CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
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Project Number
S0904

Project Title
Characterization of Series-Parallel and Total-Cross-Tied Solar Modules

Abstract

Objectives/Goals
The objective of this project is to determine if solar modules in the total-cross-tied (TCT) configuration can generate higher maximum-power than those in the series-parallel (SP) configuration.

Methods/Materials
Six 4x4 solar modules were assembled and characterized, three in the TCT configuration and three in the SP configuration. In the SP configuration, solar cells were connected in series to form a column. Several columns were then connected in parallel to each other to form a module. The TCT configuration was obtained from the SP configuration by connecting ties across each row of interconnects. Performances of the modules were measured and compared under four operating conditions: 1) modules with proper wiring connection and under uniform illumination, 2) modules under uniform illumination but each with a short circuited solar cell, 3) modules under uniform illumination but each with an open circuited solar cell, and 4) Each module with a solar cell completely blocked from illumination. In addition to experiments, equivalent circuit model parameters were extracted and circuit simulations performed to validate measurement results.

Results
When all internal wires were properly connected and the modules were uniformly illuminated, both configurations exhibited nearly identical performance. In the presence of a short-circuited cell, however, the SP module outperformed the TCT module in terms of maximum output power. Conversely, in the presence of an open-circuited or shadowed cell, the TCT module outperformed the SP module. A completely shadowed cell was found to behave like an open-circuited one. Circuit simulation results agreed with measurement data very well.

Conclusions/Discussion
Although a solar module in the SP configuration has the simplest wiring configuration and one in the TCT configuration is the most complete, the latter does not always outperform the former. Therefore, the choice of an optimum solar module configuration depends on which non-ideal operating scenario is most likely to occur.

Summary Statement
Solar modules in the total-cross-tied and the series-parallel configurations were compared experimentally and by simulation, and it was found that the choice of an optimum configuration depends on the operating scenario.

Help Received
Mr. Peter Starodub, my science research teacher, guided me throughout the entire scientific research project. My parents provided support and supervision for online procurement and experimentation at home.