ETSI TS 136 213 V8.6.0 (2009-04)

Technical Specification

LTE;
Evolved Universal Terrestrial Radio Access (E-UTRA);
Physical layer procedures
(3GPP TS 36.213 version 8.6.0 Release 8)

Reference

RTS/TSGR-0136213v860

Keywords

LTE

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

Copyright Notification

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://webapp.etsi.org/IPR/home.asp).

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 Specification (TS) has been produced by ETSI 3rd Generation Partnership Project (3GPP).

The present document may refer to technical specifications or reports using their 3GPP identities, UMTS identities or GSM identities. These should be interpreted as being references to the corresponding ETSI deliverables.

The cross reference between GSM, UMTS, 3GPP and ETSI identities can be found under http://webapp.etsi.org/key/queryform.asp.

Contents

Foreword

This Technical Specification (TS) has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of this present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

The present document specifies and establishes the characteristics of the physicals layer procedures in the FDD and TDD modes of E-UTRA.

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. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications"

[2] 3GPP TS 36.201: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Layer – General Description"

[3] 3GPP TS 36.211: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation"

[4] 3GPP TS 36.212: "Evolved Universal Terrestrial Radio Access (E-UTRA); Multiplexing and channel coding"

[5] 3GPP TS 36.214: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer – Measurements"

[6] 3GPP TS 36.101: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception"

[7] 3GPP TS 36.104: "Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception"

[8] 3GPP TS36.321, "Evolved Universal Terrestrial Radio Access (E-UTRA); Medium Access Control (MAC) protocol specification"

[9] 3GPP TS36.423, "Evolved Universal Terrestrial Radio Access (E-UTRA); X2 Application Protocol (X2AP)"

[10] 3GPP TS36.133, "Evolved Universal Terrestrial Radio Access (E-UTRA); Requirements for support of radio resource management"

[11] 3GPP TS36.331, "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC) protocol specification"

3 Definitions, symbols, and abbreviations

3.1 Symbols

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

N_{RB}^{DL}	Downlink bandwidth configuration, expressed in units of N_{sc}^{RB} as defined in [3]
N_{RB}^{UL}	Uplink bandwidth configuration, expressed in units of N_{sc}^{RB} as defined in [3]
N_{symb}^{UL}	Number of SC-FDMA symbols in an uplink slot as defined in [3]
N_{sc}^{RB}	Resource block size in the frequency domain, expressed as a number of subcarriers as defined in [3]
T_s	Basic time unit as defined in [3]

3.2 Abbreviations

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

ACK	Acknowledgement
BCH	Broadcast Channel
CCE	Control Channel Element
CQI	Channel Quality Indicator
CRC	Cyclic Redundancy Check
DAI	Downlink Assignment Index
DL	Downlink
DTX	Discontinuous Transmission
EPRE	Energy Per Resource Element
MCS	Modulation and Coding Scheme
NACK	Negative Acknowledgement
PBCH	Physical Broadcast Channel
PCFICH	Physical Control Format Indicator Channel
PDCCH	Physical Downlink Control Channel
PDSCH	Physical Downlink Shared Channel
PHICH	Physical Hybrid ARQ Indicator Channel
PRACH	Physical Random Access Channel
PRB	Physical Resource Block
PUCCH	Physical Uplink Control Channel
PUSCH	Physical Uplink Shared Channel
QoS	Quality of Service
RBG	Resource Block Group
RE	Resource Element
RPF	Repetition Factor
RS	Reference Signal
SIR	Signal-to-Interference Ratio
SINR	Signal to Interference plus Noise Ratio
SPS C-RNTI	Semi-Persistent Scheduling C-RNTI
SRS	Sounding Reference Symbol
TA	Time alignment
TTI	Transmission Time Interval
UE	User Equipment
UL	Uplink
UL-SCH	Uplink Shared Channel
VRB	Virtual Resource Block

4 Synchronisation procedures

4.1 Cell search

Cell search is the procedure by which a UE acquires time and frequency synchronization with a cell and detects the physical layer Cell ID of that cell. E-UTRA cell search supports a scalable overall transmission bandwidth corresponding to 6 resource blocks and upwards.

The following signals are transmitted in the downlink to facilitate cell search: the primary and secondary synchronization signals.

4.2 Timing synchronisation

4.2.1 Radio link monitoring

The downlink radio link quality of the serving cell shall be monitored by the UE for the purpose of indicating out-of-sync/in-sync status to higher layers.

In non-DRX mode operation, the physical layer in the UE shall every radio frame assess the radio link quality, evaluated over the previous time period defined in [10], against thresholds (Q_{out} and Q_{in}) defined by relevant tests in [10].

In DRX mode operation, the physical layer in the UE shall at least once every DRX period assess the radio link quality, evaluated over the previous time period defined in [10], against thresholds (Q_{out} and Q_{in}) defined by relevant tests in [10].

The physical layer in the UE shall in radio frames where the radio link quality is assessed indicate out-of-sync to higher layers when the radio link quality is worse than the threshold Q_{out}. When the radio link quality is better than the threshold Q_{in}, the physical layer in the UE shall in radio frames where the radio link quality is assessed indicate in-sync to higher layers.

4.2.2 Inter-cell synchronisation

[For example, for cell sites with a multicast physical channel]

4.2.3 Transmission timing adjustments

Upon reception of a timing advance command, the UE shall adjust its uplink transmission timing for PUCCH/PUSCH/SRS. The timing advance command indicates the change of the uplink timing relative to the current uplink timing as multiples of $16\,T_s$. The start timing of the random access preamble is specified in [3].

In case of random access response, 11-bit timing advance command [8], T_A, indicates N_{TA} values by index values of T_A = 0, 1, 2, ..., 1282, where an amount of the time alignment is given by $N_{TA} = T_A \times 16$. N_{TA} is defined in [3].

In other cases, 6-bit timing advance command [8], T_A, indicates adjustment of the current N_{TA} value, $N_{TA,old}$, to the new N_{TA} value, $N_{TA,new}$, by index values of T_A = 0, 1, 2,..., 63, where $N_{TA,new} = N_{TA,old} + (T_A - 31)\times 16$. Here, adjustment of N_{TA} value by a positive or a negative amount indicates advancing or delaying the uplink transmission timing by a given amount respectively.

For a timing advance command received on subframe *n*, the corresponding adjustment of the timing shall apply from the beginning of subframe *n+6*. When the UE's uplink PUCCH/PUSCH/SRS transmissions in subframe *n* and subframe *n*+1 are overlapped due to the timing adjustment, the UE shall transmit complete subframe *n* and not transmit the overlapped part of subframe *n*+1.

If the received downlink timing changes and is not compensated or is only partly compensated by the uplink timing adjustment without timing advance command as specified in [10], the UE changes N_{TA} accordingly.

5 Power control

Downlink power control determines the energy per resource element (EPRE). The term resource element energy denotes the energy prior to CP insertion. The term resource element energy also denotes the average energy taken over all constellation points for the modulation scheme applied. Uplink power control determines the average power over a DFT-SOFDM symbol in which the physical channel is transmitted.

5.1 Uplink power control

Uplink power control controls the transmit power of the different uplink physical channels.

A cell wide overload indicator (OI) and a High Interference Indicator (HII) to control UL interference are defined in [9].

5.1.1 Physical uplink shared channel

5.1.1.1 UE behaviour

The setting of the UE Transmit power P_{PUSCH} for the physical uplink shared channel (PUSCH) transmission in subframe *i* is defined by

$$P_{\text{PUSCH}}(i) = \min\{P_{\text{CMAX}}, 10\log_{10}(M_{\text{PUSCH}}(i)) + P_{\text{O\_PUSCH}}(j) + \alpha(j)\cdot PL + \Delta_{\text{TF}}(i) + f(i)\} \text{ [dBm]}$$

where,

- P_{CMAX} is the configured UE transmitted power defined in [6]
- $M_{\text{PUSCH}}(i)$ is the bandwidth of the PUSCH resource assignment expressed in number of resource blocks valid for subframe *i*.
- $P_{\text{O\_PUSCH}}(j)$ is a parameter composed of the sum of a cell specific nominal component $P_{\text{O\_NOMINAL\_PUSCH}}(j)$ provided from higher layers for *j=0* and *1* and a UE specific component $P_{\text{O\_UE\_PUSCH}}(j)$ provided by higher layers for *j=0* and *1*. For PUSCH (re)transmissions corresponding to a semi-persistent grant then *j=0* , for PUSCH (re)transmissions corresponding to a dynamic scheduled grant then *j=1* and for PUSCH (re)transmissions corresponding to the random access response grant then *j=2*. $P_{\text{O\_UE\_PUSCH}}(2) = 0$ and $P_{\text{O\_NOMINAL\_PUSCH}}(2) = P_{\text{O\_PRE}} + \Delta_{PREAMBLE\_Msg3}$, where the parameter PREAMBLE_INITIAL_RECEIVED_TARGET_POWER [8], $P_{\text{O\_PRE}}$ and $\Delta_{PREAMBLE\_Msg3}$ are signalled from higher layers.
- For *j* =0 or *1*, $\alpha \in \{0, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1\}$ is a 3-bit cell specific parameter provided by higher layers. For j=2, $\alpha(j) = 1$.
- *PL* is the downlink pathloss estimate calculated in the UE in dB and PL = referenceSignalPower – higher layer filtered RSRP, where referenceSignalPower is provided by higher layers and RSRP is defined in [5] and the higher layer filter configuration is defined in [11]
- $\Delta_{\text{TF}}(i) = 10\log_{10}((2^{MPR\cdot K_S} - 1)\beta_{offset}^{PUSCH})$ for $K_S = 1.25$ and 0 for $K_S = 0$ where K_S is given by the UE specific parameter *deltaMCS-Enabled* provided by higher layers
  - $MPR = O_{CQI} / N_{RE}$ for control data sent via PUSCH without UL-SCH data and $\sum_{r=0}^{C-1} K_r / N_{RE}$ for other cases.
    - where C is the number of code blocks, K_r is the size for code block r, O_{CQI} is the number of CQI bits including CRC bits and N_{RE} is the number of resource elements determined as

$N_{RE} = M_{\text{PUSCH}} \cdot N_{\text{sc}}^{\text{RB}} \cdot N_{\text{symb}}^{\text{PUSCH-initial}}$, where C, K_r and $N_{\text{symb}}^{\text{PUSCH-initial}}$ is defined in [4] and C, K_r and M_{PUSCH} are obtained from the initial PDCCH for the same transport block.

- $\beta_{offset}^{PUSCH} = \beta_{offset}^{CQI}$ for control data sent via PUSCH without UL-SCH data and 1 for other cases.

- δ_{PUSCH} is a UE specific correction value, also referred to as a TPC command and is included in PDCCH with DCI format 0 or jointly coded with other TPC commands in PDCCH with DCI format 3/3A whose CRC parity bits are scrambled with TPC-PUSCH-RNTI. The current PUSCH power control adjustment state is given by $f(i)$ which is defined by:
  - $f(i) = f(i-1) + \delta_{PUSCH}(i - K_{PUSCH})$ if accumulation is enabled based on the UE-specific parameter *Accumulation-enabled* provided by higher layers or if the TPC command δ_{PUSCH} is included in a PDCCH with DCI format 0 where the CRC is scrambled by the Temporary C-RNTI
    - where $\delta_{\text{PUSCH}}(i - K_{PUSCH})$ was signalled on PDCCH with DCI format 0 or 3/3A on subframe $i - K_{PUSCH}$, and where $f(0)$ is the first value after reset of accumulation.
    - The value of K_{PUSCH} is
      - For FDD, $K_{PUSCH} = 4$
      - For TDD UL/DL configurations 1-6, K_{PUSCH} is given in Table 5.1.1.1-1
      - For TDD UL/DL configuration 0
        - If the PUSCH transmission in subframe *2* or *7* is scheduled with a PDCCH of DCI format 0 in which the LSB of the UL index is set to 1, $K_{PUSCH} = 7$
        - For all other PUSCH transmissions, K_{PUSCH} is given in Table 5.1.1.1-1.
      - The UE attempts to decode a PDCCH of DCI format 0 with the UE's C-RNTI and a PDCCH of DCI format 3/3A with this UE's TPC-PUSCH-RNTI in every subframe except when in DRX
    - If DCI format 0 and DCI format 3/3A are both detected in the same subframe, then the UE shall use the δ_{PUSCH} provided in DCI format 0.
    - $\delta_{\text{PUSCH}} = 0$ dB for a subframe where no TPC command is decoded or where DRX occurs or i is not an uplink subframe in TDD.
    - The δ_{PUSCH} dB accumulated values signalled on PDCCH with DCI format 0 are given in Table 5.1.1.1-2.
    - The δ_{PUSCH} dB accumulated values signalled on PDCCH with DCI format 3/3A are one of SET1 given in Table 5.1.1.1-2 or SET2 given in Table 5.1.1.1-3 as determined by the parameter *TPC-Index* provided by higher layers.
    - If UE has reached maximum power, positive TPC commands shall not be accumulated
    - If UE has reached minimum power, negative TPC commands shall not be accumulated
    - UE shall reset accumulation
      - when an absolute TPC command is received
      - when $P_{\text{O\_UE\_PUSCH}}$ is received
      - when the UE receives random access response message
  - $f(i) = \delta_{\text{PUSCH}}(i - K_{\text{PUSCH}})$ if accumulation is not enabled based on the UE-specific parameter *Accumulation-enabled* provided by higher layers

    - where $\delta_{\mathrm{PUSCH}}(i - K_{PUSCH})$ was signalled on PDCCH with DCI format 0 on subframe $i - K_{PUSCH}$
    - The value of K_{PUSCH} is
        - For FDD, $K_{PUSCH} = 4$
        - For TDD UL/DL configurations 1-6, K_{PUSCH} is given in Table 5.1.1.1-1
        - For TDD UL/DL configuration 0
            - If the PUSCH transmission in subframe *2* or *7* is scheduled with a PDCCHof DCI format 0 in which the LSB of the UL index is set to 1, $K_{PUSCH} = 7$
            - For all other PUSCH transmissions, K_{PUSCH} is given in Table 5.1.1.1-1.
    - The δ_{PUSCH} dB absolute values signalled on PDCCH with DCI format 0 are given in Table 5.1.1.1-2.
    - $f(i) = f(i-1)$ for a subframe where no PDCCH with DCI format 0 is decoded or where DRX occurs or *i* is not an uplink subframe in TDD.
- For both types of $f(*)$ (accumulation or current absolute) the first value is set as follows:
    - If $P_{\mathrm{O\_UE\_PUSCH}}$ is received from higher layers,
        - $f(i) = 0$
    - Else
        - $f(0) = \Delta P_{rampup} + \delta_{msg2}$
            - where δ_{msg2} is the TPC command indicated in the random access response, see Section 6.2, and
            - ΔP_{rampup} is provided by higher layers and corresponds to the total power ramp-up from the first to the last preamble

Table 5.1.1.1-1 K_{PUSCH} for TDD configuration 0-6

TDD UL/DL Configuration	subframe number *i*									
	0	1	2	3	4	5	6	7	8	9
0	-	-	6	7	4	-	-	6	7	4
1	-	-	6	4	-	-	-	6	4	-
2	-	-	4	-	-	-	-	4	-	-
3	-	-	4	4	4	-	-	-	-	-
4	-	-	4	4	-	-	-	-	-	-
5	-	-	4	-	-	-	-	-	-	-
6	-	-	7	7	5	-	-	7	7	-

Table 5.1.1.1-2: Mapping of TPC Command Field in DCI format 0/3 to absolute and accumulated δ_{PUSCH} values.

TPC Command Field in DCI format 0/3	Accumulated δ_{PUSCH} [dB]	Absolute δ_{PUSCH} [dB] only DCI format 0
0	-1	-4
1	0	-1
2	1	1
3	3	4

Table 5.1.1.1-3: Mapping of TPC Command Field in DCI format 3A to δ_{PUSCH} values.

TPC Command Field in DCI format 3A	δ_{PUSCH} [dB]
0	-1
1	1

5.1.1.2 Power headroom

The UE power headroom PH valid for subframe *i* is defined by

$$PH(i) = P_{\text{CMAX}} - \{10\log_{10}(M_{\text{PUSCH}}(i)) + P_{\text{O\_PUSCH}}(j) + \alpha(j)\cdot PL + \Delta_{\text{TF}}(i) + f(i)\} \text{ [dB]}$$

where, P_{CMAX}, $M_{\text{PUSCH}}(i)$, $P_{\text{O\_PUSCH}}(j)$, $\alpha(j)$, PL, $\Delta_{\text{TF}}(i)$ and $f(i)$ are defined in section 5.1.1.1.

The power headroom shall be rounded to the closest value in the range [40; -23] dB with steps of 1 dB and is delivered by the physical layer to higher layers.

5.1.2 Physical uplink control channel

5.1.2.1 UE behaviour

The setting of the UE Transmit power P_{PUCCH} for the physical uplink control channel (PUCCH) transmission in subframe *i* is defined by

$$P_{\text{PUCCH}}(i) = \min\{P_{\text{CMAX}}, P_{\text{0\_PUCCH}} + PL + h(n_{CQI}, n_{HARQ}) + \Delta_{\text{F\_PUCCH}}(F) + g(i)\} \text{ [dBm]}$$

where

- P_{CMAX} is the configured UE transmitted power defined in [6]
- The parameter $\Delta_{\text{F\_PUCCH}}(F)$ is provided by higher layers. Each $\Delta_{\text{F\_PUCCH}}(F)$ value corresponds to a PUCCH format (*F*) relative to PUCCH format 1a, where each PUCCH format (*F*) is defined in Table 5.4-1 [3].
- $h(n)$ is a PUCCH format dependent value, where n_{CQI} corresponds to the number information bits for the channel quality information defined in section 5.2.3.3 in [4] and n_{HARQ} is the number of HARQ bits.
  - For PUCCH format 1,1a and 1b $h(n_{CQI}, n_{HARQ}) = 0$