Performance Analysis of Reconfigurable PV Module under Partial Shading Condition with Different Topologies

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Abstract:

Photovoltaics (PV) cell are a device that converts incident light into electricity. Thus far, PV arrays have had a fixed topology. Depending on the voltage and current rating the number of PV cells are connected in series and parallel respectively. However, in case of partial shading, mismatch or failure in a single PV cell in a given row, the current delivering capacity of the whole row get affected. Since the current in a given row is determined by the weakest PV cell in that row. If not taken care then it can lead to forward biasing of healthy PV cell in a module. Hence, instead of producing electricity these PV cells will start consuming it. Therefore, the forward biasing of PV cells can lead to reducing the efficiency of the whole PV module. Additionally, mismatch or partial shading can lead to hotspot creation that can lead to damaging whole PV module. Therefore, to reduce forward biasing of PV cells and hot-spot, a bypass diode is connected across a group of four PV cells.

Recently, besides the typical series-parallel topology, Total Cross-Tied (TCT), Bridge Link (BL) and Honey-Comb (H-C) based PV module's performance in various shading condition was analyzed. Each configuration has its advantages and disadvantages. However, compared to the typical series-parallel PV module, these other topologies performed much better in reducing the effect of partial shading.

In past years, a PV module embedded with CMOS switches have shown better capability in dealing with partial shading. Additionally, they can switch between different configuration in real time

that can enable in creating a power island. Hence, based on the load requirement the PV module's configuration can be switched to match power supply with demand.

In this presentation, we will present a comparative analysis between the PV module embedded with CMOS switches with different PV module configuration (TCT, BL, and H-C) operating in different shading condition. The simulation and performance analysis of PV array will be done using MATLAB and Spice. This analysis will help in understanding how each configuration responds to various partial shading conditions. Additionally, this study will be beneficial for the PV module that are used in residential home and commercial buildings. Since the PV modules that are used in solar farms have the capability of sun tracking to maximize the power generation. Whereas, the solar panels installed in the residential home and commercial buildings are standstill due to the limitation of space.