Lower Cost and Higher Performing PV Systems

Optimize PV Systems  Repower PV Systems  DC-Coupled Storage  Monitoring and O&M
Ampt String Optimizers Deliver Unmatched Value

- Optimize PV Systems
- Repower PV Systems
- DC-Coupled Storage
- Monitoring and O&M

V1500 Series
- Max system voltage: 1500 V
- Max output power: 27.7 kW

V1000 Series
- Max system voltage: 1000 V
- Max output power: 11.4 kW

V750 Series
- Max system voltage: 750 V
- Max output power: 8.7 kW

V600 Series
- Max system voltage: 600 V
- Max output power: 6.8 kW

Ampt CU
- Two-way Wireless (RF)
- String-level data for O&M
Innovative DC power management

MPP Tracking on each string eliminates mismatch.
Programmable output adapts to meet inverter and energy storage requirements.
Optimize PV Systems  Repower PV Systems  DC-Coupled Storage  Monitoring and O&M
Optimize PV Systems
Advantage of Optimized vs. Conventional Designs

**Optimized**
- More energy from string-level MPPT
- 2x number of modules per string
- 50% fewer combiners and disconnects
- 50% fewer homeruns and smaller wire
- Increase inverter rated output power to lower cost per watt

**Conventional**

Inverter with Ampt Mode®
More Energy Through Mismatch Correction

Central Inverters
1000’s of Modules per MPP Tracker

Large String Inverters
100’s of Modules per MPP Tracker

Ampt String Optimizers
10 - 30 Modules per MPP Tracker (72 cell)

More Energy

Smaller MPP zones = better correction for mismatch
Ampt String Stretch® Technology Allows 2x Longer Strings

- Output current limits allow cable ampacity to be reduced as it no longer requires margin for “over sun” conditions
- High and fixed DC bus voltage lowers current (I=P/V)

50% fewer combiners and less cabling to save on cost
**Lower Cost Inverter with Ampt Mode®**

Increasing inverter rated output power lowers cost per watt

<table>
<thead>
<tr>
<th></th>
<th>Standard</th>
<th>Ampt Mode®</th>
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</thead>
<tbody>
<tr>
<td><strong>DC electrical</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max array input voltage</td>
<td>1500 V</td>
<td>1500 V</td>
</tr>
<tr>
<td>Input voltage range</td>
<td>850 - 1500 V</td>
<td>1350 V Fixed</td>
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<tr>
<td>Rated input voltage</td>
<td>850 V</td>
<td>1350 V Higher</td>
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<tr>
<td>Max operating input current</td>
<td>3200 A</td>
<td>3200 A</td>
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<tr>
<td><strong>AC electrical</strong></td>
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<td></td>
</tr>
<tr>
<td>Rated output voltage</td>
<td>600 V</td>
<td>800 V Higher</td>
</tr>
<tr>
<td>Rated output current</td>
<td>2300 A</td>
<td>2300 A</td>
</tr>
<tr>
<td>Rated output power</td>
<td>2400 kW</td>
<td>3200 kW 33% 33% ↑</td>
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</tbody>
</table>
Repower PV Systems
Repower Existing PV Systems

**Improve System Performance**

- More energy with dual MPPT
- Ampt delivers full available power at voltage set by existing inverter (no communications required)

**Low Cost Solution**

- Enhanced O&M with string-level data via optional wireless communication
- Mounts easily
- Low cost retrofit uses existing cables and half the number of combiner circuits
3 Ways to Repower Systems with Ampt

Recover Energy

Recover energy lost from mismatch and degradation to increase production.

Upgrade Inverters

Upgrade inverters over time as each one ends its lifecycle with the newest inverter technology.

Expand to High DC/AC Ratio

Expand array size mixing new and legacy modules without overloading inverter to increase revenue.
Deploy on Existing Wiring, Combiners & Inverter

Before Upgrade

1. Disconnect strings from combiner
2. Connect one string to each Ampt input using existing cables
3. Connect Ampt output to combiner
4. Set inverter to constant or narrow-range voltage operation

Simple drop-in use for low-cost installation
String optimizers recover ~33% of annual losses

Repowering date determined by value of energy and degree of degradation

Upgrade Inverters

As each inverter ends lifecycle:

- Replace legacy inverters with the newest inverter technology
- Use 1000-volt inverters at full rated power in 600-volt systems
- Use 1500-volt inverters at full rated power in 1000-volt systems

Ampt avoids costly re-wiring and re-trenching while lowering the cost of replacement inverters
Optimizer delivers full available power at the voltage set by inverter

Ampt optimizers serve as an “adapter” between legacy arrays and modern inverters
Use Modern Inverters as Low-Cost Replacements

Ampt works with both central and string inverters

<table>
<thead>
<tr>
<th></th>
<th>Standard</th>
<th>With Ampt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum system voltage</td>
<td>1000</td>
<td>600</td>
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<tr>
<td>Input voltage at full power</td>
<td>480 – 850</td>
<td>550</td>
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<tr>
<td>Output power</td>
<td>500kW</td>
<td>500kW</td>
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<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Maximum system voltage</td>
<td>1500</td>
<td>1000</td>
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<tr>
<td>Input voltage at full power</td>
<td>850 – 1250</td>
<td>950</td>
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<tr>
<td>Output power</td>
<td>1MW</td>
<td>1MW</td>
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</tbody>
</table>

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Expand to High DC Ratio

Before Upgrade

- Add higher power modules to existing strings
- Add new strings to existing combiners
- Save 50% on EBOS when adding new sub-arrays

Ampt (2:1)

- Protects existing inverter from exceeding DC loading limits
- Eliminate mismatch losses between strings

Existing Inverter

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Mix new and legacy modules on the same inverter

MPPT eliminates mismatch between strings

Each string delivers full available power at a higher and narrow DC bus voltage
Higher DC/AC Ratio Delivers More Energy

AC Power (W) Over Sun Day

Higher production improves ROI

With Ampt, deploy high DC/AC ratio systems without overloading existing combiner boxes, cables, or inverters
Ampt Repowering Solution Delivers a High Return on Investment

15-30% return on investment
- Typical return projected over the system life

Maximized annual project revenue
- Generate more energy over the system life

Lowest cost upgrade option
- Use existing wires & combiners
- Use existing inverters

Future-proof inverter replacement
- Upgrade with low-cost, modern string or central inverters
- No re-wiring or re-trenching
DC-Coupled Storage
Ampt DC-Coupled Cost Advantage

AC-Coupled Storage

Ampt DC-Coupled Storage

More energy from string-level MPPT
2x modules per string
50% fewer combiners
50% fewer homeruns
50% lower cost battery converter
Higher DC/AC ratio (up to 3:1)
Increase inverter rated output power to lower cost per watt
Fewer transformers and switchgear

Lower Cost & Higher Performance

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Ampt DC-Coupled Performance Advantage

Storage Roundtrip Efficiency
Achieve higher roundtrip storage efficiency while increasing the operating efficiency of the inverter and battery converter.

Curtailment Harvest
Capture array power that would normally be lost by charging the battery during periods of AC power curtailment.

Mismatch Recovery
Deliver more energy by recovering mismatch losses from various sources with string-level maximum power point tracking (MPPT).

Clipped Energy Harvest
Charge the battery when the PV inverter is clipping output power. Ampt enhances this benefit with higher DC/AC ratios (up to 3:1).

Low Voltage Harvest
Charge the battery storage system when the array voltage is below the inverter turn on voltage to maximize energy production.

Mitigate Degradation
 Recover energy losses caused by variable degradation of PV cell and modules within a system to improve lifetime system performance.
Superior Storage with Ampt

Performance advantage
- Higher roundtrip efficiency
- Capture more energy
- Mitigate degradation

Reduced system cost and complexity
- Lower cost power conversion
- Standard or bi-directional inverter
- Lower cost EBOS

Scalable and flexible
- Micro-grid to large power plants
- Add storage over time with less hardware cost
- Battery technology independent

With Ampt, the PV array is Storage-Ready™ and scalable in the future
Monitoring
Optional String-Level Data for Improved O & M

Ampt String Optimizer
Wireless communication reports:
- String output current
- String daily integrated energy output

Communication Unit
- Modbus / TCP
- ±0.25% measurement accuracy
- 1 minute data interval
- Local data storage
- Power over Ethernet (PoE)

On-site Monitoring

Your Gateway

Your Ops Center

Your Customer’s Monitors

Your Data Center

On-site Monitoring

Your Gateway