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Part 2: Interference rejection performance test method between an Interrogator as defined in ISO/IEC 18000-63 and a heterogeneous wireless system

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Foreword

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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 website.

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Introduction

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 (LoRaWAN) 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 systems performance or even application failures.

Information technology — Radio frequency identification for item management —

Part 2: Interference rejection performance test method between an Interrogator as defined in ISO/IEC 18000-63 and a heterogeneous wireless system

1 Scope

This document specifies a test method to evaluate the interference rejection performance of UHF RFID interrogators covered by ISO/IEC 18000-63, and specifies the general requirements and test requirements of that test method.

NOTE The interference rejection test method of this document is different to the one in ISO/IEC 18046-3:2020, 8.5. This document covers interference effects between the tags and a heterogeneous (diverse content) wireless system. ISO/IEC 18046-3 covers interference effect between tags and homogeneous (same content) wireless systems.

This test method enables the comparison of the relative interference rejection performance among UHF RFID interrogators 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*

ISO/IEC 18046-2:2020, *Information technology — Radio frequency identification device performance test methods — Part 2: Test methods for interrogator performance*

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

3 Terms and definitions

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

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

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

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

3.1
heterogeneous wireless system
wireless system using different access technologies which share the same radio frequency band

EXAMPLE RFID, cell phone networks.

4 Symbols and abbreviated terms

4.1 Symbols

BLF	backscatter-link frequency (BLF = $1/T_{pri}$ = DR/TRcal)
P_{rcv}	interrogator receiver sensitivity power level
$P_{rcv\_under\_int}$	interrogator receiver sensitivity power level under a single wireless interference environment
P_{iRej}	interference rejection power difference between a UHF RFID interrogator and other wireless systems performance indicator
G_{dBi}	antenna gain
D	distance between the tag and the antenna
R_X	receiver
T_X	transmitter

4.2 Abbreviated terms

DUT	device under test
CSS	chirp spread spectrum
FHSS	frequency-hopping spread spectrum
SG	signal generator
TE	test equipment (RFID tag emulator)
ASK	amplitude shift keying
PSK	phase shift keying
FSK	frequency shift keying
GFSK	Gaussian frequency shift keying
BPSK	binary phase shift keying
QAM	quadrature amplitude modulation
OFDM	orthogonal frequency division multiplexing
RHCP	right hand circular polarization
LHCP	left hand circular polarization
CW	continuous wave

5 Conditions applicable to the test methods

5.1 Number of UHF RFID interrogator for testing

Unless otherwise specified, this document's test method can use a single UHF RFID interrogator. It can also be used by sampling more interrogators to satisfy statistical purposes.

5.2 Test environment

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

5.3 RF environment

The tests shall be performed in a known RF environment.

When measuring propagative tags (e.g. ISO/IEC 18000-63), an anechoic chamber is the recommended test environment.

5.4 Pre-conditioning

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

5.5 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).

5.6 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.

5.7 Test result reporting

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

5.8 Test mounting material

For the tags, the tests can 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 dielectric parameter, or other critical parameters of the material are known, they shall be mentioned in the test report.

5.9 Test communication parameters

All of the tests can be performed using communication parameters (forward and return link) to simulate the various interference signals. The test requester shall provide at least one communication parameter.

The test conditions shall be recorded in the test report.

6 Test set-up

6.1 Test setup for UHF RFID interrogator's receiver sensitivity under non-interference environment

This subclause defines the test apparatus and test circuits used to validate the reference performance of a UHF RFID interrogator. The specifics shall comply ISO/IEC 18046-2:2020, Clause 8.

The test setup shall be as shown in Figure 1 or Figure 2, using test equipment (TE), like a tag emulator or similar means, that is compliant with ISO/IEC 18000-63 in respect to all parameters that have impact on performance tests and that further allows a controlled variation of the BLF. Optionally, a phase shifter can be used. For the contactless test setup, the distance, *D*, shall be selected to ensure that the test is performed in the far field, unless a near field test is intended. If a near field test is performed, then this shall be noted in the test report.

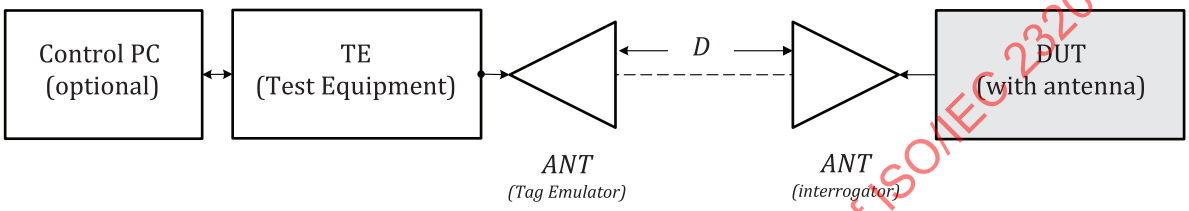

Figure 1 — Contactless test setup

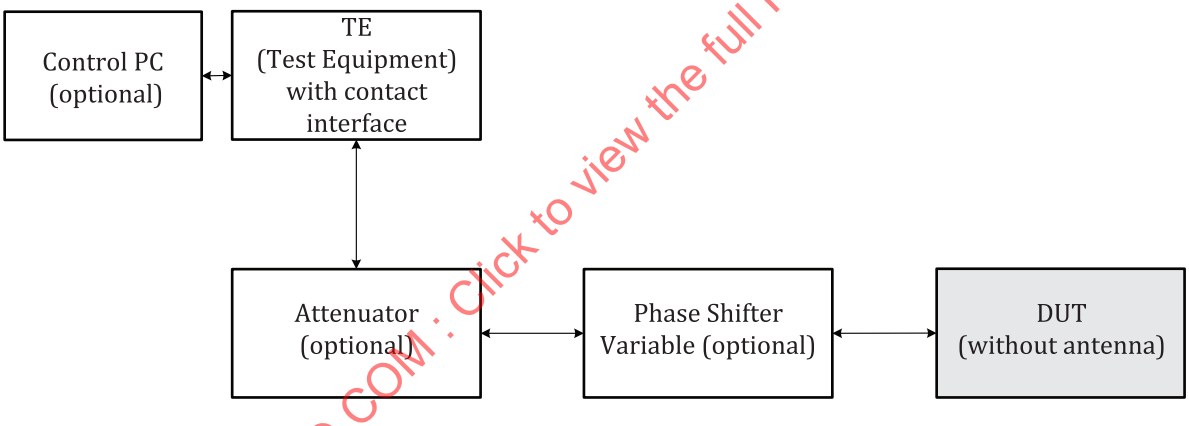

Figure 2 — Contact test setup

For the test, an interrogator shall start to inventory tags. The use of the Select command is optional and the command shall be ignored for the test.

The interrogator shall use one of the following sequences:

a) Query – Various Commands – ACK – ReqRN

b) Query – Various Commands – ACK

Various Commands can consist of one or more of the following commands: QueryRep and QueryAdjust.

The reception of a tag response by the reader shall be evaluated as successful under the condition: Reader sends Req_RN with correct Handle

6.2 Reader sends ACK with the correct RN16Test setup for UHF RFID interrogator's receiver sensitivity under interference environment

This subclause descibes the test apparatus and test circuits 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 the desired interference waveforms from sub-1GHz wireless communication technologies in the United States. 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 desired interference waveforms in the US

Technologies	Frequency MHz	Modulation	Maximum range m	Data rates kbps	Multi access	TX power (without antenna gain) dBm
UHF RFID	902 to 928	ASK/PSK	10	26,7 to 128	FHSS	30
LoRa	902 to 928	GFSK	15,000 to 20,000	0,25 to 50	CSS	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	—	0
IEEE 802.11ah	902 to 928	PSK/QAM	1,000	150 to 347,000	OFDM	30

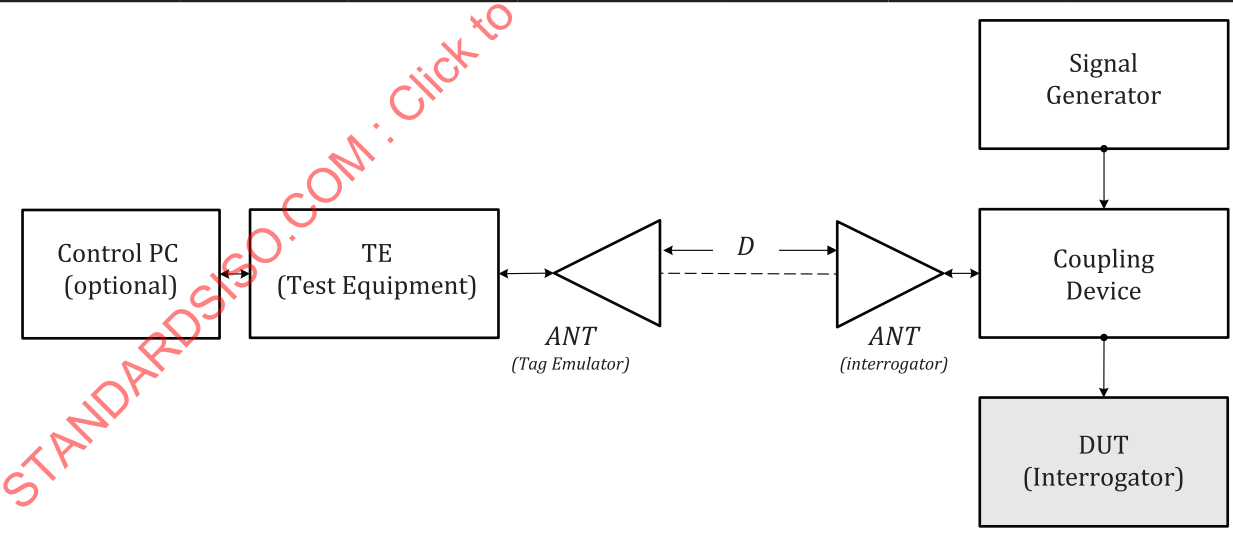

Figure 3 — Contactless test setup for rejection measurement

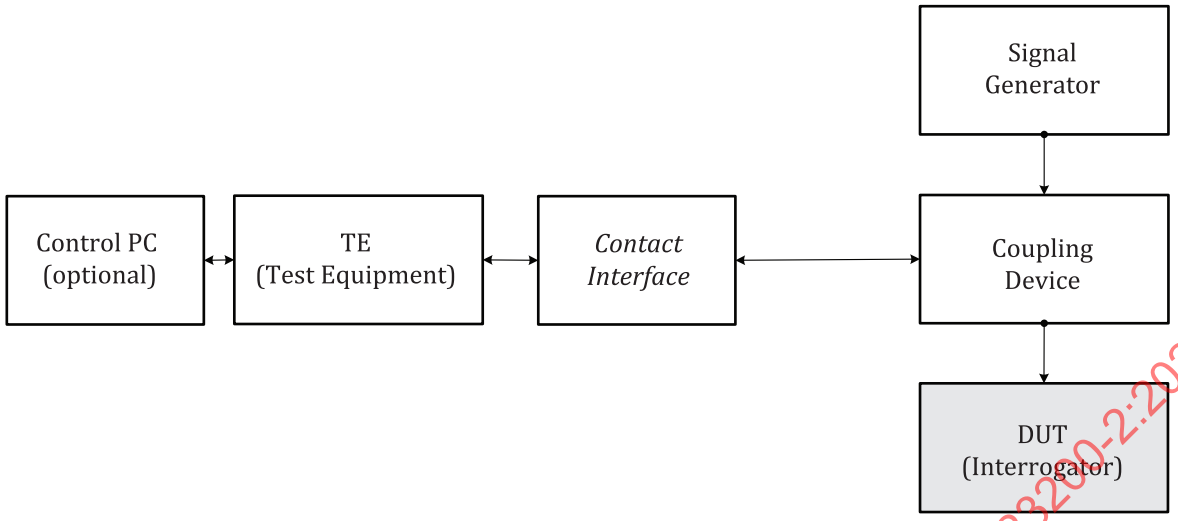

Figure 4 — Contact test setup for rejection measurement

For the contactless test setup, the distance *D* shall be selected to ensure that the test is done in the far field, unless a near field test is intended. If a near field test is done, then this shall be noted in the test report. Here, a coupling device can be implemented using a combiner isolator.

7 Test procedure

7.1 General description

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

a) Pre-test: UHF RFID interrogator's receiver sensitivity is measured under the non-interference environment. The reference performance is measured in this stage.

b) Post-test: UHF RFID interogator's receiver sensitivity is measured under the interference environment. The desired interference waveforms are implemented according to the client's requirements. The changed performance is measured in this stage.

c) Calculation: The interference rejection performace is calculated by an absolute value of changed performance difference.

d) These steps shall be repeated for randomly selected DUTs.

Figure 5 shows the block diagram of the test procedure.

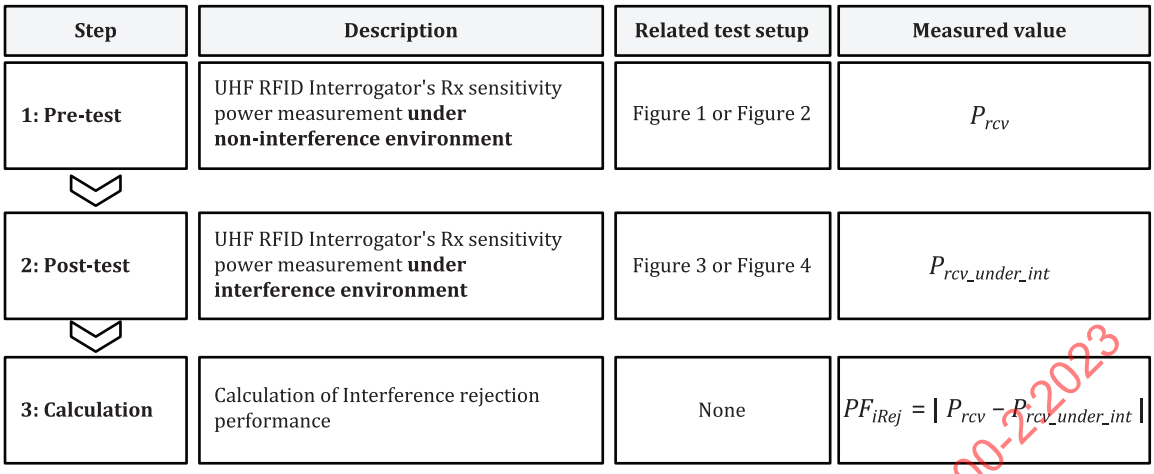

Figure 5 — Test procedure

7.2 UHF RFID interrogator's receiver sensitivity power measurement under non-interference environment

7.2.1 Purpose

This test determines the interrogator receiver sensitivity power level, P_{rcv}, which is typically reported in dBm. The test procedure is described for ISO/IEC 18000-63-based systems.

7.2.2 Test procedure

The receive sensitivity (P_{rcv}) of the UHF RFID interrogator can be changed by several parameters defined by ISO/IEC 18000-63:2021.

Therefore, the protocol parameters of Table 2 and the test conditions of Table 3 shall be recorded.

The values in ISO/IEC 18046-2:2020, Tables 6 and 7 can be utilized as a guide to the test. The recommended values for parameters TRcal, BLF, PTX and *f* in Table 2 can be used.

NOTE Local radio regulations can apply to these parameters.

Table 2 — Interrogator settings of ISO/IEC 18000-63 protocol parameters

Parameter	Recommended value	Description
Tari	12,5 µs	As in ISO/IEC 18000-63
M	4	As in ISO/IEC 18000-63
RTcal	31,25 µs (2,5 x Tari)	As in ISO/IEC 18000-63
TRcal	[example] EU: 66,66 µs (= 2,133 x RTcal) FCC: 83,34 µs (= 2,667 RTcal)	As in ISO/IEC 18000-63
DR	64/3	As in ISO/IEC 18000-63
BLF	[example] 320 kHz (FCC: 256 kHz)	Value calculated from TRcal and DR as defined in ISO/IEC 18000-63
TRext	1 (use Pilot Tone)	As in ISO/IEC 18000-63

Table 2 *(continued)*

Parameter	Recommended value	Description
PTX	[example] EU: 33 dBm erp FCC: 36 dBm eirp KR: 36 dBm eirp	Interrogator transmit power including antennas gain, if applicable. All test shall be done at the highest power level of DUT. NOTE Local radio regulations can apply. Test with lower power values are recommended, if there is an application need.
f	[example] EU: 866.3 MHz FCC: 915 MHz KR: 917 MHz to 923 MHz	Interrogator operating frequency
Others		Other parameters that are of relevance for the interrogator

Table 3 — Test conditions

Parameter	Recommended value	Description
$R_{success}$	90 %	Pass success rate - relative number of successful reads by the interrogator
N	100	Number of test round repetitions for a particular setting
BLF_{var}	±20 %	Allowed variation of BLF
BLF_{varN}	9	Number of steps for BLF variation
P_{Svar}	±90°	Allowed variation of phase shift
P_{SvarN}	9	Number of steps for phase shift variation

Test can be conducted through various combinations of the parameters defined in Table 3.

The UHF RFID interrogator's receiver sensitivity power measurement shall be done using the following procedure:

a) Setup test configuration specified in Figure 1 and Figure 2.

b) For contactless testing configurations, separate the TE (Tag emulator) from the leader antenna by D cm and record the distance.

c) Set the protocol parameter in Table 2 and the test condition parameter in Table 3 and record these parameters.

d) Set the transmission power of the DUT (Power level is defined as required by the client).

e) Check the response status of Query command.

f) If the result of e), being performed N times, is higher than the set success rate (SR), lower the backscatter power of the TE and repeat step e).

g) Record the lowest tag backscatter power value that satisfies SR as the receiver sensitivity P_{rcv}.

h) The test should proceed according to various BLFs (optional).

i) The test should proceed according to various phase shifts.

7.3 UHF RFID interrogator's receiver sensitivity power measurement under interference environment

7.3.1 Purpose

The purpose of this test is to determine the UHF RFID interrogator's receiver sensitivity under an interference environment $P_{rcv\_under\_int}$, 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 shall be increased relative to the desired electromagnetic field at the operating frequencies until the interrogator can no longer respond to the Query command.

The setup specified in 6.2 shall be used.

The UHF RFID interrogator's receiver sensitivity measurement under the interference environment ($P_{rcs\_under\_int}$) shall be done using the following procedure:

a) Setup the test configuration specified in Figure 3 and Figure 4.

b) For contactless testing configurations, separate the TE (Tag emulator) from the leader antenna by *D* cm and record the distance.

c) Set the SG parameters from the client's requirements. For example:

Table 4 — Example of SG parameters for $P_{rcs\_under\_int}$ measurement

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

d) The SG shall transmit a desired interference waveform according to the parameters given in Table 4.

e) Set the protocol parameters in Table 2 and the test condition parameters in Table 3 and record these parameters.

f) Set the transmission power of the DUT (power level is set as required by the client).

g) Check the response status of Query command.

h) If the result of g), being performed *N* times, is higher than the set SR, lower the backscatter power of the TE and repeat g).

i) Record the lowest tag backscatter power value that satisfies SR as the receiver sensitivity $P_{rcv\_under\_int}$.

j) The signal level of the signal generator may be increased by "*x*" dB or decreased by "*x*" dB and the steps g) through i) may be repeated (optional).

k) The test should proceed according to various BLFs. (optional).

l) The test should proceed according to various phase shifts.

7.4 Test report

The test report shall provide the P_{rcv} value derived in 7.2 and the $P_{rcv\_under\_int}$ value derived in 7.3 for each frequency from 860 MHz to 960 MHz. The interference rejection performance P_{iRej} can be calculated according to Formula (1):

$$P_{iRej} = | P_{rcs} - P_{rcs\_under\_int} | \quad (1)$$

In addition, the environment conditions, TE parameters, SG parameters and all other parameters shall be recorded in accordance with the example in Table 5.

Table 5 — Test report example: Parameters recorded for P_{iRej} measurement

Interference rejection performance P_{iRej}	
Test environment	
Humidity and temperature	Temperature: 23 °C Humidity: 50 %
RF environment	Fully anechoic chamber
Measurement test setup	Contactless setup D = 20 cm
Air interface protocol	ISO/IEC 18000-63
Interrogator setting	
Tari	12,5 µs
M	4
RTcal	31,25 µs (2,5 x Tari)
TRcal	83,34 µs
DR	64/3
BLF	320 kHz
TR_{ext}	1
P_{TX}	36 dBm eirp
Frequency	920,3 MHz
Test command	Query – QueryRep – ACK – ReqRN
Antenna specifications	
Interrogator antenna gain	4 dBi
Polarization of antenna	LHCP (monostatic test set-up)
Test condition	
Success rate, SR	90
Number of repetition, N	100
BLF_{var}	±20 % (optional)
BLF_{varN}	9 (optional)
PS_{var}	±90° (optional)
PS_{varN}	9 (optional)
SG parameter settings	
Center frequency	920 MHz