RJ45 Field Install Plug – Industrial Ethernet

1. SCOPE

1.1. Content

This specification covers the performance, tests, and quality requirements of the field installable RJ45 plug for use in industrial ethernet applications.

The plug meets the requirements for connectors of category 5e according to EN 50173. A shielded 4-pos. wire cable ("twisted pair") is terminated by insulation displacement contacts (IDC). A high shielding effectiveness and a robust design is guaranteed by a metal die cast housing. It can be mate with RJ45 socket, 8-pos. according to IEC 60603-7-1:2011.

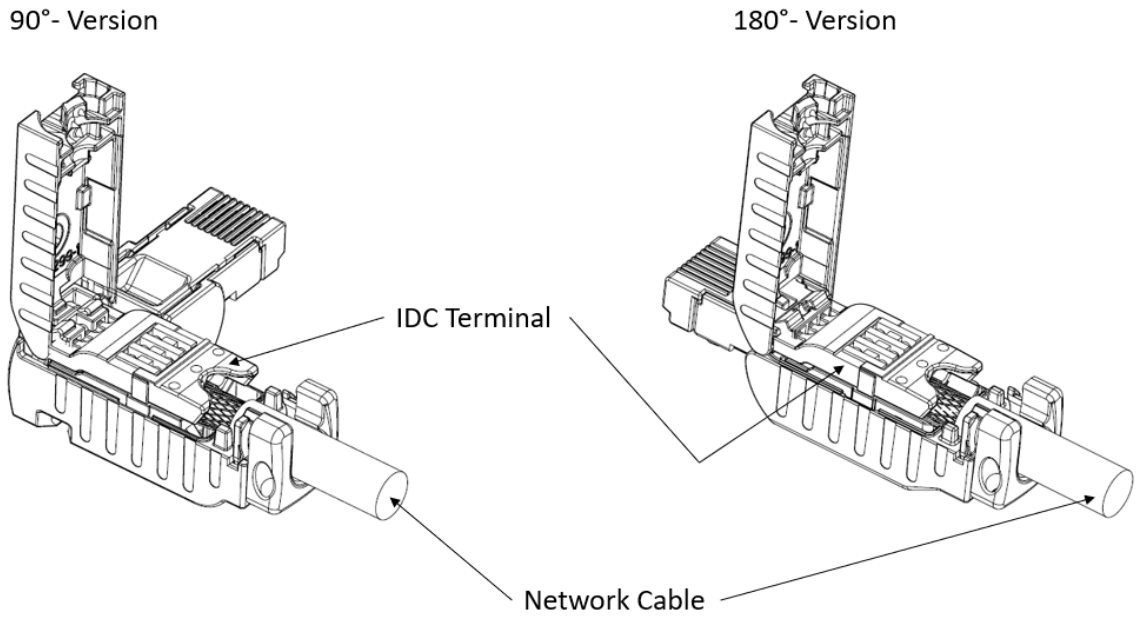

Fig. 1: RJ45 Field Install Plug (Cover Open)

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.

1.3. Qualification Test Results

Successful qualification testing on the subject product line has not been completed. The Qualification Test Report number will be issued upon successful qualification testing.

2. APPLICABLE DOCUMENTS AND FORMS

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

2.1. TE Documents

501-19315	Qualification Test Report
408-18046	Instruction Sheet for RJ45 Field Install Plug
408-18047	Instruction Sheet for RJ45 Field Install Plug 90

2.2. Customer Drawing & Name

2383216-1	RJ45 Field Install Plug
2383217-1	RJ45 Field Install Plug 90
5406299-1	Modular Jack Assembly, Single Port, 8P, Shielded, Reverse Panel Ground Tabs, CAT5e
1-406541-6	INVERTED MOD JACK ASSEMBLY, 1 X 1, SHIELDED, PANEL GROUND

2.3. Overview of The Standards Related to The Product

IEC 60603-7-1:2011	Connectors for electronic equipment part 7-1: Detail specifications for 8-way, Free and fixed connectors with common mating features, with assessed quality.
IEC 60603-7-3:2010	Connectors for electronic equipment - Part 7-3: Detail specification for 8-way, shielded, free and fixed connectors, for data transmission with frequencies up to 100 MHz
EN 50173-1:2018	Information technology - generic cabling schemes – part 1: general requirements.
IEC 60352-3:2020	Solderless connections – Part3: Solderless accessible insulation displacement connections – General requirements, test methods and practical guidance
IEC 60068-1:2013	Environmental testing – Part 1: General and Guidance.
IEC 60068-2-38:2021	Environmental testing – Part 2-38: Tests-Test Z/AD: Composite temperature/ humidity cyclic test
IEC 60068-1:2013	Environmental testing – Part 1: General and guidance.
IEC 60512-1-1:2002	Connectors for electronic equipment – Tests and measurements - Part 1-1: General examination - Test 1a: Visual examination
IEC 60512-1-2:2002	Connectors for electronic equipment – Tests and measurements - Part 1-2: General examination test – 1b: Examination of dimension and mass
IEC 60512-2-1:2002	Connectors for electronic equipment –Tests and measurements - Part 2-1: Electrical continuity and contact resistance tests - Test 2a: Contact resistance - Millivolt level method

IEC 60512-3-1:2002	Connectors for electronic equipment –Tests and measurements - Part 3-1: Insulation tests - Test 3a: Insulation resistance
IEC 60512-4-1:2003	Connectors for electronic equipment –Tests and measurements - Part 4-1: voltage stress tests - Test 4a: Voltage proof
IEC 60512-9-2:2011	Connectors for electronic equipment –Tests and measurements - Part 9-2: Endurance tests - Test 9b: Electrical load and temperature
IEC 60512-26-100:2008	Connectors for electronic equipment - Tests and measurements - Part 26-100: Measurement setup, test and reference arrangements and measurements for connectors according to IEC 60603-7 - Tests 26a to 26g
IEC 62153-4-12:2009	Metallic communication cable test methods - Part 4-12: Electromagnetic compatibility (EMC) - Coupling attenuation or screening attenuation of connecting hardware - Absorbing clamp method
IEC 60512, ITU-T K.20:2018	Resistibility of telecommunication equipment installed in a telecommunications Centre to overvoltage's and overcurrent's
IEC 60603-7:2008	Connectors for electronic equipment part 7: Detail specifications for 8-way, unshielded, Free, and fixed connectors.
IEC 60512-2-5:2003	Connectors for electronic equipment –Tests and measurements - Part 2-5: Electrical continuity and contact resistance tests - Test 2e: Contact disturbance
IEC 60512-17-3:2010	Connectors for electronic equipment - Tests and measurements - Part 17-3: Cable clamping tests - Test 17c: Cable clamp resistance to cable pull (tensile)
IEC 60512-13-2:2006	Connectors for electronic equipment –Tests and measurements - Part 13-2: Mechanical operation tests - Test 13b: Insertion and withdrawal forces
IEC 60512-9-1:2010	Connectors for electronic equipment - Tests and measurements - Part 9-1: Endurance tests - Test 9a: Mechanical operation
IEC 60512-6-4:2002	Connectors for electronic equipment - Tests and measurements - Part 6-4: Dynamic stress tests - Test 6d: Vibration (sinusoidal)
IEC 60512-11-7:2003	Connectors for electronic equipment - Tests and measurements - Part 11-7: Climatic tests - Test 11g: Flowing mixed gas corrosion test
IEC 60512-11-4:2002	Connectors for electronic equipment - Tests and measurements - Part 11-4: Climatic tests - Test 11d: Rapid change of temperature
IEC 60512-27-100:2011	Connectors for electronic equipment - Tests and measurements - Part 27-100: Signal integrity tests up to 500 MHz on 60603-7 series connectors - Tests 27a to 27g

2.4. Reference Document

109-197	Test Specification (TE Test Specification vs EIA and IEC Test Methods)
109-1	General requirements for test specifications

3. REQUIREMENTS

3.1. Design and Construction

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

3.2. Ratings

Rated Voltage	Current	Storage Temperature	Ambient Temperature
60 VDC	1.5 A per contact at 23°C	Minimum: -40°C Maximum: +85°C	Minimum: -40°C Maximum: +85°C

3.3. Test Requirements and Procedures Summary

Unless otherwise specified, all tests shall be performed at ambient environmental conditions.

TEST DESCRIPTION	REQUIREMENT	PROCEDURE
GENERAL		
General examination (Initial)	Meets requirements of product drawing.	According to IEC 60512-1-2
General examination (Initial & Final)	Meets visual requirements.	According to IEC 60512-1-1
ELECTRICAL		
Contact resistance – Millivolt level method	Contact resistance = 20 mΩ maximum	According to IEC 60512-2-1 (shield contact between the fixed and free connectors)
Contact resistance	100 mΩ maximum	According to IEC 60512-2-1 (Input to output resistance of shield)
Insulation resistance	500 MΩ minimum	According to IEC 60512-3-1 (100 V d.c method A, Mated connectors)
Voltage proof	1500 V a.c rms, 60 s No flashover or breakdown	According to IEC 60512-4-1 (All signal contacts to shield method A, Mated connectors)
Input to output resistance - Millivolt level method	Shield: 100 mΩ maximum	According to IEC 60512-2-1 (Input to output connector paths) (Mated connectors, connection points: Cable termination to cable termination)
Surge test	Test 2.1 and 2.2: Acceptance criterion A per ITU-T K.44, clause 9 Test 2.3: Acceptance criterion B per ITU-T K.44, clause 9	According to IEC 60512, ITU-T K.20:2018 (mated connectors, test 2a/2b basic test level Test 2.1.1a, 2.1.1b, 2.1.3, 2.2.1a and 2.3.1a)

MECHANICAL		
Insertion and withdrawal forces	Insertion force 30 N max. withdrawal force 30 N max.	Acc. to IEC 60512-13-2 (connector locking device depressed)
Mechanical operation	PL1: N = 750	According to IEC 60512-9-1 N/2 operations (see mechanical operation). Speed 10mm/s. rest 1s (when mated and unmated). Rest 5s (when unmated) Locking device inoperative
Vibration	10 µs, maximum	According to IEC 60512-6-4 F = 10 Hz to 500 Hz, (Amplitude = 0,35mm, Acceleration = 50m/s2 10 sweeps/axis Measurement points are the shield contacts
Gauging	All samples tested shall pass all gauges and forces	According to IEC 60603-7:2008, see annex C
Gauging continuity – contact disturbance	10 µs, maximum	Acc. to IEC 60512-2-5 annex A (shield contact)
Tensile strength of cable	Pull-out force: Cable ∅ 6.5mm ……. ≥ 100N End of the cable must not slip from insulation cable clamp	According to IEC 60512-17-3* 1 minute
ENVIRONMENTAL		
Flowing mixed gas corrosion		According to IEC 60512-11-7 (4 days/method 1 half of the samples in mated state half of the samples in unmated state)
Rapid change of temperature		Acc. to IEC 60512-11-4 (-40 °C to 70 °C Mated connectors 25 cycles t = 30 min Recovery time 2h)

Cyclic damp heat		Acc. to IEC 60068-2-38, Low temperature: 25°C High temperature: 65°C Col sub cycle - 10°C Rel. humidity: 93% Duration: 21 days (Half of the samples in mated state, half of the samples in unmated state)
Electrical load and temperature		According to IEC 60512-9-2* (500 h 70 °C Recovery period 2 h 1.6 A shield contacts, 5 specimens No current 5 specimens)
High temperature		According to IEC 60512-9-2* 500 h 70 °C Recovery period 2 h All samples in mated state
Current-carrying capacity tests temperature rise	Temp. rise <30K at 0.5A all signal lines loaded at the same time limited temperature 115°C consider max. cable performance	According to IEC 60512-5-1/5a achievable with suitable cable style. Specimens acc. To app. A + App. B
Current-temperature derating	Temp. rise <30K at 0.5A all signal lines loaded at the same time limited temperature 115°C consider max. cable performance (refer Fig. 3 for results)	According to IEC 60512-5-2/5b All contacts, connected in series
SIGNAL INTEGRITY		
Insertion loss	Mated connectors All pairs: ≤ $0.04_x\sqrt{f}$ dB from 1 MH_z to 100 MH_z. Whenever the equation results in a value less than 0.1 dB, the requirement shall revert to 0.1 dB.	Acc. to IEC 60512, 27a (All pairs, one direction)
Near-end crosstalk loss (NEXT)	Mated connectors: All pair combinations: ≥83 – 20 log (f) dB from 1 MH_z to 100 MH_z Whenever the equation results in a value greater than 75 dB, the requirement shall revert to 75 dB.	Acc. to IEC 60512, 27c (All pairs, both direction, pair to pair)
Return loss	Mated connectors: All pairs: ≥60 – 20 log (f) dB from 1 MH_z to 100 MH_z Whenever the equation results in a value greater than 30 dB,	Acc. to IEC 60512, 27b (All pairs, both direction)

	the requirement shall revert to 30 dB.	
FEXT	Mated connectors: All pair combinations: ≥75,1 – 20 log (f) dB from 1 MH_z to 100 MH_z Whenever the equation results in a value greater than 75 dB, the requirement shall revert to 75 dB.	Acc. to IEC 60512, 27d (All pairs, both direction, pair to pair)
TCL	Mated connectors: All pairs: ≥68 – 20 log (f) dB from 1 MH_z to 100 MH_z Whenever the equation results in a value greater than 50 dB, the requirement shall revert to 50 dB.	Acc. to IEC 60512, 27f (All pairs, both direction)
TCTL	Mated connectors: All pairs: ≥68 – 20 log (f) dB from 1 MH_z to 100 MH_z Whenever the equation results in a value greater than 50 dB, the requirement shall revert to 50 dB.	Acc. to IEC 60512, 27g (All pairs, both direction)
Transfer impedance	Mated connectors: All types: ≤$0.1f^{0.3}$ Ω from 1 MH_Z to 10 MH_Z ≤0.02f Ω from 10MH_Z to 80 MH_Z Where f is the frequency in MH_z	According to IEC 60512-26-100, Test 26e (Terminated with each cable construction intended to be allowed for these connectors)
Coupling attenuation	Mated connectors: All types: ≥45 dB from 30 MH_z to 100 MH_z ≥85 – 20 log (f) dB from 100 MH_z to 1000 MH_z Where f is the frequency in MH_z	According to IEC 62153-4-12 (NOTE: Coupling attenuation is assumed to be fulfilled when transverse conversion loss and transverse conversion transfer loss are met on the full bandwidth)

NOTE
Shall meet visual requirements, show no physical damage, and meet requirements of additional tests as specified in the Product Qualification and Requalification Test Sequence shown in Figure 2.

3.4. Product Qualification and Requalification Test Sequence

TEST OR EXAMINATION	TEST GROUP (a)								
	1	2	3	4	5	6	7	8	9
	TEST SEQUENCE (b)								
General examination	1/11/15	1/13	1/9	1/9	1	1/8	1	1	1/8
Contact resistance – Millivolt level method	2/9	2	2	2	2	2	2	2	2
Contact resistance	3/13	3/8/10	3/7	3/10	3	3	3	3/7	3/7
Insulation resistance	4/8	4/11	4/8	4/7	4	4/7	4	4/8	4
Voltage proof (c)	5/10/16	5/12	5	5/8	5	5	5	5/9	5
Insertion and withdrawal force	6/14								
Rapid change of temperature	7								
Cyclic damp heat	12						7		
Mechanical operation		6/9							
Flowing mixed gas corrosion		7							
Vibration			6						
Electrical load and temperature				6					
Gauging				11					
Guaging contiunity – contact disturbance (d)									
Insertion loss					6				
Near-end crosstalk loss (NEXT)					7				
Return loss					8				
FEXT					9				
TCL					10				
TCTL					11				
Input to output resistance - Millivolt level method					12				
Surge test						6			
Transfer impedance							8		
Couple attenuation							9		
High temperature							6		
Tensile strength of cable								6	
Derating									6

NOTE

(a) See appendix A.1

(b) Numbers indicate sequence in which tests are performed.

(c) Before continuing the next test step, the specimens need to be preconditioned according to IEC 60603-7:2008 under standard atmospheric conditions for testing as specified in IEC 60068-1 for a period of 24h (recovering time).

(d) Test qualification only on jack side. we are qualifying the plug only.

3.5. Classification of test groups

Groups 1, 2	Reliability of complete assembly by simulation of mechanical, electrical, thermical and Environmental stress with cable type stranded wire.
Group 3	Verification of vibration performance
Group 4	Verification of electrical performance
Group 5	Signal transmission performance (CAT5)
Group 6	Verification of surge test performance
Group 7	Verification of electrical & environmental performance
Group 8	Verification of cable clamping performance
Group 9	Verification of derating performance

3.6. Preconditioning (for IDC qualification)

For tests related to IDC contacts (test groups 1, 2, 3) every sample must be preconditioned with 9 termination cycles using the same wire type respectively wire size. The following test sequence is performed with stranded wire. Cable types specified in A.3 are used.

4. QUALITY ASSURANCE PROVISIONS

4.1. Qualification testing

A. Sample selection

The samples shall be prepared in accordance with product drawings and application specification. They shall be selected randomly from current production. In accordance with appendix A.1

B. Test sequence

Qualification inspection shall be verified by testing samples as specified in paragraph 3.4

4.2. Requalification testing

If changes significantly affecting form, fit, or function are made to the product or to the 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 Para. 3.4. Failures attributed to equipment, test setup, or operator deficiencies shall not disqualify the product.
When product failure occurs, corrective action shall be taken, and samples resubmitted for qualification. Testing to confirm corrective action is required before resubmission.

4.4. Quality conformance inspection

The applicable TE quality inspection plan will 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.

5. OTHERS

The product described herein has not been fully tested to ensure conformance to the requirements outlined above.
TE makes no representation or warranty, expressed or implied, that the product or design will comply with these requirements. Further, TE may change these requirements based on the results of additional testing and evaluation. Contact TE Engineering for further details.

A APPENDIX

A.1 Configuration of test groups

Test group	2383 216-1	2383 217-1	AWG 22 6XV1840-2AH10 (solid)	AWG 22 P49A0422 101000 (7stranded)	AWG 22 P49A0422 501000 (19stranded)	AWG 22 6XV1870-2B (7stranded)	AWG 22 6XV1870-2F (19stranded)	Remarks
1	10	5	4 x 2383216-1 2 x 2383217-1	2 x 2383216-1 1 x 2383217-1	-	-	4 x 2383216-1 2 x 2383217-1	Cable length – 300 mm
2	10	5	4 x 2383216-1 2 x 2383217-1	2 x 2383216-1 1 x 2383217-1	4 x 2383216-1 2 x 2383217-1	-	-	Cable length – 300 mm
3	10	5	4 x 2383216-1 2 x 2383217-1	2 x 2383216-1 1 x 2383217-1	-	-	4 x 2383216-1 2 x 2383217-1	Cable length – 300 mm
4	10	5	7 x 2383216-1 7 x 2383217-1	-	-	-	-	Cable length – 300 mm
5	10	5	-	-	-	10 x 2383216-1 5 x 2383217-1	-	Cable length – 300 mm
6	10	5	10 x 2383216-1 5 x 2383217-1	-	-	-	-	Cable length – 300 mm
7	20	15	10 x 2383216-1 5 x 2383217-1	5 x 2383216-1 5 x 2383217-1	5 x 2383216-1 5 x 2383217-1	-	-	Cable length – 300 mm
8	10	5	4 x 2383216-1 2 x 2383217-1	2 x 2383216-1 1 x 2383217-1	4 x 2383216-1 2 x 2383217-1	-	-	Cable length – 300 mm
9	10	5	4 x 2383216-1 2 x 2383217-1	2 x 2383216-1 1 x 2383217-1	4 x 2383216-1 2 x 2383217-1	-	-	Cable length – 300 mm

A.2 Mounting method for mechanical tests

The samples are mated to RJ45 jacks, locking device engaged and fixed with special adapted fastening item on a support panel for mechanical tests. For prevention of unwanted intrinsic resonance, the support panel should be well fixed at the test device (shaker).
Cables should be connected and mounted according to figure 2.

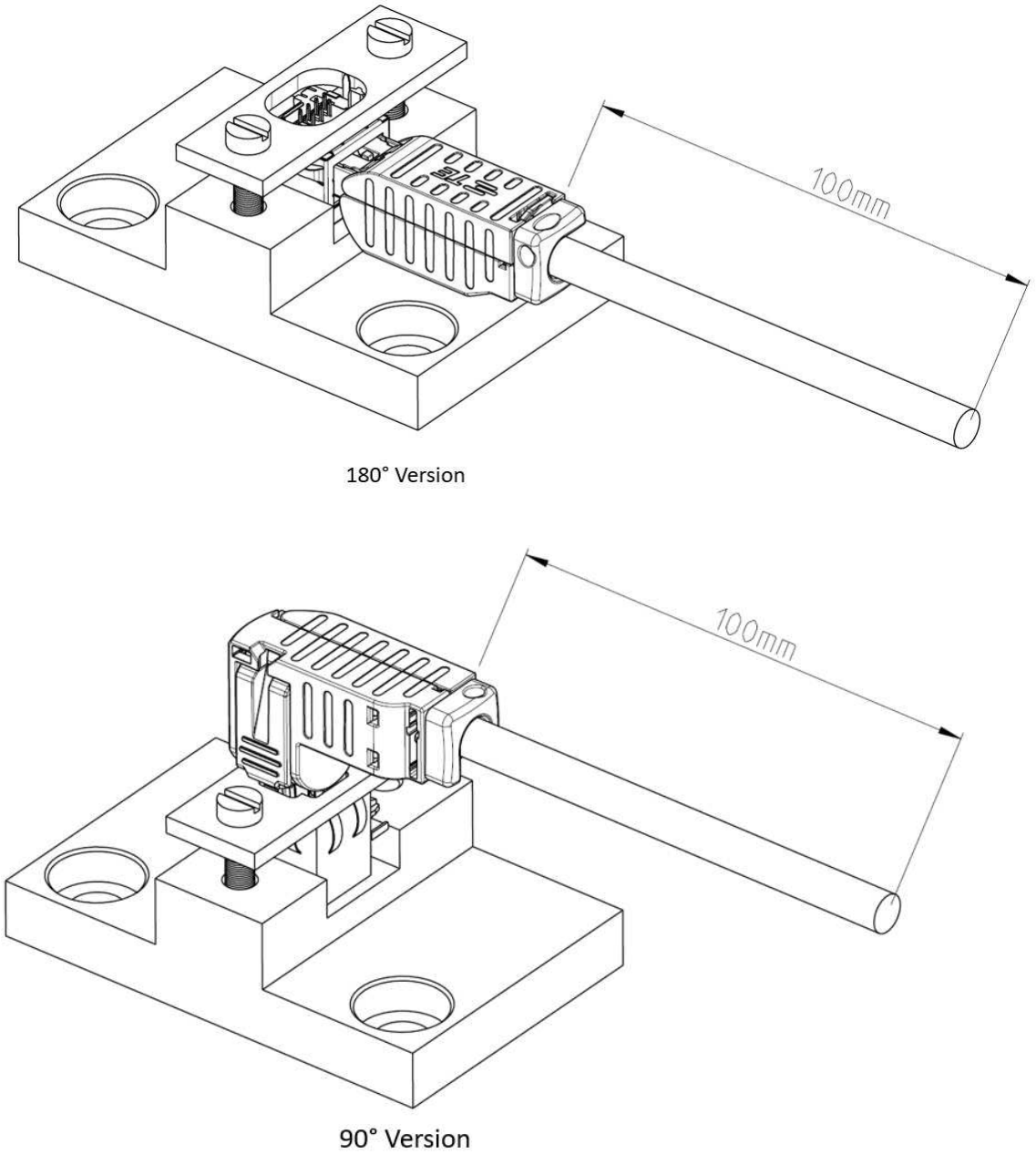

Fig. 2: Mounting method for mechanical tests without additional locking device

A.3 Cable types

Cable Diameter	Insulation Diameter	Wire Gauge	Wire Construction	Wire Type	Cable Number	Cable Type
∅ 6.5 mm	1.5 mm	0.32 mm² AWG 22	1 x ∅ 0.64 mm	Solid Wire	6XV 1840-2AH10	Standard Cable
∅ 6.5 mm	1.5 mm	0.34 mm² AWG 22	7 x ∅ 0.245 mm	Stranded Wire	P49A0422101000	Flexible cable
∅ 6.65 mm	1.55 mm	0.34 mm² AWG 22	19 x ∅ 0.15 mm	Stranded Wire	P49A0422501000	Torsion Cable
∅ 6.5 mm	1.5 mm	0.34 mm² AWG 22	7 x ∅ 0.25 mm	Stranded Wire	6XV1870-2B	Flexible Cable
∅ 6.5 mm	1.5 mm	0.34 mm² AWG 22	19 x ∅ 0.15 mm	Stranded Wire	6XV1870-2F	Torsion Cable

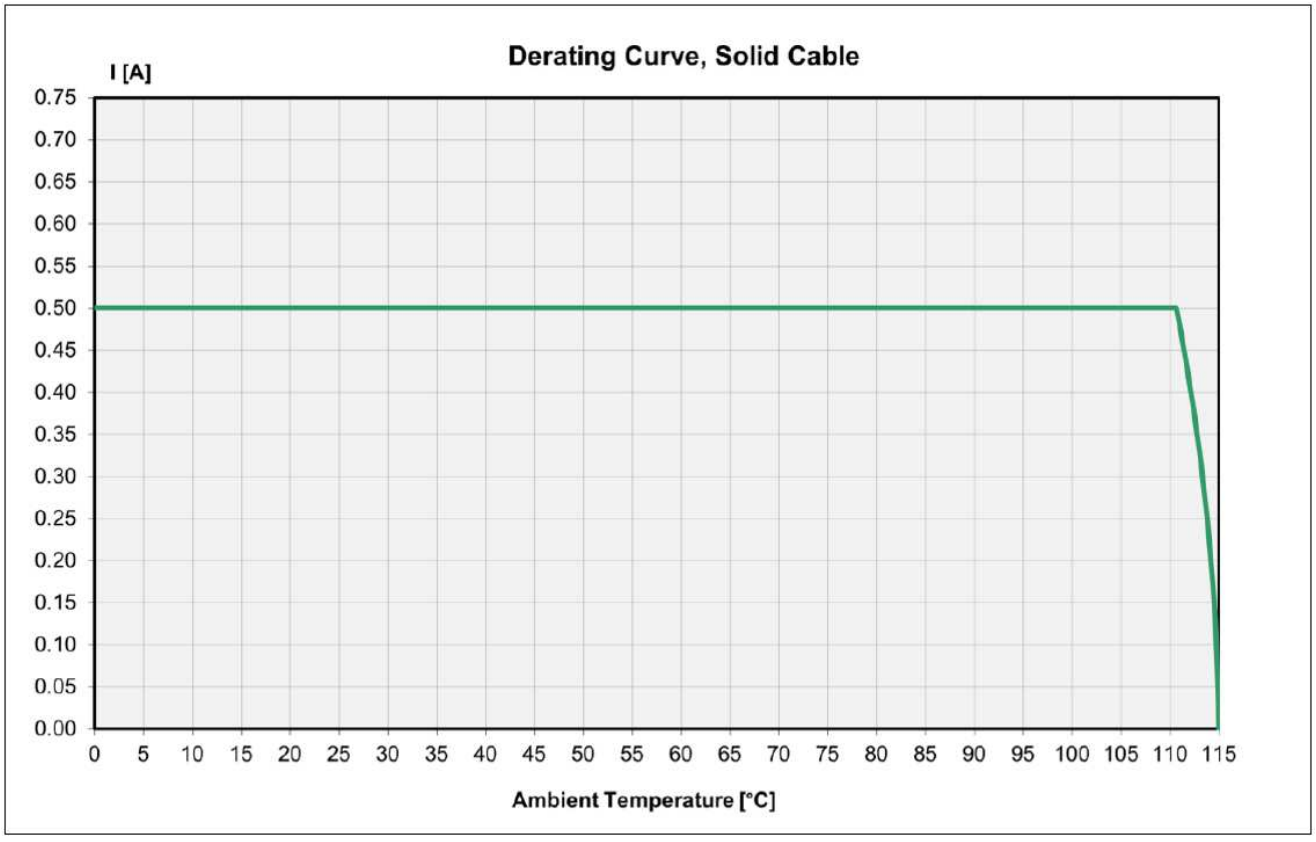

Fig. 3: Current – temperature capability (Derating diagram)