

International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

P.58

(05/2013)

SERIES P: TERMINALS AND SUBJECTIVE AND
OBJECTIVE ASSESSMENT METHODS

Objective measuring apparatus

Head and torso simulator for telephonometry

Recommendation ITU-T P.58



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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
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Recommendation ITU-T P.58

Head and torso simulator for telephonometry

Summary

Recommendation ITU-T P.58 specifies the electroacoustic characteristics of the head and torso simulator (HATS) to be used for telephonometric measurements. Both the sound generation and sound pick-up characteristics of this device are specified.

This revised Recommendation describes new distortion and output linearity requirements for the artificial mouth of the HATS (as described in Recommendation ITU-T P.51 (1996)), and describes the positioning on the HATS of the revised type 3.2 and new type 3.4 artificial ears.

The artificial ears described in this Recommendation support super-wideband as well as full-band applications. However, it should be noted that the acoustical impedance of the artificial ears has some limitations in realistically simulating human ears.

The artificial mouth described in this Recommendation supports super-wideband applications. However, it should be noted that the directionality of the artificial mouth is limited in its ability to simulate the human mouth in the super-wideband frequency range.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T P.58	1993-03-12	XII
2.0	ITU-T P.58	1996-08-30	12
2.1	ITU-T P.58 (1996) Erratum 1	2003-01-31	12
2.2	ITU-T P.58 (1996) Erratum 2	2008-07-18	12
3.0	ITU-T P.58	2011-12-14	12
4.0	ITU-T P.58	2013-05-14	12

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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.

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Table of Contents

		Page
1	Scope	1
2	References.....	1
3	Definitions	2
4	Description of the object.....	4
5	Physical dimensions of the HATS	4
	5.1 Torso.....	4
	5.2 Head.....	5
	5.3 Pinna	11
6	Acoustic characteristics	12
	6.1 Sound pick-up.....	12
	6.2 Sound generation	16
	6.3 Composite characteristics	23
7	Miscellaneous	25
	7.1 Calibration of the artificial ears	25
	7.2 DRP-ERP transfer function	26
	7.3 Stray magnetic field.....	27
	7.4 Atmospheric reference conditions	28
	7.5 Markings and calibration fixtures.....	28
	7.6 Delivery conditions	28
	7.7 Materials	28
	7.8 Stability.....	28
	Annex A – Interpolated 1/12 octave diffuse-field response	29
	Bibliography.....	30

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Recommendation ITU-T P.58

Head and torso simulator for telephonometry

1 Scope

This Recommendation specifies the electroacoustic characteristics of the head and torso simulator (HATS) for telephonometric use. Both sound emissions and sound pick-up characteristics are specified; the free-field acoustic diffraction is specified as well.

The device is intended for airborne acoustic measurements, and is not suitable for measurements that depend on vibration conduction paths such as bone conduction. The HATS is intended to provide acoustic diffraction similar to that encountered around the median human head and torso, and to generate an acoustic field similar to that generated by the human mouth, both in proximity and in the far field.

The methods of use of the HATS in telephonometry are outside the scope of this Recommendation. However, the sound pick-up and diffraction characteristics specified by this Recommendation resemble those recommended by the International Electrotechnical Commission (IEC) for the measurement of hearing aids. The electroacoustic measurement methodologies for assessing the performance of hearing aids in their telecommunication applications are then, to the extent applicable, specified by the relevant IEC publications.

The characteristics of the device are fully specified for narrowband and wideband speech measurements. Some of its characteristics are described for an enlarged frequency range enabling measurements to be performed for super-wideband speech. Regarding sound pickup, some characteristics are specified up to 20 kHz, thus enabling measurements to be performed for fullband speech as well. Regarding ear simulator acoustic impedance, characteristics are described in [IEC 60318-4] and [ITU-T P.57].

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [ITU-T O.131] Recommendation ITU-T O.131 (1998), *Quantizing distortion measuring equipment using a pseudo-random noise test signal*.
- [ITU-T P.50] Recommendation ITU-T P.50 (1999), *Artificial voices*.
- [ITU-T P.57] Recommendation ITU-T P.57 (1993), *Artificial ears*.
- [IEC 60318-4] IEC 60318-4 ed1.0:2010, *Electroacoustics – Simulators of human head and ear – Part 4: Occluded-ear simulator for the measurement of earphones coupled to the ear by means of ear inserts*.
- [IEC 60318-7] IEC 60318-7 ed1.0:2011, *Electroacoustics – Simulators of human head and ear – Part 7: Head and torso simulator for acoustic measurement of hearing aids*.
- [ISO 4869-1] ISO Standard 4869-1:1990, *Acoustics – Hearing protectors – Part 1: Subjective method for the measurement of sound attenuation*.

3 Definitions

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

3.1 artificial ear: A device for the calibration of earphones incorporating an acoustic coupler and a calibrated microphone for the measurement of the sound pressure and having an overall acoustic impedance similar to that of the median adult human ear over a given frequency band.

3.2 axis of rotation: A straight line about which the HATS can be rotated, passing through the HATS reference point (HRP), vertical to the horizontal plane and lying in the vertical plane. It is vertically oriented when the HATS is in the reference position.

3.3 azimuth angle of sound incidence: The angle between the vertical plane of the HATS and the plane defined by the axis of rotation and the test axis. When the HATS faces the sound source, the azimuth angle of sound incidence is defined as 0° . When the right ear of the HATS faces the sound source, the angle is defined as $+90^\circ$. When the left ear of the HATS faces the sound source, the angle is defined as $+270^\circ$.

3.4 diffuse field diffraction at MRP: Difference, in dB, between the third-octave spectrum level of the acoustic pressure at the mouth reference point (MRP) and the third-octave spectrum level of the acoustic pressure at the same point in a diffuse sound field with the HATS absent.

3.5 diffuse field frequency response of HATS (sound pick-up): Difference, in dB, between the third-octave spectrum level of the acoustic pressure at the ear-drum reference point (DRP) and the third-octave spectrum level of the acoustic pressure at the HATS reference point (HRP) in a diffuse sound field with the HATS absent.

3.6 ear canal entrance point (EEP): A point located at the centre of the ear canal opening.

3.7 ear canal extension: Cylindrical cavity extending the simulation of the ear canal provided by the occluded-ear simulator out to the concha cavity.

3.8 ear reference point (ERP): A virtual point for geometric reference located at the entrance to the listener's ear, traditionally used for calculating telephonometric loudness ratings.

3.9 ear simulator: Device for measuring the output sound pressure of an earphone under well-defined loading conditions in a specified frequency range. It consists essentially of a principal cavity, acoustic load networks, and a calibrated microphone. The location of the microphone is chosen so that the sound pressure at the microphone corresponds approximately to the sound pressure existing at the human ear-drum.

3.10 ear-drum reference point (DRP): A point located at the end of the ear canal, corresponding to the ear-drum position.

3.11 elevation angle of sound incidence: The angle between the reference plane and the test axis. When the vertex points towards the sound source, the elevation angle is defined as $+90^\circ$. When the test axis lies in the reference plane, the elevation angle is defined as 0° .

3.12 free-field frequency response of HATS (sound pick-up): Difference, in dB, between the third-octave spectrum level of the acoustic pressure at the ear-drum reference point (DRP) and the third-octave spectrum level of the acoustic pressure at the HATS reference point (HRP) in a free sound field with the HATS absent (test point).

3.13 free-field plane wave diffraction at MRP: Difference, in dB, between the third-octave spectrum level of the acoustic pressure at the mouth reference point (MRP) and the third-octave spectrum level of the acoustic pressure at the same point in a free sound field with the HATS absent. The characteristic is measured for a frontal sound incidence, with a propagation direction parallel to the reference axis.

- 3.14 HATS reference plane:** A plane parallel to the horizontal plane, containing the HATS reference point (HRP).
- 3.15 HATS reference point (HRP):** The point bisecting the line joining the ear canal entrance points (EEPs).
- 3.16 head and torso simulator (HATS) for telephonometry:** Manikin extending downward from the top of the head to the waist, designed to simulate the sound pick-up characteristics and the acoustic diffraction produced by a median human adult and to reproduce the acoustic field generated by the human mouth.
- 3.17 horizontal plane of HATS:** The plane containing the reference axis, perpendicular to the vertical plane. It is horizontally oriented when the HATS is in the reference position.
- 3.18 lip plane:** Outer plane of the lip ring. When the HATS is in the reference position, the lip plane is vertically oriented. The lip plane of the HATS is normally different from the plane of the mouth simulator orifice.
- 3.19 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 fixable to the HATS. The lip ring defines both the reference axis of the mouth and the mouth reference point.
- 3.20 monaural free-field frequency response of HATS (sound pick-up):** The difference, in dB, between the third-octave spectrum level of the acoustic pressure at the ear-drum reference point (DRP) for a given angle of sound incidence and the third-octave spectrum level of the acoustic pressure at the DRP for front (0°) sound incidence.
- 3.21 mouth reference point (MRP):** The point on the reference axis, 25 mm in front of the lip plane.
- 3.22 mouth-ear reference plane:** Plane containing the ear canal entrance points (EEPs) of both ears and the centre of the lip ring on the lip plane.
- 3.23 normalized free-field response (sound generation):** Difference in dB between the third-octave spectrum level of the signal delivered by the HATS 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 [ITU-T P.50]), a speech shaped random noise, a pink noise or other adequate wideband signals.
- 3.24 normalized obstacle diffraction:** Difference in dB between the third-octave spectrum level of the acoustic pressure delivered by the HATS mouth simulator 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 HATS mouth, with the disc axis coinciding with the reference axis, and is measured by generating the artificial voice (see [ITU-T P.50]), a speech shaped random noise, a pink noise or other adequate wideband signals.
- 3.25 occluded-ear simulator:** Ear simulator which simulates the inner part of the ear canal, from the tip of an ear insert to the ear-drum.
- 3.26 pinna simulator:** A device which has the approximate shape and dimensions of a median adult human pinna.
- 3.27 reference axis:** The line perpendicular to the lip plane containing the centre of the lip ring.
- 3.28 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 $\frac{1}{4}$ inch pressure microphone, mounted at the centre with the diaphragm flush with the disc surface facing the HATS.

3.29 reference position of HATS: The reference position of the HATS in the test space is intended to simulate a person in the upright position. The HATS is in the reference position when the following conditions are met:

- the reference point coincides with the test point
- the HATS reference plane is horizontal.

3.30 test axis: The line through the test point, parallel to the propagation direction of externally applied plane progressive waves in a free sound field.

3.31 test plane for measurement of the uniformity of the free field wavefront: A plane perpendicular to the test axis and containing the test point.

3.32 test point: A reproducible position in the test space at which the sound pressure level is measured with the HATS absent and at which the HATS reference point (HRP) has to be located for test purposes.

3.33 transverse plane: A plane perpendicular to the reference axis and containing the HATS reference point.

3.34 vertical plane (plane of symmetry of the HATS): A plane containing the reference axis that divides the HATS into symmetrical halves. It is vertically oriented when the HATS is in the reference position.

4 Description of the object

The head and torso simulator (HATS) is a device that accurately reproduces the sound transmission and pick-up characteristics of the median head and torso of adult humans. Only the sound emission and pick-up characteristics affecting the electroacoustic measurements of telephone sets, headsets and hands-free telecommunication devices are considered.

The HATS consists of a head mounted on a torso that extends to the waist. The head is equipped with one or two artificial ears, and a mouth simulator. The HATS is specified physically as well as acoustically, and requirements are specified for both descriptions.

5 Physical dimensions of the HATS

The HATS geometrical references are illustrated in Figure 1. The coordinate scheme for azimuth and elevation angles of the sound source is illustrated in Figure 2.

5.1 Torso

The principal dimensions of the torso are illustrated in Figure 3 and ranges are listed in Table 1. The realization of the torso shall conform to the given ranges of dimensions and guarantee the conformance to the electroacoustic performances specified in this Recommendation.

NOTE – For the relevant dimensions, reference is made to the EEP position of the ears.

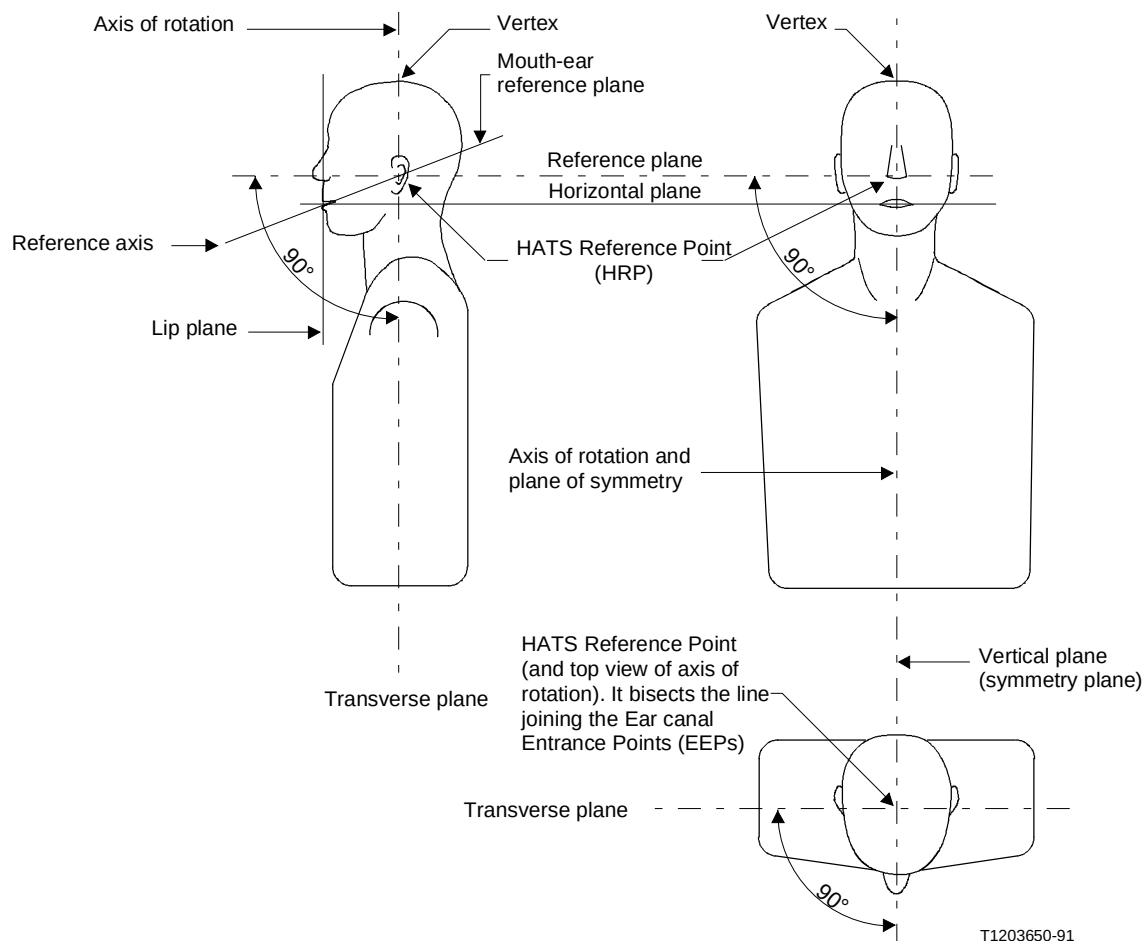


Figure 1 – HATS geometrical references

5.2 Head

The principal dimensions of the HATS head are listed in Table 1. The realization of the head shall conform to the given ranges of dimensions and guarantee the conformance to the electroacoustic performances specified in this Recommendation.

NOTE – For the relevant dimensions, reference is made to the EEP position of the ears.

The cross-sections of the head surface, excluding pinnae, shall conform to the templates reported in Figures 4, 5, 6, and 7. In order to comply with this Recommendation, the HATS shall comply both with the dimensions in Table 1 and with the cross-section templates shown in Figures 4, 5, 6, and 7.

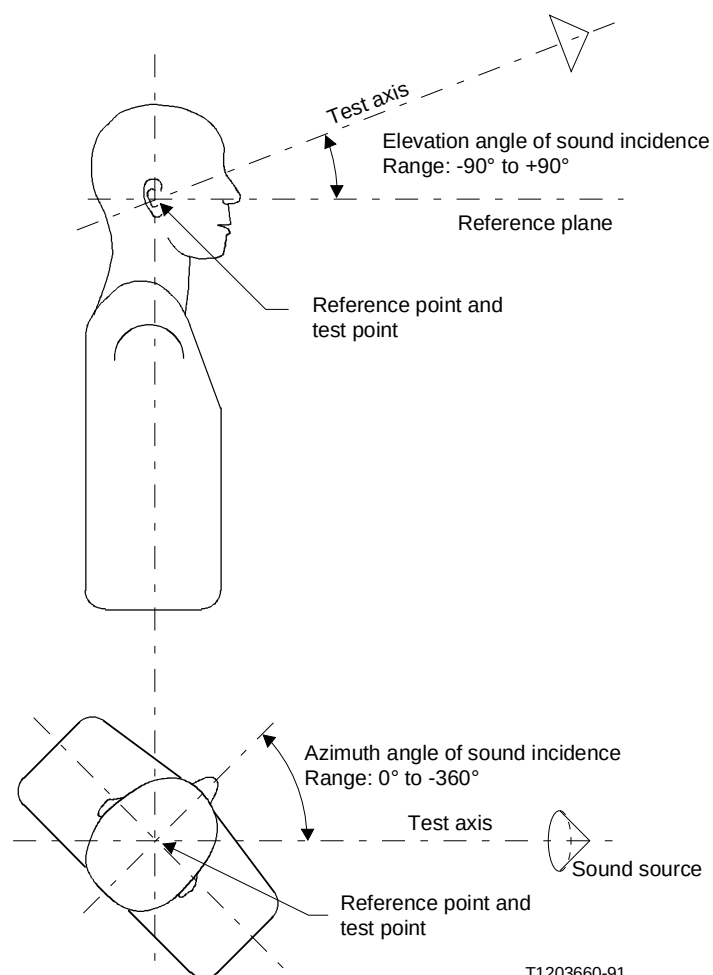


Figure 2 – Coordinate scheme for azimuth and elevation angles of the sound source

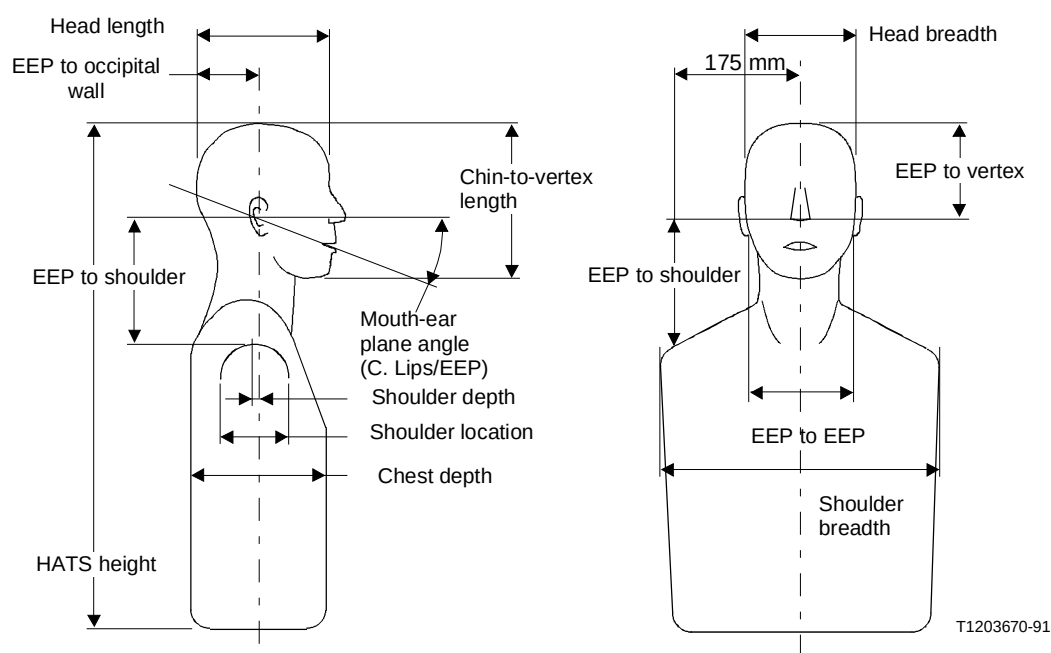


Figure 3 – HATS torso dimensions