Real-Time Anticipation and Prevention of Hot Spots by Monitoring the Dynamic Conductance of Photovoltaic Panels

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Abstract— Photovoltaic (PV) panels that experience hot spots suffer physical harm, lose power, have a lower lifetime reliability, and have higher production costs. In spite of on panel bypass diodes, the traditional mitigation method, the issue frequently approaches 100 C in ordinary monocrystalline- silicon panels. Hot spots can form in any string of cells that gets unequal illumination. The power lost in a cell that is subjected to reverse bias is restricted by bypass diodes, although hot spots still develop. Instead of forcing a partially shaded cell into reverse bias, Kernahan (Kernahan, 2015) proposes an alternative control strategy that senses the dynamic conductance |dI/dV| of a string of cells in real time and modifies its operating current.

Index Terms— **PV panels with hotspot prevention, maximum power point trackers, photovoltaic cells, photovoltaic systems, and solar energy production.**

I. INTRODUCTION

AGROWING body of literature recognizes the dangers of hot spots formed in photovoltaic panels as shaded cells are forced into reverse bias [2]–[18]. Bypass diodes were considered an acceptable mitigation technique prior to 2000, but since that time the power generated on a panel has increased by a factor of three, providing three times the power to feed a hot spot. Kernahan's technique constantly monitors the dynamic conductance of a string of cells, defined as the absolute value of the local slope $G = |dI/dV|$ at the operating point on the I-V curve. (We will use a tilde to indicate the dynamic conductance, g for a cell and for a string.) As discussed in Section III, a shaded cell that is in danger of being forced into reverse bias by the fully illuminated cells in the string exhibits a progressively smaller cell conductance, which quickly dominates the conductance of the entire string. Kernahan's technique simply adjusts the string current to keep G above a minimum value (see (2)) that assures that no cell in the string has entered reverse bias. Finally, in Section V, we summarize our findings and highlight significant PV panel layout simplifications made possible by HSP functioning of the panels—without bypass diodes.

II. RELATED WORK

A single shaded PV cell in a string of 20 or 24 cells can easily generate a hot spot, just as an isolated cell placed into reverse bias does, unless the string's current is kept low enough. which three cells indicate a longer string. Initially, all cells are fully and equally lit and so operate at the same point on their common I-V curves, which is usually the MPP.. A string of three identical, fully and equally lit PV cells operates at the same position on their shared I-V curves. All Committees: Due to PV3 shading, dark dots represent the initial operating points and red dots represent the final operating points.

III. THE PROPOSED MECHANISM

To acquire a better grasp of the HSP panel's performance—particularly at the cell level, which is difficult to measure directly—we approximated the reaction of a string. The Kernahan algorithm was used to manage the partial darkening of 230 cells. We employ a static version of the cell model developed in [5], disregarding capacitive and inductive effects that are insignificant below 1 kHz. The model estimates the photocurrent iPhoto for a given light and takes temperature into account. The model then solves iteratively for the voltage across the diode and shunt resistor for a given I cell, yielding the voltage across the cell.

IV. PERFORMANCE EVALUATION

This technique whether of traditional construction under MPPT control or of the HSP variety. Rooftop solar setups typically combine the output of Np = 10 to 20 panels wired in series. As a result, comparing an array of conventional panels with power optimizers against an of HSP panels boils down to the single- panel comparison stated above. Furthermore, the HSP controller's estimated cost of $83 is comparable to that of commercially available optimizers.

Fig.1 Output

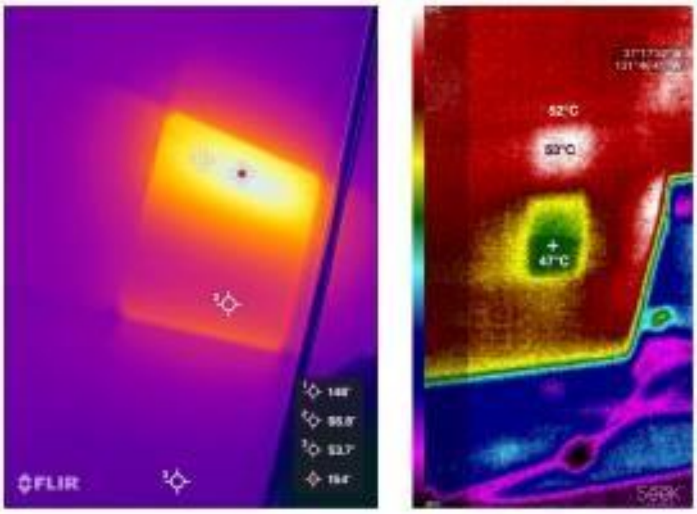

Fig.2 Panel

V. CONCLUSION

Over the last decade, a body of research has aimed to keep unshaded cells producing full power even when connected in series with shaded cells [22]-[25]. In a technique known as differential power, sophisticated power electronics have been used. DPP stands for data processing. We believe that the cost and stability of current DPP systems pose barriers to the technique's broad implementation. Kernahan's real-time solution for preventing hot spots in PV panels, on the other hand, is no less financially viable than routinely used power optimizers, and its usefulness has been experimentally verified. While the panel described here used quarter-sized cells cut from standard 15-cm cells to reduce on-panel ohmic losses (and to allow the use of defect- free portions of defective full-sized cells), the approach also works with full-sized cells. It eases manufacturing limits on cell uniformity and eliminates the need for costly heat- resistant glass coatings, but a head-to-head comparison of their output power with that of conventional panels under a variety of shading situations is still required and is in the works.

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