ETSI TS 100 488 V1.2.1 (2022-04)

**Speech and multimedia Transmission Quality (STQ);
Telephony for hearing impaired people;
Characteristics of telephone sets that provide additional receiving amplification for the benefit of the hearing impaired**

Reference
RTS/STQ-261

Keywords
amplification, hearing impairment, mobile, PWSN, telephony, terminal

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° w061004871

Contents

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The declarations pertaining to these essential IPRs, if any, are publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI Directives including the ETSI IPR Policy, no investigation regarding the essentiality of IPRs, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members. **3GPP™** and **LTE™** are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners. **oneM2M™** logo is a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners. **GSM**® and the GSM logo are trademarks registered and owned by the GSM Association.

Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Speech and multimedia Transmission Quality (STQ).

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Introduction

In January 1996 ETSI published ETSI ETS 300 488 [1]. At that time, the ETS addressed requirements and test methods for analogue and ISDN speech terminals, limited to narrow-band handset terminals. The present document is a substantial revision of ETSI ETS 300 488 [1] in order to provide requirements aligned with the technology of the time of its publication.

TIA has produced a standard ANSI/TIA PN 49 53-A [i.2] that defines the amplification for the most of speech terminals. The present document benefits of the data available in this standard.

The present document applies to several types of digital speech terminals, for all available bandwidths (narrowband and wideband). ETSI TR 103 225 [i.1] shows that a bandwidth until at least 6 kHz provides an improvement for hearing impaired people.

The present document applies to handsets, headphones and handsfree terminals.

The requirements defined for wideband terminals apply for superwideband and fullband terminals, but only in the frequency range of wideband, as the most of hearing impaired people, including older users, have more or less severe losses in high frequencies).

The present document is written with a philosophy different from ANSI/TIA PN 49 53-A [i.2]: due to the new Recommendation ITU-T P.700 [12] and investigations such as those available in STQ(21)067014 [i.3], the present document defines as a major parameter the loudness (in phons) provided by the speech terminal (instead of a conversation gain). The additional interest of loudness is the possibility to use these requirements and test methods for other speech terminals than those referred in the present document.

1 Scope

The present document specifies extra audio amplification & related characteristics of telephony terminals to meet the need of hard-of-hearing people. This revision of ETSI ETS 300 488 [1] takes into account the narrowband and wideband speech, and covers all types of speech terminals. It takes into account the severity of the hearing loss (3 categories) and also includes, the capability to modify the slope of the receiver frequency response in order to improve the intelligibility of speech.

NOTE: The present document applies to handset, headphone and Hands-free sets. When headphones are not explicitly indicated, the requirements and test methods defined for handsets apply to each earphone.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[1] ETSI ETS 300 488: "Terminal Equipment (TE); Telephony for hearing impaired people; Characteristics of telephone sets that provide additional receiving amplification for the benefit of the hearing impaired".

[2] ETSI TS 103 737: "Speech and multimedia Transmission Quality (STQ); Transmission requirements for narrowband mobile wireless terminals (handset and headset) from a QoS perspective as perceived by the user".

[3] ETSI TS 103 738: "Speech and multimedia Transmission Quality (STQ); Transmission requirements for narrowband mobile wireless terminals (hands-free) from a QoS perspective as perceived by the user".

[4] ETSI TS 103 739: "Speech and multimedia Transmission Quality (STQ); Transmission requirements for wideband mobile wireless terminals (handset and headset) from a QoS perspective as perceived by the user".

[5] ETSI TS 103 740:"Speech and multimedia Transmission Quality (STQ); Transmission requirements for wideband mobile wireless terminals (hands-free) from a QoS perspective as perceived by the user".

[6] ETSI ES 202 737: "Speech and multimedia Transmission Quality (STQ); Transmission requirements for narrowband VoIP terminals (handset and headset) from a QoS perspective as perceived by the user".

[7] ETSI ES 202 738: "Speech and multimedia Transmission Quality (STQ); Transmission requirements for narrowband VoIP loudspeaking and handsfree terminals from a QoS perspective as perceived by the user".

[8] ETSI ES 202 739: "Speech and multimedia Transmission Quality (STQ); Transmission requirements for wideband VoIP terminals (handset and headset) from a QoS perspective as perceived by the user".

[9] ETSI ES 202 740: "Speech and multimedia Transmission Quality (STQ); Transmission requirements for wideband VoIP loudspeaking and handsfree terminals from a QoS perspective as perceived by the user".

[10] Recommendation ITU-T P.10/G.100: "Vocabulary for performance, quality of service and quality of experience".

[11] Recommendation ITU-T P.501: "Test signals for use in telephony and other speech-based applications".

[12] Recommendation ITU-T P.700: "Calculation of loudness for speech communication".

[13] ETSI TS 103 558: "Speech and multimedia Transmission Quality (STQ); Methods for objective assessment of listening effort".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TR 103 225: "Speech and multimedia Transmission Quality (STQ); Transmission quality and speech intelligibility for hearing impaired people".

[i.2] ANSI/TIA PN 49 53-A.

[i.3] STQ(21)067014: "Recommendation ITU-T P.700 Loudness for speech communication terminals". Jan Reimes. Head acoustics Gmbh.

[i.4] http://www.cochlea.eu/pathologie/presbyacousie.

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

fullband telephony: transmission of speech with a nominal pass-band wider than 50 Hz to 14 000 Hz, usually understood to be 20 Hz to 20 000 Hz

NOTE: Definition from Recommendation ITU-T P.10/G.100 [10].

narrowband telephony: transmission of a signal (either speech or data) through a telephonic network with a nominal pass-band of 300 Hz to 3 400 Hz

NOTE: Definition from Recommendation ITU-T P.10/G.100 [10].

superwideband telephony: transmission of speech with a nominal pass-band wider than 100 Hz to 7 000 Hz, usually understood to be 50 Hz to 14 000 Hz

NOTE: Definition from Recommendation ITU-T P.10/G.100 [10].

wideband telephony: transmission of speech with a nominal pass-band wider than 300 Hz to 3 400 Hz, usually understood to be 100 Hz to 7 000 Hz

NOTE: Definition from Recommendation ITU-T P.10/G.100 [10].

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

2N	2 newton
dBPa	decibel, reference 1 pascal
DRP	Drum Reference Point
HFE	High Frequency Enhancement
HFT	HandsFree Terminal
HL	Hearing Loss
HLC	Hearing Loss Category
ISDN	Integrated Services Digital Network
NB	NarrowBand
RLL	Receive Loudness Level
RLR	Receive Loudness Rating
STMR	Side Tone Masking Rating
TE	Terminal Equipment
WB	WideBand

4 Hearing loss characteristics

4.1 Hearing Loss Category (HLC)

Three categories as defined in ANSI/TIA PN 49 53-A [i.2] (Mild, Moderate and Severe) are currently recognized.

4.2 Hearing loss range

The hearing loss ranges are defined for the different categories as:

- Mild: the hearing loss is between 20 dB and 40 dB.
- Moderate: the hearing loss is between 40 dB and 70 dB.
- Severe: the hearing loss is between 70 dB and 90 dB.

As a principle, normal hearing is understood as a hearing loss lower than 20 dB.

4.3 Hearing loss frequency response slope type

For perception deafness, including presbycusis, the hearing losses are mainly located in high frequencies. An example of mean hearing losses versus age (Presbycusis) may be found in [i.4].

5 Telephone receiver HFE

ANSI/TIA PN 49 53-A [i.2] defines the concept of High Frequency Enhancement (HFE) and of 3 HFE bands, for narrowband and wideband.

HFE is defined to qualify the tone control to be implemented in the terminal in order to provide a high frequency enhancement, intended to compensate hearing losses.

HFE concept is based on 3 frequency bands defined as:

- HFE Low-Band: average of 1/3 octave bands including and below 500 Hz.
- HFE Mid-Band: average of 1/3 octave bands around 1 kHz.
- HFE High-Band: average of 1/3 octave bands including and above 2 kHz.

Table 1 defines the HFE bands for narrowband and wideband:

Table 1: HFE bands for narrowband and wideband

	Narrowband		Wideband	
	Lower 1/3 oct	**Higher 1/3 oct**	**Lower 1/3 oct**	**Higher 1/3 oct**
HFE Low-Band	315 Hz	500 Hz	200 Hz	500 Hz
HFE Mid-Band	800 Hz	1,25 kHz	800 Hz	1,25 kHz
HFE High-Band	2 kHz	3,15 kHz	2 kHz	5 kHz

Combining these 3 HFE bands, the following 3 hearing loss frequency response slopes are defined for the HFE balance:

- Flat slope.
- Slight slope.
- Steep slope.

NOTE: ANSI/TIA PN 49 53-A [i.2] defines the HFE balance requirements for the three hearing loss categories as:

- For flat slope type, HFE Mid-Band shall be not more than ±4 dB of the arithmetic average of HFE Low-Band and HFE High-Band.
- For slight and steep slope types, HFE Low-Band ≤ HFE Mid-Band ≤ (HFE High-Band + 3 dB).

6 Receive-Requirements and test methodology

6.1 Loudness

6.1.1 Loudness values

Currently, the receive characteristics are defined by frequency response and loudness rating.

For such a parameter which aims to guarantee an effective amplification for the benefit of hearing impaired people, the parameter should be based on **Loudness**. As loudness takes into account both level and spectrum (for continuous speech) this parameter is more relevant than an acoustical reference and gain.

Recommendation ITU-T P.700 [12] provides measurement methods to calculate loudness expressed in phons.

If the terminal provides only an additional amplification (without HFE), the loudness for the nominal volume (which corresponds to the nominal RLR value of the relevant terminal) is assessed according to Recommendation ITU-T P.700 [12] as RLLNom. The loudness with additional amplification, RLL, is assessed according to Recommendation ITU-T P.700 [12], taking as references and gains as indicated in ANSI/TIA PN 49 53-A [i.2].

Loudness for nominal volume and without HFE is calculated according to Recommendation ITU-T P.700 [12] as RLLNom. When applying the additional amplification and each of the available HFE, loudness is calculated according to Recommendation ITU-T P.700 [12]. The loudness with additional amplification, and for each combination of additional amplification and HFE is loudness calculated with additional amplification and HFE and based on the RLLNom of the relevant speech terminal, corresponding to the nominal RLR of the terminal.

NOTE 1: The values available in table 2 are derived from the data available in STQ(21)067014, and are available for mobile wireless terminals (for narrowband and wideband).

NOTE 2: The values for RLL are calculated, using the formula defined in STQ(21)067014 [i.3]. As the conversational gain introduced is higher than the maximum level tested in STQ(21)067014 [i.3], it is assumed that the linear correlation measured in STQ(21)067014 [i.3] also applies for higher values. ANSI/TIA PN 49 53-A [i.2] defines a conversational gain referring to a nominal level produced by the terminal under test.

NOTE 3: ANSI/TIA PN 49 53-A [i.2] defines the conversation gain, instead of Loudness and the conversation, gain is the level of an acoustic input signal relative to -24 dBPa for single ear listening (e.g. Handset) or -30 dBPa for dual ear listening (e.g. HFT). These levels are different from the signals defined in the ETSI terminal standards (references from ETSI TS 103 737 [2] to ETSI ES 202 740 [9]).

For the test with handset, the pressure is defined as 2N in ANSI/TIA PN 49 53-A [i.2]. In speech terminals standards, such as ETSI ES 202 737 [6] and ETSI ES 202 738 [7] the application force is different from what is defined in ANSI/TIA PN 49 53-A [i.2]: "Unless stated otherwise the application force of 8N is used for handset testing".

Table 2: Receive Loudness Level requirements for the different speech terminals

Hearing Loss Category	Hearing loss (HL) Range	Hearing loss frequency response slope type	Telephone receiver HFE Tolerance (±4 dB)	Handset RLL phons Tolerance: (±4 dB)	Hands-free (Handheld) RLL phons Tolerance: (±4 dB)	Hands-free (Desktop) RLL phons Tolerance: (±4 dB)
Mild	20 dB to 40 dB	Flat	0 dB	95	82	86
		Slight	9 dB			
		Steep	14 dB			
Moderate	40 dB to 70 dB	Flat	0 dB	105	92	96
		Slight	9 dB			
		Steep	25 dB			
Severe	70 dB to 90 dB	Flat	0 dB	115	100	104
		Slight	9 dB			
		Steep	21 dB			

6.1.2 Test methods

6.1.2.1 For handsfree terminals

The terminal is set up according to the conditions defined in the relevant standards: ETSI TS 103 737 [2], ETSI TS 103 739 [4], ETSI ES 202 737 [6] and ETSI ES 202 739 [8] for handset terminals and ETSI TS 103 738 [3], ETSI TS 103 740 [5], ETSI ES 202 738 [7] and ETSI ES 202 740 [9] for HFT, depending on the bandwidth, the type of terminal.

The test signal to be used for the measurement shall be the British English single talk sequence described in clause 7.3.2 of Recommendation ITU-T P.501 [11].

For each recorded artificial ear signal, the loudness (in sone) of the recorded signal is calculated according to Recommendation ITU-T P.700 [12] and noted in the test report. The loudness level (in phons) is determined as follows for binaural measurements: the resulting loudnesses for left and right ears are first halved (individual loudness per ear). Both loudnesses are added (assuming perfect loudness summation). With this overall loudness, the level is finally determined according to clause 8.2 of Recommendation ITU-T P.700 [12].

6.1.2.2 For handsets and headsets

The handset or headset terminal is set up according to the conditions defined in the relevant standards: ETSI TS 103 737 [2], ETSI TS 103 739 [4], ETSI ES 202 737 [6] and ETSI ES 202 739 [8] for handset terminals and ETSI TS 103 738 [3], ETSI TS 103 740 [5], ETSI ES 202 738 [7] and ETSI ES 202 740 [9] for HFT, depending on the bandwidth and the type of terminal.

The test signal to be used for the measurement shall be the British English single talk sequence described in clause 7.3.2 of Recommendation ITU-T P.501 [11].

The loudness (in sone) of the recorded signal is calculated according to Recommendation ITU-T P.700 [12] and noted in the test report. The loudness level (in phons) is determined as follows:

- Handsets, monaural headsets: the loudness level is calculated according to clause 8.2 of Recommendation P.700 [12] by using the loudness value divided by two (loudness halving for monaural listening).
- Binaural headsets: the loudness level is calculated according to clause 8.2 of Recommendation P.700 [12] by using directly the loudness value (loudness summation for binaural listening is retained).

6.2 Receive distortion

6.2.1 Notes relative to receive distortion

NOTE 1: This parameter should be aligned on the parameters defined in ETSI standards for speech terminals.

NOTE 2: For the test with handset, the pressure is defined as 2N ANSI/TIA PN 49 53-A [i.2]. See note 2 in clause 6.1.1.

NOTE 3: These limits are compatible with the speech terminal standards.

6.2.2 Requirements

Table 3: Receive distortion requirements for the different speech terminals

Hearing Loss Category	Hearing loss (HL) Range	Hearing loss frequency response slope type	Telephone receiver HFE Tolerance (±4 dB)	Telephone receiver Distortion Handset & Hands-free 400 Hz for NB and WB 1 000 Hz for NB and WB 2 000 Hz for WB only
Mild	20 dB to 40 dB	Flat	0 dB	≥ 20 dB
		Slight	9 dB	
		Steep	14 dB	
Moderate	40 dB to 70 dB	Flat	0 dB	≥ 20 dB
		Slight	9 dB	
		Steep	25 dB	
Severe	70 dB to 90 dB	Flat	0 dB	≥ 20 dB
		Slight	9 dB	
		Steep	21 dB	

6.2.3 Test methods

6.2.3.1 Handset

The handset terminal is tested as described in the relevant standards: ETSI TS 103 737 [2], ETSI TS 103 739 [4], ETSI ES 202 737 [6] and ETSI ES 202 739 [8].

The signal used is an activation signal followed by a sine wave signal with a frequency at 400 Hz and 1 000 Hz used for the measurements for narrowband terminals and with the frequency at 400 Hz, 1 000 Hz and 2 000 Hz used for the measurements for wideband terminals.

The signal level shall be -16 dBm0.

The female speaker signal of the short conditioning sequence described in clause 7.3.7 of Recommendation ITU-T P.501 [11] shall be used for activation.

The ratio of signal to harmonic distortion shall be measured at DRP of the artificial ear with the diffuse field equalization active.

The signal to harmonic distortion ratio is measured selectively up to 10 kHz.

6.2.3.2 Handsfree

Test setup is described in the relevant standards: ETSI TS 103 738 [3], ETSI TS 103 740 [5], ETSI ES 202 738 [7] and ETSI ES 202 740 [9].

The signal used is an activation signal followed by a sine wave signal with a frequency at 400 Hz and 1 000 Hz for measurements of narrowband terminals and at a frequency at 400 Hz, 1 000 Hz and 2 000 Hz for measurements of wideband terminals. The duration of the sine-wave shall be of less than 1 second. Appropriate signals for activation and signal combinations can be found in Recommendation ITU-T P.501 [11]. The sinusoidal signal level shall be calibrated to -16 dBm0.

The female speaker signal of the short conditioning sequence described in clause 7.3.7 of Recommendation ITU-T P.501 [11] shall be used for activation. Level of this activation signal shall be -16 dBm0.

The signal to harmonic distortion ratio is measured selectively up to 10 kHz.

6.3 Receive noise

6.3.1 Requirements

In the relevant handset terminal standards the receive noise shall not be greater than -54 dBPa(A) at the maximum setting of the volume control.

In the relevant handsfree terminal standards the receive noise shall not be greater than -54 dBPa(A) at the nominal setting of the volume control and shall not be greater than -51 dBPa(A) at the maximum setting of the volume control.

NOTE: In ANSI/TIA PN 49 53-A [i.2] the requirement is respectively for handset $\geq$ 39 dB for Mild HLC, $\geq$ 42 dB for Moderate HLC, $\geq$ 47 dB for severe HLC; and respectively for handsfree $\geq$ 40 dB for Mild HLC, $\geq$ 43 dB for Moderate HLC.

6.3.2 Test method

6.3.2.1 Handset

For the test with handset, the pressure is defined as 2N in ANSI/TIA PN 49 53-A [i.2]. See note 2 in clause 6.1.1.

The handset terminal is tested as described in the relevant standards: ETSI TS 103 737 [2], ETSI TS 103 739 [4], ETSI ES 202 737 [6] and ETSI ES 202 739 [8].

The A-weighted noise level shall be measured at DRP of the artificial ear with the diffuse field equalization active. The noise level is measured until 10 kHz.

The female speaker signal of the short conditioning sequence described in clause 7.3.7 of Recommendation ITU-T P.501 [11] shall be used for activation. The activation signal level shall be -16 dBm0.

6.3.2.2 Handsfree

Test setup is described in the relevant standards: ETSI TS 103 738 [3], ETSI TS 103 740 [5], ETSI ES 202 738 [7] and ETSI ES 202 740 [9].

The A-weighted noise level shall be measured at DRP of the artificial ear with the freefield equalization active. The noise level is measured until 10 kHz.

The female speaker signal of the short conditioning sequence described in clause 7.3.7 of Recommendation ITU-T P.501 [11] shall be used for activation. Level of this activation signal shall be -16 dBm0.

The noise shall be measured just after interrupting the activation signal.

6.4 Other parameters

NOTE: ANSI/TIA PN 49 53-A [i.2] provides the possibility for an attenuation (lower than 6 dB) and a *switching time* of 50 ms.

7 Send

As a principle, the send characteristics of the terminal shall not be modified.

NOTE 1: Send frequency response and send loudness should be defined.

NOTE 2: For handset, STMR and stability should not be changed by receive amplification.

NOTE 3: ANSI/TIA PN 49 53-A [i.2] provides the possibility for an attenuation (lower than 6 dB) and a *switching time* of 50 ms.

8 Echo, Double talk

The use of amplification in the receive side may have consequences on different parameters, such as echo performance and double talk behaviour.

It is recommended for these different parameters to meet the limits as defined in the standards:

- ETSI TS 103 737 [2], ETSI TS 103 739 [4], ETSI ES 202 737 [6] and ETSI ES 202 739 [8] for handset terminals.
- ETSI TS 103 738 [3], ETSI TS 103 740 [5], ETSI ES 202 738 [7] and ETSI ES 202 740 [9] for HFT.

9 Listening effort

This parameter aims to ensure that the listeners do not have difficulty to hear and understand the received signal. It has been shown that there is a significant correlation between intelligibility and listening effort.

ETSI TS 103 558 [13] provides a method to assess the listening effort, for the acoustical interface.

NOTE: The model and values included in ETSI TS 103 558 [13] are based on tests conducted with people with typical hearing. Additional tests and investigations should be needed to take into account hearing impairments.

History

Document history		
V1.1.1	January 1996	Published as ETSI ETS 300 488
V1.2.1	April 2022	Publication