Prüfbericht-Nr.: *Test Report No.*:	**21225887.001**	**Auftrags-Nr.:** *Order No.*:	21225887	Seite 1 von 1 *Page 1 of 1*
Kunden-Referenz-Nr.: *Client Reference No.*:	3287094	**Auftragsdatum:** *Order date*:	11.07.2014	
Auftraggeber: *Client*:	Sun Integration S.A.S, ZA de l'aérodrom, 2 Rue Maryse Bastié, 67500 HAGENAU, France			
Prüfgegenstand: *Test item*:	Pitched roof installation kits			
Bezeichnung / Typ-Nr.: *Identification / Type No.*:	IntegPV Solar System			
Auftrags-Inhalt: *Order content*:	Qualification of a BIPV-mounting system according to EN 14437 as pre-test for MCS 012.			
Prüfgrundlage: *Test specification*:	EN 14437:2004 “Determination of the uplift resistance of installed clay or concrete tiles for roofing – Roof system test method"			

Wareneingangsdatum: *Date of receipt*:	11.07.2014
Prüfmuster-Nr.: *Test sample No.*:	N/A
Prüfzeitraum: *Testing period*:	29.07.2014 – 12.08.2014
Ort der Prüfung: *Place of testing*:	Cologne
Prüflaboratorium: *Testing laboratory*:	Solar Energy Assessment Center
Prüfergebnis*: *Test result**:	Pass

Dokumenten-Check
(keine Fotodokumentation erforderlich)

Document check
(no photo documentation required)

geprüft von / *tested by*:			**kontrolliert von / *reviewed by*:**		
19 August 2014	D. Kolter, project engineer		19 August 2014	L. Jakisch, business field manager	
Datum *Date*	**Name / Stellung** *Name / Position*	**Unterschrift** *Signature*	**Datum** *Date*	**Name / Stellung** *Name / Position*	**Unterschrift** *Signature*

Sonstiges / *Other*:

Zustand des Prüfgegenstandes bei Anlieferung: *Condition of the test item at delivery*:	Details im vorherigen Abschnitt *Details in the previous section*

* Legende:	1 = sehr gut	2 = gut	3 = befriedigend	4 = ausreichend	5 = mangelhaft
	P(ass) = entspricht o.g. Prüfgrundlage(n)		F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
Legend:	*1 = very good*	*2 = good*	*3 = satisfactory*	*4 = sufficient*	*5 = poor*
	P(ass) = passed a.m. test specification(s)		*F(ail) = failed a.m. test specification(s)*	*N/A = not applicable*	*N/T = not tested*

ANLAGE zum Prüfbericht-Nr.: 21225887.001
APPENDIX to Test Report No.:

EN 14437:2004

Table of content

ANLAGE zum Prüfbericht-Nr.: 21225887.001
APPENDIX to Test Report No.:

EN 14437:2004

Summary of testing

This report describes the tests performed to determine the characteristic wind uplift resistance of the IntegPV Solar System, BIPV mounting system from Sun Integration S.A.S in accordance with MCS012.

The design uplift resistance of the IntegPV Solar System was tested with two profiles (fixed with one screw each 600 mm), sheets and module clamps (bottom angle, module clamp middle and end) on two modules in parallel (landscape) when installed as described in this report is **3000.0 Pa**.

The mounting system was installed on rafters with dimension of 80x100 mm at a distance of 600 mm.

MCS012 does not have pass/fail criteria for the wind uplift resistance pf PV mounting systems. The design uplift resistance obtained from the MCS012 test should be compared with the expected design wind uplift pressure at site (with the appropriate partial factors applied). If the design uplift resistance is greater than the design wind uplift pressure then the system will be suitable for use at that particular location. If the design uplift resistance is less than the design wind uplift pressure then additional fixings could be used to provide additional uplift resistance.

Remarks:

The test results presented in this report are only applicable to the IntegPV Solar System mounting system as tested.

Summary of test locations:

All tests were performed at the *Solar Energy Assessment Center Cologne* with the exception of the following test:

Summary of deviations from the standard:

- N/A

General information

Possible test case verdicts:

- test case does not apply to the test object ..... :	N/A
- test object does meet the requirement ..... :	Passed (P)
- test object does not meet the requirement ..... :	Failed (F)
Date(s) of performance of tests ..... :	28.07.2014 – 12.08.2014

General remarks:

The test verdicts presented in this report relate only to the object tested.
This report shall not be reproduced, except in full, without the written approval of the issuing testing laboratory.
"(see Enclosure #)" refers to additional information appended to the report.
"(see appended table)" refers to a table appended to the report.

Throughout this report a point is used as the decimal separator.

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Testing procedure

Mounting system assignment:			
Model Number / Name	Model Reference	Size [mm] LxWxD	Material
Rails Aluminium	FISCHER – 900 001	2100x113.8x30	EN AW 6063 T6
Colorvis 6.3x40	ETANCO – 100 001	6.3x40	Steel + EPDM
Crochet Bas + Vis marteau et é crous	MP – 600 001	250x50x2	Steel
Crochet Inter.	FISCHER – 600 002	50x40x2	EN AW 6063
Crochet ext. Haut	FISCHER – 600 003	50x40x2	EN AW 6063
InterPV – A	MP – 1 100 001	2100x570x0.75	Magnélis ZM 350
InterPV –B	MP – 1 100 002	2100x570x0.75	Magnélis ZM 350
InterPV – Abergement Standard	MP – 1 200 001	2100x670x0.75	Magnélis ZM 350
Bavette basse	MP – 1 300 001	3500x350x0.7	ZInc

Module assignment:			
Manufacturer	Module Number / Name	Serial number	Size [mm] LxWxD
KD Energy	KD E 250-M60-VE TN	11089	1661x997x40
KD Energy	KD E 250-M60-VE TN	11085	1661x997x40

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Details of the test specimens and installation

The test specimen comprises aluminium rails which will be fixed with rivets on the sub-structure. In between the rails and to the corners, the InterPV – sheets will be installed. The modules will be placed on these rails and fixed with clamps. All components are described in the summary of testing.

Details of the system and installation procedures are included in Annex 2. Figure 1 shows a photo of the system installed in the TÜV Rheinland test rig and Figure 2 shows the PV-modules installed.

Details of the tests carried out

The test will be performed in course of the qualification for MCS 012 “Pitched Roof Installation Kits” according to EN 14437:2004 which is a test method originally designed for test wind uplift resistance of roof tiles and slates. The tests are carried out on a simulated roof structure comprising rafters at a roof pitch of 45°. Figure 3 shows the TÜV Rheinland test rig with the installed system ready for test.

The test samples were laid on the test rig as they would be installed on a roof. Pneumatic rams with suction cups were attached to the PV-modules to apply a force to simulate wind uplift loads.

The test requirements are given from the standards as below:

- Where the flashing or sealing kits provide any uplift resistance then these should be included in the test.
- The roof pitch shall be 45° ± 2°.
- A minimum of one solar panel should be tested and the test shall be repeated three times with new fixing each time.
- The uplift load shall be applied using a cable(s) or equivalent methods to provide uniform loads. This/these may be fixed to the solar collector by drilling a hole(s) through the collector or by using suction cup devices attached to the glass cover plate.
- The detailed construction of the test rig in terms of the batten sizes, rafter spacing and all fixings shall satisfy the minimum specification (worst case) of the manufacturer/supplier of the solar panel and all materials shall be of a quality typical of the real construction. The minimum requirements of BS5534 shall also be satisfied.
- Where there is a choice of fixing positions, the most onerous (weakest) shall be tested.

The testing was performed three times. If necessary, depending on the test before, new fixings were used for the next test. The load was applied in increments of 500 Pa. After each load was applied it was removed and the residual deflection was measured. The maximum deflection under load and the residual deflection were measured at the following locations:

- Measurement 1: inside edge of lower left clip on left hand panel
- Measurement 2: right hand edge of the lower centre clip between two panels
- Measurement 3: inside edge of the lower right clip on the right hand panel

The loading cycles were repeated in increasing load increments until failure occurred; where failure is defined as one of the following:

- Breakage of a mechanical fixing between PV-module and support frame
- Pull-out or breakage of the mechanical connection between the support frame and the roof structure
- Breakage of the PV-module
- The residual displacement exceeds 5mm after releasing the applied load.
- The maximum displacement exceeds 75mm

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Tables

Wind uplift test

Test date:	28.07.2014 / 12.08.2014
Examiner:	Kolter
Index Number of test rick:	2424
Climate zone:	Northern Europe / Coast
Roof pitch [°]:	45°
Tiles/Sheets type, (LxW) [mm]:	IntergPV
High bead (HxW_1xW_2) [mm]:	N/A
High bead distance [mm]:	N/A
Rafter (LxWxD) [mm]:	80x100
Rafter distance [mm]:	600
Fixing of aluminium rails	One rivet every 600 mm

Test 1

Pressure [Pa]	Under load displacement				Pressure [Pa]	Residual displacement		
	Displacement 1 [mm]	Displacement 2 [mm]	Displacement 3 [mm]			Displacement 1 [mm]	Displacement 2 [mm]	Displacement 3 [mm]
0	–	–	–		0	–	–	–
500	**-2**	**-3**	**-3**		500	**0**	**0**	**-1**
1000	**-5**	**-6**	**-6**		1000	**-1**	**-1**	**-1**
1500	**-8**	**-8**	**-8**		1500	**-2**	**-2**	**-2**
2000	**-12**	**-11**	**-9**		2000	**-2**	**-2**	**-2**
2500	**-19**	**-15**	**-12**		2500	**-3**	**-2**	**-3**
3000	**-26**	**-18**	**-16**		3000	**-5**	**-3**	**-3**
3500	**-32**	**-21**	**-17**		3500	**-11**	**-4**	**-3**
4000	**-42**	**-26**	**-21**		4000	**-15**	**-4**	**-4**
4500	**-49**	**-28**	**-24**		4500	**-19**	**-5**	**-5**
Remark: The system exceeds 5mm residual displacement after 3000 Pa and withstands 1.5 times the load.								

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Test 2

Pressure [Pa]	Under load displacement				Pressure [Pa]	Residual displacement		
	Displacement 1 [mm]	Displacement 2 [mm]	Displacement 3 [mm]			Displacement 1 [mm]	Displacement 2 [mm]	Displacement 3 [mm]
0	–	–	–		0	–	–	–
500	-8	-4	-4		500	-1	0	0
1000	-11	-5	-5		1000	-1	0	0
1500	-15	-6	-6		1500	-2	0	-1
2000	-21	-8	-8		2000	-2	-1	-2
2500	-29	-10	-9		2500	-3	-2	-2
3000	-38	-12	-11		3000	-5	-2	-3

Remark: The system exceeds 5mm residual displacement after 3000 Pa. Pulling out of self-drilling screw of wooden rafters at 3500 Pa.

Test 3

Pressure [Pa]	Under load displacement				Pressure [Pa]	Residual displacement		
	Displacement 1 [mm]	Displacement 2 [mm]	Displacement 3 [mm]			Displacement 1 [mm]	Displacement 2 [mm]	Displacement 3 [mm]
0	–	–	–		0	–	–	–
500	-5	-4	-3		500	-1	0	0
1000	-9	-5	-3		1000	-1	0	0
1500	-15	-9	-5		1500	-2	-1	-1
2000	-20	-11	-7		2000	-2	-2	-2
2500	-28	-13	-9		2500	-3	-2	-2
3000	-38	-16	-12		3000	-4	-3	-3
3500	-45	-18	-14		3500	-6	-3	-3
4000	-52	-23	-15		4000	-8	-4	-4
4500	-59	-25	-17		4500	-12	-5	-5

Remark: The system exceeds 5mm residual displacement after 3000 Pa and withstands 1.5 times the load.

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Test results

In each test the failure occurred at the same position of the mounting system:

The failure pressures from Test 1, 2 and 3 are :

- Test 1: 3000 Pa
- Test 2: 3000 Pa
- Test 3: 3000 Pa
- The residual deflection did exceed 5mm.
- The under pressure displacement did not reach the 75 mm in any time.

The characteristic mean wind uplift resistance will be calculated according to EN 14437:2004 as following:

$$R_k = R_x - k_n s_x$$

$$R_x = \frac{1}{n} \sum R_i$$

Rx is the mean uplift resistance

$$s_x = \sqrt{\frac{1}{n-1} \sum (R_i - R_x)^2}$$

s_x is the standard deviation of the resistance determined

k_n is the statistical factor = 3.37 (for sample size of 3 from Table D.1 in EN 14437)

R_i is the individual measured value from each test

Partial factor
1.1 for failure metal components
1.25 for failure by pull out of metal components
1.44 for failure in timber or by pull out from timber components
1.0 no failure, but the system exceed the limits of deviation

Calculation

	Failure pressure [Pa]
Test 1	3000
Test 2	3000
Test 3	3000
R_x	
s_x	0
$k_n s_x$	0
$R_k = R_x - k_n s_x$	
Characteristic wind uplift resistance R_k	3000
Partial factor	1.0
design uplift resistance	**3000.0**

Annex 1: List of measuring equipment

Type	Index	Last calibration	Next calibration
Mechanical load test	2424	02/2014	02/2015

Annex 2: Photo documentation

Fig. 1: sheets installed on test rig

Fig. 2: system including PV-modules installed on test rig

Fig. 3: details of the test

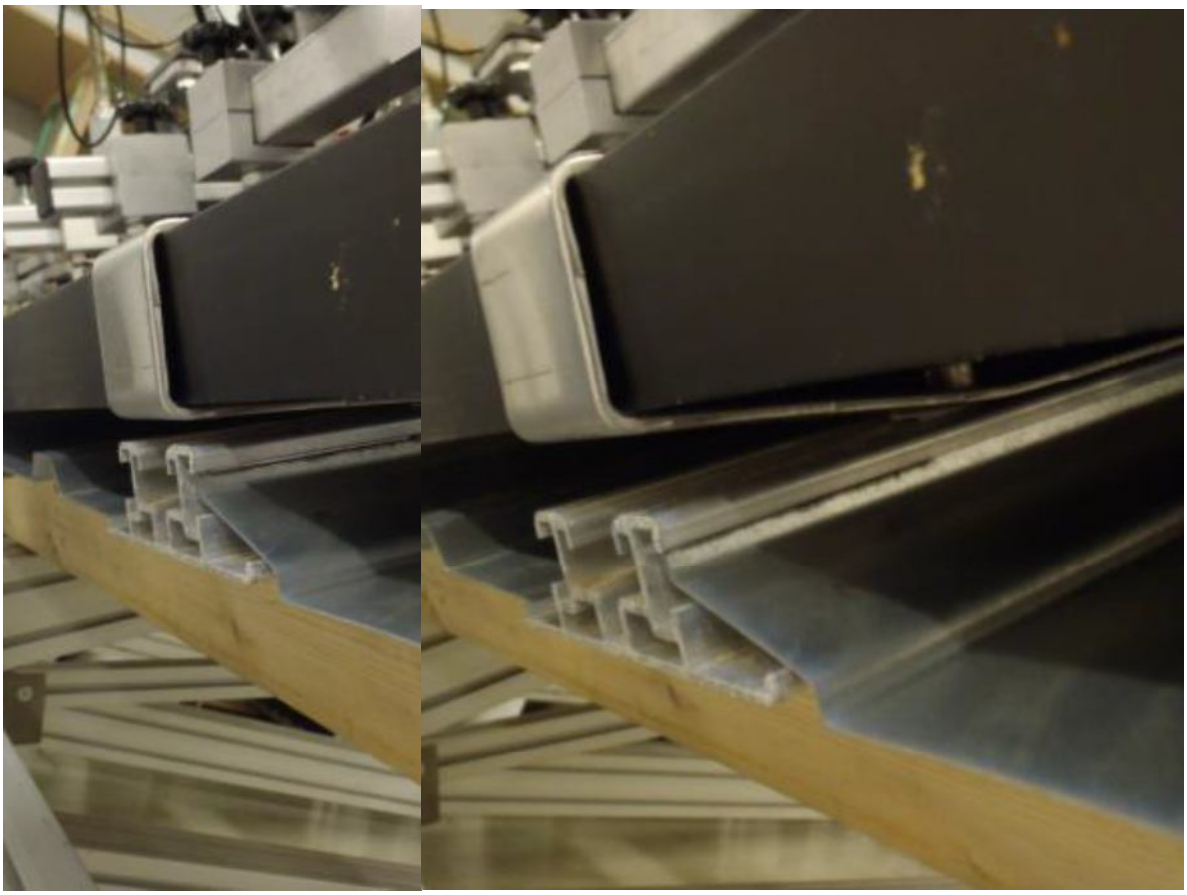

Fig. 4: details of the test

Fig. 5: details of the failure during test

Annex 3: Installation manual

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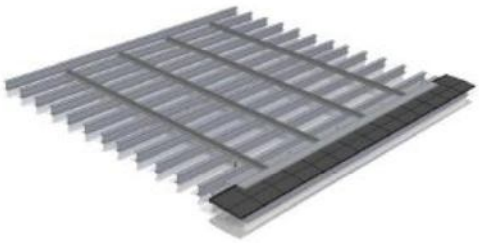
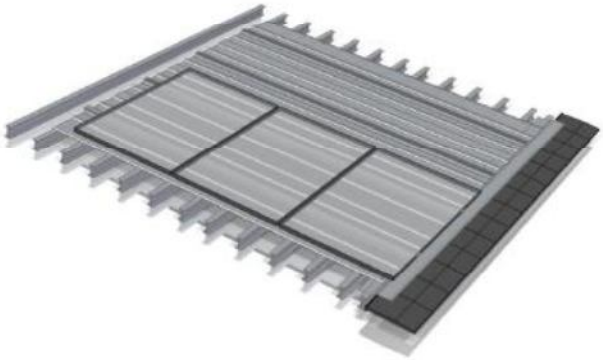
_DESCRIPTION & TECHNICAL DRAWS





Contact :
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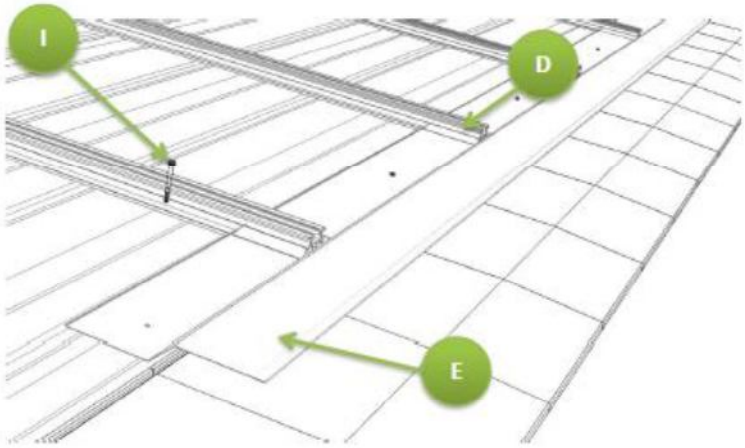
Product	Element	Picture
IntegPV - A	A	
IntegPV - B	B	
IntegPV - Abergement Standard	C	
Rails Aluminium	D	
Bavette basse	E	
Crochet Bas + Vis marteau et é crous	F	
Crochet Inter.	G	
Crochet ext. Haut	H	
Colorvis 6,3 x 40	I	
Joint compri-band	J	
Couvre-joint	K	

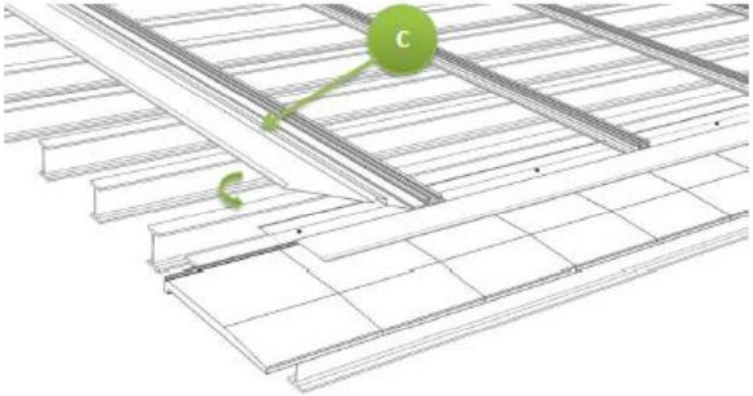
I. First Step:

- Remove all tiles except the first rank
- Fixed the sheet metal 'E' in order to cover the first rank of tiles.
- Fixed Aluminum profiles 'D' to the lathing with self-drilling screws 'I' - Secure all 1 meter

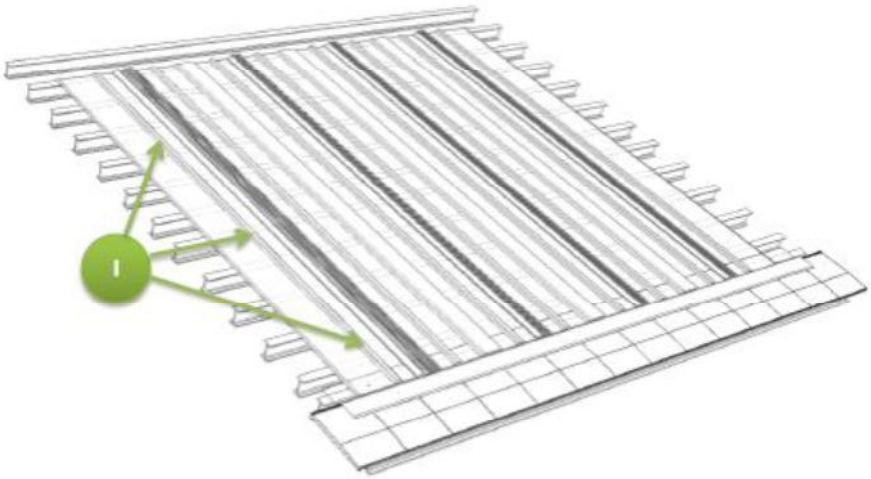


II. Place the roof metal cover:

- Insert the sheet metal 'C' in the side portions of the aluminum rail 'D'

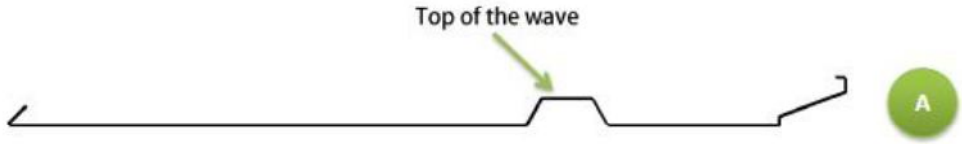


- Do the same for all of the other sheet metal 'A' & 'B' and the last side of the photovoltaic field 'C'



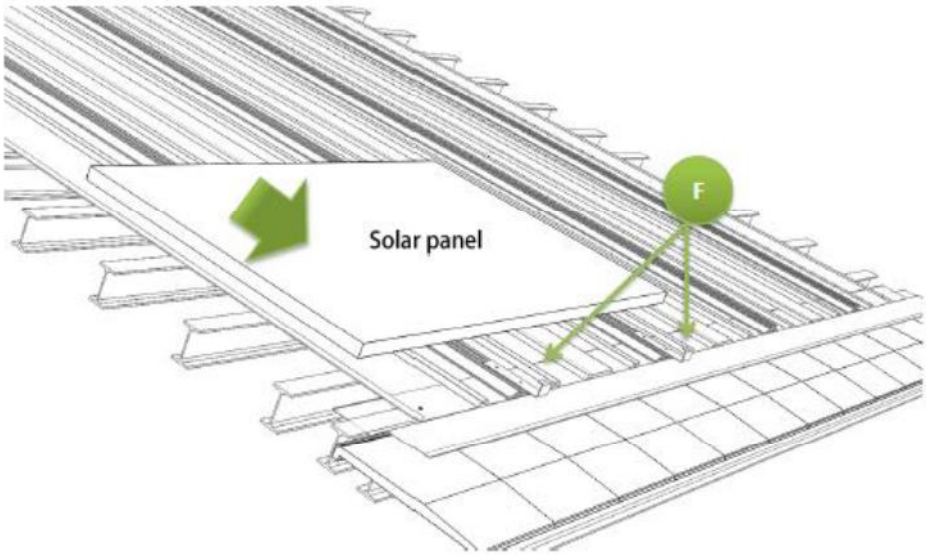
- Fixed the sheet metal every 1 meter by the top of wave with self-drilling screws :

Example:



When all the field is cover: place end-clamps to start photovoltaic modules installation

III. End-clamp, middle-clamp



- When end-clamps are locked. Move down the solar panel into the clamp.

Do the same operation for all the first rank of panels and clamps.

- Place the intermediary clamp against the panel and continue to place the rest to cover the sheet metal

Picture: Middle-clamp

or

IV. "Couvre-joint" - Join-Cover

When all solar panels are fixed, place the last piece of the system: 'Join-Cover'

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