SLOVENSKI STANDARD
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Vodniki za nadzemne vode - Vrvi iz koncentrično sukanih okroglih žic

Conductors for overhead lines - Round wire concentric lay stranded conductors

Leiter für Freileitungen - Leiter aus konzentrisch verseilten runden Drähten

Conducteurs pour lignes aériennes - Conducteurs à brins circulaires, câblés en couches concentriques

Ta slovenski standard je istoveten z: **EN 50182:2001**

ICS:

29.060.10	Žice	Wires
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SIST EN 50182:2002 **sl**

EUROPEAN STANDARD **EN 50182**

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English version

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CENELEC

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

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

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Foreword

This European Standard was prepared by the Technical Committee CENELEC TC 7, Overhead electrical conductors.

The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 50182 on 2000-11-01.

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) 2001-11-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2003-11-01

Annexes designated "normative" are part of the body of the standard. Annexes designated "informative" are given for information only. In this standard, annexes A, B, C and E are normative and annexes D and F are informative.

Contents

1 Scope

This European Standard specifies the electrical and mechanical characteristics of round wire concentric lay bare overhead electrical conductors stranded in alternate directions, with or without grease as per EN 50326, made of one or a combination of any of the following:

a) Hard drawn Aluminium as per EN 60889 designated AL1

b) Aluminium alloy as per EN 50183 designated AL2 to AL7

c) Zinc coated steel wire as per EN 50189 with grade and class designated ST1A, ST2B, ST3D, ST4A, ST5E, and ST6C.

d) Aluminium-clad steel wire as per EN 61232 with class designation 20SA (grades A and B), 27SA, 30SA and 40SA.

Conductors made of zinc coated steel wires only are not included.

2 Normative references

This European standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European standard only when incorporated in it by amendment or revision. For undated references the latest issue of the publication referred to applies.

EN 50183	Conductors for overhead lines — Aluminium-magnesium-silicon alloy wires
EN 50189	Conductors for overhead lines — Zinc coated steel wires
EN 50326[1)]	Conductors for overhead lines — Characteristics of greases
EN 60889	Hard-drawn aluminium wire for overhead line conductors.
EN 61232	Aluminium-clad steel wires for electrical purposes.
IEC 60050-466	International Electrotechnical Vocabulary (IEV) - Chapter 466: Overhead Lines.

3 Definitions

In addition to the definitions given in IEC 60050-466, the following definitions apply:

3.1
aluminium
for the purposes of this standard, aluminium is used as a generic term to mean hard drawn aluminium and aluminium alloy

3.2
direction of lay
the direction of lay is defined as right hand or left hand. With right hand lay, the wires conform to the direction of the central part of the letter Z when the conductor is held vertically. With left hand lay the wires conform to the central part of the letter S when the conductor is held vertically

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1) At draft stage

3.3
lay ratio
the ratio of the lay length to the external diameter of the corresponding layer of wires in the stranded conductor

3.4
lot
a group of conductors manufactured by the same manufacturer under similar conditions of production

NOTE 1 A lot may consist of part of or all the purchased quantity.

NOTE 2 The constitution of a lot may be agreed between the purchaser and the manufacturer

3.5
nominal
the target value of a measurable property by which a conductor or component of a conductor is identified and to which tolerances are applied

3.6
wire
a filament of drawn metal having a constant circular cross-section

3.7
rated tensile strength
an estimate of the conductor breaking load calculated using the specified tensile properties of the component wires

4 Designation system

4.1 A designation system is used to identify stranded conductors made of aluminium with or without steel wires.

4.2 Homogeneous aluminium conductors are designated ALx, where x identifies the type of aluminium. Homogeneous aluminium clad steel conductors are designated yzSA where y represents the type of steel (Grade A or B, applicable to class 20SA only), and z represents the class of aluminium cladding (20, 27, 30 or 40).

4.3 Composite aluminium/zinc coated steel conductors are designated ALx/STyz, where ALx identifies the external aluminium wires (envelope), and STyz identifies the steel core. In the designation of zinc coated steel wires, y represents the type of steel (Grades 1 to 6) and z represents the class of zinc coating (A to E).

4.4 Composite aluminium/aluminium-clad steel conductors are designated ALx/yzSA, where ALx identifies the external aluminium wires (envelope), and yzSA identifies the steel core as in 4.2.

4.5 Conductors are identified as follows:

(a) a code number giving the nominal area, rounded to an integer, of the aluminium or steel as appropriate;

(b) a designation identifying the type of wires constituting the conductor. For composite conductors the first description applies to the envelope and the second to the core.

EXAMPLES:

16-AL1:	Conductor of AL1 aluminium with an area of 15,9 mm^2, rounded to 16 mm^2.
587-AL2:	Conductor of AL2 aluminium with an area of 586,9 mm^2, rounded to 587 mm^2.
401-AL1/28-ST1A:	Conductor made of AL1 aluminium wires around a core of ST1A zinc coated steel wires with a Class A zinc coating. The integer area of AL1 wires is 401 mm^2 and that of the ST1A wires 28 mm^2.
401-AL1/28-A20SA:	Conductor made of AL1 aluminium wires around a core of grade A, class 20 aluminium-clad steel wires. The integer area of AL1 wires is 401 mm^2 and that of the A20SA wires 28 mm^2.
65-A20SA:	Conductor made of grade A, class 20 aluminium clad steel wires with an area of 65 mm^2.

5 Requirements for stranded conductor

5.1 Material

The stranded conductor shall be made from wires and with grease, whenever greased conductor is specified, as defined in clause 1.

5.2 Conductor sizes

Lists of conductor sizes in frequent use in some of the member countries are given as guidance in annex F. Conductors for existing or established designs of overhead lines as well as sizes and strandings not included in this standard may be designed and supplied as agreed upon by the manufacturer and purchaser, and the relevant requirements of this standard shall apply.

5.3 Surface condition

The surface of the conductor shall be free from all imperfections visible to the unaided eye (normal corrective lenses accepted), such as nicks, indentations, etc., not consistent with good commercial practice.

5.4 Conductor diameter

The conductor diameter shall not vary from the nominal value, specified by the purchaser, by more than:

± 1 % for diameters larger or equal to 10 mm.

± 0,1 mm for diameters smaller than 10 mm.

5.5 Stranding

5.5.1 All wires of the conductor shall be concentrically stranded.

5.5.2 Adjacent wire layers shall be stranded with reverse lay directions. The direction of lay of the external layer shall be right hand except when otherwise specified by the purchaser.

5.5.3 The wires in each layer shall be evenly and closely stranded around the underlying wire or wires.

5.5.4 The lay ratios for the zinc coated or aluminium-clad steel wire layers shall be as given in Table 1.

Table 1 - Lay ratios for zinc coated or aluminium-clad steel layers

Number of steel wires	Lay ratio							
	3 wire layer		6 wire layer		12 wire layer		18 wire layer	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
3	16	26	-	-	-	-	-	-
7	-	-	16	26	-	-	-	-
19	-	-	16	26	14	22	-	-
37	-	-	17	25	16	22	14	18
For zinc coated or aluminium-clad steel core constructions exceeding 37 wires, the lay ratio of the outer layer shall lie between 14 and 18, and the lay ratio of the inner layers shall lie between 16 and 26.								

5.5.5 The lay ratios for the aluminium layers of all types of conductor shall be as given in Table 2.

Table 2 - Lay ratios for aluminium layers

All inner layers		Outer layer	
Min.	Max.	Min.	Max.
10	16	10	14

5.5.6 In a multi-layer conductor, the lay ratio of any layer shall be equal to or less than the lay ratio of the layer immediately beneath it.

5.5.7 All steel wires shall lie naturally in their position in the stranded core, and where the core is cut, the wire ends shall remain in position or be readily replaced by hand and then remain approximately in position. This requirement also applies to the aluminium wires of a conductor.

5.5.8 Before stranding, aluminium and steel wires shall have approximately equal temperatures.

5.5.9 The conductor shall have the ability to be installed, using the purchaser's recommended installation method, without damage to the conductor. If required, this shall be demonstrated according to 6.4.9.

5.6 Joints

5.6.1 For conductors containing only one steel wire there shall be no joints made after heat treatment of the wire or rod. There shall be no joints of any kind made in the finished zinc coated or aluminium-clad steel core wire or wires during stranding.

5.6.2 No more than one jointed aluminium finished wire before stranding, as permitted in the relevant standard given in clause 2, shall be used per length of conductor.

5.6.3 During stranding, no aluminium wire welds shall be made for the purpose of achieving the required conductor length.

5.6.4 Joints are permitted in aluminium wires unavoidably broken during stranding, provided such breaks are not associated with either inherently defective wire or with the use of short lengths of aluminium wires. Joints shall conform to the geometry of the original wire, i.e. joints shall be dressed smoothly with a diameter equal to that of the parent wires and shall not be kinked.

The number of joints in aluminium wires shall not exceed those specified in Table 3. These joints shall not be closer than 15 m from a joint in the same wire or in any other aluminium wire of the completed conductor.

Joints shall be made by electric butt welding, cold pressure welding or other methods approved by the purchaser. The first type of joint shall be electrically annealed for approximately 250 mm on both sides of the weld.

5.6.5 While the joints specified in 5.6.4 are not required to meet the requirements of unjointed wires, they shall withstand a stress of not less than 75 N/mm² for annealed electric butt welded joints, and not less than 130 N/mm² for cold pressure joints.

Table 3 - Number of joints permitted in a given length

Conductor length *L* (m)				Number of joints permitted
Number of aluminium layers				
1	2	3	4	
L □ 1 500	-	-	-	2
1 500 < *L* □ 2 000	*L* □ 1 500	-	-	3
L > 2 000	1 500 < *L* □ 2 000	*L* □ 1 500	-	4
-	2 000 < *L* □ 2 500	1 500 < *L* □ 2 000	*L* □ 1 500	5
-	*L* > 2 500	2 000 < *L* □ 2 500	1 500 < *L* □ 2 000	6
-	-	2 500 < *L* □ 3 000	2 000 < *L* □ 2 500	7
-	-	3 000 < *L* □ 3 500	2 500 < *L* □ 3 000	8
-	-	*L* > 3 500	3 000 < *L* □ 3 500	9
-	-	-	3 500 < *L* □ 4 000	10
-	-	-	*L* > 4 000	11

5.7 Conductor mass per unit length

5.7.1 The conductor masses given in the Tables of annex F have been calculated for each size and stranding of conductor using densities for the aluminium, aluminium clad steel and zinc coated steel wires as given in the standards listed in clause 2. The masses do not include the mass of grease. The calculation of cross-sectional areas for aluminium, aluminium clad steel and zinc coated steel are based on the nominal diameter.

5.7.2 With the exception of the centre wire, all wires are longer than the stranded conductor and the increase in mass depends on the lay ratio used.

The increments, in per cent, for mass due to stranding, shall be as given in Table 4, which have been calculated using the commonly used lay ratios for each applicable layer of aluminium or steel wire given in annex D.

Where an oversize centre wire (king wire) is used, the appropriate increase in mass shall be applied.

5.7.3 The mass per unit length of the conductor without grease shall not vary from its nominal value by more than ± 2 %.

Table 4 - Increments due to stranding

Stranding of conductor				Increment (increase) (%)			
Aluminium		Steel		Mass		Electrical resistance	
No. of wires	No. of layers *	No. of wires	No. of layers *	Aluminium	Zn coated or Al. clad steel	Aluminium	Aluminium-clad steel
7	1	-	-	1,11	-	1,11	-
19	2	-	-	1,68	-	1,68	-
37	3	-	-	2,03	-	2,03	-
61	4	-	-	2,36	-	2,36	-
91	5	-	-	2,78	-	2,78	-
127	6	-	-	2,75	-	2,75	-
6	1	1	-	1,39	-	1,39	-
8	1	1	-	1,66	-	1,66	-
18	2	1	-	1,82	-	1,82	-
9	1	3	1	1,91	0,34	1,91	0,34
6	1	7	1	1,51	0,52	1,51	0,52
10	1	7	1	2,01	0,52	2,01	0,52
12	1	7	1	2,17	0,52	2,17	0,52
14	1	7	1	2,30	0,52	2,30	0,52
18	2	7	1	1,94	0,52	1,94	0,52
22	2	7	1	2,07	0,52	2,07	0,52
24	2	7	1	2,13	0,52	2,13	0,52
26	2	7	1	2,18	0,52	2,18	0,52
28	2	7	1	2,22	0,52	2,22	0,52
30	2	7	1	2,26	0,52	2,26	0,52
32	2	7	1	2,30	0,52	2,30	0,52
36	2	7	1	2,37	0,52	2,37	0,52
42	3	7	1	2,20	0,52	2,20	0,52
45	3	7	1	2,23	0,52	2,23	0,52
48	3	7	1	2,26	0,52	2,26	0,52
54	3	7	1	2,31	0,52	2,31	0,52
72	4	7	1	2,40	0,52	2,40	0,52
84	4	7	1	2,46	0,52	2,46	0,52
14	1	19	2	2,50	0,82	2,50	0,82
15	1	19	2	2,56	0,82	2,56	0,82
16	1	19	2	2,61	0,82	2,61	0,82
18	1	19	2	2,70	0,82	2,70	0,82
30	2	19	2	2,36	0,86	2,36	0,86
32	2	19	2	2,41	0,86	2,41	0,86
36	2	19	2	2,48	0,86	2,48	0,86
42	2	19	2	2,57	0,86	2,57	0,86
54	3	19	2	2,26	0,79	2,26	0,79
38+22	3	19	2	2,22	0,79	2,22	0,79
42+20	3	19	2	2,18	0,79	2,18	0,79
66	3	19	2	2,34	0,79	2,34	0,79
78	3	19	2	2,40	0,79	2,40	0,79
96	4	19	2	2,46	0,79	2,46	0,79
100	4	19	2	2,47	0,79	2,47	0,79
18	1	37	3	2,70	1,09	2,70	1,09
24	1	37	3	2,91	1,09	2,91	1,09
72	3	37	3	2,43	0,96	2,43	0,96
54+66	4	37	3	2,32	0,86	2,32	0,86
150	5	37	3	2,38	0,86	2,38	0,86

* Number of layers of each type of wire, not including the centre wire.

5.8 Grease

5.8.1 Whenever a greased conductor is specified, the grease shall meet the requirements of EN 50326 and shall be applied before the closing die.

5.8.2 Greases with different designations or from different manufacturers shall not be mixed within a length of conductor.

5.8.3 The mass of grease shall not vary by more than ± 20 % from the calculated value obtained using the method described in annex B.

5.9 Conductor rated tensile strength

5.9.1 The rated tensile strength of a homogeneous aluminium or aluminium clad steel conductor shall be taken as the sum of the minimum tensile strength of all the wires as defined in 5.9.3.

5.9.2 The rated tensile strength of composite ALx/STyz or ALx/yzSA conductors shall be the sum of the minimum tensile strength of the aluminium portion plus the minimum tensile strength of steel (zinc coated or aluminium clad) corresponding to an elongation compatible with that of aluminium at rupture load. For purpose of specification and practicability, this strength is taken as the tensile stress corresponding to 1 % elongation in a 250 mm gauge length before stranding.

5.9.3 The minimum tensile strength of any single wire is the product of its nominal area and the appropriate minimum stress given in the standards referenced in clause 2.

5.10 Nominal d.c. resistance

The nominal d.c. resistance at 20 °C of a conductor, expressed in Ω/km to three significant figures, is based on the resistivity value for calculation purposes and on the nominal diameter of the aluminium and aluminium clad steel wires referenced in clause 2, increased by the increments in Table 4 of this standard. For ALx/yzSA and yzSA conductors the Tables in annex F give two resistance values, a value calculated using both the aluminium and steel portions of the aluminium clad steel wires, and a value calculated using the aluminium portion only.

6 Tests

6.1 Classification of tests

Type tests are intended to verify the main characteristics of a conductor which depend mainly on its design. These tests are normally performed only once for a given conductor construction.

Sample tests are intended to guarantee the quality of conductors and compliance with the requirements of this standard.

Both type and sample tests are listed in Table 5.

Table 5 - Type and sample tests for conductors

		Type test	Sample test	Clause
Conductor	- surface condition	x	x	6.4.1
	- diameter	x	x	6.4.2
	- inertness	x	x	6.4.3
	- lay ratio and direction of lay	x	x	6.4.4
	- number and type of wires	x	x	6.4.5
	- mass per unit length	x	x	6.4.6
	- stress-strain curve	(1)	-	6.4.7
	- tensile breaking strength	(1)	-	6.4.8
	- stringing test	(1)	-	6.4.9
Aluminium wires	- diameter	x	x	6.5.2
	- tensile strength	x	x	6.5.2
	- elongation (2)	x	x	6.5.2
	- resistivity	x	x	6.5.2
	- wrapping test	x	x	6.5.2
	- welding	x	-	6.5.3
Zinc coated	- diameter	x	x	6.5.2
Steel wires	- tensile strength	x	x	6.5.2
	- stress at 1 % extension	x	x	6.5.2
	- elongation or torsion test	x	x	6.5.2
	- wrapping test	x	x	6.5.2
	- mass of zinc	x	x	6.5.2
	- zinc dip test	x	x	6.5.2
	- adhesion of zinc coating	x	x	6.5.2
Aluminium-clad	- diameter	x	x	6.5.2
Steel wires	- tensile strength	x	x	6.5.2
	- stress at 1 % extension	x	x	6.5.2
	- elongation	x	x	6.5.2
	- torsion	x	x	6.5.2
	- cladding thickness/uniformity	x	x	6.5.2
	- resistivity	x	x	6.5.2
Grease	- mass per unit length	x	x	6.6.1
	- drop point	x	x	6.6.2

(1) By agreement between the purchaser and manufacturer.

(2) Elongation test for AL1 is not required.

6.2 Sample size

When agreed by the manufacturer and the purchaser at the time of ordering, tests shall be carried out on a minimum of 10 % of the drums offered for inspection and, in such cases, each wire shall be tested. Where the manufacturer has a demonstrated capability of meeting or exceeding the requirements, the number of test samples may be reduced, with the agreement of the purchaser and manufacturer, to a level which ensures that each production lot of conductor is given adequate monitoring.

Drums to be sampled shall be selected at random, and samples taken from the outer end of the drums.

The length of the sample of conductor taken shall be sufficient to allow all tests to be performed on the same specimens of wire.

In order to check the grease, a sample of conductor shall be taken from one drum of each inspection lot.

6.3 Rounding rules

The following rounding rules shall be used for determination of compliance with this standard.

6.3.1 When the figure immediately after the last figure to be retained is less than 5, the last figure to be retained remains unchanged.

6.3.2 When the figure immediately after the last figure to be retained is greater than 5, or equal to 5 and followed by at least one figure other than zero, the last figure to be retained is increased by one.

6.3.3 When the figure immediately after the last figure to be retained is equal to 5 and followed by zeros only, the last figure to be retained remains unchanged if even and is increased by one if odd.

6.4 Properties of conductor

6.4.1 Surface condition

The surface of the conductor shall comply with the requirements of 5.3.

6.4.2 Conductor diameter

The conductor diameter shall be measured either:

(a) midway between the closing die and the capstan on the stranding machine, or

(b) at the middle of a portion of conductor, at least 3 m long and more than 5 m from either end of the conductor, under a tension of at least 2 % of the conductor rated tensile strength.

The diameter shall be the average of two readings, rounded to two decimals of a millimetre, taken at right angles to each other at the same location.

The value obtained shall comply with the requirement of 5.4.

6.4.3 Inertness

The requirement of 5.5.7 shall be met.

6.4.4 Lay ratio and direction of lay

The lay ratio of a given layer of the conductor shall be obtained by dividing the measured lay length by the diameter of the layer.

The values obtained shall comply with the requirements of 5.5. In addition the direction of each layer shall be noted and shall also comply with the requirements of 5.5.

6.4.5 Number and type of wires

The number and type of wires shall be confirmed as being in accordance with the conductor designation stated on the order.

6.4.6 Mass per unit length

The mass per unit length of a 1m sample of conductor shall be determined by using apparatus capable of achieving an accuracy of ± 0,1 %. The value obtained shall comply with the requirement of 5.7.3.

6.4.7 Stress-strain curves

6.4.7.1 If the provision of stress-strain curves is agreed between the manufacturer and purchaser at the time of placing the order, the method described in annex C shall be used.

6.4.7.2 Stress-strain curves shall be supplied as a type test when requested by the purchaser and shall represent the best knowledge of the behaviour of the conductor under load.

6.4.8 Tensile breaking strength

6.4.8.1 The sample length, between end terminations, shall be at least 400 times the conductor diameter but not less than 10 m. A shorter length may be agreed between the manufacturer and purchaser.

6.4.8.2 The breaking strength of the conductor shall be determined by pulling a conductor in a suitable tensile testing machine having an accuracy of at least ± 1 %. The rate of increase of load shall be as in C.6.8 of annex C.

6.4.8.3 At the request of the purchaser, an intermediate load may be held for a period during the test in order to allow tension fittings to be tested at the same time as the conductor.

6.4.8.4 The breaking strength of the conductor shall be determined by the load attained at which one or more wires of the conductor are fractured. The test shall be considered satisfactory if 95 % of the rated tensile strength is reached without the fracture of any wires. If fracture occurs within 5 cm of the end terminations before 95 % of the rated tensile strength has been reached, the fracture shall be deemed to have been caused by the end termination and the test shall be repeated. In this case, a change in the end terminations shall be considered. If a single wire fractures more than 5 cm from the end terminations before 95 % of the rated tensile strength has been reached, two re-tests shall be carried out on samples taken adjacent to the original sample. Both re-tested samples shall withstand 95 % of the rated tensile strength without the fracture of any wire.

6.4.9 Stringing test

Where the purchaser requires evidence that the conductor is capable of being installed using the purchaser's recommended installation method, this may be satisfied by a stringing test, an example of which is given in annex E. Alternative tests or evidence of satisfactory service experience may also be agreed.