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1. Scope

- 1) This document defines wire materials and wire types to be used for the cabling in between any low voltage, respectively low power devices and their correlated electrical feedthrough in applications like
 - magnet cryostats
 - cryogenic supply systems
 - cryogenic transport systems
 - cryogenic current lead boxes
 - auxiliary cryogenic systems within FAIR accelerators.
- 2) This document applies to low voltage, low power and low frequency applications only.
- 3) This document applies NOT to cabling for the use in cryostats which has to withstand a high radiation load.
- 4) This document is NOT related to any other purpose as aforementioned.

2. Definitions

- 1) A *low voltage application* shows a maximum operation voltage of $U_{max} \leq 60 \text{ V (DC)}$ respectively $U_{max} \leq 25 \text{ V (AC)}$ under any operation conditions.
- 2) A *low power application* shows a maximum operation power of $P_{max} \leq 0.1 \text{ W}$ under any conditions.
- 3) *Sensitive applications* in terms of this document are applications
 - where electromagnetic stray fields are inducing additional noise
 - where high measurement resolutions are required.



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3. Materials

3.1. Conductor Material Properties

- 1) The conductor material shall be made from Phosphor Bronze complying with the chemical composition (nominal): 94.8% Cu, 5% Sn, 0.2% P.
- 2) The physical properties of the material shall comply with the given typical values
 - Melting range 950 °C to 1050 °C
 - Coefficient of thermal expansion 1.78×10^{-5}
 - Electrical resistivity (annealed) 11 $\mu\Omega \cdot \text{cm}$ at 293 K
 - Electrical resistance
 - 8.56 Ω/m @ 4.2K
 - 8.83 Ω/m @ 77 K
 - 10.3 Ω/m @ 305 K
 - Specific heat 376.4 J/(kg*K)
 - Stress relief temperature (1 h): 150 °C to 225 °C
 - Thermal conductivity in W/m*K
 - 1.6 @ 4K
 - 4.6 @ 10K
 - 10 @ 20K
 - 25 @ 80K
 - 34 @ 150K
 - 48 @ 300K

3.2. Insulator Material

- 1) As insulator materials Vinyl Acetal Resin, respectively Polyimide shall be used, depended of the wire type.
- 2) The physical properties of the wire insulation shall comply with the given typical values
 - Insulation break down voltage
 - min. 250 VDC (for Vinyl Acetal Resin insulation)
 - min. 400 VDC (for Polyimide insulation)
 - Insulation thermal rating
 - min. 100°C (for Vinyl Acetal Resin insulation)
 - min. 220°C (for Polyimide insulation)



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3.3. Wire types

3.3.1. Wire configuration for sensitive applications

- 1) Wire for sensitive applications shall comply with the following properties
 - Wire configuration 2 twisted pairs of 4 single strands
 - Single strand 0.0127 mm² (diameter 0.127 mm)
 - Insulation material Vinyl Acetal Resin
 - Colour Code
 - single pair 1:
green and red
 - single pair 2:
green and orange
 - Twist pitch (single pair) 3.15 twists/cm (typical)
 - Twist pitch (double pair) 1.57 twists/cm (typical)
- 2) The materials Lakeshore Quad-Twist™ Cryogenic Wire QT-36 or equivalent in design, composition AND quality are approved for application.

3.3.2. Wire for non sensitive applications

- 1) Wire for non sensitive applications shall comply with the following properties
 - Wire configuration 4 parallel single strands bonded in plane
 - Single strand 0.0127 mm² (diameter 0.127 mm)
 - Insulation material Polyimide
 - Colour Code red, green, black, orange (in this sequence)
 - Bonding material Polyvinyl Butyral film
- 2) The materials Lakeshore Quad-Lead™ Cryogenic Wire QL-36 or equivalent in design, composition AND quality are approved for application.

4. Quality Documentation

- 1) An adequate certificate
 - stating the values for the defined properties
 - stating the error range within a production lot for defined properties
 - dated and accredited
 shall be delivered for each lot of material in use for production.

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