

**Test requirements for low voltage aerial bundled cable accessories -  
Part 2: Tension and suspension clamps for self supporting system**

Prescriptions relatives aux essais  
des accessoires pour réseaux aériens  
basse tension torsadés -  
Partie 2: Matériels d'ancrage  
et de suspension pour réseaux aériens  
en conducteurs isolés torsadés auto-portés

Prüfanforderungen für Bauteile für isolierte  
Niederspannungsfreileitungen -  
Teil 2: Abspann- und Tragklemmen  
für selbsttragende isolierte Freileitungsseile

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**CENELEC**

European Committee for Electrotechnical Standardization  
Comité Européen de Normalisation Electrotechnique  
Europäisches Komitee für Elektrotechnische Normung

**Central Secretariat: avenue Marnix 17, B - 1000 Brussels**

## Foreword

This European Standard was prepared by a sub-group of WG 11 of the Technical Committee CENELEC TC 20, Electric cables.

The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 50483-2 on 2008-12-01.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2009-12-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2011-12-01

This is Part 2 of CENELEC standard EN 50483 “*Test requirements for low voltage aerial bundled cable accessories*”, which has six parts:

- Part 1: Generalities;
  - Part 2: Tension and suspension clamps for self supporting system;
  - Part 3: Tension and suspension clamps for neutral messenger system;
  - Part 4: Connectors;
  - Part 5: Electrical ageing test;
  - Part 6: Environmental testing.
-

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## 1 Scope

EN 50483 series applies to overhead line fittings for tensioning, supporting and connecting aerial bundled cables (ABC) of rated voltage  $U_0/U (U_m)$ : 0,6/1 (1,2) kV.

This Part 2 applies to tensioning devices consisting of tension and suspension clamps designed to be used for installation of self supporting ABC defined in HD 626.

Tests described in this document are type tests.

NOTE This European standard does not invalidate existing approvals of products achieved on the basis of national standards and specifications and/or the demonstration of satisfactory service performance. However, products approved according to such national standards or specifications cannot directly claim approval to this European Standard. It may be possible, subject to agreement between supplier and purchaser, and/or the relevant conformity assessment body, to demonstrate that conformity to the earlier standard can be used to claim conformity to this standard, provided an assessment is made of any additional type testing that may need to be carried out. Any such additional testing that is part of a sequence of testing cannot be done separately.

## 2 Normative references

The following referenced documents are indispensable for the application 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.

EN 50483 series, *Test requirements for low voltage aerial bundled cable accessories*

HD 626, *Overhead distribution cables of rated voltage  $U_0/U(U_m)$ : 0,6/1 (1,2) kV*

IEC 60050-461, *International Electrotechnical Vocabulary (IEV) – Part 461: Electric cables*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-461 and the following apply.

### 3.1

#### **aerial bundled cable (ABC)**

aerial cable consisting of a group of insulated conductors which are twisted together including, or not, a non insulated conductor

[IEV 461-08-02, modified]

NOTE The terms bundled conductors, bundled cables, bundled cores, conductor bundles and bundle could be used as equivalent to the term aerial bundled cable (ABC).

### 3.2

#### **aerial-insulated-cable**

insulated cable designed to be suspended overhead and outdoors

[IEV 461-08-01]

### 3.3

#### **angle of deviation**

complementary angle to the angle defined by the two parts of the cable on both sides of the suspension clamp

**3.4**

**clamp bolt**

bolt which tightens two parts of a clamp together

**3.5**

**conductor insulation**

insulation applied on a conductor  
[IEV 461-02-02, modified]

**3.6**

**conductor (of a cable)**

part of a cable which has the specific function of carrying current  
[IEV 461-01-01]

**3.7**

**core**

assembly comprising conductor and its own insulation  
[IEV 461-04-04, modified]

**3.8**

**fixture (or fitting)**

device for attaching ABC tension or/and suspension clamps to a pole or to a wall

**3.9**

**insulation (of a cable)**

insulating materials incorporated in a cable with the specific function of withstanding voltage  
[IEV 461-02-01]

**3.10**

**minimum breaking load (MBL)**

minimum breaking load of the conductor given by HD 626 or the cable manufacturer if not defined in the standard, or minimum breaking load of the clamp given by the clamp manufacturer

**3.11**

**self supporting system**

aerial insulated system where all the cores of the ABC contribute to its support

**3.12**

**sheath**

uniform and continuous tubular covering of metallic or non metallic material, generally extruded  
[IEV 461-05-03]

**3.13**

**suspension clamp**

device which attaches an aerial insulated cable to a fixture in order to carry its weight and any specified loading  
[IEV 461-18-02, modified]

**3.14**

**tension clamp**

device which firmly attaches an aerial insulated cable to a fixture and is designed to transmit the specified mechanical tension in the cable or messenger to the supporting structure  
[IEV 461-18-01, modified]

### 3.15

#### **type test**

test required to be made before supplying a type of material covered by this standard on a general commercial basis, in order to demonstrate satisfactory performance characteristics to meet the intended application

NOTE These tests are of such a nature that, after they have been made, they need not be repeated unless changes are made to the accessory materials, design or type of manufacturing process which might change the performance characteristics.

## 4 Symbols

$g_{15}$  slippage after 15 cycles

$g_{250}$  slippage after 250 cycles

$D$  circumscribed diameter of conductor bundle (mm)

$\rho$  resistivity ( $\Omega\text{m}$ )

$\alpha$  maximum angle ( $^{\circ}$ ) of deviation of a suspension clamp as recommended by the manufacturer or specified by the customer

$T$  tension (N)

$F$  sliding force (N)

## 5 Characteristics

These fittings shall be capable of supporting the tensile loads applied to the ABC for which they are designed in accordance with the following tests.

Tension and suspension equipment shall be designed to avoid any direct or accidental contact between conductors and between any phase and metallic parts of the clamp.

## 6 Marking

See Clause 6 of EN 50483-1.

## 7 General test conditions

### 7.1 Mechanical tests

See Clause 9 of EN 50483-1.

### 7.2 Temperature

See Clause 9 of EN 50483-1.

## 8 Type tests

### 8.1 Type tests for tension clamps

The performance characteristics of all tension clamps shall be proven by satisfactorily undergoing the range of tests listed below. Each clamp shall be tested for the smallest and largest bundled conductor size for which it is marked.

The following type tests shall be carried out.

Test	Subclause
Tensile test at ambient temperature	8.1.1
Breaking load test	8.1.2
Tensile test at high temperature	8.1.3
Tensile test at low temperature	8.1.4
Dielectrical voltage test (clamp)	8.3.1
Dielectrical voltage test (ABC)	8.3.2
Clamp bolt tightening test	8.4
Environmental tests	8.5

NOTE The test procedures for 3 core and 4 core ABC are similar.

#### 8.1.1 Tensile test at ambient temperature

##### 8.1.1.1 Principle

The tension clamps shall be subjected to high mechanical loads at ambient temperature in order to ensure that they are capable of sustaining loads likely to be encountered in service without being damaged or damaging the conductor.

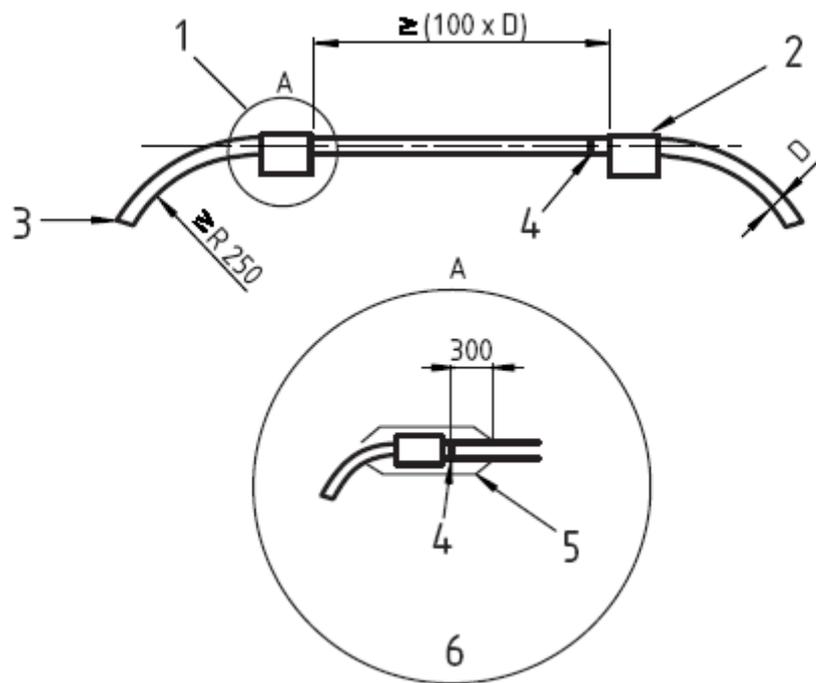
NOTE Test may be carried out on samples which have been subjected to the climatic ageing test or on the cores (see 8.5.2.1)

##### 8.1.1.2 Test arrangement

Two tension clamps shall be assembled on to the ABC, in accordance with the manufacturer's instructions, and fitted into a tensile testing machine as shown in Figure 1. The length of tails on the unloaded side of the clamps shall be a minimum of 350 mm and with a minimum radius of 250 mm.

The span between the two clamps shall be a minimum of  $100 \times D$ , where  $D$  is the circumscribed diameter of the ABC.

The test shall be carried out at ambient temperature.

**Key**

1	tension clamp	4	marking
2	second tension clamp undergoing test	5	low temperature zone
3	length of tail $\geq 350$ mm	6	arrangement for low temperature testing

**Figure 1 – Tension clamps – Tensile tests****8.1.1.3 Procedure**

The tensile load shall be applied within 15 min of the clamp being assembled on to the ABC.

The load shall be increased to 20 % of MBL of the cable, and the cores shall be marked where they exit the clamps. The load shall be maintained at that value  $\pm 10$  % for 6 h.

NOTE 1 A reduced time period may be agreed between customer and manufacturer.

The load shall then be increased to a limit of 80 % of the MBL of the cable for ABC sizes up to, and including, 95 mm<sup>2</sup>. For conductor cross sections above 95 mm<sup>2</sup> the load shall be reduced to a limit of 60 % of the MBL of the cable. This load shall be held for 60 s before the load is removed.

NOTE 2 When a clamp of a different rating is needed the clamp may be tested according to the value agreed by the manufacturer and the customer.

**8.1.1.4 Requirements**

No damage shall occur, which would affect the correct function of the tension clamp.

Slippage of the cores of the cable with respect to the clamp parts when in contact shall not exceed 10 mm.

The clamp shall pass the dielectrical voltage test detailed in 8.3.1.

The cable shall pass the dielectrical voltage test detailed in 8.3.2.

### **8.1.2 Breaking load test (optional)**

NOTE This test may be carried out on samples which have previously been subjected to the corrosion ageing test (8.5.1). In this case it is not necessary to carry out the test before the corrosion test.

#### **8.1.2.1 Principle**

The tension clamps shall be subjected to increasing mechanical loads, at ambient temperature, in order to ensure that they do not break before loads equal to or greater than the MBL of the maximum ABC size, for which the clamp is designed, are reached.

#### **8.1.2.2 Test arrangement**

Two tension clamps shall be assembled in accordance with the manufacturer's instructions on a simulated ABC made of metallic round bars or a suitable conductor of the same diameter as the ABC core and fitted into a tensile testing machine as shown in Figure 1.

To avoid any slippage between bars and the clamps, fixed stops may be used on the bars.

The test shall be carried out at ambient temperature.

#### **8.1.2.3 Procedure**

The tensile load shall be applied within 15 min of the clamp being assembled.

The load shall be increased to the MBL of the largest size of ABC core for which the clamp is designed. It shall be maintained at this load for 60 s.

The load shall then be increased until the breaking of the tension clamp occurs.

NOTE 1 When requested by the customer a different load may be increased to the MBL of the clamp given by the manufacturer to check the breaking load of the clamp.

The clamps shall not be tightened or adjusted during the test.

NOTE 2 The failure value may be noted for information.

#### **8.1.2.4 Requirements**

Neither tension clamp shall break until the test load has been held for 60 s and the MBL of the cable is reached.

### **8.1.3 Tensile test at high temperature**

#### **8.1.3.1 Principle**

The tension clamps shall be subjected to steady load, whilst the cable temperature is varied. The test shall be carried out in order to ensure that the cable does not slip through the clamp and that the clamp and the cable remain undamaged.

NOTE When a clamp of lower rating is required, for example a service clamp, this test may be omitted when agreed between the customer and manufacturer.

### 8.1.3.2 Test arrangement

Two tension clamps shall be assembled on to the ABC in accordance with the manufacturer's instructions and fitted into a tensile testing machine as shown in Figure 1.

The span between the two clamps shall be a minimum of  $100 \times D$ , where  $D$  is the circumscribed diameter of the ABC.

The test shall be carried out with a static load, which shall be found from Table 1.

**Table 1 – Static loads**

Number of cores in the ABC	Tension load ( $T$ ) for the tensile test at high temperature
2	18 % of the ABC MBL
4	20 % of the ABC MBL
NOTE When a clamp of lower rating is needed, the clamp may be tested according to another value agreed between the manufacturer and the customer.	

### 8.1.3.3 Procedure

The temperature shall be varied by passing current through the conductors.

For 2-conductor ABC the current shall flow in both conductors and for 4-conductor ABC the current shall flow in 3 conductors.

Tails of a minimum 350 mm long shall remain outside the two tension clamps to provide connection to the current source.

When the test load is reached for the first time; the cores shall be marked where they exit from the clamps. These marks shall be used for reference purposes to measure slippage.

The clamps shall not be tightened or adjusted during the test.

The test shall comprise of 100 heat cycles at a rate of 2 cycles per day during which time the tensile load shall be stabilised at  $\pm 10\%$  or adjusted at least once a day within  $\pm 5\%$  of the value defined in 8.1.3.2.

The temperature shall be measured underneath the insulation with a thermocouple.

NOTE 1 For further information on thermocouple application, see EN 50483-5, 5.4.1.

NOTE 2 The temperature should be measured at a position which is not under mechanical tension. The measuring position may be at least 1 m from the tension clamp and the end of the ABC. It may also be at the same horizontal level as the tension clamp in order to avoid any difference in air temperature.

Each temperature cycle shall consist of

- initial temperature shall be ambient,
- the conductor temperature shall be gradually increased to  $(70 \pm 3)^\circ\text{C}$ , in less than 2 h,
- this high temperature shall be maintained for 8 h,
- the conductor shall be allowed to cool naturally to ambient temperature before the next cycle begins.

**8.1.3.4 Requirements**

No damage shall occur, which could affect the correct function of the tension clamp.

After 10 days of testing, the slippage of the cores or core of the cable with respect to the clamp parts that are in contact with the cores shall not exceed 10 mm.

At the end of the testing, slippage of the cores or core of the cable with respect to the clamp parts that are in contact with the cores shall not exceed 12 mm from the starting position.

The clamp shall pass the dielectrical voltage test detailed in 8.3.1.

The ABC core shall pass the dielectrical voltage test detailed in 8.3.2.

**8.1.4 Tensile test at low temperature**

**8.1.4.1 Principle**

The tension clamps shall be subjected to a steady load, whilst at least one tension clamp and the part of the cable close to the clamp are held at low temperature. The test shall be carried out in order to ensure that the cable does not slip through the clamp and that the clamp and the cable remain undamaged.

**8.1.4.2 Test arrangement**

Two tension clamps shall be assembled on to the ABC in accordance with the manufacturer's instructions and fitted into a tensile testing machine as shown in Figure 1.

The span between the two clamps shall be a minimum of  $100 \times D$ , where  $D$  is the circumscribed diameter of the ABC.

The test is carried out with a static load, which shall be found from Table 2.

**Table 2 – Static loads**

Number of cores in the ABC	Tension load ( $T$ ) for the tensile test at low temperature
2	40 % of the ABC MBL
4	25 % of the ABC MBL
NOTE When a clamp of lower rating is needed, the clamp may be tested according to another value agreed between the manufacturer and the customer.	

**8.1.4.3 Procedure**

The cores shall be marked at the point where they exit the tension clamps. These marks shall be used for reference purposes to measure slippage. Marking shall be applied at a core loading of  $10 \text{ N/mm}^2$  before initial cooling.

At least one tension clamp and a 300 mm section of the ABC shall be cooled to  $-10 \text{ }^\circ\text{C}$  for 24 h during which time a tensile load is maintained at the value determined from Table 2 with a tolerance of  $\pm 10 \%$ .

NOTE See EN 50483-1, 9.1, for information on the use of a lower temperature.

The tension clamps and cable shall be maintained at the above load and temperature for 24 h.

The clamps shall not be tightened or adjusted during the test.

#### 8.1.4.4 Requirements

No damage shall occur, which could affect the correct function of the tension clamp.

At the end of the testing slippage of the cores, or core, of the cable with respect to the clamp parts that are in contact with the cores shall not exceed 10 mm.

NOTE The dielectrical voltage test (8.3.2) is not required if the clamp has passed the equivalent test at high temperature (8.1.3) except by agreement between the customer and the manufacturer.

### 8.2 Type tests for suspension clamps

Suspension clamps shall be designed to support the ABC and to attach to pole fittings. They shall be suitable for use at different line deviations (angle  $\alpha$ ).

The performance characteristics of all suspension clamps shall be proven by satisfactorily undergoing the range of tests listed below. Each clamp shall be tested for the smallest and largest ABC size for which it is marked.

Test	Subclause
Tensile test at ambient temperature	8.2.1
Breaking load test	8.2.2
Slip test at ambient temperature	8.2.3
Slip test at high temperature (optional)	8.2.4
Thermal test	8.2.5
Dielectrical voltage test (clamp)	8.3.1
Dielectrical voltage test (ABC)	8.3.2
Clamp bolt tightening test	8.4
Environmental tests	8.5

#### 8.2.1 Tensile test at ambient temperature

##### 8.2.1.1 Principle

This test shall be carried out to ensure that the suspension clamps are capable of sustaining loads that are experienced in service without sustaining damage or damaging the ABC cores.

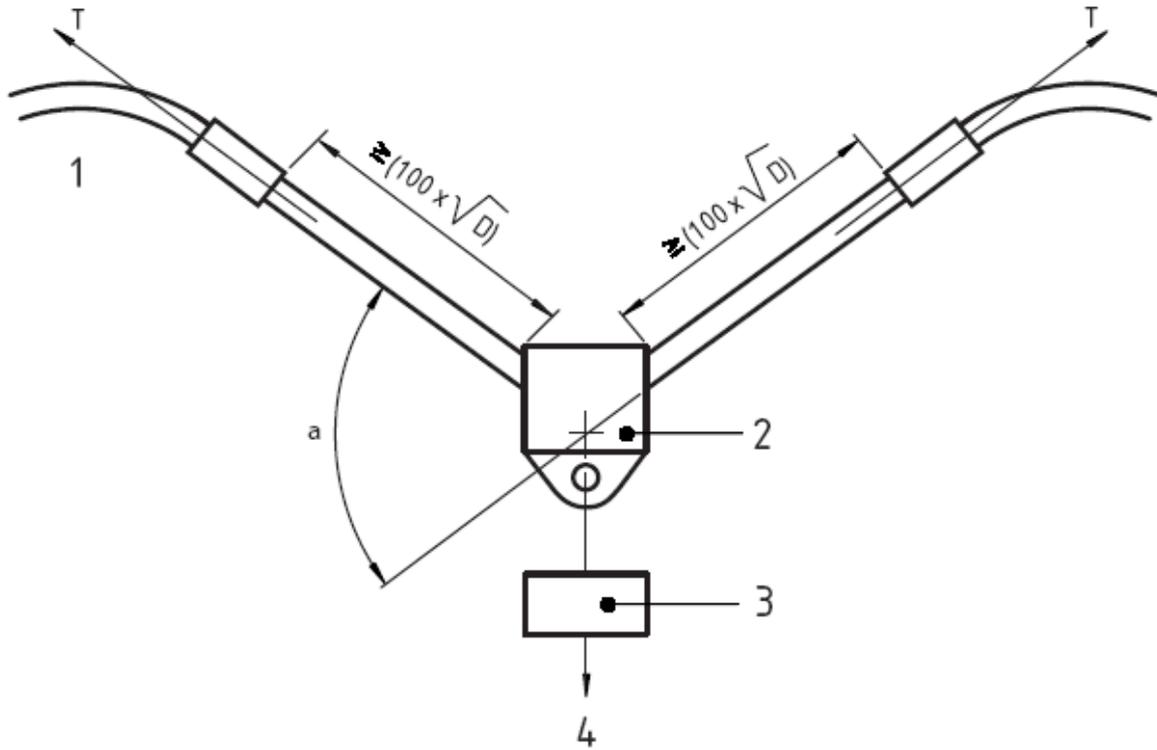
##### 8.2.1.2 Test arrangement

The test shall be carried out at ambient temperature.

Two clamps shall be tested and they shall be installed onto the ABC in a test rig similar to that shown in Figure 2.

The conductor shall be adjusted so that angle  $\alpha$  corresponds to the maximum angle of deviation in the direction shown in Figure 2 with tension load shown in Table 3.

Dimensions in millimetres



**Key**

- |   |                        |   |                              |
|---|------------------------|---|------------------------------|
| 1 | electrical connections | 3 | load                         |
| 2 | clamp under test       | 4 | load $F = 2T \sin(\alpha/2)$ |

**Figure 2 – Suspension clamp – Tensile tests**

**Table 3 – Tensile loads**

Number of cores in the ABC	Tension load ( $T$ ) for the tensile test at ambient temperature
2	40 % of the ABC MBL
4	20 % of the ABC MBL

NOTE When a clamp of lower rating is needed, the clamp may be tested according to another value agreed between the manufacturer and the customer.

**8.2.1.3 Procedure**

The load  $F$  applied to the clamp shall be equal to  $2T \times \sin(\alpha/2)$ . This load  $\pm 10\%$  shall be maintained for a period of at least 6 h.

The load  $F$  shall be increased until the tensile load in the ABC reaches  $2T$  for a 2-conductor ABC and  $3T$  for a 4-conductor ABC. The tensile load,  $T$  can be determined from Table 3.

NOTE When a clamp of lower rating is required and it is agreed between the customer and the manufacturer a lower value of tensile load ( $T$ ) may be used.

#### **8.2.1.4 Requirements**

No damage shall occur, which could affect the correct function of the suspension clamp.

The clamp shall pass the dielectrical voltage test detailed in 8.3.1.

The bundled cable shall pass the dielectrical voltage test detailed in 8.3.2.

#### **8.2.2 Breaking load test**

NOTE This test may be carried out on samples which have previously been subjected to the corrosion ageing test (8.5.1). In this case it is not necessary to carry out any mechanical tests before the corrosion test.

##### **8.2.2.1 Principle**

This test shall be carried out to ensure that the clamp does not break mechanically before the minimum breaking load of the ABC given by the manufacturer.

##### **8.2.2.2 Test arrangement**

Two clamps shall be tested.

The test shall be carried out at ambient temperature.

Instead of the ABC, the clamp shall be installed, in accordance with the manufacturer's instructions, on to a device adapted to support the suspension clamp.

A typical test arrangement is shown in Figure 2, where  $\alpha$  is the maximum angle of deviation of the suspension clamp as recommended by the manufacturer.

##### **8.2.2.3 Procedure**

The load, on the clamp, shall be increased to load  $F$  of the largest size of the ABC for which the clamp is designed.

This load shall be maintained for 60 s.

The load shall then be increased until breaking of the clamp occurs.

NOTE 1 The breaking value may be noted for information.

NOTE 2 When requested by the customer a different load may be increased to the MBL of the clamp given by the manufacturer to check the breaking load of the clamp.

##### **8.2.2.4 Requirements**

The suspension clamp shall not break until the MBL of the cable is reached, and has been held for 60 s.

#### **8.2.3 Slip test at ambient temperature**

##### **8.2.3.1 Principle**

This test shall be carried out to ensure that if high loads are applied to the ABC the suspension clamp will allow the cable to slip through the clamp without damage occurring either to the clamp or the ABC core.

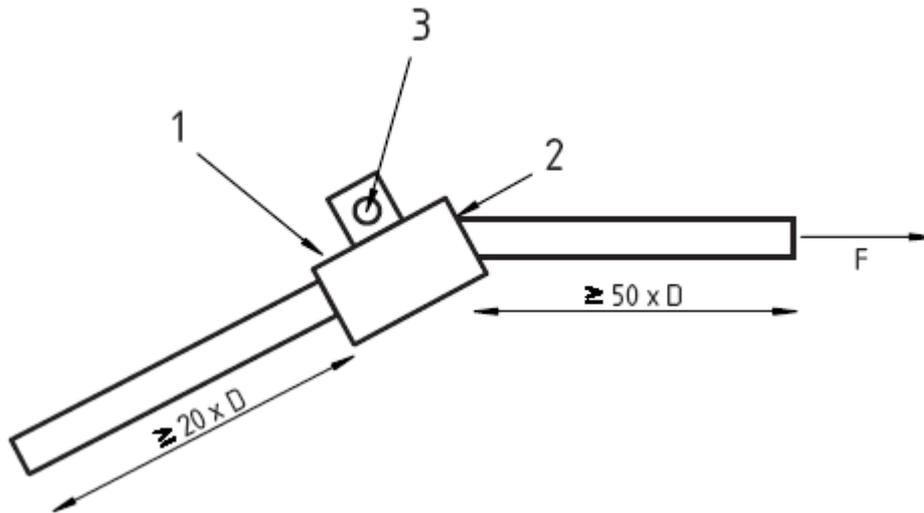
### 8.2.3.2 Test arrangement

Two clamps shall be tested. Each clamp shall be fitted into a test rig in an arrangement that is as close to the normal operating condition as possible. A typical arrangement is shown in Figure 3.

The test shall be carried out at ambient temperature.

The ABC (all cores) shall be marked at the point at which it leaves the clamp.

Dimensions in millimetres



#### Key

- 1 clamp to be tested
- 2 marking
- 3 fixed point

**Figure 3 – Slip test at ambient temperature**

NOTE Another arrangement may be agreed between manufacturer and customer, referring to EN 61284:1997, 11.4.3.

### 8.2.3.3 Procedure

A sliding force ( $F$ ) is applied longitudinally to the ABC in the direction shown in Figure 3.

The load shall be steadily increased until the ABC begins to slip through the suspension clamp.

This load shall be recorded.

### 8.2.3.4 Requirements

The load  $F$  at which the ABC slips through the clamp shall be between 500 N and 1 500 N.

No damage shall occur, which would affect the correct function of the suspension clamp or the ABC.

The clamp shall pass the dielectrical voltage test detailed in 8.3.1.

The ABC core shall pass the dielectrical voltage test detailed in 8.3.2.

NOTE Another slippage value may be agreed between manufacturer and customer.

**8.2.4 Slip test at high temperature (optional)**

This test is only for suspension clamps designed for self supporting  $4 \times 10 \text{ mm}^2$  ABC copper, and where the customer specifies a high slippage load.

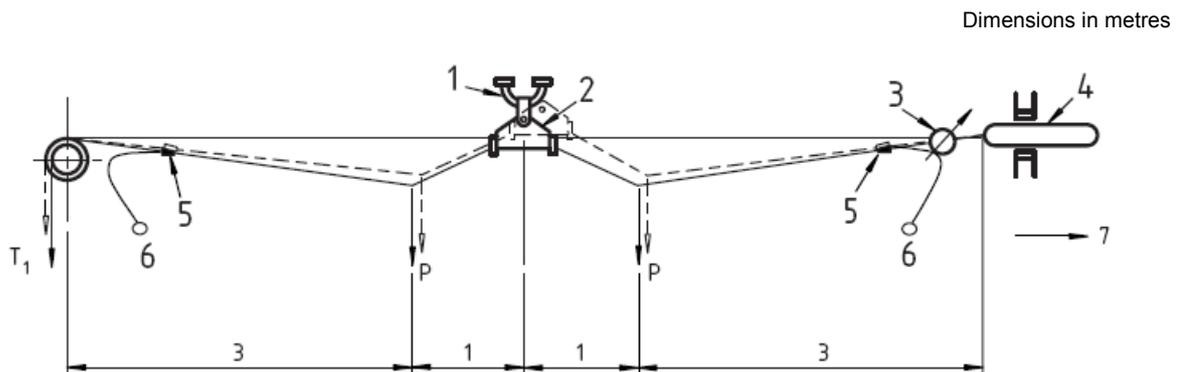
**8.2.4.1 Principle**

The test combines a heat cycle test with mechanical load applied to the ABC where the suspension clamp is attached to the fixture.

**8.2.4.2 Test arrangement**

Figure 4 shows a typical test set up. The test configuration may differ from this arrangement as long as it complies with the ABC lengths.

Suspension clamps and the ABC shall be subjected to this test, which comprises of 250 cycles, of 90 min each in which a heat cycle is combined with mechanical loads.



**Key**

1	fixture	—	suspension clamp with balanced load ( $T_2 = T_1$ )
2	suspension clamp	-----	suspension clamp with unbalanced load ( $T_2 > T_1$ )
3	tensile load measurement device	<i>P</i>	200 N (constant weight)
4	tensile load machine	$T_1$	10 % MBL of the cable (tensile load of the ABC by application of a suspended constant weight)
5	tension clamp	$T_2$	20 % MBL of the cable (tensile overload of the ABC by tensile load machine (4))
6	current source connection		
7	$T_1$ or $T_2$		

**Figure 4 – Test arrangement for slip test at high temperature**

**8.2.4.3 Procedure**

A suspension clamp shall be fitted on the ABC in the middle of a span with a length of about 8 m.

At a distance of 1 m from both sides of the suspension clamp two fixed weights, of 200 N, shall be attached on the ABC.

Before starting the first cycle the ABC shall be subjected to 10 % of its MBL and the cores shall be marked so that any slippage can be measured with respect to the suspension clamp.

An alternating current is passed through the ABC until its temperature rises to the maximum normal operational temperature of the conductor + 5 K. The temperature rise shall be achieved within 15 min and then maintained at this temperature for the next 30 min or until the total time is 45 min, if the temperature is achieved more quickly.

The temperature shall be measured underneath the insulation with a thermocouple.

NOTE 1 For further information on thermocouple application, see EN 50483-5, 5.4.1.

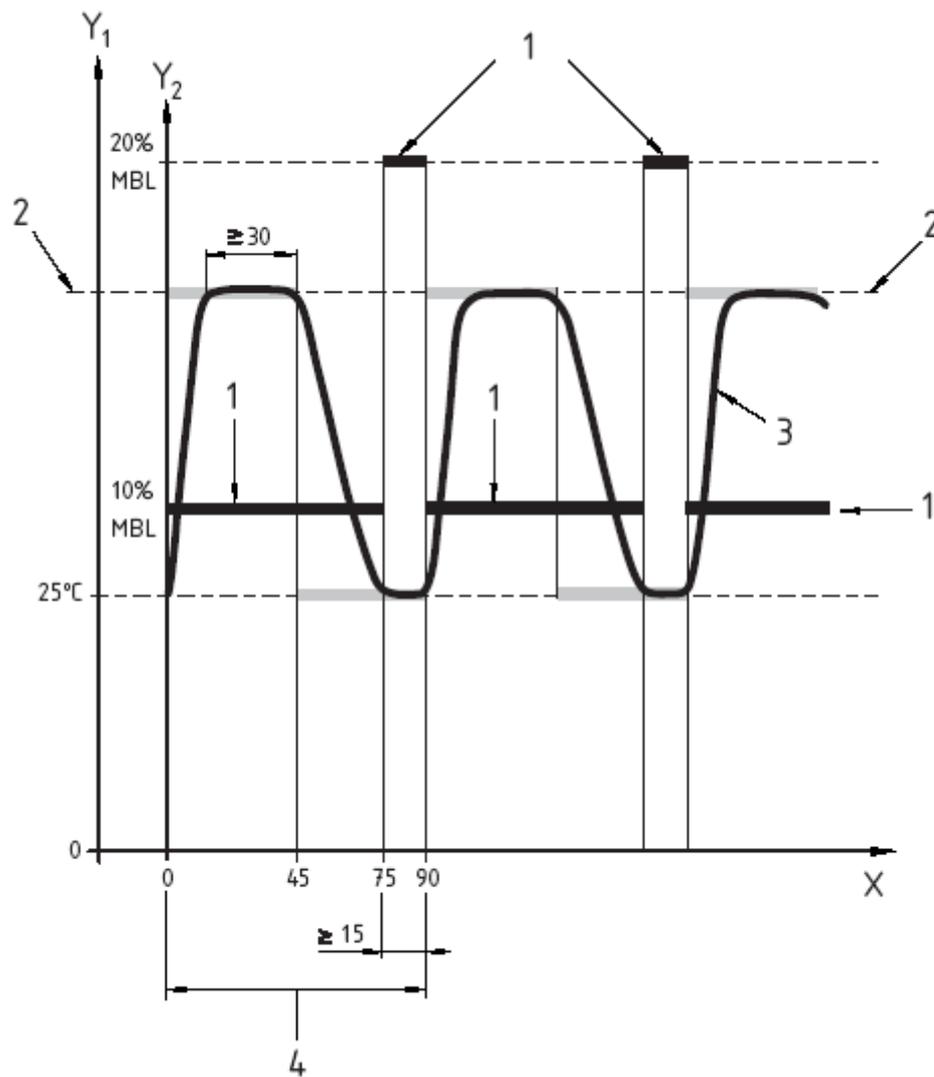
NOTE 2 The temperature may be measured at a position which is not under mechanical tension. The measuring position may be at least 1 m from the tension clamp and the end of the ABC. It may be also at the same horizontal level as the suspension clamp in order to avoid any difference in air temperature.

The ABC shall be allowed to cool to 25 °C during the next 30 min. This temperature shall be maintained for the next 15 min until the end of the cycle.

The mechanical load of 10 % of the MBL of the cable shall be maintained for the first 75 min of the cycle. During the last 15 min, once the ABC has cooled to 25 °C, the load shall be increased to 20 % of the MBL of the cable. This increase in load shall be gradually applied in not less than 5 s and not more than 60 s.

If accelerated cooling is used, it shall act on the whole of the loop, and use air within ambient temperature limits.

The mechanical and temperature cycle are shown diagrammatically in Figure 5.

**Key**

1	selected value of mechanical load	X	time in minutes
2	maximum normal operational temperature of the conductor + 5 K	Y <sub>1</sub>	temperature in °C
3	temperature profile	Y <sub>2</sub>	mechanical load in % of MBL of the cable
4	one cycle		

**Figure 5 – Cycle and temperature profile****8.2.4.4 Requirements**

The ABC slippage with regard to the suspension clamp shall comply with the following conditions:

- slippage after 15 cycles:  $g_{15} \leq 2 \text{ mm}$ ;
- slippage after 250 cycles:  $g_{250} \leq 4 \text{ mm}$ .

**8.2.5 Thermal test**

**8.2.5.1 Principle**

The suspension clamps shall be subjected to mechanical loads at high temperature in order to ensure that they are capable of sustaining loads likely to be encountered in service without being damaged or damaging the conductor.

**8.2.5.2 Test arrangement**

Two suspension clamps shall be tested.

The suspension clamps shall be assembled on to the ABC in accordance with the manufacturer’s instructions.

The clamp shall be installed in a test rig as shown in Figure 2 using the maximum angle for which the clamp is designed.

A constant mechanical load shall be maintained on the clamp throughout the test. This load is derived from Table 4 and shall be equal to  $2T \times \sin(\alpha/2)$ , where  $\alpha$  is the maximum angle of deviation of the suspension clamp, as specified by the manufacturer or specified by the customer.

Tails approximately 300 mm long shall remain outside the two tension clamps for connection to a current source.

The conductor shall be adjusted so that angle  $\alpha$  corresponds to the maximum angle in the direction shown in Figure 2 with tension derived from Table 4.

**Table 4 – Tensile loads**

Number of cores in the ABC	Tension load (T) during the thermal test
2	20 % of the ABC MBL
4	7 % of the ABC MBL
NOTE When a clamp of lower rating is needed, the clamp may be tested according to another value agreed between the manufacturer and the customer.	

**8.2.5.3 Procedure**

The load shall be increased until it reaches the constant mechanical load as specified in 8.2.5.2.

This load shall be stabilised at  $\pm 10\%$  and shall be maintained for a period of at least 6 h.

Temperature variation shall be achieved by passing current through the conductors.

For 2-conductor ABC current flows in both conductors and for 4-conductor ABC current flows in 3 conductors.

The test assembly shall undergo 100 heat cycles at a rate of 2 cycles per day.

The load shall be maintained for the duration of the test.

The conditions for each temperature cycle shall be

- an initial temperature at ambient,
- the conductor temperature gradually increased to  $(70 \pm 3) ^\circ\text{C}$ , in less than 2 h,
- this high temperature maintained for 8 h,
- the conductor and clamp allowed to cool naturally to ambient temperature before the next cycle begins.

#### **8.2.5.4 Requirements**

No damage shall occur, which could affect the correct function of the suspension clamp or the ABC.

The clamp shall pass the dielectrical voltage test detailed in 8.3.1.

The ABC cores shall pass the dielectrical voltage test detailed in 8.3.2.

### **8.3 Dielectrical voltage tests**

#### **8.3.1 Dielectrical voltage test (clamp)**

##### **8.3.1.1 Principle**

This test shall be carried out to ensure that the insulation properties of the tension or suspension clamps have not been damaged during testing. Conductive rods shall replace the insulated conductors used in the previous tests to simulate electrical breakdown of the cable insulation.

##### **8.3.1.2 Test arrangement – Tension clamps**

The test shall be carried out using conductive rods, suitable bare conductors or cores wrapped in a metallic foil, which shall replace each core of the ABC. The length of the rods or bare conductors shall be such that they protrude by 2 cm from both ends of the clamp. The protrusion shall be measured from that part of the clamp that is in contact with the conductive rod or bare conductor. The protruding ends shall be insulated where necessary.

The conductive rods, bare conductors or cores in a metallic foil shall be equivalent in diameter to the insulated conductor used in the test.

##### **8.3.1.3 Test arrangement – Suspension clamps**

The test shall be carried out using conductive rod(s), suitable bare conductor(s) or core(s) wrapped in a metallic foil, which shall replace the ABC.

The conductive rod(s), bare conductor(s) or core(s) wrapped in a metallic foil shall be equivalent in diameter to the insulated conductor used in the test.

The test shall be carried out at ambient temperature.

##### **8.3.1.4 Procedure**

A voltage of 4 kV a.c. shall be applied between the conductive rod(s) and the clamp's metallic components in contact with the fixture.

The voltage shall be maintained for 60 s. The frequency shall be as specified in EN 50483-1.

NOTE Other voltage values above 4 kV up to 10 kV may be agreed between customer and manufacturer.

### **8.3.1.5 Requirements**

No failure or flashover shall occur. The maximum leakage current is defined in EN 50483-1, 9.1.5.

## **8.3.2 Dielectrical voltage test (ABC)**

### **8.3.2.1 Principle**

This test shall be carried out to ensure that the insulation properties of the cable have not been damaged during testing.

### **8.3.2.2 Test arrangement**

The clamp shall be removed from the ABC.

The ABC shall be immersed in water ensuring that the section on which the clamp was mounted is completely immersed.

The separate conductors of the ABC shall be electrically interconnected.

A test voltage as specified in EN 50483-1, 9.1, shall be applied between the interconnected conductors and an electrode in contact with the water in which the ABC is immersed.

The resistivity of the water used in this test shall be in accordance with EN 50483-1, 9.1.6.

### **8.3.2.3 Procedure**

The ABC conductor shall be soaked in water for 4 h.

A test voltage of 4 kV a.c. shall be applied between the interconnected conductors and the water. The frequency shall be as specified in EN 50483-1.

The voltage shall be maintained for 60 s.

NOTE Other voltage values above 4 kV up to 10 kV may be agreed between customer and manufacturer.

### **8.3.2.4 Requirements**

No failure or flashover shall occur. The maximum leakage current is defined in EN 50483-1, 9.1.5.

## **8.4 Clamp bolt tightening test**

### **8.4.1 Principle**

This test shall be used for both tension and suspension clamp bolts.

This test shall be carried out to ensure that nuts and bolts used to apply the pressure needed to clamp the ABC are not damaged, and do not damage the clamp during use.

#### **8.4.2 Test arrangement**

Two clamps shall be tested.

The test shall be carried out at ambient temperature.

The clamp shall be installed onto the ABC for which the clamp is designed.

The bolts and/or nuts shall be tightened to the installation torque specified by the manufacturer.

#### **8.4.3 Procedure**

The torque shall be increased to the specified installation torque value times a factor of 1,1.

The bolts and/or nuts shall then be slackened until they exert no pressure on the ABC and the clamp becomes loose enough to remove.

NOTE The clamp may be left in place during this test.

The tightening and loosening process shall be completed 10 times.

The torque shall be increased to the lower value of either twice the specified installation torque value, or the maximum torque value recommended by the bolt manufacturer.

#### **8.4.4 Requirements**

No damage shall occur, which could affect the correct function of the clamp or its nuts and bolts.

### **8.5 Environmental tests**

In order to meet the requirements of the type tests at least one of the three corrosion tests (detailed in 8.5.1) and one of the two climatic tests (detailed in 8.5.2) shall be carried out. The choice of the test shall be agreed between the manufacturer and the customer.

#### **8.5.1 Corrosion ageing test**

See EN 50483-6, 8.4.

Before the corrosion test, the test defined in 8.1.1 or 8.2.1 is carried out using a reduced value of 75 % of the test load.

##### **8.5.1.1 Salt mist test**

See EN 50483-6, 8.4.1.

##### **8.5.1.1.1 Test criteria**

The following criteria shall be used during this test.

- Number of suspension samples shall be 2.
- Number of tension samples shall be 2.
- Number of cycles shall be 4 (4 weeks).

- The samples shall be installed so that they are positioned in a manner which is as close as possible to the orientation that would be expected in normal operation.

#### **8.5.1.1.2 Requirements**

Visual inspection shall be carried out and there shall be no significant trace of red rust for ferrous metallic parts.

NOTE Significant rusting would constitute more than 10 % of the exposed surface area of the metallic parts.

The sample's identification markings shall be legible when examined with normal or corrected vision without magnification.

No deterioration of the clamps shall occur which would impair the normal function of the clamp.

Tension clamps shall meet the requirements of the mechanical test given in 8.1.1 or 8.1.2 using a reduced value of 55 % of the test load after the corrosion test.

Suspension clamps shall meet the requirements of the mechanical test given in 8.2.1 or 8.2.2 using a reduced value of 55 % of the test load after the corrosion test.

#### **8.5.1.2 Gas atmosphere test**

See EN 50483-6, 8.4.1 and EN 50483-6, 8.4.2.

##### **8.5.1.2.1 Test criteria – Method 1 – Combined test**

See EN 50483-6, 8.4.1 and EN 50483-6, 8.4.2.1.

The following criteria shall be used during this test.

- Number of suspension samples shall be 2.
- Number of tension samples shall be 2.
- There shall be 4 cycles of 14 days. This 14-day cycle consists of 7 days of salt mist and 7 days in SO<sub>2</sub> atmosphere as defined in EN 50483-6, 8.4.1 and EN 50483-6, 8.4.2.1.
- The samples shall be installed so that they are positioned in a manner, which is as close as possible to the orientation that would be expected in normal operation.

##### **8.5.1.2.2 Test criteria – Method 2**

See EN 50483-6, 8.4.2.2.

The following criteria shall be used during this test.

- Number of suspension samples shall be 2.
- Number of tension samples shall be 2.
- There shall be 500 cycles of 2 h (approximately 6 weeks).
- The samples shall be installed so that they are positioned in a manner, which is as close as possible to the orientation that would be expected in normal operation.

### **8.5.1.2.3 Requirements (Method 1 and Method 2)**

Visual inspection shall be carried out and there shall be no significant trace of red rust for ferrous metallic parts.

NOTE Significant rusting would constitute more than 10 % of the exposed surface area of the metallic parts.

The sample's identification markings shall be legible when examined with normal or corrected vision without magnification.

No deterioration of the clamps shall occur which would impair the normal function of the clamp.

Tension clamps shall meet the requirements of the mechanical test given in 8.1.1 or 8.1.2 using a reduced value of 55 % of the test load after the corrosion test.

Suspension clamps shall meet the requirements of the mechanical test given in 8.2.1 or 8.2.2 using a reduced value of 55 % of the test load after the corrosion test.

## **8.5.2 Climatic ageing test**

See EN 50483-6, 8.5.

Before the climatic ageing test, the test defined in 8.1.1 or 8.2.1 is carried out using a reduced value of 75 % of the test load.

### **8.5.2.1 Test criteria – Method 1**

See EN 50483-6, 8.5.1.

The following criteria shall be used during this test.

- Number of suspension samples shall be 2.
- Number of tension samples shall be 2.
- There shall be 6 cycles of 1 week.
- The temperature during periods A and C shall be 70 °C or otherwise, if agreed between the customer and the manufacturer.
- The samples shall be installed so that they are positioned so that there is maximum exposure of the synthetic parts to the light source.

### **8.5.2.2 Test criteria – Method 2**

See EN 50483-6, 8.5.2.

The following criteria shall be used during this test.

- Number of suspension samples shall be 2.
- Number of tension samples shall be 2.
- There shall be 56 cycles of 1 day (8 weeks).
- The samples shall be installed so that they are positioned so that there is maximum exposure of the synthetic parts to the light source.

### **8.5.2.3 Requirements (Method 1 and Method 2)**

The sample's identification markings shall be legible when examined with normal or corrected vision without magnification.

No deterioration of the clamps shall occur which would impair the normal function of the clamp.

The clamps shall meet the requirements of the dielectrical voltage test given in 8.3.1.

Tension clamps shall meet the requirements of the mechanical test given in 8.1.1 or 8.1.2 using a reduced value of 55 % of the test load after the climatic ageing test.

Suspension clamps shall meet the requirements of the mechanical test given in 8.2.1 or 8.2.2 using a reduced value of 55 % of the test load after the climatic ageing test.

## **Bibliography**

EN 61284:1997, *Overhead lines – Requirements and tests for fittings* (IEC 61284:1997)