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IEEE Standard Method for Determining Objective Loudness Ratings of Telephone Connections

Sponsor
**Transmission Systems Committee
of the
IEEE Communications Society**

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Foreword

(This Foreword is not a part of IEEE Std 661-1979, Standard Method for Determining Objective Loudness Ratings of Telephone Connections.)

This IEEE Standard Method for Determining Objective Loudness Ratings of Telephone Connections has been prepared in response to a need by the telecommunications industry for a standard method of testing transmission performance of partial and overall telephone connections in a manner that reflects the attribute of subjective loudness. This document complements and is dependent on IEEE Std 269-1971, Standard Method for Measuring Transmission Performance of Telephone Sets. Individuals from private and government design, manufacturing, and research organizations have given freely of their time in preparing, testing, and reviewing this standard.

The IEEE will maintain this document current with the state of the technology. Comments, suggestions, and requests for interpretations should be addressed to:

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IEEE Standard

Method for Determining Objective Loudness Ratings of Telephone Connections

1. Introduction

The methods that are used to measure the transmission performance of telephone connections may be divided into two classes: objective methods and subjective methods. This standard considers an objective method that can be used for measuring telephone connections in a manner that reflects the subjective attribute of loudness with an accuracy suitable for most telephone transmission engineering problems. The performance measure is expressed in terms of a defined reference and is referred to as an objective loudness rating.

The objective method utilizes a sound source to activate the telephone transmitter, and an acoustic coupler and associated microphone (artificial ear) as an acoustic termination for the telephone receiver. The sound source consists of a source of electric energy, a special type of loudspeaker unit (artificial mouth), and such supplementary electric and acoustic components as may be required so that the ensemble provides a controlled sound field.

The artificial mouth and artificial ear provide a simpler means of measuring characteristics of telephone connections than is possible with the human mouth and ear. The practical design of artificial mouths and artificial ears is such that they only approximate their respective human counterparts. Thus telephone connection characteristics measured using these devices will only approximate and not duplicate those characteristics measured with human mouths and ears. However, experience has shown that characteristics determined using these devices are highly useful in telephone transmission engineering.

Subjective methods for rating the transmission performance of telephone connections involve human talkers and listeners. Commonly

used subjective test methods include those based on loudness assessment, articulation, and judgment. [1-4].¹ The particular method employed in any given situation depends on the transmission parameter(s) to be evaluated and on the performance measure criterion of interest, for example, articulation or loudness.

Subjective methods have the particular advantage that ratings obtained are direct measures of performance. A major disadvantage of subjective methods is that they often require large groups of human subjects for long time periods in order that the results have significance. Objective methods, on the other hand, involve somewhat simpler and better controlled measurements, and a large number of measurements can be made in a relatively short period of time. Moreover, measurements can be obtained that reflect subjective evaluation with suitable accuracy.

This standard is concerned with a specific objective method of determining the loudness ratings of telephone connections. The method is based on objective measurements and computations performed in such a manner that the numerical results obtained reflect the subjective attribute of loudness.

The method was derived, employing certain simplifying assumptions, to combine simplicity and reasonably close agreement between objectively determined results and subjective responses. (See Appendix A.) Results obtained with the method described in this standard and the relation of these results to subjective test results may vary with design, for example, size and shape of the telephone handset and the type of circuitry used to control equalization

¹ Numbers in brackets refer to those of the references listed in Section 4 of this standard.

or output level, or both. Thus, specific instances might occur where the results obtained according to the method described will not be suitable for transmission engineering purposes, and supplementary subjective measurements may be required. It would, therefore, appear desirable to establish correlation between subjective measurements and objective measurements separately for each telephone set design before the measurements obtained using the method of this standard are interpreted to reflect loudness performance under conditions of actual use.

2. Scope and Purpose

2.1 The purpose of this standard is to describe a practical and reproducible method of determining the loudness ratings of telephone connections. Loudness rating may be measured directly using appropriate test instruments and facilities, as specified in this standard, or may be computed using the amplitude-frequency characteristic of the connection measured in accordance with IEEE Std 269-1971 [5].

2.2 Loudness ratings determined using this standard may not exactly duplicate subjective loudness evaluations. Moreover, measured ratings and computed ratings determined using this standard may not agree, particularly if the connection incorporates nonlinear elements. However, differences are expected to be acceptably small for engineering purposes. For example, differences for connections utilizing linear microphones are expected to be small, resulting only from instrument and measurement error, while for connections employing nonlinear microphones, for example, carbon microphones, the differences may be larger.

NOTE: For the purposes of this standard, a linear microphone is one that exhibits a one-to-one relation between input pressure and output voltage over its normal operating range.

2.3 The procedures given in this standard may be used for determining the loudness rating of partial and complete telephone connections. For complete telephone connections, comprising overall and sidetone transmission paths, the procedures involve measurement of acoustic input and output pressures.

For partial telephone connections comprising transmitting, receiving, or connection paths,

the procedures involve measurement of acoustic pressures and electric voltages.

2.4 Transmission planning of switched telephone networks is generally accomplished by working with parts of connections, for example, customer loops (telephone sets, line facilities, and feeding bridges) or trunks, to ensure that when these parts are switched together, the resulting overall connections perform satisfactorily. When planning is based on loudness, the sum of the loudness losses determined for parts of a connection should closely approximate the loudness loss of the overall connection. For such purposes the recommended analysis bandwidth is 300-3300 Hz, which approximates the bandwidth of the more band-limiting components typically found in modern telephone networks. There may be cases in which a wider bandwidth would be desirable (see Appendix A), and the methods of this standard will accommodate such wider bandwidths.

2.5 The method of this standard is based on specification of (1) characteristics of a suitable artificial mouth, (2) a standard artificial ear, and (3) appropriate auxiliary measuring instruments and facilities. The method is intended for rating connections involving telephone sets equipped with handsets. The applicability of the method for the measurement of telephone sets incorporating special devices such as noise-exclusion transmitters, distant-talking transmitters, ear insert receivers, or noise-exclusion receivers (receivers equipped with circumaural earpads) has not been reviewed. However, the loudness theory on which this standard is based is sufficiently general that advances in the art may permit measurement of many such special devices using the methods specified in this standard.

3. Definitions

NOTE: For terms not listed in this section, see Section 3 of IEEE Std 269-1971 [5], ANSI S1.1-1960 (R1976) [6], or ANSI/IEEE Std 100-1977 [7].

3.1 Loudness Rating. The amount of frequency-independent gain that must be inserted into a system under test so that speech sounds from the system under test and a reference system are equal in loudness.

3.2 Reference System. A system that provides 0 dB acoustic gain between a mouth reference