

Voice Quality Measurements with R&S ROMES

Application Note 1SP52

Products:

R&S® ROMES

This document introduces Voice Quality Measurements with R&S ROMES and describes the configuration of the drive test software step by step. It is been considered different hardware configurations and its settings.

Mobile to Server and Mobile to Mobile scenarios are discussed. It gives advice and offers interpretations of the measurement data.

Numerous pictures and schematics allow to understand the Voice Quality issue and helps as a guideline to perform those Quality of Service measurements.

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1 Introduction

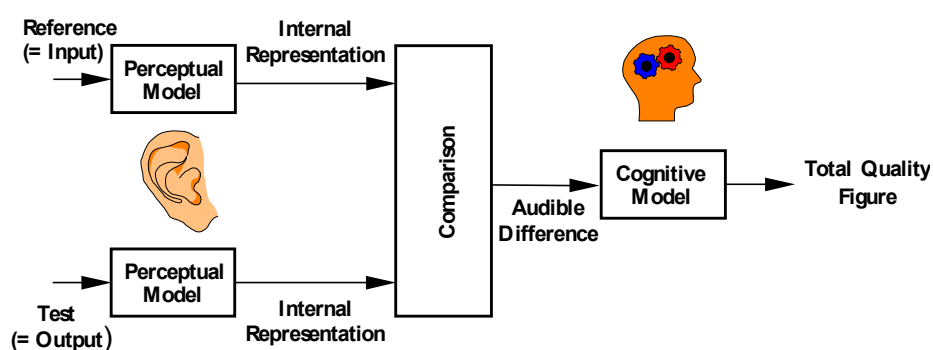
The Speech Quality Analysis allows end-to-end Tests showing how the subscriber would see the network quality/performance. The main advantage of this type of measurement is the ability to make a statement about the speech quality/performance of the uplink and downlink. It can be applied in a wide range 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 Telecommunication 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 ROMES4SQA SQA option)
- Speech sample (e.g. ITU samples or http://www.signallogic.com/index.pl?page=codec_samples#pesq)
- Digital answering machine or
- ROMES4SRV SQA Server

Required Hardware:

- High-performance PC with Windows XP for four SQAs at the same time a Pentium IV 3 GHz with Hyperthreading or Dual Core 2 GHz 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 Adapter Box for the mobile
- One of the following separate sound cards:
 - For up to two test mobiles: M-Audio Transit (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 TSML/U/Q 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.

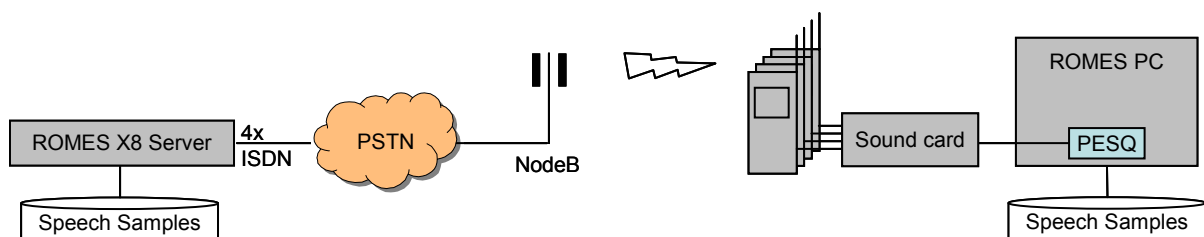


Figure 1 System constellation for Speech Quality Analysis (SQA)

4 Soundcard Setup on measurement PC

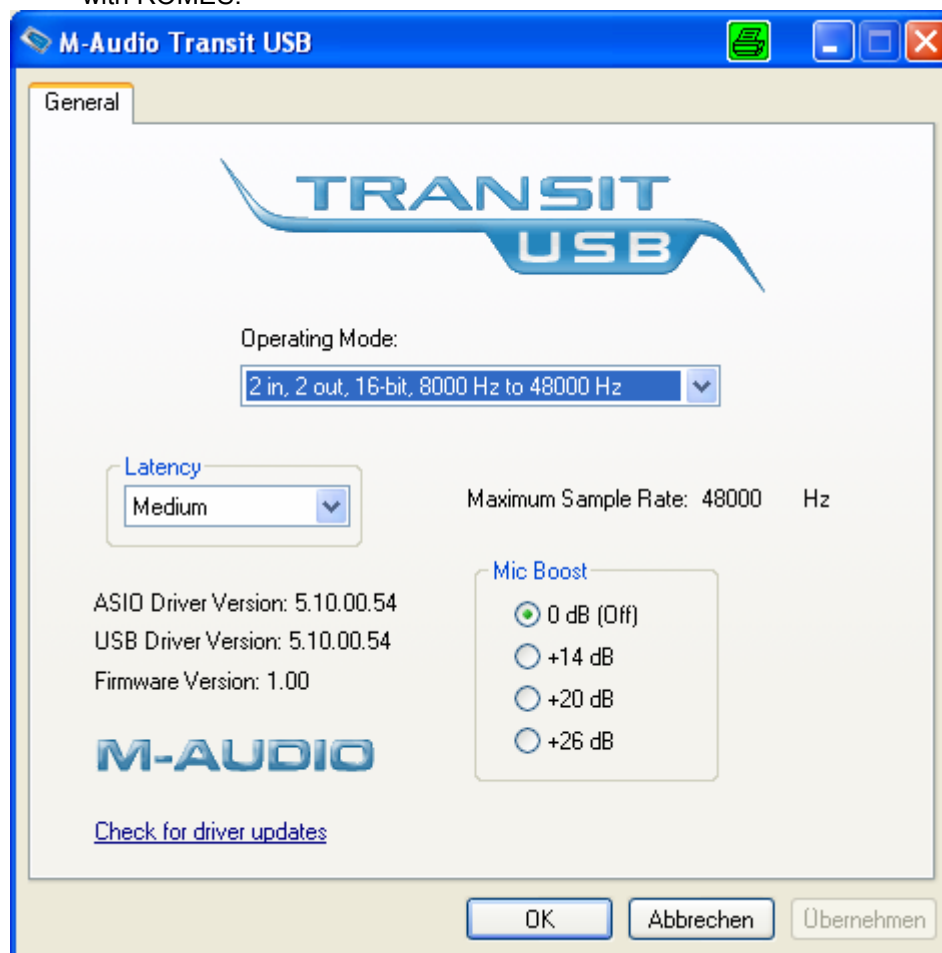
The following paragraphs explain step-by-step how to configure the drivers and the ROMES software for Voice Quality Measurements.

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.

M-Audio Transit:

- (1) Install the M-Audio Transit drivers included into the ROMES installation CD (e.g. ROMES 4.11\Firmware & Drivers\Sound Cards\M-Audio\Transit_WDM_5.10.00.0055v2.exe) without USB connection to the sound card. After successful installation connect the sound card. Use the following default settings with ROMES.



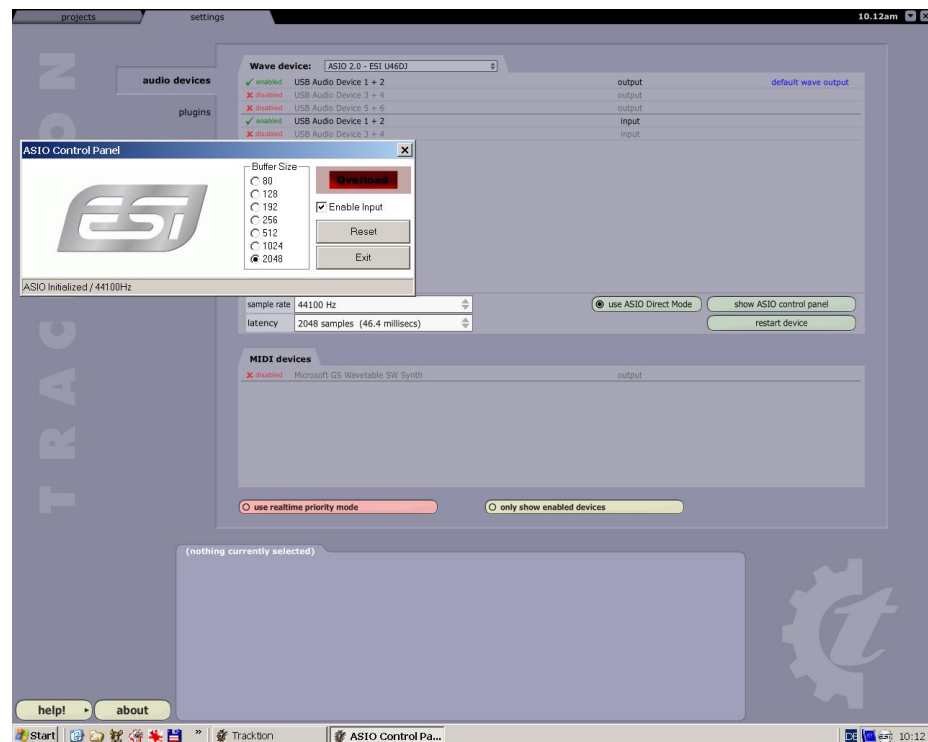
Note: The PESQ measurement show the "Attenuation" level. Adjusting this with the mobile volume control or with the "Mic Boost" for line-in attenuation.

The M-Audio Transit does not require an external power supply. For measurements with two mobiles (mobile to mobile for example) special y-cables are necessary. Those cables show tags with 2x "L/1" and 2x "R1". Both "L/1" have to be connected to one Audio Adapter Box, similar to both "R/1".

The sound card has one “line” connector for output and one “line/optical” connector for the input. The output of the sound card is always the input of the Audio Adapter Box and other way round.

ESI U46J:

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

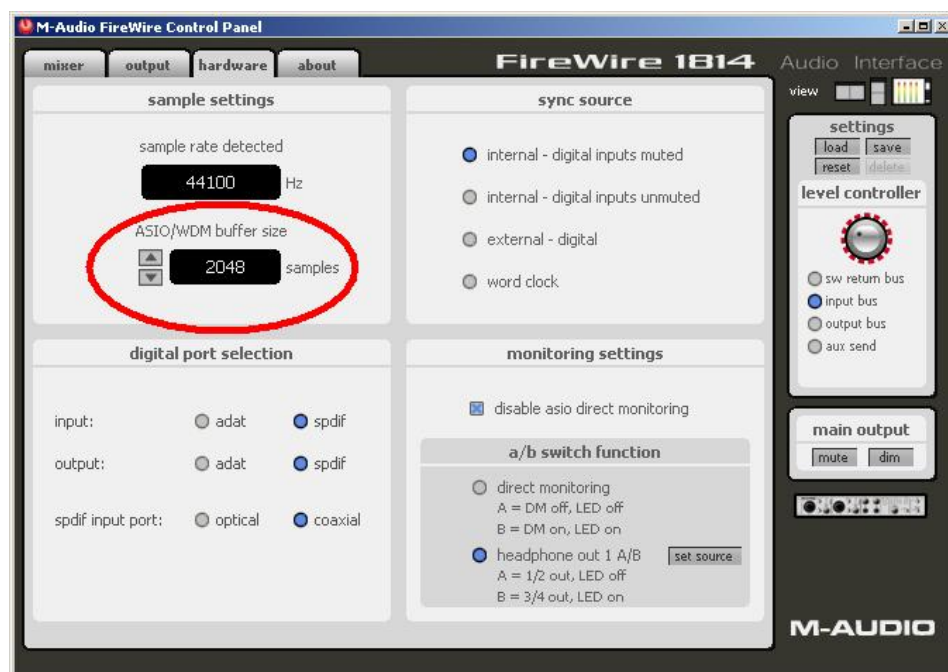


- (2) Connect the mobile to the mobile adapter box.
 - (3) Connect “out” to the “Input” connector and “in” to the “Output” connector on the rear of the box.
- Set both switches on the front to “Line”.
 - “Power” must be on.
 - “+48V” must be off.



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:

Z500 [2]

Configuration

Services

Autodialing

SQA

Actions

☒ Use autodial

☐ Autoanswer

☒ Start with Measurement

Subscriber Number

intl. format: e.g. +491701234...

+4917335004871

Mode

☒ Single Call Type

☐ Multi Call Type

Timing

☐ Constant Call Pattern (ETSI Specification) ☒ Endless Call

Max. Access Time: 20 sec Idle Time: 30 sec

Call Duration: 0 sec Min. Pause Time: 0 sec

Offset: 0 sec

Data Call

Speed: 7: 9600 bps (V.32)

Bearer Service: 0: data circuit asynchronous (U) CE: 1: non-transparent

Phone Numbers

+491625977730

Calling Convention / Preconditions

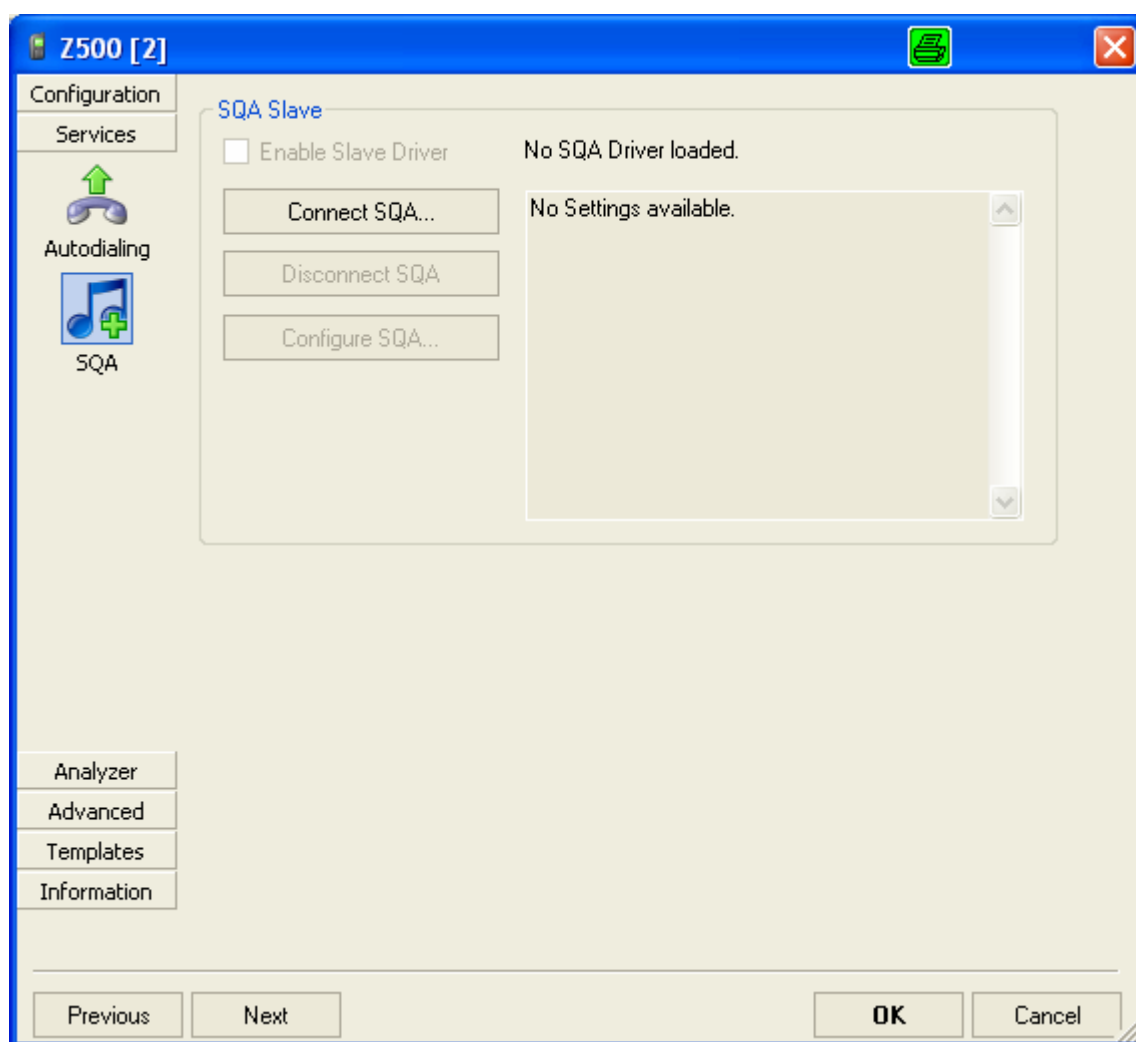
Replacement for '+': 00

Call will be initiated, if UE is registered with: Any RAT

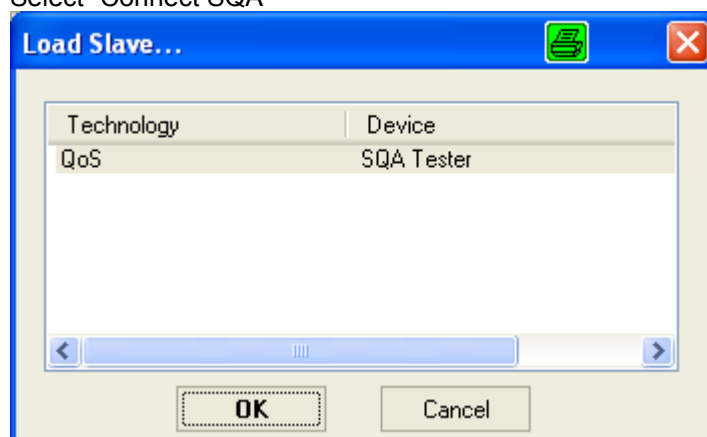
☐ Verify before start of call MCC: 0 MNC: 0 ...

Previous Next OK Cancel

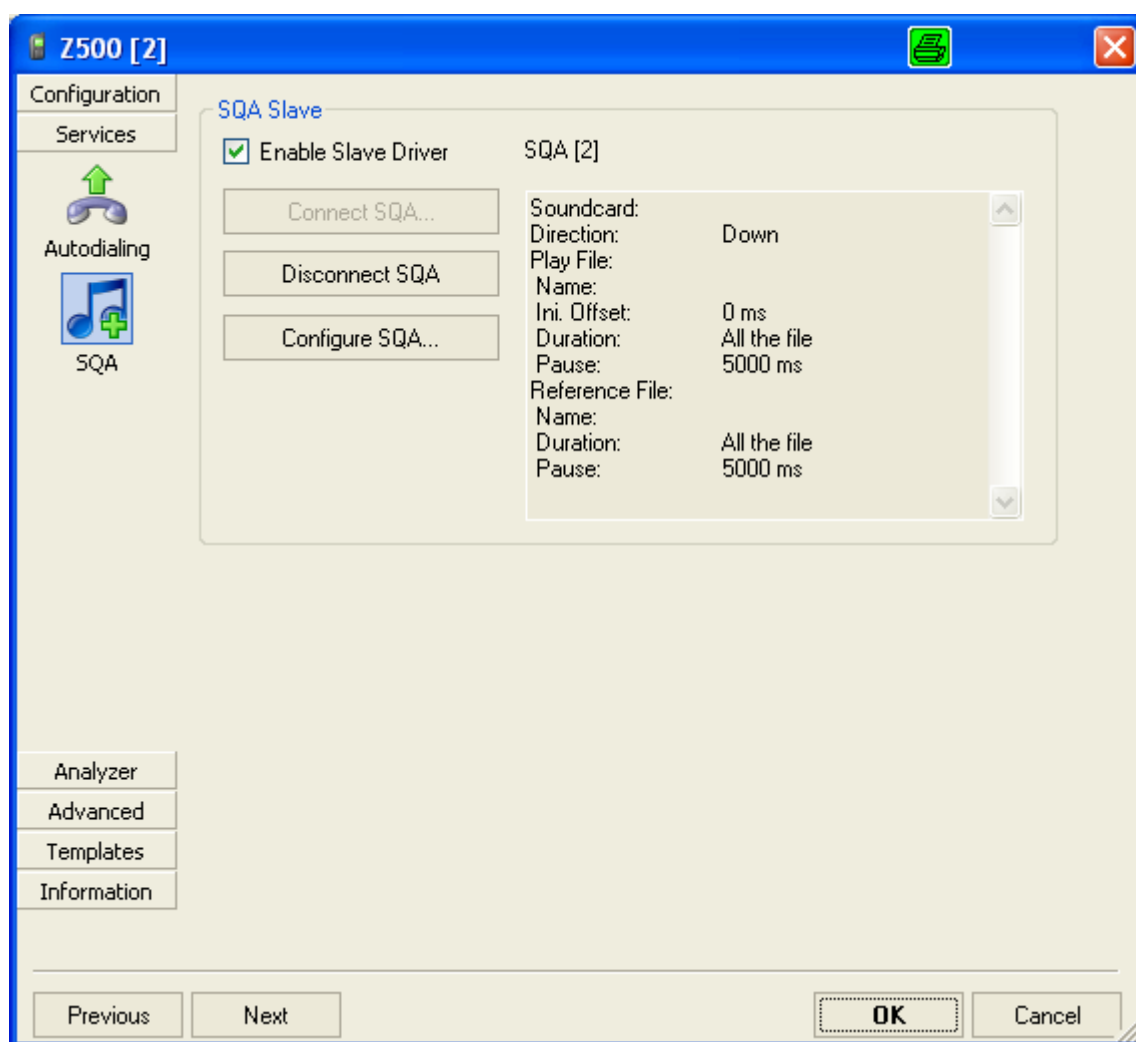
- If you are using an answering machine, do not use “Endless call”, because after a given time the wave file will be finished.
 - If you are using a ROMES SQA Server, the server must be set up for endless calls.
 - The “Phone Number” must be the correct number for the server. If you enter an incorrect 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 “SQA” and load the “Speech Quality Analyzer” menu.



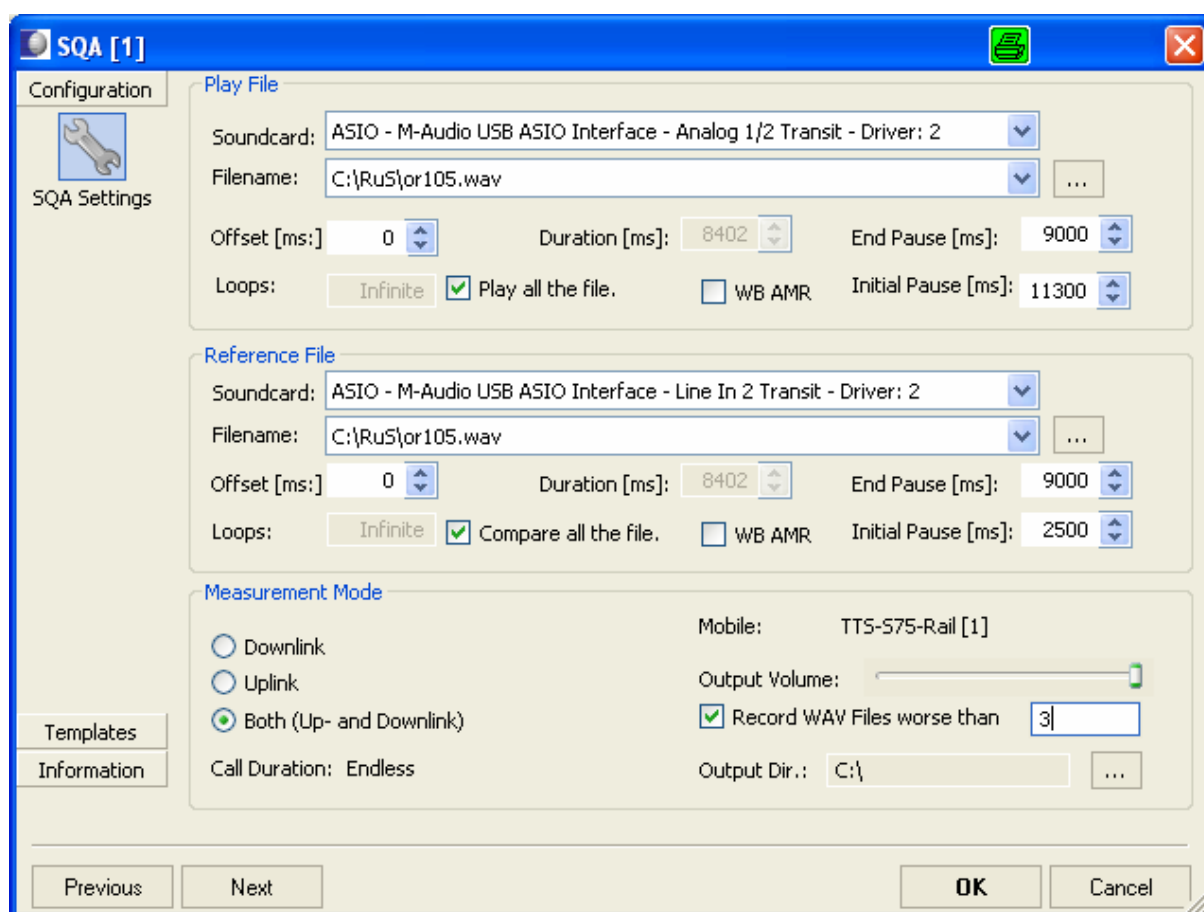
Select "Connect SQA"



Press OK.



Press "Configure SQA..."



- (3) If you are using an answering machine select "Downlink". With an SQA server can select "Both (Up- and Downlink)". 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 ASIO drivers have to be different, to avoid sound card driver conflicts.

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.

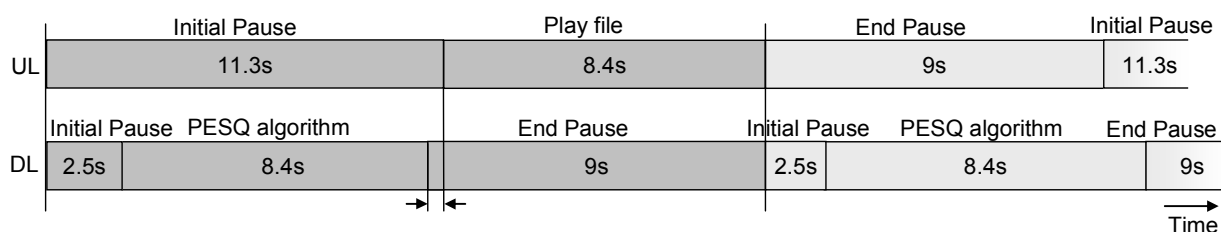


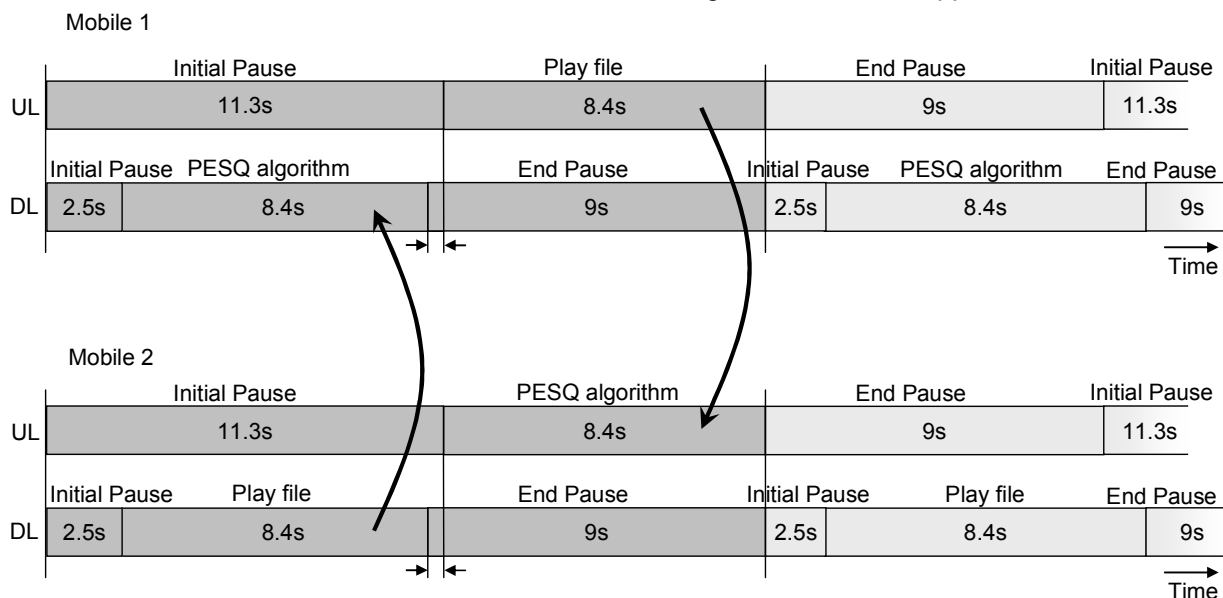
Figure 2 Timeline of the SQA settings above

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.

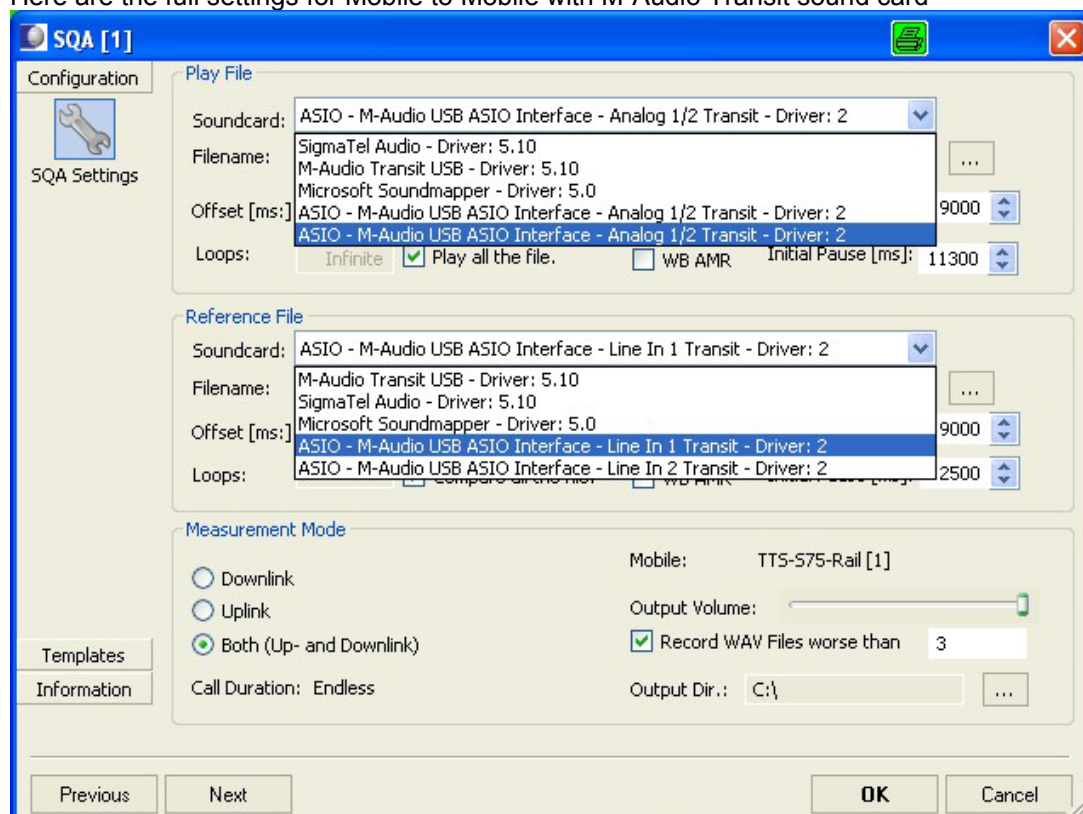
Note: The timings of the measurement system and the answering machine/ROMES Server have to be harmonized.

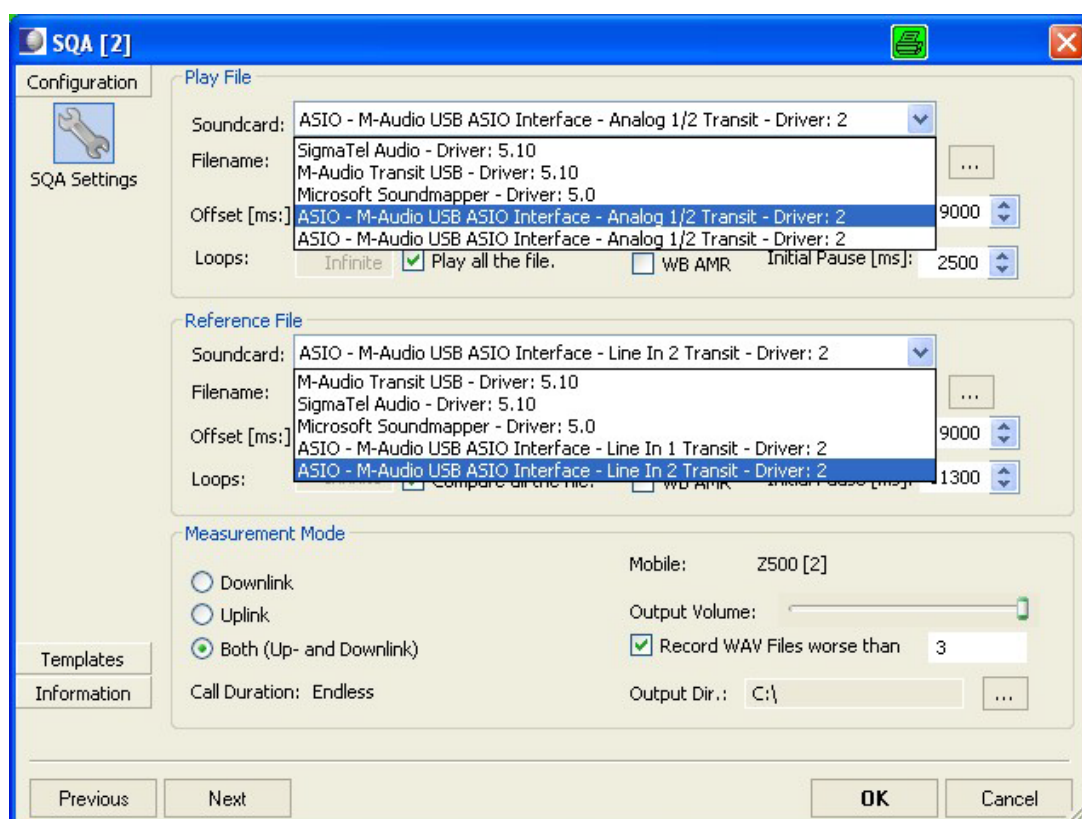
The timing in this example refers to a sample length of 8.4 seconds. The timing will change if the voice sample is been changed.

For mobile to mobile measurements the following time line can be applied.



Here are the full settings for Mobile to Mobile with M-Audio Transit sound card





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.

SQA Server Configuration

Location Settings
 Data Storage: C:\Programme\SQA_Server ... ☐ International Calls allowed Location:

Time Synchronization
 Time Provider: NTP Host: http://www.pool.ntp.org Port: 123 Time Delta: 250 [ms] Test

Call Settings
 Line 1 (selected)
☒ Valid for SQA
 Dev. Prefix Country Code Area Prefix Area Code
 49 892 254887
 MSN: 89254889
 Phone number to call:
☒ Listen for Mobile Call Serving Mode: Both
 Call Duration: 60 [s] ☐ Endless Call
 Call Window: 0 [s] Max. Access Time: 15 [s]

Outgoing Wave
 File: C:\RuS\or105.wav ... ☒ Play all the file. Initial Pause [ms]: 2500
 Offset [ms]: 0 Duration [ms]: 8402 Pause [ms]: 9000 Loops: 3 Update Loops

Incoming Wave
 File: C:\RuS\or105.wav ... ☒ Play all the file Initial Pause [ms]: 11300
 Offset [ms]: 0 Duration [ms]: 8402 Pause [ms]: 9000 Loops: 2 Update Loops
☒ Store WAV File in Meas. - File ☒ Store WAV File on Hard Disk Record Limit MOS: 3 Version 4.11.0.0/69

Messages Register Service Start Service Start Interactive Copy 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).

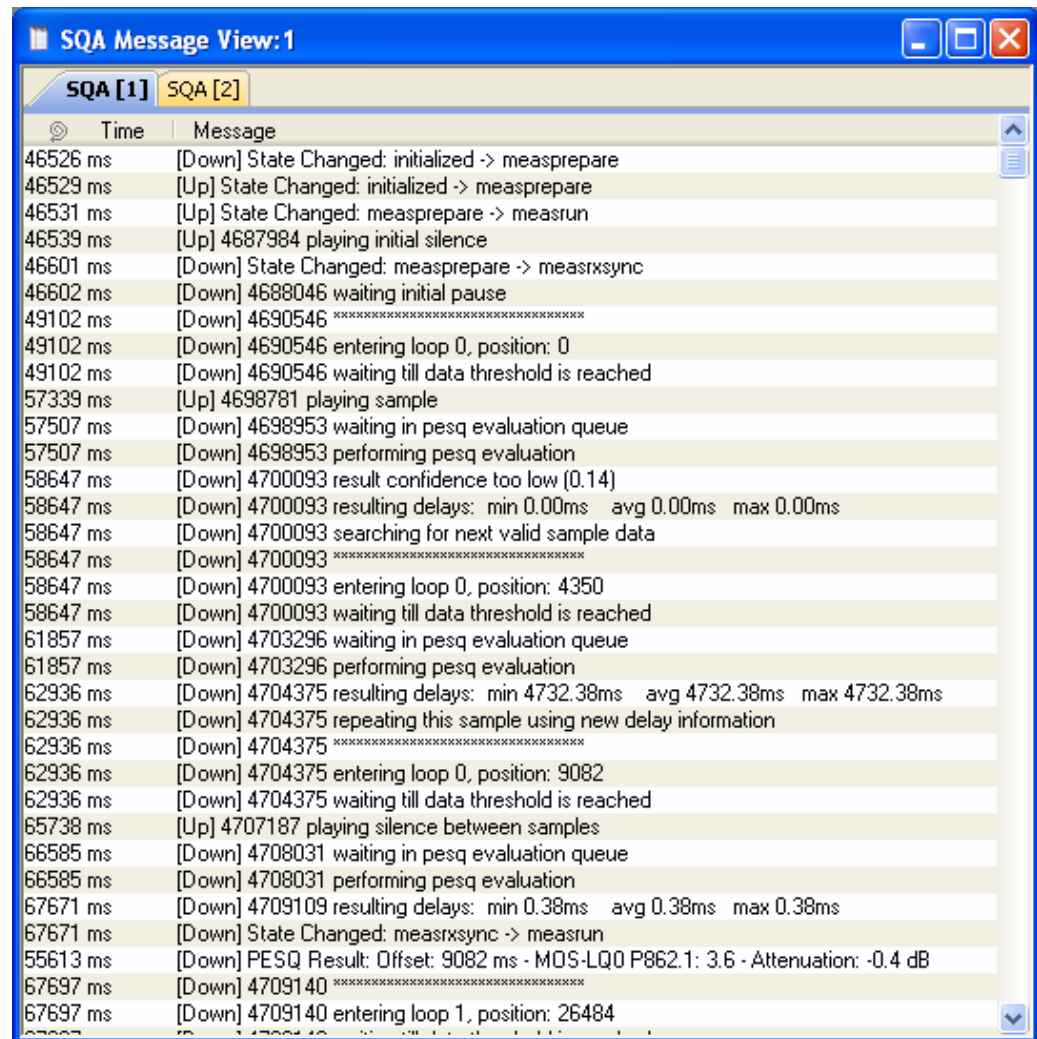
Note: to reduce CMD files, the value “Record WAV files worse than” can be reduced, or disabled

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
- Alphanumeric View with Signals from SQA Tester
- 2G/3G Layer 3 View



Time	Message
46526 ms	[Down] State Changed: initialized -> measprepare
46529 ms	[Up] State Changed: initialized -> measprepare
46531 ms	[Up] State Changed: measprepare -> measrun
46539 ms	[Up] 4687984 playing initial silence
46601 ms	[Down] State Changed: measprepare -> measrxsync
46602 ms	[Down] 4688046 waiting initial pause
49102 ms	[Down] 4690546
49102 ms	[Down] 4690546 entering loop 0, position: 0
49102 ms	[Down] 4690546 waiting till data threshold is reached
57339 ms	[Up] 4698781 playing sample
57507 ms	[Down] 4698953 waiting in pesq evaluation queue
57507 ms	[Down] 4698953 performing pesq evaluation
58647 ms	[Down] 4700093 result confidence too low (0.14)
58647 ms	[Down] 4700093 resulting delays: min 0.00ms avg 0.00ms max 0.00ms
58647 ms	[Down] 4700093 searching for next valid sample data
58647 ms	[Down] 4700093
58647 ms	[Down] 4700093 entering loop 0, position: 4350
58647 ms	[Down] 4700093 waiting till data threshold is reached
61857 ms	[Down] 4703296 waiting in pesq evaluation queue
61857 ms	[Down] 4703296 performing pesq evaluation
62936 ms	[Down] 4704375 resulting delays: min 4732.38ms avg 4732.38ms max 4732.38ms
62936 ms	[Down] 4704375 repeating this sample using new delay information
62936 ms	[Down] 4704375
62936 ms	[Down] 4704375 entering loop 0, position: 9082
62936 ms	[Down] 4704375 waiting till data threshold is reached
65738 ms	[Up] 4707187 playing silence between samples
66585 ms	[Down] 4708031 waiting in pesq evaluation queue
66585 ms	[Down] 4708031 performing pesq evaluation
67671 ms	[Down] 4709109 resulting delays: min 0.38ms avg 0.38ms max 0.38ms
67671 ms	[Down] State Changed: measrxsync -> measrun
55613 ms	[Down] PESQ Result: Offset: 9082 ms - MOS-LQO P862.1: 3.6 - Attenuation: -0.4 dB
67697 ms	[Down] 4709140
67697 ms	[Down] 4709140 entering loop 1, position: 26484

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.

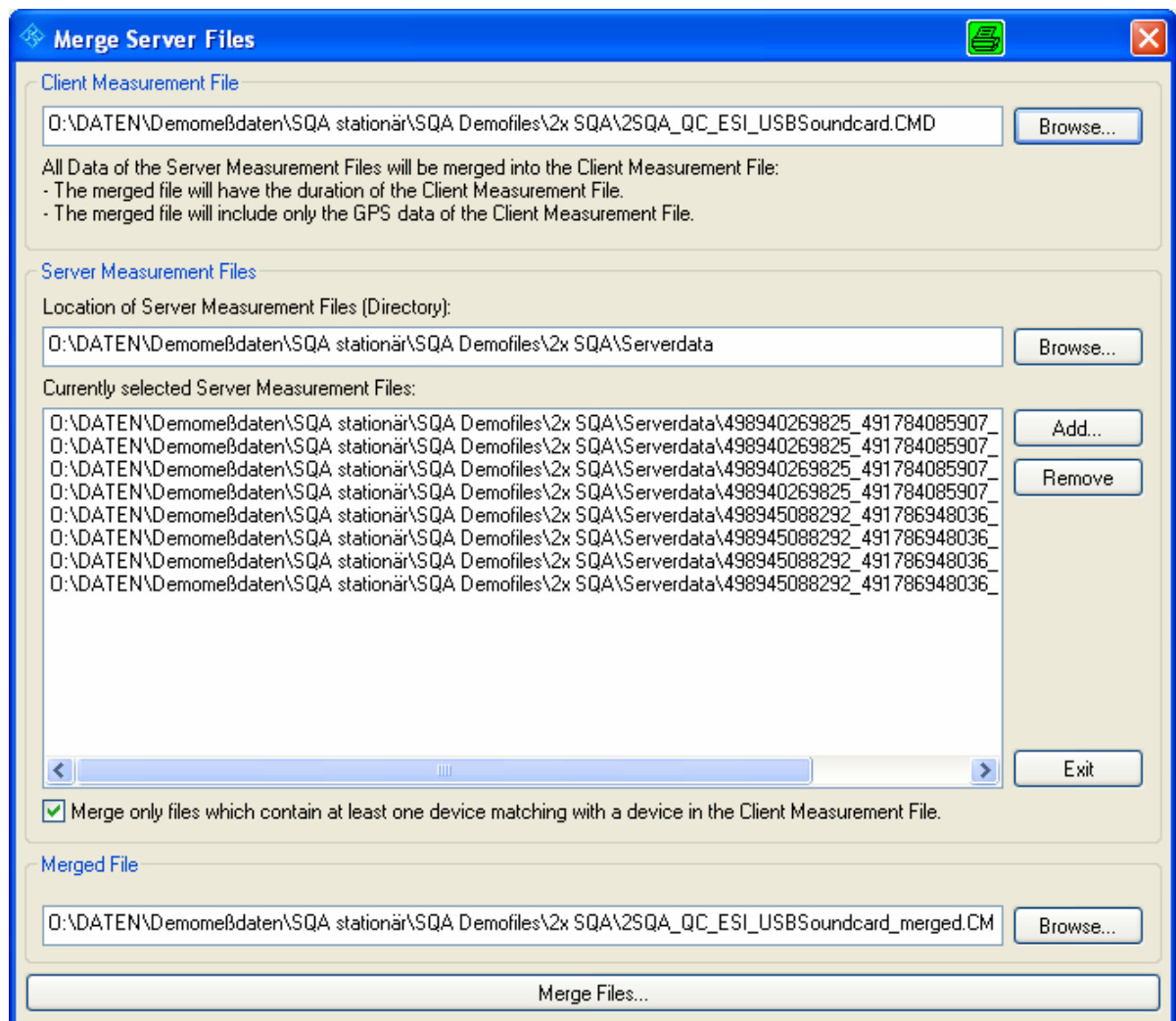
Possible reasons for no measurement values are the same as for Downlink.

Alphanumeric View: 1			
Parameter	[Unit]	SQA [1]	SQA [2]
PESQ Score P862.1 (Narrow Band)(DL)		3.537	3.825
PESQ Score P862.1 Noise (Narrow Band)(DL)		4.390	4.309
PESQ Score P862.1 Speech (Narrow Band)(DL)		3.215	3.635
MOS-LQO P862.1 (Narrow Band)(DL)		3.605	3.967
Attenuation (DL)	dB	-0.536	4.823

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-LQO 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 “Client Measurement File” select the CMD file with the basic measurement.
 With “Server Measurement Files” select the directory where the server files have been placed. You can add more files from other locations with the “Browse...” button. ROMES finds the correct files by the measurement time.
 Enter a name for the target file, if default is not suitable.
 Start merging with “Merge Files...” 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: Recommendation 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

ROMES4	1117.6885.04	Drive Test Software Platform
ROMES4REP	1117.6885.34	Drive Test Software Platform Replay Module
ROMES4SQA	1117.6885.36	ROMES Speech Quality (SQA) Mobile 1 Channel
ROMES4PESQ	1503.4214.02	PESQ Runtime License
TS4SERVER	1502.6036.40	ROMES Speech Quality SERVER
TS95ISDN	1506.9530.12	ISDN Controller for 4x Speech Quality on SQA Server
TS95PSTN	1506.9530.04	Analogue Controller for 4x Speech Quality on SQA Server
ROMES4SRV	1117.6885.38	ROMES SQA SERVER Software
TS95AUDIO	1088.1410.02	Speech Quality 2x Audio Card (USB)
TS95AUDIO	1502.5930.12	Speech Quality 2x Audio Card (FIREWIRE)
TS95AUDIO	1117.8220.02	Speech Quality 4x Audio Card (FIREWIRE)
TS-SM-AF	1074.5860.36	Audio Adaptation Kit for TrioRail S75 audio jack
TS-SM-AF	1074.5860.26	Audio Adaptation Kit for Samsung Z560/U700 audio jack
TS-SM-AF	1074.5860.42	Audio Adaptation Kit for Nokia N95 audio jack
TS-SM-AF	1074.5860.12	Audio Adaptation Kit for Qualcomm TM7200 audio jack

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Certified Quality System

ISO 9001

DQS REG. NO 1954 QM

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