

Recommendation

ITU-T P.58 (03/2023)

SERIES P: Telephone transmission quality, telephone installations, local line networks

Objective measuring apparatus

Head and torso simulator for telephonometry

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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.

The artificial ears described in this Recommendation support narrowband, wideband, and super-wideband, as well as fullband applications.

The artificial mouth described in this Recommendation supports narrowband, wideband and 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

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Keywords

HATS, head and torso simulator, quality of service measurement.

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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.

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.

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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 also specified.

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 lie 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 (1988), *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.51] Recommendation ITU-T P.51 (1996), *Artificial mouth*.
- [ITU-T P.57] Recommendation ITU-T P.57 (2021), *Artificial ears*.
- [IEC 60318-4] IEC 60318-4:2010, *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 TS 60318-7] Technical Specification IEC TS 60318-7:2017, *Electroacoustics – Simulators of human head and ear – Part 7: Head and torso simulator for the measurement of air-conduction hearing aids*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 ear canal entrance point (EEP) [b-ITU-T P.10]: A point located at the centre of the ear canal opening.

3.1.2 ear canal extension [b-ITU-T P.10]: Cylindrical cavity, extending the simulation of the ear canal provided by the occluded-ear simulator out to the concha cavity.

3.1.3 eardrum reference point (DRP) [b-ITU-T P.10]: A point located at the end of the ear canal, corresponding to the eardrum position.

3.1.4 ear reference point (ERP) [b-ITU-T P.10]: A virtual point for geometric reference located at the entrance to the listener's ear, traditionally used for calculating telephonometric loudness ratings.

3.1.5 ear simulator [b-ITU-T P.10]: 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 eardrum.

3.1.6 head and torso simulator (HATS) [b-ITU-T P.10]: 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.

3.1.7 occluded-ear simulator [b-ITU-T P.10]: Ear simulator which simulates the inner part of the ear canal, from the tip of an ear insert to the eardrum.

3.1.8 pinna simulator [b-ITU-T P.10]: A device which has the approximate shape and dimensions of a median adult human pinna.

3.1.9 reference position of HATS [b-ITU-T P.10]: 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.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 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.

NOTE – Based on [b-ITU-T P.10].

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

3.2.3 azimuth angle of sound incidence: The angle between the vertical plane of the head and torso simulator (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 $+270^\circ$.

3.2.4 diffuse field diffraction at mouth reference point: Difference, in decibels, between the third octave spectrum level of the acoustic pressure at the mouth reference point and the third octave spectrum level of the acoustic pressure at the same point in a diffuse sound field with the head and torso simulator absent.

3.2.5 diffuse field frequency response of head and torso simulator (sound pick-up): Difference, in decibels, between the third octave spectrum level of the acoustic pressure at the eardrum reference point and the third octave spectrum level of the acoustic pressure at the head and torso simulator (HATS) reference point in a diffuse sound field with the HATS absent.

3.2.6 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° .

3.2.7 free-field frequency response of head and torso simulator (sound pick-up): Difference, in decibels, between the third octave spectrum level of the acoustic pressure at the eardrum reference point and the third octave spectrum level of the acoustic pressure at the head and torso simulator (HATS) reference point in a free sound field with the HATS absent (test point).

3.2.8 free-field plane wave diffraction at mouth reference point: Difference, in decibels, between the third octave spectrum level of the acoustic pressure at the mouth reference point and the third octave spectrum level of the acoustic pressure at the same point in a free sound field with the head and torso simulator absent. The characteristic is measured for a frontal sound incidence, with a propagation direction parallel to the reference axis.

3.2.9 head and torso simulator reference plane: A plane parallel to the horizontal plane, containing the head and torso simulator reference point.

3.2.10 head and torso simulator reference point (HRP): The point bisecting the line joining the ear canal entrance points.

3.2.11 horizontal plane of head and torso simulator: The plane containing the reference axis, perpendicular to the vertical plane. It is horizontally oriented when the head and torso simulator is in the reference position.

3.2.12 lip plane: Outer plane of the lip ring. The lip plane of the head and torso simulator (HATS) is normally different from the plane of the mouth simulator orifice. The lip plane is vertically oriented when the HATS is in the reference position.

NOTE – Based on [b-ITU-T P.10].

3.2.13 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 head and torso simulator. The lip ring defines both the reference axis of the mouth and the mouth reference point.

NOTE – Based on [b-ITU-T P.10].

3.2.14 monaural free-field frequency response of head and torso simulator (sound pick-up): The difference, in decibels, between the third octave spectrum level of the acoustic pressure at the eardrum 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.

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

NOTE – Based on [b-ITU-T P.10].

3.2.16 mouth-ear reference plane: Plane containing the ear canal entrance points of both ears and the centre of the lip ring on the lip plane.

3.2.17 normalized free-field response (sound generation): Difference, in decibels, between the third octave spectrum level of the signal delivered by the head and torso simulator mouth at a given point in the free field and the third octave spectrum level of the signal delivered simultaneously at the mouth reference point. 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.

3.2.18 normalized obstacle diffraction: Difference, in decibels, between the third octave spectrum level of the acoustic pressure delivered by the head and torso simulator (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.

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

NOTE – Based on [b-ITU-T P.10].

3.2.20 reference obstacle: Disc constructed of hard, stable and non-magnetic material, such as brass, having a diameter of 63 mm and thickness 5 mm. 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 head and torso simulator.

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

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

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

3.2.24 transverse plane: A plane perpendicular to the reference axis and containing the head and torso simulator reference point (HRP).

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

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AC	Alternating Current
DC	Direct Current
DRP	eardrum Reference Point
EEP	Ear canal Entrance Point
ERP	Ear Reference Point
HATS	Head And Torso Simulator
HRP	HATS Reference Point
MRP	Mouth Reference Point

5 Conventions

None.

6 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 and acoustically, as well as corresponding requirements.

7 Physical dimensions of the head and torso simulator

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

7.1 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 dimensional ranges and guarantee conformity to the electroacoustic performance specified in this Recommendation.

NOTE – For the relevant dimensions, reference is made to the ear canal entrance point (EEP) position of the ears.

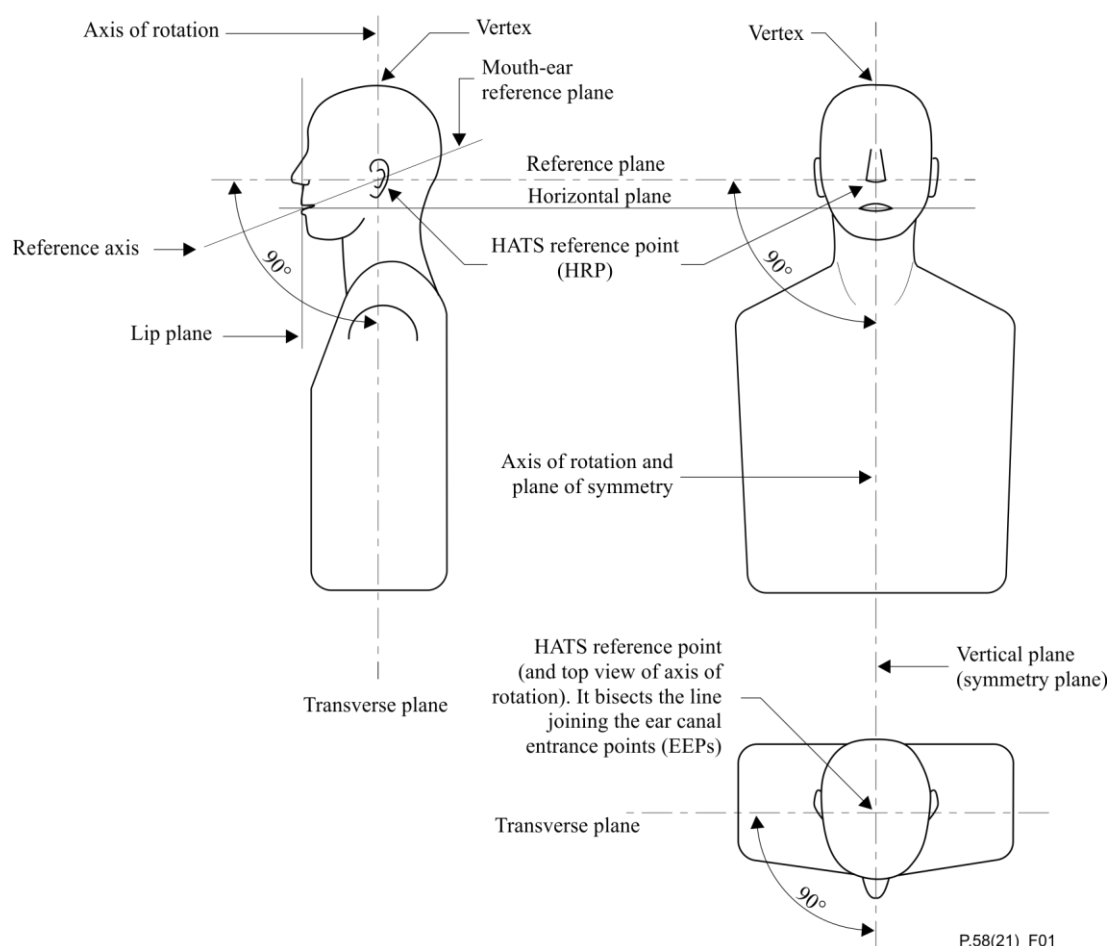


Figure 1 – HATS geometric references

7.2 Head

The principal dimensions of the head of the HATS are listed in Table 1. The realization of the head shall conform to the given dimensional ranges and guarantee conformity to the electroacoustic performance 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.