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Spectrum Management and Telecommunications

Interference-Causing Equipment Standard

AC Wire Carrier Current Devices (Unintentional Radiators)

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Canada

Preface

Interference-Causing Equipment Standard ICES-006, issue 3, *AC Wire Carrier Current Devices (Unintentional Radiators)*, replaces ICES-006, issue 2, dated June, 2009.

This issue of ICES-006 will come into force upon its publication on the Innovation, Science and Economic Development Canada (ISED) website. However, a transition period is provided, according to section 2.1, within which compliance with either ICES-006, issue 2 or ICES-006, issue 3 is accepted.

Listed below are the main changes:

- Removed requirements that are common to various ICES standards and instead added a normative reference to ICES-Gen;
- Updated the other normative references with corresponding latest editions;
- Removed the output voltage test method and limits;
- Clarified the radiated emissions (both on the test site and in-situ) test methods and limits.

Inquiries may be submitted by one of the following methods:

1. Online, using the General Inquiry form. (In the form, the Regulatory Standards Branch radio button should be selected and "ICES-006" should be specified in the General Inquiry field.)

2. By mail to the following address:

   Innovation, Science and Economic Development Canada
   Engineering, Planning and Standards Branch
   Attention: Regulatory Standards Directorate
   235 Queen Street
   Ottawa, Ontario K1A 0H5 Canada

3. By email to ic.consultationradiostandards-consultationnormesradio.ic@canada.ca

Comments and suggestions for improving this standard may be submitted online using the Standard Change Request form, or by mail or email to the above addresses.

All spectrum and telecommunications related documents are available on ISED's Spectrum Management and Telecommunications website.

Issued under the authority
of the Minister of Innovation, Science and Economic Development Canada

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Martin Proulx
Director General
Engineering, Planning and Standards Branch

Contents

1. Scope

This Interference-Causing Equipment Standard (ICES) sets out limits and methods of measurement of radiated and conducted radio frequency emissions produced by AC wire carrier current devices classified as interference-causing equipment, according to section 2.5 a of this document, as well as administrative requirements for such equipment.

2. General

2.1 Transition period

A transition period, ending July 2019, is provided, within which compliance with ICES-006, issue 2 or ICES-006, issue 3 is accepted. After the expiry of this transition period all products subject to this standard that continue to be manufactured, imported, distributed, leased, offered for sale, or sold in Canada shall comply with ICES-006 issue 3. A copy of ICES-006, issue 2, may be requested by email.

2.2 Definitions

AC wire carrier current device: a device that transmits radio frequency signals by conduction, over electric power lines, which is used in commercial, business, light industrial or residential buildings.

In-house broadband over power line (in-house BPL): a carrier current system, consisting of AC wire carrier current devices operating as unintentional radiators, which send radio frequency energy by conduction over electric power lines that are not owned, operated or controlled by an electric service provider (i.e. are within the end user's property, within which the building(s) containing in-house BPL devices are located, and which may be aerial (overhead), underground or inside the walls, floors or ceilings of user premises).

2.3 ICES-Gen compliance

In addition to this standard, the requirements of ICES-Gen, *General Requirements for Compliance of Interference-Causing Equipment*, shall apply, except where a requirement in ICES-Gen contradicts a requirement in this standard, in which case this standard shall take precedence.

2.4 Normative references

The following publications are referred to in this document. Where such a reference is made, it shall be to the edition specified, for dated references, or to the latest edition (including all published amendments, where applicable), for undated references.

In case of the ANSI standard listed below, the edition adopted by ISED shall be used, as posted on the Normative Test Standards and Acceptable Alternate Procedures website.

BETS-1, *Technical Standards and Requirements for Low Power Announce Transmitters in the Frequency Bands 525-1,705 kHz and 88-107.5 MHz*

ICES-Gen, *General Requirements for Compliance of Interference-Causing Equipment*

RSS-210, *Licence-Exempt Radio Apparatus: Category I Equipment*

CAN/CSA-IEC CISPR 16-1-1:18, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus* (Adopted IEC CISPR 16-1-1:2015, fourth edition, 2015-09), excluding its Annex K.

Note: Annex K of CAN/CSA-IEC CISPR 16-1-1:18 is not acceptable and shall not be applied for the purpose of demonstrating compliance of equipment with the requirements specified in ICES-006, due to references therein to unspecified "manufacturer calibration" requirements and procedures. Any measurement instrument used for ICES-006 measurements shall fully comply with all applicable requirements stated in CAN/CSA-IEC CISPR 16-1-1:18, excluding Annex K.

CISPR 16-1-2:2017-11, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – Coupling devices for conducted disturbance measurements*, Edition 2.1, November 2017

CISPR 16-1-4:2017-01, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Antennas and test sites for radiated disturbance measurements*, Edition 3.2, January 2017

CISPR 16-2-1:2017-06, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbance and immunity – Conducted disturbance measurements*, Edition 3.1, June 2017

CAN/CSA-IEC CISPR 16-2-3:18, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements* (Adopted IEC CISPR 16-2-3:2016, fourth edition, 2016-09)

ANSI C63.4, *American National Standard for Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz*

2.5 Classification

AC wire carrier current devices are classified as:

a. **Interference-causing equipment** where both the exciter (transmitter) and the receiver are connected to the AC wire line and any radiation of radio frequency energy is unintentional. This includes in-house BPL devices. These devices are subject to ICES-006.

b. **AC wire carrier current devices operating in the AM broadcast band** of 535 - 1705 kHz and intended for AM broadcast receivers. These devices are intentional radiators; as such, they are out of scope of ICES-006 and are instead subject to BETS-1.

c. **AC wire carrier current devices of the intentional radiator type** where the exciter is connected to the AC wire line but the receiver is not (e.g. a magnetic loop is used to pick up the received signal). These devices are classified as Category I radio apparatus; as such, they are out of scope of ICES-006 and are instead subject to RSS-210.

2.6 Instrumentation

2.6.1 Line impedance stabilization network (LISN)

A line impedance stabilization network (LISN) shall be used to measure emissions conducted back into the AC mains power line. The LISN shall comply with the requirements for the artificial mains network (AMN) specified in CISPR 16-1-2 at each frequency of measurement.

2.6.2 Measurement instrument

The measuring receiver shall comply with the requirements specified in CAN/CSA-IEC CISPR 16-1-1:18 for peak, quasi-peak, and average measuring receivers, as appropriate.

3. Technical requirements

3.1 Conducted emissions

3.1.1 Measurement method (conducted emissions)

Conducted emissions measurements on the AC mains wires shall be performed using a LISN as defined in section 2.6.1, a measurement receiver as defined in section 2.6.2, and using the method defined in either CISPR 16-2-1 or in ANSI C63.4. Measurements shall be made between each power line and ground, at the power terminal of the equipment under test (EUT), and all measured emissions shall meet the applicable limits.

3.1.2 Limits (conducted emissions)

For AC wire carrier current devices that operate below 30 MHz, conducted emissions falling within 535 – 1705 kHz shall not exceed 1000 µV measured using a quasi-peak detector.

For all other AC wire carrier current devices, the limits in table 1 below shall apply.

Table 1: Conducted emissions limits for devices operating at or above 30MHz

Frequency	Quasi-peak dB(µV)	Average dB(µV)
150 – 500 kHz	66 – 56	56 – 46
0.5 – 5 MHz	56	46
5 – 30 MHz	60	50

Note 1: At the transition frequencies, the lower limit applies.
Note 2: Within 150 – 500 kHz, both the quasi-peak and the average limits decrease linearly with the logarithm of frequency.

3.2 Radiated emissions (on a test site)

3.2.1 Measurement method (radiated emissions, on a test site)

3.2.1.1. General

Radiated emissions measurements on the AC carrier current device shall be performed using:

a. a measurement receiver as defined in section 2.6.2;

b. a test site compliant with section 3.2.1.2 (9 kHz to 30 MHz) and with CISPR 16-1-4 or ANSI C63.4 (above 30 MHz);

c. the method defined in section 3.2.1.2 (9 kHz to 30 MHz); and

d. the method defined in CAN/CSA-IEC CISPR 16-2-3:18 or in ANSI C63.4, also considering the requirements in section 3.2.1.3 (above 30 MHz).

The EUT shall be measured in the same orientation as used in actual installations. If the EUT can be installed in various orientations, it shall comply with the radiated emission limits in all orientations.

3.2.1.2. Radiated emissions measurement method (within 9 kHz to 30 MHz)

Below 30 MHz, measurements shall be taken in terms of magnetic field strength (H-field), using a "60 cm" loop antenna compliant with the applicable requirements set out in CISPR 16-1-4.

Note 1: CISPR 16-1-4 requires that the loop antenna fits within a square of 60 cm sides. This means that the loop antenna can be any smaller size, and in fact its diameter (for circular loop antenna) or largest side (for rectangular loop antenna) can never be 60 cm. However, due to traditional usage, the term "60 cm" is used to denominate this type of antenna within this document.

Note 2: Rod antennas are not permitted for final compliance radiated measurements below 30 MHz.

The antenna factor of the loop antenna shall be calibrated relative to magnetic field strength, i.e. in dB(S/m) or dB[$(\Omega m)^{-1}$] units or the linear equivalent.

The test site used for these measurements shall be compliant with the requirements for radiated emissions test site stated in CISPR 16-1-4 or ANSI C63.4 for the frequency range of 30 – 1000 MHz, except that the site need not comply with the applicable normalized site attenuation (NSA) site validation requirements.

Measurements shall be performed with the loop antenna in the two vertical polarizations, where the loop plane is perpendicular to the ground: H_X (coaxial), where the loop plane is perpendicular to the measurement axis, and H_Y (coplanar), where the loop is in the same plane as the measurement axis. In each polarization, the centre of the loop antenna shall be at 1.3 m above the ground plane and its projection on the ground plane shall be at the specified measurement distance from the boundary of the EUT's arrangement. The measurement distance shall be between 3 m and 30 m. For each antenna polarization, the EUT arrangement shall be fully rotated through all azimuth angles to find the highest emission level relative to the limit.

The field strength may be measured in the near field (i.e. measurement distance less than two wavelengths, at the frequency of measurement). The measured field strength shall be extrapolated to the limit distance using the formula indicating that the field strength varies as the inverse distance square (40 dB per decade of distance). Measurements at a minimum of two distances on at least one radial to determine the proper extrapolation formula, instead of using 40 dB per decade of distance, is also permitted; however, in this case, the radial(s) selected for measurements shall include where the highest emissions from the equipment under test are measured.

3.2.1.3. Radiated emissions measurement method (above 30 MHz)

At frequencies at or above 30 MHz, measurements shall not be taken in the near field.

Measurements shall not be performed at a distance greater than 30 metres unless it is demonstrated, in the test report, that measurements taken at a distance of 30 metres or less are not practical. In such a case, it shall be further demonstrated, in the test report, that the measuring instrument is able to detect EUT emissions with a signal-to-noise ratio of at least 6 dB and that the measuring instrument's noise floor is at least 10 dB below the applicable limit.

When performing measurements at a distance other than the distance specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB per decade of distance (inverse linearly with distance for field strength measurements).

3.2.1.4. Minimum measurement frequency range

Radiated emissions shall be measured from the lowest frequency generated or used in the EUT or from 9 kHz, whichever is greater, and up to at least the frequency shown in table 2 below:

Table 2: Upper frequency of measurement

Highest frequency generated or used in the EUT or on which the EUT operates or tunes (MHz)	Upper frequency of measurement (MHz)
< 1.705	30
≥ 1.705 and < 10	400
≥ 10 and < 30	500
≥ 30 and < 108	1000
≥ 108 and < 500	2000
≥ 500 and ≤ 1000	5000
above 1000	5th harmonic of the highest frequency or 40 GHz, whichever is lower

3.2.2 Limits (radiated emissions, on a test site)

3.2.2.1. Radiated emissions limits (9 kHz to 30 MHz)

The limits specified in this section only apply to AC wire carrier devices operating at frequencies below 30 MHz.

Magnetic field strength radiated emissions from AC wire carrier current devices shall not exceed the levels in table 3 below:

Table 3: Radiated emissions limits (9 kHz – 30 MHz)

Frequency	Magnetic field strength dB(µA/m)	Limit distance m
9 – 490 kHz	$16.1 - 20 \log_{10} (f)$	300
490 – 1705 kHz	$36.1 - 20 \log_{10} (f)$	30
1.705 – 30 MHz	-22.0	30

Note 1: At the transition frequencies, the lower limit applies.
Note 2: *f* is the measured frequency, in kHz.
Note 3: The specified limit applies for a CISPR quasi-peak measurement detector with the appropriate measurement bandwidth (see ICES-Gen), except for the 9 – 90 kHz and 110 – 490 kHz frequency ranges, where a CISPR average detector shall be used (see ICES-Gen). In these two frequency ranges an additional peak limit applies, which shall be 20 dB above the average detector limit.

AC wire carrier current devices operating within the 525 – 1705 kHz frequency range may alternatively comply with the following limit within this frequency range (see table 4), as measured using the procedure in section 3.3. Outside this band, the limits of table 3 shall apply.

Table 4: Alternative radiated emissions limits (525 – 1705 kHz)

Frequency	Magnetic field strength dB(µA/m)	Limit distance m
525 – 1705 kHz	-28.0	47715 / f

Note 1: *f* is the measured frequency, in kHz.
Note 2: The specified limit applies for a CISPR quasi-peak measurement detector with the appropriate measurement bandwidth (see ICES-Gen).
Note 3: This alternative limit may only be used for EUTs operating in this band.

3.2.2.2. Radiated emissions limits (above 30 MHz)

Electric field strength radiated emissions from AC wire carrier current devices shall not exceed the levels in table 5 below.

Table 5: Radiated emissions limits (above 30 MHz)

Frequency MHz	Electric field strength at 3 m dB(µV/m)	Electric field strength at 10 m dB(µV/m)
30 – 88	40.0	29.5
88 – 216	43.5	33.1
216 – 960	46.0	35.6
Above 960	54.0	43.5

Note 1: At the transition frequencies, the lower limit applies.
Note 2: The specified limit, up to 1000 MHz, applies for a CISPR quasi-peak measurement detector with the appropriate measurement bandwidth (see ICES-Gen). Above 1000 MHz, a CISPR average detector with a measurement bandwidth of 1 MHz or greater shall be used (see ICES-Gen). At all frequencies above 1000 MHz an additional peak limit applies, which shall be 20 dB above the average detector limit.

3.3 Radiated emissions (in-situ)

3.3.1 Equipment under test (EUT)

For the in-situ radiated emissions test cases, the EUT consists of the AC carrier current devices, including those used to transmit and those used to receive broadband over power line signals, the associated computer interface devices, as well as the building wiring and overhead and/or underground lines that connect to the electric utilities.

3.3.2 Measurement method (radiated emissions, in-situ)

In addition to the test site radiated emission measurements (see section 3.2), AC wire carrier current devices shall also be tested in-situ at least at three typical installations. The three (or more) installations shall include a combination of building types, with overhead line(s) and underground line(s), and/or other features, as applicable, such that they are demonstrably representative of most typical installations. The installations selected for testing shall not have aluminum or other metal siding or shielded wiring, such as wiring installed through metallic conduit.

At each site, the EUT shall be installed in the building on an outside wall on the ground floor (i.e. first floor). Measurements should normally be performed at a separation distance of 10 meters from the building wall. If necessary, due to ambient emissions, measurements may be performed at a distance of 3 meters. If measurements are performed at other than the limit distance, the measurement results shall be corrected as per section 3.2.1.2 or section 3.2.1.3, as appropriate, before comparing with the limit. The measurement procedure shall follow the same procedures as specified in section 3.2.1, to the extent possible; any deviations shall be documented and justified in the test report.

For those sites with overhead lines, in addition to testing around the building, testing shall also be performed at three positions along the overhead line connecting to the building. It is recommended that these measurements be performed starting at a distance of 10 meters down the line from the connection to the building (the lateral antenna distance, d_{Al}, in figure 1 below) and then at shorter distances from the building. If this test cannot be performed due to insufficient length of the overhead line, between the building connection point and the property border, this shall be stated in the test report.

Distance corrections for the overhead line measurements shall be based on the slant range distance, as defined in figure 1 below. This can be calculated as follows:

$$sd = \sqrt{(d_{An})^2 + (h_L - h_A)^2} \quad (1)$$

where

sd is the slant distance (measurement distance, for this test);

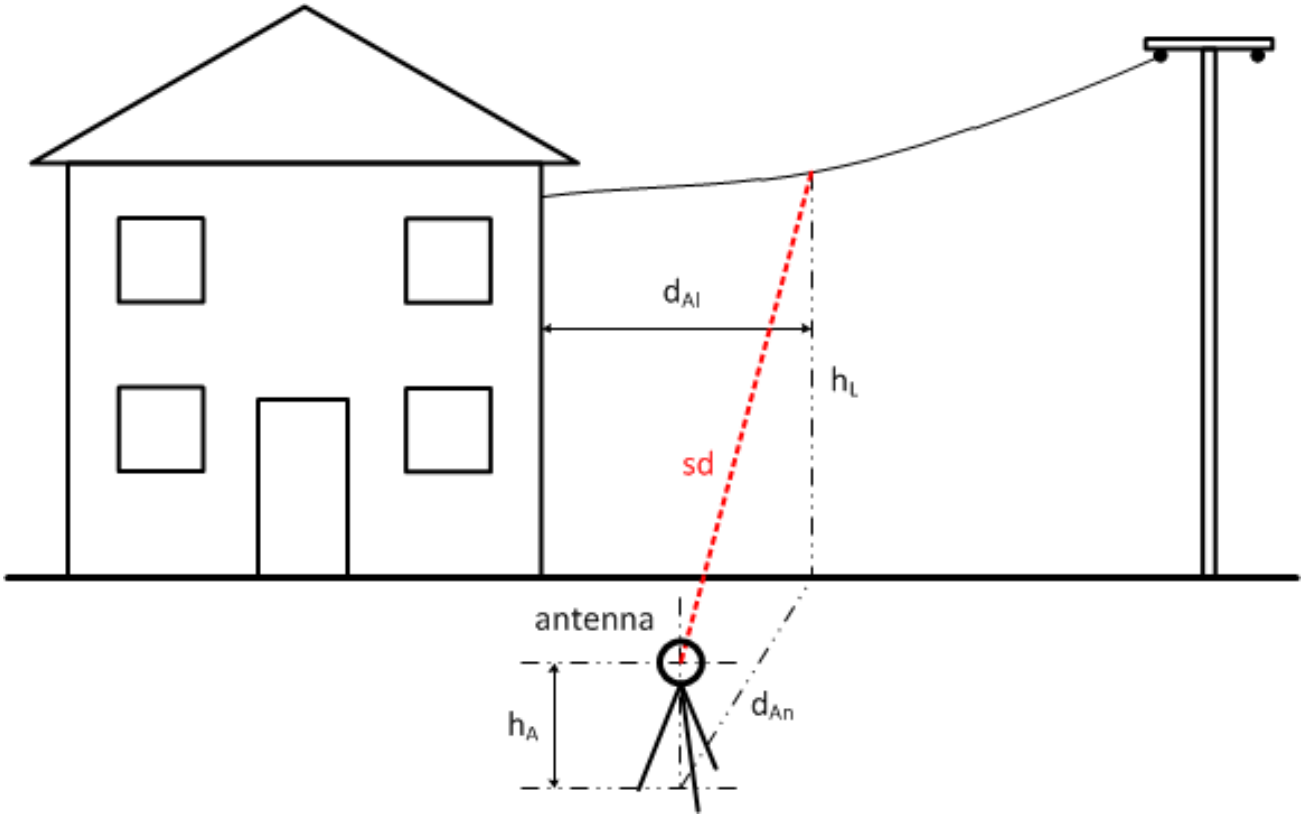
d_{An} is the normal antenna distance (the distance between the projections onto the ground of the antenna reference point and of the point on the overhead line under test that is located at the lateral antenna distance, d_{Al}, from the building connection point);

h_L is the height above the ground of the point on the overhead line under test that is located at the lateral antenna distance, d_{Al}, from the building connection point;

h_A is the height above the ground of the antenna reference point.

All these terms are also illustrated in figure 1 below. The reference point of the loop antenna is defined as its centre. For other types of antennas, the reference point is as defined in CAN/CSA-IEC CISPR 16-2-3:18 and ANSI C63.4.

Figure 1: Slant distance



3.3.3 Limits (radiated emissions, in-situ)

The limits in section 3.2.2 shall apply.

4. Administrative requirements

The labelling requirements as stated in ICES-Gen shall apply. An example of an ISED compliance label is as follows:

CAN ICES-006/NMB-006