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INTERNATIONAL STANDARD

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Coaxial communication cables –
Part 1-119: Electrical test methods – RF power for coaxial cables and cable assemblies

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COAXIAL COMMUNICATION CABLES –

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FOREWORD

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

This third edition cancels and replaces the second edition published in 2020. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) complete technical revision;
b) extension to measure also cable assemblies.

The text of this International Standard is based on the following documents:

Draft	Report on voting
46A/1622/CDV	46A/1629/RVC

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all 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 document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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- withdrawn,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

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COAXIAL COMMUNICATION CABLES –

Part 1-119: Electrical test methods – RF power for coaxial cables and cable assemblies

1 Scope

This part of IEC 61196 provides test methods for RF power rating and power withstanding of RF coaxial cables and cable assemblies at specified frequency, temperature and altitude.

This document is applicable to RF coaxial cables and cable assemblies.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
power rating
input power at a specified frequency and normalized environmental conditions, which can be handled continuously without either the maximum permissible operating voltage, or maximum inner conductor temperature being exceeded, when the cable assembly is terminated by a load corresponding to the characteristic impedance

3.2
power withstanding
ability of RF coaxial cable and cable assembly to handle power specified in the relevant specification at the temperature, altitude and frequency as specified

3.3
average power
energy transfer rate of an RF coaxial cable and cable assembly averaged over many periods of the RF waveform at the specified frequency, temperature and altitude

3.4
peak power
maximum RF power P_{max} injected in a RF coaxial cable and cable assembly with a pulse duration τ over period T with the duty factor R at the specified temperature and altitude

Note 1 to entry: The relationship of duty factor, pulse duration and period is as shown in Figure 1 and expressed as Formula (1).

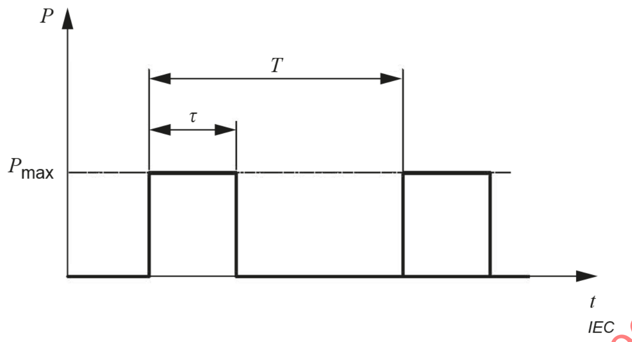

Figure 1 – Illustration of peak power

$$R = \frac{\tau}{T} \times 100\ (\%) \qquad (1)$$

where:

R is the duty factor, in %;

τ is the pulse duration, in s;

T is a period of pulse, in s.

3.5
continuous wave power
when duty factor R = 1 in Formula (1), the power curve in Figure 1 approximates a straight line

4 Preparation of test sample (TS)

4.1 Coaxial cable

Both ends of the coaxial cable should be terminated with suitable high-power RF coaxial connectors to make an RF cable assembly as a test sample (TS). The length of the cable should be long enough so that the heat dissipation caused by the connectors at both ends can be negligible. The selected connectors shall be suitable to connect to the test equipment directly. Their RF power rating shall be higher than the RF power of the coaxial cable to be tested.

For a test of average power and continuous wave power rating the temperature of the inner conductor of the TS shall be monitored.

a) Drill a small hole at the centre of the cable length and at least 0,5 m away from both sides of the TS so that a temperature sensor can be inserted to measure the temperature of the inner conductor.

b) Insert a temperature sensor (such as fibre optic temperature sensor) into the hole to measure the temperature T_i of the inner conductor.

If specified in the relevant specification the temperature of the inner conductor of the TS shall also be monitored as well for a power withstanding test. If the temperature rating of the dielectric and inner conductor is not a concern, the test can be conducted without monitoring the temperature of the inner conductor.

4.2 Cable assembly

Each cable assembly to be tested shall be a test sample (TS).

For a test of average power and continuous wave power rating the temperature of the inner conductor of the TS shall be monitored.

The TS shall be prepared as follows:

a) Drill a small hole at the centre of the cable length, and at both ends of connectors and also at both connections between the connector and the cable respectively so that a thermosensor can be inserted to measure the temperature of the inner conductor. If the least cross section of the connector is neither positioned at the end of the connector nor on the connection between connector and cable, drill also a hole on the position with the least cross section.
b) Insert a thermocouple (such as fibre optic temperature sensor) into each hole to measure the temperature T_{ix} of the inner conductor.

If specified in the relevant specification, the temperature of inner conductor of the TS shall also be monitored for a power withstanding test. If the temperature rating of the dielectric and inner conductor is not a concern, the test can be conducted without monitoring the temperature of the inner conductor.

5 Test conditions

The test shall be performed at stable conditions of temperature and atmospheric pressure.

a) Temperature stability:

   When the temperature variation of the test sample is not more than ±2 °C within 5 min, the temperature shall be considered stable.

   When using a test chamber, the temperature shall be considered stable when the temperature variation of the chamber and the test sample is no more than ±2 °C within 5 min.
b) Altitude stability:

   When the power rating is specified for a specific altitude, the altitude is considered stable when the pressure variation inside the low-pressure test chamber is within the range of ±5 % of the specified value within 10 min.

6 Test principle

A combination of power source, directional coupler, fixed attenuator (when required), power meter and load are used for the test, as shown in Figure 2. At the directional coupler, the incident power P_i is split between the coupled port P_f and the transmitted port that is connected to the TS. The reference power P_0 is measured by a power meter. If necessary, a fixed attenuator can be inserted between the directional coupler and power meter to adjust the power level to the test range of the power meter. A feed line may also be used. If a feed line is used, the input power of the test sample will be attenuated by the feed line. The TS is terminated with a load.

Since the coupling factor C (calculated from Formula (2)) of the coupler, attenuation value D (calculated from Formula (3)) of the fixed attenuator and the attenuation A of the feed line (if used) are fixed, the actual input power of the sample can be obtained from Formula (4).

$$C = 10\lg\frac{P_i}{P_f} \tag{2}$$

$$D = 10\lg\frac{P_f}{P_g} \tag{3}$$

$$P = P_o + D + C - A \tag{4}$$

where:

C coupling factor of the coupler, in dB;

P_i incident power to the coupler, in dB;

P_f power value at the coupled port, in dB;

D attenuation of the fixed attenuator, in dB;

P_g power value attenuated by the fixed attenuator, in dB;

P incident power value at the TS, in dB;

P_o reference power, in dB;

A attenuation of the feed line, in dB.

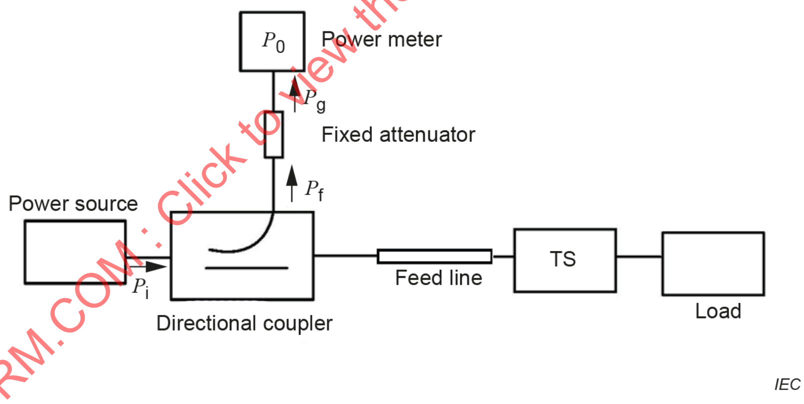

Figure 2 – Test principle

7 Test equipment

Test equipment is as follows:

a) Power source, directional coupler, fixed attenuator, power meter, high-power load or absorber. The rated power of the selected devices shall be more than 2 to 2,5 times of the maximum power measured, so as to prevent the devices from burning out due to overheating in case of non-steady power.

b) Temperature sensors to measure inner and outer conductor temperatures with sufficient sensitivity and an accuracy of ±1 °C.

c) Temperature–altitude test chamber (if applicable) meeting the test requirements as stated in the relevant specifications.

d) Test room to prevent air circulation, such as fans of the climatic cabinet. If necessary, the test room should fit into the climatic cabinet and be large enough so that the test items can be 20 cm (8 in) away from the walls of the test room.

e) Load with a voltage standing wave ratio (VSWR) of less than 1,2.

NOTE The VSWR of the load is an important factor as regards RF test results and the capability in the application, see Annex B for details.

8 Test procedure

8.1 Power withstanding

8.1.1 Average power/continuous wave power withstanding

8.1.1.1 Test procedure

The test procedure is as follows:

a) Connect the TS into the power test system as shown in Figure 2.

b) If specified in the relevant specification, for coaxial cables, use the temperature sensor to monitor inner conductor temperatures t_i in middle of the TS and record the temperature values t_i. For cable assemblies, use the temperature sensor to monitor inner conductor temperatures t_{ix} in the middle of the TS and at both ends of connectors and also at both connections between the connector and the cable respectively. Record the temperature values t_{ix}.

c) The TS shall be stored and stabilized at room temperature unless otherwise specified in the relevant specification. If the ambient temperature and/or altitude for the test are specified in the relevant specification, the TS shall be placed in a temperature and/or altitude test chamber for testing. The temperature and/or air pressure in the test chamber shall conform to the relevant specification and shall be monitored throughout the test.

d) Set test parameters of frequency and average power and continuous wave power. Start the test.

e) Keep the input power steady at that frequency for a duration as specified in the relevant specification. The temperature of the surface of the TS shall be monitored and recorded by a temperature sensor when required in the relevant specification.

f) If a frequency range is specified in the relevant specification, the maximum power shall be applied at the maximum frequency for 60 min after the temperature is stabilized.

g) If the above e) test conditions are not available, the test shall be carried out at high-frequency, middle-frequency and low-frequency points, respectively. Unless otherwise specified in the relevant specification, the high-frequency point selected in the test shall be within 10 % of the upper limit frequency of the sample, and the test duration shall not be less than 60 min. The middle-frequency point should be the approximate intermediate frequency in the frequency range, and the test duration should not be less than 20 min. The low-frequency point should be within 0,10 GHz at the lower end of the frequency range, and the test duration should not be less than 20 min.

h) The TS should be carefully observed during the test for evidence of breakdown and burning.

i) The TS shall be stored and stabilized at room temperature after the test. If specified, verify compliance to electrical specifications according to relevant standards.

8.1.1.2 Requirements

During the test, there shall be no breakdown and burning on the TS and, when specified, temperature rises of the TS and the test chamber shall comply with the relevant specifications.

8.1.1.3 Information to be given in the relevant specification

The following information shall be given in the relevant specification:

a) test conditions;
b) allowable temperature rise and position of temperature measurement;
c) test frequency and power;
d) test duration;
e) any variation from the test method of this document.

8.1.1.4 Test report

The test report shall include information such as the following:

a) test conditions;
b) test frequency and power;
c) test duration;
d) test equipment;
e) test sample number;
f) test results;
g) operator's name and test date.

8.1.2 Peak power withstanding

8.1.2.1 Test procedure

The test procedure is as follows:

a) Connect the TS into the power test system as shown in Figure 2.
b) The TS shall be stored and stabilized at room temperature unless otherwise specified in the relevant specification. If the ambient temperature and/or altitude for the test are specified in the relevant specification, the TS shall be placed in the temperature and/or altitude test chamber for testing. The temperature and/or air pressure in the test chamber shall conform to the relevant specification and shall be monitored throughout the test.
c) Set the test frequency, peak power, pulse duration, duty factor or period in accordance with the relevant specification and start the test. Unless otherwise specified in the relevant specification, the duration of the test shall not be less than 15 min. If specified in the relevant specification, the temperature of the surface of the TS should be monitored during the test.
d) The TS shall be carefully observed during the test for evidence of breakdown and burning.
e) The TS shall be stored and stabilized at room temperature after the test. If specified in the relevant specification, verify compliance to electrical specifications according to relevant standards.

8.1.2.2 Requirements

During the test there shall be no breakdown and no burning of the TS. The temperature rises of the TS and the test chamber (if specified) shall comply with the relevant specifications.

8.1.2.3 Information to be given in the relevant specification

The following information shall be given in the relevant specification:

a) test conditions;
b) test frequency and peak power;
c) duty factor, pulse width or cycle;
d) test duration;
e) any variation from the test method.

8.1.2.4 Test report

The test report shall include information such as the following:

a) test conditions;
b) test frequency and peak power;
c) duty factor, pulse duration or cycle;
d) test duration;
e) test equipment;
f) test sample number;
g) test results;
h) operator's name and test date.

8.2 Average power and continuous wave power rating

8.2.1 General

If a suitable RF power source is available, it is possible to determine the RF average power or continuous wave power rating at a specified frequency by increasing the input power until the temperature of the inner conductor reaches its maximum allowable temperature. This method is specified in 8.2.2.

Sometimes, the RF power source cannot cover all the frequency or the required power; in that case, conversion methods can be used as follows.

If a suitable RF power source is available, it is possible to determine the RF average power / continuous wave power rating at a specified frequency by increasing the input power incrementally until the temperature of the inner conductor reaches its maximum allowable temperature. This method is specified in 8.2.2.

Sometimes the RF power source cannot provide the required frequency or power. In that case, conversion methods can be used, such as the following.

a) If the RF average power/continuous wave power rating cannot be tested at the specified frequency directly, the power rating can be calculated from the test result obtained at another frequency by using the conversion per 8.2.3.
b) If there is no RF power source available that can make the temperature of the inner conductor reach its maximum allowable temperature t, but a temperature that is not more than 15 K below the maximum allowable temperature, the power rating can be extrapolated per 8.2.4. The average power ratings at different ambient temperatures from 15 °C to 40 °C can also be converted to each other per 8.2.4.
c) If no RF power source is available for large coaxial cables with very high RF average power ratings and the structure and materials of the cables are known, Annex A may be used to determine their RF average power/continuous wave power rating.

Annex A gives a low frequency (50 Hz or 60 Hz) AC power method to determine the cable's RF average power/continuous wave power rating at specified frequency. As the thermal characteristics of the cable (i.e., the thermal constants K_i and K_o) are independent of the frequency, they can be determined by low-frequency power tests. The thermal constants can be used for the RF average power rating calculation.

8.2.2 Test procedure

The test procedure is as follows:

a) Connect the TS into the power test system as shown in Figure 2.

b) For coaxial cables, use the temperature sensor to monitor the inner conductor temperature t_i in middle of the TS. Record the initial temperature value t_i when the temperature is stabilized.

c) For cable assemblies, use the temperature sensors to monitor the inner conductor temperatures t_{ix} in the middle of the TS, at both ends of connectors, and also at both connections between the connector and the cable respectively. Record the initial temperature values t_{ix} when the temperature is stabilized.

d) Set test frequency and average power/continuous wave power at a lower estimated value, and start the test.

e) Keep the input power steady as long as the temperatures stabilize and record temperature values t_i or t_{ix}.

f) Gradually increase the input power.

g) Repeat step e) and f) until any of the inner conductor temperatures t_i or t_{ix} reach the maximum allowable temperature of the inner conductor of the TS. The input power at this point is considered the power rating at this frequency. Record the power P and the inner conductor temperature T_i or t_{ix}.

h) During the test the TS should be carefully observed for evidence of breakdown and burning.

i) The TS shall be stored and stabilized at room temperature after the test. If specified in the relevant specification, verify compliance to electrical specifications according to the relevant standards.

j) If required by the relevant specification, the TS shall be placed in the temperature-altitude test chamber and tested from items b) to h) listed above. The test chamber shall be monitored for temperature and altitude during the test.

8.2.3 Conversion of average power rating at other frequencies

If the average power rating of an RF coaxial cable or a cable assembly is known at a certain frequency within the operating frequency range, the average power rating at another frequency can be calculated per Formula (5) and (6).

$$P_{\text{if}1} \times (1 - 10^{-\frac{\alpha_{f1}}{10}}) = P_{\text{if}2} \times (1 - 10^{-\frac{\alpha_{f2}}{10}}) \quad (5)$$

When α_{f1} ≤ 1 and α_{f2} ≤ 1, or $\left|\alpha_{f1} - \alpha_{f2}\right|$ ≤ 0,5 dB or ≤ 0,5 dB/m, Formula (5) can be simplified as Formula (6) as follows:

$$P_{\text{i}f1} \times \alpha_{f1} = P_{\text{i}f2} \times \alpha_{f2} \tag{6}$$

where:

α_{f1} is the insertion loss of the TS at frequency f_1, in dB;

α_{f2} is the insertion loss of the TS at frequency f_2, in dB;

$P_{\text{i}f1}$ is the average power rating at frequency f_1, in W;

$P_{\text{i}f2}$ is the average power rating at frequency f_2, in W.

8.2.4 Conversion of average power rating at different temperatures

Average power ratings at different ambient temperatures from 15 °C to 40 °C can be converted to each other. When a test at 40 °C standard ambient temperature is required in the relevant specification, the approximation of Formula (7) can be used to convert the average power rating at a certain environment temperature to the average power rating at 40 °C:

$$P = P_1 \left(\frac{t - T}{t_1 - T_1} \right)^{1{,}14} \tag{7}$$

where:

T_1 is the ambient temperature from 15 °C to 40 °C during test, in °C;

T is the standard ambient temperature (40 °C), in °C;

t_1 is the measured inner conductor temperature, from (t − 15) to t, in °C;

t is the maximum inner conductor temperature (as specified in the relevant specification);

P_1 is the input power measured under conditions t_1 and T_1, in W;

P is the power rating (at maximum allowable temperature), in W.

The conditions for Formula (7) are as follows:

a) Test environment temperature T_1 ranges from 15 °C to 40 °C;

b) For the test, the inner conductor temperature shall not be more than 15 °C below the maximum allowable temperature, ranging from (t − 15) to t.

8.2.5 Requirements

The rated power at the specified frequency shall comply with the relevant specification.

During the test, there shall be no breakdown or burning on the TS.

8.2.6 Information to be given in the relevant specification

The following information shall be given in the relevant specification:

a) test conditions;
b) test frequency;
c) the temperature of inner conductor;
d) the power rating;
e) conversion of average power rating;
f) any variation from the test method.

8.2.7 Test report

Test report shall include information such as the following:

a) test conditions;
b) test frequency;
c) the temperature of inner conductor and the power rating;
d) test equipment;
e) test sample number;
f) test results;
g) operator's name and test date.

Annex A
(informative)

Average power/continuous wave power rating – Low frequency power AC test

A.1 Test procedure

The test procedure is as follows:

a) Low frequency test and related calculation:

1) Connect the inner and outer conductors at one end of the cable under test to the two output ends of an AC current source (50 Hz or 60 Hz). The opposite cable end shall be short circuited by connecting the inner conductor to the outer conductor. Drill a small hole in the middle of the cable to the surface of the inner conductor so that a thermosensor can be inserted to measure the temperature of the inner conductor. Attach another thermosensor to the outer conductor of the TS. An arrangement of low-frequency power test equipment is shown in Figure A.1.

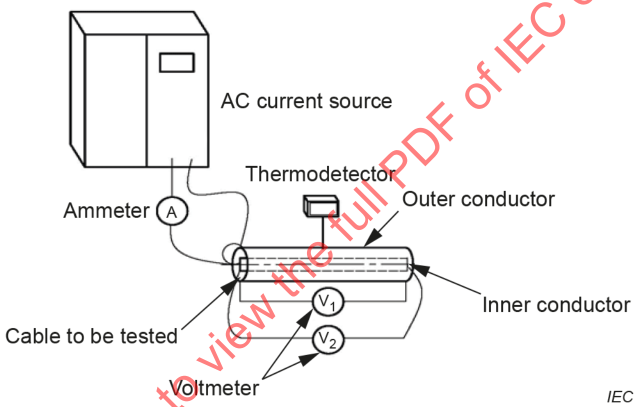

Figure A.1 – Arrangement of low-frequency power test equipment

2) Gradually increase the current until the temperature of the inner conductor reaches its maximum allowable temperature. Record the current and voltage on the inner and outer conductors, as well as the temperature T_i and T_o of the inner and outer conductors. The maximum allowable temperature of the inner conductor of the cable is determined by the materials of the cable insulation and sheath and shall be specified in the cable specification.

3) Calculate the power dissipation P_i and P_o on the inner and outer conductors of the cable by using Formulas (A.1) and (A.2).

$$P_{L\text{i}} = \frac{U_\text{i} I}{L} \tag{A.1}$$

$$P_{L\text{o}} = \frac{U_\text{o} I}{L} \tag{A.2}$$

where

U_i, U_o are the voltages at both ends of the inner and outer conductors respectively, in V;

I is the current, in A;

L is the cable length, in m;

P_{Li}, P_{Lo} are the power loss of the cable at low frequency, in W/m.

4) According to the temperature rises on the inner and outer conductors, the comprehensive thermal conductivity K_i and K_o of the medium around the inner conductor and the medium around the outer conductor can be calculated by Formula (A.3) and Formula (A.4):

$$P_{Li} = K_i\left(T_i - T_o\right) = \frac{U_i I}{L} \tag{A.3}$$

$$P_{Lo} + P_{Li} = K_o\left(T_o - T_a\right) = \frac{U_o I}{L} + \frac{U_i I}{L} \tag{A.4}$$

where

K_i and K_o are the comprehensive thermal conductivity of the medium surrounding the inner conductor and the outer conductor respectively, in W/(°C·m)

T_i, and T_o are the temperature of the inner and outer conductors respectively when the low-frequency power test is stable, in °C;

T_a is the ambient temperature during low-frequency power test, in °C.

NOTE For a certain cable structure, the medium surrounding the inner conductor and outer conductor is determined, and K_i and K_o are the inherent characteristics of the material itself and have nothing to do with frequency. Therefore, these values are unchanged in low frequency and radio frequency environments. K_i and K_o can be applied to the calculation of the radio frequency part.

b) RF attenuation test and related calculations

1) Terminate both ends of the coaxial cable with suitable RF connectors. Measure the attenuation with a vector network analyzer at different frequencies in accordance with IEC 61196-1-113.

2) according to the principle of transmission line, the attenuation of the cable at different frequencies is mainly composed of conductor attenuation and dielectric attenuation, which can be expressed by the equations listed in Formula (A.5):

$$\begin{cases} \alpha_1 = A\sqrt{f_1} + Bf_1 \\ \alpha_2 = A\sqrt{f_2} + Bf_2 \\ \alpha_i = A\sqrt{f_i} + Bf_i \end{cases} \tag{A.5}$$

where:

α_i is the attenuation constant of the cable at frequency f_i (i = 1, 2, 3,..., n), in dB/m;

f_i is the test frequency, in MHz;

A is the conductor attenuation coefficient, in dB·m^{-1}·MHz$^{-1/2}$;

B is the medium attenuation coefficient, in dB·m^{-1}·MHz^{-1}.

3) A and B can be solved from the above equations in Formula (A.5) by using Formula (A.6) and Formula (A.7), respectively:

$$A = \frac{\left[\left(\sum_{i=1}^{n} f_\mathrm{i} \times \sum_{i=1}^{n}\left(\frac{\alpha_\mathrm{i}}{\sqrt{f_\mathrm{i}}}\right)\right) - \left(\sum_{i=1}^{n}\sqrt{f_\mathrm{i}} \times \sum_{i=1}^{n}\alpha_\mathrm{i}\right)\right]}{\left[n \times \sum_{i=1}^{n} f_\mathrm{i} - \left(\sum_{i=1}^{n}\sqrt{f_\mathrm{i}}\right)^2\right]} \quad \text{(A.6)}$$

$$B = \frac{\left[n \times \sum_{i=1}^{n}\alpha_\mathrm{i} - \left(\sum_{i=1}^{n}\sqrt{f_\mathrm{i}} \times \sum_{i=1}^{n}\left(\frac{\alpha_i}{\sqrt{f_\mathrm{i}}}\right)\right)\right]}{\left[n \times \sum_{i=1}^{n} f_\mathrm{i} - \left(\sum_{i=1}^{n}\sqrt{f_\mathrm{i}}\right)^2\right]} \quad \text{(A.7)}$$

4) According to the transmission principle of the RF transmission line, the coefficient A in the attenuation Formula (A.5) is the attenuation caused by the cable conductor, including inner conductor and outer conductor. Thus, the attenuation coefficients of the inner and outer conductors can be obtained by decomposing the coefficient A by using Formula (A.8) according to the diameter and conductivity of the inner and outer conductors:

$$\begin{cases} A_\mathrm{i} = A \times \dfrac{\dfrac{C_\mathrm{i}}{a \times \sqrt{\sigma_\mathrm{i}}}}{\dfrac{C_\mathrm{i}}{a \times \sqrt{\sigma_\mathrm{i}}} + \dfrac{C_\mathrm{o}}{b \times \sqrt{\sigma_\mathrm{o}}}} \\[2ex] A_\mathrm{o} = A \times \dfrac{\dfrac{C_\mathrm{o}}{b \times \sqrt{\sigma_\mathrm{i}}}}{\dfrac{C_\mathrm{i}}{a \times \sqrt{\sigma_\mathrm{i}}} + \dfrac{C_\mathrm{o}}{b \times \sqrt{\sigma_\mathrm{o}}}} \end{cases} \quad \text{(A.8)}$$

where:

A_i and A_o are the attenuation coefficients of the inner and outer conductors respectively, in dB·m^{-1}·MHz$^{-1/2}$;

C_i and C_o are the structural coefficients of the inner and outer conductors respectively, which are equal to 1 for tubular conductors;

A and b are the equivalent diameter of the inner and outer conductors, in mm;

σ_i and σ_o are the relative conductivity of the inner and outer conductors relative to the copper conductor.

c) calculation of RF power rating

1) If the maximum rated power P_r is fed into the RF cable, the inner conductor reaches its maximum allowable temperature T_i, while the outer conductor reaches temperature T_o. The dissipation power of inner and outer conductor as well as the dielectric can be expressed by Formula (A.9), Formula (A.10) and Formula (A.11) respectively:

$$P_i = P_r \times A_i \times \sqrt{1+\gamma_i \times (T_i - 20)} \times \frac{\sqrt{f}}{4,343} \tag{A.9}$$

$$P_o = P_r \times A_o \times \sqrt{1+\gamma_o \times (T_o - 20)} \times \frac{\sqrt{f}}{4,343} \tag{A.10}$$

$$P_d = P_r \times f \times \frac{B}{4,343} \tag{A.11}$$

2) The temperature rise of the inner and outer conductors caused by the dissipated power of the inner conductor and the dissipated power of the medium under radio frequency can be expressed by Formula (A.12).

$$P_i + \frac{P_d}{2} = K_1 \times (T_i - T_o) \tag{A.12}$$

3) Under the specified frequency, the interaction of the inner conductor, dielectric and outer conductor causes temperature increase in the outer conductor, which can be expressed by Formula (A.13):

$$P_i + P_o + P_d = K_o \times (T_o - T_a) \tag{A.13}$$

where:

K_i and K_o	are the comprehensive thermal conductivity of the medium surrounding the inner conductor and the outer conductor respectively, in W/(°C·m);
A_i and A_o	are the attenuation coefficients of the inner and outer conductors respectively, in dB·m^{-1}·MHz$^{-1/2}$;
B	is the medium attenuation coefficient, in dB·m^{-1}·MHz^{-1};
γ_i and γ_o	is the temperature coefficient of the resistivity of the inner and outer conductor materials, for example, at 40 °C, for copper conductors, γ = 0,003 93, for aluminium conductors, γ = 0,004 07;
T_i	is the maximum allowable temperature of the inner conductor, in °C;
T_o	is the temperature of outer conductor, in °C;
T_a	is the ambient temperature, in °C.
f	is the specified frequency, in MHz;
P_r	is rated average power at the specified frequency f, in W;
P_i	is the dissipated power of the inner conductor, in W/m;
P_o	is the dissipated power of the outer conductor, in W/m;
P_d	is the dissipated power of the dielectric, in W/m.

In Formula (A.9) to Formula (A.13), P_r, P_i, P_o, P_d and T_o are unknown parameters and the following parameters are known:

K_i, K_o, A_i, A_o and B are parameters calculated according to above step a) and b);

γ_i and γ_o can be found in the cable design manual according to the material used in the cable;

T_a is the ambient temperature of the test given in the relevant specifications, for example 40 °C;

T_i is the maximum allowable temperature of the inner conductor specified in the relevant specifications;

f is the test frequency specified by the relevant specifications.

4) According to the five equations of Formula (A.9) to Formula (A.13), P_r and other unknown parameters can be solved and the P_r is the rated average power at the specified frequency f.

A.2 Symbols used in Annex A

For the purposes of this Annex A, 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: $a = (d_{peak,odic} + d_{root,odic})/2$

Smooth wall: $a = (d_{max.,odic} + d_{min.,odic})/2$

b mean inner diameter of outer conductor (mm)

Corrugated: $b = (d_{peak,idoc} + d_{root,idoc})/2$

Smooth wall: $b = (d_{max.,idoc} + d_{min.,idoc})/2$

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 average power (W) at frequency f

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

P_{rf2} rated RF average 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)