RESIDENTIAL PV OPTIMIZATION WITH SMA POWER+ SOLUTION
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WHAT IS SMA POWER+

SMA Power+ is the combination of the Sunny Boy string inverter line paired with a unique MLPE technology platform that allows for optimization to be deployed exactly as needed - every time, every system.

Selective deployment
for one specific need (e.g. shading)

<table>
<thead>
<tr>
<th>TS4-O</th>
<th>No communication to optimizers required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunny Boy US-40</td>
<td></td>
</tr>
</tbody>
</table>

Full deployment
for multiple needs (shading and shutdown)

<table>
<thead>
<tr>
<th>TS4-O</th>
<th>Wireless communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gateway</td>
<td></td>
</tr>
<tr>
<td>Sunny Boy US-40 with Rooftop Communications Kit</td>
<td></td>
</tr>
</tbody>
</table>
TS4-R
MODULE RETROFIT VERSION

> Designed to work with any PV module as an easy add-on unit

> Selective functionality empowers greater choice

> Slide on tool-free installation

> Replace cover, not module – no rewiring, no need to adjust the physical position in the array, etc.
POWER+ TS4-R UNITS

**TS4-R-S  Shutdown**
- Module-level data – power, voltage, current
- Manual or automatic shutdown
- NEC 2017 690.12 (B)(2)(2) Rapid Shutdown compliant ahead of Jan 1, 2019

**TS4-R-O  Optimization**
- Optimizes the string power in shading, mismatch, multiple orientations/string
- Is NOT doing MPPT at module level
- Only operating when needed (shade) → lower power losses, longer life cycle
- Includes TS4-R-S functionality (Rapid Shutdown)
### POWER+ TS4 TECHNICAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>INPUT</th>
<th>TS4-R-S</th>
<th>TS4-R-O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated DC Input Power</td>
<td></td>
<td>475W</td>
</tr>
<tr>
<td>Maximum VOC @ STC</td>
<td>75V</td>
<td></td>
</tr>
<tr>
<td>Absolute Maximum DC Input Voltage</td>
<td>90V</td>
<td></td>
</tr>
<tr>
<td>Maximum Short Circuit Current (ISC)</td>
<td>12A</td>
<td></td>
</tr>
<tr>
<td>Startup Voltage</td>
<td>16V</td>
<td></td>
</tr>
<tr>
<td>Minimum Operating Voltage (VMP)</td>
<td>16V</td>
<td></td>
</tr>
</tbody>
</table>

**OUTPUT**

| Output Power Range                 | 0 - 475W |
| Communication Type                 | 802.15.4 2.4GHz |
| Output Voltage Range               | 0-Voc    |
| Maximum System Voltage             | 1000V    |
| Maximum Series Fuse Rating         | 15A      |
| Cable Rating                       | 1000V UL |

Note that 375W versions of TS4-R-O are NOT compatible with Sunny Boy 1SP-US-40
Power+ is a solution that fully complies with NEC 2017 690.12(B)(2) – NOW –

Power+ solution is based on the Sunny Boy -1SP-US-40 inverter line.
- UL1741 SA listed
- CA Rule 21 & HI Rule 14H SRD 1.1 compliant – single file configuration!

The single Sunny Boy –US-40 platform
- is extended with SMA RSS for 2014 RS compliance (and 2017 NEC to 2019!)
- is extended with Power+ for 2017 RS compliance
SMA RAPID SHUTDOWN
SMA POWER+ SOLUTION

- Multi roof
- Some shading
- 3 Strings
- Compatible with 3 dissimilar strings
- Automatic shutdown with loss of AC power
POWER+ COMPETITIVE ADVANTAGES

Benefits of Power+ solution

> Time savings install

> Not module level MPPT – no efficiency penalty, leverage smart inverter

> Devices are optimizing only if needed – in standby mode otherwise.

  - All microinverters inverting on roof with or without shade

  - Standard DC optimizers always bucking or boosting to hit inverter voltage

  - TS4 platform working smarter not harder
Scenario 1: No shading on array

8 SolarWorld 280 modules
- $I_{mp} = 9\, \text{A}$
- $V_{mp} = 31.2\, \text{V (77 F)}$
- $V_{mp} = \sim 28\, \text{V (roof)}$
- $P \approx 250\, \text{W}$
- String power 2000W

String must provide fixed high DC voltage to inverter, but “natural” string voltage around 225 VDC

EVERY unit must boost input (module) voltage from $\sim 28\, \text{V}$ to higher output voltage $\sim 44\, \text{V}$
Scenario 1: No shading on array

8 SolarWorld 280 modules
Imp = 9A
Vmp = 31.2 V (77 F)
Vmp = ~28V (roof)
P about 250 W
String power 2000W

TS4-R-O

No optimization needed – optimizers in standby

Inverter running efficiently at “natural” string Vmp – smart!
Unshaded units must boost voltage from 28 V to ~52 V now
Shaded units going from around 28 V to ~20 V

Most units working even harder to offload inverter - why do this?
Scenario 2: Two modules shaded

Unshaded 6 devices still in standby mode.

Two shaded module devices will drop output voltage to match unshaded string current.

8 SolarWorld 280 modules
1mp = 9A
Vmp = 31.2 V (77 F)
Vmp = ~28V (roof)
P about 250 W
P shaded 100 W
String power 1700W
# POWER+ COMPETITIVE COMPARISON

<table>
<thead>
<tr>
<th></th>
<th>TS4-R-O</th>
<th>SolarEdge P400/P370</th>
<th>Enphase IQ6+/IQ6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max input DC power (W)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Clipping limit</td>
<td>475</td>
<td>400 / 370</td>
<td>400 / 330</td>
</tr>
<tr>
<td>Max DC Voltage (V)</td>
<td>90</td>
<td>80 / 60</td>
<td>62 / 48</td>
</tr>
<tr>
<td>Vmp Range (V)</td>
<td>16-75</td>
<td>8-80 / 8-60</td>
<td>27-45 / 12-37</td>
</tr>
<tr>
<td>Max DC Current (A)</td>
<td>12</td>
<td>10.1</td>
<td>15</td>
</tr>
<tr>
<td>Max output power (W)</td>
<td>475</td>
<td>405 / 370</td>
<td>280 / 230</td>
</tr>
<tr>
<td>Min devices string/branch circuit</td>
<td>4-5</td>
<td>8 / 8</td>
<td>1</td>
</tr>
<tr>
<td>Max devices string/branch circuit</td>
<td>13-14</td>
<td>25 (5250W)</td>
<td>16 x 325W modules</td>
</tr>
</tbody>
</table>

3 channels/inverter 2-3 channels/inverter 1 branch/breaker
POWER+ SYSTEM INSTALLATION - COMPONENTS

What is needed to install the Power+ solution? Three things:

1. TS4-R Devices (Or Smart Modules)
2. Sunny Boy Inverter SB X.Y-US-40
3. SMA Rooftop Communications Kit (Needed for Shutdown)
ROOFTOP COMMUNICATIONS KIT – PHASE 2

SMA Rooftop Communication Kit
ROOFCOMMKIT-P2

Gateway
Gateway Interface Board
Installation manual

Mounts on Sunny Boy -US-40 inverter communication board

Sunny Boy X.Y-1SP-US-40
POWER+ INSTALLATION PROCESS

• Install the array and TS4-R units (or Smart Modules)
• Install Gateway at the array
• Install Sunny Boy with Gateway Interface Board
• Finish installation with commissioning in Web UI of inverter
  (This can include single file configuration for CA Rule 21)
POWER+ INSTALLATION STEPS – TS4R

TS4-R units mount to the module frame, label side facing away from module backsheet.

Short connectors connect to PV module J-box leads, and longer connectors connect to build smart module string.
POWER+ INSTALLATION STEPS – GATEWAY

Gateway can be placed on module frame or attached to racking.

Port for RS485 wiring access facing away from module backsheet if attached to module frame
POWER+ SYSTEM OVERVIEW – INSTALLED

TS4-R Units on modules

Wireless Communication Gateway (installed at array)

SBX.Y-1SP-US-40

Gateway Interface board

Monitoring

Sunny Portal

Sunny Places

RS485
POWER+ SYSTEM OVERVIEW – INSTALLED

GIB board

RS485 cable (to gateway)
Commissioning of SMA Power+ systems is through Sunny Boy Web UI.
Commissioning of SMA Power+ systems is through Sunny Boy Web UI

### Module Technology

<table>
<thead>
<tr>
<th>Designation</th>
<th>Status</th>
<th>Power</th>
<th>Voltage</th>
<th>Current</th>
<th>Received Signal Strength</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA1</td>
<td>✔️</td>
<td>27 W</td>
<td>28.50 V</td>
<td>0.957 A</td>
<td>61 %</td>
<td>58.3 °F</td>
</tr>
<tr>
<td>CA2</td>
<td>✔️</td>
<td>27 W</td>
<td>28.80 V</td>
<td>0.955 A</td>
<td>60 %</td>
<td>56.3 °F</td>
</tr>
<tr>
<td>CA3</td>
<td>✔️</td>
<td>27 W</td>
<td>28.95 V</td>
<td>0.950 A</td>
<td>72 %</td>
<td>54.1 °F</td>
</tr>
<tr>
<td>CA4</td>
<td>✔️</td>
<td>27 W</td>
<td>28.70 V</td>
<td>0.955 A</td>
<td>70 %</td>
<td>56.7 °F</td>
</tr>
<tr>
<td>CA5</td>
<td>✔️</td>
<td>27 W</td>
<td>28.65 V</td>
<td>0.950 A</td>
<td>82 %</td>
<td>64.8 °F</td>
</tr>
<tr>
<td>CA6</td>
<td>✔️</td>
<td>27 W</td>
<td>28.50 V</td>
<td>0.950 A</td>
<td>87 %</td>
<td>66.8 °F</td>
</tr>
<tr>
<td>CA7</td>
<td>✔️</td>
<td>27 W</td>
<td>28.85 V</td>
<td>0.950 A</td>
<td>87 %</td>
<td>67.8 °F</td>
</tr>
</tbody>
</table>
Commissioning of SMA Power+ systems is through Sunny Boy Web UI

### SUNNY BOY 5.0

#### Devices in the system

<table>
<thead>
<tr>
<th>Device name</th>
<th>Device status</th>
<th>Serial number</th>
<th>Firmware version installed</th>
<th>Settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB5.0-ISP-US-40.406</td>
<td>✔️</td>
<td>1980000408</td>
<td>2.3.55.R</td>
<td>✔️</td>
</tr>
<tr>
<td>Tigo Gateway</td>
<td>✔️</td>
<td>00158D000003F3C9</td>
<td>G5.27 Jul 26 2017 17:51:45</td>
<td></td>
</tr>
<tr>
<td>CA1/TS4_O</td>
<td>✔️</td>
<td>4:CA81P</td>
<td>D5 3008</td>
<td></td>
</tr>
<tr>
<td>CA2/TS4_O</td>
<td>✔️</td>
<td>4:CA2CH</td>
<td>D5 3008</td>
<td></td>
</tr>
<tr>
<td>CA3/TS4_O</td>
<td>✔️</td>
<td>4:CA388</td>
<td>D5 3008</td>
<td></td>
</tr>
<tr>
<td>CA4/TS4_M</td>
<td>✔️</td>
<td>4:B266L</td>
<td>K8 3017</td>
<td></td>
</tr>
<tr>
<td>CA5/TS4_M</td>
<td>✔️</td>
<td>4:B51DS</td>
<td>K8 3017</td>
<td></td>
</tr>
<tr>
<td>CA6/TS4_S</td>
<td>✔️</td>
<td>4:A06CP</td>
<td>K8 3017</td>
<td></td>
</tr>
<tr>
<td>CA7/TS4_S</td>
<td>✔️</td>
<td>4:A779P</td>
<td>K8 3017</td>
<td></td>
</tr>
</tbody>
</table>
Module layout and registration for SMA Smart Connected in Sunny Portal
SMA SMART CONNECTED: THE NEW STANDARD IN SERVICE
WHAT IS SMA SMART CONNECTED?

> Smart Connected is a new, **FREE** service package from SMA introduced with the Sunny Boy-US-40 series

> It is built in to the inverter and requires only a simple activation process in Sunny Portal

> SMA will actively monitor the system at all times through Sunny Portal intelligent monitoring technology

> Smart Connected will detect system problems earlier, avoiding system downtime and complicated logistics

> Smart Connected will automatically detect any inverter error and initiate the repair or component replacement process

> Smart Connected is designed to help solar installers improve interactions with customers

> **Smart Connected can turn service interactions into positive experiences for system owners and installers**
SMA SMART CONNECTED OVERVIEW

**Comprehensive Monitoring**
- SMA actively monitors the system in Sunny Portal (through the active warranty period)

**Replacement components are pre-shipped**
- Significant cost savings through automated replacement process
- One truck-roll for component replacements

**Financial Compensation**
- Customers are compensated if component replacements do not meet agreed upon Smart Connected timeline

**Error alert**
- Smart Connected will detect and automatically alert to problems with the system
- Problems may be related or unrelated to the inverter

**Pre-diagnosis**
- Suggested corrective actions can be relayed before going to the site
Activation of SMA Smart Connected
During registration of the system in the Sunny Portal, simply activate SMA Smart Connected and immediately benefit from the automatic inverter monitoring by SMA. No additional hardware or software needed.

Automatic inverter monitoring
SMA automatically checks the individual inverters for anomalies around-the-clock during operation. Benefit from SMA’s many years of experience and ability to diagnose issues quickly and accurately.

Proactive communication in the event of faults
After a fault has been diagnosed and analyzed, SMA informs the installer and end customer immediately by email. All parties are optimally prepared for the troubleshooting process. This minimizes energy loss and saves time and money. Regular reports also provide valuable information about the overall system health and performance.

Replacement service
If a replacement component is necessary, SMA automatically supplies a replacement component within one to three days after fault diagnosis. The installer can contact the PV system owner to schedule the inverter repair.

Performance service
The PV system owner can claim compensation from SMA if the replacement component cannot be delivered within the agreed upon timeline.
POWER+ PAYDAY!
$50 REBATE ON EVERY POWER+ INSTALLATION

> Installers receive $50* for every Power+ Solution installed and registered in Sunny Portal from through July 31, 2018

> Cashing in is as simple as 1, 2, 3:

1. Purchase the Power+ Solution from an SMA Authorized Distributor, install the system and register for SMA Smart Connected in Sunny Portal
2. Submit your purchase information along with proof of purchase online
3. Check your mailbox for your $50 SMA pre-paid reward card

Remember the more you install, the more you earn!

(*Subject to terms and conditions)