Standard-compliant components for photovoltaic systems
Safe and cost-efficient construction and operation
Standard-compliant and safe

Whether dealing with a lightning strike, return current, overload, or just maintenance work, the comprehensive and coordinated spectrum of SENTRON protection, switching, measuring, and monitoring devices offers all the components necessary for safe construction and operation of a photovoltaic system from a single source – from DC overvoltage protection to universal current-sensitive RCCBs.
Perspectives on the supply of energy

Fossil fuels are growing scarcer, energy is becoming more and more expensive, and global warming is increasing dramatically due to rising greenhouse gas emissions – all these trends are forcing energy policy to be rethought. A decade has already passed since the European Parliament ratified Directive 2001/77/EC, “Promotion of electricity from renewable sources,” in September 2001. In conjunction with the goals of the Kyoto Protocol in regard to worldwide reduction of CO₂ emissions, the proportion of renewable energy relative to the overall energy mix is to be increased by 20 percent by 2020.
Photovoltaic systems in focus

Photovoltaic in the energy mix
Interest in photovoltaic systems (PV systems) is steadily increasing – due not just to ecological factors but to economic factors as well. PV systems are profitable not least due to the infeed tariffs guaranteed by local laws (e.g. German Renewable Energy Sources Act – EEG).

According to the most recent study of the five leading electricity markets in Europe (Germany, France, Great Britain, Italy, and Spain) by the EPIA (European Photovoltaic Industry Association), electricity from PV systems will be able to be fed into the grid on a competitive cost basis by 2013 in some countries, and by 2020 it will increasingly be established in the various European market segments.

PV energy is thus well on its way to being established as a competitive technology for the electricity markets within the European Union (EU) and is increasingly becoming an important component of the global energy mix.

Standards promote safety
A PV system needs to be safely constructed and operated according to the DIN VDE 0100-712, E DIN IEC 60269-6, and VDE 0636-6 installation standards. That is the only way to ensure the safety of persons and buildings and ultimately the long-term profitable operation of the system. A variety of protective measures need to be taken to fulfill the requirements of the standards. Our comprehensive and coordinated line of SENTRON protection, switching, measuring, and monitoring devices enables standard-compliant, safe, and profitable construction and operation of PV systems.

Highlights
- Photovoltaic systems are becoming increasingly important in the global energy mix
- Guaranteed infeed tariffs increase the profitability of PV systems
- Many standards regulate the safe construction of PV systems
- SENTRON protection, switching, measuring, and monitoring devices guarantee standard-compliant construction and operation of a PV system

Whether in industrial applications, in infrastructure, or in buildings, our comprehensive portfolio of products and systems offers safe, cost-efficient, and flexible application options for low-voltage power distribution and electrical installation technology. This portfolio also enables the safe design and operation of PV systems.
Photovoltaic application areas

System types
The market for PV systems is broken down into off-grid (< 1 kW) and on-grid systems. For on-grid systems, a differentiation is made between residential (1–10 kW) and commercial (10–500 kW) systems as well as power plants (> 500 kW).

Off-grid systems
Systems are off-grid when they have no connection to the public power grid; they are usually the sole power supply for stand-alone systems. In order to be able to make power available on a continuous basis, the power must be stored – e.g. in an accumulator. An example of an accumulator-buffered stand-alone system is a pay-and-display parking ticket vending machine. The PV generator must be dimensioned so that during the productive phase, that is, when there is direct sunlight, the electrical loads can be supplied and the batteries can be charged at the same time.

On-grid systems
In the case of on-grid systems, the power is fed into the public electricity grid. The DC voltage generated by the PV modules first needs to be converted into AC voltage by an inverter.

The main components of an on-grid system include the PV generator, which converts the light into electrical power (DC power). The heart of the system is the inverter. It provides not just the conversion of the DC voltage into AC voltage, but also controls the entire PV system. The export meter is used to measure the amount of electricity fed into the public power grid in kWh.

PV system types

<table>
<thead>
<tr>
<th>Off-grid</th>
<th>On-grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>Commercial</td>
</tr>
<tr>
<td>&lt; 1 kW</td>
<td>1 – 10 kW</td>
</tr>
<tr>
<td>- Street signs</td>
<td>Roof-mounted systems of</td>
</tr>
<tr>
<td>- Pay-and-display parking ticket vending machines</td>
<td>- Residential buildings</td>
</tr>
<tr>
<td></td>
<td>- Garages</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Sunlight becomes electricity

Functional principle
The term photovoltaic describes the direct conversion of radiant energy such as solar energy into electrical power. The conversion takes place using PV cells in PV systems. The electricity generated can be used on-site, stored in accumulator batteries, or fed into the power grid.

Set-up of the PV generator
Several PV cells are combined to form a PV module. The module voltage is typically up to 40 V. All PV modules taken together form a PV generator.

PV modules are available in three versions:
- Monocrystalline modules with efficiency of 15 to 18 %
- Polycrystalline modules with efficiency of approximately 12 to 16 %
- Thin-film modules with efficiency of approximately 6 to 10 %

The three types differ not just in regard to their manufacturing processes, their costs, and the energy required for their production, but also in regard to the protection devices that must be installed with them – depending on the rated current and maximum permitted return current of the respective module type. Our comprehensive product portfolio offers the corresponding SENTRON protection devices for each module type.

It is common for the PV modules to be connected in series and combined to form a PV string. Depending on topology, several PV strings are wired in parallel and consolidated in a string box. The voltage does not exceed 1,000 V DC. SENTRON protection, switching, measuring, and monitoring devices enable safe operation in this voltage range as well.

Highlights
- PV systems convert unlimited solar energy into electrical power
- A comprehensive portfolio includes SENTRON protection devices for all PV module types
- The SENTRON portfolio enables safe operation even for high DC voltages up to 1,000 V

Functional principle of photovoltaic

1. n-doped silicon with excess positive charge carriers (holes)
2. p-doped silicon with excess negative charge carriers (electrons)
3. Boundary layer in which the electrical field is established
4. Incident photon
   1. The impact of the photon causes the electron to enter a higher energy state, allowing it to leave its position in the crystal lattice
   2. The released electron is drawn through the boundary layer into the n-region
   3. The front contact on the upper side of the solar cell accepts the free electron, allowing current to flow
Safely disconnected and reliably protected

Safe construction and operation
The safe construction and operation of a PV system is of great importance, particularly for the system’s long-term profitability. The guidelines for installation and operation of PV systems can be found in DIN VDE 0100-712 and IEC 60364-7-712.

Safe disconnection in case of a fault
A central factor in the operation of a PV system that feeds into the local power grid is grid safety. The PV modules must be disconnected from the system at the infeed point in the event of a fault. It is also necessary to prevent infeed to the grid in the event of grid and system faults.

The standards require that isolating arresters be provided on both sides of the inverter. These must feature suitable load-switching capacity on both the DC and AC sides.

Safe disconnection in case of maintenance work
Since the PV plug connection system generally cannot be disconnected under load (for maintenance work, for example), it is absolutely necessary that switch-off equipment is provided. DC isolators designed with a suitable switching capacity for direct currents enable functions such as safe disconnection under load on all poles. The DC isolator is often already integrated into the inverter. However, DC isolators are often also recommended in connection boxes in order to enable selective disconnection of a PV string. This allows the rest of the system to continue producing electrical power.

According to the standards, isolating equipment must be provided on the AC side. The AC main switch must be able to safely disconnect the AC circuit under load on all poles. The use of switch disconnectors with suitable AC switching capacity is recommended for this.

Protection against overvoltage
PV modules and inverters are high-value electronic components that in some cases are very sensitive in their reaction to overvoltages caused by lightning strikes or grid-side overvoltages. Overvoltage protection devices for the DC and AC sides limit voltage spikes and ensure the safety and uninterrupted availability of the system.

Thunderstorms do not skip over PV systems. Due to their exposed position on roofs or in open areas, PV systems are especially vulnerable to direct or indirect lightning strikes. Overvoltage protection devices protect the system by limiting voltage spikes caused by lightning strikes. In this way they ensure the uninterrupted safety and availability of the system.
Protection on the AC side

Protection against residual currents
If there is not at least one simple isolator implemented between the AC side and the DC side, a type B residual current protection device is required. With transformerless inverters, the lack of simple (galvanic) isolation between the DC input side and the AC output side can cause smooth DC residual currents to go through to the AC side, which makes additional measures for personal and fire protection necessary. Type A residual current protection devices cannot detect these smooth DC residual currents. For this reason the devices do not trip in the event of a fault, and the intended protective function is not provided. In contrast, type B and B+ universal current-sensitive residual current circuit breakers offer optimal protection in case of smooth DC residual currents. An additional transformer ensures that the intended protective function is provided. Type B+ also offers advanced preventative protection against fire by limiting the tripping value to 420 mA.

Overcurrent protection devices
The supply cable to the inverter must be protected from overloads and short circuits in the meter area. Miniature circuit breakers of series 5SL/5SY offer reliable protection for this.

Meter panel, measurement equipment
Measuring devices are used to detect the quantity of power fed into the grid. If they are calibrated, they can also be used as the basis for settlement.

Highlights
- Type B and B+ universal current-sensitive RCCBs offer optimal protection in case of smooth DC residual currents
- Type B+ offers advanced preventative protection against fire
- MCBs provide reliable protection for the supply cables

Inverters without simple isolation: a type B residual current protection device is required, such as SIQUENCE

Own consumption of generated power
The constantly increasing number of PV systems can lead to overloading of the public power grids. That’s why own consumption of the power produced by PV systems is supported with an attractive, higher infeed tariff. This applies to systems up to 500 kWp that have connected to the grid by December 1, 2012. Own consumption is also becoming increasingly interesting due to constantly rising electricity prices. For measurement of the generated and drawn electrical power – the difference between the two is own consumption – measuring devices both on the AC side of the inverter and on the grid side can be used. If they are calibrated, they can also serve as the basis for settlement. The measuring devices used are meters with nonreverse ratchets or electronic meters that detect both energy flow directions separately. These requirements are fulfilled by our 7KT PAC1500 measuring devices. Remote querying of the measured values over the Internet is possible with the optional 7KT1 LAN coupler.
Remote DC isolation
In case of fire, a PV system represents a special hazard. Even after the inverter is isolated, the full generator voltage (up to 1,000 V DC) is present on the PV modules and cables.

If water is used to extinguish the fire, emergency personnel are at risk of fatal injury if minimum clearances are not maintained.

The solution is a 5TE2 DC isolator installed in a string box in the immediate vicinity of the PV modules. Using an undervoltage release, this isolator can be remotely tripped via a corresponding “EMERGENCY OFF” button or by switching off the grid-side power supply. If the ability to remotely switch on the PV modules is desired, a remote-controlled mechanism can be used for this.

Generator connection box
If several PV strings are interconnected, a string box is often used. It contains the terminals for the PV string cables and lines, along with blocking diodes, PV fuses, and overvoltage protection components. The string currents are conducted together to the PV inverter via the main current cable (on the DC side).

Note: The cross-section of the cable must be rated for the total string current.

The string box can also contain corresponding disconnection and measurement terminals for the later checking and measurement of the string currents. The DC side should generally be designed to be resistant to short circuits and ground faults. That means that the DC terminals within the string box and plus and minus cables (individual wires) are to be designed to be separate as well as installed in separate spaces or otherwise disconnected.

If several string boxes are installed together in one generator connection box and connected to the inverter, PV collector fuses are used.
The hot spot effect
Dirt deposits or partial shading of the PV generator cause the PV cell to generate much less current or none at all. This always leads to performance losses for the entire PV module of the affected string. Since PV cells in a PV module are connected in series, the current from the other PV cells also flows through the PV cell that is not (fully) functional. This cell can overheat in the process, possibly causing it to be destroyed (the hot spot effect). In order to protect individual PV cells or the PV module from this effect, a bypass diode is integrated into the circuit. This diode conducts the module current past the affected PV cell and prevents it from being destroyed. The number of bypass diodes in a PV module can vary depending on the PV cells in the module. The largest shading tolerance is achieved when bypass diodes are connected across every cell. However, most modules do not have more than four bypass diodes. In case of defective bypass diodes, PV fuses can also provide the required protection for the PV modules.

Protection against return currents
PV modules and connecting cables need to be protected against overloads, short circuits, and dangerous return currents. Return currents can arise on the DC side in the case of parallel switching of several PV strings – such as when short circuits or ground faults occur, but also in the event of shading of PV modules. A voltage reduction in one PV string can occur as a result, and that can cause PV modules to be thermally destroyed by the flow of current in the reverse direction. What is recommended here is the use of PV fuses that switch off the PV string in case of return currents that are too high. Return currents can also lead to cable damage and fires. That is why only fuses with the gPV tripping characteristic, developed especially for photovoltaics according to E DIN IEC 60269-6 and VDE 0636-6, may be used. In large systems, LV HRC PV fuses with rated currents up to several hundred amperes are available for protection of the collector cables and other system components.

<table>
<thead>
<tr>
<th>The hot spot effect</th>
<th>Protection against return currents</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Diagram" /></td>
<td><img src="image2.png" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>Normal operation:</strong></td>
<td>In case of conductive defective bypass diodes:</td>
</tr>
<tr>
<td>$I_{ph}$ of the respectively parallel cells is not sufficient for the breakthrough voltage of the diode from $\geq I_d = 0$.</td>
<td>The module is short-circuited and the voltage in the affected string is reduced. The total current of the other strings can ignite the PV module. For this reason a string fuse is urgently recommended with three or more parallel strings.</td>
</tr>
<tr>
<td><strong>For individual shaded cells:</strong></td>
<td></td>
</tr>
<tr>
<td>The shaded cells function as resistance and become hot (hot spot). Bypass diodes are used to prevent hot spots; the current is routed around the PV cells.</td>
<td></td>
</tr>
</tbody>
</table>
The right solution for every application

Our extensive product portfolio offers the right solution for every PV application. This includes protection of central inverters, protection of plants in a wide range of topologies, and the central section switches required by standard VDE AR-N 4105 since January 1, 2012.

### Design of a central inverter

Comprehensive protection must be provided for the central inverter. On the input side, LV HRC PV fuse systems protect against overloads and short circuits. Overvoltage protection is also required. Miniature circuit breakers or fused protection devices provide protection for the control circuit. Molded-case circuit breakers with a high switching capacity protect the AC power grid infeed. Appropriate measuring devices are used to detect the generated power quantity and quality.

### Residential/commercial systems with measurement of own consumption

For residential or commercial systems consisting of more than three strings, protection against return currents should be provided on the DC side in the form of PV fuses. DC-side overvoltage protection also needs to be provided. For increased safety in hazardous situations, such as in case of fire, a remotely tripped DC isolator that safely switches off the strings is recommended. Protection against short circuits, overloads, and overvoltages must also be provided on the AC side. For settlement purposes, especially in case of support for own consumption, suitable calibrated measuring devices are used.
Power plant: central inverter with two-stage design (DC side)

In case of a system with a central inverter and a two-stage design, the strings are initially consolidated in the first stage in string boxes and then connected to the generator connection box (see page 10) in the second stage.

With this design, DC-side voltages of up to 1,000 V arise along with high currents. This requires special protective measures.

Legend:

1. STE2 DC isolator
2. 3VL molded-case circuit breaker for DC
3. 3NW PV cylinder fuse system
4. 3NH7/3NE1 LV HRC PV fuse system
5. 5SD7 DC overvoltage protection
6. 3WL air circuit breaker up to 6,300 A
7. 3VL molded-case circuit breaker up to 1,600 A
8. 5SU55Y AC miniature circuit breaker
9. 5SP3 selective main miniature circuit breaker
10. 5SG755SE NEQ2ED fuse system
11. 3NP1 fuse switch disconnector
12. 5SD7 AC overvoltage protection
13. 5SD7 surge arrester for measuring, control, and regulation technology
14. 5SM3 residual current circuit breaker
15. 7KT PAC1500 measuring device
16. 7KM PAC measuring device
17. 5SV8 residual current monitoring device
18. SIRIUS 3RT contactors

Power plant: multiple inverters with two-stage design (AC side)

For multi-inverter systems with a two-stage design, several strings are each connected to an inverter. On the AC side, the current of several inverters is consolidated into an AC collector box (first stage). The current of the individual collector boxes is combined in another AC collector box (second stage) and ultimately fed into the grid.
Central section switch according to VDE AR-N 4105 (systems over 100 kVA)

For systems over 100 kVA, the norm VDE AR-N 4105 requires the use of motorized switches for the function of the central section switch. Redundant design is also required.

3VL molded-case circuit breakers and motorized molded-case disconnectors with corresponding auxiliary releases are intended for use as section switches for systems over 100 kVA.

Legend:

1. STE2 DC isolator
2. 3VL molded-case circuit breaker for DC
3. 3NW PV cylinder fuse system
4. 3NH7/3NE1 LV HRC PV fuse system
5. 5SD7 DC overvoltage protection
6. 3WL air circuit breaker up to 6,300 A
7. 3VL molded-case circuit breaker up to 1,600 A
8. 5S1/5SY AC miniature circuit breaker
9. 5SP3 selective main miniature circuit breaker
10. 5SG7/5SE NEOZED fuse system
11. 3NP1 fuse switch disconnector
12. 5SD7 AC overvoltage protection
13. 5SD7 surge arrester for measuring, control, and regulation technology
14. 5SM3 residual current circuit breaker
15. 7KT PAC1500 measuring device
16. 7KM PAC measuring device
17. 5SV8 residual current monitoring device
18. SIRIUS 3RT contactors
A comprehensive portfolio for the greatest possible operating safety

For the design of a PV system, a comprehensive and coordinated product portfolio is available for all system sizes and applications. These include proven, high-quality SENTRON protection, switching, measuring, and monitoring devices as well as SIVACON-ALPHA distribution and cabinet systems. The products fulfill the basic requirements for the installation and functionality of PV systems in accordance with the DIN VDE 0100-712, DIN VDE 0126, and IEC 60269-1 and -6 standards. The components simplify planning and operation. The standard rail mounting enables quick installation of the system.

### SENTRON products for the DC side (a selection)

<table>
<thead>
<tr>
<th>1</th>
<th>STE2 DC isolator</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>Switch disconnectors for isolation of PV modules in PV systems according to VDE 0100-712</td>
</tr>
<tr>
<td>-</td>
<td>Isolation of PV strings under load possible – to carry out maintenance work or for the protection of emergency personnel in case of fire, for example</td>
</tr>
<tr>
<td>-</td>
<td>The switch-off equipment should be located as near as possible to the PV generator; the use of string boxes is recommended</td>
</tr>
<tr>
<td>-</td>
<td>Can be combined with additional components of the 5SY series such as auxiliary switches, fault signal contacts, shunt trips, undervoltage releases, and remote controlled mechanisms</td>
</tr>
<tr>
<td>-</td>
<td>Can also be switched remotely using optional accessories</td>
</tr>
<tr>
<td>-</td>
<td>Separate switching position indicator for clear recognition of the switching state</td>
</tr>
<tr>
<td>-</td>
<td>Compact standard mounting rail device for applications up to 1,000 V DC</td>
</tr>
</tbody>
</table>

Standards: DIN EN 60947-3 (VDE 0660-107)

### 5SY5 universal current-sensitive miniature circuit breaker

| - | Reliable protection of DC cables against short circuits and overloads |
| - | Can be switched back on after tripped (switching position indicator) |
| - | Can be combined with additional components such as auxiliary switches, fault signal contacts, shunt trips, undervoltage releases, and remote controlled mechanisms |
| - | Can be used with 250/440 V AC and up to 250 V DC per pole |
| - | 5SY5 four-pole design up to 1,000 V DC |
| - | Available from 0.3 to 125 A |

Standards: DIN EN 60898-2 (VDE 0641-12)
3VL molded-case circuit breaker for DC

- Molded-case circuit breaker for protection of DC cables against short circuits and overloads
- Available as a circuit breaker and switch disconnector
- Used in generator connection boxes and in central inverter inputs
- Can be equipped with additional components for remote control such as motorized drives, undervoltage releases, and voltage releases
- In combination with the optional door-coupling rotary operating mechanism, optimally suited for safe isolation when the generator connection box / central inverter is closed
- Four-pole version from 25 A to 160 A available for maximum voltages of up to 1,000 V DC

Standards: DIN EN 60947-2 (VDE 0660-101)

3NW PV cylinder fuse system

- Protects DC strings and PV modules against short circuits and overloads, especially in case of return currents
- Safe shutdown in case of residual currents reduces risk of fire caused by DC electric arcs
- Safe isolation when the fuse holder is open
- Compact design (1TE)
- Flashing LED on the fuse holder signals switch-off of the fuse link
- Operational class gPV

Standards: DIN EN 60269-6 (VDE 0636-6)

3NH7/3NE1 LV HRC PV fuse system

- Protection of the elements of large PV systems as a group or collector fuse, used upstream from the inverter
- Available in sizes 1 and 2L
- For size 2L, there is a special lower part of the fuse with a swivel mechanism and full touch protection that makes it possible to safely change the fuse without handling it
- Flashing LED on the fuse holder signals switch-off of the fuse link
- Operational class gPV

Standards: DIN EN 60269-6 (VDE 0636-6)
SENTRON products for the AC side (a selection)

3WL air circuit breaker/switch disconnector

- Switching and protecting the AC output of central inverters of large PV power plants
- Optional components such as auxiliary releases, motorized drives, overcurrent releases, current sensors, auxiliary current alarm switches, automatic reset mechanisms, interlocks, and retraction drives available
- Modularity through special LCDs, ground fault current, rated current, and communication modules
- Fast and easy retrofitting as well as adaptation to different requirements

3VL molded-case circuit breaker up to 1,600 A

- Used on the AC side as a concentration switch for parallel inverters or in the output circuit of central inverters
- Optimal protection for every requirement
- Modular design reduces version diversity
- Accessories standardized across several sizes
- No performance loss up to 50 °C ambient temperature
- Complete spectrum with rated current up to 1,600 A
- Configurable alarms for some electrical measured values (voltage, current, output, harmonics, etc.)
- Can be remotely controlled
- Communication options: Modbus RTU, PROFIBUS
- Available both in thermal magnetic (16 A to 630 A) and electronic (63 A to 1,600 A) versions

Standards: DIN EN 60947-1 (VDE 0660-100); DIN EN 60947-2 (VDE 0660-101)
### SSL/SSY AC miniature circuit breaker

- Reliable protection against overloads and short circuits
- Comprehensive cable and system protection
- Protection of the control circuits in the inverter, such as for the auxiliary voltage of contactors and measuring circuits, as well as for fan motors and lighting for cabinets or containers
- Tripping characteristic: SSL miniature circuit breaker (B, C); SSY miniature circuit breaker (A, B, C, D)
- Rated switching capacity: SSL miniature circuit breaker: 6 kA; SSY miniature circuit breaker: 10 kA
- Extensive accessories, such as remote-control mechanisms

Standards: DIN EN 60898-1 (VDE 0641-11); DIN EN 60947-2 (VDE 0660-101)

### SHU 5SP3 main miniature circuit breaker

- Safe disconnection and restart of the PV system from the AC grid
- Optimal availability of the system through prevention of overloads and short circuits
- Simple and time-saving installation by snapping directly onto busbars
- Space-saving field design due to reduced mounting width
- Connection of the meter cable without tools
- Safe and high selectivity
- Selective main miniature circuit breaker operates independently of voltage
- Practical locking options
- Fulfillment of TAB 2007; operation by nonprofessionals allowed

Standards: DIN VDE 0641-21

### SSG715SE NEOZED fuse system

- Switch disconnectors with fuses and fuse switch disconnectors for protecting the infeed of the control circuits and for protecting the measuring circuits of the inverter
- For switching loads and safe switching, even in case of short circuits
- High level of protection due to NEOZED fuse links
- Compact design for optimal installation in inverters
- A wide variety of accessories, such as busbars for one-, two-, or three-phase wiring

Standards: DIN EN 60947-3 (VDE 0660-107); DIN VDE 0638
11 3NP1 fuse switch disconnector up to 630 A

- Safe disconnection of the PV system from the AC grid and restart
- Increased protection for personnel and the system
- High flexibility due to modular structure and standardized accessories
- Quick and easy installation
- Reduced costs and space requirements due to compact size
- Fast and safe conversion to cable outlet above/below
- Switching under load possible
- Used in the inverter – as a backup fuse for overvoltage protection, for protecting the compensation plant, or in AC-side collector boxes with multi-inverter systems, for example
- Flexible switching time points (simultaneous or leading) possible for the auxiliary switch
- Large assortment in various sizes and output classes

Standards: DIN EN 60947-1 (VDE 0660-100); DIN EN 60947-3 (VDE 0660-101)

12 5SD7 AC overvoltage protection

- Protection on the AC side against overvoltages triggered by lightning or switching operations from the grid
- Protection of control circuits of the inverter against overvoltages and high surge currents using type 1 lightning arresters and type 2 surge arresters
- Remote signaling upon failure of the device (optional)
- Rated voltage: 240/415 V AC
- Rated discharge surge current: 20–100 kA
- Maximum discharge surge current: 40 kA
- Combination of type 1 and 2 available

Standards: DIN EN 61643-11 (VDE 0675-6-11)

13 5SD7 surge arrester for measuring, control, and regulation technology

- Protection of signal lines, such as PROFIBUS, telecom, and sensor cables in the inverter or in the PV field

Standards: DIN EN 61643-11 (VDE 0675-6-11)
SENTRON products for the AC side (continued)

14 SSM3 residual current circuit breaker
- Fast switching in case of residual currents for special protection of human lives and assets
- Protection in case of direct touching (additional protection) with $I_{\Delta n} \leq 30 \text{ mA}$
- Protection in case of indirect touching (leakage protection) also with $I_{\Delta n} > 30 \text{ mA}$
- Protection from electrically ignited fires with $I_{\Delta n} \leq 300 \text{ mA}$
- Universal current-sensitive residual current circuit breaker (type B, B+) with an additional transformer for safe detection of smooth DC residual currents that go through the inverter to the AC side
- Intended protective function ensured for all residual current types
- Adjusted release characteristic of type B for increased operating safety
- Reduced wiring and installation expense when residual current circuit breakers with integral overcurrent protection are used

Standards: DIN EN 61008-1 (VDE 0664-10); DIN EN 61008-2-1 (VDE 0664-11); DIN EN 62423 (VDE 0664-40)

SENTRON measuring and monitoring devices (a selection)

15 7KT PAC1500 measuring devices
- Used in distribution boards
- Settlement of the drawn or generated power by the digital meter for active or reactive energy – with display of the current active and reactive power
- Using the optional LAN coupler, the measured values can also be queried over the Internet
- Calibrated versions according to the new Measuring Instruments Directive 2004/22/EC (MID) – in addition to the sum register, the values for the individual phases are stored in separate registers

Standards: DIN EN 50470-1 (VDE 0418-0-1); DIN 50470-3 (VDE 0418-0-3); DIN EN 62053-23 (VDE 0418-3-23); DIN EN 62053-31 (VDE 0418-3-31)

16 7KM PAC measuring device
- Used in the inverter for measurement of current, voltage, output, power quality, etc.
- Display and monitoring of electrical measured values within the output circuit of the inverter, allowing the quality of the power fed into the grid of the power companies to be detected, along with critical measured values that indicate failures or overloads
- Communication capability ranging from PROFINET to Modbus RTU and Ethernet with Modbus TCP

Standards: DIN EN 61557-12 (VDE 0413-12); DIN EN 62053-31 (VDE 0418-3-31); measurement precision for energy according to DIN EN 62053

17 SSV8 residual current monitoring device
- Higher system availability and operating reliability due to continuous monitoring of residual currents
- The adjustable limits for residual current and response time enable early recognition and signaling so that shutdown of the system can often be avoided
- Devices for every application: the summation current transformers are available in various sizes; the RCM devices can be used for detection and/or switching
- The monitoring devices can also provide additional fire protection

Standards: DIN EN 62020 (VDE 0663)
SIRIUS products for the AC side (a selection)

**SIRIUS 3RT contactor**

- Used as a central section switch for generation plants up to 100 kVA in accordance with VDE AR-N 4105
- Type-tested combinations (classification type 2) of SIRIUS 3RT contactors and SENTRON fuses from the 3NA and 5SE product lines
- 4-pole version for use in TN-S and TT grid systems
- 3-pole version for use in TN-C grid systems

Standards: DIN EN 60947-1 (VDE 0660-10); DIN EN 60947-4-1 (VDE 0660-102)

SIVACON ALPHA distribution board and cabinet systems (a selection)

**ALPHA SIMBOX WP small distribution board**

- For proper accommodation of the devices on the AC and DC side, such as generator connection boxes
- Rated insulation voltage: AC/DC 1,000 V
- Degree of protection: IP65
- Temperature range for use: -25 °C to +60 °C
- UV-resistant
- One- to four-tier design
- Eight enclosure sizes from 1 × 4 TE to 4 × 18 TE

Standards: DIN EN 60439-3 (VDE 0660-504)

**ALPHA 8HP molded-plastic distribution system**

- For proper accommodation of the devices on the AC and DC side, such as generator connection boxes
- Modular distribution system, nearly limitless in how it can be combined and expanded
- Can also be used as a collector box on the AC side (see multi-inverter topology)
- Extremely robust due to fiberglass-reinforced polyester
- UV- and heat-resistant
- Temperature range for use: -40 °C to +55 °C
- Rated insulation voltage: DC 1,200 V
- Safety class II
- Degree of protection: IP65
- Five enclosure sizes (basic dimensions 307 x 135.5 mm)
- Toolless closure

Standards: DIN EN 60439-1 (VDE 0660-500)
SIVACON ALPHA distribution board and cabinet systems (continued)

SIVACON BMF and BMG system cabinets

- Used as a housing for inverters or as system cabinets in PV containers
- For installation of devices and equipment of electronic and conventional control and regulation technology, as well as for low-voltage distribution boards
- A large number of specific variants available on request
- Degrees of protection: IP40 and IP54 for unventilated system cabinet, IP30 and IP40 for ventilated system cabinet
- Available sizes:
  Height: from 400 mm to 2,400 mm
  Width: from 300 mm to 1,800 mm
  Depth: from 300 mm to 1,400 mm

ALPHA terminal blocks (a selection)

ALPHA FIX terminal blocks

- For wiring of the system components in string boxes, generator connection boxes, and inverters
- Complete series for all connection methods
- Available with dielectric strength of 1,000 V DC
- Compact design and optimal handling

Standards: DIN EN 60664-1 (VDE 0110-1); DIN EN 60999; DIN EN 60947-7-1 (VDE 0611-1); DIN EN 60947-7-2 (VDE 0611-3)

The featured products only represent an extract from the complete catalogs. Please find further information and more products for different demands in the following catalogs:
- LV 11 2012
- LV 10.1 2012
- LV 10.2 2012
- IC 10.
Any questions?
One click – well-informed

LV Explorer – Discover Low Voltage in 3D

Get comprehensive and specific information about our products with the help of 3D animations, trailers and technical information.

www.siemens.com/lowvoltage/lv-explorer

Always at your disposal: our extensive support

We provide you with support from planning through commissioning and operation.

<table>
<thead>
<tr>
<th>Information</th>
<th>Planning/Orders</th>
<th>Operation/Service</th>
<th>Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>– Information and</td>
<td>– Configurations</td>
<td>– Service &amp; Support Portal</td>
<td></td>
</tr>
<tr>
<td>Download Center</td>
<td>– SIMARIS Software Tools</td>
<td>– CAx Online Generator</td>
<td></td>
</tr>
<tr>
<td>– Newsletter</td>
<td></td>
<td>– My Documentation Manager</td>
<td></td>
</tr>
<tr>
<td>– Picture Database</td>
<td></td>
<td>– Support Request</td>
<td></td>
</tr>
</tbody>
</table>

www.siemens.com/lowvoltage/support
Subject to change.
The information provided in this brochure contains descriptions or characteristics of performance which in case of actual use do not always apply as described or which may change as a result of further development of the products. An obligation to provide the respective characteristics shall only exist if expressly agreed in the terms of contract.

All rights reserved.
All product names may be brand names of Siemens Ltd or another supplier whose use by third-parties for their own purposes may violate the owner’s rights.
© Siemens AG 2012