Maximize Solar Power Using Reconfiguration Circuits

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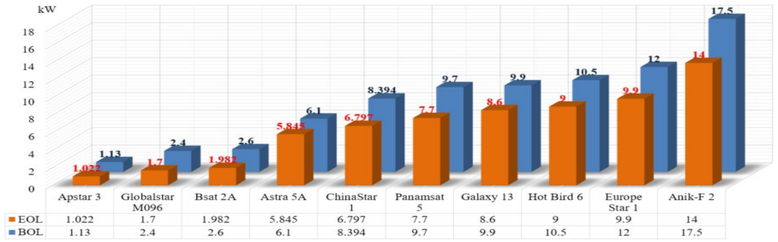
IEEE-Eta Kappa Nu

Motivation



	Apstar 3	Globalstar M096	Bsat 2A	Astra 5A	ChinaStar 1	Panamsat 5	Galaxy 13	Hot Bird 6	Europe Star 1	Anik-F 2
EOL	1.022	1.7	1.982	5.845	6.797	7.7	8.6	9	9.9	14
BOL	1.13	2.4	2.6	6.1	8.394	9.7	9.9	10.5	12	17.5

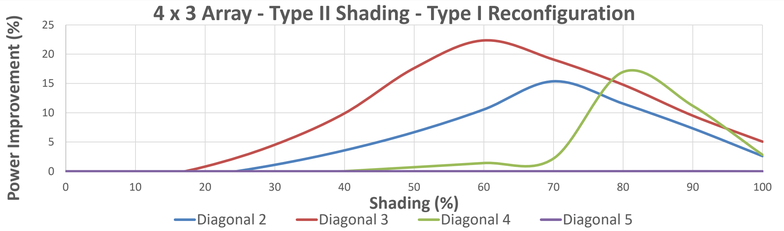
Spacecraft BOL vs EOL

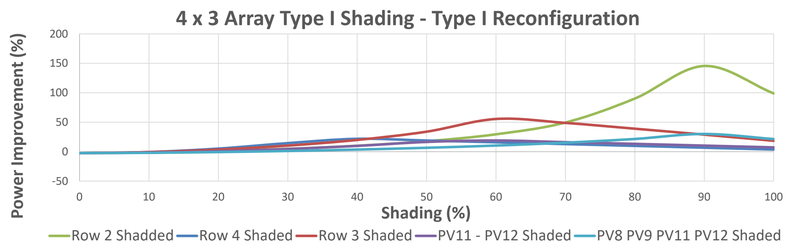
- Can terrestrial solar power be more efficiently extracted with innovation in reconfigurable hardware and algorithms?
- Preliminary research in spacecraft solar systems (where array performance can degrade from 20% to 50% over a 15-year mission) shows promise in significantly increasing available power using array reconfiguration.
- This research explores using innovative hardware, including low-loss electronic power switches, to bypass or reconfigure solar cells affected by shading.
- This approach may potentially improve output solar efficiency by up to 30% over the system's lifetime

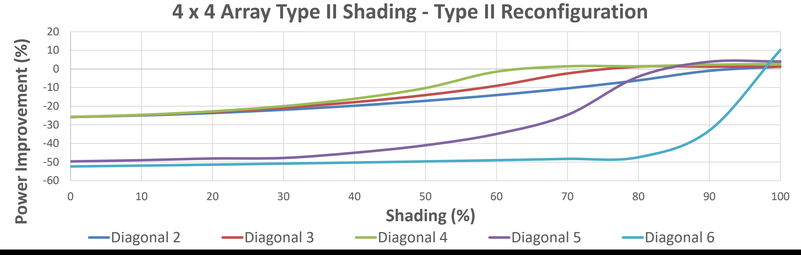
Research Focus

- Optimize and measure the reconfiguration methods of a solar array using a Total-Cross Tie (TCT) structure.
- Observe the effect of shading on asymmetric and symmetric solar array structures.
- Review data, document meaningful results, and publish in a scholarly paper.
- Define an algorithm that scales and minimizes the switches needed to reconfigure a TCT array

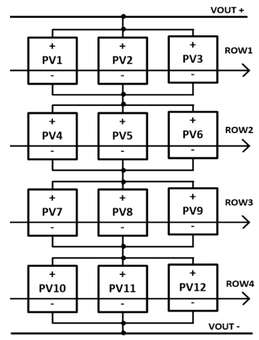
Power Improvement



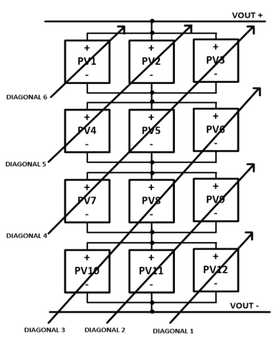




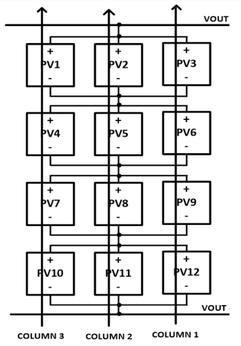
Shading Patterns



Horizontal

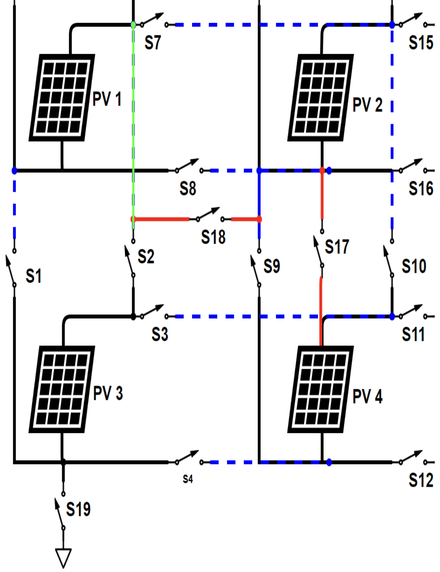


Diagonal



Vertical

Modeling the Algorithm



- Each PV has 4 switching devices.
- Stacking in an array gives: $4mn$
- A cross-tie is needed between rows and columns: $(m-1)+(n-1)$
- At the module termination some switches are not needed: (-2m -2n)
- Two control switches are needed at ground and Vout.
- Simplifying too: $S_{m,n} = 4mn - m - n$

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