Module-Integrated Power Converters Based on Universal Dock

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PHOTOVOLTAICS

Primary Goals

- ACPV module

> *"A complete, environmentally protected unit consisting of solar cells, optics, inverter, and other components, exclusive of tracker, designed to generate AC power when exposed to sunlight."*

- Cost-reduced microinverter
  - HVM cost of $0.10/watt
- Universal "dock" for PV modules
  - Industry standard for PV electronics

ACPV Modules

- PV module with AC, rather than DC, output
- ACPV module ships as complete, pretested, AC power generation
- Module-level communications

- Lower levelized cost of energy
  - Better energy harvest versus string inverters
  - Simplified system installation and design
  - No inverter to install, stock, specify, etc.
  - Lower repair and maintenance costs

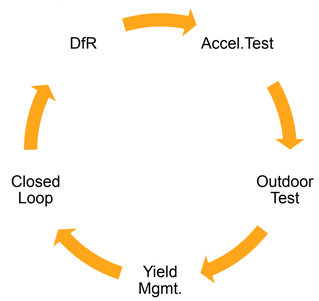
Microinverter Challenges

- Reliability
  - < 0.2% annual failure rate
  - No electrical wear-out mechanisms
- Efficiency
  - Compete with string inverters
  - Residential, 94%-96%

- Cost
  - Today's costs dropping, but higher than string inverters
  - But, must factor in installation, module, and warranty/replacement costs

Meeting The Reliability Challenge

- Design For Reliability
  - Component derating
  - Proven component technology
  - Careful vendor selection / management
  - Layout, solder joint reliability, etc.
  - Package/enclosure
  - Thermal management
- Accelerated testing
- Outdoor testing
- Yield management
- Closed loop feedback

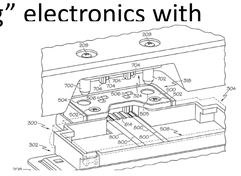


Meeting the Cost Challenge

- Offsets
  - Downstream cost savings achieved by complete integration
  - Reliability must be high enough to accrue to lifetime cost benefit
    - Don't pay for it twice
    - No truck roll, no headaches
- Electronics improvement
  - Economy of scale
    - High volume (>1M) of nearly identical microinverters
    - OEM supply model reduces inefficiencies
  - Leverage commodity components from power supply industry
    - Power FETs, passives, microcontrollers, etc
  - Much higher switching frequencies = smaller passives

Universal PV Interface

- Universal PV Interface (UPVI)
  - Develop industry standard for "docking" electronics with PV modules
  - http://www.upvi.org



- Partner with major PV vendor
  - Joint development of "PV Dock" to meet UPVI standard
- Remove barriers to market development of integrated electronics
  - No "razors and blades " approach
  - Remove cost of DC wires, connectors
  - Define the socket
  - Innovate in the electronics , compete for sockets

SunShot U.S. Department of Energy