**3GPP TSG-RAN WG4 Meeting # 109 *R4-2321132***

**Chicago, U.S, November 13 - November 17, 2023**

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| *CR-Form-v12.2* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **TS 38.101-4** | **CR** | Draft big CR | **rev** |  | **Current version:** | 18.1.0 |  |
|  | | | | | | | | |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME | **x** | Radio Access Network |  | Core Network |  |

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|  | | | | | | | | | | |
| ***Title:*** | Draft BigCR on 38.101-4 for introduction of 8Rx performance requirements | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Huawei, HiSilcon | | | | | | | | | |
| ***Source to TSG:*** | RAN4 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_ENDC\_RF\_FR1\_enh2-Perf | | | | |  | ***Date:*** | | | 2023-11-21 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | | Rel-18 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | According to chairman’s assignment, Huawei is resonsible for bigCR preparation for 8Rx demodulation and CSI requirements. | | | | | | | | |
|  | |  | | | | | | | | |
| Summary of change: | | Combined all related draft CRs:  R4-2311509 Draft CR to TS 38.101-4 for supporting of 8Rx in Rel-18(ZTE)  R4-2311909 draft CR on Inclusion of Correlation Matrices for 8Rx UEs (Apple)  R4-2313880\_draft CR on CSI requirements v01(CTC)  R4-2315041 - CR 38\_101-4 8Rx Applicability Rule (Nokia)  R4-2319330 Draft CR on 8Rx PDSCH demodulation requirements (Samsung)  R4-2315984 CR on 38.101-4 Requirements applicability for 8Rx CSI applicabaility rules(Huawei)  R4-2316977 Draft CR to 38.101-4 Reference measurement channels for 8Rx PDSCH requirements(MTK)  R4-2316978 draftCR on SDR for FR1 8 Rx (Ericsson)  R4-2321198 Introduction of 8Rx CA Performance Requirements (Nokia)  R4-2318668 Draft CR to 38.101-4 Reference measurement channels for 8Rx CA PDSCH requirements (FDD, 8 layers) (MediaTek)  R4-2319228 Draft CR to 38.101-4 for FRC for FDD 8 layers (30MHz,35MHz,40MHz, 45MHz, 50MHz) (Ericsson)  R4-2319229 Draft CR to 38.101-4 for FRC for TDD 8 layers (5MHz,10MHz,15MHz,20MHz,25MHz,30MHz) (Ericsson)  R4-2319230 Draft CR to 38.101-4 for FRC for FDD 2 layers (5MHz, 10MHz, 15MHz,20MHz,25MHz) (Ericsson)  R4-2319331 Draft CR on FRC for TDD 8 layers (40-100MHz) (Samsung)  [R4-2321197](ftp://10.10.10.10/ftp/tsg_ran/WG4_Radio/TSGR4_109/Inbox/R4-2321197.zip) Draft CR on 8Rx PDSCH CA requirements FRC for FDD 2 layers (China Telecom)  R4-2320191 CR on 38.101-4 Introduction of applicability rules for 8Rx CA requirements (Huawei,HiSilicon) | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | All 8Rx requirements will be missing | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 5.1.1.2; 5.2.4;5.5A;6.1.1;6.2.4; A.3.2.2.2; A.3.2.1.1;B.1.3; B.2.3.1.2 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **x** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | | **x** |  | Test specifications | | | | TS 38.521-4 | | |
| ***(show related CRs)*** | |  | **x** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

Start of R4-2315041

#### 5.1.1.2 Applicability of requirements for different number of RX antenna ports

The number of RX antenna ports for different RF operating bands is up to UE declaration.

The UE shall support 2, 4 or 8 RX antenna ports for different RF operating bands. The operating bands, where 4 RX antenna ports shall be the baseline, are defined in Clause 7.2 of TS 38.101-1 [6]. The UE requirements applicability for UEs with different number of RX antenna ports is defined in Table 5.1.1.2-1.

Table 5.1.1.2-1: Requirements applicability

|  |  |  |  |
| --- | --- | --- | --- |
| Supported RX antenna ports | Test type | Test list | Exceptions |
| UE supports only 2RX | PDSCH | All tests in Clause 5.2.2 |  |
|  | PDCCH | All tests in Clause 5.3.2 |  |
|  | PBCH | All tests in Clause 5.4.2 |  |
| UE supports only 4RX or both 2RX and 4RX | PDSCH | All tests in Clause 5.2.3 (Note 2) |  |
|  | PDCCH | All tests in Clause 5.3.3 (Note 2) |  |
|  | PBCH | All tests in Clause 5.4.2 or 5.4.3 (Note 1) |  |
| UE supports 8Rx, 4Rx and 2Rx | PDSCH | Tests in Clause 5.2.3.(Note 2, 3)  All tests in Clause 5.2.4.(Note 2) | If UE passes tests in Clause 5.2.4, UE can skip Test 2-1 and Test 2-2 in Clause 5.2.3 Table 5.2.3.1.1-4, Table 5.2.3.2.1-4 and Test 4-1 in Clause 5.2.3 Table 5.2.3.1.1-6, Table 5.2.3.2.1-6 |
| or | PDCCH | All tests in Clause 5.3.3.(Note 2,3) |  |
| UE supports only 8Rx and 4Rx | PBCH | All tests in Clause 5.4.3(Note 1) |  |
| UE supports only 8Rx and 2Rx | PDSCH | Tests in Clause 5.2.2.(Note 2, 4)  All tests in Clause 5.2.4.(Note 2) | If UE passes tests in Clause 5.2.4, UE can skip Test 2-1 and Test 2-2 in Clause 5.2.2 Table 5.2.2.1.1-4, Table 5.2.2.2.1-4 |
|  | PDCCH | All tests in Clause 5.3.2.(Note 2,4) |  |
|  | PBCH | All tests in Clause 5.4.2 |  |
| UE supports only 8Rx | PDSCH | All tests in Clause 5.2.4.(Note 2) |  |
|  | PDCCH | N/A |  |
|  | PBCH | N/A |  |
| Note 1: Requirements for PBCH with 4Rx is up to UE declaration  Note 2: ‘*maxMIMO-Layers-r16*’ is not configured during the performance requirements testing for UE supporting Release 16 per-BWP MIMO layer adaptation.  Note 3: 8Rx capable UEs are tested on any of the 4Rx supported RF bands by connecting 4 out of 8 Rx with data source from system simulator, and the other 4 Rx are connected with zero input, depending on UE’s declaration and AP configuration. Requirements specified with 4Rx should be applied.  Note 4: 8Rx capable UEs are tested on any of the 2Rx supported RF bands by connecting 2 out of 8 Rx with data source from system simulator, and the other 6 Rx are connected with zero input, depending on UE’s declaration and AP configuration. Requirements specified with 2Rx should be applied. | | | |

End of R4-2315041

Start of R4-2320191

5.1.1.7 Applicability of CA requirements

5.1.1.7.5 Applicability and test rules for different CA configurations and bandwidth combination sets for 8Rx UE

The performance requirement for CA UE demodulation tests for 8Rx UE in Clause 5.2A.4 are defined independent of CA configurations and bandwidth combination sets specified in Clause 5.5A of TS 38.101-1. For 8Rx UEs supporting different CA configurations and bandwidth combination sets, the applicability and test rules are defined in Table 5.1.1.7.5-1 and Table 5.1.1.7.5-2. For simplicity, CA configuration below refers to combination of CA configuration and bandwidth combination set.

**Table 5.1.1.7.5-1: Applicability and test rules for CA UE demodulation tests for 8Rx UE**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tests** | **CA capability where the tests apply** | **CA configuration from the selected CA capability where the tests apply** | **CA Bandwidth combination to be tested in priority order** | **PCell CC configuration** |
| [Test 1 in Clause 5.2A.2.1, 5.2A.3.1 and 5.2A.4.1] | CA\_C, CA\_N, CA\_AX | Table 5.1.1.7.5-2 | Largest aggregated CA bandwidth combination | Any of CCs |
| [Test 2 in Clause 5.2A.2.1, 5.2A.3.1and 5.2A.4.1] | CA\_C, CA\_N, CA\_AX | Table 5.1.1.7.5-2 | Largest aggregated CA bandwidth combination | Any of CCs |
| [Test 3 in Clause 5.2A.2.1, 5.2A.3.1and 5.2A.4.1] | CA\_AX | Table 5.1.1.7.5-2 | Largest aggregated CA bandwidth combination | TDD CC if supported, otherwise FDD CC |
| NOTE 1: In case CA\_AX with different number of X is supported then one or two CA configurations are selected based on procedure from Table 5.1.1.7.5-2. | | | | |

**Table 5.1.1.7.5-2: Selection of CA configurations for 8Rx UE**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CA capability** | **Step 1** | **Step 2** | **Step 3** | **Step 4** |
| CA\_C or CA\_N | If the UE supports CA configuration that for each CC, supported maximum number of Rx and maximum number of MIMO layers is 8:  Select the CA configurations with the maximum number of CCs, for which the supported maximum number of Rx and MIMO layers is 8.  Otherwise:  Select the CA configurations with the maximum number of CCs, conditioned that at least for one CC the supported maximum number of Rx is 8 and for each CC the supported maximum number of MIMO layers is not lower than 2 | Select any one of CA configurations, which contain CA bandwidth combination with the largest aggregated channel bandwidth and supported maximum data rate is not lower than the tested date rate, among all the selected CA configurations from Step 1. | N/A | N/A |
| CA\_AX | If the UE supports CA configuration that for each CC, supported maximum number of Rx and maximum number of MIMO layers is 8:  Select the CA configurations with the maximum number of CCs, for which the supported maximum number of Rx and MIMO layers is 8.  Otherwise:  Select the CA configurations with the maximum number of CCs, conditioned that at least for one CC the supported maximum number of Rx is 8 and for each CC the supported maximum number of MIMO layers is not lower than 2 | Select any one of CA configurations, which contain CA bandwidth combination with the largest aggregated channel bandwidth and supported maximum data rate is not lower than the tested date rate, among all the selected CA configurations from Step 1. | If the tested UE support CA configuration that for each CC, supported maximum number of Rx and maximum number of MIMO layers is 8:  Select the CA configurations with the largest number of bands and with the maximum number of CCs, for which the supported maximum number of Rx and MIMO layers is 8.  Otherwise:  Select the CA configurations with the largest number of bands and with the maximum number of CCs, conditioned that at least for one CC the supported maximum number of Rx is 8 and for each CC the supported maximum number of MIMO layers is not lower than 2 | Select any one of CA configurations, which contain CA bandwidth combination with the largest aggregated channel bandwidth and supported maximum data rate is not lower than the tested date rate, among all the selected CA configurations from Step 3. |
| NOTE 1: For CA\_AX capability, if CA configuration from step 2 is CA configuration with the largest number of bands then Step 3 and Step 4 are skipped. Otherwise, the two CA configurations selected from Step 2 and Step 4 are used for testing.  NOTE 2: Maximum supported data rate for Step 2 and Step 4 is calculated based clause 4.1.2 of TS 38.306 [14].  NOTE 3: Tested data rate for Step 2 and Step 4 is calculated based on the equation and FRCs used in the test. | | | | |

5.1.1.7.6 Applicability rule and antenna connection for CA tests with 8 RX

Within the CA configuration if any of the PCell and/or the SCells is a 4Rx supported RF band, 4 out of the 8Rx should be connected with data source from system simulator, depending on UE’s declaration and AP configuration. Requirements from Clause 5.2A.3.1 are applied.

Within the CA configuration if any of the PCell and/or the SCells is a 2Rx supported RF band, 2 out of the 8Rx should be connected with data source from system simulator, depending on UE’s declaration and AP configuration. Requirements from Clause 5.2A.2.1 are applied.

Within the CA configuration if any of the PCell and/or the SCells is a 8Rx supported RF band, all 8Rx should be connected with data source from system simulator. Requirements from Clause5.2A.4.1 are applied.

For 8Rx capable UEs, the 2Rx supported RF bands, 4Rx supported RF bands and 8Rx supported RF bands are up to UE’s declaration.

End of R4-2320191

Start of R4-2319330

### 5.2.4 8RX requirements

#### 5.2.4.1 FDD

##### 5.2.4.1.1 Minimum requirements for PDSCH Mapping Type A

The performance requirements are specified in Table 5.2.4.1.1-3, Table 5.2.4.1.1-4 and Table 5.2.4.1.1-5, with the addition of test parameters in Table 5.2.4.1.1-2 and the downlink physical channel setup according to Annex C.3.1.

The test purpose are specified in Table 5.2.4.1.1-1.

**Table 5.2.4.1.1-1: Tests purpose**

|  |  |
| --- | --- |
| **Purpose** | **Test index** |
| Verify the PDSCH mapping Type A normal performance under 8 receive antenna conditions and with different channel models, MCSs and number of MIMO layers | 1-1, 2-1, 3-1 |

Table 5.2.4.1.1-2: Test parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Duplex mode | |  | FDD |
| Active DL BWP index | |  | 1 |
| PDSCH configuration | Mapping type |  | Type A |
| k0 |  | 0 |
| Starting symbol (S) |  | 2 |
| Length (L) |  | 12 |
| PDSCH aggregation factor |  | 1 |
| PRB bundling type |  | Static |
| PRB bundling size |  | 2 |
| Resource allocation type |  | Type 0 |
| RBG size |  | Config2 |
| VRB-to-PRB mapping type |  | Non-interleaved |
| VRB-to-PRB mapping interleaver bundle size |  | N/A |
| PDSCH DMRS configuration | DMRS Type |  | Type 1 |
| Number of additional DMRS |  | 1 |
| Maximum number of OFDM symbols for DL front loaded DMRS |  | 1 for rank <= 4  2 for rank > 4 |
| DMRS ports indexes |  | {1000,1001} for Rank2  {1000-1003} for Rank4  {1000-1007} for Rank8 |
| Codebook configuration | CodebookType |  | typeI-SinglePanel for 4Tx and 8Tx |
| CodebookMode |  | 1 |
| (CodebookConfig-N1,CodebookConfig-N2) |  | (2,1) for 4Tx  (4,1) for 8Tx |
| (CodebookConfig-O1,CodebookConfig-O2) |  | (4,1) |
| RI Restriction |  | 00000010 for rank 2  00001000 for rank 4  10000000 for rank 8 |
| CSI-RS for tracking | First OFDM symbol in the PRB used for CSI-RS |  | l0 = 5 for CSI-RS resource 1 and 3  l0 = 9 for CSI-RS resource 2 and 4 |
| NZP CSI-RS for CSI acquisition | Row index |  | 6 for 8 CSI-RS ports |
| Number of HARQ Processes | |  | 4 |
| Maximum HARQ transmissions | |  | 4 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | |  | 2 |

Table 5.2.4.1.1-3: Minimum performance for Rank 2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Bandwidth (MHz) / Subcarrier spacing (kHz)** | **Modulation format and code rate** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 1-1 | R.PDSCH.1-3.1 FDD | 10 / 15 | 64QAM, 0.50 | TDLC300-100 | 2x8, ULA Medium B | 70 | [13.7] |

Table 5.2.4.1.1-4: Minimum performance for Rank 4

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Bandwidth (MHz) / Subcarrier spacing (kHz)** | **Modulation format and code rate** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 2-1 | R.PDSCH.1-3.6 FDD | 10 / 15 | 64QAM, 0.43 | TDLA30-10 | 4x8, ULA Low | 70 | [13.2] |

Table 5.2.4.1.1-5: Minimum performance for Rank 8

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Bandwidth (MHz) / Subcarrier spacing (kHz)** | **Modulation format and code rate** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 3-1 | R.PDSCH.1-3.7 FDD | 10 / 15 | 64QAM, 0.43 | TDLA30-10 | 8x8, ULA Low | 70 | [22.7] |

#### 5.2.4.2 TDD

##### 5.2.4.2.1 Minimum requirements for PDSCH Mapping Type A

The performance requirements are specified in Table 5.2.4.2.1-3, Table 5.2.4.2.1-4 and Table 5.2.4.2.1-5, with the addition of test parameters in Table 5.2.4.2.1-2 and the downlink physical channel setup according to Annex C.3.1.

The test purpose are specified in Table 5.2.4.2.1-1.

**Table 5.2.4.2.1-1: Tests purpose**

|  |  |
| --- | --- |
| **Purpose** | **Test index** |
| Verify the PDSCH mapping Type A normal performance under 8 receive antenna conditions and with different channel models, MCSs and number of MIMO layers | 1-1, 2-1, 3-1 |

Table 5.2.4.2.1-2: Test parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Duplex mode | |  | TDD |
| Active DL BWP index | |  | 1 |
| PDSCH configuration | Mapping type |  | Type A |
| k0 |  | 0 |
| Starting symbol (S) |  | 2 |
| Length (L) |  | Specific to each Reference channel |
| PDSCH aggregation factor |  | 1 |
| PRB bundling type |  | Static |
| PRB bundling size |  | 2 |
| Resource allocation type |  | Type 0 |
| RBG size |  | Config2 |
| VRB-to-PRB mapping type |  | Non-interleaved |
| VRB-to-PRB mapping interleaver bundle size |  | N/A |
| PDSCH DMRS configuration | DMRS Type |  | Type 1 |
| Number of additional DMRS |  | 1 |
| Maximum number of OFDM symbols for DL front loaded DMRS |  | 1 for rank <= 4  2 for rank > 4 |
| DMRS ports indexes |  | {1000,1001} for Rank2  {1000-1003} for Rank4  {1000-1007} for Rank8 |
| Codebook configuration | CodebookType |  | typeI-SinglePanel for 4Tx and 8Tx |
| CodebookMode |  | 1 |
| (CodebookConfig-N1,CodebookConfig-N2) |  | (2,1) for 4Tx  (4,1) for 8Tx |
| (CodebookConfig-O1,CodebookConfig-O2) |  | (4,1) |
| RI Restriction |  | 00000010 for rank 2  00001000 for rank 4  10000000 for rank 8 |
| CSI-RS for tracking | First OFDM symbol in the PRB used for CSI-RS |  | l0 = 5 for CSI-RS resource 1 and 3  l0 = 9 for CSI-RS resource 2 and 4 |
| NZP CSI-RS for CSI acquisition | Row index |  | 6 for 8 CSI-RS ports |
| Number of HARQ Processes | |  | 8 |
| Maximum HARQ transmissions | |  | 4 |
| The number of slots between PDSCH and corresponding HARQ-ACK information | |  | Specific to each TDD UL-DL pattern and as defined in Annex A.1.2 |

Table 5.2.4.2.1-3: Minimum performance for Rank 2

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Bandwidth (MHz) / Subcarrier spacing (kHz)** | **Modulation format and code rate** | **TDD UL-DL pattern** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 1-1 | R.PDSCH.2-3.1 TDD | 40 / 30 | 64QAM, 0.50 | FR1.30-1 | TDLC300-100 | 2x8, ULA Medium B | 70 | [13.5] |

Table 5.2.4.2.1-4: Minimum performance for Rank 4

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Bandwidth (MHz) / Subcarrier spacing (kHz)** | **Modulation format and code rate** | **TDD UL-DL pattern** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 2-1 | R.PDSCH.2-3.6 TDD | 40 / 30 | 64QAM, 0.43 | FR1.30-1 | TDLA30-10 | 4x8, ULA Low | 70 | [12.9] |

Table 5.2.4.2.1-5: Minimum performance for Rank 8

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Bandwidth (MHz) / Subcarrier spacing (kHz)** | **Modulation format and code rate** | **TDD UL-DL pattern** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 3-1 | R.PDSCH.2-3.7 TDD | 40 / 30 | 64QAM, 0.43 | FR1.30-1 | TDLA30-10 | 8x8, ULA Low | 70 | [22.8] |

End of R4-2319330

Start of R4-2321198

5.2A.4 8RX requirements

5.2A.4.1 Minimum requirements

For CA with different numbers of DL component carriers, the requirements are defined in Table 5.2A.4.1-4 based on the single carrier requirements for different SCSs and different bandwidth specified in Table 5.2A.4.1-1 and Table 5.2A.4.1-2, with the parameters in Table 5.2A-1 ~ Table 5.2A-3 and the downlink physical channel setup according to Annex C.3.1. The performance requirements specified in this sub-clause do not apply for UE single carrier test.

**Table 5.2A.4.1-1: Single carrier performance for FDD 15 kHz SCS for CA configurations**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Bandwidth (MHz)** | **Reference channel** | **Modulation format and code rate** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 5 | [TBD] | 64QAM, 0.5 | [TBD] | 2x8, [TBD] | 70 | [TBD] |
| 10 | [TBD] | 64QAM, 0.5 | [TBD] | 2x8, [TBD] | 70 | [TBD] |
| 15 | [TBD] | 64QAM, 0.5 | [TBD] | 2x8, [TBD] | 70 | [TBD] |
| 20 | [TBD] | 64QAM, 0.5 | [TBD] | 2x8, [TBD] | 70 | [TBD] |
| 25 | [TBD] | 64QAM, 0.5 | [TBD] | 2x8, [TBD] | 70 | [TBD] |
| 30 | [TBD] | 64QAM, 0.5 | [TBD] | 2x8, [TBD] | 70 | [TBD] |
| 40 | [TBD] | 64QAM, 0.5 | [TBD] | 2x8, [TBD] | 70 | [TBD] |
| 50 | [TBD] | 64QAM, 0.5 | [TBD] | 2x8, [TBD] | 70 | [TBD] |
| 5 | [TBD] | 64QAM, 0.43 | TDLA30-10 | 8x8, ULA Low | 70 | [TBD] |
| 10 | [TBD] | 64QAM, 0.43 | TDLA30-10 | 8x8, ULA Low | 70 | [TBD] |
| 15 | [TBD] | 64QAM, 0.43 | TDLA30-10 | 8x8, ULA Low | 70 | [TBD] |
| 20 | [TBD] | 64QAM, 0.43 | TDLA30-10 | 8x8, ULA Low | 70 | [TBD] |
| 25 | [TBD] | 64QAM, 0.43 | TDLA30-10 | 8x8, ULA Low | 70 | [TBD] |
| 30 | [TBD] | 64QAM, 0.43 | TDLA30-10 | 8x8, ULA Low | 70 | [TBD] |
| 40 | [TBD] | 64QAM, 0.43 | TDLA30-10 | 8x8, ULA Low | 70 | [TBD] |
| 50 | [TBD] | 64QAM, 0.43 | TDLA30-10 | 8x8, ULA Low | 70 | [TBD] |

**Table 5.2A.4.1-2: Single carrier performance for TDD 30 kHz SCS for CA configurations**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Bandwidth (MHz)** | **Reference channel** | **Modulation format and code rate** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** | |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 5 | [TBD] | 64QAM, 0.5 | [TBD] | 2x8, [TBD] | 70 | [TBD] |
| 10 | [TBD] | 64QAM, 0.5 | [TBD] | 2x8, [TBD] | 70 | [TBD] |
| 15 | [TBD] | 64QAM, 0.5 | [TBD] | 2x8, [TBD] | 70 | [TBD] |
| 20 | [TBD] | 64QAM, 0.5 | [TBD] | 2x8, [TBD] | 70 | [TBD] |
| 25 | [TBD] | 64QAM, 0.5 | [TBD] | 2x8, [TBD] | 70 | [TBD] |
| 30 | [TBD] | 64QAM, 0.5 | [TBD] | 2x8, [TBD] | 70 | [TBD] |
| 40 | [TBD] | 64QAM, 0.5 | [TBD] | 2x8, [TBD] | 70 | [TBD] |
| 50 | [TBD] | 64QAM, 0.5 | [TBD] | 2x8, [TBD] | 70 | [TBD] |
| 60 | [TBD] | 64QAM, 0.5 | [TBD] | 2x8, [TBD] | 70 | [TBD] |
| 80 | [TBD] | 64QAM, 0.5 | [TBD] | 2x8, [TBD] | 70 | [TBD] |
| 90 | [TBD] | 64QAM, 0.5 | [TBD] | 2x8, [TBD] | 70 | [TBD] |
| 100 | [TBD] | 64QAM, 0.5 | [TBD] | 2x8, [TBD] | 70 | [TBD] |
| 5 | [TBD] | 64QAM, 0.43 | TDLA30-10 | 8x8, ULA Low | 70 | [TBD] |
| 10 | [TBD] | 64QAM, 0.43 | TDLA30-10 | 8x8, ULA Low | 70 | [TBD] |
| 15 | [TBD] | 64QAM, 0.43 | TDLA30-10 | 8x8, ULA Low | 70 | [TBD] |
| 20 | [TBD] | 64QAM, 0.43 | TDLA30-10 | 8x8, ULA Low | 70 | [TBD] |
| 25 | [TBD] | 64QAM, 0.43 | TDLA30-10 | 8x8, ULA Low | 70 | [TBD] |
| 30 | [TBD] | 64QAM, 0.43 | TDLA30-10 | 8x8, ULA Low | 70 | [TBD] |
| 40 | [TBD] | 64QAM, 0.43 | TDLA30-10 | 8x8, ULA Low | 70 | [TBD] |
| 50 | [TBD] | 64QAM, 0.43 | TDLA30-10 | 8x8, ULA Low | 70 | [TBD] |
| 60 | [TBD] | 64QAM, 0.43 | TDLA30-10 | 8x8, ULA Low | 70 | [TBD] |
| 80 | [TBD] | 64QAM, 0.43 | TDLA30-10 | 8x8, ULA Low | 70 | [TBD] |
| 90 | [TBD] | 64QAM, 0.43 | TDLA30-10 | 8x8, ULA Low | 70 | [TBD] |
| 100 | [TBD] | 64QAM, 0.43 | TDLA30-10 | 8x8, ULA Low | 70 | [TBD] |

**Table 5.2A.4.1-3: Minimum performance for multiple CA configurations**

|  |  |  |
| --- | --- | --- |
| **Test number** | **CA duplex mode** | **Minimum performance requirements** |
| 1 | FDD 15 kHz + FDD 15 kHz | As defined in Table 5.2A.4.1-1 |
| 2 | TDD 30 kHz + TDD 30 kHz | As defined in Table 5.2A.4.1-2 |
| 3 | FDD 15 kHz + TDD 30 kHz | As defined in Table 5.2A.4.1-1 and Table 5.2A.4.1-3 per CC |
| Note 1: The applicability of requirements for different CA duplex modes, SCSs, CA configurations and bandwidth combination sets is defined in 5.1.1.7.  Note 2: For CA combinations between 8Rx and 4Rx or 2Rx, Rank 2 requirements in Tables 5.2A.4.1-1 and 5.2A.4.1-2 shall be applied for both CCs.  Note 3: For CA Combinations with two 8Rx CCs, Rank 8 requirements in Tables 5.2A.4.1-1 and 5.2A.4.1-2 shall be applied for both CCs. | | |

End of R4-2321198

Start of R4-2316978

5.5A Sustained downlink data rate provided by lower layers

5.5A.1 FR1 CA requirements

*<Editor*'*s note: Open issues to be resolved:*

*Whether same requirements apply for FR1 DC>*

The Sustained Data Rate (SDR) requirements in this clause are applicable to the FR1 CA.

The purpose of the test is to verify that the Layer 1 and Layer 2 correctly process in a sustained manner the received packets corresponding to the maximum data rate indicated by UE capabilities*.* The sustained downlink data rate shall be verified in terms of the success rate of delivered PDCP SDU(s) by Layer 2. The test case below specifies the RF conditions and the required success rate of delivered TB by Layer 1 to meet the sustained data rate requirement.

The test parameters are determined by the following procedure:

- Select one CA bandwidth combination among all supported CA configurations and set of per component carrier (CC) UE capabilities among all supported UE capabilities that provides the largest data rate in accordance with clause 4.1.2 of TS 38.306 [14].

- Set of per CC UE capabilities includes channel bandwidth, subcarrier spacing, number of PDSCH MIMO layers, modulation format and scaling factor in accordance with clause 4.1.2 of TS 38.306 [14].

- When there are multiple sets of CA bandwidth combinations and UE capabilities (channel bandwidth, subcarrier spacing, number of MIMO layer, modulation format, scaling factor) with same largest data rate, select one among sets with the smallest aggregated channel bandwidth.

- For UE not capable of 1024QAM (*pdsch-1024QAM-FR1*), for each CC in CA bandwidth combination, use Table 5.5A-5 to determine MCS based on test parameters and indicated UE capabilities.

- For UE capable of 1024QAM (*pdsch-1024QAM-FR1*), for each CC in CA bandwidth combination, use Table 5.5A-6 to determine MCS based on test parameters and indicated UE capabilities if the maximum modulation format is 10. If the maximum modulation format (*supportedModulationOrderDL*) is less than 10, use Table 5.5A-5 to determine MCS based on test parameters and indicated UE capabilities.

The TB success rate shall be higher than 85% when PDSCH is scheduled with MCS defined for the selected CA bandwidth combination and with the downlink physical channel setup according to Annex C.3.1.

The TB success rate is defined as 100%\*NDL\_correct\_rx/ (NDL\_newtx + NDL\_retx), where NDL\_newtx is the number of newly transmitted DL transport blocks, NDL\_retx is the number of retransmitted DL transport blocks, and NDL\_correct\_rx is the number of correctly received DL transport blocks.

The common test parameters are specified in Table 5.5A-1. The parameters specified in Table 5.5A-2 are applicable for tests on FDD CCs and parameters specified in Table 5.5A-3 are applicable for tests on TDD CCs.

Unless otherwise stated, no user data is scheduled on slot #0, 10 and 11 within 20 ms for SCS 15 kHz.

Unless otherwise stated, no user data is scheduled on slot #0, 20 and 21 within 20 ms for SCS 30 kHz.

----------------------------------------------------- Beginning of Change 1 ------------------------------------------------------------

**Table 5.5A-1: Common test parameters for FDD and TDD component carriers**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | | | **Unit** | **Value** |
| PDSCH transmission scheme | | |  | Transmission scheme 1 |
| EPRE ratio of PTRS to PDSCH | | | dB | N/A |
| Channel bandwidth | | | MHz | Channel bandwidth from selected CA bandwidth combination |
| Common serving cell parameters | Physical Cell ID | |  | 0 |
| SSB position in burst | |  | First SSB in Slot #0 |
| SSB periodicity | | ms | 20 |
| First DMRS position for Type A PDSCH mapping | |  | 2 |
| Cross carrier scheduling | | |  | Not configured |
| Active DL BWP index | | |  | 1 |
| Actual carrier configuration | Offset between Point A and the lowest usable subcarrier on this carrier (Note 2) | | RBs | 0 |
| Subcarrier spacing | | kHz | 15 or 30 |
| DL BWP configuration #1 | RB offset | | RBs | 0 |
| Number of contiguous PRB | |  | Maximum transmission bandwidth configuration as specified in clause 5.3.2 of TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing |
| Subcarrier spacing | | kHz | 15 or 30 |
| Cyclic prefix | |  | Normal |
| PDCCH configuration | Slots for PDCCH monitoring | |  | Each slot |
| Symbols with PDCCH | |  | Symbols #0 |
| Number of PRBs in CORESET | |  | Table 5.5A-4 |
| Number of PDCCH candidates and aggregation levels | |  | 1/AL 1 for 30 kHz / 5 MHz  1/AL4 for 15 kHz / 5 MHz, 30 kHz / 10 MHz and 30 kHz / 15 MHz  1/AL 8 for other combinations |
| CCE-to-REG mapping type | |  | Non-interleaved |
| DCI format | |  | 1\_1 |
| TCI State | |  | TCI state #1 |
| PDCCH & PDCCH DMRS Precoding configuration | |  | For number of TX = 1: No precoding;  For Number of Tx = 2:  Single Panel Type I, Randomized precoder selection for every REG bundle and updated per slot with equal probability of precoder index 0 and 2  For Number of Tx= 4:  Single Panel Type I, Randomized precoder selection for every REG bundle and updated per slot with equal probability of i\_1,1 in {1,2,3,5,6,7} and i\_2 in {0,2} |
| PDSCH configuration | Mapping type | |  | Type A |
| k0 | |  | 0 |
| PDSCH aggregation factor | |  | 1 |
| PRB bundling type | |  | Static |
| PRB bundling size | |  | Wideband |
| Resource allocation type | |  | Type 0 |
| VRB-to-PRB mapping type | |  | Non-interleaved |
| VRB-to-PRB mapping interleaver bundle size | |  | N/A |
| PDSCH DMRS configuration | DMRS Type | |  | Type 1 |
| Number of additional DMRS | |  | 1 |
| Length | |  | Rank2/4: 1  Rank 8: 2 |
| Antenna ports indexes | |  | {1000} for 1 Layer CCs {1000, 1001} for 2 Layers CCs  {1000 – 1003} for 4 Layers CCs  {1000 – 1007} for 8 Layers CCs |
| Number of PDSCH DMRS CDM group(s) without data | |  | 1 for 1 layer and 2 layers CCs  2 for 4 and 8 Layers CCs |
| PTRS configuration | | |  | PTRS is not configured |
| CSI-RS for tracking | Subcarrier indexes in the PRB used for CSI-RS | |  | k0 = 3 for CSI-RS resource 1,2,3,4 |
| OFDM symbols in the PRB used for CSI-RS | |  | l0 = 6 for CSI-RS resource 1 and 3  l0 = 10 for CSI-RS resource 2 and 4 |
| Number of CSI-RS ports (X) | |  | 1 for CSI-RS resource 1,2,3,4 |
| CDM Type | |  | 'No CDM' for CSI-RS resource 1,2,3,4 |
| Density (ρ) | |  | 3 for CSI-RS resource 1,2,3,4 |
| CSI-RS periodicity | | Slots | 15 kHz SCS: 20 for CSI-RS resource 1,2,3,4  30 kHz SCS: 40 for CSI-RS resource 1,2,3,4 |
| CSI-RS offset | | Slots | 15 kHz SCS:  10 for CSI-RS resource 1 and 2  11 for CSI-RS resource 3 and 4  30 kHz SCS:  20 for CSI-RS resource 1 and 2  21 for CSI-RS resource 3 and 4 |
| Frequency Occupation | |  | Start PRB 0  Number of PRB = ceil(BWP size /4)\*4 |
| QCL info | |  | TCI state #0 |
| NZP CSI-RS for CSI acquisition | Subcarrier indexes in the PRB used for CSI-RS | |  | k0 = 4 |
| OFDM symbols in the PRB used for CSI-RS | |  | l0 = 12 |
| Number of CSI-RS ports (X) | |  | Same as number of transmit antenna |
| CDM Type | |  | 'FD-CDM2' |
| Density (ρ) | |  | 1 |
| CSI-RS periodicity | |  | 15 kHz SCS: 20  30 kHz SCS: 40 |
| CSI-RS offset | |  | 0 |
| Frequency Occupation | |  | Start PRB 0  Number of PRB = ceil(BWP size /4)\*4 |
| QCL info | |  | TCI state #1 |
| ZP CSI-RS for CSI acquisition | Subcarrier indexes in the PRB used for CSI-RS | |  | k0 = 0 |
| OFDM symbols in the PRB used for CSI-RS | |  | l0 = 12 |
| Number of CSI-RS ports (X) | |  | 4 |
| CDM Type | |  | 'FD-CDM2' |
| Density (ρ) | |  | 1 |
| CSI-RS periodicity | |  | 15 kHz SCS: 20  30 kHz SCS: 40 |
| CSI-RS offset | |  | 0 |
| Frequency Occupation | |  | Start PRB 0  Number of PRB = ceil(BWP size/4)\*4 |
| TCI state #0 | Type 1 QCL information | SSB index |  | SSB #0 |
| QCL Type |  | Type C |
| Type 2 QCL information | SSB index |  | N/A |
| QCL Type |  | N/A |
| TCI state #1 | Type 1 QCL information | CSI-RS resource |  | CSI-RS resource 1 from 'CSI-RS for tracking' configuration |
| QCL Type |  | Type A |
| Type 2 QCL information | CSI-RS resource |  | N/A |
| QCL Type |  | N/A |
| Maximum number of code block groups for ACK/NACK feedback | | |  | 1 |
| Maximum number of HARQ transmission | | |  | 4 |
| HARQ ACK/NACK bundling | | |  | Multiplexed |
| Redundancy version coding sequence | | |  | {0,2,3,1} |
| PDSCH & PDSCH DMRS Precoding configuration | | |  | For number of TX = 1: No precoding;  For number of TX > 1: Single Panel Type I; Randomized precoder selection for every PRB bundle and updated per slot, with equal probability of each applicable i1/i2 combination or codebook  index, chosen from section 5.2.2.2.1 of TS 38.214 [12]. |
| Symbols for all unused REs | | |  | OP.1 FDD as defined in Annex A.5.1.1  OP.1 TDD as defined in Annex A.5.2.1 |
| Propagation condition | | |  | Static propagation condition  No external noise sources are applied |
| Antenna configuration | 1 layer CCs | |  | 1x2 or 1x4 |
| 2 layers CCs | |  | 2x2 or 2x4 or 2x8 |
| 4 layers CCs | |  | 4x4 or 4x8 |
| 8 layers CCs | |  | 8x8 |
| Physical signals, channels mapping and precoding | | |  | As specified in Annex B.4.1 |
| Note 1: UE assumes that the TCI state for the PDSCH is identical to the TCI state applied for the PDCCH transmission  Note 2: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing | | | | |

----------------------------------------------------------- End of Change 1 --------------------------------------------------------------

**Table 5.5A-2: Additional test parameters for FDD CC**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Duplex mode | |  | FDD |
| PDSCH configuration | Starting symbol (S) |  | 1 |
| Length (L) |  | 13 |
| Number of HARQ Processes | |  | 4 |
| K1 value | |  | 2 |

**Table 5.5A-3: Additional test parameters for TDD CC**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Duplex mode | |  | TDD |
| PDSCH configuration | Starting symbol (S) |  | 1 |
| Length (L) |  | 13 |
| Number of HARQ Processes | |  | 8 |
| K1 value | |  | Specific to each UL-DL pattern |
| TDD UL-DL pattern | |  | 15 kHz SCS: FR1.15-1  30 kHz SCS: FR1.30-1 |
| Note 1: PDSCH is scheduled only on full DL slots | | | |

**Table 5.5A-4: Number of PRBs in CORESET**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **SCS (kHz)** | **5 MHz** | **10 MHz** | **15 MHz** | **20 MHz** | **25 MHz** | **30 MHz** | **35 MHz** | **40 MHz** | **45 MHz** | **50 MHz** | **60 MHz** | **80 MHz** | **100 MHz** |
| 15 | 24 | 48 | 78 | 102 | 132 | 156 | 186 | 216 | 240 | 270 | N/A | N/A | N/A |
| 30 | 6 | 24 | 36 | 48 | 60 | 78 | 90 | 102 | 114 | 132 | 162 | 216 | 270 |

----------------------------------------------------- Beginning of Change 2 ------------------------------------------------------------

**Table 5.5A-5: MCS indexes for indicated UE capabilities**

|  |  |  |  |
| --- | --- | --- | --- |
| **Maximum number of PDSCH MIMO layers** | **Maximum modulation format** | **Scaling factor** | **MCS** |
| 1 | 8 | 1 | 26 |
| 1 | 8 | 0.8 | 21 |
| 1 | 8 | 0.75 | 20 |
| 1 | 8 | 0.4 | 11 |
| 1 | 6 | 1 | 27 |
| 1 | 6 | 0.8 | 23 |
| 1 | 6 | 0.75 | 22 |
| 1 | 6 | 0.4 | 14 |
| 1 | 4 | 1 | 16 |
| 1 | 4 | 0.8 | 16 |
| 1 | 4 | 0.75 | 16 |
| 1 | 4 | 0.4 | 10 |
| 1 | 2 | 1 | 9 |
| 1 | 2 | 0.8 | 9 |
| 1 | 2 | 0.75 | 9 |
| 1 | 2 | 0.4 | 4 |
| 2 | 8 | 1 | 26 |
| 2 | 8 | 0.8 | 21 |
| 2 | 8 | 0.75 | 20 |
| 2 | 8 | 0.4 | 11 |
| 2 | 6 | 1 | 27 |
| 2 | 6 | 0.8 | 23 |
| 2 | 6 | 0.75 | 22 |
| 2 | 6 | 0.4 | 14 |
| 2 | 4 | 1 | 16 |
| 2 | 4 | 0.8 | 16 |
| 2 | 4 | 0.75 | 16 |
| 2 | 4 | 0.4 | 10 |
| 2 | 2 | 1 | 9 |
| 2 | 2 | 0.8 | 9 |
| 2 | 2 | 0.75 | 9 |
| 2 | 2 | 0.4 | 4 |
| 4 | 8 | 1 | 26 |
| 4 | 8 | 0.8 | 23 |
| 4 | 8 | 0.75 | 22 |
| 4 | 8 | 0.4 | 12 |
| 4 | 6 | 1 | 27 |
| 4 | 6 | 0.8 | 24 |
| 4 | 6 | 0.75 | 23 |
| 4 | 6 | 0.4 | 14 |
| 4 | 4 | 1 | 16 |
| 4 | 4 | 0.8 | 16 |
| 4 | 4 | 0.75 | 16 |
| 4 | 4 | 0.4 | 11 |
| 4 | 2 | 1 | 9 |
| 4 | 2 | 0.8 | 9 |
| 4 | 2 | 0.75 | 9 |
| 4 | 2 | 0.4 | 5 |
| 8 | 8 | 1 | 24 |
| 8 | 8 | 0.8 | 23 |
| 8 | 8 | 0.75 | 22 |
| 8 | 8 | 0.4 | 12 |
| 8 | 6 | 1 | 26 |
| 8 | 6 | 0.8 | 24 |
| 8 | 6 | 0.75 | 23 |
| 8 | 6 | 0.4 | 14 |
| 8 | 4 | 1 | 16 |
| 8 | 4 | 0.8 | 16 |
| 8 | 4 | 0.75 | 16 |
| 8 | 4 | 0.4 | 11 |
| 8 | 2 | 1 | 9 |
| 8 | 2 | 0.8 | 9 |
| 8 | 2 | 0.75 | 9 |
| 8 | 2 | 0.4 | 5 |
| Note 1: MCS Index for maximum modulation format 2,4 and 6 is based on MCS index Table 1 defined in clause 5.1.3.1 of TS 38.214 [12]  Note 2: MCS Index for maximum modulation format 8 is based on MCS index Table 2 defined in clause 5.1.3.1 of TS 38.214 [12] | | | |

---------------------------------------------------------- End of Change 2 ------------------------------------------------------------

----------------------------------------------------- Beginning of Change 3 ------------------------------------------------------------

**Table 5.5A-6: 1024QAM MCS indexes for indicated UE capabilities**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Supported RX**  **antenna ports** | **Maximum number of PDSCH MIMO layers** | **Maximum modulation format** | **Scaling factor** | **MCS** |
| 2RX | 1 | 10 | 1 | 23 |
|  | 1 | 10 | 0.8 | 21 |
|  | 1 | 10 | 0.75 | 19 |
|  | 1 | 10 | 0.4 | 9 |
| 4RX | 1 | 10 | 1 | 24 |
|  | 1 | 10 | 0.8 | 21 |
|  | 1 | 10 | 0.75 | 19 |
|  | 1 | 10 | 0.4 | 9 |
|  | 2 | 10 | 1 | 23 |
|  | 2 | 10 | 0.8 | 21 |
|  | 2 | 10 | 0.75 | 19 |
|  | 2 | 10 | 0.4 | 9 |
| 8RX | 2 | 10 | 1 | 24 |
| 2 | 10 | 0.8 | 21 |
| 2 | 10 | 0.75 | 19 |
| 2 | 10 | 0.4 | 9 |
| Note 1: MCS Index for maximum modulation format 10 is based on MCS index Table 4 defined in clause 5.1.3.1 of TS 38.214 [12]  Note 2: For the band(s) on which UE supporting “Maximum modulation format” of 10, with 2 RX and 2 MIMO layers, the MCS index is derived from the rows with “Maximum modulation format” of 8 in Table 5.5A-5 | | | | |

-------------------------------------------------------- End of Change 3 --------------------------------------------------------------

End of R4-2316978

Start of R4-2315984

# 6 CSI reporting requirements (Conducted requirements)

## 6.1 General

### 6.1.1 Applicability of requirements

<Unchanged skipped>

#### 6.1.1.2 Applicability of requirements for different number of RX antenna ports

The number of RX antenna ports for different RF operating bands is up to UE declaration.

The UE shall support 2 or 4 RX antenna ports for different RF operating bands. The operating bands, where 4 RX antenna ports shall be the baseline, are defined in clause 7.2 of TS 38.101-1 [6]. The UE requirements applicability for UEs with different number of RX antenna ports is defined in Table 6.1.1.2-1.

Table 6.1.1.2-1: Requirements applicability

|  |  |  |
| --- | --- | --- |
| Supported RX antenna ports | Test type | Test list |
| UE supports only 2RX | CQI | All tests in Clause 6.2.2 |
| PMI | All tests in Clause 6.3.2 |
| RI | All tests in Clause 6.4.2 |
| UE supports only 4RX or both 2RX and 4RX | CQI | All tests in Clause 6.2.3 |
| PMI | All tests in Clause 6.3.3 |
| RI | All tests in Clause 6.4.3 |
| UE supports 2Rx, 4Rx and 8Rx, or  UE supports 4Rx and 8Rx | CQI | Tests in Clause 6.2.3(Note 1)  All tests in Clause 6.2.4 |
| PMI | All tests in Clause 6.3.3 |
| RI | All tests in Clause 6.4.3 |
| UE supports 2Rx and 8Rx | CQI | Tests in Clause 6.2.2(Note 2)  All tests in Clause 6.2.4 |
| PMI | All tests in Clause 6.3.2 |
| RI | All tests in Clause 6.4.2 |
| UE supports only 8Rx | CQI | All tests in Clause 6.2.4 |
| PMI | N/A |
| RI | N/A |
| Note 1: 8Rx capable UEs are tested on any of the 4Rx supported RF bands by connecting 4 out of 8 Rx with data source from system simulator, and the other 4 Rx are connected with zero input, depending on UE’s declaration and AP configuration. Requirements specified with 4Rx should be applied.  Note 2: 8Rx capable UEs are tested on any of the 2Rx supported RF bands by connecting 2 out of 8 Rx with data source from system simulator, and the other 6 Rx are connected with zero input, depending on UE’s declaration and AP configuration. Requirements specified with 2Rx should be applied. | | |

End of R4-2315984

Start of R4-2313880

### 6.2.4 8RX requirements

This sub-clause includes the requirements for reporting of CQI for UE equipped with 8 receiver antennas.

#### 6.2.4.1 FDD

##### 6.2.4.1.1 CQI reporting definition under AWGN conditions

The reporting accuracy of CQI under AWGN condition is determined by the reporting variance and BLER performance using the transport format indicated by the reported CQI median. The purpose of the requirements is to verify that the reported CQI values are in accordance with the CQI definition given in TS 38.214 [12]. To account for sensitivity of the input SNR the reporting definition is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

###### 6.2.4.1.1.1 Minimum requirement for period CQI reporting

For the parameters specified in Table 6.2.4.1.1.1-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) The reported CQI value according to the reference channel shall be in the range of ±1 of the reported median more than 90 % of the time.

b) If the PDSCH BLER using the transport format indicated by median CQI is less than or equal to 0.1, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 0.1.

Table 6.2.4.1.1.1-1: CQI reporting definition test

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | **Unit** | **Test 1** | | **Test 2** | |
| Bandwidth | | | MHz | 10 | | | |
| Subcarrier spacing | | | kHz | 15 | | | |
| Duplex Mode | | |  | FDD | | | |
| SNR | | | dB | [4] | [5] | [10] | [11] |
| Propagation channel | | |  | AWGN | | | |
| Antenna configuration | | |  | 4×8 with static channel specified in Annex B.1 | | | |
| Beamforming Model | | |  | As specified in Annex B.4.1 | | | |
| ZP CSI-RS configuration | CSI-RS resource Type | |  | Periodic | | | |
| Number of CSI-RS ports (*X*) | |  | 4 | | | |
| CDM Type | |  | FD-CDM2 | | | |
| Density (ρ) | |  | 1 | | | |
| First subcarrier index in the PRB used for CSI-RS (k0) | |  | Row 5,4 | | | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | |  | 9 | | | |
| CSI-RS  periodicity and offset | | slot | 5/1 | | | |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | |  | Periodic | | | |
| Number of CSI-RS ports (*X*) | |  | 4 | | | |
| CDM Type | |  | FD-CDM2 | | | |
| Density (ρ) | |  | 1 | | | |
| First subcarrier index in the PRB used for CSI-RS (k0) | |  | Row 4,(0) | | | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | |  | 13 | | | |
| NZP CSI-RS-timeConfig  periodicity and offset | | slot | 5/1 | | | |
| CSI-IM configuration | CSI-IM resource Type | |  | Periodic | | | |
| CSI-IM RE pattern | |  | 0 | | | |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | |  | (4, 9) | | | |
| CSI-IM timeConfig  periodicity and offset | | slot | 5/1 | | | |
| ReportConfigType | | |  | Periodic | | | |
| CQI-table | | |  | Table 2 | | | |
| reportQuantity | | |  | cri-RI-PMI-CQI | | | |
| timeRestrictionForChannelMeasurements | | |  | Not configured | | | |
| timeRestrictionForInterferenceMeasurements | | |  | Not configured | | | |
| cqi-FormatIndicator | | |  | Wideband | | | |
| pmi-FormatIndicator | | |  | Wideband | | | |
| Sub-band Size | | | RB | 8 | | | |
| csi-ReportingBand | | |  | 1111111 | | | |
| CSI-Report periodicity and offset | | | slot | 5/0 | | | |
| aperiodicTriggeringOffset | | |  | Not configured | | | |
| Codebook configuration (Note 1) | | Codebook Type |  | typeI-SinglePanel | | | |
| Codebook Mode |  | 1 | | | |
| (CodebookConfig-N1, CodebookConfig-N2) |  | (2,1) | | | |
| (CodebookConfig-O1, CodebookConfig-O2) |  | (4,1) | | | |
| two-one-TypeI-SinglePanel-Restriction |  | 00000001 | | | |
| RI Restriction |  | 00001000 | | | |
| Physical channel for CSI report | | |  | PUCCH | | | |
| CQI/RI/PMI delay | | | ms | 8 | | | |
| Maximum number of HARQ transmission | | |  | 1 | | | |
| Number of HARQ Processes | | |  | 4 | | | |
| Measurement channel | | |  | As specified in Table A.4-3, TBS.3-2 | | | |
| Note 1: The PMI associated to i2 = 0 is always used as the precoder regardless of the reported i2 value. | | | | | | | |

#### 6.2.4.2 TDD

##### 6.2.4.2.1 CQI reporting definition under AWGN conditions

6.2.4.2.1.1 Minimum requirement for periodic CQI reporting

The purpose of the requirements is to verify that the reported CQI values are in accordance with the CQI definition given in TS 38.214 [12]. The reporting accuracy of CQI under AWGN condition is determined by the reporting variance and BLER performance using the transport format indicated by the reported CQI median. To account for sensitivity of the input SNR the reporting definition is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

For the parameters specified in Table 6.2.4.2.1.1-1, and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) The reported CQI value according to the reference channel shall be in the range of ±1 of the reported median more than 90% of the time.

b) If the PDSCH BLER using the transport format indicated by median CQI is less than or equal to 0.1, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 0.1.

Table 6.2.4.2.1.1-1: CQI reporting definition test

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | **Unit** | **Test 1** | | **Test 2** | |
| Bandwidth | | | MHz | 40 | | | |
| Subcarrier spacing | | | kHz | 30 | | | |
| Duplex Mode | | |  | TDD | | | |
| TDD UL-DL pattern | | |  | FR1.30-1 | | | |
| SNR | | | dB | [4] | [5] | [10] | [11] |
| Propagation channel | | |  | AWGN | | | |
| Antenna configuration | | |  | 4x8 with static channel specified in Annex B.1 | | | |
| Beamforming Model | | |  | As specified in Annex B.4.1 | | | |
| ZP CSI-RS configuration | CSI-RS resource Type | |  | Periodic | | | |
| Number of CSI-RS ports (*X*) | |  | 4 | | | |
| CDM Type | |  | FD-CDM2 | | | |
| Density (ρ) | |  | 1 | | | |
| First subcarrier index in the PRB used for CSI-RS (k0) | |  | Row 5,4 | | | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | |  | 9 | | | |
| CSI-RS  periodicity and offset | | slot | 10/1 | | | |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | |  | Periodic | | | |
| Number of CSI-RS ports (*X*) | |  | 4 | | | |
| CDM Type | |  | FD-CDM2 | | | |
| Density (ρ) | |  | 1 | | | |
| First subcarrier index in the PRB used for CSI-RS (k0) | |  | Row 4,(0) | | | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | |  | 13 | | | |
| NZP CSI-RS-timeConfig  periodicity and offset | | slot | 10/1 | | | |
| CSI-IM configuration | CSI-IM resource Type | |  | Periodic | | | |
| CSI-IM RE pattern | |  | 0 | | | |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | |  | (4, 9) | | | |
| CSI-IM timeConfig  periodicity and offset | | slot | 10/1 | | | |
| ReportConfigType | | |  | Periodic | | | |
| CQI-table | | |  | Table 2 | | | |
| reportQuantity | | |  | cri-RI-PMI-CQI | | | |
| timeRestrictionForChannelMeasurements | | |  | Not configured | | | |
| timeRestrictionForInterferenceMeasurements | | |  | Not configured | | | |
| cqi-FormatIndicator | | |  | Wideband | | | |
| pmi-FormatIndicator | | |  | Wideband | | | |
| Sub-band Size | | | RB | 16 | | | |
| csi-ReportingBand | | |  | 1111111 | | | |
| CSI-Report periodicity and offset | | | slot | 10/9 | | | |
| aperiodicTriggeringOffset | | |  | Not configured | | | |
| Codebook configuration (Note 1) | | Codebook Type |  | typeI-SinglePanel | | | |
| Codebook Mode |  | 1 | | | |
| (CodebookConfig-N1, CodebookConfig-N2) |  | (2,1) | | | |
| (CodebookConfig-O1, CodebookConfig-O2) |  | (4,1) | | | |
| two-one-TypeI-SinglePanel-Restriction |  | 00000001 | | | |
| RI Restriction |  | 00001000 | | | |
| Physical channel for CSI report | | |  | PUCCH | | | |
| CQI/RI/PMI delay | | | ms | 9.5 | | | |
| Maximum number of HARQ transmission | | |  | 1 | | | |
| Number of HARQ Processes | | |  | 8 | | | |
| Measurement channel | | |  | As specified in Table A.4-3, TBS.3-4 | | | |
| Note 1: The PMI associated to i2 = 0 is always used as the precoder regardless of the reported i2 value. | | | | | | | |

**<End of change>**

End of R4-2313880

Start of R4-2316977

**START OF CHANGE 1**

**Table A.3.2.2.2-3: PDSCH Reference Channel for TDD UL-DL pattern FR1.30-1 (64QAM)**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | | | |
| Reference channel |  | R.PDSCH.2-3.1 TDD | R.PDSCH.2-3.2 TDD | R.PDSCH.2-3.3 TDD | R.PDSCH.2-3.4 TDD | R.PDSCH.2-3.5 TDD | R.PDSCH.2-3.6 TDD | R.PDSCH.2-3.7 TDD (Note 5) |
| Channel bandwidth | MHz | 40 | 40 | 40 | 40 | 20 | 40 | 40 |
| Subcarrier spacing | kHz | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| Allocated resource blocks | PRBs | 106 | 106 | 53 (Note 3) | 53 (Note 4) | 51 | 106 | 106 |
| Number of consecutive PDSCH symbols |  |  |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} |  | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} |  | 4 | 4 | 4 | 4 | 4 | 4 | NA |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} |  | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per 2 frames |  | 31 | 31 | 31 | 31 | 31 | 31 | 27 |
| MCS table |  | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| MCS index |  | 19 | 19 | 19 | 19 | 19 | 17 | 17 |
| Modulation |  | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| Target Coding Rate |  | 0.51 | 0.51 | 0.51 | 0.51 | 0.51 | 0.43 | 0.43 |
| Number of MIMO layers |  | 2 | 2 | 2 | 2 | 1 | 4 | 4 |
| Number of DMRS REs |  |  |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} |  | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} |  | 6 | 12 | 12 | 12 | 6 | 12 | 24 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} |  | 12 | 24 | 24 | 24 | 12 | 24 | 48 |
| Overhead for TBS determination |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Information Bit Payload per Slot |  |  |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 27144 | 23040 | 11528 | 11528 | 6528 | 38936 | 26120 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | Bits | 83976 | 77896 | 38936 | 38936 | 20496 | 131176 | 104496 |
| Transport block CRC per Slot |  |  |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6}for i from {1,…,39} | Bits | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | CBs | 4 | 3 | 2 | 2 | 1 | 5 | 4 |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | CBs | 10 | 10 | 5 | 5 | 3 | 16 | 13 |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 20, 21 | Bits | 160272 | 137376 | 68688 | 68688 | 38556 | 290304 | 229248 |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 53424 | 45792 | 22896 | 22896 | 12852 | 91584 | NA |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39} | Bits | 167904 | 152640 | 76320 | 76320 | 40392 | 305280 | 244224 |
| Max. Throughput averaged over 2 frames | Mbps | 118.796 | 109.768 | 54.869 | 54.869 | 28.975 | 184.88 | 141.07 |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames  Note 3: PDSCH is scheduled in PRB numbers from 0 to 52.  Note 4: PDSCH is scheduled in PRB numbers from 53 to 105.  Note 5: Two codewords and given per codeword | | | | | | | | |

**END OF CHANGE 1**

**START OF CHANGE 2**

**Table A.3.2.1.1-3: PDSCH Reference Channel for FDD (64QAM)**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | | | |
| Reference channel |  | R.PDSCH.1-3.1 FDD | R.PDSCH.1-3.2 FDD | R.PDSCH.1-3.3 FDD | R.PDSCH.1-3.4 FDD | R.PDSCH.1-3.5 FDD | R.PDSCH.1-3.6 FDD | R.PDSCH.1-3.7 FDD (Note 5) |
| Channel bandwidth | MHz | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Number of allocated resource blocks | PRBs | 52 | 52 | 26 (Note 3) | 26 (Note 4) | 52 | 52 | 52 |
| Number of consecutive PDSCH symbols |  | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per 2 frames | Slots | 19 | 19 | 19 | 19 | 19 | 19 | 19 |
| MCS table |  | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| MCS index |  | 19 | 19 | 19 | 19 | 19 | 17 | 17 |
| Modulation |  | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| Target Coding Rate |  | 0.51 | 0.51 | 0.51 | 0.51 | 0.51 | 0.43 | 0.43 |
| Number of MIMO layers |  | 2 | 2 | 2 | 2 | 1 | 4 | 4 |
| Number of DMRS REs |  | 12 | 24 | 24 | 24 | 12 | 24 | 48 |
| Overhead for TBS determination |  | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Information Bit Payload per Slot |  |  |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 1,…, 19 | Bits | 42016 | 37896 | 18960 | 18960 | 21000 | 64552 | 51216 |
| Transport block CRC per Slot |  |  |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 1,…, 19 | Bits | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |  |  |
| For Slot i = 0 | CBs | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 1,…, 19 | CBs | 5 | 5 | 3 | 3 | 3 | 8 | 7 |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 10, 11 | Bits | 78624 | 67392 | 33696 | 33696 | 39312 | 142272 | 112320 |
| For Slots i = 1,…, 9, 12, …, 19 | Bits | 82368 | 74880 | 37440 | 37440 | 41184 | 149760 | 119808 |
| Max. Throughput averaged over 2 frames | Mbps | 39.915 | 36.001 | 18.012 | 18.012 | 19.950 | 61.32 | 48.66 |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames  Note 3: PDSCH is scheduled in PRB numbers from 0 to 25.  Note 4: PDSCH is scheduled in PRB numbers from 26 to 51.  Note 5: Two codewords and given per codeword | | | | | | | | |

**END OF CHANGE 2**

End of R4-2316977

Start of R4-2318668 (Rank8, FDD 5~25MHz)

**Table A.3.2.1.1-20: PDSCH Reference Channel for FDD CC and CA scenario**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | |
| Reference channel |  | R.PDSCH.1-20.1 FDD | R.PDSCH.1-20.2 FDD | R.PDSCH.1-20.3 FDD | R.PDSCH.1-20.4 FDD |
| Channel bandwidth | MHz | 5 | 15 | 20 | 25 |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 |
| Number of allocated resource blocks | PRBs | 25 | 79 | 106 | 133 |
| Number of consecutive PDSCH symbols |  | 12 | 12 | 12 | 12 |
| Allocated slots per 2 frames | Slots | 19 | 19 | 19 | 19 |
| MCS table |  | 64QAM | 64QAM | 64QAM | 64QAM |
| MCS index |  | 17 | 17 | 17 | 17 |
| Modulation |  | 64QAM | 64QAM | 64QAM | 64QAM |
| Target Coding Rate |  | 0.43 | 0.43 | 0.43 | 0.43 |
| Number of MIMO layers |  | 4 | 4 | 4 | 4 |
| Number of DMRS REs |  | 48 | 48 | 48 | 48 |
| Overhead for TBS determination |  | 0 | 0 | 0 | 0 |
| Information Bit Payload per Slot |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A |
| For Slots i = 1,…, 19 | Bits | 24576 | 77896 | 104496 | 131176 |
| Transport block CRC per Slot |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A |
| For Slots i = 1,…, 19 | Bits | 24 | 24 | 24 | 24 |
| Number of Code Blocks per Slot |  |  |  |  |  |
| For Slot i = 0 | CBs | N/A | N/A | N/A | N/A |
| For Slots i = 1,…, 19 | CBs | 3 | 10 | 13 | 16 |
| Binary Channel Bits Per Slot |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A |
| For Slots i = 10, 11 | Bits | 54144 | 171072 | 229248 | 287424 |
| For Slots i =1,…, 9, 12, …, 19 | Bits | 57600 | 182016 | 244224 | 306432 |
| Max. Throughput averaged over 2 frames | Mbps | 23.347 | 74.001 | 99.271 | 124.617 |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames  Note 3: Two codewords and given per codeword | | | | | |

End of R4-2318668

Start of R4-2319228(Rank8, FDD 30~50MHz)

**Table A.3.2.1.1-23: PDSCH Reference Channel for FDD CC and CA scenario**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH.1-23.5 FDD | R.PDSCH.1-23.3 FDD | R.PDSCH.1-23.1 FDD | R.PDSCH.1-23.4 FDD | R.PDSCH.1-23.2 FDD |
| Channel bandwidth | MHz | 30 | 35 | 40 | 45 | 50 |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 |
| Number of allocated resource blocks | PRBs | 160 | 188 | 216 | 242 | 270 |
| Number of consecutive PDSCH symbols |  | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per 2 frames | Slots | 19 | 19 | 19 | 19 | 19 |
| MCS table |  | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| MCS index |  | 17 | 17 | 17 | 17 | 17 |
| Modulation |  | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| Target Coding Rate |  | 0.43 | 0.43 | 0.43 | 0.43 | 0.43 |
| Number of MIMO layers |  | 4 | 4 | 4 | 4 | 4 |
| Number of DMRS REs |  | 24 | 24 | 24 | 24 | 24 |
| Overhead for TBS determination |  | 0 | 0 | 0 | 0 | 0 |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 1,…, 19 | Bits | 196776 | 233608 | 262376 | 295176 | 335976 |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 1,…, 19 | Bits | 24 | 24 | 24 | 24 | 24 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slot i = 0 | CBs | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 1,…, 19 | CBs | 24 | 28 | 32 | 36 | 40 |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 10, 11 | Bits | 437760 | 514368 | 590976 | 662112 | 738720 |
| For Slots i =1,…, 9, 12, …, 19 | Bits | 460800 | 541440 | 622080 | 696960 | 777600 |
| Max. Throughput averaged over 2 frames | Mbps | 186.937 | 221.928 | 249.257 | 280.417 | 319.177 |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames  Note 3: Two codewords and given per codeword | | | | | | |

End of R4-2319228

Start of R4-2319229(Rank8, TDD 5~30MHz)

**Table A.3.2.2.2-31: PDSCH Reference Channel for TDD CC with UL-DL pattern FR1.30-1 and CA scenario**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH.2-31.1 TDD | R.PDSCH.2-31.2 TDD | R.PDSCH.2-31.3 TDD | R.PDSCH.2-31.4 TDD | R.PDSCH.2-31.5 TDD |
| Channel bandwidth | MHz | 5 | 10 | 15 | 20 | 25 |
| Subcarrier spacing | kHz | 30 | 30 | 30 | 30 | 30 |
| Number of allocated resource blocks | PRBs | 11 | 24 | 38 | 51 | 65 |
| Number of consecutive PDSCH symbols |  |  |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} |  | 4 | 4 | 4 | 4 | 4 |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} |  | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per 2 frames | Slots | 31 | 31 | 31 | 31 | 31 |
| MCS table |  | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| MCS index |  | 17 | 17 | 17 | 17 | 17 |
| Modulation |  | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| Target Coding Rate |  | 0.43 | 0.43 | 0.43 | 0.43 | 0.43 |
| Number of MIMO layers |  | 4 | 4 | 4 | 4 | 4 |
| Number of DMRS REs |  |  |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} |  | 12 | 12 | 12 | 12 | 12 |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} |  | 24 | 24 | 24 | 24 | 24 |
| Overhead for TBS determination |  | 0 | 0 | 0 | 0 | 0 |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | Bits | 4032 | 8968 | 14088 | 18960 | 24072 |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} | Bits | 13576 | 29704 | 47112 | 62504 | 79896 |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | Bits | 24 | 24 | 24 | 24 | 24 |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} | Bits | 24 | 24 | 24 | 24 | 24 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slot i = 0 | CBs | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | CBs | 1 | 2 | 2 | 3 | 3 |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} | CBs | 2 | 4 | 6 | 8 | 10 |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 10, 11 | Bits | 30096 | 65664 | 103968 | 139536 | 177840 |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | Bits | 9504 | 69120 | 32832 | 44064 | 56160 |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,9,12,…,19} | Bits | 31680 | 20736 | 109440 | 146880 | 187200 |
| Max. Throughput averaged over 2 frames | Mbps | 19.134 | 41.894 | 66.419 | 88.172 | 112.674 |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames  Note 3: Two codewords and given per codeword | | | | | | |

**Table A.3.2.2.2-32: PDSCH Reference Channel for TDD CC with UL-DL pattern FR1.30-1 and CA scenario**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH.2-32.1 TDD |  |  |  |  |
| Channel bandwidth | MHz | 30 |  |  |  |  |
| Subcarrier spacing | kHz | 30 |  |  |  |  |
| Number of allocated resource blocks | PRBs | 78 |  |  |  |  |
| Number of consecutive PDSCH symbols |  |  |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} |  | 4 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} |  | 12 |  |  |  |  |
| Allocated slots per 2 frames | Slots | 31 |  |  |  |  |
| MCS table |  | 64QAM |  |  |  |  |
| MCS index |  | 17 |  |  |  |  |
| Modulation |  | 64QAM |  |  |  |  |
| Target Coding Rate |  | 0.43 |  |  |  |  |
| Number of MIMO layers |  | 4 |  |  |  |  |
| Number of DMRS REs |  |  |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} |  | 12 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} |  | 24 |  |  |  |  |
| Overhead for TBS determination |  | 0 |  |  |  |  |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | Bits | 28680 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} | Bits | 96264 |  |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | Bits | 24 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} | Bits | 24 |  |  |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slot i = 0 | CBs | N/A |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | CBs | 4 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,19} | CBs | 12 |  |  |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A |  |  |  |  |
| For Slots i = 10, 11 | Bits | 213408 |  |  |  |  |
| For Slot i, if mod(i, 5) = 3 for i from {0,…,19} | Bits | 67392 |  |  |  |  |
| For Slot i, if mod(i, 5) = {0,1,2} for i from {1,…,9,12,…,19} | Bits | 224640 |  |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 135.692 |  |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames  Note 3: Two codewords and given per codeword | | | | | | |

End of R4-2319229

Start of R4-2319331(Rank8, TDD 50~100MHz)

**Table A.3.2.2.2-XX: PDSCH Reference Channel for TDD CC with UL-DL pattern FR1.30-1 and CA scenario**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH.2-XX.1 TDD | R.PDSCH.2-XX.2 TDD | R.PDSCH.2-XX.3 TDD | R.PDSCH.2-XX.4 TDD | R.PDSCH.2-XX.5 TDD |
| Channel bandwidth | MHz | 50 | 60 | 80 | 90 | 100 |
| Subcarrier spacing | kHz | 30 | 30 | 30 | 30 | 30 |
| Allocated resource blocks | PRBs | 133 | 162 | 217 | 245 | 273 |
| Number of consecutive PDSCH symbols |  |  |  |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} |  | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} |  | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per 2 frames |  | 27 | 27 | 27 | 27 | 27 |
| MCS table |  | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| MCS index |  | 17 | 17 | 17 | 17 | 17 |
| Modulation |  | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| Target Coding Rate |  | 0.43 | 0.43 | 0.43 | 0.43 | 0.43 |
| Number of MIMO layers |  | 4 | 4 | 4 | 4 | 4 |
| Number of DMRS REs |  |  |  |  |  |  |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} |  | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} |  | 48 | 48 | 48 | 48 | 48 |
| Overhead for TBS determination |  | 0 | 0 | 0 | 0 | 0 |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | Bits | 131176 | 159880 | 213176 | 241720 | 270576 |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | Bits | 24 | 24 | 24 | 24 | 24 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | CBs | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | CBs | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | CBs | 16 | 19 | 26 | 29 | 33 |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slots 0 and Slot i, if mod(i, 10) = {8,9} for i from {0,…,39} | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 20, 21 | Bits | 287424 | 350208 | 468864 | 529344 | 589824 |
| For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39} | Bits | 306432 | 373248 | 499968 | 564480 | 628992 |
| Max. Throughput averaged over 2 frames | Mbps | 177.088 | 215.838 | 287.788 | 326.322 | 365.278 |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames  Note 3: Two codewords and given per codeword | | | | | | |

End of R4-2319331

Start of R4-2319230(Rank2, FDD 5~25MHz)

**Table A.3.2.1.1-20: PDSCH Reference Channel for FDD CC and CA scenario**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH.1-20.1 FDD | R.PDSCH.1-20.2 FDD | R.PDSCH.1-20.2 FDD | R.PDSCH.1-20.3 FDD | R.PDSCH.1-20.4 FDD |
| Channel bandwidth | MHz | 5 | 10 | 15 | 20 | 25 |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 |
| Number of allocated resource blocks | PRBs | 25 | 52 | 79 | 106 | 133 |
| Number of consecutive PDSCH symbols |  | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per 2 frames | Slots | 19 | 19 | 19 | 19 | 19 |
| MCS table |  | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| MCS index |  | 19 | 19 | 19 | 19 | 19 |
| Modulation |  | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| Target Coding Rate |  | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| Number of MIMO layers |  | 2 | 2 | 2 | 2 | 2 |
| Number of DMRS REs |  | 12 | 12 | 12 | 12 | 12 |
| Overhead for TBS determination |  | 0 | 0 | 0 | 0 | 0 |
| Information Bit Payload per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 1,…, 19 | Bits | 19968 | 42016 | 63528 | 83976 | 106576 |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 1,…, 19 | Bits | 24 | 24 | 24 | 24 | 24 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slot i = 0 | CBs | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 1,…, 19 | CBs | 3 | 5 | 8 | 10 | 13 |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 10, 11 | Bits | 37800 | 78624 | 119448 | 160272 | 201096 |
| For Slots i =1,…, 9, 12, …, 19 | Bits | 29600 | 82368 | 125136 | 167904 | 210672 |
| Max. Throughput averaged over 2 frames | Mbps | 18.970 | 39.915 | 60.352 | 79.777 | 101.247 |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |

End of R4-2319230

Start of R4-2321197(Rank2, FDD 30~50MHz)

**Table A.3.2.1.1-X: PDSCH Reference Channel for FDD CC and CA scenario**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Unit** | **Value** | | | | |
| Reference channel |  | R.PDSCH.1-X.1 FDD | R.PDSCH.1-X.2 FDD | R.PDSCH.1-X.3 FDD | R.PDSCH.1-X.4 FDD | R.PDSCH.1-X.5 FDD |
| Channel bandwidth | MHz | 30 | 35 | 40 | 45 | 50 |
| Subcarrier spacing | kHz | 15 | 15 | 15 | 15 | 15 |
| Number of allocated resource blocks | PRBs | 160 | 188 | 216 | 242 | 270 |
| Number of consecutive PDSCH symbols |  | 12 | 12 | 12 | 12 | 12 |
| Allocated slots per 2 frames | Slots | 19 | 19 | 19 | 19 | 19 |
| MCS table |  | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| MCS index |  | 19 | 19 | 19 | 19 | 19 |
| Modulation |  | 64QAM | 64QAM | 64QAM | 64QAM | 64QAM |
| Target Coding Rate |  | 0.51 | 0.51 | 0.51 | 0.51 | 0.51 |
| Number of MIMO layers |  | 2 | 2 | 2 | 2 | 2 |
| Number of DMRS REs |  | 12 | 12 | 12 | 12 | 12 |
| Overhead for TBS determination |  | 0 | 0 | 0 | 0 | 0 |
| Information Bit Payload per Slot |  | 127080 | 151608 | 172176 | 192624 | 217128 |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 1,…, 19 | Bits |  |  |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 1,…, 19 | Bits | 24 | 24 | 24 | 24 | 24 |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
| For Slot i = 0 | CBs | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 1,…, 19 | CBs | 16 | 18 | 21 | 23 | 26 |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
| For Slot i = 0 | Bits | N/A | N/A | N/A | N/A | N/A |
| For Slots i = 10, 11 | Bits | 241920 | 284256 | 326592 | 366048 | 408384 |
| For Slots i =1,…, 9, 12, …, 19 | Bits | 253440 | 297792 | 342144 | 383328 | 427680 |
| Max. Throughput averaged over 2 frames | Mbps | 120.726 | 144.027 | 163.567 | 182.992 | 206.271 |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 ms  Note 2: Slot i is slot index per 2 frames | | | | | | |

End of R4-2321197

Start of R4-2311509

## B.1.3 UE Receiver with 8Rx

For 1 port transmission the channel matrix is defined in the frequency domain by



For 2 port transmission the channel matrix is defined in the frequency domain by



For 4 port transmission the channel matrix is defined in the frequency domain by



For 8 port transmission the channel matrix is defined in the frequency domain by



*<end of the change >*

End of R4-2311509

Start of R4-2311909

Table B.2.3.1.1-3: correlation matrices

Table B.2.3.1.1-3: correlation matrices

|  |  |
| --- | --- |
| **1x2 case** |  |
| **1x4 case** |  |
| **2x1 case** |  |
| **2x2 case** |  |
| **2x4 case** |  |
| **4x1 case** |  |
| **4x2 case** |  |
| **4x4 case** |  |
| 2x8 case |  |
| 4x8 case |  |
| 8x8 case |  |

For cases with more antennas at either gNB or UE or both, the channel spatial correlation matrix can still be expressed as the Kronecker product of  and  according to .

***<End of change 2>***

#### B.2.3.1.2 MIMO Correlation Matrices at High, Medium and Low Level

The *α* and *β* for different correlation types are given in Table B.2.3.1.2-1.

Table B.2.3.1.2-1: The *α* and *β* parameters for ULA MIMO correlation matrices

|  |  |  |
| --- | --- | --- |
| **Correlation Model** | *α* | *β* |
| **Low correlation** | 0 | 0 |
| **Medium Correlation** | 0.3 | 0.9 |
| **Medium Correlation A** | 0.3 | 0.3874 |
| **Medium Correlation B** | 0.3 | 0.005154 |
| **High Correlation** | 0.9 | 0.9 |

The correlation matrices for high, medium, medium A and low correlation are defined in Table B.2.3.1.2-2, B.2.3.1.2-3, B.2.3.1.2-4 and B.2.3.1.2-5 as below.

The values in Table B.2.3.1.2-2 have been adjusted for the 4x2 and 4x4 high correlation cases to insure the correlation matrix is positive semi-definite after round-off to 4 digit precision. This is done using the equation:



Where the value "*a*" is a scaling factor such that the smallest value is used to obtain a positive semi-definite result. For the 4x1 high correlation and 4x2 high correlation case, *a*=0.00010. For the 4x4 high correlation case, *a*=0.00012.

The same method is used to adjust the 2x4 and 4x4 medium correlation matrix in Table B.2.3.1.2-3 to insure the correlation matrix is positive semi-definite after round-off to 4 digit precision with *a* = 0.00010 and *a* = 0.00012.

***<End of change 2>***

End of R4-2311909