Booklet of Specifications

For

Telecommunication Cables

And

Ancillary Accessories

IDA TS L1 – L3
Issue 1, 2000

Info-Communications Development Authority of Singapore
Equipment and Cabling Regulation Department
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http://www.ida.gov.sg

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Specification

For

High Count PVC Cable

IDA TS L1-1
Issue 1, 2000

Info-Communications Development Authority of Singapore

Equipment and Cabling Regulation Department
8 Temasek Boulevard
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1 SCOPE

This technical specification provides requirements for 10, 20, 40, 80 and 100 pair internal distribution telephone cable of 0.5 mm diameter conductor size, unit-twin, having Poly-Vinyl Chloride (PVC) insulation and sheath.

2 CABLE CONSTRUCTION AND DIMENSIONS

2.1 CONDUCTOR

2.1.1 Material

The conductor shall be made of solid wire of annealed high conductivity copper. It shall be smoothly drawn, circular in cross section, free from defects and uniformly coated with pure tin.

2.1.2 Dimensions

The diameter of the tinned conductor in the completed cable shall be 0.5 mm ± 0.01 mm.

2.2 INSULATION

2.2.1 Material

The insulation material shall be PVC compound.

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

2.2.2 Dimensions

The insulated conductor shall be uniformly covered with the specified PVC having minimum radial thickness of 0.15 mm

The diameter of conductor with insulation shall not be more than 0.95 mm.

2.2.3 Colour

For single-colour wire, the colour shall be incorporated in the insulating compound.

The colours shall correspond with standard colours shown in IEC Publication 304: Standard Colours for insulation for low frequency Cables and Wires.

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

For two-colour wires, the following conditions shall be fulfilled:

- Spiral or ring markings shall be easily identifiable within every 15 mm length.

- Sequence of colour shall follow Table A.1 of Appendix A.

The spiral or ring markings shall be made by applying one or more ink stripes on a base colour or by direct extrusion. The base colours are in capital letters as shown in Table A.1 of Appendix A.

2.2.4 Joints

Joints in the insulated conductor shall be kept to a minimum.

2.3 CABLING ELEMENTS

Each cabling element shall be a pair of insulated conductors uniformly twisted together and designated a-wire and b-wire.

2.4 STRANDING OF ELEMENTS

The elements shall be laid up in unit construction. Each unit comprising 20 pairs shall be colour-sequenced in accordance with Table A.1 of Appendix A. The 20-pair cable shall be formed into a single unit or 2 sub-units of 10-pair or 4 sub-units of 5-pair each.

An open helical lapping of polyethylene terephthalate or polypropylene tape or suitable equivalent shall be applied over each unit or sub-unit. The tape shall be printed with identification numbers spaced at 20 mm intervals.

2.5 SHEATH

2.5.1 Material

The material of the sheath shall be grey or ivory-coloured PVC compound.

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

2.5.2 Marking on sheath

The following information shall be indelibly printed on the sheath at 300 mm spacing:

- Manufacturer's name
- Month and year of manufacture

2.5.3 Dimensions

The thickness of the sheath and the overall maximum cable diameter shall be indicated in Table A.2 of Appendix A.

In determination of the minimum sheath thickness, indentation caused by the rip cord shall be ignored.

2.6 RIP CORD

A non-metallic rip-cord shall be laid under the sheath. It shall provide an effective means of slitting the sheath longitudinally to facilitate removal.

2.7 LAY-LENGTH

The lay length shall not exceed 100 mm.

2.8 CABLE-CORE PROTECTION

The stranded cable core shall be covered overall, before sheathing with polyethylene terephthalate tape or equivalent material by any of the following methods:

- A single tight-lapping having an overlap of 20% nominal.

or

- One tape applied longitudinally with an overlap of not less than 6 mm or 20% of the tape width, whichever smaller.

2.9 SEALING OF ENDS

After completion of the electrical tests, the cable ends shall be sealed to prevent the ingress of moisture.

2.10 PACKING

The cable shall be coiled in lengths of 500 ± 1 metres and wound with transparent polythene sheet.

3 MECHANICAL REQUIREMENTS

3.1 CONDUCTOR

3.1.1 Easy soldering test

Test for easy soldering shall be carried out in accordance with sub-clause 4.8, IEC publication 189-1. The test conditions are as follows:

Temperature of solder bath	235 ± 5 °C
Solder bath size	Depth 40 mm & vol. ≥ 300 ml
Duration of immersion	2 ± 0.5 s

The conductor shall be examined for quality of solder coating. Good quality is evidenced when a free flowing of solder is seen with the wetting of the conductor ends.

3.1.2 Tensile test

The elongation at break of any sample of bare conductor taken from the completed cable shall not be less than 15%. The test shall be carried out in accordance with sub-clause 3.3, IEC publication 189-1. The test conditions are as follows:

Conditioning temperature	23 ± 5 °C
Duration of conditioning	3 hours minimum
Free-length between jaws of tensile machine	100 mm
Speed of jaw separation	100 ± 20 mm/min

Joints in the conductor should be kept to a minimum. The ultimate tensile force of 250 mm length of conductor containing a joint shall not be less than 90% of that of an adjacent length of conductor not containing a joint.

3.2 INSULATION

3.2.1 Tensile test

This test shall be carried out in accordance with sub-clause 3.3, IEC publication 189-1. The test conditions are as follows:

Conditioning temperature	23 ± 2 °C
Duration of conditioning	3 hours minimum
Free-length between jaws of tensile machine	50 mm approximately
Speed of jaw separation	250 ± 50 mm/min

The median of the measured values of tensile strength shall not be less than 12.5N/mm².

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

3.2.2 Strippability

Lengths of insulation measuring 10 and 25 mm shall be removed from each end of the test sample. The remaining 50 mm length of insulation shall be removed with a force not exceeding 5.9N at 20 ± 1°C. The preparation of sample and performance measurements shall be carried out in accordance with sub-clause 3.4.2, IEC publication 189-1. The test conditions are as follows:

Number of samples	5 x 300 mm
Length of test sample	85 mm
Speed of tensile machine	250 to 350 mm/min

3.3 SHEATH

3.3.1 Tensile test

The test conditions are as stated in section 3.2.1.

The median of the measured values of tensile strength shall not be less than 12.5 N/mm².

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

4 THERMAL STABILITY AND CLIMATIC REQUIREMENTS

4.1 INSULATION

4.1.1 Accelerated ageing test

Compliance shall be checked before and after accelerated ageing by measuring the tensile strength and the elongation at break on insulation samples in accordance with the method specified in sub-clause 3.3, IEC publication 189-1.

The accelerated ageing process shall be carried out in accordance with sub-clause 4.1, IEC publication 189-1. The test conditions are as follows:

Ageing temperature	80 °C
Duration of conditioning	7 x 24 hours
Duration of recovery	16 hours minimum

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.

4.1.2 Measurement of insulation shrinkage after overheating of conductor

This test is for reference. The insulation shall not shrink unduly when soldering the conductors. The test shall be carried out in accordance with sub-clause 4.6, IEC publication 189-1. The test conditions are as follows:

Test sample	100 ± 5 mm long with cleanly cut ends (without stripped ends)
Temperature of oven	150 ± 2 °C
Duration in oven	15 min

The measured shrinkage shall not be more than 4%.

4.1.3 Heat shock test

This test is for reference. The insulation shall withstand variations in temperature without damage. The test shall be carried out in accordance with sub-clause 4.5.1, IEC publication 189-1. The test conditions are as follows:

Number of samples	2 suitable length taken from two places separated by at least 1 m
Number of turns around mandrel	3 complete contiguous
Temperature of oven	150 ± 3 °C
Duration in oven	1 hour

The insulation shall show no crack after the test.

4.1.4 Combined shrinkage and heat shock test

This test is used to determine the extent to which the insulation shrinks or withstands damage with variations in temperature. The test shall be carried out in accordance with sub-clause 4.7, IEC publication 189-1. The test conditions are as follows:

Number of samples	2 lengths, the ends shall be clearly cut (without stripped ends) and extended at right angles to the mandrel in opposite directions for a length of 50 mm
Number of turns around mandrel	3 complete contiguous
Temperature of oven	150 ± 3 °C
Duration in oven	1 hour

The insulation shall show no crack after the test. The amount of shrinkage of the insulation from the conductor ends shall be measured and shall be recorded as a percentage of the tail length (50 mm).

In case of doubt, test should be carried out in accordance with clauses 4.1.2 and 4.1.3.

4.2 SHEATH

4.2.1 Accelerated ageing test

The test conditions and expected test requirements are similar to those mentioned in section 4.1.1.

4.2.2 Pressure test

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

The test shall be carried out in accordance with sub-clause 4.2, IEC publication 189-1. The test conditions are as follows:

Test sample	3 adjacent test pieces are taken from a sample having a length of 250 mm to 500 mm from which all internal parts have been removed
Length of test pieces	50 mm to 100 mm
Preparation of test pieces	From each piece, a strip of width $\cong {}^{1}/_{3}$ the circumference shall be cut parallel to the axis
Position of test piece in the indentation device	As shown in Figure 1
Calculation of test force	The force *F*, in Newton exerted upon each test piece of sheath, shall be given by $F = k \times 2 D d - d^2$ where, *k* is a coefficient specified in the standard for the type of cable, or, if no value is specified, $k = 0.6$ *d* = mean value of the thickness of the test piece *D* = mean value of the outer diameter of test piece *d* and *D* are expressed in mm to one decimal place and measured according to sub-clause 8 of IEC Publication 811-1-1. The calculated *F may* be rounded off downwards by < 3 %.
Heating of loaded test pieces	In an air oven for a duration of 4 hours
Chilling of loaded test pieces	At the end of the duration, test piece is rapidly cooled under load by spraying cold water on the spot where the blade is pressing. When it is cooled to a temperature where recovery of the insulation no longer occurs, the test piece shall be cooled further by immersion in cold water.
Measurement of indentation	Immediately after cooling, the indentation shall be measured on a narrow strip cut from the test piece as shown in Figures 2 and 3.

The median of the indentation values measured on the three test pieces taken from the sheath under test shall be < 50 % of the mean value of the thickness of the sample.

4.2.3 Heat shock test

The sheath shall withstand variations in temperature without damage. The test shall be carried out in accordance with sub-clause 4.5.2, IEC publication 189-1. The test conditions are as follows:

Number of samples	2 suitable length taken from two places separated by at least 1 m
Number of turns around mandrel	6 complete contiguous
Temperature of oven	150 ± 3 °C
Duration in oven	1 hour

The sheath shall show no crack.

4.3 RESISTANCE TO FLAME PROPAGATION

Combustion of the cable shall be slow and shall not spread appreciably; any flame shall die out in less than 30 seconds after removal of the gas burner.

The test shall be carried out in accordance with sub-clause 4.3, IEC publication 189-1. The test conditions are as follows:

Number of samples	1 x 600 ± 25 mm
Source of heat	Gas burner

The flame shall be applied for a continuous period of T seconds derived from the formula:

$$T=60 + m/25$$

where m is the weight in grams of the cable sample corrected to a 600 mm length.

5 ELECTRICAL REQUIREMENT

5.1 ELECTRICAL RESISTANCE OF CONDUCTOR

The electrical resistance of the tinned conductor shall not exceed 97.8 Ω/km at 20 ± 1°C. The test shall be carried out in accordance with sub-clause 5.1, IEC publication 189-1.

5.2 DIELECTRIC STRENGTH

The insulation shall remain at 500 MΩ/km while withstanding 1500 Vdc or 1000 Vrms voltage applied for 1 min without any breakdown. The test shall be carried out in accordance with sub-clause 5.2, IEC publication 189-1.

5.3 INSULATION RESISTANCE

Insulation resistance shall not be less than 500MΩ/km length at 20 ± 1°C. The test shall be carried out in accordance with sub-clause 5.3, IEC publication 189-1. The test conditions for the two different temperatures are as follows:

<u>At ambient temperature</u>	
Number of samples	1 x Complete length of finished cable
Conditioning temperature	20 ± 5°C
Conditioning period	2 hours
Test voltage	≥ 500 Vdc
Application period of test voltage	1 min
<u>At high temperature</u>	
Number of samples	1 x 10m
Water bath temperature	70 ± 2°C
Immersion period in water bath	2 hours
Test voltage	≥ 500 Vdc
Application period of test voltage	1 min

5.4 MUTUAL CAPACITANCE

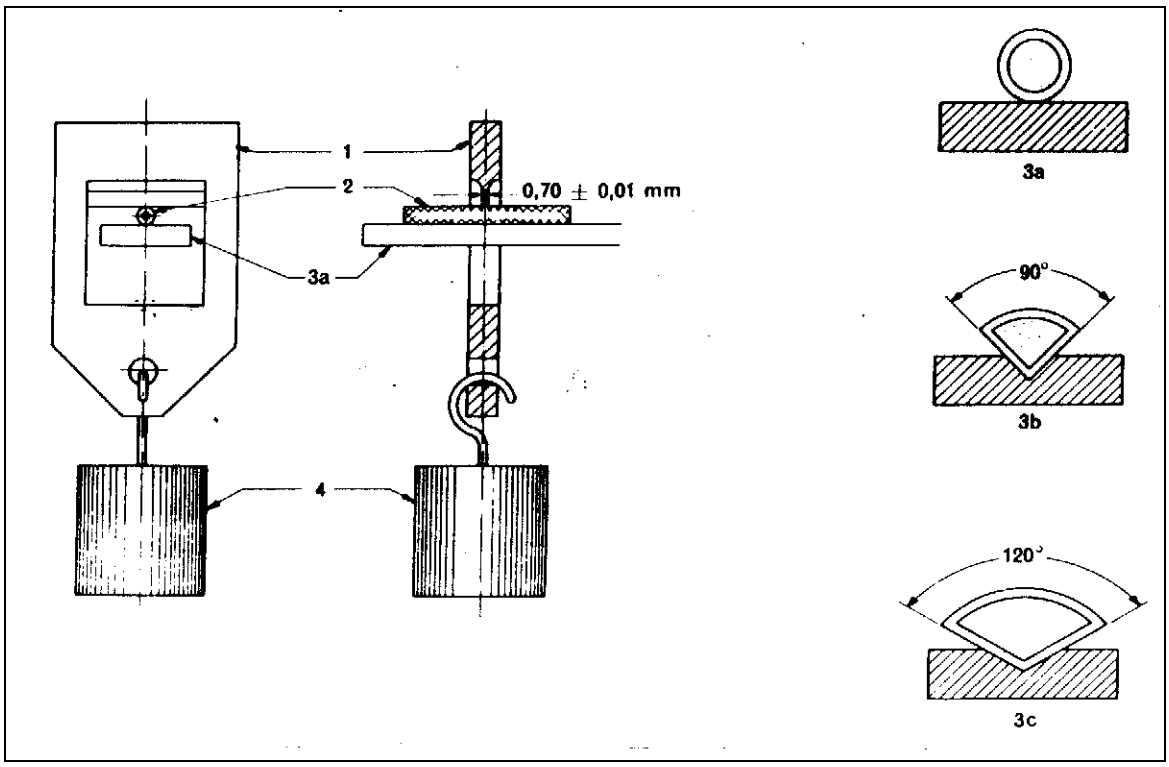
The mutual capacitance between any pair shall not exceed 120 nF/km measured in accordance with sub-clause 5.4, IEC publication 189-1. The test conditions are as follows:

Accuracy of instrument	1% of value to be measured
Frequency	500 to 2000 Hz

5.5 CAPACITANCE UNBALANCE

The capacitance unbalance between 2 pairs of different cabling elements shall be less than 400 pF per 500m length measured in accordance with sub-clause 5.5, IEC publication 189-1. The test conditions are as follows:

Accuracy of instrument	5 pF ± 5% of value to be measured
Frequency	500 to 2000 Hz



1 = testing frame 2 = sample 3a, 3b, 3c = supports 4 = load

Figure 1: **Indentation Device**

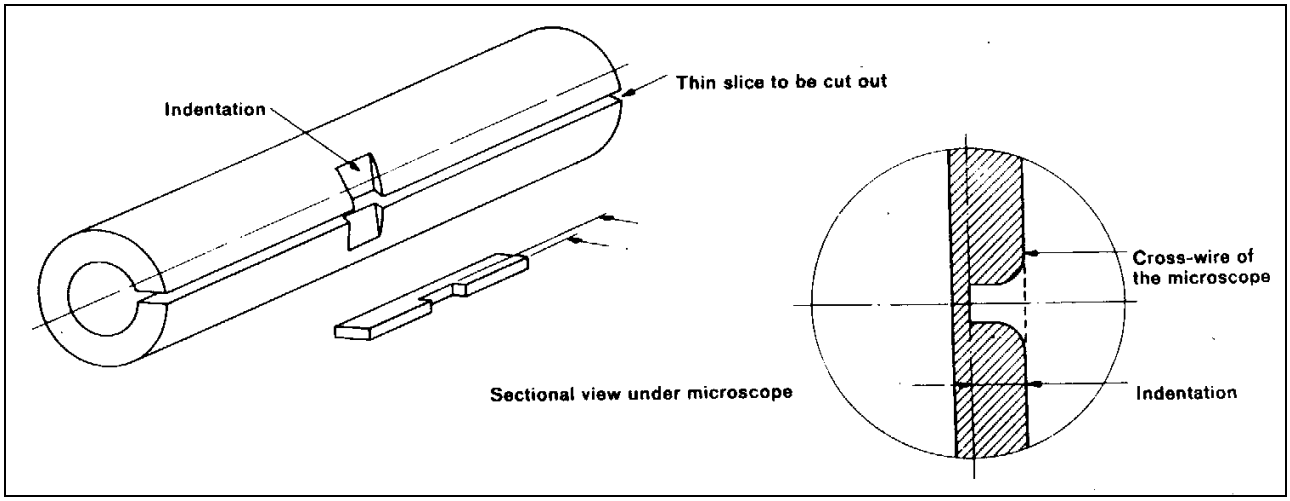


Figure 2: **Measurement of indentation**

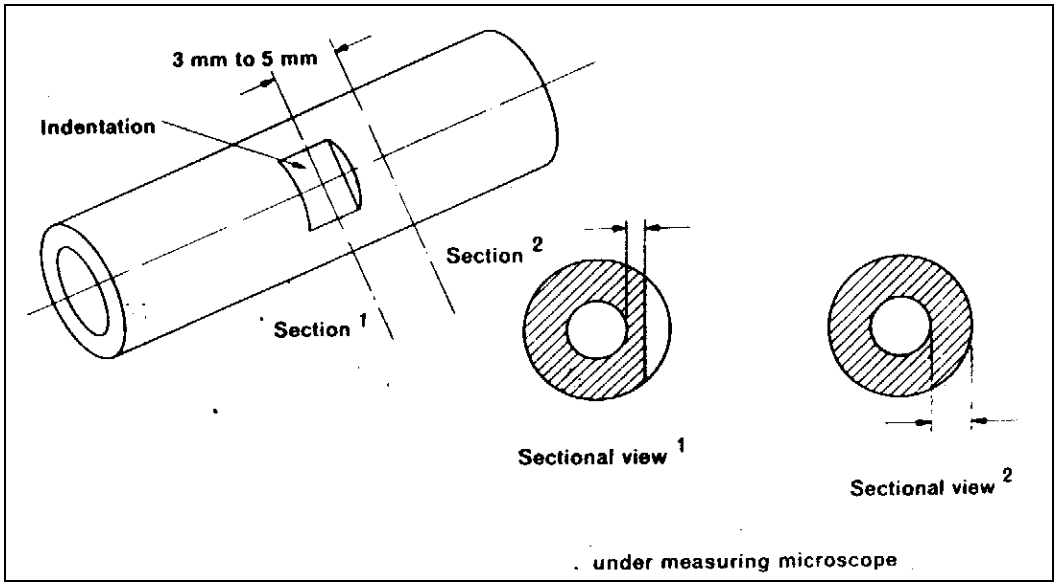


Figure 3: **Measurement of indentation for small test pieces**

Appendix A

Table A.1: **Colour Code for High Count PVC Cables**

Counting Block	Colour Block	Element No.	Colour of Wire Insulation	
			a-wire	b-wire
1	W H I T E	1 2 3 4 5	WHITE-blue WHITE-orange WHITE-green WHITE-brown WHITE-grey	white-BLUE white-ORANGE white-GREEN white-BROWN white-GREY
	R E D	6 7 8 9 10	RED-blue RED-orange RED-green RED-brown RED-grey	red-BLUE red-ORANGE red-GREEN red-BROWN red-GREY
	B L A C K	11 12 13 14 15	BLACK-blue BLACK-orange BLACK-green BLACK-brown BLACK-grey	black-BLUE black-ORANGE black-GREEN black-BROWN black-GREY
	Y E L L O W	16 17 18 19 20	YELLOW-blue YELLOW-orange YELLOW-green YELLOW-brown YELLOW-grey	yellow-BLUE yellow-ORANGE yellow-GREEN yellow-BROWN yellow-GREY
2	Same as above			
3	Same as above			
4	Same as above			
5	Same as above			

Remarks

i. For the above table, an element refers to 1 pair.

ii. The cabling sequence will be from centre to the outside.

iii. Where sub-units of either 5 or 10-element are used, it shall be used throughout.

iv. For a 20-element unit made up of 5-element sub-units, the elements of the first sub-unit shall be sequenced 1 to 5, the second 6 to 10, the third 11 to 15 and the fourth 16 to 20.

v. For a 20-element unit made up of 10-element sub-units, the elements of the first sub-unit shall be sequenced 1 to 10 and the second 11 to 20.

vi. The base colour is shown in capital letters. Colour for spiral or ring is shown in small letters.

Appendix A
(Continued)

Table A.2: Internal **Telephone Cables - 0.5 mm diameter Conductor**

Cable Type	**10 pr**	**20 pr**	**40 pr**	**80 pr**	**100 pr**
Conductor Diameter(mm)	0.5	0.5	0.5	0.5	0.5
Insulation Radial Thickness(mm)	0.15	0.15	0.15	0.15	0.15
Insulated Conductor Diameter(mm)	0.95	0.95	0.95	0.95	0.95
Minimum Sheath Thickness(mm)	0.7	0.8	0.9	1.0	1.0
Overall Cable Diameter(mm)	8.3	10.7	14.2	21.8	22.6

Specification

For

Low Count PVC Cable

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Info-Communications Development Authority of Singapore

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CONTENTS

1 SCOPE

This technical specification provides the requirements for 4, 6, 8 and 10 wire internal distribution telephone cable of 0.5 mm diameter conductor size, unit-twin, having Poly-Vinyl Chloride (PVC) insulation and sheath.

2 CABLE CONSTRUCTION AND DIMENSIONS

2.1 CONDUCTOR

2.1.1 Material

The conductor shall be made of solid wire of annealed high conductivity copper. It shall be smoothly drawn, circular in cross section, free from defects and uniformly coated with pure tin.

2.1.2 Dimensions

The diameter of the tinned conductor in the completed cable shall be 0.5 ± 0.01 mm.

2.2 INSULATION

2.2.1 Material

The insulation material shall be PVC compound.

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

2.2.2 Dimensions

The insulated conductor shall be uniformly covered with the specified PVC having minimum radial thickness of 0.15 mm.

The diameter of conductor with insulation shall not be more than 0.95 mm.

2.2.3 Colour

For single-colour wire, the colour shall be incorporated in the insulating compound.

The colours shall correspond with standard colours shown in IEC Publication 304: Standard Colours for insulation for low-frequency Cables and Wires.

Colour fastness to daylight, checked in accordance 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.

For two-colour wires, the following conditions shall be fulfilled:

- Spiral or ring markings shall be easily identifiable within every 15 mm length.

- Sequence of colour shall follow Table A.1 in Appendix A.

The spiral or ring markings shall be made by applying one or more ink stripes on a base colour or by direct extrusion. The base colours are in capital letters as shown in Table A.1 of Appendix A.

2.2.4 Joints

Joints in the insulated conductor shall be kept to a minimum.

2.3 CABLING ELEMENTS

The cabling element shall be:

- a pair of insulated conductors uniformly twisted together and designated a-wire and b-wire

or

- a quad cable of 4 numbers insulated conductor uniformly twisted together and designated a-wire, b-wire, c-wire, and d-wire. The conductors shall be so arranged such that the sequence is "a", "c", "b" and "d".

2.4 SHEATH

2.4.1 Material

The material of the sheath shall be grey or ivory-coloured PVC compound.

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

2.4.2 Marking on sheath

The following information shall be indelibly printed on the sheath at 300 mm spacing:

- Manufacturer's name
- Month and year of manufacture

2.4.3 Dimensions

The thickness of the sheath and the overall maximum cable diameter shall be indicated in Table A.2 of Appendix A.

In determination of the minimum sheath thickness, indentation caused by the rip cord shall be ignored.

2.5 RIP CORD

A non-metallic rip-cord shall be laid under the sheath. It shall provide an effective means of slitting the sheath longitudinally to facilitate removal.

2.6 LAY-LENGTH

The lay length shall not exceed 100 mm.

2.7 SEALING OF ENDS

After completion of the electrical tests, the cable ends shall be sealed to prevent the ingress of moisture.

2.8 PACKING

The cable shall be coiled in lengths of 200 ± 1 metres and wound with transparent polythene sheet.

3 MECHANICAL REQUIREMENTS

3.1 CONDUCTOR

3.1.1 Easy soldering test

Test for easy soldering shall be carried out in accordance with sub-clause 4.8, IEC publication 189-1. The test conditions are as follows:

Temperature of solder bath	235 ± 5 °C
Solder bath size	Depth 40 mm & vol. ≥ 300 ml
Duration of immersion	2 ± 0.5 s

The conductor shall be examined for quality of solder coating. Good quality is evidenced when a free flowing of solder is seen with the wetting of the conductor ends.

3.1.2 Tensile test

The elongation at break of any sample of bare conductor taken from the completed cable shall not be less than 15%. The test shall be carried out in accordance with sub-clause 3.3, IEC publication 189-1. The test conditions are as follows:

Conditioning temperature	23 ± 5 °C
Duration of conditioning	3 hours minimum
Free-length between jaws of tensile machine	100 mm
Speed of jaw separation	100 ± 20 mm/min

Joints in the conductor should be kept to a minimum. The ultimate tensile force of 250 mm length of conductor containing a joint shall not be less than 90% of that of an adjacent length of conductor not containing a joint.

3.2 INSULATION

3.2.1 Tensile test

This test shall be carried out in accordance with sub-clause 3.3, IEC publication 189-1. The test conditions are as follows:

Conditioning temperature	23 ± 2 °C
Duration of conditioning	3 hours minimum
Free-length between jaws of tensile machine	50 mm approximately
Speed of jaw separation	250 ± 50 mm/min

The median of the measured values of tensile strength shall not be less than 12.5N/mm².

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

3.2.2 Strippability

Lengths of insulation measuring 10 and 25 mm shall be removed from each end of the test sample. The remaining 50 mm length of insulation shall be removed with a force not exceeding 5.9N at 20 ± 1°C. The preparation of sample and performance measurements shall be carried out in accordance with sub-clause 3.4.2, IEC publication 189-1. The test conditions are as follows:

Number of samples	5 x 300 mm
Length of test sample	85 mm
Speed of tensile machine	250 to 350 mm/min

3.3 SHEATH

3.3.1 Tensile test

The test conditions are as stated in section 3.2.1.

The median of the measured values of tensile strength shall not be less than 12.5 N/mm².

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

4 THERMAL STABILITY AND CLIMATIC REQUIREMENTS

4.1 INSULATION

4.1.1 Accelerated ageing test

Compliance shall be checked before and after accelerated ageing by measuring the tensile strength and the elongation at break on insulation samples in accordance with the method specified in sub-clause 3.3, IEC publication 189-1 .

The accelerated ageing process shall be carried out in accordance with sub-clause 4.1, IEC publication 189-1. The test conditions are as follows:

Ageing temperature	80 °C
Duration of conditioning	7 x 24 hours
Duration of recovery	16 hours minimum

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.

4.1.2 Measurement of insulation shrinkage after overheating of conductor

This test is for reference. The insulation shall not shrink unduly when soldering the conductors. The test shall be carried out in accordance with sub-clause 4.6, IEC publication 189-1. The test conditions are as follows:

Test sample	100 ± 5 mm long with cleanly cut ends (without stripped ends)
Temperature of oven	150 ± 2 °C
Duration in oven	15 min

The measured shrinkage shall not be more than 4%.

4.1.3 Heat shock test

This test is for reference. The insulation shall withstand variations in temperature without damage. The test shall be carried out in accordance with sub-clause 4.5.1, IEC publication 189-1. The test conditions are as follows:

Number of samples	2 suitable length taken from two places separated by at least 1 m
Number of turns around mandrel	3 complete contiguous
Temperature of oven	150 ± 3 °C
Duration in oven	1 hour

The insulation shall show no crack after the test.

4.1.4 Combined shrinkage and heat shock test

This test is used to determine the extent to which the insulation shrinks or withstands damage with variations in temperature. The test shall be carried out in accordance with sub-clause 4.7, IEC publication 189-1. The test conditions are as follows:

Number of samples	2 lengths, the ends shall be clearly cut (without stripped ends) and extended at right angles to the mandrel in opposite directions for a length of 50 mm
Number of turns around mandrel	3 complete contiguous
Temperature of oven	150 ± 3 °C
Duration in oven	1 hour

The insulation shall show no crack after the test. The amount of shrinkage of the insulation from the conductor ends shall be measured and shall be recorded as a percentage of the tail length (50 mm).

In case of doubt, test should be carried out in accordance with clauses 4.1.2 and 4.1.3.

4.2 SHEATH

4.2.1 Accelerated ageing test

The test conditions and expected test requirements are similar to those mentioned in section 4.1.1.

4.2.2 Pressure test

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

The test shall be carried out in accordance with sub-clause 4.2, IEC publication 189-1. The test conditions are as follows:

Test sample	3 adjacent test pieces are taken from a sample having a length of 250 mm to 500 mm from which all internal parts have been removed
Length of test pieces	50 mm to 100 mm
Preparation of test pieces	From each piece, a strip of width $\cong {}^{1}/_{3}$ the circumference shall be cut parallel to the axis
Position of test piece in the indentation device	As shown in Figure 1

Calculation of test force	The force *F*, in Newton exerted upon each test piece of sheath, shall be given by $F = k \sqrt{2 D d - d^2}$ where, *k* is a coefficient specified in the standard for the type of cable, or, if no value is specified, $k = 0.6$ *d* = mean value of the thickness of the test piece *D* = mean value of the outer diameter of test piece *d* and *D* are expressed in mm to one decimal place and measured according to sub-clause 8 of IEC Publication 811-1-1. The calculated *F may* be rounded off downwards by < 3 %.
Heating of loaded test pieces	In an air oven for a duration of 4 hours
Chilling of loaded test pieces	At the end of the duration, test piece is rapidly cooled under load by spraying cold water on the spot where the blade is pressing. When it is cooled to a temperature where recovery of the insulation no longer occurs, the test piece shall be cooled further by immersion in cold water.
Measurement of indentation	Immediately after cooling, the indentation shall be measured on a narrow strip cut from the test piece as shown in Figures 2 and 3.

4.2.3 Heat shock test

The sheath shall withstand variations in temperature without damage. The test shall be carried out in accordance with sub-clause 4.5.2, IEC publication 189-1. The test conditions are as follows:

Number of samples	2 suitable length taken from two places separated by at least 1 m
Number of turns around mandrel	6 complete contiguous
Temperature of oven	150 ± 3 °C
Duration in oven	1 hour

The sheath shall show no crack.

4.3 RESISTANCE TO FLAME PROPAGATION

Combustion of the cable shall be slow and shall not spread appreciably; any flame shall die out in less than 30 seconds after removal of the gas burner.

The test shall be carried out in accordance with sub-clause 4.3, IEC publication 189-1. The test conditions are as follows:

Number of samples	1 x 600 ± 25 mm
Source of heat	Gas burner

The flame shall be applied for a continuous period of T seconds derived from the formula:

$$T=60 + m/25$$

where m is the weight in grams of the cable sample corrected to a 600 mm length.

5 ELECTRICAL REQUIREMENT

5.1 ELECTRICAL RESISTANCE OF CONDUCTOR

The electrical resistance of the tinned conductor shall not exceed 97.8 Ω/km at 20 ± 1°C. The test shall be carried out in accordance with sub-clause 5.1, IEC publication 189-1.

5.2 DIELECTRIC STRENGTH

The insulation shall remain at 500 MΩ/km while withstanding 1500 Vdc or 1000 Vrms voltage applied for 1 min without any breakdown. The test shall be carried out in accordance with sub-clause 5.2, IEC publication 189-1.

5.3 INSULATION RESISTANCE

Insulation resistance shall not be less than 500MΩ/km length at 20 ± 1°C. The test shall be carried out in accordance with sub-clause 5.3, IEC publication 189-1. The test conditions for the two different temperatures are as follows:

<u>At ambient temperature</u>	
Number of samples	1 x Complete length of finished cable
Conditioning temperature	20 ± 5°C
Conditioning period	2 hours
Test voltage	≥ 500 Vdc
Application period of test voltage	1 min
<u>At high temperature</u>	
Number of samples	1 x 10m
Water bath temperature	70 ± 2°C
Immersion period in water bath	2 hours
Test voltage	≥ 500 Vdc
Application period of test voltage	1 min

5.4 MUTUAL CAPACITANCE

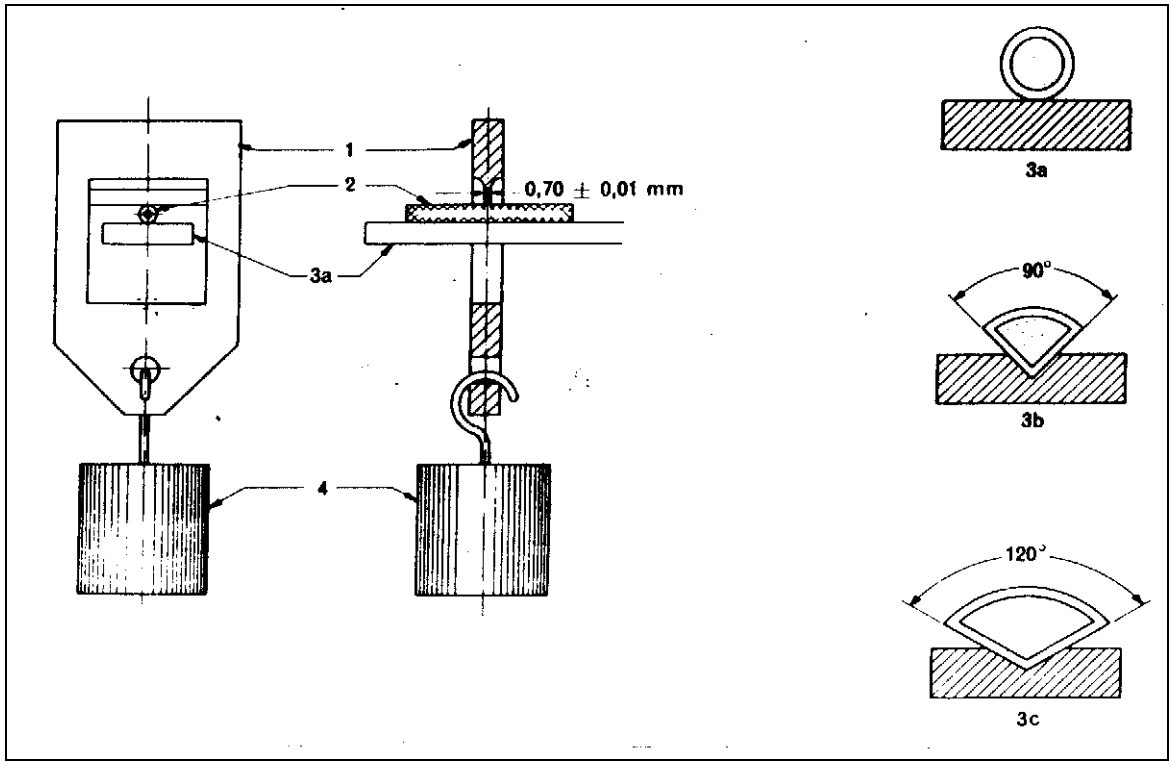
The mutual capacitance between any pair shall not exceed 120 nF/km measured in accordance with sub-clause 5.4, IEC publication 189-1. The test conditions are as follows:

Accuracy of instrument	1% of value to be measured
Frequency	500 to 2000 Hz

5.5 CAPACITANCE UNBALANCE

The capacitance unbalance between 2 pairs of different cabling elements shall be less than 400 pF per 500m length measured in accordance with sub-clause 5.5, IEC publication 189-1. The test conditions are as follows:

Accuracy of instrument	5 pF ± 5% of value to be measured
Frequency	500 to 2000 Hz



1 = testing frame 2 = sample 3a, 3b, 3c = supports 4 = load

Figure 1: **Indentation Device**

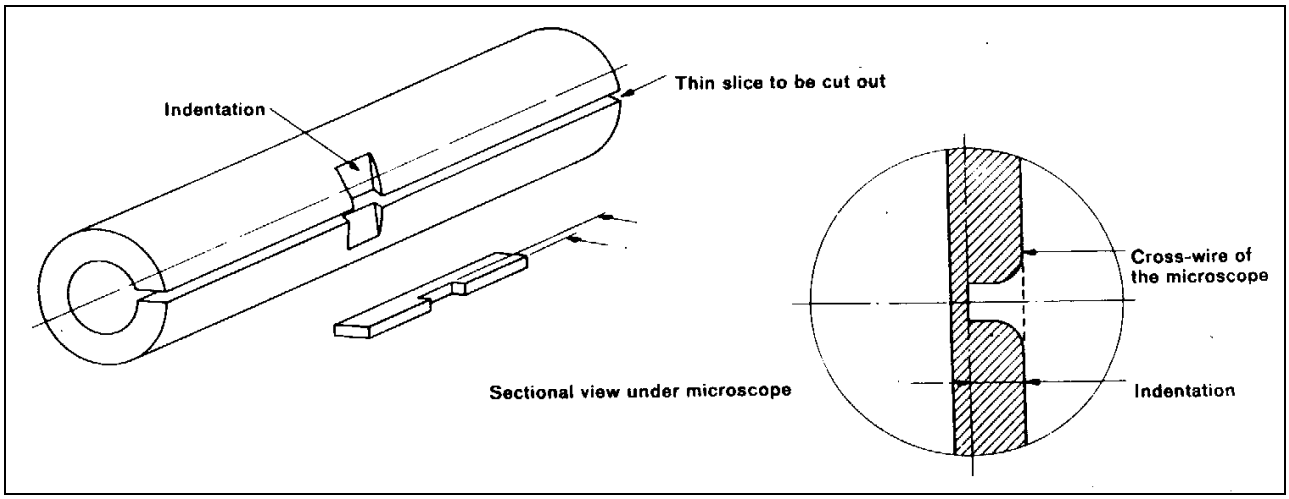


Figure 2: **Measurement of indentation**

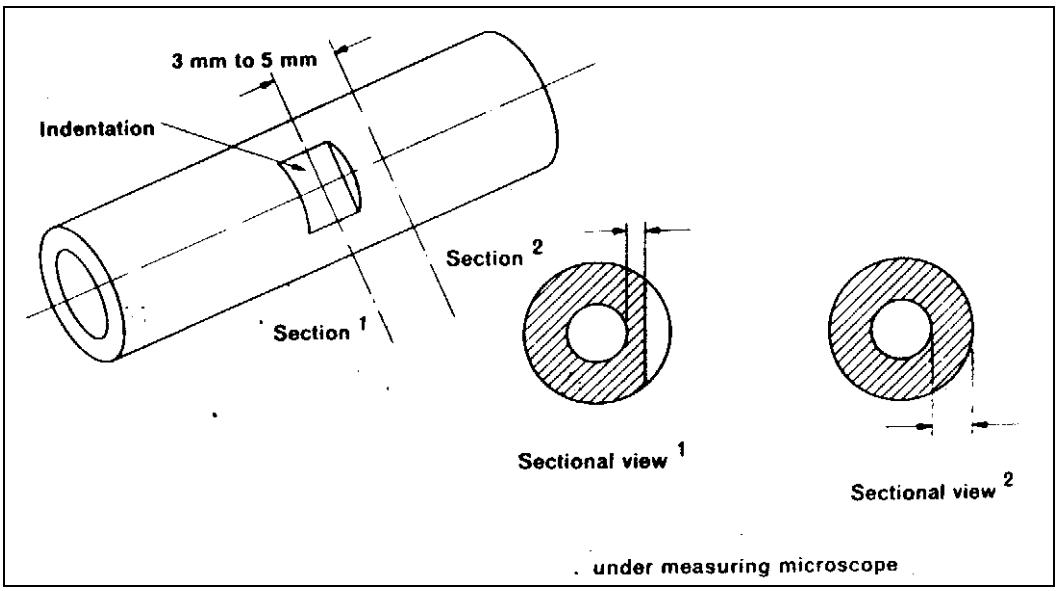


Figure 3: **Measurement of indentation for small test pieces**

Appendix A

Table A.1: **Colour Code for Low Count PVC Cable**

Cable Size	4-Wire (Quad)		Pair Count	6-Wire		8-Wire		10-wire	
				a-Wire	b-Wire	a-Wire	b-Wire	a-Wire	b-Wire
Remarks: 1. A Quad has 4-Wires. Blue and orange comprise the first element (Pair). 2. Base colours are in capital letters. Small letters represent spiral or ring markings on the base colour. 3. NA - Not applicable	a-Wire	BLUE	1	WHITE - blue	BLUE - white	WHITE - blue	BLUE - white	WHITE - blue	BLUE - white
	b-Wire	ORANGE	2	WHITE - orange	ORANGE - white	WHITE - orange	ORANGE - white	WHITE - orange	ORANGE - white
	c-Wire	GREEN	3	WHITE - green	GREEN - white	WHITE - green	GREEN - white	WHITE - green	GREEN - white
	d-Wire	BROWN	4	NA	NA	WHITE - brown	BROWN - white	WHITE - brown	BROWN - white
			5	NA	NA	NA	NA	WHITE - grey	GREY - white

Table A.2 **Internal Telephone Cables - 0.5 mm diameter Conductor**

Cable Type	4-wire	6-wire	8-wire	10-wire
Conductor Diameter(mm)	0.5	0.5	0.5	0.5
Insulation Radial Thickness (mm)	0.15	0.15	0.15	0.15
Insulated Conductor Diameter (mm)	0.95	0.95	0.95	0.95
Minimum Sheath Thickness (mm)	0.4	0.5	0.5	0.6
Overall Cable Diameter (mm)	3.5	5.3	5.8	6.5

Specification

For

4-Way Modular on Wall Socket

IDA TS L2-1
Issue 1, 2000

Info-Communications Development Authority of Singapore

Equipment and Cabling Regulation Department
8 Temasek Boulevard
#14-00 Suntec Tower Three
Singapore 038988

http://www.ida.gov.sg

CONTENTS

1 SCOPE

This technical specification provides the technical requirements for 4-way modular on-wall socket for interfacing with modular plug-ended telephone set.

2 SOCKET CONSTRUCTION AND DIMENSIONS

2.1 OVERALL CONSTRUCTION

2.1.1 The socket shall comprise a base and a cover. The base shall come with suitable knock-outs to facilitate cable entry and exit. The jack unit and the terminals shall be located at the cover.

2.1.2 The jack-opening of the socket shall be provided with a spring-loaded shutter to prevent the ingress of insects and dusts.

2.1.3 The cover shall be easily removed with a screwdriver or similar tool.

2.1.4 The material of the socket shall be high impact plastic and shall be coloured white.

2.1.5 The general dimensions of the socket are shown in Figure 1 of Appendix A.

2.2 TERMINALS

2.2.1 The socket shall come with 4 terminals. The terminals shall be electrically linked to the spring contacts of the jack unit through stranded conductor leads or similar means. The leads terminal-end shall be fitted with ring-shaped or Y-shaped lugs to facilitate easy connection to the terminals.

2.2.2 The screw-on terminals shall have Universal ("Plus"& "Minus") head and shall be able to accept wires of 0.5 mm conductor size. The terminals shall be made of Nickel-plated brass or higher equivalent materials and shall be fully tropicalised.

2.2.3 There shall be clear markings to identify each of the four terminals. The markings are E/BK, L2/RD, L1/GN and SP/YL. The definitions of the markings are found in the table of Figure 2 of Appendix A.

2.2.4 There should preferably be studs or adequate means at the terminals to keep the wires and cable lugs in place while the terminal screws are being fastened.

2.3 JACK UNIT

2.3.1 The dimensions of the jack unit shall conform to the mechanical specifications (for 6-position jack) of the Federal Communication Commission (FCC) specifications part 68 subpart F as shown in Figure 3 of Appendix A.

2.3.2 The thickness of the gold plating on each of the contact pins shall not be less than 1.27 microns (50 micro-inches). Compliance shall be checked using acceptable test method such as optical microscopy etc.

2.3.3 The colour identification of the contacts shall be in accordance with Figure 2 of Appendix A.

2.4 PACKING

Two numbers mounting screw and rawl plug shall be provided in each socket.

3 ELECTRICAL REQUIREMENTS

Unless otherwise specified, the tests and measurements below shall be carried out at a temperature of 20 ± 5°C.

3.1 DC SERIES RESISTANCE

The series resistance of the socket shall be measured by an acceptable method with the test conditions as follows:

Accuracy of measuring equipment	Within 5% of the measured value
Test current	≥ 1 Amp d.c.

The series resistance shall be less than 20 milli-ohms before the environmental, electrical and mechanical endurance tests (in sections 3.4,4.1 and 5) and less than 30 milli-ohms after these tests.

3.2 INSULATION RESISTANCE

The insulation resistance measured between each contact in turn with all other contacts connected together shall be more than 10 mega-ohms at a test voltage of 500V d.c

3.3 DIELECTRIC STRENGTH

The test conditions are as follows:

Test voltage	500 Vrms
Frequency of test voltage	50 Hz
Application period of test voltage	1 minute

The socket shall be able to withstand application of the test voltage between each contact in turn with all other contacts connected together.

3.4 ELECTRICAL ENDURANCE TEST

Each contact shall be subjected to the following conditions:

Load Current	≥ 1 Amp d.c
Application period of load current	100 hours

Compliance shall be checked by measuring the DC series resistance and insulation resistance of the socket as described in sections 3.1 and 3.2 respectively.

4 MECHANICAL REQUIREMENTS

4.1 MECHANICAL ENDURANCE TEST

The socket shall withstand 2000 cycles of insertions and withdrawal with a compatible sized plug without any degradation in its electrical and mechanical performances. Compliance shall be checked by measuring the DC series resistance and insulation resistance of the socket as described in sections 3.1 and 3.2 respectively.

4.2 IMPACT TEST

The socket shall show no visible crack or damage when subjected to ten blows. Each blow is of impact energy 0.5 Nm and directed at points evenly distributed over the socket.

5 ENVIRONMENTAL REQUIREMENTS

Compliance shall be checked by measuring the DC series resistance of the socket as described in paragraph 3.1 above after each environmental test.

5.1 DAMP HEAT TEST

The damp heat test shall be carried out in accordance with International Electro-technical Commission (IEC) recommendations 68-2-3 Test Ca with test conditions as follows:

Temperature	40 ± 2°C
Relative Humidity	93 + 2% or -3%
Duration	10 days

5.2 SALT (NACL) SPRAY TEST

Each sample shall be subjected to the Salt spray test carried out in accordance with IEC recommendations 68-2-11 Test Ka with test conditions as follows:

Salt solution concentration	5 ± 1 % by weight
Nozzle pressure	15 psi
Ambient temperature	35 ± 2°C
Duration	48 hours

5.3 HYDROGEN SULPHIDE (H_2S) TEST

The Hydrogen Sulphide test shall be carried out in accordance with IEC recommendations 68-2-43 Test Kd with test conditions as follows:

Temperature	25 ± 2°C
H_2S concentration	Saturated
Relative humidity	75 ± 2%
Duration	48 hours

Appendix A

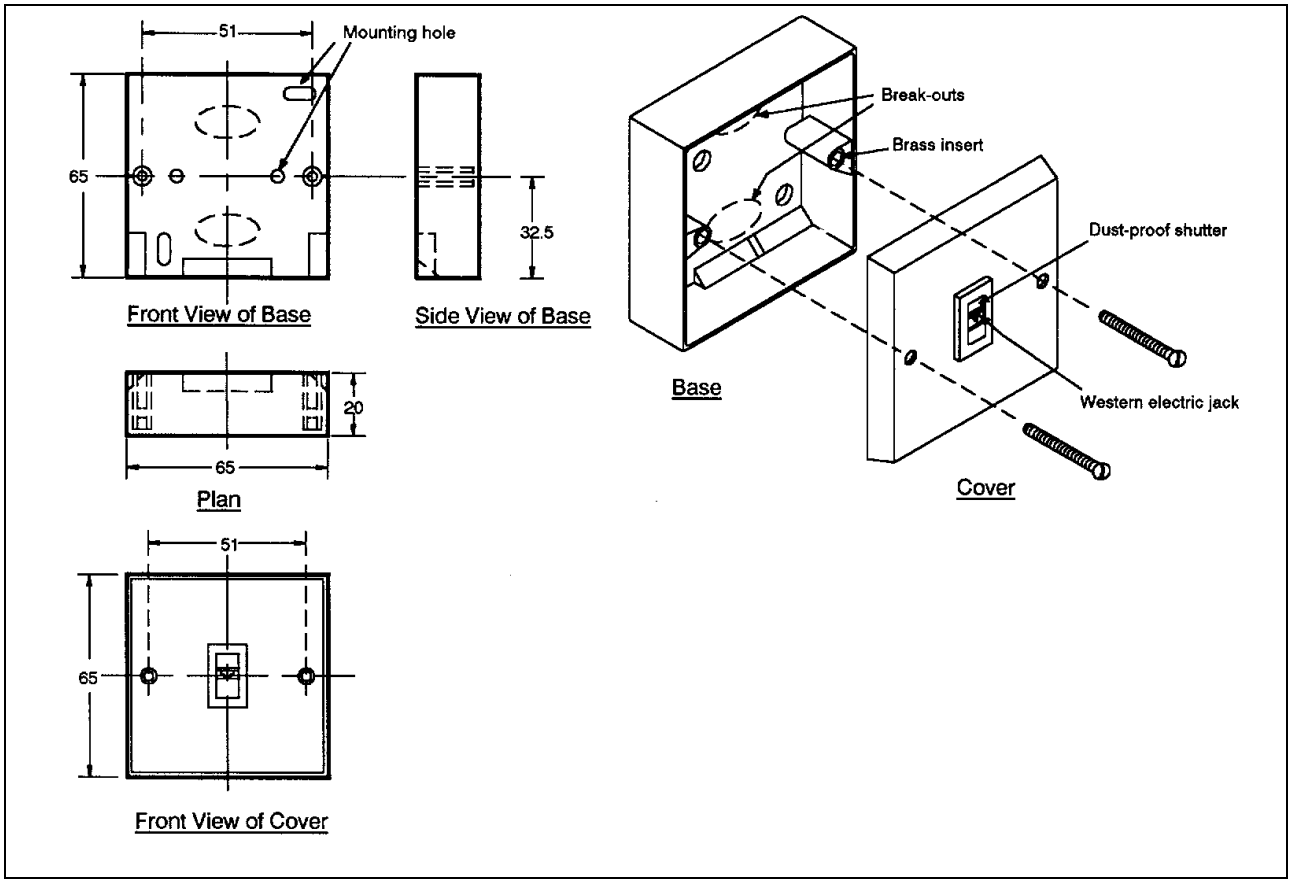
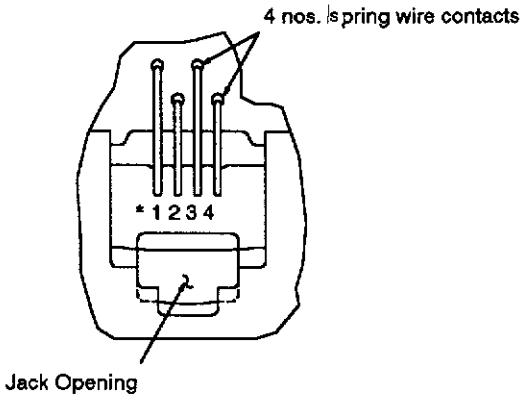


Figure 1: **Dimensions of Base & Cover for 4-way modular on wall socket**
Note: Drawn not to scale
All dimensions in mm

Appendix A



* Contact No	Colour		Designation
1	Black	(BK)	Earth
2	Red	(RD)	L2
3	Green	(GN)	L1
4	Yellow	(YL)	Spare

Note:

* Please see corresponding asterik (*) in Fig. 2 above

Figure 2: **Colour Designation for Contacts & Terminals**

Appendix A

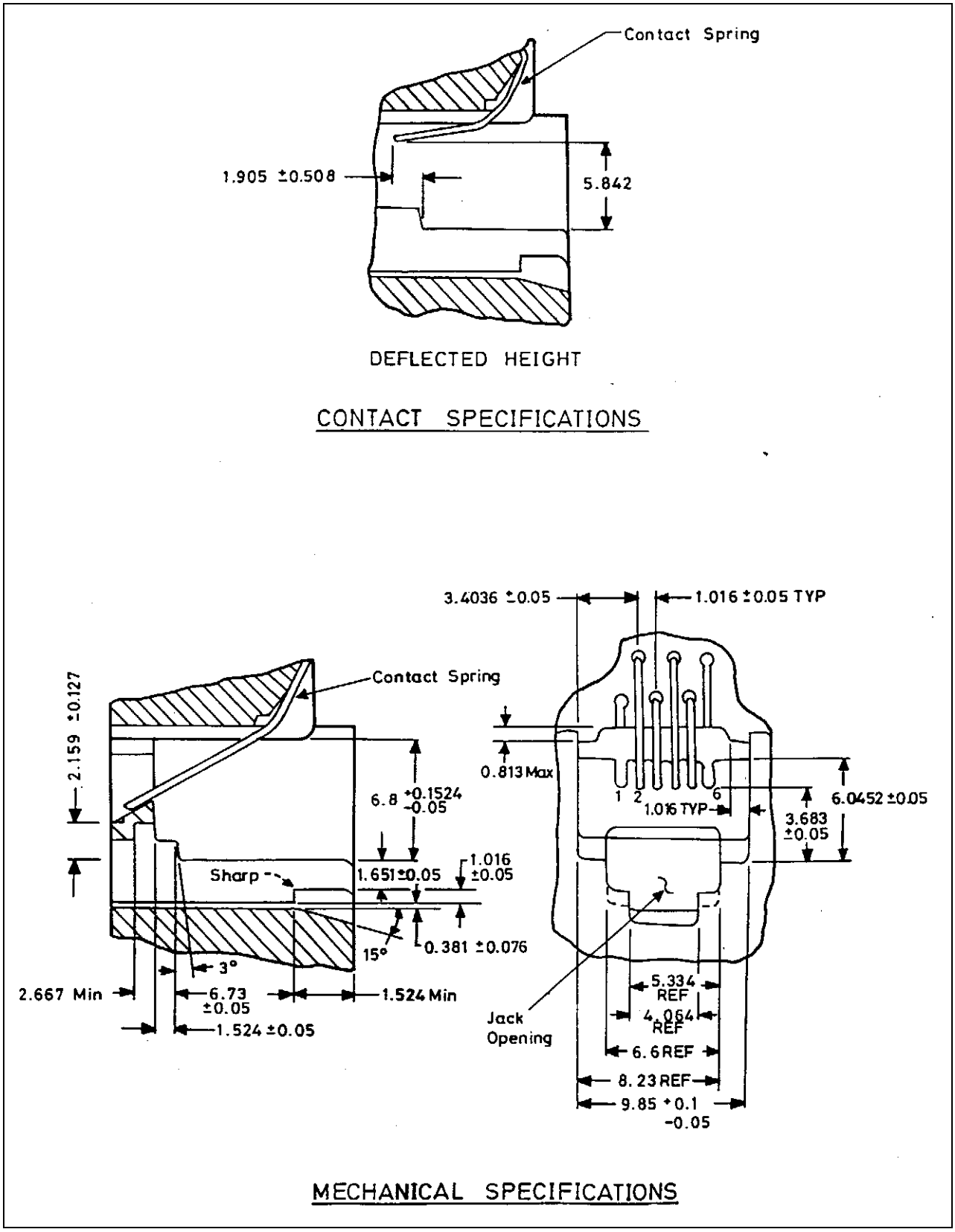


Figure 3: **Dimension of Jack Unit**
Note: Drawn not to scale
All dimensions in mm

Specification

For

2-Pair Block Terminal

IDA TS L3-1
Issue 1, 2000

Info-Communications Development Authority of Singapore

Equipment and Cabling Regulation Department
8 Temasek Boulevard
#14-00 Suntec Tower Three
Singapore 038988

http://www.ida.gov.sg

CONTENTS

1 SCOPE

This technical specification provides the technical requirements of 2-pair Block Terminal (BT) mainly used in the wiring of HDB flats.

2 PHYSICAL CONSTRUCTION

2.1 The 2-pair Block Terminal shall comprise the cover and screw terminals mounted on a base.

2.2 The cover shall be of the screw-on type sized L 70 mm x W 42 mm x H 20 mm. The screw provided for the cover shall be of the captive type.

2.3 The base shall come with two numbers countersunk through hole for mounting and suitable knock-outs to accommodate incoming and outgoing cables.

2.4 Each screw terminal shall come with suitable washer(s). There shall be separate screw terminals for incoming and outgoing cables.

2.5 Two numbers mounting screw and rawl plug shall be provided for each Block Terminal.

3 MATERIALS

3.1 The base and cover shall be made of high impact plastic coloured white.

3.2 The screws, washers and other signal carrying parts shall be made of non-ferrous materials such as Nickel-plated brass.

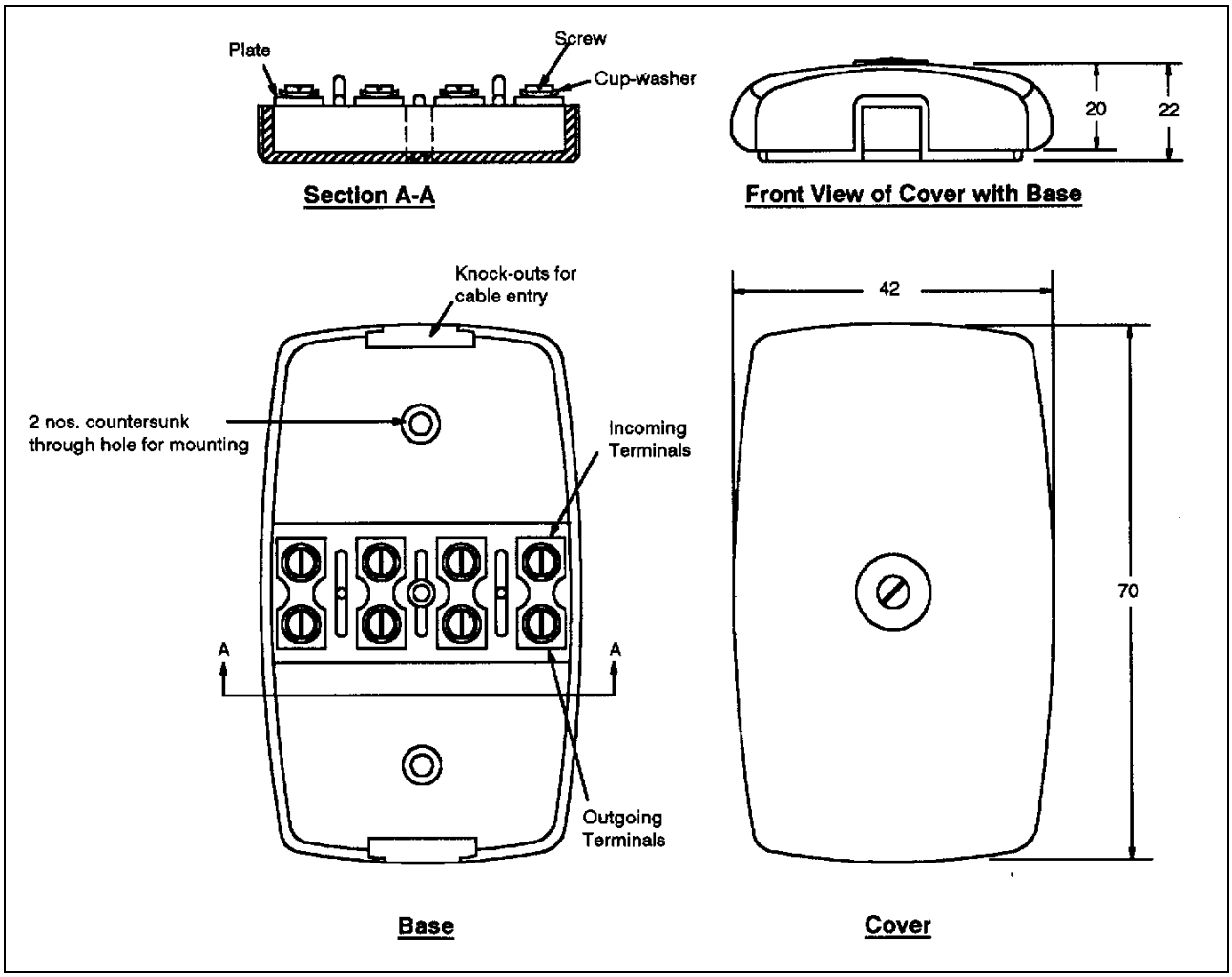


Figure 1: **Dimensions of 2-Pair Block Terminals**
Note: Drawn not to scale
All dimensions in mm

Specification

For

4-Pair Block Terminal

IDA TS L3-2
Issue 1, 2000

Info-Communications Development Authority of Singapore

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CONTENTS

1 SCOPE

This technical specification provides the technical requirements of 4-pair Block Terminal (BT) mainly used in shophouses.

2 PHYSICAL CONSTRUCTION

2.1 The 4-pair Block Terminal shall comprise the cover and screw terminals mounted on a base.

2.2 The cover shall be of the clip-on type sized L 106 mm x W 54 mm x H 23 mm.

2.3 The base shall come with two numbers countersunk through hole for mounting and suitable knock-outs to accommodate incoming and outgoing cables.

2.4 Each screw terminal shall come with suitable washer(s). There shall be separate screw terminals for incoming and outgoing cables.

2.5 Two numbers mounting screw and rawl plug shall be provided in each Block Terminal.

3 MATERIALS

3.1 The base and cover shall be made of high impact plastic coloured black.

3.2 The screws, washers and other signal carrying parts shall be made of non-ferrous materials such as Nickel-plated brass.

Appendix A

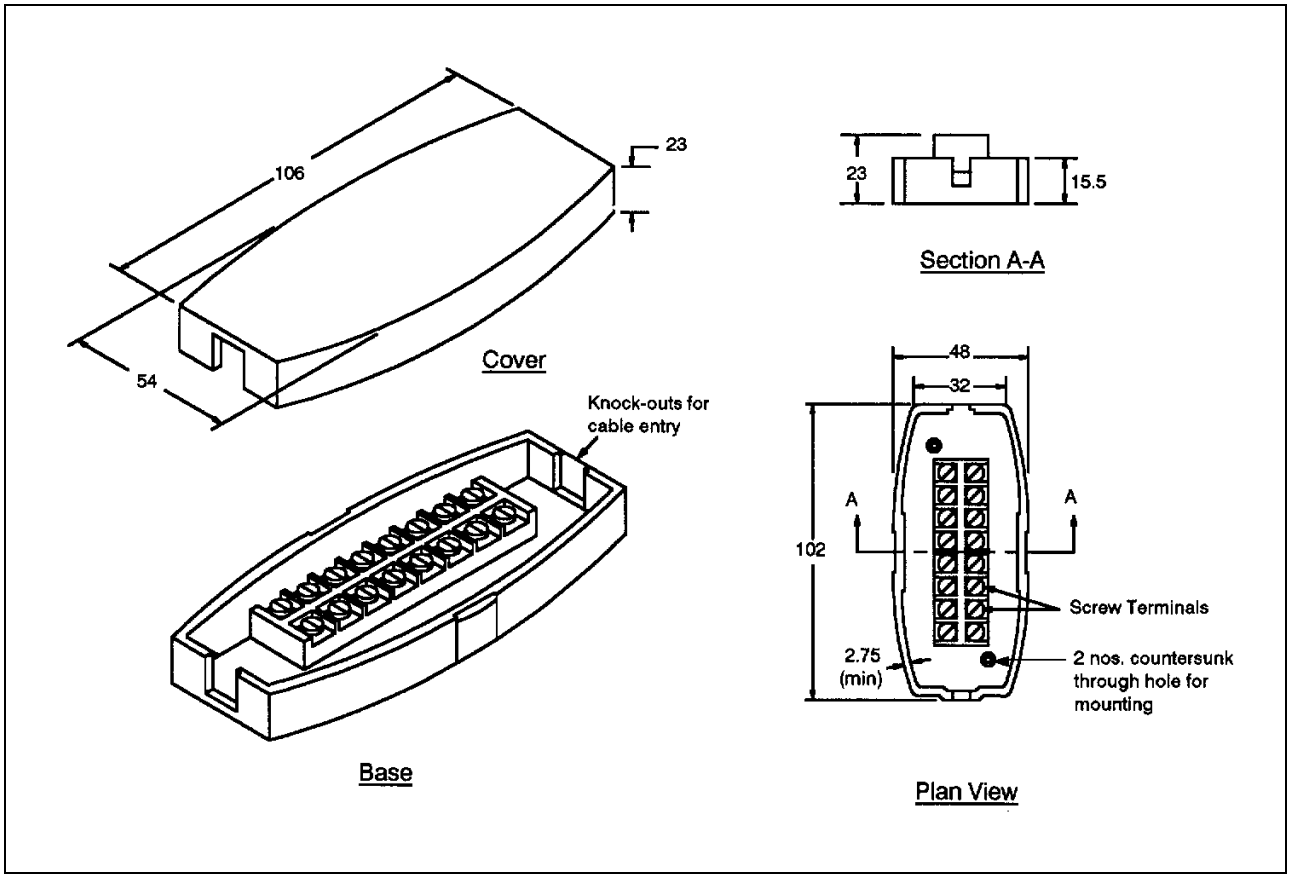

Figure 1: **Dimensions of 4-Pair Block Terminal**
Note: Drawn not to scale
All dimensions in mm

Specification

For

5-Pair Block Terminal

IDA TS L3-3
Issue 1, 2000

Info-Communications Development Authority of Singapore

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http://www.ida.gov.sg

CONTENTS

1 SCOPE

This technical specification provides the technical requirements of 5-pair Block Terminal (BT) mainly used in private residential premises.

2 PHYSICAL CONSTRUCTION

2.1 The 5-pair Block Terminal shall comprise the terminal links and screw terminals mounted onto a standard cover sized 86 mm square.

2.2 The Block Terminal shall be of size L 86 mm x W 86 mm x H 8 mm with two numbers countersunk through hole for mounting.

2.3 Each screw terminal shall come with suitable washer(s). There shall be separate screw terminals for incoming and outgoing cables.

2.4 Two numbers screw shall be provided for each Block Terminal.

3 MATERIALS

3.1 The Block Terminal shall be made of high impact plastic coloured black.

3.2 The terminal links, screws, washers and other signal carrying parts shall be made of non-ferrous materials such as Nickel-plated brass.

Appendix A

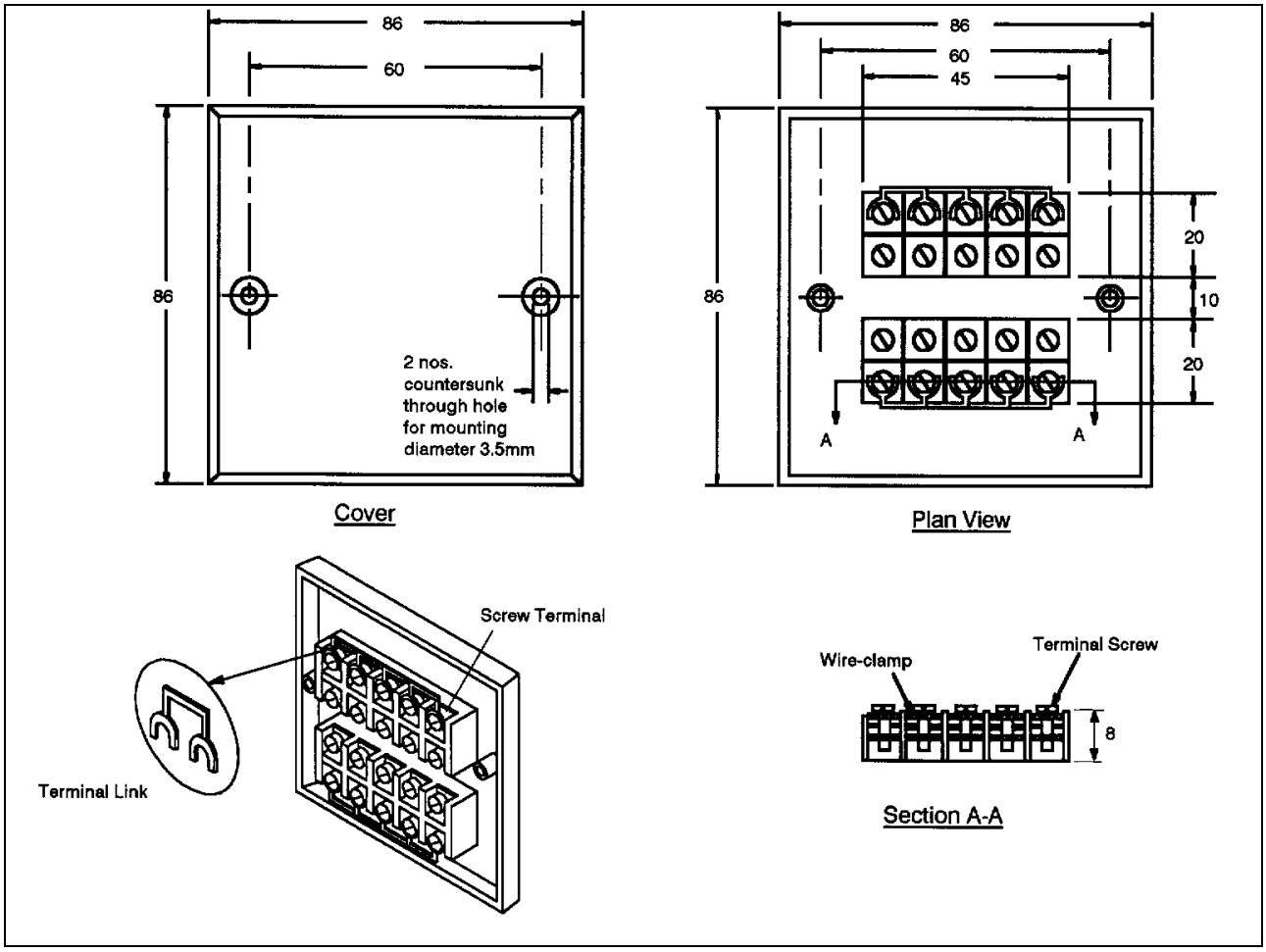

Figure 1: **Dimensions of 5-Pair Block Terminal**
Note: Drawn not to scale
All dimensions in mm

References for IDA TS L1-1: 2000 and IDA TS L1-2: 2000

IEC 189-1 (1986)	Part 1: General test and measuring methods Low- frequency cables and wires with PVC insulation and sheath Amendment 2 (1989) Amendment 3 (1992)
IEC 189-2 (1981)	Part 2: Cables in pairs, triples, quads and quintuples for inside installations Amendment 1 (1990)
IEC 68-2-20 (1979)	Part 2 : Tests - Test T : Soldering
IEC 304 (1982)	Standard Colours for insulation for low-frequency Cables and Wires
IEC 332-1 (1979)	Part 1: Tests on Electric Cables under Fire Conditions
IEC 332-2 (1989)	Part 2: Test on Single Insulated Wire. (Under consideration)
IEC 811-1-1 (1985)	Common Test Methods for Insulating and Sheathing Materials of Electric Cables Part 1: Methods for General Application Section One - Measurement of Thickness and Overall Dimensions - Tests for determining the Mechanical Properties
IEC 811-1-2 (1985)	Part 1: Methods for General Application
IEC 811-1-3 (1985)	Part 1: Methods for General Application Section Three - Methods for determining the Density - Water absorption Tests - Shrinkage Test
IEC 811-1-4 (1985)	Part 1: Methods for General Application Section Four - Test at low temperature
IEC 811-3-1 (1985)	Part 3: Methods Specific to PVC Compounds. Section One - Pressure Test at High Temperature - Tests for Resistance to Cracking Amendment 1 (1994)
IEC 855-1 (1987)	Electrical Test Methods for Electric Cables Part 1: Electrical Tests for cables, Cords and Wires for Voltages up and including 450/750 V
ISO 105 (1987)	Textile Tests for Colour Fastness
ISO 6892 (1984)	Metallic Materials - Tensile Testing
CW 1293 (1980)	Specifications for internal cabling

References for IDA TS L2-1: 2000

IEC 68-2-3 (1969)	Part 2: Tests - Test Ca: Damp heat, steady state Basic environmental testing procedures
IEC 68-2-11 (1989)	Part 2: Tests - Test Ka: Salt mist Basic environmental testing procedures
IEC 68-2-43 (1976)	Part 2: Tests - Test Kd: Hydrogen sulphide test for contacts and connections Basic environmental testing procedures
FCC specifications part 68 subpart F (1983)	Connectors