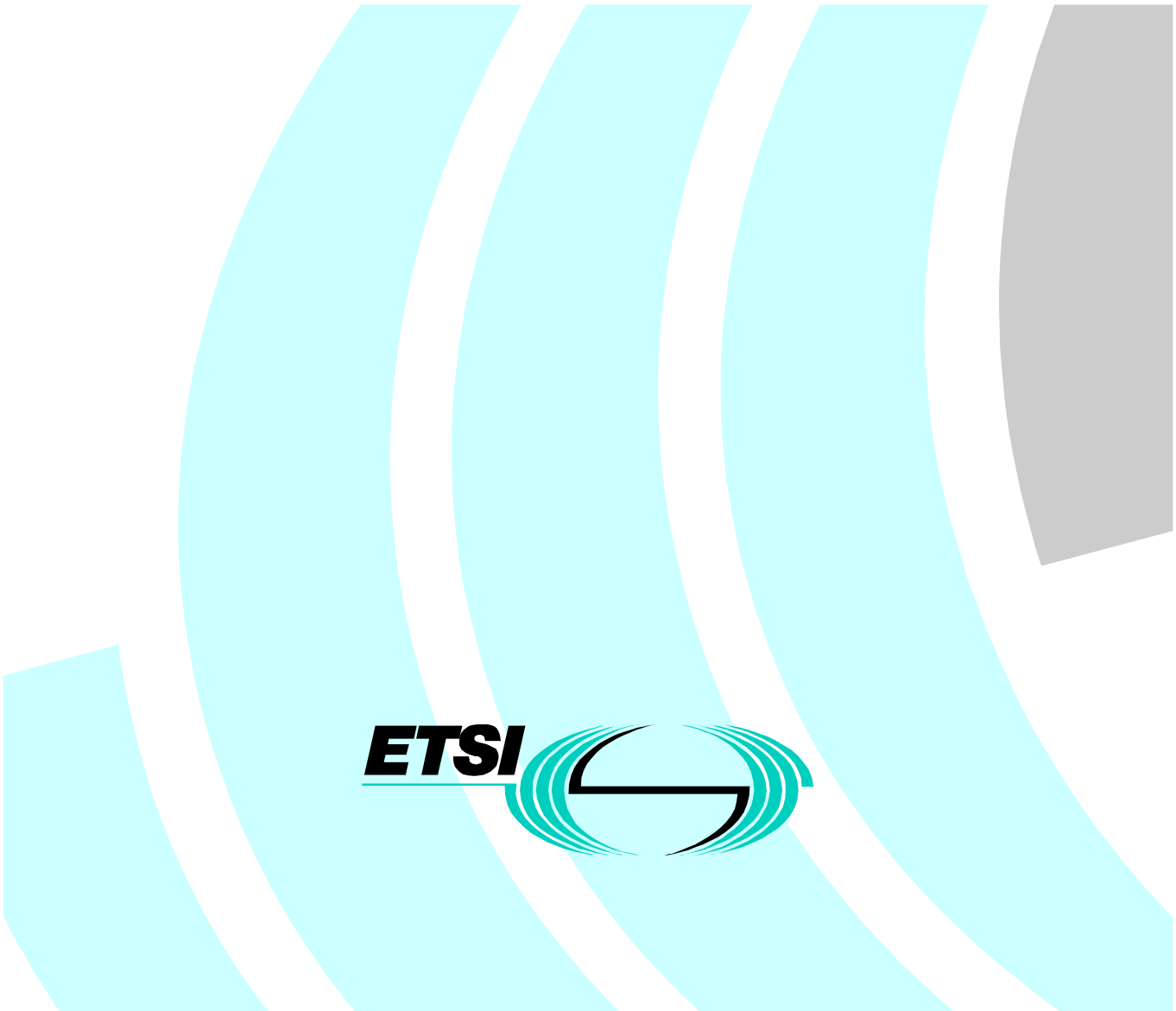
TR 101 149 V1.1.1 (1998-05)

Technical Report

2-wire analogue voice band interfaces; Terminal Equipment transmitting voice signals; Test simulation for level limitation requirements



Reference
DTR/ATA-005080 (an000ics.PDF)

Keywords
access, analogue, 2-wire, voice

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Foreword

This Technical Report (TR) has been produced by ETSI Project Analogue Terminals and Access (ATA).

Introduction

The sending level limitation requirements of in band signals are specified in TBR 21 [4] and prTBR 37 [5] by setting the mean sending level (see subclause 4.7.3.1) and the maximum instantaneous voltage (see subclause 4.7.3.2) requirements. Whilst these requirements are of course applicable to any terminal designed to be connected to the PSTN, the specified testing methods are however only enough detailed for data terminals (TBR 21 [4]) or for voice terminals whose output results from the acoustic excitation of a microphone port (prTBR 37 [5]). Further details are here provided for enabling the testing of important applications like the voice mail operations of PBXs, the integrated text-to-speech facilities of speech servers, the cross connect operations of PBXs, etc.

The present document first analyses the current requirements in prTBR 37 [5] and then addresses the mentioned applications in order to enable a harmonized application of TBR 21 [4] and prTBR 37 [5].

1 Scope

The present document studies the possibility of using a single pseudo-speech signal as test simulation for level limitation requirements. This applies to Terminal equipment (TE) transmitting voice signals and having a 2-Wire analogue voice band interface.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, subsequent revisions do apply.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] ITU-T Recommendation G.115 (1996): "Mean active speech level for announcements and speech synthesis systems".

[2] ETR 250 (1996): "Transmission and Multiplexing (TM); Speech communication quality from mouth to ear for 3,1 kHz handset telephony across networks".

[3] ITU-T Recommendation P.56 (1993): "Objective measurement of active speech level".

[4] TBR 21: "Terminal Equipment (TE); Attachment requirements for pan-European approval for connection to the analogue Public Switched Telephone Networks (PSTNs) of TE (excluding TE supporting the voice telephony service) in which network addressing, if provided, is by means of Dual Tone Multi Frequency (DTMF) signalling".

[5] prTBR 37: "Terminal Equipment (TE); Attachment requirements for pan-European approval for connection to the analogue Public Switched Telephone Networks (PSTNs) of TE supporting the voice telephony service in which network addressing, if provided, is by means of Dual Tone Multi Frequency (DTMF) signalling".

[6] TBR 38: "Public Switched Telephone Network (PSTN); Attachment requirements for a terminal equipment incorporating an analogue handset function capable of supporting the justified case service when connected to the analogue interface of the PSTN in Europe".

[7] TBR 15: "Business TeleCommunications (BTC); Ordinary and Special quality voice bandwidth 2-wire analogue leased lines (A2O and A2S); Attachment requirements for terminal equipment interface".

[8] TBR 17: "Business TeleCommunications (BTC); Ordinary and Special quality voice bandwidth 4-wire analogue leased lines (A4O and A4S); Attachment requirements for terminal equipment interface".

[9] TBR 8: "Integrated Services Digital Network (ISDN); Telephony 3,1 kHz teleservice; Attachment requirements for handset terminals".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the definitions given TBR 21 [4] and the following terms and definitions apply.

3.1.1 General terms

Installation Connection Point: a point on a user installation, intended to accept the connection of a TE.

NOTE 1: The ICP may also be part of a series connected TE.

NOTE 2: The ICP may present to the TE physical characteristics identical to those of the NTP.

3.1.2 Pseudo speech test signal

3.1.2.1 Type

pink noise: for the purpose of the present document the pink noise test signal, adjusted at the relevant reference point, shall be band limited to the frequency range 200 Hz to 3 800 Hz.

There are two recommended methods of achieving this, the choice of which depends upon the filtering technique used:

a) Where analogue filters are used the slopes of the band limiting filter shall be at least 24 dB/octave and the out-of-band attenuation shall be at least 25 dB (see figure 1). The third octave spectrum of electrically generated pink noise shall be equalized to within ± 1 dB, while acoustically generated pink noise shall be equalized (in free field) to within ± 3 dB;

NOTE 1: When measured with 1/3 octave bandwidth at standard frequencies, an ideal filtered pink noise signal will be attenuated 1,1 dB at 200 Hz and 0,9 dB at 4 kHz compared to a non-filtered pink noise signal.

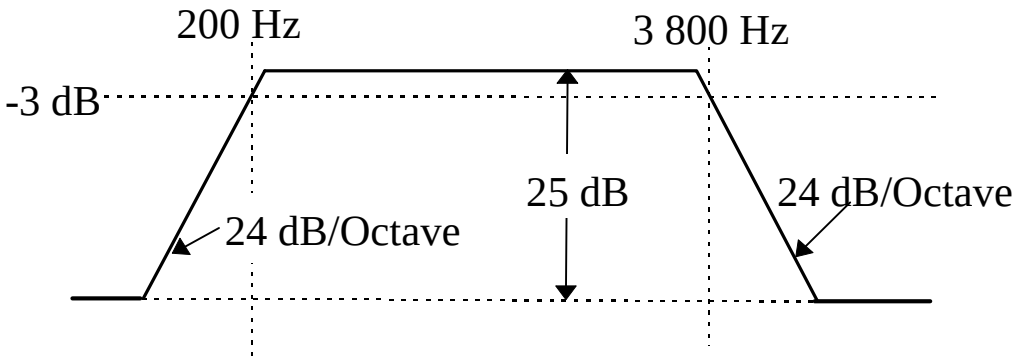

Figure 1: Response for the band-limiting filter

b) Where digital filters are used the detail of a) above applies, but with the 3 dB attenuation points set at 225 Hz and 3 563 Hz instead of 200 Hz and 3 800 Hz.

speech test signal: this shall be band-limited pink noise (see definition above) that is continuously modulated to be ON for a period of 250 ms ± 5 ms and OFF for a period of 150 ms ± 5 ms. The signal level specified refers to the level of the signal during the ON period.

pseudo speech signal: this shall be a speech test signal (see definition above) with 11 cycles and then followed by a period of 5,6 seconds ± 20 ms OFF giving an activity ratio of approximately 28 %.

NOTE 2: The total OFF time after the 11th ON burst will be 5,75 seconds.

NOTE 3: The timing tolerances given above will result in a tolerance for the r.m.s. level of ± 0,1 dB.

This pseudo speech signal is repeated for as long as is necessary for any measurements to be made.

Where the supplier declares that the pseudo speech signal is not appropriate for the intended use of the TE, an alternative test signal may be specified by the supplier providing that the overall activity ratio during a one minute period shall be within the range of 23 % to 33 %. Any alternative signal shall be adjusted to give the same r.m.s. level over a one minute period as the level for the pseudo speech signal.

3.1.2.2 Levels

nominal acoustic excitation: the application of an acoustic level of -4,7 dB Pa to the MRP (corresponding to -28,7 dBPa at the HFRP for handsfree measurements).

peak to peak voltage: peak to peak voltage for the purpose of the present document is the difference between the maximum and minimum voltage during any 10 ms window.

3.2 Abbreviations

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

e.m.f	Electromotive Force
HFRP	HandsFree Reference Point
ICP	Installation Connection Point, branch side of a TCE
ISDN	Integrated Services Digital Network
MRP	Mouth Reference Point
NTP	Network Termination Point
PBX	Private Branch Exchange
PCM	Pulse Code Modulation
PSTN	Public Switched Telephone Network
RLR	Recieve Loudness Rating
r.m.s	Root Mean Square
SLR	Sending Loudness Rating
TCP	Terminal Connection Point
TE	Terminal Equipment, subscriber equipment

4 Background: Analysis of prTBR 37 requirements (TE with acoustic transducers)

4.1 Mean sending level

The mean sending level is currently limited to -9,7 dBV. This limit shall not be exceeded when exciting the handset microphone with the pseudo speech signal set at the nominal level which is considered to be -4,7 dB Pa at the MRP.

In order to assess the coherence of this requirement with the requirements of TBR 38 [6], reference can be made to the existing literature on telephone speech levels, and in particular to ITU-T Recommendation G.115 [1]. In this Recommendation the relationship between the output active speech level (L) and the SLR of a telephone set is provided:

$$L\ (dBm) = -11 - SLR$$

The application of this relationship to a TBR 38 [6] conforming telephone set gives the nominal output level of a telephone set having the maximum allowed sensitivity (SLR = -1 dB):

$$L_{max} = -11 - (-1) = -10\ dBm = -12,2\ dBV$$

In other words, by exciting a top limited TBR 38 [6] compliant telephone set at the nominal speech level (-4,7 dBPa), the generated active speech level is equal to -12,2 dBV. The excitation condition specified in prTBR 37 [5] is however not at the nominal active speech level, as the mean acoustic level of the pseudo speech signal is 5,6 dB less than the ON level of the signal (-4,7 dBPa). The expected output mean sending level is then:

$$L_{out} = -12,2 -5,6 = -17,8 \text{ dBV}$$

NOTE: This desirable value is actually far below the specified limit (-9,7 dBV). While this discrepancy has no adverse consequences for:

- ordinary linear handset where, being them considered a justified case, the output level specification is practically overruled by the SLR requirement of TBR 38 [6]; or
- handsfree telephones, where producers normally follow handset telephony technical rules,

it can result into too loud output signals where the speech output is electronically synthesized, depends on non-linear systems or is derived from electric or digital inputs of any kind.

4.2 Instantaneous voltage 8 Vpp requirement (prTBR 37)

It is known (see ETR 250 [2]) that the standard deviation σ of the active speech level is equal to 5 dB ($2\sigma = 10$ dB). Besides, the peak factor of speech is of the order of 20 dB, but the signal can be clipped down to 12 dB with no practical prejudice for its perceived quality or loudness.

A TBR 38 [6] maximum efficiency compliant terminal (SLR = -1 dB), when stimulated with a signal 10 dB stronger than the nominal level of -4,7 dBPa, is then expected to generate a maximum output active speech level of:

$$L_{max} = -12,2 + 10 = -2,2 \text{ dBV}$$

Its practical peak value is then:

$$L_{peak} = -2,2 + 12 = 9,8 \text{ dBV}$$

i.e.:

$$V_{peak} = 3 \text{ V}$$

or:

$$Vp\text{-}p = 6 \text{ V}$$

This requirement compares well with the 8 Vp-p requirement of prTBR 37 [5].

The same TBR 38 [6] maximum efficiency compliant terminal (SLR = -1 dB), when tested with a 10 dBPa signal as specified by prTBR 37 [5] (14,7 dB stronger then the nominal level of -4,7 dBPa), is actually expected to generate a maximum output speech level of:

$$L_{max} = -12,2 + 14,7 = +2,5 \text{ dBV (ON periods of the output signal)}$$

Being the peak factor of the pink noise on which the pseudo speech signal (prTBR 37 [5] signal) is based (approximately 11 dB) the (theoretical) output peak value is then:

$$L_{peak} = 2,5 +11 = 13,5 \text{ dBV}$$

i.e.:

$$V_{peak} = 4,84 \text{ V}$$

or:

$$Vp\text{-}p = 9,7 \text{ V}$$

The 8 V requirement of prTBR 37 [5] is then adequately tested by the test method there provided.

4.3 Instantaneous voltage 5 Vpp (TBRs 21 and 37)

This requirement is tested in prTBR 37 [5] with a 0 dBPa simulation. A TBR 38 [6] maximum efficiency compliant terminal (SLR = -1 dB), when stimulated with an 0 dBPa signal (4,7 dB stronger then the nominal level of -4,7 dBPa), is then expected to generate a maximum output speech level of:

$$L_{max} = -12,2 + 4,7 = -7,5 \text{ dBV (ON periods of the output signal)}$$

Being the crest factor of the pink noise on which the pseudo speech signal (prTBR 37 [5] signal) is based (approximately 11 dB) the expected peak value is then:

$$L_{peak} = -7,5 + 11 = 3,5 \text{ dBV}$$

i.e.:

$$V_{peak} = 1,5 \text{ Vp}$$

or:

$$\text{Vp-p} = 3 \text{ Vpp}$$

Apparently this test has no particular interest, as a test with a 10 dBPa excitation is required (8 Vpp requirement). It seems nevertheless reasonable to perform this test because it corresponds to a more common simulation (users are not expected to produce 10 dBPa voice signals, it should therefore not be considered a normal use or very much on the limit of it) and a set being saturated in the 10 dBPa operating point might not be saturated in the 0 dBPa operating point, where unwanted peaks from spurious effects or too high efficiency might however occur.

4.4 Conclusions

TE complying with TBR 38 [6] and considering the adopted prTBR 37 [5] measurement methodology:

1) Implicitly fulfil the mean sending level specified with a margin of 8 dB (-17,7 dBV expected, -9,7 dBV required).

2) Can be adequately tested with respect to the 8 Vpp requirement by the prTBR 37 [5] methodology.

Besides:

3) The test of the 5 Vpp limitation with an 0 dBPa acoustic excitation ensures additionally that no harm occurs to the network.

5 TE without acoustic transducers

Three classes of devices can be considered:

1) Devices electronically generating a speech signal, i.e. synthesizers (e.g. answering machines, E-Mail-telephony integration).

2) Devices delivering to line speech signals received from digital or analogue public network lines.

3) Devices delivering to line speech signals received from digital or analogue ICP interfaces.

In all the above cases a speech signal is transmitted to line, but no acoustic excitation is locally implied for its generation. Of course all these cases shall be individually addressed in order to make sure that under no circumstances harm is caused to the network by the generated signals.

In this clause, for each class of devices, suitable input signal levels are defined for testing the output level limitations by means of the pseudo speech signal (where applicable).

5.1 Synthesizers

This kind of TE does not need external voice stimuli. This case is covered by ITU-T Recommendation G115 [1], where it is recommended that the levels of signals electronically generated shall be harmonized with the level of speech signals generated by telephone sets in actual use in a given network.

5.1.1 Mean sending level

If reference is made to TBR 38 [6] maxmum efficiency (SLR = -1 dB), then the Active Speech Level generated to the network shall not exceed -12,2 dBV (-11 + 1 -2,2), this level being measured as recommended by P.56, Method B of ITU-T Recommendation P.56 [3]. Any optimized application is then guaranteed to meet the -9,7 dBV requirement (referred to the speech mean level, integrated across a 10 sec time interval). A suitable advise should however be provided to manufacturers about the optimum setting of the output level.

5.1.2 Instantaneous voltage 5 Vpp (TBR 21)

This kind of TE normally produce signals with a limited dynamic range. The 8 Vpp peak limitation requirement seems clearly overrated with respect to this TE. The requirement can be kept for guaranteeing the network protection against the occurrence of any spurious high level peaks.

5.1.3 Conclusions

The requirements and measurement methods specified in TBR 21 [4] should normally be enough for such TEs. It seems nevertheless appropriate to provide suitable advice to manufacturers about the optimum setting of the output active speech level (-16,2 dBV).

5.2 Signals received from digital or analogue public network lines

5.2.1 Mean sending level

In this case, the excitation is either electrical or digital from the telephone line TCP interface. The nominal excitation level is that expected when the signal is delivered by a calling telephone set complying with TBR 38 [6] (SLR = 3 dB). What matters in particular is the SLR of the telephone set, inclusive of the network, up to the input port of the remote terminal. Assuming an average 13 dB end-to-end network attenuation, then the resulting SLR is:

$$\text{Typical SLR} = 3 + 13 = 16 \text{ dB}$$

The input average active speech level received under nominal conditions is then:

$$\text{Typical } L_{in} = -11 -16 -2,2 = -29,2 \text{ dBV}$$

NOTE 1: The input average active speech level is measured according to ITU-T Recommendation P.56 [3], method B.

It is recognized that the actual input level can exceed by about 10 dB the above calculated value in case of very short distance calls. In fact, assuming extreme worst case situations (TBR 38 [6] SLR = -1 and a "no-line" minimal end-to-end network attenuation of 8 dB), the resulting SLR is:

$$\text{Extreme SLR} = -1 + 8 = 7 \text{ dB}$$

And, under these conditions, the input active speech level is:

$$\text{Extreme } L_{in} = -11 -7 -2,2 = -20,2 \text{ dBV}$$

NOTE 2: This value is very close to the one used to measure RLR according to ITU-T recommendations (-12 dBVe.m.f). It is nevertheless to note that the pink noise on which the pseudo speech signal is based has a crest factor of approximately 11 dB (peaks are expected at -3 dBVe.m.f) while sinusoidal signals are normally used by ITU-T tests (peaks are expected at -9 dBVe.m.f).

The mean sending level requirement can, according to the above discussion, be tested by applying an active speech level of -14 dBVe.m.f for analogue TCPs.

For digital TCPs similar calculations could be done and a -14,5 dBm0 level (-11 -3,5) corresponds to the condition described above for analogue interfaces.

NOTE 3: 3,5 dB is the maximum sensitivity allowed for ISDN telephone sets (see TBR 8 [9]).

5.2.2 Instantaneous voltage 8 Vpp (prTBR 37)

To follow the test principles adopted for the acoustic excitation of transducers, the instantaneous voltage requirement 8 Vpp should be tested with an input signal 15 dB stronger then the one used for testing the mean sending level requirement, i.e. +1 dBVe.m.f (active speech level).

NOTE: This signal is expected to produce peaks of 1 dBVe.m.f + 2 +5 dB = 8 dBVp (5 dB = -6 dB for e.m.f to a-b conversion + 11 dB for the dynamic properties of the pink noise on which the pseudo speech signal is based) i.e. 2,5 Vp or 5 Vpp.

For digital NTPs a 0,5 dBm0 active speech level (-14,5 + 15) shall be used.

5.2.3 Instantaneous voltage 5 Vpp (TBRs 21 and 37)

To follow the test principles adopted for acoustic excitation of transducers, the instantaneous voltage requirement 5 Vpp should be tested with an input signal 5 dB stronger then the nominal active speech level, i.e. -9 dBVe.m.f (active speech level).

NOTE: This signal is expected to produce peaks of -7 dBVe.m.f + 5 dB = -2 dBVp i.e. 0,8 Vp or 1,6 Vpp.

For digital TCPs a -9,5 dBm0 active speech level shall be used.

5.2.4 Conclusions

A pseudo speech signal can be used for the purposes of testing the kind of TE identified in this clause, provided that the active speech level presented at the TCP is:

For the mean sending level requirement:	
For analogue interfaces	-14 dBVe.m.f
For digital interfaces	-14,5 dBm0
For the 8 Vpp requirement:	
For analogue interfaces	+1 dBVe.m.f
For digital interfaces	+0,5 dBm0
For the 5 Vpp requirement:	
For analogue interfaces	-9 dBVe.m.f
For digital interfaces	-9,5 dBm0

5.3 Signals received from digital or analogue ICP interfaces

For digital interfaces, once there is normally no attenuation to be considered, the values suggested above for signals received from digital or analogue public network lines (subclause 5.2) should be considered as valid for this clause as well.

NOTE: For terminal equipment (e.g. PBX) designed for connecting to their ICP interfaces telephone sets complying with proprietary (not harmonized) standards, the excitation levels are to be determined on the basis of a supplier declaration and according to the same criteria described in the present document.

5.3.1 Mean sending level

From the discussion presented in clause 4, it can be concluded that the maximum average active speech level generated by telephone sets complying with TBR 38 [6] (SLR_{max} = -1dB), when stimulated with the nominal acoustic input, is -12,2 dBV.

It can then be concluded that the corresponding nominal value for the simulation of a standard analogue ICP interface would be -6 dBVe.m.f.

5.3.2 Instantaneous voltage 8 Vpp (prTBR 37)

According to the above discussion, the requirement shall be tested with an input signal exceeding the signal used for the mean sending level test by 15 dB, for this test the value for the simulation of a standard analogue ICP would then be +9 dBVe.m.f.

5.3.3 Instantaneous voltage 5 Vpp (TBRs 21 and 37)

According to the above discussion, the requirement shall be tested with an input signal exceeding the signal used for mean sending level test by 5 dB, for this test the value for the simulation of a standard analogue ICP would then be -1 dBVe.m.f.

5.3.4 Conclusions

The pseudo speech signal can be used for the purposes of testing the kind of TE identified in this clause, provided that the active speech level presented at the standard ICP is:

For the mean sending level requirement:	
For analogue interfaces	-6 dBVe.m.f
For digital interfaces	-14,5 dBm0
For the 8 Vpp requirement:	
For analogue interfaces	+9 dBVe.m.f
For digital interfaces	+0,5 dBm0
For the 5 Vpp requirement:	
For analogue interfaces	-1 dBVe.m.f
For digital interfaces	-9,5 dBm0

6 Final conclusions

The current requirement and test methods specified in prTBR 37 [5] can be applied to the whole range of voice terminal equipment by using the relevant knowledge of ITU recommendations on speech levels specification and measurement.

The input active speech levels to be used for the different measurement scenarios are listed in the following. The assumption is made that the pseudo speech signal as specified in prTBR 37 [5] is used. For the reader's convenience, both the active speech level and the setting level (i.e. the level of the ON periods of the signal) are given, the latter being reported within parentheses. As a reference for the reader, also the prTBR 37 [5] acoustic excitation levels are reported as well.

The methodology here described to detail the test requirements in TBR 21 [4] for voice terminal equipment is also applicable in principle to the testing of voice terminals against TBR 15 [7] and TBR 17 [8] requirements.

6.1 Input signal level for the measurement of the mean sending level

For analogue TCP:	-14 dBVe.m.f	(-12 dBVe.m.f *ON*)
For digital interfaces (TCP or ICP or other):	-14,5 dBm0	(-12,5 dBm0 *ON*)
For analogue ICP:	-6 dBVe.m.f	(-4 dBVe.m.f *ON*)
For the MRP of a handset or headset:	-6,7 dBPa	(-4,7 dBPa *ON*)
For the HFRP of a handsfree TE:	-30,7 dBPa	(-28,7 dBPa *ON*)

6.2 Input signal level for the measurement of the Instantaneous voltage 8 Vpp requirement (prTBR 37, extreme loud signals)

For analogue TCP:	+1 dBVe.m.f	(+3 dBVe.m.f *ON*)
For digital interfaces (TCP or ICP or other):	+0,5 dBm0	(+2,5 dBm0 *ON*) (see note)
For analogue ICP:	+9 dBVe.m.f	(+11 dBVe.m.f *ON*)
For the MRP of a handset or headset:	+8 dBPa	(+10 dBPa *ON*)
For the HFRP of a handsfree TE:	-16 dBPa	(-14 dBPa *ON*)

NOTE: This signal is known to saturate the dynamic range of the PCM coder and shall be set by increasing by 15 dB the level set for mean level testing.

6.3 Input signal level for the measurement of the Instantaneous voltage 5 Vpp requirement (TBRs 21 and 37, normal loud signals)

For analogue TCP:	-9 dBVe.m.f	(-7 dBVe.m.f *ON*)
For digital interfaces (TCP or ICP):	-9,5 dBm0	(-7,5 dBm0 *ON*)
For analogue ICP:	-1 dBVe.m.f	(+1 dBVe.m.f *ON*)
For the MRP of a handset or headset:	-2 dBPa	(0 dBPa *ON*)
For the HFRP of a handsfree TE:	-26 dBPa	(-24 dBPa *ON*)

History

Document history		
V1.1.1	May 1998	Publication

ISBN 2-7437-2195-2
Dépôt légal : Mai 1998