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Contents

Intellectual Property Rights	2
Legal notice	2
Modal verbs terminology.....	2
Foreword.....	8
1 Scope	9
2 References	9
3 Symbols and abbreviations.....	9
3.1 Symbols.....	9
3.2 Abbreviations	10
4 Synchronization procedures	12
4.1 Cell search	12
4.2 Timing synchronization.....	12
4.2.1 Radio link monitoring.....	12
4.2.2 Inter-cell synchronization	12
4.2.3 Transmission timing adjustments	12
4.3 Timing for Secondary Cell Activation / Deactivation	13
5 Power control	14
5.1 Uplink power control.....	14
5.1.1 Physical uplink shared channel.....	14
5.1.1.1 UE behaviour	14
5.1.1.2 Power headroom	23
5.1.2 Physical uplink control channel.....	26
5.1.2.1 UE behaviour	27
5.1.3 Sounding Reference Symbol (SRS).....	31
5.1.3.1 UE behaviour	31
5.1.3.2 Power headroom for Type3 report	33
5.1.4 Power allocation for dual connectivity	34
5.1.4.1 Dual connectivity power control Mode 1.....	34
5.1.4.2 Dual connectivity power control Mode 2.....	42
5.1.5 Power allocation for PUCCH-SCell	46
5.2 Downlink power allocation	46
5.2.1 eNodeB Relative Narrowband TX Power (RNTP) restrictions	49
6 Random access procedure	50
6.1 Physical non-synchronized random access procedure.....	50
6.1.1 Timing	51
6.2 Random Access Response Grant.....	52
7 Physical downlink shared channel related procedures	55
7.1 UE procedure for receiving the physical downlink shared channel	57
7.1.1 Single-antenna port scheme	67
7.1.2 Transmit diversity scheme	68
7.1.3 Large delay CDD scheme	68
7.1.4 Closed-loop spatial multiplexing scheme	68
7.1.5 Multi-user MIMO scheme	68
7.1.5A Dual layer scheme.....	68
7.1.5B Up to 8 layer transmission scheme	68
7.1.6 Resource allocation.....	68
7.1.6.1 Resource allocation type 0	70
7.1.6.2 Resource allocation type 1	71
7.1.6.3 Resource allocation type 2	72
7.1.6.4 PDSCH starting position	73
7.1.6.4A PDSCH starting position for BL/CE UEs	75
7.1.6.5 Physical Resource Block (PRB) bundling.....	75

7.1.7	Modulation order and transport block size determination	77
7.1.7.1	Modulation order and redundancy version determination.....	78
7.1.7.2	Transport block size determination	82
7.1.7.2.1	Transport blocks not mapped to two or more layer spatial multiplexing	83
7.1.7.2.2	Transport blocks mapped to two-layer spatial multiplexing.....	91
7.1.7.2.3	Transport blocks mapped for DCI Format 1C and DCI Format 6-2.....	91
7.1.7.2.4	Transport blocks mapped to three-layer spatial multiplexing.....	92
7.1.7.2.5	Transport blocks mapped to four-layer spatial multiplexing.....	93
7.1.7.2.6	Transport blocks mapped for BL/CE UEs configured with CEModeB and PDSCH bandwidth up to 1.4MHz.....	93
7.1.7.2.7	Transport blocks mapped for BL/CE UEs <i>SystemInformationBlockType1-BR</i>	94
7.1.7.2.8	Transport blocks mapped for UEs configured with <i>ce-pdsch-maxBandwidth-config</i> value of 5 MHz or with <i>pdsch-MaxBandwidth-SC-MTCH</i> value of 24 PRBs	94
7.1.7.3	Redundancy Version determination for Format 1C	94
7.1.8	Storing soft channel bits	95
7.1.9	PDSCH resource mapping parameters.....	95
7.1.10	Antenna ports quasi co-location for PDSCH	96
7.1.11	PDSCH subframe assignment for BL/CE UE.....	97
7.2	UE procedure for reporting Channel State Information (CSI)	99
7.2.1	Aperiodic CSI Reporting using PUSCH.....	107
7.2.2	Periodic CSI Reporting using PUCCH.....	131
7.2.3	Channel Quality Indicator (CQI) definition.....	172
7.2.4	Precoding Matrix Indicator (PMI) definition	182
7.2.5	Channel-State Information – Reference Signal (CSI-RS) definition	210
7.2.6	Channel-State Information – Interference Measurement (CSI-IM) Resource definition.....	212
7.2.7	Zero Power CSI-RS Resource definition	212
7.2.8	CSI-RS Activation / Deactivation.....	212
7.3	UE procedure for reporting HARQ-ACK	213
7.3.1	FDD HARQ-ACK reporting procedure.....	213
7.3.2	TDD HARQ-ACK reporting procedure.....	217
7.3.2.1	TDD HARQ-ACK reporting procedure for same UL/DL configuration	217
7.3.2.2	TDD HARQ-ACK reporting procedure for different UL/DL configurations	229
7.3.3	FDD-TDD HARQ-ACK reporting procedure for primary cell frame structure type 1.....	236
7.3.4	FDD-TDD HARQ-ACK reporting procedure for primary cell frame structure type 2.....	237
8	Physical uplink shared channel related procedures	238
8.0	UE procedure for transmitting the physical uplink shared channel.....	238
8.0.1	Single-antenna port scheme	253
8.0.2	Closed-loop spatial multiplexing scheme	253
8.1	Resource allocation for PDCCH/EPDCCH with uplink DCI format	254
8.1.1	Uplink resource allocation type 0	254
8.1.2	Uplink resource allocation type 1	254
8.1.3	Uplink resource allocation type 2	255
8.1.4	Uplink resource allocation type 3	255
8.1.5	Uplink resource allocation type 4	256
8.1.5.1	UL Resource Block Groups	256
8.2	UE sounding procedure	257
8.3	UE HARQ-ACK procedure.....	267
8.4	UE PUSCH hopping procedure.....	269
8.4.1	Type 1 PUSCH hopping	270
8.4.2	Type 2 PUSCH hopping	270
8.5	UE Reference Symbol (RS) procedure.....	270
8.6	Modulation order, redundancy version and transport block size determination.....	271
8.6.1	Modulation order and redundancy version determination	271
8.6.2	Transport block size determination.....	277
8.6.3	Control information MCS offset determination.....	280
8.7	UE transmit antenna selection	284
8.8	Transmission timing adjustments	284
9	Physical downlink control channel procedures	284
9.1	UE procedure for determining physical downlink control channel assignment	285
9.1.1	PDCCH assignment procedure	285

9.1.2	PHICH assignment procedure.....	289
9.1.3	Control Format Indicator (CFI) assignment procedure.....	291
9.1.4	EPDCCH assignment procedure.....	291
9.1.4.1	EPDCCH starting position	298
9.1.4.2	Antenna ports quasi co-location for EPDCCH.....	299
9.1.4.3	Resource mapping parameters for EPDCCH	299
9.1.4.4	PRB-pair indication for EPDCCH	300
9.1.5	MPDCCH assignment procedure.....	300
9.1.5.1	MPDCCH starting position	307
9.1.5.2	Antenna ports quasi co-location for MPDCCH	307
9.2	PDCCH/EPDCCH/MPDCCH validation for semi-persistent scheduling	308
9.3	PDCCH/EPDCCH/MPDCCH control information procedure	309
10	Physical uplink control channel procedures	310
10.1	UE procedure for determining physical uplink control channel assignment	310
10.1.1	PUCCH format information.....	313
10.1.2	FDD HARQ-ACK feedback procedures.....	318
10.1.2.1	FDD HARQ-ACK procedure for one configured serving cell.....	318
10.1.2.2	FDD HARQ-ACK procedures for more than one configured serving cell	320
10.1.2.2.1	PUCCH format 1b with channel selection HARQ-ACK procedure.....	320
10.1.2.2.2	PUCCH format 3 HARQ-ACK procedure	324
10.1.2.2.3	PUCCH format 4 HARQ-ACK procedure	326
10.1.2.2.4	PUCCH format 5 HARQ-ACK procedure	327
10.1.3	TDD HARQ-ACK feedback procedures	328
10.1.3.1	TDD HARQ-ACK procedure for one configured serving cell.....	330
10.1.3.2	TDD HARQ-ACK procedure for more than one configured serving cell.....	342
10.1.3.2.1	PUCCH format 1b with channel selection HARQ-ACK procedure.....	342
10.1.3.2.2	PUCCH format 3 HARQ-ACK procedure	358
10.1.3.2.3	PUCCH format 4 HARQ-ACK procedure	365
10.1.3.2.4	PUCCH format 5 HARQ-ACK procedure	382
10.1.3A	FDD-TDD HARQ-ACK feedback procedures for primary cell frame structure type 2	382
10.1.4	HARQ-ACK Repetition procedure.....	384
10.1.5	Scheduling Request (SR) procedure	385
10.2	Uplink HARQ-ACK timing	386
11	Physical Multicast Channel (PMCH) related procedures.....	390
11.1	UE procedure for receiving the PMCH.....	390
11.2	UE procedure for receiving MCCH and system information change notification.....	391
12	Assumptions independent of physical channel.....	391
13	Uplink/Downlink configuration determination procedure for Frame Structure Type 2.....	391
13.1	UE procedure for determining eIMTA-uplink/downlink configuration.....	392
13A	Subframe configuration for Frame Structure Type 3	393
14	UE procedures related to Sidelink.....	396
14.1	Physical Sidelink Shared Channel related procedures.....	397
14.1.1	UE procedure for transmitting the PSSCH	397
14.1.1.1	UE procedure for determining subframes for transmitting PSSCH for sidelink transmission mode 1	398
14.1.1.1.1	Determination of subframe indicator bitmap.....	399
14.1.1.2	UE procedure for determining resource blocks for transmitting PSSCH for sidelink transmission mode 1	401
14.1.1.2.1	PSSCH resource allocation for sidelink transmission mode 1	401
14.1.1.2.2	PSSCH frequency hopping for sidelink transmission mode 1	402
14.1.1.3	UE procedure for determining subframes for transmitting PSSCH for sidelink transmission mode 2	402
14.1.1.4	UE procedure for determining resource blocks for transmitting PSSCH for sidelink transmission mode 2.....	403
14.1.1.4A	UE procedure for determining subframes and resource blocks for transmitting PSSCH for sidelink transmission mode 3	403
14.1.1.4B	UE procedure for determining subframes and resource blocks for transmitting PSSCH and reserving resources for sidelink transmission mode 4.....	404

14.1.1.4C	UE procedure for determining subframes and resource blocks for PSSCH transmission associated with an SCI format 1	404
14.1.1.5	UE procedure for PSSCH power control	406
14.1.1.6	UE procedure for determining the subset of resources to be reported to higher layers in PSSCH resource selection in sidelink transmission mode 4	407
14.1.1.7	Conditions for selecting resources when the number of HARQ transmissions is two in sidelink transmission mode 4.....	410
14.1.2	UE procedure for receiving the PSSCH.....	410
14.1.3	UE procedure for determining resource block pool and subframe pool for sidelink transmission mode 2	410
14.1.5	UE procedure for determining resource block pool and subframe pool for sidelink transmission mode 3 and 4.....	411
14.2	Physical Sidelink Control Channel related procedures.....	412
14.2.1	UE procedure for transmitting the PSCCH.....	412
14.2.1.1	UE procedure for determining subframes and resource blocks for transmitting PSCCH for sidelink transmission mode 1	415
14.2.1.2	UE procedure for determining subframes and resource blocks for transmitting PSCCH for sidelink transmission mode 2	416
14.2.1.3	UE procedure for PSCCH power control	416
14.2.2	UE procedure for receiving the PSCCH	417
14.2.3	UE procedure for determining resource block pool and subframe pool for PSCCH	417
14.2.4	UE procedure for determining resource block pool for PSCCH in sidelink transmission mode 3 and 4.....	418
15	Channel access procedures for LAA	422
15.1	Downlink channel access procedures	422
15.1.1	Channel access procedure for transmission(s) including PDSCH/PDCCH/EPDCCH	422
15.1.2	Channel access procedure for transmissions including discovery signal transmission(s) and not including PDSCH	423
15.1.3	Contention window adjustment procedure	424
15.1.4	Energy detection threshold adaptation procedure	425
15.1.5	Channel access procedure for transmission(s) on multiple carriers	426
15.1.5.1	Type A multi-carrier access procedures	426
15.1.5.1.1	Type A1	426
15.1.5.1.2	Type A2	426
15.1.5.2	Type B multi-carrier access procedure	426
15.1.5.2.1	Type B1	427
15.1.5.2.2	Type B2	427
15.2	Uplink channel access procedures	427
15.2.1	Channel access procedure for Uplink transmission(s)	427
15.2.1.1	Type 1 UL channel access procedure.....	430
15.2.1.2	Type 2 UL channel access procedure.....	431
15.2.2	Contention window adjustment procedure	431
15.2.3	Energy detection threshold adaptation procedure	432
15.2.3.1	Default maximum energy detection threshold computation procedure.....	432
16	UE Procedures related to narrowband IoT	433
16.1	Synchronization procedures	433
16.1.1	Cell search	433
16.1.2	Timing synchronization	433
16.2	Power control	434
16.2.1	Uplink power control	434
16.2.1.1	Narrowband physical uplink shared channel.....	434
16.2.1.1.1	UE behaviour.....	434
16.2.1.1.2	Power headroom.....	435
16.2.2	Downlink power allocation.....	435
16.3	Random access procedure	435
16.3.1	Physical non-synchronized random access procedure	435
16.3.2	Timing	436
16.3.3	Narrowband random access response grant	437
16.4	Narrowband physical downlink shared channel related procedures.....	437
16.4.1	UE procedure for receiving the narrowband physical downlink shared channel.....	438

16.4.1.1	Single-antenna port scheme	440
16.4.1.2	Transmit diversity scheme	440
16.4.1.3	Resource allocation	441
16.4.1.4	NPDSCH starting position	442
16.4.1.5	Modulation order and transport block size determination.....	443
16.4.1.5.1	Transport blocks not mapped for <i>SystemInformationBlockType1-NB</i>	443
16.4.1.5.2	Transport blocks mapped for <i>SystemInformationBlockType1-NB</i>	444
16.4.2	UE procedure for reporting ACK/NACK	444
16.5	Narrowband physical uplink shared channel related procedures.....	445
16.5.1	UE procedure for transmitting format 1 narrowband physical uplink shared channel.....	445
16.5.1.1	Resource allocation	446
16.5.1.2	Modulation order, redundancy version and transport block size determination.....	447
16.5.2	UE procedure for NPUSCH retransmission.....	449
16.6	Narrowband physical downlink control channel related procedures.....	449
16.6.1	NPDCCH starting position	453
16.6.2	NPDCCH control information procedure	454
16.7	Assumptions independent of physical channel related to narrowband IoT	454
16.8	UE procedure for acquiring cell-specific reference signal sequence and raster offset	454
Annex A (informative): Change history		455
History		471

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1 Scope

The present document specifies and establishes the characteristics of the physical 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.
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- 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 TS 36.321: "Evolved Universal Terrestrial Radio Access (E-UTRA); Medium Access Control (MAC) protocol specification".
- [9] 3GPP TS 36.423, "Evolved Universal Terrestrial Radio Access (E-UTRA); X2 Application Protocol (X2AP)".
- [10] 3GPP TS 36.133, "Evolved Universal Terrestrial Radio Access (E-UTRA); Requirements for support of radio resource management".
- [11] 3GPP TS 36.331, "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC) protocol specification".
- [12] 3GPP TS 36.306: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio access capabilities".

3 Symbols and abbreviations

3.1 Symbols

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

n_f System frame number as defined in [3]

n_s	Slot number within a radio frame as defined in [3]
N_{cells}^{DL}	Number of configured cells
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 abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

ACK	Acknowledgement
BCH	Broadcast Channel
CCE	Control Channel Element
CDD	Cyclic Delay Diversity
CG	Cell Group
CIF	Carrier Indicator Field
CQI	Channel Quality Indicator
CRC	Cyclic Redundancy Check
CRI	CSI-RS Resource Indicator
CSI	Channel State Information
CSI-IM	CSI-interference measurement
DAI	Downlink Assignment Index
DCI	Downlink Control Information
DL	Downlink
DL-SCH	Downlink Shared Channel
DTX	Discontinuous Transmission
EPDCCH	Enhanced Physical Downlink Control Channel
EPRE	Energy Per Resource Element
MCG	Master Cell Group
MCS	Modulation and Coding Scheme
NACK	Negative Acknowledgement
NPBCH	Narrowband Physical Broadcast Channel
NPDCCH	Narrowband Physical Downlink Control Channel
NPDSCH	Narrowband Physical Downlink Shared Channel
NPRACH	Narrowband Physical Random Access Channel
NPUSCH	Narrowband Physical Uplink Shared Channel
NPSS	Narrowband Primary Synchronization Signal
NSSS	Narrowband Secondary Synchronization Signal
NRS	Narrowband Reference Signal
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
PMCH	Physical Multicast Channel
PMI	Precoding Matrix Indicator
PRACH	Physical Random Access Channel
PRS	Positioning Reference Signal
PRB	Physical Resource Block
PSBCH	Physical Sidelink Broadcast Channel
PSCCH	Physical Sidelink Control Channel
PSCell	Primary Secondary cell

PSDCH	Physical Sidelink Discovery Channel
PSSCH	Physical Sidelink Shared Channel
PSSS	Primary Sidelink Synchronisation Signal
PUCCH	Physical Uplink Control Channel
PUCCH-SCell	PUCCH SCell
PUSCH	Physical Uplink Shared Channel
PTI	Precoding Type Indicator
RBG	Resource Block Group
RE	Resource Element
RI	Rank Indication
RS	Reference Signal
SCG	Secondary Cell Group
SINR	Signal to Interference plus Noise Ratio
SPS C-RNTI	Semi-Persistent Scheduling C-RNTI
SR	Scheduling Request
SRS	Sounding Reference Symbol
SSSS	Secondary Sidelink Synchronisation Signal
TAG	Timing Advance Group
TBS	Transport Block Size
UCI	Uplink Control Information
UE	User Equipment
UL	Uplink
UL-SCH	Uplink Shared Channel
VRB	Virtual Resource Block

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4 Synchronization 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.

A UE may assume the antenna ports 0 – 3 and the antenna port for the primary/secondary synchronization signals of a serving cell are quasi co-located (as defined in [3]) with respect to Doppler shift and average delay.

4.2 Timing synchronization

4.2.1 Radio link monitoring

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

If the UE is configured with a SCG [11] and the parameter *rlf-TimersAndConstantsSCG* is provided by the higher layers and is not set to release, the downlink radio link quality of the PSCell [11] of the SCG 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].

If higher-layer signalling indicates certain subframes for restricted radio link monitoring, the radio link quality shall not be monitored in any subframe other than those indicated.

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 synchronization

No functionality is specified in this subclause in this release.

4.2.3 Transmission timing adjustments

Upon reception of a timing advance command or a timing adjustment indication for a TAG containing the primary cell or PSCell, the UE shall adjust uplink transmission timing for PUCCH/PUSCH/SRS of the primary cell or PSCell based on the received timing advance command or a timing adjustment indication.

The UL transmission timing for PUSCH/SRS of a secondary cell is the same as the primary cell if the secondary cell and the primary cell belong to the same TAG. If the primary cell in a TAG has a frame structure type 1 and a secondary cell in the same TAG has a frame structure type 2 or frame structure 3, UE may assume that $N_{TA} \geq 624$.

If the UE is configured with a SCG, the UL transmission timing for PUSCH/SRS of a secondary cell other than the PSCell is the same as the PSCell if the secondary cell and the PSCell belong to the same TAG.

Upon reception of a timing advance command or a timing adjustment indication for a TAG not containing the primary cell or PSCell, if all the serving cells in the TAG have the same frame structure type, the UE shall adjust uplink transmission timing for PUSCH/SRS of all the secondary cells in the TAG based on the received timing advance