, short-circuit current, global maximum power (GMPP), Local maximum power (LMPP), V-I Characteristics, etc. furthermore, mismatching power losses, fill factor efficiency and power productivity can be calculated to validate the proposed solar PV array configuration.

Index Terms - Series (S), parallel (P), Series-parallel (SP), Total cross tied (TCT), Bridge-linked (BL), Honeycomb (HC), by pass diode, blocking diode.

I. INTRODUCTION

Day-by-day the need of electrical energy is increasing rapidly and the conventional source of energy are diminishing fast, with corresponding rise in cost. Beside the very large use of conventional fossil fuels which are the initial source of energy causes the serious environmental problems [1][19]. Therefore infinite renewable, clean and inaudible creation of sin energy make it one of better elected source of sustainable energy [1][10][19].

As solar energy is one of the most abundant renewable energy and has further benefit related to other power systems also play the vital role in sustainable sector for energy creation of electricity subsists done front solar energy by using PV cells or panels[13][14][15]. Solar photovoltaic cell (SPV) is reliable are maintenance free cause of power production of power that implementation daylight to produce electrical energy and power [3][21]. While designing an inexhaustible Renewable generating System, energy efficiency and productivity factor must be carefully considered to get the best of efforts and investment [3][21]. Solar photovoltaic is worldwide going on to enhancing its consultation energy-saving and decreasing the range of panel.

Because of series-parallel combination of SPV module solar photovoltaic array is form to a desired voltage and current level [6][14][20]. Series connection output voltage is increase while parallel conjugate the out-turn power is increases[14][20]. The source of renewable energy is the most prefer source, many applications are their the Indian ministry of New and Renewable Energy (MNRE) has introduced schemes of central Financial Assistance (CFA). To promote solar energy in India to achieve aspiring target of 100gw capacity by 2022. The major support is aimed to give the subsidies to venture that are growth rapidly. There are many applications of renewable energy but the supply power for remote control is most convenient application of renewable energy.

II. PHOTOVOLTAIC MODULE

For simulation and implementation of photo voltaic cell, many models are used analyze performance. Every set up and module is an advancement over the previous one with few additional component and hardware. But as the improvement occurs due to accessory of extra hardware the modules complication increases. Among all existed models, one-diode and two-diode models are commonly used the problem is that some other live model are not precise and also require many parameters to model. In between two-diode model and one diode model, commonly one diode model is to contrivance because it essential only five framework to implement and photovoltaic solar cell and has sufficient accuracy. The merit of good limberness of single diode module estimate moderation due to irradiance and temperature change. This model is shown in figure.

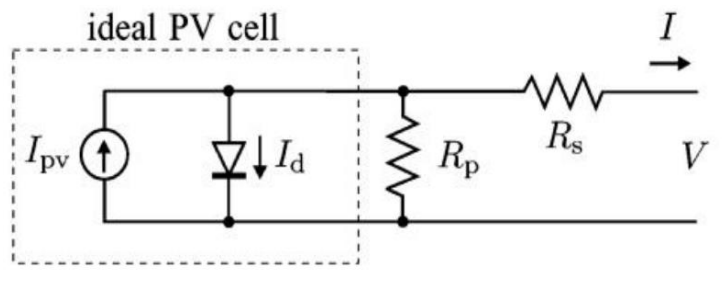


Fig.1. Comparable circuit of practical single PV appliance.

I-V characteristics equation of an ideal PV cell is given by:

$$I = I_{pv} - I_o \left[\exp \left(\frac{V+R_s I}{V_t a} \right) - 1 \right] - \frac{V+R_s I}{R_p} \quad (1)$$

Where I and IPV are the total current and photovoltaic (PV) currents, respectively.

$V_T = N_s k T / q$ represents thermal voltage of the array where N_s is number of cells in series.

The saturation current and photovoltaic (IPV & Io) can be given by:

$$I_{pv} = (I_{pv,n} + K_1 \Delta t) \frac{G}{G_n} \quad I_o = (I_{o,n} + K_1 \Delta t) \frac{G}{G_n} \quad (2)$$

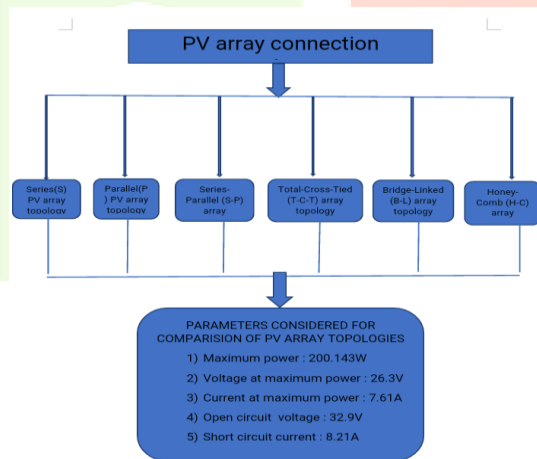
$$I_o = \frac{I_{sc,n} + K_1 \Delta t}{\exp \left(\frac{V_{oc,n} + K_2 \Delta t}{a V_t} \right) - 1} \quad I_o = \frac{I_{sc,n} + K_1 \Delta t}{\exp \left(\frac{V_{oc,n} + K_2 \Delta t}{a V_t} \right) - 1} \quad (3)$$

Where,

$A_t = T - T_n$ (T and T_n shows the actual and nominal temperatures [in Kelvin], respectively),

G stands for irradiation on the device surface in watts per square meters,

G_n stands for nominal irradiation, and K_1 and K_2 stands current and voltage coefficient respectively.



A. Series Configuration

When the PV array operates under uniform irradiance condition, all the PV modules produce same short circuit current and generates the maximum power [2][3][23]. The PV array current is restricted by the stunted irradiance on PV module. In this connection same current should flow from PV modules. Therefore, in the shaded modules production of short circuit current is equal to unshaded PV modules by the operation of reverse bias condition [10]. This is the only reason the operation of shaded modules in reverse bias, instead of delivering power they will definitely dissipates the power as in high temperature (heat) and causes hot spots on PV modules. Straight for the guarded operation of modules from hotspot effect. Each PV module bypass diodes are connected in antiparallel [1][2][10]. Due to the irradiances the voltage difference occur in between the PV modules under forward biases bypass diodes. These diodes share portion of the short circuit current of the shaded modules and improves the power generation capability by representing multiple MPPs on output characteristics of S- PV array[23].

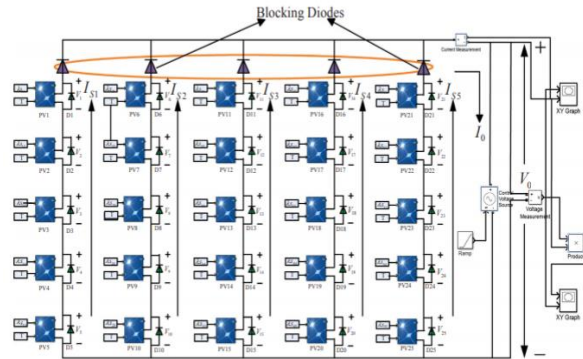


Fig.2. Simulink model of series(S) PV array Configuration.

B. Parallel configuration

In this topology all the PV modules are connected in parallel [2][5][10][19][25]. In parallel configuration voltage in equal to module voltage on current in array is separate PV module is the individual PV modules [5]. Current produces from each PV module flows without any limit in this topology regarding irradiance level. Therefore parallel interconnected PV system operates more effectively under rapidly varying solar irradiance level.

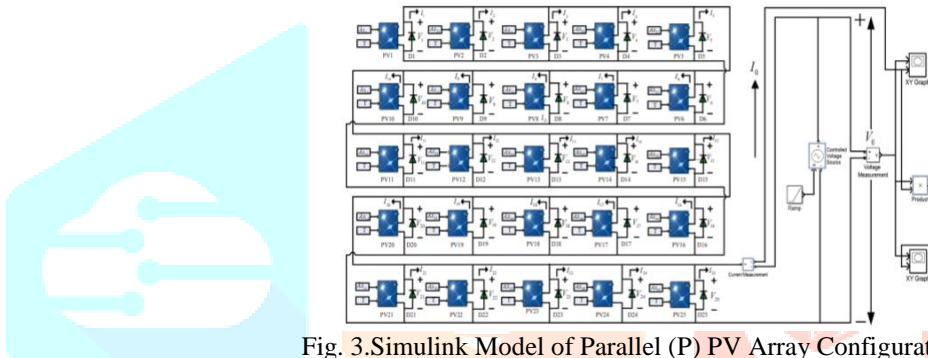


Fig. 3.Simulink Model of Parallel (P) PV Array Configuration

C. Series-parallel configuration

In a series-parallel structure, the series connected module strings are connected in parallel to from series-parallel configuration [10]. For the production of essential current in series-parallel configuration modules are first connected in sentence then in parallel fashion to meet required voltage [4][6]. The construction of series connection is easy, economical and there is no unnecessary connection. Therefore, the series combination is most commonly use in PV array [23]. Series-Parallel configuration furnishes higher power of significant voltage and current value. Hence it can be the reason that series-parallel Configuration invalidate the imperfection if series and parallel Configuration.

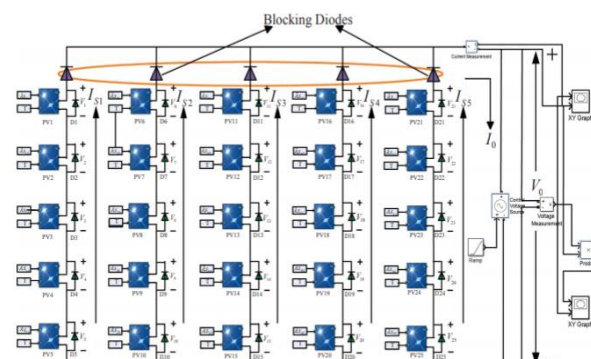


Fig. 4.Simulink model of Series-Parallel (S-P) PV array Configuration.

D. Total-Cross-Tied Configuration

Total-cross-tied configuration is obtained from series-parallel configuration. In T-C-T modules of PV array first connected in parallel and those parallel connected module are connected in series to produce appropriate power [4]. The Total-Cross-Tied Configuration, as the most complex type, connects each individual module in series and parallel with the other one at the same time.

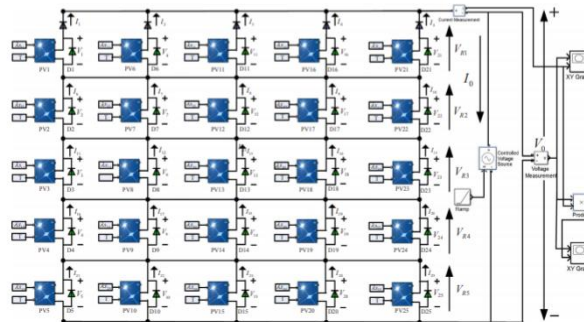


Fig. 5. Simulink model of Total-Cross-Tied (TCT) PV array Configuration.

E. Bridge-Link Configuration

Bridge-link configuration include some additional connection with respect to the series-parallel case [10]. As the number of series connection increase as the same manner the power loss production is increase in series-parallel topology between module in string for power loss reduction in series –parallel all cells or models they are connected in bridge rectifier architecture [5]. Entire bridge are tied to acquire the appropriate value of output and currents by adding the voltages in series and currents in parallel.

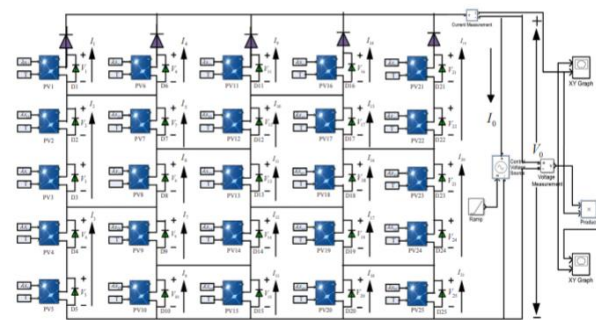


Fig. 6. Simulink model of bridge-link (BL) PV array Configuration.

F. Honeycomb Configuration

Honeycomb Configuration is the modification of Bridge Link configuration. The ties selection is a most supreme factor in honeycomb configuration. Therefore the ties can be connected in variant of two, four and six module [4]. The disadvantages of series and series-parallel PV array configuration can be overcome by employing HC PV array configuration. The PV modules are connected as same as to the hexagonal shape of HC architecture in this configuration [23]. The H-C PV array having less number of series connections compared to series and series-parallel configuration. As compared to series and series-parallel configuration are power losses are less.

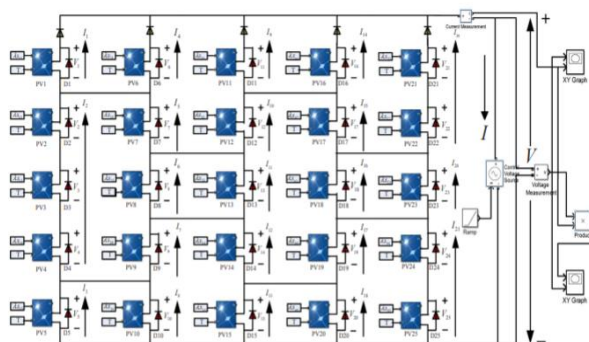


Fig. 7. Simulink model of Honeycomb (HC) PV array Configuration.

III. CONCLUSION

PV energy which is one of the energy which comes under the most favorable energy resources. A diversity of topologies prefer in this publication of review paper. Different configuration like series (S), parallel (P), series-parallel (SP), Bridge-link (BL), total-cross-tied (T-C-T), Honeycomb (HC) are analyzed. By analyzed this configuration it is observed that as the number of series connections increases the mismatching power loss increase. It is observed and analyzed that by adding the bypass diode the mismatching power loss are mitigated significantly.

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