**3GPP TSG-RAN4 Meeting #97-e *draft R4-2017578***

**Online, , 2nd Nov 2020 - 13th Nov 2020**

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| *CR-Form-v12.1* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **37.941** | **CR** | **0017** | **rev** | **1** | **Current version:** | **15.1.0** |  |
|  | | | | | | | | |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network | **x** | Core Network |  |

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| ***Title:*** |  | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Huawei | | | | | | | | | |
| ***Source to TSG:*** | R4 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | OTA\_BS\_testing-Perf | | | | |  | ***Date:*** | | | 2020-10-23 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **F** |  | | | | | ***Release:*** | | | Rel-15 |
|  | *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-15 (Release 15) Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | MU contributor terms alignment among MU tables and annexes is provided.  T shall be noted, that total MU values were not impacted by this CR.    Updated Excel spreadheets are attached. Please note, that due to outstanding [] in the TR (which are also marked in the Excel spreasheets), all the affected spreadhseets are expected to be revised during/after the meeting for [] cleanup purposes. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | * Multiple MU terms reschuffling to aling UID and their descriptions among MU tables and annex A, B, C descriptions. * Multiple terminology and wording alignments among MU controbitors entries in MU tables and MU definitions in Annex A, B, C * Multiple wording alignments among MU terms used in different OTA test methods.   Due to the modifications introduced in the TR, related Excel spreadsheets will have to be corrected accordingly (e.g. as a revision, or after the meeting during e-mail approval; first the TR corrections to be discussed). The only modification introduced in the attached Excel spreadsheets is listed below (updated cells with yellow highlight):   * Table 12.2.2.4-1 (Spreadsheet 3 - FR2 TX MU calculation tables): correction of “Uncertainty of the network analyzer” to “Uncertainty of the absolute gain of the reference antenna”; no MU values modified | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | Multiple inconsistencies and incorrect values of the MU contributors would exist in the TR. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 9.2, 9.3, 9.4, 9.5, 9.10, 10.2, 11.2, 11.3, 11.4, 12.2, 12.3, 12.4, 13.2, 13.3, 13.4, 13.5, A, B, C | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **x** | Other core specifications | | | |  | | |
| ***affected:*** | |  | **x** | Test specifications | | | |  | | |
| ***(show related CRs)*** | |  | **x** | O&M Specifications | | | |  | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

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

#### 9.2.2.3 MU value derivation, FR1

Table 9.2.2.3-1 captures uncertainty budget contributors and table 9.2.2.3-2 captures the derivation of the expanded measurement uncertainty values for EIRP accuracy measurements in Indoor Anechoic Chamber (Normal test conditions, FR1).

Table 9.2.2.3-1: Indoor Anechoic Chamber measurement uncertainty contributors for EIRP accuracy measurements, Normal test conditions, FR1

|  |  |
| --- | --- |
| **UID / Details in annex** | **Uncertainty source** |
| **Stage 2: BS measurement** | |
| A1-1 | Positioning misalignment between the BS and the reference antenna |
| A1-2 | Pointing misalignment between the BS and the receiving antenna |
| A1-3 | Quality of quiet zone |
| A1-4a | Polarization mismatch between the BS and the receiving antenna |
| A1-5a | Mutual coupling between the BS and the receiving antenna |
| A1-6 | Phase curvature |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) |
| A1-7 | Impedance mismatch in the receiving chain |
| A1-8 | Random uncertainty |
| **Stage 1: Calibration measurement** | |
| A1-9 | Impedance mismatch between the receiving antenna and the network analyzer |
| A1-10 | Positioning and pointing misalignment between the reference antenna and the receiving antenna |
| A1-11 | Impedance mismatch between the reference antenna and the network analyzer |
| A1-3 | Quality of quiet zone |
| A1-4b | Polarization mismatch between the reference antenna and the receiving antenna |
| A1-5b | Mutual coupling between the reference antenna and the receiving antenna |
| A1-6 | Phase curvature |
| C1-3 | Uncertainty of the network analyzer |
| A1-12 | Influence of the reference antenna feed cable |
| A1-13 | Reference antenna feed cable loss measurement uncertainty |
| A1-14 | Influence of the receiving antenna feed cable |
| C1-4 | Uncertainty of the absolute gain of the reference antenna |
| A1-15 | Uncertainty of the absolute gain of the receiving antenna |

NOTE: In the legacy technical reports for BS testability (RAN4) or UE testability (RAN5), the MU/TT derivation tables were using UID as counting numbers across multiple test chambers and requirement’s clauses. In this TR a simplified approach was taken with the UID’s being the annex number of the measurement uncertainty source description.

Table 9.2.2.3-2: Indoor Anechoic Chamber measurement uncertainty value derivation for EIRP accuracy measurements, Normal test conditions, FR1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | **Distribution of the probability** | **Divisor based on distribution shape** | ***ci*** | **Standard uncertainty *ui* (dB)** | | |
| f<3 GHz | **3<f<4.2 GHz** | **4.2<f<6 GHz** | **f<3 GHz** | **3<f<4.2 GHz** | **4.2<f<6 GHz** |
| Stage 2: BS measurement | | | | | | | | | | |
| A1-1 | Positioning misalignment between the BS and the reference antenna | 0.03 | 0.03 | 0.03 | Rectangular | 1.73 | 1 | 0.02 | 0.02 | 0.02 |
| A1-2 | Pointing misalignment between the BS and the receiving antenna | 0.3 | 0.3 | 0.3 | Rectangular | 1.73 | 1 | 0.17 | 0.17 | 0.17 |
| A1-3 | Quality of quiet zone | 0.1 | 0.1 | 0.1 | Gaussian | 1.00 | 1 | 0.10 | 0.10 | 0.10 |
| A1-4a | Polarization mismatch between the BS and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A1-5a | Mutual coupling between the BS and the receiving antenna | 0 | 0 | 0 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A1-6 | Phase curvature | 0.05 | 0.05 | 0.05 | Gaussian | 1.00 | 1 | 0.05 | 0.05 | 0.05 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A1-7 | Impedance mismatch in the receiving chain | 0.14 | 0.33 | 0.33 | U-shaped | 1.41 | 1 | 0.10 | 0.23 | 0.23 |
| A1-8 | Random uncertainty | 0.1 | 0.1 | 0.1 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| Stage 1: Calibration measurement | | | | | | | | | | |
| A1-9 | Impedance mismatch between the receiving antenna and the network analyzer | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.04 | 0.04 | 0.04 |
| A1-10 | Positioning and pointing misalignment between the reference antenna and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A1-11 | Impedance mismatch between the reference antenna and the network analyzer | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.04 | 0.04 | 0.04 |
| A1-3 | Quality of quiet zone | 0.1 | 0.1 | 0.1 | Gaussian | 1.00 | 1 | 0.10 | 0.10 | 0.10 |
| A1-4b | Polarization mismatch between the reference antenna and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A1-5b | Mutual coupling between the reference antenna and the receiving antenna | 0 | 0 | 0 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A1-6 | Phase curvature | 0.05 | 0.05 | 0.05 | Gaussian | 1.00 | 1 | 0.05 | 0.05 | 0.05 |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.2 | 0.2 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A1-12 | Influence of the reference antenna feed cable | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| A1-13 | Reference antenna feed cable loss measurement uncertainty | 0.06 | 0.06 | 0.06 | Gaussian | 1.00 | 1 | 0.06 | 0.06 | 0.06 |
| A1-14 | Influence of the receiving antenna feed cable | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A1-15 | Uncertainty of the absolute gain of the receiving antenna | 0 | 0 | 0 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.44** | **0.54** | **0.54** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **0.87** | **1.06** | **1.06** |

*----------------------------- Next modified section -----------------------------*

#### 9.2.3.3 MU value derivation, FR1

Table 9.2.3.3-1 captures uncertainty budget contributors and Table 9.2.3.3-2 captures the derivation of the expanded measurement uncertainty values for EIRP accuracy measurements in CATR (Normal test conditions, FR1).

Table 9.2.3.3-1: CATR measurement uncertainty contributors for EIRP accuracy measurements, Normal test conditions, FR1

|  |  |
| --- | --- |
| **UID / Details in annex** | **Uncertainty source** |
| **Stage 2: BS measurement** | |
| A2-1a | Misalignment and pointing error of BS (for EIRP) |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) |
| A2-2a | Standing wave between BS and test range antenna |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) |
| A2-4a | QZ ripple experienced by BS |
| A2-12 | Frequency flatness of test system |
| **Stage 1: Calibration measurement** | |
| C1-3 | Uncertainty of the network analyzer |
| A2-5a | Mismatch of receiver chain between receiving antenna and measurement receiver |
| A2-6 | Insertion loss of receiver chain |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) |
| A2-7 | Influence of the calibration antenna feed cable |
| C1-4 | Uncertainty of the absolute gain of the reference antenna |
| A2-8 | Misalignment positioning system |
| A2-1b | Misalignment and pointing error of calibration antenna |
| A2-9 | Rotary joints |
| A2-2b | Standing wave between calibration antenna and test range antenna |
| A2-4b | QZ ripple experienced by calibration antenna |
| A2-11 | Switching uncertainty |

NOTE: In the legacy technical reports for BS testability (RAN4) or UE testability (RAN5), the MU/TT derivation tables were using UID as counting numbers across multiple test chambers and requirement’s clauses. In this TR a simplified approach was taken with the UID’s being the annex number of the measurement uncertainty source description.

Table 9.2.3.3-2: CATR MU value derivation for EIRP accuracy measurements, Normal test conditions, FR1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| A2-1a | Misalignment and pointing error of BS (for EIRP) | 0.00 | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A2-2a | Standing wave between BS and test range antenna | 0.21 | 0.21 | 0.21 | U-shaped | 1.41 | 1 | 0.15 | 0.15 | 0.15 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A2-4a | QZ ripple experienced by BS | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| A2-12 | Frequency flatness of test system | 0.25 | 0.25 | 0.25 | Gaussian | 1.00 | 1 | 0.25 | 0.25 | 0.25 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A2-5a | Mismatch of receiver chain between receiving antenna and measurement receiver | 0.13 | 0.33 | 0.33 | U-shaped | 1.41 | 1 | 0.09 | 0.23 | 0.23 |
| A2-6 | Insertion loss of receiver chain | 0.18 | 0.18 | 0.18 | Rectangular | 1.73 | 1 | 0.10 | 0.10 | 0.10 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A2-7 | Influence of the calibration antenna feed cable | 0.02 | 0.02 | 0.02 | U-shaped | 1.41 | 1 | 0.02 | 0.02 | 0.02 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A2-8 | Misalignment positioning system | 0.00 | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| A2--1b | Misalignment and pointing error of calibration antenna | 0.50 | 0.50 | 0.50 | Exp. normal | 2.00 | 1 | 0.25 | 0.25 | 0.25 |
| A2-9 | Rotary joints | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.03 | 0.03 | 0.03 |
| A2-2b | Standing wave between calibration antenna and test range antenna | 0.09 | 0.09 | 0.09 | U-shaped | 1.41 | 1 | 0.06 | 0.06 | 0.06 |
| A2-4b | QZ ripple experienced by calibration antenna | 0.01 | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 | 0.01 |
| A2-11 | Switching uncertainty | 0.26 | 0.26 | 0.26 | Rectangular | 1.73 | 1 | 0.15 | 0.15 | 0.15 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.57** | **0.65** | **0.65** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **1.11** | **1.27** | **1.27** |

*----------------------------- Next modified section -----------------------------*

#### 9.2.3.4 MU value derivation, FR2

The MU assessment was carried out using a CATR chamber only however other chamber types are not precluded if suitable MU assessment is done.

A CATR MU budget was assessed in order to determine acceptable MU for the EIRP accuracy measurement in FR2. The CATR test setup and calibration and measurement procedures for FR2 are expected to be similar to those of FR1, although the test chamber dimensions and associated MU values will scale due to the shorter wavelengths and larger relative array apertures.

Table 9.2.3.4-1 captures the uncertainty budget contributors and table 9.2.3.4-2 captures the derivation of the expanded measurement uncertainty values for EIRP accuracy measurements in CATR (Normal test conditions, FR2).

Table 9.2.3.4-1: CATR measurement uncertainty contributors for EIRP accuracy measurements, Normal test conditions, FR2

|  |  |
| --- | --- |
| **UID / Details in annex** | **Uncertainty source** |
| **Stage 2: BS measurement** | |
| A2-1a | Misalignment and pointing error of BS (for EIRP) |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) - high power |
| A2-2a | Standing wave between BS and test range antenna |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) |
| A2-4a | QZ ripple experienced by BS |
| A2-12 | Frequency flatness of test system |
| **Stage 1: Calibration measurement** | |
| C1-3 | Uncertainty of the network analyzer |
| A2-5a | Mismatch of receiver chain between receiving antenna and measurement receiver |
| A2-6 | Insertion loss of receiver chain |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) |
| A2-7 | Influence of the calibration antenna feed cable |
| C1-4 | Uncertainty of the absolute gain of the reference antenna |
| A2-8 | Misalignment positioning system |
| A2-1b | Misalignment and pointing error of calibration antenna (for EIRP)t |
| A2-9 | Rotary joints |
| A2-2b | Standing wave between calibration antenna and test range antenna |
| A2-4b | QZ ripple experienced by calibration antenna |
| A2-11 | Switching uncertainty |

NOTE: In the legacy technical reports for BS testability (RAN4) or UE testability (RAN5), the MU/TT derivation tables were using UID as counting numbers across multiple test chambers and requirement’s clauses. In this TR a simplified approach was taken with the UID’s being the annex number of the measurement uncertainty source description.

Table 9.2.3.4-2: CATR MU value derivation for EIRP accuracy measurements, Normal test conditions, FR2

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | |
| 24.25<f <29.5GHz | 37<f <40GHz | 24.25<f <29.5GHz | 37<f <40GHz |
| **Stage 2: BS measurement** | | | | | | | | |
| A2-1a | Misalignment and pointing error of BS (for EIRP) | 0.20 | 0.20 | Exp. normal | 2.00 | 1 | 0.10 | 0.10 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) - high power | 0.50 | 0.70 | Normal | 1.00 | 1 | 0.50 | 0.70 |
| A2-2a | Standing wave between BS and test range antenna | 0.03 | 0.03 | U-shaped | 1.41 | 1 | 0.02 | 0.02 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.01 | 0.01 | Normal | 1.00 | 1 | 0.01 | 0.01 |
| A2-4a | QZ ripple experienced by BS | 0.40 | 0.40 | Normal | 1.00 | 1 | 0.40 | 0.40 |
| A2-12 | Frequency flatness of test system | 0.25 | 0.25 | Normal | 1.00 | 1 | 0.25 | 0.25 |
| **Stage 1: Calibration measurement** | | | | | | | | |
| C1-3 | Uncertainty of the network analyzer | 0.30 | 0.30 | Normal | 1.00 | 1 | 0.30 | 0.30 |
| A2-5a | Mismatch of receiver chain between receiving antenna and measurement receiver | 0.43 | 0.57 | U-shaped | 1.41 | 1 | 0.30 | 0.40 |
| A2-6 | Insertion loss of receiver chain | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.01 | 0.01 | Normal | 1.00 | 1 | 0.01 | 0.01 |
| A2-7 | Influence of the calibration antenna feed cable | 0.21 | 0.29 | U-shaped | 1.41 | 1 | 0.15 | 0.21 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.52 | 0.52 | Rectangular | 1.73 | 1 | 0.30 | 0.30 |
| A2-8 | Misalignment positioning system | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 |
| A2-1b | Misalignment and pointing error of calibration antenna (for EIRP) | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 |
| A2-9 | Rotary joints | 0.00 | 0.00 | U-shaped | 1.41 | 1 | 0.00 | 0.00 |
| A2-2b | Standing wave between calibration antenna and test range antenna | 0.09 | 0.09 | U-shaped | 1.41 | 1 | 0.06 | 0.06 |
| A2-4b | QZ ripple experienced by calibration antenna | 0.01 | 0.01 | Normal | 1.00 | 1 | 0.01 | 0.01 |
| A2-11 | Switching uncertainty | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | **0.89** | **1.06** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | **1.74** | **2.07** |

*----------------------------- Next modified section -----------------------------*

#### 9.2.4.3 MU value derivation, FR1

Table 9.2.4.3-1 captures the uncertainty budget contributors and table 9.2.4.3-2 captures the derivation of the expanded measurement uncertainty values for EIRP accuracy measurements in One Dimensional Compact Range.

Table 9.2.4.3-1: One Dimensional Compact Range measurement accuracy contributors for EIRP accuracy measurements, FR1

|  |  |
| --- | --- |
| **UID / Details in annex** | **Uncertainty source** |
| **Stage 2: BS measurement** | |
| A4-1 | Misalignment and pointing error of BS |
| A4-2a | Standing wave between BS and test range antenna |
| A4-3a | Quiet zone ripple experienced by BS |
| A4-4a | Phase curvature across the BS antenna |
| A4-5a | Polarization mismatch between BS and receiving antenna |
| A4-6a | Mutual coupling between BS and receiving antenna |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) |
| A4-7 | Impedance mismatch in receiving chain |
| A4-8a | RF leakage (BS connector terminated and test range antenna connector cable terminated) |
| **Stage 1: Calibration measurement** | |
| A4-9 | Misalignment positioning system |
| A4-10 | Pointing error between reference antenna and test range antenna |
| A4-11 | Impedance mismatch in path to reference antenna |
| A4-12 | Impedance mismatch in path to compact probe |
| A4-2b | Standing wave between reference antenna and receiving antenna |
| A4-3b | Quiet zone ripple experienced by reference antenna |
| A4-4b | Phase curvature across the reference antenna |
| A4-5b | Polarization mismatch between reference antenna and receiving antenna |
| A4-6b | Mutual coupling between reference antenna and receiving antenna |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) |
| A4-13 | Influence of the reference antenna feed cable (flexing cables, adapters, attenuators, connector repeatability) |
| A4-14 | Mismatch of receiver chain |
| A4-15 | Insertion loss of receiver chain |
| C1-4 | Uncertainty of the absolute gain of the reference antenna |
| A4-8b | RF leakage (SGH connector terminated and test range antenna connector cable terminated) |

NOTE: In the legacy technical reports for BS testability (RAN4) or UE testability (RAN5), the MU/TT derivation tables were using UID as counting numbers across multiple test chambers and requirement’s clauses. In this TR a simplified approach was taken with the UID’s being the annex number of the measurement uncertainty source description.

Table 9.2.4.3-2: One Dimensional Compact Range MU value derivation for EIRP accuracy measurements, FR1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UID** | **Uncertainty source** | **Uncertainty value (dB)** | | | **Distribution of the probability** | **Divisor based on distribution shape** | ***ci*** | **Standard uncertainty *ui* (dB)** | | |
| **f<3 GHz** | **3<f<4.2 GHz** | **4.2<f<6 GHz** | **f<3 GHz** | **3<f<4.2 GHz** | **4.2<f<6 GHz** |
| **Stage 2: BS measurement** | | | | | | | | | | |
| A4-1 | Misalignment and pointing error of BS | 0.00 | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| A4-2a | Standing wave between BS and test range antenna | 0.18 | 0.18 | 0.18 | U-shaped | 1.41 | 1 | 0.13 | 0.13 | 0.13 |
| A4-3a | Quiet zone ripple experienced by BS | 0.03 | 0.03 | 0.03 | Gaussian | 1.00 | 1 | 0.03 | 0.03 | 0.03 |
| A4-4a | Phase curvature across the BS antenna | 0.01 | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 | 0.01 |
| A4-5a | Polarization mismatch between BS and receiving antenna | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| A4-6a | Mutual coupling between BS and receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A4-7 | Impedance mismatch in receiving chain | 0.01 | 0.01 | 0.01 | U-shaped | 1.41 | 1 | 0.00 | 0.01 | 0.01 |
| A4-8a | RF leakage (BS connector terminated and test range antenna connector cable terminated) | **0.00** | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| **Stage 1: Calibration measurement** | | | | | | | | | | |
| A4-9 | Misalignment positioning system | 0.00 | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| A4-10 | Pointing error between reference antenna and test range antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A4-11 | Impedance mismatch in path to reference antenna | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.04 | 0.04 | 0.04 |
| A4-12 | Impedance mismatch in path to compact probe | 0.03 | 0.03 | 0.03 | U-shaped | 1.41 | 1 | 0.02 | 0.02 | 0.02 |
| A4-2b | Standing wave between reference antenna and receiving antenna | 0.09 | 0.09 | 0.09 | U-shaped | 1.41 | 1 | 0.06 | 0.06 | 0.06 |
| A4-3b | Quiet zone ripple experienced by reference antenna | 0.18 | 0.18 | 0.18 | Gaussian | 1.00 | 1 | 0.18 | 0.18 | 0.18 |
| A4-4b | Phase curvature across the reference antenna | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A4-5b | Polarization mismatch between reference antenna and receiving antenna | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| A4-6b | Mutual coupling between reference antenna and receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A4-13 | Influence of the reference antenna feed cable (flexing cables, adapters, attenuators, connector repeatability) | 0.08 | 0.08 | 0.08 | Rectangular | 1.73 | 1 | 0.05 | 0.05 | 0.05 |
| A4-14 | Mismatch of receiver chain | 0.20 | 0.30 | 0.30 | U-shaped | 1.41 | 1 | 0.14 | 0.21 | 0.21 |
| A4-15 | Insertion loss of receiver chain | 0.18 | 0.18 | 0.18 | Rectangular | 1.73 | 1 | 0.10 | 0.10 | 0.10 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A4-8b | RF leakage (SGH connector terminated and test range antenna connector cable terminated) | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.46** | **0.56** | **0.56** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **0.90** | **1.10** | **1.10** |

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#### 9.2.5.3 MU value derivation, FR1

Table 9.2.5.3-1 captures the uncertainty budget contributors and table 9.2.5.3-2 captures the derivation of the expanded measurement uncertainty values for EIRP accuracy measurements in Near Field Test Range.

Standard uncertainty values for the signal generator, network analyzer and reference antenna are according to the test equipment uncertainty values, as captured in annex C.

Table 9.2.5.3-1: NFTR measurement accuracy contributors for EIRP accuracy measurements, FR1

|  |  |
| --- | --- |
| **UID / Details in annex** | **Uncertainty source** |
| **Stage 2: BS measurement** | |
| A3-1 | Axes intersection |
| A3-2 | Axes orthogonality |
| A3-3 | Horizontal pointing |
| A3-4 | Probe vertical position |
| A3-5 | Probe horizontal/vertical pointing |
| A3-6 | Measurement distance |
| A3-7 | Amplitude and phase drift |
| A3-8 | Amplitude and phase noise |
| A3-9 | Leakage and crosstalk |
| A3-10 | Amplitude non-linearity |
| A3-11 | Amplitude and phase shift in rotary joints |
| A3-12 | Channel balance amplitude and phase |
| A3-13 | Probe polarization amplitude and phase |
| A3-14 | Probe pattern knowledge |
| A3-15 | Multiple Reflections |
| A3-16 | Room scattering |
| A3-17 | BS support scattering |
| A3-18 | Scan area truncation |
| A3-19 | Sampling point offset |
| A3-20 | Spherical mode truncation |
| A3-21 | Positioning |
| A3-22 | Probe array uniformity |
| A3-23 | Mismatch of receiver chain |
| A3-24 | Insertion loss of receiver chain |
| A3-25 | Uncertainty of the absolute gain of the probe antenna |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) |
| A3-26 | Measurement repeatability - positioning repeatability |
| A3-33 | Frequency flatness of test system |
| **Stage 1: Calibration measurement** | |
| C1-3 | Uncertainty of the network analyzer |
| A3-27 | Mismatch of receiver chain |
| A3-28 | Insertion loss of receiver chain |
| A3-29 | Mismatch in the connection of the calibration antenna |
| A3-30 | Influence of the calibration antenna feed cable |
| A3-31 | Influence of the probe antenna cable |
| C1-4 | Uncertainty of the absolute gain of the reference antenna |
| A3-32 | Short term repeatability |

NOTE: In the legacy technical reports for BS testability (RAN4) or UE testability (RAN5), the MU/TT derivation tables were using UID as counting numbers across multiple test chambers and requirement’s clauses. In this TR a simplified approach was taken with the UID’s being the annex number of the measurement uncertainty source description.

Table 9.2.5.3-2: NFTR measurement uncertainty value derivation for EIRP accuracy measurements, FR1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UID** | **Uncertainty source** | **Uncertainty value (dB)** | | | **Distribution of the probability** | **Divisor based on distribution shape** | ***ci*** | **Standard uncertainty *ui* (dB)** | | |
| **f<3 GHz** | **3<f<4.2 GHz** | **4.2<f<6 GHz** | **f<3 GHz** | **3<f<4.2 GHz** | **4.2<f<6 GHz** |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| A3-1 | Axes intersection | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-2 | Axes orthogonality | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-3 | Horizontal pointing | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-4 | Probe vertical position | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-5 | Probe horizontal/vertical pointing | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-6 | Measurement distance | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-7 | Amplitude and phase drift | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-8 | Amplitude and phase noise | 0.02 | 0.02 | 0.02 | Gaussian | 1.00 | 1 | 0.02 | 0.02 | 0.02 |
| A3-9 | Leakage and crosstalk | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-10 | Amplitude non-linearity | 0.04 | 0.04 | 0.04 | Gaussian | 1.00 | 1 | 0.04 | 0.04 | 0.04 |
| A3-11 | Amplitude and phase shift in rotary joints | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-12 | Channel balance amplitude and phase | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-13 | Probe polarization amplitude and phase | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-14 | Probe pattern knowledge | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-15 | Multiple reflections | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-16 | Room scattering | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| A3-17 | BS support scattering | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-18 | Scan area truncation | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-19 | Sampling point offset | 0.01 | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 | 0.01 |
| A3-20 | Spherical mode truncation | 0.02 | 0.02 | 0.02 | Gaussian | 1.00 | 1 | 0.02 | 0.02 | 0.02 |
| A3-21 | Positioning | 0.03 | 0.03 | 0.03 | Rectangular | 1.73 | 1 | 0.02 | 0.02 | 0.02 |
| A3-22 | Probe array uniformity | 0.06 | 0.06 | 0.06 | Gaussian | 1.00 | 1 | 0.06 | 0.06 | 0.06 |
| A3-23 | Mismatch of receiver chain | 0.28 | 0.28 | 0.28 | U-Shaped | 1.41 | 1 | 0.20 | 0.20 | 0.20 |
| A3-24 | Insertion loss of receiver chain | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-25 | Uncertainty of the absolute gain of the probe antenna | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A3-26 | Measurement repeatability - positioning repeatability | 0.15 | 0.15 | 0.15 | Gaussian | 1.00 | 1 | 0.15 | 0.15 | 0.15 |
| A3-33 | Frequency flatness of test system | 0.25 | 0.25 | 0.25 | Normal | 1.00 | 1 | 0.25 | 0.25 | 0.25 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A3-27 | Mismatch of receiver chain | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-28 | Insertion loss of receiver chain | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-29 | Mismatch in the connection of the calibration antenna | 0.02 | 0.02 | 0.02 | U-Shaped | 1.41 | 1 | 0.01 | 0.01 | 0.01 |
| A3-30 | Influence of the calibration antenna feed cable | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-31 | Influence of the probe antenna cable | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A3-32 | Short term repeatability | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.52** | **0.56** | **0.56** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **1.01** | **1.10** | **1.10** |

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#### 9.2.6.3 MU value derivation, FR1

Table 9.2.6.3-1 captures the uncertainty budget contributors and table 9.2.6.3-2 captures the derivation of the expanded measurement uncertainty values for EIRP accuracy measurements in PWS.

Table 9.2.6.3-1: PWS measurement accuracy contributors for EIRP accuracy measurements, FR1

|  |  |
| --- | --- |
| **UID / Details in annex** | **Uncertainty source** |
| **Stage 2: BS measurement** | |
| A7-1a | Misalignment and pointing error of BS |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) |
| A7-2a | Longitudinal position uncertainty (i.e. standing wave and imperfect field synthesis) for BS antenna |
| A7-3 | RF leakage (calibration antenna connector terminated) |
| A7-4a | QZ ripple experienced by BS |
| A7-5 | Miscellaneous uncertainty |
| A7-14 | System non-linearity |
| A7-13 | Frequency flatness of test system |
| **Stage 1: Calibration measurement** | |
| C1-3 | Uncertainty of the network analyzer |
| A7-6 | Mismatch (i.e. reference antenna, network analyser and reference cable) |
| A7-7 | Insertion loss of receiver chain |
| A7-3 | RF leakage (calibration antenna connector terminated) |
| A7-8 | Influence of the calibration antenna feed cable |
| C1-4 | Uncertainty of the absolute gain of the reference antenna |
| A7-9 | Misalignment of positioning system |
| A7-1b | Misalignment and pointing error of calibration antenna |
| A7-10 | Rotary joints |
| A7-2b | Longitudinal position uncertainty (i.e. standing wave and imperfect field synthesis) for calibration antenna |
| A7-4b | QZ ripple experienced by calibration antenna |
| A7-11 | Switching uncertainty |
| A7-12 | Field repeatability |

NOTE: In the legacy technical reports for BS testability (RAN4) or UE testability (RAN5), the MU/TT derivation tables were using UID as counting numbers across multiple test chambers and requirement’s clauses. In this TR a simplified approach was taken with the UID’s being the annex number of the measurement uncertainty source description.

Table 9.2.6.3-2: PWS measurement uncertainty value derivation for EIRP accuracy measurements, FR1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UID** | **Uncertainty source** | **Uncertainty value (dB)** | | | **Distribution of the probability** | **Divisor based on distribution shape** | ***ci*** | **Standard uncertainty *ui* (dB)** | | |
| **f<3 GHz** | **3<f<4.2 GHz** | **4.2<f<6 GHz** | **f<3 GHz** | **3<f<4.2 GHz** | **4.2<f<6 GHz** |
| **Stage 2: BS measurement** | | | | | | | | | | |
| A7-1a | Misalignment and pointing error of BS | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A7-2a | Longitudinal position uncertainty (i.e. standing wave and imperfect field synthesis) for BS antenna | 0.05 | 0.14 | [0.14] | Rectangular | 1.73 | 1 | 0.03 | 0.08 | [0.08] |
| A7-3 | RF leakage (calibration antenna connector terminated) | 0.09 | 0.09 | 0.09 | Normal | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| A7-4a | QZ ripple experienced by BS | 0.42 | 0.43 | [0.43] | Rectangular | 1.73 | 1 | 0.24 | 0.25 | [0.25] |
| A7-5 | Miscellaneous uncertainty | 0.00 | 0.00 | 0.00 | Normal | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A7-14 | System non-linearity | 0.10 | 0.10 | [0.10] | Rectangular | 1.73 | 1 | 0.06 | 0.06 | [0.06] |
| A7-13 | Frequency flatness of test system | 0.13 | 0.13 | 0.13 | Rectangular | 1.73 | 1 | 0.08 | 0.08 | 0.08 |
| **Stage 1: Calibration measurement** | | | | | | | | | | |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A7-6 | Mismatch (i.e. reference antenna, network analyzer and reference cable) | 0.13 | 0.33 | 0.33 | U-shaped | 1.41 | 1 | 0.09 | 0.23 | 0.23 |
| A7-7 | Insertion loss of receiver chain | 0.18 | 0.18 | 0.18 | Rectangular | 1.73 | 1 | 0.10 | 0.10 | 0.10 |
| A7-3 | RF leakage (calibration antenna connector terminated) | 0.09 | 0.09 | 0.09 | Normal | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| A7-8 | Influence of the calibration antenna feed cable | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A7-9 | Misalignment of positioning system | 0.00 | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| A7-1b | Misalignment and pointing error of calibration antenna | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| A7-10 | Rotary joints | 0.00 | 0.00 | 0.00 | U-shaped | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A7-2b | Longitudinal position uncertainty (i.e. standing wave and imperfect field synthesis) for calibration antenna | 0.12 | 0.12 | [0.12] | Rectangular | 1.73 | 1 | 0.07 | 0.07 | [0.07] |
| A7-4b | QZ ripple experienced by calibration antenna | 0.20 | 0.20 | 0.20 | Rectangular | 1.73 | 1 | 0.12 | 0.12 | 0.12 |
| A7-11 | Switching uncertainty | 0.02 | 0.02 | 0.02 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A7-12 | Field repeatability | 0.06 | 0.12 | [0.12] | Normal | 1.00 | 1 | 0.06 | 0.12 | [0.12] |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.50** | **0.61** | **[0.61]** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **0.98** | **1.19** | **[1.19]** |

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#### 9.3.2.3 MU value derivation, FR1

Table 9.3.2.3-1: Indoor Anechoic Chamber measurement uncertainty value derivation for EIRP accuracy measurements in Extreme test conditions, FR1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| A1-1 | Positioning misalignment between the BS and the reference antenna | 0.03 | 0.03 | 0.03 | Rectangular | 1.73 | 1 | 0.02 | 0.02 | 0.02 |
| A1-2 | Pointing misalignment between the BS and the receiving antenna | 0.30 | 0.30 | 0.30 | Rectangular | 1.73 | 1 | 0.17 | 0.17 | 0.17 |
| A1-17 | Quality of quiet zone (extreme test conditions) | 0.60 | 0.60 | 0.60 | Gaussian | 1.00 | 1 | 0.60 | 0.60 | 0.60 |
| A1-4a | Polarization mismatch between the BS and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A1-5a | Mutual coupling between the BS and the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A1-6 | Phase curvature | 0.05 | 0.05 | 0.05 | Gaussian | 1.00 | 1 | 0.05 | 0.05 | 0.05 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A1-7 | Impedance mismatch in the receiving chain | 0.14 | 0.33 | 0.33 | U-shaped | 1.41 | 1 | 0.10 | 0.23 | 0.23 |
| A1-8 | Random uncertainty | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| A1-19 | Radome loss variation | 0.40 | 0.40 | 0.40 | Rectangular | 1.73 | 1 | 0.23 | 0.23 | 0.23 |
| A1-18 | Wet radome loss variation | 0.95 | 0.95 | 0.95 | Gaussian | 1.00 | 1 | 0.95 | 0.95 | 0.95 |
| A1-20 | Change in absorber behavior | 0.10 | 0.10 | 0.10 | Gaussian | 1.00 | 1 | 0.10 | 0.10 | 0.10 |
| A1-16 | Frequency flatness of test system | 0.25 | 0.25 | 0.25 | Gaussian | 1.00 | 1 | 0.25 | 0.25 | 0.25 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| A1-9 | Impedance mismatch between the receiving antenna and the network analyzer | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.04 | 0.04 | 0.04 |
| A1-10 | Positioning and pointing misalignment between the reference antenna and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A1-11 | Impedance mismatch between the reference antenna and the network analyzer | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.04 | 0.04 | 0.04 |
| A1-3 | Quality of quiet zone (normal test conditions) | 0.10 | 0.10 | 0.10 | Gaussian | 1.00 | 1 | 0.10 | 0.10 | 0.10 |
| A1-4b | Polarization mismatch between the reference antenna and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A1-5b | Mutual coupling between the reference antenna and the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A1-6 | Phase curvature | 0.05 | 0.05 | 0.05 | Gaussian | 1.00 | 1 | 0.05 | 0.05 | 0.05 |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A1-12 | Influence of the reference antenna feed cable | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| A1-13 | Reference antenna feed cable loss measurement uncertainty | 0.06 | 0.06 | 0.06 | Gaussian | 1.00 | 1 | 0.06 | 0.06 | 0.06 |
| A1-14 | Influence of the receiving antenna feed cable | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A1-15 | Uncertainty of the absolute gain of the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **1.26** | **1.29** | **1.29** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **2.46** | **2.53** | **2.53** |

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#### 9.3.3.3 MU value derivation, FR1

Table 9.3.3.3-1: CATR MU value derivation for EIRP accuracy measurements in Extreme test conditions

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UID** | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| A2-1a | Misalignment and pointing error of BS (for EIRP) | 0.00 | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) – high power | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A2-2a | Standing wave between BS and test range antenna | 0.21 | 0.21 | 0.21 | U-shaped | 1.41 | 1 | 0.15 | 0.15 | 0.15 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A2-13 | Quality of quiet zone (extreme test conditions) | 0.60 | 0.60 | 0.60 | Gaussian | 1.00 | 1 | 0.60 | 0.60 | 0.60 |
| A2-12 | Frequency flatness of test system | 0.25 | 0.25 | 0.25 | Gaussian | 1.00 | 1 | 0.25 | 0.25 | 0.25 |
| A2-14 | Wet radome loss variation | 0.40 | 0.40 | 0.40 | Rectangular | 1.73 | 1 | 0.23 | 0.23 | 0.23 |
| A2-15 | Radome loss variation | 0.95 | 0.95 | 0.95 | Gaussian | 1.00 | 1 | 0.95 | 0.95 | 0.95 |
| A2-16 | Change in absorber behavior | 0.10 | 0.10 | 0.10 | Gaussian | 1.00 | 1 | 0.10 | 0.10 | 0.10 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.00 |
| A2-5a | Mismatch of receiver chain between receiving antenna and measurement receiver | 0.13 | 0.33 | 0.33 | U-shaped | 1.41 | 1 | 0.09 | 0.23 | 0.23 |
| A2-6 | Insertion loss of receiver chain | 0.18 | 0.18 | 0.18 | Rectangular | 1.73 | 1 | 0.10 | 0.10 | 0.10 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A2-7 | Influence of the calibration antenna feed cable | 0.02 | 0.02 | 0.02 | U-shaped | 1.41 | 1 | 0.02 | 0.02 | 0.02 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A2-8 | Misalignment positioning system | 0.00 | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| A2-1b | Misalignment and pointing error of calibration antenna (for EIRP) | 0.50 | 0.50 | 0.50 | Exp. normal | 2.00 | 1 | 0.25 | 0.25 | 0.25 |
| A2-9 | Rotary joints | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.03 | 0.03 | 0.03 |
| A2-2b | Standing wave between calibration antenna and test range antenna | 0.09 | 0.09 | 0.09 | U-shaped | 1.41 | 1 | 0.06 | 0.06 | 0.06 |
| A2-4b | QZ ripple experienced by calibration antenna (normal test conditions) | 0.01 | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 | 0.01 |
| A2-11 | Switching uncertainty | 0.26 | 0.26 | 0.26 | Rectangular | 1.73 | 1 | 0.15 | 0.15 | 0.15 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **1.28** | **1.32** | **1.30** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **2.51** | **2.58** | **2.55** |

#### 9.3.3.4 MU value derivation, FR2

Table 9.3.3.4-1: CATR MU value derivation for EIRP accuracy measurements in Extreme test conditions, FR2

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | |
| 24.25<f ≤29.5GHz | 37<f ≤40GHz | 24.25<f ≤29.5GHz | 37<f ≤40GHz |
| **Stage 2: BS measurement** | | | | | | | | |
| A2-1a | Misalignment and pointing error of BS (EIRP) | 0.20 | 0.20 | Exp. normal | 2.00 | 1 | 0.10 | 0.10 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) - high power | 0.50 | 0.70 | Gaussian | 1.00 | 1 | 0.50 | 0.70 |
| A2-2a | Standing wave between BS and test range antenna | 0.03 | 0.03 | U-shaped | 1.41 | 1 | 0.02 | 0.02 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 |
| A2-13 | QZ ripple with BS extreme test conditions) | 0.70 | 0.70 | Gaussian | 1.00 | 1 | 0.70 | 0.70 |
| A2-12 | Frequency flatness of test system | 0.25 | 0.25 | Gaussian | 1.00 | 1 | 0.25 | 0.25 |
| A2-15 | Radome loss variation | 0.50 | 0.50 | Gaussian | 1.00 | 1 | 0.50 | 0.50 |
| A2-14 | Wet radome loss variation | 0.90 | 0.90 | Gaussian | 1.00 | 1 | 0.90 | 0.90 |
| A2-16 | Change in absorber behavior | 0.50 | 0.50 | Gaussian | 1.00 | 1 | 0.50 | 0.50 |
| **Stage 1: Calibration measurement** | | | | | | | | |
| C1-3 | Uncertainty of the network analyzer | 0.30 | 0.30 | Gaussian | 1.00 | 1 | 0.30 | 0.30 |
| A2-5a | Mismatch of receiver chain between receiving antenna and measurement receiver | 0.43 | 0.57 | U-shaped | 1.41 | 1 | 0.30 | 0.40 |
| A2-6 | Insertion loss of receiver chain | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 |
| A2-7 | Influence of the calibration antenna feed cable | 0.21 | 0.29 | U-shaped | 1.41 | 1 | 0.15 | 0.21 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.52 | 0.52 | Rectangular | 1.73 | 1 | 0.30 | 0.30 |
| A2-8 | Misalignment positioning system | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 |
| A2-1b | Misalignment and pointing error of calibration antenna (for EIRP) | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 |
| A2-9 | Rotary joints | 0.00 | 0.00 | U-shaped | 1.41 | 1 | 0.00 | 0.00 |
| A2-2b | Standing wave between calibration antenna and test range antenna | 0.09 | 0.09 | U-shaped | 1.41 | 1 | 0.06 | 0.06 |
| A2-4b | QZ ripple experienced by calibration antenna (normal test conditions) | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 |
| A2-11 | Switching uncertainty | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | **1.56** | **1.66** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | **3.05** | **3.25** |

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#### 9.4.2.3 MU value derivation, FR1

As the DL RS power is an absolute measurement most of the uncertainties from the EIRP accuracy remain the same. Also it can be noted that the measured signal is a wanted signal and hence will be beam formed in the same way as the wanted signal, hence any errors which may be dependent on the beam shape will be the same as for the EIRP accuracy measurement.

Table 9.4.2.3-1: Indoor Anechoic Chamber measurement uncertainty value derivation for OTA E-UTRA DL RS power measurement

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UID** | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| A1-1 | Positioning misalignment between the BS and the reference antenna | 0.03 | 0.03 | 0.03 | Rectangular | 1.73 | 1 | 0.02 | 0.02 | 0.02 |
| A1-2 | Pointing misalignment between the BS and the receiving antenna | 0.30 | 0.30 | 0.30 | Rectangular | 1.73 | 1 | 0.17 | 0.17 | 0.17 |
| A1-3 | Quality of quiet zone | 0.10 | 0.10 | 0.10 | Gaussian | 1.00 | 1 | 0.10 | 0.10 | 0.10 |
| A1-4a | Polarization mismatch between the BS and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A1-5a | Mutual coupling between the BS and the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A1-6 | Phase curvature | 0.05 | 0.05 | 0.05 | Gaussian | 1.00 | 1 | 0.05 | 0.05 | 0.05 |
| C3-1 | DL-RS MU derived from conducted specification | 0.41 | 0.56 | 0.56 | Gaussian | 1.00 | 1 | 0.41 | 0.56 | 0.56 |
| A1-7 | Impedance mismatch in the receiving chain | 0.14 | 0.33 | 0.33 | U-shaped | 1.41 | 1 | 0.10 | 0.23 | 0.23 |
| A1-8 | Random uncertainty | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| A1-9 | Impedance mismatch between the receiving antenna and the network analyzer | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.04 | 0.04 | 0.04 |
| A1-10 | Positioning and pointing misalignment between the reference antenna and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A1-11 | Impedance mismatch between the reference antenna and the network analyzer. | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.04 | 0.04 | 0.04 |
| A1-3 | Quality of quiet zone | 0.10 | 0.10 | 0.10 | Gaussian | 1.00 | 1 | 0.10 | 0.10 | 0.10 |
| A1-4b | Polarization mismatch between the reference antenna and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A1-5b | Mutual coupling between the reference antenna and the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A1-6 | Phase curvature | 0.05 | 0.05 | 0.05 | Gaussian | 1.00 | 1 | 0.05 | 0.05 | 0.05 |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A1-12 | Influence of the reference antenna feed cable | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| A1-13 | Reference antenna feed cable loss measurement uncertainty | 0.06 | 0.06 | 0.06 | Gaussian | 1.00 | 1 | 0.06 | 0.06 | 0.06 |
| A1-14 | Influence of the receiving antenna feed cable | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A1-15 | Uncertainty of the absolute gain of the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.59** | **0.73** | **0.73** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **1.15** | **1.44** | **1.44** |

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#### 9.4.3.3 MU value derivation, FR1

As the DL RS power is an absolute measurement most of the uncertainties form the EIRP accuracy remain the same. Also it can be noted that the measured signal is a wanted signal and hence will be beam formed in the same way as the wanted signal, hence any errors which may be dependent on the beam shape will be the same as for the EIRP accuracy measurement.

Table 9.4.3.3-1: CATR MU value derivation for OTA E-UTRA DL RS power measurement

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| A2-1a | Misalignment and pointing error of BS (for EIRP) | 0.00 | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| C3-1 | DL-RS MU derived from conducted specification | 0.41 | 0.56 | 0.56 | Gaussian | 1.00 | 1 | 0.41 | 0.56 | 0.56 |
| A2-2a | Standing wave between BS and test range antenna | 0.21 | 0.21 | 0.21 | U-shaped | 1.41 | 1 | 0.15 | 0.15 | 0.15 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A2-4a | QZ ripple experienced by BS | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| A2-12 | Frequency flatness of test system | 0.25 | 0.25 | 0.25 | Gaussian | 1.00 | 1 | 0.25 | 0.25 | 0.25 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A2-5a | Mismatch of receiver chain between receiving antenna and measurement receiver | 0.13 | 0.33 | 0.33 | U-shaped | 1.41 | 1 | 0.09 | 0.23 | 0.23 |
| A2-6 | Insertion loss of receiver chain | 0.18 | 0.18 | 0.18 | Rectangular | 1.73 | 1 | 0.10 | 0.10 | 0.10 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A2-7 | Influence of the calibration antenna feed cable | 0.02 | 0.02 | 0.02 | U-shaped | 1.41 | 1 | 0.02 | 0.02 | 0.02 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A2-8 | Misalignment positioning system | 0.00 | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| A2-1b | Misalignment and pointing error of calibration antenna (for EIRP) | 0.50 | 0.50 | 0.50 | Exp. normal | 2.00 | 1 | 0.25 | 0.25 | 0.25 |
| A2-9 | Rotary joints | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.03 | 0.03 | 0.03 |
| A2-2b | Standing wave between calibration antenna and test range antenna | 0.09 | 0.09 | 0.09 | U-shaped | 1.41 | 1 | 0.06 | 0.06 | 0.06 |
| A2-4b | QZ ripple experienced by calibration antenna | 0.01 | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 | 0.01 |
| A2-11 | Switching uncertainty | 0.26 | 0.26 | 0.26 | Rectangular | 1.73 | 1 | 0.15 | 0.15 | 0.15 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.69** | **0.81** | **0.81** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **1.35** | **1.60** | **1.60** |

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#### 9.4.4.3 MU value derivation, FR1

Table 9.4.4.3-1: NFTR measurement uncertainty value derivation for OTA E-UTRA DL RS power measurement

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| A3-1 | Axes intersection | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-2 | Axes orthogonality | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-3 | Horizontal pointing | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-4 | Probe vertical position | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-5 | Probe horizontal/vertical pointing | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-6 | Measurement distance | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-7 | Amplitude and phase drift | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-8 | Amplitude and phase noise | 0.02 | 0.02 | 0.02 | Gaussian | 1.00 | 1 | 0.02 | 0.02 | 0.02 |
| A3-9 | Leakage and crosstalk | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-10 | Amplitude non-linearity | 0.04 | 0.04 | 0.04 | Gaussian | 1.00 | 1 | 0.04 | 0.04 | 0.04 |
| A3-11 | Amplitude and phase shift in rotary joints | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-12 | Channel balance amplitude and phase | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-13 | Probe polarization amplitude and phase | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-14 | Probe pattern knowledge | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-15 | Multiple reflections | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-16 | Room scattering | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| A3-17 | BS support scattering | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-18 | Scan area truncation | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-19 | Sampling point offset | 0.01 | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 | 0.01 |
| A3-20 | Spherical mode truncation | 0.02 | 0.02 | 0.02 | Gaussian | 1.00 | 1 | 0.02 | 0.02 | 0.02 |
| A3-21 | Positioning | 0.03 | 0.03 | 0.03 | Rectangular | 1.73 | 1 | 0.02 | 0.02 | 0.02 |
| A3-22 | Probe array uniformity | 0.06 | 0.06 | 0.06 | Gaussian | 1.00 | 1 | 0.06 | 0.06 | 0.06 |
| A3-23 | Mismatch of receiver chain | 0.28 | 0.28 | 0.28 | U-Shaped | 1.41 | 1 | 0.20 | 0.20 | 0.20 |
| A3-24 | Insertion loss of receiver chain | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-25 | Uncertainty of the absolute gain of the probe antenna | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| C3-1 | DL-RS MU derived from conducted specification | 0.41 | 0.56 | 0.56 | Gaussian | 1.00 | 1 | 0.41 | 0.56 | 0.56 |
| A3-26 | Measurement repeatability - positioning repeatability | 0.15 | 0.15 | 0.15 | Gaussian | 1.00 | 1 | 0.15 | 0.15 | 0.15 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A3-27 | Mismatch of receiver chain | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-28 | Insertion loss of receiver chain | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-29 | Mismatch in the connection of the calibration antenna | 0.02 | 0.02 | 0.02 | U-Shaped | 1.41 | 1 | 0.01 | 0.01 | 0.01 |
| A3-30 | Influence of the calibration antenna feed cable | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-31 | Influence of the probe antenna cable | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A3-32 | Short term repeatability | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.59** | **0.71** | **0.71** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **1.17** | **1.39** | **1.39** |

*----------------------------- Next modified section -----------------------------*

#### 9.4.5.3 MU value derivation, FR1

As the DL RS power is an absolute measurement most of the uncertainties form the EIRP accuracy remain the same. Also it can be noted that the measured signal is a wanted signal and hence will be beam formed in the same way as the wanted signal, hence any errors which may be dependent on the beam shape will be the same as for the EIRP accuracy measurement.

Table 9.4.5.3-1: PWS MU value derivation for OTA E-UTRA DL RS power measurement

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| A7-1a | Misalignment and pointing error of BS | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| C3-1 | DL-RS MU derived from conducted specification | 0.41 | 0.56 | 0.56 | Gaussian | 1.00 | 1 | 0.41 | 0.56 | 0.56 |
| A7-2a | Longitudinal position uncertainty (i.e. standing wave and imperfect field synthesis) for BS antenna | 0.05 | 0.14 | [0.14 | Rectangular | 1.73 | 1 | 0.03 | 0.08 | [0.08] |
| A7-3 | RF leakage (calibration antenna connector terminated) | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| A7-4a | QZ ripple experienced by BS | 0.42 | 0.43 | [0.43] | Rectangular | 1.73 | 1 | 0.24 | 0.25 | [0.25] |
| A7-5 | Miscellaneous uncertainty | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A7-14 | System non-linearity | 0.10 | 0.10 | [0.10] | Rectangular | 1.73 | 1 | 0.06 | 0.06 | [0.06] |
| A7-13 | Frequency flatness of test system | 0.13 | 0.13 | 0.13 | Rectangular | 1.73 | 1 | 0.08 | 0.08 | 0.08 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A7-6 | Mismatch (i.e. reference antenna, network analyser and reference cable) | 0.13 | 0.33 | 0.33 | U-shaped | 1.41 | 1 | 0.09 | 0.23 | 0.23 |
| A7-7 | Insertion loss of receiver chain | 0.18 | 0.18 | 0.18 | Rectangular | 1.73 | 1 | 0.10 | 0.10 | 0.10 |
| A7-3 | RF leakage (calibration antenna connector terminated) | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| A7-8 | Influence of the calibration antenna feed cable | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A7-9 | Misalignment of positioning system | 0.00 | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| A7-1b | Misalignment and pointing error of calibration antenna | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| A7-10 | Rotary joints | 0.00 | 0.00 | 0.00 | U-shaped | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A7-2b | Longitudinal position uncertainty (i.e. standing wave and imperfect field synthesis) for calibration antenna | 0.12 | 0.12 | [0.12] | Rectangular | 1.73 | 1 | 0.07 | 0.07 | [0.07] |
| A7-4b | QZ ripple experienced by calibration antenna | 0.20 | 0.20 | 0.20 | Rectangular | 1.73 | 1 | 0.12 | 0.12 | 0.12 |
| A7-11 | Switching uncertainty | 0.02 | 0.02 | 0.02 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A7-12 | Field repeatability | 0.06 | 0.12 | [0.12] | Gaussian | 1.00 | 1 | 0.06 | 0.12 | [0.12] |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.63** | **0.78** | **[0.78]** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **1.24** | **1.53** | **[1.53]** |

*----------------------------- Next modified section -----------------------------*

### 9.5.6 Maximum accepted test system uncertainty

Maximum test system uncertainties derivation methodology was described in clause 5.1. The maximum accepted test system uncertainty values was derived based on test system specific values.

According to the methodology referred above, the common maximum accepted test system uncertainty values for the OTA output power dynamics tests can be derived from values captured in tables 6.5.5-1 to 6.5.5-5, separately for each of the defined frequency ranges. The common maximum values are applicable for all test methods addressing certain OTA output power dynamics test requirement. Based on the input values, the expanded uncertainty *ue* (1.96σ - confidence interval of 95 %) values were derived.

The output power dynamic range MU for FR1 for up to 4.2 GHz was agreed to be the same as for eAAS WI. It is expected that the measurement chamber setup, calibration and measurement procedures and the MU budget will be identical for E-UTRA and NR.

Furthermore, for the frequency range 4.2 – 6 GHz, the chamber and instrument uncertainties are the same as those for the frequency range 3 – 4.2 GHz, assuming testing of a BS designed for operation in licensed spectrum. The MU value was agreed to be ± 0.4 dB for all bands up to 6 GHz.

For FR2: Similarly to FR1, since the OTA output power dynamic range requirement is a relative measurement, only the test equipment uncertainty is of importance. Based on expected test equipment uncertainty, the output power dynamic range MU for FR2 was decided to be ± 0.4 dB (same as for FR1).

Table 9.5.6-1: Test system specific measurement uncertainty values for the OTA E-UTRA and NR total power dynamic range test

|  |  |  |  |
| --- | --- | --- | --- |
|  | Expanded uncertainty *ue* (dB) | | |
|  | f ≦ 3GHz | 3GHz < f ≦ 4.2 GHz | 4.2GHz < f ≦ 6GHz |
| Indoor Anechoic Chamber | 0.41 | 0.41 | 0.41 |
| Compact Antenna Test Range | 0.39 | 0.39 | 0.39 |
| Near Field Test Range | 0.39 | 0.39 | 0.39 |
| Plane Wave Synthesizer | 0.39 | 0.39 | 0.39 |
| **Common maximum accepted test system uncertainty** | **0.4** | **0.4** | **0.4** |

Table 9.5.6-2: Test system specific measurement uncertainty values for the UTRA inner loop power control steps test

|  |  |  |  |
| --- | --- | --- | --- |
|  | Expanded uncertainty *ue* (dB) | | |
|  | f ≦ 3GHz | 3GHz < f ≦ 4.2 GHz | 4.2GHz < f ≦ 6GHz |
| Indoor Anechoic Chamber | 0.1 | 0.1 | 0.1 |
| Compact Antenna Test Range | 0.1 | 0.1 | 0.1 |
| Near Field Test Range | 0.1 | 0.1 | 0.1 |
| Plane Wave Synthesizer | 0.1 | 0.1 | 0.1 |
| **Common maximum accepted test system uncertainty** | **0.1** | **0.1** | **0.1** |

Table 9.5.6-3: Test system specific measurement uncertainty values for the UTRA power control dynamic range test

|  |  |  |  |
| --- | --- | --- | --- |
|  | Expanded uncertainty *ue* (dB) | | |
|  | f ≦ 3GHz | 3GHz < f ≦ 4.2 GHz | 4.2GHz < f ≦ 6GHz |
| Indoor Anechoic Chamber | 1.1 | 1.1 | 1.1 |
| Compact Antenna Test Range | 1.1 | 1.1 | 1.1 |
| Near Field Test Range | 1.1 | 1.1 | 1.1 |
| Plane Wave Synthesizer | 1.1 | 1.1 | 1.1 |
| **Common maximum accepted test system uncertainty** | **1.1** | **1.1** | **1.1** |

Table 9.5.6-4: Test system specific measurement uncertainty values for the UTRA total power dynamic range test

|  |  |  |  |
| --- | --- | --- | --- |
|  | Expanded uncertainty *ue* (dB) | | |
|  | f ≦ 3GHz | 3GHz < f ≦ 4.2 GHz | 4.2GHz < f ≦ 6GHz |
| Indoor Anechoic Chamber | 0.3 | 0.3 | 0.3 |
| Compact Antenna Test Range | 0.3 | 0.3 | 0.3 |
| Near Field Test Range | 0.3 | 0.3 | 0.3 |
| Plane Wave Synthesizer | 0.3 | 0.3 | 0.3 |
| **Common maximum accepted test system uncertainty** | **0.3** | **0.3** | **0.3** |

Table 9.5.6-5: Test system specific measurement uncertainty values for the UTRA IPDL time mask test

|  |  |  |  |
| --- | --- | --- | --- |
|  | Expanded uncertainty *ue* (dB) | | |
|  | f ≦ 3GHz | 3GHz < f ≦ 4.2 GHz | 4.2GHz < f ≦ 6GHz |
| Indoor Anechoic Chamber | 0.7 | 0.7 | 0.7 |
| Compact Antenna Test Range | 0.7 | 0.7 | 0.7 |
| Near Field Test Range | 0.7 | 0.7 | 0.7 |
| Plane Wave Synthesizer | 0.7 | 0.7 | 0.7 |
| **Common maximum accepted test system uncertainty** | **0.7** | **0.7** | **0.7** |

An overview of the MU values for all the requirements is captured in clause 17.

*----------------------------- Next modified section -----------------------------*

### 9.5.7 Test Tolerance for OTA output power dynamics

Considering the methodology described in clause 5.1, Test Tolerance values for OTA output power dynamics were derived based on values captured in clause 9.5.6.

The TT was decided to be the same as the MU in FR1.

Table 9.5.7-1: Test Tolerance values for the OTA total power dynamic range, FR1

|  |  |  |  |
| --- | --- | --- | --- |
|  | f ≦ 3GHz | 3GHz < f ≦ 4.2 GHz | 4.2 GHz < f ≦ 6 GHz |
| Test Tolerance (dB) | 0.4 | 0.4 | 0.4 |

Table 9.5.7-2: Test Tolerance values for the OTA total power dynamic range, FR2

|  |  |  |
| --- | --- | --- |
|  | 24.25<f <29.5GHz | 37 <f <40GHz |
| Test Tolerance (dB) | 0.4 | 0.4 |

Table 9.5.7-3: Test Tolerance values for the UTRA inner loop power control steps

|  |  |  |  |
| --- | --- | --- | --- |
|  | f ≦ 3GHz | 3GHz < f ≦ 4.2 GHz | 4.2GHz < f ≦ 6GHz |
| Test Tolerance (dB) | 0.1 | 0.1 | 0.1 |

Table 9.5.7-4: Test Tolerance values for the UTRA power control dynamic range

|  |  |  |  |
| --- | --- | --- | --- |
|  | f ≦ 3GHz | 3GHz < f ≦ 4.2 GHz | 4.2GHz < f ≦ 6GHz |
| Test Tolerance (dB) | 1.1 | 1.1 | 1.1 |

Table 9.5.7-5: Test Tolerance values for the UTRA total power dynamic range

|  |  |  |  |
| --- | --- | --- | --- |
|  | f ≦ 3GHz | 3GHz < f ≦ 4.2 GHz | 4.2GHz < f ≦ 6GHz |
| Test Tolerance (dB) | 0.3 | 0.3 | 0.3 |

Table 9.5.7-6: Test Tolerance values for the UTRA IPDL time mask

|  |  |  |  |
| --- | --- | --- | --- |
|  | f ≦ 3GHz | 3GHz < f ≦ 4.2 GHz | 4.2GHz < f ≦ 6GHz |
| Test Tolerance (dB) | 0.7 | 0.7 | 0.7 |

An overview of the TT values for all the requirements is captured in clause 18.

*----------------------------- Next modified section -----------------------------*

Table 9.7.3.3-1: CATR MU value derivation for power uncertainty aspects of OTA EVM, FR1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UID** | **Uncertainty source** | **Uncertainty value (dB)** | | | **Distribution of the probability** | **Divisor based on distribution shape** | ***ci*** | **Standard uncertainty *ui* (dB)** | | |
| **f<3 GHz** | **3<f<4.2 GHz** | **4.2<f<6 GHz** | **f<3 GHz** | **3<f<4.2 GHz** | **4.2<f<6 GHz** |
| **Stage 2: BS measurement** | | | | | | | | | | |
| A2-2a | Standing wave between BS and test range antenna | 0.21 | 0.21 | 0.21 | U-shaped | 1.41 | 1 | 0.15 | 0.15 | 0.15 |
| A2-4a | QZ ripple experienced by BS | 0.09 | 0.09 | 0.09 | Normal | 1 | 1 | 0.09 | 0.09 | 0.09 |
| **Stage 1: Calibration measurement** | | | | | | | | | | |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.18** | **0.18** | **0.18** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **0.34** | **0.34** | **0.34** |

*----------------------------- Next modified section -----------------------------*

Table 9.7.5.3-1: PWS MU value derivation for power uncertainty aspects of OTA EVM, FR1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UID** | **Uncertainty source** | **Uncertainty value (dB)** | | | **Distribution of the probability** | **Divisor based on distribution shape** | ***ci*** | **Standard uncertainty *ui* (dB)** | | |
| **f<3 GHz** | **3<f<4.2 GHz** | **4.2<f<6 GHz** | **f<3 GHz** | **3<f<4.2 GHz** | **4.2<f<6 GHz** |
| **Stage 2: BS measurement** | | | | | | | | | | |
| A7-2a | Longitudinal position uncertainty (i.e. standing wave and imperfect field synthesis) for BS antenna | 0.05 | 0.14 | [0.14] | Rectangular | 1.73 | 1 | 0.03 | 0.08 | [0.08] |
| A7-4a | QZ ripple experienced by BS | 0.42 | 0.43 | [0.43] | Rectangular | 1.73 | 1 | 0.24 | 0.25 | [0.25] |
| **Stage 1: Calibration measurement** | | | | | | | | | | |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.24** | **0.26** | **[0.26]** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **0.48** | **0.51** | **[0.51]** |

*----------------------------- Next modified section -----------------------------*

#### 9.10.2.3 MU value derivation, FR2

The MU assessment was carried out using a CATR chamber only. However other chamber types are not precluded if suitable MU assessment is done.

The CATR test setup and calibration and measurement procedures for FR2 are expected to be similar to those of FR1, although the test chamber dimensions and associated MU values will scale due to the shorter wavelengths and larger relative array apertures. However, it is noted that in order to achieve the test instrument uncertainties that were assumed, calibration of the spectrum analyzer may be needed.

Table 9.10.2.3-1: Compact antenna test range uncertainty assessment for EIRP measurements for transmitter OFF power and transmitter transient period

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UID** | Uncertainty source | Uncertainty value | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | |
| 24.25<f ≤29.5GHz | 37<f ≤40GHz | 24.25<f ≤29.5GHz | 37<f ≤40GHz |
| **Stage 2: BS measurement** | | | | | | | | |
| A2-1a | Misalignment and pointing error of BS (for EIRP) | 0.20 | 0.20 | Exp. normal | 2.00 | 1 | 0.10 | 0.10 |
| C1-9 | Uncertainty of the RF power measurement equipment standard uncertainty σ (dB) of the absolute level for a time domain wideband measurement for FR2 | 1.25 | 1.45 | Gaussian | 1.00 | 1 | 1.25 | 1.45 |
| A2-2a | Standing wave between BS and test range antenna | 0.03 | 0.03 | U-shaped | 1.41 | 1 | 0.02 | 0.02 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 |
| A2-4a | QZ ripple experienced by BS | 0.40 | 0.40 | Gaussian | 1.00 | 1 | 0.40 | 0.40 |
| A2-12 | Frequency flatness of test system | 0.25 | 0.25 | Gaussian | 1.00 | 1 | 0.25 | 0.25 |
| **Stage 1: Calibration measurement** | | | | | | | | |
| C1-3 | Uncertainty of the network analyzer | 0.30 | 0.30 | Gaussian | 1.00 | 1 | 0.30 | 0.30 |
| A2-5b | Mismatch of receiver chain for low power receiver | 0.72 | 0.72 | U-shaped | 1.41 | 1 | 0.51 | 0.51 |
| A2-6 | Insertion loss of receiver chain | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 |
| A2-7 | Influence of the calibration antenna feed cable | 0.21 | 0.29 | U-shaped | 1.41 | 1 | 0.15 | 0.21 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.52 | 0.52 | Rectangular | 1.73 | 1 | 0.30 | 0.30 |
| A2-8 | Misalignment positioning system | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 |
| A2-1b | Misalignment and pointing error of calibration antenna (for EIRP) | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 |
| A2-9 | Rotary joints | 0.00 | 0.00 | U-shaped | 1.41 | 1 | 0.00 | 0.00 |
| A2-2b | Standing wave between calibration antenna and test range antenna | 0.09 | 0.09 | U-shaped | 1.41 | 1 | 0.06 | 0.06 |
| A2-4b | QZ ripple experienced by calibration antenna | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 |
| A2-11 | Switching uncertainty | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | **1.50** | **1.68** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | **2.95** | **3.29** |

*----------------------------- Next modified section -----------------------------*

#### 10.2.3.3 MU value derivation, FR1

Table 10.2.3.3-1 captures derivation of the expanded measurement uncertainty values for OTA sensitivity measurements in CATR (Normal test conditions, FR1).

Table 10.2.3.3-1: CATR MU value derivation for OTA sensitivity measurements, Normal test conditions, FR1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| B2-1a | Misalignment and pointing error of BS | 0.00 | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| B2-2 | Standing wave between BS and test range antenna | 0.21 | 0.21 | 0.21 | U-shaped | 1.41 | 1 | 0.15 | 0.15 | 0.15 |
| C1-2 | Uncertainty of the RF signal generator | 0.46 | 0.46 | 0.46 | Gaussian | 1.00 | 1 | 0.46 | 0.46 | 0.46 |
| B2-3 | RF leakage & dynamic range, test range antenna cable connector terminated | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B2-4a | QZ ripple experienced by BS | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| B2-9 | Miscellaneous uncertainty | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| B2-5 | Mismatch of transmit chain (i.e. between transmitting measurement antenna and BS) | 0.13 | 0.33 | 0.33 | U-shaped | 1.41 | 1 | 0.09 | 0.23 | 0.23 |
| B2-6 | Insertion loss of transmitter chain | 0.18 | 0.18 | 0.18 | Rectangular | 1.73 | 1 | 0.10 | 0.10 | 0.10 |
| B2-7 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B2-8 | Influence of the calibration antenna feed cable | 0.02 | 0.02 | 0.02 | U-shaped | 1.41 | 1 | 0.02 | 0.02 | 0.02 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| B2-9 | Miscellaneous uncertainty | 0.00 | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| B2-4b | QZ ripple experienced by calibration antenna | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| B2-10 | Rotary joints | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.03 | 0.03 | 0.03 |
| B2-1b | Misalignment and pointing error of calibration antenna | 0.50 | 0.50 | 0.50 | Exp. normal | 2.00 | 1 | 0.25 | 0.25 | 0.25 |
| B2-11 | Misalignment positioning system | 0.00 | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| B2-12 | Standing wave between SGH and test range antenna | 0.09 | 0.09 | 0.09 | U-shaped | 1.41 | 1 | 0.06 | 0.06 | 0.06 |
| B2-13 | Switching uncertainty | 0.26 | 0.26 | 0.26 | Rectangular | 1.73 | 1 | 0.15 | 0.15 | 0.15 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.68** | **0.71** | **0.71** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **1.33** | **1.40** | **1.40** |

#### 10.2.3.4 MU value derivation, FR2

Table 10.2.3.4-1 captures derivation of the expanded measurement uncertainty values for OTA sensitivity measurements in CATR (Normal test conditions, FR2).

Table 10.2.3.4-1: CATR MU value derivation for OTA sensitivity measurement, FR2

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UID** | **Uncertainty source** | **Uncertainty value** | | **Distribution of the probability** | **Divisor based on distribution shape** | ***ci*** | **Standard uncertainty *ui* (dB)** | |
| **24.25<f<29.5GHz** | **37<f<40GHz** | **24.25<f<29.5GHz** | **37<f<40GHz** |
| **Stage 2: BS measurement** | | | | | | | | |
| B2-1a | Misalignment and pointing error of BS | 0.2 | 0.2 | Exp. normal | 2.00 | 1 | 0.10 | 0.10 |
| B2-2 | Standing wave between BS and test range antenna | 0.21 | 0.21 | U-shaped | 1.41 | 1 | 0.15 | 0.15 |
| C1-2 | Uncertainty of the RF signal generator | 0.9 | 0.9 | Gaussian | 1.00 | 1 | 0.90 | 0.90 |
| B2-3 | RF leakage & dynamic range, test range antenna cable connector terminated | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 |
| B2-4a | QZ ripple experienced by BS | 0.4 | 0.4 | Gaussian | 1.00 | 1 | 0.40 | 0.40 |
| B2-9 | Miscellaneous uncertainty | 0 | 0 | Gaussian | 1.00 | 1 | 0.00 | 0.00 |
| **Stage 1: Calibration measurement** | | | | | | | | |
| C1-3 | Uncertainty of the network analyzer | 0.3 | 0.3 | Gaussian | 1.00 | 1 | 0.30 | 0.30 |
| B2-5 | Mismatch of transmit chain (i.e. between transmitting measurement antenna and BS) | 0.43 | 0.57 | U-shaped | 1.41 | 1 | 0.30 | 0.40 |
| B2-6 | Insertion loss of transmitter chain | 0.12 | 0.12 | Rectangular | 1.73 | 1 | 0.07 | 0.07 |
| B2-7 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 |
| B2-8 | Influence of the calibration antenna feed cable | 0.21 | 0.29 | U-shaped | 1.41 | 1 | 0.15 | 0.21 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.52 | 0.52 | Rectangular | 1.73 | 1 | 0.30 | 0.30 |
| B2-11 | Misalignment positioning system | 0 | 0 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 |
| B2-4b | QZ ripple experienced by calibration antenna | 0.1 | 0.1 | Gaussian | 1.00 | 1 | 0.10 | 0.10 |
| B2-10 | Rotary joints | 0 | 0 | U-shaped | 1.41 | 1 | 0.00 | 0.00 |
| B2-1b | Misalignment and pointing error of calibration antenna | 0 | 0 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 |
|  |  |  |  |  |  |  |  |  |
| B2-12 | Standing wave between SGH and test range antenna | 0.09 | 0.09 | U-shaped | 1.41 | 1 | 0.06 | 0.06 |
| B2-13 | Switching uncertainty | 0.1 | 0.1 | Rectangular | 1.73 | 1 | 0.06 | 0.06 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | **1.15** | **1.19** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | **2.25** | **2.33** |

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#### 10.2.4.3 MU value derivation, FR1

Table 10.2.4.3-1 captures derivation of the expanded measurement uncertainty values for OTA sensitivity measurements in One Dimensional Compact Range.

Table 10.2.4.3-1: One Dimensional Compact Range measurement uncertainty value derivation for OTA sensitivity measurements, FR1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| Stage 2: BS measurement | | | | | | | | | | |
| B4-1 | Misalignment BS and pointing error | 0.00 | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| B4-2a | Standing wave between BS and test range antenna | 0.18 | 0.18 | 0.18 | U-shaped | 1.41 | 1 | 0.13 | 0.13 | 0.13 |
| B4-3a | Quiet zone ripple experienced by BS | 0.03 | 0.03 | 0.03 | Gaussian | 1.00 | 1 | 0.03 | 0.03 | 0.03 |
| C1-2 | Uncertainty of the RF signal generator | 0.46 | 0.46 | 0.46 | Gaussian | 1.00 | 1 | 0.46 | 0.46 | 0.46 |
| B4-4 | Phase curvature | 0.01 | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 | 0.01 |
| B4-5a | Polarization mismatch between BS and transmitting antenna | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| B4-6a | Mutual coupling between BS and transmitting antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| B4-7 | Impedance mismatch in transmitter chain | 0.01 | 0.01 | 0.01 | U-shaped | 1.41 | 1 | 0.00 | 0.01 | 0.01 |
| B4-8 | RF leakage and dynamic range | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| Stage 1: Calibration measurement | | | | | | | | | | |
| B4-9 | Misalignment positioning system | 0.00 | 0.00 | 0.00 | Exp. Normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| B4-10 | Pointing error between reference antenna and test range antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| B4-11 | Impedance mismatch in path to reference antenna | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.04 | 0.04 | 0.04 |
| B4-12 | Impedance mismatch in path to compact probe | 0.03 | 0.03 | 0.03 | U-shaped | 1.41 | 1 | 0.02 | 0.02 | 0.02 |
| B4-2b | Standing wave between reference antenna and test range antenna | 0.15 | 0.15 | 0.15 | U-shaped | 1.41 | 1 | 0.11 | 0.11 | 0.11 |
| B4-3b | Quiet zone ripple experienced by reference antenna | 0.18 | 0.18 | 0.18 | Gaussian | 1.00 | 1 | 0.18 | 0.18 | 0.18 |
| B4-4 | Phase curvature | 0.01 | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 | 0.01 |
| B4-5b | Polarization mismatch between reference antenna and transmitting antenna | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| B4-6b | Mutual coupling between reference antenna and transmitting antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| B4-13 | Influence of reference antenna feed cable (flexing cables, adapters, attenuators, connector repeatability) | 0.08 | 0.08 | 0.08 | Rectangular | 1.73 | 1 | 0.05 | 0.05 | 0.05 |
| B4-14 | Mismatch of transmitter chain | 0.20 | 0.30 | 0.30 | U-shaped | 1.41 | 1 | 0.14 | 0.21 | 0.21 |
| B4-15 | Insertion loss of transmitter chain | 0.18 | 0.18 | 0.18 | Rectangular | 1.73 | 1 | 0.10 | 0.10 | 0.10 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| B4-16 | RF leakage (SGH connector terminated and test range antenna connector cable terminated) | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.66** | **0.73** | **0.73** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **1.29** | **1.43** | **1.43** |

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#### 10.2.5.3 MU value derivation, FR1

Table 10.2.5.3-1 captures derivation of the expanded measurement uncertainty values for OTA sensitivity measurements in Near Field Test Range.

Standard uncertainty values for the signal generator, network analyzer and reference antenna are according to the test equipment uncertainty values, as captured in annex C.

Table 10.2.5.3-1: NFTR measurement uncertainty value derivation for OTA sensitivity measurements, FR1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| B3-1 | Axes intersection | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B3-2 | Axes orthogonality | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B3-3 | Horizontal pointing | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B3-4 | Probe vertical position | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B3-5 | Probe horizontal/vertical pointing | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B3-6 | Measurement distance | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B3-7 | Amplitude and phase drift | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B3-8 | Amplitude and phase noise | 0.02 | 0.02 | 0.02 | Gaussian | 1.00 | 1 | 0.02 | 0.02 | 0.02 |
| B3-9 | Leakage and crosstalk | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B3-10 | Amplitude non-linearity | 0.04 | 0.04 | 0.04 | Gaussian | 1.00 | 1 | 0.04 | 0.04 | 0.04 |
| B3-11 | Amplitude and phase shift in rotary joints | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B3-12 | Channel balance amplitude and phase | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B3-13 | Probe polarization amplitude and phase | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B3-14 | Probe pattern knowledge | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B3-15 | Multiple reflections | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B3-16 | Room scattering | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| B3-17 | BS support scattering | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B3-18 | Scan area truncation | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B3-19 | Sampling point offset | 0.01 | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 | 0.01 |
| B3-20 | Mode truncation | 0.02 | 0.02 | 0.02 | Gaussian | 1.00 | 1 | 0.02 | 0.02 | 0.02 |
| B3-21 | Positioning | 0.03 | 0.03 | 0.03 | Rectangular | 1.73 | 1 | 0.02 | 0.02 | 0.02 |
| B3-22 | Probe array uniformity | 0.06 | 0.06 | 0.06 | Gaussian | 1.00 | 1 | 0.06 | 0.06 | 0.06 |
| B3-23 | Mismatch of transmitter chain | 0.28 | 0.28 | 0.28 | U-Shaped | 1.41 | 1 | 0.20 | 0.20 | 0.20 |
| B3-24 | Insertion loss of transmitter chain | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B3-25 | Uncertainty of the absolute gain of the probe antenna | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| C1-2 | Uncertainty of the RF signal generator | 0.46 | 0.46 | 0.46 | Gaussian | 1.00 | 1 | 0.46 | 0.46 | 0.46 |
| B3-26 | Measurement repeatability - positioning repeatability | 0.15 | 0.15 | 0.15 | Gaussian | 1.00 | 1 | 0.15 | 0.15 | 0.15 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| B3-27 | Mismatch of transmitter chain | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B3-28 | Insertion loss of transmitter chain | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B3-29 | Mismatch in the connection of the calibration antenna | 0.02 | 0.02 | 0.02 | U-Shaped | 1.41 | 1 | 0.01 | 0.01 | 0.01 |
| B3-30 | Influence of the calibration antenna feed cable | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B3-31 | Influence of the probe antenna cable | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| B3-32 | Short term repeatability | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.63** | **0.63** | **0.63** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **1.24** | **1.24** | **1.24** |

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#### 10.2.6.3 MU value derivation, FR1

Table 10.2.6.3-1 captures derivation of the expanded measurement uncertainty values for OTA sensitivity measurements in PWS.

Table 10.2.6.3-1: Plane wave synthesizer MU value derivation for OTA sensitivity measurements, FR1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| Stage 2: BS measurement | | | | | | | | | | |
| B5-1a | Misalignment and pointing error of BS | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| C1-2 | Uncertainty of the RF signal generator | 0.46 | 0.46 | 0.46 | Gaussian | 1.00 | 1 | 0.46 | 0.46 | 0.46 |
| B5-2a | Longitudinal position uncertainty (i.e. standing wave and imperfect field synthesis) for BS antenna | 0.05 | 0.14 | [0.14] | Rectangular | 1.73 | 1 | 0.03 | 0.08 | [0.08] |
| B5-3 | RF leakage (calibration antenna connector terminated) | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| B5-4a | QZ ripple experienced by BS | 0.42 | 0.43 | [0.43] | Rectangular | 1.73 | 1 | 0.24 | 0.25 | [0.25] |
| B5-5 | Miscellaneous uncertainty | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| B5-14 | System non-linearity | 0.10 | 0.10 | [0.10] | Rectangular | 1.73 | 1 | 0.06 | 0.06 | [0.06] |
| B5-13 | Frequency flatness of test system | 0.13 | 0.13 | 0.13 | Rectangular | 1.73 | 1 | 0.08 | 0.08 | 0.08 |
| Stage 1: Calibration measurement | | | | | | | | | | |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| B5-6 | Mismatch (i.e. reference antenna, network analyser and reference cable) | 0.13 | 0.33 | 0.33 | U-shaped | 1.41 | 1 | 0.09 | 0.23 | 0.23 |
| B5-7 | Insertion loss of transmit chain | 0.18 | 0.18 | 0.18 | Rectangular | 1.73 | 1 | 0.10 | 0.10 | 0.10 |
| B5-3 | RF leakage (calibration antenna connector terminated) | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| B5-8 | Influence of the calibration antenna feed cable | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| B5-9 | Misalignment of positioning system | 0.00 | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| B5-1b | Misalignment and pointing error of calibration antenna | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| B5-10 | Rotary joints | 0.00 | 0.00 | 0.00 | U-shaped | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| B5-2b | Longitudinal position uncertainty (i.e. standing wave and imperfect field synthesis) for calibration antenna | 0.12 | 0.12 | [0.12] | Rectangular | 1.73 | 1 | 0.07 | 0.07 | [0.07] |
| B5-4b | QZ ripple experienced by calibration antenna | 0.20 | 0.20 | 0.20 | Rectangular | 1.73 | 1 | 0.12 | 0.12 | 0.12 |
| B5-11 | Switching uncertainty | 0.02 | 0.02 | 0.02 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| B5-12 | Field repeatability | 0.06 | 0.12 | [0.12] | Gaussian | 1.00 | 1 | 0.06 | 0.12 | [0.12] |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.67** | **0.71** | **[0.71]** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **1.31** | **1.40** | **[1.40]** |

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#### 11.2.2.3 MU value derivation, FR1

Table 11.2.2.3-1 captures derivation of the expanded measurement uncertainty values for OTA BS output power measurements in Indoor Anechoic Chamber (Normal test conditions, FR1).

Table 11.2.2.3-1: IAC MU value derivation for EIRP measurement of OTA BS output power, FR1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UID** | **Uncertainty source** | **Uncertainty value (dB)** | | | **Distribution of the probability** | **Divisor based on distribution shape** | ***ci*** | **Standard uncertainty *ui* (dB)** | | |
| **f<3 GHz** | **3<f<4.2 GHz** | **4.2<f<6 GHz** | **f<3 GHz** | **3<f<4.2 GHz** | **4.2<f<6 GHz** |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| A1-1 | Positioning misalignment between the BS and the reference antenna | 0.03 | 0.03 | 0.03 | Rectangular | 1.73 | 1 | 0.02 | 0.02 | 0.02 |
| A1-2 | Pointing misalignment between the BS and the receiving antenna | 0.3 | 0.3 | 0.3 | Rectangular | 1.73 | 1 | 0.17 | 0.17 | 0.17 |
| A1-3 | Quality of quiet zone | 0.1 | 0.1 | 0.1 | Gaussian | 1.00 | 1 | 0.10 | 0.10 | 0.10 |
| A1-4a | Polarization mismatch between the BS and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A1-5a | Mutual coupling between the BS and the receiving antenna | 0 | 0 | 0 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A1-6 | Phase curvature | 0.05 | 0.05 | 0.05 | Gaussian | 1.00 | 1 | 0.05 | 0.05 | 0.05 |
| C1-1 | Uncertainty of the RF power measurement equipment | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A1-7 | Impedance mismatch in the receiving chain | 0.14 | 0.33 | 0.33 | U-shaped | 1.41 | 1 | 0.10 | 0.23 | 0.23 |
| A1-8 | Random uncertainty | 0.1 | 0.1 | 0.1 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| A1-9 | Impedance mismatch between the receiving antenna and the network analyzer | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.04 | 0.04 | 0.04 |
| A1-10 | Positioning and pointing misalignment between the reference antenna and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A1-11 | Impedance mismatch between the reference antenna and the network analyzer | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.04 | 0.04 | 0.04 |
| A1-3 | Quality of quiet zone | 0.10 | 0.10 | 0.10 | Gaussian | 1.00 | 1 | 0.10 | 0.10 | 0.10 |
| A1-4b | Polarization mismatch for reference antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A1-5b | Mutual coupling between the reference antenna and the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A1-6 | Phase curvature | 0.05 | 0.05 | 0.05 | Gaussian | 1.00 | 1 | 0.05 | 0.05 | 0.05 |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A1-12 | Influence of the reference antenna feed cable | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| A1-13 | Reference antenna feed cable loss measurement uncertainty | 0.06 | 0.06 | 0.06 | Gaussian | 1.00 | 1 | 0.06 | 0.06 | 0.06 |
| A1-14 | Influence of the receiving antenna feed cable | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A1-15 | Uncertainty of the absolute gain of the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.44** | **0.54** | **0.54** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **0.87** | **1.06** | **1.06** |
| **TRP summation error** | | | | | | | | **0.75** | **0.75** | **0.75** |
| **Total MU** | | | | | | | | **1.15** | **1.30** | **1.30** |

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#### 11.2.3.3 MU value derivation, FR1

Table 11.2.3.3-1 captures derivation of the expanded measurement uncertainty values for OTA BS output power measurements in CATR (Normal test conditions, FR1).

Table 11.2.3.3-1: CATR MU value derivation for OTA BS output power measurement, FR1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| A2-18a | Misalignment and pointing error of BS (for TRP) | 0.30 | 0.30 | 0.30 | Rectangular | 1.73 | 1 | 0.173 | 0.173 | 0.173 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.140 | 0.260 | 0.260 |
| A2-2a | Standing wave between BS and test range antenna | 0.21 | 0.21 | 0.21 | U-shaped | 1.41 | 1 | 0.148 | 0.148 | 0.148 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.001 | 0.001 | 0.001 |
| A2-4a | QZ ripple experienced by BS | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.093 | 0.093 | 0.093 |
| A2-12 | Frequency flatness of test system | 0.25 | 0.25 | 0.25 | Gaussian | 1.00 | 1 | 0.250 | 0.250 | 0.250 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A2-5a | Mismatch or receiver chain between receiving antenna and measurement receiver | 0.13 | 0.33 | 0.33 | U-shaped | 1.41 | 1 | 0.09 | 0.23 | 0.23 |
| A2-6 | Insertion loss of receiver chain | 0.18 | 0.18 | 0.18 | Rectangular | 1.73 | 1 | 0.10 | 0.10 | 0.10 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A2-7 | Influence of the calibration antenna feed cable | 0.02 | 0.02 | 0.02 | U-shaped | 1.41 | 1 | 0.02 | 0.02 | 0.02 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A2-8 | Misalignment positioning system | 0.00 | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| A2-18b | Misalignment and pointing error of calibration antenna (for TRP) | 0.50 | 0.50 | 0.50 | Exp. normal | 2.00 | 1 | 0.25 | 0.25 | 0.25 |
| A2-9 | Rotary joints | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.03 | 0.03 | 0.03 |
| A2-2b | Standing wave between calibration antenna and test range antenna | 0.09 | 0.09 | 0.09 | U-shaped | 1.41 | 1 | 0.06 | 0.06 | 0.06 |
| A2-4b | QZ ripple experienced by calibration antenna | 0.01 | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 | 0.01 |
| A2-11 | Switching uncertainty | 0.26 | 0.26 | 0.26 | Rectangular | 1.73 | 1 | 0.15 | 0.15 | 0.15 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.59** | **0.67** | **0.67** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **1.16** | **1.31** | **1.31** |
| **TRP summation error** | | | | | | | | **0.75** | **0.75** | **0.75** |
| **Total MU** | | | | | | | | **1.39** | **1.51** | **1.51** |

#### 11.2.3.4 MU value derivation, FR2

A CATR MU budget was assessed in order to determine acceptable MU for the EIRP accuracy measurement in FR2. The CATR test setup and calibration and measurement procedures for FR2 are expected to be similar to those of FR1, although the test chamber dimensions and associated MU values will scale due to the shorter wavelengths and larger relative array apertures.

Table 11.2.3.4-1 captures derivation of the expanded measurement uncertainty values for OTA BS output power measurements in CATR (Normal test conditions, FR2).

Table 11.2.3.4-1: CATR MU value derivation for OTA BS output power measurement, FR2

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | |
| 24.25<f ≤29.5GHz | 37<f ≤40GHz | 24.25<f ≤29.5GHz | 37<f ≤40GHz |
| **Stage 2: BS measurement** | | | | | | | | |
| A2-1a | Misalignment and pointing error of BS (for EIRP) | 0.20 | 0.20 | Exp. normal | 2.00 | 1 | 0.10 | 0.10 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) - high power | 0.50 | 0.70 | Gaussian | 1.00 | 1 | 0.50 | 0.70 |
| A2-2a | Standing wave between BS and test range antenna | 0.03 | 0.03 | U-shaped | 1.41 | 1 | 0.02 | 0.02 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 |
| A2-4a | QZ ripple experienced by BS | 0.40 | 0.40 | Gaussian | 1.00 | 1 | 0.40 | 0.40 |
| A2-12 | Frequency flatness of test system | 0.25 | 0.25 | Gaussian | 1.00 | 1 | 0.25 | 0.25 |
| **Stage 1: Calibration measurement** | | | | | | | | |
| C1-3 | Uncertainty of the network analyzer | 0.30 | 0.30 | Gaussian | 1.00 | 1 | 0.30 | 0.30 |
| A2-5a | Mismatch of receiver chain between receiving antenna and measurement receiver | 0.43 | 0.57 | U-shaped | 1.41 | 1 | 0.30 | 0.40 |
| A2-6 | Insertion loss of receiver chain | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 |
| A2-7 | Influence of the calibration antenna feed cable | 0.21 | 0.29 | U-shaped | 1.41 | 1 | 0.15 | 0.21 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.52 | 0.52 | Rectangular | 1.73 | 1 | 0.30 | 0.30 |
| A2-8 | Misalignment positioning system | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 |
| A2-1b | Misalignment and pointing error of calibration antenna (for EIRP) | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 |
| A2-9 | Rotary joints | 0.00 | 0.00 | U-shaped | 1.41 | 1 | 0.00 | 0.00 |
| A2-2b | Standing wave between calibration antenna and test range antenna | 0.09 | 0.09 | U-shaped | 1.41 | 1 | 0.06 | 0.06 |
| A2-4b | QZ ripple experienced by calibration antenna | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | **0.88** | **1.05** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | **1.73** | **2.07** |
| **TRP summation error** | | | | | | | **1.20** | **1.20** |
| **Total MU** | | | | | | | **2.11** | **2.39** |

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#### 11.2.4.3 MU value derivation, FR1

Table 11.2.4.3-1 captures derivation of the expanded measurement uncertainty values for OTA BS output power measurements in NFTR (Normal test conditions, FR1).

Table 11.2.4.3-1: NFTR MU value derivation for power density pattern measurement, FR1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| A3-1 | Axes intersection | 0.00 | 0.00 | 0.00 | Gaussian | 1 | 1 | 0.00 | 0.00 | 0.00 |
| A3-2 | Axes orthogonality | 0.00 | 0.00 | 0.00 | Gaussian | 1 | 1 | 0.00 | 0.00 | 0.00 |
| A3-3 | Horizontal pointing | 0.00 | 0.00 | 0.00 | Gaussian | 1 | 1 | 0.00 | 0.00 | 0.00 |
| A3-4 | Probe vertical position | 0.00 | 0.00 | 0.00 | Gaussian | 1 | 1 | 0.00 | 0.00 | 0.00 |
| A3-5 | Probe horizontal/vertical pointing | 0.00 | 0.00 | 0.00 | Gaussian | 1 | 1 | 0.00 | 0.00 | 0.00 |
| A3-6 | Measurement distance | 0.00 | 0.00 | 0.00 | Gaussian | 1 | 1 | 0.00 | 0.00 | 0.00 |
| A3-7 | Amplitude and phase drift | 0.00 | 0.00 | 0.00 | Gaussian | 1 | 1 | 0.00 | 0.00 | 0.00 |
| A3-8 | Amplitude and phase noise | 0.02 | 0.02 | 0.02 | Gaussian | 1 | 1 | 0.02 | 0.02 | 0.02 |
| A3-9 | Leakage and crosstalk | 0.00 | 0.00 | 0.00 | Gaussian | 1 | 1 | 0.00 | 0.00 | 0.00 |
| A3-10 | Amplitude non-linearity | 0.04 | 0.04 | 0.04 | Gaussian | 1 | 1 | 0.04 | 0.04 | 0.04 |
| A3-11 | Amplitude and phase shift in rotary joints | 0.00 | 0.00 | 0.00 | Gaussian | 1 | 1 | 0.00 | 0.00 | 0.00 |
| A3-12 | Channel balance amplitude and phase | 0.00 | 0.00 | 0.00 | Gaussian | 1 | 1 | 0.00 | 0.00 | 0.00 |
| A3-13 | Probe polarization amplitude and phase | 0.00 | 0.00 | 0.00 | Gaussian | 1 | 1 | 0.00 | 0.00 | 0.00 |
| A3-14 | Probe pattern knowledge | 0.00 | 0.00 | 0.00 | Gaussian | 1 | 1 | 0.00 | 0.00 | 0.00 |
| A3-15 | Multiple reflections | 0.00 | 0.00 | 0.00 | Gaussian | 1 | 1 | 0.00 | 0.00 | 0.00 |
| A3-16 | Room scattering | 0.09 | 0.09 | 0.09 | Gaussian | 1 | 1 | 0.09 | 0.09 | 0.09 |
| A3-17 | BS support scattering | 0.00 | 0.00 | 0.00 | Gaussian | 1 | 1 | 0.00 | 0.00 | 0.00 |
| A3-21 | Positioning | 0.03 | 0.03 | 0.03 | Rectangular | 1.73 | 1 | 0.02 | 0.02 | 0.02 |
| A3-22 | Probe array uniformity | 0.06 | 0.06 | 0.06 | Gaussian | 1 | 1 | 0.06 | 0.06 | 0.06 |
| A3-23 | Mismatch of receiver chain | 0.28 | 0.28 | 0.28 | U-Shaped | 1.41 | 1 | 0.20 | 0.20 | 0.20 |
| A3-24 | Insertion loss of receiver chain | 0.00 | 0.00 | 0.00 | Gaussian | 1 | 1 | 0.00 | 0.00 | 0.00 |
| A3-25 | Uncertainty of the absolute gain of the probe antenna | 0.00 | 0.00 | 0.00 | Gaussian | 1 | 1 | 0.00 | 0.00 | 0.00 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1 | 1 | 0.14 | 0.26 | 0.26 |
| A3-26 | Measurement repeatability - positioning repeatability | 0.15 | 0.15 | 0.15 | Gaussian | 1 | 1 | 0.15 | 0.15 | 0.15 |
| A3-33 | Frequency flatness of test system | 0.25 | 0.25 | 0.25 | Gaussian | 1 | 1 | 0.25 | 0.25 | 0.25 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1 | 1 | 0.13 | 0.20 | 0.20 |
| A3-27 | Mismatch of receiver chain | 0.00 | 0.00 | 0.00 | Gaussian | 1 | 1 | 0.00 | 0.00 | 0.00 |
| A3-28 | Insertion loss of receiver chain | 0.00 | 0.00 | 0.00 | Gaussian | 1 | 1 | 0.00 | 0.00 | 0.00 |
| A3-29 | Mismatch in the connection of the calibration antenna | 0.02 | 0.02 | 0.02 | U-Shaped | 1.41 | 1 | 0.01 | 0.01 | 0.01 |
| A3-30 | Influence of the calibration antenna feed cable | 0.00 | 0.00 | 0.00 | Gaussian | 1 | 1 | 0.00 | 0.00 | 0.00 |
| A3-31 | Influence of the probe antenna cable | 0.00 | 0.00 | 0.00 | Gaussian | 1 | 1 | 0.00 | 0.00 | 0.00 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.7321 | 1 | 0.29 | 0.25 | 0.25 |
| A3-32 | Short term repeatability | 0.09 | 0.09 | 0.09 | Gaussian | 1 | 1 | 0.09 | 0.09 | 0.09 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.52** | **0.56** | **0.56** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **1.01** | **1.10** | **1.10** |
| **TRP summation error** | | | | | | | | **0.75** | **0.75** | **0.75** |
| **Total MU** | | | | | | | | **1.26** | **1.33** | **1.33** |

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#### 11.2.5.3 MU value derivation, FR1

Table 11.2.5.3-1 captures derivation of the expanded measurement uncertainty values for OTA BS output power measurements in Reverberation Chamber (Normal test conditions, FR1).

Table 11.2.5.3-1: Reverberation chamber MU value derivation for OTA BS output power, FR1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A6-1 | Impedance mismatch in the receiving chain | 0.20 | 0.20 | 0.20 | U-shaped | 1.41 | 1 | 0.14 | 0.14 | 0.14 |
| A6-2 | Random uncertainty | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| A6-3 | Reference antenna radiation efficiency | 0.20 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.20 | 0.20 | 0.20 |
| A6-4 | Mean value estimation of reference antenna mismatch efficiency | 0.15 | 0.15 | 0.15 | Gaussian | 1.00 | 1 | 0.15 | 0.15 | 0.15 |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A6-5 | Influence of the reference antenna feed cable | 0.20 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.20 | 0.20 | 0.20 |
| A6-6 | Mean value estimation of transfer function | 0.27 | 0.27 | 0.27 | Gaussian | 1.00 | 1 | 0.27 | 0.27 | 0.27 |
| A6-7 | Uniformity of transfer function | 0.50 | 0.50 | 0.50 | Gaussian | 1.00 | 1 | 0.50 | 0.50 | 0.50 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.70** | **0.75** | **0.75** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **1.37** | **1.46** | **1.46** |

#### 11.2.5.4 MU value derivation, FR2

Table 11.2.5.4-1 captures derivation of the expanded measurement uncertainty values for OTA BS output power measurements in Reverberation Chamber (Normal test conditions, FR2).

Table 11.2.5.4-1: Reverberation chamber MU value derivation for OTA BS output power, FR2

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | |
| 24.25<f ≤29.5GHz | 37<f ≤40GHz | 24.25<f ≤29.5GHz | 37<f ≤40GHz |
| **Stage 2: BS measurement** | | | | | | | | |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) - high power | 0.50 | 0.70 | Gaussian | 1.00 | 1 | 0.50 | 0.70 |
| A6-1 | Impedance mismatch in the receiving chain | 0.20 | 0.20 | U-shaped | 1.41 | 1 | 0.14 | 0.14 |
| A6-2 | Random uncertainty | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 |
| **Stage 1: Calibration measurement** | | | | | | | | |
| A6-3 | Reference antenna radiation efficiency | 0.30 | 0.30 | Gaussian | 1.00 | 1 | 0.30 | 0.30 |
| A6-4 | Mean value estimation of reference antenna mismatch efficiency | 0.27 | 0.27 | Gaussian | 1.00 | 1 | 0.27 | 0.27 |
| C1-3 | Uncertainty of the network analyzer | 0.30 | 0.30 | Gaussian | 1.00 | 1 | 0.30 | 0.30 |
| A6-5 | Influence of the reference antenna feed cable | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.20 | 0.20 |
| A6-6 | Mean value estimation of transfer function | 0.27 | 0.27 | Gaussian | 1.00 | 1 | 0.27 | 0.27 |
| A6-7 | Uniformity of transfer function | 0.50 | 0.50 | Gaussian | 1.00 | 1 | 0.50 | 0.50 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | **0.94** | **1.06** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | **1.85** | **2.08** |

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#### 11.2.6.3 MU value derivation, FR1

Table 11.2.6.3-1 captures derivation of the expanded measurement uncertainty values for OTA BS output power measurements in PWS.

Table 11.2.6.3-1: PWS MU value derivation for OTA BS output power

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| Stage 2: BS measurement | | | | | | | | | | |
| A7-1a | Misalignment and pointing error of BS | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A7-2a | Longitudinal position uncertainty (i.e. standing wave and imperfect field synthesis) for BS antenna | 0.05 | 0.14 | [0.14] | Rectangular | 1.73 | 1 | 0.03 | 0.08 | [0.08] |
| A7-3 | RF leakage (calibration antenna connector terminated) | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| A7-4a | QZ ripple experienced by BS | 0.42 | 0.43 | [0.43] | Rectangular | 1.73 | 1 | 0.24 | 0.25 | [0.25] |
| A7-5 | Miscellaneous uncertainty | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A7-14 | System non-linearity | 0.10 | 0.10 | [0.10] | Rectangular | 1.73 | 1 | 0.06 | 0.06 | [0.06] |
| A7-13 | Frequency flatness of test system | 0.13 | 0.13 | 0.13 | Rectangular | 1.73 | 1 | 0.08 | 0.08 | 0.08 |
| Stage 1: Calibration measurement | | | | | | | | | | |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A7-6 | Mismatch (i.e. reference antenna, network analyser and reference cable) | 0.13 | 0.33 | 0.33 | U-shaped | 1.41 | 1 | 0.09 | 0.23 | 0.23 |
| A7-7 | Insertion loss of receiver chain | 0.18 | 0.18 | 0.18 | Rectangular | 1.73 | 1 | 0.10 | 0.10 | 0.10 |
| A7-3 | RF leakage (calibration antenna connector terminated) | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| A7-8 | Influence of the calibration antenna feed cable | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A7-9 | Misalignment of positioning system | 0.00 | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| A7-1b | Misalignment and pointing error of calibration antenna | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| A7-10 | Rotary joints | 0.00 | 0.00 | 0.00 | U-shaped | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A7-2b | Longitudinal position uncertainty (i.e. standing wave and imperfect field synthesis) for calibration antenna | 0.12 | 0.12 | [0.12] | Rectangular | 1.73 | 1 | 0.07 | 0.07 | [0.07] |
| A7-4b | QZ ripple experienced by calibration antenna | 0.20 | 0.20 | 0.20 | Rectangular | 1.73 | 1 | 0.12 | 0.12 | 0.12 |
| A7-11 | Switching uncertainty | 0.02 | 0.02 | 0.02 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A7-12 | Field repeatability | 0.06 | 0.12 | [0.12] | Gaussian | 1.00 | 1 | 0.06 | 0.12 | [0.12] |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.50** | **0.61** | **[0.61]** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **0.98** | **1.19** | **[1.19]** |
| **TRP summation error** | | | | | | | | **0.75** | **0.75** | **0.75** |
| **Total MU** | | | | | | | | **[1.23]** | **[1.40]** | **[1.40]** |

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#### 11.3.2.3 MU value derivation, FR1

Table 11.3.2.3-1: IAC MU value derivation for the absolute ACLR measurement

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| A1-1 | Positioning misalignment between the BS and the reference antenna | 0.03 | 0.03 | 0.03 | Rectangular | 1.73 | 1 | 0.02 | 0.02 | 0.02 |
| A1-2 | Pointing misalignment between the BS and the receiving antenna | 0.30 | 0.30 | 0.30 | Rectangular | 1.73 | 1 | 0.17 | 0.17 | 0.17 |
| A1-3 | Quality of quiet zone | 0.10 | 0.10 | 0.10 | Gaussian | 1.00 | 1 | 0.10 | 0.10 | 0.10 |
| A1-4a | Polarization mismatch between the BS and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A1-5a | Mutual coupling between the BS and the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A1-6 | Phase curvature | 0.05 | 0.05 | 0.05 | Gaussian | 1.00 | 1 | 0.05 | 0.05 | 0.05 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A1-7 | Impedance mismatch in the receiving chain | 0.14 | 0.33 | 0.33 | U-shaped | 1.41 | 1 | 0.10 | 0.23 | 0.23 |
| A1-8 | Random uncertainty | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| A1-9 | Impedance mismatch between the receiving antenna and the network analyzer | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.04 | 0.04 | 0.04 |
| A1-10 | Positioning and pointing misalignment between the reference antenna and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A1-11 | Impedance mismatch between the reference antenna and the network analyzer. | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.04 | 0.04 | 0.04 |
| A1-3 | Quality of quiet zone | 0.10 | 0.10 | 0.10 | Gaussian | 1.00 | 1 | 0.10 | 0.10 | 0.10 |
| A1-4b | Polarization mismatch between the reference antenna and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A1-5b | Mutual coupling between the reference antenna and the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A1-6 | Phase curvature | 0.05 | 0.05 | 0.05 | Gaussian | 1.00 | 1 | 0.05 | 0.05 | 0.05 |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A1-12 | Influence of the reference antenna feed cable | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| A1-13 | Reference antenna feed cable loss measurement uncertainty | 0.06 | 0.06 | 0.06 | Gaussian | 1.00 | 1 | 0.06 | 0.06 | 0.06 |
| A1-14 | Influence of the receiving antenna feed cable | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A1-15 | Uncertainty of the absolute gain of the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.44** | **0.54** | **0.54** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **0.87** | **1.06** | **1.06** |
| **TRP summation error** | | | | | | | | **0.75** | **0.75** | **0.75** |
| **Total MU** | | | | | | | | **1.15** | **1.30** | **1.30** |

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#### 11.3.3.3 MU value derivation, FR1

Table 11.3.3.3-1: CATR MU value derivation for the EIRP measurement of the absolute OTA ACLR, FR1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | | |
| A2-18a | Misalignment and pointing error of BS (for TRP) | 0.30 | 0.30 | 0.30 | Rectangular | 1.73 | 1 | 0.17 | 0.17 | 0.17 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A2-2a | Standing wave between BS and test range antenna | 0.21 | 0.21 | 0.21 | U-shaped | 1.41 | 1 | 0.15 | 0.15 | 0.15 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A2-4a | QZ ripple experienced by BS | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| A2-12 | Frequency flatness of test system | 0.25 | 0.25 | 0.25 | Gaussian | 1.00 | 1 | 0.25 | 0.25 | 0.25 |
| **Stage 1: Calibration measurement** | | | | | | | | | | |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A2-5a | Mismatch of receiver chain between receiving antenna and measurement receiver | 0.13 | 0.33 | 0.33 | U-shaped | 1.41 | 1 | 0.09 | 0.23 | 0.23 |
| A2-6 | Insertion loss of receiver chain | 0.18 | 0.18 | 0.18 | Rectangular | 1.73 | 1 | 0.10 | 0.10 | 0.10 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A2-7 | Influence of the calibration antenna feed cable | 0.02 | 0.02 | 0.02 | U-shaped | 1.41 | 1 | 0.02 | 0.02 | 0.02 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A2-8 | Misalignment positioning system | 0.00 | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| A2-18b | Misalignment and pointing error of calibration antenna (for TRP) | 0.50 | 0.50 | 0.50 | Exp. normal | 2.00 | 1 | 0.25 | 0.25 | 0.25 |
| A2-9 | Rotary joints | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.03 | 0.03 | 0.03 |
| A2-2b | Standing wave between calibration antenna and test range antenna | 0.09 | 0.09 | 0.09 | U-shaped | 1.41 | 1 | 0.06 | 0.06 | 0.06 |
| A2-4b | QZ ripple experienced by calibration antenna | 0.01 | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 | 0.01 |
| A2-11 | Switching uncertainty | 0.26 | 0.26 | 0.26 | Rectangular | 1.73 | 1 | 0.15 | 0.15 | 0.15 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.59** | **0.67** | **0.67** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **1.16** | **1.31** | **1.31** |
| **TRP summation error** | | | | | | | | **0.75** | **0.75** | **0.75** |
| **Total MU** | | | | | | | | **1.39** | **1.51** | **1.51** |

Table 11.3.3.3-2: CATR MU value derivation for the EIRP measurement of the relative OTA ACLR, FR1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| A2-18a | Misalignment and pointing error of BS (a) (for TRP) | 0.30 | 0.30 | 0.30 | Rectangular | 1.73 | 1 | 0.17 | 0.17 | 0.17 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A2-4a | QZ ripple experienced by BS | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| A2-12 | Frequency flatness of test system | 0.25 | 0.25 | 0.25 | Gaussian | 1.00 | 1 | 0.25 | 0.25 | 0.25 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A2-5a | Mismatch of receiver chain between receiving antenna and measurement receiver | 0.13 | 0.33 | 0.33 | U-shaped | 1.41 | 1 | 0.09 | 0.23 | 0.23 |
| A2-6 | Insertion loss of receiver chain | 0.18 | 0.18 | 0.18 | Rectangular | 1.73 | 1 | 0.10 | 0.10 | 0.10 |
| A2-11 | Switching uncertainty | 0.26 | 0.26 | 0.26 | Rectangular | 1.73 | 1 | 0.15 | 0.15 | 0.15 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.42** | **0.54** | **0.54** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **0.83** | **1.06** | **1.06** |
| **TRP summation error** | | | | | | | | **0.75** | **0.75** | **0.75** |
| **Total MU** | | | | | | | | **1.12** | **1.30** | **1.30** |

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#### 11.3.3.4 MU value derivation, FR2

A CATR MU budget was assessed in order to determine acceptable MU for the EIRP accuracy measurement in FR2. The CATR test setup and calibration and measurement procedures for FR2 are expected to be similar to those of FR1, although the test chamber dimensions and associated MU values will scale due to the shorter wavelengths and larger relative array apertures. However, it is noted that in order to achieve the test instrument uncertainties that were assumed, calibration of the spectrum analyzer may be needed.

For relative ACLR, the MU budget for CATR was assessed as follows:

Table 11.3.3.4-1: CATR MU value derivation for the EIRP measurement of the absolute OTA ACLR, FR2

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | |
| 24.25<f ≤29.5GHz | 37<f ≤40GHz | 24.25<f ≤29.5GHz | 37<f ≤40GHz |
| **Stage 2: BS measurement** | | | | | | | | |
| A2-1a | Misalignment and pointing error of BS (for EIRP) | 0.20 | 0.20 | Exp. normal | 2.00 | 1 | 0.10 | 0.10 |
| C1-7 | RF power measurement equipment (e.g. spectrum analyzer, power meter) - low power (UEM, absolute ACLR) | 0.90 | 0.90 | Gaussian | 1.00 | 1 | 0.90 | 0.90 |
| A2-2a | Standing wave between BS and test range antenna | 0.03 | 0.03 | U-shaped | 1.41 | 1 | 0.02 | 0.02 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 |
| A2-4a | QZ ripple experienced by BS | 0.40 | 0.40 | Gaussian | 1.00 | 1 | 0.40 | 0.40 |
| A2-12 | Frequency flatness of test system | 0.25 | 0.25 | Gaussian | 1.00 | 1 | 0.25 | 0.25 |
| **Stage 1: Calibration measurement** | | | | | | | | |
| C1-3 | Uncertainty of the network analyzer | 0.30 | 0.30 | Gaussian | 1.00 | 1 | 0.30 | 0.30 |
| A2-5b | Mismatch of receiver chain for low power | 0.72 | 0.72 | U-shaped | 1.41 | 1 | 0.51 | 0.51 |
| A2-6 | Insertion loss in receiver chain | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 |
| C2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 |
| A2-7 | Influence of the calibration antenna feed cable | 0.21 | 0.29 | U-shaped | 1.41 | 1 | 0.15 | 0.21 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.52 | 0.52 | Rectangular | 1.73 | 1 | 0.30 | 0.30 |
| A2-8 | Misalignment positioning system | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 |
| A2-1b | Misalignment of calibration antenna and test range antenna | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 |
| A2-9 | Rotary joints | 0.00 | 0.00 | U-shaped | 1.41 | 1 | 0.00 | 0.00 |
| A2-2b | Standing wave between calibration antenna and test range antenna | 0.09 | 0.09 | U-shaped | 1.41 | 1 | 0.06 | 0.06 |
| A2-4b | QZ ripple experienced by calibration antenna | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 |
| A2-11 | Switching uncertainty | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | **1.23** | **1.24** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | **2.41** | **2.43** |
| **TRP summation error** | | | | | | | **1.20** | **1.20** |
| **Total MU** | | | | | | | **2.69** | **2.71** |

Table 11.3.3.4-2: CATR MU value derivation for the EIRP measurement of the relative OTA ACLR, FR2

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | |
| 24.25<f ≤29.5GHz | 37<f ≤40GHz | 24.25<f ≤29.5GHz | 37<f ≤40GHz |
| **Stage 2: BS measurement** | | | | | | | | |
| A2-1a | Misalignment and pointing error of BS (for EIRP) | 0.20 | 0.20 | Exp. normal | 2.00 | 1 | 0.10 | 0.10 |
| C1-8 | Uncertainty of RF power measurement equipment (e.g. spectrum analyzer, power meter) - relative (ACLR) | 0.75 | 0.90 | Gaussian | 1.00 | 1 | 0.75 | 0.90 |
| A2-4a | QZ ripple experienced by BS | 0.40 | 0.40 | Gaussian | 1.00 | 1 | 0.40 | 0.40 |
| A2-12 | Frequency flatness of test system | 0.25 | 0.25 | Gaussian | 1.00 | 1 | 0.25 | 0.25 |
| **Stage 1: Calibration measurement** | | | | | | | | |
| C1-3 | Uncertainty of the network analyzer | 0.30 | 0.30 | Gaussian | 1.00 | 1 | 0.30 | 0.30 |
| A2-5a | Mismatch of receiver chain between receiving antenna and measurement receiver | 0.43 | 0.57 | U-shaped | 1.41 | 1 | 0.30 | 0.40 |
| A2-6 | Insertion loss in receiver chain | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 |
| A2-11 | Switching uncertainty | 0.10 | 0.10 | Rectangular | 1.73 | 0 | 0.06 | 0.06 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | **0.99** | **1.14** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | **1.94** | **2.23** |
| **TRP summation error** | | | | | | | **1.20** | **1.20** |
| **Total MU** | | | | | | | **2.28** | **2.54** |

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#### 11.3.4.3 MU value derivation, FR1

Table 11.3.4.3-1 captures derivation of the expanded measurement uncertainty values for OTA ACLR measurements in NFTR (Normal test conditions, FR1).

Table 11.3.4.3-1: NFTR MU value derivation for absolute ACLR measurement

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| A3-1 | Axes intersection | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-2 | Axes orthogonality | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-3 | Horizontal pointing | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-4 | Probe vertical position | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-5 | Probe horizontal/vertical pointing | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-6 | Measurement distance | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-7 | Amplitude and phase drift | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-8 | Amplitude and phase noise | 0.02 | 0.02 | 0.02 | Gaussian | 1.00 | 1 | 0.02 | 0.02 | 0.02 |
| A3-9 | Leakage and crosstalk | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-10 | Amplitude non-linearity | 0.04 | 0.04 | 0.04 | Gaussian | 1.00 | 1 | 0.04 | 0.04 | 0.04 |
| A3-11 | Amplitude and phase shift in rotary joints | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-12 | Channel balance amplitude and phase | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-13 | Probe polarization amplitude and phase | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-14 | Probe pattern knowledge | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-15 | Multiple reflections | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-16 | Room scattering | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| A3-17 | BS support scattering | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-21 | Positioning | 0.03 | 0.03 | 0.03 | Rectangular | 1.73 | 1 | 0.02 | 0.02 | 0.02 |
| A3-22 | Probe array uniformity | 0.06 | 0.06 | 0.06 | Gaussian | 1.00 | 1 | 0.06 | 0.06 | 0.06 |
| A3-23 | Mismatch of receiver chain | 0.28 | 0.28 | 0.28 | U-Shaped | 1.41 | 1 | 0.20 | 0.20 | 0.20 |
| A3-24 | Insertion loss of receiver chain | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-25 | Uncertainty of the absolute gain of the probe antenna | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A3-26 | Measurement repeatability - positioning repeatability | 0.15 | 0.15 | 0.15 | Gaussian | 1.00 | 1 | 0.15 | 0.15 | 0.15 |
| A3-33 | Frequency flatness of test system | 0.25 | 0.25 | 0.25 | Gaussian | 1.00 | 1 | 0.25 | 0.25 | 0.25 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A3-27 | Mismatch of receiver chain | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-28 | Insertion loss of receiver chain | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-29 | Mismatch in the connection of the calibration antenna | 0.02 | 0.02 | 0.02 | U-Shaped | 1.41 | 1 | 0.01 | 0.01 | 0.01 |
| A3-30 | Influence of the calibration antenna feed cable | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A3-31 | Influence of the probe antenna cable | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A3-32 | Short term repeatability | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.52** | **0.56** | **0.56** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **1.01** | **1.10** | **1.10** |
| **TRP summation error** | | | | | | | | **0.75** | **0.75** | **0.75** |
| **Total MU** | | | | | | | | **1.26** | **1.33** | **1.33** |

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#### 11.3.5.3 MU value derivation, FR1

Table 11.3.5.3-1 captures derivation of the expanded measurement uncertainty values for relative ACLR measurements in Reverberation Chamber (Normal test conditions, FR1).

Table 11.3.5.3-2 captures derivation of the expanded measurement uncertainty values for absolute ACLR measurements in Reverberation Chamber (Normal test conditions, FR1).

Table 11.3.5.3-1: Reverberation Chamber MU value derivation for relative ACLR measurement

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A6-1 | Impedance mismatch in the receiving chain | 0.20 | 0.20 | 0.20 | U-shaped | 1.41 | 1 | 0.14 | 0.14 | 0.14 |
| A6-2 | Random uncertainty | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| A6-3 | Reference antenna radiation efficiency | 0.20 | 0.20 | 0.20 | Gaussian | 1 | 1 | 0.20 | 0.20 | 0.20 |
| A6-4 | Mean value estimation of reference antenna mismatch efficiency | 0.15 | 0.15 | 0.15 | Gaussian | 1 | 1 | 0.15 | 0.15 | 0.15 |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1 | 1 | 0.13 | 0.20 | 0.20 |
| A6-5 | Influence of the reference antenna feed cable | 0.20 | 0.20 | 0.20 | Gaussian | 1 | 1 | 0.20 | 0.20 | 0.20 |
| A6-6 | Mean value estimation of transfer function | 0.27 | 0.27 | 0.27 | Gaussian | 1 | 1 | 0.27 | 0.27 | 0.27 |
| A6-7 | Uniformity of transfer function | 0.50 | 0.50 | 0.50 | Gaussian | 1 | 1 | 0.50 | 0.50 | 0.50 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.70** | **0.75** | **0.75** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **1.37** | **1.46** | **1.46** |

Table 11.3.5.3-2: Reverberation chamber MU value derivation for absolute ACLR measurement

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A6-1 | Impedance mismatch in the receiving chain | 0.20 | 0.20 | 0.20 | U-shaped | 1.41 | 1 | 0.14 | 0.14 | 0.14 |
| A6-2 | Random uncertainty | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| A6-3 | Reference antenna radiation efficiency | 0.20 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.20 | 0.20 | 0.20 |
| A6-4 | Mean value estimation of reference antenna mismatch efficiency | 0.15 | 0.15 | 0.15 | Gaussian | 1.00 | 1 | 0.15 | 0.15 | 0.15 |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A6-5 | Influence of the reference antenna feed cable | 0.20 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.20 | 0.20 | 0.20 |
| A6-6 | Mean value estimation of transfer function | 0.27 | 0.27 | 0.27 | Gaussian | 1.00 | 1 | 0.27 | 0.27 | 0.27 |
| A6-7 | Uniformity of transfer function | 0.50 | 0.50 | 0.50 | Gaussian | 1.00 | 1 | 0.50 | 0.50 | 0.50 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.70** | **0.75** | **0.75** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **1.37** | **1.46** | **1.46** |

#### 11.3.5.4 MU value derivation, FR2

Table 11.3.5.4-1 captures derivation of the expanded measurement uncertainty values for relative ACLR measurements in Reverberation Chamber (Normal test conditions, FR2).

Table 11.3.5.4-2 captures derivation of the expanded measurement uncertainty values for absolute ACLR measurements in Reverberation Chamber (Normal test conditions, FR2).

Table 11.3.5.4-1: Reverberation chamber MU value derivation for absolute ACLR measurement, FR2

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | |
| 24.25<f ≤29.5GHz | 37<f ≤40GHz | 24.25<f ≤29.5GHz | 37<f ≤40GHz |
| **Stage 2: BS measurement** | | | | | | | | |
| C1-7 | RF power measurement equipment (e.g. spectrum analyzer, power meter) - low power (UEM, absolute ACLR) | 0.90 | 0.90 | Gaussian | 1.00 | 1 | 0.90 | 0.90 |
| A6-1 | Impedance mismatch in the receiving chain | 0.20 | 0.20 | U-shaped | 1.41 | 1 | 0.14 | 0.14 |
| A6-2 | Random uncertainty | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 |
| **Stage 1: Calibration measurement** | | | | | | | | |
| A6-3 | Reference antenna radiation efficiency | 0.30 | 0.30 | Gaussian | 1.00 | 1 | 0.30 | 0.30 |
| A6-4 | Mean value estimation of reference antenna mismatch efficiency | 0.27 | 0.27 | Gaussian | 1.00 | 1 | 0.27 | 0.27 |
| C1-3 | Uncertainty of the network analyzer | 0.30 | 0.30 | Gaussian | 1.00 | 1 | 0.30 | 0.30 |
| A6-5 | Influence of the reference antenna feed cable | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.20 | 0.20 |
| A6-6 | Mean value estimation of transfer function | 0.27 | 0.27 | Gaussian | 1.00 | 1 | 0.27 | 0.27 |
| A6-7 | Uniformity of transfer function | 0.50 | 0.50 | Gaussian | 1.00 | 1 | 0.50 | 0.50 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | **1.20** | **1.20** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | **2.36** | **2.36** |

Table 11.3.5.4-2: Reverberation chamber MU value derivation for relative ACLR measurement, FR2

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | |
| 24.25<f ≤29.5GHz | 37<f ≤40GHz | 24.25<f ≤29.5GHz | 37<f ≤40GHz |
| **Stage 2: BS measurement** | | | | | | | | |
| C1-8 | Uncertainty of RF power measurement equipment (e.g. spectrum analyzer, power meter) - relative (ACLR) | 0.75 | 0.90 | Gaussian | 1.00 | 1 | 0.75 | 0.90 |
| A6-1 | Impedance mismatch in the receiving chain | 0.20 | 0.20 | U-shaped | 1.41 | 1 | 0.14 | 0.14 |
| A6-2 | Random uncertainty | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 |
| **Stage 1: Calibration measurement** | | | | | | | | |
| A6-3 | Reference antenna radiation efficiency | 0.30 | 0.30 | Gaussian | 1.00 | 1 | 0.30 | 0.30 |
| A6-4 | Mean value estimation of reference antenna mismatch efficiency | 0.27 | 0.27 | Gaussian | 1.00 | 1 | 0.27 | 0.27 |
| C1-3 | Uncertainty of the network analyzer | 0.30 | 0.30 | Gaussian | 1.00 | 1 | 0.30 | 0.30 |
| A6-5 | Influence of the reference antenna feed cable | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.20 | 0.20 |
| A6-6 | Mean value estimation of transfer function | 0.27 | 0.27 | Gaussian | 1.00 | 1 | 0.27 | 0.27 |
| A6-7 | Uniformity of transfer function | 0.50 | 0.50 | Gaussian | 1.00 | 1 | 0.50 | 0.50 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | **1.10** | **1.20** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | **2.15** | **2.36** |

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#### 11.3.6.3 MU value derivation, FR1

The MU value derivation for absolute ACLR measurements is the same as in clause 11.2.6.3 (i.e. OTA BS output power).

Table 11.3.6.3-1 captures derivation of the expanded measurement uncertainty values for relative ACLR measurements in PWS.

Table 11.3.6.3-1: PWS MU value derivation for relative ACLR measurement

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤ 3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| Stage 2: BS measurement | | | | | | | | | | |
| A7-1a | Misalignment and pointing error of BS | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| C1-1 | Uncertainty of the RF power measurement equipment  (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A7-4a | QZ ripple experienced by BS | 0.42 | 0.43 | [0.43] | Rectangular | 1.73 | 1 | 0.24 | 0.25 | [0.25] |
| A7-13 | Frequency flatness of test system | 0.13 | 0.13 | 0.13 | Rectangular | 1.73 | 1 | 0.08 | 0.08 | 0.08 |
| Stage 1: Calibration measurement | | | | | | | | | | |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A7-6 | Mismatch (i.e. reference antenna, network analyser and reference cable) | 0.13 | 0.33 | 0.33 | U-shaped | 1.41 | 1 | 0.09 | 0.23 | 0.23 |
| A7-7 | Insertion loss of receiver chain | 0.18 | 0.18 | 0.18 | Rectangular | 1.73 | 1 | 0.10 | 0.10 | 0.10 |
| A7-11 | Switching uncertainty | 0.02 | 0.02 | 0.02 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.35** | **0.49** | **[0.49]** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **0.69** | **0.96** | **[0.96]** |
| **TRP summation error** | | | | | | | | **0.75** | **0.75** | **0.75** |
| **Total MU** | | | | | | | | **1.02** | **1.22** | **[1.22]** |

Table 11.3.6.3-2: PWS MU value derivation for absolute ACLR measurement

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| Stage 2: BS measurement | | | | | | | | | | |
| A7-1a | Misalignment and pointing error of BS | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A7-2a | Longitudinal position uncertainty (i.e. standing wave and imperfect field synthesis) for BS antenna | 0.05 | 0.14 | [0.14] | Rectangular | 1.73 | 1 | 0.03 | 0.08 | [0.08] |
| A7-3 | RF leakage (calibration antenna connector terminated) | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| A7-4a | QZ ripple experienced by BS | 0.42 | 0.43 | [0.43] | Rectangular | 1.73 | 1 | 0.24 | 0.25 | [0.25] |
| A7-5 | Miscellaneous uncertainty | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A7-14 | System non-linearity | 0.10 | 0.10 | [0.10] | Rectangular | 1.73 | 1 | 0.06 | 0.06 | [0.06] |
| A7-13 | Frequency flatness of test system | 0.13 | 0.13 | 0.13 | Rectangular | 1.73 | 1 | 0.08 | 0.08 | 0.08 |
| Stage 1: Calibration measurement | | | | | | | | | | |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A7-6 | Mismatch (i.e. reference antenna, network analyser and reference cable) | 0.13 | 0.33 | 0.33 | U-shaped | 1.41 | 1 | 0.09 | 0.23 | 0.23 |
| A7-7 | Insertion loss of receiver chain | 0.18 | 0.18 | 0.18 | Rectangular | 1.73 | 1 | 0.10 | 0.10 | 0.10 |
| A7-3 | RF leakage (calibration antenna connector terminated) | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| A7-8 | Influence of the calibration antenna feed cable | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A7-9 | Misalignment of positioning system | 0.00 | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| A7-1b | Misalignment and pointing error of calibration antenna | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| A7-10 | Rotary joints | 0.00 | 0.00 | 0.00 | U-shaped | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A7-2b | Longitudinal position uncertainty (i.e. standing wave and imperfect field synthesis) for calibration antenna | 0.12 | 0.12 | [0.12] | Rectangular | 1.73 | 1 | 0.07 | 0.07 | [0.07] |
| A7-4b | QZ ripple experienced by calibration antenna | 0.20 | 0.20 | 0.20 | Rectangular | 1.73 | 1 | 0.12 | 0.12 | 0.12 |
| A7-11 | Switching uncertainty | 0.02 | 0.02 | 0.02 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A7-12 | Field repeatability | 0.06 | 0.12 | [0.12] | Gaussian | 1.00 | 1 | 0.06 | 0.12 | [0.12] |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.50** | **0.61** | **[0.61]** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **0.98** | **1.19** | **[1.19]** |
| **TRP summation error** | | | | | | | | **0.75** | **0.75** | **0.75** |
| **Total MU** | | | | | | | | **1.24** | **1.40** | **[1.40]** |

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#### 11.4.2.3 MU value derivation, FR1

Table 11.4.2.3-1 captures derivation of the expanded measurement uncertainty values for OTA OBUE or OTA SEM measurements in Indoor Anechoic Chamber (Normal test conditions, FR1).

Table 11.4.2.3-1: IAC MU value derivation for OTA OBUE or OTA SEM measurement, FR1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| A1-1 | Positioning misalignment between the BS and the reference antenna | 0.03 | 0.03 | 0.03 | Rectangular | 1.73 | 1 | 0.02 | 0.02 | 0.02 |
| A1-2 | Pointing misalignment between the BS and the receiving antenna | 0.30 | 0.30 | 0.30 | Rectangular | 1.73 | 1 | 0.17 | 0.17 | 0.17 |
| A1-3 | Quality of quiet zone | 0.10 | 0.10 | 0.10 | Gaussian | 1.00 | 1 | 0.10 | 0.10 | 0.10 |
| A1-4a | Polarization mismatch between the BS and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A1-5a | Mutual coupling between the BS and the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A1-6 | Phase curvature | 0.05 | 0.05 | 0.05 | Gaussian | 1.00 | 1 | 0.05 | 0.05 | 0.05 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A1-7 | Impedance mismatch in the receiving chain | 0.14 | 0.33 | 0.33 | U-shaped | 1.41 | 1 | 0.10 | 0.23 | 0.23 |
| A1-8 | Random uncertainty | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| A1-9 | Impedance mismatch between the receiving antenna and the network analyzer | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.04 | 0.04 | 0.04 |
| A1-10 | Positioning and pointing misalignment between the reference antenna and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A1-11 | Impedance mismatch between the reference antenna and the network analyzer. | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.04 | 0.04 | 0.04 |
| A1-3 | Quality of quiet zone | 0.10 | 0.10 | 0.10 | Gaussian | 1.00 | 1 | 0.10 | 0.10 | 0.10 |
| A1-4b | Polarization mismatch between the reference antenna and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A1-5b | Mutual coupling between the reference antenna and the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A1-6 | Phase curvature | 0.05 | 0.05 | 0.05 | Gaussian | 1.00 | 1 | 0.05 | 0.05 | 0.05 |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A1-12 | Influence of the reference antenna feed cable | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| A1-13 | Reference antenna feed cable loss measurement uncertainty | 0.06 | 0.06 | 0.06 | Gaussian | 1.00 | 1 | 0.06 | 0.06 | 0.06 |
| A1-14 | Influence of the receiving antenna feed cable | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A1-15 | Uncertainty of the absolute gain of the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.44** | **0.54** | **0.54** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **0.87** | **1.06** | **1.06** |
| **TRP summation error** | | | | | | | | **0.75** | **0.75** | **0.75** |
| **Total MU** | | | | | | | | **1.15** | **1.30** | **1.30** |

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#### 11.4.3.3 MU value derivation, FR1

Table 11.4.3.3-1 captures derivation of the expanded measurement uncertainty values for OTA OBUE or OTA SEM measurements in CATR (Normal test conditions, FR1).

Table 11.4.3.3-1: CATR MU value derivation for OTA OBUE or OTA SEM measurement, FR1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| A2-18a | Misalignment and pointing error of BS (for TRP) | 0.30 | 0.30 | 0.30 | Rectangular | 1.73 | 1 | 0.17 | 0.17 | 0.17 |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A2-2a | Standing wave between BS and test range antenna | 0.21 | 0.21 | 0.21 | U-shaped | 1.41 | 1 | 0.15 | 0.15 | 0.15 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A2-4a | QZ ripple experienced by BS | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| A2-12 | Frequency flatness of test system | 0.25 | 0.25 | 0.25 | Gaussian | 1.00 | 1 | 0.25 | 0.25 | 0.25 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A2-5a | Mismatch of receiver chain between receiving antenna and measurement receiver | 0.13 | 0.33 | 0.33 | U-shaped | 1.41 | 1 | 0.09 | 0.23 | 0.23 |
| A2-6 | Insertion loss of receiver chain | 0.18 | 0.18 | 0.18 | Rectangular | 1.73 | 1 | 0.10 | 0.10 | 0.10 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A2-7 | Influence of the calibration antenna feed cable | 0.02 | 0.02 | 0.02 | U-shaped | 1.41 | 1 | 0.02 | 0.02 | 0.02 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A2-8 | Misalignment positioning system | 0.00 | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| A2-1b | Misalignment and pointing error of calibration antenna (for EIRP) | 0.50 | 0.50 | 0.50 | Exp. normal | 2.00 | 1 | 0.25 | 0.25 | 0.25 |
| A2-9 | Rotary joints | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.03 | 0.03 | 0.03 |
| A2-2b | Standing wave between calibration antenna and test range antenna | 0.09 | 0.09 | 0.09 | U-shaped | 1.41 | 1 | 0.06 | 0.06 | 0.06 |
| A2-4b | QZ ripple experienced by calibration antenna | 0.01 | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 | 0.01 |
| A2-11 | Switching uncertainty | 0.26 | 0.26 | 0.26 | Rectangular | 1.73 | 1 | 0.15 | 0.15 | 0.15 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.59** | **0.67** | **0.67** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **1.16** | **1.31** | **1.31** |
| **TRP summation error** | | | | | | | | **0.75** | **0.75** | **0.75** |
| **Total MU** | | | | | | | | **1.39** | **1.51** | **1.51** |

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#### 11.4.3.4 MU value derivation, FR2

A CATR MU budget was assessed in order to determine acceptable MU for the EIRP accuracy measurement in FR2. The CATR test setup and calibration and measurement procedures for FR2 are expected to be similar to those of FR1, although the test chamber dimensions and associated MU values will scale due to the shorter wavelengths and larger relative array apertures. However, it is noted that in order to achieve the test instrument uncertainties that were assumed, calibration of the spectrum analyzer may be needed.

Table 11.4.3.4-1 captures derivation of the expanded measurement uncertainty values for OTA OBUE measurements in CATR (Normal test conditions, FR2).

Table 11.4.3.4-1: CATR MU value derivation for OTA OBUE measurement, FR2

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | |
| 24.25<f ≤29.5GHz | 37<f ≤40GHz | 24.25<f ≤29.5GHz | 37<f ≤40GHz |
| **Stage 2: BS measurement** | | | | | | | | |
| A2-18a | Misalignment and pointing error of BS (for TRP) | 0.30 | 0.30 | Exp. normal | 2.00 | 1 | 0.15 | 0.15 |
| C1-7 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) - low power (UEM, absolute ACLR) | 0.90 | 0.90 | Gaussian | 1.00 | 1 | 0.90 | 0.90 |
| A2-2a | Standing wave between BS and test range antenna | 0.03 | 0.03 | U-shaped | 1.41 | 1 | 0.02 | 0.02 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 |
| A2-4a | QZ ripple experienced by BS | 0.40 | 0.40 | Gaussian | 1.00 | 1 | 0.40 | 0.40 |
| A2-12 | Frequency flatness of test system | 0.25 | 0.25 | Gaussian | 1.00 | 1 | 0.25 | 0.25 |
| **Stage 1: Calibration measurement** | | | | | | | | |
| C1-3 | Uncertainty of the network analyzer | 0.30 | 0.30 | Gaussian | 1.00 | 1 | 0.30 | 0.30 |
| A2-5b | Mismatch of receiver chain for low power receiver | 0.72 | 0.72 | U-shaped | 1.41 | 1 | 0.51 | 0.51 |
| A2-6 | Insertion loss in receiver chain | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 |
| A2-7 | Influence of the calibration antenna feed cable | 0.21 | 0.29 | U-shaped | 1.41 | 1 | 0.15 | 0.21 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.52 | 0.52 | Rectangular | 1.73 | 1 | 0.30 | 0.30 |
| A2-8 | Misalignment positioning system | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 |
| A2-1b | Misalignment and pointing error of calibration antenna (for EIRP) | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 |
| A2-9 | Rotary joints | 0.00 | 0.00 | U-shaped | 1.41 | 1 | 0.00 | 0.00 |
| A2-2b | Standing wave between calibration antenna and test range antenna | 0.09 | 0.09 | U-shaped | 1.41 | 1 | 0.06 | 0.06 |
| A2-4b | QZ ripple experienced by calibration antenna | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 |
| A2-11 | Switching uncertainty | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | **1.23** | **1.24** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | **2.42** | **2.44** |
| **TRP summation error** | | | | | | | **1.20** | **1.20** |
| **Total MU** | | | | | | | **2.70** | **2.72** |

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#### 11.4.5.3 MU value derivation, FR1

Table 11.4.5.3-1 captures derivation of the expanded measurement uncertainty values for OTA OBUE or OTA SEM measurement in Reverberation chamber (Normal test conditions, FR1).

Table 11.4.5.3-1: Reverberation chamber MU value derivation for OTA OBUE or OTA SEM measurement, FR1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz | f≤3 GHz | 3<f≤4.2 GHz | 4.2<f≤6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | Gaussian | 1.00 | 1 | 0.14 | 0.26 | 0.26 |
| A6-1 | Impedance mismatch in the receiving chain | 0.20 | 0.20 | 0.20 | U-shaped | 1.41 | 1 | 0.14 | 0.14 | 0.14 |
| A6-2 | Random uncertainty | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| A6-3 | Reference antenna radiation efficiency | 0.20 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.20 | 0.20 | 0.20 |
| A6-4 | Mean value estimation of reference antenna mismatch efficiency | 0.15 | 0.15 | 0.15 | Gaussian | 1.00 | 1 | 0.15 | 0.15 | 0.15 |
| C1-3 | Uncertainty of the network analyzer | 0.20 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.20 | 0.20 | 0.20 |
| A6-5 | Influence of the reference antenna feed cable | 0.20 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.20 | 0.20 | 0.20 |
| A6-6 | Mean value estimation of transfer function | 0.27 | 0.27 | 0.27 | Gaussian | 1.00 | 1 | 0.27 | 0.27 | 0.27 |
| A6-7 | Uniformity of transfer function | 0.50 | 0.50 | 0.50 | Gaussian | 1.00 | 1 | 0.50 | 0.50 | 0.50 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **0.71** | **0.75** | **0.75** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **1.40** | **1.46** | **1.46** |

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#### 11.4.5.4 MU value derivation, FR2

Table 11.4.5.4-1 captures derivation of the expanded measurement uncertainty values for OTA OBUE measurements in Reverberation chamber (Normal test conditions, FR2).

Table 11.4.5.4-1: Reverberation chamber MU value derivation for OTA OBUE measurement, FR2

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | |
| 24.25<f ≤29.5GHz | 37<f ≤40GHz | 24.25<f ≤29.5GHz | 37<f ≤40GHz |
| **Stage 2: BS measurement** | | | | | | | | |
| C1-7 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) - low power (UEM, absolute ACLR) | 0.90 | 0.90 | Gaussian | 1.00 | 1 | 0.90 | 0.90 |
| A6-1 | Impedance mismatch in the receiving chain | 0.20 | 0.20 | U-shaped | 1.41 | 1 | 0.14 | 0.14 |
| A6-2 | Random uncertainty | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 |
| **Stage 1: Calibration measurement** | | | | | | | | |
| A6-3 | Reference antenna radiation efficiency | 0.30 | 0.30 | Gaussian | 1.00 | 1 | 0.30 | 0.30 |
| A6-4 | Mean value estimation of reference antenna mismatch efficiency | 0.27 | 0.27 | Gaussian | 1.00 | 1 | 0.27 | 0.27 |
| C1-3 | Uncertainty of the network analyzer | 0.30 | 0.30 | Gaussian | 1.00 | 0.3 | 0.30 | 0.30 |
| A6-5 | Influence of the reference antenna feed cable | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.20 | 0.20 |
| A6-6 | Mean value estimation of transfer function | 0.27 | 0.27 | Gaussian | 1.00 | 1 | 0.27 | 0.27 |
| A6-7 | Uniformity of transfer function | 0.50 | 0.50 | Gaussian | 1.00 | 1 | 0.50 | 0.50 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | **1.20** | **1.20** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | **2.36** | **2.36** |

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#### 12.2.2.3 MU value derivation, FR1

For FR1 a general directional 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 directional chamber (Normal test conditions, FR1).

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

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UID** | **Uncertainty source** | **Uncertainty value (dB)** | | | **Distribution of the probability** | **Divisor based on distribution shape** | ***ci*** | **Standard uncertainty *ui* (dB)** | | |
| **30MHz<f≤6 GHz** | **6GHz<f ≤19GHz** | **19GHz<f ≤26GHz** | **30MHz<f≤6 GHz** | **6GHz<f ≤19GHz** | **19GHz<f ≤26GHz** |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| A5-1 | Positioning misalignment between the BS and the reference antenna | 0.03 | 0.03 | 0.03 | Rectangular | 1.73 | 1 | 0.02 | 0.02 | 0.02 |
| A5-2 | Pointing misalignment between the BS and the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A5-3 | Quality of quiet zone | 0.10 | 0.10 | 0.10 | Gaussian | 1.00 | 1 | 0.10 | 0.10 | 0.10 |
| A5-4a | Polarization mismatch between the BS and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A5-5a | Mutual coupling between the BS and the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A5-6a | Phase curvature across the BS antenna | 0.05 | 0.05 | 0.05 | Gaussian | 1.00 | 1 | 0.05 | 0.05 | 0.05 |
| C3-3 | Transmitter mandatory spurious emissions - Conducted Uncertainty (minus miss match) | 1.00 | 2.00 | 2.00 | Gaussian | 1.00 | 1 | 1.00 | 2.00 | 2.00 |
| A5-7 | Impedance mismatch in the receiving chain | 0.20 | 0.45 | 0.45 | U-shaped | 1.41 | 1 | 0.14 | 0.32 | 0.32 |
| A5-8 | Random uncertainty | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| A5-17 | Measurement antenna frequency variation | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| A5-18 | FSPL estimation error | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A5-16 | Frequency flatness of test system | 0.25 | 0.25 | 0.25 | Gaussian | 1.00 | 1 | 0.25 | 0.25 | 0.25 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| A5-9 | Impedance mismatch between the receiving antenna and the network analyzer | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.04 | 0.04 | 0.04 |
| A5-10 | Positioning and pointing misalignment between the reference antenna and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A5-11 | Impedance mismatch between the reference antenna and the network analyzer | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.04 | 0.04 | 0.04 |
| A5-3 | Quality of quiet zone | 0.10 | 0.10 | 0.10 | Gaussian | 1.00 | 1 | 0.10 | 0.10 | 0.10 |
| A5-4b | Polarization mismatch between the reference antenna and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A5-5b | Mutual coupling between the reference antenna and the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A5-6b | Phase curvature across the reference antenna | 0.05 | 0.05 | 0.05 | Gaussian | 1.00 | 1 | 0.05 | 0.05 | 0.05 |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A5-12 | Influence of the reference antenna feed cable | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| A5-13 | Reference antenna feed cable loss measurement uncertainty | 0.06 | 0.06 | 0.06 | Gaussian | 1.00 | 1 | 0.06 | 0.06 | 0.06 |
| A5-14 | Influence of the receiving antenna feed cable | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A5-15 | Uncertainty of the absolute gain of the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **1.11** | **2.08** | **2.08** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **2.17** | **4.07** | **4.07** |
| **TRP summation error** | | | | | | | | **0.75** | **0.75** | **0.75** |
| **Total MU** | | | | | | | | **2.29** | **4.14** | **4.14** |

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#### 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).

Up to 40 GHz the OBUE MU values are assumed.

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) |
| 40GHz<f ≤60GHz | 40GHz<f ≤60GHz |
| **Stage 2: BS measurement** | | | | | | |
| A1-1 | Positioning misalignment between the BS and the reference antenna | 0.02 | Rectangular | 1.73 | 1 | 0.01 |
| A1-2 | Pointing misalignment between the BS and the receiving antenna | 0.00 | Rectangular | 1.73 | 1 | 0.00 |
| A1-3 | Quality of quiet zone | 0.10 | Gaussian | 1.00 | 1 | 0.10 |
| A1-4a | Polarization mismatch between the BS and the receiving antenna | 0.02 | Rectangular | 1.73 | 1 | 0.01 |
| A1-5a | Mutual coupling between the BS and the receiving antenna | 0.00 | Rectangular | 1.73 | 1 | 0.00 |
| A1-6 | Phase curvature | 0.05 | Gaussian | 1.00 | 1 | 0.05 |
| C1-7 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) - low power (UEM, absolute ACLR) | 0.60 | Gaussian | 1.00 | 1 | 0.60 |
| A1-16 | Frequency flatness of test system | 0.25 | Gaussian | 1.00 | 1 | 0.25 |
| A1-21 | Uncertainty of the LNA (FR2 only) | 0.00 | Gaussian | 1.00 | 1 | 0.00 |
| A1-22 | Uncertainty of the mixer (FR2 only) | 2.25 | Gaussian | 1.00 | 1 | 2.25 |
| A1-7 | Impedance mismatch in the receiving chain | 0.42 | U-shaped | 1.41 | 1 | 0.30 |
| A1-8 | Random uncertainty | 0.10 | Rectangular | 1.73 | 1 | 0.06 |
| **Stage 1: Calibration measurement** | | | | | | |
| A1-9 | Impedance mismatch between the receiving antenna and the network analyzer | 0.57 | U-shaped | 1.41 | 1 | 0.40 |
| A1-10 | Positioning and pointing misalignment between the reference antenna and the receiving antenna | 0.43 | Rectangular | 1.73 | 1 | 0.25 |
| A1-11 | Impedance mismatch between the reference antenna and the network analyzer. | 0.57 | U-shaped | 1.41 | 1 | 0.40 |
| A1-3 | Quality of quiet zone | 0.10 | Gaussian | 1.00 | 1 | 0.10 |
| A1-4b | Polarization mismatch between the reference antenna and the receiving antenna | 0.02 | Rectangular | 1.73 | 1 | 0.01 |
| A1-5b | Mutual coupling between the reference antenna and the receiving antenna | 0.00 | Rectangular | 1.73 | 1 | 0.00 |
| A1-6 | Phase curvature | 0.07 | Gaussian | 1.00 | 1 | 0.07 |
| C1-3 | Uncertainty of the network analyzer | 0.30 | Gaussian | 1.00 | 1 | 0.30 |
| A1-12 | Influence of the reference antenna feed cable | 0.18 | Rectangular | 1.73 | 1 | 0.10 |
| A1-13 | Reference antenna feed cable loss measurement uncertainty | 0.10 | Gaussian | 1.00 | 1 | 0.10 |
| A1-14 | Influence of the receiving antenna feed cable | 0.18 | Rectangular | 1.73 | 1 | 0.10 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.52 | Rectangular | 1.73 | 1 | 0.30 |
| A1-15 | Uncertainty of the absolute gain of the receiving antenna | 0.00 | Rectangular | 1.73 | 1 | 0.00 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | 2.49 |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | 4.88 |
| **TRP summation error** | | | | | | 0.75 |
| **Total MU** | | | | | | **4.94** |

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#### 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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) |
| 40GHz<f ≤60GHz | 40GHz<f ≤60GHz |
| **Stage 2: BS measurement** | | | | | | |
| A2-18a | Misalignment and pointing error of BS (for TRP) | 0.30 | Exp. normal | 2.00 | 1 | 0.15 |
| C1-7 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) - low power (UEM, absolute ACLR) | 0.60 | Gaussian | 1.00 | 1 | 0.60 |
| A2-19 | Uncertainty of the LNA (FR2 only) | 0.00 | Gaussian | 1.00 | 1 | 0.00 |
| A2-20 | Uncertainty of the mixer (FR2 only) | 2.25 | Gaussian | 1.00 | 1 | 2.25 |
| A2-2a | Standing wave between BS and test range antenna | 0.21 | Gaussian | 1.00 | 1 | 0.21 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.00 | Gaussian | 1.00 | 1 | 0.00 |
| A2-4a | QZ ripple experienced by BS | 0.09 | Gaussian | 1.00 | 1 | 0.09 |
| A2-12 | Frequency flatness of test system | 0.25 | Gaussian | 1.00 | 1 | 0.25 |
| A2-10 | Miscellaneous uncertainty | 0.00 | Rectangular | 1.73 | 1 | 0.00 |
| **Stage 1: Calibration measurement** | | | | | | |
| C1-3 | Uncertainty of the network analyzer | 0.30 | Gaussian | 1.00 | 1 | 0.30 |
| A2-5a | Mismatch of receiver chain between receiving antenna and measurement receiver | 0.57 | U-shaped | 1.41 | 1 | 0.40 |
| A2-5b | Mismatch of receiver chain for low power receiver | 0.00 | U-shaped | 1.41 | 1 | 0.00 |
| A2-6 | Insertion loss of receiver chain | 0.18 | Rectangular | 1.73 | 1 | 0.10 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.00 | Gaussian | 1.00 | 1 | 0.00 |
| A2-7 | Influence of the calibration antenna feed cable | 0.29 | U-shaped | 1.41 | 1 | 0.21 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.52 | Rectangular | 1.73 | 1 | 0.30 |
| A2-8 | Misalignment positioning system | 0.00 | Exp. normal | 2.00 | 1 | 0.00 |
| A2-1b | Misalignment and pointing error of calibration antenna (for EIRP) | 0.00 | Exp. normal | 2.00 | 1 | 0.00 |
| A2-9 | Rotary joints | 0.00 | U-shaped | 1.41 | 1 | 0.00 |
| A2-2b | Standing wave between calibration antenna and test range antenna | 0.09 | U-shaped | 1.41 | 1 | 0.06 |
| A2-4b | QZ ripple experienced by calibration antenna | 0.01 | Gaussian | 1.00 | 1 | 0.01 |
| A2-11 | Switching uncertainty | 0.43 | Rectangular | 1.73 | 1 | 0.25 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | **2.45** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | **4.81** |
| **TRP summation error** | | | | | | **1.20** |
| **Total MU** | | | | | | **4.96** |

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#### 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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | | | |
| 380 MHz < f ≦ 3 GHz | 3 < f ≦ 6 GHz | 6 < f ≦ 12.75 GHz | 12.75 < f ≦ 19 GHz | 19<f ≤26GHz | 380 MHz < f ≦ 3 GHz | 3< f ≦ 6 GHz | 6 < f ≦ 12.75 GHz | 12.75 < f ≦ 19 GHz | 19<f ≤26GHz |
| **Stage 2: BS measurement** | | | | | | | | | | | | | | |
| C1-1 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) | 0.14 | 0.26 | 0.26 | 0.37 | 0.37 | Gaussian | 1.00 | 1.00 | 0.14 | 0.26 | 0.26 | 0.37 | 0.37 |
| A6-1 | Impedance mismatch in the receiving chain | 0.20 | 0.20 | 0.45 | 0.45 | 0.45 | U-shaped | 1.41 | 1.00 | 0.14 | 0.14 | 0.32 | 0.32 | 0.32 |
| A6-2 | Random uncertainty | 0.10 | 0.10 | 0.10 | 0.1 | 0.10 | Rectangular | 1.73 | 1.00 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| **Stage 1: Calibration measurement** | | | | | | | | | | | | | | |
| A6-3 | Reference antenna radiation efficiency | 0.50 | 0.50 | 0.50 | 0.5 | 0.50 | Gaussian | 1.00 | 1.00 | 0.50 | 0.5 | 0.5 | 0.5 | 0.5 |
| A6-4 | Mean value estimation of reference antenna mismatch efficiency | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | Gaussian | 1.00 | 1.00 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | 0.2 | 0.20 | Gaussian | 1.00 | 1.00 | 0.13 | 0.2 | 0.2 | 0.2 | 0.2 |
| A6-5 | Influence of the reference antenna feed cable | 0.20 | 0.20 | 0.20 | 0.2 | 0.20 | Gaussian | 1.00 | 1.00 | 0.20 | 0.2 | 0.2 | 0.2 | 0.2 |
| A6-6 | Mean value estimation of transfer function | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | Gaussian | 1.00 | 1.00 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 |
| A6-7 | Uniformity of transfer function | 1.50 | 1.50 | 1.50 | 1.5 | 1.50 | Gaussian | 1.00 | 1.00 | 1.50 | 1.5 | 1.5 | 1.5 | 1.5 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | |  |  | **1.66** | **1.68** | **1.70** | **1.72** | **1.72** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | |  |  | **3.25** | **3.29** | **3.34** | **3.38** | **3.38** |

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) |
| 40GHz<f ≤60GHz | 40GHz<f ≤60GHz |
| **Stage 2: BS measurement** | | | | | | |
| C1-7 | Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter) - low power (UEM, absolute ACLR) | 0.60 | Gaussian | 1.00 | 1 | 0.60 |
| A6-1 | Impedance mismatch in the receiving chain | 0.45 | U-shaped | 1.41 | 1 | 0.32 |
| A6-2 | Random uncertainty | 0.10 | Rectangular | 1.73 | 1 | 0.06 |
| **Stage 1: Calibration measurement** | | | | | | |
| A6-3 | Reference antenna radiation efficiency | 0.50 | Normal | 1.00 | 1 | 0.50 |
| A6-4 | Mean value estimation of reference antenna mismatch efficiency | 0.27 | Normal | 1.00 | 1 | 0.27 |
| C1-3 | Uncertainty of the network analyzer | 0.30 | Gaussian | 1.00 | 1 | 0.30 |
| A6-5 | Influence of the reference antenna feed cable | 0.20 | Normal | 1.00 | 1 | 0.20 |
| A6-6 | Mean value estimation of transfer function | 0.27 | Normal | 1.00 | 1 | 0.27 |
| A6-7 | Uniformity of transfer function | 1.50 | Normal | 1.00 | 1 | 1.50 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | **1.80** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | **3.53** |

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#### 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

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UID** | **Uncertainty source** | **Uncertainty value (dB)** | | | **Distribution of the probability** | **Divisor based on distribution shape** | ***ci*** | **Standard uncertainty *ui* (dB)** | | |
| **30MHz <f≤6 GHz** | **6<f ≤ 19GHz** | **19<f ≤ 26GHz** | **30MHz <f≤ 6 GHz** | **6<f ≤ 19GHz** | **19<f ≤ 26GHz** |
| **Stage 2: BS measurement** | | | | | | | | | | |
| A5-1 | Positioning misalignment between the BS and the reference antenna | 0.03 | 0.03 | 0.03 | Rectangular | 1.73 | 1 | 0.02 | 0.02 | 0.02 |
| A5-2 | Pointing misalignment between the BS and the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A5-3 | Quality of quiet zone | 0.10 | 0.10 | 0.10 | Gaussian | 1.00 | 1 | 0.10 | 0.10 | 0.10 |
| A5-4a | Polarization mismatch between the BS and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A5-5a | Mutual coupling between the BS and the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A5-6a | Phase curvature across the BS antenna | 0.05 | 0.05 | 0.05 | Gaussian | 1.00 | 1 | 0.05 | 0.05 | 0.05 |
| C3-4 | Receiver spurious emissions - Conducted Uncertainty (minus mismatch) | 1.00 | 2.00 | 2.00 | Gaussian | 1.00 | 1 | 1.00 | 2.00 | 2.00 |
| A5-7 | Impedance mismatch in the receiving chain | 0.20 | 0.45 | 0.45 | U-shaped | 1.41 | 1 | 0.14 | 0.32 | 0.32 |
| A5-8 | Random uncertainty | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| A5-17 | Measurement antenna frequency variation | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| A5-18 | FSPL estimation error | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A5-16 | Frequency flatness of test system | 0.25 | 0.25 | 0.25 | Gaussian | 1.00 | 1 | 0.25 | 0.25 | 0.25 |
| A5-19 | Measurement system dynamic range uncertainty | 0.51 | 0.51 | 0.51 | Gaussian | 1.00 | 1 | 0.51 | 0.51 | 0.51 |
| **Stage 1: Calibration measurement** | | | | | | | | | | |
| A5-9 | Impedance mismatch between the receiving antenna and the network analyzer | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.04 | 0.04 | 0.04 |
| A5-10 | Positioning and pointing misalignment between the reference antenna and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A5-11 | Impedance mismatch between the reference antenna and the network analyzer | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.04 | 0.04 | 0.04 |
| A5-3 | Quality of quiet zone | 0.10 | 0.10 | 0.10 | Gaussian | 1.00 | 1 | 0.10 | 0.10 | 0.10 |
| A5-4b | Polarization mismatch between the reference antenna and the receiving antenna | 0.01 | 0.01 | 0.01 | Rectangular | 1.73 | 1 | 0.01 | 0.01 | 0.01 |
| A5-5b | Mutual coupling between the reference antenna and the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| A5-6b | Phase curvature across the reference antenna | 0.05 | 0.05 | 0.05 | Gaussian | 1.00 | 1 | 0.05 | 0.05 | 0.05 |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A5-12 | Influence of the reference antenna feed cable | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| A5-13 | Reference antenna feed cable loss measurement uncertainty | 0.06 | 0.06 | 0.06 | Gaussian | 1.00 | 1 | 0.06 | 0.06 | 0.06 |
| A5-14 | Influence of the receiving antenna feed cable | 0.05 | 0.05 | 0.05 | Rectangular | 1.73 | 1 | 0.03 | 0.03 | 0.03 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A5-15 | Uncertainty of the absolute gain of the receiving antenna | 0.00 | 0.00 | 0.00 | Rectangular | 1.73 | 1 | 0.00 | 0.00 | 0.00 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **1.22** | **2.14** | **2.14** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **2.39** | **4.19** | **4.19** |
| **TRP summation error** | | | | | | | | **0.75** | **0.75** | **0.75** |
| **Total MU** | | | | | | | | **2.50** | **4.25** | **4.25** |

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#### 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

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤ 4.2 GHz | 4.2<f≤ 6 GHz | f≤ 3 GHz | 3<f≤ 4.2 GHz | 4.2<f≤ 6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| A2-18a | Misalignment and pointing error of BS (for TRP) | 0.30 | 0.30 | 0.30 | Rectangular | 1.73 | 1 | 0.17 | 0.17 | 0.17 |
| C3-5 | Additional (COEX) emissions - Conducted Uncertainty (minus mismatch) | 1.02 | 1.28 | 1.53 | Gaussian | 1.00 | 1 | 1.02 | 1.28 | 1.53 |
| A2-2a | Standing wave between BS and test range antenna | 0.21 | 0.21 | 0.21 | U-shaped | 1.41 | 1 | 0.15 | 0.15 | 0.15 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A2-4a | QZ ripple experienced by BS | 0.09 | 0.09 | 0.09 | Gaussian | 1.00 | 1 | 0.09 | 0.09 | 0.09 |
| A2-17 | Measurement system dynamic range uncertainty | 0.51 | 0.51 | 0.51 | Gaussian | 1.00 | 1 | 0.51 | 0.51 | 0.51 |
| A2-12 | Frequency flatness of test system | 0.25 | 0.25 | 0.25 | Gaussian | 1.00 | 1 | 0.25 | 0.25 | 0.25 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| C1-3 | Uncertainty of the network analyzer | 0.13 | 0.20 | 0.20 | Gaussian | 1.00 | 1 | 0.13 | 0.20 | 0.20 |
| A2-5a | Mismatch of receiver chain between receiving antenna and measurement receiver | 0.13 | 0.33 | 0.33 | U-shaped | 1.41 | 1 | 0.09 | 0.23 | 0.23 |
| A2-6 | Insertion loss of receiver chain | 0.18 | 0.18 | 0.18 | Rectangular | 1.73 | 1 | 0.10 | 0.10 | 0.10 |
| A2-3 | RF leakage (SGH connector terminated & test range antenna connector cable terminated) | 0.00 | 0.00 | 0.00 | Gaussian | 1.00 | 1 | 0.00 | 0.00 | 0.00 |
| A2-7 | Influence of the calibration antenna feed cable | 0.02 | 0.02 | 0.02 | U-shaped | 1.41 | 1 | 0.02 | 0.02 | 0.02 |
| C1-4 | Uncertainty of the absolute gain of the reference antenna | 0.50 | 0.43 | 0.43 | Rectangular | 1.73 | 1 | 0.29 | 0.25 | 0.25 |
| A2-8 | Misalignment positioning system | 0.00 | 0.00 | 0.00 | Exp. normal | 2.00 | 1 | 0.00 | 0.00 | 0.00 |
| A2-1b | Misalignment and pointing error of calibration antenna (for EIRP) | 0.50 | 0.50 | 0.50 | Exp. normal | 2.00 | 1 | 0.25 | 0.25 | 0.25 |
| A2-9 | Rotary joints | 0.05 | 0.05 | 0.05 | U-shaped | 1.41 | 1 | 0.03 | 0.03 | 0.03 |
| A2-2b | Standing wave between calibration antenna and test range antenna | 0.09 | 0.09 | 0.09 | U-shaped | 1.41 | 1 | 0.06 | 0.06 | 0.06 |
| A2-4b | QZ ripple experienced by calibration antenna | 0.01 | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 | 0.01 |
| A2-11 | Switching uncertainty | 0.26 | 0.26 | 0.26 | Rectangular | 1.73 | 1 | 0.15 | 0.15 | 0.15 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **1.28** | **1.51** | **1.73** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **2.51** | **2.96** | **3.38** |
| **TRP summation error** | | | | | | | | **0.75** | **0.75** | **0.75** |
| **Total MU** | | | | | | | | **2.62** | **3.05** | **3.47** |

*----------------------------- Next modified section -----------------------------*

#### 13.2.2.3 MU value derivation, FR1

Table 13.2.2.3-1: General chamber MU value derivation for TDD OFF power level measurement

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3 <f ≤ 4.2 GHz | 4.2<f≤ 6 GHz | f≤3 GHz | 3<f≤ 4.2 GHz | 4.2<f≤ 6 GHz |
| Stage 2: BS measurement | | | | | | | | | | |
| C2-9 | Uncertainty related to the selection of the CLTA ( | 1.5 | 1.5 | 1.5 | Rectangular | 1.73 | 1 | 0.87 | 0.87 | 0.87 |
| C2-10 | Uncertainty related to the placement of the CLTA | 1.7 | 1.7 | 1.7 | Rectangular | 1.73 | 1 | 0.98 | 0.98 | 0.98 |
| C2-12 | Uncertainty related to measuring close to noise floor Tx OFF | 1 | 1 | 1 | Gaussian | 1.00 | 1 | 1.00 | 1.00 | 1.00 |
| C2-13 | Impedance mismatch between feeder cable and CLTA | 0.14 | 0.23 | 0.25 | U-Shaped | 1.41 | 1 | 0.10 | 0.16 | 0.18 |
| C2-14 | Gain variations in LNA | 0.1 | 0.1 | 0.1 | Gaussian | 1.00 | 1 | 0.10 | 0.10 | 0.10 |
| A5-8 | Random uncertainty | 0.1 | 0.1 | 0.1 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| C1-5 | Measurement receiver (co-location) | 0.41 | 0.74 | 0.8 | Gaussian | 1.00 | 1 | 0.41 | 0.74 | 0.80 |
| A5-20 | Reflections in anechoic chamber | 0.01 | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 | 0.01 |
| C2-15 | Gain variations in measurement amplifier | 0.1 | 0.1 | 0.1 | Gaussian | 1.00 | 1 | 0.10 | 0.10 | 0.10 |
| **Stage 1: Calibration measurement** | | | | | | | | | | |
| C1-6 | Noise figure measurement accuracy | 0.2 | 0.2 | 0.2 | Gaussian | 1.00 | 1 | 0.2 | 0.2 | 0.2 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **1.72** | **1.83** | **1.86** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **3.37** | **3.59** | **3.64** |

UID are referenced to annex A, B or C as appropriate.

*----------------------------- Next modified section -----------------------------*

#### 13.3.2.3 MU value derivation, FR1

Table 13.3.2.3-1: General chamber MU value derivation for co-location emissions level measurement

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤ 4.2 GHz | 4.2<f≤ 6 GHz | f≤3 GHz | 3<f≤ 4.2 GHz | 4.2<f≤ 6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| C2-9 | Uncertainty related to the selection of the CLTA | 1.5 | 1.5 | 1.5 | Rectangular | 1.73 | 1 | 0.87 | 0.87 | 0.87 |
| C2-10 | Uncertainty related to the placement of the CLTA | 1.7 | 1.7 | 1.7 | Rectangular | 1.73 | 1 | 0.98 | 0.98 | 0.98 |
| C2-11 | Uncertainty related to measuring close to noise floor - Emissions | 0.68 | 0.68 | 0.68 | Gaussian | 1.00 | 1 | 0.68 | 0.68 | 0.68 |
| C2-13 | Impedance mismatch between feeder cable and CLTA | 0.14 | 0.23 | 0.25 | U-Shaped | 1.41 | 1 | 0.10 | 0.16 | 0.18 |
| C2-14 | Gain variations in LNA | 0.1 | 0.1 | 0.1 | Gaussian | 1.00 | 1 | 0.10 | 0.10 | 0.10 |
| A5-8 | Random uncertainty | 0.1 | 0.1 | 0.1 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| C1-5 | Measurement receiver (co-location) | 0.41 | 0.74 | 0.8 | Gaussian | 1.00 | 1 | 0.41 | 0.74 | 0.80 |
| A5-20 | Reflections in anechoic chamber | 0.01 | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 | 0.01 |
| C2-15 | Gain variations in measurement amplifier | 0.1 | 0.1 | 0.1 | Gaussian | 1.00 | 1 | 0.10 | 0.10 | 0.10 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| C1-6 | Noise figure measurement accuracy | 0.2 | 0.2 | 0.2 | Gaussian | 1 | 1 | 0.2 | 0.2 | 0.2 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **1.55** | **1.68** | **1.71** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **3.05** | **3.29** | **3.34** |

UID are referenced to annex A, B or C as appropriate.

*----------------------------- Next modified section -----------------------------*

#### 13.4.2.3 MU value derivation, FR1

Table 13.4.2.3-1: MU for OTA transmitter intermodulation interferer signal

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤ 4.2 GHz | 4.2<f≤ 6 GHz | f≤3 GHz | 3<f≤ 4.2 GHz | 4.2<f≤ 6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| C2-9 | Uncertainty related to the selection of the CLTA | 1.50 | 1.50 | 1.50 | Rectangular | 1.73 | 1 | 0.87 | 0.87 | 0.87 |
| C2-10 | Uncertainty related to the placement of the CLTA | 1.70 | 1.70 | 1.70 | Rectangular | 1.73 | 1 | 0.98 | 0.98 | 0.98 |
| C2-13 | Impedance mismatch between feeder cable and CLTA | 0.14 | 0.23 | 0.25 | U-Shaped | 1.41 | 1 | 0.10 | 0.16 | 0.18 |
| A5-8 | Random uncertainty | 0.10 | 0.10 | 0.10 | Rectangular | 1.73 | 1 | 0.06 | 0.06 | 0.06 |
| A5-20 | Reflections in anechoic chamber | 0.01 | 0.01 | 0.01 | Gaussian | 1.00 | 1 | 0.01 | 0.01 | 0.01 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| C3-6 | TX IMD - conducted measurement uncertainty | 1.00 | 1.10 | 1.20 | Gaussian | 1.00 | 1 | 1.00 | 1.10 | 1.20 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **1.65** | **1.72** | **1.79** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **3.24** | **3.37** | **3.50** |

UID are referenced to annex A, B or C as appropriate.

*----------------------------- Next modified section -----------------------------*

#### 13.5.2.3 MU value derivation, FR1

The MU for the interferer signal is as follows:

Table 13.5.2.3-1: MU for co-location blocking interferer signal

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Uncertainty source | Uncertainty value (dB) | | | Distribution of the probability | Divisor based on distribution shape | *ci* | Standard uncertainty *ui* (dB) | | |
| f≤3 GHz | 3<f≤ 4.2 GHz | 4.2<f≤ 6 GHz | f≤3 GHz | 3<f≤ 4.2 GHz | 4.2<f≤ 6 GHz |
| **Stage 2: BS measurement** | | | | | | | | | |  |
| C2-9 | Uncertainty related to the selection of the CLTA | 1,50 | 1,50 | 1,50 | Rectangular | 1,73 | 1 | 0,87 | 0,87 | 0,87 |
| C2-10 | Uncertainty related to the placement of the CLTA | 1,70 | 1,70 | 1,70 | Rectangular | 1,73 | 1 | 0,98 | 0,98 | 0,98 |
| C2-13 | Impedance mismatch between feeder cable and CLTA | 0,14 | 0,23 | 0,25 | U-Shaped | 1,41 | 1 | 0,10 | 0,16 | 0,18 |
| A5-8 | Random uncertainty | 0,10 | 0,10 | 0,10 | Rectangular | 1,73 | 1 | 0,06 | 0,06 | 0,06 |
| A5-3 | Quality of quiet zone | 0,10 | 0,10 | 0,10 | Gaussian | 1,00 | 1 | 0,10 | 0,10 | 0,10 |
| **Stage 1: Calibration measurement** | | | | | | | | | |  |
| C3-7 | Colocation blocking - conducted measurement uncertainty | 1,00 | 1,10 | 1,20 | Gaussian | 1,00 | 1 | 1,00 | 1,10 | 1,20 |
| **Combined standard uncertainty (1σ) (dB)** | | | | | | | | **1,65** | **1,72** | **1,79** |
| **Expanded uncertainty (1.96σ - confidence interval of 95 %) (dB)** | | | | | | | | **3,24** | **3,37** | **3,51** |

UID are referenced to annex A, B or C as appropriate.

*----------------------------- Next modified section -----------------------------*

Annex A (informative):  
Radiated TX measurement error contribution descriptions

# A.1 Indoor Anechoic Chamber

This clause describes measurement uncertainty contributors for TX measurements in Indoor Anechoic Chamber.

NOTE: Several MU contributor descriptions are defined in a way combining both BS for the measurement stage and calibration/reference antenna for calibration stage, e.g. for A1-4 this contribution is denoted as A1-4a for polarization mismatch between the BS and the receiving antenna, and as A1-4b for polarization mismatch between the reference antenna and the receiving antenna.

**A1-1 Positioning misalignment between the BS and the reference antenna**

This contribution originates from the misalignment of the manufacturer declared coordinate system reference point of the BS and the phase centre of the reference antenna. The uncertainty makes the space propagation loss between the BS and the receiving antenna at the BS measurement stage (i.e. Stage 2) different from the space propagation loss between the reference antenna and the receiving antenna at the calibration stage (i.e. Stage 1).

**A1-2 Pointing misalignment between the BS and the receiving antenna**

This contribution originates from the misalignment of the testing direction and the *beam peak direction* of the receiving antenna due to imperfect rotation operation. The pointing misalignment may happen in both azimuth and vertical directions and the effect of the misalignment depends highly on the beamwidth of the beam under test. The same level of misalignment results in a larger measurement error for a narrower beam.

**A1-3 Quality of quiet zone (normal test conditions)**

This contribution originates from a reflectivity level of an anechoic chamber. The reflectivity level is determined from the average standard deviation of the electric field in the quiet zone. By repeating a free space VSWR measurement in 15° grid in elevation and azimuth, 264 standard deviation values in both polarizations are determined. From these values an average standard deviation of electric field in the quiet zone can be calculated from the equation:



Where:

 is the number of angular intervals in elevation,

 is the number of angular intervals in azimuth, and

 is elevation of single measurement .

If an efficiency calibration with omni-directional calibration antenna is performed, the effect of reflectivity level decreases in Stage 1 (i.e. calibration measurement) and  may be divided by factor 2. This is due to correcting impact of data averaging in this type of calibration. Efficiency calibration done with sampling step ≤ 30°, can be considered to have at least four independent samples.  may be divided by factor 2 also in Stage 2 (i.e. BS measurement) for the same reason.

It's likely that asymmetry of the field probe will have a very small impact on this measurement uncertainty contributor, however, an upper bound to probe symmetry should be considered.

NOTE: This MU contributor is defined for normal test conditions. MU contributor for the quality of QZ in extreme test conditions is defined in A1-17.

**A1-4 Polarization mismatch between the BS (a) / reference antenna (b) and the receiving antenna**

This contribution originates from the misaligned polarization between the BS/reference antenna and the receiving antenna.

**A1-5 Mutual coupling between the BS (a) / reference antenna (b) and the receiving antenna**

This contribution originates from mutual coupling between the BS/reference antenna and the receiving antenna. Mutual coupling degrades not just the antenna efficiency, i.e. the EIRP value, but it can alter the antenna's radiation pattern as well. For indoor anechoic chamber, usually the spacing between the BS/reference antenna and the receiving antennas is large enough so that the level of mutual coupling might be negligible.

**A1-6 Phase curvature**

This contribution originates from the finite far field measurement distance, which causes phase curvature across the antenna of BS/reference antenna.

**A1-7 Impedance mismatch in the receiving chain**

This contribution originates from multiple reflections between the receiving antenna and the power measurement equipment. The multiple reflections can produce an overall reflection that depends not only upon the individual reflections of each part but their reflective interactions as well. The combination loss by the overall reflection can be higher or lower than individual loss by multiple reflections. The combination loss is called the mismatch error and leads to the measurement uncertainty.

**A1-8 Random uncertainty**

The random uncertainty characterizes the undefined and miscellaneous effects which cannot be forecasted. One can estimate this type of uncertainty with a repeatability test by making a series of repeated measurement with a reference BS without changing anything in the measurement set-up.

**A1-9 Impedance mismatch between the receiving antenna and the network analyzer**

This contribution originates from multiple reflections between the receiving antenna and the network analyzer. After appropriate calibration, the network analyzer may not introduce impedance mismatch error, but the error still happens between the receiving antenna feed cable and the receiving antenna.

**A1-10 Positioning and pointing misalignment between the reference antenna and the receiving antenna**

This contribution originates from reference antenna alignment and pointing error. In this measurement if the maximum gain directions of the reference antenna and the receiving antenna are aligned to each other, this contribution can be considered negligible and therefore set to zero.

**A1-11 Impedance mismatch between the reference antenna and the network analyzer**

This contribution originates from multiple reflections between the reference antenna and the network analyzer. After appropriate calibration, the network analyzer may not introduce impedance mismatch error, but the error still happens between the reference antenna feed cable and the reference antenna.

**A1-12 Influence of the reference antenna feed cable**

In the calibration Stage 1, the influence of the calibration antenna feed cable is assessed by measurements. A measurement for calibration may be repeated with a reasonably differing routing of the feed cable. Largest difference among the results is entered to the uncertainty budget with a rectangular distribution.

**A1-13 Reference antenna feed cable loss measurement uncertainty**

Before performing the calibration, the reference antenna feed cable loss have to be measured. The measurement can be done with a network analyzer to measure its S21 and uncertainty is introduced.

**A1-14 Influence of the receiving antenna feed cable**

If the probe antenna is directional (i.e. peak gain >+5 dBi, e.g. horn, LPDA, etc.) and the same probe antenna cable configuration is used for both stages, the uncertainty is considered systematic and constant 🡺 0.00 dB value.

In other cases a technical study should be done.

**A1-15 Uncertainty of the absolute gain of the receiving antenna**

The uncertainty appears in both stages and it is thus considered systematic and constant 🡺 0.00 dB value.

**A1-16 Frequency flatness of test system**

This uncertainty contribution to account for the frequency interpolation error caused by a finite frequency resolution during the calibration stage.

**A1-17 Quality of quiet zone (extreme test conditions)**

This contribution is related to the ambient quality of the quiet zone for normal test conditions (i.e. A1-3) which originates from a reflectivity level of an anechoic chamber. The reflectivity level is determined from the average standard deviation of the electric field in the quiet zone. As the environmental enclosure is larger than the BS and the material of the environmental chamber may cause some reflection and refraction the quite zone flatness will be effected. The quality of the quiet zone for the extreme test is therefore larger that for the ambient due to the environmental enclosures effect.

NOTE: This MU contributor is defined for extreme test conditions. MU contributor for the quality of QZ in normal test conditions is defined in A1-3.

**A1-18 Wet radome loss variation (extreme test conditions)**

The environmental chamber radome will be an ineffective thermal isolator and will have extreme temperatures on the inside and the OTA chamber ambient temperature on the outside. In such conditions condensation is inevitable. This uncertainty is due to the variation in the radome loss due to condensation on the environmental chamber radome.

**A1-19 Radome loss variation (extreme test conditions)**

The environmental chamber radome will affect the path between the BS and the test antenna due to both its insertion loss and also reflection and refraction from the materials surface. The loss is dependent on the material as well as its proximity to the BS. The uncertainty is the residual uncertainly of the total loss after calibration.

**A1-20 Change in absorber behaviour (extreme test conditions)**

The environmental chamber will contain RF absorptive material to prevent reflections within the chamber. This RF absorptive material will be subjected to the extreme temperatures inside the environmental chamber and hence its properties will change. This uncertainty accounts for the effect of that change in behavior.

**A1-21** **Uncertainty of the LNA (FR2 only)**

To maintain a low noise figure for the measurement system (possibly considering the addition of a down conversion mixer for high frequencies) and LNA may be required. The variation in the gain of the LNA after the calibration procedure is accounted for in this uncertainty contribution.

**A1-22** **Uncertainty of the Mixer (FR2 only)**

Higher frequency emissions beyond the upper frequency range of the measurement equipment require down converting prior to measurement. The uncertainty introduced by the down conversion is accounted for in this uncertainty contribution.

# A.2 Compact Antenna Test Range

This clause describes measurement uncertainty contributors for TX measurements in Compact Antenna Test Range.

NOTE: Several MU contributor descriptions are defined in a way combining both BS for the measurement stage and calibration/reference antenna for calibration stage, e.g. for A1-4 this contribution is denoted as A1-4a for polarization mismatch between the BS and the receiving antenna, and as A1-4b for polarization mismatch between the reference antenna and the receiving antenna.

**A2-1 Misalignment and pointing error of BS (a) /calibration antenna (b) (for EIRP)**

This contribution denotes uncertainty in BS/calibration antenna alignment and BS/calibration antenna pointing error. In this measurement the BS/calibration antenna is aligned to maximum, also allowing for a zero contribution for polarization mismatch uncertainty. By adjusting for maximums to align, this contribution can be a small contribution. The calibration antenna's phase centre and polarization purity changes slightly according to the frequency. Therefore, there should be some uncertainty reserved for this. To ensure that the point error is at a minimal, this contribution should be captured using the antenna pattern cut which is broadest (in the case of the BS this would most likely be in the azimuth domain).

NOTE: This MU contributor used different values for the EIRP measurement and for TRP measurement. Therefore, those two were explicitly differentiated in the MU derivation tables, i.e. A2-1 for EIRP, A2-18 for TRP.

**A2-2 Standing wave between BS (a) / calibration antenna (b) and test range antenna**

This value is extracting the uncertainty value and standard deviation of gain ripple coming from standing waves between BS and test range antenna. This value can be captured by moving the BS towards the test range antenna as the standing waves go in and out of phase causing a ripple in measured gain.

**A2-3 RF leakage (SGH connector terminated & test range antenna connector cable terminated)**

This contribution denotes noise leaking in to connector and cable(s) between test range antenna and receiving equipment. The contribution also includes the noise leakage between the connector and cable(s) between SGH/reference antenna and transmitting equipment.

**A2-4 QZ ripple experienced by BS (a) /calibration antenna (b) (normal test conditions)**

This is the quiet zone (QZ) ripple experienced by the BS/calibration antenna during the measurement or calibration phase. The purpose of this component is to capture the contributions that the reflections from the walls, roof and floor that will add to the EIRP measurement. The sum of all these reflections from the walls, range reflector (if applicable), roof and floor will give the overall value for the QZ ripple. In other words, the uncertainty component from the wall will not be separated from the roof or the floor. The purpose of this uncertainty component is to capture the overall reflections from the chamber walls experienced by the BS/calibration antenna. To capture the full effect of the QZ ripple a distance of 1λ should be measured from each of the BS/calibration antenna physical aperture edges, i.e. total QZ distance = physical aperture length +2 λ, to ensure the full volume of the QZ is captured in the uncertainty measurement.

NOTE: This MU contributor is defined for normal test conditions. MU contributor for the quality of QZ in extreme test conditions is defined in A2-13.

**A2-5 Mismatch of receiver chain (i.e. between receiving antenna and measurement receiver (a) / low power receiver (b))**

This uncertainty is the residual uncertainty contribution coming from multiple reflections between the receiving antenna and the test receiver equipment. This value can be captured through measurement by measuring the S11 towards the receive antenna and also towards the test receiver. The mismatch between the antenna reflection and the receiver reflection can also be calculated. If the same cable is used for calibration Stage 1, this can be considered systematic and negligible.

**A2-6 Insertion loss of receiver chain**

This uncertainty is the residual uncertainty contribution coming from introducing an antenna at the end of the cable. If this cable does not change/move between the calibration Stage 1 and the measurement Stage 2, the uncertainty is assumed to be systematic and negligible during the measurement stage. Alternatively, the insertion loss can also be calculated by taking the measurement of the cable where port 2 is the end of the cable connected to the BS or calibration antenna.

IL = -20log10|S21| dB

**A2-7 Influence of the calibration antenna feed cable, i.e. flexing cables, adapters, attenuators, extra pathloss cable & connector repeatability**

During the calibration phase this cable is used to feed the calibration antenna and any influence it may have upon the measurements is captured. This is assessed by repeated measurements while flexing the cables and rotary joints. The largest difference between the results is recorded as the uncertainty.

**A2-8 Misalignment positioning system**

This contribution originates from uncertainty in sliding position and turn table angle accuracy. If the calibration antenna is aligned to maximum this contribution can be considered negligible and therefore set to zero.

**A2-9 Rotary joints**

If applicable the contribution of this uncertainty the accuracy in changing from azimuth to vertical measurements.

**A2-10 Miscellaneous uncertainty**

The term 'miscellaneous uncertainty' is used to define all the unknown, unquantifiable, etc. uncertainties associated with EIRP measurements. This term should include truly random effects as well as systematic uncertainties, such as that arising from dissimilarity between the patterns of the reference antenna (SGH) and the BS.

**A2-11 Switching uncertainty**

The purpose of the switching unit is to switch electromechanically different RF path to different measurement instruments of different measurement modes. The electromechanical switching clearly reduces the errors arising from manual switching work. Switching is also used to measure the path loss values of each polarization component. Even though the electromechanical switching is preferable during path loss and antenna performance measurements, some minor uncertainties can occur when the switch states are programmed to change their polarity.

**A2-12 Frequency flatness of test system**

This uncertainty contribution to account for the frequency interpolation error caused by a finite frequency resolution during the calibration stage.

**A2-13 Quality of quiet zone (extreme test conditions)**

This contribution is related to the ambient quality of the quiet zone for normal test conditions (A2-4) which originates from a reflectivity level of an anechoic chamber. The reflectivity level is determined from the average standard deviation of the electric field in the quiet zone. As the environmental enclosure is larger than the BS and the material of the environmental chamber may cause some reflection and refraction the quite zone flatness will be effected. The quality of the quiet zone for the extreme test is therefore larger that for the ambient due to the environmental enclosures effect. **A2-14 Wet radome loss variation (extreme test conditions)**

The environmental chamber radome will be an ineffective thermal isolator and will have extreme temperatures on the inside and the OTA chamber ambient temperature on the outside. In such conditions condensation is inevitable. This uncertainty is due to the variation in the radome loss due to condensation on the environmental chamber radome.

**A2-15 Radome loss variation (extreme test conditions)**

The environmental chamber radome will affect the path between the BS and the test antenna due to both its insertion loss and also reflection and refraction from the materials surface. The loss is dependent on the material as well as its proximity to the BS. The uncertainty is the residual uncertainly of the total loss after calibration.

**A2-16 Change in absorber behaviour (extreme test conditions)**

The environmental chamber will contain RF absorptive material to prevent reflections within the chamber. This RF absorptive material will be subjected to the extreme temperatures inside the environmental chamber and hence its properties will change. This uncertainty accounts for the effect of that change in behavior.

**A2-17 Measurement system dynamic range uncertainty**

Uncertainty associated with the addition of each of the directional power measurements to calculate the TRP due to the limited dynamic range of the OTA test system causing an overestimation.

**A2-18 Misalignment and pointing error of BS (a) /calibration antenna (b) (for TRP)**

This contribution denotes uncertainty in BS/calibration antenna alignment and BS/calibration antenna pointing error and its effect on the TRP calculation. The pointing error for TRP emissions measurement is larger than for EIRP (A2-1).

NOTE: This MU contributor used different values for the EIRP measurement and for TRP measurement. Therefore, those two were explicitly differentiated in the MU derivation tables, i.e. A2-1 for EIRP, A2-18 for TRP.

**A2-19** **Uncertainty of the LNA (FR2 only)**

To maintain a low noise figure for the measurement system (possibly considering the addition of a down conversion mixer for high frequencies) and LNA may be required. The variation in the gain of the LNA after the calibration procedure is accounted for in this uncertainty contribution

**A2-20** **Uncertainty of the mixer (FR2 only)**

Higher frequency emissions beyond the upper frequency range of the measurement equipment require down converting prior to measurement. The uncertainty introduced by the down conversion is accounted for in this uncertainty contribution.

# A.3 Near Field Test Range

This clause describes measurement uncertainty contributors for TX measurements in Near Field Test Range.

**A3-1 Axes intersection**

This is a mechanical uncertainty term and aim to find the uncertainty related with the lateral displacement between the horizontal and vertical axes of the BS positioner. This can result in sampling the field on a non-ideal sphere. This uncertainty is assumed to have a Gaussian distribution.

**A3-2 Axes orthogonality**

The difference from 90° of the angle between the horizontal and vertical axes also results in sampling the field on a non-ideal sphere. This uncertainty is assumed to have a Gaussian distribution.

**A3-3 Horizontal pointing**

The horizontal mispointing of the horizontal axis to the probe reference point for Theta = 0° also results in sampling the field on a non-ideal sphere. This uncertainty is assumed to have a Gaussian distribution.

**A3-4 Probe vertical position**

The vertical displacement of the probe reference point from the horizontal axis results in sampling the field on a non-ideal sphere. This uncertainty is assumed to have a Gaussian distribution.

**A3-5 Probe horizontal/vertical pointing**

The horizontal or vertical mispointing of the probe z-axis from the intersection point of the horizontal/vertical axis. This uncertainty is assumed to have a Gaussian distribution.

**A3-6 Measurement distance**

This is the knowledge of the distance between the intersection point of the horizontal and vertical axis and probe reference point. This uncertainty is assumed to have a Gaussian distribution.

**A3-7 Amplitude and phase drift**

The system drift due to temperature variations the signal at BS location to drift in amplitude and phase. This uncertainty is assumed to have a Gaussian distribution.

**A3-8 Amplitude and phase noise**

This uncertainty is due to the noise level of the test range so that the S/N ratio should be determined or measured at the BS location. The noise level is usually measured with a Spectrum Analyzer. This uncertainty is assumed to have a Gaussian distribution.

**A3-9 Leakage and crosstalk**

This uncertainty can be addressed by measurements on the actual system setup. The leakage and crosstalk cannot be separated from the random amplitude and phase errors so that the relative importance should be determined. This uncertainty is assumed to have a Gaussian distribution.

**A3-10 Amplitude non-linearity**

This uncertainty is the linearity of the receiver used for the measurement. It can be taken from the data sheet of the receiver.

**A3-11 Amplitude and phase shift in rotary joint**

This uncertainty is due to the variation of the rotary joint. It can be measured and is assumed to have a Gaussian distribution.

**A3-12 Channel balance amplitude and phase**

This uncertainty is relevant for systems which are using dual polarized probes and polarization switches. The amplitude and phase difference between two signal channels of the receiver includes the difference between the probe ports, difference between the channels of the polarization switch, connecting cables and reflection coefficients. This uncertainty is assumed to have a Gaussian distribution.

**A3-13 Probe polarization amplitude and phase**

The amplitude and phase of the probe polarization coefficients should be measured. This uncertainty is assumed to have a Gaussian distribution.

**A3-14 Probe pattern knowledge**

The probe(s) pattern(s) is assumed to be known so that the BS measurement in near field can be corrected when performing the near field to far field transform. There is no direct dependence between the BS pattern and the probe pattern in near field measurements. This uncertainty is assumed to have a Gaussian distribution.

**A3-15 Multiple reflections**

The multiple reflections occur when a portion of the transmitted signal is reflected form the receiving antenna back to the transmitting antenna and re-reflected by the transmitting antenna back to the receiving antenna. This uncertainty can be determined by multiple measurements of the BS when at different distance from the probes. This uncertainty is assumed to have a Gaussian distribution.

**A3-16 Room scattering**

As for the multiple reflections, a portion of the transmitted signal is reflected by either the absorbers or other structures in the measurement anechoic chamber before being received by the receiving antenna. This effect can be isolated from the multiple reflections by testing the BS in different positions, separated by λ/4 with respect to the anechoic chamber and comparing these measurements with the reference. This uncertainty is assumed to have a Gaussian distribution.

**A3-17 BS support scattering**

This is the uncertainty due to the BS supporting structure on the signal level. This uncertainty is assumed to have a Gaussian distribution.

**A3-18 Scan area truncation**

This uncertainty does affect this near field measurement. It can be addressed by comparing the measurement result when scanning the full area. This uncertainty is assumed to have a Gaussian distribution.

**A3-19 Sampling point offset**

This uncertainty has an influence in near field and far field. It is assumed to have a Gaussian distribution.

**A3-20 Spherical mode truncation**

The measured near field is expanded using a finite set of spherical modes. The number of modes is linked to number of samples. The filtering effect generated by the finite number of modes can improve measurement results by removing signals from outside the physical area of the BS. Care should be taken in order to make sure the removed signals are not from the BS itself. This uncertainty is usually negligible.

**A3-21 Positioning**

The relative position of the probe array is not ideal. This uncertainty is assumed to have a rectangular distribution.

**A3-22 Probe array uniformity**

This is the uncertainty due to the fact that different probes are used for each physical position. Different probes have different radiation patterns. Generally, the probe array is calibrated so that the uniformity of the probes is achieved.

**A3-23 Mismatch of receiver chain**

If the same chain configuration (including the measurement receiver; the probe antenna and other elements) is used in both stages, the uncertainty is considered systematic and constant 🡺 0.00 dB value.

If it is not the case, this uncertainty contribution has to be taken into account and should be measured or determined by the method described in TR 25.914 [24]. This uncertainty is assumed to have a U-shaped distribution.

**A3-24 Insertion loss of receiver chain**

It is composed of the following:

- Insertion loss of the probe antenna cable.

- Insertion loss of the probe antenna attenuator (if used).

- Insertion loss of RF relays (if used).

If the same chain configuration is used for measurement and calibration, the uncertainty due to the above components is considered systematic and constant 🡺 0.00 dB value. This uncertainty is assumed to have a Gaussian distribution.

**A3-25 Uncertainty of the absolute gain of the probe antenna**

This uncertainty appears in the both stages and it is thus considered systematic and constant🡺 0.00 dB value.

**A3-26 Measurement repeatability - positioning repeatability**

This uncertainty is due to the repositioning of the BS in the test setup. It can be addressed by repeating the corresponding measurement 5 times. Calculate the standard deviation of the metric obtained and use that as the measurement uncertainty. For tests that require multiple setups, the worst-case standard deviation is used. This uncertainty is assumed to have a Gaussian distribution.

**A3-27 Mismatch of receiver chain**

If the same chain configuration (including the measurement receiver; the probe antenna and other elements) is used in both stages, the uncertainty is considered systematic and constant 🡺 0.00 dB value.

If it is not the case, each uncertainty contribution has to be taken into account and should be measured or determined and then taking the total of all non-zero mismatch uncertainty contribution from all parts by root-sum-squares (RSS) method. This uncertainty is assumed to have a Gaussian distribution.

**A3-28 Insertion loss of receiver chain**

If the same chain configuration is used for measurement and calibration, the uncertainty due to the above components is considered systematic and constant 🡺 0.00 dB value. This uncertainty is assumed to have a Gaussian distribution.

**A3-29 Mismatch in the connection of the calibration antenna**

This is the uncertainty from the mismatch in the connection between the system coax cable and the calibration antenna. This uncertainty is from the mismatch between the cable and the reference antenna that is used for calibration. It is determined by the S11 of the reference antenna and the S11 of the cable to which the antenna is connected i.e. if using an SGH antenna for calibration and 10 dB pad is inserted on the cable connecting to the antenna this uncertainty contribution can be considered negligible. This uncertainty is assumed to have a U-shaped distribution.

**A3-30 Influence of the calibration antenna feed cable**

This uncertainty is due to the impact of the feeding cable on the radiation properties of the calibration antenna. In case of using either a standard horn or standard gain horn, the impact of the cable is to be considered negligible thus the uncertainty 🡺 0.00 dB value. In case of using a dipole-like antenna, the uncertainty should be addressed by measuring this impact. This uncertainty is assumed to have a Gaussian distribution.

**A3-31 Influence of the probe antenna cable**

If the same chain configuration is used for measurement and calibration, the uncertainty due to the above components is considered systematic and constant 🡺 0.00 dB value. This uncertainty is assumed to have a Gaussian distribution.

**A3-32 Short term repeatability**

It can be addressed by performing a repeatability test of the calibration antenna. This uncertainty is assumed to have a Gaussian distribution.

**A3-33 Frequency flatness of test system**

This uncertainty contribution to account for the frequency interpolation error caused by a finite frequency resolution during the calibration stage.

# A.4 One Dimensional Compact Range

This clause describes measurement uncertainty contributors for TX measurements in One Dimensional Compact Range.

NOTE: Several MU contributor descriptions are defined in a way combining both BS for the measurement stage and calibration/reference antenna for calibration stage, e.g. for A1-4 this contribution is denoted as A1-4a for polarization mismatch between the BS and the receiving antenna, and as A1-4b for polarization mismatch between the reference antenna and the receiving antenna.

**A4-1 Misalignment and pointing error of BS**

This contribution denotes uncertainty in BS alignment and BS pointing error. In this measurement the BS is aligned to maximum, also allowing for a zero contribution for polarization mismatch uncertainty. By adjusting for maximums to align, this contribution can be a small contribution. The reference antenna´s phase centre and polarization purity changes slightly according to the frequency. Therefore, there should be some uncertainty reserved for this. To ensure that the pointing error is at a minimal, this contribution should be captured using the antenna pattern cut which is broadest (in the case of the BS this would most likely be in the azimuth domain).

**A4-2 Standing wave between BS (a) / reference antenna (b) and test range antenna**

This value is extracting the uncertainty value and standard deviation of gain ripple coming from standing waves between BS and test range antenna. This value can be captured by moving the BS towards the test range antenna as the standing waves go in and out of phase causing a ripple in measured gain.

**A4-3 Quiet zone ripple experienced by BS (a) / reference antenna (b)**

This is the quiet zone (QZ) ripple experienced by the BS/reference antenna during the measurement phase. The purpose of this component is to capture the contributions that the reflections from the walls, roof and floor that will add to the EIRP measurement. The sum of all these reflections from the walls, range reflector (if applicable), roof and floor will give the overall value for the QZ ripple. In other words, the uncertainty component from the wall will not be separated from the roof or the floor. The purpose of this uncertainty component is to capture the overall reflections from the chamber walls experienced by the BS/reference antenna. To capture the full effect of the QZ ripple a distance of 1λ must be measured from each of the BS/reference antenna physical aperture edges, i.e. total QZ distance = physical aperture length + 2 λ, to ensure the full volume of the QZ is captured in the uncertainty measurement.

**A4-4 Phase curvature** **across the BS antenna (a) / reference antenna (b)**

This contribution originates from the finite far field measurement distance, which causes phase curvature across the antenna of BS (a) / reference antenna (b).

**A4-5 Polarization mismatch between BS (a) / reference antenna (b) and receiving antenna**

This contribution originates from the misaligned polarization between the BS/reference antenna and the receiving antenna.

**A4-6 Mutual coupling between BS (a) / reference antenna (b) and receiving antenna**

This contribution originates from mutual coupling between the BS/reference antenna and the receiving antenna. Mutual coupling degrades not just the antenna efficiency, i.e. the EIRP value, but it can alter the antenna’s radiation pattern as well. For compact range chamber, usually the spacing between the BS/reference antenna and the receiving antennas is large enough so that the level of mutual coupling might be negligible.

**A4-7 Impedance mismatch in receiving chain**

This contribution originates from multiple reflections between the receiving antenna and the measurement equipment. The multiple reflections can produce an overall reflection that depends not only upon the individual reflections of each part but their reflective interactions as well. The combination loss by the overall reflection can be higher or lower than individual loss by multiple reflections. The combination loss is called the mismatch error and leads to the measurement uncertainty.

**A4-8 RF leakage (BS (a) / SGH (b) connector terminated and test range antenna connector cable terminated)**

This contribution denotes noise leaking into connector and cable(s) between test range antenna and receiving equipment. The contribution also includes the noise leakage between the connector and cable(s) between SGH/reference antenna and transmitting equipment.

**A4-9 Misalignment positioning system**

This contribution originates from uncertainty in sliding position and turn table angle accuracy. If the calibration antenna is aligned to maximum this contribution can be considered negligible and therefore set to zero.

**A4-10 Pointing error between reference antenna and test range antenna**

This contribution originates from the misalignment of the testing direction and the *beam peak direction* of the receiving antenna due to imperfect rotation operation. The pointing misalignment may happen in both azimuth and vertical directions and the effect of the misalignment depends highly on the beamwidth of the beam under test. The same level of misalignment results in a larger measurement error for a narrower beam.

**A4-11 Impedance mismatch in path to reference antenna**

This contribution originates from multiple reflections between the reference antenna and the measurement equipment. After appropriate calibration, the measurement equipment may not introduce impedance mismatch error, but the error still happens between the reference antenna feed cable and the reference antenna.

**A4-12 Impedance mismatch in path to compact probe**

This contribution originates from multiple reflections between the receiving antenna and the measurement equipment. After appropriate calibration, the measurement equipment may not introduce impedance mismatch error, but the error still happens between the receiving antenna feed cable and the receiving antenna.

**A4-13 Influence of reference antenna feed cable (i.e. flexing cables, adapters, attenuators, connector repeatability)**

During the calibration phase this cable is used to feed the reference antenna and any influence it may have upon the measurements is captured. This is assessed by repeated measurements while flexing the cables and rotary joints. The largest difference between the results is recorded as the uncertainty.

**A4-14 Mismatch of receiver chain (i.e. between receiving antenna and measurement equipment)**

This uncertainty is the residual uncertainty contribution coming from multiple reflections between the receiving antenna and the test receiver equipment. This value can be captured through measurement by measuring the S11 towards the receive antenna and also towards the test receiver. The mismatch between the antenna reflection and the receiver reflection can also be calculated. If the same cable is used for calibration stage, this can be considered systematic and negligible.

**A4-15 Insertion loss of receiver chain**

This uncertainty is the residual uncertainty contribution coming from introducing an antenna at the end of the cable. If this cable does not change/move between the calibration and the measurement stage, the uncertainty is assumed to be systematic and negligible during the measurement stage. Alternatively, the insertion loss can also be calculated by taking the measurement of the cable where port 2 is the end of the cable connected to the BS or reference antenna.

IL = -20log10|S21| dB

# A.5 General Chamber

This clause describes the measurement uncertainty contributors for TX measurements in general chamber.

NOTE: Several MU contributor descriptions are defined in a way combining both BS for the measurement stage and calibration/reference antenna for calibration stage, e.g. for A1-4 this contribution is denoted as A1-4a for polarization mismatch between the BS and the receiving antenna, and as A1-4b for polarization mismatch between the reference antenna and the receiving antenna.

**A5-1 Positioning misalignment between the BS and the reference antenna**

This contribution originates from the misalignment of the manufacturer declared coordinate system reference point of the BS and the phase centre of the reference antenna. The uncertainty makes the space propagation loss between the BS and the receiving antenna at the BS measurement stage (i.e. Stage 2) different from the space propagation loss between the reference antenna and the receiving antenna at the calibration stage (i.e. Stage 1).

**A5-2 Pointing misalignment between the BS and the receiving antenna**

This contribution originates from the misalignment of the testing direction and the *beam peak direction* of the receiving antenna due to imperfect rotation operation. The pointing misalignment may happen in both azimuth and vertical directions and the effect of the misalignment depends highly on the beamwidth of the beam under test. The same level of misalignment results in a larger measurement error for a narrower beam.

**A5-3 Quality of quiet zone**

This contribution originates from a reflectivity level of an anechoic chamber. The reflectivity level is determined from the average standard deviation of the electric field in the quiet zone. By repeating a free space VSWR measurement in 15° grid in elevation and azimuth, 264 standard deviation values in both polarizations are determined. From these values an average standard deviation of electric field in the quiet zone can be calculated from the equation:



Where:

 is the number of angular intervals in elevation,

 is the number of angular intervals in azimuth, and

 is elevation of single measurement .

If an efficiency calibration with omni-directional calibration antenna is performed, the effect of reflectivity level decreases in Stage 1 (i.e. calibration measurement) and  may be divided by factor 2. This is due to correcting impact of data averaging in this type of calibration. Efficiency calibration done with sampling step ≤ 30°, can be considered to have at least four independent samples.  may be divided by factor 2 also in Stage 2 (i.e. BS measurement) for the same reason.

It's likely that asymmetry of the field probe will have a very small impact on this measurement uncertainty contributor, however, an upper bound to probe symmetry should be considered.

**A5-4 Polarization mismatch between the BS (a) /reference antenna (b) and the receiving** antenna

This contribution originates from the misaligned polarization between the BS/reference antenna and the receiving antenna.

**A5-5 Mutual coupling between the BS (a) /reference antenna (b) and the receiving antenna**

This contribution originates from mutual coupling between the BS/reference antenna and the receiving antenna. Mutual coupling degrades not just the antenna efficiency, i.e. the EIRP value, but it can alter the antenna's radiation pattern as well. For indoor anechoic chamber, usually the spacing between the BS/reference antenna and the receiving antennas is large enough so that the level of mutual coupling might be negligible.

**A5-6 Phase curvature** **across the BS antenna (a) /reference antenna (b)**

This contribution originates from the finite far field measurement distance, which causes phase curvature across the antenna of BS (a) /reference antenna (b).

**A5-7 Impedance mismatch in the receiving chain**

This contribution originates from multiple reflections between the receiving antenna and the power measurement equipment. The multiple reflections can produce an overall reflection that depends not only upon the individual reflections of each part but their reflective interactions as well. The combination loss by the overall reflection can be higher or lower than individual loss by multiple reflections. The combination loss is called the mismatch error and leads to the measurement uncertainty.

**A5-8 Random uncertainty**

The random uncertainty characterizes the undefined and miscellaneous effects which cannot be forecasted. One can estimate this type of uncertainty with a repeatability test by making a series of repeated measurement with a reference BS without changing anything in the measurement set-up.

**A5-9 Impedance mismatch between the receiving antenna and the network analyzer**

This contribution originates from multiple reflections between the receiving antenna and the network analyzer. After appropriate calibration, the network analyzer may not introduce impedance mismatch error, but the error still happens between the receiving antenna feed cable and the receiving antenna.

**A5-10 Positioning and pointing misalignment between the reference antenna and the receiving antenna**

This contribution originates from reference antenna alignment and pointing error. In this measurement if the maximum gain directions of the reference antenna and the receiving antenna are aligned to each other, this contribution can be considered negligible and therefore set to zero.

**A5-11 Impedance mismatch between the reference antenna and the network analyzer**

This contribution originates from multiple reflections between the reference antenna and the network analyzer. After appropriate calibration, the network analyzer may not introduce impedance mismatch error, but the error still happens between the reference antenna feed cable and the reference antenna.

**A5-12 Influence of the reference antenna feed cable**

In the calibration Stage 1, the influence of the calibration antenna feed cable is assessed by measurements. A measurement for calibration may be repeated with a reasonably differing routing of the feed cable. Largest difference among the results is entered to the uncertainty budget with a rectangular distribution.

**A5-13 Reference antenna feed cable loss measurement uncertainty**

Before performing the calibration, the reference antenna feed cable loss have to be measured. The measurement can be done with a network analyzer to measure its S21 and uncertainty is introduced.

**A5-14 Influence of the receiving antenna feed cable**

If the probe antenna is directional (i.e. peak gain >+5 dBi, e.g. horn, LPDA, etc.) and the same probe antenna cable configuration is used for both stages, the uncertainty is considered systematic and constant 🡺 0.00 dB value.

In other cases a technical study should be done.

**A5-15 Uncertainty of the absolute gain of the receiving antenna**

The uncertainty appears in both stages and it is thus considered systematic and constant 🡺 0.00 dB value.

**A5-16 Frequency flatness of test system**

This uncertainty contribution to account for the frequency interpolation error caused by a finite frequency resolution during the calibration stage.

**A5-17 Measurement antenna frequency variation**

For wide band measurement the measurement antenna gain will vary considerably over frequency. The gain can be calibrated however variation may still remain between calibration frequency steps. This uncertainty accounts for the variation between the calibrated steps.

**A5-18 FSPL estimation error**

For wide band measurement the measurement free space path loss in the chamber will vary with frequency. The loss can be calibrated however this uncertainty accounts for the variation between the calibrated steps.

**A5-19 Measurement system dynamic range uncertainty**

Uncertainty associated with the addition of each of the directional power measurements to calculate the TRP due to the limited dynamic range of the OTA test system causing an overestimation.

**A5-20 Reflections in anechoic chamber**

Uncertainty associated with the reflections in the chamber changing the coupling between the BS and the CLTA.

# A.6 Reverberation Chamber

This clause describes measurement uncertainty contributors for TX measurements in Reverberation Chamber.

**A6-1 Impedance mismatch in the receiving chain**

This contribution originates from multiple reflections between the receiving antenna and the power measurement equipment. The multiple reflections can produce an overall reflection that depends not only upon the individual reflections of each part but their reflective interactions as well. The combination loss by the overall reflection can be higher or lower than individual loss by multiple reflections. The combination loss is called the mismatch error and leads to the measurement uncertainty.

**A6-2 Random uncertainty**

The random uncertainty characterizes the undefined and miscellaneous effects which cannot be forecasted. One can estimate this type of uncertainty with a repeatability test by making a series of repeated measurement with a reference BS without changing anything in the measurement set-up.

**A6-3 Reference antenna radiation efficiency**

This contribution is a residue of uncertainty of reference antenna radiation efficiency after calibration.

**A6-4 Mean value estimation of reference antenna mismatch efficiency**

This contribution originates from the error of the estimated mean related to the use of a finite number of samples in the measurement of the reference antenna mismatch efficiency. The mean value estimation is calculated as where is the standard deviation of the series of measured values.

**A6-5 Influence of the reference antenna feed cable**

Before performing the calibration, the reference antenna feed cable loss has to be measured. The measurement can be done with a network analyzer to measure its S21 and uncertainty is introduced.

**A6-6 Mean value estimation of transfer function**

This contribution originates from the error of the estimated mean related to the use of a finite number of samples in the measurement of the transfer function. The mean value estimation is calculated as where is the standard deviation of the series of measured values.

**A6-7 Uniformity of transfer function**

Standard deviation over BS positions and rotations of the transfer function . This uncertainty expresses the variations of measured TRP values with respect to translations and rotations of the BS. Ideally, the TRP does neither depend on translations nor rotations of the BS.

# A.7 Plane Wave Synthesizer

This clause describes measurement uncertainty contributors for TX measurements in Plane Wave Synthesizer.

NOTE: Several MU contributor descriptions are defined in a way combining both BS for the measurement stage and calibration/reference antenna for calibration stage, e.g. for A1-4 this contribution is denoted as A1-4a for polarization mismatch between the BS and the receiving antenna, and as A1-4b for polarization mismatch between the reference antenna and the receiving antenna.

**A7-1 Misalignment and pointing error of BS (a) /calibration antenna (b)**

This contribution denotes uncertainty in BS/calibration antenna alignment and BS/calibration antenna pointing error. In this measurement the BS/calibration antenna is aligned to maximum, also allowing for a zero contribution for polarization mismatch uncertainty. By adjusting for maximums to align, this contribution can be a small contribution. The calibration antenna's phase centre and polarization purity changes slightly according to the frequency. Therefore, there should be some uncertainty reserved for this. To ensure that the point error is at a minimal, this contribution should be captured using the antenna pattern cut which is broadest (in the case of the BS this would most likely be in the azimuth domain).

**A7-2 Longitudinal position uncertainty (i.e. standing wave and imperfect field synthesis) for BS antenna (a) /calibration antenna (b)**

This value covers the effect of standing wave between BS or calibration antenna and the test range antenna, but also counts for the PWS imperfect field synthesis over distance. This value can be captured by moving the BS or calibration antenna towards the test range antenna.

**A7-3 RF leakage (calibration antenna connector terminated)**

This contribution denotes noise leaking in to connector and cable(s) between test range antenna and receiving equipment. The contribution also includes the noise leakage between the connector and cable(s) between reference antenna and transmitting equipment.

**A7-4** **QZ ripple experienced by BS (a) /calibration antenna (b)**

This is the quiet zone (QZ) ripple experienced by the BS/reference antenna during the measurement phase. The purpose of this component is to capture the contributions that the reflections from the walls, roof and floor that will add to measurements. The sum of all these reflections from the walls, roof and floor will give the overall value for the QZ ripple. In other words, the uncertainty component from the wall will not be separated from the roof or the floor. The purpose of this uncertainty component is to capture the overall reflections from the chamber walls experienced by the BS/reference antenna. i

**A7-5 Miscellaneous uncertainty**

The term 'miscellaneous uncertainty' is used to define all the unknown, unquantifiable, etc. uncertainties associated with EIRP measurements. This term should include truly random effects as well as systematic uncertainties, such as that arising from dissimilarity between the patterns of the reference antenna and the BS.

**A7-6 Mismatch (i.e. reference antenna, network analyser and reference cable)**

This uncertainty is the residual uncertainty contribution coming from multiple reflections between the receiving antenna and the test receiver equipment. This value can be captured through measurement by measuring the S11 towards the receive antenna and also towards the test receiver. The mismatch between the antenna reflection and the receiver reflection can also be calculated. If the same cable is used for calibration Stage 1, this can be considered systematic and negligible.

**A7-7 Insertion loss of receiver chain**

This uncertainty is the residual uncertainty contribution coming from introducing an antenna at the end of the cable. If this cable does not change/move between the calibration Stage 1 and the measurement Stage 2, the uncertainty is assumed to be systematic and negligible during the measurement stage. Alternatively, the insertion loss can also be calculated by taking the measurement of the cable where port 2 is the end of the cable connected to the BS or calibration antenna.

IL = -20log10|S21| dB

**A7-8 Influence of the calibration antenna feed cable (i.e. flexing cables, adapters, attenuators, extra pathloss cable & connector repeatability)**

During the calibration phase this cable is used to feed the calibration antenna and any influence it may have upon the measurements is captured. This is assessed by repeated measurements while flexing the cables and rotary joints. The largest difference between the results is recorded as the uncertainty.

**A7-9 Misalignment of positioning system**

This contribution originates from uncertainty in sliding position and turn table angle accuracy. If the calibration antenna is aligned to maximum this contribution can be considered negligible and therefore set to zero.

**A7-10 Rotary joints**

If applicable, this uncertainty term corresponds to the accuracy in changing from azimuth to vertical measurements.

**A7-11 Switching uncertainty**

The purpose of the switching unit is to switch electromechanically different RF path to different measurement instruments of different measurement modes. The electromechanical switching clearly reduces the errors arising from manual switching work. Switching is also used to measure the path loss values of each polarization component. Even though the electromechanical switching is preferable during path loss and antenna performance measurements, some minor uncertainties can occur when the switch states are programmed to change their polarity.

**A7-12 Field repeatability**

Each execution of field calibration of the measurement antenna array to find the PWS settings provides a slightly different set of settings for the RF components for each antenna path. This results in variation of the synthesized plane wave in the QZ and variation of PWS antenna to reference antenna coupling. This variation is described by field repeatability term.

**A7-13 Frequency flatness of test system**

This uncertainty contribution to account for the frequency interpolation error caused by a finite frequency resolution during the calibration stage.

**A7-14 System non-linearity**

This uncertainty term is calculated as RSS of the following items, assuming a rectangular distribution:

- System non-linearity in time. This is assessed by repeated measurements over a period of time (e.g. 60 minutes) for the same reference power transmitted by the reference antenna. The largest difference between the results is recorded as the uncertainty.

- System non-linearity in power. This is assessed by repeated measurements over a range of transmitted powers. The largest delta between the increments on the receiving side versus the transmitting side is recorded as the uncertainty.

Annex B (informative):  
Radiated RX measurement error contribution descriptions

# B.1 Indoor Anechoic Chamber

This clause describes measurement uncertainty contributors for RX measurements in Indoor Anechoic Chamber.

NOTE: Several MU contributor descriptions are defined in a way combining both BS for the measurement stage and calibration/reference antenna for calibration stage, e.g. for A1-4 this contribution is denoted as A1-4a for polarization mismatch between the BS and the receiving antenna, and as A1-4b for polarization mismatch between the reference antenna and the receiving antenna.

**B1-1 Positioning misalignment between the BS and the reference antenna**

This contribution originates from the misalignment of the manufacturer declared coordinate system reference point of the BS and the phase centre of the reference antenna. The uncertainty makes the space propagation loss between the BS and the transmitting antenna at the BS measurement stage (i.e. Stage 2) different from the space propagation loss between the reference antenna and the transmitting antenna at the calibration stage (i.e. Stage 1).

**B1-2 Pointing misalignment between the BS and the transmitting antenna**

This contribution originates from the misalignment of the testing direction and the *beam peak direction* of the transmitting antenna due to imperfect rotation operation. The pointing misalignment may happen in both azimuth and vertical directions and the effect of the misalignment depends highly on the beamwidth of the beam under test. The same level of misalignment results in a larger measurement error for a narrower beam.

**B1-3 Quality of quiet zone**

This contribution originates from a reflectivity level of an anechoic chamber. The reflectivity level is determined from the average standard deviation of the electric field in the quiet zone. By repeating a free space VSWR measurement in 15 ° grid in elevation and azimuth, 264 standard deviation values in both polarizations are determined. From these values an average standard deviation of electric field in the quiet zone can be calculated from the equation:



where:

 is the number of angular intervals in elevation,

 is the number of angular intervals in azimuth, and

 is elevation of single measurement .

If an efficiency calibration with omni-directional calibration antenna is performed, the effect of reflectivity level decreases in Stage 1 (i.e. calibration measurement) and  may be divided by factor 2. This is due to correcting impact of data averaging in this type of calibration. Efficiency calibration done with sampling step ≤ 30°, can be considered to have at least four independent samples.  may be divided by factor 2 also in stage 2 (i.e. BS measurement) for the same reason.

It's likely that asymmetry of the field probe will have a very small impact on this measurement uncertainty contributor, however, an upper bound to probe symmetry should be considered.

**B1-4 Polarization mismatch between the BS (a) / reference antenna (b) and the transmitting antenna**

This contribution originates from the misaligned polarization between the BS (a) /reference antenna (b) and the transmitting antenna.

**B1-5 Mutual coupling between the BS (a) /reference antenna (b) and the transmitting antenna**

This contribution originates from mutual coupling between the BS (a) /reference antenna (b) and the transmitting antenna. Mutual coupling degrades not just the antenna efficiency, but it can alter the antenna's radiation pattern as well. For indoor anechoic chamber, usually the spacing between the transmitting antenna and the BS/reference antenna is large enough so that the level of mutual coupling might be negligible.

**B1-6 Phase curvature**

This contribution originates from the finite far-field measurement distance, which causes phase curvature across the antenna of the BS/reference antenna.

**B1-7 Impedance mismatch in the transmitting chain**

This contribution originates from multiple reflections between the transmitting antenna and the signal generator. The multiple reflections can produce an overall reflection that depends not only upon the individual reflections of each part but their reflective interactions as well. The combination loss by the overall reflection can be higher or lower than individual loss by multiple reflections. The combination loss is called the mismatch error and leads to the measurement uncertainty.

**B1-8 Random uncertainty**

The random uncertainty characterizes the undefined and miscellaneous effects which cannot be forecasted. One can estimate this type of uncertainty with a repeatability test by making a series of repeated measurement with a reference BS without changing anything in the measurement set-up.

**B1-9 Impedance mismatch between the transmitting antenna and the network analyzer**

This contribution originates from multiple reflections between the transmitting antenna and the network analyzer. After appropriate calibration, the network analyzer may not introduce impedance mismatch error, but the error still happens between the transmitting antenna feed cable and the transmitting antenna.

**B1-10 Positioning and pointing misalignment between the reference antenna and the transmitting antenna**

This contribution originates from reference antenna alignment and pointing error. In this measurement if the maximum gain direction of the reference antenna and the transmitting antenna are aligned to each other, this contribution can be considered negligible and therefore set to zero.

**B1-11 Impedance mismatch between the reference antenna and the network analyzer**

This contribution originates from multiple reflections between the reference antenna and the network analyzer. After appropriate calibration, the network analyzer may not introduce impedance mismatch error, but the error still happens between the transmitting antenna feed cable and the transmitting antenna.

**B1-12 Influence of the reference antenna feed cable**

In the calibration Stage 1, the influence of the calibration antenna feed cable is assessed by measurements. A measurement for calibration may be repeated with a reasonably differing routing of the feed cable. Largest difference among the results is entered to the uncertainty budget with a rectangular distribution.

**B1-13 Reference antenna feed cable loss measurement uncertainty**

Before performing the calibration, the reference antenna feed cable loss have to be measured. The measurement can be done with a network analyzer to measure its S21 and uncertainty is introduced.

**B1-14 Influence of the transmitting antenna feed cable**

If the probe antenna is directional (i.e. peak gain >+5 dBi e.g. horn, LPDA, etc.) and the same probe antenna cable configuration is used for both stages, the uncertainty is considered systematic and constant 🡺 0.00 dB value.

**B1-15 Uncertainty of the absolute gain of the transmitting antenna**

The uncertainty appears in both stages and it is thus considered systematic and constant 🡺 0.00 dB value.

# B.2 Compact Antenna Test Range

This clause describes measurement uncertainty contributors for RX measurements in Compact Antenna Test Range.

NOTE: Several MU contributor descriptions are defined in a way combining both BS for the measurement stage and calibration/reference antenna for calibration stage, e.g. for A1-4 this contribution is denoted as A1-4a for polarization mismatch between the BS and the receiving antenna, and as A1-4b for polarization mismatch between the reference antenna and the receiving antenna.

**B2-1 Misalignment and pointing error of BS (a) /calibration antenna (b)**

This contribution denotes uncertainty in BS (a) /calibration antenna (b) alignment and BS (a) /calibration antenna (b) pointing error. In this measurement the BS (a) /calibration antenna (b) is aligned to maximum, also allowing for a zero contribution for polarization mismatch uncertainty. By adjusting for maximums to align, this contribution can be a small contribution. The calibration antenna's phase centre and polarization purity changes slightly according to the frequency. Therefore, there should be some uncertainty reserved for this. To ensure that the point error is at a minimal, this contribution should be captured using the antenna pattern cut which is broadest (in the case of the BS this would most likely be in the azimuth domain).

**B2-2 Standing wave between BS and test range antenna**

This value is extracting the uncertainty value and standard deviation of gain ripple coming from standing waves between BS and test range antenna. This value can be captured by moving the BS towards the test range antenna as the standing waves go in and out of phase causing a ripple in measured gain.

**B2-3 RF leakage & dynamic range, test range antenna cable connector terminated**

This contribute denotes noise leaking in to connectors and cables between test range antenna and receiving equipment.

**B2-4 QZ ripple experienced by BS (a) /calibration antenna (b)**

This is the quiet zone ripple experienced by the BS (a) /calibration antenna (b) during the measurement phase. The purpose of this component is to capture the contributions that the reflections from the walls, roof and floor that will add to the EIS measurement. The sum of all these reflections from the walls, roof and floor will give the overall value for the QZ ripple. In other words, the uncertainty component from the wall will not be separated from the roof or the floor. The purpose of this uncertainty component is to capture the overall reflections from the chamber walls experienced by the BS (a) /calibration antenna (b). To capture the full effect of the QZ ripple a distance of 1λ should be measured from each of the BS (a) /calibration antenna (b) physical aperture edges, i.e. total QZ distance = physical aperture length + 2 λ, to ensure the full volume of the QZ is captured in the uncertainty measurement.

**B2-5 Mismatch of transmit chain (i.e. between transmitting measurement antenna and BS)**

This uncertainty is the residual uncertainty contribution coming from multiple reflections between the transmitting antenna and the signal generation equipment. This value can be captured through measurement by measuring the S11 towards the transmit antenna and also towards the test signal generator equipment. The mismatch between the antenna reflection and the transmit reflection can also be calculated.

**B2-6 Insertion loss of transmit chain**

This uncertainty is the residual uncertainty contribution coming from introducing an antenna at the end of the cable. If this cable does not change/move between the calibration Stage 1 and the BS measurement Stage 2, the uncertainty is assumed to be systematic. Alternatively, the insertion loss can also be calculated by taking the measurement of the cable where port 2 is the end of the cable connected to the measurement antenna.

IL = -20log10|S21| dB

**B2-7 RF leakage (SGH connector terminated & test range antenna connector terminated)**

This contribution denotes noise leaking in to connector and cable(s) between test range antenna and receiving equipment. The contribution also includes the noise leakage between the connector and cable(s) between SGH/reference antenna and transmitting equipment.

**B2-8 Influence of the calibration antenna feed cable (i.e. flexing cables, adapters, attenuators & connector repeatability)**

During the calibration phase this cable is used to feed the calibration antenna and any influence it may have upon the measurements is captured. This is assessed by repeated measurements while flexing the cables and rotary joints. The largest difference between the results is recorded as the uncertainty.

**B2-9 Miscellaneous uncertainty**

The term 'miscellaneous uncertainty' is used to define all the unknown, unquantifiable, etc. uncertainties associated with EIRP measurements. This term should include truly random effects as well as systematic uncertainties, such as that arising from dissimilarity between the patterns of the reference antenna (SGH) and the BS.

**B2-10 Rotary joints**

If applicable the contribution of this uncertainty is the accuracy in changing from azimuth to vertical measurements.

**B2-11 Misalignment positioning system**

This contribution originates from uncertainty in sliding position and turn table angle accuracy. If the calibration antenna is aligned to the maximum then this contribution can be considered negligible and therefore set to zero.

**B2-12 Standing wave between SGH and test range antenna**

This value is extracting the uncertainty value and standard deviation of gain ripple coming from standing waves between BS and test range antenna. This value can be captured by moving the BS towards the test range antenna as the standing waves go in and out of phase causing a ripple in measured gain.

**B2-13 Switching uncertainty**

The purpose of the switching unit is to switch electromechanically different RF path to different measurement instruments of different measurement modes. The electromechanical switching clearly reduces the errors arising from manual switching work. Switching is also used to measure the path loss values of each polarization component. Even though the electromechanical switching is preferable during path loss and antenna performance measurements, some minor uncertainties can occur when the switch states are programmed to change their polarity.

# B.3 Near Field Test Range

This clause describes measurement uncertainty contributors for RX measurements in Near Field Test Range.

**B3-1 Axes intersection**

This is a mechanical uncertainty term and aim to find the uncertainty related with the lateral displacement between the horizontal and vertical axes of the BS positioner. This can result in sampling the field on a non-ideal sphere. This uncertainty is assumed to have a Gaussian distribution.

**B3-2 Axes orthogonality**

The difference from 90 ° of the angle between the horizontal and vertical axes also results in sampling the field on a non ideal sphere. This uncertainty is assumed to have a Gaussian distribution.

**B3-3 Horizontal pointing**

The horizontal mispointing of the horizontal axis to the probe reference point for Theta = 0 ° also results in sampling the field on a non-ideal sphere. This uncertainty is assumed to have a Gaussian distribution.

**B3-4 Probe vertical position**

The vertical displacement of the probe reference point from the horizontal axis results in sampling the field on a non ideal sphere. This uncertainty is assumed to have a Gaussian distribution.

**B3-5 Probe horizontal/vertical pointing**

The horizontal or vertical mispointing of the probe z-axis from the intersection point of the horizontal/vertical axis. This uncertainty is assumed to have a Gaussian distribution.

**B3-6 Measurement distance**

This is the knowledge of the distance between the intersection point of the horizontal and vertical axis and probe reference point. This uncertainty is assumed to have a Gaussian distribution.

**B3-7 Amplitude and phase drift**

The system drift due to temperature variations causes the signal at BS location to drift in amplitude and phase. This uncertainty is assumed to have a Gaussian distribution.

**B3-8 Amplitude and phase noise**

This uncertainty is due to the noise level of the test range so that the S/N ratio should be determined or measured at the BS location. The noise level is usually measured with a spectrum analyzer. This uncertainty is assumed to have a Gaussian distribution.

**B3-9 Leakage and crosstalk**

This uncertainty can be addressed by measurements on the actual system setup. The leakage and crosstalk cannot be separated from the random amplitude and phase errors so that the relative importance should be determined. This uncertainty is assumed to have a Gaussian distribution.

**B3-10 Amplitude non-linearity**

This uncertainty is the linearity of the receiver used for the measurement. It can be taken from the data sheet of the receiver.

**B3-11 Amplitude and phase shift in rotary joint**

This uncertainty is due to the variation of the rotary joint. It can be measured and is assumed to have a Gaussian distribution.

**B3-12 Channel balance amplitude and phase**

This uncertainty is relevant for systems which are using dual polarized probes and polarization switches. The amplitude and phase difference between two signal channels of the receiver includes the difference between the probe ports, difference between the channels of the polarization switch, connecting cables and reflection coefficients. This uncertainty is assumed to have a Gaussian distribution.

**B3-13 Probe polarization amplitude and phase**

The amplitude and phase of the probe polarization coefficients should be measured. This uncertainty is assumed to have a Gaussian distribution.

**B3-14 Probe pattern knowledge**

The probe(s) pattern(s) is assumed to be known so that the BS measurement in near field can be corrected when performing the near field to far field transform. There is no direct dependence between the BS pattern and the probe pattern in near field measurements. This uncertainty is assumed to have a Gaussian distribution.

**B3-15 Multiple reflections**

The multiple reflections occur when a portion of the transmitted signal is reflected form the receiving antenna back to the transmitting antenna and re-reflected by the transmitting antenna back to the receiving antenna. This uncertainty can be determined by multiple measurements of the BS when at different distance from the probes. This uncertainty is assumed to have a Gaussian distribution.

**B3-16 Room scattering**

As for the multiple reflections, a portion of the transmitted signal is reflected by either the absorbers or other structures in the measurement anechoic chamber before being received by the receiving antenna. This effect can be isolated from the multiple reflections by testing the BS in different positions, separated by λ/4 with respect to the anechoic chamber and comparing these measurements with the reference. This uncertainty is assumed to have a Gaussian distribution.

**B3-17 BS support scattering**

This is the uncertainty due to the BS supporting structure on the signal level. This uncertainty is assumed to have a Gaussian distribution.

**B3-18 Scan area truncation**

This uncertainty does affect the near field measurement. It can be addressed by comparing the measurement result when scanning the full area. This uncertainty is assumed to have a Gaussian distribution.

**B3-19 Sampling point offset**

This uncertainty has an influence in near field and far field. It is assumed to have a Gaussian distribution.

**B3-20 Mode truncation**

The measured near field is expanded using a finite set of spherical modes. The number of modes is linked to number of samples. The filtering effect generated by the finite number of modes can improve measurement results by removing signals from outside the physical area of the BS. Care should be taken in order to make sure the removed signals are not from the BS itself. This uncertainty is usually negligible.

**B3-21 Positioning**

The relative position of the probe array is not ideal. This uncertainty is assumed to have a rectangular distribution.

**B3-22 Probe array uniformity**

This is the uncertainty due to the fact that different probes are used for each physical position. Different probes have different *radiation patterns*. This uncertainty is assumed to have a Gaussian distribution.

**B3-23 Mismatch of transmitter chain**

If the same chain configuration (including the vector signal generator; the probe antenna and other elements) is used in both stages, the uncertainty is considered systematic and constant 🡺 0.00 dB value.

If it is not the case, this uncertainty contribution has to be taken into account and should be measured or determined by the method described in TR 25.914 [14]. This uncertainty is assumed to have a U-shaped distribution.

**B3-24 Insertion loss of transmitter chain**

It is composed of the following:

- Insertion loss of the probe antenna cable.

- Insertion loss of the probe antenna attenuator (if used).

- Insertion loss of RF relays (if used).

If the same chain configuration is used for measurement and calibration, the uncertainty due to the above components is considered systematic and constant 🡺 0.00 dB value. This uncertainty is assumed to have a Gaussian distribution.

**B3-25 Uncertainty of the absolute gain of the probe antenna**

This uncertainty appears in the both stages and it is thus considered systematic and constant🡺 0.00 dB value.

**B3-26 Measurement repeatability - positioning repeatability**

This uncertainty is due to the repositioning of the BS in the test setup. It can be addressed by repeating the corresponding measurement 10 times. Calculate the standard deviation of the metric obtained and use that as the measurement uncertainty. For tests that require multiple setups, the worst-case standard deviation is used. This uncertainty is assumed to have a Gaussian distribution.

**B3-27 Mismatch of transmitter chain**

If the same chain configuration (including the measurement receiver; the probe antenna and other elements) is used in both stages, the uncertainty is considered systematic and constant 🡺 0.00 dB value.

If it is not the case, this uncertainty contribution has to be taken into account and should be measured or determined by the method described in TR 25.914 [14]. This uncertainty is assumed to have a Gaussian distribution.

**B3-28 Insertion loss of transmitter chain**

If the same chain configuration is used for measurement and calibration, the uncertainty due to the above components is considered systematic and constant 🡺 0.00 dB value. This uncertainty is assumed to have a Gaussian distribution.

**B3-29 Mismatch in the connection of the calibration antenna**

This is the uncertainty from the mismatch in the connection between the system coax cable and the calibration antenna. It should be measured or determined by the method described in TR 25.914 [14]. This uncertainty is assumed to have a U-shaped distribution.

**B3-30 Influence of the calibration antenna feed cable**

This uncertainty is due to the impact of the feeding cable on the radiation properties of the calibration antenna. In case of using either a standard horn or standard gain horn, the impact of the cable is to be considered negligible thus the uncertainty 🡺 0.00 dB value. In case of using a dipole-like antenna, the uncertainty should be addressed by measuring this impact. This uncertainty is assumed to have a Gaussian distribution.

**B3-31 Influence of the probe antenna cable**

If the same chain configuration is used for measurement and calibration, the uncertainty due to the above components is considered systematic and constant 🡺 0.00 dB value. This uncertainty is assumed to have a Gaussian distribution.

**B3-32 Short term repeatability**

It can be addressed by performing a repeatability test of the calibration antenna. This uncertainty is assumed to have a Gaussian distribution.

# B.4 One Dimensional Compact Range

This clause describes measurement uncertainty contributors for RX measurements in One Dimensional Compact Range.

NOTE: Several MU contributor descriptions are defined in a way combining both BS for the measurement stage and calibration/reference antenna for calibration stage, e.g. for A1-4 this contribution is denoted as A1-4a for polarization mismatch between the BS and the receiving antenna, and as A1-4b for polarization mismatch between the reference antenna and the receiving antenna.

**B4-1 Misalignment BS and pointing error**

This contribution denotes uncertainty in BS alignment and BS pointing error. In this measurement the BS is aligned to maximum, also allowing for a zero contribution for polarization mismatch uncertainty. By adjusting for maximums to align, this contribution can be a small contribution. The reference antenna´s phase centre and polarization purity changes slightly according to the frequency. Therefore, there should be some uncertainty reserved for this. To ensure that the pointing error is at a minimal, this contribution should be captured using the antenna pattern cut which is broadest (in the case of the BS this would most likely be in the azimuth domain).

**B4-2 Standing wave between BS (a) /reference antenna (b) and test range antenna**

This value is extracting the uncertainty value and standard deviation of gain ripple coming from standing waves between BS/reference antenna and test range antenna. This value can be captured by moving the BS (a) /reference antenna (b) towards the test range antenna as the standing waves go in and out of phase causing a ripple in measured gain.

**B4-3 Quiet zone ripple experienced by BS (a) /reference antenna (b)**

This is the quiet zone (QZ) ripple experienced by the BS (a) / reference antenna (b) during the measurement phase. The purpose of this component is to capture the contributions that the reflections from the walls, roof and floor that will add to the EIS measurement. The sum of all these reflections from the walls, roof and floor will give the overall value for the QZ ripple. In other words, the uncertainty component from the wall will not be separated from the roof or the floor. The purpose of this uncertainty component is to capture the overall reflections from the chamber walls experienced by the BS (a) / reference antenna (b). To capture the full effect of the QZ ripple a distance of 1λ must be measured from each of the BS (a) / reference antenna (b) physical aperture edges, i.e. total QZ distance = physical aperture length + 2 λ, to ensure the full volume of the QZ is captured in the uncertainty measurement.

**B4-4 Phase curvature**

This contribution originates from the finite far-field measurement distance, which causes phase curvature across the antenna of the BS/reference antenna.

**B4-5 Polarization mismatch between BS (a) /reference antenna (b) and transmitting antenna**

This contribution originates from the misaligned polarization between the BS (a) /reference antenna (b) and the transmitting antenna.

**B4-6 Mutual coupling between BS (a) /reference antenna (b) and transmitting antenna**

This contribution originates from mutual coupling between the BS (a) /reference antenna (b) and the transmitting antenna. Mutual coupling degrades not just the antenna efficiency, but it can alter the antenna’s *radiation pattern* as well. For compact range chamber, usually the spacing between the transmitting antenna and the BS (a) /reference antenna (b) is large enough so that the level of mutual coupling might be negligible.

**B4-7 Impedance mismatch in transmitting chain**

This contribution originates from multiple reflections between the transmitting antenna and the signal generator. The multiple reflections can produce an overall reflection that depends not only upon the individual reflections of each part but their reflective interactions as well. The combination loss by the overall reflection can be higher or lower than individual loss by multiple reflections. The combination loss is called the mismatch error and leads to the measurement uncertainty.

**B4-8 RF leakage and dynamic range**

This contribute denotes noise leaking into connectors and cables between test range antenna and receiving equipment.

**B4-9 Misalignment positioning system**

This contribution originates from uncertainty in sliding position and turn table angle accuracy. If the reference antenna is aligned to the maximum then this contribution can be considered negligible and therefore set to zero.

**B4-10 Pointing error between reference antenna and test range antenna**

This contribution originates from the misalignment of the testing direction and the *beam peak direction* of the transmitting antenna due to imperfect rotation operation. The pointing misalignment may happen in both azimuth and vertical directions and the effect of the misalignment depends highly on the beamwidth of the beam under test. The same level of misalignment results in a larger measurement error for a narrower beam.

**B4-11 Impedance mismatch in path to reference antenna**

This contribution originates from multiple reflections between the reference antenna and the measurement equipment. After appropriate calibration, the measurement equipment may not introduce impedance mismatch error, but the error still happens between the reference antenna feed cable and the reference antenna.

**B4-12 Impedance mismatch in path to compact probe**

This contribution originates from multiple reflections between the transmitting antenna and the measurement equipment. After appropriate calibration, the measurement equipment may not introduce impedance mismatch error, but the error still happens between the transmitting antenna feed cable and the transmitting antenna.

**B4-13 Influence of reference antenna feed cable (flexing cables, adapters, attenuators and connector repeatability)**

During the calibration phase this cable is used to feed the reference antenna and any influence it may have upon the measurements is captured. This is assessed by repeated measurements while flexing the cables and rotary joints. The largest difference between the results is recorded as the uncertainty.

**B4-14 Mismatch of transmitter chain (i.e. between transmitting measurement antenna and BS)**

This uncertainty is the residual uncertainty contribution coming from multiple reflections between the transmitting antenna and the signal generation equipment. This value can be captured through measurement by measuring the S11 towards the transmit antenna and also towards the test signal generator equipment. The mismatch between the antenna reflection and the transmit reflection can also be calculated.

**B4-15 Insertion loss of transmitter chain**

This uncertainty is the residual uncertainty contribution coming from introducing an antenna at the end of the cable. If this cable does not change/move between the calibration and the BS measurement stage, the uncertainty is assumed to be systematic. Alternatively, the insertion loss can be calculated by taking the measurement of the cable where port 2 is the end of the cable connected to the measurement antenna.

IL = -20log10|S21| dB

**B4-16 RF leakage (SGH connector terminated and test range antenna connector terminated)**

This contribution denotes noise leaking into connector and cable(s) between test range antenna and receiving equipment. The contribution also includes the noise leakage between the connector and cable(s) between SGH/reference antenna and transmitting equipment.

# B.5 Plane Wave Synthesizer

This clause describes measurement uncertainty contributors for RX measurements in Plane Wave Synthesizer.

NOTE: Several MU contributor descriptions are defined in a way combining both BS for the measurement stage and calibration/reference antenna for calibration stage, e.g. for A1-4 this contribution is denoted as A1-4a for polarization mismatch between the BS and the receiving antenna, and as A1-4b for polarization mismatch between the reference antenna and the receiving antenna.

**B5-1 Misalignment and pointing error of BS (a) /calibration antenna (b)**

This contribution denotes uncertainty in BS/calibration antenna alignment and BS/calibration antenna pointing error. In this measurement the BS/calibration antenna is aligned to maximum, also allowing for a zero contribution for polarization mismatch uncertainty. By adjusting for maximums to align, this contribution can be a small contribution. The calibration antenna's phase centre and polarization purity changes slightly according to the frequency. Therefore, there should be some uncertainty reserved for this. To ensure that the point error is at a minimal, this contribution should be captured using the antenna pattern cut which is broadest (in the case of the BS this would most likely be in the azimuth domain).

**B5-2 Longitudinal position uncertainty (i.e. standing wave and imperfect field synthesis) for BS antenna (a) /calibration antenna (b)**

This value covers the effect of standing wave between BS or calibration antenna and the test range antenna, but also counts for the PWS imperfect field synthesis over distance. This value can be captured by moving the BS or calibration antenna towards the test range antenna.

**B5-3 RF leakage (calibration antenna connector terminated)**

This contribution denotes noise leaking in to connector and cable(s) between test range antenna and receiving equipment. The contribution also includes the noise leakage between the connector and cable(s) between reference antenna and transmitting equipment.

**B5-4** **QZ ripple experienced by BS (a) /calibration antenna (b)**

This is the quiet zone (QZ) ripple experienced by the BS/reference antenna during the measurement phase. The purpose of this component is to capture the contributions that the reflections from the walls, roof and floor that will add to measurements. The sum of all these reflections from the walls, roof and floor will give the overall value for the QZ ripple. In other words, the uncertainty component from the wall will not be separated from the roof or the floor. The purpose of this uncertainty component is to capture the overall reflections from the chamber walls experienced by the BS/reference antenna.

**B5-5 Miscellaneous uncertainty**

The term 'miscellaneous uncertainty' is used to define all the unknown, unquantifiable, etc. uncertainties associated with EIRP measurements. This term should include truly random effects as well as systematic uncertainties, such as that arising from dissimilarity between the patterns of the reference antenna and the BS.

**B5-6 Mismatch (i.e. reference antenna, network analyser and reference cable)**

This uncertainty is the residual uncertainty contribution coming from multiple reflections between the receiving antenna and the test receiver equipment. This value can be captured through measurement by measuring the S11 towards the receive antenna and also towards the test receiver. The mismatch between the antenna reflection and the receiver reflection can also be calculated. If the same cable is used for calibration Stage 1, this can be considered systematic and negligible.

**B5-7 Insertion loss of transmit chain**

This uncertainty is the residual uncertainty contribution coming from introducing an antenna at the end of the cable. If this cable does not change/move between the calibration Stage 1 and the measurement Stage 2, the uncertainty is assumed to be systematic and negligible during the measurement stage. Alternatively, the insertion loss can also be calculated by taking the measurement of the cable where port 2 is the end of the cable connected to the BS or calibration antenna.

IL = -20log10|S21| dB

**B5-8 Influence of the calibration antenna feed cable, i.e. flexing cables, adapters, attenuators, extra pathloss cable & connector repeatability**

During the calibration phase this cable is used to feed the calibration antenna and any influence it may have upon the measurements is captured. This is assessed by repeated measurements while flexing the cables and rotary joints. The largest difference between the results is recorded as the uncertainty.

**B5-9 Misalignment of positioning system**

This contribution originates from uncertainty in sliding position and turn table angle accuracy. If the calibration antenna is aligned to maximum this contribution can be considered negligible and therefore set to zero.

**B5-10 Rotary joints**

If applicable, this uncertainty term corresponds to the accuracy in changing from azimuth to vertical measurements.

**B5-11 Switching uncertainty**

The purpose of the switching unit is to switch electromechanically different RF path to different measurement instruments of different measurement modes. The electromechanical switching clearly reduces the errors arising from manual switching work. Switching is also used to measure the path loss values of each polarization component. Even though the electromechanical switching is preferable during path loss and antenna performance measurements, some minor uncertainties can occur when the switch states are programmed to change their polarity.

**B5-12 Field repeatability**

Each execution of field calibration of the measurement *antenna array* to find the PWS settings provides a slightly different set of settings for the RF components for each antenna path. This results in variation of the synthesized plane wave in the QZ and variation of PWS antenna to reference antenna coupling. This variation is described by field repeatability term.

**B5-13 Frequency flatness of test system**

This uncertainty contribution to account for the frequency interpolation error caused by a finite frequency resolution during the calibration stage.

**B5-14 System non-linearity**

This uncertainty term is calculated as RSS of the following items, assuming a rectangular distribution:

- System non-linearity in time. This is assessed by repeated measurements over a period of time (e.g. 60 minutes) for the same reference power transmitted by the reference antenna. The largest difference between the results is recorded as the uncertainty.

- System non-linearity in power. This is assessed by repeated measurements over a range of transmitted powers. The largest delta between the increments on the receiving side versus the transmitting side is recorded as the uncertainty.

Annex C (informative):  
Test equipment uncertainty values

# C.1 Test equipment measurement error contribution descriptions

**C1-1 Uncertainty of the RF power measurement equipment (e.g. spectrum analyzer, power meter)**

The receiving device used to measure the received signal level in the EIRP tests either as an absolute level or as a relative level. These receiving devices to name a few are spectrum analyzers, network analyzers or power meter. These devices will have an uncertainty contribution of their own; this value declared by the test gear vendor should be recorded as this uncertainty contribution. If a power meter is used then both measurement uncertainty and out of band noise is considered as part of the contribution. This uncertainty value can be found in table C2-1 and was a result of compromised value in order to align all test methods having this uncertainty contribution.

**C1-2 Uncertainty of the RF signal generator**

The use of this signal generator introduces an uncertainty on the absolute output level. The uncertainty value will be indicated in the manufacturer's data sheet in logs. This uncertainty value can be found in Annex C2-1 and was a result of compromised value in order to align all test methods having this uncertainty contribution.

**C1-3 Uncertainty of the network analyser: Drift (temp, oscillators, filters, etc.) start-to-end time of measurements**

This uncertainty includes all the uncertainties involved in the S21 measurement (including drift and frequency flatness) with a network analyzer, and will be calculated from the manufacturer's data in logs. This uncertainty also includes analyzer uncertainty for multi-polarization (2 or more ports) measured simultaneously. This uncertainty value can be found in table C2-1 and was a result of compromised value in order to align all test methods having this uncertainty contribution.

**C1-4 Uncertainty of the absolute gain of the reference antenna**

This uncertainty consists of the uncertainty of the gain value associated with the gain value denoted from the antenna calibration. This uncertainty value can be found in table C.2-1 and was a result of compromised value in order to align all test methods having this uncertainty contribution.

**C1-5 Measurement receiver (co-location)**

Error for the receiver used to measure the noise floor level in the co-location test.

**C1-6 Noise figure measurement accuracy**

Noise figure calibration accuracy used for the low power levels used during the co-location measurements.

**C1-7 RF power measurement equipment (e.g. spectrum analyser, power meter) - low power (UEM, absolute ACLR)**

Measurement equipment error associated with measuring low power absolute high frequency (FR2) unwanted emissions.

**C1-8 RF power measurement equipment (e.g. spectrum analyzer, power meter) - relative (ACLR)**

Measurement equipment error associated with measuring low power relative high frequency (FR2) unwanted emissions.

**C1-9 RF power measurement equipment standard uncertainty σ (dB) of the absolute level for a time domain wideband measurement for FR2**

Measurement equipment error associated with measuring low power, wide band time domain high dynamic range signals required for the Tx OFF transient test.

# C.2 Measurement Equipment uncertainty values

The following uncertainty distribution and standard uncertainty (σ) values proposed by test vendors are adopted for the RF power measurement equipment, RF signal generator, and network analyzer to calculate the uncertainty budget.

Table C.2-1: Test equipment uncertainty values for FR1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Instrument | Use case | Measurement Uncertainty type | Standard uncertainty σ (dB) | | | Probability distribution |
| f ≦ 3 GHz | 3 GHz < f ≦ 4.2 GHz | 4.2<f≤6 GHz |
| C1-1 | RF power measurement equipment (e.g. spectrum analyzer, power meter) | Measurement stage | Total amplitude accuracy  (with input levels down to ‑70 dBm) | 0.14 | 0.26 | 0.26 | Gaussian |
| C1-2 | RF signal generator | Measurement stage | Level error | 0.46 | 0.46 | 0.46 | Gaussian |
| C1-3 | Network analyzer | Calibration stage | Accuracy of transmission measurements | 0.13 | 0.20 | 0.2 | Gaussian |
| C1-5 | Measurement receiver (co-location) | Measurement stage | Amplitude accuracy | 0.41 | 0.74 | 0.8 | Gaussian |
| C1-6 | Noise figure measurement accuracy | Calibration stage | Amplitude accuracy | 0.2 | 0.2 | 0.2 | Gaussian |
| NOTE: Standard uncertainty values were derived from datasheets of mid-tier to high-end RF signal generators, spectrum analyzers, and VNAs. Standard uncertainty values of power measurement equipment were derived from datasheet of spectrum analyzers. | | | | | | | |

Table C.2-2: Test equipment uncertainty values for FR2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| UID | Instrument | Standard uncertainty σ (dB) | | Probability distribution |
| 24.25 < f ≦ 29.5GHz | 37 < f ≦ 40GHz |
| C1-1 | RF power measurement equipment (e.g. spectrum analyzer, power meter) - high power (EIRP, TRP) | 0.50 | 0.70 | Gaussian |
| C1-2 | RF signal generator | 0.90 | 0.90 | Gaussian |
| C1-3 | Network analyzer | 0.30 | 0.30 | Gaussian |
| C1-7 | RF power measurement equipment (e.g. spectrum analyzer, power meter) - low power (UEM, absolute ACLR) | 0.90 | 0.90 | Gaussian |
| C1-8 | RF power measurement equipment (e.g. spectrum analyzer, power meter) - relative (ACLR) | 0.75 | 0.90 | Gaussian |
| C1-9 | RF power measurement equipment standard - absolute level for a time domain wideband measurement for FR2 | 1.25 | 1.45 | Gaussian |

The following uncertainty distribution and standard uncertainty (σ) value for the reference antenna derived as the maximum of companies' proposals are adopted in all test methods to calculate the uncertainty budget.

Table C.2-3: Reference antenna uncertainty value for FR1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| UID | Instrument | Use case | Standard uncertainty σ (dB) | | | Probability distribution |
| f ≦ 3 GHz | 3 GHz < f ≦ 4.2 GHz | 4.2 < f ≦ 6 GHz |
| C1-4 | Reference antenna | Calibration stage | 0.29 | 0.25 | 0.25 | Rectangular |

Table C.2-4: Reference antenna uncertainty value for FR2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| UID | Instrument | Use case | Standard uncertainty σ (dB) | | Probability distribution |
| 24.25<f ≦ 29.5GHz | 37<f ≦ 40GHz |
| C1-4 | Reference antenna | Calibration stage | 0.3 | 0.3 | Rectangular |

# C.3 MU of TE derived from conducted specification

For a number of test cases the conducted measurement uncertainty used in TS 36.141 [22] is used to estimate the uncertainty contributing of the conducted part (filters, limiters, switches etc.) of the OTA test set up.

Where appropriate the mismatch uncertainty is removed from the conducted uncertainty so that it is not included twice in the calculation.

**C3-1 DL-RS MU derived from conducted specification**

Conducted MU (1.96σ) from TS 36.141 [22]: ±0.8 dB, f ≤ 3.0 GHz, ±1.1 dB, 3.0 GHz < f ≤ 4.2 GHz

Conducted contribution for OTA MU budget (1σ): ±0.41 dB, f ≤ 3.0 GHz, ±0.56 dB, 3.0 GHz < f ≤ 4.2 GHz

**C3-2 Total power dynamic range conducted uncertainty**

Conducted MU (1.96σ) from TS 36.141 [22]: ±0.4 dB

Conducted contribution for OTA MU budget (1σ): ±0.2 dB

**C3-3 Transmitter mandatory spurious emissions**

Conducted MU (1.96σ) from TS 36.141 [22]: 9 kHz < f ≤ 4 GHz: ±2.0 dB, 4 GHz < f ≤ 19 GHz: ±4.0 dB

Conducted contribution for OTA MU budget (1σ): 9 kHz < f ≤ 4 GHz: ±1.0 dB, 4 GHz < f ≤ 19 GHz: ±2.0 dB

**C3-4 Receiver spurious emissions**

Conducted MU (1.96σ) from TS 36.141 [22]: 30M Hz < f ≤ 4 GHz: ±2.0 dB, 4 GHz < f ≤ 19 GHz: ±4.0 dB

Conducted contribution for OTA MU budget (1σ): 9 kHz < f ≤ 4 GHz: ±1.0 dB, 4 GHz < f ≤ 19 GHz: ±2.0 dB

**C3-5 Additional (co-existence) spurious emissions**

Conducted MU (1.96σ) from TS 36.141 [22]: ±2.0 dB for > -60dBm, f ≤ 3.0GHz, ±2.5 dB, 3.0GHz < f ≤ 4.2GHz,

±3.0 dB, 4.2GHz < f ≤ 6.0GHz

Conducted contribution for OTA MU budget (1σ): ±1.0 dB for > -60dBm, f ≤ 3.0GHz, ±1.28 dB, 3.0GHz < f ≤ 4.2GHz, ±1.53 dB, 4.2GHz < f ≤ 6.0GHz

**C3-6 TX IMD - conducted measurement uncertainty**

Conducted MU (1.96σ) from TS 36.141 [22]: ±1.0 dB

Conducted contribution for OTA MU budget (1σ): ±1.0 dB, f ≤ 3.0GHz, ±1.1 dB, 3.0 GHz < f ≤ 4.2 GHz, ± 1.2 dB, 4.2 GHz < f ≤ 6.0 GHz

**C3-7 Colocation blocking - conducted measurement uncertainty**

Conducted accuracy of the co-location blocking interferer is the same as the TX IMD interferer.

Table C.3-1: MU derived from the conducted specification

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| UID | Requirement | Use case | Standard uncertainty σ (dB) | | | | Probability distribution |
| f ≦ 3GHz | 3GHz < f ≦ 4.2 GHz | 4.2GHz < f ≦ 6 GHz | 6GHz < f ≦ 26 GHz |
| C3-1 | DL-RS MU derived from conducted specification | Measurement stage | 0.41 | 0.56 | 0.56 | N/A | Gaussian |
| C3-2 | Total power dynamic range conducted uncertainty | 0.2 | 0.2 | 0.2 | N/A |
| C3-3 | Transmitter mandatory spurious emissions | 1.0 | | | 2.0 |
| C3-4 | Receiver spurious emissions | 1.0 | | | 2.0 |
| C3-5 | Additional (co-existence) spurious emissions | 1.02 | 1.28 | 1.53 | N/A |
| C3-6 | TX IMD - conducted measurement uncertainty | 1 | 1.1 | 1.2 | N/A |
| C3-7 | Colocation blocking - conducted measurement uncertainty | 1 | 1.1 | 1.2 | N/A |

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