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First and Only Fully GCF-Validated Wideband Audio Test Platform

In November 2009, the Global Certification Forum (GCF) has raised the priority of 2G/3G wideband audio test cases to priority "1" making them compulsory for all 2G/3G mobile phones with AMR-WB audio codec applying for market entry anywhere in the world.

To test a mobile phone's conformity with these requirements, a GCF-validated test platform needs to be used. At the moment, the ACQUA test platforms offered by HEAD acoustics, TP 89 based on the measurement front end MFE III.1 and TP 90 based on the MFE VI.1, are the **only** ones validated for **all** test cases.

The measurements are based on the 3GPP standards TS 26.131 and TS 26.132. The test signal in most cases is the artificial voice defined in ITU-T Recommendation P.50 and stipulated in P.501. Using closely speech-resembling test signals ensures the highest reliability of the test results.

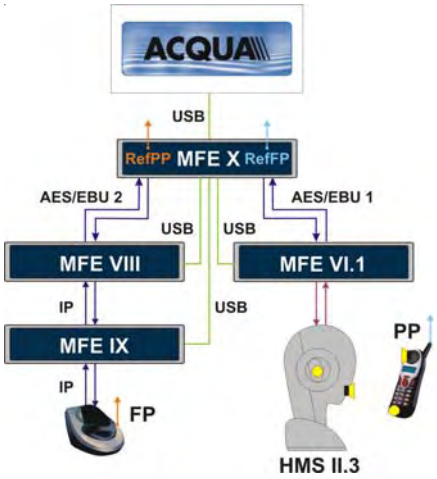
Test Spec.	Test Case	Test Case Title	Priority	TP89 ACQUA with MFE III.1	TP90 ACQUA with MFE VI.1
26.132	8.2.2.1	Sending Loudness Rating (SLR)	1	✓	✓
26.132	8.2.2.2	Receiving Loudness Rating (RLR)	1	✓	✓
26.132	8.3.1	Idle Channel Noise - Sending	1	✓	✓
26.132	8.3.2	Idle Channel Noise - Receiving	1	✓	✓
26.132	8.4.1	Sending Sensitivity / Frequency Response	1	✓	✓
26.132	8.4.2	Receiving Sensitivity / Frequency Response	1	✓	✓
26.132	8.5.1	Sidetone Characteristics / Connections with Handset UE	1	✓	✓
26.132	8.5.4	Sidetone Characteristics / Sidetone delay for handset	1	✓	✓
26.132	8.6	Stability Loss	1	✓	✓
26.132	8.7.3	Acoustic Echo Control in a handset UE	1	✓	✓
26.132	8.8.1	Sending Distortion	1	✓	✓
26.132	8.8.2	Receiving Distortion	1	✓	✓
26.132	8.9	Ambient Noise Rejection	1	✓	✓

2G/3G AMR-WB wideband audio test cases specified by GCF, all with priority 1, all supported by HEAD acoustics test platforms TP89 / TP90

NG-DECT/CAT-iq™ Testing with MFE X and CAT-IQ 2.0

MFE X (Code 6481) is the new front end for acoustic measurements of NG-DECT/CAT-iq™ terminals, e.g. according to the new CAT-iq™ audio test specification of the DECT Forum (cf. further below).

MFE X serves as "Reference Portable Part" (RefPP) and as "Reference Fixed Part" (RefFP) for acoustic measurements of cordless terminals. As required by CAT-iq™, it supports modern wideband and IP connections as well as the classic DECT telephony.



Example configuration

Front view MFE X

MFE X is used in conjunction with the following system components:

- ACQUA (communication analysis system, version 2.4.200 with extensions or later)
- HMS II.3 (artificial head measurement system) with HHP III (handset positioning mechanism),
- MFE VI.1 (analog measurement front end with integrated mouth amplifier),
- MFE VIII (IP reference gateway)
- MFE IX (IP network impairment simulator with WLAN/WiFi access point).

CAT-iq™ (Cordless Advanced Technology - Internet and Quality) has successfully been introduced into the market as the successor of the DECT standard by the DECT Forum. CAT-iq™ is continously developed in further versions and requires a certification of terminals by means of measurement systems approved by the DECT Forum and used by qualified test laboratories.

As official partner of the DECT Forum HEAD acoustics is actively involved in the further development of the CAT-iq™ audio test specification.

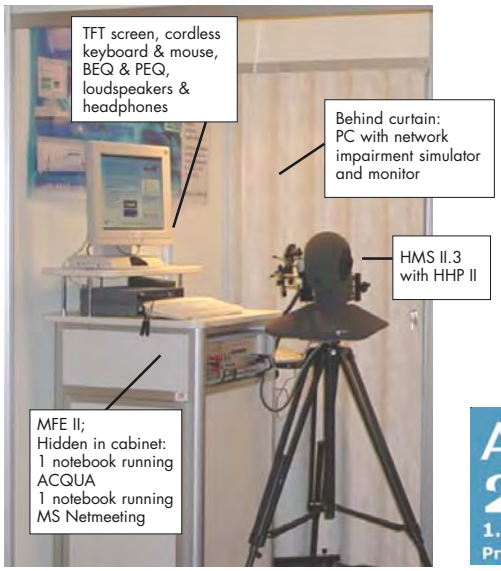
The current draft of CAT-iq™ 2.0 is based on the ETSI Standard EN 300 176-2. The new ACQUA measurement standard CAT-IQ 2.0 (Code 6794) contains the full implementation of all measurements specified by EN 300 176-2 as automated test suite for the communication analysis system ACQUA.

10 Years of Experience in VoIP Testing

Already at the end of the last millennium, HEAD acoustics was a pioneer in VoIP speech quality testing. In 1999, the communication analysis system CAS (the DOS-based predecessor of ACQUA) was successfully used for IP-based speech quality tests in R&D and consulting projects.

The next year saw the first ETSI VoIP Speech Quality Test Event (SQTE) being conducted on a joint initiative of HEAD acoustics and the European Telecommunications Standardization Institute (ETSI). The subsequent SQTEs have meanwhile become a must-attend event for VoIP equipment manufacturers. While the continously developed test methods have set new standards for VoIP testing, the SQTE test results have turned into important marketing tools for the manufacturers and are even used for buying decisions, e.g. by network operators.

In 2001, the first test setup using the then newly introduced ACQUA was shown at the VON Europe conference and expo in Stockholm. It consisted of the following measurement setup (cf. photo on the right): an IP phone and an IP client PC were connected to a second PC, operating a Linux-based network impairment simulator and monitor. On the client PC, phone calls were established via MS NetMeeting. The measurement access was realized by connecting the IP phone acoustically via HMS II.3 with HHP II to MFE II, and connecting the client PC electrically to MFE II. Measurements were performed according to the newly developed HEAD Quality Standards HQS-IP and HQS-HFT.



Public premiere of first ACQUA VoIP test system at VON Europe 2001

Several ETSI SQTEs and VON events later, HEAD acoustics made an essential contribution to the first VO.IP Germany event in 2005 by providing live VoIP tests to selected exhibitors. The VO.IP Germany live tests were continued in 2006 and 2007, but had to be stopped in 2008 because the event had become too big to provide sufficient test capabilities. Instead, HEAD acoustics participated as regular exhibitor and promptly won the VO.IP Germany Award 2008 in the services category with the ACQUA VoIP testing system and three new front ends (VoIP reference gateway MFE VIII, IP network impairment simulator and monitor MFE IX, POTS adapter HPO). In 2009, the event was renamed to VOICE+IP Germany and HEAD acoustics was awarded 2nd prize for the brand-new NG-DECT/CAT-iq™ acoustic test system, again including a new IP-capable front end (MFE X, cf. page 1).

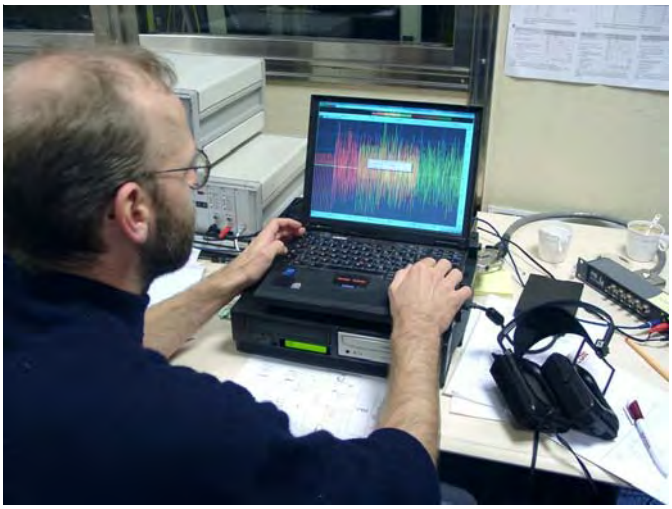
Award 2009 Dienste/Services VOICE+IP Germany 2. Platz HEAD acoustics® Produkt: CAT-iq Akustik-Testsystem

AWARD 2008 1. Platz Dienste/Services Produkt: ACQUA VO.IP Germany Kongressmesse für Voice- und IP Kommunikation HEAD acoustics®

VO.IP Germany Award logos

From a rather experimental, DOS- and Linux-based test setup with only one front end originally built for the "plain old telephony system" in 1999 to a state-of-the-art fully-fledged VoIP test system completely developed by HEAD acoustics as it now exists in 2009, this is an impressive example how research and development combined with practical experience and commitment to excellence can be transformed into innovative high-tech measurement solutions.

Of course, this brief outline on the HEAD acoustics history of VoIP testing only reflects a few highlights of 10 years of continous development as well as constantly increasing know-how and experience. However, it illustrates that HEAD acoustics is indeed a technology leader and will continue to make essential contributions to better audio and voice quality in today's and future telecommunication worlds.



Impressions from the 1st ETSI VoIP Speech Quality Test Event 2000

New and Revised Standards in 2009

For more than 20 years HEAD acoustics has made important contributions to the development of new telecommunication standards by closely cooperating with standardization institutes and telecom industry organizations (3GPP, 3GPP2, ITU-T, ETSI, TIA, GCF, PTCRB, DECT Forum etc.). The relevant standards are implemented into test suites for use with the communication analysis system ACQUA to allow automated measurements according to standard specifications or advanced analyses based on the comprehensive experience of HEAD acoustics.

The following table gives an overview of all measurement standards currently available for ACQUA (as of Dec. 01, 2009). The standards which were newly implemented or revised in 2009 are marked in yellow.

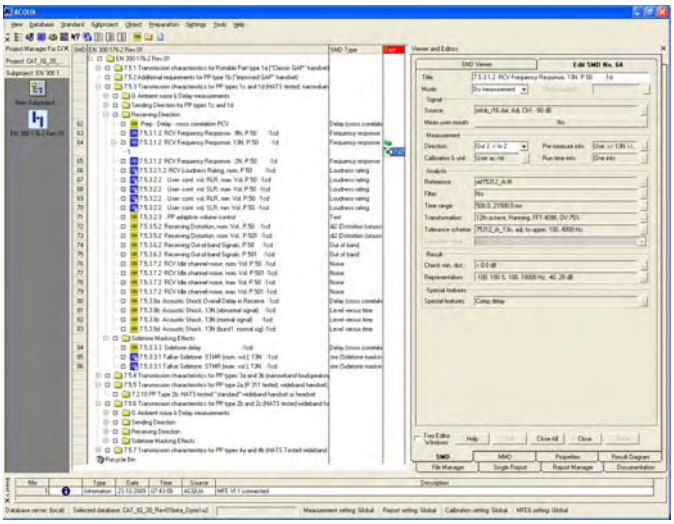
Among the highlights of the new standards developments are:

- CAT-IQ 2.0: new implementation of current DECT Forum draft, based on EN 300 176-2 (cf. page 1)
- ES 202737/38/39/40: full implementation of all narrow- and wideband tests specified by ETSI
- VDA-HFT-GE: now based on latest version 1.6 of the VDA specification
- P.1100: new car hands-free specification for American market
- TS 26131-32: now with GCF validation for all priority 1 wideband audio test cases (cf. page 1)

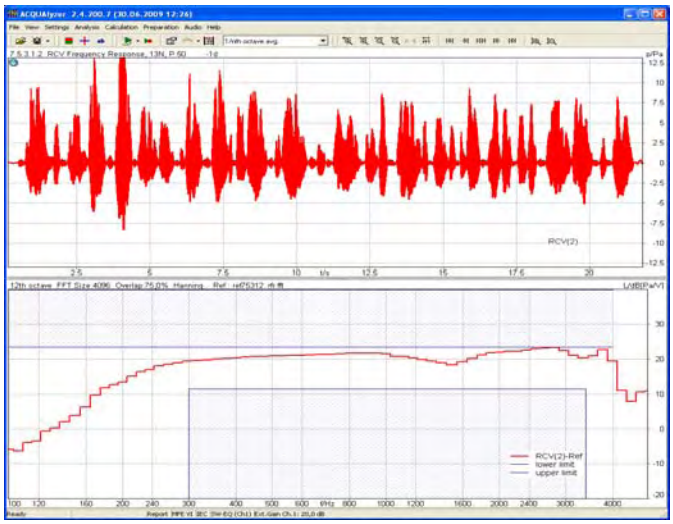
Code	Short Name	Rev.	Title	Min. Ver.
6788	C.S0056	1	3GPP2 Electroacoustic Performance for CDMA 2000 Mobile Stations	2.2.100
6793	CAT-IQ 1.0	1	CAT-IQ 1.0, Wideband NG-DECT Terminals	2.3.300
6794	CAT-IQ 2.0	1beta1	CAT-IQ 2.0, Wideband NG-DECT Terminals, EN 300 176-2	2.4.200
6781	CTIA	1	CTIA, Acoustical Performance AMPS/CDMA (TDMA)	1.2.400
6747	EG 201 121	-	ETSI EG 201 121, Advisory Notes for ETSI TBR 21	*
6745	EIA/TIA-470B	-	EIA/TIA 470 B (North America), Analog Phones	*
6756	EIA/TIA-628	-	EIA/TIA 628 (North America), Acoust. Part, TDMA phones	*
6789	EN 50332	2	Maximum Sound Pressure Measurement Headphone and Portable Audio Equipment	2.3.300
6795	ES 202 737/38	1	Narrowband IP Phones, ETSI ES 202 737 / ES 202 738	2.4.200
6796	ES 202 739/40	1	Wideband IP Phones, ETSI ES 202 739 / ES 202 740	2.4.200
6782 / 6847	ES 203 021	1	Basic Attachment Requirements for Analog Terminals (available as Standard Only / as ACOPT 22 incl. Hardware)	2.3.300
6741	ES 203 038	2	ETSI ES 203 038, Analog Phones	2.4.200
6712	ETS 300 245-3	-	ETS 300-245 Part 3, Digital Hands-Free Telephones	*
6707 / 6821	ETS 300 778-1	2	CLIP according to Standard ETS 300 778-1 (available as Standard Only / as ACOPT 11)	2.0.100
6791	FCC 68.316/7	1	Hearing Aid Compatibility, FCC 47 CFR CH.1 § 68.316/7	2.4.100
6751	FZ TSEC	2	"Deutsche Telekom" Standard, Network Speech Echo Cancellers	1.1.310*
6779	FZ TSEC-L	2	"Deutsche Telekom" Standard, Network Speech Echo Cancellers incl. Limits	1.1.310*
6722	G.165	-	ITU-T G.165, Network Speech Echo Cancellers	*
6750	G.168	7	ITU-T G.168, Network Speech Echo Cancellers	2.4.200
6744	GBT I	3	GBT/T 15279-94 (China), Analog Phones	2.3.100
6773	HQS-EA	2	HEAD acoustics Quality Standard, Electroacoustic Tests	1.2.300
6774	HQS-EC	1	HEAD acoustics Quality Standard, Speech Echo Cancellers	1.1.310*
6775	HQS-HA	1	HEAD acoustics Quality Standard, Hearing Aids	1.2.100
6766	HQS-HFT-GE	2	HEAD acoustics Quality Standard, GSM Hands-Free	2.3.100
6769	HQS-IP	3	HEAD acoustics Quality Standard, VoIP Terminals & Gateways	2.4.100
6786	HQS-IP-gateway	3	HEAD acoustics Quality Standard, VoIP Gateways	2.4.100
6787	HQS-IP-phones	3	HEAD acoustics Quality Standard, VoIP Terminals	2.4.100
6776	HQS-mobile	4 SP1	HEAD acoustics Quality Standard, Mobile Phones	2.3.300
6785	HQS-mobile-additions	2 SP1	Extension of HQS-mobile for Vodafone Tests of Headsets, Hands-Free and MP3	2.3.300
6784	HQS-MP3	1	HEAD acoustics Quality Standard, MP3 and other Wideband Audio Compression	2.3.300
6825	I-CTR37	2	I-CTR 37, Attachment Requirements for Pan-European Approval for Connection to the Analogue PSTNs of TE (cf. ACOPT 15)	2.0.100
6845	MCMC-TS	1 SP1	Malaysia Standard MCMC TS (T)	2.4.100U
6797	P.1100	1	Narrowband Car Hands-free, ITU-T P.1100	2.4.100
6711	TBR 10	3	ETSI TBR 10, DECT Phones	2.1.100
6824	TBR 21	2	TBR 21, European Approval for Connection to the Analog PSTN (cf. ACOPT 14)	2.0.100
6721	TBR 8	5	ETSI TBR 8, ISDN Phones	2.0.100
6772	TIA 810	4	EIA/TIA 810 (North America), Digital & VoIP Terminals	2.3.100
6783	TIA 920	1	EIA/TIA-920 (North America), Wideband Digital- and VoIP Terminals	2.1.100
6777	TS 26131-32	4_GCF_PTCRB	3GPP TS 26.131/132, 3G Terminals	2.4.200
6742	TS 51.010-1	6	3GPP TS 51.010-1 (former GSM 11.10), GSM Mobile Handsets	2.3.300
6770	VDA-HFT-GE	3 SP2	VDA-Specification, Car Hands-free Terminals	2.3.400

* standard can be imported into ACQUA (recommended ACQUA version: 1.2.100 or later)

Note: For standard upgrades, the ACQUA version of the target standard is required as listed above.



New measurement standard CAT-IQ 2.0 in analysis system ACQUA



Measurement signal and analysis result of a frequency response measurement

New ACOPTs since ACQUA 2.4.200

With the new version 2.4.200 of the analysis system ACQUA, three new ACOPTs (ACQUA Options) for psychoacoustic analyses (loudness/sharpness/roughness), room acoustics measurements (based on MLS signals) and STI calculations (speech transmission index, STITEL/STIPA/RASTI) have become available. The key features of the new ACOPTs are described below. More detailed information on the new analyses, calculations and measurements available with ACOPT 25/26/27 can be found in the ACQUA help system.

ACOPT 25 - Option Psychoacoustic SMDs

Subjective evaluation of sound events does not always correspond to the values measured via standard measurement and analysis techniques. Whether a sound is felt to be pleasant or annoying is often based on the subjective criteria of the test person listening.

Psychoacoustics is centered on research methods of signal analysis whose results show a linear connection to subjectively perceived sound evaluation. The parameters influencing auditory perception include the dimensions Loudness, Sharpness and Roughness.

ACOPT 25 provides a single measurement descriptor (SMD) which allows to conduct various psychoacoustic analyses. The analyses provided by this SMD are also selectable from the ACQUAlyzer menu "Analysis".

Selectable analysis methods:

- Loudness vs. Time
- Spec. Loudness
- Spec. Loudness vs. Time
- Sharpness vs. Time
- Roughness vs. Time (Hearing Model)
- Spec. Roughness (Hearing Model)
- Spec. Roughness vs. Time (Hearing Model)

ACOPT 26 - Option Roomacoustics

When analyzing acoustic systems today (rooms, test laboratory, car interior, etc.), its measured impulse response is a very capable representation to figure out characteristics or examine problems.

HEAD acoustics provides ACOPT 26 to measure (room) impulse responses, reverberation time (also versus frequency bands), decay spectra and other acoustical parameters according to DIN EN ISO 3382:2000-3.

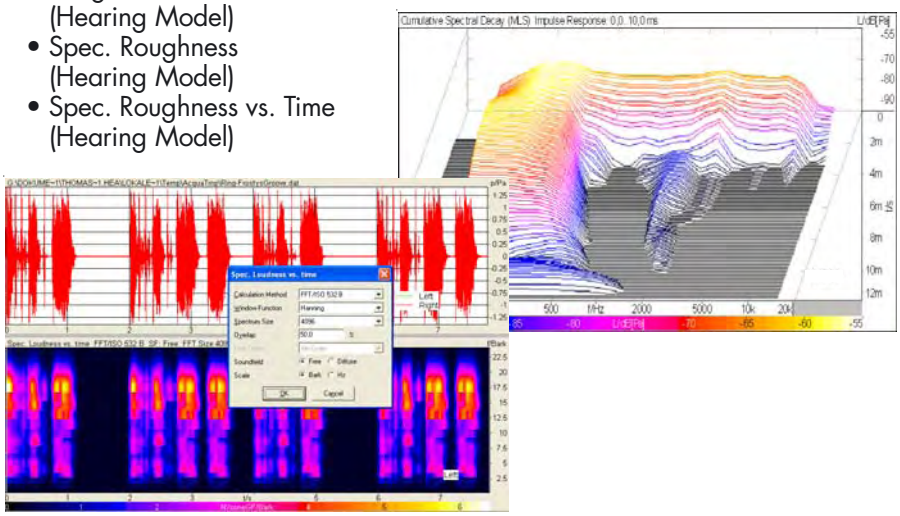
The impulse response of a system can be measured by using a maximum length sequence (MLS) signal, record the response of the system and process it by the Hadamard transformation, which takes advantage of the structure of the MLS source signal.

Key Features:

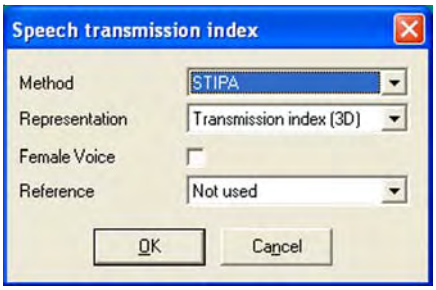
- Measuring Impulse responses with MLS signals
- Reverberation time vs. bands (Octave, 3rd/6th/12th Octave)
- Cumulative spectral decay plots
- Measurement of single values acc. to DIN EN ISO 3382:
  - Reverberation time RT30, RT60
  - Early decay time EDT
  - Clarity C50, C80
  - Directness D50, D80
  - Center time Ts
- EEB (Early Energy Balance) acc. to ITU-T P.340: objectively represents the subjective impression of reverberance

Selectable analysis methods:

- Impulse Response (MLS)
- Decay vs. Bands (MLS)
- Cumulative Spectral Decay (MLS)



Left: Example spec. loudness vs. time; Right: Example cumulative spectral decay (MLS)



Selection of parameters for STITEL/STIPA/RASTI calculation

ACOPT 27 - Option STI/RASTI

The Speech Transmission Index (STI) is a method to measure speech intelligibility which usually decreases during transmission for several reasons like noise and distortion (electric transmission) or echoes and background noises (acoustic transmission).

The STI is based on the measurement of the modulation applied to the intensity envelopes of signals. The measurement takes into account the frequency range of speech (125Hz to 8kHz) as well as the typical modulation frequencies appearing in speech (0.63Hz to 12.5Hz). If the transmission is disturbed, the amount of modulation decreases. For the complete determination of the STI all modulation grades in all octaves of the aforementioned frequency range are measured in third octave spacing, resulting to 7 (the number of octaves) multiplied 14 (the number of modulation frequencies) measurement points.

STITEL, STIPA and RASTI are simplified methods fo measuring the STI. They allow calculating the STI from one single measurement.

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