Voice over LTE (VoLTE) Speech Quality Measurements

Application Note

Products:

- R&S®CMW500
- R&S®CMWrun
- R&S®UPV
- R&S®UPV66

This application note and associated application software may be used to conduct psychoacoustic speech quality evaluation for Voice over LTE (VoLTE) connections.

The measurements are based on recommendations ITU-T P.862 and ITU-T P.863, respectively.

The CMWrun example sequences perform decoder/encoder calibration, connection setup for the UE under test and subsequent speech quality analysis under IP impairment conditions.

Application Note
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ROHDE&SCHWARZ

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1 Overview

Cellular Radio Operators face an increasing pressure to free existing spectrum as currently used for voice-centric services in order to allow its re-use for a broad range of integrated media applications. This means existing circuit-switched voice services have to be offered as just one of many applications on a packet-switched network without sacrificing the quality users have come to expect.

Stand-alone or integrated media voice is and will remain a key application for mobile radio service subscribers. Operators of such services strive to ensure or even improve voice quality despite the additional challenges that a packet-based transmission of speech entails.

The VoLTE (Voice over LTE) packet service uses the IMS (IP Multimedia Subsystem) as architecture. One of the key enablers for the architecture is the Session Initiation Protocol (SIP) e.g. used for negotiating the codec type, AMR-NB (Adaptive Multirate-narrow band) or AMR–WB (wideband) and coderate (e.g. 23.85 kbps).

VoLTE uses the AMR-WB codec and can transfer signals with twice the sample rate (16000 Hz) as classic circuit switched systems, e.g. AMR-NB, GSM-HR (half-rate) or GSM-FR (full rate). VoLTE on one hand has advantage of an enhanced frequency spectrum and on the other hand variable latency and possible IP impairments.

The described solution in this application note explains the measuring of speech quality with the PESQ (Perceptual Evaluation of Speech Quality) and POLQA (Perceptual Objective Speech Quality Assessment) algorithm. As successor of PESQ, the new POLQA method is designed for additional test applications such as SWB (Super Wideband Mode), bandwidth extensions etc.. A further benefit of this algorithm is that the resulting MOS-LQO (Mean Objective Score – Listening Quality Objective) results measured with other radio access technologies (e.g. GSM, CDMA2000) are comparable to each other.

This application note describes how to perform VoLTE PESQ and POLQA measurements with an R&S®CMW500 Wideband Communication Tester and an R&S®UPV Audio Tester manually or fully automatically using an example test sequence for the R&S®CMWrun Sequencer Software Tool. It contains an automated POLQA / PESQ measurement similar as described in reference [7]. The test establishes a call to a LTE mobile or PC card, configures IP impairments, calibrates the audio interface for R&S®UPV (decoder/encoder) and performs either a POLQA measurement according to recommendation ITU-T P.863 or PESQ measurement according to recommendation ITU-T P.862 of the speech signal received (downlink) or transmitted (uplink) by the user equipment (UE).

The following abbreviations are used in the following text for R&S® test equipment:

- The R&S®CMW500 Wideband Communication Tester is referred to as CMW500.
- The R&S®UPV Audio Analyzer is referred to as UPV.
- R&S®CMWrun is referred to as CMWrun.
- R&S® refers to Rohde & Schwarz GmbH und Co KG

2 Hardware Setup

2.1 VoLTE Test Setup

This setup is used for measurements based on an electrical audio connection and consists of:

1. **CMW500** Communication Tester is connected to the LTE UE via RF. It provides IMS infrastructure, establishes a VoLTE call and transmits RTP packets to and from the UE. Be sure to use the LAN Switch 2 (Rear) connector for remote control with the static IP address **172.22.1.4**.
2. **UPV** Audio Analyzer for performing POLQA and PESQ measurements of downlink and uplink audio signals. It must be set to the static IP address **172.22.3.1**.
3. **Remote PC** equipped with a LAN interface with a static IP address **172.22.2.2** and CMWrun v1.7.8.15 or higher installed.
4. **LTE UE** – with IMS / VoLTE capability.

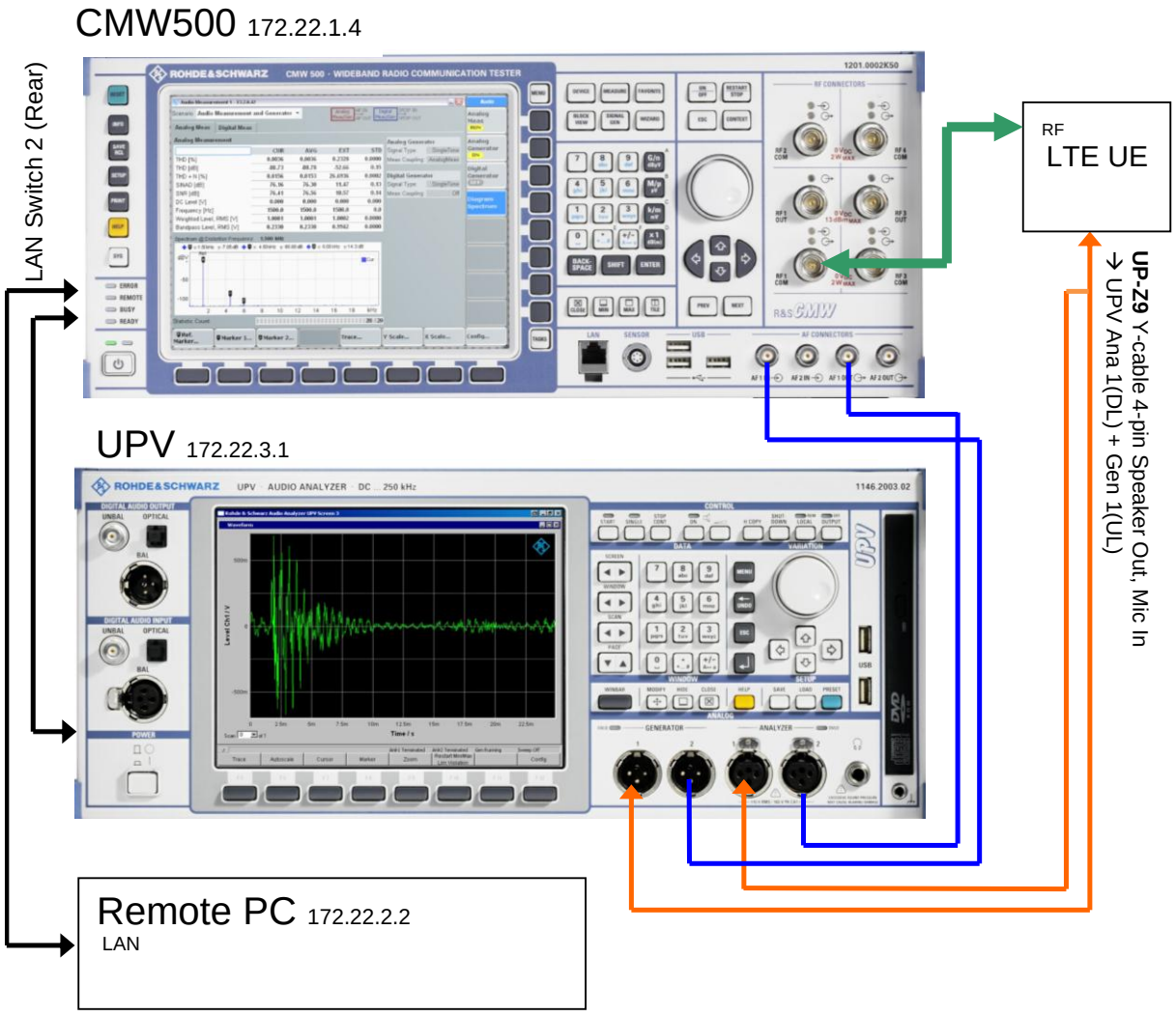


Figure 2-1: VoLTE test setup with CMW500 and UPV (schematic)

The LAN cables from the Remote PC and the UPV are connected to the LAN Switch 2 at the rear of the CMW500.

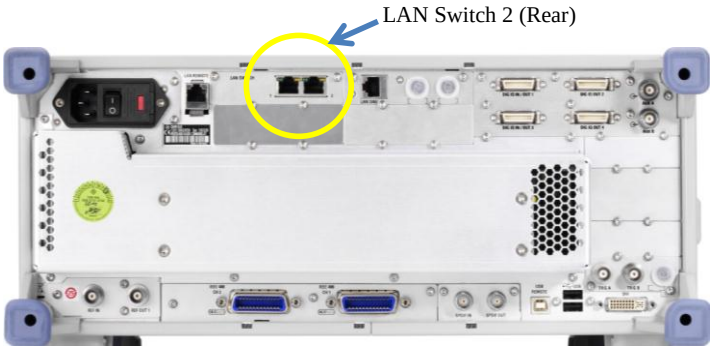


Fig. 2-1: CMW500 LAN Switch 2

CMW500 – LAN Switch 2 (Rear)

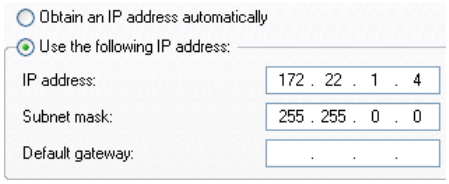


Fig. 2-2: CMW500 LAN remote config (default)

UPV – LAN connector

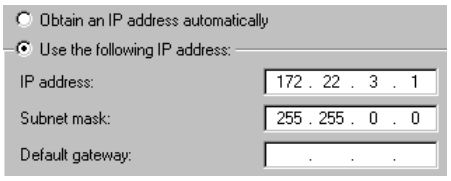


Fig. 2-3: UPV LAN remote configuration

Remote PC – LAN connector

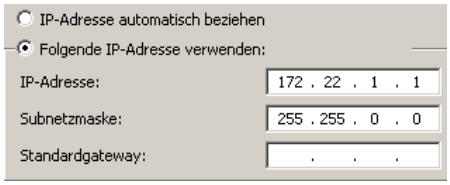


Fig. 2-4: Remote PC LAN Configuration

Fig. 2-5: VoLTE test setup with CMW500 and UPV

2.2 Required Cables, Adapters and Connectors

2.2.1 Neutrik NA2 MBNC

XLR Male to BNC Female e.g. http://www.thomann.de/de/neutrik_na_2_mbnc.htm

Fig. 2-6: XLR Male to BNC Female Adapter

This adapter type is connected to the UPV Analyzer 2 input.

2.2.2 Neutrik NA2 FBNC

XLR Female to BNC Female e.g. http://www.thomann.de/de/neutrik_na_2_fbnc.htm

Fig. 2-7: XLR Female to BNC Female Adapter

This Adapter type is connected to the UPV Generator 2 output.

2.2.3 2 x BNC Cables 0.5m

Two BNC cables 0.5m e.g. http://www.thomann.de/de/pro_snake_bncleitung_05m.htm

Fig. 2-8: BNC cable

For connecting UPV Analyzer 2 and Generator 2 to the CMW Audio Board (AF IN 1 and AF OUT 1).

2.2.4 Y-Cable 4-pole 3.5 mm Jack Plug to XLR-male and XLR-female

The UP-Z9 cable set contains two Y-cables with each a 4-pin 3.5 mm jack plug on one and an XLR-male and XLR-female connector on the other side. The 3.5 mm jack comes in 2 variations for Apple and other smart phones.

3 Software Requirements

For running VoLTE POLQA / PESQ test plans with CMWrun following software environment must be installed on the CMW500, UPV and PC:

3.1 CMW500

On the CMW500 following software options are mandatory (version numbers should be equal are higher):

- Base firmware ≥ 3.2.40
- DAU firmware ≥ 3.2.30
- LTE firmware ≥ 3.2.70
- WCDMA firmware ≥ 3.2.70
- Audio Speech firmware ≥ 3.2.12

3.2 UPV

On the UPV following firm- and software is mandatory (version numbers should be equal or higher).

- UPV firmware ≥ 3.3.1.758 – The latest revision can be downloaded at http://www.rohde-schwarz.com/en/firmware/upv
- POLQA_CAL_macro ≥ 1.2.0

3.2.1 POLQA_CAL

POLQA_CAL_120.msi must be installed on the UPV. It supplies remote commands for calibration and PESQ / POLQA measurements. The VoLTE_SpeechQualityMeasurement test item in CMWrun uses this macro by default.

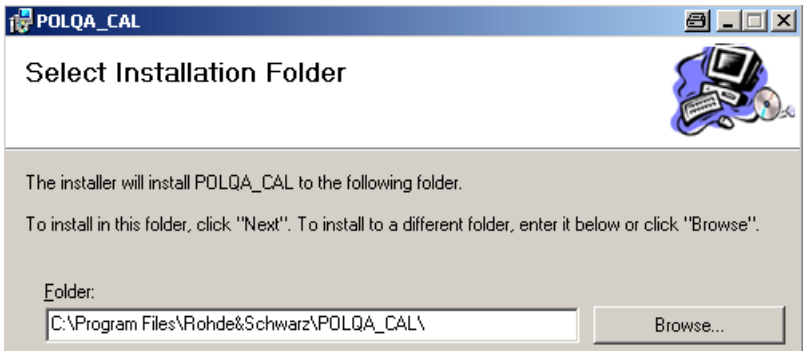


Figure 3-1: POLQA_CAL installation on UPV

3.3 Remote PC

3.4 R&S CMWrun

Install **CMWRUN** 1.7.8.15 or higher on the **REMOTE PC**. Unzip the file **VOLTE_CAMPAIGN_DEMO_AUDIO-BOARD.ZIP** to the CMWrun directory <Windows data directory>**\CMWRUN FILES\MY TEST PLANS**.

4 CMW500 Configuration for Manual Testing

4.1 LTE Settings

This example uses an LTE / VoLTE phone operating in band 13. For performing an IMS call it is necessary to configure certain LTE cell and IMS server parameters.

1. Enable LTE signaling by activating the LTE Signaling 1 checkbox.

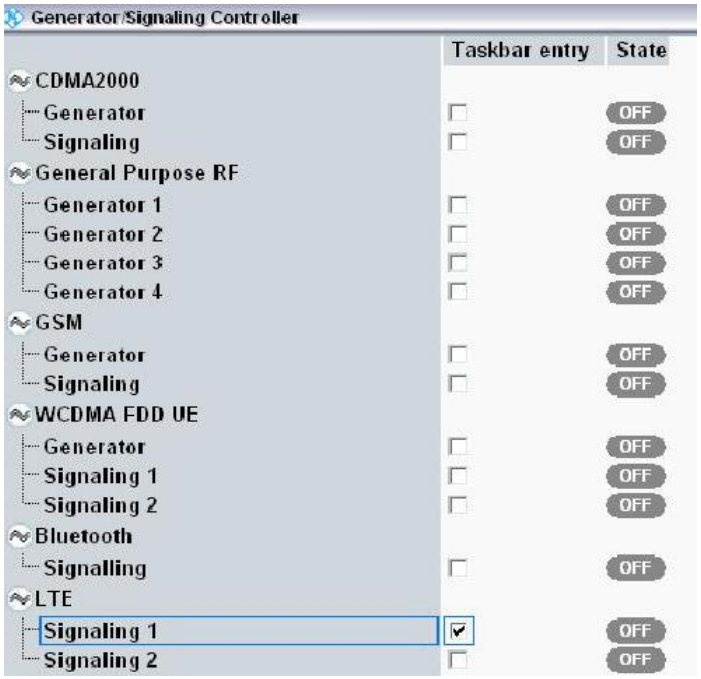


Fig. 4-1: Select LTE Signaling

2. In the LTE Signaling 1 menu set the required Operating Band. Make sure that the DAU has been enabled first.

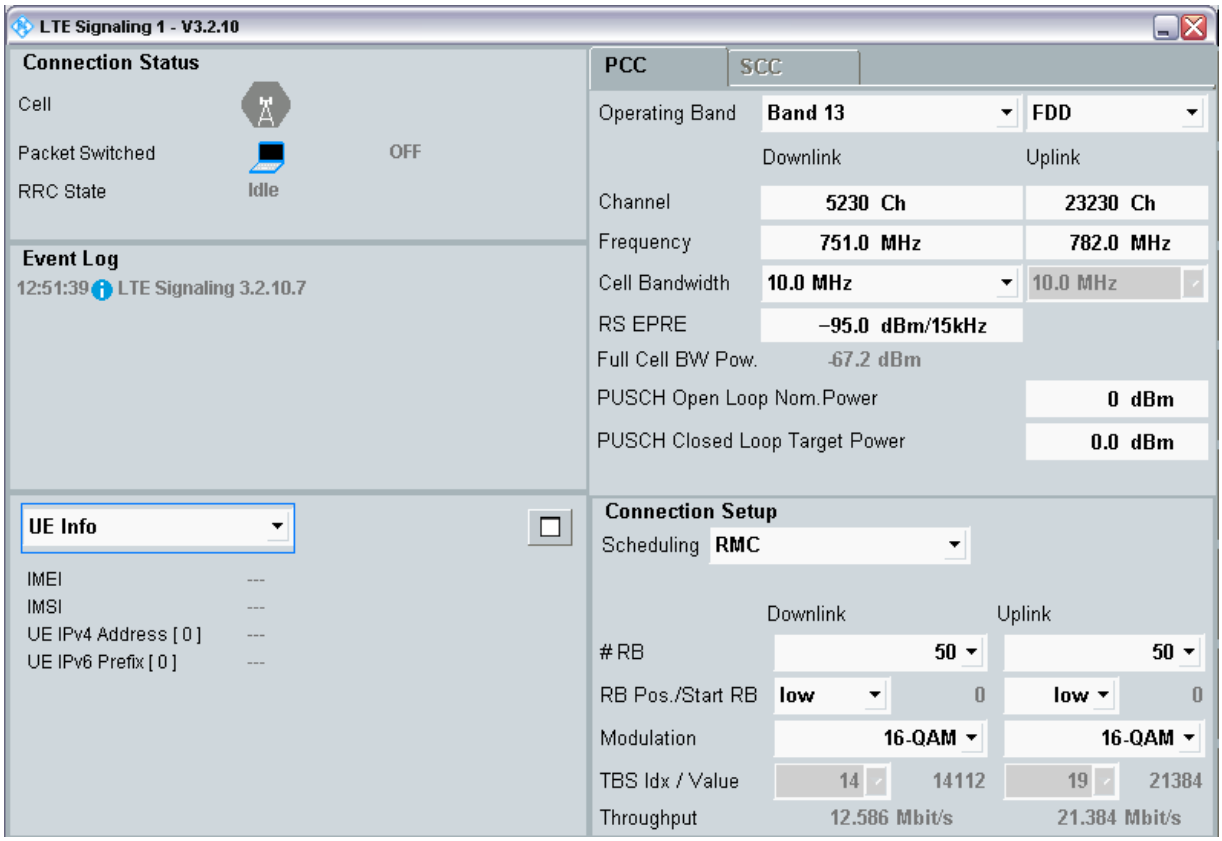


Fig. 4-2: LTE Signaling Menu

3. Go to the **LTE SIGNALING CONFIGURATION** page by pressing the **CONFIGURE** button, enable the Speech Codec and select Connection Type Data Application.

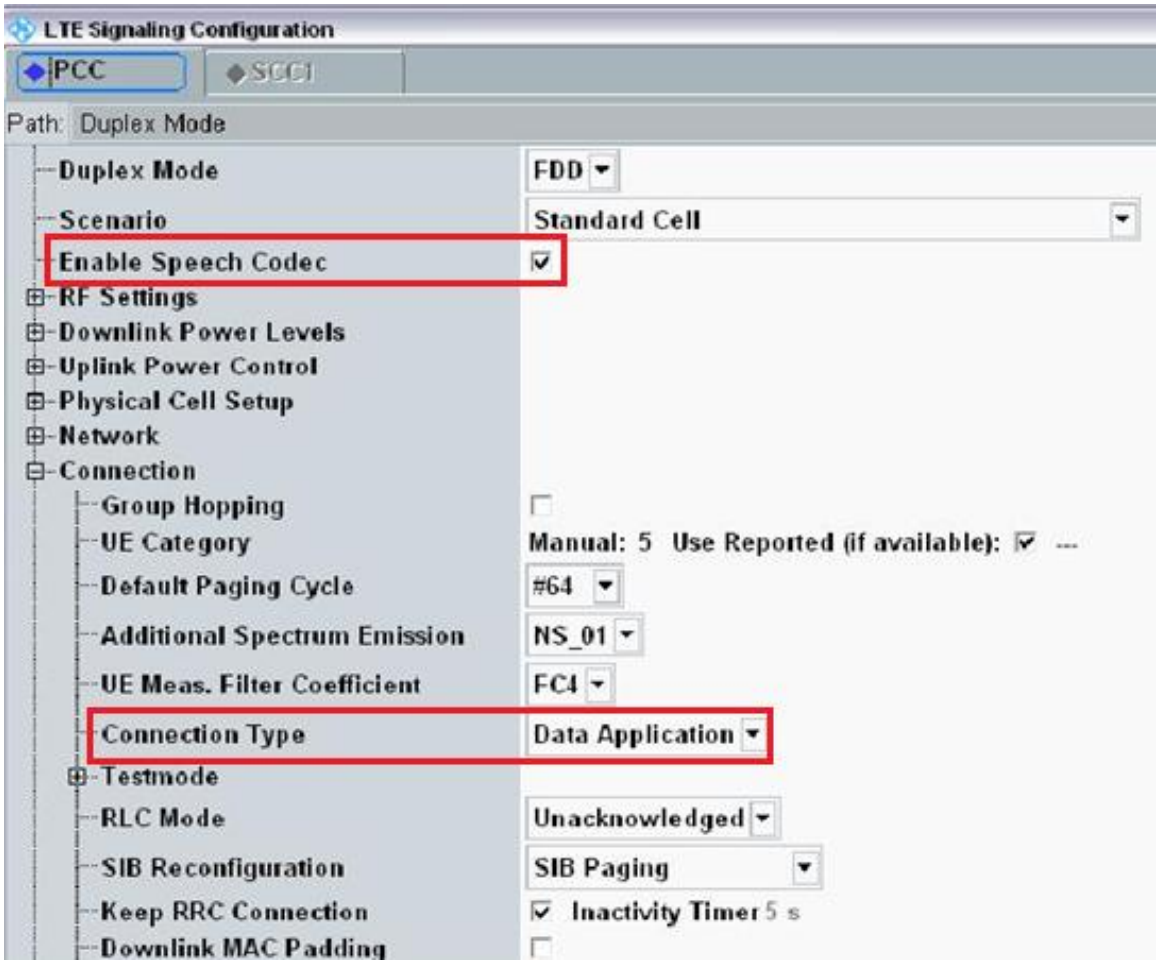


Fig. 4-3: LTE Signaling Configuration

Some phones require the Accept Multiple Default Bearer checkbox to be enabled.

- Disabled: Only the 1st default bearer of a UE is accepted. Additional requests are rejected.
- Enable: So many bearers are established as UE requests.

An IP address is assigned for each bearer, so only enable the parameter if necessary.

4. Make sure that IMS Voice over **PS SESSION INDICATOR** = **SUPPORTED**. In case of **NOT SUPPORTED** the DUT performs a CSFB instead of an IMS registration.

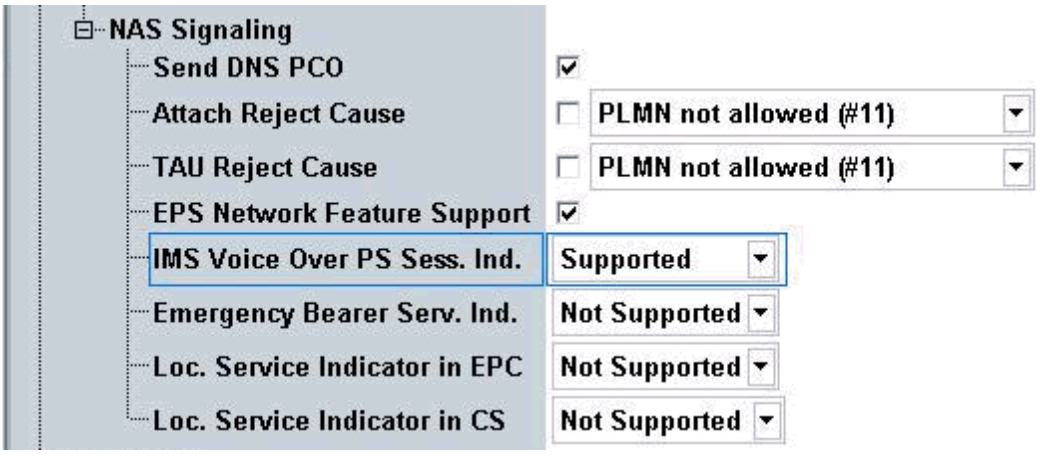


Fig. 4-4: IMS Configuration for Mercuro IMS Client

5. Configure the Network parameters Identify and Security Settings according to the DUT capabilities.

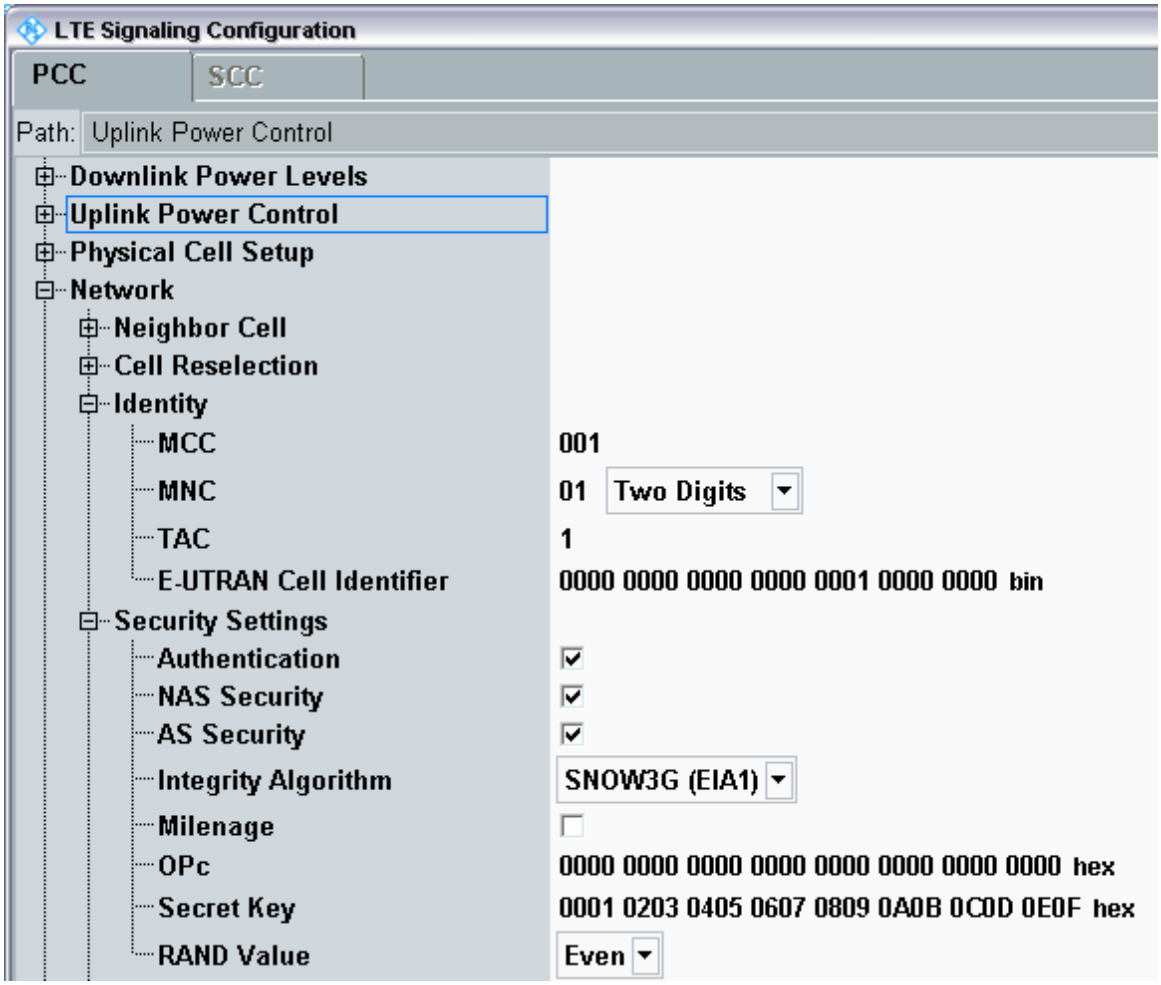


Fig. 4-5: LTE Network Settings

4.2 Audio Measurement Settings

1. Open the Audio Measurement tab by pressing the soft key Measure and enabling the Audio → Measurements 1 checkbox.

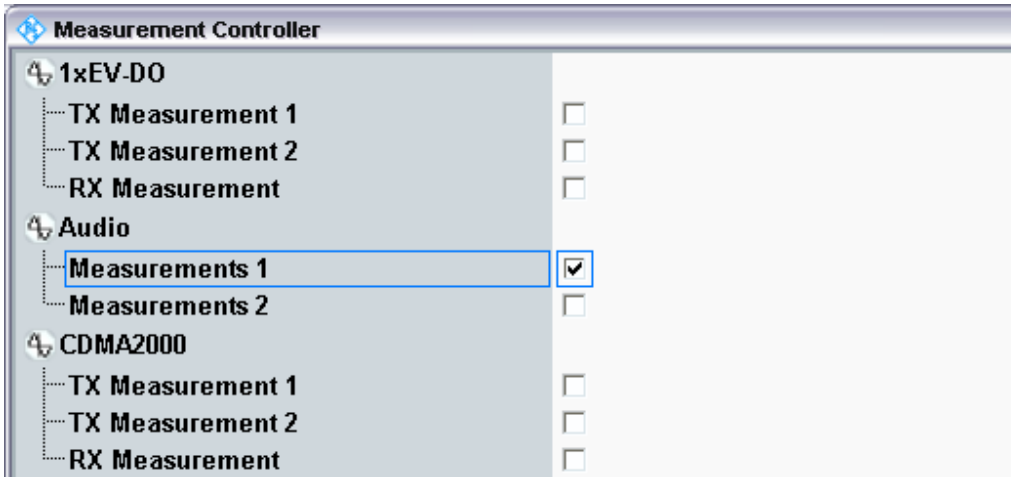


Fig. 4-6: Select Audio Measurement

2. Open the Audio Measurement tab and choose the scenario **EXTERNAL ANALOG SPEECH ANALYSIS**. Set the Input and Output Level Full-Scale (Peak) to following values.

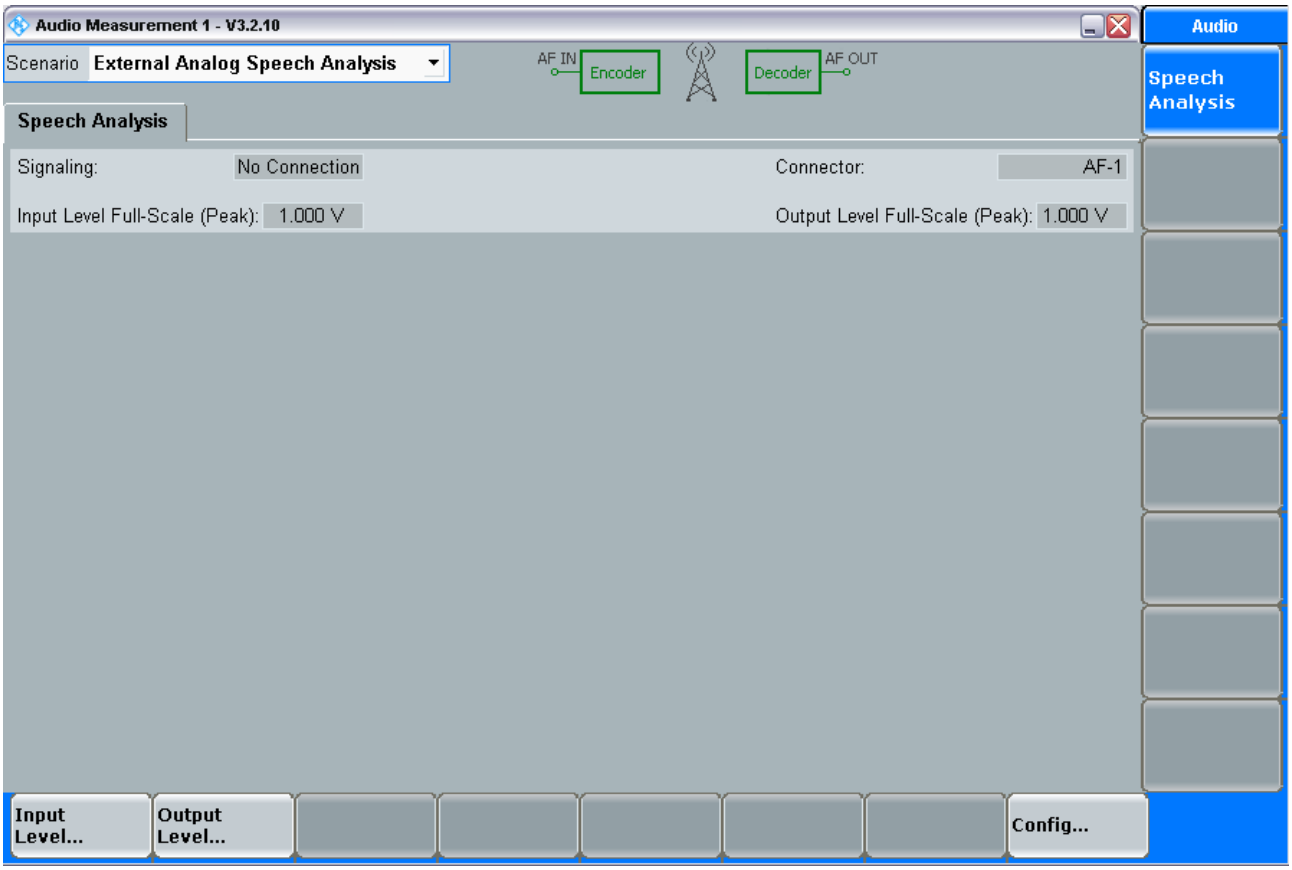


Fig. 4-7: Audio Input and Output Level

The internal CMW audio board does not need to be calibrated. If the UPV requires a calibration step, load the *.ccl pseudo calibration files for encoder and decoder cal which should contain the input and output levels of the CMW500, e.g. 1.00 V (Peak).

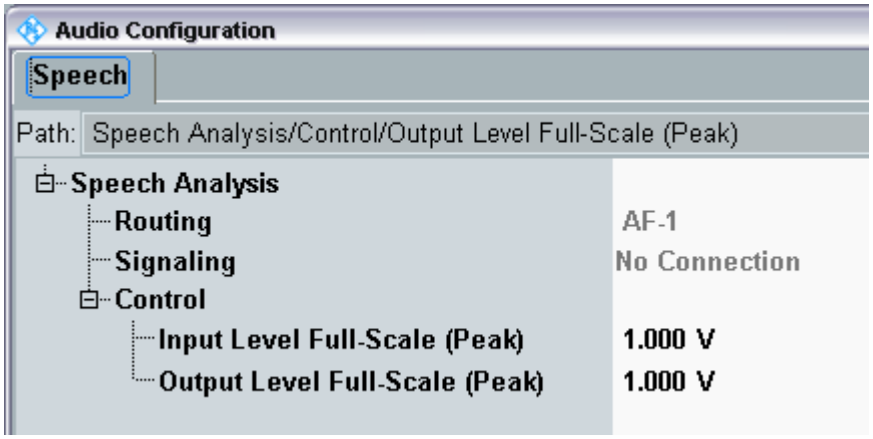


Fig. 4-8: CMW Audio Board Input / Output Level Full-Scale (Peak)

The voltage values in the files named below must contain the same value as set in the **AUDIO CONFIGURATION → SPEECH** menu:

CMW_ENC_1V.CCL:

UPV_1GA50_CAL
encoder
1.000000

CMW_DEC_1V.CCL:

UPV_1GA50_CAL
decoder
1.000000

4.3 Data Application Unit Settings

1. Open the Data Application Unit by enabling the **DATA APPL.** → **MEASUREMENT 1** checkbox in the Measurement Controller menu.

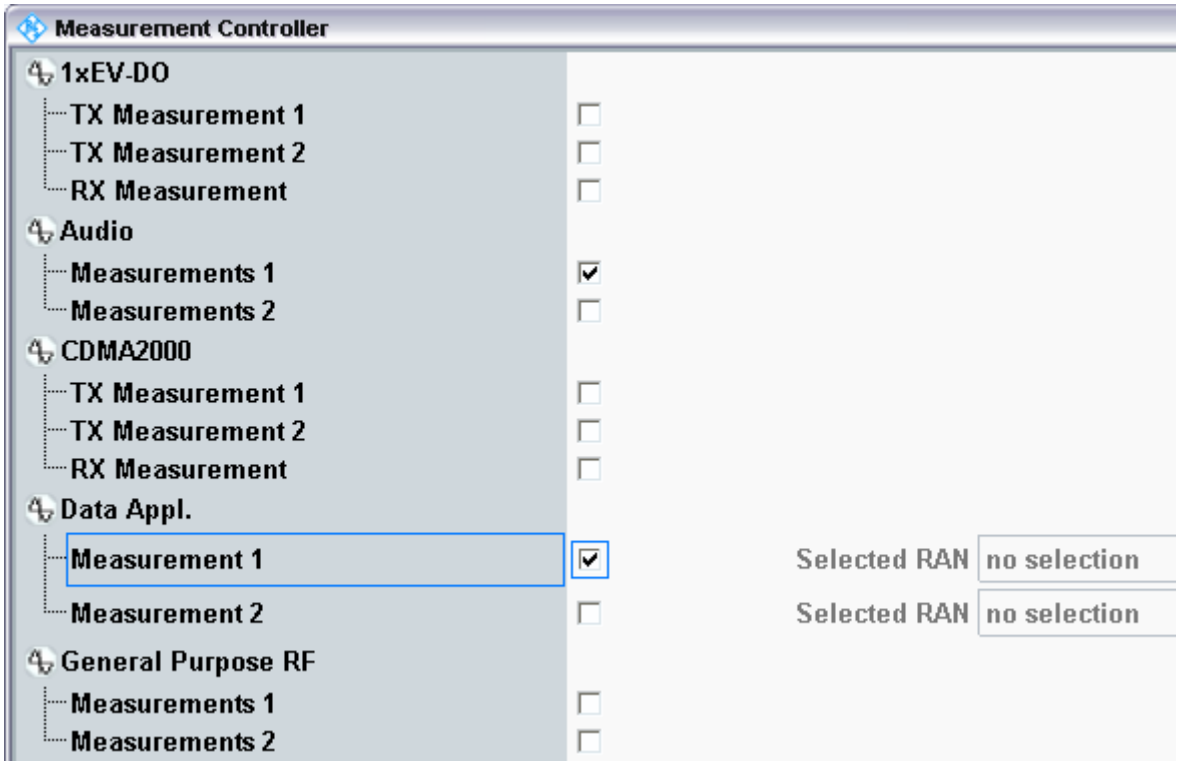


Fig. 4-9: Select DAU menu

2. Open the Data Application Unit and click on the **CONFIGURE SERVICES** soft key on the right.

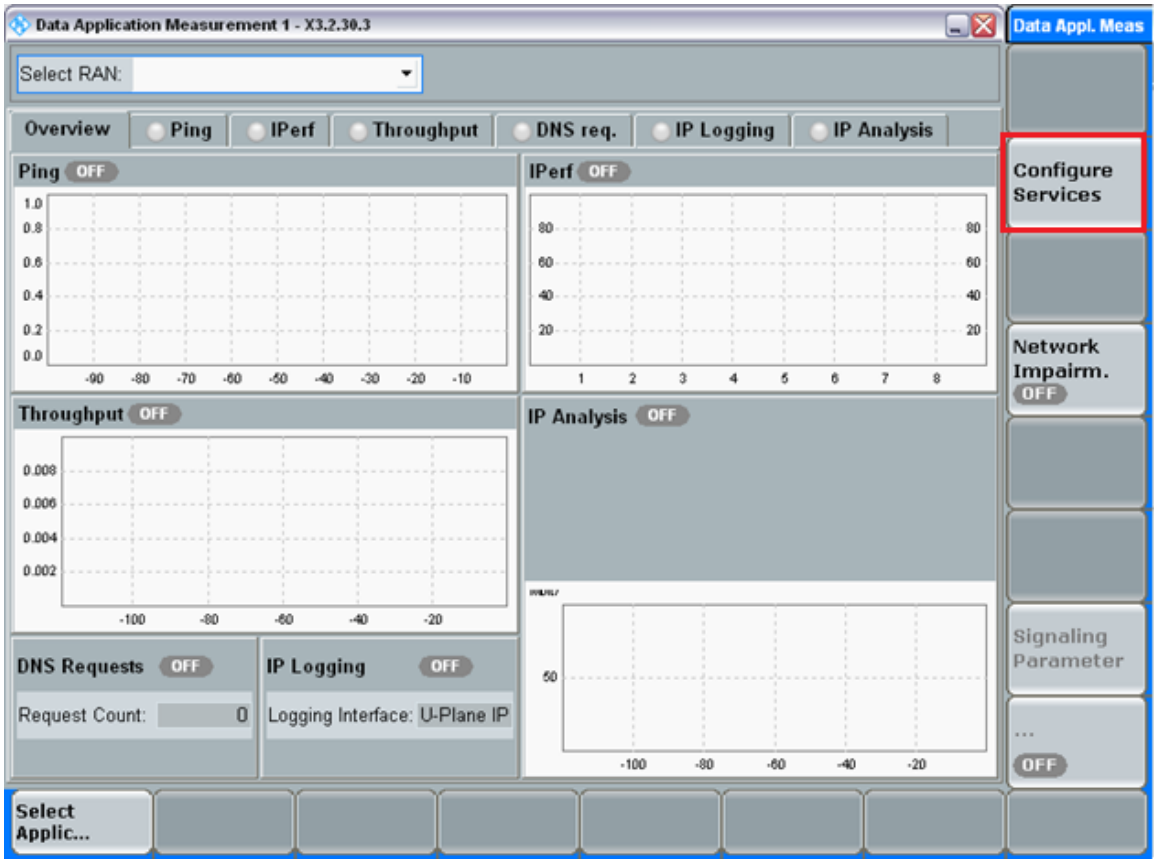


Fig. 4-10: Data Application Measurement

3. Open the IMS Configuration by pressing the **CONFIG…** button in the IMS tab of the DAC and expand the **VOICE OVER IMS** element in the internal tree.

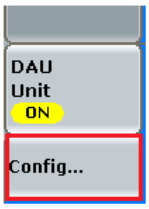


Fig. 4-11: Config… button of the DAC (Data Application Control)

4. Choose the appropriate **PRECONDITIONS** for the UE.

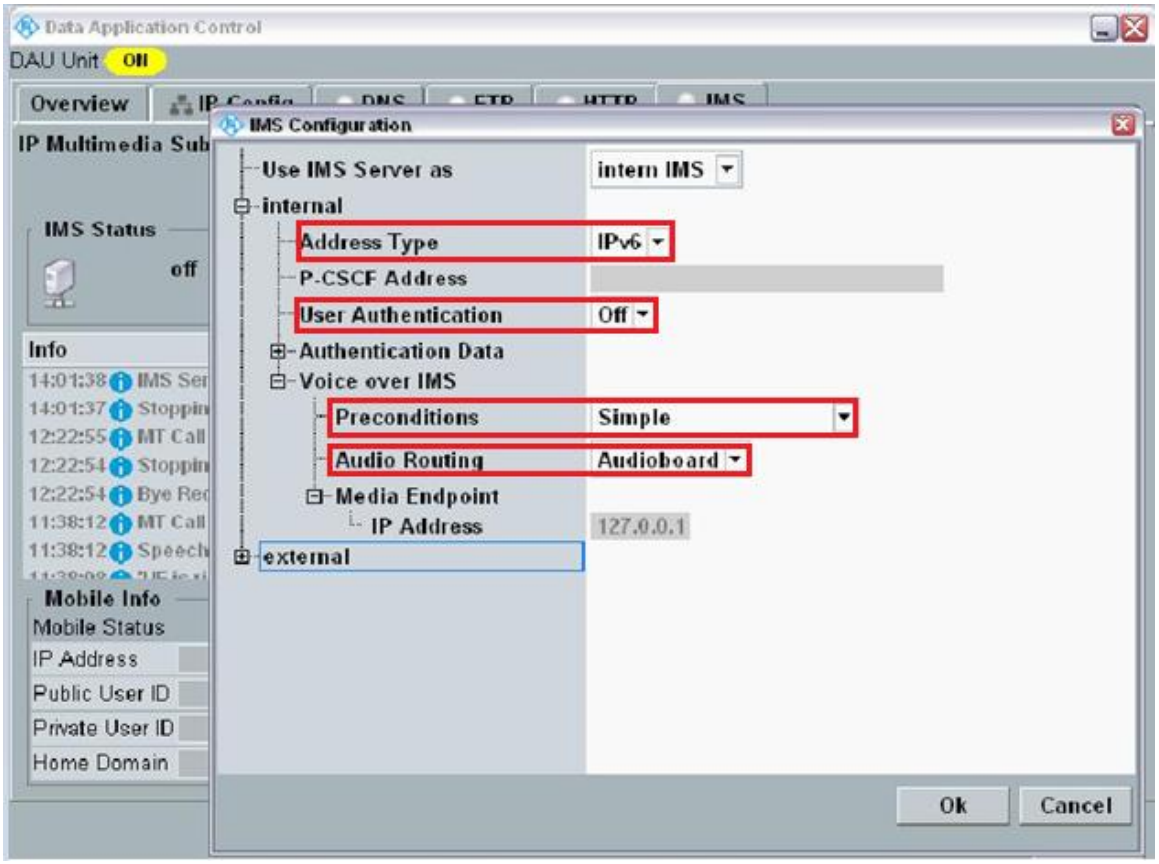


Fig. 4-12: IMS Configuration for Verizon IMS Client

Note: There are different recommended configuration settings depending on the phone used.

Settings	AT&T	Verizon
Address Type	IPv6	IPv6
User Authentification	Off	Off
Preconditions	Preconditions	Simple
Audio Routing	Audioboard	Audioboard

Table 4-1: Mobile specific settings

5. Activate the IMS server by clicking on the ON/OFF button. The IMS server automatically connects with the CMW Audio Board. The Info indicator will show that the IMS server has started successfully.

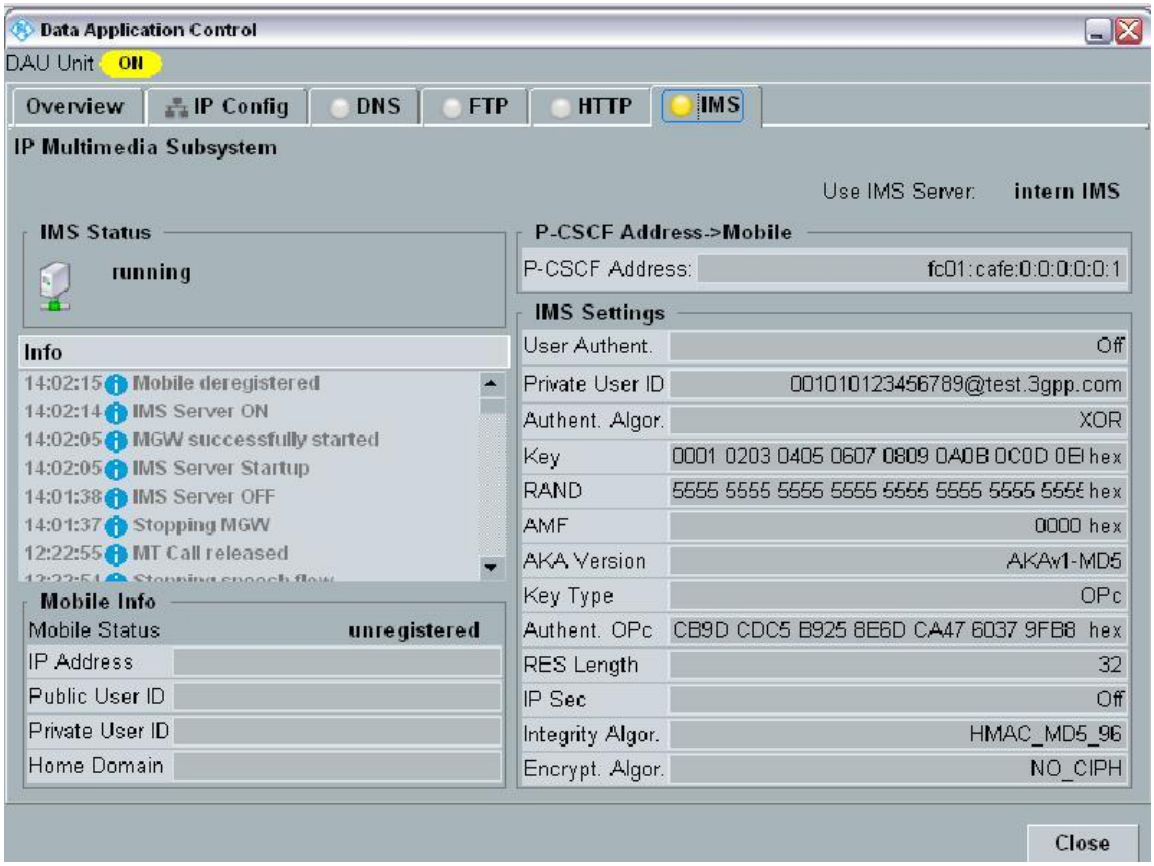


Fig. 4-13: Data Application Control (IMS activated)

Memorize all the settings mentioned in this chapter since they are also needed for the automated test solution with CMWrun.

5 Establishing a manual Voice over IMS Call

The CMW-Z50 CMW500 Handset option allows quick check, if the audio signal to and from the mobile is transmitted correctly before a UPV is connected as shown in Fig. 2-1.

Fig. 5-1: CMW-Z50 Handset

It is simply connected the AF IN 1(2) and AF OUT 1(2) of the CMW500.

1. Start the RAN signaling with the handset connected.
2. Configure LTE in E2E (End to End) mode.
3. Connect the UE to the CMW500 RF COM port.

4. Attach UE to the cell by enabling LTE signaling.

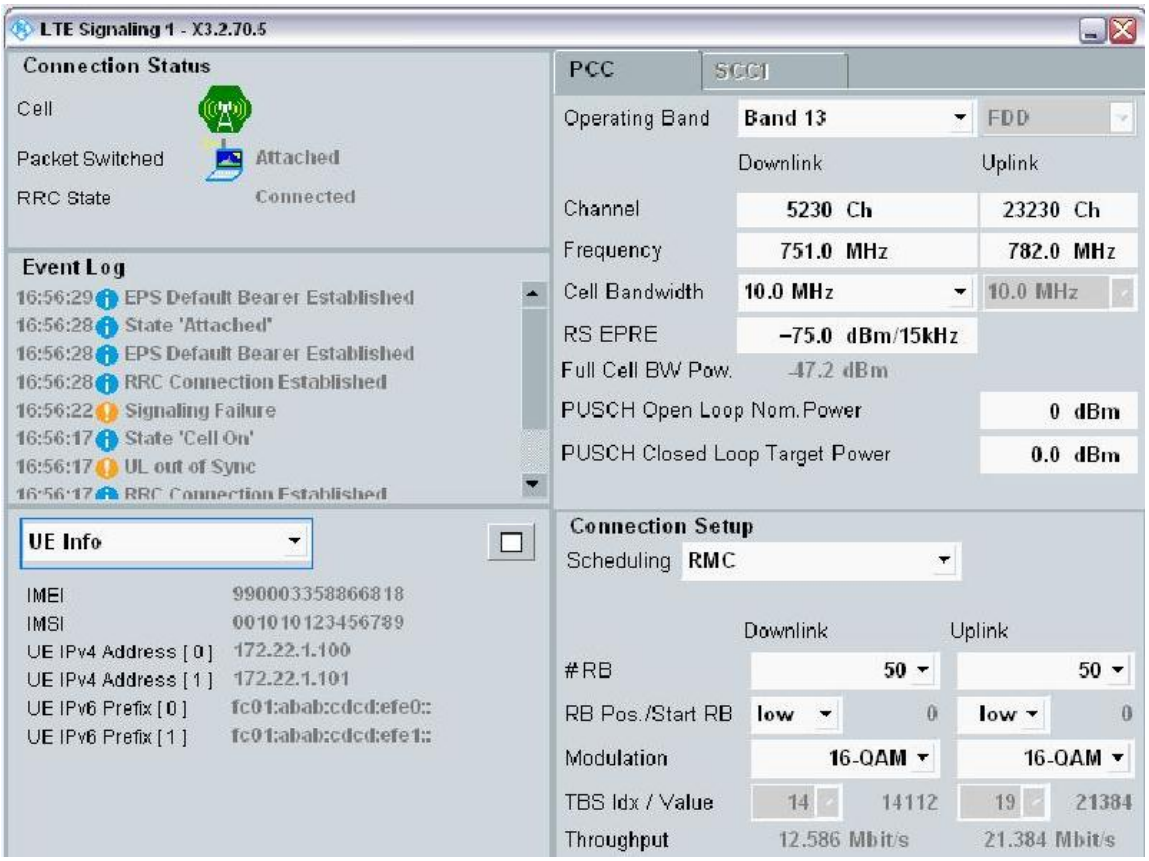


Fig. 5-2: LTE Signaling State Attached

5. After the LTE cell registration, the IMS client running on the UE will register to the CMW500 IMS server. The registration event is displayed in the IMS status log.

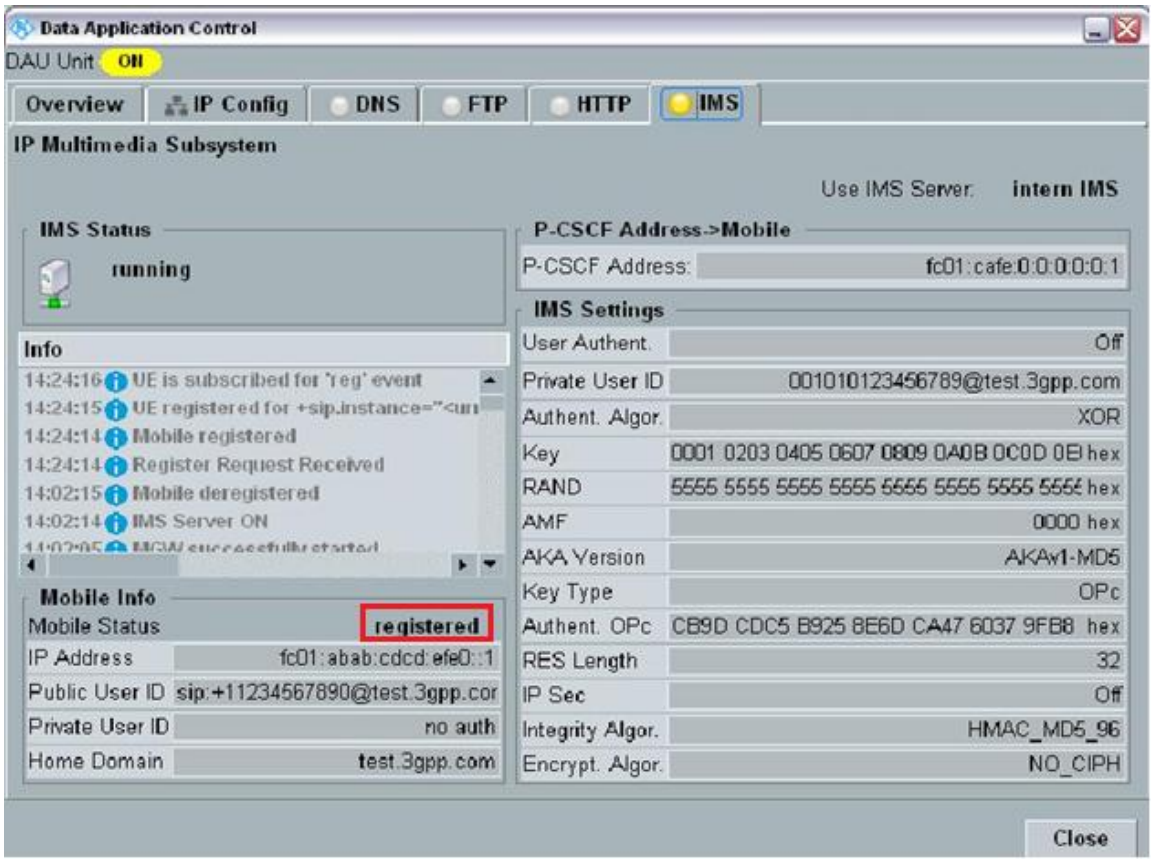


Fig. 5-3: IMS server with registered UE

6. A VoLTE call can be initiated by the UE by dialing a random number. The IMS server will pick up a call from any number.

   Alternatively the mobile can be called from the DAU (as done in automated tests) by pressing the **VOICE OVER IMS** soft key. An additional configuration window will appear. Select Call Type Audio, AMR Type Narrowband or Wideband and one or more AMR Codecs supported by the UE. The VoLTE call is initiated by pressing the **CALL** soft key.

After the VoLTE call has been established, the downlink and uplink audio transmission is active and can be tested with the CMW-Z50. The speech going into the CMW-Z50 microphone should be audible on the mobile phone speaker after a small delay. The speech going into the mobile phone microphone should be audible on the CMW-Z50 speaker after a small delay.

6 VoLTE POLQA / PESQ Measurements with CMWrun

6.1 CMWrun Configuration

The following VoLTE DLLs are part of the CMWrun / CMW-KT51 General Purpose Package.

- RohdeSchwarz.CMWrun.GP.UPV.SpeechQualityMeasurement.dll
- VoLTE_SpeechQualityMeasurement.dll

Note: The VoLTE applications above require following CMWrun options:

- CMW-KT051 for E2E and VoLTE Speech Quality Applications
- CMW-KT055 for LTE CallSetup

Start CMWrun. Before loading the test plan it is necessary to define the devices' resource strings in the **RESOURCES → SCPI CONNECTIONS…** menu. For the VoLTE Speech Quality Measurement a CMU500 Communication Tester and a UPV Audio Analyzer are required. Set the SCPI connections for the CMW500 and UPV.

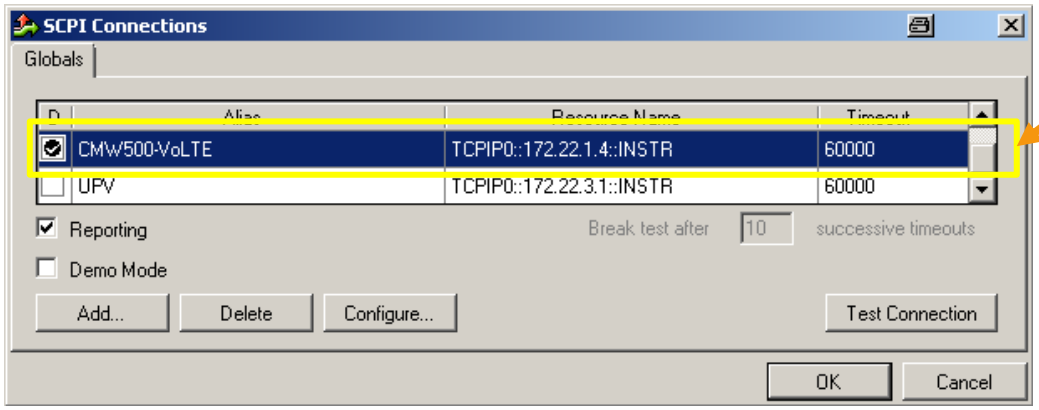


Fig. 6-1: CMRrun SCPI Connections menu

Make sure to set the UPV Timeout to 60 seconds by pressing **CONFIGURE…** to avoid timeout errors. Do the same for the CMW500. Set the CMW500 as default instrument (checkbox ON).

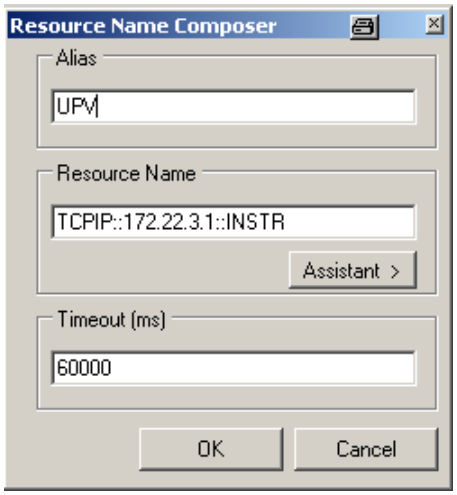


Fig. 6-2: Set UPV Resource Name and Timeout

6.2 POLQA Test Campaign for Multiple Speech Codecs

The figure below shows an example of a campaign for POLQA measurements with all VoLTE WB- and NB-AMR codecs.

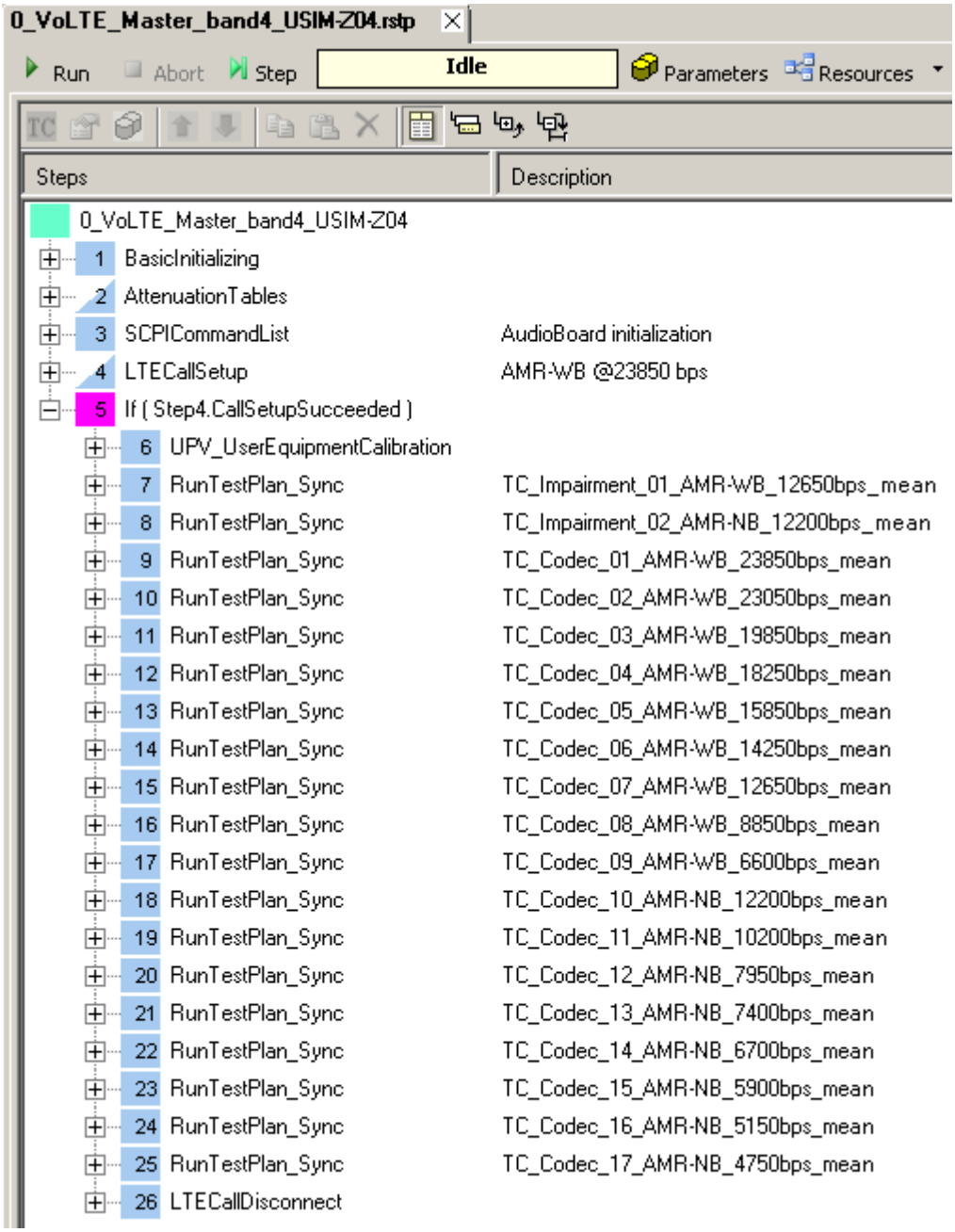


Fig. 6-3: CMWrun – VoLTE test campaign with all NB/WB-AMR Codecs

Test campaign management is supported since CMWrun v1.7.8.03. A master test plan is only performed once and performs the basic initialization, sets the RF attenuation, initializes the internal CMW AudioBoard, performs an LTE / VoLTE call and DAU / IMS initialization, calibrates the mobile phones speaker output and microphone input and finally disconnects the LTE / VoLTE call.

6.2.1 BasicInitializing

This component handles the basic configuration and e.g. resets the CMW500 to default settings. By double clicking **BASICINITIALIZING** a configuration window opens. Check **RESET INSTRUMENT(S)**. This should always be performed to ensure identical starting conditions on different systems.

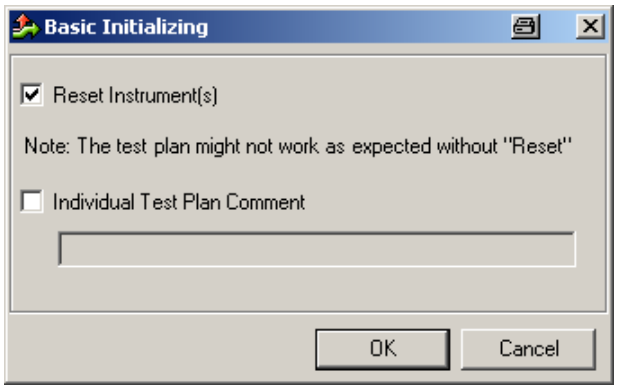


Fig. 6-4: Basis Initializing

6.2.2 SCPICommandList

This menu item contains SCPI commands for initializing the CMW AudioBoard.

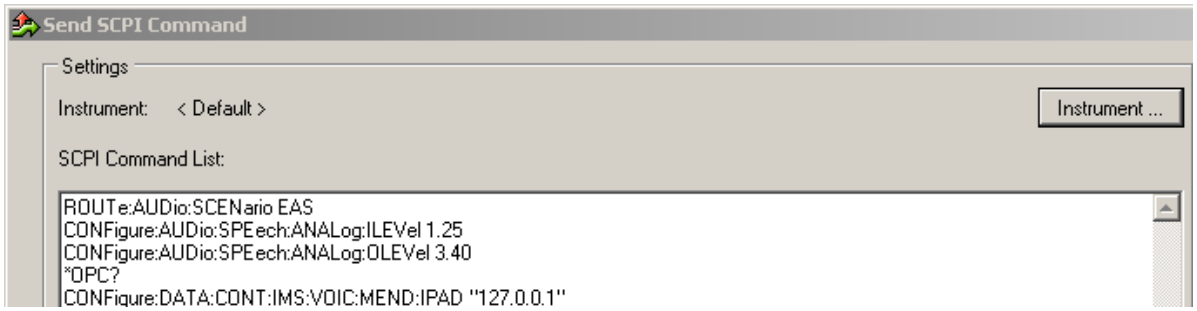
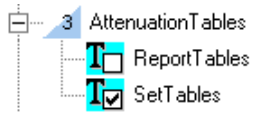


Fig. 6-5: CMW AudioBoard Initialization

The <Default> instrument must have been set to CMW500 in the **SCPI CONNECTIONS** menu (see Fig. 6-1).

6.2.3 Attenuation Tables



This test item allows setting of input and output attenuation values to compensate RF components such as cables, mixers, directional couplers, etc. The attenuations can be set to constant values or be changed by user interaction at runtime.

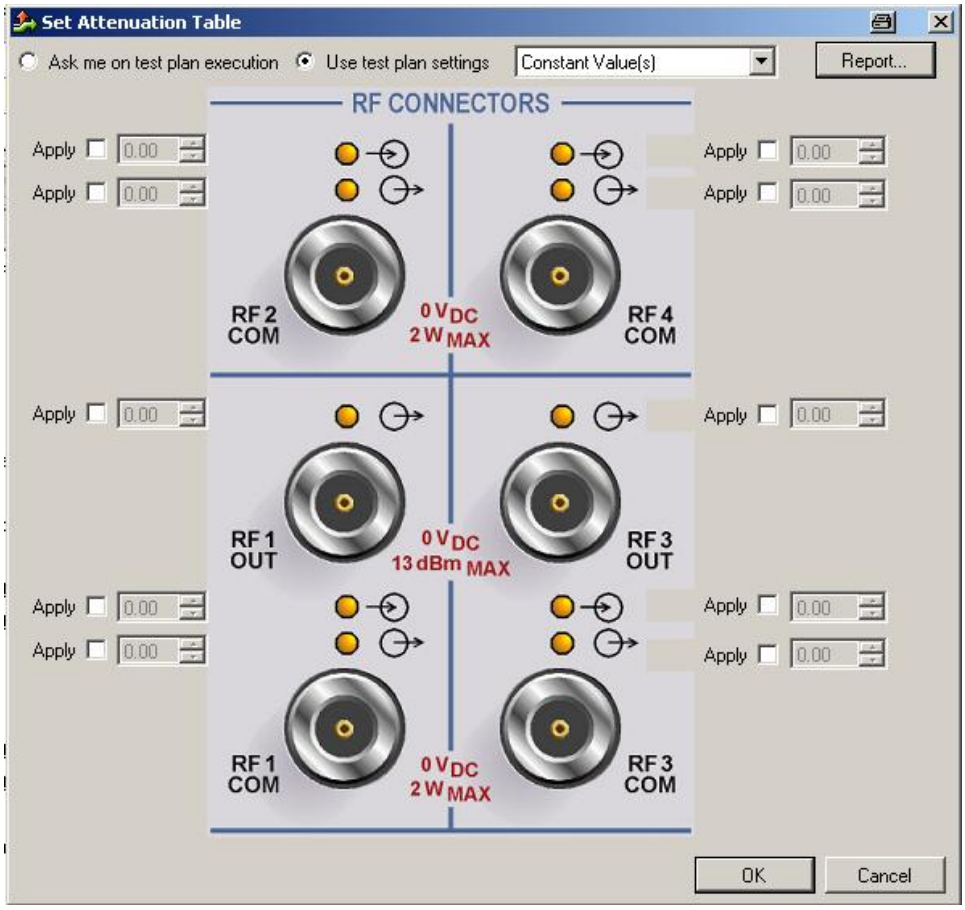
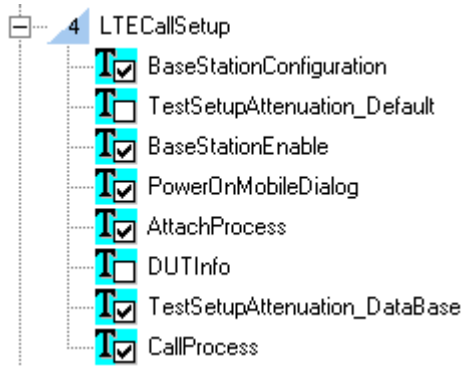


Fig. 6-6: Set Attenuation Table

6.2.4 LTECallSetup



As soon as IMS is turned ON, an LTE cell is established were the UE can attached to. The following screen shot shows the configuration window which opens when double clicking **LTECALLSETUP** in the list:

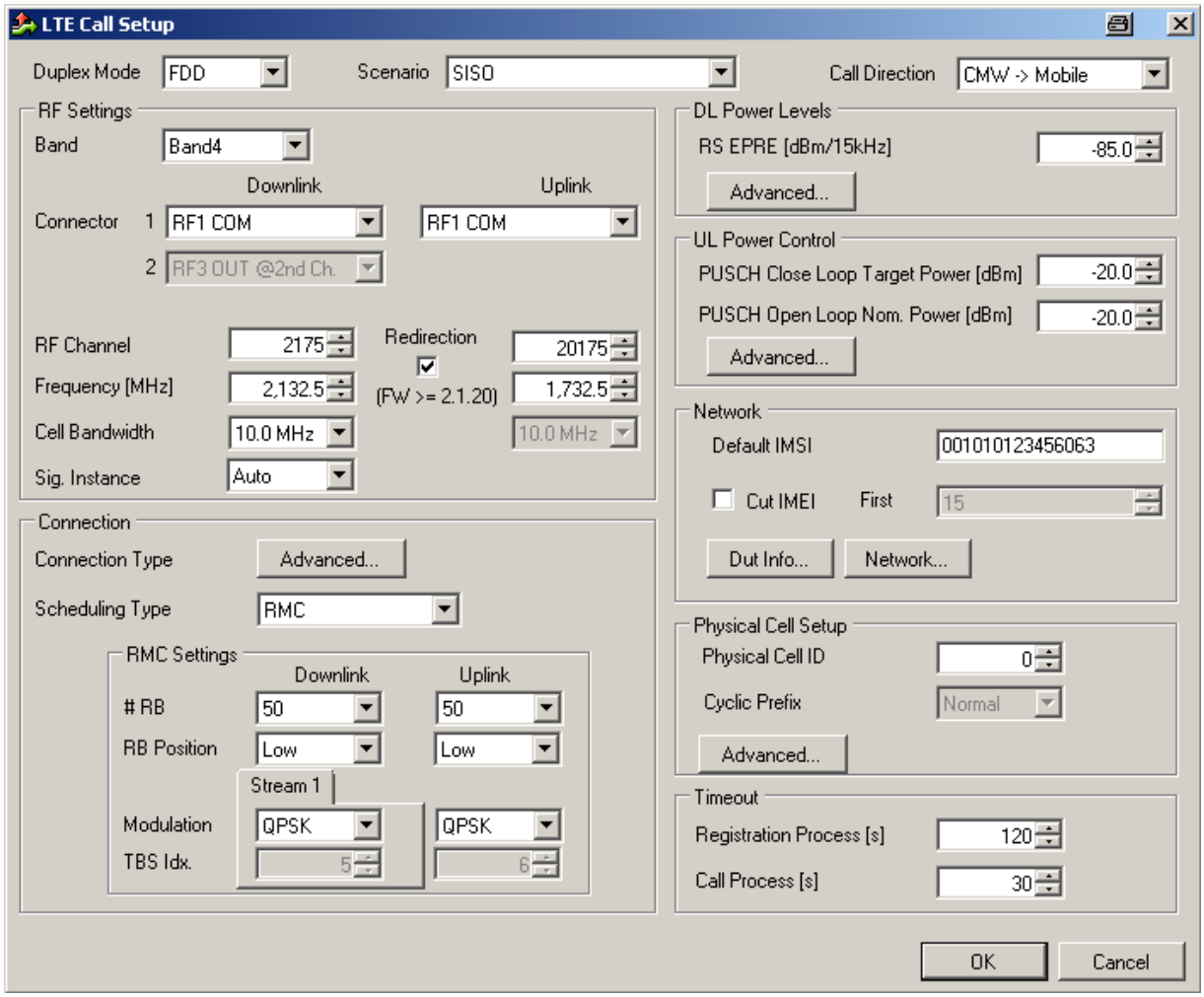


Fig. 6-7: LTE Call Setup

Please make sure that the UE parameters are entered correctly or else the UE will not be attached and the test terminated.

LTE Call Setup parameters in our example that differ from default:

- **SCENARIO** = SISO
- **BAND** = Band4
- **RF DOWNLINK CONNECTOR 1** = RF 1 COM
- **RF UPLINK CONNECTOR** = RF 1 COM
- **SCHEDULING TYPE** = RMC
- **#RB** = 50 (DL), 50 (UL)
- **MODULATION** = QPSK (DL), QPSK (UL)

CONNECTION TYPE → ADVANCED… parameters:

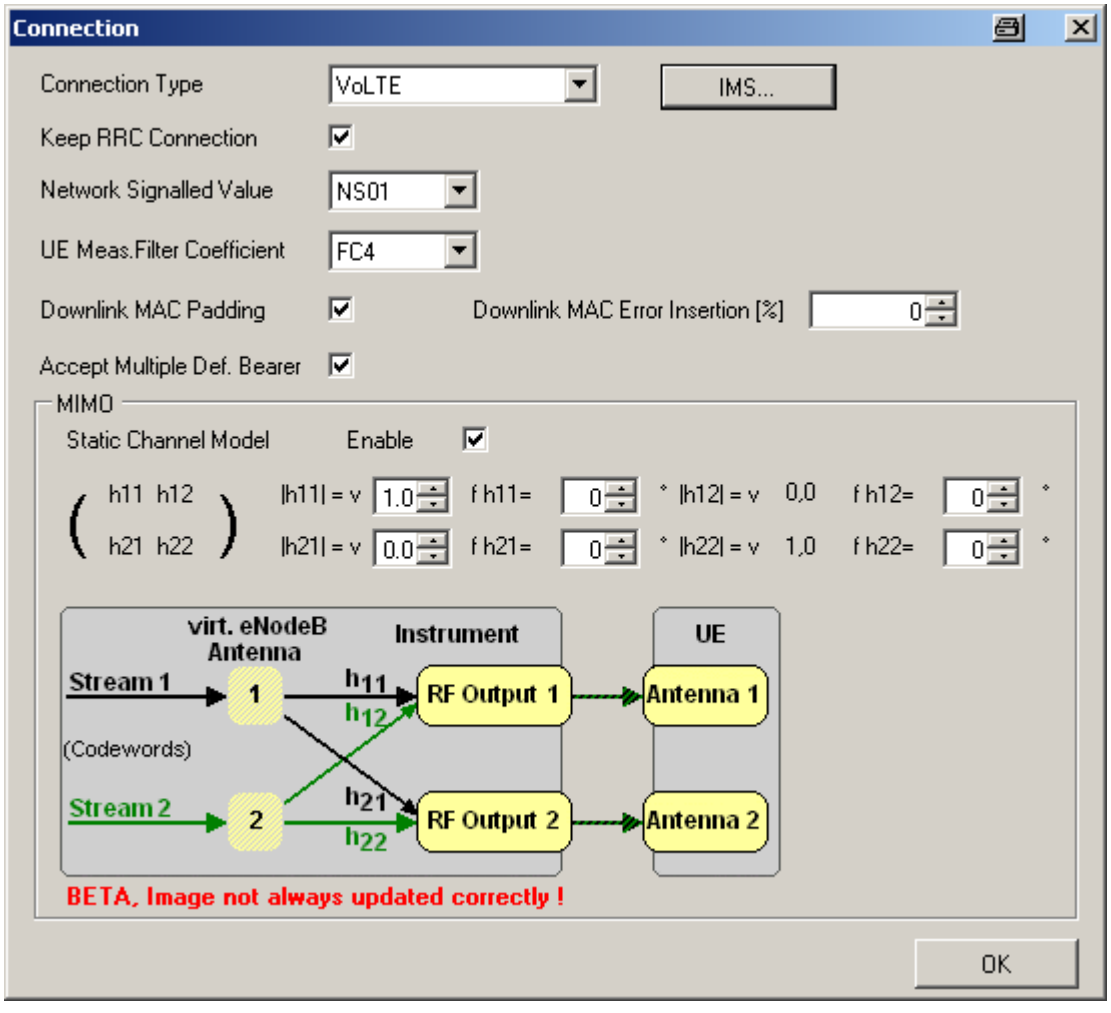


Figure 6-1: Connection Parameters

- **CONNECTION TYPE** = VoLTE

Click on the **IMS…** button to enter the IMS Setup menu.

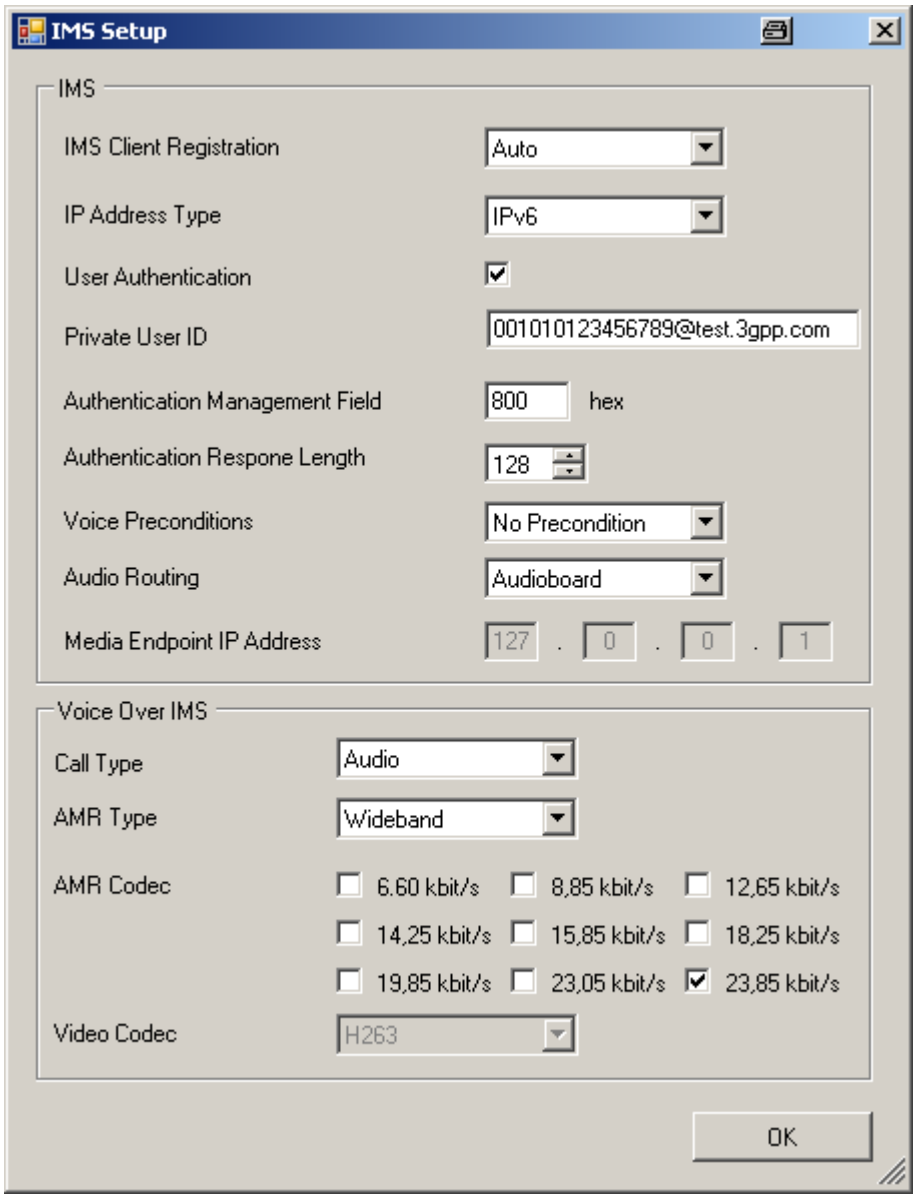


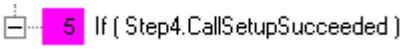
Fig. 6-8: IMS Setup

The following parameters may vary with different mobile manufacturers.

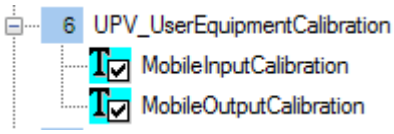
- **IMS CLIENT REGISTRATION** – Manual or Auto, which is sufficient in most cases.
- **IP ADDRESS TYPE** – IPv4 or **IPV6**.
- **USER AUTHENTICATION** – Default ON.
- **VOICE PRECONDITIONS** – With Precondition, **NO PRECONDITION** or Simplified Call Flow.
- **AUDIO ROUTING** – Use internal CMW **AUDIOBOARD**.
- **CALL TYPE** – **AUDIO** or Video.

- **AMR TYPE – WIDEBAND** or Narrowband.
- **AMR CODEC** – Select codec rate (highest value) and possible alternative rates, i.e. **23.85 KBIT/S**.

If the LTE call is successful (if (Step3.CallSetupSucceeded) the test will continue, if not, an error message will be displayed and the test stopped.



6.2.5 UPV_UserEquipmentCalibration



The mobile input / output calibration requires valid decoder / encoder calibration values and an active VoLTE speech connection. The mobile input calibration determines the full-scale peak input voltage of the mobile under test which is connected to UPV generator output 1. The mobile output calibration determines the full-scale peak output voltage of the mobile under test which is connected to UPV analyzer input 1. Perform a calibration when you change the mobile or load stored values from an earlier calibration.

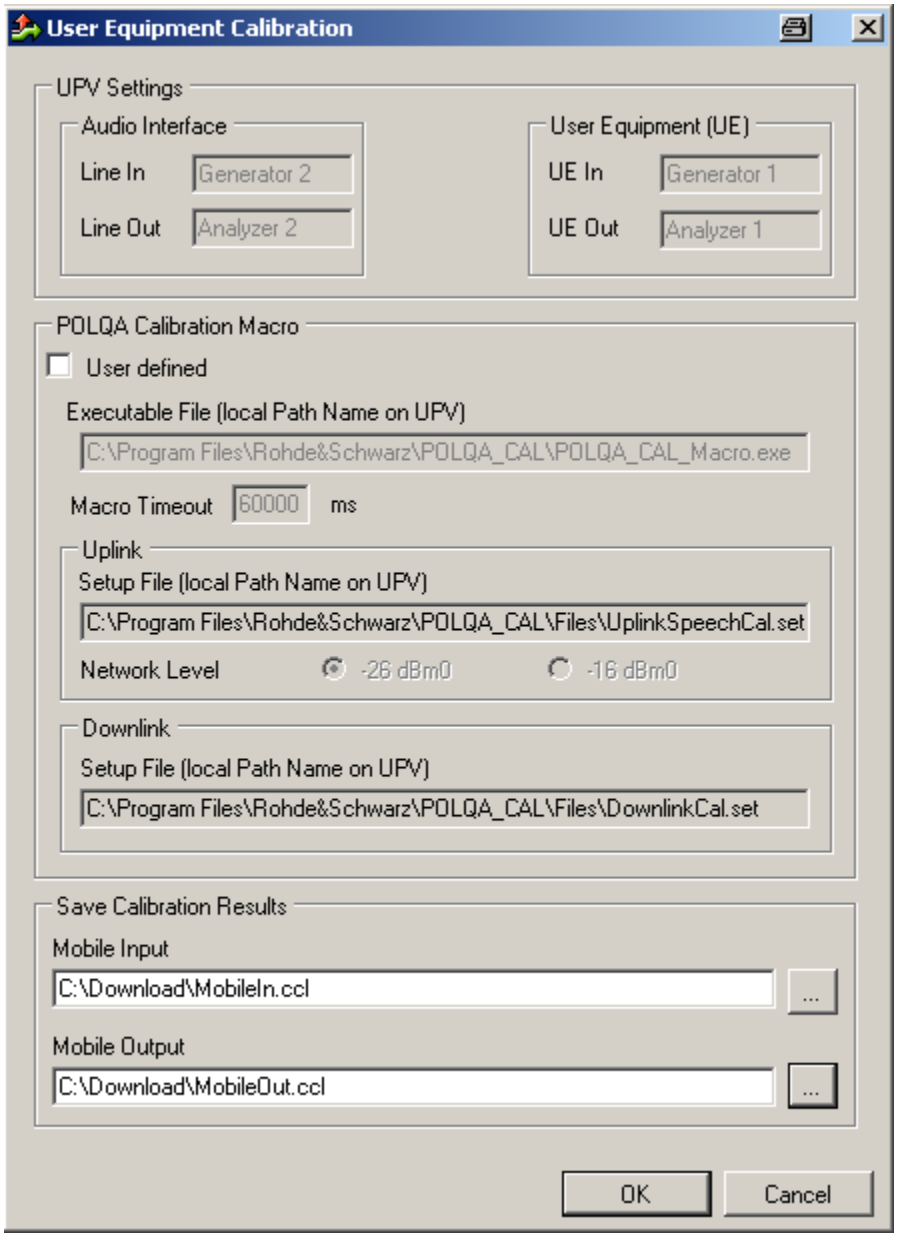


Fig. 6-9: User Equipment Calibration

- **UPV SETTINGS** – Indicates the necessary audio cabling
- **MEDIA SERVER SETTINGS** – Select User defined mode only if custom media server is used.
- **POLQA CALIBRATION MACRO** – Select User define only if custom calibration macro is used.
- **SAVE CALIBRATION RESULTS** – The Mobile Input calibration file contains the peak voltage supplied by UPV generator 2 output, while the Mobile Output calibration File contains the peak voltage supplied by the mobile output.

After these steps, the **RUNTESTPLAN_SYNC** test items execute further slave test plans to change the codecs and perform a POLQA measurement on the R&S UPV.

After all the slave tests have been completed the results are merged to a single measurement report. Dealing with simple scripts instead of huge and complex test plans simplifies maintenance. The UE call setup and operator specific IMS settings can be handled by separate test plans requiring no changes in the sub-scripts calling the POLQA algorithm. The figure below shows how this works:

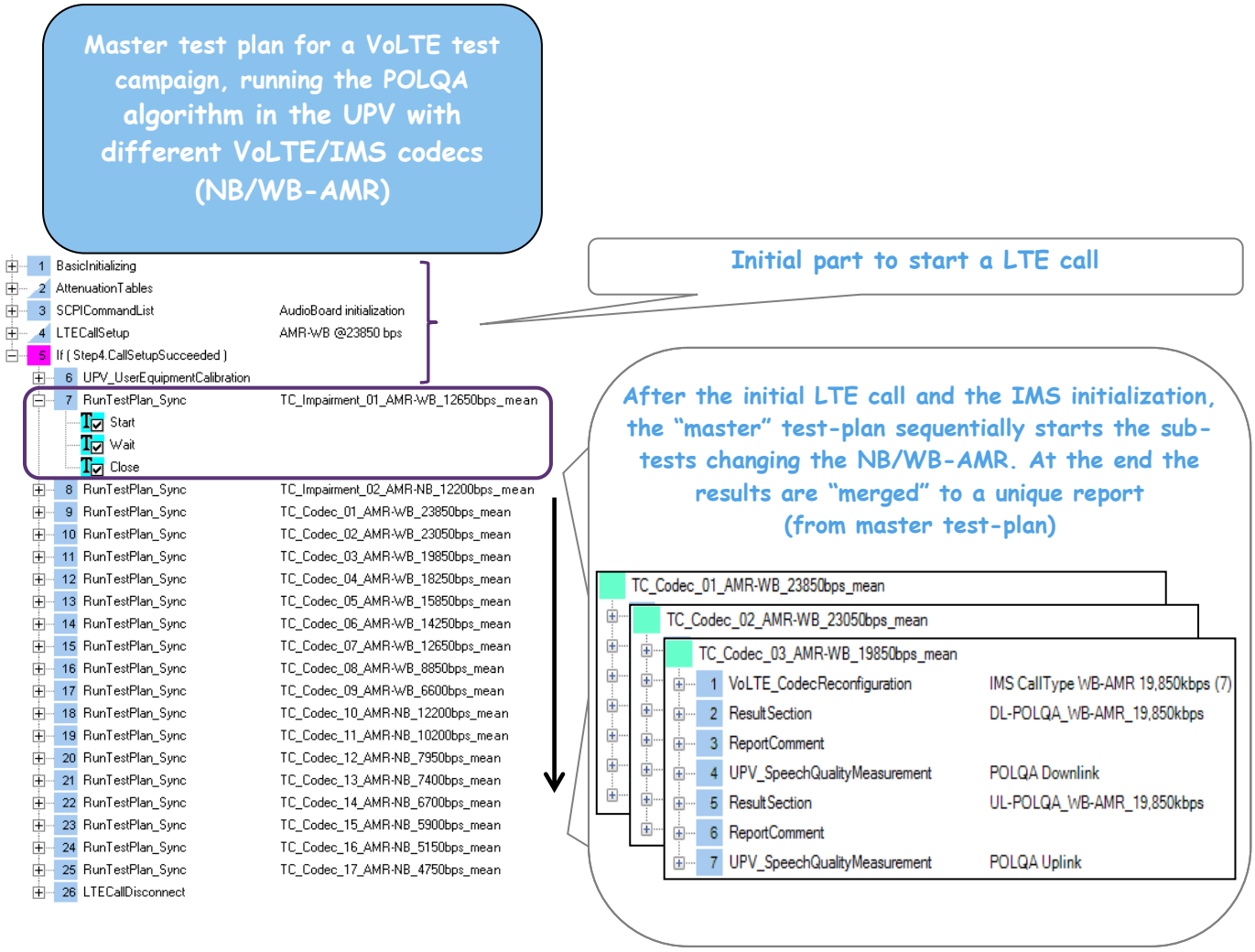


Fig. 6-10: CMWrun – Master and Slave test plan for a VoLTE test campaign

The master test plan controls the POLQA campaign for all VoLTE codecs and IP impairments. This is ideal for regression tests, since the POLQA algorithm takes time and needs to be repeated several times for statistical confidence. Therefore the campaign approach with CMWrun is mandatory to reduce test time and user interaction.

6.2.6 TestPlan_Sync

The TestPlan_Sync test item allows definition a slave test plan and various execution conditions.

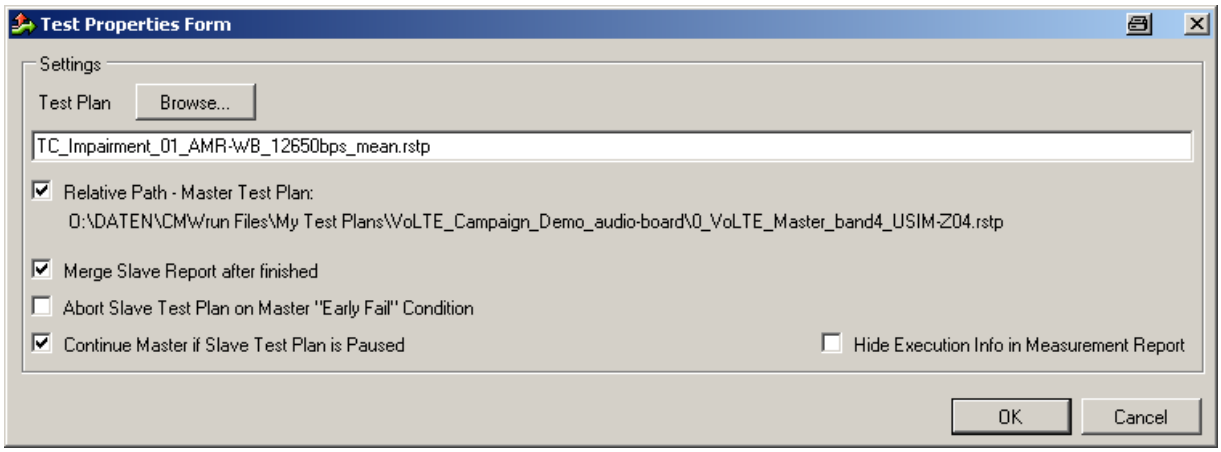
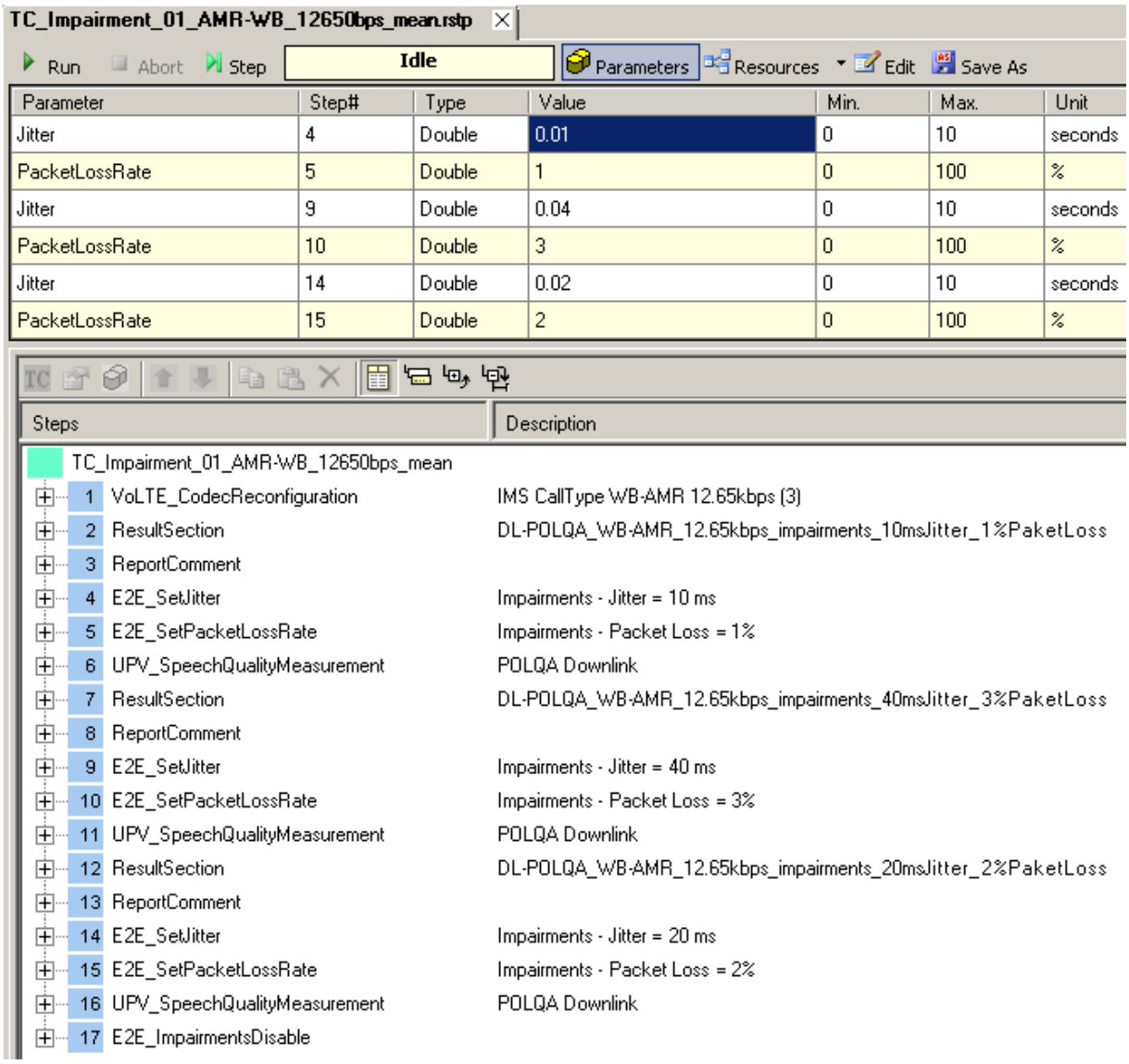


Fig. 6-11: TestPlan_Sync

- **RELATIVE PATH – MASTER TEST PLAN** – If checked, the test plan file is in the same directory as the master test plan.
- **MERGE SLAVE REPORT AFTER FINISHED** – If checked, this test report is merged to the master test plan report.
- **CONTINUE MASTER IF SLAVE TEST PLAN IS PAUSED** – If checked, the Master Test Plan continues with the next test item if the slave test plan is paused.

The slave test plan in this example is TC_Impairment_01_AMR-WB_12650bps_mean.rstp which contains all POLQA related test items.



Parameter	Step#	Type	Value	Min.	Max.	Unit
Jitter	4	Double	0.01	0	10	seconds
PacketLossRate	5	Double	1	0	100	%
Jitter	9	Double	0.04	0	10	seconds
PacketLossRate	10	Double	3	0	100	%
Jitter	14	Double	0.02	0	10	seconds
PacketLossRate	15	Double	2	0	100	%

Fig. 6-12: TC_Impairment_AMR-WB_12650bps_mean test plan

This test plan is suited for our example since it contains all POLQA related test items.

6.2.6.1 VoLTE_CodecReconfiguration

This test item allows to change the VoLTE call and codec parameters during an active LTE / VoLTE call.

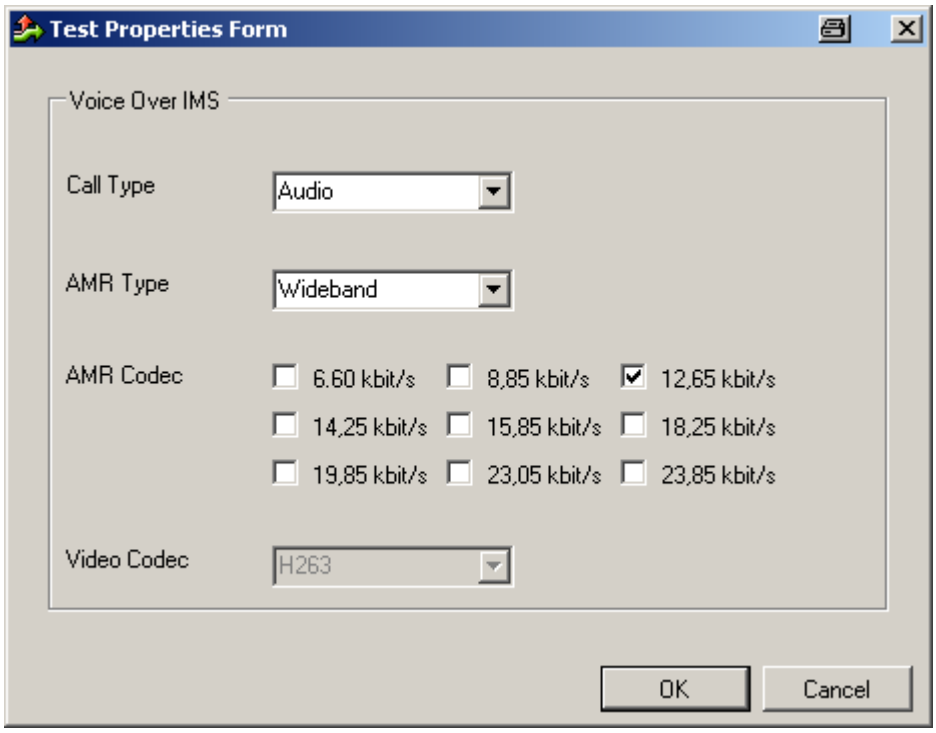
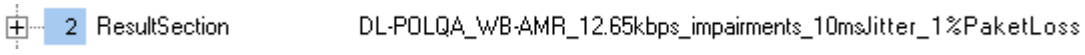


Fig. 6-13: VoLTE_CodecReconfiguration

- **CALL TYPE** – Video or Audio (default)
- **AMR TYPE** – Wideband or Narrowband (default)
- **AMR CODEC** – 12.65 kbps in this test item.
- **VIDEO CODEC** – H263 (default) or H264. Only active if Call Type = Video.

6.2.6.2 Result Section



Defines a name for the appended section in the test report.

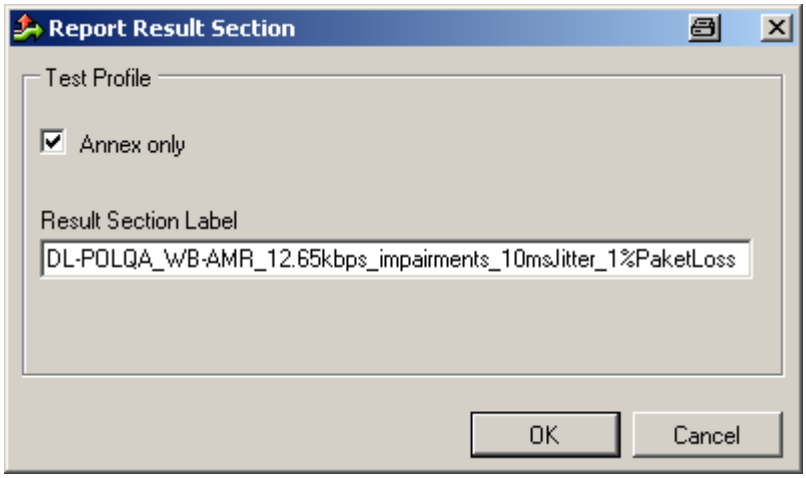
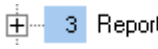


Fig. 6-14: Report Result Section

- **ANNEX ONLY** – If checked, appends the results at the end of the test report.

6.2.6.3 Report Comment



Allows adding a detailed comment in the test report.

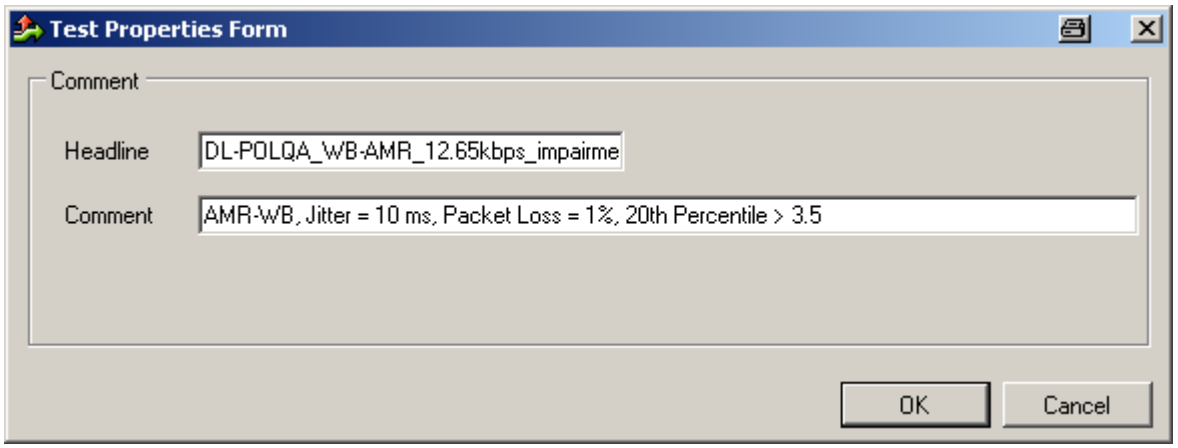


Fig. 6-15: Report Comment

6.2.6.4 E2E_SetJitter

Adds an artificial jitter to the IP stream, simulating real-world internet connectivity. This stresses the AMR codec which must maintain a decent voice quality under tightened transmission conditions.

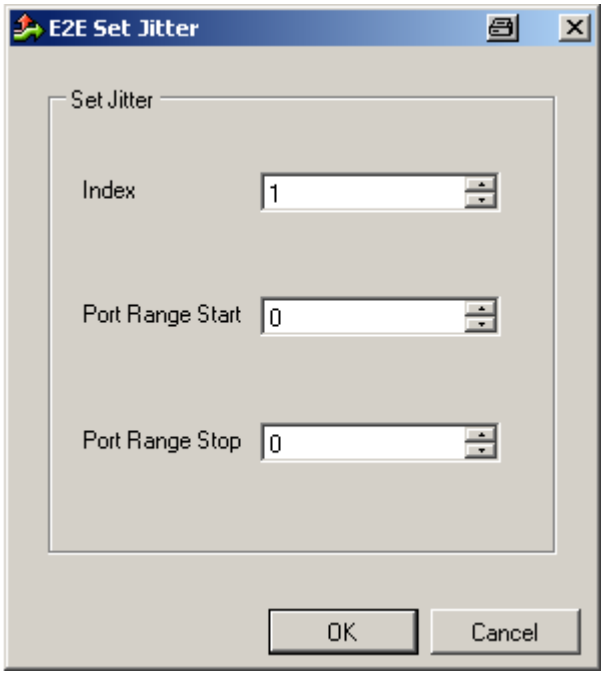


Fig. 6-16: E2E Set Jitter

The Index, Port Range Start and Port Range Stop controls are actually global parameters that are defined in the parameters display above the test case.

Parameter	Step#	Type	Value	Min.	Max.	Unit
Jitter	4	Double	0.01	0	10	seconds

Fig. 6-17: E2E Set Jitter global parameters

This corresponds to test item #4

- **INDEX** = Value = 0.01 secs = 10 ms jitter.
- Port Range Start = Min. = lower jitter limit 0 seconds.
- Port Range Stop = Max. = upper jitter limit 10 seconds.

6.2.6.5 E2E_SetPacketLossRate

The E2E_SetPacketLossRate artificially degrades a signal by not transmitting a dedicated number of data packets.

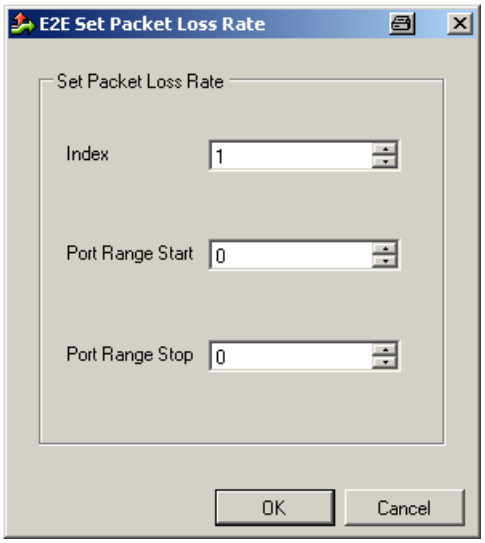


Fig. 6-18: E2E Set Packet Loss Rate

The Index, Port Range Start and Port Range Stop controls are actually global parameters that are defined in the parameters display above the test case.

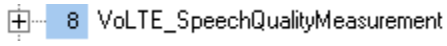
PacketLossRate	5	Double	1	0	100	%

Fig. 6-19: Set Packet Loss Rate global parameters

This corresponds to test item #5

- **INDEX** = Value = 1 %.
- Port Range Start = Min. = lower packet loss rate limit 0 %.
- Port Range Stop = Max. = upper packet loss rate limit 100 %.

6.2.6.6 VoLTE_SpeechQualityMeasurement



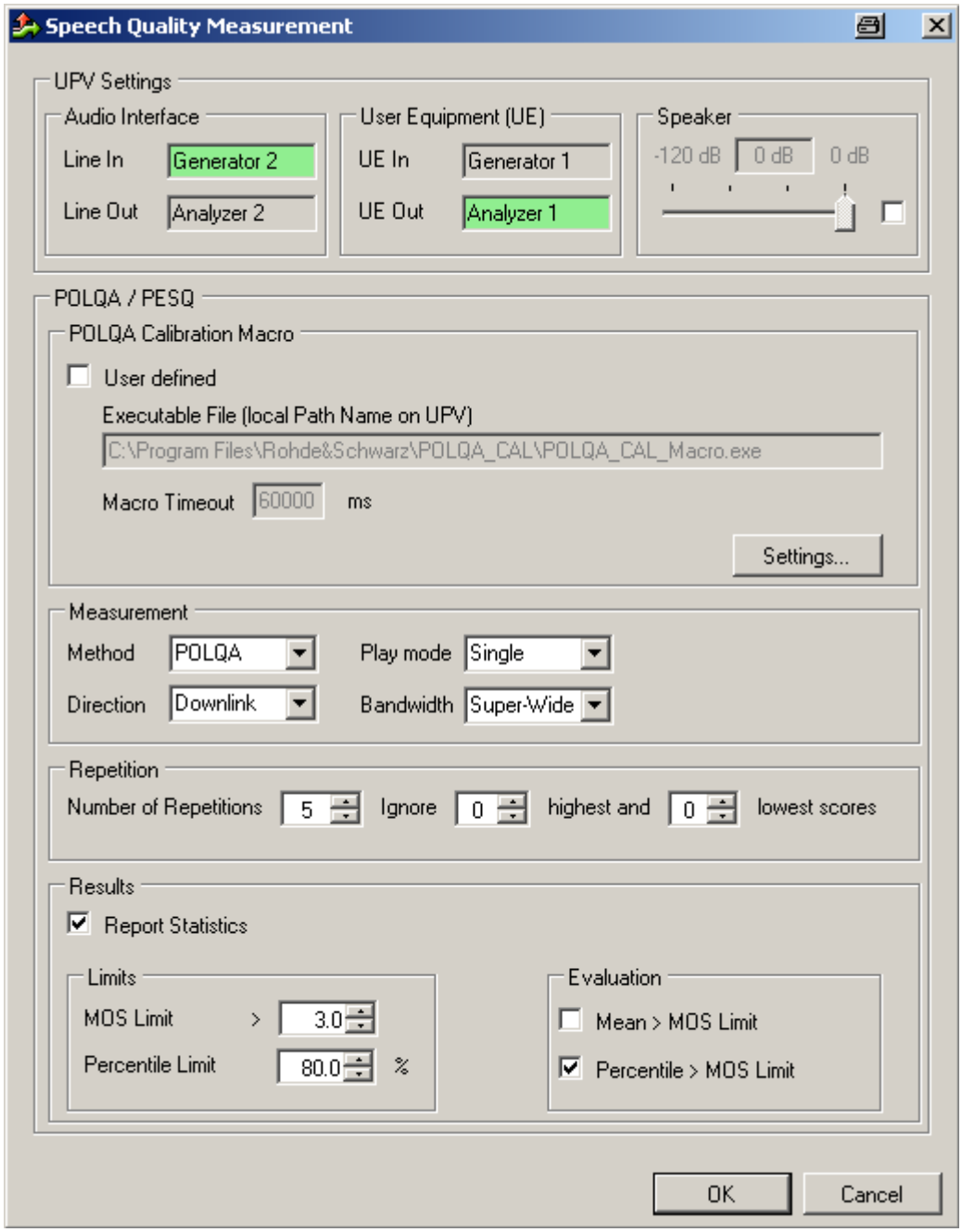


Fig. 6-20: Speech Quality Measurement

Parameters for the POLQA / PESQ measurement are set in this test item.

- **UPV SETTINGS** – The green **AUDIO INTERFACE** and **USER EQUIPMENT** indicators depend on the Measurement Direction. The UPV input signal can be monitored by activating the **SPEAKER** checkbox.
- **POLQA CALIBRATION MACRO** – Select **USER DEFINE** only if custom calibration macro is used. The **MACRO SETTINGS** can be edited by clicking the **SETTINGS…** button (see Fig. 6-18).

  MACRO SETTINGS – Define the default settings of the POLQA_Cal Macro which runs on the UPV and performs calibration and measurement tasks.

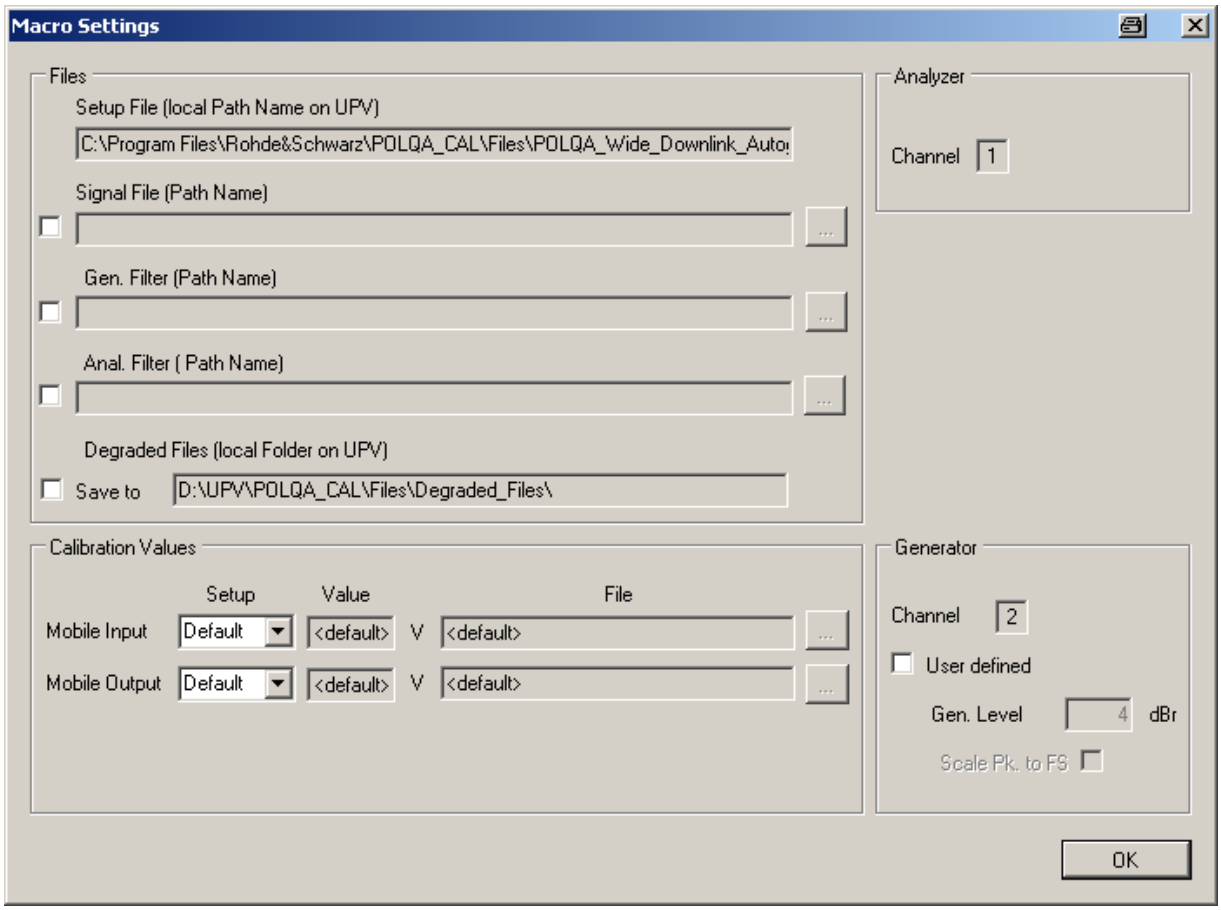


Fig. 6-21: Macro Settings

The parameters the need to be changed are the Setup modes of the Decoder, Encoder, Mobile Input and Mobile Output Calibration Values.

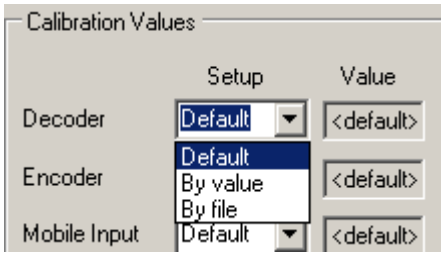


Fig. 6-22: Modes for Calibration Values

- **DEFAULT** – Uses current active calibration values from the UPV. These values are updated with every calibration step of the setup.
- **BY VALUE** – Allows to enter custom values which are stored in the test plan itself.
- **BY FILE** – Allows reading calibration values from a custom file which has been previously generated.

- **MEASUREMENT**
  - **METHOD** – Select POLQA or PESQ measurement.
  - **DIRECTION** – **DOWNLINK** (base station to mobile) or **UPLINK** (mobile to base station)
  - **PLAY-MODE** – **SINGLE** or **CONTINUOUS**. In Continuous mode the 1st MOS/LQO value is stored. The following PESQ / POLQA measurements are repeated infinitely.
  - **BANDWIDTH** – **SUPER-WIDE** (POLQA and PESQ) or **NARROW** (only PESQ).

- **REPETITION** – Number of Repetitions 1...999. A number for highest and lowest can be entered to eliminate extreme values from the statistic.
- **RESULTS** – Enable or disable Report Statistics.
  - **MOS LIMIT** – Test passed if MOS/LQO value > MOS limit. Default 3.5.
  - **PERCENTILE LIMIT** – Default 80.0%.
  - **MEAN > MOS LIMIT** – Means that the mean MOS/LQO value

$$mean = \frac{\sum_{k=1}^{NumRep+1} (MOS_k)}{NumRep + 1}$$

    must be larger than the MOS Limit for the test item to pass.
  - **PERCENTILE > MOS LIMIT** – means that 80% of the **NUMBER OF REPETITIONS** +1 must pass, i.e. must exceed the MOS Limit for the test item to pass.

6.2.6.7 E2E_ImpairmentsDisable

Turns OFF E2E jitter, packet loss rate and delay.

6.2.7 LTECallDisconnect

Drops the LTE connection.

6.3 Running the Test

The example below shows how to run the **VoLTE_Speech Quality Meas.rstp** test plan. In this test plan the POLQA MOS/LQO is measured for uplink and downlink at ideal conditions and then a second time with IP delay, jitter and packet loss turned ON.

To start the test, press the **Run** arrow in CMWrun.

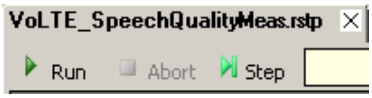
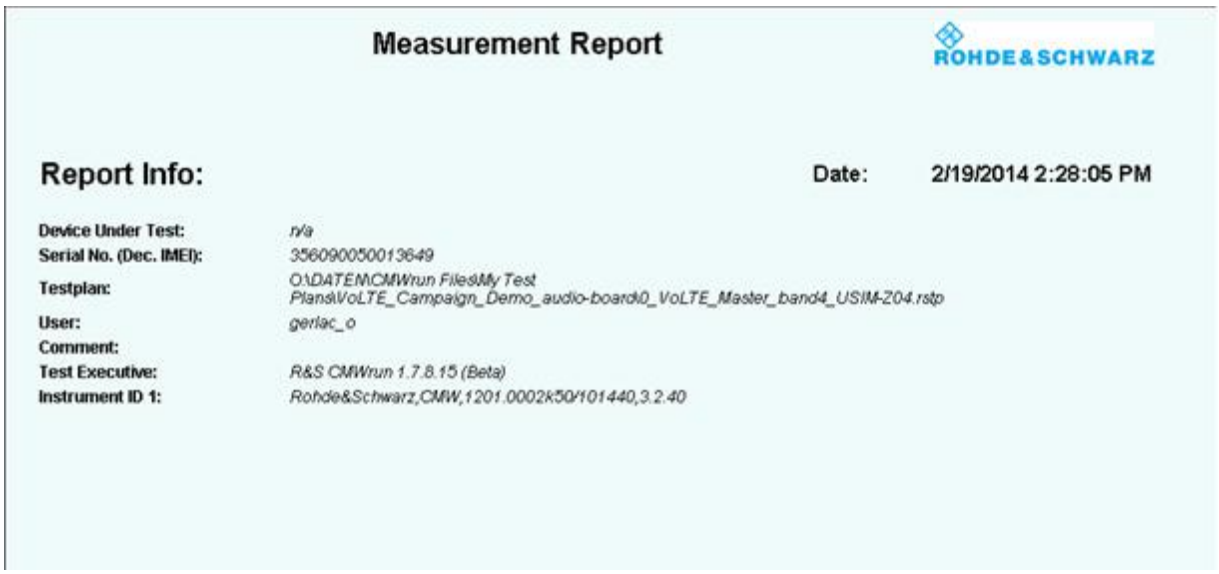


Fig. 6-23: Start a Test Plan

After the test plan has been completed a result table similar to the following is displayed.



Summary:

Test Start Time:	*2/19/2014 2:28:05 PM*
Test End Time:	*2/19/2014 3:14:01 PM*
Total Test Time:	*00:45:56*
Weighted Test Time:	*00:45:56*
Test Items Passed:	*43*
Test Items Failed:	*19*
Number of Test Items:	*62*
Errors:	*2*

Basic Initiation: Initialization of Instrument.

Instrument reset:
CMW - Done !

LTE Call Setup: Base Station Configuration

LTE FDD, Band4
DL Channel 2175, DL Frequency 2132.5, DL Cell Bandwidth 10.0 MHz
UL Channel 20175, UL Frequency 1732.5, UL Cell Bandwidth 10.0 MHz
Connection Type: VoLTE
Call Direction: CMW -> Mobile

LTE Call Setup: Base Station Enable

Base Station Enabled in 105.9s
IMS Enabled in 9.8s

LTE Call Setup: Power On Mobile Box

LTE Call Setup: Attach Process

Attach Process		Timeout	Elapsed Time	Unit	Status
Attached		120	63.2	s	Passed
IMS Registered		120	5	s	Passed

LTE Call Setup: DUT Info

Test Item	Lower Limit	Upper Limit	Measured	Unit	Status
DUT Info					
IMEI	---	---	356090050013649	---	Passed

LTE Call Setup: Call Process

Call Process		Timeout	Elapsed Time	Unit	Status
Connection Established		30	6.8	s	Passed

UPV_UserEquipmentCalibration: Mobile Input Calibration

Mobile Input calibrated in 48.8 s

Test Item			Measured	Unit	Status
Mobile Input Speech Calibration *@Network Level: -16 dBm0*			0.1226	V	Passed

UPV_UserEquipmentCalibration: Mobile Output Calibration

Mobile Output calibrated in 11.8 s

Test Item			Measured	Unit	Status
Mobile Output Calibration *@Network Level: -16 dBm0*			0.9011	V	Passed

RunTestPlan_Sync: Start

Test Plan "O:\DATEN\CMWrun Files\My Test Plans\VoLTE_Campaign_Demo_audio-board\TC_Impairment_01_AMR-WB_12650bps_mean.rstp" started

RunTestPlan_Sync: Wait

Waiting for Test Plan "O:\DATEN\CMWrun Files\My Test Plans\VoLTE_Campaign_Demo_audio-board\TC_Impairment_01_AMR-WB_12650bps_mean.rstp" to finish
Test Plan "O:\DATEN\CMWrun Files\My Test Plans\VoLTE_Campaign_Demo_audio-board\TC_Impairment_01_AMR-WB_12650bps_mean.rstp" finished

VoLTE Codec: Reconfiguration

VoLTE Codec reconfigured
AMR Wideband CODEC: 12,65 kbit/s

UPV_SpeechQualityMeasurement: POLQA Measurement

Start Measurement: POLQA - Downlink, Super-Wide, Single-Mode
1 / 5 . . .
<– MOS=3.9342
2 / 5 . . .
<– MOS=3.9143
3 / 5 . . .
<– MOS=3.9703
4 / 5 . . .
<– MOS=3.8698
5 / 5 . . .
<– MOS=3.9111

Test Item	Lower Limit	Avg. Delay	Measured		Status
Measurement (Ref.-File: 'C:/UPV/Config/ref/PolqaRef48000.wav' - Downlink, Super-Wide, Single-Mode)					
POLQAMeasurement *001*	---	178.2 ms	3.9342	---	
POLQAMeasurement *002*	---	178.1 ms	3.9143	---	
POLQAMeasurement *003*	---	177.5 ms	3.9703	---	
POLQAMeasurement *004*	---	177.9 ms	3.8698	---	
POLQAMeasurement *005*	---	177.8 ms	3.9111	---	

Test Item	Min MOS	Max MOS	Avg MOS	StdDev	
Statistics (Ref.-File: 'C:/UPV/Config/ref/PolqaRef48000.wav' - Downlink, Super-Wide, Single-Mode)					
POLQA Measurement *5 trial(s)*	3.8698	3.9703	3.9199	0.0328	
Median	---	---	3.9143	---	
03rd Percentile	---	---	3.8747	---	
10th Percentile	---	---	3.8863	---	
25th Percentile	---	---	3.9111	---	
50th Percentile (Median)	---	---	3.9143	---	
75th Percentile	---	---	3.9342	---	
90th Percentile	---	---	3.9559	---	
97th Percentile	---	---	3.9660	---	

Test Item	MOS Limit	Percentile Limit	Calculated		Status
Evaluation (Ref.-File: 'C:/UPV/Config/ref/PolqaRef48000.wav' - Downlink, Super-Wide,Single-Mode)					
POLQA Measurement *80.00th Percentile > 3.00*	3.00	80.00 %	100.00 %	---	Passed

Fig. 6-24: Excerpt of VoLTE Campaign Demo AudioBoard

7 Literature

[1] R&S®UPV Operating Manual

[2] Application Note 1GA49, “Psychoacoustic Audio Quality Measurements Using R&S®UPV Audio Analyzer”

[3] Application Note 1GA50, “ Calibration Tool for PESQ® Speech Quality Tests”

[4] Application Note 1GA63, “”

[5] Application Note 1MA119 "PESQ® Measurement for GSM with R&S®CMUgo"

[6] Application Note 1MA136 "PESQ® Measurement for CDMA2000 with R&S®CMUgo"

[7] Application Note 1MA137 "PESQ® Measurement for WCDMA with R&S®CMUgo"

[8] Application Note 1MA149 “VoIP Measurements for WiMAX"

[9] Application Note 1MA202 “Next-Generation (3G/4G) Voice Quality Testing with POLQA®"

8 Additional Information

Please send your comments and suggestions regarding this application note to

TM-Applications@rohde-schwarz.com

9 Ordering Information

Ordering Information		
Wideband Radio Communication Tester		
CMW500	**Wideband Radio Comm. Tester**	**1201.0002K50**
CMW-PS503	Basic Assembly (mainframe), 70 MHz to 3.3 GHz	1208.7154.02
CMW-S550B	Basic Interconnection, flexible link, for non-signaling, signaling and IQ access	1202.4801.03
CMW-S590A	RF front end, advanced functionality	1202.5108.02
CMW-S600B	CMW500 front panel with display/keypad	1202.0102.03
CMW-B570B	RF Converter (TRX)	1202.5008.03
CMW-S100A	Baseband Measurement Unit, 1 GByte memory	1202.4701.02
CMW-B300B	Signaling Unit Wideband (SUW), for WCDMA / LTE	1202.6304.02
CMW-B450D	Data Application Unit, H450A (hw opt.)	1202.8759.05
CMW-B660A	Option Carrier	1202.7000.02
CMW-B661A	Ethernet Switch Board	1202.7100.02
CMW-B690B	OCXO, high stability	1202.6004.02
CMW-B400	Audio Analyzer/Generator Board	1207.8457.02
CMW-B405	Speech Codec Board	1207.8257.02
CMW-PK45	E2E Bundle including IP Enabler, IMS, and IP Measurements and Analysis	1207.6354.03
CMW-KS500	LTE FDD Release 8, SISO, signaling/network emulation	1203.6108.02
CMW-KS510	LTE Release 8, SISO, signaling / network emulation, advanced functionality	1203.9859.02
Audio Analyzer		
UPV	**Audio Analyzer, analog interfaces, DC to 250 kHz**	**1146.2003.02**
Or UPV66	**Audio Analyzer without display/keypad**	**1146.2003.66**
UPV-K9	Base Software for Mobile Phone Tests incl. cables and adapters	1402.0008.02
UPV-K91	UMTS/GSM Mobile Phone Tests	1402.0108.02
UPV-K61	Speech Quality Measurement PESQ, to ITU-T rec. P.862	1401.7309.02
UPV-K63	Listening Quality Analysis POLQA, to ITU-T rec. P.863	1402.1156.02
UPV-K1	Universal Sequence Controller	1401.7009.02
Optional:		
UPV-K4	Remote Control for IEC625 / IEEE488, RS232, USB and LAN	1401.9001.02
UPV-K92	CDMA2000 Mobile Phone Tests	1402.0608.02
UPV-K62	Audio Quality Measurement PEAQ, to ITU-R rec. BS.1387	1401.7750.02
UPV-B3	Second Analog Generator, DC to 80 kHz	1401.4806.02
CMWrun Software Sequencer Tool		
CMWPC	PC based CMW applications	1201.0002.90
CMW-KT051	R&S®CMWrun sequencer tool, CMWrun generic proposal	1203.4157.02
CMW-KT055	R&S®CMWrun sequencer tool, LTE applications	1207.2107.02

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Rohde & Schwarz is an independent group of companies specializing in electronics. It is a leading supplier of solutions in the fields of test and measurement, broadcasting, radiomonitoring and radiolocation, as well as secure communications. Established more than 75 years ago, Rohde & Schwarz has a global presence and a dedicated service network in over 70 countries. Company headquarters are in Munich, Germany.

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Environmental commitment

- Energy-efficient products
- Continuous improvement in environmental sustainability
- ISO 14001-certified environmental management system

Certified Quality System
ISO 9001

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