Glass-glass PV module samples for laboratory testing

Appealing glass/glass-based BIPV click-&-go envelope solutions

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Adaptable and adaptive RES envelope solutions to maximise energy harvesting and optimize EU building and district load matching

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Executive Summary

This document addresses the technical specifications and detailed designs of BIPV samples selected for laboratory testing, based on the solutions selected for the demo sites from the proposed options of the glass-glass BIPV modules designs described in this document.

The procedure started with several discussions including all partners in the LDWG (local demo working group) supporting the demo owners´ selection of the glass-glass BIPV modules for each demo site among the different solutions proposed by ONYX. This phase ends with the decision of using two different types of BIPV modules in all the demos, one for roof with dimensions of 1420 mm x 900 mm, and a second one for façade, with dimensions of 350 mm x 900 mm. Once these solutions were approved, a testing plan was defined. The testing plan was based on standards from the construction sector and from the PV sector, covering all the project needs. As a result of the definition of the testing plan, the samples needed were set in terms of units, dimensions and composition according to the standards.

The document is organised as follows. First, the glass-glass PV modules selected for each demo site are summarised. Then, the testing plan designed and the number and characteristics of the samples required for performing those tests are presented. Finally, the designs of the samples are provided. Pictures of all the samples manufactured for testing purposes will be included in other documents, with the results of the laboratory testing for window block products and the results of all laboratory testing performed for the PV click-&-go envelope solutions, respectively.

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1. Selected PV modules for each demo site

In order to understand the testing plan that will be carried out, in the following table the glass-glass PV modules designed and selected for each demo are summarised.

Table 1: Selected PV modules for demo sites

Selected PV modules for demo sites	PV module configuration				Location					
	Front glass	Rear glass	Technology Cells	color	Ludvika (SWE)		Campi Bisenzio (IT)		Saint Aubin (FR)	
					Roof	Façade	Roof	Façade	Roof	Façade
900 mm x 350 mm Glass-glass monocrystalline Si technology + Click & GO	3 mm tempered glass	3 mm tempered glass + frit	Mono crystalline Si Poly crystalline Si	Black Terracotta						
1420 mm x 900 mm Glass-glass monocrystalline Si technology + Click & GO	3 mm tempered glass	3 mm tempered glass + frit	Mono crystalline Si	Black						
1508 mm x1325 mm Glass-glass monocrystalline Si technology + Click & GO	4 mm tempered glass	4 mm tempered glass + frit	Mono crystalline Si	Black						

Once the different modulations have been identified, the summary of samples needed for testing is provided in the following section, including also window block samples.

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2. Summary of PV samples for testing

The summary of PV samples classified per constructive solution and per test are provided in the tables below.

Table 2: Summary of roof samples needed for testing

Summary of samples needed for testing	Testing on roof		
	Reaction to Fire (classification tests)	Wind load resistance	Impact resistance (Hail impact)
	CEN TS 1187	Internal procedure based on EAD 090062-00-0404	61215-2:2016
900 mm x 350 mm Glass-glass monocrystalline Si technology + Click & GO	3	-	-
1420 mm x 900 mm Glass-glass monocrystalline Si technology + Click & GO	3	3	2
400 mm x 900 mm Glass-glass monocrystalline Si technology + Click & GO	4	-	-
TOTAL UNITS	15		

Table 3: Summary of façade samples needed for testing

Summary of samples needed for testing	Testing on façade		
	Reaction to Fire (classification tests)	Wind load resistance	Impact resistance (on façade)
	EN13823	EAD 090062-00-0404	EAD 090062-00-0404
900 mm x 350 mm Glass-glass monocrystalline Si technology	-	3	3
1420 mm x 900 mm Glass-glass monocrystalline Si technology	-	-	-
1500 mm x 500 mm Glass-glass monocrystalline Si technology + Click & GO	3	-	-
500 mm x 207 mm Glass-glass monocrystalline Si technology + Click & GO	3	-	-
500 mm x 800 mm Glass-glass monocrystalline Si technology + Click & GO	3	-	-
1000 mm x 800 mm Glass-glass monocrystalline Si technology + Click & GO	3	-	-
1000 mm x 207 mm Glass-glass monocrystalline Si technology + Click & GO	3	-	-
TOTAL UNITS	21		

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Table 4: Summary of window block samples needed for testing

Summary of samples needed for testing	Testing for Window block		
	Reaction to Fire (classification tests)	Wind load resistance (Façade system Window block - suction)	Impact resistance (on façade)
	EN13823	EAD 090062-00-0404	EAD 090062-00-0404
1508 mm x 1325 mm Glass-glass monocrystalline Si technology	-	3	3
TOTAL UNITS	6		

In addition to those tests, there are other common tests that are independent of the constructive solution. The summary of those tests and the PV samples needed are provided in the following table.

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Table 5: Summary of PV samples needed for general testing

Summary of samples needed for testing	General testing								
	Reaction to Fire (Ignitability of products)	Impact resistance test	Resistance against manual attack	Humidity test	High temperature test	UV preconditioning test (MQT10)	Thermal cycling (TC) (MQT11)	Humidity freeze (HF) (MQT12)	Damp Heat (DH) (MQT13)
	EN 11925-2	EN 12600	EN 356	ISO 12543- Part 4	ISO 12543- Part 4	61215-2:2016			
250 mm x 90 mm Glass-glass monocrystalline Si technology	6	-	-	-	-	-	-	-	-
1938 mm x 876mm Glass-glass monocrystalline Si technology	-	12	-	-	-	-	-	-	-
1100 mm x 900 mm Glass-glass monocrystalline Si technology + Click & GO	-	-	8	-	-	-	-	-	-
200 mm x 380 mm Glass-glass monocrystalline Si technology + Click & GO	-	-	-	6	6	-	-	-	-
200 mm x 200 mm Glass-glass monocrystalline Si technology + Click & GO	-	-	-	-	-	6	-	-	-
360 mm x 360 mm Glass-glass monocrystalline Si technology + Click & GO	-	-	-	-	-	-	7	6	6
Total by type	6	32				25			
TOTAL UNITS	63								

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3. Total PV samples for testing

In the following tables, the compilation of all the glass-glass modules samples necessary for laboratory testing and the complete description of each sample are presented.

Table 6: Total PV samples for testing

Samples for testing PV glass glass modules for demo sites	Type of testing			
	Fire reaction	Mechanical resistance of system	Mechanical resistance of glass	Ageing test and PV performance
900 mm x 350 mm Glass-glass monocrystalline Si tech.	3	6	-	-
1420 mm x 900 mm Glass-glass monocrystalline Si tech.	3	5	-	-
1508 mm x 1325 mm Glass-glass monocrystalline Si tech.	-	6	-	-
Samples for testing, requirements set by standards				
400 mm x 900 mm Glass-glass monocrystalline Si tech.	4	-	-	-
1500 mm x 500 mm Glass-glass monocrystalline Si tech.	3	-	-	-
500 mm x 207 mm Glass-glass monocrystalline Si tech.	3	-	-	-
500 mm x 800 mm Glass-glass monocrystalline Si tech.	3	-	-	-
1000 mm x 800 mm Glass-glass monocrystalline Si tech.	3	-	-	-
1000 mm x 207 mm Glass-glass monocrystalline Si tech.	3	-	-	-
250 mm x 90 mm Glass-glass monocrystalline Si tech.	6	-	-	-
1938 mm x 876mm Glass-glass monocrystalline Si tech.	-	-	12	-
1100 mm x 900 mm Glass-glass monocrystalline Si tech.	-	-	8	-
200 mm x 380 mm Glass-glass monocrystalline Si tech.	-	-	-	12
200 mm x 200 mm Glass-glass monocrystalline Si tech.	-	-	-	6
360 mm x 360 mm Glass-glass monocrystalline Si tech.	-	-	-	19
Total by type	31	17	20	37
SUMMARY OF SAMPLES	105			

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Table 7: Samples complete description

Dimensions (mm)	glass composition	Active module	cells per module	Junction box + glass-hole	Structure
Samples for testing, Demo site designs					
350 mm x 900 mm	3+3 (both tempered glass)	Yes	2x5	Yes	Yes. 1 system for 3 modules
1420 mm x 900 mm	3+3 (both tempered glass)	Yes	8x5	Yes	Yes, one system per module
1508 mm x 1325 mm	4+4 (both tempered glass)	Yes	9x8	Yes	Yes, one system per module
Samples for testing, requirements set by standards					
1500mm x 500 mm	3+3 (both tempered glass)	Not required	1x9	Yes	**3 x** (1 system for each glass unit). 15 systems in total
500 mm x 207 mm	3+3 (both tempered glass)	Not required	1x3	Yes	
500 mm x 800 mm	3+3 (both tempered glass)	Not required	3x5	Yes	
1000 mm x 800 mm	3+3 (both tempered glass)	Not required	1x6	Yes	
1000 mm x 207mm	3+3 (both tempered glass)	Not required	6x1	Yes	
400 mm x 900 mm	3+3 (both tempered glass)	Not required	2x5	Yes	Yes. 1 for each module
250 mm x 90 mm	3+3 (both tempered glass)	No	Without cells	No	No
1938 mm x 876 mm	3+3 (both tempered glass)	Not required	1x10	No	No
1938 mm x 876 mm	4+4 (both tempered glass)	Not required	1x10	No	No
200 mm x 380 mm	3+3 (both tempered glass)	Not required	1x2	No	No
200 mm x 380 mm	4+4 (both tempered glass)	Not required	1x2	No	No
1100 mm x 900 mm	3+3 (both tempered glass)	Not required	1x6	No	No
1100 mm x 900 mm	4+4 (both tempered glass)	Not required	1x6	No	No
200 mm x 200 mm	3+3 (both tempered glass)	Yes	1	Yes	No
200 mm x 200 mm	4+4 (both tempered glass)	Yes	1	Yes	No
360 mm x 360 mm	3+3 (both tempered glass)	Yes	2x2	Yes	No
360 mm x 360 mm	4+4 (both tempered glass)	Yes	2x2	Yes	No

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4. Glass-glass PV samples designs

In the following subsections, the designs of all the glass-glass BIPV modules necessary for laboratory testing organised by type of test to be performed are included.

4.1 Glass-glass BIPV testing samples for CEN TS 1187

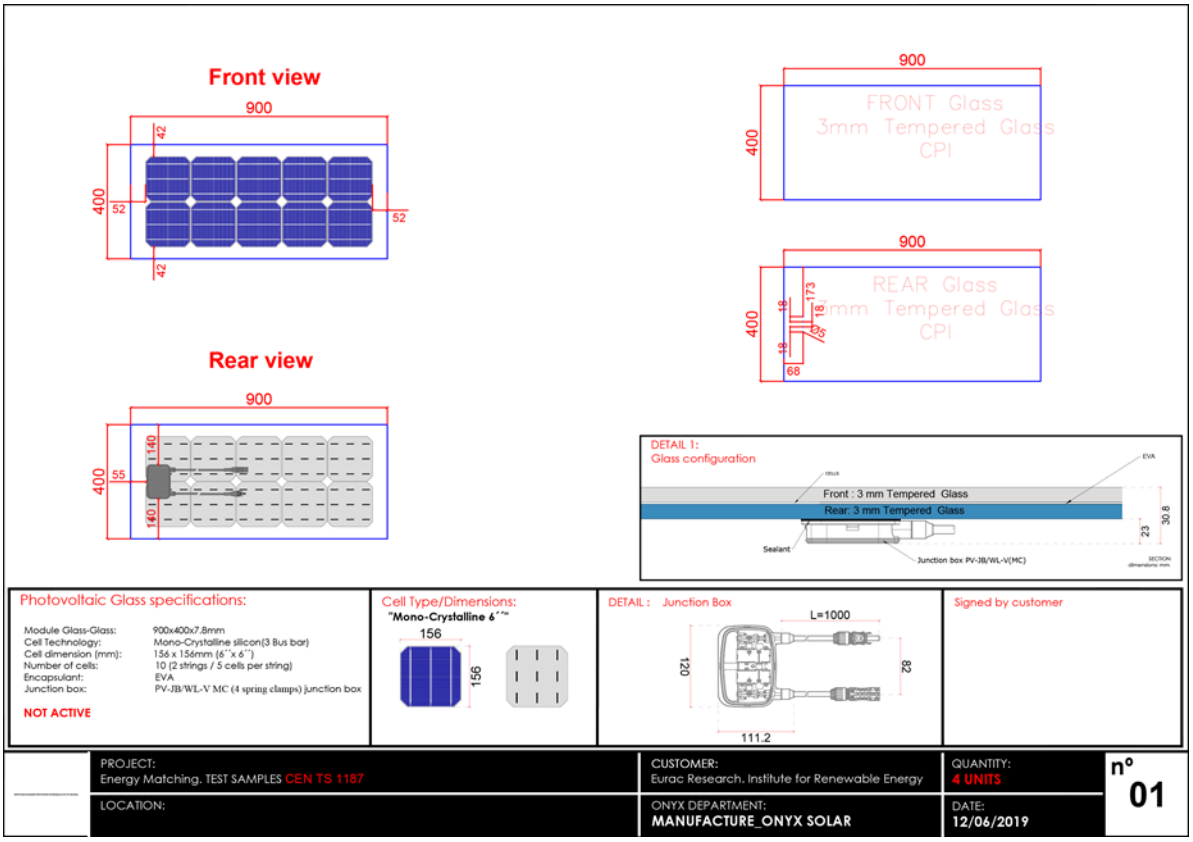

Figure 1: 900 mm x 400 mm c-Si glass-glass design (3+3)

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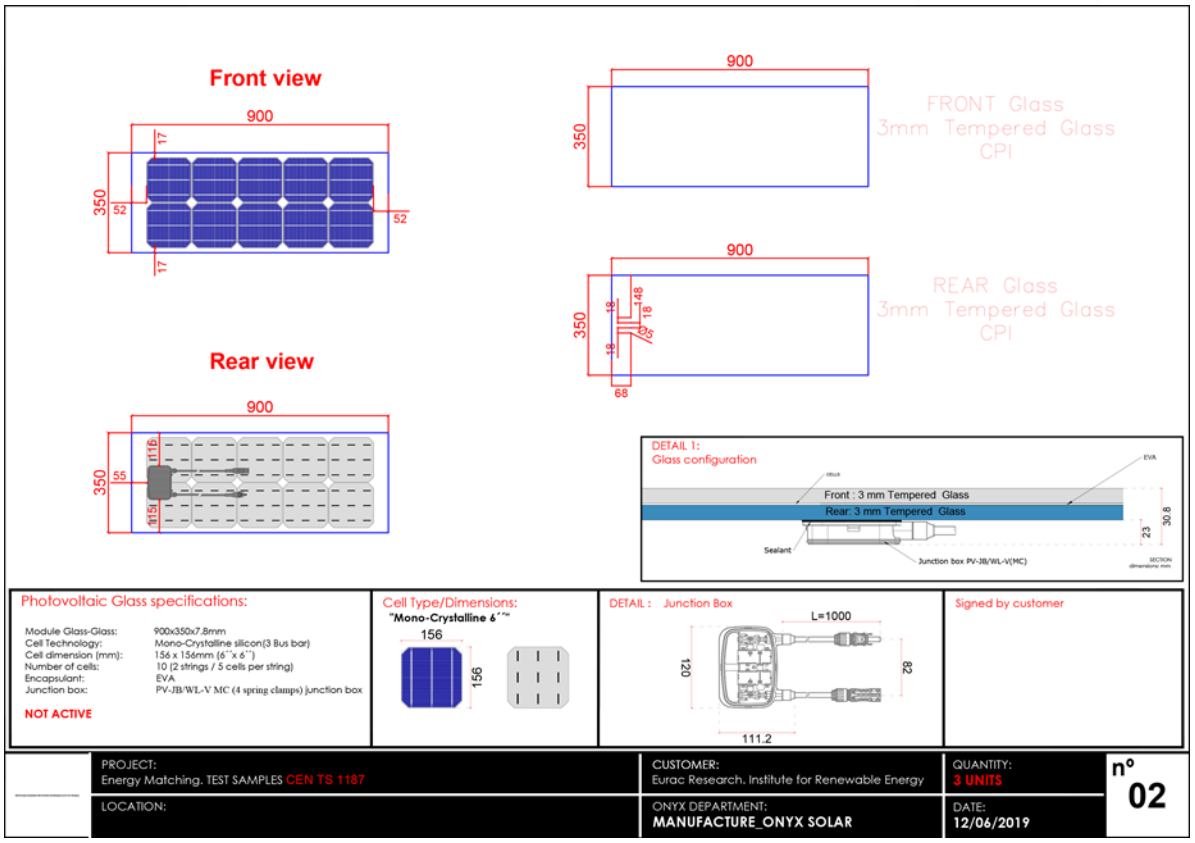

Figure 2: 900 mm x 350 mm c-Si glass-glass design (3+3)

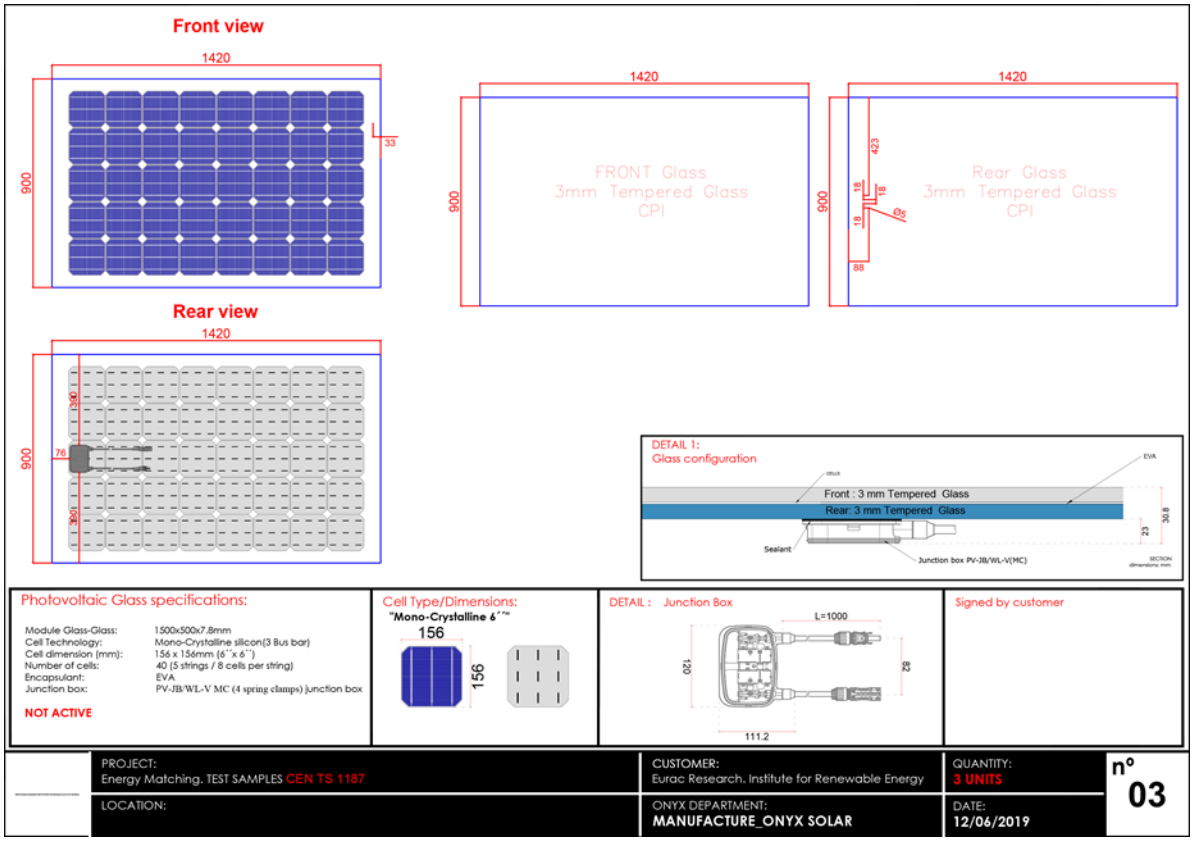

Figure 3: 1420 mm x 900 mm c-Si glass-glass design (3+3)

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4.2 Glass-glass BIPV testing samples for EAD 090062-00-0404

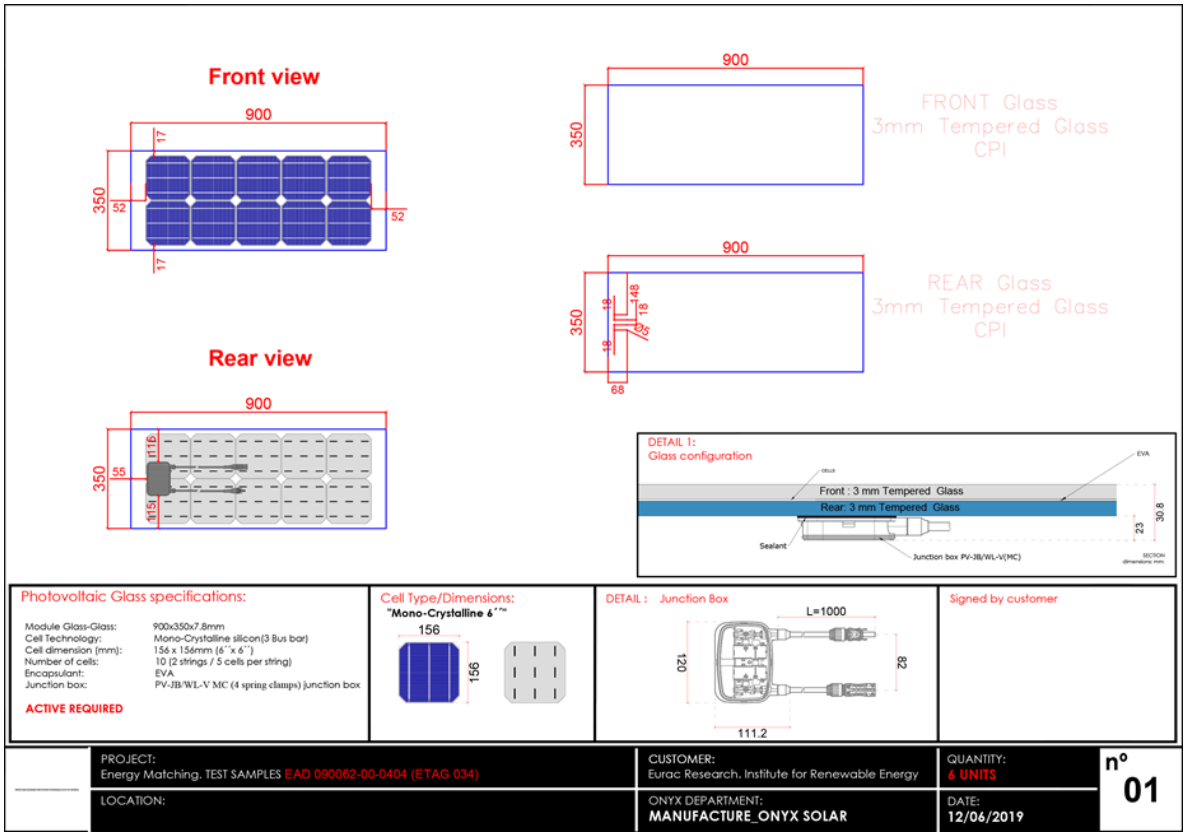

Figure 4: 900 mm x 350 mm c-Si glass-glass design (3+3)

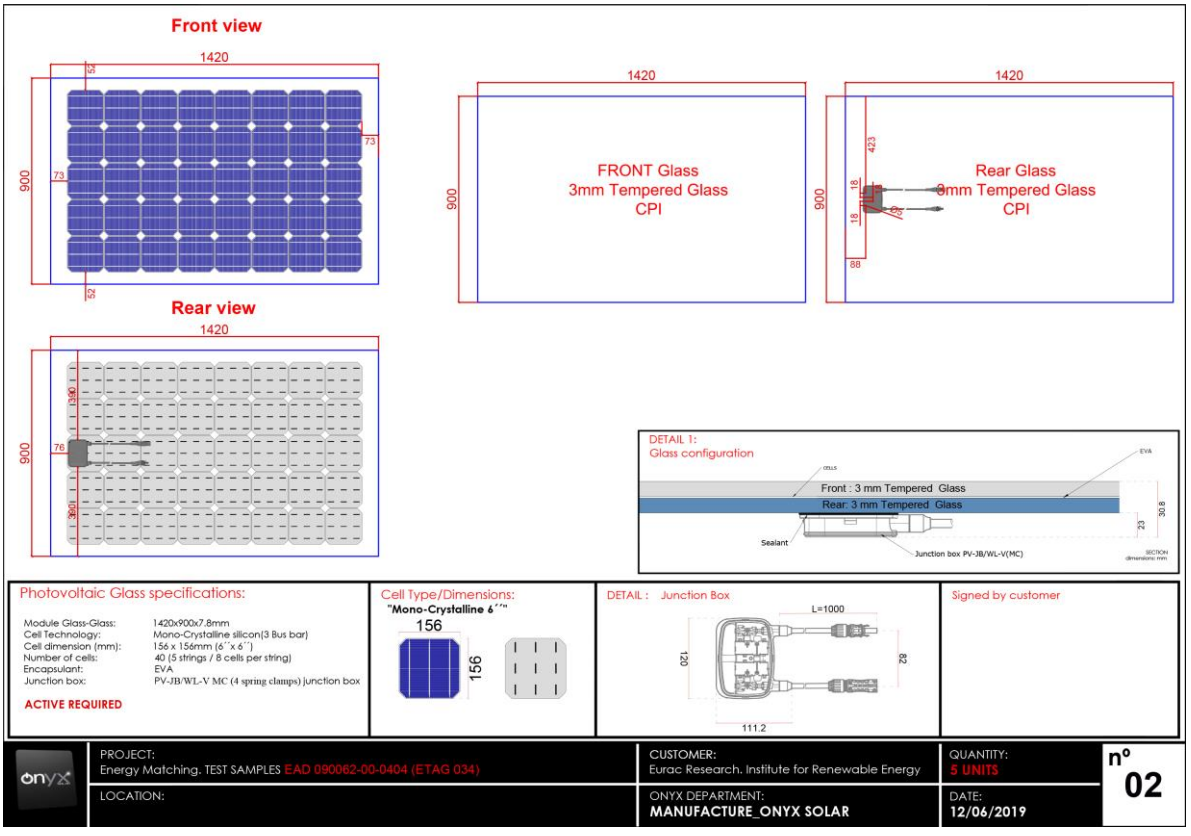

Figure 5: 1420 mm x 900 mm c-Si glass-glass design (3+3)

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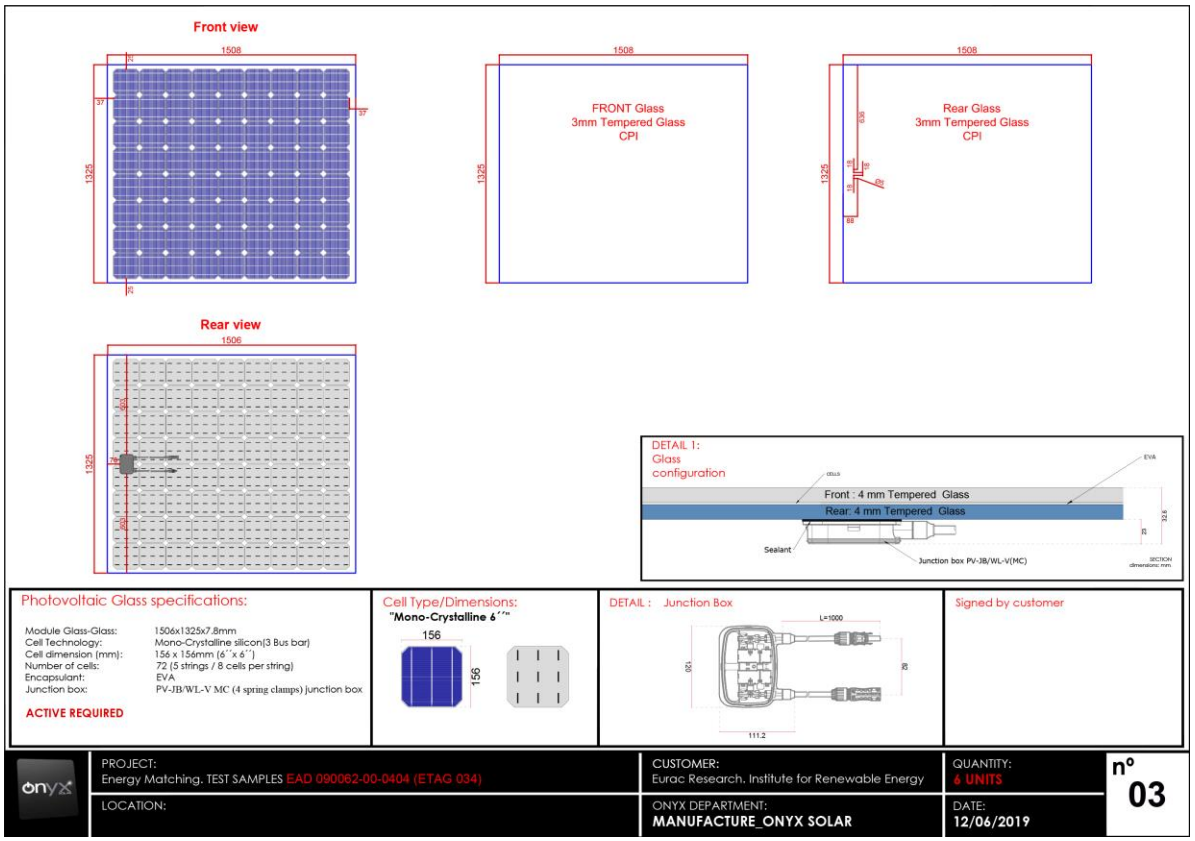

Figure 6: 1506 mm x 1325 mm c-Si glass-glass design (4+4)

4.3 Glass-glass BIPV testing samples for EN 356

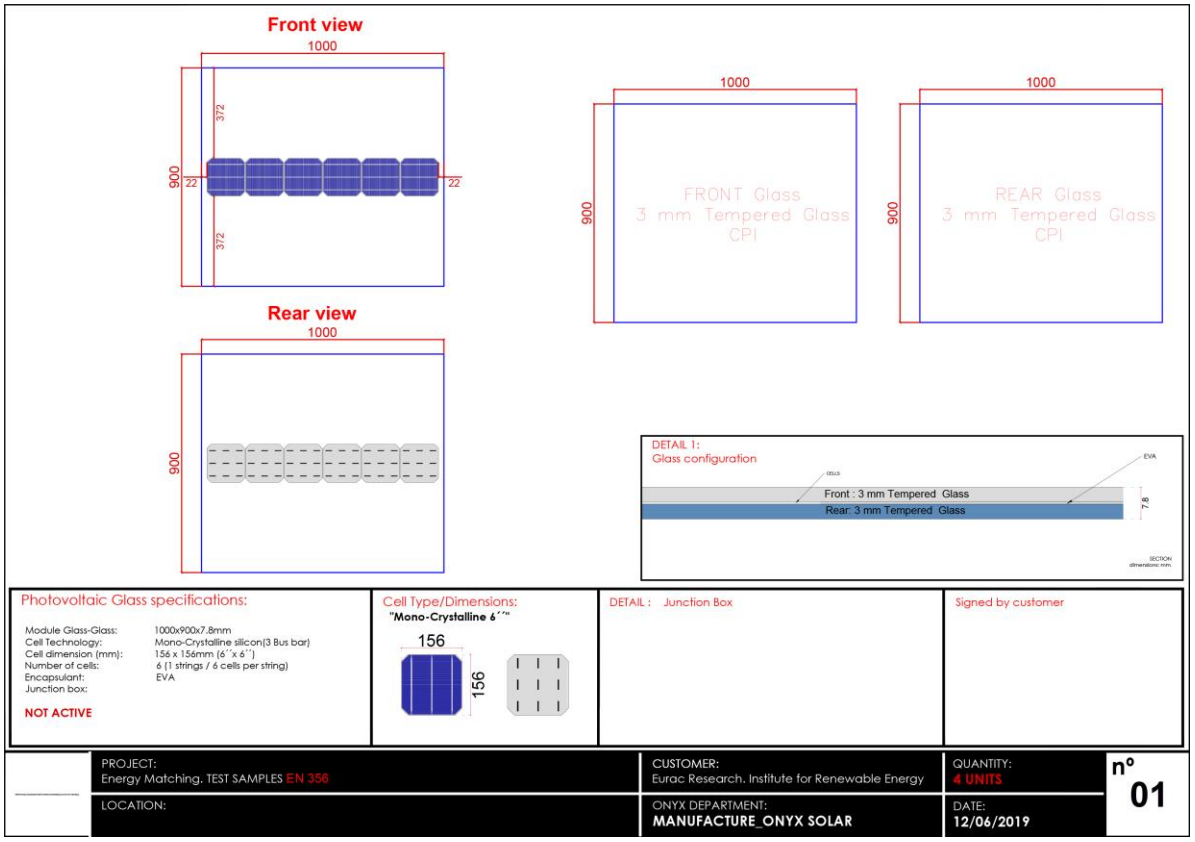

Figure 7: 1000 mm x 900 mm c-Si glass-glass design (3+3)

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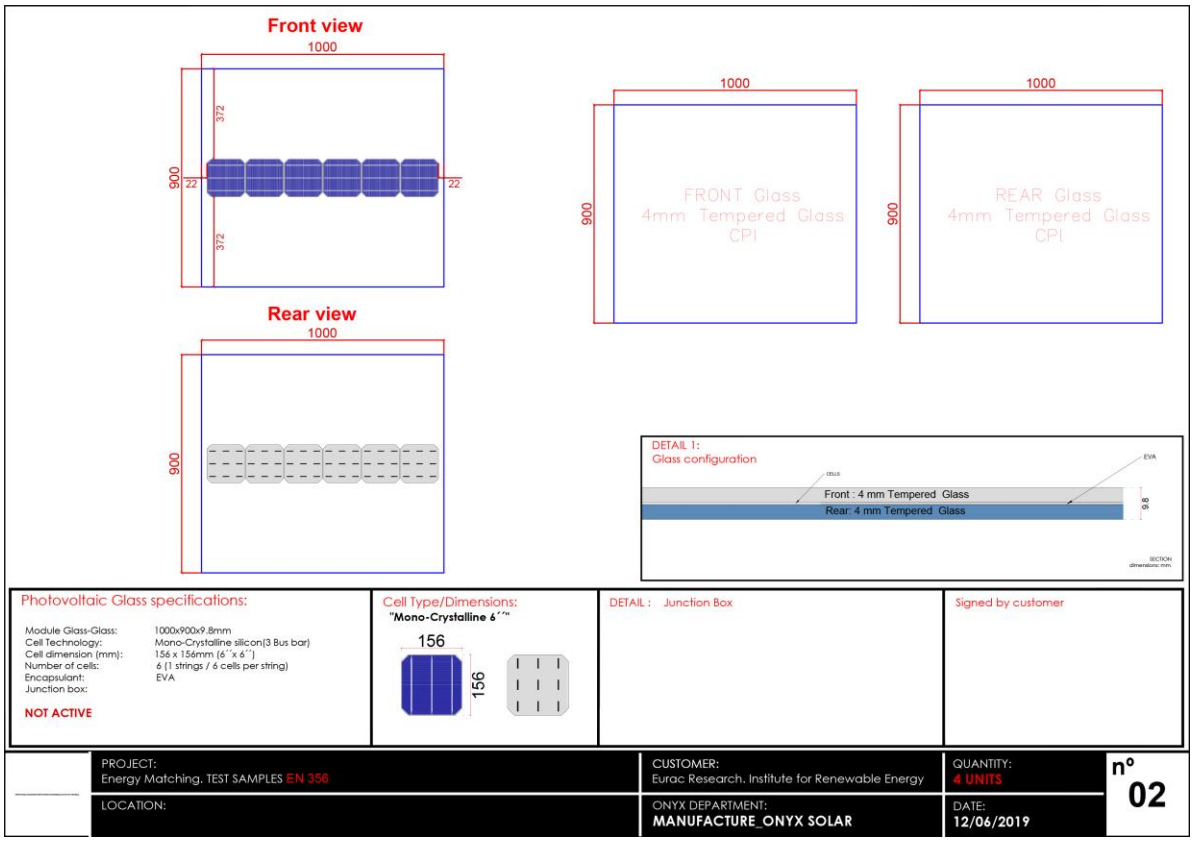

Figure 8: 1000 mm x 900 mm c-Si glass-glass design (4+4)

4.4 Glass-glass BIPV testing samples for EN 11925-2

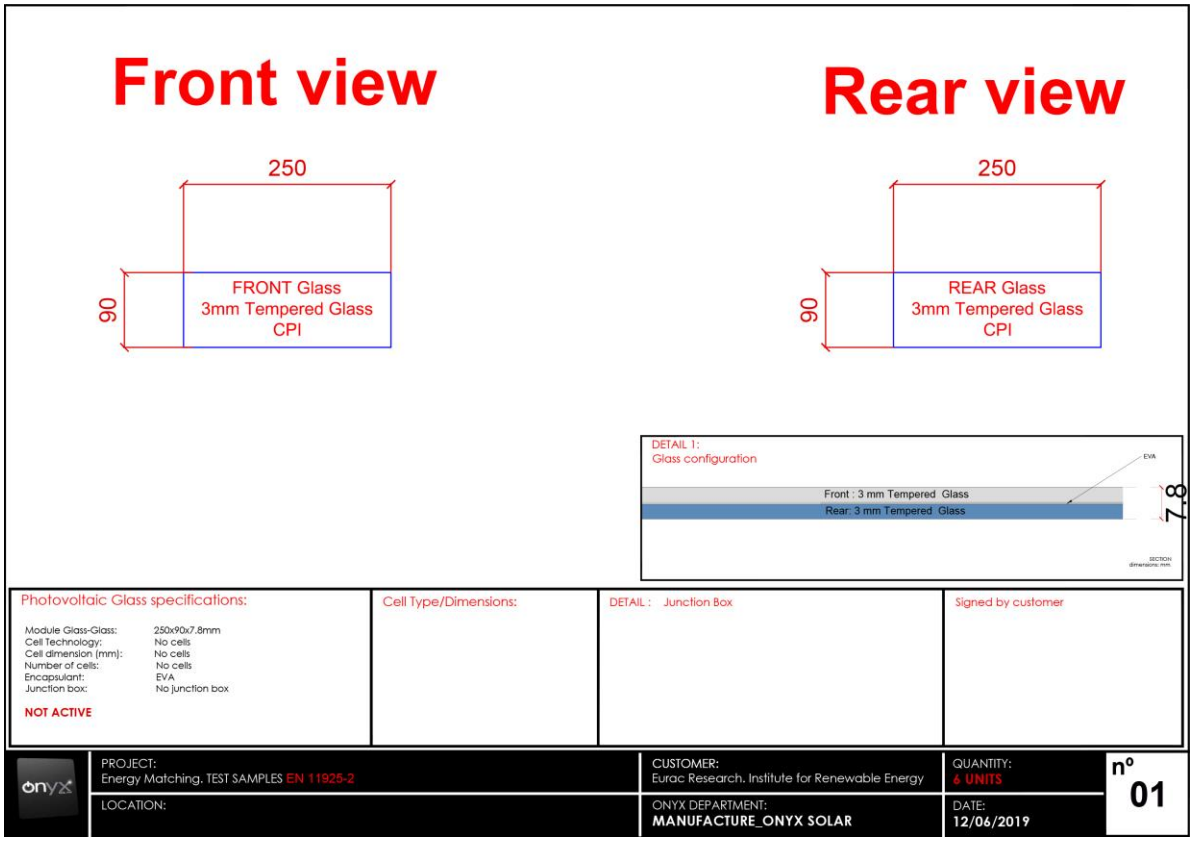

Figure 9: 250 mm x 90 mm c-Si glass-glass design (3+3)

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4.5 Glass-glass BIPV testing samples for EN 12600

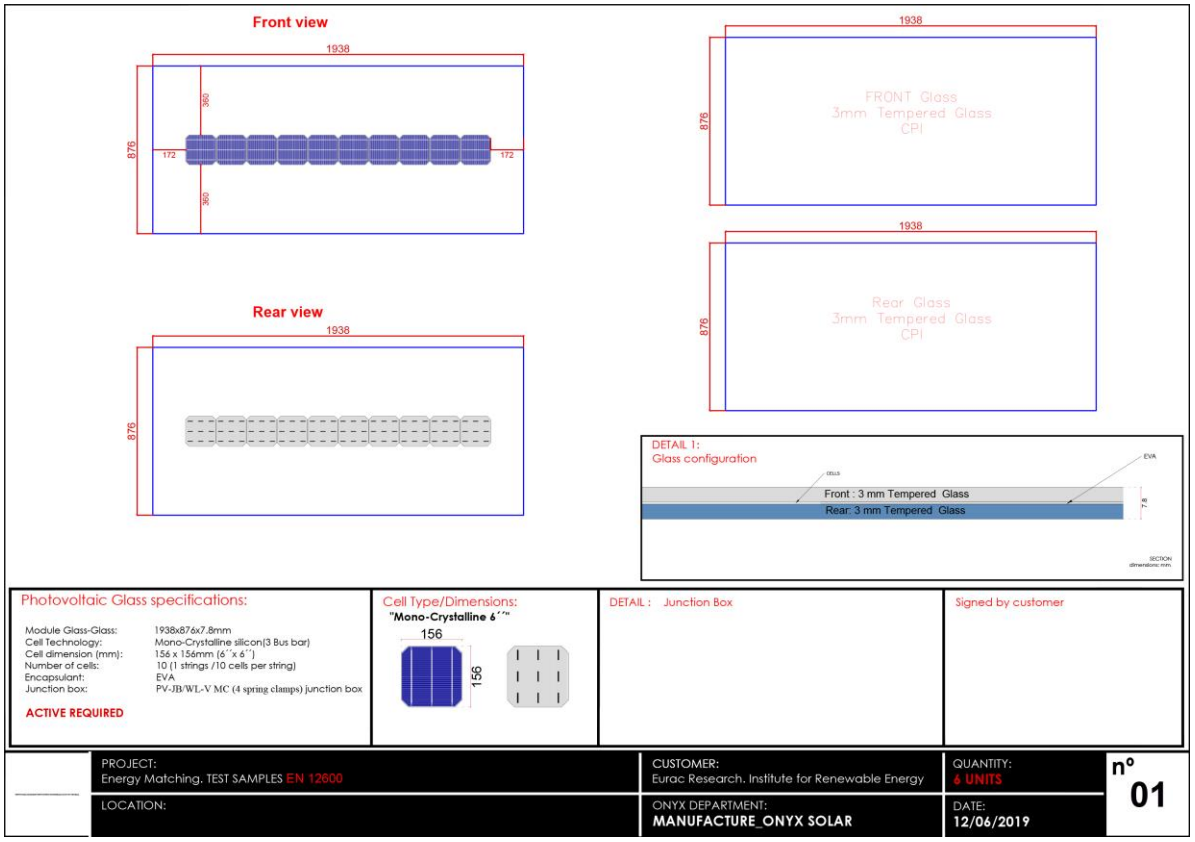

Figure 10: 1938 mm x 876 mm c-Si glass-glass design (3+3)

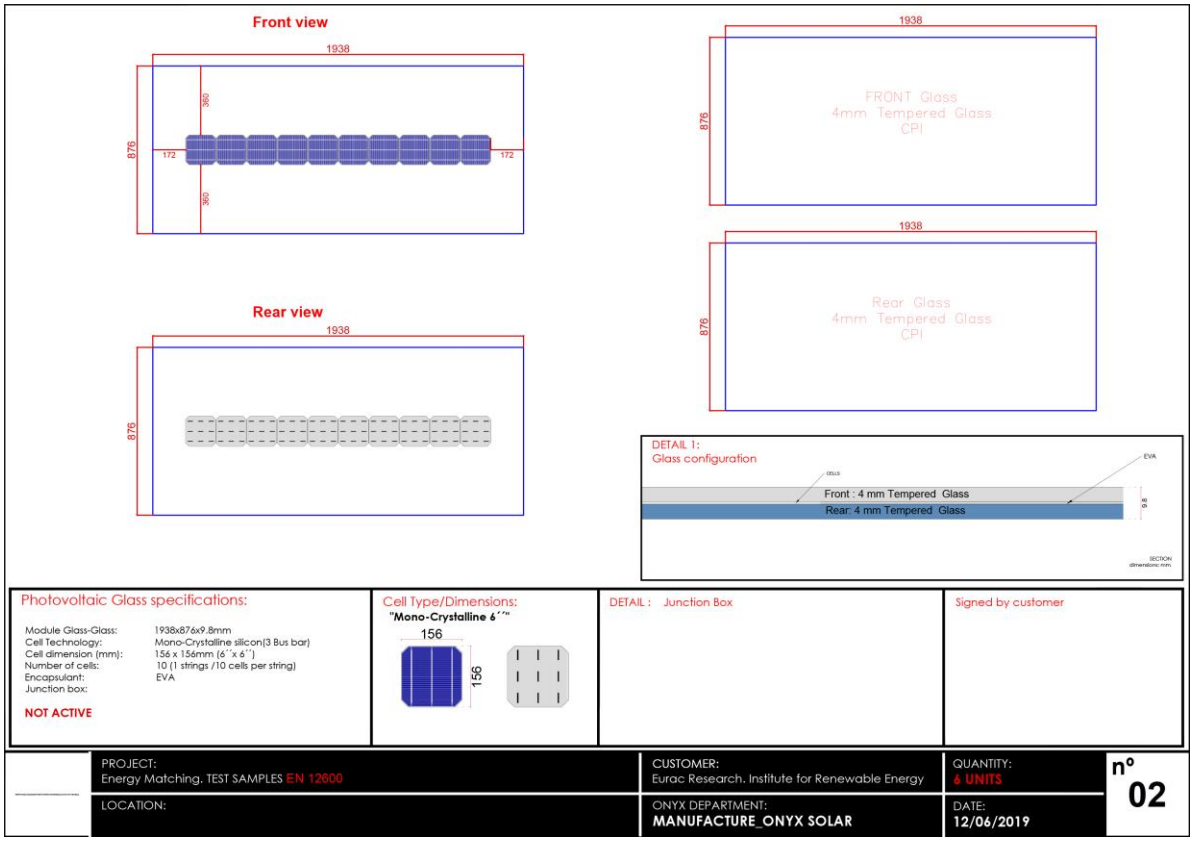

Figure 11: 1938 mm x 876 mm c-Si glass-glass design (4+4)

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4.6 Glass-glass BIPV testing samples for EN 13823

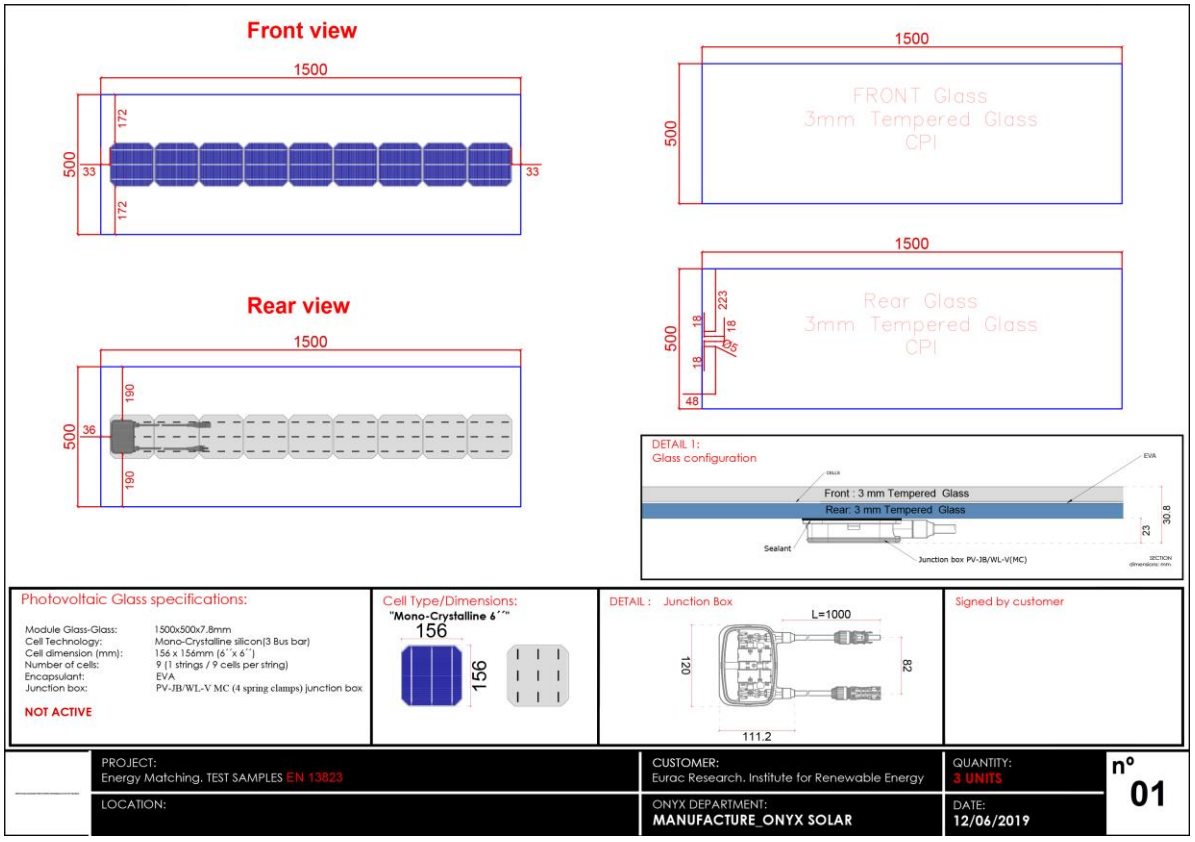

Figure 12: 1500 mm x 500 mm c-Si glass-glass design (3+3)

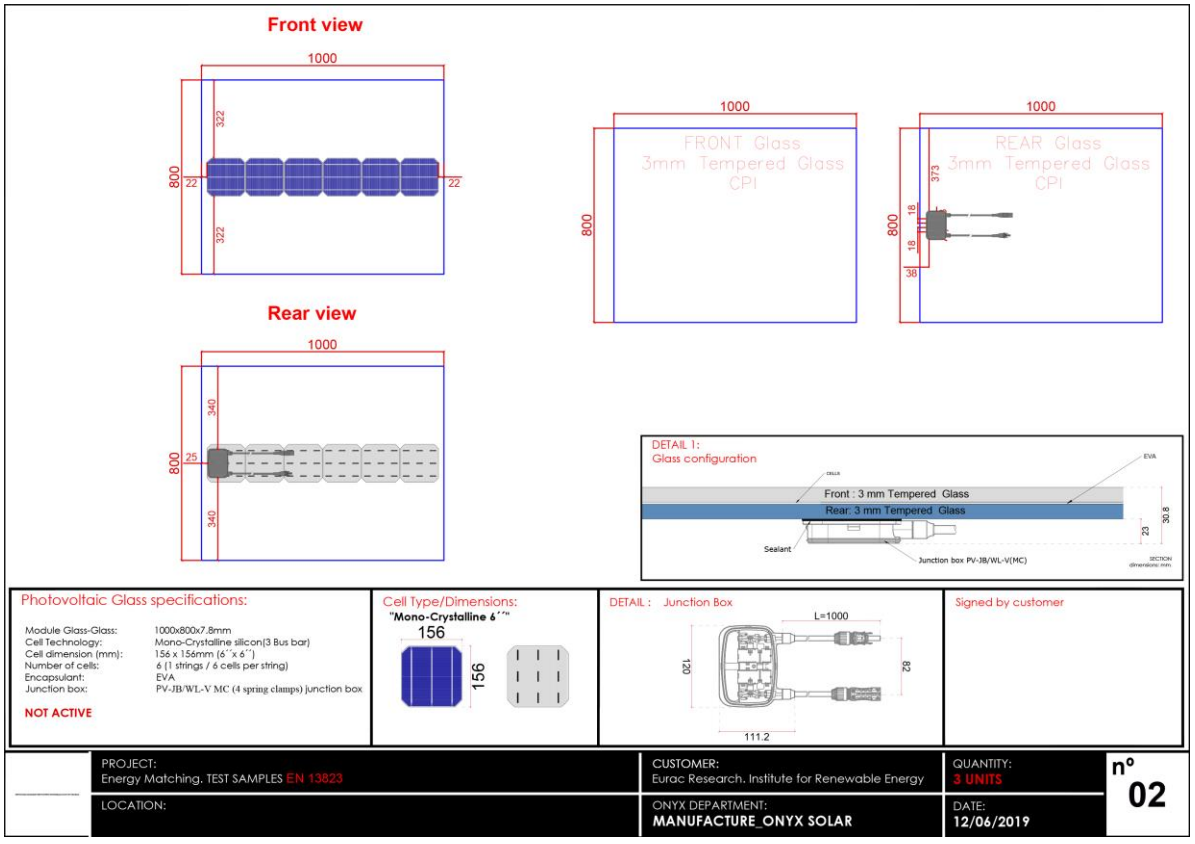

Figure 13: 1000 mm x 800 mm c-Si glass-glass design (3+3)

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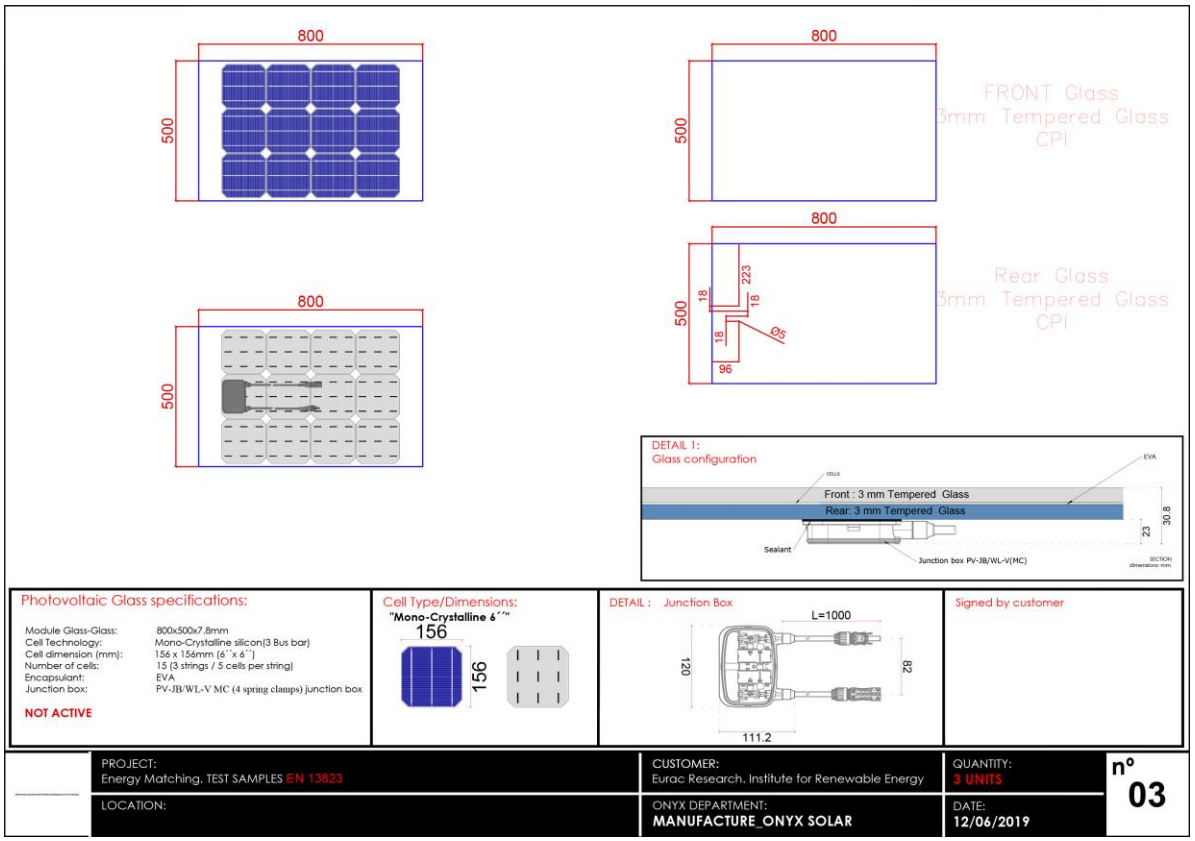

Figure 14: 800 mm x 500 mm c-Si glass-glass design (3+3)

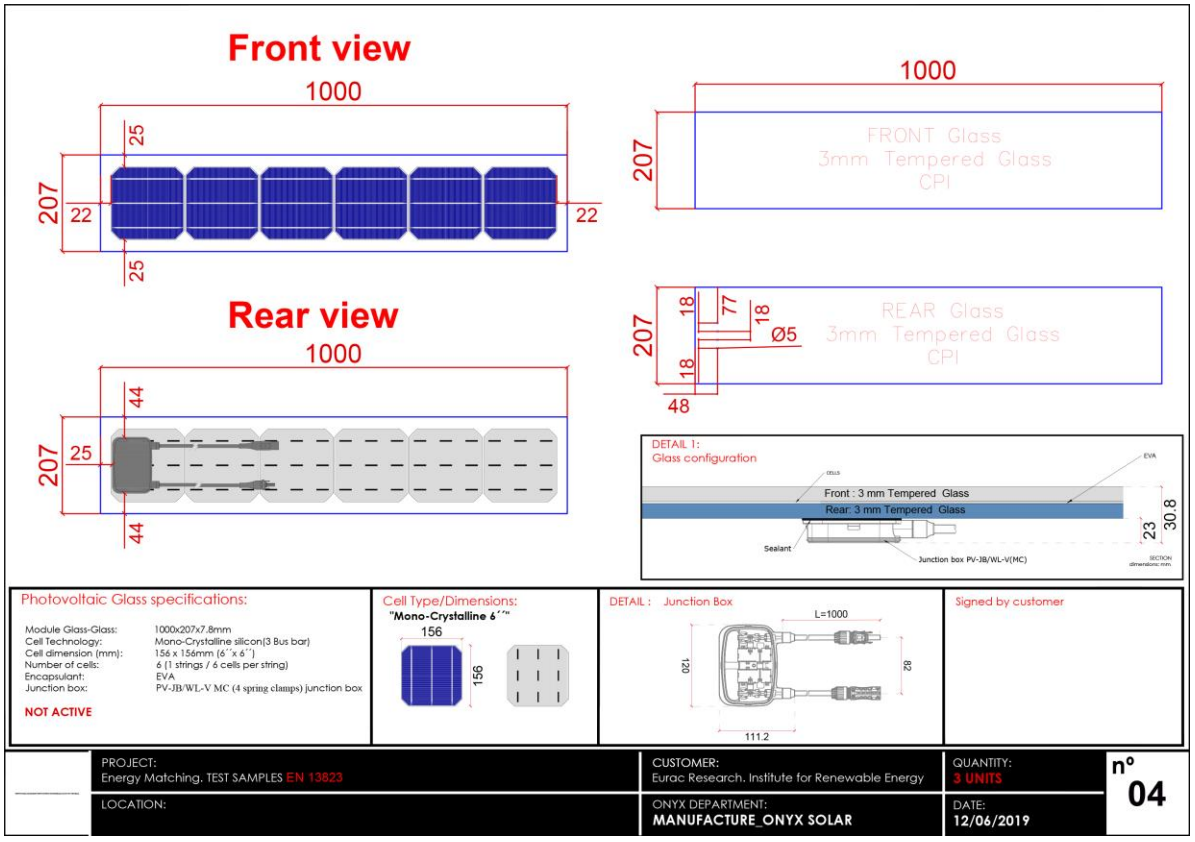

Figure 15: 1000 mm x 207 mm c-Si glass-glass design (3+3)

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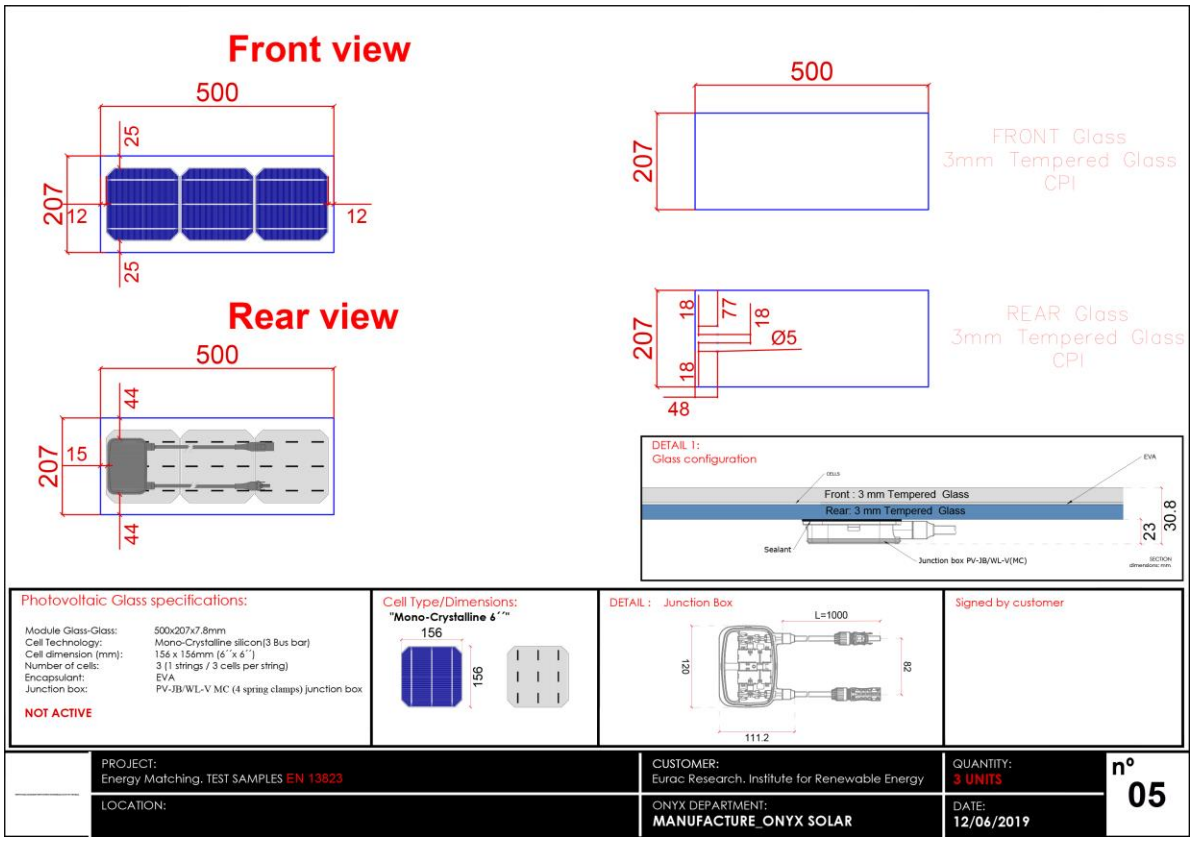

Figure 16: 500 mm x 207 mm c-Si glass-glass design (3+3)

4.7 Glass-glass BIPV testing samples for IEC 61215-2

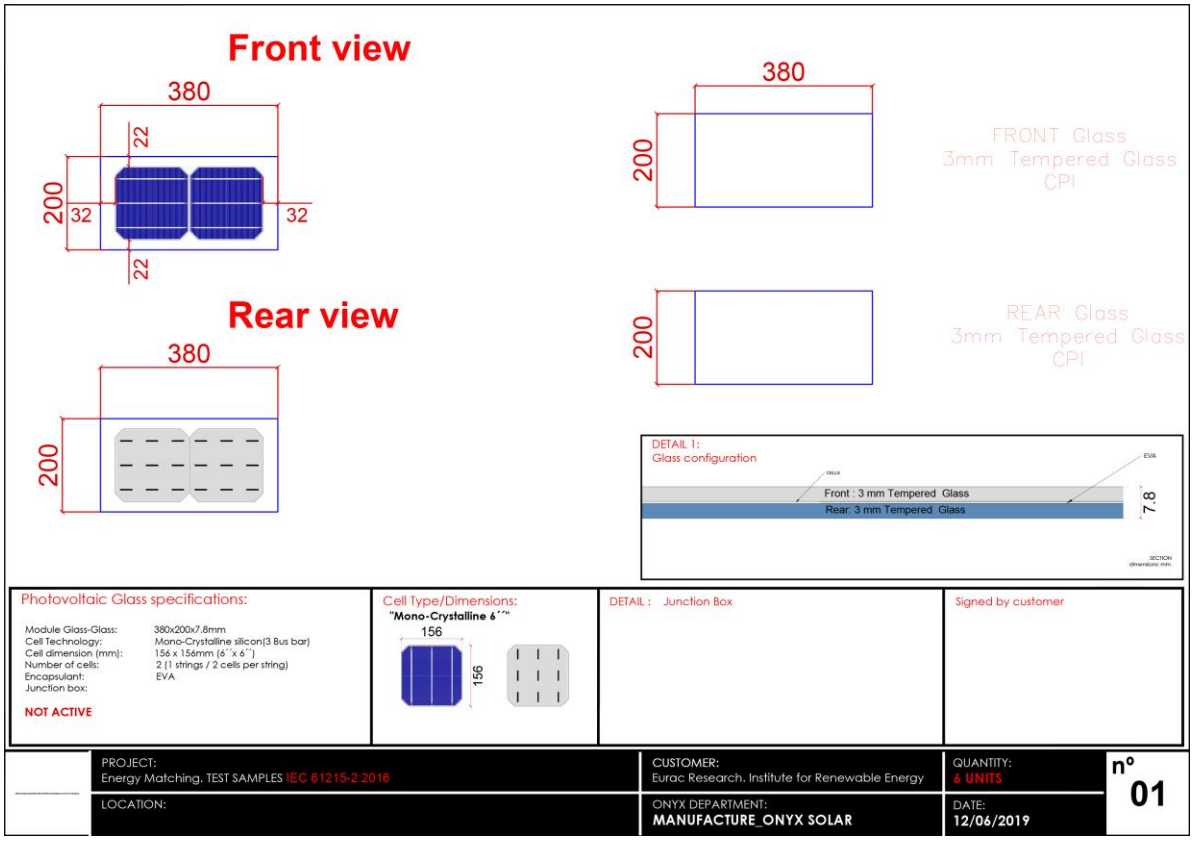

Figure 17: 380 mm x 200 mm c-Si glass-glass design (3+3)

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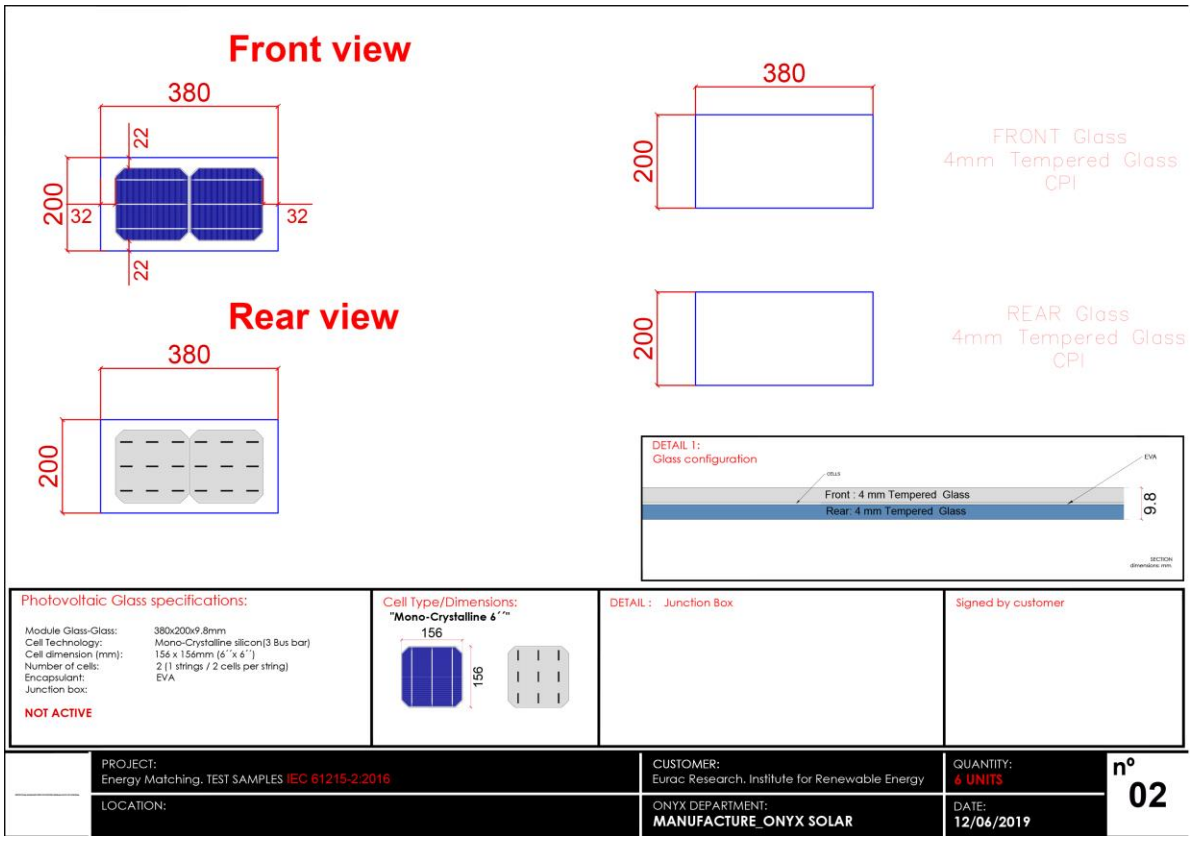

Figure 18: 380 mm x 200 mm c-Si glass-glass design (4+4)

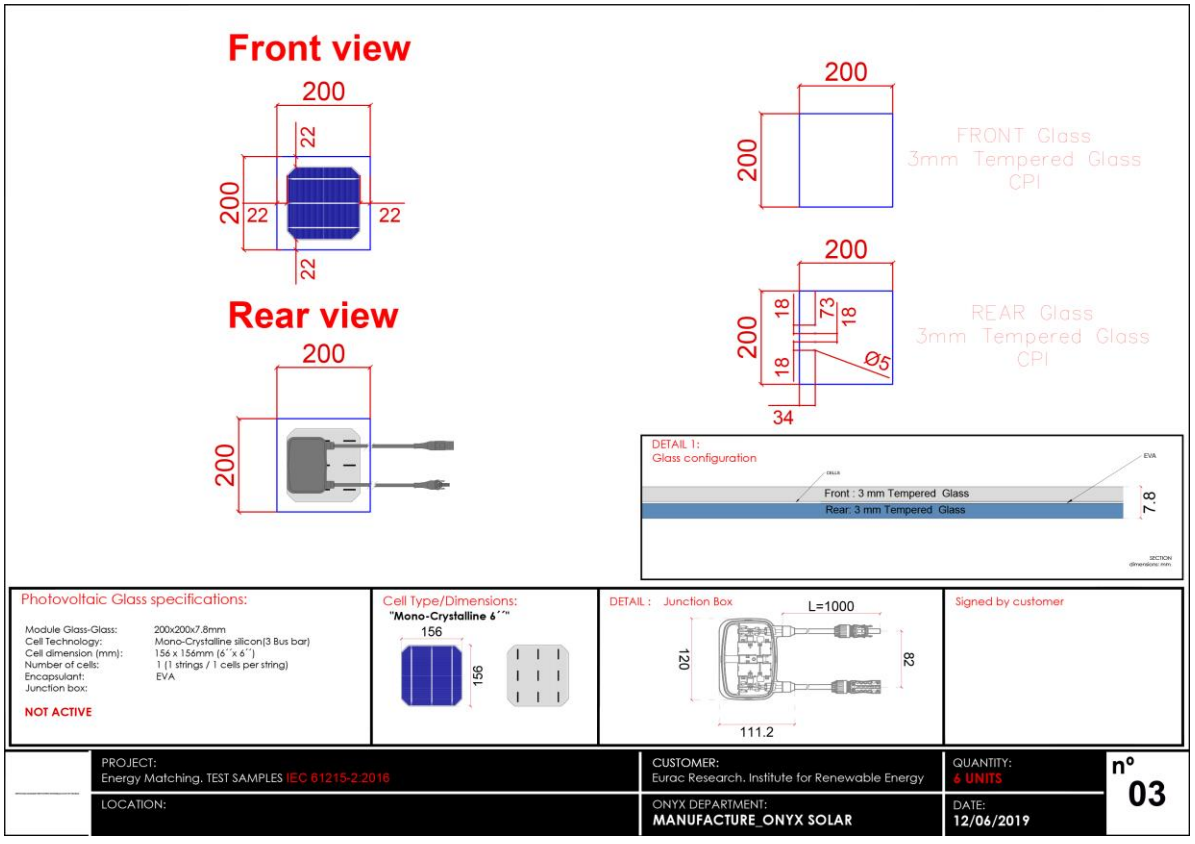

Figure 19: 200 mm x 200 mm c-Si glass-glass design (3+3)

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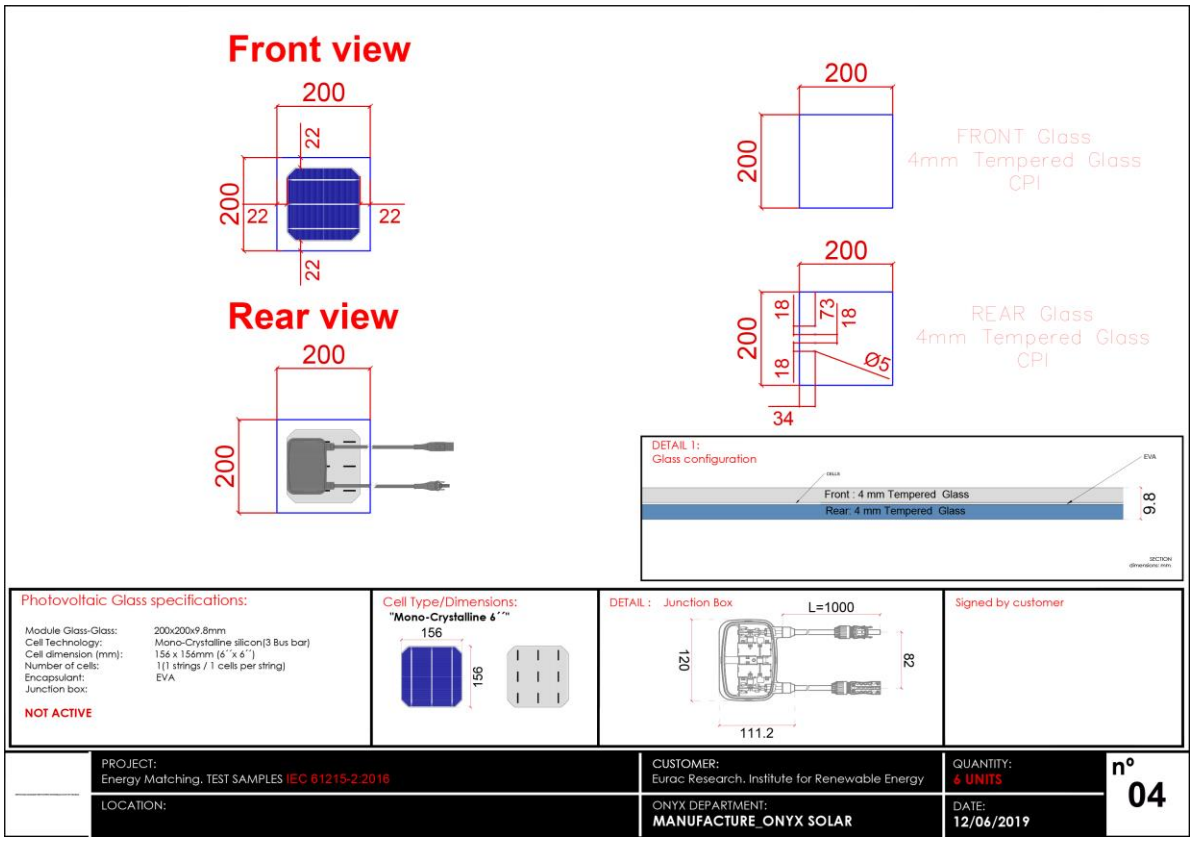

Figure 20: 200 mm x 200 mm c-Si glass-glass design (4+4)

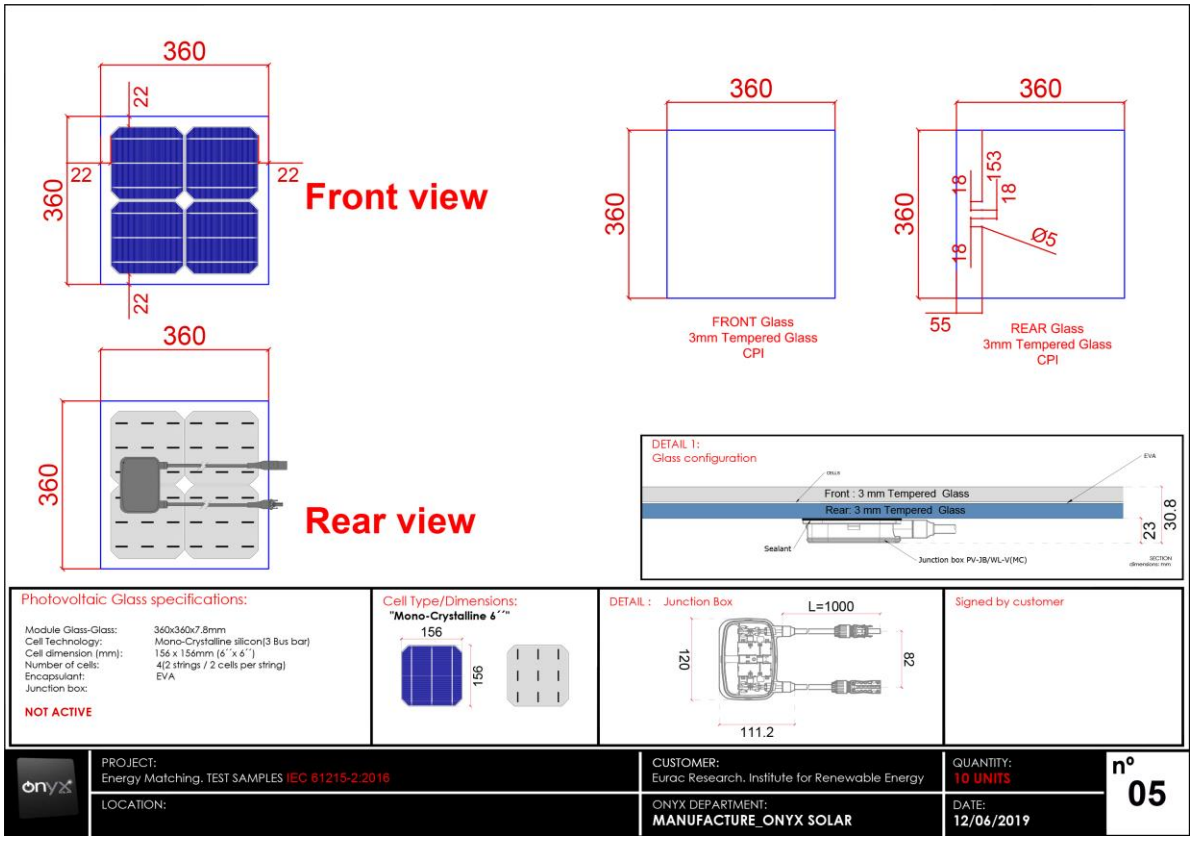

Figure 21: 360 mm x 360 mm c-Si glass-glass design (3+3)

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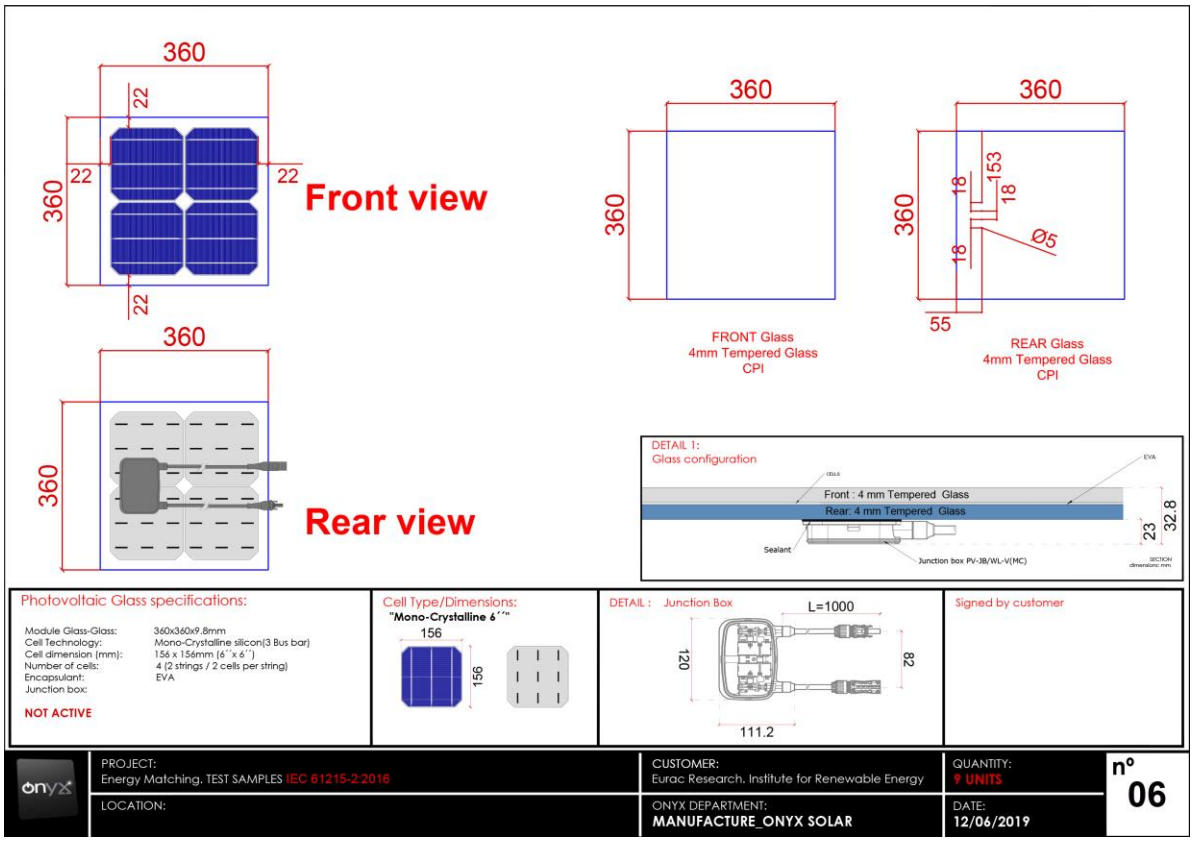

Figure 22: 360 mm x 360 mm c-Si glass-glass design (4+4)

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Technical references

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