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**CABLE, "SPACEWIRE", ROUND,
QUAD USING SYMMETRIC CABLES,
FLEXIBLE, -200 TO +180°C,**

ESCC Detail Specification No. 3902/003

**ISSUE 1
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1. GENERAL

1.1 SCOPE

This specification details the ratings, physical and electrical characteristics, test and inspection data for cable, "spacewire", round, quad using symmetric cables, flexible, -200 to +180 °C. It shall be read in conjunction with ESCC Generic Specification No.3902, the requirements of which are supplemented herein.

1.2 COMPONENT TYPE VARIANTS

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

1.3 MAXIMUM RATINGS

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

1.4 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:-

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

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

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 DIMENSIONS AND CHARACTERISTICS

The physical dimensions and characteristics of the datalines specified herein, are shown in Table 1(a) and Figure 2 respectively.

1.6 FUNCTIONAL DIAGRAM

Not applicable.



TABLE 1(a) - TYPE VARIANTS

| Variant | Z ₀ (Ω) | AWG | Inner Conductor | | | | Insul. Wire Max. ∅ (mm) | Filler ∅ (mm) | Shield | |
|---------|-----------------------|-----|----------------------------|----------------|----------------------------------|-----------------------------|-------------------------------|---------------------|---------|------------------|
| | | | No. of Strands x ∅ (mm) | Max. ∅ (mm) | Nom. Sect. (mm ²) | Max. d.c. Resist. (Ω/km) | | | Constr. | Strand ∅ (mm) |
| 01 | 100 | 28 | 7x0.126 | 0.39 | 0.089 | 256 | 1.2 | 1.0 | BS | 0.079 |

| Symmetric Cable Characteristics | | Filler RC | Binder RC | Outer Shield | | Round Cable Characteristics | | Bend Radius |
|---------------------------------|------------------------|-----------|----------------|--------------|------------------|-----------------------------|------------------------|--------------|
| Max. ∅ (mm) | Max. Weight (kg/km) | ∅ (mm) | Nom. ∅ (mm) | Constr. | Strand ∅ (mm) | Max. ∅ (mm) | Max. Weight (kg/km) | Min. (mm) |
| 2.7 | 12 | 1.0 | 0.004 | BS | 0.102 | 7.5 | 85 | 45 |

TABLE 1(b) - MAXIMUM RATINGS

| No. | Characteristics | Symbol | Maximum Ratings | Unit | Remarks |
|-----|--------------------------------|------------------|-----------------|------------------|-------------------------|
| 1 | Operating Voltage (Continuous) | V _{op} | 200 | V _{rms} | - |
| 2 | Current | I | 1.5 | A | |
| 3 | Operating Frequency | f _M | 400 100 | MHz Mbit/sec | 10 metres. Assembly |
| 4 | Operating Temperature Range | T _{op} | - 200 to + 180 | °C | T _{amb} Note 1 |
| 5 | Storage Temperature Range | T _{stg} | - 200 to + 180 | °C | - |
| 6 | Soldering Temperature | T _{sol} | + 250 | °C | Note 2 |

NOTES

1. Precautions shall be taken such that the aggregate temperature of the datalines (ambient plus rise), due to power dissipation, does not exceed the maximum operating temperature.
2. For 5 seconds maximum.

FIGURE 1 - PARAMETER DERATING INFORMATION

FIGURE 1(a) - ALLOWABLE CURRENT VERSUS TEMPERATURE

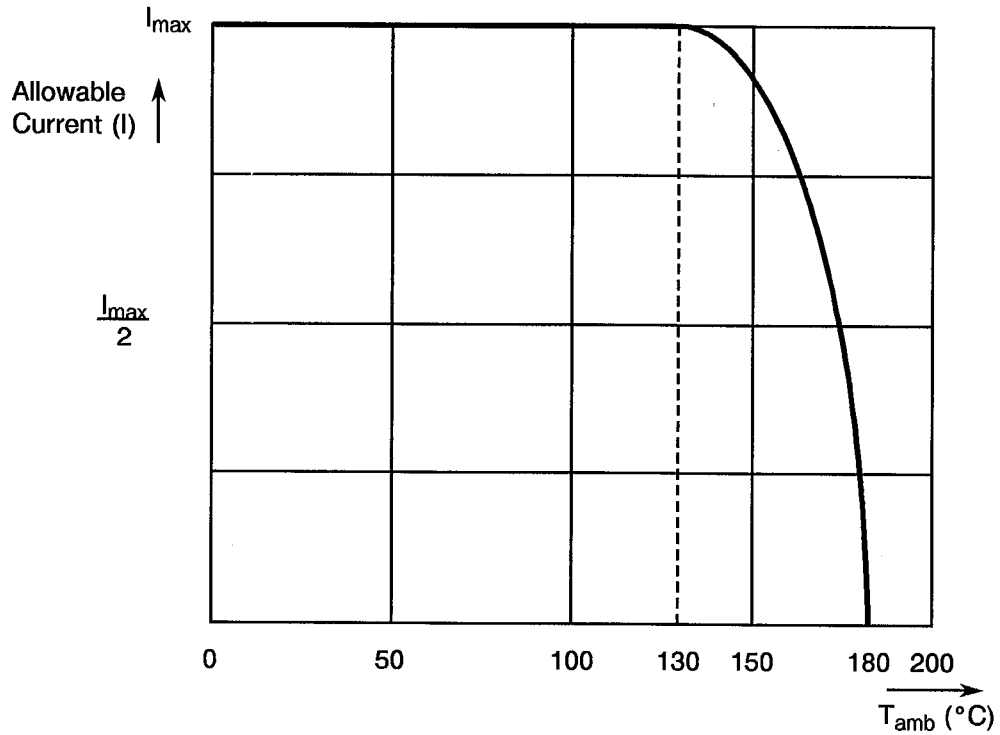


FIGURE 1(b) - MINIMUM SHIELDING EFFECTIVENESS

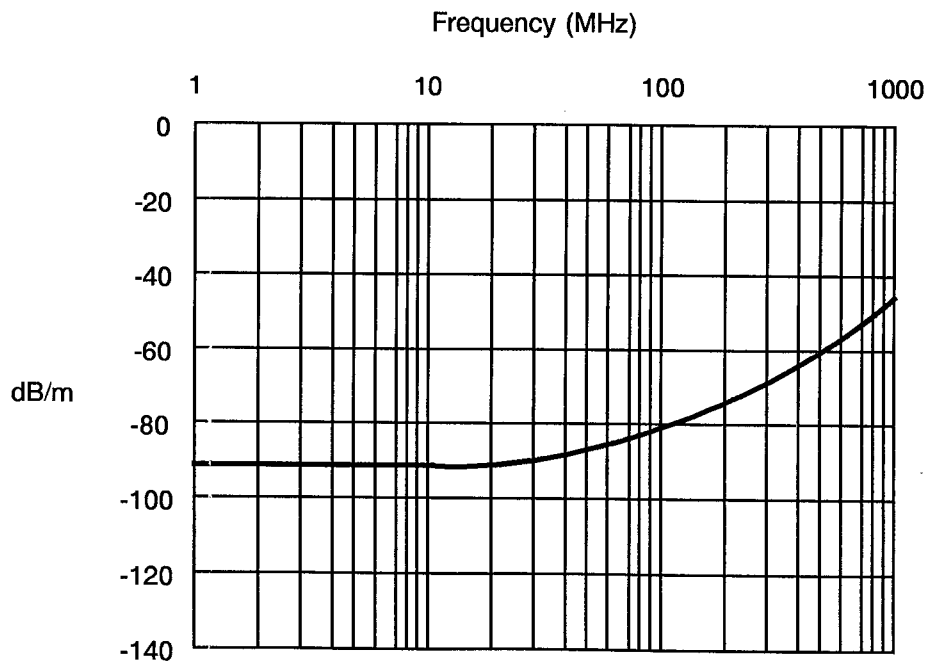
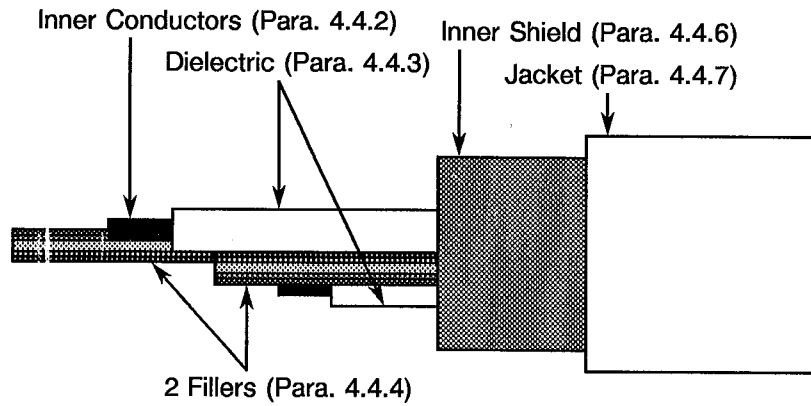


FIGURE 2 - PHYSICAL CHARACTERISTICS

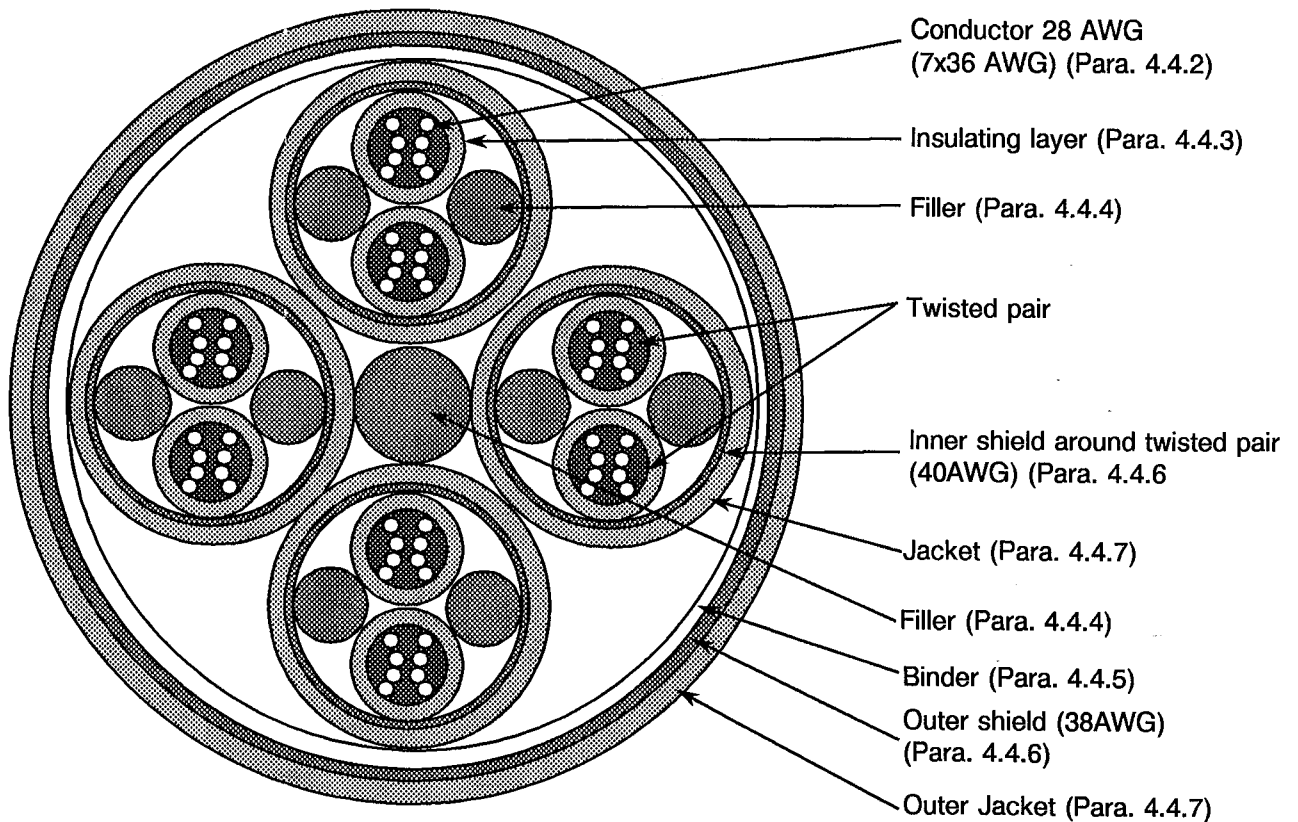
FIGURE 2(a) - SINGLE SYMMETRIC CABLE




NOTES

1. See Table 1(a) for dimensions.

FIGURE 2(b) - ROUND CABLE



| | | |
|--|---|--|
|  | <p style="text-align: center;">ESCC Detail Specification No. 3902/003</p> | <p style="text-align: right;">PAGE 9 ISSUE 1</p> |
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2. APPLICABLE DOCUMENTS

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

- (a) ESCC Generic Specification No. 3902, Cables, Coaxial, Radio Frequency, Flexible.
- (b) ESA PSS-01-301, Derating Requirements Applicable to Electronic, Electrical and Electro-Mechanical Components.
- (c) MIL-C-17, Cables, Radio Frequency, Flexible and Semirigid, General Specification for.
- (d) IEC Publication No. 96-1, Radio Frequency Cables, Part 1: General Requirements and Measuring Methods.

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. 3902 shall apply. In addition, the following definitions shall be used:-

- | | |
|------------------|-----------------------------|
| Cables | = Datalines (general term). |
| Symmetrical Type | = Balanced Shielded Lines. |
| BS | = Braided Shield. |
| RC | = Round Cable |

4. REQUIREMENTS

4.1 GENERAL

The complete requirements for procurement of the finished round cable specified herein shall be as stated in this specification and ESCC Generic Specification No. 3902. Deviations from the Generic Specification, applicable to this Detail Specification only, are listed in Para. 4.2.

Deviations from the applicable Generic Specifications 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.

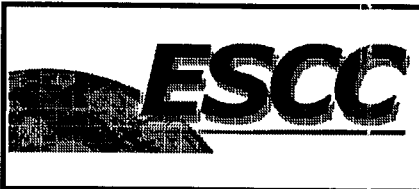
4.2 DEVIATIONS FROM GENERIC SPECIFICATION

4.2.1 Deviations from Special In-process Controls

- (a) Para. 5.3.1, Insulation Flaws (Spark Test): Shall be performed using 1.4kV at 3.0kHz

4.2.2 Deviations from Final Production Tests (Chart II)

- (a) Para. 9.7, Voltage Test: To be performed in accordance with Para. 4.8.13 of this specification.
- (b) Para. 9.10, Characteristic Impedance: To be performed in accordance with Para. 4.8.14 of this specification.
- (c) Para. 9.11, Attenuation: Shall not be performed.
- (d) Para. 9.12, Structural Return Loss: Shall not be performed.



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

None.

4.2.4 Deviations from Qualification Tests (Chart IV)

- (a) Para. 9.7, Voltage Test: To be performed in accordance with Para. 4.8.13 of this specification.
- (b) Para. 9.10, Characteristic Impedance: To be performed in accordance with Para. 4.8.14 of this specification.
- (c) Para. 9.11, Attenuation: Shall not be performed.
- (d) Para. 9.12, Structural Return Loss: Shall not be performed.
- (e) Shielding Effectiveness: Shall be performed in accordance with Para. 4.8.17 of this specification at any point in Chart IV.

4.2.5 Deviations from Lot Acceptance Tests (Chart V)

- (a) Para. 9.11, Attenuation: Shall not be performed.
- (b) Para. 9.12, Structural Return Loss: Shall not be performed.

4.3 MECHANICAL REQUIREMENTS

4.3.1 Dimension Check

The dimensions of the datalines 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 the Table following for list of parameters to be checked).

4.3.2 Weight

The maximum weight of the datalines specified herein shall be measured in accordance with Para. 9.2 of ESCC Generic Specification No. 3902 and shall be as specified in Table 1(a) of this specification.

4.3.3 Adhesion of the Inner Conductor

Minimum stripping force: 1.0N.

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 components 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 Construction of Round Cable

4.4.1.1 Generic Construction

The round cable with symmetric cables consists of four impedance controlled datalines with an overall shield and jacket. The datalines are constructed such that two conductors, each evenly centred within a dielectric, are twisted together with two fillers and then covered by a shield and jacket in accordance with Figure 2(a).

LIST OF PARAMETERS TO BE CHECKED

| PARAMETER | TABLE 1(a) | FIGURE 2 | PARA. 4.4 |
|-------------------------------|------------|----------|-----------|
| <u>COMPOSITION</u> | | | |
| Conductor Gauge | X | | |
| Number of Conductors | X | | |
| Shielding | X | | |
| Number of Shields and Type | | X | |
| Jacket | | | X |
| <u>INNER CONDUCTOR</u> | | | |
| Nature | | | X |
| Outer Diameter | X | | |
| Number of Strands | X | | |
| Strand Diameter | X | | |
| Silver Thickness | | | X |
| Length of Lay | | | X |
| <u>DIELECTRIC CORE</u> | | | |
| Composition | | X | X |
| Nature | | | X |
| Thickness | X | | |
| Concentricity | | | X |
| Outer Diameter | X | | |
| <u>SHIELDING</u> | | | |
| Number of Strands | | | X |
| Type of Shielding | | | X |
| Strand Diameter | X | | |
| Tape Thickness | | | X |
| Tape Overlap | | | X |
| Silver Thickness | | | X |
| Shielding Lay | | | X |
| Shield Coverage | | | X |
| <u>FILLER</u> | | | |
| Nature | | X | X |
| Outer Diameter | X | | |
| <u>BINDER</u> | | | |
| Nature | | X | X |
| <u>JACKET</u> | | | |
| Composition | | | X |
| Thickness | | | X |
| Outer Diameter | X | | |



4.4.1.2 Lay Length of Symmetric Cables

The lay length of all symmetric cables twisted together shall not be less than 12 times and not more than 16 times the outside diameter of the unshielded and unjacketed cable. This requirement will lead to the following lay length and/or twist per metre respectively.

| Lay Length (mm) | | Twists/Metre | |
|-----------------|------|--------------|------|
| Min. | Max. | Min. | Max. |
| 24 | 32 | 32 | 41 |

4.4.1.3 Lay Length of the complete Cable

Four sets of symmetric cables twisted together shall not be less than 12 times and not more than 16 times the outside diameter of two symmetric cables. This construction shall be the core to be covered by a binder and a braided shield, i.e. outer conductor. This construction is then covered by an outermost jacket in accordance with Figure 2(b).

| Lay Length (mm) | |
|-----------------|------|
| Min. | Max. |
| 57 | 77 |

4.4.2 Inner Conductor

4.4.2.1 Material Characteristics

All strands used in the manufacture of the conductor shall be silver-coated high strength copper alloy.

On silver-coated strands, the thickness of silver shall be 2.0µm minimum.

For high strength copper alloy conductors, the tensile characteristics shall be not less than 6.0% in elongation and 35kg/mm² in tensile strength.

For determination of the conductor resistance at +20°C, as mentioned in Para. 9.5 of ESCC Generic Specification No. 3902, the α coefficient for copper alloy is 0.0035.

4.4.2.2 Stranding

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

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



4.4.3 Dielectric

4.4.3.1 Material

Any dielectric material shall be virgin material, i.e. expanded, microporous PTFE or wrapped PTFE with only those additives that are necessary for processing and pigmentation.

| |
|----------------------------|
| Material |
| Expanded, microporous PTFE |

4.4.3.2 Construction

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

The nominal diameter of the dielectric shall be in accordance with Table 1(a).

4.4.4 Filler

Fillers shall be used so as to ensure a smooth and uniform diameter under the shielding in order to contribute to a uniform impedance over the length of the cable.

4.4.4.1 Material

The filler material as used for the symmetric cables shall be expanded, microporous PTFE with only those additives necessary for processing.

The filler material as used for the round cable shell shall be PTFE with only the additives necessary for processing.

4.4.4.2 Construction

The filler material shall be extruded or wrapped from tapes to the diameters as given in Table 1(a).

4.4.5 Binder

Applicable to completed round cable only.

Binders shall be used as appropriate over completed round cable core.

4.4.5.1 Material

The material shall be virgin, wrapped, expanded, microporous PTFE with only those additives necessary for processing.

4.4.5.2 Construction

The material shall be wrapped with an overlap of 50% maximum.

4.4.6 Shield

The terms "inner shield" and "outer shield" shall be used.

1 type of shield shall be used:-

(a) Braided Shield (BS).

4.4.6.1 Material Characteristics

All strands shall meet the requirements for silver-coated annealed copper as outlined in Para. 4.4.2.1 of this specification, but the thickness of silver shall be 2.5µm minimum.

Any strand shall show a 10% minimum elongation.

4.4.6.2 Construction

The strand size shall be as specified in Table 1(a) of this specification.

(a) Braided Shield

The braided shield type shall be of push-back type and provide not less than 90% coverage. The coverage factor K is calculated as follows:-

$$K = (2F - F^2)$$

$$F = \frac{N \times P \times d}{\sin \alpha}$$

$$\tan \alpha = 2\pi \frac{(D \times 2d) \times P}{C}$$

- K = coverage (%).
- N = number of strands.
- d = shield strand diameter (mm).
- α = angle of shield with cable axis in degrees.
- D = effective diameter of core under shield (mm).
- C = number of carriers.
- P = serving pitch/mm.

4.4.7 Jacket

The cable shall have jackets for each of the inner symmetric cables and an outer jacket for the complete round cable.

4.4.7.1 Material Characteristics

The material shall be a layer of extruded fluoropolymer PFA, with only those additives that are necessary for processing and pigmentation.

4.4.7.2 Construction

The PFA shall be extruded such that the construction underneath is centred evenly within the jacket. The wall thickness for the inner jackets shall be 0.15mm maximum, and for the outer jacket 0.25mm maximum.

4.4.8 Colours

The dielectric material, the fillers and the jackets shall be white.



4.5 MARKING

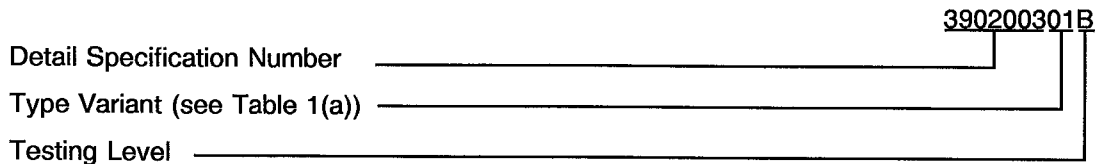
4.5.1 General

The marking of all spools of finished datalines 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 SCC Component Number.
- (b) Characteristics.
- (c) Traceability Information.
- (d) Additional Marking.

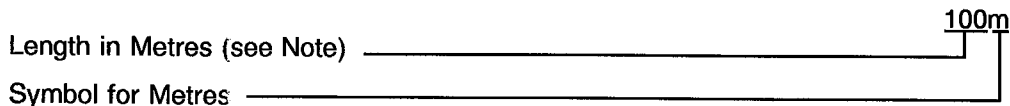
4.5.2 The SCC Component Number

Each component shall bear the SCC Component Number which shall be constituted and marked as follows:



4.5.3 Characteristics

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



N.B.

Whenever the length is less than 100 metres, insert a zero in the first block (example: 075m). If more than 1 length of finished round 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 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. Unless otherwise specified, the measurements shall be performed at $T_{amb} = +22 \pm 3$ °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 (CHARTS IV AND V OF ESCC GENERIC SPECIFICATION NO. 3902)**4.8.1 Mechanical Properties of Conductor**

As detailed in Paras. 4.4.2.1 and 4.4.6.1 of this specification.

4.8.2 Alternate Bending ResistanceThe applied weights and bending diameter for alternate bending resistance are given in Table A.
Number of cycles : 500 minimum.**TABLE A - ALTERNATE BENDING RESISTANCE, LOAD AND DIAMETER**

| Type | Z ₀ (Ω) | Weight (kg) | Bending Diameter (mm) |
|------|--------------------|-------------|-----------------------|
| RC | 100 | 1.3 | 70 |

4.8.3 Accelerated Ageing StabilityAgeing temperature : +200 ± 5 °C.
Shrinkage/Protrusion : See Table B.
Wrap Test : Mandrel diameters as per Table C.**TABLE B - SHRINKAGE/PROTRUSION**

| Type | Z ₀ (Ω) | Max. Shrinkage or Protrusion (mm) |
|------|--------------------|-----------------------------------|
| RC | 100 | 2.0 |

Maximum Capacitance Change : +7.0%.

4.8.4 Cold Bend TestChamber temperature : -80 ± 5 °C.
Mandrel diameter and load : See Table C.**TABLE C - COLD BEND TEST, MANDREL DIAMETERS AND LOADS**

| Type | Z ₀ (Ω) | Weight (kg) | Mandrel Diameter (mm) |
|------|--------------------|-------------|-----------------------|
| RC | 100 | 1.3 | 70 |

4.8.5 Solderability

No particular conditions are applicable.



4.8.6 Corona Extinction Voltage

As per Table 2.

4.8.7 Resistance to Fluids

No particular conditions are applicable.

4.8.8 Flammability Resistance

No particular conditions are applicable.

4.8.9 Radiation Resistance

- (a) Insulation Resistance : Shall stay within specified limits, see Table 2.
- (b) Voltage Test : Shall stay within specified limits, see Table 2.
- (c) Maximum Capacitance Change : + 7.0%.
- (d) Maximum Impedance Change : + 7.0%.
- (e) Corona extinction voltage : Shall stay within specified limits, see Table 2.

4.8.10 Outgassing

No particular conditions are applicable.

4.8.11 Long-term Ageing Test

Ageing temperature : + 180 ± 5 °C.

- (a) Insulation Resistance : Shall stay within specified limits, see Table 2.
- (b) Voltage Test : Shall stay within specified limits, see Table 2.
- (c) Maximum Capacitance Change : + 7.0%.
- (d) Maximum Impedance Change : + 7.0%.
- (e) Corona extinction voltage : Shall stay within specified limits, see Table 2.

4.8.12 Atomic Oxygen Resistance

The outer surface of the datalines is resistant against atomic oxygen and shall be verified in accordance with the requirements of the Qualifying Space Agency (Q.S.A.).

4.8.13 Voltage Test

The voltage test shall be performed in accordance with ESCC Generic Specification No. 3902, Para. 9.7, with the exception that the whole length of each produced lot shall be tested with the d.c. voltages specified in Table 2 for a minimum of 1 minute.

4.8.14 Characteristic Impedance

The characteristic impedance of all symmetric cables shall be measured according to MIL-C-17, Para. 4.8.7 using a time domain reflectometer (T.D.R.), with a symmetrical input/output. All measurements shall be performed on cables with a minimum length of 3.0 metres.

Impedance reference shall be defined before test.

4.8.15 Attenuation

Not applicable.

4.8.16 Structural Return Loss

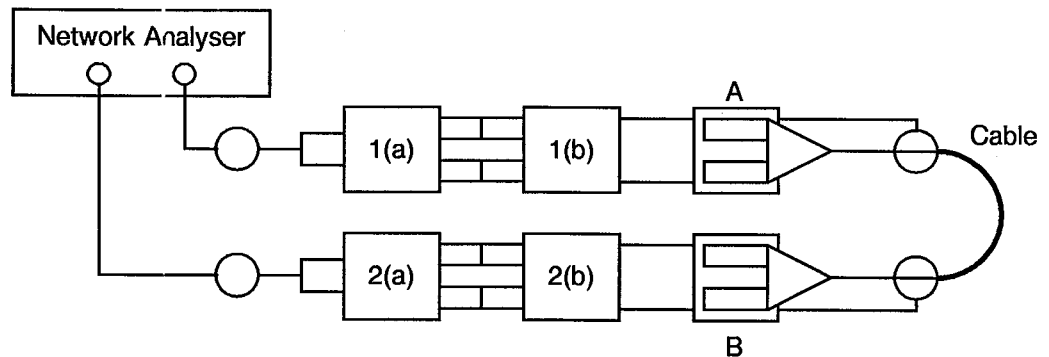
Not applicable.

4.8.17 Shielding Effectiveness

The shielding effectiveness of the cables shall be determined. Since the shielding effectiveness or transfer impedance respectively is a characteristic which is dependent only on constructional parameters, its performance shall be measured only once during qualification in accordance with IEC 96-1, 46 A 142 and Figure 1(b) of this specification.

4.8.18 Time Delay

The time delay of the balanced shielded lines shall be measured in accordance with Table 2 using a network analyser on a minimum length of 3.0 metres.



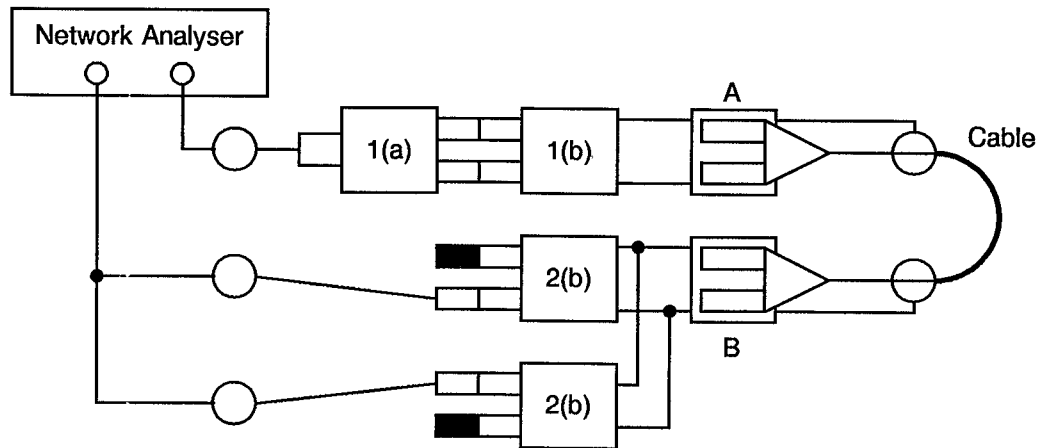
- 1(a) and 2(a) : Symmetrical Transformers ($1 \times 50\Omega$ to $2 \times 50\Omega$)
- 1(b) and 2(b) : Impedance Matching (50Ω to $75/100/120\Omega$)
- A and B : Clamp connection

A symmetrical 50Ω signal will be produced by the network analyser (0.3 - 3000 MHz), split into 2 symmetrical signals 1(a) and transformed to the desired impedance of the balanced shielded line under test 1(b). After the signal has passed the cable under measurement, the signal will be impedance matched to 50Ω 2(b) and retransformed to a single signal 2(a).

The specimen cable is connected to input and output A and B, and the time delay between input and output is measured and displayed by the network analyser.

4.8.19 Time Delay Conductor Difference

The time delay conductor difference of the balanced shielded lines shall be measured in accordance with Table 2 using a network analyser on a minimum length of 3.0 metres.



- 1(a) : Symmetrical Transformers ($1 \times 50\Omega$ to $2 \times 50\Omega$)
- 1(b) and 2(b) : Impedance Matching (50Ω to $75/100/120\Omega$)
- A and B : Clamp connection

A symmetrical 50Ω signal will be produced by the network analyser (0.3 - 3000 MHz), split into 2 symmetrical signals 1(a) and transformed to the desired impedance of the balanced shielded line under test 1(b). After the signal has passed 1 line of the symmetrical cable, connected to input A and output B, the signal will be impedance matched to 50Ω 2(b). The 1 open port of the impedance matching pad will be terminated by 50Ω .

This procedure shall be repeated for the second single line of the symmetrical cable, and both values shall be compared, with the conductor difference displayed by the network analyser.

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

| Type | ESCC Gen. Spec. No. 3902 | | | | | | |
|------|---|---|--|---|------------|--|--|
| | Para. 9.6 | Para. 9.6 | Para. 9.7 | Para. 9.9 | Para. 9.10 | Para. 9.20 | |
| | No. 1 | No. 2 | No. 3 | No. 4 | No. 5 | No. 6 | |
| | Characteristic Diel. Strength of Inner Jacket (kVac) | Characteristic Diel. Strength of Outer Jacket (kVac) | Characteristic Voltage Test (Diel. Core) (kVdc) | Characteristic Capacitance (Max.) (pF/m) | | Characteristic Impedance (Ω) | Characteristic Corona Extinction Voltage (Vac) |
| | | | Cond. - Cond. | Cond. - Shield | | | |
| RC | 1.5 | 2.0 | 1.4 | 50 | 90 | 100 ± 6 | 500 |

| No. | Characteristic | ESCC Gen. 3902 | This Specification | Limits |
|-----|----------------------------|-------------------|-----------------------|-----------------|
| 7 | Inner Conductor Resistance | Para. 9.5 | - | See Table 1(a) |
| 8 | Insulation Resistance | Para. 9.8 | - | 5000MΩ × km |
| 9 | Shielding Effectiveness | - | Para. 4.8.17 | See Figure 1(b) |

SYMMETRIC CABLES

| This Specification | | |
|--|---|---|
| Para. 4.8.18 | Para. 4.8.19 | Para. 4.8.19 |
| No. 10 | No. 11 | No. 12 |
| Characteristic Time Delay (Max.) (nsec/m) | Characteristic Conductor Time Delay Difference (Max.) (nsec/m) Per Pair | Characteristic Conductor Time Delay Difference (Max.) (nsec/m) Pair to Pair |
| 4.3 | 0.08 | 0.13 |

| | | | |
|--|---|--|----------------------------|
|  | <p>ESCC Detail Specification No. 3902/003</p> | | <p>PAGE 21 ISSUE 1</p> |
|--|---|--|----------------------------|

APPENDIX 'A'

AGREED DEVIATIONS FOR W.L. GORE AND ASSOCIATES GmbH (D)

| ITEMS AFFECTED | DESCRIPTION OF DEVIATIONS |
|-------------------------------------|--|
| Para. 4.2.2 | Para. 9.14, Anthony and Brown Test: May be performed as the last test in Chart II. |
| Paras. 4.4.3.1, 4.4.4.1 and 4.4.5.1 | Expanded microporous PTFE tape shall be GORE-TEX®. |

NOTES

1. GORE-TEX® = Registered Trade Mark of Gore.