IEC 61196-4

Edition 3.0 2015-09

INTERNATIONAL STANDARD

colour inside

Coaxial communication cables –
Part 4: Sectional specification for radiating cables

IEC 61196-4:2015-09(en)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue
The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org
The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
More than 60 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

IEC 61196-4

Edition 3.0 2015-09

INTERNATIONAL STANDARD

colour inside

Coaxial communication cables –
Part 4: Sectional specification for radiating cables

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.120.10

ISBN 978-2-8322-2892-0

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

COAXIAL COMMUNICATION CABLES –

Part 4: Sectional specification for radiating cables

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61196-4 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.

This third edition cancels and replaces the second edition published in 2004. This edition constitutes a technical revision.

The main changes with respect to the previous edition are as follows:

– a definition for coupling loss was added,
– Clause 4 "Materials and cable construction" was added,
– rated temperature range, operating frequency and radiating characteristics as standard rating and characteristics were added,
– identification, marking and labeling was added,

– the tables of test procedures were revised,
– quality assessment and packaging was added,
– Annex C, “Coupling loss around circumferential orientation of radiating cable” was added
– Annex D “Radiating intensity around circumferential orientation of radiating cable” was added.

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

FDIS	Report on voting
46A/1256/FDIS	46A/1273/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.

This publication is to be read in conjunction with IEC 61196-1:2005.

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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

COAXIAL COMMUNICATION CABLES –

Part 4: Sectional specification for radiating cables

1 Scope

This part of IEC 61196 applies to radiating coaxial communication cables. These cables are intended for use in wireless communication systems, such as tunnels, railways, highways, subways, elevators and other installations in which conventional antenna transmission is not satisfactory or even impossible.

It is to be read in conjunction with IEC 61196-1:2005.

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 60068-1:2013, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-61, *Environmental testing – Part 2-61: Test methods: Test Z/ABDM: Climatic sequence*

IEC 60332-1-2, *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame*

IEC TS 60695-7-50, *Fire hazard testing – Part 7-50: Toxicity of fire effluent – Estimation of toxic potency – Apparatus and test method*

IEC TS 60695-7-51, *Fire hazard testing – Part 7-51: Toxicity of fire effluent – Estimation of toxic potency: Calculation and interpretation of test results*

IEC 60754-1, *Test on gases evolved during combustion of materials from cables – Part 1: Determination of the halogen acid gas content*

IEC 60811-406, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 406: Miscellaneous tests – Resistance to stress cracking of polyethylene and polypropylene compounds*

IEC 61034-2:2005, *Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements*

IEC 61196-1:2005, *Coaxial communication cables – Part 1: Generic specification – General, definitions and requirements*

IEC 61196-1-1, *Coaxial communication cables – Part 1-1: Capability approval for coaxial cables*

IEC 61196-1-100, *Coaxial communication cables – Part 1-100: Electrical test methods – General requirements*

IEC 61196-1-101, *Coaxial communication cables – Part 1-101: Electrical test methods – Test for conductor d.c. resistance of cable*

IEC 61196-1-102, *Coaxial communication cables – Part 1-102: Electrical test methods – Test for insulation resistance of cable dielectric*

IEC 61196-1-103, *Coaxial communication cables – Part 1-103: Electrical test methods – Test for capacitance of cable*

IEC 61196-1-105, *Coaxial communication cables – Part 1-105: Electrical test methods – Test for withstand voltage of cable dielectric*

IEC 61196-1-106, *Coaxial communication cables – Part 1-106: Electrical test methods – Test for withstand voltage of cable sheath*

IEC 61196-1-108, *Coaxial communication cables – Part 1-108: Electrical test methods – Test for characteristic impedance, phase and group delay, electrical length and propagation velocity*

IEC 61196-1-112, *Coaxial communication cables – Part 1-112: Electrical test methods – Test for return loss (uniformity of impedance)*

IEC 61196-1-115, *Coaxial communication cables – Part 1-115: Electrical test methods – Test for regularity of impedance (pulse/step function return loss)*

IEC 61196-1-200, *Coaxial communication cables – Part 1-200: Environmental test methods – General requirements*

IEC 61196-1-201, *Environmental test methods – Part 1-201: Environmental test methods – Test for cold bend performance of cable*

IEC 61196-1-300, *Coaxial communication cables – Part 1-300: Mechanical test methods – General requirements*

IEC 61196-1-301, *Coaxial communication cables – Part 1-301: Mechanical test methods – Test for ovality*

IEC 61196-1-302, *Coaxial communication cables – Part 1-302: Mechanical test methods – Test for eccentricity*

IEC 61196-1-314:2006, *Coaxial communication cables – Part 1-314: Mechanical test methods – Test for bending*

IEC 61196-1-317, *Coaxial communication cables – Part 1-317: Mechanical test methods – Test for crush resistance of cable*

IEC TR 62222, *Fire performance of communication cables installed in buildings*

IEC 62230:2006, *Electric cables – Spark-test method*

3 Terms and definitions

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

3.1
radiating (coaxial) cable
coaxial communication cable with outer conductors that are intentionally not completely closed, so that part of the electromagnetic wave energy transmitted or received through the cable is coupled by a bidirectional transmission system formed by the outer conductor of the cable and the external environment

Note 1 to entry: The coupling intensity between cable and mobile equipment depends on:

– construction of the cable;
– characteristics of antenna (such as the type, the orientation, gain, etc.);
– distance and orientation of the mobile antenna from the cable;
– nature of ambient atmosphere;
– operating frequency range;
– manner of installation of the cable;
– shape, material and size of surrounding buildings.

3.2
coupling loss
L_c
ratio of the power P_t transmitted into the radiating cable at one point to the power P_r received by a half-wavelength dipole antenna located at a distance from the radiating cable at the same point (see formula 1)

Note 1 to entry: It is an important parameter of radiating coaxial cables to distinguish it from general coaxial communications cables.

$$L_c = 10 \log_{10} \frac{P_t}{P_r} \tag{1}$$

where

L_c is the coupling loss, in dB;
P_t is the transmission power in the radiating cable at one point, in W;
P_r is the receiving power of the half-wavelength dipole antenna at a distance from the radiating cable at the same point, in W.

4 Materials and cable construction

4.1 Cable construction

The cable construction shall be in accordance with 4.2 to 4.5 of this standard and the requirements stated in the detail specification.

4.2 Inner conductor

4.2.1 Conductor material

Subclauses 4.4.1 to 4.4.3 of IEC 61196-1:2005 apply.

The conductor material shall be as stated in the relevant cable detail specification.

4.2.2 Conductor construction

The conductor shall consist of a solid wire or corrugated or smooth tube, etc.

In addition, 4.4.4 of IEC 61196-1:2005 applies.

The inner conductor diameter (and thickness for smooth tube inner conductor) shall be stated in the detail specification.

For corrugated inner conductor, peak diameter and root diameter and pitch shall be specified in the detail specification.

The tolerance on the inner conductor shall be specified in the detail specification.

4.3 Dielectric

The dielectric material shall be as stated in the relevant cable detail specification.

The construction of the dielectric shall be one of the following:

– solid dielectric,
– air spaced dielectric,
– semi air spaced dielectric (e.g. cellular polymer dielectric).

The diameter and tolerance shall be stated in the detail specification.

4.4 Outer conductor

The outer conductor material shall be as stated in the relevant cable detail specification.

The typical structure of outer conductor shall be braiding with lower coverage, or slotted tape(s) rounding, or slotted corrugated tube, or slotted smooth tube, etc.

For corrugated outer conductor, peak diameter and root diameter and pitch shall be as specified in the detail specification.

The diameter and thickness of the outer conductor shall be specified in the detail specification.

The tolerance on the outer conductor shall be specified in the detail specification.

4.5 Sheath

The sheath of a cable shall be in accordance with Subclause 4.7 of IEC 61196-1:2005 with the following amendments and additions:

a) The outer sheath of the cable shall be as specified in the detail specification.
b) The diameter and thickness and tolerance of sheath shall be as stated in the detail specification.
c) For self-supporting cable, the cable design will be an 8-figure design including a messenger wire. The messenger wire position versus the coupling holes will be such that it favours the foreseen radiating pattern.
d) For cables intended for outdoor use or exposed to sunlight, the cable shall pass the UV stability test according to IEC specification. (A respective UV test procedure is under consideration.)
e) A non-conductive ribbon or tape under the sheath may be permitted.

5 Standard rating and characteristics

5.1 Nominal characteristic impedance

The nominal characteristic impedance shall be specified in the detail specification. Typical impedance should be 50 Ω and 75 Ω.

5.2 Rated temperature range

The operational, storage, and installation temperature range shall be specified in the detail specification.

5.3 Operating frequency

Operating frequency range shall be specified in the detail specification.

6 Identification, marking and labeling

6.1 Cable identification

Subclause 6.1 of IEC 61196-1:2005 applies.

6.2 Cable marking

The cable marking shall be applied to the sheath. The marking shall consist of the IEC cable type number as given in 6.1.1 of IEC 61196-1:2005 and/or the manufacturer's designated marking when specified in the detail specification.

When applicable, the marking of installation or radiating direction shall be specified in the detail specification.

6.3 Labelling

Labelling shall be provided in accordance with 6.3 of IEC 61196-1:2005 and the detail specification.

7 Tests of finished cables

7.1 General

When tested in accordance with the IEC 61196-1 series, the requirements given below shall apply.

Unless otherwise specified, all measurements shall be carried out under standard atmospheric conditions for testing in accordance with Clause 5 of IEC 60068-1:2013.

Applicable test methods shall be in accordance with the IEC 61196-1-100, IEC 61196-1-200, IEC 61196-1-300 series according to Clause 2 and other test methods specified herein.

7.2 Electrical testing of the finished cable (see Table 1)

Table 1 – Electrical testing

Subclause	Test procedure	Parameter	Requirements/Remarks
7.2.1	IEC 61196-1-110 (Under consideration)	Continuity	Inner conductor shall be continuous. Outer conductor shall be continuous.
7.2.2	IEC 61196-1-101	Inner and outer conductor direct current resistance	When required, value in accordance with the detail specification
7.2.3	IEC 61196-1-103	Test for capacitance	When required, value in accordance with the detail specification
7.2.4	IEC 61196-1-105	Withstand voltage of dielectric	Value in accordance with the detail specification
7.2.5	IEC 61196-1-106 (or IEC 62230)	Withstand voltage of sheath (or spark test)	Value in accordance with the detail specification
7.2.6	IEC 61196-1-102	Insulation resistance	Unless specified in detail specification,$\geq 10^4$ MΩ·km
7.2.7	IEC 61196-1-108	Mean characteristic impedance	Value in accordance with the detail specification
7.2.8	IEC 61196-1-112	Return loss	Value in accordance with the detail specification. Return loss shall be measured on an uncoiled cable (see Annex A).
7.2.9	Annex A	Attenuation constant	Value in accordance with the detail specification
7.2.9	Annex B	Coupling loss	Value in accordance with the detail specification
7.2.10	Annexes C and D	Radiating characteristics	In addition to the coupling loss specified in Annex B, when required, radiating characteristics may also be evaluated by testing the cable according to Annexes C and D, for assessing the radiating pattern.

7.3 Environmental testing (see Table 2)

Table 2 – Environmental testing

Subclause	Test procedure	Parameter	Requirements/remarks
7.3.1	IEC 61196-1-215 (Under consideration)	Ageing	Unless otherwise specified, the temperature value is: 200 °C ± 5 °C (FEP sheath) 98 °C ± 2 °C (PVC sheath) 90 °C ± 2 °C (LSZH and PE sheath) Duration:168 h or specified in detail specification. Requirements after ageing and cooling down to room temperature: a) No cracks in the elements of cable b) No black spots in the outer conductor
7.3.2	IEC 61196-1-201	Cold bend performance	No physical damages of conductors, dielectric and sheaths. The return loss shall remain within the specified limits in Table 1 after cable returns to room temperature.
7.3.3	IEC 60068-2-61	Climatic sequence – method 1	When required, CUT shall be specified in the detail specification T_A = minimum environmental rated temperature T_B = maximum environmental rated temperature t_1 = 16 h, unless otherwise specified in the detail specification. Humidity: 55 °C, 93 % RH 1 day (after cold and heat) No. of cycles: 2, unless otherwise specified in the detail specification. No physical damages shall be visible in the cable. The return loss shall remain within the specified limits in Table 1. Insulation resistance shall be within specified limits.
7.3.4	IEC 60811-406	Resistance to stress cracking	No physical damages shall be visible in the cable.

7.4 Mechanical testing (see Table 3)

Table 3 – Mechanical testing

No.	Test methods	Parameter	Requirements/remarks
7.4.1	IEC 61196-1:2005 Subclause 4.2	Visual examination	The sheath shall be free of cracks, splits, irregularities, and imbedded foreign material. The outer conductor shall be free of black spots or cracks.
7.4.2	IEC 61196-1:2005 Subclause 4.3	Dimensional examination	Value in accordance with the detail specification
7.4.3	IEC 61196-1-301	Ovality of inner conductor	When applicable, value in accordance with the detail specification
7.4.4	IEC 61196-1-301	Ovality of outer conductor	When applicable, value in accordance with the detail specification
7.4.5	IEC 61196-1-301	Ovality of dielectric	Value in accordance with the detail specification
7.4.6	IEC 61196-1-302	Eccentricity of dielectric	Value in accordance with the detail specification
7.4.7	IEC 61196-1-302	Eccentricity of sheath	When applicable, value in accordance with the detail specification
7.4.8	IEC 61196-1-314	Cable bending under tension	Clause 8 of IEC 61196-1-314 shall be used with the details specified herein or in the detail specification: 1) length of the cable and length bent under tension; 2) radius, R, of rollers / cylinders / mandrels; 3) distance, Y; 4) bending angle, grad; 5) moving speed; 6) number of moving cycles:1; 7) tensile load. Requirements: • The maximum impedance irregularity shall be within the specified limit (test procedure under study) [a] • No physical damage in cable elements
7.4.9	IEC 61196-1-317	Crush resistance of cable	When applicable, load shall be specified in the detail specification, applied for 2 min. After a 2 min recovery time, the maximum impedance irregularity shall be within the specified limit (test procedure under study). [a] No physical damage of the sheath or jacket.
[a] Test method according to IEC 61196-1-115 is not applicable for radiating cables. Radiating cables have apertures in the outer conductor which by default create impedance discontinuities. The level of impedance change caused by an aperture depends on its shape and size.			

7.5 Fire performance testing (see Table 4)

When intended to be installed in buildings, these cables may fall under the requirements of local, regional or governmental regulations for fire and safety standards.

When not subject to regulation, fire performance testing may be performed according Table 4.

Table 4 – Fire performance testing

Subclause	Test procedure	Parameter	Requirements/Remarks
7.5.1	IEC 60332-1-2	Flame propagation	When required, according to the detail specification
7.5.2	IEC 60754-1	Halogen acid gas emission	When required, according to the detail specification
7.5.3	IEC TS 60695-7-50 IEC TS 60695-7-51	Toxic gas emission	When required, according to the detail specification
7.5.4	IEC 61034-2	Smoke density	When required, according to the detail specification

NOTE For more information on fire performance testing, refer to IEC TR 62222.

8 Quality assessment

When specified in the detail specifications, capability approval shall be in accordance with IEC 61196-1-1.

9 Delivery and storage

Delivery of cables shall be in accordance with Clause 9 of IEC 61196-1:2005.

Annex A
(normative)

Attenuation constant

A.1 Procedure

A.1.1 General

Measurements can be carried out by one of the two methods, where the free-space method shall be the arbitration method when there is an argument:

– ground-level method;
– free-space method.

A.1.2 Ground-level method

The arrangement of the cable is given in Figure A.1. The cable is laid on non-metallic spacers which gives the cable a distance from the concrete floor of 10 cm to 12 cm.

The cable shall be at least of the length 10 λ, where λ is the cable wavelength of the measuring frequency, but not shorter than 50 m.

A.1.3 Free-space method

The arrangement of the cable is given in Figure A.2. The cable is laid on non-metallic posts at a height of 1,5 m to 2 m.

The cable shall be at least of the length 10 λ, where λ is the cable wavelength of the measuring frequency, but not shorter than 50 m.

A.2 Measurement (see Figures A.1 and A.2)

Adjust the signal generator frequency and record the output power level with a spectrum analyser or equivalent. If the source is built into the measurement device, a cable of known attenuation can be used to connect the far end of the cable (output port B).

Feed the signal to port A of the cable and record the power level at port B.

The nominal characteristic impedance of the cable shall be matched to the nominal impedance of the test set-up.

A.3 Evaluation

Compute attenuation constant as:

$$\alpha = \frac{N_{\mathrm{e}} - N_{\mathrm{s}}}{L} \times 100 \qquad \text{(A.1)}$$

where

α is the attenuation constant, in dB/100 m;

N_{e} is the power level at cable input (port A), in dBm;

N_s is the power level at cable end (port B), in dBm;

L is the length of the cable, in m.

NOTE Since resistive loss and coupling loss are both present, α cannot be corrected for the temperature.

A.4 Requirement

The attenuation constant shall not be higher than the values specified in the detail specification.

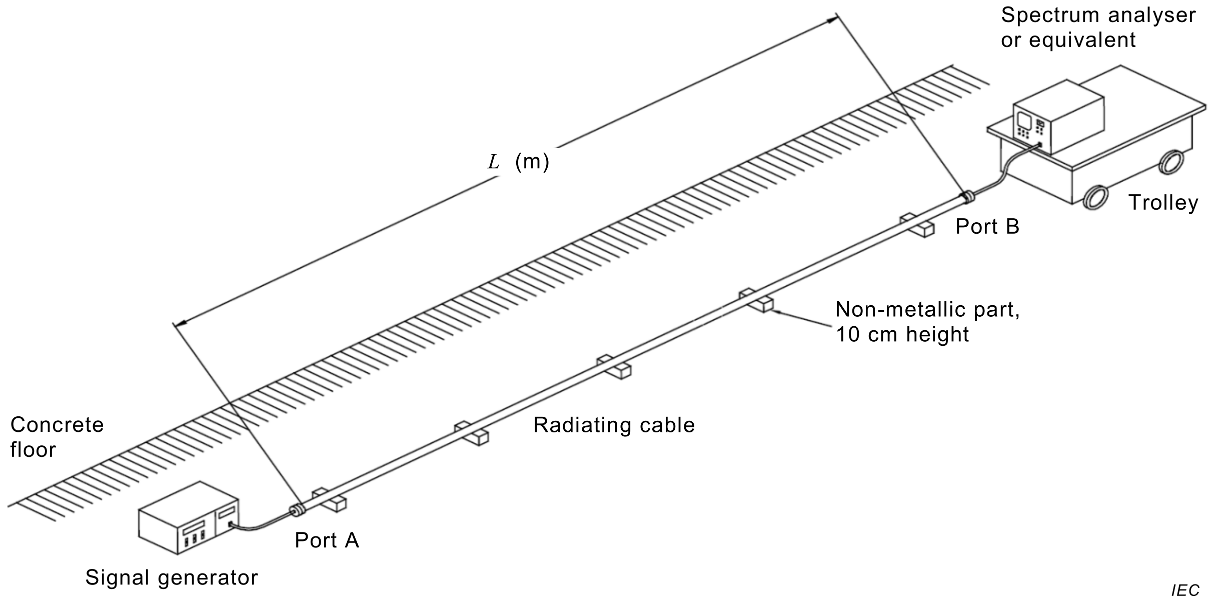


Figure A.1 – Attenuation constant with ground-level method

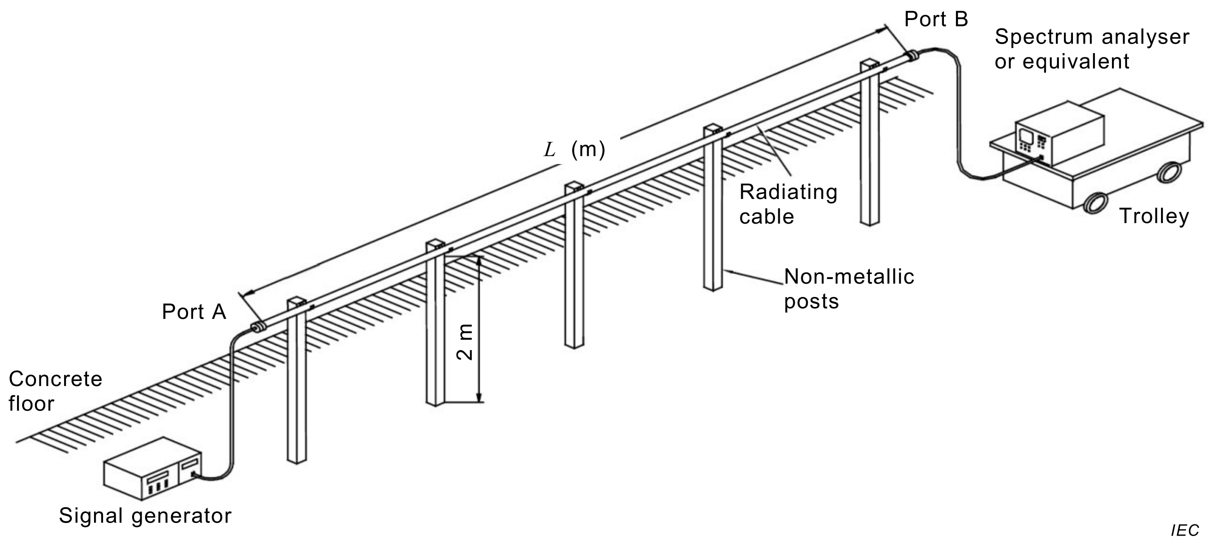


Figure A.2 – Attenuation constant with free-space method

Annex B
(normative)

Coupling loss (far field)

B.1 Procedure

B.1.1 General

Measurements can be carried out by one of the two methods, where the free-space method shall be the arbitration methods when there is an argument:

– ground-level method;
– free-space method.

B.1.2 Ground-level method

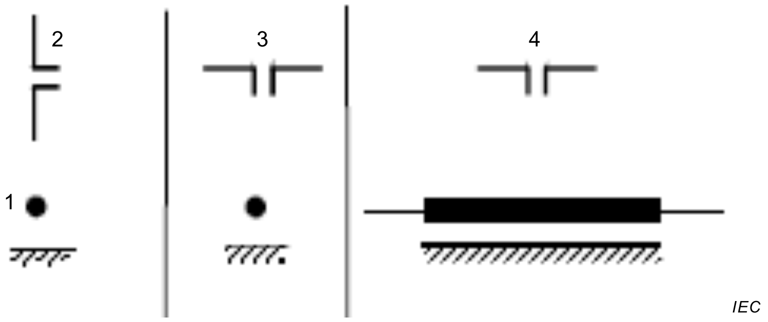
The arrangement of the cable is given in Figure B.1. The cable is laid on non-metallic spacers which give the cable a distance from the concrete floor of 10 cm to 12 cm.

The cable shall be at least of the length 10 λ and not less than 50 m, where λ is the cable wavelength of the measuring frequency.

The antenna is fixed to a trolley and moved along the cable, the centre of the antenna positioned vertically above the cable at a distance of about 2 m (or the distance which user requests). Preferably a half-wavelength dipole shall be used.

NOTE Additional distances may be added in the detail specification.

The spatial orientation of the antenna shall be as specified in the detail specification.



Key

1 cable
2 radial
3 orthogonal
4 parallel

Figure B.1 – Antenna orientations with ground-level method

B.1.3 Free-space method

The arrangement of the cable is given in Figure B.2. The cable is laid on non-metallic posts at a height of 1,5 m to 2 m.

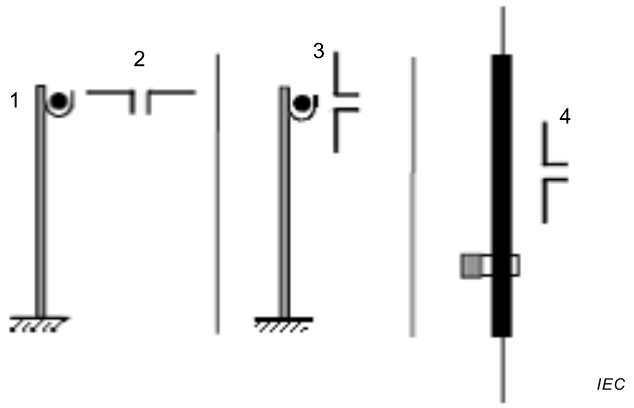
The cable shall be at least of the length 10 λ and not less than 50 m, where λ is the cable wavelength of the measuring frequency.

The antenna is put on a trolley and moved parallel to the cable. The height of the antenna centre shall be the same as that of the cable and its horizontal distance from the cable shall be about 2 m (see note in B.1.2). Preferably a half-wavelength dipole shall be used. Type and gain of antenna used shall be stated in the test report.

No other metallic parts than the cable and the antenna shall be included within a cylinder of 2 m (min.) in diameter surrounding the axis of the cable and the centre of the antenna.

The spatial orientation of the antenna shall be as specified in the detail specification.

For basic antenna orientations for a dipole, see Figure B.2.



Key

1 cable
2 radial
3 orthogonal
4 parallel

Figure B.2 – Antenna orientations with free-space method

B.2 Measurement (see Figures B.3 and B.4)

Adjust the generator frequency and output power level.

Feed the signal to port A of the cable.

Record the power level received by the antenna as a function of the distance of the antenna from the input port A of the cable by a spectrum analyser or equivalent.

There should be sufficient local resolution for the measurement to be valid. Therefore, 10 measurements per half-wavelength should be made to calculate the coupling loss for reception probabilities up to 95 %. To calculate higher reception probabilities, a sampling rate of 20 measurements per half-wavelength should be made. If there is an argument the total number of measurement shall not be less than 1 000.

B.3 Evaluation

Compute local coupling loss as:

$$L_{\mathrm{c}}(z) = N_{\mathrm{e}} - N_{\mathrm{r}}(z) - (\alpha \cdot z) - G \tag{B.1}$$

where

G is the gain of the antenna;

$L_c(z)$ is the level of local coupling loss from the input end (z) of cable, in dB;

N_e is the power level at the cable input, in dBm;

N_r is the power level at the antenna, in dBm;

α is the attenuation constant, in dB/100 m;

z is the distance from cable input to the antenna, in 100 m.

Cable with periodic structures of radiating apertures create an RF field with a main lobe moving from the feeding end (port A) of the radiating cable to the terminated end (port B) with increasing frequency. The frequency specific lobe angle has to be considered when eliminating end effects from the test results for the statistical evaluation of reception probability.

The measured coupling loss is characterized by two typical figures:

– Coupling loss L_{c50} (median value): 50 % reception probability, 50 % of the measured local values are smaller than this value.
– Coupling loss L_{c95}: 95 % reception probabilities, 95 % of the measured local values are smaller than this value.

Mean value of coupling loss:

If the coupling loss has been measured with three antenna orientations, which are orthogonal to each other, the coupling loss can be given as the mean value of the measuring results.

As the coupling loss is a logarithmic figure, the mean coupling loss is derived from the absolute figures of the three antenna orientations:

$$L_{c,mean} = -10 \cdot \log\left(\frac{1}{3}\left(10^{-\frac{L_{c,1}}{10}} + 10^{-\frac{L_{c,2}}{10}} + 10^{-\frac{L_{c,3}}{10}}\right)\right) \qquad (B.2)$$

where

$L_{c,1}$, $L_{c,2}$ and $L_{c,3}$ are the coupling losses for the three orthogonal antenna orientations, in dB.

B.4 Requirement

The characteristic values of coupling loss for a given reception probability shall not exceed the values specified in the detail specification.

B.5 Test report

Test report shall give the following information:

a) test sample length;
b) test temperature;
c) test method;
d) antenna type;
e) antenna gain;
f) antenna orientation;
g) the distance between antenna and radiating cable (if not 2 m).

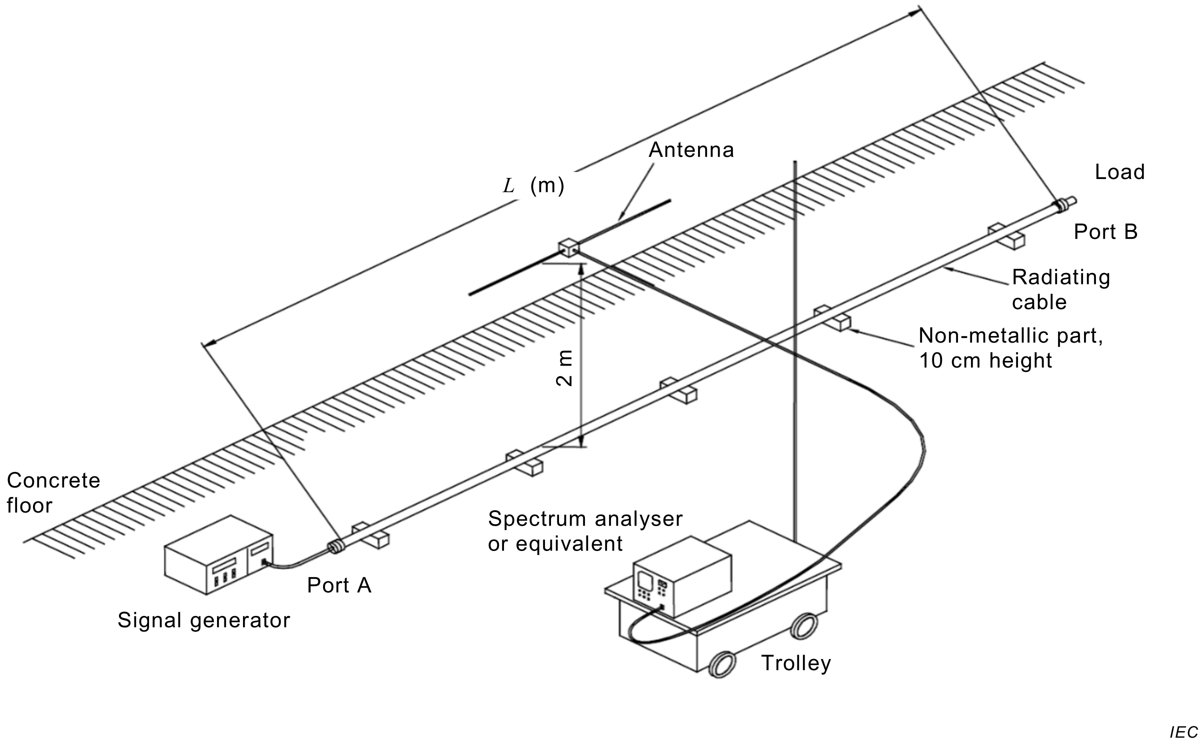


Figure B.3 – Coupling loss with ground-level method

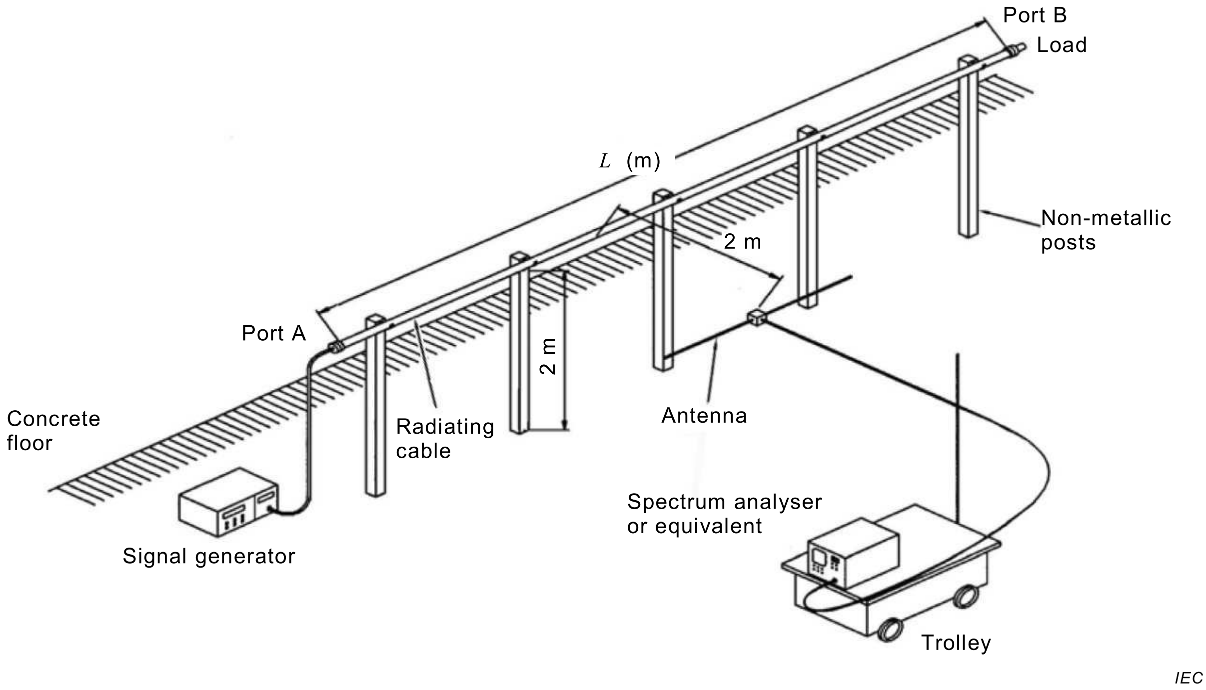


Figure B.4 – Coupling loss with free-space method

Annex C
(informative)

Coupling loss around circumferential orientation of radiating cable

C.1 General

If required the radiation characteristics of radiating cable around the circumferential orientation (Y-Z) can be evaluated in addition to the coupling loss specified in Annex B. Annex C gives an evaluating method of radiating characteristics by the coupling loss around circumferential orientation of radiating cable.

C.2 Definitions

C.2.1 Coupling loss chart around circumferential orientation of radiating cable (Y-Z)

Chart made of the coupling losses measured around radiating cable in a perpendicular distance. It represents coupling loss magnitude around radiating cable.

C.2.2 Out-of roundness of coupling loss chart around circumferential orientation of radiating cable

Out-of roundness of coupling loss is the difference between the maximum and the minimum coupling loss in a specified angle area φ of the coupling loss chart measured in circumferential orientation.

It represents the uniformity of coupling loss in a specified φ angle area around circumferential orientation, as shown in formula (C.1).

Out-of roundness of coupling loss chart:

$$= \frac{L_{\mathrm{c,max}} - L_{\mathrm{c,min}}}{2} \qquad \text{(C.1)}$$

where

$L_{\mathrm{c,max}}$ is the the maximum coupling loss in angle φ area;

$L_{\mathrm{c,min}}$ is the the minimum coupling loss in angle φ area.

C.3 Test method

The cable shall be at least of the length 10 λ and not less than 50 m, where λ is the cable wavelength of the measuring frequency.

Arrangement of cable is the same as Figure B.3.

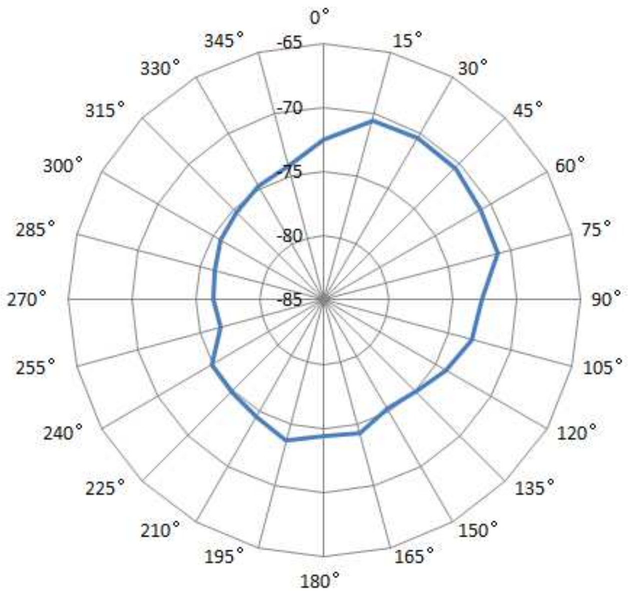
Rotate the radiating cable so that its slots are oriented to the antenna in 0° and measure and calculate the coupling loss $L_{\mathrm{c},\ 0}$ according to Annex B (it may be represented in $L_{\mathrm{c50,0}}$ in 50 % reception probability or in $L_{\mathrm{c95}\ ,\ 0}$ in 95 % reception probability, as specified in Clause B.3).

Rotate the cable 360° in counter clockwise, and measure and calculate the coupling loss $L_{\mathrm{c},\varphi}$ in each 15° interval (or smaller than that) in the same way above.

C.4 Calculation

Draw the chart $L_{c,\varphi} \sim \varphi$, as shown in Figure C.1.

Find the maximum coupling loss and minimum coupling loss in a specified φ angle area and calculate the out-of -roundness of coupling loss as shown in formula (C.1).



IEC

Test sample and length: SLR-50-22(7/8 "), 50 m

Test temperature: 26 °C

Test method: free space method

The orientation of antenna: perpendicularity (Y direction)

Test frequency: 900 MHz

Reception probability of coupling loss: 95 %

Figure C.1 – Example of coupling loss chart around circumferential orientation of radiating cable

C.5 Requirements

When required, the coupling loss chart around circumferential orientation and its out-of roundness in specified φ angle area shall be less than the values specified.

C.6 Test report

Test report shall give the following information:

a) test sample length;
b) test temperature;
c) test method;
d) antenna type;
e) antenna gain;
f) antenna orientation;

g) measuring frequency;
h) distance between antenna and radiating cable (if not 2 m);
i) reception probability of coupling loss.

Annex D
(under study)

Radiating intensity around circumferential orientation of radiating cable

NOTE Most radiating cables are made with periodically arranged apertures building a longitudinal antenna array. The characteristic beam forming requires the superposition of electromagnetic fields generated by multiple groups of apertures. Depending on the frequency band of operation, the periodic structure can have a length of several meters. Therefore, the described test method, using a short cable section of only 2 m, is not appropriate to determine the behaviour of a long cable with periodically arranged apertures.

D.1 General

If required the radiation characteristics of radiating cable around the circumferential orientation (Y-Z) can be evaluated.

Annex D gives an evaluation method of the radiation characteristics by the radiation intensity around the circumferential orientation of radiating cable.

D.2 Definitions

D.2.1 Radiation intensity chart around circumferential orientation of radiating cable (Y-Z)

The radiation intensity measured around a radiating cable in perpendicular distance represents the radiation intensity in circumferential orientation.

D.2.2 Out-of roundness of radiation intensity chart around circumferential orientation of radiating cable

Out-of-roundness of radiation intensity is the difference between the maximum and the minimum radiation intensity in a specified angle area φ in the radiation intensity chart around the circumferential orientation.

It represents the uniformity of radiation intensity in a specified φ angle area around circumferential orientation, as shown in formula (D.1).

$$\text{Out} - \text{of} - \text{roundness of radiation intensity} = \frac{P_{\text{max}} - P_{\text{min}}}{2} \tag{D.1}$$

where

P_{max} is the maximum radiation intensity in angle φ area;

P_{min} is the minimum radiation intensity in angle φ area.

D.3 Test method

The radiating cable shall be arranged as in Figure D.1 by using the free-space method and aligning to source antenna in homopolarity. The length of cable shall not be less than 2 m and the test point shall be in the middle of the sample. It should be done in anechoic chamber when there is an argument.

Rotate the radiating cable so that its slots are oriented to the antenna in 0° and measure the radiating intensity P_0.

Rotate the cable 360° in counter clockwise, and measure the radiation intensity P_φ in each 5° interval (or smaller than that) in the same way above.

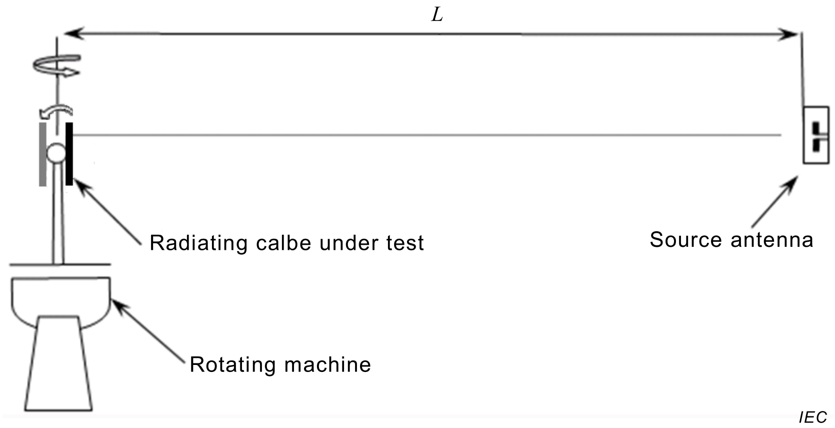
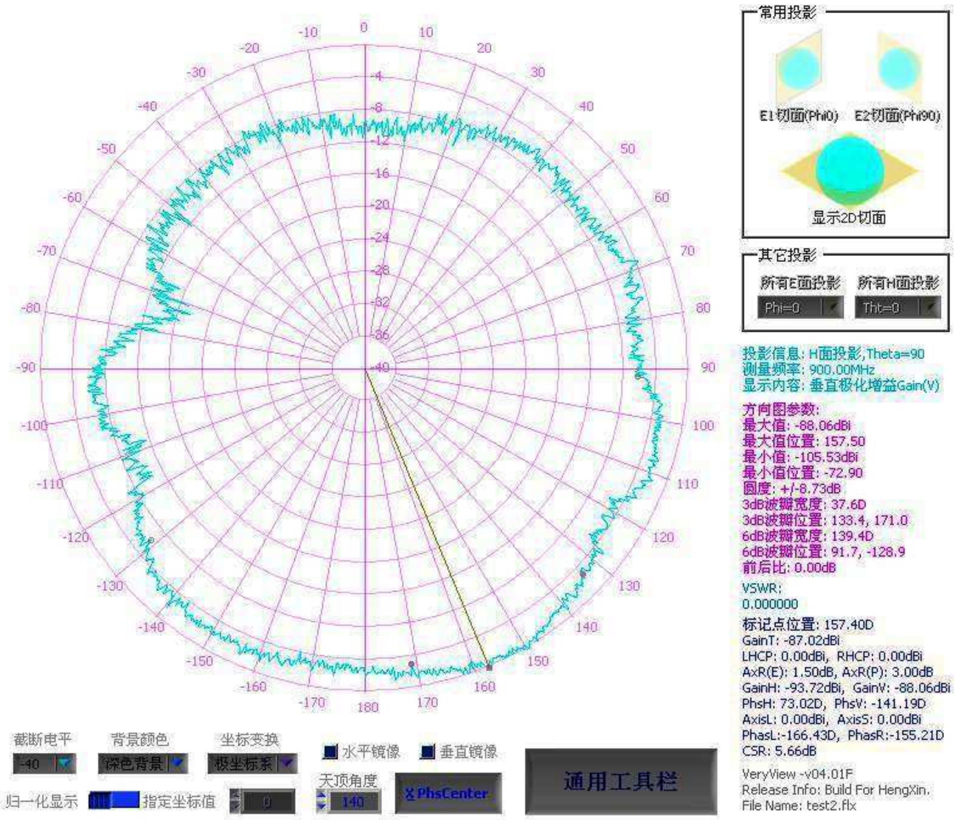


Figure D.1 – Example of testing arrangement of radiation intensity chart around circumferential orientation of radiating cable

D.4 Calculation

Draw the chart $P_\varphi \sim \varphi$ as shown in Figure D.2.

Find the maximum radiation intensity and minimum radiation intensity in a specified φ angle area and calculate the out-of-roundness of radiating intensity as shown in formula (D.1).



IEC

Test sample and length: SLR-50-22(7/8 ″), 2 m

Test temperature: 28 °C

Test method: free space method in an anechoic chamber

Source of antenna: BBHA9120G

Test frequency: 900 MHz

The distance (L) between radiating cable and antenna: 38 m

Figure D.2 – Example of radiation intensity chart around circumferential orientation of radiating cable

NOTE BBHA9120G is a double didged broadband horn antenna from Schwarzbeck[1].

D.5 Requirements

If required the radiation intensity chart around the circumferential orientation and its out-of-roundness in the specified angle φ shall be within the specified values.

---

[1] Schwarzbeck is an example of a suitable product available commercially. This information is given for the convenience of users of this standard and does not constitute an endorsement by IEC of this product.

D.6 Test report

Test report shall give the following information:

a) test sample length;
b) test temperature; test method; source antenna;
c) measuring frequency;
d) distance (L) between antenna and radiating cable;
e) testing point in radiating cable (if not in the middle of the cable).

Bibliography

IEC 61196-1-209, *Coaxial communication cables – Part 1-209: Environmental test methods – Thermal cycling*[2]

IEC 61196-1-110, *Coaxial communication cables – Part 1-110: Electrical test methods – Test for continuity*[3]

IEC 61196-1-215, *Coaxial communication cables – Part 1-215: Environmental test methods – High temperature cable ageing*[4]

____

[2] Under consideration.

[3] Under consideration.

[4] Under consideration.

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

3, rue de Varembé
PO Box 131
CH-1211 Geneva 20
Switzerland

Tel: + 41 22 919 02 11
Fax: + 41 22 919 03 00
info@iec.ch
www.iec.ch