

Qualification Test Report
SOLARLOK PV BAR Junction Box Series

TE Connectivity (Shanghai) Co., Ltd.

1. Introduction

1.1. Purpose

Testing was performed on PV BAR Junction Box to determine its conformance to the requirements of Product Specification 108-137167, Rev. A.

1.2. Scope

This specification covers performance, tests and qualification summary for the TE Connectivity SOLARLOK PV BAR Junction Box series distributing energy captured by solar panels used in the Photovoltaic (PV) industry.

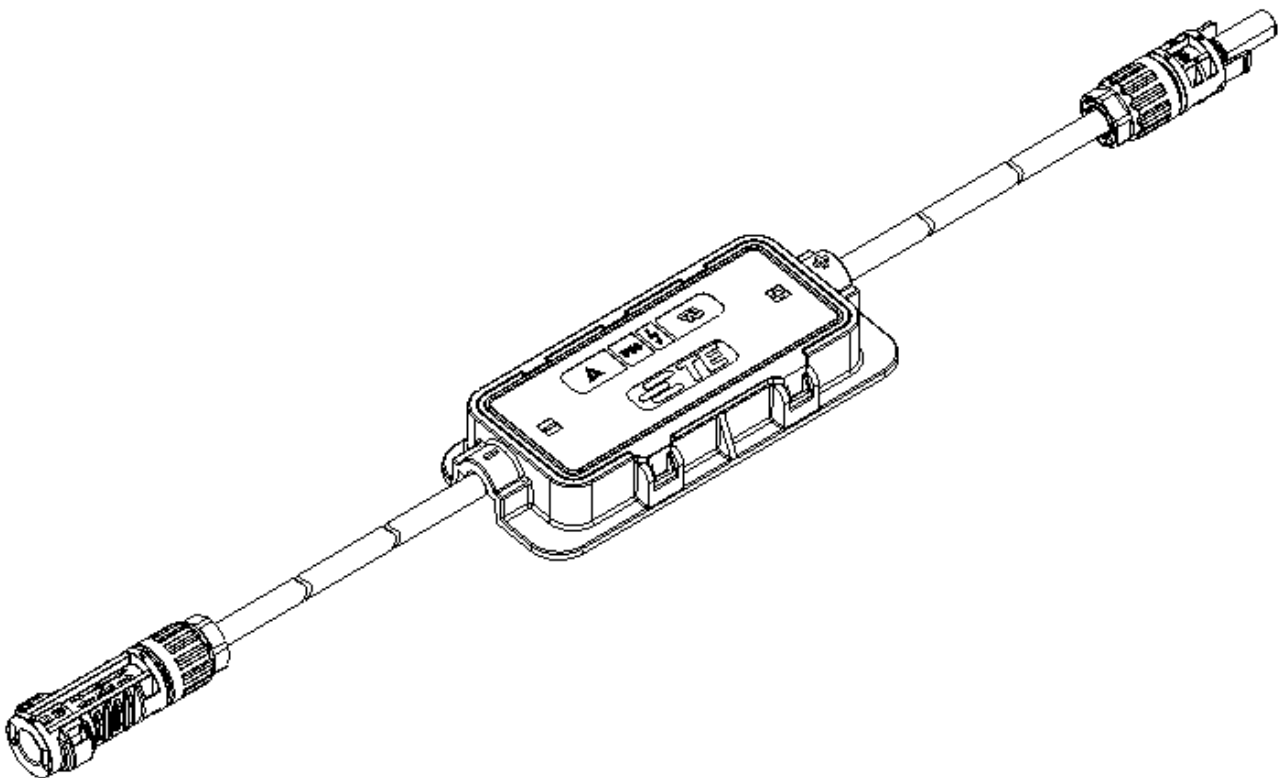


Fig. 1
Junction Box Overview

1.3. Ratings

Model Code	Rated System Voltage	Rated Current
PVBAR4GBY3TA	TUV:1500V DC/UL:1500V DC	15A
PVBAR4GBR3TA	TUV:1000V DC/UL:1000V DC	15A

- Operating temperature -40°C ~+85°C
- Storage temperature -40°C ~+85°C
- IP Code IP68
- Application class Class A
- Wire size 4.0mm² /AWG12

1.4. Environmental Conditions

Unless otherwise stated, the following environmental conditions prevailed during testing:

Temperature: 15°C to 35°C

Relative Humidity: 25% to 75%

2. Test Requirements Summary

3.5.1 GENERAL INSPECTIONS			
No.	Test Description	Requirement	Procedure According
1	Marking	The marking shall be indelible and easily legible.	Visual examination <i>Per IEC62790</i>
2	Technical documentation	Information according to 4.2.3 and additional information	Visual examination <i>Per IEC62790</i>
3	Approval of attached components	Components shall comply with the relevant standards.	Visual examination <i>Per IEC62790</i>
3.5.2 Material Test			
No.	Test Description	Requirement	Procedure According
1	Resistance against ageing	The sealing characteristic shall not be impaired; Compliance shall be checked by verifying the IP-code according to EN 60529.	Accelerated ageing in oven. Gaskets, e.g. separate polymer seals, shall be stored in a heating cabinet for 240 h at (100 ± 5) °C and subsequently cooled down for 16 h at ambient temperature. <i>Per IEC62790</i>
3.5.3 Constructional Requirements			

No.	Test Description	Requirement	Procedure According
1	Degree of protection	No ingress of dust and water	Test IP-code per IEC 60529 Gaskets shall be aged Per IEC62790
2	Mold Stress-Relief Distortion Test	Not cause softening of the material as determined by handling immediately after the conditioning, nor shall there be shrinkage, warpage, or other distortion as judged after cooling to room temperature	One sample of the complete equipment (in the case of an enclosure) or the part under consideration, is to be placed in a full draft circulating air oven maintained at a uniform temperature at least 10°C (18°F) higher than the maximum temperature of the material measured under actual operating conditions, but not less than 70°C (158°F) in any case. The sample is to remain in the oven for 7 hours. After its careful removal from the oven and return to room temperature, the sample is to be investigated Per Section 25 of UL Subject 3730

3.5.4 Mechanical Tests

No.	Test Description	Requirement	Procedure According
1	Terminations and connection methods	Fix position of terminals	Visual examination, of protection for lead or cable Per IEC62790
		Requirements of relevant clauses shall be fulfilled.	Mechanical test of suitability of terminals and connections Per IEC62790
2	Cord anchorage	a) Elongation less than 2mm b) Torsion shall not exceed 45°.	Pull- and Torsion Test Pull the cable for duration of 1 s, 50 times with a force of 30N, afterwards apply a torque of 0.1Nm for 1 min. Per IEC62790
3	Mechanical strength at lower temperatures	No damage, which may impair function	Placed on a steel of 20mm thickness for 5h in -40°C, then knock 4 uniformly distributed positions with 1 joule evenly on specimen Per IEC62790
4	Retention on the mounting surface	No loosening or displacement of Specimen; Insulation resistance not less than 400 MΩ	Pre aged at TC 200 and Damp heat test respectively, A force of 40 N shall be gradually increased and applied for 30 min in each direction parallel to the mounting surface and perpendicular to the mounting surface. Wet leakage current test according to Per IEC62790
5	Strain relief test	Without transfer of the force to the electrical connection, or damage to the lead or cable, and its connecting means; Without damage to the connector, the junction box, or the mounting of the connector to the junction box, or separation of the two mating connectors.	A lead or cable for connection to external wiring, or a lead or cable terminated at both ends on the shall withstand for 1 min a force of 20 lb (89 N) applied in any direction permitted by the construction; A separable connector not enclosed by a wiring compartment, and such connector's joining to its mating connector, 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 Per Section 26 of UL Subject 3730
6	Crush Test	Without resulting in any of the following: a) Reduction of spacing below the minimum acceptable values. b) Making bare live parts or internal wiring accessible to contact. c) Such breakage, cracking, rupture, and the like as to produce an adverse effect on the insulation. d) Producing any other condition that would increase the likelihood of electric shock or fire, or both, during use of the equipment.	The junction box are to be supported on the mounting side by a fixed rigid supporting surface, in the position that is recommended by the manufacturer. Crushing force is to be applied to the exposed surfaces of the junction boxes for 1 min. The compression force is to be applied by flat surfaces each 102 by 254 mm (4 by 10 inches). Each force applicator is to exert 45.4 kg (100 lb.) on the sample. Per Section 27 of UL Subject 3730
7	Wiring Compartment Securement Test	The tensile force required to separate a wiring compartment or box from a module shall not be less than 35 lb. (155.7 N) or 4 times the wiring compartment or box weight, whichever is greater	Samples are to be tested in the as-received condition, after being conditioned in accordance with Temperature Cycling Test and after conditioning in accordance with Humidity Test Per clause 42 of UL1703

3.5.5 Electrical Tests

No.	Test Description	Requirement	Procedure According
1	Dielectric strength (r.m.s. withstand voltage)	No flashover or breakdown of voltage	Apply an r.m.s. withstand voltage (50/60 Hz) with a r.m.s.-value of 2 000 V + 4 times rated voltage for 1 min. Per IEC62790
2	Dielectric strength (impulse withstand)	No flashover or breakdown of voltage	Impulse withstand test with a voltage having a 1,2/50 μ s waveform according to EN 60060-1 with three impulses of each polarity and an interval of at least 1s between pulses. Per IEC62790
3	Wet leakage current test	Insulation resistance shall be not less than 400 M Ω	A shallow through or tank of sufficient size to enable the module with frame to be placed in the solution in a flat, horizontal position, it shall contain a water/wetting agent solution meeting the following requirements: resistivity: 3500 Ω .cm or less surface tension: 0.03N.m ⁻¹ or less temperature: 22 °C \pm 3 °C applied a 500V or the maximum rated system voltage of the module(Per 10.15 of IEC 61215) Hold this voltage for 2 min. Per IEC62790
4	Bypass diode thermal test	a) the diode T _j shall not exceed the diode manufacture maximum rating T _j b) no evidence of major visual defects;	Heat the specimen to (75 \pm 5) °C. Apply a current to the specimen equal to the rated current \pm 2 % of the junction box. After 1 h, measure the temperature of each

		c) The diode shall be still operational.	bypass diode and at the insulating material, where the highest temperature is expected. Increase the applied current to 1,25 times of the rated current of the junction box while maintaining the box temperature at $(75 \pm 5) ^\circ\text{C}$. Maintain the current flow for 1 h. Per IEC62790
5	Temperature test	No part shall attain a temperature that would: a) Ignite materials or components; b) Cause the temperature limits of surfaces, materials, or components as described in Table 22.1, to be exceeded; c) Cause the Relative Thermal Index – 20 degrees C of polymeric materials to be exceeded; or d) Cause creeping, distortion, sagging, charring or similar damage to any part of the product, if such damage or deterioration may impair the performance of the product under the requirements of this Outline.	Test the junction box at equilibrium while conducting rated current in the forward direction (minus to plus) through the tabbing (diodes shall be replaced in the circuit with representative tabbing); Per Section 22 of UL Subject 3730

3.5.6 Environment Tests

No.	Test Description	Requirement	Procedure According
1	Damp heat test	No visible damages, which could impair function or safety	Test temperature: $(+ 85 \pm 2) ^\circ\text{C}$; Relative humidity: $(+ 85 \pm 5) \%$; 5N force is applied vertically; Test duration: 1 000 h. Per IEC62790
3	Humidity-freeze test	No evidence of major visual defects	From $+85 ^\circ\text{C} \pm 2 ^\circ\text{C}$, 85% RH $\pm 5\%$ to $-40 ^\circ\text{C} \pm 2 ^\circ\text{C}$; 20h Min at upper, 0.5h Max at lower; The transfer time between upper and lower temperature shall not exceed $100 ^\circ\text{C}/\text{h}$; 10 cycles Per IEC62790
3	Thermal cycle test	No visible damages, which could impair function or safety	From $-40 ^\circ\text{C} \pm 2 ^\circ\text{C}$ to $+85 ^\circ\text{C} \pm 2 ^\circ\text{C}$; The transfer time between upper and lower temperature shall not exceed $100 ^\circ\text{C}/\text{h}$; Rated current is applied during the temperature from $25 ^\circ\text{C}$ to $+85 ^\circ\text{C}$. 200 cycles. Per IEC62790
4	Salt Mist Corrosion Test	a) No corrosion influence performance b) The insulation resistance shall not be less than 400 M Ω c) The overall resistance shall not increase by more than 5 % of the	Salt mist test according to any one of the severities included in IEC 60068-2-52, severity 3 Per IEC 61701

		initial value.	
5	Annex B test	No visible damages, which could impair function or safety	Humidity- freeze test: 24 hours; Dry heat test: 48 hours; Thermal shock test: 5 cycles; Damp heat test: 1000 hours; Per IEC62790

3. Qualification Test Sequences

Test Items		Test Group											
		A	B	C	D	E	F	G	H	I	J		
		Test Sequence (a)											
3.5.1.1	Marking	1											
3.5.1.2	Technical documentation	2											
3.5.1.3	Approval of attached components	3											
3.5.2.1	Resistance against ageing				3								
3.5.3.1	Degree of protection				1, 4	1							
3.5.3.2	Mold Stress-Relief Distortion Test			2									
3.5.4.1	Terminations and connection methods		1										
3.5.4.2	Cord anchorage		2										
3.5.4.3	Mechanical strength at lower temperatures		3										
3.5.4.4	Retention on the mounting surface					8	6						
3.5.4.5	Strain relief test		4	3									
3.5.4.6	Crush Test		5										
3.5.4.7	Wiring Compartment Securement Test		6			10		7					
3.5.5.1	Dielectric strength (r.m.s. withstand voltage)					2, 5	1, 4	1, 5		1, 4			
3.5.5.2	Dielectric strength (impulse withstand)					6							
3.5.5.3	Wet leakage current test				2, 5	3, 7, 9	2, 5, 7	2, 6	2	2, 5	2		
3.5.5.4	Bypass diode thermal test								1				
3.5.5.5	Temperature test			1									
3.5.6.1	Thermal cycle test (Test cycle 50)							3					
3.5.6.2	Damp heat test						3						
3.5.6.3	Humidity-freeze test							4					
3.5.6.4	Thermal cycle test (Test cycle 200)					4							
3.5.6.5	Salt Mist Corrosion Test									3			
3.5.6.6	Annex B test										1		

(a) Numbers indicate the sequence in which the tests are performed.

(b) Test Group A,B is single test, for others tests to be performed consecutively in order

4. Summary of test results

Examination of product – all test groups

Test Description		Requirement/ Test Condition	Test Result	Judgement
Group A	Marking	Indelible and easily legible	-	Pass
	Technical documentation	Visual examination	-	Pass
	Approval of attached components	Visual examination	-	Pass
Group B	Terminations and connection methods	Pull test	>350N	Pass
	Cord anchorage	Pull- and torsion test	No abnormalities	Pass
	Mechanical strength at lower temperatures	-40°C,5hrs , 1J.No damage, which may impair function	No abnormalities	Pass
	Strain relief test	89N,1 Minute	No abnormalities	Pass
	Crush Test	No physical damage	No abnormalities	Pass
	Wiring Compartment Securement Test	155.7N Min.	>300N	Pass
Group C	Temperature test	See Section 22 of UL Subject 3730	No abnormalities	Pass
	Mold Stress-Relief Distortion Test	No physical damage	No abnormalities	Pass
	Strain relief test	89N,1 min.	No abnormalities	Pass
Group D	Degree of protection	IPX7,1m, 30 min.	No water ingress	Pass
	Wet leakage current test	DC1000V,2 min., no less than 400 MΩ	>1000 MΩ	Pass
	Resistance against ageing	100°C, 240 hrs	No abnormalities	Pass
	Degree of protection	IPX7,1m, 30 min.	No ingress water	Pass
	Wet leakage current test	DC1000V,2 min., no less than 400 MΩ	>1000 MΩ	Pass
Group E	Degree of protection	IPX7,1m, 30 min.	No ingress water	Pass
	Dielectric strength (r.m.s. withstand voltage)	AC6000V(2 000 V +4 x rated voltage), 1 min. No flashover or breakdown of voltage	No abnormalities	Pass
	Wet leakage current test	DC1000V,2 min., no less than 400 MΩ	>1000 MΩ	Pass
	Thermal cycle test	200 cycles from -40°C to + 90°C	No abnormalities	Pass
	Dielectric strength (r.m.s. withstand voltage)	AC6000V(2 000 V +4 x rated voltage), 1 min. No flashover or breakdown of voltage	No abnormalities	Pass
	Dielectric strength (impulse withstand)	Impulse voltage12KV(1,2/50μs),1s No flashover or breakdown of voltage	No abnormalities	Pass
	Wet leakage current test	DC1000V,2 min., no less than 400 MΩ	>1000 MΩ	Pass
	Retention on the mounting surface	40N,30 min. No loosening or displacement	No abnormalities	Pass
Wet leakage current test	DC1000V,2 min., no less than 400 MΩ	>1000 MΩ	Pass	

	Wiring Compartment Securement Test	155.7N Min.	>300N	Pass
Group F	Dielectric strength (r.m.s. withstand voltage)	AC6000V(2 000 V +4 x rated voltage), 1 min. No flashover or breakdown of voltage	No abnormalities	Pass
	Wet leakage current test	DC1000V,2 min., no less than 400 MΩ	>1000 MΩ	Pass
	Damp heat test	1 000 h at + 85°C, 85 % RH	No abnormalities	Pass
	Dielectric strength (r.m.s. withstand voltage)	AC6000V(2 000 V +4 x rated voltage), 1 min. No flashover or breakdown of voltage	No abnormalities	Pass
	Wet leakage current test	DC1000V,2 min., no less than 400 MΩ	>1000 MΩ	Pass
	Retention on the mounting surface	40N,30 min. No loosening or displacement	No abnormalities	Pass
	Wet leakage current test	DC1000V,2 min., no less than 400 MΩ	>1000 MΩ	Pass
Group G	Dielectric strength (r.m.s. withstand voltage)	AC6000V(2 000 V +4 x rated voltage), 1 min. No flashover or breakdown of voltage	No abnormalities	Pass
	Wet leakage current test	DC1000V,2 min., no less than 400 MΩ	>1000 MΩ	Pass
	Thermal cycle test	50 cycles from -40°C to + 90°C	No abnormalities	Pass
	Humidity-freeze test	10 cycles from + 85 °C , 85% RH to -40 °C	No abnormalities	Pass
	Dielectric strength (r.m.s. withstand voltage)	AC6000V(2 000 V +4 x rated voltage), 1 min. No flashover or breakdown of voltage	No abnormalities	Pass
	Wet leakage current test	DC1000V,2 min., no less than 400 MΩ	>1000 MΩ	Pass
	Wiring Compartment Securement Test	155.7N Min.	>300N	Pass
Group H	Bypass diode thermal test	One hour at I _{sc} and 75°C One hour at 1,25 times I _{sc} and 75°C, I _{sc} =11A Min.	T _j measured < T _j diode	Pass
	Wet leakage current test	DC1000V,2 min., no less than 400 MΩ	>1000 MΩ	Pass
Group I	Dielectric strength (r.m.s. withstand voltage)	AC6000V(2 000 V +4 x rated voltage), 1 min. No flashover or breakdown of voltage	No abnormalities	Pass
	Wet leakage current test	DC1000V,2 min., no less than 400 MΩ	>1000 MΩ	Pass
	Salt Mist Corrosion Test	Per IEC 60068-2-52	No abnormalities	Pass
	Dielectric strength (r.m.s. withstand voltage)	AC6000V(2 000 V +4 x rated voltage), 1 min. No flashover or breakdown of voltage	No abnormalities	Pass
	Wet leakage current test	DC1000V,2 min., no less than 400 MΩ	>1000 MΩ	Pass
Group J	Humidity-freeze test	24 hours from + 85°C, 85% RH to -40 °C	No abnormalities	Pass
	Dry heat test	48 hours;	No abnormalities	Pass
	Thermal shock test	5 cycles;	No abnormalities	Pass
	Damp heat test	1000 hours;	No abnormalities	Pass
	Wet leakage current test	DC1000V,2 min., no less than 400 MΩ	>1000 MΩ	Pass
	Visual check	No bubble, no crack, no deformation.	No abnormalities	Pass