

Test Report issued under the responsibility of:

TÜV SÜD Product Service GmbH  
Ridlerstr. 65  
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Germany



<b>TEST REPORT</b> <b>IEC 61730</b> <b>PV Module Safety Qualification</b> <b>Part 1: Requirements for construction and Part 2: Requirements for testing</b>	
<b>Report Number</b> ..... :	64290170581761 part 2 of 2
<b>Date of issue</b> ..... :	2023-07-21
<b>Total number of pages</b> .....	42
<b>TÜV SÜD Branch</b> .....	TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
<b>Applicant's name</b> .....	Trina Solar Co., Ltd.
<b>Address</b> ..... :	No. 2 TianHe Road, Trina PV Industrial Park, New District, 213031 Chang-zhou City, Jiangsu Province, P.R.CHINA
<b>Test specification:</b>	
<b>Standard</b> .....	IEC 61730-1:2016 IEC 61730-2:2016
<b>Test procedure</b> .....	TÜV SÜD Mark
<b>Non-standard test method</b> .....	Performance at Effective Irradiance was performed according to IEC 60904-1-2
<b>Test Report Form No.</b> .....	IEC61730a
<b>Test Report Form(s) Originator</b> .... :	TÜV SÜD Product Service GmbH
<b>Master TRF</b> .....	Dated 2016-12
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<b>Test item description</b> ..... :	Photovoltaic (PV) Module(s)	
<b>Trade Mark</b> ..... :		
<b>Manufacturer</b> .....	Trina Solar Co., Ltd.	
<b>Address</b> ..... :	No. 2 TianHe Road, Trina PV Industrial Park, New District, 213031 Chang-zhou City, Jiangsu Province, P.R.CHINA	
<b>Model/Type reference</b> .....	See page 8 of this report	
<b>Ratings</b> ..... :	See page 8 of this report	
<b>Testing procedure and testing location:</b>		
<input checked="" type="checkbox"/>	<b>TÜV SÜD Branch:</b>	TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
<b>Location/address</b> .....		No. 151 Heng Tong Road, Shanghai 200070, P. R. China
<input checked="" type="checkbox"/>	<b>Associated Testing Laboratory:</b>	Changzhou HuaYang Inspection and Testing Technology Co., Ltd.
<b>Testing location/address</b> ..... :		NO.8 Lanxiang Road, Wujin Economic Development Zone, Changzhou, Jiangsu, China
<b>Tested by (name + signature)</b> .....		Yang Xu 
<b>Approved by (name + signature)</b> ..... :		Qiaoying Li
<input type="checkbox"/>	<b>Testing procedure: TMP/CTF Stage 1:</b>	
<b>Testing location/address</b> ..... :		
<b>Tested by (name + signature)</b> .....		
<b>Approved by (name + signature)</b> ..... :		
<input type="checkbox"/>	<b>Testing procedure: WMT/CTF Stage 2:</b>	
<b>Testing location/address</b> ..... :		
<b>Tested by (name + signature)</b> .....		
<b>Witnessed by (name + signature)</b> ..... :		
<b>Approved by (name + signature)</b> ..... :		
<input type="checkbox"/>	<b>Testing procedure: SMT/CTF Stage 3 or 4:</b>	
<b>Testing location/address</b> ..... :		
<b>Tested by (name + signature)</b> .....		
<b>Witnessed by (name + signature)</b> ..... :		
<b>Approved by (name + signature)</b> ..... :		
<b>Supervised by (name + signature)</b> .....		

<p><b>List of Attachments (including a total number of pages in each attachment):</b>  Installation manual (Attachment 1, total pages 37)  Photographs (Attachment 2, total pages 10)  Component datasheets / certificates (Attachment 3, total pages N/A)</p>	
<p><b>Summary of testing:</b></p>	
<p><b>Tests performed (name of test and test clause):</b>  1. Based on project 64290170581760A1, update the higher end power class of models TSM-xxxNEG9R.28, TSM-xxxNEG19RC.20 and TSM-xxxNEG21C.20, with a power change of less than 10%.  Gate 1 was performed on TSM-460NEG9R.28, TSM-620NEG19RC.20 and TSM-710NEG21C.20 respectively.  The test sample can cover the following modules:  144 cells:  TSM-xxxNEG9RC.20, TSM-xxxNEG9RC.25,  TSM-xxxNEG9RC.28, TSM-xxxNEG9RC.27,  TSM-xxxNEG9RC.29, TSM-xxxNEG9RC.B0,  TSM-xxxNEG9RC.B5, TSM-xxxNEG9RC.B8,  TSM-xxxNEG9RC.B7, TSM-xxxNEG9RC.B9,  (xxx=375-460, in steps of 5)   TSM-xxxNEG9R.20, TSM-xxxNEG9R.25,  TSM-xxxNEG9R.28, TSM-xxxNEG9R.27,  TSM-xxxNEG9R.29, TSM-xxxNEG9R.B0,  TSM-xxxNEG9R.B5, TSM-xxxNEG9R.B8,  TSM-xxxNEG9R.B7, TSM-xxxNEG9R.B9,  (xxx=375-460, in steps of 5)   132 cells:  TSM-xxxNEG21C.20, TSM-xxxNEG21C.25,  TSM-xxxNEG21C.27, TSM-xxxNEG21C.28,  TSM-xxxNEG21C.29  (xxx=635-710, in steps of 5)  120 cells:  TSM-xxxNEG20C.20, TSM-xxxNEG20C.25,  TSM-xxxNEG20C.27, TSM-xxxNEG20C.28,  TSM-xxxNEG20C.29 (xxx=580-645, in steps of 5).   132 cells:  TSM-xxxNEG19RC.20, TSM-xxxNEG19RC.25,  TSM-xxxNEG19RC.27, TSM-xxxNEG19RC.28,  TSM-xxxNEG19RC.29, (xxx=525-620, in steps of 5)   TSM-xxxNEG19R.20, TSM-xxxNEG19R.25,</p>	<p><b>Testing location:</b>  Changzhou HuaYang Inspection and Testing Technology Co., Ltd.  NO.8 Lanxiang Road, Wujin Economic Development Zone, Changzhou, Jiangsu, China</p>

TSM-xxxNEG19R.27, TSM-xxxNEG19R.28, TSM-xxxNEG19R.29, (xxx=525-620, in steps of 5)	
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**Summary of compliance with National Differences:**

IEC 61730-1:2016 was approved by CENELEC as EN IEC 61730-1:2018 without any modification.

IEC 61730-2:2016 was approved by CENELEC as EN IEC 61730-2:2018 without any modification.

**The product fulfils the requirements of EN 61730-1: 2018 & EN 61730-2: 2018 & EN IEC 61730-1:2018/AC:2018-06 & EN IEC 61730-2:2018/AC:2018-06**

**Copy of marking plate:**

The artwork below may be only a draft. The use of certification marks on a product must be authorized by the respective NCBS that own these marks.

**Trinasolar**  
TSM-620NEG19RC.20



Maximum Power(Pmax)	620W *
Maximum Power Voltage(Vmp)	41.4V
Maximum Power Current(Impp)	14.99A
Open Circuit Voltage(Voc)	49.6V *
Short Circuit Current(Isc)	15.91A*
Maximum Series Fuse	35A
Power Selection	0 ~+ 5W
Maximum System Voltage	1500V
Electrical Rating At STC: AM1.5 1000W/m² Tc=25°C	

\*Considering LID, the power range of the certification authority, tolerance (Pmax) ±3%, (Voc) ±3%, (Isc) ±5%  
For field connections, use minimum 4mm²(No. 12AWG)copper wires insulated for a minimum 90°C

 **WARNING-ELECTRICAL HAZARD**  
This module produces electricity when exposed to light.  
Follow all applicable electrical safety precautions.

Trina Solar Co., Ltd.  
No.2 TianHe Road, Trina PV Industrial Park, New District, Changzhou City,  
Jiangsu Province 213031, P. R. China  
www.trinasolar.com



Made in China

**Trinasolar**  
TSM-710NEG21C.20



Maximum Power(Pmax)	710W *
Maximum Power Voltage(Vmp)	40.9V
Maximum Power Current(Impp)	17.36A
Open Circuit Voltage(Voc)	49.0V *
Short Circuit Current(Isc)	18.40A*
Maximum Series Fuse	35A
Power Selection	0 ~+ 5W
Maximum System Voltage	1500V
Electrical Rating At STC: AM1.5 1000W/m² Tc=25°C	

\*Considering LID, the power range of the certification authority, tolerance (Pmax) ±3%, (Voc) ±3%, (Isc) ±5%  
For field connections, use minimum 4mm²(No. 12AWG)copper wires insulated for a minimum 90°C

 **WARNING-ELECTRICAL HAZARD**  
This module produces electricity when exposed to light.  
Follow all applicable electrical safety precautions.

Trina Solar Co., Ltd.  
No.2 TianHe Road, Trina PV Industrial Park, New District, Changzhou City,  
Jiangsu Province 213031, P. R. China  
www.trinasolar.com



Made in China

**Trinasolar**

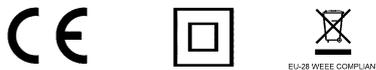


TSM-460NEG9R.28

Maximum Power	(Pmax)	460W *
Maximum Power Voltage	(Vmp)	45.4V
Maximum Power Current	(Impp)	10.14A
Open Circuit Voltage	(Voc)	53.8V *
Short Circuit Current	(Isc)	10.81A *
Maximum Series Fuse		25A
Power Selection		0 ~ +5W
Maximum System Voltage		1500V
*Considering LID, the power range of the certification authority, tolerance (Pmax) ±3%, (Voc) ±3%, (Isc) ±4% )		
Electrical Rating At STC AM=1.5 IRRADIANCE=1000W/m² Temp.=25°C		

For field connections, use minimum 4mm²(No. 12AWG)copper wires insulated for a minimum 90°C

 **WARNING-ELECTRICAL HAZARD**  
This module produces electricity when exposed to light.  
Follow all applicable electrical safety precautions.



Trina Solar Co., Ltd.  
No.2 TianHe Road, Trina PV Industrial Park, New District, Changzhou City,  
Jiangsu Province 213031, P. R. China  
www.trinasolar.com

Made in China

<b>Test item particulars</b> .....:	See test procedures
<b>Accessories and detachable parts included in the evaluation</b> .....	N/A
<b>Mounting system used</b> .....:	Specified in the user manual
<b>Other options included</b> .....	N/A
<b>Possible test case verdicts:</b>	
- test case does not apply to the test object.....:	N/A
- test object does meet the requirement.....:	P (Pass)
- test object does not meet the requirement.....:	F (Fail)
<b>Abbreviations used in the report:</b>	
Pmax – Maximum power	PD – Partial Discharge
Vmp – Maximum power voltage	RTI – Relative Thermal Endurance Index
Imp – Maximum power current	STC – Standard Test Conditions
Isc – Short circuit current	TC – Thermal Cycling
Voc – Open circuit voltage	CTI – Comparative Tracking Index
FF – Fill factor	MST – Module Safety Test
HF – Humidity Freeze	DH – Damp Heat
RTE –Relative thermal endurance index	TI – Temperature Index
P1 –Pollution degree 1	P2 –Pollution degree 2
P3 –Pollution degree 3	
<b>Testing:</b>	
<b>Date of receipt of test item</b> .....	2023-07-14
<b>Date (s) of performance of tests</b> .....	2023-07-14/2023-07-19

<b>General remarks:</b>	
<p>"(See Enclosure #)" refers to additional information appended to the report.          "(See appended table)" refers to a table appended to the report.</p> <p>Throughout this report a <input type="checkbox"/> comma / <input checked="" type="checkbox"/> point is used as the decimal separator.</p>	
<b>Manufacturer's Declaration per sub-clause 4.2.5 of IEC61730:</b>	
The application for obtaining a TÜV SÜD Test Certificate includes more than one factory location and a declaration from the Manufacturer stating that the sample(s) submitted for evaluation is (are) representative of the products from each factory has been provided ..... :	<input checked="" type="checkbox"/> <b>Yes</b> <input type="checkbox"/> <b>Not applicable</b>
<b>When differences exist; they shall be identified in the General product information section.</b>	
Name and address of factory (ies)..... :	<p>Trina Solar Co., Ltd.          Address: No. 2 TianHe Road, Trina PV Industrial Park, New District, 213031 Changzhou City, Jiangsu Province, PEOPLE'S REPUBLIC OF CHINA</p> <p>Yancheng Trina Solar Guoneng PV Science &amp; Technology Co., Ltd.          Address: No.101 Wutaishan Road, Yancheng Economic &amp; Technological Development Zone, 224007 Yancheng City, Jiangsu Province, PEOPLE'S REPUBLIC OF CHINA</p> <p>Trina Solar Science &amp; Technology (Thailand) Ltd.          Address: No.7/496 Moo.6, T. Mabyangporn, A. Pluakdang, Rayong 21140, THAILAND</p> <p>Trina Solar (Suqian) Technology Co., Ltd.          Address: 1599 Guangzhou Road, Suqian Economic and Technological Development Zone, 223814 Suqian City, Jiangsu Province, PEOPLE'S REPUBLIC OF CHINA</p> <p>Trina Solar Yiwu Technology Co., Ltd.          Address: No.801, Longqi Road, Suxi Town, 322009 Yiwu City, Zhejiang Province, PEOPLE'S REPUBLIC OF CHINA</p> <p>TRINA SOLAR ENERGY DEVELOPMENT COMPANY LIMITED          Address: Lot CN-14, Yen Binh Industrial Zone, Hong Tien Ward, Pho Yen City, Thai Nguyen Province, Vietnam</p> <p>Trina Solar (Yancheng Dafeng) Co., Ltd.          Address: No. 19, Tonggang Avenue, Dafeng Port</p>

	<p>District, Yancheng City Jiangsu Province, PEOPLE'S REPUBLIC OF CHINA</p> <p>Inner Mongolia Tiansheng New Technology Co., Ltd. (no.117928) New Energy Technology Industrial Base, Dalu Industrial Park, Zhun-geer Economic Development Zone, Zhungeer Banner, Ordos City, Inner Mongolia Autonomous Region, P. R. China</p> <p>Trina Solar (Yancheng) New Energy Co., Ltd. (118708) Room 201, Comprehensive Building, No. 66, Jiuhuashan Road, Yancheng Economic and Technological Development Zone, 224007 Yancheng City, Jiangsu Province, P.R. China</p> <p>Jiangsu Huapeng Photovoltaic Technology Co., Ltd. (115500) No. 118, Jingang Road, Yangzhou economic and Technological Development Zone, 225100 Yangzhou City, Jiangsu Province, PEOPLE'S REPUBLIC OF CHINA</p> <p>Lianyungang Shenzhou New Energy Co., Ltd. (077751) No.8 Xiamen Road, Ganyu Economic Development Zone, Lianyungang, Jiangsu 222100, P. R. China</p> <p>Zhejiang Winhi New Energy Co.,Ltd. (120490) Tonggang 1st Road, Dinghai District, Zhoushan City, Zhejiang Province, China</p> <p>Zhejiang Beyondsun Green Energy Technology Co., Ltd. (109511) No.888 Zhili Section of G318 Zhili Town,Huzhou City,Zhejiang Province,China</p> <p>Anhui Guosheng New Energy Technology Co., Ltd. (116755) No. 8 Kaixing Road, Qinglongshan Industrial Park Lieshan District 235025 Huaibei City, Anhui Province PEOPLE'S REPUBLIC OF CHINA</p> <p>Jiangsu Zhongqing Photovoltaic Technology Co., Ltd. (119915) No. 26, north of Taishan Road, Xinyi High-tech Zone, Xinyi City, Jiangsu Province, P.R. China</p> <p>Trina Solar (Huai an) Technology Co., Ltd. (120685)</p>
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	<p>No. 189, Shenzhen East Road, Huai'an Economic and Technological Development Zone, 223300, Jiangsu Province, P.R.China</p> <p>Trina Solar (Qinghai) Technology Co.,Ltd. (120695) Zone II, No.17, Planning Fifth Road, Shangxin Zhuang Town, Huang-zhong District, Xining city, Qinghai Province, P.R.China</p> <p>Yancheng Runda PV Co., Ltd. (116659) No. 199, Yanqiao Road, Jianhu County, Jiangsu Province, P.R.China</p>
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<b>General product information:</b>			
<b>PV module type reference</b> ..... : See page 9~11 in part 1 of this report			
<b><u>Product Electrical Ratings at STC</u></b>			
Nominal maximum power (Pmax, tolerance) .....: See page 9~11 in part 1 of this report			
Nominal open circuit voltage at (Voc, tolerance) .....: See page 9~11 in part 1 of this report			
Nominal short circuit current at (Isc, tolerance) .....: See page 9~11 in part 1 of this report			
Nominal maximum power voltage (Vmp) .....: See page 9~11 in part 1 of this report			
Nominal maximum power current (Imp) .....: See page 9~11 in part 1 of this report			
<b><u>Product Safety Ratings</u></b>			
Maximum systems operating voltage .....: 1500VDC			
Maximum over-current protection rating .....: 20A or 25A or 30A or 35A			
Safety class in accordance with IEC 61140.....: Class II			
Fire safety class .....: Class C according to UL790			
Recommended maximum series/parallel module configurations .....: Refer to manual document			
<b><u>Scope of Module Safety Qualification Testing:</u></b>			
<input type="checkbox"/> Initial module safety qualification			
<input checked="" type="checkbox"/> Extension of module safety qualification			
Original test report ref. no. ....: 64290170581760A1			
<b><u>Model differences and modification:</u></b>			
<input type="checkbox"/> Change in cell technology		<input type="checkbox"/> Change in cell interconnect materials/technique	
<input type="checkbox"/> Modification to encapsulation system		<input type="checkbox"/> Modification to junction box/el. termination	
<input type="checkbox"/> Modification to superstrate		<input type="checkbox"/> Change in el. circuit of an identical package	
<input type="checkbox"/> Modification to backsheet/substrate		<input type="checkbox"/> Higher or lower output by 10 %	
<input type="checkbox"/> Modification to frame/mounting structure		<input type="checkbox"/> Increase in module size	
<input type="checkbox"/> Removal of frame		<input type="checkbox"/> Modification to bypass diode	
<input type="checkbox"/> Modification to edge sealing		<input type="checkbox"/> Increased max system voltage	
<input type="checkbox"/> Modification to cut cells		<input checked="" type="checkbox"/> Others (See summary of testing)	
<b>Module group assignment:</b>			
Sample #	Type/model	Sample S/N	Remark
HA2023TL-0761-001X	TSM-460NEG9R.28	A12230700100186	—
HA2023TL-0761-002X	TSM-460NEG9R.28	A12230700100189	—
HA2023TL-0762-001X	TSM-620NEG19RC.20	A05230700203715	—
HA2023TL-0762-002X	TSM-620NEG19RC.20	A05230700203208	—

HA2023TL-0763-001X	TSM-710NEG21C.20	A12230700100207	—
HA2023TL-0763-002X	TSM-710NEG21C.20	A12230700100206	—
Supplementary information: N/A			

- Note (1)** Use the “General product information” field to give any information on model differences within a product type family covered by the test report.
- Note (2)** Use the “General product information” field to describe the range of electrical and safety ratings, if the TRF covers a type family of modules.
- Note (3)** Use Annex 1 to list the used materials and components of the module (manufacturer/supplier and type reference)

<b>IEC 61730-1: Part 1: Requirements for construction</b>			
Clause	Requirement + Test	Result - Remark	Verdict
<b>4</b>	<b>Classification, applications and intended use</b>		P
	The PV modules shall be classified according to IEC 61140 (Class 0, II, III) .....	Class II	—
	The PV modules are marked in accordance with 5.2.2.		P
<b>5</b>	<b>Requirements for design and construction</b>		P
<b>5.1</b>	<b>General</b>		P
	All PV modules are suitable for operation in outdoor non-weather protected locations, exposed to direct and indirect (albedo) solar radiation, in an environmental temperature range of at least –40 °C to +40 °C and up to 100 % relative humidity as well as rain.		P
	Compliance is verified by evaluation of materials, components and PV module construction as well as tests specified in IEC 61730-2.		P
	The provided assemblies of the product don't involve any action that is likely to affect compliance with the requirements of the IEC 61730 series.		P
	Incorporation of a PV module into the final assembly doesn't require any alteration of the PV module from its originally evaluated form.		N/A
	All PV module mounting and wiring methods specified in the installation instructions are evaluated for compliance with the IEC 61730 series.		P
	Compliance with the IEC 61730 series assesses the impact of the mounting and wiring methods on the safety of the PV modules, but does not assess the safety or suitability of the mounting or wiring methods for their intended use, see IEC 61215. These are subject to additional requirements or local code requirements.		P
	The construction of a PV module is such that equipotential bonding continuity, if applicable, is not interrupted by installation.		P
	Any adjustable or movable structural part is provided with a locking device to reduce the likelihood of unintentional movement, if any such movement may result in a risk of fire, electric shock, or injury to persons.		N/A
	PV modules don't have accessible burrs, sharp edges or sharp points that can cause injury to users or service persons. Edges and points that appear to be sharp by inspection, comply with the sharp edge test (MST 06).		P

IEC 61730-1: Part 1: Requirements for construction			
Clause	Requirement + Test	Result - Remark	Verdict
	Parts are prevented from loosening or turning if such loosening or turning may result in a risk of fire, electric shock, or injury to persons. Compliance for components is verified by specific tests described in the relevant standards or screw connection test (MST 33).		P
Supplementary information:			

<b>5.2</b>	<b>Marking and documentation</b>		P
<b>5.2.1</b>	<b>General</b>		
	Instructions related to safety are in an official language of the country where the equipment is to be installed.	In English	P
<b>5.2.2</b>	<b>Marking</b>		P
<b>5.2.2.1</b>	<b>General</b>		P
	Each PV module shall include the following clear and indelible markings		—
	a) Name, registered trade name, or registered trade mark of manufacturer		P
	b) Type or model number designation;	TSM-460NEG9R.28 for example	P
	c) Serial number	Provided under superstrate near the top rail of frame	P
	d) Date and place of manufacture; alternatively serial number assuring traceability of date and place of manufacture	serial number allowing to trace the date and place of manufacture	P
	e) Polarity of terminals or leads	“+” and “-”	P
	f) “Maximum system voltage” or “ $V_{sys}$ ”	1500V DC	P
	g) Class of protection against electrical shock, in accordance with Clause 4 of IEC 61730-1:2016	Class II	P
	h) “voltage at open-circuit” or “ $V_{oc}$ ” including manufacturing tolerances;	53.8±3% for example	P
	i) “Current at short-circuit,” or “ $I_{sc}$ ” including manufacturing tolerances;	10.81±4% for example	P
	j) “PV module maximum power” or “ $P_{max}$ ” including manufacturing tolerances;	460±3% for example	P
	k) Compliance “Maximum overcurrent protection rating”, is verified by reverse current overload test (MST 26).	20A or 25A for example	P
	All electrical data is shown as relative to standard test conditions (STC) (1 000 W/m <sup>2</sup> , (25 ± 2) °C, AM 1.5 according to IEC 60904-3).		P
	International symbols is used where applicable		P

IEC 61730-1: Part 1: Requirements for construction			
Clause	Requirement + Test	Result - Remark	Verdict
	Compliance is verified according to visual inspection (MST 01) and durability of markings (MST 05).		P
	PV connectors or wiring is marked in accordance to IEC 62852 with a symbol "Do not disconnect under load", as given in Annex A in standards IEC 61730-1:2016. Symbol or warning notice is imprinted or labelled close to connector. PV connectors is clearly marked indicating the terminal polarity.		P
	For Class II and Class 0 PV modules, the  (IEC 60417-6042: Caution, risk of electric shock) symbol shall be applied near the PV module electrical connection means.		P
	PV modules shall be marked to indicate the classes as follows: Class II:  Class 0: No symbol Class III: 		P
	PV modules provided with a functional earth connection are provided with a symbol  according to 5.2.2.2.2, Figure 3:		N/A
	PV modules provided with terminals for field wiring rated only for use with copper wire are marked, at or adjacent to the terminals, with the statement "Use copper wire only", "Cu only", or the equivalent.		N/A
	PV modules provided with terminals for field wiring rated only for use with a different specific wiring material is marked with a similar statement referring to the rated material.		N/A
	PV modules provided with terminals for field wiring rated for use with all types of wiring material do not need to be marked.		N/A
<b>5.2.2.2</b>	<b>Symbols</b>		
<b>5.2.2.2.1</b>	<b>Equipotential bonding</b>		
	A wiring terminal or bonding location of a PV module intended to accommodate a field installed bonding conductor for equipotential bonding is identified with the appropriate symbol IEC 60417-5021 (DB:2002-10) (IEC 61730-1:2016 Figure 2)). Alternatively IEC 60417-5017 (IEC 61730-1:2016, Figure 1) can be used. No other terminal or location is identified in this manner.		P
<b>5.2.2.2.2</b>	<b>Functional earthing</b>		

<b>IEC 61730-1: Part 1: Requirements for construction</b>			
Clause	Requirement + Test	Result - Remark	Verdict
	A wiring terminal or bonding location of a PV module intended to accommodate a field installed functional earthing conductor is identified with the appropriate symbol (IEC 60417-5018 (DB: 2002-10) (IEC 61730-1:2016 Figure 3).		P
<b>5.2.3</b>	<b>Documentation</b>		P
	PV modules are supplied with documentation describing the methods of electrical and mechanical installation as well as the electrical ratings of the PV module.		P
	The documentation states the Class under which the PV module was qualified and any specific limitations required for that Class.		P
	The documentation states the environmental conditions to which the module has been qualified, which by default includes a temperature range of – 40 °C to +40 °C and wind/snow load including safety factor.		P
	It is ensured that appropriate documentation for safe installation, use, and maintenance is available to installers and operators.		P
	Environmental conditions to which a PV module has been qualified may include IEC 61701 or IEC 62716		N/A
	The documentation shall contain the following information:		—
	all information required by 5.2.2.1 with exception of c), d) and e);		P
	recommended maximum series/parallel PV module configurations;	Refer to manual document	P
	the current rating of overcurrent protection, as determined in MST 26.		P
	manufacturer's stated tolerance for $V_{oc}$ , $I_{sc}$ and maximum power output $P_{max}$ under standard test conditions;	Refer to manual document or nameplate	P
	temperature coefficient for voltage at open-circuit		P
	temperature coefficient for maximum power;		P
	temperature coefficient for short-circuit current.		P
	All electrical data is shown as relative to standard test conditions (1 000 W/m <sup>2</sup> , (25 ± 2) °C, AM 1,5 according to IEC 60904-3).	—	P
	International symbols are used where applicable	—	P
	The electrical documentation includes a detailed description of the electrical installation wiring method to be used. This description includes:		—
	the minimum cable diameters for PV modules intended for field wiring		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	any limitations on wiring methods and wire management that apply to the junction box for the PV module		P
	the size, type, material, and temperature rating of the conductors to be used		P
	type of terminals for field wiring		N/A
	specific PV connector model/types and manufacturer to which the PV module connectors can be mated		P
	the bonding method(s) to be used (if applicable) are specified. All provided or specified hardware are identified in the documentation		P
	the type and ratings of bypass diode to be used (if applicable)		p
	limitations to the mounting situation (e.g. slope, mounting means, cooling)		P
	a statement indicating the fire rating(s) and the applied standard, or a statement that resistance to external fire sources was not evaluated, as well as the limitations to that rating (e.g. installation slope, sub structure or other applicable installation information);		P
	a statement indicating the minimum mechanical means for securing the PV module (as evaluated during the mechanical load test (MST 34));		P
	a statement indicating the maximum altitude the PV module is designed for. De-ratings can be applied.	Up to 2000m	P
	The documentation for roof mounting shall include:		—
	a statement indicating the minimum mechanical means for securing the PV module to the roof (as evaluated during the mechanical load test according (MST 34);		P
	details of the specific parameter(s) when the fire rating is dependent on a specific mounting structure, specific spacing, or specific means of attachment to the roof or structure.		P
	The documentation includes a statement advising that external or otherwise artificially concentrated sunlight shall not be directed onto the front or back face of the PV module (if not qualified for).		P
	Assembly instructions are provided with a product shipped in subassemblies, and are detailed and adequate to the degree required to facilitate complete and safe assembly of the product to specifications set forth in the IEC 61730 standard series.	—	N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	To facilitate proper system sizing the manufacturer includes relevant parameters in the installation instructions that allow system layout based not only on STC values given in the documentation. For example a safety factor for $V_{oc}$ and $I_{sc}$ of 1,25 is recommended since irradiance is often higher than 1 000 W/m <sup>2</sup> and temperature below 25 °C may raise $V_{oc}$ .		P
	The following or equivalent statement are included: "Under normal conditions, a photovoltaic module is likely to experience conditions that produce higher current and/or voltage than reported at standard test conditions. Accordingly, the values of $I_{sc}$ and $V_{oc}$ marked on this PV module should be multiplied by a factor of 1,25 when determining component voltage ratings, conductor current ratings, and size of controls (e.g. inverter) connected to the PV output."		P
Supplementary information: N/A			

<b>5.3</b>	<b>Electrical components and insulation</b>		P
<b>5.3.1</b>	<b>General</b>		—
	PV modules consist of the following electrical components and insulation:		P
	the internal wiring, e.g. solar cell and cell interconnects (see 5.3.2)		P
	external wiring and output cables (see 5.3.3)		P
	connectors (see 5.3.4)		P
	junction boxes for PV modules (see 5.3.5)		P
	frontsheet and backsheet (see 5.3.6)		P
	insulation barriers (see 5.3.7)		N/A
	electrical connections (see 5.3.8)		P
	encapsulant (see 5.3.9)		P
	bypass diodes (see 5.3.10)		P
<b>5.3.2</b>	<b>Internal wiring</b>		P
	Internal wiring has sufficient current carrying capacity for the relevant application.		P
	Depending on the pollution degree at the place where the internal wiring is located precautions against corrosion have to be taken		P
	In case that insulation for the internal wiring is necessary it fulfils the relevant requirements for the relevant application according to 5.5.2.3		P

<b>IEC 61730-1: Part 1: Requirements for construction</b>			
Clause	Requirement + Test	Result - Remark	Verdict
	Compliance is checked by inspection and by reverse current overload test (MST 26).		P
<b>5.3.3</b>	<b>External wiring and cables</b>		P
	External wires and cables shall fulfil the requirements of EN 50618		P
<b>5.3.4</b>	<b>Connectors</b>		P
	External DC connectors fulfil the requirements of IEC 62852.		P
	Connectors are marked in accordance with 5.2.2.		P
<b>5.3.5</b>	<b>Junction boxes for PV modules</b>		P
	Junction boxes for PV modules fulfil the requirements of IEC 62790		P
<b>5.3.6</b>	<b>Frontsheets and backsheets</b>		P
	Front- and backsheets are typically compositions of layered materials, such as films, adhesives or coatings, in which at least one material layer delivers the relied upon electrical insulation and other layers may provide extended protection of the relied upon insulation against the environmental factors.		P
	Layers of frontsheets and backsheets which are relied upon for insulation withstand all relevant mechanical, electrical, thermal, and environmental stresses, with compliance demonstrated at the material or component level.		P
	Layers which represent a part of a tracking path (creepage) are classified into a material group (see 5.6.3.3).		P
	In general polymeric frontsheets and backsheets meet the relevant requirements of section 5.5.2, with compliance demonstrated by the tests in IEC 61730-2.		N/A
	If these sheets are used as relied upon insulation they at a minimum fulfil the requirements of 5.6.4.3 for insulation in thin layers.		N/A
	In addition, polymeric front- and backsheets used as relied upon insulation meet the requirements of 5.5.2.3.		N/A
	The values for TI or RTE (RTI) according to 5.5.2.3.3 are evaluated under consideration of particular requirements for flexible multilayer sheets given in IEC 60216-2. Relevant RTI values evaluated in accordance to UL 746B are accepted as an alternative to RTE.		N/A
	Adhesion of the front- and backsheet, e.g. to the encapsulant or glass, are appropriate. Compliance is checked by passing the IEC 61730-2 test sequence.		P
<b>5.3.7</b>	<b>Insulation barriers</b>		N/A

<b>IEC 61730-1: Part 1: Requirements for construction</b>			
Clause	Requirement + Test	Result - Remark	Verdict
	An insulation barrier withstand all relevant mechanical, electrical, thermal, and environmental stresses.		N/A
	In general a polymeric insulation barrier meet the relevant requirements of 5.5.2.		N/A
	It is held in place and is not adversely affected to the extent that its required electrical and mechanical properties fall below the minimum acceptable values for the application.		N/A
	The removal of the insulation barrier is only possible by using a tool.		N/A
	Compliance is checked by passing the IEC 61730-2 test sequence.		N/A
<b>5.3.8</b>	<b>Electrical connections</b>		<b>P</b>
<b>5.3.8.1</b>	<b>General</b>		—
	Electrical connections are designed that contact pressure is not transmitted through insulating material other than ceramic, pure mica or other material with suitable characteristics, unless there is sufficient resiliency in the metallic parts to compensate for any shrinkage or yielding of the insulating material.		P
	Prevention is taken that connections do not become loose, e.g. by using a washer.		P
	Compliance is checked by visual inspection (MST 01), continuity test of equipotential bonding (MST 13) and screw connection test (MST 33), if applicable.		P
	The end of a stranded conductor is not consolidated by soft soldering in places where the conductor is subject to contact pressure unless the method of clamping is designed so as to reduce the likelihood of a bad contact or if the soldered portion is maintained outside the contact area of the connection.		P
	Precautions are taken that under operation clamping units or other terminations are prevented from thermal and mechanical stress which might impair electrical conductivity.		P
<b>5.3.8.2</b>	<b>Terminals for external cables and PV connector ribbons</b>		<b>N/A</b>
	Terminals for electrical connections are suitable for the type and range of conductor cross-sectional areas according to specification of the manufacturer.		N/A
	They meet the requirements of IEC 62790.		N/A
	Insulated terminals is designed in a manner where a possible displacement that may result in a reduction of clearances and creepage distances is prevented		N/A
<b>5.3.8.3</b>	<b>Splices and connections inside a PV module</b>		<b>P</b>

<b>IEC 61730-1: Part 1: Requirements for construction</b>			
Clause	Requirement + Test	Result - Remark	Verdict
	Splices and connections inside a PV module other than those for terminals of external cables and PV connector ribbons are mechanically secured and shall provide electrical continuity.		P
	Electrical connections is soldered, welded, conductively adhered, crimped, or otherwise securely connected.		P
	A soldered or conductively adhered joint is additionally mechanically secured.		P
<b>5.3.9</b>	<b>Encapsulants</b>		P
	The technical properties of encapsulant are suitable for the intended application. In particular:		—
	the rated operating temperature range include the temperature range of the intended application;		P
	the material group, the insulation resistance and the dielectric strength is suitable for the intended application.		P
	Compliance is checked by passing the IEC 61730-2 test sequence.		P
<b>5.3.10</b>	<b>Bypass diodes</b>		P
	Bypass diodes is rated to withstand the current and voltage for their intended use.	—	P
	Compliance is checked by bypass diode thermal test (MST 25), hot-spot endurance test (MST 22), bypass diode functionality test (MST 07) and visual inspection (MST 01).	—	P
Supplementary information: N/A			

<b>5.4</b>	<b>Mechanical and electromechanical connections</b>		P
<b>5.4.1</b>	<b>General</b>		—
	Typically found in a PV module are the following mechanical connections:		P
	connections within a frame		P
	PV module mounting interfaces such as frame or backrail to glass or backsheet via adhesive (silicone, rubber, etc.);		P
	frame to clamp of a mounting system;		P
	means for equipotential bonding;		P
	means for the attachment of junction box to the PV modules (silicone, tape, etc.);		P
	mechanical connections within the laminate		N/A
	Mechanical connections are able to durably withstand the thermal, mechanical, and environmental stresses occurring in the application without decreasing the integrity of the connection below safe levels.		P

<b>IEC 61730-1: Part 1: Requirements for construction</b>			
Clause	Requirement + Test	Result - Remark	Verdict
	Compliance is checked by inspection and during the mechanical load test (MST 34), module breakage test (MST 32), materials creep test (MST 37) and, if applicable, continuity of equipotential bonding tests (MST 13).		P
	Individual material requirements are given in 5.5.		P
	Parts intended to be removed is only detachable with the aid of tools.		P
	Lids that are attached without screws has one or several detectable facilities, e.g. recesses, which enable tools to be deployed in order to remove them. If the lid is removed correctly, the tool shall not come into contact with the active parts.		P
	For mechanical connections friction between surfaces, such as simple spring pressure, is not acceptable as the sole means to inhibit the turning or loosening of a part. Physical properties or constructions that provide an interference or form fit to prevent unintended movement or rotation of the component comply with this requirement.		P
<b>5.4.2</b>	<b>Screw connections</b>		N/A
	Screws and mechanical connections, the failure of which might cause the PV module to become unsafe, withstand the mechanical stresses occurring in normal use.		N/A
	Screws are not made of a material which is soft or liable to creep.		N/A
	Screws which are operated for maintenance purposes are not insulating material if their replacement by a metal screw could impair supplementary or reinforced insulation.		N/A
	Screws used to provide mechanical stability and continuity for equipotential bonding, e.g. fixing screws in frames and other components, comply with the requirement in the first paragraph of this subclause. At least one screw per electrical mechanical connection shall ensure the electrically connection between the metallic components. Compliance is checked by inspection and by test for general screw connection (MST 33a).		N/A
	Screws used for mechanical and electrical connections with a nominal diameter of less than 3 mm is screw into metal.		N/A
	For screws used for mechanical and electrical connections two full threads engage into the metal.		N/A
	Screwed and other fixed connections between different parts of the PV module are made in such a way that they do not come loose through torsion, bending stresses, vibration, etc., as may occur in normal use. Compliance is checked by inspection and by test for locking screws (MST 33b).		N/A

<b>IEC 61730-1: Part 1: Requirements for construction</b>			
Clause	Requirement + Test	Result - Remark	Verdict
<b>5.4.3</b>	<b>Rivets</b>		N/A
	Rivets which serve as electrical as well as mechanical connections are locked against loosening. A noncircular shank or an appropriate notch may be sufficient.		N/A
<b>5.4.4</b>	<b>Thread-cutting screws</b>		N/A
	Thread-cutting screws and self-tapping screws are not be used for the interconnection of current-carrying parts made of metal which is soft or liable to creep, such as zinc or aluminium.		N/A
	Thread-forming screws (sheet metal screws) are not be used for the connection of current carrying parts, unless they clamp these parts directly in contact with each other, and are provided with suitable locking means.		N/A
	Thread-cutting (self-tapping) screws are not be used for the connection of current-carrying parts unless they generate a full form standard machine screw thread. However, screws of the latter type shall not be used if they are likely to be operated by the user or installer.		N/A
	Thread-cutting and thread-forming screws, used to provide continuity for equipotential bonding, are such that it is not necessary to disturb the connection in normal use.		N/A
	For equipotential bonding one screw is permitted if two full threads engaged the metal.		N/A
<b>5.4.5</b>	<b>Form/press/tight fit</b>		P
	Form/press/tight fits of metallic components not separately equipotentially bonded is electrically connected.		P
	Compliance is checked by inspection and module breakage test (MST 32) and static mechanical load test (MST 34) and test of continuity of equipotential bonding (MST 13) pre and post the MST 32 and MST 34 tests.		P
<b>5.4.6</b>	<b>Connections by adhesives</b>		P
	Compliance is checked with mechanical load test (MST 34), test of continuity of equipotential bonding (MST 13) and module breakage test (MST 32) for mounting means adhesives and with robustness of termination test (MST 42 and MST 17) for junction-box adhesives.		P
	Adhesion of a polymer relied upon for insulation to another insulating layer is appropriate for the application.		P
	If the connection by adhesive should be considered as cemented joint the requirements according to 5.6.4.2 are applied. A peel test (MST 35) and a lap shear test (MST 36) are applied in 5.6.4.2 for verification of cemented joints.		N/A

<b>IEC 61730-1: Part 1: Requirements for construction</b>			
Clause	Requirement + Test	Result - Remark	Verdict
<b>5.4.7</b>	<b>Other connections</b>		P
	Other connections such as, for example, welded or soldered, are investigated by visual inspection (MST 01).		P
	Other connections which are relied upon for equipotential bonding are checked with test of continuity of equipotential bonding (MST 13).		P
	Materials and processes for creating the connections are appropriate for the intended use.		P
Supplementary information: N/A			

<b>5.5</b>	<b>Materials</b>		P
<b>5.5.1</b>	<b>General</b>		P
	General compliance is checked with tests in accordance to IEC 61730-2.		P
<b>5.5.2</b>	<b>Polymeric materials</b>		P
<b>5.5.2.1</b>	<b>General</b>		P
	Polymeric materials are able to durably and safely withstand the electrical, mechanical, thermal, environmental, and corrosive stresses occurring in the application, and are resistant to electrical and mechanical property degradation.		P
	Polymeric parts which ensure either the electrical or mechanical safety of the PV module, or both, are resistant to electrical and mechanical property degradation and comply with the requirements of the materials creep test (MST 37) depending on their constructive function in the PV module.		P
	Polymeric materials used in PV modules as part of a cemented joint additionally comply with 5.6.4.2.		N/A
<b>5.5.2.2</b>	<b>Endurance to weathering stress</b>		P
	Polymeric materials are durable to weathering stress occurring in the application		P
	Components are evaluated to the relevant requirement in the applicable component standard.		P
<b>5.5.2.3</b>	<b>Polymeric materials used as electrical insulation</b>		P
<b>5.5.2.2</b>	<b>Endurance to electrical stress</b>		P
	Materials used as electrical insulation withstand electrical stresses which occur in the application both in the unconditioned and preconditioned cases.		P
	If relevant for clearance and creepage distance evaluation insulating materials are assigned a materials group designation based on a CTI rating.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	Insulating materials between conductive parts of different polarity or between conductive parts and accessible surfaces are assessed according to their material group designation based on their CTI rating (see B.2.2.4.2), if those materials are a part of a creepage distance.		P
	CTI rating is required from each surface, on which tracking could occur, e.g. at inner front and/or backsheet layer surface to encapsulant, if applicable. See Clause B.9. Figures B.2, B.3 and B.4.		P
	Whenever electrical stress is present through a material layer (not along an interface or surface) the concept of distance through insulation is applicable and CTI is not required.	Pollution degree 1	P
	Additionally, the following PV module tests apply: – Insulation test (MST 16) before and after preconditioning, and – Impulse voltage test (MST 14).		P
<b>5.5.2.3.3</b>	<b>Endurance to thermal stress – RTE (RTI) or TI (mechanical/electrical)</b>		P
	Materials used as relied upon insulation have a minimum relative thermal endurance, relative thermal index or temperature index (RTE/RTI or TI) in accordance with IEC 60216-5 or IEC 60216-1 equal to or greater than the maximum normalized operating temperature of the material as measured in the particular mounting situation (e.g. roof mounted) during the temperature test (MST 21), or 90 °C, whichever is higher. For open rack mounted PV modules, the normalized measured maximum PV module operating temperature can be assumed to be 90 °C, so the insulation RTE/RTI or TI rating shall be at least 90 °C. To ensure that the electrical and mechanical properties are provided through the expected lifetime the TI and RTE (RTI) values have to be evaluated as mechanical and electrical ones according to IEC 60216-2. Relevant RTI values evaluated in accordance to UL 746B are accepted as an alternative to RTE.		P
<b>5.5.2.3.4</b>	<b>Polymeric insulating materials used as external parts</b>		P
	External polymeric parts of the PV module whose deterioration could impair the safety meet the following additional requirements:		—
	a) flammability class minimum V-1 according to IEC 60695-11-10 (not applicable to insulation in thin layers; those are covered only by MST 24);	Junction box meet the IEC 62790 requirements Connector meet the IEC 62852 requirements Cable meet the EN50618 requirements	P

<b>IEC 61730-1: Part 1: Requirements for construction</b>			
Clause	Requirement + Test	Result - Remark	Verdict
	b) ball pressure test according to IEC 60695-10-2 with a temperature of 75 °C (not applicable to insulation in thin layers);	Junction box meet the IEC 62790 requirements Connector meet the IEC 62852 requirements Cable meet the EN50618 requirements	P
	c) ignitability test (MST 24) in final application (laminated or the PV module);		P
	d) peel test for proof of cemented joints according to IEC 61730-2 (MST 35), where applicable;		N/A
	e) lap shear strength test (MST 36), where applicable.		N/A
<b>5.5.2.3.5</b>	<b>Polymeric insulating parts supporting live parts</b>		P
	Polymeric parts which are not components of the laminate whose deterioration could impair the safety of the PV module are evaluated with the module level ignitability test MST 24.		P
	Other than elastomeric polymeric materials (e.g. duroplastic) shall meet the following additional requirements:		—
	a) Flammability class minimum HB according to IEC 60695-11-10.	Junction box meet the IEC 62790 requirements Connector meet the IEC 62852	P
	b) Ball pressure test according to IEC 60695-10-2 with a temperature of 125 °C.	Junction box meet the IEC 62790 requirements Connector meet the IEC 62852	P
	c) Materials creep test (MST 37).		P
<b>5.5.2.4</b>	<b>Polymeric materials used for mechanical functions</b>		P
	Materials used for mechanical functions have a minimum mechanical relative thermal endurance, relative thermal index or temperature index (RTE/RTI or TI) in accordance with IEC 60216-5 or IEC 60216-1 equal to or greater than the maximum normalized operating temperature of the material as measured in the particular mounting situation (e.g. roof mounted) during the temperature test (MST 21), or 90 °C, whichever is higher.		N/A
<b>5.5.3</b>	<b>Metallic materials</b>		P
<b>5.5.3.1</b>	<b>General</b>		P
	In accordance with IEC 60950-1 metal parts designed for applications in climates with wet or humid ambient conditions are not in contact to metal parts that have a difference of their electrochemical potentials of more than 600 mV.		P
	Larger electrochemical potential differences are permissible if the contact points of these materials are designed to remain dry.		N/A

<b>IEC 61730-1: Part 1: Requirements for construction</b>			
Clause	Requirement + Test	Result - Remark	Verdict
	Electrochemical potentials for specific material combinations are taken into consideration.		P
	Iron or mild steel as a part of the product are plated, painted, or enamelled for protection against corrosion.		N/A
	The corrosion protection at a minimum shall be at least equivalent to a zinc coating of 0,015 mm thickness.		N/A
	Simple sheared or cut edges and punched holes are not required to be additionally protected, provided these features do not affect the mechanical bonding, mounting or structural performance of the PV module.		P
	Compliance is checked by inspection.		P
<b>5.5.3.2</b>	<b>Current carrying parts</b>		P
	Under normal operation current-carrying parts have a sufficient mechanical strength and electrical conductivity.		P
	If environmental conditions may cause corrosion current-carrying materials (metal, polymeric based, etc.) are protected against corrosion, e.g. by coating.		P
	In case of current-carrying parts consisting of corrosion protective coated metal the coating are capable of preventing corrosion according to either one of ISO 1456, ISO 1461, ISO 2081 or ISO 2093.		N/A
	If the current-carrying parts may be stressed by abrasion, coated metal parts are not allowed.		N/A
	Other materials are protected accordingly.		N/A
<b>5.5.4</b>	<b>Adhesives</b>		P
	Adhesives are appropriate for the application. Compliance is checked by relevant tests of IEC 61730-2, including lap shear strength test (MST 36), peel test (MST 35), robustness of terminations test (MST 42), mechanical load test (MST 34), and visual inspection (MST 01), accessibility test (MST 11), wet leakage current test (MST 17) pre- and post- test sequences, where applicable.		P
	If an adhesive is part of the relied upon electrical insulation it has to meet the requirements of 5.5.2.3.3.		N/A
Supplementary information: Specific requirements for adhesives are under consideration.			

<b>5.6</b>	<b>Protection against electric shock</b>		P
<b>5.6.2</b>	<b>Protection against accessibility to hazardous live parts</b>		P

<b>IEC 61730-1: Part 1: Requirements for construction</b>			
Clause	Requirement + Test	Result - Remark	Verdict
<b>5.6.2.1</b>	<b>General</b>		
	PV modules are constructed to provide adequate protection against accessibility to hazardous live parts (> 35 V DC).		P
	For Class 0 PV modules, accessible parts shall be separated from hazardous live parts by at least basic insulation.		N/A
	Class II PV modules shall be so constructed and enclosed that only parts separated from hazardous live parts by double or reinforced insulation are accessible.		P
	In Class III PV modules live parts are not considered as hazardous, so a separation from accessible parts is not needed.		N/A
	To ensure sufficient functionality and protection against hazardous lighting arc, live parts of different polarity are separated by at least functional insulation.		N/A
	Compliance is checked by visual inspection (MST 01) and by accessibility test (MST 11).		P
	Materials used for realizing protection against accessibility of hazardous live parts by means of enclosure, insulation barrier or relied upon insulation comply with the requirements of 5.5.2 due to their application.		P
<b>5.6.2.2</b>	<b>Protection by means of enclosures and insulation barriers</b>		P
	Enclosures or insulation barriers are so designed that, after mounting, the live parts are not accessible. This requirement is fulfilled even if there is any deformation of the housing and/or cover as a result of mechanical and thermal stress, which can occur during normal use. Furthermore, the degree of protection of the housing is not be impaired by this possible deformation.		P
	Parts of enclosures and insulation barriers that provide protection in accordance with these requirements are not removable without the use of a tool. Lids which are attached without screws have one or several detectable features, e.g. recesses, which enable tools to be deployed in order to remove them. If the lid is removed correctly the tool may not come into contact with the live parts.		P
	An insulation barrier is held in place and is not adversely affected by influences expected during normal operation to the extent that its necessary electrical and mechanical properties fall below the minimum acceptable values for the application.		N/A
	Parts shall be prevented from loosening or turning if such loosening or turning may result in a risk of fire, electric shock, or injury to persons.		P
<b>5.6.2.3</b>	<b>Protection by means of insulation of live parts</b>		P

<b>IEC 61730-1: Part 1: Requirements for construction</b>			
Clause	Requirement + Test	Result - Remark	Verdict
	An insulation material providing the sole insulation between a live part and an accessible metal part, or between uninsulated live parts not of the same potential, is of adequate thickness and of a material appropriate for the application. If the maximum power dissipation between two neighbouring cells is less than 15 W (based on solar cell rating), neighbouring solar cells connected in series have no special insulation requirements		P
	Required type of insulation as defined in IEC 61140 is as below:		—
	For class 0, Protection required against direct contact is required. Besides, basic insulation between live parts and accessible metal parts, basic insulation between live parts and accessible surfaces, and basic insulation between live parts of different potential of the same circuit are required		N/A
	For class II, Protection required against direct contact is required. Besides, reinforce insulation between live parts and accessible metal parts, reinforce insulation between live parts and accessible surfaces, and basic insulation between live parts of different potential of the same circuit are required		P
	For class III, Protection required against direct contact is not required. Besides, function insulation between live parts and accessible metal parts, function insulation between live parts and accessible surfaces, and function insulation between live parts of different potential of the same circuit are required		N/A
Supplementary information: N/A			
<b>5.6.3</b>	<b>Insulation coordination</b>		P
<b>5.6.3.2</b>	<b>Pollution degree</b>		—
<b>5.6.3.3</b>	<b>Material groups</b>		—
<b>5.6.3.4</b>	<b>Clearances (cl) and creepage distances (cr)</b>		P
	Minimum clearances (cl) and creepage distances (cr) between internal live parts and outer accessible surfaces	TSM-xxxNEG9R.28: 12.8mm TSM-xxxNEG21C.20: 11.0mm TSM-xxxNEG19RC.20: 12.5mm	P

<b>IEC 61730-1: Part 1: Requirements for construction</b>			
Clause	Requirement + Test	Result - Remark	Verdict
	Minimum clearances (cl) and creepage distances (cr) between live parts of different potential inside a PV module	TSM-xxxNEG9R.28: 1.2mm TSM-xxxNEG21C.20: 0.3mm TSM-xxxNEG19RC.20: 0.8mm	P
	Minimum clearances (cl) and creepage distances (cr) between terminals of different polarity of rewirable junction boxes		N/A
Supplementary information: N/A			
<b>5.6.4</b>	<b>Distance through insulation (dti)</b>		P
<b>5.6.4.2</b>	<b>Cemented joints</b>		—
	Distance through cemented joints		—
	Dry volume resistivity as measured according to IEC 62788-1-2, method A.		—
	Wet volume resistivity as measured according to IEC 62788-1-2, method A.		—
<b>5.6.4.3</b>	<b>Insulation in thin layers</b>		N/A
	a) Single-layer sheet providing relied upon insulation		—
	Thickness of single layer		—
	RTI / RTE / TI as defined in 5.5.2.3.3		—
	Dielectric strength for reinforced insulation		—
	b) Multi-layer sheets providing relied upon insulation if single layers are characterized individually:		—
	Thickness of each layer, and sum thickness		—
	RTI / RTE / TI for each layer as defined in 5.5.2.3.3		—
	Dielectric strength for basic insulation for each layer		—
	c) Multi-layer sheets providing relied upon insulation if single layers are not characterized individually:		—
	Thickness of combined thickness of all layers		—
	RTI / RTE / TI for combined layers as defined in 5.5.2.3.3		—
	Dielectric strength of entire multi-layer sheet providing relied upon insulation fulfill requirements for reinforced insulation.		—
Supplementary information: N/A			

<b>IEC 61730-2: Part 2: Requirements for testing</b>			
Clause	Requirement + Test	Result - Remark	Verdict
<b>10</b>	<b>Test Procedures</b>		
	Safety qualification testing includes the following Module Safety Tests (MST) of IEC 61730-2:		
10.2	MST 01 – Visual inspection .....	see table 10.2	P
10.3	MST 02 – Performance at STC .....	see table 10.3	P
10.4	MST 03 – Maximum power determination .....	see table 10.4	P
10.5	MST 04 – Insulation thickness test .....	see table 10.5	N/A
10.6	MST 05– Durability of markings.....	see table 10.6	N/A
10.7	MST 06– Sharp edge test.....	see table 10.7	N/A
10.8	MST 07– Bypass diode functionality test.....	see table 10.8	N/A
10.9	MST 11 – Accessibility test.....	see table 10.9	N/A
10.10	MST 12 – Cut susceptibility test .....	see table 10.10	N/A
10.11	MST 13 – Continuity test of equipotential bonding:	see table 10.11	N/A
10.12	MST 14 – Impulse voltage test .....	see table 10.12	N/A
10.13	MST 16 – insulation test .....	see table 10.13	N/A
10.14	MST 17 – Wet leakage current test .....	see table 10.14	N/A
10.15	MST 21 – Temperature test.....	see table 10.15	N/A
10.16	MST 22 – Hot-spot test.....	see report no.:	N/A
10.17	MST 23 – Fire test .....	see table 10.17	N/A
10.18	MST 24 – Ignitability test .....	see table 10.18	N/A
10.19	MST 25 – Bypass diode thermal test.....	see report no.:	N/A
10.20	MST 26 – Reverse current overload Test.....	see table 10.20	N/A
10.21	MST 32 – Module breakage test.....	see table 10.21	N/A
10.22	MST 33 – Screw connections test .....	see table 10.22	N/A
10.23	MST 34 – Static mechanical load test .....	see report no.:	N/A
10.24	MST 35 – Peel test .....	see table 10.24	N/A
10.25	MST 36 – Lap shear strength test .....	see table 10.25	N/A
10.26	MST 37 – Materials creep test.....	see table 10.26	N/A
10.27	MST 42 – Robustness of terminations test.....	see report no.:	N/A
10.28	MST 51 – Thermal cycling test .....	see report no.:	N/A
10.29	MST 52 – Humidity freeze test .....	see table 10.29	N/A
10.30	MST 53 – Damp heat test.....	see report no.:	N/A
10.31	MST 54 – UV preconditioning test .....	see table 10.31	N/A
10.32	MST 55 – Cold conditioning.....	see table 10.32	N/A
10.33	MST 56 – Dry heat conditioning .....	see table 10.33	N/A

<b>IEC 61730-2: Part 2: Requirements for testing</b>			
Clause	Requirement + Test	Result - Remark	Verdict
Supplementary information: N/A			

IEC 61730-2: Part 2: Requirements for testing			
Clause	Requirement + Test	Result - Remark	Verdict

10.2	TABLE: Visual Inspection - MST 01 (Initial)		P
Test Date [YYYY-MM-DD] .....	2023-07-14		—
Sample No.	Nature and position of findings		—
HA2023TL-0761-001X	No major visual defects found		P
HA2023TL-0761-002X	No major visual defects found		P
HA2023TL-0762-001X	No major visual defects found		P
HA2023TL-0762-002X	No major visual defects found		P
HA2023TL-0763-001X	No major visual defects found		P
HA2023TL-0763-002X	No major visual defects found		P
Supplementary information: N/A			

10.3	TABLE: Performance at STC – MST 02(Front)					
Test Date [YYYY-MM-DD] .....	2023-07-19					—
Irradiance (W/m2) .....	1000					—
Module temperature (°C) .....	25					—
Test method .....	<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight					—
Rated Isc including manufacturing tolerances ..	10.81±4%					—
Rated Voc including manufacturing tolerances ..	53.8±3%					—
Sample #	Isc [A]	Voc [V]	Imp [A]	Vmp [V]	Pmp [W]	FF [%]
HA2023TL-0761-001X	10.789	52.289	10.283	44.565	458.250	81.23
HA2023TL-0761-002X	10.771	52.275	10.256	44.628	457.725	81.29
Supplementary information: N/A						

10.3	TABLE: Performance at STC – MST 02					
Test Date [YYYY-MM-DD] .....	2023-07-19					—
Irradiance (W/m2) .....	1000					—
Module temperature (°C) .....	25					—
Test method .....	<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight					—
Rated Isc including manufacturing tolerances ..	15.91±5%					—
Rated Voc including manufacturing tolerances ..	49.6±3%					—
Sample #	Isc [A]	Voc [V]	Imp [A]	Vmp [V]	Pmp [W]	FF [%]

IEC 61730-2: Part 2: Requirements for testing						
Clause	Requirement + Test			Result - Remark		Verdict
HA2023TL-0762-001X	15.999	47.935	15.275	40.130	613.001	79.93
HA2023TL-0762-002X	16.017	47.825	15.323	39.919	611.669	79.85
Supplementary information: N/A						

10.3	TABLE: Performance at STC – MST 02(Back)					
Test Date [YYYY-MM-DD] .....	2023-07-19					—
Irradiance (W/m2) .....	1000					—
Module temperature (°C) .....	25					—
Test method .....	<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight					—
Rated Isc including manufacturing tolerances .....	N/A					—
Rated Voc including manufacturing tolerances .....	N/A					—
Sample #	Isc [A]	Voc [V]	Imp [A]	Vmp [V]	Pmp [W]	FF [%]
HA2023TL-0762-001X	12.288	47.481	11.669	40.725	475.235	81.45
HA2023TL-0762-002X	12.504	47.516	11.904	39.922	475.235	79.99
Supplementary information: N/A						

10.3	TABLE: Performance at BNPI – MST 02					
Test Date [YYYY-MM-DD] .....	2023-07-19					—
Irradiance (W/m2) .....	1104					—
Module temperature (°C) .....	25					—
Test method .....	<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight					—
Rated Isc including manufacturing tolerances .....	N/A					—
Rated Voc including manufacturing tolerances .....	N/A					—
Sample #	Isc [A]	Voc [V]	Imp [A]	Vmp [V]	Pmp [W]	FF [%]
HA2023TL-0762-001X	17.701	48.104	16.363	41.329	676.252	79.42
HA2023TL-0762-002X	17.693	48.024	16.857	40.016	674.558	79.39
Supplementary information: N/A						

10.3	TABLE: Performance at STC – MST 02(Front)					
Test Date [YYYY-MM-DD] .....	2023-07-19					—

IEC 61730-2: Part 2: Requirements for testing						
Clause	Requirement + Test			Result - Remark		Verdict
Irradiance (W/m <sup>2</sup> ) .....	1000					—
Module temperature (°C) .....	25					—
Test method .....	<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight					—
Rated I <sub>sc</sub> including manufacturing tolerances ..	18.40±5%					—
Rated V <sub>oc</sub> including manufacturing tolerances .....	49.0±3%					—
Sample #	I <sub>sc</sub> [A]	V <sub>oc</sub> [V]	I <sub>mp</sub> [A]	V <sub>mp</sub> [V]	P <sub>mp</sub> [W]	FF [%]
HA2023TL-0763-001X	18.387	47.915	17.662	40.384	713.251	80.96
HA2023TL-0763-002X	18.401	47.865	17.573	40.401	709.984	80.61
Supplementary information: N/A						

10.3	TABLE: Performance at STC – MST 02(Back)					
Test Date [YYYY-MM-DD] .....	2023-07-19					—
Irradiance (W/m <sup>2</sup> ) .....	1000					—
Module temperature (°C) .....	25					—
Test method .....	<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight					—
Rated I <sub>sc</sub> including manufacturing tolerances ..	N/A					—
Rated V <sub>oc</sub> including manufacturing tolerances .....	N/A					—
Sample #	I <sub>sc</sub> [A]	V <sub>oc</sub> [V]	I <sub>mp</sub> [A]	V <sub>mp</sub> [V]	P <sub>mp</sub> [W]	FF [%]
HA2023TL-0763-001X	14.450	47.600	13.700	40.907	560.435	81.48
HA2023TL-0763-002X	14.478	47.520	13.696	40.749	558.102	81.12
Supplementary information: N/A						

10.3	TABLE: Performance at BNPI – MST 02					
Test Date [YYYY-MM-DD] .....	2023-07-19					—
Irradiance (W/m <sup>2</sup> ) .....	1106					—
Module temperature (°C) .....	25					—
Test method .....	<input checked="" type="checkbox"/> Simulator <input type="checkbox"/> Natural sunlight					—
Rated I <sub>sc</sub> including manufacturing tolerances ..	N/A					—
Rated V <sub>oc</sub> including manufacturing tolerances .....	N/A					—
Sample #	I <sub>sc</sub> [A]	V <sub>oc</sub> [V]	I <sub>mp</sub> [A]	V <sub>mp</sub> [V]	P <sub>mp</sub> [W]	FF [%]

<b>IEC 61730-2: Part 2: Requirements for testing</b>						
Clause	Requirement + Test			Result - Remark		Verdict
HA2023TL-0763-001X	20.359	48.029	18.985	41.477	787.456	80.53
HA2023TL-0763-002X	20.336	48.058	19.339	40.504	783.325	80.15
Supplementary information: N/A						

**ANNEX 1: CONSTRUCTIONAL DETAILS**

<b>A1.1</b>	<b>MODULE TYPE/S</b>
	a. TSM-xxxNEG9R.28 (xxx=375-460, in steps of 5) b. TSM-xxxNEG21C.20 (xxx=635-710, in steps of 5) c. TSM-xxxNEG19RC.20 (xxx=525-620, in steps of 5)

<b>A1.2</b>	<b>MODULE DESIGN</b>	
	Module dimensions (L x W x H) [mm] .....	a. 1762 x 1134 x 30 mm b. 2384 x 1303 x 33mm c. 2384 x 1134 x 30mm
	Weights.....	a. 21.8 kg(approx) b. 38.3 kg(approx) c. 33.4 kg(approx)
	Front/Rear cover bonding classification .....	<input type="checkbox"/> rigid/flexible <input checked="" type="checkbox"/> rigid/rigid <input type="checkbox"/> flexible/flexible

<b>A1.3</b>	<b>SOLAR CELL</b>	
	Cell type reference .....	Trina Solar Co., Ltd. a. Cell type: TSC-D6GB-14BB, Bifacial, N-topcon Monocrystalline Silicon Solar Cells b. Cell type: TSC-D6GB-18BB, Bifacial, N-topcon Monocrystalline Silicon Solar Cells c. Cell type: TSC-D6GB-16BB, Bifacial, N-topcon Monocrystalline Silicon Solar Cells
	Cell dimensions L x W x T ( $\pm$ %) [mm] .....	a. 182 x 70(1/3 cut) b. 210 x 105(1/2 cut) c. 182x 105(1/2 cut)
	Cell thickness [ $\mu$ m] .....	143 $\pm$ 14.3
	Cell area [cm <sup>2</sup> ] .....	a. 127 b. 220 c. 191

<b>A1.4</b>	<b>IDENTIFICATION OF MATERIALS</b>	
	Front cover.....	Trina Solar Co., Ltd. Type: AR-Coating glass a. Thickness:1.6 mm b,c. Thickness:2.0 mm

Rear cover .....	Trina Solar Co., Ltd. a. Type: Tempered glass Thickness:1.6 mm b,c. Type: Tempered Glass with PV side white coating Thickness:2.0 mm
Encapsulation material front side .....	Hangzhou First Applied Material Co., LTD Type: EP304 Thickness: 0.45±0.05 mm
Encapsulation material back side .....	Hangzhou First Applied Material Co., LTD a.Type: F806W b,c. Type: F406P Thickness: 0.45±0.05 mm.
Frame parts .....	Trina Solar Co., Ltd. 6005-T6 a. Cross-section graph: TS-DR-G9(30)- 070-04 b. Cross-section graph: TS-DR-G21(33)- 070 c. Cross-section graph: TS-DR-G19R(30)- 070-01
Mounting parts .....	N/A
Adhesive for frame .....	Shanghai Huitian New Material Co., Ltd. Type: HT906Z
Edge sealing .....	N/A
Internal wiring .....	N/A
Cell connector .....	Trina Solar Co., Ltd. Cross section: $\Phi 0.32$ Coating Sn60Pb40
String connector .....	Trina Solar Co., Ltd. Cross section: 0.25×4.0/6.0/7.5mm, Coating Sn60Pb40
Soldering material.....	N/A
Fluxing agent .....	Singapore Asahi solder technology(wuxi) co.,Ltd. Type: SF56
Junction box.....	Trina Solar Co., Ltd. Type: TS306x, DC 1500 V
Cable .....	Trina Solar Co., Ltd. Type: 62930 IEC 131 1X4,0mm <sup>2</sup> , 1500V DC, HALOGEN FREE LOW SMOK
Connector .....	Trina Solar Co., Ltd. Type: TS4
Bypass diode .....	Trina Solar Co., Ltd. a. Type: TM3045-20 b,c. Type:TM3045-25
Potting material.....	Shanghai Huitian New Material Co., Ltd. Type: 5299W-S
Adhesive for junction box .....	Shanghai Huitian New Material Co., Ltd. Type: HT906Z

	Additional material (e. g. fixing tape, insulation tape).....:	3M Type: UV-T
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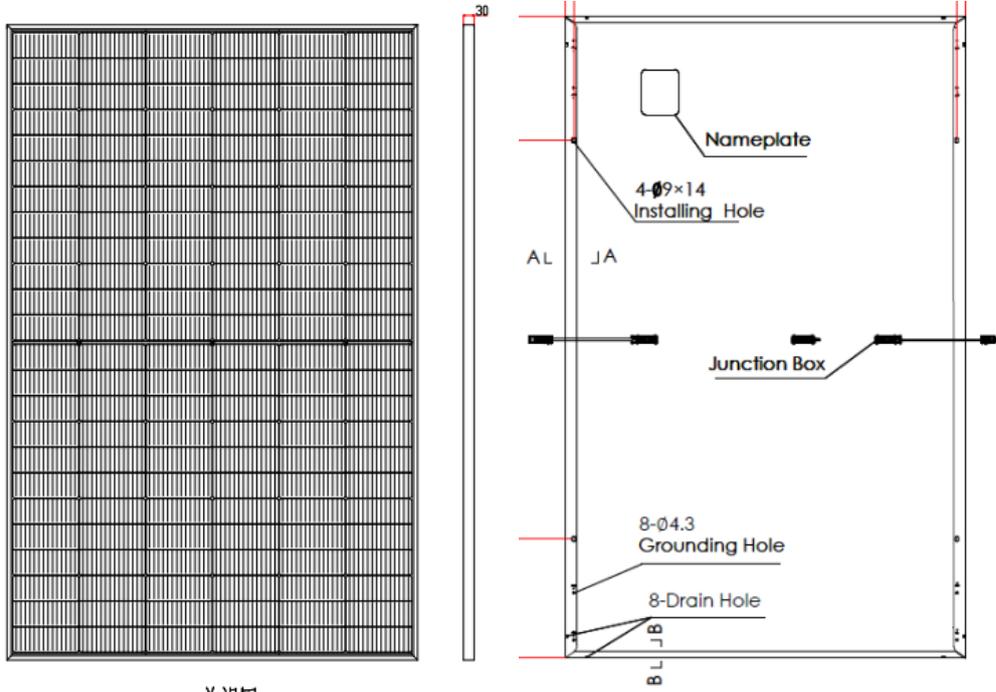
<b>A1.5</b>	<b>MODULE DESIGN - MINIMUM DISTANCES</b>	
	Between cells.....:	a.1.2mm b.0.3mm c.0.8mm
	Between cell and accessible surfaces.....:	a.13.0mm b.11.0 mm c.13.0mm
	Between any current carrying part and accessible surfaces .....	a.12.8mm b.11.0 mm c.12.5mm

<b>A1.6</b>	<b>MODULE DESIGN - ELECTRICAL CONFIGURATION</b>	
	Total number of cells .....	a.144 b.c.132
	Serial-parallel connection of cells .....	SP
	Cells per bypass diode .....	a.48 b.c.44
	No. of bypass diodes .....	3

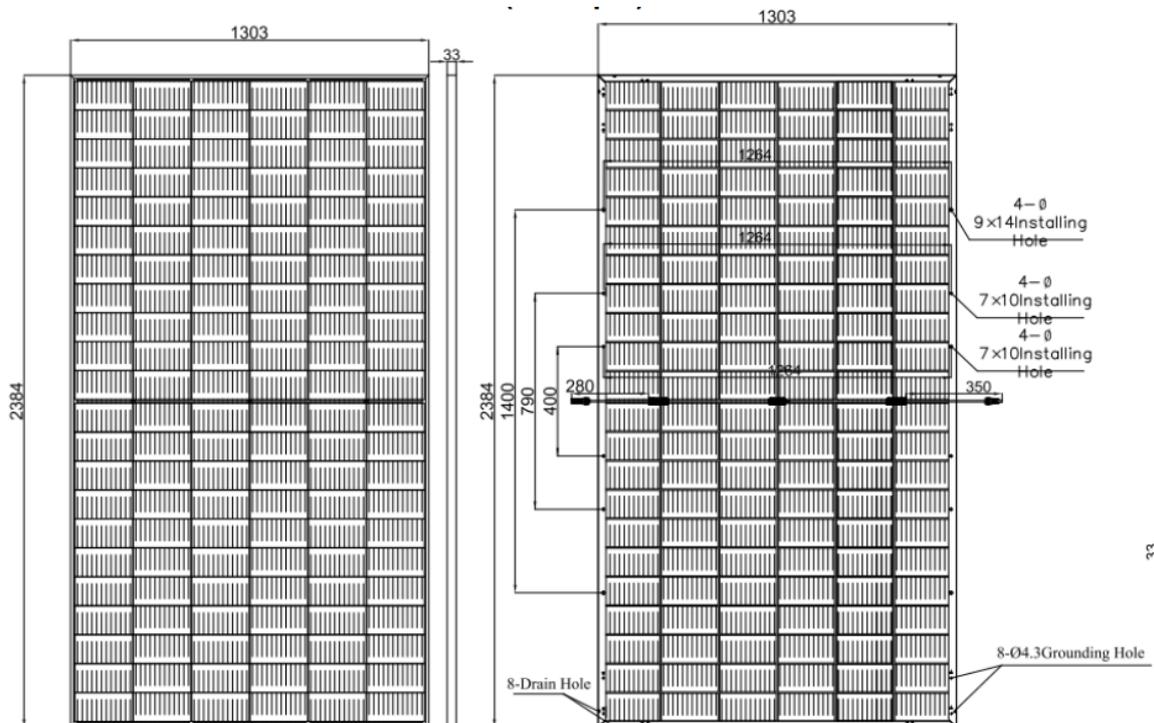
**ANNEX 2:**

**CONSTRUCTURE DETAILS**

TSM-xxxNEG9R.28

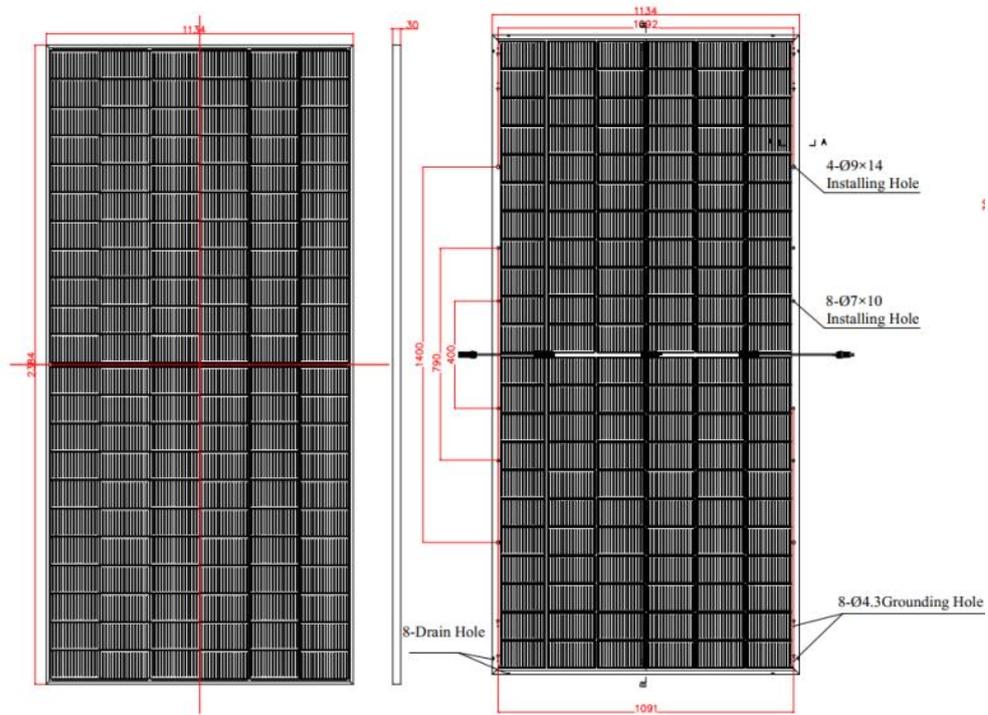


TSM-xxxNEG21C.20

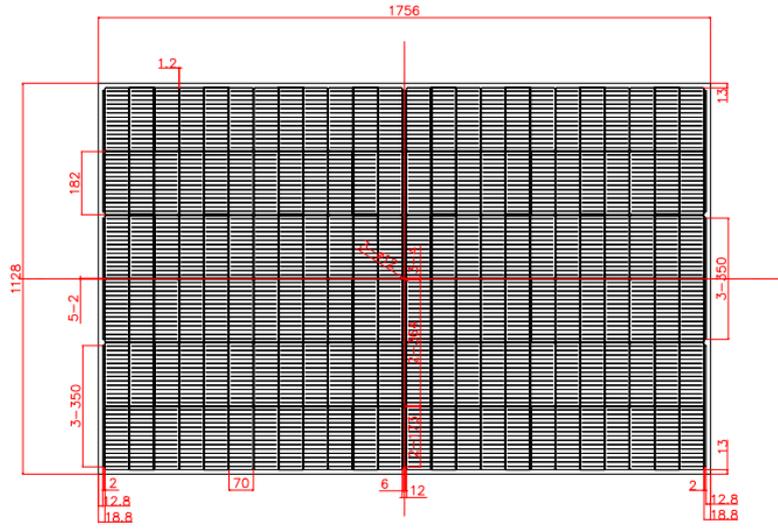


TRF No. IEC61730a

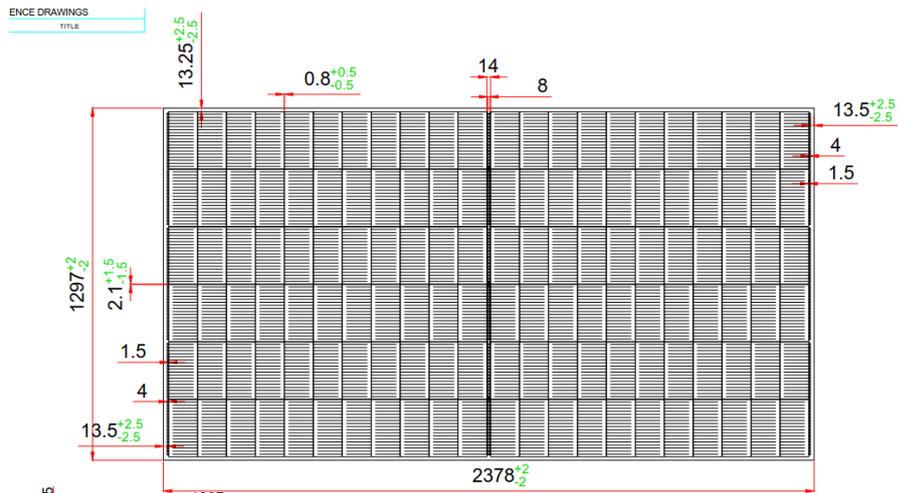
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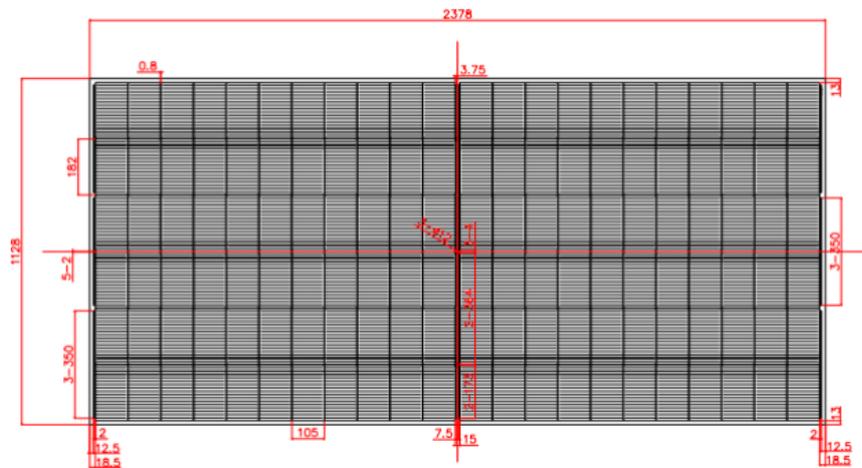
ELECTRIC CLEARANCE DIAGRAM:  
TSM-xxxNEG9R.28



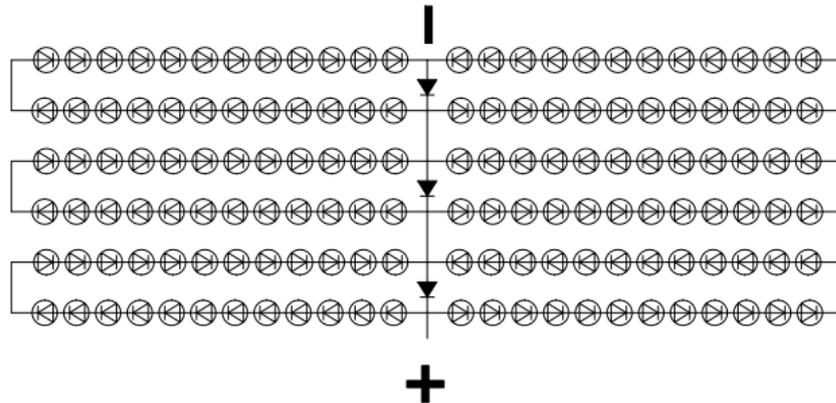
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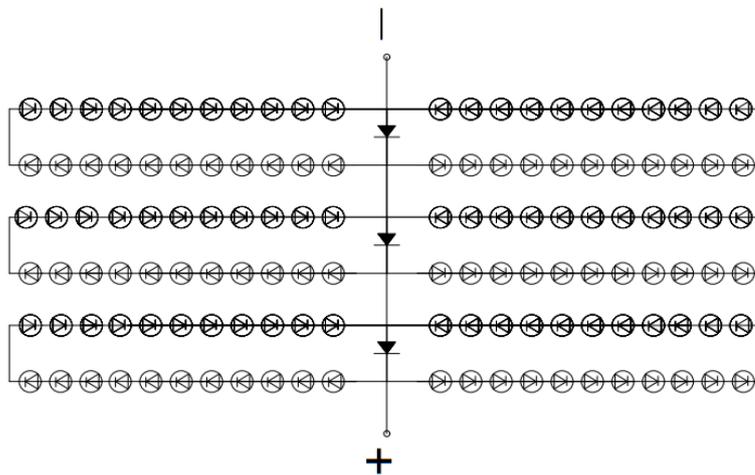
TSM-xxxNEG19RC.20



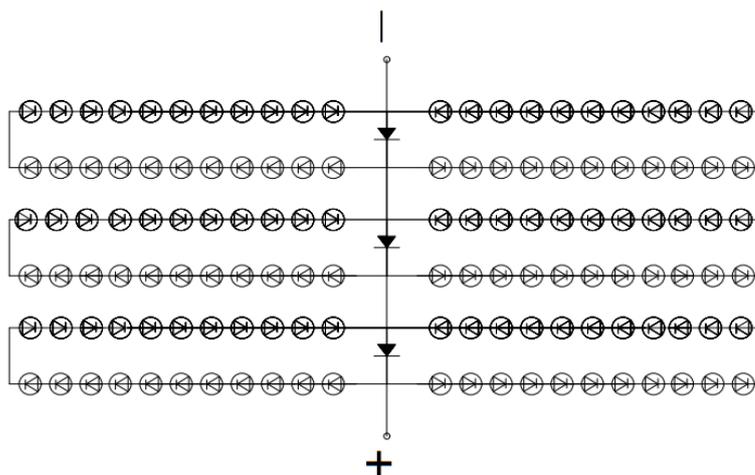
Circuit diagram:  
TSM-xxxNEG9R.28



TSM-xxxxNEG21C.20



TSM-xxxNEG19RC.20



----- End of TRF No. IEC61730a series-----

TRF No. IEC61730a