**IS 694 : 2010**
(Reaffirmed 2015)
**(Reaffirmed 2020)**

*भारतीय मानक*

# 450/750 वोल्ट की और तक की कार्यकारिता वोल्टता के लिए द ढ़ और लचीले चालक वाली पोलीविनाइल क्लोराइड से विद्युत रोधित अनावरित और आवरित केबल/डोरी

*( चौथा पुनरीक्षण )*

*Indian Standard*

# POLYVINYL CHLORIDE INSULATED UNSHEATHED AND SHEATHED CABLES/CORDS WITH RIGID AND FLEXIBLE CONDUCTOR FOR RATED VOLTAGES UP TO AND INCLUDING 450/750 V

*( Fourth Revision )*

ICS 621.315.211 [621.315.616.96]



**B U R E A U O F I N D I A N S T A N D A R D S**
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*May 2011*

**Price Group 8**

Power Cables Sectional Committee, ETD 09

FOREWORD

This Indian Standard (Fourth Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Power Cables Sectional Committee had been approved by the Electrotechnical Division Council.

This standard was originally published in 1955 and was subsequently revised in 1964 when it was split up in two parts, Part 1 dealing with copper conductors and Part 2 dealing with aluminium conductors. Second revision was brought out in 1977 when the two parts were merged, including the requirements of weatherproof cables previously covered in IS 3035 (Part 1) : 1965 'Thermoplastic insulated weatherproof cables: Part 1 PVC insulated and PVC sheathed'. The two voltage grades specified as 250/440 V and 650/1 100 V were also merged. The third revision of this standard was brought out to take into account the experience gained since then to align with the international practices, to the extent considered appropriate.

Major changes in this revision include the following:

a) Modification of the rated voltage up to and including 450/750 V ac in line with International Electrotechnical Commission (IEC) Specification.
b) Inclusion of heat resistant PVC insulated and sheathed cable upto 85°C and inclusion of Type D insulation and ST3 type sheath for flexible cords for 70°C general application.
c) Inclusion of flame retardant (FR) and flame retardant low smoke and halogen (FR-LSH) PVC cable.
d) Introduction of reference number for each type of cable allocated for easy identification.
e) Expansion of the scope of core identification expanded.
f) Expansion of range of single and multi core sheathed and unsheathed cables.
g) This standard has been divided into 3 sections.
h) Clarity provided for testing different types of cables covered in this standard including test requirements of FR and FR-LSH PVC Cables.
j) The range for single and multi core PVC insulated and sheathed cords defined.
k) Inclusion of limited use of tinned copper conductor for special purpose cable.

While formulating this standard, assistance has been drawn from the following IEC and British Standards:

| | |
|---|---|
| IEC 60227-1 (2007-10) Ed. 3.0 | Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V — Part 1: General requirements |
| IEC 60227-2 (2003-04) Ed. 2.1 | Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V — Part 2: Test methods |
| IEC 60227-2-am1 (2003-03) Ed. 2.0 | Amendment 1 — Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V — Part 2: Test methods |
| IEC 60227-3 (1997-11) Ed. 2.1 | Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V — Part 3: Non-sheathed cables for fixed wiring |
| IEC 60227-3-am1 (1997-07) Ed. 2.0 | Amendment 1 — Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V — Part 3: Non-sheathed cables for fixed wiring |
| IEC 60227-4 (1997-12) Ed. 2.1 | Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V — Part 4: Sheathed cables for fixed wiring |
| IEC 60227-4-am1 (1997-07) Ed. 2.0 | Amendment 1 — Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V — Part 4: Sheathed cables for fixed wiring |
| IEC 60227-5 (2003-07) Ed. 2.2 | Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V — Part 5: Flexible cables (cords) |

(*Continued on third cover*)

(*Continued from second cover*)

| | |
|---|---|
| IEC 60227-5-am2 (2003-06) Ed. 2.0 | Amendment 2 — Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V — Part 5: Flexible cables (cords) |
| IEC 60719 (1992-03) Ed. 2.0 | Calculation of the lower and upper limits for the average outer dimensions of cables with circular copper conductors and of rated voltages up to and including 450/750 V |
| IEC 60228 (2004-11) Ed. 3.0 | Conductors of insulated cables |
| BS 6500 : 1984 | Insulated flexible cords and cables |

The composition of the Committee, responsible for the formulation of this standard is given at Annex B.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

# AMENDMENT NO. 1 SEPTEMBER 2012
# TO
# IS 694 : 2010 POLYVINYL CHLORIDE INSULATED UNSHEATHED AND SHEATHED CABLES/CORDS WITH RIGID AND FLEXIBLE CONDUCTOR FOR RATED VOLTAGES UP TO AND INCLUDING 450/750 V

***(Fourth Revision)***

(*Foreword*, *para* 2, *last sentence*) — Delete.

(*Foreword*, *para* 2) — Insert the following after para 2:

'The third revision was brought out in 1990 in which the terms used for the type of cables for use under special conditions had been rationalized, single core flexible cables and five core flexible cords had been added, overall dimensions had been stipulated and reference to the Indian Standards on conductor, insulation, sheath and methods of tests had been added. Also for single core sheathed cables, the process of single extrusion of insulation and sheath had been deleted. The fourth revision of this standard has been brought out to take into account the experience gained since then to align with the international practices, to the extent considered appropriate.'

[*Foreword*, *para* 3 (d)] — Substitute the following for existing:

'd) Thermal stability test included for both insulation and sheath.'

[*Foreword, para* 3 (e)] — Delete the word 'expanded'.

(*Page* 1 , *clause* **1.1,** *line* 11) — Delete the word 'category'.

(*Page* 1, *clause* **1.1,** *Note* 3, *last line*) — Substitute '1 125 V' *for* '1 500 V'.

**Price Group 2**

**Amendment No. 1 to IS 694 : 2010**

(*Page* 1, *clause* **1.1,** *Note* 9, *Section* 2) — Insert 'Non-sheathed' before 'Single core'.

(*Page* 2 , *clause* **3.6,** *para* 2) — Substitute 'expressed' *for* 'expresses'.

(*Page* 2 , *clause* **4.1**) — Substitute the following for existing clause:

'**4.1 Material**

The conductor shall be composed of annealed, bare or tinned high conductivity copper wires complying with IS 8130.
The conductor shall be composed of aluminum wires complying with IS 8130.
A separator tape made of suitable material may be applied over conductor at the discretion of the manufacturer.'

[*Page* 3, *clause* **5.1 (c)**] — Substitute the following for the existing:

'c) Type D – Flexible cords'

(*Page* 6, *clause* **13**, *Informal table*) — Insert 'Earth continuity conductor ECC and suitable for low temperature SZ' after PVC sheath.

(*Page* 6, *clause* **15.2**(d), *line* 2) — Insert 'and halogen' after smoke.

[*Page* 7, *Table* 1, *Sl No*. (ii), (e), *col* 2] — Insert 'and sheath' after insulation.

[*Page* 7, *Table* 1, *Sl No*. (ii), (f), *col* 2] — Insert 'and sheath' after insulation.

[*Page* 7, *Table* 1, *Sl No*. (ii), (f), *col* 4] — Substitute 'IS 5831' *for* 'IS 8130'.

[*Page* 7, *Table* 1, *Sl No*. (ii), (g), *col* 4] — Substitute 'IS 5831' *for* 'IS 8130'.

[*Page* 7, *Table* 1, *Sl No*. (iii), (c) (8), *col* 3] — Substitute '02' *for* '01,02,FR and FR-LSH'.

[*Page* 7, *Table* 1, *Sl No*. (iii), (c) (9), *col* 3] — Substitute '02, FR and FR-LSH' *for* '01,02,FR and FR-LSH'.

[*Page* 7, *Table* 1, *Sl No*. (iii), (d) (11), *col* 2] — Insert the following after 11)

| | | | |
|---|---|---|---|
| '12) Cold bend test | 02 | IS 5831 | 20 |
| 13) Cold impact test | 02 | IS 5831 | 21' |

[*Page* 7, *Table* 1, *Sl No*. (iii), (e) (2), *col* 2] — Delete and renumber the subsequent numbers.

(*Page* 9, *Section* 2) — Insert 'NON-SHEATHED' before SINGLE CORE CABLES in the title.

(*Page* 9, *clause* **16**) — Substitute the following for the existing title:

'SINGLE CORE NON-SHEATHED CABLES WITH RIGID CONDUCTOR (CLASS 1 OR CLASS 2) FOR GENERAL PURPOSE (70°C) OR HEAT RESISTANT (85°C)'

(*Page* 9, *clause* **17**) — Substitute the following for the existing title:

'SINGLE CORE NON-SHEATHED CABLES WITH FLEXIBLE CONDUCTOR FOR GENERAL PURPOSE (70°C) OR HEAT RESISTANT (85°C)'

(*Page* 10, *clause* **18**) — Substitute the following for the existing title:

'SINGLE AND MULTICORE CIRCULAR PVC INSULATED AND SHEATHED CABLES WITH RIGID CONDUCTOR (CLASS 1 OR CLASS 2) FOR GENERAL PURPOSE (70°C) OR HEAT RESISTANT (85°C)'

**Amendment No. 1 to IS 694 : 2010**

(*Page* 11, *clause* **18.2**) — Substitute the following for the existing clause:

'**18.2 Tests**

The compliance with the requirement of **18.1** shall be checked by inspection and by tests given in Table 1.'

(*Page* 11, *clause* **19**) — Substitute the following for the existing title:

'SINGLE AND MULTICORE CIRCULAR PVC INSULATED AND SHEATHED CABLES/CORDS WITH FLEXIBLE CONDUCTOR (CLASS 5) FOR GENERAL PURPOSE (70°C) OR HEAT RESISTANT (85°C)'.

(*Page* 12*, clause* **19.1.5**, *para* 1, *line* 1) — Substitute the following for the existing line

'The sheath shall be PVC compound type ST3 in'.

(*Page* 12, *clause* **19.1.5**, *para* 4) — Substitute the following for the existing para:

'The thickness of PVC sheath determined by taking average of number of measurements shall not be less than nominal value ($t_s$) specified in Table 5 for fixed installation and Table 6 for flexible PVC insulated and sheathed cables and Table 7 for flexible insulated and sheathed cords and flexible twin twisted and twin parallel cable by more than 0.1 mm + 0.15 $t_s$.'

(*Page* 12, *clause* **20**) — Substitute the following for the existing title:

'MULTICORE CIRCULAR PVC INSULATED AND SHEATHED CABLES WITH FLEXIBLE CONDUCTOR (CLASS 5) FOR GENERAL PURPOSE (70°C) OR HEAT RESISTANT (85°C)'.

(*Page* 12, *clause* **20.1.3**, *para* 1, *line* 3) — Substitute 'Lay-up of cores' *for* 'lay of cores'.

(*Page* 12, *clause* **20.1.4**, *line* 1) — Delete 'For sheathed cable'.

(*Page* 13, *Table* 6, *col* 4 to *col* 8) — Substitute the following for the existing heading:
'Nominal Thickness of sheath, $t_s$'.
.

(*Page* 13, *Table* 7) — Substitute the following for the existing table heading:

'Flexible PVC Insulated and Sheathed Cords (Circular) and Flexible Twisted Twin and Parallel Twin Cable'

(*Page* 13, *Table* 7, *col* 4 to *col* 8) — Substitute the following for the existing heading:

'Nominal Thickness of Sheath, $t_s$'.

(*Page* 14, *clause* **21**) — Substitute the following for the existing clause:

'PARALLEL TWIN AND TWISTED TWIN FLEXIBLE PVC INSULATED NON-SHEATHED CORDS WITH FLEXIBLE CONDUCTOR (CLASS 5) FOR GENERAL PURPOSE (70°C) OR HEAT RESISTANT (85°C)'

(*Page* 12, *clause* **21.1.2**, *line* 5) — Substitute 'Table 7' *for* 'Table 10'.

(*Page* 12, *clause* **21.1.3**, *last sentence*) — Substitute the following for the last line:

'The dimension shall be as per Table 7 and the lay up of cores shall be as per Table 8.'

(*Page* 12, *clause* **20.1.4,** *last para*) — Delete 'The sheath shall be absent in case of unsheathed cable'.

(*Page* 14, *clause* **22**) — Substitute the following for the existing clause:

**Amendment No. 1 to IS 694 : 2010**

'TWO AND THREE CORE FLAT CABLES WITH PVC INSULATION AND SHEATH HAVING STRANDED OR FLEXIBLE CONDUCTOR (CLASS 2 OR CLASS 5) FOR GENERAL PURPOSE (70°C) OR HEAT RESISTANT (85°C)'

(ETD 09)

Reprography Unit, BIS, New Delhi, India

# AMENDMENT NO. 2 JULY 2014
# TO
# IS 694 : 2010 POLYVINYL CHLORIDE INSULATED UNSHEATHED AND SHEATHED CABLES/CORDS WITH RIGID AND FLEXIBLE CONDUCTOR FOR RATED VOLTAGES UP TO AND INCLUDING 450/750 V

***(Fourth Revision)***

(*Foreword*, *para* 2, *line* 5) — Substitute '1 100' *for* '1 100'.

[*Foreword*, *para* 3, *Sl No.* (c)] — Delete and renumber.

(*Page* 1, *clause* **1.1**, *line* 9) — Substitute '1 125' *for* '1 500'.

(*Page* 2, *clause* **2,** *line* 15) — Substitute '8130 : 2013' *for* '8130 : 1984'.

(*Page* 2, *clause* **2**) — Insert 'IS 13360 (Part 6/See 9) : 2001 Determination of Density of Smoke from the Burning or Decomposition of Plastics ' at the end.

(*Page* 2, *clause* **4.1**, *para* 1, *line* 2) — Substitute 'shall Comply to' *for* 'Complying with'.

(*Page* 2, *clause* **4.1**, *para* 3, *sentence* 2) — Delete last sentence.

(*Page* 3, *clause* **5.2**, *line* 5) — Substitute 'by visual inspection' *for* 'by inspection and manual test'.

[*Page* 3, *clause* **8.1**, *para* 1, *Sl No.* (c)] — Substitute 'flexible cables and cords' *for* 'flexible cables'.

(*Page* 5, *clause* **10.7**, *sentence* 2) — Substitute 'The minimum measured value of temperature index shall be 250ºC at which the oxygen index is 21.' for the existing.

(*Page* 5, *clause* **10.8**) — Substitute 'The test shall be conducted as per 'IS 13360 (Part 6/See 9) : 2001 — Determination of density of smoke from the Burning or decomposition of plastics. Maximum smoke density rating (percent) — 60' *for* 'Under preparation'.

**Amendment No. 2 to IS 694 : 2010**

(*Page* 5, *clause* **10.9.2**, *para* 1, *sentence* 2) — Substitute 'bath' for 'batch'.

(*Page* 5, *clause* **12.1**, *para* 2) — Substitute '**11.1**' *for* '**3.1**'.

[*Page* 7, *Table* 1, *Sl No*. (ii), (p), *col* 5] — Delete.

[*Page* 7, *Table* 1, *Sl No*. (iii), (c) (14), *and* (d) (11), *col* 1] — Substitute 'Test for smoke density rating' *for* 'Test for smoke density'.

[*Page* 7, *Table* 1, *Sl No.* (iii), (c) (14), *and* (d) (11), *col* 5] — Delete.

(*Page* 9, *Section* 2, *clause* **16** and wherever it appears in the standard) — Substitute 'unsheathed' *for* 'non-sheathed'.

(*Page* 9, *clause* **16.1.2,** *para* 1**,** *sentence* 3) — Delete.

(*Page* 10, *clause* **17.1.2,** *para* 2) — Substitute 'Table 1' *for* 'Table 2'.

(*Page* 10, *Table* 3, *Title*) — Insert ' / HR ' after General Purpose.

(*Page* 11, *Table* 4*, Title*) — Insert ' / HR ' after General Purpose.

(*Page* 11*, clause* **18.1.4**, *para* 1, *sentence* 2) — Delete.

(*Page* 12, *clause* **19.1.5**, *para* 1, *sentence* 2) — Delete.

[*Page* 12, *clause* **19.1.5**, (*see also Amendment No.* 1)] — Substitute 'Table 4' *for* 'Table 5'.

(*Page* 12, *clause* **20.1.4**, *para* 1, *sentence* 2) — Delete.

(*Page* 16, *clause* **22.1.4**, *para* 1, *sentence* 2) — Delete.

(ETD 09)

Publication Unit, BIS, New Delhi, India

# AMENDMENT NO. 3 JULY 2015
# TO
# IS 694 : 2010 POLYVINYL CHLORIDE INSULATED UNSHEATHED AND SHEATHED CABLES/CORDS WITH RIGID AND FLEXIBLE CONDUCTOR FOR RATED VOLTAGES UP TO AND INCLUDING 450/750 V

***(Fourth Revision)***

(*First cover page*) — Substitute '1 100 V' *for* '450/750 V'.

[*Second cover page*, *Para* 3, *Sl No*. (a)] — Delete.

(*page* 1, *Title*) — Substitute '1 100 V' *for* '450/750 V'.

[*Page* 1, *clause* **1.1**, *line* 5] — Substitute '1100 V' *for* '450/750 V' and in other subsequent clauses, wherever exists.

(*Page* 5, *clause* **12.1.1**, *Para* 2) — Substitute the following for the existing para:

'For every 15 mm length of core, one of these colours shall cover approximately, but not exceeding, 70 percent of the surface of the core, the other colour covering the remainder'.

[*Page* 6, *clause* **13** (*see also Amendment No*. 1)] — Delete 'Earth continuity conductor ECC and'.

(*Page* 6, *Fig.* 1) — Substitute the following 'Fig.1' for the existing:

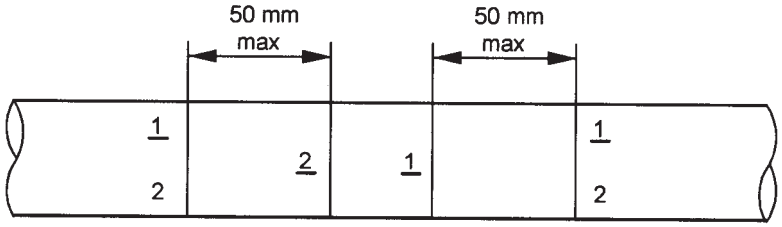


FIG. 1 PREFERRED ARRANGEMENT OF MARKING

(*Page* 6, *clause* **15.2**) — substitute j) *for* J).

[*Page* 7, *Table* 1, *Sl No*. (iii) (c) (9), *col* 3(*see also Amendment No*. 1)] — Substitute '02' *for* '02, FR and FR-LSH'

[*Page* 8, *Table* 1, *Sl No*. 7 *of* (iii) (e) (7), *col* 2] — Substitute 'Flex test (flexible cords for sizes upto 5 cores, with cross-sectional area of 2.5 $mm^2$)' *for* 'Flex test (flexible cords for sizes limited to 5 cores, with cross-sectional area of 2.5 $mm^2$)'.

(*Page* 8, *Table* 2, *col* 4, *heading*) — Substitute 'Flexible Cables and Cords' *for* 'Flexible Cables'.

(*Page* 9, *clause* **15.2**) — Delete "p) approximate gross mass", and renumber subsequent clauses.

(*Page* 9, *clause* **16.1.2**, *para* 1 (*see also Amendment No*. 2)] — Insert the following text at the end of first paragraph:

'However, FR/FR-LSH cables shall meet properties given in Table 1, wherever applicable pertaining to this type of cables.'

[*Page* 10, *Table* 3, *Sl No*. (iii)] — Insert the following values and renumber subsequent Sl Nos.:

| **Sl No.** | **Nominal Cross Sectional Area of Conductor .** $mm^2$ | **Class of Conductor** | **Thickness Of Insulation Nominal (ts)** mm | **Maximum Overall Diameter** mm |
|---|---|---|---|---|
| iv) | 1.0 | 2 | 0.7 | 3.2 |

[*Page* 11, *Table* 4, *Sl No*. (iv) *and* (v), *col* 3] — Substitute '0.6' *for* '0.7' and '0.7mm' *for* '0.8 mm', respectively.

**Price Group 2**

**Amendment No. 3 to IS 694 : 2010**

[*Page* 11, *clause* **18.1.4** (*see also Amendment No*. 2)] **—** Insert the following text at the end of first paragraph:

'However, FR/FR-LSH cables shall meet properties given in Table 1, wherever applicable, pertaining to this type of cables.'

[*Page* 12, *clause* **19.1.5** (*see also Amendment No*. 2)] **—** Substitute the following text for the existing second sentence:

'However, FR/FR-LSH cables shall meet properties given in Table 1, wherever applicable, pertaining to this type of cables.'

[*Page* 12, *clause* **20.1.4** (*see also Amendment No*. 2)] **—** Insert the following text at the end of first paragraph:

'However, FR/FR-LSH cables shall meet properties given in Table 1, wherever applicable, pertaining to this type of cables.'

(*Page* 13, *Table* 5) **—** Substitute the following table for the existing:

| Sl No. | Nominal cross sectional areas of conductor | Nominal thickness of insulation (ti) | Nominal thickness of Sheath (ts) | | | | Overall Dimensions, Max | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Single core | Two core | Three core | Four core | Single core | Two core | Three core | Four core |
| | $mm^2$ | mm | mm | mm | mm | mm | mm | mm | mm | mm |
| i | 1 | 0.6 | 1.1 | 1.2 | 1.2 | 1.2 | 5.3 | 8.2 | 8.8 | 9.9 |
| ii | 1.5 | 0.7 | 1.1 | 1.2 | 1.2 | 1.3 | 5.9 | 9.4 | 10.2 | 11.5 |
| iii | 2.5 | 0.8 | 1.1 | 1.3 | 1.3 | 1.3 | 6.7 | 10.9 | 11.8 | 13.3 |
| iv | 4 | 0.8 | 1.2 | 1.3 | 1.3 | 1.4 | 7.2 | 12.0 | 13.0 | 14.6 |
| v | 6 | 0.8 | 1.2 | 1.4 | 1.4 | 1.4 | 8.1 | 13.7 | 14.8 | 16.7 |
| vi | 10 | 1 | 1.2 | 1.5 | 1.5 | 1.6 | 9.5 | 16.5 | 17.8 | 20.0 |
| vii | 16 | 1 | 1.3 | 1.5 | 1.6 | 1.6 | 10.6 | 18.9 | 20.4 | 22.9 |
| viii | 25 | 1.2 | 1.3 | 1.6 | 1.7 | 1.8 | 12.2 | 22.1 | 23.8 | 26.8 |
| ix | 35 | 1.2 | 1.4 | 1.7 | 1.8 | 1.9 | 13.6 | 24.9 | 26.8 | 30.1 |
| x | 50 | 1.4 | 1.4 | 1.9 | 1.9 | 2.0 | 15.6 | 28.7 | 31.0 | 34.8 |
| xi | 70 | 1.4 | 1.5 | 2.0 | 2.0 | 2.2 | 17.3 | — | 34.7 | 38.9 |
| xii | 95 | 1.6 | 1.5 | 2.1 | 2.2 | 2.3 | 19.2 | — | 38.9 | 43.6 |
| xiii | 120 | 1.6 | 1.6 | 2.2 | 2.3 | 2.4 | 20.7 | — | 42.1 | 47.2 |

[*Page* 15, *Table* 9, *col* (3), (6), (9), (12) *and* (15)] — Insert '$t_i$' at the end of text 'Nominal Thickness of Insulation'

[*Page* 15, *Table* 9, *col* (4), (7), (10), (13) *and* (16)] — Substitute 'Nominal Thickness of Sheath ($t_s$)' *for* 'Nominal Sheathing'

[*Pages* 14 to 16, *clause* **22.1.1.1 (**b)] — Substitute the following for the existing and renumber subsequent Sl No.:

b) *For* **1.0, 1.5** and **2.5** $mm^2$, copper conductor shall be either stranded (class 2) or flexible (class 5);

c) *For* aluminium conductor of sizes 1.5, 2.5, 4, 6 and 10 mm sizes, it shall be either solid (class 1) or stranded (class 2) and all sizes above 10 sq mm shall stranded.

(*Page* 16, *Table* 10, *Sl No*. 4*, col* 6) — Substitute '12.0 × 5.6 $mm^2$' for 3 C × 1.5 $mm^2$ size for existing values.

(*Amendment No*. 1 *against clauses* **21.1.2** *and clause* **21.1.3**) — The '*page* 14' shall be substituted for '*page* 12'.

(ETD 09)

Publication Unit, BIS, New Delhi, India

*Indian Standard*

# POLYVINYL CHLORIDE INSULATED UNSHEATHED AND SHEATHED CABLES/CORDS WITH RIGID AND FLEXIBLE CONDUCTOR FOR RATED VOLTAGES UP TO AND INCLUDING 450/750 V

*( Fourth Revision )*

## 1 GENERAL

### 1.1 Scope

This standard covers general requirements of single and multicore cables/cords with rigid as well as flexible annealed bare/tinned copper and aluminium conductor, insulated and sheathed (if any) with polyvinyl chloride (PVC) for rated voltages up to and including 450/750 V ac, 50 Hz used in electric power and lighting including cables for outdoor and low temperature use. These cables may be used on dc systems for rated voltages up to and including 1 500 V to earth. This standard also includes cables with fire performance category in FR (Flame retardant) and category FR-LSH (Flame retardant low smoke and halogen) with conductor temperature not exceeding 70°C or 85°C. These cables require to qualify and comply the testing as specified in the respective category.

NOTES

**1** The term cord is used for the flexible cables up to 5 cores covering the sizes up to 2.5 mm².

**2** For cables for outdoor use, the cables shall meet requirements of additional ageing test given in Table 1.

**3** The cables covered in this standard are suitable for use on ac single or three phase (earthed or unearthed) systems for rated voltages $U_0/U$ up to and including 450 /750 V, 50 Hz. The cables may be used on dc system for rated voltages up to and including 1 500 V to earth.

**4** The cables covered in this standard are suitable for use where the combination of ambient temperature and temperature rise due to load results in a continuous conductor temperature not exceeding 70°C or 85°C.

**5** The following types of cables are not covered in this standard:

a) Telephone cables,
b) PVC data transmission cables,
c) Instrumentation cables,
d) PVC insulated screened communication cables (braid/ wires/tapes), and
e) Flexible power cord other than PVC insulated.

**6** The tests specified in Sections 1, 2 and 3 shall meet the requirements specified in IS 8130 for conductors, IS 5831 for PVC insulation and sheath and tested as per the test methods given in relevant parts of IS 10810 series.

**7** This standard covers the following categories of cables:

| *Category Code* | *Environment Description* |
|---|---|
| 01 | Cables for indoor installation |
| 02 | Cables for outdoor installations |
| FR | Flame retardant |
| FR-LSH | Flame retardant low smoke and halogen |

**8** This standard does not cover the requirements of flame retardance test for bunched cables.

**9** The specification is divided into following 3 sections, namely:

| | |
|---|---|
| Section 1 | General requirements |
| Section 2 | Single core cables/cords for fixed and flexible wiring |
| Section 3 | Sheathed single and multicore cables/cords for fixed and flexible wiring |

## 2 REFERENCES

The standards given below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standard indicated below:

| *IS No.* | *Title* |
|---|---|
| 1885 (Part 32) : 1993/IEC 50-461 : 1984 | Electrotechnical vocabulary: Part 32 Electric cables |
| 4905 : 1968 | Methods for random sampling |
| 5831 : 1984 | PVC insulation and sheath of electric cables |
| 8130 : 1984 | Conductors for insulated electric cables and flexible cords |
| 10418 : 1982 | Drums for electric cables |
| 10810 | Methods of test for cables: |
| (Part 0) : 1984 | General |
| (Part 1) : 1984 | Annealing test for wires used in conductors |
| (Part 2) : 1984 | Tensile test for aluminium wires |

| *IS No.* | *Title* |
|---|---|
| (Part 3) : 1984 | Wrapping test for aluminium wires |
| (Part 4) : 1984 | Persulphate test of conductor |
| (Part 5) : 1984 | Conductor resistance test |
| (Part 6) : 1984 | Thickness of thermoplastic and elastomeric insulation and sheath |
| (Part 7) : 1984 | Tensile strength and elongation at break of thermoplastic and elastomeric insulation and sheath |
| (Part 10) : 1984 | Loss of mass test |
| (Part 11) : 1984 | Thermal ageing in air |
| (Part 12) : 1984 | Shrinkage test |
| (Part 14) : 1984 | Heat shock test |
| (Part 15) : 1984 | Hot deformation test |
| (Part 20) : 1984 | Cold bend test |
| (Part 21) : 1984 | Cold impact test |
| (Part 43) : 1984 | Insulation resistance |
| (Part 44) : 1984 | Spark test |
| (Part 45) : 1984 | High voltage test |
| (Part 53) : 1984 | Flammability test |
| (Part 58) : 1998 | Oxygen index test |
| (Part 59) : 1988 | Determination of the amount of halogen acid gas evolved during combustion of polymeric materials taken from cables |
| (Part 60) : 1988 | Thermal stability of PVC insulation and sheath |
| (Part 64) : 2003 | Measurement of temperature index |

## 3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 1885 (Part 32) and IS 10810 (Part 0) and the following shall apply.

**3.1 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.

**3.2 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.

**3.3 Type Tests** — 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 or manufacturing process, which might change the performance characteristics.

**3.4 Acceptance Tests** — Tests carried out on samples taken out from a lot for the purpose of acceptance of lot.

**3.5 Routine Tests** — Tests conducted by manufacturer on all finished lengths to demonstrate the integrity of the cable.

**3.6 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 expresses by the combination of two values $U_o/U$ expressed in volts:

$U_o$ being the rms value between any insulated conductor and the earth.

$U$ being the rms value between any two-phase conductors of 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 apply both to the value $U_o$ and to the value $U$.

In direct current system the nominal voltage of the systems shall not be higher than 1.5 times the rated voltage of the cable.

**3.7 Nominal Value** — The value by which a quantity is designated and which is often used in tables. Usually, in this standard, nominal values give rise to values to be checked by measurements taking into account specified tolerances.

## SECTION 1 GENERAL REQUIREMENTS

## 4 CONDUCTOR

### 4.1 Material

The conductors shall consist of annealed, bare or tinned of high conductivity copper wires complying with Class 1 or Class 2 or Class 5 as per IS 8130.

The conductor shall be composed of aluminium wires complying to IS 8130.

A separator tape made of suitable material may be applied over conductor at the discretion of the manufacturer. The aluminium conductors shall be of Class 1 or Class 2 as per IS 8130 for sizes up to and including 10 mm$^2$ and stranded type as per Class 2 of IS 8130 for the sizes above 10 mm$^2$.

### 4.2 Electrical Resistance

The resistance of each conductor at 20°C shall be in accordance with the requirements of IS 8130 for the given class of conductor.

Compliance shall be checked by the test given in Table 1, Sl No. (i) (a).

The classes of the conductors relevant to the various types of cables are given in Section 2 and Section 3.

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

Nominal cross-sectional area of conductor of cables covered in this standard are given in respective tables.

In case of tinned copper conductor, the persulphate test shall be conducted as per IS 8130 and as per IS 10810 (Part 4).

## 5 INSULATION

### 5.1 Material

The insulation shall be of polyvinyl chloride compound of the type specified for each type of cable (*see also* Section 2 and Section 3):

a) *Type* A — Cables for fixed installation
b) *Type* C — Heat-resistant cables (HR)
c) *Type* D — Flexible cables and cords

The PVC shall conform to IS 5831. The test requirements for this compound are as per IS 5831 and as mentioned in the respective sections.

The single core unsheathed cables (*see* Section 2) with fire performance for category FR and FR-LSH, the insulation shall satisfy the relevant special FR/FR-LSH properties. In case of sheathed cables with fire performance for category FR and FR-LSH (*see* Section 3), the insulation need not be with FR/FR-LSH properties.

### 5.2 Application to the Conductor

The insulation shall be so applied that it fits closely on the conductor. 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.

### 5.3 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 relevant tables given in Section 2 and Section 3.

The smallest of the measured values of thickness of insulation ($t_i$) shall not fall below the nominal value ($t_i$) specified in the relevant table by more than (0.1 mm +0.1 $t_i$).

### 5.4 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.

The compliance shall be checked by carrying out tensile strength and elongation test, for respective type of PVC, as per Table 1 of IS 5831. The applicable test values shall be obtained from Table 1 of IS 5831, for appropriate type of PVC.

## 6 FILLER

### 6.1 Material

The fillers shall be composed of one of the following or of any combination of the following:

a) A compound based on unvulcanized rubber or plastics; or
b) Natural or synthetic textiles; or
c) Paper; or
d) PVC

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

The filler material shall be suitable for operating temperature of the cable and compatible with other components of the cable. This shall not be harder than the PVC used for insulation and sheath.

### 6.2 Application

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

## 7 BINDER TAPE

Binder tape shall consist of plastic or proof textile material. This is optional and may be provided as per the agreement between the purchaser and the supplier.

## 8 SHEATH

### 8.1 Material

The sheath shall be polyvinyl chloride compound of the type specified for each type of cable (*see also* Section 3) as given below:

a) *Type* ST1 — cables for fixed installations
b) *Type* ST2 — cables sheathed with 85°C HRPVC compound
c) *Type* ST3 — flexible cables

The PVC shall conform to IS 5831. Test requirements for these compounds are as per Table 2 of IS 5831.

For the cables with fire performance category FR and FR-LSH, sheathing compound shall satisfy the relevant special FR/FR-LSH properties.

### 8.2 Application

The sheath shall be extruded in a single layer,

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

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

In certain cases, indicated in the particular specifications (*see* Section 3) the sheath may penetrate into the spaces between the cores, thus forming a filling.

### 8.3 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 Section 3. However, the thickness of PVC sheath determined by taking average of number of measurements, shall be not less than nominal value ($t_s$) specified in relevant tables and smallest of the measured value shall not fall below the nominal value ($t_s$) specified by more than (0.1 mm + 0.15 $t_s$).

Compliance shall be checked by testing the dimensional requirements specified in Section 3 and as per test method given in IS 10810 (Part 6).

### 8.4 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.

The compliance shall be checked by carrying out tensile strength and elongation test, and shall meet the requirements given in Table 2 of IS 5831, for respective type of PVC.

## 9 OVERALL DIMENSIONS

The mean overall dimensions of the cables shall be within the limits specified in the tables given in Section 2 and Section 3.

### 9.1 Ovality

The difference between maximum and minimum measured values of overall diameter of sheathed circular cables shall not exceed 15 percent of the maximum measured value at the same cross-section.

## 10 TESTS

The testing on the cables will be conducted as given in Table 1 for each category of the cable listed under scope.

### 10.1 High Voltage Test (Water Immersion Test)

The core shall be carefully removed from a sample approximately 3 m long from the finished multi core cable. In case of single core cable, the cores should be selected from the coil. They shall be so immersed in a water bath at 60 ± 3°C that their ends protrude at least 200 mm above the water level. After 24 h, voltage of 3 kV (rms) shall be applied between conductors and water. This voltage shall be raised to 6 kV (rms) within 10 s and held constant at this value for 5 min. If the sample fails in this test, one more sample shall be subjected to this test, which should pass.

The cores which have passed the preliminary test given in **10.1** shall be subsequently tested with a dc voltage of 1.2 kV in the same water-bath at the same temperature.

The conductor shall be connected to the negative pole and water to the positive pole of dc supply by means of copper electrode. The core shall withstand this dc voltage test for total 240 h without breakdown.

### 10.2 High Voltage Test (at Room Temperature)

In case of multi core cables and cords, the same shall withstand without breakdown an ac voltage of 3 kV (rms) or a dc voltage of 7.2 kV applied for a period of 5 min for each test connection.

Single core cables shall be immersed in water at ambient temperature 1 h before the testing and the test voltage shall be applied between conductor and water for the specified period.

### 10.3 Spark Test

Spark test may be carried out as an alternate to high voltage as per IS 10810 (Part 44) on single core unsheathed cables. The voltage shall be as specified below:

| *Thickness of Insulation* mm | *Test Voltage* kV (rms) |
|---|---|
| Up to and including 1.0 | 6 |
| Above 1.0 and up to and including 1.5 | 10 |
| Above 1.5 and up to and including 2.0 | 15 |
| Above 2.0 and up to and including 2.5 | 20 |
| Above 2.5 | 25 |

### 10.4 Flammability Test

The testing is conducted in accordance with IS 10810 (Part 53).

The period of burning after removal of flame shall not exceed 60 s and unaffected portion from the lower edge of the top clamp shall be at least 50 mm.

### 10.5 Oxygen Index Test

The test shall be conducted as per IS 10810 (Part 58) on samples at 27 ± 2°C. The oxygen index shall not be less than 29 percent.

**10.6 Test for Halogen Acid Gas Evolution**

The test shall be conducted as per IS 10810 (Part 59). The level of halogen acid gas evolved shall not exceed 20 percent by weight.

**10.7 Test for Temperature Index**

The test shall be conducted as per IS 10810 (Part 64). The minimum measured value of temperature index shall be 21 percent at a temperature of 250°C

**10.8 Smoke Density Rating**

Under preparation.

**10.9 Additional Ageing Test (for Cables for Outdoor Use)**

These additional type tests shall be conducted on cables for outdoor use (Category 02 type).

**10.9.1** *Ageing of Sample*

A sample, 6 m long, of the finished cable shall be suspended in a heating chamber and exposed to a temperature of 80 ± 2°C for a period of 168 h. Immediately after this, the sample shall be placed in a bath of boiling water for a period of 8 h and in a water-bath at 27 ± 2°C for 16 h. This procedure shall be repeated on 5 successive days. The ends of the sample shall always protrude at least 200 mm above the water level throughout the period and sequence of testing.

**10.9.2** *Testing and Evaluation*

A sample, 5 m long, taken from the conditioned sample as stated above shall be tested for high voltage test in accordance with **10.2**. The test has however, to be carried out on the finished cable and in a water batch at 60 ± 3°C.

The remaining conditioned sample shall be submitted to cold bend or cold impact test as appropriate.

**10.10 Flex Test**

Under consideration

**10.11 Persulphate Test**

This test is conducted for the tinned copper conductor as per method specified in IS 10810 (Part 4) and the requirements are as per **6.1.1** of IS 8130.

**11 IDENTIFICATION**

The manufacturer shall be identified throughout the length of the cable by manufacturers' name or trade-mark being printed, indented or embossed on the cable. In case none of these methods can be employed, or if the purchaser so desires, colour identification threads in accordance with the scheme to be approved by Bureau of Indian Standards shall be employed. The printing, indentation or embossing shall be done on the insulation in case of unsheathed cables and on the sheath in case of sheathed cables. The distance between any two consecutive printing, indentation or embossing shall not be more than 1 m

**11.1 Durability**

In case of printed marking, it shall be durable and compliance with the requirements. The compliance with requirement shall be checked by trying to remove the marking of manufacturer's name or trade-mark and the colours of cores or numerals by rubbing lightly ten times with a piece of cotton wool or cloth soaked in water.

**11.2 Legibility**

All markings shall be clear and 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.

**12 CORE IDENTIFICATION**

Each core shall be identified as follows:

a) In case of cables for fixed wiring upto and including four cores shall be identified as per Table 2.
b) The flexible cables/cords having upto and including 25 cores shall be marked as per the colour scheme given in Table 2.
c) Any other colour scheme agreed to between the purchaser and manufacturer.

**12.1 General Requirements**

Identification of the cores of a cable shall be achieved by the use of coloured insulation or other suitable method. The colouring with skin type is allowed provided it meets the desired testing as given in the standard.

The colours shall be clearly identifiable and durable. Durability shall be checked by the test given in **3.1**.

**12.1.1** *Colour Combination Yellow and Green*

In case of yellow-green cables used for earthing, the distribution of the colours shall comply with the following condition:

For every 15 mm length of core, one of these colours shall cover at least 30 percent and not more than 70 percent of the surface of the core, the other colour covering the remainder.

**12.2 Core Identification by Numbers**

In case of core identification with help of numbering

instead of colour identification following shall be applicable. 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 yellow-green core, if any, shall comply with the requirement of **12.1.1** 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.

**12.2.1** *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 between consecutive numbers shall not exceed 50 mm.

The arrangement of the marks is shown in Fig. 1.

**12.2.2** *Durability*

Printed numerals shall be durable. Compliance with this requirement shall be checked by the test given in **11.1**.

## 13 CABLE CODE

The following code shall be used for designating the cable:

| *Constituent* | *Code Letter* |
|---|---|
| Aluminium conductor | A |
| PVC insulation | Y |
| PVC sheath | Y |
| Suitable for outdoor use | OU |
| PVC with FR properties | FR |
| PVC with FR-LSH properties | FR-LSH |

NOTES

**1** No code letter is required when the conductor material is copper.

**2** In case of copper single core unsheathed PVC cable with FR or FR-LSH properties, the abbreviation FR or FR-LSH to be used after the complete cable code that is for example, Y (FR) or Y (FR-LSH).

**3** In case of copper multicore PVC insulated and sheathed cable with FR or FR-LSH properties, the abbreviation FR or FR-LSH to be used after the cable code, that is for example YY (FR) or YY (FR-LSH)

## 14 SAMPLING OF CABLES

See Annex A.

## 15 PACKING AND MARKING

**15.1** The cable shall be either wound on drums (*see* IS 10418) or reels or supplied in coils packed.

**15.2** The cable shall carry the following information either stenciled on the reel or drum or contained in a label attached to it:

a) Reference to this Indian Standard, for example, *see* IS 694;
b) Manufacturer's name, brand name or trade-mark;
c) Type of cable and voltage grade;
d) In cases of flame retardant PVC the word 'FR' and in case of flame retardant low smoke type the word 'FR-LSH' to be used;
e) Number of cores;
f) Nominal cross-sectional area of conductor;
g) In case of tinned copper conductor the word 'ATC' to be used;
h) Cable code;
J) Colour of core (in case of single core cables);
k) Length of cable on the reel, drum or coil;
m) Number of lengths on the reel, drum or coil (if more than one);
n) Direction of rotation of drum (by means of arrow) in case packed in wooden drums;

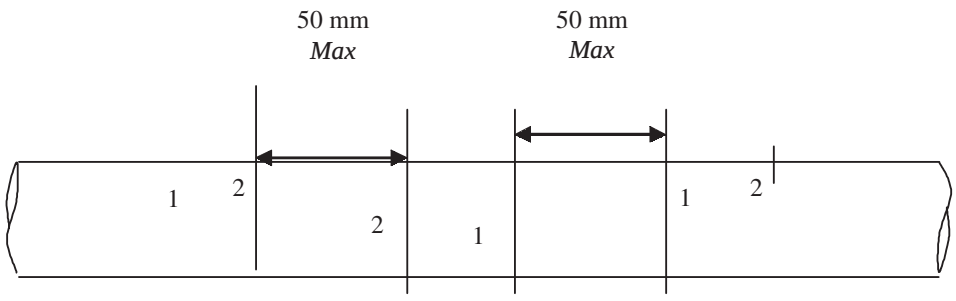


FIG. 1 PREFERRED ARRANGEMENT OF MARKING

**Table 1 Tests**
(*Clauses* 1.1, 4.2 *and* 10)

| Sl No. | Test | Category | Requirements, Ref to IS No./ Clause of this Standard | Method of Test, Ref to Part of IS 10810 |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| i) | *Routine tests*: | | | |
| | a) Conductor resistance test | 01, 02, FR and FR-LSH | IS 8130 | 5 |
| | b) High voltage test or Spark test | 01, 02, FR and FR-LSH | 10.2 or 10.3 | 45 or 44 |
| ii) | *Acceptance tests*: | | | |
| | a) Annealing test (for copper) | 01, 02, FR and FR-LSH | IS 8130 | 1 |
| | b) Tensile test (for aluminium) | 01, 02, FR and FR-LSH | IS 8130 | 2 |
| | c) Wrapping test (for aluminium) | 01, 02, FR & FR-LSH | IS 8130 | 3 |
| | d) Conductor resistance test | 01, 02, FR and FR-LSH | IS 8130 | 5 |
| | e) Test for thickness of insulation | 01, 02, FR and FR-LSH | As per relevant tables- Tables 3 to 10 | 6 |
| | f) Tensile strength and elongation at break of insulation | 01, 02, FR and FR-LSH | IS 8130 | 7 |
| | g) Insulation resistance test | 01, 02, FR and FR-LSH | IS 8130 | 43 |
| | h) High voltage test or spark test | 01, 02, FR and FR-LSH | 10.2 or 10.3 | 45 or 44 |
| | J) Flammability test | 01, 02, FR and FR-LSH | 10.4 | 53 |
| | k) Oxygen index test | FR and FR-LSH | 10.5 | 58 |
| | m) Test for temperature index | FR and FR-LSH | 10.7 | 64 |
| | n) Test for halogen acid gas evaluation | FR-LSH | 10.6 | 59 |
| | p) Test for smoke density rating | FR-LSH | 10.8 | Under preparation |
| | q) Persulphate test (for tinned copper conductor cable only) | 01, 02, FR and FR-LSH | 10.11 | 4 |
| iii) | *Type tests*: | | | |
| | a) Tests on conductor: | | | |
| | 1) Annealing test (for copper) | 01, 02, FR and FR-LSH | IS 8130 | 1 |
| | 2) Tensile test (for aluminium) | 01, 02, FR and FR-LSH | IS 8130 | 2 |
| | 3) Wrapping test (for aluminium) | 01, 02, FR and FR-LSH | IS 8130 | 3 |
| | 4) Conductor resistance test | 01, 02, FR and FR-LSH | IS 8130 | 5 |
| | 5) Persulphate test (for tinned copper conductor cable only) | 01, 02, FR and FR-LSH | 10.11 and 6.1.1 of IS 8130 | 4 |
| | b) Test for overall dimensions and thickness of insulation /sheath | | As per relevant tables— Tables 3 to 10 | 6 |
| | c) Physical tests for insulation: | | | |
| | 1) Tensile strength and elongation at break | 01, 02, FR and FR-LSH | IS 5831 | 7 |
| | 2) Loss of mass test | 01, 02, FR and FR-LSH | IS 5831 | 10 |
| | 3) Ageing in air oven | 01, 02, FR and FR-LSH | IS 5831 | 11 |
| | 4) Shrinkage test | 01, 02, FR and FR-LSH | IS 5831 | 12 |
| | 5) Heat shock test | 01, 02, FR and FR-LSH | IS 5831 | 14 |
| | 6) Hot deformation | 01, 02, FR and FR-LSH | IS 5831 | 15 |
| | 7) Thermal stability | 01, 02, FR and FR-LSH | IS 5831 | 60 |
| | 8) Cold bend test | 01, 02, FR and FR-LSH | IS 5831 | 20 |
| | 9) Cold impact test | 01, 02, FR and FR-LSH | IS 5831 | 21 |
| | 10) Flammability test | 01, 02, FR and FR-LSH | 10.4 | 53 |
| | 11) Oxygen index test | FR and FR-LSH | 10.5 | 58 |
| | 12) Test for temperature index | FR and FR-LSH | 10.7 | 64 |
| | 13) Test for halogen acid gas evaluation | FR-LSH | 10.6 | 59 |
| | 14) Test for smoke density | FR-LSH | 10.8 | Under preparation |
| | d) Physical tests for sheath (removed from the finished cable): | | | |
| | 1) Tensile strength and elongation at break | 01, 02, FR and FR-LSH | IS 5831 | 7 |
| | 2) Loss of mass test | 01, 02, FR and FR-LSH | IS 5831 | 10 |
| | 3) Ageing in air oven | 01, 02, FR and FR-LSH | IS 5831 | 11 |
| | 4) Shrinkage test | 01, 02, FR and FR-LSH | IS 5831 | 12 |
| | 5) Heat shock test | 01, 02, FR and FR-LSH | IS 5831 | 14 |
| | 6) Hot deformation | 01, 02, FR and FR-LSH | IS 5831 | 15 |
| | 7) Thermal stability | 01, 02, FR and FR-LSH | IS 5831 | 60 |
| | 8) Oxygen index test | FR and FR-LSH | 10.5 | 58 |
| | 9) Test for temperature index | FR and FR-LSH | 10.7 | 64 |
| | 10) Test for halogen acid gas evaluation | FR-LSH | 10.6 | 59 |
| | 11) Test for smoke density | FR-LSH | 10.8 | Under preparation |
| | e) Test on completed cable: | | | |
| | 1) High voltage test (water immersion test) | 01, 02, FR and FR-LSH | 10.1 | 45 |

**Table 1** (*Concluded*)

| Sl No. | Test | Category | Requirements, Ref to IS No./ Clause of this Standard | Method of Test, Ref to Part of IS 10810 |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| 2) | High voltage test or Spark test | 01, 02, FR and FR-LSH | 10.2 or 10.3 | 45 or 44 |
| 3) | Insulation resistance | 01, 02, FR and FR-LSH | IS 5831 | 43 |
| 4) | High voltage test | 01, 02, FR and FR-LSH | 10.2 | 45 |
| 5) | Flammability test | 01, 02, FR and FR-LSH | 10.4 | 53 |
| 6) | Additional ageing test (OU cables only) | 02, FR and FR-LSH | 10.9 | — |
| 7) | Flex test (flexible cords for sizes limited to 5 cores with cross-sectional area of 2.5 mm²) | 01, 02, FR and FR-LSH | 10.10 | Under consideration |

NOTE — The properties/testing for FR /FR-LSH cables as mentioned in this standard is applicable only for the cables covered in this standard.

**Table 2 Core Identification**
(*Clause* 12)

| Sl No. (1) | No. of Cores (2) | Cables for Fixed Wiring and Cords (3) | Flexible Cables (4) |
|---|---|---|---|
| i) | 1 | Red, black, yellow, blue, white, grey | Red, black, yellow, blue, white, grey |
| ii) | 2 | Red and black | Red and black |
| iii) | 3 | Red, yellow and blue | Red, black and yellow-green or red, yellow and blue |
| iv) | 4 | Red, yellow, blue and black | Red, yellow, blue and yellow-green or red, yellow, blue and black |
| v) | 5 | — | Red, yellow, blue, black and grey or yellow, blue, green white and yellow-green |
| vi) | 6 | — | Red, yellow, blue, green, white and yellow-green<br>Alternatively insulation cores shall be of the same colour either in black or grey or any other colour in agreement with purchaser and the manufacturer with number coded and with yellow/green in outer most layer as last core |
| vii) | 7 | — | Red, yellow, blue, green, white, black and yellow-green<br>Alternatively insulation cores shall be of the same colour either in black or grey or any other colour in agreement with purchaser and manufacturer with number coded and with yellow/green in outer most layer as last core |
| viii) | 8 | — | Red, yellow, blue, green, white, black, grey and yellow-green<br>Alternatively insulation cores shall be of the same colour either in black or grey or any other colour in agreement with purchaser and manufacturer with number coded and with yellow/green in outer most layer as last core |
| ix) | 9 | — | Red, yellow, blue, green, white, black, grey, orange and yellow-green<br>Alternatively insulation cores shall be of the same colour either in black or grey or any other colour in agreement with the purchaser and the manufacturer or number coded and with yellow/green in outer most layer as last core |
| x) | 10 | — | Red, yellow, blue, green, white, black, grey, orange, brown and yellow-green<br>Alternatively insulation cores shall be of the same colour either in black or grey or any other colour in agreement with the purchaser and the manufacturer or number coded and with yellow/green in outer most layer as last core |
| xi) | 11 | — | Red, yellow, blue, green, white, black, grey, orange, brown, pink and yellow-green<br>Alternatively insulation cores shall be of the same colour either in black or grey or any other colour in agreement with the purchaser and the manufacturer with number coded and with yellow/green in outer most layer as last core |
| xii) | 12 | — | Red, yellow, blue, green, white, black, grey, orange, brown, pink, violet and yellow-green<br>Alternatively insulation cores shall be of the same colour either in black or grey or any other colour in agreement with the purchaser and the manufacturer with number coded and with yellow/green in outer most layer as last core |

**Table 2** (*Concluded*)

| Sl No. (1) | No. of Cores (2) | Cables for Fixed Wiring and Cords (3) | Flexible Cables (4) |
|---|---|---|---|
| xiii) | 13 to 25 cores | — | Two adjacent cores in each layer blue and yellow (reference and direction core), and other remaining cores — Grey or alternatively insulation cores shall be of the same colour either in black or grey or any other colour in agreement with the purchaser and the manufacturer with number coded and with yellow/green in outer most layer as last core |

NOTES

**1** In case of single-core cables used for control wiring of switchgear, any colour other than the above shall be permissible as agreed to between the purchaser and the supplier.

**2** The colour of insulation for parallel twin flexible cords may be red, black, yellow, blue, white or grey. The cores may be identified by a longitudinal rib on one core.

**3** In case of single core cables and cords, manufacturers may provide one or two longitudinal ribs (stripes) of suitable colour applied by extrusion. The above-mentioned colours shall however be used as base colours. The base colour shall cover a majority of the surface, so as to facilitate easy visual identification of the same. In case two ribs (stripes) are provided, they shall be diametrically opposite to each other.

**4** For cables and cords with more than five cores, as an alternative, it is permissible to have all cores of the same colour. In such case, the cores shall be numbered sequentially (Hindu-Arabic numerals printed on the surface of the cores), starting with '1' for the innermost layer. The gap between two successive printings shall not exceed 50 mm.

p) Approximate gross mass;
q) Country of manufacture;
r) Year of manufacture; and
s) The word suitable for outdoor use, wherever applicable.

**15.2.1** *BIS Certification Marking*

The cable (packed coil, reel, drum or label) may also be marked with the Standard Mark.

**15.2.1.1** The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which a licence for the use of the Standard Mark may be granted to the manufacturers or producers may be obtained from the Bureau of Indian Standards.

## SECTION 2 SINGLE CORE CABLES/CORDS FOR FIXED AND FLEXIBLE WIRING

### 16 SINGLE CORE NON-SHEATHED CABLES WITH RIGID CONDUCTOR (CLASS 1 OR CLASS 2) FOR GENERAL PURPOSE (MAXIMUM CONDUCTOR TEMPERATURE 70°C OR 80°C)

#### 16.1 Construction

**16.1.1** *Conductor*

**16.1.1.1** The conductor shall comply with requirements of IS 8130 for Class 1 for solid and for Class 2 for stranded conductor. The sizes covered for the conductor are:

a) 0.5 to 10.0 mm$^2$ : Class 1 and 2
b) 16 mm$^2$ and above : Class 2

**16.1.2** *Insulation*

Insulation shall be polyvinyl chloride compound of Type A or Type C (HR) as per IS 5831, applied around the conductor. The insulation thickness shall comply with the specified values given in col 4 of Table 3. The standard also covers cables with fire performance categories FR and FR-LSH.

The smallest of the measured values of thickness of insulation shall not fall below the nominal value ($t_i$) specified in Table 3 by more than (0.1 mm + 0.1 $t_i$).

**16.1.3** *Overall Diameter*

The maximum overall diameter shall not exceed the value given in col 5 of Table 3.

#### 16.2 Tests

Compliance with the requirements of **16.1** shall be checked by inspection and by the tests given in Table 1.

### 17 SINGLE CORE NON-SHEATHED CABLES WITH FLEXIBLE CONDUCTOR FOR GENERAL PURPOSE (MAXIMUM CONDUCTOR TEMPERATURE 70°C OR 85°C)

#### 17.1 Construction

**17.1.1** *Conductor*

**17.1.1.1** The conductor shall comply with the requirements given in IS 8130 for Class 5 conductors. The sizes covered are from 0.5 to 300 mm$^2$.

**17.1.2** *Insulation*

The insulation shall be PVC compounds of Type D or Type C (HR) as per IS 5831, applied around the conductor. The standard also covers cables with fire performance categories FR and FR-LSH.

The insulation thickness shall comply with specified values given col 3 of Table 4. However FR/FR-LSH cables shall meet properties given in Table 2, wherever applicable pertaining to this type of cable.

The smallest of the measured values of thickness of insulation shall not fall below the nominal value ($t_i$) specified in Table 4 by more than (0.1 mm + 0.1 $t_i$).

**17.1.3** *Overall Diameter*

The maximum overall diameter shall not exceed the value given in col 4 of Table 4.

**17.2 Tests**

Compliance with requirement of **17.1** shall be checked by inspection and by the test given in Table 1.

## SECTION 3 SHEATHED SINGLE AND MULTICORE CABLES/CORDS FOR FIXED AND FLEXIBLE WIRING

### 18 SINGLE AND MULTICORE CIRCULAR PVC INSULATED AND SHEATHED CABLES WITH RIGID CONDUCTOR (CLASS 1 AND CLASS 2) FOR GENERAL PURPOSE ) FOR MAXIMUM CONDUCTOR TEMPERATURE (70°C OR 85°C)

**18.1 Construction**

**18.1.1** *Conductor*

**18.1.1.1** The conductor shall comply with requirements of IS 8130 Class 1 for solid and Class 2 for stranded conductor.

a) No. of cores — 1, 2, 3, or 4
b) Sizes — 1.0 to 120 mm$^2$

**18.1.2** *Insulation*

The insulation shall be of PVC of Type A or Type C

**Table 3 Dimensions of Single Core Non-sheathed Cables with Rigid Conductor (Class 1 or Class 2) for General Purpose (Maximum Conductor Temperature 70°C or 85°C)**
(*Clauses* 16.1.2 *and* 16.1.3)

| Sl No. | Nominal Cross-Sectional Area of Conductor | Class of Conductor | Thickness of Insulation Nominal ($t_i$) | Maximum Overall Diameter |
|---|---|---|---|---|
| | mm$^2$ | | mm | mm |
| (1) | (2) | (3) | (4) | (5) |
| i) | 0.5 | 1 | 0.6 | 2.3 |
| ii) | 0.75 | 1 | 0.6 | 2.5 |
| iii) | 1.0 | 1 | 0.6 | 2.7 |
| iv) | 1.5 | 1 | 0.7 | 3.2 |
| v) | 1.5 | 2 | 0.7 | 3.3 |
| vi) | 2.5 | 1 | 0.8 | 3.9 |
| vii) | 2.5 | 2 | 0.8 | 4.0 |
| viii) | 4.0 | 1 | 0.8 | 4.4 |
| ix) | 4.0 | 2 | 0.8 | 4.6 |
| x) | 6.0 | 1 | 0.8 | 5.0 |
| xi) | 6.0 | 2 | 0.8 | 5.2 |
| xii) | 10.0 | 1 | 1.0 | 6.4 |
| xiii) | 10.0 | 2 | 1.0 | 6.7 |
| xiv) | 16.0 | 2 | 1.0 | 7.8 |
| xv) | 25.0 | 2 | 1.2 | 9.7 |
| xvi) | 35.0 | 2 | 1.2 | 10.9 |
| xvii) | 50.0 | 2 | 1.4 | 12.8 |
| xviii) | 70.0 | 2 | 1.4 | 14.6 |
| xix) | 95.0 | 2 | 1.6 | 17.1 |
| xx) | 120.0 | 2 | 1.6 | 18.8 |
| xxi) | 150.0 | 2 | 1.8 | 20.9 |
| xxii) | 185.0 | 2 | 2.0 | 23.3 |
| xxiii) | 240.0 | 2 | 2.2 | 26.6 |
| xxiv) | 300.0 | 2 | 2.4 | 29.6 |
| xxv) | 400.0 | 2 | 2.6 | 33.2 |
| xxvi) | 500.0 | 2 | 2.8 | 37.5 |
| xxvii) | 630.0 | 2 | 3.0 | 42 |

**Table 4 Single Core Non-sheathed Cable with Flexible Conductor for General Purpose (for Maximum Conductor Temperature 70°C or 85°C)**
(*Clause* 17.1.2)

| Sl No. | Nominal Cross-Sectional Area of Conductor | Thickness of Insulation Nominal ($t_i$) | Maximum Overall Diameter |
|---|---|---|---|
| | $mm^2$ | mm | mm |
| (1) | (2) | (3) | (4) |
| i) | 0.5 | 0.6 | 2.6 |
| ii) | 0.75 | 0.6 | 2.8 |
| iii) | 1.0 | 0.6 | 3.0 |
| iv) | 1.5 | 0.7 | 3.4 |
| v) | 2.5 | 0.8 | 4.1 |
| vi) | 4.0 | 0.8 | 4.8 |
| vii) | 6.0 | 0.8 | 5.3 |
| viii) | 10.0 | 1.0 | 7.0 |
| ix) | 16.0 | 1.0 | 8.1 |
| x) | 25.0 | 1.2 | 10.2 |
| xi) | 35.0 | 1.2 | 11.7 |
| xii) | 50.0 | 1.4 | 13.9 |
| xiii) | 70.0 | 1.4 | 16.0 |
| xiv) | 95.0 | 1.6 | 18.2 |
| xv) | 120.0 | 1.6 | 20.2 |
| xvi) | 150.0 | 1.8 | 22.5 |
| xvii) | 185.00 | 2.0 | 24.9 |
| xviii) | 240.0 | 2.2 | 28.4 |
| xix) | 300.0 | 2.4 | 31.0 |

(HR) as per IS 5831, applied around the conductor. The thickness shall comply with specified values given in Table 5.

The smallest of the measured values of thickness of insulation shall not fall below the nominal value ($t_i$) specified in the relevant table by more than (0.1 mm + 0.1 $t_i$).

**18.1.3** *Assembly of Cores*

For cables with 2 cores and above, the cores shall be twisted together to form the core assembly.

**18.1.4** *Sheath*

The sheath shall be PVC compound of Type ST1 in case of 70°C and ST2 (HR) in case of HR PVC type as per IS 5831, applied around the laid up cores. In case of cables with fire performance category FR and FR-LSH, the necessary care shall be taken for formulation to meet the additional special testing. The sheath shall fit closely and shall be capable of being removed without damage to the inner core. The sheath thickness shall comply with specified values given in Table 5.

The thickness of PVC sheath determined by taking average ($t_s$) of number of measurements, shall not be less than nominal value ($t_s$) specified in Table 5 and the smallest of the measured values shall not fall below nominal value specified in Table 5 by more than 0.1 mm + 0.15 $t_s$.

The colour of sheath shall be black or any other colour as agreed between the purchaser and the supplier.

**18.1.5** *Ovality*

The difference between maximum and minimum measured values of overall diameter of sheathed circular cables shall not exceed 15 percent of the maximum measured values at the same cross-section.

**18.1.6** *Overall Dimensions*

The mean overall dimensions shall be within the upper limit as given in Table 5.

**18.2 Tests**

The compliance with the requirement of **18.1** and shall be checked by inspection by test given in Table 1.

## 19 SINGLE AND MULTICORE CIRCULAR PVC INSULATED AND SHEATHED CABLES/CORDS WITH FLEXIBLE CONDUCTOR (CLASS 5) FOR GENERAL PURPOSE (MAXIMUM CONDUCTOR TEMPERATURE 70°C OR 85°C)

**19.1 Construction**

**19.1.1** *Flexible Cable*

**19.1.1.1** The conductors shall comply with requirements given in IS 8130 for Class 5.

a) *Conductor material*— Annealed bare copper or annealed tinned copper
b) *No. of conductors* — 1, 2, 3, 4 and 5 core cable
c) *Sizes covered* — 4.00 to 300 $mm^2$

NOTE — In general annealed tinned copper being used up to 16 $mm^2$ only.

**19.1.2** *Flexible Cords*

**19.1.2.1** The conductors shall comply with requirements given in IS 8130 for Class 5.

a) *Conductor material* — Annealed bare copper or annealed tinned copper
b) *No. of conductors* — 1, 2, 3, 4 and 5 core cords
c) *Sizes covered* — 0.5 to 2.50 mm²

**19.1.3** *Insulation*

The insulation shall be PVC compound Type D in case of general purpose and Type C (HR) in case of HR PVC type cable as per IS 5831, applied around each conductor. The insulation thickness shall comply with specified values given in Table 6 for flexible cable and Table 7 for flexible cords.

The smallest of the measured values of thickness of insulation shall not fall below the nominal value ($t_i$) specified in the relevant table by more than (0.1 mm + 0.1 $t_i$).

**19.1.4** *Assembly of Cores*

In case of circular cables with 2 core and above, the cores shall be twisted together to form core assembly as recommended in Table 8.

**19.1.5** *Sheath*

The sheath shall be PVC compound type PVC ST3 in case of general purpose and ST2 (HR) in case of HR PVC type as per IS 5831, applied around the cores. In case of cables with improved fire performance FR and FR-LSH, the necessary care shall be taken for formulation to meet the additional special testing. The sheath thickness shall comply with the specified values given in Table 6 for flexible cable and Table 7 for flexible cords.

The sheath may fill the space between cores thus forming a filling, but it shall not adhere to the cores. The assembly of cores may be surrounded by a separator, which shall not adhere to cores.

The assembly of circular cord shall have a practically circular cross-section.

The thickness of PVC sheath determined by taking average of number of measurements, shall not be less than nominal value ($t_s$) specified in Table 4 and the smallest of the measured values shall not fall below nominal value specified in Table 6 or Table 7 for flexible cables and flexible cords respectively by more than 0.1 mm + 0.15 $t_s$.

The colour of sheath shall be black or any other colour as agreed to between the purchaser and the supplier.

**19.1.6** *Ovality*

The difference between maximum and minimum measured values of overall diameter of sheathed circular cables shall not exceed 15 percent of the maximum measured values at the same cross-section.

**19.1.7** *Overall Dimensions*

The mean overall dimensions of circular cords shall be within the limits given in Table 6.

**19.2 Tests**

Compliance with the requirements of **19.1** shall be checked by inspection and by tests given in Table 1.

## 20 MULTICORE CIRCULAR PVC INSULATED AND SHEATHED CABLES WITH FLEXIBLE CONDUCTOR (CLASS 5) FOR GENERAL PURPOSE (FOR MAXIMUM CONDUCTOR TEMPERATURE 70°C OR 85°C)

**20.1 Construction**

**20.1.1** *Conductor*

**20.1.1.1** The conductor shall comply with the requirements given in IS 8130 for Class 5 conductor.

a) *No. of conductor* — 6 to 25 cores
b) *Sizes covered* — 0.5 to 2.5 mm²

**20.1.2** *Insulation*

The insulation shall be PVC compound Type D in case of general purpose and Type C (HR) in case of HR PVC type as per IS 5831, applied around each conductor.

The insulation thickness shall comply with the specified value given in Table 9.

The smallest of the measured values of thickness of insulation ($t_i$) shall not fall below the nominal value ($t_i$) specified in the relevant table by more than (0.1 mm + 0.1 $t_i$).

**20.1.3** *Assembly of Cores and Fillers*

The cores shall be twisted together, where appropriate, in several concentric layers, as the case may be. The recommended plan for lay of cores is given in Table 8.

Around each layer a tape may be applied as per the agreement between the purchaser and the supplier, which may cover cores fully or partially. The tape shall not adhere to the cores.

**20.1.4** *Sheath*

For sheathed cable, the sheath shall be of PVC compound type ST3 in case of general PVC or ST2 (HR) type in case of HR PVC cables as per IS 5831, applied around the laid up cores. In case of cables with improved fire performance category FR and FR-LSH, the necessary care shall be taken for formulation to meet the additional special testing. An optional tape may be applied between the cores and outer sheath. The thickness ($t_s$) of PVC sheath determined by taking

average of number of measurements, shall not be less than nominal value ($t_s$) specified in Table 9 and the smallest of the measured values shall not fall below nominal value by more than 0.1 mm + 0.15 $t_s$.

**Table 5 PVC Insulated Circular Sheathed Cables for Fixed Wiring (Circular)**
(*Clauses* 18.1.2, 18.1.4 *and* 18.1.6)

| Sl No. | Nominal Cross-Sectional Area of Conductor | Nominal Thickness of Insulation ($t_i$) | Nominal Thickness of Sheath ($t_s$) | | | | Overall Dimensions, *Max* | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Single Core | Two Core | Three Core | Four Core | Single Core | Two Core | Three Core | Four Core |
| | mm$^2$ | mm | mm | mm | mm | mm | mm | mm | mm | mm |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| i) | 1.0[1)] | 0.6 | 0.8 | 0.9 | 0.9 | 0.9 | 4.7 | 8.2 | 8.6 | 9.2 |
| ii) | 1.5 | 0.6 | 0.8 | 0.9 | 0.9 | 0.9 | 5.0 | 8.8 | 9.2 | 10.0 |
| iii) | 2.5 | 0.7 | 0.8 | 1.0 | 1.0 | 1.0 | 5.8 | 10.5 | 11.0 | 12.0 |
| iv) | 4 | 0.8 | 0.9 | 1.0 | 1.1 | 1.1 | 6.8 | 12.0 | 13.0 | 14.0 |
| v) | 6 | 0.8 | 0.9 | 1.1 | 1.1 | 1.2 | 7.8 | 13.5 | 14.5 | 15.5 |
| vi) | 10 | 1.0 | 0.9 | 1.2 | 1.2 | 1.3 | 8.8 | 16.5 | 17.5 | 19.5 |
| vii) | 16 | 1.0 | 1.0 | 1.3 | 1.3 | 1.4 | 10.5 | 19.0 | 20.0 | 22.5 |
| viii) | 25 | 1.2 | 1.1 | 1.4 | 1.5 | 1.6 | 12.5 | 23.0 | 24.5 | 27.5 |
| ix) | 35 | 1.2 | 1.1 | 1.5 | 1.6 | 1.7 | 13.5 | 25.5 | 27.5 | 30.5 |
| x) | 50 | 1.4 | 1.2 | 1.6 | 1.7 | 1.8 | 15.5 | 29.5 | 31.5 | 35.0 |
| xi) | 70 | 1.4 | 2.4 | 2.4 | 2.5 | 2.8 | 17.5 | 35.0 | 37.0 | 41.4 |
| xii) | 95 | 1.6 | 1.5 | 2.7 | 2.9 | 3.1 | 21.0 | 40.5 | 43.2 | 48.1 |
| xiii) | 120 | 1.6 | 1.5 | 2.9 | 3.1 | 3.4 | 22.5 | 44.0 | 47.3 | 52.8 |

[1)] For copper conductor only.

**Table 6 Flexible PVC Insulated and Sheathed Cables (Circular)**
(*Clauses* 19.1.3, 19.1.5 *and* 19.1.7)

| Sl No. | Nominal Cross-Sectional Area of Conductor | Nominal Thickness of Insulation ($t_i$) | Nominal Thickness of Sheath | | | | | Overall Diameter, *Max* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Single Core | Two Core | Three Core | Four Core | Five Core | Single Core | Two Core | Three Core | Four Core | Five Core |
| | mm² | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) |
| i) | 4 | 0.8 | 1 | 1 | 1 | 1 | 1.1 | 6.8 | 11.6 | 12.4 | 13.6 | 15.3 |
| ii) | 6 | 0.8 | 1.1 | 1.1 | 1.2 | 1.2 | — | 7.5 | 13.0 | 13.8 | 15.47 | — |
| iii) | 10 | 1 | 1.3 | 1.3 | 1.4 | 1.4 | — | 9.4 | 16.5 | 17.69 | 19.5 | — |
| iv) | 16 | 1 | 1.4 | 1.4 | 1.4 | 1.4 | — | 10.9 | 19.4 | 20.6 | 23.0 | — |
| v) | 25 | 1.2 | 1.4 | 1.4 | 1.5 | 1.6 | — | 13.6 | 23.8 | 25.6 | 28.5 | — |
| vi) | 35 | 1.2 | 1.6 | 1.6 | 1.6 | 1.7 | — | 15.5 | 27.2 | 29.3 | 32.7 | — |
| vii) | 50 | 1.4 | 2.0 | 2.0 | 2.0 | 2.0 | — | 18.1 | 32.0 | 34.6 | 38.6 | — |
| viii) | 70 | 1.4 | 2.2 | 2.2 | 2.2 | 2.2 | — | 20.8 | 36.8 | 39.6 | 44.3 | — |
| ix) | 95 | 1.6 | 2.4 | 2.4 | 2.4 | 2.4 | — | 23.6 | 41.8 | 47.0 | 50.2 | — |
| x) | 120 | 1.6 | 2.5 | 2.5 | 2.5 | 2.5 | — | 26.0 | 46.2 | 51.0 | 55.7 | — |
| xi) | 150 | 1.8 | — | — | 2.6 | 2.6 | — | — | — | 54.8 | 62.1 | — |
| xii) | 185 | 2 | — | — | 2.8 | 2.8 | — | — | — | 61.2 | 68.5 | — |
| xiii) | 240 | 2.2 | — | — | 3.0 | 3.0 | — | — | — | 69.7 | 77.9 | — |
| xiv) | 300 | 2.4 | — | — | 3.2 | 3.2 | — | — | — | 75.7 | 84.7 | — |

**Table 7 Dimensions of Flexible PVC Insulated and Sheathed Cords (Circular) and Flexible Twin Twisted and Twin Parallel Cable**
(*Clauses* 19.1.3 *and* 19.1.5)

| Sl No. | Nominal Cross-Sectional Area of Conductor | Nominal Thickness of Insulation ($t_i$) | Nominal Sheathing Wall Thickness | | | | | Overall Dimension, *Max* | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Single Core | Twin Core | Three Core | Four Core | Five Core | Single Core | Twin Core | Three Core | Four Core | Five Core | Parallel Twin | Twisted Twin |
| | mm² | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) |
| i) | 0.5 | 0.6 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 4.3 | 6.9 | 7.3 | 8.0 | 8.7 | 2.6 × 5.2 | 5.2 |
| ii) | 0.75 | 0.6 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 4.5 | 7.3 | 7.7 | 8.4 | 9.2 | 2.8 × 5.6 | 5.6 |
| iii) | 1.0 | 0.6 | 0.9 | 0.9 | 0.9 | 0.9 | 1.0 | 4.7 | 7.6 | 8.1 | 8.8 | 9.6 | 3.0 × 6.0 | 6.0 |
| iv) | 1.5 | 0.6 | 0.9 | 0.9 | 0.9 | 1.0 | 1.0 | 5.4 | 8.9 | 9.4 | 10.4 | 11.4 | 3.3 × 6.6 | 6.6 |
| v) | 2.5 | 0.7 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 6.2 | 10.3 | 10.9 | 12.0 | 13.2 | 4.0 × 8.0 | 8.0 |
| vi) | 4 | 0.8 | — | — | — | — | — | — | — | — | — | — | 4.8 × 9.6 | 9.6 |

**Table 8 Recommended Lay-up of Cores**
(*Clauses* 19.1.4, 20.1.3 *and* 21.1.3)

| Sl No. | No. of Cores | Lay-up |
|---|---|---|
| (1) | (2) | (3) |
| i) | 2 | 2 |
| ii) | 3 | 3 |
| iii) | 4 | 4 |
| iv) | 5 | 5 |
| v) | 6 | 6 |
| vi) | 7 | 1-6 |
| vii) | 8 | 1-7 |
| viii) | 9 | 1-8 |
| ix) | 10 | 2-8 |
| x) | 11 | 3-8 |
| xi) | 12 | 3-9 |
| xii) | 13 | 3-10 |
| xiii) | 14 | 4-10 |
| xiv) | 15 | 5-10 |
| xv) | 16 | 5-11 |
| xvi) | 17 | 5-12 |
| xvii) | 18 | 0-6-12 |
| xviii) | 19 | 1-6-12 |
| xix) | 20 | 1-7-12 |
| xx) | 21 | 1-7-13 |
| xxi) | 22 | 2-7-13 |
| xxii) | 23 | 2-8-13 |
| xxiii) | 24 | 2-8-14 |
| xxiv) | 25 | 2-8-15 |

The colour of sheath shall be black or any other colour as agreed to between the purchaser and the supplier.

The sheath shall be absent in case of unsheathed cable.

**20.1.5** *Ovality*

The difference between maximum and minimum measured values of overall diameter of sheathed circular cables shall not exceed 15 percent of the maximum measured values at the same cross-section.

**20.2 Tests**

The compliance with the requirements of **20.1** above shall be checked by inspection and tests given in Table 1.

## 21 PARALLEL TWIN AND TWISTED TWIN FLEXIBLE PVC INSULATED UNSHEATHED CORDS (CLASS 5) FOR GENERAL PURPOSE (FOR MAXIMUM CONDUCTOR TEMPERATURE 70°C OR 85°C)

**21.1 Construction**

**21.1.1** *Conductor*

**21.1.1.1** The conductor shall comply with the requirements given in IS 8130 class 5 conductor.

a) *No. of conductor* — 2
b) *Sizes covered* — 0.5 to 4.0 mm²

**21.1.2** *Insulation*

The insulation shall be PVC compound Type D in case of general purpose and Type C (HR) in case of HR PVC type as per IS 5831, applied around each conductor. The insulation thickness shall comply with the specified value given in Table 10. The smallest of the measured values of thickness of insulation ($t_i$) shall not fall below the nominal value ($t_i$) specified in the relevant table by more than (0.1 mm +0.1 $t_i$).

**21.1.3** *Assembly of Cores*

The cores shall be twisted together for twin twisted cables with lay. For twin parallel cables, the cables shall be laid parallel to each other. The construction and dimensions shall be as given in Table 8.

**21.2 Tests**

The compliance with the requirements of **21.1** shall be checked by inspection and tests given in Table1.

## 22 TWO AND THREE CORE FLAT CABLES WITH PVC INSULATION AND SHEATHED (CLASS 2 OR 5) FOR GENERAL PURPOSE( FOR MAXIMUM CONDUCTOR TEMPERA TURE 70°C OR 85°C)

**22.1 Construction**

**22.1.1** *Conductor*

**22.1.1.1** The conductor shall comply with the requirements given in IS 8130.

a) *No. of conductors* — 2 and 3.
b) For 1.5 and 2.5 mm² the conductor shall be

**Table 9 Flexible PVC Insulated and Sheathed Cables (Circular)**

(*Clauses* 20.1.2 *and* 20.1.4)

| Sl No. | No. of Cores | 0.50 mm² | | | 0.75 mm² | | | 1.00 mm² | | | 1.50 mm² | | | 2.50 mm² | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Nominal Thickness of Insulation | Nominal Sheathing | Overall Dimension *Max* | Nominal Thickness of Insulation | Nominal Sheathing | Overall Dimension *Max* | Nominal Thickness of Insulation | Nominal Sheathing | Overall Dimension *Max* | Nominal Thickness of Insulation | Nominal Sheathing | Overall Dimension *Max* | Nominal Thickness of Insulation | Nominal Sheathing | Overall Dimension *Max* |
| | | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) |
| i) | 6 | 0.6 | 0.9 | 9.5 | 0.6 | 1.0 | 10.0 | 0.6 | 1.0 | 10.5 | 0.6 | 1.0 | 12.4 | 0.7 | 1.1 | 14.5 |
| ii) | 7 | 0.6 | 0.9 | 9.5 | 0.6 | 1.0 | 10.0 | 0.6 | 1.0 | 10.5 | 0.6 | 1.0 | 12.4 | 0.7 | 1.1 | 14.5 |
| iii) | 8 | 0.6 | 1.0 | 11.1 | 0.6 | 1.0 | 11.8 | 0.6 | 1.0 | 12.4 | 0.6 | 1.1 | 14.7 | 0.7 | 1.2 | 17.3 |
| iv) | 9 | 0.6 | 1.0 | 11.8 | 0.6 | 1.1 | 12.4 | 0.6 | 1.1 | 13.1 | 0.6 | 1.1 | 15.6 | 0.7 | 1.3 | 18.3 |
| v) | 10 | 0.6 | 1.0 | 12.0 | 0.6 | 1.1 | 12.7 | 0.6 | 1.1 | 13.4 | 0.6 | 1.1 | 16.0 | 0.7 | 1.3 | 18.7 |
| vi) | 11 | 0.6 | 1.0 | 12.0 | 0.6 | 1.1 | 12.7 | 0.6 | 1.1 | 13.4 | 0.6 | 1.1 | 16.0 | 0.7 | 1.3 | 18.7 |
| vii) | 12 | 0.6 | 1.0 | 12.4 | 0.6 | 1.1 | 13.1 | 0.6 | 1.1 | 13.9 | 0.6 | 1.1 | 16.5 | 0.7 | 1.3 | 19.4 |
| viii) | 13 | 0.6 | 1.0 | 13.1 | 0.6 | 1.1 | 13.8 | 0.6 | 1.1 | 14.6 | 0.6 | 1.2 | 17.4 | 0.7 | 1.3 | 20.5 |
| ix) | 14 | 0.6 | 1.1 | 13.1 | 0.6 | 1.1 | 13.8 | 0.6 | 1.1 | 14.6 | 0.6 | 1.2 | 17.4 | 0.7 | 1.3 | 20.5 |
| x) | 15 | 0.6 | 1.1 | 13.5 | 0.6 | 1.2 | 14.3 | 0.6 | 1.2 | 15.1 | 0.6 | 1.2 | 18.1 | 0.7 | 1.4 | 21.3 |
| xi) | 16 | 0.6 | 1.1 | 13.8 | 0.6 | 1.2 | 14.6 | 0.6 | 1.2 | 15.4 | 0.6 | 1.2 | 18.4 | 0.7 | 1.4 | 21.7 |
| xii) | 17 | 0.6 | 1.1 | 14.6 | 0.6 | 1.2 | 15.4 | 0.6 | 1.2 | 16.3 | 0.6 | 1.3 | 19.5 | 0.7 | 1.4 | 23.0 |
| xiii) | 18 | 0.6 | 1.1 | 14.6 | 0.6 | 1.2 | 15.4 | 0.6 | 1.3 | 16.3 | 0.6 | 1.3 | 19.5 | 0.7 | 1.4 | 23.3 |
| xiv) | 19 | 0.6 | 1.1 | 14.6 | 0.6 | 1.2 | 15.4 | 0.6 | 1.3 | 16.3 | 0.6 | 1.3 | 19.5 | 0.7 | 1.4 | 23.8 |
| xv) | 20 | 0.6 | 1.2 | 15.4 | 0.6 | 1.3 | 16.3 | 0.6 | 1.4 | 17.3 | 0.6 | 1.4 | 20.7 | 0.7 | 1.5 | 24.4 |
| xvi) | 21 | 0.6 | 1.2 | 15.4 | 0.6 | 1.3 | 16.3 | 0.6 | 1.4 | 17.3 | 0.6 | 1.4 | 20.7 | 0.7 | 1.5 | 25.0 |
| xvii) | 22 | 0.6 | 1.2 | 16.3 | 0.6 | 1.3 | 17.3 | 0.6 | 1.4 | 18.2 | 0.6 | 1.4 | 21.9 | 0.7 | 1.5 | 25.8 |
| xviii) | 23 | 0.6 | 1.2 | 16.3 | 0.6 | 1.3 | 17.3 | 0.6 | 1.4 | 18.2 | 0.6 | 1.4 | 21.9 | 0.7 | 1.5 | 26.3 |
| xix) | 24 | 0.6 | 1.2 | 17.1 | 0.6 | 1.3 | 18.2 | 0.6 | 1.4 | 19.2 | 0.6 | 1.4 | 23.0 | 0.7 | 1.5 | 27.2 |
| xx) | 25 | 0.6 | 1.2 | 17.1 | 0.6 | 1.3 | 19.0 | 0.6 | 1.4 | 19.2 | 0.6 | 1.4 | 23.0 | 0.7 | 1.5 | 27.9 |

either stranded (Class 2) or flexible (Class 5).

c) For 0.50 mm², 0.75 mm², 1.00 mm², 4 mm² and above, the conductor shall be flexible (Class 5).

d) Sizes covered are 0.5 to 95 mm² for 3 cores flat and 0.5 to 50 mm² for flat twin.

**22.1.2** *Insulation*

The insulation shall be PVC compound Type A in case of general purpose or Type C (HR) in case of HR PVC type as per IS 5831, applied around each conductor.

The insulation thickness ($t_i$) shall comply with the specified value given in Table 10.

The smallest of the measured values of thickness of insulation ($t_i$) shall not fall below the nominal value ($t_i$) specified in the relevant table by more than (0.1 mm +0.1 $t_i$).

**22.1.3** *Assembly of Cores*

The cores shall be laid in the flat formation.

**22.1.4** *Sheath*

The sheath shall be PVC compound type ST1 in case of general purpose PVC or ST2 (HR) type in case of HR PVC cables as per IS 5831, applied around the laid up cores. In case of cables with improved fire performance category FR and FR-LSH, the necessary care shall be taken for formulation to meet the additional special testing. An optional tape may be applied between the cores and outer sheath. The thickness ($t_s$) of PVC sheath determined by taking average of number of measurements, shall not be less than nominal value ($t_s$) specified in Table 10 and the smallest of the measured values shall not fall below nominal value by more than 0.1 mm + 0.15 $t_s$.

The colour of sheath shall be black or any other colour as agreed to between the purchaser and the supplier.

**22.2 Tests**

The compliance with the requirements of **22.1** above shall be checked by inspection and tests given in Table 1.

**Table 10 Dimensions of Insulated and Sheathed Two and Three Core Flat Cables**
(*Clauses* 21.1.2, 22.1.2 *and* 22.1.4)

| Sl No. | Nominal Cross-Sectional Area of Conductor | Nominal Thickness of Insulation ($t_i$) | Nominal Thickness of Sheath ($t_s$) | Overall Dimensions, *Max* ($W \times H$) | |
|---|---|---|---|---|---|
| | | | | 2 Core | 3 Core |
| | $mm^2$ | mm | mm | mm | mm |
| (1) | (2) | (3) | (4) | (5) | (6) |
| i) | 0.5 | 0.6 | 0.9 | 7.2 × 4.9 | 9.6 × 4.9 |
| ii) | 0.75 | 0.6 | 0.9 | 7.8 × 5.2 | 10.5 × 5.2 |
| iii) | 1.0 | 0.6 | 0.9 | 8.0 × 5.4 | 11.0 × 5.4 |
| iv) | 1.5 | 0.6 | 0.9 | 8.6 × 5.6 | 10.7 ×5.3 |
| v) | 2.5 | 0.7 | 1.0 | 10.5 × 6.6 | 13.0 × 6.2 |
| vi) | 4.0 | 0.8 | 1.0 | 12.0 × 7.4 | 15.3 × 7.1 |
| vii) | 6.0 | 0.8 | 1.1 | 13.0 × 8.0 | 19.2 × 8.4 |
| viii) | 10.0 | 1.0 | 1.4 | 16.0 × 9.6 | 24.2 × 10.4 |
| ix) | 16.0 | 1.0 | 1.4 | 18.5 × 11.0 | 29.0 × 12.4 |
| x) | 25.0 | 1.2 | 2.0 | 22.5 × 13.0 | 36.5 × 15.7 |
| xi) | 35.0 | 1.2 | 2.0 | 25.5 × 14.5 | 40.5 × 17.2 |
| xii) | 50.0 | 1.4 | 2.2 | 29.0 × 16.5 | 46.5 × 19.3 |
| xiii) | 70.0 | 1.4 | 2.2 | — | 52.0 × 21.0 |
| xiv) | 95.0 | 1.6 | 2.4 | — | 61.0 × 24.5 |

# ANNEX A
(*Clause* 14)

## SAMPLING OF CABLES

### A-1 LOT

In any consignment the cables of the same size and type manufactured under essentially similar conditions of production shall be grouped together to constitute a lot.

### A-2 SCALE OF SAMPLING

**A-2.1** Samples shall be taken and tested from each lot for ascertaining the conformity of the lot to the requirement of the specification.

**A-2.2** The number of samples to be selected shall depend on col 1 and col 2 of table 11. These samples shall be taken at random.

**A-2.2.1** In order to ensure the randomness of selection, procedure given in IS 4905 may be followed.

### A-3 NUMBER OF TESTS AND CRITERION FOR CONFORMITY

From each of the drum/coils/reels selected according to col 1 and col 2 of Table 11, suitable lengths of test samples shall be taken. These test samples shall be subjected to each of the acceptance tests. A test sample is called defective, if it fails in any one of the acceptance tests. If the number of defectives is less than or equal to the corresponding permissible number given in col 3 of Table 11, the lot shall be declared as conforming to the requirements of the acceptance tests; otherwise not.

**Table 11 Sampling of Cables**
(*Clauses* A-2.2 *and* A-3)

| Number of Drums/Coils/ Reels in the Lot | Number of Drums/Coils/Reels to be Taken as Sample | Permissible Number of Defectives |
|---|---|---|
| (*N*) | (*n*) | (*a*) |
| (1) | (2) | (3) |
| Up to 50 | 3 | 0 |
| 51-100 | 5 | 0 |
| 101-300 | 8 | 0 |
| 301 and above | 13 | 1 |

# ANNEX B
(*Foreword*)

## COMMITTEE COMPOSITION

Power Cables Sectional Committee, ETD 09

| *Organization* | *Representative(s)* |
|---|---|
| Central Power Research Institute, Bangalore | Shri S. Rama Prasath (***Chairman***) |
| Brihan Mumbai Electric Supply & Transport Undertaking, Mumbai | Shri D. S. Khalap<br>Shri N. N. Samuel (*Alternate*) |
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| Central Electricity Authority, New Delhi | Shri M. S. Satija<br>Shri H. R. Arora (*Alternate*) |
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| National Thermal Power Corporation Ltd, Noida | Shri Atul Shrivastva<br>Shri Rahul Agarwal (*Alternate*) |
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| *Organization* | *Representative(s)* |
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| Tata Consulting Engineers, Mumbai | Shri H. G. Brahme<br>Shri I. R. Patil (*Alternate*) |
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Scientist E , BIS

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**Amendments Issued Since Publication**

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