ETSI TS 101 602 V1.1.1 (2013-07)

Technical Specification

Electromagnetic compatibility and Radio spectrum Matters (ERM); Technical Specification on Preliminary Tests and Trial to verify mitigation techniques used by RFID systems for sharing spectrum between RFID and ER-GSM

Reference

DTS/ERM-TG34-19

Keywords

DAA, ER-GSM, radio, RFID

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

Individual copies of the present document can be downloaded from:
http://www.etsi.org

The present document may be made available in more than one electronic version or in print. In any case of existing or perceived difference in contents between such versions, the reference version is the Portable Document Format (PDF). In case of dispute, the reference shall be the printing on ETSI printers of the PDF version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at
http://portal.etsi.org/tb/status/status.asp

If you find errors in the present document, please send your comment to one of the following services:
http://portal.etsi.org/chaircor/ETSI_support.asp

Contents

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (http://ipr.etsi.org).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

Introduction

In order to accommodate the spectrum needs for the increasing number of RFID devices and systems, an extension band has been requested for high power RFID systems in the range between 915 MHz and 921 MHz. This band is already used by RFID in several countries worldwide and its designation in Europe would increase its functionality and simplify the international movement of goods using RFID identification systems. In Europe, part of this new frequency band will be shared between the primary user GSM-R and RFID. In order to guarantee an interference-free coexistence between the two systems, mechanisms should be implemented by RFID systems to reduce the probability of interference to GSM-R to a minimum. These techniques can be either regulatory, or technical mechanisms or of an operational nature.

The present document includes the results of the conformance test, preliminary tests, field trials specification and tests results of UHF RFID systems using the cognitive mitigation techniques and procedures defined in [i.1] and [i.2].

1 Scope

The present document describes the test plan and the results of a series of tests and measurements that were performed to verify the effectiveness of cognitive mitigation techniques applied to UHF RFID systems sharing the band 918 MHz to 921 MHz with GSM-R.

2 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 referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

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

2.1 Normative references

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

[1] ETSI EN 302 208 (V1.4.1): "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".

2.2 Informative references

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 TS 102 902 (V1.2.1): "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.2] ETSI TS 102 903 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Compliance tests for cognitive interference mitigation for use by UHF RFID using Detect-And-Avoid (DAA) or other similar techniques".

[i.3] ETSI ERM TG34: ERM-TG34#23-03, Measurement Report, Feasibility Tests between E-GSM-R and UHF RFID at Kolberg, Germany, 25th to 26th June 2009.

[i.4] ETSI TR 102 649-2 (V1.3.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Technical characteristics of Short Range Devices (SRD) and RFID in the UHF Band; System Reference Document for Radio Frequency Identification (RFID) and SRD equipment; Part 2: Additional spectrum requirements for UHF RFID, non-specific SRDs and specific SRDs".

[i.5] ISO/IEC 18000-63:2013: "Information technology -- Radio frequency identification for item management -- Part 63: Parameters for air interface communications at 860 MHz to 960 MHz Type C".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

Cognitive Radio System (CRS): radio system (optionally including multiple entities and network elements), which has the following capabilities:

- obtains knowledge of the radio operational environment and established policies and monitors usage patterns and users' needs;
- adjusts dynamically and autonomously its operational parameters and protocols according to this knowledge in order to achieve predefined objectives, e.g. minimize a loss in performance or increase spectrum efficiency; and
- learns from the results of its actions in order to further improve its performance.

demonstrator: interrogator extended with means to detect (E)R-GSM band use by railways under the scope of the present document

Detect and Avoid: (DAA): technique used to protect radio communication services by avoiding co-channel operation

NOTE: Before transmitting, a system senses the channel within its operational bandwidth in order to detect the possible presence of other systems. If the channel is occupied, the system avoids transmission until the channel becomes available.

Downlink (DL): direction of communication from master to slave, where in the case of a typical RFID system the direction flows from the interrogator to tag

Dynamic Frequency Allocation (DFA): protocol that allows for changing transmit frequency during operation

Dynamic Power Control (DPC): capability that enables the transmitter output power of a device to be adjusted during operation in accordance with its link budget requirements or other conditions

ER-GSM: extended Railways GSM 900 band from 873 to 880 MHz / from 918 to 925 MHz (includes R-GSM band)

fixed: physically fixed, non-moving device; includes temporary installations as well

GSM-R: standard based GSM system for use by Railways in the designated R-GSM/ER-GSM band

interrogator: fixed or mobile data capture and identification device using a radio frequency electromagnetic field to stimulate and effect a modulated data response from a transponder or group of transponders in its vicinity

link adaptation: result of applying all of the control mechanisms used in Radio Resource Management to optimize the performance of the radio link

Listen Before Talk (LBT): spectrum access protocol requiring a cognitive radio to perform spectrum sensing before transmitting

location awareness: capability that allows a device to determine its location to a defined level of precision

master: controls the radio resource changing actions (a device that controls the actions of other dependent devices)

mobile: physically moving device

radio environment map: integrated multi-domain database that characterises the radio environment in which a cognitive radio system finds itself

NOTE: It may contain geographical information, available radio communication services, spectral regulations and policies, and the positions and activities of co-located radios.

R-GSM: Railways GSM 900 band from 876 to 880 MHz / from 921 to 925 MHz

Service Level Agreement (SLA): defined level of service agreed between the contractor and the service provider

slave: performs the commands transmitted by its Master

Tari: length of a binary zero for interrogator to tag communication in ISO/IEC 18000-63 [i.5]

Uplink (UL): direction of communication from Slave to Master

white space: part of the spectrum, which is available for a radio communication application at a given time in a given geographical area on a non-interfering/non-protected basis with regard to other services with a higher national priority

3.2 Symbols

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

α	pathloss exponent in the Friis Equation
dB	decibel
d	distance
f	frequency measured under normal test conditions
fc	centre frequency of carrier transmitted by interrogator
λ	wavelength
Ω	Resistance
Δf	frequency offset

3.3 Abbreviations

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

ARFCN	Absolute Radio Frequency Channel Number
BCCH	Broadcast Control Channel
BLF	Backscatter Link Frequency
BTS	Base Transceiver Station
CEPT	Conférence Européenne des Postes et des Télécommunications
DAA	Detect And Avoid
DB	Deutsche Bahn
DL	Downlink
EPC	Electronic Product Code
ER-GSM	Extended Railways GSM
GSM	Global System for Mobile communications
GSM-R	Global System for Mobile communication for Railways applications
ICE	Inter-City-Express
M	Miller subcarrier index
RBW	Resolution BandWidth
RF	Radio Frequency
RFID	Radio Frequency Identification
R-GSM	Railways Global System for Mobile communications
STF	Special Task Force
TCH	Traffic Channel
TDMA	Time Division Multiple Access
TX	Transmitter
UHF	Ultra High Frequency
UII	Unique Item Identifier
UL	Uplink
USB	Universal Serial Bus

4 Background Information

4.1 DAA process

The flow diagram at figure 1 shows the decision tree for determining whether a channel is available in the ER-GSM band for use by RFID.

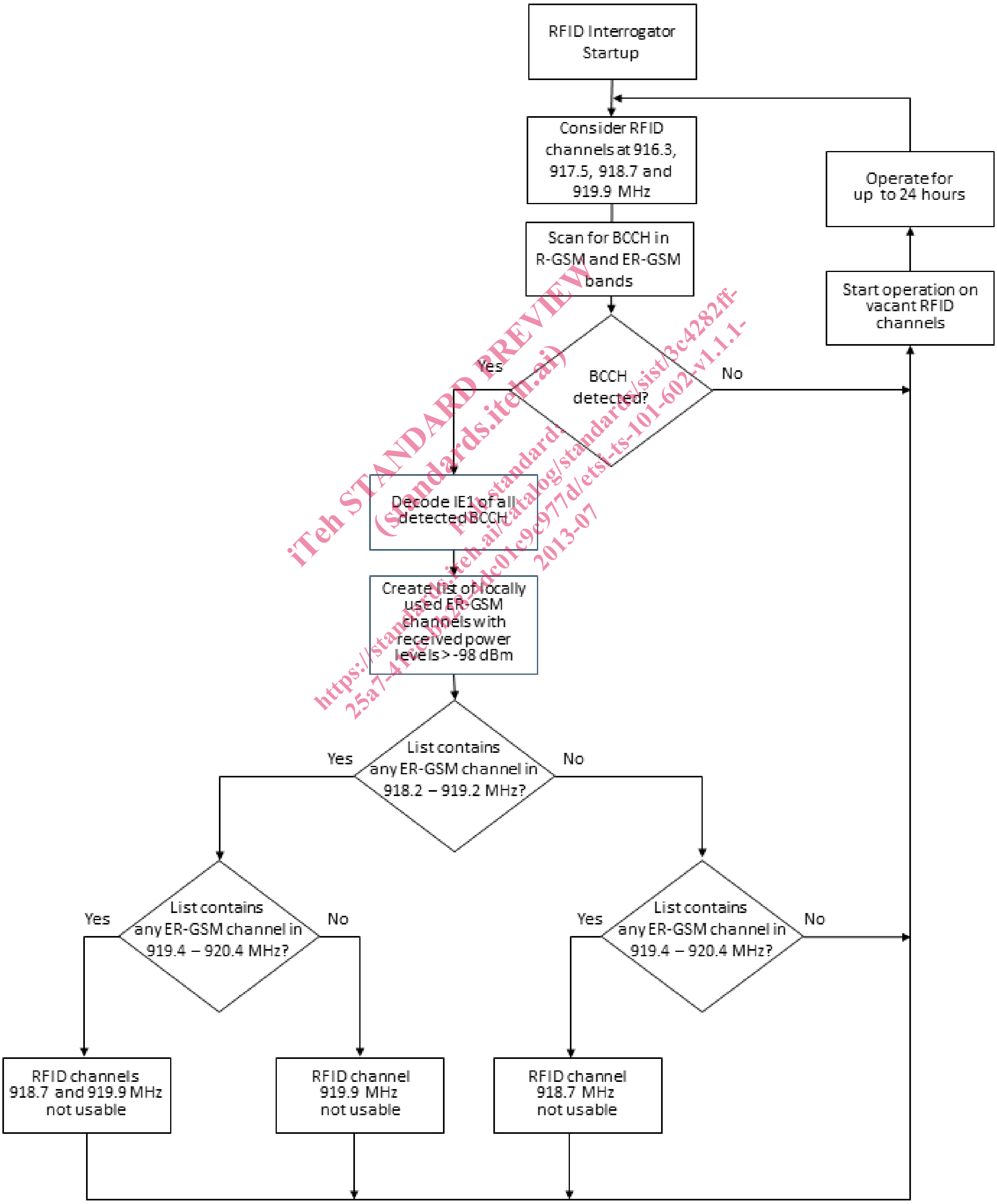

Figure 1: GSM-R DL detection for ER-GSM band and RFID DAA process

4.2 GSM-R

GSM-R is an application based on GSM technology used by the railways. In Europe, GSM-R uses the 876 MHz to 880 MHz band (uplink) and the 921 MHz to 925 MHz band (downlink). In addition, the frequency ranges 873 MHz to 876 MHz (uplink) and 918 MHz to 921 MHz (downlink) may be used by CEPT member states as extension bands for GSM-R. The extension bands are called ER-GSM. In Germany these extension bands are already licensed to Deutsche Bahn AG.

GSM carrier spacing is 200 kHz. Each GSM carrier has 8 logical channels, which means that 8 different communication links are simultaneously possible.

GSM-R is a TDMA system, with frame periods of 4,612 ms for each physical channel. Each TDMA frame consists of 8 logical channels (time slots). One or more of these slots are used for BCCH transmissions.

For GSM-R the first carrier includes one or two time slots for BCCH. Deutsche Bahn for instance always uses two timeslots, which means that the remaining 6 channels are for TCH. Any additional GSM-R carriers provide additional 8 timeslots which can be used for communication while the mobile terminals are listening to the BCCH transmitted on the first carrier.

5 Test Equipment

5.1 RFID equipment

5.1.1 Hardware

The RFID test equipment should comprise two demonstrators (modified interrogators) with RFID antennas and the means to detect (E)R-GSM transmissions. Each interrogator should at least support ISO/IEC 18000-63 [i.5].

Approximately 50 UHF RFID tags should be provided for communication with each demonstrator, which means a total of 100 tags. Each tag should at least support ISO/IEC 18000-63 [i.5] with a 96 bit UII / EPC.

5.1.2 Software

The Check time for Railways Operation t_{CRO} is the interval at which an interrogator automatically checks which ER-GSM channels have been allocated. For equipment in the field this time shall not exceed 24 hours. For the tests t_{CRO} shall be no more than 60 seconds to allow completion of the tests within a reasonable time.

5.2 GSM-R equipment

GSM-R equipment is used for both the R-GSM and ER-GSM band.

In order to perform the tests the following hardware configurations should be made available by the test lab.

A base transceiver station (BTS) configured to generate two GSM-R carriers:

- first carrier with BCCH
- second carrier with only TCH

The first and second carrier transmit power shall be variable to generate a received power at the demonstrator from -47 dBm down to -104 dBm.

In order to ensure that all TCH in the first carrier are occupied, they need to be blocked by either voice or data communication. All additional traffic need to be handled on a separate TCH on the second carrier, which will provide 8 timeslots for voice and data communication.

In order to ensure traffic on the TCH of the second GSM-R carrier, up to 8 GSM-R terminals are required.

6 Specification for conformance tests

Within this clause the term "interrogator" is used instead of "demonstrator" in order to fit to the terminology used in EN 302 208 [1]. The term demonstrator, however, is used in the ToR of ETSI STF 397.

These tests have been taken from [1] and have been modified according to [i.4].

6.1 Radiated power (e.r.p.)

This measurement applies to equipment with an integral antenna and to equipment supplied with an external antenna. Both radiated and conducted methods of measurement are permitted. Where the conducted method is used the conducted power shall be adjusted to take into account the gain of the antenna and be stated as e.r.p.

If the equipment is designed to operate with different carrier powers, the provider shall declare the rated power for each level or range of levels.

6.1.1 Definition

The effective radiated power is the product of the power supplied to the antenna and its gain relative to a half wave dipole in the direction of maximum gain in the absence of modulation.

6.1.2 Method of measurement

These measurements shall be performed with an un-modulated carrier at the highest power level at which the transmitter is intended to operate.

For both methods of measurement the measuring receiver shall be set up in accordance with the requirements of [1], clause 6.6.

6.1.2.1 Radiated measurement

This measurement shall be carried out under normal test conditions only (see [1], clause 5.3).

Step 1: On a test site, selected from [1], annex A, the interrogator shall be placed at the specified height on a support, as specified in [1], annex A, and in the position closest to normal use as declared by the provider.

Step 2: A test antenna shall be oriented initially for vertical polarization and shall be chosen to correspond to the carrier frequency of the interrogator. The output of the test antenna shall be connected to a measuring receiver.

Step 3: The interrogator shall be set to transmit continuously, without modulation, on one of the high power channels. The measuring receiver shall be positioned in the far field as defined in [1], annex A and tuned to the frequency of the transmission under test.

Step 4: The test antenna shall be raised and lowered through the specified heights until the maximum signal level is detected by the measuring receiver.

Step 5: The interrogator shall then be rotated through 360º in the horizontal plane, until the maximum signal level is detected by the measuring receiver.

Step 6: The test antenna shall be raised and lowered again through the specified heights until the maximum signal level is detected by the measuring receiver. The maximum signal level detected by the measuring receiver shall be noted.

Step 7: The antenna of the interrogator shall be rotated in the horizontal plane in both directions to positions where the signal at the measuring receiver is reduced by 3 dB. The total angle of rotation (which is the horizontal beamwidth of the antenna) shall be recorded.

Step 8: The interrogator shall be replaced by a substitution antenna as defined in [1], clause A.1.5. The substitution antenna shall be connected to a calibrated signal generator. The substitution antenna shall be orientated for vertical polarization and the length of the substitution antenna shall be adjusted to correspond to the frequency of transmission of the interrogator. If necessary, the setting of the input attenuator of the measuring receiver shall be adjusted in order to increase the sensitivity of the measuring receiver.

Step 9: The test antenna shall be raised and lowered through the specified heights to ensure that the maximum signal is received.

Step 10: The input signal to the substitution antenna shall be adjusted to give a level at the measuring receiver that is equal to the radiated power previously measured from the interrogator, corrected for any change to the setting of the input attenuator to the measuring receiver.

Step 11: The input level to the substitution antenna shall be recorded as power level, corrected for any change of input attenuator setting of the measuring receiver.

Step 12: The measurement shall be repeated with the test antenna and the substitution antenna orientated for horizontal polarization.

Step 13: The measure of the effective radiated power is the larger of the two levels recorded at the input to the substitution antenna, corrected if necessary for the gain of the substitution antenna.

Step 14: With the interrogator fitted into a suitable test fixture, the relative change of the effective radiated power between normal and extreme test conditions (see clauses 5.4.1 and 5.4.2 applied simultaneously) shall be compared. Any increase in the radiated power under extreme test conditions shall not cause the level to exceed the limit specified in clause 6.1.3.

6.1.2.2 Conducted measurement

Where an interrogator is fitted with an external antenna connector it is permissible to measure the conducted power. In this case the provider shall declare the maximum gain and beamwidth(s) of the external antenna(s) at the time that the equipment is presented for test.

Step 1: The transmitter shall be configured to operate on one of the high power channels shown in figure 2 and shall be connected to an artificial antenna (see [1], clause 6.2). The carrier or mean power delivered to this artificial antenna shall be measured under normal test conditions (see [1], clause 5.3).

Step 2: The measurement shall be repeated under extreme test conditions (see [1], clauses 5.4.1 and 5.4.2 applied simultaneously).

Step 3: The recorded value shall be corrected for each of the antenna gains and be stated in e.r.p. To calculate the allowed conducted power with a circularly polarized antenna, the following formula shall be used:

$$P_C = P_{erp} - G_{IC} + 5{,}15 + C_L \text{ dBm}$$

Where:

P_C = interrogator conducted transmit power in dBm;

G_{IC} = antenna gain of a circular antenna in dBic;

C_L = total cable loss in dB.

Step 4: Where the interrogator switches between multiple transmitter outputs, the power level shall be measured at each output.

6.1.3 Limits

The effective radiated power on each of the four high power channels specified in figure 2 shall not exceed 36 dBm e.r.p.