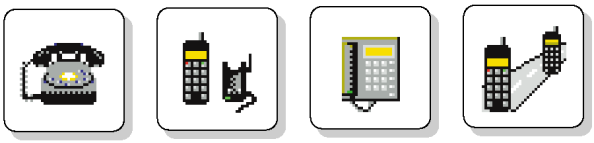
HEAD acoustics®

ACQUA

Advanced Communication Quality Analysis

Configurations



Analog Telephony

Analog Network Access

Digital Telephony

Hands-free Telephony

Hands-free
in Motor Vehicles

Mobile Telephony:
DECT
GSM
UMTS

Network Configurations:
Echo Canceller
DCME
VoIP

Electroacoustic
Quality Measurements
in Telephone Networks

ACQUA – Advanced Communication Quality Analysis

The Advanced Communication Quality Analysis ACQUA is a dual channel signal analyzer and signal generator optimized for telecommunication measurements.

ACQUA is a data acquisition, measurement and analysis system for nearly all applications in telecommunications. ACQUA is suitable for measurements and analysis of terminal equipment, network components, answering machines and complete point-to-point measurements of single networks or network configurations. In addition to meeting the requirements of international standards such as ITU-T, ETSI and IEEE, ACQUA provides a wide variety of special measurements and evaluations necessary for the development of modern telecommunication equipment.

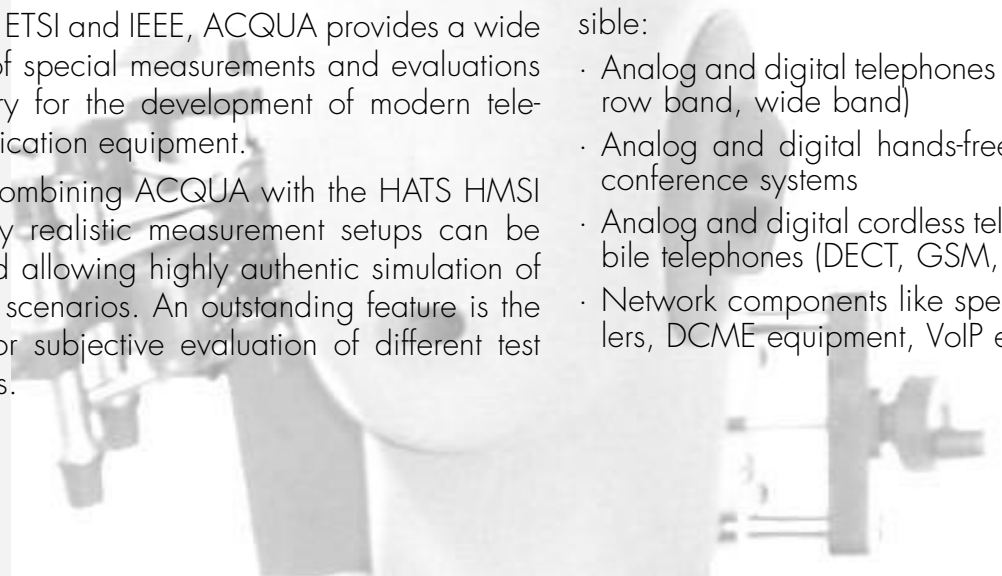
When combining ACQUA with the HATS HMSI II.3, very realistic measurement setups can be achieved allowing highly authentic simulation of real use scenarios. An outstanding feature is the ability for subjective evaluation of different test situations.

ACQUA has three main fields of application:

- Automated data acquisition and analysis of standard measurements for terminal equipment and transmission lines of bandwidth up to 20 kHz.
- Analysis of transmission systems with non-linear, time-variant transfer characteristics.
- Experimental development and optimization of terminal equipment, networks and network components.

When connected to the different frontends for signal conditioning, measurement of almost all equipment in the field of telecommunications is possible:

- Analog and digital telephones with handset (narrow band, wide band)
- Analog and digital hands-free equipment and conference systems
- Analog and digital cordless telephones and mobile telephones (DECT, GSM, UMTS, CT1+)
- Network components like speech echo cancellers, DCME equipment, VoIP etc.

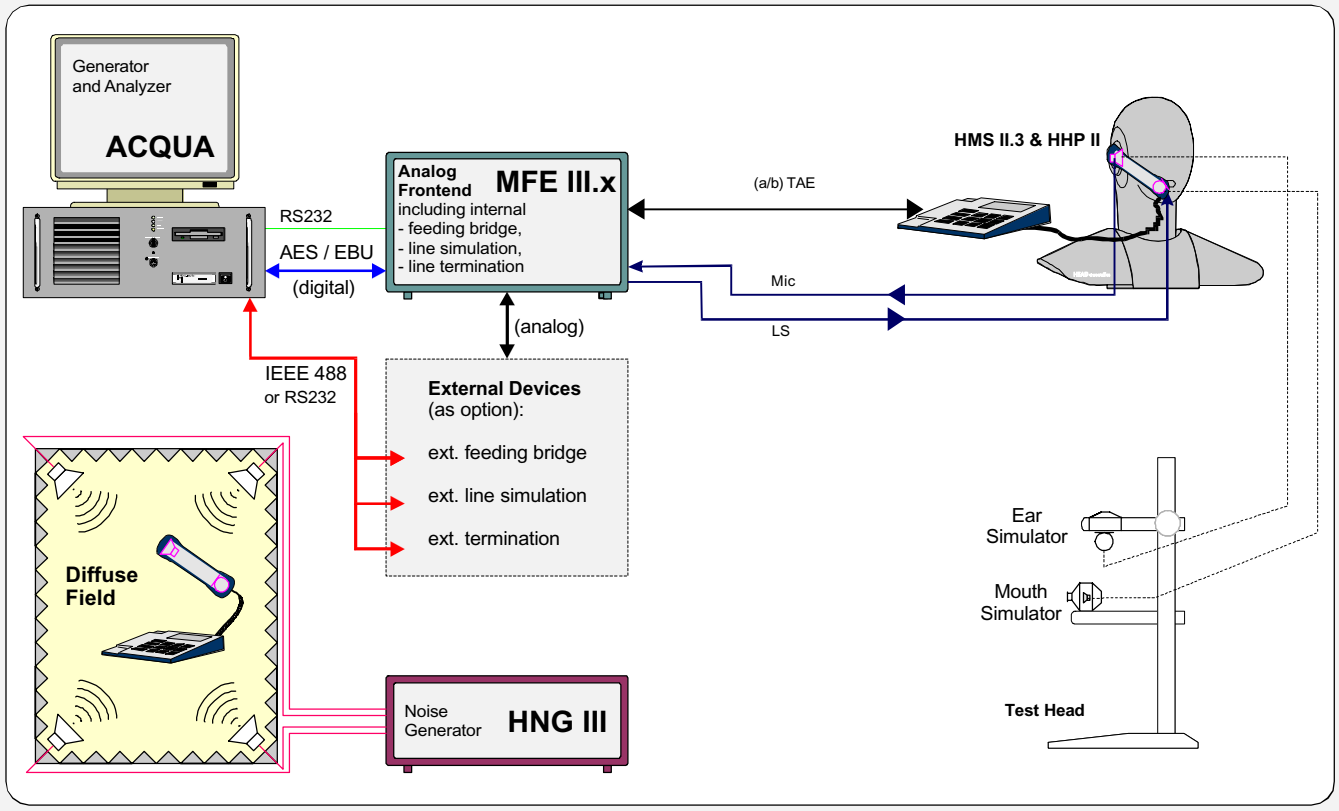


Key Features

- Full expandable system solution for measuring acoustics and network access for different standards of telephony:
  - Analog telephony
  - Analog network access
  - Digital telephony
  - Cordless (DECT, CT1+, ...)
  - GSM/UMTS
  - Hands-free telephony (in cars, offices, ...)
  - Voice over IP (VoIP) equipment
  - Echo Canceller (EC)
- Predefined test cases for fast, automated measurements according to standards
- Possibility to automate documentation
- Possibility to build custom standards and measuring sequences
- Data base for archiving time signals, transfer functions, test results and test conditions
- Measurements with any test signals
- Outstanding possibilities for signal preparation and manipulation to optimize quality
- Subjective evaluation of measurement objects, especially important for non-linear, time-variant systems
- A/B comparison of different measurement objects

Analog Telephony

- Handset
- Hands-free
- Answering Machine
- Cordless



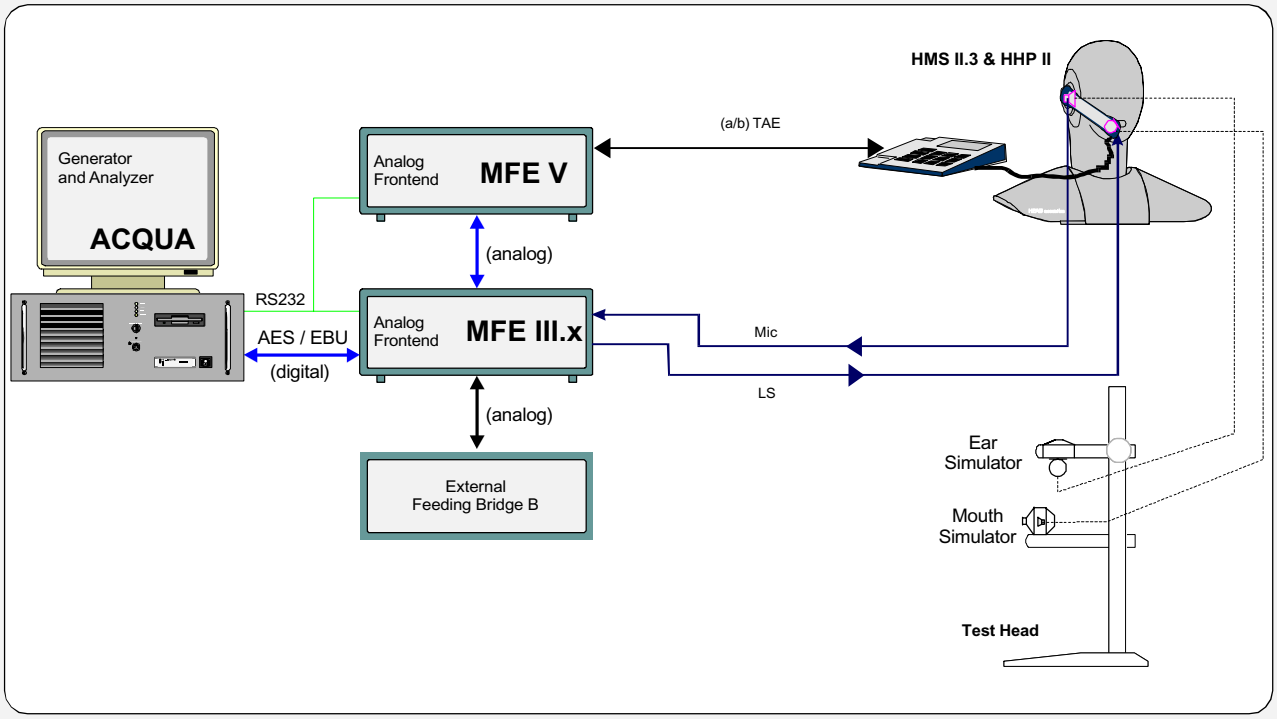
Equipment under Test	Standard	Hardware	Software
Handset	BAPT 223ZV24 (Germany)	ACQUA (6810) MFE III.1 (6201) HNG III.1 (6510) External Feeding Bridge B 4 Loudspeakers	ZV24 (6719)
Handset	FTZ 121 TR 8 part 1 (Germany)	ACQUA (6810) MFE III.1 (6201) HNG III.1 (6510) External Feeding Bridge B 4 Loudspeakers	121TR8-1 (6724)
Handset	SR 784.103.12/2.4 (Switzerland)	ACQUA (6810) MFE III.1 (6201)	BAKOM (6728)
Handset	B00-21A (France)	ACQUA (6810) MFE III.1 (6201) External Line Simulation	B0021A (6743)
Handset	ETSI - TBR 38 (Europe)	ACQUA (6810) MFE III.1 (6201)	TBR38 (6741)
Handset	GB/T 15278-94 (China)	ACQUA (6810) MFE III.1 (6201) External Line Simulation	GBT I (6744)

Equipment under Test	Standard	Hardware	Software
Handset	TIA EIA-470-B (USA, Canada)	ACQUA (6810) MFE III.1 (6201) External Line Simulation	EIA/TIA (6745)
Answering Machine	FTZ 121 TR 8 part 8 (Germany)	ACQUA (6810) MFE III.1 (6201)	121TR8-8 (6726)
Hands-free	FTZ 121 TR 8 part 2 (Germany)	ACQUA (6810) MFE III.1 (6201)	121TR8-2 (6736)
Loud-speaking	FTZ 121 TR 8 part 3 (Germany)	ACQUA (6810) MFE III.1 (6201)	121TR8-3 (6737)
Cordless	BAPT 222ZV80 (Germany)	ACQUA (6810) MFE III.1 (6201) HNG III.1 (6510) External Feeding Bridge B 4 Loudspeakers	ZV80 (6718)
Cordless	FTZ 121 TR 8 part 4 (Germany)	ACQUA (6810) MFE III.1 (6201) HNG III.1 (6510) External Feeding Bridge B 4 Loudspeakers	21TR8-4 (6725)

Further standards available on customers' request

Analog Network Access

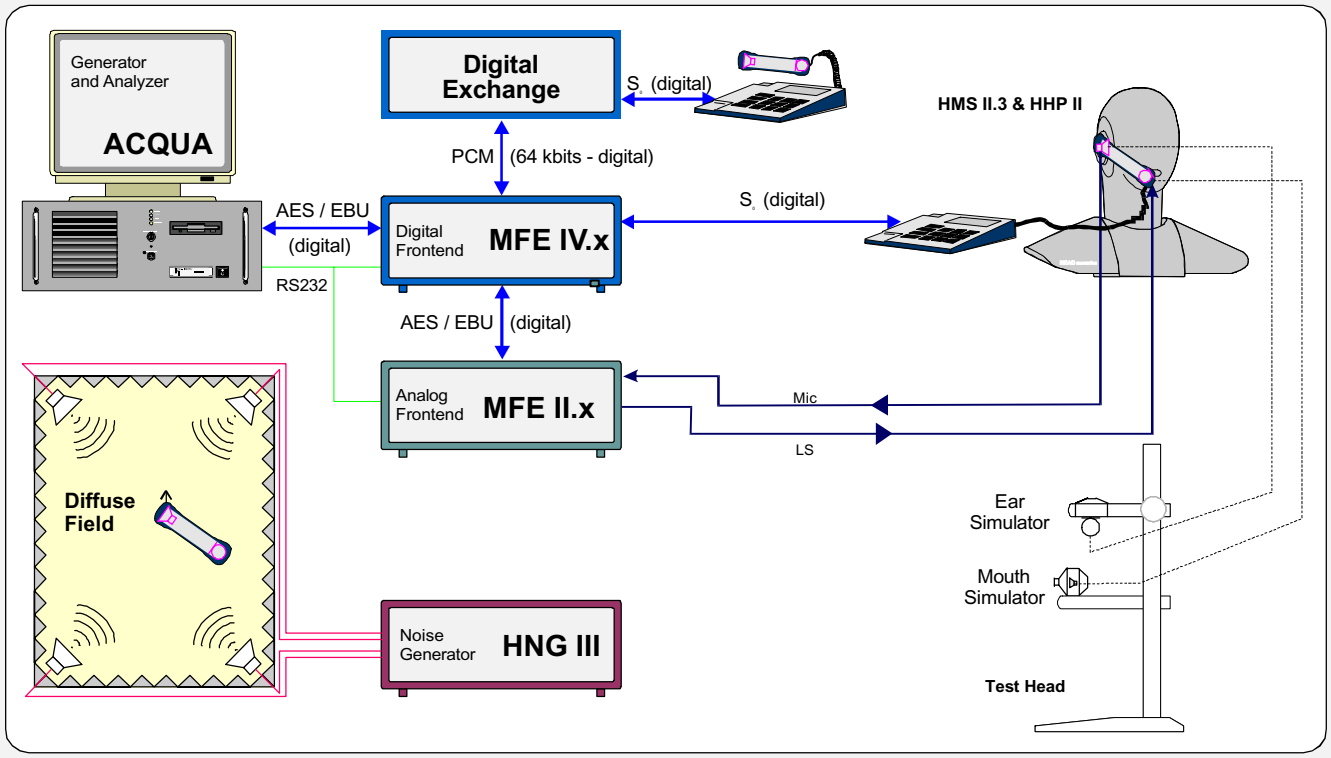
- Telephone
- FAX Machine
- Modem



Standard	Hardware	Software
BAPT 223ZV5 (Germany)	ACQUA (6810) MFE III.1 (6201) MFE V.1 (6401) Feeding Bridge B	COP ZV5 (6715) COP 4 (6734)
ETSI - TBR 21 (Europe) I-CTR 37	ACQUA (6810) MFE III.1 (6201) MFE V.1 (6401)	COP TBR 21 (6739)
BAPT 223ZV5 + TBR 21	ACQUA (6810) MFE III.1 (6201) MFE V.1 (6401) Feeding Bridge B	COP ANA (6748) COP 4 (6734)

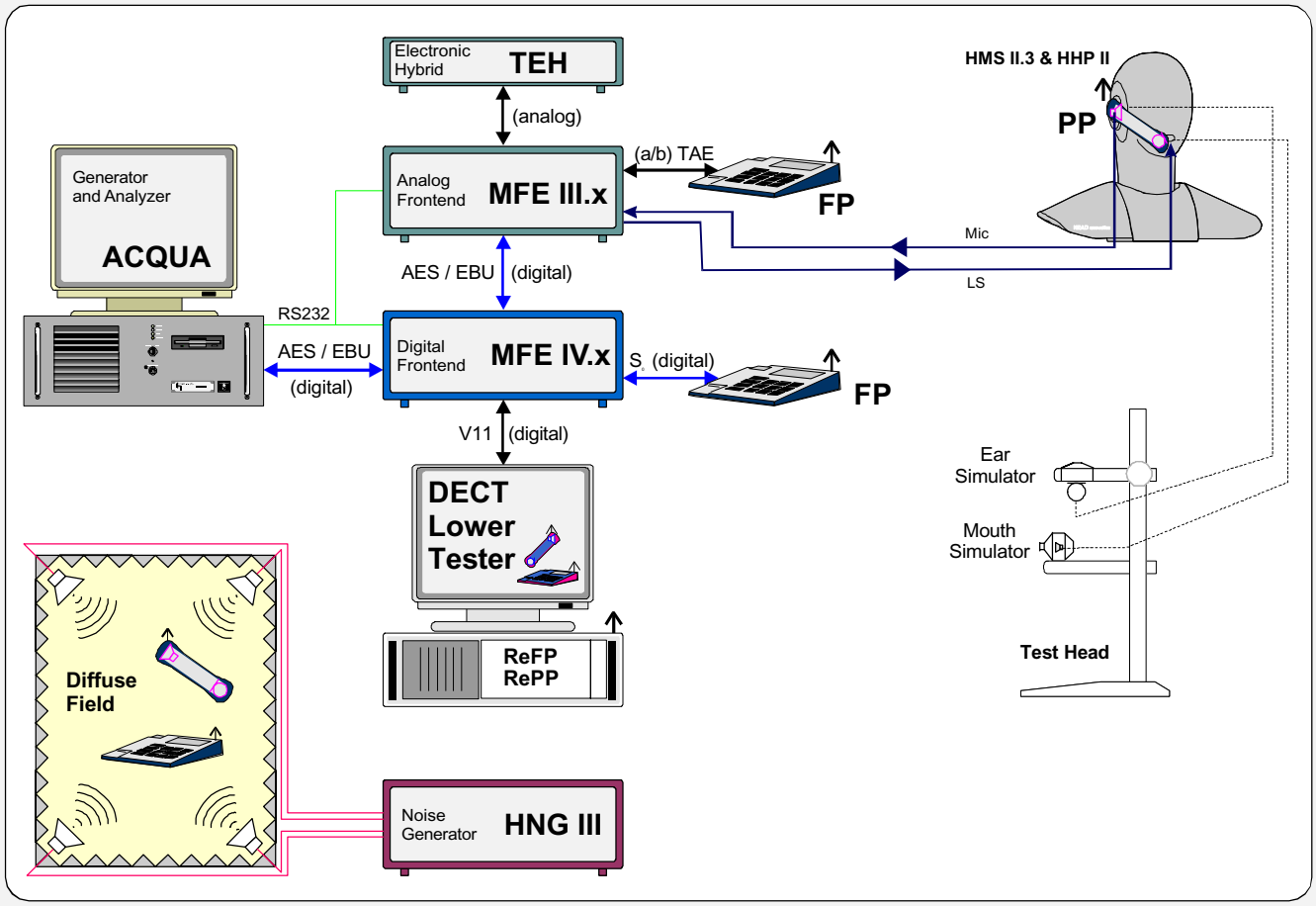
Digital Telephony

- Handset
- Hands-free
- Answering Machine



Equipment under Test	Standard	Hardware	Software
Handset	ETSI TBR 8 (Europe)	ACQUA (6810) MFE II (6100) MFE IV.1 (6301) HNG III.1 (6510)	TBR 8 (6721)
Hands-free	ETSI ETS 300 245 part 3 (Europe)	ACQUA (6810) MFE II (6100) MFE IV.1 (6301) HNG III.1 (6510)	ETS 245-3 (6712)
Answering Machine	FTZ 121 TR 8 part 8 (Germany)	ACQUA (6810) MFE II (6100) MFE IV.1 (6301) HNG III.1 (6510)	121 TR 8-8D (6746)

DECT TBR10 – Acoustic Measurement System



Tests Performed: (Complete Audio Tests Available)

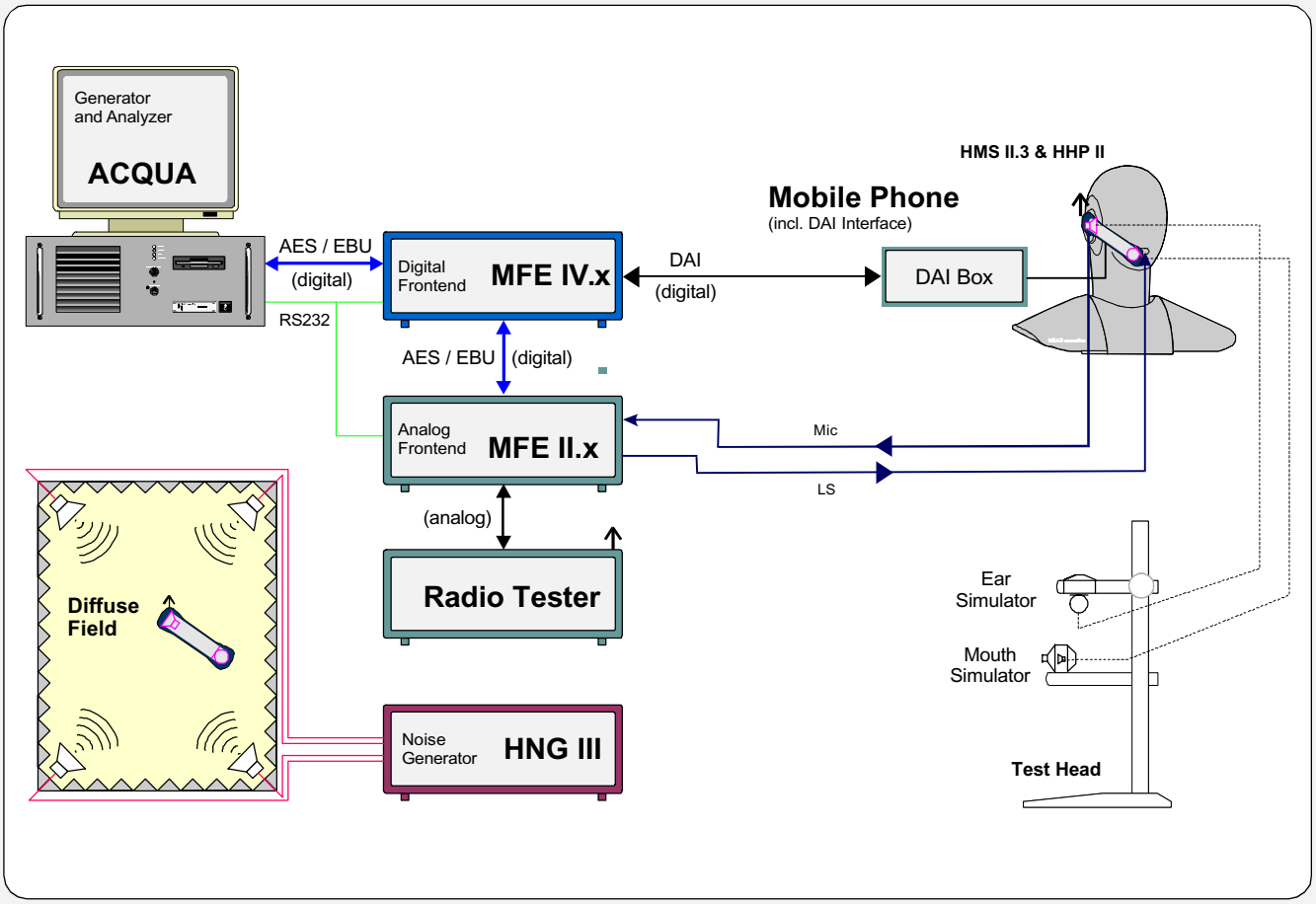
7.7 PP Sending Frequency Response
7.8 PP Receiving Frequency Response
7.9 PP Loudness Rating
7.10 User-controlled Volume Control in the PP
7.11 PP Talker Sidetone Masking Rating
7.12 Listener Sidetone (LST)
7.13 Terminal Coupling Loss (TCL_w) of a PP
7.14 FP Echo Control Functions with a 4-Wire Interface
7.15 Stability Loss - Fixed Geometry
7.16 Stability Loss - Variable Geometry
7.18 Sending Distortion
7.19 Receiving Distortion
7.20 Sidetone Distortion
7.21 Out of Band (Sending)
7.22 Out of Band (Receiving)
7.22 Sending Noise
7.23 Sending Noise (Narrow Band)
7.24 Receiving Noise
7.25 Sampling Frequency Level (Receiving)
7.26 Acoustic Shock
7.27 DECT Network Delay
7.28 PP Delay
7.29 FP Delay
7.30 Echo Control at the Network Side
7.31 Variation of Gain with Input Level – Sending
7.32 Variation of Gain with Input Level – Receiving

Equipment Required:

ACQUA	(6810)
MFE III.1	(6201)
MFE IV.1	(6301)
TEH I	(6290)
TBR 10	(6711)
MDO II.2	(6383)
HNG III.1	(6510)
NGE	(6521)

4 Loudspeakers
Artificial Ear
Artificial Mouth
Test Head
Reference Fixed Part
Reference Portable Part

GSM/UMTS – Acoustic Measurement System



Tests Performed:	(Complete Audio Tests (according to TS 26.131 & TS 26.132)) (Complete Audio Tests according to GSM 11.10) (Complete Audio Tests according to EN 300 903 (GSM 03.50))

30.1 Sending Sensitivity/Frequency Response
30.2 Sending Loudness Rating
30.3 Receiving Sensitivity/Frequency Response
30.4 Receiving Loudness Rating
30.5.1 Sidetone Masking Rating (STMR)
30.5.2 Listener Sidetone Rating (LSTR)
30.6.1 Echo Loss Male Voice (EL)
30.6.1 Echo Loss Female Voice (EL)
30.6.2 Stability Margin
30.7 Distortion
30.8 Sidetone Distortion
30.9 Out-of-band Signals
30.10 Idle Channel Noise

Equipment Required:

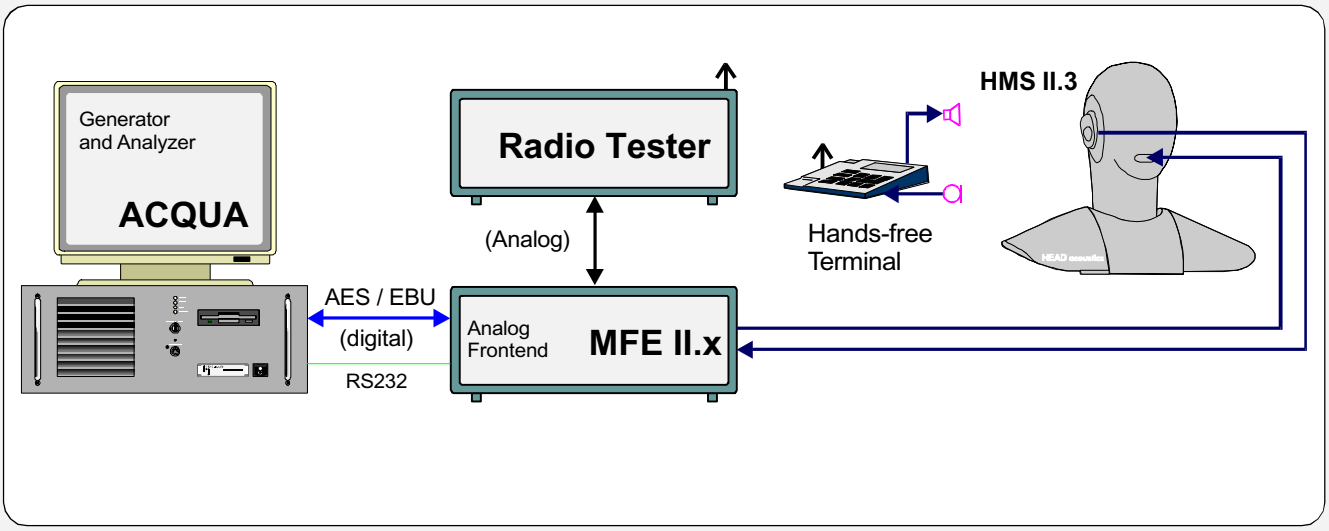
ACQUA (6810)
MFE II (6100)
MFE IV.1 (6301)
NGE (6521)
DAI (6399)
HNG III.1 (6510)
GSM 11.10 (6742)
TS 26.131/2

4 Loudspeakers
Artificial Ear
Artificial Mouth
Test Head

Radio Tester: CMD55, or
CMU200, or
HP89xx

Hands-free Telephone Measurement System

(also available for office type hands-free terminals)



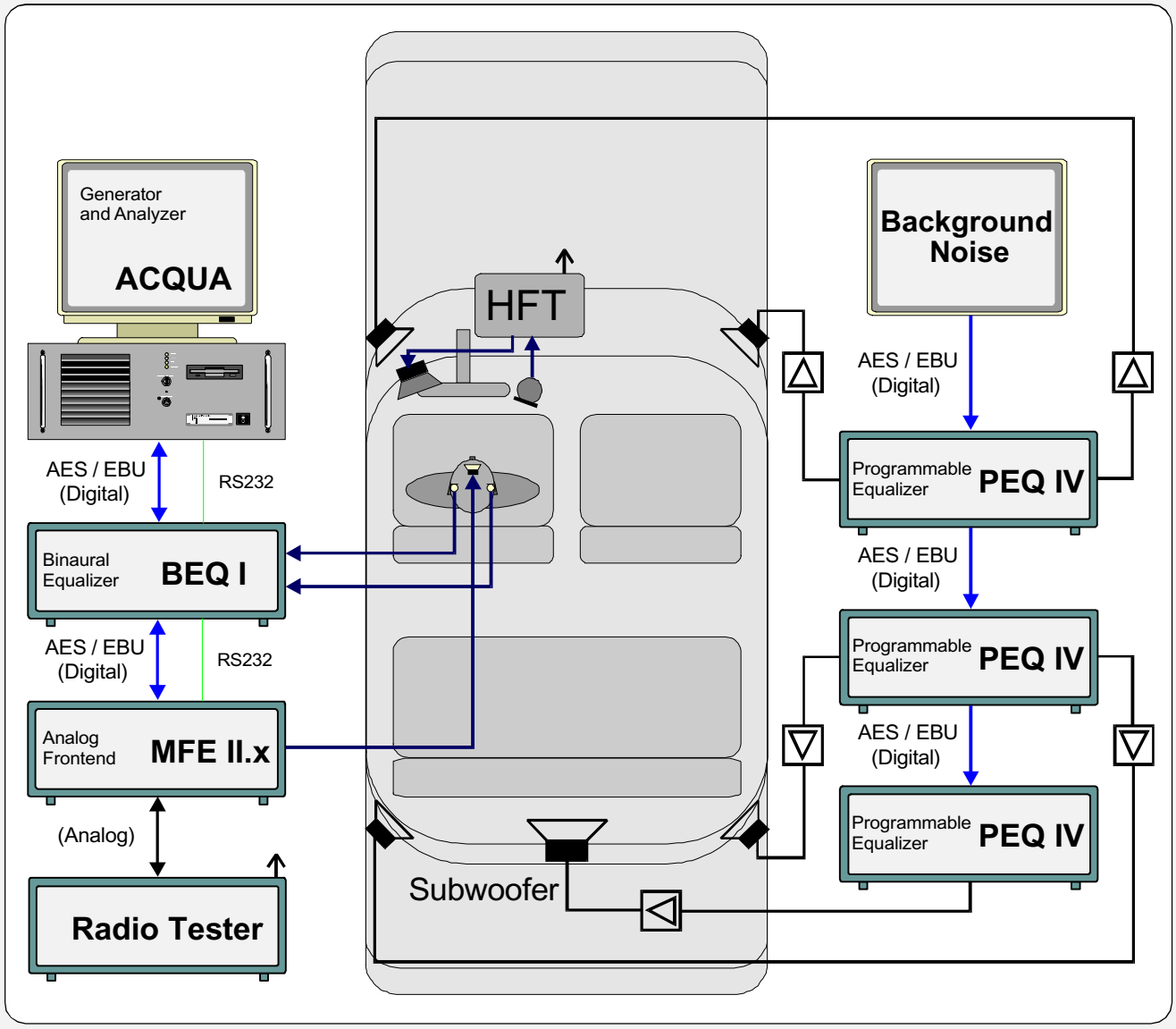
Tests Performed:

0	Delay Measurements
0.1	Delay in Sending Direction
0.2	Delay in Receiving Direction
0.3	Echo Delay
1	Signal Level in Receiving Direction
2	Level Switching
2.1	Level Switching in Sending Direction
2.2	Level Switching in Receiving Direction
3	Frequency Response
3.1	Frequency Response in Sending Direction
3.2	Frequency Response in Receiving Direction
4	Loudness Ratings
4.1	Sending Loudness Rating
4.2	Receiving Loudness Rating
5	Distortion
5.1	Distortion in Sending Direction
5.2	Distortion in Receiving Direction
6	Simulated Double Talk
6.1	Simulated Double Talk, Sending Direction
6.2	Simulated Double Talk, Receiving Direction
7	Attenuation of Level Switching Device
7.1	Attenuation in Sending Direction
7.2	Attenuation in Receiving Direction
8	Switching Time
8.1	Switch-on, Switch-over Time in Sending Direction
8.2	Switch-on, Switch-over time in Receiving Direction
9	Sensitivity for Speech-like Signals
9.1	Minimum Level to Switch-on in Sending Direction
9.2	Minimum Level to Switch-on in Receiving Direction
10	Background Noise Transmission
11	Echo Measurement
11.1	Single Talk Condition: Echo Level, Convergence, Echo Attenuation G.122
11.2	Double Talk Condition: Detection of Echo, Echo Attenuation G.122
12	Recordings with Real Speech

Equipment Required:

ACQUA	(6810)
MFE II	(6100)
HMS II.3	(1230)
HQS-HFT G	(6766)
Radio Tester:	CMD55, or CMU 200, or HP89xx (not required for office-type terminals)

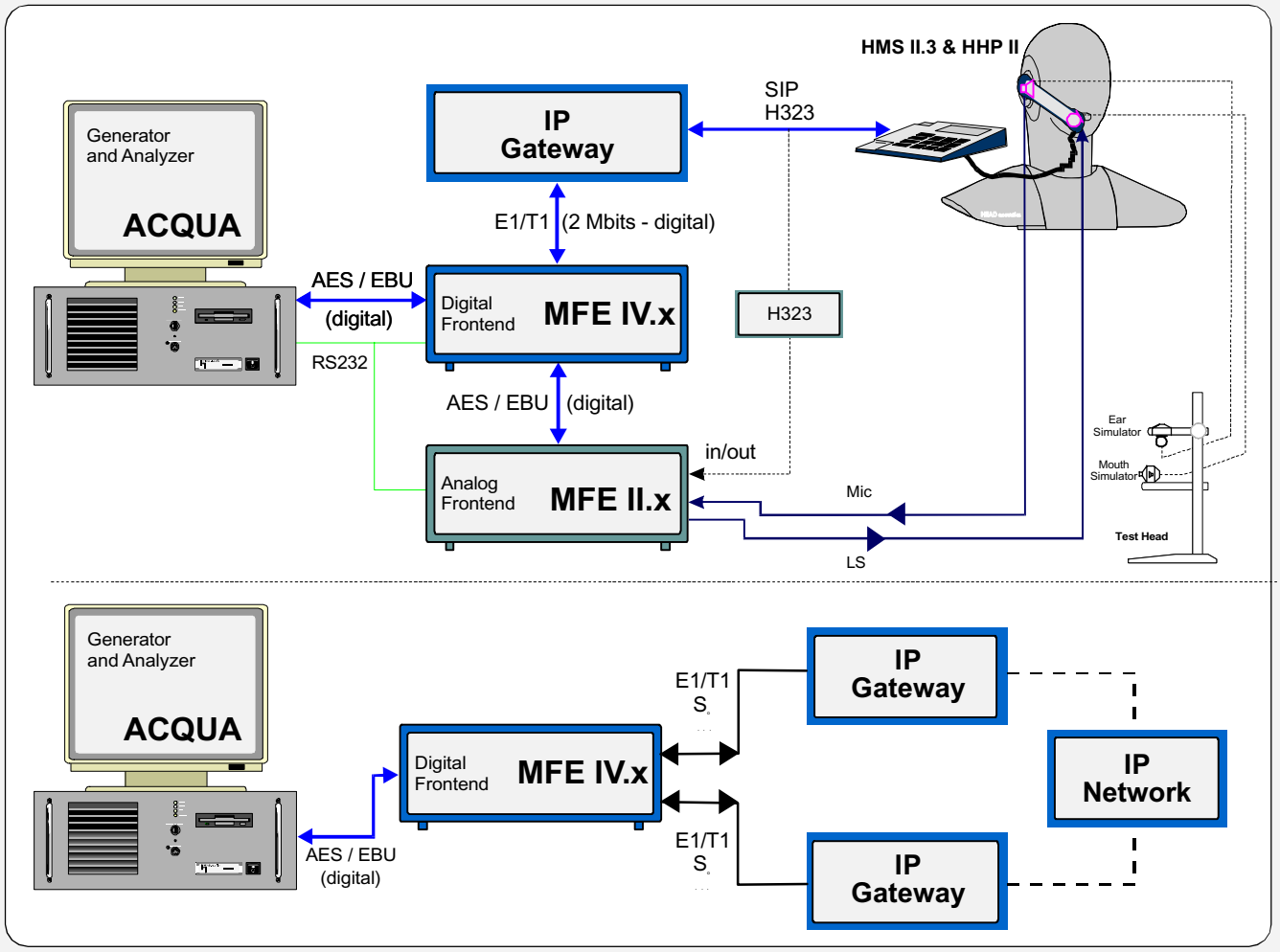
Hands-free Telephone Car Setup



Equipment Required:		Equipment Required:
ACQUA (6810) MFE II (6100) HQS-HFT G (6766) HMS II.3 (1230) HIS L (1231) BEQ I (1306) Radio Tester: CMD 55, or CMU 200, or HP89xx		PEQ IV (2482) [3 Pcs.] HSW II (2951) [Subwoofer] External Amplifiers Digital Source for Generating Background Noise

VoIP - Acoustic Measurement System

(example configurations)



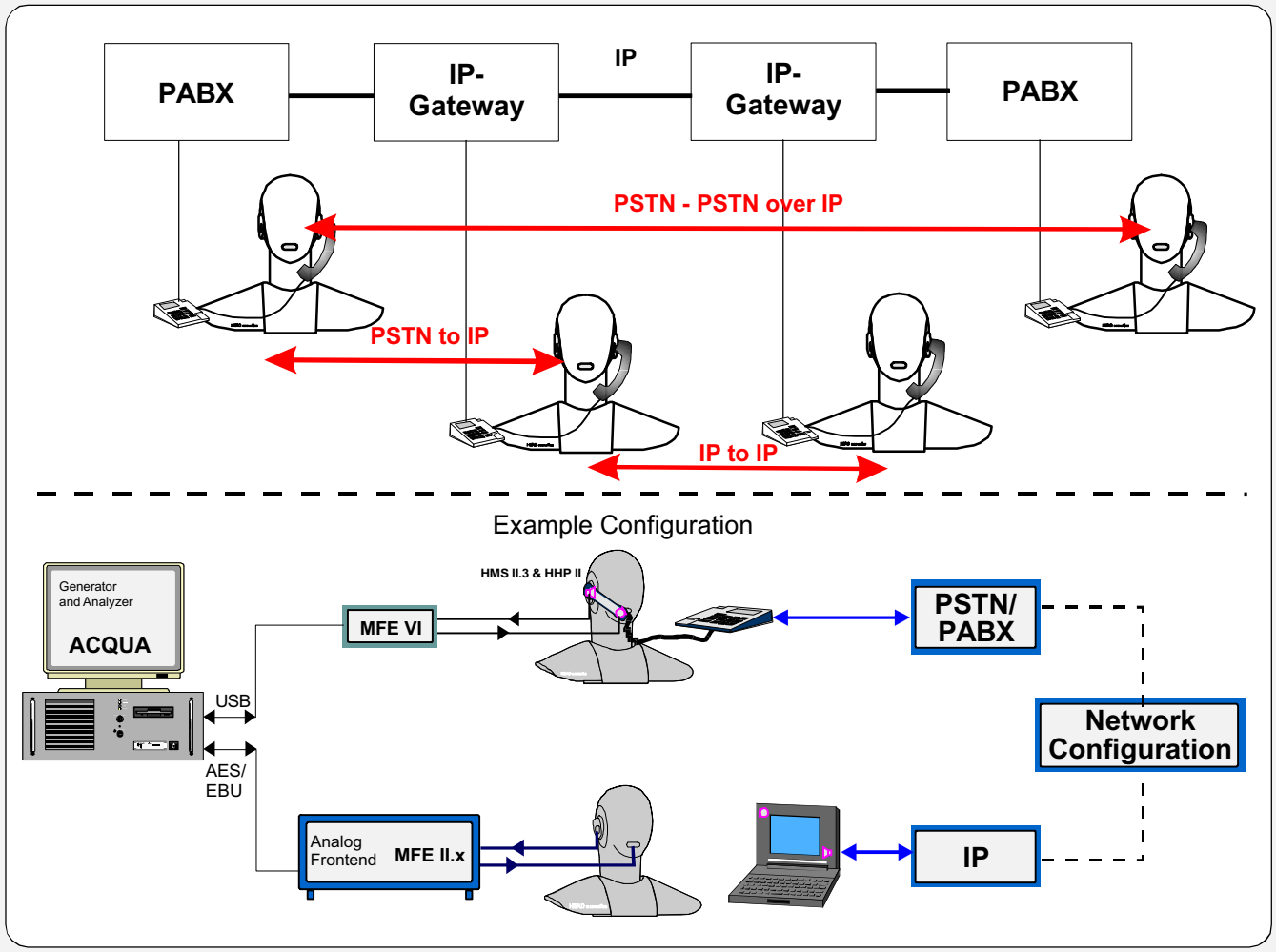
Tests Performed:

0	Delay Measurements
0.1	Delay in Sending Direction
0.2	Delay in Receiving Direction
0.3	Echo Delay
1	Level Switching
1.1	Level Switching in Sending Direction
1.2	Level Switching in Receiving Direction
2	Frequency Response
2.1	Frequency Response in Sending Direction
2.2	Frequency Response in Receiving Direction
3	Loudness Ratings
3.1	Sending Loudness Rating
3.2	Receiving Loudness Rating
4	Distortion
4.1	Distortion in Sending Direction
4.2	Distortion in Receiving Direction
5	Attenuation
5.1	Attenuation in Sending Direction
5.2	Attenuation in Receiving Direction
6	Simulated Double Talk
6.1	Simulated Double Talk, Sending Direction
6.2	Simulated Double Talk, Receiving Direction
7	Echo Measurement
7.1	Single Talk Condition: Echo Level, Echo Attenuation G.122
7.2	Convergence, Convergence in the Presence of Background Noise
7.3	Spectral Echo Attenuation vs. Time
7.4	Adaption with AM/FM Signals, Echo Attenuation G.122 Double Talk
8	TOSQA
8.1	TOSQA Sending Direction
8.2	TOSQA Receiving Direction

Equipment Required:

ACQUA	(6810)
MFE II	(6100)
MFE IV.0	(6303)
PMA I	(6351)
HMS II.3	(1230)
HHP II	(1354)
HQS IP-AE	(6769)
COP 7	(6768)

VoIP - End-to-End Scenarios



Tests Performed:

0	Delay Measurements
0.1	Delay in Sending Direction
0.2	Delay in Receiving Direction
0.3	Echo Delay
2	Frequency Response
2.1	Frequency Response in Sending Direction
2.2	Frequency Response in Receiving Direction
3	Loudness Ratings
3.1	Sending Loudness Rating
3.2	Receiving Loudness Rating
3.3	Junction Loudness Rating
3.4	Overall Loudness Rating
4.	Automatic Gain Control (AGC)
5.	Activation Sensitivity for Speech-like Test Signals
6.	Simulated Double Talk
6.1	Double Talk Performance in Receiving Direction
6.2	Double Talk Performance in Sending Direction
7.	Quality of Background Noise Transmission
8.	Minimum Activation Level
9.	Comfort Noise Implementation
10.	Echo Measurements
11.	Convergence Tests Echo Attenuation
12.	Spectral Echo Characteristics
13.	Echo During Double Talk
14.	Speech Quality Based on TOSQA

Advanced Analysis Possibilities with ACQUA

Signal Analysis

ACQUA is a dual-channel analyzer with a special generator/editor component for producing user-specific signals and signal trains. The analyzer is able to transfer time signals to memory in real-time at a sampling rate of 44.1kHz or 48 kHz. In combination with measurement front-ends (MFE), ACQUA uses high-resolution A/D converters for recording analog signals. Digital signals are captured through corresponding interfaces to ITU-T Recommendation G.703, S_0 Interface, DAI, TTL, E1/T1 and V.11 Interface in MFE.x .

Two further digital channels are available for generating and reading marks which may be set anywhere along the time line, thus allowing determination of e.g. test device delays. The recording technology used guarantees permanent availability of measured signals for time and frequency domain analysis.

Signal analysis using ACQUA means:

- Separate channel calibration of the measurement system in dB_V, dB_m, dB_{SPL}, dB_{Pa}, dB_{m0} and dB_{rn}.
- Analysis in the time domain and determination of level, time constants, delay, etc.
- Analysis in the frequency domain and determination of loudness ratings, sidetone masking rating, listener sidetone, terminal coupling loss, transfer functions, equalization and noise.
- User-specific tolerance scheme.
- Free selection of FFT values from 32 to 32768 points.
- Spectrographic and 3-D display, useful for investigating the transfer function of systems with time-variant transfer characteristics, for example, hands-free and GSM/UMTS equipment or echo cancellers.
- Delay (cross correlation)
- Active speech level (P. 56)
- Speech quality e.g. based on TOSQA

Filters

Signal manipulation in ACQUA is possible using digital filters. The user may modify any recorded signal extensively. During subjective signal evaluation e.g. the effects of transfer function modification can be directly monitored. Similarly, annoying frequency components can be identified and eliminated.

ACQUA allows simulation of acoustic modifications. It thus becomes possible, for example, to test in advance whether a desired loudness rating can be achieved by a given modification. This saves expensive experimentation time. The FIR filter in ACQUA provides straightforward equalization of measured transfer functions e.g. of the artificial mouth.

The following filter options are available:

IIR Filters

- Band-pass, band-stop, high-pass, low-pass and all-pass, 1 st to 4th orders, with variable center frequency and Q factor
- Parametric band-pass, band-stop, high-pass and low-pass with variable center frequency, Q factor, amplification or attenuation

FIR Filters

- Filter editor for comprehensive editing of transfer functions according to magnitude and phase
- Transfer of measured transfer functions using various source files e.g. speech samples
- Inversion of measured transfer functions for exact equalization of the test device
- On-line filtering up to 160 points
- Off-line filtering up to 2048 points

Generator/Editor

The ACQUA generator/editor component is the essential advantage the system has over traditional analyzers. The user can compose any measurement sequence as desired. Access to standard measurement signals stored on the hard disk, such as white noise, pink noise or sine is possible any time. These signal trains can be combined with others in any way required. This allows measurements with the artificial voice signal according to ITU-T Recommendation P.50, the test signals as described in ITU-T Recommendation P.501 (e.g. CSS), alongside measurements using the Composite Source Signal standardized in ITU-T and ETSI. ACQUA has been designed flexibly so that signals included in any future recommendations or guidelines can be easily incorporated.

Facilities thus include:

- Selection of any previously recorded or generated signal trains as measurement signal
- Standard measurement signals such as white noise, pink noise, sine or pseudo noise
- Dual-channel, independent-of-channel measurement signal composition
- Simulation of speech situations including duplex operation

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