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INTERNATIONAL STANDARD

Coaxial communication cables –
Part 1-119: Electrical test methods – RF power rating

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FOREWORD

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International Standard IEC 61196-1-119 has been prepared by subcommittee 46A: Coaxial cables, of IEC technical committee 46: Cables, wires, waveguides, R.F. connectors, R.F. and microwave passive components and accessories.

The text of this standard is based on the following documents:

FDIS	Report on voting
46A/1094/FDIS	46A/1116/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts in the IEC 61196 series published under the general title *Coaxial communication cables* can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

COAXIAL COMMUNICATION CABLES –

Part 1-119: Electrical test methods – RF power rating

1 Scope

This part of IEC 61196 defines the requirements to determine the average power handling capability of a coaxial cable at specified frequencies at ambient temperatures.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61196-1, *Coaxial communication cables – Part 1: Generic specification – General, definitions and requirements*

IEC 61196-1-113, *Coaxial communication cables – Part 1-113: Electrical test methods – Test for attenuation constant*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61196-1, as well as the following apply.

3.1
RF power rating
maximum average input power that a cable can continuously handle when terminated in its characteristic impedance at a reference ambient temperature and RF frequency

Note 1 to entry: RF power rating is determined by the power level at which the temperature at any location in the cable does not exceed the allowable maximum temperature rating of the materials used in the cable's construction.

Note 2 to entry: Typically, the inner conductor temperature determines the maximum operating temperature.

Note 3 to entry: The test RF signal is a pure sinusoidal, without any modulation.

4 Symbols

For the purposes of this document, the following symbols apply.

K_i thermal constant of the insulation (W/(°C•m))

K_o thermal constant of outer sheath (W/(°C•m))

A attenuation constant associated with the conductors $\left(\frac{\text{dB}}{\text{m}\cdot\sqrt{\text{MHz}}}\right)$

A_i attenuation constant of inner conductor $\left(\frac{\text{dB}}{\text{m}\cdot\sqrt{\text{MHz}}}\right)$

A_o attenuation constant of outer conductor $\left(\frac{\text{dB}}{\text{m}\cdot\sqrt{\text{MHz}}}\right)$

B attenuation constant for the dielectric material $\left(\frac{\text{dB}}{\text{m}\cdot\text{MHz}}\right)$

a mean outer diameter of inner conductor (mm)

Corrugated: Mean = (peak + root)/2

Smooth wall = (max + min)/2

b mean inner diameter of outer conductor (mm)

Corrugated: Mean = (peak + root)/2

Smooth wall = (max + min)/2

C_i corrugation factor of inner conductor:

Ratio of the distance that compares the non-corrugated (conversion of corrugated length to an equivalent smooth wall length) to the cable corrugated length.

$C_i > 1$ for corrugated cable

$C_i = 1$ for smooth wall

C_o corrugation factor of outer conductor

Ratio of the distance that compares the non-corrugated (conversion of corrugated length to an equivalent smooth wall length) to the cable corrugated length.

$C_i > 1$ for corrugated cable

$C_i = 1$ for smooth wall

P_{in} RF input power (W)

P_r rated RF power (W) at frequency f

P_{rf1} rated RF power (W) at frequency f_1

P_{rf2} rated RF power (W) at frequency f_2

P_i power dissipated in inner conductor (W/m)

P_o power dissipated in outer conductor (W/m)

σ_i conductivity of inner conductor (relative to copper)

σ_o conductivity of outer conductor (relative to copper)

γ_i temperature coefficient of resistance for inner conductor

γ_o temperature coefficient of resistance for outer conductor

α_c attenuation of cable, at frequency f (dB/100 m)

α_{f1} attenuation of cable, at frequency f_1 (dB/100 m)

α_{f2} attenuation of cable, at frequency f_2 (dB/100 m)

α_i attenuation of inner conductor, at frequency f (dB/100 m)

α_o attenuation of outer conductor, at frequency f (dB/100 m)

T_i inner conductor temperature (°C)

T_o outer conductor temperature (°C)

T_a test ambient temperature (°C)

T_{ri} inner conductor temperature rise (°C)

T_{ro} outer conductor temperature rise (°C)

R_T maximum rated ambient temperature (°C)

5 Methodology

5.1 Method A

If a suitable RF power source is available, it is possible to determine the input power required for a conductor temperature to reach its limiting value (i.e. the average power rating), per 6.2. This provides measurements at one frequency and generally needs to be adjusted to other frequencies by knowing the RF cable attenuation.

5.2 Method B

Cables of large diameter, however, have high average power ratings, and a suitable RF source may not be available for such direct test. The following methodology allows the RF average power rating to be determined by using low frequency (50 Hz or 60 Hz) AC power to determine the required thermal characteristics. The low frequency AC data needs to be combined with RF data because the relative conductor power dissipations are different. Also there is no dissipation in the dielectric in the low frequency case, but at RF frequencies this becomes significant.

6 Temperature test

6.1 Procedure: General considerations

A cable of sufficient length shall be used so that the temperatures measured at the centre of the cable are not influenced by heat sinking effects at the ends of the cable.

Thermocouples should be chosen and sized to eliminate the possibility of heat sinking effects, particularly with thin walled cables.

There shall be sufficient air space around the cable under test to allow natural air circulation.

Temperature measurements on the inner and outer conductors shall be made at the centre of the cable length and 0,5 m away from both sides of the centre point.

Sufficient power should be applied for a conductor temperature to reach its maximum value, determined by the materials used in the cable construction.

The test is conducted for sufficient duration for the conductors to reach constant temperatures.

The measured results and determination of the average power rating are adjusted for an ambient temperature of 40 °C (or other specified ambient temperature).

6.2 Procedure: RF test – Method A

The input of the cable shall be connected to the RF power source capable of delivering the specified power at the specified test frequency at the load.

The load side of the cable shall be terminated in its characteristic impedance that is capable of handling the power.

The input power, P_{in}, at the test frequency shall be monitored.

It is recommended to drill a small hole into the cable just above the inner conductor. A fibre optic thermocouple should be placed within 1 mm above the surface of the inner conductor to measure the temperature.

The input power, at room temperature (T_a), shall be increased in stages until maximum component temperature ratings are reached. The conductor temperatures are allowed to stabilize at each stage and then recorded.

Each conductor temperature rise (T_{ri} and T_{ro}) at each stage above the room temperature (T_a) is determined for each input power level by subtracting the T_a from the measured conductors (T_i or T_o) temperature.

For each stage, T_i and T_o shall be determined for R_T by adding T_{ri} and T_{ro} to R_T.

Compare the recalculated T_i and T_o at R_T to the maximum temperature ratings of the cable components. The power rating is the level that does not exceed the maximum temperature ratings of the cable components.

The increase in conductor temperature above ambient temperature is determined for each input power level. The average power rating is that power which will cause an increase in conductor temperature above ambient equal to the difference between the maximum conductor temperature and the reference ambient (usually 40 °C).

6.3 Procedure: Low frequency power AC test – Method B

The input of the cable shall be connected to a 50 Hz or 60 Hz source capable of delivering sufficient current carrying capacity.

The opposite cable end shall be short circuited by connecting the inner conductor to the outer conductor.

Adjust the current levels to within 15 % of the maximum temperature ratings of the cable components.

The current, the voltages across both inner and outer conductors and the conductor temperatures (when they have stabilized) shall be measured and recorded. From the voltage and current values, the dissipated powers in the inner and outer conductors (P_i and P_o) are determined.

The thermal constants K_i and K_o are derived from the following equations:

$$P_i = K_i \times (T_i - T_o) \qquad (1)$$

$$P_i + P_o = K_o \times (T_o - T_a) \qquad (2)$$

7 Attenuation test

7.1 Conduct attenuation test

An attenuation test shall be conducted in accordance with IEC 61196-1-113 to determine the attenuation at a test ambient at several frequencies over the operating band of the cable. This attenuation response will be used to determine the coefficient for the conductors and dielectric which will then be used in the RF power calculations or used in determining RF power at other frequencies.

7.2 Calculate A and B coefficients – Method B

The A and B coefficients in Formula (3) are calculated by performing a least squares analysis, which is a fit of the measured attenuation and frequency data: