Service and Maintenance

Be a solar expert
The SMA Solar Academy

> Transfer of knowledge
> Well-matched comprehensive seminar program
> Small, medium and large scale PV-plants
Organizational matters

> Solar Academy contact data

  > Phone: +49 (0)561-9522-4884

  > E-Mail: Solaracademy@SMA.de

> Download areas:

  > http://www.SMA.de/handout
### Seminar contents

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Safety in PV systems and in handling of SMA inverters

"I only believe what I can see ..."

Apply this when handling electricity and your life is

in danger!
Danger analysis

> Voltage
> Current
> Electric arc
> Onsite conditions (weather, setting up, etc.)
Safety rules for working in and on electrical installations

> Works to be done by electrically qualified persons only

> The five safety rules and special features in PV plants

1. **Disconnect** (electrically qualified person, -DC do not disconnect under load!)
2. **Ensure that the device cannot be reconnected** (AC cable protection)
3. **Ensure that no voltage is present** (electrically qualified person)
4. **Ground and short-circuit** (not DC!)
5. **Cover or shield any adjacent live parts/components.**
Electric arc

> Switching under load will cause an electric arc

> With AC, electric arc quenching can occur (electric spark)

> With DC, the electric arc remains active

➤ Danger of skin burns
Inverter – Connection area

> No danger from the mounted lid
> Disconnect AC and DC voltages before working on the device
> Never leave a not electrically qualified person alone with the opened device
Measurements using the multimeter

> Use only multimeter of overvoltage category CAT III/CAT IV (up to 1000 V)
  e.g., TietzschDSP Multisafe

> Before each use, check the multimeter and measurement cables for damage

> Make sure the measuring socket is correct (V↔A mixed up)

> Conduct current measurements only with current clamp. e.g., Benning CM 7
ESD – Electrostatic Discharge:

An efficient electrostatic discharge caused by difference of potential.

> Palpable at 3500 V
> Audible at 4500 V
> Visible > 8000 V

Some components are already damaged or destroyed when operated at voltages from 15 V.
### ESD

**NOTICE!**

Electrostatic discharges can damage the inverter.

> Internal component parts of the inverter can be irreparably damaged by static electric discharge.

> Before touching any component, ground yourself by connecting the ESD wrist strap to the inverter enclosure (equipotential bonding).
Requirements for Inverters and Topologies
Requirements for grid monitoring regarding PV inverter topology

Requirements for protection technology of grid-connected PV plants

> Basis: VDE* application guide VDE-AR-N 4105** "Power Generating Plants on the Low-Voltage Grid", main points: Grid and plant protection (G/P protection) and static grid support

> G/P protection function: disconnecting the plant in case of a grid fault

> Required parts of G/P protection:

  > Frequency reduction and frequency increase protection
  > Voltage drop and increase protection
  > Islanding detection (active)
  > Fail-safe operation
  > Redundant switch unit

* VDE - Association for Electrical, Electronic & Information Technologies

** Note: until Dec 12, 2011 VDE 0126-1-1 as well as VDE 4105-AR-N 4105 are valid, from Jan 1, 2012 only VDE-AR-N 4105 will be valid!
Grid monitoring - Inverters with Transformers - VDE 0126 1-1
Grid monitoring - Inverter without Transformer - VDE 0126 1-1
VDE 0126 1-1 / A1 - interim arrangement

Grid monitoring according to VDE 0126-1-1

> 240 V voltage range  
  > Max. time until disconnection  
> Frequency  
  > Max. time until disconnection  
> Islanding detection  
  > Active detection of stand-alone  
  > Grid operation  
  > Max. time until disconnection  
> DC feed-in  
> Residual current  
> Leakage current

184 V to 264.5 V
0.2 s
47.5 Hz to 50.2 Hz
0.2 s
New: VDE 0126 1-1/ A1 -transition to VDE AR-N 4105 –
Trip frequencies are changed up to 51.5 Hz
- device dependent -
max. 1 A
max. 30 mA
Max. 300 mA
FNN interim arrangement VDE 0126 1-1 / A1

<table>
<thead>
<tr>
<th>Inverter</th>
<th>Pre-set limiting value</th>
<th>Characteristic-curve method MSRL (up to 51.5 Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB 1200/1700</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>SB 2500/3000</td>
<td>50.9 / 50.3 Hz</td>
<td></td>
</tr>
<tr>
<td>SB 20/25/3000HF-30</td>
<td>50.4 Hz</td>
<td></td>
</tr>
<tr>
<td>SB 33/3800</td>
<td>50.4 / 50.7 Hz</td>
<td></td>
</tr>
<tr>
<td>SB 3 / 4 / 5000TL-20</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>SMC 46/50/6000A</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>SMC 7000HV-11</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>SMC 6/7/8000TL</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>SMC 9/10/11000TL-10</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>SMC 9/10/11000TLRP-10</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>STP 8/10/12/15/17000TL-10</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
Decentralized and close to the customer

More than 98% of the PV plants feed into the low voltage grid:

- High voltage grids are loaded only minimally
- The increasing number of generators call for an intelligent energy management
- Monitoring and complying with standards is essential
- Code of Practice VDE-AR-N 4105
The new VDE application guide (VDE-AR-N 4105) – What's new?

<table>
<thead>
<tr>
<th>Plant power from 3.68 kVA up to 13.8 kVA</th>
<th>Plant power greater than 13.8 kVA up to 30 kVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provision of reactive power, displacement power factor (\cos(\phi)) from 0.95 \text{ under-excited} to 0.95 \text{ over-excited}</td>
<td>Provision of reactive power, displacement power factor (\cos(\phi)) from 0.90 \text{ under-excited} to 0.90 \text{ over-excited}</td>
</tr>
<tr>
<td>Max. 4.6 kVA unbalanced load per line conductor</td>
<td>Deployment of three-phase inverters or communication-based coupling of three single-phase devices for power exceeding 4.6 kVA per phase</td>
</tr>
</tbody>
</table>
The new VDE application guide (VDE-AR-N 4105) – What's new?

<table>
<thead>
<tr>
<th>Plant power greater than 30 kVA up to 100 kVA</th>
<th>Plant power greater than 100 kVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provision of reactive power, displacement power factor $\cos(\phi)$ from $0.90_{\text{under-excited}}$ to $0.90_{\text{over-excited}}$</td>
<td>Provision of reactive power, displacement power factor $\cos(\phi)$ from $0.90_{\text{under-excited}}$ to $0.90_{\text{over-excited}}$</td>
</tr>
<tr>
<td>External fail-safe central grid and plant protection system</td>
<td>External fail-safe central grid and plant protection system</td>
</tr>
<tr>
<td>Deployment of three-phase inverters or communication-based coupling of three single-phase devices for power exceeding 4.6 kVA per phase</td>
<td>Deployment of three-phase inverters or communication-based coupling of three single-phase devices for power exceeding 4.6 kVA per phase</td>
</tr>
<tr>
<td>There is no longer a prescribed disconnection point that must be accessible at all times</td>
<td>There is no longer a prescribed disconnection point that must be accessible at all times</td>
</tr>
<tr>
<td></td>
<td>Option of remote power limitation by grid operator (100 kW)</td>
</tr>
</tbody>
</table>
Overview of SMA inverters compliant to VDE-AR-N 4105 – up to 4.6 kVA

<table>
<thead>
<tr>
<th>Product identification</th>
<th>Max. Power [kVA]</th>
<th>Complies with AR 4105</th>
<th>Reactive Power supply</th>
<th>Use for 3-phase power distribution grids</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB 1200</td>
<td>1.2</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SB 1300TL-10</td>
<td>1.3</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SB 1600TL-10</td>
<td>1.6</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SB 1700</td>
<td>1.7</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SB 2100TL</td>
<td>2.1</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SB 20/25/3000HF-30</td>
<td>2/ 2.5/ 3</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SB 2500/3000TLST-21</td>
<td>2.5/ 3</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>SB 3300-11/3800-11</td>
<td>3.6 / 3.8</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>SB 3/4/5000TL-21</td>
<td>3/ 4/ 4.6 *</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>SMC 4600A-11</td>
<td>4.6 *</td>
<td>✓</td>
<td>✓</td>
<td>With communicative coupling</td>
</tr>
</tbody>
</table>

* limitation to 4.6 kVA für SB 5000TL-21 and SMC 4600A-11 only for AR 4105
## Overview of SMA inverters compliant to VDE-AR-N 4105 – up to 5 kVA

<table>
<thead>
<tr>
<th>Product identification</th>
<th>Max. power [kVA]</th>
<th>Complies with AR 4105</th>
<th>Reactive power supply</th>
<th>Use for 3-phase power distribution grids</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMC 5/6000A-11</td>
<td>5.5 / 6</td>
<td>✓</td>
<td>✓</td>
<td>With communicative coupling</td>
</tr>
<tr>
<td>SMC 7000HV-11</td>
<td>7</td>
<td>✓</td>
<td>✓</td>
<td>With communicative coupling</td>
</tr>
<tr>
<td>SMC 9/10/11000TLRP-10</td>
<td>9/ 10/ 11</td>
<td>✓</td>
<td>✓</td>
<td>With communicative coupling</td>
</tr>
<tr>
<td>STP 8/10/12/15/ 17000TL-10</td>
<td>8/ 10/ 12/15/17</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Functionality and Topology
Pulse Width Modulation - PWM

> Functional principle – Changing DC to AC takes place in the inverter
Inverter – Topologies

> Inverters with transformers
  > Galvanic isolation
  > PV array can be grounded

> Inverters with HF* transformers
  Galvanic isolation
  > PV array can be grounded
  > Small, lightweight, efficient.

(*high frequency)
Inverter – Topologies

> Inverter, transformerless
  > without step-up converter
  > High efficiency
  > Light weight

> Inverter, transformerless
  > with step-up converter
  > High efficiency
  > Wide input voltage range
  > Light weight
Inverter – Topologies

> Multistring inverter with boost converter
   (Transformerless technology)
> Wide input voltage range
> Different modules, string length, alignment and orientation possible
Inverter – Topologies

> Sunny Tripower –
  Three phases to the grid
  > Symmetrical grid load
  > Asymmetrical inputs
  > High efficiency

> Sunny Tripower – 20000TL-HE
  > Symmetrical grid load
  > High efficiency
SUNNY TRIPOWER – Optiprotect

Normal operation

> Current monitoring of all string inputs
  > Detect reverse current
  > Detect reverse polarity
> DC disconnection possible via ESS*

Short-circuit operation (fault conditions)

> The PV array is short-circuited
> The PV array and inverter are in a safe state
> DC disconnection via ESS only with a currentless generator possible

*ESS- Electronic Solar Switch
SUNNY TRIPOWER – Electronic string fuse

Installation information electronic string fuse

> Check the DC connector for correct polarity
> Observe correct order for string connections
  > If there are more than 2 strings, always start with connecting the first string to input B, to ensure that the electronic string fuse is working in case of a reverse polarity on input A
> No mixed connections between input areas
  > The string positive terminal at input A and string negative terminal at input B deactivate the electronic string fuse
> External string collection boxes
  > When using external string collection boxes, the functionality of the electronic string fuse may be limited
Overvoltage protection

> 3 classifications for surge protectors
   > Coarse protection, SPD* type I, capable of carrying lightning current
   > Medium protection, SPD type II, close-coupling protection
   > (Fine protection, SPD type III, close-coupling protection covered with three internal varistors

> Coordination
   > Type II connected, if type I is used
   > If necessary additional protectors (For distances more than 10 m)

*SPD - Surge Protective Device
Overvoltage protection – SMA inverter special features

> One MPP tracker
  > One protector sufficient
  > After collecting the strings
  > String fuses according to fuses
  > Not applicable for integrated fuses

> Multistring
  > One set of protectors per input
Overvoltage protection – STP special features

> Type II overvoltage protection can be retrofitted
  > Behind the string protection

> Fault indicator relay of protector on communication and display

> Three or five modules (only input A or A+B)

> Position of protector on the inverter sufficient?
  > If needed also at building entrance
SMA Multi-Function Relay

Provided as standard in:

> Sunny Boy 3000/4000/5000TL-21
> Sunny Tripower 8000/10000/12000/15000/17000TL-10
> For Sunny Boy 2000/2500/3000HF-30

(Optional retrofitting via RS485 Quick Module)

> Range of usage

> Error signaling contact
> Temperature-based connection of an external fan
> Switch between communication devices
> If a specific power is exceeded, switch as follows
  > Universally used signal
  > With a minimum switch-on time to connect loads
Plant design check with Sunny Design
Design Check

> Inverter and PV array are aligned
Plant design: general

> +70 °C:

MPP voltage > min. inverter input voltage

> -10 °C:

Open-circuit voltage < max. input voltage inverter
# Inverter / PV array Compatibility Check

## SMA Solar Technology AG

### Compatibility Check

<table>
<thead>
<tr>
<th>PV-Generator 1</th>
<th>1 x 30 2100TL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>SMA 2100TL</td>
</tr>
<tr>
<td>Rated Power</td>
<td>2,10 kW</td>
</tr>
<tr>
<td>Efficiency</td>
<td>94.9 %</td>
</tr>
<tr>
<td>Nominal Voltage</td>
<td>230V (200V / 400V)</td>
</tr>
</tbody>
</table>

### Performance Data

<table>
<thead>
<tr>
<th>PV-Generator 1</th>
<th>1 x 30 2100TL</th>
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<tr>
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<td>2,10 kW</td>
</tr>
<tr>
<td>Nominal Voltage</td>
<td>230V (200V / 400V)</td>
</tr>
</tbody>
</table>

### Technical Specifications

- **Rated Power:** 2,10 kW
- **Efficiency:** 94.9%
- **Nominal Voltage:** 230V (200V / 400V)

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SMA Solar Technology AG

M-PSER-1-DE-en_WW-124010 39
Installation & Commissioning

Take the manual...

 Read the manual!
 Read and comply with installation manual!
Plant Monitoring – Monitoring & Controlling
Monitoring & Controlling – RS485 Concept

> Wired plant monitoring
  > Data transmission with max. 50 devices
  > Max. data cable length: 1200 m

Typical RS485 data bus configuration with termination and bias resistances
Monitoring & Controlling – RS485 Concept

> Request data bus cable
  > Cross-section: min. 2 x 2 x 0.22 mm² or min. 2 x 2 AWG 24
  > Shielded, twisted pair data cable (Twisted Pair).
  > Shield cover: copper barrier braid with a barrier thickness of approx. 85%
  > Bus termination-
    typically on the data logger and on the "last" inverter
  > No laying of the bus cables parallel to energy lines
Monitoring & Controlling – Typical faults in the field

> Short circuits between the data cables DATA+, DATA-, and GND
> Swapped data cables DATA+ or DATA-
> Cable or shield breakage
> Position of the bus termination is incorrect (or bus termination doesn't exist)
> Max. cable length exceeded
> Wrong cable type
> Improper single feeder

➤ Visual Inspection
➤ Measurement
Monitoring & Controlling – Taking Measurements using the Multimeter

> Check for short-circuits
  > between the data cables DATA+, DATA-, or GND and the shielding using the multimeter

> Measure the resistance in the RS485 data bus between the data cables D+ and D-

**Precondition: The data logger is not connected to RS485-data bus**

> For 1 cable termination (data logger at the end of the bus),
  > the resistance value has to be in the approximate range 121 to 170 ohm.

> For 2 cable termination (data logger at the end of the bus),
  > the resistance value has to be in the approximate range 61 to 125 ohm
Monitoring & Controlling – *Bluetooth®* Concept

**Typical system design – Wireless transmission**

- **Electricity generation**
  1. SUNNY BOY
  2. Solar generator

- **System monitoring**
  3. SUNNY BEAM WITH *Bluetooth®*
  4. SUNNY EXPLORER
  5. SUNNY PORTAL
  6. SUNNY WEBBOX with *Bluetooth®*
  7. SUNNY SENSORBOX with *Bluetooth®*
  8. Mobile access

*In connection with SMA Power Injector with Bluetooth*
Monitoring & Controlling – Bluetooth® Concept

> Long-range reception with automatic cross-linking
> Fast and reliable
> Up to 50 participants

> Bluetooth® interface for retrofitting Sunny Boy, Sunny Mini Central and Windy Boy
Monitoring & Controlling – Bluetooth® Concept

Bluetooth® Wireless Technology - max. range

HF / NG / Sunny Tripower

SMA Bluetooth® Piggy Back Plus

max. 100 m

Sunny Beam Bluetooth®

PC with Bluetooth® & Sunny Explorer

HF / NG / Sunny Tripower

SMA Bluetooth® Piggy Back Plus

max. 100 m

Sunny Beam Bluetooth®

PC with Bluetooth® & Sunny Explorer
Monitoring & Controlling – Bluetooth® Concept

SMA Bluetooth® Wireless Technology in Practice

> Sunny Mini Central 9000TL, 10000TL, 11000TL
  with SMA Bluetooth® PiggyBack

> Sunny Mini Central 9000TL, 10000TL, 11000TL
  with SMA Bluetooth® PiggyBack
Monitoring & Controlling

> LED

> Display

> Graphic display

> Sunny Beam

> Sunny Explorer

> Sunny WebBox

> Sunny Portal
## Error processing

<table>
<thead>
<tr>
<th>Error</th>
<th>Sunny Boy Classics</th>
<th>Event: Sunny Boy HF</th>
<th>Event: Sunny Boy NG</th>
<th>Event: Sunny Tripower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grid voltage/ frequency</td>
<td>Code 2/ Code 3</td>
<td>1, 2, 3, 4, 5, 7, 8</td>
<td>1, 2, 3, 4, 5, 7, 8, 9, 10, 11</td>
<td>1, 2, 3, 4, 5, 7</td>
</tr>
<tr>
<td>Overvoltage PV</td>
<td>Code 4</td>
<td>34</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>Device fault</td>
<td>Code 5</td>
<td>38, 60-64, 65, 66, 68, 77</td>
<td>38, 60-64, 65, 66, 68, 69</td>
<td>38, 60-64, 65, 66, 68, 69, 77</td>
</tr>
<tr>
<td>Leakage current</td>
<td>Code 6</td>
<td>6</td>
<td>6, 36</td>
<td>6, 36</td>
</tr>
<tr>
<td>Drastic change in differential current</td>
<td>Code 7</td>
<td>37</td>
<td>37</td>
<td>37</td>
</tr>
<tr>
<td>DC start conditions</td>
<td>All LEDs on/off</td>
<td>33, 39</td>
<td>33, 39</td>
<td>13, 33, 39</td>
</tr>
<tr>
<td>Riso</td>
<td>LED red</td>
<td>35, 74</td>
<td>35, 74</td>
<td>35, 74</td>
</tr>
<tr>
<td>Device-specific messages</td>
<td></td>
<td>42, 67, 70, 71.72, 73, 75, 78, 90</td>
<td>67, 70, 71, 72, 73, 90</td>
<td>40, 67, 70, 71, 72, 73, 75, 81, 82, 83, 84, 90</td>
</tr>
</tbody>
</table>
Error processing

Disturbance line voltage/power frequency

> Occurrence sporadic or in intervals
  > Mostly grid-related – Ripple control signals, disconnect/reconnect loads
  > Device with disturbances connected to the grid

> Permanent occurrence:
  > Check the installation/cabling
  > SCB*
  > RCD, fuses (characteristic?) – monitor as applicable when tripped repeatedly

> Potential between N and PE (typically lower than 5-6 V!)

> line voltage
  > Line conductor -> PE, line conductor -> N (close to limiting value? monitor during start-up)

*Selective circuit breaker/selective line protection
Error processing

PV overvoltage

> Occurs in initial installation
  > Immediately disconnect device from the PV array
  > ESS, disconnect the DC plug
  > Check sizing (Sunny Design, inverter datasheet)

> Occurs after installation
  > Voltage increases in cool temperatures
  > ESS, disconnect the DC plug
  > Check sizing (Sunny Design, inverter datasheet)

-Warranty loss
Check PV voltage and ground fault

Checking the DC cabling:
with multimeter

1. PV voltage (positive-negative)
2. Ground fault monitoring (positive GND)
3. Ground fault monitoring (negative GND)

- Conduct measures on each string!
- Riso measures with the appropriate isolation measuring device
  (Notice: surge arrester!)
Error processing

Device fault

> Check the installation
  > Line voltage
  > installation

> If possible, find data in the data logger/portal
  > Prior "Riso" messages -> check varistor

> Contact the SMA Service Line
  > Transfer device data
    > Serial number
    > Equipment, e.g. communication
**Error processing**

Leakage current/drastic change in differential current/Riso messages

> Immediately disconnect transformerless devices from the PV array
  > Check voltage of PV array
    > DC+ → PE, DC- → PE, DC+ → DC-
  > Visual inspection (crack in module, damage caused by rodents, damaged insulation?)
  > Isolation Test
  > Module frames, frame integrated in equipotential bonding
    > Corrosion of connections

> Occurrence only in moisture/foggy/rainy condition
  > Cracks in a module
  > Check isolation
  > Find data in the data logger/portal
  > Moisture ingress
    > Generator connection
    > Connecting the PV modules
Error processing

Leakage currents

> PV array stretched across the area
  > Module field takes up a large area => plate-type capacitor between module and roof area

> Influences:
  > Distance and area to grounded parts (frame/sub-structures, sheet metal roof)
  > Alternating voltage against ground
  => operation-related currents from inverter and grounding of the PV array
Error processing

Insulation resistance PV array

> Ris o of the inverter
> Ris o of the lines and modules
> High isolation resistance of a PV module

\[ R_{\text{iso}} = \frac{R_{\text{Module}}}{\text{Quantity of Modules}} \]

> E.g. 150 thin-film PV panel per inverter take up an area of 108 m²
  > Possible isolation resistance: 370 kΩ (less than 500 kΩ in accordance with VDE 0126-1-1)
  > Influenced by moisture, imprecise installation, surge arrester

DIN EN 61646
DIN IEC 61215

DIN VDE 0126-1-1
Error processing

DC start conditions

> Classic Sunny Boy inverters (without graphic display)
  > PV connected (reverse polarity?)
  > PV voltage sufficient (PV start)
  > PV voltage stays steady (dawn light, snow on modules, fog)
    > ESS (type?)
    > Check value of voltage, DC plug
    > Check sizing (Sunny Design, inverter datasheet)
    > Find data, data logger/portal

> Sunny Boy with graphic display
  > Display message
  > Start conditions -> design check
Error processing

Reverse Currents

> Reverse currents due to short circuits (e.g., bypass diodes) and double ground faults

> Value of reverse current depends on
  > Number of parallel strings
  > Number of short-circuited modules

> Protecting/avoiding
  > Max. 2 (-3) strings in parallel (multi string)
  > String diodes (not recognized by standard)
  > String fuses (dimensioning rules?)
**Maintenance/Tests**

Routine checks of plant – components & yields
**Maintenance**

**PV Array:**

> Check frame
  > Roofing, lightning protection

> Visual module check
  > Cells/PV-modules
  > Damage (cracks in the glass, DC cable)
  > Cable, plug

Source: Mannheimer
## Maintenance

Check PV array:

> Electrical test of each PV string (safety rules!)
  > DC +/- (keeping record) plus Riso
    (At the very least DC +/- against PE)
  > Curve tracer (e.g. Tritec)
  > Thermal images

> Electrical test AC
  > Safety features
  > Grid monitoring
    (Observing the specifications, safety regulations)

> Inverter status

Thermal images: hot spot due to Shading of a lightning protection rod
Maintenance

Check inverter:

> DC connection ESS

> Cooling
  > Heat sink (Classics)
    (Clean it if applicable)

> Fan test, NG, HF, STP
  (Clean it if applicable)
Maintenance

Create maintenance report!

> Ask customers to keep record of yield monthly (meter)

> Sunny Portal

> Compare yields
Commissioning/Maintenance – Exemplary Commissioning Report

Comissioning - Report:

Customer:
Address: ____________________________________________
Phone: ____________________________________________
Cell-phone: ____________________________
Email: ____________________________

Plant Location:
Address: ____________________________________________

Installer:
Installer: ____________________________________________
Address: ____________________________________________
Phone: ____________________________________________

Comissioning:
Name, First name: ____________________________
Company: ____________________________________________

Plant Data:
Plant size: ____________________________ kWp

Measurement:

R_{ground-Const.}: ____________ Ω
Date: ____________________________
R_{iso} PV-Array: ____________ W/m²
Solar Radiation:

P_{dc} = ____________ W  P_{ac} = ____________ W

PV-Array: (____ x ____ ) (Parallel x Series)

Plant:

String 1:
- ____________________________
- ____________________________
- ____________________________

String X: ____________________________

Feed-in meter: ____________________________ kWh

SMA Solar Technology AG
M-PSER-1-DE-en_WW-124010
Service
Service Line – Telephone support with expert advice

> Advice in case of technical questions on all SMA products

> Support in installing and commissioning PV plants

> Our SMA Service Line employees in Germany are at your disposal from Monday to Friday between 7.00 a.m. and 7.00 p.m. and on Saturdays between 8.00 a.m. and 2.00 p.m. during the summer months*

<table>
<thead>
<tr>
<th>Product</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunny Boy, Sunny TriPower</td>
<td>+49 561 9522-1499</td>
</tr>
<tr>
<td>Sunny Mini Central</td>
<td>+49 561 9522-2499</td>
</tr>
<tr>
<td>Communication devices</td>
<td>+49 561 9522-399</td>
</tr>
<tr>
<td>Sunny Island</td>
<td>+49 561 9522-299</td>
</tr>
<tr>
<td>Sunny Central</td>
<td>+49 176 888 222 44</td>
</tr>
<tr>
<td>SMS Callback</td>
<td>+49 561 9522-2499</td>
</tr>
</tbody>
</table>

*during the winter months, you can call our SMA Service Line Mondays to Fridays from 8.00 a.m. to 6.00 p.m. and Saturdays from 08.00 a.m. to 2.00 p.m.
On-Site Service – Support Straight from Source

Thanks to our 42 customer-service stations we are able to guarantee our customers a widespread availability and prompt support.

Upon customer's request, we offer:

> to replace SMA inverters
> to support the customer in commissioning
> to inspect PV plants
> to inspect SMA communication products
Global presence: Supporting you locally is our business

Yield security through technical expertise

> 42 service hubs in Germany
> 43 service hubs in 17 additional countries (effective March 2012)

Additional service hubs are currently established

> South Africa
> Chile
Replacement Service – Device Replacement for fast Availability

> Maximum availability of replacement inverters observing highest quality standards

> Minimized downtimes

> If a call or an online request is received until 5.00 p.m., the replacement inverter is generally shipped the same day (< 40 kg)

> The customer will receive a comparable state-of-the-art device, including all updates and modifications
Replacement Service – Device Replacement for fast Availability (II)

> If a device is replaced within the warranty period, the remaining warranty period carries over to the replacement device

> In any event, we provide a full one-year warranty on all replacement devices whether or not the original warranty is still valid

 Possibility to order by fax, Service Line, Internet at www.SMA.de/Service
Manufacturer's warranty

Our inverters come with a standard **five-year** manufacturer's warranty.

If a repair is needed during this time, we will immediately send you a state-of-the-art replacement device with all the necessary updates.

You can choose to request the help of our skilled service technicians to carry out the device replacement.
Extended warranty – Safety throughout the whole Plant Lifespan

> Would you like to take advantage of this device replacement service, the support of our service technicians as well as of the Serviceline, even after the factory warranty has expired

> Extension of the manufacturer's warranty to 10, 15, 20 or 25 years is possible

> You can opt for this extended warranty within the first five years

For complete information, visit our Online Service Center at www.SMA.de/Service.
Always up to date with the Sunny Newsletter

go.sma.de/news
Let’s be realistic and try the impossible!