POWER WIRES FOR CRIMPING, LOW FREQUENCY, 600V, -200 TO +200°C

BASED ON TYPE SPP

ESCC Detail Specification No. 3901/017

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1 GENERAL

1.1 SCOPE

This specification details the ratings, physical and electrical characteristics, test and inspection data for Power Wires for Crimping, Low Frequency, 600V, -200 to +200 °C, Based on Type SPP.

It shall be read in conjunction with ESCC Generic Specification No. 3901, the requirements of which are supplemented herein.

1.2 TYPE VARIANTS

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

1.3 MAXIMUM RATINGS

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

1.4 PARAMETER DERATING INFORMATION

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

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

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

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

  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.

1.5 PHYSICAL CHARACTERISTICS

The physical characteristics of the wires specified herein are shown in Figure 2 and Table 1(a).

1.6 FUNCTIONAL DIAGRAM

Not applicable.

TABLE 1(a) – TYPE VARIANTS

Variant No.	Wire Size AWG	Stranding No. of Strands × Diameter (mm)	Conductor Characteristics			Finished Wire Characteristics	
			Max Ø (mm)	Nom Sect. (mm^2)	Max Ohmic Resistance (Ω/km)	Max Ø (mm)	Max Weight (kg/km)
02	4	19×7×0.454RU	6.5	22	0.91	7.7	232
03	8	19×7×0.287RC	4.2	8.6	2.38	5.3	98

NOTES:
1. RC = rope lay; RU = rope unilay.

TABLE 1(b) – MAXIMUM RATINGS

No.	Characteristics	Symbol	Maximum Rating	Unit	Remarks
1	Voltage	V_P	600	V_{rms}	
2	Maximum Current (Note 1)	I_{max}	 45 81	A	For AWG: 8 4
3	Operating Temperature Range	T_{amb}	-200 to +200	°C	
4	Storage Temperature Range	T_{stg}	-200 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

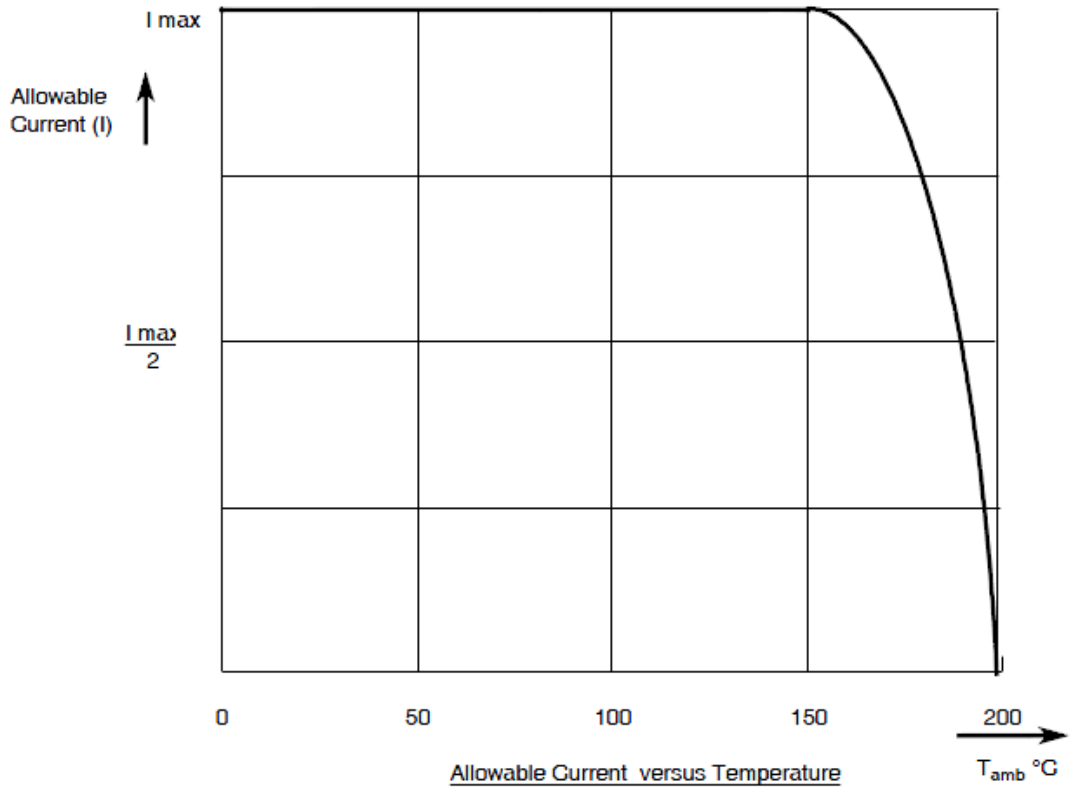
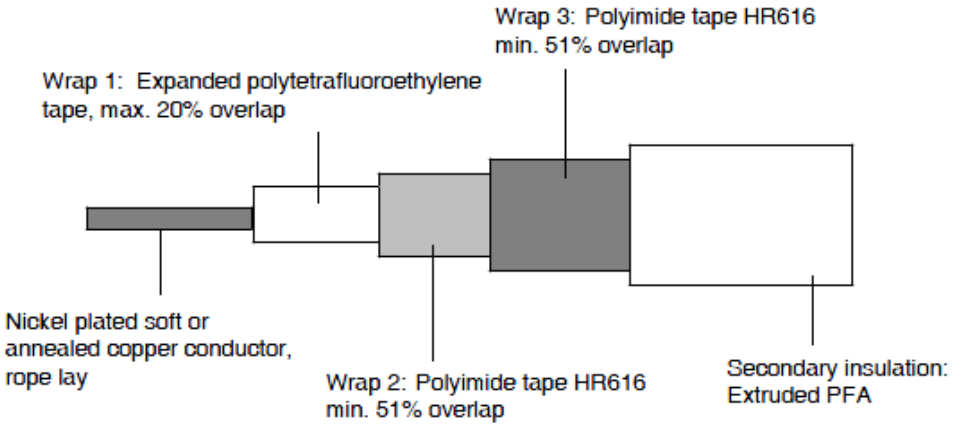


FIGURE 2 – PHYSICAL CHARACTERISTICS

Dimensions are given in Table 1(a)

FINISHED WIRES



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, Wires and Cables, Electrical, 600V, Low Frequency.
(b) ASTM-B355, Standard Specification for Nickel-Coated Soft or Annealed Copper Wire.

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 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)

(a) Para. 9.25, Solderability: Not applicable.

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. 9.15, Shrinkage shall be less than 5mm.
(b) Para. 9.24, Soldering: Not applicable.
(c) Para. 9.25, Solderability: Not applicable.
(d) Para. 9.10, Anthony & Brown test: Not applicable.
(e) Para. 9.12, Accelerated Ageing: Para. 9.12.2 is applicable.
(f) Para. 9.29, Long-term Ageing: test samples shall be aged as free coils (as per Para. 9.12.2).

4.2.5 Deviations from Lot Acceptance Tests (Chart V)

(a) Para. 9.24, Soldering: Not applicable.
(b) Para. 9.10, Anthony & Brown test: Not applicable.
(c) Para. 9.15, Shrinkage shall be less than 5mm.
(d) Para. 9.25, Solderability: Not applicable.
(e) Para. 9.12, Accelerated Ageing: Para. 9.12.2 is applicable.

4.3 MECHANICAL REQUIREMENTS

4.3.1 Dimension Check

The dimensions of the finished wires 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			
Gauge	X		
Insulation		X	
Jacket		X	
CONDUCTOR			
Nature			X
Outer diameter	X		
Number of strands	X		
Strand diameter	X		
Length of lay			X
Nickel thickness			X
INSULATION			
Composition		X	X
Thickness			X
Concentricity			X
Outer diameter	X		
Core identification			X

4.3.2 Weight

The maximum weight of the finished wires 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 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 nickel-plated oxygen-free copper. On nickel-plated strands, the thickness of the nickel shall be 1.2µm minimum.

On all nickel-plated copper conductors, any strand shall show a 10% minimum elongation.

4.4.1.2 Stranding

The conductors shall be rope lay as specified in Table 1(a). Strand and rope members shall be concentrically stranded using unilay concentric (commonly known as "unilay") or counter directional concentric (commonly known as "concentric") constructions.

Concentric stranding shall be defined as a central core surrounded by one or more layers of helically wound strands in a fixed round geometric arrangement.

In "unilay" constructions the successive layers have the same lay direction and lay length.

In "concentric" constructions the lay direction of successive layers are alternately reversed with increasing lay lengths.

The length of lay of the outer layer of stranded members forming the conductor shall be maximum:

- 77mm for AWG 4
- 51mm for AWG 8

In all cases the standard direction of lay of the outer layer is left hand.

4.4.2 Insulation

4.4.2.1 Material

The primary insulating material shall be polyimide over expanded polytetrafluoroethylene, both with only those additives that are necessary for processing.

The secondary insulation material shall be virgin perfluoralcoxycopolymer with only those additives that are necessary for processing and pigmentation.

4.4.2.2 Construction

The insulation shall have a uniform cross-section throughout the length of the wire and the conductor shall be evenly centred in the insulation.

The insulation shall consist of 1 wrapped layer of expanded polytetrafluoroethylene tape and 2 wrapped layers of polyimide tapes as specified in Figure 2.

4.4.3 Colour Coding

The colour of the finished wires shall be the following colours of the secondary insulation.

Colours:

- AWG 8: Red
- AWG 4: Yellow

4.5 MARKING

4.5.1 General

The marking of all spools of finished wires 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 qualified components symbol (for ESCC qualified components only).
(b) The ESCC Component Number (see Note 1).
(c) Traceability Information.
(d) Additional Marking.

NOTES:

1. Whenever more than one length of cable is wound on a single spool, the full marking for each length including the ESCC Component Numbers shall be marked on the spool. The characteristic code(s) for each length (see Para. 4.5.2.1(a)) may be marked separately on the spool.

4.5.2 The ESCC Component Number

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

Example: 390101702B100m

- Detail Specification Number: 3901017
- Component Type Variant Number (see Table 1(a)): 02 (as required)
- Testing Level (B is mandatory): B
- Characteristic Code: cable length: 100m (as required; see Para. 4.5.2.1(a))

4.5.2.1 Characteristics Codes

Characteristics to be codified as part of the ESCC Component Number shall be as follows:

(a) Cable Length:
The required length of the cable wound on each spool expressed by means of the following codes. The unit quantity shall be metre (m).

Nominal Length (m)	Code
X	00Xm
XX	0XXm
XXX	XXXm

4.5.3 Traceability Information

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

4.5.4 Additional Marking

Each spool shall bear the Manufacturer's Quality Control Inspector's stamp.

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.

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.

TABLE A – MANDREL DIAMETERS AND LOADS FOR FINISHED WIRES

Wire Size AWG	Mandrel Diameter (mm)	Applied Weight (kg)
4	75	1.8
8	50	1.3

(Table B is not applicable)

4.8.4 Voltage Test
No particular conditions are applicable.

4.8.5 Shrinkage
The shrinkage temperature shall be +200±5 °C. The shrinkage shall be according to Para. 4.2.4 of this specification.

4.8.6 Blocking
The blocking temperature shall be +230±5 °C. Cooling down to room temperature: 16 hours for AWG 4.

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

Wire Size AWG	Mandrel Diameter (mm)	Applied Weight (kg)
4	60	1.8
8	30	1.3

4.8.8 Cut-through Resistance
The mean load measured during 9 tests shall not be less than the relevant value specified below:

Wire Size AWG Requirements	4	8
Cut-through Load (N)	680	800

4.8.9 Notch Resistance
The depth of notch shall be 0.1mm.

4.8.10 Flammability Resistance
No particular conditions are applicable.

4.8.11 Resistance to Fluids
No particular conditions are applicable.

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 Requirements	4	8
Scrape Abrasion Load (N)	17	12

4.8.14 Soldering
Not applicable.

4.8.15 Solderability
Not applicable.

4.8.16 Radiation Resistance
No particular conditions are applicable.

4.8.17 Overload Resistance
No particular conditions are applicable.

4.8.18 Outgassing in Vacuum
No particular conditions are applicable.

4.8.19 Long-term Ageing Test
The long-term ageing temperature shall be +200±5°C.

4.8.20 Atomic Oxygen Resistance

The outer surface of the single insulated wires is resistant against atomic oxygen and shall be verified according to the requirements of the ESCC Executive.

TABLE 2 – ELECTRICAL MEASUREMENTS AT ROOM TEMPERATURE

No.	Characteristics	Specification and 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	3	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	750	MΩ.km
5	Surface Resistance	ESCC No. 3901, Section 9	Para. 9.22	125	MΩ.mm