

# ETSI TS 136 211 V14.12.0 (2019-10)



**LTE;**  
**Evolved Universal Terrestrial Radio Access (E-UTRA);**  
**Physical channels and modulation**  
**(3GPP TS 36.211 version 14.12.0 Release 14)**

*Standard PREVIEW*  
*Full standard available at: <https://standards.iteh.ai/catalog/standards/sist/255255e9-9949-b213-456d-9118-994bcc01a61d/etsi-ts-136-211-v14-12-0-2019-10>*



---

**Reference**RTS/TSGR-0136211vec0

---

---

**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**

---

The present document can be downloaded from:

<http://www.etsi.org/standards-search>

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the prevailing version of an ETSI deliverable is the one made publicly available in PDF format at [www.etsi.org/deliver](http://www.etsi.org/deliver).

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

<https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx>

If you find errors in the present document, please send your comment to one of the following services:

<https://portal.etsi.org/People/CommiteeSupportStaff.aspx>

---

**Copyright Notification**

---

No part may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm except as authorized by written permission of ETSI.

The content of the PDF version shall not be modified without the written authorization of ETSI.

The copyright and the foregoing restriction extend to reproduction in all media.

© ETSI 2019.

All rights reserved.

**DECT™**, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members.

**3GPP™** and **LTE™** are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners.

**oneM2M™** logo is a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners.

**GSM®** and the GSM logo are trademarks registered and owned by the GSM Association.

---

# Intellectual Property Rights

## Essential patents

IPRs essential or potentially essential to normative deliverables 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 (<https://ipr.etsi.org/>).

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.

## Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

---

# Legal notice

This Technical Specification (TS) has been produced by the ETSI 3<sup>rd</sup> Generation Partnership Project (3GPP).

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

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

---

# Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

# 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 .....	13
4 Frame structure.....	14
4.1 Frame structure type 1 .....	14
4.2 Frame structure type 2 .....	15
4.3 Frame structure type 3 .....	16
5 Uplink.....	18
5.1 Overview .....	18
5.1.1 Physical channels.....	18
5.1.2 Physical signals.....	18
5.2 Slot structure and physical resources.....	18
5.2.1 Resource grid.....	18
5.2.2 Resource elements .....	20
5.2.3 Resource blocks .....	20
5.2.4 Narrowbands and widebands .....	20
5.2.5 Guard period for narrowband and wideband retuning.....	21
5.3 Physical uplink shared channel.....	23
5.3.1 Scrambling.....	23
5.3.2 Modulation.....	24
5.3.2A Layer mapping.....	25
5.3.2A.1 Layer mapping for transmission on a single antenna port.....	25
5.3.2A.2 Layer mapping for spatial multiplexing .....	25
5.3.3 Transform precoding.....	26
5.3.3A Precoding.....	26
5.3.3A.1 Precoding for transmission on a single antenna port.....	26
5.3.3A.2 Precoding for spatial multiplexing .....	26
5.3.4 Mapping to physical resources.....	29
5.4 Physical uplink control channel.....	32
5.4.1 PUCCH formats 1, 1a and 1b .....	33
5.4.2 PUCCH formats 2, 2a and 2b .....	36
5.4.2A PUCCH format 3 .....	37
5.4.2B PUCCH format 4 .....	39
5.4.2C PUCCH format 5 .....	39
5.4.3 Mapping to physical resources.....	40
5.5 Reference signals.....	43
5.5.1 Generation of the reference signal sequence.....	43
5.5.1.1 Base sequences of length $3N_{sc}^{RB}$ or larger.....	43
5.5.1.2 Base sequences of length less than $3N_{sc}^{RB}$ .....	44
5.5.1.3 Group hopping .....	47
5.5.1.4 Sequence hopping .....	48
5.5.1.5 Determining virtual cell identity for sequence generation .....	48
5.5.2 Demodulation reference signal .....	49
5.5.2.1 Demodulation reference signal for PUSCH .....	49
5.5.2.1.1 Reference signal sequence.....	49
5.5.2.1.2 Mapping to physical resources .....	52
5.5.2.2 Demodulation reference signal for PUCCH.....	52

5.5.2.2.1	Reference signal sequence.....	52
5.5.2.2.2	Mapping to physical resources .....	54
5.5.3	Sounding reference signal.....	55
5.5.3.1	Sequence generation.....	55
5.5.3.2	Mapping to physical resources.....	55
5.5.3.3	Sounding reference signal subframe configuration .....	58
5.6	SC-FDMA baseband signal generation .....	59
5.7	Physical random access channel.....	60
5.7.1	Time and frequency structure .....	60
5.7.2	Preamble sequence generation.....	67
5.7.3	Baseband signal generation.....	72
5.8	Modulation and upconversion .....	73
6	Downlink.....	74
6.1	Overview .....	74
6.1.1	Physical channels.....	74
6.1.2	Physical signals.....	74
6.2	Slot structure and physical resource elements .....	75
6.2.1	Resource grid .....	75
6.2.2	Resource elements .....	76
6.2.3	Resource blocks .....	77
6.2.3.1	Virtual resource blocks of localized type .....	77
6.2.3.2	Virtual resource blocks of distributed type .....	77
6.2.4	Resource-element groups.....	79
6.2.4A	Enhanced Resource-Element Groups (EREGs).....	79
6.2.5	Guard period for half-duplex FDD operation .....	80
6.2.6	Guard Period for TDD Operation .....	80
6.2.7	Narrowbands and widebands .....	80
6.2.8	Guard period for narrowband and wideband retuning .....	81
6.3	General structure for downlink physical channels.....	81
6.3.1	Scrambling .....	82
6.3.2	Modulation.....	83
6.3.3	Layer mapping .....	83
6.3.3.1	Layer mapping for transmission on a single antenna port.....	83
6.3.3.2	Layer mapping for spatial multiplexing .....	83
6.3.3.3	Layer mapping for transmit diversity.....	86
6.3.4	Precoding .....	86
6.3.4.1	Precoding for transmission on a single antenna port.....	86
6.3.4.2	Precoding for spatial multiplexing using antenna ports with cell-specific reference signals .....	86
6.3.4.2.1	Precoding without CDD .....	86
6.3.4.2.2	Precoding for large delay CDD .....	87
6.3.4.2.3	Codebook for precoding and CSI reporting.....	88
6.3.4.3	Precoding for transmit diversity .....	89
6.3.4.4	Precoding for spatial multiplexing using antenna ports with UE-specific reference signals.....	90
6.3.5	Mapping to resource elements .....	91
6.4	Physical downlink shared channel.....	91
6.4.1	Physical downlink shared channel for BL/CE UEs .....	93
6.5	Physical multicast channel .....	95
6.6	Physical broadcast channel.....	95
6.6.1	Scrambling.....	96
6.6.2	Modulation.....	96
6.6.3	Layer mapping and precoding .....	96
6.6.4	Mapping to resource elements .....	96
6.7	Physical control format indicator channel.....	97
6.7.1	Scrambling .....	98
6.7.2	Modulation.....	98
6.7.3	Layer mapping and precoding .....	98
6.7.4	Mapping to resource elements .....	98
6.8	Physical downlink control channel.....	99
6.8.1	PDCCH formats.....	99
6.8.2	PDCCH multiplexing and scrambling .....	99
6.8.3	Modulation.....	100

6.8.4	Layer mapping and precoding .....	100
6.8.5	Mapping to resource elements .....	100
6.8A	Enhanced physical downlink control channel .....	101
6.8A.1	EPDCCH formats .....	101
6.8A.2	Scrambling .....	103
6.8A.3	Modulation .....	103
6.8A.4	Layer mapping and precoding .....	103
6.8A.5	Mapping to resource elements .....	103
6.8B	MTC physical downlink control channel .....	104
6.8B.1	MPDCCH formats .....	104
6.8B.2	Scrambling .....	105
6.8B.3	Modulation .....	106
6.8B.4	Layer mapping and precoding .....	106
6.8B.5	Mapping to resource elements .....	106
6.9	Physical hybrid ARQ indicator channel .....	109
6.9.1	Modulation .....	109
6.9.2	Resource group alignment, layer mapping and precoding .....	110
6.9.3	Mapping to resource elements .....	111
6.10	Reference signals .....	113
6.10.1	Cell-specific Reference Signal (CRS) .....	113
6.10.1.1	Sequence generation .....	114
6.10.1.2	Mapping to resource elements .....	114
6.10.2	MBSFN reference signals .....	116
6.10.2.1	Sequence generation .....	116
6.10.2.1.1	Sequence generation for 15 kHz and 7.5 kHz subcarrier spacing .....	116
6.10.2.1.2	Sequence generation for 1.25 kHz subcarrier spacing .....	116
6.10.2.2	Mapping to resource elements .....	117
6.10.2.2.1	Mapping to resource elements for 15 kHz and 7.5 kHz subcarrier spacing .....	117
6.10.2.2.1	Mapping to resource elements for 1.25 kHz .....	118
6.10.3	UE-specific reference signals associated with PDSCH .....	118
6.10.3.1	Sequence generation .....	119
6.10.3.2	Mapping to resource elements .....	120
6.10.3A	Demodulation reference signals associated with EPDCCH or MPDCCH .....	125
6.10.3A.1	Sequence generation .....	125
6.10.3A.2	Mapping to resource elements .....	126
6.10.4	Positioning reference signals .....	127
6.10.4.1	Sequence generation .....	128
6.10.4.2	Mapping to resource elements .....	128
6.10.4.3	Positioning reference signal subframe configuration .....	130
6.10.5	CSI reference signals .....	131
6.10.5.1	Sequence generation .....	132
6.10.5.2	Mapping to resource elements .....	132
6.10.5.3	CSI reference signal subframe configuration .....	140
6.11	Synchronization signals .....	140
6.11.1	Primary synchronization signal (PSS) .....	140
6.11.1.1	Sequence generation .....	140
6.11.1.2	Mapping to resource elements .....	141
6.11.2	Secondary synchronization signal (SSS) .....	142
6.11.2.1	Sequence generation .....	142
6.11.2.2	Mapping to resource elements .....	143
6.11A	Discovery signal .....	144
6.12	OFDM baseband signal generation .....	145
6.13	Modulation and upconversion .....	145
7	Generic functions .....	147
7.1	Modulation mapper .....	147
7.1.1	BPSK .....	147
7.1.2	QPSK .....	147
7.1.3	16QAM .....	147
7.1.4	64QAM .....	148
7.1.5	256QAM .....	150
7.2	Pseudo-random sequence generation .....	153

8	Timing	153
8.1	Uplink-downlink frame timing	153
9	Sidelink	154
9.1	Overview	154
9.1.1	Physical channels	154
9.1.2	Physical signals	154
9.1.3	Handling of simultaneous sidelink and uplink/downlink transmissions	154
9.2	Slot structure and physical resources	155
9.2.1	Resource grid	155
9.2.2	Resource elements	155
9.2.3	Resource blocks	156
9.2.4	Resource pool	156
9.2.5	Guard period	156
9.3	Physical Sidelink Shared Channel	156
9.3.1	Scrambling	156
9.3.2	Modulation	157
9.3.3	Layer mapping	157
9.3.4	Transform precoding	157
9.3.5	Precoding	157
9.3.6	Mapping to physical resources	157
9.4	Physical Sidelink Control Channel	158
9.4.1	Scrambling	158
9.4.2	Modulation	158
9.4.3	Layer mapping	158
9.4.4	Transform precoding	158
9.4.5	Precoding	158
9.4.6	Mapping to physical resources	158
9.5	Physical Sidelink Discovery Channel	159
9.5.1	Scrambling	159
9.5.2	Modulation	159
9.5.3	Layer mapping	159
9.5.4	Transform precoding	159
9.5.5	Precoding	159
9.5.6	Mapping to physical resources	159
9.6	Physical Sidelink Broadcast Channel	159
9.6.1	Scrambling	159
9.6.2	Modulation	159
9.6.3	Layer mapping	160
9.6.4	Transform precoding	160
9.6.5	Precoding	160
9.6.6	Mapping to physical resources	160
9.7	Sidelink Synchronization Signals	160
9.7.1	Primary sidelink synchronization signal	160
9.7.1.1	Sequence generation	160
9.7.1.2	Mapping to resource elements	160
9.7.2	Secondary sidelink synchronization signal	161
9.7.2.1	Sequence generation	161
9.7.2.2	Mapping to resource elements	161
9.8	Demodulation reference signals	161
9.9	SC-FDMA baseband signal generation	163
9.10	Timing	163
10	Narrowband IoT	164
10.1	Uplink	164
10.1.1	Overview	164
10.1.1.1	Physical channels	164
10.1.1.2	Physical signals	164
10.1.2	Slot structure and physical resources	164
10.1.2.1	Resource grid	164
10.1.2.2	Resource elements	165
10.1.2.3	Resource unit	165

10.1.3	Narrowband physical uplink shared channel .....	166
10.1.3.1	Scrambling .....	166
10.1.3.2	Modulation .....	166
10.1.3.3	Layer mapping .....	166
10.1.3.4	Transform precoding .....	166
10.1.3.5	Precoding .....	166
10.1.3.6	Mapping to physical resources .....	166
10.1.4	Demodulation reference signal .....	167
10.1.4.1	Reference signal sequence .....	167
10.1.4.1.1	Reference signal sequence for $N_{sc}^{RU} = 1$ .....	167
10.1.4.1.2	Reference signal sequence for $N_{sc}^{RU} > 1$ .....	168
10.1.4.1.3	Group hopping .....	169
10.1.4.2	Mapping to physical resources .....	170
10.1.5	SC-FDMA baseband signal generation .....	170
10.1.6	Narrowband physical random access channel .....	171
10.1.6.1	Time and frequency structure .....	171
10.1.6.2	Baseband signal generation .....	173
10.1.7	Modulation and upconversion .....	173
10.2	Downlink .....	173
10.2.1	Overview .....	173
10.2.1.1	Physical channels .....	173
10.2.1.2	Physical signals .....	174
10.2.2	Slot structure and physical resource elements .....	174
10.2.2.1	Resource grid .....	174
10.2.2.2	Resource elements .....	174
10.2.2.3	Guard period for half-duplex FDD operation .....	174
10.2.3	Narrowband physical downlink shared channel .....	174
10.2.3.1	Scrambling .....	174
10.2.3.2	Modulation .....	174
10.2.3.3	Layer mapping and precoding .....	175
10.2.3.4	Mapping to resource elements .....	175
10.2.4	Narrowband physical broadcast channel .....	176
10.2.4.1	Scrambling .....	176
10.2.4.2	Modulation .....	176
10.2.4.3	Layer mapping and precoding .....	176
10.2.4.4	Mapping to resource elements .....	176
10.2.5	Narrowband physical downlink control channel .....	177
10.2.5.1	NPDCCH formats .....	177
10.2.5.2	Scrambling .....	177
10.2.5.3	Modulation .....	177
10.2.5.4	Layer mapping and precoding .....	177
10.2.5.5	Mapping to resource elements .....	177
10.2.6	Narrowband reference signal (NRS) .....	178
10.2.6.1	Sequence generation .....	180
10.2.6.2	Mapping to resource elements .....	180
10.2.6A	Narrowband positioning reference signal (NPRS) .....	181
10.2.6A.1	Sequence generation .....	181
10.2.6A.2	Mapping to resource elements .....	182
10.2.6A.3	NPRS subframe configuration .....	183
10.2.7	Synchronization signals .....	184
10.2.7.1	Narrowband primary synchronization signal (NPSS) .....	184
10.2.7.1.1	Sequence generation .....	184
10.2.7.1.2	Mapping to resource elements .....	184
10.2.7.2	Narrowband secondary synchronization signal (NSSS) .....	184
10.2.7.2.1	Sequence generation .....	184
10.2.7.2.2	Mapping to resource elements .....	185
10.2.8	OFDM baseband signal generation .....	186
10.2.9	Modulation and upconversion .....	186
<b>Annex A (informative):</b>	<b>Change history .....</b>	<b>187</b>
History .....		197



---

# Foreword

This Technical Specification has been produced by the 3<sup>rd</sup> 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 the 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.

**ITeH STANDARD PREVIEW**  
(standards.iteh.ai)  
Full standard:  
<https://standards.iteh.ai/catalog/standards/sist/adee9949-b7d3-456d-9118-994bcc01a61d/etsi-ts-136-211-v14.12.0-2019-10>

---

# 1 Scope

The present document describes the physical channels for evolved 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); 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"

---

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