**3GPP TSG- Meeting #R4-221xxxx**

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| *CR-Form-v12.2* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  |  | **CR** |  | **rev** |  | **Current version:** |  |  |
|  | | | | | | | | |
| *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:*** | Introducing Beam Failure Detection and TCI state switch test cases in FR2-2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** |  | | | | | | | | | |
| ***Source to TSG:*** |  | | | | | | | | | |
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| ***Work item code:*** |  | | | | |  | ***Date:*** | | |  |
|  |  | | | |  | |  | | |  |
| ***Category:*** |  |  | | | | | ***Release:*** | | |  |
|  | *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:*** | | Addition of test case in accordance to work split defined for ext71GHz RRM performance. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Addition of beam failure detection and link recovery test cases, and addition of TCI state switch test cases in FR2-2 | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | The requirements for beam failure detection and active TCI state switch will not be tested | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **x** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  | **x** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **x** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | | **R4-2216260** | | | | | | | | |

### <Start of change 1>

#### A.7.5.5.X1 Beam Failure Detection and Link Recovery Test for FR2-2 PCell configured with SSB-based BFD and LR in non-DRX mode

##### A.7.5.5.X1.1 Test Purpose and Environment

The purpose of this test is to verify that the UE properly detects SSB-based beam failure in the set q0 configured for a serving cell and that the UE performs correct SSB-based link recovery based on beam candidate set q1. The purpose is to test the downlink monitoring for beam failure detection within the UEs active DL BWP, during the evaluation period, and link recovery, when no DRX is used. This test will partly verify the SSB based beam failure detection and link recovery for an FR2-2 serving cell requirements in clause 8.5.

The test parameters are given in Tables A.7.5.5.X1.1-1, A.7.5.5.X1.1-2, A.7.5.5.X1.1-3 and A.7.5.5.X1.1-4 below. There is one cell, cell 1 which is the active cell, in the test. The test consists of five successive time periods, with time duration of T1, T2, T3, T4 and T5 respectively. Figure A.7.5.5.X1.1-1 shows the variation of the downlink SNR of the SSB in set q0 in the active cell to emulate SSB based beam failure. Figure A.7.5.5.X1.1-1 additionally shows the variation of the downlink L1-RSRP of the SSB in set q1 of the candidate beam used for link recovery. Prior to the start of the time duration T1, the UE shall be fully synchronized to cell 1. The UE shall be configured for periodic CSI reporting with a reporting periodicity of 5 ms. In the test, DRX configuration is not enabled. The UE is configured to perform inter-frequency measurements using GP ID #0 (40ms) in test 1.

Table A.7.5.5.X1.1-1: Supported test configurations for FR2-2 PCell

|  |  |
| --- | --- |
| Configuration | Description |
| 1 | TDD duplex mode, 120 kHz SSB SCS, 100 MHz bandwidth |
| 2 | TDD duplex mode, 480 kHz SSB SCS, 400 MHz bandwidth |
| 3 | TDD duplex mode, 960 kHz SSB SCS, 400 MHz bandwidth |
| Note: The UE is only required to pass in one of the supported test configurations in FR2-2 | |

Table A.7.5.5.X1.1-2: General test parameters for FR2-2 PCell for SSB-based beam failure detection and link recovery testing in non-DRX mode

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter** | | **Test**  **Config.** | **Unit** | **Value** | **Comment** |
|  | |  |  | **Test 1** |  |
| Active PCell | | 1-2-3 |  | Cell 1 |  |
| RF Channel Number | | 1-2-3 |  | 1 |  |
| Duplex mode | | 1-2-3 |  | TDD |  |
| TDD Configuration | | 1-2-3 |  | TDDConf.3.1 |  |
| BWchannel | | 1-2 |  | 100: NRB,c = 66 |  |
|  | | 3 |  | 400: NRB,c = 33 |  |
| Data RBs allocated | | 1-2 |  | 66 |  |
|  | | 3 |  | 33 |  |
| PDSCH/PDCCH subcarrier spacing | | 1 | kHz | 120 |  |
|  | | 2 |  | 480 |  |
|  | | 3 |  | 960 |  |
| DL initial BWP configuration | | 1-2-3 |  | TBD |  |
| DL dedicated BWP configuration | | 1-2-3 |  | TBD |  |
| UL initial BWP configuration | | 1-2-3 |  | TBD |  |
| UL dedicated BWP configuration | | 1-2-3 |  | TBD |  |
| PDSCH Reference Channel | | 1 |  | TBD |  |
| 2 | TBD |  |
|  | | 3 |  | TBD |  |
| RMSI CORESET Reference Channel | | 1 |  | TBD |  |
| 2 | TBD |  |
|  | | 3 |  | TBD |  |
| Dedicated CORESET Reference Channel | | 1 |  | TBD |  |
| 2 | TBD |  |
|  | | 3 |  | TBD |  |
| OCNG parameters | | 1-2-3 |  | OP.1 |  |
| CP length | | 1-2-3 |  | Normal |  |
| PDSCH/PDCCH TCI state | | 1-2-3 |  | TCI.State.0 |  |
| CSI-RS for tracking | | 1-2-3 |  | TBD |  |
| SSB Configuration | | 1 |  | TBD |  |
| 2 | TBD |  |
|  | | 3 |  |  |  |
| SMTC Configuration | | 1-2-3 |  | SMTC.3 |  |
| PRACH Configuration | | 1-2-3 |  | TBD | A.3.8.3.2 |
| DRX configuration | | 1-2-3 |  | OFF |  |
| SSB index assigned as BFD RS (q0) | | 1-2-3 |  | 0 |  |
| SSB index assigned as CBD RS (q1) | | 1-2-3 |  | 1 |  |
| SSB index assigned as RLM RS | | 1-2-3 |  | 0,1 |  |
| Beam failure detection transmission parameters | DCI format | 1-2-3 |  | 1-0 |  |
| Number of Control OFDM symbols | 1-2-3 |  | 2 |  |
| Aggregation level | 1-2-3 | CCE | 8 |  |
| Ratio of hypothetical PDCCH RE energy to average SSS RE energy | 1-2-3 | dB | 0 |  |
| Ratio of hypothetical PDCCH DMRS energy to average SSS RE energy | 1-2-3 | dB | 0 |  |
| DMRS precoder granularity | 1-2-3 |  | REG bundle size |  |
| REG bundle size | 1-2-3 |  | 6 |  |
| Gap pattern ID | | 1-2-3 |  | gp0 |  |
| gapOffset | | 1-2-3 | ms | 0 |  |
| rlmInSyncOutOfSyncThreshold | | 1-2-3 |  | absent | Value 0 is applied. (Table 8.1.1-1). |
| rsrp-ThresholdSSB | | 1 | dBm/SCS | -95 | Threshold used for Qin\_LR\_SSB |
| 2 | -89 |
|  | | 3 |  | -86 |  |
| powerControlOffsetSS | | 1-2-3 |  | db0 | Used for deriving rsrp-ThresholdCSI-RS |
| beamFailureInstanceMaxCount | | 1-2-3 |  | n1 | see TS 38.321 [7], clause 5.17 |
| beamFailureDetectionTimer | | 1-2-3 |  | pbfd4 | see TS 38.321 [7], clause 5.17 |
| CSI-RS configuration for CSI reporting | | 1-2-3 |  | TBD |  |
| reportConfigType | | 1-2-3 |  | periodic |  |
| reportQuantity | | 1-2-3 |  | cri-RI-PMI-CQI |  |
| CSI reporting periodicity | | 1-2-3 | slot | 40 |  |
| CSI reporting offset | | 1-2-3 | slot | 4 |  |
| T310 | | 1-2-3 | ms | 1000 |  |
| N310 | | 1-2-3 |  | 2 |  |
| T1 | | 1-2-3 | s | 1 | The UE shall be fully synchronized to cell 1 during T1 |
| T2 | | 1-2-3 | s | TBD |  |
| T3 | | 1-2-3 | s | TBD |  |
| T4 | | 1-2-3 | s | 0 |  |
| T5 | | 1-2-3 | s | TBD |  |
| D1 | | 1-2-3 | s | TBD |  |
| Note 1: All configurations are assigned to the UE prior to the start of time period T1.  Note 2: UE-specific PDCCH is not transmitted after T1 starts. | | | | | |

Table A.7.5.5.X1.1-3: Cell specific test parameters for FR2-2 PCell for SSB-based beam failure detection and link recovery testing in non-DRX mode

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | | Unit | Test 1 | | | | |
|  | |  | T1 | T2 | T3 | T4 | T5 |
| AoA setup | |  | Setup 1 defined in A.3.15 | | | | |
| Assumption for UE beams Note 10 | |  | Rough | | | | |
| EPRE ratio of PDCCH DMRS to SSS | | dB | 0 | | | | |
| EPRE ratio of PDCCH to PDCCH DMRS | | dB |  | | | | |
| EPRE ratio of PBCH DMRS to SSS | | dB |  | | | | |
| EPRE ratio of PBCH to PBCH DMRS | | dB |  | | | | |
| EPRE ratio of PSS to SSS | | dB |  | | | | |
| EPRE ratio of PDSCH DMRS to SSS | | dB |  | | | | |
| EPRE ratio of PDSCH to PDSCH DMRS | | dB |  | | | | |
| EPRE ratio of OCNG DMRS to SSS | | dB |  | | | | |
| EPRE ratio of OCNG to OCNG DMRS | | dB |  | | | | |
| SNR\_SSB of set q0 | Config 1-2-3 | dB | 5Note 11 | -3Note 11 | -12 | -12 | -12 |
| SNR\_SSB of set q1 | Config 1-2-3 | dB | 0.2 | 0.2 | 20.2 | 20.2 | 20.2 |
| SSB\_RP of set q1 | Config 1 | dBm/ | -104.5 | -104.5 | -84.5 | -84.5 | -84.5 |
|  | Config 2 | SCS | -98.5 | -98.5 | -78.5 | -78.5 | -78.5 |
|  | Config 3 |  | -95.5 | -95.5 | -75.5 | -75.5 | -75.5 |
|  | Config 1,2,3 | dBm/120 KHz | -104.7 | | | | |
| Propagation condition | |  | TDL-A 30ns 75Hz | | | | |
| Note 1: OCNG shall be used such that the resources in Cell 1 are fully allocated and a constant total transmitted power spectral density is achieved for all OFDM symbols.  Note 2: The uplink resources for CSI reporting are assigned to the UE prior to the start of time period T1.  Note 3: NZP CSI-RS resource set configuration for CSI reporting are assigned to the UE prior to the start of time period T1.  Note 4: Measurement gap configuration is assigned to the UE prior to the start of time period T1.  Note 5: The timers and layer 3 filtering related parameters are configured prior to the start of time period T1.  Note 6: The signal contains PDCCH for UEs other than the device under test as part of OCNG.  Note 7: SNR levels correspond to the signal to noise ratio over the SSS REs.  Note 8: The SNR in time periods T1, T2, T3, T4 and T5 is denoted as SNR1, SNR2 and SNR3 respectively in figure A.7.5.5.X1.1-1.  Note 9: The SNR values are specified for testing a UE which supports 2RX on at least one band. For testing of a UE which supports 4RX on all bands, the SNR during T3 is modified as specified in clause A.3.6.  Note 10: Information about types of UE beam is given in B.2.1.3 and does not limit UE implementation or test system implementation.  Note 11: This value allows up to 1dB degradation from applied SNR to UE baseband | | | | | | | |

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**Figure A.7.5.5.X1.1-1: SNR and L1-RSRP variation SSB for SSB-based beam failure detection and link recovery testing in non-DRX mode**

##### A.7.5.5.X1.2 Test Requirements

The UE behaviour during time durations T1, T2, T3, T4 and T5 shall be as follows:

During the time duration T1 and T2, the UE shall transmit uplink signal at least in all subframes configured for CSI transmission on Cell 1.

During the period from time point A to time point B the UE shall transmit uplink signal in Cell 1 in all uplink slots configured for CSI transmission according to the configured periodic CSI reporting for Cell 1.

During T3 the UE shall detect beam failure and initiate link recovery. During T4 and T5 the UE measures and evaluate beam candidate from beam candidate set q1.

No later than time point F occurring no later than D1 = TBD+10 ms after the start of T5, the UE shall transmit preamble on a beam associated with the candidate beam set q1. The UE shall not transmit preamble on a beam associated with the candidate beam set q1 earlier than time point B.

Test is concluded once the test equipment has received the initial preamble transmission from the UE. The rate of correct events observed during repeated tests shall be at least 90%.

#### A.7.5.5.X2 Beam Failure Detection and Link Recovery Test for FR2-2 PCell configured with SSB-based BFD and LR in DRX mode

##### A.7.5.5.X2.1 Test Purpose and Environment

The purpose of this test is to verify that the UE properly detects SSB-based beam failure in the set q0 configured for a serving cell and that the UE performs correct SSB-based link recovery based on beam candidate set q1. The purpose is to test the downlink monitoring for beam failure detection within the UEs active DL BWP, during the evaluation period, and link recovery, when DRX is used. This test will partly verify the SSB based beam failure detection and link recovery for an FR2-2 serving cell requirements in clause 8.5.

The test parameters are given in Tables A.7.5.5.X2.1-1, A.7.5.5.X2.1-2, A.7.5.5.X2.1-3, A.7.5.5.X2.1-4 and A.7.5.5.X2.1-5 below. There is one cell, cell 1 which is the active cell, in the test. The test consists of five successive time periods, with time duration of T1, T2, T3, T4 and T5 respectively. Figure A.7.5.5.X2.1-1 shows the variation of the downlink SNR of the SSB in set q0 in the active cell to emulate SSB based beam failure. Figure A.7.5.5.X2.1-1 additionally shows the variation of the downlink L1-RSRP of the SSB in set q1 of the candidate beam used for link recovery. Prior to the start of the time duration T1, the UE shall be fully synchronized to cell 1. The UE shall be configured for periodic CSI reporting with a reporting periodicity of 5 ms. In the test, DRX configuration is enabled in PCell and DRX inactivity timer has already been expired, i.e. UE tries to decode PDCCH and to send periodic CQI during the period when On-duration timer is running. Time alignment timers shall be set to “infinity” so that UL timing alignment is maintained during the test.

Table A.7.5.5.X2.1-1: Supported test configurations for FR2-2 PCell

|  |  |
| --- | --- |
| Configuration | Description |
| 1 | TDD duplex mode, 120 kHz SSB SCS, 100 MHz bandwidth |
| 2 | TDD duplex mode, 480 kHz SSB SCS, 400 MHz bandwidth |
| 3 | TDD duplex mode, 960 kHz SSB SCS, 400 MHz bandwidth |
| Note: The UE is only required to pass in one of the supported test configurations in FR2-2 | |

Table A.7.5.5.X2.1-2: General test parameters for FR2-2 PCell for SSB-based beam failure detection and link recovery testing in DRX mode

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter** | | **Test**  **Config.** | **Unit** | **Value** | **Comment** |
|  | |  |  | **Test 1** |  |
| Active PCell | | 1-2-3 |  | Cell 1 |  |
| RF Channel Number | | 1-2-3 |  | 1 |  |
| Duplex mode | | 1-2-3 |  | TDD |  |
| TDD Configuration | | 1-2-3 |  | TDDConf.3.1 |  |
| BWchannel | | 1 |  | 100: NRB,c = 66 |  |
|  | | 2 |  | 400: NRB,c = 66 |  |
|  | | 3 |  | 100: NRB,c = 33 |  |
| Data RBs allocated | | 1-2-3 |  | 66 |  |
| PDSCH/PDCCH subcarrier spacing | | 1 | kHz | 120 |  |
|  | | 2 |  | 480 |  |
|  | | 3 |  | 960 |  |
| DL initial BWP configuration | | 1-2-3 |  | TBD |  |
| DL dedicated BWP configuration | | 1-2-3 |  | TBD |  |
| UL initial BWP configuration | | 1-2-3 |  | TBD |  |
| UL dedicated BWP configuration | | 1-2-3 |  | TBD |  |
| PDSCH Reference Channel | | 1 |  | TBD |  |
| 2 | TBD |  |
|  | | 3 |  | TBD |  |
| RMSI CORESET Reference Channel | | 1 |  | TBD |  |
| 2 | TBD |  |
|  | | 3 |  | TBD |  |
| Dedicated CORESET Reference Channel | | 1 |  | TBD |  |
| 2 | TBD |  |
|  | | 3 |  | TBD |  |
| OCNG parameters | | 1-2-3 |  | OP.1 |  |
| CP length | | 1-2-3 |  | Normal |  |
| PDSCH/PDCCH TCI state | | 1-2-3 |  | TCI.State.0 |  |
| CSI-RS for tracking | | 1-2-3 |  | TBD |  |
| SSB Configuration | | 1 |  | TBD |  |
| 2 | TBD |  |
|  | | 3 |  | TBD |  |
| SMTC Configuration | | 1-2-3 |  | SMTC.3 |  |
| PRACH Configuration | | 1-2-3 |  | TBD | A.3.8.3.2 |
| DRX configuration | | 1-2-3 |  | DRX.3 | A.3.3.3 |
| SSB index assigned as BFD RS (q0) | | 1-2-3 |  | 0 |  |
| SSB index assigned as CBD RS (q1) | | 1-2-3 |  | 1 |  |
| SSB index assigned as RLM RS | | 1-2-3 |  | 0,1 |  |
| Beam failure detection transmission parameters | DCI format | 1-2-3 |  | 1-0 |  |
| Number of Control OFDM symbols | 1-2-3 |  | 2 |  |
| Aggregation level | 1-2-3 | CCE | 8 |  |
| Ratio of hypothetical PDCCH RE energy to average SSS RE energy | 1-2-3 | dB | 0 |  |
| Ratio of hypothetical PDCCH DMRS energy to average SSS RE energy | 1-2-3 | dB | 0 |  |
| DMRS precoder granularity | 1-2-3 |  | REG bundle size |  |
| REG bundle size | 1-2-3 |  | 6 |  |
| Gap pattern ID | | 1-2-3 |  | N/A |  |
| rlmInSyncOutOfSyncThreshold | | 1-2-3 |  | absent | Value 0 is applied. (Table 8.1.1-1). |
| rsrp-ThresholdSSB | | 1 | dBm/SCS | -95 | Threshold used for Qin\_LR\_SSB |
| 2 | -92 |
|  | |  |  |  |  |
| powerControlOffsetSS | | 1-2-3 |  | db0 | Used for deriving rsrp-ThresholdCSI-RS |
| beamFailureInstanceMaxCount | | 1-2-3 |  | n1 | see TS 38.321 [7], clause 5.17 |
| beamFailureDetectionTimer | | 1-2-3 |  | pbfd4 | see TS 38.321 [7], clause 5.17 |
| CSI-RS configuration for CSI reporting | | 1-2-3 |  | TBD |  |
| reportConfigType | | 1-2-3 |  | periodic |  |
| reportQuantity | | 1-2-3 |  | cri-RI-PMI-CQI |  |
| CSI reporting periodicity | | 1-2-3 | slot | 40 |  |
| CSI reporting offset | | 1-2-3 | slot | 4 |  |
| T310 | | 1-2-3 | ms | 1000 |  |
| N310 | | 1-2-3 |  | 2 |  |
| T1 | | 1-2-3 | s | 1 | The UE shall be fully synchronized to cell 1 during T1 |
| T2 | | 1-2-3 | s | TBD |  |
| T3 | | 1-2-3 | s | TBD |  |
| T4 | | 1-2-3 | s | 0 |  |
| T5 | | 1-2-3 | s | TBD |  |
| D1 | | 1-2-3 | s | TBD |  |
| Note 1: All configurations are assigned to the UE prior to the start of time period T1.  Note 2: UE-specific PDCCH is not transmitted after T1 starts. | | | | | |

Table A.7.5.5.X2.1-3: Cell specific test parameters for FR2-2 PCell for SSB-based beam failure detection and link recovery testing in DRX mode

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | | Unit | Test 1 | | | | |
|  | |  | T1 | T2 | T3 | T4 | T5 |
| AoA setup | |  | Setup 1 defined in A.3.15 | | | | |
| Assumption for UE beams Note 10 | |  | Rough | | | | |
| EPRE ratio of PDCCH DMRS to SSS | | dB | 0 | | | | |
| EPRE ratio of PDCCH to PDCCH DMRS | | dB |  | | | | |
| EPRE ratio of PBCH DMRS to SSS | | dB |  | | | | |
| EPRE ratio of PBCH to PBCH DMRS | | dB |  | | | | |
| EPRE ratio of PSS to SSS | | dB |  | | | | |
| EPRE ratio of PDSCH DMRS to SSS | | dB |  | | | | |
| EPRE ratio of PDSCH to PDSCH DMRS | | dB |  | | | | |
| EPRE ratio of OCNG DMRS to SSS | | dB |  | | | | |
| EPRE ratio of OCNG to OCNG DMRS | | dB |  | | | | |
| SNR\_SSB of set q0 | Config 1,2,3 | dB | 5Note 11 | -3Note 11 | -12 | -12 | -12 |
| SNR\_SSB of set q1 | Config 1,2,3 | dB | 0.2 | 0.2 | 20.2 | 20.2 | 20.2 |
| SSB\_RP of set q1 | Config 1 | dBm/SCS | -104.5 | -104.5 | -84.5 | -84.5 | -84.5 |
|  | Config 2 |  | -98.5 | -98.5 | -78.5 | -78.5 | -78.5 |
|  | Config 3 |  | -95.5 | -95.5 | -75.5 | -75.5 | -75.5 |
|  | Config 1-2 | dBm/120 KHz | -104.7 | | | | |
| Propagation condition | |  | TDL-A 30ns 75Hz | | | | |
| Note 1: OCNG shall be used such that the resources in Cell 1 are fully allocated and a constant total transmitted power spectral density is achieved for all OFDM symbols.  Note 2: The uplink resources for CSI reporting are assigned to the UE prior to the start of time period T1.  Note 3: NZP CSI-RS resource set configuration for CSI reporting are assigned to the UE prior to the start of time period T1.  Note 4: Void  Note 5: The timers and layer 3 filtering related parameters are configured prior to the start of time period T1.  Note 6: The signal contains PDCCH for UEs other than the device under test as part of OCNG.  Note 7: SNR levels correspond to the signal to noise ratio over the SSS REs.  Note 8: The SNR in time periods T1, T2, T3, T4 and T5 is denoted as SNR1, SNR2 and SNR3 respectively in figure A.7.5.5.X2.1-1.  Note 9: The SNR values are specified for testing a UE which supports 2RX on at least one band. For testing of a UE which supports 4RX on all bands, the SNR during T3 is modified as specified in clause A.3.6.  Note 10: Information about types of UE beam is given in B.2.1.3 and does not limit UE implementation or test system implementation.  Note 11: This value allows up to 1dB degradation from applied SNR to UE baseband. | | | | | | | |

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**Figure A.7.5.5.X2.1-1: SNR and L1-RSRP variation for SSB-based beam failure detection and link recovery testing in non-DRX mode**

##### A.7.5.5.X2.2 Test Requirements

The UE behaviour during time durations T1, T2, T3, T4 and T5 shall be as follows:

During the time duration T1 and T2, the UE shall transmit uplink signal at least in all subframes configured for CSI transmission on Cell 1.

During the period from time point A to time point B the UE shall transmit uplink signal in Cell 1 in all uplink slots configured for CSI transmission according to the configured periodic CSI reporting for Cell 1.

During T3 the UE shall detect beam failure and initiate link recovery. During T4 and T5 the UE measures and evaluate beam candidate from beam candidate set q1.

No later than time point F occurring no later than D1 = TBD+10 ms after the start of T5, the UE shall transmit preamble on a beam associated with the candidate beam set q1. The UE shall not transmit preamble on a beam associated with the candidate beam set q1 earlier than time point B.

Test is concluded once the test equipment has received the initial preamble transmission from the UE. The rate of correct events observed during repeated tests shall be at least 90%.

### <End of change 1>

### <Start of change 2>

#### A.7.5.8.X1 MAC-CE based active TCI state switch in FR2-2

A.7.5.8.X1.1 NR PCell FR2-2 active TCI state switch for a known TCI state

A.7.5.8.X1.1.1 Test Purpose and Environment

The purpose of this test is to verify the active TCI state switch delay requirement defined in clause 8.10.3. Supported test configuration is shown in Table A.7.5.8.X1.1.1-1.

The test scenario comprises of one NR PCell (Cell 1) as given in Table A.7.5.8.X1.1.1-2. Cell-specific parameters of NR PCell are specified in Table A.7.5.8.X1.1.1-3 below. The OTA related test parameters for FR2-2 are shown in Table A.7.5.8.X1.1.1-4.

PDCCHs indicating new transmissions shall be sent continuously on PCell to ensure that the UE would have ACK/NACK sending.

Before the test starts,

- UE is connected to Cell 1 (PCell) on radio channel 1 (PCC).

- UE is configured with 2 different TCI states for PCell, PDCCH TCI state 0 (QCL’d to SSB0) and TCIstate 1 (QCL’d to SSB1), in Cell 1 before starting the test.

- UE is indicated in TCI state 0 as the active PDCCH TCI state

The test consists of two time periods, T1 and T2. Figure A.7.5.8.X1.1.1-1 and Figure A.7.5.8.X1.1.1-2 show the Time multiplexed (allocation in Frequency is symbolic) downlink transmissions from each Angle of Arrival. During T1 only SSB to which PDCCH-TCI-state0 is QCL’d is transmitted. At the beginning of T2, the SSB corresponding to TCI state 1 starts transmitting. The UE is configured to provide periodic L1-RSRP reports. In slot n which is within 1280ms of UE providing L1-RSRP report with results for both SSB0 and SSB1, UE receives a MAC-CE command indicating a switch to TCI state 1. *tci-PresentInDCI* is not configured in the PDSCH configuration, i.e. TCI state for the PDSCH is identical to the PDCCH TCI state.

The test equipment verifies that UE can be scheduled on PCell on TCI state 0 till n+ THARQ +3 ms. The test equipment also verifies the TCI state switch time in PCell by scheduling the UE on TCI state 1 after n+ THARQ +3 ms + (Tfirst-SSB + TSSB-proc).

Table A.7.5.8.X1.1.1-1: Supported test configurations

|  |  |
| --- | --- |
| Config | Description |
| 1 | NR 120 kHz SSB SCS, 100 MHz bandwidth, TDD duplex mode |
| 2 | NR 480 kHz SSB SCS, 400 MHz bandwidth, TDD duplex mode |
| 3 | NR 960 kHz SSB SCS, 400 MHz bandwidth, TDD duplex mode |
| Note: The UE is only required to pass in one of the supported test configurations in FR2-2 | |

Table A.7.5.8.X1.1.1-2: General test parameters for TCI state switch

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Unit | Value | Comment |
| NR RF Channel Number |  | 1 | One NR radio channel is used for this test |
| Active PCell |  | Cell 1 | PCell on RF channel number 1. |
| CP length |  | Normal |  |
| DRX |  | OFF |  |
| T1 | s | 0.2 |  |
| T2 | s | 0.2 |  |

Table A.7.5.8.X1.1.1-3: NR Cell specific test parameters for TCI state switch

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | | Test config | Unit | Cell 1 |
| Frequency Range | | 1,2,3 |  | FR2-2 |
| Duplex mode | | 1,2,3 |  | TDD |
| TDD configuration | | 1,2,3 |  | TDDConf.3.1 |
| BWchannel | | 1 |  | 100 MHz: NRB,c = 66 |
|  | | 2 |  | 400 MHz: NRB,c = 66 |
|  | | 3 |  | 400 MHz: NRB,c = 33 |
| Data RBs allocated | | 1-2 |  | 66 |
|  | | 3 |  | 33 |
| Initial DL BWP Configuration | | 1,2,3 |  | DLBWP.0.2 |
| Dedicated DL BWP Configuration | | 1,2,3 |  | DLBWP.1.1 |
| Initial UL BWP Configuration | | 1,2,3 |  | ULBWP.0.2 |
| Dedicated UL BWP Configuration | | 1,2,3 |  | ULBWP.1.1 |
| PDSCH Reference measurement channel | | 1 |  | SR.3. 2 TDD |
|  | | 2 |  | TBD |
|  | | 3 |  | TBD |
| RMSI CORESET parameters | | 1 |  | CR.3.1 TDD |
|  | | 2 |  | TBD |
|  | | 3 |  | TBD |
| Dedicated CORESET parameters | | 1 |  | CCR.3.1 TDD |
|  | | 2 |  | TBD |
|  | | 3 |  | TBD |
| OCNG Patterns | | 1,2,3 |  | OP. 5 |
| SSB Configuration | | 1 |  | SSB.1 FR2 |
|  | | 2 |  | TBD |
|  | | 3 |  | TBD |
| SMTC Configuration | | 1,2,3 |  | SMTC.1 |
| TCI State 0 | | 1,2,3 |  | TCI.State.0 |
| TCI State 1 | | 1,2,3 |  | TCI.State.1 |
| TRS Configuration | | 1 |  | TRS.2.1 TDD |
|  | | 2 |  | TBD |
|  | | 3 |  | TBD |
| Correlation Matrix and Antenna Configuration | | 1,2,3 |  | 1x2 Low |
| EPRE ratio of PSS to SSS | | 1,2,3 | dB | 0 |
| EPRE ratio of PBCH DMRS to SSS | |  |  |  |
| EPRE ratio of PBCH to PBCH DMRS | |  |  |  |
| EPRE ratio of PDCCH DMRS to SSS | |  |  |  |
| EPRE ratio of PDCCH to PDCCH DMRS | |  |  |  |
| EPRE ratio of PDSCH DMRS to SSS | |  |  |  |
| EPRE ratio of PDSCH to PDSCH | |  |  |  |
| EPRE ratio of OCNG DMRS to SSS(Note 1) | |  |  |  |
| EPRE ratio of OCNG to OCNG DMRS (Note 1) | |  |  |  |
| Propagation Condition | |  |  | AWGN |
|  | Note 1: OCNG shall be used such that a constant total transmitted power spectral density is achieved for all OFDM symbols. | | | |

Table A.7.5.8.X1.1.1-4: OTA related test parameters for TCI state switch

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | | Test | Unit | Cell 1 | | | | |
|  | | Config |  | SSB0 | | SSB1 | | |
|  | |  |  | T1 | T2 | T1 | | T2 |
| Angle of arrival configuration | | 1,2,3 |  | Setup 3 according to clause A.3.15.3 | | | | |
|  | |  |  | AoA1 | | | AoA2 | |
| Assumption for UE beams Note 6 | | 1,2,3 |  | Rough | | | | |
| Ês | | 1 | dBm/SCS | -80.6 | -80.6 | -Infinity | | -80.6 |
|  | | 2 |  | -74.6 | -74.6 | -Infinity | | -74.6 |
|  | | 3 |  | -71.6 | -71.6 | -Infinity | | -71.6 |
| SS B\_RP Note 2 | | 1 | dBm/ SCS | -80.6 | -80.6 | -Infinity | | -80.6 |
|  | | 2 |  | -74.6 | -74.6 | -Infinity | | -74.6 |
|  | | 3 |  | -71.6 | -71.6 | -Infinity | | -71.6 |
| BB Note 7 | | 1,2,3 | dB | 8.3 | 8.3 | -Infinity | | 8.3 |
| IoNote2 | | 1 | dBm/95.04 MHz Note4 | -56.0 | -56.0 | - Infinity | | -56.0 |
|  | | 2,3 | dBm/380.16 MHz | -49,98 | -49,98 | - Infinity | | -49,98 |
|  | Note 1: Void  Note 2: SS B\_RP and Io levels have been derived from other parameters for information purposes. They are not settable parameters themselves.  Note 3: Void  Note 4: Equivalent power received by an antenna with 0 dBi gain at the centre of the quiet zone  Note 5: As observed with 0dBi gain antenna at the center of the quiet zone.  Note 6: Information about types of UE beam is given in B.2.1.3 and does not limit UE implementation or test system implementation.  Note 7: Calculation of Es/IotBB includes the effect of UE internal noise up to the value assumed for the associated Refsens requirement in clause 7.3.2 of TS 38.101-2 [19], and an allowance of 1dB for UE multi-band relaxation factor ΔMBP from TS 38.101-2 [19] Table 6.2.1.3-4. | | | | | | | |



Figure A.7.5.8.X1.1.1-1: Time multiplexed downlink transmissions during T1



Figure A.7.5.8.X1.1.1-2: Time multiplexed downlink transmissions during T2

A.7.5.8.X1.1.2 Test Requirements

During T2, UE shall send L1-RSRP report with results for both SSB0 and SSB1.

After receiving MAC-CE command in slot n, UE shall:

- be able to continue to receive on TCI state 0 till n+ THARQ +3 ms

- be able to start receiving on TCI state 1 after n+ THARQ +5 ms + Tfirst-SSB

#### A.7.5.8.X2 RRC based active TCI state switch in FR-2

A.7.5.8.X2.1 NR PCell FR2-2 active TCI state switch for a known TCI state

A.7.5.8.X2.1.1 Test Purpose and Environment

The purpose of this test is to verify the active TCI state switch delay requirement defined in clause 8.10.3. Supported test configuration is shown in Table A.7.5.8.X2.1.1-1.

The test scenario comprises of one NR PCell as given in Table A.7.5.8.X2.1.1-2. Cell-specific parameters of NR PCell is specified in Table A.7.5.8.X2.1.1-3 below. The OTA related test parameters for FR2-2 is shown in Table A.7.5.8.X2.1.1-4.

PDCCHs indicating new transmissions shall be sent continuously on PCell to ensure that the UE would have ACK/NACK sending.

Before the test starts,

- UE is connected to Cell 1 (PCell) on radio channel 1 (PCC).

- UE is configured with 1 TCI state for PCell, PDCCH-TCI-state0 (QCL’d to SSB0)

- UE is indicated in TCI state0 as the active TCI state

The test consists of two time periods, T1 and T2. Figure A.7.5.8.X2.1.1-1 and Figure A.7.5.8.X2.1.1-2 show the Time multiplexed (allocation in Frequency is symbolic) downlink transmissions from each Angle of Arrival. During T1 only SSB to which TCI-state0 is QCL’d is transmitted. At the beginning of T2, the SSB corresponding to TCI-state1 starts transmitting. The UE is configured to provide periodic L1-RSRP reports. In slot n which is within 1280 ms of UE providing L1-RSRP report with results for both SSB0 and SSB1, UE receives a RRC command indicating a switch to TCI-state1.

The test equipment verifies the TCI state switch time in PCell by scheduling the UE on TCI state 1 after n+ TRRC\_processing  + Tfirst-SSB + 2ms.

Table A.7.5.8.X2.1.1-1: Supported test configurations

|  |  |
| --- | --- |
| Config | Description |
| 1 | NR 120 kHz SSB SCS, 100 MHz bandwidth, TDD duplex mode |
| 2 | NR 480 kHz SSB SCS, 400 MHz bandwidth, TDD duplex mode |
| 3 | NR 960 kHz SSB SCS, 400 MHz bandwidth, TDD duplex mode |
| Note: The UE is only required to pass in one of the supported test configurations in FR2-2 | |

Table A.7.5.8.X2.1.1-2: General test parameters for TCI state switch

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Unit | Value | Comment |
| NR RF Channel Number |  | 1 | One NR radio channel is used for this test |
| Active PCell |  | Cell 1 | PCell on RF channel number 1. |
| CP length |  | Normal |  |
| DRX |  | OFF |  |
| T1 | s | 0.2 |  |
| T2 | s | 2 |  |

Table A.7.5.8.X2.1.1-3: NR Cell specific test parameters for TCI state switch

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | | Test Config | Unit | Cell 1 |
| Frequency Range | | 1,2,3 |  | FR2-2 |
| Duplex mode | | 1,2,3 |  | TDD |
| TDD configuration | | 1,2,3 |  | TDDConf.3.1 |
| BWchannel | | 1 |  | 100 MHz: NRB,c = 66 |
|  | | 2 |  | 400 MHz: NRB,c = 66 |
|  | | 3 |  | 400 MHz: NRB,c = 33 |
| Data RBs allocated | | 1,2 |  | 66 |
|  | | 3 |  | 33 |
| Initial DL BWP Configuration | | 1,2,3 |  | DLBWP.0.2 |
| Dedicated DL BWP Configuration | | 1,2,3 |  | DLBWP.1.1 |
| Initial UL BWP Configuration | | 1,2,3 |  | ULBWP.0.2 |
| Dedicated UL BWP Configuration | | 1,2,3 |  | ULBWP.1.1 |
| PDSCH Reference measurement channel | | 1 |  | SR.3. 2 TDD |
|  | | 2 |  | TBD |
|  | | 3 |  | TBD |
| RMSI CORESET parameters | | 1 |  | CR.3.1 TDD |
|  | | 2 |  | TBD |
|  | | 3 |  | TBD |
| Dedicated CORESET parameters | | 1 |  | CCR.3.1 TDD |
|  | | 2 |  | TBD |
|  | | 3 |  | TBD |
| OCNG Patterns | | 1,2,3 |  | OP. 5 |
| SSB Configuration | | 1 |  | SSB.1 FR2 |
|  | | 2 |  | TBD |
|  | | 3 |  | TBD |
| SMTC Configuration | | 1,2,3 |  | SMTC.1 |
| TCI State 0 | | 1,2,3 |  | TC. State.0 |
| TCI State 1 | | 1,2,3 |  | TCI.State.1 |
| reportConfigType | | 1,2,3 |  | ssb-Index-RSRP |
| reportConfigType | | 1,2,3 |  | periodic |
| Number of reported RS | | 1,2,3 |  | 2 |
| L1-RSRP reporting period | | 1,2,3 | slot | TBD |
| timeRestrictionForChannelMeasurements | | 1,2,3 |  | configured |
| TRS Configuration | | 1 |  | TRS.2.1 TDD |
|  | | 2 |  | TBD |
|  | | 3 |  | TBD |
| Correlation Matrix and Antenna Configuration | | 1,2,3 |  | 1x2 Low |
| EPRE ratio of PSS to SSS | | 1,2,3 | dB | 0 |
| EPRE ratio of PBCH DMRS to SSS | |  |  |  |
| EPRE ratio of PBCH to PBCH DMRS | |  |  |  |
| EPRE ratio of PDCCH DMRS to SSS | |  |  |  |
| EPRE ratio of PDCCH to PDCCH DMRS | |  |  |  |
| EPRE ratio of PDSCH DMRS to SSS | |  |  |  |
| EPRE ratio of PDSCH to PDSCH | |  |  |  |
| EPRE ratio of OCNG DMRS to SSS(Note 1) | |  |  |  |
| EPRE ratio of OCNG to OCNG DMRS (Note 1) | |  |  |  |
| Propagation Condition | | 1,2,3 |  | AWGN |
|  | Note 1: OCNG shall be used such that a constant total transmitted power spectral density is achieved for all OFDM symbols. | | | |

Table A.7.5.8.X2.1.1-4: OTA related test parameters for TCI state switch

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Test Config | Unit | Cell 1 | | | | |
|  |  |  | SSB0 | | SSB1 | | |
|  |  |  | T1 | T2 | T1 | | T2 |
| Angle of arrival configuration | 1,2,3 |  | Setup 3 according to clause A.3.15.3 | | | | |
|  |  |  | AoA1 | | | AoA2 | |
| Assumption for UE beams Note 6 | 1,2,3 |  | Rough | | | | |
| Ês | 1 | dBm/SCS | -80.6 | -80.6 | -Infinity | | -80.6 |
|  | 2 |  | -74.6 | -74.6 | -Infinity | | -74.6 |
|  | 3 |  | -71.6 | -71.6 | -Infinity | | -71.6 |
| SS B\_RP Note 2 | 1 | dBm/ SCS | -80.6 | -80.6 | -Infinity | | -80.6 |
|  | 3 |  | -74.6 | -74.6 | -Infinity | | -74.6 |
|  | 3 |  | -71.6 | -71.6 | -Infinity | | -71.6 |
| BB Note 7 | 1,2,3 | dB | 8.3 | 8.3 | -Infinity | | 8.3 |
| IoNote2 | 1 | dBm/95.04 MHz Note4 | -6.0 | -56.0 | - Infinity | | -56.0 |
|  | 2,3 | dBm/380.16 MHz | -49,98 | -49,98 | - Infinity | | -49,98 |
|  | Note 1: Void  Note 2: SS B\_RP and Io levels have been derived from other parameters for information purposes. They are not settable parameters themselves.  Note 3: Void  Note 4: Equivalent power received by an antenna with 0 dBi gain at the centre of the quiet zone  Note 5: As observed with 0dBi gain antenna at the center of the quiet zone.  Note 6: Information about types of UE beam is given in B.2.1.3 and does not limit UE implementation or test system implementation.  Note 7: Calculation of Es/IotBB includes the effect of UE internal noise up to the value assumed for the associated Refsens requirement in clause 7.3.2 of TS 38.101-2 [19], and an allowance of 1dB for UE multi-band relaxation factor ΔMBP from TS 38.101-2 [19] Table 6.2.1.3-4. | | | | | | |



Figure A.7.5.8.X2.1.1-1: Time multiplexed downlink transmissions during T1



Figure A.7.5.8.X2.1.1-2: Time multiplexed downlink transmissions during T2

A.7.5.8.X2.1.2 Test Requirements

During T2, UE shall send L1-RSRP report with both SSB0 and SSB1.

After receiving RRC command in slot n, UE shall be able to start receiving on TCI state 1 after n+ TRRC\_processing  + Tfirst-SSB + 2ms.

### <End of change 2>