

PV4-S/S1 Connector

1. SCOPE

1.1. Content

This specification covers the performance, tests and quality standards for a connecting system which allows the electrical connection of photovoltaic (PV) panels.

The connectors do not disconnect under load. The connectors are marked polarity symbol (+/-). It is important to take care of the polarity before connecting. The connectors are to be used only to interconnect firmly fixed cables!

The connector allows for 2.5 mm² / 14 AWG, 4.0 mm² / 12 AWG and 6.0 mm² / 10 AWG cable (see Fig.1 and Fig.2), see §3.3 for UL and TÜV Rheinland approved cables.



See Fig 1
Connector Male
PV4-SMx/S1Mx.....
(PN 2270024)



See Fig 2
Connector Female
PV4-SFx/S1Fx.....
(PN 2270025)

1.2. Qualification

When tests are performed, the following specified specifications and standards shall be used. All inspections shall be performed using the applicable inspection plan and product drawing.

License holder: Tyco Electronics Austria GmbH, Schrackstrasse 1, 3830 Waidhofen/Thaya, Austria.

2. APPLICABLE DOCUMENTS

The following documents form part of this specification to the extent specified herein. In the case of a conflict between the requirements of this specification and the product drawing or of conflicts between the requirements of this specification and the referenced documents, this specification shall take precedence.

2.1. TE Connectivity Documents

- A. 109-1: General Requirements for Test Specifications
- B. Customer drawing and name
 - C-2270024 Pin Connector (Male)
 - C-2270025 Socket Connector (Female)
- C. 114-137077: Application Specification
- D. 501-137077 Qualification report
- E. 502-153521 Verification new Pinch ring PV4-S

2.2. Other Documents

- IEC 62852: Connectors for photovoltaic systems - Safety requirements and tests
- EN 60068: Environmental testing
- EN 60512-1: Connectors for electronic equipment -- Test and measurements
- EN 60529: Degrees of Protection Provided by Enclosures (IP Code)
- EN 60664-1: Insulation coordination for equipment within low-voltage systems (Part 1)
- EN 61215: Crystalline silicon terrestrial Photovoltaic (PV) Modules – Design Qualification and Type Approval
- EN 61646: Thin-film terrestrial photovoltaic (PV) modules -Design qualification and type approval
- EN 60695: Fire hazard testing (Part 2-10, Part 11-10,)
- UL1703: Flat-Plate Photovoltaic Modules and Panels
- UL6703: Connector for use in photovoltaic systems
- UL746C: Polymeric materials-use in electrical equipment evaluations
- UL486A-486B: Wire Connectors
- EN ISO 4892-2: Plastics – Methods of exposure to laboratory light sources
- Safety class II

3. REQUIREMENTS

3.1. Design and Construction

Product shall be of the design, construction and physical dimensions specified on the applicable product drawing.

3.2. Materials

Materials used in the construction of this product shall be as specified on the applicable product drawing.

3.3. Ratings

- Rated Voltage TÜV Rheinland:
PV4-SFx: 1000 V dc
PV4-S1Fx 1500 V dc
UL: 1000 V/1500 V dc
- Rated Current (At 85°C ambient) 35 A Max. for 2.5 mm² (TÜV Rheinland IEC62852)
40 A Max. for 4.0 mm² (TÜV Rheinland IEC62852)
45 A Max. for 6.0 mm² (TÜV Rheinland IEC62852)
35 A Max. for 14 AWG (UL6703)
40 A Max. for 12 AWG (UL6703)
50 A Max. for 10 AWG (UL6703)
- Ambient temperature -40 °C to +85 °C
- Protection Degree IP 65, IP 67 and IP68 (1m, 24h)
- Protection Class II
- Cable Wire size 2.5 mm² / 14 AWG, 4.0 mm² / 12 AWG
and 6.0 mm² / 10 AWG;
- Cable Jacket Diameter UL approved:
ø6.0 mm to ø7.8 mm
- Approved cable by TÜV Rheinland:
TE Connectivity 62930 IEC 131 1x2.5 mm² HALOGEN FREE LOW SMOKE R50434134
TE Connectivity 62930 IEC 131 1x 4 mm² HALOGEN FREE LOW SMOKE R50434134
TE Connectivity 62930 IEC 131 1x 6 mm² HALOGEN FREE LOW SMOKE R50434134
TE Connectivity 62930 IEC 131 1x 2.5 mm² HALOGEN FREE LOW SMOKE R50429356
TE Connectivity 62930 IEC 131 1x 4 mm² HALOGEN FREE LOW SMOKE R50429356
TE Connectivity 62930 IEC 131 1x 6 mm² HALOGEN FREE LOW SMOKE R50429356
- Overvoltage category III
- Pollution degree 2

3.4. Performance and Test Description

Product shall be designed to meet the electrical, mechanical and environmental performance requirements specified in §3.5. Unless otherwise specified, all tests shall be performed at ambient environmental conditions per IEC 62852 and UL6703.

3.5. Test Requirements and Procedures Summary

The here below mention testing are executed by TE Connectivity internally.

General inspections			
No.	Test Items	Requirements	Procedure according
3.5.1	Visual and dimensional examination	Meets requirements of product drawing	IEC 60512-1-1/-2, Test 1a and 1b
Mechanical inspections			
3.5.2	Terminations and connection methods	The Min. values of the pull out force shall be 230 N for 2.5 mm ² ; 310 N for 4 mm ² and 360 N for 6 mm ² See Table 1 of EN 60352-2 5.5 of IEC 62852	Pull out force test of crimped connections 5.5 of IEC 62852
3.5.3	Contact retention force in insert	No damage likely to impair function	Shall withstand for at least 200 N in any direction permitted by the construction, either directly or through any wire or cable 5.15.2 of IEC 62852
3.5.4	Insertion force (Mating force)	The Max. values of insertion force shall be 70N	The specified force shall be applied in the direction of the insertion of the unmated pair with the rate of 50mm/min.
3.5.5	Effectiveness of connector coupling device (Separation force)	Connector with locking device or with snap-in device shall withstand a load of 150N~250N	The specified force shall be applied in the direction of the separation of the mated pair with the rate of 50mm/min. 6.3.14 of IEC 62852
3.5.6	Mechanical Operation (Durability)	1) 100 operation cycles without load 2) No damage likely to impair function 5.11.1 of IEC 62852	Shall be engaged and disengaged by means of A) a device simulating normal operating conditions, the speed of insertion and withdrawal shall be approximately 0.01m/s with a rest in the unmated position of approximately 30s B) manual mating/un-mating 300 Max. cycle per hour 6.3.5 of IEC 62852
3.5.7	Bending Test (flexing)	100 repeat bends 5.11.2 of IEC 62852	The cable is loaded with a weight such that the force applied is 20N (in Figure 1) 6.3.6 of IEC 62852
3.5.8	Mechanical strength at lower temperature (Impact test)	No breakage and crack (test per clause 30 of UL1703)	Impact normal to the surface with 51mm diameter smooth steel sphere, weight 535g, falling through a vertical distance of 1.295m. at 25 °C and also after being cooled and maintained for 3h at a temperature of minus 35 ± 2. °C 30 of UL1703

3.5.9	Strain Relief Test	Without damage to the connector, or separation of the two mating connectors.	shall withstand for 1 min a force of 20 lb (89 N) applied in any direction permitted by the construction, either directly or through any wire or cable attached to the mating connector, clause 22 of UL1703
3.5.10	Mold Stress Relief Distortion Test	Shall not cause soften of the material as determined by handling immediately after the condition, nor shall there be shrinkage, warpage, or other distortion as judged after cooling to room temperature	The sample is to be placed in a full draft circulating air oven maintained at a uniform temperature at least 10°C higher than the temperature of the material measured under actual operating conditions, but not less than 70°C in any case, remain in the oven for 7 hours per 61.1 according to Table 4.1 29 of UL746C
3.5.11	Crush Resistance Test	Without resulting in any of the following: a) Reduction of spacing below the min. acceptable values b) Making bare live parts or internal wiring accessible to contact c) Producing any other condition that would increase the likelihood of electric shock or fire or both, during use of the equipment	Crushing force is to be applied to the exposed surface of the enclosure. The compression force is to be applied by flat surface each 102 by 254mm. Each force applicator is to exert 45.4 kg on the sample for 1 minute. 29 of UL 746C
3.5.12	Static Heating Sequence Test	As a result of the tests, there shall be no breakage of the conductor or any strand of a stranded conductor, stripping of threads, shearing of parts, or other damage to the connector.	1) Static heating test: 60 Hz test current for the conductor size being tested until stable temperatures are reached without exceeding a 50°C temperature rise above ambient temperature. 2) Secureness test (30 Mins is preferred). 3) Pull out test: connectors shall be subjected to a direct pull. 9.3 of UL 486A-486B
3.5.13	Mechanical Sequence Test	As a result of the tests, there shall be no breakage of the conductor or any strand of a stranded conductor, stripping of threads, shearing of parts, or other damage to the connector.	The same connector and entry holes subjected to the secureness test shall be subjected to a direct pull of a specified in Table 27. For a connector intended to secure more than one conductor at a time by a single clamping means, only those conductor that have been subjected to the secureness test shall be subjected to the pullout test. The pull shall be exerted by means of dead weights 9.4 of UL 486A-486B

Electrical inspections				
3.5.14	Contact Resistance	Initial	Max. 0.5mΩ	Test current:1A Measure points ^a at the end of the termination
		Final	Deviation of the contact resistance shall be no more than 50% of the initial reference value (0.5 mΩ)	
3.5.15	Temperature Rise Test	temperature rise(ΔT) of a connector shall not exceed 30°C 5.13 of IEC 62852		- length of test cable = 500mm $\pm$ 50mm - test shall be carried out with rated current as specified at ambient temperature:85°C - the test shall be continued until a constant temperature is obtained Per test 5a of EN 60512 6.3.4 of IEC 62852
3.5.16	Dielectric Voltage Withstand Test (Impulse)	No flashover or breakdown of voltage 5.10 of IEC 62852		Impulse test voltage according to Table 5, applied three impulses of each polarity and interval of at least 1s between impulses. 6.3.8a) of IEC 62852
3.5.17	Dielectric Voltage Withstand Test (Voltage Proof)	No flashover or breakdown of voltage 5.10 of IEC 62852		The test voltage shall be applied between all live parts and accessible surface, withstand voltage (50/60Hz) with a r.m.s value of 2000V plus (4 times rated voltage) for 1 min. 6.3.8b) of IEC 62852
3.5.18	Wet Insulation Resistance Test	Insulation resistance shall be not less than 400 MΩ		The connectors are to be maintained above the solution level and are to be thoroughly wetted by pouring the solution over these areas. Un-insulated terminations are not to be wetted. Water/wetting agent solution meeting the following requirements: resistivity: 3500 Ω .cm or less surface tension: 0.03N.m ⁻¹ or less temperature: 22 $\pm$ 3°C In both polarities, applied a 1500V dc

Environmental inspections			
3.5.19	Dry Heat	No damage likely to impair function	1000h at upper limit temperature 11i of IEC 61512
3.5.20	Temperature Cycle Test	No damage likely to impair function	-40±2°C to +90±2°C, Dwell time: 0.5 ~ 1.75h each extreme, Cycle time: 6h Max. Rate of change: 120°C/h Max. 200 cycles with current rating, see Figure 35.1 35 of UL1703
3.5.21	Damp Heat	No damage likely to impair function	1000h at +85°C±2°C and 85%±5%RH, 10.13 of IEC 61215 Per 6.3.12 of IEC 62852
3.5.22	Thermal Shock Test	No damage likely to impair function	200 cycle temperature change from 85°C to -40°C, transfer duration <3min Follow 6.3.11 IEC 62852
3.5.23	Humidity Freezing Test	No damage likely to impair function	10 cycles from +85°C±2°C, 85%RH ±2.5% to -40°C±2°C, see Figure 36.1 36 of UL1703
3.5.24	Weather Resistance	Visual examination: No cracks	Irradiance: 550W/m ² Wave band: 290nm-800nm Black standard temperature: 65°C Relative humidity: 65% Cycle: 18 min spraying, 102min drying with Xenon-lamp Total duration: 500 h EN ISO 4892-2
3.5.25	Degree of protection	no live parts shall be accessible by test finger (Gap 1.6mm Min) 5.4.1 of IEC 62852	Test finger IP20 at 10N Per 60529 Per 6.3.3.1 of IEC 62852
3.5.26	Degree of protection IP code	IP 68, No ingress of water or dust 5.9 of IEC 62852	Test IP 68 (1m, 24h) per IEC 60529 Per 6.3.3.2 of IEC 62852

Insulation Material inspections			
3.5.27	Flammability (Enclosure)	Flammability class V-0 (See yellow card of material)	Insulation material for outer housing material. Certificate of material supplier or test of the final product according to EN60695-11-10 Per 5.20.1a) of IEC 62852
		No inflame	Glow wire test with 650°C according to EN 60695-2-10 Per 5.20.1c) of IEC 62852
3.5.28	Flammability (support for live part)	Flammability class HB (See yellow card of material)	Insulation material for keeping live parts in position. Certificate of material supplier or test of the final product according to EN60695-11-10 5.20.2a) of IEC 62852
		No inflame	Glow wire test with 750°C according to EN 60695-2-10 5.20.2c) of IEC 62852

Number of Specimen as below table:

Table 1 - Number of Specimen		
Test	Description	Numbers
Group A	Mechanical test, Separate specimen,	2 ^a
Group B	Service life test, Mated	3
Group C	Thermal Test, Mated	3
Group D	Thermal cycle Test, Mated	3
Group E	Thermal Shock Test, Mated	3
Group F	Humidity Freezing Test, Mated	3
Group G	Insulation Material Test	3
Group H	Degree of protection Test	2
Group I	Impact Test	3
Group J	Strain Relief Test	3
Group K	Crush Resistance Test	3
Group L	Static Heating Sequence Test	4
Group M	Mechanical Sequence Test	4
Group N	Mold Stress Relief Distortion Test	3
Group O	Temperature Rise Test	1
Group P	Banding Test	
a: Each test item is for themselves separate tests		

3.6. Test Sequences

Test or Examination	Test Group															
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
	Test Sequence (a)															
Visual and dimensional examination	1,3	1,5	1,5	1,6	1,5	1,5	1,6	1,5	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,4
terminations and connection methods	2															
contact retention force in insert	2															
insertion force (mating force)	2															
effectiveness of connector coupling device (separation force)	2															
Mechanical Operation (Durability)		3														
Bending Test (flexing)																2
Mechanical strength at lower temperature (Impact test)									2							
Strain Relief Test										2						
Mold Stress Relief Distortion Test														2		
Crush Resistance Test											2					
Static Heating Sequence Test												2				
Mechanical Sequence Test													2			
Contact Resistance		2,4	2,4													3
Temperature Rise Test															2	
Dielectric Voltage Withstand Test (Impulse)				3												
Dielectric Voltage Withstand Test (Voltage Proof)				4	4	3	3	4								
Wet Insulation Resistance				5		4										
Test																
Dry Heat			3													
Temperature Cycle Test				2												
Damp Heat					3											
Thermal Shock Test					2											
Humidity Freezing Test						2										
Weather Resistance							2									

Degree of protection								2								
Degree of protection IP code								3								
Flammability (Enclosure)								4								
Flammability (support for live part)								5								

Notes:

- 1) Numbers indicate the sequence in which the tests are performed.

4. QUALITY ASSURANCE PROVISIONS

4.1. Qualification Testing

A. Specimen Selection

Specimens shall be prepared in accordance with applicable Instruction Sheets and shall be selected at random from current production.

B. Test Sequence

The samples shall be prepared in accordance with product drawings. They shall be selected at random from current production.

4.2. Requalification Testing

If changes significantly affecting form, fit or functions are made to the product or manufacturing process, product assurance shall coordinate requalification testing, consisting of all or part of the original testing sequence as determined by development/product, quality and reliability engineering.

4.3. Acceptance

Acceptance is based on verification that the product meets the requirements of paragraph 3.5. Failures attributed to equipment, test setup or operator deficiencies shall not disqualify the product. If product failure occurs, corrective action shall be taken and specimens resubmitted for qualification. Testing to confirm corrective action is required before re-submittal.

4.4. Quality Conformance Inspection

The applicable quality inspection plan shall specify the sampling acceptable quality level to be used. Dimensional and functional requirements shall be in accordance with the applicable product drawing and this specification. Bulk wire resistance shall be subtracted from resistance readings.

Annex

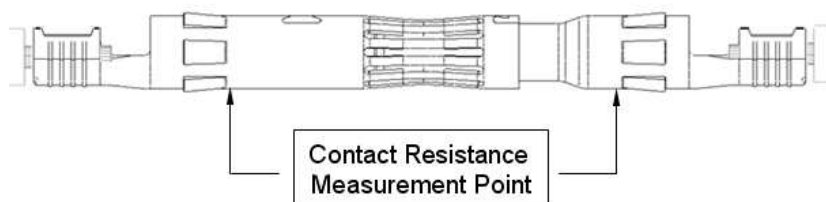


Figure 1

Contact Resistance Measure Point illustration

Annex A

Documentation Change Record

LTR	Clause	Page	Change Description	DATE	DWN	APRD
A			New release	2014.11 .10	LW	PY
A1	Item 3.3		Change the TÜV 1000V to TÜV 1500V	2015.05 .04	LW	DT
A2	Item 3.5.4 and 3.5.5	4	Changed 25.4mm/min to 50mm/min	14 JAN 2016	KR	ZY
A3	3.3	3	Change rate voltage	1 JUN 2016	LW	ZY
A4	Item 3.4,3.5 and 3.6	4-9	Upgrade from EN 50521 to IEC 62852	20 SEP 2017	SG	SM
A5	Several	Multi	Update to IEC 62930 for cables and different editorial corrections (mm ² to mm ² and space between numbers and units)	6 April 2020	C. v. Steenderen	M. Zucca
A6	Several	Multi	Corrected as per TÜV Rheinland CDF	15 April 2020	C. v. Steenderen	M. Zucca
A7	§1.1 & §3.3	1 & 3	Added cable reference in §1.1 to §3.3. §3.3 added model code to TÜV Rheinland rating	27 May 2020	C. v. Steenderen	M. Zucca
A8	§3.3	3	Added new UL rating	10 Dec 2020	C. v. Steenderen	M. Zucca
A9	§2.1	2	Added 501 and Pinch ring 502 verification report	20 January 2021	C. v. Steenderen	M. Zucca