BS EN 50143:2009

BSI British Standards

Cables for signs and luminous-discharge-tube installations operating from a no-load rated output voltage exceeding 1 000 V but not exceeding 10 000 V

National foreword

This British Standard is the UK implementation of EN 50143:2009. It supersedes BS EN 50143:1999 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee GEL/20, Electric cables, to Subcommittee GEL/20/17, Low voltage cables.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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EUROPEAN STANDARD

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EN 50143

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Supersedes EN 50143:1997 + A1:2003

English version

Cables for signs and luminous-discharge-tube installations operating from a no-load rated output voltage exceeding 1 000 V but not exceeding 10 000 V

Câbles pour installations d'enseignes et de tubes à décharges lumineuses fonctionnant avec une tension à vide supérieure à 1 000 V mais ne dépassant pas 10 000 V

Leitungen für Leuchtröhrengeräte und Leuchtröhren-Anlagen mit einer Leerlaufspannung von über 1 000 V, aber nicht über 10 000 V

CENELEC

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

Central Secretariat: avenue Marnix 17, B - 1000 Brussels

Ref. No. EN 50143:2009 E

Foreword

This European Standard was prepared by 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 50143 on 2009-02-01.

This European Standard supersedes EN 50143:1997 + A1:2003.

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)	2010-02-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2012-02-01

Contents

Figures

Tables

Introduction

This revision of EN 50143 is made at the request of the European Sign Federation (ESF). It supports EN 50107.

By comparison with EN 50143:1997 the number of cable types has been rationalised. One new type (type L) has been introduced, and four types (types A, C1, D1 and H) withdrawn.

The object of the European Standard remains unchanged, namely:

- to standardise cables and cords that are safe and reliable when properly used in relation to the technical requirements of the installation of which they form a part;

- to state the characteristics and manufacturing requirements directly or indirectly bearing on safety; and

- to specify methods for checking conformity with those requirements.

1 Scope

EN 50143 applies to single core cables of rated voltages up to and including 5/10 kV (U_o/U) used with electric signs and high-voltage luminous-discharge-tube installations. These cables are for use in installations complying with EN 50107.

The particular types of cables are specified in Clauses 7 to 10 of this standard.

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 50107 (series)		Signs and luminous-discharge-tube installations operating from a no-load rated output voltage exceeding 1 kV but not exceeding 10 kV
EN 50267-2-1		Common test methods for cables under fire conditions - Tests on gases evolved during combustion of materials from cables - Part 2-1: Procedures - Determination of the amount of halogen acid gas
EN 50267-2-2	1998	Common test methods for cables under fire conditions - Tests on gases evolved during combustion of materials from cables - Part 2-2: Procedures - Determination of degree of acidity of gases for materials by measuring pH and conductivity
EN 50363-1	2005	Insulating, sheathing and covering materials for low voltage energy cables - Part 1: Cross-linked elastomeric insulating compounds
EN 50363-3	2005	Insulating, sheathing and covering materials for low voltage energy cables - Part 3: PVC insulating compounds
EN 50363-4-1	2005	Insulating, sheathing and covering materials for low voltage energy cables - Part 4-1: PVC sheathing compounds
EN 50395	2005	Electrical test methods for low voltage energy cables
EN 50396	2005	Non electrical test methods for low voltage energy cables
EN 60228		Conductors of insulated cables (IEC 60228)
EN 60332-1-2		Tests on electric and optical fibre cables under fire conditions - Part 1-2: Test for vertical flame propagation for a single insulated wire or cable - Procedure for 1 kW pre-mixed flame (IEC 60332-1-2)
EN 60684-2		Flexible insulating sleeving - Part 2: Methods of test (IEC 60684-2)
EN 60811 (series)		Insulating and sheathing materials of electric and optical cables - Common test methods (IEC 60811 series)
EN 61034-2		Measurement of smoke density of cables burning under defined conditions - Part 2: Test procedure and requirements (IEC 61034-2)

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
type tests (symbol T)
tests required to be made before supplying a type of cable 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 in the cable materials, design or type of manufacturing process which might change the performance characteristics.

3.2
sample tests (symbol S)
tests made on samples of completed cable, or components taken from a completed cable adequate to verify that the finished product meets the design specifications

3.3
routine tests (symbol R)
tests made on all production cable lengths to demonstrate their integrity

4 Rated voltage

The rated voltage of a cable is the reference voltage for which the cable is designed, and which serves to define the electrical tests.

The rated voltage is expressed by the combination of two values U_o/U, expressed in volts:

- U_o being the r.m.s. value between any insulated conductor and "earth" (metal covering of the cable or the surrounding medium);

- U being the r.m.s. value between any two phase-conductors of a system of single-core cables.

In an alternating current system, the rated voltage of a cable shall be at least equal to the nominal voltage of the system for which it is intended.

This condition applies both to the value U_o and to the value U.

In a direct current system, the maximum permanent operating voltage of the system is stated in Table 1.

Table 1 - Maximum permitted voltages against rated voltage of cable in an a.c. system

Rated voltage of cable (U_0/U)	**Maximum permanent permitted operating voltage (a.c.) of the system (Conductor-earth)**
kV	kV max.
2,5/5	2,75
3/6	3,3
5/10	5,5

5 General requirements for the construction of cables

5.1 Conductors

5.1.1 Construction

The classes of the conductors relevant to the various types of cables are given in Clauses 7 to 10.

5.1.2 Check of construction

Compliance with the requirements of 5.1.1, including the requirements of EN 60228, shall be checked by inspection and by measurement.

5.1.3 Electrical resistance

The resistance of each conductor at 20 °C shall be in accordance with the requirements of EN 60228 for the given class of conductor.

Compliance shall be checked by the test given in Clause 5 of EN 50395.

5.2 Insulation

5.2.1 Material

The insulation shall be a compound as specified for each type of cable in Clauses 7 to 10.

The test requirements for these compounds are specified for the particular cable.

Maximum material operating temperatures are stated in the relevant part of EN 50363.

5.2.2 Application to the conductor

The insulation may consist of one or more bonded layers. The insulation shall be so applied that it fits closely on the conductor and it shall be possible to remove the insulation without damage to the remaining insulation, to the conductor, or to the tin coating. If required, compliance shall be checked by inspection and by manual test. The insulation shall be applied by an extrusion process, cross-linked where required, and shall form a compact and homogeneous body.

5.2.3 Thickness

The mean value of the thickness of insulation shall not be less than the specified value for each type and size of cable.

However, the thickness at any one place may be less than the specified value provided that the difference does not exceed 0,1 mm + 10 % of the specified value.

Compliance shall be checked by the test given in 4.1 of EN 50396.

5.3 Oversheath

5.3.1 Material

The oversheath shall be a compound of the type specified for each type of cable in Clauses 7 to 10.

The test requirements for these compounds are specified for the particular cable.

5.3.2 Application

The oversheath shall be extruded.

5.3.3 Thickness

The mean value of the thickness of the oversheath shall not be less than the specified value for each type and size of cable.

However, the thickness at any place may be less than the specified value provided that the difference does not exceed 0,1 mm + 15 % of the specified value.

Compliance shall be checked by the test given in 4.2 of EN 50396.

5.3.4 Overall dimensions

The mean overall dimensions of the cable shall be within the limits specified in the tables for each type and size of cable in Clauses 7 to 10.

The difference between any two values of the overall diameter of sheathed circular cables at the same cross-section (ovality) shall not exceed 15 % of the upper limit specified for the mean overall diameter.

Compliance shall be checked by the test given in 4.4 of EN 50396.

5.4 Non-metallic components of halogen free cables

All non-metallic components of cable types C2 and D2 shall be halogen free. This shall be checked by the procedure given in Annex A, unless otherwise specified for the particular cable.

6 Cable types

6.1 General

Cables to this European Standard shall be one of the following types:

a) Cables with a rated voltage 5 kV/10 kV

B	Silicone rubber insulated cable, unscreened, unsheathed
C2	Silicone rubber insulated cable, unscreened and halogen-free sheathed
D2	Silicone rubber insulated cable, screened and halogen-free sheathed
E	PVC insulated cable, screened with drain wire and with PVC sheath
F	PVC insulated cable, PVC sheathed, or PVC insulated cable with flexible protective conductor and PVC sheathed
G	PVC insulated cable, unscreened, unsheathed

b) Cables with a rated voltage 2,5 kV/5 kV

K	Cable with a reduced thickness composite insulation of polyethylene and PVC

c) Cables with a rated voltage 3 kV/6 kV

L	Silicone rubber insulated cable, unscreened, unsheathed

6.2 Requirements

The cables shall meet the general requirements of Clause 5 and the requirements given in Clauses 7 to 10 for the particular cable.

7 Silicone rubber insulated cables (types B, C2 and D2)

7.1 Construction

7.1.1 Conductor

Number of conductors: 1

The conductors shall comply with the requirements of EN 60228, for class 5 conductors.

The wires shall be tinned annealed copper.

7.1.2 Insulation

The insulation shall be silicone rubber compound of type EI 2 to EN 50363-1 applied around the conductor by extrusion.

The thickness of the insulation shall comply with the specified value given in Table 2, column 2.

7.1.3 Braided screen

When a braided screen is required (cable type D2) it shall consist of tinned annealed copper wires of 0,2 mm nominal diameter.

The braid shall cover at least 84 % of the surface area of the core.

NOTE A separator tape of suitable material may be used under and/or over the braid.

7.1.4 Sheath

The sheath of type C2 and D2 cables shall be a halogen-free compound type ZM 1, complying with the requirements given in Annex C, applied around the core by extrusion in a single layer.

The thickness of sheath shall comply with the specified value given in Table 2, column 5.

The sheath shall be capable of being removed without damage to the core insulation or metallic screen.

7.1.5 Overall diameter

The mean overall diameter shall be within the limits given in Table 2, columns 6 and 7.

7.2 Tests

7.2.1 General

Compliance with the requirements of 7.1 shall be checked by inspection and by the tests given in Tables 3 and 4.

The requirements to be met for the compatibility test shall be as given in Annex D.

7.2.2 Smoke emission of cable

When tested in accordance with the method and procedure given in EN 61034-2, cables of types C2 and D2 shall exceed 60 % light transmittance throughout the test.

7.3 Maximum continuous conductor temperature

For type B cable the maximum continuous conductor temperature in operation is 180 °C.

For cables type C2 and D2 the maximum continuous conductor temperature in operation is 90 °C.

NOTE Where cables type C2 and D2 are installed with the sheath removed, the temperature may be raised to 180 °C.

Table 2 - General data for cables type B, C2 and D2 to EN 50143

1	2	3	4	5	6	7	8
Cable type	**Nominal cross-sectional area of conductor**	**Thickness of insulation**	**Screen**	**Thickness of sheath**	**Overall diameter**		**Insulation resistance at 20 °C minimum**
			Diameter of braid wire		min.	max.	
	mm²	mm	mm	mm	mm	mm	MΩ.km
B	1,0	2,5	-	-	6,0	7,2	7 500
C2	1,0	2,5	-	0,9	7,8	9,0	7 500
D2	1,0	2,5	0,2	0,9	8,8	10,2	7 500

Table 3 - Tests for cables type B, C2 and D2 to EN 50143

1	2	3	4	5
Ref. no.	**Tests**	**Category of test**	**Test method described in**	
			EN	**(Sub)clause**
1	**Electrical tests**			
1.1	Resistance of conductors	T, S	50395	5
1.2	Voltage test on completed cable at 15 kV for 5 min:			
	- screened	T, S	50143	E.1.1 & E.1.2
	- unscreened	T, S	50143	E.1.1 & E.1.3
1.3	Long term resistance to breakdown at 20 kV and at –20 °C	T	50143	E.2
1.4	Insulation resistance at 20 °C	T, S	50395	8.1
1.5	Absence of faults on insulation	R	50395	10
1.6	Absence of faults on sheath	R	50395	10
2	**Provisions covering constructional and dimensional characteristics**			
2.1	Checking of compliance with constructional provisions	T, S	50143	Inspection and manual tests
2.2	Measurement of insulation thickness	T, S	50396	4.1
2.3	Percentage cover of braid	T, S	50143	F.2
2.4	Measurement of sheath thickness	T, S	50396	4.2
2.5	Measurement of overall diameter:			
2.5.1	- mean value	T, S	50396	4.4
2.5.2	- ovality	T, S	50396	4.4
3	**Insulation material tests**	T	50363-1 [a]	-
4	**Sheath material tests**	T	50143	Annex C
5	**Compatibility test**	T	60811-1-2	8.1.4
6	**Impact test at low temperature**	T	60811-1-4	8.5
7	**Tests under fire conditions**			
7.1	Test on single vertical cable	T	60332-1-2	-
7.2	Smoke emission	T	61034-2	-
8	**Assessment of halogens for all non-metallic materials**	T, S	50143	Annex A

[a] This European Standard includes all the test methods and requirements for the material. Material to be tested is taken from the finished cable.

Table 4 - List of applicable tests for cables type B, C2 and D2

1	2	3	4	5
Ref. no.	**Tests**	**Applicability of test Cable type**		
		B	**C2**	**D2**
1	**Electrical tests**			
1.1	Resistance of conductors	X	X	X
1.2	Voltage test on complete cable at 15 kV for 5 min:			
	- screened	-	-	X
	- unscreened	X	X	-
1.3	Long term resistance to breakdown at 20 kV and –20 °C	-	X [a]	X
1.4	Insulation resistance at 20 °C	X	X	X
1.5	Absence of faults on insulation	X	X	X
1.6	Absence of faults on sheath	-	X	X
2	**Constructional and dimensional tests**			
2.1	Checking of compliance with constructional provisions	X	X	X
2.2	Measurement of thickness of insulation	X	X	X
2.3	Percentage cover of braid	-	-	X
2.4	Thickness of sheath	-	X	X
2.5	Measurement of overall diameter	X	X	X
3	**Insulation material tests**	X	X	X
4	**Sheath material tests**	-	X	X
5	**Compatibility test**	-	X	X
6	**Impact test**			
6.1	- at -5 °C	X	-	-
6.2	- at -25 °C	-	X	X
7	**Tests under fire conditions**			
7.1	Test on single vertical cable	X	X	X
7.2	Smoke emission of cable	-	X	X
8	**Assessment of halogens for all non-metallic materials**	-	X	X

[a] Not applicable if the optional drain wire is present.

8 PVC insulated cables (types E, F and G)

8.1 Construction

8.1.1 Conductor

Number of conductors: 1

The conductors shall comply with the requirements of EN 60228 for Class 5 conductors.

The wires shall be of tinned annealed copper.

8.1.2 Insulation

The insulation shall be polyvinyl chloride compound of type TI 1 to EN 50363-3 applied around the conductor by extrusion in a single layer.

The thickness of insulation shall comply with the specified value given in Table 5, column 3.

8.1.3 Metallic tape screen (type E only)

The screen shall consist of a folded zinc tape, the thickness of which shall be approximately 0,25 mm.

The tape shall fit closely to the insulated core and shall give complete cover. The tape may be corrugated.

8.1.4 Drain wire (types E and F)

For type E cables a 1,5 mm² tinned drain wire consisting of parallel or bunched individual strands of about 0,3 mm diameter shall be applied longitudinally, either over or under the screen of folded zinc tape, and in contact with the tape.

Type F cables may have a drain wire applied under the PVC sheath.

8.1.5 Sheath

The sheath shall be polyvinyl chloride compound of type TM 1 to EN 50363-4-1 applied around the core by extrusion in a single layer.

The thickness of sheath shall comply with the specified value given in Table 5, column 5.

The sheath shall be capable of being removed without damage to the insulation, the drain wire or metal screen.

8.1.6 Overall diameter

The mean overall diameter shall be within the limits given in Table 5, columns 8 and 9.

8.2 Tests

Compliance with the requirements of 8.1 shall be checked by inspection and by the tests given in Tables 6 and 7.

The requirements to be met for the compatibility test shall be as given in Annex D.

8.3 Maximum continuous conductor temperature

For cables type E, F and G the maximum continuous conductor temperature in operation is 70 °C.

Table 5 - General data for cables type E, F and G to EN 50143

1	2	3	4	5	6	7	8	9	10
Cable type	**Nominal cross-sectional area of conductor**	**Thickness of insulation**	**Screen approximate thickness**	**Thickness of sheath**	**Drain wire [a]**		**Overall diameter**		**Insulation resistance (min.) at 70 °C**
					Nominal cross-sectional area	**Diameter of individual wires approx.**	min.	max.	
	mm²	mm	mm	mm	mm²	mm	mm	mm	MΩ.km
E	1,5	2,5	0,25	1,0	1,5	0,3	9,5	11,5	0,022 5
F [a]	1,5	2,5	-	1,0	1,5	0,3	8,5	10,5	0,022 5
G	1,5	2,5	-	-	-	-	6,2	7,5	0,022 5

[a] For cable type F the drain wire is optional.

Table 6 - Tests for cables type E, F and G to EN 50143

1	2	3	4	5
Ref. no.	**Tests**	**Category of test**	**Test method described in**	
			EN	**(Sub)clause**
1	**Electrical tests**			
1.1	Resistance of conductors	T, S	50395	5
1.2	Voltage test on complete cable at 15 kV for 5 min:			
1.2.1	- screened	T, S	50143	E.1.1 & E.1.2
1.2.2	- unscreened	T, S	50143	E.1.1 & E.1.3
1.3	Long term resistance to breakdown at 20 kV and -20 °C	T	50143	E.2
1.4	Insulation resistance at 70 °C	T, S	50395	8.1
1.5	Long term resistance of insulation to d.c.	T	50395	9
1.6	Absence of faults on insulation	R	50395	10
1.7	Absence of faults on sheath	R	50395	10
2	**Constructional and dimensional tests**			
2.1	Checking of compliance with constructional provisions	T, S	50143	Inspection and manual tests
2.2	Measurement of thickness of insulation	T, S	50396	4.1
2.3	Thickness of metallic tape screen	T, S	50143	F.1
2.4	Thickness of sheath	T, S	50396	4.2
2.5	Measurement of overall diameter:			
2.5.1	- mean value	T, S	50396	4.4
2.5.2	- ovality	T, S	50396	4.4
3	**Insulation material tests**	T	50363-3 [a]	-
4	**Sheath material tests**	T	50363-4-1 [a]	-
5	**Compatibility test**	T	60811-1-2	8.1.4
6	**Impact test at -5 °C**	T	60811-1-4	8.5
7	**Test under fire conditions**			
7.1	Test on single vertical cable	T	60332-1-2	-

[a] This European Standard includes all the test methods and requirements for the material. Material to be tested is taken from the finished cable.

Table 7 - List of applicable tests for cables type E, F and G

1	2	3	4	5
Ref. no.	**Tests**	**Applicability of test Cable type**		
		E	**F**	**G**
1	**Electrical tests**			
1.1	Resistance of conductors	X	X	X
1.2	Voltage test on complete cable at 15 kV for 5 min:			
	- screened	X	-	-
	- unscreened	-	X	X
1.3	Long term resistance to breakdown at 20 kV and –20 °C	-	X [a]	X
1.4	Insulation resistance at 70 °C	X	X	X
1.5	Long term resistance of insulation to d.c.	X	X	X
1.6	Absence of faults on insulation	X	X	X
1.7	Absence of faults on sheath	X	-	-
2	**Constructional and dimensional tests**			
2.1	Checking of compliance with constructional provisions	X	X	X
2.2	Measurement of thickness of insulation	X	X	X
2.3	Thickness of metallic tape screen	X	-	-
2.4	Thickness of sheath	X	X	-
2.5	Measurement of overall diameter	X	X	X
3	**Insulation material tests**	X	X	X
4	**Sheath material tests**	X	X	-
5	**Compatibility test**	X	X	-
6	**Impact test at -5 °C**	X	X	X
7	**Test under fire conditions**			
7.1	Test on single vertical cable	X	X	X

[a] Not applicable if the optional drain wire is present.

9 Cables with a composite insulation of polyethylene and PVC (type K)

9.1 Construction

9.1.1 Conductors

Number of conductors: 1

The conductors shall comply with the requirements of EN 60228 for class 5 conductors.

The wires shall be of tinned annealed copper.

9.1.2 Insulation

The insulation shall be applied in two layers, the inner layer of polyethylene complying with the requirements of Annex G of this part and the outer layer of polyvinyl chloride compound type TI 2 to EN 50363-3. The insulation, when tested as a complete sample, shall comply with all the requirements of this clause.

The thickness of insulation shall comply with the specified value given in Table 8, column 2.

The thickness of the inner layer of polyethylene shall be not less than 60 %, and not more than 80 % of the specified value for the complete insulation.

9.1.3 Overall diameter

The mean overall diameter shall be within the limits given in Table 8, columns 3 and 4.

9.2 Tests

Compliance with the requirements of 9.1 shall be checked by inspection and by the tests given in Table 9.

The requirements to be met for the compatibility test shall be as given in Annex D.

9.3 Maximum continuous conductor temperature

For cable type K the maximum continuous conductor temperature in operation is 60 °C.

Table 8 - Dimensions of cables type K to EN 50143

1	2	3	4
Nominal cross-sectional area of conductor	**Thickness of insulation**	**Overall diameter**	
		min.	max.
mm²	mm	mm	mm
1,0	1,5	4,0	4,8

Table 9 - Tests for cables type K to EN 50143

1	2	3	4	5
Ref. no.	**Tests**	**Category of test**	**Test method described in**	
			EN	**(Sub)clause**
1	**Electrical tests**			
1.1	Resistance of conductors	T, S	50395	5
1.2	Voltage test on completed cable at 7,5 kV for 5 min	T, S	50143	E.1.1 & E.1.3
1.3	Long term resistance to breakdown at 10 kV and at –20 °C	T	50143	E.2
1.4	Absence of faults on insulation	R	50395	10
2	**Provisions covering constructional and dimensional characteristics**			
2.1	Checking of compliance with constructional provisions	T, S	50143	Inspection and manual tests
2.2	Measurement of insulation thickness	T, S	50396	4.1
2.3	Measurement of overall diameter:			
2.3.1	- mean value	T, S	50396	4.4
2.3.2	- ovality	T, S	50396	4.4
3	**Insulation material tests**	T	Annex F & 50363-3 [a]	-
4	**Compatibility test**	T	60811-1-2	8.1.4
5	**Impact test at –5 °C**	T	60811-1-4	8.5

[a] This European Standard includes all the test methods and requirements for the material. Material to be tested is taken from the finished cable.

10 Silicone rubber insulated cables (type L)

10.1 Construction

10.1.1 Conductor

Number of conductors: 1

The conductors shall comply with the requirements of EN 60228, for class 5 conductors.

The wires shall be tinned annealed copper.

10.1.2 Insulation

The insulation shall be silicone rubber compound of type EI 2 to EN 50363-1 applied around the conductor by extrusion.

10.1.3 Overall diameter

The mean overall diameter shall be within the limits given in Table 10, columns 2 and 3.

10.2 Tests

Compliance with the requirements of 10.1 shall be checked by inspection and by the tests given in Table 11.

10.3 Maximum continuous conductor temperature

For type L cable the maximum continuous conductor temperature in operation is 180 °C.

Table 10 - General data for cables type L to EN 50143

1	2	3	4
Nominal cross-sectional area of conductor	**Overall diameter**		**Insulation resistance at 20 °C minimum**
	min.	max.	
mm²	mm	mm	MΩ.km
1,0	5,0	n/s	7 500
NOTE n/s = not specified.			

Table 11 - Tests for cables type L to EN 50143

1	2	3	4	5
Ref. no.	**Tests**	**Category of test**	**Test method described in**	
			EN	**(Sub)clause**
1	**Electrical tests**			
1.1	Resistance of conductors	T, S	50395	5
1.2	Voltage test on completed cable at 7,5 kV for 5 min	T, S	50143	E.1.1 & E.1.3
1.3	Long term resistance at 10 kV to breakdown at –20 °C	T	50143	E.2
1.4	Insulation resistance at 20 °C	T, S	50395	8.1
1.5	Absence of faults on insulation	R	50395	10
2	**Provisions covering constructional and dimensional characteristics**			
2.1	Checking of compliance with constructional provisions	T, S	50143	Inspection and manual tests
2.2	Measurement of overall diameter:			
2.2.1	- mean value	T, S	50396	4.4
2.2.2	- ovality	T, S	50396	4.4
3	**Insulation material tests**	T	50363-1 [a]	-
4	**Impact test at –25 °C**	T	60811-1-4	8.5
5	**Tests under fire conditions**			
5.1	Test on single vertical cable	T	60332-1-2	-

[a] This European Standard includes all the test methods and requirements for the material. Material to be tested is taken from the finished cable.

11 Test methods

11.1 General

The methods of carrying out the tests specified in this European Standard are given in EN 50395, EN 50396, EN 60228, EN 60332-1-2, EN 60811, EN 61034-2 and in the relevant annexes of this European Standard.

The tests applicable to each type of cable are given in the particular clause.

11.2 Classification of test according to the frequency with which they are carried out

The tests specified are type tests (symbol T) and/or sample tests (symbol S) and/or routine tests (symbol R) as defined in Clause 3. The symbols T, S and R are used in the relevant tables for the particular cables in Clauses 7 to 10.

11.3 Sampling

If a mark is indented in the insulation or sheath, the samples used for the tests shall be taken so as to include marking.

11.4 Pre-conditioning

All the tests shall be carried out not less than 16 h after the extrusion, or cross-linking (if any), of the insulation or sheathing compounds.

11.5 Test temperature

Unless otherwise specified, tests shall be made at ambient temperature.

11.6 Test voltage

Unless otherwise specified, the test voltages shall be a.c. 49 Hz to 61 Hz of approximately sine wave form, the ratio peak value/r.m.s value being equal to $\sqrt{2}$ with a tolerance of ± 7 %.

All a.c. test voltages quoted are r.m.s values.

12 Marking

12.1 Indication of origin

Cables shall be provided with an identification of origin consisting of either

a) the manufacturer's identification thread, or

b) the continuous marking of the manufacturer's name or trademark, or (if legally protected) identified by one of the following alternative methods:
   - printed tape within the cable;
   - printing, indenting or embossing on the outer surface of the cable.

12.2 Indication of cable type and rated voltage

Each cable shall be marked with the standard number (EN 50143), the cable type, as designated by 6.1, and the rated voltage in volts.

EXAMPLE Cable type B, the marking shall be:
EN 50143-B-5000V/10000V

The marking shall be by one of the methods given in 12.1.

12.3 Continuity of marks

Unless otherwise specified in the particular specification, each specified mark shall be regarded as continuous if the distance between the end of one complete set of marks and the beginning of the next identical mark does not exceed

- 550 mm if the marking is on the outer surface of the cable,
- 275 mm if the marking is on the insulation or on a tape.

NOTE A "specified mark" is any mandatory mark covered by this European Standard.

Figure 1 shows an example of the marking as used on the outer surface of the cable.

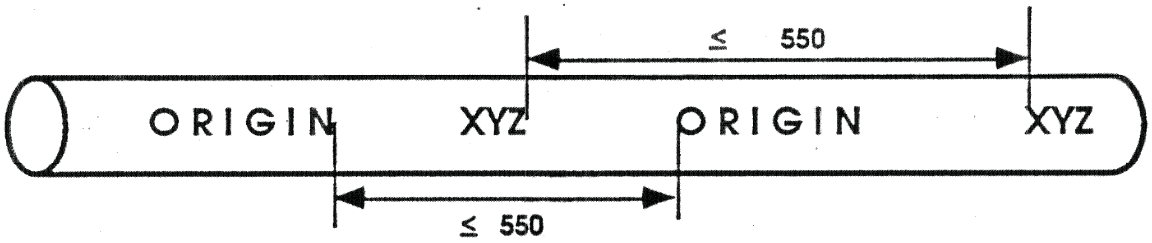

Figure 1 - Example of marking used on the outer surface of a cable

12.4 Additional marking

Additional marking may be specified in the particular specifications.

12.5 Durability

Mandatory printed markings shall be durable.

Compliance with this requirement shall be checked by trying to remove the marking of the manufacturer's name or trademark or numerals by rubbing lightly ten times with a piece of cotton wool or cloth soaked in water.

12.6 Legibility

All markings shall be legible. Printed markings shall be in contrasting colours.

The colours of the identification thread shall be easy to recognise or easily be made recognisable, if necessary, by cleaning with a suitable solvent.

12.7 Use of the name CENELEC

The name CENELEC, in full or abbreviated, shall not be directly marked on, or in, the cables.

13 **Guide to use** (informative)

Guidance on the safe and correct usage of the cables in this European Standard is given in EN 50107.

Annex A
(normative)

Requirements for halogens

A.1 Requirements for extruded material - Type and sample test

The insulation and sheath shall meet the following requirements:

a) Type test

The material shall be tested to all the tests in Table A.1.

Table A.1 - Test method, measurement, requirements

	Test method	Measurement	Requirements
1	EN 50267-2-2	pH and conductivity	pH ≥ 4,3 and conductivity ≤ 10 µS/mm
2	EN 50267-2-1	Chlorine and bromine content expressed as HCl	≤ 0,5 %
3a	EN 50143, Annex B	Halogen: fluorine	If negative: stop test; no further test needed. Accept material.
			If positive: do test according to 3b.
3b	EN 60684-2	Fluorine content	≤ 0,1 %

b) Sample test

The material shall be tested to the sequential test programme in Table A.2.

Table A.2 - Sequential test programme

	Test method	Measurement	Result	Outcome
Stage 0	EN 50143, Annex B	Halogen: Fluorine, Chlorine and Bromine		If negative: stop test; no further test needed Accept material
				If positive: continue with stage 1
Stage 1	EN 50267-2-2	pH	< 4,3	Reject material
			≥ 4,3	Evaluate conductivity
		Conductivity	≤ 2,5 µS/mm	Accept material No further testing needed
		Conductivity	> 10 µS/mm	Reject material
		Conductivity (s)	> 2,5 µS/mm but ≤ 10 µS/mm	Test to EN 50267-2-1
Stage 2	EN 50267-2-1	Chlorine and bromine Content expressed as HCl	> 0,5 %	Reject material
			≤ 0,5 %	Test to EN 60684-2
Stage 3	EN 60684-2	Fluorine content	> 0,1 %	Reject material
			≤ 0,1 %	Accept material

A.2 Requirements for non-extruded materials - Type and sample test

The materials shall meet the following requirements:

If the combined mass of all non-extruded materials (including separator tapes and fillers) is ≤ 5 % wt/wt of the total combustible material in the cable, the test to EN 50267-2-2 (Table A.1, no. 1) shall be carried out on each component of materials. Each component shall meet the requirements for pH and conductivity of ≥ 4,3 and ≤ 10 µS/mm, respectively.

A layer comprising a number of tapes of the same material shall be regarded as one component.

If the combined mass of separator tapes and fillers is > 5 % wt/wt of the total combustible materials, then each of the components shall meet the requirements for extruded material according to Table A.1.

For the test according to 3a of Table A.1, the sample may be prepared from all tapes. If the result is positive, it must be repeated on each component.

Annex B
(normative)

Determination of halogens - Elemental test

Warning

Owing to its potentially hazardous nature, the fusion operation should be carried out in a fume cupboard, using a safety screen.

B.1 Equipment

- Bunsen burner

- 3 small/medium soda glass test tubes (approximately 50 mm x 10 mm)

- Test tube holder

- Evaporating basin/mortar

- Wire gauze

- Funnel

- Filter paper

B.2 Materials

- Unknown sample

- Sodium metal

- Dilute nitric acid (5 %)

- Aqueous silver nitrate (5 %)

- Dilute ammonia (10 %)

- Freshly made up zirconium-alizarin red S reagent

- Glacial acetic acid

- Acid/pH indicator papers

B.3 Procedure

B.3.1 Sodium fusion

Place 200 mg – 250 mg of the sample into the bottom of a small soda glass test tube. Add 10 ml of distilled/de-ionized water to the evaporating basin and place this in the fume cupboard behind the safety screen. Whilst holding the test tube firmly with the test tube holder at an angle of 45° – 60° to the vertical, introduce a piece of freshly cut, clean sodium (about the size of a small pea) (200 mg – 250 mg) into the mouth of the test tube without allowing it to come into contact with the sample. With the safety screen in place, heat the sodium gently until it melts and runs down on to the sample (there may be a vigorous reaction when the molten sodium reaches the sample if halogens are present). Heat the tube gently for about 1 min, then more strongly until the lower 20 mm of the tube glows red hot. Plunge the red hot tube into the water in the evaporating basin, immediately placing the gauze on top. (The gauze prevents any loss of material when the tube shatters on contact with the water.) Allow any unreacted sodium to react before grinding up the solution and glass. Filter, and separate the filtrate into two equal portions.

B.3.2 Chlorine and Bromine

To the first portion of the filtrate, add sufficient nitric acid to make the solution acidic. Boil this solution until its total volume has been reduced by half (this is to remove any HCN or H_2S, if present, which would interfere with the test). Add 1 ml silver nitrate solution; a white or yellowish-white precipitate indicates the presence of halogen (Cl, Br) in the original sample. (If the liquor is decanted, and the precipitate is white and readily soluble in dilute ammonia, then chloride is present.)

B.3.3 Fluorine

To the second portion of the filtrate, acidify with glacial acetic acid. Boil this solution until its total volume has been reduced by half. Add 2 to 3 drops freshly prepared zirconium lake reagent (equal volumes of: a) Alizarin solution: 0,05 g Alizarin Red-S in 50 ml distilled water, b) Zirconium solution: 0,05 g zirconium nitrate in 10 ml concentrated HCl diluted with 50 ml distilled water). Heat at 40 °C for 1 h. The presence of fluoride is indicated by the red/pink colouration being bleached to yellow.

Annex C
(normative)

Requirements for the non-electrical tests for type ZM 1 sheath

Table C.1

1	2	3	4	5	6
Ref. no.	**Test**	**Unit**	**Type of compound**	**Test method described in**	
			ZM 1	**EN**	**(Sub)clause**
1	**Tensile strength and elongation at break**				
1.1	Properties in the state as delivered			60811-1-1	9.2
1.1.1	Values to be obtained for the tensile strength: - median, min.	N/mm²	9		
1.1.2	Values to be obtained for the elongation at break: - median, min.	%	100		
1.2	Properties after ageing in air			60811-1-2	8.1.3.1
1.2.1	Ageing conditions: - temperature - duration of treatment	°C h	100 ± 2 10 x 24		
1.2.2	Values to be obtained for the tensile strength: - median, min. - variation [a], max.	N/mm² %	- - 30		
1.2.3	Values to be obtained for the elongation at break: - median, min. - variation [a], max.	% %	100 ± 40		
2	**Heat shock test**			60811-3-1	9.2
2.1	Test conditions: - temperature - duration of treatment	°C h	130 ± 2 1		
2.2	Result to be obtained		Absence of cracks		
3	**Pressure test at high temperature**			60811-3-1	8.2
3.1	Test conditions: - force exerted by the blade - duration of heating under load - temperature	N h °C	[b] [b] 80 ± 2	60811-3-1 60811-3-1	8.2.4 8.2.5
3.2	Result to be obtained: - median of the depth of indentation, maximum	%	50		

Table C.1 *(continued)*

1	2	3	4	5	6
Ref. no.	**Test**	**Unit**	**Type of compound**	**Test method described in**	
			ZM 1	**EN**	**(Sub)clause**
4	**Bending test at low temperature**			60811-1-4	8.2
4.1	Test conditions:				
	- temperature	°C	- 15 ± 2		
	- period of application of low temperature	h		60811-1-4	8.2.3
4.2	Result to be obtained		Absence of cracks		
5	**Assessment of halogens**				
5.1	pH, min.		4,3	50267-2-2	
5.2	Conductivity, max.	µS/mm	10,0	50267-2-2	
5.3	Amount of halogen acid gas:				
	- HCl and HBr, max.		0,5	50267-2-1	
	- HF, max. [c]		0,1	60684-2	

[a] Variation: difference between the median value after ageing and the median value without ageing, expressed as a percentage of the latter.

[b] See test method referred to in columns 5 and 6.

[c] This test need not be performed if a negative result is obtained for fluorine in the test to Annex A.

Annex D
(normative)

Requirements for the compatibility test

D.1 Test conditions

The sample shall be aged in accordance with the designated test method, and:

- for 7 days at (80 ± 2) °C for TI 1, PE, TI 2 and TM 1;

- for 10 days at (100 ± 2) °C for EI 2 and ZM 1.

D.2 Requirements

At the conclusion of the ageing period the insulation and sheath shall meet the requirements given in Table D.1 below.

Table D.1 - Requirements

Parameter		Units	Insulation				Sheath	
			TI 1	PE	TI 2	EI 2	TM 1	ZM 1
Tensile strength	- median, min.	N/mm^2	12,5	10	10,0	4,0	12,5	-
	- variation [a], max.	%	± 20	± 30	± 20	-	± 20	- 30
Elongation at break	- median, min.	%	125	300	150	120	125	100
	- variation [a], max.	%	± 20	± 30	± 20	-	± 20	± 40

[a] The variation is the difference between the respective values obtained prior to and after ageing, expressed as a percentage of the former.

Annex E
(normative)

Electrical test methods

E.1 Voltage tests for complete cable

E.1.1 General

The voltage and test duration shall be as given for the particular single-core cable. The test value shall be achieved within 1 min and the duration shall be taken from when the specified voltage is reached. Unless otherwise specified voltage tests are to be carried out at ambient temperature.

E.1.2 Screened cables

On screened cables, the test voltage shall be applied between the conductors and the metallic screen, which shall be earthed.

E.1.3 Unscreened cables

Unscreened cables shall be immersed in water at room temperature for 12 h and the test voltage then applied between conductor and water.

E.2 Long term resistance to breakdown

E.2.1 General

Samples of unscreened cable of minimum length 500 mm and having completed the test of E.1.3 shall be subjected to a long term breakdown test at a temperature of (-20 ± 2) °C for a period of 200 h without breakdown. The voltage to be applied is given in the particular specification.

E.2.2 Apparatus

A "V" shaped-trough of insulating material approximately 400 mm long with each edge 10 mm long shall have 3 slots cut out at distances of 100 mm, 200 mm and 300 mm from one end. The slots shall be (2 ± 0,2) mm wide and cut to within (3 ± 0,2) mm of the angle (see Figure E.1).

E.2.3 Method

The cable samples shall be laid in the trough, and copper wires with a diameter of (1,78 ± 0,1) mm, preformed so that they are in contact with at least half the circumference of the cable, shall be laid in the slots. The assembly shall be placed in a suitable low temperature chamber. The wires shall be connected together and earthed. The test voltages shall be applied between the cable conductor and the earthed wires (see Figure E.2).

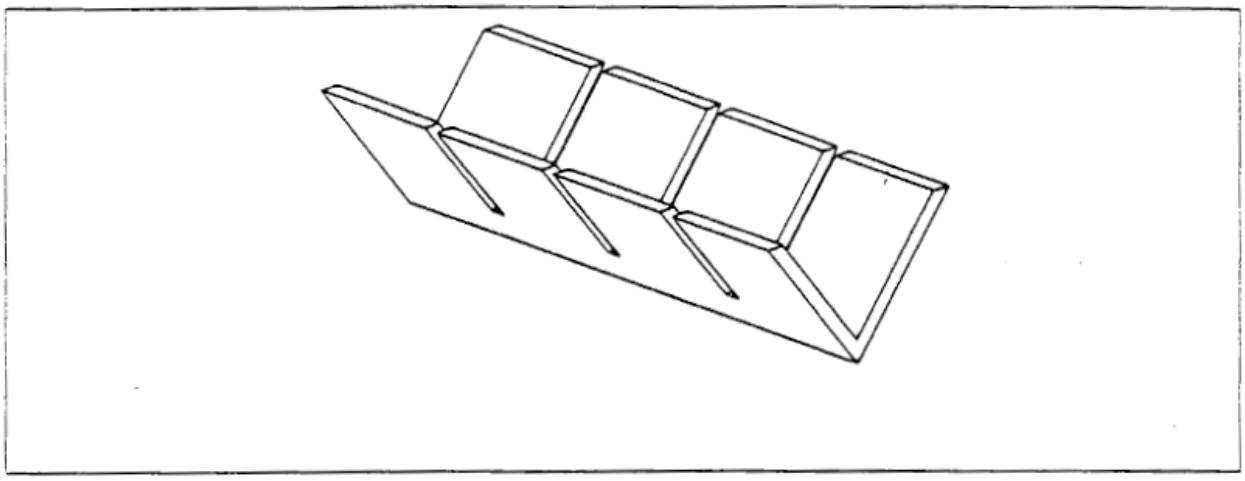

Figure E.1 - Cable trough

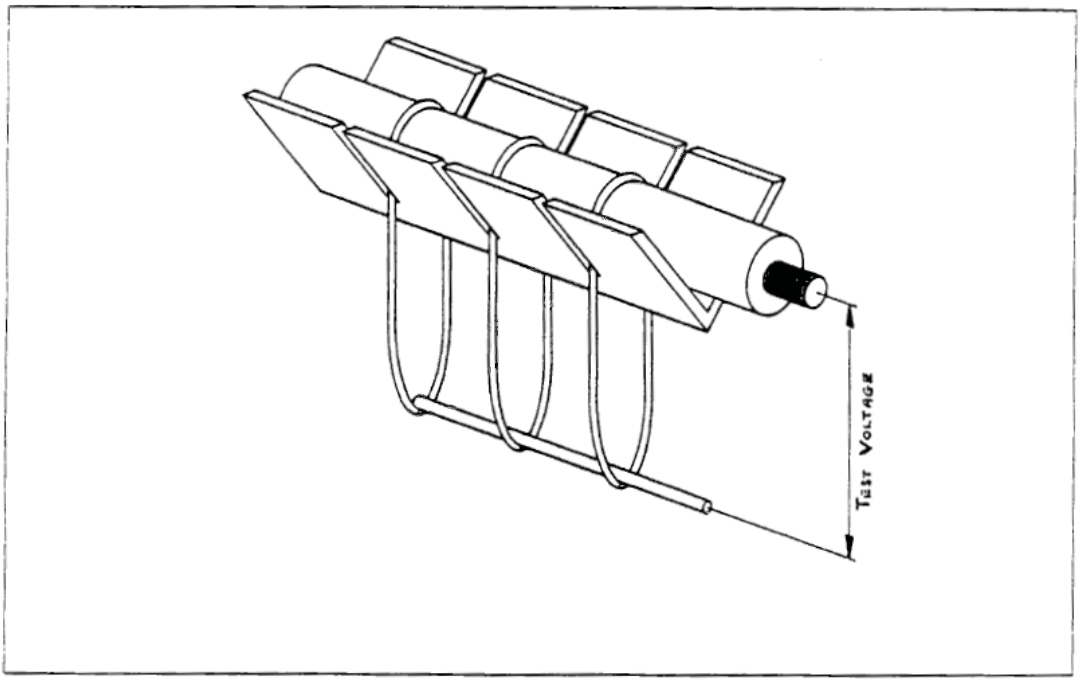

Figure E.2 - Test arrangement for resistance to long term breakdown

Annex F
(normative)

Non-electrical test methods

F.1 Measurement of thickness of metallic tapes

Take and straighten a sample of each metallic tape, remove the non-metallic coating if any, and determine the tape thickness at six different places by using a micrometer or Vernier calliper with flat noses. Take the smallest value to be compared with the specified thickness with a tolerance given in the particular specification.

F.2 Percentage coverage of a braided metallic layer

The percentage coverage "*B*" of the braiding shall be calculated by the following formula:

$$B = \frac{100d}{q}\left(m_1 n_1 + m_2 n_2 - m_1 n_1 m_2 n_2 \frac{d}{q}\right) \quad \text{(F.1)}$$

where

$$q = \frac{\pi DS}{\sqrt{\pi^2 D^2 + S^2}} \quad \text{(F.2)}$$

D = mean diameter of braiding (= diameter over sheath + 2d), mm

d = nominal diameter of the wires of the braid, mm

S = lay of the wires of the braiding, mm

m_1 = number of spindles in one direction

m_2 = number of spindles in the other direction

n_1/n_2 = number of wires per spindle

Annex G
(normative)

Requirements for the non-electrical tests for polyethylene insulation

Table G.1

1	2	3	4	5	6
Ref no.	**Test**	**Units**	**Polyethylene layer**	**Test method described in**	
				EN	**(Sub)clause**
1	**Tensile test without ageing**			60811-1-1	9.1
1.1	Ultimate tensile strength				
	- median, min.	N/mm²	10		
1.2	Elongation at break				
	- median, min.	%	300		
2	**Tensile test after ageing of complete cable in air oven (compatibility)**			60811-1-2	8.1.4
2.1	Temperature of oven	°C	80 ± 2		
	Duration of ageing	h	7 x 24		
2.2	Ultimate tensile strength				
	- median, min.	N/mm²	10		
	- variation, max.	%	± 30		
2.3	Elongation at break				
	- median, min.	%	300		
	- variation, max.	%	± 30		

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