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Technical Report

Broadband Radio Access Networks (BRAN);
Consideration of requirements for Mobile Terminal Station (TS)
in Broadband Wireless Access Systems (BWA)
in the 3 400 MHz to 3 800 MHz Frequency Band

Reference
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Keywords
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Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Broadband Radio Access Networks (BRAN).

Introduction

The present report deals with the consideration of requirements for mobile terminal stations in broadband wireless systems in the frequency band 3 400 MHz to 3 800 MHz. The detailed scope of the present document can be found in clause 1.

In November 2006 CEPT SE19 finalized its studies on the co-existence between mobile and fixed/nomadic broadband wireless systems in the 3 400 MHz to 3 800 MHz band. The outcome of SE19 [6] lead to the decision to open this band also for mobile use, which is reflected in ECC/DEC/(07)02 [1].

For fixed broadband wireless systems in this band it has to be noted that there exists already a harmonized European standard EN 302 326-2 [3] developed within ETSI.

1 Scope

The present document is a technical report of the "Broadband Radio Access Network (BRAN); Consideration of requirements for Mobile Terminal Station (TS) in Broadband Wireless Access Systems (BWA) in the 3 400 MHz to 3 800 MHz Frequency Band" work item. This work item was adopted at ETSI BRAN#50.

The purpose of this work item is to detail the technical and operational conditions with Terminal Stations operating in the 3 400 MHz to 3 800 MHz frequency range implemented under the flexible usage mode conditions identified in ECC Decision(07)02 [1]. It particularly focuses on the developments required within the standards framework to support the MWA aspects identified in the Decision.

2 References

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2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

Not Applicable.

2.2 Informative references

[1] ECC/DEC/(07)02: Electronic Communications Committee, "ECC Decision of 30 March 2007 on availability of frequency bands between 3400-3800 MHz for the harmonized implementation of Broadband Wireless Access systems(BWA)".

[2] CEPT/ERC/REC 74-01E: "Unwanted Emissions in the Spurious Domain", October 2005.

[3] ETSI EN 302 326-2: "Fixed Radio Systems; Multipoint Equipment and Antennas; Part 2: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive for Digital Multipoint Radio Equipment".

[4] ETSI EN 301 908-6 (V3.2.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Base Stations (BS), Repeaters and User Equipment (UE) for IMT-2000 Third-Generation cellular networks; Part 6: Harmonized EN for IMT-2000, CDMA TDD (UTRA TDD) (UE) covering essential requirements of article 3.2 of the R&TTE Directive".

[5] BRAN50d035r1: "Broadband Radio Access Networks (BRAN); Broadband Data Transmission Systems in 2500-2690 MHz, Harmonized EN covering essential requirements of article 3.2 of the R&TTE 1999/5/EC", April 2007.

[6] SE19(06)74: "Final Summary of the 37th SE19 meeting", 21-22 Nov. 2006.

[7] SE19(06)70: "Inter-System MWA MS to MWA MS Coexistence Analysis in 3.5 GHz Band for Unsynchronized TDD Systems or TDD Adjacent to FDD Systems", Motorola, UK Broadband, Clearwire Denmark, WiMax Telecom Europe 22-22 November 2006.

[8] ETSI TS 125 102 (V7.2.0): "Universal Mobile Telecommunications System (UMTS); User Equipment (UE) radio transmission and reception (TDD) (3GPP TS 25.102 version 7.2.0 Release 7)".

[9] 3GPP TR 25.889 (V6.0.0): "Feasibility study considering the viable deployment of UTRA in additional and diverse spectrum arrangements".

[10] ECC/REC/(04)05: "ECC Recommendation (04)05 Guidelines for Accommodation and Assignment of Multipoint Fixed Wireless Systems in Frequency Bands 3.4-3.6 GHz and 3.6-3.8 GHz".

[11] IEEE 802.16.3c-01: "Channel Models for Fixed Wireless Applications".

[12] SE19(06)54, Motorola: "MWA Systems for FWA/NWA Systems Coexistence Analysis in 3.5 GHz Band", 6-8 September 2006.

[13] R4-061076(V0.4.0): "E-UTRA Radio Frequency (RF) system scenarios," 3GPP TSG RAN WG4#40, Tallinn, Estonia, August 28 - September 1, 2006.

[14] WiMAX Forum: "Sharing studies in the 2 500-2 690 MHz band between IMT-2000 and broadband wireless access (BWA) systems," ITU-R WP8F/597, October 2005.

[15] ITU-T Report M.2030: "Coexistence between IMT-2000 time division duplex and frequency division duplex terrestrial radio interface technologies around 2 600 MHz operating in adjacent bands and in the same geographical area".

NOTE: Available at http://www.itu.int/publ/R-REP-M.2030/en.

[16] IEEE 802.16e: "IEEE Standard for Local and Metropolitan Area Networks - Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems - Amendment for Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands".

[17] ETSI TS 125 101: "Universal Mobile Telecommunications System (UMTS); User Equipment (UE) radio transmission and reception (FDD) (3GPP TS 25.101 version 8.1.0 Release 8)".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

Automatic Transmit Power Control (ATPC): function implemented to offer a dynamic power control

maximum radiated output power: maximum mean radiated output power (EIRP) declared by the manufacturer

maximum radiated power density: maximum mean radiated output power (EIRP) density, defined as dBm/MHz

3.2 Symbols

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

dB	deciBel
dBc	deciBel relative to carrier
dBm	deciBel relative to 1 mW
f_c	center frequency
GHz	GigaHertz
kHz	kiloHertz
MHz	MegaHertz

3.3 Abbreviations

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

ACIR	Adjacent Channel Interference Ratio
ACLR	Adjacent Channel Leakage power Ratio
ACS	Adjacent Channel Selectivity
AMC	Adaptative Modulation and Coding
ATPC	Automatic Transmit Power Control
BER	Bit Error Rate
BW	BandWidth
BWA	Broadband Wireless Access
CDF	Cumulative Distribution Function
EIRP	Equivalent Isotropically Radiated Power
FDD	Frequency Division Duplex
FER	Frame Error Rate
LOS	Line Of Sight
MWA	Mobile Wireless Access
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiplexing Access
PA	Power Amplifier
PER	Packet Error Rate
PL	PathLoss
PSD	Power Spectrum Density
PUSC	Partial Usage of SubCarriers
SINR	Signal to Interference and Noise Ratio
TDD	Time Division Duplex
TPC	Transmit Power Control
TS	Terminal Station
UE	User Equipment
WCDMA	Wideband Code Division Multiple Access

4 Study of Tx and Rx requirements

4.1 Transmitter maximum radiated output power

4.1.1 Definition

The maximum power of the transmitter has to be defined in terms of maximum radiated power. The term maximum radiated power density and maximum radiated output power are defined in clause 3.1.

4.1.2 Limits

The limit of the maximum radiated power density is 25 dBm/MHz according to ECC/DEC/(07)02 [1].

This leads to different maximum radiated output power figures for the different channel bandwidth. Table 4.1 shows as example these different figures for a number of channel bandwidths.

Table 4.1: Maximum radiated output power for different channel bandwidth

Channel bandwidth	Maximum radiated output power
5 MHz	32 dBm
7 MHz	33,5 dBm
10 MHz	35 dBm

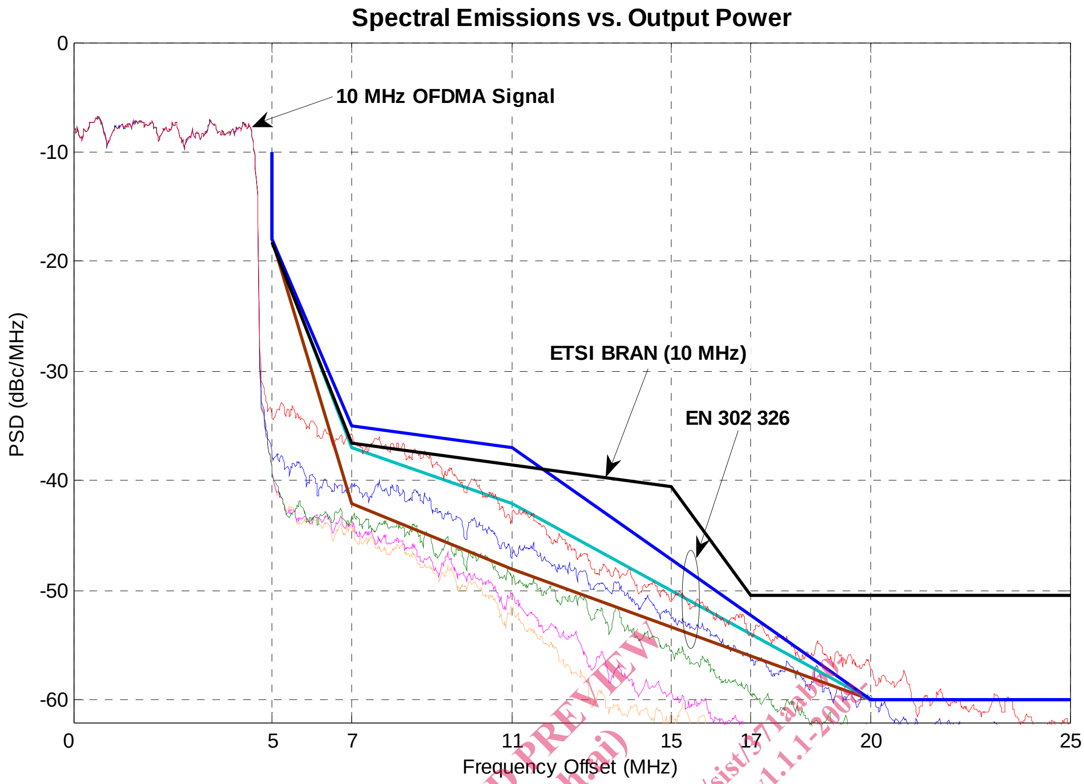
4.1.3 Output Power tolerance

The maximum radiated output power should be declared by the supplier. The error of the maximum radiated output power should be within a tolerance of ±2 dB under normal conditions.

4.2 Emission discussion

The question of feasible emission limits for OFDMA systems has been raised in many forums. The final establishment of one or more mask limits will have important impact to handset performance. This clause addresses some measured data on an OFDM transmitter and describes the impact to the handset due to emission masks.

The limiting element for close-in emissions of a typical transmitter system at high power is the power amplifier. Figure 4.1 shows spectrum data captured from a 3G WCDMA PA, using a 10 MHz OFDMA modulated signal, at different levels of output power (5 MHz and 7 MHz OFDMA results would be similar). It also compares the spectrum data with the emission limits of several proposals. The output powers at which the different masks are satisfied are determined by visual inspection and do not represent any final determination of compliance but can be used for first order comparison reasons.



NOTE: The units of this plot are in dBc/MHz; the output power is normalized to 0 dB such that the attenuation of out-of-band emissions relative to the output power is shown.

Figure 4.1: Transmitter Emissions vs Output Power

Table 4.2 summarizes the difference in output power at which the PA meets each mask relative to the TFES emission mask [4] (10 MHz spectrum emission mask scaled version of 5 MHz option, which is also proposed in [5]). The proposed TFES mask is very similar to the 3GPP WCDMA mask (from TS 125 101 [17]), the main difference being scaling offsets to accommodate a 10 MHz channel bandwidth. The power amplifier used to collect this data of course can be redesigned such that each mask is met at the desired output power however the resized device will consume additional power as the mask gets more restrictive (shown in tables 4.2 and 4.3, column 3).

NOTE: Task Force for ERM and MSG for Harmonized Standards for IMT2000 (ERM: Electromagnetic Compatibility and Radio Spectrum Matters; MSG: ETSI Mobile Standards Group).

Table 4.2: Emissions Mask Impact on TDD Transmitter

TDD (Duty Cycle = 45 %; Post PA Loss = 2,5 dB)		
Emission Mask	**Power Backoff (dB)**	**Increase in Current (to reach 24 dBm)**
ETSI BRAN (10 MHz)	0,0 (24,0 dBm)	1,00 x
EN 302 326-2 [3] (EMO = 2)	0,5 (23,5 dBm)	1,10 x
EN 302 326-2 [3] (EMO = 4)	1,2 (22,8 dBm)	1,18 x
FCC (Part 27)	2,3 (21,7 dBm)	1,37 x
EN 302 326-2 [3] (EMO = 6)	2,9 (21,1 dBm)	1,49 x
802.16 (WirelessHUMAN)	5,0 (19,0 dBm)	2,13 x

Table 4.3: Emissions Mask Impact on FDD Transmitter

FDD (Duty Cycle = 100 %; Post PA Loss = 4,5 dB)		
Emission Mask	**Power Backoff (dB)**	**Increase in Current (to reach 24 dBm)**
BRAN (10 MHz Option)	0,0 (24,0 dBm)	1,00 x
EN 302 326-2 [3] (EMO = 2)	0,5 (23,5 dBm)	1,10 x
EN 302 326-2 [3] (EMO = 4)	1,2 (22,8 dBm)	1,18 x
FCC (Part 27)	2,3 (21,7 dBm)	1,37 x
EN 302 326-2 [3] (EMO = 6)	2,9 (21,1 dBm)	1,49 x
802.16 (WirelessHUMAN)	5,0 (19,0 dBm)	2,13 x

NOTE: Absolute PA power is shown in parenthesis next to the amount of power reduction.

For a TDD transmitter to achieve 24 dBm of power at the antenna and using an assumption of 2,5 dB loss between the PA and antenna, the PA power is 26,5 dBm. To comply with the more restrictive masks at 24 dBm antenna power the power amplifier has to be modified. Table 4.2 reports the average amount of current required by the modified PA, and the increase in current drain over the reference case, to meet the required antenna power.

An FDD transmitter has an estimated 2 dB of extra post PA loss because of the duplex filter; the PA power is 28,5 dBm. The increase in PA power and the increase in duty cycle result in higher current drain and higher power dissipation in the FDD transmitter compared to TDD. Again, to comply with the more restrictive masks at 24 dBm antenna power, the power amplifier has to be modified. At a certain point, highlighted in yellow in table 4.3, the high PA current creates more heat than a handset can safely handle.

The tradeoff between emissions and PA power consumption is clear: compliance with the 802.16 mask will cost more than twice as much current as compliance with the TFES mask. For the 3,5 GHz band the TFES mask is presently the only mask that may allow for power consumption (and corresponding battery life) of TDD and especially FDD mobile terminal stations to be competitive with mobile handsets deployed in the 2,5 GHz band.

Figure 4.2 shows the TFES mask for the three channel bandwidth options 5 MHz, 7 MHz and 10 MHz in the 3,5 GHz band. The 5 MHz option is exactly the same like TFES [4]. For the 7 MHz and 10 MHz option the mask is slightly adapted to facilitate the shape of the OFDMA signal and to achieve the same ACLR figure as for the 5 MHz case. The actual limits for all 3 channel bandwidth options are shown in annex A.

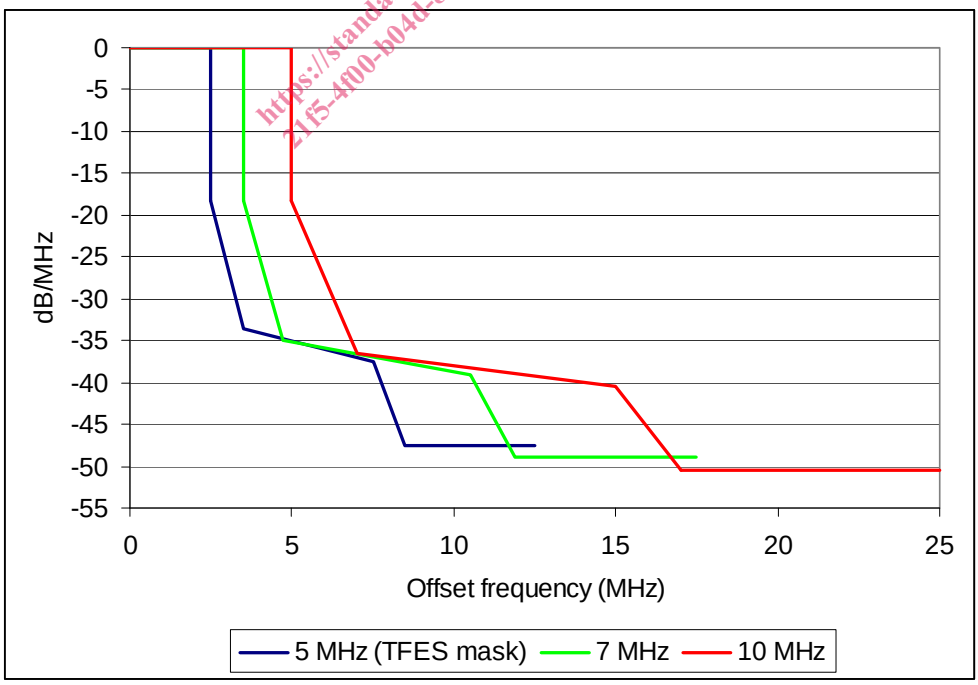


Figure 4.2: Mask for 5 MHz, 7 MHz and 10 MHz option