# PESQ® Measurement for WCDMA with R&S®CMUgo Application Note

## Products:

- | R&S<sup>®</sup>SMU200A | R&S<sup>®</sup>AMU200A
- | R&S<sup>®</sup>CMU200
- | R&S<sup>®</sup>UPV

Recent mobile test methods could not evaluate the quality of data reduced speech signals with different coded and decoded signals. The Perceptual Evaluation of Speech Quality (PESQ) provides the solution for this measuring problem. WCDMA PESQ is an add-on tool for CMUgo for automatic measurement of the PESQ for WCDMA mobile phones according to recommendation ITU-T P.862.1 and P.862.2 featuring selectable fading profiles and variable Additional White Gaussian Noise (AWGN).

PESQ<sup>®</sup> is a registered trademark of OPTICOM Dipl.-Ing. M. Keyhl GmbH, Germany and of Psytechnics Ltd., UK

O.Gerlach

Application Note

04.2009-1MA137\_0e



Table of Contents

1	Overview	4
2	Introduction to PESQ	4
2.1	PESQ Value and MOS Value	6
3	PESQ Measurement According to ITU P.862.1	8
3.1	Hardware Configuration	8
3.2	Flowchart of the PESQ Measurement	10
3.3	Manual PESQ Measurement	11
3.3.1	WCDMA Call Setup	11
3.3.2	WCDMA PESQ Measurement	12
3.4	Automatic PESQ Measurement with CMUgo	22
3.4.1	Configuring and Starting the PESQ Measurement Sequence	24
3.4.2	Storage and Further Processing of Measurement Data	30
4	Literature	33
5	Additional Information	33
6	Ordering Information	34

# 1 Overview

Recent mobile test methods could not evaluate the quality of data reduced speech signals with different coded and decoded signals. The Perceptual Evaluation of Speech Quality (PESQ) provides the solution for this measuring problem. WCDMA PESQ is an add-on tool for CMUgo for automatic measurement of the PESQ for WCDMA mobile phones according to recommendation ITU-T P.862 featuring selectable fading profiles and variable Additional White Gaussian Noise (AWGN). It features selectable fading profiles for up to 40 paths and variable Additional White Gaussian Noise (AWGN) for realistic receiving.

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

- The R&S® CMU200 Universal Radio Communication Tester is referred to as CMU.
- The R&S® SMU200A Vector Signal Generator is referred to as SMU.
- The R&S® AMU200A Baseband Signal Generator and Fading Simulator is referred to as AMU.
- The R&S® UPV Audio Analyzer is referred to as UPV.
- R&S® refers to Rohde & Schwarz GmbH und Co KG

# 2 Introduction to PESQ

The "Perceptual Evaluation of Speech Quality" (PESQ) measurement method, which was published by the International Telecommunications Union in 2001 as recommendation ITU-T P.862, enables measurements to be made on speech signals that are transmitted at low bit rates using high compression psychoacoustic coding methods. PESQ employs an algorithm that enables these signals to be evaluated by comparing them with reference signals. The R&S UPV supports this measuring method, with the software licensed by Opticom GmbH in Erlangen (Germany). A common feature of all psychoacoustic coding methods is that they utilize the properties of human hearing to clip the transmitted signal so that the portions of the signal that would in any case not be perceived are removed from the signal. Speech can be compressed more easily as other types of signals, since it occupies considerably less band-width. When speech compression is used, it is necessary to be able to determine objectively, with the aid of psychoacoustic measuring methods, whether the speech transmission technique produces unacceptable degrading of the perceiving speech quality.

PESQ was developed using a large number of recordings containing sentences spoken by a variety of speakers in a variety of languages. The recordings were made using several different speech encoders with different levels of quality and with typical network transmission disturbances. In a series of listening tests, an adequate number of test listeners classified these examples on a speech quality scale ranging from 1 (bad) to 5 (excellent).

The goal in the development of PESQ was a method for determining an objective measurement that correlates very well with the listening test results, based on comparing the original, non-degraded speech signal (the reference signal) with the degraded signal (the measured signal). To perform a PESQ measurement, the reference signal must be connected to the input of the system under test and the measurement signal must be taken from the output of the system under test (see Fig. 1).

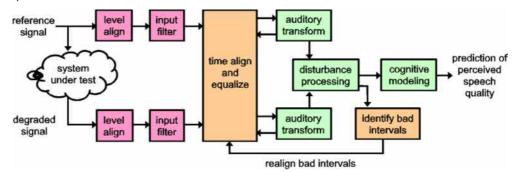


Fig. 1 Algorithm of PESQ Measurement in UPV

In Fig. 2 the R&S instruments involved in the PESQ measurement setup for a downlink and their function is shown. The UPV provides the reference audio speech signal, the CMU modulates the baseband signal to RF which has been interfered by the SMU / AMU with fading and AWGN. The mobile phone demodulates the RF signal and supplies the degraded audio signal (system under test). The UPV performs the PESQ measurement which determines the speech quality of the mobile phone receiver.

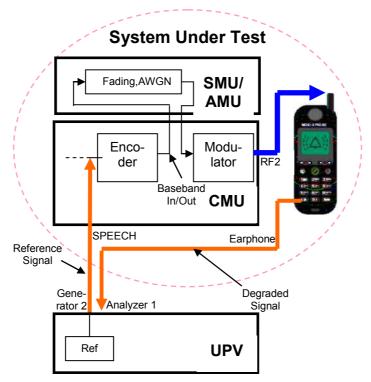
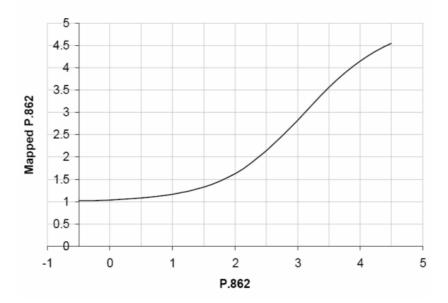


Fig. 2 PESQ Measurement with R&S Instruments

The setup for an uplink measurement is similar, but reversed. The reference signal is provided from the UPV into the mobile phone's microphone input. The mobile modulates the baseband signal to RF. The CMU demodulates the RF signal and supplies the audio signal to the UPV for the PESQ measurement.

## 2.1 PESQ Value and MOS Value

Over the course of time, the ITU has developed several different methods for calculating objective measurements from the average values of the listening test results. This calculation is performed by using a mapping function such as the example shown below.



#### P.862 Algorithm's Mapping Function

Fig. 3 P.862 Algorithm's Mapping Function

The average values from the listening tests are plotted on the Y axis, and the associated PESQ values in accordance with ITU P862.1 are shown on the X axis. This constraint will help ensure that MOS-LQO scores will be comparable for all implementations of ITU P.862.

The R&S UPV implements the three most important standards which differ only slightly from each other and have been approved by the ITU:

- ITU P.862: The measured value is the "PESQ Score" or the "PESQ MOS" (Mean Opinion Score). The range of values extends from -0.5 (worst) to +4.5 (best). In addition, measurements can be made with reference to the speech component or the silence component of the signal. The latter is particularly interesting because it shows how well the codec replaces background noise.
- ITU P.862.1: The measured value is the "MOS-LQON" (listening quality objective narrowband). The range of values extends from–0.5 (worst) to +4.5 (best). The following chapters describe the manual and automatic measurement with the included CMUgo test item WCDMAPesq.dll based on this measurement standard.

Analyzer Fi	- D ×	
Function	PESQ	
According to	MOS P862.1	•

Fig. 4 UPV PESQ Version

• ITU P.862.2: This is the wideband extension of P.862. The measured value is the "MOS-LQOW" (listening quality objective wideband). The range of values extends from–0.5 (worst) to +4.5 (best). Note that measurements obtained using this option cannot be compared with results obtained in accordance with P.862 or P.862.1.

In Addition to the overall results, the measurements can be made by calculating PESQ values for the active speech intervals or for the silence intervals of the signal. The latter is of particular interest because it shows how well the codec may substitute background noise.

Note that for wideband PESQ the PESQ score is not used, but only the mapped MOS-LQO. In Order to use common terms in both narrow- and wideband mode, it is strongly recommended to always use the PESQ-LQO, which is mapped either by Recommendation P.862.1 for narrowband or by P.862.2 for wideband speech.

The R&S® UPV audio analyzer uses the short forms "PESQ" for PESQ and "MOS" for MOS-LQO.

Hardware Configuration

# 3 PESQ Measurement According to ITU P.862.1

## 3.1 Hardware Configuration

For manual and automatic PESQ (MOS LQO) measurement of the uplink or downlink signal featuring fading and AWGN the hardware (R&S<sup>®</sup>CMU, R&S<sup>®</sup>SMU or R&S<sup>®</sup>AMU, and R&S<sup>®</sup>UPV) must be configured as follows:

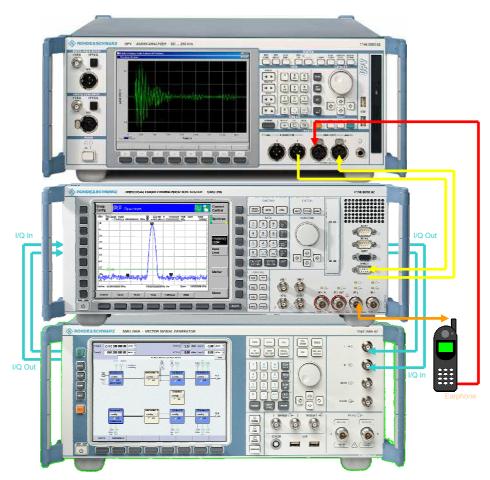


Fig. 5 Hardware Configuration

CMU I/Q Output (I/Q connector)  $\rightarrow$  SMU / AMU I/Q Input SMU / AMU I/Q Output  $\rightarrow$  CMU I/Q Input (I/Q connector) CMU RF2 output  $\leftarrow \rightarrow$  mobile phone RF connector UPV GENERATOR2  $\rightarrow$  CMU SPEECH connector input Mobile earphone output  $\rightarrow$  UPV ANALYZER1 input

Hardware Configuration

CMU SPEECH connector output → UPV ANALZER2 input

A mobile phone can be connected to the UPV either with an acoustic coupler or by cutting off the earphone of a regular headset and reconnecting it to an XLR male plug.

#### **Software Requirement**

The UPV requires option UPV-K61 PESQ measurements. PESQ measurements require the **CMU-B85** coder and decoder to be calibrated first by the UPV (See pages 13 and 14 for details). The macros **DECODER.EXE** and **ENCODER\_PESQ.EXE** must be installed with the included file **CMUCAL\_PESQ.MSI** which needs to be copied to the UPV via USB Stick or LAN and executed on the UPV. In order to run the macros the Universal Sequence Controller option **UPV-K1** needs to be installed on the UPV. In order to run CMUgo the Remote Control option **UPV-K4** needs to be installed on the UPV.

Flowchart of the PESQ Measurement

## 3.2 Flowchart of the PESQ Measurement

The following flowchart shows the necessary steps to perform a PESQ measurement for WCDMA.

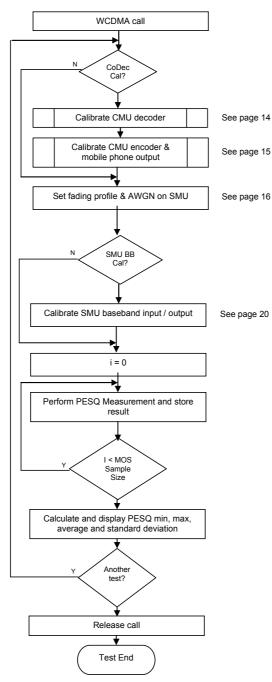


Fig. 6 WCDMA PESQ Measurement

## 3.3 Manual PESQ Measurement

The following section shows in detail the necessary steps to perform a PESQ measurement manually. In order to ensure repeatability of measurement results it is recommended to preset all instruments involved (CMU, SMU / AMU, UPV).

## 3.3.1 WCDMA Call Setup

First establish a WCDMA call.

- 1. Set the desired call parameters on the CMU, e.g. WCDMA RF channel and power.
- 2. Register and establish the call

<b>I</b>	CDM/	A FDD <sup>B</sup>	land Receiv	∕er Qualit	Y CM OFF HSUPA HSDPA		Connect Control
	FDD Conne	ction Con	trol	PS:	Idle	CS: Co	onnected
RF Chn. Downlink RF Chn. Uplink		.0 mHz	10720 9770	Di	itched - Voice sconnect th by pressing t sconnect UE key.	the	Signal Off Unregister
Downlink Power	<b>– 50.</b> Output Ch.	<b>6 dBm</b> Pwr (lor)					Disconnect UE (CS)
UE Power Control	<b>33.</b> Max. allow.	<b>0 dBm</b>	– 20.0 dBm JL Target Power		vitched - HSDPA Waiting for tach from th	r	Connect UE (PS)
Openloop Power			 Signature			Voice 🛓	Dedicated Chan. (CS)
		<b>5 dBm</b> ed Power			Operating	Band I 里	Band Select
Connection	Handover	UE Signal	BS Signal	Network	AF/RF ⊕	Sync.	1 2

Fig. 7 WCDMA Call Setup

#### 3.3.2 WCDMA PESQ Measurement

1. Turn CMU-B17 TX Path to **ByPASS w. I/Q IF OUT**. and RX Path to **ByPASS**. This ensures that the call will not be lost if the SMU / AMU is set to a non proper state, e.g. baseband input turned OFF, AWGN level too high etc. The CMU baseband output level must be attenuated by 3 dB to avoid peak distortion at the SMU / AMUU baseband input.

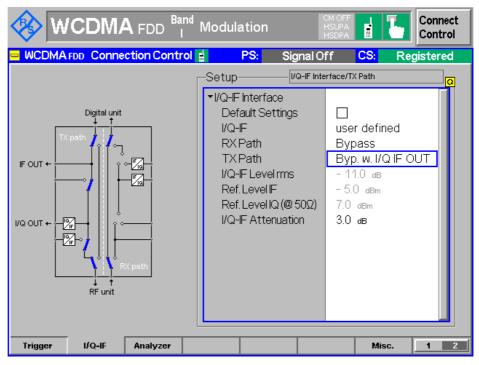
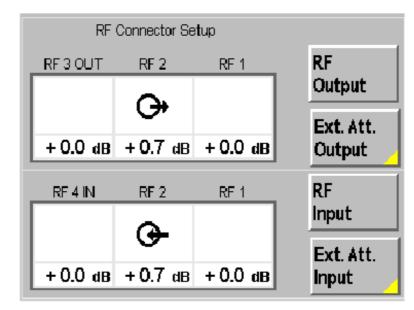


Fig. 8 CMU-B17 RX/TX Bypass

Remote-control command:			
CONF:IQIF:TXP BYIQ	//	feed IQ to SMU/AMU BB input	
IQIF:ATT 3.0	//	I/Q-IF attenuation	

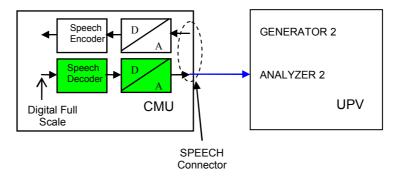


 Select RF2 input, RF2 output on CMU. Enter the cable loss to the mobile e.g. 0.7 dB.

Fig. 9 CMU RF Connector Setup

Remote-control command: INP RF2;OUTP RF2

3. For the first measurement perform a decoder calibration since it is instrument specific. The decoder output is measured for a digital full-scale signal applied to the speech decoder.



#### Fig. 10 Signal Path for Decoder Calibration

Set Voice Coder to DECODER CAL on the CMU.

WCDMA FDD Band Re	ceiver Qual	CM OFF HSUPA HSDPA	Connect Control
😑 WCDMA FDD Connection Control 🛔	PS:	ldle	<mark>CS:</mark> Signal On
-Setup		Circuit Switched/V	oice Settings/
<ul> <li>Node-B Settings</li> <li>Circuit Switched Default Settings DCH (Dedicated Chn.) Type</li> <li>RMC Settings</li> <li>Voice Settings Voice Source</li> <li>Adaptive Multi Rate (NB AMR)</li> <li>Signalling RAB Settings</li> <li>Packet Switched</li> <li>HSDPA HS-DSCH</li> <li>HSUPA</li> <li>Downlink Physical Channels</li> <li>TPC Settings</li> <li>Compressed Mode Settings</li> </ul>	Decoder Ca	al	
Connection Handover UE Signal BS Sig	nal Network	AF/RF ⊕	Sync. 1 2

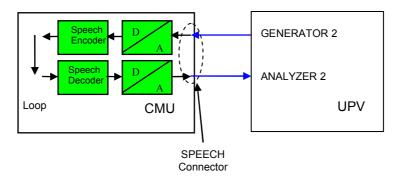
Fig. 11 Decoder Calibration

Remote-control command: CONF:BSS:DCH:VOIC:SOUR DCAL

Start the decoder calibration on the UPV with the menu SEQUENCE  $\rightarrow$  EXECUTE MACRO  $\rightarrow$  DECODERCAL.EXE.

```
Remote-control commands:
SYST:PROG:EXEC 'C:\\Program Files\\
Rohde&Schwarz\\CMUCal_PESQ\\DecoderCal.exe'
SYST:MEM:STR1? // Continue when 'OK'
```

4. It is necessary to perform a encoder calibration the first time since it is instrument specific. It measures the encoder input voltage which is required for a digital full-scale signal at the speech encoder.



#### Fig. 12 Signal Path for Encoder Calibration

Set the Voice Coder to ENCODER CAL on the CMU.

WCDMA FDD Band Re	ceiver Qual	IITY CM OFF HSUPA HSDPA	Conne Contro	
😑 WCDMA FDD Connection Control 🛓	PS:	ldle	CS: Signal On	
-Setup		Circuit Switched/V	oice Settings/	0
<ul> <li>Node-B Settings</li> <li>Circuit Switched Default Settings DCH (Dedicated Chn.) Type</li> <li>RMC Settings</li> <li>Voice Settings Voice Source</li> <li>Adaptive Multi Rate (NB AMR)</li> <li>Signalling RAB Settings</li> <li>Packet Switched</li> <li>HSDPA HS-DSCH</li> <li>HSUPA</li> <li>Downlink Physical Channels</li> <li>TPC Settings</li> <li>Compressed Mode Settings</li> </ul>	□ Voice Encoder Ca	3		
Connection Handover UE Signal BS Sig	nal Network	AF/RF ⊕+	Sync.	2

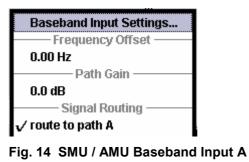
#### Fig. 13 Encoder Calibration

Remote-control command: CONF:BSS:DCH:VOIC:SOUR ECAL

# Start the encoder calibration on the UPV with the menu SEQUENCE $\rightarrow$ EXECUTE MACRO $\rightarrow$ CMUCAL\_PESQ.EXE.

```
Remote-control commands:
SYST:PROG:EXEC 'C:\\Program Files\\
Rohde&Schwarz\\CMUCal_PESQ\\EncoderCal_PESQ.exe'
SYST:MEM:STR1? // Continue when 'OK'
```

5. Route SMU / AMU baseband input to path A or B (if available).



Remote-control command: BBIN:ROUT A

6. Route SMU baseband output to path A (if available).

Impairments
I/Q Impairments (Digital Baseband)
AWGN
AWGN
I/Q Out
Settings
🗸 I/Q Out from A

Fig. 15 SMU / AMU Baseband Output A

Remote-control command: BB:IQO:SOUR A

9. Turn the SMU / AMU fading simulator ON and select a fading profile e.g. **3GPP** CASE 1 (UE/BS).

REMOTE		A: ALC-Auto		Info
Fading A				8.0
			State	On
Set To Default	Save/Recall	Standard	3GPP Case	1 (UE/BS)
	Ge	aneral Settings		
Configuration	Fine Delay 50MHz	Speed Unit	km/h	
Common Speed For All P	aths	Keep Constant	Speed	
ignal Dedicated To	RF Output	Virtual RF	1.000 0	000 000 00 GHz
Restart Event	Auto	7	Restart	formation and a second
gnore RF Changes < 5%	F or	Frequency Hop. Mod	de Off	
		Path Settings		
Path Table	Path Delay Wizard	Coupled Parameters	Insertion Loss	s Configuration
o °- Y			Sta	tic Path Rayleig
10- 20- 30- 40- 50-			Gau	ussDA8 Gauss
40-			Gau	uss (0.08 fd) WM Rid
50-			Gau	uss (0.1 fd)
and the second	0.20 0.30 0.40 0.50	0.60 0.70 0.60	0.90 1.00 D	elay / µs

Fig. 16 Fading Simulator Configuration

Remote-control commands: FSIM:ILOS:MODE NORM FSIM ON FSIM:STAN G3UEC1

10. Turn the SMU / AMU AWGN ON and set the parameters as defined in the Recommendation ITU-T P.862.

State	On
Mode	Additive Noise
System Bandwidth	3.840 0 MHz 💌
Minimum Noise/System Bandwidth Ratio	1.0
Noise Bandwidth	3.840 0 MHz
Display Mode	RF
Noise Level Configuration Ar Set Noise Level Via	nd Output Results
Set Noise Level Via	C/N
Set Noise Level Via Reference Mode	C/N 🗾
Set Noise Level Via Reference Mode Bit Rate	C/N Carrier 100.000 000 kbps
Set Noise Level Via Reference Mode Bit Rate Carrier/Noise Ratio	C/N Carrier 100.000 000 kbps 10.00 dB

#### Fig. 17 AWGN Settings

Remote-control commands: AWGN:STAT ON AWGN:BWID 3.84 MHZ AWGN:BWID:RAT 1 AWGN:POW:MODE CN AWGN:POW:RMOD CARR AWGN:POW:CARR -60.0 AWGN:CNR 10.0

- 11. Calculate the SMU / AMU insertion loss by subtracting the base-band output level from the baseband input level. The baseband insertion loss can be compensated with the CMU RF level. If using the AMU, an alternative method is to slightly increase the output level to remove the insertion loss.
- 12. Turn SMU / AMU baseband input ON.

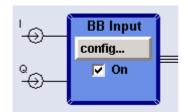


Fig. 18 SMU / AMU Baseband Input ON

```
Remote-control command:
SOUR:BBIN:STAT ON
```

Perform SMU / AMU Auto Level Set (baseband input calibration) at the beginning of the test sequence. The WCDMA output signal level is specified at 0.5Vp = 0.0 dBfs = +7.0 dBm for 50 Ohm resistance. Tolerances are instrument- and cable-specific.

Remote-control command: BBIN:ALEV:EXEC

• SMU / AMU baseband input level → 6.76 dBm

🧱 Baseband Input Settings	
State	On
Mode	Analog Input 💽
I/Q Swap	🥅 On
Baseband In	put Level
Measurement Period	2 s 💌
Auto Level Set	
Crest Factor	0.44 dB 💌
РЕР	0.21 dBFS 💌
Level	6.76 dBm 💌

Fig. 19 SMU / AMU Baseband Input Level

Remote-control command: BBIN:POW:RMS?

SMU / AMU baseband output level can be found in the I/Q impairments menu  $\rightarrow$  -13.77 dBfs = -6.77 dBm referred to 0.5Vp and 50 Ohms.

🧱 I/Q Impairments A (Digital Baseband) 📃 🗆 🔯							
I/Q Impairments							
State	Off						
l Offset	0.00 %						
Q Offset	0.00 %						
Gain Imbalance	0.000 dB 💌						
Quadrature Offset	0.00 deg 💌						
🔽 Optimize Internal I/C	Q Impairments For RF Output						
Optimization Mode	fast 💌						
Baseband Signal Level							
Crest Factor	13.79 dB						
Peak Level	0.02 dBFS						
Signal Level (RMS)	-13.77 dBFS						

Fig. 20 SMU / AMU Baseband Output Level

```
Remote-control command: BB:POW:RMS?
```

- 14. Compensate SMU / AMU insertion and cable loss with the CMU RF External Attenuation Output control.
   → SOUR:CORR:LOSS:OUTP2 14.23 (= Cable Loss Baseband Output Level + Baseband Input Level = 0.7 dB + 6.77 dBm + 6.76 dBm).
- 15. Enter cable loss for mobile uplink (TX) with CMU RF External Attenuation Input control (e.g. 0.7 dB, see Fig. 9).

```
Remote-control command:
SOUR:CORR:LOSS:INP2 0.7
```

16. Turn CMU-B17 Fading ON to loop the baseband signal from the CMU to the SMU / AMU input.

Γ	-Setup ——— I/Q·	- IF Interface/I/Q - IF	] <mark>@</mark>
	▼I/Q - IF Interface		
	Default Settings		
	I/Q-IF	Fading Path	

Fig. 21 CMU Fading Path ON

Remote-control command: CONF:IQIF:RXTX FPAT

17. Perform a PESQ measurement on the UPV (the parameters were already set by the decoder / encoder calibration, p.16).

Remote-control commands:	
INIT:CONT OFF;*WAI	// Trigger measurement
SENSe:DATA?	// Read PESQ value

The MOS sample count defines how many measurements must be taken so you should keep track of all the results. The actual PESQ value according to Recommendation ITU-T P.862 is the resulting average. It is also convenient to determine the minimum, maximum and standard deviation of a test.

## 3.4 Automatic PESQ Measurement with CMUgo

The R&S software tool CMUgo allows you to generate custom test sequences for the CMU plus one or more additional R&S instruments such as generators, analyzers, power meters, step attenuators. It offers automatic instrument configuration, test and documentation. The test results can be saved in several typical file formats, allowing post-processing with e.g. Excel, MatLAB etc. CMUgo Installation and Configuration

CMUgo v1.9.8 (or later), the WCDMAPesq measurement DLL and the demo sequence WCDMA PESQ Demo can be downloaded from <u>http://www.rohde-</u> <u>schwarz.com/appnote/1MA137.html</u>. Please install CMUgo first and then unzip the updated DLLs to the CMUgo directory. Before performing the sequence **WCDMA PESQ DEMO.SEQ** define the CMU, SMU / AMU and UPV GPIB addresses in CMUgo first.

1. The CMU address is defined by selecting the menu **CONFIGURATION** → **REMOTE PORT**. Select the **PRIMARY ADDRESS** (default 20), check the **ACTIVATE** box and press **OK**.

Configure Remote	Port				×
	C COM 2:	C COM 3; C COM 7;			OK Cancel
			Configure		
IEEE 488.2		ational Instruments gilent Controller Car		Board Index 0 💌 hpib	
20			Searching		
Timeout (sec.)					

Fig. 22 CMUgo Configure Remote Port

2. The SMU / AMU is defined in the menu **CONFIGURATION** → **AUXILIARY GPIB PORT 1**. Set the **DEVICE NAME** (SMU / AMU), **PRIMARY ADDRESS**, check **ENABLE** Port and press OK.

Auxiliary GPIB	Port 1		8	x
-Device Name-				
ļ	SMU			
- Primary Address	;]	- Secondary Add	ress	
F	28		0	
EOT Mode		-EOS Character		
[	1		0	
- Timeout				_
F	600		ОК	
			Cancel	
Enable Port 🔽				

Fig. 23 Auxiliary GPIB Port 1

3. The UPV is defined in the menu Configuration → AUXILIARY GPIB PORT 2. Set the DEVICE NAME (UPV), PRIMARY ADDRESS, check ENABLE PORT and press OK.

For better compatibility with future CMUgo versions we recommend you to check the menu item **OPTIONS**  $\rightarrow$  **SAVE CONFIGURATION AND REPORT AS XML FILE**.

## 3.4.1 Configuring and Starting the PESQ Measurement Sequence

Load the included measurement sequence with Configuration  $\rightarrow$  Configure Tests  $\rightarrow$  LOAD SEQUENCE...  $\rightarrow$  WCDMA PESQ DEMO.SEQ.

Available		Item	Selected	
WCDMA BER Search       A         WCDMA Call Release       WCDMA Call Testset         WCDMA Call Testset       WCDMA Call Testset         WCDMA Call Testset       WCDMA Fading SMU         WCDMA Find Attenuation       WCDMA Find Attenuation         WCDMA Noduletest       WCDMA Out of Sync         WCDMA Dut of Sync       WCDMA Out of Sync         WCDMA Dut of Sync       WCDMA Dut of Sync         WCDMA Dut of Sync       WCDMA Dut of Sync         WCDMA Dut of Sync       WCDMA Phase Discontinuitly         WCDMA Testpatterns A. H       WCDMA UE Add. RX Spur. Emissions Band I         WCDMA UE Add. RX Spur. Emissions Band II       WCDMA UE Add. RX Spur. Emissions Band II         WCDMA UE Add. RX Spur. Emissions Band IV       WCDMA UE Add. RX Spur. Emissions Band IX         WCDMA UE Add. RX Spur. Emissions Band IX       WCDMA UE Add. RX Spur. Emissions Band IX	S	1 2 3 4 5 6 7	Basic Initializing WCDMA Call Setup WCDMA FESQ Measurement WCDMA FESQ Measurement WCDMA Call Release Test End	Jor/loc = 10 d Jor/loc = 0 d Jor/loc = -2 d
WEDMA_PESQ_DEMO.SEQ			Properties	
Load Sequence Save Sequence	î î		Duplicate Test Item	í í

Fig. 24 CMUgo Sequence

The sequence consists of following functions

**BASIC INITIALIZING** – This function is necessary to define the required CMU function groups, e.g. WCDMA 1900 FDD (signaling), etc. The CMU groups are controlled via the secondary GPIB address (SAD). Basic Initializing automatically detects or defines according secondary addresses required automatically.

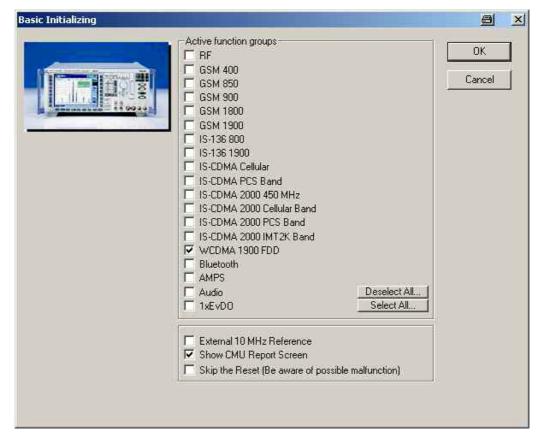


Fig. 25 Basic Initializing

**WCDMA CALL SETUP** – This function registers the phone and establishes a call. The example is for a US Cellular (BC0) network, the RF level is set to -50.6 dBm.

	Band		- Channel Config	uration		
	Operating Band I	•		J Default Code	Level (dB)	OK
A COLUMN AND A COLUMN AND	RF Downlink Channel:	10720	P-CPICH:	o Derault (Lode	-10	Cancel
·····································	Frequency (MHz)	2144	P-SCH:		-15	
A STATE OF STATE	RF Uplink Channet	9770	S-SCH:		-15	
	Frequency (MHz)	1954	P-CCPCH		-15	
	Duplex Space (MHz):	10.00	S-CCPCH:	R [	125	
	and the second	190			2 -15	
	RF Level (dBm):	-50.6	PICH:	R	2 -8.3	
			AICH:	M	3 -8.3	
			DPDCH:		6 -10.3	
	Call Setup Voice					
	C Call from Mobile C Call fro	m CMU	DPCCH/DPDC	'H Olliset		
	Wait Before Calling [Sec.]: Maximum Time (Sec.) Forced Paging	1 30		Keep RI	al Call Setup F RC Connection F configuration F Detach F	
	AMR		1	Additional Setting	1 24	
	Attenuations Input Attenuation (dB): Dutput Attenuation (dB): CMU Connector: C RF1	0.5 0.5 © RF2	Analyzer Settin Manual Level ( Manual Level ( Autoranging	dBm): vel follows Channe	0 Configuration	
	C Open Loop Power Measurement		1	Measurement Sett	ngs	

Fig. 26 WCDMA Call Setup

Wait one second before calling to make sure the mobile doesn't miss the call. The **CHANNEL Configuration** complies to TS 34.121 WCDMA performance testing. Set the loss of the cable between UE and CMU as Input- and Output Attenuation.

AMR Configuration		e x
	AMR / WBAMR Selection	
	<ul> <li>₩ 4.75 kbps</li> <li>5.15 kbps</li> <li>5.90 kbps</li> <li>6.70 kbps</li> <li>7.40 kbps</li> <li>7.95 kbps</li> <li>10.20 kbps</li> <li>12.20 kbps</li> </ul>	
	Wideband AMR	ОК

Then set the correct AMR CONFIGURATION (SELECTION H in our example).

Fig. 27 AMR Configuration

**WCDMA PESQ MEASUREMENT** – Sets the SMU / AMU fading profile, AWGN level (Eb/No), compensates the insertion loss and performs a PESQ measurement.

WCDMA PESQ Measurement			a 🔊
Instruments: CMU200, SMU200, UPV	DCH Parameters       Propagation Condition     3GPP Case 1 (UE)       Ior / Ioc	10 dB 60 dBm 10 dB 3 7	TCH Parameters       RF Channel       Band Select       Op. Band I       Attenuations       CMU Cable Loss DL       0.5       dB       SMU / AMU Baseband       BBin       BBout       Calibrate       2 \$
	Show Detailed Results Description	r/loc = 10 dB	Auxiliary GPIB Port 1 (Fading Simulator) Preset 🗭 SMU Auxiliary GPIB Port 2 (Audio Analyzer) Preset 🗭 UPV OK Cancel

Fig. 28 WCDMA PESQ Measurement

Following parameters can be varied:

**PROPAGATION CONDITION** – Selects the WCDMA fading profile (default 3GPP Case 1 (UE)). The selection **None** turns fading OFF.

IOR/ IOC - Signal (Ior) to Noise (Ioc) SNR ratio.

**DOWNLINK MOS SAMPLE SIZE** – Number of samples taken for PESQ measurement. Typical values according to the Recommendation ITU-T P.862 are 40, 75, 150, 200. Each sample takes approximately 15 seconds.

**CODEC CALIBRATION** – UPV calibrates the CMU Decoder/Encoder path when checked. This needs to be performed in the prescribed CMU calibration cycle. The complete calibration process takes approximately 30 seconds. **PESQ MIN** – Lower Pass/Fail limit of the average PESQ value.

**SHOW DETAILED RESULTS** – Additionally shows all measured PESQ values as defined in MOS Sample Size besides the Mean, Min, Max and standard deviation.

**CMU CABLE LOSS DL** – The downlink cable loss of the RF cable from the CMU to the mobile.

**CMU CABLE LOSS UL** – The uplink cable loss of the RF cable from the mobile to the CMU. The DL and UL values are usually the same except when a directional coupler is used for example.

**CALIBRATION** – Calibrates the SMU / AMU baseband input. This automatically adapts the wanted signal to the AWGN level and only required when the network is changed (see WCDMA Call Setup).

AUXILIARY GPIB PORT 1 (FADING SIMULATOR) – This is the symbolic name of the fading simulator, e.g. SMU / AMU. It must match the CMUgo menu CONFIGURATION  $\rightarrow$  AUXILIARY GPIB PORT 1.

AUXILIARY GPIB PORT 2 (AUDIO ANALYZER) – This is the symbolic name of the audio analyzer, e.g. UPV. It must match the CMUgo menu CONFIGURATION  $\rightarrow$  AUXILIARY GPIB PORT 2.

**WCDMA CALL RELEASE** – Releases the call and unregisters the phone and is necessary for setting the CMU and phone into a defined initial condition.

Call Release Configuration		8	×
	Type Release from Mobile     Release from Testset CMU      Free all CMU resources     Call Release     Maximum Time (sec.)	20	
	OK	Cancel	

Fig. 29 WCDMA Call Release

**TEST END** – Must be located at the end of every test sequence (\*.seq) to free CPU memory and resources.

Configure Test End	
	<ul> <li>Start Autosave Procedures</li> <li>Count NANs as failed tests</li> <li>Dialog closes automatically</li> </ul>
	after (Sec): 3
	OK. Cancel

Fig. 30 Test End

#### 3.4.2 Storage and Further Processing of Measurement Data

When the example sequence has been performed correctly, the following message will be displayed when the **SHOW REPORT SCREEN** box in the **BASIC INITIALIZING** function has been checked.

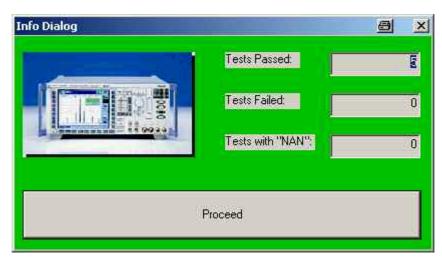


Fig. 31 Info Dialog

After pressing Proceed the measurement report is visible.

# Measurement Report Schule&schwarz

Operator:	noname		Freitag, 13. Februar 2009	16:38:4
CMU Ident:	Rohde&Schwarz, CMU 200-1100.0008.02	2,102652,V5.03		
Options:	0,B17,B21Var14,B52Var14,B53Var14,B5	4Var14,856Var14,866,COPR0	C_FULL,B83,B85,B89,B95,PC	MCIA
	WDDC400,U99,K14,K20,K21,K22,K23,K	42,K43,K45,K47,K53,K54,K56,I	(60,K61,K62,K63,K64,K65,K66	,K67
	K68,K69,K83,K84,K85,K86,K88,K96,K83	9,K849,K859,K869,FMR6,Intel	Celeran,256 MB	
	rxtx1			
Sequence:				
	Test Name and Condition	Lower Limit Upp	er Limit   Measured Value	P/F
Operating Band	1, Channel DL/UL 10720/9770, RF Level-50	.6 dBm, Attenuation (In/Out) 0.	5/0.5 dB	
P-CPICH: -10.0	00 dB, P-SCH: -15.00 dB, S-SCH: -15.00 dB,	Р-ССРСН: -15.00 dB, S-ССРС	:H: -15.00 dB	
PICH: -8.30 dB,	AICH -8.30 dB, DPDCH (Code 6): -10.30 dE	3, DPCCH/DPDCH Offset 0.00	dB	
MCC 1, MNC 1,	, LAC 1 CallType Signalling RAB Cell DCH :	1.7 kbps, AMR Profile H		
IMSI: 00101012	23456063, Serial Number: 35154700-058160-	8		
Call to Mobile:	:		passed	1
Ins.Loss=15.38	dB lon/loc=10.00dB loc=-60.00dBm Prop.C	ond=G3UEC1_DPCH_Ec/lor=-	10.00dB	
PESQ Min/Ma	ax/StdDev	3.27	3.46 0.08	
			3.27	
			3.38	
			3.46	
PESQ Measure	ement lon/loc = 10 dB	2.00	3.37	1
Ins.Loss=19.12	dB lon/loc=0.00dB loc=-60.00dBm Prop.Co	nd=G3UEC1_DPCH_Ec/lor=_10	0.00dB	
PESQ Min/Ma	a×/StdDev	2.77	3.13 0.16	
			3.13	
			2.84	
			2.77	
PESQ Measure	ement lon/loc = 0 dB	2.00	2.91	1
Ins.Loss=20.12	dB lor/loc=2.00dB loc=60.00dBm Prop.C	and=G3UEC1_DPCH_Ec/lor=_1	0.00dB	
PESQ Min/Ma	ax/StdDev	2.13	2.46 0.14	
			2.13	
			2.31	
			2.46	
PESQ Measure	ement lo#loc = -2 dB	2.00	2.30	1
Call Release T	leet.		passed	1

MS Serial Number: 35154700-058160-8

Result: (Execution Time: 291.2 Seconds) 5 Tests passed / 0 Tests failed

Fig. 32 CMUgo Measurement Report

The report can be stored in the in the proprietary CMUgo format (\*.mdf) with FILE  $\rightarrow$  SAVE or exported, for example to Excel format with FILE  $\rightarrow$  EXPORT DATA  $\rightarrow$  TO EXCEL....

Measurement Re	eport				
Date & Time:	Freitag, 13. F	ebruar 2009	16:38:42		
Operator:	noname				
CMU Ident:	Rohde&Schw	arz,CMU 200	)-1100.0008.02,10	0265	2,V5.03
Options:	0,B17,B21Va	r14,B52Var14	4,B53Var14,B54\	/ar14	I,B56Var
			21,K22,K23,K42		
	K68,K69,K83	,K84,K85,K8	6,K88,K96,K839,	K849	9,K859,k
	rxtx1				
Sequence:					
Test Name and Condition	Lower Limit	Upper Limit	Measured Value	Unit	P/F
Operating Band I, Channel DL/UL 10720/91	770, RF Level-50.	6 dBm, Attenua	tion (In/Out) 0.57 0.5	5 dB	
P-CPICH: -10.00 dB, P-SCH: -15.00 dB, S-	SCH: -15.00 dB, I	₽-ССРСН: -15.0 Г	00 dB, S-CCPCH: -1:	5.00 a	(B
PICH: -8.30 dB, AICH -8.30 dB, DPDCH (C	ode 6): -10.30 dB	, ОРССНІ́ОРОС	CH Offset 0.00 dB		
MOOA MARCA LACA CONTRA CONTRA		7 44 4 4 9 9 9 9 7 7			
MCC 1, MNC 1, LAC 1 CallType Signalling	RAB Cell DCH 1	.7 KDps, AMR F	rotile H		
IMSI: 001010123456063,Serial Number: 35	5154700_058160_2	3			
Call to Mobile:					Passed
Ins.Loss=15.38dB lon/loc=10.00dB loc=-6	0.00dBm_Prop.Co	nd=G3UEC1 L	DPCH Ec/lor=10.00	1B	
PESQ Min/Max/StdDev	3,26753402	3,4590192	0,078580238		
			3,267534018		
			3,380215168		
			3,459019184		
PESQ Measurement lor/loc = 10 dB	2		3,36892279		Passed

#### Fig. 33 Excel Sheet

The \*.xls file is perfectly suited for further processing of the data with another Excel sheet or any Windows Application capable of copy and paste import. Simply mark the column containing the single PESQ measurements and drag and drop it to your desired application.

# 4 Literature

[1] Technical Specification Group Radio Access Network; User Equipment (UE) conformance specification; **3GPP TS 34.121-1 V 8.3.0**, June 2008

[2] Rohde & Schwarz; Manual Windows Application CMUgo, April 2006

[3] Rohde & Schwarz; Application Note: <u>PESQ Measurement for GSM with CMUgo</u>, 1MA119, September 2008

[4] Rohde & Schwarz; Application Note: <u>PESQ Measurement for CDMA2000<sup>®</sup> with</u> <u>CMUgo</u>, 1MA136, October 2008

[5] Rohde & Schwarz; Application Note: <u>Psychoacoustic Audio Quality</u> <u>Measurements Using R&S<sup>®</sup>UPV Audio Analyzer</u>, 1GA49, April 2009

# **5** Additional Information

Please send your comments and suggestions regarding this application note to

TM-Applications@rohde-schwarz.com

Visit the CMUgo website at

http://www2.rohdeschwarz.com/en/products/test\_and\_measurement/product\_categories/mobile\_ra dio/CMU200-|-Software-|-24-|-2674.html

or as a registered user in GLORIS the CMU Customer Web at

https://extranet.rohde-schwarz.com/

# 6 Ordering Information

Ordering Information	Ordering Information					
Radio Communication Tes	ster					
CMU200		1100.0008.02				
CMU-B17	IQ/IF analogue interface	1100.6906.02				
CMU-B21	Universal Signaling Unit	1100.5200.54				
CMU-B56	HW option: 3GPP Signalling Module	1150.1850.54				
CMU-B68	HW-option: layer 1-board	1149.9809.02				
CMU-Kxx Bands 112 available	SW option: WCDMA-Signaling					
Vector Signal Generator	1	1				
SMU200A		1141.2005.02				
SMU-B13	Baseband Main Module	1141.8003.04				
SMU-B14	Fading Simulator	1160.1800.02				
SMU-B15	Fading Simulator ext. (optional)	1160.2288.02				
SMU-B17	Analog baseband input	1142.2880.02				
SMU-K62	AWGN	1159.8511.02				
<b>Baseband Signal Generate</b>	or	1				
AMU200A		1402.4090.02				
AMU-B13	Baseband Main Module	1141.8003.04				
AMU-B14	Fading Simulator	1160.5600.02				
AMU-B15	Fading Simulator ext. (optional)	1160.5700.02				
AMU-B17	Analog Baseband Input	1142.5900.02				
AMU-K62	AWGN	1159.7202.02				
Audio Analyzer	-	-				
UPV	(0 Hz - 250 kHz)	1146.2003.02				
Or						
UPV66	(0 Hz - 250 kHz)	1146.2003.66				
UPV-K1	Universal Sequence Controller	1401.7009.02				
UPV-K4	Remote Control	1401.9001.02				
UPV-K61	Software f. PESQ Measurements	1401.7309.02				

For additional information see the Rohde & Schwarz website <u>www.rohde-schwarz.com</u> or contact your local representative.

Note: Not all options are described in detail. The use of the R&S<sup>®</sup>SMATE Vector Generator is also possible.

#### About Rohde & Schwarz

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 75 years ago, Rohde & Schwarz has a global presence and a dedicated service network in over 70 countries. Company headquarters are in Munich, Germany.

#### **Regional contact**

Europe, Africa, Middle East +49 1805 12 42 42\* or +49 89 4129 137 74 customersupport@rohde-schwarz.com

North America 1-888-TEST-RSA (1-888-837-8772) customer.support@rsa.rohde-schwarz.com

Latin America +1-410-910-7988 customersupport.la@rohde-schwarz.com

Asia/Pacific +65 65 13 04 88 customersupport.asia@rohde-schwarz.com

Certified Quality System ISO 9001 DQS REG. NO 1954 QM

Certified Environmental System ISO 14001 DQS REG. NO 1954 UM

This application note and the supplied programs may only be used subject to the conditions of use set forth in the download area of the Rohde & Schwarz website.

Rohde & Schwarz GmbH & Co. KG Mühldorfstraße 15 | D - 81671 München Phone + 49 89 4129 - 0 | Fax + 49 89 4129 – 13777

www.rohde-schwarz.com