Application Note

SIMPLIFYING 5G NR 3GPP R&D RF CONFORMANCE TESTING

SA Mode According to 3GPP 38.521-1

Products:

R&S®CMX500

Markus Bühler | 1C111 | Version 0e | 06.2025

https://www.rohde-schwarz.com/appnote/1C111

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1 Overview

Device certification for compliance with 3GPP specifications is a crucial step in the launch of 5G NR user equipment (UE). As the demand for high-performance connectivity continues to rise, ensuring that devices meet industry standards is essential for delivering reliable and efficient service. To ensure optimal modem performance, RF conformance testing needs to be initiated early in the product development process. This approach enables teams to swiftly identify and address potential issues, minimizing delays and enhancing the overall quality of the final product.

The R&S®CMX500 3GPP RF conformance WebGUI solution offers a fast and intuitive platform for executing NR-FR1 Standalone (SA) test cases in accordance with the 3GPP 38.521-1 specification. Its manual verification capabilities make it particularly well-suited for early-stage validation, debugging, and step-by-step verification of test cases, leveraging the comprehensive toolset provided by the R&S®CMX500 WebGUI.

This application note serves as a comprehensive guide for R&D professionals, detailing the setup, configuration, execution, and verification of selected 3GPP test cases with just a few clicks in the GUI. Please note that the test steps outlined in this document require the CMX-KC661B license (SA FR1 3GPP RF Test Scenarios), in addition to the NR signaling license CMX-KS600B and the NR FR1 measurement license CMX-KM600. All descriptions, configurations and limits are based on [1].

2 Introduction

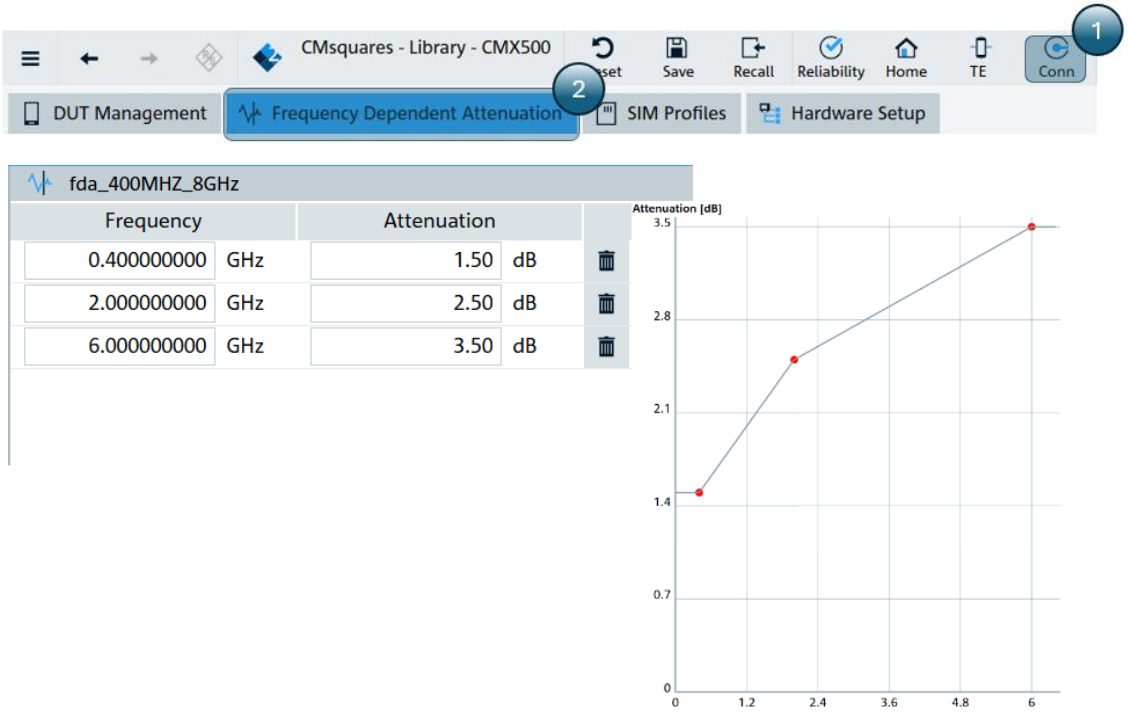
Procedures described in this application note may be streamlined or simplified compared to the full 3GPP conformance requirements, ensuring an intuitive and user-friendly interface while still delivering meaningful RF conformance results. Users have the flexibility to configure signaling and cell-related settings to align with their specific test objectives. The test case will automatically adjust relevant settings, including reference measurement channel (RMC) configurations, UL power control settings, and additional spectrum emission values, based on the selected test case and test ID as specified in [1].

The R&S®CMSequencer 3GPP 5G SA pre-conformance solution, included with the KC661 license, enhances the GUI test cases by providing automated execution, validation, and comprehensive reporting capabilities. For testing with CMSequencer, please refer to this dedicated application note: https://www.rohde-schwarz.com/appnote/1C110.

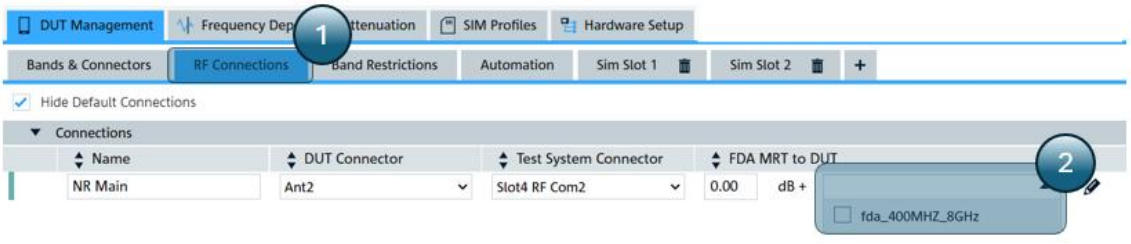
For strict conformance testing, Rohde & Schwarz offers dedicated solutions, such as the R&S®TS8980 for 3GPP RF conformance.

2.1 Preparation

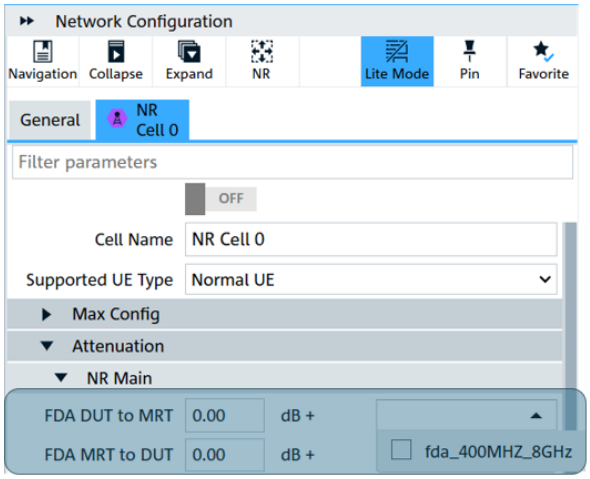
1. Make sure that the signal path attenuation is compensated
    - Attenuation tables can be defined in the *Frequency Dependent Attenuation* tab



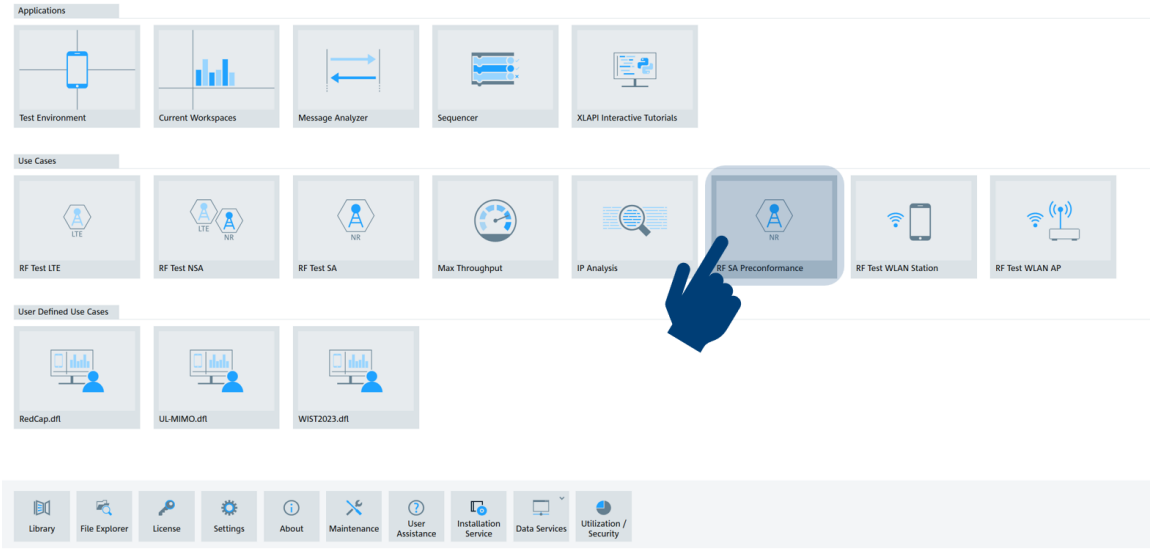
    - Attenuation tables / fixed values are linked to a specific RF path in the *RF Connections* tab



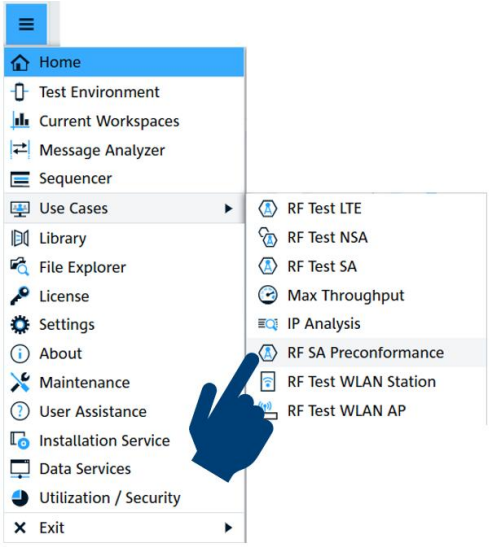
- Alternatively, tables and offsets can be set directly in the cell settings



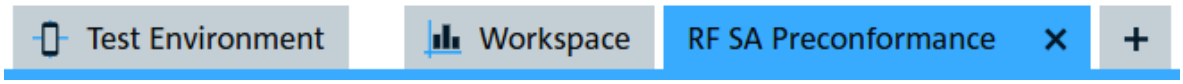
2. Open the 3GPP Pre-conformance testing workspace via *Home* → *Use Cases* or



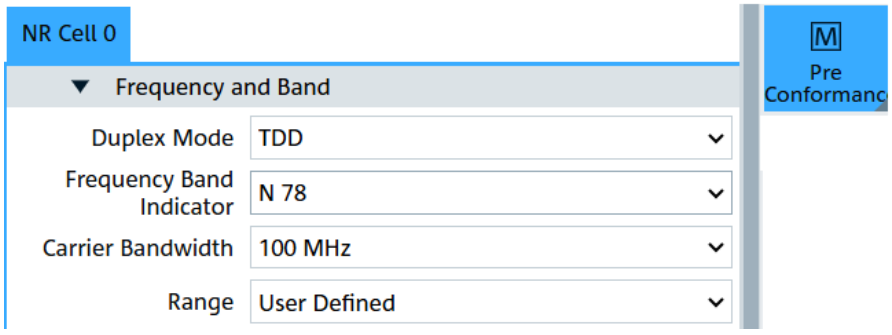
via the menu



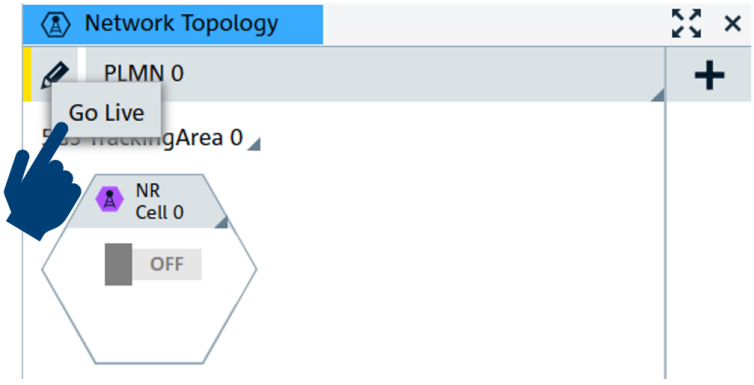
3. The CMX will load the *RF SA Preconformance* workspace:



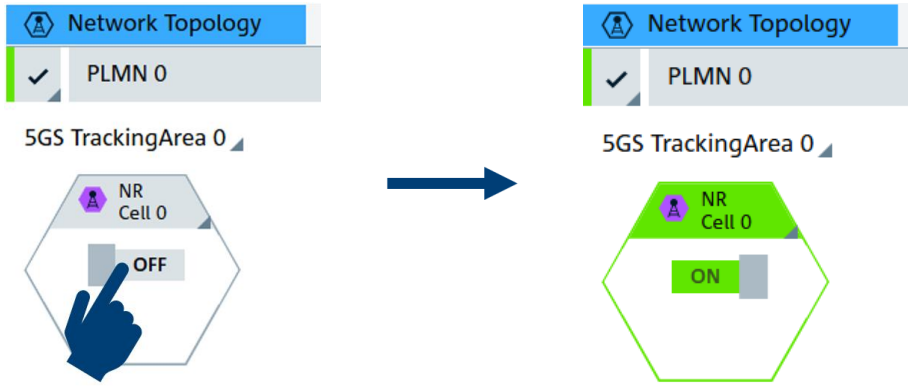
4. In the workspace, configure the band and frequency settings to test using the configuration sidebar



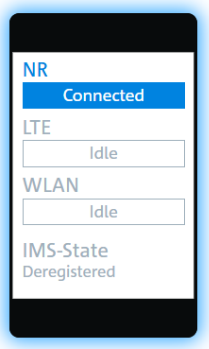
5. Start the network emulation (right click  , then select *Go Live*)



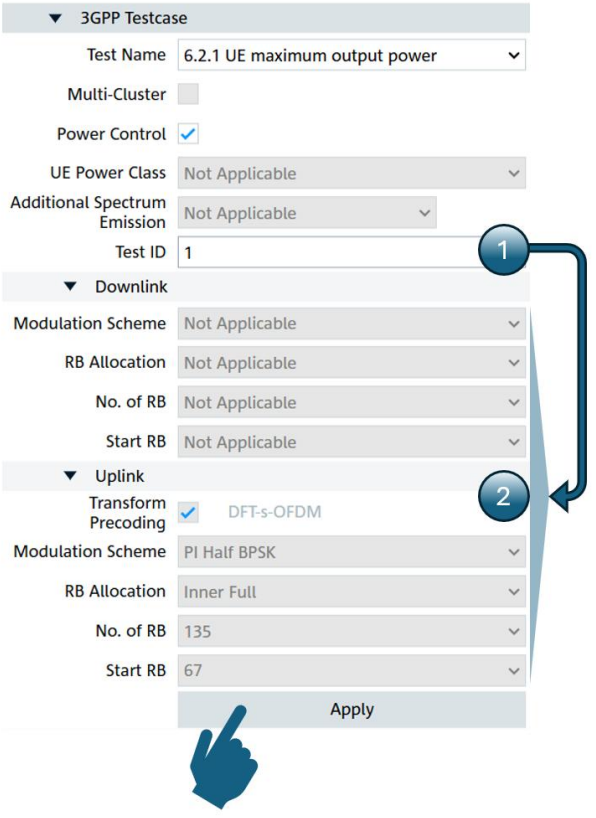
6. Switch the cell on by clicking the toggle button



7. Make sure the DUT is connected



8. Select a test case and Test ID to execute
    - Test IDs are based on tables for the respective test cases in 38-521-1.
    - Choosing a Test ID (1) will configure the RB allocation and modulation scheme according to the specification. The DL and UL configuration per Test ID can be read from the GUI (2)

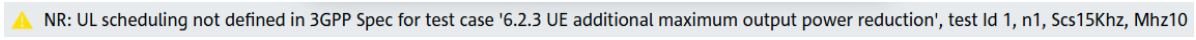


    - Click *Apply* to execute the test case

Important notes:

1. The TC descriptions in chapter 3 assume that the setting for automatic DUT UL power configuration is active: 

.
2. Users should be aware of the respective UE capabilities as these are not processed by the TCs.
3. Selecting a test case will not overwrite user configured signaling parameters. Users need to make sure that the current configuration is suitable for the selected test case.
4. Test IDs are sometimes only specified for a certain frequency + BW combination. The CMX will display “not applicable” for the UL scheduling if there is no matching configuration for the chosen Test ID. The event log at the bottom of the interface will display a corresponding warning:

   Applying the settings in this case will revert to a generic default configuration.
5. For PUCCH TCs:
   - PUCCH TCs will by default show “not applicable” as the Uplink section only displays PUSCH related settings.
   - UL parameters will show *not applicable* for the PUCCH subtests, as only the PUSCH scheduling is displayed. The PUCCH configuration will be applied according to 38.521-1.
   - There is no UL PUSCH scheduled for PUCCH subtests according to 38.521-1. It is recommended to switch data on the UE off. Every scheduling request for UL resources from the UE will lead to call drops, as no PUSCH resources are available.

3 RF Conformance Test Cases

3.1 6.2.1 UE maximum output power

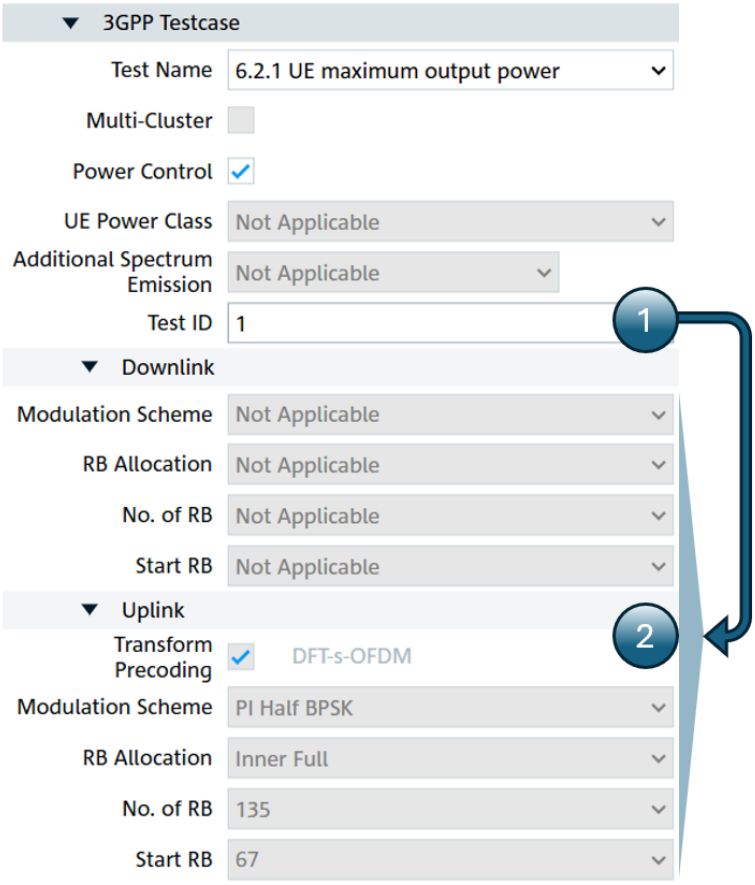
Purpose:

This test case is for verifying that the error for the UE maximum output power does not exceed the range prescribed by the specified nominal maximum output power and tolerance.

An excessively high maximum output power could interfere with other channels or systems. Insufficient maximum power would decrease the coverage area.

Test Procedure:

1. Follow the initial steps in chapter 2.1 then choose a Test ID
   a. The Test ID (1) configures RB Allocation and modulation scheme (2)



2. Apply the configuration and verify the measured DUT UL power to be within the specified range

Verification:

The DUT output power must be within the specified level according to *38.521-1 table 6.2.1.5-1* to *6.2.1.5-2a.*

The expected power per UE power class is the same over all bands, while the specification allows a tolerance of at least ± 2 dB for the given values, with a higher tolerance for certain bands.

UE Power Class	
	Specified Maximum UE Power
PC 3	23 dB
PC 2	26 dB
PC 1	31 dB

The specification additionally allows a frequency dependent Test Tolerance (TT):

Test Tolerance (TT)		
Frequency Range	**BW ≤ 40MHz**	**40MHz < BW ≤ 100MHz**
f ≤ 3.0GHz	0.7 dB	1 dB
3.0GHz < f ≤ 6 GHz	1 dB	1 dB

Example: Power Class 3 (PC3) DUT on n78

1. Specified max power range for PC3 is 23 dBm with a tolerance of +2+TT /-3-TT dB for n78 with TT being 1 dB.

2. CMX TX power measurement within 3GPP limits

Statistic Count	Allocation	Modulation
20/20	No. RB: 25 Offset RB: 12	π/2-BPSK

▼ Power	
	Current
TX Power (dBm)	23.42

3.2 6.2.2 UE maximum output power reduction (MPR)

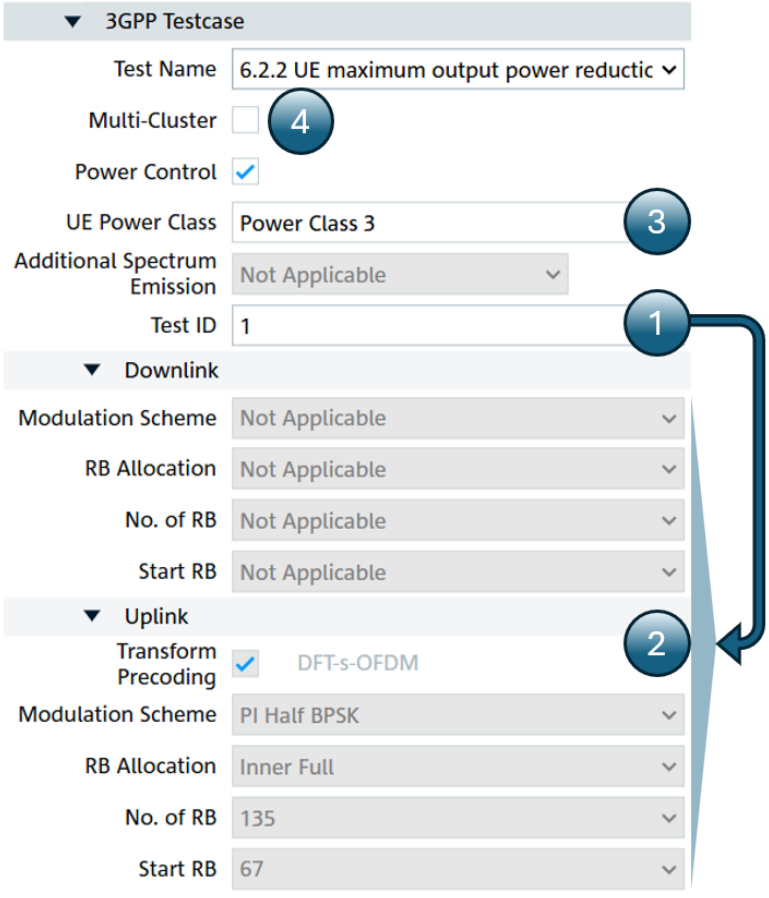
Purpose:

The UE is allowed to reduce the maximum output power due to higher order modulations and transmit bandwidth configurations, which will cause higher crest factors presenting a challenge for power amplifier design.

Test Procedure:

1. Follow the steps in chapter 2.1 then choose a Test ID

   ➔ The Test ID (1) configures RB Allocation and modulation scheme (2) depending on DUT power class (3) and frequency resource allocation (Single-/Multi-Cluster) (4)



   Note: PC 3 UEs tested on band n40, n41, n77, n78 and n79 supporting the UE capability powerBoosting-pi2BPSK need to have the setting *powerBoostPi2BPSK* enabled for Test IDs 1,2,3 and 4 (38.521-1 Table 6.2.2.4.1-1): powerBoostPi2BPSK ☑

2. Apply the configuration

Verification:

The DUT output power must be within the limits specified in *38.521-1 Tables 6.2.2.5-1 to 6.2.2.5-10* with a frequency dependent Test Tolerance (TT).

Test Tolerance (TT)		
Frequency Range	**BW ≤ 40MHz**	**40MHz < BW ≤ 100MHz**
f ≤ 3.0GHz	0.7 dB	1 dB
3.0GHz < f ≤ 6 GHz	1 dB	1 dB

The specification additionally allows a frequency dependent Test Tolerance (TT) (see 6.2.1 UE maximum output power)

Following tables are extracts from [1] for the most common configurations:

Table 6.2.2.5-1 Contiguous allocation for Power Class 3 n1, n2, n3, n5, n7, n8, n12, n13, n14, n20, n25, n26, n30, n31, n34, n38, n39, n40, n41, n50, n51, n53, n54, n65, n66, n70, n72, n74, n85, n91, n92, n93, n94, n100, n101, n106

Test ID	1	2-3	4	5,9,39	6-8,37-38	10-13	14-16,27	18-19	20-22	23	24-26,28-30	31-32	34-36
Upper limit (dBm)	28.0 + TT	28.0 + TT	28.0 + TT	25.0 + TT	25.0 + TT	25.0 + TT	25.0 + TT	25.0 + TT	25.0 + TT	25.0 + TT	25.0 + TT	25.0 + TT	25.0 + TT
Lower limit (dBm)	23.8 - TT	20.5 - TT	22.8 - TT	21.0 - TT	20.5 - TT	20.0 - TT	19.0 - TT	18.0 - TT	14.5 - TT	19.5 - TT	17.5 - TT	16.0 - TT	11.5 - TT

Note: Relaxed lower limits apply for Table 6.2.2.5-1 in case that the transmission BW is confined within +/- 4 MHz of the lowest/highest specified frequency for band n2, n3, n7, n8, n12, n20, 25, n26, n41

Table 6.2.2.5-3 Contiguous allocation for Power Class 3 n48, n77, n78, n79

Test ID	1	2-3	4	5, 9, 39	6-8, 37-38	10-13	14-16, 27	17-19	20-22	23	24-26, 28-30	31-33	34-36
Upper limit (dBm)	28.0 + TT	28.0 + TT	28.0 + TT	25.0 + TT	25.0 + TT	25.0 + TT	25.0 + TT	25.0 + TT	25.0 + TT	25.0 + TT	25.0 + TT	25.0 + TT	25.0 + TT
Lower limit (dBm)	22.8 - TT	19.5 - TT	21.8 - TT	20.0 - TT	19.5 - TT	19.0 - TT	18.0 - TT	17.5 - TT	14.5 - TT	18.5 - TT	17.0 - TT	16.0 - TT	11.5 - TT

Example: PC3 DUT on n78 with Test ID 22 (256 QAM; full allocation)

1. Specified max power range for these settings with MPR is between 14.5 dBm – TT (*Lower limit*) and 25 dBm + TT (*upper limit* as in *Table 6.2.2.5-3*) with *TT* being 1 dB (BW 100 MHz; 3 GHz < f ≤ 4.2 GHz)

2. CMX TX power measurement within 3GPP limits:

Statistic Count	Allocation	Modulation
20/20	No. RB: 270 Offset RB: 0	E256_QAM

▼ Power	
	Current
TX Power (dBm)	19.27

3.3 6.2.3 UE additional maximum output power reduction (A-MPR)

Purpose:

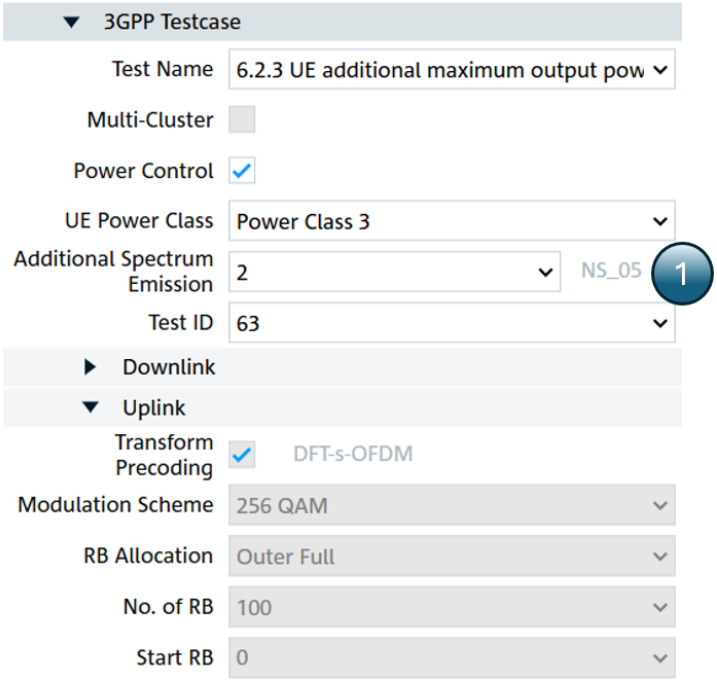
Additional emission requirements can be signaled for various reasons by the network through unique network signaling (NS) values. Additional maximum power reduction (A-MPR) is allowed for the maximum output power. The total reduction to UE maximum output power is MPR (from 6.2.2) or A-MPR (from 6.2.3), whichever is larger.

NS values are mapped to different bands, while not every band is linked to a NS value.

Test Procedure:

1. Follow the steps in chapter 2.1 then choose an applicable NS value

   ➔ The CMX allows the selection of all applicable NS values through the *Additional Spectrum Emission* dropdown menu (1). Band n1 with an Additional Spectrum Emission value of 2 is for example mapped to NS_05.

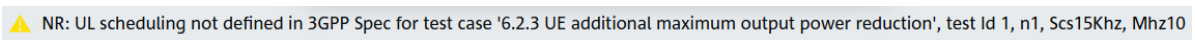


2. Select a valid Test ID

   a. The Test ID configures RB Allocation and modulation scheme depending on DUT power class

   ➔ The CMX allows the selection of all Test IDs. Resulting modulation and RB allocation are displayed for each valid Test ID upon selection.

   ➔ Test IDs in 38.521-1 Tables 6.2.3.4.1-1 to 6.2.3.4.1-33 for this test case are specified for a certain BW + frequency configuration resulting in many “not applicable” selections. Please check the event log at the bottom of the GUI and refer to *Notes* section in chapter 2.1.



3. Apply the configuration

Verification

The DUT output power must be within the limits specified in 38.521-1 Tables 6.2.3.5-1 to 6.2.3.5-39 with a frequency dependent Test Tolerance (see 6.2.1 UE maximum output power). Tables 6.2.3.5-1 to 6.2.3.5-39 are very extensive and thus not included in this application note.

Example: PC3 DUT on n1 using NS_05 with Test ID 63 (256 QAM; outer full allocation)

1. Specified max power range for these settings with A-MPR is between 4 dBm – TT (*Lower limit*) and 25 dBm + TT (*upper limit* as in *Table 6.2.3.5-6*) with *TT* being 1 dB (BW 100 MHz; 3 GHz < f ≤ 4.2 GHz)

2. CMX TX power measurement within 3GPP limits:

Statistic Count	Allocation	Modulation
20/20	No. RB: 100 Offset RB: 0	E256_QAM

▼ Power	
	Current
TX Power (dBm)	17.07

3.4 6.2.4 Configured transmitter power

Purpose:

To verify that the UE does not exceed the minimum between the allowed maximum UL TX power signaled by the network through the p-Max parameter, and the maximum UE power for the UE power class.

Test Procedure:

1. Follow the steps in chapter 2.1 then configure the p-Max parameter to one of the 4 specified test points:

   p-Max can be configured in the ▼ Power Control section: p-Max ☑ -10 dBm

Test Point	p-Max
1	-10
2	10
3	15
4	20

2. Choose Test ID
   a. The Test ID configures RB Allocation and modulation scheme
3. Apply the configuration

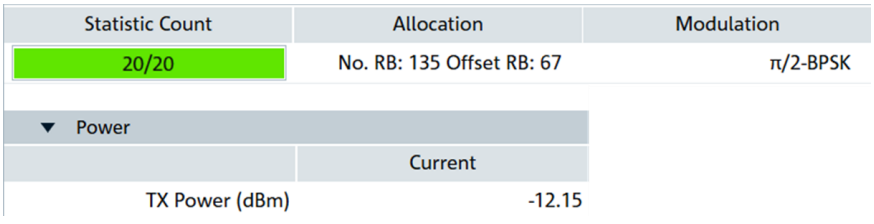
Verification

The DUT output power must be within the limits specified in 38.521-1 Tables 6.2.4.5-1 to 6.2.4.5-1b with a frequency dependent Test Tolerance (see 6.2.1 UE maximum output power)

Test Point	p-Max	Measured UE output power / dBm	
1	-10	-10 dBm ± (7+TT)	
2	10	10 dBm ± (6+TT)	
3	15	15 dBm ± (5+TT)	
4	20	Test ID 1, 2	20 dBm + 2.5+TT/-3-TT (n24, n77, n78, 79) 20 dBm ±(2.5+TT) (all other bands)
		Test ID 3	23 dBm +2+TT/-2-TT (n40, n41) 23 dBm +2+TT/-3-TT (n77, n78, n79)

Example: PC3 DUT on n78 with Test ID 1 (π/2 BPSK; Inner full allocation) on Test Point 1

1. Specified max power range for these settings within -10 dBm ± (7+TT) with TT being 1 dB
2. CMX TX power measurement within 3GPP limits:



3.5 6.3.1 Minimum output power

Purpose:

To verify the UE's ability to transmit with a broadband output power below the value specified in the test requirement when the power is set to a minimum value.

Test Procedure:

1. Follow the steps in chapter 2.1 then choose a Test ID
    a. The Test ID configures RB Allocation and modulation scheme
2. Apply the configuration and verify the measured DUT UL power to be within the specified range

Verification:

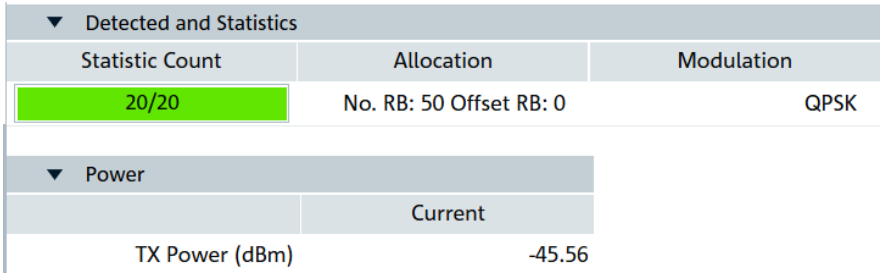
The DUT output power must be within the specified level according to *38.521-1 Table 6.3.1.5-1* with a frequency dependent Test Tolerance from *Table 6.3.1.5-2*:

BW / MHz	Minimum output power / dBm
3	-40+TT
5	-40+TT
10	-40+TT
15	-40+TT
20	-40+TT
25	-39+TT
30	-38.2+TT
35	-37.6+TT
40	-37+TT
45	-36.5+TT
50	-36+TT
60	-35.2+TT
70	-34.6+TT
80	-34+TT
90	-33.5+TT
100	-33+TT

Test Tolerance (TT)		
Frequency Range	**BW ≤ 40MHz**	**40MHz < BW ≤ 100MHz**
f ≤ 3.0GHz	1 dB	1.3 dB
3.0GHz < f ≤ 6 GHz	1.3 dB	1.3 dB

Example: DUT on n78 with 100 MHz BW:

1. Specified min power range for 100 MHz BW is -33 dBm + TT (1.3 dB):
2. CMX TX power measurement within 3GPP limits

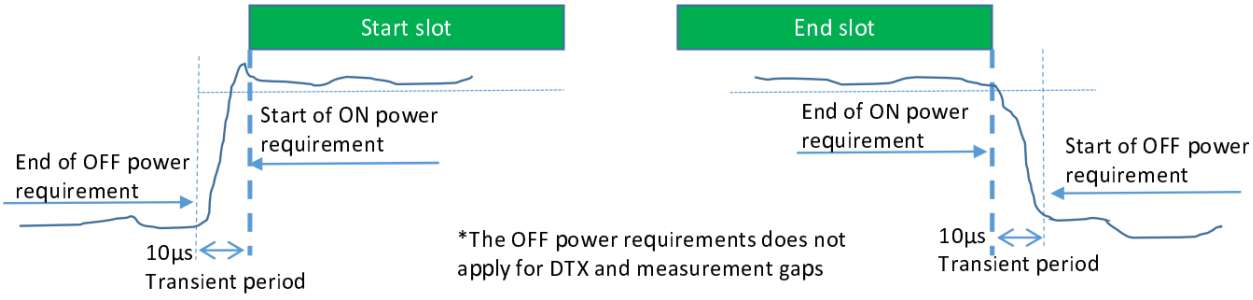


3.6 6.3.3.2 General ON/OFF time mask

Purpose:

To verify that the general ON/OFF time mask meets the requirements. The transmit power time mask for transmit ON/OFF defines the transient period(s) allowed between transmit OFF power and transmit ON power symbols (transmit ON/OFF). Transmission of the wrong power increases interference to other channels or increases transmission errors in the uplink channel.

Figure 6.3.3.2.3-1 in 38.521-1 specifies the ON/OFF requirements as follows:

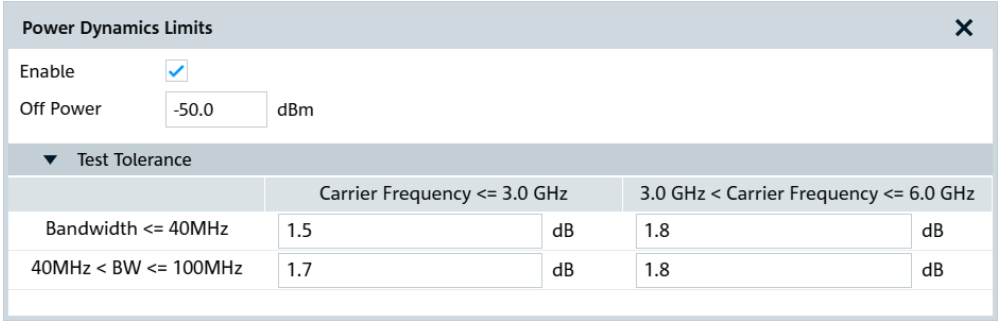


Test Procedure:

1. Follow the steps in chapter 2.1 then choose a Test ID
    a. The Test ID configures RB Allocation and modulation scheme
2. Apply the configuration and verify the measured DUT ON/OFF power using the *Power Dynamics* square.

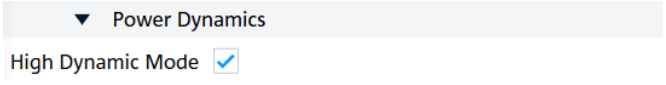
Verification:

The DUT OFF power is automatically verified by the *Power Dynamics* measurement using the specified limits. The limit verification in the measurement can be disabled or modified in the *Multi Eval* measurement tab under ▼ Limits → Power Dynamics... :



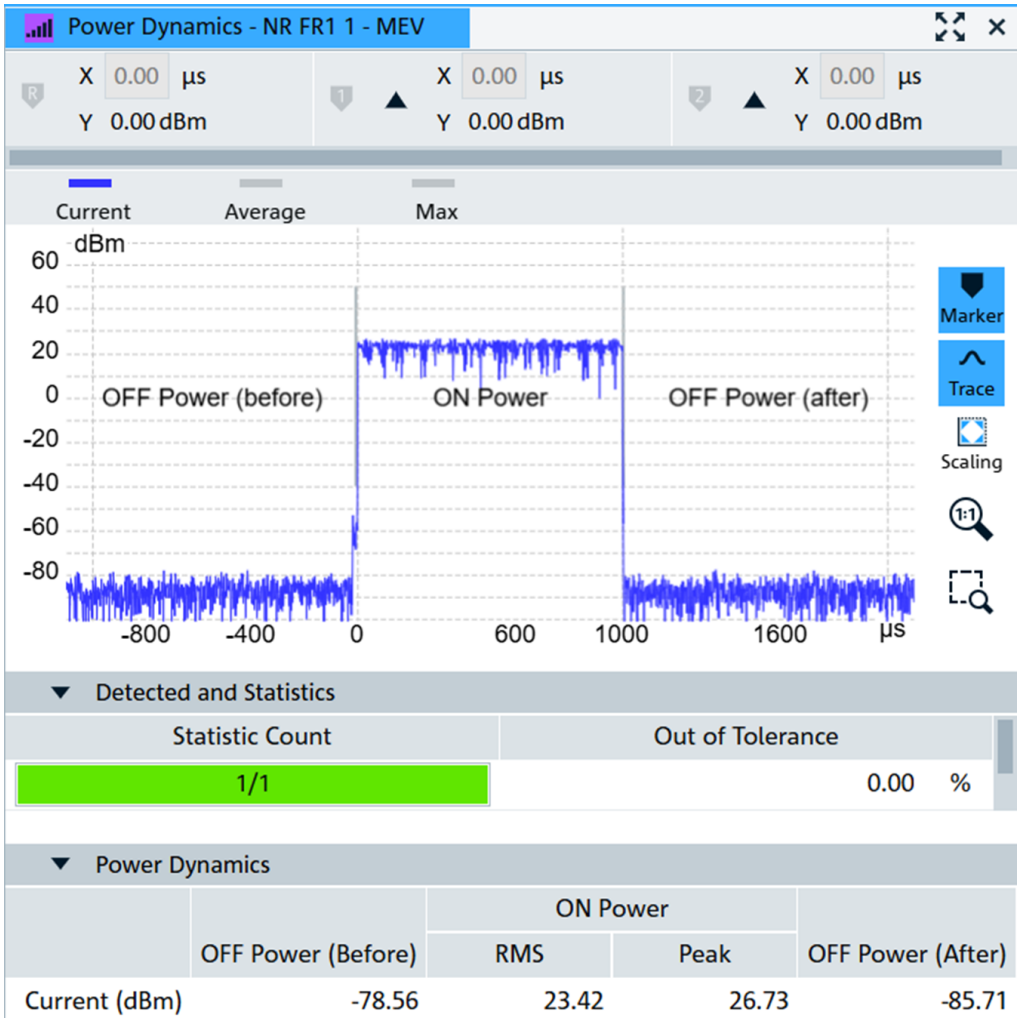
The DUT ON power requirement are the same as in test case 6.2.1.

Note: For best results, enable *High Dynamic Mode* in the *Multi Eval* measurement tab. Make sure that no BLER measurement is running before enabling this mode.



Example: PC3 DUT on n78 with 100 MHz BW:

1. Specified OFF power range for 100 MHz BW is ≤-50 dBm - TT (1.8 dB)
2. Specified ON power range is 23 dBm with a tolerance of +2+TT /-3-TT dB with TT being 1 dB (See 6.2.1 UE maximum output power)
3. CMX *Power Dynamics* measurement (*High Dynamic Mode*) within 3GPP limits



3.7 6.3.4.2 Absolute power tolerance

Purpose:

To verify the ability of the UE transmitter to set its initial output power to a specific value at the start of a contiguous transmission or non-contiguous transmission with a long transmission gap.

Test Procedure:

1. Follow the steps in chapter 2.1 then choose a Test ID
    a. The Test ID configures RB Allocation and modulation scheme
2. The CMX will automatically set the required initial UL power values from which to continue
    a. Configure the power control related settings to following values:
        i. TPC: Keep
        ii. ss-PBCH-BlockPower: 18 dBm (15 kHz SCS) or 21 dBm (30 kHz SCS)
3. Configure the setting *p0-Nominal with Grant* to one of the specified test points

Test Point	*p0-Nominal with Grant*
1	-114
2	-100

4. Apply the configuration and verify the measured DUT UL power to be within the specified range

Verification:

The DUT output power must be within the limits specified in 38.521-1 Tables 6.3.4.2.5-1 (TP1) and 6.3.4.2.5-2 (TP2) with a frequency dependent Test Tolerance (TT) as part of the power tolerance (±9+TT dB)

		BW / dBm														
		5	10	15	20	25	30	35	40	45	50	60	70	80	90	100
Test Point 1	SCS15	-17.6	-14.4	-12.6	-11.3	-10.4	-9.6	-8.9	-8.3	-7.8	-7.3	N/A	N/A	N/A	N/A	N/A
	SCS30	-18.2	-14.8	-12.8	-11.5	-10.5	-9.7	-9	-8.3	-7.8	-7.4	-6.5	-5.8	-5.2	-4.7	-4.2
	SCS60	N/A	-15.2	-13	-11.8	-10.7	-9.8	-9.1	-8.5	-7.9	-7.5	-6.6	-5.9	-5.3	-4.8	-4.3
Test Point 2	SCS15	-3.6	-0.4	1.4	2.7	3.6	4.4	5.1	5.7	6.2	6.7	N/A	N/A	N/A	N/A	N/A
	SCS30	-4.2	-0.8	1.2	2.5	3.5	4.3	5	5.7	6.2	6.6	7.5	8.2	8.8	9.3	9.8
	SCS60	N/A	-1.2	1	2.3	3.3	4.2	4.9	5.5	6.1	6.5	7.4	8.1	8.7	9.2	9.7

Test Tolerance (TT)		
Frequency Range	**BW ≤ 40MHz**	**40MHz < BW ≤ 100MHz**
f ≤ 3.0GHz	1 dB	1.4 dB
3.0GHz < f ≤ 6 GHz	1.4 dB	1.4 dB

Example: DUT on n78 with 100 MHz BW and TP1:

1. Specified expected measured power: -4.2 dBm with a tolerance of ±(9+1.4) dB
2. CMX TX power measurement within 3GPP limits

Statistic Count	Allocation	Modulation
20/20	No. RB: 273 Offset RB: 0	QPSK

▼ Power	
	Current
TX Power (dBm)	-8.25

3.8 6.3.4.3 Relative power tolerance

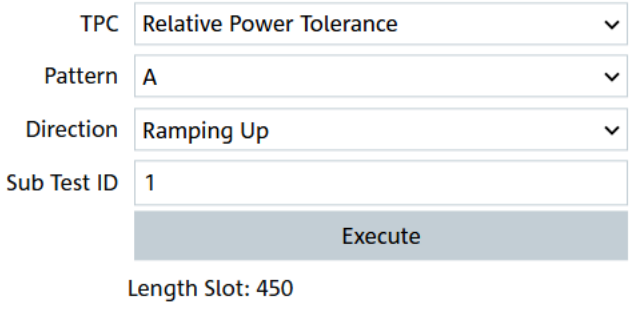
Purpose:

To verify the ability of the UE transmitter to set its output power in a target sub-frame relatively to the power of the most recently transmitted reference sub-frame if the transmission gap between these sub-frames is less than or equal to 20ms.

Test Procedure:

Note: This TC is initially accessible via *NR Cell Configuration: Power → Power Control → TPC → Relative Power Tolerance.* It will be added to the 3GPP workspace configuration in later SW versions

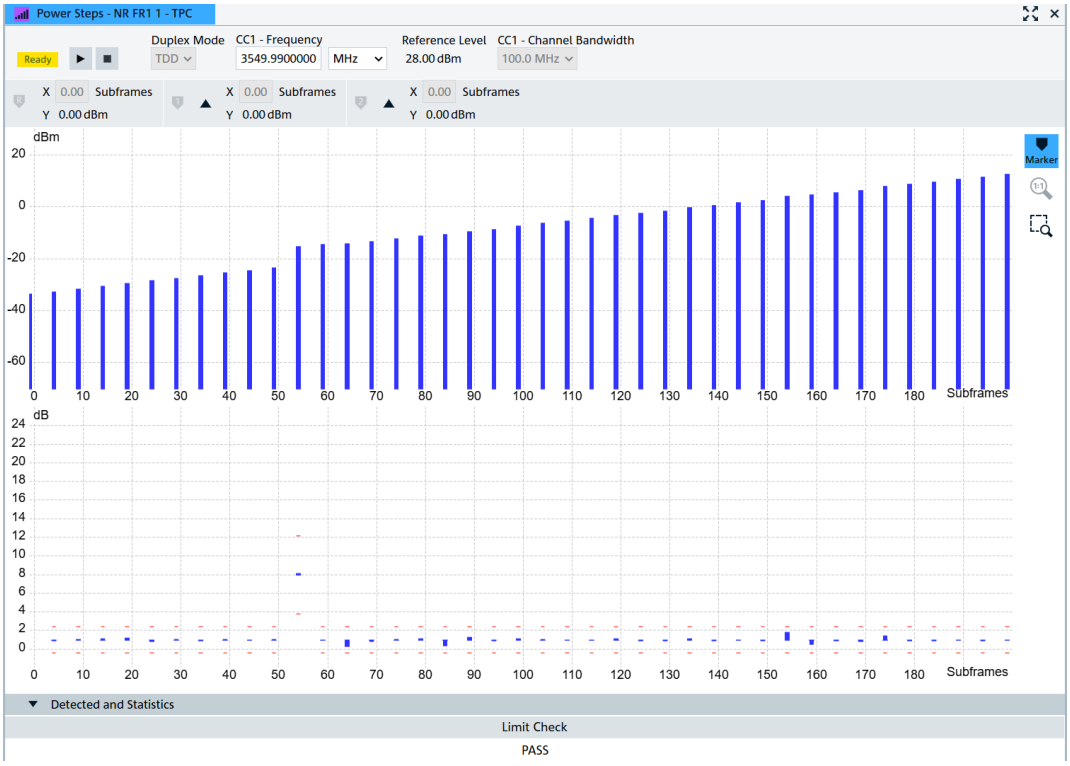
1. Follow the steps in chapter 2.1 and click *Apply*
    - The CMX will prepare the signaling and measurement for testing
2. Choose the test *Pattern*, *Direction* and *Sub Test ID* for testing in the configuration tab on the right and click *Execute*



Verification:

The CMX will execute the test pattern and measure the respective UL power steps. The measurement automatically performs limit checks according to 38.521-1

Example: DUT on n78 with with Pattern A, Ramping Up, Sub Test ID 1



3.9 6.3.4.4 Aggregate power tolerance PUCCH/PUSCH

Purpose:

To verify the ability of the UE transmitter to maintain its power during non-contiguous transmissions within 21ms in response to 0 dB commands with respect to the first UE transmission and all other power control parameters kept constant.

Test Procedure:

1. Follow the steps in chapter 2.1 then choose a Test ID
    a. The Test ID configures RB Allocation and modulation scheme.
    b. See notes for PUCCH subtests in chapter 2.1.
2. Set *TPC* to *Keep* to verify the ability of the DUT to maintain its UL power
3. Apply the configuration and measure the power of 5 consecutive PUCCH/PUSCH transmissions to verify that the DUT is able to maintain its power within the required time

Verification:

The DUT must maintain its UL power over 5 consecutive PUCCH/PUSCH transmissions within the tolerance defined in Table 6.3.4.4.5-1 with a test tolerance (TT) of 0.7 dB:

UL channel	Test requirement for consecutive 2nd and later power measurements
PUCCH	Measurements shall be within ± (2.5 + TT) dB of the 1st measurement.
PUSCH	Measurements shall be within ± (3.5 + TT) dB of the 1st measurement.

Note: Set the measurement to 30 Subframes to measure PUCCH/PUSCH within the required time window

Example: DUT on n78 30 kHz SCS measured with PUSCH

1. Specified expected measured deviation from the first measured slot: ±(3.5+0.7) dB
2. CMX TX power measurement within 3GPP limits

TX Measurement - NR FR1 1 - MEV

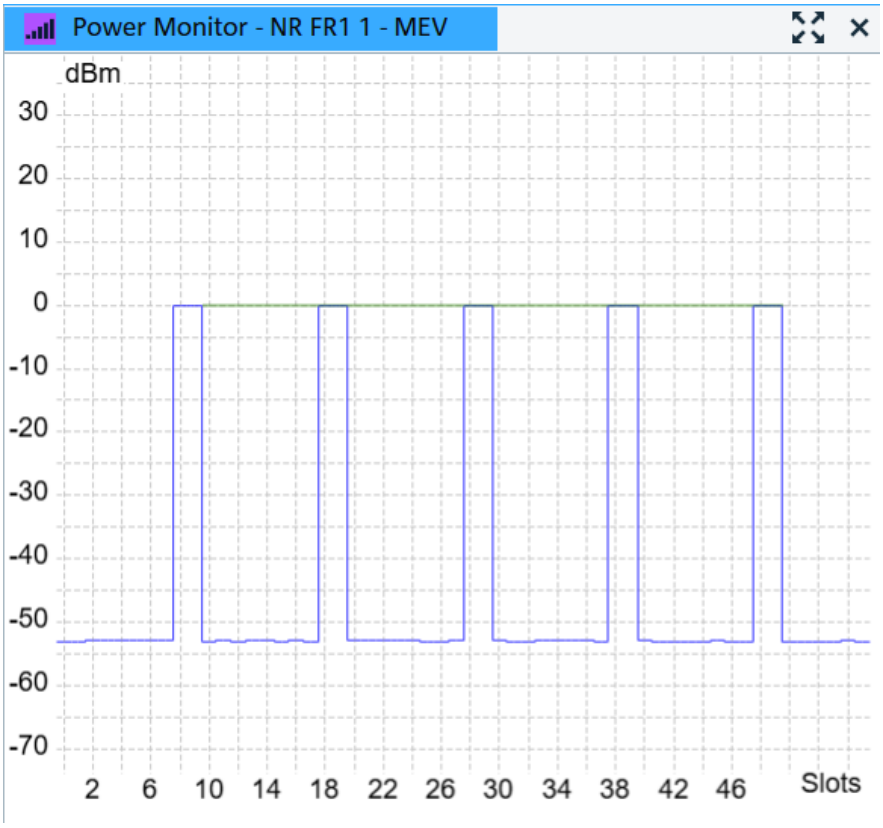
Detected and Statistics

Statistic Count	Allocation	Modulation	Channel Type
20/20	No. RB: 273 Offset RB: 0	QPSK	PUSCH

Power

	Current	Average	Min	Max
TX Power (dBm)	-0.00	-0.12	-0.24	-0.00

Power monitor measurement with 5 consecutive PUSCH transmissions. Green line from the first measured PUSCH transmission added for better illustration:



3.10 6.4.1 Frequency error

Purpose:

This test verifies the ability of both, the receiver and the transmitter, to process frequency correctly.

Receiver: to extract the correct frequency from the stimulus signal, offered by the System simulator, under ideal propagation conditions and low level.

Transmitter: to derive the correct modulated carrier frequency from the results, gained by the receiver.

Test Procedure:

1. Follow the steps in chapter 2.1 then choose a Test ID
    a. The Test ID configures RB Allocation and modulation scheme
2. Set *Total Cell Power* to the REFSENS value defined in Table 7.3.2.5-1.

   Note: The DL power will be adapted automatically in future FW versions
3. Apply the configuration and verify the measured DUT frequency error to be within the specified range

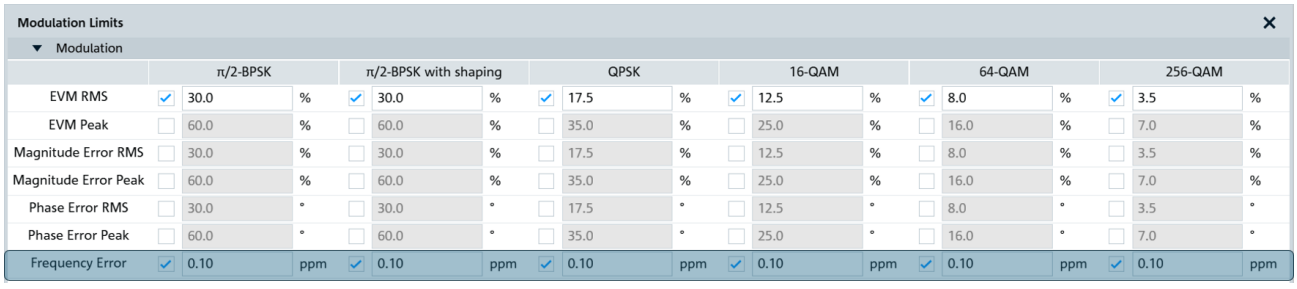
Verification:

The frequency error results must be within $|\Delta f| \leq (0.1\ PPM + 15\ Hz)$

Example: DUT on n78 with center frequency of 3549.99 MHz

1. Specified absolute max frequency error is $\leq (350\ Hz + 15\ Hz)$

   The CMX automatically checks the Frequency error limit of 0.1 PPM in the *TX Measurement.* This can be seen in the ▼ Limits → Modulation... setting:



Modulation Limits

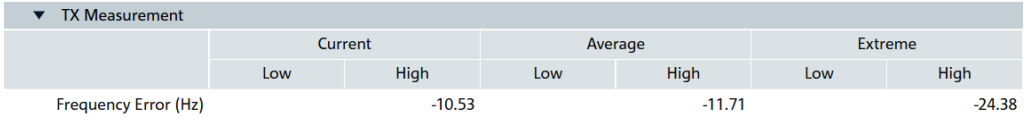
▼ Modulation

	π/2-BPSK		π/2-BPSK with shaping		QPSK		16-QAM		64-QAM		256-QAM	
EVM RMS	30.0	%	30.0	%	17.5	%	12.5	%	8.0	%	3.5	%
EVM Peak	60.0	%	60.0	%	35.0	%	25.0	%	16.0	%	7.0	%
Magnitude Error RMS	30.0	%	30.0	%	17.5	%	12.5	%	8.0	%	3.5	%
Magnitude Error Peak	60.0	%	60.0	%	35.0	%	25.0	%	16.0	%	7.0	%
Phase Error RMS	30.0	°	30.0	°	17.5	°	12.5	°	8.0	°	3.5	°
Phase Error Peak	60.0	°	60.0	°	35.0	°	25.0	°	16.0	°	7.0	°
Frequency Error	0.10	ppm	0.10	ppm	0.10	ppm	0.10	ppm	0.10	ppm	0.10	ppm

2. CMX frequency error measurement within 3GPP limits

▼ Detected and Statistics

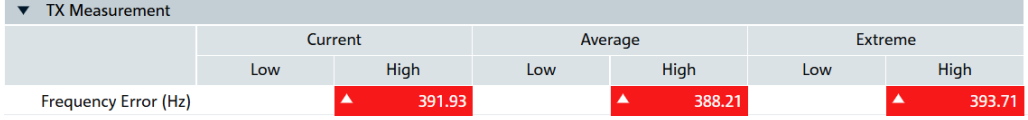
Statistic Count	Allocation	Modulation
20/20	No. RB: 270 Offset RB: 0	QPSK



▼ TX Measurement

	Current		Average		Extreme	
	Low	High	Low	High	Low	High
Frequency Error (Hz)		-10.53		-11.71		-24.38

Automatically highlighted in **red** if out of limits



▼ TX Measurement

	Current		Average		Extreme	
	Low	High	Low	High	Low	High
Frequency Error (Hz)		▲ 391.93		▲ 388.21		▲ 393.71

3.11 6.4.2.1 Error Vector Magnitude PUCCH/PUSCH

Purpose:

The Error Vector Magnitude is a measure of the difference between the reference waveform and the measured waveform.

Test Procedure:

1. Follow the steps in chapter 2.1 then choose a Test ID
    a. The Test ID configures RB Allocation and modulation scheme
    b. See notes for PUCCH subtests in chapter 2.1.
2. Apply the configuration and verify the measured DUT EVM to be within the specified range
3. The TC requires EVM measurements at DUT max and min power.
    a. The CMX will automatically set max power first.

    After the max power EVM verification, the DUT needs to be configured to min power using *TPC Closed Loop* settings

    Below table lists required minimum power (Pmin) according to 38.521-1 Table 6.3.1.3-1. Target power for 256QAM Test IDs is Pmin + 10 dB.

Channel BW / MHz	Minimum output power
3-20 MHz	-40
25-100 MHz	$-40+10\log_{10}(BW_{Channel}/20)$

Verification:

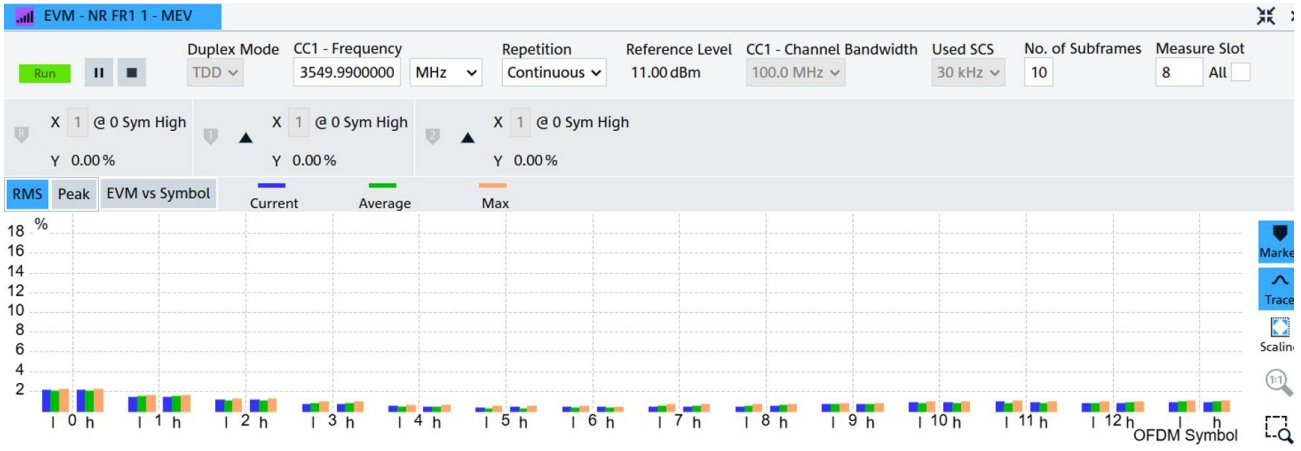
The EVM measurement results must be lower than the maximum error % in Table 6.4.2.1.5-1 with a TT defined in Table 6.4.2.1.5-2.

Modulation	Average EVM Level / %
Pi/2-BPSK	30 + TT
QPSK	17.5 + TT
16 QAM	12.5 + TT
64 QAM	8 + TT
256 QAM	3.5 + TT

Modulation	TT / %
All except 256QAM	0
256 QAM @max power	0.3
256 QAM @min power	1.1

Example: DUT on n78 with 100 MHz BW with PUCCH Test ID 1 (QPSK)

1. Specified maximum EVM is 17.5 + 0 %
2. CMX EVM measurement within 3GPP limits



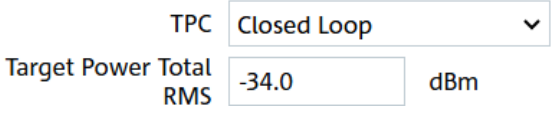
Detected and Statistics

Statistic Count	Allocation	Modulation	Channel Type	Out of Tolerance	View Filter Throughput
20/20	No. RB: 1 Offset RB: 0	QPSK	PUCCH	0.00 %	100 %

EVM

	Current		Average		Extreme		Std Dev	
EVM	Low	High	Low	High	Low	High	Low	High
EVM RMS (%)	0.86	0.86	0.88	0.88	0.97	0.96	0.04	0.04
EVM Peak (%)	2.27	2.29	2.59	2.55	2.82	2.81	0.14	0.14
EVM DMRS (%)	1.01	1.01	1.05	1.04	1.12	1.11	0.04	0.04

3. Measure EVM at min power using TPC closed loop power settings. For 100 MHz BW, the min power according to Table 6.3.1.3-1 is slightly lower than 33 dB:



3.12 6.4.2.2 Carrier leakage

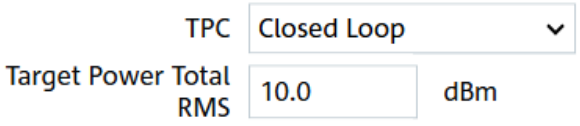
Purpose:

Carrier leakage expresses itself as unmodulated sine wave with the carrier frequency or center frequency of aggregated transmission bandwidth configuration. It is an interference of approximately constant amplitude and independent of the amplitude of the wanted signal.

The purpose of this test is to exercise the UE transmitter to verify its modulation quality in terms of carrier leakage.

Test Procedure:

1. Follow the steps in chapter 2.1 then choose a Test ID
    a. The Test ID configures RB Allocation and modulation scheme
2. Apply the configuration and verify the measured DUT carrier leakage to be within the specified range
    a. The measurements are specified for different UL target power ranges, which can be set using the *TPC Closed Loop* settings. Test Step 1 UL target power is set automatically upon test case selection:



Test Step	Target Power Level / dBm
1	10
2	0
3	-30
4	Pmin from Table 6.3.1.3-1 (see TC 6.4.2.1)

Note: The target power is defined to be within a specific range given by the Test system uncertainty and UE step size and tolerances. Using the CMX target power control will ensure that the UL power is well within the specified range.

Verification:

The carrier leakage results must not exceed the relative limits from Table 6.4.2.2.5-1 with a TT of 0.8 dB.

Test Step	Relative limit / dBc
1	-28 + TT
2	-25 + TT
3	-20 + TT
4	-10 + TT

Example: DUT on n78 with 100 MHz BW on Test Step 1 (10 dBm target power)

1. Relative limit for Test Step 1 is -27.2 dBc
2. CMX Carrier leakage measurement within 3GPP limits

TX Measurement - NR FR1 1 - MEV

Run	Duplex Mode	CC1 - Frequency		Repetition	Reference Level	CC1 - Channel Bandwidth	Used SCS	No. of Subframes	Measure Slot
	TDD	3549.9900000	MHz	Continuous	28.20 dBm	100.0 MHz	30 kHz	10	8 All

Detected and Statistics

Statistic Count	Allocation	Modulation	Channel Type	Out of Tolerance	View Filter Throughput
20/20	No. RB: 1 Offset RB: 1	QPSK	PUSCH	0.00 %	100 %

Power

	Current	Average	Min	Max	Std Dev
TX Power (dBm)	9.52	9.48	9.31	9.65	0.05
Peak Power (dBm)	13.27	13.29	13.14	14.23	0.08
RB Power (dBm)	9.58	9.53	9.37	9.71	0.05

TX Measurement

	Current		Average		Extreme		Std Dev	
	Low	High	Low	High	Low	High	Low	High
EVM RMS (%)	1.69	1.69	2.31	2.31	2.94	2.94	0.38	0.38
EVM Peak (%)	8.90	8.91	11.17	11.18	14.66	14.66	1.80	1.80
EVM DMRS (%)	0.86	0.86	1.31	1.31	1.69	1.70	0.26	0.26
Magnitude Error RMS (%)	1.57	1.57	2.14	2.14	2.77	2.77	0.35	0.35
Magnitude Error Peak (%)	8.85	8.86	11.07	11.09	14.66	14.66	1.80	1.80
Magnitude Error DMRS (%)	0.80	0.80	1.23	1.23	1.60	1.60	0.24	0.24
Phase Error RMS (°)	0.36	0.36	0.51	0.51	0.61	0.61	0.09	0.09
Phase Error Peak (°)	1.09	1.09	2.17	2.17	3.00	3.00	0.68	0.68
Phase Error DMRS (°)	0.13	0.13	0.19	0.19	0.31	0.31	0.05	0.05
IQ Offset (dBc)		-63.93		-64.98		-60.71		1.22
Frequency Error (Hz)		-7.25		-10.10		-23.20		3.31
Frequency Error (ppm)		-0.00		-0.00		-0.01		0.00
Sample Clock Error (ppm)		-2.03		-1.31		-11.73		4.68
Timing Error (Ts)		-0.76		-0.91		2.82		0.44
OBW (MHz)		0.42		0.48		0.54		0.04

3.13 6.4.2.3 In-band emissions PUCCH/PUSCH

Purpose:

The in-band emissions are a measure of the interference falling into the non-allocated resources blocks.

The in-band emission is defined as the average emission across 12 sub-carriers and as a function of the RB offset from the edge of the allocated UL transmission bandwidth. The in-band emission is measured as the ratio of the UE output power in a non–allocated RB to the UE output power in an allocated RB.

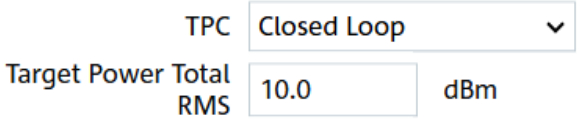
The purpose of this test is to exercise the UE transmitter to verify its modulation quality in terms of in-band emissions.

Test Procedure:

1. Follow the steps in chapter 2.1 then choose a Test ID
    a. The Test ID configures RB Allocation and modulation scheme

    Notes for PUCCH Subtests:

    - Parameters will show *not applicable* for the PUCCH subtests, as only the PUSCH scheduling is displayed. The PUCCH configuration will be applied according to 38.521-1
    - There is no UL PUSCH scheduled according to 38.521-1. It is recommended to switch data on the UE off. Every scheduling request for UL resources from the UE will lead to call drops, as no PUSCH resources are available.
2. Apply the configuration and verify the measured DUT in-band emissions to be within the specified range
    a. The measurements are specified for different UL target power ranges, which can be set using the *TPC Closed Loop* settings:



Test Step	Target Power Level / dBm
1	10
2	0
3	-30
4	Pmin from Table 6.3.1.3-1 (see TC 6.4.2.1)

Note: The target power is defined to be within a specific range given by the Test system uncertainty and UE step size and tolerances. Using the CMX target power control will ensure that the UL power is well within the specified range.

Verification:

The in-band emissions results must not exceed the values from Table 6.4.2.3.5-1. The specification defines separate limits over the whole carrier BW. Limits are automatically checked by the CMX500 within the *Inband Emission* measurement.

Example: DUT on n78 with 100 MHz BW on Test Step 1 (10 dBm target power)

1. The CMX500 automatically checks the Frequency error limit of 0.1 PPM in the *TX Measurement.*

   This can be seen in the ▼ Limits → Modulation... setting:

Modulation Limits

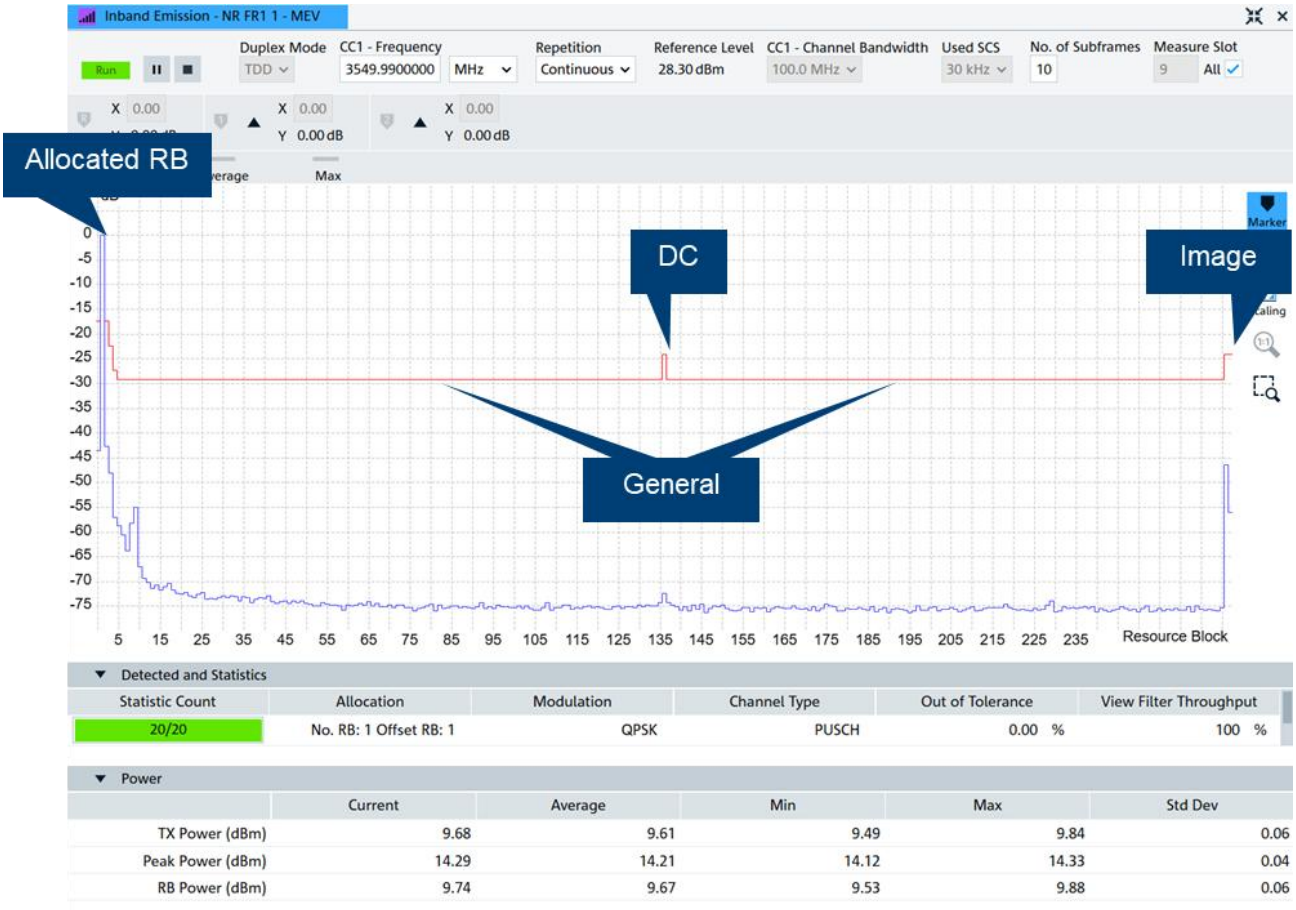
▶ Modulation

▶ IQ Offset

▼ IBE

	π/2-BPSK		π/2-BPSK with shaping		QPSK		16-QAM		64-QAM		256-QAM	
Enable	☑		☑		☑		☑		☑		☑	
General Min	-29.2	dB	-29.2	dB	-29.2	dB	-29.2	dB	-29.2	dB	-29.2	dB
General EVM	30.0	%	30.0	%	17.5	%	12.5	%	8.0	%	3.5	%
General RB Power	-57.0	dBm	-57.0	dBm	-57.0	dBm	-57.0	dBm	-57.0	dBm	-57.0	dBm
IQ Image > 10 dBm	-27.2	dB	-27.2	dB	-27.2	dB	-27.2	dB	-27.2	dB	-27.2	dB
IQ Image <= 10 dBm	-24.2	dB	-24.2	dB	-24.2	dB	-24.2	dB	-24.2	dB	-24.2	dB

2. CMX in-band emissions measurement within 3GPP limits



	Current	Average	Min	Max	Std Dev
TX Power (dBm)	9.68	9.61	9.49	9.84	0.06
Peak Power (dBm)	14.29	14.21	14.12	14.33	0.04
RB Power (dBm)	9.74	9.67	9.53	9.88	0.06

3.14 6.4.2.4 EVM equalizer spectrum flatness

Purpose:

The zero-forcing equalizer correction applied in the EVM measurement process must meet a spectral flatness requirement for the EVM measurement to be valid. The EVM equalizer spectrum flatness is defined in terms of the maximum peak-to-peak ripple of the equalizer coefficients (dB) across the allocated uplink block, at which the equalizer coefficients are generated by the EVM measurement process.

Test Procedure:

1. This test distinguishes between 2 frequency ranges within a band that are defined for normal and extreme conditions. This description will focus on normal conditions, as these are generally used. The frequency ranges are calculated based on the specified range for the respective band with F_{UL_Low} and F_{UL_High} being the minimum and maximum frequencies and F_{UL_Meas} the measured sub-carrier frequency.
    a. Range 1 (normal conditions): $F_{UL\_Meas} - F_{UL\_Low} \geq 3$ MHz and $F_{UL\_High} - F_{UL\_Meas} \geq 3$ MHz
    b. Range 2 (normal conditions): $F_{UL\_Meas} - F_{UL\_Low} < 3$ MHz or $F_{UL\_High} - F_{UL\_Meas} < 3$ MHz

       Example: n78 (3300 MHz – 3800 MHz); normal conditions

        i. Range 1: 3303 – 3797 MHz
        ii. Range 2: 3300 – 3302.99 MHz and 3797.01 – 3800 MHz

       Note: This test covers either one or both frequency ranges depending on the chosen range within the NR band (low – mid - high). Using a low or high range setting will generally cover both frequency Range 1 and Range 2 while a mid-range cell is likely only located within frequency Range 1
2. Follow the steps in chapter 2.1 then choose a Test ID
    a. The Test ID configures RB Allocation and modulation scheme
3. Apply the configuration and verify the measured DUT in-band emissions to be within the specified range

Verification:

The measured peak-to-peak variation of the EVM equalizer coefficients shall not exceed the maximum ripple as specified in 38.521-1 Tables 6.4.2.4.5-1 to 6.4.2.4.5-2. The maximum variation of coefficients is defined in Figure 6.4.2.4.5-1.

Limits are automatically checked by the CMX500 within the *Equalizer Spectrum Flatness* measurement.

Example: DUT on n78 with 100 MHz BW on low-range (carrier center at 3350.01 MHz)

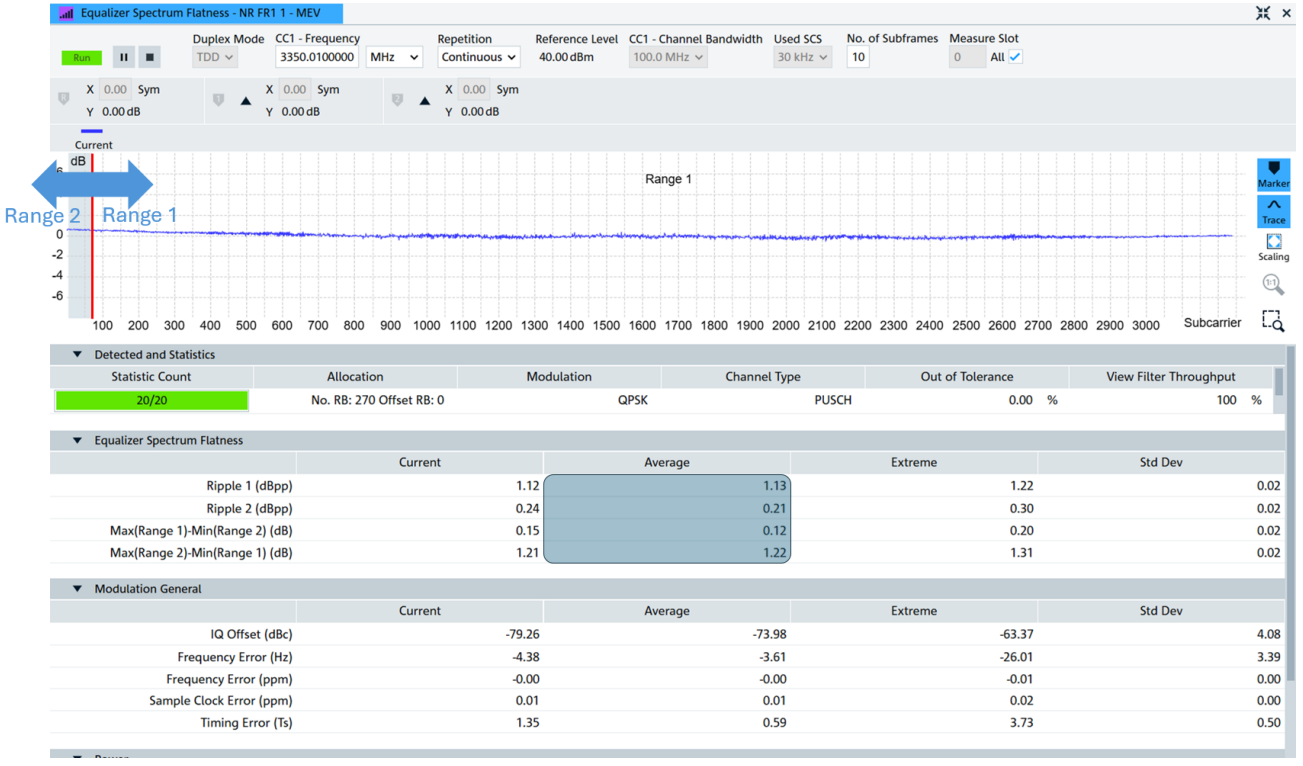
1. The CMX automatically checks the specified limits in the *Equalizer Spectrum Flatness* measurement. The parameters from the relevant tables and figures are reflected in the ▼ Limits → Modulation... setting:

Modulation Limits

- Modulation
- IQ Offset
- IBE
- IQ Offset @ Output Power
- Spectrum Flatness

	π/2-BPSK		π/2-BPSK with shaping		QPSK		16-QAM		64-QAM		256-QAM	
Enable	✓		✓		✓		✓		✓		✓	
Range 1	5.4	dBpp	7.4	dBpp	5.4	dBpp	5.4	dBpp	5.4	dBpp	5.4	dBpp
Range 2	9.4	dBpp	15.4	dBpp	9.4	dBpp	9.4	dBpp	9.4	dBpp	9.4	dBpp
Max(Range 1) - Min(Range 2)	6.4	dB	0.0	dB	6.4	dB	6.4	dB	6.4	dB	6.4	dB
Max(Range 2) - Min(Range 1)	8.4	dB	0.0	dB	8.4	dB	8.4	dB	8.4	dB	8.4	dB
Band Edge Distance	3.0	MHz	0.0	MHz	3.0	MHz	3.0	MHz	3.0	MHz	3.0	MHz

2. CMX Equalizer Spectrum Flatness measurement within 3GPP limits:



3.15 6.4.2.5 EVM equalizer spectrum flatness for Pi/2 BPSK

Purpose:

The zero-forcing equalizer correction applied in the EVM measurement process must meet a spectral flatness requirement for the EVM measurement to be valid. The EVM equalizer spectrum flatness is defined in terms of the maximum peak-to-peak ripple of the equalizer coefficients (dB) across the allocated uplink block, at which the equalizer coefficients are generated by the EVM measurement process.

Test Procedure:

1. Similar to 6.4.2.4, this test distinguishes between 2 frequency ranges within a band. The frequency ranges are calculated based on the center frequency of the allocated BW F_{Center} and the measured sub-carrier frequency F_{UL_Meas}.
    a. Range 1: $||F_{UL-Meas} - F_{Center}| \leq X;$ with X being 25% of the allocated PRBs
    b. Range 2: $||F_{UL-Meas} - F_{Center}| > X;$ with X being 25% of the allocated PRBs

    → The allocated BW is divided into 4 parts, with the outer 2 parts belonging to Range 2 and the inner parts to Range 1
2. Follow the steps in chapter 2.1 then choose a Test ID
    a. The Test ID configures RB Allocation and modulation scheme

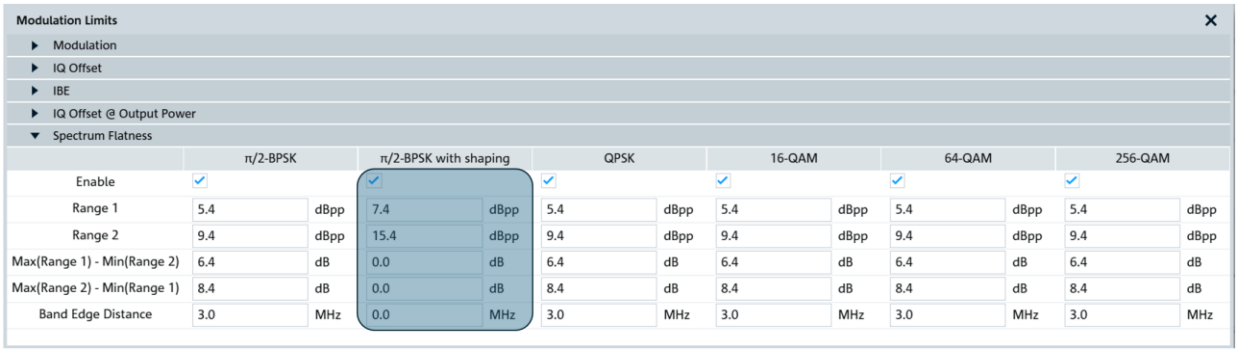
    Note: This test case only applies to PC3 UEs with support for the UE capability powerBoosting-pi2BPSK powerBoostPi2BPSK ☑ (Test ID1) or lowPAPR-DMRS-PUSCHwithPrecoding-r16 (Test ID 2)
3. Apply the configuration and verify the measured DUT in-band emissions to be within the specified range

Verification:

The measured peak-to-peak variation of the EVM equalizer coefficients shall not exceed the maximum ripple as specified in 38.521-1 Table 6.4.2.5.5-1 and Figure 6.4.2.5.5-1. Limits are automatically checked by the CMX500 within the *Equalizer Spectrum Flatness* measurement.

Example: DUT on n78 with 100 MHz BW

1. The parameters from Figure 6.4.2.5.5-1 are reflected in the ▼ Limits → Modulation... setting:



	π/2-BPSK		π/2-BPSK with shaping		QPSK		16-QAM		64-QAM		256-QAM	
Enable	☑		☑		☑		☑		☑		☑	
Range 1	5.4	dBpp	7.4	dBpp	5.4	dBpp	5.4	dBpp	5.4	dBpp	5.4	dBpp
Range 2	9.4	dBpp	15.4	dBpp	9.4	dBpp	9.4	dBpp	9.4	dBpp	9.4	dBpp
Max(Range 1) - Min(Range 2)	6.4	dB	0.0	dB	6.4	dB	6.4	dB	6.4	dB	6.4	dB
Max(Range 2) - Min(Range 1)	8.4	dB	0.0	dB	8.4	dB	8.4	dB	8.4	dB	8.4	dB
Band Edge Distance	3.0	MHz	0.0	MHz	3.0	MHz	3.0	MHz	3.0	MHz	3.0	MHz

2. CMX Equalizer Spectrum Flatness measurement within 3GPP limits:

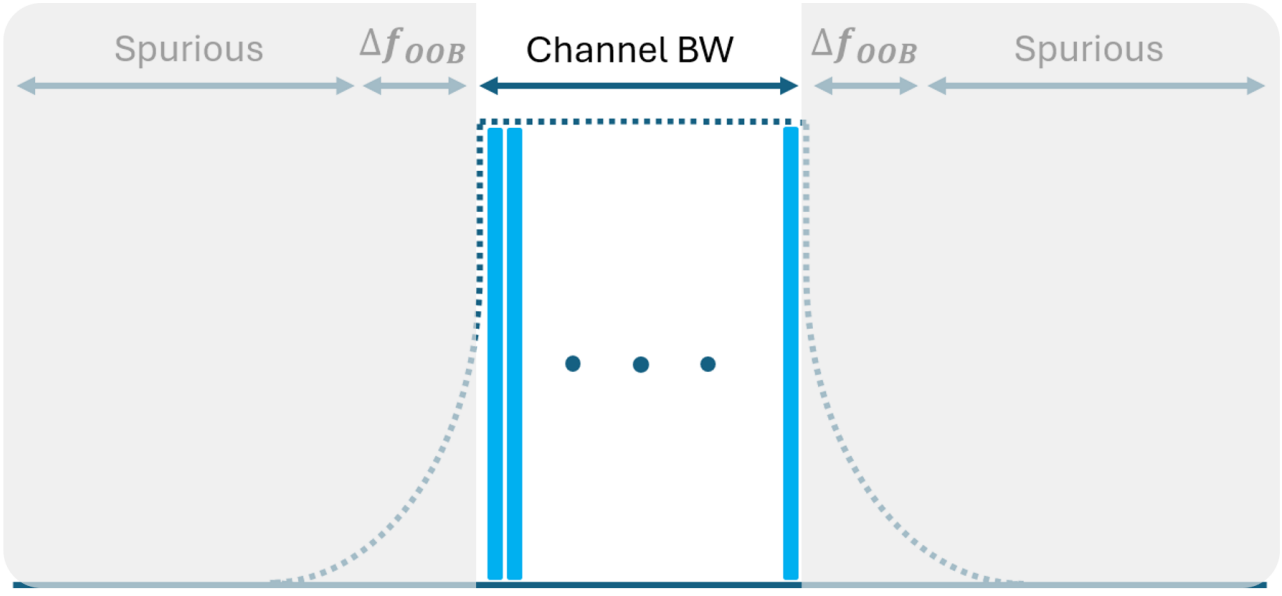
    Equivalent to 6.4.2.4 EVM equalizer spectrum flatness

3.16 6.5.1 Occupied bandwidth

Purpose:

To verify that the UE occupied bandwidth for all transmission bandwidth configurations supported by the UE are less than their specific limits.

Occupied bandwidth is defined as the bandwidth containing 99 % of the total integrated mean power of the transmitted spectrum on the assigned channel.



Test Procedure:

1. Follow the steps in chapter 2.1 then choose a Test ID
    a. The Test ID configures RB Allocation and modulation scheme
2. Apply the configuration and verify the measured DUT occupied bandwidth to be within the specified range

Verification:

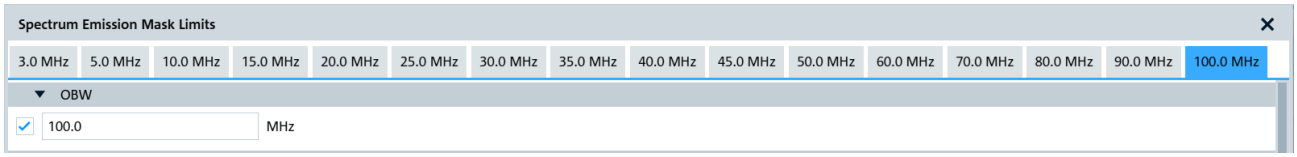
The measured occupied bandwidth shall not exceed the values from 38.521-1 Table 6.5.1.5-1:

	NR channel BW / MHz															
	3	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100
Occupied BW / MHz	3	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100

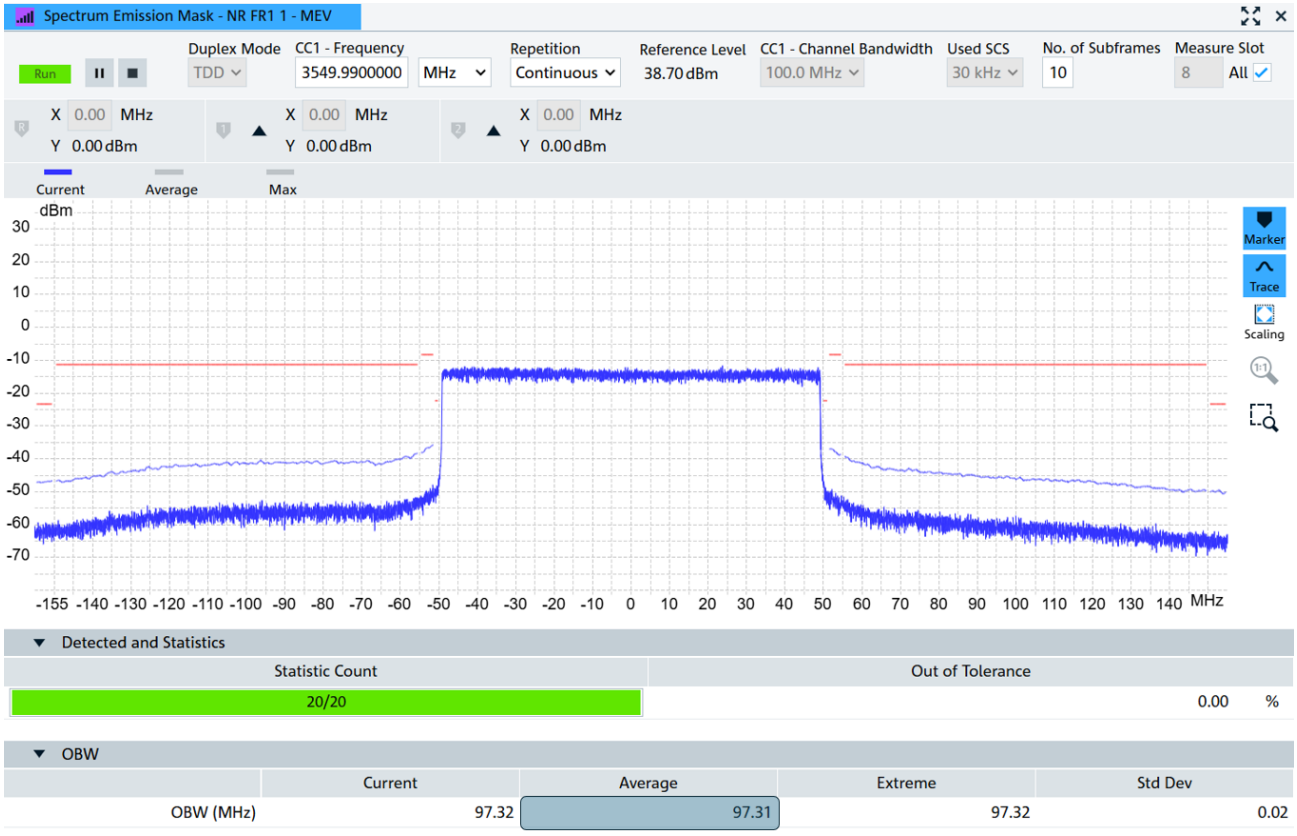
Limits are automatically checked by the CMX500 within the *Spectrum Emission Mask* measurement.

Example: DUT on n78 with 100 MHz BW mid channel

1. The parameters from Table 6.5.1.5-1 are reflected in the Limits → Spectrum Emission Mask... setting:



2. CMX Occupied Bandwidth measurement within 3GPP limits:

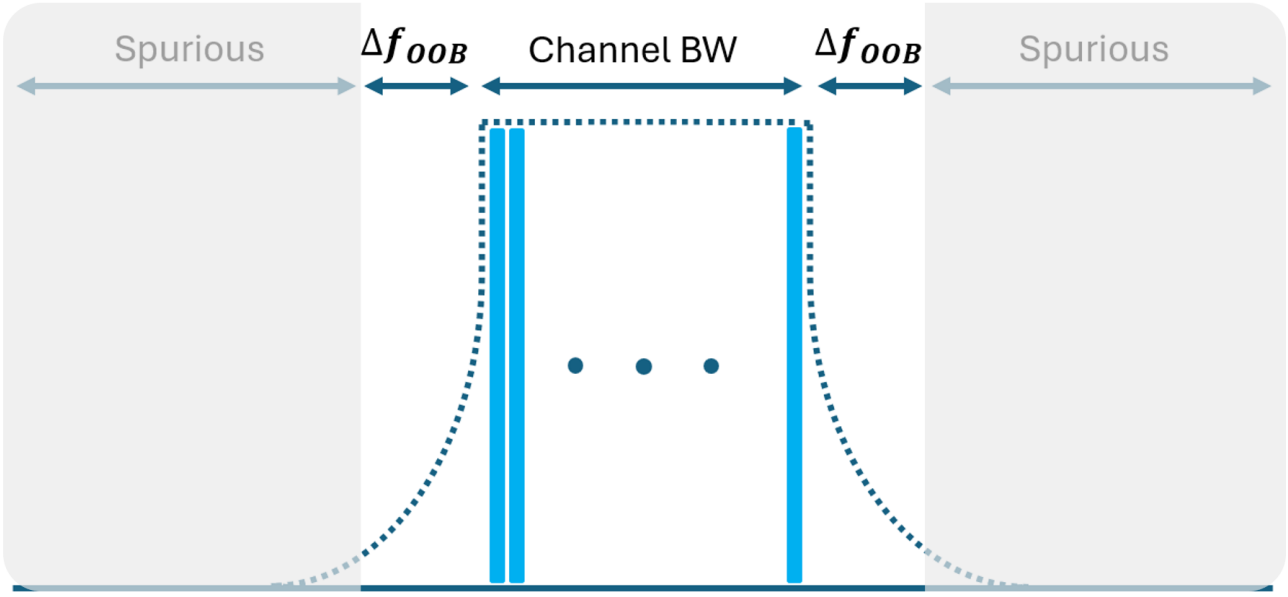


3.17 6.5.2.2 Spectrum emission mask

Purpose:

To verify that the power of any UE emission shall not exceed specified level for the specified channel bandwidth.

Out-of-band emissions are unwanted emissions immediately outside the nominal channel. They result from the modulation process and from non-linearity in the transmitter, but they do not include spurious emissions.



Test Procedure:

1. Follow the steps in chapter 2.1 then choose a Test ID
    a. The Test ID configures RB Allocation and modulation scheme depending on DUT power class
2. Apply the configuration and verify the measured DUT occupied bandwidth to be within the specified range

Verification:

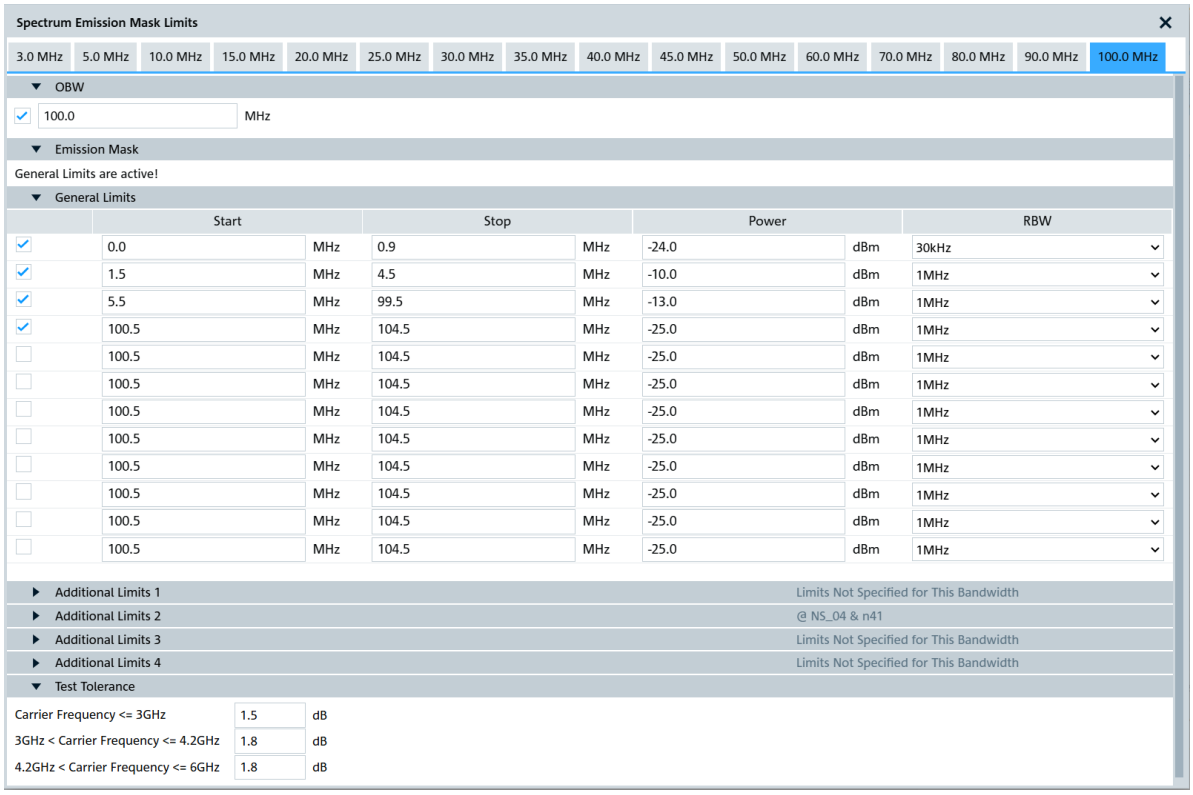
The measured mean power of the UE in the channel bandwidth shall meet the requirements from testcase 6.2.2 UE maximum output power reduction (MPR).

The power of any UE out of band emission (within Δf_{OOB}) shall be within the requirements in 38.521-1 Table 6.5.2.2.5-1.

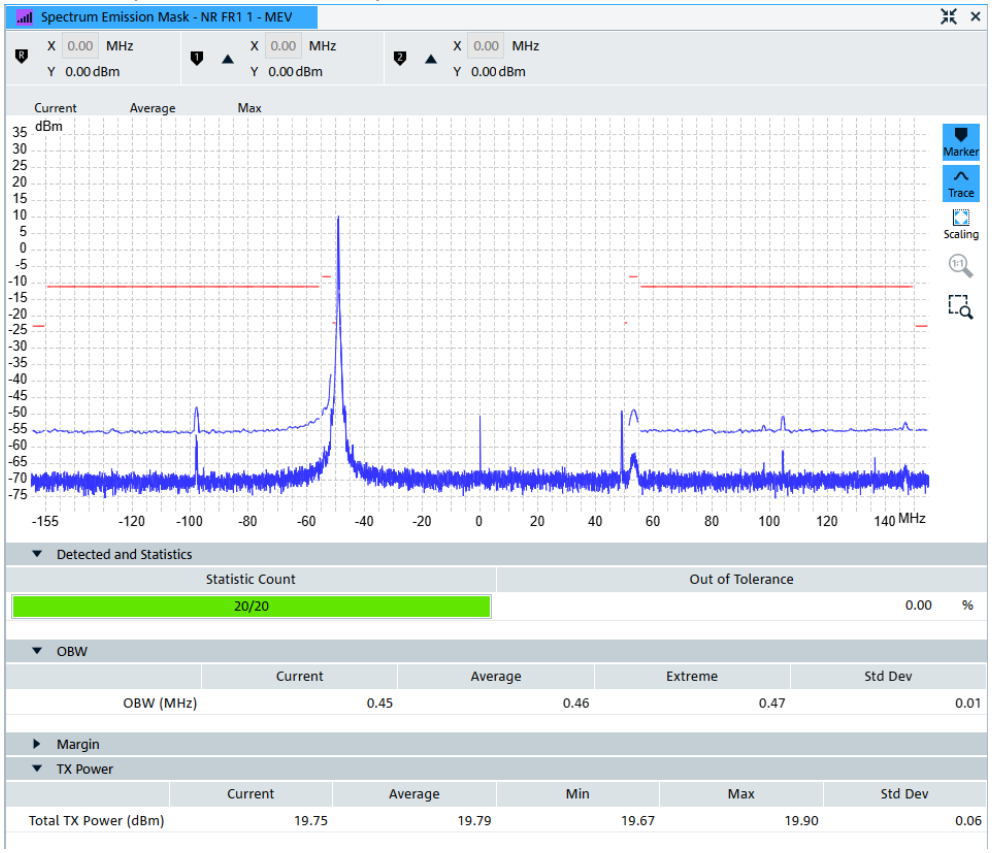
Limits are automatically checked by the CMX500 within the *Spectrum Emission Mask* measurement.

Example: DUT on n78 with 100 MHz BW mid channel on Test ID1 (Edge 1 RB Left)

1. The parameters from Table 6.5.2.2.5-1 are reflected in the Limits → Spectrum Emission Mask... setting:



2. CMX Occupied Bandwidth and power measurement within 3GPP limits:

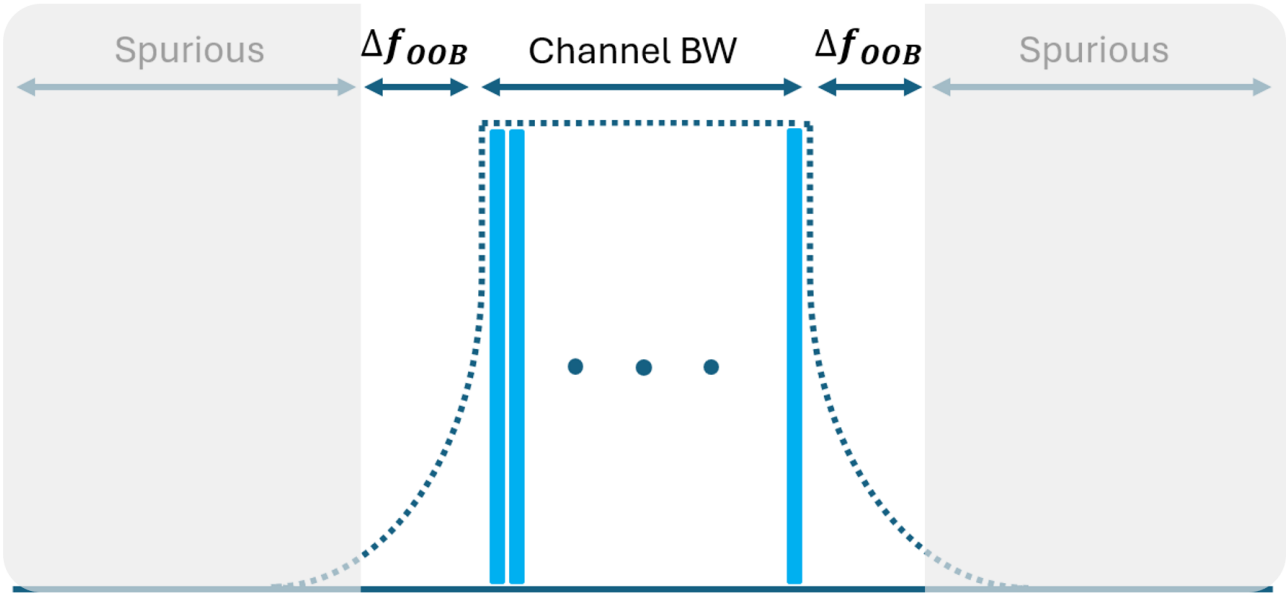


3.18 6.5.2.3 Additional spectrum emission mask

Purpose:

To verify that the power of any UE emission shall not exceed specified level for the specified channel bandwidth under the deployment scenarios where additional requirements are specified.

Out-of-band emissions are unwanted emissions immediately outside the nominal channel. They result from the modulation process and from non-linearity in the transmitter, but they do not include spurious emissions.



Test Procedure:

1. Choose a valid band mapped to an applicable NS value
    a. Only following NS values are used for additional spectrum emissions calculations

NS_03	NS_03U	NS_04	NS_06	NS_07	NS_21	NS_27	NS_35
n2, n25, n66, n70, n86	n2, n25, n66, n86	n41	n12, n85, n14	n13	n30 (rel-17)	n48	n71

    ➔ The CMX allows the selection of all applicable NS values through the *Additional Spectrum Emission* dropdown menu. Band n2 with an Additional Spectrum Emission value of 2 is for example mapped to NS_03.

2. Follow the steps in chapter 2.1 then choose a Test ID
    a. The Test ID configures RB Allocation and modulation scheme depending on DUT power class

    ➔ The CMX allows the selection of all Test IDs. Resulting modulation and RB allocation are displayed for each valid Test ID upon selection.

    ➔ Test IDs for this test case are specified in 6.2.3 UE additional maximum output power reduction (A-MPR). Please check the event log at the bottom of the GUI and refer to *Notes* section in chapter 2.1.

    ⚠ NR: UL scheduling not defined in 3GPP Spec for test case '6.2.3 UE additional maximum output power reduction', test Id 1, n1, Scs15Khz, Mhz10

3. Apply the configuration

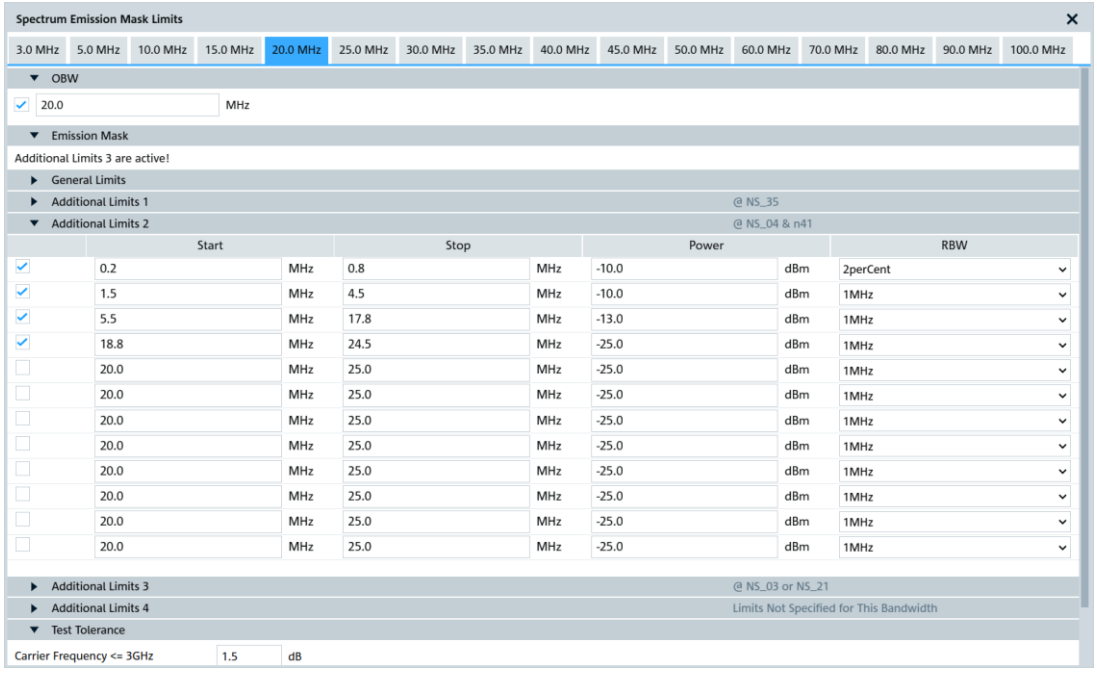
Verification:

The measured mean power of the UE in the channel bandwidth shall meet the requirements from testcase 6.2.3 UE additional maximum output power reduction (A-MPR).

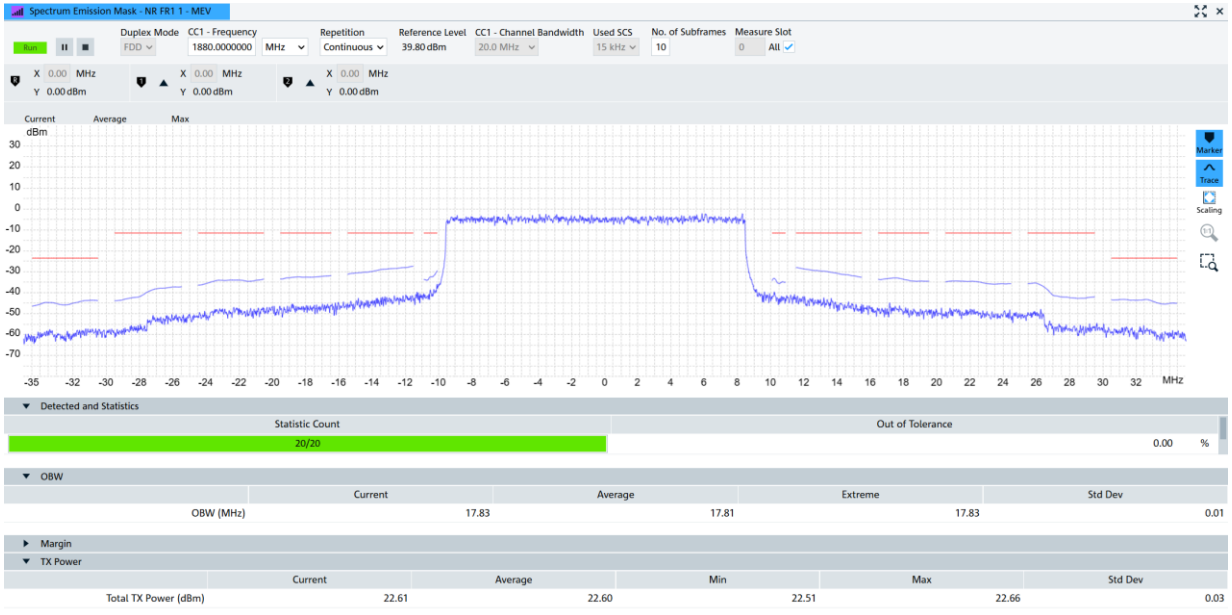
The additional requirements for the respective NS values are specified in Tables 6.5.2.3.5.1-1 to 6.5.2.3.5.9-1. Limits are automatically checked by the CMX500 within the *Spectrum Emission Mask* measurement.

Example: PC3 DUT on n2 using NS_04 with Test ID 6 (QPSK; Outer Full)

1. The parameters from Tables 6.5.2.3.5.1-1 to 6.5.2.3.5.9-1 are reflected in the ▼ Limits → Spectrum Emission Mask... setting in the *Additional Limits* tab:



2. CMX Occupied Bandwidth and power measurement within 3GPP limits:



3.19 6.5.2.4.1 NR ACLR

Purpose:

To verify that UE transmitter does not cause unacceptable interference to adjacent channels in terms of Adjacent Channel Leakage power Ratio (ACLR).

Adjacent channel leakage power Ratio (ACLR) is the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency.

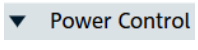
Test Procedure:

1. Follow the steps in chapter 2.1 then choose a Test ID
    a. The Test IDs from 6.2.2 UE maximum output power reduction (MPR) are used for this TC
    b. Test IDs configure RB Allocation and modulation scheme depending on DUT power class

    ➔ The CMX allows the selection of all Test IDs. Resulting modulation and RB allocation are displayed for each valid Test ID upon selection.

    Note: PC 3 UEs tested on band n40, n41, n77, n78 and n79 supporting the UE capability powerBoosting-pi2BPSK need to have the setting *powerBoostPi2BPSK* enabled for Test IDs 1,2,3 and 4 (38.521-1 Table 6.2.2.4.1-1)

    Note: PC 1 and PC2 UEs: Testing required with and without setting the parameter p-Max 23 dBm.

    p-Max can be configured in the 

section: 

2. Apply the configuration

Verification:

The measured UE mean power in the channel bandwidth shall be within the limits defined for 6.2.2 UE maximum output power reduction (MPR).

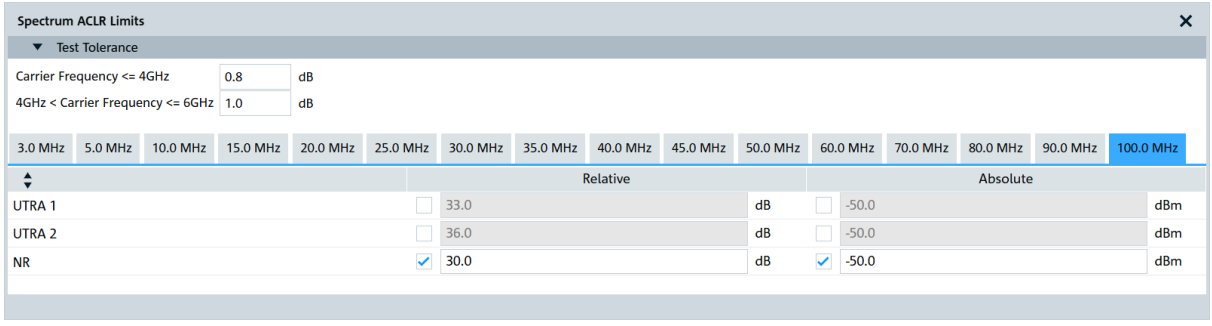
If the measured adjacent channel power is > -50 dBm, then the measured NR ACLR shall be higher than the limits in Table 6.5.2.4.1.5-2 with a TT of 0.8 dB:

	PC1	PC2	PC3
NR ACLR / dB	37	31	30

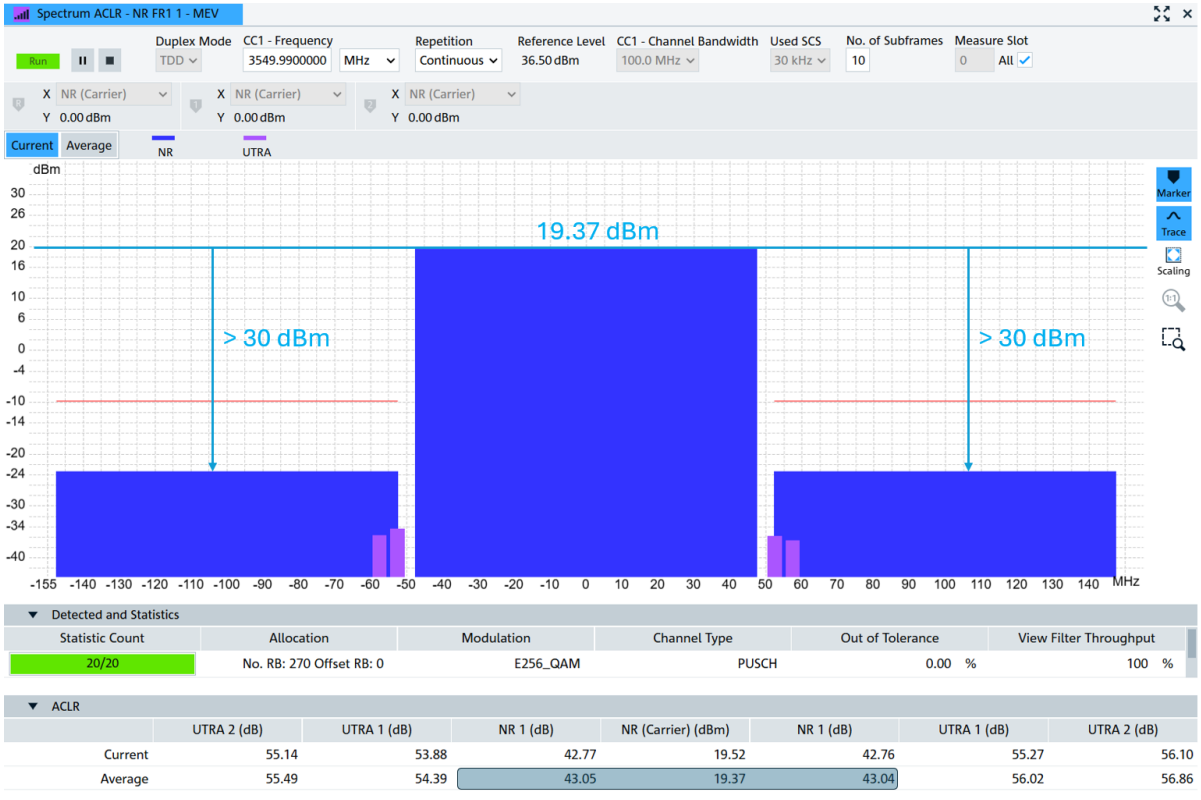
Limits are automatically checked by the CMX500 within the *Spectrum ACLR* measurement.

Example: PC3 DUT on n78 with Test ID 22 (256 QAM; full allocation)

1. The parameters from Table 6.5.2.4.1.5-2 for PC3 DUTs are reflected in the ▼ Limits → Spectrum ACLR... setting:



2. The measured mean power within the channel BW must be within 6.2.2 UE maximum output power reduction (MPR) limits. In this case: 14.5 dBm – TT and 25 dBm + TT (see section 3.2).
3. CMX NR ACLR measurement within 3GPP limits:



3.20 6.5.2.4.2 UTRA ACLR

Purpose:

To verify that UE transmitter does not cause unacceptable interference to adjacent channels in terms of Adjacent Channel Leakage power Ratio (ACLR).

UTRA adjacent channel leakage power Ratio (ACLR) is the ratio of the filtered mean power centred on the assigned NR channel frequency to the filtered mean power centered on an adjacent UTRA channel frequency.

Test Procedure:

1. Choose a valid band mapped to an applicable NS value
    a. Only following NS values are used for additional spectrum emissions calculations (38.521-1 Table 6.5.2.4.2.4.3-1)

NS_03U	NS_05U	NS_43U	NS_100
n2, n25, n66, n86	n1, n84	n8, n81	n1, n2, n3, n5, n8, n25, n66

2. Follow the steps in chapter 2.1 then choose a Test ID
    1. The Test IDs and requirements from 6.2.3 UE additional maximum output power reduction (A-MPR) are used for this TC
    2. Test IDs configure RB Allocation and modulation scheme depending on DUT power class

    ➔ The CMX allows the selection of all Test IDs. Resulting modulation and RB allocation are displayed for each valid Test ID upon selection.

3. Apply the configuration

Verification:

The measured UE mean power in the channel bandwidth shall be within the limits defined for the appropriate configuration in 6.2.3 UE additional maximum output power reduction (A-MPR).

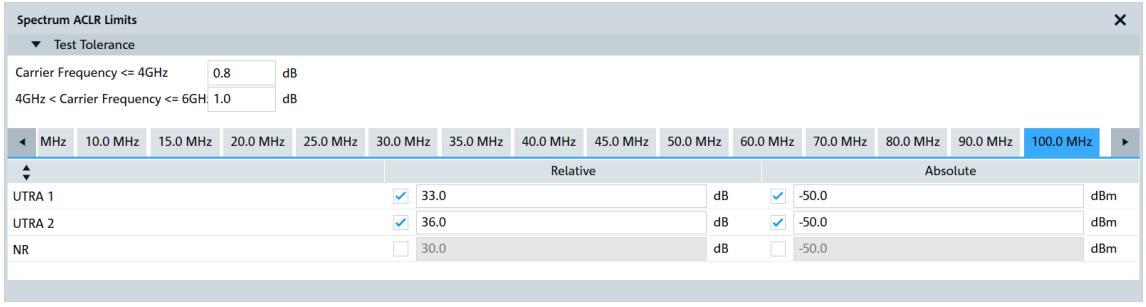
If the measured adjacent channel power is > -50 dBm, then the measured UTRA ACLR shall be higher than the limits in Table 6.5.2.4.2.5-2 with a TT of 0.8 dB:

PC3	UTRA 1 / dB	UTRA 2 / dB
UTRA ACLR / dB	33	36

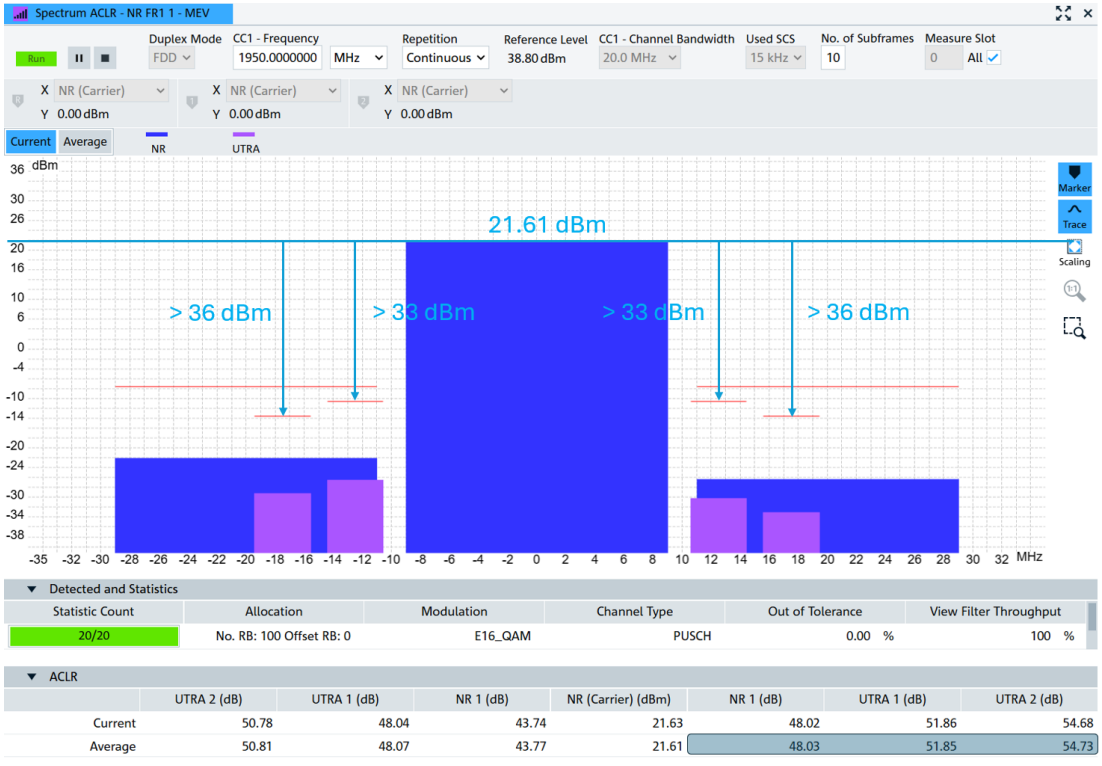
Limits are automatically checked by the CMX500 within the *Spectrum ACLR* measurement.

Example: PC3 DUT on n1 using NS_100 with Test ID 12 (64 QAM; Outer Full)

1. The parameters from Table 6.5.2.4.2.5-2 for PC3 DUTs are reflected in the ▼ Limits → Spectrum ACLR... setting:



2. The measured mean power within the channel BW must be within 6.2.3 UE additional maximum output power reduction (A-MPR) limits.
    a. *Lower limit:* 17.5 dBm – TT and *Upper limit* 25 dBm + TT (38-521-1 Table 6.2.3.5-12).
3. CMX UTRA ACLR measurement within 3GPP limits:



3.21 7.3.2 Reference sensitivity power level

Purpose:

The test purpose is to verify the ability of the UE to receive data with a given average throughput for a specified reference measurement channel, under conditions of low signal level, ideal propagation and no added noise.

The reference sensitivity power level REFSENS is the minimum mean power applied to each one of the UE antenna ports for all UE categories, at which the throughput shall meet or exceed the requirements for the specified reference measurement channel.

Test Procedure:

1. Choose the NS value to match the values specified in Tables 7.3.2.4.3.2-1 to 7.3.2.4.3.8-1

NS_01	NS_03	NS_06	NS_21	NS_27	NS_35	NS_45	NS_56
OTHERS	n2, n25, n66, n70	n12, n13, n14	n30	n48	n71	n53	n24

2. Follow the steps in chapter 2.1 then choose a Test ID
    a. Test IDs configure RB Allocation and modulation scheme depending on DUT power class
3. Apply the configuration
4. Set the appropriate REFSENS DL signal level as defined in 38.521-1
    a. Table 7.3.2.5-1a (FDD) or 7.3.2.5-1b (TDD) for 2 RX antennas connected or
    b. Table 7.3.2.5-2a (FDD) or 7.3.2.5-2a (TDD) if 4 RX antennas connected
    c. Table 7.3.2.5-2c and Table 7.3.2.5-2d for PC2 UE on FDD bands

    REFSENS equals the *Total Cell Power* configuration in the NR Cell settings

    Note: The DL power will be adapted automatically in future FW versions
5. Verify the DUT throughput against test requirements with 2 RX antenna ports tested
    a. The test needs to be repeated with 4 RX antennas connected if supported by the UE

Verification:

The measured TP shall be ≥ 95% of the maximum possible TP using the specified $P_{REFSENS}$

Example 1: PC3 DUT on n1 (15 kHz SCS) with 20 MHz BW using NS_01

1. Configure $P_{REFSENS}$ = -93.8 dBm (Table 7.3.2.5-1a) as *Total Cell Power*

Example 2: PC3 DUT on n78 (30 kHz SCS) with 100 MHz BW using NS_01

1. Configure $P_{REFSENS}$ = -85.5 dBm (Table 7.3.2.5-1b) as *Total Cell Power:*
   - $P_{REFSENS} = -96.1 + 10log_{10}\left(\frac{N_{RB}}{24}\right) + TT$
2. CMX TP measurement with TP ≥ 95%

BLER - RX Meas

Run

Downlink

	Overall		NR Cell 0	
			SSB EPRE (dBm)	Total Cell Pow...
			-120.7	-85.5
	Relative	Absolute	Relative	Absolute
ACK	100.00 %	11440	100.00 %	11440
NACK	0.00 %	0	0.00 %	0
DTX	0.00 %	0	0.00 %	0
BLER	0.00 %		0.00 %	
Throughput	Relative	MBit/s	Relative	MBit/s
Average	100.00 %	19.72	100.00 %	19.72
Scheduled	---	19.72	---	19.72

▶ Streams

Uplink

			NR Cell 0	
	Relative	Absolute	Relative	Absolute
CRC Passed	100.00 %	4160	100.00 %	4160
CRC Failed	0.00 %	0	0.00 %	0
DTX	0.00 %	0	0.00 %	0
BLER	0.00 %		0.00 %	
Throughput	Relative	MBit/s	Relative	MBit/s
CRC Passed	100.00 %	5.33	100.00 %	5.33
Scheduled	---	5.33	---	5.33

3.22 7.4 Maximum input level

Purpose:

Maximum input level tests the UE's ability to receive data with a given average throughput for a specified reference measurement channel, under conditions of high signal level, ideal propagation and no added noise. A UE unable to meet the throughput requirement under these conditions will decrease the coverage area near to a gNodeB.

Test Procedure:

1. Follow the steps in chapter 2.1 then choose a Test ID
    a. Test IDs configure RB Allocation and modulation scheme
2. Apply the configuration
3. Set the appropriate DL signal level for *Total Cell Power* as defined in 38.521-1 Table 7.4.5-1 (TT = 0.7 dB up to 3 GHz; else 1 dB):

Channel BW / MHz		3, 5, 10, 15, 20	25, 30, 35, 40, 45, 50	60, 70, 80, 90, 100
Total Cell Power / dBm	64 QAM	-25 – TT	-25 + $10\log_{10}$(BW/20) -TT	-20 - TT
	256 QAM 1024 QAM	-27 – TT	-27 + $10\log_{10}$(BW/20) -TT	-22 - TT

Note: The DL power will be adapted automatically in future FW versions

4. Verify the DUT throughput against test requirements

Verification:

The measured TP shall be ≥ 95% of the maximum possible TP using the specified *Total Cell Power*

Example: DUT on n78 (30 kHz SCS) with 100 MHz BW

1. Configure *Total Cell Power* to -20 dBm: Total Cell Power -20.0 dBm
2. CMX TP measurement with TP ≥ 95%:

BLER - RX Meas

Run

Downlink

	Overall		NR Cell 0	
			SSB EPRE (dBm)	Total Cell Pow...
			-55.2	-20.0
	Relative	Absolute	Relative	Absolute
ACK	100.00 %	11000	100.00 %	11000
NACK	0.00 %	0	0.00 %	0
DTX	0.00 %	0	0.00 %	0
BLER	0.00 %		0.00 %	
Throughput	Relative	MBit/s	Relative	MBit/s
Average	100.00 %	148.82	100.00 %	148.82
Scheduled	---	148.82	---	148.82

4 Literature

[1] 3GPP TS38.521-1 V18.4.0 (2024-11), "5G; NR; User Equipment (UE) conformance specification; Radio transmission and reception; Part 1: Range 1 Standalone".

5 Ordering information

Designation	Type	Order No.
CMX500 Radio Communication Tester	R&S®CMX500	1201.0002K70
CMX500 Basic Assembly	R&S®CMX-PB70H	1222.0676.09
Accelerator Unit	R&S®CMX-B200A	1222.0747.02
CMX Processing Unit	R&S®CMX-B300C	1222.0801.04
CMX RF Unit	R&S®CMX-B600B	1222.0953.03
NR Signaling Enabler Rel.15, Basic Level	R&S®CMX-KS600B	1222.1672.02
NR Signaling Enabler Rel. 15	R&S®CMX-KS600B	1222.1672.02
NR SA FR1 3GPP RF Test Scenarios	R&S®CMX-KC661B	1222.4513.02
NR FR1 measurements	R&S®CMX-KM600	1222.4013.02

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