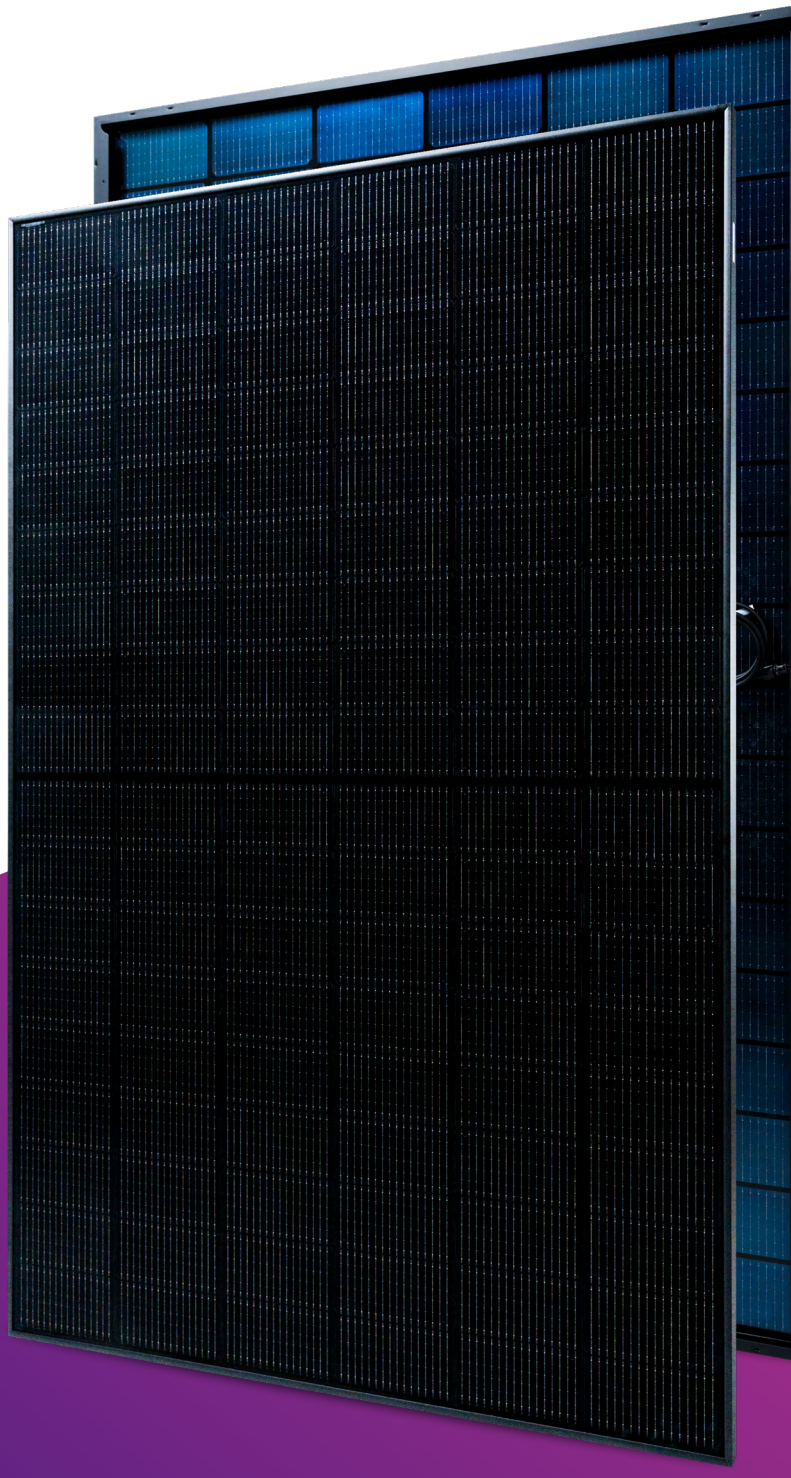
1KOMMA5°
3.1 MODULE

INSTALLATION MANUAL

Photovoltaic module model

1KOMMA5°-TC/FB/B-02.2-460
1KOMMA5°-TC/FB/B-02.2-465
1KOMMA5°-TC/FB/B-02.2-470

1KOMMA5°-TC/TP/B-02.2-460
1KOMMA5°-TC/TP/B-02.2-465
1KOMMA5°-TC/TP/B-02.2-470



Change History

Version	Date	Change
1.0	10.11.2025	· Release of Preliminary Version

Installation Manual
Meets the safety requirements of IEC 61215 and IEC 61730

Electrical System
This installation manual contains important information regarding safety and the installation and operation of the modules that you should familiarise yourself with before using the modules.

1

Introduction

This installation manual ("manual") from 1KOMMA5° Technology GmbH, Neuer Wall 35, 20354 Hamburg, Germany ("1K5°"), outlines how to properly install the photovoltaic modules sold by 1K5° ("PV modules"). The manual only includes the PV modules offered under the 1KOMMA5° and installed in the spatial scope of applicability starting from 10.11.2025. The scope of applicability of this manual includes Australia, Denmark, Germany, Finland, Netherland, Spain and Sweden.

This document contains detailed instructions and safety precautions for the installation, electrical connection and maintenance. The PV modules may only be installed by certified installation technicians licensed by 1K5°. The notices and instructions in this manual must be followed. Non-compliance with the notices can result in personal injury and property damage. It is important to comply with all relevant safety regulations when planning and installing the PV modules. The installation manual must be kept near the PV modules for their entire service life. The installation manual must be passed on to the subsequent owner or user of the PV modules. Further applicable documents must be complied with. You can find more information on our website: www.1KOMMA5.com

The PV modules from 1KOMMA5° meet the requirements of IEC/UL 61215 and IEC/UL 61730 and are qualified for Application Class A (corresponds to the requirements of Safety Class II). The PV modules can be used in publicly accessible systems that work with more than 50 V DC or 240 W. The modules meet the requirements of fire protection class UL Type 29 or IEC Class C.

2

Safety Instructions

2.1 General Instructions

In order to ensure that persons and PV modules are not harmed, it is important to comply with the following safety instructions. The entire PV module must be installed in accordance with recognised technical standards. All public regulations and specifications, national standards, technical connection conditions, accident prevention regulations, applicable guidelines set forth by the property insurer, technical rules set forth by the roofing trade and all other relevant guidelines must be complied with when planning, installing, operating and maintaining PV modules connected to the grid. The requirements may vary depending on the installation site, e.g., roof systems and open space systems. The requirements may also vary depending on the system voltage and DC/AC applications. PV modules generate DC current when they are exposed to sunlight or other light sources. Irrespective of whether or not the PV module is connected, direct contact with the live parts of the module, e.g., the wiring connection, can result in injuries or even death. The safety of the installation technician and other persons involved must be ensured during the installation and use of the PV modules. Please use appropriate module accessories such as fuses, circuit breakers, and grounding connectors according to local regulations.

2.2 Safety precautions while working on the module

- Before installation, make sure the installation permit and requirements for the installation inspection meet the local requirements. During the installation, applicable safety regulations for all components must be complied with including cables, terminals, charging monitors, batteries, inverters, etc.
- The installation and maintenance may only be carried out by certified installation technicians licensed by 1K5°. Safety helmets, insulated gloves and safety shoes must be worn and insulated tools must be used during the installation in order to prevent direct contact with direct current of 30 volts or more. Working in a dry environment with dry tools is required.
- The modules should never be left unsecured and without a mount and we advise not stacking them to avoid damage.
- To identify the front, the serial number is on the front side in the top left corner, and on the top right side of the frame. The side without junctionboxes is designed as front side.
- It is important not to walk on the module (front and back), not to let them fall and to protect them against falling objects. Leaning or kneeling on the modules (front and back) is prohibited.

- The PV modules should not be touched at the connection cables or connection socket and should not be carried in this manner, either. To remove and transport the module, using a glass suction cup or holding them only by the module frame is recommended. For longer transport routes, the modules should always be kept upright.
- It is important to avoid damaging or scratching the back of the module and the module must not be set down hard. Particular care is warranted when the module is set down on an edge.
- Do not expose the modules and its electrical contacts to any unauthorized chemical substance (e.g., oil, lubricant, pesticide, etc.).
- It is important to protect plug contacts against contamination and, if needed, to carry out appropriate cleaning measures.
- Do not drill or nail into the frames or weld anything to them. Do not drill any holes into the glass surface and do not apply paint or adhesive to the module.
- Modules with broken glass surfaces or cracks in the foil on the back are irreparably damaged and may not be used. Be careful, as any contact with the surface of the module or mount can cause electric shock. Broken or damaged modules should be disposed of in accordance with regulations.
- Do not disassemble, modify or alter the PV modules. Do not remove any parts that were installed by 1K5° unless you have first obtained approval. Otherwise, this may void the warranty.

2.3 Safety precautions during installation

- Installation work is prohibited on windy days. During the installation, no unauthorised persons or children may be near the system or PV modules.
- Before installation, the connection socket, cables and plug connectors must be checked for damage and contamination. No damaged or contaminated PV modules may be installed.
- Unloading and unpacking instructions have to be followed.
- If the PV modules are not installed on a level surface, suitable safety precautions must be taken and protective equipment must be used to prevent injuries and damage resulting from modules falling or other safety risks.
- PV modules are not equipped with an on/off switch and can only be switched off by depriving them of light. To this end, the front and back can be covered with a cloth, cardboard or another completely opaque material.
- Disconnecting conductors carrying DC current can result in flashover, therefore, before starting any work on the PV modules, in particular before disconnecting the plug connectors in the DC circuit, the inverter must be disconnected from the alternating current grid.

- When working on modules that are exposed to light, all provisions and directives pertaining to work on live electrical systems must be complied with. It must also be noted that the low-voltage range (<120 V DC) can be exceeded when modules are connected in series, therefore, particular care is warranted.
- During the installation and operation while exposed to light, touching the electrical connection terminals or cable ends should be avoided.
- Keep all electrical contacts clean and dry at all times. Both connectors per module (male, female) must be covered with a plastic cover if the connection is not made immediately during the installation process in the field.
- When carrying out mechanical or electrical installation work, no jewellery or accessories made of metal may be worn. No electrically conducting parts may be inserted into the bushings or connection sockets.
- Electrical connections should never be interrupted and plugs should not be pulled out while the circuit is live.
- Touching electrically charged module components like connection terminals can result in burns, spark development and electric shock resulting in death, even if the module is not connected.
- Only insulated tools and rubber gloves approved for electrical installation work should be used.
- It is important to not put the module cables under mechanical stress and to ensure that drainage openings are not covered and that no water can flow in the direction of the plug connections.
- If needed, appropriate lightning protection measures must be taken. If the building has a lightning protection system, the module frames and the mounting system must be integrated into the exterior lightning protection system and additional surge protection devices may be necessary. Engaging a lightning protection specialist is recommended.
- Installation technicians are required to obtain information about fire safety guidelines and requirements for houses and buildings from the local authorities. The construction and installation on the roof can impact fire safety and errors in these areas can be dangerous in the event of a fire. If the modules are installed on the roof, they should be mounted on a fireproof surface approved for this purpose.
- If necessary, components like fault current switches and circuit breakers, fuses and charging switches should be installed.
- The PV modules should not be placed near devices or locations where gas is generated or can accumulate. PV modules should not be installed near easily inflammable materials or vapours. It is important to note that PV modules are not explosion protected equipment.
- Do not artificially concentrate sunlight on a module.
- Keep the junction box cover closed at all times. Prior to installation, remove all metallic jewelry to prevent accidental exposure to live circuits.
- If modules are used as balcony modules, local norm regulations must be followed. For the German market, German DiBt with abZ for overhead installations can't be provided. The installer shall bear the safety risks and losses caused by the module being not firmly fixed.

2.4 Safety precautions during storage and transport

- PV modules should be stored in a dark, dry and ventilated location. If the PV modules are stored in an environment that cannot be controlled, the storage period must not exceed 3 months if the exterior packaging remains intact. Storage requirements: relative humidity < 85% and temperature range of -40°C to 50°C.
- If the PV module is not in use, it should be stored in the original packaging from 1K5° and the packaging should be protected against being damaged.
- While transporting the PV modules to the project site, the PV modules must remain in the original packaging.
- Unloading the modules at wind speeds higher than 6 or in severe rain or snow is prohibited.
- Ensuring safety when unloading the PV modules is required. The PV modules should be placed in a protective device and then lifted onto the roof to prevent the packaging box from warping and hitting the wall during the lifting process.
- The bending radius of the cable must be at least four times of the outside cable diameter.
- Modules must always be unpacked and installed at least by two people and handled at the frame parts.
- Before unpacking, make sure the packaging box is in good condition. The packaging tape and packaging foil should be carefully removed using appropriate tools. Forced removal is prohibited to avoid damaging the modules.
- Do not stack the modules on top of one another to avoid damage.

3

Planning

3.1 Area of application

The modules are only suitable for the following areas of application:

Recommended environment temperature	-40 °C to 50 °C
Permissible module operating temperature	-40 °C to +70 °C
Maximum tested snow/wind load under standard installation conditions	+5,400 Pa / -3,600 Pa
Rated load (taking a safety factor of 1.5 into account)	+3,600 Pa / -2,400 Pa
Module Temperature rating (C98)	70 °C

The modules may not be installed in the locations specified below:

- in closed rooms
- above 2,000 m above sea level
- on the surface of a body of water
- in locations where backwater can accumulate (e.g., as a result of floods)
- near easily inflammable gases or vapours (e.g., petrol stations)
- in locations in which chemical substances might come into contact with parts of the module (e.g., oil or solvents)
- in the immediate vicinity of air conditioning and ventilation systems.
- The modules must not be installed as a replacement for roofs or façades.

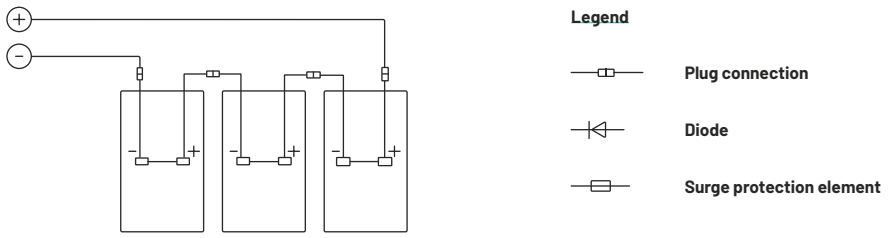
The corrosion may occur where the modules frame is connected to the bracket or where the grounding is connected. 1KOMMA5°-TC/FB/B-02.2 and 1KOMMA5°-TC/TP/B-02.2 Modules can be installed 50 m away from the ocean side, and related parts and components should be protected with anticorrosion.

3.2 Electrical design

- The nominal electrical values of the module are measured under standard test conditions (STC) (STC: 1000 W/m^2 radiation strength, AM 1.5 spectrum and a cell temperature of 25°C).
- Only modules with the same output class may be connected to each other.
- The electrical properties and maximum system voltage and tolerances for Isc, Voc and Pmpp can be found on the PV module's data sheet or type plate.
- Since a module can deliver a higher current and/or higher voltage due to special environmental conditions, a safety factor of 1.25 must be taken into account for the electrical variables (Voc, Isc) under standard test conditions.
- Using UV-resistant PV cables is recommended. They must have a gauge of at least 4 mm^2 (12 AWG).
- The individual system components (modules, fuses, inverters, etc.) must be calibrated to each other according to their technical properties. Identical connection plugs (same manufacturer, same plug models) must be selected for the extension and connection cables.
- The local, regional and national regulations for the installation of electrical systems must be complied with.
- Bypass Diode and Cabling Specifications: Features a repairable Sunter type 40SQ045 bypass diode and an IEC 131 1x4.0mm^2 stranded tinned copper cable, rated for operating temperatures from -40°C to +125°C.
- The connectors are made by Stäubli Electrical Connectors AG, type PV-KST4-EVO2A/xy and PV-KBT4-EVO2A/xy.

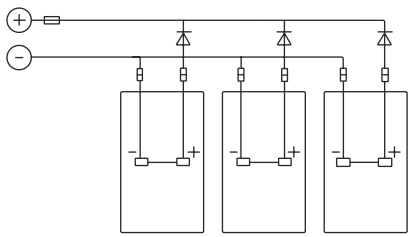
Series connection

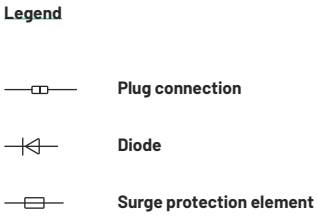
- The PV modules can be connected in series to achieve the desired total voltage. The current strength (Impp) of the modules connected in series should be the same because the maximum current is defined by the module with the lowest current strength.
- The maximum open circuit voltage of the system must not exceed the maximum system voltage of the module. The maximum system voltage can be found on the label and data sheet.
- The maximum number of modules in series results from the maximum system voltage (Usys) divided by 1.25 times the open-circuit voltage (Voc). The resulting number is then rounded down.



Parallel connection

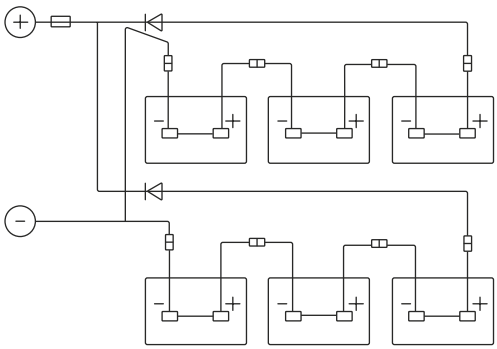
- The modules can be connected in parallel to achieve the desired total current. The voltage (Vmpp) of the modules connected in parallel should be the same.
- To prevent back current, a back current fuse (e.g., blocking diode) is required.
- The cable gauge of the extension cable must be adapted to the maximum current carrying capacity of the circuitry.
- Only 2 strings may be connected in parallel.

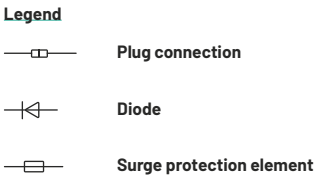




Combined connection

- The modules can also be connected in combination.
- All components must be calibrated to each other and the individual connection instructions, series and parallel connection must be taken into account.
- The same number of modules must be connected in the respective series string (same string voltage).
- Additional safety precautions must be taken to protect the cable and modules against surges.





Avoid Shading

- Modules shall not be permanently shaded (including partial shading, spot shading, even shading or uneven shading) under any circumstance. Permanent shading includes shading of the same cell, cell row, or module portion for extended and repeated periods of time (e.g.,more than 200 daylight hours over the warrantied service lifetime). Power dissipated in fully or partially shaded cells will result in power loss, reduced yield and can cause localized overheating, which in turn may negatively impact the module service lifetime. Permanent shading may cause accelerated ageing of the encapsulation material and place thermal stress on the bypass diodes. This would void the module's warranty unless properly mitigated through the use of Module Level Power Electronic (MLPE) devices.
- Regular maintenance is required to keep modules clean. Particular measures should be taken to avoid permanent shading from dirt or debris (e.g., plants, bird droppings,
- Do not install modules directly behind any object (e.g., tree, antenna, etc.) to prevent occurrence of permanent shading.
- Even temporary partial shading will reduce the energy yield. A module can be considered to be unshaded if its entire surface is free from shading all year round, including on the shortest day of the year.

Optimum Orientation and Tilt

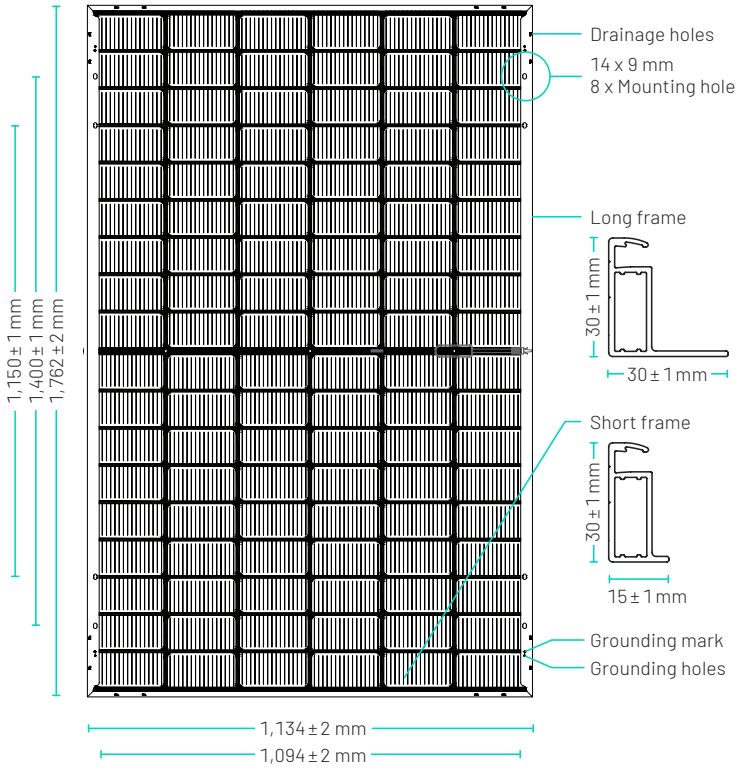
- To maximize the annual yield, please calculate the optimum orientation and tilt for PV modules in that specific installation site. The highest yields are achieved when sunlight shines perpendicularly onto the PV modules.
- The Solar modules must be installed in the European Economic Area including Switzerland, Norway and UK with a minimum inclination angle of 5° in relation to horizontal. The maximum installation angle must follow national norm and safety requirements.
- The modules must be securely attached. To do this, use special elevated installations or assembly kits for use with photovoltaic systems.
- The modules must be adjusted to the same installation angle for the same photovoltaic generator on string level for standard installation concepts.

4

Mechanical installation

4.1 Module alignment

- To ensure fire resistance on the roof, the minimum distance between the frame of the PV module and the surface of the roof is 10 cm. For sheet metal and trapezoidal roofs, the minimum distance between the frame of the PV module and the nearest point of the roof can be reduced up to 4.5 cm.
- The modules can be installed upright or horizontally.
- Make sure no water can accumulate. Rain and run-off water must be able to drain freely. The drainage openings in the module frame must not be covered or sealed.
- The recommended minimum slope is 10°. The maximum slope must be determined in accordance with locally applicable regulations.
- Optimum sun exposure results in maximum energy yield. The PV modules should therefore be installed facing the sun. Shadows and partial shadows must be avoided (e.g., by trees, buildings, overhead lines, etc.).
- In the Southern hemisphere, the modules should typically face north to achieve maximum energy yield. The most important dimensions for the installation can be found in the following figure:



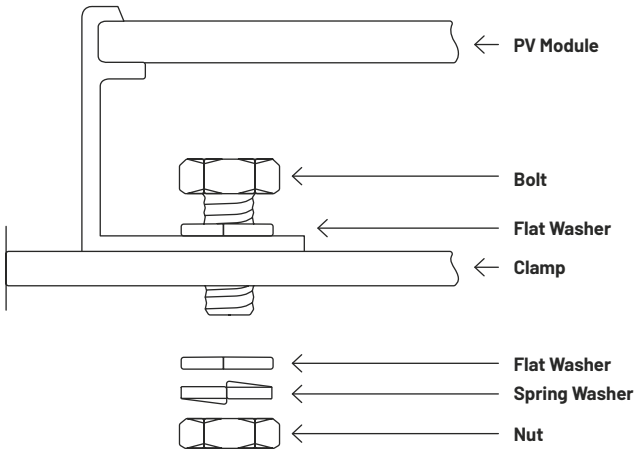
4.2 Mounting Instructions

The applicable regulations pertaining to work safety, accident prevention and securing the construction site must be observed. Workers and third-party personnel shall wear or install fall arrest equipment. Any third party need to be protected against injuries and damages.

- The mounting design must be certified by a registered professional engineer. The mounting design and procedures must comply with all applicable local codes and requirements from all relevant authorities.
- The module is considered to be in compliance with IEC/UL 61730 and IEC/UL 61215 only when the module is mounted in the manner specified by the mounting instructions included in this installation manual.
- The system designer and installer are responsible for load calculations and for proper design of support structure.
- Any module without a frame (laminate) shall not be considered to comply with the requirements of IEC/UL 61730 unless the module is mounted with hardware that has been tested and evaluated with the module under this standard or by a field Inspection certifying that the installed module complies with the requirements of IEC/UL 61730.
- Standard modules can be mounted onto a support structure using one of several approved methods as described below. For information about other installation methods, please contact your local representative. Failure to use a recognized installation method will void the limited warranty.
- Use appropriate corrosion-proof fastening materials. All mounting hardware (bolts, spring washers, flat washers, nuts) should be hot dip galvanized or stainless steel.
- Use a torque wrench for installation.
- Do not drill additional holes or modify the module frame.
  Doing so will void the limited warranty.
- Standard modules can be installed in either landscape or portrait orientations. Refer to the detailed instructions for further guidance. Please note that in areas with heavy snowfall (> 2400 Pa) further countermeasures such the use of additional support bars should be considered to avoid snow loads damaging the lowest row of modules.
- The loads described in this manual correspond to test loads. For installations complying with IEC/UL 61215 and IEC/UL 61730, a safety factor of 1.5 should be applied for calculating the equivalent maximum authorized design loads. Project design loads depend on construction, applicable standards, location and local climate. Determination of the design loads is the responsibility of the racking suppliers and/or professional engineers. For detailed information, please follow local structural code or contact your professional structural engineer.

4.3 Mounting Method: Bolting

- The mechanical load test with these mounting methods were performed according to IEC/UL 61215.
- Modules should be bolted to supporting structures through the mounting holes in the rear frame flanges only.
- In areas with heavy wind loads, additional mounting points should be used. The system designer and the installer are responsible for correctly calculating the loads and ensuring that the supporting structure meets all the applicable requirements.
- Each module must be securely fastened at a minimum of 4 points on two opposite sides.
- Tightening torques should be 12~16 N•m for M8 coarse thread bolts, depending on bolt class.
- Tightening torques should be 6~9 N•m for M6 coarse thread bolts, depending on bolt class.
- Accessories material selection should be based on application environment.
- When using 30 mm height frame module, it is recommended to select L ≤ 20 mm length fasteners.
- The method and the specifications of the fixing parts are shown in the figure 3 below.



Specific requirements for parts Accessories:

	Model	Material	
Bolt	M8	M6	Q235B/SUS304
Washer	2pcs, thickness ≥ 1.5 mm and outside diameter = 16 mm	2pcs, thickness ≥ 1.5 mm and outside diameter = 12-18 mm	Q235B/SUS304
Spring Washer	8	6	Q235B/SUS304
Nut	M8	M6	Q235B/SUS304

4.4 Mounting Method: Clamping

- The mechanical load test with these mounting methods were performed according to IEC/UL 61215.
- Top or bottom clamping methods will vary and are dependent on the mounting structures. Please follow the mounting guidelines recommended by the mounting system supplier.
- Each module must be securely fastened at a minimum of four points on two opposite sides. The clamps should be positioned symmetrically. The clamps should be positioned according to the authorized position ranges.
- Install and tighten the module clamps to the mounting rails using the torque stated by the mounting hardware manufacturer. M8 bolt and nut are used for this clamping method.
- Tightening torques should be within 18~24 N•m for M8 coarse thread bolts, depending on the bolt class. For the bolt grade, the technical guideline from the fastener suppliers should be followed. Different recommendations from specific clamping hardware suppliers should prevail.
- The system designer and installer are responsible for load calculations and for proper design of support structure.
- 1K5° limited warranty may be void in cases where improper clamps or unsuitable installation methods are found. When installing inter-modules or end-type clamps, please take the following measures into account:

  1. Do not bend the module frame.
  2. Do not touch or cast shadows on the front glass.
  3. Do not damage the surface of the frame (to the exception of the clamps with grounding pins).

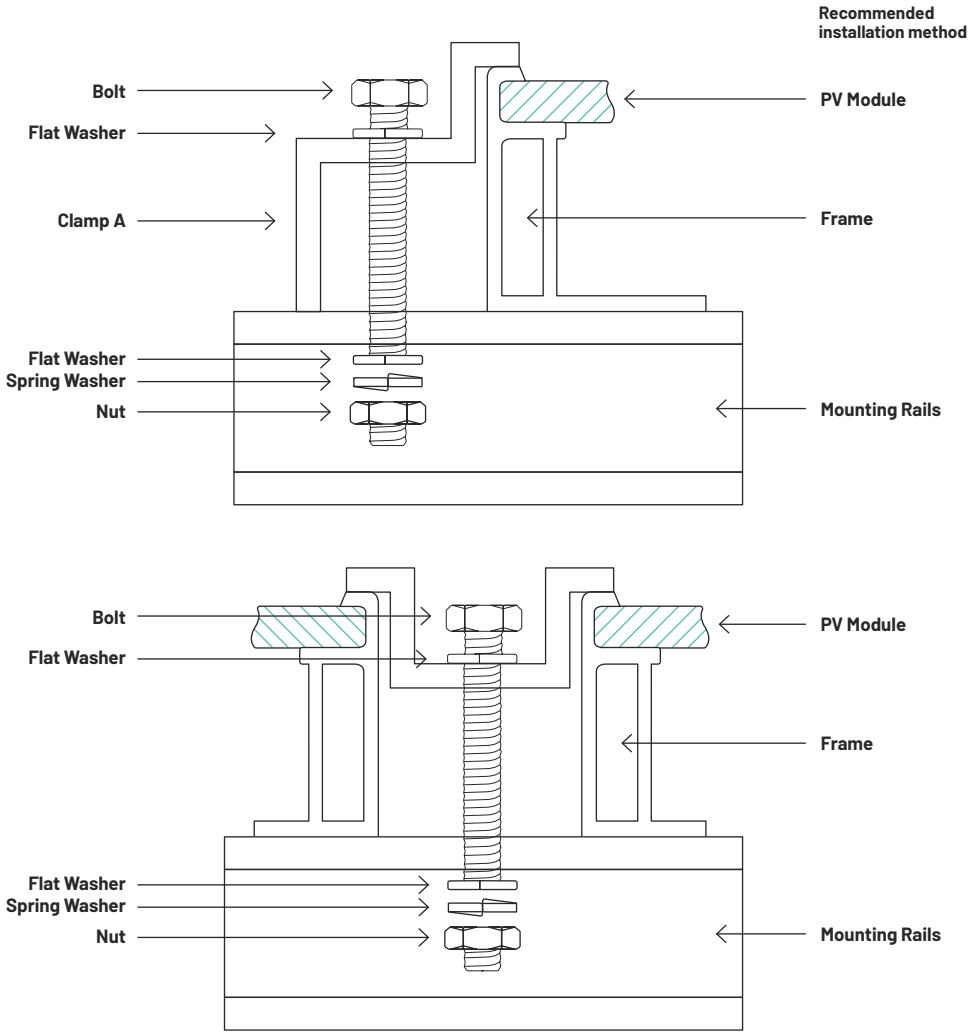
4. Ensure the clamps overlap the module frame by at least 10mm but no more than 12mm.

5. Minimum clamp length is at least 50 mm.

6. Ensure the clamp thickness is at least 3 mm.

7. The definition of the clamping range results from the distance between outer edge of the module to the middle of the used clamp.

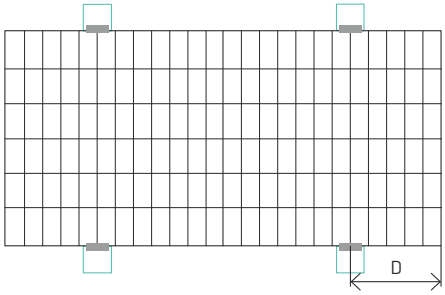
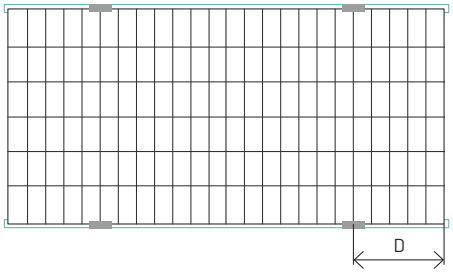
- Clamp material should be anodized aluminum alloy or stainless steel.
The mounting details are shown in the following figure.

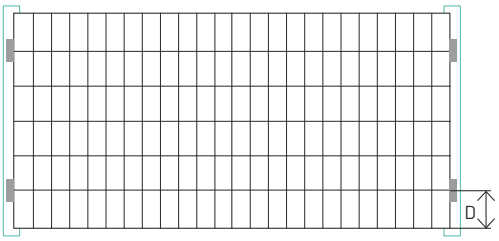
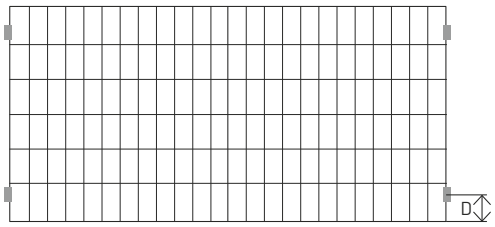
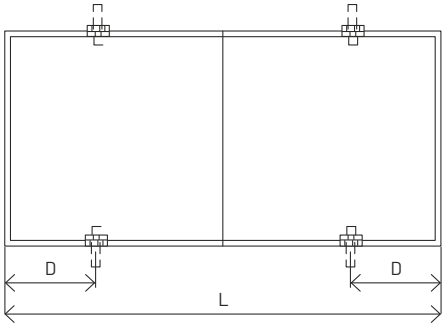


4.5 Installation methods

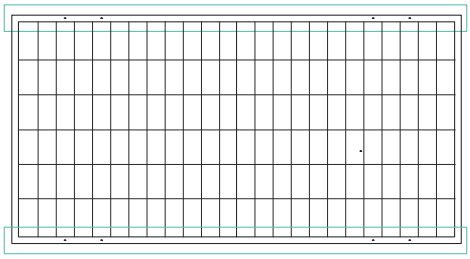
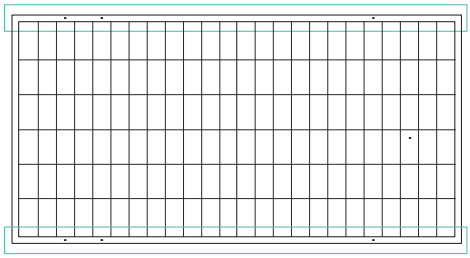
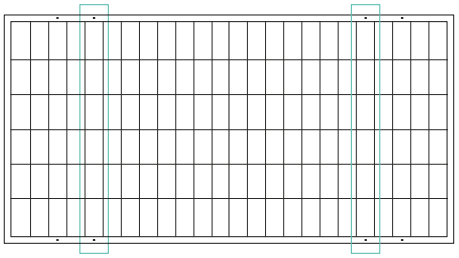
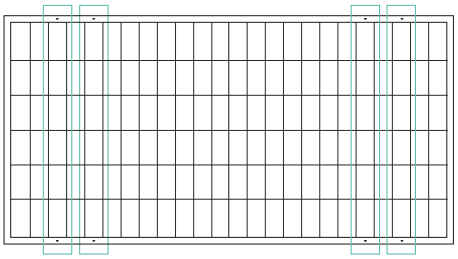
The PV modules can be installed transverse to the mounting frame (installation method 1 and 3) or parallel to the PV module frame (installation method 2). The PV modules can also be mounted with four pivot points (installation method 4). "D" indicates the mounting range. When using clamps to mount the modules, each module must be mounted with at least 4 clamps. The clamping range can be extended up to 30cm if the load is reduced accordingly and reliable installation is ensured.

Module model	1KOMMA5°-TC/FB/B-02.2 1KOMMA5°-TC/TP/B-02.2
Pallet dimensions [L × W × H, mm]	1,800 × 1,140 × 1,250
Max. Test Load, Push/Pull [Pa]	Front 5,400 / Back -3,600
Max. Design Load, Push/Pull (Pa)	Front 3,600 / Back -2,400

Installation method 1	Rails perpendicular to the long side of the frame	
Test load [Pa]	+5,400 / -2,400 Pa	
Mounting range [mm]	(1/5L-50 mm) < D < (1/5L+50 mm)	
Test load [Pa]	+2,600 / -1,800 Pa	
Mounting range [mm]	190 mm < D < 295 mm	
Installation method 2	Rails overlapping the long-side frame	
Test load [Pa]	+3,600 / -2,400 Pa	
Mounting range [mm]	(1/5L-50 mm) < D < (1/5L+50 mm)	

Installation method 3	Rails that overlap with the frame on the short side	
Test load [Pa]	+2,400 / -1,600 Pa	
Mounting range [mm]	(1/4 W - 50 mm) < D < (1/4 W + 50 mm)	
Installation method 4	Four clamps on the short side of the frame	
Test load [Pa]	+1,800 / -1,600 Pa	
Installation method 5	Mounting by four clamps without mounting rails cross the long frame	
Test load [Pa]	+2,600 / -2,200 Pa	
Mounting range [mm]	(1/4 L - 50 mm) < D < (1/4 L + 50 mm)	

4.6 Mounting Method: Bolt

Installation method 6	Outer four holes, mounting rails parallel the long frame	
Test load [Pa]	+2,800 / -2,400 Pa	
Installation method 7	Inner four holes (1,150 mm holes), mounting rails parallel the long frame	
Test load [Pa]	+2,400 / -2,400	
Installation method 8	Inner four holes (1,150 mm holes), mounting rails cross the long frame	
Test load [Pa]	+5,400 / -2,400 Pa	
Installation method 9	8 bolts at the long frame, mounting rails cross the long frame	
Test load [Pa]	+5,400 / -3,600 Pa	

5

Electrical installation

5.1 Safety

The previously mentioned safety precautions must be taken during installation (p. 5f).

5.2 Electrical connection

- Take all necessary precautions during installation, operation and servicing of the modules to avoid electrical hazards.
- All electrical connections must be securely closed.
- Contact with a direct voltage of 30 V is dangerous, electrical shock or burn can occur, any contact above those voltages can be fatal.
- If the direct voltage of the entire system exceeds 100 V, the installation, operation and maintenance must be performed by a licensed electrician, unless the local regulations for handling electrical systems specify otherwise.
- Module electrical ratings are measured under Standard Test Conditions (STC) of 1000 W/m2 irradiance, with an AM1.5 spectrum, and a cell temperature of 25°C and marked on nameplate.
- Detailed electrical characteristics of modules can be found in the data sheets.
- The maximum open circuit voltage of the system must not exceed the maximum system voltage of the module:

$$\text{Maximum system voltage} \geq N \times V_{OC} \times C_{VOC}$$

  In this formula, N is the number of PV modules in a single string and Voc is the open-circuit voltage of the individual PV modules (see data sheet).

- The maximum reverse current resistance of the module has must be followed. Certified adequate overcurrent blocking devices (fuse or current interruption) should be used depending on the safety values.
- As a manufacturer, Stäubli Electrical Connectors AG guarantees interconnectivity and pluggability within the Stäubli Multi-Contact® connector family taking into account the system voltage up to 1,000 V. They also guarantee interconnectivity and pluggability for the Stäubli Multi-Contact® connector EVO2 and EVO2A. Due to the gap of technical performances between MC4 connectors and MC4-EVO2A connectors, only the lower technical parameters from both connectors, such as the rated voltage and the rated current, are available in case of cross-connection. Please note that Stäubli does not recognize a compatibility between Stäubli PV-connectors and the connectors from other manufactures. For other connectors, please refer to its supplier's usage instructions.

- During system cabling, please pay attention to the correct cross-sections and connections permitted for the maximum short-circuit current intensity of the module. The cable must have a minimum cross-section of 4mm^2 and the isolation must be permitted for the maximum system voltage.
- During assembly, beware of tensile force relief on the module connection cable.
- The socket, cable and connector must not be moistened or cleaned with oily, greasy or alcohol-based substances.
- The modules are fitted with pre-installed bypass diodes ex-works, which are inside the socket.
- Under certain conditions, a module may produce more current or voltage than its Standard Test Conditions rated power. As a result, the module short-circuit current under STC should be multiplied by 1.25, and a correction factor should be applied to the open-circuit voltage, when determining component ratings and capacities. Depending on your local regulations, an additional 1.25 multiplier for the short-circuit current (giving a total multiplier of 1.56) may be applicable when sizing conductors and fuses.
- Alternatively, a more accurate correction factor for the open-circuit voltage can be calculated using the following formula:

$$\text{Maximum system voltage } C_{VOC} = 1 - \alpha_{VOC} \times (25 - T_{MIN})$$

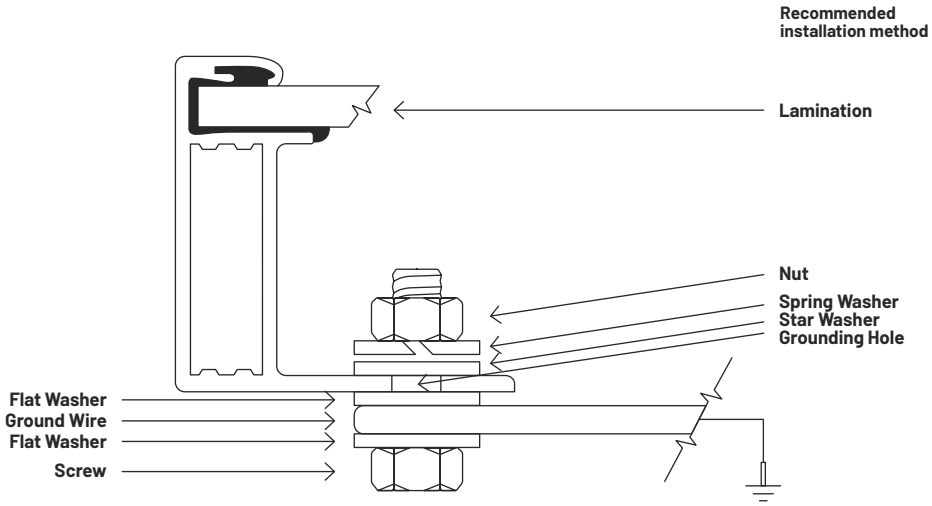
- T (°C) is the lowest expected ambient temperature at the system installation site.
- αVoc (% / °C) is the voltage temperature coefficient of the selected module (refer to corresponding datasheet).
- Electrical calculations and design must be performed by a competent engineer or consultant.
- Please contact the technical support team for additional information pertaining to engineering optimization and approval of project specific module string lengths.

5.3 Grounding

- Regional or national requirements must be followed, and they can include an obligation to ground module frames.
- Grounding module frames may also be necessary for preventing lightning strikes/overvoltage.
- Adequate grounding connection must be installed as per the regulations and standards accordingly.
- 1K5° modules provide grounding holes and they are marked on the rear frame side (frame C-side) with a grounding symbol (IEC 61730-1). All conductive connection junctions must be firmly fixed.
- Grounding connections should be installed by a qualified electrician. Connect module frames together using adequate grounding cables: the use of 4 - 14 mm^2 (AWG 6-12) copper wire is recommended.
- Do not drill any extra ground holes for convenience as this will void the modules limited warranty.
- All bolts, nuts, flat washers, lock washers and other relevant hardware should be made of stainless steel, unless otherwise specified.
- The grounding method described below is recommended by 1KOMMA5°.

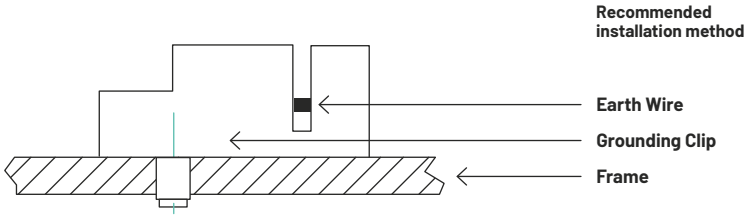
Grounding by grounding bolt

Use M4 bolt and washers to bond the ground wire and aluminum frame through the grounding holes (as shown figure 1). The tightening torque is 3 - 7 N.m. All nuts and washers should be made of stainless steel.



Grounding by using grounding clamp

As shown in the figure, the grounding clip assembly consists of a slider, base, and self-captivating thread-cutting screw or 8-32 screw and hex nut. The grounding clip accepts solid uninsulated copper wire sizes 10 or 12 AWG.



6

Maintenance and care

6.1 Maintenance

- The system should be regularly inspected by a certified installation technician.
- Do not make modifications to any component of the PV module (diode, junction box, connectors or others).
- The glass surface, the frame and the connections should be regularly checked for damage.
- All electrical components should be inspected to ensure they are free of corrosion and the connection contacts are good.
- If a module has to be replaced, follow the disassembly and disposal instructions. In addition, a module with the same electrical properties should be used.
- After an extraordinary weather event (storm, hail, snow, etc.), the modules should be checked for damage by a certified installation technician.
- Module glass cracks. Special attention: avoiding rolling up sand and gravel to break the glass during the inspection of the operation and maintenance vehicles; Avoiding defects or breakage of glass caused by splashing of hard objects such as sand and gravel when using a lawn mower for weeding operations.

6.2 Care

- Do not clean the modules until they have cooled down.
- The glass should never be touched with bare hands as this can leave fingerprints. Instead, rubber gloves should be worn when carrying out maintenance, washing or cleaning the modules in order to protect the PV modules from being damaged and the installation technician from electric shocks.
- Carefully remove leaves, snow, ice or other contamination using a broom. If there is sand or heavier dirt, be careful in order to avoid scratches.
- A generous amount of water should be used to remove heavy contamination. Do not use tap water; instead, only use demineralised water or rainwater. Stubborn contamination can also be soaked.
- The use of the following agents and items is prohibited: abrasive cleaning agents like abrasive powders, polishing compounds, steel wool and scrapers, cleaning units made of steel, chemical cleaning agents; acids, lye, bleach powder and strong alkalines; high-pressure cleaners, steam blasters or brushes.
- Low air pressure can be used to clean soft dirt
- Cleaning agents that are highly acidic or alkaline, cleaning agents containing hydrofluoric acid (HF) and pure alcohol or pure acetone may not be used.
- The ingredients of cleaning products should be checked before use. Manual cleaning or hand washing can be carried out using alcohol-based cleaning agents. Cleaning can also be carried out using a soap-water solution. Cleaning agent residues should be removed from the surface of the glass.

7

Disassembly and disposal

Compliance with the following instructions is required while disassembling the modules:

- The system may only be disassembled by certified installation technicians licensed by 1K5°.
- Before disassembly, the inverter must be switched off and its switch-off interval must be completed. The modules must be disconnected from the inverter.
- The components should be inspected for damage.
- The plugs must be disconnected using suitable specialist tools.
- The PV modules and the substructure must be disassembled using suitable specialist tools.
- PV modules and other components should be securely packed for transport.

Our partner, take-e-away, picks up and disposes of PV modules. You can find more information on their website: https://kundenportal.take-e-way.de/

8

Liability Disclaimer

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