

VALOE



IBC modules with conductive back sheet

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BACK CONTACT
WORKSHOP
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Valoe Corporation

- A Finnish Technology Company specializing in Photovoltaic (PV) Technology
- Developing new efficient methods to generate renewable solar electricity in innovative ways.
- Established in 1981 (Savcor), listed on the NASDAQ OMX Helsinki Ltd.
- Head Office in Mikkeli, Finland
- Factories in Juva, Finland, and Vilnius, Lithuania



Experienced Technology Provider

- Valoe is a technology provider specializing in next generation solar technologies.
- Valoe has a history of 40 years, and its DNA is based on Material sciences, Industrial automation, and Software. We have operated multiple production locations around the world mass producing specialized components for the world's leading companies in telecon, automotive and consumer electronics.
- Since 2014 Valoe has concentrated its development efforts solely for Solar PV technology.

Company Focus

- Valoe develops and manufactures PV modules based on the Back Contact Technology.
- Valoe offers full technology package from concept design to mass production.
- Back Contact Technology allows unparalleled flexibility when solar modules are designed. Valoe sells its proprietary ODD FORM modules.
- The Back Contact Modules are environmentally friendly, non-toxic and, at the end of their service life, recyclable.
- Valoe's Current focus is on the Vehicle Integrated Photo Voltaics (ViPV).

Cell Production

- Valoe has own IBC cell production plant in Vilnius, Lithuania
- ISO 9001:2015 certified



Benefits of In-house Production of IBC Cells

- Custom cell designs: A cell can be designed to be cut into different sizes and shapes
 - From 10x10mm mini cell to 158x158mm full cell
 - Square, rectangle and free form possible
- Own production allows long term commitments
 - Long product lifetimes
 - Change reviews according to customer needs
- Low environmental footprint
- Ethical considerations in the manufacturing chain

Valoe Module Plant in Juva, Finland

5500m² of industrial space with R&D
Laboratories and Testing Lab

Three production lines for Modules

Development of the new equipment,
products and processes

Iso 9001 certified, IATF/ISO TS 16949 under
development (to be certified in 2024)

Modules overview

- 2D modules
 - Glass –glass for Solar Building Integration (BiPV)
 - Full polymer-based modules
 - Sandwich structured modules with composites
- Odd Form Modules
 - Sandwich structured PV modules
 - Polymer/composite modules
 - Semi-transparent modules
 - 3D shaped modules (also double curved surfaces)
- Small Custom designed modules for IoT applications



PV on cold reefers

Valoe pilots PV enabled cold reefers in real operating conditions

4 units will be used by different customers to evaluate benefits

Valoe provides both PV and balance of system to run standard TRU on electricity for batteries.

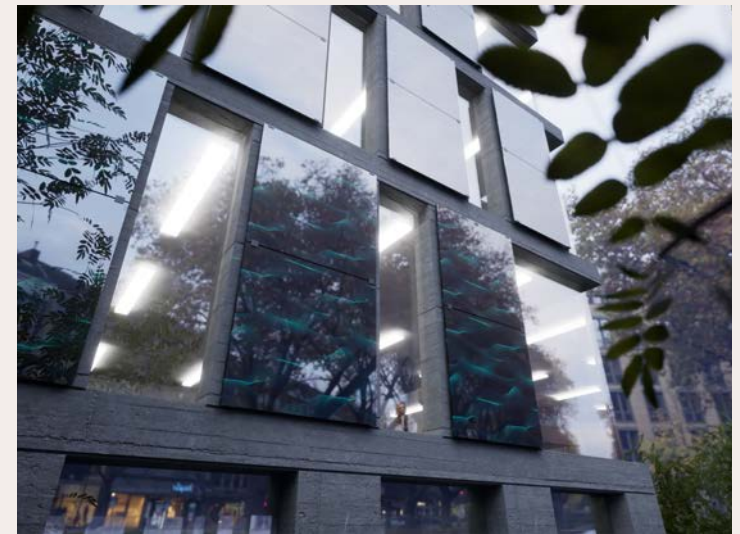
PV modules and racking are specifically designed for this application.



IBC cells combined with backsheet technology have very uniform black appearance

This forms great background for further decoration

Valoe co-operates with glass construction companies (such as Itä-Helsingin Lasi) to provide these building materials to construction companies



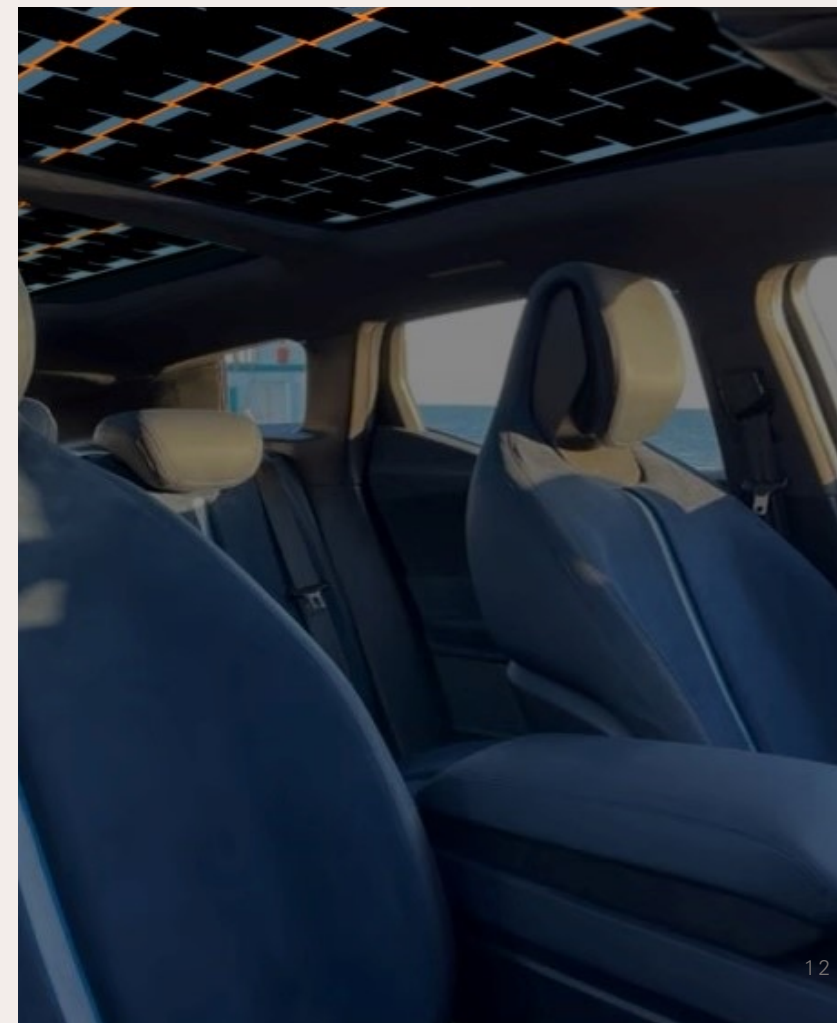
Valoe ODD Form modules

1. Freedom of form and shape
2. Freedom of cell placement
 - No need for bypass diodes
 - No hot spot possible
 - More string routing possibilities
3. Damage resilient design
4. Environment friendly material sets
 - No lead, RoHS compliant
 - Recyclable
 - Low CO2 footprint



Back Contact and IBC Cell Allow Freedom for Cell Placement

- Cells do not have to align.
- Cells can have free spacing.
- Cells may be rotated to any angle.
- Cells may follow shapes or form design features. Additional print layers may be added to complete a design.
- $\frac{1}{2}$, $\frac{1}{4}$ and $\frac{1}{8}$ th cells currently possible. Other cell forms by requests.

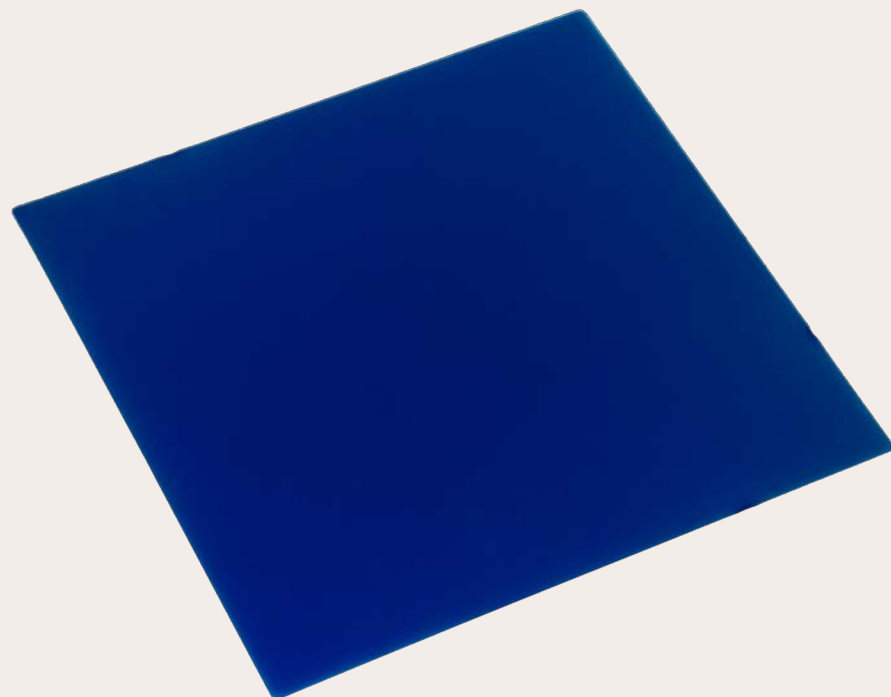


Low breakdown voltage - No need for bypass diodes

Valoe IBC cells have low breakdown voltage

- No hot spots
- Longer strings possible
- Better string layouts
 - Allocating for directional mismatch
 - Allocating for partial shading
 - Better designs

ViPV



What does the low breakdown voltage mean?

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Breakdown voltage impact on number of bypassed cells

For Valoe IBC cells:

$$\begin{aligned} V_{BD} &= 5 \text{ [V]} \\ V_{OC} &\cong 0.68 \text{ [V]} \\ V_{F,diode} &\cong 0,4 \text{ [V]} \end{aligned}$$

The maximum number of cells to be bypassed are:

$$n_{max} < \frac{V_{BD} - V_F}{V_{OC}} + 1$$

$$n_{max} < 8$$

For other more typical cell technologies:

$$\begin{aligned} V_{BD} &\cong 20 \text{ [V]} \\ V_{OC} &\cong 0.68 \text{ [V]} \\ V_{F,diode} &\cong 0,4 \text{ [V]} \end{aligned}$$

The maximum number of cells to be bypassed are:

$$n_{max} < \frac{V_{BD} - V_F}{V_{OC}} + 1$$

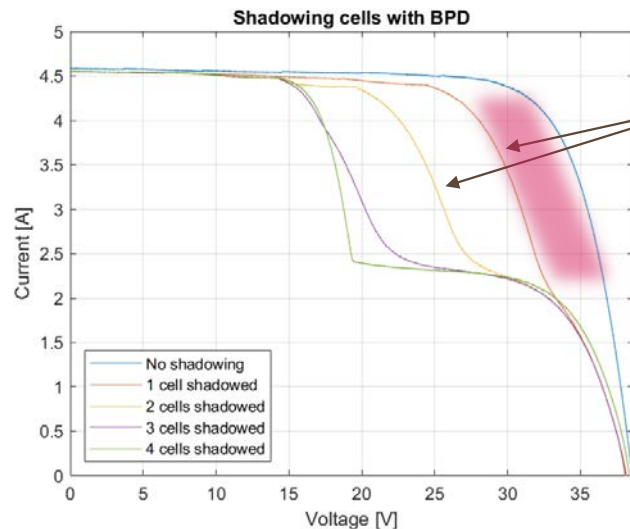
$$n_{max} < 28$$

Breakdown voltage impact on hotspot occurrence

In both cases, we could not bypass less cells than the theoretical limits due to design restrictions

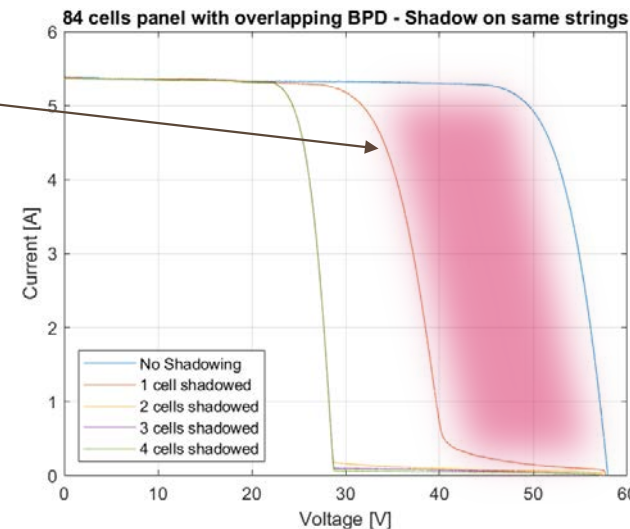
Valoe ¼ IBC cells
 $V_{BD} \cong 5 V, I_{SC} \cong 2.25 A$
 BPD every ~25 cells

Typical ½ PERC cells
 $V_{BD} \cong 20 V, I_{SC} \cong 5.4 A$
 BPD every ~40 cells



Dissipated power by 1 cell :
 $2.25 \cdot 5 = 11.25 W$

Hotspot occurrence



Dissipated power by 1 cell :
 $5.4 \cdot 20 = 108 W$

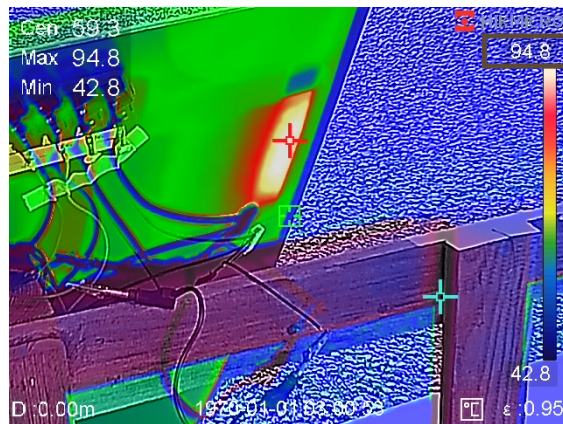
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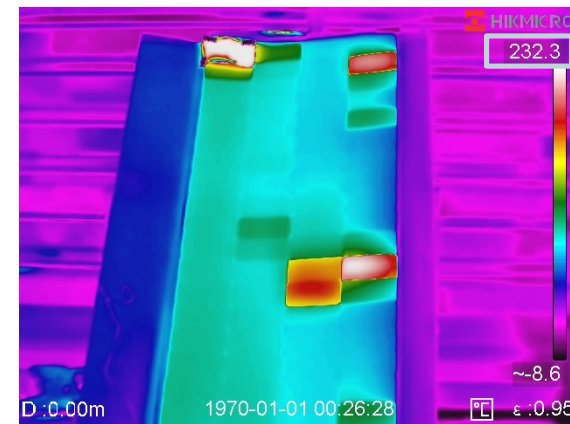
Valoe ¼ IBC cells
 $V_{BD} \cong 5 V, I_{SC} \cong 2.35 A$
 BPD every ~25 cells

Typical ½ PERC cells
 $V_{BD} \cong 20 V, I_{SC} \cong 5.2 A$
 BPD every ~40 cells

No damage



94.8°C vs 232.3°C



Permanent Damage !!

The advantage of having cells with lower V_{BD} → Manageable temperatures in case of hotspot !

IBC modules with conductive backsheet

- Technology available and industrialized by Valoe
- Design freedom:
 - Placement of cells
 - String design to mitigate shading and orientation mismatch
 - 3D shape, also double curvature
 - Connection location and type (automotive grade connectors commercially available)
 - Fully opaque or semi-transparent
- Low breakdown voltage means:
 - No hot spot risk
 - Placement of diodes can be designed based on shading & connection location

Thank You

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