**3GPP TSG-RAN4 Meeting #116R4-251xxxx (Rev of R4-2511644)**

**Bengaluru, India, 25th - 29th August, 2025**

**Agenda item:** 7.10.3.3

**Source:** Keysight Technologies UK Ltd, CAICT, Spirent Communications, ETS-Lindgren

**Title:** TP to TR 38.762:MU and CM aspects

**Document for:** Approval

# Introduction

This contribution is incorporating proposals from [1] into [2]. Additionally, it is removing various [] in the TP and implements the limits agreed in [3].

# Discussion

**Proposal 1: Approve the TP to address MUs and close on CE aspects.**

# References

1. R4-2509916, On Preliminary MU Budget for DynMIMO OTA TCs, Keysight Technologies UK Ltd, Spirent Communications, CAICT, ETS-Lindgren, 3GPP TSG-RAN4 Meeting #116, August 2025
2. TR 38.762, Multiple Input Multiple Output (MIMO) Over-the-Air (OTA) dynamic test methodology for FR1 UEs
3. R4-2508782, Way Forward for [115][337] TRP\_TRS\_MIMO\_OTA\_Ph3, vivo, 3GPP TSG-RAN WG4 Meeting #115

**<<< START OF CHANGES >>>**

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

- In the case where the same reference is dated and undated, the specific reference to the document in the test plan shall be considered to determine if the dated and undated version is to be used.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 38.101-1: "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone".

[3] 3GPP TR 37.977: "Verification of radiated multi-antenna reception performance of User Equipment (UE)".

[4] 3GPP TS 38.151: "Multiple Input Multiple Output (MIMO) Over-the-Air (OTA) performance requirements".

[5] 3GPP TR 38.827: "Study on radiated metrics and test methodology for the verification of multi-antenna reception performance of NR User Equipment (UE)".

[6] L. Hentilä, P. Kyösti and P. Heino, "Evaluation of beam forming and multi antenna techniques in non-stationary propagation scenarios with HW emulator," 2012 International ITG Workshop on Smart Antennas (WSA), Dresden, 2012, pp. 347-351. Online: <https://ieeexplore.ieee.org/document/6181232>

[7] 3GPP TR 38.901 V18.0.0 (2024-03): "Study on channel model for frequencies from 0.5 to 100 GHz".

[8] 3GPP TS 38.101-4: "User Equipment (UE) radio transmission and reception; Part 4: Performance requirements".

[9] 3GPP TS 38.214: "NR; Physical layer procedures for data".

[10] 3GPP TS 38.551: “User Equipment (UE) Multiple Input Multiple Output (MIMO) Over-the-Air (OTA) performance; Conformance testing”

<<< Skip Unchanged Sections >>>

### 6.3.5 Test procedure

The communication tester shall record the TP with the maximum downlink power set to -80 dBm/15 kHz in the required 200 ms increments throughout the entire duration of the model instead of the TP being queried periodically from the control PC. The TMT trace shall be recorded as a function of time, synchronized with the start of the channel model to reliably calculate the desired CDF and subsequently the CTMT metrics, as outlined in Clause 5. After the completion of the channel model, the recorded TP results shall be made available from the communication tester to the control PC, e.g., as comma separated value list over SCPI or as file via remote file system.

## 6.4 UE positioning in MPAC

In order to minimize measurement uncertainty, it is important that test house ensures the DUT is oriented within the chamber’s test zone in a standardized manner. The “black-box” testing approach is adopted for NR MIMO OTA testing, i.e., the physical centre of the DUT shall be placed in the centre of the test zone.

Two aspects are considered to determine the DUT antenna spacing and positioning guidelines. The maximum antenna spacing in the DUT shall be within the limit determined by the MPAC system’s ability to emulate the spatial correlation function and the power stability of the field incident on the DUT. The DUT shall wholly reside within the 300 mm test zone under all DUT positioning conditions. Clause B.2 provides a preliminary set of normative DUT orientation conditions.

The maximum antenna spacing in the DUT shall be defined as 1.7 wavelength at the centre frequency of the band under test. Testing is not required in any band where the maximum antenna spacing of any two antennas is greater than 1.7 wavelengths.

<<< Skip Unchanged Sections >>>

# 8 Channel model validation

## 8.1 General

<Editor’s note: Additional frequencies for validation measurements are not precluded.>

This clause describes the MIMO OTA validation measurements required to ensure that the test conditions are correctly implemented and hence capable of generating the propagation environment, as described by the model, within the designated test zone.

The channel model validations defined in this Clause apply only to the channel models defined in this document, i.e., the channel models with full path loss model [7] and the UE noise limited environment.

The following validation measurements shall be performed at 2450 MHz:

* Path Loss (PL)
* Power Delay Profile (PDP)
* Doppler/Temporal correlation (TCF)
* Spatial Correlation (SCF)
* Cross-polarization (XPO)

The target values of validation items defined in following clauses are obtained computationally from propagation parameters of Annex A using the specified antennas. The reference channel model is ideal and primarily does not consider multi-probe OTA limitations. The only exception is the LOS path, which is quantized to the closest probe of MPAC configuration as defined in Clause 7.1. This quantization affects the target statistical values of spatial correlation in Clause 8.2.5.

## 8.2 Validation of the dynamic channel models

### 8.2.1 Measurement Setup

The measurement setup includes the following equipment listed in Table 8.2.1-1.

Table 8.2.1-1: Required Measurement Equipment

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Item | Quantity | Item | PL | PDP | TCF | SCF | XPO |
| 1 | 1 | Channel Emulator (CE) | x | x | x | x | x |
| 2 | 1 | Signal Generator (SG) (Optional, Note 1-2) | x | (x) | x | (x) | x |
| 3 | 1 | Signal Analyser (SAN) | x | (x) | x | (x) | x |
| 4 | 1 | Vector Network Analyser (VNA) (Note 3) | - | (x) | - | (x) | - |
| 5 | 1 | Dipole | x | x | x | x | x |
| 6 | 1 | Loop | - | - | - | - | x |
| Note 1. VNA can typically generate CW.  Note 2. Some gNB emulators can generate NR/AWGN signals in non-signaling mode.  Note 3. Frequency domain method uses VNA and time domain method SG + SAN. | | | | | | | |

#### 8.2.1.1 Network Analyser (VNA) Setup

Figure 8.2.1.1-1 shows a typical network analyser setup for channel model validation purposes.



Figure 8.2.1.1-1: Setup for Anechoic Chamber VNA Measurements

#### 8.2.1.2 Signal Analyser (SAN) Setup

Figure 8.2.1.2-1 shows a typical signal generator and signal analyser setup for channel model validation purposes. Depending on CE implementation, the trigger direction between SAN and CE needs to be adjusted, i.e., from SAN to CE or from CE to SAN.



Figure 8.2.1.2-1: Setup for Signal Analyser Measurements

### 8.2.2 Validation of dynamic path loss

#### 8.2.2.1 PL Method of Measurement

The intention of this validation measurement is to capture the emulated dynamic path loss (PL) as it is realized in the centre of the test zone. Measurement antenna is a vertical dipole.

The measurement antenna is placed in the centre of the test zone. Time domain technique depicted in Figure 8.2.1.2-1 is used. Table 8.2.2.1-1 outlines the settings for the channel emulator, signal generator, and signal analyser respectively.

The time domain technique (time sweep) is used for the validation. A signal generator transmits a CW signal through the test system. The CW signal is split to two input ports of fading emulator that correspond to the two first signal streams of the gNB emulator, i.e., two orthogonally polarized co-located gNB antennas. The signal is received by a test antenna within the test area. Finally, the signal is collected by a signal analyser and the measured signal is stored. Signal generator and signal analyser settings are listed in Tables 8.2.2.1-2 and 8.2.2.1-3, respectively. The measurement is triggered to start with the time instant 0 of the channel model and to stop at the last time instant of the channel model.

Table 8.2.2.1-1: MPAC Dynamic Channel Model Specification

| Item | Unit | Value |
| --- | --- | --- |
| Centre frequency | MHz | 2450 |
| Channel emulator mode | N/A | Triggered start and stop |
| Channel model |  | As specified in Clause 7.1 |
| Mobile speed | km/h | Dynamic, as specified in Clause 7.1 |

Table 8.2.2.1-2: MPAC Path Loss Signal Generator Settings

| Item | Unit | Value |
| --- | --- | --- |
| Centre frequency | MHz | 2450 |
| Output Power | dBm | Function of the CE. Sufficiently above Noise Floor |

Table 8.2.2.1-3: MPAC Path Loss Signal Analyser Settings

| Item | Unit | Value |
| --- | --- | --- |
| Centre frequency | MHz | 2450 |
| Sampling | Hz | At least 15 times bigger than the max Doppler spread (*fd=v/λ)* |
| Observation time | s | One full duration of the channel model route. |

The channel emulator should issue a trigger signal when the channel model is started. When the channel model is run to the end, another trigger signal is issued. A time domain trace with the SAN is collected. Data recording is synchronized with the channel emulator trigger.

The PL validation is performed with the maximum downlink power at -80 dBm/15kHz while ensuring that the signal level exceeds the noise level during the entire dynamic PL validation.

#### 8.2.2.2 PL Measurement Antenna

The measurement antenna shall be a vertically-oriented dipole.

#### 8.2.2.3 PL Measurement Results Analysis

The measured channel gains (inverse of path loss) are averaged over time segments and normalized such that the maximum value across all segments is 0 dB. The resulting normalized channel gains are the target values.

Lengths of time segment and time increment between segments in seconds are specified separately for both models. Example values for start and end time of UMa route segments are given in Table 8.2.2.3-1 and of the UMi route segments are given in Table 8.2.2.3-2.

Table 8.2.2.3-1: Start and end times of time segments for UMa route

|  |  |  |
| --- | --- | --- |
| Segment number | Start time [s] | End time [s] |
| 1 | 1 | 5 |
| 2 | 10 | 15 |
| 3 | 21 | 42 |
| 4 | 47 | 52 |
| 5 | 62 | 67 |
| 6 | 82 | 87 |
| 7 | 90 | 95 |
| 8 | 102 | 107 |
| 9 | 115 | 120 |

Table 8.2.2.3-2: Start and end times of time segments for UMi route

|  |  |  |
| --- | --- | --- |
| Segment number | Start time [s] | End time [s] |
| 1 | 1 | 5 |
| 2 | 10 | 20 |
| 3 | 30 | 40 |
| 4 | 44 | 54 |
| 5 | 60 | 70 |
| 6 | 77 | 82 |
| 7 | 90 | 95 |

#### 8.2.2.4 PL Target Values

The target values for the UMa route are specified in Table 8.2.2.4-1 and illustrated in Figure 8.2.2.4-1 while the target values for the UMi route are specified in Table 8.2.2.4-2 and illustrated in Figure 8.2.2.4-2.

Table 8.2.2.4-1: UMadyn Dynamic Path Gain (Path Loss) Target Values for the Measured Normalized Channel Gain for the UMa Route with full path loss model [7]

|  |  |
| --- | --- |
| Segment # | UMadyn PL Target [dB] |
| 1 | -0.8 |
| 2 | 0 |
| 3 | -29.5 |
| 4 | -27.6 |
| 5 | -21.5 |
| 6 | -30.1 |
| 7 | -0.1 |
| 8 | -19.8 |
| 9 | -0.7 |

A graph with blue dots and lines

Description automatically generated

Figure 8.2.2.4-1: UMadyn Dynamic Path Gain (Path Loss) Targets for the Measured Normalized Channel Gain for the UMa Route with full path loss model [7]

Table 8.2.2.4-2: UMidyn Dynamic Path Gain (Path Loss) Target Values for the Measured Normalized Channel Gain for the UMi Route with full path loss model [7]

|  |  |
| --- | --- |
| Segment # | UMidyn PL Target [dB] |
| 1 | -7.5 |
| 2 | 0 |
| 3 | -16.6 |
| 4 | -12.9 |
| 5 | -16.5 |
| 6 | -0.9 |
| 7 | -0.7 |



Figure 8.2.2.4-2: UMidyn Dynamic Path Gain (Path Loss) Targets for the Measured Normalized Channel Gain for the UMi Route with full path loss model [7]

### 8.2.3 Validation of Power Delay Profile (PDP)

#### 8.2.3.1 General

The purpose of this item is to validate the slow variation of power delay profile as observed by the DUT due to the dynamic channel model. PDP can be measured either by using the frequency sweep method and a network analyser or alternatively the time domain method with wideband signal transmitted through the test system. In both options the test signal is received by a test antenna in the test zone. The variation of PDP in the reference channel model is caused by the change of path delays and powers along the route. There are two categories of channel segments (defined in Tables 8.2.2.3-1 and 8.2.2.3-2) in the UMadyn and UMidyn models. Firstly, those with same CDL model throughout the segment, meaning that only the initial delay changes during the segment but excess delays remain unchanged, i.e., quasi time invariant. Secondly, some segments have different CDL models on preceding and subsequent way-points, meaning that both the initial delay and excess delays are time variant during the segment. Channel segments with quasi time invariant and time variant excess delays are validated differently.

In the UMadyn model the channel segments 1, 2, 6, 7, and 9 are in the first category and segments 3, 4, 5, and 8 in the second. In the UMidyn model, the channel segments 2, 6, and 7 are in the first category and segments 1, 3, 4, and 5 in the second.

The validation is done by observing the measured channel impulse responses and averaging them to a PDP estimate. PDP can be evaluated either by using the frequency sweep method and a network analyser or alternatively the time domain method with wideband signal transmitted through the test system. In both options the test signal is received by a test antenna in the test zone.

#### 8.2.3.2 PDP Method of Measurement using Frequency-Domain Technique

A network analyser transmits frequency tones through the test system when the frequency sweep technique is used in the validation. See Figure 8.2.1.1-1 for the block diagram. The signal is received by a test antenna within the test area. During each frequency sweep the channel model is paused by the channel emulator. After the sweep, channel model is stepped to the next time instant and paused again for the next frequency sweep. The time increment between consecutive frequency sweeps measuring the frequency responses of channel model instances is defined in Table 8.2.3.2-1. It is at most the inverse of twice the maximum Doppler frequency, i.e., .

Channel model segments are specified in Tables 8.2.2.3-1 and 8.2.2.3-2. At the first time instant of a segment the model is paused and the complex channel frequency response is measured and stored. This is repeated with the specified time increment until the whole time segment is covered. The sequence of measured channel responses of the segment is analysed as defined in Clause 8.2.3.5. The subsequent channel segments are measured then correspondingly. Network analyser settings are defined in Table 8.2.3.2-1. The measured channel frequency response of channel model segment at frequency and channel model time instant is

where is the lowest frequency point, is the index of frequency point, is the spacing between frequency points, is the first time instant of segment , is the index of time instants, and is the increment between measured time instants.

Table 8.2.3.2-1: MPAC PDP Network Analyser Settings

| Item | Unit | Value |
| --- | --- | --- |
| Bandwidth | MHz | 200 |
| Number of frequency points | - | ≥1101 |
| Number of traces | - | One per every CIR within the segment |

#### 8.2.3.3 PDP Method of Measurement using Time-Domain Technique

<Editor’s note: The detailed procedure will be updated at a later time.>

This clause is to define the PDP Method of Measurement using Time-Domain Technique.

#### 8.2.3.4 PDP Measurement Antenna

The measurement antenna shall be a vertically-oriented dipole.

#### 8.2.3.5 PDP Measurement Results Analysis using Frequency-Domain Technique

The first operation is to remove the quasi time-variant initial delay from measured responses . The initial delay at each time instant is calculated by dividing the instantaneous link distance with the speed of light (in vacuum). It is removed from each frequency response by time shifting in frequency domain and a new delay shifted response is

These responses are then transformed to impulse responses

By the inverse Fourier transformation, where = 5 ns is the width of a delay bin and is the index of the delay bin. Note that due to different cable lengths, calibration etc. of test setups the resulting measured PDPs must be further shifted such that the first path component of PDPs is set on zero excess delay. This can be done either by visual observation or by correlating the resulting dynamic PDPs with theoretical reference PDPs and choosing the delay shift yielding best correlation.

Segments with quasi time invariant excess delays for UMa route: 1, 2, 6, 7, and 9 and for UMi route: 2, 6, and 7:

Power delay profile for each segment is determined by the time average

Finally, the normalized PDP is

All values of below −40 dB are neglected in validation. Peaks, i.e., local maxima of (in dB scale) are identified and chosen as the target value of the time segment.

Segments with time variant excess delays for UMa are 3, 4, 5, and 8 and for UMi are 1, 3, 4, and 5:

These validation segment must be treated differently since straightforward averaging of the power per delay bin over the time domain would provide erroneous result. Therefore, PDPs are evaluated per cluster (tap) index not per delay bin in the case of time variant excess delays. The procedure is as follows. First, the excess delay at the first and the last measured time instant of the segment is determined from time interpolated model parameters for each cluster . The excess delay of th cluster is linearly interpolated for each time sample of the measurement and then quantized to the delay resolution supported by the measurement. The resulting quantized cluster excess delay at th time sample is . Then dynamic powers of clusters on segment are calculated as the sum of powers over time samples in delay bins determined by . Since cluster powers are dispersed across neighbouring delay bins due to limited measurement bandwidth, also the previous and the successive delay bin are included in the summation. This is expressed by the formula

Finally, the measured power per cluster is normalized such that the maximum cluster power per segment becomes unity

#### 8.2.3.6 PDP Measurement Results Analysis using Time-Domain Technique

<Editor’s note: The detailed procedure will be updated at a later time.>

This clause is to define the PDP Measurement Results Analysis using Time-Domain Technique.

#### 8.2.3.7 PDP Target Values

The target values for the UMa route are specified in [Table 8.2.3.7-1](#_Hlk176087530) and illustrated in [Figure 8.2.3.7-1](#_Hlk176087417) which uses the time segments defined in [Table 8.2.2.3-1](#_Hlk176085569); the original PDP values without any processing related to the delay resolution are tabulated in Table 8.2.3.7-2. The target values for the UMi route are specified in [Table 8.2.3.7-3](#_Hlk176087530) and illustrated in [Figure 8.2.3.7-2](#_Hlk176087417) which uses the time segments defined in [Table 8.2.2.3-2](#_Hlk176085569); the original PDP values without any processing related to the delay resolution are tabulated in Table 8.2.3.7-4. Note that red lines in the figures denote the power per excess delay and blue lines the power per cluster index. Entries of the table contain either discrete excess delay/power pairs or cluster index/power pairs, depending on the segment type. In the case of segments with time variant excess delays the initial and final excess delays of clusters must be as specified in the model parameter tables in Annex A and rounded to the delay resolution supported by the measurement bandwidth (1/200 MHz = 5 ns). The window used in the bandwidth filtering is a Chebyshev window with 120 dB sidelobe factor, discussed in some more detail in Clause 8.2.3.8.

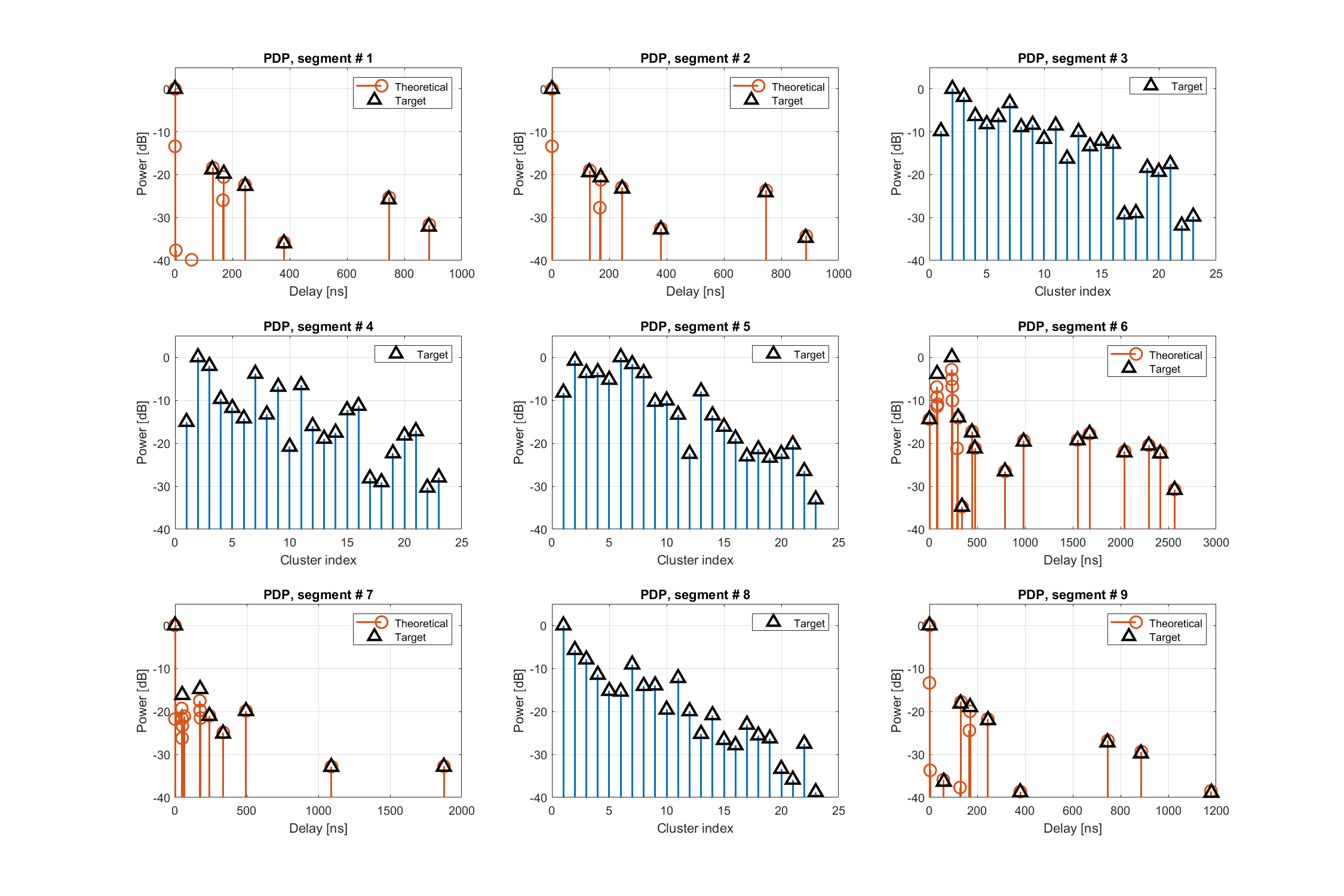


Figure 8.2.3.7-1 Target PDP Segments of the UMadyn Channel Model with full path loss model [7]

Table 8.2.3.7-1 UMadyn PDP Targets of the UMa Route with full path loss model [7]

|  |  |  |
| --- | --- | --- |
| Segment # |  | UMadyn Target PDP |
| 1 | Delay [ns] | 0, 130, 170, 245, 380, 745, 885 |
| Power [dB] | 0, -18.8, -19.8, -22.6, -36.0, -25.8, -32.1 |
| 2 | Delay [ns] | 0, 130, 170, 245, 380, 745, 885 |
| Power [dB] | 0, -19.4, -20.6, -23.2, -32.8, -24.1, -34.7 |
| 3 | Cluster index | 1, 2, ..., 23 |
| Power [dB] | -9.8, 0.0, -1.9, -6.3, -8.2, -6.6, -3.3, -8.9, -8.3, -11.7, -8.5, -16.3, -10.0, -13.4, -12.1, -12.8, -29.3, -29.0, -18.4, -19.3, -17.5, -31.9, -29.8 |
| 4 | Cluster index | 1, 2, ..., 23 |
| Power [dB] | -15.0, 0.0, -2.0, -9.7, -11.8, -14.2, -3.9, -13.3, -6.9, -20.8, -6.5, -16.0, -19.0, -17.5, -12.3, -11.3, -28.2, -29.1, -22.3, -18.2, -17.2, -30.3, -28.0 |
| 5 | Cluster index | 1, 2, ..., 23 |
| Power [dB] | -8.2, -0.8, -3.7, -3.5, -5.2, 0.0, -1.6, -3.7, -10.4, -10.1, -13.4, -22.5, -7.9, -13.5, -16.2, -18.9, -23.1, -21.4, -23.4, -22.5, -20.3, -26.5, -33.1 |
| 6 | Delay [ns] | 0, 80, 235, 300, 340, 445, 475, 790, 985, 1550, 1675, 2040, 2295, 2415, 2565] |
| Power [dB] | -14.4, -3.9, 0.0, -14.0, -34.7, -17.5, -21.2, -26.5, -19.6, -19.3, -17.8, -22.1, -20.5, -22.4, -30.8 |
| 7 | Delay [ns] | 0, 50, 175, 240, 335, 495, 1090, 1875 |
| Power [dB] | 0, -16.2, -14.8, -21.0, -25.2, -19.9, -32.9, -32.9 |
| 8 | Cluster index | 1, 2, ..., 23 |
| Power [dB] | 0.0, -5.7, -7.9, -11.5, -15.2, -15.4, -9.1, -14.1, -13.9, -19.6, -12.2, -19.9, -25.2, -20.9, -26.6, -27.9, -23.1, -25.6, -26.3, -33.3, -35.9, -27.5, -38.8 |
| 9 | Delay [ns] | 0, 60, 130, 170, 245, 380, 745, 885, 1180 |
| Power [dB] | 0, -36.3, -18.2, -19.0, -22.0, -38.8, -27.2, -29.8, -38.9 |

Table 8.2.3.7-2 UMadyn Ideal PDP of the UMa Route with full path loss model [7]

|  |  |  |
| --- | --- | --- |
| Segment # |  | UMadyn Ideal PDP |
| 1 | Delay [ns] | 0, 0, 3, 58, 132, 167, 170, 244, 380, 747, 887 |
| Power [dB] | 0, -13.38, -37.64, -39.84, -18.35, -25.97, -20.55, -22.35, -35.81, -25.32, -31.66 |
| 2 | Delay [ns] | 0, 132, 167, 170, 244, 380, 747, 887 |
| Power [dB] | 0, -13.37, -18.99, -27.69, -21.19, -22.99, -32.56, -23.66, -34.28 |
| 3 | Cluster index | 1, 2, ..., 23 |
| Power [dB] | -9.8, 0.0, -1.9, -6.3, -8.2, -6.6, -3.3, -8.9, -8.3, -11.7, -8.5, -16.3, -10.0, -13.4, -12.1, -12.8, -29.3, -29.0, -18.4, -19.3, -17.5, -31.9, -29.8 |
| 4 | Cluster index | 1, 2, ..., 23 |
| Power [dB] | -15.0, 0.0, -2.0, -9.7, -11.8, -14.2, -3.9, -13.3, -6.9, -20.8, -6.5, -16.0, -19.0, -17.5, -12.3, -11.3, -28.2, -29.1, -22.3, -18.2, -17.2, -30.3, -28.0 |
| 5 | Cluster index | 1, 2, ..., 23 |
| Power [dB] | -8.2, -0.8, -3.7, -3.5, -5.2, 0.0, -1.6, -3.7, -10.4, -10.1, -13.4, -22.5, -7.9, -13.5, -16.2, -18.9, -23.1, -21.4, -23.4, -22.5, -20.3, -26.5, -33.1 |
| 6 | Delay [ns] | 0, 76, 79, 81, 85, 232, 235, 239, 240, 289, 299, 340, 447, 476, 790, 987, 1551, 1675, 1999, 2042, 2296, 2417, 2564 |
| Power [dB] | -11.50, -4.04, -8.52, -6.34, -8.04, 0.00, -2.20, -3.90, -7.18, -18.30, -11.17, -31.84, -14.35, -18.25, -23.64, -16.48, -16.34, -14.89, -38.14, -18.98, -17.56, -19.24, -27.89] |
| 7 | Delay [ns] | 0, 0, 47, 49, 49, 51, 65, 173, 175, 178, 240, 337, 495, 1091, 1876 |
| Power [dB] | 0, -21.78, -19.32, -21.62, -26.21, -23.32, -21.13, -17.54, -19.74, -21.54, -21.01, -24.89, -19.88, -32.82, -32.75 |
| 8 | Cluster index | 1, 2, ..., 23 |
| Power [dB] | 0.0, -5.7, -7.9, -11.5, -15.2, -15.4, -9.1, -14.1, -13.9, -19.6, -12.2, -19.9, -25.2, -20.9, -26.6, -27.9, -23.1, -25.6, -26.3, -33.3, -35.9, -27.5, -38.8 |
| 9 | Delay [ns] | 0, 0, 3, 58, 128, 132, 167, 170, 244, 380, 747, 887, 1178 |
| Power [dB] | 0, -13.38, -33.69, -35.89, -37.69, -17.78, -24.44, -19.98, -21.78, -38.64, -26.76, -29.33, -38.52 |

A graph of a graph

AI-generated content may be incorrect.

Figure 8.2.3.7-2 Target PDP Segments of the UMidyn Channel Model with full path loss model [7]

Table 8.2.3.7-3 UMidyn PDP Targets of the UMi Route with full path loss model [7]

|  |  |  |
| --- | --- | --- |
| Segment # |  | UMidyn Target PDP |
| 1 | Cluster index | 1, 2, ...17 |
| Power [dB] | 0, -21.8, -22.5, -24.3, -16.8, -16.7, -16.5, -18.3, -25.5, -24.5, -29.6, -24, -30, -34.7, -39.9, -39.8, -37.7 |
| 2 | Delay [ns] | 0, 35, 75, 95, 140, 430, 510, 680 |
| Power [dB] | 0, -35.3, -17.5, -18.5, -21.5, -28.9, -28.2, -37.5 |
| 3 | Cluster index | 1, 2, ..., 23 |
| Power [dB] | -17.1, 0, -2.8, -2.8, -4.8, -1.6, -2, -4.4, -5.9, -9, -6.1, -26.4, -7.5, -21.5, -20.3, -10.7, -15.2, -16.2, -16.8, -16.8, -15.5, -19.2, -23.6 |
| 4 | Cluster index | 1, 2, ..., 23 |
| Power [dB] | -11.3, 0, -2.5, -4.3, -6.1, -2, -2, -5.2, -7.8, -11.5, -8.4, -21.8, -9.3, -15.9, -16.6, -13.6, -21, -20.8, -19.5, -19.3, -18, -24.4, -27.7 |
| 5 | Cluster index | 1, 2, ..., 23 |
| Power [dB] | -11, 0, -2, -5.6, -7.5, -5.9, -3.1, -8.2, -8.1, -11.2, -8.4, -17.6, -9.4, -14.4, -13.3, -12.5, -27.1, -26.7, -17.5, -18.8, -16.6, -30.1, -28.9 |
| 6 | Delay [ns] | 0, 30, 100, 140, 195, 285 |
| Power [dB] | 0, -20.4, -17, -26.1, -33.6, -20.1 |
| 7 | Delay [ns] | 0, 30, 100, 140, 195, 285 |
| Power [dB] | 0, -20.7, -16.2, -24.4, -30.6, -20.1 |

Table 8.2.3.7-4 UMidyn Ideal PDP of the UMi Route with full path loss model [7]

|  |  |  |
| --- | --- | --- |
| Segment # |  | UMidyn Ideal PDP |
| 1 | Cluster index | 1, 2, ...17 |
| Power [dB] | 0, -21.8, -22.5, -24.3, -16.8, -16.7, -16.5, -18.3, -25.5, -24.5, -29.6, -24, -30, -34.7, -39.9, -39.8, -37.7 |
| 2 | Delay [ns] | 0, 0, 2, 33, 74, 76, 96, 98, 141, 431, 511, 679] |
| Power [dB] | 0, -13.37, -32.64, -34.84, -36.64, -17.26, -23.33, -19.46, -21.26, -28.65, -27.97, -37.28 |
| 3 | Cluster index | 1, 2, ..., 23 |
| Power [dB] | -17.1, 0, -2.8, -2.8, -4.8, -1.6, -2, -4.4, -5.9, -9, -6.1, -26.4, -7.5, -21.5, -20.3, -10.7, -15.2, -16.2, -16.8, -16.8, -15.5, -19.2, -23.6 |
| 4 | Cluster index | 1, 2, ..., 23 |
| Power [dB] | -11.3, 0, -2.5, -4.3, -6.1, -2, -2, -5.2, -7.8, -11.5, -8.4, -21.8, -9.3, -15.9, -16.6, -13.6, -21, -20.8, -19.5, -19.3, -18, -24.4, -27.7 |
| 5 | Cluster index | 1, 2, ..., 23 |
| Power [dB] | -11, 0, -2, -5.6, -7.5, -5.9, -3.1, -8.2, -8.1, -11.2, -8.4, -17.6, -9.4, -14.4, -13.3, -12.5, -27.1, -26.7, -17.5, -18.8, -16.6, -30.1, -28.9 |
| 6 | Delay [ns] | 0, 0, 27, 29, 29, 30, 37, 100, 101, 103, 138, 195, 286 |
| Power [dB] | 0, -21.78, -35.18, -37.48, -21.47, -39.18, -25.24, -19.88, -22.08, -23.88, -25.87, -33.54, -20.01 |
| 7 | Delay [ns] | 0, 0, 27, 29, 29, 30, 37, 100, 101, 103, 138, 195, 286 |
| Power [dB] | 0, -21.82, -29.86, -32.16, -23.40, -33.86, -23.77, -19.06, -21.26, -23.06, -24.14, -30.53, -20.01 |

#### 8.2.3.8 Chebyshev Window Function

The Chebyshev window is a finite impulse response (FIR) window for *L* samples designed to minimize the main-lobe width for a specified side-lobe level, *r*, in decibels. It is based on the Chebyshev polynomials of the first kind. The Chebyshev window is designed such that all side-lobes in its frequency response have equal height (equiripple behaviour), and its main lobe is as narrow as possible for a given side-lobe attenuation level. The window coefficients are symmetric around the centre.

The Chebyshev window is defined in the frequency domain as:

where

and

A prominent function to create this window is the chebwin function in MATLAB®, e.g, w=chebwin(2001,120) which creates a 2001-point Chebyshev window with 120 dB of side-lobe attenuation as shown in Figure 8.2.3.8-1.



Figure 8.2.3.8-1: Visualization of the Chebyshev window with 120dB of side-lobe attenuation using MATLAB®

### 8.2.4 Validation of Doppler/Temporal Correlation

#### 8.2.4.1 TCF Method of Measurement

The purpose of this item is to validate the slow variation of Doppler effect due of the dynamic channel model. This is done indirectly by observing the temporal correlation function (TCF). TCF at a few time lags are evaluated from the measured narrowband signal transmitted through the test system.

The time domain technique (time sweep) is used for the validation. See the block diagram of the setup in Figure 8.2.1.2-1. A signal generator transmits a CW signal through the test system. The signal is received by a test antenna within the test area. Finally, the signal is collected by a signal analyser and the measured signal is stored. Signal analyser and signal generator settings are defined in Tables 8.2.4.1-1 and 8.2.4.1-2. The measurement is triggered to start with the time instant 0 of the channel model and to stop at the last time instant of the channel model.

Table 8.2.4.1-1: MPAC TCF Signal Generator Settings

| Item | Unit | Value |
| --- | --- | --- |
| Centre frequency | MHz | 2450 |
| Output Power | dBm | Function of the CE. Sufficiently above Noise Floor |

Table 8.2.4.1-2: MPAC TCF Signal Analyser Settings

| Item | Unit | Value |
| --- | --- | --- |
| Centre frequency | MHz | 2450 |
| Sampling | Hz | At least 15 times bigger than the max Doppler spread (fd=v/λ) |
| Observation time | s | One full duration of the channel model route. |

The signal analyser records I/Q samples at the rate of 15 times the maximum Doppler frequency (72.24 Hz). The full model length is measured at once.

#### 8.2.4.2 TCF Measurement Antenna

The measurement antenna shall be a vertically-oriented dipole.

#### 8.2.4.3 TCF Measurement Results Analysis

Segments of recorded I/Q samples are selected, autocorrelation of I/Q samples of a segment is calculated, and a few samples of the resulting temporal correlation function are picked for the validation. Time lags to be picked for TFC are 4.6 ms and 20.2 ms.

#### 8.2.4.4 TCF Target Values

The target values for the UMa route are specified in [Table 8.2.4.4-1](#_Hlk176087530) and illustrated in [Figure 8.2.4.4-1](#_Hlk176087417) which uses the time segments defined in [Table 8.2.2.3-1](#_Hlk176085569" \s "1,68642,68657,4094,TABLHEADER BEST,Table 4.2.1.2-1). The target values for the UMi route are specified in [Table 8.2.4.4-2](#_Hlk176087530) and illustrated in [Figure 8.2.4.4-2](#_Hlk176087417) which uses the time segments defined in [Table 8.2.2.3-2](#_Hlk176085569). Estimated temporal correlation values at time lag ms and ms are illustrated in the top and bottom figure, respectively. Target values are shown within time segment limits.

A graph of a graph of a graph

AI-generated content may be incorrect.

**Figure 8.2.4.4-1: UMadyn****Temporal Correlation Function of UMa Route for Two Different TFC Time Lags**

Table 8.2.4.4-1: Dynamic UMadyn Temporal Correlation Targets of the UMa Route with full path loss model [7]

|  |  |  |
| --- | --- | --- |
| Segment # | UMadyn Target TCF at ms | UMadyn Target TCF at ms |
| 1 | 0.970 | 0.876 |
| 2 | 0.961 | 0.879 |
| 3 | 0.994 | 0.886 |
| 4 | 0.436 | 0.355 |
| 5 | 0.648 | 0.345 |
| 6 | 0.521 | 0.100 |
| 7 | 0.801 | 0.228 |
| 8 | 0.837 | 0.398 |
| 9 | 0.939 | 0.616 |

A diagram of a graph

AI-generated content may be incorrect.

**Figure 8.2.4.4-2: UMidyn Temporal Correlation Function of UMi Route for Two Different TFC Time Lags**

Table 8.2.4.4-2: Dynamic UMidyn Temporal Correlation Targets of the UMi Route with full path loss model [7]

|  |  |  |
| --- | --- | --- |
| Segment # | Target UMidyn TCF at ms | Target UMidyn TCF at ms |
| 1 | 0.871 | 0.436 |
| 2 | 0.952 | 0.857 |
| 3 | 0.513 | 0.188 |
| 4 | 0.698 | 0.064 |
| 5 | 0.744 | 0.374 |
| 6 | 0.959 | 0.813 |
| 7 | 0.965 | 0.854 |

### 8.2.5 Validation of Spatial Correlation

#### 8.2.5.1 SCF Method of Measurement

The purpose of this item is to validate the slow variation of angular power distribution as observed by the DUT due of the dynamic channel model. The variation of PAS in the reference channel model is caused by the change of path angles, path powers, and UE orientation along the route. The validation is done indirectly by observing the spatial correlation function (SCF). SCF is evaluated from the measured narrowband signal transmitted through the test system and received by a test antenna in a few spatial positions within the test zone.

The time domain technique (time sweep) is used for the validation. See the block diagram of the setup in Figure 8.2.1.2-1. A signal generator transmits a CW signal through the test system. The CW signal is split to two input ports of fading emulator that correspond to the two first signal streams of the gNB emulator. The signal is received by a test antenna in a specific position within the test area. Finally, the signal is collected by a signal analyser and the measured signal is stored. Signal analyser and signal generator settings are defined in Tables 4.2.3.1-1 and 4.2.3.1-2. The measurement is triggered to start with the time instant 0 of the channel model and to stop at the last time instant of the channel model. The position of test antenna is changed and the measurement is repeated. All spatial positions are illustrated in Figure 8.2.5.1-1.

Table 8.2.5.1-1: MPAC SCF Signal Generator Settings

| Item | Unit | Value |
| --- | --- | --- |
| Centre frequency | MHz | 2450 |
| Output Power | dBm | Function of the CE. Sufficiently above Noise Floor |

Table 8.2.5.1-2: MPAC SCF Signal Analyser Settings

| Item | Unit | Value |
| --- | --- | --- |
| Centre frequency | MHz | 2450 |
| Sampling | Hz | At least 15 times bigger than the max Doppler spread (fd=v/λ) |
| Observation time | s | One full duration of the channel model route. |

The full model length is measured at once.

A graph of a function

Description automatically generated

Figure 8.2.5.1-1: Spatial sampling points within the test zone at 2450 MHz

Table 8.2.5.1-3: Spatial sample points, i.e., positions of test antenna for the SCF validation at 2450 MHz

| Point number | x [mm] | y [mm] | z [mm] |
| --- | --- | --- | --- |
| #1 (reference point) | 0 | -150 | 0 |
| #2 | -22.88 | -148.29 | 0 |
| #3 | -86.27 | -122.71 | 0 |
| #4 | -149.90 | -5.73 | 0 |

#### 8.2.5.2 SCF Measurement Antenna

The measurement antenna shall be a vertically-oriented dipole

#### 8.2.5.3 SCF Measurement Results Analysis

Time segments of recorded I/Q samples are selected. For each time segment the cross correlation (with zero time lag) of I/Q samples measured in different spatial sample points is calculated. Spatial sample points picked for SFC have at maximum Euclidian distance D*d* = 1.7 wavelength to the reference sample point. Absolute values of estimated complex spatial correlations per time segment are chosen as the target SCF values.

#### 8.2.5.4 SCF Target Values

The target values for the UMa route are specified in [Table](#_Hlk176088316) 8.2.5.4-1 and illustrated in [Figure 8.2.5.4-1](#_Hlk176088241), which uses the time segments along the dynamic UMadyn model proposed in [Table 8.2.2.3-1](#_Hlk176085569). The target values for the UMi route are specified in [Table](#_Hlk176088316) 8.2.5.4-2 and illustrated in [Figure 8.2.5.4-2](#_Hlk176088241), which uses the time segments along the dynamic UMidyn model proposed in [Table 8.2.2.3-2](#_Hlk176085569). Estimated spatial correlation values at spatial spacing  mm,  mm, and  mm (referenced to reference point #1) are illustrated in Figures 8.2.5.4-1 and 8.2.5.4-2. Target values are shown within time segment limits.

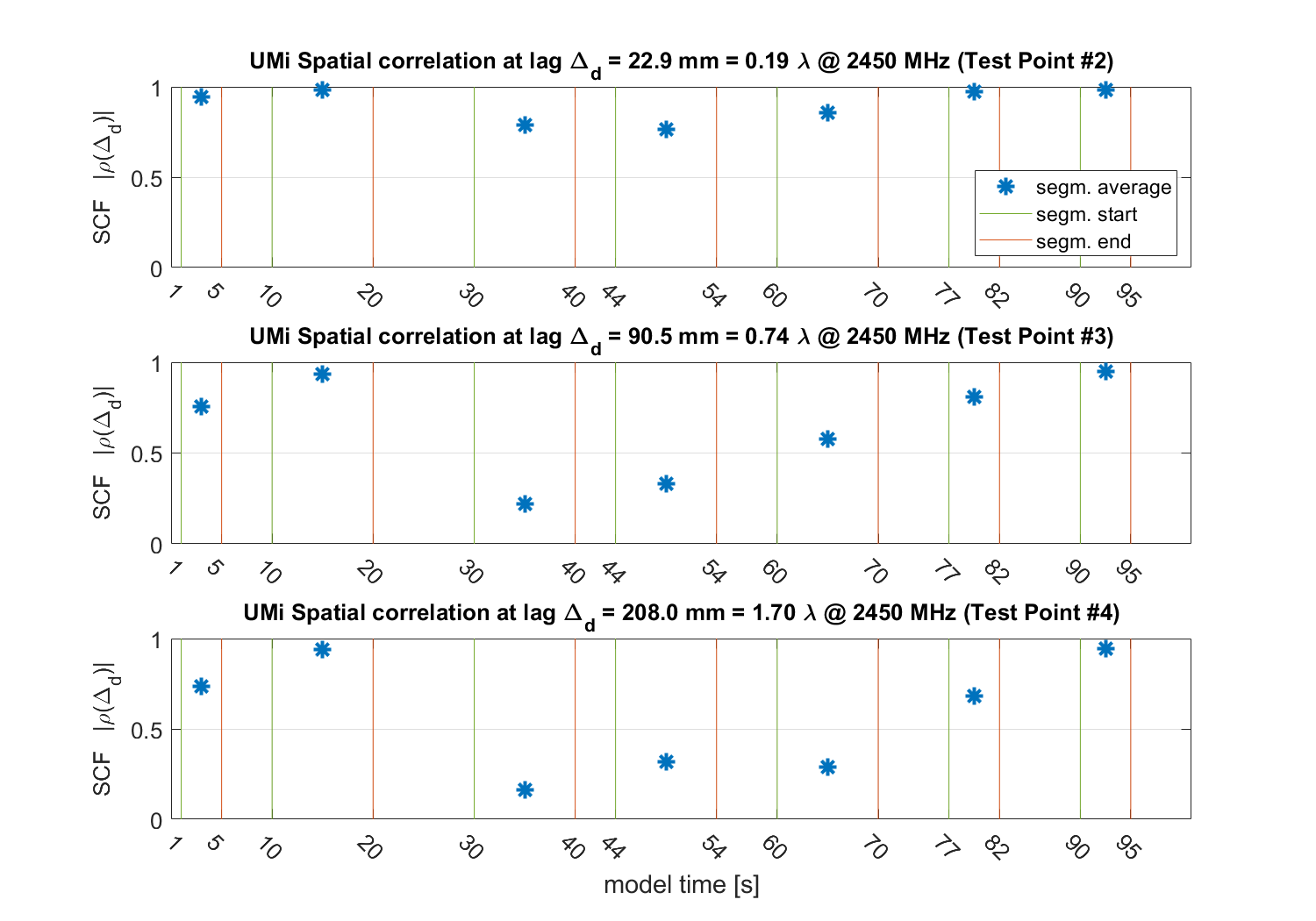
A diagram of a graph

AI-generated content may be incorrect.

**Figure 8.2.5.4-1: UMadyn** **Spatial Correlation Function of UMa Route with full path loss model [7] for Three Different SFC Test Antenna Positions**

Table 8.2.5.4-1: UMadyn Spatial Correlation Targets of the UMa Route with full path loss model [7] for 2450 MHz

|  |  |  |  |
| --- | --- | --- | --- |
| Segment # | Target SCF at mm | Target SCF at mm | Target SCF at mm |
| 1 | 0.986 | 0.908 | 0.932 |
| 2 | 0.963 | 0.611 | 0.326 |
| 3 | 0.800 | 0.159 | 0.111 |
| 4 | 0.699 | 0.721 | 0.492 |
| 5 | 0.831 | 0.414 | 0.156 |
| 6 | 0.794 | 0.392 | 0.454 |
| 7 | 0.928 | 0.482 | 0.366 |
| 8 | 0.835 | 0.285 | 0.610 |
| 9 | 0.959 | 0.575 | 0.220 |



**Figure 8.2.5.4-2: UMidyn** **Spatial Correlation Function of UMi Route with full path loss model [7] for Three Different SFC Test Antenna Positions**

Table 8.2.5.4-2: UMidyn Spatial Correlation Targets of the UMi Route with full path loss model [7] for 2450 MHz

|  |  |  |  |
| --- | --- | --- | --- |
| Segment # | Target SCF at mm | Target SCF at mm | Target SCF at mm |
| 1 | 0.944 | 0.755 | 0.733 |
| 2 | 0.981 | 0.936 | 0.937 |
| 3 | 0.787 | 0.221 | 0.162 |
| 4 | 0.764 | 0.329 | 0.320 |
| 5 | 0.856 | 0.577 | 0.288 |
| 6 | 0.973 | 0.809 | 0.684 |
| 7 | 0.982 | 0.951 | 0.943 |

### 8.2.6 Validation of Cross-Polarization

#### 8.2.6.1 XPO Method of Measurement

This measurement checks how well the measured vertically or horizontally polarized power levels follow expected values of cross polarization (XPO).

The time domain technique (time sweep) is used for the validation. See the block diagram of the setup in Figure 8.2.1.2-1. A signal generator transmits a CW signal through the test system. The CW signal is split to two input ports of fading emulator that correspond to the two first signal streams of the gNB emulator, i.e., that correspond to two co-located ±45° slanted linearly polarized elements. The signal is received by a vertically polarized test antenna within the test area. Finally, the signal is collected by a signal analyser and the measured signal is stored. Signal generator and signal analyser settings are listed in Tables 8.2.6.1-1 and 8.2.6.1-2. The measurement is triggered to start with the time instant 0 of the channel model and to stop at the last time instant of the channel model. The measurement is repeated with a horizontally polarized test antenna, placed in the same position. The result is a stored sequence of channel gains of segment received with the vertically and horizontally polarized test antennas are denoted and , respectively, where Note that the time increment and correspondingly the number of stored time samples is different in this measurement as compared to the PDP measurement.

Table 8.2.6.1-1: MPAC path loss Signal Generator Settings

| Item | Unit | Value |
| --- | --- | --- |
| Centre frequency | MHz | 2450 |
| Output Power | dBm | Function of the CE. Sufficiently above Noise Floor |

Table 8.2.6.1-2: MPAC path loss Signal Analyser Settings

| Item | Unit | Value |
| --- | --- | --- |
| Centre frequency | MHz | 2450 |
| Sampling | Hz | At least 15 times bigger than the max Doppler spread (fd=v/λ) |
| Observation time | s | One full duration of the channel model route. |

#### 8.2.6.2 XPO Measurement Antenna

Measurement antennas shall be a vertically-oriented dipole and a loop.

#### 8.2.6.3 XPO Measurement Results Analysis

The measured channel gains (inverse of path loss) are averaged over each time segment to obtain average powers

The resulting V/H power ratios

of time segments are the target values.

#### 8.2.6.4 XPO Target Values

The target values for the UMa route are specified in [Table 8.2.6.4-1](#_Hlk176088899) and illustrated in [Figure 8.2.6.4-1](#_Hlk176088781) which uses the time segments defined in [Table 8.2.2.3-1](#_Hlk176085569). The target values for the UMi route are specified in [Table 8.2.6.4-2](#_Hlk176088899) and illustrated in [Figure 8.2.6.4-2](#_Hlk176088781) which uses the time segments defined in [Table 8.2.2.3-2](#_Hlk176085569).



Figure 8.2.6.4-1: Simulated Dynamic Narrowband UMadyn Polarization Power Ratios with Time Segment Limits for the UMa Route with full path loss model [7]

Table 8.2.6.4-1: UMadyn Polarization Power Ratio Target Values for the Measured Channel Gain with V and H Polarized Test Antenna for the UMa Route with full path loss model [7]

|  |  |
| --- | --- |
| Segment # | UMadyn XPO Target [dB] |
| 1 | 22.2 |
| 2 | 22.4 |
| 3 | 8.5 |
| 4 | 9.5 |
| 5 | 7.4 |
| 6 | 7.0 |
| 7 | 18.5 |
| 8 | 12.2 |
| 9 | 22.0 |



Figure 8.2.6.4-2: Simulated Dynamic Narrowband UMidyn Polarization Power Ratios with Time Segment Limits for the UMi Route with full path loss model [7]

Table 8.2.6.4-2: UMidyn Polarization Power Ratio Target Values for the Measured Channel Gain with V and H Polarized Test Antenna for the UMi Route with full path loss model [7]

|  |  |
| --- | --- |
| Segment # | UMidyn XPO Target [dB] |
| 1 | 18 |
| 2 | 21.7 |
| 3 | 8.6 |
| 4 | 8.1 |
| 5 | 8.5 |
| 6 | 21.1 |
| 7 | 20.7 |

## 8.3 Validation pass/fail criteria

### 8.3.1 General

This clause defines the pass/fail limit of FR1 MPAC system for FR1 dynamic channel model validation.

### 8.3.2 Pass/Fail Criteria of dynamic path loss

This clause defines the pass/fail criteria of dynamic path loss.

The dynamic path loss pass/fail limit is specified as ± 2 dB.

### 8.3.3 Pass/Fail Criteria of PDP

This clause defines the pass/fail criteria of PDP. The detailed pass/fail limits for each cluster of CDL-C UMadyn and CDL-C UMidyn are defined in Table 8.3.3-1.

Table 8.3.3-1: PDP pass/fail limits for CDL-C UMadyn and CDL-C UMidyn channel model validation

|  |  |  |
| --- | --- | --- |
|  | Power Tolerance | Delay Tolerance |
| Paths from 0dB to 10dB | ±1dB | ±6ns |
| Paths from 10dB to 20dB | ±2.5dB | ±6ns |
| Paths from 20dB to 30dB | ±5dB | ±6ns |
| Paths from 30dB to 40dB | ±10dB | ±6ns |

### 8.3.4 Pass/Fail Criteria of Doppler/Temporal correlation

This clause defines the pass/fail criteria of doppler/temporal correlation.

The pass/fail limits for theoretical temporal correlation defined in Clause 8.2.4.4 above 0.3 are formed as bands of ±0.1 of correlation capped at 1 at the high end. Additionally, when the theoretical temporal correlation drops below 0.3, the limits are formed at bands of ±0.3 of correlation capped at 0 at the low end. The pass/fail limits are tabulated in Tables 8.3.4-1 and 8.3.4-2 for the UMa and UMi routes, respectively.

Table 8.3.4-1: Dynamic UMadyn Temporal Correlation Pass/Fail Limits of the UMa Route with full path loss model [7]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Segment # | UMadyn TCF at ms | | UMadyn TCF at ms | |
| **Lower** | **Upper** | **Lower** | **Upper** |
| 1 | 0.870 | 1 | 0.776 | 0.976 |
| 2 | 0.861 | 1 | 0.779 | 0.979 |
| 3 | 0.894 | 1 | 0.786 | 0.986 |
| 4 | 0.336 | 0.536 | 0.255 | 0.455 |
| 5 | 0.548 | 0.748 | 0.245 | 0.445 |
| 6 | 0.421 | 0.621 | 0.000 | 0.400 |
| 7 | 0.701 | 0.901 | 0 | 0.528 |
| 8 | 0.737 | 0.937 | 0.298 | 0.498 |
| 9 | 0.839 | 1 | 0.516 | 0.716 |

Table 8.3.4-2: Dynamic UMidyn Temporal Correlation Pass/Fail Limits of the UMi Route with full path loss model [7]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Segment # | UMidyn TCF at ms | | UMidyn TCF at ms | |
| **Lower** | **Upper** | **Lower** | **Upper** |
| 1 | 0.771 | 0.971 | 0.336 | 0.536 |
| 2 | 0.852 | 1 | 0.757 | 0.957 |
| 3 | 0.413 | 0.613 | 0.188 | 0 |
| 4 | 0.598 | 0.798 | 0.364 | 0 |
| 5 | 0.644 | 0.844 | 0.274 | 0.474 |
| 6 | 0.859 | 1 | 0.713 | 0.913 |
| 7 | 0.865 | 1 | 0.754 | 0.954 |

### 8.3.5 Pass/Fail Criteria of Spatial correlation

This clause defines the pass/fail criteria of spatial correlation.

The pass/fail limits for spatial correlation are formed as bands of ±10% of correlation capped at 100% for the upper limit for target correlation defined in Clause 8.2.5.4 of 35% and above. For target correlations below 35%, the band is widened to ±20% capped at 0%. The pass/fail limits are tabulated in Tables 8.3.5-1 and 8.3.5-2 for the UMa and UMi routes, respectively.

Table 8.3.5-1: UMadyn Spatial Correlation Pass/Fail Limits of the UMa Route with full path loss model [7] for 2450 MHz

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Segment # | SCF at mm | | SCF at mm | | SCF at mm | |
| Lower | Upper | Lower | Upper | Lower | Upper |
| 1 | 0.887 | 1 | 0.817 | 0.999 | 0.839 | 1 |
| 2 | 0.867 | 1 | 0.550 | 0.672 | 0.261 | 0.391 |
| 3 | 0.720 | 0.88 | 0.127 | 0.191 | 0.089 | 0.133 |
| 4 | 0.629 | 0.769 | 0.649 | 0.793 | 0.443 | 0.541 |
| 5 | 0.748 | 0.914 | 0.373 | 0.455 | 0.125 | 0.187 |
| 6 | 0.715 | 0.873 | 0.353 | 0.431 | 0.409 | 0.499 |
| 7 | 0.835 | 1 | 0.434 | 0.530 | 0.329 | 0.403 |
| 8 | 0.752 | 0.919 | 0.228 | 0.342 | 0.549 | 0.671 |
| 9 | 0.863 | 1 | 0.518 | 0.633 | 0.176 | 0.264 |

Table 8.3.5-2: UMidyn Spatial Correlation Pass/Fail Limits of the UMi Route with full path loss model [7] for 2450 MHz

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Segment # | SCF at mm | | SCF at mm | | SCF at mm | |
| Lower | Upper | Lower | Upper | Lower | Upper |
| 1 | 0.850 | 1 | 0.680 | 0.831 | 0.660 | 0.806 |
| 2 | 0.883 | 1 | 0.842 | 1 | 0.843 | 1 |
| 3 | 0.708 | 0.866 | 0.177 | 0.265 | 0.130 | 0.194 |
| 4 | 0.688 | 0.840 | 0.263 | 0.395 | 0.256 | 0.384 |
| 5 | 0.770 | 0.942 | 0.519 | 0.635 | 0.230 | 0.346 |
| 6 | 0.876 | 1 | 0.728 | 0.890 | 0.616 | 0.752 |
| 7 | 0.884 | 1 | 0.856 | 1 | 0.849 | 1 |

### 8.3.6 Pass/Fail Criteria of Cross-polarization

This clause defines the pass/fail criteria of cross-polarization.

The cross-polarization ratio pass/fail limit is specified as ±2dB.

<<< Skip Unchanged Sections >>>

Annex C:  
Measurement uncertainty

<Editor’s note: This Annex can be modified by RAN5 outcome. >

# C.1 Preliminary MU assessment for MPAC

This clause defines the preliminary measurement uncertainty (MU) budget, as shown in Table C-1, for FR1 MPAC systems supporting Dynamic MIMO OTA test cases.

Table C-1: Preliminary measurement uncertainty budget for FR1 MPAC system and Dynamic MIMO OTA

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| UID | Description of uncertainty contribution | Example value (410 MHz <f ≤ 3 GHz) [dB] | Example value (3 GHz < f ≤ 7.125GHz) [dB] | Distribution of the probability | Std Uncertainty (410 MHz < f ≤ 3 GHz) [dB] | Std Uncertainty (3 GHz < f ≤ 7.125GHz) [dB] |
| **Stage 2: DUT measurement** | | | | | |  |
| 1 | Mismatch for measurement process | 0 | 0 | U-Shaped | 0 | 0 |
| 2 | Measure distance uncertainty | 0 | 0 | Normal | 0 | 0 |
| 3 | Quality of quiet zone | 0.5 | 0.5 | Actual | 0.50 | 0.50 |
| 4 | Base Station simulator | 1.3 | 1.3 | Normal | 0.65 | 0.65 |
| 5 | Channel Emulator |  |  | Actual | 0.84 | 0.84 |
| - absolute output power | 1.5 | 1.5 | (Normal - power; |
| - output signal stability | 0.5 | 0.5 | rect-stability) |
| - output stability with temperature | 0.4 | 0.4 |  |
| 6 | Dynamic Channel Modelling (Note 1) | [0.75] | [0.75] | Normal | [0.38] | [0.38] |
| 7 | Amplifier uncertainties | 0.7 | 0.7 | Rectangular | 0.40 | 0.40 |
| 8 | Random uncertainty | 0.4 | 0.4 | Normal | 0.2 | 0.2 |
| 9 | Throughput measurement: output level step resolution | 0 | 0 | Rectangular | 0 | 0 |
| 10 | Signal flatness | 0 | 0 | Normal | 0 | 0 |
| **Stage 1: Calibration measurement** | | | | | |  |
| 11 | Mismatch for calibration process | 0.2 | 0.2 | U-Shaped | 0.14 | 0.14 |
| - loopback cable path |
| - system input path |
| - reference antenna |
| 12 | Reference antenna positioning misalignment | 0 | 0 | Normal | 0 | 0 |
| 13 | Quality of quiet zone | 0.5 | 0.5 | Rectangular | 0.29 | 0.29 |
| 14 | Total uncertainty of the Network Analyzer | 0.2 | 0.5 | Normal | 0.1 | 0.25 |
| 15 | Uncertainty of an absolute gain of the calibration antenna | 0.58 | 0.58 | Normal | 0.29 | 0.29 |
| 16 | Offset of the Phase Centre of the Reference Antenna | 0 | 0 | Normal | 0 | 0 |
| **Total Expanded Uncertainty, U, with 95 % Confidence Interval** | | | | | **[2.71]** | **[2.75]** |
| Note 1: This MU value will need to be addressed/finalized by RAN5. | | | | | | |

# C.2 MU contribution descriptions for MPAC

Most MU elements are described further in Clause B.2 of TS 38.551 with the exception of the MU element ‘Dynamic Channel Modelling’ in Table C-1. This element takes into account the temporal variation of CDL models and the traversing of the UE on a synthesized route; its MU value of [0.75] dB was chosen arbitrarily for the preliminary RAN4 budget and needs to be further investigated and defined by RAN5.

**<<< END OF CHANGES >>>**