

# ETSI TS 138 214 V15.6.0 (2019-07)



TECHNICAL SPECIFICATION

**5G;  
NR;**

**Physical layer procedures for data  
(3GPP TS 38.214 version 15.6.0 Release 15)**

*Standard PREVIEW  
(standards.iteh.ai)  
Full standards list: <https://standards.iteh.ai/catalog/standards/sist/955dac45-1800-4d8c-82e4-552267843695/etsi-ts-138-214-v15.6.0-2019-07>*



---

Reference

RTS/TSGR-0138214vf60

---

Keywords

---

5G

**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 ETSI 3rd 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.....	5
1 Scope .....	6
2 References .....	6
3 Definitions, symbols and abbreviations .....	7
3.1 Definitions .....	7
3.2 Symbols.....	7
3.3 Abbreviations .....	7
4 Power control .....	8
4.1 Power allocation for downlink .....	8
5 Physical downlink shared channel related procedures .....	9
5.1 UE procedure for receiving the physical downlink shared channel .....	9
5.1.1 Transmission schemes .....	10
5.1.1.1 Transmission scheme 1 .....	10
5.1.2 Resource allocation.....	10
5.1.2.1 Resource allocation in time domain .....	10
5.1.2.1.1 Determination of the resource allocation table to be used for PDSCH.....	11
5.1.2.2 Resource allocation in frequency domain .....	14
5.1.2.2.1 Downlink resource allocation type 0.....	15
5.1.2.2.2 Downlink resource allocation type 1 .....	15
5.1.2.3 Physical resource block (PRB) bundling.....	16
5.1.3 Modulation order, target code rate, redundancy version and transport block size determination.....	17
5.1.3.1 Modulation order and target code rate determination .....	19
5.1.3.2 Transport block size determination .....	22
5.1.4 PDSCH resource mapping .....	25
5.1.4.1 PDSCH resource mapping with RB symbol level granularity .....	25
5.1.4.2 PDSCH resource mapping with RE level granularity .....	26
5.1.5 Antenna ports quasi co-location.....	27
5.1.6 UE procedure for receiving downlink reference signals.....	29
5.1.6.1 CSI-RS reception procedure.....	29
5.1.6.1.1 CSI-RS for tracking .....	30
5.1.6.1.2 CSI-RS for L1-RSRP computation.....	31
5.1.6.1.3 CSI-RS for mobility .....	31
5.1.6.2 DM-RS reception procedure .....	32
5.1.6.3 PT-RS reception procedure .....	33
5.1.7 Code block group based PDSCH transmission.....	35
5.1.7.1 UE procedure for grouping of code blocks to code block groups .....	35
5.1.7.2 UE procedure for receiving code block group based transmissions.....	35
5.2 UE procedure for reporting channel state information (CSI) .....	36
5.2.1 Channel state information framework.....	36
5.2.1.1 Reporting settings .....	36
5.2.1.2 Resource settings.....	36
5.2.1.3 (void).....	37
5.2.1.4 Reporting configurations.....	37
5.2.1.4.1 Resource Setting configuration .....	39
5.2.1.4.2 Report Quantity Configurations .....	40
5.2.1.4.3 L1-RSRP Reporting.....	41
5.2.1.5 Triggering/activation of CSI Reports and CSI-RS .....	41
5.2.1.5.1 Aperiodic CSI Reporting/Aperiodic CSI-RS.....	41
5.2.1.5.2 Semi-persistent CSI/Semi-persistent CSI-RS.....	43
5.2.1.6 CSI processing criteria .....	44

5.2.2	Channel state information.....	45
5.2.2.1	Channel quality indicator (CQI).....	45
5.2.2.1.1	(void).....	47
5.2.2.2	Precoding matrix indicator (PMI).....	47
5.2.2.2.1	Type I Single-Panel Codebook.....	47
5.2.2.2.2	Type I Multi-Panel Codebook.....	54
5.2.2.2.3	Type II Codebook.....	58
5.2.2.2.4	Type II Port Selection Codebook.....	64
5.2.2.3	Reference signal (CSI-RS).....	67
5.2.2.3.1	NZP CSI-RS.....	67
5.2.2.4	Channel State Information – Interference Measurement (CSI-IM).....	68
5.2.2.5	CSI reference resource definition.....	69
5.2.3	CSI reporting using PUSCH.....	70
5.2.4	CSI reporting using PUCCH.....	72
5.2.5	Priority rules for CSI reports.....	73
5.3	UE PDSCH processing procedure time.....	73
5.4	UE CSI computation time.....	75
6	Physical uplink shared channel related procedure.....	76
6.1	UE procedure for transmitting the physical uplink shared channel.....	76
6.1.1	Transmission schemes.....	77
6.1.1.1	Codebook based UL transmission.....	77
6.1.1.2	Non-Codebook based UL transmission.....	78
6.1.2	Resource allocation.....	79
6.1.2.1	Resource allocation in time domain.....	79
6.1.2.1.1	Determination of the resource allocation table to be used for PUSCH.....	80
6.1.2.2	Resource allocation in frequency domain.....	82
6.1.2.2.1	Uplink resource allocation type 0.....	83
6.1.2.2.2	Uplink resource allocation type 1.....	83
6.1.2.3	Resource allocation for uplink transmission with configured grant.....	84
6.1.3	UE procedure for applying transform precoding on PUSCH.....	85
6.1.4	Modulation order, redundancy version and transport block size determination.....	85
6.1.4.1	Modulation order and target code rate determination.....	87
6.1.4.2	Transport block size determination.....	90
6.1.5	Code block group based PUSCH transmission.....	91
6.1.5.1	UE procedure for grouping of code blocks to code block groups.....	91
6.1.5.2	UE procedure for transmitting code block group based transmissions.....	92
6.2	UE reference signal (RS) procedure.....	92
6.2.1	UE sounding procedure.....	92
6.2.1.1	UE SRS frequency hopping procedure.....	95
6.2.1.2	UE sounding procedure for DL CSI acquisition.....	96
6.2.1.3	UE sounding procedure between component carriers.....	96
6.2.2	UE DM-RS transmission procedure.....	98
6.2.3	UE PT-RS transmission procedure.....	99
6.2.3.1	UE PT-RS transmission procedure when transform precoding is not enabled.....	99
6.2.3.2	UE PT-RS transmission procedure when transform precoding is enabled.....	101
6.3	UE PUSCH frequency hopping procedure.....	102
6.4	UE PUSCH preparation procedure time.....	103
<b>Annex A (informative):</b>	<b>Change history.....</b>	<b>105</b>
History.....		107

---

# Foreword

This Technical Specification 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 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.

**PREVIEW**  
iTech STANDARD  
(standards.itih.ai)  
Full standard:  
<https://standards.itih.ai/catalog/standards/sist/955dac45-1800-4d8c-82e4-552267843695/etsi-ts-138-214-v15.6.0-2019-07>

---

# 1 Scope

The present document specifies and establishes the characteristics of the physical layer procedures of data channels for 5G-NR.

---

# 2 References

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

- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications"
- [2] 3GPP TS 38.201: " NR; Physical Layer – General Description"
- [3] 3GPP TS 38.202: "NR; Services provided by the physical layer"
- [4] 3GPP TS 38.211: "NR; Physical channels and modulation"
- [5] 3GPP TS 38.212: "NR; Multiplexing and channel coding"
- [6] 3GPP TS 38.213: "NR; Physical layer procedures for control"
- [7] 3GPP TS 38.215: "NR; Physical layer measurements"
- [8] 3GPP TS 38.101: "NR; User Equipment (UE) radio transmission and reception"
- [9] 3GPP TS 38.104: "NR; Base Station (BS) radio transmission and reception"
- [10] 3GPP TS 38.321: "NR; Medium Access Control (MAC) protocol specification"
- [11] 3GPP TS 38.133: "NR; Requirements for support of radio resource management"
- [12] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification"
- [13] 3GPP TS 38.306: "NR; User Equipment (UE) radio access capabilities"
- [14] 3GPP TS 38.423: "NG-RAN; Xn signalling transport"
- [15] 3GPP TS 36.211: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation"

## 3 Definitions, symbols and abbreviations

### 3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

### 3.2 Symbols

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

### 3.3 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].

BWP	Bandwidth part
CBG	Code block group
CP	Cyclic prefix
CQI	Channel quality indicator
CPU	CSI processing unit
CRB	Common resource block
CRC	Cyclic redundancy check
CRI	CSI-RS Resource Indicator
CSI	Channel state information
CSI-RS	Channel state information reference signal
CSI-RSRP	CSI reference signal received power
CSI-RSRQ	CSI reference signal received quality
CSI-SINR	CSI signal-to-noise and interference ratio
CW	Codeword
DCI	Downlink control information
DL	Downlink
DM-RS	Dedicated demodulation reference signals
EPRE	Energy per resource element
L1-RSRP	Layer 1 reference signal received power
LI	Layer Indicator
MCS	Modulation and coding scheme
PDCCH	Physical downlink control channel
PDSCH	Physical downlink shared channel
PSS	Primary Synchronisation signal
PUCCH	Physical uplink control channel
QCL	Quasi co-location
PMI	Precoding Matrix Indicator
PRB	Physical resource block
PRG	Precoding resource block group
PT-RS	Phase-tracking reference signal
RB	Resource block
RBG	Resource block group
RI	Rank Indicator
RIV	Resource indicator value
RS	Reference signal
SLIV	Start and length indicator value
SR	Scheduling Request
SRS	Sounding reference signal
SS	Synchronisation signal
SSS	Secondary Synchronisation signal
SS-RSRP	SS reference signal received power



SS-RSRQ	SS reference signal received quality
SS-SINR	SS signal-to-noise and interference ratio
TB	Transport Block
TCI	Transmission Configuration Indicator
TDM	Time division multiplexing
UE	User equipment
UL	Uplink

## 4 Power control

### 4.1 Power allocation for downlink

The gNB determines the downlink transmit EPRE.

For the purpose of SS-RSRP, SS-RSRQ and SS-SINR measurements, the UE may assume downlink EPRE is constant across the bandwidth. For the purpose of SS-RSRP, SS-RSRQ and SS-SINR measurements, the UE may assume downlink EPRE is constant over SSS carried in different SS/PBCH blocks. For the purpose of SS-RSRP, SS-RSRQ and SS-SINR measurements, the UE may assume that the ratio of SSS EPRE to PBCH DM-RS EPRE is 0 dB.

For the purpose of CSI-RSRP, CSI-RSRQ and CSI-SINR measurements, the UE may assume downlink EPRE of a port of CSI-RS resource configuration is constant across the configured downlink bandwidth and constant across all configured OFDM symbols.

The downlink SS/PBCH SSS EPRE can be derived from the SS/PBCH downlink transmit power given by the parameter *ss-PBCH-BlockPower* provided by higher layers. The downlink SSS transmit power is defined as the linear average over the power contributions (in [W]) of all resource elements that carry the SSS within the operating system bandwidth.

The downlink CSI-RS EPRE can be derived from the SS/PBCH block downlink transmit power given by the parameter *ss-PBCH-BlockPower* and CSI-RS power offset given by the parameter *powerControlOffsetSS* provided by higher layers. The downlink reference-signal transmit power is defined as the linear average over the power contributions (in [W]) of the resource elements that carry the configured CSI-RS within the operating system bandwidth.

For downlink DM-RS associated with PDSCH, the UE may assume the ratio of PDSCH EPRE to DM-RS EPRE ( $\beta_{DMRS}$  [dB]) is given by Table 4.1-1 according to the number of DM-RS CDM groups without data as described in Subclause 5.1.6.2. The DM-RS scaling factor  $\beta_{PDSCH}^{DMRS}$  specified in Subclause 7.4.1.1.2 of [4, TS 38.211] is given by

$$\beta_{PDSCH}^{DMRS} = 10^{\frac{\beta_{DMRS}}{20}}.$$

**Table 4.1-1: The ratio of PDSCH EPRE to DM-RS EPRE**

Number of DM-RS CDM groups without data	DM-RS configuration type 1	DM-RS configuration type 2
1	0 dB	0 dB
2	-3 dB	-3 dB
3	-	-4.77 dB

When the UE is scheduled with a PT-RS port associated with the PDSCH,

- if the UE is configured with the higher layer parameter *epre-Ratio*, the ratio of PT-RS EPRE to PDSCH EPRE per layer per RE for PT-RS port ( $\rho_{PTRS}$ ) is given by Table 4.1-2 according to the *epre-Ratio*, the PT-RS scaling factor  $\beta_{PTRS}$  specified in subclause 7.4.1.2.2 of [4, TS 38.211] is given by  $\beta_{PTRS} = 10^{\frac{\rho_{PTRS}}{20}}$ .
- otherwise, the UE shall assume *epre-Ratio* is set to state '0' in Table 4.1-2 if not configured.

Table 4.1-2: PT-RS EPRE to PDSCH EPRE per layer per RE ( $\rho_{PTRS}$ )

epre-Ratio	The number of PDSCH layers					
	1	2	3	4	5	6
0	0	3	4.77	6	7	7.78
1	0	0	0	0	0	0
2	reserved					
3	reserved					

For link recovery, as described in clause 6 of [6, TS 38.213] the ratio of the PDCCH EPRE to NZP CSI-RS EPRE is assumed as 0 dB.

## 5 Physical downlink shared channel related procedures

### 5.1 UE procedure for receiving the physical downlink shared channel

For downlink, a maximum of 16 HARQ processes per cell is supported by the UE. The number of processes the UE may assume will at most be used for the downlink is configured to the UE for each cell separately by higher layer parameter *nrofHARQ-ProcessesForPDSCH*, and when no configuration is provided the UE may assume a default number of 8 processes.

A UE shall upon detection of a PDCCH with a configured DCI format 1\_0 or 1\_1 decode the corresponding PDSCHs as indicated by that DCI. For any HARQ process ID(s) in a given scheduled cell, the UE is not expected to receive a PDSCH that overlaps in time with another PDSCH. The UE is not expected to receive another PDSCH for a given HARQ process until after the end of the expected transmission of HARQ-ACK for that HARQ process, where the timing is given by Subclause 9.2.3 of [6]. In a given scheduled cell, the UE is not expected to receive a first PDSCH in slot *i*, with the corresponding HARQ-ACK assigned to be transmitted in slot *j*, and a second PDSCH starting later than the first PDSCH with its corresponding HARQ-ACK assigned to be transmitted in a slot before slot *j*. For any two HARQ process IDs in a given scheduled cell, if the UE is scheduled to start receiving a first PDSCH starting in symbol *j* by a PDCCH ending in symbol *i*, the UE is not expected to be scheduled to receive a PDSCH starting earlier than the end of the first PDSCH with a PDCCH that ends later than symbol *i*. In a given scheduled cell, for any PDSCH corresponding to SI-RNTI, the UE is not expected to decode a re-transmission of an earlier PDSCH with a starting symbol less than *N* symbols after the last symbol of that PDSCH, where the value of *N* depends on the PDSCH subcarrier spacing configuration  $\mu$ , with  $N=13$  for  $\mu=0$ ,  $N=13$  for  $\mu=1$ ,  $N=20$  for  $\mu=2$ , and  $N=24$  for  $\mu=3$ .

When receiving PDSCH scheduled with SI-RNTI or P-RNTI, the UE may assume that the DM-RS port of PDSCH is quasi co-located with the associated SS/PBCH block with respect to Doppler shift, Doppler spread, average delay, delay spread, spatial RX parameters when applicable.

When receiving PDSCH scheduled with RA-RNTI the UE may assume that the DM-RS port of PDSCH is quasi co-located with the SS/PBCH block or the CSI-RS resource the UE used for RACH association and transmission with respect to Doppler shift, Doppler spread, average delay, delay spread, spatial RX parameters when applicable. When receiving a PDSCH scheduled with RA-RNTI in response to a random access procedure triggered by a PDCCH order which triggers non-contention based random access procedure for the SpCell [10, TS 38.321], the UE may assume that the DM-RS port of the received PDCCH order and the DM-RS ports of the corresponding PDSCH scheduled with RA-RNTI are quasi co-located with the same SS/PBCH block or CSI-RS with respect to Doppler shift, Doppler spread, average delay, delay spread, spatial RX parameters when applicable.

When receiving PDSCH in response to a PUSCH transmission scheduled by a RAR UL grant or corresponding PUSCH retransmission the UE may assume that the DM-RS port of PDSCH is quasi co-located with the SS/PBCH block the UE selected for RACH association and transmission with respect to Doppler shift, Doppler spread, average delay, delay spread, spatial RX parameters when applicable.

If the UE is not configured for PUSCH/PUCCH transmission for at least one serving cell configured with slot formats comprised of DL and UL symbols, and if the UE is not capable of simultaneous reception and transmission on serving cell  $c_1$  and serving cell  $c_2$ , the UE is not expected to receive PDSCH on serving cell  $c_1$  if the PDSCH overlaps in time

with SRS transmission (including any interruption due to uplink or downlink RF retuning time [10]) on serving cell  $c_2$  not configured for PUSCH/PUCCH transmission.

The UE is not expected to decode a PDSCH scheduled in the primary cell with C-RNTI or MCS-C-RNTI and another PDSCH scheduled in the primary cell with CS-RNTI if the PDSCHs partially or fully overlap in time.

The UE is not expected to decode a PDSCH scheduled with C-RNTI, MCS-C-RNTI, or CS-RNTI if another PDSCH in the same cell scheduled with RA-RNTI partially or fully overlap in time.

The UE in RRC\_IDLE and RRC\_INACTIVE modes shall be able to decode two PDSCHs each scheduled with SI-RNTI, P-RNTI, RA-RNTI or TC-RNTI, with the two PDSCHs partially or fully overlapping in time in non-overlapping PRBs.

On a frequency range 1 cell, the UE shall be able to decode a PDSCH scheduled with C-RNTI, MCS-C-RNTI, or CS-RNTI and, during a process of P-RNTI triggered SI acquisition, another PDSCH scheduled with SI-RNTI that partially or fully overlap in time in non-overlapping PRBs, unless the PDSCH scheduled with C-RNTI, MCS-C-RNTI, or CS-RNTI requires Capability 2 processing time according to subclause 5.3 in which case the UE may skip decoding of the scheduled PDSCH with C-RNTI, MCS-C-RNTI, or CS-RNTI.

On a frequency range 2 cell, the UE is not expected to decode a PDSCH scheduled with C-RNTI, MCS-C-RNTI, or CS-RNTI if in the same cell, during a process of P-RNTI triggered SI acquisition, another PDSCH scheduled with SI-RNTI partially or fully overlap in time in non-overlapping PRBs.

The UE is expected to decode a PDSCH scheduled with C-RNTI, MCS-C-RNTI, or CS-RNTI during a process of autonomous SI acquisition.

If the UE is configured by higher layers to decode a PDCCH with its CRC scrambled by a CS-RNTI, the UE shall receive PDSCH transmissions without corresponding PDCCH transmissions using the higher-layer-provided PDSCH configuration for those PDSCHs.

## 5.1.1 Transmission schemes

Only one transmission scheme is defined for the PDSCH, and is used for all PDSCH transmissions.

### 5.1.1.1 Transmission scheme 1

For transmission scheme 1 of the PDSCH, the UE may assume that a gNB transmission on the PDSCH would be performed with up to 8 transmission layers on antenna ports 1000-1011 as defined in Subclause 7.3.1.4 of [4, TS 38.211], subject to the DM-RS reception procedures in Subclause 5.1.6.2.

## 5.1.2 Resource allocation

### 5.1.2.1 Resource allocation in time domain

When the UE is scheduled to receive PDSCH by a DCI, the *Time domain resource assignment* field value  $m$  of the DCI provides a row index  $m + 1$  to an allocation table. The determination of the used resource allocation table is defined in sub-clause 5.1.2.1.1. The indexed row defines the slot offset  $K_0$ , the start and length indicator  $SLIV$ , or directly the start symbol  $S$  and the allocation length  $L$ , and the PDSCH mapping type to be assumed in the PDSCH reception.

Given the parameter values of the indexed row:

- The slot allocated for the PDSCH is  $\left\lceil n \cdot \frac{2^{\mu_{\text{PDSCH}}}}{2^{\mu_{\text{PDCCH}}}} \right\rceil + K_0$ , where  $n$  is the slot with the scheduling DCI, and  $K_0$  is

based on the numerology of PDSCH, and  $\mu_{\text{PDSCH}}$  and  $\mu_{\text{PDCCH}}$  are the subcarrier spacing configurations for PDSCH and PDCCH, respectively, and

- The starting symbol  $S$  relative to the start of the slot, and the number of consecutive symbols  $L$  counting from the symbol  $S$  allocated for the PDSCH are determined from the start and length indicator  $SLIV$ :

if  $(L-1) \leq 7$  then

$$SLIV = 14 \cdot (L-1) + S$$

else

$$SLIV = 14 \cdot (14-L+1) + (14-1-S)$$

where  $0 < L \leq 14 - S$ , and

- The PDSCH mapping type is set to Type A or Type B as defined in sub-clause 7.4.1.1.2 of [4, TS 38.211].

The UE shall consider the  $S$  and  $L$  combinations defined in table 5.1.2.1-1 as valid PDSCH allocations:

**Table 5.1.2.1-1: Valid  $S$  and  $L$  combinations**

PDSCH mapping type	Normal cyclic prefix			Extended cyclic prefix		
	$S$	$L$	$S+L$	$S$	$L$	$S+L$
Type A	{0,1,2,3} (Note 1)	{3,...,14}	{3,...,14}	{0,1,2,3} (Note 1)	{3,...,12}	{3,...,12}
Type B	{0,...,12}	{2,4,7}	{2,...,14}	{0,...,10}	{2,4,6}	{2,...,12}

Note 1:  $S = 3$  is applicable only if  $dmrs\text{-}TypeA\text{-}Position = 3$

When receiving PDSCH scheduled by DCI format 1\_1 in PDCCH with CRC scrambled by C-RNTI, MCS-C-RNTI, CS-RNTI, or PDSCH scheduled without corresponding PDCCH transmission using *sps-Config* and activated by DCI format 1\_1, if the UE is configured with *pdsch-AggregationFactor*, the same symbol allocation is applied across the *pdsch-AggregationFactor* consecutive slots. The UE may expect that the TB is repeated within each symbol allocation among each of the *pdsch-AggregationFactor* consecutive slots and the PDSCH is limited to a single transmission layer. The redundancy version to be applied on the  $n^{\text{th}}$  transmission occasion of the TB is determined according to table 5.1.2.1-2.

**Table 5.1.2.1-2: Applied redundancy version when *pdsch-AggregationFactor* is present**

$r_{vid}$ indicated by the DCI scheduling the PDSCH	$r_{vid}$ to be applied to $n^{\text{th}}$ transmission occasion			
	$n \bmod 4 = 0$	$n \bmod 4 = 1$	$n \bmod 4 = 2$	$n \bmod 4 = 3$
0	0	2	3	1
2	2	3	1	0
3	3	1	0	2
1	1	0	2	3

A PDSCH reception in a slot of a multi-slot PDSCH reception is omitted according to the conditions in Subclause 11.1 of [6, TS38.213].

The UE is not expected to receive a PDSCH with mapping type A in a slot, if the PDCCH scheduling the PDSCH was received in the same slot and was not contained within the first three symbols of the slot.

The UE is not expected to receive a PDSCH with mapping type B in a slot, if the first symbol of the PDCCH scheduling the PDSCH was received in a later symbol than the first symbol indicated in the PDSCH time domain resource allocation.

#### 5.1.2.1.1 Determination of the resource allocation table to be used for PDSCH

Table 5.1.2.1.1-1 defines which PDSCH time domain resource allocation configuration to apply. Either a default PDSCH time domain allocation A, B or C according to tables 5.1.2.1.1-2, 5.1.2.1.1-3, 5.1.2.1.1-4 and 5.1.2.1.1-5 is applied, or the higher layer configured *pdsch-TimeDomainAllocationList* in either *pdsch-ConfigCommon* or *pdsch-Config* is applied.

Table 5.1.2.1.1-1: Applicable PDSCH time domain resource allocation

RNTI	PDCCH search space	SS/PBCH block and CORESET multiplexing pattern	<i>pdsch-ConfigCommon</i> includes <i>pdsch-TimeDomainAllocationList</i>	<i>pdsch-Config</i> includes <i>pdsch-TimeDomainAllocationList</i>	PDSCH time domain resource allocation to apply
SI-RNTI	Type0 common	1	-	-	Default A for normal CP
		2	-	-	Default B
		3	-	-	Default C
SI-RNTI	Type0A common	1	No	-	Default A
		2	No	-	Default B
		3	No	-	Default C
		1,2,3	Yes	-	<i>pdsch-TimeDomainAllocationList</i> provided in <i>pdsch-ConfigCommon</i>
RA-RNTI, TC-RNTI	Type1 common	1, 2, 3	No	-	Default A
		1, 2, 3	Yes	-	<i>pdsch-TimeDomainAllocationList</i> provided in <i>pdsch-ConfigCommon</i>
P-RNTI	Type2 common	1	No	-	Default A
		2	No	-	Default B
		3	No	-	Default C
		1,2,3	Yes	-	<i>pdsch-TimeDomainAllocationList</i> provided in <i>pdsch-ConfigCommon</i>
C-RNTI, MCS-C-RNTI, CS-RNTI	Any common search space associated with CORESET 0	1, 2, 3	No	-	Default A
		1, 2, 3	Yes	-	<i>pdsch-TimeDomainAllocationList</i> provided in <i>pdsch-ConfigCommon</i>
C-RNTI, MCS-C-RNTI, CS-RNTI	Any common search space not associated with CORESET 0	1,2,3	No	No	Default A
		1,2,3	Yes	No	<i>pdsch-TimeDomainAllocationList</i> provided in <i>pdsch-ConfigCommon</i>
		UE specific search space	1,2,3	No/Yes	Yes