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TELEPHONE TRANSMISSION QUALITY
OBJECTIVE MEASURING APPARATUS

ARTIFICIAL MOUTH

ITU-T Recommendation P.51

(Previously "CCITT Recommendation")

FOREWORD

The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the International Telecommunication Union. The 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 Conference (WTSC), which meets every four years, established the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

ITU-T Recommendation P.51 was revised by the ITU-T Study Group XII (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

NOTES

1 As a consequence of a reform process within the International Telecommunication Union (ITU), the CCITT ceased to exist as of 28 February 1993. In its place, the ITU Telecommunication Standardization Sector (ITU-T) was created as of 1 March 1993. Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.

In order not to delay publication of this Recommendation, no change has been made in the text to references containing the acronyms "CCITT, CCIR or IFRB" or their associated entities such as Plenary Assembly, Secretariat, etc. Future editions of this Recommendation will contain the proper terminology related to the new ITU structure.

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

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ARTIFICIAL MOUTH

(amended at Mar del Plata, 1968; Geneva, 1972, 1976, 1980;
Malaga-Torremolinos, 1984; Melbourne, 1988 and Helsinki, 1993)

1 Scope

This Recommendation specifies the artificial mouth for telephonometric use. The methods of use of the artificial mouth are outside the scope of this Recommendation.

2 Object

The artificial mouth is a device that approximates the acoustic field generated by the human mouth in the near field. It is used for measuring objectively the sending characteristics of handset-equipped telephone sets as specified in Recommendation P.64. It may also be used for measuring the sending characteristics of loudspeaking telephones at distances up to 0.5 m from the lip plane, but the accuracy with which it reproduces the sound field is slightly reduced.

3 Definitions

For the purposes of this Recommendation, the following definitions apply:

3.1 **artificial mouth**: A device consisting of a loudspeaker mounted in an enclosure and having a directivity and radiation pattern similar to those of the average human mouth.

3.2 **lip ring**: Circular ring of thin rigid rod, having a diameter of 25 mm and less than 2 mm thick. It shall be constructed of non-magnetic material and be solidly fixed to the case of the artificial mouth. The lip ring defines both the reference axis of the mouth and the mouth reference point.

3.3 **lip plane**: Outer plane of the lip ring. The lip plane is normally different from the plane of the mouth simulator orifice.

3.4 **reference axis**: The line perpendicular to the lip plane containing the centre of the lip ring.

3.5 **vertical plan**: A plane containing the reference axis that divides the artificial mouth into symmetrical halves. It shall be vertically oriented in order to reproduce the acoustic field generated by a person in the upright position.

3.6 **horizontal plane**: The plane containing the reference axis, perpendicular to the vertical plane. It shall be horizontally oriented in order to reproduce the acoustic field generated by a person in the upright position.

3.7 **mouth reference point (MRP)**: The point on the reference axis, 25 mm in front of the lip plane.

3.8 **normalized free-field response**: Difference in dB between the third-octave spectrum level of the signal delivered by the artificial mouth at a given point in the free field and the third-octave spectrum level of the signal delivered simultaneously at the MRP. The characteristic is measured by generating the artificial voice (see Recommendation P.50) a speech-shaped random noise, a pink noise, or other adequate wideband signals.

3.9 **reference obstacle**: Disc constructed of hard, stable and non-magnetic material, such as brass, having a diameter of 63 mm and 5 mm thick. In order to measure the normalized obstacle diffraction of the mouth simulator, it shall be fitted with a ¼ inch pressure microphone, mounted at the centre with the diaphragm flush with the disc surface facing the artificial mouth.

3.10 **normalized obstacle diffraction**: Difference in dB between the third-octave spectrum level of the acoustic pressure delivered by the artificial mouth at the surface of the reference obstacle and the third-octave spectrum level of the pressure simultaneously delivered at the point on the reference axis, 500 mm in front of the lip plane. The characteristic is defined for positions of the reference obstacle in front of the artificial mouth, with the disc axis coinciding with the reference axis, and is measured by generating the artificial voice (see Recommendation P.50), a speech-shaped random noise, a pink noise, or other adequate wideband signals.

3.11 **artificial voice**: A mathematically defined signal which reproduces human speech characteristics, relevant to the characterization of linear and non-linear telecommunication systems. It is intended to give a satisfactory correlation between objective measurements and tests with real speech.

3.12 **electrical artificial voice**: The artificial voice produced as an electric signal, for testing transmission channels or other electric devices.

3.13 **acoustic artificial voice**: Acoustic signal at the MRP (Mouth Reference Point) of the artificial mouth. It complies with the same time and spectral specifications as the electrical artificial voice.

4 Acoustic characteristics of the artificial mouth

4.1 Normalized free-field response

The normalized free-field response is specified at seventeen points: ten in the near field and seven in the far field. Near-field points are listed in Table 1, while far-field points are listed in Table 2.

NOTE – It shall be noticed that points in Table 2 lie on a plane parallel to the lip plane.

Table 3 provides the normalized free-field response of the artificial mouth, together with tolerances, for the bandwidth between 100 Hz and 8 kHz. The requirements at each point not lying in the vertical plan shall also be met by the correspondent point in the symmetrical half-space.

The characteristic shall be checked by using appropriate microphones, as specified in Table 4. Pressure microphones shall be oriented with their axes perpendicular to the sound direction, while free-field microphones shall be oriented with their axes parallel to the direction of sound.

If a compressor microphone is used with the artificial mouth, it (or an equivalent dummy) shall be left in place while checking the normalized free-field response.

TABLE 1/P.51

Coordinates of points in the near field

Measurement point	On-axis displacement from the lip plane (mm)	Off-axis; perpendicular displacement (mm)
1	12,5	0
2	50	0
3	100	0
4	140	0
5	0	20 horizontal
6	0	40 horizontal
7	25	20 horizontal
8	25	40 horizontal
9	25	20 vertical (downwards)
10	25	40 vertical

TABLE 2/P.51

Coordinates of points in the far field

Measurement point	Distance from the lip plane (mm)	Azimuth angle (horizontal) (degree)	Elevation angle (vertical) (degree)
11	500	0	0
12	500	0	+15
13	500	0	+30
14	500	0	−15
15	500	0	−30
16	500	15	0
17	500	30	0

TABLE 3a/P.51

Normalized free-field response on axis in the near field

Frequency	Measurement point				
(Hz)	1 (dB)	2 (dB)	3 (dB)	4 (dB)	Tolerance (dB)
100	4.2	–5.0	–11.0	–13.6	±1.5
125	4.2	–5.0	–10.9	–13.6	±1.5
160	4.2	–5.0	–10.7	–13.6	±1.5
200	4.0	–5.0	–10.7	–13.3	±1.5
250	4.0	–5.0	–10.6	–13.2	±1.5
315	4.0	–5.0	–10.6	–13.2	–1.5/+1
400	4.0	–5.0	–10.6	–13.2	–1.5/+1
500	4.1	–5.0	–10.6	–13.2	–1.5/+1
630	4.2	–4.9	–10.5	–13.4	–1.5/+1
800	4.2	–4.8	–10.5	–13.4	±1.0
1000	4.1	–4.8	–10.4	–12.9	±1.0
1250	3.9	–4.8	–10.2	–12.7	±1.0
1600	3.8	–4.8	–10.0	–12.7	±1.0
2000	3.6	–4.7	–10.0	–12.7	±1.0
2500	3.5	–4.6	–9.4	–12.3	±1.0
3150	3.6	–4.6	–9.4	–12.0	±1.0
4000	3.7	–4.6	–9.7	–12.3	±1.5
5000	3.7	–4.5	–9.7	–12.6	±1.5
6300	3.8	–4.5	–9.7	–12.6	–1.5/+2
8000	3.8	–4.9	–10.0	–12.7	–1.5/+2

TABLE 3b/P.51

Normalized free-field response off axis in the near field

Frequency	Measurement point						
(Hz)	5[a)] (dB)	6 (dB)	7 (dB)	8 (dB)	9 (dB)	10 (dB)	Tolerance (dB)
100	5.2	–1.7	–1.4	–4.0	–1.6	–4.2	±1.5
125	5.2	–1.7	–1.3	–3.8	–1.5	–4.2	±1.5
160	5.2	–1.7	–1.2	–3.8	–1.5	–4.2	±1.5
200	5.2	–1.7	–1.2	–3.8	–1.5	–4.2	±1.5
250	5.2	–1.8	–1.3	–3.8	–1.4	–4.2	±1.5
315	5.1	–1.8	–1.3	–3.8	–1.3	–4.2	±1.0
400	5.1	–1.8	–1.3	–3.8	–1.3	–4.0	±1.0
500	5.0	–1.6	–1.3	–3.8	–1.3	–3.9	–1.5/+1
630	5.0	–1.6	–1.3	–3.8	–1.3	–3.9	–1.5/+1
800	5.0	–1.6	–1.3	–3.8	–1.3	–4.0	–1.5/+1
1000	4.8	–1.7	–1.3	–3.9	–1.3	–4.1	–1.5/+1
1250	4.8	–1.8	–1.4	–4.0	–1.3	–4.3	–1.5/+1
1600	4.7	–1.8	–1.4	–3.8	–1.3	–4.0	–1.5/+1
2000	4.7	–1.8	–1.2	–3.7	–1.3	–3.6	–1.5/+1
2500	4.7	–1.9	–1.0	–3.6	–1.1	–3.5	–1.5/+1
3150	4.7	–2.1	–1.1	–3.5	–1.2	–3.4	–1.5/+1
4000	4.5	–2.9	–1.5	–4.1	–1.3	–3.0	±1.5
5000	3.8	–4.0	–1.5	–4.8	–1.3	–3.7	±1.5
6300	3.2	–4.8	–1.8	–5.2	–1.7	–3.7	±1.5
8000	2.5	–5.2	–2.0	–6.0	–2.2	–4.2	±1.5

a) The measurements on the human mouth at point 5 are quite scattered, so the response at this point is only indicatively provided and no tolerance apply.

TABLE 3c/P.51

Normalized free field response in the far field

Measurement point	Frequency range 100 Hz a 8 kHz	
	Response (dB)	Tolerance (dB)
11	–24.0	–3/+4
12	–24.0	–3/+4
13	–25.0	± 3.0
14	–24.0	–3/+4
15	–25.0	± 3.0
16	–24.0	–3/+4
17	–25.0	± 3.0

TABLE 4/P.51

Recommended microphone types for free-field measurements

Measurement point	Microphone size (maximum) (inch)	Microphone equalization
1, 2, 5, 6, 7, 8, 9, 10	1/4	Pressure
3, 4	1/2	Pressure
11, 12, 13, 14, 15, 16, 17	1	Free-field
MRP	1/4	Pressure

4.2 Normalized obstacle diffraction

The normalized obstacle diffraction of the artificial mouth is defined at three points on the references axis, as specified in Table 5.

If a compressor microphone is used with the artificial mouth, it (or an equivalent dummy) shall be left in place while checking the normalized obstacle diffraction.

TABLE 5/P.51

Normalized obstacle diffraction

Frequency (Hz)	Measurement point			
	18 (12.5 mm) (dB)	19 (25 mm) (dB)	20 (50 mm) (dB)	Tolerance (dB)
100	34.2	28.5	23.2	+3/–2
125	34.0	28.5	22.9	+3/–2
160	34.0	28.8	22.9	+3/–2
200	33.2	28.0	22.1	+3/–2
250	33.2	28.0	22.0	+3/–2
315	33.9	28.5	22.5	–1/+2.5
400	33.8	28.5	22.4	–1/+2.5
500	33.3	27.9	21.9	–1/+2.5
630	33.0	27.5	21.5	–1/+2.5
800	32.1	26.6	20.9	–1/+2.5
1000	31.3	25.9	20.3	–1/+2.5
1250	31.0	25.8	20.3	–1/+2.5
1600	30.9	26.0	21.1	–1/+2.5
2000	30.6	26.7	22.0	–1/+2.5
2500	31.0	27.8	24.7	–1/+2.5
3150	31.0	28.0	24.0	–1/+2.5
4000	31.6	28.8	24.3	a)
5000	33.2	28.4	23.9	a)
6300	33.7	27.5	24.0	a)
8000	32.0	24.5	19.5	a)

a) Only indicative values – Tolerances not specified.

4.3 Maximum deliverable sound pressure level

The artificial mouth shall be able to deliver steadily the acoustic artificial voice at sound pressure levels up to at least +6 dBPa at the MRP.

4.4 Harmonic distortion

When delivering sine tones, with amplitudes up to +6 dBPa at the MRP, the harmonic distortion of the acoustic signal (delivered at the MRP) shall comply with the limits specified in Table 6.

TABLE 6/P.51

Maximum harmonic distortion of the artificial mouth

	Distorsion harmonique	
	2nd harmonic	3nd harmonic
100 Hz-125 Hz	< 10%	< 10%
125 Hz-200 Hz	< 4%	< 4%
200 Hz-8 kHz	< 1%	< 1%

4.5 Linearity

In positive or negative variation of 6 dB of the feeding electrical signal shall produce corresponding variation of 6 dB ± 0.5 dB at the MRP for outputs in the range −14 dBPa to +6 dBPa. This requirement shall be met both for complex excitations, such as the artificial voice, and for sine tones in the range 100 Hz to 8 kHz.

5 Miscellaneous

5.1 Delivery conditions

The artificial mouth shall be delivered by the manufacturer with the mechanical fixtures required to place the ½ inch calibration microphone at he MRP, as specified in Recommendation P.64. Suitable markings shall be engraved on the device housing for identifying the vertical plane position.

Each artificial mouth shall be delivered with a calibration chart specifying the fre-field radiation and obstacle diffraction characteristics as defined in the Recommendation.

5.2 Stability

The device shall be stable and reproducible.

5.3 Stray magnetic field

Neither the d.c. nor the a.c. magnetic stray fields generated by the artificial mouth shall influence the signal transduced by microphone under test.

It is recommmended that the a.c. stray field produced at the MRP shall lie below the curve formed by the following coordinates.

Frequency (Hz)	Magnetic output (dB A/m/Pa)
200	–10
1 000	–40
10 000	–40

It is also recommended that the d.c. stray field at the MRP be lower than 400 A/m.

NOTE – The recommended d.c. stray field limit of 400 A/m applies specifically to artificial mouths intended for measuring electromagnetic microphones. For measuring other kinds of microphones, a higher limit of 1200 A/m is acceptable.

5.4 Declaration of model type

The artificial mouth used shall always be stated in test reports.

NOTE – The use of different artificial mouths that comply with the present Recommendation may given different results within the tolerances specified above. To increase the measurement precision suitable compensation techniques shall then be used in the measurement methodologies in order to correct for the individual differences.