

EXASUN

X-TILE



INSTALLATION GUIDELINES: ELECTRICAL SAFETY



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rev1604122023(EN)

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If you have any questions regarding this product guidelines or any other specific aspect related to the X-Tile BIPV module or X-Tile BIPV roofing system in question, please contact EXASUN's sales via the following contact:

EXASUN B.V.

Laan van Ypenburg 122
2497 GC Den Haag
The Netherlands

T: (+31) 088-4343-888
sales@exasun.com
www.exasun.com

About EXASUN

EXASUN B.V. is an innovative Dutch company focused on the research, development, and manufacturing of building-integrated photovoltaic (BIPV) modules. We use high efficiency mono-c Si PERC solar cells, innovative colouring processes, and a glass/glass module construction. This combination of technologies allows EXASUN to continuously improve and develop BIPV modules with long operating life, fire safe, with excellent aesthetics and easy building integration for truly building-integrated PV roofing systems.

X-Tile Series

The X-Tile BIPV System provides another flexible and truly BIPV roofing solution that can be used for roofing systems where, whether due to architectural constraints or local regulations, a roofing solution including both BIPV module and conventional ceramic tiles is required. This BIPV module can be installed with conventional roofing battens. A customized design allows the BIPV module to directly interlock with the Koramic Actua 10 ceramic tile from Wienerberger AG.

The X-Tile module, also referred to as *X-Tile*, is a 28-cell single string glass/glass module with a width of 1302 mm and envelop dimensions equivalent to five ceramic tiles mounted in a row. This BIPV module is available in black and later as well in terracotta version to blend with the Actua 10 tile colours.

Mission

EXASUN is committed to become a leading company on BIPV technology solutions by accelerating sustainable development through innovation. EXASUN achieves this through continuous close collaborations with installers, architects, research institutes, certifying bodies and other main players in the PV industry.

Disclaimer of Liability

At EXASUN, as a BIPV photovoltaic module manufacturer, we strive to inform and instruct our collaborators to the best of our knowledge. However, the installation techniques, handling, correct PV system dimensioning and integration and use of this BIPV module are beyond EXASUN's control. Therefore, EXASUN does not assume any liability and/or responsibility for the loss, damage, direct or indirect hazards to human or animals, or expenses resulting from improper installation, handling, attempt to reverse engineer, misuse or for any claim that resulted due to failing to adopt the required local codes, guidelines, and norms for PV technology. Any attempt to modify, refit parts, reverse engineer, signs of mishandling, act of negligence or bad faith will void the module warranty.

As part of EXASUN's policy to continuously improve its products and adjust to customer needs, EXASUN reserves the right to make changes to the product, specifications, manuals, or technical datasheets without prior notice.

Guide Intended Use

This installation guide is intended for the **X-Tile** product FAMILY, MODELS: XT028H-085BK-E. The guidelines and recommendations herein presented are intended for the European photovoltaic market regarding electrical safety and basic building code requirements. For applications or markets not explicitly covered in this guide, please contact EXASUN's sales.

1. General Information

1.1 Introduction

This document has been prepared by EXASUN B.V. and is based on the marking and documentation requirements for photovoltaic modules according to IEC 61730-1:2016 and NEN-EN 50380:2016 standards. It contains information regarding the safe handling and installation of EXASUN's BIPV glass/glass photovoltaic modules. This guide was thought for certified or qualified professionals with the necessary expertise to perform installation or maintenance on PV systems built with EXASUN's solar modules.

Installers must read and understand the suggested guidelines before starting any task related to installation, operation, and maintenance (O&M) involving EXASUN's solar modules. The installation should follow all the safety recommendations in this guide as well local, national, and European directives related to the photovoltaic industry and necessary infrastructure used for installation, O&M.

2. Safe Handling and Installation



WARNING: All the handling and installation of the product in question must be done by qualified personnel only. Always ensure extreme safety precautions.



Handling and installation must be performed according to national, local, and European guidelines and norms.

2.1 Workplace Safety Rules

- Wear protective safety clothing, namely: work clothing (that do not limit movement), non-slip shoes, insulating gloves and helmet.
- Do not wear metallic jewellery or other personal items that may cause electrical shock while working with PV modules.

- Use only insulated tools that are approved for working on electrical installations.
- Make sure that there is always at least two people working together.
- Do not work in bad weather. PV modules may be blown away due to strong winds.
- Check scaffolding and ladders and ensure they are safe and working well.
- Do not expose unconnected modules to rain. Nor work while raining or snowing, it may result in accidents due to slipping or loss of balance.
- Use only approved equipment (connectors, wiring, grounding, ...) in the PV system. Do not combine third party modules with EXASUN's modules in the same PV system.

2.2 Module Handling

- When unpacking and handling, always lift the module. Do not scratch, drop, stand on or hit the module with sharp tools.
- Keep the module front-glass free of dirt or finger marks by wearing gloves.
- Do not lift or carry the module by the junction-box (J-box) cables.
- For temporary repacking, always use soft spacers to prevent direct contact of glass/metal or glass/glass parts.
- For long storing periods, always take measures to cover the DC connectors to prevent dust or water ingress. Store the modules in a cool and dry environment.
- Do not use excessive pressure to force the module into its final mounting position.

- Do not carry modules on your back or head. Nor attempt to carry multiple modules simultaneously.

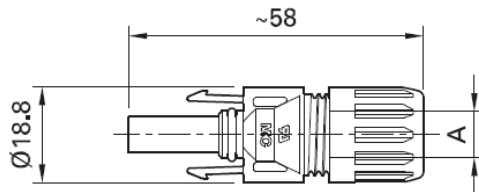


ISO 7010 – M009: Wear protective gloves that can also protect from hazards due to the possibility of sharp edges and burrs in metal parts.

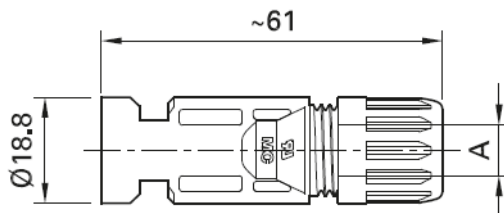
3. Electrical Information

3.1 Polarity of Leads

- Female MC4 connector: **Positive (+)**
(Stäubli: PV-KBT4/xy-UR)



- Male MC4 connector: **Negative (-)**
(Stäubli: PV-KST4/xy-UR)



3.2 J-Box Elec. Ratings

J-Box Electrical Ratings acc. IEC 62790

J-box rated input current	35 A
Diode technology	Schottky
Number of diodes per module	1
Diode max. forward current (I_F)	40 A
Diode max. reverse voltage (V_R)	45 V

3.3 Protection Against Electrical Shock

- Safety Class II protection against electrical shock acc. to IEC 61730-1. For applications where general user access and contact with insulated live parts is anticipated.
- Safety Class II PV modules (single module or combined) may have electrical outputs with voltage, current, and power at hazardous levels.

- Class II equipment is marked acc. to IEC 60417-5172 with the following symbol and meaning.



IEC 60417-5172: Class II equipment.

3.5 Wiring, Cables, and Connectors

- Minimum cable diameter of $1 \times 4 \text{ mm}^2$ (AWG 12). And working temperatures of -40°C to 85°C . Use of black coloured cables with high UV-resistance is recommended.
- Use DC H1Z2Z2-K (acc. to EN 50618) standard DC solar cable intended for the interconnection of photovoltaic modules and module arrays. Use appropriate cable harnessing components to guide and fix the wiring.
- To prevent short-circuit and grounding problems, cables of opposite polarities should be laid apart from each other.
- While designing the string lay-out, minimize induction loop enclosed area by routing the return wire along the string path, minimizing enclosed surface area. See the examples of good and bad string layouts in ANNEX A.
- Use only safe and certified MC4 original connectors with IP67 or higher protection degree.



WARNING: PV industry demands that connector compatibility should only be accepted for connectors of same type family and manufacturer!

- J-box connectors must be mated with original MC4 approved connectors. DC connectors in use are approved acc. to IEC 62852 and marked with the following symbol and meaning:



IEC 60417-6070

Do not disconnect under load.



Do not disconnect under load.

3.5 PV Module Electrical Ratings

Module FAMILY: X-Tile

ELECTRICAL DATA ^{1,2,3}		X-TILE MODEL
PROPERTIES	UNITS	XT028H-085BK-E (BLACK)
Module max. power (P_{MAX}) ($\pm 5\%$)	[W]	85
Open-circuit voltage (V_{OC}) ($\pm 1\%$)	[V]	19.5
Short-circuit current (I_{SC}) ($\pm 2\%$)	[A]	5.8
Max. power-point voltage (V_{MPP})	[V]	16.3
Max. power-point current (I_{MPP})	[A]	5.3
Max. System DC voltage (V_{SYS})	[V]	1000 V
Electrical shock protection (Safety Class)	[-]	Class II
Max. Overcurrent protection rating	[A]	15 A
Temperature coefficient for V_{OC} (β)	[%/°C]	-0.251
Temperature coefficient for I_{SC} (α)	[%/°C]	+0.048
Temperature coefficient for P_{MAX} (γ)	[%/°C]	-0.320
Nom. Module Operating Temperature (NMOT)	[°C]	32.8
Performance at NMOT (MQT 06.2)	[W]	83.7
Performance at low irradiance (MQT 07)	[W]	20.4
Recommended maximum series N_s (and parallel) ⁴ PV module configuration ⁴	[-]	40 modules 2 strings

- 1) Data given relative to standard test conditions (STC): 1000 W/m², 25°C, AM 1.5.
- 2) And based on laboratory tests performed according to IEC 61215-2:2016 (MQT 06.1) and IEC 60904-1 Ed. 3.
- 3) Environmental temperature range of at least -40°C to +40°C and up to 100% relative humidity as well as rain.
- 4) This recommendation is based on V_{SYS} with a safety factor of 1.25. Qualified personnel may define their own safety factor using local expectations for irradiation and temperature. When doing so, ensure the DC string voltage never exceeds V_{SYS} .

3.6 Protective Devices

- A single photovoltaic bypass diode is employed as protective device.



Bypass replacement and/or uncovering by means of removing its potting adhesive, or any other means, is not allowed!

3.7 Altitude of Operation

- The BIPV module (design clearances and creepage distances) is rated to operate at an altitude up to 2000 [m] acc. IEC 61730-1. For applications requiring greater altitudes please contact our sales department.

3.8 Ratings – Important Note

- Under normal conditions, a PV module is likely to experience conditions that produce current and voltage higher than the values reported at standard test conditions (STC).
- The values of I_{SC} and V_{OC} marked on this PV module should be multiplied by a factor of 1.25 to define component ratings, conductor current ratings, sizing of controls and other Balance of System (BoS) components.

NOTE: A safety factor of 1.25 for V_{OC} and I_{SC} is recommended given that solar irradiance may occasionally be higher than 1000 W/m². Temperature below 25°C may increase V_{OC} . Qualified personnel may define their own safety factor based on local expectations for irradiation and temperature. When doing so, ensure the string voltage of V_{SYS} is not exceeded under any circumstances.

- External or any other source of artificially concentrated sunlight shall not be directed onto the front- or back-face of the PV module. Doing so may result in temporary or permanent damage and safety risks.

3.9 Cell and Module Interconnection

- According to IEC 61215-2:2016 norm, cell interconnection is classified as Case S: Series connection of all cells in a single string. The 28 cells are connected in a single string protected by a diode. A representative electrical schematic for this BIPV module is given in ANNEX B - Cell and Module Interconnection.

3.10 Earthing and Lightning Protection

- Good practices, structural earthing and lightning protection systems for buildings should be adopted acc. to IEC 62305, national, and other relevant EU directives.
- Air termination systems for roof structures (e.g., peaked roofs) must be used. Lightning protection components must comply with the EN 50164, local, national, and other relevant norms.

4. Module and Assembly

4.1 Mounting Type

- According to IEC 63092-1 the BIPV module mounting type belongs to category: Category A: Sloped, roof-integrated, not accessible from within the building.
- The allowed minimum and maximum roof tilt angle are 20° and 75°, respectively. Mutual shading of PV module may occur depending on the geographical latitude and azimuth of the system.

4.2 PV Module PD and MG

- The pollution degree (PD) is 2, which means that normally, dry, non-conductive pollution occurs, but temporary conductivity caused by condensation is to be expected.
- The material Group (MG) is 1. Crucial solid insulating materials were tested acc. to IEC 60112 resulting Proof Tracking Index (PTI) ≥ 600 [V].

4.3 Assembly Information

- Assembly instructions and technical data are provided in ANNEX A to facilitate the complete and safe BIPV module assembly.
- The manual only covers basic physical installation and electrical safety guidelines. The detailed physical installation will be covered in a separate manual.
- Design Load: Front 3600 Pa and back 1600 Pa. The test load is therefore set to 5400 Pa and 2400 Pa, respectively, with the safety factor of 1.5.
- However the Exasun X-Tile modules have been designed to withstand the temporary live load of an adult person (weighing max. 100 kg) during installation or maintenance, it is strongly recommended not to step on the modules, or impose mechanical stress, to prevent damage to the cells and to reduce the risk of falling or slipping. At all times avoid impact with hard and/or sharp objects of all sizes.
- The mounting of the BIPV panels requires a customized aluminium extrusion brackets, along with panel and storm hooks, all provided by EXASUN.

NOTE: The effective screw-in length, pull-out and bearing resistance, loads and safety factors must be determined for each individual case according to the materials in use (wood density), plank thickness, angle to wood grain, type of connection, thread penetration depth, climatic region, and others. The recommended screws may not be the perfect choice for all situations. Please consult with EXASUN to select a suitable fastening screw length and alloy.

IMPORTANT: EXASUN cautions against the use of roof flashing materials prone to release metal oxides that may cause irreversible glass stains.

5. BIPV System-Level Tests

- The X-Tile BIPV system was subjected to wind-uplift resistance, weathertightness (wind-driven rain), and exposure to external fire tests according to national and EU standards.
- The Koramic Actua 10 Black Engobe from Wienerberger B.V. is the ceramic tile used during these tests.

6. Certifications and Compliance

6.1 PV Module Qualification

BIPV module was subjected to the PV module qualification according to:

- IEC 61215-1:2016 / EN 61215-1:2016.
- IEC 61215-2:2016 / EN 61215-2:2016.
- IEC 61215-1-1:2016 / EN 61215-1-1:2016.
- IEC 61730-1:2016 / EN IEC 61730-1:2018.
- IEC 61730-2:2016 / EN IEC 61730-2:2018.
- IEC 61701:2022 / EN IEC 61701:2020 (M:6)
- DIN EN ISO 12543-4:2022-03

The X-Tile BIPV system was tested for:

- Wind-uplift resistance acc. to NEN EN 14437:2020 Ontw. and NEN 7250:2021.
- Watertightness (wind-driven rain tests: Combination A and B) performed acc. to NEN 2778:2015 and CEN/TR 15601:2012.
- Exposure to external fire tests acc. to NEN 6063:2019 and CEN/TS 1187:2012.
- Extreme mechanical loading 5400/2400 Pa (Front/Back) acc. to MST 34 IEC 61730-2:2016/ EN IEC 61730-2:2016
- Extreme hail test 55 mm diameter @ 33.9 m/s. acc. to MQT 17 IEC 61215-1:2021/ EN IEC 61215-1:2020
- Proof Tracking Index (PTI): Solid insulating materials tested acc. to IEC 60112.

The BIPV module marking (nameplate – see ANNEX C, and documentation are written based on the IEC 61730-1:2016, the NEN-EN 50380, and the IEC 61215-1:2016 standard.

The BIPV module is compliant with:

- CE Mark: Product assessment in conformity with the relevant EU harmonized legislation. And conform the Low Voltage Directive (LVD) (2014/35/EU) and the norms abovementioned.
- Directive (EU) 2018/849 on circular economy, end-of-life cycle, and management on waste electrical and electronic equipment (WEEE).
- Collection and recycling of Dutch PV modules through the Stichting Organisatie Producentenverantwoordelijkheid E-waste Nederland (Stichting OPEN).

6.2 Relevant Norms

[IEC 61215-1:2016](#) (as amended): Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 1: Test requirements.

[IEC 61215-2:2016](#) (as amended): Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test procedures.

[IEC 61730-1:2016](#) (as amended): Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction.

[IEC 61730-2:2016](#) (as amended): Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing.

[NEN-EN 50583-1:2016](#) (as amended): Photovoltaics in buildings – Part 1: BIPV modules.

[NEN-EN 50583-2:2016](#) (as amended): Photovoltaics in buildings – Part 2: BIPV systems.

[EN 14437:2020 Ontw.](#) (as amended): Determination of the uplift resistance of installed clay or concrete tiles for roofing – Roof system test method.

[NEN 7250:2021](#) (as amended): Solar energy systems – Integration in roofs and facades – Building aspects.

[NEN 2778:2015](#) (as amended): Moisture control in buildings.

[CEN/TR 15601:2012](#) (as amended): Hygrothermal performance of buildings – Resistance to wind-driven rain of roof coverings with discontinuously laid small elements – Test methods.

[NEN 6063:2019](#) (as amended): Test method for external fire exposure to roofs.

[CEN/TS 1187:2012](#) (as amended): Test methods for external fire exposure to roofs.

[NEN-EN 50380:2017](#) (as amended) - Marking and documentation requirements for Photovoltaic Modules.

[EN 62305-1:2010](#) (as amended): Protection against lightning – Part 1: General principles.

[IEC 62561-1:2017](#) (as amended): Lightning protection system components (LPSC) – Part 1: Requirements for connection components.

[EAD 330046-01-0602 \(2016\)](#) – Fastening Screws for Metal Members and Sheeting.

[ETA-17/1005 DoP 1122-1](#) – JD-PLUS self-tapping screws (Screws for use in timber constructions).

[NEN 6707](#) – Fastening of roof coverings – Requirements and determination methods.

[NEN-EN 1991-1-4](#) – Eurocode 1: Loads on structures – part 1-4: General loads – Wind load

ANNEX A – System Installation

The EXASUN X-Tile BIPV roofing system is a watertight fully building-integrated photovoltaic (BIPV) hybrid roofing system that can be used standalone or together with the Actua 10 roof tile.

The following instructions are to ensure proper installation of the basic EXASUN X-Tile components. Please refer to www.exasun.com for a full installation manual for the physical installation with tips and CAD details to ensure a

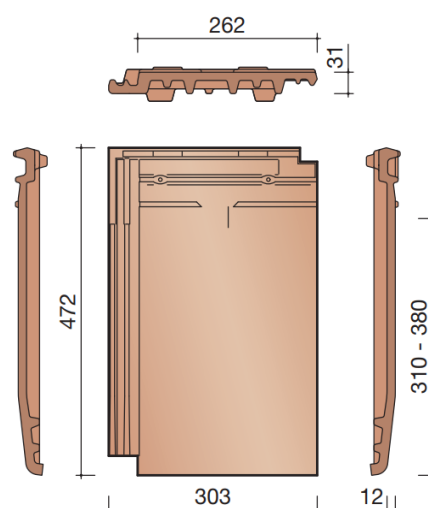
complete and safe mounting of the BIPV-module.

Mounting Guidelines, O&M

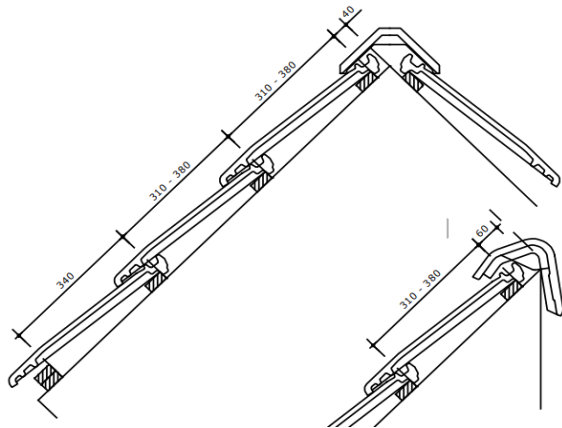
1. The X-Tile BIPV module was designed to interface with the Actua 10 tile roofing system. With the envelop-dimensions of $1308 \times 430 \text{ mm}^2$ the BIPV module allows to replace five ceramic tiles per unit. It can be installed with batten distance ranging between 360-380 mm. Shorter is not possible due to modules covering the cells of the module below.



2. The Actua 10 roof tile envelop-dimensions is of $303 \times 472 \text{ mm}^2$. It requires a batten spacing of 310 to 380 mm and minimum roof pitch angle of 20° .



The Actua 10 has a mass of 4.5 kg and requires 10 to 12.3 tiles/m². Tile specifications are given according to NEN-EN 1304.



3. Before the BIPV modules can be installed, the roof needs to be equipped with a vapour-permeable watertight roofing membrane suitable for use under BIPV systems. Recommended specifications are membrane with min. flammability class of B-s1,d0 (EN 13501-1), working temperature of -40°C to 90°C, and water tightness class of W1.
4. Proper ventilation is essential for the system to function for longer periods of time. Verify a minimum counter batten thickness of 21 mm with a spacing of 600 mm (max.650 mm). Also, the batten minimum thickness is 21 mm. Ventilation at the gutter can be ensured by Wienerberger ventilating roof base profiles. Ventilation at the ridge is provided by using, ventilating Actua 10 roof tiles. The number of which depends on the roof tilt, azimuth, and length. Inform with your local sales person for details.
5. The X-Tile BIPV-modules are removable on a per-module basis, although the standard working order of roof tiles is advised, e.g. from the bottom right to the top left. Ensure that the X-Tile's are surrounded by roof tiles, all of which are fastened with Actua roof tile hooks.
6. When the X-Tile is mounted above a roof tile, an EPDM rubber seal (*Z-profile*) must be installed on the roof tile. Use the stainless steel 4.5 x 60 mm Actua Roof tile screws and the screw holes incorporated in the roof tile

for this. This seal has two functions: ensuring the watertightness and preventing the direct contact between the ceramic-tile and the BIPV module glass. The long screw keeps the roof tiles on the battens, even in extreme wind conditions where the X-Tile batten hook may (temporarily) deform and push the roof tiles below off the batten.

The following steps apply:

- Align the Z-profile with the screw holes of the roof tiles, so, the small ridge in the profiles guides the screw.
- Use Wienerberger's roof tile screws (Stainless steel 4.5 x 60 mm) to fix the Z-profile together with the Actua 10 tile.
- Trim the ends of the Z-profile such that the ceramic-tile interlocks (groove and tongue) interfacing with the X-Tile, are clear from any rubber.
- Ensure that ceramic-tile clearance and alignment are correct. Any set of 5-tiles must match and interlock with the BIPV module(s) installed on the next row.



NOTE: Perform a visual inspection onsite. Ensure that mishandled or damaged panels are not installed in the BIPV roofing system. The replacement of a single or multiple BIPV modules after building construction completion is a costly operation.



7. Use the included batten connectors or batten bracket to fasten the modules to the battens by placing the blocks into the top milled holes of left- and right-side gutter.



8. Before fixing the batten connectors to the batten, X-Tile storm hook needs to be mounted on the milled hole of the right-side gutter of every X-Tile with a rotating motion along its length-axis.

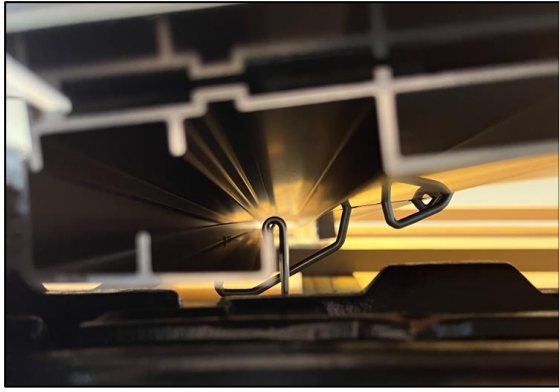
When it is inserted correctly, there is an audible click, and the hook should fit

somewhat loosely in the milled hole. Make sure the ends are properly inserted and secure.



- Tilt the module with the left side forward to carefully place the storm hook behind the roof tile. Then, carefully place the left side of the module back in plane of the roof tiles and slide it to the right up to the desired spacing between the panel and the adjacent roofing element.





9. To fix the batten connectors, ensure that the ceramic-tile is already well fixed into position.

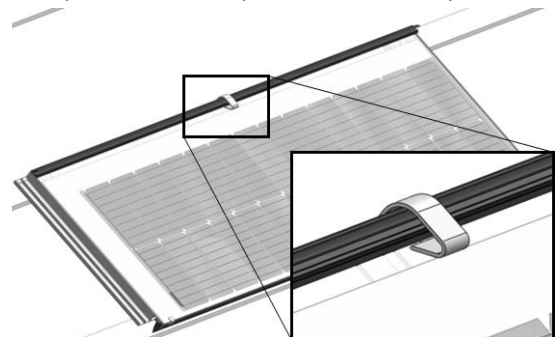
The batten connectors do not need to be screwed in for the installation up to 20 m in wind zones 1, 2, and 3 according to NEN 6707 and NEN-EN 1991-1-4, with the exception of the coastal part of wind zone 1. Here, the batten connectors require a screwed connection to the batten. For this, we recommend the 4.5 x 45 Wienerberger stainless steel roof tile screw, preferably with rubber washer.



Pre-drill the hole to ensure accurate alignment and to avoid the batten splitting. For installations with roof ridges higher than 20 m, consult an contractor regarding wind load calculations.



10. For certain installations, the X-Tiles may show bending in the middle of the module. To keep a fixed distance between the module and the batten, the “Wevolt X-Tile support clip” may be used on an X-Tile where another X-Tile is placed above. For the top row of X-Tiles with roof tiles installed above, use an additional batten instead of the clip. The support clip is installed by positioning it centered on the top edge of the module and pushing it down until it clicks. The flat part at the clip opening should be supporting the rear side of the module, as shown in the figure below. The top rubber seal may be slightly compressed at the position of the clip.



11. Every X-Tile also needs to be secured on the left-side gutter using a panel hook with the accompanying screw.



12. Secure all roof tiles interfacing with X-Tile BIPV modules with the Wienerberger Actua stainless steel roof tile hook. It is an important step to guarantee the proper watertightness and wind-uplift resistance. This is done as follows:

- Place the tile-hook bend around the left edge of roof tile. Slide the tile-hook until it meets the 21 mm wooden batten and nail it up to the thick section of the hook.



- Make sure the tile-hook is under tension. The rubber seal below the BIPV module should be in a slightly compressed mode.



NOTE: It is recommended to slightly compress the top seal (on the lower row of BIPV modules or ceramic-tile) before completely nailing the tile-hook. This ensures the required watertightness and prevents the module from vibrating during severe wind gusts.

- The installer should then slide the hand along and below the module lower edge to ensure that the lip of the sealing rubber remains straight and points outward.



NOTE: The roofing substructure must be such that the tilt angle difference at the transition from BIPV module to the (upper) ceramic-tile row does not result in direct ceramic-tile/glass contact. Direct contact between ceramic-tile and BIPV panel during and after installation must be prevented. Avoid scratching and/or cracking the BIPV module glass.

Glass scratches or microcracks will result in crack grow and propagation. And eventually in radial or concentric fracture depending on the severity of the contact. This in turn may lead to water permeation and safety concerns.



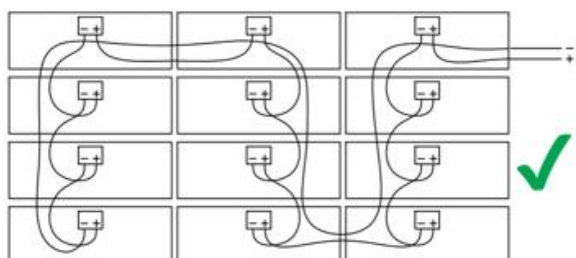
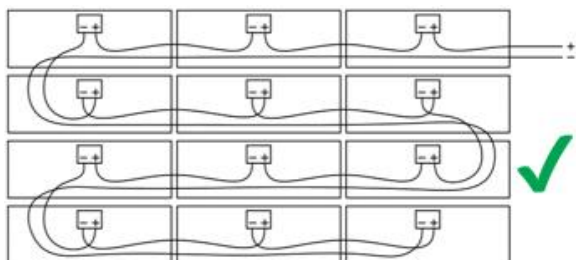
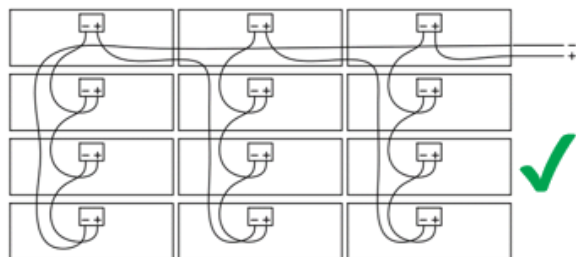
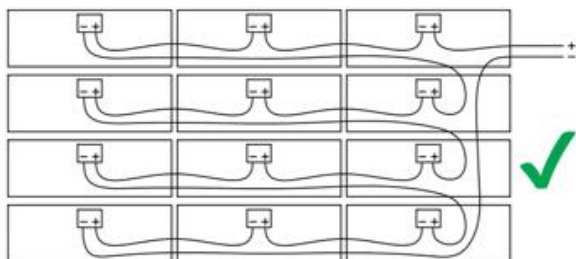
NOTE: Perform a visual inspection onsite. Ensure that mishandled or damaged panels are not installed in the BIPV roofing system. The replacement of a single or multiple BIPV modules after building construction completion is a costly operation.

13. After connecting the MC4 connectors, ensure no connectors are in contact with the roof area. The cables may be strapped to the battens to ensure this. When running DC cabling ensure using the correct crimping tool and matching MC4 connectors on the DC string cabling. Do not exceed the max. V_{sys} while incorporating appropriate safety factors.

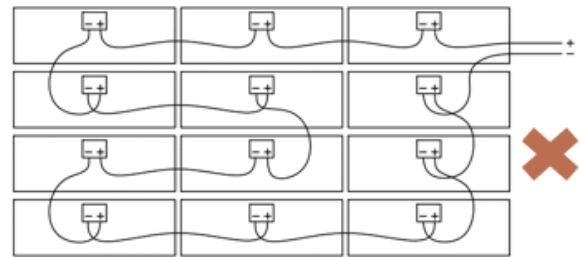


NOTE: Minimize induction loop enclosed area by routing the return wire along the string path. The figures below illustrate good and bad wire routing layouts.

Example of good routing layouts



An example of a bad routing layout



For maintenance or replacement, individual modules can be removed in any given order. Ensure the system uses the DC switch on the inverter. Press the module down to release some of the tile hook pressure on the gutter. Use knife or screwdriver to rotate the hook away from the left-side gutter. Then slide the module upwards. Tilt the module by lifting the left side, then, slide the module out in its entirety. Be aware that the MC4 cables are still connected and verify the system is shut down before disconnecting the cables.

Precautions must be taken to protect the PV system against wildlife, namely:

- Bird screens, guards and bird barriers designed to prevent birds or rodents from nesting underneath the PV roofing system.
- Guards to prevent rodents from chewing the PV cables outer jacket or any other solid-insulating part.

Additional Notes

IMPORTANT: The installer bears responsibility for the installation. Always perform a visual inspection onsite. Ensure that mishandled or damaged panels are not installed in the BIPV roofing system.

For outdoor (fully exposed) screws, screws with a sealing washer and anti-corrosion material must be selected. Acc. EAD 330046-01-0602, fastening screws that are partly/completely exposed to external weather or similar conditions (\geq C2 corrosion acc. to EN ISO 12944-2) must be of stainless steel or protected against corrosion.

Detailed information regarding wind, snow, and other combined actions (loads) on PV modules is given in EN 1991-1-3:

- The Netherlands, Belgium, and France fall within the *Centre West* climatic region.
- Acc. EN 1991-1-4, The Netherlands is divided into 3 wind-load zones (I, II and III) and sub-zones (costal, non-urbanized, and urbanized). Besides the PV module dead load, the builder and installer must consider these different structural factors.
- Use proper PPE gloves:

EN 60903



EN 60903: Live working – Electrical insulating gloves.

NOTE: Insulating gloves **Class 0** (VDC ≤ 1500 V) must be worn to prevent/protect against electrical shock.

Operation and Maintenance (O&M)

- If the BIPV modules become dirty and the module can be accessed safely, it is recommended to clean with water and a lint-free non-abrasive soft cloth.
- When using other cleaning products, ensure its suitability for PV glass. Always make a pre-test in a less visible spot to check whether it may cause harm or result in permanent discoloration.
- Do not use strong cleaning agents that may chemically attack the surface of the glass, create microcracks on plastic parts

or weaken the adhesive of surface mounted parts.

- When cleaning snow, especially for prolonged periods of snowy weather, it is recommended to use a roof rake with a soft rubber squeegee-like head and telescopic handle. However, the best way to remove snow is to let it melt by itself.
- Always ensure that no artificial or natural elements obstruct openings that prevent the cooling of the PV roofing system by natural convection. Natural convection is needed to ensure the long-term stability of the BIPV modules and to obtain the maximum energy yield from the PV system. Ensure a well-ventilated system: Build a sufficiently ventilated ridge and roof base.
- Make sure that condensate water can always escape the roof by gravity drainage such that the water flow reaches the external walls of the building.
- Use PV system monitoring tools to check for any possible system fault. In case of electrical or mechanical intervention, the O&M must be performed by authorized professionals.

WARNING: As a truly BIPV system, the X-Tile roofing system provides the primary barrier against wind and rain. Installation must be performed with the outmost care. Please refer to the complementary information available on the EXASUN website [Downloads](#) section for additional technical details on the PV system installation.

ANNEX B - Cell and Module Interconnection

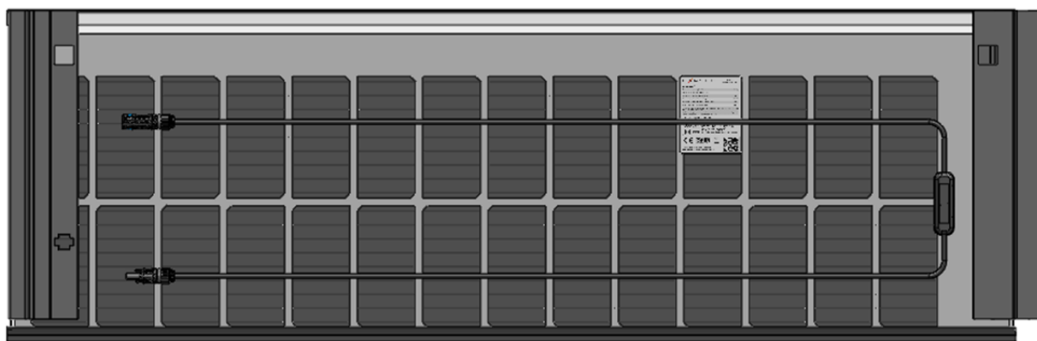
Cell Interconnection: According to the IEC 61215-2:2016 the X-Tile module cell interconnection is classified as *Case S: Series connection of all cells in a single string*. The 28-cell string is protected by a single diode.

- X-Tile BIPV module – Front and back CAD view (not-to-scale).

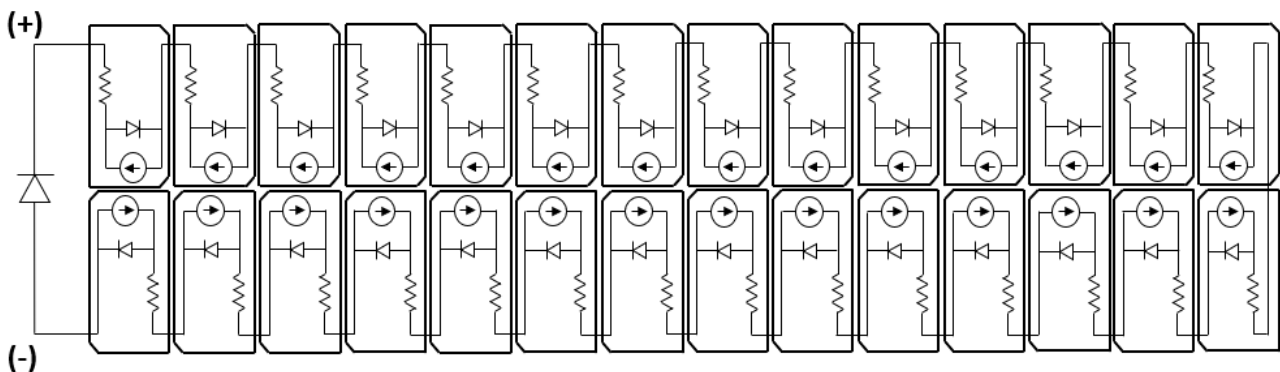
Module Front Side



Module Back Side



- X-Tile BIPV module: Simplified electrical schematic.



X-Tile BIPV Module Interconnection

- For series-connected PV modules the voltages add up. However, the currents do not add up.
- The maximum voltage from N_s series-connected modules in a single string (V_{string}) cannot exceed the system voltage (V_{sys}): $V_{string} \leq V_{sys}$.
- The temperature (T_M)-adjusted V_{OC} , I_{SC} and P_{mpp} are obtained as follows:

$$V_{OC}(T_M, G_{STC}) = V_{OC}(STC)[1 + \beta(T_M - T_{STC})] \quad (1)$$

$$I_{SC}(T_M, G_{STC}) = I_{SC}(STC)[1 + \alpha(T_M - T_{STC})] \quad (2)$$

$$P_{mpp}(T_M, G_{STC}) = P_{mpp}(STC)[1 + \gamma(T_M - T_{STC})] \quad (3)$$

- The maximum series-connected modules ($N_{s,max}$) can be obtained as follows:

$$V_{OC,max} = SF \times V_{OC}[1 + t_{2,up}/100\%] \quad (4)$$

$$N_{s,max} \leq \frac{V_{sys}}{V_{OC,max}} \quad (5)$$

The SF and $t_{2,up}$ values in equation (4) indicate the safety factor, which in this case is 1.25, and the V_{OC} upper tolerance, respectively.

For more accurate calculation of $N_{s,max}$ for a specific location, $V_{OC,max}$ can be obtained by inserting local minimum temperature in equation (1) ($V_{OC,max} = V_{OC}(T_M, G_{STC})$).

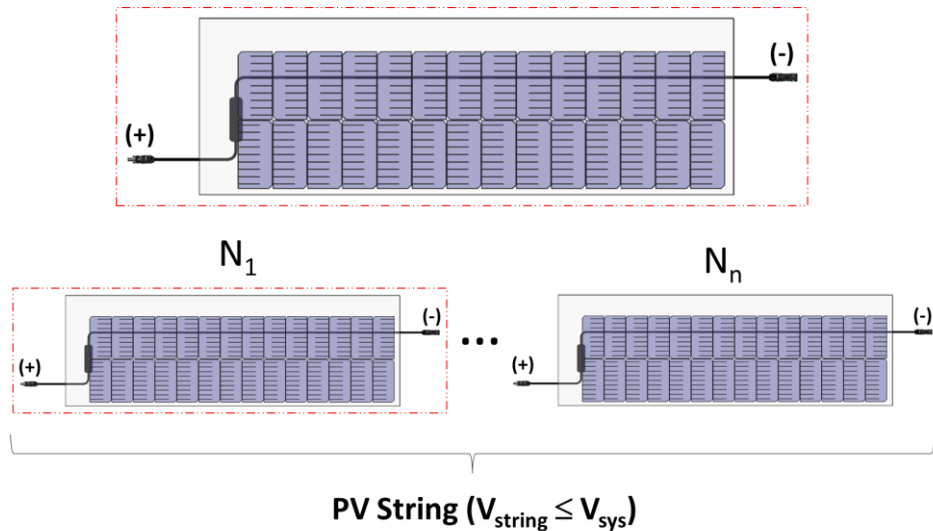
- The temperature-adjusted (T_M) string voltage (V_{string}) and current (I_{string}) must not exceed the inverter specification. ($V_{string} = N_s \times V_{OC}(T_M, G_{STC})$).



WARNING: PV Systems for multifamily solar systems must ensure that the mounting structure and any electrical connection only span over the roof area corresponding to a single family-roof. Ensure that the installation is performed according to local building code regarding fire safety, thermal-, and acoustic properties.



- X-Tile BIPV system: String connection example (front view).



ANNEX C - PV Module Nameplate

The X-Tile BIPV module nameplate (label) is defined according to IEC 61730 and IEC 61215 standards. The image below shows an example of the nameplate for the BIPV module MODEL: **XT028H-085BK-E** with the respective description for each required field.

NOTE: The unique ID used for traceability purposes (place and data of manufacture) is a tamper-proof barcode ID, separated from the main PV module nameplate, that is encapsulated within each PV module laminate.

EXASUN **X-TILE**
XT028H-085BK-E

Electrical Data ^{1,2}	
Rated Power (P_{max}) (± 5%):	85 [W]
Open Circuit Voltage (V_{oc}) (± 1%):	19.5 [V]
Short Circuit Current (I_{sc}) (± 2%):	5.8 [A]
Max. System (DC) Voltage (V_{sys}):	1000 [V]
Electrical Shock Protection (Safety Class):	Class II
Max. Overcurrent Protection Rating:	15 [A]

1) Data given relative to Standard Test Conditions (STC): 1000 W/m², (25 ± 2)°C and AM 1.5, according to IEC 60904-3.

2) Traceability (date and place of manufacture) assured by anti-tampering serial number encapsulated within the PV module laminate.

- Safety Tested (MST) acc. IEC 61730.
- Qualification (MQT) acc. IEC 61215.

WARNING: Risk of electrical shock!

- Unit outputs HV even at low light conditions.
- Do not disconnect under load.
- Handling only by qualified personnel.
- Use approved-only MC4 electrical connectors.

CE partner van stichting **OPEN** e-waste opgelost

Laan van Ypenburg 122, 2497 GC The Hague **1663061458**

BIPV MADE IN THE NETHERLANDS

QR Code

Labels and Markings:

- Name, registered trade name.** (EXASUN)
- Type or model number designation.** (XT028H-085BK-E)
- Module maximum power (P_{max}), including binning and tolerances.** (85 [W])
- Voltage at open-circuit (V_{oc}), including tolerances.** (19.5 [V])
- Current at short-circuit (I_{sc}), including tolerances.** (5.8 [A])
- Maximum system voltage (V_{sys}).** (1000 [V])
- Class of protection against electrical shock (acc. to IEC61140 and IEC 61730-1).** (Class II)
- IEC 61730-1: Max. Overcurrent Protection Rating (OCP) (verified by MST.26).** (15 [A])
- Statement: Elec. Data shown relative to STC conditions.**
- Date and place of manufacture (or statement regarding traceability).**
- IEC 50380-2017: Reference to all relevant certificates (acc. to EN 45011) for safe installation and use.**
- For Class II: The warning symbol (IEC 60417-6042) and message must be included.**
- Other symbols include:**
 - IEC 60417-5172 (Class II equipment).
 - IEC 60417-6070 (Do not disconnected under load).
 - IEC 60417-6070 (Direct current).
- QR code encoding a URL link to a specific PV module product listed on the website.**
- Label reference number.** (1663061458)
- Relevant logos:**
 - CE marking: indicates that the PV module fulfills the requirements acc. to relevant European product directives, quality and safety standards.
 - Affiliated with Stichting Organisatie Producentenverantwoordelijkheid E-waste Nederland (Stichting OPEN) as of March 2021.