

# PAKISTAN STANDARD

**Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V**

**Part-3: Non-sheathed cables for fixed wiring**



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# **Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V**

## **Part-3: Non-sheathed cables for fixed wiring**

### **0. FOREWORD**

- 0.1 This Pakistan Standard was adopted by the authority of the Board of Directors of Pakistan Standard and Quality Control Authority after the draft prepared by the Technical Committee for “**Electric Cables**” (TC-7)” had been approved and endorsed by the National Standards Committee on 27 June 2007.
- 0.2 This Pakistan Standard was adopted on the basis of IEC: 60227-3 since IEC Standard have been established in 1997, hence it is deemed necessary to adopt the International standard to keep abreast with the latest technology and as par with IEC standard.
- 0.3 This Pakistan Standard is an adoption of IEC: 60227-3-2007 Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V Part-2 Non-sheathed cables for fixed wiring,” and its use hereby acknowledged with thanks.
- 0.4 This standard is subject to periodical review in order to keep pace with the development in industry. Any suggestions for improvement shall be recorded and placed before the revising committee in due course.
- 0.5 This standard is intended chiefly to cover the technical provisions relating to this standard and it does not include all the necessary provisions of a Contract.

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IEC 60811-3-1:1985, *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 60811-3-2:1985, *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*

## **2 Single-core non-sheathed cable with rigid conductor for general purposes**

### **2.1 Code designation**

60227 IEC 01.

### **2.2 Rated voltage**

450/750 V.

### **2.3 Construction**

#### **2.3.1 Conductor**

Number of conductors: 1.

The conductors shall comply with the requirements of IEC 60228:

- class 1 for solid conductors;
- class 2 for stranded conductors.

#### **2.3.2 Insulation**

The insulation shall be polyvinyl chloride compound of Type PVC/C applied around the conductor.

The insulation thickness shall comply with the specified value given in column 3 of table 1.

The insulation resistance shall be not less than the values given in column 5 of table 1.

#### **2.3.3 Overall diameter**

The mean overall diameter shall not exceed the upper limit given in column 4 of table 1.

Table 1 – General data for type 60227 IEC 01

1	2	3	4	5	6
Nominal cross-sectional area of conductor mm <sup>2</sup>	Class of conductor IEC 60228	Thickness of insulation Specified value mm	Mean overall diameter		Minimum insulation resistance at 70 °C MΩ·km
			Lower limit mm	Upper limit mm	
1,5	1	0,7	2,6	3,2	0,011
1,5	2	0,7	2,7	3,3	0,010
2,5	1	0,8	3,2	3,9	0,010
2,5	2	0,8	3,3	4,0	0,009
4	1	0,8	3,6	4,4	0,0085
4	2	0,8	3,8	4,6	0,0077
6	1	0,8	4,1	5,0	0,0070
6	2	0,8	4,3	5,2	0,0065
10	1	1,0	5,3	6,4	0,0070
10	2	1,0	5,6	6,7	0,0065
16	2	1,0	6,4	7,8	0,0050
25	2	1,2	8,1	9,7	0,0050
35	2	1,2	9,0	10,9	0,0043
50	2	1,4	10,6	12,8	0,0043
70	2	1,4	12,1	14,6	0,0035
95	2	1,6	14,1	17,1	0,0035
120	2	1,6	15,6	18,8	0,0032
150	2	1,8	17,3	20,9	0,0032
185	2	2,0	19,3	23,3	0,0032
240	2	2,2	22,0	26,6	0,0032
300	2	2,4	24,5	29,6	0,0030
400	2	2,6	27,5	33,2	0,0028

## 2.4 Tests

Compliance with the requirements of 2.3 above shall be checked by inspection and by the tests given in table 2.

## 2.5 Guide to use

Maximum conductor temperature in normal use: 70 °C.

NOTE – Other guidelines are under consideration.

**Table 2 – Tests for type 60227 IEC 01**

1	2	3	4	
Ref. No.	Test	Category of test	Test method described in IEC	Subclause
1	<i>Electric test</i>			
1.1	Resistance of conductors	T, S	60227-2	2.1
1.2	Voltage test at 2 500 V	T, S	60227-2	2.2
1.3	Insulation resistance at 70 °C	T	60227-2	2.4
2	<i>Provisions covering constructional and dimensional characteristics</i>		60227-1 and 60227-2	
2.1	Checking of compliance with constructional provisions	T, S	60227-1	Inspection and manual tests
2.2	Measurement of insulation thickness	T, S	60227-2	1.9
2.3	Measurement of overall diameter	T, S	60227-2	1.11
3	<i>Mechanical properties of insulation</i>			
3.1	Tensile test before ageing	T	60811-1-1	9.1
3.2	Tensile test after ageing	T	60811-1-2	8.1.3.1
3.3	Loss of mass test	T	60811-3-2	8.1
4	<i>Pressure test at high temperature</i>	T	60811-3-1	8.1
5	<i>Elasticity and impact strength at low temperature</i>			
5.1	Bending test for insulation	T	60811-1-4	8.1
5.2	Elongation test for insulation <sup>1)</sup>	T	60811-1-4	8.3
5.3	Impact test for insulation	T	60811-1-4	8.5
6	<i>Heat shock test</i>	T	60811-3-1	9.1
7	<i>Test of flame retardance</i>	T	60332-1	

<sup>1)</sup> Only applicable if the overall diameter of the cable exceeds the limits specified in the test method.

### 3 Single-core non-sheathed cable with flexible conductor for general purposes

#### 3.1 Code designation

60227 IEC 02.

#### 3.2 Rated voltage

450/750 V.

#### 3.3 Construction

##### 3.3.1 Conductor

Number of conductors: 1.

The conductors shall comply with the requirements given in IEC 60228 for class 5 conductors.

### 3.3.2 Insulation

The insulation shall be polyvinyl chloride compounds of type PVC/C, applied around the conductor.

The insulation thickness shall comply with the specified value given in column 2 of table 3.

The insulation resistance shall be not less than the value given in column 4 of table 3.

**Table 3 – General data for type 60227 IEC 02**

1	2	3	4	5
Nominal cross-sectional area of conductor  mm <sup>2</sup>	Thickness of insulation  Specified value mm	Mean overall diameter		Minimum insulation resistance at 70 °C  MΩ·km
		Lower limit mm	Upper limit mm	
1,5	0,7	2,8	3,4	0,010
2,5	0,8	3,4	4,1	0,009
4	0,8	3,9	4,8	0,007
6	0,8	4,4	5,3	0,006
10	1,0	5,7	6,8	0,0056
16	1,0	6,7	8,1	0,0046
25	1,2	8,4	10,2	0,0044
35	1,2	9,7	11,7	0,0038
50	1,4	11,5	13,9	0,0037
70	1,4	13,2	16,0	0,0032
95	1,6	15,1	18,2	0,0032
120	1,6	16,7	20,2	0,0029
150	1,8	18,6	22,5	0,0029
185	2,0	20,6	24,9	0,0029
240	2,2	23,5	28,4	0,0028

### 3.3.3 Overall diameter

The mean overall diameter shall not exceed the upper limit given in column 3 of table 3.

### 3.4 Tests

Compliance with the requirements of 3.3 shall be checked by inspection and by the tests given in table 4.

### 3.5 Guide to use

Maximum conductor temperature in normal use: 70 °C.

NOTE – Other guidelines are under consideration.

Table 4 – Tests for type 60227 IEC 02

1	2	3	4	
Ref. No.	Test	Category of test	Test method described in IEC	Subclause
1	<i>Electric test</i>			
1.1	Resistance of conductors	T, S	60227-2	2.1
1.2	Voltage test at 2 500 V	T, S	60227-2	2.2
1.3	Insulation resistance at 70 °C	T	60227-2	2.4
2	<i>Provisions covering constructional and dimensional characteristics</i>		60227-1 and 60227-2	
2.1	Checking of compliance with constructional provisions	T, S	60227-1	Inspection and manual tests
2.2	Measurement of insulation thickness	T, S	60227-2	1.9
2.3	Measurement of overall diameter	T, S	60227-2	1.11
3	<i>Mechanical properties of insulation</i>			
3.1	Tensile test before ageing	T	60811-1-1	9.1
3.2	Tensile test after ageing	T	60811-1-2	8.1.3.1
3.3	Loss of mass test	T	60811-3-2	8.1
4	<i>Pressure test at high temperature</i>	T	60811-3-1	8.1
5	<i>Elasticity at low temperature</i>			
5.1	Bending test for insulation	T	60811-1-4	8.1
5.2	Elongation test for insulation <sup>1)</sup>	T	60811-1-4	8.3
6	<i>Heat shock test</i>	T	60811-3-1	9.1
7	<i>Test of flame retardance</i>	T	60332-1	

<sup>1)</sup> Only applicable if the overall diameter of the cable exceeds the limits specified in the test method.



#### 4 Single-core non-sheathed cable with solid conductor for internal wiring for a conductor temperature of 70 °C

##### 4.1 Code designation

60227 IEC 05.

##### 4.2 Rated voltage

300/500 V.

##### 4.3 Construction

###### 4.3.1 Conductor

Number of conductors: 1.

The conductors shall comply with the requirements given in IEC 60228 for class 1 conductors.

###### 4.3.2 Insulation

The insulation shall be polyvinyl chloride compound of type PVC/C, applied around the conductor.

The insulation thickness shall comply with the specified value given in column 2 of table 5.

The insulation resistance shall be not less than the value given in column 4 of table 5.

###### 4.3.3 Overall diameter

The mean overall diameter shall not exceed the upper limit given in column 3 of table 5.

**Table 5 – General data for type 60227 IEC 05**

1	2	3	4	5
Nominal cross-sectional area of conductor mm <sup>2</sup>	Thickness of insulation Specified value mm	Mean overall diameter		Minimum insulation resistance at 70 °C MΩ·km
		Lower limit mm	Upper limit mm	
0,5	0,6	1,9	2,3	0,015
0,75	0,6	2,1	2,5	0,012
1	0,6	2,2	2,7	0,011

##### 4.4 Tests

Compliance with the requirements of 4.3 shall be checked by inspection and by the tests given in table 6.

#### 4.5 Guide to use

Maximum conductor temperature in normal use: 70 °C.

NOTE – Other guidelines are under consideration.

**Table 6 – Tests for type 60227 IEC 05**

1	2	3	4	
Ref. No.	Test	Category of test	Test method described in IEC	Subclause
1	<i>Electric test</i>			
1.1	Resistance of conductors	T, S	60227-2	2.1
1.2	Voltage test at 2 000 V	T, S	60227-2	2.2
1.3	Insulation resistance at 70 °C	T	60227-2	2.4
2	<i>Provisions covering constructional and dimensional characteristics</i>		60227-1 and 60227-2	
2.1	Checking of compliance with constructional provisions	T, S	60227-1	Inspection and manual tests
2.2	Measurement of insulation thickness	T, S	60227-2	1.9
2.3	Measurement of overall diameter	T, S	60227-2	1.11
3	<i>Mechanical properties of insulation</i>			
3.1	Tensile test before ageing	T	60811-1-1	9.1
3.2	Tensile test after ageing	T	60811-1-2	8.1.3.1
3.3	Loss of mass test	T	60811-3-2	8.1
4	<i>Pressure test at high temperature</i>	T	60811-3-1	8.1
5	<i>Elasticity at low temperature</i>			
5.1	Bending test for insulation	T	60811-1-4	8.1
6	<i>Heat shock test</i>	T	60811-3-1	9.1
7	<i>Test of flame retardance</i>	T	60332-1	

## 5 Single-core non-sheathed cable with flexible conductor for internal wiring for a conductor temperature of 70 °C

### 5.1 Code designation

60227 IEC 06.

### 5.2 Rated voltage

300/500 V.

### 5.3 Construction

#### 5.3.1 Conductor

Number of conductors: 1.

The conductors shall comply with the requirements given in IEC 60228 for class 5 conductors.

#### 5.3.2 Insulation

The insulation shall be polyvinyl chloride compound of type PVC/C, applied around the conductor.

The insulation thickness shall comply with the specified values given in column 2 of table 7.

The insulation resistance shall be not less than the value given in column 4 of table 7.

#### 5.3.3 Overall diameter

The mean overall diameter shall not exceed the upper limit given in column 3 of table 7.

**Table 7 – General data for type 60227 IEC 06**

1	2	3	4	5
Nominal cross-sectional area of conductor mm <sup>2</sup>	Thickness of insulation Specified value mm	Mean overall diameter		Minimum insulation resistance at 70 °C MΩ·km
		Lower limit mm	Upper limit mm	
0,5	0,6	2,1	2,5	0,013
0,75	0,6	2,2	2,7	0,011
1	0,6	2,4	2,8	0,010

### 5.4 Tests

Compliance with the requirements of 5.3 shall be checked by inspection and by the tests given in table 8.

## 5.5 Guide to use

Maximum conductor temperature in normal use: 70 °C.

NOTE – Other guidelines are under consideration.

**Table 8 – Tests for type 60227 IEC 06**

1	2	3	4	
Ref. No.	Test	Category of test	Test method described in IEC	Subclause
1	<i>Electric test</i>			
1.1	Resistance of conductors	T, S	60227-2	2.1
1.2	Voltage test at 2 000 V	T, S	60227-2	2.2
1.3	Insulation resistance at 70 °C	T	60227-2	2.4
2	<i>Provisions covering constructional and dimensional characteristics</i>		60227-1 and 60227-2	
2.1	Checking of compliance with constructional provisions	T, S	60227-1	Inspection and manual tests
2.2	Measurement of insulation thickness	T, S	60227-2	1.9
2.3	Measurement of overall diameter	T, S	60227-2	1.11
3	<i>Mechanical properties of insulation</i>			
3.1	Tensile test before ageing	T	60811-1-1	9.1
3.2	Tensile test after ageing	T	60811-1-2	8.1.3.1
3.3	Loss of mass test	T	60811-3-2	8.1
4	<i>Pressure test at high temperature</i>	T	60811-3-1	8.1
5	<i>Elasticity at low temperature</i>			
5.1	Bending test for insulation	T	60811-1-4	8.1
6	<i>Heat shock test</i>	T	60811-3-1	9.1
7	<i>Test of flame retardance</i>	T	60332-1	

## 6 Single-core non-sheathed cable with solid conductor for internal wiring for a conductor temperature of 90 °C

### 6.1 Code designation

60227 IEC 07.

### 6.2 Rated voltage

300/500 V.

### 6.3 Construction

#### 6.3.1 Conductor

Number of conductors: 1.

The conductors shall comply with the requirements given in IEC 60228 for class 1 conductors.

#### 6.3.2 Insulation

The insulation shall be polyvinyl chloride compound of type PVC/E, applied around the conductor.

The insulation thickness shall comply with the specified value given in column 2 of table 9.

The insulation resistance shall be not less than the value given in column 4 of table 9.

#### 6.3.3 Overall diameter

The mean overall diameter shall not exceed the upper limit given in column 3 of table 9.

**Table 9 – General data for type 60227 IEC 07**

1	2	3	4	5
Nominal cross-sectional area of conductor mm <sup>2</sup>	Thickness of insulation Specified value mm	Mean overall diameter		Minimum insulation resistance at 90 °C MΩ·km
		Lower limit mm	Upper limit mm	
0,5	0,6	1,9	2,3	0,015
0,75	0,6	2,1	2,5	0,013
1	0,6	2,2	2,7	0,012
1,5	0,7	2,6	3,2	0,011
2,5	0,8	3,2	3,9	0,009

### 6.4 Tests

Compliance with the requirements of 6.3 shall be checked by inspection and by the tests given in table 10.

## 6.5 Guide to use

Maximum conductor temperature in normal use: 90 °C.

In circumstances in which it is possible to guard against thermoplastic flow, and reduced insulation resistance can be tolerated, PVC compound suitable for continuous use at 90 °C can be operated at temperatures up to 105 °C for a reduced total working duration.

NOTE – Other guidelines are under consideration.

**Table 10 – Tests for type 60227 IEC 07**

1	2	3	4	
Ref. No.	Test	Category of test	Test method described in IEC	Subclause
1	<i>Electric test</i>			
1.1	Resistance of conductors	T, S	60227-2	2.1
1.2	Voltage test at 2 000 V	T, S	60227-2	2.2
1.3	Insulation resistance at 90°C	T	60227-2	2.4
2	<i>Provisions covering constructional and dimensional characteristics</i>		60227-1 and 60227-2	
2.1	Checking of compliance with constructional provisions	T, S	60227-1	Inspection and manual tests
2.2	Measurement of insulation thickness	T, S	60227-2	1.9
2.3	Measurement of overall diameter	T, S	60227-2	1.11
3	<i>Mechanical properties of insulation</i>			
3.1	Tensile test before ageing	T	60811-1-1	9.1
3.2	Tensile test after ageing	T	60811-1-2	8.1.3.1
3.3	Loss of mass test	T	60811-3-2	8.1
4	<i>Pressure test at high temperature</i>	T	60811-3-1	8.1
5	<i>Elasticity at low temperature</i>			
5.1	Bending test for insulation	T	60811-1-4	8.1
6	<i>Heat shock test</i>	T	60811-3-1	9.1
7	<i>Test of flame retardance</i>	T	60332-1	
8	<i>Thermal stability</i>	T	60811-3-2	9

## 7 Single-core non-sheathed cable with flexible conductor for internal wiring for a conductor temperature of 90 °C

### 7.1 Code designation

60227 IEC 08.

### 7.2 Rated voltage

300/500 V.

### 7.3 Construction

#### 7.3.1 Conductor

Number of conductors: 1.

The conductors shall comply with the requirements given in IEC 60228 for class 5 conductors.

#### 7.3.2 Insulation

The insulation shall be polyvinyl chloride compound of type PVC/E, applied around the conductor.

The insulation thickness shall comply with the specified value given in column 2 of table 11.

The insulation resistance shall be not less than the value given in column 4 of table 11.

#### 7.3.3 Overall diameter

The mean overall diameter shall not exceed the upper limit given in column 3 of table 11.

**Table 11 – General data for type 60227 IEC 08**

1	2	3	4	5
Nominal cross-sectional area of conductor mm <sup>2</sup>	Thickness of insulation Specified value mm	Mean overall diameter		Minimum insulation resistance at 90 °C MΩ·km
		Lower limit mm	Upper limit mm	
0,5	0,6	2,1	2,5	0,013
0,75	0,6	2,2	2,7	0,012
1	0,6	2,4	2,8	0,010
1,5	0,7	2,8	3,4	0,009
2,5	0,8	3,4	4,1	0,009

### 7.4 Tests

Compliance with the requirements of 7.3 shall be checked by inspection and by the test given in table 12.

## 7.5 Guide to use

Maximum conductor temperature in normal use: 90 °C.

In circumstances in which it is possible to guard against thermoplastic flow, and reduced insulation resistance can be tolerated, PVC compound suitable for continuous use at 90 °C can be operated at temperatures up to 105 °C for a reduced total working duration.

NOTE – Other guidelines are under consideration.

**Table 12 – Tests for type 60227 IEC 08**

1	2	3	4	
Ref. No.	Test	Category of test	Test method described in IEC	Subclause
1	<i>Electric test</i>			
1.1	Resistance of conductors	T, S	60227-2	2.1
1.2	Voltage test at 2 000 V	T, S	60227-2	2.2
1.3	Insulation resistance at 90 °C	T	60227-2	2.4
2	<i>Provisions covering constructional and dimensional characteristics</i>		60227-1 and 60227-2	
2.1	Checking of compliance with constructional provisions	T, S	60227-1	Inspection and manual tests
2.2	Measurement of insulation thickness	T, S	60227-2	1.9
2.3	Measurement of overall diameter	T, S	60227-2	1.11
3	<i>Mechanical properties of insulation</i>			
3.1	Tensile test before ageing	T	60811-1-1	9.1
3.2	Tensile test after ageing	T	60811-1-2	8.1.3.1
3.3	Loss of mass test	T	60811-3-2	8.1
4	<i>Pressure test at high temperature</i>	T	60811-3-1	8.1
5	<i>Elasticity at low temperature</i>			
5.1	Bending test for insulation	T	60811-1-4	8.1
6	<i>Heat shock test</i>	T	60811-3-1	9.1
7	<i>Test of flame retardance</i>	T	60332-1	
8	<i>Thermal stability</i>	T	60811-3-2	9



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