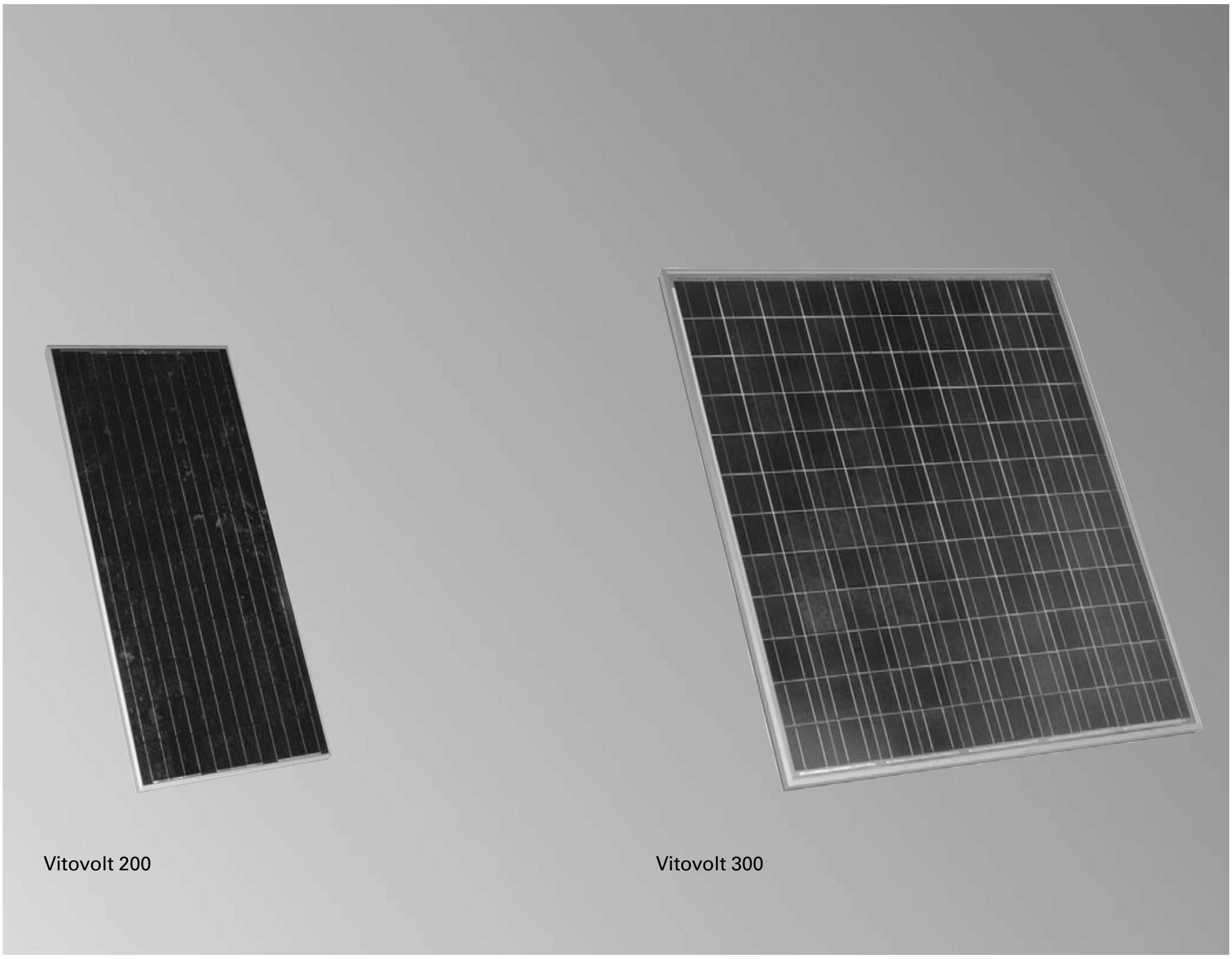
Technical guide



Vitovolt 200

Vitovolt 300

File in:
Vitotec technical guide folder, register 8

Photovoltaic solar panels from Viessmann – the right solution for every application

For the generation of solar power

Vitovolt 200
Framed single-pane panel

Vitovolt 300
High quality two-pane panel with robust aluminium frame

5822 240-4 GB 5/2005

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1.1 Finance options

In Germany, the level of feed-in remuneration is subject to the year of commissioning of the photovoltaic system. The energy supplier pays this reimbursement to the system user over a period of 20 years plus the time in operation during the year of commissioning. In future the level of reimbursement for new systems will be reduced by 5 % p.a.
Systems with an electrical output below 5 MW are supported.

The minimum reimbursement increases respectively, if the system is not installed on a roof or as part of a roof and forms an essential part of the building (PV panel on the building wall).

The following table lists the new levels of reimbursement for 2004, which are differentiated according to system output and location. Further information and framework conditions are listed in paragraph 11 of the Photovoltaic Priority Act to the EEG [Renewable Energies Act].

Level of reimbursement per kWh in cents

Installation	System output	Year of commissioning 2005	2006
Roof	< 30 kW_p	54.5	51.8
	> 30 kW_p	51.9	49.3
	> 100 kW_p	51.3	48.7
Walls, etc.	< 30 kW_p	59.3	56.3
	> 30 kW_p	56.6	53.8
	> 100 kW_p	56.1	53.2
At ground level (all sizes or open installations)		43.4	40.6

Loans at favourable terms for measures to utilise renewable energies, including measures as immediate consequence of the utilisation of systems in existing or new homes can be applied for from the Kreditanstalt für Wiederaufbau (KfW) [Germany] as part of the CO_2 reduction program.
As part of this program, combined heat and power systems (CHP), heat pumps, solar heating systems, biomass and biogas systems, photovoltaic systems, geo-thermal systems, the installation of heat exchangers and heat recovery equipment are financed.

Support from several sources is possible, as long as the total sum of support received does not exceed the total expenditure.

Addresses
Information from:
Kreditanstalt für Wiederaufbau (KfW)
Postfach 11 11 41
D-60046 Frankfurt
Tel: 01801 / 33 55 77
Fax: 069 / 74 31-6 43 55

iz@kfw.de
http://www.kfw.de

Information from:
Kreditanstalt für Wiederaufbau (KfW)
Postfach 04 03 45
D-10062 Berlin
Tel: 030 / 2 02 64-50 50
Fax: 030 / 2 02 64-54 45

However, loan applications cannot be made direct to the KfW, but must instead be handled by your own bank or a bank acting on your behalf.

As part of a cooperation agreement with the Deutschen Umweltbank, Viessmann offers a simple and unbureaucratic process for financing a PV system.
Further information under www.viessmann.com

Some local authorities and energy suppliers offer additional grants for installing PV systems.

1.2 Permits, insurance, service and inspection

Planning permission

The planning permission for photovoltaic systems is subject to regional and national variations. Your local planning officer will advise you accordingly.

Insurance

Since relatively large sums are invested in photovoltaic systems, appropriate insurance is essential.
Insurance will protect the owner's investment, particularly when systems are financed by outside sources.

Liability insurance
The owner or developer is responsible for any third party losses resulting from the system installation or operation. You can cover yourself against this risk by taking out a third party liability insurance, which you could do by adding the installation to your private liability insurance.

System insurance
System damage (property loss) through environmental influences, theft, vandalism, structural failures or through operating errors, can be covered by an electronics insurance which covers all losses – a so-called "fully comprehensive insurance" for solar power stations. This insurance also offers compensation if the system is out of use for prolonged periods.
If the photovoltaic system is included in an existing fire and buildings insurance, substantially more favourable premiums may be realised if the system user is also the house owner.
If the system is to be included in an existing insurance policy, the system user should ask the insurance company to confirm the insured risk and the extent of insurance cover in writing, otherwise the system may not be adequately covered.

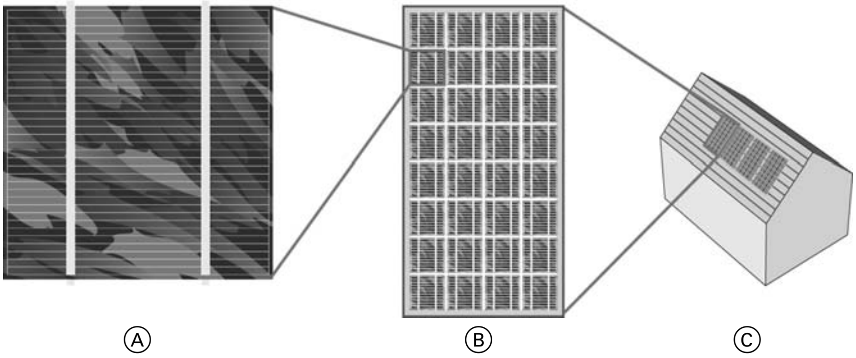
Maintenance and inspection

Photovoltaic systems generally represent maintenance-free technology. The energy is gained without mechanical or chemical processes, i.e. only through electro-physical processes. The system is therefore free from wear and tear.

Photovoltaic energy is the most environmentally friendly way of generating electrical power. The system is exceptionally reliable due to its composition from long-life components without moving parts. The user only needs to monitor the proper operation and to check the energy yield. Regular checks ensure that the system delivers optimum yields and thereby achieves high efficiency levels.
Every kWh failure means that cash is lost. The user should check and record the meter readings and any special events (maintenance work) at least every month. This should include recording at least the monthly system yield, as this enables the early recognition of faults and their cause. Comparisons with earlier years and neighbouring systems will assist in ensuring that the system operates properly.

1.3 Photovoltaic system

Solar cell – Solar panel – Solar generator

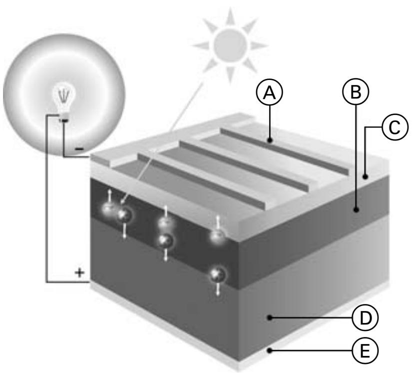


Ⓐ Solar cell Ⓑ Solar panel Ⓒ Solar generator

The solar cell is the smallest component of a photovoltaic system. A great number of solar cells are linked to form a single panel. A common photovoltaic system comprises several solar panels, the so-called solar generator.

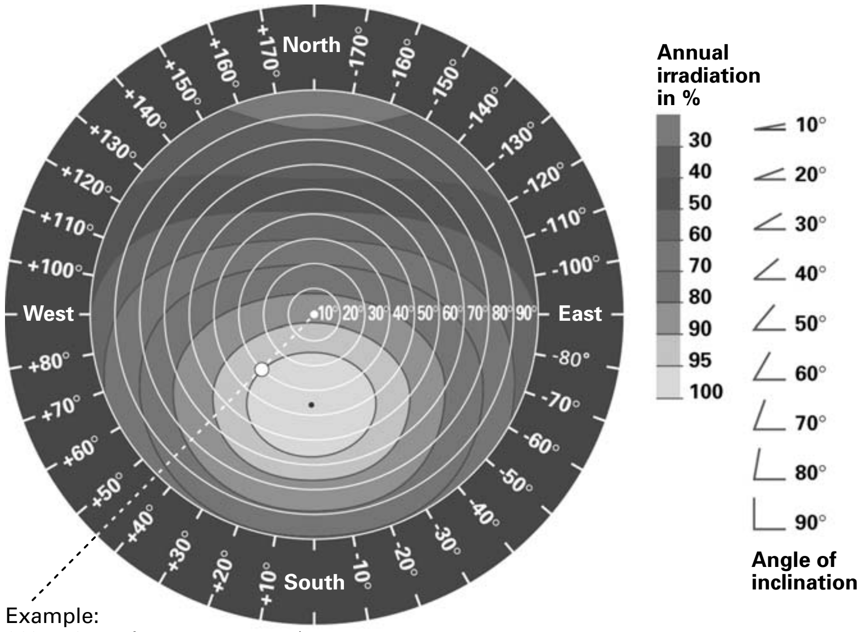
The highly pure silicone is deliberately contaminated with boron (p-doped) at the point of manufacture. Phosphorous atoms are inserted on the side facing the sun (n-doped). In the boundary layer (p-n junction) an electrical field is created that has its negative pole p-doped and its positive pole n-doped. After this separation, electrons will be taken off the silicone atoms in an n-doped direction. The resulting fault (hole) migrates in a reverse direction.
The p-n junction provides the electrical activity through an electron surplus on the side facing the sun and an electron shortage at the back.
If a consumer is connected to these poles, a current flows. The electrons released by the photons migrate from the negative to the positive pole, i.e. there is a current from the positive to the negative pole. Contrary to mechanical power generation, e.g. by a bicycle dynamo, there are no mechanical moving parts in a solar cell, which theoretically provides an unlimited service life.

Sectional view of a solar cell



Ⓐ Negative electrode
Ⓑ Boundary layer
Ⓒ n-doped silicone
Ⓓ p-doped silicone
Ⓔ Positive electrode

Influence of alignment, inclination and shading



Example:
30°; 45° south-west → ≈ 95%

Optimum alignment and inclination
In Germany, the solar generator provides the highest solar yield over an annual average when facing south with an inclination of approx. 30 to 35 degrees to the horizontal plane. The installation of a solar power system is even viable when the installation deviates quite significantly from the above (south-westerly to south-easterly alignment, 25 to 55 degrees inclination).

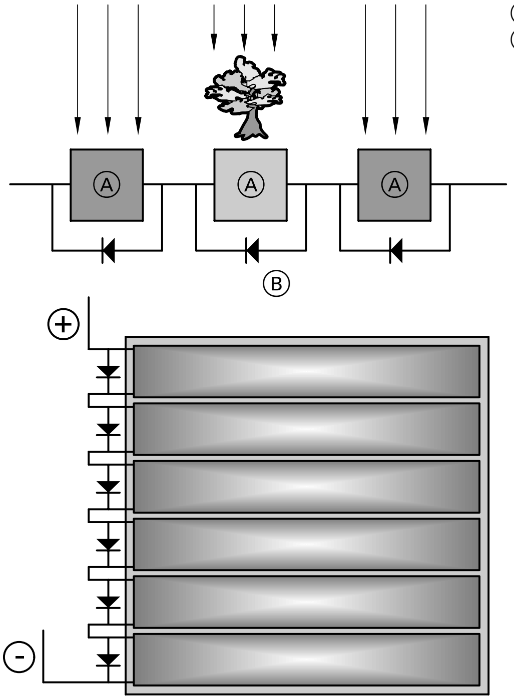
The graph illustrates the yield reduction resulting from an installation of the solar generator which is less than perfect. A lower inclination is more favourable if the solar generator cannot be pointed south. A photovoltaic system with a 30° slope and a south-westerly orientation of 45° still achieves 95% of its optimum yield. Even with an easterly or westerly alignment, you can still expect 85% with a roof inclination between 25 and 40°.

A steeper orientation would be more favourable in winter, however the system achieves two thirds of its yield in the summer months. With a roof inclination of between 25 and 40° and deviations of up to 45° from south, the reduction in returns is negligible. On the other hand, an angle of inclination less than 20° should be avoided, otherwise the solar generator will become contaminated.

Because photovoltaic systems require large roof areas, the generator surface may have to be split over different roof areas. If these surfaces have different orientations and slopes, each solar generator must be operated with its own inverter to achieve an optimum match and therefore yield.
However, this is not required if only the inclination is different.

Shade reduces energy yield
Position and size the solar generator so that the influence of structures, trees, power lines, etc. which would shade the panels, is minimised. Also consider how neighbouring properties are likely to be developed or planted up.
Large gaps should be retained between the generator surface and chimneys or other objects which throw shadows over a roof. Aerials and similar movable objects may be fitted to other parts of the roof.

Hot-spot effects



Ⓐ Solar cell
Ⓑ Bypass diode

When all cells of the photovoltaic panel are wired in series, and any cell is shaded, that cell will act as an electrical resistance, i.e. as consumer. This causes the so-called ”Hot-spot effect”. The entire array can only supply as much current as can flow through the shaded cell, which will become hotter.
The ”hot-spot effect” should always be avoided.

- It reduces the system output.
- It causes damage to the shaded cells through overheating.

Viessmann photovoltaic panels are equipped with bypass diodes. If a row of cells is shaded, the bypass diode opens and the current bypasses that row of cells.

Utilisation of generated power

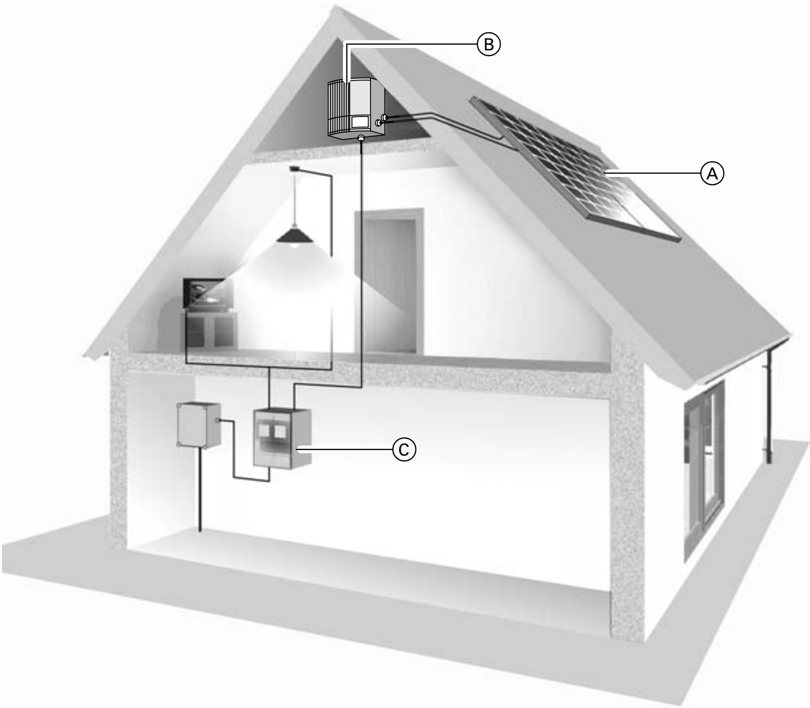
Inverter function
Photovoltaic panels supply DC power. However, AC power is required to be fed into the grid. Therefore, one of the main tasks of the inverter is to change the DC power into AC power suitable for the grid – with the highest possible level of efficiency.
In addition the inverter constantly regulates the optimum operating point of the system (MPP – maximum power point) and so matches the system to the dynamic weather and radiation conditions. The ENS function is another task of the inverter.
ENS means a circuit which safely separates the photovoltaic system from the grid during mains failure or work on the grid (ENS = **E**quipment for **M**ains monitoring with associated **C**ontrol components in series [abbreviation translated from German]).

The inverter must separate the photovoltaic system from the mains, if the power supply system is switched OFF, e.g. for maintenance purposes. Otherwise power from the photovoltaic system will be fed into the grid, causing a risk to the maintenance personnel. Maintenance of the inverter switching criteria are checked in accordance with VDEW guidelines and ENS regulations.

In addition the power fed into the mains by the inverter must not exceed the harmonic content set by EN 60555.
The inverter must meet the legal requirements regarding the electro-magnetic compatibility of equipment.

The inverter used by Viessmann meets the ENS function, as well as the EN 60555 requirements and those regarding EMC.

Feeding generated solar power into the grid



Ⓐ Photovoltaic panel
Ⓑ Inverter
Ⓒ Feed meter

Due to the fixed payment for power generated by photovoltaic systems prescribed by the Renewable Energy Act (EEG) [Germany], see page 3, almost all systems in Germany are installed to feed their power into the grid. This power is almost exclusively fed into the grid. The power required for domestic purposes is completely drawn from the grid through a sealed junction box equipped with mains fuses.

A meter box housing the supply electricity meter is located downstream of the junction box. The power generated by the photovoltaic process is fed into the grid immediately upstream of the supply meter. A feed meter is required to measure the power fed into the grid, i.e. additional meter space should be allocated.

Meters generally belong to the power supply company, which normally charges rent for such meters.

Only **authorised** electricians may connect photovoltaic systems to the grid. Generally this installer would also clarify the terms of connection with the local energy supply company.

Lightning protection

Lightning protection systems must be differentiated between systems for protecting against direct or indirect lightning strikes.

External lightning protection in case of direct lightning strikes
Only in exceptional cases will a lightning protection system be required after installing a photovoltaic system, e.g. in particularly exposed locations.
If a lightning protection system is installed for the building, the fixing construction of the PV panel must be connected to this with a short connection. Otherwise the fixing construction must be connected to the earthing cable with a suitable, electrically sound wire, e.g. heating pipes or continuous metal DHW pipes, that must also be connected to an earthing conductor. Observe the requirements of DIN VDE 0190.

For separate fixing designs, ensure satisfactory earthing and that an adequate distance to roof-mounted power supply masts is maintained. As roof standards must not be earthed, contact of both parts must be prevented. Buildings which are not equipped with a lightning protection system should not be equipped with such a system for the photovoltaic system either, as dangerous excess voltages could be induced through photovoltaic systems protected by lightning conductor systems and earthing. If the photovoltaic system noticeably protrudes above the roof line, e.g. on flat roofs, the installation of a lightning protection system should be assessed by an expert.

Internal lightning protection against voltage surges
Anti-surge conductors in the inverter protect the panels and the electronics against dangerous voltage surges. Voltage surge conductors are more efficient the closer they are fitted to the photovoltaic panel, where necessary at the expense of accessibility.

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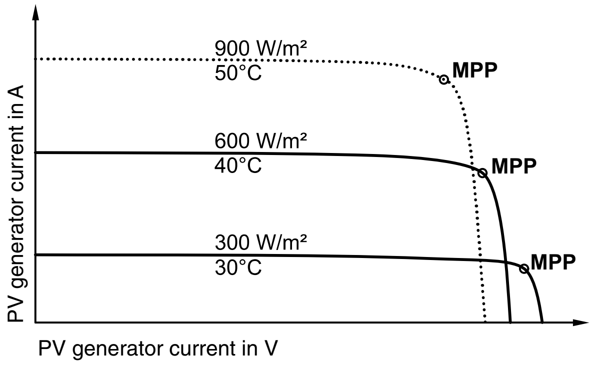
2.1 Specification – photovoltaic panel



MPP = Maximum power point (maximum output) at STC
STC = Standard test conditions

The illustration shows three good curves for a PV panel under different operating conditions.
At the point at which the curves meet on the Y-axis (PV generator current), the current is at its strongest and the voltage is nil. This maximum current strength is referred to as a ”short circuit current”. It is heavily dependent upon the irradiation level.

The voltage is at its strongest at the point at which the curves meet on the X-axis (PV generator current), but the current is nil. This is referred to as ”idle voltage”.

The stated output of the PV panel is the calculated value from the momentary current and the voltage. These electrical parameters are not fixed during operation; they change according to irradiation level and solar cell temperature, recognisable by the changing curves. The MPP control in the inverter constantly looks for the operating point on the curves, at which voltage and current achieve their optimum values, i.e at which the output is greatest.

No output is produced at either operating points of ”idle voltage” and ”short circuit current”.

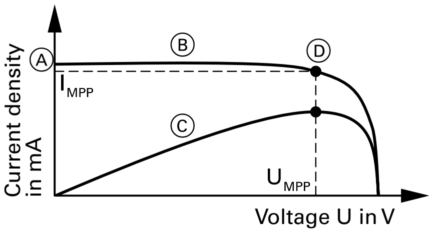
See the corresponding datasheet for further details regarding the photovoltaic panel.

2.2 Specification – inverter

Efficiency

Inverters work in various output ranges, subject to solar intensity. Therefore, simply quoting the maximum efficiency is insufficient for assessing the rated output. Consequently, the ”European efficiency” was defined, which is based on the mean European irradiation distribution and offers a comparative basis for different inverters.

Output control



Ⓐ Short circuit (I_{SC})
Ⓑ I-U curve
Ⓒ Output
Ⓓ MPP

Different weather causes the operating point of max. output MPP to shift. By constantly readjusting itself, the inverter ”homes in” on the MPP to achieve as high an energy yield as possible.

Electrical connection

The power supply of the inverter requires a 3-pole supply (L, N, PE).
To maintain the power supply conditions regarding the ENS function, the impedance at the inverter should always be lower than 1 Ω.
The impedance is the sum of the mains impedance at the domestic power supply connection and all resistance values of other cables and terminals up to the inverter.

The power supply terminals on the inverter are designed for wires up to 6 mm^2.

Notes on the provision of fuses

As current circuit fuse (power protection) we recommend a 16 A (or 10 A) safety fuse.
NEOKIT made by Lindner or a circuit breaker with characteristics D or K.
Consumers must not be connected to this circuit. Subject to local conditions, observe all applicable regulations, i.e. regarding selectivity, etc.
An additional RCD can be installed into the power supply line.

Using inverters

The different safety classes of inverters vary according to the installation location.

- In buildings that do not fall under the definition of fire or moisture-proof rooms, inverters with a safety class of **IP 21** are sufficient.
- For buildings such as flats or adjoining rooms, an inverter with a safety class such as **IP 44** can be used.
- Electrical material that would be used for normal use (e.g installation in agricultural buildings) must use an inverter with a safety class of at least **IP 44**.
- In rooms or areas used for housing livestock or preparing and processing animal feed, manure, plants or animal products, a specially designed **Outdoor inverter** with a safety class of **IP 45** can be used.

Inverters should not be installed in rooms with a high level of dust or areas where there are flammable materials.

See the corresponding datasheet of the PV panel for further specifications regarding the inverter.

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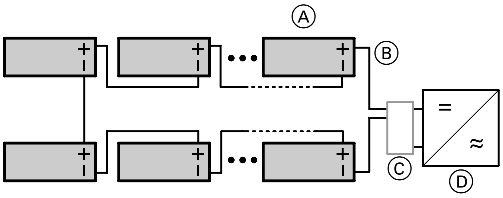
2.3 Standard delivery

Packing units
- Vitovolt 200
  2 and/or 6 panels
- Vitovolt 300
  6 or 20 panels

Order the required number of packing units to achieve the required system size.

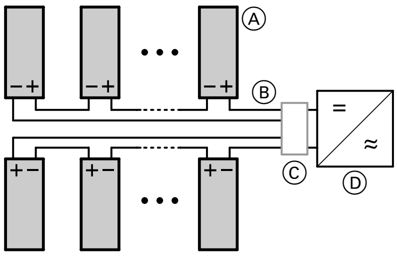
The correct inverters for the system output and the required number of connection cables (which may also be used as extension cables) to connect the panel with the inverter and DC isolator must be ordered separately.
The correct fixing set must be ordered according to installation type.

Example for a system with 1 string (panels in series)



To be ordered
Ⓐ Corresponding number of panel packing units
Ⓑ Connection cables
Ⓒ DC isolator (if required)
Ⓓ Inverter

Example for a system with 2 strings (panels in series)



To be ordered
Ⓐ Corresponding number of panel packing units
Ⓑ Connection cables
Ⓒ DC isolator (if required)
Ⓓ Inverter

2.4 Choice of inverters

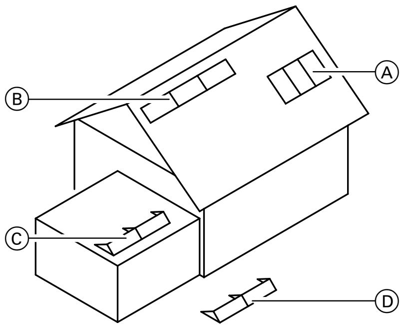
The correct inverter and correct number of DC isolators can be selected according to the required number of PV panels. Observe the max. number of panels per string which can be connected to each inverter.
Systems with more strings must always be constructed with the same number of panels.

Note
The correct routing of cables is an important measure to protect against induced excess voltages. Positive and negative cables should be routed as closely as possible to each other to keep the area created by this power circuit and therefore the induced excess voltages small.

Frequently, this aspect is ignored or neglected when routing cables, as a rigid adherence to this consideration often leads to longer cable runs and therefore higher installation costs. However, for the sake of effective excess voltage protection, this aspect should be taken into consideration.

3.1 Installation

Installation options

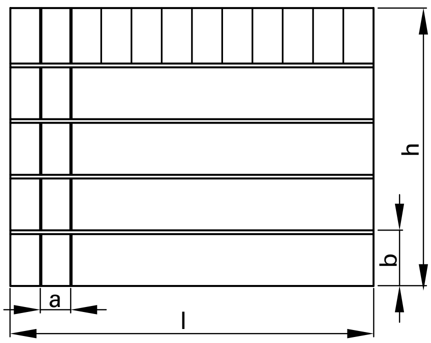


Vitovolt 200
Ⓐ Pitched roofs, vertical installation
Ⓑ Pitched roofs, horizontal installation
Ⓒ Flat roofs, elevated
Ⓓ Freestanding installations, elevated

Vitovolt 300
Ⓐ Pitched roofs, vertical installation
Ⓑ Pitched roofs, horizontal installation

Calculating the required surface area

Vertical installation

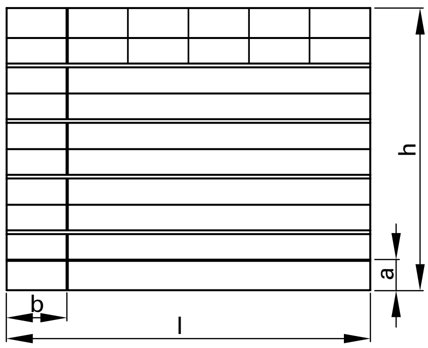


a Panel width
b Panel length

$l = n \cdot a + (n - 1) \cdot 25$ mm*1
$h = n \cdot b + (n - 1) \cdot 25$ mm*1

n = number of panels

Horizontal installation



$l = n \cdot b + (n - 1) \cdot 25$ mm*1
$h = n \cdot a + (n - 1) \cdot 25$ mm*1

*1 *Clearance between panels or between neighbouring panels or panels one above another.*

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3.2 Fixing systems

Viessmann offers universal fixing systems designed for individual positioning according to the required system output.

The fixing systems are suitable for virtually all forms of roof and roofing. They are suitable for the installation of 2, 3 and 4 panels next to or above each other.

Assembly kits are available for the installation of **Vitovolt 200** on flat roofs.

Pitched roofs – rooftop installation

- Roof hooks which are matched to the relevant roof cover, are installed with matching mounting rails on the roof rafters.

  Note
  If panels are installed without roof hooks, i.e on sheet steel roofs, the mounting rails are affixed directly to the on-site substructure using clamping bolts.

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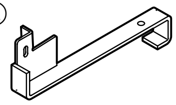

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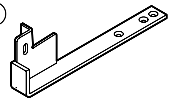

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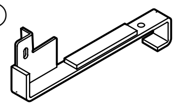

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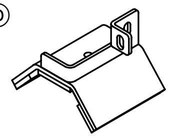

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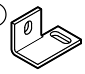

Ⓐ Roof tile cover
Ⓑ Slate cover
Ⓒ Plain tile cover
Ⓓ Corrugated sheet cover
Ⓔ Sheet steel roof

Large scale systems

Viessmann also offers specially designed fixing accessories for large photovoltaic systems using the **Vitovolt 200**:
- Roofs with rafters and roof tile cover
  - Rafter bolts
  - Mounting rails
  - Screws and nuts
- Roofs with purlin construction and corrugated sheet cover
  - Headless studs
  - Installation angle
  - Mounting rails
  - Screws and nuts

Connection cables, plugs, sockets and services cases can be ordered for connection to the mains.

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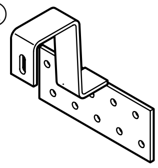

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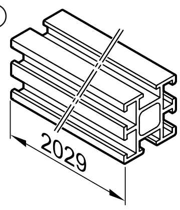

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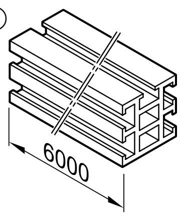

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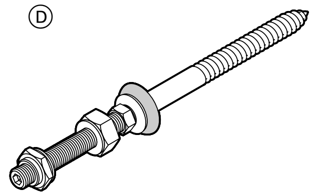
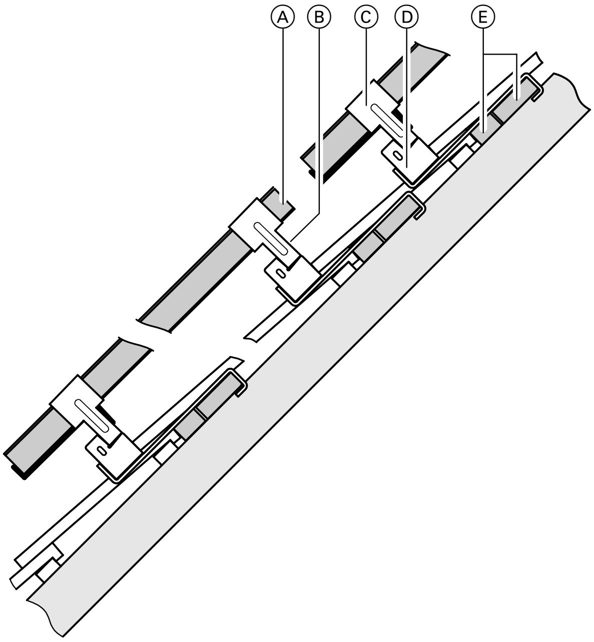


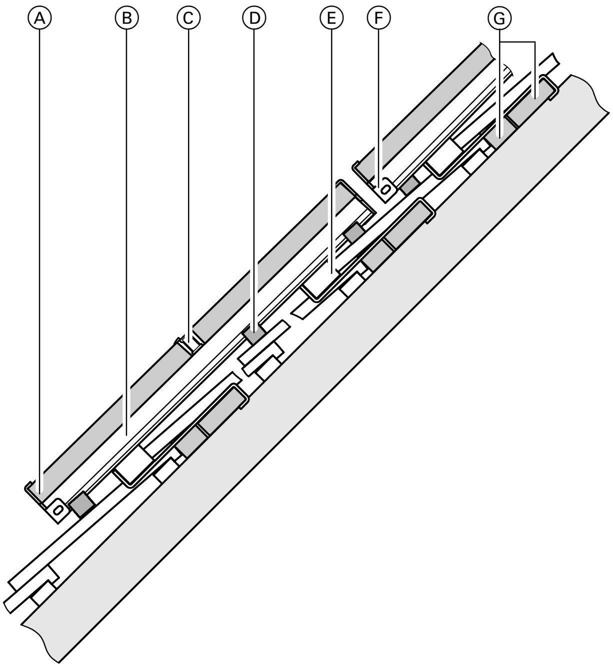
Ⓐ Rafter bolts
Ⓑ Mounting rails 40 x 40 x 2029
Ⓒ Mounting rails 44 x 44 x 6000
Ⓓ Headless studs

Vertical installation



Ⓐ PV panel
Ⓑ Mounting rail
Ⓒ End clamp
Ⓓ Roof hooks
Ⓔ Timber (only for roof tile cover)

Horizontal installation



Ⓐ PV panel
Ⓑ Mounting rail
Ⓒ Centre clamp
Ⓓ Support (only for Vitovolt 200)
Ⓔ Roof hooks
Ⓕ End clamp
Ⓖ Timber (only for roof tile cover)

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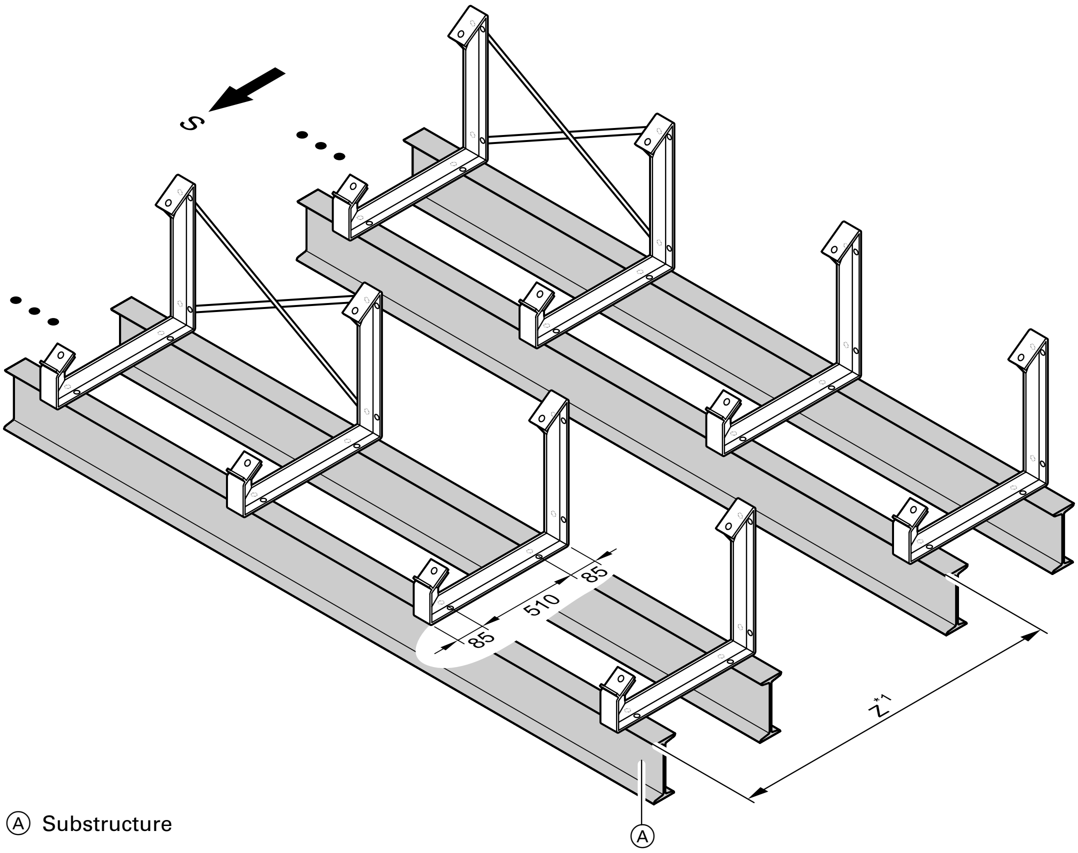
Flat roofs (only for Vitovolt 200)

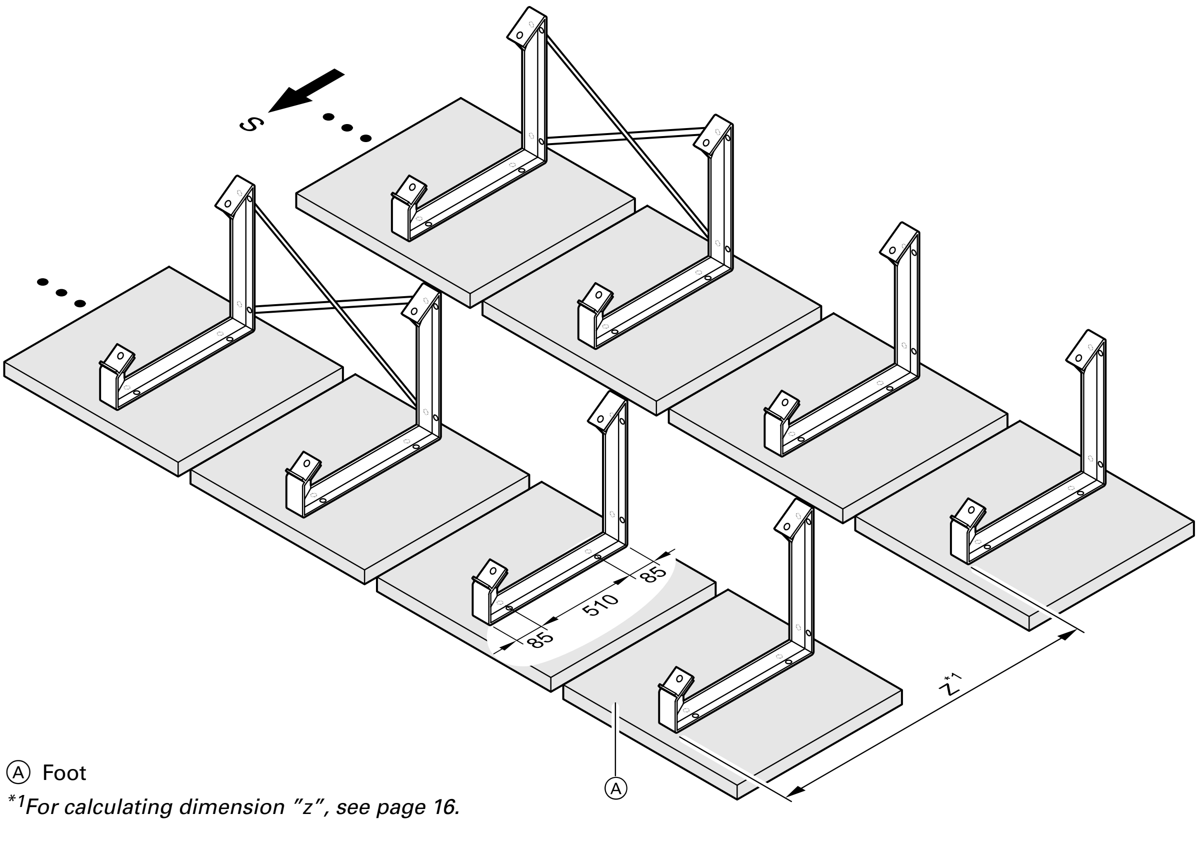
In flat roof installations, the PV panels are mounted **horizontally**. Ties are required for 1 to 6 panels connected in series.

Installation on substructures



Ⓐ Substructure

Installation with feet



Ⓐ Foot

*1 *For calculating dimension "z", see page 16.*

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Foot weight to DIN 1055 at an inclination angle of 35°

If the PV panels are secured against slippage, only take into account the static loads to prevent lifting.

Note
Structural analyses, e.g. for substructures installed on site, are carried out on request by:

Ingenieurbüro für Baustatik
Dipl.-Ing. Gerhard Nolte
Auf der Heide 1
35066 Frankenberg

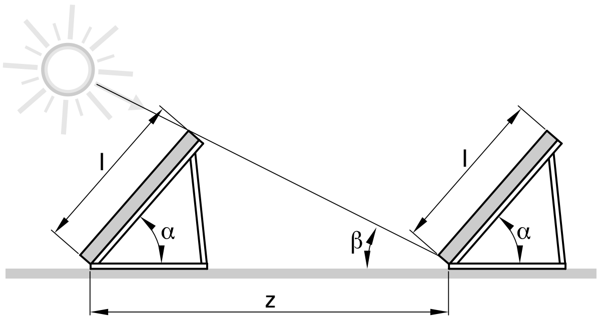
		Secured against slippage			Secured against lifting		
Installation height above ground	**m**	**to 8**	**8 to 20**	**20 to 100**	**to 8**	**8 to 20**	**20 to 100**
Foot weight	kg	267	439	613	108	183	261

Calculating the gap between rows of panels

When installing several rows of panels in sequence, exact dimensions (dimension "z") must be kept, in order to avoid unwanted shading.

Determine solar angle β.
This should be chosen so that the midday sun on 21.12. falls on the panels without being obstructed by shading.
In Germany this angle (dependent upon latitude) is between 12° (Flensburg) and 20° (Freiburg).

Example
Würzburg is located at approx 50° latitude.
Solar angle = 90° – 23.5° – latitude
(23.5° should be accepted as the constant)
90° – 23.5° – 50° = 16.5°



z = Panel row distance
l = Panel height

α = Angle of panel inclination
β = Angle of the sun

Use the following formula:

$$\frac{z}{l} = \frac{\sin(180° - (\alpha + \beta))}{\sin \beta}$$

l = 1500 mm
α = 35°
β = 16.5°

$$z = \frac{l \cdot \sin(180° - (\alpha + \beta))}{\sin \beta}$$

$$z = \frac{1500\ \text{mm} \cdot \sin(180° - 51.5°)}{\sin 16.5°}$$

z = 4133 mm

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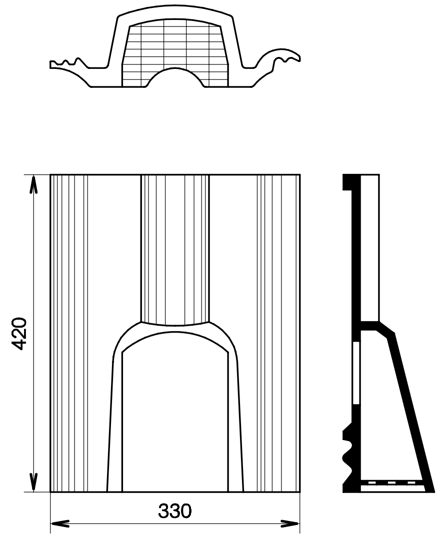
3.3 General installation information

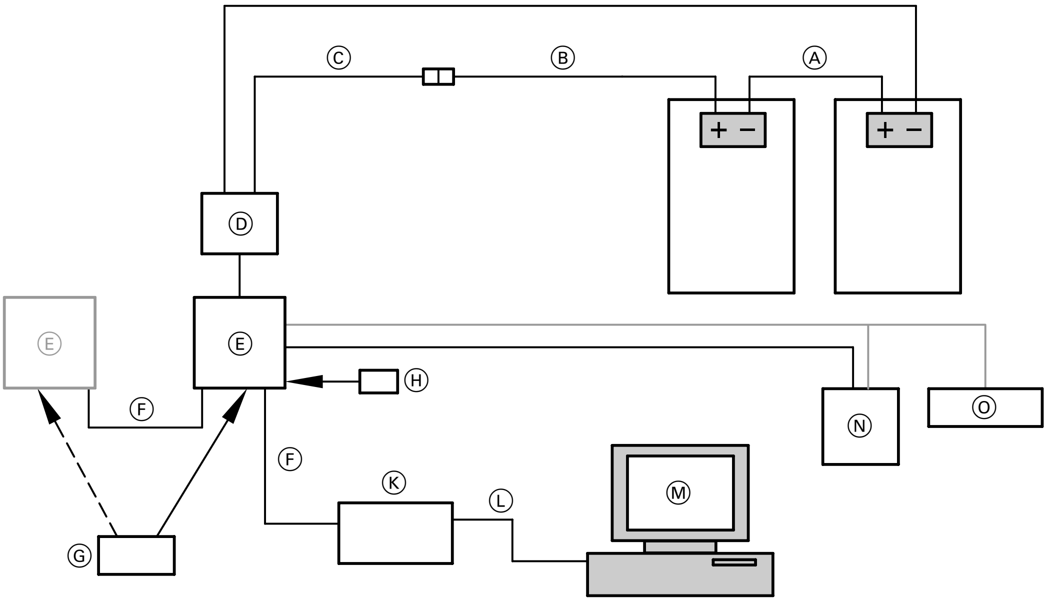
- Observe max. load and distance from the edge of the roof for the substructure to DIN 1055.
- In the case of flat roofs with plastic roofing membranes, install supports only with an intermediate layer (protective mats).
- The connection cables must be routed through a suitable outlet (ventilation tile).



Roof tile Type	Vent cross-section cm²
Frankfurter tile	32
Double-S	30
Taunus tile	27
Harz tile	27

- Safeguard the connecting cable against attack by birds and small animals.
- Provide a trap door in the roof in the vicinity of the photovoltaic panels to facilitate inspection and maintenance.

4.1 Accessories



Ⓐ Extension cable
to interconnect the panels below each other between individual panels, 3 m long, 4 mm^2.
Ⓑ Connection cables
to connect the panels to the inverter, 15 m long, 4 mm^2
Ⓒ Extension cable
to extend the connection cable, 15 m long, 4 mm^2
Ⓓ DC isolator:
Separates the generator (PV panel) at DC side of the inverter
Ⓔ Inverter
Ⓕ 1.0 m long data cable for RS 485 interface to connect several inverters below each other
Ⓖ Data transfer interface
PCB for integration into the inverter
Acts in larger systems of several inverters as link between the individual inverters (RS 485) and must be installed in **each** inverter. (Integral power supply for internal/external options; conductive separation from the inverter.)

Ⓗ SIGNAL CARD for monitoring the system for control error notification
Ⓚ Datalogger box (with software)
Separate casing with integral interface data transfer.
Suitable for recording data for up to 100 inverters (RS 485).
A connection to a PC (RS 232) enables the setting of parameters, maintenance and remote data transfer,
or
”EASY” datalogger box (for **a single** inverter).

Ⓛ 2.0 m long data cable for RS 232 interface to connect to the PC
Ⓜ PC
Ⓝ Meter (on site)
Ⓞ Large display
With impulse counter and software for valid public display of:
- Current output in W
- Day energy in kWh
- Total energy in kWh

Only for internal applications

Not shown:
20.0 m long data cable for RS 485 interface, with loose plug-in connectors.

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4.2 Design and implementation

Proceeding systematically during the installation of a mains-connected photovoltaic system
simplifies the design phase; careful preparation saves time during the assembly and installation.

Some detailed questions are part of the daily routine for an expert contractor, others are new territory for experts too, where mains-connected photovoltaic systems are concerned.

Steps leading to a solar power station

1. Information and consultation
2. Designing and sizing the system
3. Checking, whether planning permission is required.
   In most cases solar heating power systems do not require planning permission, provided they are installed on pitched roofs or are integrated into the roof surface. However, local planning regulations (local area plan) and regulations in connection with listed buildings may deviate from this standard. An enquiry at your local planning office will provide the necessary information.
4. Creating an offer and clarifying the financing and any funding options.
5. Installing and connecting the system to the grid.
6. Commissioning and instructing the user.
7. Operating and checking yield, fiscal matters.

Planning checklist
Clarify the following questions before designing and building a mains-connected photovoltaic system:

- Where should the panels be installed (pitched roof, flat roof, wall, freestanding)?
- On what base should the panels be fitted (material of roof cover, type of wall cladding)?
- Establish the inclination and orientation of the panel array (inclination in degrees, deviation from south).
- How large should the system be (available surface, budget)?
- Will the panels be shaded (antenna, balcony, chimney, trees, neighbouring building)?
- How can the cables be routed inside the building (dormant chimney, supply duct, existing electrical ducts, cable channel on the building exterior, e.g. along a gutter pipe)?
- How should the inverter be installed (freestanding, under the roof, in the cellar)?
- Is a meter slot available or can such a space be created without too much effort within the meter box (e.g. utilisation of a space for a tariff time switch or position an existing tariff time switch ”piggy-back” onto a meter)?
- Who is the responsible power supplier?

4.3 Glossary

AC current
Current which constantly alternates its direction. Conventional AC current changes its direction 100 times per second (50 Hz) and provides a rated voltage of 230 V.

Amorphous solar cell
Thin-film solar panel made from non-crystalline (amorphous) material, e.g. silicone, vacuum metallised onto glass or stainless steel film, saving materials.

Conventional energy sources
Fossil fuels, such as coal, mineral oil, natural gas and uranium.

Cost-covering payment
Annually determined energy generation costs for solar power according to an energy-efficiency calculation for the current year of construction, as issued by the Strompreisaufsicht Nordrhein-Westfalen. This term has its origin in the support concept by the same name of the Aachener Solarenergie-Fördervereins.

Diffused radiation
Non-directional sunlight, diffused by clouds, particles, etc.

Direct radiation
Direct sunlight which hits the earth’s surface without diffusion.

Electron
In physics, the electrical current flow is explained by the movement of electrons. The electron is an atomic particle which carries the electrical charge (model).

Energy
Electrical energy is measured in watt hours (1000 Wh = 1 kWh), which should not be confused with the momentary power watt (W) or the peak power watt peak (W_p) or kW_p.

Energy return time
Energetic ”amortisation time”, during which the photovoltaic system generates that amount of energy, which was required for its manufacture.

ENS
Safety circuit for network monitoring of the inverter. The abbreviation ”ENS” means: Two pieces of independent equipment for monitoring a network with associated switching devices, wired in series.

Feed-in remuneration [in Germany]
The local power supply company must buy power and pay a minimum price (payment) in accordance with EEG regulations.

”Garden hose” effect
Many solar cells are wired in series in a photovoltaic system. If a solar cell or part of a solar panel is covered up (e.g. through shading), the current flow will be reduced at that point, which acts like a kink in a garden hose. Various technical data relating to solar panels too have this effect: the weakest link (panel) determines the maximum output.

Generator wiring chamber (GWC)
Junction box where the cables of the solar generator are brought together. In addition, safety elements for panel lines and to protect against lightning excess voltages are integrated; frequently a switch is also included.

Global radiation
The volume of energy as total from direct and diffused radiation – generally relates to 1 m^2 of horizontal surface.

4.3 Glossary

Grid
(public power supply system, national grid)
The grid joins all power stations and consumers (network).

Hot-spot effect
The destruction of a solar cell through heat development when a panel is partially shaded. This is prevented by means of bypass diodes.

Idle voltage
Intensity of voltage between the positive and negative pole of a power source (e.g. solar panel), when no consumer is connected.

Inverter
Inverter with mains synchronisation and mains monitoring, which transforms the DC current (e.g. solar current) generated by the solar panel, which is connected to the power supply system, into conventional AC current and feeds it into the grid.

Mains coupling
The connection of decentralised power generators, e.g. solar power systems and the grid.

Mains feed system
Contrary to the island system, this system is connected to the grid and requires no storage batteries.

Mono-crystalline solar cell
In mono-crystalline solar cells, the material (silicone) is arranged at the atomic level in a perfectly regular crystal.

MPP - Maximum Power Point
A point on the panel curve where the solar generator generates its maximum output, which depends on irradiation and temperature.

Output
Momentary output of an electrical consumer or power generator (power station, solar heating system), measured in watts (W) and not to be confused with electrical power (Wh). The watt peak (W_p) states the peak output of a solar generator (cell, panel) under STC.

Partial load range
A photovoltaic system only rarely produces peak power (kW_p), but generally less, depending on the momentary brightness. This means the system and its components (inverter) operate in the partial load range, as they only produce a portion of their maximum output.

Photovoltaic (PV)
Terminology relating to the generation of electrical power from solar light.

p-n junction
If a semiconductor is contaminated by external atoms, the originally non-conductive material becomes conductive, i.e. either positive (electron shortage) or negative (electron surplus). If two such layers are immediately side by side, the boundary layer is referred to as the p-n junction. In this boundary layer an electrical field is formed inside the material.

Poly-crystalline solar cells
During manufacture, the material forms many individual crystals, which can be recognised by the frosted appearance of the surface.

Power supply connection point
The connection point of the inverter in the domestic electrical installation or the grid.

RCD switch
Earth leakage protection in the electrical installation serving to protect people against electrical shocks when touching mains voltage.

Renewable energies
Sources of energy which do not consume a finite raw material, but tap into natural cycles, are described as renewable (sun, wind, hydro power, bio-energy); in most cases tides, sea currents and geo-heat are also counted as such sources.

Renewable Energy Act (EEG) [Germany]
The [German] "Act for the prioritising of renewable energies" (Federal Act) prescribes minimum payments, terms of connection and other contractual conditions for feeding power from renewable energies into the grid, became law on the 1 April 2000.

Semiconductor
Material which in its physically pure state, is non-conductive and can be made conductive by deliberate contamination.

Short circuit current
Intensity of current, when the positive and negative poles of the solar generator are joined together (short circuit).

Solar cell
An individual element for gaining solar power, which directly transforms solar light on the basis of a purely physical process without any mechanical or chemical processes and without material consumption, theoretically offering an unlimited service life (size approx. 10 x 10 up to 15 x 15 cm).

Solar collector
Component for gaining heat from sunlight (thermal solar energy).

Solar generator
All solar panels of a solar power generator system.

Solar hours
Special weather recorders log the hours of sunshine – the number of hours sunshine enable the calculation of the directly irradiated energy – global irradiation is the precise value for this measurement.

Solar panel (photovoltaic panel)
Individual component of a solar generator. The solar panel electrically combines many solar cells which are encapsulated against weather influence.

STC (Standard Test Conditions)
Standard conditions, under which the electrical parameters of a solar panel are measured, to enable a comparison between the products of various manufacturers.

Thin-film solar panel
The solar cells are made in a material-saving process by direct vacuum metallisation onto a carrier material (glass, stainless steel film), where they only create a thin layer.

W_p (watt peak) **and kW_p** (kilowatt peak)
See output and energy.

Yield factor
States the factor by which a solar heating/power system yields more energy during its operation life than was required for its creation.

Viessmann Werke GmbH & Co
D-35107 Allendorf
Tel: +49 6452 70-0
Fax: +49 6452 70-27 80
www.viessmann.de

Viessmann Limited
Hortonwood 30, Telford
Shropshire, TF1 7YP, GB
Tel: +44 1952 675000
Fax: +44 1952 675040
E-mail: info-uk@viessmann.com

5822 240 GB