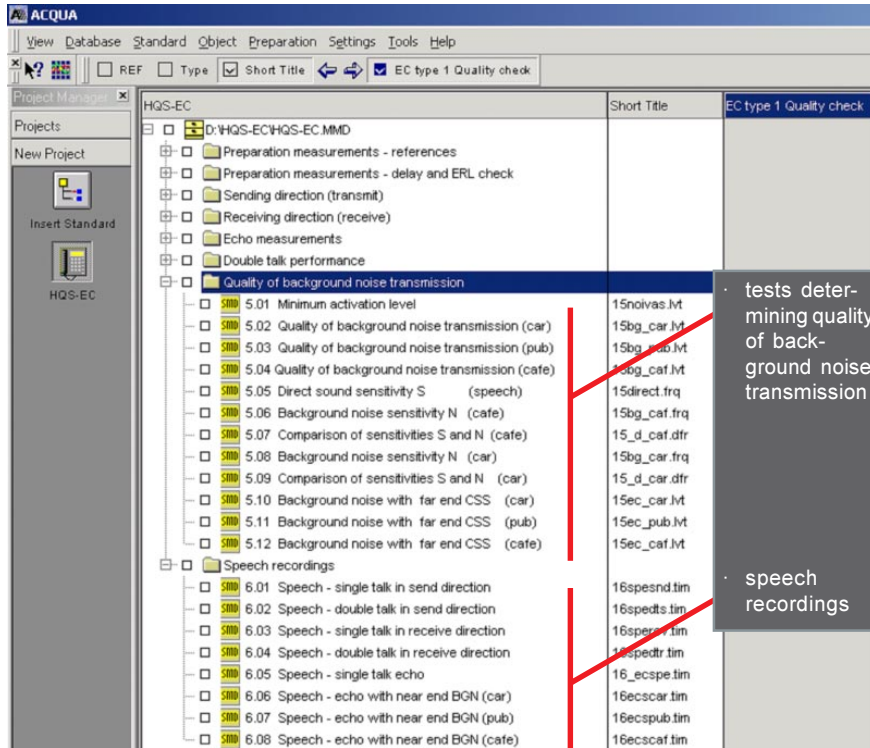


HQS-EC

(Code 6774)

HEAD acoustics Quality Standard
 Speech Quality of Echo Cancellers



HQS-EC test sequence in communication analysis system ACQUA

OVERVIEW

Speech quality assessment of echo cancellers is quite a challenge due to the various kinds of signal processing involved (e.g. adaptive filters and non-linear processors in telephone networks or various speech coders, voice activity detection and other signal processing in VoIP scenarios).

Echo cancellers typically also introduce undesired artifacts like temporal clipping, limited double talk performance or modulation of background noise. All these aspects have a significant influence on conversational speech quality. Current national and international standards, however, are not suited to assess the corresponding parameters.

To solve this problem HQS-EC has been developed by HEAD acoustics, providing advanced tests for the analysis of

- *Speech transmission quality*
- *Echo*
- *Double talk performance*
- *Quality of background noise transmission*

For manufacturers HQS-EC offers objective guidelines to optimize their echo cancellers. For administrations it provides selection criteria to ensure a high quality level.

Preconditions for Testing

ITU-T Recommendation G.168 digital network echo cancellers can be regarded as an accepted international reference for echo cancellers. G.168 defines objective tests that if passed will ensure a minimum level of performance for echo cancellers installed in a network. It is therefore regarded as necessary that echo cancellers meet the requirements given in this recommendation in order to ensure a minimum quality performance accepted worldwide.

But G.168 does not guarantee a sufficient performance quality under critical conversational situations like double talk or in the presence of background noise. Moreover it does not specify nor imply any selection criteria for echo cancellers. The test cases specified in G.168 are limited and - for reasons of simplification - only use test signals like Hoth noise which do not represent realistic background noise scenarios. In addition to these specified objective tests G.168 explicitly recommends that echo cancellers should be optimized by manufacturers based on the experience of subjective tests or alternatively using more sophisticated quality tests representing more realistic test scenarios.

HQS-EC was developed for this purpose. The tests implemented in HQS-EC are based on the experiences in subjective testing and rely

on test signals described in ITU-T Recommendation P.501. Appropriate analysis methods as recommended in ITU-T Recommendation P.502 are implemented.

The tests according to HQS-EC neither substitute the tests according to ITU-T Recommendation G.168 nor repeat those tests with different test signals or test scenarios. Instead, they should be regarded as additional tests providing realistic test scenarios in order to determine conversational speech quality parameters for echo cancellers not covered by G.168. The HQS-EC tests are independent of G.168 tests.

The main test aspects are as follows:

Speech transmission quality

Besides standardized parameters like frequency responses, junction loudness rating (JLR) and automatic gain control these tests determine activation thresholds and switching sensitivities in both directions. Analysis methods like PESQ or TOSQA2001 are implemented in order to determine the objective listening quality MOS-LQO according to ITU-T Recommendation P.800.1 (corresponding PESQ or TOSQA licenses are required).

These tests are carried out under single talk conditions in receive direction, i.e. from the far end to the near end and in transmit direction from the near end hybrid to the far end.

Echo

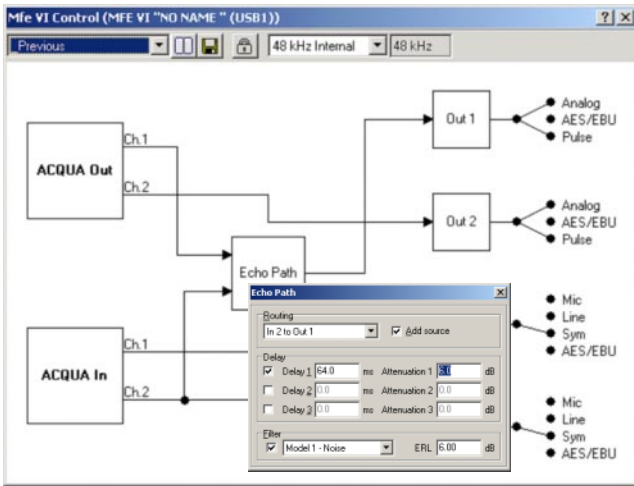
The echo measurements determine parameters that are not covered by the G.168 tests like echo loss analysis according to ITU-T G.122, spectral echo attenuation or a spectrographic analysis of initial convergence versus time and frequency.

Double talk performance

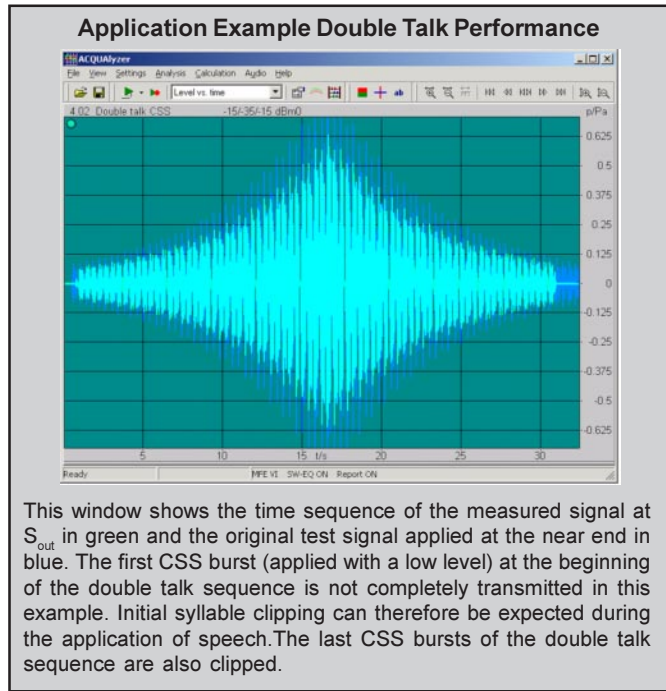
Apart from the quality of background noise tests the double talk performance tests are the most important and powerful part of HQS-EC. They mainly concentrate on the two parameters speech syllable clipping introduced by any non-linear processing like NLP implementations and echo disturbances during double talk. The tests are based on specific test signals as described in ITU-T P.501.

A combination of two uncorrelated Composite Source signals simulating the far end and the near end signal respectively is used. These two signals are applied with level variations of 20 dB in both directions. While applying the appropriate analysis methods as described in ITU-T P.502 parameters like double talk sensitivity, hangover times for the NLP, switching times and the divergence of the adaptive filter can be measured.

Another test signal used in these double talk performance tests consists of two uncorrelated AM/FM modulated signals again simulating the near end and far end subscriber.



MFE VI settings window with echo path subwindow



This window shows the time sequence of the measured signal at S_{out} in green and the original test signal applied at the near end in blue. The first CSS burst (applied with a low level) at the beginning of the double talk sequence is not completely transmitted in this example. Initial syllable clipping can therefore be expected during the application of speech. The last CSS bursts of the double talk sequence are also clipped.

This test signal (also specified in ITU-T P.501) allows the determination of echo components during double talk by appropriate comb filter techniques without freezing adaptation.

The experience from extensive subjective tests of different echo cancellers clearly demonstrates the importance of high-quality double talk performance. HQS-EC provides the appropriate test signals and analyses methods for a detailed double talk performance evaluation and optimization.

Quality of background noise transmission

Subjective conversational tests also pointed out that the quality of background noise transmission from the near end to the far end subscriber may be significantly impaired by non-optimized implementations. Typically subscribers complain about modulated or even interrupted background noise sometimes masked by non-optimized comfort noise injection. In order to evaluate this transmission aspect in detail, tests are implemented in HQS-EC using noise signals with Hoth spectrum (ITU-T P.800) with increasing level versus time and

even realistic background noise scenarios recorded in a driving car, a pub or a students café. These signals are applied with and without far end Composite Source signals. The transmission quality is analyzed in transmit direction in order to optimize or compare different implementations.

Listening example using real speech

In addition to the objective tests real speech recordings under single and double talk conditions are implemented in HQS-EC. The reason for this is obvious: Although speech signals are unsuitable and difficult to analyse in terms of determining important transmission parameters, these recordings provide listening examples suited to demonstrate the advantages and drawbacks of different implementations. This is especially useful for listeners who are perhaps not completely involved in all details of echo canceller implementations or realizations but need to be informed in an efficient way.

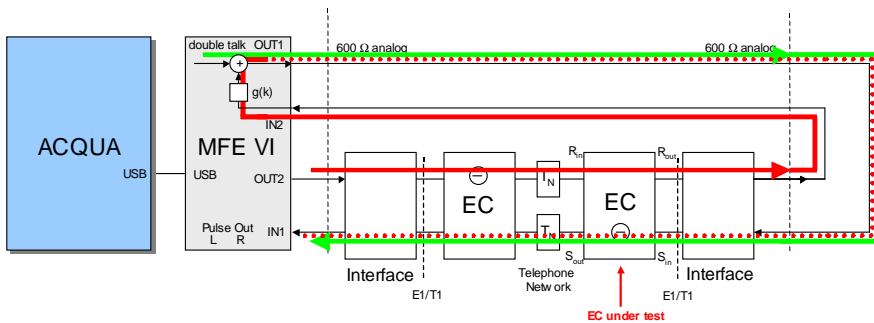
These speech signals are applied under defined test conditions comparable to the

objective tests using the test signal described above. Recordings are carried out under single talk conditions in receiving and transmit direction. Moreover, double talk sequences composed of a male and female voice are implemented in order to generate listening examples for this important conversational aspect where both subscribers interact. The use of male and female voices is helpful in order to distinguish between the near end signal and potential echo signals.

Other sequences using real speech are implemented in HQS-EC applying a realistic background noise signal at the near end recorded in a driving car, a pub or a students café. After a few seconds a speech signal is applied in receiving direction for the echo canceller. In this scenario the signal in transmit direction is recorded and can also be used as a listening example.

Delivery Items

Disk or CD with HQS-EC standard



Typical measurement setup using ACQUA and MFE VI providing the echo path simulations
Red: receiving direction; Green: double talk signal; Dotted red: echo

represented by