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ISO 24631-4

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Radiofrequency identification of animals —

Part 4: Evaluation of performance of RFID transceivers conforming with ISO 11784 and ISO 11785

Identification des animaux par radiofréquence —

Partie 4: Évaluation de la performance des émetteurs-récepteurs RFID conformes à l'ISO 11784 et à l'ISO 11785

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 24631-4 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 19, *Agricultural electronics*.

ISO 24631 consists of the following parts, under the general title *Radiofrequency identification of animals*:

— *Part 1: Evaluation of conformance of RFID transponders with ISO 11784 and ISO 11785 (including granting and use of a manufacturer code)*

— *Part 2: Evaluation of conformance of RFID transceivers with ISO 11784 and ISO 11785*

— *Part 3: Evaluation of performance of RFID transponders conforming with ISO 11784 and ISO 11785*

— *Part 4: Evaluation of performance of RFID transceivers conforming with ISO 11784 and ISO 11785*

Introduction

ISO has appointed ICAR (International Committee for Animal Recording) as the registration authority (RA) competent to register manufacturer codes used in the radiofrequency identification (RFID) of animals in accordance with ISO 11784 and ISO 11785.

ISO 24631 defines means, based upon ICAR test procedures [1], for evaluating and verifying both the conformance and performance of RFID devices in respect of ISO 11784 and ISO 11785. Only those results emanating from RA-approved test centres are recognized.

This part of ISO 24631 deals with the performance of RFID transceivers. Measurements are made using transponder emulation circuits, ensuring that the transceiver testing is always performed against the same, known stimuli.

Radiofrequency identification of animals —

Part 4:
Evaluation of performance of RFID transceivers conforming with ISO 11784 and ISO 11785

1 Scope

This part of ISO 24631 provides the means of evaluating the performance of ISO 11784- and ISO 11785-conformant RFID (radiofrequency identification) transceivers used in the individual identification of animals.

The test procedures specified in this part of ISO 24631 are recognized by the FECAVA (Federation of European Companion Animals Veterinary Association) and WSAVA (World Small Animal Veterinarian Association) and as such can be applied also to companion animals.

2 Conformance

Test centres approved by the registration authority (RA) shall perform transceiver testing using the procedures specified in Clause 7 and shall report the test results to the RA. These tests are in accordance with the technical requirements of ISO 11784 and ISO 11785. The manufacturer shall apply for transceiver testing by completing and submitting to the RA the application form provided in Annex A. Only transceivers that have been issued an approval reference number by the RA (see ISO 24631-2) may be tested. A transceiver test report shall be accorded to a manufacturer whose product has been tested as per Clause 7.

3 Normative references

The following referenced documents are indispensable for the application 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.

ISO 3166-1, *Codes for the representation of names of countries and their subdivisions — Part 1: Country codes*

ISO 11784:1996, *Radio frequency identification of animals — Code structure*

ISO 11785:1996, *Radio frequency identification of animals — Technical concept*

ISO 24631-1:2009, *Radiofrequency identification of animals — Part 1: Evaluation of conformance of RFID transponders with ISO 11784 and ISO 11785 (including granting and use of a manufacturer code)*

4 Terms and definitions

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

4.1
approval reference number
number issued to the manufacturer of an approved transceiver by the registration authority

EXAMPLE ISO 24631-2 2009-02-001

NOTE It comprises the reference of the International Standard for which approval is made, the year of issue (4 digits), the type of device tested ("02" for transceivers according to this part of ISO 24631) and the running number (3 digits) referencing the transceivers tested successfully during that year.

4.2
country code
three-digit numeric code representing a country in accordance with ISO 3166-1

4.3
ISO 11784 and ISO 11785 transceiver
transceiver that reads at least both FDX-B and HDX transponders as defined in ISO 11784 and ISO 11785

4.4
ISO 11784 and ISO 11785 transponder
radiofrequency identification (RFID) device that transmits its transponder code according to ISO 11784 and ISO 11785 when activated by a transceiver

4.5
manufacturer
company that submits an application for testing transceivers for conformance with ISO 11784 and ISO 11785

4.6
manufacturer code
MFC
three-digit number granted by the RA to a manufacturer under the conditions set forth in ISO 24631-1:2009, Annex E, whose range and placement within the code structure are in accordance with ISO 11784

NOTE Only one manufacturer code is granted to the same manufacturer.

4.7
RA-approved test centre
accredited test centre meeting the criteria of the registration authority

NOTE Accreditation: third-party attestation related to a conformity assessment body conveying formal demonstration of its competence to carry out specific conformity assessment tasks (see Reference [3]).

4.8
RA-approved transponder
transponder approved by the registration authority

4.9
reference transponder
transponder used to test a transceiver, selected from the different RA-approved transponder types

4.10
registration authority
RA
entity that approves test laboratories and issues and registers manufacturer and product codes

4.11
transceiver
device used to communicate with the transponder

4.12
transponder
radiofrequency identification (RFID) device that transmits its stored information when activated by a transceiver and that may be able to store new information

NOTE See ISO 24631-1 for definitions of the main types.

4.13
transponder code
code programmed in the transponder, as defined in ISO 11784:1996, Table 1, and in ISO 11785

4.14
transponder emulation circuit
circuit used to substitute for a transponder, built from well-defined components and an arbitrary waveform generator (AWG)

4.15
transceiver under test
TUT
mobile transceiver that has passed conformance testing in accordance with ISO 24631-2

5 Abbreviated terms

AWG advanced waveform generator

FDX-B full duplex communication protocol (conforming to ISO 11785, excluding protocols mentioned in ISO 11785:1996, Annex A)

FSK frequency shift keying

HDX half duplex communication protocol

MFC manufacturer code

NP0 negative positive zero

NRZ non-return to zero

RA registration authority

RF radiofrequency

RFID radiofrequency identification

TEC transponder emulation circuit

TUT transceiver under test

6 Application

6.1 The application submitted to the RA for testing the performance of a transceiver shall consist of a covering letter and the application form presented in Annex A. The RA shall confirm receipt of the application to the manufacturer within two weeks. By signing the application form, the manufacturer agrees to fulfil the provisions of this part of ISO 24631.

6.2 The test centre shall be approved by the RA.

6.3 The RA maintains a list of approved test centres, from which the manufacturer may choose the centre that will test his transceiver product.

6.4 A performance test application alone shall only be accepted for a transceiver type and model already issued an approval reference number by the RA. If a transceiver product does not have an approval reference number, the test shall only be performed in combination with transceiver conformance testing in accordance with ISO 24631-2.

6.5 The manufacturer shall send a transceiver and all necessary accessories to the RA-approved test centre. It is permitted to request the RA-approved test centre to use a transceiver already used for conformance testing. The manufacturer shall ensure that the equipment is able to display or store the transponder codes during testing.

6.6 The RA-approved test centre shall verify the transceivers using the test procedures specified in Clause 7.

6.7 The RA-approved test centre shall prepare a confidential report of the results and shall send two copies (and an electronic version) of the report to the chairman of the RA.

6.8 The RA chairman shall inform the manufacturer of the test results in a letter together with a copy of the report.

6.9 The tested transceivers shall be kept by the RA-approved test centre, under the ownership of the RA.

6.10 The RA shall make publicly available the main results of the test, including a photograph of the approved transceiver. A manufacturer shall have the right to refuse that the results be made publicly available or to request their withdrawal from public availability. In the first case, the manufacturer shall send a request to the RA not to publish, within two weeks of having received the test report. In the second, the manufacturer shall send a request to the RA and the RA shall remove the results from public availability within four weeks of receipt of this request.

6.11 The RA shall do everything within its power to protect the integrity of this procedure with regard to ISO 11784 and ISO 11785.

7 Test procedures

7.1 Test apparatus

7.1.1 Transponder emulation circuit (TEC), designed in accordance with Annex B.

The TEC shall be used in the place of an FDX-B or HDX transponder in order to guarantee comparability of results between the different tests and ensure that results will be reproducible in every laboratory, whenever needed. Built from standard components, it also serves to avoid deviations that can occur due to progress in technology or the spread in production of commercially available transponders.

7.2 Test conditions

The test conditions shall be as follows.

Ambient temperature:	minimum 15 °C and maximum 30 °C
Ambient humidity:	minimum 40 % rH and maximum 80 % rH
Ambient noise floor and ambient peak noise:	< 30 dBµV/m (bandwidth 2,7 kHz) 50 Hz to 1 MHz during measurements

Special attention shall be given to spurious emissions, which can be emitted, for example, by insufficiently shielded computer monitors. The electromagnetic test conditions of the measurements shall be checked by carrying out the measurements both with and without a transponder in the field.

7.3 Measurement of reading distance diagram

7.3.1 Purpose

The purpose of this test is to determine the reading test distance as a function of the transponder coil position relative to the transceiver antenna, and also called *antenna pattern*. It is applied to the paths:

— transceiver to transponder (downlink), which is the activation field strength parameter;

— transponder to transceiver (uplink), which is the sensitivity parameter.

7.3.2 Transponder orientation

The *optimum* orientation for the different antenna types is as follows.

a) **TUT with loop antenna**

1) Air-coil transponder, as used with the TEC: the transponder shall be orientated parallel to the antenna plane.

2) Ferrite-coil transponder: it shall be orientated perpendicular to the antenna plane.

b) **TUT with ferrite antenna**

1) Air-coil transponder, as used with the TEC: the antenna plane shall be orientated perpendicular to the axis of the ferrite antenna of the TUT.

2) Ferrite-coil transponder: measurements shall be performed in the optimum orientation, in which the transponder is orientated in parallel with the antenna axis of the TUT's ferrite coil, as well as in a *minimum* orientation, in which the transponder is oriented perpendicular to the optimum orientation.

7.3.3 Test geometry

The measurements shall be performed in a test plane. Within that plane, the origin or reference point is well defined in respect to the housing of the transceiver antenna.

a) Transceiver loop antenna: the test plane shall be perpendicular to the antenna.

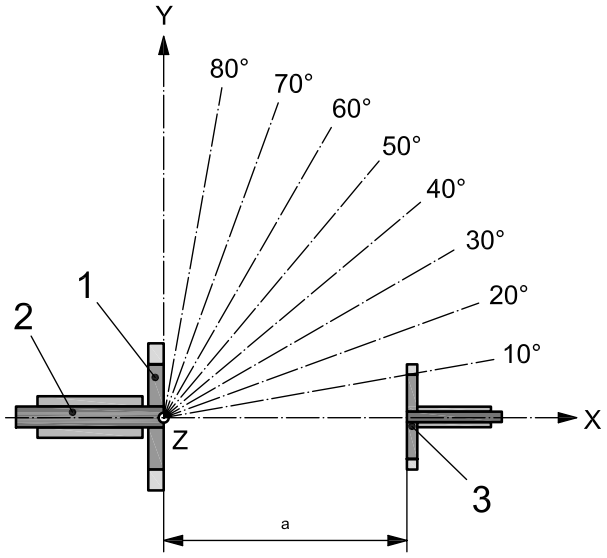
b) Ferrite antenna: the axis of the ferrite shall lie within the test plane.

Polar coordinates shall be applied for the position of the air-coil of the TEC. The measurements shall be taken in 10° steps, as shown in Figure 1.

The TEC coil shall be aligned, as appropriate, in accordance with 7.3.2.

For a symmetric antenna design, only 10 measurements are required to define the complete three-dimensional reading range of the transceiver.

However, if the transceiver antenna has been designed so as not to emit a symmetric field around its axis, or if it has a non-symmetric sensitivity characteristic, 20 measurements shall be performed in two orthogonal test planes, such as X-Y and X-Z. See Figures 1 and 2.



Key

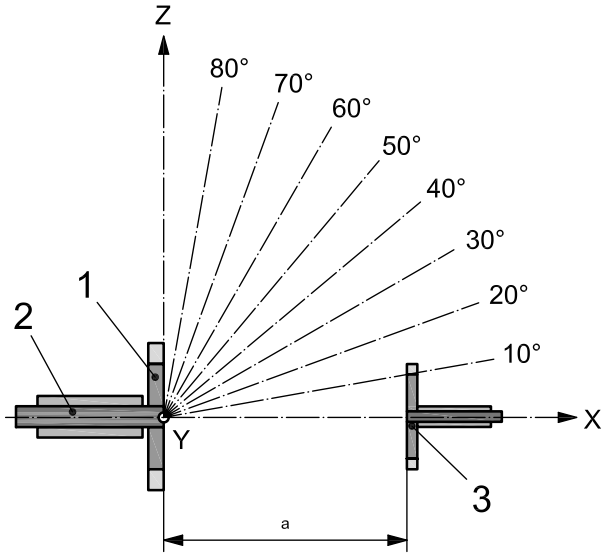
1 transceiver antenna

2 TUT

3 TEC or field sensor

a Distance measurement.

Figure 1 — X–Y measurement plane of transceiver vs. TEC



Key

1 transceiver antenna

2 TUT

3 TEC or field sensor

a Distance measurement.

Figure 2 — X–Z measurement plane of transceiver vs. TEC

7.3.4 Procedure

The purpose of the test is to find a curve that shows the reading distance obtained with the two defined TEC. In each direction, determine the reading distance when the transceiver is triggered for a reading period of 1 s when within that time period the reading was successful. The envelope of the maximum reading distances reflects a transceiver's performance. If the number of test points is not sufficient to draw the envelope curve, test additional direction points between the 10° steps. For an example, see Annex C.

Record the following for each measurement.

— Test type: type of transponder (FDX-B, HDX)

— Test plane: orientation of plane relative to housing of TUT; reference point, X-Y or X-Z

— Test direction: 0° to 90°

— Measured maximum distance in centimetres

— Ambient temperature: in degrees Celsius

— Ambient humidity (relative value): as a percentage

— Ambient noise floor and ambient peak noise: $A/m/\sqrt{Hz}$ (< 40 dBµV/m)

7.4 Measurement of transceiver response time

7.4.1 Purpose

The purpose of this measurement is to determine the time elapsed between pressing the trigger at the transceiver and the appearance of the successfully read number on the display.

7.4.2 Test geometry

The TEC shall be placed at the axis of the reader antenna, with the transponder's air coil orientated parallel to the reader antenna coil. The distance from the reader antenna shall be 70 % of the maximum reading distance (see 7.3).

7.4.3 Procedure

Trigger the TUT manually. An auxiliary receiver shall pick up the downlink signal from the transceiver. This receiver shall trigger a clock. The appearance of the successful reading shall be detected by an optical sensor, which shall stop the clock.

No separate output is required at the reader.

Alternatively, if the TUT is equipped with a suitable data interface, this may be used.

Record the following for each measurement.

— Distance between TEC air coil and TUT antenna housing

— Time elapsed between detection of downlink signal and appearance on-screen of correct code; 30 samples shall be taken and the average given in the test protocol

— Ambient temperature in degrees Celsius

— Ambient humidity (relative value) as a percentage

— Ambient noise floor and ambient peak noise at 60 kHz to 150 kHz before and after measuring

See Annex B for the test set-up parameters (threshold voltage at the AWG trigger).

Annex A
(normative)

Test application form

This form is also available on the RA web site: http://www.icar.org/

RA approval date:					Date:
Company name:			**Address:**		
Device type:	Portable reader with integrated antenna				☐
	Portable reader with external antenna				☐
	Portable reader with integrated and optional external antenna				☐
	Other:				☐
The document of a notified body stating conformance with EN 300 330 document is enclosed					☐
Device name: **Device serial number:**			**RA approval reference number:**		
Physical characteristics:					
Dimensions ($l \times w \times h$):				Mass:	
Separate antenna:	No	☐	Yes	☐	
Communication (not to be tested)	No	☐	Yes	☐	If yes, provide specifications
Photograph of the device:					
The undersigned agrees to abide by the provisions of ISO 24631-4.					
Date:	**Name:**			**Position:**	

Annex B
(normative)

Transponder emulation circuit (TEC) design specifications

B.1 Reference air coil

See Table B.1 for the values of the component characteristics. The reference air coil can be supplied by the manufacturer of the corresponding coil manufacturer.

Table B.1 — Reference air coil component characteristics values

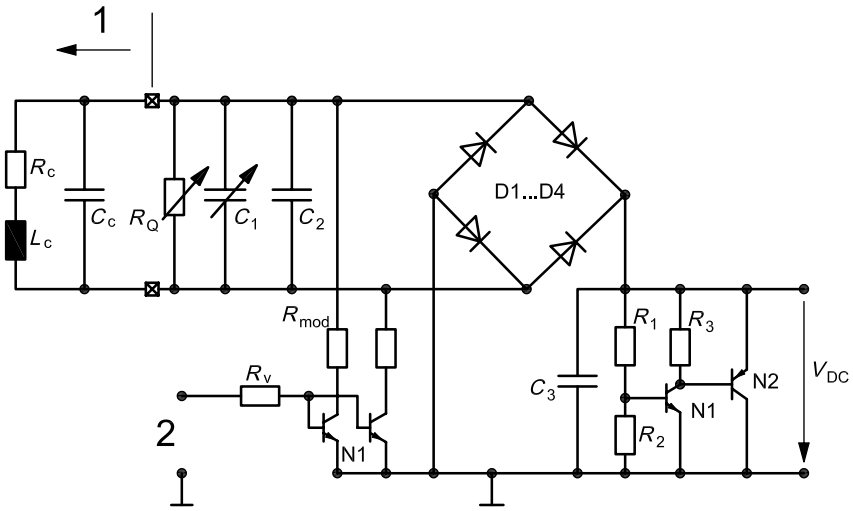
Characteristic	Value	Description/comment
L_S	6,5 mH	Reference air coil inductance
Q_L	30	Reference air-coil Q (quality) factor
Inner coil diameter	15,7 mm	Reference air-coil dimension
Outer coil diameter	18,4 mm	Reference air-coil dimension
Coil thickness	[a]	Reference air-coil dimension
Coil wire	4 mm × 0,8 mm	Reference air coil component
C_L	< 5 pF	Reference air-coil stray capacitance

[a] To be decided.

B.2 FDX-B TEC

B.2.1 General

The FDX-B transponder emulation circuit can be built from standard components that are commercially available. The circuit diagram is shown in Figure B.1 and the component characteristic values are specified in Table B.2.



Key

1 coil

2 antenna pattern

D1…D4 diodes, 1N4148

N1 transistor, BC 546B

N2 transistor, BC 556B

NOTE See Table B.2.

Figure B.1 — FDX-B transponder emulation circuit diagram

Table B.2 — TEC component values

Component	Value	Description/comment
C_1	3,5 pF to 22 pF	Trimmer for adjusting resonance frequency
C_2	200 pF (2//100)	Use NP0 capacitors
C_3	10 nF	
R_1	430 kΩ	
R_2	51 kΩ	
R_3	20 kΩ	
R_{MOD}	1,8 kΩ	
R_V	1 kΩ	
R_Q	100 kΩ to 220 kΩ	Trimmer for a resulting Q_{LC} of 30

B.2.2 Set-up and trimming procedure for the FDX-B emulation

Place the TEC in a continuous RF field and measure voltage, V_{DC}, with a high impedance (> 10 MΩ) voltmeter. The distance between the transceiver coil and the reference air coil shall be fixed so that a V_{DC} value of around 2 V is obtained. Adjust trimmer, R_Q, for a resulting quality factor, Q_{LC}, of 30 and trimmer C_1 to obtain the maximum V_{DC} during the resonance frequency trimming.

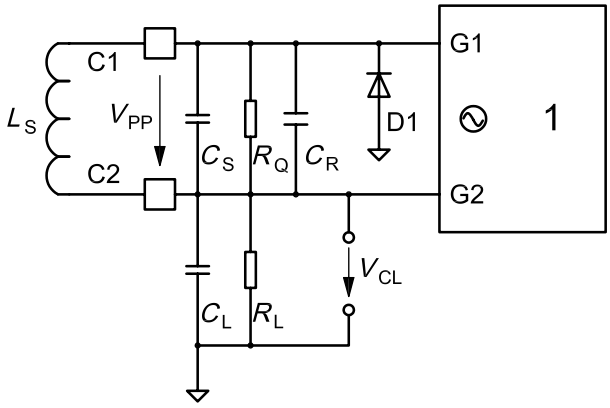
The aim is to simulate the worst-case situation for the FDX-B reading distance, corresponding to operation at close to minimum activation field strength. This minimum field strength generates a threshold voltage at V_{DC}. The field strength parameter is defined as a *reading distance* curve whenever the threshold voltage is reached.

This threshold voltage is attained when $V_{DC} = 1{,}3$ V. The sensitivity parameter is defined as the reading distance whenever the TUT receives and correctly decodes the signal emitted by the TEC. Owing to this, the 128 bit pattern generator shall be triggered whenever the threshold voltage at V_{DC} is reached. Provisions shall be taken to ensure that the advanced waveform generator (AWG) is synchronized to the 134,2 kHz carrier of the TUT's activation field.

B.3 HDX TEC

B.3.1 General

The HDX transponder emulation circuit can be built from standard components that are commercially available. The circuit diagram is shown in Figure B.2 and the component characteristic values specified in Table B.3.



Key

1	advanced waveform generator (AWG)
C1, C2	coils 1 and 2
D1	diode 1, 1N4148
G1, G2	generators 1 and 2

NOTE See Table B.2.

Figure B.2 — HDX transponder emulation circuit diagram

Table B.3 — HDX TEC component values

Characteristic	Value	Description/comment
C_S	560 pF	Use NP0 capacitors
C_R	3,5 pF to 22 pF	Trimmer
C_L	120 nF	
R_L	2,2 MΩ	
R_Q	100 kΩ to 220 kΩ	Trimmer for a resulting Q_{LC} of 60

B.3.2 Working principle

An AWG drives the HDX transponder emulation circuit with its standard 50 Ω output so that the worst-case situation of the return signal is simulated. The AWG stimulates the NRZ-encoded, FSK-modulated return signal at (124 ± 2) kHz to transmit a binary "1" and (134,2 ± 1,5) kHz to transmit a binary "0". The duration of each bit is defined to last 16 cycles. The AWG generates the data stream either on its own or driven by an external controller, delivering the binary information of a 112 bit data telegram as defined in ISO 11784 and ISO 11785.

B.3.3 Set-up and trimming procedure for the HDX-B emulation

Place the HDX TEC, without connecting the AWG, in a continuous RF field and measure voltage V_{CL} with a high impedance (> 10 MΩ) voltmeter. The distance between the reader coil and the reference air coil shall be fixed so that a V_{CL} value of around 2 V is obtained. Adjust trimmer C_R to obtain the maximum V_{CL} for resonance frequency trimming, and trimmer R_Q for a resulting quality factor, Q_{LC}, of 60.

The minimum activation field strength for HDX may be determined by disconnecting the AWG and checking that the minimum supply voltage at the end of the 50 ms charge phase is $V_{CL} = 5$ V. The field strength parameter is defined as the *reading distance* curve whenever this minimum voltage is reached. The aim is to simulate the worst-case situation for the HDX reading distance, corresponding to the situation at the end of the data transmission. Owing to this, the AWG output level shall be adjusted for a V_{PP} of 4 V at the coil pins, which is equivalent to a minimum supply voltage, V_{CL}, from the storage capacitor, in volts:

$$V_{CL} = V_{PP}/2 - V_{D1}$$

$$V_{CL} = 4/2 - 0{,}5 = 1{,}5$$

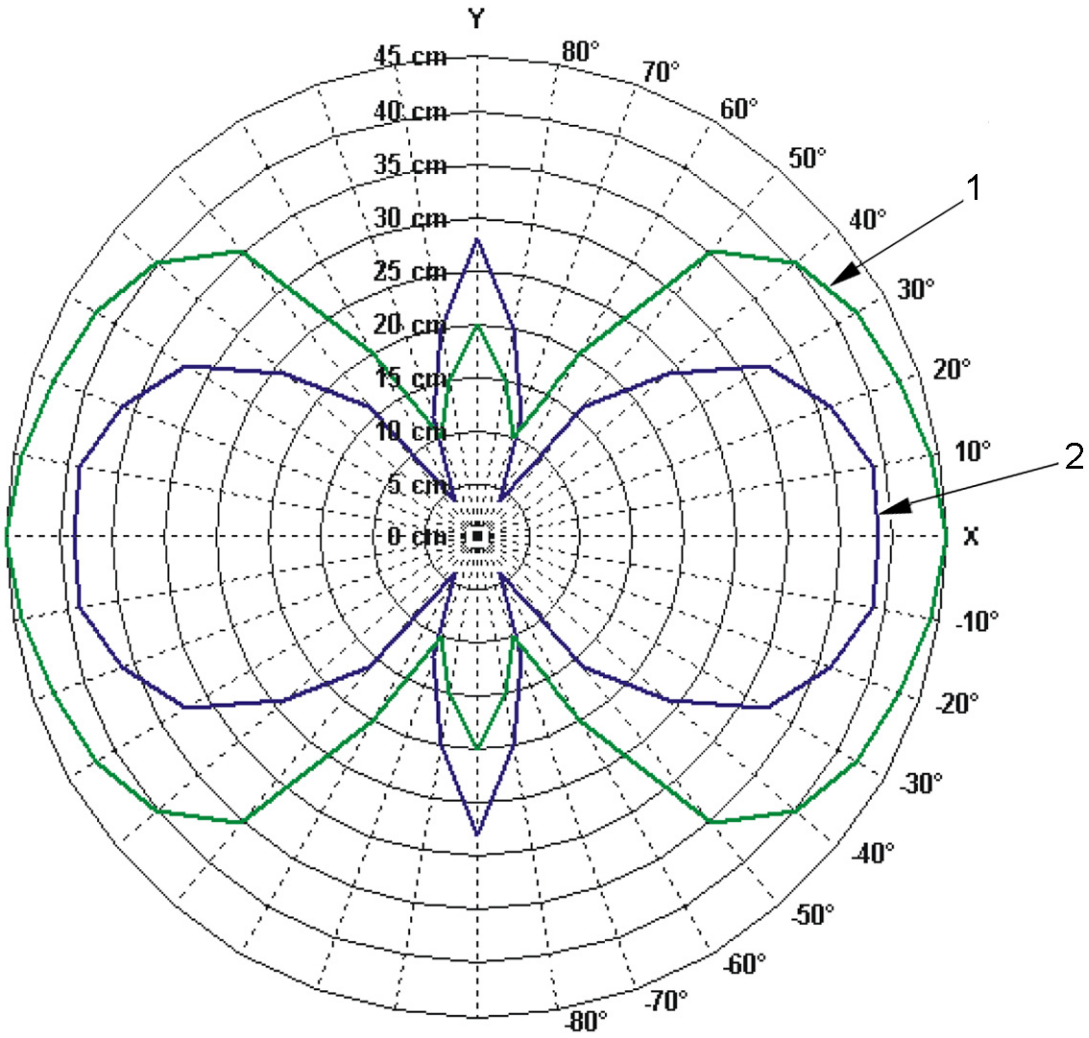
Measure V_{CL} with a high impedance (> 10 MΩ) d.c. voltmeter at C_L and set up the AWG output accordingly. The sensitivity parameter is defined as the reading distance whenever the TUT receives and correctly decodes the signal emitted by the TEC.

Provisions shall be taken to ensure that the AWG is triggered to emit the data stream after the TUT's 50 ms charge phase (134,2 kHz) is terminated according to the time slots specified in ISO 11785.

Annex C
(informative)

Example of distance diagram

See Figure C.1.



Key

1 transponder type 1

2 transponder type 2

Figure C.1 — Transceiver sensitivity in X–Y plane

Bibliography

[1] *International agreement of recording practices*. ICAR Guidelines approved by the General Assembly held in Kuopio, Finland on 9 June 2006

[2] ERC recommendation 70-03, *Relating to the Use of Short Range Devices* (SRD)[1)]

[3] ISO/IEC 17000, *Conformity assessment — Vocabulary and general principles*

[4] EN 300 330, *ElectroMagnetic Compatibility and Radio Spectrum Matters (ERM); Short Range Devices (SRD); Technical characteristics and test methods for radio equipment in the frequency range 9 kHz to 25 MHz and inductive loop systems in the frequency range 9 kHz to 30 MHz*[2)]

1) CEPT (Conférence Européenne des Administrations des Postes et des Télécommunications) publication.

2) European Telecommunications Standards Institute (ETSI) standard.

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