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# Foreword

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# 1 Scope

The present document describes the physical channels for evolved UTRA.

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# 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); LTE physical layer; General description".
- [3] 3GPP TS 36.212: "Evolved Universal Terrestrial Radio Access (E-UTRA); Multiplexing and channel coding".
- [4] 3GPP TS 36.213: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures".
- [5] 3GPP TS 36.214: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer; Measurements".
- [6] 3GPP TS 36.104: "Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception".
- [7] 3GPP TS 36.101: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) 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 36.331, "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC) Protocol specification"
- [10] 3GPP TS 36.304, "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) procedures in idle mode"

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# 3 Symbols and abbreviations

## 3.1 Symbols

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

$(k, l)$	Resource element with frequency-domain index $k$ and time-domain index $l$
$a_{k,l}^{(p)}$	Value of resource element $(k, l)$ [for antenna port $p$ ]
$D$	Matrix for supporting cyclic delay diversity

$D_{RA}$	Density of random access opportunities per radio frame
$f_0$	Carrier frequency
$f_{RA}$	PRACH resource frequency index within the considered time-domain location
$f_{PRB,hop}^{PRACH}$	PRACH frequency hopping offset, expressed as a number of resource blocks
$l_{NPDCCHstart}$	Start symbol in slot 0 for NPDCCH
$l_{NPDSCHstart}$	Start symbol in slot 0 for NPDSCH
$M_{sc}^{PSBCH}$	Bandwidth for PSBCH transmission, expressed as a number of subcarriers
$M_{RB}^{PSBCH}$	Bandwidth for PSBCH transmission, expressed as a number of resource blocks
$M_{sc}^{PSCCH}$	Bandwidth for PSCCH transmission, expressed as a number of subcarriers
$M_{RB}^{PSCCH}$	Bandwidth for PSCCH transmission, expressed as a number of resource blocks
$M_{sc}^{PSDCH}$	Bandwidth for PSDCH transmission, expressed as a number of subcarriers
$M_{RB}^{PSDCH}$	Bandwidth for PSDCH transmission, expressed as a number of resource blocks
$M_{sc}^{PSSCH}$	Scheduled bandwidth for PSSCH transmission, expressed as a number of subcarriers
$M_{RB}^{PSSCH}$	Scheduled bandwidth for PSSCH transmission, expressed as a number of resource blocks
$M_{sc}^{PUSCH}$	Scheduled bandwidth for uplink transmission, expressed as a number of subcarriers
$M_{RB}^{PUSCH}$	Scheduled bandwidth for uplink transmission, expressed as a number of resource blocks
$M_{rep}^{NPUSCH}$	Scheduled number of repetitions of a NPUSCH transmission
$M_{rep}^{NPDSCH}$	Scheduled number of repetitions of a NPDSCH transmission
$M_{sc}^{NPUSCH}$	Scheduled bandwidth for uplink NPUSCH transmission, expressed as a number of subcarriers
$M_{identical}^{NPUSCH}$	Number of repetitions of identical slots for NPUSCH
$M_{bit}^{(q)}$	Number of coded bits to transmit on a physical channel [for codeword $q$ ]
$M_{symb}^{(q)}$	Number of modulation symbols to transmit on a physical channel [for codeword $q$ ]
$M_{symb}^{layer}$	Number of modulation symbols to transmit per layer for a physical channel
$M_{symb}^{ap}$	Number of modulation symbols to transmit per antenna port for a physical channel
$N$	A constant equal to 2048 for $\Delta f = 15$ kHz, 4096 for $\Delta f = 7.5$ kHz and 8192 for $\Delta f = 3.75$ kHz
$N_{CP,l}$	Downlink cyclic prefix length for OFDM symbol $l$ in a slot
$N_{CS}$	Cyclic shift value used for random access preamble generation
$N_{cs}^{(1)}$	Number of cyclic shifts used for PUCCH formats 1/1a/1b in a resource block with a mix of formats 1/1a/1b and 2/2a/2b
$N_{RB}^{(2)}$	Bandwidth available for use by PUCCH formats 2/2a/2b, expressed in multiples of $N_{sc}^{RB}$
$N_{RB}^{HO}$	The offset used for PUSCH frequency hopping, expressed in number of resource blocks (set by higher layers)
$N_{ID}^{cell}$	Physical layer cell identity
$N_{ID}^{Ncell}$	Narrowband physical layer cell identity
$N_{ID}^{MBSFN}$	MBSFN area identity
$N_{ID}^{SL}$	Physical layer sidelink synchronization identity
$N_{ID}^{PRS}$	Positioning reference signal identity
$N_{RB}^{DL}$	Downlink bandwidth configuration, expressed in multiples of $N_{sc}^{RB}$
$N_{RB}^{min,DL}$	Smallest downlink bandwidth configuration, expressed in multiples of $N_{sc}^{RB}$
$N_{RB}^{max,DL}$	Largest downlink bandwidth configuration, expressed in multiples of $N_{sc}^{RB}$
$N_{RB}^{UL}$	Uplink bandwidth configuration, expressed in multiples of $N_{sc}^{RB}$
$N_{RB}^{min,UL}$	Smallest uplink bandwidth configuration, expressed in multiples of $N_{sc}^{RB}$
$N_{RB}^{max,UL}$	Largest uplink bandwidth configuration, expressed in multiples of $N_{sc}^{RB}$

$N_{RB}^{SL}$	Sidelink bandwidth configuration, expressed in multiples of $N_{sc}^{RB}$
$N_{SF}$	Number of scheduled subframes for NPDSCH transmission
$N_{symb}^{NPSS}$	Number of symbols for NPSS in a subframe
$N_{symb}^{NSSS}$	Number of symbols for NSSS in a subframe
$N_{sc}^{RU}$	Number of consecutive subcarriers in an UL resource unit for NB-IoT
$N_{seq}^{RU}$	Number of reference signal sequences available for the UL resource unit size
$N_{RU}$	Number of scheduled UL resource units for NB-IoT
$N_{NB}^{UL}$	Total number of uplink narrowbands
$N_{WB}^{UL}$	Total number of uplink widebands
$N_{sc}^{UL}$	Number of subcarriers in the frequency domain for NB-IoT
$N_{acc}$	Number of consecutive absolute subframes over which the scrambling sequence stays the same
$N_{abs}^{PUSCH}$	Total number of absolute subframes a PUSCH with repetition spans, expressed as a number of absolute subframes
$N_{rep}^{PUSCH}$	Number of repetitions of a PUSCH transmission
$N_{NB}^{ch,UL}$	Number of consecutive absolute subframes over which PUCCH or PUSCH stays at the same narrowband before hopping to another narrowband, expressed as a number of absolute subframes
$f_{NB,hop}^{PUSCH}$	Narrowband offset between one narrowband and the next narrowband a PUSCH hops to, expressed as a number of uplink narrowbands
$N_{abs}^{PUCCH}$	Total number of absolute subframes a PUCCH with repetition spans, expressed as a number of absolute subframes
$N_{rep}^{PUCCH}$	Number of repetitions of a PUCCH transmission
$N_{rep}^{PRACH}$	Number of PRACH repetitions per preamble transmission attempt
$N_{sf}^{RA}$	Number of subframes allowed for preamble transmission within a 1024-frame interval
$N_{start}^{PRACH}$	PRACH starting subframe periodicity
$N_{rep}^{NPRACH}$	Number of NPRACH repetitions per preamble transmission attempt
$N_{period}^{NPRACH}$	NPRACH resource periodicity
$N_{sc,offset}^{NPRACH}$	Frequency location of the first sub-carrier allocated to NPRACH
$N_{sc}^{NPRACH}$	Number of sub-carriers allocated to NPRACH
$N_{sc,cont}^{NPRACH}$	Number of starting sub-carriers allocated for UE initiated random access
$N_{start}^{NPRACH}$	NPRACH starting subframe
$N_{MSG3}^{NPRACH}$	Fraction for starting subcarrier index for UE support for multi-tone msg3 transmission
$N_{gap,period}$	Periodicity for NPDSCH/NPDCCH gaps
$N_{gap,duration}$	Duration for NPDSCH/NPDCCH gaps
$N_{gap,threshold}$	Threshold for applying NPDDCH/NPDCCH gaps
$N_{NB}^{DL}$	Total number of downlink narrowbands
$N_{WB}^{DL}$	Total number of downlink widebands
$N_{abs}^{PDSCH}$	Total number of absolute subframes a PDSCH with repetition spans, expressed as a number of absolute subframes
$N_{rep}^{PDSCH}$	Number of repetitions of a PDSCH transmission
$N_{NB}^{ch,DL}$	Number of consecutive absolute subframes over which MPDCCH or PDSCH stays at the same narrowband before hopping to another narrowband, expressed as a number of absolute subframes
$N_{NB,hop}^{ch,DL}$	Number of narrowbands over which MPDCCH or PDSCH frequency hops

$f_{\text{NB,hop}}^{\text{DL}}$	Narrowband offset between one narrowband and the next narrowband an MPDCCH or PDSCH hops to, expressed as a number of downlink narrowbands
$N_{\text{PDSCH}}^{\text{SIB1-BR}}$	Number of times a PDSCH carrying SIB1-BR is transmitted over 8 radio frames
$N_{\text{abs}}^{\text{MPDCCH}}$	Total number of absolute subframes a MPDCCH with repetition spans , expressed as a number of absolute subframes
$N_{\text{rep}}^{\text{MPDCCH}}$	Number of repetitions of a MPDCCH transmission
$N_{\text{abs,ss}}^{\text{MPDCCH}}$	Total number of absolute subframes a MPDCCH search space with maximum repetition level spans, expressed as a number of absolute subframes
$N_{\text{rep,ss}}^{\text{MPDCCH}}$	Maximum repetition level of a MPDCCH search space
$N_{\text{ECCE}}^{\text{MPDCCH}}$	Number of ECCEs in a subframe for one MPDCCH
$N_{\text{symb}}^{\text{DL}}$	Number of OFDM symbols in a downlink slot
$N_{\text{symb}}^{\text{UL}}$	Number of SC-FDMA symbols in an uplink slot
$N_{\text{symb}}^{\text{retune}}$	Number of symbols in a guard period for narrowband or wideband retuning
$N_{\text{slots}}^{\text{UL}}$	Number of consecutive slots in an UL resource unit for NB-IoT
$N_{\text{symb}}^{\text{SL}}$	Number of SC-FDMA symbols in a sidelink slot
$N_{\text{sc}}^{\text{RB}}$	Resource block size in the frequency domain, expressed as a number of subcarriers
$N_{\text{sb}}$	Number of sub-bands for PUSCH frequency-hopping with predefined hopping pattern
$N_{\text{RB}}^{\text{sb}}$	Size of each sub-band for PUSCH frequency-hopping with predefined hopping pattern, expressed as a number of resource blocks
$N_{\text{sc}}^{\text{RA}}$	Size of narrow-band random-access resource in number of subcarriers
$N_{\text{SP}}$	Number of downlink to uplink switch points within the radio frame
$N_{\text{RS}}^{\text{PUCCH}}$	Number of reference symbols per slot for PUCCH
$N_{\text{TA}}$	Timing offset between uplink and downlink radio frames at the UE, expressed in units of $T_s$
$N_{\text{TA offset}}$	Fixed timing advance offset, expressed in units of $T_s$
$N_{\text{TA,SL}}$	Timing offset between sidelink and timing reference frames at the UE, expressed in units of $T_s$
$n_{\text{PUCCH}}^{(1,\bar{p})}$	Resource index for PUCCH formats 1/1a/1b
$n_{\text{PUCCH}}^{(2,\bar{p})}$	Resource index for PUCCH formats 2/2a/2b
$n_{\text{PUCCH}}^{(3,\bar{p})}$	Resource index for PUCCH formats 3
$n_{\text{PDCCH}}$	Number of PDCCHs present in a subframe
$n_{\text{PRB}}$	Physical resource block number
$n_{\text{PRB}}^{\text{RA}}$	First physical resource block occupied by PRACH resource considered
$n_{\text{PRB offset}}^{\text{RA}}$	First physical resource block available for PRACH
$n_{\text{sc}}^{\text{RA}}$	Subcarrier occupied by NPRACH resource considered
$n_{\text{VRB}}$	Virtual resource block number
$n_{\text{RNTI}}$	Radio network temporary identifier
$n_{\text{ID}}^{\text{SA}}$	Sidelink group destination identity
$n_f$	System frame number
$n_s$	Slot number within a radio frame
$n_{\text{sf}}^{\text{abs}}$	Absolute subframe number
$n_{\text{sf}}^{\text{RA}}$	Index for subframes allowed for preamble transmission
$P$	Number of antenna ports used for transmission of a channel
$p$	Antenna port number
$q$	Codeword number
$r_{\text{RA}}$	Index for PRACH versions with same preamble format and PRACH density