

Installation Guide

for Terran Generon solar rooftiles



GENERON
Make your roof ready for the sun





Valid from: January 1, 2024.

All previously issued Installation Guide for Terran solar rooftiles are hereby superseded.

This guide conforms to specifications and regulations in force in Hungary in August 21, 2023. Users are responsible for conformance to specifications and regulations in force in their own region.

Note: The manufacturer reserves the right to technical changes. Not responsible for damages arising from printing errors. Design, planning or installation guides provided by Terrán Tetőcserép Gyártó Ltd. are not intended to replace professional supervision of construction and do not exempt the architect, designer and builder from liability for any specific building.

terran-generon.com

1. THE ROOF IS THE APEX OF THE HOUSE IN SOLAR TECHNOLOGY, TOO	4
2. WHY TERRAN IS THE BEST CHOICE	5
3. PRODUCT SPECIFICATIONS	6
3.1 General information	6
3.2 Technical data	6
4. APPLICATION TECHNIQUES	10
4.1 Principles	10
4.1.1 Areas of application	10
4.1.2 Efficiency, orientation	10
4.1.3 Location	11
4.1.4 Construction	12
4.1.5 Roof surface requirement, extra weight, roof structure load	13
4.1.6 Energy storage	13
4.1.7 Failure	13
4.1.8 Safety regulations	13
4.2 Roofing	13
4.2.1 General information	13
4.2.2 Waterproof, rainproof cover	14
4.2.3 Terran Generon design and application requirements	14
4.2.4 Underlayment and underlayment insulation planning	15
4.2.5 Underlayment and underlayment insulation design	15
4.2.6 Coverage	18
4.2.7 Attaching the tiles	18
4.2.8 Battens	19
4.2.9 Coverage width and length, batten distance	20
4.2.10 Spacer	20
4.2.11 Cable routing	20
4.2.12 Ventilation	20
4.2.13 Snow retardation	21
4.2.14 Eaves and ridge nodes design	22
5. ELECTRICAL PLANNING AND INSTALLATION	23
5.1 General information	23
5.2 Technical data	23
5.3 Rectifier diodes	23
5.4 Junction box	23
5.5 Inverter types to be used	23
5.6 Safety regulations	24
5.7 Installation	25
5.7.1 Connection of Generon products	25
5.7.2 Serial connection	25
5.7.3 Fault protection	25
5.7.4 Air circulation	26
5.8 Maintenance	26
5.8.1 Periodic cleaning	26
5.8.2 Visual inspection	26

1. The roof is the apex of the house in solar technology, too

ENERGY EFFICIENT, AESTHETIC SOLUTION FROM TERRAN



AESTHETIC

Tasteful and stylish solution without compromise.

Aesthetic, eco-friendly solution without compromise. The GENERON roof tile is a revolutionary innovation in professional application of 21st century technologies.



INTEGRATED

Protection and renewable energy under one roof.

What makes Terran Generon solar roof tiles unique is the special way the solar cells are integrated with the surface of the roof tile so their installation and appearance is almost identical to traditional roof tiles. All this while ensuring the original protective function of the roof.



SYSTEMATIC

Roofing and solar energy production in one.

A successful blend of Terran's century of roof tile manufacturing experience with modern technology. The goal of Generon's development was to produce an aesthetic, eco-friendly and efficient energy producing roof system without compromise.



SIMPLE

Easy, effective, fast and safe installation.

This is how Terran Generon becomes a solar roof!

GENERON

Make your roof ready for the sun



2. Why Terran is the best choice



100 years of experience

Close to a century of experience and knowledge taught us to make exceptional quality roof tiles, about 95 million pieces annually.

modern manufacturing technology

We manufacture our roof tiles with Central Europe's most modern technologies and market them in 9 countries.

leader in roof tile manufacturing

In Hungary alone, nearly 26.000 families choose Terran roof tiles for their roofing needs.

robotics

We have automated our factory in Boly using robotic technologies.

eco-friendly

Terran's commitment is evidenced by the solar farm built in Boly which supplies the entire plant's electric energy needs.

warranty

We stand behind our Generon solar roof tiles with a 25-year product and performance (80%) guarantee. As a first among Hungarian roof tile manufacturers, we offer a 50-year warranty for our other concrete roof tiles. Details are found under General Terms and Conditions.

natural raw materials

We use natural raw materials (water, iron oxide, cement and sand) of exceptional quality to make our roof tiles.

wide product range

Broad selection of colors and form factors are available, in 4 form factors, 4 surface treatment options and countless colors.

domestic brand, international standards

100% Hungarian family-owned Terran brand is known and renowned in 9 countries.

innovation

The experience of the past, the technology of the future. We strive to offer you the best possible solution for a dependable, safe, long-lasting and energy-efficient roof.

trusted brand

In addition to the growing number of satisfied customers, we have received numerous professional distinctions recently: Construma Grand Prize, BestBuy Award, or the Hungarian- (six times) and SuperBrands (twice) recognitions.

3. Product specifications

3.1 General description

The solar cell integrated into the roof covering surface (IN-ROOF) offers a unique solution for both roof tile and solar energy. A solar module is attached to each roof tile with a special adhesive; thus, the appearance and installation is almost identical to traditional roof tiles.

The photovoltaic system's features:

- installation doesn't require separate support or frame
- puncturing the roof tile is not needed, so waterproofing is completely ensured

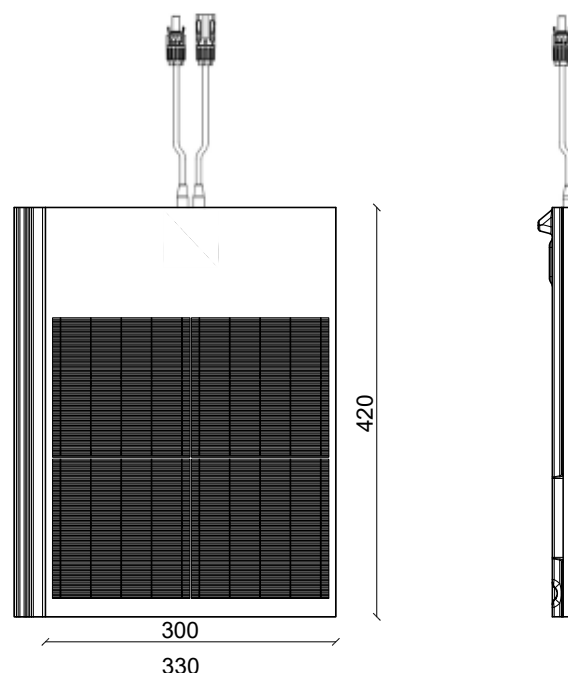
- negligible increase in the load on the roof structure
- simple, efficient and safe installation
- excellent energy production even in case of low light or high temperature
- low failure rates
- can be connected to the grid or operated off-line
- aesthetic, uniform roof line, great curb appeal

3.2 Technical data

3.2.1. Generon DARK, compatible with Zenit Max

Solar concrete roof tile	
Dimensions	330 x 420 mm
Product weight	6,10 kg
Coverage width	300 mm
Base product	High-density colored concrete element
Harmonized technical standard	EN 490:2011
Mechanical strength	> 1200 N
Watertight	> 20 hours
Certificate of fire protection	B-s1, d0 MSZ EN 13501-1:2007+A1:2010
Behavior against external fire	B _{roof} (t1) MSZ EN 13501-5:2005+A1:2010

Photovoltaic module	
Cell type	Monocrystalline
Front cover	3.2 mm hardened solar glass, highly transparent
Nominal performance	15,5 Wp
Current at nominal Power	7,14 A
Voltage at nominal Power	2,17 V
Current at short-circuit	7,83 A
Voltage at open-circuit	2,77 V
Number of cells	4
Cabling	520 mm long, 4 mm ² solar cable with PV4 connector

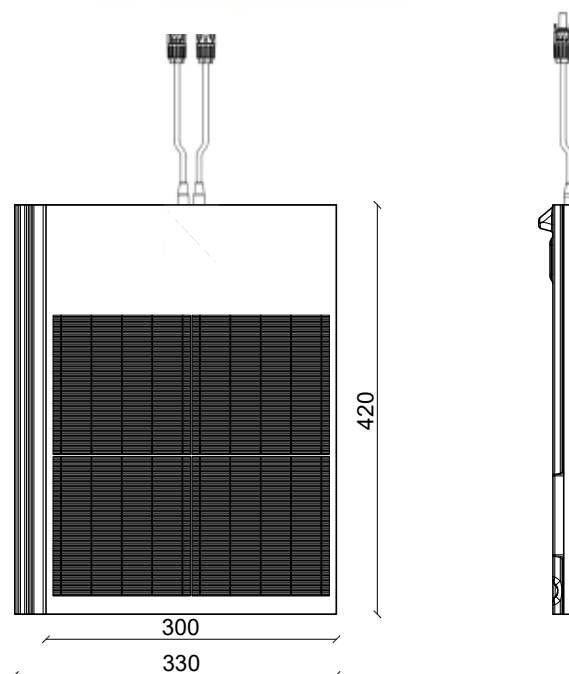


3. Product specifications

3.2.2. Generon RED, compatible with Zenit Max

Solar concrete roof tile	
Dimensions	330 x 420 mm
Product weight	6,10 kg
Coverage width	300 mm
Base product	High-density colored concrete element
Harmonized technical standard	EN 490:2011
Mechanical strength	> 1200 N
Watertight	> 20 hours
Certificate of fire protection	B-s1, d0 MSZ EN 13501-1:2007+A1:2010
Behavior against external fire	B _{roof} (t1) MSZ EN 13501-5:2005+A1:2010

Photovoltaic module	
Cell type	Monocrystalline
Front cover	3.2 mm hardened solar glass, highly transparent
Nominal performance	10,5 Wp
Current at nominal Power	5,14 A
Voltage at nominal Power	2,17 V
Current at short-circuit	5,71 A
Voltage at open-circuit	2,77 V
Number of cells	4
Cabling	520 mm long, 4 mm ² solar cable with PV4 connector



3. Product specifications

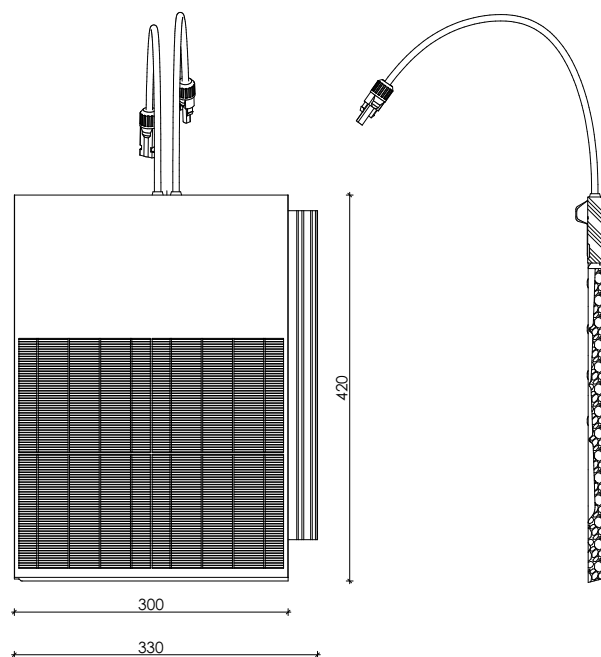
3.2.3. Generon DARK, compatible with Rundo

Solar concrete roof tile

Dimensions	330 x 420 mm
Product weight	5.90 kg
Coverage width	300 mm
Base product	High-density colored concrete element
Harmonized technical standard	EN 490:2011
Mechanical strength	> 1200 N
Watertight	> 20 hours
Certificate of fire protection	B-s1, d0 MSZ EN 13501-1:2007+A1:2010
Behavior against external fire	B _{roof} (t1) MSZ EN 13501-5:2005+A1:2010

Photovoltaic module

Cell type	Monocrystalline
Front cover	3.2 mm hardened solar glass, highly transparent
Nominal performance	15,0 Wp
Current at nominal Power	6.52 A
Voltage at nominal Power	2.31 V
Current at short-circuit	7,31 A ±5%
Voltage at open-circuit	2,73 V ±5%
Number of cells	4
Cabling	520 mm long, 4 mm ² solar cable with PV4 connector



3. Product specifications

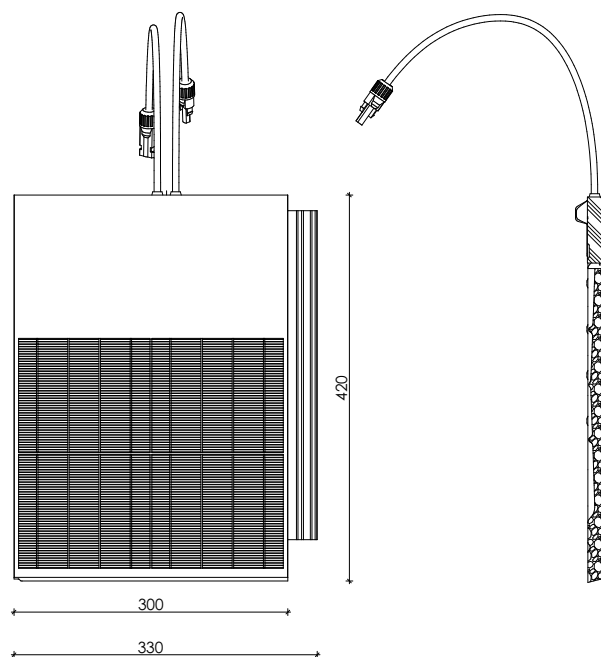
3.2.4. Generon RED, compatible with Rundo

Solar concrete roof tile

Dimensions	330 x 420 mm
Product weight	5.90 kg
Coverage width	300 mm
Base product	High-density colored concrete element
Harmonized technical standard	EN 490:2011
Mechanical strength	> 1200 N
Watertight	> 20 hours
Certificate of fire protection	B-s1, d0 MSZ EN 13501-1:2007+A1:2010
Behavior against external fire	B _{roof} (t1) MSZ EN 13501-5:2005+A1:2010

Photovoltaic module

Cell type	Monocrystalline
Front cover	3.2 mm hardened solar glass, highly transparent
Nominal performance	10,0 Wp
Current at nominal Power	4,69 A
Voltage at nominal Power	2,21 V
Current at short-circuit	5,11 A
Voltage at open-circuit	2,72 V
Number of cells	4
Cabling	520 mm long, 4 mm ² solar cable with PV4 connector



4. Application Techniques

4.1 Principles

4.1.1 Areas of application

This building product is intended as roof covering for outdoor raised-roof residential, commercial and public buildings. It also generates electricity. The result is an eco-friendly, energy producing roof which on top of its aesthetic appeal, is

technically superior, environmentally friendly, cost-efficient and easy to install.

4.1.2 Efficiency, orientation

The efficiency of the system is similar to the efficiency of traditional solar panels and the same principles apply to their orientation.

The optimal annual energy production in Hungary is with a due south orientation and a 35° roof pitch.

	W	SW	S	SE	E
20°	0.84	0.93	0.97	0.93	0.84
25°	0.83	0.94	0.99	0.94	0.83
30°	0.82	0.95	0.99	0.95	0.82
35°	0.80	0.94	1.00	0.94	0.80
40°	0.79	0.93	0.99	0.93	0.79
45°	0.77	0.92	0.99	0.92	0.77

The table shows the efficiency percentage relative to due south orientation and 35° roof pitch.

The exact amount of usable solar energy depends on the location within the country, the orientation and pitch of the roof.

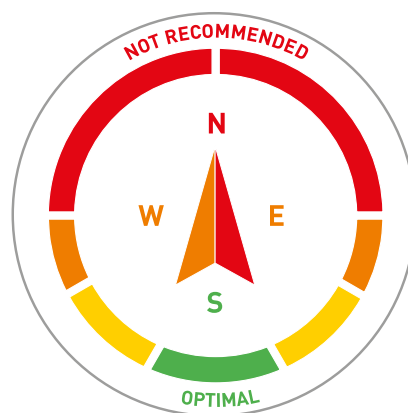
As a rough estimate, an ideally oriented 1 kWp capacity solar installation can generate close to 1100 kWh of electric energy.

1 kWp solar cell → 1100 kWh/year

In the southern or northern regions of Hungary, a ±10% deviation can be seen.

The solar cells don't work in the shade, however shade covering a part of the system does not disable the system.

This amount of energy can be generated by a Generon D4RK system with 1 kWp output and optimal orientation in Hungarian conditions on approximately 6–6,4 square meters of roof area.

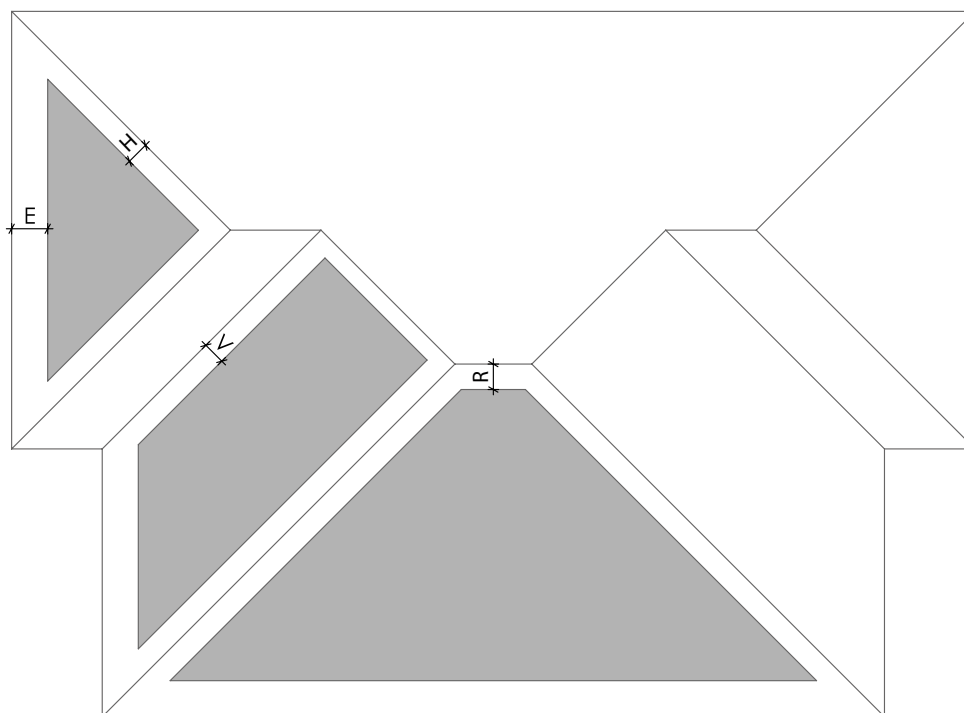


4. Application Techniques

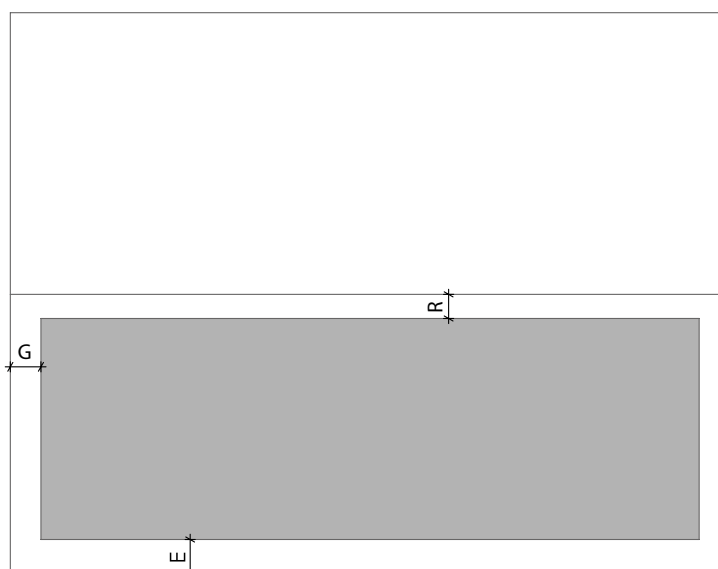
4.1.3 Orientation

4.1.3.1 Conceptual layout

Terran Generon can be installed on roof sections that have acceptable orientation and pitch. Appropriate distances must be kept from eaves, hips, ridges, gables and valleys.



	Roof part	Tile rows	Distance
E	Eaves	3	84 - 93 cm
H	Hips	1.5 - 2	45 - 60 cm
R	Ridges	2	56 - 62 cm
V	Valleys	1.5 - 2	45 - 60 cm
G	Gable ends	1.5 - 2	45 - 60 cm

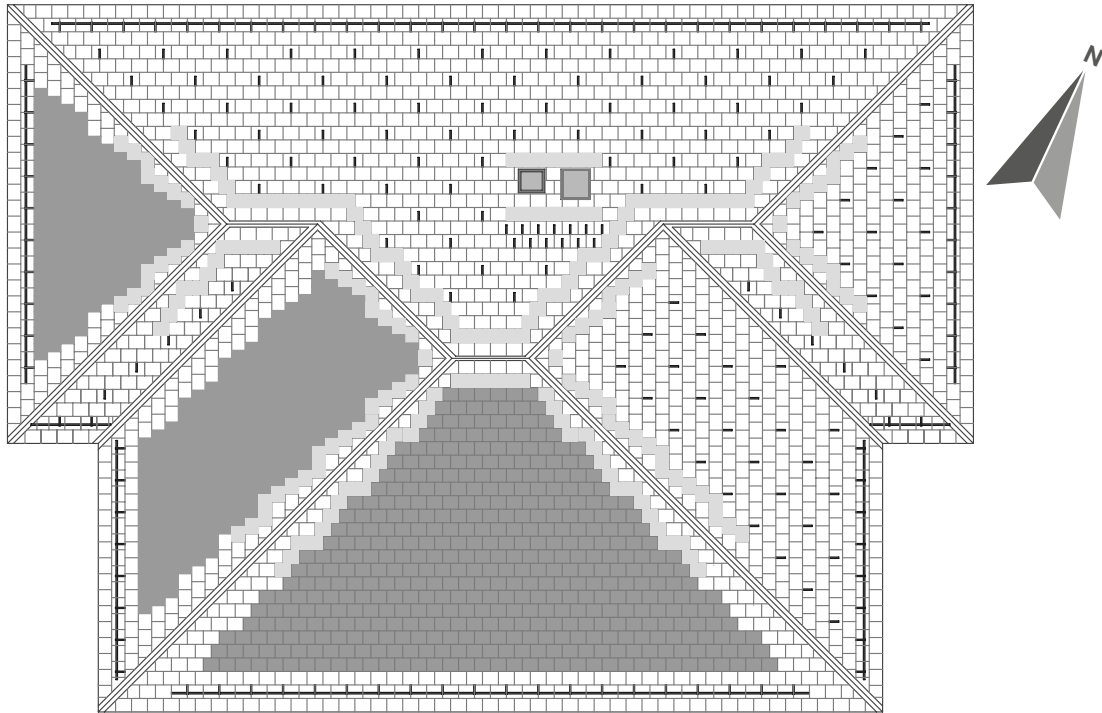


4. Application Techniques

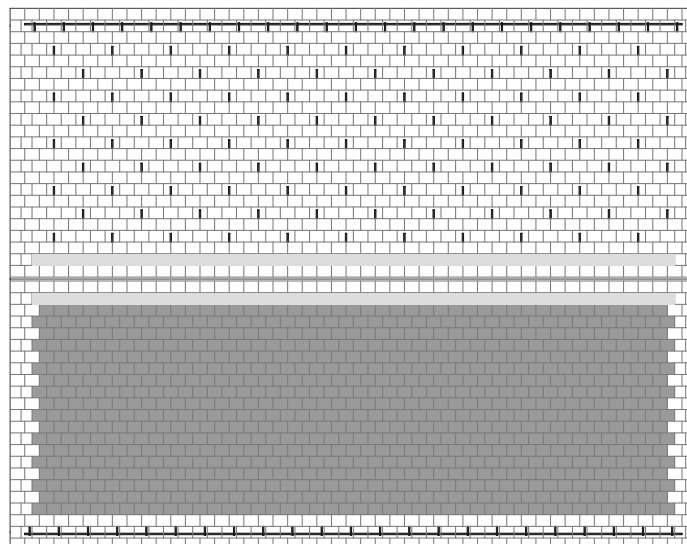
4.1.3.2 Layout

It is essential to plan the layout of the tiles to ensure accurate placement. Room must be provided for snow stops, vent

pipes and cut tiles. Care must be taken to select the appropriate batten distance as defined under 4.2.1. below.



-  Generon, solar roof tile
-  Terran Zenit Max roof tile
-  Snow stops
-  Snow rails
-  Air vent tiles



4.1.4 Installation

Terran Generon solar cells can only be used with flat surface Terran Zenit Max and Rundo roof tiles.

During installation it is essential to properly connect the solar modules and the electrical system. Connection to the electrical circuit is subject to proper authorization. The electrical connection plan is prepared by a licensed electrical engineer. The installation is identical to the methods used for traditional roof tiles. For flat

surface, grooved products a minimal roof pitch of 30 degrees is needed to ensure waterproofing (rainproofing), although with the proper selection of underlayment these can be used with lower roof pitch, strictly adhering to the guidelines for roof underlayment (see 4.2.3.). When replacing Zenit Max or Rundo tiles, spacers (with connections) must be installed.

4. Application Techniques

4.1.5 Roof coverage requirement, excess weight, roof structure load

The Terran system is similar in efficiency with over-the-roof systems, thus a similar roof area is needed to get similar performance.

A 4 kWp system would supply an average household in Hungary, for which, in case of ideal orientation, a 24–26 m² surface area of Terran Generon Dark solar roof tiles is adequate.

With Terran solar roof tiles, the surface coverage is identical to material used in other areas of the roof. There is no

need to install additional battens. Generon does not add any meaningful weight to the roof, does not break the roof's aesthetic lines and projects a consistent roof texture.

The above information applies to an ideal southern orientation and a 35 degree inclination. In conditions that deviate from ideal conditions, the energy yield of a PV system must be estimated using the correction factor according to point 4.1.2.

4.1.6 Energy storage

Similar to other systems, the Terran solar roof feeds into the electrical system, for which authorization is needed from the electricity supplier (utility or electric company). Measurement is with a bidirectional electric meter.

It is technically possible to operate Generon “off-grid”, or in isolation, independent of an electric supplier, however at present the battery technology makes this approach significantly more expensive.

4.1.7 Failure

In case of failure, the failing element can be replaced with an element of the same size. The system is designed so that the failure or partial shadow of a single element does not

cause a failure of the entire system, it remains operational until the failing element is replaced.

4.1.8 Safety requirements

During installation, the roofing as well as the electrical installation rules must be obeyed. Sunlight causes the start of electric current generation. In case of improper or careless installation, the risk of electrical shock exists. The voltage can be as high as 1000 V with significant current. Due to

the nature of direct current, the danger of electric shock is higher than one caused by alternating current. Thus, the cable connections must be performed by a professional, solar-trained electrician.

Additional warnings are under 5.5. Safety requirements.

4.2 Roofing

For questions related to roofing not covered here, the guidelines of the Terran Application Notes apply.

4.2.1 General information

Terran Generon is only available on flat surface roof tiles in the Zenit Max or Rundo product families. The base material is colored concrete with special surface protection applied. Prior to installing Zenit Max or Rundo tiles, the silicon backing strip must be removed to ensure a pre-

cise fit. The tiles must be installed by replacing the spacers (at connections). Current information about available colors and products are shown on the Price List.

4. Application Techniques

4.2.1.1. In case of covering with Rundo roof tiles

General information					
Batten size		min. 30/50 mm (at most in case of 80 cm rafter beam distance) min. 40/60 mm (in case of 30-100 cm rafter beam distance)			
Coverage length, batten distance		min. 285 mm (regardless of pitch), max. 310 mm (depending on pitch)			
Side overlap		30 mm			
Top overlap		min. 110 mm (regardless of pitch), max. 140 mm (depending on pitch)			
Mode of attachment		vidi poglavlje			
Roof pitch	Minimum overlap	Batten distance	Tiles needed (pcs/m ²)	Generon weight (kg/roof m ²)	Tömeg Rundo (kg/roof m ²)
45–60°	11 cm	28,5 – 31 cm	10,75	61,28	47,30
35–45°	12 cm	28,5 – 30 cm	11,11	63,33	48,88
30–35°	13 cm	28,5 – 29 cm	11,49	65,49	50,56
below 30°			not applicable		

For specific roof pitch, detailed requirements for underlayment can be found under 4.2.3.

4.2.1.2. In case of covering with Zenit Max roof tiles

General information					
Batten size		min. 30/50 mm (at most in case of 80 cm rafter beam distance) min. 40/60 mm (in case of 30-100 cm rafter beam distance)			
Coverage length, batten distance		min. 315 mm (regardless of pitch), max. 340 mm (depending on pitch)			
Side overlap		30 mm			
Top overlap		min. 80 mm (regardless of pitch) max. 105 mm (depending on pitch)			
Mode of attachment		vidi poglavlje			
Roof pitch	Minimum overlap	Batten distance	Tiles needed (pcs/m ²)	Generon weight (kg/roof m ²)	Tömeg Zenit Max (kg/roof m ²)
over 35°	8 cm	31,5 – 34,0 cm	9,80	59,78	49,98
25–35°	9,5 cm	31,5 – 32,5 cm	10,26	62,59	52,33
20–25°	10,5 cm	31,5 – 31,5 cm	10,58	64,54	53,96
below 20°			not applicable		

For specific roof pitch, detailed requirements for underlayment can be found under 4.2.3.

4.2.2 Water- and rainproof roofing

Roof tiles create a waterproof and rainproof shell. Depending on the type of tile, waterproofing can be ensured for each specific roof pitch angle (α_k) and higher. The waterproof, rainproof roof is such that during rapid water flow, meaningful precipitation cannot get under it under normal circumstances (Dr. Laszlo Gabor: Building structures III.). In other words, a certain amount of precipitation (rain torrent, powdered snow) can get under the shell as a result of wind pressure, then it naturally evaporates through ventilation. Its temporary presence does not damage the roof. We impose

additional requirements for the underlayment if any of the following factors are present:

- finished or unfinished mansard or attic;
- composite roof profile;
- rafter longer than 10 meters;
- unusual weather (snow, wind, powdery snow);
- special purpose interior space.

In case of multiple factors, higher grade of underlayment is recommended as per the underlayment guidelines.

4. Application Techniques

4.2.3 Terran Generon planning and application requirements

Flat profile, grooved Terran Generon solar tiles require a minimum pitch of 30 degrees to ensure waterproofing (rain-proofing). Lower pitched roof can be covered by selecting the proper underlayment strictly adhering to the underlayment

guidelines. **Generon cannot be used with a roof pitch below 20 degrees even with the use of accessories.**

Roof pitch (α)	Without usage factors	One additional usage factor	Two additional usage factors	$\geq$ three additional usage factors
$\alpha \geq 30^\circ$	—	free-hanging underlayment	free-hanging underlayment	free overlap underlayment
$30^\circ > \alpha \geq 24^\circ$ *	free-hanging underlayment	free-hanging underlayment	free overlap underlayment	windproof underlayment
$24^\circ > \alpha \geq 20^\circ$ *	watertight insulation	waterproof insulation	waterproof insulation	waterproof insulation
$\alpha < 20^\circ$	not applicable			

* Not applicable for Rundo

4.2.4 Planning for underlayment, insulation

4.2.4.1 General requirements

It is imperative, that in case of all finished mansards and attics, appropriate underlayment and insulation be installed. Only construction grade underlayment may be installed. For Terran roofs, MediFol underlayment products are recommended.

Underlayment or underlayment insulation must be specified during planning. Design support is offered by the Underlayment Planning and Installation Guidelines (ÉMSZ) and the manufacturer's application notes. Deviation from the planned underlayment or underlay-

ment insulation is permitted only with prior approval of the architect, documentation of the change in the construction log, and in accordance with prevailing regulations.

Underlayment and underlayment insulation must be protected from UV radiation, exposure must be limited. The shell is ideally installed shortly after installing the underlayment.

4.2.4.2 Grades of underlayment, underlayment insulation

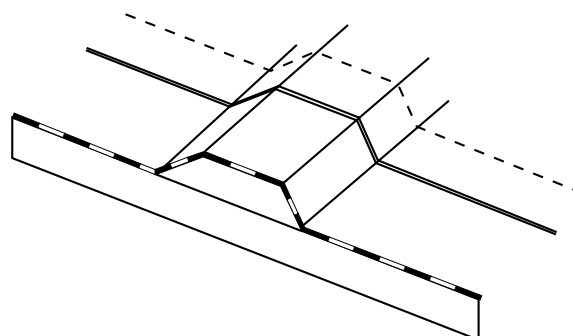
Free-hanging underlayment: Suspended underlayment laid loosely over the rafters without a base, or other solution in accordance with the applicable regulations.

Free overlap underlayment: For a full-surface substrate (e.g. decking or step-resistant thermal insulation), a free-hanging underlayment or other solution in accordance with the applicable regulations.

Windproof underlayment: For full-surface substrates (e.g. decking, or step-resistant thermal insulation), a welded, glued or stuffed with sealed overlap, or other solution conforming to applicable regulations is acceptable.

Waterproof underlayment: Bituminous or plastic sheet laid under the battens on a full-surface base with waterproof connections. A nail sealing tape must be placed under the battens to ensure watertightness.

Waterproof underlayment insulation: Bituminous or plastic sheet made with waterproof connections is laid under the battens over the whole surface.



Waterproof underlayment insulation installation (ÉMSZ 2006)

4. Application Techniques

4.2.5 Underlayment, underlayment insulation planning

Only approved construction-grade materials are permitted to be designed and installed for roof substructure. Minimize the exposure of the underlayment and underlayment insula-

tion to ultraviolet radiation, regardless of the manufacturer's statement about months of UV resistance.

4.2.5.1 Underlayment

Vapor-permeable films may come in contact with building structures sensitive to moisture due to the special fabric that allows vapor to permeate over its entire surface.

Advantages of vapor-permeable (diffusion) film:

- The otherwise required air gap between the foil and the thermal insulation is not needed.

- The gap between the rafters can be completely filled with insulation.
- The foil can be applied without break over hips, ridges and valleys, if the insulation alignment allows it.
- Installation around roof openings (chimney, skylight, air pipe, etc.) is simpler and thus less error-prone.

4.2.5.2 Types of Underlayment

MediFol Generon LONGLIFE Plus

Can be laid directly on decking or thermal insulation, multilayer vapor-permeable with HDPE membrane, watertight barrier with self-adhesive tape backing. High heat resistance (+100°C).



Width	1.50 m
Roll length	50 m
Roll area	75 m ²
Material required	roof m ² + 15%
Material	High Density Polyethylene (HDPE)
Fastening	nailed to battens
Tensile strength	345 N/290 N/50 mm
Weight	148 g/m ²
Color	grey
Sd value	~0.03 m
Heat resistance	-40 °C – +100 °C
Watertightness	W1

MediFol TOP270

Recommended primarily for low pitch roofs. It can be laid directly on the decking or thermal insulation. Three-layer vapor-permeable underlayment. It can also be used as a watertight underlayment insulation provided that the roof pitch is within the manufacturer's specifications ($\alpha \geq \alpha_k - 10^\circ$).



Width	1.50 m
Roll length	25 m
Roll area	37.5 m ²
Material required	roof m ² + 15%
Material	polyester fleece with water-repellent coating
Fastening	nailed to battens
Tensile strength	320 N/200 N/50 mm
Weight	270 g/m ²
Color	grey
Sd value	~0.02 m
Heat resistance	-40 °C – +100 °C
Watertightness	W1

4. Application Techniques

MediFol SILVER

Can be laid directly on decking or thermal insulation. Monolithic polyurethane membrane encapsulated by three-layer, water-resistant vapor-permeable underlayment with self-adhesive tape backing. High heat resistance (+100°C).



Width	1.50 m
Roll length	25 m
Roll area	37.5 m ²
Material required	roof m ² + 15%
Material	monolithic polyurethane membrane
Fastening	nailed to battens
Tensile strength	500 N/420 N/50 mm
Weight	230 g/m ²
Color	salmon
Sd value	~0.1 m
Heat resistance	-40 °C – +100 °C
Watertightness	W1

MediFol EXTREME

It can also be used as a watertight underlayment insulation provided that the roof pitch is within the manufacturer's specifications ($\alpha \geq 10^\circ$).

The overlaps must be connected by hot air welding or a cold solvent solution. Extreme welding tape must be applied above the counterbattens. Care must be taken to ensure that the counterbatten is made of dry material.



Width	1.50 m
Roll length	25 m
Roll area	37.5 m ²
Material required	roof m ² + 15%
Material	thermoplastic polyurethane
Fastening	nailed to battens
Tensile strength	420 N/490 N/50 mm
Weight	360 g/m ²
Color	black
Sd value	~0.2 m
Heat resistance	-40 °C – +80 °C
Watertightness	W1



4. Application Techniques

4.2.6 Layout

Terran Generon solar cell roof covering must be installed with spacers (connected). The offset in case of Zenit Max is one half and in case of Rundo, one quarter tile width. Along the eaves, the ridges, the valleys, the wall and gable

ends 1,5-3 rows of tiles must be covered with elements of the Zenit Max or Rundo product lines as detailed in point 4.1.3.1. **Solar roof tiles must NOT be cut.** When tiles need to be cut, use matching Zenit Max or Rundo roof tiles.



4.2.7 Tile Fastening

Drilling or screwing Terran Generon solar roof tiles is not permitted. When using Zenit Max or Rundo tiles, screwing must be according to the following. Terran Generon integrated with Zenit Max or Rundo tiles must conform to storm safety regulations.

Storm resistance of concrete tile roof coverings – in case of roof pitch not exceeding 45 degrees – is excellent even without special fastening. Depending on geography and the building's geometry, it may occasionally be necessary to use fasteners over the surface of a lower pitch roof. In places where the weight of the concrete tile does not provide sufficient loading force against the lifting effect of the wind, the tiles shall be secured with corrosion-resistant fasteners. The relevant standard for fastening is the EUROCODE series of standards, MSZ EN 1991-1-4 (Effects on load-bearing structures; parts 1-4: Wind effect).

The edges and corners are considered critical zones for wind. The lifting force from wind eddies can also be critical on hip roof surfaces, along valleys, and around roof superstructures (skylight, dormer, chimney, etc.)

Regardless of roof pitch, tiles along the eaves, hip, ridge, saddle or half saddle, as well as adjoining tiles, must be fastened. In all cases, cut tiles must be fastened.

At the eaves, the lifting force of the wind acting on the tiles must be reduced by lower decking, in addition, it is necessary to secure the eaves tiles with storm clips and eaves clips, possibly by screwing. The situation is particularly unfavorable for mansard roofs where the angle of pitch changes, so the edge tiles of the lower pitch section must also be fastened.

Fastening can be done with corrosion-resistant storm clips, eaves clips, screws or a combination of these. Nailing should be avoided. The screw diameter is min. 4.5 mm. Screws must be driven into the slat at least 24 mm. Storm clips or eaves clips (storm clips „E”) made of stainless steel or alloys (e.g. zinc-aluminum alloys) must be used. When storm clips and eaves clips are used together, the securing force is increased in the lower part of the tile, which is usually a statically better solution compared to screwing, and its maintenance is easier. However, above an angle of pitch of 60 degrees, screwing cannot be completely avoided.

4. Application Techniques

4.2.7.1 Storm clip GZR and MX

The storm clip GZR ensures storm proofing by attaching to the battens as well as snapping into Terran Generon's side drain groove. The material is a zinc-aluminum alloy. It can be used with batten thickness of 30/50 mm and 40/60 mm, respectively.

The MX parts should be used for Zenit Max and the GZR parts for Rundo.



4.2.8 Slats

4.2.8.1 Battens

The roof battens used must comply with MSZ 17300/2 for 1st Class quality. Sawn timber must be of good quality, robust and free from damage. Chemical protection is also needed against insects and fungi.

In addition to the quality of the roof battens, its cross-section is most important, as inadequate cross-section may cause the batten to bend between the rafters, causing aesthetic and structural problems.



4.2.8.2 Counterbatten, ventilated air gap

To ensure adequate air flow between the shell and the underlayment, counterbatten must be used. Terran Generon requires a minimum of 7.5 cm air gap.

The volume of air flow diminishes as the angle of the roof pitch decreases or as the length of the rafters increases.

The less favorable flow technology situation must be compensated for by further increasing the thickness of the ventilated air layer.



4. Application Techniques

4.2.9 Coverage width and length, slat distance

Cover width is the width covered by a roof tile. The deck width can be determined based on the number of roof tiles. Roof width is the distance between the outer edges of the fascia boards. The roof tile length is 42 cm. The permissible minimum overlap changes depending on the roof pitch, which results in different batten spacings. **For the Zenit Max-compatible Terran Generon, the maximum overlap allowed is 10.5 cm. In this case, the roof tile**

requirement is 10-10.5 pieces/m² depending on the roof pitch and the batten spacing. For the Rundo-compatible Terran Generon, the maximum permitted overlap is 13.5 cm. In this case, the roof tile requirement is 11-11.7 pieces/m² depending on the roof pitch and the batten spacing. The coverage width and coverage length diagrams can be found in the Installation Guide from Terran Kft.

4.2.10 Spacer, cableing

A spacer must be installed on top of the battens. The spacer ensures that the cables are far enough from the underlayment and that the volume of the ventilated air gap is not reduced significantly.

The spacer installed must be round edged and plastic coated. When laying the cables, ensure that the MC4 cable and the connector do not come into direct contact with the wood structure. If necessary, a spacer must also be used here.

The DC side cable sections must be fitted with a standard solar DV cable (H1Z2Z2-K, 1x4 mm² or 1x6 mm²)



4.2.11. Cable routing

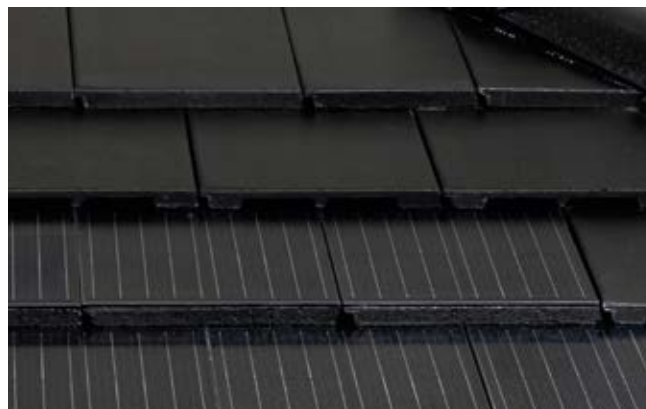
The cable sleeve with a self-adhesive surface on the entire back side ensures a professional, watertight connection in the places where the solar cable breaks through the underlay. The self-adhesive surface is 150 mm x 150 mm in size, the passable diameter is 15-22 mm.



4.2.12 Ventilation

The air gap(s) under the shell must be ventilated for structural reasons. Air rises due to chimney effect and to temperature and pressure differences around the building.

Terran Generon requires a min. 7.5 cm ventilated air gap.



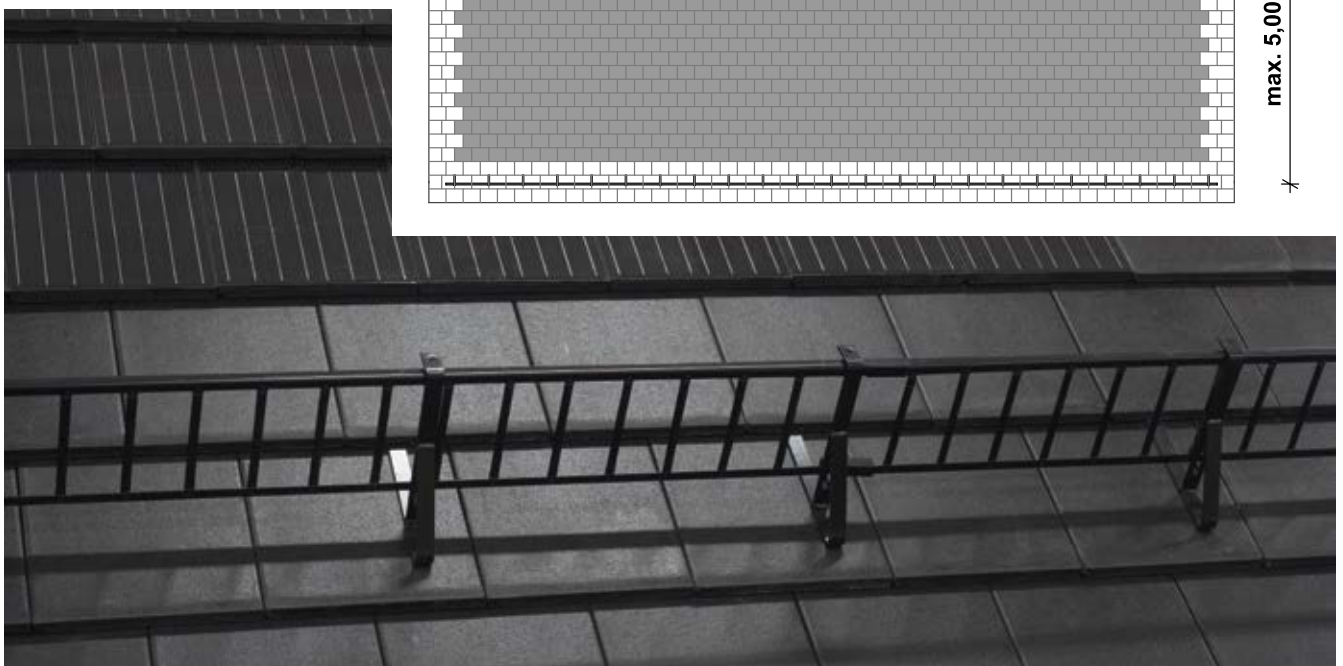
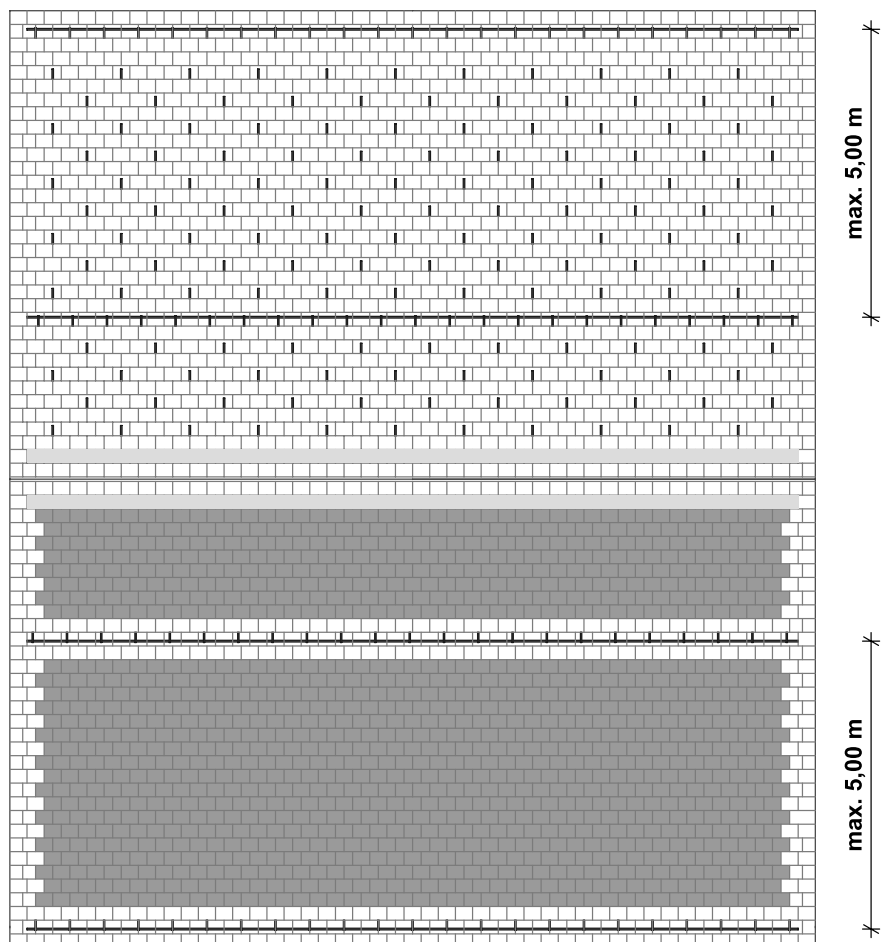
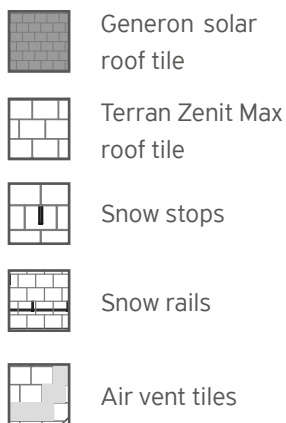
4. Application Techniques

4.2.13 Snow stop

Weather conditions in our region necessitate the installation of appropriate protection against the effects of winter on our roofs. One of the most important such protection is to keep the snow on the roof as it melts.

Terran Generon integrated with Zenit Max or Rundo tiles must also comply with snow stop regulations. Particular care must be taken that Terran Generon tiles remain free of shade, otherwise electrical power generation will be drastically reduced and the module may become damaged. Con-

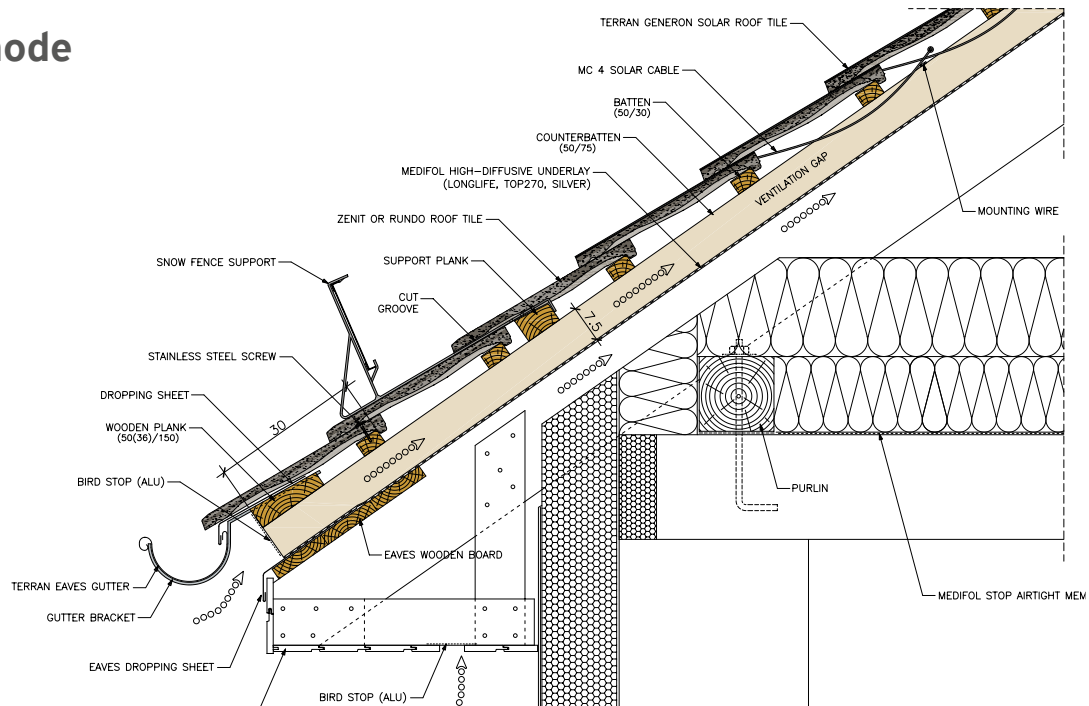
sider this when installing snow stops or rails. If necessary, Terran Zenit Max and Rundo rows must be lain between the Terran Generon rows, upon which snow retention devices can be placed. Adjoining the snow rail supports, enough material must be removed from the tile so that the tile does weigh down the rail support.



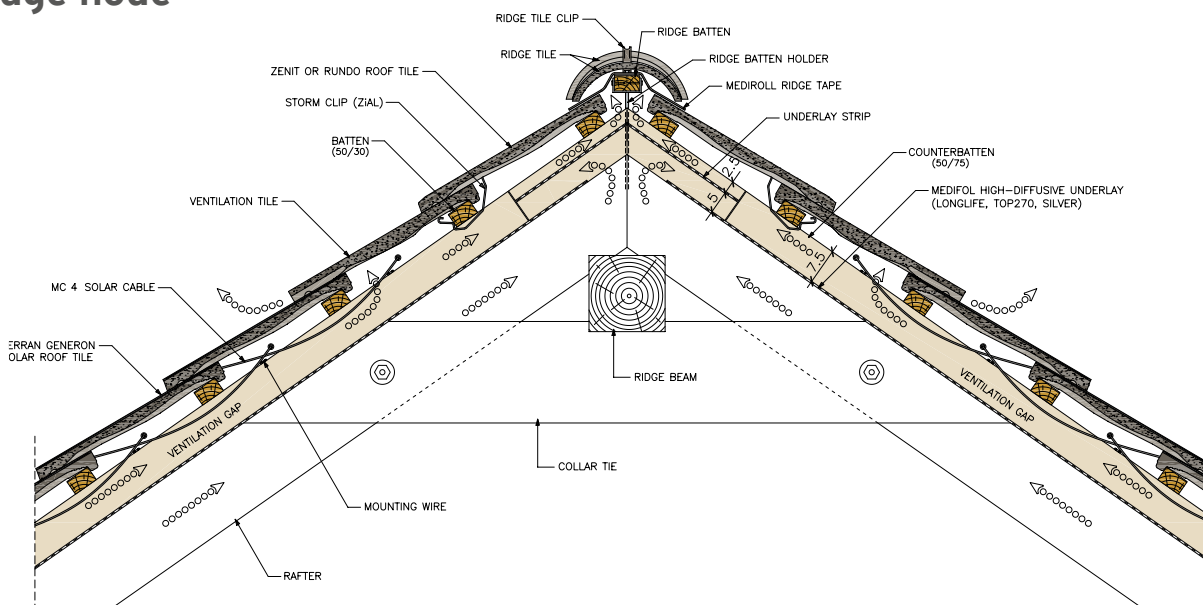
4. Application Techniques

4.2.14 Eave and ridge design

Eave node



Ridge node



5. Electrical planning and installation

5.1 General information

A high degree of proficiency is required to install solar modules. If the DC voltage exceeds 100 V, the installation may only be carried out by a qualified electrician or contractor. A qualified technician should be aware of the risk of injury, including electric shock.

Terran Generon solar roof tiles are equipped with a special weatherproof junction box developed for this purpose. The cables on the solar cell are also resistant to weather and UV radiation, and the connector at the end allows the modules to be connected quickly and easily. The cabling should be supported by non-combustible spacers placed above the tiles.

5.2 Technical details

In the production of Terran Generon solar roof tiles, high-efficiency monocrystalline silicon cells are installed. The cells convert the energy of solar radiation directly into electrical energy.

The cells are laminated in a tempered glass - EVA - Tedlar system so that they are weather resistant (including hail) and electrically insulating.

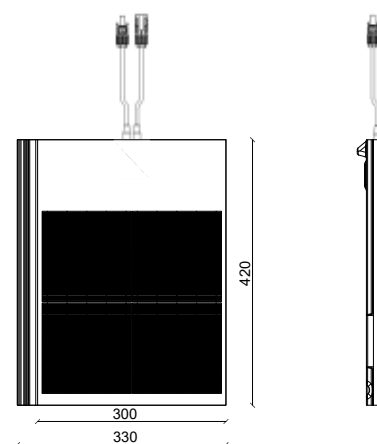
Junction boxes with IP65 protection have rectifier diodes. The laminate is fixed to a concrete tile substrate and the resulting element can be installed as a conventional tile.

Solar cell performance is tested under standard measurement conditions (STC) with irradiation of 1000 W/m² at a temperature of 25°C and at an atmospheric pressure of 1.5 AM.

Read the complete Installation Guide before installation. During installation of solar panels, electrical wiring can cause electric shock and burns. A solar cell produces low voltage direct current when exposed to sunlight or artificial light. By connecting the modules in series, the voltage values add up, so the higher voltage in a multi-module system presents a serious hazard.

Solar roof tiles must fully comply with regulations for solar systems. It is especially important to follow the National Fire Protection Regulation (OTSZ) and the Fire Protection Technical Guidelines (TvMI). In some cases, e.g. long interior DC cabling, the use of a DC isolator switch is required.

Under real conditions, the power output may differ from these values, so the correction factors (azimuth, tilt angle, etc.) must be taken into account when sizing the system.



5.3 Rectifier diodes

When a cell is in shadow, it does not produce energy but acts as resistor. The current flowing through this resistor generates heat, which can damage the cells, so an alternate (parallel)

path must be provided for the current using bypass diodes. Each Terran Generon solar roof tile has a rectifier diode built into the rear junction box.

5.4 Junction box

The junction box is located on the back of the roof tile. Made of special UV-resistant plastic, it has IP65 protection. Each junction box is equipped with two 0.52 m long special solar

cables. Both terminals indicate the polarity. The cables are double insulated with a section of 4 mm².

5.5 Inverter types to be used

For safe operation, an inverter with an arc fault protection function according to the IEC standard (IEC 63027:2023 or UL1699B) can be used, or if the inverter does not have an

arc protection feature, then it is necessary to install arc protection.

5. Electrical planning and installation

5.6 Safety regulations

Risk of electric shock when installing, cabling and connecting solar elements.

Solar cells generate DC current when exposed sunlight or artificial light.

Under normal conditions, a photovoltaic module is likely to experience conditions that produce more current and/or voltage than reported at standard test conditions. Accordingly, the values of I_{sc} and V_{oc} marked on this module should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor current ratings, and size of controls connected to the PV output.

It is recommended to keep solar roof tiles in their original packaging until ready to install.

Only qualified specialists are authorized to install and connect solar roof tiles. Keep children away from installation.

The solar cell must only be used for its intended purpose.

Drilling holes in the product is not permitted and it renders the warranty void.

Do not disassemble the product, do not remove factory-installed components.

Cabling remain live even after disconnecting the inverter!

All applicable regulations must be followed when planning and installing the system, with special attention paid to the National Fire Protection Regulation (OTSZ) as well as Fire Protection Technical Guidelines (TvMI).

Do not touch the terminals when the solar panel is exposed to light. Always use an electrically insulated tool. The solar panel must not be lifted by the connectors.



When installing a solar roof tile or connecting cables, it is advisable to cover the entire surface. This will reduce the risk of electric shock.



Elements should only be installed in dry weather.



dry

Do not step on the solar elements!



Be careful not to drop the solar element or allow objects to fall on it.



Solar elements must not be stored without support because the glass may break. Broken modules cannot be repaired. Care must be taken not to bump or put pressure on the sides.



Beware of sharp edges!



Concentrating light on the module is prohibited!



5. Electrical planning and installation

5.7 Installation

5.7.1 Connection of Generon products

Improper connection causes malfunctions and, in the worst case, sparks can cause a fire too.

Only the MC4 DC connector provided by the product manufacturer can be used on the DC cable network.



IMPORTANT! When linking connectors, make sure that they click into each other!

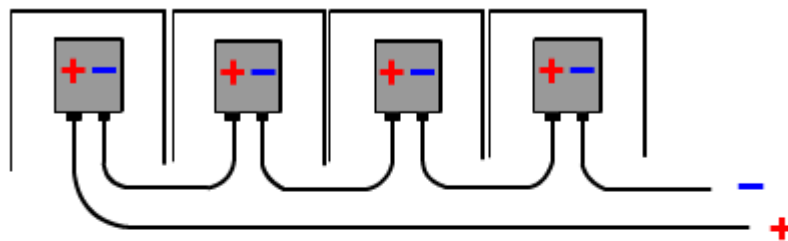


IMPORTANT! After linking the plugs - as shown in the picture - the proper connection must be checked by pulling them apart!

5.7.2 Series connection

The tiles can be connected in series, so the voltage value increases. Maximum series pcs of Generon: 330 pcs. Parallel configuration according to the inverter type. As shown in the figure below, the positive terminal of one module must be connected to the negative terminal of the other module. When connecting in series, the maximum permissible sys-

tem voltage must be observed and only the correct number of solar cells may be connected. Only solar cells of the same type (same operating current) can be connected.



5.7.3 Shock protection

The Terran Generon product has no conductive part, so it is not necessary to provide a separate ground. In case of the

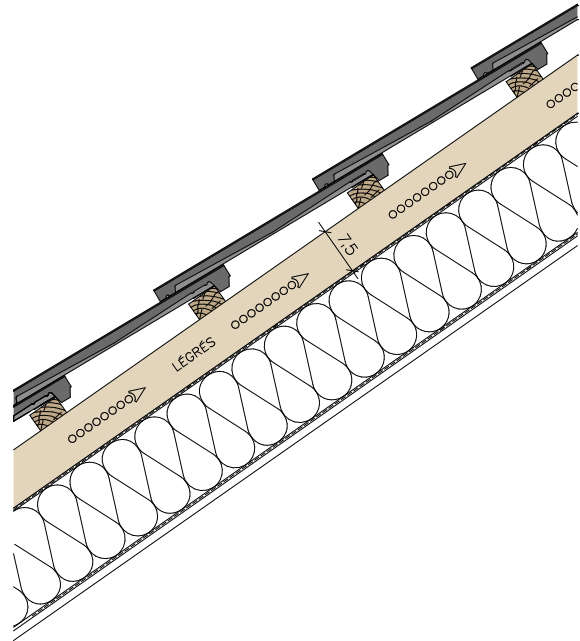
roof structure becomes electrically conductive, it must be connected to the GFCI system of the building!

5. Electrical planning and installation

5.7.4 Air circulation

The air layer under the shell must be ventilated for structural reasons. Ventilation occurs when there is a general upward movement of air in the gaps of the cross-section due to temperature difference caused by chimney effect and due to pressure differences around the building.

With Terran Generon, a ventilated air gap of at least 7.5 cm is required. The efficiency of solar cells decreases with rising temperature. The air circulation has a cooling effect, so the heat can dissipate.



5.8 Maintenance

Photovoltaic solar roof tiles require very little maintenance due to their unique design. They have no moving parts and operate in a closed system, protected from the environment by insulation. In addition, Terran's strict quality control ensures flawless operation.

Maintenance may include the following steps depending on the degree of contamination:

1. Periodic cleaning of solar roof tiles
2. Visual inspection of solar roof tiles for damage

5.8.1 Periodic cleaning

Dirt accumulated on the transparent surface of the solar cell reduces its performance and can damage the cells. In many cases, rain can reduce dirt, cleaning the surface to an acceptable level. If the dirt persists, it can be removed by occa-

sional cleaning with water or other non-abrasive cleansers. If possible, have the cleaning performed by a professional! Working at heights involves risks.

5.8.2 Visual inspection

The main purpose of system production (status signals, production value monitoring) and visual inspection of solar panels is to discover possible surface damage. Examples are broken or cracked glass. In such case, contact your local reseller or Terran directly. Due to the material charac-

teristics of the natural silicon used in the production of solar panels, they may differ in shade, so the warranty does not cover such color differences. More details in the GTC in force at all times.



Development is our nature

Terran is so much more than
just one of the finest concrete
roof tiles in the world.

Terran is a state of mind:
security, safety, elegance and
beauty, enduring value, energy
savings and caring for the
environment.

The Terran state of mind is
your peace of mind.