**3GPP TSG-RAN WG4 Meeting #94-e draft R4-2002440**

**Electronic Meeting, 24 Feb. – 6 Mar., 2020**

**Source:** Huawei

**Title:** TP to the TR 37.941: Out-of-band TRP requirements

**Agenda Item:** 8.19.2

**Document for:** Agreement

# Introduction

In this contribution we provide TP to External TR on OTA BS testing for the out-of-band TRP requirements section.

Technical content is based on the draft TR shared on the RAN4 Drafts reflector before the e-meeting. Technical content is sourced from the following legacy TRs (indicated by individual Track Changes IDs), with additional text corrections applied by the Rapporteur:

* TR 37.842, v13.3.0
* TR 37.843, v15.6.0
* TR 38.817-02, v15.6.0

Structure of sections is based on the TR Skeleton as in [2].

The MU / TT values in the text were highlighted for the purpose of values cross-checking in the final version of the TR, once the MU and TT sections are completed with corrected and updated inputs from the Excel spreadsheet.

# References

[1] RP-193225 Over the air (OTA) base station (BS) testing TR, WID

[2] R4-2001807 Skeleton for TR 37.941 on OTA BS testing, Rel-15

# TP to the External TR on OTA BS testing

*------------------------------ Modified section ------------------------------*

# 12 Out-of-band TRP requirements

## 12.1 General

The TRP MU consists of an MU per-point and a *TRP summation error* (SE) which allows for errors in the calculation of the TRP from multiple directional power measurements and allows for a sparse grid to be used to reduce measurement time. The total MU is calculated as follows:



Refer to subclause 6.3.6 for the SE value derivation.

## 12.2 Transmitter mandatory spurious emissions

### 12.2.1 General

Subclause 12.2 captures MU and TT values derivation for the TX mandatory spurious emissions TRP requirement in Normal test conditions.

The conducted spurious emission requirement MU is split up into a number of frequency ranges as in table 12.2.1-1.

Table 12.2.1 -1: MU values for conducted spurious emission requirement

|  |  |
| --- | --- |
| Transmitter spurious emissions, mandatory requirements | MU (dB) |
| 30 MHz ≤ f ≤ 4 GHz | 2.0 |
| 4 GHz < f ≤ 19 GHz | 4.0 |

The conducted analysis based on UTRA/E-UTRA frequencies which were all below 4.2 GHz (at the time), the break point in the MU is hence somewhat related to the in-band and out-of-band MU analysis. As in-band MU analysis is now being done up to 6 GHz (for the LAA and NR bands) it is sensible to change the frequency break point to 6 GHz.

The spurious emission requirements cover a large frequency range from 30MHz to 26GHz, many of the chambers chosen for analysis cannot cover this entire range. The MU analysis is therefore based on a general chamber analysis rather than any specific method. Other chambers may of course be used as long as the MU is within the specified value (or the test requirement is offset appropriately) and they are suitable for the frequencies being tested.

The spurious emissions requirements of the *BS type 2-O* are between 30 MHz to the 2nd harmonic of the DL operating band. Currently the upper frequency limit calculated MU is 60 GHz.

This range can be split into a number of regions:

**30 MHz < f ≤ 6 GHz**

This region also exists in FR1, the same MU is assumed for FR2 and for FR1

**6 GHz < f ≤ 18 GHz**

This is also an FR1 region however the MU values assumed in FR1 is larger than the in-band MU for FR2 which is at a higher frequency. An FR2 BS will likely be smaller than an FR1 BS and hence the chamber can be smaller and the requirements on the quiet zone can be relaxed. In addition, the test equipment is suitable for much higher frequencies (FR2 in band is above the frequency range) implying a low uncertainty. The MU in the region therefore is assumed to be the same as the FR2 in-band MU.

**18 GHz < f ≤ 40 GHz**

This frequency range covers the FR2 in-band region. The in-band MU budget is found in subclause 12.3.1.2.2.

**40 GHz < f ≤ 60 GHz**

This frequency range is above the in-band region, the measured frequencies are above the measurement frequency of the test equipment and hence a mixer is used to down convert the measured frequency to within the range of the test equipment.

It is not necessary to measure TRP in the far field as a large enough range may be impractical for the frequency range being considered.

### 12.2.2 General chamber

#### 12.2.2.1 Measurement system description

As the BS antenna radiating dimensions are fixed then the far field distance increases (FF ≈ 2d2/λ). At 12.75 GHz the far field distance for a 1.5m BS antenna array is almost 200 m, this is clearly impractical in an indoor chamber (and the path loss would also make measurement difficult), so spurious emission testing will not always be in the far field. This is acceptable as the requirement is TRP and hence it is not necessary to measure in the far field however it needs to be considered when looking at MU.

Considerations of the large frequency range must also be considered, including the chamber performance (quiet zone), the calibration effectiveness and the available reference and test antennas over the frequency range.

Measurement system description is captured in subclause 7.7.

#### 12.2.2.2 Test procedure

##### 12.2.2.2.1 Stage 1: Calibration

Calibration procedure for the general chamber is captured in subclause 8.7.

NOTE: The calibration for the out-of-band measurements should be repeated for each frequency being tested and each test antenna.

##### 12.2.2.2.2 Stage 2: BS measurement

The testing procedure consists of the following steps:

1) Place the BS at the positioner.

2) Align the manufacturer declared coordinate system orientation of the BS with the test system.

3) Measurements shall use appropriate measurement bandwidth.

4) The measurement device characteristics shall be: Detection mode: True RMS.

5) Set the BS to transmit according to the applicable test configuration

6) Align the BS and the test antenna such that measurements to determine TRP can be performed (see subclause 6.3.3 for the TRP measurement procedures).

7) Measure the emission at the specified frequencies with specified measurement bandwidth.

8) Repeat step 6 - 7 for all directions in the appropriated TRP measurement grid needed for full TRP estimation (see subclause 6.3.3 for the TRP measurement procedures) and for frequency points to be tested.

NOTE 1: the TRP measurement grid may not be the same for all measurement frequencies.

NOTE 2: the frequency sweep or the TRP measurement grid sweep may be done in any order.

9) Calculate TRP at each specified frequency using the directional measurements.

#### 12.2.2.3 MU value derivation, FR1

For FR1 an general chamber and reverberation chamber was analysed for the MU derivation. Table 12.2.2.3-1 captures derivation of the expanded measurement uncertainty values for OTA TX spurious emissions measurements in general chamber (Normal test conditions, FR1).

Table 12.2.2.3-1: General chamber MU value derivation for the TX spurious emissions, FR1

*Editor’s note: placeholder for the MU table based on the Excel spreadsheet.*

#### 12.2.2.4 MU value derivation, FR2

As opposed to FR1, for FR2 the IAC, CATR and reverberation chamber were analysed separately for the MU value derivation. Table 12.2.2.4-1 captures derivation of the expanded measurement uncertainty values for OTA TX spurious emissions measurements in IAC (Normal test conditions, FR2).

Table 12.2.2.4-1: IAC MU value derivation for TX spurious emissions, FR2

*Editor’s note: placeholder for the MU table based on the Excel spreadsheet.*

### 12.2.3 Compact Antenna Test Range

#### 12.2.3.1 Measurement system description

#### 12.2.3.2 Test procedure

##### 12.2.3.2.1 Stage 1: Calibration

##### 12.2.3.2.2 Stage 2: BS measurement

#### 12.2.3.3 MU value derivation, FR2

Table 12.2.3.3-1 captures derivation of the expanded measurement uncertainty values for OTA TX spurious emissions measurements in CATR (Normal test conditions, FR2).

Table 12.2.3.3-1: CATR value derivation for TX spurious emissions, FR2

*Editor’s note: placeholder for the MU table based on the Excel spreadsheet.*

### 12.2.4 Reverberation chamber

#### 12.2.4.1 Measurement system description

Measurement system description is captured in subclause 7.7.

#### 12.2.4.2 Test procedure

##### 12.2.4.2.1 Stage 1: Calibration

Calibration procedure for the Reverberation chamber is captured in subclause 8.7.

NOTE: The calibration for the out-of-band measurements should be repeated for each frequency being tested and each test antenna.

##### 12.2.4.2.2 Stage 2: BS measurement

TRP measurement procedure for the Reverberation chamber is captured in subclause 11.2.5.2.2 (OTA BS output power).

#### 12.2.4.3 MU value derivation

Table 12.2.3.4-1 captures derivation of the expanded measurement uncertainty values for OTA TX spurious emissions measurements in Reverberation Chamber (Normal test conditions).

Table 12.2.4.3-1: Reverberation Chamber value derivation for TX spurious emissions, 380 MHz – 26 GHz

*Editor’s note: placeholder for the MU table based on the Excel spreadsheet.*

Table 12.2.4.3-2: Reverberation Chamber value derivation for TX spurious emissions, 18 GHz – 60 GHz

*Editor’s note: placeholder for the MU table based on the Excel spreadsheet.*

### 12.2.5 Maximum accepted test system uncertainty



Whilst the TRP estimation does not require far-fieldConsidering the methodology described in subclause 5.1, Test Tolerance values for OTA transmitter spurious emissions were derived based on values captured in subclause 12.2.3.

Frequency range specific Test Tolerance values for the OTA TX spurious emissions test are defined in table 12.7.1-1.

Hence, we have the following MU values for the whole spurious emissions range (for FR1 and FR2 cases):

Table 12.2.5-1: Spurious emissions MU values



*Editor’s note: placeholder for the MU table based on the Excel spreadsheet.*

### 12.2.6 Test Tolerance for OTA TX spurious emissions

The conduced test tolerance for the mandatory spurious emissions requirements is zero. As the requirements are set by regulatory limits the same test tolerance is used for OTA.

TT = 0.

## 12.3 Receiver spurious emissions

### 12.3.1 General

Subclause 12.3 captures MU and TT values derivation for the RX spurious emissions TRP requirement in Normal test conditions.

The conducted receiver spurious emission requirement MU is the same as for the TX spurious emissions, the measurement technique is the same and the power level is > -60 dBm (where there is a break point for conducted power measurement accuracy), so this is reasonable.

For the OTA receiver emissions requirements however the lower power level of the requirement reduces the dynamic range of the TRP measurement and reduces measurement accuracy.

Considering that the loss in the chamber is based on the wanted signal being in the far field the per point noise floor is assumed to be approx. -100 dBm and the receiver emissions level translated to the test equipment is approx. -90 dBm. Hence the TRP calculation has only a 10 dB dynamic range.

An uncertainty of 1 dB is added to the TRP uncertainty budget to account for this additional uncertainty.

### 12.3.2 General chamber

#### 12.3.2.1 Measurement system description

As the BS antenna radiating dimensions are fixed then the far field distance increases (FF ≈ 2d2/λ). At 12.75 GHz the far field distance for a 1.5 m BS antenna array is almost 200 m, this is clearly impractical in an indoor chamber (and the path loss would also make measurement difficult), so spurious emission testing will not always be in the far field. This is acceptable as the requirement is TRP and hence it is not necessary to measure in the far field however it needs to be considered when looking at MU.

Considerations of the large frequency range must also be considered, including the chamber performance (quiet zone), the calibration effectiveness and the available reference and test antennas over the frequency range.

Measurement system description is captured in subclause 7.7.

#### 12.3.2.2 Test procedure

##### 12.3.2.2.1 Stage 1: Calibration

Calibration procedure for the general chamber is captured in subclause 8.7.

NOTE: The calibration for the out-of-band measurements should be repeated for each frequency being tested and each test antenna.

##### 12.3.2.2.2 Stage 2: BS measurement

The measurement procedure is the same as described in subclause 12.2.2.2.2 (i.e. OTA TX spurious emissions in general chamber).

#### 12.3.2.3 MU value derivation, FR1

Table 12.3.2.3-1 captures derivation of the expanded measurement uncertainty values for OTA RX spurious emissions measurements in general chamber (Normal test conditions, FR1).

Table 12.3.2.3-1: General chamber MU value derivation for RX spurious emissions, FR1

*Editor’s note: placeholder for the MU table based on the Excel spreadsheet.*

### 12.3.3 Maximum accepted test system uncertainty

The TRP MU is very similar to that for the transmitter mandatory spurious emissions. However, the receiver requirements are at a much lower power level so TRP calculation may be affected by the noise floor of the measurement system.

This range can be split into a number of regions:

**30 MHz < f ≤ 6 GHz**

The same value is assumed for receiver spurious emissions as for transmitter spurious emissions. This is the same as the in band FR2 MU value.

**6 GHz < f ≤ 18 GHz**

The same value is assumed for receiver spurious emissions as for transmitter spurious emissions. This is the same as the in band FR2 MU value.

**18 GHz < f ≤ 40 GHz**

The same value is assumed for receiver spurious emissions as for transmitter spurious emissions. This is calculated in clause 12.7.1.2.

**40 GHz < f ≤ 60 GHz**

The same value is assumed for receiver spurious emissions as for transmitter spurious emissions. This is calculated in clause 12.7.1.2.

Table 12.7.2.2-1: Receiver spurious emissions MU values

|  |  |  |
| --- | --- | --- |
| Frequency range | MU (dB) | Comment |
| 30 MHz < f ≦ 6 GHz | 2.5 | Same as FR1 |
| 6 GHz < f ≦ 18 GHz | 2.7 | Same as FR2 in-band |
| 18 GHz < f ≦ 40 GHz | 2.7 | Same as FR2 in-band |
| 40 GHz < f ≦ 60 GHz | 5 |  |

#### 12.3.4 Test Tolerance for OTA RX spurious emissions

The conduced test tolerance for the receiver spurious emissions requirements is zero. However for OTA BS the receiver spurious emissions requirements only apply to TTD in OFF mode. As such the limit is set by RAN4 to be considerably lower than the equivalent regulatory requirement.

In addition due to the difficulty in measuring low levels of TRP close to the measurement system noise floor the risk of false failures is high. As the risk is due to the noise floor of the measurement system it cannot be mitigated by BS design.

Hence it has been agreed that for receiver spurious emissions the TT = MU.

## 12.4 Additional (co-existence) spurious emissions

### 12.4.1 General

Subclause 12.4 captures MU and TT values derivation for the additional (co-existence) spurious emission TRP requirement in Normal test conditions.

The additional spurious emissions requirements consist of the co-existence emissions requirements, and some additional regional requirements such as the protection of PHS and 700 and 800 public safety.

The conducted MU are consistent with the mandatory spurious emissions MU.



The test set up for the OTA additional emissions requirements is the same as that for the mandatory spurious emissions in subclause 12.2.1. However, the additional spurious emissions are at a much lower level than the mandatory requirements so the additional effect of the test system dynamic range must be considered in the same way as the receiver emissions requirements.

Unlike the other spurious emissions requirements the additional (co-existence) requirements are specified for other 3GPP bands and as such can be measured in the same chambers as the in-band measurements.

As the CATR MU budget results is the largest MU and is used for setting the in-band MU values only the CATR MU is analysed below. However any suitable IAC or NFTR chamber can be used.

### 12.4.2 Compact Antenna Test Range

#### 12.4.2.1 Measurement system description

The CATR method only is described as it provides the worst MU budget for the additional requirements MU analysis.

Measurement system description is captured in subclause 7.3, with the Compact Antenna Test Range measurement system setup depicted on figure 8.3-1.

#### 12.4.2.2 Test procedure

##### 12.4.2.2.1 Stage 1: Calibration

Calibration procedure for the Compact Antenna Test Range is captured in subclause 8.3.

NOTE : The calibration for the out-of-band measurements should be repeated for each frequency being tested and each test antenna.

##### 12.4.2.2.2 Stage 2: BS measurement

The reference procedure can be found in subclause 11.2.3.2.2 (i.e. OTA BS output power in CATR).

The appropriate parameters in step 4 is the mean power of additional spurious emissions test over the measurement BW described in the test requirement.

#### 12.4.2.3 MU value derivation, FR1

Table 12.4.2.3-1 captures derivation of the expanded measurement uncertainty values for additional (co-existence) OTA TX spurious emissions measurements in CATR (Normal test conditions, FR1).

Table 12.4.2.3-1: CATR MU value derivation for additional (co-existence) OTA TX spurious emissions

*Editor’s note: placeholder for the MU table based on the Excel spreadsheet.*

### 12.4.3 Maximum accepted test system uncertainty

The additional spurious emission requirements including the co-existence with other BS in the same geographical area are based on existing co-existence with other 3GPP bands so the frequency ranges for the uncertainty assessment are different from the mandatory spurious emissions. In this case the uncertainty budgets for the in-band chambers are considered in the MU analysis. As the TRP level is at a low power level the measurement system dynamic range uncertainty is also considered as with the receiver spurious emissions.

Table 12.3.3-1: Test system specific MU values for the Additional (co-existence) spurious emissions measurement

*Editor’s note: placeholder for the MU table based on the Excel spreadsheet.*

NOTE: There are currently no additional spurious emissions requirements or co-existence requirements for FR2.

### 12.4.4 Test Tolerance for additional spurious emissions requirements

The conduced test tolerance for the additional spurious emissions requirements is zero.

However for OTA BS, the difficulty in measuring TRP of the additional spurious emissions requirements at low levels close to the measurement system noise floor means the high risk of false failures. As the risk is due to the noise floor of the measurement system it cannot be mitigated by BS design.

As the 3GPP to 3GPP co-existence requirements are not regulatory but set by RAN4 to assist with co-existence of 3GPP systems in the same geographical area it is acceptable for RAN4 to set the TT value to be non-zero.

Hence it has been agreed that for 3GPP to 3GPP co-existence spurious emissions the TT = MU.

Table 12.4.4-1: TT values for the Additional (coexistence) spurious emissions measurement

*Editor’s note: placeholder for the TT table based on the Excel spreadsheet.*

For PHS, and public safety additional requirements the TT = 0 dB.

Some additional requirements such as the protection of PHS and the 700 and 800 MHz public safety bands, are regulatory so it is not possible to have a non-zero TT, hence for these requirements the TT is zero.

*----------------------------- End of modified section ------------------------------*