TECHNICAL REPORT

ISO/IEC TR 18047-6

First edition
2006-06-01

Information technology — Radio frequency identification device conformance test methods —

Part 6:
Test methods for air interface communications at 860 MHz to 960 MHz

Technologies de l'information —

Méthodes d'essai de conformité du dispositif d'identification de radiofréquence —

Partie 6: Méthodes d'essai pour des communications d'une interface d'air à 860 MHz et jusqu'à 960 MHz

Reference number
ISO/IEC TR 18047-6:2006(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

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

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

In exceptional circumstances, the joint technical committee may propose the publication of a Technical Report of one of the following types:

— type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

— type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;

— type 3, when the joint technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

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

ISO/IEC TR 18047-6, which is a Technical Report of type 2, was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

ISO/IEC TR 18047 consists of the following parts, under the general title *Information technology — Radio frequency identification device conformance test methods*:

— *Part 2: Test methods for air interface communications below 135 kHz*

— *Part 3: Test methods for air interface communications at 13,56 MHz*

— *Part 4: Test methods for air interface communications at 2,45 GHz*

— *Part 6: Test methods for air interface communications at 860 MHz to 960 MHz*

— *Part 7: Test methods for active air interface communications at 433 MHz*

Introduction

ISO/IEC 18000 defines the air interfaces for radio frequency identification (RFID) devices used in item management applications. ISO/IEC 18000-6 defines the air interface for these devices operating at frequencies from 860 MHz to 960 MHz.

The purpose of ISO/IEC TR 18047 is to provide test methods for conformance with the various parts of ISO/IEC 18000.

Each part of ISO/IEC TR 18047 contains all measurements required to be made on a product in order to establish whether it conforms to the corresponding part of ISO/IEC 18000. For this part of ISO/IEC TR 18047, each interrogator needs to be assessed for operation with both types A and B, while each tag is only required to support at least one of the types A or B.

It should be noted that measurement of tag and interrogator performance is covered by ISO/IEC TR 18046.

Information technology — Radio frequency identification device conformance test methods —

Part 6:
Test methods for air interface communications at 860 MHz to 960 MHz

1 Scope

This part of ISO/IEC TR 18047 defines test methods for determining the conformance of radio frequency identification devices (tags and interrogators) for item management with the specifications given in ISO/IEC 18000-6, but does not apply to the testing of conformity with regulatory or similar requirements.

The test methods require only that the mandatory functions, and any optional functions which are implemented, be verified. This may, in appropriate circumstances, be supplemented by further, application-specific functionality criteria that are not available in the general case.

The interrogator and tag conformance parameters in this part of ISO/IEC TR 18047 are the following:

- type-specific conformance parameters including nominal values and tolerances;
- parameters that apply directly affecting system functionality and inter-operability.

The following are not included in this part of ISO/IEC TR 18047:

- parameters that are already included in regulatory test requirements;
- high-level data encoding conformance test parameters (these are specified in ISO/IEC 15962).

Unless otherwise specified, the tests in this part of ISO/IEC TR 18047 are to be applied exclusively to RFID tags and interrogators defined in ISO/IEC 18000-6.

Clause 4 describes all necessary conformance tests.

2 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/IEC 18000-6: *Information technology — Radio frequency identification for item management — Part 6: Parameters for air interface communications at 860 MHz to 960 MHz*
- ISO/IEC 19762, (all parts), *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary*
- ISBN 92-67-10188-9, 1993, *ISO Guide to the expression of uncertainty in measurement*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19762 apply.

3.2 Symbols

For the purposes of this document, the symbols given in ISO/IEC 19762 and the following apply.

D Modulation depth of data coding pulse

M Modulation Index

Tf Fall time

Tr Rise Time

3.3 Abbreviated terms

For the purposes of this document, the abbreviated terms given in ISO/IEC 19762 and the following apply.

DUT Device under test

RCS Radar cross section

∆RCS Change in radar cross section

RBW Resolution Bandwidth

VBW Video Bandwidth

4 Conformance tests for ISO/IEC 18000-6— 860 to 960 MHz

4.1 General

This part of ISO/IEC TR 18047 specifies a series of tests to determine the conformance of interrogators and tags. The results of these tests shall be compared with the values of the parameters specified in ISO/IEC 18000-6 to determine whether the interrogator or tag under test conforms.

For Part 6, each interrogator needs to be assessed for operation with both types A and B, while each tag is only required to support at least one of the types A or B.

4.2 Default conditions applicable to the test methods

4.2.1 Test environment

Unless otherwise specified, testing shall take place in an environment of temperature 23 ° +/- 3 °C and of non-condensing humidity from 40 % to 60 %

4.2.2 Pre-conditioning

Where pre-conditioning is required by the test method, the identification tags to be tested shall be conditioned to the test environment for an appropriate time period, which shall be recorded.

4.2.3 Default tolerance

Unless otherwise specified, a default tolerance of ± 5 % shall be applied to the quantity values given to specify the characteristics of the test equipment (e.g. linear dimensions) and the test method procedures (e.g. test equipment adjustments).

4.2.4 Noise floor at test location

Noise floor at test location shall be measured with the spectrum analyser in the same conditions as the measurement of the DUT, with a span of 10 MHz: RBW, VBW and antenna.

The spectrum analyser shall be configured in acquisition for at least 1 minute.

The maximum of the measured amplitude shall be 20 dB below the value of the amplitude of the measured tag backscatter operating at minimum power ($P_{I,min}$, see clause 4.6.2.2), and the tag placed at 10 λ from the measurement antenna.

Special attention has to be given to spurious emissions, e.g., insufficiently shielded computer monitors. The electromagnetic test conditions of the measurements shall be checked by performing the measurements with and without a tag in the field.

4.2.5 Total measurement uncertainty

The total measurement uncertainty for each quantity determined by these test methods shall be stated in the test report.

NOTE Basic information is given in “ISO Guide to the expression of uncertainty in measurement”, ISBN 92-67-10188-9, 1993.

4.3 Setup of equipment for interrogator tests

4.3.1 General

The DUT shall be an interrogator including an antenna.

All conformance measurements and setups shall be done in an anechoic chamber as defined in Annex A.

Dependent of the regulatory requirements all measurements shall be done at one of the test frequencies in Table 1.

Table 1 — Test frequencies

Test carrier frequency	Comment
866 MHz	Recommended for tests under European regulations
910 MHz	Recommended for tests under Korean or US regulations
922 MHz	Recommended for tests under Australian regulations
953 MHz	Recommended for tests under Japan regulations

NOTE With the test frequencies specified in Table 1 all frequencies of the entire band from 860 MHz to 960 MHz are within ± 2,5 % of one of the test frequencies.

4.3.2 Sense antenna

Where applicable, tests shall be carried out using a sense antenna, which shall be a substantially non-reactive non-radiating load of 50 Ω equipped with an antenna connector. The Voltage Standing Wave Ratio (VSWR) at the 50 Ω connector shall not be greater than 1,2 : 1 over the frequency range of the measurement.

4.3.3 Interrogator modulation test setup

For this test the sense antenna shall always be placed and orientated for optimum field strength reception in the direction of the major power radiation of the interrogator antenna according Figure 1 at a distance d_S which is defined in clause 4.5.1.2.

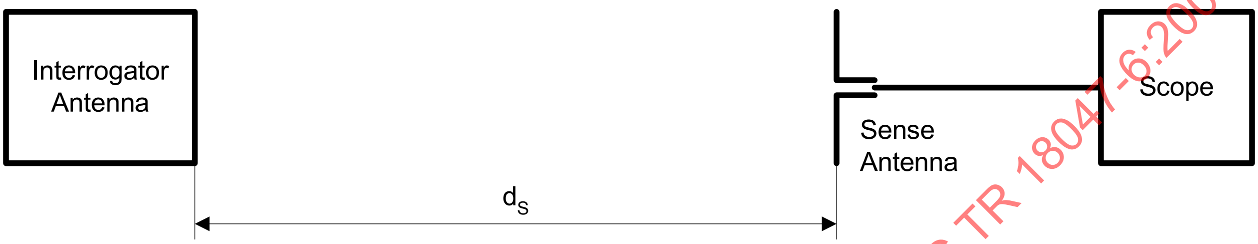


Figure 1 — Interrogator modulation test setup

4.3.4 Interrogator demodulation and turn around time test setup

For this test the tag emulator as defined in Annex E shall be placed and orientated for optimum field strength reception in the direction of the major power radiation of the interrogator according Figure 2 at a distance d_{TE}, which is defined in clause 4.5.2.2.

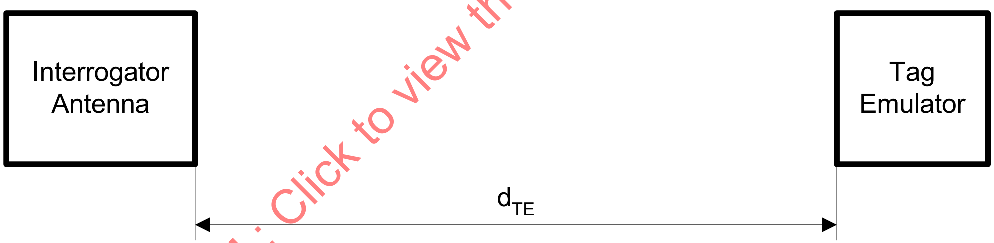


Figure 2 — Interrogator demodulation and turn around test setup

4.4 Setup of equipment for tag tests

4.4.1 General

The DUT shall be a tag including all means in order to be capable to communicate with an interrogator.

When tests require use of an interrogator this shall be an interrogator including antenna that conforms to ISO/IEC 18000-6 according to the methods defined in this part of ISO/IEC TR 18047, or it shall be a numerical generator including antenna. Furthermore, the interrogator shall support the minimum tag response to interrogator command turn around time.

The interrogator antenna shall fulfil the specification of Table 2.

Table 2 — Interrogator antenna requirements for tag tests

Symbol	Parameter	Minimum Value	Maximum Value
L	Maximum Interrogator antenna dimension	0,1 m	$\sqrt{\frac{\lambda\, d_T}{2}}$
G_I	Interrogator antenna gain	2 dBi	8 dBi

All conformance measurements and setups shall be done in an anechoic chamber as defined in Annex A.

Dependent of the regulatory requirements all measurements shall be done at either of the test frequencies in Table 1.

4.4.2 Tag demodulation and turn around time test setup

For this test the tag shall be placed and oriented for optimum field strength reception in the direction of the major power radiation of the interrogator in a distance

$$d_{T,IA} > \frac{2L^2}{\lambda}\,,\; d_{T,MA} > \frac{2L^2}{\lambda}$$

with L being the maximum dimension of the interrogator antenna according Figure 3.

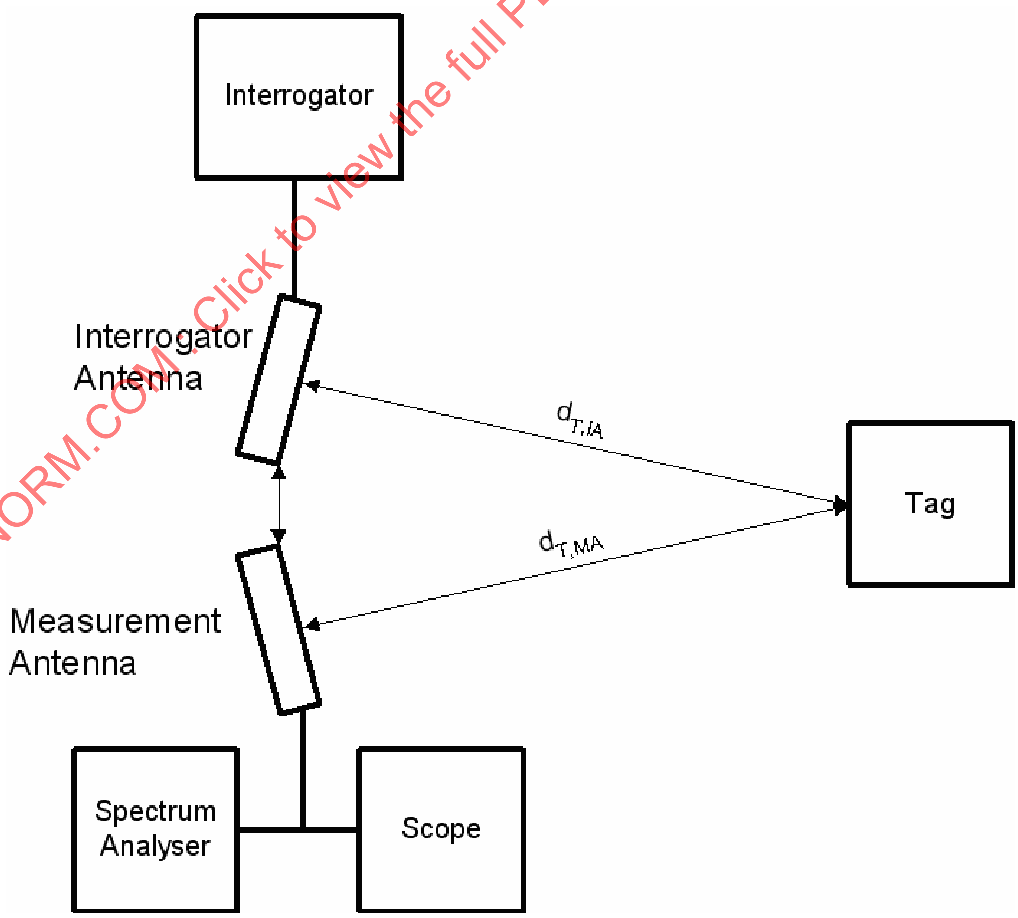


Figure 3 — Tag demodulation test setup

4.4.3 Tag backscatter test setup

For this test the test interrogator antenna setup, where the interrogator may alternately also be realized with a vector signal generator according Annex G, shall consist of a set of two mechanically assembled antennas specifically designed to reduce the signal coupling between each other. One shall be used as interrogator antenna while the second, shall be used as measurement antenna and shall be connected either to a spectrum analyser or to an oscilloscope as specified according Annex C.

The main lobe axis of these two antennas cross each other with an angle value that shall be lower than 15°. The tag under test shall be placed at this focal point and oriented for optimum field strength reception.

The distances between the tag and the antennas are $d_{T,IA}$ and $d_{T,MA}$ respectively.

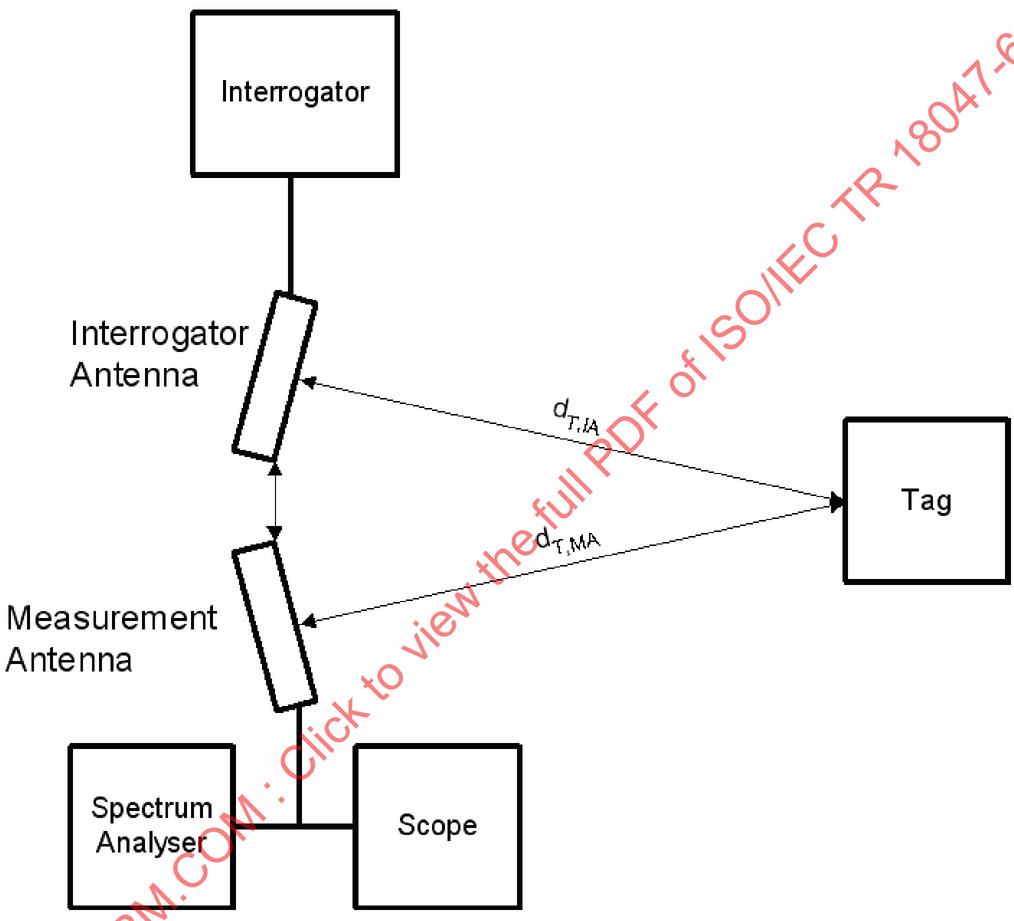


Figure 4 — Tag backscatter test setup

Table 3 — Tag backscatter setup parameters

Symbol	Name	Description
$d_{T,IA}$	Interrogator antenna to tag distance	
$d_{T,MA}$	Measurement antenna to tag distance	
G_{IA}	Gain of interrogator antenna	The maximum antenna opening value, measured at -3 dB gain of the maximum gain shall be +/- 30°
G_{MA}	Gain of measurement antenna	The maximum antenna opening value, measured at -3 dB gain of the maximum gain shall be +/- 30°

The residual signal coupling between the two antennas shall be less as an isolation value of 45dB

L shall be the greater value of the Interrogator and Measurement Antenna.

The spectrum analyser shall be to a RBW of 30 kHz, a VBW of 100 kHz. The minimum span should be at least 1 MHz or 8 times the data rate, whichever is greater. The frequency analyser shall use max peak detection.

For this test the tag shall be setup to provide only one modulation frequency. Therefore the tag shall except for the preamble, only reply with a bit stream of zero data bits.

4.4.4 Tag response time

The setup for this test shall be as described in chapter 4.4.2.

4.4.5 Tag bit rate accuracy test setup

The setup for this test shall be as described in chapter 4.4.2.

4.4.6 Tag state storage time test setup

The setup for this test shall be as described in chapter 4.4.2.

4.5 Functional tests of interrogator

4.5.1 Interrogator modulation test

4.5.1.1 Test objective

The objective of this test is to verify that the interrogator provides the appropriate modulation waveform required for operation of tags.

4.5.1.2 Test procedure

The interrogator shall transmit a mandatory command according Table 4 at the maximum power allowed under the regulations of the selected carrier frequency for testing.

Table 4 — Mandatory commands to be used for the different types

Type	Command	Command Coding
A	Init_round_all	See clause B.1.1
B	GROUP_SELECT_EQ	See clause B.2.1

In case the interrogator is intended for operation of non-overlapping RF bands, then this test shall be done for each RF band.

Measurements shall be done with a sense antenna positioned at a distance $d_S = 3\lambda$ and $d_S = 10\lambda$ and for each operation mode.

A digital oscilloscope as specified in Annex C and the sense antenna shall be used to record the waveform provided by the interrogator.

4.5.1.3 Test report

The test report shall give the measured values of the parameters according Table 5 for type A and according Table 6 for type B. The pass/fail condition is determined whether the measured values are within the requirements as specified in ISO/IEC 18000-6. Furthermore, the DUT and the sense antenna orientation and position, as well as the used interrogator output power and the used operation frequency shall be recorded.

Table 5 — Measurements to be made for type A

Type	Parameter	Conditions
A	D	Default modulation operation mode
A	Tapr	Default modulation operation mode
A	Tapf	Default modulation operation mode

Table 6 — Measurements to be made for type B

Type	Parameter	Conditions
B	M	Low index interrogator modulation mode
B	Tr	Low index interrogator modulation mode
B	Tf	Low index interrogator modulation mode
B	M	High index interrogator modulation mode
B	Tr	High index interrogator modulation mode
B	Tf	High index interrogator modulation mode

4.5.2 Interrogator demodulation and turn around time

4.5.2.1 Test objective

The objectives of this test are to verify whether the interrogator is capable of:

— demodulating signals from the tags

— receiving the data transmitted by the tag emulator after the minimum specified turn-around time

4.5.2.2 Test procedure

The interrogator shall transmit a mandatory command according Table 7 at the maximum power allowed under the regulations of the selected carrier frequency for testing.

Table 7 — Mandatory commands to be used for the different types

Type	Command	Command Coding	Response Coding
A	Init_round_all	See clause B.1.1	See clause B.1.1
B	GROUP_SELECT_EQ	See clause B.2.1	See clause B.2.1

After the command provided by the interrogator has been sent and after the minimum turn around time, a tag emulator as specified in Annex E shall transmit a typical response to the command according Table 7 at a minimum ΔRCS specified in ISO/IEC 18000-6 Tag: 7d. The tag emulator does not need to demodulate the command, but shall only detect its end to respond after the minimum turn-around time.

When the interrogator is intended for operation of non-overlapping RF bands this test shall be done for each RF band.

Measurements shall be done with a tag emulator positioned at $d_{TE} = 10\ \lambda$ for both the minimum and maximum tag response data rate, i.e. the turn around time from interrogator command to tag response.

In case the interrogator is design for shorter communication distances, then the distance d_{TE} may be decreased and the actual used value shall be mentioned in test report.

The interrogator (digital) demodulator shall accept the tag response including verification of the CRC.

4.5.2.3 Test report

The test report shall contain the tag emulator distance to the interrogator and the ΔRCS value setup in the tag emulator. Furthermore, also the set up turnaround time from the tag emulator, the DUT and the tag emulator orientation and position, as well as the used interrogator output power and the used operation frequency shall be recorded.

4.6 Functional tests of tag

4.6.1 Tag demodulation and turn around time

4.6.1.1 Test objective

The objectives of this test are to verify whether the tag is capable of:

— demodulating signals from the interrogator

— receiving the data transmitted by the interrogator after the minimum specified response to command turn-around time

4.6.1.2 Test procedure

The test interrogator shall transmit a mandatory command according Table 8.

Table 8 — Mandatory commands to be used for the different types

Type	Command	Command Coding
A	Init_round_all	See clause B.1.1
B	GROUP_SELECT_EQ	See clause B.2.1

The tag (DUT) shall receive the command provided by the interrogator and shall provide an appropriate response. After complete reception of the tag response the interrogator shall generate a new command according Table 9 within the minimum specified turn around time between tag response and interrogator command.

Table 9 — Second Mandatory commands to be used for the different types

Type	Command	Command Coding
A	Next_slot	See clause B.1.2
B	GROUP_SELECT_EQ	See clause B.2.1

Measurements shall be done by verifying that the tag detected the command appropriately by means of evaluation of its response. Measurements shall be done at P_I = 1,2 $P_{I,min}$ or the minimum tag activation power density $S_{T,min}$ for each operation type of the interrogator command data rate.

The power density $S_{T,min}$ is related to the test interrogator radiated power $P_{I,min}$ as following:

$$P_{I,min} = 4\pi d_{T,IA}^2 S_{T,min} \frac{1}{G_{IA}}$$

In case the interrogator is design for shorter communication distances, then the distance d_{TE} may be decreased and the actual used value shall be mentioned in test report.

The test shall be seen as successful, when it could be shown that the tag sent the correct response for both commands including verification of the CRC.

The interrogator waveform shall contain the setups of the waveform for the respective types according Table 10.

Table 10 — Setups of waveforms

Type	Setup number	Setup description	Parameter setting
A	A-1	Minimum modulation depth	D = Dmin
A	A-2	Medium modulation depth	D = (Dmax + Dmin)/2
A	A-3	Maximum modulation depth	D = Dmax
B	B-1	Minimum modulation index for low modulation index operation mode	M = Mmin
B	B-2	Maximum modulation index for low modulation index operation mode	M = Mmax
B	B-3	Minimum modulation index for high modulation index operation mode	M = Mmin
B	B-4	Maximum modulation index for high modulation index operation mode	M ≥ 99% * Mmax

4.6.1.3 Test report

The test result shall be recorded as successful or unsuccessful. The test report shall contain the tag distance to the interrogator. Furthermore, also the set up turn around time from the tag response to interrogator command, the DUT and the interrogator orientation and position, as well as the used interrogator output power and the used operation frequency shall be recorded.

4.6.2 Tag backscatter

4.6.2.1 Test objective

The objective of this test is to verify that the tag provides the appropriate modulation waveform and backscatter strength required to be successfully detected and received by the interrogator.

4.6.2.2 Test procedure

The interrogator shall transmit a mandatory command according Table 11 at the minimum power ($P_{I,min}$) where a successful tag response can be identified with the spectrum analyser.

Table 11 — Mandatory commands to be used for the different types

Type	Command	Command Coding
A	Init_round_all	See clause B.1.1
B	GROUP_SELECT_EQ	See clause B.2.1

Measurements shall be done with a tag positioned $d_{T,IA} = 3\,\lambda$ and $d_{T,MA} = 3\,\lambda$ away from the interrogator antenna at

$$P_I = 1{,}2\,P_{I,min}$$

for each operation mode.

The setup of figure 4 shall be used. The interrogator may be replaces by a vector signal generator according Annex H.

A digital scope as specified in Annex C shall be used to record the waveform provided by the tag.

A spectrum analyser as specified in Annex D shall be used to record the power spectrum responded by the tag.

Delta RCS shall be measured by using the parameters as defined in Table 12.

Using the setup of Figure 4, the RCS is given by the following formula:

$$RCS = \frac{P_M}{P_I} \cdot \left[\frac{4\pi}{\lambda^2} \cdot \frac{(4\pi d_{T,IA}{}^2)}{G_{IA}} \cdot \frac{(4\pi d_{T,MA}{}^2)}{G_{MA}} \right] = \frac{P_M}{P_I} .K$$

Table 12 — Parameters used for Delta RCS test

Symbol	Name	Description
PM	Measured power at the carrier frequency	Power measured by the spectrum analyser at the measurement antenna
PI	Delivered power at the carrier frequency	Power delivered by the Vector Signal Generator
K	Calibration factor	Factor depending on the distances, gains of the antennas and the wavelength.

In order to measure RCS for evaluation of ΔRCS, the following procedure shall be applied for the measurement of the RCS corresponding to the two states of the tag.

- The tag shall shown in Figure 4 shall be placed by the reference antenna described in Annex H.
- The UHF transmission shall be calibrated in order to extract the calibration factor K to be used for the determination of RCS.
- For all following tests the tag to be tested shall be used.
- The interrogator shall send mandatory command according Table 11 and the spectrum analyser shall be setup to measure the tag response with the appropriately selected triggering parameters recording the response maximum and minimum transmission occurring around the carrier frequency.
- The maximum of the recorded value shall be RCS1m.
- The minimum of the recorded value shall be RCS0m.
- RCS1 and RCS0 shall be calculated from RCS1m and RCS0m considering the measured calibration factor K.
- ΔRCS shall be calculated as ΔRCS = RCS1 - RCS0.

In case the interrogator is intended for operation of non-overlapping RF bands, then this test shall be done for each RF band.

4.6.2.3 Test report

The test report shall give the measured values of ΔRCS. The pass/fail condition is determined whether the measured values are within the requirements as specified in figures in ISO/IEC 18000-6 and the evaluated

ΔRCS is at least above the value from ISO/IEC 18000-6. Furthermore, the DUT and the interrogator orientation and position, as well as the used interrogator output power and the used operation frequency shall be recorded.

4.6.3 Tag response time

4.6.3.1 Test objective

The objective of this test is to verify the tag response time according to Table 13 referencing the parameters in ISO/IEC 18000-6.

Table 13 — Minimum turn-around times for the different types

Type	Parameter
A	Trs
B	Quiet

4.6.3.2 Test procedure

The interrogator shall transmit a mandatory command according Table 14 at the maximum power allowed under the regulations of the selected carrier frequency for testing.

Table 14 — Mandatory commands to be used for the different types

Type	Command	Command Coding
A	Init_round_all	See clause B.1.1
B	GROUP_SELECT_EQ	See clause B.2.1

The measurements shall be done using the tag backscatter test setup, the tag positioned $d_{T,IA} = 3\ \lambda$ and $d_{T,MA} = 3\ \lambda$ away from the test interrogator antennas.

The response time shall be measured by a scope as specified in Annex C.

NOTE An example for the measurements is given in clause F.1.

4.6.3.3 Test report

The test report shall give the measured values of turn around time. The pass/fail condition is determined whether the measured values are within the requirements for the response time specified to the respective part.

4.6.4 Tag bit rate

4.6.4.1 Test objective

The objective of this test is to verify the bit rate accuracy and data rate of the return link by verification of the parameters listed in Table 15.

Table 15 — Parameters for the different types

Type	Parameter
A	Trlb
B	Trlb

4.6.4.2 Test procedure

The interrogator shall transmit a mandatory command according Table 16 at the maximum power allowed under the regulations of the selected carrier frequency for testing.

Table 16 — Mandatory commands to be used for the different types

Type	Command	Command Coding
A	Init_round_all	See clause B.1.1
B	GROUP_SELECT_EQ	See clause B.2.1

The tag response waveform shall be recorded by a oscilloscope as specified in Annex C using the tag backscatter test setup, the tag positioned $d_{T,IA} = 3\ \lambda$ and $d_{T,MA} = 3\ \lambda$ away from the test interrogator antennas.

The bit rate accuracy shall be measured on the preamble of the tag response for each type respectively.

The average on the first seven bits of preamble shall be used to measure the bite rate accuracy.

4.6.4.3 Test report

The test report shall give the measured values of bit rate calculated according the following formulas:

$$T_{B7} = 7_{Trlb}$$

$$bit\ rate = \frac{7}{7 \cdot T_{B7}}$$

The pass/fail condition is determined whether the measured values are within the requirements as specified in clause 6.5.4 for type A and type B in ISO/IEC 18000-6.

4.6.5 Tag state storage time

4.6.5.1 Test objective

The objective of this test is to verify the state storage time of the tag if the energising field is absent or insufficient.

4.6.5.2 Test procedure

The interrogator shall transmit a mandatory command according Table 17 at the maximum power allowed under the regulations of the selected carrier frequency for testing.

Table 17 — Mandatory commands to be used for the different types

Type	Command
A	Init_round_all
B	READ

After the end of mandatory command sent by the generator, the field shall be shut down for a specified time during two tag states:

For type A the following shall be done:

a) Quiet state

The test shall be executed for shutoff time equal to the lower limit value of time defined in ISO/IEC 18000-6 on which the tag has to keep the Quiet-state.

b) Other states

The test shall be executed for shutoff time equal to the lower limit value of time defined in ISO/IEC 18000-6 during which the tag has to retain its state.

NOTE An example for the measurements is given in clause F.2

For type B the following shall be done:

— The test shall be executed for a shutoff time of t_{DE_SB} defined in ISO/IEC 18000-6 and the flag DE_SB shall be still be set when verified.

4.6.5.3 Test report

The test report shall give the tested values of limit storage state time. The pass/fail condition is determined whether the measured values are within the requirements in the ISO/IEC 18000-6 Timing Specification for Tag state storage for Type A and t_{DE_SB} for Type B.

Annex A
(informative)

Test measurement site

A.1 Test sites and general arrangements for measurements involving the use of radiated fields

This annex describes the three most commonly available test sites, an anechoic chamber, an anechoic chamber with a ground plane and an Open Area Test Site (OATS), which may be used for radiated tests. These test sites are generally referred to as free field test sites. Both absolute and relative measurements can be performed in these sites. Where absolute measurements are to be carried out, the chamber should be verified.

NOTE: To ensure reproducibility and tractability of radiated measurements only these test sites should be used in measurements in accordance with the present document.

A.1.1 Anechoic chamber

An anechoic chamber is an enclosure, usually shielded, whose internal walls, floor and ceiling are covered with radio absorbing material, normally of the pyramidal urethane foam type. The chamber usually contains an antenna support at one end and a turntable at the other. A typical anechoic chamber is shown in figure A.1.

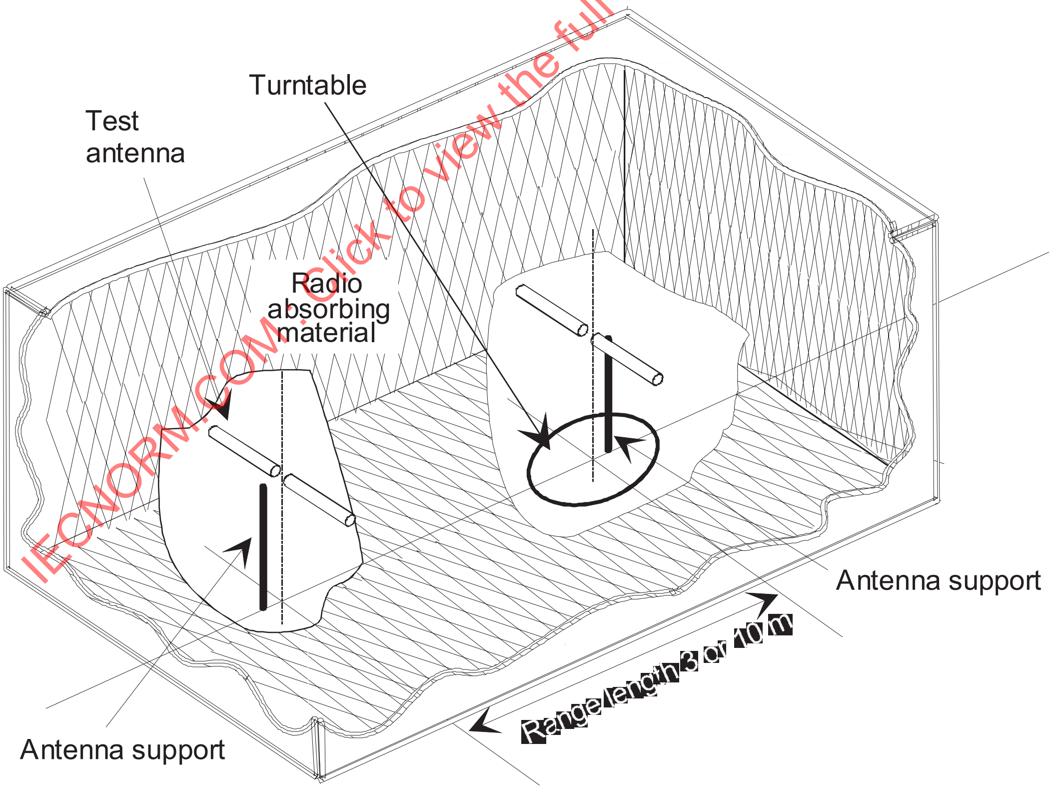


Figure A.1 — A typical Anechoic Chamber

The chamber shielding and radio absorbing material work together to provide a controlled environment for testing purposes. This type of test chamber attempts to simulate free space conditions.

The shielding provides a test space, with reduced levels of interference from ambient signals and other outside effects, whilst the radio absorbing material minimizes unwanted reflections from the walls and ceiling which can influence the measurements. In practice it is relatively easy for shielding to provide high levels (80 dB to 140 dB) of ambient interference rejection, normally making ambient interference negligible.

A turntable is capable of rotation through 360° in the horizontal plane and it is used to support the test sample (DUT) at a suitable height (e.g. 1 m.) above the ground plane. The chamber shall be large enough to allow the measuring distance of at least 3 m or $2(d_1+d_2)^2/\lambda$ (m), whichever is greater (see subclause A.2.5). The distance used in actual measurements shall be recorded with the test results.

The anechoic chamber generally has several advantages over other test facilities. There is minimal ambient interference, minimal floor, ceiling and wall reflections and it is independent of the weather. It does however have some disadvantages which include limited measuring distance and limited lower frequency usage due to the size of the pyramidal absorbers. To improve low frequency performance, a combination structure of ferrite tiles and urethane foam absorbers is commonly used.

All types of emission, sensitivity and immunity testing can be carried out within an anechoic chamber without limitation.

A.1.2 Anechoic chamber with a conductive ground plane

An anechoic chamber with a conductive ground plane is an enclosure, usually shielded, whose internal walls and ceiling are covered with radio absorbing material, normally of the pyramidal urethane foam type. The floor, which is metallic, is not covered and forms the ground plane. The chamber usually contains an antenna mast at one end and a turntable at the other. A typical anechoic chamber with a conductive ground plane is shown in figure A.2.

This type of test chamber attempts to simulate an ideal Open Area Test Site whose primary characteristic is a perfectly conducting ground plane of infinite extent.

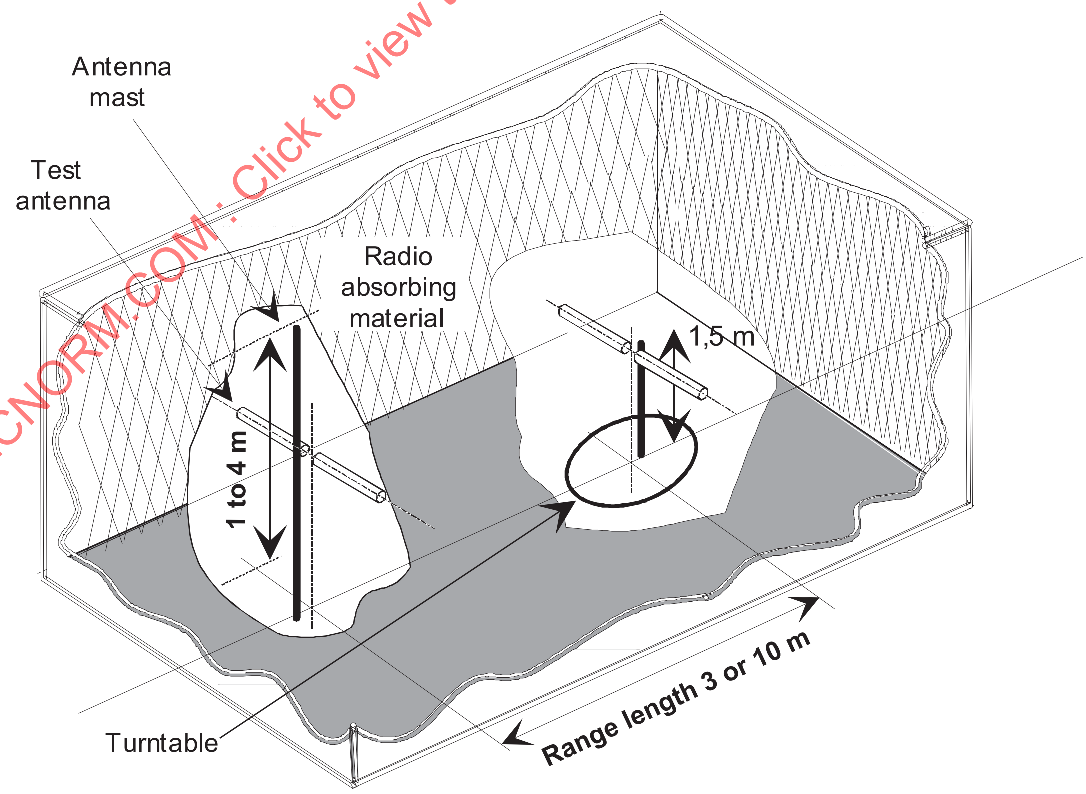


Figure A.2 — A typical Anechoic Chamber with a conductive ground plane

In this facility the ground plane creates the wanted reflection path, such that the signal received by the receiving antenna is the sum of the signals from both the direct and reflected transmission paths. This creates a unique received signal level for each height of the transmitting antenna (or DUT) and the receiving antenna above the ground plane.

The antenna mast provides a variable height facility (from 1 m to 4 m) so that the position of the test antenna can be optimised for maximum coupled signal between antennas or between a DUT and the test antenna.

A turntable is capable of rotation through 360° in the horizontal plane and it is used to support the test sample (DUT) at a specified height, usually 1,5 m. above the ground plane. The chamber shall be large enough to allow the measuring distance of at least 3 m or $2(d_1+d_2)^2/\lambda$ (m), whichever is greater (see subclause A.2.4). The distance used in actual measurements shall be recorded with the test results.

Emission testing involves firstly 'peaking' the field strength from the DUT by raising and lowering the receiving antenna on the mast (to obtain the maximum constructive interference of the direct and reflected signals from the DUT) and then rotating the turntable for a 'peak' in the azimuth plane. At this height of the test antenna on the mast, the amplitude of the received signal is noted. Secondly the DUT is replaced by a substitution antenna (positioned at the DUT's phase or volume centre), which is connected to a signal generator. The signal is again 'peaked' and the signal generator output adjusted until the level, noted in stage one, is again measured on the receiving device.

Receiver sensitivity tests over a ground plane also involve 'peaking' the field strength by raising and lowering the test antenna on the mast to obtain the maximum constructive interference of the direct and reflected signals, this time using a measuring antenna which has been positioned where the phase or volume centre of the DUT will be during testing. A transform factor is derived. The test antenna remains at the same height for stage two, during which the measuring antenna is replaced by the DUT. The amplitude of the transmitted signal is reduced to determine the field strength level at which a specified response is obtained from the DUT.

A.1.3 Open area test site (OATS)

An Open Area Test Site comprises a turntable at one end and an antenna mast of variable height at the other end above a ground plane, which in the ideal case, is perfectly conducting and of infinite extent. In practice, whilst good conductivity can be achieved, the ground plane size has to be limited. A typical Open Area Test Site is shown in figure A.3.

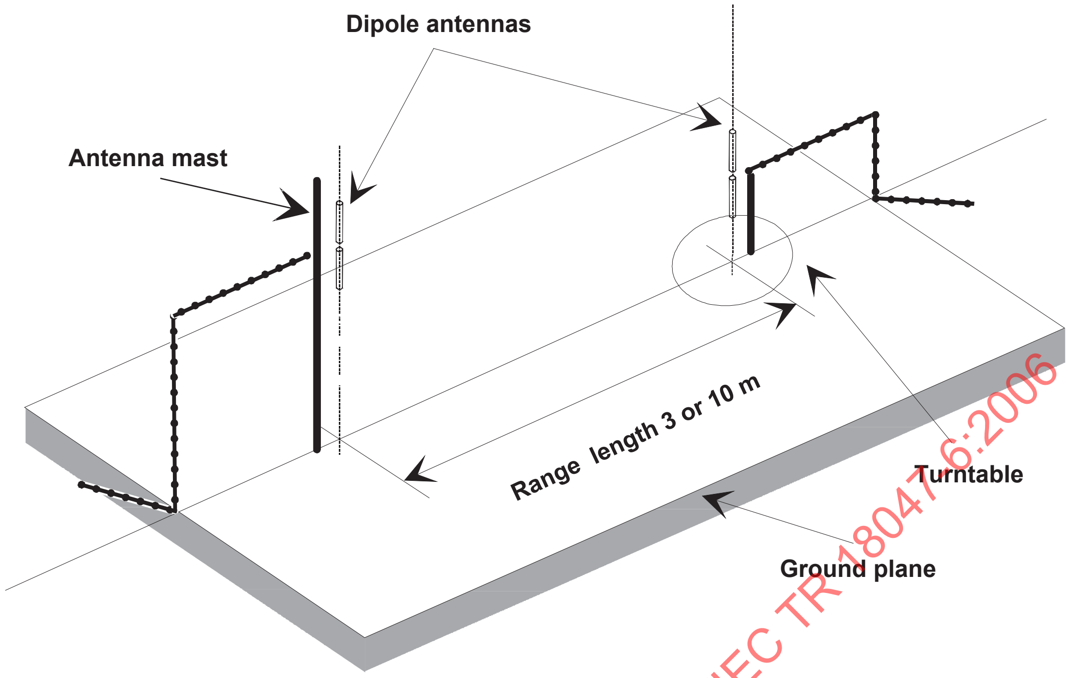


Figure A.3 — A typical Open Area Test Site

The ground plane creates a wanted reflection path, such that the signal received by the receiving antenna is the sum of the signals received from the direct and reflected transmission paths. The phasing of these two signals creates a unique received level for each height of the transmitting antenna (or DUT) and the receiving antenna above the ground plane.

Site qualification concerning antenna positions, turntable, measurement distance and other arrangements are same as for anechoic chamber with a ground plane. In radiated measurements an OATS is also used by the same way as anechoic chamber with a ground plane.

Typical measuring arrangement common for ground plane test sites is presented in the figure A.4.

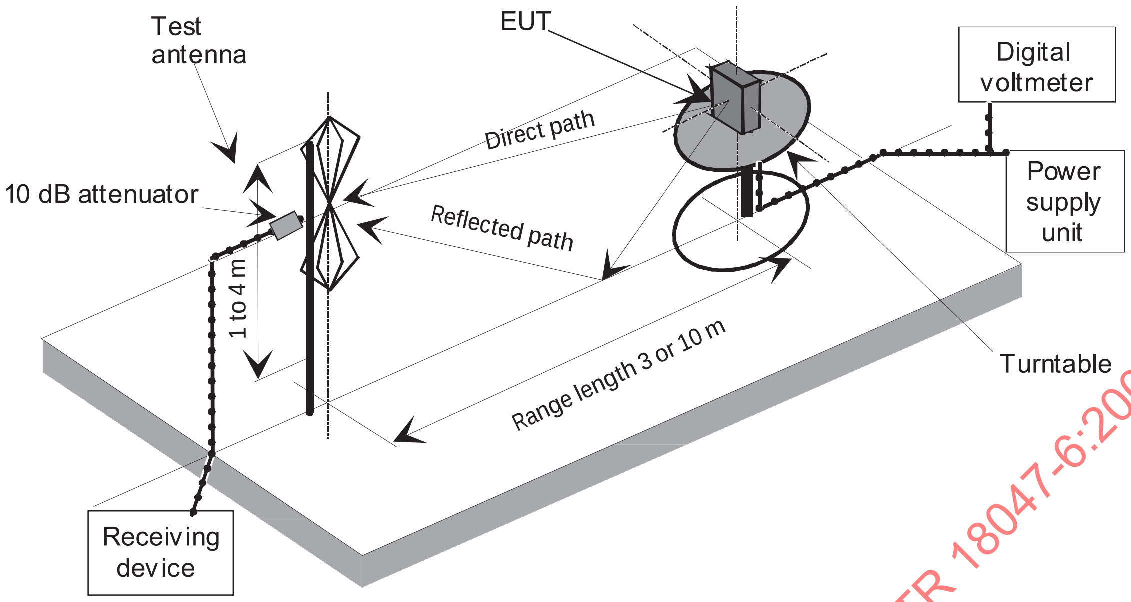


Figure A.4 — Measuring arrangement on ground plane test site (OATS set-up for spurious emission testing)

A.1.4 Test antenna

A test antenna is always used in radiated test methods. In emission tests (i.e. frequency error, effective radiated power, spurious emissions and adjacent channel power) the test antenna is used to detect the field from the DUT in one stage of the measurement and from the substitution antenna in the other stage. When the test site is used for the measurement of receiver characteristics (i.e. sensitivity and various immunity parameters) the antenna is used as the transmitting device.

The test antenna should be mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization which, on ground plane sites (i.e. anechoic chambers with ground planes and Open Area Test Sites), should additionally allow the height of its centre above the ground to be varied over the specified range (usually 1 to 4 metres).

In the frequency band 30 MHz to 1 000 MHz, dipole antennas (constructed in accordance with ANSI C63.5) are generally recommended. For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. For spurious emission testing, however, a combination of bicones and log periodic dipole array antennas (commonly termed 'log periodics') could be used to cover the entire 30 MHz to 1 000 MHz band. Above 1 000 MHz, waveguide horns are recommended although, again, log periodics could be used.

NOTE: The gain of a horn antenna is generally expressed relative to an isotropic radiator.

A.1.5 Substitution antenna

The substitution antenna is used to replace the DUT for tests in which a transmitting parameter (i.e. frequency error, effective radiated power, spurious emissions and adjacent channel power) is being measured. For measurements in the frequency band 30 MHz to 1 000 MHz, the substitution antenna should be a dipole antenna (constructed in accordance with ANSI C63.5). For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. For measurements above 1 000 MHz, a waveguide horn is recommended. The centre of this antenna should coincide with either the phase centre or volume centre.

A.1.6 Measuring antenna

The measuring antenna is used in tests on a DUT in which a receiving parameter (i.e. sensitivity and various immunity tests) is being measured. Its purpose is to enable a measurement of the electric filed strength in the vicinity of the DUT. For measurements in the frequency band 30 MHz to 1000 MHz, the measuring antenna should be a dipole antenna (constructed in accordance with ANSI C63.5). For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. The centre of this antenna should coincide with either the phase centre or volume centre (as specified in the test method) of the DUT.

A.1.7 Stripline arrangement

A.1.7.1 General

The stripline arrangement is a RF coupling device for coupling the integral antenna of an equipment to a 50 Ω radio frequency terminal. This allows the radiated measurements to be performed without an open air test site but in a restricted frequency range. Absolute or relative measurements can be performed; absolute measurements require a calibration of the stripline arrangement.

A.1.7.2 Description

The stripline is made of three highly conductive sheets forming part of a transmission line, which allows the equipment under test to be placed within a known electric field. They shall be sufficiently rigid to support the equipment under test.

Two examples of stripline characteristics are given below:

		IEC 489-3 App. J	FTZ No512 TB 9
Useful frequency range	MHz	1 to 200	0,1 to 4000
Equipment size limits	length	200 mm	1 200 mm
(antenna included):	width	200 mm	1 200 mm
	height	250 mm	400 mm

A.1.7.3 Calibration

The aim of calibration is to establish at any frequency a relationship between the voltage applied by the signal generator and the field strength at the designated test area inside the stripline.

A.1.7.4 Mode of use

The stripline arrangement may be used for all radiated measurements within its calibrated frequency range.

The method of measurement is the same as the method using an open air test site with the following change. The stripline arrangement input socket is used instead of the test antenna.

A.2 Guidance on the use of radiation test sites

This clause details procedures, test equipment arrangements and verification that should be carried out before any of the radiated tests are undertaken. These schemes are common to all types of test sites described in annex A.

A.2.1 Verification of the test site

No test should be carried out on a test site, which does not possess a valid certificate of verification. The verification procedures for the different types of test sites described in annex A (i.e. anechoic chamber, anechoic chamber with a ground plane and Open Area Test Site) are given in TR 102 273, Parts 2, 3 and 4, respectively.

A.2.2 Preparation of the DUT

The manufacturer should supply information about the DUT covering the operating frequency, polarization, supply voltage(s) and the reference face. Additional information, specific to the type of DUT should include, where relevant, carrier power, channel separation, whether different operating modes are available (e.g. high and low power modes) and if operation is continuous or is subject to a maximum test duty cycle (e.g. 1 minute on, 4 minutes off).

Where necessary, a mounting bracket of minimal size should be available for mounting the DUT on the turntable. This bracket should be made from low conductivity, low relative dielectric constant (i.e. less than 1,5) material(s) such as expanded polystyrene, balsa wood, etc.

A.2.3 Power supplies to the DUT

All tests should be performed using power supplies wherever possible, including tests on DUT designed for battery-only use. In all cases, power leads should be connected to the DUT's supply terminals (and monitored with a digital voltmeter) but the battery should remain present, electrically isolated from the rest of the equipment, possibly by putting tape over its contacts.

The presence of these power cables can, however, affect the measured performance of the DUT. For this reason, they should be made to be "transparent" as far as the testing is concerned. This can be achieved by routing them away from the DUT and down to the either the screen, ground plane or facility wall (as appropriate) by the shortest possible paths. Precautions should be taken to minimize pick-up on these leads (e.g. the leads could be twisted together, loaded with ferrite beads at 0,15 m spacing or otherwise loaded).

A.2.4 Range length

The range length for all these types of test facility should be adequate to allow for testing in the far-field of the DUT i.e. it should be equal to or exceed:

$$\frac{2(d_1 + d_2)^2}{\lambda}$$

where:

d_1 is the largest dimension of the DUT/dipole after substitution (m);

d_2 is the largest dimension of the test antenna (m);

λ is the test frequency wavelength (m).

It should be noted that in the substitution part of this measurement, where both test and substitution antennas are half wavelength dipoles, this minimum range length for far-field testing would be:

$$2\lambda$$

It should be noted in the test report when either of these conditions is not met so that the additional measurement uncertainty can be incorporated into the results.

NOTE 1 For the fully anechoic chamber, no part of the volume of the DUT should, at any angle of rotation of the turntable, fall outside the "quiet zone" of the chamber at the nominal frequency of the test.

NOTE 2 The "quiet zone" is a volume within the anechoic chamber (without a ground plane) in which a specified performance has either been proven by test, or is guaranteed by the designer/manufacture. The specified performance is usually the reflectivity of the absorbing panels or a directly related parameter (e.g. signal uniformity in amplitude and phase). It should be noted however that the defining levels of the quiet zone tend to vary.

NOTE 3 For the anechoic chamber with a ground plane, a full height scanning capability, i.e. 1 to 4 m, should be available for which no part of the test antenna should come within 1 m of the absorbing panels. For both types of Anechoic Chamber, the reflectivity of the absorbing panels should not be worse than -5 dB.

NOTE 4 For both the anechoic chamber with a ground plane and the Open Area Test Site, no part of any antenna should come within 0,25 m of the ground plane at any time throughout the tests. Where any of these conditions cannot be met, measurements should not be carried out.

A.2.5 Site preparation

The cables for both ends of the test site should be routed horizontally away from the testing area for a minimum of 2 m (unless, in the case both types of anechoic chamber, a back wall is reached) and then allowed to drop vertically and out through either the ground plane or screen (as appropriate) to the test equipment. Precautions should be taken to minimize pick up on these leads (e.g. dressing with ferrite beads, or other loading). The cables, their routing and dressing should be identical to the verification set-up.

NOTE For ground reflection test sites (i.e. anechoic chambers with ground planes and Open Area Test Sites), which incorporate a cable drum with the antenna mast, the 2 m requirement may be impossible to comply with.

Calibration data for all items of test equipment should be available and valid. For test, substitution and measuring antennas, the data should include gain relative to an isotropic radiator (or antenna factor) for the frequency of test. Also, the VSWR of the substitution and measuring antennas should be known.

The calibration data on all cables and attenuators should include insertion loss and VSWR throughout the entire frequency range of the tests. All VSWR and insertion loss figures should be recorded in the log book results sheet for the specific test.

Where correction factors/tables are required, these should be immediately available.

For all items of test equipment, the maximum errors they exhibit should be known along with the distribution of the error e.g.:

- cable loss: ± 0,5 dB with a rectangular distribution;
- measuring receiver: 1,0 dB (standard deviation) signal level accuracy with a Gaussian error distribution.

At the start of measurements, system checks should be made on the items of test equipment used on the test site.

A.3 Coupling of signals

A.3.1 General

The presence of leads in the radiated field may cause a disturbance of that field and lead to additional measurement uncertainty. These disturbances can be minimized by using suitable coupling methods, offering signal isolation and minimum field disturbance (e.g. optical and acoustic coupling).

A.3.2 Data Signals

Isolation can be provided by the use of optical, ultra sonic or infra red means. Field disturbance can be minimized by using a suitable fibre optic connection. Ultra sonic or infra red radiated connections require suitable measures for the minimization of ambient noise.

A.4 Standard test position

The standard position in all test sites, except the stripline arrangement, for equipment which is not intended to be worn on a person, including hand held equipment, shall be on a non conducting support, height 1,5 m, capable of rotating about a vertical axis through the equipment. The standard position of the equipment shall be the following:

a) for equipment with an internal antenna, it shall be placed in the position closest to normal use as declared by the manufacturer;

b) for equipment with a rigid external antenna, the antenna shall be vertical;

c) for equipment with a non rigid external antenna, the antenna shall be extended vertically upwards by a non conducting support.

Equipment, which is intended to be worn on a person, may be tested using a simulated man as support.

The simulated man comprises a rotatable acrylic tube filled with salt water, placed on the ground.

The container shall have the following dimensions:

- Height: 1,7 ± 0,1 m;
- Inside diameter: 300 ± 5 mm;
- Sidewall thickness: 5 ± 0,5 mm.

The container shall be filled with a salt (NaCl) solution of 1,5 g per litre of distilled water.

The equipment shall be fixed to the surface of the simulated man, at the appropriate height for the equipment.

NOTE: To reduce the weight of the simulated man it may be possible to use an alternative tube, which has a hollow centre of 220 mm maximum diameter.

In the stripline arrangement the equipment under test or the substitution antenna is placed in the designated test area in the normal operational position, relative to the applied field, on a pedestal made of a low dielectric material (dielectric constant less than 2).

A.5 Test fixture

The test fixture is only needed for the assessment of integral antenna equipment

A.5.1 Description

The test fixture is a radio frequency coupling device associated with an integral antenna equipment for coupling the integral antenna to a 50 Ω radio frequency terminal at the working frequencies of the equipment under test. This allows certain measurements to be performed using the conducted measurement methods. Only relative measurements may be performed and only those at or near frequencies for which the test fixture has been calibrated.

In addition, the test fixture may provide:

a) a connection to an external power supply;

b) in the case of assessment of speech equipment, an audio interface either by direct connection or by an acoustic coupler.

In the case of non-speech equipment, the test fixture can also provide the suitable coupling means e.g. for the data output.

The test fixture shall normally be provided by the manufacturer.

The performance characteristics of the test fixture shall be approved by the testing laboratory and shall conform to the following basic parameters:

a) the coupling loss shall not be greater than 30 dB;

b) a coupling loss variation over the frequency range used in the measurement, which does not exceed 2 dB;

c) circuitry associated with the RF coupling shall contain no active or non-linear devices;

d) the VSWR at the 50 Ω socket shall not be more than 1,5 over the frequency range of the measurements;

e) the coupling loss shall be independent of the position of the test fixture and be unaffected by the proximity of surrounding objects or people. The coupling loss shall be reproducible when the equipment under test is removed and replaced;

f) the coupling loss shall remain substantially constant when the environmental conditions are varied.

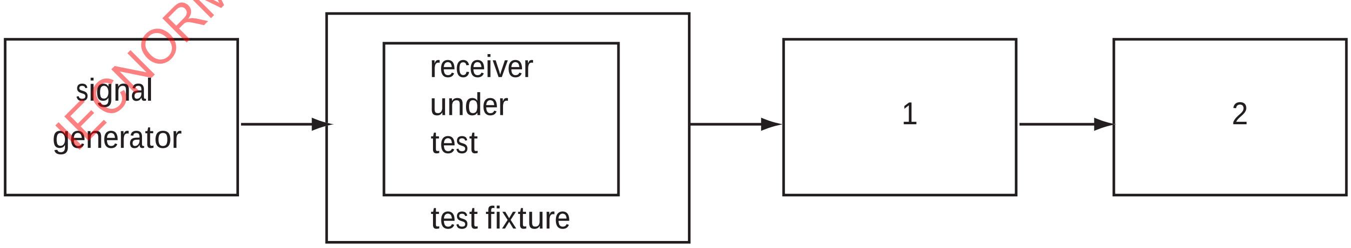
The characteristics and calibration shall be included in the test report.

A.5.2 Calibration

The calibration of the test fixture establishes a relationship between the output of the signal generator and the field strength applied to the equipment placed in the test fixture.

The calibration is valid only at a given frequency and for a given polarization of the reference field.

The actual set-up used depends on the type of the equipment (e.g. data, speech etc.)



1) Coupling device,

2) Device for assessing the performance, e.g. distortion factor, BER measuring device etc.

Figure A.5 — Measuring arrangement for calibration

Method of calibration:

a) Measure the sensitivity expressed as a field strength, as specified in the present document and note the value of this field strength in dBμV/m and the polarization used.

b) Place the receiver in the test fixture, which is connected to the signal generator. The level of the signal generator producing:

- a bit error ratio of 0,01, or
- a message acceptance ratio of 80 %, as appropriate,

shall be noted.

The calibration of the test fixture is the relationship between the field strength in dBμV/m and the signal generator level in dBμV emf. This relationship is expected to be linear.

A.5.3 Mode of use

The test fixture may be used to facilitate some of the measurements in the case of equipment having an integral antenna.

It is used in particular for the measurement of the radiated carrier power and usable sensitivity expressed as a field strength under extreme conditions.

For the transmitter measurements calibration is not required as relative measuring methods are used.

For the receiver measurements calibration is necessary as absolute measurements are used.

To apply the specified wanted signal level expressed in field strength, convert it into the signal generator level (emf) using the calibration of the test fixture. Apply this value to the signal generator.

Annex B
(normative)

Command coding for conformance tests for the different types of ISO/IEC 18000-6

B.1 Command coding for type A

B.1.1 Init_round_all command and response

Table B.1 — Init_round_all command format

Protocol extension	Command	SUID flag	Round size	CRC-5
0 hex	0A hex	0 hex	0 hex	Generated according ISO/IEC 18000-6

Table B.2 — Init_round_all response

Preamble	Flags	Tag type	Battery status	Signature	Random number	First n bits of memory	CRC-16
According ISO/IEC 18000-6	0 hex	Any 1 bit value	Any 1 bit value	Any 4 bit value	Any 8 bit value	According ISO/IEC 18000-6	Checked according ISO/IEC 18000-6

B.1.2 Next slot command and response

Table B.3 — Next_slot command format

Protocol extension	Next_slot	Tag signature	CRC-5
0 hex	02 hex	00 hex	Generated according ISO/IEC 18000-6

B.2 Command coding for type B

B.2.1 GROUP_SELECT_EQ command and response

Table B.4 — GROUP_SELECT_EQ command

Preamble	Delimiter	Command	Address	Mask	WORD_DATA	CRC-16
According ISO/IEC 18000-6	Depending on the intended response data rate either Start delimiter 1 or 2 may be used.	00 hex	00 hex	00 hex	00 00 00 00 00 00 00 00 hex	Generated according ISO/IEC 18000-6

Table B.5 — GROUP_SELECT_EQ response

Preamble	ID	CRC-16
According ISO/IEC 18000-6	Any 64 bit identifier	Checked according ISO/IEC 18000-6bits

Annex C
(normative)

Technical performance of the digital oscilloscope

The digital sampling oscilloscope shall be capable of sampling at a rate of at least 100 million samples per second with a resolution of at least 8 bits at optimum scaling when a diode detector mode is available. If no diode detector is not available then an oscilloscope with 1 GHz bandwidth and 5 Gsamples/s shall be used.

The oscilloscope should have the capability to output the sampled data as a text file to facilitate mathematical and other operations such as windowing on the sampled data using external software programmes.