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Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Special Mobile Group (SMG).

The present document has been elaborated by the Layer 1 expert group of SMG2 "Radio aspects", as a part of the work in defining and describing Layer 1 of the Universal Mobile Telecommunications System (UMTS) Terrestrial Radio Access (UTRA).

The present document describes the radio transmission and reception parameters in UTRA/TDD.

1 Scope

This Technical Report specifies the minimum RF characteristics of the TDD mode of UTRA. The main objectives of the document are to be a part of the full description of the UTRA Layer 1, and to serve as a basis for the drafting of the technical specification (TS).

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] Reference 1.

3 Definitions, symbols and abbreviations

3.1 Definitions

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

Power Setting: The value of the control signal, which determines the desired transmitter, output Power. Typically, the power setting would be altered in response to power control commands.

Maximum Power Setting: The highest value of the Power control setting which can be used.

Maximum output Power: This refers to the measure of power when averaged over the transmit timeslot at the maximum power setting.

Peak Power: The instantaneous power of the RF envelope which is not expected to be exceeded for [99.9%] of the time.

Maximum peak power: The peak power observed when operating at a given maximum output power.

Average Power: The average transmitter output power obtained over any specified time interval, including periods with no transmission. *<Editor: This definition would be relevant when considering realistic deployment scenarios where the power control setting may vary. >*

Maximum average Power: The average transmitter output power obtained over any specified time interval, including periods with no transmission, when the transmit timeslots are at the maximum power setting. *<Editor The average power at the maximum power setting would also be consistent with defining a long term average power>*

3.2 Symbols

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

<symbol> <Explanation>

3.3 Abbreviations

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

ACPR	Adjacent Channel Power Ratio
ACS	Adjacent Channel Selectivity
BER	Bit Error Rate
BS	Base Station
CW	Continuous wave (unmodulated signal)
DL	Down link (forward link)
EIRP	Equivalent Isotropic Radiated Power
FDD	Frequency Division Duplexing
FER	Frame Error Rate
PPM	Parts Per Million
RSSI	Received Signal Strength Indicator
SIR	Signal to Interference ratio
TDD	Time Division Duplexing
TPC	Transmit Power Control
UE	User Equipment
UL	Up link (reverse link)
UTRA	UMTS Terrestrial Radio Access

4 Status

The main objective of this clause is to provide a summary of the approval status of the various clauses of the present document. The level of progress is defined as follows:

- No proposal exists.
- A proposal(s) exists but no working assumption has been made.
- A working assumption has been taken and the text contained in that clause may have been update in line with that assumption.

This clause is assumed to be finalised.

Reference should be made to the current XX18 (status and study document) for other open issues. Unless stated otherwise only the agreed working assumptions are indicated below.

Table 1

Clause/ subclause number	Section description	Status
6, 7	Transmitter characteristics Receiver characteristics	Some of the physical layer parameters proposed in these clausess will need to be re-considered in order to reflect the final version of the system scenario document in XX17 (Radio Frequency System Scenarios)
8	Performance requirements	Some of the physical layer parameters proposed in these clausess will need to be re-considered in order to reflect the final version of the link level simulation results in document XX20 (UTRA Link level simulation results)
5.2	Frequency bands	The deployment of TDD in the 1 920 MHz to 1 980 MHz band is an open item.

5 Frequency bands and channel arrangement

5.1 General

The information presented in this clause is based on a chip rate of [4.096] Mcps. Appropriate adjustments should be made for other chip rate options.

5.2 Frequency bands

UTRA/TDD is designed to operate in the following bands:

- 1 900 MHz to 1 920 MHz: UL and DL transmission;
- 2 010 MHz to 2 025 MHz: UL and DL transmission.

NOTE: Deployment in other frequency bands is not precluded.

5.3 TX–RX separation

No TX-RX frequency separation is required as Time Division Duplexing (TDD) is employed. Each TDMA frame consists of 16 timeslots where each timeslot can be allocated to either transmit or receive.

5.4 Channel arrangement

5.4.1 Channel spacing

The nominal channel spacing is [5] MHz, but this can be adjusted to optimise performance in a particular deployment scenario.

5.4.2 Channel raster

The channel raster is 200 kHz, which means that the carrier frequency must be a multiple of 200 kHz.

5.4.3 Channel number

The carrier frequency is designated by the UTRA absolute radio frequency channel number (UARFCN).

6 Transmitter characteristics

6.1 General

Unless detailed the transmitter characteristic are specified at the antenna connector of the UE. For UE with integral antenna only, a reference antenna with a gain of 0 dBi is assumed.

6.2 Transmit power

6.2.1 User Equipment output power

The User Equipment output power profile can be used to define a range of output powers for use in different system scenarios. For User Equipment using directive antennas for transmission, a class dependent limit will be placed on the maximum EIRP (Equivalent Isotropic Radiated Power).

The following examples of Power Classes define the capability of the User Equipment in terms of the maximum output power:

Table 2: UE power classes

UE Power Class	Maximum output power
1	[+33] dBm
2	[+27] dBm
3	[+24] dBm
4	[+21] dBm
5	[+10] dBm
6	[0] dBm

NOTE 1: The maximum output power refers to the measure of power when averaged over the transmit timeslot at the maximum power control setting.

NOTE 2: The mask for transmit power level versus time is an item for further study. *<Editor the values proposed are the same as the examples proposed for the FDD mode, however a delta may be applicable for TDD terminals based on a realizable transceiver architectures>*

NOTE 3: The maximum output power shall be specified with respect to a defined reference condition (power control status, type of timeslot {physical channel} and averaging method). The reference conditions are for further study.

NOTE 4: For multi-code operation the maximum output power will be reduced by the difference of peak to average ratio between single and multi-code transmission.

NOTE 5: Power classes 5 and 6 are envisaged for unlicensed operation.

NOTE 6: User Equipment(s) employing the above power classes shall meet the applicable RF emission specification(s). The means for meeting such specification such as limiting the long-term average power and associated control mechanism are items for further study.

6.2.2 Base station output power

The base station output power profile can be used to cater for different system scenarios. The following examples of base station classes can be considered for the various system scenarios.

Table 3: BS power classes

Base station class	System scenarios
1	Macro
2	Micro
3	Pico
4	Residential (unlicensed operation)

6.3 Frequency stability

Frequency stability is ability of the UE and BS to transmit and maintain the assigned carrier frequency.

6.3.1 UE frequency stability

The UE carrier frequency shall be accurate to within ±[0.1] PPM compared to signal received from the BS (these signals will have an apparent error due to BS frequency error and Doppler shift). In the later case, signals from the BS must be averaged over sufficient time that errors due to noise or interference are allowed for within the above ±[0.1] PPM figure.

6.3.2 BS frequency stability

1) The frequency stability of the BS shall be accurate to within ± [0.05] PPM for RF frequency generation.

2) For some BS classes the frequency stability of the BS(s) shall be accurate to within ± [ ] PPM for the RF frequency generation.

6.4 BS synchronisation

Dependent on the different system scenarios, it may be necessary for some of the BS classes to operate in a synchronised mode in order to decrease the inter-system interference, improve inter-system handover and optimise the system capacity. *<Editor this item is for further study>*

6.5 Output power dynamics

Power control is used to limit the interference level. The transmitter uses a quality based power control on both the uplink and downlink.

6.5.1 Open loop power control

Open loop power control is the ability of the UE transmitter to sets it's output power to a specified value. An example of open loop power control is when the received signal at the UE is used as an initial reference. If it's too low the UE is assumed to be far from the base station and transmits with a high power. If it's too high the UE it is assumed to be close in and transmits at low power. For TDD mode the reciprocity of the channel allows accurate estimation of the required open loop transmit power. This procedure can be used during normal operation as well as for sending access requests.

6.5.2 Closed loop power control

Closed loop power control is the ability of the UE / BS transmitter to adjust its output power in response to the UL/DL received signal. Both the UL and DL closed loop power control is based on a minimum update rate equal to the frame rate.

6.5.3 Power control setting step size

The power control step is the minimum step change in the UL/DL transmitter output power in response to an associated DL/UL received signal.

a) Up link (UL) [1.5 - 3] dB.

b) Down link (DL) [1.5 - 3] dB.

6.5.4 Minimum transmit power

The minimum controlled output power of the UE/BS is when the power control setting is set to a minimum value. This is when both the closed loop and open loop power control indicates a minimum transmit output power is required.

a) Up link (UL) [-50] dBm.

b) Down link (DL) [-] dBm.

6.5.5 Dynamic range

The power control dynamic range is the difference between the maximum transmits output power and the minimum transmits output power.

a) UE: Up link (UL) [80] dB.

b) BS: Down link (DL) [30] dB.

6.5.6 Power control cycles per second

The rate of change for the UL/DL transmitter power control step is as follows:

UE Up link (UL) [100 – 800] Hz.

The maximum rate may differ for open and closed loop power control.

BS Down link (DL) [100 – 800] Hz.

The maximum rate may differ for open and closed loop power control. In addition within one timeslot the power of all active codes are to be balanced within a range of 20 dB.

6.6 Output RF spectrum emissions

6.6.1 Occupied bandwidth

Occupied bandwidth is a measure of the bandwidth containing 99% of the total integrated power for the transmitted spectrum and is centred on the assigned frequency. The occupied channel bandwidth is less than 5 MHz based on a chip rate of 4.096 Mcps.

6.6.2 Out of band emissions

Out of band emissions are unwanted emissions immediately outside the [channel] bandwidth resulting from the modulation process and non-linearity in the transmitter but excluding spurious emissions. This out of band emission limit can be specified in terms of a spectrum emission mask or adjacent channel power ratio for the transmitter.

6.6.2.1 Spectrum emission mask

The emission mask will be different for the type of UE(s) and BS(s) and may depend on the power class, single / multi-code allocation, UL/DL switching point, etc and is an item for further study.

6.6.2.2 Adjacent channel power ratio (ACPR)

Adjacent channel power ratio (ACPR) is the ratio of the transmitted power within a reference bandwidth of [4.096 MHz) to the power measured within a reference bandwidth of [4.096 MHz] centred on the adjacent(s) channel(s).

6.6.2.2.1 UE ACPR

Table 4: UE ACPR

UE channel	ACPR limit
± First adjacent channel	[ ] dB
± Second adjacent channel	[ ] dB

NOTE: In order to ensure that switching transients due to the variable UL/DL switching points do not degrade the ACPR value the reference measurement conditions are a item for further study.

The possibility is being considered of dynamically relaxing the ACP requirements for User Equipment(s) under conditions when this would not lead to significant interference (with respect to other system scenario or UMTS operators). This would be carried out under network control, primarily to facilitate reduction in UE power consumption.

6.6.2.2.2 BS ACPR

Table 5: BS ACPR

BS channel	ACPR limit
± First adjacent channel	[ ] dB
± Second adjacent channel	[ ] dB

NOTE: In order to ensure that switching transients due to the variable UL/DL switching points do not degrade the ACPR value the reference measurements conditions are an item for further study.

6.6.3 Spurious emissions

Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emission, intermodulation products and frequency conversion products, but exclude out of band emissions.

The frequency boundary and the detailed transitions of the limits between the requirement for out band emissions and spectrum emissions is an item for further study. Guidance can be taken from the applicable tables from ITU-R Recommendations SM.329 and from the ERC Recommendations that are currently under progress.

6.7 Transmit intermodulation

The transmit intermodulation performance is a measure of the capability of the transmitter to inhibit the generation of signals in its non linear elements caused by presence of the wanted signal and an interfering signal reaching the transmitter via the antenna.

6.7.1 UE intermodulation attenuation

User Equipment(s) transmitting in close vicinity of each other can produce intermodulation products, which can fall into the UE, or BS receive band as an unwanted interfering signal. The UE intermodulation attenuation is defined by the ratio of the output power of the wanted signal to the output power of the intermodulation product when an interfering signal is added at a level below the wanted signal.

For a UE transmitter operating at the nominal power defined by its class, the intermodulation attenuation shall be at least [ ] dB for an intermodulation component when an interfering CW signal shall be applied at a frequency offset of [ ] MHz and with a power level of [ ]dB below the power level of the wanted signal.

6.7.2 BS intermodulation attenuation

In a BS intermodulation may be caused by combining several RF channels to feed a single antenna, or when BS(s) are operated in close vicinity of each other. In this case the BS(s) can produce intermodulation products, which can fall into the UE/BS receiver band.

The BS intermodulation attenuation is defined by the ratio of the output power of the wanted signal to the output power of the intermodulation product when an interfering signal is added at a level below the wanted signal.

6.8 Modulation Accuracy

Modulation accuracy is the ability of the transmitter to generate the ideal signal. The difference between the measured and the theoretical modulated waveform is the modulation accuracy.

7 Receiver characteristics

7.1 General

Unless detailed the receiver characteristic are specified at the antenna connector of the UE . For UE with an integral antenna only, a reference antenna with a gain of 0 dBi is assumed. UE with an integral antenna may be taken into account by converting these power levels into field strength requirements, assuming a 0-dBi gain antenna.

7.2 Diversity characteristics

A suitable receiver structure using coherent reception in both channel impulse response estimation, and code tracking procedures is assumed. Three forms of diversity are considered to be available in UTRA/TDD.

Table 6: Diversity characteristics for UTRA/TDD

Time diversity	Channel coding and interleaving in both up link and down link
Multi-path diversity	Joint Detection, rake receiver or other suitable receiver structure
Space diversity	Antenna diversity with maximum ratio combing in the base station and optionally in the User Equipment(s). Possibility for downlink transmit diversity in the base station.

<Editor based on current discussions on diversity this clause will need to be reviewed to reflect any changes>

7.3 Reference sensitivity level

The reference sensitivity is the minimum receiver input power measured at the antenna port at which the [FER/BER] does not exceed the specific value indicated in subclauses 7.3.1 and 7.3.2.

7.3.1 UE reference sensitivity level

For the different services with corresponding data rates, the reference sensitivity level of the UE shall be specified in table 7 below.

Table 7: UE reference sensitivity levels

Data rate	UE reference sensitivity level (dBm)	[FER/BER]

NOTE: The performance will need to be specified for the different classes of User Equipment(s) identified in subclause 6.2.1 and is an item for further study.

7.3.2 BS reference sensitivity level

For the different services with corresponding data rates, the reference sensitivity level of the BS shall be specified in table 8 below.

Table 8: BS reference sensitivity levels

Data rate	BS reference sensitivity level (dBm)	[FER/BER]

NOTE: The performance will need to be specified for the different classes of base station(s) identified in subclause 6.2.2 and is an item for further study.

7.4 Dynamic range

The receiver dynamic range is the input power range at the [UE/BS] antenna port over which the [FER/BER} does not exceed a specific rate.

The static [BER/FER] reference performance as specified in subclauses 7.3.1 and 7.3.2 should be met over a receiver input range of [ ] dB above the specified reference sensitivity level.

7.5 Adjacent channel selectivity

Adjacent channel selectivity (ACS) is a measure of the receiver ability to receive a wanted signal at is assigned channel frequency in the presence of a modulated signal in the adjacent channel.

The static reference performance as specified in subclauses 7.3.1 and 7.3.2 should be met when the following signals are applied to the receiver.

A wanted signal at the assigned channel frequency, 3 dB above the static reference level.

A modulated interfering adjacent channel signal with a level of [ ] dBm.

7.6 Blocking characteristics

The blocking characteristics is a measure of the receiver ability to receive a wanted signal at is assigned channel frequency in the presence of an unwanted interferer on frequencies other than those of the spurious response or the adjacent channels; without this unwanted input signal causing a degradation of the performance of the receiver beyond a specified limit. The blocking performance shall apply at all frequencies except those at which a spurious response occur.

The static reference performance as specified in subclauses 7.3.1 and 7.3.2 should be met when the following signals are applied to the receiver.

A wanted signal at the assigned channel frequency, 3 dB above the static reference level.

A interfering signal at [frequency(s)] offset from the nominal assigned channel below a level of [ ] dBm.

< Editor The frequency range (in band/out of band) and level of the interfering signal is an item for further study>

7.7 Spurious response

Spurious response is a measure of the receiver's ability to receive a wanted signal on its assigned channel frequency without exceeding a given degradation due to the presence of an unwanted CW interfering signal at any other frequency at which a response is obtained i.e. for which the blocking limit is not met.

The static reference performance as specified in subclauses 7.3.1 and 7.3.2 should be met when the following signals are applied to the receiver.

A wanted signal at the assigned channel frequency, 3 dB above the static reference level.

A CW interfering signal below a level of [ ] dBm.

The number of allowed spurious responses would be an item for further study.

7.8 Intermodulation characteristics

Third and higher order mixing of the two interfering RF signals can produce an interfering signal in the band of the desired channel. Intermodulation response rejection is a measure of the capability of the receiver to receiver a wanted signal on its assigned channel frequency in the presence of two or more interfering signals which have a specific frequency relationship to the wanted signal.

The static reference performance as specified in subclauses 7.3.1 and 7.3.2 should be met when the following signals are applied to the receiver.

A wanted signal at the assigned channel frequency, 3 dB above the static reference level.

A interfering signal at frequency [f_1] and frequency [f_2] with a level of [   ] dBm.

7.9 Spurious emissions

8 Performance requirement

8.1 General

Performance requirements are specified for a number of test environments and multi-path channel classes.

8.2 Dynamic reference sensitivity performance

The minimum required dynamic reference sensitivity performance is specified according to the traffic rate and the propagation conditions.

8.2.1 UE sensitivity performance

8.2.2 BS sensitivity performance

8.3 Rx synchronisation characterisitics

Annex A (informative): Transmit power levels versus time

Annex B (informative): Propagation conditions

Annex C (informative): Environmental conditions History

History

Document history		
Date	Version	Comment
12/12/98	0.0.2	Proposed first draft for submission to the UMTS LI meeting in Espoo, Helsinki 14-18th Dec 1998
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