Solar Energy

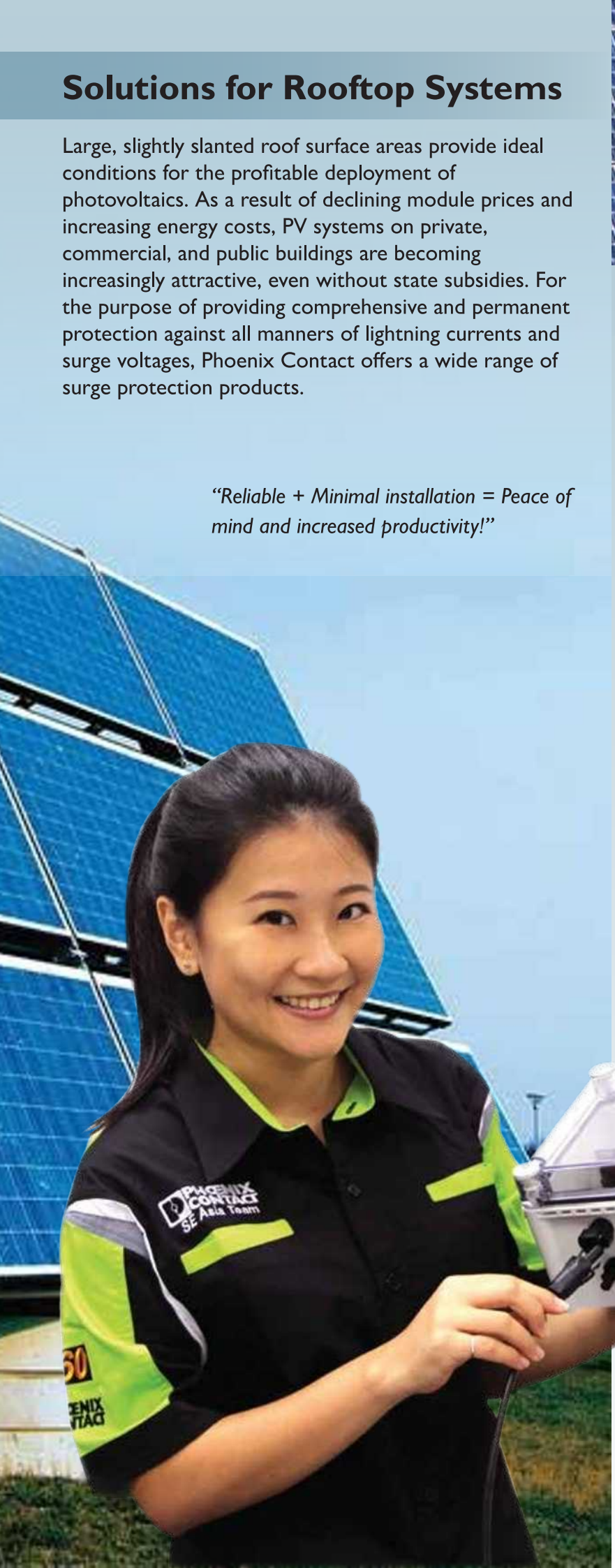
String Combiner Boxes for PV

PHOENIX CONTACT
INSPIRING INNOVATIONS

Solutions for Rooftop Systems

Large, slightly slanted roof surface areas provide ideal conditions for the profitable deployment of photovoltaics. As a result of declining module prices and increasing energy costs, PV systems on private, commercial, and public buildings are becoming increasingly attractive, even without state subsidies. For the purpose of providing comprehensive and permanent protection against all manners of lightning currents and surge voltages, Phoenix Contact offers a wide range of surge protection products.

"Reliable + Minimal installation = Peace of mind and increased productivity!"



Your Advantages

- Robust and durable components: all sets are installed in housing which is protected against dust and jet water (IP66)
- Fast installation, thanks to the pre-assembled of the PV sets
- Easy connections with SUNCLIX plug-in connector system
- Customer-specific PV set solutions on request

PV Rooftop Systems: Surge Protection

It is not always a direct lightning strike in the PV module that causes surge voltage damage. Surge voltages can also be coupled over module surfaces and DC voltage cables. With PV sets, Phoenix Contact offers reliable system solutions that protect the inverter directly before the DC and AC voltage inputs. The surge couplings are thereby diverted straight to the ground potential, protecting the inverters and other sensitive devices against surge voltage.

Surge protection: PV set solutions

PV sets			
Order No.	**5801146**	**5801147**	**5801135**
Description	**PV-SET 2-1 / 1000/F-SPD-SD-SC** ☑ 2 Strings for 1 MPPT ☑ 2 LED Fuse Holder ☑ 1 DC Surge Protector ☑ 1 DC Disconnector ☑ 6 SUNCLIX connector	**PV-SET 2-2 / 1000/F-SPD-SD-SC** ☑ 2 Strings for 2 MPPT ☑ 2 LED Fuse Holder ☑ 2 DC Surge Protector ☑ 2 DC Disconnector ☑ 8 SUNCLIX connector	**PV-SET 4-2 / 1000/F-SPD-SD-SC** ☑ 4 Strings for 2 MPPT ☑ 4 LED Fuse Holder ☑ 2 DC Surge Protector ☑ 2 DC Disconnector ☑ 12 SUNCLIX connector
Cross Section	2.5...6 mm2 (PV Cables) 6...10 mm2 (GND Cable)	2.5...6 mm2 (PV Cables) 6...10 mm2 (GND Cable)	2.5...6 mm2 (PV Cables) 6...10 mm2 (GND Cable)
IP-Protection Class	66	66	66
Dimension of Enclosure (in mm)	W190 X L280 X H130	W280 X L380 X H130	W280 X L380 X H130
Weight	2kg	4kg	4kg
Operation Position	Wall Assembly	Wall Assembly	Wall Assembly
Operating Temperature Range	-25 °C ... +55 °C (>50 °C derating)	-25 °C ... +60 °C (>55 °C derating)	-25 °C ... +55 °C (>45 °C derating)
Rated Operating Voltage, Ue	830V DC	830V DC	830V DC
Open-Circuit Maximum Voltage, $U_{oc\ max}$	1000V DC	1000V DC	1000V DC
Rated Current In (per string)	10 A DC (Max. Operating Temp. 50 °C)	10 A DC (Max. Operating Temp. 55 °C)	10 A DC (Max. Operating Temp. 45 °C)
Short-Circuit Current Maximum Current, $I_{sc\ max}$ (per string)	10A DC (per string)	10A DC (per string)	10A DC (per string)
Max. Discharge Current (8/20)µs	40kA	40kA	40kA
Test Standard	EN 61439-1:2011, EN 61439-2:2011	EN 61439-1:2011, EN 61439-2:2011	EN 61439-1:2011, EN 61439-2:2011

Connectors & Accessories

Phoenix Contact offers numerous cabling solutions that perfectly tailored to the requirements of PV systems. These were designed with durability, quick and easy installation in mind. The SUNCLIX plug-in connectors for field assembly can be mounted within approximately 10 - 15 seconds without special tools. This ensures long-term system availability even under extreme atmospheric influences. Phoenix Contact also offers a high-quality hand tool for every application. Avoid unnecessary searching by storing your tools in a clear way: with the Solar toolset, the right tools are clearly arranged and always in hand, particularly for on-site operations.

Connectors, Cables & Accessories

SUNCLIX plug-in connectors, distributors and adapter			
Order No.	**Pin (-) 1774687** **Socket (+) 1774674**	**Y distributor (+/--) 1787726** **Y distributor (-/++) 1787739**	**1704982**
Description	**PV-CM-S 2,5-6 (-)** **PV-CF-S 2,5-6 (+)** ☑ Rated Voltage 1100 V ☑ Nominal Current Max. 40A ☑ Spring-cage Connection	**PV-YC 6/ 1-0,12-SO3 (-/++)** **PV-YC 6/ 1-0,12-SO3 (+/--)** ☑ Rated Voltage 1100V ☑ Nominal Current Max. 40A ☑ Length 120mm	**PV-AS-MC4/6-150-MN-SET** Adapter set for converting MC4 connectors to SUNCLIX
gPV fuses, protective caps and solar cables			
Order No.	**Varies**	**1785430**	**Varies**
Description	☑ gPV characteristics, 1000VDC ☑ Available in 2, 4, 6, 8, 10, 12, 14, 15 and 16A	**PV-C PROTECTION CAP**	☑ Cross Section 2.5mm² …6.0mm² ☑ Electron beam cross-linked, TUV type approved ☑ -40°c to +120°c max. conductor temperature

Tools

Tool kit Solar			
Order No.	**1212071**	**1204517**	**1212511**
Description	TOOL KIT SOLAR	SZF 1-0.6X3.5	WIREFOX-D SR 6-1

Safety and Performance Related Design of String Connection Boxes for Photovoltaic System

1. Introduction

String combiner boxes (SCBs) are used in multi-string PV systems to combine the single strings electrically and connect them with the input terminals of the inverter. Nowadays, SCB are designed for 2 up to 32 strings and they can be equipped additionally with:

- DC isolators used to disconnect the panels from the inverter for maintenance purposes.
- Diodes to prevent reverse current flow
- String fuses
- Surge protective devices (SPDs) to provide effective protection against surge currents and voltages
- Monitoring units, e. g. string current monitoring systems

The design of a SCB requires fundamental knowledge in the field of:

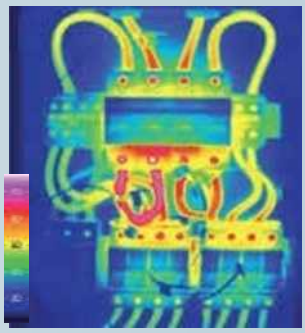
- Low-voltage switchgear assemblies (EN 61439-2:2011) — including the thermal design and heat management
- Surge protection
- Selection of DC isolators, which are able to withstand the expected surge currents

These issues are addressed by this work. The results presented provide practical information for the design of string SCBs.

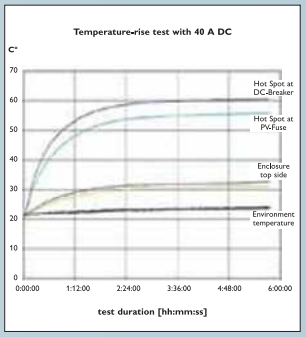
2. Heat Management

- Heat generated in string fuses can lead to a strong heating-up of the SCB.
- To prevent danger resulting from this, thermal overload has to be prevented under operating conditions.
- High current long-term tests have to be performed to ensure that the temperature inside the SCB does not exceed critical values (hot spot detection can be advantageous, technical data of the fuses has to be considered).

String combiner box (SCB)



Temperature distribution during current flow



Development of temperature recorded at different measuring points

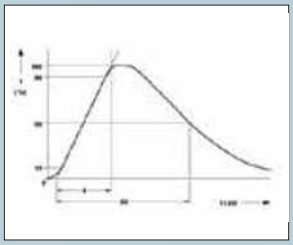
3. Wiring and Components

The integration of surge protective devices requires a special "surge current optimised" design:

- The cabling has to be designed to withstand surge currents (mechanical and thermal stress)
- The cables have to be selected for the max. operating current and the short circuit behaviour
- DC isolators have to be selected by additional tests beyond EN 61439-2:2011 concerning immunity against surge currents
- High-grade SPDs tested according to prEN 50539-11 fulfills highest safety requirements

Surge current generator for generation of test impulses

SCB during a surge load test



8/20 µs surge-current impulse

4. Results and Conclusion

- The heat generated under operating conditions by string fuses and as well DC isolators, has to be considered in the thermal design. Long term tests to simulate real operating conditions should be performed for qualification testing of SCBs to ensure safe behaviour.
- Tests according to EN 61439-2:2011 – "Low-voltage switchgear and controlgear assemblies. Power switchgear and controlgear assemblies." are appropriate for this purpose. An infrared camera can be advantageously used for the hotspot detection.
- In case of using surge protection devices, surge current tests should be performed to ensure that the whole assembly and especially the DC isolator can withstand a certain level of surge current stress without failure and then required protection performance is achieved.

Further information on the products presented here and on the world of solutions from Phoenix Contact can be found at
www.phoenixcontact.com.sg

PHOENIX CONTACT (SEA) Pte Ltd
105 Eunos Avenue 3
#04-00
Singapore 409836
Phone: +65 6435 9800
Fax: +65 6443 0039
Email: info@phoenixcontact.com.sg

PHOENIX CONTACT (Thailand) Co. Ltd.
797, 1st and 2nd Floor
Rama 9 Road
Bangkapi, Huai Khwang,
Bangkok 10310 **Thailand**
Phone: +66 2 719 7957-8,
+66 2 719 7357-8
Fax: +66 2 719 7359
Email: info@phoenixcontact.co.th

PHOENIX CONTACT (Malaysia) Sdn Bhd
B-G-32, Jalan Tropicana Selatan 1
Merchant Square
47410 Petaling Jaya
Selangor Darul Ehsan, **Malaysia**
Phone: +60(3) 7883 0283
Fax: +60(3) 7883 0216
Email: info@phoenixcontact.com.my

PHOENIX CONTACT (SEA) Pte Ltd
Vietnam Representative Office
2nd Floor, Green Star Building
70 Pham Ngoc Tach Street,
Dist. 3, Ho Chi Minh City, **Vietnam**
Phone: +84 8 3820 7807
Fax: +84 8 3820 7713
Email: info@phoenixcontact.com.vn

PT PHOENIX CONTACT
German Center, Suite 6210-6240
Jl. Kapt. Subijanto DJ, Bumi Serpong Damai
Tangerang 15321, **Indonesia**
Phone: +62 21 531 531 71
Fax: +62 21 531 531 72
Email: info@phoenixcontact.co.id

PHOENIX CONTACT (Phils.) Inc.
Unit 2R, 2nd floor Commercial Center
Lee Gardens Condominium
Lee Street Corner Shaw Boulevard
Mandaluyong City 1552, **Philippines**
Phone: +63 2 817 7843
Fax: +63 2 817 7844
Email: info@phoenixcontact.com.ph

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