

Voice Quality Measurements with R&S ROMES SQA

Application Note 1SP52_0E

This document introduces Voice Quality Measurements and describes the configuration of the R&S ROMES Software as well as the R&S ROMES Speech Server. It gives advice and offers interpretations of the measurement data.



Subject to change - S. Schindler, 10/06 - 1SPV52_0E

PESQ

Contents

1	Introduction	3
2	Background	3
	PĚSQ	
	MOS	3
3		4
	Required Software:	4
	Required Hardware:	4
4	Soundcard Setup on measurement PC	5
5	ROMES Setup	7
6	ROMES Server Setup	11
	Preparation for an answering machine	11
	Preparation for an SQA server	11
7	Test Measurement	13
	Merge Function	14
8	Abbreviations	15
9	References	15
1	0 Ordering information	
	-	

1 Introduction

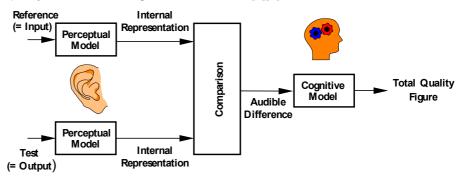
The Speech Quality Analysis allows end-to-end Tests showing how the subscriber would see the network quality/performance. The main advantage of this type of measurement is the ability to make a statement about the speech quality/performance of the uplink and downlink. It can be applied in a wide range of technologies and could lead to comparisons between transmit methods and terminals.

2 Background

PESQ

Perceptual Evaluation of Speech Quality (PESQ) is an enhanced perceptual quality measurement standard for voice quality in telecommunications. PESQ was developed by the International Telecommuncation Union ITU-T and belongs to the series P for telephone transmission quality. The full standard name is ITU-T P.862. PESQ is designed for end-to-end voice quality testing under real network conditions, like VoIP, POTS, ISDN, GSM or UMTS.

The principle of PESQ is based on the comparison of two equal audio samples. One is transmitted and received through the mobile phone network, the other serves as reference. If the difference between the samples is high, the voice quality decreases during the transmission. [1][2]



MOS

The Mean Opinion Score describes a method for a subjective assessment of speech and video quality in telecommunications. It was developed and standardized as ITU-T P.800. The MOS is the arithmetic mean of all the individual scores and can range from 1 (worst) to 5 (best).

5	Excellent	Imperceptible
4	Good	Perceptible but not annoying
3	Fair	Slightly annoying
2	Poor	Annoying
1	Bad	Very annoying

Table 1 MOS Quality Impairment

3 Requirements

Required Software:

- ROMES 3.60 SP2 or higher with SQA and Mobile options
- Device driver from the ROMES CD for the soundcard used
- Device driver from the ROMES CD for the mobiles used (with USB connector)
- PESQ license file (comes with ROMES-Z8 SQA option)
- Speech sample (e.g. ITU samples or <u>http://www.signalogic.com/index.pl?page=codec_samples#pesq</u>)
- Digital answering machine or
- ROMES-X8 SQA Server

Required Hardware:

 High-performance PC with Windows XP for four SQAs at the same time a Pentium IV 3 GHz with Hyperthreading and one GByte main memory is required.

Note: PCs with lower performance are restricted to two SQAs

- Server PC or PC based digital answering machine
- Mobiles with data connection cable
- Audio connection kit for the mobile
- One of the following separate sound cards:
 - For one test mobile: Sound Blaster Audigy 2 NX (USB)
 - For up to four test mobiles: ESI U46DJ (USB)
 - For up to four test mobiles: M-Audio Firewire IEEE1394

USB soundcards require an USB 2.0 connector. Firewire soundcards require a separate Firewire card in the PC. To connect an M-Audio soundcard and an R&S TSMU you will need either one Firewire card with two connectors or one built-in Firewire Controller and a Firewire card connector and ROMES 4.0.

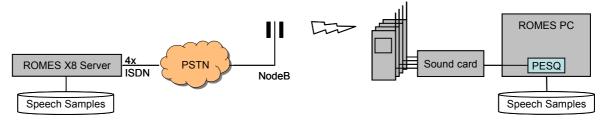


Figure 1 System constellation for Speech Quality Anaysis (SQA)

4 Soundcard Setup on measurement PC

The following paragraphs explain step-by-step how to configure the drivers and the ROMES software for Voice Quality Measurements.

Install the soundcards as described by the manufacturers. For software installation use the device drivers from the ROMES CD, or download the current device drivers from the manufacturers web site.

Note: Do not use the device drivers which comes with the hardware or which Windows XP installs automatically.

Sound Blaster Audigy 2 NX: No further setup is required (do not use the Windows XP device drivers!) Connect the mobile to the mobile adapter box. Connect "out" to the "Line In" connector and "in" to the "Front" connector.

ESI U46J:

(1) Modify the buffer size of the soundcard to maximum (2048) using the software "Tracktion" which comes with the soundcard.

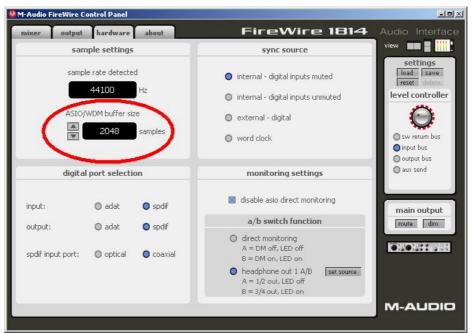
projects settings			10.12am 💽
	Wave device: ASIO 2.0 - ESI U46D)	•	
audio devices	venabled USB Audio Device 1 + 2 Kdsabled USB Audio Device 3 + 4	output	default wave output
	K disabled USB Audio Device 3 + 4 K disabled USB Audio Device 5 + 6		
plugins	✓ enabled USB Audio Device 1 + 2	input	
	K disabled USB Audio Device 3 + 4		
ASIO Control Panel	×		
E 57	Butter Size Description C 80 C C 182 IP Enoble Input C 256 G sest C 1024 Reset C 1024 Exit		
ASIO Initialized / 44100Hz			
	sample rate 44100 Hz	(show ASIO control panel
	latency 2048 samples (46.4 millisecs)	\$	restart device
	MIDI devices x disabled Microsoft GS Wavetable SW Synth		
	Researched Priceosoft GS Wavetable SW Synth		
	O use realtime priority mode	O only show enabled devices	
(nothing	currently selected)		
heip! • about			
ಶ Start 📴 🏠 👸 🍕 🌞 💾 👋 💇	Tracktion 🧳 ASIO Control Pa		🔯 🚾 🥪 10:1

- (2) Connect the mobile to the mobile adapter box.
- (3) Connect "out" to the "Input" connector and "in" to the "Output" connector on the rear of the box.
- Set both switches on the front to "Line".
- "Power" must be on.
- "+48V" must be off.



M-Audio:

(1) Modify the buffer size of the soundcard to maximum (2048) using the M-Audio software



- (2) Connect the mobile to the mobile adapter box.
- (3) Connect "out" to the "unbalanced input" connector and "in" to the "bal/unbal output" connector on the rear of the box.



- Both "Mic/Line" buttons at the hardware tab must be pushed in.
- "Power" must be on.
- "Phantom Power", "Pad" and "A/B" must all be off.

With a laptop use the 12 V input. With a desktop PC the box will get power via the Firewire connector.

5 ROMES Setup

Copy the PESQ License file into the directory "PESQLicenseFile" in the ROMES directory.

Install a GPS receiver it will be essential for the merge function of the uplink and downlink results. The following steps have to be repeated for each mobile.

(1) Load the ROMES driver of your mobile and configure the autodialing as shown below:

2500 [1]	×
Configuration Expert Mode NQA Settings Autodialing Hand	lover Analyser Remo
Actions Use autodial Autoanswer incoming calls Timing Constant Call Pattern (ETGI Specification) Max. Access Time: 15 sec Idle Time: 20 sec Call Duration: 60 sec Offset: 0 sec Findless Call	Mode Single Call Type Multi Call Type Type of Call Voice Call Data Call Video Call
Data Call Speed: Bearer Service: CE: Phone Numbers Server number	▼ ▼ ▼
Subscriber Number (mandatory for S/VQA) use international format: e.g. +491701234 Mobile number	rk fore start of call MNC: 0
ОК	Cancel Help

- If you are using an answering machine, do not use "Endless call", because after a given time the wave file will be finished.
- If you are using a ROMES SQA Server, the server must be set up for endless calls.
- The "Phone Number" must be the correct number for the server. If you enter an incorrect number you will not get the SQA measurement values because the sound input is usually completely different.
- The "Subscriber Number" is the telephone number of your SIM card. It must be correct for uplink measurement. If it is not correct the CMD files of the SQA server can not be merged correctly.
- (2) Press OK and load the ROMES Mobile Driver dialog again. This time select the "Speech Quality Analyzer" tab.

Z500 [1]	<u>></u>
Autodialing Handover Analyser Ren	note Receiver Speech Quality Analyser Mobile
SQA Slave	
	SQA Driver loaded.
Connect SQA No) Settings available.
Disconnect SQA	
Configure SQA	
	
	OK Cancel Help

Select "Connect SQA"

Load Slave	×
Technolgy	Device
QoS	SQA Tester
(OK)	Cancel
OK	Cancel

Press OK.

Z500 [1]			X
Autodialing Handover Analyser	Remote Receiver	Speech Quality Analyser	Mobile
SQA Slave	SQA [1]		
Connect SQA Disconnect SQA	Soundcard: Direction: Play File: Name:	ASID - ASID 2.0 - ESI L Both C:\RuS\RomesV30\Sp	
Configure SQA	Ini. Offset: Duration: Pause: Reference File:	9000 ms All the file 5000 ms	
	Name: Ini. Offset: Duration: Pause:	C:\RuS\RomesV30\Sp 10000 ms All the file 9000 ms	
	0	Cancel	Help

Check "Enable Speech Quality" and press "Configure SQA".

SQA[1]		×					
SQA Settings Info							
Play File	Play File						
Soundcard:	Soundcard: ASIO - ASIO 2.0 - ESI U46DJ - USB Audio Device 1 - Driver: 2						
Filename:	Filename: C:\RuS\RomesV30\SpeechSamples\or105.wav						
Offset [ms:]	0 - Duration [ms]: 8402 - End Pause [ms]: 5000 -						
Loops:	Infinite Play all the file. Initial Pause [ms]: 9000						
- Reference File-							
Soundcard:	ASIO - ASIO 2.0 - ESI U46DJ - USB Audio Device 1 - Driver: 2						
Filename:	C:\RuS\RomesV30\SpeechSamples\or105.wav						
Offset [ms:]	0 Duration [ms]: 8402 End Pause [ms]: 9000						
Loops:	Infinite All the file will be played. Initial Pause [ms]: 10000						
- Measurement M	1ode						
C Downlink	Mobile: Z500 [1]						
C Uplink	Output Volume:						
Both (Up- a	Both (Up- and Downlink) Record WAV Files worse than						
Call Duration:	Call Duration: Endless Output Dir.: C:\RuS\RomesV30\Speet						
	OK Cancel Help						

- (3) If you are using an answering machine select "Downlink". With an SQA server you have to configure reference files and pauses to match your server configuration. (see Figure 2)
- (4) Select the correct audio card for each mobile. For M-Audio and ESI U46DJ only use the ASIO sound drivers.

The "Output Dir" must be different for each SQA even if it is not used.

If you are using an answering machine and want to use the "Initial pause" add a silent prefix with the length of the initial pause to the edited reference file.

	Initial Pause	Play file End Pause Initia		Play file		End Pause		Play file End Pause Ir		Initial Pause
UL	10s	8.4s			9s	10s				
	Initial Pause PESQ algorithm	End Pause	Initia	al Pause	PESQ algorithm	End Pause				
DL	1s 8.4s	9s	1s		8.4s	9s				
	-	←				Time				

Figure 2 Timeline of the SQA settings above

It is recommended to adjust the "End Pause" and the "Initial Pause" so that the uplink and the downlink do not overlay. The PESQ values could decrease.

Note: The timings of the measurement system and the answering machine/ROMES Server have to be harmonized.

6 ROMES Server Setup

Preparation for an answering machine

With an digital answering machine you will only be able to measure the downlink.

Configure the answering machine so that it will accept the incoming call immediately. Prepare the wave file: With an audio editing software such as "Audacity" the wave file should repeat the sample file many times (60 times for example).

At the beginning of the wave file you should add a silence of at least 2500 ms. Use the unchanged sample file on the client PC.

Preparation for an SQA server

The ROMES Speech Quality Analyser Server allows Speech Quality Tests for the downlink and uplink. This option offers a real end-to-end test solution.

In outgoing wave mode, the server plays sound files to a calling device. In incoming wave mode the server measures speech quality of sound coming from a calling device using the PESQ algorithm. The measurement results are stored in CMD files which can later be merged into a destination CMD file by the ROMES application.

QoS ISDN Server Configuration				<u>_ ×</u>
Call Settings				
TAPI Devices				
AVM ISDN TAPI Services (Cntrl 1) AVM ISDN TAPI Services (Cntrl 1) AVM ISDN TAPI Services (Cntrl 2) AVM ISDN TAPI Services (Cntrl 2) AVM ISDN TAPI Services (Cntrl 3) AVM ISDN TAPI Services (Cntrl 3) AVM ISDN TAPI Services (Cntrl 4) AVM ISDN TAPI Services (Cntrl 4)	Valid for SQA MSN Phone number to call Call Duration: Max. Access Time:	10 sec	Serving Mode Both	*
	Data Storage	C:\VoiceAndVideoServer\M	easData	
Coutgoing Wave				
Soundcard AVM Sound Playback 1	▼ File	C:\VoiceAndVideoServer\Re	ef\or105.wav	
Offset [ms:] 0 Duration [ms]: 8402	2 Pause [ms]: 90	, 100 Loops: 246808 F	Play all the file. Up	date Loops
Initial Pause [ms]: 1000 Ou	tput Volume:			
Incoming Wave				
Soundcard AVM Sound Recorder 1	▼ File	C:\VoiceAndVideoServer\Re	f\or105.wav	
Offset [ms:] 0 Duration [ms]: 8402	Pause [ms]: 90	00 Loops: 246808 🔽	Play all the file Up	date Loops
Initial Pause [ms]: 10000	Record WAV Files	worse than 5		
Location Settings				
Number Prefix Country Code 49 A	irea Prefix 📃 Area	Code 89 Loo	ation Servername	
Messages				
			Versi	on 3.60.0.3
Clear Messages Unregister Service	Start Service	Stop Interactive	Apply	Quit

Configure the server for your measurement requirements. Each controller (here "AVM ISDN TAPI Service") must be configured separately. To get correct measurement results both the server and the ROMES SQA driver must be configured correspondingly. To get files which can be merged, the location settings must be correct. For a setup with both uplink and downlink the pauses must be configured so that no overlapping of speech output occurs. Speech output on mobile and server sides results in incorrect (degraded) speech measurement. Output volume should be set to maximum.

For merging the system time of the server must be correct. Either connect GPS or use Internet synchronization via Network Time Protocol (NTP).

Note: to reduce CMD files, the value "Record WAV files worse than" can be reduced, or disabled

7 Test Measurement

For Downlink both the volume of the mobile phone and the volume on the soundcard for line input must be on maximum.

Try to start a measurement with ROMES. Appropriate Views are:

- SQA Message View
- UMTS/GSM NQA State View
- Alpanumeric View with Signals from SQA Tester
- 2G/3G Layer 3 View

📋 SQA Messa	age View:1	
SQA[1] < 2500)[1]> SQA[2] <z500[2]> </z500[2]>	
D Time	Message	
11:24:16	entering loop 0	
11:24:16	waiting till data threshold is reached	
11:24:25	performing pesq evaluation	
11:24:26	playing sample	
11:24:26	resulting delays: min 894.50 avg 910.63 max 914.63	
11:24:26	repeating this sample using new delay information	
11:24:26	***************************************	
11:24:26	entering loop 0	
11:24:26	waiting till data threshold is reached	
11:24:26	performing pesq evaluation	
11:24:27	resulting delays: min -16.50 avg 0.15 max 3.63	
11:24:27	State Changed: measrxsync -> measrun	
11:24:27	PESQ Result: Offset: 911 ms - MOS-LQ0 P862.1: 3.8 - Attenuation: 0.3 dB	
11:24:27	******************************	
11:24:27	entering loop 1	
11:24:27	waiting till data threshold is reached	
11:24:34	playing silence between samples	-

Use the SQA Message View for verification: If you get MOS-LQO values the setup is OK. If the attenuation is negative (that means you have gain) reduce the input level setting of the soundcard. The best value for attenuation is 0 dB.

If you get no MOS-LQO in the SQA message view, only the values for resulting delays, either the connection is too bad to get measurement results, the sample files are not equal, the volume is too low, or you are using old device drivers for the soundcard. Check the connection by calling the answering machine or SQA server and listen.

If you get a value of 0 for resulting delays there is no speech on the connection or the setup of the soundcard is wrong. Try to call the answering machine. Try to record a file with the soundcard to check the functionality.

For uplink set the output volume of the soundcard to the lower third. Start the SQA server as "Interactive". Call the ROMES SQA Server with output power set to max. Decrease the output power until speech sounds undisturbed. Start an Uplink measurement. If you get MOS-LQO values in the message view of the SQA server, change the output volume of your soundcard to get an attenuation of 0 dB at the Server Site.

Possible reasons for no measurement values are the same as for Downlink.

Merge Function

C Alphanumeric View:1				
Parameter	[Unit]	SQA[1]	SQA[2]	
PESQ Score (DL) PESQ Score Noise (DL) PESQ Score Speech (DL) MOS-LQ0 P862.1 (DL) Attenuation (DL)	dB	3.599 4.076 3.540 3.688 0.291		

PESQ Score:	PESQ Score according to P.862
PESQ Score Noise:	PESQ Score during silent periods
PESQ Score Speech:	PESQ Score during active speech periods
MOS-LGO P862.1:	Listening Quality Objective Mean Opinion Score
Attenuation:	Attenuation between the two input signals in dB

Merge Function

The Merge Function integrates the SQA Server Measurement CMD Files with the existing CMD file from the Drive Test System, so that Uplink and Downlink data can be evaluated together.

🚸 Merge Server Files	×
File to Patch	
C:\RuS\RomesV30\MeasData\SQA\SQA_measured.CMD	
Directory Server Files	
C:\RuS\RomesV30\MeasData\SQA\Serverdata	
C:\RuS\RomesV30\MeasData\SQA\Serverdata\498940269825_4917840 C:\RuS\RomesV30\MeasData\SQA\Serverdata\498940269825_4917840	Add
C:\RuS\RomesV30\MeasData\SQA\Serverdata\498940269825_491784(C:\RuS\RomesV30\MeasData\SQA\Serverdata\498940269825_491784(Remove
C:\RuS\RomesV30\MeasData\SQA\Serverdata\498945088292_4917865 C:\RuS\RomesV30\MeasData\SQA\Serverdata\498945088292_4917865	Patch
C:\RuS\RomesV30\MeasData\SQA\Serverdata\498945088292_4917865 C:\RuS\RomesV30\MeasData\SQA\Serverdata\498945088292_4917865	
Target File	
C:\RuS\RomesV30\MeasData\SQA\SQA_merged.CMD	
	Exit

For "File to Patch" select the CMD file with the basic measurement.

Merge Function

With "Directory Server Files" select the directory where the server files have been placed. You can add more files from other locations with the "Add" button. ROMES finds the correct files by the measurement time.

Enter a name for the target file. Be aware that the "File to Patch" and "Target File" are not the same.

Start merging with "Patch" button.

Possible errors:

Time frame of the files is incorrect: Setup SQA server and measuring PC with the correct time and repeat the measurement.

Files could be merged but the resulting file has two different SQAs for each mobile: The subscriber number is wrong.

8 Abbreviations

GSM	Global System for Mobile Communications
IEEE	Institute of Electrical and Electronics Engineers
ITU	International Telecommunication Union
MOS	Mean Opinion Score
NQA	Network Quality Analyzer
PESQ	Perceptual Evaluation of Speech Quality
SQA	Speech Quality Analyzer
UMTS	Universal Mobile Telecommunication System

9 References

[1] International Telecommunication Union ITU-T: Recommandation P-Series; <u>http://www.itu.int/rec/T-REC-P/e</u>; (1.September 2006)

[2] PESQ; http://www.pesq.org/; (1. September 2006)

Additional Information

This application note is updated from time to time. Please visit the website <u>www.rohde-schwarz.com</u> in order to download new versions.

Please send any comments or suggestions about this application note to <u>TM-</u><u>Applications@rsd.rohde-schwarz.com</u>.

10 Ordering information

ROMES	1143.7991.30	Drive Test Software Platform
ROMES-R	1143.7991.03	Drive Test Software Platform Replay Module
ROMES4SQA	1143.8123.44	ROMES Speech Quality (SQA) Mobile 1 Channel
ROMES4VQA	1143.8123.46	ROMES Video Quality (VQA) Mobile 1 Channel
TS4SERVER	1502.6036.40	ROMES Speech Quality SERVER
TS4SERVER	1502.6036.44	ROMES Video / Speech Quality SERVER
TS95ISDN	1506.9530.02	ISDN Controller for 4x Speech Quality on SQA Server
TS95PSTN	1506.9530.04	Analog Controller for 4x Speech Quality on SQA Server
ROMES4SRV	1143.8123.80	ROMES SERVER Software
ROMES4SQS	1143.8123.82	ROMES SERVER Speech Quality (SQA)
ROMES4VQS	1143.8123.84	ROMES SERVER Video Quality (VQA)
TS95AUDIO	1502.5930.04	Speech Quality 1x Audio Card (USB)
TS95AUDIO	1502.5930.06	Speech Quality 4x Audio Card (USB)
TS95AUDIO	1502.5930.02	Speech Quality 4x Audio Card (FIREWIRE)
TS-SM-AF	1074.5860.02	Audio Adaptation Kit for Samsung Z500 style audio jack
TS-SM-AF	1074.5860.12	Audio Adaptation Kit for Qualcomm TM62xx style audio jack
TS-SM-AF	1074.5860.22	Audio Adaptation Kit for Nokia audio jack
TS-SM-AF	1074.5860.32	Audio Adaptation Kit for Sagem OT290 audio jack



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