TEST REPORT

Report No.	:	S23021000701001
Product	:	Semi Flexible Solar Panels FSP Series
Model No.	:	FSP55W, FSPBK55W, FSP70W, FSPBK70W, FSP110W, FSPBK110W, FSP150W, FSPBK150W, FSP200W, FSPBK200W, FSP220W, FSPBK220W, FSP245W, FSPBK245W, FSP270W, FSPBK270W, FSP300W
Applicant	:	Distribuciones Solares del Principado S.L
Address	:	Pol.Ind La Roza, nave 25 33199 Granda (Siero), Principado de Asturias
Issued by	:	Shenzhen NTEK Testing Technology Co., Ltd.
Lab Location	:	1/F, Building E, Fenda Science Park, Sanwei Community, Xixiang Street, Bao'an District, Shenzhen 518126 P.R. China
Telephone:	:	400-800-6106, 0755-2320 0050, 2320 0090

Report No. S23021000701001

TEST REPORT
EN IEC 61730-1:2018 AND EN IEC 61730-2: 2018
Photovoltaic (PV) module safety qualification –
Part 1: Requirements for construction Part 2: Requirements for testing

Report Number	S23021000701001
Tested by	Trond Tian
Approved by	Henson Dong
Date of issue	Feb 15, 2023

Testing laboratory	Shenzhen NTEK Testing Technology Co., Ltd.
Address	1/F, Building E, Fenda Science Park, Sanwei Community, Xixiang Street, Bao'an District, Shenzhen 518126 P.R. China
Testing location	(Same as above)

Applicant Name	Distribuciones Solares del Principado S.L
Address	Pol.Ind La Roza, nave 25 33199 Granda (Siero), Principado de Asturias

Test specification

Standard	EN IEC 61730-1: 2018; EN IEC 61730-2: 2018
Procedure deviation	N.A
Non-standard test method	N.A

Test Item description	Semi Flexible Solar Panels FSP Series
Trade mark	Eleksol
Model	FSP55W, FSPBK55W, FSP70W, FSPBK70W, FSP110W, FSPBK110W, FSP150W, FSPBK150W, FSP200W, FSPBK200W, FSP220W, FSPBK220W, FSP245W, FSPBK245W, FSP270W, FSPBK270W, FSP300W
Manufacturer	Shenzhen Sungold Solar co., Ltd
Manufacturer address	2-5 Floor, H Building,Wen Tao Industrial Park, Ying Ren Shi, Shi Yan Town, Bao'an District, ShenZhen ,Guangdong, China
Rating	Voc:31.2V, Vmp:26.4V, Imp:11.36A, Isc:12.04A, Pmax:300W

GENERAL INFORMATION	
Abbreviations used in the report:	
HF – Humidity Freeze	TC – Temperature Cycling
DH – Damp Heat	Vmp – Maximum power voltage
Imp – Maximum power current	Voc – Open circuit voltage
Isc - Short circuit current	FF – Fill Factor
Pmp – Maximum power	α – Current temperature coefficient
MQT – Module Quality Tests	β – Voltage temperature coefficient
STC – Standard Test Conditions	δ – power temperature coefficient
NMOT – Nominal Module Operating Temperature (20°C, 800 W/m²)	VFMrated – Rated diode(s) forward voltage
VFM – Measured diode(s) forward voltage	NP – Nameplate
m_1 – the measurement uncertainty in % of laboratory for Pmax	m_2 – the measurement uncertainty in % of laboratory for Voc
m_3 – the measurement uncertainty in % of laboratory for Isc	t_1 – the manufacturer's rated lower production tolerance in % for Pmax
t_2 – the manufacturer's rated upper production tolerance in % for Voc	t_3– the manufacturer's rated upper production tolerance in % for Isc
r – Pmax measurement reproducibility	
Possible test case verdicts:	
- test case does not apply to the test object .....:	(N)/A
- test object does meet the requirement.....:	(P)ass
- test object does not meet the requirement.....:	(F)ail

General remarks:

The test results 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 comma (point) is used as the decimal separator.

Unless otherwise specified, models FSP300W are chosen as representative models to perform all tests.

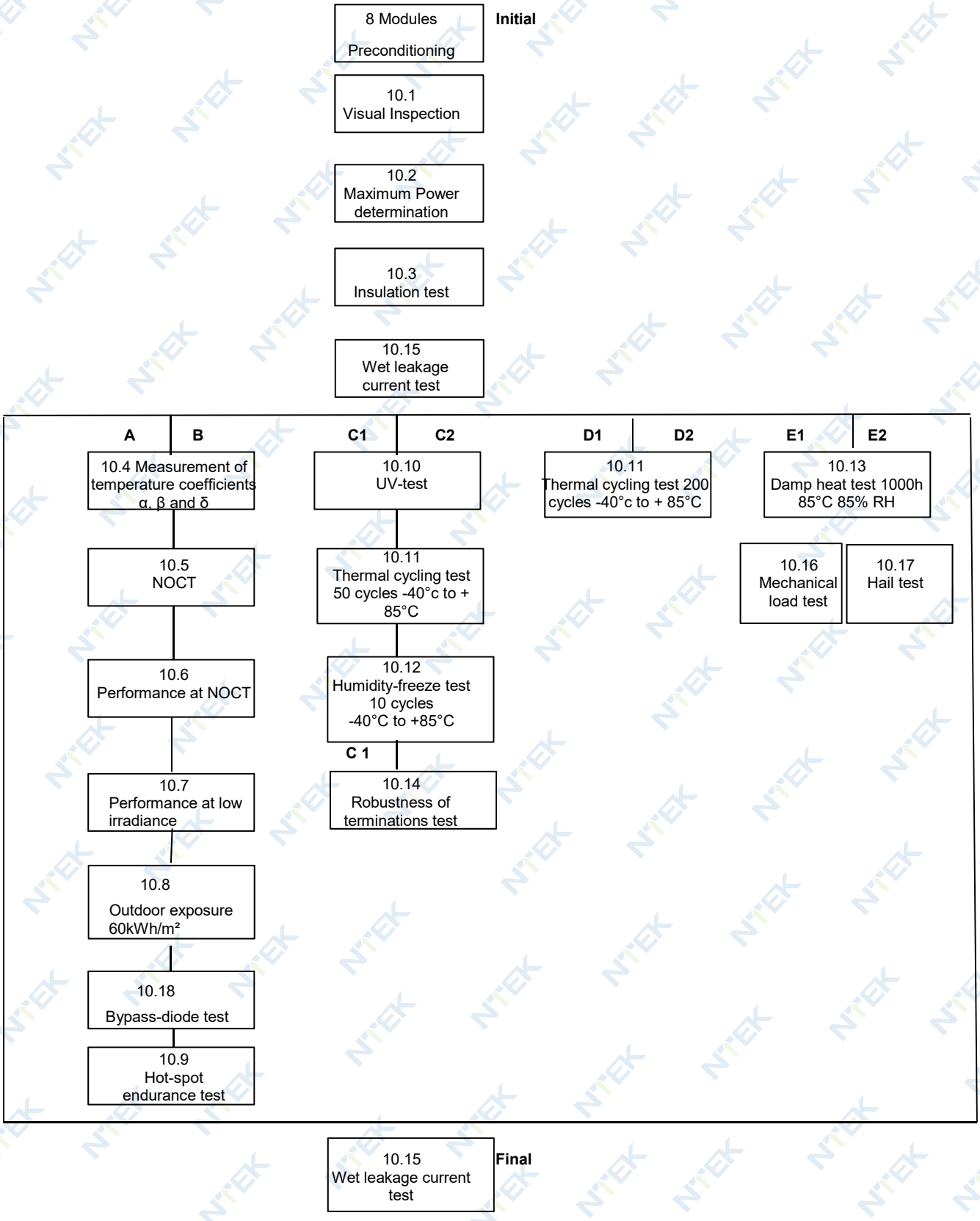
-All the test data in this report S23021000701001 is refer to the test data in initial report S21051500904001, only add the model in the report , the model internal circuit is exactly the same just the power difference.

Module type	FSP00W
Voc [V]	31.2
Vmp [V]	26.4
Imp [Adc]	11.36
Isc [Adc]	12.04
Pmp [W]	300

Testing procedure

- ☒ New module type
- ☐ Modifications (if yes, please choose the applicable modification according to the Retesting Guideline)
- ☐ Change in cell technology Modification to encapsulation system Modification to superstrate
- ☐ Increase in module size Modification to backsheet/ substrate
- ☐ Modification to frame and/ or mounting structure Modification to junction box/ electrical termination Change in cell interconnect materials or technique
- ☐ Change in electrical circuit of an identical package
- ☐ Higher or lower power output (by 10%) in the identical package including size and using the identical cell process
- ☐ Qualification of a frameless module after the design has received certification as a framed module
- ☐ Change in bypass diode or number of diodes

10 TEST PROCEDURES (if it is not a full test, strikethrough ~~non-performed test~~)
Note: Deviations from test sequence are possible but must be documented.



EN IEC 61730-2			
Clause	Requirement + Test	Result - Remark	Verdict
4 CLASSIFICATION, APPLICATIONS AND INTENDED USE			
4.1 General			
	The module has been evaluated for the following Class (IEC 61140)……:	☐ Class 0 ☐ Class II ☒ Class III	—
4.5 Intended use			
	PV modules are installed in the following special applications:		—
	Building attached PV (BAPV)	☐yes ☒no	—
	Building integrated PV (BIPV)	☐yes ☒no	—
	Applications in areas where snow and / or wind load exceeding loads as tested in IEC 61730-2 are expected	☐yes ☒no	—
	Applications at environmental temperature exceeding the limits indicated in of IEC 61730-1:2016	☐yes ☒no	—
	other (please specify)	☒yes, as follows: Portable outdoor products ☐no	—
5 REQUIREMENTS FOR DESIGN AND CONSTRUCTION			
5.1 General			—
	PV module 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
	Product shipped from the factory as	☒completely assembled ☐subassemblies	—
	The provided assemblies of the product do not 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 does not require any alteration of the PV module from its originally evaluated form.		P
	Equipotential bonding continuity is not interrupted by installation		P
	Any adjustable or movable structural part are provided with a locking device		P
	PV modules have no accessible burrs, sharp edges or sharp points	See Table 45	P
	Parts are prevented from loosening or turning	See Table 47 and 48	P

EN IEC 61730-2			
Clause	Requirement + Test	Result - Remark	Verdict
5.2 Marking and documentation			
5.2.1	Instructions related to safety are in an official language of the country where the equipment is to be installed.		P
5.2.2 Marking			
5.2.2.1 General			
	Each PV module includes the following clear and indelible markings:		—
	a) Name, registered trade name, or registered trade mark of manufacturer		P
	b) Type or model number designation		P
	c) Serial number		P
	d) Date and place of manufacture; alternatively serial number assuring traceability of date and place of manufacture		P
	e) Polarity of terminals or leads		P
	f) —Maximum system voltage‖ or ‖Vsys‖		P
	g) Class of protection against electrical shock, in accordance with Clause 4 of IEC 61730-1:2016		P
	h) —Voltage at open-circuit‖ or —Voc‖ including manufacturing tolerances		P
	i) —Current at short-circuit‖ or —Isc‖ including manufacturing tolerances		P
	j) —PV module maximum power‖ or —Pmax‖ including manufacturing tolerances		P
	k) —Maximum overcurrent protection rating‖		N
	All electrical data are shown as relative to standard test conditions (STC) (1 000 W/m^2, (25 ± 2) °C, AM 1.5 according to IEC 60904-3).		P
	International symbols are used where applicable.		P
	PV connectors or wiring are marked in accordance to IEC 62852 with a symbol „Do not disconnect under load‖.		P
	Symbol or warning notice are imprinted or labelled close to connector		P
	PV connectors are 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 is applied near the PV module electrical connection means.		N

EN IEC 61730-2			
Clause	Requirement + Test	Result - Remark	Verdict
	PV modules are marked to indicate the class	☐class II: ☒class III: ☐class 0: no symbol	P
	PV modules provided with a functional earth connection (see section 5.2.2.2.2)	—	—
	PV modules 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
	PV modules with terminals for field wiring rated only for use with a different specific wiring material are marked with a similar statement referring to the rated material.		N
5.2.2.2 Symbols			
5.2.2.2.1 Equipotential bonding			
	Bonding conductor for equipotential bonding is identified with:	;	N
	No other terminal or location is identified in this manner		P
5.2.2.2.2 Functional earthing			
	Field installed functional earthing conductor is identified with the symbol:		N
5.2.3 Documentation			
	Documentation concerning electrical and mechanical installation provided.		N
	Class (see 5.2.2.1) is stated, including specific limitations required for that Class.		P
	Environmental conditions to which the module has been qualified are stated.		—
	concerning temperature range, typically -40 °C to +40 °C		P
	concerning wind/snow load including safety factor		P
	Documentation for safe installation, use, and maintenance is available for installers and operators.		P
	The documentation contains the following information:		—
	– Name, registered trade name, or registered trade mark of manufacturer		P
	– Type or model number designation		P
	– —Maximum system voltage‖ or ‖Vsys‖		P
	– Class of protection against electrical shock		P

EN IEC 61730-2			
Clause	Requirement + Test	Result - Remark	Verdict
	– —Voltage at open-circuit‖ or —Voc‖ including manufacturing tolerances at STC		P
	– —Current at short-circuit‖ or —Isc‖ including manufacturing tolerances at STC		P
	– —PV module maximum power‖ or —Pmax‖ including manufacturing tolerances at STC		P
	– —Maximum overcurrent protection rating‖	See Table 34	N
	– Recommended maximum series / parallel PV module configurations		N
	– Temperature coefficient for voltage at open-circuit		—
	– Temperature coefficient for maximum power		—
	– Temperature coefficient for short-circuit current		—
	All electrical data shall be shown as relative to standard test conditions (1 000 W/m^2, (25 ± 2) °C, AM 1.5 according to IEC 60904-3).		P
	International symbols are used		P
	The electrical documentation includes a detailed description of the electrical installation wiring, including:		P
	– Minimum cable diameters for PV modules intended for field wiring		P
	– Limitations on wiring methods and wire management that apply to the junction box for the PV module		P
	– Size, type, material, and temperature rating of the conductors		P
	– Type of terminals for field wiring		P
	– Specific PV connector model / types and manufacturer to which the PV module connectors can be mated		P
	– The bonding method(s), if applicable, is specified including all provided or specified hardware		P
	– The type and ratings of bypass diode to be used (if applicable)		N
	– Limitations to the mounting situation (e.g. slope, mounting means, cooling)		P
	– A statement indicating	fire rating(s) and applied standards statement regarding resistance to external fire sources not evaluated	P

EN IEC 61730-2			
Clause	Requirement + Test	Result - Remark	Verdict
	– Limitations regarding fire ratings (e.g. installation slope, sub structure or other applicable installation information)		N
	– A statement indicating the minimum mechanical means for securing the PV module		N
	– A statement indicating the maximum altitude		N
	The documentation for roof mounting includes:		—
	– A statement indicating the minimum mechanical means for securing the PV module to the roof		N
	– Specific parameter(s) when the fire rating is dependent on a specific mounting structure are provided e.g. specific spacing, or specific means of attachment to the roof or structure.		N
	A statement concerning artificially concentrated sunlight		N
	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		N
	The installation instructions include relevant parameters specified by manufacturer or the following statement or the equivalent: *"Under normal conditions, a photovoltaic module is likely to experience conditions that produce more current and/or voltage than reported at standard test conditions. Accordingly, the values of ISC and VOC marked on this module should be multiplied by a factor of 1,25 when determining component voltage ratings, conductor current ratings, and size of controls connected to the PV output."*		N
5.3 Electrical components and insulation			
5.3.2 Internal wiring			
	Internal wiring has sufficient current carrying capacity for the relevant application.		P
5.3.3 External wiring and cables			
	External wires and cables fulfil the requirements of	☒EN 50618 ☐IEC 62930.	P
5.3.4 Connectors			
	External DC connectors fulfil the requirements of IEC 62852.		P

EN IEC 61730-2			
Clause	Requirement + Test	Result - Remark	Verdict
5.3.5 Junction boxes for PV modules			
	Junction boxes for PV modules fulfil the requirements of IEC 62790.		P
5.3.6 Frontsheets and backsheets			
	Frontsheet:		—
	Material Frontsheet:	☒Glass ☐Polymeric material ☐Others.	—
	Polymeric frontsheets meet relevant requirements of section 5.5.2	See 5.5.2	P
	Polymeric frontsheets used as relied upon insulation fulfil requirements of		—
	- 5.6.4.3 for insulation in thin layers	See 5.6.4.3	P
	- 5.5.2.3 for electrical insulation	See 5.5.2.3	P
	Thermal index frontsheet (see also 5.5.2.3.3):	☐TI : ☒RTE : ☐RTI :	—
	Adhesion to encapsulant or glass is appropriate	Compliance is checked by test sequences of IEC 61730-2 listed in this report.	P
	Backsheet:		—
	Material Backsheet:	☐Glass ☒Polymeric material ☐Others.	—
	Polymeric backsheets meet relevant requirements of section 5.5.2	See 5.5.2	P
	Polymeric backsheets used as relied upon insulation fulfil requirements of		P
	- 5.6.4.3 for insulation in thin layers	See 5.6.4.3	P
	- 5.5.2.3 for electrical insulation	See 5.5.2.3	P
	Thermal index backsheet (see also 5.5.2.3.3):	☐TI : ☒RTE : ☐RTI :	—
	Adhesion to encapsulant or glass is appropriate	Compliance is checked by test sequences of IEC 61730-2 listed in this report.	P
5.3.7 Insulation barriers			
	Polymeric insulation barrier meets the relevant requirements of 5.5.2	See 5.5.2	P
	Barrier held in place while keeping its required electrical and mechanical properties		P
	Removal of barrier only possible by using a tool		P
5.3.8 Electrical connections			
5.3.8.1 General			

EN IEC 61730-2			
Clause	Requirement + Test	Result - Remark	Verdict
	Terminations are so designed, that the contact pressure is not transmitted through insulating material except ceramic, mica or other adequate material. Compliance checked by MST 01		P
	Measures are taken to prevent connections becoming loose, e.g. by using a washer.	See Table 11 and Table 48	P
	End of a stranded conductor is not consolidated by soft soldering.		P
	Measures are taken to prevent contact stress impairing electrical conductivity.		P
5.3.8.2 Terminals for external cables and PV connector ribbons			
	Terminals for electrical connections are suitable for the type and range of conductor cross-sectional areas and meet the relevant requirements of IEC 62790.		P
	Insulated terminals are designed such that a reduction of clearances and creepage distances by displacement is prevented.		P
5.3.8.3 Splices and connections inside a PV module			
	Splices and connections are mechanically secured and provide electrical continuity.		P
	Electrical connections are soldered, welded, conductively adhered, crimped, or otherwise securely connected.		P
	A soldered or conductively adhered joint is additionally mechanically secured.		P
5.3.9 Encapsulants			
	Thermal properties are sufficient for intended application.		P
	The insulation properties according to 5.5.2.3 are met, if applicable.	See 5.5.2.3.2	P
5.3.10 Bypass diodes			
	Bypass diodes are rated to withstand the current and voltage for their intended use.	See Table 31 and Table 46	N
5.4 Mechanical and electromechanical connections			
5.4.1 General			
	Type of connection:	☐Connection within frame Mounting ☐interfaces via adhesive ☐frame to clamp a mounting system ☐Equipotential bonding ☐Attachment of junction box ☐mechanical connections within the laminate;	N

EN IEC 61730-2			
Clause	Requirement + Test	Result - Remark	Verdict
	Mechanical connections are durable to withstand the thermal, mechanical, and environmental stresses occurring in the application.	See Table 38, Table 13 and Table 11	P
	Removable parts are only detachable with the aid of tools.		P
	Lids attached without screws have one or several detectable facilities for enabling tools.		P
	No contact of tools with the live parts when the lid is removed.		P
	No friction between surfaces as the sole means to inhibit the turning or loosening of a part, unless provisions to prevent unintended movement or rotation of the component is given.		N
5.4.2 Screw connections			
	Screws and mechanical connections withstand the mechanical stresses occurring in normal use.		P
	Screws are not made of a material which is soft or liable to creep.		P
	Screws used to provide mechanical stability and continuity for equipotential bonding withstand the mechanical stresses occurring in normal use.		P
	At least one screw per electrical- mechanical connection ensures the electrical connection between the metallic components		P
	Screws used for mechanical and electrical connections with a nominal diameter of less than 3 mm are screwed into metal.		P
	For screws used for mechanical and electrical connections two full threads are engaged into the metal.		P
	Screwed and other fixed connections are in such a way that they do not come loose through torsion, bending stresses, vibration, etc.		P
5.4.3 Rivets			
	Rivets which serve as electrical as well as mechanical connections are locked against loosening.		P
5.4.4 Thread-cutting screws			
	Thread-cutting and self-tapping screws are not used for interconnection of current-carrying parts made of a material which is soft or liable to creep.		P
	No thread-forming or thread-cutting (self-tapping) screws (sheet metal screws) are used for the connection of current-carrying parts.		P
	Thread-cutting (self-tapping) screws not be used if they are likely to be operated by the user or installer.		N

EN IEC 61730-2			
Clause	Requirement + Test	Result - Remark	Verdict
	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
	For equipotential bonding one screw is permitted if two full threads engage the metal		N
5.4.5 Form/press / tight fit			
	Form/press/tight fits of metallic components which are not separately equipotentially bonded are electrically connected.		P
	Requirements of MST 32 and MST 34 are met, continuity of equipotential bonding (MST 13) is provided before and after the MST 32 and MST 34 tests	See Table 38, Table 39 and Table 11	P
5.4.6 Connections by adhesives			
	Connections by adhesive for mounting means are sufficient.	See Table 38, Table 39 and Table 11	N
	Fixing of junction box by adhesive is sufficient.	See Table 27, and Table 10	N
	Adhesion of a polymer relied upon for insulation to another insulating layer is appropriate for the application.		P
	Requirements for adhesive materials are met	See 5.5.4	P
	Connection by adhesive which is considered as cemented joint fulfils the requirements of 5.6.4.2.	See 5.6.4.2	P
5.4.7 Other connections			
	Other connections such as, welded or soldered, as well as Materials and processes for creating the connections are appropriate for the application and for the intended use.	See Table 6 and Table 43	P
	Other connections which are relied upon for equipotential bonding fulfil the requirements of (MST 13).	See Table 11	N
5.5 Materials			
5.5.2 Polymeric materials			
5.5.2.1 General			
	Polymeric materials are able to durably and safely withstand the electrical, mechanical, thermal, environmental, and corrosive stresses occurring in the application.	Assessed polymeric parts see Annex 2 (BOM). Test results see subsequent sections	P
	Polymeric materials are resistant to electrical and mechanical property degradation.	Test results see subsequent sections	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.	Test results see subsequent sections	P

EN IEC 61730-2			
Clause	Requirement + Test	Result - Remark	Verdict
	They comply with the requirements of the materials creep test (MST 37) depending on their constructive function in the PV module.	See Table 13	P
	Polymeric material used as a part of a cemented joint fulfils additionally the requirements of 5.6.4.2.	See 5.6.4.2	P
5.5.2.2 Endurance to weathering stress			
	Polymeric materials of the module and its components are durable to weathering stress.	Test results see subsequent sections	P
5.5.2.3 Polymeric materials used as electrical insulation			
5.5.2.3.1 General			
	Material relied upon for insulation are of adequate thickness, as described in Tables 3 and 4.	See Table 49 and Annex 2 (BOM)	N
	The temperature limits of materials used as insulation are not less than the maximum measured operating temperature of the specific material in application, as measured during the temperature test (MST 21).	See Table 32	P
5.5.2.3.2 Endurance to electrical stress			
	Materials used as electrical insulation are in compliance with the insulation coordination requirements	See 5.6.3	P
5.5.2.3.3 Endurance to thermal stress			
	Materials used as relied upon insulation have a mechanical and electrical relative thermal endurance, relative thermal index or temperature index (RTE/RTI or TI) appropriate for the application, at least 90 °C.	☐ TI : ☒ RTE : ☐ RTI : Assessed polymeric parts see Annex 2 (BOM) See Table 32	P
5.5.2.3.4 Polymeric insulating materials used as external parts			
	External polymeric parts of the PV module meet the following requirements:		—
	- flammability class minimum V-1		P
	- ball pressure test with a temperature of 75 °C		P
	- ignitability test in final application	See Table 37	P
	- peel test of cemented joints	See Table 39	P
	- lap shear strength test	See Table 40	N
5.5.2.3.5 Polymeric insulating parts supporting live parts			
	External parts of insulating material supporting live parts including connections, and parts of polymeric material providing supplementary insulation or reinforced insulation, are sufficiently resistant to heat.		P
	Polymeric parts which are not components of the laminate fulfil the requirements of ignitability test		P
	Other than elastomeric polymeric materials meet the following requirements:		—

EN IEC 61730-2			
Clause	Requirement + Test	Result - Remark	Verdict
	- flammability class minimum HB	Assessed polymeric parts see Annex 2 (BOM)	N
	- ball pressure test with a temperature of 125 °C		N
	- material creep test	See Table 13	P
5.5.2.4 Polymeric materials used for mechanical functions			
	Materials used for mechanical functions have a mechanical relative thermal endurance, relative thermal index or temperature index (RTE/RTI or TI) appropriate for the application, at least 90 °C.	☐ TI : ☒ RTE : ☐ RTI :	P
5.5.3 Metallic materials			
5.5.3.1 General			
	Metal parts are not in contact to metal parts having a difference of their electrochemical potentials of more than 600 mV.	Assessed parts see Annex 2 (BOM)	N
	Iron or mild steel are plated, painted, or enamelled for protection against corrosion.		N
	Corrosion protection is at least equivalent to a zinc coating of 0.015 mm thickness	Assessed parts see Annex 2 (BOM) See Table 6	N
5.5.3.2 Current carrying parts			
	Assessed parts:		P
	Current-carrying parts have sufficient mechanical strength and electrical conductivity.	See Table 32 See Table 34 See Table 11	P
	Current-carrying materials are protected against corrosion.		P
	The coating for protective coated metal is capable of preventing corrosion according to either one of the listed standards.	☐ ISO 1456 ☒ ISO 1461 ☐ ISO 2081 ☐ ISO 2093	P
	Coated metal not used if the current-carrying parts are stressed by abrasion.		N
5.5.4 Adhesives			
	Adhesives are appropriate for the application.	See Tables 40, Table 39, Table 27, Table 29, Table 12, and Table 10	P
	Adhesive as part of the relied upon electrical insulation meets the requirements of 5.5.2.3.3	See 5.5.2.3.3	P
5.6 Protection against electric shock			
5.6.1 General			
	Adequate protection against contact with hazardous live parts provided		P

EN IEC 61730-2			
Clause	Requirement + Test	Result - Remark	Verdict
	Specimen pose no risk of electric shock.		P
5.6.2 Protection against accessibility to hazardous live parts			
5.6.2.1 General			
	Class of module	See safety ratings	—
	For class 0 and Class II modules adequate protection against accessibility to hazardous live parts (> 35 V DC) provided.	See Table 12	N
Table 2 of 5.6.2.3	For Class 0 PV modules, accessible metal parts and accessible surfaces as well as live parts of different potential of the same circuit are separated by at least basic insulation.		N
	For Class II PV modules construction provide separation between accessible parts or accessible surfaces and hazardous live parts by double or reinforced insulation.		N
Table 2 of 5.6.2.3	For Class II PV modules, live parts of different potential of the same circuit are separated by double or reinforced insulation.		N
	For Class III PV modules separation between accessible parts or accessible surfaces and hazardous live parts by functional insulation.		P
Table 2 of 5.6.2.3	In Class III PV modules live parts of different polarity are separated by at least functional insulation.		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
5.6.2.2 Protection by means of enclosures and insulation barriers			
	Enclosures or insulation barriers are so designed that, after mounting, the live parts are not accessible (even after possible deformation)		P
	Degree of protection of the housing is not impaired by any possible deformation.		P
	Parts of enclosures and insulation barriers that provide protection are not removable without the use of a tool.		P
	Lids which are attached without screws have one or several detectable features, e.g. recesses,		P
	Tool to open the lid do not come into contact with the live parts if lid is removed correctly.		P
	Insulation barrier are held in place and are not affected by influences expected during normal operation. Electrical and mechanical properties don't fall below the minimum acceptable values for the application.		P

EN IEC 61730-2			
Clause	Requirement + Test	Result - Remark	Verdict
	Parts are prevented from loosening or turning.		P
5.6.2.3 Protection by means of insulation of live parts			
	Insulation materials providing the sole insulation between a live part and an accessible metal part, or between uninsulated live parts not of the same potential, are of adequate thickness and of a material appropriate for the application.		P
	Requirements of Table 2	see 5.6.2.1 of this report	—
5.6.3 Insulation coordination			
5.6.3.1	Components comply with the requirements for their relevant standards	See Annex 2	P
5.6.3.2	Pollution degree	See Table 1, Table 2, Table 3	—
5.6.3.3	Material group	See Table 1, Table 2, Table 3	—
5.6.3.4	Clearance and creepage distance		N
	Derating factor for altitude above 2000 m is considered		N
5.6.4 Distance through insulation (dti)			
5.6.4.1 General			
	Polymeric materials for cemented insulation parts and insulation in thin layers shall withstand environmental, thermal, electrical and mechanical stresses as far as they occur.	See 5.5.2	P
	Distances through insulation (dti) of solid insulation comply with the minimum distance as required:		N
	System voltage…….:	See safety ratings	—
	Distance through insulation req./meas. (mm):		N
	The insulation fulfils the material classification as given in IEC 60216-1, IEC 60216-2 and IEC 60216-5 (RTE/TI/RTI).	See annex 2	N
5.6.4.2 Cemented joints			
	Cemented joints were considered as	☒ Edge seal ☒ Interface between Junction Box and mounting surface ☐ others	—
	Distances along cemented joints comply with the minimum distances as required in table 3 or table 4:		N
	System voltage…….:	See safety ratings	P
	Distance along cemented joints req./meas.		N
	A distance can be considered as cemented joint if following requirements are met:		—

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Clause	Requirement + Test	Result - Remark	Verdict
	- Neither cracks nor voids in the insulating compounds have been occurred which either by themselves or in combination reduces the distances through the cemented joint below the required values.		P
	- No breakdown at MST 16 (initial and final test)with a 1,35 times higher tests voltage:	No breakdown	P
	Test voltage (V):		—
	No breakdown at MST 17 (initial and final test)with a 1,35 times higher tests voltage:	No breakdown	P
	Test voltage (V):		—
	The electrically insulating adhesive/sealant have a volume resistivity:		—
	- of greater than 50 × 10^6 Ω cm (dry)		P
	- and greater than 10 × 10^6 Ω cm (wet).		N
	rigid / rigid: lap shear test MST 36 rigid / flexible: Peel test MST 35	See Table 40 and Table 39	P
	Supplement information: Above mentioned tests have to be performed for each cemented joint. Also the materials and their properties have to be listed in annex 1		
5.6.4.3	**Insulation in thin layers**		N
	Relied upon insulation in thin layers is applied at	☒ Backsheet ☐ Front sheet ☒ insulation within laminate ☐ others	P
	Initial Construction of Insulation in thin layers complies with requirements concerning thickness under consideration of figure 4 as described in table 3 or 4	See Annex 2	N
	Construction of Insulation in thin layers complies with requirements concerning RTE/TI/RTI	See Annex 2	N
	Insulation in thin layers provide sufficient dielectric strength:	See Annex 2	N
	Test voltage for single-layer sheet and for entire multi-layer sheet providing relied upon insulation (2000V + 4 times system voltage)…….:	See Annex 2	N
	Test voltage for each layer of a multi-layer providing relied upon insulation (1000V + 2 times system voltage)…….:	See Annex 2	N
	Informative parameter evaluated according to IEC 62788-2 are presented	See Annex 2	N
	Single-layer sheet as well as entire multi-layer sheet in final application comply with following:		N
	- Minimum thickness according to lines 1b) of Table 3 and Table 4, (not less than 30µm) req./meas. (mm),:	See Table 49	N

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Clause	Requirement + Test	Result - Remark	Verdict
	- Dielectric strength for basic insulation is provided after cut susceptibility test (MST 12) (1000V + 2 times system voltage)	See Table 41	N
	Test voltage (V):		N

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Clause	Requirement + Test	Result - Remark	Verdict

8 TESTING

TEST SEQUENCES SEE IEC 61730-2

Deviations from test sequence are possible but must be documented. See also table 5-

10 TEST PROCEDURES			
10.1 General: Safety qualification testing included the following Module Safety Tests (MST) of IEC 61730-2			
Initial Testing			
10.2	MST 01 – Visual inspection.....:	See appended Table 6	P
10.3	MST 02 - Performance at STC.....:	See appended Table 7	P
10.4	MST 03 – Maximum power determination.....:	See appended Table 8	P
10.13	MST 16 – Insulation test.....:	See appended Table 9	P
10.14	MST 17 – Wet leakage current test.....:	See appended Table 10	N
10.11	MST 13 – Continuity test of equipotential bonding:	See appended Table 11	N
10.9	MST 11 – Accessibility test.....:	See appended Table 12	N
Sequence A			
10.26	MST 37 – Materials creep test.....:	See appended Table 13	P
10.11	MST 13 – Continuity test of equipotential bonding:	See appended Table 11	N
10.9	MST 11 – Accessibility test.....:	See appended Table 12	N
Sequence B			
10.30	MST 53 – Damp heat test 200h.....:	See appended Table 14	P
10.31	MST 54 – UV test 60kWh/m².....:	See appended Table 15	P
10.29	MST 52 – Humidity freeze test .....:	See appended Table 16	P
10.31	MST 54 – UV test 60kWh/m².....:	See appended Table 17	P
10.29	MST 52 – Humidity freeze test .....:	See appended Table 18	P
Sequence B1			
10.32	MST 55 – Cold conditioning .....:	See appended Table 19	P
10.33	MST 56 – Dry heat conditioning .....:	See appended Table 20	P
10.29	MST 52 – Humidity freeze test .....:	See appended Table 21	P
10.32	MST 55 – Cold conditioning .....:	See appended Table 22	P
10.29	MST 52 – Humidity freeze test .....:	See appended Table 23	P
Sequence C			
10.31	MST 54 – UV test 15kWh/m².....:	See appended Table 24	P

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Clause	Requirement + Test	Result - Remark	Verdict
10.28	MST 51 – Thermal cycling 50 test.....:	See appended Table 25	P
10.29	MST 52 – Humidity freeze test.....:	See appended Table 26	P
10.27	MST 42 – Robustness of terminations test.....:	See appended Table 27	P
Sequence D			
10.30	MST 53 – Damp heat test.....:	See appended Table 28	P
10.23	MST 34 – Static mechanical load test.....:	See appended Table 29	P
Sequence E			
10.28	MST 51 – Thermal cycling 200 test.....:	See appended Table 30	P
Sequence F			
10.19	MST 25 – Bypass diode thermal test.....:	See appended Table 31	P
10.15	MST 21 – Temperature Test.....:	See appended Table 32	P
10.16	MST 22 – Hot-spot endurance Test.....:	See appended Table 33	P
10.20	MST 26 – Reverse current overload test.....:	See appended Table 34	N
Sequence G			
10.12	MST 14 – Impulse voltage test.....:	See appended Table 35	N
Other tests			
10.17	MST 23 – Fire Test.....:	See appended Table 36	N
10.18	MST 24 – Ignitability test.....:	See appended Table 37	P
10.21	MST 32 – Module breakage test.....:	See appended Table 38	P
10.24	MST 35 – Peel test.....:	See appended Table 39	P
10.25	MST 36 – Lap shear strength test.....:	See appended Table 40	N
Final Testing			
10.10	MST 12 – Cut susceptibility test.....:	See appended Table 41	N
10.11	MST 13 – Continuity test of equipotential bonding:	See appended Table 11	N
10.9	MST 11 – Accessibility test.....:	See appended Table 12	N
10.4	MST 03 – Maximum power determination.....:	See appended Table 42	P
10.1	MST 01 – Visual inspection.....:	See appended Table 43	P
10.6	MST 05 – Durability of markings.....:	See appended Table 44	P
10.7	MST 06 – Sharp edge test.....:	See appended Table 45	P
10.8	MST 07 – Bypass diode functionality test.....:	See appended Table 46	P
10.22	MST 33a – General screw connections test.....:	See appended Table 47	P
10.22	MST 33b – Locking Screw connections test.....:	See appended Table 48	P
10.5	MST 04 – Insulation thickness test.....:	See appended Table 49	N
Supplementary information:			

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Clause	Requirement + Test	Result - Remark	Verdict

Table 5: Overview of MST items for each test sample

MST item	Sample No.													
	1	2	3	4	5	6	7	8	9	10				
Control module	X													
MST 01 – Visual inspection	X													
MST 02 – Performance at STC	X													
MST 03 – Maximum power determination	X													
MST 04 – Insulation thickness test														
MST 05 – Durability of markings	X													
MST 06 – Sharp edge test	X													
MST 11 – Accessibility test														
MST 12 – Cut susceptibility test														
MST 13 – Continuity test of equipotential bonding														
MST 14 – Impulse voltage test														
MST 16 – Insulation test	X													
MST 17 – Wet leakage current test														
MST 21 – Temperature Test	X													
MST 22 – Hot-spot endurance Test	X													
MST 23 – Fire Test														
MST 24 – Ignitability test	X													
MST 25 – Bypass diode thermal test	X													
MST 26 – Reverse current overload test														
MST 32 – Module breakage test	X													
MST 33 – Screw connections test	X													
MST 34 – Static mechanical load test	X													
MST 35 – Peel test	X													
MST 36 – Lap shear strength test:														
MST 37 – Materials creep test:	X													
MST 42 – Robustness of terminations test	X													
MST 51 – Thermal cycling test 50	X													
MST 51 - Thermal cycling test 200	X													
MST 52 – Humidity freeze test	X													
MST 53 – Damp heat test 200 h	X													
MST 53 – Damp heat test 1000 h	X													
MST 54 – UV test 15 KWh/m²	X													
MST 54 – UV test 60 KWh/m²	X													
MST 55 – Cold conditioning	X													
MST 56 – Dry heat conditioning	X													

Legend:

X…… Test performed,

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Clause	Requirement + Test	Result - Remark	Verdict

Table 6: MST 01 - Initial Visual inspection			
Test Date (YYYY-MM-DD)....:			—
Sample # 1	Findings....:	Yes ..... No	P
	Nature and position of findings – comments or attach photos	See the Photo Documentation	—
Sample #2	Findings....:	Yes ..... No	P
	Nature and position of findings – comments or attach photos	See the Photo Documentation	—
Sample # 3	Findings....:	Yes ..... No	P
	Nature and position of findings – comments or attach photos	See the Photo Documentation	—
Sample # 4	Findings....:	Yes ..... No	P
	Nature and position of findings – comments or attach photos	See the Photo Documentation	—
Sample # 5	Findings....:	Yes ..... No	P
	Nature and position of findings – comments or attach photos	See the Photo Documentation	—
Sample # 6	Findings....:	Yes ..... No	P
	Nature and position of findings – comments or attach photos	See the Photo Documentation	—
Sample # 7	Findings....:	Yes ..... No	P
	Nature and position of findings – comments or attach photos	See the Photo Documentation	—
Sample # 8	Findings....:	Yes ..... No	P
	Nature and position of findings – comments or attach photos	See the Photo Documentation	—
Sample # 9	Findings....:	Yes ..... No	P
	Nature and position of findings – comments or attach photos	See the Photo Documentation	—
Sample # 10	Findings....:	Yes ..... No	P
	Nature and position of findings – comments or attach photos	See the Photo Documentation	—
Supplementary information: For creepage distances and clearances see Table 1, Table 2, Table 3 and Table 4			

Table 7: MST 02 - Performance at STC		
Sample.....	Sample 1	—
Test Date [YYYY-MM-DD].....		—
Irradiance (W/m2)	1000	—

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Clause	Requirement + Test	Result - Remark	Verdict

Module temperature (°C)			25			—
Test method			Simulator Natural sunlight			—
Rated Isc including manufacturing tolerances.						—
Rated Voc including manufacturing tolerances						—
Isc [A]	Voc [V]	Imp [A]	Vmp [V]	Pmp [W]	FF [%]	Result
6.72	42.8	6.3	36.3	230	75.76	P
Supplementary information:						

Table 8: MST 03 - Maximum power determination							
Test Date [YYYY-MM-DD] ..... :							—
Irradiance (W/m2) ..... :			1000				—
Module temperature (°C) ..... :			25				—
Test method			Simulator Natural sunlight				—
Sample #	Voc [V]	Isc [A]	Pmp [W]	Vmp [V]	Imp [A]	FF [%]	Result
Sample 1	42.35	6.32	255.1	35.4	6.12	74.25	P
Supplementary information:							

Table 9: MST 16 - Initial Insulation test					
Test Date (YYYY-MM-DD)					—
Test Voltage applied (V, DC)					—
Sample #	Measured	Required	Dielectric breakdown		Result
	MΩ	MΩ	Yes (description)	No	
Sample 1	>5000	5000	—	No	P
Supplementary information: Size of module [m²]					

Table 10: MST 17 - Initial Wet leakage current test				
Test Date (YYYY-MM-DD)				—
Test Voltage applied (V, dc)				—
Solution resistivity (Ω cm)	< 3500 Ω cm at 22 ± 2°C			—
Solution temperature (°C)				—
Sample #	Measured (MΩ)		Required (MΩ)	Result
—	—		—	—
Supplementary information: Size of module [m²]				

Table 11: MST 13 - Continuity test of equipotential bonding		
Test Date Initial examination (YYYY-MM-DD)		—

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Clause	Requirement + Test	Result - Remark		Verdict
Test Date Final examination (YYYY-MM-DD)				—
Maximum over-current protection rating (A).				—
Current applied (A)				—
Location of designated grounding point.....				—
Location of second contacting point				—
Sample #	Position in test sequence:	Voltage [V]	Resistance [Ω]	

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Clause	Requirement + Test	Result - Remark		Verdict
1	Initial examination	—	—	—
	Preconditioning: MST 54, MST 51, MST 52, MST 42, MST 12	—	—	—
	Final examination	—	—	—
2	Initial examination	—	—	—
	Preconditioning: MST 51, MST 12			—
	Final examination	—	—	—
3	Initial examination	—	—	—
	Preconditioning: MST 53, MST 34, MST 12	—	—	—
	Final examination	—	—	—
4	Initial examination	—	—	—
	Preconditioning: MST 37	—	—	—
	Final examination	—	—	—
5	Initial examination	—	—	—
	Preconditioning: MST 53, MST 54, MST 52, MST 54, MST 52, MST 12	—	—	—
	Final examination	—	—	—
6	Initial examination	—	—	—
	Preconditioning: MST 55, MST 56, MST 52, MST 55, MST 52, MST12	—	—	—
	Final examination	—	—	—
7	Initial examination	—	—	—
	Preconditioning: MST 32	—	—	—
	Final examination	—	—	—
Supplementary information:				

Table 12: MST 11 - Accessibility test				
Test Date **Initial** examination (YYYY-MM-DD)				—
Test Date **Final** examination (YYYY-MM-DD)				—
Sample #	Position in test sequence:			
1	Initial examination, access?	Yes	No	—
	Preconditioning: MST 54, MST 51, MST 52, MST 42, MST 12, MST 13			—
	Final examination, access?	Yes	No	—
2	Initial examination, access?	Yes	No	—

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Clause	Requirement + Test	Result - Remark	Verdict

	Preconditioning: MST 51, MST 12, MST 13		—
	Final examination, access?	Yes No	—
3	Initial examination, access?	Yes No	—
	Preconditioning: MST 53, MST 34, MST 12, MST 13		—
	Final examination, access?	Yes No	—
4	Initial examination, access?	Yes No	—
	Preconditioning: MST 37, MST 13		—
	Final examination, access?	Yes No	—
5	Initial examination, access?	Yes No	—
	Preconditioning: MST 53, MST 54, MST 52, MST 54, MST 52, MST 12, MST 13		—
	Final examination, access?	Yes No	—
6	Initial examination, access?	Yes No	—
	Preconditioning: MST 55, MST 56, MST 52, MST 55, MST 52, MST12		—
	Final examination, access?	Yes No	—
Supplementary information:			

SEQUENCE A						
Sample #	2					—
Table 13: MST 37 - Materials creep test						
Test Date (YYYY-MM-DD) start/end						—
Duration [h]..... 200						—
Applied temperature [°C]						—
MST 01: Visual inspection after materials creep test						—
Test Date (YYYY-MM-DD).....						—
Findings.....				Yes ..... No		P
Nature and position of findings – comments or attach photos						—
Supplementary information: For clearance and creepage distances see table XYZ						
MST 16: Insulation test after materials creep test						—
Test Date (YYYY-MM-DD).....						—
Test Voltage applied (V, dc) 20						—
Measured		Required		Dielectric breakdown		Result
MΩ		MΩ		Yes (description)	No	
>5000		5000		---	No	P

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Clause	Requirement + Test	Result - Remark	Verdict

MST 17: Wet leakage current test after materials creep test		—
Test Date (YYYY-MM-DD).....		—
Test Voltage applied (V, dc).....		—
Solution resistivity (Ω cm)	< 3500 Ω cm at 22 ± 2°C	—
Solution temperature (°C)		—
Measured(MΩ)	Required (MΩ)	Result
—	—	—
Supplementary information:		

SEQUENCE B				
Sample #	3			—
Table 14: MST 53 - Damp heat test				
Test Date (YYYY-MM-DD) start/end.....				—
Duration [h]	200			—
MST 01: Visual inspection after Damp heat test				—
Test Date (YYYY-MM-DD)				—
Findings	Yes ..... No			P
Nature and position of findings – comments or attach photos				—
MST 16: Insulation test after Damp heat test				P
Test Date (YYYY-MM-DD)				—
Test Voltage applied (V, DC)	20			—
Measured	Required	Dielectric breakdown		Result
MΩ	MΩ	Yes (description)	No	
>5000	5000	---	No	P
Supplementary information:				

Table 15: MST 54 - UV test			
Test Date (YYYY-MM-DD) start/end.....			—
Module temperature [°C]	60		—
Irradiation total [kWh/ m²]	60		—
Open circuits.....		Yes ..... No	P
MST 01: Visual inspection after UV test			—
Test Date (YYYY-MM-DD)			—
Findings		Yes ..... No	P
Nature and position of findings – comments			—

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Clause	Requirement + Test	Result - Remark	Verdict

or attach photos				
MST 16: Insulation test after UV test				—
Test Date (YYYY-MM-DD).....				—
Test Voltage applied (V, DC)		20		—
Measured	Required	Dielectric breakdown		Result
MΩ	MΩ	Yes (description)	No	
>5000	5000	---	No	P
Supplementary information: --				

Table 16: MST 52 -Humidity freeze test				
Test Date (YYYY-MM-DD) start/end				—
Total cycles (10)		10		—
Open circuits.....		Yes..... No		P
MST 01: Visual inspection after Humidity freeze test				—
Test Date (YYYY-MM-DD).....				—
Findings.....		Yes..... No		P
Nature and position of findings – comments or attach photos				—
MST 16: Insulation test after Humidity freeze test				—
Test Date (YYYY-MM-DD).....				—
Test Voltage applied (V, DC)		20		—
Measured	Required	Dielectric breakdown		Result
MΩ	MΩ	Yes (description)	No	
>5000	5000	---	No	P
Supplementary information:				

Table 17: MST 54 - UV test			
Test Date (YYYY-MM-DD) start/end.....			—
Module temperature [°C]		60	—
Irradiation total [kWh/ m²]		60	—
Open circuits.....		Yes ..... No	P
MST 01: Visual inspection after UV test			—
Test Date (YYYY-MM-DD).....			—
Findings		Yes ..... No	P
Nature and position of findings – comments or attach photos			—

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Clause	Requirement + Test	Result - Remark	Verdict

MST 16: Insulation test after UV test				
Test Date (YYYY-MM-DD).....				—
Test Voltage applied (V, DC)	20			—
Measured	Required	Dielectric breakdown		Result
MΩ	MΩ	Yes (description)	No	
>5000	5000	---	No	P
Supplementary information:				

Table 18: MST 52 - Humidity freeze test				
Test Date (YYYY-MM-DD) start/end.....				—
Total cycles (10)	10			—
Open circuits.....	Yes ..... No			
MST 01: Visual inspection after Humidity freeze test				—
Test Date (YYYY-MM-DD).....				—
Findings	Yes ..... No			P
Nature and position of findings – comments or attach photos				—
MST 16: Insulation test after Humidity freeze test				—
Test Date (YYYY-MM-DD).....				—
Test Voltage applied (V, DC)	20			—
Measured	Required	Dielectric breakdown		Result
MΩ	MΩ	Yes (description)	No	
>5000	5000	---	No	P
MST 17: Wet leakage current test after humidity freeze 10 test				—
Test Date (YYYY-MM-DD).....				—
Test Voltage applied (V, dc) 20				—
Solution resistivity (Ω cm).....	< 3500 Ω cm at 22 ± 2°C			—
Solution temperature (°C).....				—
Measured (MΩ)	Required (MΩ)			Result
—	—			—
Supplementary information:				

SEQUENCE B1		
Sample #	4	—
Table 19: MST 55 - Cold conditioning		
Test Date (YYYY-MM-DD) start/end.....		—

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Clause	Requirement + Test	Result - Remark	Verdict

Temperature [°C] Duration [h]	-40 / 48			—
MST 01: Visual inspection after Cold conditioning				—
Test Date (YYYY-MM-DD).....				—
Findings	Yes..... No			P
Nature and position of findings – comments or attach photos				—
MST 16: Insulation test after Cold conditioning				—
Test Date (YYYY-MM-DD).....				—
Test Voltage applied (V, DC)	20			—
Measured	Required	Dielectric breakdown		Result
MΩ	MΩ	Yes (description)	No	
>5000	5000	---	No	P
Supplementary information: --				

Table 20: MST 56 - Dry heat conditioning				
Test Date (YYYY-MM-DD) start/end.....				—
Temperature [°C] Duration [h]	90 / 200			—
MST 01: Visual inspection after Dry heat conditioning				—
Test Date (YYYY-MM-DD).....				—
Findings	Yes..... No			P
Nature and position of findings – comments or attach photos				—
MST 16: Insulation test after Dry heat conditioning				—
Test Date (YYYY-MM-DD).....				—
Test Voltage applied (V, DC)	20			—
Measured	Required	Dielectric breakdown		Result
MΩ	MΩ	Yes (description)	No	
>5000	5000	---	No	P
Supplementary information:				

Table 21: MST 52 - Humidity freeze test			
Test Date (YYYY-MM-DD) start/end.....			—
Total cycles (10).....	10		—
Open circuits	Yes..... No		P
MST 01: Visual inspection after Humidity freeze test			—
Test Date (YYYY-MM-DD).....			—

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Clause	Requirement + Test	Result - Remark	Verdict

Findings		Yes ..... No		P
Nature and position of findings – comments or attach photos				—
MST 16: Insulation test after Humidity freeze test				—
Test Date (YYYY-MM-DD)				—
Test Voltage applied (V, DC)		20		—
Measured	Required	Dielectric breakdown		Result
MΩ	MΩ	Yes (description)	No	
>5000	5000	---	No	P
Supplementary information:				

Table 22: MST 55 - Cold conditioning				
Test Date (YYYY-MM-DD) start/end.....				—
Temperature [°C] / Duration [h] ..... -		40 / 48		—
MST 01: Visual inspection after Cold conditioning				—
Test Date (YYYY-MM-DD)				—
Findings		Yes ..... No		P
Nature and position of findings – comments or attach photos				—
MST 16: Insulation test after Cold conditioning				—
Test Date (YYYY-MM-DD)				—
Test Voltage applied (V, DC) 20				—
Measured	Required	Dielectric breakdown		Result
MΩ	MΩ	Yes (description)	No	
>5000	5000	---	No	P
Supplementary information:				

Table 23: MST 52 - Humidity freeze test			
Test Date (YYYY-MM-DD) start/end.....			—
Total cycles (10).....		10	—
Open circuits.....		Yes ..... No	P
MST 01: Visual inspection after Humidity freeze test			—
Test Date (YYYY-MM-DD)			—
Findings			P
Nature and position of findings – comments or attach photos			—

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Clause	Requirement + Test	Result - Remark	Verdict

Test Date (YYYY-MM-DD).....				—
Test Voltage applied (V, DC) 20				—
Measured	Required	Dielectric breakdown		Result
MΩ	MΩ	Yes (description)	No	
>5000	5000	---	No	P
MST 17: Wet leakage current test after humidity freeze test				—
Test Date (YYYY-MM-DD).....				—
Test Voltage applied (V, dc).....				—
Solution resistivity (Ω cm).....	< 3500 Ω cm at 22 ± 2°C			—
Solution temperature (°C).....				—
Measured [MΩ]		Required [MΩ]		Result
—		—		—
Supplementary information:				

SEQUENCE C				
Sample #	5			—
Table 24: MST 54 - UV test				
Test Date (YYYY-MM-DD) start/end.....				—
Module temperature [°C]	60			—
Irradiation total [kWh/ m²]	15			—
Open circuits.....	Yes ..... No			P
MST 01: Visual inspection after UV test				—
Test Date (YYYY-MM-DD).....				—
Findings				P
Nature and position of findings – comments or attach photos				—
MST 16: Insulation test after UV test				—
Test Date (YYYY-MM-DD).....				—
Test Voltage applied (V, DC).....	20			—
Measured	Required	Dielectric breakdown		Result
MΩ	MΩ	Yes (description)	No	
>5000	5000	---	No	P
Supplementary information:				

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Clause	Requirement + Test	Result - Remark	Verdict

Table 25: MST 51 - Thermal cycling test				
Test Date (YYYY-MM-DD) start/end.....				—
Total cycles (50)	50			—
Applied current (A)				—
Limiting voltage (V)				—
Open circuits.....	Yes ..... No			P
MST 01: Visual inspection after Thermal cycling test				—
Test Date (YYYY-MM-DD).....				—
Findings	Yes ..... No			P
Nature and position of findings – comments or attach photos				—
MST 16: Insulation test after Thermal cycling test				—
Test Date (YYYY-MM-DD).....				—
Test Voltage applied (V, DC)	20			—
Measured	Required	Dielectric breakdown		Result
MΩ	MΩ	Yes (description)	No	
>5000	5000	---	No	P
Supplementary information: --				

Table 26: MST 52 - Humidity freeze test				
Test Date (YYYY-MM-DD) start/end.....				—
Total cycles (10).....	10			—
Open circuits.....	Yes ..... No			P
MST 01: Visual inspection after Humidity freeze test				—
Test Date (YYYY-MM-DD).....				—
Findings	Yes ..... No			P
Nature and position of findings – comments or attach photos				—
MST 16: Insulation test after Humidity freeze test				—
Test Date (YYYY-MM-DD).....				—
Test Voltage applied (V, DC) 20				—
Measured	Required	Dielectric breakdown		Result
MΩ	MΩ	Yes (description)	NO	—
>5000	5000	---	NO	P
MST 17: Wet leakage current test after humidity freeze test				—
Test Date (YYYY-MM-DD).....				—

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Clause	Requirement + Test	Result - Remark	Verdict

Test Voltage applied (V, dc)		—
Solution resistivity (Ω cm)	< 3500 Ω cm at 22 ± 2°C	—
Solution temperature (°C)		—
Measured (MΩ)	Required (MΩ)	Result
—	—	—
Supplementary information:		

Table 27: MST 42 - Robustness of terminations test		
Test Date (YYYY-MM-DD)		—
MQT 14.1: Retention of junction box on mounting surface		
Supplementary information:		
MST 01: Visual inspection after retention of junction box on mounting surface		
Test Date (YYYY-MM-DD)		—
Findings	Yes ..... No	P
Nature and position of findings – comments or attach photos		—
MST 17: Wet leakage current test after retention of junction box on mounting surface		
Test Date (YYYY-MM-DD)		—
Test Voltage applied [V]		—
Solution resistivity (Ω cm)	< 3500 Ω cm at 22 ± 2°C	—
Solution temperature (°C)		—
Measured [MΩ]	Required [MΩ]	Result
—	—	—
Supplementary information:		

SEQUENCE D		
Sample #	6	—
Table 28: MST 53 - Damp heat test		
Test Date (YYYY-MM-DD) start/end		—
Total hours (1000).....	1000	—
MST 01: Visual inspection after damp heat test		—
Test Date (YYYY-MM-DD)		—
Findings	Yes ..... No	P
Nature and position of findings – comments or attach photos		—

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Clause	Requirement + Test	Result - Remark	Verdict

MST 16: Insulation test after damp heat test				—
Test Date (YYYY-MM-DD).....				—
Test Voltage applied (V, DC)				—
Measured	Required	Dielectric breakdown		Result
MΩ	MΩ	Yes (description)	No	
>5000	5000	---	No	P
MST 17: Wet leakage current test after damp heat test				—
Test Date (YYYY-MM-DD).....				—
Test Voltage applied (V, dc).....				—
Solution resistivity (Ω cm).....	< 3500 Ω cm at 22 ± 2°C			—
Solution temperature (°C).....				—
Measured (MΩ)	Required (MΩ)			Result
—	—			—
Supplementary information:				

Table 29: MST 34 - Static mechanical load test			
Test Date (YYYY-MM-DD).....			—
Mounting method.....			—
Design Load [Pa] / Safety factor ɣm			—
Load applied to	front side	back side	—
Mechanical load [Pa]			—
First cycle time (start/end)	1h	1h	—
Intermittent open-circuit (yes/no).....	No	No	P
Second cycle time (start/end).....	1h	1h	—
Intermittent open-circuit (yes/no).....	No	No	P
Third cycle time (start/end).....	1h	1h	—
Intermittent open-circuit (yes/no).....	No	No	P
Supplementary information: Maximum bending at module centre xx mm.			
MST 01: Visual inspection after Static mechanical load test			—
Test Date (YYYY-MM-DD).....			—
Findings	Yes ..... No		P
Nature and position of findings – comments or attach photos			—
MST 16: Insulation test after Static mechanical load test			—
Test Date (YYYY-MM-DD).....			—
Test Voltage applied (V, DC).....	30		—

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Clause	Requirement + Test	Result - Remark	Verdict

Measured	Required	Dielectric breakdown		Result
MΩ	MΩ	Yes (description)	No	
>5000	5000	---	No	P
MST 17: Wet leakage current test after Static mechanical load test				—
Test Date (YYYY-MM-DD).....				—
Test Voltage applied (V, dc).....				—
Solution resistivity (Ω cm).....	< 3500 Ω cm at 22 ± 2°C			—
Solution temperature (°C)				—
Measured (MΩ)		Required (MΩ)		Result
—		—		—
Supplementary information:				

SEQUENCE E				
Sample #	7			—
Table 30: MST 51 - Thermal cycling test				
Test Date (YYYY-MM-DD) start/end.....				—
Total cycles (200) 200				—
Applied current (A)				—
Limiting voltage (V)				—
Open circuits.....	Yes ..... No			
MST 01: Visual inspection after Thermal cycling test				—
Test Date (YYYY-MM-DD).....				—
Findings	Yes ..... No			
Nature and position of findings – comments or attach photos				—
MST 16: Insulation test after Thermal cycling test				—
Test Date (YYYY-MM-DD).....				—
Test Voltage applied (V, DC)				—
Measured	Required	Dielectric breakdown		Result
MΩ	MΩ	Yes (description)	No	
>5000	5000	---	No	P
MST 17: Wet leakage current test after Thermal cycling test				—
Test Date (YYYY-MM-DD).....				—
Test Voltage applied (V, dc).....				—
Solution resistivity (Ω cm).....	< 3500 Ω cm at 22 ± 2°C			—
Solution temperature (°C).....				—

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Clause	Requirement + Test	Result - Remark	Verdict

Measured (MΩ)	Required (MΩ)	Result
—	—	—

Supplementary information:

SEQUENCE F					
Sample #	8				—
Table 31: MST 25 - Bypass diode thermal test					
Test Date [YYYY-MM-DD] start/end					—
Module temperature [°C]	90±5				—
Number of diodes in junction box.....	3				—
Diode manufacturer.....					—
Diode type designation.....	30SQ045				—
Max. permissible junction temperature Tmax [°C] (according to diode datasheet)					—
Step 1, Determination of VD versus TJ characteristic					—
Ambient temperature of the junction box [°C]...	30 ± 2	50 ± 2	70 ± 2	90 ± 2	—
Pulsed current.....	12	12	12	12	P
Voltage drop [V].....	0.65	0.68	0.63	0.60	P
VD versus TJ characteristic					
Max. permissible junction temperature Tjmax [°C] (according to diode datasheet)					
Step 2, Bypass diode thermal test					—
	Diode 1	Diode 2	Diode 3		Result
Current flow applied [A].....	12	12	12		P
Max. diode surface temperature allowed Tjmax [°C], ...	136	133	135		P
Voltage drop [V] after 1h	0.57	0.56	0.57		P
Calculated max. junction temperature Tjcalc [°C]	107	106	109		P
Tjcalc < Tjmax (test passed)? yes/no	yes	yes	yes		P
Current flow (1.25 * Isc) [A]	15	15	15		P
Bypass diode remain(s) functional (yes/no)	yes	yes	yes		P
Remarks: See Table 46 for the test details of bypass diode functionality test					
MST 01: Visual inspection after Bypass diode thermal test					—
Test Date [YYYY-MM-DD]					
Findings.....	☐ Yes..... ☐ No				
Nature and position of findings – comments					P

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Clause	Requirement + Test	Result - Remark	Verdict

MST 16: Insulation test after Bypass diode thermal test				—
Test Date (YYYY-MM-DD).....				—
Test Voltage applied (V, DC)		1500		—
Measured	Required	Dielectric breakdown		Result
MΩ		Yes (description)	No	
≥40	57		No	P
MST 17: Wet leakage current test after Bypass diode thermal test				—
Test Date [YYYY-MM-DD]:				—
Test Voltage applied [V]:		1000		—
Solution resistivity [Ω cm).....		< 3500 Ω cm at 22 ± 2°C		—
Solution temperature [°C].....				—
Measured [MΩ]		Required [MΩ]		Result
≥40		58		P
Supplementary information:				

Table 32: MST 21 - Temperature Test				
Reference solar irradiance (W/m²).....	1000 W/m²			—
Reference ambient temperature (°C).....	30.4°C			—
Module at MPP				
Measuring location:	Component temperature T_{OBS} (°C)	Normalized temperature T_{CON} (°C)	Component temperature limit (°C)	—
Terminal enclosure interior surface	67.9	78.6	85	P
Field wiring terminals	63.8	66.7	85	P
PV module frontsheet above the centre cell	64.2	67.5	85	P
PV module backsheet below the centre cell	67.5	68.4	85	P
Insulation of the field wiring leads	62.1	63.5	90	P
External connector bodies	58.6	60.4	90	P
Bypass diode bodies				N
Frame				N
MST 01: Visual inspection after Temperature Test				—
Test Date (YYYY-MM-DD).....				—
Findings	Yes ..... No			P
Nature and position of findings – comments or attach photos				—

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Clause	Requirement + Test	Result - Remark	Verdict

Test Date (YYYY-MM-DD).....				—
Test Voltage applied (V, DC).....		50		—
Measured	Required	Dielectric breakdown		Result
MΩ	MΩ	Yes (description)	No	
>5000	5000	---	No	P
MST 17: Wet leakage current test after Temperature Test				—
Test Date (YYYY-MM-DD).....				—
Test Voltage applied (V, dc).....				—
Solution resistivity (Ω cm).....		< 3500 Ω cm at 22 ± 2°C		—
Solution temperature (°C).....				—
Measured (MΩ)		Required (MΩ)		Result
—		—		—
Supplementary information:				

Table 33: MST 22 - Hot-spot endurance test					
Test Date (YYYY-MM-DD) start/end.....					—
Cell interconnection circuit.....	☐ S	☐ SP	☐ PS		—
Irradiance during each cycle.....					—
Module temperature at thermal equilibrium in each cycle [°C]					—
Determination of worst case cell					—
Maximum measured cell temperature in each cycle [°C].....					—
Shading rate [%] or number of cells shaded.....					—
Test hours for each cycle					—
MST 01: Visual inspection after hot-spot endurance test					—
Test Date (YYYY-MM-DD).....					—
Findings	☐ Yes	☐ No			P
Nature and position of findings – comments or attach photos					—
MST 02: Maximum power determination after hot-spot endurance test					—
Test Date [YYYY-MM-DD].....					—
Module temperature [°C]	25°C				—
Irradiance [W/m²] 1000					—

Voc [V]	Isc [A]	Pmp [W]	Vmp [V]	Imp [A]	FF [%]
43.38	6.79	294.55	37.1	6.25	78.72

MST 16: Insulation test after hot-spot endurance test				—
Test Date (YYYY-MM-DD).....				—
Test Voltage applied [V]				—
Measured	Required	Dielectric breakdown		Result
MΩ	MΩ	Yes (description)	No	
>5000	5000	—	No	P
MST 17: Wet leakage current test after hot-spot endurance test				—
Test Date (YYYY-MM-DD).....				—
Test Voltage applied [V]				—
Solution resistivity [Ω cm).....		< 3500 Ω cm at 22 ± 2°C		—
Solution temperature [°C].....				—
Measured [MΩ]		Required [MΩ]		Result
—		—		—
Supplementary information:				

Table 34: MST 26 - Reverse current overload test			
Test Date (YYYY-MM-DD)……:			—
Module over-current protection rating (A)…:			—
Test current (A)……:			—
Range of applied voltage (V)……..:			—
Test duration……:	2 hours		—
Observations			Result
☐ No flaming of the module			
☐ No flaming or charring of the cheesecloth			
☐ No flaming of the tissue paper			
☐ MST 17 requirements fulfilled (see appended Table MST17)			
Supplementary information: Max. measured temperature: xx°C			
MST 01: Visual inspection after Reverse current overload test			—
Test Date (YYYY-MM-DD) :			—
Findings :	☐ Yes ☐ No		
Nature and position of findings – comments or attach photos			—
MST 16: Insulation test after Reverse current overload test			—
Test Date (YYYY-MM-DD) :			—
Test Voltage applied (V, DC) :			—
Measured	Required	Dielectric breakdown	Result
MΩ	MΩ	Yes (description)	No

MST 17: Wet leakage current test after Reverse current overload test		—
Test Date (YYYY-MM-DD) :		—
Test Voltage applied (V, dc) :		—
Solution resistivity (Ω cm) :	< 3500 Ω cm at 22 ± 2°C	—
Solution temperature (°C) :	23	—
Measured (MΩ)	Required (MΩ)	Result
Supplementary information:		

SEQUENCE G		
Sample #:	**16**	**—**
Table 35: MST 14 - Impulse voltage test		
Test Date (YYYY-MM-DD) ..... :		—
Maximum system voltage (V)..... :		—
Required Impulse voltage (V)..... :		—
Measured Impulse voltage (V) ..... :		
T_1 (µs)..... :		
T_2 (µs)..... :		
Thickness of conductive foil (mm) ..... :		—
Results		
☐ No evidence of dielectric breakdown or surface tracking observed ☐ No evidence of major visual defects (see table MST 01 below)		
MST 01: Visual inspection after Impulse voltage test		—
Test Date (YYYY-MM-DD)..... :		—
Findings.....	☐ Yes ..... ☐ No	
Nature and position of findings – comments or attach photos		—
MST 16: Insulation test after Impulse voltage test		—
Test Date (YYYY-MM-DD).....		—
Test Voltage applied (V, DC)		—

Measured	Required	Dielectric breakdown		Result
MΩ	MΩ	Yes (description)	No	
Supplementary information:				

OTHER TESTS		
Sample #:		—
Table 36: MST 23 - Fire test		
Test Date (YYYY-MM-DD).....		—
Module fire resistance class (A, B, C).....		—
No. of modules provided to create the test assembly		—
☐ The module complies with the requirements for the fire resistance class		—
Supplementary information:		

Sample #: 1		P
Table 37: MST 24 - Ignitability test		
Test Date (YYYY-MM-DD)		—
Flame application point.....	50mm above the bottom edge of the sample	P
Surface exposure.....	☐ Yes ☐ No	P
Backsheet foil exposure.....	☐ Yes ☐ No	P
Frame adhesive exposure	☐ Yes ☐ No	P
Edge exposure.....	☐ Yes ☐ No	P
Junction box adhesive exposure	☐ Yes ☐ No	P
Type label exposure.....	☐ Yes ☐ No	P
Backrail adhesive exposure.....	☐ Yes ☐ No	P
Ignition occurs	☐ Yes ☐ No	P
Flame spread less as 150 mm	☐ Yes ☐ No	P
Length of destroyed area	>1500mm	P
Supplementary information:		

Sample #:		
Table 38: MST 32 - Module breakage test		
Test Date (YYYY-MM-DD).....		P
Weight of impactor (kg).....	5.066	P
Thickness of sample (mm).....	>5mm	P
Mounting technique used.....	No breakage	P
	No separation from frame or mounting structure	P
	Breakage occurred, no shear or opening large enough for a 76 mm diameter sphere to pass freely developed	P
	Breakage occurred, no particles larger than 65 cm² ejected from sample	P
	Continuity of equipotential bonding provided, see table 10.11	N
Nature and position of findings – comments or attach photos		Result
		P
Supplementary information:		

Sample #:	10	—
Table 39: MST 35 - Peel test (only for cemented joints)		
Test Date (YYYY-MM-DD).....		—
Location	Flexible Frontsheet Flexible Backsheet Rigid Frontsheet Rigid Backsheet Other areas	P
Width of cemented joint	≤ 10 mm > 10mm	P
Description of area		—
Arithmetic mean M1 of adhesion force of unconditioned samples [N]	36	—
Arithmetic mean M2 of adhesion force of samples conditioned with sequence B [N]	68	—
Loss of adhesion force:		P
Supplementary information:		

Sample #:		—
Table 40: MST 36 - Lap shear strength test (only for cemented joints)		
Test Date (YYYY-MM-DD).....		—
Preconditioning:		
MST 53 Test Date (YYYY-MM-DD) start/end....		—
MST 54 Test Date (YYYY-MM-DD) start/end....		—
MST 52 Test Date (YYYY-MM-DD) start/end....		—
MST 54 Test Date (YYYY-MM-DD) start/end....		—
MST 52 Test Date (YYYY-MM-DD) start/end....		—
Arithmetic mean M1 of adhesion force of unconditioned samples [N]		—
Arithmetic mean M2 of adhesion force of samples conditioned with sequence B [N]		—
Loss of adhesion force:		—
Supplementary information:		

Table 41: MST 12 - Cut susceptibility test			
Test Date (YYYY-MM-DD)..... :			—
Applied force (N) .....:			—
MST 01 Visual inspection after cut test			—
Test Date (YYYY-MM-DD)..... :			—
Sample # 5	Findings..... :	Yes..... No	—
	Nature and position of findings – comments or attach photos		—
Sample # 7	Findings..... :	Yes..... No	—
	Nature and position of findings – comments or attach photos		—
Sample # 9	Findings..... :	Yes..... No	—
	Nature and position of findings – comments or attach photos		—
Sample # 14	Findings..... :	Yes..... No	—
	Nature and position of findings – comments or attach photos		—
	Findings..... :	Yes..... No	—
	Nature and position of findings – comments or attach photos		—

MST 16: Insulation test after cut test					—
Test Date (YYYY-MM-DD)..... :					—
Test Voltage applied (V, DC) ..... :					—
Sample #	Measured	Required	Dielectric breakdown		Result
	MΩ	MΩ	Yes (description)	No	
5		5000	---	No	—
7		5000	---	No	—
9		5000	---	No	—
14		5000	---	No	—
15		5000	---	No	—

MST 17: Wet leakage current test after cut test			
Test Date (YYYY-MM-DD).....			—
Test Voltage applied (V, dc).....			—
Solution resistivity (Ω cm)	< 3500 Ω cm at 22 ± 2°C		—
Solution temperature (°C)			—
Sample #	Measured (MΩ)	Required (MΩ)	Result
			—
Supplementary information:			

Table 42: MST 03 - Maximum power determination final						
Test Date (YYYY-MM-DD).....						—
Module temperature (°C)	25					—
Irradiance (W/m²).....	1000					—
Sample #	Voc (V)	Isc (A)	Pmp (W)	Vmp (V)	Imp (A)	FF (%)
1	31.56	11.8	373.35	25.28	10.69	72.38
Supplementary information:						

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Clause	Requirement + Test	Result - Remark	Verdict

Table 43: MST 01 - Final Visual inspection			
Test Date (YYYY-MM-DD).....			—
Sample # 1	Findings.....	Yes..... No	P
	Nature and position of findings – comments or attach photos		—
	Nature and position of findings – comments or attach photos		—
Supplementary information:			

Table 44: MST 05 - Durability of markings							
Test Date (YYYY-MM-DD).....							—
Sample #	Markings legible		Not easily removable		No curling		Result
1	Yes	No	Yes	No	Yes	No	P
Supplementary information:							

Table 45: MST 06 - Sharp edge test		
Test Date (YYYY-MM-DD) :		—
Sample #	Accessible surfaces free of sharp edges, burrs etc.	Result
1	☐ Yes ☑ No	P
Supplementary information:		

Table 46: MST 07 - Bypass diode functionality test				
Test Date (YYYY-MM-DD) .....:				—
☐ Method A				—
Ambient temperature [°C] .....:				—
Current flow applied [A] .....:				—
Sample #	VFM	VFMrated	VFM = (N × VFMrated) ± 10 %	Result
1			☐ Yes ☐ No	
4			☐ Yes ☐ No	
5			☐ Yes ☐ No	
7			☐ Yes ☐ No	
9			☐ Yes ☐ No	
14			☐ Yes ☐ No	
15			☐ Yes ☐ No	

☐ Method B							—
Sample #	IV curve after shading						Result
	Diode 1 working properly		Diode 2 working properly		Diode 3 working properly		
1	☐ Yes	☐ No	☐ Yes	☐ No	☐ Yes	☐ No	
4	☐ Yes	☐ No	☐ Yes	☐ No	☐ Yes	☐ No	
5	☐ Yes	☐ No	☐ Yes	☐ No	☐ Yes	☐ No	
7	☐ Yes	☐ No	☐ Yes	☐ No	☐ Yes	☐ No	
9	☐ Yes	☐ No	☐ Yes	☐ No	☐ Yes	☐ No	
14	☐ Yes	☐ No	☐ Yes	☐ No	☐ Yes	☐ No	
15	☐ Yes	☐ No	☐ Yes	☐ No	☐ Yes	☐ No	
Supplementary information:							

Table 47: MST 33a - Test for general screw connections			
Test Date (YYYY-MM-DD).....:			—
Sample #	Thread diameter [mm]	Torque [Nm]	Result
1			
Supplementary information:			

Table 48: MST 33b - Test for locking screws			
Test Date (YYYY-MM-DD) .....:			—
Sample #	Thread diameter [mm]	Torque [Nm]	Result
1			
Supplementary information:			

Sample #	4		—
Table 49: MST 04 - Insulation thickness test			
Test Date (YYYY-MM-DD) ..... :			—
Max. System voltage ..... :			—
Thickness of insulation acc. datasheet ..... :			—
Required thickness of insulation ..... :			—
Measurement uncertainty..... :			—
Location		Measured thickness (including uncertainty)	Result
Supplementary information:			

Attachment 2 – Photo Documentation

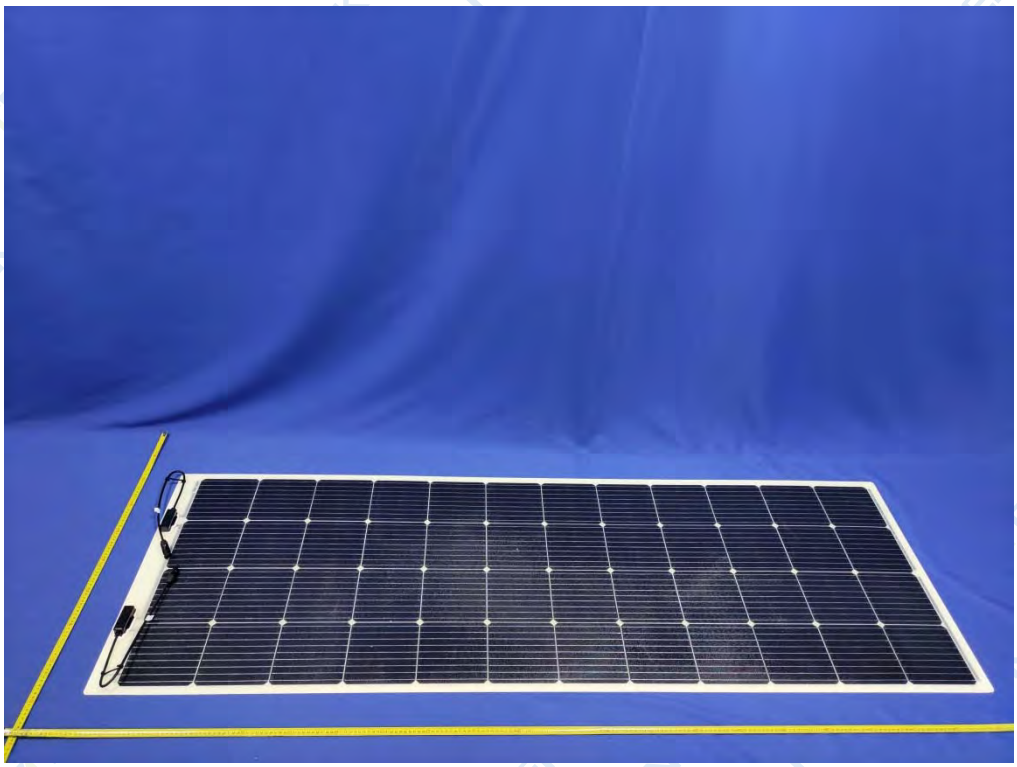

Fig.1

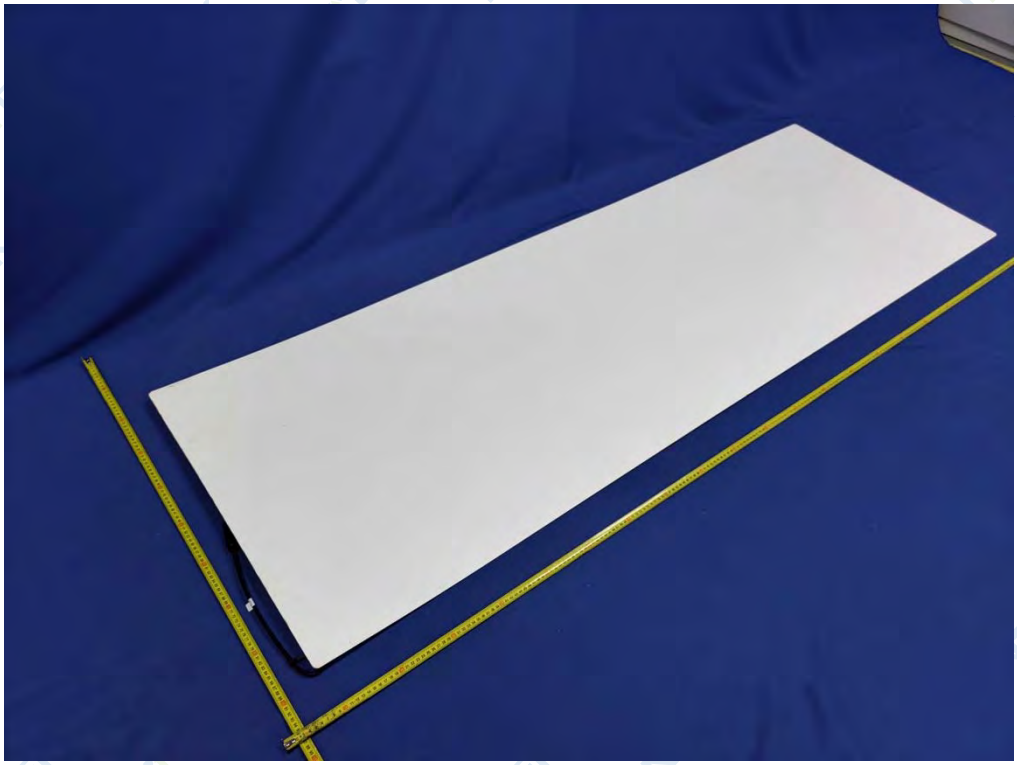

Fig.2

Fig.3

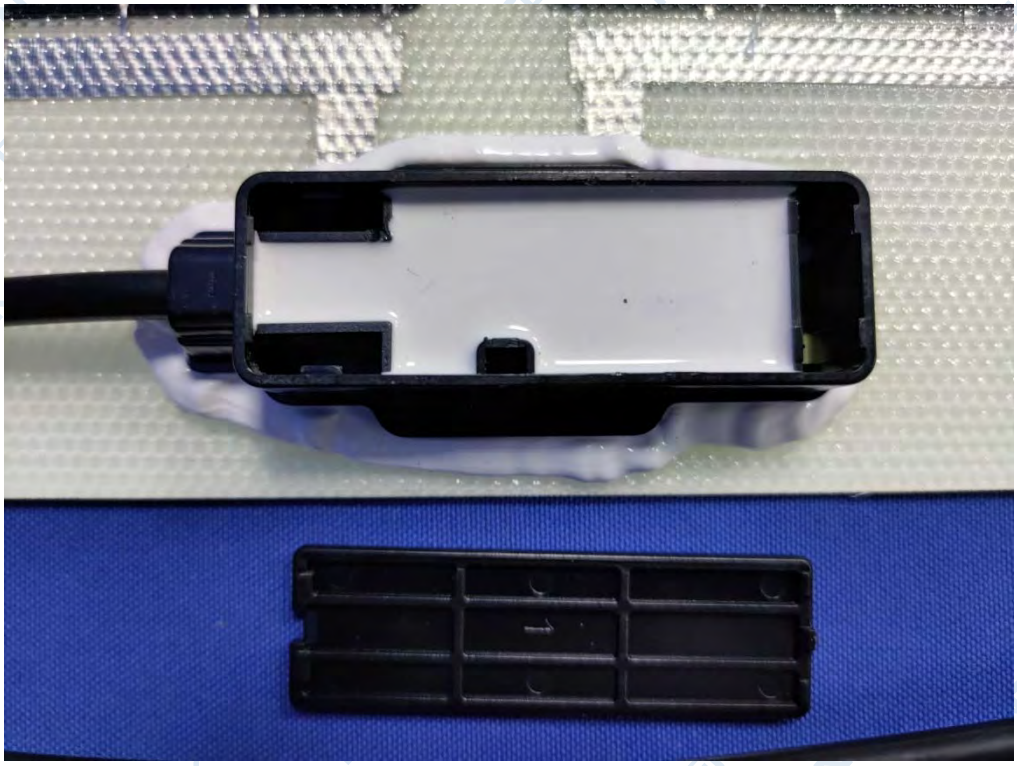

Fig.4

*****END OF REPORT*****