Technical Construction File

For

Kaer Technology Co.,Ltd.

Terminal

Model:

SV,RV,FDD,MDD,E,TE,EN,SNB,RNB,DBN,PIN,BN,L-BN,TPT,MPD,FRD,FDFD,PBDD,PTV,DBV,BV,V,LSV,HV,FSV,LBV,ESV,ERV,EFDD,EMDD,EPTV,EDBV,BNY,FLDNY,FDFN,FDFNY,MDFN,MDFNY,SC,JG,GTY,C45,DTG,DTS,OT,DT,DL,GT-G,GL-G,DTL,DTL-2,DTL-5,JG-2,GTL,SC(JGY),SC(JGB),AUS,DIN GTY,DIN DL,JBL,JBT,JB-TL,T/J,CAPG,APG,CCT,CCA,WCJB,JM,JJC,CAU,CAL,CAPTAU,MJPB,MJPT,MJPTN,GPH,LYF

Prepared For : **Kaer Technology Co.,Ltd.**
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Report Number: **TTCF0426-LVD**

Date of Test: **Apr.29, 2024**
Date of Report: **Apr.29, 2024**

TEST REPORT DECLARATION

Applicant : Kaer Technology Co.,Ltd.

Address : No.230, Wei 20th Road, Yueqing Economic Development Zone,
Zhejiang Province, China

Manufacturer : Kaer Technology Co.,Ltd.

Address : No.230, Wei 20th Road, Yueqing Economic Development Zone,
Zhejiang Province, China

EUT Description : Terminal

Model No. : SV

Remark : N/A

Test Procedure Used:

EN IEC 61238-1-1:2019

The results of this test report are only valid for the mentioned equipment under test. The test report with all its sub-reports, e.g. tables, photographs and drawings, is copyrighted. Unauthorized utilization, especially without permission of the test laboratory, is not allowed and punishable. For copying parts of the test report, a written permission by the test laboratory is needed.

The test results of this report relate only to the tested sample identified in this report.

Date of Test : Apr.29, 2024

CHINA CEPREI (SICHUAN) LABORATORY
TESTING SEAL

Prepared by : Jack

(Jack)

Checked by : Gina

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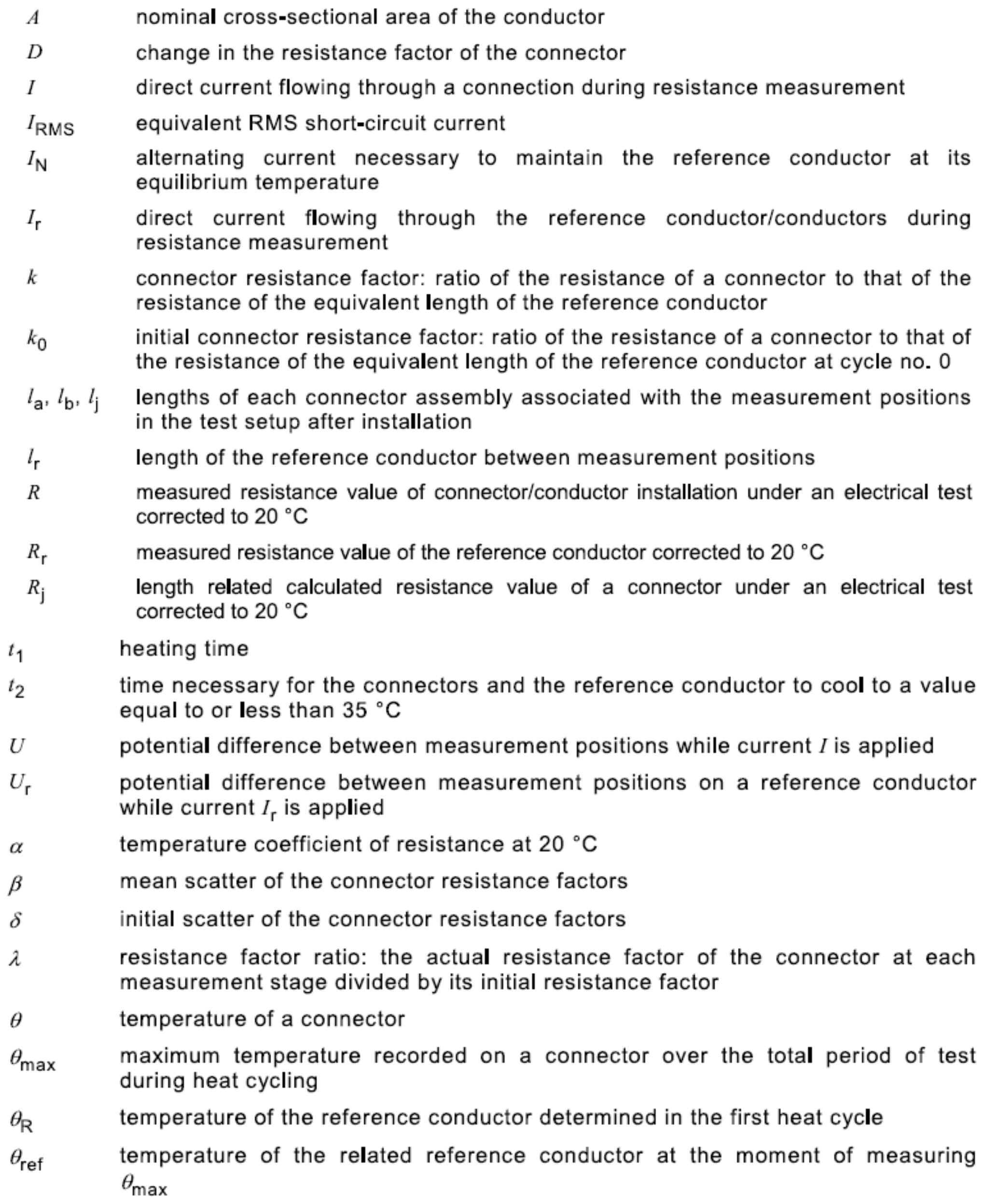
Approved by : Johnson

(Johnson)

EN IEC 61238-1-1:2019

Clause	Requirement-Test	Result-Remark	Verdict
1	Scope		P
	This part of IEC 61 238 applies to compression and mechanical connectors for power cables for rated voltages up to 1 kV (Um = 1 , 2 kV) , for example buried cables or cables installed in buildings, having a) conductors complying with IEC 60228 having nominal cross-sectional areas between 2, 5 mm2 and 1 200 mm2 for copper and between 1 6 mm2 and 1 200 mm2 for aluminium; b) a maximum continuous conductor temperature not exceeding 90 °C. This document is not applicable to connectors for overhead line conductors nor to connectors with a sliding contact. The object of this document is to define the type test methods and requirements which apply to compression and mechanical connectors for power cables with copper or aluminium conductors. The reference method is to perform the tests on unused conductors.		P
2	Normative references		P
	The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.		P
3	Terms and definitions		P
	For the purposes of this document, the terms and definitions given in IEC 60050-461 and the following apply. ISO and IEC maintain terminological databases for use in standardization at the following addresses: • IEC Electropedia: available at http: //www. electropedia.org/ • ISO Online browsing platform: available at http: //www. iso.org/obp		P
4	Symbols		P

EN IEC 61238-1-1:2019			
Clause	**Requirement-Test**	**Result-Remark**	**Verdict**
	 A nominal cross-sectional area of the conductor D change in the resistance factor of the connector I direct current flowing through a connection during resistance measurement I_{RMS} equivalent RMS short-circuit current I_N alternating current necessary to maintain the reference conductor at its equilibrium temperature I_r direct current flowing through the reference conductor/conductors during resistance measurement k connector resistance factor: ratio of the resistance of a connector to that of the resistance of the equivalent length of the reference conductor k_0 initial connector resistance factor: ratio of the resistance of a connector to that of the resistance of the equivalent length of the reference conductor at cycle no. 0 l_a, l_b, l_j lengths of each connector assembly associated with the measurement positions in the test setup after installation l_r length of the reference conductor between measurement positions R measured resistance value of connector/conductor installation under an electrical test corrected to 20 °C R_r measured resistance value of the reference conductor corrected to 20 °C R_j length related calculated resistance value of a connector under an electrical test corrected to 20 °C t_1 heating time t_2 time necessary for the connectors and the reference conductor to cool to a value equal to or less than 35 °C U potential difference between measurement positions while current I is applied U_r potential difference between measurement positions on a reference conductor while current I_r is applied α temperature coefficient of resistance at 20 °C β mean scatter of the connector resistance factors δ initial scatter of the connector resistance factors λ resistance factor ratio: the actual resistance factor of the connector at each measurement stage divided by its initial resistance factor θ temperature of a connector θ_{max} maximum temperature recorded on a connector over the total period of test during heat cycling θ_R temperature of the reference conductor determined in the first heat cycle θ_{ref} temperature of the related reference conductor at the moment of measuring θ_{max}		P
5	General		P
5.1	Definition of classes		P
	Although it is not possible to define precisely the service conditions for all applications, the following requirements have been identified. a) Electrical requirements: Class A These are connectors intended for electricity distribution or industrial networks in which they can be subjected to short-circuits of relatively high intensity and duration. As a consequence, Class A connectors are suitable for the majority of applications. Class B These are connectors for networks in which overloads or short-circuits are rapidly cleared		P

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Clause	**Requirement-Test**	**Result-Remark**	**Verdict**
	by the installed protective devices, for example fast-acting fuses. b) Mechanical requirements: Class 0 Connectors subjected to practically no mechanical pull-out force. These are for example, connectors inside switchgear where the cable or conductors are secured or anchored. Class 1 Connectors subjected to a mechanical pull-out force related to the conductor nominal cross-sectional area and material (according to Table 4) but limited to a 20 kN pull-out force. These are for example connectors for underground cable joints. Class 2 Connectors subjected to a mechanical pull-out force above 20 kN and related to the conductor nominal cross-sectional area and material (according to Table 4). This Class 2 is only applicable to conductor nominal cross-sectional areas ⩾ 400 mm2 for copper and⩾ 630 mm2 for aluminium. These are for example connectors in cable installations where thermomechanical forces are estimated to exceed 20 kN. Hence, the five classes correspond to the following tests: Class A: heat cycling and short-circuit tests; Class B: heat cycling test only; Class 0: no mechanical test; Class 1: mechanical test with limited maximum tensile force; Class 2: mechanical test with no maximum tensile force.		
5.2	Conductor		P
	The following information shall be recorded in the test report: − conductor material ; − nominal cross-sectional area, dimensions and shape; − detail of conductor construction shall be given when known, or can be determined by inspection, for example: • class according to IEC 60228 (solid , stranded and flexible) ; • compacted or non-compacted for stranded conductor; • number and arrangement of strands; • type of plating, if applicable; • type of impregnation, water blocking, etc. , if applicable.		P
5.3	Connectors and installation procedure		P
	The following information shall be recorded in the test report:		P

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Clause	**Requirement-Test**	**Result-Remark**	**Verdict**
	− the assembly method or the installation instruction that is to be used; − tooling, dies and any necessary setting; − if not part of the delivered product, for example at cable conductor termination: bolts, nuts, washers, lubricant, torque, etc. ; − preparation of contact surfaces, if applicable, for example cleaning, brushing and/or greasing of inner and/or outer conductor and/or connector surfaces; − identification of the connector, for example name of the supplier, drawing, reference number, type.		
5.4	Range of approval		P
	In general , tests made on one type of connector/conductor combination apply to that arrangement only. However, to limit the number of tests, when using the same conductor material , the following is permitted: − a connector which can be used on stranded round conductors or on stranded sectorshaped conductors which have been rounded, is approved for both types if satisfactory results are obtained on a compacted round conductor; − a connector which covers a range of consecutive cross-sectional areas shall be approved, if satisfactory results are obtained on the smallest and the largest cross-sectional areas; − if a connector is a through connector for two conductors of different cross-sectional areas, shapes, or materials, and if the jointing method and the connector barrels used have already been tested separately for each cross-sectional area, no additional test is necessary. If not, and if it is required for bimetallic through connectors, additional tests shall be made using the conductor having the highest temperature of the two conductors, as reference conductor; − if a type test for a range taking mechanical connector is passed on the biggest possible conductor cross-sectional area, this result is also valid for similar connector designs with the same material of the connector body but bigger outer diameter provided that the design of the conductor clamping channel (inner diameter, shape, etc.), quantity and design of clamping screws (torque, material , size, shear-off characteristic, etc.) are identical ; − if a manufacturer can clearly demonstrate that common and relevant connector design criteria were used for a family of connectors,		P

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Clause	**Requirement-Test**	**Result-Remark**	**Verdict**
	conformity to this document is achieved by successfully testing the largest, the smallest and two intermediate connector sizes; exception no. 1 : for a family of connectors consisting of five sizes, only the largest connector, the smallest connector, and one connector of a representative intermediate size need to be tested; exception no. 2: for a family of connectors consisting of four sizes or less, only the largest connector and the smallest connector need to be tested; − if conformity to this document is achieved by successfully testing a connector on a dry conductor then approval is achieved for the same conductor used in an impregnated paper insulated cable; − for connectors where one or both sides are designed for a range of cross-sectional areas, and a common clamping or crimping arrangement serves for the connection of the different cross-sectional areas, then mechanical tests on conductors with the largest and smallest cross-sectional areas shall be carried out according to Clause 7 for connectors according to Class 1 or Class 2; − if conformity to this document is achieved by successfully testing a mechanical connector on round stranded aluminium conductors, this type test approval can be applied to solid aluminium conductors of the same cross-sectional area(s) ; − if conformity to this document is achieved by successful testing of a through connector, this type test approval can apply to the barrel of a termination which uses the same design criteria. Approval of the complete termination can be achieved if the termination connection does not influence the barrel performance, proven through design parameters, drawings or through thermal verification tests; − if conformity to this document is achieved by successfully testing a connector on a conductor with water blocking, approval is achieved for the same conductor without any water blocking but not for the same conductor with different types of water blocking ; − if conformity to IEC 61238-1-3 is achieved by successfully testing a connector, approval is achieved for the same classes and conductors in this document.		
6	Electrical tests		P
6.1	Installation		P
	6.1.1 General All conductors of the same nominal cross-sectional area in the test loop shall be taken		P

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Clause	**Requirement-Test**	**Result-Remark**	**Verdict**
	fromthe same conductor length. For each series of tests, six connectors shall be installed in accordance with the manufacturer’s instructions, on a bare conductor or on a conductor that has had the insulation removed before assembly, to form a test loop together with the corresponding reference conductor. For stranded conductors, potential differences between the strands at potential measuring positions can cause errors in measuring electrical resistance. Equalizers according to Annex A shall be used to overcome this problem and to ensure uniform current distribution in the reference conductor and between connectors at the equalizer positions. The recommended method is to prepare equalizers on the test loop before installing connectors. The test loop shall be installed in a location where the air is calm. The ambient temperature of the test location shall be between 1 5 °C and 30 °C. For conductor cross-sectional areas above 1 000 mm2, it is allowed to increase the ambient temperature range of the test location between 1 5 °C and 40 °C. At the end of the cooling phase the ambient temperature shall be between 1 5 °C and 30 °C. In the case of solid conductors, the potential measuring positions shall be as close as possible to the connector in order to reduce la and lb close to zero. The test loop may be of any shape according to Figure 2 or Figure 3 provided that it is arranged in such a way that there is no adverse effect from the floor, walls and ceiling, other test loops and adjacent test branches. To facilitate the short-circuit test for connectors according to Class A, the loop may be disassembled as shown in Figure 2 b) . In this case, the sectioning connections shall not influence the temperatures of the test objects during heating. Retightening of bolts or screws of the connectors under test is not permitted.		
	6. 1 .2 Through connectors and terminations The test loop shown in Figure 2 indicates the dimensions that shall be used. Where terminal lugs or mechanical connectors for terminal bars are to be tested, they shall be bolted to linking bars in accordance with the manufacturer's instructions or other relevant standards/specifications defining methods and instructions for fastening terminations. These		P

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Clause	**Requirement-Test**	**Result-Remark**	**Verdict**
	linking bars shall, at the point of connection, be of the same dimensions and thickness as the palm, and also of the same material. It may be necessary to adjust the thermal characteristics of the linking bar outside the point ofconnection, to achieve the temperatures specified in 6. 3. For terminal lugs, the use of linking bars is the recommended test method although it is alternatively possible to test terminal lugs with palms connected directly to palms. If it is requested that the terminal lug test includes an evaluation of the performance of the bolted palm when connected to a specified plant terminal, then the linking bar method shall be used and the linking bar ends, or an intermediate piece, shall be defined and described in material, size and surface coating.		
	6. 1 .3 Branch connectors When the branch connector is intended for a branch nominal cross-sectional area equal to the main, or a nominal cross-sectional area immediately above or below the main, it is treated as a through connector between the main and the branch, and the test method for through connectors as shown in Figure 2 is applicable. In other cases, the test loop shall be as shown in Figure 3. Where a type of connector makes it necessary for the main conductor to be cut, that part of the connector which acts as a through connector, shall also be tested as for through connectors.		P
6.2	Measurements		P
	6.2. 1 General Measurements shall be made at stages throughout the test according to Table 2.		P
	6.2.2 Electrical resistance measurements The resistance measurements shall be made under steady temperature conditions of both the test loop and test location. The ambient temperature shall be between 1 5 °C and 30 °C. The recommended method is to pass a direct current of up to 1 0 % of the estimated heat cycling current, through the connectors and the reference conductor, without significantly increasing the temperature and to measure the potential difference between two specific potential measuring positions. The ratio of potential difference and direct current is the electrical resistance between those two positions.		P

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Clause	Requirement-Test	Result-Remark	Verdict
	To decrease the uncertainty of the resistance measurement, it is recommended that the direct current is adjusted to the same value throughout the electrical test. For branch conductors assembled in accordance with Figure 4, the whole of the measuring current shall flow through that part of the connector whose potential difference is being measured. Switches or disconnecting terminals may be provided for this purpose. Thermoelectric voltages may affect the uncertainty of low resistance measurements (of theorder of 10 μΩ). If this is suspected, the recommended method is to take two resistance measurements with the direct measuring current reversed between readings. The mean of the two readings is then the actual resistance of the sample. The potential measuring positions shall be as indicated in Figure 4 and Annex B. The various lengths shall be measured individually to enable the actual connector resistances to be determined. The temperature of connector and reference conductor shall be recorded when resistance measurements are made. For direct comparison, the resistance values shall be corrected to 20 °C. Information on the recommended method is also given in Annex B. Temperature measurements at these positions shall be made during the heat cycling test. Indirect resistance readings: － voltage measurements shall have a device uncertainty within ± 0,5 % or ± 10 μV, by taking the greater value; － current measurements shall have a device uncertainty within ± 0,5 % or ± 0,1 A, by taking the greater value. Direct resistance readings: Resistance measurements shall have a device uncertainty within ± 1 % or ± 0,5 μΩ, by taking the greater value when the instrument is calibrated against a certified standard resistance.		
	6.2.3 Temperature measurements Temperatures of both connectors and reference conductors shall be measured at the positions indicated in Figure 4. The recommended method of temperature measurement is to		P

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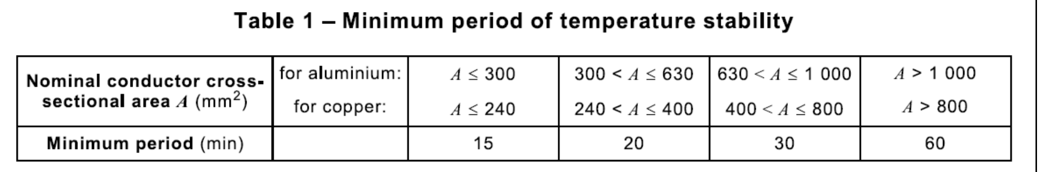
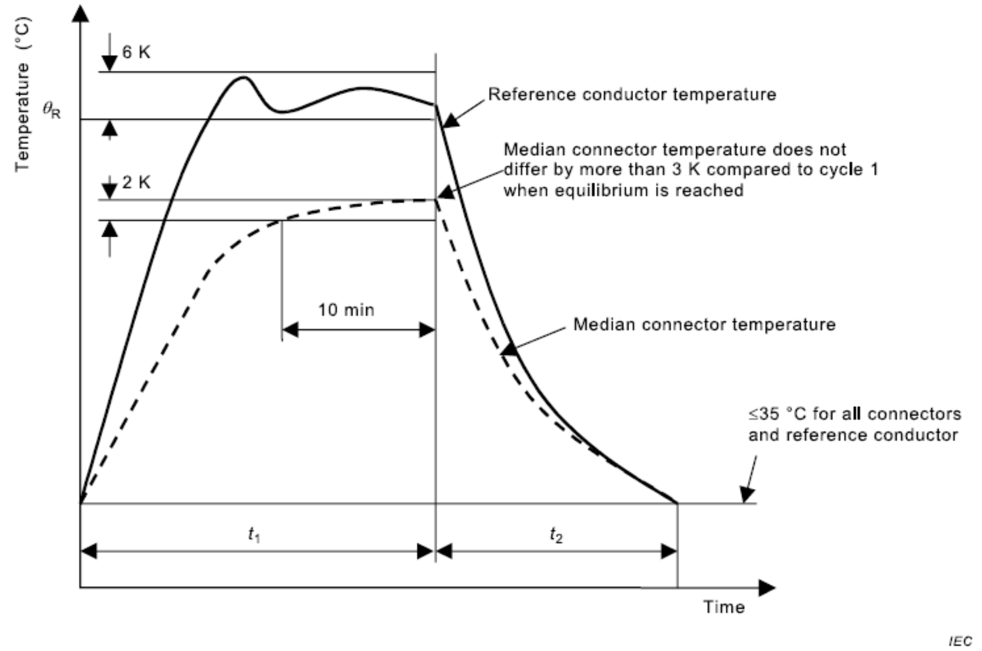
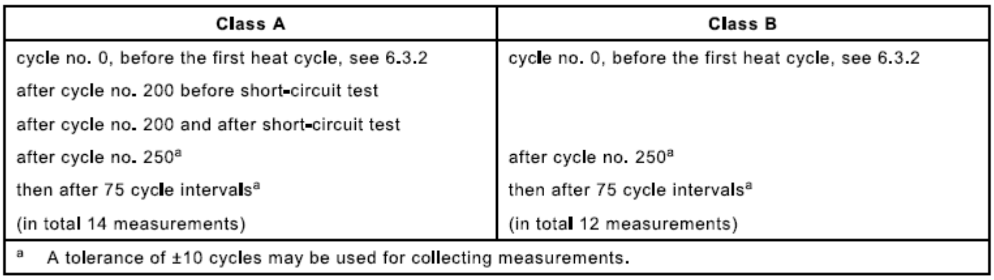
Clause	**Requirement-Test**	**Result-Remark**	**Verdict**
	use thermocouples. The temperature measurements shall have a device uncertainty within±2 K.		
6.3	Heat cycling test		P
	6.3. 1 General The heat cycling test shall be made with alternating current.		P
	6.3.2 First heat cycle The object of the first heat cycle is to determine the reference conductor temperature to be used for subsequent cycles and also to identify the median connector (see 3. 1 2) at equilibrium. Equilibrium is reached when the reference conductor and the connectors do not vary in temperature by more than ± 2 K during application of the heating current. Minimum periods tomaintain temperature stability are defined in Table 1 . a) Through connectors and terminations Current is circulated in the test loop, bringing the reference conductor to 1 20 °C at equilibrium. If the temperature of the median connector is equal to or greater than 1 00 °C, the reference conductor temperature for subsequent heat cycles shall be deemed to be 1 20 °C. If not, then the current shall be increased until the median connector temperature reaches 1 00 °C at equilibrium, subject to the reference conductor temperature not exceeding 1 40 °C. If the temperature of the median connector does not reach 1 00 °C, even with a reference conductor temperature of 1 40 °C, the test shall be continued at that temperature. The measured reference conductor temperature θ R shall then be used for subsequent heat cycles (1 20 °C ⩽ θ R ⩽ 1 40 °C). Where linking bars are used for terminal lugs, the temperature at the midpoint of the bar linking the palms should also be measured . This temperature should be equal to the temperature of the reference conductor θ R, with a tolerance of ±5 K. b) Branch connectors Where it is necessary to use the circuit shown in Figure 3, current shall be circulated in the test loop, bringing the main reference conductor and the three branch reference conductors to 1 20 °C at equilibrium. To achieve this, the currents in the three branches shall be adjusted bycurrent injection or impedance control . If the temperature of the median connector according to definition 3. 1 2 is then equal to or greater than 1 00 °C, the reference conductor temperature		P

<table>
<tr><th colspan="4">EN IEC 61238-1-1:2019</th></tr>
<tr><th>Clause</th><th>Requirement-Test</th><th>Result-Remark</th><th>Verdict</th></tr>
<tr><td></td><td>for subsequent heat cycles shall be deemed to be 120 °C. If not, then the current shall be increased in the loop until the median connector temperature reaches 100 °C at equilibrium, provided the reference conductors do not exceed 140 °C. It may be necessary at this stage,
and also at intervals throughout the test, to adjust the current in an individual branch so as to ensure that each branch reference temperature is the same as the main reference
temperature with a tolerance of ±2 K. The measured reference conductor temperature θR on the main and branch conductors, shall then be used for subsequent heat cycles
(120 °C ⩽ θ R ⩽ 140 °C).</td><td></td><td></td></tr>
<tr><td></td><td colspan="2">
Table 1 – Minimum period of temperature stability
<table>
<tr><td>Nominal conductor cross-sectional area A (mm^2)</td><td>for aluminium:
for copper:</td><td>$A \le 300$
$A \le 240$</td><td>$300 < A \le 630$
$240 < A \le 400$</td><td>$630 < A \le 1\,000$
$400 < A \le 800$</td><td>$A > 1\,000$
$A > 800$</td></tr>
<tr><td>Minimum period (min)</td><td></td><td>15</td><td>20</td><td>30</td><td>60</td></tr>
</table></td><td>P</td></tr>
<tr><td></td><td>6.3.3 Second heat cycle
The object of this second heat cycle is to determine the heat cycle duration and temperature profile which will be used on the test loop for all subsequent heat cycles. Current is circulated
in the loop until the main reference conductor temperature reaches the value θ R determined in 6. 3. 2, with a tolerance of 0+6K and the median connector temperature is stable within a band
of 2 K over a 10 min period and does not differ by more than 3 K compared to the temperature measured during the first heat cycle.
For branch connectors that need to use the circuit shown in Figure 3, current is circulated in
the loop until the branch reference conductor temperature reaches the value θ R determined in 6. 3. 2, with a tolerance of 0+6K and the main reference conductor temperature reaches the value θ R determined in 6.3.2, with a tolerance of 46−+K. The median connector temperature is stable within a band of 2 K over a 10 min period and does not differ by more than 3 K
compared to the temperature measured during the first heat cycle.
At the beginning of the heat cycle, an elevated current up to 150 % of IN may be used as the preferred method, to reduce the heating period.
The current shall thereafter be decreased or regulated to a mean value of the current close to IN to ensure stable conditions during the</td><td></td><td>P</td></tr>
</table>

EN IEC 61238-1-1:2019			
Clause	**Requirement-Test**	**Result-Remark**	**Verdict**
	median-connector control period. It may be necessary to use more than one cycle to determine the second heat cycle. The reference conductor temperature shall be the control parameter, in order to keep the temperature profile during the heat cycling test. In this way, the fluctuation of the ambient temperature will not affect the temperature profile of the reference conductor within the tolerances given in this document. The determined heating profile of the reference conductor containing the characteristics of temperatures during time, as shown in Figure 1 , shall be recorded and reproduced for all subsequent heat cycles. The heating period t1 is followed by a cooling period t2 to bring the temperatures of all connectors and the reference conductor to values ⩽ 35 ° C. It may be necessary in subsequent heat cycles to adjust t2 to ensure that the temperature conditions are reached, in particular during the measurement of resistances in order to respect the conditions of 6. 2. 2. If accelerated cooling is used , it shall act on the whole of the loop, and use air within ambient temperature limits. The total period t1 + t2 constitutes a heat cycle (see Figure 1).		
	 **Figure 1 – Example of second heat cycle profile**		P

<table>
<tr><th colspan="4">EN IEC 61238-1-1:2019</th></tr>
<tr><th>Clause</th><th>Requirement-Test</th><th>Result-Remark</th><th>Verdict</th></tr>
<tr><td></td><td>6.3.4 Subsequent heat cycles
A total of 1 000 heat cycles shall be made according to 6. 3.3. After the cooling period of the
cycles indicated in Table 2, the resistance and temperature of each connector and each reference conductor shall be recorded as described in 6. 2. The maximum temperature of each
connector during the cycle just prior to or following the resistance measurements shall also be recorded.</td><td></td><td>P</td></tr>
<tr><td></td><td>
Table 2 – Electrical resistance measurements during the electrical test
<table>
<tr><th>Class A</th><th>Class B</th></tr>
<tr><td>cycle no. 0, before the first heat cycle, see 6.3.2</td><td>cycle no. 0, before the first heat cycle, see 6.3.2</td></tr>
<tr><td>after cycle no. 200 before short-circuit test</td><td></td></tr>
<tr><td>after cycle no. 200 and after short-circuit test</td><td></td></tr>
<tr><td>after cycle no. 250[a]</td><td>after cycle no. 250[a]</td></tr>
<tr><td>then after 75 cycle intervals[a]</td><td>then after 75 cycle intervals[a]</td></tr>
<tr><td>(in total 14 measurements)</td><td>(in total 12 measurements)</td></tr>
<tr><td colspan="2">[a] A tolerance of ±10 cycles may be used for collecting measurements.</td></tr>
</table></td><td></td><td>P</td></tr>
<tr><td>6.4</td><td>Short-circuit test for connectors according to Class A</td><td></td><td>P</td></tr>
<tr><td></td><td>6.4. 1 General
The short-circuit test shall be made with alternating current.
After finishing 200 heat cycles, six short-circuit currents shall be applied on each connector.
After each short-circuit current application , the test loop shall be cooled to a temperature
⩽ 35 ° C.
The measured initial reference conductor temperature, the current and the duration, as well as the Joule integral of each short-circuit current application shall be recorded in the test
report.
When through connectors are used to connect different conductors in the same test, the conductor with the highest nominal electrical resistance per unit length shall be used as reference conductor.
When branch connectors are used, the short-circuit current shall be applied from the main conductor to the branch conductor for each connector under test.
As stated in 6. 1 . 1 the test loop may be</td><td></td><td>P</td></tr>
</table>

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Clause	**Requirement-Test**	**Result-Remark**	**Verdict**
	disassembled for this test. Since the short-circuit test is intended to reproduce the thermal effects of high currents only, the recommended method is to use a concentric return conductor in order to reduce the electro-dynamic forces. The test arrangements shall be described in the test report. For aluminium conductor nominal cross-sections > 400 mm2 and for copper > 300 mm2, preheating up to 90 °C may be used. However, for nominal cross-sectional areas exceeding 630 mm2 for copper or 1 000 mm2 for aluminium, the defined parameters (45 kA and 5 s) are insufficient to reach 250 °C. When determining the short-circuit current RMS value, a device taking into account the DC component should be used. Alternatively, the determination of I2t can be obtained using the method described in Annex E, noting this method does not take into account the DC component of the current.		
	6.4.2 Aluminium conductors with cross-sectional areas below 1 000 mm2 and copper conductors with cross-sectional areas below 630 mm2 The short-circuit test current level shall be such, that it raises the reference conductor from a temperature ⩽ 35 ° C to a temperature between 250 ° C and 270 ° C. The duration of the short-circuit test current shall be (0 51 0 1,,+−) s with a maximum current of 25 kA. If the required short-circuit test current exceeds this value, a longer duration ⩽ 5 s with a current between 25 kA and 45 kA shall be used. The minimal applicable adiabatic Joule integral I2ADt, which raises the temperature of the reference conductor to 250 °C, shall be calculated according to the formula in Annex D, aswell as the maximum applicable adiabatic		P

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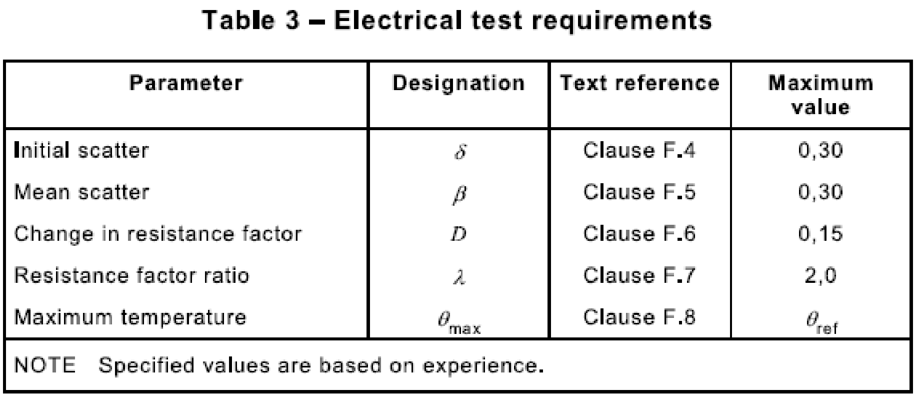
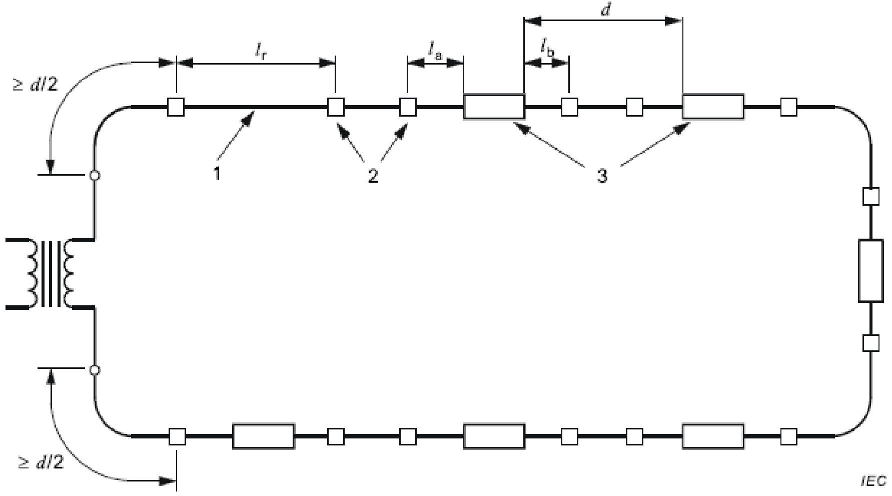
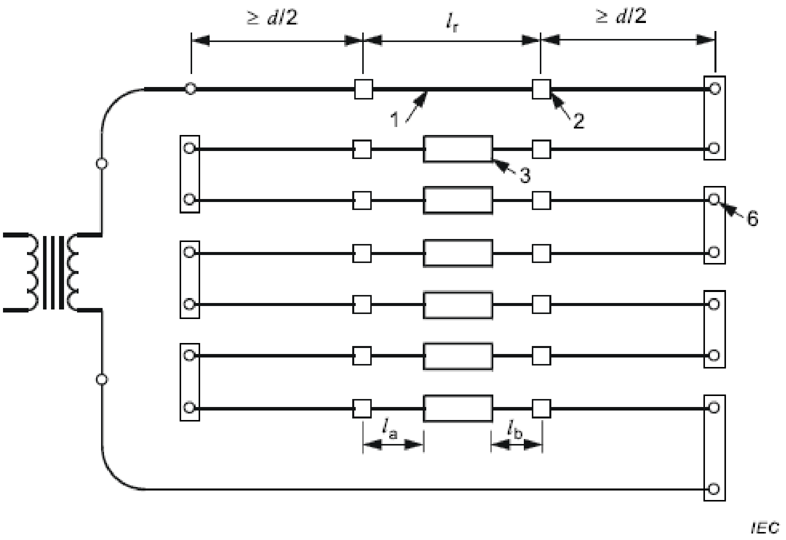
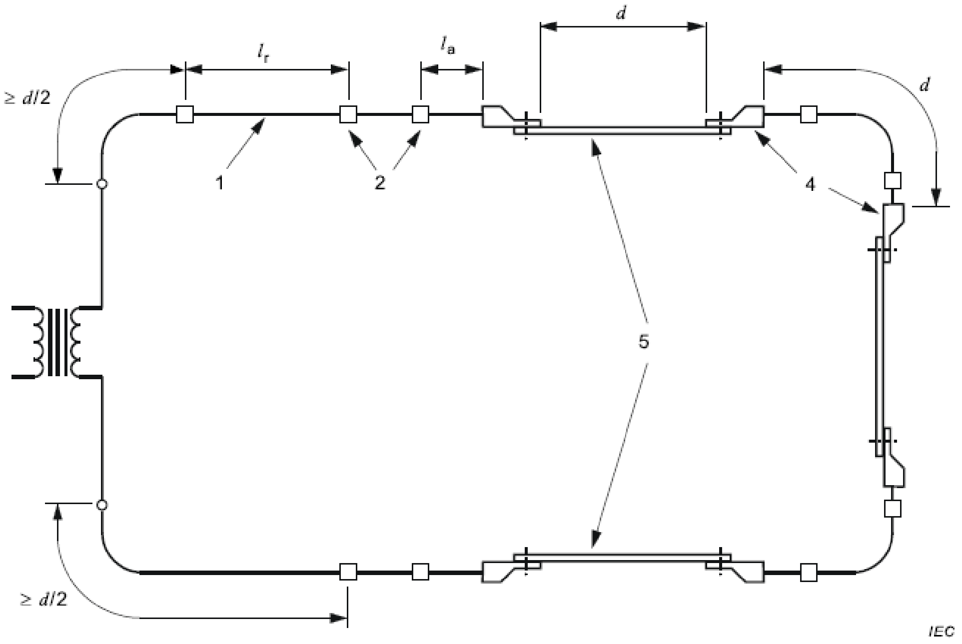
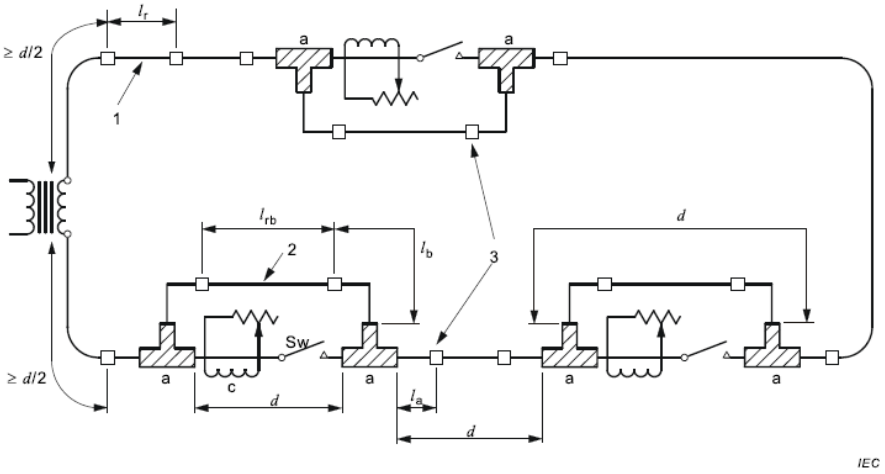
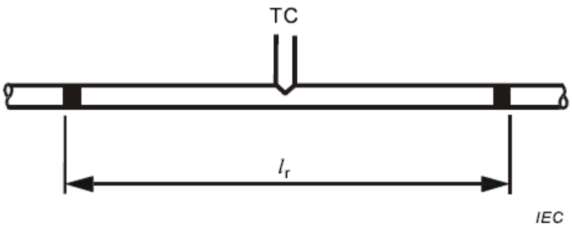
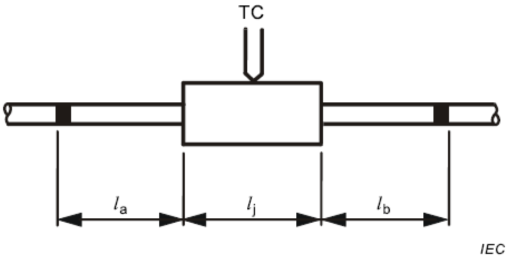
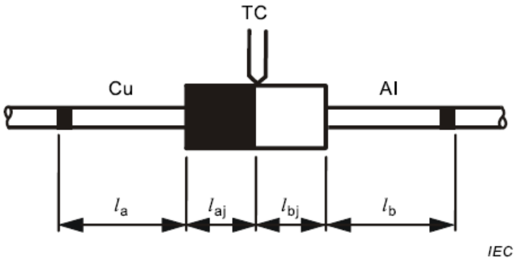
Clause	Requirement-Test	Result-Remark	Verdict
	Joule integral I2ADt necessary to reach a final temperature of 270 °C. The adiabatic Joule integral I2ADt used for each short-circuit current application during the short-circuit test shall be between both previous calculated values of Joule integrals I2ADt.		
	6.4.3 Aluminium conductors with cross-sectional areas ⩾ 1 000 mm2 and copper conductors with cross-sectional areas ⩾ 630 mm2 A short-circuit test current of 45 kA for 5 s shall be applied.		P
6.5	Assessment of results		P
	An individual connector resistance factor k enables a common method of connector assessment to be made over the range of conductor cross-sectional areas applicable to this document. The parameters listed below shall be calculated according to Annex F: a) The connector resistance factor k shall be calculated according to Clause F.3, for each of the six connectors at all the measurement intervals listed in Table 2. b) The initial scatter δ , between the six initial values of k0, measured before heat cycling, shall be calculated according to Clause F.4. c) The mean scatter β , between the six values of k, averaged over the last 11 measurement intervals, shall be calculated according to Clause F.5. d) The change in resistance factor D for each of the six connectors shall be calculated according to Clause F. 6. D is the change in the value of k taken over the last 11 measurement intervals, calculated as a fraction of the mean value of k in this interval ; e) The resistance factor ratio λ shall be calculated according to Clause F. 7. f) The maximum temperature θmax on each connector shall be recorded according to Clause F.8.		P
6.6	Requirements		P

<table>
<tr><th colspan="4">EN IEC 61238-1-1:2019</th></tr>
<tr><th>Clause</th><th>Requirement-Test</th><th>Result-Remark</th><th>Verdict</th></tr>
<tr><td></td><td>The six connectors shal l satisfy the requi rements shown in Table 3. I f one connector out of the six does not satisfy one or more of the requi rements, a re-test may be carried out. I n this event, al l six new connectors shal l satisfy the requi rements.
I f more than one connector out of the six do not satisfy one or more of the requi rements, no re-test is permi tted and the type of connector shal l be deemed as not conforming to this document.</td><td></td><td>P</td></tr>
<tr><td></td><td colspan="2">
Table 3 – Electrical test requirements
<table>
<tr><th>Parameter</th><th>Designation</th><th>Text reference</th><th>Maximum value</th></tr>
<tr><td>Initial scatter</td><td>δ</td><td>Clause F.4</td><td>0,30</td></tr>
<tr><td>Mean scatter</td><td>β</td><td>Clause F.5</td><td>0,30</td></tr>
<tr><td>Change in resistance factor</td><td>D</td><td>Clause F.6</td><td>0,15</td></tr>
<tr><td>Resistance factor ratio</td><td>λ</td><td>Clause F.7</td><td>2,0</td></tr>
<tr><td>Maximum temperature</td><td>θ_{max}</td><td>Clause F.8</td><td>θ_{ref}</td></tr>
<tr><td colspan="4">NOTE Specified values are based on experience.</td></tr>
</table></td><td>P</td></tr>
<tr><td>6.7</td><td>Examples of electrical test loop configurations and associated parameters</td><td></td><td>P</td></tr>
<tr><td></td><td>See Figures 2, 3 and 4.</td><td></td><td>P</td></tr>
<tr><td></td><td colspan="2">

a) Through connectors – principle test loop</td><td>P</td></tr>
</table>

EN IEC 61238-1-1:2019			
Clause	**Requirement-Test**	**Result-Remark**	**Verdict**
	 **b) Through connectors with separable sections according to 6.1.1**		P
	 **c) Terminal lugs – principle test loop**		P
	where: $d \geq 80\sqrt{A}$ or 500 mm, whichever is the greater A is the corresponding conductor nominal cross-sectional area, in mm^2 $l_r \geq l_a + l_b + l_j$ (for l_j, see Figure 4) For stranded conductors: l_a, $l_b \approx 15\sqrt{A}$ or 150 mm, whichever is the greater **Key** 1 reference conductor 2 equalizers (for stranded conductors) 3 through connectors 4 terminal lugs 5 linking bars 6 disconnecting terminals **Figure 2 – Typical electrical test loops for through connectors and terminal lugs**		P

EN IEC 61238-1-1:2019			
Clause	**Requirement-Test**	**Result-Remark**	**Verdict**
	 where: $d \geq 80\sqrt{A}$ or 500 mm, whichever is the greater A is the main conductor cross-sectional area, in mm^2 l_r, $l_{rb} \geq l_a + l_b + l_j$ (for l_j, see Figure 4) For stranded conductors: l_a, $l_b \approx 15\sqrt{A}$ or 150 mm, whichever is the greater **Key** 1 main reference conductor 2 branch reference conductor 3 equalizer (for stranded conductors) a branch connector c current control Sw switch (for branch resistance measurement) a distance of d/2 between switch and connectors should be used **Figure 3 – Typical electrical test loop for branch connectors**		P
	 Formula: $R_r = \frac{U_r}{I_r} \times \frac{1}{1+\alpha(\theta_r - 20)}$ **a) Reference conductor**		P
	 Formulas: $R_j = R - R_r \times \frac{(l_a + l_b)}{l_r}$ $k = \frac{R_j}{R_r} \times \frac{l_r}{l_j}$ Reference: same conductor on both sides **b) Through connector**		P

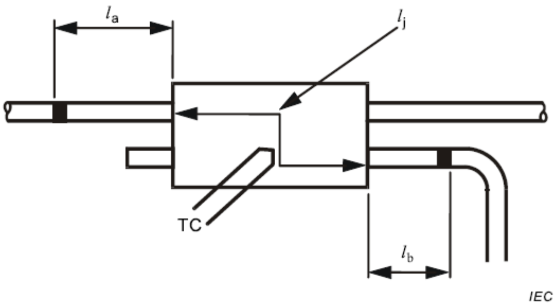
<table>
<tr><th colspan="4">EN IEC 61238-1-1:2019</th></tr>
<tr><th>Clause</th><th>Requirement-Test</th><th>Result-Remark</th><th>Verdict</th></tr>
<tr><td></td><td colspan="2">


Formulas:

$$R_j = R - \left(\frac{R_r\text{Cu}}{l_r\text{Cu}}\times l_a + \frac{R_r\text{Al}}{l_r\text{Al}}\times l_b\right)$$

$$k = \frac{R_j}{\frac{R_r\text{Cu}}{l_r\text{Cu}}\times l_{aj} + \frac{R_r\text{Al}}{l_r\text{Al}}\times l_{bj}}$$

References: copper and aluminium conductors

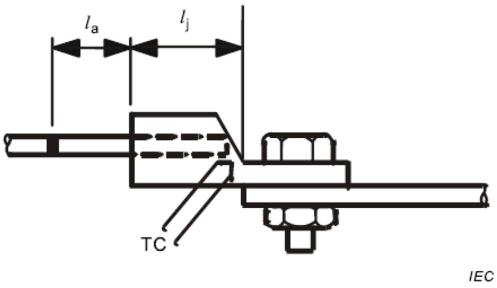
c) **Bimetallic through connector**
</td><td>P</td></tr>
<tr><td></td><td colspan="2">


Formulas:

$$R_j = R - \left(\frac{R_r\text{main}}{l_r\text{main}}\times l_a + \frac{R_r\text{branch}}{l_r\text{branch}}\times l_b\right)$$

$$k = \frac{R_j}{R_r\text{branch}}\times\frac{l_r\text{branch}}{l_j}$$

References: main and branch conductors

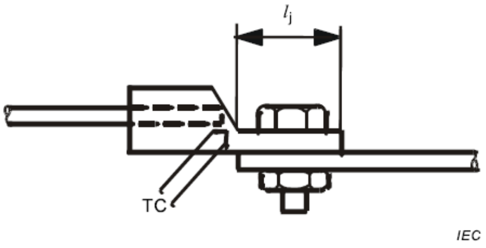
d) **Branch connector**
</td><td>P</td></tr>
<tr><td></td><td colspan="2">


Formulas:

$$R_j = R - R_r \times \frac{l_a}{l_r}$$

$$k = \frac{R_j}{R_r}\times\frac{l_r}{l_j}$$

Reference: conductor

e) **Barrel of terminal lug**
</td><td>P</td></tr>
<tr><td></td><td colspan="2">


Formulas:

$$R_j = R$$

$$k = \frac{R_j}{R_r}\times\frac{l_r}{l_j}$$

Reference: conductor

f) **Palm of terminal lug**
</td><td>P</td></tr>
</table>

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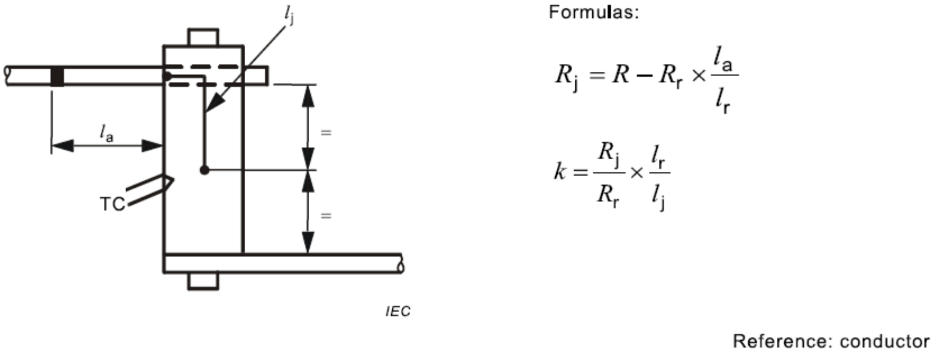
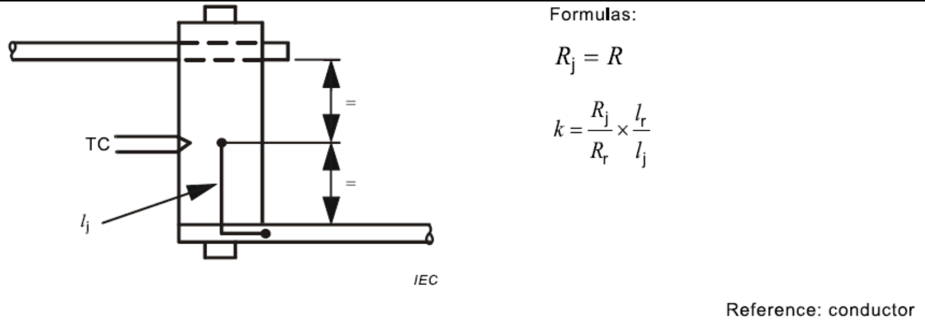
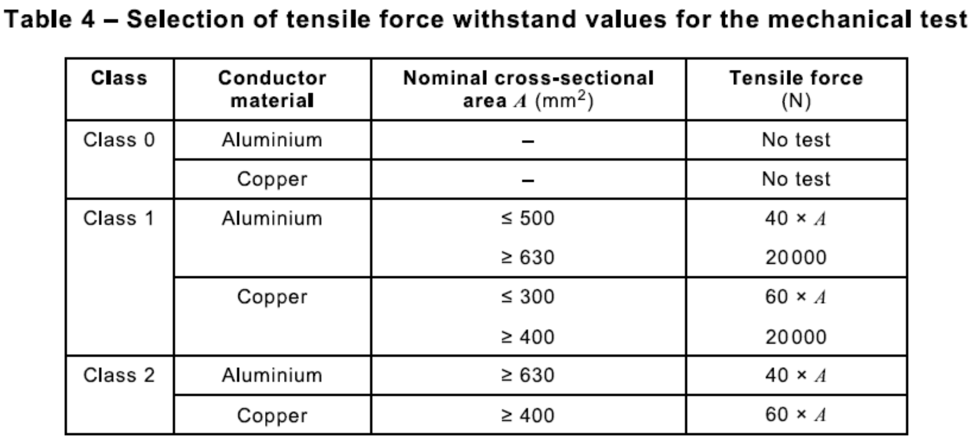
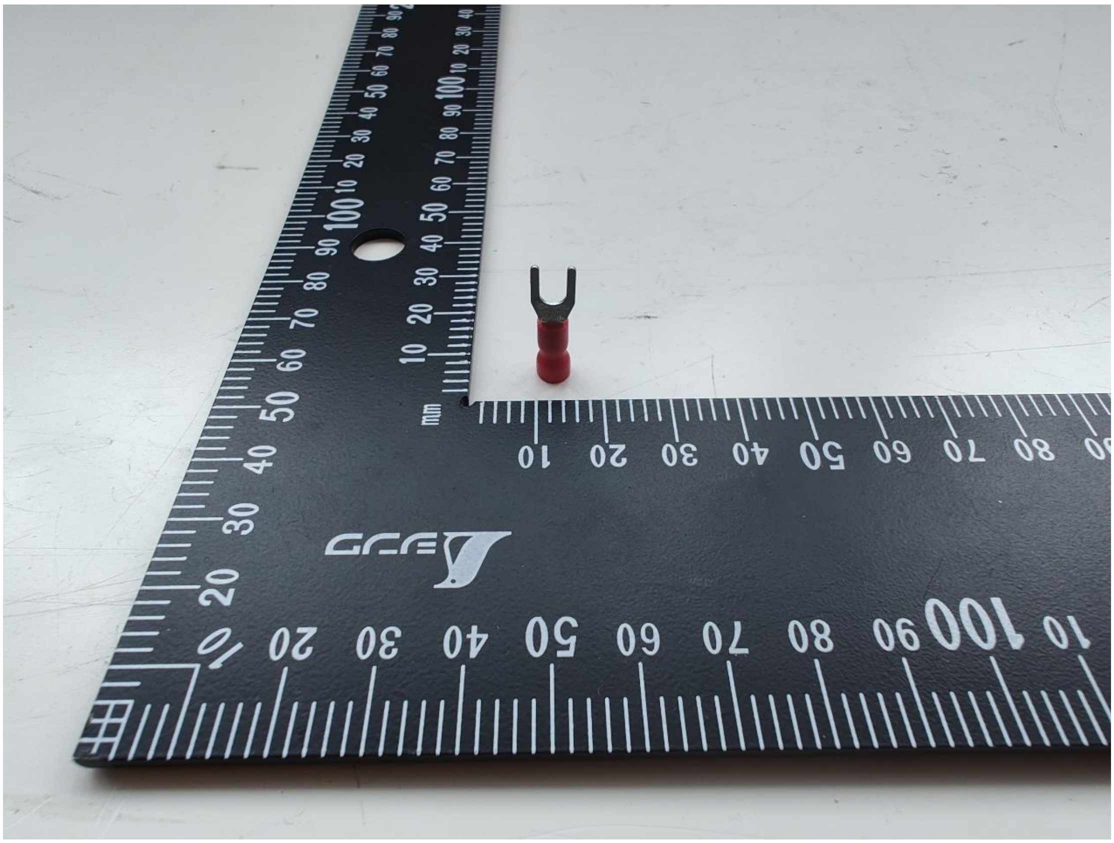
Clause	Requirement-Test	Result-Remark	Verdict
	 Formulas: $R_j = R - R_r \times \frac{l_a}{l_r}$ $k = \frac{R_j}{R_r} \times \frac{l_r}{l_j}$ g) Connection to the conductor for a mechanical connector		P
	 Formulas: $R_j = R$ $k = \frac{R_j}{R_r} \times \frac{l_r}{l_j}$ h) Connection to a terminal bar for a mechanical connector **Key** TC = Temperature measurement positions **Figure 4 – Typical cases of resistance measurements**		P
7	Mechanical test		P
7.1	General		P
	The purpose of this test is to ensure an acceptable mechanical strength for the connections to the conductors of power cables.		P
7.2	Method		P
	The test shall be made on three additional connectors having the same combination of conductors and installation procedure as used for the electrical test. The recommended conductor length between connectors or between connector and tensile test machine jaws is ⩾ 500 mm. The rate of application of the load shall not exceed 10 N per square millimeter of nominal cross-sectional area and per second up to 25 % of the value in Table 4 in order to mark the conductor relatively to the connector, then up to the value in Table 4, which is then maintained for 1 min. The applicable tolerance for applying the		P

<table>
<tr><th colspan="4">EN IEC 61238-1-1:2019</th></tr>
<tr><th>Clause</th><th>Requirement-Test</th><th>Result-Remark</th><th>Verdict</th></tr>
<tr><td></td><td>mechanical load shall be within ± 5 %.
When the axes of two conductors are not aligned, the connector shall be fixed and the force
applied in the axis of the clamping channel on each conductor core. One sample of connector shall be used per tensile test.
For example for a branch connector as shown in Figure 4 d) , six connectors are needed , three samples are required for testing the main conductor and three samples for the branch conductor.
If the connector is tested electrically for conductors of different nominal cross-sectional area,
three connectors shall be tested individually with the same conductor as used in the electrical test, in accordance with Table 4.</td><td></td><td></td></tr>
<tr><td></td><td colspan="2">
Table 4 – Selection of tensile force withstand values for the mechanical test
<table>
<tr><th>Class</th><th>Conductor material</th><th>Nominal cross-sectional area A (mm^2)</th><th>Tensile force (N)</th></tr>
<tr><td>Class 0</td><td>Aluminium</td><td>–</td><td>No test</td></tr>
<tr><td></td><td>Copper</td><td>–</td><td>No test</td></tr>
<tr><td>Class 1</td><td>Aluminium</td><td>≤ 500</td><td>40 × A</td></tr>
<tr><td></td><td></td><td>≥ 630</td><td>20000</td></tr>
<tr><td></td><td>Copper</td><td>≤ 300</td><td>60 × A</td></tr>
<tr><td></td><td></td><td>≥ 400</td><td>20000</td></tr>
<tr><td>Class 2</td><td>Aluminium</td><td>≥ 630</td><td>40 × A</td></tr>
<tr><td></td><td>Copper</td><td>≥ 400</td><td>60 × A</td></tr>
</table></td><td>P</td></tr>
<tr><td>7.3</td><td>Requirements</td><td></td><td>P</td></tr>
<tr><td></td><td>Not more than 3 mm slippage shall occur during the last minute of the test.</td><td></td><td>P</td></tr>
<tr><td>8</td><td>Test reports</td><td></td><td>P</td></tr>
<tr><td>8.1</td><td>General</td><td></td><td>P</td></tr>
<tr><td></td><td>The type test results according to this document may be presented in separate test reports.</td><td></td><td>P</td></tr>
<tr><td>8.2</td><td>Electrical tests</td><td></td><td>P</td></tr>
<tr><td></td><td>The test report shall include the following information:
－ connector class (see 5. 1) ;
－ conductor used (see 5. 2) ;
－ connector and installation procedure (see 5. 3);</td><td></td><td>P</td></tr>
</table>

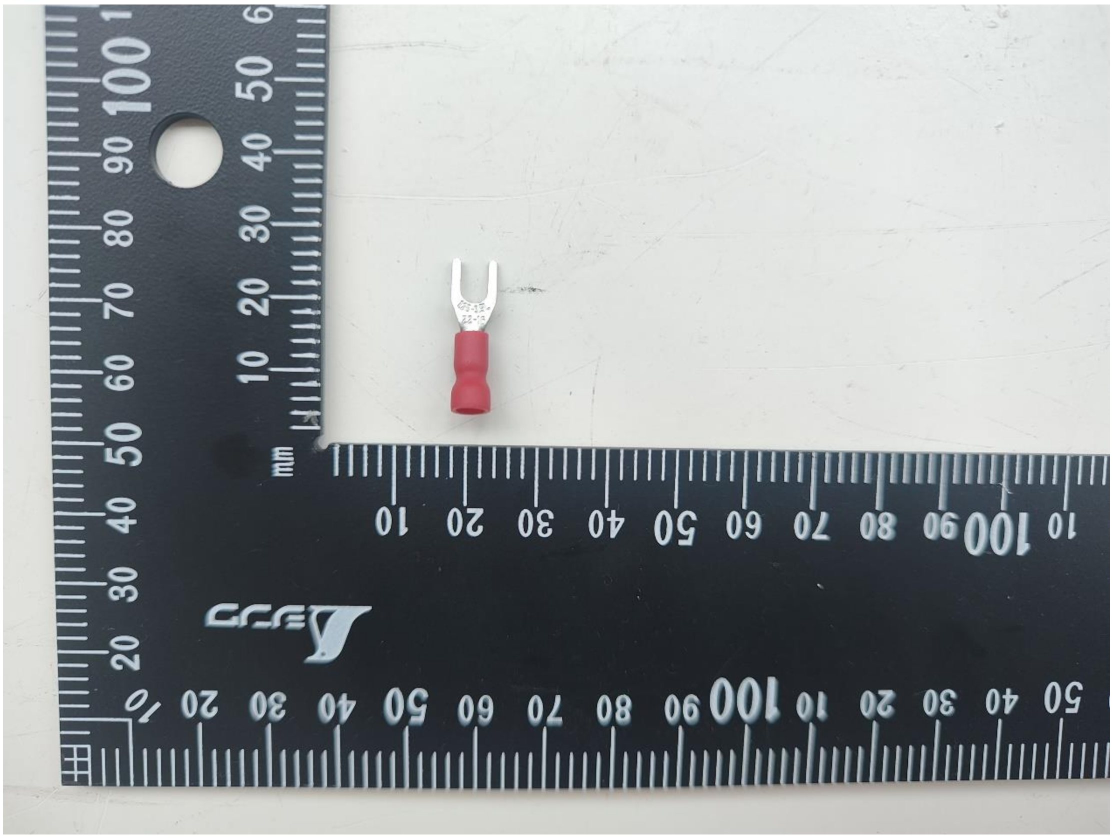
EN IEC 61238-1-1:2019			
Clause	**Requirement-Test**	**Result-Remark**	**Verdict**
	− installation for example in the case of terminations, where bolted connections are not supplied and not described by the manufacturer, for example palms of cable lugs, where additional information shall be given about material , surface and lubrication of used bolts, nuts, washers and applied torques; − temperature measurement method (see 6. 2. 3) ; − current IN at equilibrium temperature (see 6. 3. 2) ; − for Class A the short-circuit test parameters (see 6. 4); − test loop configuration; − values and graph of the connector resistance factor k versus the cycle number (see 6. 5) ; − values and graph of the maximum temperatures versus the cycle number (see 6. 3. 4); − results of the electrical test (see Table 3) . It is advisable to show a graph of the temperature profile of the second cycle (see 6. 3. 3) .		
8.3	Mechanical test		P
	The test report shall include the following information: − connector class (see 5. 1) ; − conductor used (see 5. 2) ; − connector and installation procedure (see 5. 3); − results of the mechanical test. Provided by IHS Markit under license with IEC		P

Annex：Technical Information

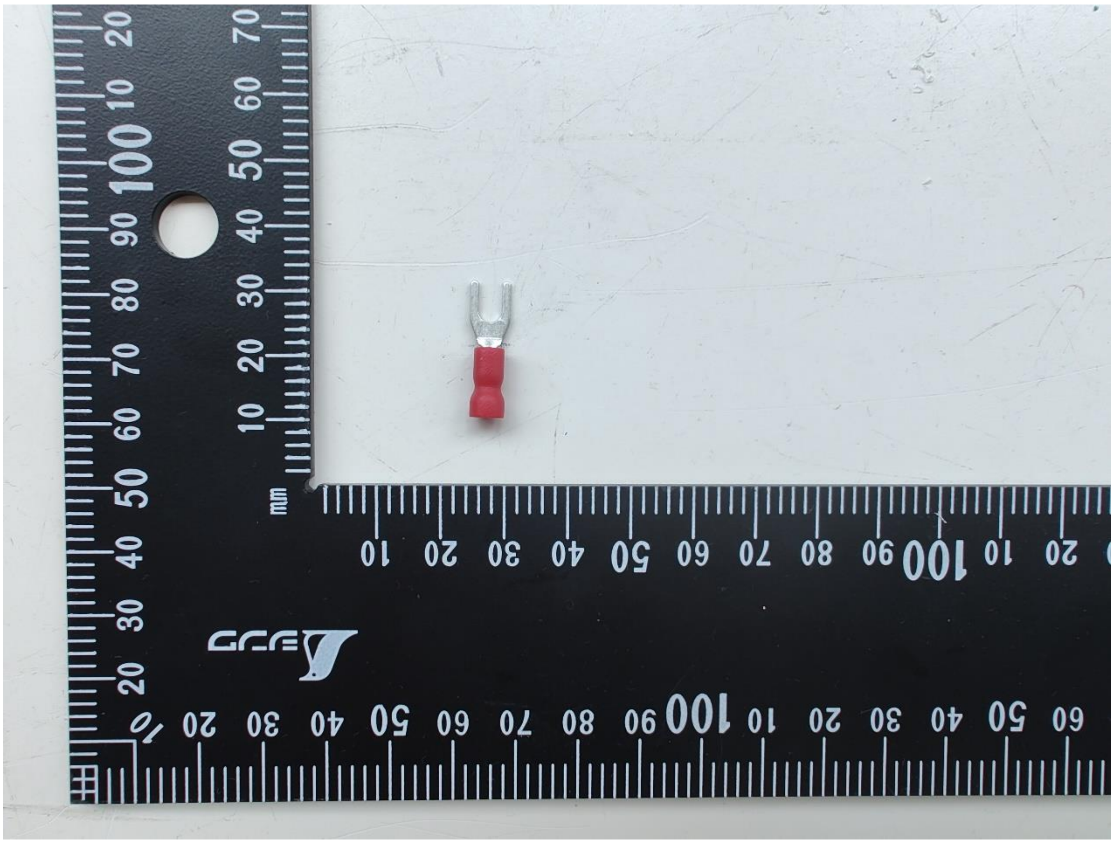
(1) Product Photos



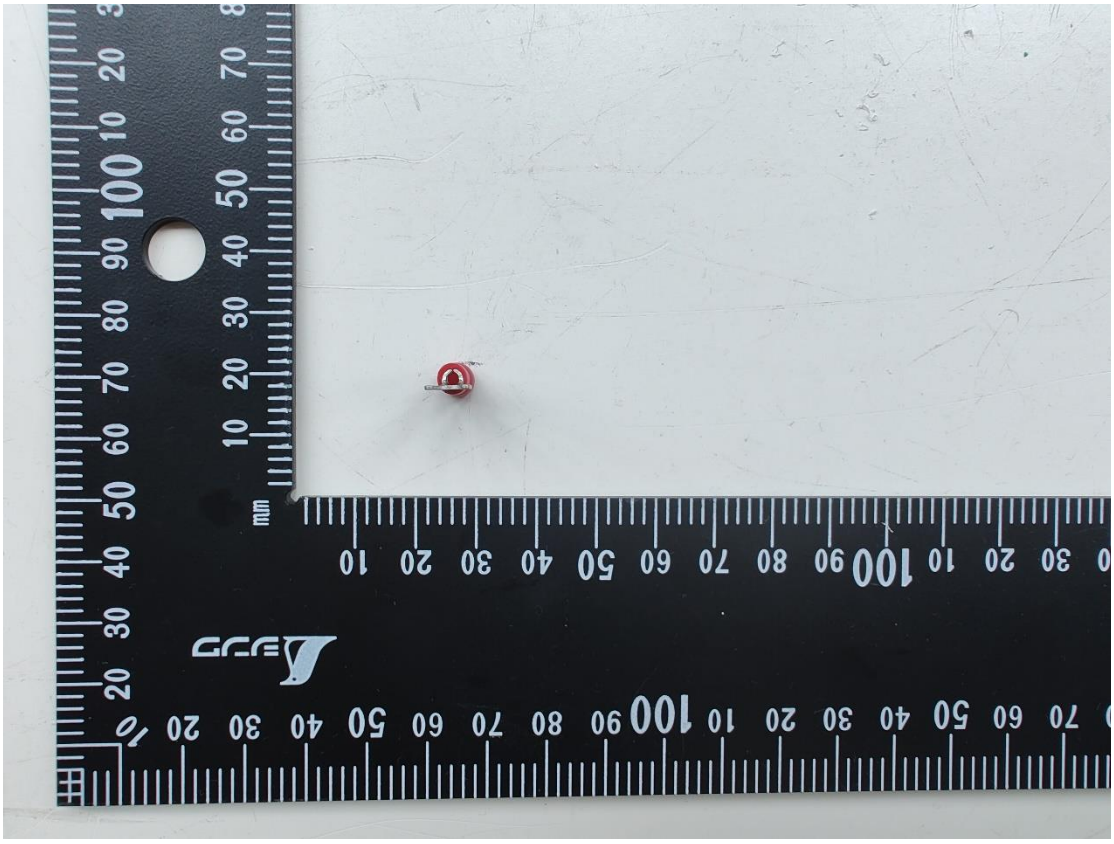
A.1



A.2



A.3



A.4