LTE Downlink Carrier Aggregation RF Measurements with the R&S®CMW500 according to 3GPP TS 36.521-1

Application Note

Products:

- R&S®CMW500

The 3GPP TS 36.521-1 “Radio transmission and reception” LTE User Equipment (UE) conformance specification defines the measurement procedures for LTE terminals with regard to their transmitting characteristics, receiving characteristics and performance requirements as part of the 3G Long Term Evolution (3G LTE) standard.

This application note describes how to use the LTE Frequency Division Duplex (FDD) and Time Division Duplex (TDD) measurement functionality associated with the Downlink Carrier Aggregation feature of the R&S®CMW500 wideband radio communication tester to perform LTE R10 receiver measurements according to this test specification.

ROHDE&SCHWARZ

Application Note

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Table of Contents

1 Introduction

The R&S ®CMW500 signaling and measurement solution can be used to perform all the transmitter and receiver tests specified in TS 36.521-1 for 3GPP Downlink Carrier Aggregation (DL CA). This document provides a step-by-step guide to performing Release-10 DL CA measurements with the R&S®CMW500 LTE callbox according to **3GPP TS 36.521-1 V12.2**, Clause 7. No transmitter test cases are defined for DL CA in V12.2 without UL CA device testing. This description refers to the functionality provided with **Version 3.2.80 of the R&S®CMW500 firmware**. This document will be updated to specify relevant changes resulting from new firmware releases.

This application note (AN) shall function as an extension of application note 1CM94 *"LTE RF Measurements with the R&S®CMW500 according to 3GPP TS 36.521-1"* for R10 Downlink Carrier Aggregation (DL CA) without Uplink Carrier Aggregation (UL CA). It is recommended to read 1CM94 before this AN to gain a basic understanding of ***the R&S®CMW500*** concept of operation.

The tests described here are limited to those without a requirement for complicated external instruments such as spectrum analyzers and filters. Spurious measurements, transmitter intermodulation, and out-of-band blocking tests, for example, are not covered. To see other tests that can be performed with such additional equipment, please refer to the latest R&S®CMW500 capability list found on the CMW customer web:

https://extranet.rohde-schwarz.com

1.1 Understanding Test Case Suffixes

According to **3GPP TS 36.521-1**, DL CA test case numbers must be followed by the suffix ‘A’ (compare to R8). In addition to this suffix, an extension is used to identify various requirements for different kinds of CA. The extensions in **3GPP TS 36.521-1 V12.2** differ from those used in V11.2 and are listed below:

‘.1’ – Intra-band contiguous DL CA and UL CA
‘.2’ – Intra-band contiguous DL CA without UL CA
‘.3’ – Inter-band DL CA without UL CA
‘.4’ – Intra-band non-contiguous DL CA without UL CA

As the test procedure applies equally to all of the above, these digital number suffixes are replaced with ‘.*x*’ in this AN, and the different requirements for each type of DL CA are highlighted.

1.2 Understanding Bandwidth Class

The aggregated transmission bandwidth configuration (ATBC) consists of a number of aggregated physical resource blocks (PRB).

CA bandwidth class indicates a combination of maximum ATBC and a maximum number of component carriers (CC).

Three classes are defined in R10 and R11:

Class A: ATBC ≤ 100, maximum number of CC = 1
Class B: ATBC ≤ 100, maximum number of CC = 2
Class C: 100 < ATBC ≤ 200, maximum number of CC = 2

Test requirements may vary according to bandwidth class, especially for intra-band DL CA.

1.3 Setting Up Downlink Carrier Aggregation (DL CA) Mode

Two signalling unit widebands (B300B) and the KS502 (FDD) / KS552 (TDD) and KS512 software options are required to support 2DL CA testing. Two B510F fading boards and the KE100, KE500 and KS520 software options are needed to test Chapters 8 and 9. Testing of 3 DL CA requires three signalling unit widebands (B300B).

1.3.1 CA Scenario Selection

To activate DL CA, click on the *Scenario* dropdown button on the Signalling *Config* page. The diagram below shows all of the choices available with a CMW outfitted with two signalling unit widebands, four TRx boards and two fading boards. Some options may not appear in the dropdown menu depending on the hardware and software options installed.

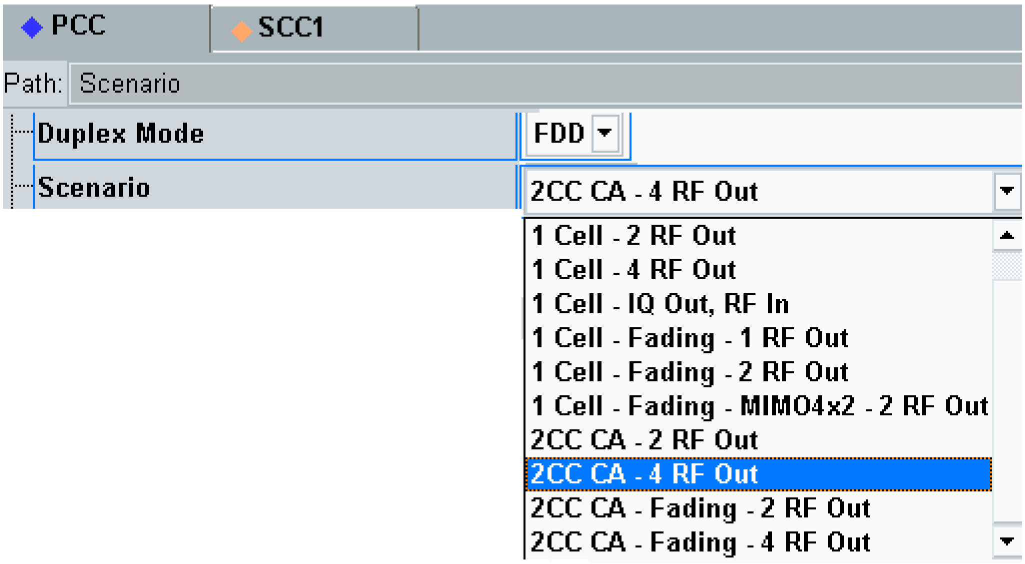


Fig. 1: CA scenario selection.

- 2CC CA – 2 RF Out: both component carriers (CC) can transmit in SISO (TM1) or single layer beamforming (TM7) mode; only two RF channels are required.
- 2CC CA – 4 RF Out: both CCs can transmit in SIMO (TM1), transmit diversity (TM2), 2x2 MIMO (TM3, TM4), single layer or dual layer beamforming (TM7, TM8) mode; four RF channels are required.
- 2CC CA – Fading – 2 RF Out: fading profiles can be activated for 2CC CA – 2 RF Out scenarios. Fading board is required. KE500 is required to activate internal fading profile.
- 2CC CA – Fading – 4 RF Out: fading profiles can be activated for 2CC CA – 4 RF Out scenarios. Fading board is required. KE500 is required to activate internal fading profile.

The SCC1 tab is activated following CA scenario selection.

Click on the SCC1 tab to view all the secondary CC1 (SCC1) settings. It is similar to Primary CC (PCC) configuration page.

The Scenario option can only be selected in Cell ON or Cell OFF. This setting will be greyed out once the mobile phone has been registered with the CMW.

It is recommended to use a CMW with 4 configured RF channels. If the CMW has only 2 RF channels, an external splitter will be needed to feed the signal to all of the receiving antennas. The External Attenuation setting should include the attenuation caused by the external splitter.

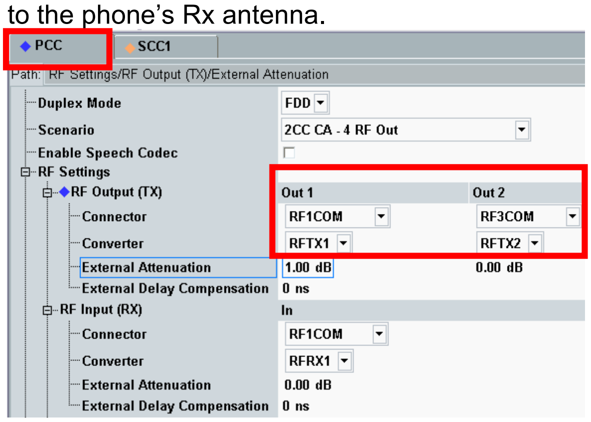
1.3.2 RF port selection

With the Advanced RF frontend, the PCC and SCC signals can be transmitted from the same RF *Connector* port using different RF *Converters*. The *External Attenuation* value can be set separately.

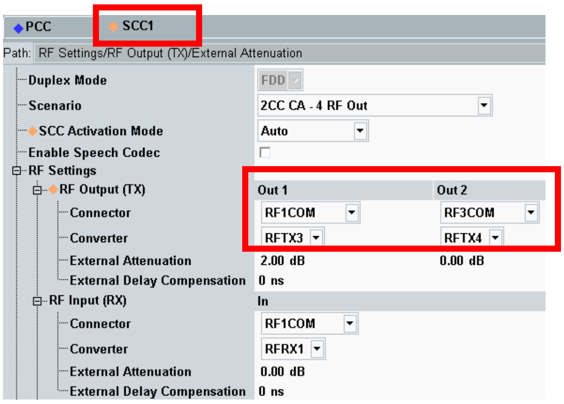
For 2CC CA – 2 RF Out scenarios, the default setting uses the RF1COM for both PCC and SCC.

For 2CC CA – 4 RF Out scenarios, the default setting uses RF1COM and RF2COM for PCC and RF3COM and RF4COM for SCC.

The RF port setting below is recommended for DUTs that support a combined PCC/SCC antenna. RF1COM should be connected to the mobile's Tx/Rx antenna, while RF3COM is linked to the phone's Rx antenna.



a: PCC RF port configuration



b: SCC RF port configuration

c: Connecting the CMW500 to a CA DUT with a dual-antenna design

Fig. 2: RF settings for PCC and SCC and the connection setup between CMW500 and DUT.

This AN describe DL CA testing only. If the mobile phone under test also supports UL CA, *the RF Input (Rx)* for SCC1 should be configured to a different RF *Converter*.

1.3.3 SCC Settings

For the R&S CMW500 LTE firmware V3.2.80, there are no limitations on PCC SCC band combinations as long the same Duplex is used. The SCC band, channel, bandwidth and connection type are all configurable via the SCC tab.

On the SCC1 Configuration page, set the *SCC Activation Mode* to '*Auto*' or '*Manual*'. The default value is '*Auto.'*
If '*Manual'* is selected, the procedure for turning on / off SCC, SCC add / delete RRC and SCC activate / deactivate MAC needs to be done manually. Fig. 4 and Fig. 5 show the buttons to press and sequence for this. '*Auto*' is the recommended setting for all purposes except troubleshooting.

SCC Activation Mode can only be changed in Cell ON or Cell OFF. This setting will be greyed out once the mobile phone has been registered with the CMW.

The SCC State should be "*MAC Activated*" before starting a throughput test.

Fig. 3 shows the LTE signaling screen when SCC is connected.

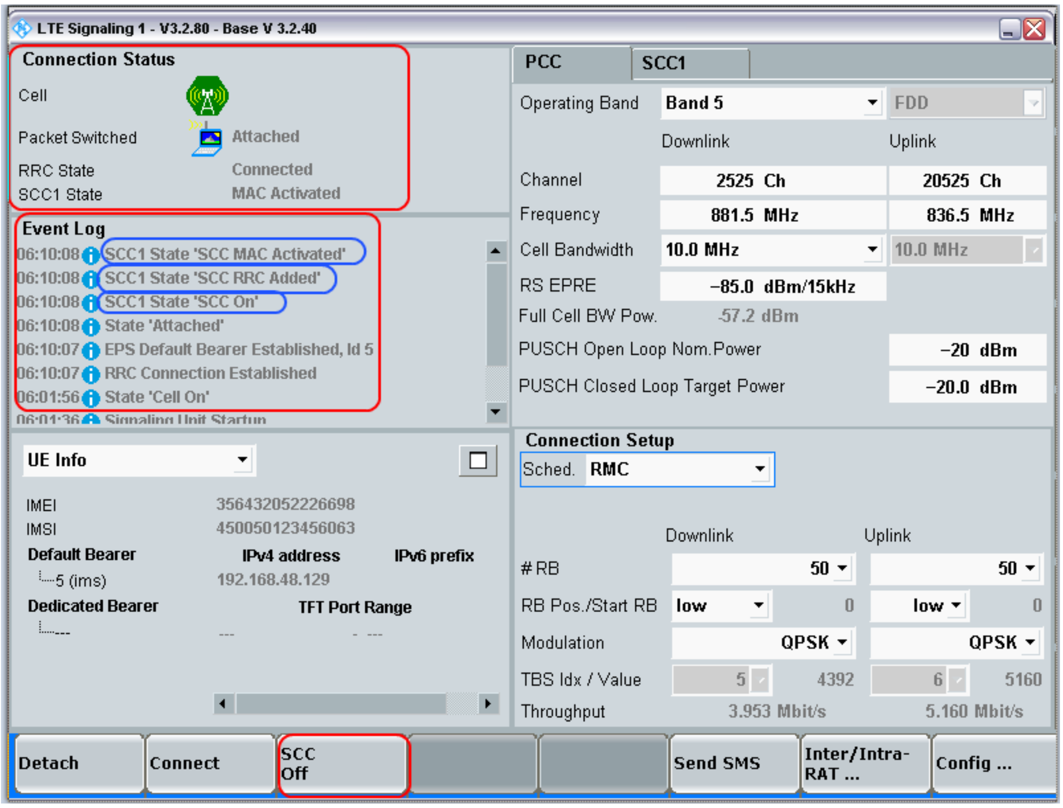


Fig. 3: SCC activated.

1. 2. 3.

Fig. 4: SCC manual activation process.

1. 2. 3.

Fig. 5: SCC manual deactivation process.

1.4 Generic Setup for DL CA

1.4.1 Physical Cell ID

According to 36.521, section 7.1 for CA tests, Cell ID = 0 applies to P-Cell, and Cell ID = 1 is used for S-Cell. This setting is located under *Physical Cell Setup*. The default value in LTE Firmware V3.2.80 is determined by specification.

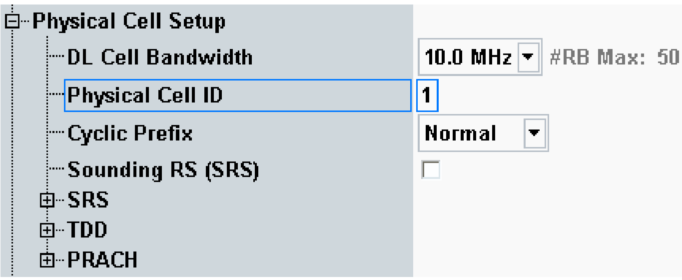


Fig. 6: Physical Cell ID setting.

1.4.2 OCNG

OCNG should be activated during all tests required for DL CA. It can be found under *Downlink Power Levels* and should be activated for both PCC and SCC.

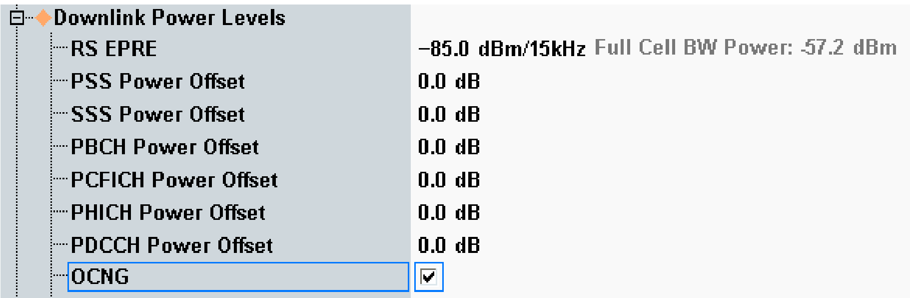


Fig. 7: OCNG activation.

1.4.3 MIMO Settings

The *MIMO Settings* are located in the *Connection* category. Prior to testing, the correct *Transmission Mode* and *DCI Format* must be set.

Receiver characteristics testing, (TM1) is used for all of chapter 7. For chapter 8 and 9, this setting varies according to test case and is specified in each.

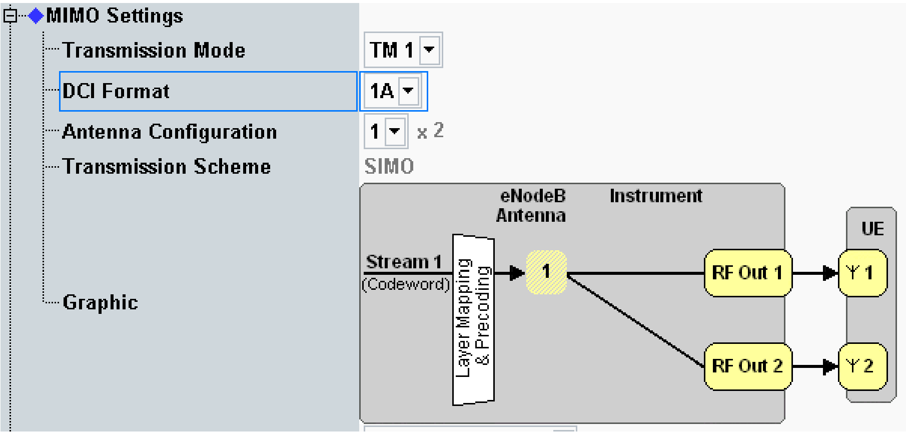


Fig. 8: MIMO settings.

Only *TM1* and *TM8* can be supported if the '*2CC CA – 2 RF Out' scenario* is selected.
Once the mobile phone has been registered with the CMW, possibilities for changing the *Transmission Mode* and *DCI Format* are limited depending on the *Duplex* and *Scenario* settings. It is therefore recommended to properly set the *Duplex* and Scenario prior to switching on the phone.

1.5 Throughput Measurement

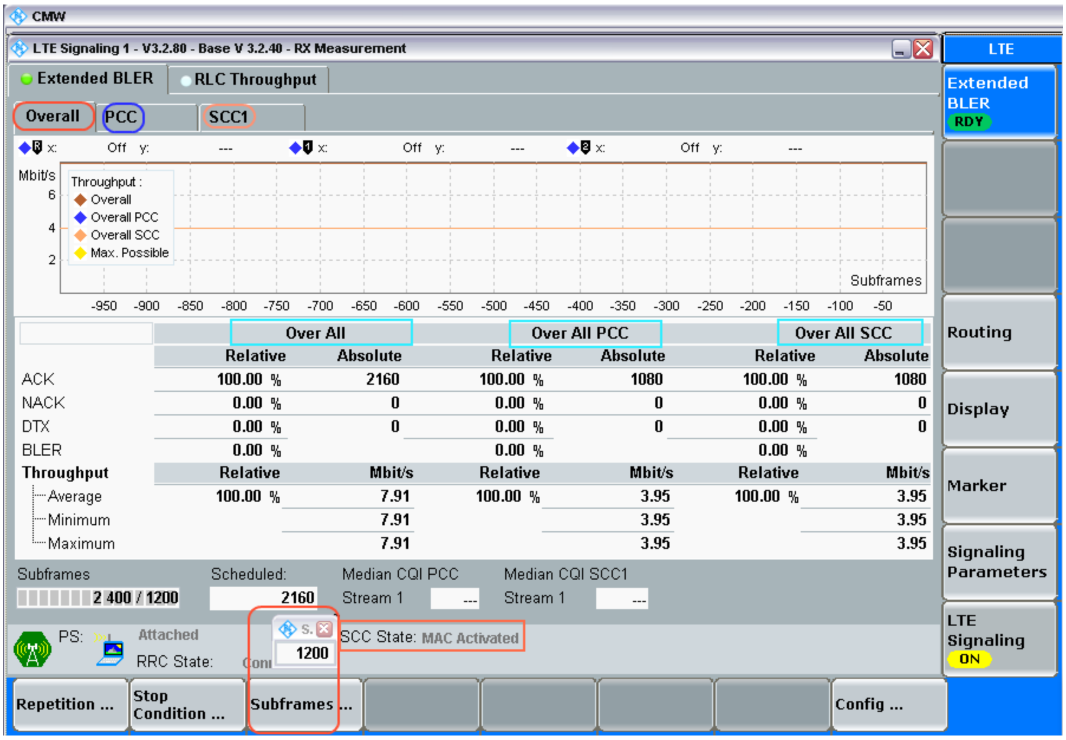


Fig. 9: Extended BLER (throughput) measurement result.

The CA throughput measurement display is similar to that for R8 measurement and features additional tabs with detailed Overall, PCC and SCC results. Click on each tab to view these details.

1.5.1 BLER Error Ratio Calculation

1.5.1.1 Error Ratio Calculation for Receiver Characteristics

According to TS 36.521-1 Annex G.2. Annex G.2A for CA, (NACK + DTX) / (NACK+ DTX + ACK) is the error ratio (ER) for receiver characteristics testing, and it is based on the standard concept defined in G.2.

The error ratio formula in the CMW500 can be selected under *LTE RX Meas. Page* > *Extended BLER* > *Config* page as shown in the figure below. The default setting is *"(NACK + DTX) / (NACK+ DTX + ACK)*".

No early pass or early fail should be implemented for receiver characteristics testing. The *Stop Condition* should be '*None*' (default value).

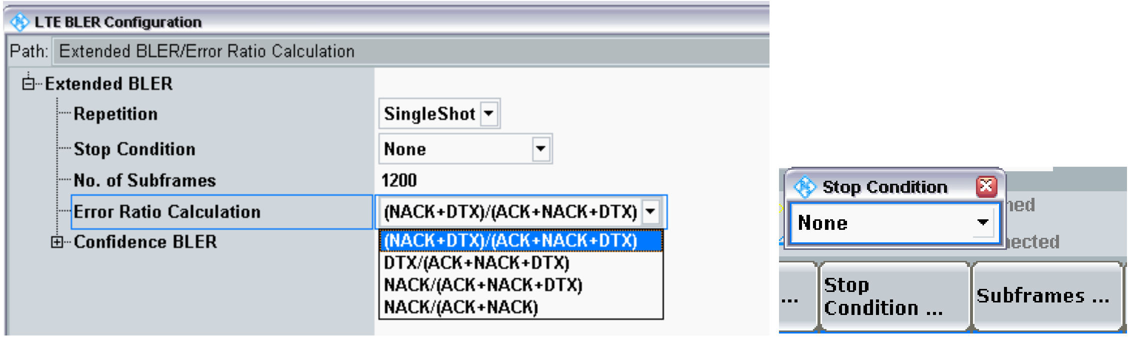


Fig. 10: Error ratio calculation formula.

2 Receiver Characteristics

2.1 Generic Test Description for Receive Tests

The receiver test items listed in Table 1 are described in this application note. The CMW500 supports the rest of the test items according to the specification. They are not listed, however, in this application note, as they require external filters or spectrum analyzers and describing the relevant procedures would exceed the scope of this short application note. Users are encouraged to contact their local sales representative regarding the pre-conformance / conformance test system provided by Rohde-Schwarz for those tests.

Table 1: Receiver test cases described in this application note.

	TS 36.521-1 Section	Test case	*Additional generator required*
1	7.3A	Reference sensitivity level for CA	*No*
2	7.4A	Maximum input level for CA	*No*
3	7.5A	Adjacent channel selectivity for CA	*Yes/ LTE Signal(4TRx required)*
4	7.6.1A	In-band blocking for CA	*Yes/ LTE Signal(4TRx required)*
5	7.6.3A	Narrowband blocking for CA	*Yes/ CW Signal(4TRx required)*
6	7.8.1A	Wideband intermodulation for CA	*Yes/CW & LTE Signal (4TRx required)*

The example measurement screenshots in this chapter were taken based on a device supporting CA_3A-5A (10M + 10M) with a combined PCC/SCC antenna.

2.1.1 Interference Description

Extra interference that coexists with the LTE communication signal is required to perform test cases 7*.5A, 7.6.1A, 7.6.3A* and *7.8.1A*, and there are many ways of generating the necessary interference signal. It is possible, for instance, to use an external generator such as an R&S®SMU/SMW/SMBV to create the interference signal. Alternatively, it is possible to generate the interference signal with the third RF channel of the R&S®CMW500 so as to avoid the need for an external instrument.

With the internal generator method, only the '*2CC CA – 2 RF Out*' scenario should be selected. This leaves the third and the fourth RF channels for interference signal generation. In this case, the user needs a combiner to merge the useful signal and interference signal as well as a power splitter to distribute the combined signal to both receiving antennas. Proper RF attenuation needs to be set in CMW500 to ensure the signal received at the DUT receiver antenna port has the correct power according to the specification. An example of this setup is shown in Fig. 11, but it is not applicable if the DUT's PCC and SCC antennas are separated.

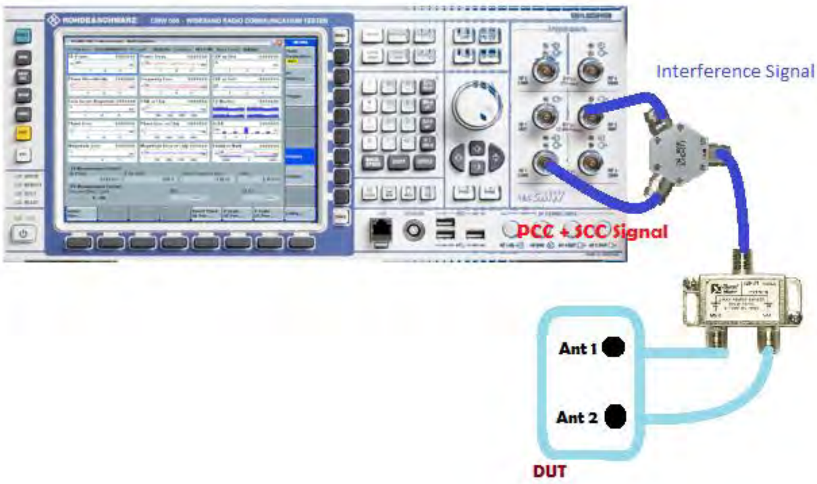


Fig. 11: Setup for testing with an internal interference generator.

Detailed interference settings are described in the separate test steps for the test cases. Please note that the R&S®CMW500 should use the GPRF generator (ARB mode) to create the interference signal in test cases 7.5A and 7.6.1A. This means that a number of ARB files are required. Additionally, users are encouraged to pay close attention to the cable-loss calibration in this setup, as it varies depending on the type of combiner used.

Two interference signals are required for 7.8.1. One is a CW signal, and the other is an ARB signal, meaning a total of four 4 RF signals must be generated, including the LTE signal. Only CMWs equipped with four TRx channels can perform this test.

Interference signal frequency setting details for each CA configuration are available in the CMWRun report both in Demo mode and real execution cases.

2.1.2 Uplink Power Settings

A typical note for CA receiver test cases is "The transmitter shall be set to 4dB below P_{CMAX_L} or $P_{CMAX\_L\_CA}$ as defined in Clause 6.2.5A". P_{CMAX_L} applies to DUTs supporting DL CA only, and $P_{CMAX\_L\_CA}$ applies to DUTs supporting DL CA and UL CA.

For DL CA-only DUTs, the formula for calculating the uplink power for UE transmission is the same as the R8 requirements. As for all bands, the uplink RB number specified in TS 36.521-1 receiver tests for CA satisfies the 1 dB maximum power reduction defined in TS 36.521-1, Table 6.2.3.3-1. The P_{CMAX_L} is 22 dBm or 30 dBm for HPUE if there is no applicable additional maximum power reduction. Notes 2,5,6 in TS 36.521-1, Table 6.2.2.3-1 do not apply.

For DUTs that also supporting UL CA, the power reduction should be referred to TS 36.521-1, Table 6.2.3A.*x*.3-1 (where *x* refers to a different DL CA as mentioned in section 1.1).

A similar concept for the CMW500 close loop power setting is referred to in 1CM94 for DL CA-only DUTs. This close loop power setting should be (P_{CMAX_L} – 4 – 1.7) if the carrier frequency is f ≤ 3.0GHz or (P_{CMAX_L} – 4 – 2) if the carrier frequency is 3.0GHz < f ≤ 4.2GHz.

2.1.3 Filter Coefficient Setting

The filter coefficient should be set as ‘fc8’ for all receiver tests. It can be modified in a connected state.

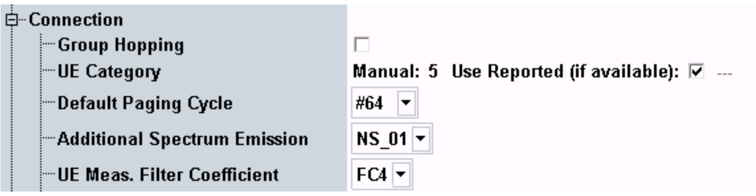


Fig. 12: Filter coefficient setting.

2.1.4 Uplink Resource Block Allocation

If the DUT does not support UL CA, the uplink resource block configuration follows TS 36.521-1, Table 7.3.5-2.
If the DUT supports UL CA, the uplink resource block configuration follows the test specific Test Configuration Table defined in the relevant test cases.

2.2 Reference Sensitivity Level for CA (TS 36.521-1, 7.3A.*x*)

The purpose of this test is to verify the CA-supported UE’s ability to receive data at a given average throughput for a specified reference measurement channel under conditions involving a low signal level, ideal propagation and no added noise.
An UE that is unable to meet the throughput requirement under these conditions will decrease the effective coverage area of an e-NodeB.

2.2.1 Test Description

The purpose of the test is to verify the sensitivity level with QPSK modulation and full RB allocation in the downlink.

The minimum conformance requirement for all the CA band class combinations is defined in TS 36.521-1, Chapter 7.3A.1.3. The minimum number of samples defined is found in TS 36.521-1, Annex G.2A (1003 per CC).

Generally speaking, the cell full bandwidth (BW) power should follow the formula below. Exceptions are permitted for certain CA configurations. The exception conditions are defined in TS 36.521-1, Tables 7.3A.1.3-0a and 7.3A.1.3-0b. New versions may include more exception definitions.

$\boldsymbol{P_{REFSENS\_CA} = P_{REFSENS\_R8} - \Delta RIB, c}$ ------- ***Equation 1***

Where
- P_{refsen_R8} refers to 3GPP TS 36.521-1, Table 7.3.5-1.
$-\ \Delta\mathrm{RIB}, c$ refers to 3GPP TS 36.521-1, Tables 7.3A.1.3-0 and 7.3A.1.3-2. The value should be 0 if the CA configuration is not listed in the table.

A network signalling value must be applied for certain CA configurations (summarized in the table below). This network signaling value should be applied only when the PCC is the *Uplink Band* listed in the table. In all other cases, it should be *NS_01* e.g., for CA_4A-12A, the *PCC Network Signaling* value should be "*NS_06*" only when the PCC is band 12 and the SCC is band 4. The *PCC Network Signaling* value should be "*NS_01*".when the PCC is band 4 and the SCC is band 12.

UL resource allocation is defined in *Test Description* for each CA configuration (TS 36.521-1 TC7.3A.*x*.4). It generally follows Table 7.3.3-2 for definitions not provided in the specification.

Table 2: Summary of network signalling (NS) settings for specified CA configuration.

E-UTRA CA Configuration	Uplink Band	Network Signalling value
CA_4A-12A	12	NS_06
CA_4A-17A	17	NS_06
CA_2A-29A	2	NS_03

2.2.2 Test Procedure

For general test conditions and settings, please refer to Section 2.1 of this application note.

Step 1. Preset the instrument.
Step 2. Set *Duplex* mode.
Step 3. If the DUT has combined antennas for the PCC and SCC, connect the DUT to the CMW500 as shown in Fig. 2 and set the *Scenario* to "*2CC CA – 4 RF Out*" or "*2CC CA – 2 RF Out*". as depicted in Fig. 11. If the DUT has separate PCC and SCC antennas, connect each RF port to the corresponding DUT antenna port and select the appropriate scenario for the connection.
Step 4. Set the *RF Output Connector/Converter* and *RF Input Connector/Converter* accordingly.
Step 5. Set the correct *External Attenuation* for each port and cell.
Step 6. Set the *Transmission Mode* to '*TM1*' and the *DCI Format* to '*1A*'.
Step 7. Set the *PCC network signalling values* to match those specified in Table 2. Use "*NS_01*" for bands not listed in this table (e.g. CA_3A-5A).
Step 8. Enable the LTE cell. Power on the LTE UE so that it attaches to the network and press *Connect* to establish the connection.
Step 9. Set the testing *Cell Bandwidth, DL Channel*, *Downlink and Uplink #RB*, *Modulation* and *RB Pos./Start RB* for both the PCC and SCC (defined in TS 36.521-1 7.3A.*x*.4.1 *Initial conditions where x* represents the number used for various types of CA configurations).
Step 10. Set *Active TPC Setup* to *Max Power* to ensure that the UE power reaches its maximum.
Step 11. Enable *OCNG*. This can be done before powering on the DUT.
Step 12. Go to the *LTE RX Meas.* pPage and set *Subframes >= 1200* (1200 is the next smallest number greater than 1003) in accordance with the specification.
Step 13. Set the DL EPRE to Resource Element power based on the calculated $P_{REFSENS\_CA}$, from $\boldsymbol{P_{REFSENS\_CA} = P_{REFSENS\_R8} - \Delta RIB,c}$ ------- Equation 1 for both the PCC and SCC. Please be aware that $P_{REFSENS\_CA}$ is the total cell power for the corresponding PCC or SCC. This has a fixed relationship with the *RS EPRE* (reference signal energy per resource element) used in the R&S®CMW500, which is:

$$P_{REFSENS\_CA} = \text{RS EPRE} + 10 * \log10(\text{N\_RE})$$

N_RE is the number of resource elements (12 *[number of RBs]) and the number of RBs depends on the DL PCC / SCC cell bandwidth.
Consequently, a Band 3 10 MHz-bandwidth RS EPRE needs to be set to *–121.1 dBm* to achieve $P_{REFSENS}$ = –93.3 dBm. (–93.3 dBm – 10*log10(600) = –121.1 dBm)

Measure the throughput achieved under these conditions. In this example, the throughput is *7.91 Mbps*, which represents 100 % of the scheduled throughput according to the *RMC* settings and can be seen directly on the measurement screen.

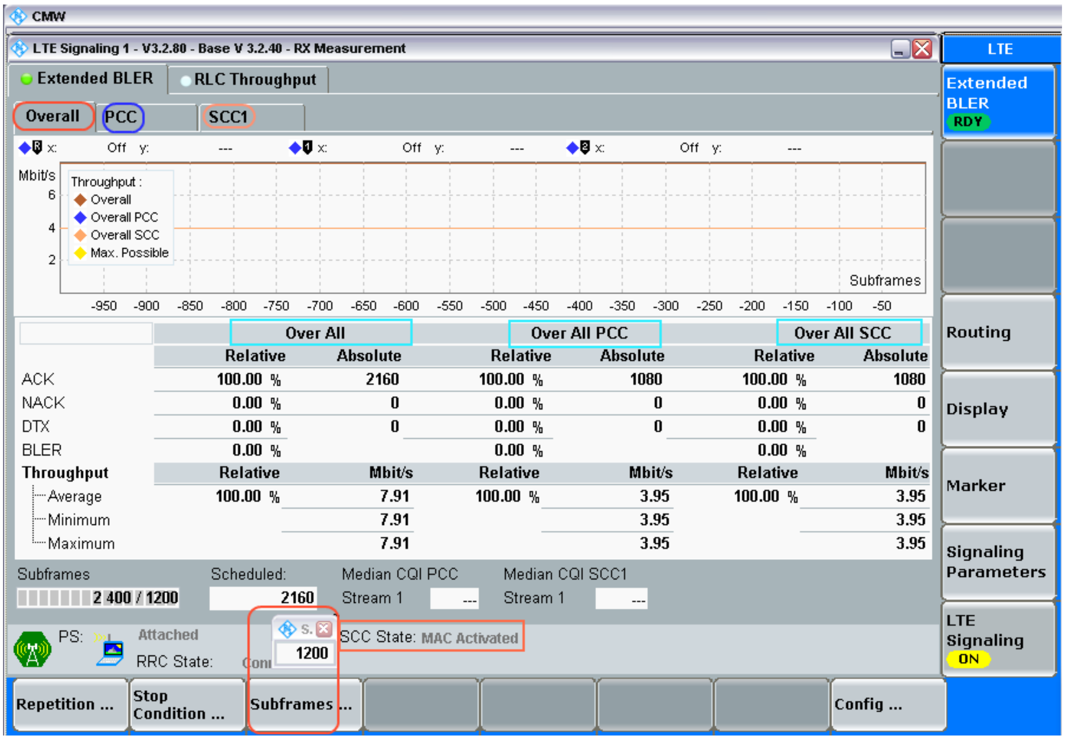


Fig. 13: Measurement screen of the block error rate (BLER) test for reference sensitivity testing.

2.2.3 Test Requirements

The throughput must be ≥ 95 % of the maximum throughput specified for the reference measurement channels under the parameters provided in TS 36.521-1, Table 7.3A.x.5-1.

2.3 Maximum Input Level for CA (TS 36.521-1, 7.4A)

The maximum input level test evaluates the CA-supported UE’s ability to receive data at a given average throughput for a specified reference measurement channel under conditions involving a high signal level, ideal propagation and no added noise.
An UE that is unable to meet the throughput requirement under these conditions will decrease the coverage area near an e-NodeB.

2.3.1 Test Description

This test is carried out with 64 QAM modulation and full RB allocation in the downlink for both PCC and SCC. The values to be selected for the bandwidth, frequency and RMC, along with details on the UL RB allocations, are defined in TS 36.521-1, Table 7.4A.x.4.1-1.

For carrier aggregation, UE maximum input level is defined as the mean power received at the UE antenna port over the aggregated channel bandwidth, at which the specified relative throughput shall meet or exceed the minimum requirements for the specified reference measurement channel over each component carrier. In summary, the total aggregated DL transmitting cell power with all CCs for bandwidth class A and C UEs should be -22.7dBm. For inter-band DL CA, the DL transmitting power should be -25.7dBm per CC. For bandwidth class B UEs, the aggregated DL Cell power with all CCs should be -25.7dBm.

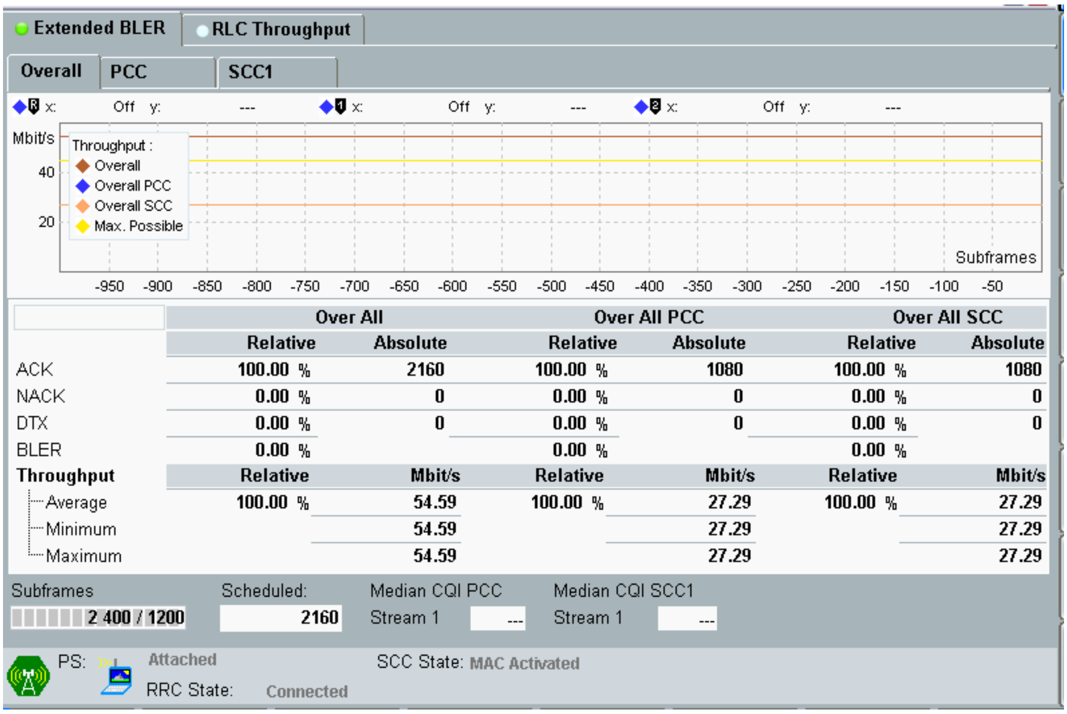
The UE transmitter power should be set to 4dB below P_{CMAX_L} or $P_{CMAX\_L\_CA}$ as defined in Clause 6.2.5A. The CMW500 close loop power setting is explained in section 2.1.2.

2.3.2 Test Procedure

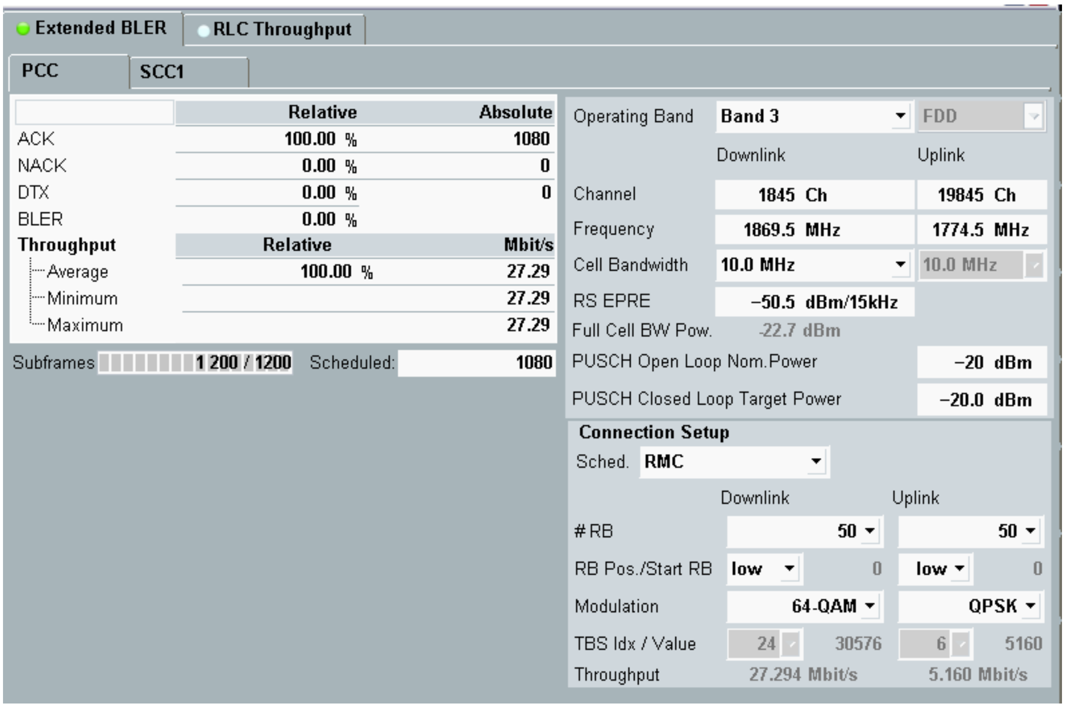
For general test conditions and settings, please refer to Section 2.1 of this application note.

Step 1. Preset the instrument.
Step 2. Set *Duplex* Mode.
Step 3. If the DUT has combined antennas for the PCC and SCC, connect the DUT to the CMW500 as shown in Fig. 2 and set the *Scenario* to "*2CC CA – 4 RF Out*" or "*2CC CA – 2 RF Out*" as shown in as Fig. 11. If the DUT has separate antennas for PCC and SCC, connect each RF port to the corresponding DUT antenna port and select the appropriate scenario for the connection.
Step 4. Set the *RF Output Connector/Converter* and *RF Input Connector/Converter* accordingly.
Step 5. Set the correct *External Attenuation* for each port and cell.
Step 6. Set the *Transmission Mode* to '*TM1*' and the *DCI Format to* '*1A*'.
Step 7. Enable the LTE cell. Power on the LTE UE so that it attaches to the network and press *Connect* to establish the connection.
Step 8. Set the testing *Cell Bandwidth, DL Channel*, *Downlink and Uplink #RB*, *Modulation* and *RB Pos./Start RB* for both the PCC and SCC (defined in TS 36.521-1 7.4A.*x*.4.1 *Initial conditions* where *x* represents the number used for various types of CA configurations).
Step 9. Set *Active TPC Setup* to *Close Loop* and *Closed Loop Target Power, 16.3dBm* (calculated according to Section *2.1.2*) to ensure that the UE power reaches its required range.
Step 10. Enable *OCNG*. This can be done before powering on the DUT.
Step 11. Go to the *LTE RX Meas.* page and set *Subframes >= 1200* (1200 is the next smallest number greater than 1003) in accordance with the specification.
Step 12. Adjust the DL *RS EPRE* so that the *Full Cell BW Pow.* indicates *-25.7dBm* (*RS EPRE = -50.5dBm/15kHz* for 10M BW) for both the PCC and SCC.

Measure the throughput achieved under these conditions. In this example, the throughput is *54.59 Mbps*, which represents 100% of the scheduled throughput according to the *RMC* settings. The *Throughput* rate can be found directly on the measurement screen.



a. Full screen view for throughput



b. Full screen view for BLER

Fig. 14: Measurement screen of the block error rate (BLER) test for maximum input level testing.

2.3.3 Test Requirements

The throughput must be ≥ 95 % of the maximum throughput specified for the reference measurement channels under the parameters provided in TS 36.521-1, Table 7.4A.x.5-1.

2.4 Adjacent Channel Selectivity for CA (TS 36.521-1, 7.5A)

Adjacent channel selectivity (ACS) for CA tests the UE's ability to receive data at a given average throughput for a specified reference measurement channel. This occurs in the presence of an adjacent channel signal at a given frequency offset from the assigned channel's center frequency under conditions of ideal propagation and without added noise.

An UE that is unable to meet the throughput requirement under these conditions will decrease the coverage area when other e-NodeB transmitters are present on the adjacent channel.

2.4.1 Test Description

This test is carried out with QPSK modulation and full RB allocation in the downlink for both PCC and SCC. The values to be selected for bandwidth, frequency and RMC, as well as UL RB allocation details are defined in TS 36.521-1, Table 7.5A.x.4.1-1. The interference signal is a modulated LTE signal.

For inter-band CA, the interference signal setting is relative to the SCC as specified in TS 36.521-1, Section 7.5A.3.5. For Case 1, the Interferer power should be $P_{REFSENS\_CA\ \_SCC}$ +45.5, where $P_{REFSENS\_CA\_SCC}$ is calculated according to $\boldsymbol{P_{REFSENS\_CA} = P_{REFSENS\_R8} - \Delta RIB,c}$ ------- Equation 1. Interferer frequency setting details are defined in TS 36.521-1, Tables 7.5A.3.5-2 and 7.5A.3.5-3.

For intra-band Contiguous CA, the interferer signal frequency is an adjacent channel on either side of the aggregated downlink signal. It has a specified frequency offset and its power is relative to the total aggregated power for Case 1. The power level should be Aggregated Power + 22.5 dB for Case 1. The frequency offset is dependent of the adjacent CC calculated in Table 3.

Table 3: Interference frequency settings.

Rx Parameter	Units	Channel Bandwidth (SCC for inter-band CA or adjacent CC for intra-band contiguous CA)					
		1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
$BW_{Interferer}$	MHz	1.4	3	5	5	5	5
$F_{Interferer}$ (offset from SCC for inter-band CA or adjacent CC for intra-band contiguous CA)	MHz	**1.4+0.0025 /** -1.4-0.0025	**3+0.0075 /** -3-0.0075	**5+0.0025 /** -5-0.0025	**7.5+0.0075 /** -7.5-0.0075	**10+0.0125 /** -10-0.0125	**12.5+0.0025 /** -12.5-0.0025

The interference frequency details are yet to be defined for intra-band noncontiguous CA.

For Case 1, the UE transmitter power should be set to 4dB below P_{CMAX_L} or $P_{CMAX\_L\_CA}$ as defined in Clause 6.2.5A. The CMW500 close loop power setting is explained in section 2.1.2.

For case 2, the UE transmitter power should be set to 24dB below P_{CMAX_L} or $P_{CMAX\_L\_CA}$ as defined in Clause 6.2.5A.

The interference signal offset is understood as specified in the *1CM94* TC7.5 Test Description.

Section 2.1.1 describes procedures for connecting the DUT to the CMW500.

For Case 1, the DL cell power for each CC should be $P_{REFSENS\_CA}$+14, where $P_{REFSENS\_CA}$ is the calculated CC cell power according to $\boldsymbol{P_{REFSENS\_CA} = P_{REFSENS\_R8} - \Delta RIB,c}$ ------- Equation 1.

2.4.2 Test Procedure

For general test conditions and settings, please refer to Section 2.1 of this application note.

For details on setting up the interference signal, please refer to Section 2.1.1 of this application note. The detailed interference signal settings are as shown in Fig. 15.

Upon completion of instrument *Preset*,

1. Prepare the interferer signal:
   a. Activate *General Purpose RF Generator 1*
   b. Set the appropriate routing and attenuation
   c. Load the waveform:
      Set the *Baseband Mode* to *ARB*.
      Load the interferer waveform according the bandwidth. The same three free interferer waveforms are used for R8 receiver testing cases, which are downloadable with application note 1CM94.

      I_B014_free.wv – Bandwidth = 1.4 MHz
      I_B030_free.wv – Bandwidth = 3 MHz
      I_B050_free.wv – Bandwidth = 5 MHz

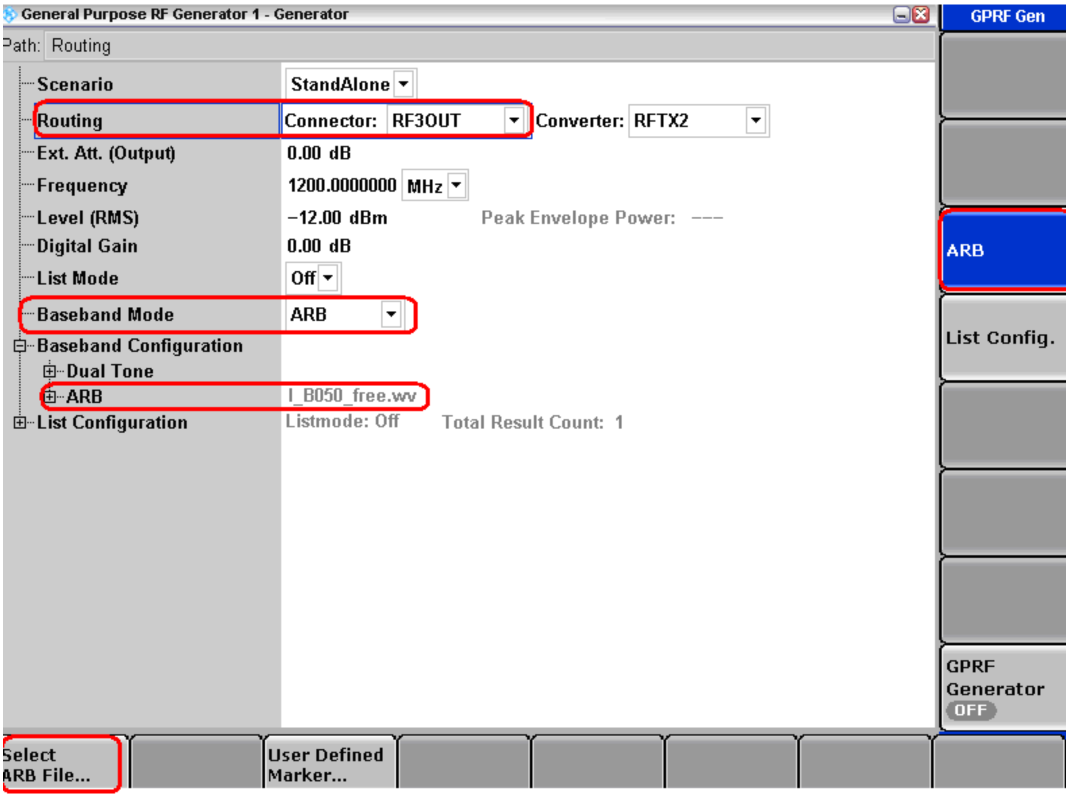


Fig. 15: Interference signal settings.

2. Set up the LTE signalling and start the test:

Step 1. Set *Duplex* Mode.

Step 2. If the DUT has combined antennas for the PCC and SCC, connect the DUT to the CMW500 as shown in Fig. 11 and set the Scenario to "*2CC CA – 2 RF Out*".

Step 3. Set the *RF Output Connector/Converter* and *RF Input Connector/Converter* accordingly.

Step 4. Set the correct *External Attenuation* for each port and cell.
Step 5. Set the *Transmission Mode* to '*TM1*' and the *DCI Format to* '*1A*'.
Step 6. Enable the LTE cell. Power on the LTE UE so that it attaches to the network and press *Connect* to establish the connection.
Step 7. Set the testing *Cell Bandwidth, DL Channel*, *Downlink and Uplink #RB*, *Modulation* and *RB Pos./Start RB* for both the PCC and SCC (TS 36.521-1 7.5A.*x*.4.1 *Initial conditions* where *x* represents the number used for various types of CA configurations).
Step 8. Set *Active TPC Setup* to *Close Loop* and *Closed Loop Target Power, 16.3dBm* (calculated according to Section *2.1.2*) to ensure that the UE power reaches its required range.
Step 9. Enable *OCNG*. This can be done before powering on the DUT.
Step 10. Go to the *LTE RX Meas.* page and set *Subframes >= 1200* (1200 is the next smallest number greater than 1003) in accordance with the specification.
Step 11. Go to *GPRF Sig. 1,* set the correct *Frequency* and *Level(RMS)* and turn on the signal.
Step 12. Adjust the DL *RS EPRE* so that the *Full Cell BW Pow.* indicates ($P_{REFSENS\_CA}$ + 14 dB) for both the PCC and SCC.
Step 13. Measure the throughput achieved under these conditions. For a measurement window display example, refer to Fig. 14.
Step 14. Change the *GPRF Sig. 1 Frequency* and carry out the measurement again. This concludes Test Case 1.
Step 15. Change the *GPRF Sig. 1 Level* to *-25dBm* and the LTE DL *RS EPRE* so that the *Full Cell BW Pow.* indicates the required cell power (-56.5dBm for Inter-band CA) for both the PCC and SCC.
Step 16. Measure the throughput achieved under these conditions. For measurement window display example, refer to Fig. 14.
Step 17. Change the *GPRF Sig. 1 Frequency* and carry out the measurement again. This concludes Test Case 2.

2.4.3 Test Requirements

The throughput must be ≥ 95 % of the maximum throughput specified for the reference measurement channels under the parameters provided in TS 36.521-1, Tables 7.5A.x.5-2 and 7.5A.x.5-3.

2.5 In-Band Blocking for CA (TS 36.521-1, 7.6.1A)

In-band blocking is defined for unwanted interference signals within a range extending 15 MHz above and below the UE receive band. Within this range, the relative throughput must meet or exceed the requirements for the specified measurement channels.
The absence of in-band blocking capabilities decreases the coverage area when other e-NodeB transmitters are present (except in adjacent channels and for spurious response).

2.5.1 Test Description

This test is carried out with QPSK modulation and full RB allocation in the downlink for both the PCC and SCC. The values to be selected for bandwidth, frequency and RMC as well as UL RB allocation details are defined in TS 36.521-1, Table 7.6.1A.x.4.1-1.

The interference in this test is an LTE signal with the interference settings specified in TS 36.521-1, Tables 7.6.1A.x.5-1 and 7.6.1A.x.5-2. The interference frequency should be set at multiple test points within +/– 15 MHz of the UE receive band following the same testing concept as TC7.6.1 for R8. The frequency gap between the test points should equal the bandwidth of the interferer.

Although their descriptions differ slightly, the principle behind interferer signal frequency offsets for inter-band CA and intra-band contiguous CA is the same.

The UE transmitter power should be set to 4dB below P_{CMAX_L} or $P_{CMAX\_L\_CA}$ as defined in Clause 6.2.5A. The CMW500 close loop power setting is explained in section 2.1.2.

The DL cell power for each CC should be $P_{REFSENS\_CA}$ plus the channel bandwidth specific value defined in TS 36.521-1, Table 7.6.1A.x.5-1, where $P_{REFSENS\_CA}$ is the calculated CC cell power derived from $\boldsymbol{P_{REFSENS\_CA} = P_{REFSENS\_R8} - \Delta RIB,c}$ ------- Equation 1.

Table 4: In-band blocking parameters for intra-band contiguous CA (source: TS 36.521-1, Table 7.6.1A.1.5-1, Table 7.6.1A.1.5-2).

Rx Parameter	**Units**	**CA Bandwidth Class**				
		B	**C**	**D**	**E**	**F**
Power per CC in aggregated transmission bandwidth configuration	dBm	REFSENS + CA Bandwidth Class Specific Value Below				
			12			
$BW_{Interferer}$	MHz		5			
$F_{Ioffset,\ case\ 1}$	MHz		7.5			
$F_{Ioffset,\ case\ 2}$	MHz		12.5			

CA Configuration	**Parameter**	**Unit**	**Case 1**	**Case 2**
	$P_{Interferer}$	dBm	-56	-44
	$F_{Interferer}$	MHz	$=-F_{offset} - F_{Ioffset,case\ 1}$ & $=+F_{offset} + F_{Ioffset,case\ 1}$	$\leq -F_{offset} - F_{Ioffset,case\ 2}$ & $\geq +F_{offset} + F_{Ioffset,case\ 2}$
CA_1C, CA_7C, CA_38C, CA_39C,CA_40C,CA_41C	$F_{Interferer}$ (Range)	MHz	(Note 2)	$F_{DL\_low} - 15$ to $F_{DL\_high} + 15$
Note 1: For certain bands, the unwanted modulated interfering signal may not fall inside the UE receive bandwithin the 15 MHz below or above the UE receive band. Note 2: For each carrier frequency, the requirement is valid for two frequencies: a. Carrier frequency $-F_{offset} - F_{Ioffset,\ case\ 1}$ b. Carrier frequency $+F_{offset} + F_{Ioffset,\ case\ 1}$ Note 3: F_{offset} offset from the frequency of the adjacent CC being tested to the edge of aggregated channel bandwidth. Note 4: The $F_{interferer}$ (offset) is relative to the frequency of the adjacent CC being tested should be further adjusted to $\lfloor F_{interferer}/0.015+0.5 \rfloor 0.015+0.0075$ MHz to be offset from the sub-carrier raster for interferer signal above the wanted signal and adjusted to $\lfloor F_{interferer}/0.015+0.5 \rfloor 0.015-0.0075$ MHz to be offset from the sub-carrier raster for interferer signal below the wanted signal.				

Table 5: In-band blocking parameters for inter-band CA (source: TS 36.521-1, Table 7.6.1A.3.5-1, Table 7.6.1A.3.5-2).

Rx Parameter	**Units**	**Channel Bandwidth**					
		1.4 MHz	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
Power in transmission bandwidth configuration for each CC	dBm	REFSENS + Channel Bandwidth Specific Value Below					
		6	6	6	6	7	9

$BW_{Interferer}$	MHz	1.4	3	5	5	5	5
$F_{Ioffset, case 1}$	MHz	2.1+0.0125	4.5+0.0075	7.5+0.0125	7.5+0.0025	7.5+0.0075	7.5+0.0125
$F_{Ioffset, case 2}$	MHz	3.5+0.0075	7.5+0.0075	12.5+0.0075	12.5+0.0125	12.5+0.0025	12.5+0.0075

E-UTRA SCC Band	Parameter	Unit	Case 1	Case 2	Case 3	Case 4
	$P_{Interferer}$	dBm	-56	-44	-30	[-30]
	$F_{Interferer}$ (offset from SCC)	MHz	=-BW/2 – $F_{Ioffset,case 1}$ & =+BW/2 + $F_{Ioffset,case 1}$	≤-BW/2 – $F_{Ioffset,case 2}$ & ≥+BW/2 + $F_{Ioffset,case 2}$	-BW/2 – 15 & -BW/2 – 9	-BW/2 – 10
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 18, 19, 20, 21, 22, 23, 25, 26, 33, 34, 35, 36, 37, 38 ,39, 40, 41	$F_{Interferer}$	MHz	(Note 2)	F_{DL_low} – 15 to F_{DL_high} + 15		
12	$F_{Interferer}$	MHz	(Note 2)	F_{DL_low} – 10 to F_{DL_high} + 15		F_{DL_low} – 10
17	$F_{Interferer}$	MHz	(Note 2)	F_{DL_low} – 9 to F_{DL_high} + 15	F_{DL_low} – 15 and F_{DL_low} – 9	

Note 1: For certain bands, the unwanted modulated interfering signal may not fall inside the UE receive band the 15 MHz below or above the UE receive band.
Note 2: For each carrier frequency the requirement is valid for two frequencies:
a. Carrier frequency -BW/2 - $F_{Ioffset, case 1}$
b. Carrier frequency +BW/2 + $F_{Ioffset, case 1}$
Note 3: $F_{Interferer}$ range values for unwanted modulated interfering signal are interferer center frequencies
Note 4: Case 3 and Case 4 only apply to assigned UE channel bandwidth of 5 MHz

2.5.2 Test Procedure

For general test conditions and settings, please refer to Section 2.1 of this application note.

For details on setting up the interference signal, please refer to Section 2.1.1 of this application note. The detailed interference signal settings are the same as shown in Fig. 15.

The test steps, including interferer signal settings, are the same as for Test Case 7.5A.

2.5.3 Test Requirements

The throughput must be ≥ 95 % of the maximum throughput specified for the reference measurement channels under the parameters provided in TS 36.521-1, Tables 7.6.1A.x.3.5-1 and 7.6.1A.x.3.5-1.

2.6 Narrowband Blocking for CA (TS 36.521-1, 7.6.3A)

The purpose of this test is to verify a receiver's ability to receive an E-UTRA signal at its assigned CA channel frequency in the presence of an unwanted narrowband continuous wave (CW) interferer at a frequency that is less than the nominal channel spacing.

The lack of narrowband blocking capabilities decreases the coverage area when other e-NodeB transmitters are present.

2.6.1 Test Description

This test is carried out with QPSK modulation and full RB allocation in the downlink for both the PCC and SCC. The values to be selected for the bandwidth, frequency and RMC as well as UL RB allocation details are defined in TS 36.521-1, Table 7.6.3A.x.4.1-1.

The interference in this test is a continuous wave (CW) signal with the interference settings specified in TS 36.521-1, Table 7.6.3A.x.5-1. The interference signal level is -55dBm for all BWs.

Although their descriptions differ slightly, the principle behind the interferer signal frequency offsets for inter-band CA and intra-band contiguous CA is the same.

The UE transmitter power should be set to 4dB below P_{CMAX_L} or $P_{CMAX\_L\_CA}$ as defined in Clause 6.2.5A. The CMW500 close loop power setting is explained in Section 2.1.2.

The DL cell power for each CC should be $P_{REFSENS\_CA}$ plus the channel bandwidth specific value defined in TS 36.521-1, Table 7.6.3A.x.5-1, where $P_{REFSENS\_CA}$ is the calculated CC cell power derived from $\boldsymbol{P_{REFSENS\_CA} = P_{REFSENS\_R8} - \Delta RIB,c}$ ------- Equation 1.

Table 6: Narrowband blocking parameters: interference power setting and frequency offset for intra-band contiguous CA and inter-band CA.

Parameter	**Unit**	**SCC for Inter-Band CA and Adjacent CC for Intra-Band Contiguous CA**					
		1.4 MHz	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
P_{uw} (CW)	dBm	-55	-55	-55	-55	-55	-55
F_{uw} (Offset from the SCC for inter-band CA or the adjacent CC for intra-band contiguous CA)	MHz	0.9075	1.7025	2.7075	5.2125	7.7025	10.2075

2.6.2 Test Procedure

For general test conditions and settings, please refer to Section 2.1 of this application note. The values to be selected for bandwidth, frequency and RMC as well s RB allocation details are defined in TS 36.521-1, Table 7.6.3A.x. 4.1-1.

For details on setting up the interference signal, please refer to Section 2.1.1 of this application note. The detailed interference signal settings are to be configured as shown in Fig. 16.

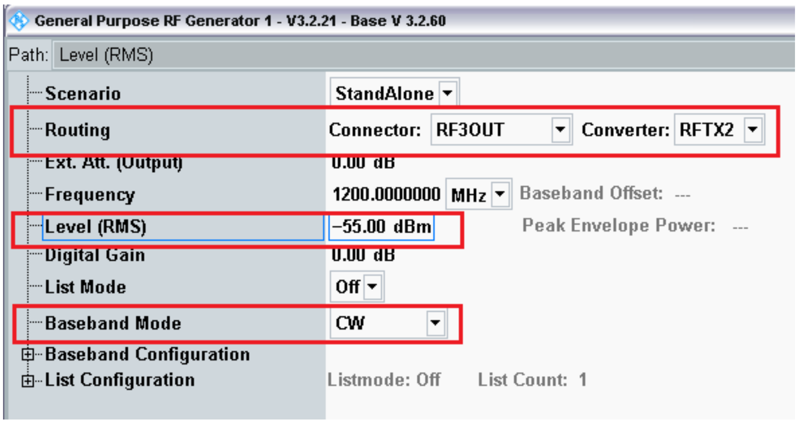


Fig. 16: Interference signal settings for the narrowband blocking test.

Upon completion of instrument *Preset*,
Prepare the interferer signal:

a. Activate *General Purpose RF Generator 1*
b. Set the proper routing as shown in Fig. 16.
c. Ensure the *Baseband Mode* is set to *CW*.
d. Set the correct *Ext. Att (Output)*

The test steps are the same as for Test Case 7.5A. Only the interference signal setting is different.

2.6.3 Test Requirements

The throughput must be ≥ 95 % of the maximum throughput specified for the reference measurement channels under the parameters provided in TS 36.521-1, Tables 7.6.1A.x.3.5-1 and 7.6.3A.x.3.5-1.

2.7 Wideband Intermodulation (TS 36.521-1, 7.8.1)

Intermodulation response tests the UE's ability to receive data with a given average throughput for a specified reference measurement channel. This occurs in the presence of two or more interfering signals with a specific frequency relationship to the wanted signal under conditions of ideal propagation and no added noise.

2.7.1 Test Description

This test is carried out with QPSK modulation and full RB allocation in the downlink for both the PCC and SCC. The values to be selected for bandwidth, frequency and RMC as well as RB allocation details are defined in TS 36.521-1, Table 7.8.1A.x.4.1-1.

In this test, two interference signals must be generated: one CW signal (interferer 1) and one LTE signal (interferer 2). The interference settings are specified in TS 36.521-1, Table 7.8.1A.x.5-1.

Table 7: Wideband intermodulation parameters: interference power setting and frequency offset for intra-band contiguous CA and inter-band CA.

Rx Parameter	Units	SCC for Inter-Band CA or Adjacent CC for Intra-Band Contiguous CA					
		1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
$P_{Interferer\ 1}$ (CW)	dBm	-46					
$P_{Interferer\ 2}$ (Modulated)	dBm	-46					
$BW_{Interferer\ 2}$		1.4	3	5			
$F_{Interferer\ 1}$ (Offset from SCC)	MHz	+/- 2.7MHz	+/- 6MHz	+/- 10MHz	+/- 12.5MHz	+/- 15MHz	+/- 17.5MHz
$F_{Interferer\ 2}$ (Offset from SCC)	MHz	2*$F_{Interferer\ 1}$					
		+/- 5.4MHz	+/- 12MHz	+/- 20MHz	+/- 25MHz	+/- 30MHz	+/- 35MHz

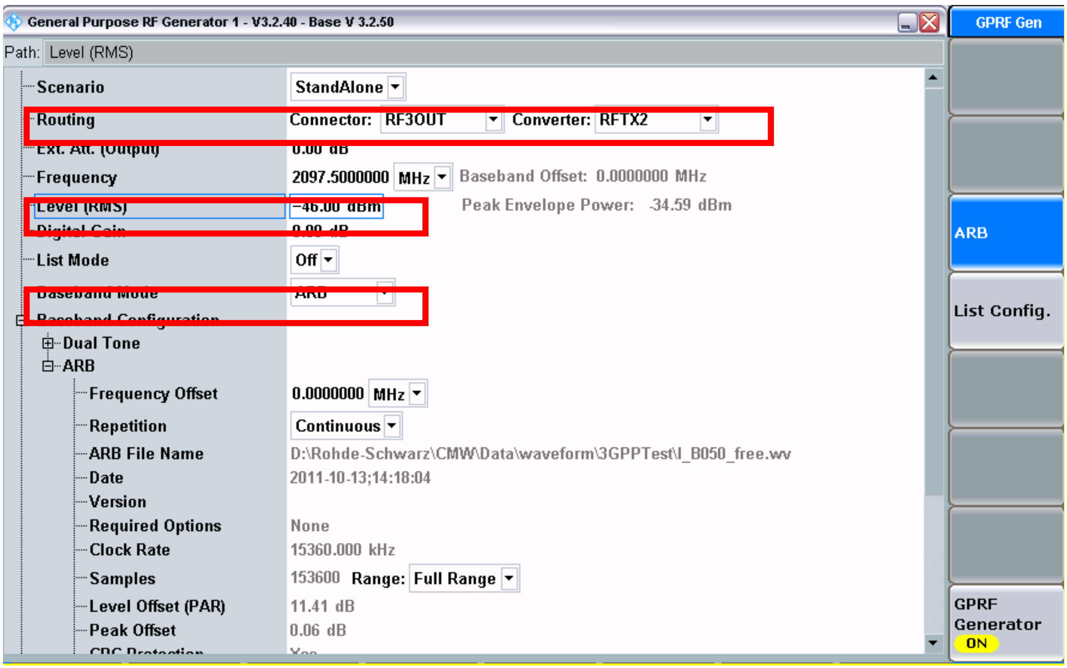
Although their descriptions differ slightly, the principle behind the interferer signal frequency offsets for inter-band CA and intra-band contiguous CA is the same.

The UE transmitter power should be set to 4dB below P_{CMAX_L} or $P_{CMAX\_L\_CA}$ as defined in Clause 6.2.5A. The CMW500 close loop power setting is explained in Section 2.1.2.

The DL cell power for each CC should be $P_{REFSENS\_CA}$ plus the channel bandwidth specific value defined in TS 36.521-1, Table 7.6.1A.x.5-1, where $P_{REFSENS\_CA}$ is the calculated CC cell power derived from $P_{REFSENS\_CA} = P_{REFSENS\_R8} - \Delta RIB,c$ ------- Equation 1.

2.7.2 Test Procedure

A CMW500 with 4 RF channels is required for this test, as it involves an LTE signal, two interference signals, a CW signal and an ARB signal. Only one B110 is required. Please refer to Section 2.4.2 (7.5A Test Procedure) for information on loading the ARB waveform.



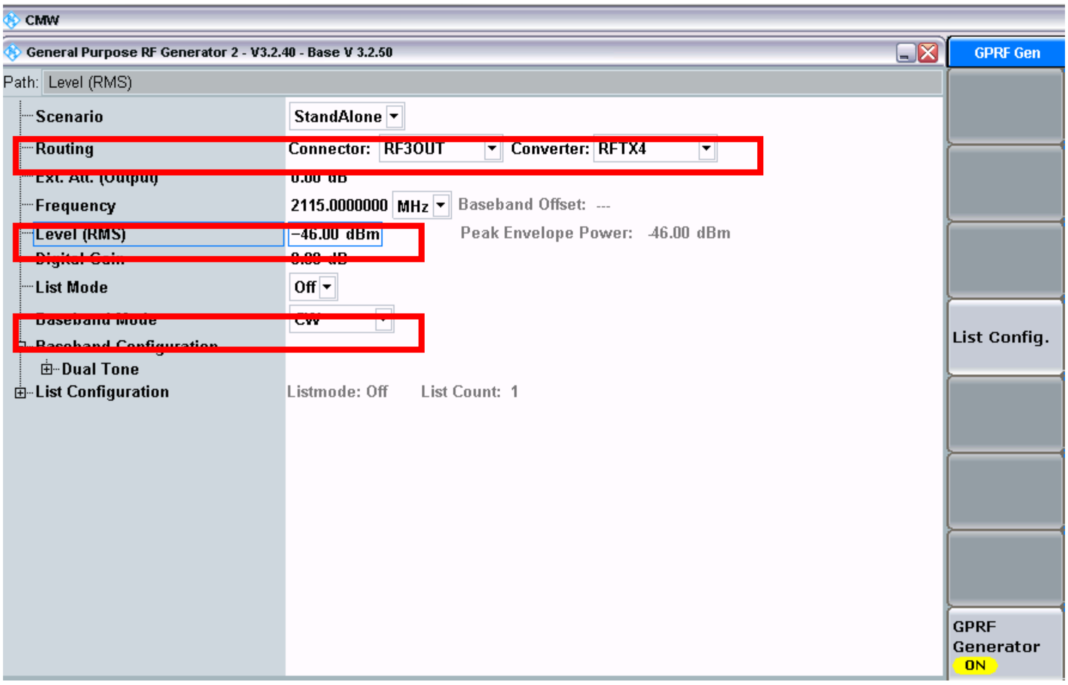


Fig. 17: General purpose RF generator 1 & 2 settings.

Upon completion of instrument *Preset*,

1. Prepare the interferer signal:
   a. Activate *General Purpose RF Generator 1*
   b. Set the proper routing and attenuation
   c. Load the waveform:

   Set the *Baseband Mode* to *ARB*.
   Load the interferer waveform according the bandwidth. Three free interferer waveforms are included in this application note package, and they should be saved to the R&S®CMW500:

   I_B014_free.wv – Bandwidth = 1.4 MHz
   I_B030_free.wv – Bandwidth = 3 MHz
   I_B050_free.wv – Bandwidth = 5 MHz

   d. Activate *General Purpose RF Generator II*
   e. Set the proper routing and attenuation

2. Setup the LTE signalling and start the test:

Step 1. Set *Duplex* Mode.
Step 2. If the DUT has combined antennas for the PCC and SCC, connect the DUT to the CMW500 as shown in Fig. 11 and set the Scenario to “*2CC CA – 2 RF Out*”.
Step 3. Set the *RF Output Connector/Converter* and *RF Input Connector/Converter* accordingly.
Step 4. Set the correct *External Attenuation* for each port and cell.
Step 5. Set the *Transmission Mode* to ‘*TM1*’ and the *DCI Format* to ‘*1A*’.
Step 6. Enable the LTE cell. Power on the LTE UE so that it attaches to the network and press *Connect* to establish the connection.
Step 7. Set the testing *Cell Bandwidth, DL Channel*, *Downlink and Uplink #RB*, *Modulation* and *RB Pos./Start RB* for both the PCC and SCC (defined in TS 36.521-1 7.8.1A.*x*.4.1 *Initial conditions*, where *x* represents the number used for various types of CA configurations).

Step 8. Set *Active TPC Setup* to *Close Loop* and *Closed Loop Target Power, 16.3dBm* (calculated according to Section *2.1.2*) to ensure that the UE power reaches its required range.
Step 9. Enable *OCNG*. This can be done before powering on the DUT.
Step 10. Go to the *LTE RX Meas.* page and set *Subframes* >= *1200* (1200 is the next smallest number greater than 1003) in accordance with the specification.
Step 11. Go to *GPRF Sig. 1* and set the correct *Frequency* and *Level(RMS), -46dBm*. Turn on the signal.
Step 12. Go to *GPRF Sig. II* and set the correct *Frequency* and *Level(RMS) , -46dBm.* Turn on the signal.
Step 13. Adjust the DL *RS EPRE* so that the *Full Cell BW Pow.* indicates ($P_{REFSENS\_CA}$ + channel bandwidth specific value, according to Table 7.8.1A.x.5-1) for both the PCC and SCC.
Step 14. Measure the throughput achieved under these conditions. For the measurement window display, please refer to Fig. 14.
Step 15. Change the *GPRF Sig. 1 Frequency* and *GPRF Sig. 2 Frequency* and carry out the measurement again.

2.7.3 Test Requirements

The throughput must be ≥ 95 % of the maximum throughput specified for the reference measurement channels under the parameters provided in TS 36.521-1, Table 7.8.1A.x.5-3.

3 Using CMWRun

LTE3GPPv11.2 is available for CMWRun Version 1.8.0. The limits and configurations are based on TS 36.521-1 V11.2. The table below provides a list of supported test cases for TS 36.521-1. The list will be updated, and it is recommended to execute it with CMW500 LTE firmware version 3.2.82.

Table 8: LTE3GPPv11.2 supported test cases (CMWRun V1.8.0).

Chapter **Release**	**6**	**7**	**8**	**9**
R8 / R9	6.2.2 / 6.2.2_1	7.3	8.2.1.1.1	9.2.1.1
	6.2.3 / 6.2.3_1	7.4	8.2.1.1.1_1	9.2.2.1
	6.2.4 / 6.2.4_1	7.5	8.2.1.2.1	9.3.2.1.1 / 9.3.2.1_1
	6.2.5 / 6.2.5_1	7.6.1	8.2.1.2.1_1	9.2.1.2
	6.3.2	7.6.3	8.2.1.3.1	9.2.2.2
	6.3.4.1	7.8.1	8.2.2.1.1	9.3.1.2
	6.3.4.2		8.2.2.1.1_1	
	6.3.5.1 / 6.3.5_1.1		8.2.1.1.1	
	6.3.5.2 / 6.3.5_1.2		8.2.1.1.1_1	
	6.3.5.3 / 6.3.5_1.3		8.2.2.3.1	
	6.5.1			
	6.5.2.1			
	6.5.2.1A			
	6.5.2.2			
	6.5.2.3			
	6.5.2.4			
	6.6.1			
	6.6.2.1			
	6.6.2.3			
	6.6.3.1			
R10	6.2.5A.2 (required by 36.521 V10.2)	7.3A.2/3		
		7.4A.2/3		
		7.5A.2/3		
		7.6.1A.2/3		
		7.6.3A.2/3		
		7.8.1A.2/3		

Fig. 18 shows the LTE 3GPP TS36.521 configuration window. The user can select the Duplex, UE Category, Power Class, test cases, Non-CA bands, CA bands and channels to be tested. Various automatic power cycling methods are also enabled to handle call-drop contingencies. The sections below provide the details of the configurations. Details on DUT power cycle automation can be found in *application note 1CM94* "LTE RF Measurements with the R&S®CMW500 according to 3GPP TS 36.521-1", *Section 7.4.*

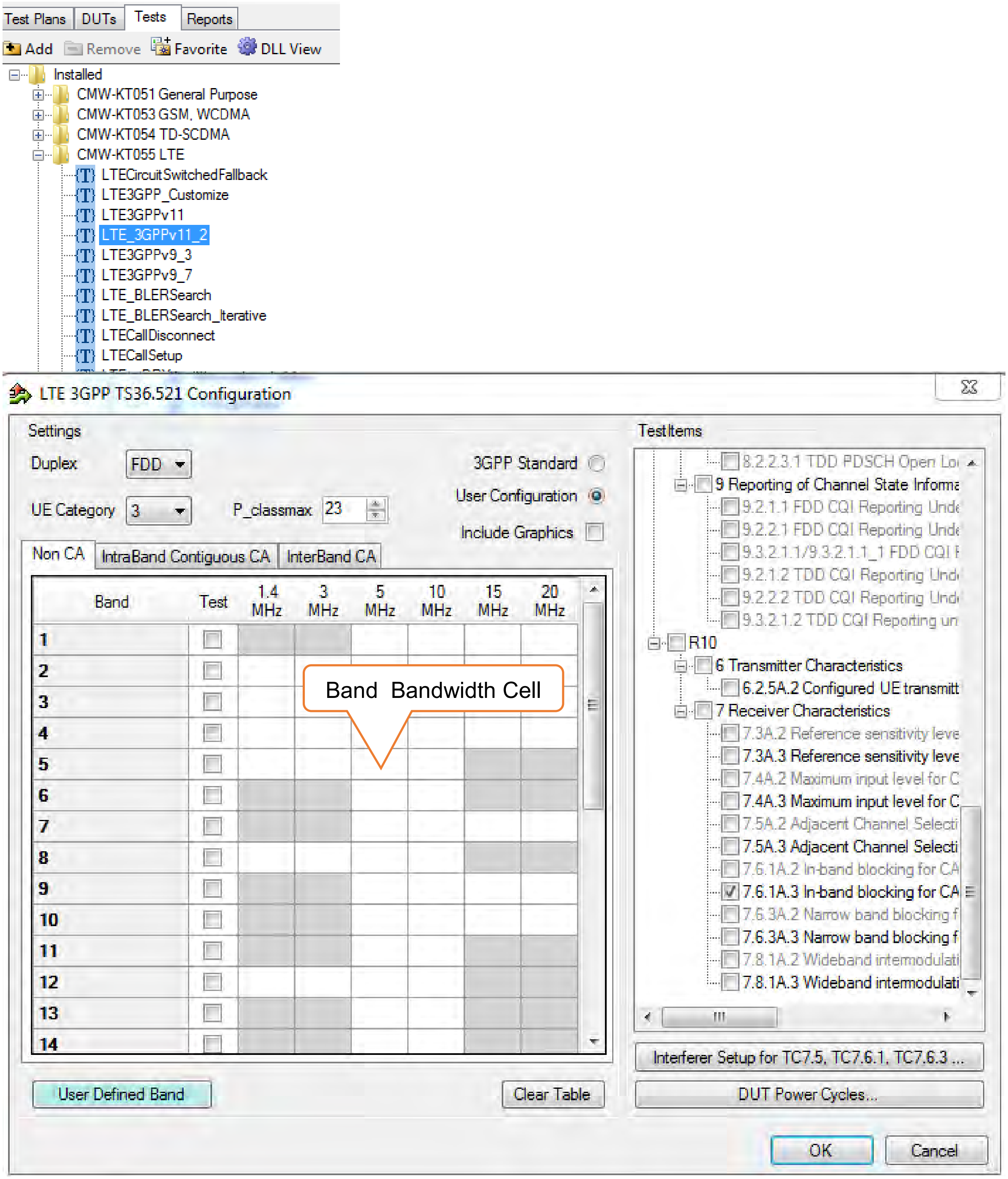


Fig. 18: CMWRun LTE 3GPP TS36.521 V11.2 configuration.

3.1 General Configurations

Duplex – Select FDD or TDD. Configuring for both FDD and TDD is NOT currently supported. Users should sequence two LTE_3GPPv11_2 into their test plan (one for TDD and one for FDD).

UE Category – The UL configuration for certain tests will differ for various UE categories. This value must be configured accordingly. For UE categories above 5, please select '5', as the UL configuration is the same for categories 5 and above.

P_classmax – Set the maximum UE output power. This value is used to differentiate normal DUTs from high output power DUTs.

3GPP Standard – If selected, only the channels and bandwidths required for the selected bands will be tested.

User Configuration – If selected, all channels and bandwidths listed in the configuration table will be tested. This is the only mode, in which the user can define the channels to be tested. Double clicking on any Band_Bandwdith cell brings up a separate window. Placing the cursor over a particular Band Bandwidth cell displays the full channel configuration.

Include Graphics – If selected, all the graphics are displayed. In not selected, only the Relative Power Control graphic result is displayed.

3.2 User-Defined Band Channel Configurations

The listed non-CA bands and CA bands listed are those defined in TS36.521-1 V11.2. The "*User Defined Band*" button provides definitions for non-3GPP defined CA band combinations and BW combinations. "*User Configuration*" must be selected in order to activate "*User Defined Band*".

Non-CA: user-defined band that allows users to test non-3GPP defined bandwidths.

Intra-band contiguous CA: user-defined band, which enables users to define non-3GPP defined contiguous DLCA bands.

Inter-band CA: user-defined band that makes it possible to define non-3GPP defined DL inter-band CA combinations. It is designed not to swap the PCC and SCC automatically in user defined cases. The user needs to manually configure the swapped PCC and SCC bands, i.e., both USER_3A_28A and USER 28A_3A have to be added in order to test all band 3 and band 28 combinations.

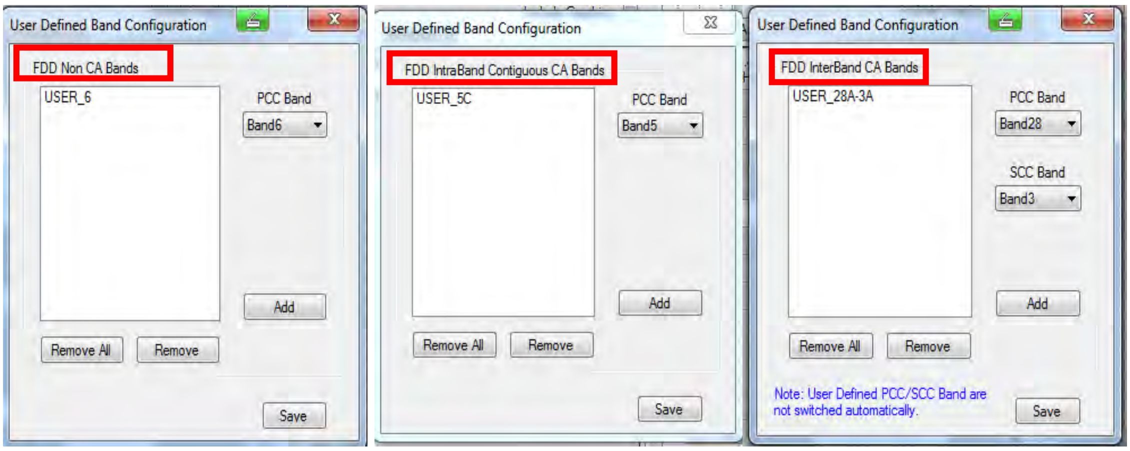


Fig. 19: Addition of a user-defined band for testing.

Double clicking on any non-greyed Band_Bandwidth cell brings up a window for test channel configuration.

Fig. 20 shows how to configure user-defined testing channels for CA Band28_3A. Band 28 supports 5M BW and band 3 supports 20M BW.

Step1: Double click on the 5MHz cell to bring up the configuration window for the 5MHz BW.
Step2: Select *Band28* and configure the channels to be tested.
Step3: Select *Band3* and ensure that the channel list is empty.
Step4: Click *Save* to save the 5MHz configurations.
Step5: Double click on the 20MHz cell to bring up the configuration window for the 20MHz BW.
Step6: Select *Band28* and ensure that the channel list is empty.
Step7: Select *Band3* and configure the channels to be tested.
Step8: Click *Save* to save the configurations.

The full channel configuration can be viewed by placing the cursor over the 5MHz or 20MHz cell. Channel separation between the two bands is indicated by a colon (':'). If an empty string is displayed before this character, it means that no channel has been configured for the PCC of that particular BW. If an empty string comes after a colon, it signifies that no channel has been configured for the SCC of that particular BW. The channels configured for the PCC and SCC with different/same BW are automatically combined in corresponding sequence. This means that the number of channels must be the same for the PCC and SCC.

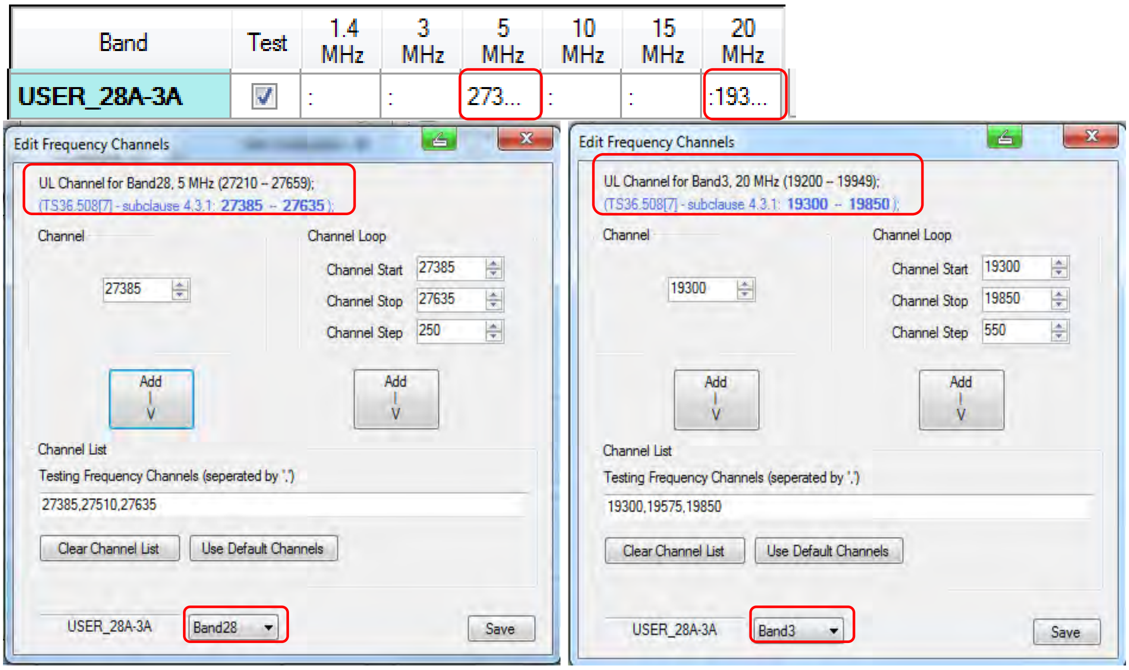


Fig. 20: Inter-band CA channel configuration

4 Literature

[1] 3GPP TS 36.521-1
Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) conformance specification; Radio transmission and reception;
Part 1: Conformance testing

[2] 3GPP TS 36.508
Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Packet Core (EPC); Common test environments for User Equipment (UE) conformance testing

[3] R&S®CMW500 Wideband Radio Communication Tester Operating Manual

5 Additional Information

Please send your comments and suggestions regarding this application note to:
Jenny.Chen@rohde-schwarz.com or
Guenter.Pfeifer@rohde-schwarz.com

In addition, please visit the R&S®CMW500 website at:
www.rohde-schwarz.com/product/CMW500

6 Ordering Information

Please visit our website (www.rohde-schwarz.com) and contact your local Rohde & Schwarz sales office for further assistance.

Ordering Information		
Name	**Description**	**Order number**
R&S®CMW500	Wideband Radio Communication Tester	1201.0002K50
R&S®CMW-PS503	R&S®CMW500 Basic Assembly	1208.7154.02
R&S®CMW-S100A	Baseband Measurement Unit	1202.4701.02
R&S®CMW-S570B	RF Converter (TRX)	1202.5008.03
R&S®CMW-S550B	Baseband Interconnection Board (Flexible Link)	1202.4801.03
R&S®CMW-B570B	Extra RF Converter (TRX)	1202.8659.03
R&S®CMW-B570B	Extra RF Converter (TRX)	1202.8659.03
R&S®CMW-B570B	Extra RF Converter (TRX)	1202.8659.03
R&S®CMW-S590D	RF Front-End Module Advanced	1202.5108.03
R&S®CMW-B590D	Extra RF Front-End Module Advanced	1202.8707.03
R&S®CMW-S600B	Front Panel with Display/Keypad	1201.0102.03
R&S®CMW-B620A	Digital Video Interface (DVI) Module	1202.5808.02
R&S®CMW-B300B	Signalling Unit Wideband (SUW+)	1202.6304.03
R&S®CMW-B300B	Signalling Unit Wideband (SUW+)	1202.6304.03
R&S®CMW-KS500	LTE FDD Release 8, SISO, signalling/network emulation, basic functionality	1203.6108.02
R&S®CMW-KM500	LTE FDD Release 8, TX measurement, uplink	1203.5501.02
R&S®CMW-KS550	LTE TDD (TD-LTE) Release 8, signalling/network emulation, basic functionality	1204.8904.02
R&S®CMW-KM550	LTE TDD (TD-LTE) Release 8, TX measurement, uplink	1203.8952.02
R&S®CMW-KS510	LTE Release 8, SISO, signalling/network emulation, advanced functionality	1203.9859.02
R&S®CMW-KS502	LTE FDD Release 10, CA, signalling/network emulation, basic functionality	1208.6029.02
R&S®CMW-KS512	LTE Release 10, CA, signalling/network emulation, advanced functionality	1208.6041.02
R&S®CMW-KT055	LTE, CMWRun sequencer software tool	1207.2107.02
R&S®CMW-Z05	Nano UICC Test Card, supporting 3GPP SIM/USIM/ISIM/CSIM applications	1208.5651.02