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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

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

This second edition cancels and replaces the first edition (ISO/IEC 18047-6:2012), which has been technically revised.

The main changes compared to the previous edition are as follows:

— Tag demodulation test setup now includes a monostatic setup with the use of a circulator;

— new tests for Tag link timings T5, T6 and T7 (defined in ISO/IEC 18000-63:2015 and related to delayed and in-process tag reply); and

— new tests related to ISO/IEC 18000-63:2015 like Tag memory overruns, Kill command, unauthorized write commands and optional commands that involve C-flag, ResponseBuffer, security features and untraceability.

Introduction

ISO/IEC 18000 series defines the air interfaces for radio frequency identification (RFID) devices used in item management applications. ISO/IEC 18000-61, ISO/IEC 18000-62, ISO/IEC 18000-63 and ISO/IEC 18000-64 define the air interface for these devices operating at frequencies from 860 MHz to 960 MHz.

ISO/IEC 18047 series provides test methods for conformance with the various parts of the ISO/IEC 18000 series.

Each part of ISO/IEC 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 document, each interrogator and each tag needs to support at least one of the types A or B or C or D.

NOTE Test methods for interrogator and tag performance are covered by ISO/IEC 18046 series.

Clause 5 describes all necessary conformance tests for ISO/IEC 18000-61.

Clause 6 describes all necessary conformance tests for ISO/IEC 18000-62.

Clause 7 describes all necessary conformance tests for ISO/IEC 18000-63.

Clause 8 describes all necessary conformance tests for ISO/IEC 18000-64.

Clause 9 describes all necessary conformance tests for ISO/IEC 18000-63:2015, Clause 7.

Clause 10 describes all necessary conformance tests for ISO/IEC 18000-63:2015, 7.5.

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 document defines test methods for determining the conformance of radio frequency identification (RFID) devices (tags and interrogators) for item management with the specifications given in ISO/IEC 18000-61, ISO/IEC 18000-62, ISO/IEC 18000-63 and ISO/IEC 18000-64, 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, are verified. This can, 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 document are the following:

— type-specific conformance parameters including nominal values and tolerances;

— parameters that apply directly affecting system functionality and inter-operability.

Parameters that are already included in regulatory test requirements are not included in this document.

Unless otherwise specified, the tests in this document are intended to be applied exclusively to RFID tags and interrogators defined in ISO/IEC 18000-61, ISO/IEC 18000-62, ISO/IEC 18000-63 and ISO/IEC 18000-64.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 18000-61:2012, *Information technology — Radio frequency identification for item management — Part 61: Parameters for air interface communications at 860 MHz to 960 MHz Type A*

ISO/IEC 18000-62:2012, *Information technology — Radio frequency identification for item management — Part 62: Parameters for air interface communications at 860 MHz to 960 MHz Type B*

ISO/IEC 18000-63:2015, *Information technology — Radio frequency identification for item management — Part 63: Parameters for air interface communications at 860 MHz to 960 MHz Type C*

ISO/IEC 18000-64, *Information technology — Radio frequency identification for item management — Part 64: Parameters for air interface communications at 860 MHz to 960 MHz Type D*

ISO/IEC 19762, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary*

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.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

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
d_1	distance between the interrogator and test antenna
d_2	distance between test antenna and DUT tag
d_s	distance between the interrogator antenna and sense antenna
$d_{T,IA}$	interrogator antenna to tag distance
$d_{T,MA}$	measurement antenna to tag distance
d_{TE}	distance between the interrogator antenna and tag emulator
G_{IA}	gain of interrogator antenna
G_{MA}	gain of measurement antenna
Icir	isolation of a circulator
K	calibration factor
L	maximum interrogator antenna dimension
M	modulation index
P_I	delivered power at the carrier frequency
P_M	measured power at the carrier frequency
T_f	fall time
T_r	rise time

3.3 Abbreviated terms

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

BLF	backscatter-link frequency (BLF = $1/T_{pri}$ = DR/TRcal)
DUT	device under test
RCS	radar cross-section
ΔRCS	change in radar cross-section
RBW	resolution bandwidth
VBW	video bandwidth

4 Default conditions applicable to the test methods

4.1 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 Pre-conditioning

4.2.1 General

The interrogators and tags to be tested shall be conditioned to the test environment for a period of 24 h before testing.

4.2.2 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).

4.2.3 Noise floor at test location

Noise floor at test location shall be measured for at least 1 min with the spectrum analyser using the same conditions as for the measurement of the DUT.

The maximum of the measured noise amplitude measured in a 10 kHz bandwidth shall be −60 dB from 0,5 GHz to 2 GHz and −90 dBm around the frequency of the main signal of the tag backscatter signal.

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.

4.2.4 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/IEC Guide 98-3.

5 Setup of test equipment

5.1 Setup of test equipment for interrogator tests

5.1.1 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.

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
915 MHz	Recommended for tests under Japan, Korean, Australian or US regulations

NOTE With the test frequencies specified in Table 1, all frequencies of the entire band from 860 MHz to 930 MHz are within ±2,9 % of one of the test frequencies. All practically used frequencies in the frequency bands 860 MHz to 870 MHz, 900 MHz to 930 MHz are within ±1,7 % of the test frequencies.

5.1.2 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 2 : 1 over the frequency range of the measurement.

5.1.3 Test apparatus and test circuits for ISO/IEC 18000-61, ISO/IEC 18000-62 and ISO/IEC 18000-63 interrogator

5.1.3.1 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 DUT interrogator antenna according to Figure 1 at a distance, d_s, of 0,8 m to 1,1 m.

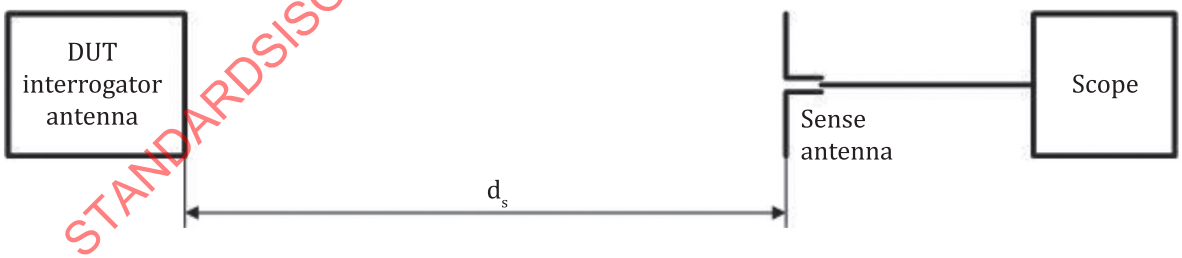


Figure 1 — Interrogator modulation test setup

5.1.3.2 Interrogator demodulation and turn-around time test setup

For this test, the tag emulator as defined in Annex D shall be placed and orientated for optimum field strength reception in the direction of the major power radiation of the DUT interrogator antenna according to Figure 2 at a distance, d_{TE}, of 0,8 m to 1,1 m.

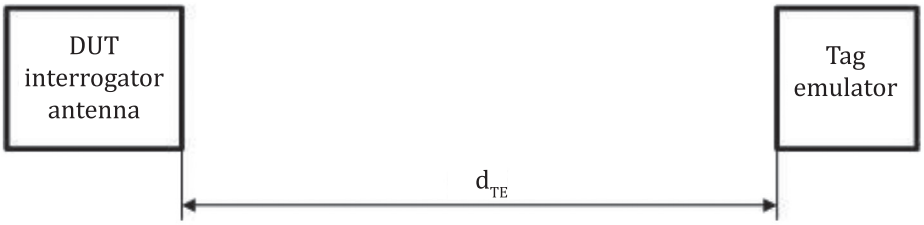


Figure 2 — Interrogator demodulation and turn-around test setup

5.2 Setup of test equipment for tag tests

5.2.1 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 a measurement equipment that fulfills the requirements in order to act as interrogator and in particular it shall support the minimum tag response to interrogator command turn-around time.

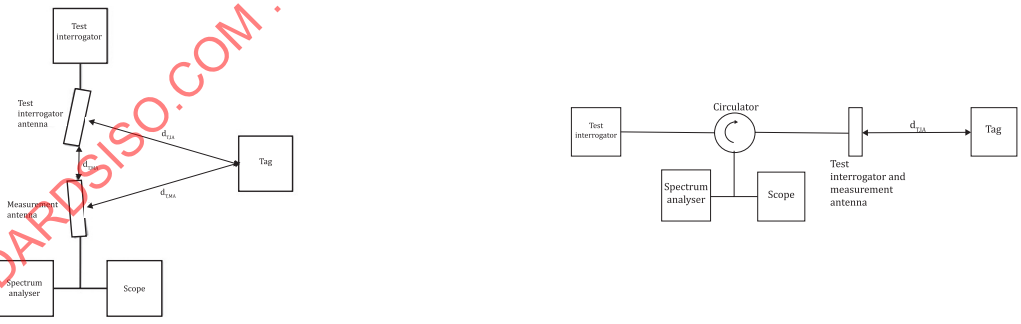
All conformance measurements and setups shall be done in an anechoic chamber as defined in Annex A.

All measurements shall be done at one of the test frequencies in Table 1.

5.2.2 Test apparatus and test circuits for ISO/IEC 18000-61, ISO/IEC 18000-62, ISO/IEC 18000-63 and ISO/IEC 18000-64 tags

5.2.2.1 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.



a) Bistatic setup **b) Monostatic setup**

Figure 3 — Tag demodulation test setup

5.2.2.2 Tag backscatter test setup

For this test, two different setups may be used.

In a first one [see Figure 3 a)], the test interrogator antenna setup (the interrogator may alternately also be realized with a signal generator according Annex C) 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 in Annex C. 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 [see Figure 3 a)].

The tag backscatter test setup parameters are defined in Table 2.

Table 2 — Tag backscatter setup parameters

Symbol	Name	Description
$d_{T,IA}$	Interrogator antenna to tag distance	0,8 m to 1,1 m
$d_{T,MA}$	Measurement antenna to tag distance	0,8 m to 1,1 m
G_{IA}	Gain of interrogator antenna	The maximum 3 dB beam width shall be ±35°
G_{MA}	Gain of measurement antenna	The maximum 3 dB beam width shall be ±35°
Icir	Isolation of the circulator	The minimum isolation of the circulator shall be 20 dB

In a second one [see Figure 3 b)], the test interrogator antenna setup (the interrogator may alternately also be realized with a signal generator according Annex C) shall consist of a single antenna specifically designed to transmit the signal from the interrogator and to receive the signal backscattered from the tag under test. This antenna shall be connected to the interrogator and to either a spectrum analyser or an oscilloscope as specified in Annex C via a circulator. The tag under test shall be oriented for optimum field strength reception. The distance between the tag and the antenna is $d_{T,IA}$ [see Figure 3 b)].

The tag backscatter test setup parameters are defined in Table 2.

5.2.2.3 Tag response time

The setup for this test shall be as described in 5.2.2.1.

5.2.2.4 Tag bit rate accuracy test setup

The setup for this test shall be as described in 5.2.2.1.

5.2.2.5 Tag state storage time test setup

The setup for this test shall be as described in 5.2.2.1.

6 Conformance tests for ISO/IEC 18000-61

6.1 Functional tests of interrogator

6.1.1 Interrogator modulation test

6.1.1.1 Test objective

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

6.1.1.2 Test procedure

The interrogator shall transmit an **Init_round_all** command at the maximum power of the selected carrier frequency for testing.

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

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

6.1.1.3 Test report

The test report shall give the measured values of the parameters according to Table 3. The pass/fail condition is determined whether the measured values are within the requirements as specified in ISO/IEC 18000-61. 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 3 — Measurements to be made

Parameter	Conditions
D	Default modulation operation mode
T_{apr}	Default modulation operation mode
T_{apf}	Default modulation operation mode

6.1.2 Interrogator demodulation and turn-around time

6.1.2.1 Test objective

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

— demodulating signals from the tags, and

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

6.1.2.2 Test procedure

The interrogator shall transmit an **Init_round_all** command (see B.1.1) at the maximum power of the selected carrier frequency for testing.

After the command provided by the interrogator has been sent and after the minimum turn-around time, a tag emulator as specified in Annex D shall transmit a typical response to the **Init_round_all** command at a minimum ΔRCS specified in ISO/IEC 18000-61. 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 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 designed 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.

6.1.2.3 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 turn-around 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.

6.2 Functional tests of tag

6.2.1 Tag demodulation and turn-around time

6.2.1.1 Test objective

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

— demodulating signals from the interrogator, and

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

6.2.1.2 Test procedure

The test interrogator shall transmit an **Init_round_all** (see B.1.1) command.

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 **Next_slot** command within the minimum specified turn-around time between tag response and interrogator command.

Measurements shall be done by verifying that the tag detects the command appropriately by means of evaluation of its response. Measurements shall be done at $P_I = 1{,}2\ P_{I,min}$.

In case the interrogator is designed 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 setup of the waveform for the respective types according to Table 4.

Table 4 — Setup of waveforms

Setup number	Setup description	Parameter setting
A-1	Minimum modulation depth	$D = D_{min}$
A-2	Medium modulation depth	$D = (D_{max} + D_{min})/2$
A-3	Maximum modulation depth	$D = D_{max}$

6.2.1.3 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 setup 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.

6.2.2 Tag backscatter

6.2.2.1 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.

Measurements are carried out in an anechoic chamber either in bistatic antennas configuration as shown in Figure 3 a) with the tag positioned in the far field of the transmit antenna or in monostatic antenna configuration [see Figure 3 b)].

6.2.2.2 Test procedure

Measurements shall be done with power $P_{I,min}$, where $P_{I,min}$ is the minimum power allowing the DUT tag activation.

A vector signal analyser as specified in Annex C shall be used to record the quadrature baseband voltages I and Q versus time.

Test setup shall be calibrated to determine antennas gain and mismatch, circulator isolation and insertion loss and also cables loss, to be taken into account for all power measurements.

The delta radar cross-section measurement procedure is as follows.

1) The signal generator shall be set to the required test frequency.

2) The signal generator amplitude shall be set to a value that allows the DUT tag activation.

3) Using the power meter, determine the power at the entrance of the transmit antenna, P_e, which is defined as the average power measured over at least 100 µs period during the continuous wave signal following the signal generator command.

4) The signal analyser shall be set to measure the quadrature baseband I and Q power versus time with a sampling rate of at least 5 Msps.

5) With the tag placed in the anechoic chamber, the analyser shall be set to capture the complex IQ power for at least during 10 symbols of tag reply.

6) Calculate the difference of power from the DUT tag backscattering according to Formula (1):

$$\Delta P_{\text{tag}}(\text{rms}) = \frac{1}{2Z_0} \cdot \left(\left(I_{r,1} - I_{r,0} \right)^2 + \left(Q_{r,1} - Q_{r,0} \right)^2 \right) \quad (1)$$

where

Z_0 is the wave resistance of the measurement equipment and is usually 50 Ω.

7) Calculate the ΔRCS of the DUT tag using Formula (2):

$$\Delta\text{RCS} = \frac{\Delta P_{\text{tag}}}{P_e} \frac{4\pi d^4}{G_{0t} G_{0r}} \left(\frac{4\pi}{\lambda} \right)^2 \quad (2)$$

6.2.2.3 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 ISO/IEC 18000-61 and the evaluated ΔRCS is at least above the value from ISO/IEC 18000-61. 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.

6.2.3 Tag response time

6.2.3.1 Test purpose

The objective of this test is to verify the tag response time, T_{rs}, referencing the parameters in ISO/IEC 18000-61.

6.2.3.2 Test procedure

The interrogator shall transmit a **Init_round_all** command (see B.1.1) at the maximum power of the selected carrier frequency for testing.

The measurements shall be done using the tag backscatter test setup.

The response time shall be measured by an oscilloscope as specified in Annex C.

NOTE An example for the measurements is given in E.1.

6.2.3.3 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 for ISO/IEC 18000-61.

6.2.4 Tag bit rate

6.2.4.1 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 T_{rlb} parameter.

6.2.4.2 Test procedure

The interrogator shall transmit a **Init_round_all** command (see B.1.1) at the maximum power of the selected carrier frequency for testing.

The tag response waveform shall be recorded by an oscilloscope as specified in Annex C using the tag backscatter test setup.

The bit rate accuracy shall be measured on the preamble of the tag response.

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

6.2.4.3 Test report

The test report shall give the measured values of bit rate calculated according to Formula (3) and Formula (4):

$$T_{B7} = 7 \times T_{rlb} \tag{3}$$

$$\text{bit rate} = \frac{7}{T_{B7}} \tag{4}$$

The pass/fail condition is determined whether the measured values are within the requirements as specified in ISO/IEC 18000-61.

6.2.5 Tag state storage time

6.2.5.1 Test objective

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

6.2.5.2 Test procedure

The interrogator shall transmit a **Init_round_all** command (see B.1.1) at the maximum power of the selected carrier frequency for testing.

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

For ISO/IEC 18000-61, 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 18000-61 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 18000-61 during which the tag has to retain its state.

NOTE An example for the measurements is given in E.2.

6.2.5.3 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 18000-61:2012, 6.5.2.

7 Conformance tests for ISO/IEC 18000-62

7.1 Functional tests of interrogator

7.1.1 Interrogator modulation test

7.1.1.1 Test objective

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

7.1.1.2 Test procedure

The interrogator shall transmit a **GROUP_SELECT_EQ** command (see B.2.1) at the maximum power of the selected carrier frequency for testing.

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

7.1.1.3 Test report

The test report shall give the measured values of the parameters according to Table 5. The pass/fail condition is determined if the measured values are within the requirements as specified in ISO/IEC 18000-62. 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

Parameter	Conditions
M	Low index interrogator modulation mode
T_r	Low index interrogator modulation mode
T_f	Low index interrogator modulation mode
M	High index interrogator modulation mode
T_r	High index interrogator modulation mode
T_f	High index interrogator modulation mode

7.1.2 Interrogator demodulation and turn-around time

7.1.2.1 Test objective

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

— demodulating signals from the tags, and

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

7.1.2.2 Test procedure

The interrogator shall transmit a **GROUP_SELECT_EQ** command (see B.2.1) at the maximum power of the selected carrier frequency for testing.

After the command provided by the interrogator has been sent and after the minimum turn-around time, a tag emulator as specified in Annex D shall transmit a typical response to the **GROUP_SELECT_EQ** command at a minimum ΔRCS specified in ISO/IEC 18000-62. The tag emulator does not need to demodulate the command, but shall only detect its end to respond after the minimum turn-around time.

Measurements shall be done 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 designed 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.

7.1.2.3 Test report

The test report shall contain the tag emulator distance to the interrogator and the ΔRCS value setup in the tag emulator. Furthermore, the set up turn-around 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.

7.2 Functional tests of tag

7.2.1 Tag demodulation and turn-around time

7.2.1.1 Test objective

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

— demodulating signals from the interrogator, and

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

7.2.1.2 Test procedure

The test interrogator shall transmit a **GROUP_SELECT_EQ** command (see 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 **GROUP_SELECT_EQ** command within the minimum specified turn-around time between tag response and interrogator command.

Measurements shall be done by verifying that the tag detects the command appropriately by means of evaluation of its response. Measurements shall be done at $P_I = 1{,}2\ P_{I,min}$.

In case the interrogator is designed 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 can be shown that the tag sent the correct response for both commands including verification of the CRC.

The interrogator waveform shall contain the setup of the waveform for the respective types according to Table 6.

Table 6 — Setup of waveforms

Setup number	Setup description	Parameter setting
B-1	Minimum modulation index for low modulation index operation mode	$M = M_{min}$
B-2	Maximum modulation index for low modulation index operation mode	$M = M_{max}$
B-3	Minimum modulation index for high modulation index operation mode	$M = M_{min}$
B-4	Maximum modulation index for high modulation index operation mode	$M \approx 99\ \% * M_{max}$

7.2.1.3 Test report

The test result shall be recorded as successful or unsuccessful. The test report shall contain the tag distance to the interrogator. Furthermore, 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.

7.2.2 Tag backscatter

7.2.2.1 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.

Measurements are carried out in an anechoic chamber in either bistatic antennas configuration as shown in Figure 3 a) with the tag positioned in the far field of the transmit antenna or in monostatic configuration [see Figure 3 b)].

7.2.2.2 Test procedure

Measurements shall be done with power $P_{I,min}$, where $P_{I,min}$ is the minimum power allowing the DUT tag activation.

A vector signal analyser as specified in Annex C shall be used to record the quadrature baseband voltages I and Q versus time.

Test setup shall be calibrated to determine antennas gain and mismatch, circulator isolation and insertion loss and also cables loss, to be taken into account for all power measurements.

The delta radar cross-section measurement procedure is as follows.

1) The signal generator shall be set to the required test frequency.

2) The signal generator amplitude shall be set to a value that allows the DUT tag activation.

3) Using the power meter, determine the power at the entrance of the transmit antenna, P_e, which is defined as the average power measured over at least 100 µs period during the continuous wave signal following the signal generator command.

4) The signal analyser shall be set to measure the quadrature baseband I and Q power versus time with a sampling rate of at least 5 Msps.

5) With the tag placed in the anechoic chamber, the analyser shall be set to capture the complex IQ power for at least during 10 symbols of tag reply.

6) Calculate the difference of power from the DUT tag backscattering according to Formula (5):

$$\Delta P_{\text{tag}}(\text{rms}) = \frac{1}{2Z_0} \cdot \left(\left(I_{r,1} - I_{r,0} \right)^2 + \left(Q_{r,1} - Q_{r,0} \right)^2 \right) \tag{5}$$

where

Z_0 is the wave resistance of the measurement equipment and is usually 50 Ω.

7) Calculate the ΔRCS of the DUT tag using Formula (6):

$$\Delta\text{RCS} = \frac{\Delta P_{\text{tag}}}{P_e} \frac{4\pi d^4}{G_{0t} \cdot G_{0r}} \left(\frac{4\pi}{\lambda} \right)^2 \tag{6}$$

7.2.2.3 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 ISO/IEC 18000-62 and the evaluated ΔRCS is at least above the value given in ISO/IEC 18000-62. 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.

7.2.3 Tag response time

7.2.3.1 Test objective

The objective of this test is to verify the tag response time Quiet referencing the parameters in ISO/IEC 18000-62.

7.2.3.2 Test procedure

The interrogator shall transmit a **GROUP_SELECT_EQ** command (see B.2.1) at the maximum power of the selected carrier frequency for testing.

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 an oscilloscope as specified in Annex C.

NOTE An example for the measurements is given in E.1.

7.2.3.3 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 type.

7.2.4 Tag bit rate

7.2.4.1 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 T_{rlb} parameter.

7.2.4.2 Test procedure

The interrogator shall transmit a **GROUP_SELECT_EQ** command (see B.2.1) at the maximum power of the selected carrier frequency for testing.

The tag response waveform shall be recorded by an oscilloscope as specified in Annex C using the tag backscatter test setup.

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.

7.2.4.3 Test report

The test report shall give the measured values of bit rate calculated according to Formula (7) and Formula (8) (see Annex E):

$$T_{\text{rlb\_average}} = \frac{\sum_1^7 T_{\text{rlb}_n}}{7} \tag{7}$$

$$\text{bit rate} = \frac{1}{T_{\text{rlb\_average}}} \tag{8}$$

The pass/fail condition is determined whether the measured values are within the requirements as specified in ISO/IEC 18000-62.

7.2.5 Tag state storage time

7.2.5.1 Test objective

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

7.2.5.2 Test procedure

The interrogator shall transmit a **READ** command at the maximum power of the selected carrier frequency for testing.

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

The test shall be executed for a shutoff time of t_{DF_SB} defined in ISO/IEC 18000-62 and the flag DE_SB shall still be set when verified.

NOTE An example for the measurements is given in E.2.

7.2.5.3 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 18000-62:2012, 6.3.1.3.2.

8 Conformance tests for ISO/IEC 18000-63

8.1 Functional tests of interrogator

8.1.1 Interrogator data encoding

8.1.1.1 Purpose

The purpose of this test is to verify that the tolerance on all interrogator data encoding parameters shall be ±1 % as described in ISO/IEC 18000-63.

8.1.1.2 Procedure

The interrogator data encoding measurement procedure is as follows.

1) The DUT interrogator shall be configured for transmitting at the maximum power with the first supported frequency and modulation type.

2) The DUT interrogator shall be set with all parameters defined in Table 7 and with the first test case parameters defined in Table 8 for variable parameters.

3) The DUT interrogator shall be set to send a **QUERY** command followed by the continuous wave.

4) The signal analyser shall be set to power versus time mode.

5) Wait until signal analyser is triggered, capture all the demodulated trace power versus time.

6) Measure data-0 and data-1 durations from interrogator preamble trace.

7) Steps 2) to 6) shall be repeated for all the test cases that are supported by the DUT interrogator.

8) Steps 2) to 7) shall be repeated for all DUT interrogator-supported frequencies and modulations.

Table 7 — Interrogator data encoding test parameters

TEST: Interrogator data encoding				
RF PARAMETERS				
Power EIRP (dBm): **max power authorized**			Frequency (MHz): **Interrogator supported frequencies**	
Modulation type: **Interrogator supported modulations**			Modulation index : **Variable**	
PROTOCOL SETTINGS				
Command: **Query**				
Parameters	DR: **64/3**	M: **1**	Trext: **1**	
Timings	Tari (µs): **Variables**	PW (µs): **0,5* Tari**	RTcal (µs): **A fixed number of times of Tari**	TRcal (µs): **Variable**

Table 8 — Interrogator data encoding test cases

	Tari (µs) = **data_0**	**RTcal** (µs)	**Modulation index** (%)
1	6,25	2,5*Tari (data_1= 9,375 µs)	80
2			100
3		3*Tari (data_1= 12,5 µs)	80
4			100
5	12,5	2,5*Tari (data_1= 18,75 µs)	80
6			100
7		3*Tari (data_1= 25 µs)	80
8			100
9	25	2,5*Tari (data_1= 37,5 µs)	80
10			100
11		3*Tari (data_1= 50 µs)	80
12			100

8.1.1.3 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail; the pass condition for each point is obtained if the tolerance for the duration of data-0 and data-1 are lower than 1 % for all the test conditions.

8.1.2 Interrogator RF envelope parameters

8.1.2.1 Purpose

The purpose of this test is to verify all the parameters pulse modulation depth, rise time, fall time and PW, and shall be the same for a data-0 and a data-1 as described in ISO/IEC 18000-63.

8.1.2.2 Procedure

The interrogator RF envelope parameters measurement procedure is as follows.

1) The DUT interrogator shall be configured for transmitting at the maximum power, at the first supported frequency and modulation type.
2) The DUT interrogator shall be set with all parameters defined in Table 9 and with the first test case parameters defined in Table 10 for variable test parameters.
3) The DUT interrogator shall be set to send a **QUERY** command followed by the continuous wave.
4) The signal analyser shall be set to power versus time mode.
5) Wait until signal analyser is triggered, capture all the demodulated trace power versus time.
6) Measure the DUT interrogator PW and envelope rise and fall time as described in ISO/IEC 18000-63. The parameter pulse modulation depth shall be measured.
7) Steps 2) to 6) shall be repeated for all the test cases that are supported by the DUT interrogator.
8) Steps 2) to 7) shall be repeated for all DUT interrogator-supported frequencies and modulations.

Table 9 — Interrogator RF envelope test parameters

TEST: Interrogator RF envelope parameters				
RF PARAMETERS				
Power EIRP (dBm): **max power authorized**			Frequency (MHz): **Interrogator supported frequencies**	
Modulation type: **Interrogator supported modulations**			Modulation index: Variable	
PROTOCOL SETTINGS				
Command: **Query**				
Parameters	DR: **64/3**	M: **1**	Trext: **1**	
Timings	Tari (µs): **Variables**	PW (µs): **Variable**	RTcal (µs): **A fixed number times of Tari**	TRcal (µs): **Variable**

Table 10 — Interrogator RF envelope test cases

	Tari (µs) **= data_0**	**PW** (µs)	**Modulation index** (%)
1	6,25	2 (PW min)	80
2			100
3		0,525*Tari (PW max)	80
4			100
5	12,5	0,256*Tari (PW min)	80
6			100
7		0,525*Tari (PW max)	80
8			100
9	25	0,256*Tari (PW min)	80
10			100
11		0,525*Tari (PW max)	80
12			100

8.1.2.3 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail; the pass condition for each point is obtained if the value of the parameters shall be in the limit maximum and minimum as specified in ISO/IEC 18000-63.

8.1.3 Interrogator RF power-up and power-down parameters

8.1.3.1 Purpose

The purpose of this test is to verify that the interrogator power-up and power down RF envelopes shall comply with RF envelope specified in ISO/IEC 18000-63.

8.1.3.2 Procedure

The interrogator RF power-up and power-down measurement procedure is as follows.:

1) The DUT interrogator shall be configured for transmitting at the maximum power, at the first supported frequency and modulation type.

2) The DUT interrogator under test shall be set to be powered on to transmit a CW and then powered off.

3) The signal analyser shall capture all the interrogator signal trace.

4) Measure the interrogator rise time, fall time, settling time, signal level when off, undershoot and overshoot as described in ISO/IEC 18000-63.

5) In the interrogator power-up trace, verify that once the carrier level has risen above the 10 % level, the power-up envelope shall rise monotonically until at least the ripple limit, Ml, and that the RF envelope shall not fall below the 90 % point during interval, Ts.

6) In the interrogator power-down trace, verify that once the carrier level has fallen below the 90 % level, the power-down envelope shall fall monotonically until the power limit Ms.

7) Steps 2) to 6) shall be repeated for all DUT interrogator-supported frequencies and modulations.

8.1.3.3 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail; the pass condition is obtained if the value of the parameters shall be in the limit maximum and minimum specified in ISO/IEC 18000-63. Monotonicity shall be as required for the power-up and power-down of the RF waveform

8.1.4 Interrogator preamble parameters

8.1.4.1 Purpose

The purpose of this test case is to verify that the preamble shall comprise a fixed-length start delimiter, a data-0 symbol, a R ≥ T calibration (RTcal) symbol and a T ≤ R calibration (TRcal) symbol as described in ISO/IEC 18000-63.

8.1.4.2 Procedure

The interrogator preamble parameters measurement procedure is as follows.

1) The DUT interrogator shall be configured for transmitting at the maximum power, at the first supported frequency and modulation type.

2) The DUT interrogator shall be set with all parameters defined in Table 11 and with the first test case parameters defined in Table 12 for variable test parameters.

3) The DUT interrogator shall be set to send a **QUERY** command followed by the continuous wave.

4) The signal analyser shall capture all the interrogator signal traces.

5) Measure the interrogator delimiter duration, data-0 duration, RTcal and TRcal timings as defined in ISO/IEC 18000-63.

6) Steps 2) to 5) shall be repeated for all the test cases that are supported by the DUT interrogator.

7) Steps 3) to 6) shall be repeated for all DUT interrogator-supported frequencies and modulations.

Table 11 — Interrogator preamble test parameters

TEST: Interrogator preamble parameters				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Interrogator supported frequencies**	
Modulation type: **Interrogator supported modulations**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command : **Query**				
Parameters	DR: **64/3**	M: **1**	Trext: **1**	
Timings	Tari (µs): **Variable**	PW (µs): **0,5*Tari**	RTcal (µs): **Variable**	TRcal (µs): **Variable**

Table 12 — Interrogator preamble test cases

	Tari (µs)	**RTcal** (µs)	**TRcal** (µs)
1	6,25	2,5*Tari	1,1*RTcal
2			3*RTcal
3		3*Tari	1,1*RTcal
4			3*RTcal
5	12,5	2,5*Tari	1,1*RTcal
6			3*RTcal
7		3*Tari	1,1*RTcal
8			3*RTcal
9	25	2,5*Tari	1,1*RTcal
10			3*RTcal
11		3*Tari	1,1*RTcal
12			3*RTcal

8.1.4.3 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail; the pass condition is obtained for each test point if the tolerance for the duration of data-0, RTcal and TRcal shall be lower than 1 % for all the test conditions and the delimiter shall be 12,5 µs ± 5 %.

8.1.5 Interrogator link timing T2

8.1.5.1 Purpose

The purpose of this test is to verify that the DUT interrogator meets the timing parameter T2.

8.1.5.2 Procedure

The interrogator link timing T2 measurement procedure is as follows.

1) The DUT interrogator shall be configured for transmitting at the maximum power, at the first supported frequency and modulation type.

2) The DUT interrogator shall be set with all parameters defined in Table 13 and with the first test case parameters defined in Table 14 for variable test parameters.

3) The DUT interrogator shall be set to send a **QUERY** command followed by the continuous wave.

4) Set the tag emulator to backscatter an RN16 reply. The RN16 shall be sent after the typical value for T1. The DUT interrogator will send its ACK.

5) The signal analyser shall capture all demodulated trace power versus time (**Query** + **RN16** + **ACK**).

6) Measure the link parameter, finding the end of RN16 frequency variation and the beginning of ACK frequency variation.

7) Steps 4) to 5) shall be repeated for all the test cases that are supported by the DUT interrogator.

8) Steps 4) to 6) shall be repeated for all DUT interrogator supported frequencies and modulations.

Table 13 — Interrogator link timing T2 test parameters

TEST: Tag link timing parameter T2				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: **Query**				
Parameters	DR: **Variable**	M: **1**	Trext: **1**	
Timings	Tari (µs): **Variable**	PW (µs): **0,5*Tari**	RTcal (µs): **3*Tari**	TRcal (µs): **Variable**

Table 14 — Tag link timing parameter T2 test cases

	Tari (µs)	**DR**	**TRcal** (µs)
1	6,25	64/3	33,3 (BLF = 640 KHz)
2		8	25,0 (BLF = 320 KHz)
3	12,5	64/3	66,7 (BLF = 320 KHz)
4		8	50,0 (BLF = 160 KHz)
5	25	64/3	224,5 (BLF = 95 KHz)
6		8	200 (BLF = 40 KHz)

8.1.5.3 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail; the pass condition is obtained for each test point if the measured time value shall be between T2 min and T2 max. 20 Tpri applies as the test is an interrogator test.

8.1.6 Interrogator link timing T3

8.1.6.1 Purpose

The purpose of this test is to verify that the DUT interrogator meets the timing parameter T3, which define the time an interrogator waits, after T1, before it issues another command.

8.1.6.2 Procedure

The interrogator link timing T3 measurement procedure is as follows.

1) The DUT interrogator shall be configured for transmitting at the maximum power, at the first supported frequency and modulation type.

2) The signal analyser shall be set to power versus time mode.

3) The DUT interrogator shall be set with all parameters defined in Table 15 and with the first test case parameters defined in Table 16 for variable test parameters.

4) Set DUT interrogator to transmit a **Select** command followed by **Query** command.

5) The signal analyser shall capture all demodulated trace power versus time (**Select** + **Query**).

6) Measure the link timing T3 + T1, finding the end of **Query** frequency variation and the beginning of **QueryRep** frequency variation; the link parameter T3 is calculated by subtracting the T1 maximum value to the measured time (T1 + T3).

7) Steps 3) to 6) shall be repeated for all the test cases that are supported by the DUT interrogator.

8) Steps 3) to 7) shall be repeated for all DUT interrogator-supported frequencies and modulations.

Table 15 — Tag link timing parameter T3 test parameters

TEST: Tag link timing parameter T3				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: **Query**				
Parameters	DR: **Variable**	M: **1**	Trext: **1**	
Timings	Tari (µs): **Variable**	PW (µs): **0,5*Tari**	RTcal (µs): **3*Tari**	TRcal (µs): **Variable**

Table 16 — Tag link timing parameter T3 test cases

	Tari (µs)	**DR**	**TRcal** (µs)
1	6,25	64/3	33,3 (BLF = 640 KHz)
2		8	25,0 (BLF = 320 KHz)
3	12,5	64/3	66,7 (BLF = 320 KHz)
4		8	50,0 (BLF = 160 KHz)
5	25	64/3	224,5 (BLF = 95 KHz)
6		8	200 (BLF = 40 KHz)

8.1.6.3 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail; the pass condition is obtained for each test point if the measured time value shall be greater than the minimum value for T3 according to ISO/IEC 18000-63.

8.1.7 Interrogator link timing T4

8.1.7.1 Purpose

The purpose of this test case is to verify that the DUT interrogator meets the timing parameter T4, which define the minimum time between interrogator commands.

8.1.7.2 Procedure

The interrogator link timing T4 measurement procedure is as follows.

1) The DUT interrogator shall be configured for transmitting at the maximum power, at the first supported frequency and modulation type.

2) The signal analyser shall be set to power versus time mode.

3) The DUT interrogator shall be set with all parameters defined in Table 17 and with the first test case parameters defined in Table 18 for variable test parameters.

4) Set DUT to initiate an inventory round, transmitting a **Query** command followed by **QueryRep** command.

5) The signal analyser shall capture all demodulated trace power versus time (**Query** + **QueryRep**).

6) Measure the link timing T4, finding the end of **select** frequency variation and the beginning of Query frequency variation.

7) Steps 3) to 6) shall be repeated for all the test cases that are supported by the DUT interrogator.

8) Steps 3) to 7) shall be repeated for all DUT interrogator-supported frequencies and modulations.

Table 17 — Interrogator link timing parameter T4 test parameters

TEST: Interrogator link timing parameter T4				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: **Query**				
Parameters	DR: **Variable**	M: **1**	Trext: **1**	
Timings	Tari (µs): **Variable**	PW (µs): **0,5*Tari**	RTcal (µs): **3*Tari**	TRcal (µs): **Variable**

Table 18 — Interrogator link timing parameter T4 test cases

	Tari (µs)	**DR**	**TRcal** (µs)
1	6,25	64/3	33,3 (BLF = 640 KHz)
2		8	25,0 (BLF = 320 KHz)
3	12,5	64/3	66,7 (BLF = 320 KHz)
4		8	50,0 (BLF = 160 KHz)
5	25	64/3	224,5 (BLF = 95 KHz)
6		8	200 (BLF = 40 KHz)

8.1.7.3 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail; the pass condition is obtained for each test point if the measured time value shall be greater than the minimum value for T4 according to ISO/IEC 18000-63.

8.2 Functional tests of tag

8.2.1 Tag frequency range

8.2.1.1 Purpose

The purpose of this test is to verify that the DUT tag shall be capable of receiving power from and communicating with interrogators within the frequency range from 860 MHz to 930 MHz.

8.2.1.2 Procedure

The tag frequency range measurement procedure is as follows.

1) The test interrogator shall be that its antenna sends the maximum permissible power.

2) A **QUERY** command shall be continuously sent followed by the continuous wave.

3) If the oscilloscope detects a tag response within 100 ms then the test step is PASS. Otherwise, it is FAIL.

4) Steps 2) and 3) shall be repeated for all the frequencies defined in Table 19.

Table 19 — Tag frequency range test parameters

TEST: Tag frequency range				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: **Query**				
Parameters	DR: **8**	M: **1**	Trext: **0**	
Timings	Tari (µs): **25**	PW (µs): **12,5**	RTcal (µs): **62,5**	TRcal (µs): **100**

8.2.1.3 Test report

The test report shall give for each test point all communication parameters and the test verdict pass or fail; the pass condition for each point is obtained when the signal analyser is triggered that means that the tag is working at the test frequency.

8.2.2 Tag demodulation capability

8.2.2.1 Purpose

The purpose of this test is to verify that the DUT tag shall be capable of demodulating all three modulation types DSB-ASK, SSB-ASK and PR-ASK.

8.2.2.2 Procedure

The tag demodulation capability measurement procedure is as follows.

1) The waveform generator amplitude shall be set to the maximum permissible value.

2) The signal analyser trigger shall be set to frequency mask trigger waiting tag response; the signal analyser trigger will be active if the tag response is present.

3) The signal generator shall be set with all parameters defined in Table 20 and with the first test case parameters defined in Table 21 for variable test parameters.

4) A **QUERY** command shall be continuously sent followed by the continuous wave.

5) Wait until the signal analyser is triggered, if it is not triggered in 1 s, then finish the test case.

6) Steps 3) to 5) shall be repeated for all the test cases defined in Table 21.

Table 20 — Tag demodulation capability test parameters

TEST: Tag demodulation capability				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **Variable**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: **Query**				
Parameters	DR: **8**	M: **1**	Trext: **0**	
Timings	Tari (µs): **25**	PW (µs): **12,5**	RTcal (µs): **62,5**	TRcal (µs): **100**

Table 21 — Tag demodulation capability test cases

	Frequency (MHz)	**Modulation type**
1	866	DSB-ASK
2		SSB-ASK
3		PR-ASK
4	915	DSB-ASK
5		SSB-ASK
6		PR-ASK

8.2.2.3 Test report

The test report shall give for each test point all communication parameters and the test verdict pass or fail; the pass condition for each point is obtained when the signal analyser is triggered that means that the tag is working at the test frequency and modulation.

8.2.3 Tag duty cycle

8.2.3.1 Purpose

The purpose of this test is to verify that the duty cycle for FM0 and Miller encoding shall be a minimum of 45 % and a maximum of 55 % with a nominal value of 50 %.

8.2.3.2 Procedure

The tag duty cycle measurement procedure is as follows.

1) The waveform generator amplitude shall be set to the maximum permissible value.
2) The signal analyser shall be set to power versus time mode.
3) The signal generator shall be set with all parameters defined in Table 22 and with the first test case parameters defined in Table 23 for variable test parameters
4) A **QUERY** command shall be continuously sent followed by the continuous wave.
5) Wait until signal analyser is triggered, capture the demodulated tag reply trace power versus time.
6) In the demodulated trace data, measure the duty cycle for 00-data and 11-data sequence in case of FM0 tag encoding and for 0-data and 1-data for Miller tag encoding.
7) Steps 3) to 6) shall be repeated for all the test cases defined in Table 23.

Table 22 — Tag duty cycle test parameters

TEST: Tag duty cycle				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: **Query**				
Parameters	DR: **Variable**	M: **Variable**	Trext: **0**	
Timings	Tari (µs): **Variable**	PW (µs): **0,5*Tari**	RTcal (µs): **3*Tari**	TRcal (µs): **Variable**

Table 23 — Tag duty cycle test cases

	Frequency (MHz)	**M**	**D**	**Tari** (µs)	**TRcal** (µs)		**Frequency** (MHz)	**M**	**D**	**Tari** (µs)	**TRcal** (µs)
1	866	1	64/3	6,25	33,3 (BLF = 640 KHz)	13	915	1	64/3	6,25	33,3 (BLF = 640 KHz)
2			64/3	12,5	66,7 (BLF = 320 KHz)	14			64/3	12,5	66,7 (BLF = 320 KHz)
3			8	25	200 (BLF = 40 KHz)	15			8	25	200 (BLF = 40 KHz)
4		2	64/3	6,25	33,3 (BLF = 640 KHz)	16		2	64/3	6,25	33,3 (BLF = 640 KHz)
5			64/3	12,5	66,7 (BLF = 320 KHz)	17			64/3	12,5	66,7 (BLF = 320 KHz)
6			8	25	200 (BLF = 40 KHz)	18			8	25	200 (BLF = 40 KHz)
7		4	64/3	6,25	33,3 (BLF = 640 KHz)	19		4	64/3	6,25	33,3 (BLF = 640 KHz)
8			64/3	12,5	66,7 (BLF = 320 KHz)	20			64/3	12,5	66,7 (BLF = 320 KHz)
9			8	25	200 (BLF = 40 KHz)	21			8	25	200 (BLF = 40 KHz)
10		8	64/3	6,25	33,3 (BLF = 640 KHz)	22		8	64/3	6,25	33,3 (BLF = 640 KHz)
11			64/3	12,5	66,7 (BLF = 320 KHz)	23			64/3	12,5	66,7 (BLF = 320 KHz)
12			8	25	200 (BLF = 40 KHz)	24			8	25	200 (BLF = 40 KHz)

8.2.3.3 Test report

The test report shall give for each test point all communication parameters and the test verdict pass or fail; the pass condition for FM0 tag encoding (M = 1) is obtained if the measured duty cycle of 00 or 11 sequence is in the range 50 % ± 5 %; for Miller tag encoding (M = 2, 4, 8), the pass condition is obtained if the duty cycle of 0 or 1 symbol is in the range 50 % ± 5 %.

8.2.4 Tag preamble

8.2.4.1 Purpose

The purpose of this test is to verify that the FM0 and Miller preamble signalling shall be as described in ISO/IEC 18000-63.

8.2.4.2 Procedure

The tag preamble measurement procedure is as follows.

1) The waveform generator amplitude shall be set to the maximum permissible value.
2) The signal analyser shall be set to power versus time mode.
3) The signal generator shall be set with all parameters defined in Table 24 and with the first test case parameters defined in Table 25 for variable test parameters.
4) A **QUERY** command shall be continuously sent followed by the continuous wave.
5) Wait until signal analyser is triggered, capture the demodulated tag reply trace power versus time.
6) In the demodulated trace data, capture and verify the tag preamble.
7) Steps 3) to 6) shall be repeated for all the test cases defined in Table 25.

Table 24 — Tag preamble test parameters

TEST: Tag preamble				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: **Query**				
Parameters	DR: **8**	M: **Variable**	Trext: **Variable**	
Timings	Tari (µs): **25**	PW (µs): **12,5**	RTcal (µs): **62,5**	TRcal (µs): **100**

Table 25 — Tag preamble test cases

	Frequency (MHz)	**M**	**Trext**
1	866	1	0
2			1
3		2	0
4			1
5		4	0
6			1
7		8	0
8			1
9	915	1	0
10			1
11		2	0
12			1
13		4	0
14			1
15		8	0
16			1

8.2.4.3 Test report

The test report shall give for each test point all communication parameters and the test verdict pass or fail; the pass condition is obtained if the DUT tag preamble is as described in ISO/IEC 18000-63.

8.2.5 Tag link frequency tolerance and variation

8.2.5.1 Purpose

The purpose of this test is to verify that the tag can backscatter its reply with a variable link frequency from 40 kHz to 640 kHz with the tolerance defined in ISO/IEC 18000-63 and to verify that the frequency variation during the tag backscattering is in the range ±2,5 %.

8.2.5.2 Procedure

The tag link frequency tolerance and variation measurement procedure is as follows.

1) The waveform generator amplitude shall be set to the maximum permissible value.
2) The signal analyser shall be set to power versus time mode.
3) The signal generator shall be set with all parameters defined in Table 26 and with the first test case parameters defined in Table 27 for variable test parameters.
4) A **QUERY** command shall be continuously sent followed by the continuous wave.
5) Wait until signal analyser is triggered, capture the demodulated tag reply trace power versus time.
6) Measure the tag link frequency from the demodulated trace data for each symbol and determine the minimum and maximum value.
7) Steps 3) to 5) shall be repeated for all the test cases defined in Table 27.

Table 26 — Tag link frequency tolerance and variation test parameters

TEST: Tag link frequency tolerance and variation				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: **Query**				
Parameters	DR: **Variable**	M: **1**	Trext: **1**	
Timings	Tari (µs): **Variable**	PW (µs): **0,5*Tari**	RTcal (µs): **3*Tari**	TRcal (µs): **Variable**

Table 27 — Tag link frequency tolerance and variation test cases

	Frequency (MHz)	**Tari** (µs)	**D**	**TRcal** (µs)
1	866	6,25	64/3	33,3 (BLF=640 KHz)
2		12,5	64/3	66,7 (BLF=320 KHz)
3		25	8	200 (BLF=40 KHz)
4	915	6,25	64/3	33,3 (BLF=640 KHz)
5		12,5	64/3	66,7 (BLF=320 KHz)
6		25	8	200 (BLF=40 KHz)

8.2.5.3 Test report

The test report shall give for each test point all communication parameters and the test verdict pass or fail; the pass condition for each point is obtained if the tag link frequency respects the tolerances defined in ISO/IEC 18000-63 and the variation of the link frequency during tag backscattering is in the range ±2,5 %.

8.2.6 Tag link timing T1

8.2.6.1 Purpose

The purpose of this test is to verify that the tag meets the link timing parameter T1 which defined the time from interrogator transmission to tag response.

8.2.6.2 Procedure

The tag timing parameter T1 measurement procedure is as follows.

1) The waveform generator amplitude shall be set to the maximum permissible value.
2) The signal analyser shall be set to power versus time mode.
3) The signal generator shall be set with all parameters defined in Table 28 and with the first test case parameters defined in Table 29 for variable test parameters.
4) A **QUERY** command shall be continuously sent followed by the continuous wave.
5) Wait until signal analyser is triggered, capture the demodulated tag reply trace power versus time.
6) Measure the tag link timing parameter T1, from the last rising edge of the last bit of the interrogator transmission to the first rising edge of the tag response.
7) Steps 3) to 5) shall be repeated for all the test cases defined in Table 29.

Table 28 — Tag link timing T1 test parameters

TEST: Tag link timing T1				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: **Query**				
Parameters	DR: **Variable**	M: **1**	Trext: **1**	
Timings	Tari (µs): **Variable**	PW (µs): **0,5*Tari**	RTcal (µs): **3*Tari**	TRcal (µs): **Variable**

Table 29 — Tag link timing T1 test cases

	Frequency (MHz)	**Tari** (µs)	**D**	**TRcal** (µs)
1	866	6,25	64/3	33,3 (BLF = 640 KHz)
2		12,5	64/3	66,7 (BLF = 320 KHz)
3		25	8	200 (BLF = 40 KHz)
4	915	6,25	64/3	33,3 (BLF = 640 KHz)
5		12,5	64/3	66,7 (BLF = 320 KHz)
6		25	8	200 (BLF = 40 KHz)

8.2.6.3 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail; the pass condition for each point is obtained if the measured link timing parameter T1 is in the range MAX(RTcal,10Tpri) × (1 ± FT) ± 2 µs as defined in ISO/IEC 18000-63.

8.2.7 Tag link timing T2

8.2.7.1 Purpose

The purpose of this test is to verify that the tag meets the link timing parameter T2 and that the tag under test shall backscatter its UII in response to an ACK command that occurs within T2 minimum of 3Tpri and T2 maximum of 32Tpri and shall not backscatter its UII in response to an ACK command that occurs beyond the T2 maximum of 32Tpri.

8.2.7.2 Procedure (reply state)

The tag link timing parameter T2 measurement procedure is as follows.

1) The waveform generator amplitude shall be set to the maximum permissible value.
2) The signal analyser shall be set to power versus time mode.
3) The signal generator shall be set with all parameters defined in Table 30 and with the first test case parameters defined in Table 31 for variable test parameters.
4) A **QUERY** command shall be continuously sent followed by the continuous wave.
5) Wait until signal analyser is triggered, capture the demodulated tag reply trace power versus time.
6) The signal analyser shall be set to send an ACK command with the backscattered RN16. The command shall be sent at T2 minimum and a tag does respond to an Interrogator.
7) The steps 3) to 5) shall be repeated for the following:
   i) a tag DOES respond to an interrogator command issued at 20Tpri;
   ii) a tag DOES NOT respond to an interrogator command issued at 32Tpri.
8) Steps 3) to 7) shall be repeated for all the test cases defined in Table 31.

Table 30 — Tag link timing T2 test parameters

TEST: Tag link timing T2				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: **Query, Ack**				
Parameters	DR: **Variable**	M: **1**	Trext: **1**	
Timings	Tari (µs): **Variable**	PW (µs): **0,5*Tari**	RTcal (µs): **3*Tari**	TRcal (µs): **Variable**

8.2.7.3 Procedure (acknowledge state)

The tag link timing parameter T2 measurement procedure is as follows.

1) The waveform generator amplitude shall be set to the maximum permissible value.
2) The signal analyser shall be set to power versus time mode.
3) The signal generator shall be set with all parameters defined in Table 31 and with the first test case parameters defined in Table 32 for variable test parameters.
4) A QUERY command shall be continuously sent followed by the continuous wave.

5) The signal analyser shall be set to send an ACK command with the backscattered RN16. The command shall be sent after T2 = 10Tpri.

6) Wait until signal analyser is triggered, capture the demodulated tag reply trace power versus time.

7) The signal analyser shall be set to send an REQ_RN command with the previously backscattered RN16. The command shall be sent at T2 minimum and a tag does respond to an interrogator.

8) Steps 3) to 7) shall be repeated for the following:

   i) a tag DOES respond to an interrogator command issued at 20Tpri;

   ii) a tag DOES NOT respond to an interrogator command issued at 32Tpri.

9) Steps 3) to 8) shall be repeated for all the test cases defined in Table 32.

Table 31 — Tag link timing T2 test parameters

TEST: Tag link timing T2				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90** %	
PROTOCOL SETTINGS				
Command: **Query, Ack, Req_RN**				
Parameters	DR: **Variable**	M: **1**	Trext: **1**	
Timings	Tari (µs): **Variable**	PW (µs): **0,5*Tari**	RTcal (µs): **3*Tari**	TRcal (µs): **Variable**

Table 32 — Tag link timing T2 test cases

	Frequency (MHz)	**Tari** (µs)	**D**	**TRcal** (µs)
1	866	6,25	64/3	33,3 (BLF = 640 KHz)
2		12,5	64/3	66,7 (BLF = 320 KHz)
3		25	8	200 (BLF = 40 KHz)
4	915	6,25	64/3	33,3 (BLF = 640 KHz)
5		12,5	64/3	66,7 (BLF = 320 KHz)
6		25	8	200 (BLF = 40 KHz)

8.2.7.4 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail; the pass condition for each point is obtained if the tag does not respond to the ACK command.

8.2.8 Tag link timing T5

8.2.8.1 Purpose

The purpose of this test is to verify that the tag meets the link timing parameter T5 which defined the time from interrogator transmission to tag response for a *delayed* tag reply.

8.2.8.2 Procedure

The tag timing parameter T5 measurement procedure is as follows.

1) The waveform generator amplitude shall be set to the maximum permissible value.

2) The signal analyser shall be set to power versus time mode.

3) The signal generator shall be set with all parameters defined in Table 33 and with the first test case parameters defined in Table 34 for variable test parameters.

4) Issue a command that uses *delayed* reply timing followed by the continuous wave.

5) Wait until signal analyser is triggered, capture the demodulated tag reply trace power versus time.

6) Measure the tag link timing parameter T5, from the last rising edge of the last bit of the interrogator transmission to the first rising edge of the tag response.

7) Steps 3) to 5) shall be repeated for all the test cases defined in Table 34.

Table 33 — Tag link timing T5 test parameters

TEST: Tag link timing T5				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**		Frequency (MHz): **Variable**		
Modulation type: **DSB-ASK**		Modulation index: **90 %**		
PROTOCOL SETTINGS				
Command: command that uses delayed reply timing (Example: WRITE)				
Parameters	DR: **Variable**	M: **1**	Trext: **1**	
Timings	Tari (µs): **Variable**	PW (µs): **0,5*Tari**	RTcal (µs): **3*Tari**	TRcal (µs): **Variable**

Table 34 — Tag link timing T5 test cases

	Frequency (MHz)	**Tari** (µs)	**D**	**TRcal** (µs)
1	866	6,25	64/3	33,3 (BLF = 640 KHz)
2		12,5	64/3	66,7 (BLF = 320 KHz)
3		25	8	200 (BLF = 40 KHz)
4	915	6,25	64/3	33,3 (BLF = 640 KHz)
5		12,5	64/3	66,7 (BLF = 320 KHz)
6		25	8	200 (BLF = 40 KHz)

8.2.8.3 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail; the pass condition for each point is obtained if the measured link timing parameter T5 is in the range [MAX(RTcal,10Tpri) × (1 – FT) – 2 µs; 20 ms] as defined in ISO/IEC 18000-63.

8.2.9 Tag link timing T6

8.2.9.1 Purpose

The purpose of this test is to verify that the tag meets the link timing parameter T6 which defined the time from interrogator transmission to first tag response for an *in-process* tag reply.

8.2.9.2 Procedure

The tag timing parameter T6 measurement procedure is as follows.

1) The waveform generator amplitude shall be set to the maximum permissible value.

2) The signal analyser shall be set to power versus time mode.

3) The signal generator shall be set with all parameters defined in Table 35 and with the first test case parameters defined in Table 36 for variable test parameters.

4) Issue a command that uses *in-process* reply timing followed by the continuous wave.

5) Wait until signal analyser is triggered, capture the demodulated tag reply trace power versus time.

6) Measure the tag link timing parameter T6, from the last rising edge of the last bit of the interrogator transmission to the first rising edge of the tag response.

Table 35 — Tag link timing T6 test parameters

TEST: Tag link timing T6				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command : command that uses in-process reply timing (Example: AUTH)				
Parameters	DR: **Variable**	M: **1**	Trext: **1**	
Timings	Tari (µs): **Variable**	PW (µs): **0,5*Tari**	RTcal (µs): **3*Tari**	TRcal (µs): **Variable**

Table 36 — Tag link timing T6 test cases

	Frequency (MHz)	**Tari** (µs)	**D**	**TRcal** (µs)
1	866	6,25	64/3	33,3 (BLF = 640 KHz)
2		12,5	64/3	66,7 (BLF = 320 KHz)
3		25	8	200 (BLF = 40 KHz)
4	915	6,25	64/3	33,3 (BLF = 640 KHz)
5		12,5	64/3	66,7 (BLF = 320 KHz)
6		25	8	200 (BLF = 40 KHz)

8.2.9.3 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail; the pass condition for each point is obtained if the measured link timing parameter T6 is in the range [MAX(RTcal,10Tpri) × (1 – FT) – 2 µs; 20 ms] as defined in ISO/IEC 18000-63.

8.2.10 Tag link timing T7

8.2.10.1 Purpose

The purpose of this test is to verify that the tag meets the link timing parameter T7 which defined the time between tag responses for an *in-process* tag reply.

8.2.10.2 Procedure

The tag timing parameter T7 measurement procedure is as follows.

1) The waveform generator amplitude shall be set to the maximum permissible value.

2) The signal analyser shall be set to power versus time mode.

3) The signal generator shall be set with all parameters defined in Table 37 and with the first test case parameters defined in Table 38 for variable test parameters.

4) Issue a command that uses *in-process* reply timing followed by the continuous wave.

5) Wait until signal analyser is triggered, capture the demodulated tag reply trace power versus time.

6) Measure the tag link timing parameter T7 from the last rising edge of the last bit of the interrogator transmission to the first rising edge of the tag response.

Table 37 — Tag link timing T7 test parameters

TEST: Tag link timing T7				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: command that uses in-process reply timing (Example: AUTH)				
Parameters	DR: **Variable**	M: **1**	Trext: **1**	
Timings	Tari (µs): **Variable**	PW (µs): **0,5*Tari**	RTcal (µs): **3*Tari**	TRcal (µs): **Variable**

Table 38 — Tag link timing T7 test cases

	Frequency (MHz)	**Tari** (µs)	**D**	**TRcal** (µs)
1	866	6,25	64/3	33,3 (BLF = 640 KHz)
2		12,5	64/3	66,7 (BLF = 320 KHz)
3		25	8	200 (BLF = 40 KHz)
4	915	6,25	64/3	33,3 (BLF = 640 KHz)
5		12,5	64/3	66,7 (BLF = 320 KHz)
6		25	8	200 (BLF = 40 KHz)

8.2.10.3 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail; the pass condition for each point is obtained if the measured link timing parameter T7 is in the range [MAX(250 µs, $T2_{max}$); 20 ms] as defined in ISO/IEC 18000-63.

8.2.11 Tag state diagram

8.2.11.1 Purpose

The purpose of this test is to verify that the DUT tag implements the correct state machine as described in ISO/IEC 18000-63.

8.2.11.2 Procedure

The tag state diagram testing procedure is as follows.

1) The waveform generator amplitude shall be set to the maximum permissible value.

2) The tag's Access Password and Kill Password shall be set to non-zero for an appropriate pre-conditioning of the test.

3) The signal analyser shall be set to power versus time mode.

4) The signal generator shall be set with all parameters defined in Table 39.

5) The DUT tag shall be set to the first test initial state "Ready" in order to put the DUT tag into the test initial state, lookup the corresponding state transition sequence in Table 40, then set the signal generator to apply the state transitions described in the state transition sequence column by looking up the corresponding commands in Table 41.

6) Set the signal generator to send all commands defined in ISO/IEC 18000-63:2015, Table B.1.

7) Check if the DUT tag is in the expected target state.

8) Steps 2) to 4) shall be repeated for all tag state, **Arbitrate**, **Acknowledged**, **Open**, **Secured**, **Killed**.

Table 39 — Tag state diagram testing

TEST: Tag state diagram testing					
RF PARAMETERS					
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **866 or 915**		
Modulation type: **DSB-ASK**			Modulation index: **90 %**		
PROTOCOL SETTINGS					
Command: **Query**					
Parameters	DR: **8**	M: **1**	Trext: **0**		DR: **8**
Timings	Tari (µs): **25**	PW (µs): **12,5**	RTcal (µs): **62,5**	TRcal (µs): **100**	Tari (µs): **25**

Table 40 — State transition sequence table

Test initial state	State transition sequence
Power Off	—
Ready	Power Off → Ready
Arbitrate	Power Off → Ready → Arbitrate
Reply	Power Off → Ready → Arbitrate → Reply
Acknowledged	Power Off → Ready → Arbitrate → Reply → Acknowledged
Open	Power Off → Ready → Arbitrate → Reply → Acknowledged → Open
Secured	Power Off → Ready → Arbitrate → Reply → Acknowledged → Open → Secured
Killed	Power Off → Ready → Arbitrate → Reply → Acknowledged → Open → Secured → Killed

Table 41 — State transition table

State → Next state	**Signal generator command**		**DUT tag reply**
Power Off → Ready	**Power On**	→	
		←	**None**
Ready → Arbitrate	**Query** [slot<> 0]	→	
		←	**None**
Arbitrate → Reply	**QueryAdjust** [slot = 0]	→	
		←	**New RN16**
Reply → Acknowledged	**ACK** [valid RN16]	→	
		←	**UII** {00000_2, truncated UII, CRC-16}
Acknowledged → Open	**Req_RN** [valid RN16 and access password<>0]	→	
		←	**Handle**
Open → Secured	**Access** [valid handle and valid access password]	→	
		←	**Handle**
Secured → Killed	**Kill** [valid handle and valid kill password]	→	
		←	**Handle**

8.2.11.3 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail; the pass condition for each point is obtained if the tag implements all correct transition from all diagram states.

8.2.12 Tag backscatter (optional)

8.2.12.1 General

As ISO/IEC 18000-63 does not specify a minimum backscatter value, this test is informative; however, it is used for performance measurements. ISO/IEC 18046-3 refers to this test.

8.2.12.2 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.

Measurements are carried out in an anechoic chamber either in bistatic antennas configuration as shown in Figure 3 a) with the tag positioned in the far field of the transmit antenna or in monostatic antenna configuration [see Figure 3 b)].

8.2.12.3 Test procedure

Measurements shall be done with power $P_{I,min}$, where $P_{I,min}$ is the minimum power allowing the DUT tag activation.

A vector signal analyser as specified in Annex C shall be used to record the quadrature baseband voltages I and Q versus time.

Test setup shall be calibrated to determine antennas gain and mismatch, circulator isolation, insertion loss and mismatch and also cables loss, to be taken into account for all power measurements.

The delta radar cross-section measurement procedure is as follows.

1) The signal generator shall be set to the required test frequency.

2) The signal generator amplitude shall be set to a value that allows the DUT tag activation.

3) Using the power meter, determine the power at the entrance of the transmit antenna P_e, which is defined as the average power measured over at least 100 µs period during the continuous wave signal following the signal generator command.

4) The signal analyser shall be set to measure the quadrature baseband I and Q power versus time with a sampling rate of at least 5 Msps.

5) With the tag placed in the anechoic chamber, the analyser shall be set to capture the complex IQ power for at least during 10 symbols of tag reply.

6) Calculate the difference of power from the DUT tag backscattering according to Formula (9):

$$\Delta P_{\text{tag}}(\text{rms}) = \frac{1}{2Z_0} \cdot \left(\left(I_{r,1} - I_{r,0} \right)^2 + \left(Q_{r,1} - Q_{r,0} \right)^2 \right) \tag{9}$$

where

Z_0 is the wave resistance of the measurement equipment and is usually 50 Ω.

7) Calculate the ΔRCS of the DUT tag using Formula (10):

$$\Delta\mathrm{RCS} = \frac{\Delta P_{\mathrm{tag}}}{P_{\mathrm{e}}} \frac{4\pi d^4}{G_{0t} \cdot G_{0r}} \left(\frac{4\pi}{\lambda} \right)^2 \tag{10}$$

8.2.12.4 Test report

The test report shall give the measured values of ΔRCS. 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.

The pass/fail condition is not determined as ISO/IEC 18000-63 does not specify a minimum ΔRCS value.

8.3 Additional protocol related tests

In ISO/IEC 18000-63, some commands are mandatory, others are optional. Conforming tags and interrogators shall support all mandatory commands. Conforming tags and interrogators may or may not support optional commands. If a tag or an interrogator implements an optional command then it shall implement it in the manner specified in ISO/IEC 18000-63 and additional conformance tests parameters, procedures and reports are described hereafter.

8.3.1 Memory overruns

8.3.1.1 Purpose

The purpose of this test is to verify that operations in one logical memory bank do not access memory locations in another bank.

8.3.1.2 Procedure

The memory overruns measurement procedure is as follows.

1) The test parameters are those described in Table 42 and the interrogator shall be that its antenna sends the maximum permissible power.
2) Initialize all (writable) memory locations in each bank with the value 0x0000.
3) Issue a sequence of Write commands to write the PC with 0x3000 and the remaining UII memory with 0x1111.
4) Verify, using the Read command, that no memory location in another bank has been overwritten.
5) Issue a sequence of Write commands to write the entire USER memory bank with 0x2222.
6) Verify, using the Read command, that no memory location in another bank has been overwritten.
7) Issue a sequence of Write commands to write the entire RESERVED memory bank with 0x3333.
8) Verify, using the Read command, that no memory location in another bank has been overwritten.
9) Issue a sequence of Write commands to attempt to write the entire TID memory bank with 0x4444.
10) Verify, using the Read command, that no memory location in TID or another bank has been overwritten.

Table 42 — Memory overruns test parameters

TEST: Memory overruns	
RF PARAMETERS	
Power EIRP (dBm): **maximum power authorized**	Frequency (MHz): **Variable**

Table 42 *(continued)*

Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: variable				
Parameters	DR: **64/3**	M: **2**	Trext: **1**	
Timings	Tari (µs): **12,5**	PW (µs): **0,5*Tari**	RTcal (µs): **31,25**	TRcal (µs): **66,7**

8.3.1.3 Test report

The test report shall give all communication parameters and the test verdict pass or fail; the pass condition is obtained if no memory overrun has been detected for any memory bank.

8.3.2 Kill command

8.3.2.1 Purpose

The purpose of this test is to verify that operations that involve Kill command and Kill password are compliant with ISO/IEC 18000-63.

8.3.2.2 Procedure

The kill command measurement procedure is as follows.

1) The test parameters are those described in Table 43 and the interrogator shall be that its antenna sends the maximum permissible power.

2) Issue a Kill command to a tag with a zero-valued kill password.

3) Verify that the tag backscatters an error code and does not execute the kill.

Table 43 — Kill command test parameters

TEST: Kill command				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: Kill				
Parameters	DR: **8**	M: **2**	Trext: **1**	
Timings	Tari (µs): **25**	PW (µs): **0,5*Tari**	RTcal (µs): **75**	TRcal (µs): **100** **6,7**

8.3.2.3 Test report

The test report shall give all communication parameters and the test verdict pass or fail; the pass condition is obtained if the tag backscatters an error code or does not execute the kill.

8.3.3 Unauthorized Write command

8.3.3.1 Purpose

The purpose of this test is to verify that if an interrogator attempts to write to the kill or access password, UII or TID memory banks, or File_0 and these memory locations are permalocked; or to the kill or access password, UII or TID memory banks, or File_0 and these memory locations are locked

unwriteable and the Tag is in the open state; or to a permalocked block in File_N, N>0 of User memory; or to memory that is untraceably hidden and the Interrogator has a deasserted Untraceable privilege; or to a file for which the Interrogator does not have sufficient privileges; then the Tag shall not execute the Write and instead treat the command's parameters as unsupported.

8.3.3.2 Procedure

The unauthorized Write command measurement procedure is as follows.

1) The test parameters are those described in Table 44 and the interrogator shall be that its antenna sends the maximum permissible power.
2) Attempt to write the PC value in open state while the UII memory is locked.
3) Verify that the Tag replies with an error message and that the memory has not been written.
4) Attempt to write a permalocked memory location from secured state.
5) Verify that the Tag replies with an error message and that the memory has not been written.
6) Attempt to write a permalocked block in File_N, N>0 of USER memory.
7) Verify that the Tag replies with an error message and that the memory has not been written.
8) Attempt to write to a memory location that is untraceably hidden with a deasserted Untraceable privilege.
9) Verify that the Tag replies with an error message and that the memory has not been written.

Table 44 — Unauthorized Write command test parameters

TEST: Unauthorized Write				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: Write				
Parameters	DR: **64/3**	M: **4**	Trext: **1**	
Timings	Tari (µs): **12,5**	PW (µs): **0,5*Tari**	RTcal (µs): **31,25**	TRcal (µs): **66,7** **6,7**

8.3.3.3 Test report

The test report shall give all communication parameters and the test verdict pass or fail. The pass condition is obtained if the tag backscatters in each tested cases an error code and if the referred memory has not been written.

8.3.4 Optional commands and features

8.3.4.1 Purpose

The purpose of these tests is to verify that if interrogators and tags implement optional commands, they have implemented these commands as described in ISO/IEC 18000-63.

8.3.4.2 Procedure

For all the following tests, the test parameters are those described in Table 45 and the interrogator shall be that its antenna sends the maximum permissible power.

Table 45 — Optional commands test parameters

TEST: C-flag and ResponseBuffer				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: Write				
Parameters	DR: **64/3**	M: **4**	Trext: **1**	
Timings	Tari (µs): **12,5**	PW (µs): **0,5*Tari**	RTcal (µs): **31,25**	TRcal (µs): **66,7** **6,7**

Test 1: A tag shall set C = 0 upon receiving either an access command with SenRep = 0 or a Challenge command and shall set C = 1 after finishing its processing and storing its response (result or error code) in its ResponseBuffer.

1) The test parameters are those described in Table 45 and the interrogator shall be that its antenna sends the maximum permissible power.

2) Read XPC_W1 value to verify that the initial value of C-flag is “0”.

3) Issue a ReadBuffer command to verify that the Tag deallocated its ResponseBuffer and does not execute the ReadBuffer command.

4) Issue a Challenge or an Authenticate command, configured according to a supported cryptographic suite with SenRep = 0.

5) Read XPC_W1 value to verify that the value of C-flag has changed to “1”.

6) Issue a ReadBuffer command to verify that the Tag executes the command and verify the content of the ResponseBuffer.

Test 2: If an access command with SenRep = 0 or a Challenge command specifies IncRepLen = 0 then a Tag shall not include a length field with its stored response, so the first word of the stored response shall be at ResponseBuffer location 00h.

1) The test parameters are those described in Table 45 and the interrogator shall be that its antenna sends the maximum permissible power.

2) Issue a Challenge or an Authenticate command, configured according to a supported cryptographic suite with SenRep = 0 and IncRepLen = 0.

3) Verify that no length field is contained in the ResponseBuffer by using the ReadBuffer command.

Test 3: If the command specifies IncRepLen = 1 then ResponseBuffer bits 00h to 0Eh shall contain the length of the stored response in bits; ResponseBuffer bit 0Fh shall contain an even parity bit that the Tag computes over bits 00h to 0Eh and the first word of the stored response shall be at ResponseBuffer location 10h.

1) The test parameters are those described in Table 45 and the interrogator shall be that its antenna sends the maximum permissible power.

2) Issue a Challenge or an Authenticate command configured according to a supported cryptographic suite with SenRep = 0 and IncRepLen = 1.

3) Verify that the length field is contained in the ResponseBuffer by using the ReadBuffer command.

Test 4: A Tag shall retain data in its ResponseBuffer with the persistence of its C-flag.

1) The test parameters are those described in Table 45 and the interrogator shall be that its antenna sends the maximum permissible power.

2) Issue a Challenge or an Authenticate command configured according to a supported cryptographic suite with SenRep = 0.

3) Switch off the carrier after successful tag response.

4) Read XPC_W1 after the persistence of the C-flag and verify that C = 0.

5) Issue a ReadBuffer command to verify that the Tag deallocated its ResponseBuffer.

Test 5: Authenticate.

1) Issue an Authenticate command configured according to a supported cryptographic suite.

2) Verify that the Tag backscatters a valid response.

Test 6: AuthComm.

1) Issue an AuthComm command configured according to a supported cryptographic suite.

2) Verify that the Tag backscatters a valid response and verify that the interrogator decodes the tag response according to the specification.

Test 7: SecureComm.

1) Issue an SecureComm command configured according to a supported cryptographic suite.

2) Verify that the Tag backscatters a valid response.

Test 8: KeyUpdate.

1) Issue a KeyUpdate command configured according to a supported cryptographic suite.

2) Verify that the Tag backscatters a valid response.

Test 9: TagPrivilege

1) Issue a TagPrivilege command configured according to a supported cryptographic suite.

2) Verify that the Tag backscatters a valid response.

Test 10: Untraceable.

1) Issue an Untraceable command that is configured to hide the User memory.

2) Verify that the Read command is only executed for an Interrogator that has an asserted Untraceable privilege.

3) Issue another Untraceable command which is configured to expose the User memory.

4) Verify that the Read command is executed independent from the Untraceable privilege of the Interrogator.

5) Deassert Tag privilege bit 13 (Untraceable), associated with the access password or with a cryptographic suite, by issuing a TagPrivilege command.

6) Issue an Untraceable command that is configured to hide the User memory.

7) Verify that the Read command is not executed.

Test 11: FileOpen.

1) Issue a FileOpen command command configured according to a supported cryptographic suite.

2) Verify that the Tag backscatters a valid response.

8.3.4.3 Test report

The test report shall give all communication parameters and the test verdict pass or fail for all the tested optional commands.

9 Conformance tests for ISO/IEC 18000-64

9.1 Functional tests of interrogator

9.1.1 Interrogator modulation test

9.1.1.1 Test objective

The objective of this test is to verify that the interrogator does not modulate in any way while singulating tags.

9.1.1.2 Test procedure

The interrogator shall transmit a CW carrier at the maximum permissible power of the selected carrier frequency for testing. Ten tags shall be placed in front of the interrogator at 50 % of maximum reading range.

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 spectrum analyser as specified in Annex C and the sense antenna shall be used to record the spectrum provided by the interrogator. It shall also be verified that the interrogator was successfully singulating all 10 tags.

9.1.1.3 Test report

The test report shall give the measured values of the parameters according to Table 46.

Table 46 — Measurements to be made

Parameter	Conditions
BW	30 dB bandwidth <100 Hz

9.1.2 Interrogator demodulation and data decoding

9.1.2.1 Test objective

The objective of this test is to verify whether the interrogator is capable of demodulating signals from the tags, including multiple TTO pages and verification of TID-U CRC.

9.1.2.2 Test procedure

The interrogator shall transmit a CW carrier at the maximum permissible power. A tag emulator as specified in Annex D shall transmit a ISO/IEC 18000-64 response as per Table 47 using the minimum *maximum_hold-off_time* as specified in ISO/IEC 18000-64 and at a minimum ΔRCS specified in ISO/IEC 18000-64. All other parameters shall be set at the nominal values as specified.

Measurements shall be done with a tag emulator positioned at d_{TE} = 10 λ.

In case the interrogator is designed 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.

Table 47 — Measurements to be made

Tag emulator configuration		Test outcome	Notes
1	PPE Modulation	Verify parameters for PPE modulation	Assume verification of preamble and modulation is correct if data is decoded.
1.1	TID-U Only	Verify single page detection	
1.2	TID-U Only with CRC error	Verify TID-U error detection	Assume detection of one CRC error implies all CRC errors shall be detected.
1.3	TID-U with seven data pages containing a random distribution of an equal amount of 1 and 0 bits.	Verify multi page data decoding	
1.4	For TID-S, construct four random (as in 1.3) data sets according to the examples in ISO/IEC 18000-64 numbered as follows: — Case 1: $E0_h$ format; — Case 2: $E0_h$ format with padded UII Segment; — Case 3: $E3_h$ format; — Case 4: Maximum length $E2_h$ format. Perform the following tests for each case: — All data correct; — UII CRC error; — Data CRC error.	Verify structured data decoding and CRC error detection	Assume a single correct decoding of random data of structured data set is representative. It is recommended that the four cases contain different data and data configurations.
1.5	Using Case 1 of 1.5, add a simple sensor page according to ISO/IEC 18000-64. Perform the following tests: — Simple Sensor data correct; — Simple Sensor data with a CRC error.	Verify simple sensor decoding.	

Table 47 *(continued)*

Tag emulator configuration		Test outcome	Notes
2	Miller Modulation	Verify parameters for Miller modulation	
2.1	Perform tests 1.1-16 on Miller modulation with link bits disabled.	Verify data decoding on Miller modulation	
2.2	Use case 4 on Miller modulation with link bits enabled. Perform the following tests: — No errors induced; — Induce a link bit CRC error; — Induce a link bit down count error: — Missing page 1, — Missing middle page, — Missing last page.	Verify link bit decoding	

9.1.2.3 Test report

The test report shall contain the tag emulator distance to the interrogator and the ΔRCS value setup in the tag emulator. Furthermore, the used interrogator output power and the used operation frequency shall be recorded.

9.2 Functional tests of tag

9.2.1 General

9.2.1.1 General

As ISO/IEC 18000-64 does not specify a minimum backscatter value, this test is informative, however, is used for performance measurements. ISO/IEC 18046-3 refers to this test.

9.2.1.2 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.

Measurements are carried out in an anechoic chamber in bistatic antennas configuration as shown in Figure 3 with the tag positioned in the far field of the transmit antenna.

9.2.1.3 Test procedure

Measurements shall be done with power $P_{I,min}$, where $P_{I,min}$ is the minimum power allowing the DUT tag activation.

A vector signal analyser as specified in Annex C shall be used to record the quadrature baseband voltages I and Q versus time.

Test setup shall be calibrated to determine antennas gain and mismatch and also cables loss to be taken into account for all power measurements.

The delta radar cross-section measurement procedure is as follows.

1) The signal generator shall be set to the required test frequency.

2) The signal generator amplitude shall be set to a value that allows the DUT tag activation.

3) Using the power meter, determine the power at the entrance of the transmit antenna, P_e, which is defined as the average power measured over at least 100 µs period during the continuous waves signal following the signal generator command.

4) The signal analyser shall be set to measure the quadrature baseband I and Q power versus time with a sampling rate of at least 5 Msps.

5) With the tag placed in the anechoic chamber, the analyser shall be set to capture the complex IQ power for at least during 10 symbols of tag reply.

6) Calculate the difference of power from the DUT tag backscattering according to Formula (11):

$$\Delta P_{\text{tag}}(\text{rms}) = \frac{1}{2Z_0} \cdot \left(\left(I_{r,1} - I_{r,0} \right)^2 + \left(Q_{r,1} - Q_{r,0} \right)^2 \right) \tag{11}$$

where

Z_0 is the wave resistance of the measurement equipment and usually 50 Ω.

7) Calculate the ΔRCS of the DUT tag using Formula (12):

$$\Delta\text{RCS} = \frac{\Delta P_{\text{tag}}}{P_e} \frac{4\pi d^4}{G_{0t} \cdot G_{0r}} \left(\frac{4\pi}{\lambda} \right)^2 \tag{12}$$

9.2.1.4 Test report

The test report shall give the measured values of ΔRCS. 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.

The pass/fail condition is not determined as ISO/IEC 18000-64 does not specify a minimum ΔRCS value.

9.2.2 Data encoding

9.2.2.1 Test objective

The objective of this test is to verify the data encoding of the tag.

9.2.2.2 Test procedure

For each data encoding type supported by the tag, program the tag with representative data and record the TagMsg transmitted by the tag. The encoding types as specified in ISO/IEC 18000-64 are as follows:

— TID-U only;

— TID-U with zero or more data pages, the test to be performed with zero and eight data pages;

— TID-S with the four cases as specified in Table 47;

— optional simple sensor encoding for each of the above types.

9.2.2.3 Test report

The test report shall provide all data types tested and the result.

9.2.3 Link bits

9.2.3.1 Test objective

The objective of this test is to verify the correctness of the link bits as specified in ISO/IEC 18000-64.

9.2.3.2 Test procedure

Record all the symbols of a tag transmission and inspect the link bits for correctness. The tag should be configured for:

— 1 page;

— 4 pages;

— 8 pages.

9.2.3.3 Test report

The test report shall provide the tag configuration and result.

9.2.4 Tag timing parameters

9.2.4.1 Test objective

The objective of this test is to verify the tag transmission's statistical distribution referencing the parameters in ISO/IEC 18000-64.

9.2.4.2 Test procedure

A signal generator shall transmit a CW carrier at the maximum permissible power.

An oscilloscope shall record the start and end of each TagMsg transmission as specified in ISO/IEC 18000-64.

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 test as specified in Table 48 shall be performed for each modulation type supported.

The test shall be performed for the tag configured for 1 page and should be performed for 8 pages and maximum transmission pages supported if the test equipment can be configured to detect the start and end of multi-page transmissions.

The tag test set shall consist of a 100 randomly selected tags from a large sample of tags (more than 10,000). All tags must be set to the minimum value of *maximum_hold-off_time*.

Table 48 — Measurements to be made

Tag emulator configuration		Test method	Report
1	Verify the value of Rt_1 to be greater or equal than *minimum_listen_time*.	For the full set of tags, perform the following steps. a) Place 10 tags in the beam of the signal generator. b) Toggle the CW a 100 cycles for 5 ms on and 5 ms off. c) Record any tag modulations.	Note the timing of any tag modulations occurred. The test fails if any tag has modulated.
2	Verify the value of Rt_n to be greater or equal than *symbol_detect_time* for n greater than 1.	For each tag of the set, perform the following steps. a) Place the tag in the beam of the signal generator. b) Switch CW on for 20 s. c) Record each TagMsg transmission start and end.	Note and record any gap between end of transmission and start of transmission less than *symbol_detect_time*. The test fails if any gap is less than *symbol_detect_time*.
3	Verify the randomness of Rt_n.	Using the data recoded in test 2, calculate the gap between each TagMsg transmission and note the transmission count with the first transmission being 1. The first transmission gap is measured from the time the CW is switched on. Calculate the mean and median of the gaps to determine the randomness of the gaps for all: — first transmissions; — first 2 transmissions; — first 5 transmissions; — first 20 transmissions; — all transmissions.	The mean and median values shall be no less than 15 ms.

9.2.4.3 Test report

The test report shall indicate the deviation of the norm values as specified in ISO/IEC 18000-64.

9.2.5 Tag bit rate

9.2.5.1 Test objective

The objective of this test is to verify the bit rate accuracy and data rate of the return link.

9.2.5.2 Test procedure

The interrogator shall transmit a CW carrier at the maximum permissible power.

The tag response waveform shall be recorded by an 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.

9.2.5.3 Test report

The test report shall give the measured values of bit rate calculated according to Formula (13) and Formula (14):

$$T_{B7} = 7 \times T_{rlb} \tag{13}$$

$$\text{bit rate} = \frac{7}{T_{B7}} \tag{14}$$

The pass/fail condition is determined whether the measured values are over the full temperature range as specified in ISO/IEC 18000-64.

9.2.6 Tag multi-page timing

9.2.6.1 Test objective

The objective of this test is to verify tag multi-page timing

9.2.6.2 Test procedure

The interrogator shall transmit a CW carrier at the maximum permissible power. The tag shall be configured to transmit an ID plus the maximum number of data pages supported.

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

The spacing between each of the packets shall be measured.

9.2.6.3 Test report

The test report shall give the spacing in terms of number of bits calculated according to Formula (15):

$$\text{spacing} = \frac{T_{measured}}{T_{bit}} \tag{15}$$

The pass/fail condition is determined whether the measured values are as specified in ISO/IEC 18000-64.

9.2.7 Tag LBT

9.2.7.1 Test objective

The objective of this test is to verify that the tag will suspend in the presence of interrogator modulation.

9.2.7.2 Test procedure

The interrogator shall transmit a CW carrier at the maximum permissible power of the selected carrier frequency for testing for 2 ms, thereafter it will modulate the carrier with five pulses as specified in ISO/IEC 18000-64.

The tag response waveform shall be recorded by an oscilloscope as specified in Annex C using the tag backscatter test setup, the tag positioned $d_{T,IA}$ = 3 λ and $d_{T,MA}$ = 3 λ away from the test interrogator antennas. It shall be verified that there are no tag responses for a minimum period of *TOTAL_Wakeup_timeout* as specified in ISO/IEC 18000-64 after the five pulses.

9.2.7.3 Test report

The test report shall note any tag responses received within a time *TOTAL_Wakeup_timeout.*

10 Conformance tests for ISO/IEC 18000-63 battery-assisted passive (BAP)

10.1 Tag functional tests

The minimum requirements for BAP tags to support ISO/IEC 18000-63:2015, Clause 7 (Battery-assisted passive) is to support all commands and features of ISO/IEC 18000-63, and that flag persistence has the slightly altered definition of meaning that persistence times begin at the point that tag receive signal strength drops below sensitivity instead of the battery-free definition relative to tag being energized.

10.1.1 Battery-assisted passive tag persistence time test

10.1.1.1 Purpose

The purpose of this test is to verify that the DUT battery-assisted tag shows the persistence time as defined in ISO/IEC 18000-63:2015, Table 7.1.

The persistence time for battery-assisted tag mean the time that the flag maintains its state before resetting to a default after the tag loss of signal relative to the tag sensitivity level.

10.1.1.2 Procedure

The battery-assisted passive tag persistence time measurement procedure is as follows.

1) The waveform generator amplitude shall be set to the maximum permissible value.

2) The signal analyser trigger shall be set to frequency mask trigger waiting tag response; the signal analyser trigger will be active if the tag response is present.

3) The signal generator shall be set with all RF parameters defined in Table 49.

4) A **SELECT** command shall be sent with protocol settings parameters defined in Table 49 and with the first test case parameters defined in Table 50 for variable test parameters (this command set the DUT tag in the test session to inventoried State B).

5) The waveform generator amplitude shall be set to a value below the tag sensitivity level (typically zero) during the persistence time $\mathbf{T_{persistence}}$ defined in Table 50 first test case.

6) A **QUERY** command shall be sent with protocol settings parameters defined in Table 49 and with the first test case parameters defined in Table 50 for variable test parameters.

7) Wait until the signal analyser is triggered, if it is not triggered in 1 s, then finish the test case.

8) Steps 3) to 7) shall be repeated for all the test cases defined in Table 50.

Table 49 — BAP tag persistence time test parameters

TEST: BAP tag persistence time				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **866 or 915 or 953**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Commands				
Query parameters	DR: **8**	M: **1**	Sel/Session: **Variable**	Target: **Variable**
Select parameters	Target: Variable	Action: 100 (deassert SL or Flag->B)	Length: 0	
Timings	Tari (µs): **25**	PW (µs): **12,5**	RTcal (µs): **62,5**	TRcal (µs): **100**

Table 50 — BAP tag persistence time test cases

	Select [Target]	**$T_{persistence}$**	**Query [Sel]**	**Query [Session]**	**Query [Flag]**
1	S0	Min: 50 µs	Sel : All	S0	B
2		Max: 500 µs			A
3	S1	500 ms	Sel : All	S1	B
4		5 s			A
5	S2	2 s	Sel : All	S2	B
6		20 s			A
7	S3	2 s	Sel : All	S3	B
8		20 s			A
9	SL	2 s	Sel : ~ SL	Any	Any
10		20 s	Sel : SL		Any

10.1.1.3 Test report

The test report shall give for each test point all communication parameters and the test verdict pass or fail, the pass condition for each point is obtained when the signal analyser is triggered that means that the tag is reply to the QUREY command.

11 Conformance tests for ISO/IEC 18000-63 Manchester mode battery-assisted passive (BAP)

The Manchester mode BAP is based on the requirements in ISO/IEC 18000-63:2015, 7.5. A device conforming to ISO/IEC 18000-63:2015, 7.5 (Manchester mode battery-assisted passive) shall also support all other mandatory requirements of ISO/IEC 18000-63. The requirements in ISO/IEC 18000-63:2015, 7.5 include only the additional requirements that the conformant device shall support. The conformance tests for ISO/IEC 18000-63:2015, 7.5 are specified below.

11.1 Functional tests of interrogator

11.1.1 Interrogator RF envelope parameters

11.1.1.1 Purpose

The purpose of this test is to verify all the RF modulation parameters pulse for a data-0 and a data-1 as described in ISO/IEC 18000-63:2015, 7.5.

11.1.1.2 Procedure

The interrogator RF envelope parameters measurement procedure is as follows.

1) The DUT interrogator shall be configured for transmitting at the maximum power, at the first supported frequency and modulation type.

2) The DUT interrogator shall be set with all parameters defined in Table 51 and with the first test case parameters defined in Table 52 for variable test parameters.

3) The DUT interrogator shall be set to send a Short Manchester **ACTIVATION** followed by **QUERY** command followed by the continuous wave.

4) The signal analyser shall be set to power versus time mode.

5) Wait until signal analyser is triggered, capture all the demodulated trace power versus time.

6) Measure the DUT interrogator envelope parameters as described in ISO/IEC 18000-63:2015, 7.5.

7) The steps 2) to 6) shall be repeated for all the test cases that are supported by the DUT interrogator.

Table 51 — Interrogator RF envelope test parameters

TEST: Interrogator RF envelope parameters				
RF PARAMETERS				
Power EIRP (dBm): **max power authorized**			Frequency (MHz): **Interrogator supported frequencies**	
Modulation type: **Interrogator supported modulations**			Modulation index: **Variable**	
PROTOCOL SETTINGS				
Command: **Activation + Query**				
Parameters	M: **8**	Trext: **1**	T2ext: **0**	
Timings	Forward data rate (Kbps): **Variables**	BLF: 160 KHz		

Table 52 — Interrogator RF envelope test cases

	Forward data rate (Kbps)
1	128
2	64
3	32
4	16
5	8

11.1.1.3 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail; the pass condition for each point is obtained if the value of the parameters shall be in the limit maximum and minimum as specified in ISO/IEC 18000-63:2015, 7.5.2.1.5.

11.1.2 Interrogator activation minimum dwell time, T_A

11.1.2.1 Purpose

The purpose of this test is to verify that the DUT interrogator meets the Manchester mode timing parameter, T_A.

11.1.2.2 Procedure

The interrogator link timing ,T_A, measurement procedure is as follows.

1) The DUT interrogator shall be configured for transmitting at the maximum power, at the first supported frequency and modulation type.

2) The DUT interrogator shall be set with all parameters defined in Table 53 and with the first test case parameters defined in Table 54 for variable test parameters.

3) The DUT interrogator shall be set to send a Short Manchester **ACTIVATION** followed by **QUERY** command followed by the continuous wave.

4) The signal analyser shall capture all demodulated trace power versus time (**Activation+Query**).

5) Measure the link parameter, finding the end of **Activation** and the beginning of **Query**.

6) Steps 3) to 5) shall be repeated for all the test cases that are supported by the DUT interrogator.

Table 53 — Interrogator link timing T_A test parameters

TEST: Tag link timing parameter T_A				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: **Activation + Query**				
Parameters	M: **8**	Trext: **1**	T2ext: 0	
Timings	Forward data rate: **Variable**			

Table 54 — Interrogator link timing parameter T_A test cases

	Forward data rate (Kbps)
1	8
2	16
3	32 32 64 128
4	64
5	128

11.1.2.3 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail, the pass condition is obtained for each test point if the measured time value shall be greater than the maximum tag activation time T_A.

11.1.3 Interrogator link timing T2

11.1.3.1 Purpose

The purpose of this test is to verify that the DUT interrogator meets the Manchester mode timing parameter T2.

11.1.3.2 Procedure

The interrogator link timing T2 measurement procedure is as follows.

1) The DUT interrogator shall be configured for transmitting at the maximum power, at the first supported frequency and modulation type.

2) The DUT interrogator shall be set with all parameters defined in Table 55 and with the first test case parameters defined in Table 56 for variable test parameters.

3) The DUT interrogator shall be set to send a Short Manchester **ACTIVATION** followed by **QUERY** command followed by the continuous wave.

4) Set the tag emulator to backscatter an RN16 reply, the RN16 shall be sent after the typical value for T1, the DUT interrogator will send its ACK.

5) The signal analyser shall capture all demodulated trace power versus time (**Activation+Query+RN16+ACK**).

6) Measure the link parameter, finding the end of RN16 frequency variation and the beginning of ACK frequency variation.

7) The steps 3) to 6) shall be repeated for all the test cases that are supported by the DUT interrogator.

Table 55 — Interrogator link timing T2 test parameters

TEST: Tag link timing parameter T2				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: **Activation + Query**				
Parameters	M: **8**	Trext: **1**	T2ext: 0	
Timings	Forward data rate: **Variable**	BLF (KHz): **Variable**		

Table 56 — Interrogator link timing parameter T2 test cases

	Forward data rate (Kbps)	**BLF** (KHz)
1	8	120
2	16	160
3	32	192
4	64	240
5	128	320

11.1.3.3 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail; the pass condition is obtained for each test point if the measured time value shall be between T2 min and T2 max.

11.1.4 Interrogator link timing T3

11.1.4.1 Purpose

The purpose of this test is to verify that the DUT interrogator meets the timing parameter T3, which define the time an interrogator waits, after T1, before it issues another command.

11.1.4.2 Procedure

The interrogator link timing T3 measurement procedure is as follows.

1) The DUT interrogator shall be configured for transmitting at the maximum power, at the first supported frequency and modulation type.

2) The signal analyser shall be set to power versus time mode.

3) The DUT interrogator shall be set with all parameters defined in Table 57 and with the first test case parameters defined in Table 58 for variable test parameters.

4) Set DUT interrogator to transmit Short Manchester **Activation** followed by the **Select** command followed by the **Query** command.

5) The signal analyser shall capture all demodulated trace power versus time (**Select** + **Query**).

6) Measure the link timing T3 + T1, finding the end of **Query** frequency variation and the beginning of **QueryRep** frequency variation, the link parameter T3 is calculated by subtracting the T1 maximum value to the measured time (T1 + T3).

7) Steps 3) to 6) shall be repeated for all the test cases that are supported by the DUT interrogator.

Table 57 — Tag link timing parameter T3 test parameters

TEST: Tag link timing parameter T3				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**		Frequency (MHz): **Variable**		
Modulation type: **DSB-ASK**		Modulation index: **90 %**		
PROTOCOL SETTINGS				
Command: **Activation + Select + Query**				
Parameters	M: **1**	Trext: **1**		
Timings	Forward data rate: **Variable**			

Table 58 — Tag link timing parameter T3 test cases

	Forward data rate (Kbps)	**BLF** (KHz)
1	8	120
2	16	160
3	32	192
4	64	240
5	128	320

11.1.4.3 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail; the pass condition is obtained for each test point if the measured time value shall be greater than the minimum value for T3 according to ISO/IEC 18000-63:2015, 7.5.

11.1.5 Interrogator link timing T4

11.1.5.1 Purpose

The purpose of this test case is to verify that the DUT interrogator meets the timing parameter T4, which define the minimum time between interrogator commands.

11.1.5.2 Procedure

The interrogator link timing T4 measurement procedure is as follows.

1) The DUT interrogator shall be configured for transmitting at the maximum power, at the first supported frequency and modulation type.

2) The signal analyser shall be set to power versus time mode.

3) The DUT interrogator shall be set with all parameters defined in Table 59 and with the first test case parameters defined in Table 60 for variable test parameters.

4) Set DUT to initiate an inventory round, transmitting a Short Manchester **ACTIVATION** followed by the **QUERY** command followed by **QueryRep** command.

5) The signal analyser shall capture all demodulated trace power versus time (**Query** + **QueryRep**).

6) Measure the link timing T4, finding the end of **select** frequency variation and the beginning of Query frequency variation.

7) Steps 3) to 6) shall be repeated for all the test cases that are supported by the DUT interrogator.

Table 59 — Tag link timing parameter T4 test parameters

TEST: Tag link timing parameter T4				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: **Activation + Query + QueryRep**				
Parameters	M: **1**	Trext: **1**		
Timings	Forward data rate: **Variable**			

Table 60 — Tag link timing parameter T4 test cases

	Forward data rate (Kbps)	**BLF** (KHz)
1	8	120
2	16	160
3	32	192
4	64	240
5	128	320

11.1.5.3 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail; the pass condition is obtained for each test point if the measured time value shall be greater than the minimum value for T4 according to ISO/IEC 18000-63:2015, 7.5.

11.2 Functional tests of tag

11.2.1 Tag demodulation capability

11.2.1.1 Purpose

The purpose of this test is to verify that the DUT tag shall be capable of demodulating a DSB-ASK modulated reader command signal with Manchester encoding.

11.2.1.2 Procedure

The tag demodulation capability measurement procedure is as follows.

1) The waveform generator amplitude shall be set to the maximum permissible value.

2) The signal analyser trigger shall be set to frequency mask trigger waiting tag response; the signal analyser trigger will be active if the tag response is present.

3) The signal generator shall be set with all parameters defined in Table 61 and with the first test case parameters defined in Table 62 for variable test parameters.

4) A short Manchester **ACTIVATION** followed by the **QUERY** command shall be continuously sent followed by the continuous wave.

5) Wait until the signal analyser is triggered, if it is not triggered in 1 s, then finish the test case.

6) Steps 3) to 5) shall be repeated for all the test cases defined in Table 62.

Table 61 — Tag demodulation capability test parameters

TEST: Tag demodulation capability				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **Variable**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: **Activation + Query**				
Parameters	M: **8**	Trext: **1**	T2ext: 0	
Timings	Forward data rate (Kbps): **8**	BLF: 160 KHz		

Table 62 — Tag demodulation capability test cases

	Frequency (MHz)	**Modulation type**
1	866	DSB-ASK
2	915	DSB-ASK

11.2.1.3 Test report

The test report shall give for each test point all communication parameters and the test verdict pass or fail; the pass condition for each point is obtained when the signal analyser is triggered that means that the tag is working at the test frequency and modulation.

11.2.2 Tag link frequency tolerance and variation

11.2.2.1 Purpose

The purpose of this test is to verify that the tag can backscatter its reply with a variable link frequency from 40 kHz to 640 kHz with ±2,0 % tolerance as defined in ISO/IEC 18000-63:2015, 7.5.

11.2.2.2 Procedure

The tag link frequency tolerance and variation measurement procedure is as follows.

1) The waveform generator amplitude shall be set to the maximum permissible value.
2) The signal analyser shall be set to power versus time mode.
3) The signal generator shall be set with all parameters defined in Table 63 and with the first test case parameters defined in Table 64 for variable test parameters.
4) A short Manchester **ACTIVATION** followed by the **QUERY** command shall be continuously sent followed by the continuous wave.
5) Wait until signal analyser is triggered, capture the demodulated tag reply trace power versus time.
6) Measure the tag link frequency from the demodulated trace data for each symbol and determine the minimum and maximum value.
7) Steps 3) to 5) shall be repeated for all the test cases defined in Table 64.

Table 63 — Tag link frequency tolerance test parameters

TEST: Tag link frequency tolerance				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: **Activation + Query**				
Parameters	M: **8**	Trext: **1**	T2ext: 0	
Timings	Forward data rate (Kbps): **Variables**	BLF: Variable		

Table 64 — Tag link frequency tolerance and variation test cases

	Frequency (MHz)	**Forward data rate** (Kbps)	**BLF** (KHz)
1	866	128	640
2		32	320
3		8	40
4	915	128	640
5		32	320
6		8	40

11.2.2.3 Test report

The test report shall give for each test point all communication parameters and the test verdict pass or fail; the pass condition for each point is obtained if the tag link frequency respects the tolerances defined in ISO/IEC 18000-63:2015, 7.5.

11.2.3 Tag link timing T1

11.2.3.1 Purpose

The purpose of this test is to verify that the tag meets the link timing parameter T1 which defined the time from interrogator transmission to tag response.

11.2.3.2 Procedure

The tag timing parameter T1 measurement procedure is as follows.

1) The waveform generator amplitude shall be set to the maximum permissible value.

2) The signal analyser shall be set to power versus time mode.

3) The signal generator shall be set with all parameters defined in Table 65 and with the first test case parameters defined in Table 66 for variable test parameters.

4) A Short Manchester **ACTIVATION** followed by the **QUERY** command shall be continuously sent followed by the continuous wave.

5) Wait until signal analyser is triggered, capture the demodulated tag reply trace power versus time.

6) Measure the tag link timing parameter T1, from the last rising edge of the last bit of the Interrogator transmission to the first rising edge of the Tag response.

7) The steps 3) to 5) shall be repeated for all the test cases defined in Table 66.

Table 65 — Tag link timing T1 test parameters

TEST: Tag link timing T1				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: **Activation + Query**				
Parameters	M: **8**	Trext: **1**	T2ext: 0	
Timings	Forward data rate (Kbps): **Variables**	BLF: Variable		

Table 66 — Tag link timing T1 test cases

	Frequency (MHz)	**Forward data rate** (Kbps)	**BLF** (KHz)
1	866	128	640
2		32	320
3		8	40
4	915	128	640
5		32	320
6		8	40

11.2.3.3 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail, the pass condition for each point is obtained if the measured link timing parameter T1 is within the range defined in ISO/IEC 18000-63:2015, 7.5.

11.2.4 Tag link timing T2

11.2.4.1 Purpose

The purpose of this test is to verify that the tag meets the link timing parameter T2; the tag under test shall not start backscattering its UII before the T2 minimum defined in ISO/IEC 18000-63:2015, 7.5.

11.2.4.2 Procedure (reply state)

The tag link timing parameter T2 measurement procedure is as follows.

1) The waveform generator amplitude shall be set to the maximum permissible value.
2) The signal analyser shall be set to power versus time mode.
3) The signal generator shall be set with all parameters defined in Table 67 and with the first test case parameters defined in Table 69 for variable test parameters.
4) A short Manchester **ACTIVATION** followed by the **QUERY** command shall be continuously sent followed by the continuous wave.
5) Wait until signal analyser is triggered, capture the demodulated tag reply trace power versus time.
6) The signal analyser shall be set to send an ACK command with the backscattered RN16. The command shall be sent immediately before T2 minimum.
7) Steps 3) to 5) shall be repeated for the following:
   i) a tag DOES respond to an interrogator command issued at 0,25Tbit;
   ii) a tag DOES respond to an interrogator command issued at 4Tbit;
   iii) a tag DOES NOT respond to an interrogator command issued at 8Tbit.
8) Steps 3) to 7) shall be repeated for all the test cases defined in Table 69.

Table 67 — Tag link timing T2 test parameters

TEST: Tag link timing T2				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: **Activation + Query + ACK**				
Parameters	M: **8**	Trext: **1**	T2ext: 0	
Timings	Forward data rate (Kbps): **Variables**	BLF: Variable		

11.2.4.3 Procedure (acknowledge state)

The tag link timing parameter T2 measurement procedure is as follows.

1) The waveform generator amplitude shall be set to the maximum permissible value.
2) The signal analyser shall be set to power versus time mode.
3) The signal generator shall be set with all parameters defined in Table 68 and with the first test case parameters defined in Table 69 for variable test parameters.
4) A QUERY command shall be continuously sent followed by the continuous wave.

5) The signal analyser shall be set to send an ACK command with the backscattered RN16. The command shall be sent after T2 = 10Tpri.

6) Wait until signal analyser is triggered, capture the demodulated tag reply trace power versus time.

7) The signal analyser shall be set to send an REQ_RN command with the previously backscattered RN16. The command shall be sent immediately before T2 minimum.

8) Steps 3) to 7) shall be repeated for the following:

   i) a tag DOES respond to an interrogator command issued at 0,25Tbit;

   ii) a tag DOES respond to an interrogator command issued at 4Tbit;

   iii) a tag DOES NOT respond to an interrogator command issued at 8Tbit.

9) Steps 3) to 8) shall be repeated for all the test cases defined in Table 69.

Table 68 — Tag link timing T2 test parameters

TEST: Tag link timing T2				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: **Query, Ack, Req_RN**				
Parameters	M: **8**	Trext: **1**	T2ext: 0	
Timings	Forward data rate (Kbps): **Variables**	BLF: Variable		

Table 69 — Tag link timing T2 test cases

	Frequency (MHz)	**Forward data rate** (Kbps)	**BLF** (KHz)
1	866	128	640
2		32	320
3		8	40
4	915	128	640
5		32	320
6		8	40

11.2.4.4 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail; the pass condition for each point is obtained if the tag does not respond to the ACK command.

11.2.5 Tag activation time maximum, T_A

11.2.5.1 Purpose

The purpose of this test is to verify that the tag meets the maximum activation timing parameter, T_A, which defined the time from the last bit of the activation command to ready to receive the first bit of the preamble of a normal command.

11.2.5.2 Procedure

The tag timing parameter, T_A, measurement procedure is as follows.

1) The waveform generator amplitude shall be set to the maximum permissible value.

2) The signal analyser shall be set to power versus time mode.

3) The signal generator shall be set with all parameters defined in Table 70 and with the first test case parameters defined in Table 71 for variable test parameters.

4) A short Manchester **ACTIVATION** followed by the **QUERY** command shall be continuously sent followed by the continuous wave.

5) Wait until signal analyser is triggered, capture the demodulated tag reply trace power versus time.

6) Measure the tag link timing parameter, T_A, from the last edge of the last bit of the interrogator activation command to the first edge of the first preamble bit of a normal command. The measured value is the shortest T_A time which the tag successfully responds.

7) Steps 3) to 5) shall be repeated for all the test cases defined in Table 71.

Table 70 — Tag link timing T_A test parameters

TEST: Tag link timing T_A				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: **Activation + Query**				
Parameters	M: **8**	Trext: **1**	T2ext: 0	
Timings	Forward data rate (Kbps): **Variables**	BLF: Variable		

Table 71 — Tag link timing T_A test cases

	Forward data rate (Kbps)	**BLF** (KHz)
1	128	640
2	64	320
3	32	240
4	16	160
5	8	120

11.2.5.3 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail; the pass condition for each point is obtained if the measured link timing parameter, T_A, is within the range defined in ISO/IEC 18000-63:2015, 7.5.

11.2.6 Tag stateful hibernate timer

11.2.6.1 Purpose

The purpose of this test is to verify that the tag meets the stateful hibernate timer accuracy requirements which defined the time from the last bit of the tag response to the next command to the expiration of the hibernate timer.

11.2.6.2 Procedure

The tag timing hibernate timer measurement procedure is as follows.

1) The waveform generator amplitude shall be set to the maximum permissible value.

2) The signal analyser shall be set to power versus time mode.

3) The signal generator shall be set with all parameters defined in Table 72 and with the first test case parameters defined in Table 73 for variable test parameters.

4) A long Manchester **ACTIVATION** with session locking selected and hibernate timer set to 1 s followed by the **QUERY** command shall be continuously sent followed by the continuous wave.

5) Wait until signal analyser is triggered, capture the demodulated tag reply trace power versus time.

6) Measure the tag hibernate timer from the last edge of the last bit of the tag response to the next command to the first edge of the first subsequent Query response from the tag.

7) Steps 3) to 5) shall be repeated for all the test cases defined in Table 73.

Table 72 — Tag stateful hibernate timer test parameters

TEST: Tag link timing T_A				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **Variable**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Command: **Activation + Query + ACK + Next**				
Parameters	M: **8**	Trext: **1**	T2ext: 0	
Timings	Forward data rate (Kbps): **32 Kbps**	BLF: 160 KHz		

Table 73 — Tag stateful hibernate timer test cases

	Session	**Hibernate timeout** (s)
1	S0	1
2		8
3	S1	1
4		8
5	S2	1
6		8
7	S3	1
8		8

11.2.6.3 Test report

The test report shall give for each test case all communication parameters and the test verdict pass or fail; the pass condition for each point is obtained if the measured stateful hibernate timer accuracy is within the range defined in ISO/IEC 18000-63:2015, 7.5.

12 Conformance tests for ISO/IEC 18000-63 Sensor support

12.1 Tag functional tests

Two classes of sensors are supported by ISO/IEC 18000-63, simple sensor (SS) and full-function sensor (FS).

12.1.1 Simple sensor test

12.1.1.1 Purpose

The purpose of this test is to verify that the DUT tag support the simple sensor (SS) functionality as defined in ISO/IEC 18000-63:2015, Clause 8.

12.1.1.2 Procedure

The simple sensor test measurement procedure is as follows.

1) The waveform generator amplitude shall be set to the maximum permissible value.
2) The signal analyser shall be set to power versus time mode.
3) The signal generator shall be set with all parameters defined in Table 74.
4) A **QUERY** + **ACK [RN16]** commands shall be continuously sent followed by the continuous wave.
5) Wait until signal analyser is triggered, capture the demodulated tag reply (**UII+SSD**) trace power versus time.

Table 74 — Simple sensor test parameters

TEST: BAP tag persistence time				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **866 or 915 or 953**	
Modulation type: **DSB-ASK**			Modulation index: **90 %**	
PROTOCOL SETTINGS				
Commands				
Query parameters	DR: **8**	M: **1**		
Timings	Tari (µs): **25**	PW (µs): **12,5**	RTcal (µs): **62,5**	TRcal (µs): **100**

12.1.1.3 Test report

The test report shall give all communication parameters and the test verdict pass or fail, the pass condition is obtained when the DUT tag reply to ACK command fulfils to all requirements of Table 75 as defined in ISO/IEC 18000-63:2015, Clause 8.

Table 75 — Simple sensor test pass conditions

1	XPC_W1 bit 215h shall be set to 1 to indicate the presence of a simple sensor.
2	The 32bits simple sensor data (SSD) shall be appended to the tag UII according to ISO/IEC 18000-63:2015, Clause 8.
3	The 32bits simple sensor data (SSD) shall be as defined in ISO/IEC 24753 and ISO/IEC 18000-63:2015, Annex O.
4	The five most significant bits of the PacketPC shall indicate the length of the UII + SSD.

13 Full-function sensor test

13.1 Purpose

The purpose of this test is to verify that the DUT tag support the full-function sensor (FS) functionality as defined in ISO/IEC 18000-63:2015, Clause 9.

13.2 Procedure

The full-function sensor test measurement procedure is as follows.

1) The waveform generator amplitude shall be set to the maximum permissible value.

2) The signal analyser shall be set to power versus time mode.

3) The signal generator shall be set with all parameters defined in Table 76.

4) A **READ (Memory Bank: 10_2)** command shall be continuously sent followed by the continuous wave.

5) Wait until signal analyser is triggered, capture the demodulated tag reply (**TID**) trace power versus time.

Table 76 — Full-function sensor test parameters

TEST: Full-function sensor				
RF PARAMETERS				
Power EIRP (dBm): **maximum power authorized**			Frequency (MHz): **866 or 915 or 953**	
Modulation type: **DSB-ASK**			Modulation index: **90** %	
PROTOCOL SETTINGS				
Commands				
READ parameters	MenBank: **10_2(TID)**	WordPtr: **20h**		
Timings	Tari (µs): **25**	PW (µs): **12,5**	RTcal (µs): **62,5**	TRcal (µs): **100**

13.2.1 General

13.2.1.1 Test report

The test report shall give all communication parameters and the test verdict pass or fail; the pass condition is obtained when the DUT tag reply to READ command fulfils to all requirements of Table 77 as defined in ISO/IEC 18000-63:2015, Clause 8.

Table 77 — Full-function sensor test pass conditions

1	XPC_W1 bit 216h shall be set to 1 to indicate the presence of a full-function sensor.
2	The SAM Address shall be stored in the TID memory according to ISO/IEC 18000-63:2015, Clause 8.
3	Tag shall provide a 32-bit SAM Address pointing to the starting word address of a Sensor Address Map.
4	Tag shall have a SAM Address ≠ 0.

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.

To ensure reproducibility and tractability of radiated measurements, only these test sites should be used in measurements in accordance with this 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.