**3GPP TSG-RAN WG4 Meeting # 107 R4-23XXXXX**

Incheon, KR, May 22 – May 26, 2023

**Agenda item:** 8.19.3

**Source:** Moderator (Apple)

**Title:** Topic summary for [107][327] NR\_demod\_enh3\_Part2

**Document for:** Information

# Introduction

This TDoc summarizes the proposals on Absolute physical layer throughput requirements with link adaptation under AI 8.19.2. The aim is to close all the open issues in this meeting and agree on draftCRs.

# Topic #1: Absolute physical layer throughput requirements with link adaptation

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2307266](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307266.zip) | Qualcomm, Inc. | **Proposal 1:** Consider the following points for application layer throughput requirement   * 2x2 TDD,FDD, FR2: 15% and 35% * 2x4 FDD: 50% * 2x4 TDD: 35%   RAN4 can discuss how much margin is needed based on the new alignment/impairment results.  **Observation 1:** If introducing release independence to have the ATP tests as potential alternatives to operator defined tests with similar configurations is a common objective shared among operators, release independence of ATP tests can reduce the number of tests from UE perspective.  **Proposal 2:** If release independence is agreed, it should be optional to Release 17. |
| [R4-2307337](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307337.zip) | Apple | ***Observation #1:*** *With 4RX rank 2 is reported from low SNR ~2dB.*  ***Observation #2:*** *The lowest SNR of 0 dB is likely in the rank transition SNR with 4RX which is not suitable to define requirements.*  ***Observation #3:*** *There is no benefit in having 2 test points in the rank 2 SNR range with 4RX.*  **Proposal #1: Define requirements with 2 SNR points corresponding to rank 1 and rank 2 SNR range for 2RX.**  **Proposal #2: Define requirements with 1 SNR point in rank 2 SNR range for 4RX.**  ***Observation #4:*** *It might not be easy to align results across many test points given 9 contributing companies.*  ***Observation #5:*** *There is no good reason to have the same test point across different test cases.*  **Proposal #3: Select test points with minimum span in SNR.**  **Proposal #4: In case there is no test point with SNR span < 2.5 dB, discard outlier results until span is within 2.5 dB.**  **Proposal #5: Use X=0.5 dB for QPSK, 16QAM, 0.8 dB for 64QAM.**  ***Observation #6****: There are already operator specific test for Application /Phy layer throughput requirements.*  ***Observation #7:*** *Introducing requirements as release independent increases test burden on UE*  **Proposal #6: The requirements for physical layer TP with link adaptation are applicable from Rel-18 and not release independent from Rel-15.** |
| [R4-2307338](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307338.zip) | Apple | Simulation Results |
| R4-2307339 | Apple | Reserved for Summary of simulation results |
| [R4-2307471](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307471.zip) | Nokia, Nokia Shanghai Bell | **Test point T (%) selection**   1. A high number (9) companies have provided simulation results. With so many companies providing results outlier results can be removed until <= 2.5dB is reached 2. When considering the candidate test points, remove outlier results until <=2.5dB span is achieved. 3. Define ATP requirements with the following testpoints:  |  |  |  | | --- | --- | --- | | Test Case | test point 1:  T % (SNR, Gspan) | test point 2:  T % (SNR, Gspan) | | FR1 FDD 2x2 | 15% (6.5 dB, 2.1 dB) | 35% (16.5 dB, 2.5dB) [one outlier removed] | | FR1 TDD 2x2 | 15% (7.1 dB, 1.8 dB) | 35% (17.5 dB, 2.4 dB) | | FR1 FDD 2x4 | 15% (3.3 dB, 1.9 dB) | 55% (16.5dB, 2.3dB) (one outlier removed) | | FR1 TDD 2x4 | 15% (3.6 dB, 2.2 dB) | 55% (16.8dB, 2.0dB) (two outliers removed) | | FR2-1 (TDD 2x2) | 15% (4.4 dB, 2.1 dB) | 40% (15.1 dB, 1.8 dB) |   **X dB margin**   1. Apply X dB margin per modulation order to impairment results; X = [0.5] dB for QPSK, X = [0.5] dB for 16QAM ; X = [0.8] dB for 64QAM, X = [0.8] dB for 256QAM   **Applicability and release independence**  We see Rel-17 UEs as being capable of supporting the requirements defined in this WID. In addition, we understand that some Rel-15/Rel-16 UEs might not support the requirements. We see option 1.a as a good compromise enabling Rel-15/Rel-16 UEs to declare compliance and having compliance mandatory from Rel-17 and onwards.   1. For applicability and release independence we support option 1.a:  *- Optional for Rel-15 and Rel-16 UEs based on declaration*   *- Mandatory for all Rel-17 and forward UEs.*   **DraftCR for FR2-1 ATP requirements**  According to drafting rules, it is not allowed to introduce void sections.   1. RAN4 to decide if void sections should be introduced to keep same structure as for existing sections.   Existing FRC sections in 38.101-4 are defined with fixed MCS. This is not useable for link adaptation.   1. Introduce new FRC sections to support link adaptation.   The requirement specification needs to contain the directives on how to handle the re-transmission cases.   1. Include the information on how the test shall handle the re-transmission as notes in new FRC section. |
| [R4-2307598](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307598.zip) | CMCC | draft CR for FR1 4Rx FDD |
| [R4-2307624](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307624.zip) | China Telecom | ***Proposal 1:*** *For the test requirement value for link adaptation requirements, cover both rank 1 with lower modulation order (QPSK/16QAM) and rank 2 with higher modulation order (64QAM/256QAM).*  ***Proposal 2:*** *For the test requirement value for link adaptation requirements:*   * *For FR1 2T2R: Test the SNR points at 10% or 15% and 35% or larger max TP.* * *For FR1 2T4R: Test the SNR points at 10% and 45% or larger max TP.* * *For FR2: Test the SNR points at 10% or 15% and 40% or larger max TP.*   ***Proposal 3:*** *If the results still cannot be well-aligned, reuse the following SNR requirement value deriving rule we agreed for the Rel-17 UE demodulation enhancement WI:*   * *RAN4 does not consider the farthest result(s) from the ideal AVERAGE value, until the span becomes 2.5 dB or less. The final requirements are derived from AVERAGE impairment results with the corresponding ideal results whose span is within 2.5 dB*   ***Proposal 4:*** *The absolute physical layer throughput requirements with link adaptation is release independent from Rel-15 with the following applicability rule:*   * *Optional for Rel-15 and Rel-16 UEs.* * *Mandatory for all Rel-17 and forward UEs without applicability rules.* |
| [R4-2307625](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307625.zip) | China Telecom | Simulation results |
| [R4-2307626](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307626.zip) | China Telecom | Draft CR on ATP requirements for FR1 TDD 4Rx |
| R4-2307627 | China Telecom | Reserved for Big CR on ATP requirements |
| [R4-2307819](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307819.zip) | Samsung | **Proposal 1:** For # of test points, we prefer option 1 (two test points for both 2Rx and 4Rx cases).  **Observation 1:** The span at some T% of max TP points are much higher than 2.5dB. If we eliminate the minimum and maximum SNR values for the T% of max TP points, we could observe that the span will be limited in 2.5dB and the average SNR is almost same as before.  **Proposal 2:** Test points: SNRs at 10% and 35% max TP for 2Rx cases (both FR1 and FR2); SNRs at 20% and 50% max TP for FR1 4Rx cases.  **Proposal 3:** For the SNR average and span calculation at T% of max TP, eliminate the minimum and maximum SNR values at T% of max TP.  **Proposal 4:** For X dB margin, use option 1 (0.5dB for QPSK/16QAM and 0.8dB for 64QAM/256QAM).  **Proposal 5:** support Option 1a for applicability and release independency. |
| [R4-2307820](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307820.zip) | Samsung | draft CR for FR1 TDD 2Rx |
| [R4-2307857](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307857.zip) | MediaTek inc. | **Observation #1:** We can select aligned 2 test points for all tests with reasonable span.  **Observation #2:** We can resolve large span issue with extra margin in requirements, and we are also fine to remove outliers.  **Proposal #1:** For Issue 2-1-1 Test point T (%) selection Issue A, we support Option 3. We can find 2 reasonable test points for each test.  **Proposal #2:** For Issue 2-1-1 Test point T (%) selection Issue B, we support resolving large span issue with extra margin in requirements, and we are also fine to remove outliers.  **Proposal #3:** For Issue 2-1-2 X dB margin, we prefer Option 2. It would be more straightforward to use single margin value. We can also compromise to Option 1 if there are strong concerns from other companies.  **Proposal #4:** For Issue 2-2 Applicability and release independence we support Option 2. We still think that Rel-18 test should be defined as applicable from Rel-18 because we are using the latest performance to define requirements. |
| [R4-2307941](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307941.zip) | Nokia, Nokia Shanghai Bell | DraftCR on ATP Requirements for FR2-1 |
| [R4-2308429](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2308429.zip) | Ericsson | **Observation 1:** For 2Rx UE, SNR spans corresponding to 10%, 15% and 40% of the maximum throughput are less than 2.5dB.  **Proposal 1:** For 2Rx UE ATP requirements, set two test criteria: T=15% and T=40% of the maximum throughput.  **Proposal 2:** For 2Rx UE ATP requirements, set SNR test points from the values by adding the margin to the average of the impairment results, where the margin is 0.5dB for T=15% and 0.8dB for T=40%.  **Observation 2:** For 4Rx UE, SNR spans corresponding to 10%, 15% and 60% of the maximum throughput are less than 2.5dB.  **Proposal 3:** For 4Rx UE ATP requirements, set one test criteria: T=60% of maximum throughput.  **Proposal 4:** For 4Rx UE ATP requirements, set SNR test points from the values by adding the margin to the average of the impairment results, where the margin is 0.8dB.  **Proposal 5:** ATP requirements can be applicable from Rel-17. |
| [R4-2308867](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2308867.zip) | Huawei,HiSilicon | **Proposal 1:** Choose single test point for 2Rx and 4Rx by splitting two test points into cases with different duplex mode:   * FR1 FDD 2x2: 15% (Rank1) * FR1 FDD 2x4: 50% (Rank2) * FR1 TDD 2x2: 15% (Rank1) * FR1 TDD 2x4: 35% (Rank1) * FR2 TDD 2x2: 40% (Rank2)   **Proposal 2:** Companies add XdB margin to there impairment results and final results are derived from the average of impairment results from all companies without additional margin.  **Proposal 3:** Support Option 2. The absolute physical layer throughput requirement with link adaptation should be applicable from Rel-18 and not release independent from Rel-15. |
| [R4-2309377](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2309377.zip) | Apple | Draft CR for FR1 FDD 2RX |

## Open issues summary

### Sub-topic 1-1 – Absolute Physical Layer TP Requirements

The Phy layer TP requirements have been agreed to be defined as follows:

* Average SNR of impairments results to achieve T% of maximum throughput + X dB margin
  + Use Gspan = [2.5] dB to check if the results are aligned
  + The maximum throughput is defined as with TBS corresponding to CQI index 15 with rank Y for 2Rx/4Rx UE, e.g., Y=2 for both 2Rx/4Rx UEs.

**Issue 1-1-1: Number of test points**

* *Status in last meeting WF R4-2305915*
* Option 1. Two test points for 2Rx and 4 Rx.
* Option 2. Two test points for 2Rx and 1 test point for 4 Rx.
* Option 3. Single test point for 2Rx and 4 Rx
* Observations
  + Qualcomm: Rank 1 with 2x4 is in low SNR region
  + Apple:
    - With 4RX rank 2 is reported from low SNR ~2dB.
    - The lowest SNR of 0 dB is likely in the rank transition SNR with 4RX which is not suitable to define requirements.
    - There is no benefit in having 2 test points in the rank 2 SNR range with 4RX.
* Proposals
  + Option 1. Two test points for 2Rx and 4 Rx. (Nokia, CTC, Samsung, MTK)
  + Option 2. Two test points for 2Rx and 1 test point for 4 Rx (Qualcomm, Apple, Ericsson)
  + Option 3. Single test point for 2Rx and 4 Rx (Huawei)
* Recommended WF
  + Further discuss

**Issue 1-1-2: Outlier results handling**

* Proposals
  + Option 1: Discard outlier results until span is within 2.5 dB (Apple, Nokia, CTC, Samsung, MTK)
  + Option 2: Select points with span < 2.5 dB (Apple, Ericsson)
* Recommended WF
  + *Select Option 1 based on majority view*

**Issue 1-1-3: Test point T (%) selection**

* *Status in last meeting WF R4-2305915*

Candidate test pool based on alignment simulation results in R4-2304257

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| --- | --- | --- |
| Test Case | Candidate test point 1:  T % (SNR, Gspan) | Candidate test point 2:  T % (SNR, Gspan) |
| FR1 FDD 2x2 | 10% (3.2 dB, 1.6 dB)  15% (6.5 dB, 2.1 dB) | 40% (**18.5** dB, 2.4 dB) |
| FR1 TDD 2x2 | 10% (3.6 dB, 1.9 dB)  15% (7.1 dB, 1.8 dB) | 35% (17.5 dB, 2.4 dB) |
| FR1 FDD 2x4 | 15% (3.3 dB, 1.9 dB) | 50% (15.2 dB, 2.5 dB) |
| FR1 TDD 2x4 | 15% (3.6 dB, 2.2 dB) | 50% (15.4 dB, **2.8** dB)  35% (10.7 dB, 2.3 dB) |
| FR2-1 (TDD 2x2) | 15% (4.4 dB, 2.1 dB) | 40% (**15.1** dB, 1.8 dB) |

* + Discuss in the next meeting with the following aspect based on the updated results if any.
    - SNR options considering uniqueness of test SNR coverage
    - T (%) based on alignment results considering Gspan
    - Final SNR with X dB margin is within range of [0 20] for FR1 and [0 16] for FR2.
  + It does not preclude the possibility of T(%) adjustment with [+- 5% steps] or removal of outlier results from Gspan perspective.
* Latest simulation results (alignment)

The max feasible T% is added based on 20-2.5 dB for FR1 and 16-2.5 dB for FR2-1 since final requirements (avg of impairment results + XdB) shall be ≤ 20dB for FR1 and ≤16 dB for FR2-1.

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| FR1 FDD 2x2: Maximum feasible T% is 35%   |  |  |  |  | | --- | --- | --- | --- | | Tput | Average | Span | Samples | | 10% | 3.2 | 1.6 | 10 | | 15% | 6.7 | 2.1 | 10 | | 20% | 9.8 | 2.6 | 10 | | 25% | 12.5 | 3.0 | 10 | | 30% | 14.8 | 3.5 | 10 | | 35% | 16.8 | 3.7 | 10 | | 40% | 18.6 | 2.4 | 9 | | FR1 TDD 2x2: Maximum feasible T% is 30%   |  |  |  |  | | --- | --- | --- | --- | | Tput | Average | Span | Samples | | 10% | 3.5 | 2.1 | 9 | | 15% | 7.0 | 2.3 | 10 | | 20% | 10.2 | 2.0 | 10 | | 25% | 13.0 | 2.6 | 10 | | 30% | 15.5 | 2.7 | 10 | | 35% | 17.7 | 2.4 | 10 | | 40% | 19.1 | 0.7 | 6 | |

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| FR1 FDD 2x4: Maximum feasible T% is 55%   |  |  |  |  | | --- | --- | --- | --- | | Tput | Average | Span | Samples | | 10% | 0.4 | 0.9 | 9 | | 15% | 3.2 | 1.9 | 10 | | 20% | 5.5 | 3.3 | 10 | | 25% | 7.3 | 3.3 | 10 | | 30% | 8.9 | 3.1 | 10 | | 35% | 10.6 | 2.9 | 10 | | 40% | 12.1 | 2.7 | 10 | | 45% | 13.7 | 2.6 | 10 | | 50% | 15.3 | 2.5 | 10 | | 55% | 16.6 | 2.3 | 9 | | 60% | 17.9 | 2.5 | 9 | | FR1 TDD 2x4: Maximum feasible T% is 55%   |  |  |  |  | | --- | --- | --- | --- | | Tput | Average | Span | Samples | | 10% | 0.7 | 1.4 | 8 | | 15% | 3.5 | 2.2 | 10 | | 20% | 5.5 | 2.9 | 10 | | 25% | 7.3 | 2.6 | 10 | | 30% | 9.0 | 2.4 | 10 | | 35% | 10.7 | 2.3 | 10 | | 40% | 12.3 | 2.6 | 10 | | 45% | 13.8 | 2.8 | 10 | | 50% | 15.4 | 2.8 | 10 | | 55% | 16.9 | 2.8 | 9 | | 60% | 18.4 | 1.5 | 7 | |

FR2-1 TDD 2x2: Maximum feasible T% is 35%

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| --- | --- | --- | --- |
| Tput | Average | Span | Samples |
| 10% | 1.4 | 1.8 | 8 |
| 15% | 4.4 | 2.1 | 8 |
| 20% | 7.0 | 2.7 | 8 |
| 25% | 9.5 | 2.8 | 8 |
| 30% | 11.5 | 2.3 | 8 |
| 35% | 13.4 | 1.7 | 8 |
| 40% | 15.1 | 1.8 | 8 |

* Proposals

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test Case** | **Qualcomm** | **Apple** | **Nokia** | **CTC** | **Samsung** | **MTK** | **Ericsson** | **Huawei** |
| FR1 FDD 2x2 (Max 35%) | 15%, 35% | 10/15/20% TBA | 15%,35% | 10/15%, 35% | 10%,35% | 15%,35% | 10%,40% | 15% |
| FR1 TDD 2x2 (Max 30%) | 15%, 35% | 10/15/20% TBA | 15%,35% | 10/15%, 35% | 10%,35% | 15%,35% | 10%,40% | 15% |
| FR1 FDD 2x4 (Max 55%) | 50% | 15/50/55% | 15%,55% | 10%,45% | 20%,50% | 15%,35% | 60% | 50% |
| FR1 TDD 2x4 (Max 55%) | 35% | 15/30/35/50% | 15%,55% | 10%,45% | 20%,50% | 15%,35% | 60% | 35% |
| FR2-1  (Max 35%) | 15%, 35% | 10/15% 30/35% | 15%,40% | 10/15%, 40% | 10%,35% | 15%,35% | 10%,40% | 40% |

The proposed values in red are higher than max feasible T%

**Issue 1-1-4: X dB margin**

* *Status in last meeting WF R4-2305915*
  + Option 1: Apply X dB margin per modulation order to impairment results

X = [0.5] dB for QPSK, X = [0.5] dB for 16QAM

X = [0.8] dB for 64QAM, X = [0.8] dB for 256QAM

Note that the modulation order would be based on median value over companies’ own median statistics on CQI.

* + Option 2: Apply single X dB margin to impairment results (e.g. X=0.5 dB or else)
* Proposals
  + Option 1: 0.5 dB for QPSK, 16QAM; 0.8 dB for 64QAM, 256QAM (Apple, Nokia, Samsung, MTK (compromise), Ericsson)
  + Option 2: 0.5 dB for all points (MTK)
  + Option 3: Companies add their own X dB margin to impairment results (Huawei)
* Recommended WF
  + *Select Option 1 based on majority view*

### Sub-topic 1-2 - Release Independence

**Issue 1-2-1: Release independence**

* *Status in last meeting WF R4-2305915*
  + Option 1: The requirement with link adaptation should be applicable for all NR UEs without any new applicability rules, and the requirement should be release independent from Rel-15
  + Option 1.a: Proposal considering declaration
    - Optional for Rel-15 and Rel-16 UEs based on declaration
    - Mandatory for all Rel-17 and forward UEs.
  + Option 2: The absolute physical layer throughput requirement with link adaptation should be applicable from Rel-18 and not release independent from Rel-15.
* Observations
  + Qualcomm: If release independence for ATP tests is an alternative to operator defined tests, then release independent ATP tests can reduce test burden.
  + Apple: There are already operator specific test for Application /Phy layer throughput requirements. Introducing requirements as release independent increases test burden on UE.
  + Nokia: We see Rel-17 UEs as being capable of supporting the requirements defined in this WID. In addition, we understand that some Rel-15/Rel-16 UEs might not support the requirements.
* Proposals
  + Option 1: Release independent from Rel-15
  + Option 1a: Release independent for Rel-15, Rel-16 based on UE declaration. Mandatory for Rel-17 and beyond (Nokia, CTC, Samsung)
  + Option 2: Applicable from Rel-18 (Apple, MTK, Huawei)
  + Option 3: Release independent from Rel-17 (Qualcomm, Ericsson)
* Recommended WF
  + Further discuss

### Sub-topic 1-3 – Issues related to CR drafting

**Issue 1-3-1: Void Sections**

Discuss if we should introduce void sections to keep the same structure as existing specs

* Proposals
  + Option 1: Introduce void sections and preserve same structure as existing sections
  + Option 2: Only introduce required sections for APT requirements
* Recommended WF
  + Further discuss

**Issue 1-3-2: FRCs for APT with link adaptation**

New FRCs for APT requirements

* Proposals
  + Option 1: Introduce new FRCs (Nokia)
  + Option 2: Other option
* Recommended WF
  + Further discuss

**Issue 1-3-3: On Re-transmission handling**

Where to capture CQI/PMI/RI on re-TX in spec?

* Proposals
  + Option 1: In the new FRC table notes (Nokia)
  + Option 2: Other option
* Recommended WF
  + Further discuss

### Sub-topic 1-4 – Draft CRs to review

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| [R4-2307598](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307598.zip) | CMCC | draft CR for FR1 4Rx FDD |
| [R4-2307626](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307626.zip) | China Telecom | Draft CR on ATP requirements for FR1 TDD 4Rx |
| [R4-2307820](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307820.zip) | Samsung | draft CR for FR1 TDD 2Rx |
| [R4-2307941](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2307941.zip) | Nokia, Nokia Shanghai Bell | DraftCR on ATP Requirements for FR2-1 |
| [R4-2309377](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2309377.zip) | Apple | Draft CR for FR1 FDD 2RX |