REMODULE1.4 TOPCON

README & PRODUCTION MANUAL

In this document the are outlined the product details for Biosphere Solar's ReModule 1.4 product. This version goes under Biosphere Solar's new brand name ReModule. ReModule 1.4 comes in two versions, the 1.4-120-TOPCON with 120 half cells and the 1.4-108-TOPCON with 108 half cells. In the past months, multiple sample batches have been delivered and tested. Based on the tests we have improved the design to make subsequent modules more resistant against thermal and mechanical stress. This documentation should make the module fully reproducible and help you improve the product with us. This project is licensed under the CERN OHL S, meaning that you must submit any improvements made to the product owner. Comments and improvements on the documentation can be sent team@biosphere.solar. The Biosphere Solar Team is looking forward to your contributions!

Introduction

ReModule 1.4 TopCon is the latest evolution in Biosphere Solar's dis-assemblable PV module line. Compared to previous iterations, the 1.4 uses 3.2mm tempered glass, making it resistant against mechanical stress, yet lightweight. As with all previous Biosphere modules, ReModule 1.4 does not have any lamination. This makes it possible to open the module at end-of-life, and repair, refurbish or recycle at high-value. Some of the aspects of the module are still under research, such as PID, fire rating, and projected lifetime (see test results and engineering challenges). Biosphere Solar's current goal is to scale up production, increase module efficiency, and realise medium-scale technology demonstrations. This serves towards the company's long term mission of setting fair and circular standards in the solar industry and market.

3D Model

The CAD models of our design can be found here:

- V1.4-120-TOPCON
- V1.4-108-TOPCON

List Of Images

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ReModule 1.4 Technical Specifications.

Specifications	**V1.4-108**	**V1.4-120**
Cell type	Topcon 182mm	Topcon 182mm
Amount of half-cut Cells	108	120
Junction box	3	3
Weight [kg]	33.78	36.97
Length [mm]	1741	1929
Width [mm]	1134	1134
Aspect ratio	1.535	1.701
Thickness (no Frame) [mm]	7.4	7.4
Thickness (With Frame) [mm]	30	30
Area [m2]	1.97	2.19
Cable Dimensions	2pc 100 mm * 4 mm2	2pc 100 mm * 4 mm2
Connector type	MC4	MC4
By-pass diodes	3	3
Product passport/materials used/labeling	Precompliance testing	Precompliance testing
Country of Manufacturing	China	China
Optional Frame material	Aluminium	Aluminium
Structure type	glass - glass	glass - glass
Kind of glass used	3.2mm low-iron tempered solar glass	3.2mm low-iron tempered solar glass

Electrical Data	**Cell**	Variance (+/-)	**Module V1.4-108**	**Module V1.4-120**
Nominal Max. Power (PMax) [W]	3.962	-2.92%	430	480
Open Circuit Voltage (Voc) [V]	0.699	-1.86%	37.75	41.94
Short Circuit Current (Isc) [A]	6.865	-0.42%	12.272	12.308
Maximum Power Voltage [V]	0.612	-1.63%	33.05	36.72
Maximum Power Current [A]	6.474	-1.26%	11.573	11.607
CTM Efficiency			89.38%	89.64%
Vmp/Voc ratio			87.55%	87.55%
Overcurrent protection [A]				
Fill Factor (FF) [-]			82.57%	82.57%
Temperature Coefficient (Isc) [%/K]	0.046		0.046	0.046
Temperature Coefficient (IVoc) [%/K]	-0.26		-0.26	-0.26
Temperature Coefficient (Pmax) [%/K]	-0.32		-0.32	-0.32
Efficiency percentage	24.00%	-2.9%	21.45%	21.45%

Other

Maximum System Voltage	1500 V DC
Operating temperature	-40°C / +85°C
Product Warranty	10 years
Power Warranty	30 years
Supply Chain Transparency	Full cell & primary component supplier transparency
Fire rating	N/A
IV curves	N/A
LCA Carbon Footprint	Thesis_ LCA - Fulvia
Interconnection Type	Stringed, FBC
Life expectancy	30 years
Maximum static load front side	N/A
Maximum static load back side	N/A
Maximum Hail impact resistance	N/A
Certificates (IEC & ISO)	N/A
Objective clients (target group)	B2G, B2B, European focus
IPXX rating	N/A

Production Methods

Since the ReModule is a relatively new module concept in the solar industry, many factories don't have the necessary equipment. Currently, production batches are at medium scale, with most processes running semi-automatically. Small-scale production can be done largely by hand, whereas large scale volumes need to be automated to bring down the labour costs. Biosphere Solar offers specialised services to adapt existing production lines and new production lines to the ReModule concept. This requires some low-cost high throughput processes which can be run in parallel to conventional laminated module production.

	Sample Production (<36pc)	**Medium Scale Production (36- 720pc)**	**Large Scale Production (>720pc)**
Step 1: Front Glass Loading	manual	semi-automated glass loader	automatic glass loading machine
Step 2: Stringing	stringer	stringer	stringer
Step 3: Cell String Lay-Up and Bussing	automated lay-up, manual bussing	automated lay-up manual bussing	automated lay-u, automated bussing
Step 4: Edge seal and Spacer Dot Extrusion	manual tape placement, cutting dots by hand, placing dots by hand	manual tape placement, CNC dots extrusion	automated hot-melt butyl extrusion & CNC dots extrusion
Step 5: Back Glass Placement	manual	semi-automated glass loader	automatic glass loading machine
Step 6: Edge Seal Pressing	with a laminator	with a laminator	automatic heated press
Step 7: EL	before step 4 and after production	before step 4 and after production	before step 4 and after production
Step 8: JB Soldering and Potting	manual	semi-automatic	automatic
Step 9: Framing	manual	automatic	automatic

BOM

V1.4-120 - Bill of Materials (BOM)

Part No	Part name	Category	Description	Main Material Composition	Metric	Unit
F1	Front Glass	Frame	Low-iron tempered glass (3.2mm)	Soda-Lime Glass	2.17	m2
F2	Back Glass	Frame	Low-iron tempered glass with 3 holes (3.2mm)	Soda-Lime Glass	2.17	m2
C1	TOPCON Cells	Cells	182x91 M10 half-cut TOPCon cells	c-Si	120	pc
S1	Edge Seal	Encapsulation	Edge sealant	Helioseal PVS 101 Tape	6.06	m
E1	Tabbing Wire	Electrical	To connect the cells into strings	Tin, Flux, Copper (no Lead)	225.31	m
E2	Bus Bars	Electrical	To connect the cell strings	Tin, Flux, Copper (no Lead)	4.512	m
S2	Spacer Dots	Encapsulation	Glass and cell spacer	UV-Cured Adhesive	0.273	g
S3	Potting gel	Encapsulation	Glass-Hole Sealant	Silicone potting	0.00236	l
E3	MC4 Connectors	Electrical	Connects module	Plastic Polymer, Rubber	2	pc
E4	Cables	Electrical	Connects module	PVC/PE/PP, Copper, (Halogen Free)	2	m
E5	Junction Boxes	Electrical	Connection box between busbar wire and cables and contains bypass diodes	Polymer, PCB, Diodes, etc	3	pc
F3	Aluminium profile	Frame	Frame for 2x3.2mm glass, mounted using silicone sealant	Aluminium	6126.2	mm

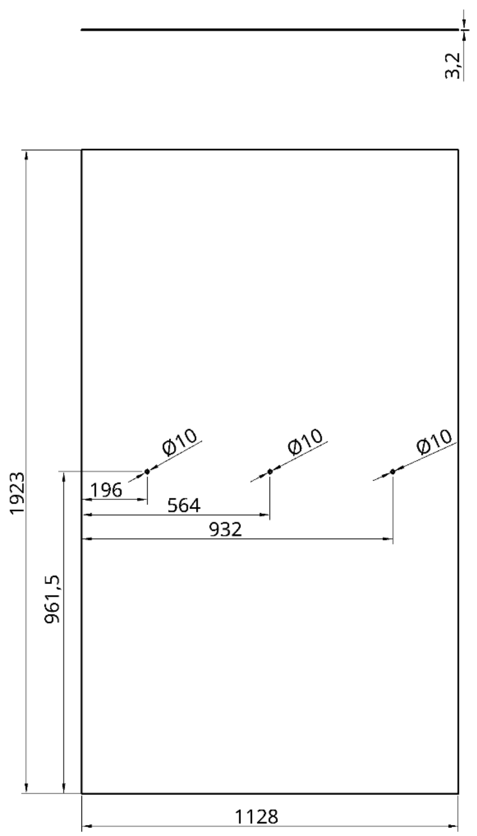
V1.4-108 Bill of Materials (BOM)

Part No	Part name	Category	Description	Main Material Composition	Metric	Unit
F1	Front Glass	Frame	Low-iron tempered glass (3.2mm)	Soda-Lime Glass	1.96	m2
F2	Back Glass	Frame	Low-iron tempered glass with 3 holes (3.2mm)	Soda-Lime Glass	1.96	m2
C1	Bi-facial TOPCON Cells	Cells	182x91 M10 half-cut TOPCon cells	c-Si	108	pc
S1	Edge Seal	Encapsulation	Edge sealant	Helioseal PVS 101 Tape	5.68	m
E1	Tabbing Wire	Electrical	To connect the cells into strings	Tin, Flux, Copper (no Lead)	202.78	m
E2	Bus Bars	Electrical	To connect the cell strings	Tin, Flux, Copper (no Lead)	4.512	m
S2	Spacer Dots	Encapsulation	Glass and cell spacer	UV-cured adhesive	0.702	g
S3	Potting gel	Encapsulation	Glass-Hole Sealant	Silicone potting	0.00236	l
E3	MC4 Connectors	Electrical	Connects module	Plastic Polymer, Rubber	2	MC4 connector
E4	Cables	Electrical	Connects module	PVC/PE/PP, Copper, (Halogen Free)	2	1m cable
E5	Junction Boxes	Electrical	Connection box between busbar wire and cables and contains bypass diodes	Polymer, PCB, Diodes, etc	3	Junction box
F3	Aluminium profile	Frame	Frame for 2x3.2mm glass, mounted using silicone sealant	Aluminium	5750.48	mm

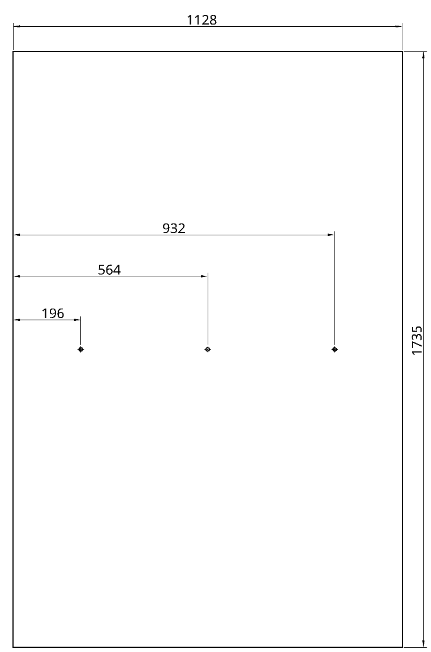
All dimensions can be viewed in the CAD model

Glass Dimensions

The 3 junction box holes in the back glass can be made in the standard positions (center Y) and with a standard diameter. An example of the values used is given here, but deviations in the X axis are possible without compromising the module design. In addition, two 10mm holes are added on the sides of the module which Biosphere Solar will use for their proprietary liquid filling process. All dimensions are from the centerpoint of the holes:



ReModule 1.4-120-TOPCON Back glass drawing (PDF File Attached)



ReModule 1.4-108 TOPCON Back Glass drawing (PDF File Attached)

Assembly Steps

The assembly is sunny side down, following the steps below.

STEP 1: Front Glass Loading

Load the front glass onto the production conveyer.

STEP 2: Stringing

Produce 12 strings with 10 cells each, with a 2.05mm spacing between the cells, and 7 mm extra tabbing wire at the end.

STEP 3: Cell String Lay-Up and Bussing

Lay up cell strings in a series pattern according to Figure 1 and attachment 2. The cells may be fixated with a taping machine. Bus bars are attached as usual to create series connections with wires exiting the centred holes for 3 junction boxes.

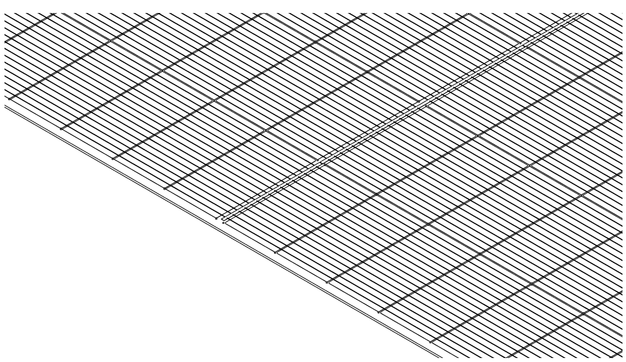


Figure 1. Technical drawing of cell string series pattern

Ensure that the total solder assembly does not exceed 1mm in the z axis.

STEP 4: Edge Seal and Spacer Dots Extrusion

This step replaces lamination. It consists of placing UV-cured adhesive in small dots throughout the module to hold the cell strings in place, and Kömmerling Helioseal PVS101 PIB tape at the module edges. This is done by hand for small volume production and automatically for large volume production. Attachment 2 and Figure 2 shows the pattern of extrusion. Although the pattern is illustrated without cells, the extrusion takes place with the cells present. A DXF file of the spacer dot extrusion will additionally be provided for automated production. The extrusion is an 11-mm PIB edge seal, and a pattern of 2 mm UV-cured spacer dots.

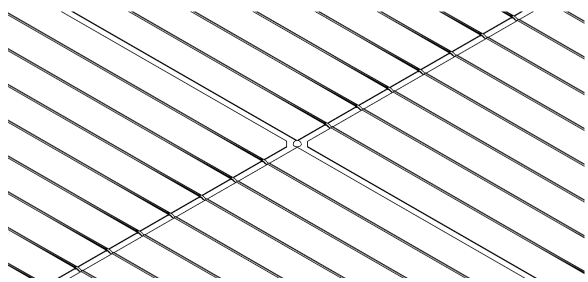


Figure 2. Snippet of adhesive dot placement

As a first step, place the Kömmerling Helioseal PVS101 PIB tape around the four edges of the module. See the attached file “Helioseal PVS 101 - Technical Information” for instructions on the application. Note that the PIB on the corners of the glass should be placed as follows:

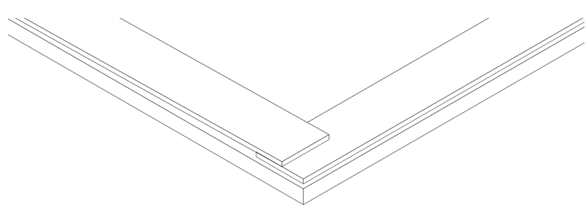


Figure 3. Edge seal corner layup

Ensuring overlap at the corners, and 1mm spacing between the PIB and the edge of the module. The overlapping edge will heal during the heat press treatment/lamination.

As a second step, prepare for the spacer dot placement. For this, the module with strings and PIB is entered into the spacer dot dispenser. The DXF file for spacer dot placement is found in attachment 5. Appendix 1 shows some alternative manual and semi-automated methods of spacer dot placement.

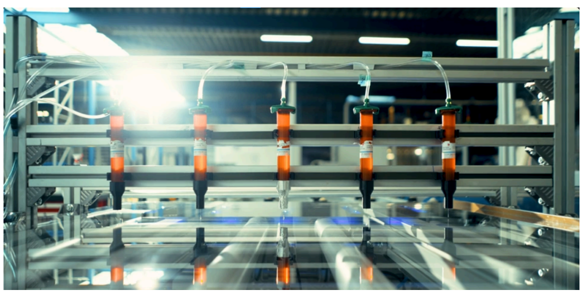


Figure 4. Spacer dot placement machine

All spacer dots should be cured in the machine using the integrated UV light.

STEP 5: Back glass placement

When the edge seal and all the dots are placed, place the back glass on the module. This can be done manually, since the spacer dots will hold a 1mm spacing between the glass sheets. Ensure that the bus bar wires sticking up are passed through the glass holes while placing the back glass on the module.

Figure 5. Back glass layup

IMPORTANT: Seal off the holes with bus bars by pressing PIB tape into the hole, making sure the wires do not short, and that there is PIB all around the wires to prevent wires touching the glass. For proper sealing, try to make sure that there is at least a 10 mm path from any point outside the module, to any point inside the module.

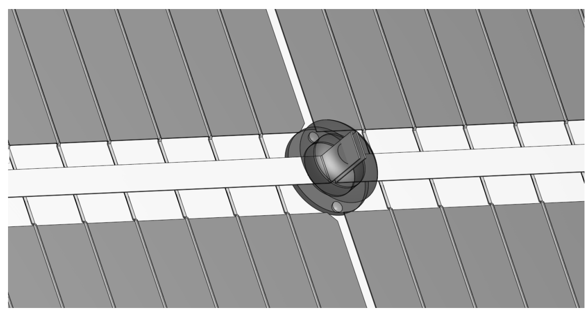


Figure 6. Junction box hole with bus bars exiting

Check whether there will be liquid filling on the module. If not, the extra holes can also be sealed with PIB before entering the laminator.

STEP 6: Sealant Heating & Pressing

WITH LAMINATOR

If you have access to a large laminator, place the entire module in the laminator and heat the module uniformly to around **90°C** and **0.3 atm at 6-7 minutes**. This is considerably faster and requires less energy than laminating conventional EVA modules.

When the module comes out of the laminator, inspect the edges and the middle of the panel and check if the seal has been pressed and melted properly. Visually the seal should turn from dark gray to black in terms of color. Make sure there are no air bubbles or inconsistencies in the sealant. If this occurs, place it in the laminator with the same temperature and pressure setting for 1-2 minutes. Also make sure the sealant around the junction box holes and the spacer dots are making contact with both the front and the back glass.

For patterned glass it is recommended to either use a higher temperature and/or pressure: if the pattern is inside, making contact with the edge sealant can be more challenging. Alternatively keep the pattern at the exterior so the smooth side is touching the edge sealant.

WITHOUT LAMINATOR

If you do not have access to a large laminator then you can use clamps and a heat gun (and heating bed if you have one) will be needed to seal the edges manually. If your clamp has a metal contact surface then some wooden beams will be needed on both sides of the panel in between the contact surfaces of the frames to provide cushioning and prevent shattering of the glass.

Figure 7. Semi-manual sealing of edge-sealant

Visually inspect the color of the edge seal to see if it has been pressed and warmed properly. It should turn from dark grey to black. Make sure there are no air bubbles or inconsistencies in the sealant. If this occurs, press again and apply extra heat with the heat gun. You might notice that with only the heat gun and without a heating bed it is tricky to seal the middle edge seal strip close to the holes.

STEP 7: Electroluminescence (EL) and IV Curve

For quality control, test the module at this point using EL and/or IV.

STEP 8: Junction box Soldering & Potting

Place the junction boxes by passing the wires through. Solder or clamp the junction boxes depending on the specification. Each junction box has slightly different instructions, ensure you follow the given directions for the JB of use. Pot the junction box as normal with 2 component silicone sealant, close the junction boxes. Note that there is research going into reusable and repairable junction boxes, some of which are now entering the market.

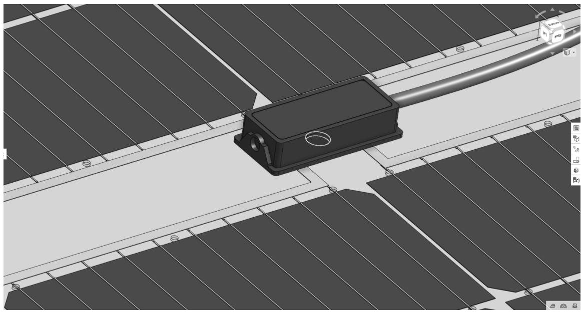


Figure 8. Junction box layup

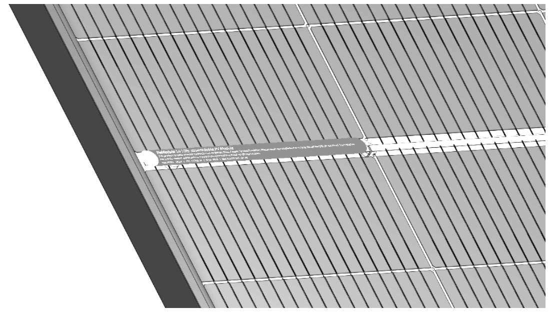


Figure 9. Labelling setup

If there will not be liquid filling, you can cover the holes on the side with Junction boxes and pot these as well.

STEP 9: Framing

Use silicone to attach the frame as usual. A special frame for 2x3.2mm glass is used. For a technical drawing, see attachment 4. Note that easily disassemblable frames are being researched and are now entering the market; we aim to use these in future versions.

STEP 10: Liquid Filling (Optional)

Liquid filling is still under development at Biosphere Solar. Currently, a vacuum pump is used to draw air out of the module, and fill it with liquids. More documentation on liquid filling will follow in version 1.5 or version 2.

STEP 11: Labelling, Packaging & Shipping

Place the product label according to the technical drawing in Attachment 5. The PDF print of the labels is available in Attachment 6.

After labelling, package the module and ship.

V1.4 Disassembly Manual

The key advantage of Biosphere Solar modules is that they can be disassembled. At any time during the production process or at the end of life it may be necessary to disassemble broken modules. This is done as follows:

1. Identify broken elements through visual inspection or EL
2. Prepare replacement strings
3. Remove frame by mechanically separating the frame corners
4. Place sucker on front glass and apply **slight** lift pressure (do not lift the module entirely)
5. Cut edge seal and adhesive pins using a (heated) wire saw or cutter
6. Lift front glass off
7. Desolder and remove broken strings
8. Place and resolder new strings
9. Remove old sealant thoroughly and apply new sealant (a razor or cutter can effectively remove the old sealant)
10. Re-attach frame using silicone bond

Test Results

Biosphere Solar is working towards CE and IEC61215 certification. For CE, Biosphere Solar is sending a report to a recognized notified body who can approve our self-audit. For IEC61215 some pre-compliance testing (see below) is being carried out in-house and with our partners (e.g. TNO, TU Delft). Even though many of these tests have not been completed yet, other laminate free module initiatives, such as TPedge and NICE have passed similar tests.

Given the high costs of IEC certification it is preferable to finalise the liquid filling procedure before starting certification, in order to avoid having to re-certify after liquid filling is completed.

Performance & IV Curve

Current results show that the performance of air filled modules is about 5% lower than that of EVA laminated modules, whereas liquid-filled modules can reach similar or even higher efficiency than EVA laminated modules. For more information, see Rijsman (2025).

Impact Breakage Test [TO TEST]

Previous impact breakage tests (also called hail tests) on the Remodule 1.3 found that 2mm semi-tempered glass is not sufficient to withstand hail impacts according to the IEC61214 standard. Therefore, Remodule 1.4 uses 3.2mm tempered glass.

Damp Heat Test [ONGOING]

Thermal Cycling [ONGOING]

Humidity Freeze

Model: V1.3-108 TOPCON Results: No major visual defect according to IEC61215-1 Section 8.

Future adaptations: Combine with other tests in sequence similar what has been specified from the standard.

EL images

EL images are completed using an IR camera. For the roof version it was done at 40V and the utility version around 45V. Of test modules produced, some shaded cells and microcracks were found suggesting the need to improve the design of the cell bed. See images here:

V1.1 EL

Static Mechanical Load [TO DO]

Insulation Test [TO DO]

UV Research & Testing [TO COMPLETE]

Currently researching additives and coatings to protect the TOPCON cells from UV damage

Wet Leakage Current [TO DO]

Will be carried out at a small scale.

PID Research & Testing [TO DO]

Dynamic Mechanical Load [TO COMPLETE]

Using the Remodule 1.3-144 cell modules, multiple cells cracked during the DML test with only push-neutral cycles, however; this does not indicate a failure of the test but requires combined testing with the climate chamber tests. The detailed test documents can be accessed on request. More test results will follow.

Fire Safety Test [TO DO]

For fire class, each material has to be tested individually. Here, the foil and sealants are most critical.

Engineering Challenges

The following challenges are open for contributions.

Post Breakage Performance

Lack of post breakage integrity is a key downside of laminate-free module designs. When a laminated module goes through glass breakage, the module materials still stay in one piece. When laminate-free modules break, their components disperse.

One idea previously tested is an adhesive film on one or both glass sheets. These films are commonly used in building glass to enhance safety. The foils used in V1.1 were 3M S40. We also looked into 3M PPF. The advantage of S40 is its high strength. PPF could also be a good option since it doubles as an anti-reflective and anti-soiling coating.

The downside of these foils is that they come with a very high price of about €130,-/m at scale. We would need about 4 meters of this foil roll per module. Therefore, their use is not economically feasible at this point. Another downside is their impact on performance, since they contain UV-blocking agents. Our IV-curve measurements showed a +/-10Wp drop in performance with the S40 foil. The PPF was not tested. Finally, the foils have been observed to peel and whiten during damp-heat tests.

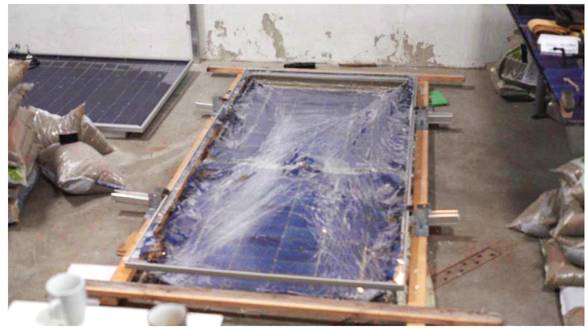


Figure 10. Image of a broken Remodule 1.3

Biosphere Solar is currently undertaking a quantified risk assessment to research exactly how many modules are expected to reach breakage, and whether this forms a hazard to people and the environment. Until then, all Biosphere Solar modules face the risk of breakage and dispersion. Remodule 1.4 features warning labels indicating this issue.

Production and Transport Failures

Remodule 1.3-TOPCON faced extensive issues with cell cracking during both production and transportation in the past. This issue is being further examined. Our hypothesis is that alternative spacer dot configurations and liquid filling may mitigate this issue. In addition, using more resilient cell types, such as IBC, helps.

Liquid Filling & Material

Biosphere Solar has successfully completed academic research to verify the potential of liquid-filled modules. This research will be published on our website. However, the exact liquid still needs to be formulated based on a range of criteria (from fire-safety to optical properties, to electric properties, to cost, etc.). Currently, Biosphere Solar has a patent pending on this innovation.

In addition, the filling process also still needs to be developed. For this reason, we initially want to do this off the production line, so interruptions in the liquid filling process do not halt the production line. At a later stage, once the process is more established, we will move it in-line.

Circularity of Frames

The frames we currently use are not very dis-assemblable. They are attached with silicone adhesive, and cannot be manually removed. Instead, a deframing machine is required which sometimes breaks the glass. Additionally, the removed frames often can't be reused directly because of deformation. Therefore we would like to redesign our frames for ease of disassembly and possibility for reuse. And of course this should not come at the expense of decreased mechanical strength

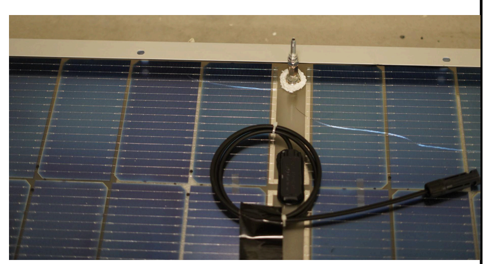
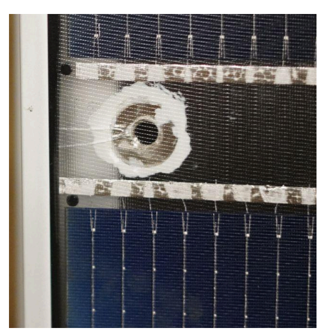
Acknowledgement

This documentation is a compilation of various projects undertaken by Biosphere Solar and supported financially by the EU. Details of the projects can be found on our website. A special thanks goes out to our passionate supporter Jan, thank you for donating the times when we needed it most.

Finally, to all the supporters (financial or otherwise) and contributors of Biosphere Solar, you are what has kept many of us going when short-circuited modules repeatedly shattered our hopes of a circular future - we've gotten past it and will do so again! Thank you!

ReModule 1.3-108-TOPCON Production Results

The following table highlights the results from the last factory production of ReModule 1.3. In general, we found that it seems the dots do not play a role in preventing shifting of the cells. If that is the case, the dots are only there to keep the glass sheets together and can be bigger and placed in the openings of the cell corners instead of the small gaps between the cell. The following table highlights the results from connecting a liquid filling interface to the glass holes

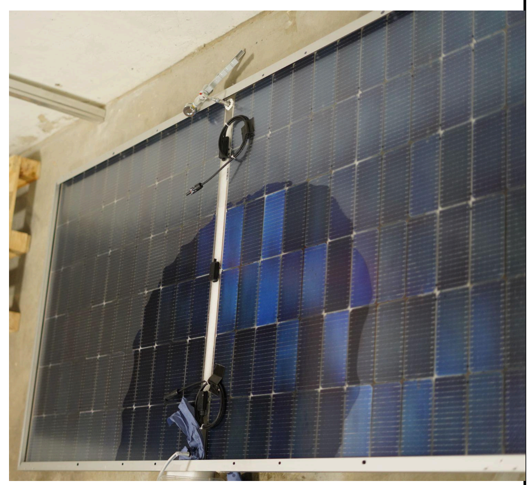
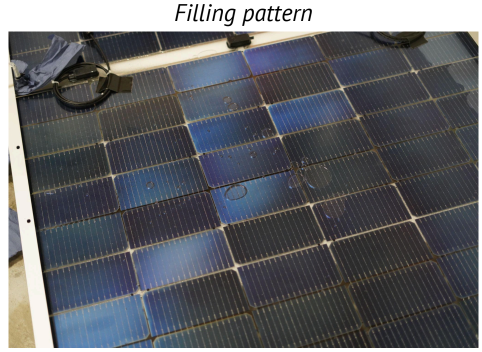
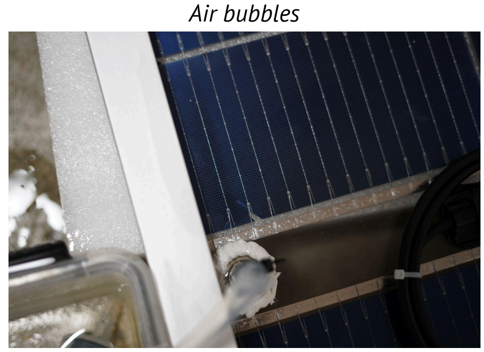
Module #	Dot configuration	Observations	Images
1	2 dot	No problem occurred. Feels tightly fastened.	
2	2 dot	No problem occurred	
5	4 dot	No problem occurred. After a week, the hole still seems dry.	
6	4 dot	No problem occurred. After a week, some oil was found around the hole. Further investigation is needed to make sure this comes from the hole seal or edge seal.	
7	4 dot	Cracks in the black glass coming from the hole after tightening the filling nut with the hand. The module already made some cracking sound while laying it down.	
14	6 dot	No problem occurred	
15	6 dot	Crack from the hole.	

Results filling methods

Below are the test results from our previous liquid filling tests. In this liquid filling test, the liquid was actively entered into the module by pumping it through the filling hole. In ReModule 1.4, the liquid filling will be attempted by drawing a vacuum out of the inner volume, and drawing in the liquid through a tube.

Mod-ule #	Dot configur-ation	Filling method	Observations	Images
1	2 dots on the wire	1. UR-P-IE	While filling the tubes came loose because of the pressure. We decided to fill another one. And add tie-wraps for the next.	-
2	2 dots on the wire	1. UR-P-IE	Dots are getting loose after filling a certain amount of liquid. The liquid is heavy and puts pressure on the two glass sheets pushing them away from each other. The pressure is that high that at a certain point the dots get loose. Edge seal is leaking. The edge seal got completely separated from the front glass at certain points, letting all the oil flow out.	 *Filling pattern*
14	6 dot	1. UR-P-IE	Dots are getting loose after filling a certain amount of liquid. The	

			liquid is heavy and puts pressure on the two glass sheets pushing them away from each other. The pressure is that high that at a certain point the dots get loose. Edge seal is leaking. The edge seal got completely separated from the front glass at certain points, letting all the oil flow out.	
5	4 dot	2. F-IE	The oil did not reach the corners of the module. Pumping the air did help to get the liquid more to the top middle of the module, but not in the corners. The air could not be pumped more, because otherwise the liquid would get into the pump. A few of the dots got loose, but most of them hold, so that is an improvement compared to the horizontal filling (UR-P-IE). The edge seal seemed to stay intact for two days of having the module placed in the same position. After two days the module was moves (keeping it flat) to	 *Filling pattern*  *Liquid drops feasible on the edge of the module*

			another place in the workspace. After the weekend the module got leaking from one edge. It is not sure if this happened during the transportation of the module (carrying it flat by two people) or because of the time and fatigue of the PIB.	
6	4 dot	3. F-NRV-I	The under pressure was too little to suck the liquid in from the other side. First tried to push in the liquid with a syringe, but that gave a lot of air bubbles. Went back to the old method of using the pump (1). Liquid was distributing more evenly over the module. Still the edges were not reached. A lot of air bubbles got trapped The vacuum was not maintained. An underpressure of XX was reached, over time the underpressure went back to zero. One cell is broken, not sure if that happened during the liquid filling or before. After the christmas holiday the module started leaking.	 *Filling pattern*  *Air bubbles*  *Broken cell*

Attachments

1. Back glass drawing
2. String layup and bussing drawing
3. Spacer dot drawing
4. Frame drawing
5. Spacer dot DXF file

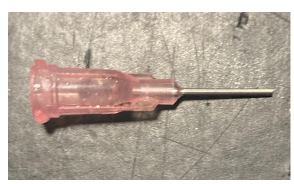
Label PDF

Appendix 1: Glue Dispensing Archive.

Please check this document Instruction Manual Glue Dispenser on the detailed assembly and use of our semi-automated dispenser in which we use to dispense and cure dots.

For manual dispensing look at 02. In-house dispensing instructions

Equipment

Dispensing machine	
Syringe adapter 30CC/50CC	
Needle tip coned 18G	
Syringe 50CC UV-cured adhesive	
UV light	
Compressed air	

Settings

Make sure the compressed air inlet is below 5 bar

Vacuum dispensing machine: turn on until no droplet is falling (find minimum)

Pressure dispensing machine: turn on full

Dot layer 1:
Set time 0.5 seconds
Cure 15 seconds → depend on which light they have

Dot layer 2:
Set time 0.5 seconds
Cure 15 seconds

Steps

The spacer dots are dispensed between the cells.

1. Create the first dot layer by dispensing for 0.5 seconds by pushing the button once
2. Turn on the UV light from below the glass
1. Cure for 15 seconds
2. Turn off the UV light
3. On top of the first layer, create a second layer by dispensing for 0.5 seconds by pushing the button once
4. Immediately turn on the UV light from below the glass
5. Cure for 15 seconds
6. Turn off the UV light

Repeat for each dot

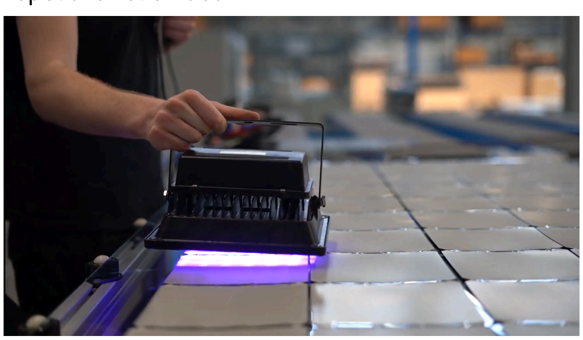


Figure 11. Manual UV curing

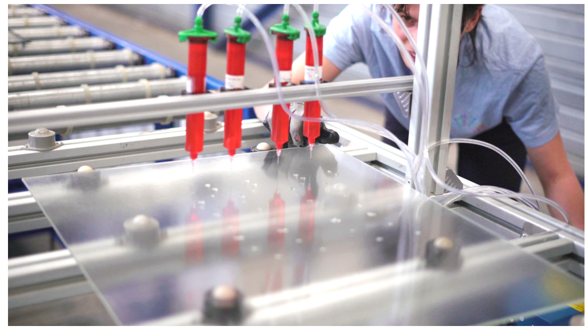


Figure 12. Extruding dots from a mounted position (can also be done by holding the syringes manually)

OLD METHOD: PIB DOTS

First, use a perforator to create dots from the Helioseal PVS 101 tape with a height of 1 mm and diameter of 4 mm. The amount of dots needed per module is 140 for the 120 cell module and 126 for the V2U. The dots can be cut from the Helioseal PVS101 PIB tape using the following tool:

Figure 13. Cutting up of PIB dots

Next, place the spacer dots with a tweezer at the positions given in the technical drawings. This process is done by hand. The pictures below show the process of placing the spacer dots, although they are in a different position.

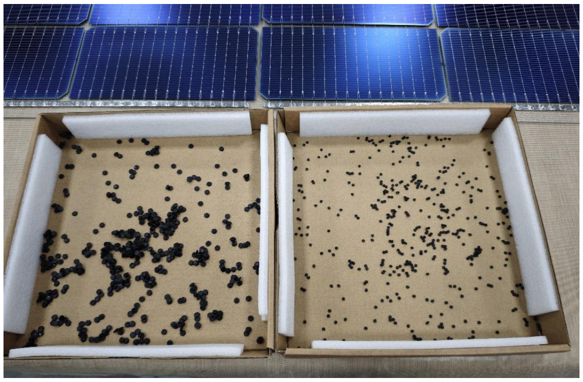


Figure 14. Image of spacer dots of varying sizes

Here you can see a close up of how the spacer dots function. They keep the cells in place by holding them by or in between the string interconnections, and maintain the 1-mm spacing between the back and front glass throughout.

Figure 15. Manual placement of spacer dots