ITU-T

International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

P.502

Amendment 1
(05/2010)

SERIES P: TERMINALS AND SUBJECTIVE AND OBJECTIVE ASSESSMENT METHODS

Objective measuring apparatus

Objective test methods for speech communication systems using complex test signals

Amendment 1: New Appendix III – Automated double talk analysis procedure

Recommendation ITU-T P.502 (2000) – Amendment 1

International Telecommunication Union

ITU-T P-SERIES RECOMMENDATIONS

TERMINALS AND SUBJECTIVE AND OBJECTIVE ASSESSMENT METHODS

Vocabulary and effects of transmission parameters on customer opinion of transmission quality	Series	P.10
Voice terminal characteristics	Series	P.30 P.300
Reference systems	Series	P.40
Objective measuring apparatus	**Series**	**P.50** **P.500**
Objective electro-acoustical measurements	Series	P.60
Measurements related to speech loudness	Series	P.70
Methods for objective and subjective assessment of speech quality	Series	P.80 P.800
Audiovisual quality in multimedia services	Series	P.900
Transmission performance and QoS aspects of IP end-points	Series	P.1000
Communications involving vehicles	Series	P.1100

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T P.502

Objective test methods for speech communication systems using complex test signals

Amendment 1

New Appendix III – Automated double talk analysis procedure

Summary

Amendment 1 to Recommendation ITU-T P.502 adds new Appendix III to the Recommendation. The appendix describes the methodology for an objective post analysis of measured double talk curves.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T P.502	2000-05-18	12
1.1	ITU-T P.502 (2000) Amend. 1	2010-05-27	12

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Recommendation ITU-T P.502

Objective test methods for speech communication systems using complex test signals

Amendment 1

New Appendix III – Automated double talk analysis procedure

1) New Appendix III

Add the following new Appendix III.

Appendix III

Automated double talk analysis procedure

(This appendix does not form an integral part of this Recommendation)

III.1 Introduction

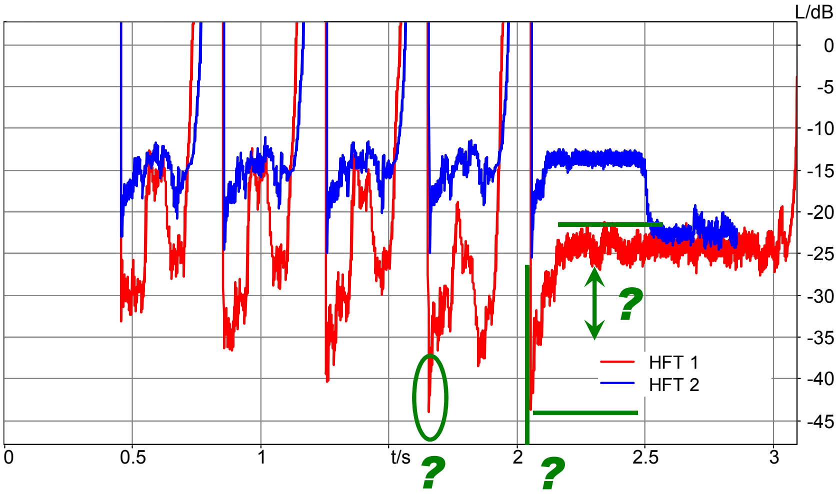
[ITU-T P.340] describes test methods for double talk analyses of hands-free terminals based on signals and analysis procedures standardized in this Recommendation and in [ITU-T P.501]. These measurements allow the analysis of the attenuation range in sending and receiving directions based on double talk composite source signals. Basically, the measurements are performed by subtracting the time dependent level of a transmitted test signal during double-talk by its corresponding time synchronized level during single talk. However, due to slight time misalignments, non-linear, time variant signal processing and other fractures, an objective analysis which can be performed reproducibly and unambiguously in different labs is not always possible. The result often depends on the interpretation of the operator. This appendix describes a new procedure which allows the automated objective analysis in a clearly defined way.

The method has been proven to reduce the ambiguity in interpretation of double talk measurements. The accuracy of this method in predicting the mean value of the attenuation range derived by a jury of test conductors manually calculating the attenuation range is unknown. Currently, this method is only intended to check consistency in measurements between labs. The method was not validated in a formal double talk test.

The procedure described is based on the double talk composite source signal (CSS) which is currently used for double talk testing. However, the method described is not limited to CSS but may be applied to other double talk signals as well. It is intended that real speech signals be used for testing instead of speech-like signals, if possible. This work is ongoing. It should be noted that if the method described here is applied to other test signals, the method needs to be adapted especially with respect to the histogram limitations.

III.2 Proposal for an automated double talk analysis procedure

A typical result of the analysis of modern terminals with respect to the attenuation range in the sending direction is given in Figure III.1.



HFT: Hands-free (telephone) set

Figure III.1 – Typical results of a double talk test based on the attenuation range measurement [ITU-T P.340]

It can be seen, that the blue (HFT 2) curve is already somewhat difficult to interpret with respect to the amount of attenuation inserted during double talk. An unambiguous interpretation of the red (HFT 1) curve is nearly impossible because at different times different attenuations are inserted; the attenuation versus time is highly time-variant. In such cases, the time history signal, as well as some additional subjective verification of the measured result, is currently used in order to finally determine the attenuation range during double talk. However, this does not always lead to the same interpretation of the results by different operators. In order to achieve a clear, consistent and unambiguous interpretation result, an objective procedure is needed. A proposal for such a procedure, which could also be applied for other types of double talk test signals, is shown in Figure III.2.

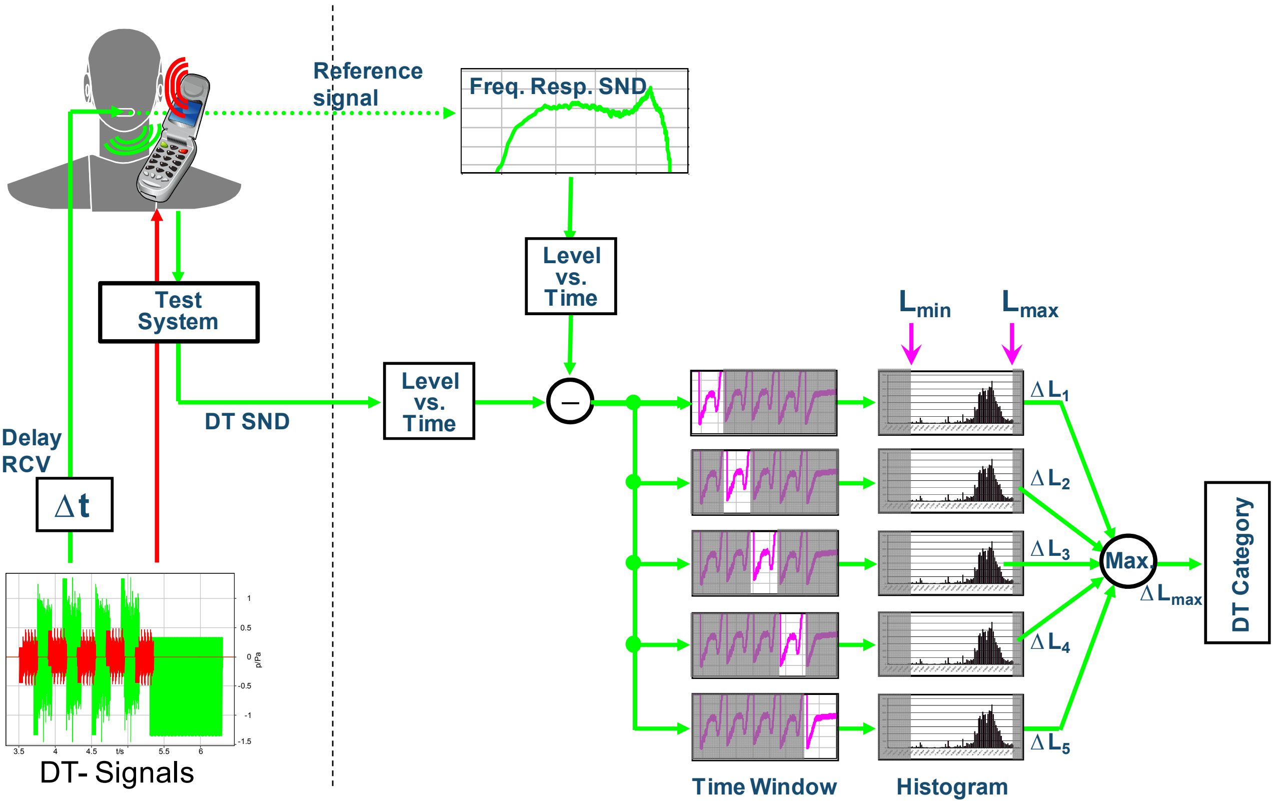


Figure III.2 – Principle of the proposed automated double talk analysis

The double talk signal is time aligned to the delay inserted by the telephone and the test equipment, and presented to the terminal as described in [ITU-T P.340] ("Δt"). Instead of using the unfiltered double talk CSS signal as reference, the reference signal used is the transmitted test signal for the individual direction (sending or receiving) without the double talk signal present. Such reference signal includes possible automatic gain control (AGC) influence as well as the individual transfer function of the device under test. Based on the transmitted signal and the new reference signal, the double talk analysis is performed through the individual interpretation of each CSS burst from the transmitted double talk signal (see Figure III.2). For each CSS burst a level histogram is created, and from this level histogram the amount of attenuation is determined ($a_{h,DT,SND}$ and $a_{h,DT,RCV}$ respectively, according to [ITU-T P.340]). The $a_{h,DT,SND}$ that is finally observed determines the double talk category (for the sending direction in this case).

The histogram creation and the calculation of attenuation relevant for the final double talk rating is described in the following more in detail using the analysis example in Figure III.3. It shows the level versus time difference representation of the CSS bursts of a modern terminal in the sending direction (level of the transmitted signal referred to the level of filtered reference signal):

- The level versus time L(k) is calculated according to [b-IEC 61672] (i.e., DIN EN 61672) with a time constant of 5 ms for both signals ($L_{DT,SND}(k)$ and $L_{Ref}(k)$). The difference between both signals ΔL(k) is calculated as $\Delta L(k) = L_{DT,SND}(k) - L_{Ref}(k)$.
- Minimum and maximum limits for the histogram are derived from minimum and maximum level difference ($\Delta L_{min} = \min\{\Delta L(k)\}$ and $\Delta L_{max} = \max\{\Delta L(k)\}$).
- Division of histogram in 100 equally spaced bins between the minimum and the maximum histogram limits, ΔL_{min} and ΔL_{max}.

- Deletion of the lower 20% and the upper 15% histogram values. New, "effective" histogram limits are given by $\Delta L_{min20\%}$ and $\Delta L_{max15\%}$. This can be interpreted as a smoothing of the curve, which allows the suppression of slight level variations not important for the subjective perception, as well as of some strong peaks which last only for a short period of time and are also not important for the subjective double talk quality perception.
- Calculation of attenuation range $a_{h,DT,SND}$ according to [ITU-T P.340] as the difference between $\Delta L_{min20\%}$ and $\Delta L_{max15\%}$, i.e., $a_{h,DT,SND} = \Delta L_{max15\%} - \Delta L_{min20\%}$.

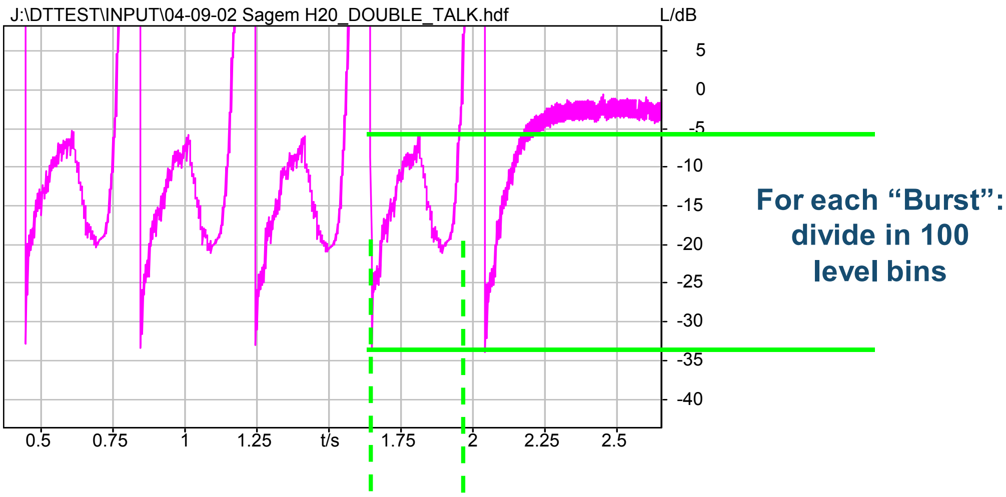


Figure III.3 – Result of a double talk analysis of a modern terminal displayed as level difference versus time

The result of this level bin is a histogram representation as shown in Figure III.4, which is different for each CSS burst.

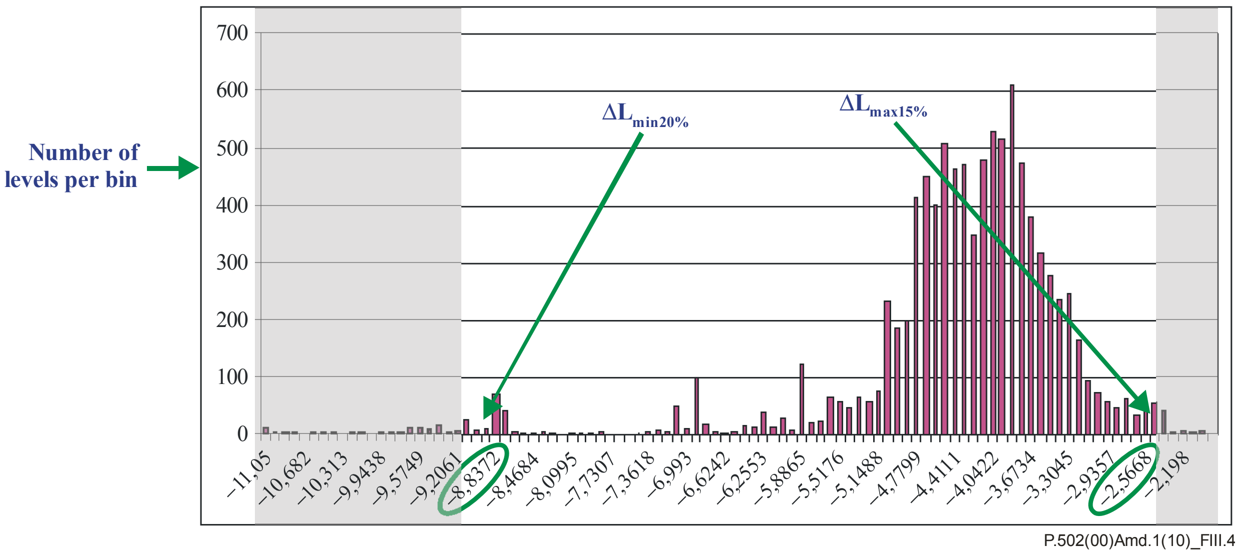


Figure III.4 – Histogram representation of the first level versus time representation from Figure III.3

The values 15% and 20% were developed empirically based on subjective experts' evaluation of 58 different types of mobile phones. With this subjective experts evaluation, a double talk type class mean error between the subjective experts evaluation and the described objective procedures of a mean = 0.0172 and an RMSI = 0.82 could be achieved.

Although this objective post analysis for ITU-T P.340 signals has not yet been evaluated in a formal subjective listening test, it can be stated that such defined analysis of double talk would greatly improve the comparability of measurement results in different labs, while at the same time showing some reasonable correlation with subjective experts' evaluations.

The described post analysis is not limited to the CSS bursts currently defined in [ITU-T P.501], the main body of this Recommendation and [ITU-T P.340], but can be performed in the same way with different types of double talk signals. The analysis could be also applied for double talk signals based on real speech. However, if applied, the parameters of the histogram treatment need to be adapted. This work is under study.

2) Bibliography

Add the following new reference:

[b-IEC 61672] IEC 61672, *Electroacoustics – Sound level meters*.

– Part 1 (2002): *Specifications*.

– Part 2 (2003): *Pattern evaluation tests*.

– Part 3 (2006): *Periodic tests*.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	**Terminals and subjective and objective assessment methods**
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects and next-generation networks
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2010