



Technical Specification

**Electromagnetic compatibility  
and radio spectrum matters (ERM);  
The specification and implementation of design changes to  
interrogators and specification of the test plan for  
the Preliminary Tests and the Trial;  
Modification of interrogators and specification of  
test plans for the Preliminary Tests and Trial**

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Reference

DTS/ERM-TG34-11

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Keywords

DAA, ER-GSM, radio, RFID

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## Foreword

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

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## Introduction

In order to accommodate the spectrum needs for the increasing number of RFID devices and systems, an extension band for high power RFID systems in the range between 915 MHz and 921 MHz has been requested. 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, a part of this new frequency band has to be shared between the primary user ER-GSM and RFID. In order to guarantee an interference-free coexistence between the two systems, mechanisms have to be implemented by RFID systems to reduce the probability of interference to an acceptable minimum. These techniques can be either of regulatory, technical or operational nature.

The present document includes a description of the modifications made to the hardware and software of two UHF RFID interrogators in order to implement demonstrators with the Detect-Avoid-Avoid (DAA) technique defined in TS 102 902 [i.1] and TS 102 903 [i.2]. In addition a specification of acceptance tests for the modified interrogators is provided.

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# 1 Scope

The present document specifies the practical implementation of the DAA mitigation technique for UHF RFID systems sharing the band 918 MHz to 921 MHz with ER-GSM. It covers the required modifications to UHF RFID interrogators as well as the subsequent acceptance tests. The purpose of the modified interrogators, (also called demonstrators) is to validate a subset of the mitigation techniques specified in [i.1] and [i.2]. The present document only covers the design modification and acceptance tests.

The system tests together with ER-GSM will be covered in TR 101 602 [i.7].

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# 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>.

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## 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: "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: "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] EIRENE System Requirements Specification Version 15.1.
- [i.4] ETSI TS 144 018: "Digital cellular telecommunications system (Phase 2+); Mobile radio interface layer 3 specification; Radio Resource Control (RRC) protocol (3GPP TS 44.018 version 10.6.0 Release 10)".
- [i.5] ETSI TR 102 649-2: "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.6] ISO/IEC 18000-6:2010: "Information technology -- Radio frequency identification for item management -- Part 6: Parameters for air interface communications at 860 MHz to 960 MHz".

- [i.7] ETSI TR 101 602: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Technical Report on Preliminary Tests and Trial to verify mitigation techniques for sharing spectrum between RFID and ER-GSM".

## 3 Definitions, symbols and abbreviations

### 3.1 Definitions

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

**Detect And Avoid (DAA):** technology 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

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

**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

**mobile:** physically moving device

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

### 3.2 Symbols

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

dB	decibel
f	frequency measured under normal test conditions

### 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
DAA	Detect and Avoid
DL	Downlink
ECC	Electronic Communications Committee
EIRENE	European Integrated Railway Radio Enhanced Network
ER-GSM	Extended Railways GSM
GSM	Global System for Mobile Communication
GSM-R	GSM - Railway
IE	Information Element
M	Number of subcarrier cycles per symbol
RFID	Radio Frequency Identification
R-GSM	Railways Global System for Mobile communications
Tari	Reference time interval for a data-0 in Interrogator-to-tag signalling
TCH	Traffic Channel
TX	Transmitter

UHF            Ultra High Frequency  
UL             Uplink

## 4 Background Information

The present document specifies the requirements for test interrogators as needed for validation of the successful co-existence of RFID with ER-GSM when operating in the same frequency band. The railways require a comprehensive trial of the mitigation technique before giving their formal agreement for RFID to share the band with ER-GSM. A successful outcome to the trial will also assist ECC in recommending the designation of additional spectrum for RFID at UHF.

The European Commission has identified RFID as a technology that can bring fundamental improvements to the Community. This is not only in terms of improvements to the efficiency of business but also in terms of the quality of people's lives. Already RFID is being adopted at an increasing rate across a wide range of applications. For example in 2010 global sales of RFID tags at UHF grew to 1,2 billion (see note), which is 73 % higher than market predictions. By 2022 it is estimated that the global annual consumption of tags at UHF will have reached 86 billion (see note).

NOTE: Source IDTechEx.

To make provision for this growth in demand, in 2008 ETSI submitted a request to ECC for additional spectrum at UHF for RFID. Details of this request are described in SRDoc TR 102 649-2 [i.5]. The document identified that the frequency range 915 MHz to 921 MHz, which acts as a guard band between the uplink and downlink for GSM, was substantially unused. ECC was asked to consider whether this band could be designated for use by RFID.

Not long afterwards the railways requested the extension of the GSM-R band to include the frequency range 918 MHz to 921 MHz paired with 873 MHz to 876 MHz. The ECC agreed to this request. In subsequent discussions between the railways and ERM\_TG34, the railways agreed to share the band with RFID systems with one obligation, RFID community has to provide reliable techniques to ensure GSM-R operation without causing harmful interferences.

## 5 RFID Interrogator modifications

### 5.1 System concept

The RFID interrogators to be used as demonstrators should be developed to support downlink detection of the R-GSM or ER-GSM signal. The downlink detection may be done by use of an external receiver, or the RFID receiver, which also detects the tag responses. The antenna could be a dedicated antenna to receive the R-GSM/ER-GSM transmissions, or instead one or more of the RFID antennas may be used.

The demonstrators shall support the data rates and subcarriers intended for the 400 kHz TX channels and the 1 200 kHz channel spacing.

### 5.2 Hardware modifications

#### 5.2.1 RFID specific

The demonstrators shall support at least the combinations of forward and return link settings as specified in Table 1.

**Table 1: Forward and return link settings**

Forward link	Return link
Tari <= 10 $\mu$ s (towards 6,25 $\mu$ s)	M=4, BLF = 320 kHz
Tari <= 10 $\mu$ s (towards 6,25 $\mu$ s)	M=4, BLF = 640 kHz

The demonstrator shall support the following transmit channels as in Table 2.

**Table 2: Forward and return link settings**

Frequency/MHz	Comment
916,3	See note 1
917,5	See note 1
918,7	See note 1
919,9	See note 1
919,3	See note 2
920,5	See note 2
921,7	See note 2
922,9	See note 2

NOTE 1: For use if ER-GSM band is supported by railways test equipment.  
 NOTE 2: For use if ER-GSM band is not supported by railways test equipment and instead the channel frequencies have to be shifted by 3 MHz to be able to use R-GSM equipment.

## 5.2.2 Railways specific

Each demonstrator shall have means to detect BCCH channels in the R-GSM and ER-GSM band.

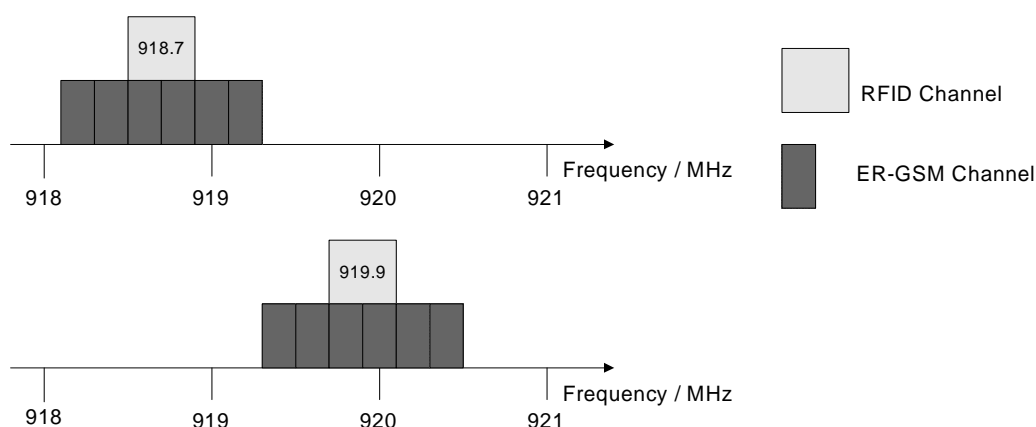
The demonstrator shall be capable of scanning the (E)R-GSM downlink band and receive signals from the BCCH channel in the whole (E)R-GSM band. The demonstrator shall successfully receive and decode every BCCH transmission identified in that spectrum. The message of relevance within the Broadcast Channel is the SYSTEM INFORMATION TYPE 1 (see clause 9.1.31 of TS 144 018 [i.4]) message containing the Cell Channel Description IE.

From the received information corresponding to the BCCH Cell Channel Description IE, the demonstrators shall create a list of all ARFCN used by (E)R-GSM in the local area of operation.

The detection of the BCCH information shall be possible down to -98 dBm, which is the minimum coverage power specified for non-high speed railways tracks (see [i.3]).

The demonstrator shall not use any of the RFID TX channels with a centre frequency of less than 700 kHz from any channel stored in the ARFCN list, if the received GSM-R power level is  $\geq$  -96 dBm.

Figure 1 shows which ER-GSM channels prevent the use of either the 918,7 MHz or the 919,9 MHz RFID TX channel.



**Figure 1: Illustration of interference between ER-GSM and RFID channels**

Each demonstrator shall perform the BCCH and TCH detection routine after turn-on and thereafter at selectable intervals  $\leq$  60 seconds.

NOTE: As a detection interval of 24 hour interval is not applicable for testing purposes, 60 seconds have been selected instead.



## 5.3 Software modifications

Each demonstrator shall provide the means to select or deselect any channel from Table 2. This is required in order to switch between R-GSM and ER-GSM band tests, as well as to emulate that certain channels are not available.

Furthermore, the demonstrator shall implement the detection period as in clause 5.2.2.

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# 6 RFID Interrogator acceptance test

## 6.1 RFID standards

The demonstrator shall fulfil ISO/IEC 18000-6:2010 [i.6] Type C as far as required for these tests.

In particular the following will be verified as specified in clause 5.2.1:

- Tari
- M
- BLF

## 6.2 ETSI standards

Based on the principle test methods of EN 302 208 [1] the following items shall be tested as specified in SRDoc TR 102 649-2 [i.5]:

- Interrogator spectrum mask (EN 302 208-1 (V1.4.1) [1], clauses 8.3, 8.4 and 8.5; SRDoc TR 102 649-2 [i.5], clauses 7.2.2 and B.1.3).
- Tag spectrum mask (EN 302 208-1 (V1.4.1) [1], clause 10; SRDoc TR 102 649-2 [i.5], clauses 7.2.2 and B.1.3).

## 6.3 (E)R-GSM mitigation tests

This clause defines the requirements for a RFID interrogator operating in the ER-GSM band to prove its capabilities to detect and identify a BCCH channel and to respond as required in clause 5.2.2.

### 6.3.1 (E)R-GSM detection and decoding

This test is to show the interrogator's capability to receive and to decode a transmitted (E)R-GSM BCCH properly. It shall be repeated for three different GSM-R received signal levels (-60 dBm, -85 dBm and -98 dBm) and at least three different ARFCNs. The test interrogator shall store the ARFCN channels and present it via a serial terminal or as text file. The test passes if the TCHs reported match those transmitted in the Cell Channel Description IE and the interrogator stops transmitting in the channels overlapping with ER-GSM.

### 6.3.2 Detection at start-up of interrogator

This test shall be done to confirm that the interrogator does detect ER-GSM channels at start-up of the interrogator.

For this test a channel in the ER-GSM band shall be allocated for railway use. After turning on the interrogator it shall report the used ER-GSM channels for railways within 60 seconds and furthermore will have demonstrated that the relevant RFID channel has been removed from the RFID channel select list.

This test shall be repeated 5 times for each of the three different GSM-R received signal levels -60 dBm, -85 dBm and -98 dBm and the test passes if the interrogator correctly reports the ER-GSM channels allocated for railway use and avoids them accordingly.

### 6.3.3 Detection at start-up of (E)R-GSM BTS

This test shall be done to confirm that the interrogator does detect ER-GSM channels at start-up of a GSM-R BTS.

For this test an interrogator shall be running and a BTS signal shall be turned on with a channel in the ER-GSM band allocated for railway use. After turning on the BTS the interrogator shall report the used ER-GSM channels for railways within 60 seconds and furthermore will have demonstrated that the relevant RFID channel has been removed from the RFID channel select list.

This test shall be repeated 5 times for of each of the three different GSM-R received signal levels -60 dBm, -85 dBm and -98 dBm and the test passes if the interrogator correctly reports the ER-GSM channels allocated for railway use and avoids them accordingly.

## 6.4 Acceptance test results

On completion of the acceptance tests, the results will be added in annex B as a revision of the present document.

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## Annex A (informative): UHF RFID Interrogator modification description

Will be added after completion of the design work and after the acceptance tests.

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## Annex B (informative): UHF RFID Interrogator acceptance test results

Will be added after completion of the design work and after the acceptance tests.

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## Annex C (informative): Bibliography

ETSI TR 101 537: "Electromagnetic compatibility and radio spectrum matters (ERM); Second co-existence test between ER-GSM with RFID".

EIRENE Functional Requirements Specification Version 7.1.

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## History

<b>Document history</b>		
V1.1.1	July 2012	Publication