

n-type bifacial solar cell Standard Specifications **PBF-I2-M0**

Rev. 2
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Table of Contents

1. Scope of applications
2. Warranty
3. Revise of specifications
4. Classification and front side electrical characteristics
5. Rear side electrical characteristics
6. Reverse current
7. Appearance
8. Materials and manufacturing process
9. Packaging
10. Labeling
11. Documents
12. Operating suggestions

1. Scope of applications

This specification is applied to n-type bifacial solar cell : **PBF-I2-M0** which is delivered from PVG Solutions Inc. (hereinafter referred to as "PVGS").

2. Warranty

PVGS shall warrant the items listed from clause 4 to 11 at the time of shipping. Discussions will be held when the doubtful products are delivered.

3. Revise of specifications

The items described in this document may change in compliance with laws and the customers' purchase orders, or for the convenience of manufacturing and delivery. PVGS shall inform or consult prior to the change.

4. Classification and front side electrical characteristics

Classification and front side electrical characteristics are shown in Table 4-1. All cells are measured by IV tester and classified with the efficiency.

Table 4-1 Electrical characteristics (Front side)

Class	Rated value		Representative Value					
	Efficiency	Max Power	Max Power	Open Circuit Voltage	Short Circuit Current	Voltage at Max power point	Current at Max power point	
	Eff	Pmax	Pmax	Voc	Isc	Vpm	Ipm	
	[%]	[W]	[W]	[V]	[A]	[V]	[A]	
200	19.9 Eff < 20.1	4.76 W < 4.80	4.78	0.646	9.26	0.548	8.73	
198	19.7 Eff < 19.9	4.71 W < 4.76	4.73	0.643	9.21	0.545	8.68	
196	19.5 Eff < 19.7	4.66 W < 4.71	4.68	0.640	9.16	0.542	8.64	
194	19.3 Eff < 19.5	4.61 W < 4.66	4.64	0.637	9.11	0.540	8.59	
192	19.1 Eff < 19.3	4.56 W < 4.61	4.59	0.635	9.06	0.538	8.53	

* Measurement conditions (in accordance with IEC 60904-3:2008; STC):

Temperature 25 , Air Mass 1.5G , Irradiance 1kW/m2

* The representative values are calculated from the past production data and not a guaranteed value.

5. Rear side electrical characteristics

IV characteristics of the rear side shall not be measured in mass production. The reference rear side efficiency is shown in Table 5-1, which is 84 to 98 % of that of the front side.

Table 5-1 Electrical characteristics (Rear side)

Front side Eff.				Rear side Eff.		
Class	Eff [%]			Eff [%]		
	Min	Representative	Max	Min	Representative	Max
200	20.0	20.0	20.2	16.8	19.2	19.6
198	19.8	19.8	20.0	16.6	19.0	19.4
196	19.6	19.6	19.8	16.5	18.8	19.2
194	19.4	19.4	19.6	16.3	18.6	19.0
192	19.2	19.2	19.4	16.1	18.4	18.8

* These values are calculated from the past production data and not a guaranteed value.

6. Reverse current

Reverse current (I_{rev}) is shown in Table 6-1

Table 6-1 Reverse current

Measuring Voltage	Reverse current
[V]	[A]
-12	Less than 2.5

7. Appearance

The main specifications are shown in Table 7-1. Cell dimensions are shown in the Attached diagram 7-1 and 7-2.

Table 6-1 Main specifications

No.	Item	Specification
1	Dimension	Length : 156.0 ± 0.5mm Diameter : 200.0 ± 1.0 mm
2	Thickness	180 ± 20µm *1
3	Warpage	70µm
4	Corner shape	Circular
5	Color of ARC	Purplish red to Dark blue
6	Front side busbar	Quantity : 3 Pitch: 52 ± 0.3mm Width: 1.5 ± 0.3mm Thickness : 17 ⁺¹⁰ _{.7} µm
7	Rear side busbar	Quantity : 3 Pitch: 52 ± 0.3mm Width: 1.5 ± 0.3mm Thickness: 17 ⁺¹⁰ _{.7} µm

*1: Electrode thickness is not included. It is controlled by measuring weight of the texture etched wafers.

8. Materials and manufacturing process

Main cell materials and manufacturing process are shown in Table 8-1 .

Table 8-1 Materials and manufacturing process

Item	Materials	Manufacturing process
Wafer	n-type mono crystalline silicon	-
AR coating	Silicon nitride(SiNx)	Coating by PECVD
Front electrode	Silver(Ag)	Screen printing, co-firing
Rear electrode	Silver(Ag)	Screen printing, co-firing

9. Packaging

The packaging has passed in JIS Z0200 drop height level 1 test.
100 cells will be stacked together per class inside cardboard box.
Each cardboard box will be vacuum-packed and then housed into delivery cardboard box.
Each delivery cardboard box contains up to 16 cardboard boxes.
Packing example is shown in Fig. 9-1 and 9-2.

* Delivery box size: 500 × 510 × 300 [mm], Max. weight 22 [kg]



Fig. 9-1 Packing example



Fig. 9-2 Packing example

10. Labeling

Label content to be put on cardboard box will be shown Table 10-1.

Label will be put on the side of cardboard box. The arrow direction on the label, “ This direction is front side ”, shows the cell front side (+ side).

Label design may change without prior notice within the range that does not change the content or purpose of label.

Table 10-1 Label content example (Example of class 196)

Item	Example
This direction is front side	
Size	156mm x 156mm x 180µm
Class	196
Lot No.	<u>XXXX</u>
Pcs	100

The label content and position to be put on delivery box will be shown in Table 10-2(a) and Fig. 10-1. When the delivery box contains several class cells, label shown in Table 10-2(b) shall be attached per classes contained.

Table 10-2(a) Label content example

Item	Example
P-NO.	(Number for PVGS internal use)
Case No.	(Box number)/(Total box number per shipment)

Table 10-2(b) Label content example

Item	Example
Class	(Class)
Pcs	(Total quantity per box)



Fig. 10-1 Label position example

11. Documents

The documents to be attached per shipment will be shown in Table 11.

The example of certificate of Inspection will be shown in Fig. 11-1.

Table 11 List of documents

Name of document	Content	
Packing list	Shipping date, Product name, Class, Quantity	One document per shipping
Certificate of inspection	Inspection sign, Lot number list	One document per shipping

Packing list and Certificate of inspection shall be inserted into a transparent envelope which will be attached to the side of delivery box.

The position of the envelope is shown in Fig. 11-1.

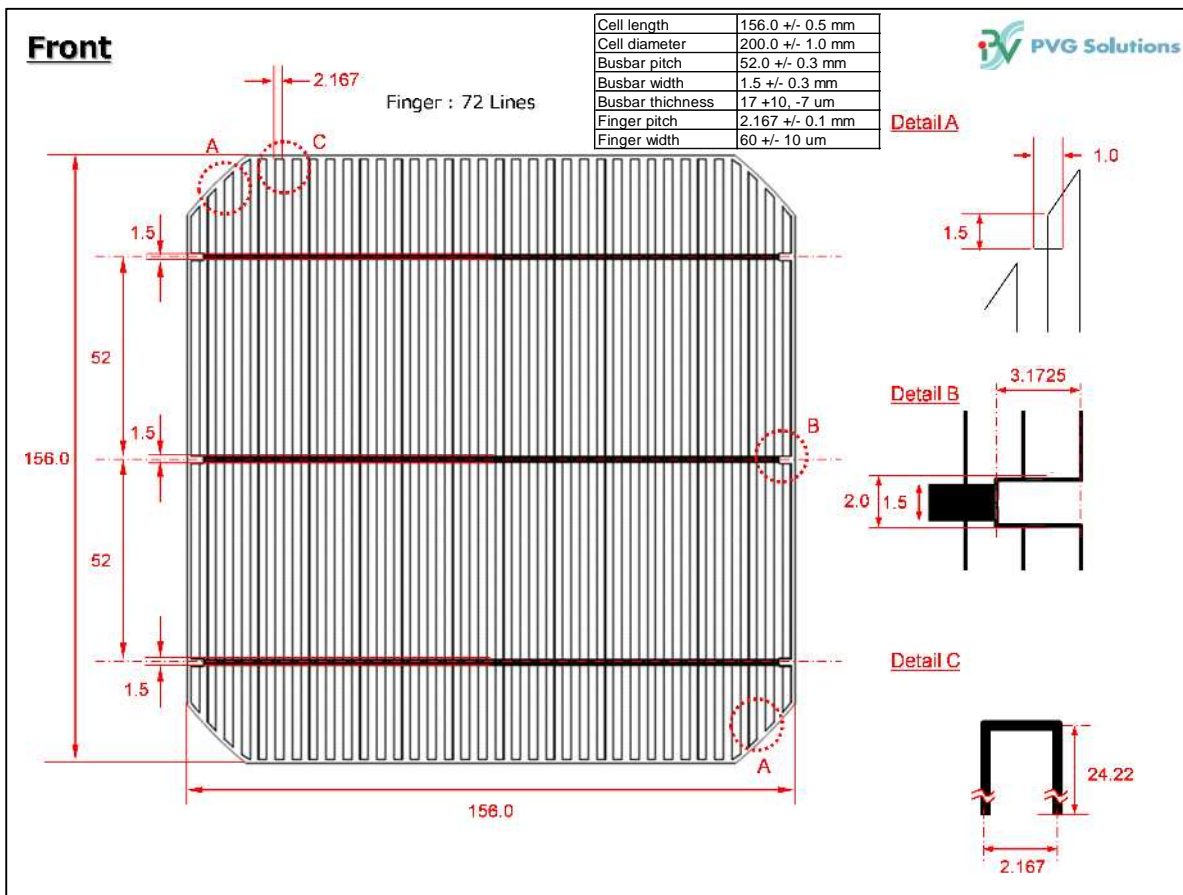


Fig. 11-1 Example of envelope with Packing List and Certificate of Inspection.

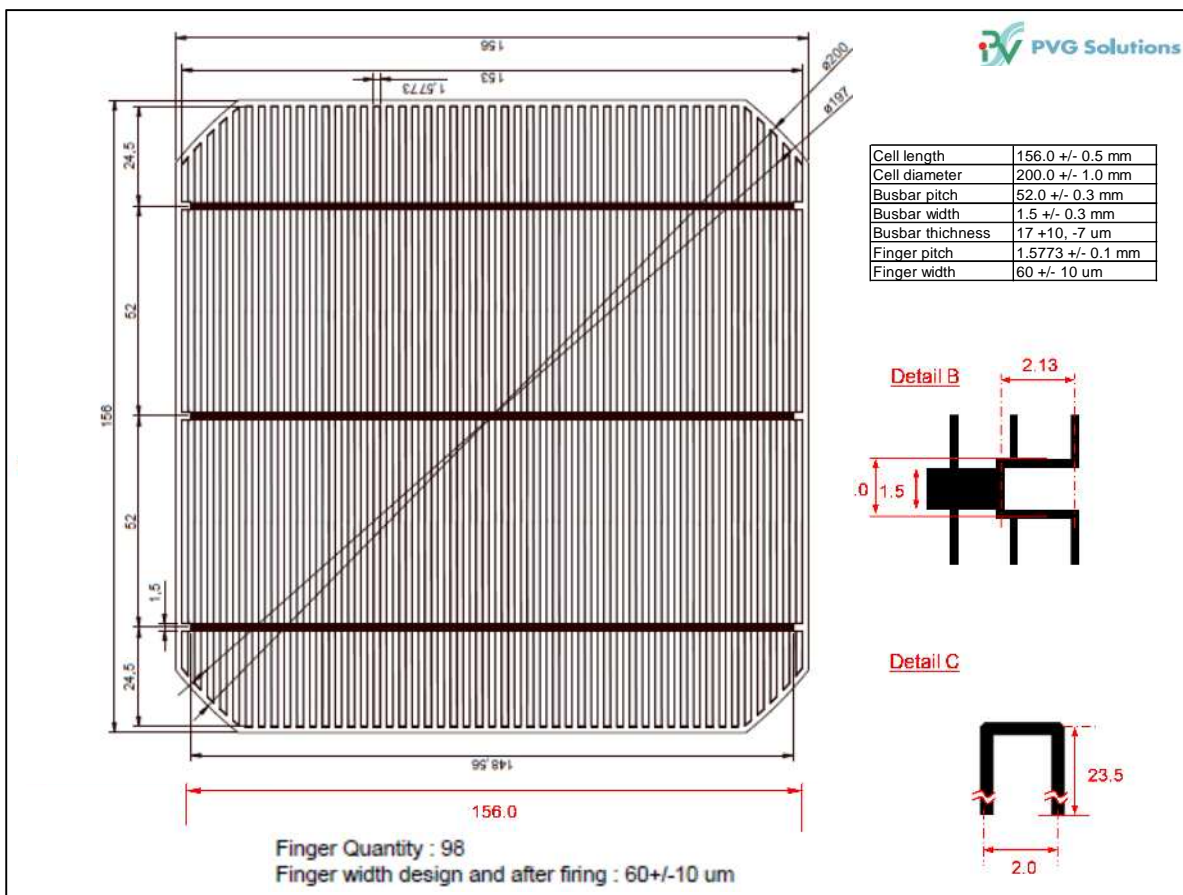
12. Operating suggestions

Please do not touch the cells directly by bare hands. It will be cause of negative influence to electrical performance and appearance. Please wear clean gloves when touching cells.

Attached Diagram 7-1



Attached Diagram 7-2



XXXX XXXX

Certificate of Inspection

P-No. XXX

Ship Date: MM/DD/YY

Case No	Product Name	Class	Lot No.	Quantity
	PBF-I2-M0	XXX		XXXX

We hereby certify that the above product(s) have been through appropriate inspections to satisfy the below items defined in Standard Specification:

Clause 4	Classification and Front side Electrical Characteristics
Clause 5	Reverse Current
Clause 6	Appearance

Note

Plant Manager	QC Group	Inspector

Fig. 11-1 Example of certificate of Inspection