**3GPP TSG-<TSG/WG> Meeting #** **103-e *R4-2209828***

**Electronic Meeting, May 9- May 20, 2022**

|  |
| --- |
| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
|  |
|  | **38.101-4** | **CR** | **0286** | **rev** | **-** | **Current version:** | **17.4.0** |  |
|  |
| *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 |  |

|  |
| --- |
|  |
| ***Title:***  | BigCR: Introduction of MMSE-IRC receiver for intra cell inter user interference |
|  |  |
| ***Source to WG:*** | Huawei, HiSilicon |
| ***Source to TSG:*** | RAN 4 |
|  |  |
| ***Work item code:*** | NR\_demod\_enh2-Perf |  | ***Date:*** | 2022-05-23 |
|  |  |  |  |  |
| ***Category:*** | B |  | ***Release:*** | Rel-17 |
|  | *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 canbe 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 the indication of chairman, RAN 4 should prepare the big CR for intra cell inter user MMSE IRC receiver requirements |
|  |  |
| ***Summary of change:*** | Combined following CRs to one big CR:* R4-2210954 (China Telecom): Draft CR on PDSCH 4Rx demod requirements for MU-MIMO IRC
* R4-2210955 (Ericsson): draftCR: FRC for MU-MIMO
* R4-2210956 (Huawei,HiSilicon): DraftCR: introduction of MU-MIMO Beamforming model in TS 38.101-4
* R4-2210957 (Huawei,HiSilicon): Draft CR: Introduction of PDSCH requirements for intra cell inter user interference MMSE-IRC receiver for 2RX
 |
|  |  |
| ***Consequences if not approved:*** | The corresponding requirements for intra-cell inter-user IRC will be missing  |
|  |  |
| ***Clauses affected:*** | 5.2.2.1.16(New), 5.2.2.2.17(New), 5.2.3.1.16(New), 5.2.3.2.17(New), A.3.2.1.x (New), A.3.2.2.y (New), B.4.2(New) |
|  |  |
|  | **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:*** |  |

***<R4-2210957>***

##### 5.2.2.1.16 Minimum requirements for PDSCH with intra cell inter user interference

The performance requirements are specified in Table 5.2.2.1.16-3 and Table 5.2.2.1.16-4, with the addition of test parameters in Table 5.2.2.1.16-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.16-1.

**Table 5.2.2.1.X-1: Tests purpose**

|  |  |
| --- | --- |
| **Purpose** | **Test index** |
| Verify the PDSCH performance under 2 receive antenna conditions when the PDSCH transmission of target UE is interfered by co-scheduled UE  | 1-1 |

**Table 5.2.2.1.X-2: Test parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Unit | Target UE | Co-scheduled UE |
| 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 |
| Antenna ports indexes |  | 1000 | 1001 |
| Number of PDSCH DMRS CDM group(s) without data |  | 1 | 1 |
| PDSCH & PDSCH DMRS Precoding configuration |  | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i1, i2 combination, and with PRB bundling granularity | Single Panel Type I, Random precoder selection updated per slot and with PRB bundling granularity. Any column of precoder matrix is not equal to any column of precoder matriax of Target UE |
| MU-MIMO Beamforming Model |  | As specified in [B.4.2] |
| Number of HARQ Processes |  | 4 | N/A |
| The number of slots between PDSCH and corresponding HARQ-ACK information |  | 2 | N/A |

**Table 5.2.2.1.X-3: Minimum performance for PDSCH of target UE with intra-cell inter user interference**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test num** | **Reference channel** | **Bandwidth (MHz) / Subcarrier spacing (kHz)** | **Modulation format and code rate** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Reference value** |
| **Target UE** | **Co-scheduled UE** | **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 1-1 | [R.PDSCH.1-2.1 FDD] | 10 / 15 | 16QAM, 0.48 | Random 16QAM symbols | TDLC300-100 | 2x2, ULA Low | 70 | [TBD] |

##### 5.2.2.2.17 Minimum requirements for PDSCH with intra cell inter user interference

The performance requirements are specified in Table 5.2.2.1.17-3 and Table 5.2.2.1.17-4, with the addition of test parameters in Table 5.2.2.1.17-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.2.1.17-1.

**Table 5.2.2.1.Y-1: Tests purpose**

|  |  |
| --- | --- |
| **Purpose** | **Test index** |
| Verify the PDSCH performance under 2 receive antenna conditions when the PDSCH transmission of target UE is interfered by co-scheduled UE  | 1-1  |

**Table 5.2.2.1.Y-2: Test parameters**

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Unit | Target UE | Co-scheduled UE |
| Duplex mode |  | TDD |
| 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 |
| Antenna ports indexes |  | 1000 | 1001 |
| Number of PDSCH DMRS CDM group(s) without data |  | 1 | 1 |
| PDSCH & PDSCH DMRS Precoding configuration |  | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i1, i2 combination, and with PRB bundling granularity | Single Panel Type I, Random precoder selection updated per slot and with PRB bundling granularity. Any column of precoder matrix is not equal to any column of precoder matriax of Target UE |
| MU-MIMO Beamforming Model |  | As specified in [B.4.2] |
| Number of HARQ Processes |  | 8 | N/A |
| 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 | N/A |

**Table 5.2.2.1.17-3: Minimum performance for PDSCH of target UE with intra-cell inter user interference**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| Target UE | Co-scheduled UE | Fraction ofmaximumthroughput(%) | SNR (dB) |
| 1-1 | [R.PDSCH.2-2.1 TDD] | 40 / 30 | 16QAM, 0.48 | Random 16QAM symbols | FR1.30-1 | TDLC300-100 | 2x2, ULA Low  | 70 | TBD |

***<R4-2210954>***

5.2.3.1.16 Minimum requirements for PDSCH with intra-cell inter-user interference

The performance requirements are specified in Table 5.2.3.1.16-3 and Table 5.2.3.1.16-4, with the addition of test parameters in Table 5.2.3.1.16-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.1.16-1.

**Table 5.2.3.1.16-1: Tests purpose**

|  |  |
| --- | --- |
| **Purpose** | **Test index** |
| Verify PDSCH performance under 4 receive antenna conditions, when the PDSCH transmission of target UE is interfered by co-scheduled UE.  | 1-1, 2-1 |

Table 5.2.3.1.16-2: Test parameters

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Unit | Target UE | Co-scheduled UE |
| 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 |
| Antenna ports indexes |  | {1000} for test 1-1{1000, 1001} for test 2-1 | {1001} for test 1-1{1002, 1003} for test 2-1 |
| Number of PDSCH DMRS CDM group(s) without data |  | 1 for test 1-12 for test 2-1 | 1 for test 1-12 for test 2-1 |
| PDSCH & PDSCH DMRS Precoding configuration |  | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i1, i2 combination, and with PRB bundling granularity | Single Panel Type I, Random precoder selection updated per slot and with PRB bundling granularity. Any column of precoder matrix is not equal to any column of precoder matriax of Target UE for test 1-1Select the precoder to ensure orthogonality with the precoder for the target PDSCH for test 2-1 |
| MU-MIMO Beamforming Model |  | As specified in [B.4.2] |
| Number of HARQ Processes |  | 4 | N/A |
| The number of slots between PDSCH and corresponding HARQ-ACK information |  | 2 | N/A |

Table5.2.3.1.16-3: Minimum performance for target UE with Rank 1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition  | Correlation matrix and antenna configuration | Reference value |
| Target UE | Co-scheduled UE | Fraction ofmaximumthroughput(%) | SNR (dB) |
| 1-1 | [R.PDSCH.1-2.1 FDD] | 10 / 15 | 16QAM, 0.48 | Random 16QAM symbols | TDLC300-100 | 2x4, ULA Low  | 70 | TBD |

Table5.2.3.1.16-4: Minimum performance for target UE with 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 |
| Target UE | Co-scheduled UE | Fraction ofmaximumthroughput(%) | SNR (dB) |
| 2-1 | [R.PDSCH.x-1.1 FDD] | 10 / 15 | 16QAM, 0.48 | Random 16QAM symbols | TDLA30-10  | 4x4, ULA Low  | 70 | TBD |

**<End of change 1>**

**<Start of change 2>**

5.2.3.2.17 Minimum requirements for PDSCH with intra-cell inter-user interference

The performance requirements are specified in Table 5.2.3.2.17-3 and and Table 5.2.3.2.17-4, with the addition of test parameters in Table 5.2.3.2.17-2 and the downlink physical channel setup according to Annex C.3.1.

The test purposes are specified in Table 5.2.3.2.17-1.

**Table 5.2.3.2.17-1: Tests purpose**

|  |  |
| --- | --- |
| **Purpose** | **Test index** |
| Verify PDSCH performance under 4 receive antenna conditions, when the PDSCH transmission of target UE is interfered by co-scheduled UE.  | 1-1, 2-1 |

Table 5.2.3.2.17-2: Test parameters

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Unit | Target UE | Co-scheduled UE |
| Duplex mode |  | TDD |
| 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 |
| Antenna ports indexes |  | {1000} for test 1-1{1000, 1001} for test 2-1 | {1001} for test 1-1{1002, 1003} for test 2-1 |
| Number of PDSCH DMRS CDM group(s) without data |  | 1 for test 1-12 for test 2-1 | 1 for test 1-12 for test 2-1 |
| PDSCH & PDSCH DMRS Precoding configuration |  | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i1, i2 combination, and with PRB bundling granularity | Single Panel Type I, Random precoder selection updated per slot and with PRB bundling granularity. Any column of precoder matrix is not equal to any column of precoder matriax of Target UE for test 1-1Select the precoder to ensure orthogonality with the precoder for the target PDSCH for test 2-1 |
| MU-MIMO Beamforming Model |  | As specified in [B.4.2] |
| Number of HARQ Processes |  | 8 | N/A |
| 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 | N/A |

Table5.2.3.1.17-3: Minimum performance for target UE with Rank 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |
| Target UE | Co-scheduled UE | Fraction ofmaximumthroughput(%) | SNR (dB) |
| 1-1 | [R.PDSCH.2-2.1 TDD] | 40 / 30 | 16QAM, 0.48 | Random 16QAM symbols | FR1.30-1 | TDLC300-100 | 2x4, ULA Low  | 70 | TBD |

Table 5.2.3.2.17-4: Minimum performance for target UE with 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 |
| Target UE | Co-scheduled UE | Fraction ofmaximumthroughput(%) | SNR (dB) |
| 2-1 | [R.PDSCH.y-1.1 TDD] | 40 / 30 | 16QAM, 0.48 | Random 16QAM symbols | FR1.30-1 | TDLA30-10 | 4x4, ULA Low  | 70 | TBD |

***<R4-2210955>***

#### A.3.2.1.x Reference measurement channels for Intra-cell Inter-UE interference scenario

Table A.3.2.1.x-1: PDSCH Reference Channel for FDD Intra-cell Inter-UE interference scenario

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Unit** | **Value** |
| Reference channel |  | R.PDSCH.x-1.1 FDD | R.PDSCH.x-1.2 FDD |  |  |  |
| Channel bandwidth | MHz | 10 | 10 |  |  |  |
| Subcarrier spacing | kHz | 15 | 15 |  |  |  |
| Number of allocated resource blocks | PRBs | 52 | 52 |  |  |  |
| Number of consecutive PDSCH symbols |  | 12 | 12 |  |  |  |
| Allocated slots per 2 frames | Slots | 19 | 19 |  |  |  |
| MCS table |  | 64QAM | 64QAM |  |  |  |
| MCS index |  | 13 | 13 |  |  |  |
| Modulation |  | 16QAM | 16QAM |  |  |  |
| Target Coding Rate |  | 0.48 | 0.48 |  |  |  |
| Number of MIMO layers |  | 1 | 2 |  |  |  |
| Number of DMRS REs |  | 12 | 24 |  |  |  |
| Overhead for TBS determination |  | 0 | 0 |  |  |  |
| Information Bit Payload per Slot  |  |  |  |  |  |  |
|  For Slot i = 0 | Bits | N/A | N/A |  |  |  |
|  For Slots i = 1,…, 19 | Bits | 13064 | 24072 |  |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
|  For Slot i = 0 | Bits | N/A | N/A |  |  |  |
|  For Slots i = 1,…, 19 | Bits | 24 | 24 |  |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
|  For Slot i = 0 | CBs | N/A | N/A |  |  |  |
|  For Slots i = 1,…, 19 | CBs | 2 | 3 |  |  |  |
| Binary Channel Bits Per Slot |  |  |  |  |  |  |
|  For Slot i = 0 | Bits | N/A | N/A |  |  |  |
|  For Slots i = 10, 11 | Bits | 26208 | 47424 |  |  |  |
|  For Slots i = 1,…, 9, 12, …, 19 | Bits | 27456 | 49920 |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 12.411 | 22.868 |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 msNote 2: Slot i is slot index per 2 frames |

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

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

#### A.3.2.2.y Reference measurement channels for Intra-cell Inter-UE interference scenario

Table A.3.2.2.y-1: PDSCH Reference Channel for TDD Intra-cell Inter-UE interference scenario

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Unit** | **Value** |
| Reference channel |  | R.PDSCH.y-1.1 TDD | R.PDSCH.y-1.2 TDD |  |  |  |
| Channel bandwidth | MHz | 40 | 40 |  |  |  |
| Subcarrier spacing | kHz | 30 | 30 |  |  |  |
| Allocated resource blocks | PRBs | 106 | 106 |  |  |  |
| Number of consecutive PDSCH symbols |  |  |  |  |  |  |
|  For Slot i, if mod(i, 10) = 7 for i from {0,…,39} |  | 4 | 4 |  |  |  |
|  For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} |  | 12 | 12 |  |  |  |
| Allocated slots per 2 frames |  | 31 | 31 |  |  |  |
| MCS table |  | 64QAM | 64QAM |  |  |  |
| MCS index |  | 13 | 13 |  |  |  |
| Modulation |  | 16QAM | 16QAM |  |  |  |
| Target Coding Rate |  | 0.48 | 0.48 |  |  |  |
| Number of MIMO layers |  | 1 | 2 |  |  |  |
| Number of DMRS REs |  |  |  |  |  |  |
|  For Slot i, if mod(i, 10) = 7 for i from {0,…,39} |  | 6 | 12 |  |  |  |
|  For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} |  | 12 | 24 |  |  |  |
| Overhead for TBS determination |  | 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 |  |  |  |
|  For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 8456 | 14600 |  |  |  |
|  For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | Bits | 26632 | 49176 |  |  |  |
| 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 |  |  |  |
|  For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 24 | 24 |  |  |  |
|  For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6}for i from {1,…,39} | Bits | 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 |  |  |  |
|  For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | CBs | 2 | 2 |  |  |  |
|  For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,39} | CBs | 4 | 6 |  |  |  |
| 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 |  |  |  |
|  For Slots i = 20, 21 | Bits | 53424 | 96672 |  |  |  |
|  For Slot i, if mod(i, 10) = 7 for i from {0,…,39} | Bits | 17808 | 30528 |  |  |  |
|  For Slot i, if mod(i, 10) = {0,1,2,3,4,5,6} for i from {1,…,19,22,…,39} | Bits | 55968 | 101760 |  |  |  |
| Max. Throughput averaged over 2 frames | Mbps | 37.644 | 69.308 |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 msNote 2: Slot i is slot index per 2 frames |

***<R4-2210956>***

# B.4 Physical signals, channels mapping and precoding

## B.4.1 General

Unless otherwise stated, the transmission on antenna port(s) is defined by using a precoder matrix  of size , where is the number of physical transmit antenna elements configured per test , is the number of ports for a reference signal or physical channel configured per test, and is the first port for that reference signal or physical channel as defined in clauses 7.3 and 7.4 in TS 38.211 [9]. This precoder takes as an input a block of signals for antenna port(s) , , , with  being the number of modulation symbols per antenna port including the reference signal symbols, and generates a block of signals the elements of which are to be mapped onto the frequency-time index pair as per the test configuration but transmitted on different physical antenna elements:

For Clause 6 and 8, the transmission of PDCCH and PDCCH DMRS on antenna port is defined by using a precoder matrix  of size 2x1. This precoder takes as an input a block of signals for antenna port(s) , and generates a block of signals the elements of which are to be mapped onto the frequency-time index pair as per the test configuration but transmitted on different physical antenna elements:

The precoder matrix is specific to the test case configuration.  is defined in Clause 5.2.2.2 of TS 38.214 [12].

The transimison on PT-RS antenna port is associated (using same precoder) with the lowest indexed DM-RS antenna port among the DM-RS antenna ports assigned for the PDSCH.

The physical antenna elements are identified by indices, where  is the number of physical antenna elements configured per test.

Modulation symbols with (i.e. PSS, SSS, PBCH and DM-RS for PBCH) are directly mapped to first physical antenna element.

Modulation symbols  for CSI-RS resources which configured for tracking with one port are directly mapped to first physical antenna element.

Modulation symbols  for CSI-RS resources which configured for beam refinement with one port are directly mapped to first physical antenna element.

Modulation symbols  for NZP CSI-RS which configured for CSI acquisition with  are mapped to the physical antenna index  where is the number of NZP CSI-RS ports configured per test.

## B.4.2 Beamforming for MU-MIMO

The transmission on antenna port(s) , with being the number of co-scheduled UEs allocated for different antenna ports in one RE is defined by using a precoder matrix of size , where is the number of physical transmit antenna elements configured per test , is the number of ports for UE *n* for a reference signal or physical channel configured per test, is the precoder matrix for UE *n* which isspecific to the test case configuration, and is the first port for UE *n* for that reference signal or physical channel as defined in clauses 7.3 and 7.4 in TS 38.211 [9]. This precoder takes as an input a block of signals for antenna port(s) , , , with being the number of modulation symbols per antenna port including the reference signal symbols, and generates a block of signals the elements of which are to be mapped onto the frequency-time index pair as per the test configuration but transmitted on different physical antenna elements:

The is specific to test case configuration and defined to maintain the average per UE signal power as