

Test report no.: <i>Prüfbericht-Nr.:</i>	CN231QW2 001	Order No.: <i>Auftragsnr.:</i>	190146878	Page 1 of 16 <i>Seite 1 von 16</i>
Client reference no.: <i>Kunden-Referenz-Nr.:</i>	2496213	Order date: <i>Auftragsdatum:</i>	2023-04-03	
Client: <i>Auftraggeber:</i>	Qingdao Huaqiang Wire & Cable Co., Ltd. No.1 of Huaqiang Road industrial Park Jiaoxi Town Jiaozhou City, Qingdao 266300 Shandong P.R. China			
Test item: <i>Prüfgegenstand:</i>	Cables for Photovoltaic-Systems			
Identification / Type no.: <i>Bezeichnung / Typ-Nr.:</i>	PV1-F 1X4mm2			
Order content: <i>Auftrags-Inhalt:</i>	T-Mark			
Test specification <i>Prüfgrundlage:</i>	2 PfG 1169/08.2007 Kabel und Leitungen - Leitungen für Photovoltaic Systeme Electric cables for photovoltaik systems			
Date of sample receipt: <i>Wareneingangsdatum:</i>	2023-04-10			
Test sample no: <i>Prüfmuster-Nr.:</i>	Engineering sample			
Testing period: <i>Prüfzeitraum:</i>	2023-04-11 – 2023-06-20			
Place of testing: <i>Ort der Prüfung:</i>	See other below for details			
Testing laboratory: <i>Prüflaboratorium:</i>	TÜV Rheinland (China) Ltd.			
Test result*: <i>Prüfergebnis*:</i>	Pass			
tested by: <i>geprüft von:</i>			authorized by: <i>genehmigt von:</i>	
Date: 2023-06-30 <i>Datum:</i>	Jiaxin Peng/PE	Issue date: 2023-06-30 <i>Ausstellungsdatum:</i>	Vivian Ren /Report Authorizer	
Position / Stellung:	Expert/Sachverständige(r)	Position / Stellung:	Expert/Sachverständige(r)	
Other: <i>Sonstiges:</i>	1. Place of testing: Shanghai Intelligent Service and Technology Co. Ltd East zone, Building 14, No. 1000, Jinhai Road, Pudong New District, Shanghai, P.R.China 2. Attachment 1. Used MTE.			
Condition of the test item at delivery: <i>Zustand des Prüfgegenstandes bei Anlieferung:</i>	Test item complete and undamaged Prüfmuster vollständig und unbeschädigt			
* Legend:	P(ass) = passed a.m. test specification(s)	F(ail) = failed a.m. test specification(s)	N/A = not applicable	N/T = not tested
* Legende:	P(ass) = entspricht o.g. Prüfgrundlage(n)	F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
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Remarks
Anmerkungen

- | | |
|----------|--|
| 1 | <p>The equipment used during the specified testing period was calibrated according to our test laboratory calibration program. The equipment fulfils the requirements included in the relevant standards. The traceability of the test equipment used is ensured by compliance with the regulations of our management system. Detailed information regarding test conditions, equipment and measurement uncertainty is available in the test laboratory and could be provided on request.</p> <p><i>Alle eingesetzten Prüfmittel waren zum angegebenen Prüfzeitraum gemäß eines festgelegten Kalibrierungsprogramms unseres Prüfhauses kalibriert. Sie entsprechen den in den Prüfprogrammen hinterlegten Anforderungen. Die Rückverfolgbarkeit der eingesetzten Prüfmittel ist durch die Einhaltung der Regelungen unseres Managementsystems gegeben.</i></p> <p><i>Detaillierte Informationen bezüglich Prüfkonditionen, Prüfequipment und Messunsicherheiten sind im Prüflabor vorhanden und können auf Wunsch bereitgestellt werden.</i></p> |
| 2 | <p>As contractually agreed, this document has been signed digitally only. TÜV Rheinland has not verified and unable to verify which legal or other pertaining requirements are applicable for this document. Such verification is within the responsibility of the user of this document. Upon request by its client, TÜV Rheinland can confirm the validity of the digital signature by a separate document. Such request shall be addressed to our Sales department. An environmental fee for such additional service will be charged.</p> <p><i>Wie vertraglich vereinbart, wurde dieses Dokument nur digital unterzeichnet. Der TÜV Rheinland hat nicht überprüft, welche rechtlichen oder sonstigen diesbezüglichen Anforderungen für dieses Dokument gelten. Diese Überprüfung liegt in der Verantwortung des Benutzers dieses Dokuments. Auf Verlangen des Kunden kann der TÜV Rheinland die Gültigkeit der digitalen Signatur durch ein gesondertes Dokument bestätigen. Diese Anfrage ist an unseren Vertrieb zu richten. Eine Umweltgebühr für einen solchen zusätzlichen Service wird erhoben.</i></p> |
| 3 | <p>Test clauses with remark of * are subcontracted to qualified subcontractors and described under the respective test clause in the report. Deviations of testing specification(s) or customer requirements are listed in specific test clause in the report.</p> <p><i>Prüfklausel mit der Note * wurden an qualifizierte Unterauftragnehmer vergeben und sind unter der jeweiligen Prüfklausel des Berichts beschrieben. Abweichungen von Prüfspezifikation(en) oder Kundenanforderungen sind in der jeweiligen Prüfklausel im Bericht aufgeführt.</i></p> |
| 4 | <p>The decision rule for statements of conformity, based on numerical measurement results, in this test report is based on the "Zero Guard Band Rule" and "Simple Acceptance" in accordance with ILAC G8:2019 and IEC Guide 115:2021, unless otherwise specified in the applied standard mentioned on Page 1 of this report or requested by the customer. This means that measurement uncertainty is not taken in account and hence also not declared in the test report. For additional information to the resulting risk based of this decision rule please refer to ILAC G8:2019.</p> <p><i>Die Entscheidungsregel für Konformitätserklärungen basierend auf numerischen Messergebnissen in diesem Prüfbericht basiert auf der "Null-Grenzwert-Regel" und der "Einfachen Akzeptanz" gemäß ILAC G8:2019 und IEC Guide 115:2021, es sei denn, in der auf Seite 1 dieses Berichts genannten angewandten Norm ist etwas anderes festgelegt oder vom Kunden gewünscht. Dies bedeutet, dass die Messunsicherheit nicht berücksichtigt wird und daher auch nicht im Prüfbericht angegeben wird. Zu weiteren Informationen bezüglich des Risikos durch diese Entscheidungsregel siehe ILAC G8:2019.</i></p> |
| 5 | <p>Other:</p> <p>All tests according to the standard 2 PFG 1169/08.07 in this report were performed to the complete cable PV1-F 1X4mm² (black insulation and black sheath) and PV1-F 1X4mm² (black insulation and red sheath) which were provided by the client with 300m for each type.</p> <p>Please refer to test report 50272706 001 for thermal endurance test.
This test report contains 16 pages and an attachment 1 with 1 page for testing equipment list.</p> |

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Table 3 Tests for halogen free PV-cable**1 Electrical tests****1.1 Resistance of conductors**

Testing method according to EN 50395 clause 5

Test conditions

Length of the test sample for each type : 1 m

Ambient temperature : 20°C

Type	Obtained value R_t Ω	Obtained value R_{20} Ω/km	Specified value (max.) Ω/km	
PV1-F 1X4mm ² (red)	-	5,02	5,09	P
PV1-F 1X4mm ² (black)	-	5,02	5,09	P

1.2 Voltage test on complete cable with AC or DC

Testing method according to EN 50395 clause 6

Test conditions

Length of the test sample for each type : 20 m

Period of immersion in water : 1h

Temperature of the water : 20°C

Test voltage applied (AC or DC) : 6,5 kVAC

Duration of application of voltage : 5 min

Test result	: PV1-F 1X4mm ² (red)	No breakdown	P
	: PV1-F 1X4mm ² (black)	No breakdown	P

1.3 Absence of faults at complete cable

Testing method according to EN 50395 clause 10

It is required during factory inspection.

P**1.4 Surface resistance of sheath**

Testing method according to EN 50395 clause 11

Test conditions

Number of the test sample for each type : 3

Length of the test sample : 250 mm

Distance between two electrodes : 100 mm

Ambient temperature : 20°C

Humidity : 65 %

Duration of test : 24 h

Test voltage applied : 500 V DC

Type	Diameter of test sample mm	Obtained value Ω	Calculated value Ω	Specified value (min.) Ω	
PV1-F 1X4mm ² (red)	5,41	$6,73 \times 10^{13}$	$9,4 \times 10^{12}$	10^9	P
PV1-F 1X4mm ² (black)	5,41	$4,18 \times 10^{13}$	$7,1 \times 10^{12}$	10^9	P

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1.5 Insulation at complete cable

Testing method according to EN 50395 clause 8

a. Insulation at complete cable at 20°C

Test conditions

Length of the test sample for each type : 5 m
 Active measuring length : 100 cm
 Temperature : 20°C
 Duration of the test : 2 h
 Test voltage applied : 500 V DC

Type	Diameter of test sample mm	Diameter of conductors mm	Obtained value Ω	Calculated value $\Omega \cdot \text{cm}$	Specified value (min.) $\Omega \cdot \text{cm}$	
PV1-F 1X4mm ² (red)	3,816	-	7,97x10 ¹¹	5,3x10 ¹⁵	10 ¹⁴	P
PV1-F 1X4mm ² (black)	3,857	-	5,68x10 ¹¹	3,6x10 ¹⁵	10 ¹⁴	P

b. Insulation at complete cable at 90°C

Test conditions

Length of the test sample for each type : 5 m
 Active measuring length : 100 cm
 Temperature : 90°C
 Duration of the test : 2 h
 Test voltage applied : 500 V DC

Type	Diameter of test sample mm	Diameter of conductors mm	Obtained value Ω	Calculated value $\Omega \cdot \text{cm}$	Specified value (min.) $\Omega \cdot \text{cm}$	
PV1-F 1X4mm ² (red)	3,816	-	8,42x10 ⁸	5,6x10 ¹²	10 ¹¹	P
PV1-F 1X4mm ² (black)	3,857	-	7,94x10 ⁸	5,0x10 ¹²	10 ¹¹	P

1.6 Long term resistance of insulation to d.c.

Testing method according to Annex D

Test conditions

Length of the test sample for each type : 5 m
 Temperature of water (water containing 3% NaCl) : 85°C
 Duration of test : 240 h
 Test voltage : 0,9 kVDC

Test result	:	PV1-F 1X4mm ² (red)	An increase of less than 10% of leakage current on the average for a time of 24h and no breakdown or damage on surface	P
		PV1-F 1X4mm ² (black)	An increase of less than 10% of leakage current on the average for a time of 24h and no breakdown or damage on surface	P

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Voltage test on complete cable with AC or DC afterwards

Testing method according to EN 50395 clause 6

Test conditions

Period of immersion in water : 1h
 Temperature of the water : 20°C
 Test voltage applied : 1k VAC
 Duration of application of voltage : 5 min

Test result : PV1-F 1X4mm² (red) No breakdown **P**
 PV1-F 1X4mm² (black) No breakdown **P**

2. Constructional and dimensional tests**2.1 Checking of compliance with constructional provisions**

Testing method according to EN 50396 clause 5.1 and EN 60228

Marking:  TÜV 2 PfG 1169 PV1-F 1X4mm² Qingdao Huaqiang Wire & Cable Co., Ltd.**Durability of marking:** By rubbing lightly ten times with a piece of cotton cloth soaked in water**Continuity of marks:** Spacing between 2 marks: ≤550mm**Material of sheath:** Halogen free crosslinked polyolefin FPV120-2**Colour of sheath:** black, red**Material of insulation:** Halogen free crosslinked polyolefin FPV120-1**Colour of insulation:** black**Material of conductors:** Tinned copper wire, purity of copper 99,96%**Construction of conductors:** Strand, flexible circular copper, tin-coated

P
P

Type	Diameter of wires in conductor mm	Number of wires in conductor
PV1-F 1X4mm ² (red)	0,29	50
	Maximum diameter of wires in conductor: 0,31 mm P	
PV1-F 1X4mm ² (black)	0,29	50
	Maximum diameter of wires in conductor: 0,31 mm P	

2.2 Measurement of thickness of insulation

Testing method according to EN 50396 Clause 4.1

Test conditions

Number of the test sample for each type : 3

Number of the measurement for each sample : 6

Type	Obtained minimum value of thickness mm	Minimum thickness of insulation mm	
PV1-F 1X4mm ² (red)	0,52	0,5	P
PV1-F 1X4mm ² (black)	0,57	0,5	P

2.3 Measurement of thickness of sheath

Testing method according to EN 50396 clause 4.2

Test conditions

Number of the test sample for each type : 3

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Number of the measurement for each sample : 6

Type	Obtained minimum value of thickness mm	Minimum thickness of sheath mm	
PV1-F 1X4mm ² (red)	0,77	0,5	P
PV1-F 1X4mm ² (black)	0,78	0,5	P

2.4 Measurement of overall dimensions

2.4.1&2.4.2 Mean value and Ovality

Testing method according to EN 50396 clause 4.4

Test conditions

Number of the test sample for each type : 3

Type	Minimum /Maximum value of overall diameter mm	Obtained mean value of overall diameter mm	Calculated Ovality %	Ovality (max.) %	
PV1-F 1X4mm ² (red)	-	5,6	2	15	P
PV1-F 1X4mm ² (black)	-	5,6	4	15	P

Remark: The upper limit of mean overall diameter shall be established by agreement between customer and the manufacturer.

3 Pressure test at high temperature at complete cable

Testing method according to EN 60811-3-1

Test Condition

Length of the test sample for each type : 20 m

Temperature : 140°C

Duration of heating under load : 240 min

Coefficient K : 0,6

Voltage test on complete cable with AC or DC afterwards

Testing method according to EN 50395 clause 6

Test conditions

Period of immersion in water : 1 h

Temperature of the water : 20°C

Test voltage applied : 6,5k VAC

Duration of application of voltage : 5 min

Test result	:	PV1-F 1X4mm ² (red)	No breakdown	P
		PV1-F 1X4mm ² (black)	No breakdown	P

Type	Overall diameter (D) mm	Mean thickness (δ) mm	Compressing force N	Depth of penetration mm	%	(max.) %	
PV1-F 1X4mm ² (red)	5,57	1,64	2,37	0,428	26	50	P
PV1-F 1X4mm ² (black)	5,57	1,64	2,37	0,40	24	50	P

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4 Damp heat test

Testing method according to EN 60068-2-78

Test conditions

Number of the test sample for each type : 1
 Temperature : 90°C
 Relative humidity : 85 %
 Duration of treatment : 1000 h

Mechanical properties after damp test:

Type	Test sample	Width of test sample mm	Thickness of test sample mm	Obtained tensile force N	Obtained tensile strength N/mm ²	Obtained elongation-at-break %
PV1-F 1X4mm ² (red)	sheath	3,64	0,91	53,4	13,5	170
PV1-F 1X4mm ² (black)	sheath	3,48	0,87	48,5	13,1	160

Variation before and after damp test:

Type	Test sample	Variation of tensile strength %	Variation of tensile strength (max.) %	Variation of elongation-at-break %	Variation of elongation-at-break (max.) %	
PV1-F 1X4mm ² (red)	sheath	+9	-30	-12	-30	P
PV1-F 1X4mm ² (black)	sheath	+6	-30	-6	-30	P

5 Resistance against acid and alkaline solution

Testing method according to EN 60811-2-1 clause 10

Test conditions

Number of the test sample for each type : 5
 Temperature : 23°C
 Duration of treatment : 168 h
 Density of N-oxal-acid : 45 g/l

Type	Test sample	Width of test sample mm	Thickness of test sample mm	Obtained tensile force N	Obtained tensile strength N/mm ²	Obtained elongation-at-break %	Elongation-at-break (min.) %	
PV1-F 1X4mm ² (red)	sheath	3,72	0,93	52,1	14,0	170	100	P
PV1-F 1X4mm ² (black)	sheath	3,36	0,84	45,2	13,5	170	100	P

Variation before and after the test:

Type	Test sample	Variation of tensile strength %	Variation of tensile strength (max.) %	
PV1-F 1X4mm ² (red)	sheath	+4	±30	P
PV1-F 1X4mm ² (black)	sheath	+3	±30	P

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Test conditions

Number of the test sample for each type : 5
 Temperature : 135°C
 Duration of treatment : 168 h
 Density of N-sodium hydroxide solution : 40 g/l

Type	Test sample	Width of test sample mm	Thickness of test sample mm	Obtained tensile force N	Obtained tensile strength N/mm ²	Obtained elongation-at-break %	Elongation-at-break (min.) %	
PV1-F 1X4mm ² (red)	sheath	3,76	0,94	55,4	14,6	160	100	P
PV1-F 1X4mm ² (black)	sheath	3,32	0,83	45,7	13,8	150	100	P

Variation before and after the test:

Type	Test sample	Variation of tensile strength %	Variation of tensile strength (max.) %	
PV1-F 1X4mm ² (red)	sheath	+8	±30	P
PV1-F 1X4mm ² (black)	sheath	+5	±30	P

6**Test of influence**

Testing method according to Annex A

Ageing conditions

Number of the test sample for each type : 3
 Temperature of air oven : 150°C
 Duration of treatment : 168 h

Mechanical properties after ageing:

Type	Test sample	Cross-section $A=\pi (D-\delta) \delta$ mm ²	Obtained tensile force N	Obtained tensile strength N/mm ²	Obtained elongation-at-break %
PV1-F 1X4mm ² (red)	insulation	3,816	100,8	15,1	250
PV1-F 1X4mm ² (black)	insulation	3,857	103,7	14,0	270

Type	Test sample	Width of test sample mm	Thickness of test sample mm	Obtained tensile force N	Obtained tensile strength N/mm ²	Obtained elongation-at-break %
PV1-F 1X4mm ² (red)	sheath	3,56	0,89	52,2	14,7	160
PV1-F 1X4mm ² (black)	sheath	3,32	0,83	50,9	15,5	170

Variation before and after the test:

Type	Test sample	Variation of tensile strength %	Variation of tensile strength (max.) %	Variation of elongation-at-break %	Variation of elongation-at-break (max.) %	
PV1-F 1X4mm ² (red)	insulation	+9	±30	+14	±30	P
	sheath	+13	-30	-6	±30	P

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PV1-F 1X4mm ² (black)	insulation	+9	±30	+8	±30	P
	sheath	+18	-30	+6	±30	P

7 Cold impact test at -40°C

Testing method according to Annex E

Test conditions

Number of the test sample for each type : 3
 Temperature : -40°C
 Duration of treatment : 16 h
 Mass of test probe : 200 g

Type	Overall diameter of test sample(D)	Mass of the hammer	Falling height of the hammer	
	mm	g	mm	
PV1-F 1X4mm ² (red)	5,41	100	-	D ≤15mm
PV1-F 1X4mm ² (black)	5,41	100	-	D ≤15mm

Test result : PV1-F 1X4mm² (red) No cracks on inner and outer surface of sheath as well as on outer surface of insulation **P**
 PV1-F 1X4mm² (black) No cracks on inner and outer surface of sheath as well as on outer surface of insulation **P**

8 Cold bending test (for diameter of cable < 12,5mm)

Testing method according to EN 60811-1-4 clause 8.2

Test conditions

Number of the test sample for each type : 2
 Temperature : -40°C
 Duration of treatment : 16 h

Type	Overall diameter of test sample (D) mm	Diameter of the mandrel mm	Number of the turns	
PV1-F 1X4mm ² (red)	5,41	-	4	4,5mm<D≤6,5mm
PV1-F 1X4mm ² (black)	5,41	-	4	4,5mm<D≤6,5mm

Test result : PV1-F 1X4mm² (red) No cracks have been determined **P**
 PV1-F 1X4mm² (black) No cracks have been determined **P**

9 Cold elongation test (for diameter of cable ≥ 12,5mm)**N/A**

Testing method according to EN 60811-1-4 clause 8.4

10 Ozone resistance at complete cable

Testing method according to EN 50396 clause 8.1.3

Test conditions

Number of the test sample for each type : 3
 Length for each sample : 200 mm
 Temperature : 40°C

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Relative humidity : 55%
 Ozone concentration (by volume) : $250 \times 10^{-6} \%$
 Duration of treatment : 72 h

Test result : PV1-F 1X4mm² (red) No cracks have been determined **P**
 PV1-F 1X4mm² (black) No cracks have been determined **P**

11 Weathering/UV-resistance

Testing method according to HD 605/A1 clause 2.4.20

Test conditions

Number of the test sample for each type : 1
 Temperature : 65°C
 Relative humidity : 65 %
 Spray cycle: spraying : 18 min
 Drying with xenon arc lamp : 102 min
 Power at wavelength 300nm to 400nm : 60W/m²
 Duration of treatment : 720 h

Bending test afterwards

Testing method according to EN 60811-1-4 clause 8.2

Test conditions

Temperature : 20°C
 Duration of treatment : 16 h

Type	Overall diameter of test sample (D) mm	Diameter of the mandrel mm	Number of the turns	
PV1-F 1X4mm ² (red)	5,6	28	-	4,5mm<D≤6,5mm
PV1-F 1X4mm ² (black)	5,6	28	-	4,5mm<D≤6,5mm

Test result : PV1-F 1X4mm² (red) No cracks have been determined **P**
 PV1-F 1X4mm² (black) No cracks have been determined **P**

12 Dynamic penetration test

Testing method according to Annex F

Test conditions

Number of the test sample for each type : 1
 Number of the measurement : 4
 Temperature : 20°C
 Diameter of Needle of spring steel : 0,45 mm
 Increasing rate of penetration force applying to the needle : 1N/s

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Type	Diameter of conductors (D _n) mm	Mean value of Penetration force F N	Penetration Force	
			$F=150 \cdot (D_n)^{1/2}$ (min.) N	
PV1-F 1X4mm ² (red)	-	285	237	P
PV1-F 1X4mm ² (black)	-	291	237	P

13**Notch propagation**

Testing method according to Annex G

Test conditions

Number of the test sample for each type : 1 at each test temperature
 Depth of each notch at four point on each test sample : 0,05 mm
 Highest temperature : 85°C
 Ambient temperature : 20°C
 Lowest temperature : -15°C
 Duration of treatment : 3 h

Type	Overall diameter of test sample mm	Diameter of the mandrel mm
PV1-F 1X4mm ² (red)	-	18
PV1-F 1X4mm ² (black)	-	18

Voltage test on complete cable with AC or DC afterwards

Testing method according to EN 50395 clause 6

Test conditions

Period of immersion in water : 1 h
 Temperature of the water : 20°C
 Test voltage applied : 0,3 kVAC
 Duration of application of voltage : 5 min

Test result	: PV1-F 1X4mm ² (red)	No breakdown	P
	: PV1-F 1X4mm ² (black)	No breakdown	P

14**Shrinkage test at complete cable**

Testing method according to EN 60811-1-3 clause 11

Test conditions

Number of the test sample for each type : 1
 Length of each test sample : 300 mm
 Temperature : 120°C
 Duration of treatment : 1h
 Thermal cycles : 5

Type	Initial length (L ₁) mm	Final length (L ₂) mm	Calculated percentage shrinkage $\Delta L = (L_1 - L_2) / L_1 \times 100$ %	Shrinkage (max.) %	
PV1-F 1X4mm ² (red)	300,0	298,0	1	2	P
PV1-F 1X4mm ² (black)	300,0	299,0	0,3	2	P

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15 Test under fire condition**15.1 Test for vertical flame propagation at complete cable**

Testing condition according to EN 60332-1-2

Test conditions

Number of the test sample for each type : 1
 Length of the application : 600 mm
 Time of flame application : 60 s

Test result : PV1-F 1X4mm ² (red)	The distance between the lower edge of the top support and the onset of charring is <u>407</u> mm (min. 50mm) The distance between the charring extends downwards and the lower edge of the top support is <u>500</u> mm (max. 540mm)	P
PV1-F 1X4mm ² (black)	The distance between the lower edge of the top support and the onset of charring is <u>405</u> mm (min. 50mm) The distance between the charring extends downwards and the lower edge of the top support is <u>504</u> mm (max. 540mm)	P

15.2 Assessment of halogen**15.2.1 Absence of halogen**

Testing condition according to Annex B

pH and conductivity

Testing method according to EN 50267-2-2

Test conditions

Number of the test sample : 1
 Weight of each test sample : 1000 mg
 Rate of air flow : (0,0157·D²) l·h⁻¹ (D=38mm)
 Duration of combustion : 30 min.

Type	Test sample	pH value	pH value (min.)	conductivity μS/mm	Conductivity (max.) μS/mm	
PV1-F 1X4mm ² (red)	insulation	7,1	4,3	0,77	10	P
	sheath	6,6	4,3	0,69	10	P
PV1-F 1X4mm ² (black)	insulation	6,3	4,3	0,83	10	P
	sheath	6,5	4,3	0,80	10	P

Chlorine- and Bromine content, expressed in HCl

Testing method according to EN 50267-2-1

Test conditions

Number of the test sample for isolation as well as sheath : 1
 Rate of air flow : (0,0157·D²) l·h⁻¹ (D=38mm)

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Type	Test sample	Weight of sample g	Volume of 0,1M ammonium thiocyanate solution used in the determination ml	Volume of 0,1M ammonium thiocyanate solution used in the blank test ml	Chlorine- and Bromine content, expressed in HCl %	Chlorine- and Bromine content, expressed in HCl (max.) %	
PV1-F 1X4mm ² (red)	insulation	0,71	20,1	20,1	<0,5	0,5	P
	sheath	0,68	20,1	20,1	<0,5	0,5	P
PV1-F 1X4mm ² (black)	insulation	0,78	20,1	20,1	<0,5	0,5	P
	sheath	0,74	20,1	20,1	<0,5	0,5	P

15.2.2
Determination of halogens

Testing condition according to Annex C

Fluoride content

Testing method according to EN 60684-2

Test conditions

Number of the test sample for isolation as well as sheath : 1
 Testing method : Ion selective electrode method
 Burning supporting : 2 to 3 drops dodecanol
 Absorbent : 5 ml 0,5M sodium hydroxide solution
 Buffer reagent added : 5 ml TISAB
 Atomic weight of fluoride : 19,0 mol/L

Type	Test sample	Weight of the test sample mg	Obtained fluoride concentration in solution mg/L	Obtained fluoride content %	Fluoride content (max.) %	
PV1-F 1X4mm ² (red)	insulation	26,3	0,0687	<0,02	0,1	P
	sheath	26,1	0,0651	<0,02	0,1	P
PV1-F 1X4mm ² (black)	insulation	27,2	0,0727	<0,02	0,1	P
	sheath	28,4	0,0715	<0,02	0,1	P

Table 4 Requirements for halogen free insulation and sheath compounds
1
Mechanical characteristics
1.1
Properties before ageing

Testing method according to EN 60811-1-1 clause 9.2

Test conditions

Number of the test sample of insulation : 5
 as well as sheath for each type
 Distance between two marks : 20 mm
 Rate of separation : 250 mm/min

Type	Test sample	Cross-section $A = \pi (D - \delta) \delta$ (mm ²)	Obtained tensile force (N)	Obtained tensile strength (N/mm ²)	Tensile strength (min.) N/mm ²	Obtained elongation-at-break (%)	Elongation-at-break (%) (min.) %	
PV1-F 1X4mm ² (red)	insulation	3,816	120,5	13,9	8,0	220	125	P
PV1-F 1X4mm ² (black)	insulation	3,857	115,2	12,9	8,0	250	125	P

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Type	Test sample	Width of test sample mm	Thickness of test sample mm	Obtained tensile force N	Obtained tensile strength N/mm ²	Tensile strength (min.) N/mm²	Obtained elongation-at-break (%)	Elongation-at-break (min.) %	
PV1-F 1X4mm ² (red)	sheath	3,99	0,97	59,9	13,5	8,0	179	125	P
PV1-F 1X4mm ² (black)	sheath	3,64	0,91	57,0	13,1	8,0	160	125	P

1.2 Properties after ageing in oven

Testing method according to EN 60811-1-2 clause 8.1

Ageing conditions

Number of the test sample of insulation : 5

as well as sheath for each type

Temperature : 150 °C

Duration of treatment : 7 x 24 h

Type	Test sample	Cross-section $A=\pi (D-\delta) \delta$ (mm ²)	Obtained tensile force (N)	Obtained tensile strength (N/mm ²)	Tensile strength (min.) N/mm²	Obtained elongation-at-break (%)	Elongation-at-break (min.) %	
PV1-F 1X4mm ² (red)	insulation	3,816	120,5	16,5	8,0	270	125	P
PV1-F 1X4mm ² (black)	insulation	3,857	115,2	15,9	8,0	310	125	P

Type	Test sample	Width of test sample mm	Thickness of test sample mm	Obtained tensile force N	Obtained tensile strength N/mm ²	Tensile strength (min.) N/mm²	Obtained elongation-at-break (%)	Elongation-at-break (min.) %	
PV1-F 1X4mm ² (red)	sheath	3,99	0,97	59,9	15,8	8,0	160	125	P
PV1-F 1X4mm ² (black)	sheath	3,64	0,91	57,0	15,8	8,0	160	125	P

Variation before and after ageing:

Type	Test sample	Variation of tensile strength %	Variation of tensile strength (max.) %	Variation of elongation-at-break %	Variation of elongation-at-break (max.) %	
PV1-F 1X4mm ² (red)	insulation	+19	-30	+23	-30	P
	sheath	+17	-30	-6	-30	P
PV1-F 1X4mm ² (black)	insulation	+23	-30	+24	-30	P
	sheath	+21	-30	+6	-30	P

1.3 Hot set test

Testing method according to EN 60811-2-1 clause 9

Test conditions

Number of the test sample of insulation : 2

as well as sheath for each type

Length of the test sample : 100 mm

Distance between two marks : 20 mm

Temperature of the air oven : 250°C

Duration under load : 15 min.

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 Mechanical stress : 20 N/cm²

Type	Test sample	Elongation under load %	Elongation under load (max.) %	Permanent elongation after cooling %	Permanent elongation after cooling (max.) %	
PV1-F 1X4mm ² (red)	insulation	48	100	-5	25	P
	sheath	33	100	-3	25	P
PV1-F 1X4mm ² (black)	insulation	68	100	0	25	P
	sheath	33	100	-3	25	P

1.4
Thermal endurance properties

Testing method according to EN 60216-2

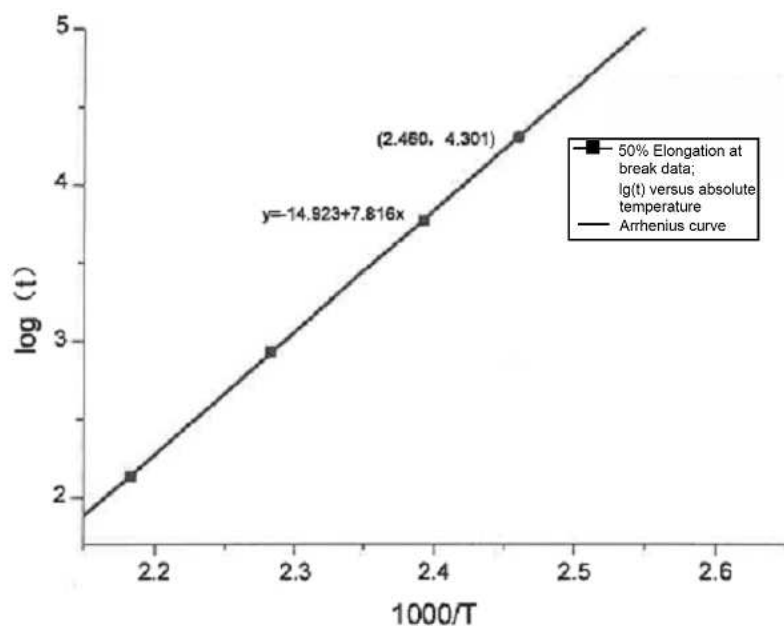
Test conditions

Temperature Index : 120

Selected exposure temperatures : 185°C, 165°C, 145°C

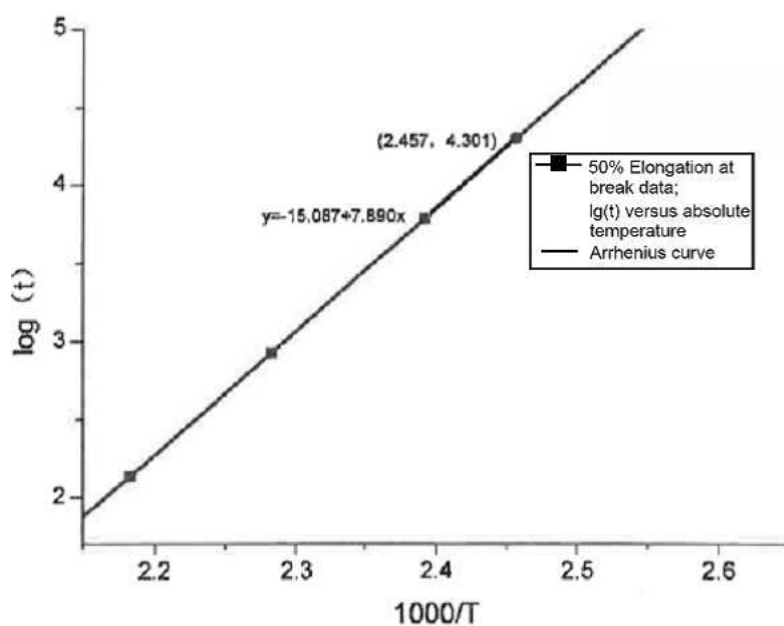
Elongation at break : 50 %

Test sample	Time to end-point at exposure temperature 185°C hour	Specified time (min.) h	Time to end-point at exposure temperature 165°C hour	Time to end-point at exposure temperature 145°C hour	Specified time (min.) h	Obtained absolute temperature K	Absolute temperature (min.) K	
insulation	136	100	851	5856	5000	407	393	P
sheath	136	100	844	6062	5000	407	393	P

Thermal endurance graph for insulation material

 (Remark: The value of t is equal to 20,000 h at $\lg(t)=4,30$)

Thermal endurance graph for sheath material

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(Remark: The value of t is equal to 20,000 h at lg(t)=4,30)

1.5

Cold elongation test

N/A

Testing method according to EN 60811-1-4 clause 8.4

End of the test report

Equipment List

Contract No.: ISTCW23-1043

Equipment No.	Equipment Name	Calibration Date
ISTCW-M-002-2016	AC dielectric strength tester	2022/06/21 ~ 2023/06/20
ISTCW-M-018-2016	DC resistance measuring device	2022/07/01 ~ 2023/06/30
ISTCW-M-038-2016	Constant temperature and humidity test chamber	2022/07/01 ~ 2023/06/30
ISTCW-M-040-2016	Single cable vertical combustion test device	2023/06/17 ~ 2024/06/16
ISTCW-M-042-2016	Automatic measuring system for wire and cable structure parameters	2022/07/01 ~ 2023/06/30
ISTCW-M-047-2016	Low temperature tensile device	2023/05/30 ~ 2025/05/29
ISTCW-M-048-2016	Low temperature impulse device	2023/05/30 ~ 2025/05/29
ISTCW-M-049-2016	Low temperature bending device	2023/05/30 ~ 2025/05/29
ISTCW-M-054-2016	Multi-parameter tester (fluorine ion)	2023/02/15 ~ 2024/02/14
ISTCW-M-067-2016	Outside micrometer tester	2023/02/21 ~ 2024/02/20
ISTCW-M-069-2016	Straight steel ruler	2023/08/03 ~ 2023/08/02
ISTCW-M-070-2016	Straight steel ruler	2022/10/13 ~ 2023/10/12
ISTCW-M-071-2016	Ageing chamber	2023/06/17 ~ 2024/06/16
ISTCW-M-140-2017	Ageing chamber	2023/06/17 ~ 2024/06/16
ISTCW-M-152-2017	Ageing chamber	2023/06/17 ~ 2024/06/16
ISTCW-M-172	Ozone testing chamber	2022/06/20 ~ 2023/06/19
ISTCW-M-198	UV testing chamber	2023/02/28 ~ 2024/02/27
ISTCW-M-205	Glass thermostatic water bath	2022/06/21 ~ 2023/06/20
ISTCW-M-207	Tensile testing machine	2022/07/01 ~ 2023/06/30
ISTCW-M-211	AC dielectric strength tester	2023/06/06 ~ 2024/06/05
ISTCW-M-225	Insulation resistance measuring device	2022/10/09 ~ 2023/10/08
ISTCW-M-231	Tensile testing machine	2022/07/01 ~ 2023/06/30
ISTCW-M-234	Insulation resistance measuring device	2022/07/16 ~ 2023/07/15
ISTCW-M-249	Glass thermostatic water bath	2022/06/21 ~ 2023/06/20
ISTCW-M-270	Ageing chamber	2023/06/17 ~ 2024/06/16
ISTCW-M-271	Ageing chamber	2023/06/17 ~ 2024/06/16
ISTCW-M-272	Low temperature testing chamber	2022/07/01 ~ 2023/06/30
ISTCW-M-281	Electronic scales	2022/07/18 ~ 2023/07/17
ISTCW-M-295	Halogen acid gas release measuring device	2022/06/21 ~ 2023/06/20
ISTCW-M-306	pH device	2023/08/09 ~ 2023/08/08
ISTCW-M-307	Conductivity device	2023/08/09 ~ 2023/08/08

