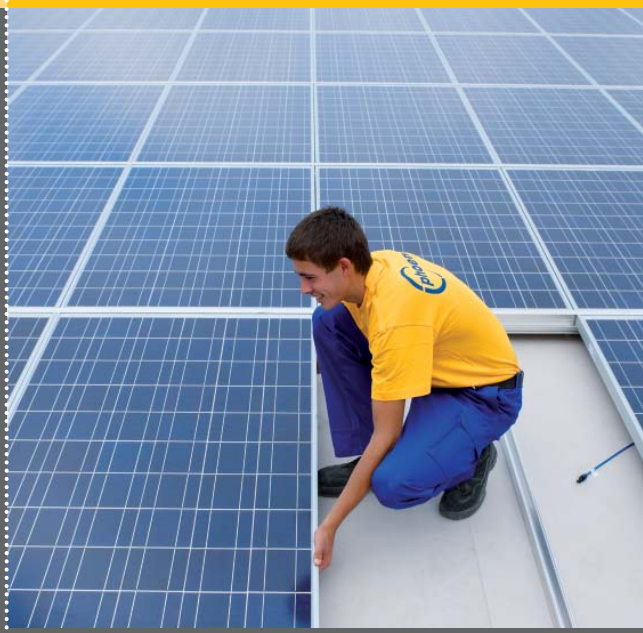


Phoenix TectoSmart
Insertion-based system
Installation instructions

THE PHOENIX TECTOSMART INSERTION-BASED SYSTEM – THE ADVANTAGES AT A GLANCE

- Tested by TÜV, RAL seal of quality for all components
- At least 30 % shorter installation time compared to on-roof systems
- Long service life due to aluminium and V2A stainless steel components
- Floating module design
- Suitable for all framed modules and laminates
- Modules plane/parallel to the roof tiles on one level
- Good rear ventilation, no condensation
- Clear separation of trades

CONTENTS **PAGE**

1. Safety instructions

FOR YOUR OWN PROTECTION, THE PROTECTION OF OTHERS AND PROTECTION OF THE SOLAR SYSTEM WE ASK THAT YOU TAKE NOTE OF THE FOLLOWING POINTS:

- These installation instructions are intended for mounting solar energy systems up to a maximum roof ridge height of 25 metres. The system must be modified for installations at heights above this. Please contact your Phoenix Solar partner or directly contact Phoenix Solar AG for more information.

- All work on solar modules entails work on live electrical components. The full open-circuit voltage of the solar modules can be generated as soon as light shines on them. The only way to achieve zero voltage is to cover the modules with some type of opaque material.

- The maximum permissible system voltage of the solar modules must never be exceeded.

- When working in the vicinity of electrical overhead lines, or with string open-circuit voltages exceeding 120V DC, you are no longer within the safe low voltage range. In these cases, please be sure to observe the special accident prevention regulations.

- Electrical work must always be performed using insulated tools.

- When working at heights above three metres, appropriate safety mechanisms must be installed to prevent personnel from falling.

- The electrical installation between inverters and the public mains grid should only be performed by a qualified and approved electrician.

LIABILITY NOTICE

Since the circumstances or methods of installation, commissioning, use and/or maintenance of the solar system lie outside the control of Phoenix Solar AG the company accepts no liability of any kind for loss, damages or costs resulting from incorrect installation, commissioning, use and/or maintenance of the solar system.

2. Tools required

- Pencil
- Tape measure/folding ruler
- Tension string
- Hexagonal wrench key (spanner size 6)
- Cordless screwdriver with adjustable torque

3. Overview of the components

Insertion rail

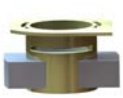
Seal

Base rail

Compensation profile (optional)

Clamping profile

Cable duct (optional)



Threaded nut

Rail connector brackets

4. Roof preparation

Roof rafters or purlins are required for the installation of the Phoenix TectoSmart mounting system. The spacing between rafters/purlins can be irregular and up to three metres. Battens and if applicable counter battens are not required with this system. Wooden roof planking is installed on the rafters/purlins so that a conventional waterproof roofing membrane can be fixed on it. The roofing membrane will later serve as the water-bearing layer. Water runs off behind the modules and is discharged via the roof gutter.

Determining the required planking strength:

$D = l_W / 30$ D = planking strength

l_W = rafter clearance

Fix the roofing membrane to the verge, ridge and eaves.

Note: Please respect the regulations of the roofer association in your respective country (e.g. Central Association of the German Roofing Trade – Regelwerk des Deutschen Dachdeckerhandwerks).

Attention: The planking, roofing membrane and the sheets for fixing are not provided by Phoenix Solar AG.

Figures 1 and 2: Roof with an installed water-bearing layer and the Phoenix TectoSmart mounting system

5. Installation instructions

5.1 DETERMINING THE EXTERNAL DIMENSIONS OF THE SOLAR ENERGY SYSTEM

Special care must be taken when measuring the roof. The more precision taken in this installation step, the easier the later installation steps will be.

Note: Increased wind uplift and wind pressure values at the edge and corner region of the roof must be anticipated. These values have to be taken into consideration when planning the installation.

System height = module height x (number of rows + 0.015)
System or row width = module width x number of modules per row

5.2 INSTALLING THE BASE RAIL

Fasten the base rail vertically to the roof planking, which has been covered with the waterproof roofing membrane, and cut the profiles to fit the length of the previously determined system height. Next, drill 7-mm holes in the base rail with a spacing of approx. 1 metre (depending on the wind load according to DIN 1055 part 4). (Base rail also with pre-cut drill holes available.)

Please glue the seals to the rear of the base rail around the drill holes.

Attention: The holes in the base rail may never be drilled with the seals already glued in place.

Note: Seals are only glued in order to facilitate installation and do not serve any static purpose.

Fix the base rail to the roof planking using a self-drilling façade screw 6.5 x 120. One base rail should be fixed on each rafter.

Note: It is possible to keep a couple of centimetres spacing between the joints of the base rail to insert the cables.

5.3 INSTALLING THE INSERTION RAIL

Fix the clamping profile to the base rail using a threaded nut and an Allen bolt M8 x 20. At the same time place the insertion rail with the upper groove in the clamping profile and tighten the Allen bolt with a maximum torque of 12-15 Nm.

5. Installation instructions

Note: Always clamp the insertion rail at the upper groove. In case of higher wind loads we recommend installing two clamping profiles in each position (top and bottom).

Figure 3: Base rail with threaded nut

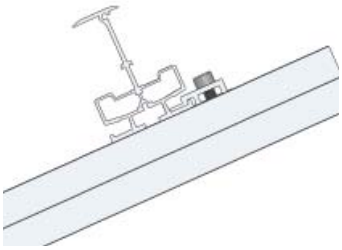


Figure 4: Base rail with insertion rail and clamping profile

Align the base rail and tighten the clamping profile with a maximum torque of 15 Nm. The distance between the individual insertion rails is the module height plus 7 mm. Make sure to always maintain this exact distance. To guarantee that the correct distance is maintained we recommend using a distance gauge (e.g. of wood).

The insertion rail has been designed for modules with a frame height of 50 mm. When installing modules with a smaller frame height you must install a compensation profile (Figure 5) on each insertion rail. It is inserted into the insertion rail directly by hand and guarantees that the modules are securely fixed in the insertion rail.

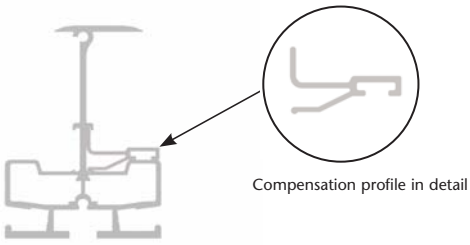


Figure 5: Insertion rail with compensation profile for modules with low frame height

Figure 6: Insertion rail on TectoSun 3 rail

Note: The installation can also be combined with the TectoSun 3 rail system.

5. Installation instructions

5.4 INSTALLING THE RAIL CONNECTOR BRACKETS

To connect multiple insertion rails, insert the rail connector bracket and the rail connector pin onto the end of the profile (see Figure 7). Fasten the rail connector bracket on the side through the rail using the provided self-cutting screw (see Figure 8).

Insert the tapered notch of the rail connector pin into the insertion rail. The use of a hammer is recommended.

Note: After insertion, it is very difficult to remove the pin.

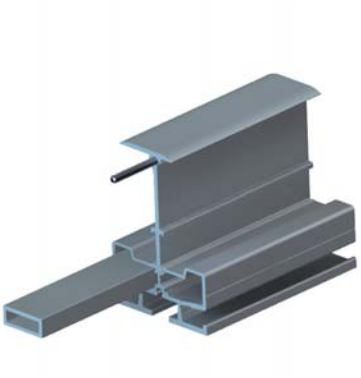


Figure 7: Insertion rail with pin and connector

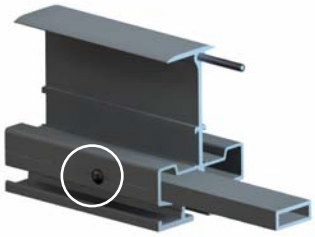


Figure 8: Fixed connector with screw

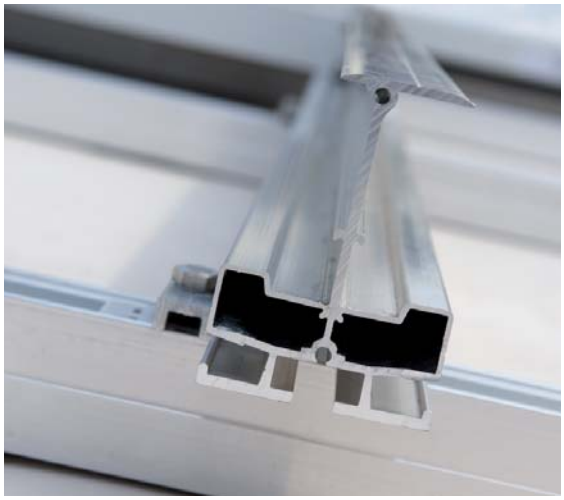


Figure 9: Insertion rail cross-section

Figure 10: Front view of the connection between two insertion rails

Do not install the insertion rails completely flush with each other. A gap of approx. three to five mm must exist between the rails to compensate for expansion at high temperatures.

Note: The cantilever length of the insertion rail (insertion rail overhang from the last base rail) must not exceed 40 cm.

5. Installation instructions

5.5 INSTALLING THE MODULES

Insert the module into the upper insertion rail at a slight angle (Figure 10) and push it in as far as it will go. Then place the module in the bottom insertion rail and let it slide down carefully.

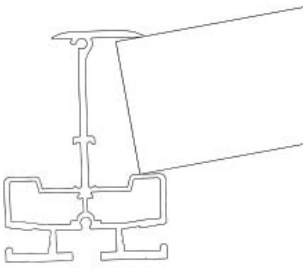


Figure 11: Step 1

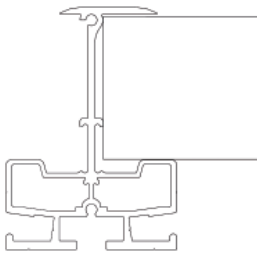


Figure 12: Step 2

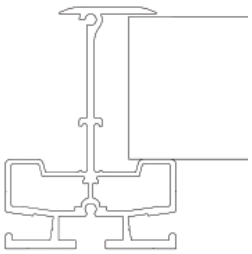


Figure 13: Step 3

5.6 CABLING THE MODULES

Cable the modules immediately after mounting them. If row connectors are required (see chapter 7 Lightning protection) then these should be installed at this point.

Note: Measure the open-circuit voltage and insulation resistance of every string immediately after installation. This allows potential mistakes and their sources to be quickly identified.

5.7 INSTALLING THE INVERTER

Please follow the installation instructions of the respective manufacturer when mounting the inverter.

6. Maximum spacing of the base rail

ROOF PITCH	MODULE HEIGHT	WIND PRESSURE Q *	SNOW LOADING SK ** IN KN/M²			
Degrees	m	KN/m²	0.65	0.85	1.00	1.75
30	1.20	0.50	2.52	2.41	2.34	2.07
		0.80	2.30	2.22	2.17	1.96
		0.95	2.21	2.15	2.10	1.92
		1.15	2.12	2.06	2.02	1.86
	1.60	0.50	2.29	2.19	2.20	1.93
		0.80	2.09	2.02	2.07	1.85
		0.95	2.01	1.95	2.01	1.81
		1.15	1.92	1.87	1.94	1.76
	1.80	0.50	2.20	2.10	2.15	1.87
		0.80	2.01	1.94	2.02	1.80
		0.95	1.93	1.87	1.97	1.76
		1.15	1.85	1.80	1.91	1.72
	1.90	0.50	2.16	2.07	2.12	1.84
		0.80	1.97	1.90	2.00	1.77
		0.95	1.90	1.84	1.95	1.74
		1.15	1.82	1.77	1.89	1.70
40	1.20	0.50	2.32	2.23	2.29	2.03
		0.80	2.09	2.03	2.14	1.93
		0.95	2.01	1.96	2.07	1.88
		1.15	1.91	1.87	2.00	1.83
	1.60	0.50	2.07	1.99	2.10	1.83
		0.80	1.88	1.82	1.99	1.76
		0.95	1.81	1.76	1.94	1.73
		1.15	1.72	1.68	1.88	1.69
	1.80	0.50	2.03	1.95	2.10	1.83
		0.80	1.83	1.78	1.99	1.76
		0.95	1.76	1.71	1.94	1.73
		1.15	1.67	1.64	1.88	1.69
	1.90	0.50	1.99	1.91	2.07	1.80
		0.80	1.80	1.74	1.97	1.74
		0.95	1.72	1.68	1.92	1.71
		1.15	1.64	1.61	1.86	1.67
50	1.20	0.50	2.42	2.35	2.45	2.20
		0.80	2.16	2.11	2.25	2.07
		0.95	2.07	2.02	2.17	2.01
		1.15	1.96	1.93	2.08	1.94
	1.60	0.50	2.20	2.25	2.33	2.06
		0.80	1.96	2.05	2.16	1.96
		0.95	1.88	1.97	2.09	1.91
		1.15	1.78	1.88	2.02	1.85
	1.80	0.50	2.12	2.21	2.27	2.00
		0.80	1.89	2.02	2.12	1.91
		0.95	1.80	1.95	2.06	1.87
		1.15	1.71	1.86	1.98	1.82
	1.90	0.50	2.08	2.19	2.25	1.98
		0.80	1.85	2.01	2.10	1.89
		0.95	1.77	1.94	2.04	1.85
		1.15	1.68	1.85	1.92	1.80

* Gust wind speed pressure
** Characteristic value of the snow loading on the ground

7. Lightning protection

7.1 EXTERNAL LIGHTNING PROTECTION AND GROUNDING

If the building is equipped with an external lightning protection system then the solar system must be connected to it over the shortest possible path (as per DIN VDE 0185 Lightning Protection System). If this is not possible then (with reference to the regulations for antenna systems) this conductor can be connected internally through the building – but not through rooms and areas containing inflammable or explosive materials. To avoid flashover and induction dangers, the conductor must be kept away from other electrical circuits.

To avoid lightning flashovers, make sure to maintain a separation distance between the solar energy system and the lightning conductor.

Calculation of the separation distance:

S = ki* (kc / Km)* i (m)

S = separation distance
kc = coefficient, dependent on the geometric arrangement
ki = coefficient, dependent on the selected lightning protection class
Km = coefficient, dependent on the material in the separation

If the building does not possess a lightning protection system then it is currently a matter of contention as to whether the DIN VDE 0855 standard can be applied to solar systems. If this standard is used, the mounting system and the module frames must be grounded. If the DIN VDE 0855 standard is not used then the solar generator does not need to be grounded. However, connection to the building grounding is always recommended.

Conversely, when using transformerless inverters all conducting parts of the solar system and the mounting system must be grounded. If the system is not grounded then this can result in capacitive voltages that are dangerous to humans.

The grounding can be achieved (e.g.) via the system connection to the equipotential bonding bar of the house or via an external grounding stake. Type NYM-J or NYY-Y grounding cables with a minimum cross section of 16 mm² satisfy the current regulatory requirements.

The grounding device to which the solar system is connected must be tested for correct operation. The results of this test should be recorded in a test or commissioning log for the system.

7. Lightning protection

7.2 INTERNAL LIGHTNING PROTECTION – OVERVOLTAGE PROTECTION

The internal lightning protection minimises damage caused by overvoltages that may occur. Impermissibly high voltages at the solar modules can be reduced via simple measures when laying the module cables. In the case of a lightning strike near to the solar modules the extremely high rate of change of current from the lightning can induce high induction voltages across the mounted modules and module cables.

Attention: The larger the effective area generated by the modules and cables, the higher the induced voltage.

This type of overvoltage can be reduced through careful consideration when laying the DC cables.

Figure 14 shows an unsuitable cable layout that can result in very high induction voltages capable of destroying the solar modules and the inverter. Figure 15 shows a correct cable layout that reduces the effective area generated by the cables and thus reduces the danger to the solar modules and inverter.

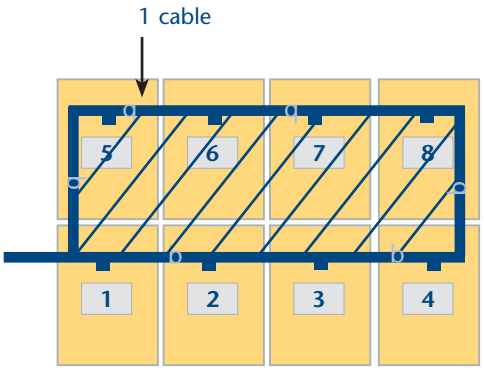


Figure 14: Incorrect cabling without row connectors (the cables generate a large area)

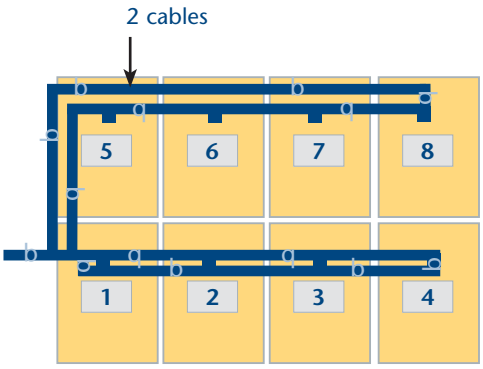


Figure 15: Correct cabling with row connectors (the cables generate a small area)

Surge arresters at the solar generator or the inverter can also help to reduce overvoltage. Usually, inverters already have a built-in varistor for limiting overvoltages.

8. Standards and regulations

The recognized engineering standards and the relevant accident prevention regulations must always be followed when installing a solar system.

The following rules, regulations and standards must be followed:

TAB 2000	Technical connection requirements for connecting to the low voltage grid of the energy supply companies
VDEW Guideline	For parallel operation of photovoltaic power generation systems with the low voltage grid of the energy consumer
BGV A2	Electrical systems and equipment
BGV C22	Construction work
BGV D35	Ladders and steps
BGV A1	Accident prevention regulations
DIN VDE 0100	Installation of low voltage systems
DIN 1052-2	Wooden structures: Mechanical connections
DIN 1055	Design loads for buildings
DIN 18299	General rules for all types of construction work
DIN 18338	Roof covering and roof sealing works
DIN 18451	Erection of scaffolding
DIN EN 60728-11	Safety requirements for cable networks and antennas
VDI 6012	Decentralised energy systems in buildings

Important: This document refers to German standards and regulations.

PHOENIX SOLAR
AN INTERNATIONAL LEADING PHOTOVOLTAIC SYSTEMS COMPANY

Having emerged from a solar initiative by the German Energy Users Association (Bund der Energieverbraucher e.V.), Phoenix Solar AG is today one of the largest integrators of solar energy systems and accessories. The headquarters of the TecDAX-listed company is in Sulzemoos near Munich. With a branch office in Ulm, sales offices throughout Germany and subsidiaries in Spain, Italy, Greece, France, Singapore and Australia, Phoenix Solar currently (April 2010) employs more than 300 people.

Since the company was founded in 1999, Phoenix Solar's business model has been oriented towards the joint development between partners and customers of optimal photovoltaic system solutions that are tailored to the customer's every need. For this, Phoenix Solar has an extensive product portfolio and offers comprehensive service: from planning, developing, installing and maintaining large-scale solar energy systems to providing advice in investment issues and selling solar energy systems and components to sales partner in the Phoenix Solar network.

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