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**Information technology — Radio  
frequency identification for item  
management —**

Part 1:

**Interference rejection performance  
test method between a tag as  
defined in ISO/IEC 18000-63 and a  
heterogeneous wireless system**

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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.

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](http://www.iso.org/directives)) or [www.iec.ch/members\\_experts/refdocs](http://www.iec.ch/members_experts/refdocs)).

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For an explanation of 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 [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html). In the IEC, see [www.iec.ch/understanding-standards](http://www.iec.ch/understanding-standards).

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

A list of all parts in the ISO/IEC 23200 series can be found on the ISO and IEC websites.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html) and [www.iec.ch/national-committees](http://www.iec.ch/national-committees).

## Introduction

This document provides test procedures and method to evaluate the impact on tag as defined in ISO/IEC 18000-63 of interference generated by other wireless systems. The interference rejection test method of this document is different to ISO/IEC 18046-3:2012, 8.8. This document covers interference effect between the tags and heterogeneous wireless system, while ISO/IEC 18046-3 covers interference effect between tags and homogeneous wireless systems.

Ultra-high-frequency (UHF) radio frequency identification (RFID) is a wireless technology that connects billions of everyday items to the Internet of Things (IoT), enabling consumers and businesses to identify, locate, authenticate, and engage each item. IoT applications require a data connection between the physical and digital world, and UHF RFID is the ideal technology to bridge these realms with the ability to bring low cost, unique identification to everyday items. Low-power wide-area networks (LPWAN) operate at long read ranges of 2 km to 3 km. While LoRaWAN devices have a very slow data-transfer rate, they are useful for transmitting sensor data. For example, LoRaWAN, WiFi-Halow (802.11ah), Sigfox, NB-IoT, WB-IoT, and LTE-M are representative technologies.

The frequencies used by LoRaWAN systems differ by region and country, as do the frequency bands designated for UHF RFID systems. In particular, LoRaWAN and RFID systems use different power levels and heterogeneous protocols in shared frequency bands. They are susceptible to interference generated by other wireless systems. This harsh signal propagation environment combined with interference from coexisting wireless technologies can lead to a degradation of the performance or even application failures. To evaluate possible interference on UHF RFID systems, industrial stakeholders make a constructive discussion on how to overcome interference problems.

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# Information technology — Radio frequency identification for item management —

## Part 1:

# Interference rejection performance test method between a tag as defined in ISO/IEC 18000-63 and a heterogeneous wireless system

## 1 Scope

This document defines a test method to evaluate the interference rejection performance of tags covered by ISO/IEC 18000-63 and a heterogeneous wireless system using different access technologies, e.g. radio frequency identification and cell phone network.

It specifies the general requirements and test requirements.

The test method in this document makes it possible to compare the relative interference rejection performance among tags under a single wireless interference environment. In addition, this document can be used in a benchmarking test according to requirements in a given application or service.

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

## 3 Terms and definitions

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

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

## 4 Symbols and abbreviated terms

ANT <sub>TX</sub>	T <sub>X</sub> interrogator antenna in the bistatic test set-up
ANT <sub>RX</sub>	R <sub>X</sub> interrogator antenna in the bistatic test set-up
ANT <sub>TRX</sub>	interrogator antenna in the monostatic test set-up
ANT <sub>INT</sub>	antenna connected to the radio frequency interference source
CW	continuous wave

$D_{\text{Interference}}$	distance between the tag and the antenna connected to the RF interference source
$D_{\text{Interrogator}}$	distance between the tag and the interrogator antenna
DUT	device under test
$G_{\text{dBi}}$	antenna gain
GFSK	Gaussian frequency shift keying
LHCP	left hand circular polarization
OFDM	orthogonal frequency division multiplexing
$P_{\text{min}}$	minimum power required to activate a UHF RFID tag. $P_{\text{min}}$ is the power at the position of a tag
$P_{\text{min\_under\_int}}$	$P_{\text{min}}$ under a single wireless interference environment
$PF_{\text{iRej}}$	interference rejection performance between a UHF RFID tag and other wireless systems
QAM	quadrature amplitude modulation
RHCP	right hand circular polarization
$R_{\text{x}}$	receiver
SG	signal generator
TE	test equipment (RFID interrogator emulator)
$T_{\text{x}}$	transmitter

## 5 Conditions applicable to the test methods

### 5.1 Test environment

Unless otherwise specified, testing shall take place in an air environment with a temperature of  $23\text{ °C} \pm 3\text{ °C}$  ( $73\text{ °F} \pm 5\text{ °F}$ ) and relative humidity within the range of 40 % to 60 %.

### 5.2 Radio frequency (RF) environment

The tests shall be performed in a known RF environment.

For measurements of propagative tags (ISO/IEC 18000-63), an anechoic chamber is the recommended test environment.

### 5.3 Pre-conditioning

Where pre-conditioning is required by the test method, the identification interrogators to be tested shall be conditioned to the test environment for a period of 24 h before testing.

### 5.4 Default tolerance

Unless otherwise specified, a default tolerance of  $\pm 5\%$  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).

## 5.5 Total measurement uncertainty

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

NOTE Basic information is given in ISO/IEC Guide 98-3.

## 5.6 Test result reporting

Each test result shall be reported with the DUTs tested. Optionally, for statistical evaluation, minimum value, maximum value, mean value and standard deviation may be reported as well.

## 5.7 Test mounting material

For the tags, the tests may be performed with or without applying a mounting material. When the mounting material is defined by the tag manufacturer, the tests shall be performed with the specified mounting material in free air.

If the indicative dielectric parameter or other critical parameters of the material are known, they shall be mentioned in the test report.

## 5.8 Test communication parameters

All of the tests may be performed for various communication parameters (forward and return link).

The test conditions shall be recorded in the test report.

## 6 Test set-up

### 6.1 DUT placement

The DUT shall be placed in the far field according to [Figure 1](#) or [Figure 2](#). The distance,  $D$ , shall be as in [Formula \(1\)](#):

$$D = \frac{2L^2}{\lambda} \quad (1)$$

where

$\lambda$  is the wavelength at the centre frequency of the interrogator;

$L$  is the maximum dimension of the interrogator antenna.

### 6.2 Test setup for tag's $R_x$ sensitivity power measurement under non-interference environment

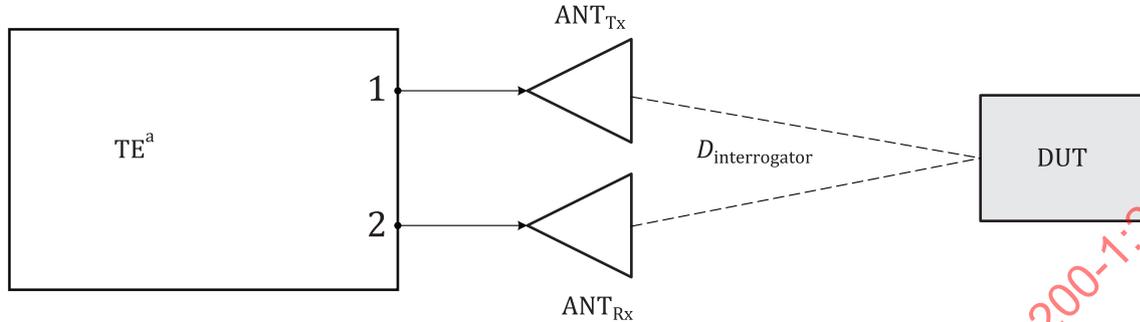
#### 6.2.1 Test apparatus and test circuits

This subclause defines the test apparatus and test circuits to be used to validate the reference performance of a tag.

The test setup shall be as in [Figure 1](#) or [Figure 2](#) using test equipment (TE) like an interrogator emulator or similar means that is compliant with ISO/IEC 18000-63.

6.2.2 Setup of the devices

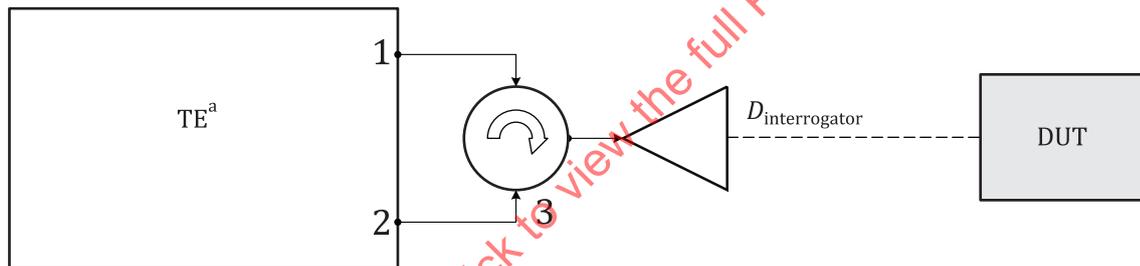
The test setup shall be either the bistatic test set-up shown in [Figure 1](#) or the monostatic test setup shown in [Figure 2](#). The test equipment shall be sensitive enough to be able to measure tag’s receive sensitivity power level  $P_{min}$ .



Key

- 1  $T_x$  port
- 2  $R_x$  port
- <sup>a</sup> Interrogator simulator.

Figure 1 — Bistatic test setup



Key

- 1  $T_x$  port
- 2  $R_x$  port
- 3 circulator
- <sup>a</sup> Interrogator simulator.

Figure 2 — Monostatic test setup

The DUT shall be mounted either on the material with a relative permittivity of approximately 1 or on the material provided by the client. In order to maximize the tag’s receive sensitivity, the boresight of the DUT should be oriented toward the centre of the interrogator antenna.

The distance  $D$  shall be at least as defined in [Formula \(1\)](#) to do the measurements in the far field.  $D_{interrogator}$  distance is recommended to be 50 cm.

6.2.3 Antenna polarization and requirements

For the tag sensitivity tests, a linear (vertical and horizontal) or circular polarized antenna should be used. However, in the case of the Bistatic test setup, there should be sufficient isolation between the  $T_x$  and  $R_x$  antennas of the interrogator.

The circulator (or directional coupler) used in the monostatic test setup should have sufficient isolation to prevent mutual interference.

### 6.3 Test setup for tag's $R_x$ sensitivity power measurement under interference environment

#### 6.3.1 Sub-1GHz wireless communications technologies

This clause defines the test apparatus and test circuits to be used to measure the changed performance of a DUT under the given interference environment.

The desired interference waveform shall be set to the required operating frequency, amplitude and modulation techniques by the signal generator (SG).

[Table 1](#) summarizes key features of sub-1GHz wireless communications technologies (e.g. US). The radio frequency bands of the wireless communications technologies are managed independently by each country's regulatory authority. Most of these technologies use an operating frequency band of 902 MHz to 928 MHz, which is one of the industrial, scientific, and medical (ISM) bands.

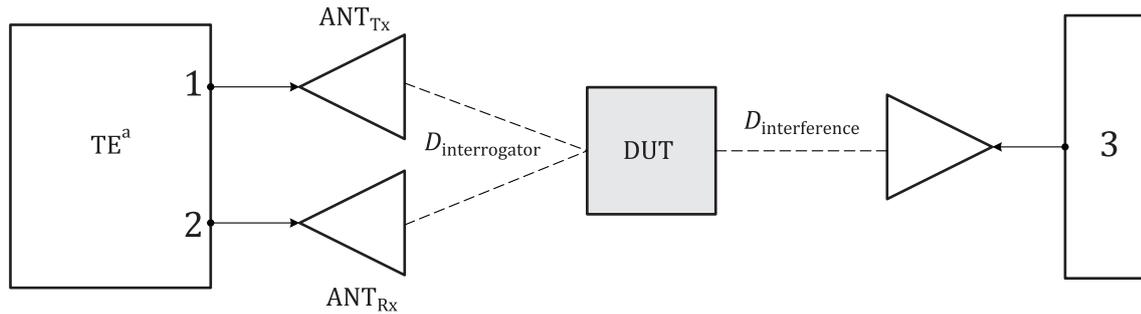
[Figure 3](#) and [Figure 4](#) show the test setup arrangements for interference rejection measurement:

**Table 1 — Key features of sub-1GHz wireless communications technologies (e.g. US)**

Technologies	Frequency MHz	Modulation	Max. range m	Data rates kbps	Multi access	$T_x$ power (without antenna gain) dBm
UHF RFID	902 to 28	ASK/PSK	10	26.7 to 128	Freq. Hopping SS	30
LoRa	902 to 928	GFSK	15 000 to 20 000	0.25 to 50	Chirp SS	30
SigFox	902 to 928	BPSK/GFSK	3 000 to 10 000	0.1	Ultra Narrow Band	14
Wi-SUN	902 to 928	GFSK	1 000	50 to 300	OFDM	13
Z-Wave	908.42	GFSK	30	100	N.A.	0
IEEE 802.11ah	902 to 928	PSK/QAM	1 000	150 to 347 000	OFDM	30

#### 6.3.2 Setup of the devices

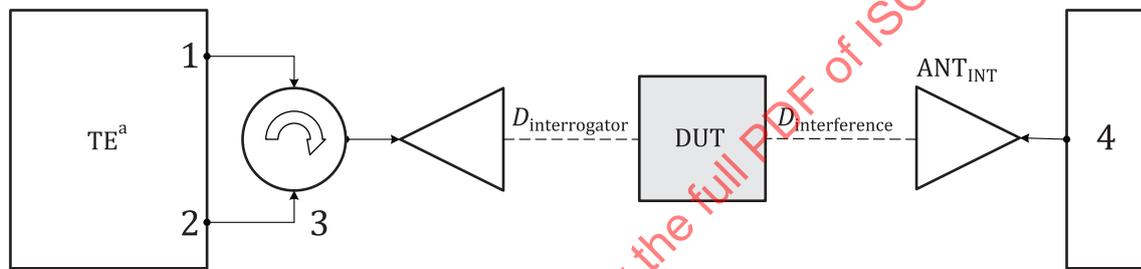
The test setup shall be either the bistatic test set-up shown in [Figure 3](#) or the monostatic test setup shown in [Figure 4](#). The test equipment should be sensitive enough to be able to measure the tag's  $R_x$  sensitivity power level  $P_{min}$ . The interference antenna ( $ANT_{INT}$ ) connected to the signal generator should be located in a straight line from the opposite side of the DUT. If it is located in other positions, the information shall be recorded in the test report.



**Key**

- 1  $T_X$  port
- 2  $R_X$  port
- 3 interferer (RF signal generator)
- <sup>a</sup> Interrogator simulator.

**Figure 3 — Bistatic test setup for interference rejection measurement**



**Key**

- 1  $T_X$  port
- 2  $R_X$  port
- 3 circulator
- 4 interferer (RF signal generator)
- <sup>a</sup> Interrogator simulator.

**Figure 4 — Monostatic test setup for interference rejection measurement**

The DUT shall be mounted either on the material with a relative permittivity of approximately 1 or on the material provided by the client.

The distance  $D$  shall be at least as defined in [Formula \(1\)](#) to do the measurements in the far field.  $D_{interrogator}$  is recommended to be 50 cm or 1 m. On the other hand,  $D_{interference}$  is recommended to be 1 m. The  $G_{dBi}$  of the interference ANT or  $D_{interference}$  can be changed to implement the specific interference environment required by the client. The information shall be recorded in the test report.

**6.3.3 Antenna polarization and requirements**

For interference rejection performance tests, a linear or circularly polarized antennas may be used. It is generally recommended to use a circularly polarized antenna to separate the polarization of the  $ANT_{INT}$  and  $ANT_{TRX}$  in the monostatic test setup. For example, the interrogator may be connected to a RHCP antenna ( $ANT_{TRX}$ ) while SG may be connected to a LHCP antenna ( $ANT_{INT}$ ). Each polarization has an orthogonal counterpart (vertical and horizontal, RHCP and LHCP). In this case, the circulator (or directional coupler) can be used to achieve more than 30 dB isolation between  $R_X$  mode and  $T_X$  mode of the interrogator.

In the bistatic test setup, the  $ANT_{TX}$  and  $ANT_{RX}$  shall be isolated enough to not limit the tag's  $R_X$  sensitivity power measurement. Furthermore, a wall for absorbing an electromagnetic wave may be used between the  $ANT_{INT}$  and interrogator antennas to eliminate interference waveform affect to the interrogator antennas.

## 7 Test procedure

### 7.1 General description

The stages in the test procedure for interference rejection performance measurement are as follows.

- 1) Pre-test: Tag's  $R_X$  sensitivity power measurement under non-interference environment. The reference performance is measured in this stage.
- 2) Post-test: Tag's  $R_X$  sensitivity power measurement under interference environment. The desired interference waveforms are implemented according to client's requirements. The changed performance is measured in this stage.
- 3) Calculation: The interference rejection performance is calculated by an absolute value of changed performance difference.
- 4) These steps shall be repeated for 30 randomly selected DUTs.

Figure 5 shows the block diagram of the test procedure.

Step	Description	Related test setup	Measured value
1 : Pre-test	UHF RFID tag's Rx sensitivity power measurement <b>under non-interference environment</b>	Figure 1 or Figure 2	$P_{min}$
2 : Post-test	UHF RFID tag's Rx sensitivity power measurement <b>under interference environment</b>	Figure 3 or Figure 4	$P_{min\_under\_int}$
3 : Calculation	Calculation of interference rejection performance	None	$PF_{iRej} =   P_{min} - P_{min\_under\_int}  $

Figure 5 — Test procedure

### 7.2 Tag's $R_X$ sensitivity power measurement under non-interference environment

#### 7.2.1 Purpose

The purpose of this test is to determine the tag's  $R_X$  sensitivity power  $P_{min}$ , which is typically recorded in dBm.

#### 7.2.2 Test procedure

For the 860 MHz to 960 MHz frequency band as defined by ISO/IEC 18000-63, the electromagnetic field strength generated from the TE shall be changed until the tag modulation is detected and it responds. This test shall be done with a frequency step of 5 MHz, covering from at least 860 MHz to 960 MHz. However, the frequency range or step may be changed according to each national regulation, application

and specific requirements. In this case, the changed TE parameters shall be recorded in the report. For this test, the test setup described in 6.2.1 is used.

The tag's  $R_X$  sensitivity power ( $P_{min}$ ) measurement shall be done by use of the following procedure.

- 1) The tag is positioned on the test setup specified in Figure 1 and Figure 2.
- 2) Set the TE parameters from the client's requirements. For example, see Table 2.

**Table 2 — TE parameters for  $PF_{iRej}$  measurement**

Parameter	Example
Frequency range	Start frequency: 860 MHz End frequency: 960 MHz
Frequency step	5 MHz
Interrogator transmit power (without antenna gain)	Minimum: 0 dBm Maximum: 30 dBm
Interrogator transmit power step	0.1 dB
Test command	Select - Query - ACK (Note: It is suggested to select the minimal possible time T4.)

- 3) The interrogator signals shall be generated and transmitted continuously using the TE. The interrogator transmit power shall be increased step by step (for example, 0,1 dB) until the complete tag response can be measured by the test command defined in Table 2.
- 4) In case the tag response is wrong, then step 3) shall be repeated with higher interrogator transmit power. In order to reduce the measurement time a binary search using values below and above the expected result may be applied as well.
- 5) The tag's  $R_X$  sensitivity power ( $P_{min}$ ) shall be calculated and recoded using the TE.
- 6) Steps 3) to 5) shall be repeated by increasing the frequency by a maximum of 5 MHz to the next frequency step from 860 MHz to 960 MHz.
- 7) Repeat steps 1) through 6) for the 30 randomly selected tags.

### 7.3 Tag's $R_X$ sensitivity power measurement under interference environment

#### 7.3.1 Purpose

The purpose of this test is to determine the tag's  $R_X$  sensitivity power under interference environment  $P_{min\_under\_int}$  which is typically recorded in dBm.

#### 7.3.2 Test procedure

The sub-1 GHz interference waveforms shall be generated and transmitted by a signal generator according to key features of a specific wireless technology. Then, the interferer's transmit power is to be increased relative to the desired electromagnetic field at the operating frequencies until the tag can no longer demodulate the desired generator command.

The setup specified in 6.3.1 shall be used.

The tag's  $R_X$  sensitivity power measurement under interference environment ( $P_{min\_under\_int}$ ) shall be done by use of the following procedure.

- 1) The tag is positioned on the test setup specified in Figure 1 and Figure 2.
- 2) Set the TE parameters from the client's requirements described in Table 2.

- 3) Set the SG parameters from the client's requirements. For example, see [Table 3](#).

**Table 3 — SG parameters for  $PF_{iRej}$  measurement**

Parameter	Example
Desired interference waveform	LoRaWAN
— Centre frequency	920 MHz
— Modulation	GFSK
— Bandwidth	500 kHz
— Duty cycle	80 %
— Transmit power (amplitude)	27 dBm
Antenna gain	6 dBi

- 4) The SG shall transmit a desired interference waveform according to the conditions given in [Table 3](#).
- 5) The interrogator signals shall be generated and transmitted continuously using the defined TE. The interrogator transmit power shall be increased step by step (For example, 0.1 dB) until the complete tag response can be measured by the test command defined in [Table 2](#).
- 6) In case the tag response is wrong, then step 5) shall be repeated with higher interrogator transmit power. In order to reduce the measurement time a binary search using values below and above the expected result may be applied as well.
- 7) The tag's  $R_X$  sensitivity power ( $P_{\min\_under\_int}$ ) shall be calculated and recoded using the TE.
- 8) Steps 5) to 7) shall be repeated by increasing the frequency by a maximum of 5 MHz to the next frequency step from 860 MHz to 960 MHz.
- 9) Repeat steps 1) through 8) for the 30 randomly selected tags.

#### 7.4 Test report

The test report shall provide the  $P_{\min}$  value derived in [7.2](#) and the  $P_{\min\_under\_int}$  value derived in [7.3](#) for each frequency from 860 MHz to 960 MHz. The interference rejection performance,  $PF_{iRej}$ , can be calculated according to [Formula \(2\)](#):

$$PF_{iRej} = | P_{\min} - P_{\min\_under\_int} | \quad (2)$$

In addition, the environment conditions, TE parameters, SG parameters and all these parameters shall be recorded according to the example in [Table 4](#).

**Table 4 — Test report example: Parameters that shall be recorded for this  $PF_{iRej}$  measurement**

Title: Interference rejection performance ( $PF_{iRej}$ )	
Mounting material	Expanded polystyrene
<b>Test environment</b>	
Humidity and temperature	Temperature: 23 °C Humidity: 50 %
RF environment	Fully anechoic chamber
Measurement test set-up	Bistatic (or monostatic) — $D_{interference}$ : 1 m — $D_{interrogator}$ : 0.5 m — Location of $ANT_{INT}$ : opposite direction of tag
Air interface protocol	ISO/IEC 18000-63

**Table 4** (continued)

<b>TE parameter settings (Interrogator simulator)</b>	
— Frequency range	Start frequency: 860 MHz End frequency: 960 MHz
— Frequency step	5 MHz
— Interrogator transmit power	Minimum: 0 dBm Maximum: 30 dBm
— Interrogator transmit power step	0.1 dB
— Test command	Select – Query – ACK (Note: It is suggested to select the minimal possible time T4.)
<b>Antenna specifications</b>	
Interrogator antenna gain	4 dBi
— Polarization of interrogator antenna	ANT <sub>RX</sub> : LHCP ANT <sub>TX</sub> : RHCP ANT <sub>TRX</sub> : N/A
Interferer antenna gain	2 dBi
— Polarization of ANT <sub>INT</sub>	VLP
<b>Isolation characteristics</b>	
Isolation between ANT <sub>TX</sub> and ANT <sub>RX</sub> (at carrier frequency)	30 dB
Isolation between ANT <sub>INT</sub> and ANT <sub>RX</sub> (at carrier frequency)	30 dB
Isolation between ANT <sub>INT</sub> and ANT <sub>TRX</sub> (at carrier frequency)	N/A
<b>SG parameter settings</b>	
— Centre frequency	920 MHz
— Signal profiles	Modulation: GFSK modulated CW Bandwidth: 250 kHz Duty Cycle: 95 %
— Transmit power (Amplitude)	-18 to 6 dBm (Step: 6 dB)
<b>Set-up photo</b>	