ETSI TR 103 059 V1.2.1 (2013-11)

Technical Report

Electromagnetic compatibility and Radio spectrum Matters (ERM); Short-Range Devices (SRD) for operation in the 13,56 MHz band; System Reference Document for Radio Frequency Identification (RFID) equipment

Reference

RTR/ERM-TG28-046

Keywords

radio, RFID, short range, SRD, SRDOC

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 Report (TR) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

Executive summary

The present document analyses the potential and status of 13,56 MHz RF Identification Systems and the need for regulatory and standard improvements as:

- 13 MHz RFID systems cover the widest range of markets and applications among the RFID families, this is detailed in clause 6.1 and annex A.
- The prospects for the next decade for the 13,56 MHz RFID technology is that these RFIDs have the highest turnover and increase rate compared to other frequencies. The rate is estimated for about 50 % or higher of all SRD applications. This is based on:
  - the mature and versatile 13,56 MHz technology is providing either large reading range with high data rates and bulk reading capability or very high data rates at low reading ranges needed for the required safety and security features and as requested by the EC mandate M436 for private/public and commercial use;
  - 13,56 MHz systems are used in a large amount of installed systems covering various markets. The present document covers two different application types which require different TX emission masks for different emission levels and bandwidths:
    a) Narrowband/long range applications as used in libraries, access control, logistics and materials handling, waste management, apparel tagging in manufacturing laundry services, etc. These systems are typically installed in industrial or shopping sites. From all 13,56 MHz applications they represent some 3 % of all deployed systems.
    b) Wideband/short range applications for use in ticketing and payment systems to secure transactions (i.e. smart cards, e-Passport, mass transportation tickets), NFC, employing authentication to provide secure identification mechanisms for persons and objects. These systems represent about 97 % of the market for 13,56 MHz RFID systems.
  - All 13,56 MHz RFID systems feature unique properties as highest spectrum efficiency as dense operation of 13,56 MHz RFID systems in a given area.
- 13,56 MHz frequency band is harmonized in all three ITU regions which assures coverage of all markets.

Furthermore recent developments in the evolution of the technology and ISO standards as well as market developments or requirements in social, public, commercial and industrial areas have shown the need for amending the ERC/REC 70-03, annex 9 as well as amending the EN 300 330-1 [i.2] as presented in the present document.

Introduction

The present document has been developed to support the co-operation between ETSI and the Electronic Communications Committee (ECC) of the European Conference of Post and Telecommunications Administrations (CEPT) for internal reference within ETSI [i.1].

RFIDs have been in use for almost all areas of the industrial-commercial, the public and private sector.

Especially the 13,56 MHz RFID technology is matured and has achieved tag deployment rates in the several billion unit range. This frequency is highly attractive because of the global harmonization of this frequency band since it is an ISM band in all 3 ITU regions.

The 13,56 MHz RFIDs use the inductive near field propagation mode which has the unique advantage of allowing a high reader field strength without disturbing the in-band or adjacent band radio services because of the fast field strength roll-off of 60 dB/Decade [i.2] and [i.5].

This means that the reading range is confined or limited while RFID's using EM/far-field operation can suffer from reflections and diffractions.

The two most limiting factors for 13,56 MHz RFIDs are regulatory constraints with regard to the modulation allowance level which is addressed in the present document.

1 Scope

The present document provides information on short range device equipment for RFIDs operating in the 13,56 MHz frequency range from 13,553 MHz to 13,567 MHz and covering the requirements for carrier and the associated modulation emissions.

The present document includes the necessary information to support the co-operation between ETSI and the ECC including:

- market information;
- technical information;
- regulatory issues.

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 reference 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.

Not applicable.

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] ECC-ETSI MoU (version of April 2004).

[i.2] ETSI EN 300 330-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment in the frequency range 9 kHz to 25 MHz and inductive loop systems in the frequency range 9 kHz to 30 MHz; Part 1: Technical characteristics and test methods".

[i.3] ERC Report 69 (February 1999): "Propagation model and interference range calculations for inductive systems 10 kHz - 30 MHz".

NOTE: Available at: http://www.satoworldwide.com/news_releases_02062008_DIP.htm.

[i.4] Wired Science: "New RFID Tag could mean the end of Bar Codes".

NOTE: Available at: http://www.satoworldwide.com/news_releases_02062008_DIP.htm.

[i.5] ERC Report 44 (January 1997): "Sharing between inductive systems and radiocommunication systems in the band 9 - 135 kHz".

[i.6] ECC Report 74: "Compatibility between radio frequency identification devices (rfid), and the radioastronomy service at 13 MHz".

[i.7] Poly IC printed electronics.

NOTE: Available at: http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=1233745&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D1233745.

[i.8] ISO/IEC 14443-2 "Identification cards - Contactless integrated circuit(s) cards - Proximity cards - Part 2: Radio frequency power and signal interface.

[i.9] ISO/IEC 15693-1 "Identification cards - Contactless integrated circuit cards -- Vicinity cards -- Part 1: Physical characteristics".

[i.10] ERC Recommendation 70-03: "Relating to the use of short range devices (srd)".

[i.11] ISO/DIS 17367: "Supply chain applications of RFID - Product tagging".

[i.12] CEN EN 14803: "Identification and/or determination of the quantity of waste".

[i.13] FM(10)092 Annex 24: "Dynamic Evolution of RFID Market".

[i.14] Klaus Finkenzeller: "RFID Handbook", Chapter 5.1.11: "Selection of frequency for inductive coupled RFID systems", issue 2008, ISBN 978-3-446-41200-2.

[i.15] VDC Market Report: "RFID and related solutions".

[i.16] EETimes publishes an article about PolyIC: "Organic RFID breakthroughs detailed".

NOTE: Available at: http://www.eetimes.com/document.asp?doc_id=1170339.

[i.17] ISO/IEC 18000-3: " Information technology - Radio frequency identification for item management - Part 3: Parameters for air interface communications at 13,56 MHz".

[i.18] ISO/IEC 10536: "Identification cards -- Contactless integrated circuit(s) cards".

[i.19] ISO/IEC TR 18047-3: "Information technology -- Radio frequency identification device conformance test methods -- Part 3: Test methods for air interface communications at 13,56 MHz".

[i.20] ISO/IEC 15693-3: "Identification cards - Contactless integrated circuit cards - Vicinity cards - Part 3: Anticollision and transmission protocol".

[i.21] ISO/IEC 10373-4: "Identification cards -- Test methods -- Part 4: Contactless integrated circuit cards".

[i.22] ISO/IEC 10373-6: "Identification cards - Test methods - Part 6: Proximity cards".

[i.23] ISO/IEC 10373-7: "Identification cards -- Test methods -- Part 7: Vicinity cards".

[i.24] ETSI EN 302 291: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Close Range Inductive Data Communication equipment operating at 13,56 MHz".

[i.25] ISO/IEC 18092: "Information technology -- Telecommunications and information exchange between systems -- Near Field Communication -- Interface and Protocol (NFCIP-1)".

[i.26] ECMA 340: "Near Field Communication Interface and Protocol (NFCIP-1)".

[i.27] Void.

[i.28] ISO/IEC 18046 (parts 1 to 3): "Information technology -- Radio frequency identification device performance test methods".

[i.29] ISO/IEC18000-1: "Information technology -- Radio frequency identification for item management -- Part 1: Reference architecture and definition of parameters to be standardized".

[i.30] ITU Radio Regulations.

[i.31] Void.

[i.32] ECC Report 67: Compatibility study for generic limits for the emission levels of inductive SRDs below 30 MHz.

[i.33] RFID report BNetzA: Measurements to characterize HF RFID signals and to determine the interference to the HF broadcast service: M66-17R0-SE24-at-13MHz-Test-Report.

[i.34] Liaison statement from ETSI-ERM to ECC WGSE #63 dated 2012-11-07, Doc. ECC/SE(13)016.

[i.35] M436: Standardization Mandate To The European Standardization Organization Organizations CEN, CENELEC and ETSI In The Field Of Information And Communication Technologies Applied To Radio Frequency (RFID And Systems.

[i.36] Summary for the 13.56 MHz RFID Measurement campaign (for BC.

[i.37] ETSI Liaison statement from ECC WGSE to ETSI-ERM: SE(13)049A20-LS to ETSI TC ERM on ETSI TR 103 059 for RFID 13.56 MHz.doc.

[i.38] "Measuring Lean benefits using Radio Frequency Identification (RFID) technology".

NOTE: http://www.rfidinfo.jp/whitepaper/381.pdf.

[i.39] 2006/771/EC: Commission Decision of 9 November 2006 on harmonisation of the radio spectrum for use by short-range devices.

3 Definitions, symbols and abbreviations

3.1 Definitions

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

bulk reading: extension of single reading to a set of tags within the illumination field

identification system: equipment consisting of a transmitter(s), receiver(s) (or a combination of the two) and an antenna(s) to identify objects by means of a transponder

Short Range Devices (SRDs): radio devices which provide either unidirectional or bi-directional communication and which have low capability of causing interference to other radio equipment

tag: device that responds to an interrogation signal

3.2 Symbols

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

P	Power
R	Distance
f	frequency
f_C	carrier frequency in Hz
H	magnetic field strength
kB/s	Data transmission speed
λ	Wave length

3.3 Abbreviations

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

AIDC	Automatic Identification and Data Capture
AM	Amplitude Modulation
ANFR	Agence Nationale des Fréquences
ASK	Amplitude Shift Keying

BC	BroadCasting
DRM	Digital Radio Mondiale
EAS	Electronic Article Surveillance
ECC	Electronic Communications Committee
EM	ElectroMagnetic
EPC	Electronic Product Code
ERC	European Radiocommunications Committee
FD	Full Duplex
HF	High Frequency
IC	Integrated Circuit
ISM	Industrial Scientific Medical
ISO	International Standards Organisation
LF	Low Fequency
LS	Liason Statement
NB	Narrow Band
NFC	Near Field Communication
NRZ	Non Return Zero
PSK	Phase Shift Keying
RF	Radio Frequency
RR	Radio Regulations
RX	Radio Receiver
SRD	Short Range Device
TG	Task Group
TX	Transmitter
UHF	Ultra High Frequency
WB	Wide BAnd

4 Comments on the System Reference Document

4.1 Comments on the revised version 1.2.1

No comments are received to date.

4.2 Revised items in version 1.2.1

The revision of V1.2.1 covers two different application families. The combined transmitter mask of the version V1.1.1 has been changed in clause 8 to two individual transmitter masks for a Narrowband/Long range and a Wideband/Short range application.

The main changes are in:

- Executive summary
- Clause 6.1, Market information
- Clause 7, Technical information (7.1.1, 7.2.1 and 7.3)
- Clause 8 Radio spectrum request and justification (8.1, 8.1.1, 8.2 and 8.2.2)
- Clause 9, Regulations, (9.1, 9.2 and 9.3)

Other revisions concern textual updates in various places.

5 Background information

5.1 The current situation

RFIDs operating at 13,56 MHz meet a number of different market requirements and have reached the highest market acceptance and penetration among all other RFID technologies operating at other frequency ranges.

The increase rate over the next decade is about 50 % or higher. This is based on an already high level of installed systems and particularly the number of tags. This high level of acceptance is due to the versatile yet simple 13,56 MHz inductive technology.

13,56 MHz benefits are:

- Frequency band is harmonized → in ITU regions 1, 2 and 3
- Near field properties RFIDs have distinct features → well defined and limited operating range
- Very high spectrum efficient technology → 13,56 MHz ±7 kHz is sufficient
- High coverage of Standards → by global standards (ISO) and regional as well as different application specific standards
- Highest data rate and bidirectional communications → up to 423 kB/s for sophisticated, secure data transmission and anti-collision and up to 30 MB/s for short distance systems
- Low cost structure → using mature and high volume technologies
- Choice of technology for or short or long operating ranges → at very high or high data rates

Regarding the achievable operating range, the regulation for the carrier field strength level was increased from 42 dBµA/m to 60 dBµA/m a few years ago in order to provide higher reading ranges and to meet the market demands. At the time, the market primarily required read-only tags and the achievable high reading range was effectively enabled by the 60 dBµA/m limit.

The increased complexity of RFID systems, the level of sophistication of the various applications, last but not least the need for data protection and enhanced capability for data security have dictated the shift from read-only and unidirectional data communication to bidirectional communication between reader and the tag. New applications necessitate the bandwidth increase from ±900 kHz to ±7 MHz.

Bidirectional communication to the tags is essential for present RFID systems with sophisticated protocols e.g. for addressing individual tags, and also enabling data security functions. For bulk reading environments fast protocols for tag serialization is required, which is only feasible with bidirectional communication.

The large majority of the RFID systems respectively the tags are passive, this is a precondition for high market penetration and reliable operation at low cost. Passive tags face a number of limitations for realizing the chip technology, especially if bidirectional communication between reader and tag is required.

The bidirectional communication requires that the tag activation signal is to be ASK or PSK modulated. The ASK modulation level has to be minimum ~10 % (respectively a modulation index of 18 %) in order to be reliably detected by the passive tags.

The present modulation mask, initially defined for operation at a carrier level of 42 dBµA/m, works satisfactorily with the present modulation mask level of 9 dBµA/m. However using the increased carrier level of 60 dBµA/m the modulation level of 9 dBµA/m is too low.

The present document supports the need for amending the modulation emission levels and defines the required modulation mask to allow reliable bidirectional communication at the carrier operation level of 60 dBµA/m.

The present modulation mask, initially defined for operation at a carrier level of 42 dBµA/m, works satisfactorily with the present modulation mask level of 9 dB/µA/m but with the increased carrier level the modulation level is too low and no longer functional to support bidirectional communication at 60 dBµA/m.