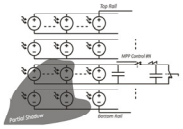
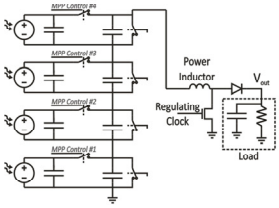
Power Conditioning for Organic Solar Cells

ACHIEVEMENTS: A new method for extracting power from organic photovoltaic cell arrays has been developed. The technique, called Time-Domain Array Reconfiguration (TDAR) improves overall system efficiency by 30%-50% over fixed-array techniques. These efficiency improvements are enabled by a novel approach to harnesses efficiency at the system level, analyzing the trade-off between maximizing the efficiency of each PV cell, operating the power converter circuits at a high efficiency, while maintaining a low system complexity.

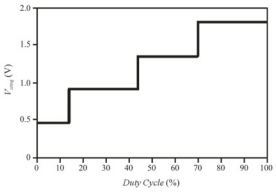
The Problem of Partial Shading



The TDAR Architecture Solution



Array Output with Duty Cycle



TDAR uses duty cycle to get each cell as close to the maximum power point transfer (MPPT) as possible)

Comparison to other Techniques

Technique	$EQE_{p.}$	$\varepsilon_{power\_conditioning}$	Complexity
Fixed Array	50% of MPP	High	Low-Moderate
Parallel Cells	Close to MPP	Low	High
Array Reconfig.	Close to MPP	High	High
TDAR	Close to MPP	High	Low

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IMPACT: The novel TDAR architecture allows photovoltaic cells to be partially shaded while still approaching their point of maximum power transfer to the overall array output. Instead of bypassing inefficient cells (whether by shading, degradation, or some other issue), the TDAR technique uses duty cycle to manipulate each cell close to its maximum power point (MPP).

DISCUSSION: In this work, we have developed a novel photovoltaic array architecture that uses organic solar cells to operate in a range of partially shaded or otherwise compromised environments (where full illumination is not possible). The architecture enables power output in these compromised situations higher and more efficient than other architectures without prohibitive system complexity. The photovoltaic array control is fabricated on silicon and integrated with organic photovoltaic cells to reduce overall system size, complexity, and cost, while still achieving efficiency improvements over other means to assemble photovoltaic cells.

KEY PERSONNEL:
University of Washington: Vaibhav Vaidya, Alex Jen, Denise Wilson, Hin-Lap Yip