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INTERNATIONAL STANDARD

Coaxial communication cables –
Part 1-209: Environmental test methods – Thermal cycling

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International Standard IEC 61196-1-209 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/1298/FDIS	46A/1301/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 website 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- withdrawn,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 1-209: Environmental test methods – Thermal cycling

1 Scope

This part of IEC 61196 specifies a test method to determine the ability of a coaxial cable to withstand the effects of temperature cycling on its transmission performance.

The purpose of this procedure is to accelerate the effects of temperature cycling on a cable.

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 60068-2-14, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 62506, *Methods for product accelerated testing*

3 Terms and definitions

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

4 Symbols

ΔT difference between the upper and lower exposure temperature limits, in °C

ΔT_1 difference between the upper and lower operational temperature limits, in °C

ΔT_i temperature change difference other than ΔT_1, in °C

ζ_Test transition rate of temperature of the test, in °C/minute

A adjustment factor for the number of cycles for different transition temperature rates and exposure temperatures limits than standard conditions

A_tr adjustment factor for the number of cycles with regards to the transition rate

$A_{\Delta T}$ adjustment factor for the number of cycles with regards to the upper and lower exposure temperatures

5 Method

5.1 Thermal cycle profile method

The test shall be done in accordance with the IEC 60068-2-14 with a transition time of 2 °C/minute. The temperature exposure time should be at the upper and lower operational limits of cable (ΔT_1) as given in relevant cable specification, unless otherwise modified as described in 5.2.

A cycle shall consist of one complete exposure at upper and lower temperature test limits.

Twenty cycles should be conducted.

The time exposed at the upper and lower test temperatures shall be sufficient for the DUT to reach the specified temperature.

Mass and exposure times are given in Table 1.

Table 1 – Mass and exposure times

Mass of specimen/fixtures	**Exposure time** hr
≤ 30 g	¼
> 30 g to ≤ 150 g	½
> 150 g to ≤ 1,5 kg	1
> 1,5 kg to ≤ 7,5 kg	1,5
>7,5 kg to ≤ 15 kg	2
> 15 kg to ≤ 75 kg	3
> 75 kg to ≤ 150 kg	4
> 150 kg	8

5.2 Adjustment factors

5.2.1 General

The number of cycles should be adjusted when the transition rate and temperature change varies from 5.1 by the following:

$$N = 20 \times A_{tr} \times A_{\Delta T} \quad (1)$$

The calculation will most likely lead to a number that will not be an integer and therefore will contain a fraction of a complete cycle. Any fraction of a cycle should be adjusted to the next higher integer number.

5.2.2 Transition rate adjustment factor

The number of cycles should be adjusted to other transition rates according to equation (1) and (2).

$$A_{\text{tr}} = \left(\frac{2}{\varsigma_{\text{Test}}} \right)^{1/3} \tag{2}$$

The maximum adjustment factor should be limited to 4.

5.2.3 Upper and lower temperature exposure test adjustment factor

If different temperature exposure limits are used, the number of cycles should be adjusted as specified by the following.

$$A_{\Delta T} = \left(\frac{\Delta T_1}{\Delta T_i} \right)^{2,5} \tag{3}$$

5.3 Sample

Electrical and mechanical tests shall be done on a 50 m ± 5 m length unless otherwise specified. Each test shall require a minimum of one sample.

The samples shall be loosely coiled in the test chamber to ensure that adjacent windings have airspace between each coil, adjacent samples, and walls of the chamber.

The mechanical sample shall be cut flush at both ends.

Suitable connectors shall be attached for the electrical tests.

Tests that should be considered are: impedance, return loss, passive intermodulation distortion, contact resistance, etc.

5.4 Requirements

The mechanical test shall monitor dielectric and conductor movement. The criteria for acceptance shall be described in the detailed specification.

The RF performance characteristics shall be evaluated at the conclusion of the test and may be also evaluated at intervals during the test. The criteria for acceptance shall be specified in the detailed specification.

6 Test report

The test report shall include

- initial measurement;
- number of samples tested;
- sample length;
- connector used;
- test conditions
  - low temperature,
  - high temperature,
  - rate of temperature change,
  - number of cycles,
  - duration of cycle,
  - details of sample placement;
- final measurements and changes in results from the initial measurements;
- calculations made;
- deviations from the standard method.

Annex A
(informative)

Reliability acceleration factor

The effects of thermal cycling in use may be accelerated by increasing the temperature range and transition time from what is the normal operation. This is known as the acceleration factor A_{TC}.

$$A_{TC} = \left(\frac{\Delta T_1}{\Delta T_2} \right)^m \cdot \left(\frac{\varsigma_1}{\varsigma_2} \right)^{1/n} \tag{A.1}$$

where

ΔT_1 is the change in temperature that occurs in test 1;

ΔT_2 is the change in temperature that occurs in test 2 or actual change in usage;

ς_1 is the ramp speed in test that occurs in test 1;

ς_2 is the ramp speed that occurs in test 2 or actual ramp rate in usage;

m is a number for the difference between the exposure test limits and is determined by the component/material;

n is a number for the transition rate of temperature.

In actual use, the thermal cycle profile may not be consistent from day to day and therefore some approximation shall be used.

The m and n may be obtained from testing, field experience, data sources, etc.

Additional information can be obtained in IEC 62506.

Comments

If the acceleration factor is 25, which means 1 thermal cycle is equivalent to 25, thermal cycles of the base line model shall be used. If the baseline model is 1 day of use, an acceleration factor is equivalent to 25 days of use for each cycle.

Typically daily operational cycles are complex and more than one cycle occurs per day. It is typical practice to model these multiple cycles as one cycle to make the complications easy. However, one can use each mini-cycle and perform individual calculations.

The degree that acceleration can be achieved may be limited based on the temperature ratings of the materials used in the construction of the cable.

The m and n exponents can be determined form experimentation, however, when they are not known, a conservative number of 2,5 is used for m and 1/3 is used for n.

Example 1:

Perform a test on two 50 m cables with one having connectors on both ends and the other having its ends cut flush.

The operational temperature limits are: –50 °C and +70 °C.

The cable mass is of 1 kg per meter.

The standard test would be a lower exposure test temperature of –50 °C and an upper exposure test temperature of +70 °C. The transition time would be 1 h (120 °C/60 minutes or 2 °C/minute).

The DUT mass in the chamber is 100 kg and using Table 1, this would provide an exposure test duration of 4 h.

Example 2

The same test above, except that the test will be done at –50 °C at the lower exposure temperature and at +90 °C for the upper exposure temperature with a ramp rate of 1 °C per minute.

The transition rate adjustment factor from equation (2) is as follows:

$$A_{\mathrm{tr}} = \left(\frac{1}{2}\right)^{1/3} = 0{,}79 \tag{A.2}$$

The operational exposure temperature adjustment factor from equation (3) is as follows:

$$A_{\Delta T} = \left(\frac{140}{120}\right)^{2{,}5} = 1{,}47 \tag{A.3}$$

The adjustment factor is: $A_{\mathrm{tr}} \times A_{\Delta T}$ = 1,17 and the number of cycles could be reduced by 1,17.

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