# POLYIMIDE INSULATED WIRES AND CABLES, LOW FREQUENCY, 600V, -100 TO +200°C

## ESCC Detail Specification No. 3901/002

| | |
|---|---|
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| DCR No. | CHANGE DESCRIPTION |
|---|---|
| 702 | Specification updated to incorporate editorial and technical changes per DCR. |

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# 1 GENERAL

## 1.1 SCOPE

This specification details the ratings, physical and electrical characteristics, test and inspection data for Polyimide Insulated Wires and Cables, Low Frequency, 600V, -100 to +200°C. It shall be read in conjunction with ESCC Generic Specification No. 3901, the requirements of which are supplemented herein.

**NOTE**: These wires and cables shall not be used in the presence or vicinity of hydrazine or nitrogen tetroxide.

## 1.2 TYPE VARIANTS

Variants of the basic types of wires and cables specified herein which are also covered by this specification, are listed in Table 1(a).

## 1.1 MAXIMUM RATINGS

The maximum ratings, applicable to the finished wires and cables specified herein, which shall not be exceeded at any time during use or storage in controlled space environment, are scheduled in Table 1(b).

## 1.2 PARAMETER DERATING INFORMATION

The derating information applicable to the finished wires and cables specified herein is as follows:

- The maximum current for each wire used in a bundle shall be:

$$I_{Bmax}=I_{max} \times \frac{29 - n}{28} \text{ (for } 1 < n < 15\text{)}$$

$$I_{Bmax}=\frac{I_{max}}{2} \text{ (for } n \geq 15\text{)}$$

  where n = number of wires in the bundle.
- The temperature derating information is shown in Figure 1 with maximum current $I_{max}$ for a single wire.
- The derating factors contained herein indicate maximum stress values and do not preclude further derating.

## 1.3 PHYSICAL CHARACTERISTICS

The physical characteristics of the finished wires and cables specified herein are shown in Figures 2(a), 2(b) and 2(c) and their dimensions in Table 1(a).

## 1.4 FUNCTIONAL DIAGRAM

Not applicable.

**TABLE 1(a) – TYPE VARIANTS**

| Variant No. | Shielded | Un-Shielded | No. of Cores | Wire Size (AWG) | Stranding No of Strands x Diameter (mm) | Conductor Characteristics | | | Shield Strand Ø (mm) | Core Max Ø (mm) | Finished Wire or Cable Characteristics | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Max Ø (mm) | Nom Section ($mm^2$) | Max Ohmic Resistance (Ω/km) | | | Max Ø (mm) | Max Weight (kg/km) |
| Variants 01 through 30 deleted, not to be used | | | | | | | | | | | | |
| 31 | | x | 2 | 26 | 19x0.10 (1) | 0.53 | 0.15 | 155 | - | 0.78 | 1.64 | 4.42 |
| 32 | | x | 2 | 24 | 19x0.12 (1) | 0.64 | 0.21 | 110 | - | 0.88 | 1.84 | 5.91 |
| 33 | | x | 2 | 22 | 19x0.16 | 0.85 | 0.38 | 53.5 | - | 1.08 | 2.24 | 9.41 |
| 34 | | x | 2 | 20 | 19x0.20 | 1.04 | 0.60 | 33.8 | - | 1.28 | 2.64 | 14.2 |
| 35 | | x | 2 | 18 | 19x0.25 | 1.29 | 0.93 | 21.6 | - | 1.53 | 3.15 | 21.3 |
| 36 | | x | 3 | 26 | 19x0.10 (1) | 0.53 | 0.15 | 155 | - | 0.78 | 1.76 | 6.45 |
| 37 | | x | 3 | 24 | 19x0.12 (1) | 0.64 | 0.21 | 110 | - | 0.88 | 1.97 | 8.81 |
| 38 | | x | 3 | 22 | 19x0.16 | 0.85 | 0.38 | 53.5 | - | 1.08 | 2.4 | 14.3 |
| 39 | | x | 3 | 20 | 19x0.20 | 1.04 | 0.60 | 33.8 | - | 1.28 | 2.84 | 21.1 |
| 40 | | x | 3 | 18 | 19x0.25 | 1.29 | 0.93 | 21.6 | - | 1.53 | 3.4 | 31.6 |
| 41 | x | | 1 | 26 | 19x0.10 (1) | 0.53 | 0.15 | 148 | 0.08 | 0.78 | 1.13 | 3.85 |
| 42 | x | | 1 | 24 | 19x0.12 (1) | 0.64 | 0.21 | 105 | 0.08 | 0.88 | 1.23 | 4.75 |
| 43 | x | | 1 | 22 | 19x0.16 | 0.85 | 0.38 | 50.9 | 0.08 | 1.08 | 1.43 | 6.86 |
| 44 | x | | 1 | 20 | 19x0.20 | 1.04 | 0.60 | 32.2 | 0.08 | 1.28 | 1.63 | 9.43 |
| 45 | x | | 1 | 18 | 19x0.25 | 1.29 | 0.93 | 20.6 | 0.10 | 1.53 | 1.92 | 13.8 |
| 46 | x | | 2 | 26 | 19x0.10 (1) | 0.53 | 0.15 | 155 | 0.08 | 0.78 | 2.01 | 8 |
| 47 | x | | 2 | 24 | 19x0.12 (1) | 0.64 | 0.21 | 110 | 0.10 | 0.88 | 2.24 | 10.5 |
| 48 | x | | 2 | 22 | 19x0.16 | 0.85 | 0.38 | 53.5 | 0.10 | 1.08 | 2.65 | 14.8 |
| 49 | x | | 2 | 20 | 19x0.20 | 1.04 | 0.60 | 33.8 | 0.10 | 1.28 | 3.03 | 20.2 |
| 50 | x | | 2 | 18 | 19x0.25 | 1.29 | 0.93 | 21.6 | 0.12 | 1.53 | 3.58 | 29.6 |
| 51 | x | | 3 | 26 | 19x0.10 (1) | 0.53 | 0.15 | 155 | 0.10 | 0.78 | 2.15 | 11.2 |

| Variant No. | Shielded | Un-Shielded | No. of Cores | Wire Size (AWG) | Stranding No of Strands x Diameter (mm) | Conductor Characteristics | | | Shield Strand Ø (mm) | Core Max Ø (mm) | Finished Wire or Cable Characteristics | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Max Ø (mm) | Nom Section ($mm^2$) | Max Ohmic Resistance (Ω/km) | | | Max Ø (mm) | Max Weight (kg/km) |
| 52 | x | | 3 | 24 | 19x0.12 (1) | 0.64 | 0.21 | 110 | 0.10 | 0.88 | 2.36 | 14 |
| 53 | x | | 3 | 22 | 19x0.16 | 0.85 | 0.38 | 53.5 | 0.10 | 1.08 | 2.82 | 20.2 |
| 54 | x | | 3 | 20 | 19x0.20 | 1.04 | 0.60 | 33.8 | 0.12 | 1.28 | 3.26 | 29.4 |
| 55 | x | | 3 | 18 | 19x0.25 | 1.29 | 0.93 | 21.6 | 0.15 | 1.53 | 3.86 | 44.1 |
| 56 | | x | 1 | 26 | 19x0.10 (1) | 0.53 | 0.15 | 148 | - | - | 0.78 | 1.93 |
| 57 | | x | 1 | 24 | 19x0.12 (1) | 0.64 | 0.21 | 105 | - | - | 0.88 | 2.64 |
| 58 | | x | 1 | 22 | 19x0.16 | 0.85 | 0.38 | 50.9 | - | - | 1.08 | 4.25 |
| 59 | | x | 1 | 20 | 19x0.20 | 1.04 | 0.60 | 32.2 | - | - | 1.28 | 6.49 |
| 60 | | x | 1 | 18 | 19x0.25 | 1.29 | 0.93 | 20.6 | - | - | 1.53 | 9.79 |
| 61 | | x | 1 | 28 | 19x0.08 (1) | 0.43 | 0.10 | 242 | - | - | 0.68 | 1.23 |
| 62 | | x | 2 | 28 | 19x0.08 (1) | 0.43 | 0.10 | 254 | - | 0.68 | 1.43 | 2.7 |
| 63 | | x | 3 | 28 | 19x0.08 (1) | 0.43 | 0.10 | 254 | - | 0.68 | 1.53 | 3.95 |
| 64 | x | | 1 | 28 | 19x0.08 (1) | 0.43 | 0.10 | 242 | 0.08 | 0.68 | 1.07 | 3.05 |
| 65 | x | | 2 | 28 | 19x0.08 (1) | 0.43 | 0.10 | 254 | 0.08 | 0.68 | 1.8 | 5.7 |
| 66 | x | | 3 | 28 | 19x0.08 (1) | 0.43 | 0.10 | 254 | 0.10 | 0.68 | 1.92 | 8.1 |
| 67 | x | | 4 | 28 | 19x0.08 (1) | 0.43 | 0.10 | 254 | 0.10 | 0.68 | 2.15 | 10.15 |
| 68 | x | | 4 | 26 | 19x0.10 (1) | 0.53 | 0.15 | 155 | 0.10 | 0.78 | 2.4 | 13.3 |
| 69 | x | | 4 | 24 | 19x0.12 (1) | 0.64 | 0.21 | 110 | 0.10 | 0.88 | 2.65 | 16.5 |
| 70 | x | | 4 | 22 | 19x0.16 | 0.85 | 0.38 | 53.5 | 0.12 | 1.08 | 3.17 | 26.4 |
| 71 | x | | 4 | 20 | 19x0.20 | 1.04 | 0.60 | 33.8 | 0.15 | 1.28 | 3.7 | 38.8 |
| 72 | x | | 5 | 28 | 19x0.08 (1) | 0.43 | 0.10 | 254 | 0.10 | 0.68 | 2.27 | 12.1 |
| 73 | x | | 5 | 26 | 19x0.10 (1) | 0.53 | 0.15 | 155 | 0.10 | 0.78 | 2.56 | 15.8 |
| 74 | x | | 1 | 28 | 19x0.08 (1) | 0.43 | 0.10 | 242 | 0.08 | 0.68 | 1.02 | 2.95 |

| Variant No. | Shielded | Un-Shielded | No. of Cores | Wire Size (AWG) | Stranding No of Strands x Diameter (mm) | Conductor Characteristics | | | Shield Strand Ø (mm) | Core Max Ø (mm) | Finished Wire or Cable Characteristics | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Max Ø (mm) | Nom Section ($mm^2$) | Max Ohmic Resistance (Ω/km) | | | Max Ø (mm) | Max Weight (kg/km) |
| 75 | x | | 1 | 26 | 19x0.10 (1) | 0.53 | 0.15 | 148 | 0.08 | 0.78 | 1.09 | 3.75 |
| 76 | x | | 1 | 24 | 19x0.12 (1) | 0.64 | 0.21 | 105 | 0.08 | 0.88 | 1.19 | 4.65 |
| 77 | x | | 1 | 22 | 19x0.16 | 0.85 | 0.38 | 50.9 | 0.08 | 1.08 | 1.39 | 6.75 |
| 78 | x | | 1 | 20 | 19x0.20 | 1.04 | 0.60 | 32.2 | 0.08 | 1.28 | 1.59 | 9.3 |
| 79 | x | | 1 | 18 | 19x0.25 | 1.29 | 0.93 | 20.6 | 0.10 | 1.53 | 1.87 | 13.65 |
| 80 | x | | 2 | 28 | 19x0.08 (1) | 0.43 | 0.10 | 254 | 0.08 | 0.68 | 1.67 | 5.5 |
| 81 | x | | 2 | 26 | 19x0.10 (1) | 0.53 | 0.15 | 155 | 0.08 | 0.78 | 1.87 | 7.4 |
| 82 | x | | 2 | 24 | 19x0.12 (1) | 0.64 | 0.21 | 110 | 0.10 | 0.88 | 2.1 | 9.8 |
| 83 | x | | 2 | 22 | 19x0.16 | 0.85 | 0.38 | 53.5 | 0.10 | 1.08 | 2.5 | 14 |
| 84 | x | | 2 | 20 | 19x0.20 | 1.04 | 0.60 | 33.8 | 0.10 | 1.28 | 2.9 | 19.4 |
| 85 | x | | 2 | 18 | 19x0.25 | 1.29 | 0.93 | 21.6 | 0.12 | 1.53 | 3.4 | 28.2 |
| 86 | x | | 3 | 28 | 19x0.08 (1) | 0.43 | 0.10 | 254 | 0.10 | 0.68 | 1.81 | 7.9 |
| 87 | x | | 3 | 26 | 19x0.10 (1) | 0.53 | 0.15 | 155 | 0.10 | 0.78 | 2.2 | 10.6 |
| 88 | x | | 3 | 24 | 19x0.12 (1) | 0.64 | 0.21 | 110 | 0.10 | 0.88 | 2.24 | 13.3 |
| 89 | x | | 3 | 22 | 19x0.16 | 0.85 | 0.38 | 53.5 | 0.10 | 1.08 | 2.67 | 19.2 |
| 90 | x | | 3 | 20 | 19x0.20 | 1.04 | 0.60 | 33.8 | 0.12 | 1.28 | 3.14 | 28.4 |
| 91 | x | | 3 | 18 | 19x0.25 | 1.29 | 0.93 | 21.6 | 0.15 | 1.53 | 3.67 | 42 |

**NOTES:**

1. Copper alloy.

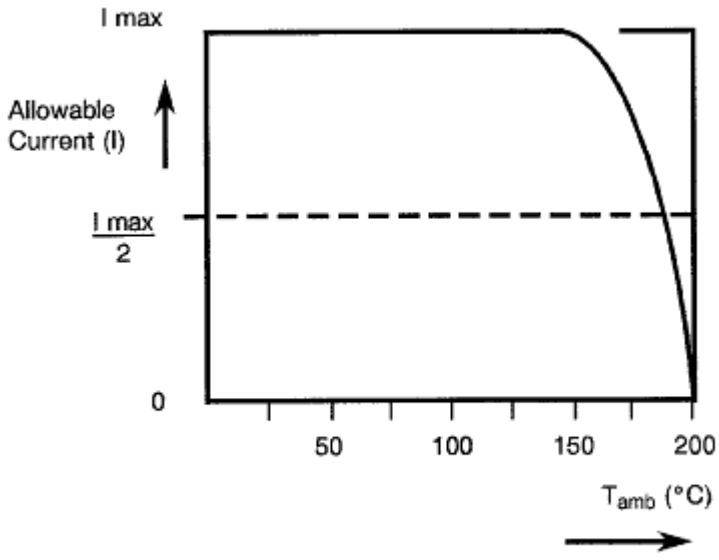
**TABLE 1(b) MAXIMUM RATINGS**

| No. | Characteristics | Symbols | Maximum Ratings | Units | Remarks |
|---|---|---|---|---|---|
| 1 | Voltage | $V_P$ | 600 | Vrms | |
| 2 | Maximum Current (Note 1) | $I_{max}$ | 1.5<br>2.5<br>3.5<br>5<br>7.5<br>10 | A | For AWG 28<br>For AWG 26<br>For AWG 24<br>For AWG 22<br>For AWG 20<br>For AWG 18 |
| 3 | Operating Temperature Range | $T_{amb}$ | -100 to +200 | °C | |
| 4 | Storage Temperature Range | $T_{stg}$ | -100 to +200 | °C | |

**NOTES:**

1. The above specified current will generate a temperature rise of approximately 50°C above ambient temperature in a vacuum environment. Precautions shall be taken to prevent the total temperature of the wire (ambient plus rise) exceeding the continuous operating temperature of the wire.

**FIGURE 1 - PARAMETER DERATING INFORMATION**




Allowable Current versus Temperature

**FIGURE 2 – PHYSICAL CHARACTERISTICS**

Dimensions are given in Table 1(a)

FIGURE 2(a) - FINISHED WIRES

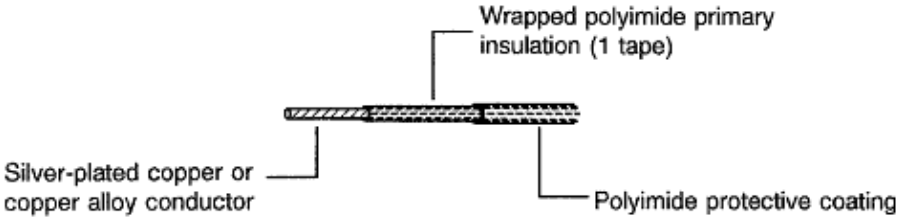



FIGURE 2(b) - SHIELDED AND JACKETED CABLES

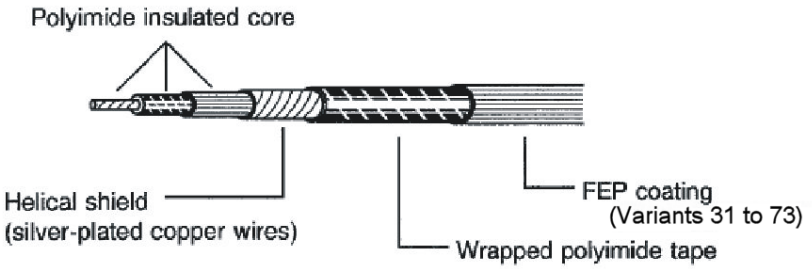
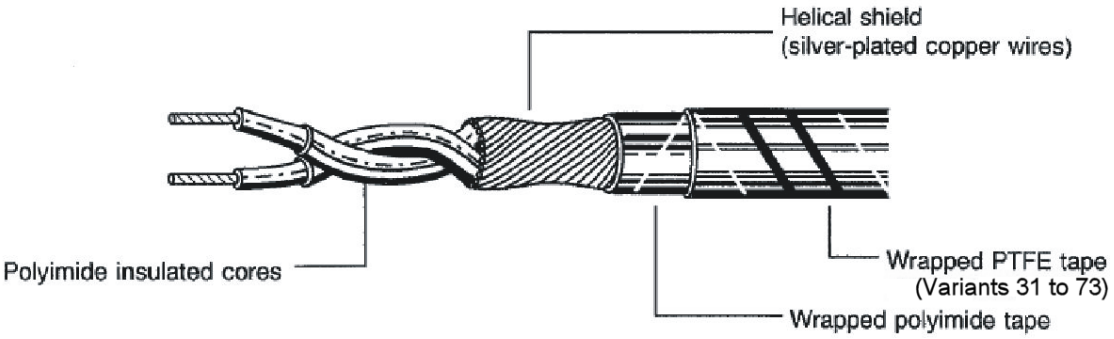



FIGURE 2(c) - SHIELDED AND JACKETED CABLES



## 2 APPLICABLE DOCUMENTS

The following documents form part of this specification and shall be read in conjunction with it:

(a) ESCC Generic Specification No. 3901 for Wires and Cables, Electrical, 600V, Low Frequency.
(b) MIL-DTL-81381 for Wire, Electric, Polyimide-insulated, Copper or Copper Alloy.

## 3 TERMS, DEFINITIONS, ABBREVIATIONS, SYMBOLS AND UNITS

For the purpose of this specification, the terms, definitions, abbreviations, symbols and units specified in ESCC Basic Specification No. 21300 and ESCC Generic Specification No. 3901 shall apply.

## 4 REQUIREMENTS

### 4.1 GENERAL

The complete requirements for procurement of the finished wires and cables specified herein are stated in this specification and ESCC Generic Specification No. 3901. Deviations from the Generic Specification, applicable to this specification only, are listed in Para. 4.2.

Deviations from the applicable Generic Specification and this Detail Specification, formally agreed with specific Manufacturers on the basis that the alternative requirements are equivalent to the ESCC requirements and do not affect the components' reliability, are listed in the Appendices attached to this specification.

### 4.2 DEVIATIONS FROM GENERIC SPECIFICATION

#### 4.2.1 Deviations from Special In-process Controls

None.

#### 4.2.2 Deviations from Final Production Tests (Chart II)

None.

#### 4.2.3 Deviations from Burn-in and Electrical Measurements (Chart III)

Not applicable.

#### 4.2.4 Deviations from Qualification Tests (Chart IV)

(a) Para. 9.21, Resistance to Fluids: To be modified as stated in Para. 4.8.11 of this specification.

#### 4.2.5 Deviations from Lot Acceptance Tests (Chart V)

None.

### 4.3 MECHANICAL REQUIREMENTS

#### 4.3.1 Dimension Check

The dimensions of the finished wires and cables specified herein shall be checked; they shall conform to those shown in Table 1(a), Figure 2 and Para. 4.4 of this specification (see below for the list of parameters to be checked).

**LIST OF PARAMETERS TO BE CHECKED**

| Parameter | Table 1(a) | Figure 2 | Para. 4.4 |
|---|---|---|---|
| Composition | | | |
| Number of conductors | X | | |
| Gauge | X | | |
| Shielding | X | | |
| Jacket | | X | |
| Conductor | | | |
| Nature | | | X |
| Outer diameter | X | | |
| Number of strands | X | | |
| Strand diameter | X | | |
| Length of lay | | | X |
| Silver thickness | | | X |
| Insulation | | | |
| Composition | | X | X |
| Protective coating | | X | X |
| Thickness | | | X |
| Overlapping | | | X |
| Outer diameter | X | | |
| Shielding | | | |
| Number of strands | X | | |
| Type of shielding | | | X |
| Strand diameter | X | | |
| Nature | | X | X |
| Silver thickness | | | X |
| Shielding lay | | | X |
| Shield coverage | | | X |
| Jacket | | | |
| Composition | | X | X |
| Protective coating | | X | X |
| Thickness | | | X |
| Overlapping | | | X |
| Outer diameter | X | | |
| Stripe dimensions | | | X |

4.3.2 Weight

The maximum weight of the finished wires and cables specified herein shall be as specified in Table 1(a).

4.4 MATERIALS AND FINISHES

The materials and finishes shall be as specified herein. Where a definite material is not specified, a material which will enable the wires and cables specified herein to meet the performance requirements of this specification shall be used. Acceptance or approval of any constituent material does not guarantee acceptance of the finished product.

4.4.1 Conductor

*4.4.1.1 Material Characteristics*

All strands used in the manufacture of the conductors shall be silver-coated, soft or annealed, oxygen-free high conductivity copper from AWG 18 to 22 inclusive and silver-coated, high strength copper alloy from AWG 24 to 28. On silver-coated strands, the thickness of the silver shall be 2 microns minimum.

On all copper conductors, any strand shall show a 10% minimum elongation. On all high-strength copper alloy conductors, any strand shall show a 6% minimum elongation at break and a 350N/mm$^2$ minimum tensile strength.

The resistance of the conductors shall be determined at +20°C in accordance with Para. 9.5 of ESCC Generic Specification No. 3901, where the 'α' coefficient for copper alloy is 0.0035.

*4.4.1.2 Stranding*

The conductors shall be constructed of concentrically laid strands to produce a smooth and uniform conductor of circular cross-section and free from any high strands or other surface irregularities.

The length of the left-hand lay of the external layer shall not be less than 8, nor more than 16 times the maximum conductor diameter specified in Table 1(a).

4.4.2 Insulation

*4.4.2.1 Material*

Any insulating material shall be virgin polyimide with only those additives that are necessary for processing and pigmentation.

*4.4.2.2 Construction*

The insulation shall consist of 1 wrapped ribbon, the overlapping of which shall be equal to, or more than, 67%. Each ribbon (30µm of thickness) shall conform to 0.1/1.0/0.1 type according to MIL-DTL-81381. The insulation shall have a uniform cross-section throughout the length of the cable and the conductor shall be evenly centred in the insulation. The nominal wall thickness, including the polyimide protective coating, shall be 0.11mm.

*4.4.2.3 Insulation Colour*

The insulation colour is prescribed in relation to the wire size as shown in the table of Para. 4.4.7.

4.4.3 Assembly

A multicore cable shall be constructed by assembling the cores in a right-hand concentric lay. The length of lay shall not be less than 10, nor more than 14 times the maximum multicore assembly diameter as detailed in Table 1(a). A Teflon PTFE filler is necessary in the centre of the 4- and 5-core cables.

4.4.4 Shield

*4.4.4.1 Material*

Shield strands shall meet the requirements for silver-coated annealed copper as outlined in Para. 4.4.1.1 of this specification.

*4.4.4.2 Construction*

The shield shall be wound closely and helically around the strands and provide not less than 92% coverage, 'K' being calculated by the following formula:

$$K = \frac{n.d\sqrt{(L^2 + P^2)}}{P.L}$$

where:

- K = % coverage
- n = total number of shield strands
- d = mean shield strand diameter
- L = apparent shielding lay
- P = outside perimeter of the shielded cable

where:

- for a single core cable: $P = \pi(D + d)$
- for a multicore cable: $P = \pi(D + d) + xD$

where:

- D = mean diameter of core insulation
- x = the number of cores

**NOTE:** The shield may exhibit an occasional gap between strands provided that:

- the coverage coefficient meets the required value
- the gap width and gap length are no more than 0.5mm and 50mm respectively

4.4.5 Jacket

For single-core shielded cable:

- 2 Layers minimum of polyimide tape, type .1/1/.1 according to MIL-DTL-81381, coated with pigmented FEP before identification by coloured stripes on the outside.

or

- 2 layers minimum of polyimide tape type .1/1/.1 according to MIL-DTL-81381, with coloured stripes on the outside.

For multicore shielded cables:

- 1 Layer minimum of polyimide tape, type .1/1/.1 according to MIL-DTL-81381, plus 1 layer of coloured PTFE tape with coloured stripes on the outside.

or

- 2 layers minimum of polyimide tape type .1/1/.1 according to MIL-DTL-81381, with coloured stripes on the outside.

For multicore unshielded cable:

- 1 Layer minimum of polyimide tape, type .1/1/.1 according to MIL-DTL-81381, with coloured stripes on the outside.

4.4.6 Coloured Stripes

*4.4.6.1 Colour Identification*

Colour identification shall be as specified in Para. 4.4.7. Coloured stripes shall be helically applied on the jacket and grouped in accordance with the following rule:

- 1-core cable: 1 narrow stripe
- 2-core cable: 2 narrow stripes
- 3-core cable: 3 narrow stripes except AWG 28: no stripes
- 4-core cable: 1 wide stripe
- 5-core cable: 1 wide plus 1 narrow stripe

*4.4.6.2 Stripe Dimensions*

- Narrow stripe width: 0.6mm.
- Wide stripe width: 1.6mm.
- Space between stripes: 1mm.
- General tolerance: ±30%.

4.4.7 Colour Identification Code

The colour identification code for insulation, jacket and stripes shall be as specified in the following table.

**COLOUR IDENTIFICATON CODE**

| Wire Size (AWG) | Insulation Colour | Jacket Colour | | Colour of Stripes |
|---|---|---|---|---|
| | | Polyimide | PTFE or FEP Coating | |
| 28 | Brown | Amber | White | Brown |
| 26 | Black | Amber | White | Black |
| 24 | Khaki-beige (straw-like) | Amber | Light blue | White |
| 22 | Red | Amber | White | Red |
| 20 | Green | Amber | White | Green |
| 18 | Yellow | Amber | White | Yellow |

4.5 MARKING

4.5.1 General

The marking of all spools of finished wires and cables delivered to this specification shall be in accordance with the requirements of ESCC Basic Specification No. 21700. Each spool shall be marked in respect of:

(a) The ESCC Component Number.
(b) Characteristics.
(c) Traceability Information.
(d) Additional Markings.

4.5.2 The ESCC Component Number

Each spool shall bear the ESCC Component Number which shall be constituted and marked as follows:

Example: 390100244B

- Detail Specification Number: 3901002
- Type Variant (see Table 1(a)): 44
- Testing Level: B

4.5.3 Characteristics

The characteristics shall show the length(s) of finished wire or cable wound on each spool and shall be marked as follows:

Example: 100m

- Length in metres (see Note): 100
- Symbol for metres: m

**NOTE:** Whenever the length is less than 100 metres, insert a zero in the first block (example: 075m). If more than one length of finished wire or cable is wound on a spool, the characteristics of each length shall be marked as above.

4.5.4 Traceability Information

Each spool shall be marked in respect of traceability information in accordance with the requirements of ESCC Basic Specification No. 21700.

4.5.5 Additional Marking

Each spool shall bear the cable manufacturer's Quality Control Inspector's stamp or initials.

4.6 ELECTRICAL MEASUREMENTS

4.6.1 Electrical Measurements at Room Temperature

The parameters to be measured at room temperature are scheduled in Table 2. The measurements shall be performed at $T_{amb}$ = +22±3°C.

4.6.2 Electrical Measurements at High and Low Temperatures

Not applicable.

4.6.3 Circuits for Electrical Measurements

Not applicable.

4.7 BURN-IN TESTS

Not applicable.

4.8 ENVIRONMENTAL AND ENDURANCE TESTS

4.8.1 Mechanical Properties of Conductor

As detailed in Para. 4.4.1.1 of this Specification.

4.8.2 Accelerated Ageing

Ageing Temperature +230±5°C.

The mandrel diameter and appropriate weight used for accelerated age testing of the finished wires is given in Table A.

**TABLE A - MANDREL DIAMETERS AND LOADS FOR FINISHED WIRES**

| Wire Size (AWG) | Mandrel Diameter (mm) | Weight (kg) |
|---|---|---|
| 28 | 6.0 | 0.125 |
| 26 | 6.0 | 0.25 |
| 24 | 6.0 | 0.25 |
| 22 | 6.0 | 0.4 |
| 20 | 6.0 | 0.4 |
| 18 | 10 | 0.5 |

4.8.3 Wrap Test at Ambient Temperature

The mandrel diameters and applied loads for wrap testing of finished wires are given in Table A. The mandrel diameters and applied loads for screened and jacketed cables are given in Table B.

**TABLE B – MANDREL DIAMETERS AND LOADS FOR SHIELDED AND JACKETED CABLES**

| Cable Size (AWG) | Number of Cores | Mandrel Diameter (mm) | Load (kg) |
|---|---|---|---|
| 28 | 1 | 6.0 | 0.125 |
| 26 | 1 | 6.0 | 0.25 |
| 24 | 1 | 6.0 | 0.25 |
| 22 | 1 | 6.0 | 0.4 |
| 20 | 1 | 6.0 | 0.4 |
| 18 | 1 | 10 | 0.5 |
| 28 | 2 | 6.0 | 0.25 |
| 26 | 2 | 6.0 | 0.5 |
| 24 | 2 | 12 | 0.5 |
| 22 | 2 | 12 | 0.8 |
| 20 | 2 | 12 | 0.8 |
| 18 | 2 | 12 | 1.0 |
| 28 | 3 | 12 | 0.4 |
| 26 | 3 | 12 | 0.75 |
| 24 | 3 | 12 | 0.75 |
| 22 | 3 | 12 | 1.2 |

| Cable Size (AWG) | Number of Cores | Mandrel Diameter (mm) | Load (kg) |
|---|---|---|---|
| 20 | 3 | 12 | 1.2 |
| 18 | 3 | 12 | 1.5 |
| 28 | 4 | 12 | 0.5 |
| 26 | 4 | 12 | 1.0 |
| 24 | 4 | 12 | 1.0 |
| 22 | 4 | 12 | 1.6 |
| 20 | 4 | 12 | 1.6 |
| 28 | 5 | 12 | 0.7 |
| 26 | 5 | 12 | 1.2 |

4.8.4 Voltage Test
No particular conditions are applicable.

4.8.5 Shrinkage
The shrinkage temperature shall be +230±5°C

4.8.6 Blocking
The blocking temperature shall be +200±5°C.

4.8.7 Cold Bend Test
The mandrel diameters and loads shall be as specified in Table C.

**TABLE C – MANDREL DIAMETERS AND LOADS FOR FINISHED WIRES OR CORES**

| Wire Size (AWG) | Mandrel Diameter (mm) | Weight (kg) |
|---|---|---|
| 28 | 6.0 | 0.125 |
| 26 | 6.0 | 0.25 |
| 24 | 6.0 | 0.25 |
| 22 | 6.0 | 0.4 |
| 20 | 6.0 | 0.4 |
| 18 | 10 | 0.5 |

4.8.8 Cut-through Resistance

The mean load measured during the required tests shall not be less than the relevant value specified below:

| Wire Size (AWG) | 28 | 26 | 24 | 22 | 20 | 18 |
|---|---|---|---|---|---|---|
| Cut-through Load (kg) | 9 | 12 | 14 | 18 | 23 | 31 |

4.8.9 Notch Resistance

The depth of notch shall be 0.04 mm.

4.8.10 Flammability

No particular conditions are applicable.

4.8.11 Resistance to Fluids

Tests (e) and (f) shall not be performed.

4.8.12 Surface Resistance

No particular conditions are applicable.

4.8.13 Abrasion Resistance

The weight to be applied to the needle is specified below:

| Wire Size (AWG) | 28 | 26 | 24 | 22 | 20 | 18 |
|---|---|---|---|---|---|---|
| Scrape Abrasion Load (kg) | 350 | 450 | 500 | 600 | 650 | 750 |

4.8.14 Soldering

No particular conditions are applicable.

4.8.15 Solderability

No particular conditions are applicable.

4.8.16 Radiation Resistance

No particular conditions are applicable.

4.8.17 Overload Resistance

No particular conditions are applicable.

4.8.18 Long-term Ageing Test

The long-term ageing temperature shall be +200°C.

4.8.19 Anthony and Brown Test

No particular conditions are applicable.

**TABLE 2 - ELECTRICAL MEASUREMENTS AT ROOM TEMPERATURE**

| No. | Characteristics | Spec. and/or Test Method | Test Condition | Limits | Unit |
|---|---|---|---|---|---|
| 1 | Conductor Resistance | ESCC No. 3901, Section 9 | Para. 9.5 | Table 1(a) | Ω/km |
| 2 | Spark Test | ESCC No. 3901, Section 9 | Para. 9.6 | Insulation : 3<br>Jacket : 1.5 | kV |
| 3 | Voltage Test | ESCC No. 3901, Section 9 | Para. 9.7 | Para. 9.7 | kV |
| 4 | Insulation Resistance | ESCC No. 3901, Section 9 | Para. 9.8 | Insulation : 750<br>Jacket : 30 | MΩ.km |
| 5 | Surface Resistance | ESCC No. 3901, Section 9 | Para. 9.22 | : 125 | MΩ.mm |