SKMM FTS LFCW
Rev. 1.01:2007

TECHNICAL SPECIFICATION FOR LOW-FREQUENCY CABLES AND WIRES WITH PVC INSULATION AND PVC SHEATH

Suruhanjaya Komunikasi dan Multimedia Malaysia
Off Pesiaran Multimedia, 63000 Cyberjaya, Selangor Darul Ehsan, Malaysia

FOREWORD

This Technical Specification was developed under the authority of the Malaysian Communications and Multimedia Commission (SKMM) under the Communications and Multimedia Act 1998 (CMA 98) and the relevant provisions on technical regulation of Part VII of the CMA 98. It is based on recognised International Standards documents.

This Technical Specification specifies the specification to conform for approval of telecommunications device.

NOTICE

This Specification is subject to review and revision

CONTENTS

Foreword i

1 Scope 1

2 Normative references 1

3 Abbreviations 1

4 Requirements 2
4.1 Technical requirements 2
4.2 Marking requirements 2

Section A Technical requirements for interconnection cables 3

Section B Technical requirements for internal wiring 13

Section C Technical requirements for internal wiring for general purpose 19

Tables

1 Elongation at break of the bare conductor 16

2 Colour code 25

3 Unit identification 28

4 Dimension and test requirements of insulated conductors 28

5 Cables in pairs, triples, quads and quintuples for inside installation 29

6 Cables in pairs for digital exchanges 30

7 Single equipment wires 32

8 Equipment wires in pairs and triples 33

CONTENTS *(continued)*

Figures

1 Cabling elements 12

2 Insulated conductor and pair construction 34

3 Triple construction 34

Annexes

A Colour Code 25

B Unit identification 28

C Dimensions and test requirements of insulated conductors 28

D Cables in pairs, triples, quads and quintuples for inside installation 29

E Cables in pairs for digital exchanges (with screening) 30

F Calculation of the maximum diameter of cables 31

G Single equipment wires 32

H Equipment wires in pairs and triples 33

I Calculation of the maximum diameter of insulated conductors 34

J Construction 34

LOW-FREQUENCY CABLES AND WIRES WITH PVC INSULATION AND PVC SHEATH

1. Scope

This Technical Specification covers the requirements for:

a) cable for inside installations, intended for the interconnection of the transmission equipment, telephone and telegraph equipment, and equipment for data processing.

b) cable for internal wiring of telecommunication equipment, and industrial and consumer electronic equipment.

2. Normative references

The following normative references are indispensable for the application of this Technical Specification. For dated references, only the edition cited applies. For undated references, the latest edition of the normative references (including any amendments) applies.

IEC 60189-1	*Low-frequency cables wires with PVC insulation and PVC sheath – Part 1: General test and measuring methods*
IEC 60189-2	*Low-frequency cables wires with PVC insulation and PVC sheath – Part 2: Cables in pairs, triples, quads and quintuples for inside installation with Amendment 1 and Amendment 2.*
IEC 60189-3	*Low-frequency cables wires with PVC insulation and PVC sheath – Part 3: Equipment wires with solid or stranded conductor, PVC insulated, in singles, pairs and triples.*
IEC 60304	*Standard Colour for Insulation for Low-frequency Cables and Wires.*
ISO Standard 105	*Textiles - Tests for colour fastness - Part A01: General principles of testing*
IEC 60344	*Guide to the Calculation of Resistance of Plain and Coated Copper Conductors of Low-frequency Cable and Wires*
IEC 60028	*International Standard of resistance for copper*
IEC 60304	*Standard colours for insulation for low-frequency for cables wires*
IEC 60332-3	*Test on electric cables under fire conditions - Part 3: Tests on bunched wires or cables*

3. Abbreviations

PVC	Polyvinyl Chloride
EMC	Electromagnetic Compatibility
IEC	International Electrotechnical Commission

4. Requirements

4.1 Technical requirements

The cable for interconnection in transmission equipment, telephone and telegraph equipment, and equipment for data processing shall comply with technical requirement as stipulated in Section A.

The cable for internal wiring in telecommunication equipment, and industrial and consumer electronic equipment shall comply with technical requirement as stipulated in Section B.

4.2 Marking requirements

The requirements shall be marked with the following information:

a) supplier/manufacturer's name or identification mark;

b) supplier/manufacturer's model or type reference; and

c) other markings as required by the relevant standards.

The marking shall be legible, indelible and readily visible. All information on the marking shall be either in Bahasa Melayu or English Language.

Section A

Technical requirements for interconnection cables in telecommunication equipments

1. Cable construction and dimensions

1.1 Conductor

1.1.1 Conductor material

The conductor shall consist of annealed copper, uniform in quality and free from defects. The properties of the copper shall be in accordance with IEC 60028.

1.1.2 Type of conductor

The conductor shall consist of single strand, circular in section.

1.1.3 Conductor finish

The conductor may be either plan or tinned.

1.1.4 Conductor dimensions

The conductor is designated by its nominal diameter.

Dimensions are given in Annex C.

1.1.5 Continuity of conductor

Normally the conductor shall be drawn in one piece. In cases of necessity, joints in the conductor are permitted provided that the tensile strength of a joint is not less than 85 % of the tensile strength of the un-jointed conductor.

1.2 Insulation

1.2.1 Insulation material

The insulation shall consist of polyvinyl chloride (PVC).

NOTE. The term “polyvinyl chloride” denotes a plasticized compound of polyvinly chloride or vinychloride vinylacetate copolymers.

1.2.2 Insulation thickness

The insulation shall be perfectly continuous having a thickness as uniform as possible and not less than the value specified in Annex C.

The minimum thickness of the insulation shall be measured in accordance with the method specified in 2.2.1.1 of IEC 60189-1.

1.2.3 Application of the insulation

The insulation shall be applied to fit closely to the conductor without adhering to it.

The striping properties of the insulation shall be checked in accordance with the method specified in 3.4.1 of IEC 60189-1.

It shall be possible to strip the insulation from the conductor easily and without damage to the insulation, to the conductor, or to the tinning, if any.

In particular cases, however, for example where wires are to be used employing wire wrapping techniques, or where mechanical stripping devices are being used, a controlled method of test may be required. In such cases, by agreement between purchaser and manufacturer, the method specified in 3.4.2 or 3.4.3 of IEC 60189-1 shall be adopted.

1.2.4 Colour of insulation

The insulated conductors shall be coloured by one colour or by two different colours.

Colours shall correspond reasonably with the standard shown in IEC 60304.

Colour fastness to daylight, checked in accordance with ISO Standard 105, shall be rated at not less than standard 4, prolonging the exposure until the contrast is equivalent to grade 4 on the grey scale.

When two colours are used, the following conditions shall be fulfilled:

- marking shall be rings or helices; if helices, single helices are preferred, double helices however are allowed;

- marking may be by helical bicolour extrusion;

- markings printed or painted on the insulation shall adhere satisfactorily;

- markings shall be easily identifiable within any 15 mm length of the insulated conductor;

- the distance of repetition of the marking shall be not less than 4 mm, measured from centre to centre parallel to the axis;

- the width of the rings or helices and the width of their spacing measured parallel to the axis, shall be approximately constant and shall be not less than 1.5 mm; and

- the width of the rings or helices need not be the same as that of the spacing.

NOTE. For wires identified by ring marking, neither the registration of the two half-bands nor the complete encirclement of the wire is critical.

1.3 Cabling elements

A cabling element (Figure 1) shall be:

- a pair of two insulated conductors twisted together and designated wire *a* and wire *b* respectively; or

- a triple of three insulated conductors twisted together and designated wire *a*, wire *b* and wire *c* respectively; or

- a quad of four insulated conductors twisted together and designated wire *a*, wire *b* wire *c* and wire *d* respectively; or

- a quintuple of five insulated conductors made up in one of the following ways;

a) five insulated conductors, twisted together and designated wire *a*, wire *b*, wire *c*, wire *d* and wire *e*;

b) four insulated conductors, twisted together and designated wire *a*, wire *b*, wire *c* and wire *d* and one designated wire *e* not twisted;

c) two insulated conductors, twisted together and designated wire *a* and wire *b*, combined with two insulated conductors, twisted together and designated wire *c* and wire *d*, and one wire designated *e*.

The maximum length of lay in the finished cable shall be 120 mm.

NOTE. Forming the element with a variable lay can lead to the infrequent occurrence of the maximum lay being longer than specified.

1.4 Binding of elements

If a thread or tape is used to bind the cabling elements, it shall preferably consist of non-hygroscopic material.

1.5 Stranding of elements

1.5.1 Concentric layer cables

All the cabling elements shall be stranded in concentric layers.

One single insulated conductor may be added for metering purposes; its diameter shall preferably be the same as that of other conductors and its insulation shall be coloured WHITE-red.

NOTES:

1. When necessary, fillers, preferably of non-hygroscopic material, can be used to obtain a round cable core.

2. The successive layers of cabling elements may be separated from each other by interlayer binders, preferably of non-hygroscopic material.

1.5.2 Unit cables

The cabling elements shall be bunched together in units of 20 cabling elements, or, if necessary, in sub-units of five or ten cabling elements. In cables for digital exchanges the cabling elements, if necessary, shall be bunched together preferably in units of two, four or eight elements.

The unit, and sub-units, if any, shall be stranded together.

One single insulated conductor may be added for metering purposes; its diameters shall preferably be the same as that of the other conductors and its insulation shall be coloured WHITE-red.

1.6 Sequence of elements

1.6.1 Concentric layer cables

The numbering sequence of the cabling elements shall be from the centre of the cable to the outside layer.

The direction of counting shall be the same in each layer (clockwise or counter-clockwise).

1.6.2 Unit cables

The numbering sequence of the cabling elements in each unit or sub-unit shall be from the centre to the outside.

NOTE. Some techniques or stranding may allow changes in the relative positions of cabling elements in the units and sub-units.

When sub-units of five elements are used, they shall consist exclusively, and in the following sequence, of elements 1-5, 6-10, 11-15 and 16-20. When sub-units of ten elements are used, they shall consist exclusively, and in the following sequence, of elements 1-10 and 11-20.

1.7 Total number of elements

When the units of 20 cabling elements or the subunits of five or ten cabling elements are used, the preferred total number of cabling elements shall be a multiple of five elements for cables comprising a total of up to 30 elements; a multiple of ten elements for cables comprising a total of more than 30, but not more than 60 elements; and a multiple of 20 elements for cables comprising a total of more than 60 elements. When the units of two, four or eight cabling elements are used, the preferred total number of cabling elements shall be a multiple of four elements for cables comprising a total of up to 24 elements and a multiple of eight elements for cables comprising a total of more than 24 elements.

The single insulated conductor for metering does not count as an element.

All elements assembled together form the core of the cable.

1.8 Identification of the cabling elements and of the insulated conductors

Identification of the cabling elements and of the insulated conductors in a cable with concentric stranding or in each unit of a cable with unit stranding shall be based on a code of colours.

All cabling elements shall be identified by the *a* and *b* wires only, the *c*, *d* and *e* wires each having a distinctive identification colour which shall be the same in all cabling elements.

The code is given in Annex A. For cables with unit stranding of 20 cabling elements or with subunits of five or ten cabling elements, the full colour code, or counting block No. 1 only may be used. For cables with unit stranding of two, four or eight cabling elements, the colour code is the same given in Annex A, with the exclusion of the colours corresponding to the cabling elements 5, 10, 15, 20, etc.

NOTE. For cables using single coloured conductors only, every wire in the cable may be individually identified at the request of the purchaser. In such cases, this can be done by adding a tracer to the standard colour given in Annex A. The tracer does not replace the colour code, but is an optional addition to be specified by the purchaser who requires it.

1.9. Sequence and identification of the units

The numbering sequence of the units in the cable shall be from the centre of the cable.

If the counting block No.1 only is used, each unit of the cable shall be identified by an open helical lapping, preferably of non-hygroscopic material of distinctive colour.

The preferred colour code for unit identification lapping is given in Annex B.

Alternatively, a tape, on which the number of the unit is printed, may be used. The height of the printed number shall be not less than 3 mm and the spacing measured from centre to centre of the printing, shall be not more than 20 mm.

In cables comprising more than 20 cabling elements and using counting block No. 1, only sub-units shall carry the identification tape corresponding to the unit of which they form part.

1.10. Wrapping

The core of the cable may be wrapped with a protective layer of preferably non-hygroscopic material (for example, a helical or longitudinal lapping of one or more tapes with overlap or a thin continues sheath).

If a screen is provided, the protective layer shall be mandatory.

1.11. Screening

The core of the cable may be provided with a screen, if necessary. It shall consist of copper or aluminium tape of 0.04 mm minimum thickness, or of a thin tape of the same materials, of 0.008 mm minimum thickness, laminated to a plastic tape.

The tape shall be wound helically or applied longitudinally round the wrapped core with an overlap of at least 20 % or 6 mm, whichever is the less.

Alternatively, two tapes with breaking joint shall be permitted when the screen consist of copper or aluminium tape.

One or more tinned copper wires shall be included in the cable in continuous contact with the surface of the metal tape. The wires may be of circular section or flat; the total cross-section shall be not less than 0.125 mm^2.

The screen may be provided with an outer protective layer of preferably non-hygroscopic material (for example, a longitudinal or helical wrapping of one or more tapes with overlap).

1.12. Rip cord

A non-metallic rip cord may be provided.

1.13. Sheath

1.13.1 Sheath material

The sheath shall consist of polyvinyl chloride.

1.13.2 Sheath thickness

The sheath shall be perfectly continuous having a thickness as uniform as possible and not less than the values specified in Annex D for cables with unit stranding of 20 cabling elements o with sub-units of five or ten cabling elements and in Annex E for cables with unit stranding of four or eight cabling elements.

The minimum thickness of the sheath shall be determined in accordance with the method specified in 2.2.1 of IEC 60189-1.

1.13.3 Application of the sheath

The sheath shall be applied to fit closely to the core of the cable.

The sheath shall not adhere to the insulation of the conductors of the outer layer, nor to the screen or protective layer, if provided.

NOTE. Adhesion of the sheath to a screen consisting of a metal tape laminated to a plastic tape is permissible.

1.13.4 Colour of sheath

The colour of the sheath shall be preferably grey.

NOTE. An alternative sheath colour may be specified by the purchaser who requires it.

1.14. Finished cable

1.14.1 Diameter of cable over sheath

The diameter over the sheath of the finished cable shall not exceed the value given in Annex D.

This value shall be calculated in accordance with the method given in Annex F.

The diameter over the sheath of the finished cable shall be measured in accordance with the method specified in 2.2.3 of IEC 60189-1.

1.14.2 Sealing of ends

The ends of the finished cable shall be adequately sealed to prevent ingress of moisture.

Sealing shall be carried out immediately after inspection and acceptance tests.

1.15 Delivery

Delivery shall be made on reels or in coils protected in a suitable manner.

2. Mechanical requirements

2.1 Conductor

Elongation at break of the bare conductor shall be not less than:

10 % for solid conductor of 0.4 mm diameter; and

15 % for solid conductor over 0.4 mm diameter.

Compliance shall be checked by measuring the elongation at break in accordance with the method specified in 3.3 of IEC 60189-1.

If the conductor is tinned, the amount of tin per unit area shall be adequate for soldering the conductor to the terminals without difficulty.

Compliance shall be checked by means of the solder test on samples of the conductors in accordance with the method specified in 4.7 of IEC 60189-1.

Good tinning shall be evidenced by free flowing of the solder with wetting of the conductor ends.

2.2 Insulation

The insulation shall have adequate mechanical strength and elasticity. These properties shall remain sufficiently constant during normal use.

Compliance shall be checked before and after accelerated ageing by measuring the tensile strength and the elongation at break on sample of the insulation in accordance with the method specified in 3.3 of IEC 60189-1.

The accelerated ageing conditioning is specified in 4.1 of IEC 60189-1.

The median of the measured values of tensile strength shall be not less than 12.5 N/mm^2 (12.5 MPa).

The median of the measured values of elongation at break shall be not less than 125 % for single colour insulation and 100 % for extruded bicolour insulation.

Moreover, the difference between the median values for tensile strength and elongation obtained before and after accelerated ageing shall not exceed 20 % of the median values before accelerated ageing.

NOTES:

1. The values specified for tensile strength and for elongation at break are independent and non-concomitant minima. An insulation with one characteristic of near-minimum value should present a value well above the minimum for the other characteristic. As a provisional recommendation, the insulation should be such that the product of tensile strength in N/mm^2 (MPa) and the elongation percentage at break should be not less than 1 750, or 1 400 in the case of extruded bicolour insulation.

2. The median values is the middle value if an odd number of values is obtained or the average of the two middle values if an even number of values is obtained. The test results should have been arranged in sequence of increasing values.

2.3 Sheath

The sheath shall have adequate mechanical strength and elasticity. These properties shall stay sufficiently constant during normal use.

Compliance shall be checked before and after accelerated ageing by measuring the tensile strength and the elongation at break on samples of the sheath in accordance with the method specified in 3.3 of IEC 60189-1.

The median of the measured values of tensile strength shall be not less than 12.5 N/mm^2 (12.5 MPa).

The median of the measured values of elongation at break shall be not less than 125 %.

Moreover, the difference between the median values for tensile strength and elongation obtained before and after accelerated ageing shall not exceed 20 % of the median values before ageing.

3. Thermal stability and climatic requirements

3.1 Insulation

3.1.1 Measurement of insulation shrinkage after overheating of conductor

The insulation shall not shrink unduly when soldering the conductors.

Compliance shall be checked in accordance with the test specified in 4.6 of IEC 60189-1.

The measured shrinkage shall be not more than 4 %.

3.1.2 Heat shock test

The insulation shall withstand variations in temperature without suffering damage.

Compliance shall be checked in accordance with the test specified in 4.5.1 of IEC 60189-1.

The insulation shall show no cracks.

3.2 Sheath

3.2.1 Pressure test

The sheath shall be sufficiently resistant to external pressure when exposed to moderately high temperature.

Compliance shall be checked in accordance with the test specified in 4.2 of IEC 60189-1.

3.2.2 Heat shock test

The sheath shall withstand variations in temperatures without suffering damage.

Compliance shall be checked in accordance with the test specified in 4.5.2 of IEC 60189-1.

The sheath shall show no cracks.

3.3 Resistance to flame propagation

Resistance to flame propagation shall be checked in accordance with the test specified in 4.3.2 of IEC 60189-1.

Performance of fire non-propagation in accordance with IEC 60332-3 may be required.

4. Electrical requirements

4.1 Electrical resistance of conductor

The electrical resistance of the conductor measured at a temperature of 20 °C shall not exceed the values specified in Annex C.

Calculation of these resistance values is based on IEC 60344, using the k_1 value for tinned conductors and k_3 and k_4 for twisting and cabling lay factors greater than 16.

If the twisting and cabling lay factors are 16 or less, IEC 60344 shall be applied with the corresponding values of k_3 and k_4.

The same resistance values apply also to plain conductors.

The method for measuring the resistance and also for correcting the measured values for length and temperature are specified in 5.1 of IEC 60189-1.

4.2 Dielectric strength

The insulation shall withstand the application for 1 min without breakdown of the voltage specified in Annex C.

The method for checking the dielectric strength is specified in 5.2 of IEC 60189-1.

4.3 Insulation resistance

Insulation resistance measured at a temperature of 20 °C shall be less than the value specified in Annex C.

The method for measurement of insulation resistance is specified in 5.3 of IEC 60189-1.

4.4 Mutual capacitance

The mutual capacitance of any pair of conductors shall not exceed 120 nF/km.

The method for measurement of mutual capacitance is specified in 5.4 of IEC 60189-1.

NOTE. Measurement of mutual capacitance is optional.

4.5 Capacitance unbalance

The capacitance unbalance between any two pairs of different cabling elements shall not exceed 400 pF per 500 m length of cable.

The method for measurement of capacitance unbalance is specified in 5.5 of IEC 60189-1.

NOTE. Measurement of capacitance unbalance is optional.

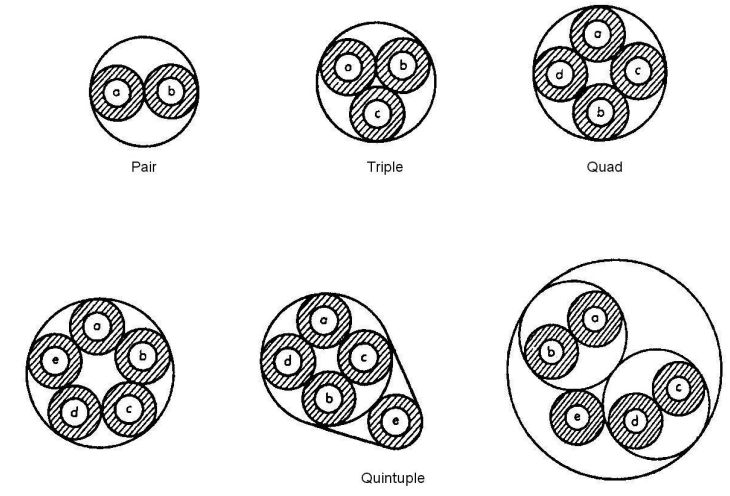

Figure 1. Cabling elements

Section B

Technical requirements for internal wiring in telecommunication equipments

1. Wire construction and dimensions for telecommunication equipment

1.1 Conductor

1.1.1 Conductor material

The conductor shall consist of annealed copper, uniform in quality and free defects. The properties of the copper shall be in accordance with IEC 60028.

The three smallest conductors (0.12 mm and 0.15 mm diameter and 0.035 mm^2 cross-sectional areas) shall consist of copper alloy, uniform in quality and free from defects. Copper alloy may also be used for other small conductor gauges.

1.1.2 Type of conductor

The conductor may be either solid or stranded.

The solid conductor shall consist of a single strand circular in section.

This stranded conductor shall consist of several strands of circular cross-section assembled either by concentric layer stranding or by bunching, and without insulation between them.

1.1.3 Conductor finish

The solid conductor may be either plain or tinned.

1.1.4 Conductor dimensions

The solid conductor is designated by its nominal diameter.

This stranded conductor is designated by its nominal cross-sectional area, the number of strands, and maximum diameter of strands.

Dimensions are given in Annexes G and H.

1.1.5 Continuity of conductor

Normally the conductor shall be drawn in one piece. In cases of necessity, joints in the conductor are permitted provided that the tensile strength of a joint is not less than 85 % of the tensile strength of the unjointed conductor. Joints in a complete stranded conductor are not permitted.

2. Insulation for telecommunication equipment

2.2.1 Insulation material

The insulation shall consist of PVC.

NOTE. The initials "PVC" denote a plasticized compound of polyvinyl chloride or vinylchloride-vinylacetate copolymers.

2.2.2 Insulation thickness

The insulation shall be perfectly continuous having a thickness as uniform as possible and not less than the value specified in Annex G.

The maximum diameter of the wire shall be calculated in accordance with the method given in Annex I.

The minimum thickness of the insulation shall be measured in accordance with the method specified in 2.2.1.1 of IEC 60189-1.

2.2.3 Application of the insulation

The insulation shall be applied to fit closely to the conductor without adhering to it.

The stripping properties of the insulation shall be checked in accordance with the method specified in 3.4.1 of IEC 60189-1.

It shall be possible to strip the insulation from the conductor easily and without damage to the insulation to the conductor, or to the tinning, if any.

In particular cases, however, for example where wires are to be used employing wire-wrapping techniques, or where mechanical stripping devices are being used, a controlled method of test may be required. In such cases, by agreement between purchaser and manufacturer, the method specified in 3.4.2 or 3.4.3 of IEC 60189-1 shall be adopted.

2.2.4 Colour of insulation

The insulated conductors shall be coloured by one colour by two different colours.

Colours shall correspond reasonably with the standard colours shown in IEC 60304.

Colour fastness to daylight, checked according to ISO Standard 105, shall be rated at not less than standard 4, prolonging the exposure until the contrast is equivalent to grade 4 on the grey scale.

When two colours are used, the following conditions shall be fulfilled:

- markings shall be rings or helices; if helices, single helices are preferred, double helices, however, are allowed;

- markings may be made by helical bicolour extrusion;

- markings shall be easily identifiable within any 15 mm length of the insulated conductor

- the distance of repetition of the markings shall be not less than 4 mm, measured from centre to centre parallel to the axis;

- the width of the rings or helices and the width of their spacing shall be not less than 1.5 mm, measured parallel to the axis; the widths shall be approximately constant along the insulated conductor; and

- the width of the rings or helices need not be the same as that of the spacing.

NOTE. For wires identified by ring marking, neither the registration of the two half-bands nor the complete encirclement of the wire is critical.

The choice of colour or combinations of colour shall be made in the following order of preference,

- the 12 standard colours shown in IEC 60304;

- the following 19 easily identifiable combinations of two standard colours:

RED-black	YELLOW-violet
RED-blue	GREEN-black
ORANGE-green	GREEN-red
ORANGE-blue	BLUE-black
ORANGE-violet	GREY-red
YELLOW-black	GREY-blue
YELLOW-red	WHITE-black
YELLOW-green	WHITE-red
YELLOW-blue	WHITE-green
	WHITE-blue

- the following 20 less easily identifiable combinations of two standard colours:

BROWN-black	GREY-black	GREEN-brown
BROWN-blue	GREY-violet	WHITE-brown
ORANGE-black	GREY-brown	WHITE-orange
ORANGE-grey	RED-brown	WHITE-violet
ORANGE-brown	GREEN-grey	WHITE-grey
ORANGE-red	GREEN-violet	WHITE-yellow
VIOLET-black	GREEN-blue	

NOTES:

1. The colour combination YELLOW-green is reserved for protectional earth wires exclusively.

2. Except in the case of bicolour extrusion, the colour printed in capitals should be known as the “base colour”; it should be:

a) the extruded colour;

b) it should have the greater area of exposure on the finished wire.

2.3 Twisting of insulated conductors

The construction shall be (see Annex D):

- a single insulated conductor, or
- a pair of two insulated conductors twisted together and designated “wire a” and “wire b” respectively or
- a triple of three insulated conductors twisted together and designated “wire a”, “wire b” and “wire c” respectively.

The maximum lay length shall not exceed 120 mm.

2.4 Identification of insulated conductors

Identification of insulated conductors shall be in accordance with 2.2.4 above. The colour combinations for the identification or pair and triples are not specified in this standard.

2.5 Delivery

Delivery shall be made on reels or in coils protected in a suitable manner.

3. Mechanical requirements for telecommunication equipment

3.1 Conductor

Elongation at break of the bare conductor shall be not less than the value specified in table 1.

Table 1. Elongation at break of the bare conductor

Nominal diameter of wire		Minimum elongation	
Above (mm)	**Up to (mm)**	**Copper (%)**	**Copper alloy (%)**
-	0.12	-	6.0
0.12	0.2	8.0	6.0
0.2	0.4	10.0	8.0
0.4	-	15.0	-

Compliance shall be checked by measuring the elongation at break in accordance with the method specified in 3.3 of IEC 60189-1.

If the conductor is tinned, the amount of tin per unit area shall be adequate for soldering the conductor to the terminals without difficulty.

Compliance shall be checked by means of the solder test on samples of the conductors in accordance with the method specified in 4.7 of IEC 60189-1.

Good tinning shall be evidenced by free flowing of the solder with wetting of the conductor ends.

3.2 Insulation

The insulation shall have adequate mechanical strength elasticity. These properties shall remain sufficiently constant during normal use.

Compliance shall be checked before and after accelerated ageing by measuring the tensile strength and the elongation at break on samples of the insulation in accordance with the method specified in 3.3 of IEC 60189-1.

The accelerated ageing conditioning is specified in 4.1 of IEC 60189-1.

The median of the measured values of tensile strength shall be not less than 12.5 N/mm^2 (12.5 MPa). (See Notes 1 and 2 hereafter).

The median of the measured values of elongation at break shall be not less than 125 % for single-colour insulation, and 100 % for extruded bicolour insulation whose minimum thickness is 0.3 mm or less.

Moreover, the difference between the median values for tensile strength and elongation obtained before and after accelerated ageing shall not exceed 20 % of the median values before ageing.

NOTES:

1. The values specified for tensile strength and for elongation at break are independent and non-concomitant minima. An insulation with one characteristic of near-minimum value should present a value well above the minimum for the other characteristic.

As a provisional recommendation, the insulation should be such that the product of tensile strength in N/mm^2 (MPa) and the elongation percentage at break should be not less than 1 750, or 1 400 in the case of extruded bicolour insulation whose minimum thickness is 0.3 mm or less.

2. The median value is the middle value if an odd number of values is obtained or the average of the two middle values if an even number of values is obtained. The test results should have been arranged in sequence of increasing values.

4. Thermal stability and climatic requirements for telecommunication equipment

4.1 Measurement of insulation shrinkage after over-heating of conductor

The insulation shall not shrink unduly when soldering the conductor.

Compliance shall be checked in accordance with the method specified in 4.6 of IEC 60189-1.

The measured shrinkage shall be not more than 4 %.

4.2 Resistance to flame propagation

Resistance to flame propagation shall be checked in accordance with the method specified in 4.3.1 of IEC 60189-1.

4.3 Heat shock test

The insulation shall withstand variations in temperature without suffering damage.

Compliance shall be checked in accordance with the method specified in 4.5.1 of IEC 60189-1.

The insulation shall show no cracks.

5. Electrical requirements for telecommunication equipment

5.1 Electrical resistance of conductor

The electrical resistance of the conductor measured at a temperature of 20 °C, shall not exceed the value specified in Annex G and Annex H.

Calculation of these values is based on IEC 60344, using the k_1 value for tinned conductors, the k_2 value for stranded conductors and, in the case of pairs and triples, the k_3 value for a twisting factor greater than 16. The same resistance values may also be applied to plain conductors.

The method for measuring the resistance and also for correcting the measured values for length and temperature are specified in 5.1 of IEC 60189-1.

5.2 Dielectric strength

The insulation shall withstand the application for 1 min without breakdown of the voltage specified in Annex G and Annex H.

The method for checking the dielectric strength is specified in 5.2 of IEC 60189-1.

5.3 Insulation resistance

Insulation resistance measured at a temperature of 20 °C shall be not less than the value specified in Annex G.

The method for measuring the insulation resistance is specified in 5.3 of IEC 60189-1.

NOTE. The minimum value of insulation resistance at a higher temperature is under consideration.

Section C

Technical requirements for internal wiring for general purpose

1. Wire construction and dimensions for general purpose

1.1 Conductor

1.1.1 Conductor material

The conductor shall consist of annealed copper, uniform in quality and free from defects. The properties of the copper shall be in accordance with IEC 60028.

The three smallest conductors (0.12 mm and 0.15 mm diameter and 0.035 mm^2 cross-sectional areas) shall consist of copper alloy, uniform in quality and free from defects. Copper alloy may also be used for other small conductor gauges.

1.1.2 Type of conductor

The conductor may be either solid or stranded.

The solid conductor shall consist of a single strand circular in section.

This stranded conductor shall consist of several strands of circular cross-section assembled either by concentric layer stranding or by bunching, and without insulation between them.

1.1.3 Conductor finish

The conductor may be either plain or tinned.

1.1.4 Conductor dimensions

The solid conductor is designated by its nominal diameter.

This stranded conductor is designated by its nominal cross-sectional area, the number of strands, and maximum diameter of strands.

Dimensions are given in Annex G and Annex H.

1.1.5 Continuity of conductor

Normally the conductor shall be drawn in one piece. In cases of necessity, joints in the conductor are permitted provided that the tensile strength of a joint is not less than 85 % of the tensile strength of the unjointed conductor. Joints in a complete stranded conductor are not permitted.

1.2 Insulation for general purpose

1.2.1 Insulation material

The insulation shall consist or PVC.

NOTE. The initials “PVC” denote a plasticized compound of polyvinyl chloride or vinychloride-vinylacatete copolymers.

1.2.2 Insulation thickness

The insulation shall be perfectly continuous having a thickness as uniform as possible and not less than the value specified in Annex G.

The maximum diameter of the wire shall be calculated in accordance with the method given in Annex I.

The minimum thickness of the insulation shall be measured in accordance with the method specified in 2.2.1.1 of IEC 60189-1.

1.2.3 Application of the insulation

The insulation shall be applied to fit closely to the conductor without adhering to it.

The stripping properties of the insulation shall be checked in accordance with the method specified in 3.4.1 of IEC 60189 -1.

It shall be possible to strip the insulation from the conductor easily and without damage to the insulation, to the conductor, or to the tinning, if any.

In particular cases, however, for example where wires are to be used employing wire-wrapping techniques, or where mechanical stripping devices are being used, a controlled method of test may be required. In such cases, by agreement between purchaser and manufacturer, the method specified in 3.4.2 or 3.4.3 of IEC 60189-1 shall be adopted.

1.2.4 Colour of insulation

The insulated conductors shall be coloured by one colour or by two different colours.

Colours shall correspond reasonably with the standard colours shown in IEC 60304.

Colour fastness to daylight, checked according to ISO Standard 105, shall be rated at not less than standard 4, prolonging the exposure until the contrast is equivalent to grade 4 on the grey scale.

When two colours are used, the following conditions shall be fulfilled:

- markings shall be rings or helices; if helices, single helices are preferred, double helices, however, are allowed;

- marking may be made by helical bicolour extrusion;

- markings printed or painted on the insulation shall adhere satisfactorily;

- markings shall be easily identifiable within any 15 mm length of the insulated conductor;

- the distance of repetition of the markings shall be not less than 4 mm, measured from centre to centre parallel to the axis;

- the width of the rings or helices and the width of their spacing shall be not less than 1.5 mm, measured parallel to the axis; the widths shall be approximately constant along the insulated conductor; and

- the width of the rings or helices need not be the same as that of the spacing.

NOTE: For wires identified by ring marking, neither the registration of the two half-bands nor the complete encirclement of the wire is critical.

The choice of colours or combinations of colours shall be made in the following order of preference;

- the 12 colours shown in IEC 60304;

- the following 19 easily identifiable combinations of two standard colours:

RED-black	YELLOW-violet
RED-blue	GREEN-black
ORANGE-green	GREEN-red
ORANGE-blue	BLUE-black
ORANGE-violet	GREY-red
YELLOW-black	GREY-blue
YELLOW-red	WHITE-black
YELLOW-green	WHITE-red
YELLOW-blue	WHITE-green
	WHITE-blue

- the following 20 less easily identified combinations of two standard colours:

BROWN-black	GREY-black	GREEN-brown
BROWN-blue	GREY-violet	WHITE-brown
ORANGE-black	GREY-brown	WHITE-orange
ORANGE-grey	RED-brown	WHITE-violet
ORANGE-brown	GREEN-grey	WHITE-grey
ORANGE-red	GREEN-violet	WHITE-yellow
VIOLET-black	GREEN-blue	

NOTES:

1. The colour combination YELLOW-green is reserved for protectional earth wires exclusively.

2. Except in the case of bicolour extrusion, the colour printed in capitals should be known as the “base colour”;

a) The extruded colour; and

b) it should have the greater are of exposure on the finished wire.

1.3 Twisting of insulated conductors

The construction shall be (see Annex J):

- a single insulated conductor; or
- a pair of two insulated conductors twisted together and designated “wire a” and “wire b” respectively; or
- a triple of three insulated conductors twisted together and designated “wire a”, “wire b” and “wire c” respectively.

The maximum lay length shall exceed 120 mm.

1.4 Identification of insulated conductors

Identification of insulated conductors shall be in accordance with 6.2.4 above. The colour combination for the identification of pair and triples are not specification in this standard.

1.5 Delivery

Delivery shall be made on reels or in coils protected in a suitable manner.

2. Mechanical requirements for general purpose cables

2.1 Conductor

Elongation at break of the bare conductor shall be not less than the value specified in Table 1.

Table 1. Elongation at break of the bare conductor

Nominal diameter of wire		Minimum elongation	
Above (mm)	**Up to (mm)**	**Copper (%)**	**Copper alloy (%)**
-	0.12	-	6.0
0.12	0.2	8.0	6.0
0.2	0.4	10.0	8.0
0.4	-	15.0	-

Compliance shall be checked by measuring the elongation at break in accordance with the method specified in 3.3 of IEC 60189-1.

If the conductor is tinned, the amount of tin per unit area shall be adequate for soldering the conductor to the terminals without difficulty.

Compliance shall be checked by means of the solder test on samples of the conductors in accordance with the method specified in 4.7 of IEC 60189-1.

Good tinning shall be evidenced by free flowing of the solder with wetting of the conductor ends.

2.2 Insulation

The insulation shall have adequate mechanical strength and elasticity. These properties shall remain sufficiently constant during normal use.

Compliance shall be checked before and after accelerated ageing by measuring the tensile strength and the elongation at break on samples of the insulation in accordance with the method specified in 3.3 of IEC 60189-1.

The accelerated ageing conditioning in specified in 4.1 of IEC 60189-1.

The median of the measured values of tensile strength shall be not less than 10.0 N/mm^2 (10.0 MPa). (See Notes 1 and 2 hereafter).

The median of the measured values of elongation at break shall be not less than 150 % for single-colour insulation, and 125 % for extruded bicolour insulation whose minimum thickness is 0.3 mm or less.

Moreover, the difference between the median values for tensile strength and elongation obtained before and after accelerated ageing shall not exceed 20 % of the median values before ageing.

NOTES:

1. The values specified for tensile strength and for elongation at break are independent and non-concomitant minima. An insulation with one characteristic of near-minimum value should present a value well above the minimum for the other characteristic.

As a provisional recommendation the insulation should be such that the product of tensile strength in N/mm^2 (MPa) and the elongation percentage at break should be not less than 1 750, or 1 400 in the case of extruded bicolour insulation whose minimum thickness is 0.3 mm or less.

2. The median value is the middle value if an odd number of values is obtained or the average of the two middle values if an even number of values is obtained. The test results should an even number of values is obtained. The test results should have been arranged in sequence of increasing values.

8. Thermal stability and climatic requirements for general purpose cables

8.1 Measurement of insulation shrinkage after over-heating of conductor

The insulation shall not shrink unduly when soldering the conductor.

Compliance shall be checked in accordance with the method specified in 4.6 IEC 60189-1.

The measured shrinkage shall be not more than 4 %.

8.2 Resistance to flame propagation

Resistance to flame propagation shall checked in accordance with the method specified in 4.3.1 of IEC 60189-1.

Any combustion of the insulation shall be slow and shall not spread appreciably; any flame shall have died out in less than 30 s after removal of the burner.

NOTE. For conductor diameters less than 0.4 mm, the test result may be affected by the possibility of the conductor fusing during the test.

8.3 Heat shock test

The insulation shall withstand variations in temperature without suffering damage.

Compliance shall checked in accordance with the method specified in 4.5.1 of IEC 60189-1.

The insulation shall show no cracks.

9. Electrical requirements for general purpose cables

9.1 Electrical resistance of conductor

The electrical resistance of the conductor measured at a temperature of 20 °C, shall not exceed the value specified in Annex G and Annex H.

Calculation of these values is based on IEC 60344, using the k_1, value for tinned conductors, k_2, value for stranded conductors and, in the case of pairs and triples, the k_3 value for a twisting factor greater than 16. The same resistance values may also be applied to plain conductors.

The method for measuring the resistance and also for correcting the measured values for length and temperature are specified in 5.1 of IEC 60189-1.

9.2 Dielectric strength

The insulation shall withstand the application for 1 min without breakdown of the voltage specified in Annex G and Annex H.

The method for checking the dielectric strength is specified in 5.2 of IEC 60189-1.

9.3 Insulation resistance

Insulation resistance measured at a temperature of 20 °C shall be not less than the value specified in Annex G.

The method for measuring the insulation resistance is specified in 5.3 of IEC 60189-1.

NOTE. The minimum value of insulation resistance at a higher temperature is under consideration.

Annex A

Colour code

Table 2. Colour code

Counting block	Colour block	Cabling element	Colour of insulation	
			***a*-wire**	***b*-wire**
1	1	1	white	blue
		2	white	orange
		3	white	green
		4	white	brown
		5	white	grey
	2	6	red	blue
		7	red	orange
		8	red	green
		9	red	brown
		10	red	grey
	3	11	black	blue
		12	black	orange
		13	black	green
		14	black	brown
		15	black	grey
	4	16	yellow	blue
		17	yellow	orange
		18	yellow	green
		19	yellow	brown
		20	yellow	grey
2	5	21	WHITE-blue	blue
		22	WHITE-blue	orange
		23	WHITE-blue	green
		24	WHITE-blue	brown
		25	WHITE-blue	grey
	6	26	RED-blue	blue
		27	RED-blue	orange
		28	RED-blue	green
		29	RED-blue	brown
		30	RED-blue	grey
	7	31	black-BLUE	blue
		32	black-BLUE	orange
		33	black-BLUE	green
		34	black-BLUE	brown
		35	black-BLUE	grey
	8	36	YELLOW-blue	blue
		37	YELLOW-blue	orange
		38	YELLOW-blue	green
		39	YELLOW-blue	brown
		40	YELLOW-blue	grey

(continued)

Counting block	Colour block	Cabling element	Colour of insulation	
			***a*-wire**	***b*-wire**
3	9	41	WHITE-orange	blue
		42	WHITE-orange	orange
		43	WHITE-orange	green
		44	WHITE-orange	brown
		45	WHITE-orange	grey
	10	46	red-ORANGE	blue
		47	red-ORANGE	orange
		48	red-ORANGE	green
		49	red-ORANGE	brown
		40	red-ORANGE	grey
	11	51	black-ORANGE	blue
		52	black-ORANGE	orange
		33	black-ORANGE	green
		54	black-ORANGE	brown
		55	black-ORANGE	grey
	12	56	YELLOW-orange	blue
		57	YELLOW-orange	orange
		58	YELLOW-orange	green
		59	YELLOW-orange	brown
		60	YELLOW-orange	grey
4	13	61	WHITE-green	blue
		62	WHITE-green	orange
		63	WHITE-green	green
		64	WHITE-green	brown
		65	WHITE-green	grey
	14	66	red-GREEN	blue
		67	red-GREEN	orange
		68	red-GREEN	green
		69	red-GREEN	brown
		70	red-GREEN	grey
	15	71	black- GREEN	blue
		72	black- GREEN	orange
		73	black- GREEN	green
		74	black- GREEN	brown
		75	black- GREEN	grey
	16	76	YELLOW- green	blue
		77	YELLOW- green	orange
		78	YELLOW- green	green
		79	YELLOW- green	brown
		80	YELLOW- green	grey

(continued)

Counting block	Colour block	Cabling element	Colour of insulation	
			***a*-wire**	***b*-wire**
5	17	81	WHITE-brown	blue
		82	WHITE- brown	orange
		83	WHITE- brown	green
		84	WHITE- brown	brown
		85	WHITE- brown	grey
	18	86	RED-brown	blue
		87	RED-brown	orange
		88	RED-brown	green
		89	RED-brown	brown
		90	RED-brown	grey
	19	91	black-BROWN	blue
		92	black- BROWN	orange
		93	black- BROWN	green
		94	black- BROWN	brown
		95	black- BROWN	grey
	20	96	YELLOW-brown	blue
		97	YELLOW-brown	orange
		98	YELLOW-brown	green
		99	YELLOW-brown	brown
		100	YELLOW-brown	grey
5	21	101	WHITE-grey	blue
		102	WHITE-grey	orange
		103	WHITE-grey	green
		104	WHITE-grey	brown
		105	WHITE-grey	grey
	22	106	red-GREY	blue
		107	red-GREY	orange
		108	red-GREY	green
		109	red-GREY	brown
		110	red-GREY	grey
	23	111	black-GREY	blue
		112	black-GREY	orange
		113	black-GREY	green
		114	black-GREY	brown
		115	black-GREY	grey
	24	116	YELLOW-grey	blue
		117	YELLOW-grey	orange
		118	YELLOW-grey	green
		119	YELLOW-grey	brown
		120	YELLOW-grey	grey

NOTES:

1. The *c*, *d* and *e* wires, if any, shall be identically coloured in all elements:

c = turquoise, *d* = violet, *e* = ORANGE-green.

2. Except in the case of bicolour extrusion, the colour printed in capitals shall be known as the “base colour”; it shall be:
a = the extruded colour,
b = the colour presenting the greater area of exposure on the finished wire.

Annex B

Unit identification

Table 3. Unit identification

No.	1	2	3	4	5
Colour	blue	orange	green	brown	grey
No.	6	7	8	9	10
Colour	white	red	black	yellow	violet

Annex C

Dimensions and test requirements of insulated conductors

Table 4. Dimension and test requirements of insulated conductors

Conductor		**Insulation**	**Test requirements**	
Nominal diameter (mm)	Maximum resistance (Ω /km)	Minimum thickness (mm)	Dielectric strength test voltage (V)	Minimum insulation resistance (M Ω /km)
0.4	153	0.15	1 000 a.c.	500
0.5	97.8	0.15	or	
0.6	67.9	0.15	1 500 d.c.	
0.8	37.5	0.25	1 500 a.c. or 2 250 d.c.	

Annex D

Cables in pairs, triples, quads and quintuples for inside installations (with screening)

Table 5. Cables in pairs, triples, quads and quintuples for inside installation

Number of cabling elements	0.4 mm diameter conductor								0.5 mm diameter conductor							
	Minimum sheath thickness (mm)				Maximum overall diameter of cables (mm) [1)]				Minimum sheath thickness (mm)				Maximum overall diameter of cable (mm)[1)]			
	Pairs	Triples	Quads	Quintuples	Pairs	Triples	Quads	Quintuples	Pairs	Triples	Quads	Quintuples	Pairs	Triples	Quads	Quintuples
5	0.6	0.6	0.7	0.7	6.5	7.0	8.5	9.0	0.6	0.6	0.7	0.7	7.0	8.0	9.0	10.0
10	0.7	0.7	0.8	0.8	8.5	9.5	11.0	12.0	0.7	0.7	0.8	0.9	9.0	10.5	12.0	13.5
15	0.7	0.8	0.8	0.9	9.5	11.0	12.5	14.0	0.7	0.8	0.9	0.9	10.5	12.0	14.0	15.5
20	0.8	0.8	0.9	0.9	11.0	12.0	14.0	15.5	0.8	0.9	0.9	0.9	12.0	13.5	15.5	17.5
25	0.8	0.9	0.9	0.9	12.0	13.5	15.5	17.0	0.8	0.9	0.9	1.0	13.0	14.5	17.0	19.0
30	0.8	0.9	0.9	0.9	12.5	14.5	16.5	18.5	0.9	0.9	0.9	1.0	14.0	15.5	18.0	20.5
40	0.9	0.9	0.9	1.0	14.5	16.0	18.5	21.0	0.9	0.9	1.0	1.0	15.5	17.5	20.5	23.0
50	0.9	0.9	1.0	1.0	15.5	17.5	20.5	23.0	0.9	1.0	1.0	1.15	17.0	19.5	22.5	26.0
60	0.9	1.0	1.0	1.15	17.0	19.0	22.0	25.5	0.9	1.0	1.0	1.15	18.5	21.0	24.5	28.0
80	1.0	1.0	1.15	1.15	19.0	21.5	25.5	28.5	1.0	1.0	1.15	1.35	21.0	23.5	28.0	32.0
100	1.0	1.0	1.15	1.35	21.0	23.5	28.0	32.0	1.0	1.15	1.35	1.35	23.0	26.5	31.5	35.5
120	1.0	1.15	1.15	1.35	22.5	26.0	30.0	34.5	1.15	1.15	1.35	1.6	25.5	28.5	34.0	39.0
140	1.0	1.15	1.35	1.6	24.0	27.5	33.0	37.5	1.15	1.35	1.35	1.6	27.0	31.0	36.5	41.5
160	1.15	1.15	1.35	1.6	26.0	29.0	34.5	40.0	1.15	1.35	1.6	1.6	28.5	33.0	39.0	44.0

Number of cabling elements	0.6 mm diameter conductor								0.8 mm diameter conductor							
	Minimum sheath thickness (mm)				Maximum overall diameter of cables (mm)[1)]				Minimum sheath thickness (mm)				Maximum overall diameter of cable (mm)[1)]			
	Pairs	Triples	Quads	Quintuples	Pairs	Triples	Quads	Quintuples	Pairs	Triples	Quads	Quintuples	Pairs	Triples	Quads	Quintuples
5	0.6	0.7	0.7	0.8	7.5	8.5	9.5	11.0	0.7	0.8	0.9	0.9	10.0	11.5	13.5	14.5
10	0.7	0.8	0.8	0.9	10.0	11.5	13.0	14.5	0.9	0.9	0.9	1.0	13.5	15.5	17.5	19.5
15	0.8	0.8	0.9	0.9	11.5	13.0	15.0	16.5	0.9	0.9	1.0	1.0	15.5	17.5	20.5	23.0
20	0.8	0.9	0.9	1.0	13.0	14.5	17.0	19.0	0.9	1.0	1.0	1.15	17.5	20.0	23.0	26.5
25	0.9	0.9	0.9	1.0	14.5	16.0	18.5	21.0	1.0	1.0	1.15	1.15	19.5	21.5	25.5	29.0
30	0.9	0.9	1.0	1.0	15.5	17.0	20.0	22.5	1.0	1.0	1.15	1.35	21.0	23.5	27.5	31.5
40	0.9	1.0	1.0	1.15	17.0	19.5	22.5	26.0	1.0	1.15	1.35	1.35	23.5	27.0	32.0	36.0
50	0.9	1.0	1.15	1.15	18.5	21.0	25.0	28.5	1.15	1.15	1.35	1.6	26.0	29.5	35.0	40.0
60	1.0	1.0	1.15	1.35	20.5	23.0	27.0	31.0	1.15	1.35	1.6	1.6	28.5	32.5	38.5	43.5
80	1.0	1.15	1.35	1.35	23.0	26.5	31.0	35.0	1.35	1.6	1.6	1.6	32.5	37.5	44.0	49.5
100	1.15	1.15	1.35	1.6	25.5	29.0	34.5	39.5	1.35	1.6	1.6	1.6	35.5	41.0	48.5	55.0
120	1.15	1.35	1.6	1.6	27.5	32.0	38.0	42.5	1.6	1.6	1.6	1.6	39.5	44.5	52.5	59.5
140	1.15	1.35	1.6	1.6	29.5	34.0	40.5	45.5	1.6	1.6	1.6	1.6	42.0	47.5	56.0	64.0
160	1.35	1.35	1.6	1.6	32.0	36.0	43.0	48.5	1.6	1.6	1.6	1.6	44.5	50.5	59.5	68.0

Annex E

Cables in pairs for digital exchanges (with screening)

Table 6. Cables in pairs for digital exchanges

Number of cabling elements	0.4 mm diameter conductor		0.5 mm diameter conductor	
	Minimum sheath thickness (mm)	Maximum overall diameter of cables (mm) [1)]	Minimum sheath thickness (mm)	Maximum overall diameter of cable (mm)[1)]
	Pairs	Pairs	Pairs	Pairs
2	0.4	5	0.4	5.5
4	0.4	6	0.6	6.5
8	0.4	7	0.7	8.5
12	0.6	8.5	0.7	9.5
16	0.6	9.5	0.7	10.5
24	0.7	11.5	0.8	12.5
32	0.7	12.5	0.9	14.5
48	0.7	14.5	-	-
64	-	-	0.9	19
128	0.9	22.5	-	-
NOTE. For unscreened cables, the maximum outer diameter shall be reduced by 0.5 mm.				
[1)] For engineering calculation purposes				

Annex F

Calculation of the maximum diameter of cables

The value of (D_g + 10 %) calculated in accordance with IEC 60649 using a total thickness of 0.3 mm for wrapping and screening, is rounded to the nearest two decimal places, that is to say XX.XX.

The value is the rounded upwards to the first decimal place if the value is 5 mm or less, for example 4.61 rounded to 4.7.

If the value is greater than 5 mm, it is rounded to the first decimal place and further rounded upwards to the next multiple of 0.5 mm.

For example: 25.05 rounded to 25.1 then 25.5
25.04 rounded to 25.0 then 25.0.

Annex G

Single equipment wires

Table 7. Single equipment wires

Conductor					Insulation		Test requirements		
Nominal diameter	Nominal section	Number of strands	Maximum diameter of strands	Maximum resistance	Minimum thickness	Maximum diameter	Dielectric strength test voltage	Minimum insulation resistance	
								General purposes	Telecommunication equipment
mm	mm^2		mm	Ω/km [3]	mm	mm [4]	V	MΩ.km	MΩ.km
0.12[1]				1 646		0.55			
0.15[1]				1 054		0.55			
0.20				593		0.60			
	0.035[1]	7	0.09	571		0.65	500 a.c.		
0.25				379	0.12	0.65	or	10	50
	0.055	7	0.11	365		0.70	750 d.c		
	0.079	7	0.13	242		0.80			
0.32				225		0.75			
	0.124	7	0.16	155		0.90			
0.40				144		0.90	1 000 a.c.		
0.50				92.2		1.00	or		
	0.22	7	0.21	87.2	0.15	1.10	1 500 d.c	10	200
0.60				64.0		1.10			
	0.50	28	0.16	38.8		1.80			
		16	0.21	38.2					
0.80				36.0		1.60	1 500 a.c.	10	200
	0.75	42	0.16	25.8	0.25	2.00	or		
		24	0.21	25.4			2 250 d.c		
1.00				22.8		1.85			
	1.00	32	0.21	19.1		2.55	2 000 a.c		
	1.50	30	0.26	13.0	0.40	2.90	or	10	200
1.40				12.0[2]		2.65	3 000 d.c.		

NOTES.

[1] These conductors are only in copper alloy.
[2] This value is based on a solid conductor size of 1.38 mm nominal diameter.
[3] Add 20 % to these values for copper alloy conductors.
[4] For engineering calculation purposes.

Annex H

Equipment wires in pairs and triples

Table 8. Equipment wires in pairs and triples

Conductor					Insulation		Test requirements	
Nominal diameter	Nominal section	Number of strands	Maximum diameter of strands	Maximum resistance	Minimum thickness	Maximum diameter	Dielectric strength test voltage	Minimum insulation resistance
mm	mm^2		mm	Ω /km [2]	mm	mm [3]	V	M Ω.km
0.12[1]				1 712		0.55		
0.15[1]				1 096		0.55		
0.20				616		0.60		
	0.035[1]	7	0.09	594		0.65	500 a.c.	
0.25				394	0.12	0.65	or	50
	0.055	7	0.11	380		0.70	750 d.c	
	0.079	7	0.13	252		0.80		
0.32				234		0.75		
	0.124	7	0.16	161		0.90		
0.40				148		0.90	1 000 a.c.	
0.50				95.0		1.00	or	200
	0.22	7	0.21	89.9	0.15	1.10	1 500 d.c	
0.60				65.9		1.10		

NOTES.

[1] These conductors are only in copper alloy.
[2] Add 20 % to these values for copper alloy conductors.
[3] For engineering calculation purposes.

Annex I

Calculation of the maximum diameter of insulated conductors

The nominal diameter d_i is calculated in accordance with IEC 60649.

The value (d_i + 10 %) is calculated and rounded to the nearest two decimal places

that is to say: X.XX

The second decimal place figure (0.0x) is then rounded up in steps of 0.05

for examples: 1.81 rounded to 1.85
1.86 rounded to 1.90

Annex J

Construction

Figure 2. Insulated conductor and pair construction

Construction

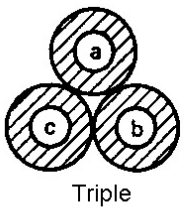

Figure 3. Triple construction