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.

**ROHDE&SCHWARZ**

Contents

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]
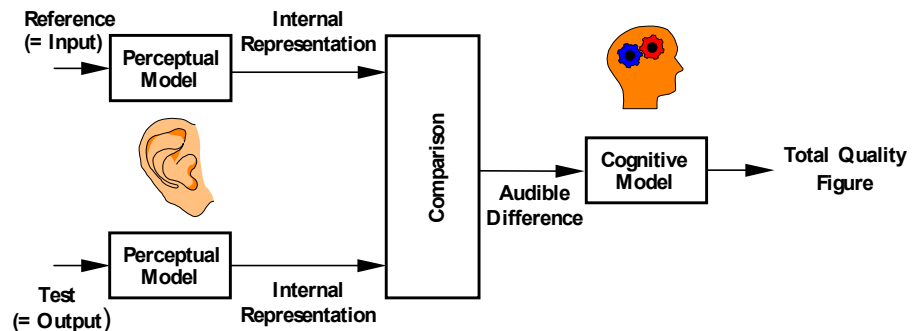
MOS

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 http://www.signalogic.com/index.pl?page=codec_samples#pesq)

– 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.
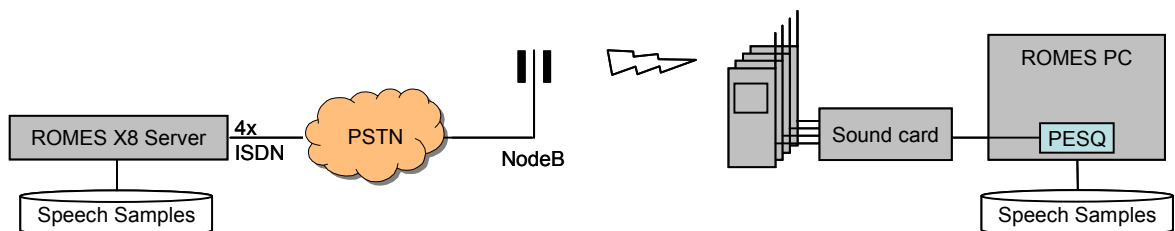

Figure 1 System constellation for Speech Quality Anaysis (SQA)

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.
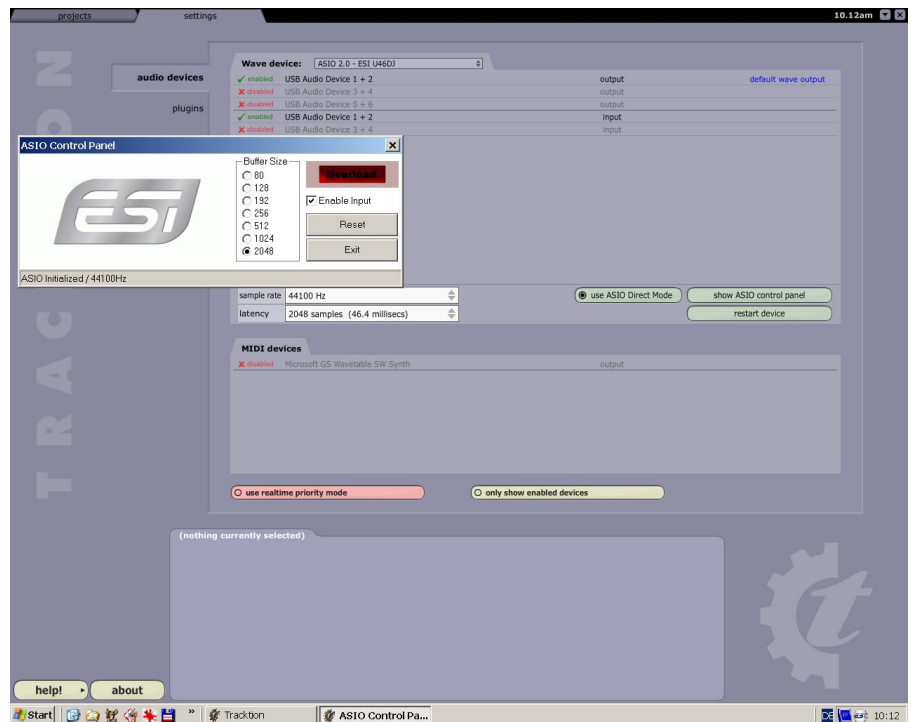
(2) Connect the mobile to the mobile adapter box.

(3) Connect "out" to the "Input" connector and "in" to the "Output" connector on the rear of the box.
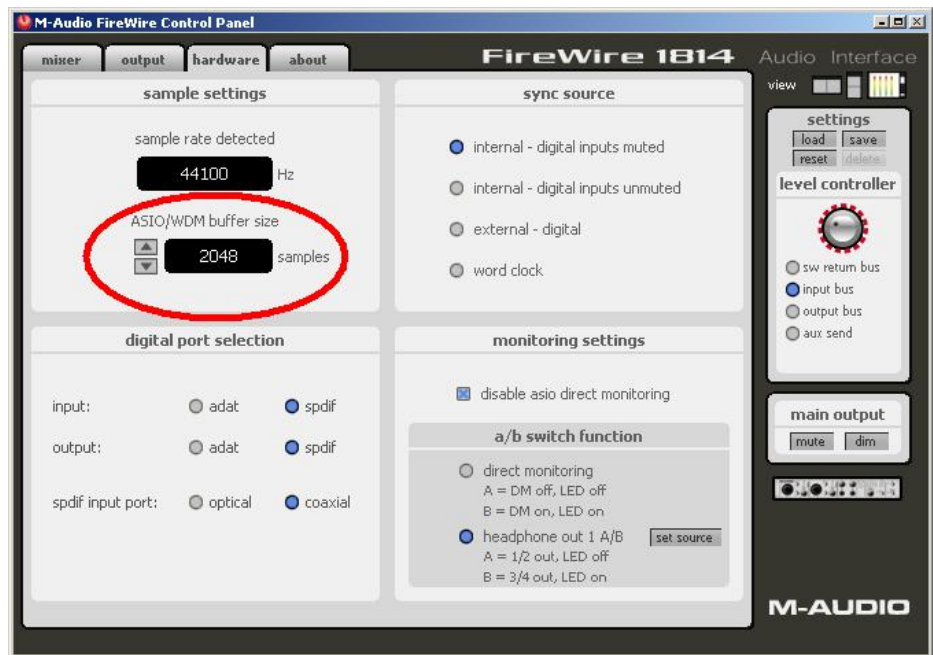
- Set both switches on the front to "Line".

- "Power" must be on.

- "+48V" must be off.

Required Hardware:

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.
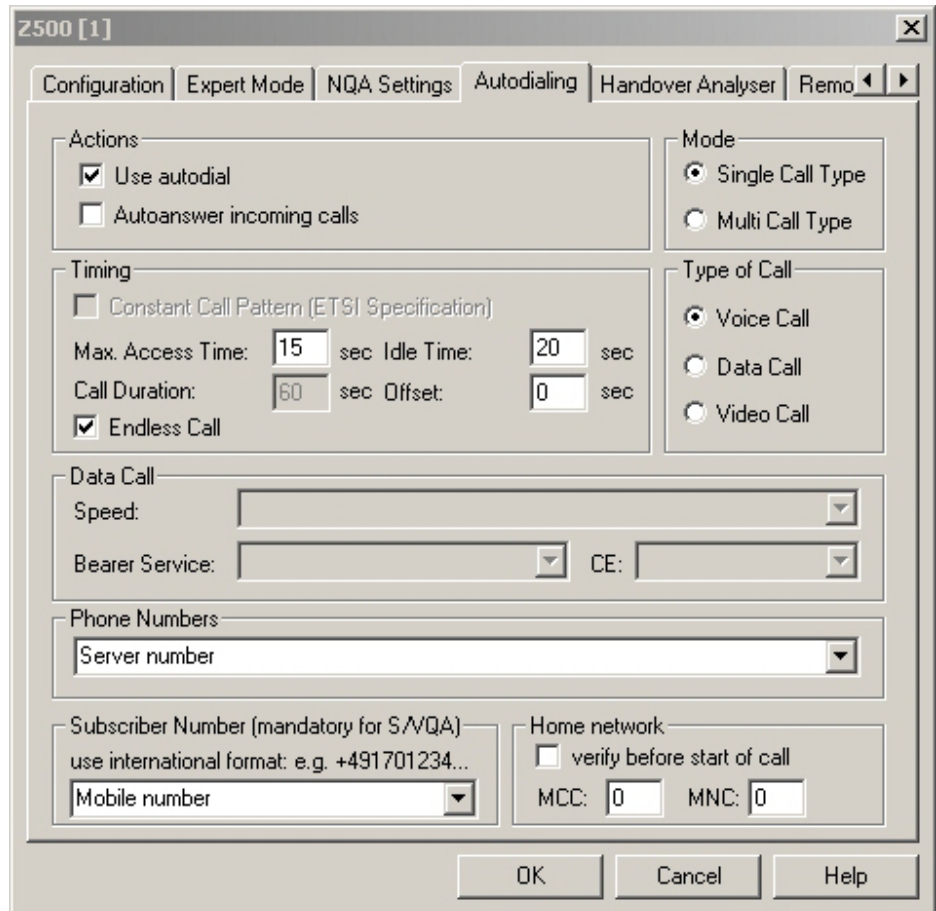
5 ROMES Setup

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:

- 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.
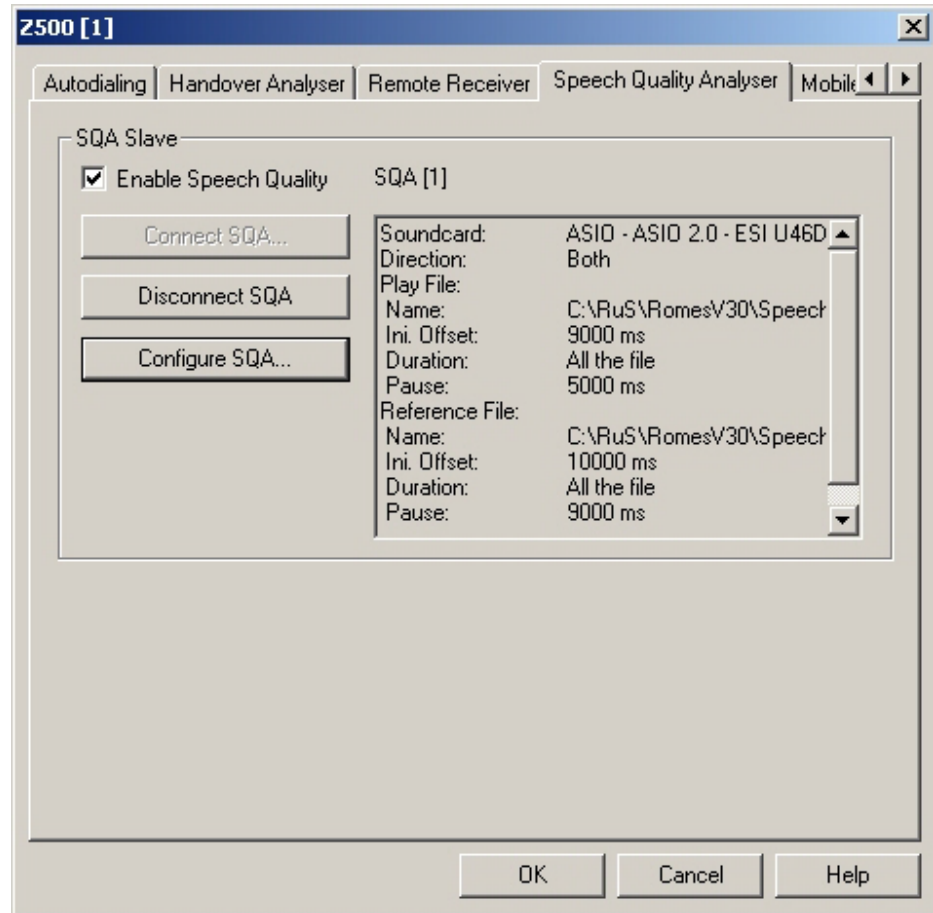
Required Hardware:
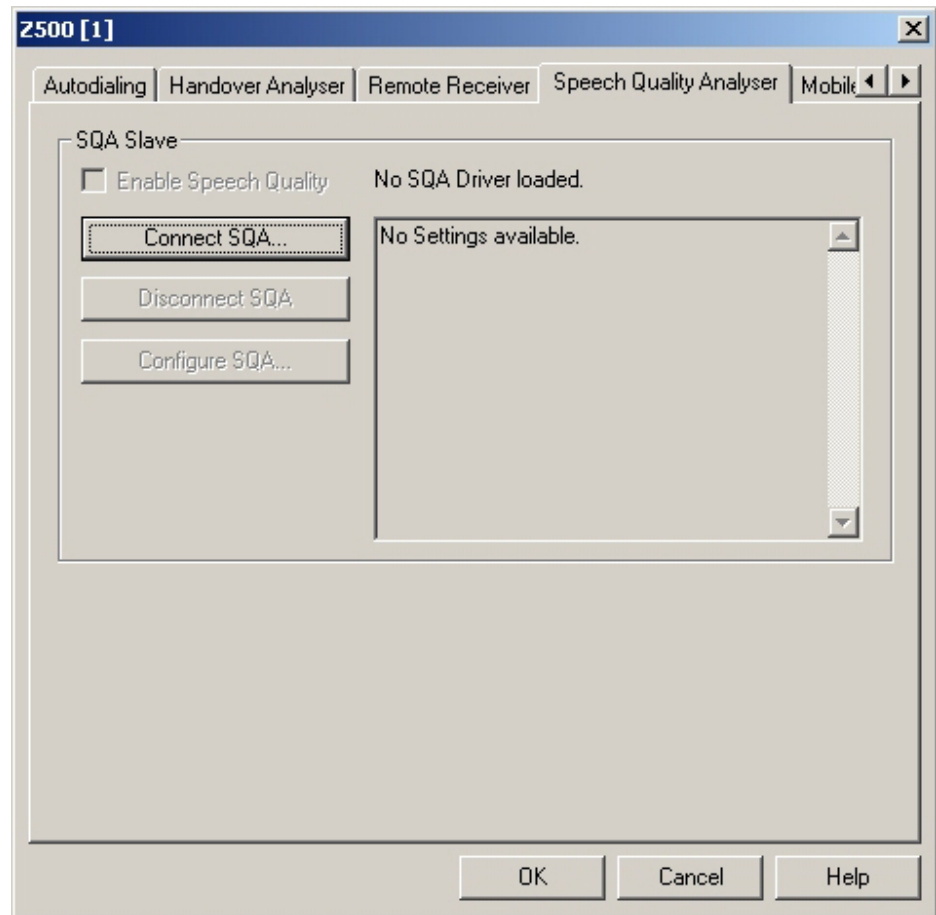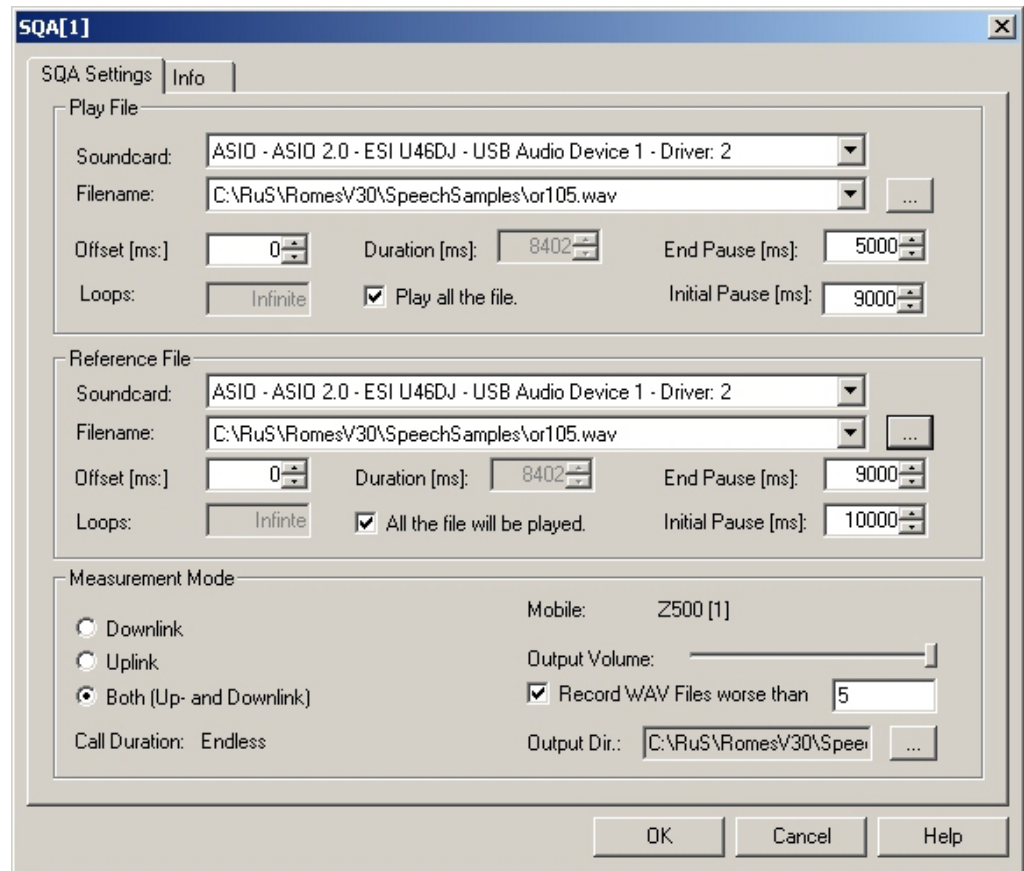

Select "Connect SQA"
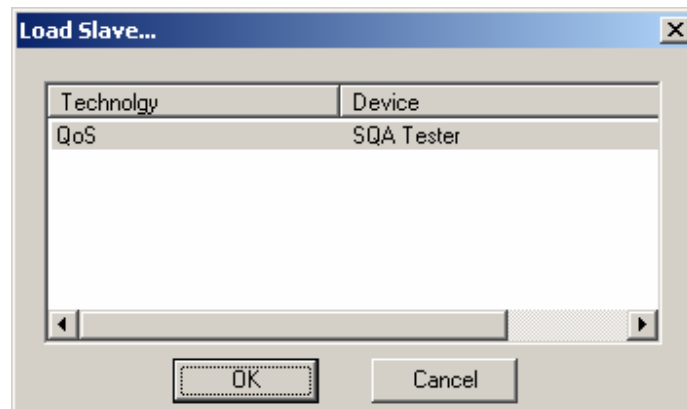
Press OK.

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

(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.
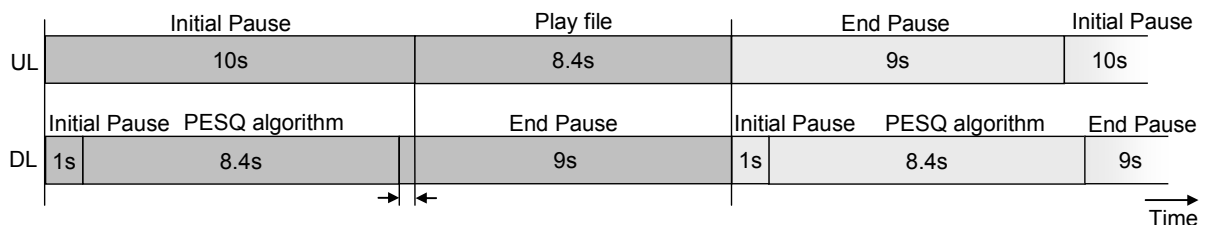

Figure 2 Timeline of the SQA settings above

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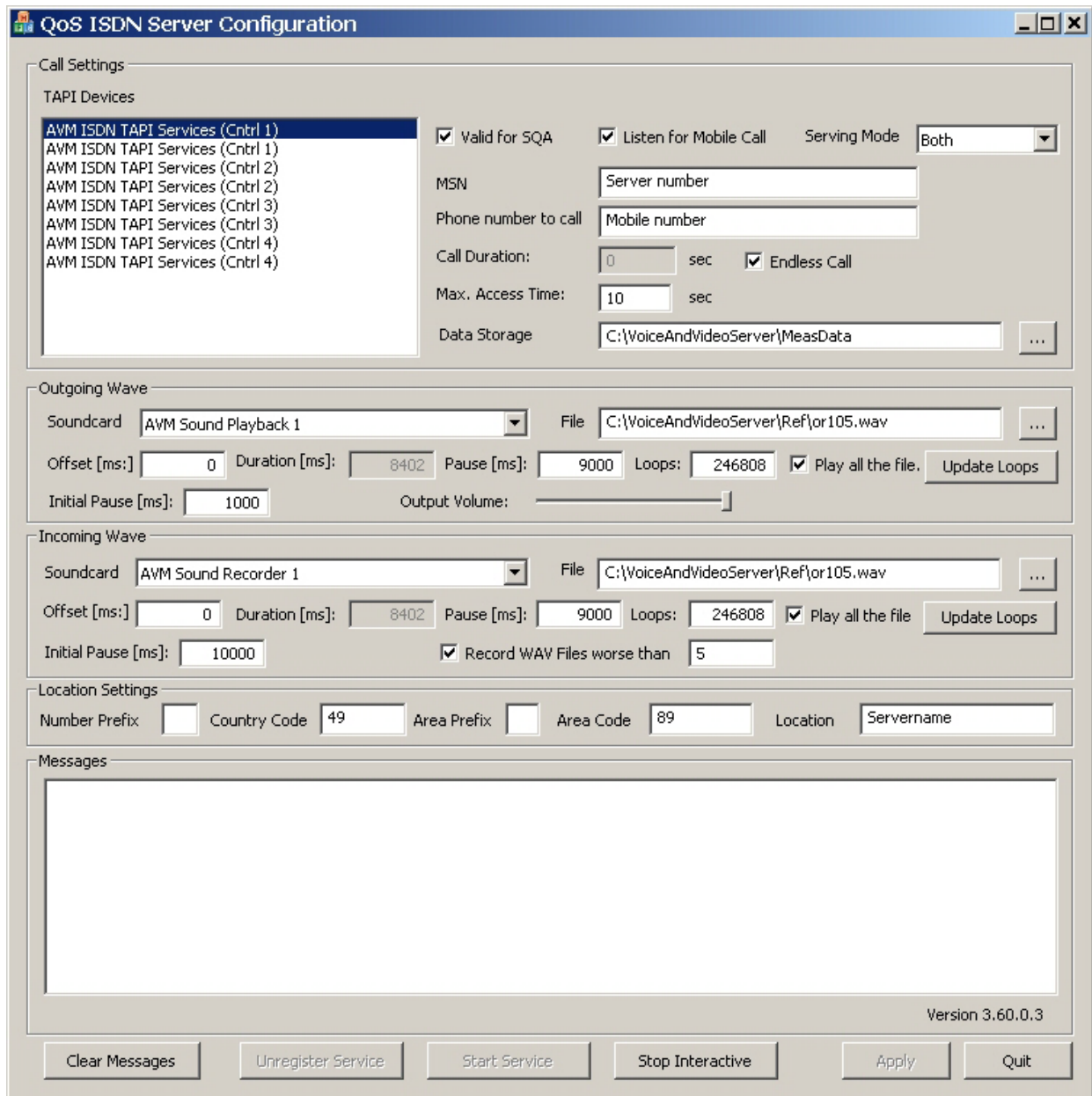
At the beginning of the wave file you should add a silence of at least 2500 ms. Use the unchanged sample file on the client PC.

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.

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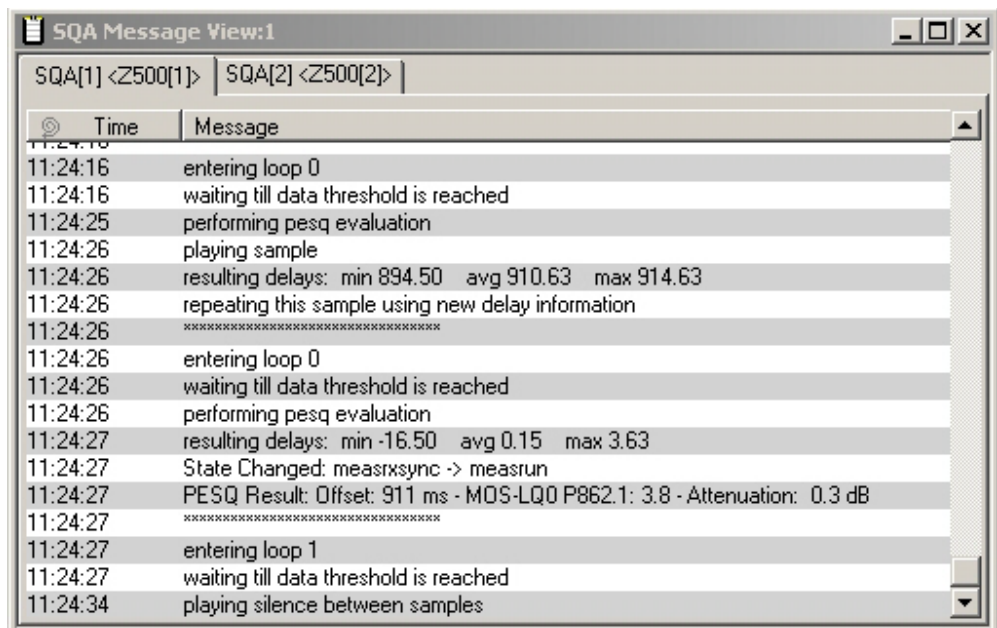
Use the SQA Message View for verification: If you get MOS-LQO values the setup is OK. If the attenuation is negative (that means you have gain) reduce the input level setting of the soundcard. The best value for attenuation is 0 dB.

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.

Parameter	[Unit]	SQA[1]	SQA[2]
PESQ Score (DL)		3.599	
PESQ Score Noise (DL)		4.076	
PESQ Score Speech (DL)		3.540	
MOS-LQ0 P862.1 (DL)		3.688	
Attenuation (DL)	dB	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.
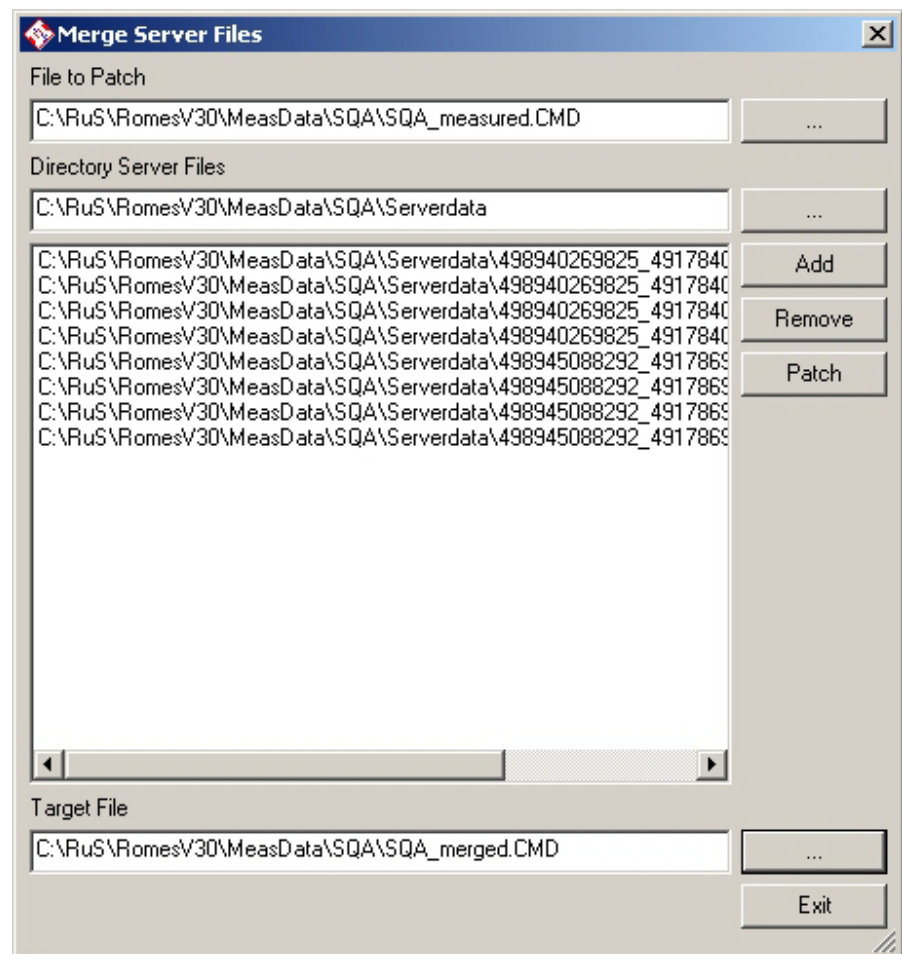
For "File to Patch" select the CMD file with the basic measurement.

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; http://www.itu.int/rec/T-REC-P/e; (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 www.rohde-schwarz.com in order to download new versions.

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

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