**3GPP TSG-RAN WG4 Meeting # 107 R4-2310020**

**Incheon, KR, May 22nd – May 26th , 2023**

**Agenda item:** 8.14.6

**Source:** Moderator (Huawei)

**Title:** Topic summary for [107][137] NR\_ATG\_UERF\_part2

**Document for:** Information

# Introduction

This agenda item will handle all contributions related to NR ATG UE RF requirements with the following sub-topics.

1. General aspects and Tx requirements
2. Rx requirements
3. We also have two TPs R4-2308571 / R4-2309168 which may be treated online.

# Topic #1: ATG UE general aspects and Tx RF requirements

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2308570**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2308570.zip) | Huawei, HiSilicon | **Proposal 1: [the minimum of maximum output power] can be replaced by “Rated output power”, i.e. mean power level indicated by UE at maximum modulation order and full PRB configurations and associated with a particular operating band.**  **Proposal 2: The [the minimum of maximum output power] at maximum modulation order and full PRB configurations shall remain with +2 dB and -2 dB of the new capability as reported by ATG UE.**  **Proposal 3: The range of this IE *P-Max* from -30 to 33dBm is not enough for ATG UE. Whether to extend the range of *P-Max* or introduce a similar new IE with larger range for ATG can be further discussed.**  **Proposal 4: it’s proposed to define the following Pcmax,f,c. Otherwise, network signalling Pemax can’t restrain the output power of ATG UE for compliance with regulation.**  **The UE is allowed to set its configured maximum output power PCMAX,f,c for carrier f of serving cell c in each slot. The configured maximum output power PCMAX,f,c is set within the following bounds:**  **PCMAX\_L,f,c ≤ PCMAX,f,c ≤ PCMAX\_H,f,c with**  **PCMAX\_L,f,c = MIN {PEMAX,c, PMaxOutputPowerClass}**  **PCMAX\_H,f,c = PEMAX,c**  **where**  **PEMAX,c is the value given by [either the *p-Max* IE or the field *additionalPmax* of the *NR-NS-PmaxList IE]*, whichever is applicable according to TS 38.331[7];**  **PMaxOutputPowerClass is the maximum UE output power at maximum modulation order and full PRB configurations which is indicated by ATG UE;**  **Proposal 5: To specify Minimum output power for ATG UE with following requirements.**   |  |  |  |  |  | | --- | --- | --- | --- | --- | | Channel bandwidth | (MHz) | 5,10,15,20 | 25,30,35,40,45,50 | 60,70,80,90,100 | | REF\_SCS | (kHz) | 15 | | 30 | | Minimum output power | (dBm) | -20 | -20+10log10 (BWChannel /20) | -20+10log10 (BWChannel /20) | | Measurement bandwidth | (MHz) | MBW=REF\_SCS\*(12\*NRB+1)/1000 | | | | NOTE: The minimum output power value is rounded to the nearest number down to one decimal point. | | | | | |
| [**R4-2308571**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2308571.zip) | Huawei, HiSilicon | **The following text proposals on configured output power requirements were proposed referring to the previous WFs.** |
| [**R4-2308745**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2308745.zip) | Ericsson | [Proposal 1 The tolerance could be ±2 dB](#_Toc135052604)  [Proposal 2 Suggest using [lower bound of maximum power range]](#_Toc135052605)  [Proposal 3 The minimum output power for ATG UE is -25 dBm for 2 GHz and -20 dBm for 4 GHz.](#_Toc135052606)  [Proposal 4 UL 256QAM should be supported for ATG UE.](#_Toc135052607)  [Proposal 5 It is proposed to define the Pcmax following the definition in TS 38101-1](#_Toc135052608) |
| [**R4-2309168**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2309168.zip) | ZTE Corporation | This contribution provides a text proposal to TS38.876 [1] on sub-clause 7.1 and 7.1.1. |
| [**R4-2309171**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2309171.zip) | ZTE Corporation | **Observation 1:** based on the initial simulation results in Case 2 and Case 10, it should be sufficient to reuse the legacy FR1 UE PC3 ACLR requirement 30dBc requirement for ATG UE.  **Proposal 1:** to reuse FR1 PC3 ACLR requirement for ATG CPE;  **Proposal 2:** the minimum output power for ATG UE could be [-3dBm/100MHz] and scale with other BW.  **Proposal 3:** not to define the UL 256QAM for ATG CPE.  **Proposal 4:** for configured output power of ATG CPE, propose not to configured Tx power defined similar as IAB-MT.  **Proposal 5:** for Additional SEM for ATG CPE, propose not to define it unless there are any regulatory requirement if necessary.  **Proposal 6:** for UE coexistence requirement for ATG CPE, propose not to define it.  **Proposal 7:** for ATG UE with phase antenna array, the RF requirement should be defined on the sum of measurement of all TAB connectors. |
| [**R4-2309240**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2309240.zip) | Qualcomm Incorporated | **Proposal 1: The ATG UE maximum output power shall remain within +2dB and -2dB of the rated maximum output power at maximum modulation order and full PRB configurations indicated by new capability.**  **Proposal 2: Do not define power class for ATG UE. The rated maximum output power at maximum modulation order and full PRB configurations is reported by UE via new capability.**  **Proposal 3: RAN4 to clarify in the specification that 40dBm is set as the upper limit of MoP at any modulation order and PRB configuration.**  **Proposal 4: For co-channel interference management reason, network should be able to configure the UE transmit power. Option 1 is preferred.** |
| [**R4-2309439**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2309439.zip) | CMCC | **Proposal 1: Suggest defining two ATG UE types as shown in Table 1, and other definitions of ATG UE types are also welcome to be discussed during this meeting.**  *Table 1. Definition of suffixes*   |  |  | | --- | --- | | Clause suffix | Variant | | None | Single Carrier | | A | Carrier Aggregation (CA) | | B | Dual-Connectivity (DC) | | C | Supplement Uplink (SUL) | | D | UL MIMO | | E | V2X | | F | Shared spectrum channel access | | G | Tx Diversity (TxD) | | H | Carrier Aggregation(CA) with UL MIMO | | I | RedCap | | J | ATG UE (with omni-direction antenna) | | K | ATG UE (with antenna array) |   **Observation 1: As ATG network deployment in figure 1, the minimum distance for the non sub-array model is 6.7 km, and the minimum distance for the sub-array model is 15.1 km.**  **Proposal 2: Considering the possibility of ATG serving the aircraft directly above in the future still exists, 3km could be used as the minimum distance between ATG UE from BS.**  **Proposal 3: -25dBm/MHz could be used as the minimum output power for 2GHz and -20dBm/MHz could be used for 4GHz.**  **Proposal 4: 256 QAM should be supported for ATG UE.**  **Proposal 5: The P-Max for ATG could be define as INTEGER (-63..64).** |
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*The moderator can suggest a limited number of papers which could be presented.*

## Open issues summary

*Before f2f meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 1-1 General aspects

*Sub-topic description:*

*Open issues and candidate options before f2f meeting:*

**Issue 1-1-1: Definition of suffixes**

*In RAN4#104bis meeting, we have the following way forward for suffix.*

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| --- |
| **<Way forward >**: It’s better to define ATG UE requirements in separate subclause with suffix J in 38.101-1..   * NOTE: Separate specification could also be considered if eventually the content has too much differences with the existing TN UE. |

* Proposals
  + Proposal 1: Suggest defining two ATG UE types as shown in Table 1, and other definitions of ATG UE types are also welcome to be discussed during this meeting.

*Table 1. Definition of suffixes*

|  |  |
| --- | --- |
| Clause suffix | Variant |
| None | Single Carrier |
| A | Carrier Aggregation (CA) |
| B | Dual-Connectivity (DC) |
| C | Supplement Uplink (SUL) |
| D | UL MIMO |
| E | V2X |
| F | Shared spectrum channel access |
| G | Tx Diversity (TxD) |
| H | Carrier Aggregation(CA) with UL MIMO |
| I | RedCap |
| J | ATG UE (with omni-direction antenna) |
| K | ATG UE (with antenna array) |

* Recommended WF
  + TBA

**Issue 1-1-2: How to specify the requirements for ATG UE with phase antenna array**

* Proposals
  + Proposal 1:
    - for ATG UE with phase antenna array, the RF requirement should be defined on the sum of measurement of all TAB connectors.
    - for ATG UE with phase antenna array, the Rx RF requirement should be defined on top of each TAB connector.
* Recommended WF
  + TBA

### Sub-topic 1-2 Tx RF requirements

*Sub-topic description:*

*Open issues and candidate options before f2f meeting:*

**Issue 1-2-1: The discussion on term “[the minimum of maximum output power]” indicated by UE at maximum modulation order and full PRB configurations.**

* Proposals
  + Option 1: [the minimum of maximum output power] can be replaced by “Rated output power”, i.e. mean power level indicated by UE at maximum modulation order and full PRB configurations and associated with a particular operating band.
  + Option 2: The rated maximum output power at maximum modulation order and full PRB configurations is reported by UE via new capability.
  + Option 3: Suggest using [lower bound of maximum power range]
* Recommended WF
  + Option 1 and option 2 can be merged. It’s recommended to go either option 1 or option 2.

**Issue 1-2-2: The discussion on the accuracy/tolerance of the [rated maximum output power] at maximum modulation order and full PRB configurations**

Moderator’s note: previous agreement in R4-2220543

**The tolerance of ATG UE MOP can be ±2dB.**

* Proposals
  + Option 1: The ATG UE maximum output power shall remain within +2dB and -2dB of the rated maximum output power at maximum modulation order and full PRB configurations indicated by new capability.
  + Option 2: Others
* Recommended WF
  + Option 1

**Issue 1-2-3: Configured output power:**

* Proposals
  + Option 1: it’s proposed to define the following Pcmax,f,c
    - Rationale:
      * For co-channel interference management reason, network should be able to configure the UE transmit power. Option 1 is preferred.
      * It’s proposed to define the following Pcmax,f,c. Otherwise, network signalling Pemax can’t restrain the output power of ATG UE for compliance with regulation.
      * It is still important for the network to be able to configure a Pmax in case there are regulatory limits.

**The UE is allowed to set its configured maximum output power PCMAX,f,c for carrier f of serving cell c in each slot. The configured maximum output power PCMAX,f,c is set within the following bounds:**

**PCMAX\_L,f,c ≤ PCMAX,f,c ≤ PCMAX\_H,f,c with**

**PCMAX\_L,f,c = MIN {PEMAX,c, PMaxOutputPowerClass}**

**PCMAX\_H,f,c = PEMAX,c**

**where**

**PEMAX,c is the value given by [either the *p-Max* IE or the field *additionalPmax* of the *NR-NS-PmaxList IE]*, whichever is applicable according to TS 38.331[7];**

**PMaxOutputPowerClass is the maximum UE output power at maximum modulation order and full PRB configurations which is indicated by ATG UE;**

* + - Option 1a: RAN4 to clarify in the specification that 40dBm is set as the upper limit of MoP at any modulation order and PRB configuration. (Moderator’s Note: if I understand this proposal correctly, do you mean **PCMAX\_H,f,c should be improved to include 40dBm restriction?**)
    - Option 1b: It is proposed to define the Pcmax following the definition in TS 38101-1
  + Option 2: for configured output power of ATG CPE, propose not to configured Tx power defined similar as IAB-MT.
  + Option 3: Others.
* Recommended WF
  + Configured output power for ATG UE should be specified. The details/wordings can be further discussed considering Option 1, Option 1a and Option 1b.

**Issue 1-2-3a: The range extension of this IE P-Max:**

* Proposals
  + Option 1: The P-Max for ATG could be define as INTEGER (-63..64)
  + Option 2: others.
* Recommended WF
  + Option 1

**Issue 1-2-4: Minimum output power**

Last meeting, we have the WF:

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| --- |
| **<Way forward>**: **FFS the** **assumption of minimum distance between ATG BS and ATG UE to derive the minimum output power.** |

* Proposals on the assumption of minimum distance between ATG BS and ATG UE to derive the minimum output power
  + Option 1: Considering the possibility of ATG serving the aircraft directly above in the future still exists, 3km could be used as the minimum distance between ATG UE from BS.
  + Option 2: Others.
* Recommended WF

Option 1

* Proposals on Minimum output power
  + Option 1: The minimum output power for ATG UE is -25 dBm for 2 GHz and -20 dBm for 4 GHz. [Ericsson, CMCC]
    - 3km minimum distance between ATG BS and ATG UE is assumed.
  + Option 2: [Huawei]

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| --- | --- | --- | --- | --- |
| Channel bandwidth | (MHz) | 5,10,15,20 | 25,30,35,40,45,50 | 60,70,80,90,100 |
| REF\_SCS | (kHz) | 15 | | 30 |
| Minimum output power | (dBm) | -20 | -20+10log10 (BWChannel /20) | -20+10log10 (BWChannel /20) |
| Measurement bandwidth | (MHz) | MBW=REF\_SCS\*(12\*NRB+1)/1000 | | |
| NOTE: The minimum output power value is rounded to the nearest number down to one decimal point. | | | | |

* + Option 3: the minimum output power for ATG UE could be [-3dBm/100MHz] and scale with other BW [ZTE]
    - Based on coexistence study. TBD (20km??) minimum distance assumption
  + Option 4: Others.
* Recommended WF

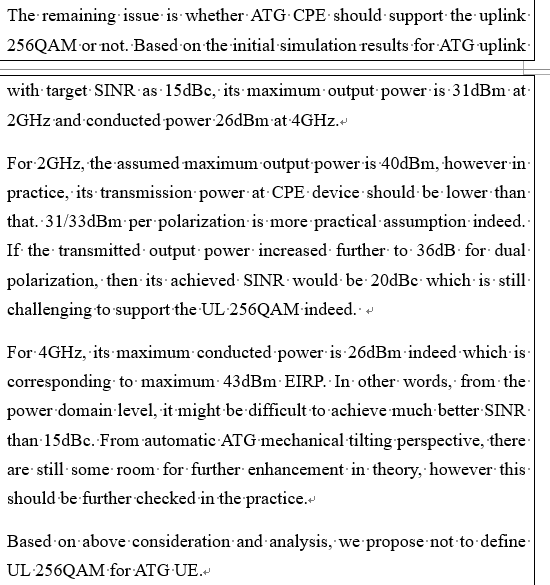
TBD

**Issue 1-2-5: whether to support 256QAM: (Some arguments are listed below for each side)**

**(R4-2309439 CMCC)** Based on the result, 2GHz CPE UL with 36dbc has 25% probability for 256QAM and CPE with 4GHz has 29% probability for 256QAM. Consider of these results, 256 QAM should be supported for ATG UE.

**(R4-2308745 Ericsson)** The SNR at the receiver side for 2GHz and 4GHz are shown in Figure 1. When the aircraft is closer to the BS, the SNR above 25 dB can be seen.

**(R4-2309171 ZTE)**



* Proposals
  + Option 1: UL 256QAM should be supported for ATG UE. [Ericsson, CMCC]
  + Option 2: not to define the UL 256QAM for ATG CPE. [ZTE]
* Recommended WF
  + Option 1

**Issue 1-2-6: ACLR**

* Proposals
  + Option 1: to reuse FR1 PC3 ACLR requirement for ATG CPE.
  + Option 2: Others
* Recommended WF
  + Option 1

**Issue 1-2-7: Additional SEM for ATG CPE**

* Proposals
  + Option 1: propose not to define it unless there are any regulatory requirement if necessary
  + Option 2: Others
* Recommended WF
  + Option 1

**Issue 1-2-8: UE coexistence requirement for ATG CPE**

* Proposals
  + Option 1: propose not to define it.
  + Option 2: Others.
* Recommended WF
  + TBD

# Topic #2: ATG UE Rx RF requirements

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2308572**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2308572.zip) | Huawei, HiSilicon | **Proposal 1: when deriving the maximum input level for ATG scenario, the antenna gains from both BS and UE sides should be considered. 3km minimum distance between BS and UE and 2GHz centre frequency can be assumed.**  **Proposal 2: to use -30dBm as the maximum input level for 4GHz ATG UE.**  **Proposal 3: to use -40dBm as the maximum input level for 2GHz ATG UE.**  **Observation 1:** **the maximum input level for ATG UE** **can’t be smaller than the requirements specified for NTN UE** **due to the closer minimum distance.**  **Proposal 4: It’s proposed to reuse the existing in-band blocking requirements in TS 38.101-1 for ATG UE.**  **Proposal 5: The requirements for OOB blocking and spurious response specified in TS 38.101-1 can be reused for ATG UE.**  **Proposal 6: to reuse Intermodulation characteristics requirements specified in TS 38.101-1 for ATG UE.** |
| [**R4-2308746**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2308746.zip) | Ericsson | In the previous sections we made the following observations:  [Observation 1 Whether or not to specify two requirements for maximum input level depends on whether the antenna array and deployment assumption are expected to lead to a significant difference.](#_Toc135052668)  [Observation 2 The out-of-band blocking requirement depends on the environment of other radio transmitters and radar systems.](#_Toc135052669)  [Observation 3 The spurious response requirement depends on the environment of other radio transmitters and radar systems.](#_Toc135052670)  Based on the discussion in the previous sections we propose the following:  [Proposal 1 Propose to use -56 dBm interference power level for in-band blocking.](#_Toc135052671)  [Proposal 2 It is not necessary to consider blocking from other ATG networks when assessing the in-band blocking requirement.](#_Toc135052672)  [Proposal 3 The RX intermodulation requirement should be considered after the maximum input level and blocking requirements are determined.](#_Toc135052673) |
| [**R4-2309172**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2309172.zip) | ZTE Corporation | **Observation 1:** based on the initial simulation results in Case 3 and Case 11, it should be sufficient to reuse the legacy FR1 UE PC3 ACS requirement 33dBc requirement for ATG UE.  **Proposal 1:** the maximum input power could be relaxed around 30dBc.  **Proposal 2:** for in-band blocking requirement of ATG CPE, propose to use the existing requirements in TS 38.101-1 as baseline and further discuss whether it could be relaxed further since the expected blocking signal should be lower compared with the handheld smartphone.  **Proposal 3:** for OOBB requirement of ATG CPE, propose to use the existing requirements in TS 38.101-1 as baseline and further discuss whether it could be relaxed further since the expected blocking signal should be lower compared with the handheld smartphone.  **Proposal 4:** for receiver spurious response requirement, propose to the same as TN and its power level of interfering signal could be further investigated similar as in-band blocking and out of band blocking.  **Proposal 5:** for Rx IMD requirement of ATG CPE, propose not to define the requirement.  **Proposal 6:** for ATG UE with phase antenna array, the Rx RF requirement should be defined on top of each TAB connector. |
| [**R4-2309440**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_107/Docs/R4-2309440.zip) | CMCC | **Proposal 1: Considering the possibility of ATG serving the aircraft directly above in the future still exists, 3km could be used as the minimum distance between ATG UE from BS.**  **Observation 1: max input level is -37dBm for 2GHz and -19dBm for 4GHz with min 3km distance assumption.**  **Proposal 2: Define two sets of max input level requirements based on antenna types.** |
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*The moderator can suggest a limited number of papers which could be presented.*

## Open issues summary

*Before f2f meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions..*

### Sub-topic 2-1 Rx RF requirements

*Sub-topic description:*

*Open issues and candidate options before f2f meeting:*

**Issue 2-1-1: Maximum input level**

Last meeting, we have achieved WF:

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| --- |
| **<Way forward>: Further to discuss whether we need to specify two sets of RF requirements for maximum input level.**  **<Way forward>: FFS the assumption of minimum distance between ATG BS and ATG UE to derive the maximum input level.** |

* **A) Proposals on the assumption of minimum distance between ATG BS and ATG UE to derive the Maximum input level**
  + Proposal 1: Considering the possibility of ATG serving the aircraft directly above in the future still exists, 3km could be used as the minimum distance between ATG UE from BS.
  + Proposal 2: when deriving the maximum input level for ATG scenario, the antenna gains from both BS and UE sides should be considered. 3km minimum distance between BS and UE and 2GHz centre frequency can be assumed..
* Recommended WF

If possible, the assumption of minimum distance between ATG BS and ATG UE for Issue 1-2-4 minimum output power can be reused for Maximum input level

* **B) Proposals on whether to specify two sets of RF requirements for maximum input level**
* **Observation in R4-2308746:** Whether or not to specify two requirements for maximum input level depends on whether the antenna array and deployment assumption are expected to lead to a significant difference.
  + Option 1: Yes, Define two sets of max input level requirements based on antenna types.
  + Option 2: Others
* Recommended WF
  + Option 1.
* **C) Proposals on Maximum input level**
* **Observation in R4-2309440:** max input level is -37dBm for 2GHz and -19dBm for 4GHz with min 3km distance assumption.

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| --- | --- | --- |
|  | **Omni-direction antenna** | **Antenna array** |
| Carrier frequency (GHz) | 2 | 4 |
| Distance (km) | 3 | 3 |
| Path Loss (dB) | 108 | 114 |
| BS output power (dBm) | 46 | 53 |
| BS antenna gain can assume (dBi) | 25.1 | 25.1 |
| ATG UE antenna gain (dBi) | 0 | 17 |
| Maximum input level (dBm) | -37 | -19 |

* + Option 1: (3km minimum distance assumption)
    - to use -30dBm as the maximum input level for 4GHz ATG UE.
    - to use -40dBm as the maximum input level for 2GHz ATG UE.
  + Option 2: the maximum input power could be relaxed around 30dBc. (-50dBm? 20km minimum distance assumption? )
  + Option 3: Others
* Recommended WF
  + TBA.

**Issue 2-1-2: In-band blocking requirements**

* Proposals
  + Option 1:
    - Propose to use -56 dBm interference power level for in-band blocking
    - It is not necessary to consider blocking from other ATG networks when assessing the in-band blocking requirement..
  + Option 2: It’s proposed to reuse the existing in-band blocking requirements in TS 38.101-1 for ATG UE
  + Option 3: for in-band blocking requirement of ATG CPE, propose to use the existing requirements in TS 38.101-1 as baseline and further discuss whether it could be relaxed further since the expected blocking signal should be lower compared with the handheld smartphone.
* Recommended WF
  + TBA

**Issue 2-1-3: Out-of-band blocking requirements/ Spurious response**

**Observation in R4-2308746:**

**The out-of-band blocking/ Spurious response requirement depends on the environment of other radio transmitters and radar systems.**

* Proposals
  + Option 1: The requirements for OOB blocking and spurious response specified in TS 38.101-1 can be reused for ATG UE.
  + Option 2: Others
* Recommended WF
  + TBA

**Issue 2-1-4: Intermodulation characteristics**

* Proposals
  + Option 1: to reuse Intermodulation characteristics requirements specified in TS 38.101-1 for ATG UE.
  + Option 2: The RX intermodulation requirement should be considered after the maximum input level and blocking requirements are determined.
  + Option 3: for Rx IMD requirement of ATG CPE, propose not to define the requirement.
* Recommended WF
  + Option 2. Postpone the discussion on this issue.