الهيئة السعودية للمواصفات والمقاييس والجودة

Saudi Standards, Metrology and Quality Org (SASO)

FINAL DRAFT

SASO/FDS/IEC 60227-1:2020

IEC 60227-1:2007

الكابلات المعزولة بعديد كلوريد الفينيل لجهود مقننة حتى ٤٥٠/٧٥٠ فولت – الجزء ١: المتطلبات العامة

Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V - Part 1: General requirements

ICS: 29.060.20

THIS DOCUMENT IS A DRAFT SAUDI STANDARD CIRCULATED FOR COMMENT. IT IS, THEREFORE SUBJECT TO CHANGE AND MAY NOT BE REFERRED TO AS A SAUDI STANDARD UNTIL APPROVED BY THE BOARD OF DIRECTORS.

Foreword

Saudi Standards, Metrology and Quality Organization (SASO) has adopted Standard No. (IEC 60227-1:2007) “Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V - Part 1: General requirements" issued by (IEC) in English. This standard has been approved as a Saudi Standard with national modifications.

This SASO IEC 60227-1:2020 standard is a modified adoption of International Standard IEC 60227-1:2007, (Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V - Part 1: General requirements). Standard has been varied as indicated to take account of Kingdom of Saudi Arabia conditions. The modifications are specified in Annex AA and Annex AB.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

POLYVINYL CHLORIDE INSULATED CABLES OF RATED VOLTAGES UP TO AND INCLUDING 450/750 V –

Part 1: General requirements

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60227-1 has been prepared by IEC technical committee 20: Electric cables.

This third edition of IEC 60227-1 cancels and replaces the second edition, published in 1993, amendment 1 (1995) and amendment 2 (1997) The document 20/903/FDIS, circulated to the National Committees as amendment 3, led to the publication of this new edition.

The text of this standard is based on the second edition, its amendments 1 and 2, and the following documents:

FDIS	Report on voting
20/903/FDIS	20/910/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

POLYVINYL CHLORIDE INSULATED CABLES OF RATED VOLTAGES UP TO AND INCLUDING 450/750 V –

Part 1: General requirements

1 General

1.1 Scope

This part of International Standard IEC 60227 applies to rigid and flexible cables with insulation, and sheath if any, based on polyvinyl chloride, of rated voltages U_0/U up to and including 450/750 V used in power installations of nominal voltage not exceeding 450/750 V a.c.

NOTE For some types of flexible cables the term cord is used.

The particular types of cables are specified in IEC 60227-3, IEC 60227-4, etc. The code designations of these types of cables are given in Annex A.

The test methods specified in Parts 1, 3, 4, etc. are given in IEC 60227-2, IEC 60332-1-2 and in the relevant parts of IEC 60811.

1.2 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.

IEC 60173, *Colours of the cores of flexible cables and cords*

IEC 60227-2, *Polyvinyl chloride insulated cables of rated voltage up to and including 450/750 V – Part 2: Test methods*

IEC 60227-3, *Polyvinyl chloride insulated cables of rated voltage up to and including 450/750 V – Part 3: Non-sheathed cables for fixed wiring*

IEC 60227-4, *Polyvinyl chloride insulated cables of rated voltage up to and including 450/750 V – Part 4: Sheathed cables for fixed wiring*

IEC 60227-5, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 5: Flexible cables (cords)*

IEC 60228, *Conductors of insulated cables*

IEC 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 60811-1-1, *Common test methods for insulating and sheathing materials of electric cables and optical cables – Part 1: Methods for general application –Measuring of thickness and overall dimensions – Tests for determining the mechanical properties*

IEC 60811-1-2, *Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section Two: Thermal ageing methods*

IEC 60811-1-4, *Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section Four: Tests at low temperature*

IEC 60811-3-1, *Common test methods for insulating and sheathing materials of electric cables – Part 3: Methods specific to PVC compounds – Section One: Pressure test at high temperature – Tests for resistance to cracking*

IEC 60811-3-2, *Common test methods for insulating and sheathing materials of electric cables – Part 3: Methods specific to PVC compounds – Section Two: Loss of mass test – Thermal stability tests*

IEC 62440, *Electric cables – Guide to use for cables with a rated voltage not exceeding 450/750V*[1]

2 Definitions

For the purpose of this standard the following definitions shall apply.

2.1 Definitions relating to insulating and sheathing materials

2.1.1 Polyvinyl chloride compound (PVC)

Combination of materials suitably selected, proportioned and treated, of which the characteristic constituent is the plastomer polyvinyl chloride or one of its copolymers. The same term also designates compounds containing both polyvinyl chloride and certain of its polymers.

2.1.2 Type of compound

The category in which a compound is placed according to its properties, as determined by specific tests. The type designation is not directly related to the composition of the compound.

2.2 Definitions relating to the tests

2.2.1 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. 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 or design which might change the performance characteristics.

2.2.2 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.

---

1 In preparation.

2.3 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_0/U, expressed in volts:

U_0 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 multicore cable or 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_0 and to the value U.

In a direct current system, the nominal voltage of the system shall be not higher than 1,5 times the rated voltage of the cable.

NOTE The operating voltage of a system may permanently exceed the nominal voltage of such a system by 10 %. A cable can be used at a 10 % higher operating voltage than its rated voltage if the latter is at least equal to the nominal voltage of the system.

3 Marking

3.1 Indication of origin and cable identification

Cables shall be provided with an indication of the manufacturer, which shall be either an identification thread or a repetitive marking of the manufacturer's name or trade-mark.

Cables for use at a conductor temperature exceeding 70 °C shall also be marked either with the code designation or with the maximum conductor temperature.

Marking may be by printing or by reproduction in relief on or in the insulation or sheath.

3.1.1 Continuity of marks

Each specified mark shall be regarded as continuous if the distance between the end of the mark and the beginning of the next identical mark does not exceed

– 550 mm if the marking is on the outer sheath of the cable;
– 275 mm if the marking is
  a) on the insulation of an unsheathed cable;
  b) on the insulation of a sheathed cable;
  c) on a tape within a sheathed cable.

3.2 Durability

Printed markings shall be durable. Compliance with this requirement shall be checked by the test given in 1.8 of IEC 60227-2.

3.3 Legibility

All markings shall be legible.

The colours of the identification threads shall be easy to recognize or easily made recognizable, if necessary, by cleaning with petrol or other suitable solvent.

4 Core identification

Each core shall be identified as follows:

– in cables having up to and including five cores by colour, see 4.1;
– in cables having more than five cores by number, see 4.2.

NOTE The colour scheme, and in particular the scheme for rigid multicore cables, is under consideration.

4.1 Core identification by colours

4.1.1 General requirements

Identification of the cores of a cable shall be achieved by the use of coloured insulation or other suitable method.

Each core of a cable shall have only one colour, except the core identified by a combination of the colours green-and-yellow.

The colours green and yellow,when not in combination, shall not be used for any multicore cable.

NOTE The colours red and white should preferably be avoided.

4.1.2 Colour scheme

The preferred colour scheme for flexible cables and single-core cables is:

– single-core cable: no preferred colour scheme;
– two-core cable: no preferred colour scheme;
– three-core cable: either green-and-yellow, blue, brown,
or, brown, black, grey
– four-core cable: either green-and-yellow, brown, black, grey,
or blue, brown, black, grey
– five-core cable: either green-and-yellow, blue, brown, black, grey,
or blue, brown, black, grey, black.

The colours shall be clearly identifiable and durable. Durability shall be checked by the test given in 1.8 of IEC 60227-2.

4.1.3 Colour combination green-and-yellow

The distribution of the colours for the core coloured green-and-yellow shall comply with the following condition (which is in accordance with IEC 60173): for every 15 mm length of core, one of these colours shall cover at least 30 % and not more than 70 % of the surface of the core, the other colour covering the remainder.

NOTE Information on the use of the colours green-and-yellow and blue.

It is understood that the colours green and yellow, when they are combined as specified above, are recognized exclusively as a means of identification of the core intended for use as earth connection or similar protection, and that the colour blue is intended for the identification of the core intended to be connected to neutral. If, however, there is no neutral, blue can be used to identify any core except the earthing or protective conductor.

4.2 Core identification by numbers

4.2.1 General requirements

The insulation of the cores shall be of the same colour and numbered sequentially, except for the core coloured green-and-yellow, if one is included.

The green-and-yellow core, if any, shall comply with the requirement of 4.1.3 and shall be in the outer layer.

The numbering shall start by number 1 in the inner layer.

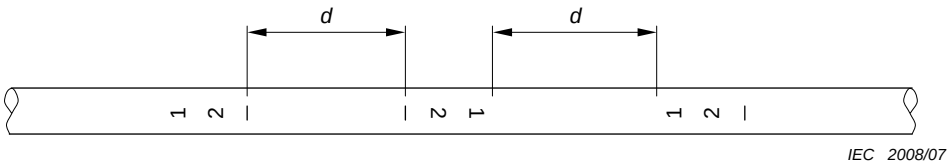
The numbers shall be printed in arabic numerals on the outer surfaces of the cores. All the numbers shall be of the same colour, which shall contrast with the colour of the insulation. The numerals shall be legible.

4.2.2 Preferred arrangement of marking

The numbers shall be repeated, at regular intervals along the core, consecutive numbers being inverted in relation to each other.

When the number is a single numeral, a dash shall be placed underneath it. If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. The spacing *d* between consecutive numbers shall not exceed 50 mm.

The arrangement of the marks is shown in the figure below.



4.2.3 Durability

Printed numerals shall be durable. Compliance with this requirement shall be checked by the test given in 1.8 of IEC 60227-2.

5 General requirements for the construction of cables

5.1 Conductors

5.1.1 Material

The conductors shall consist of annealed copper, except for the wires of tinsel cords, for which a copper alloy may be used. The wires may be plain or tinned.

5.1.2 Construction

The maximum diameters of the wires of flexible conductors – other than the conductors of tinsel cords – and the minimum number of the wires of rigid conductors shall be in accordance with IEC 60228.

The classes of the conductors relevant to the various types of cables are given in the particular specifications (see IEC 60227-3, IEC 60227-4, etc.).

Conductors of cables for fixed installations shall be circular solid, circular stranded or compacted circular stranded conductors.

For tinsel cords each conductor shall comprise a number of strands or groups of strands, twisted together, each strand being composed of one or more flattened wires of copper or copper alloy, helically wound on a thread of cotton, polyamide or similar material.

5.1.3 Check on construction

Compliance with the requirements of 5.1.1 and 5.1.2, including the requirements of IEC 60228, shall be checked by inspection and by measurement.

5.1.4 Electrical resistance

For cables – other than tinsel cords – the resistance of each conductor at 20 °C shall be in accordance with the requirements of IEC 60228 for the given class of the conductor.

Compliance shall be checked by the test given in 2.1 of IEC 60227-2.

5.2 Insulation

5.2.1 Material

The insulation shall be polyvinyl chloride compound of the type specified for each type of cable in the particular specifications (see IEC 60227-3, IEC 60227-4, etc.).

Type PVC/C in the case of cables for fixed installation.

Type PVC/D in the case of flexible cables.

Type PVC/E in the case of heat-resistant cables for internal wiring.

The test requirements for these compounds are specified in Table 1.

The maximum operating temperatures for cables insulated with any of the above types of compound and covered by the particular specifications (see IEC 60227-3, IEC 60227-4, etc.) are given in those publications.

5.2.2 Application to the conductor

The insulation shall be so applied that it fits closely on the conductor, but for cables other than tinsel cords, it shall be possible to remove it without damage to the insulation itself, to the conductor or to the tin coating if any. Compliance shall be checked by inspection and by manual test.

5.2.3 Thickness

The mean value of the thickness of insulation shall be not less than the specified value for each type and size of cable shown in the tables of the particular specifications (IEC 60227-3, IEC 60227-4, etc.).

However, the thickness at any 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 1.9 of IEC 60227-2.

5.2.4 Mechanical properties before and after ageing

The insulation shall have adequate mechanical strength and elasticity within the temperature limits to which it may be exposed in normal use.

Compliance shall be checked by carrying out the tests specified in Table 1.

The applicable test methods and the results to be obtained are specified in Table 1.

Table 1 – Requirements for the non-electrical tests for polyvinyl chloride (PVC) insulation

1	2	3	4	5	6	7	
Reference No.	**Test**	**Unit**	**Type of component**			**Test method described in**	
			PVC/C	**PVC/D**	**PVC/E**	**IEC**	**subclause**
1	*Tensile strength and elongation at break*					60811-1-1	9.1
1.1	Properties in the state as delivered						
1.1.1	Values to be obtained for the tensile strength: – median, min.	N/mm^2	12,5	10,0	15,0		
1.1.2	Values to be obtained for the elongation at break: – median, min.	%	125	150	150		
1.2	Properties after ageing in air oven					60811-1-2 and 60811-1-1	8.1.3.1 and 9.1
1.2.1	Ageing conditions: – temperature – duration of treatment	°C h	80 ± 2 7 × 24	80 ± 2 7 × 24	135 ± 2 10 × 24		
1.2.2	Values to be obtained for the tensile strength: – median, min. – variation [1], max.	N/mm^2 %	12,5 ±20	10,0 ±20	15,0 ±25		
1.2.3	Values to be obtained for the elongation at break: – median, min. – variation [1], max.	% %	125 ±20	150 ±20	150 ±25		
2	*Loss of mass test*					60811-3-2	8.1
2.1	Ageing conditions: – temperature – duration of treatment	°C h	80 ± 2 7 × 24	80 ± 2 7 × 24	115 ± 2 10 × 24		
2.2	Values to be obtained for the loss of mass, max.	mg/cm^2	2,0	2,0	2,0		
3	*Compatibility test* [2]						
3.1	Ageing conditions	°C h	80 ± 2 7 × 24	80 ± 2 7 × 24	100 ± 2 10 × 24	60811-1-2	8.1.4
3.2	Mechanical properties after ageing Values to be obtained		As in references Nos. 1.2.2 and 1.2.3				
4	*Heat shock test*					60811-3-1	9.1
4.1	Test conditions: – temperature – duration of treatment	°C h	150 ± 2 1	150 ± 2 1	150 ± 2 1		
4.2	Results to be obtained		Absence of cracks				

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

[2] If applicable, see 5.3.1.

Table 1 *(continued)*

1	2	3	4	5	6	7	
Reference No.	**Test**	**Unit**	**Type of component**			**Test method described in**	
			PVC/C	**PVC/D**	**PVC/E**	**IEC**	**subclause**
5	*Pressure test at high temperature*					60811-3-1	8.1
5.1	Test conditions: – force exercised by the blade – duration of heating under load		See 8.1.4 of IEC 60811-3-1 See 8.1.5 of IEC 60811-3-1				
	– temperature	°C	80 ± 2	70 ± 2	90 ± 2		
5.2	Results to be obtained: – median of the depth of penetration, max.	%	50	50	50		
6	*Bending test at low temperature*					60811-1-4	8.1
6.1	Test conditions: – temperature [1)] – period of application of low temperature	°C	–15 ± 2 See 8.1.4 and 8.1.5 of IEC 60811-1-4	–15 ± 2	–15 ± 2		
6.2	Results to be obtained		Absence of cracks				
7	*Elongation test at low temperature*					60811-1-4	8.3
7.1	Test conditions: – temperature [1)] – period of application of low temperature	°C	–15 ± 2 See 8.3.4 and 8.3.5 of IEC 60811-1-4	–15 ± 2	–		
7.2	Result to be obtained: – elongation without break, min.	%	20	20	–		
8	*Impact test at low temperature* [2)]					60811-1-4	8.5
8.1	Test conditions: – temperature [1)] – period of application of low temperature	°C	–15 ± 2 See 8.5.5 of IEC 60811-1-4	–15 ± 2	–		
	– mass of hammer		See 8.5.4 of IEC 60811-1-4				
8.2	Results to be obtained		See 8.5.6 of IEC 60811-1-4				
9	*Thermal stability test*					60811-3-2	9
9.1	Test conditions: – temperature	°C	–	–	200 ± 0,5		
9.2	Result to be obtained: – mean value of the thermal stability time, min.	min	–	–	180		

[1)] Due to climatic conditions, national standards may require a lower test temperature to be used.
[2)] If specified in the particular specifications (IEC 60227-3, IEC 60227-4, etc.).

5.3 Filler

5.3.1 Material

Unless otherwise specified in the particular specifications (IEC 60227-3, IEC 60227-4, etc.), the fillers shall be composed of one of the following or of any combination of the following:

– a compound based on unvulcanized rubber of plastics; or

– natural or synthetic textiles; or

– paper.

When the filler is composed of unvulcanized rubber, there shall be no harmful interactions between its constituents and the insulation and/or the sheath. Compliance with this requirement shall be checked by the test given in 8.1.4 of IEC 60811-1-2.

5.3.2 Application

For each type of cable, the particular specifications (IEC 60227-3, IEC 60227-4, etc.) specify whether that cable includes fillers or whether the sheath or inner covering may penetrate between the cores, thus forming a filling.

The fillers shall fill the spaces between the cores giving the assembly a practically circular shape. The fillers shall not adhere to the cores. The assembly of cores and fillers may be held together by a film or tape.

5.4 Extruded inner covering

5.4.1 Material

Unless otherwise specified in the particular specifications (IEC 60227-4, etc.), the extruded inner covering shall be composed of a compound based on unvulcanized rubber or plastics.

Where the inner covering is composed of unvulcanized rubber, there shall be no harmful interactions between its constituents and the insulation and/or the sheath.

Compliance with this requirement shall be checked by the test given in 8.1.4 of IEC 60811-1-2.

5.4.2 Application

The extruded inner covering shall surround the cores and may penetrate the spaces between them giving the assembly a practical circular shape. The extruded inner covering shall not adhere to the cores.

For each type of cable, the particular specifications (IEC 60227-4, etc.) indicate whether that cable includes an extruded inner covering or not, or whether the outer sheath may penetrate between the cores, thus forming a filling.

5.4.3 Thickness

Unless otherwise specified in the particular specifications (IEC 60227-4, etc.), no measurement is required for the extruded inner covering.

5.5 Sheath

5.5.1 Material

The sheath shall be polyvinyl chloride compound of the type specified for each type of cable in the particular specifications (see IEC 60227-4, etc.):

– type PVC/ST4 in the case of cables for fixed installations;
– type PVC/ST5 in the case of flexible cables;
– type PVC/ST9 in case of oil-resistant flexible cables;
– type PVC/ST10 in the case of cables sheathed with a 90° polyvinyl chloride compound.

The test requirements for these compounds are specified in Table 2.

5.5.2 Application

The sheath shall be extruded in a single layer:

a) on the core, in the case of single-core cables;

b) on the assembly of cores and fillers or inner covering, if any, in the case of other cables.

The sheath shall not adhere to the cores. A separator, consisting of a film or tape, may be placed under the sheath.

In certain cases, indicated in the particular specifications (IEC 60227-4, etc.), the sheath may penetrate into the spaces between the cores, thus forming a filling (see 5.4.2).

5.5.3 Thickness

The mean value of the thickness shall not be less than the specified value for each type and size of cable shown in the tables of the particular specifications (IEC 60227-4, etc.).

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, unless otherwise specified.

Compliance shall be checked by the test given in 1.10 of IEC 60227-2.

5.5.4 Mechanical properties before and after ageing

The sheath shall have adequate mechanical strength and elasticity within the temperature limits to which it may be exposed in normal use.

Compliance shall be checked by carrying out the tests specified in Table 2.

The applicable test values and the results to be obtained are specified in Table 2.

Table 2 – Requirements for the non-electrical test for polyvinyl chloride (PVC) sheaths

1	2	3	4	5	6	7	8	
Reference No.	Test	Unit	Type of compound				Test method described in	
			PVC/ ST4	PVC/ ST5	PVC/ ST9	PVC/ ST10	IEC	clause/ subclause
1	*Tensile strength and elongation at break*						60811-1-1	9.2
1.1	Properties in the state as delivered							
1.1.1	Values to be obtained for the tensile strength: – median, min.	N/mm^2	12,5	10,0	10,0	10, 0		
1.1.2	Values to be obtained for the elongation at break – median, min.	%	125	150	150	150		
1.2	Properties after ageing in the air oven						60811-1-2	8.1
1.2.1	Ageing conditions: – temperature – duration of treatment	 °C h	 80 ± 2 7 × 24	 80 ± 2 7 × 24	 80 ± 2 7 × 24	 135 ± 2 10 × 24	60811-1-1	9.2
1.2.2	Values to be obtained for the tensile strength: – median, min. – variation[1], max.	 N/mm^2 %	 12,5 ±20	 10,0 ±20	 10,0 ±20	 10,0 ±25		
1.2.3	Values to be obtained for the elongation at break: – median, min. – variation[1], max.	 % %	 125 ±20	 150 ±20	 150 ±20	 150 ±25		
2	*Loss of mass test*						60811-3-2	8.2
2.1	Ageing conditions: – temperature – duration of treatment	 °C h	As in reference No. 1.2.1			115 ± 2 10 × 24		
2.2	Values to be obtained for the loss of mass, max.	mg/cm^2	2,0	2,0	2,0	2,0		
3	*Compatibility test* [2]						60811-1-2	8.1.4
3.1	Ageing conditions: – temperature – duration of treatment	 °C h	As in reference No. 1.2.1			100 ± 2 10 × 24		
3.2	Mechanical properties after ageing Values to be obtained		As in references Nos. 1.2.2 and 1.2.3					
4	*Heat shock test*						60811-3-1	9.2
4.1	Test conditions: – temperature – duration of treatment	 °C h	 150 ± 2 1	 150 ± 2 1	 150 ± 2 1	 150 ± 2 1		
4.2	Result to be obtained		Absence of cracks					

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

[2] Only applicable when called up by the particular cable standard, see also 5.3.1.

Table 2 *(continued)*

1	2	3	4	5	6	7	8	
Reference No.	**Test**	**Unit**	**Type of compound**				**Test method described in**	
			PVC/ ST4	**PVC/ ST5**	**PVC/ ST9**	**PVC/ ST10**	**IEC**	**clause/ subclause**
5	*Pressure test at high temperature*						60811-3-1	8.2
5.1	Test conditions: – force exercised by the blade – duration of heating under load – temperature	 h °C	 80 ± 2	 70 ± 2	 70 ± 2	 90 ± 2	 60811-3-1 60811-3-1	 8.2.4 8.2.5
5.2	Results to be obtained: – median of the depth of penetration, max.	%	50	50	50	50		
6	*Bending test at low temperature*						60811-1-4	8.2
6.1	Test conditions: – temperature[1)] – period of application of low temperature	°C h	–15 ± 2	–15 ± 2	–15 ± 2	–15 ± 2	 60811-1-4	 8.2.3
6.2	Results to be obtained		Absence of cracks					
7	*Elongation test at low temperature*						60811-1-4	8.4
7.1	Test conditions: – temperature[1)] – period of application of low temperature	°C h	–15 ± 2	–15 ± 2	–15 ± 2	–15 ± 2	 60811-1-4	 8.4.4 and 8.4.5
7.2	Result to be obtained: – elongation without break, min.	%	20	20	20	20		
8	*Impact test at low temperature*						60811-1-4	8.5
8.1	Test conditions: – temperature[1)] – period of application of low temperature – mass of hammer	°C h	–15 ± 2	–15 ± 2	–15 ± 2	–15 ± 2	 60811-1-4 60811-1-4	 8.5.5 8.5.4
8.2	Result to be obtained						60811-1-4	8.5.6
9	*Mechanical properties after immersion in mineral oil*						60811-2-1	10
9.1	Test conditions: – temperature of oil – duration of immersion in oil	 °C h	 – –	 – –	 90 ± 2 24	 – –		
9.1.1	Value to be obtained for the tensile strength: – variation max.[2)]	 %	 –	 –	 ±30	 –		
9.1.2	Value to be obtained for the elongation at break:[2)] – variation max.	 %	 –	 –	 ±30	 –		
10	*Minimum thermal stability at 200 °C*	min	–	–	–	180	60811-3-2	9

1) Due to climatic conditions, national standards may require the use of a lower test temperature.

2) Variation is the difference between the median value after ageing and the median value without ageing, expressed as a percentage of the latter.

5.6 Tests on completed cables

5.6.1 Electrical properties

The cables shall have adequate dielectric strength and insulation resistance.

Compliance shall be checked by carrying out the tests specified in Table 3.

The test methods and the results to be obtained are specified in Table 3.

Table 3 – Requirements for electrical tests for PVC insulated cables

1	2	3	4	5	6	7	
Reference No.	**Test**	**Unit**	**Rated voltage of cables**			**Test method described in**	
			300/ 300 V	**300/ 500 V**	**450/ 750 V**	**IEC**	**subclause**
1	*Measurement of the resistance of conductors*					60227-2	2.1
1.1	Values to be obtained, max.		See IEC 60228 and particular specifications (IEC 60227-3, IEC 60227-4, etc.)				
2	*Voltage test on completed cables*					60227-2	2.2
2.1	Test conditions:						
	– minimum length of the sample	m	10	10	10		
	– minimum period of immersion in water	h	1	1	1		
	– temperature of the water	°C	20 ± 5	20 ± 5	20 ± 5		
2.2	Voltage applied (a.c.)	V	2 000	2 000	2 500		
2.3	Duration of each application of voltage, min.	min	5	5	5		
2.4	Results to be obtained		No breakdown				
3	*Voltage test on cores*					60227-2	2.3
3.1	Test conditions:						
	– length of sample	m	5	5	5		
	– minimum period of immersion in water	h	1	1	1		
	– temperature of the water	°C	20 ± 5	20 ± 5	20 ± 5		
3.2	Applied voltage (a.c.) according to specified thickness of insulation:						
	– up to and including 0,6 mm	V	1 500	1 500	–		
	– exceeding 0,6 mm	V	2 000	2 000	2 500		
3.3	Duration of each application of voltage, min.	min	5	5	5		
3.4	Results to be obtained		No breakdown				
4	*Measurement of insulation resistance*					60227-2	2.4
4.1	Test conditions:						
	– length of sample	m	5	5	5		
	– previous voltage test as in Ref. Nos. 2 or 3						
	– minimum period of immersion in hot water	h	2	2	2		
	– temperature of water		See tables in the particular specifications				
4.2	Results to be obtained		(IEC 60227-3, IEC 60227-4, etc.)				

5.6.2 Overall dimensions

The mean overall dimensions of the cables shall be within the limits specified in the tables in the particular specifications (see IEC 60227-3, IEC 60227-4, etc.).

The difference between any two values of the overall diameter of sheathed circular cables of 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 tests given in 1.11 of IEC 60227-2.

5.6.3 Mechanical strength of flexible cables

The flexible cables shall be capable of withstanding bending and other mechanical stresses occurring in normal use.

When specified in the particular specifications (see IEC 60227-5, etc.), compliance shall be checked by the test given in Clause 3 of IEC 60227-2.

5.6.3.1 Flexing test for flexible cables

See 3.1 of IEC 60227-2.

During the test with 15 000 backward and forward movements, i.e. 30 000 single strokes, neither interruption of the current nor short circuit between the conductors shall occur.

After the test, the sample shall withstand the voltage test carried out in accordance with 2.2 of IEC 60227-2.

5.6.3.2 Bending test for tinsel cord

See 3.2 of IEC 60227-2.

During the test with 60 000 bending cycles, i.e. 120 000 single strokes, interruption of the current shall not occur.

After the test, the sample shall withstand the voltage test carried out in accordance with 2.2 of IEC 60227-2, the voltage, however, being 1 500 V and applied only between the conductors connected together and the water.

5.6.3.3 Snatch test for tinsel cord

See 3.3 of IEC 60227-2.

During the test, interruption of the current shall not occur.

5.6.3.4 Test for separation of cores

See 3.4 of IEC 60227-2.

The force shall be between 3 N and 30 N.

5.6.4 Flame retardance

All the cables shall comply with the test specified in IEC 60332-1-2.

6 Guide to use of the cables

See the future IEC 62440.

Annex A
(normative)

Code designation

Cables of the types covered by this standard are designated by two numerals, preceded by the reference number of this standard.

The first numeral indicates the basic class of cable; the second numeral indicates the particular type within the basic class.

The classes and types are as follows:

0. Non-sheathed cables for fixed wiring.
   - 01. Single-core non-sheathed cable with rigid conductor for general purposes (60227 IEC 01).
   - 02. Single-core non-sheathed cable with flexible conductor for general purposes (60227 IEC 02).
   - 05. Single-core non-sheathed cable with solid conductor for internal wiring for a conductor temperature of 70 °C (60227 IEC 05).
   - 06. Single-core non-sheathed cable with flexible conductor for internal wiring for a conductor temperature of 70 °C (60227 IEC 06).
   - 07. Single-core non-sheathed cable with solid conductor for internal wiring for a conductor temperature of 90 °C (60227 IEC 07).
   - 08. Single-core non-sheathed cable with flexible conductor for internal wiring for a conductor temperature of 90 °C (60227 IEC 08).
1. Sheathed cables for fixed wiring.
   - 10. Light polyvinyl chloride sheathed cable (60227 IEC 10).
4. Non-sheathed flexible cables for light duty.
   - 41. Flat tinsel cord (60227 IEC 41).
   - 43. Cord for decorative chains (60227 IEC 43).
5. Sheathed flexible cables for normal duty.
   - 52. Light polyvinyl chloride sheathed cord (60227 IEC 52).
   - 53. Ordinary polyvinyl chloride sheathed cord (60227 IEC 53).
7. Sheathed flexible cables for special duty.
   - 71c Circular polyvinyl chloride sheathed lift cable and cable for flexible connections (60227 IEC 71c).
   - 71f Flat polyvinyl chloride sheathed lift cables and cables for flexible connections (60227 IEC 71f).

_____

Annex AA
(normative)

National Modifications

This annex is National modifications which replaces the requirements of IEC 60227-1 clause 2 (Definitions) and clause 3 (Marking) by the following:

2 Definitions

For the purpose of this standard the following definitions shall apply.

2.1 Definitions relating to insulating sheathing materials

2.1.1 Polyvinyl chloride compound (PVC)

Combination of materials suitably selected, proportioned and treated, of which the characteristic constituent is the plastomer polyvinyl chloride or one of its copolymers. The same term also designates compounds containing both polyvinyl chloride and certain of its polymers.

2.1.2 Type of compound

The category in which a compound is placed according to its properties, as determined by specific tests. The type designation is not directly related to the composition of the compound.

2.2 Definitions relating to the tests

2.2.1 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. 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 or design which might change the performance characteristics.

2.2.2 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.

2.3 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 *Uo/U*, expressed in volts:

Uo 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 multicore cable or 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 *Uo* and to the value *U*.

In a direct current system, the nominal voltage of the system shall be not higher than 1,5 times the rated voltage of the cable.
NOTE The operating voltage of a system may permanently exceed the nominal voltage of such a system by 10 %. A cable can be used at a 10 % higher operating voltage than its rated voltage if the latter is at least equal to the nominal voltage of the system.
When only one voltage is mentioned, it is considered as the value of *U*

2.4 Additional wires types definitions:

2.4.1 THHN

THHN stands for: Thermoplastic High Heat-resistant Nylon-jacketed wire.

2.4.2 THWN

THWN stands for: Thermoplastic Heat and water-resistant Nylon-jacketed wire.

2.4.3 TFFN

TFFN stands for: Thermoplastic Flexible Fixture Nylon-jacketed wire.

3 Marking

3.1 Indication of origin and cable identification

Cables shall be provided with an indication of the manufacturer, which shall be either an identification thread or a repetitive marking of the manufacturer's name or trade-mark.
Wires and cables to be marked either with the code designation or with the maximum conductor temperature.
Marking may be by printing or by reproduction in relief on or in the insulation or sheath.

3.1.1 Product surface marking

The following details should be marked on cables and wires surface:

- Identification of the manufacturer
- Code designation or the maximum conductor temperature
- Voltage rating
- Conductor material
- Conductor size
- Number of cores (in multicores products)
- Country of origin

3.1.1.1 Continuity of marks

Each specified mark shall be regarded as continuous if the distance between the end of the mark and the beginning of the next identical mark does not exceed:

- 550 mm if the marking is on the outer sheath of the cable;
- 275 mm if the marking is
  a) on the insulation of an unsheathed cable;
  b) on the insulation of a sheathed cable;
  c) on a tape within a sheathed cable.

3.1.2 Product packaging marking

The following details should be marked on the product packaging:

- Identification of the manufacturer
- Code designation or the maximum conductor temperature
- Voltage rating
- Conductor material
- Conductor size
- Number of cores (in multicores products)
- Country of origin
- Manufacturing year and month
- Length in meters.

3.2 Durability

Printed markings shall be durable. Compliance with this requirement shall be checked by the test given in 1.8 of SASO IEC 60227-2.

3.3 Legibility

All markings shall be legible.
The colours of the identification threads shall be easy to recognize or easily made recognizable, if necessary, by cleaning with petrol or other suitable solvent.

Annex AB
(normative)

National Modifications

This annex is National modifications which remove Annex A from IEC 60227-1:2007 and replace it by annex AB to include additional code designations by the following:

Code designation

Cables of the types covered by this standard are designated by two numerals, preceded by the reference number of this standard.

The first numeral indicates the basic class of cable; the second numeral indicates the particular type within the basic class.

The additional types are designated by three numerals, the first number indicates the basic class of the cables; the second and third numerals indicate the particular type within the basic class.

The classes and types are as follows:

0. Non-sheathed cables for fixed wiring.

01. Single-core non-sheathed cable with rigid conductor for general purposes (60227 IEC 01).

02. Single-core non-sheathed cable with flexible conductor for general purposes (60227 IEC 02).

05. Single-core non-sheathed cable with solid conductor for internal wiring for a conductor temperature of 70 °C (60227 IEC 05).

06. Single-core non-sheathed cable with flexible conductor for internal wiring for a conductor temperature of 70 °C (60227 IEC 06).

07. Single-core non-sheathed cable with solid conductor for internal wiring for a conductor temperature of 90 °C (60227 IEC 07).

08. Single-core non-sheathed cable with flexible conductor for internal wiring for a conductor temperature of 90 °C (60227 IEC 08).

083. Single-core nylon-jacketed cable with flexible conductor for internal wiring in dry and wet conditions for a conductor temperature of 90 °C dry and 75 °C wet (THHN/THWN UL 083).

066. Single-core nylon-jacketed cable with flexible conductor for internal fixed wiring for a conductor temperature of 90 °C (TFFN UL 066).

1. Sheathed cables for fixed wiring.

10. Light polyvinyl chloride sheathed cable (60227 IEC 10).

4. Non-sheathed flexible cables for light duty.

41. Flat tinsel cord (60227 IEC 41).

43. Cord for decorative chains (60227 IEC 43).

5. Sheathed flexible cables for normal duty.

52. Light polyvinyl chloride sheathed cord (60227 IEC 52).

53. Ordinary polyvinyl chloride sheathed cord (60227 IEC 53).

7. Sheathed flexible cables for special duty.

71c Circular polyvinyl chloride sheathed lift cable and cable for flexible connections (60227 IEC 71c).

71f Flat polyvinyl chloride sheathed lift cables