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Electromagnetic compatibility and Radio spectrum Matters (ERM); Peer-to-Peer Digital Private Mobile Radio using FDMA with a channel spacing of 6,25 kHz with e.r.p. of up to 500 mW

Reference

RTS/ERM-TGDMR-320

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Foreword

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

1 Scope

The present document covers digital private mobile radio equipment operating in peer-to-peer mode only.

The equipment is based on FDMA with channel spacing of 6,25 kHz supporting voice and data applications.

It covers only hand portable equipment complying with EN 301 166-2 [1] and having an integral antenna.

This equipment is for use:

i) In accordance with ECC/DEC/(05)12 [i.1] on harmonized frequencies, technical characteristics, exemption from individual licensing and free carriage and use of digital PMR 446 applications operating in the frequency band 446,100 MHz to 446,200 MHz.

NOTE 1: The technical requirements for Digital PMR 446 included in ECC/DEC/(05)12 [i.1] are: operation in the frequency range 446,100 MHz to 446,200 MHz, maximum e.r.p. of 500 mW, and a maximum transmitter time-out-time of 180 seconds.

ii) In the frequency band 149,01875 MHz to 149,11875 MHz under exemption from individual licensing.

NOTE 2: These requirements are: maximum e.r.p. of 500 mW, and a maximum transmitter time-out-time of 180 seconds.

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.

[1] ETSI EN 301 166-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Radio equipment for analogue and/or digital communication (speech and/or data) and operating on narrow band channels and having an antenna connector; Part 2: Harmonized EN covering essential requirements of article 3.2 of the R&TTE Directive".

[2] Void.

[3] ETSI ETS 300 230: "Radio Equipment and Systems (RES); Land mobile service; Binary Interchange of Information and Signalling (BIIS) at 1200 bit/s (BIIS 1 200)".

[4] MPT 1327 (June 1997): "A Signalling Standard for Trunked Private Land Mobile Radio Systems".

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] CEPT ECC/DEC/(05)12: "ECC Decision of 28 October 2005 on harmonized frequencies, technical characteristics, exemption from individual licensing and free carriage and use of digital PMR 446 applications operating in the frequency band 446.1-446.2 MHz".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

bearer service: type of telecommunication service that provides the capability for the information transfer between user network interfaces, involving only low layer functions (layers 1 to 3 of the OSI model)

NOTE: Confirmed Data and Unconfirmed Data are examples of bearer services.

burst: short duration RF signal that may cause interference to a dPMR™ transmission item

call: complete sequence of related transactions between radios

NOTE: Transactions may be one or more items containing specific call related information.

Configured Services and Facilities (CSF): those functions available in the radio after re-programming

Control plane (C-plane): part of the protocol stack dedicated to control and data services

feature: attribute intrinsic to a station, e.g. MS has an address

Handportable Station (HS): physical grouping that contains all of the mobile equipment that is used to obtain dPMR™ mobile services and operating with an integral antenna

initial services and facilities: those functions available in the radio at point of sale (out-of-the box functions)

late entry: where receiving stations that have missed the start of a transmission are able to recover all information about the call from data that is interspersed within each superframe

logical channel: distinct data path between logical endpoints

payload: bits in the information field

peer-to-peer mode: mode of operation where radios may communicate outside the control of a network

NOTE: This is communication technique where any radio unit may communicate with one or more other radio units without the need for any additional equipment (e.g. BS).

personalization: address and configuration information that characterizes a particular dPMR™ HS

NOTE: This information may be implanted by the installer before putting an HS into service.

physical channel: FDMA transmission

polite protocol: Listen Before Transmit (LBT) protocol

NOTE: This is a medium access protocol that implements a LBT function in order to ensure that the channel is free before transmitting.

prefix: most significant digit of a HS address in the user domain

Protocol Data Unit (PDU): unit of information consisting of protocol control information (signalling) and possibly user data exchanged between peer protocol layer entities

radio frequency channel: radio frequency carrier (RF carrier)

NOTE: This is a specified portion of the RF spectrum. The RF carrier separation is 6,25 kHz.

Received Signal Strength Indication (RSSI): root mean squared value of the signal received at the receiver antenna

signalling: exchange of information specifically concerned with the establishment and control of connections, and with management, in a telecommunication network

simplex: mode of working by which information can be transferred in both directions but not at the same time

NOTE: Simplex is also known as half duplex.

superframe: four concatenated FDMA frames

NOTE: A superframe has a length of 320 ms.

supplementary service: supplementary service modifies or supplements a tele-service or bearer service

NOTE: Consequently, it cannot be offered to a user as a standalone service. It is offered together with or in association with a tele-service or bearer service. The same supplementary service may be common to a number of telecommunication services. Late entry is an example of supplementary service.

telecommunication service: offered by a dPMR™ entity in order to satisfy a specific telecommunication requirement

tele-service: type of telecommunication service that provides the complete capability, including terminal equipment functions, for communication between users

NOTE: Individual voice calls and group voice calls are examples of tele-services.

user numbering: decimal representation of dPMR™ air interface addresses, as seen by the user, i.e. user visible numbering

User plane (U-plane): part of the protocol stack dedicated to user voice services

vocoder socket: 216 bits vocoder payload

wildcard: character in the user domain that represents all digits 0 to 9

3.2 Symbols

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

B_2	algorithm that converts HS dialable talkgroup addresses between the User Interface and the Air Interface
dBm	absolute power level relative to 1 mW, expressed in dB
dBp	power relative to the average power transmitted during an item in deciBel
Eb	Energy per bit
No	Noise per Hz

3.3 Abbreviations

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

4FSK	Four-level Frequency Shift Keying
ACK	ACKnowledgment
AI	Air Interface
ARQ	Automatic Retransmission reQuest
CC	Channel Code
CCH	Control CHannel
CCITT	Comité Consultatif International Téléphonique et Télégraphique
CCL	Call Control Layer
CI	Call Information
CM	Communications Mode
Cont	Continuation flag
C-plane	Control-plane
CRC	Cyclic Redundancy Checksum for data error detection
CRC-D	Cyclic Redundancy Check - Data field
CSF	Configured Services and Facilities
CTCSS	Continuous Tone Carrier Squelch System
Di-bit	2 bits grouped together to represent a 4-level symbol
DLL	Data Link Layer

DP	Data Position
dPMR™	digital Private Mobile Radio
e.r.p.	effective radiated power
ESN	Electronic Serial Number
ET	End Type
FDMA	Frequency Division Multiple Access
FEC	Forward Error Correction
FN	Frame Numbering
FS	Frame Sync
FSK	Frequency Shift Keying
HI	Header Information
HS	Handportable Station
HSs	Handheld Station
HT	Header Type
ID	IDentifier
IP	Internet Protocol
ISF	Initial Services and Facilities
LBT	Listen Before Transmit
LEN	data byte Length
MFID	Manufacturer's FID
MMI	Man Machine Interface
MS	Mobile Station
MSB	Most Significant Bit
NACK	Negative ACKnowledgment
OACSU	Off Air Call Set Up
OSI	Open System Interconnection
PAR	Parameter data
PDF	Packet Data Format
pdM	Number of packet data frames
PDU	Protocol Data Unit
PL	Physical Layer
PMR	Private Mobile Radio
PTT	Push-To-Talk
RES	Radio Equipment and Systems
RF	Radio Frequency
RSSI	Received Signal Strength Indication
SF	SuperFrame
SLD	SLow Data
SYNC	SYNChronization
TBD	To Be Done
TCH	Traffic CHannel
U-plane	User-plane

4 Overview

The present document describes a narrow band Digital Private Mobile Radio system which employs a Frequency Division Multiple Access (FDMA) technology with an RF carrier bandwidth of 6,25 kHz.

The present document describes the Physical Layer (PL) and the Data Link Layer (DLL) of the Air Interface (AI) as well as the standardized services and facilities of the radio. Radio equipments which conform to the present document shall be interoperable at the PL and DLL with equipment from other manufacturers.

The present document describes 2 levels of functionality (services and facilities) that can be offered by the equipment. For the purposes of interoperability, a basic level of services and facilities (ISF) is defined along with a simplified mode of addressing such that all radios shall be capable of interoperating without the need for any set-up or programming at the point of sale. An advanced level of services and facilities (CSF) is also defined for those equipments that can be re-programmed to offer a higher level of functionality.

Where manufacturers have declared compliance to the "Standard User Interface" for CSF radios, the MMI shall also comply with the relevant requirements of annex A.

The present document does not provide the specification or operational detail for system implementations which include but are not limited to, vocoder, security, data, and other interfaces.

4.1 Protocol architecture

The purpose of this clause is to provide a model where the different functions and processes are identified and allocated to different layers in the protocol stack.

The protocol stack in this clause and all other related clauses describe and specify the interfaces, but this stack does not imply or restrict any implementation.

The protocol architecture which is defined herein follows the generic layered structure, which is accepted for reference description and specification of layered communication architectures.

The present document defines the protocols for the following 3 layered model as shown in figure 1.

The base of the protocol stack is the Physical Layer (PL) which is the layer 1.

The Data Link Layer (DLL), which is the layer 2, shall handle sharing of the medium by a number of users. At the DLL, the protocol stack shall be divided vertically into two parts, the User plane (U-plane), for transporting information without addressing capability (e.g. voice or data stream), and the Control plane (C-plane) for signalling with addressing capability, as illustrated by figure 1.

The Call Control Layer (CCL), which is layer 3, lies in the C-plane and is responsible for control of the call (addressing, facilities, etc.), provides the services supported by the radio, and supports the Data Service. U-plane access at layer 2 (DLL) supports voice service.

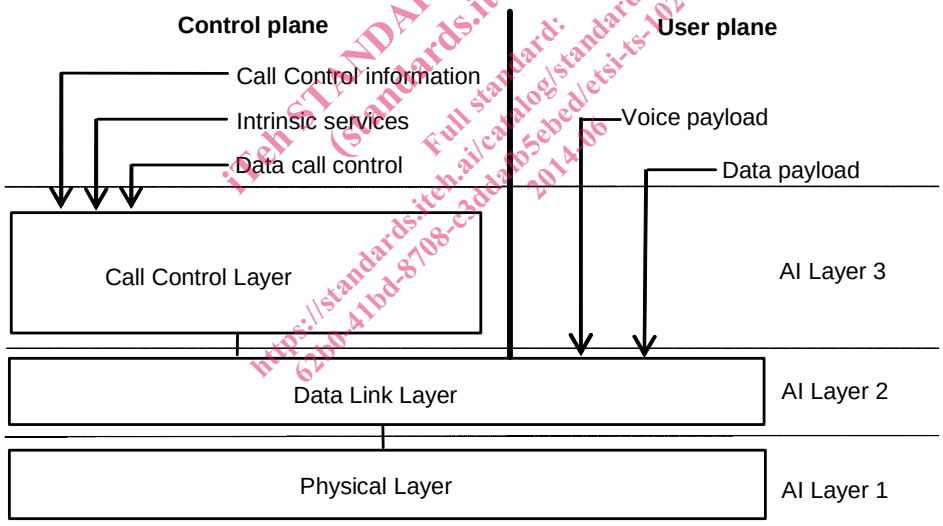

Figure 1: Protocol stack

4.1.1 Air Interface Physical Layer (layer 1)

The Air Interface layer 1 shall be the physical interface. It shall deal with the physical transmission, composed of bits, which is to be sent and/or received. The Physical Layer is described in clause 12. The Air Interface layer 1 shall contain the following functions:

- modulation and demodulation;
- transmitter and receiver switching;
- RF characteristics;
- bits and symbol definition;
- frequency and symbol synchronization;

- transmission item building.

4.1.2 Air Interface Data Link Layer (layer 2)

The Air Interface layer 2 shall handle logical connections and shall hide the physical medium from the upper layers. The Data Link Layer is described in clauses 7 to 10.

The main functions are as follows:

- channel coding (FEC, CRC);
- interleaving, de-interleaving and bit ordering;
- acknowledgement and retry mechanism;
- media access control and channel management;
- framing, superframe building and synchronization;
- transmission and parameter definition;
- link addressing (source and/or destination);
- interfacing of voice applications (vocoder data) with the PL;
- data bearer services;
- exchanging signalling and/or user data with the CCL.

4.1.3 Air Interface Call Control Layer (layer 3)

Air Interface layer 3 (CCL) is applicable only to the C-plane, and shall be an entity for the services and facilities supported by the radio on top of the layer 2 functionality.

The CCL provides the following functions:

- establishing, maintaining and terminating of calls;
- individual or group call transmission and reception;
- destination addressing;
- support of intrinsic services (late entry, call divert, etc.);
- data call control.

4.2 FDMA Structure

4.2.1 Overview of the transmission structure

The described solution is based on a FDMA structure.

All transmissions are asynchronous, since there is no entity to provide frame or slot timing.

The physical resource available to the radio system is an allocation of the radio spectrum.

A transmission item is a period of RF carrier that is modulated by a data stream. The physical channel of an FDMA transmission is required to support the logical channels.

A logical channel is defined as a logical communication pathway between two or more parties. The logical channels represent the interface between the protocol and the radio subsystem. The logical channels may be separated into two categories:

- the traffic channels carrying speech or data information; and
- control channels carrying signalling.

4.2.2 Transmission format

The FDMA transmission is made up of 80 ms payload frames, each comprising 384 bits.

Payload frame:

a	b	c	d	e	f

a: 24 bits FrameSync2 (FS2) or ChannelCode (CC) bits
b: 72 bits Control Channel (CCH) data
c: 72 bits Traffic channel (TCH)
d: 72 bits TCH
e: 72 bits TCH
f: 72 bits TCH

Four 80 ms payload frames are concatenated to form a superframe of 320 ms.

Superframe:

FS2	CCH	Payload	CC	CCH	Payload	FS2	CCH	Payload	CC	CCH	Payload

The Header frame is of 80 ms (384 bits) in length.

Header:

P	FS1	HI0	CC	HI1

P: Preamble, minimum of 72 bits
FS1: 48 bit Frame Sync 1 sequence
HI0: Header Information 0, 120 bits
CC: Channel Code, 24 bits
HI1: Header Information 1, 120 bits

The End message is a shortened 96 bit frame.

End:

FS3	END

FS3: Frame sync, 24 bits
END: End data, 72 bits

NOTE: Type 3 data transmissions (packet data) use a different framing structure.

4.2.3 Transmission sequences

Voice or data payload continuous transmission:

These transmissions are always started with a Header frame containing a preamble (for bit synchronization) and a frame synch (for frame synchronization). The Header is followed by a series of Superframes that contain both the payload (voice or data) and the information about the call such that receiving stations can implement late entry. A call always consists of an integral number of superframes and is terminated by an End frame.