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**Electromagnetic compatibility and
Radio spectrum Matters (ERM);
Radio Frequency Identification Equipment operating in the
band 865 MHz to 868 MHz with power levels up to 2 W and
in the band 915 MHz to 921 MHz with power levels up to 4 W;
Part 1: Technical requirements and methods of measurement**

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Foreword

This European Standard (EN) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

The present document is part 1 of a multi-part deliverable covering Radio Frequency Identification Equipment operating in the band 865 MHz to 868 MHz with power levels up to 2 W and in the band 915 MHz to 921 MHz with power levels up to 4 W e.r.p., as identified below:

Part 1: "Technical requirements and methods of measurement";

Part 2: "Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

National transposition dates	
Date of adoption of this EN:	16 February 2015
Date of latest announcement of this EN (doa):	31 May 2015
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	30 November 2015
Date of withdrawal of any conflicting National Standard (dow):	30 November 2015

Modal verbs terminology

In the present document **"shall"**, **"shall not"**, **"should"**, **"should not"**, **"may"**, **"may not"**, **"need"**, **"need not"**, **"will"**, **"will not"**, **"can"** and **"cannot"** are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

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Introduction

The present document includes improvements to the previous version of the standard that take advantage of technical developments within the RFID industry. In addition it includes provisions for RFID to operate in a new band at 915 MHz to 921 MHz at power levels up to 4 W e.r.p.

Annex A provides normative specifications concerning radiated measurements.

Annex B provides normative specifications for the mitigation technique for sharing spectrum with ER-GSM.

1 Scope

The present document covers the minimum characteristics considered necessary in order to make the best use of the available frequencies. It does not necessarily include all the characteristics that may be required by a user, nor does it necessarily represent the optimum performance achievable.

Radio frequency identification products covered within the present document are considered by definition short-range devices. Power limits up to a maximum of 2 W e.r.p. are specified for this equipment in the frequency band 865 MHz to 868 MHz and up to a maximum of 4 W e.r.p. in the frequency band 915 MHz to 921 MHz.

The present document applies to RFID interrogators and tags operating together as a system. For each specified band, four high power channels are made available for use by interrogators. The tags respond with a modulated signal preferably in the adjacent low power channels. Interrogators may be used with either integral or external antennas.

ElectroMagnetic Compatibility (EMC) requirements are covered by ETSI EN 301 489-1 [i.1] and ETSI EN 301 489-3 [i.2].

The types of equipment covered by the present document are as follows:

- fixed interrogators;
- portable interrogators;
- batteryless tags;
- battery assisted tags;
- battery powered tags.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

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NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

- [1] ETSI TR 100 028 (V1.4.1) (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".
- [2] ETSI TR 102 273 (V1.2.1) (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties".
- [3] ANSI C63.5-2006: "American National Standard for Calibration of Antennas Used for Radiated Emission Measurements in Electromagnetic Interference".
- [4] ETSI TS 144 018 (V11.5.0) (2013-07): "Digital cellular telecommunications system (Phase 2+); Mobile radio interface layer 3 specification; Radio Resource Control (RRC) protocol (3GPP TS 44.018 version 11.5.0 Release 11)".

- [5] Technical Report FTZ No 512 TB 9: "Construction of a Stripline".

2.2 Informative references

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The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

- [i.1] ETSI EN 301 489-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements".
- [i.2] ETSI EN 301 489-3: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 3: Specific conditions for Short-Range Devices (SRD) operating on frequencies between 9 kHz and 246 GHz".
- [i.3] Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (R&TTE Directive).
- [i.4] IEC 60489-3 Appendix J Second edition (1988): "Methods of measurement for radio equipment used in the mobile services. Part 3: Receivers for A3E or F3E emissions" (pages 156 to 164).
- [i.5] Void.
- [i.6] ETSI TS 102 902 (V1.2.2): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Methods, parameters and test procedures for cognitive interference mitigation towards ER-GSM for use by UHF RFID using Detect-And-Avoid (DAA) or other similar techniques".
- [i.7] EIRENE System Requirements Specification Version 15.1.

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

adaptive frequency agility: technique that allows an interrogator to change its frequency of operation automatically from one channel to another

assigned frequency band: frequency band within which the emission by a device is authorized

battery assisted tag: transponder that includes a battery to enhance its receive performance and power its internal circuitry

batteryless tag: transponder that derives all of the power necessary for its operation from the field generated by an interrogator

battery powered tag: transponder that uses the power from its battery to perform all of its operational functions

conducted measurements: measurements which are made using a direct 50 Ω connection to the equipment under test

dedicated antenna: removable antenna supplied and type tested with the radio equipment, designed as an indispensable part of the equipment

dense interrogator mode: RFID operating mode in which multiple interrogators can transmit simultaneously in the same channel while tags respond in the adjacent channels

effective radiated power: product of the power supplied to the antenna and its gain relative to a half wave dipole in the direction of maximum gain

ER-GSM: extended band of 918 MHz to 960 MHz used by the railways

external antenna: antenna that may be connected to an interrogator via its external connector

Full Tests (FT): all tests specified in the present document

global scroll: mode in which an interrogator is able to read the same tag continuously for test purposes only applications

integral antenna: permanent fixed antenna, which may be built-in, designed as an indispensable part of the equipment

interrogator: equipment that will activate an adjacent tag and read its data

NOTE: It may also enter or modify the information in a tag.

Limited Tests (LT): limited tests (see clauses 4.2.1 to 4.2.2.3 of the present document) are as follows:

- transmitter frequency error and frequency stability under low voltage conditions for mains operated equipment, see clause 8.1 of the present document;
- transmitter frequency stability under low voltage conditions, see clause 8.2 of the present document;
- transmitter effective radiated power, see clause 8.3 of the present document.

lower band: frequency range 865,0 MHz to 868,0 MHz designated for use by RFID

provider: means the manufacturer, or his authorized representative or the person responsible for placing on the market

radiated measurements: measurements which involve the absolute measurement of a radiated field

R-GSM: interoperable band of 921 MHz to 960 MHz used by the railways

scan mode: specific test mode of an interrogator that detects a signal on a pre-selected channel and transmits automatically on another channel

NOTE: See clause B.1.3.

tag: transponder that holds data and responds to an interrogation signal

talk mode: transmission of intentional radiation by an interrogator

upper band: the frequency range 915,0 MHz to 921,0 MHz designated for use by RFID

3.2 Symbols

For the purposes of the present document, the following symbols apply:

dB	decibel
d	distance
C_L	Total cable loss in dB
f	frequency measured under normal test conditions
f_c	centre frequency of carrier transmitted by interrogator
f_e	the maximum frequency drift as measured in clause 8.1.2 b)
G_{IC}	Gain of a circular antenna in dBic
Ω	Ohms
λ	wavelength

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ANSI	American National Standards Institute
ARFCN	Absolute Radio Frequency Channel Number
BCCH	Broadcast Control CHannel
BER	Bit Error Ratio
BTS	Base Transceiver Station
BW	Bandwidth
CEPT	European Conference of Postal and Telecommunications administrations
DAA	Detect And Avoid
e.r.p.	effective radiated power
EMC	ElectroMagnetic Compatibility
emf	electromotive force
ERC	European Radio communication Committee
ER-GSM	Extended Railways GSM
EUT	Equipment Under Test
FM	Frequency Modulation
FT	Full Tests
FTZ	Foreign Trade Zone (sometimes called Free Trade Zone)
GSM-R	Global System for Mobile communication for Railways applications
IE	Information Element
LT	Limited Tests
OATS	Open Area Test Site
ppm	part per million
R&TTE	Radio and Telecommunications Terminal Equipment
RBW	Resolution Bandwidth
RF	Radio Frequency
RFID	Radio Frequency Identification
R-GSM	Railway GSM
SRD	Short Range Device
TCH	Traffic Channel
TX	Transmitter
VSWR	Voltage Standing Wave Ratio

4 Technical requirement specifications

4.1 General requirements

Interrogators shall transmit on any of the high power channels specified in clause 4.2.2.1 for the purpose of communicating with tags at power levels up to the limits specified in clause 8.3.3.

When operating in the lower band, 865 MHz to 868 MHz, an interrogator may transmit a continuous signal on any of the high power channels for a period not exceeding the limit defined in clause 8.6.3. At the end of the transmission the interrogator shall not transmit again on the same channel for the period defined in clause 8.6.3. Alternatively the interrogator may switch immediately to any one of the other high power channels and send a further continuous transmission in accordance with the requirements of clause 8.6.3. There is no limit to the number of times that this process may be repeated.

For the lower band interrogators shall support trigger techniques that indicate the presence or arrival of objects that may be tagged. Irrespective of the application, an interrogator operating in the lower band shall stop transmitting after it has ceased to read any further tags, as specified in clause 8.6.3.

For operation in the upper band, 915 MHz to 921 MHz, interrogators shall transmit on any of the high power channels but for no longer than is necessary to complete the intended operation.

In some member states the upper sub-band 918 MHz to 921 MHz is allocated to the railways for ER-GSM. Where this applies sharing of this sub-band by RFID with ER-GSM is permitted provided RFID systems operate in accordance with agreed mitigation techniques. These are specified in clause 8.7 and annex B and require interrogators to use ER-GSM receiver(s), or equivalent, covering either the frequency range 918 MHz to 925 MHz or R-GSM receivers covering the frequency range 921 MHz to 925 MHz. Each interrogator may be fitted with its own (E)R-GSM receiver module. Alternatively it is permissible for a single (E)R-GSM receiver to monitor BCCH messages and serve all of the interrogators on a site. Where this applies the antenna of the (E)R-GSM receiver shall be positioned to ensure maximum coverage.

In some member states parts of the upper band are allocated for the exclusive use of the military and government services. This applies predominantly to the lower sub-band 915 MHz to 918 MHz. Interrogators capable of operating in this band shall provide a means to prevent operation at the restricted frequencies in the applicable member states.

In a preferred method of operation tags, that are activated by an interrogator transmitting in a high power channel, respond in the adjacent low power channels. This technique is called the dense interrogator mode. It has the benefit of separating the frequencies of transmission of the interrogators and tags, allowing multiple interrogators to share the same channel thereby improving system performance. It also minimizes the generation of inter-modulation products, which may disrupt the behaviour of tags.

Interrogators may also operate in a presence sensing mode in which they periodically transmit to determine whether tags have entered their interrogation zones. When operating in this mode, interrogators shall restrict the length of each transmission to less than 1 s and the period between successive transmissions shall be no less than 100 ms. Once an interrogator has determined the presence of tags, it will commence its reading routine.

It is permissible for interrogators to transmit simultaneously in both the lower and upper bands.

4.2 Presentation of equipment for testing purposes

Equipment submitted for testing shall fulfil the requirements of the present document on all frequencies over which it is intended to operate.

Providers shall select frequencies of operation in accordance with the channel plans defined in clause 4.2.2.1 and in accordance with the power levels defined in clause 8.3.3.

If equipment is designed to operate with different carrier powers, measurement of each parameter of the transmitter shall be performed at the highest power level in each band at which the interrogator is intended to operate.

To simplify and harmonize the testing procedures between the different testing laboratories, measurements shall be performed according to the present document on samples of equipment as defined in clauses 4.2.1 to 4.5. These clauses are intended to give confidence that the requirements set out in the present document have been met without the necessity of performing the full measurements at all frequencies.

4.2.1 Choice of model for testing

The provider shall supply one or more samples of the equipment, as appropriate, for testing.

If an equipment has several optional features considered not to affect the RF parameters then tests need only be performed on the equipment configured with that combination of features considered to be the most complex, as proposed by the provider and agreed by the test laboratory.

In the case of hand portable equipment without a 50 Ω external antenna connector, see clause 4.2.6.

4.2.2 Operational frequency ranges

4.2.2.1 Lower band

Interrogators operating in the lower band shall use any of the four specified high power channels illustrated in figure 1. The centre frequency of the lowest channel shall be 865,7 MHz and the band width of each high power channel shall be 200 kHz. The remaining three high power channels shall be spaced at equal intervals of 600 kHz. Tags should respond in the dense interrogator mode within the low power channels. A diagram of the channel plan for the lower band is shown in figure 1.

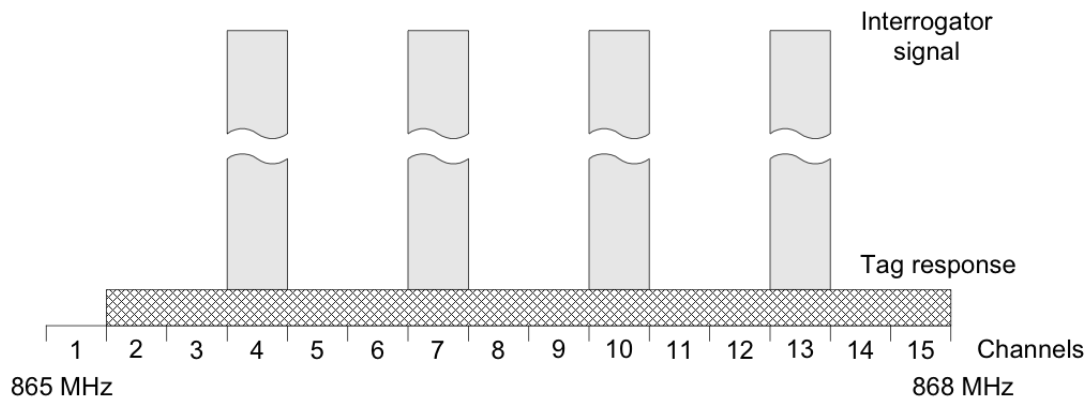


Figure 1: Channel plan for lower band

4.2.2.2a Upper band

For the upper band the centre frequency of the lowest channel shall be 916,3 MHz and the band width of each high power channel shall be 400 kHz. The remaining three high power channels shall be spaced at equal intervals of 1,2 MHz. Tags shall respond in the dense interrogator mode within the low power channels.

A diagram of the channel plan for the upper band is shown in figure 2.

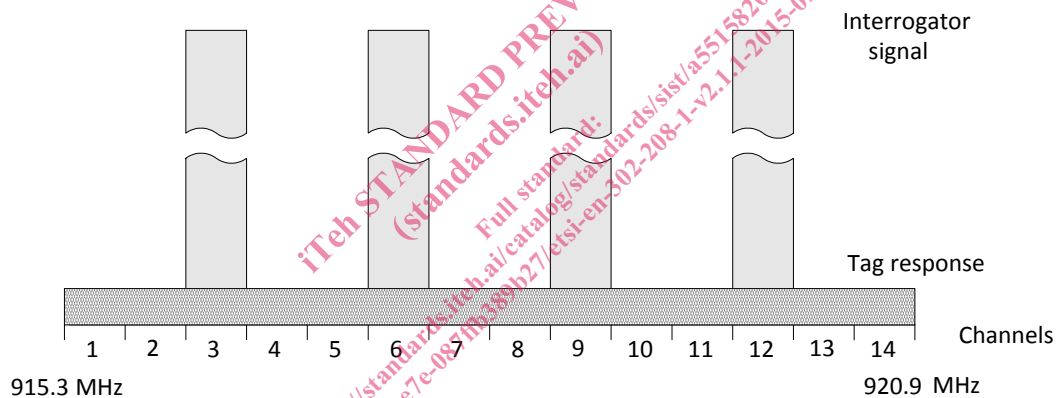


Figure 2: Channel plan for upper band

4.2.2.2b Channel range

When submitting equipment for testing, the provider shall state the frequencies of the band(s) and channels on which the interrogator will operate. The provider shall also confirm that the interrogator shall operate on each of the declared channels without any change to the circuit or trimming of discrete components.

Trimming is an act by which the value (in this case relating to frequency) of a component is changed within the circuit. This act may include the physical alteration, substitution (by components of similar size and type) or activation/de-activation (via the setting of soldered bridges) of components.

4.2.2.3 Testing of operational frequencies

Figures 3 and 4 show the centre frequencies of the four high power channels permitted for use by interrogators within the two bands designated for RFID. Full (FT) and Limited (LT) Tests, as defined in clause 3.1, shall be carried out in the applicable channels at the frequencies shown in figures 3 and 4.