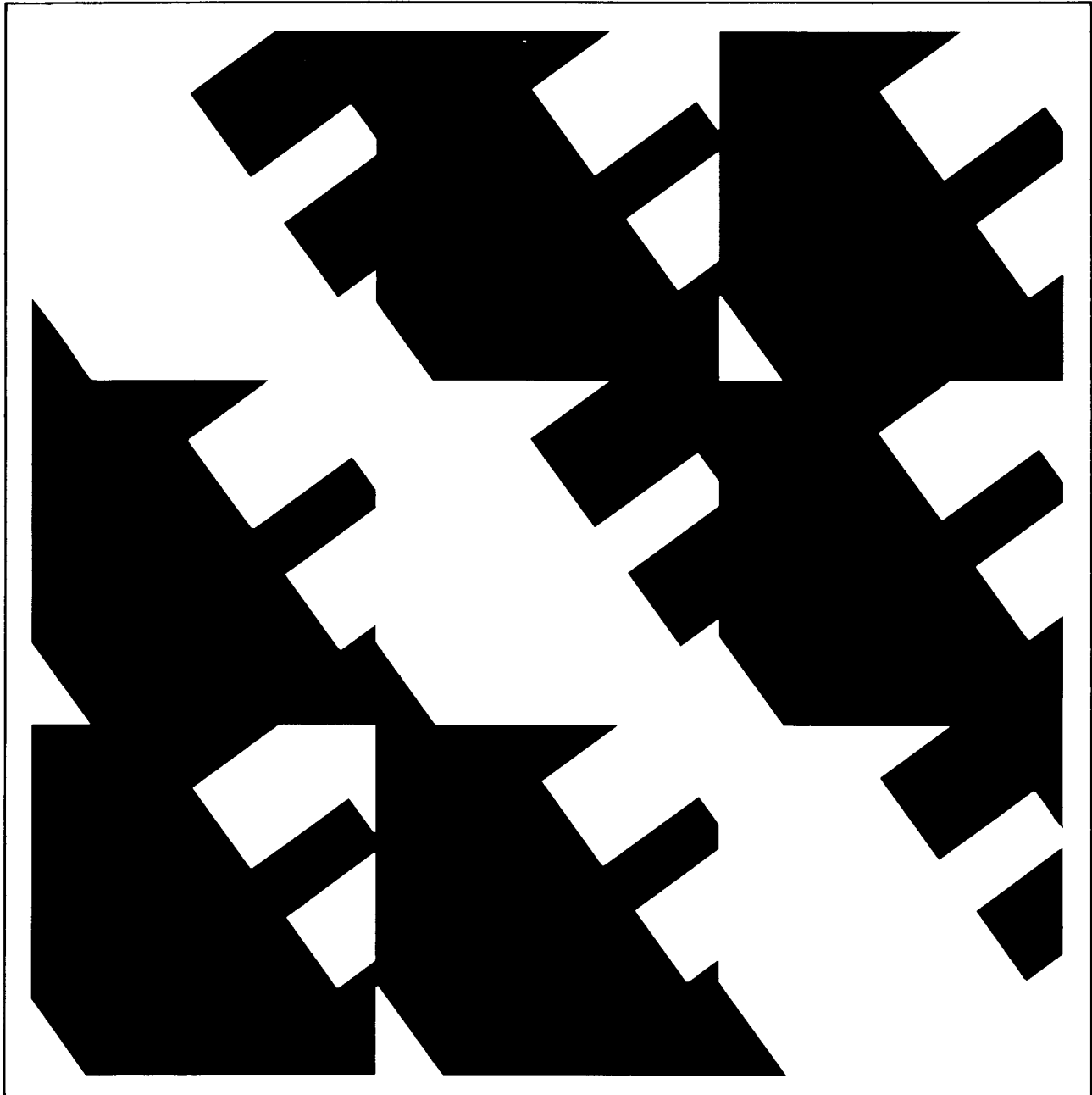


IEEE Standard for Functional Requirements for Methods and Equipment for Measuring the Performance of Tone Address Signaling Systems

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Measuring the Performance of Tone
Address Signaling Systems**

Sponsor

**Standards Coordination and Liaison Committee
of the
IEEE Communications Society**

Approved March 13, 1986
IEEE Standards Board

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Foreword

(This Foreword is not a part of ANSI/IEEE Std 752-1986, IEEE Standard for Functional Requirements for Methods and Equipment for Measuring the Performance of Tone Address Signaling Systems.)

The rapidly expanding growth of national and international telecommunication, the increasingly sophisticated application of new technologies, and the increasing interconnection of new devices with the telecommunications network have imposed more stringent requirements on all elements comprising the network. Consequently, it is essential that effective means for evaluating the address signaling performance of telecommunications equipment and channels be established. In order to assure that such an effort yields meaningful and repeatable results, capable of being used for comparisons of similar equipment, to assure the maximum effective performance of devices connected to the telecommunication network, and to assure the maximum overall performance of the network, it is essential that agreed upon techniques of measurement and general test equipment specifications be standardized.

Section 2 of this standard provides brief descriptions of applicable tone address signaling techniques and definitions of the related signaling parameters that affect performance. Section 3 describes the classes of instruments intended to measure the parameters presented in Section 2. It also provides details on the techniques necessary to perform these measurements. Section 4 provides performance and operating requirements for the test equipment that will satisfy this standard.

Suggestions for improvement of this standard will be welcomed. They should be sent to the Secretary

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An American National Standard

IEEE Standard for Functional Requirements for Methods and Equipment for Measuring the Performance of Tone Address Signaling System

1. Introduction and References

1.1 Introduction

1.1.1 Purpose and Scope. The purpose of this standard is twofold. The first purpose is to establish and define requirements for methods which can be used to measure the performance of tone address signaling systems used with voice frequency telecommunications equipment. The second purpose is to establish functional requirements for test equipment needed to make the measurements. Standard conditions such as those possible with these methods and means are mandatory if consistent and repeatable test results are to be obtained.

This document will be limited to the parameters of tone signaling systems used in the North-American network that affect address signal performance. These parameters shall be measured at appropriate access points within the telecommunications switching system, on associated local subscriber loops, on trunks interconnecting switching systems, or on station apparatus.

1.1.2 Organization. Section 2 of this document provides brief descriptions of applicable tone address signaling techniques and the related signaling parameters that affect performance. Section 3 describes the classes of instruments intended to measure the parameters presented in Section 2. It also provides details on the techniques necessary to perform these measurements. Section 4 provides performance

and operating requirements for the test equipment that will satisfy this standard.

1.1.3 Reason for Issue. For many years telecommunication operating companies and equipment manufacturers have agreed on the general techniques necessary to measure tone address signaling characteristics. Unfortunately, this agreement has not resulted in industry standard methods and means that produce uniform test results or equipment performance specifications. With the increasingly innovative application of emerging technologies and the current trend toward interconnect of privately owned devices with the public network, it is essential that appropriate standards be established for determining and evaluating address signaling performance characteristics of telecommunications equipment. Furthermore, it is critical that uniform measurement methods be associated with compliance testing with these performance standards. It is these specifications that are addressed in this document.

The basic requirements of this document will tend to assure uniform and meaningful equipment specifications, performance characteristics and test results. It is vital that the industry embrace and employ these requirements.

1.1.4 Compliance to Standard. Performance characteristics or test information obtained in accordance with this standard should contain a notation such as the following:

Tone address signaling characteristics are measured in accordance with this standard, for Class (1, 2, or 3) Instruments.

1.2 References. This standard shall be used in conjunction with the following publications:

- [1] ANSI/ASTM D21-97-1968, (R1979) Standard Test Methods for Adhesion of Organic Coatings.¹
- [2] ANSI/IEEE Std 4-1978, IEEE Standard Techniques for High-Voltage Testing.
- [3] ANSI/IEEE Std 743-1984, IEEE Standard Methods and Equipment for Measuring the Transmission Characteristics of Analog Voice Frequency Circuits.
- [4] ANSI/IEEE Std 753-1983, IEEE Standard Functional Methods and Equipment for Measuring the Performance of Dial-Pulse (DP) Address Signaling Systems.
- [5] ANSI/NFPA 70-1987, National Electrical Code.
- [6] CCITT Red Book vol VI Specification of Signaling Systems R1 and R2.²
- [7] EIA RS-464-1979, Private Branch Exchange (PBX) Switching Equipment for Voiceband Applications.³
- [8] EIA RS-470-1981, Telephone Instruments with Loop Signaling for Voiceband Applications.
- [9] IEC 320-1981, Appliance Couplers for Household and Similar General Purposes.⁴
- [10] Notes on the BOC INTRA-LATA Networks-1983.

¹ANSI Publications are available from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018.

²CCITT publications are available in the US from National Technical Information Service, Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161.

³EIA Publications are available from Electronic Industries Association, 2001 Eye Street, NW Washington, DC 20006.

⁴IEC Publications are available in the US from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018.

2. General Information

2.1 Description of Signaling Methods. The requirements of this standard establish and define methods that shall be used to measure the address signaling performance of systems employing tone signaling. These requirements also stipulate criteria for the test instruments that shall be used to perform these measurements.

Address signaling is the transmission of information that identifies the intended destination of a message in a switched network communications system. The different methods of tone address signaling included in this standard are:

- (1) Single frequency (SF)
- (2) Multifrequency (MF)
- (3) Dual-tone multifrequency (DTMF)

2.1.1 Single-frequency signaling is a signaling method in which an in-band 2600 Hz or out-of-band 3700 Hz single-frequency tone is placed on the voice path. The tone is on during the idle condition, pulsed during dialing, and off when the circuit is being used. SF signaling is generally used for address signaling and supervision on trunk facilities between systems and on special private circuits. Measurement of the dial-pulse characteristics of SF signaling is covered in ANSI/IEEE Std 753-1983 [4].⁵

2.1.2 In multifrequency signaling, address information is transmitted by sending out simultaneously a combination of two frequencies out of a possible total of six. MF signaling is generally used for address signaling on trunk circuits.

2.1.3 Dual-tone multifrequency signaling is a method of signaling in which a combination of two frequencies, one of a lower group of frequencies and one of a higher group of frequencies, is used to transmit address information from customer premise equipment.

2.2 Definitions. The parameters and characteristics of tone signaling that are addressed in this standard are as follows:

composite level. In two-tone signaling systems, the total power of the two tones comprising a specific signal present condition.

⁵The numbers in brackets correspond to those of the references listed in 1.2.

cycle time. Synonymous with pulse period.

interdigit (interdigital) time. The time interval between successive signal present intervals during which no signal present condition exists. This time includes the signal off condition and transition intervals between signal off condition and signal present condition on both state transitions.

pulse period. When sending a sequence of signals, the time interval from the start of one signal present condition to the start of the next signal present condition.

response to signal removal. The time interval from the end of signal present condition to the time the receiver indication terminates.

response to signal start. The time interval from start of a signal present condition to the time at which the appropriate indication occurs in the receiver.

response to tone removal. The time interval from the end of tone present condition to the time the receiver indication terminates.

response to tone start. The time interval from start of a tone present condition to the time at which the appropriate indication occurs in the receiver.

signal decay time. The time interval between the end of the signal present condition and the beginning of the signal off condition at the end of the signal under consideration.

signal duration. The time interval during which a signal present condition exists continuously.

signal off. Any condition where all the constituent tones of a tone signaling system are below a specified OFF level for each tone. In a single-tone signaling system, tone off and signal off are synonymous terms.

NOTE: During a signal off condition, tones that are not used in the signaling system may be at a higher level.

signal present. Any condition where the presence of tone or tones is sufficient to be recognized as a valid digital or supervisory signal. In a single-tone signaling system, tone present and

signal present are synonymous terms; in a two-tone signaling system the signal present state exists where two and only two tones each meet the tone present condition, and the two tones represent a valid combination.

signal rise time. The time interval between the end of the signal off condition and the beginning of the signal present condition at the beginning of a tone signal.

skew. In a two-tone signal, the time interval from the start of the lower-frequency tone present condition to the start of the higher-frequency tone present condition. Skew is negative if the higher-frequency tone starts before the lower-frequency tone.

tone decay time. The time interval between the end of the tone present condition and the beginning of the tone off condition at the end of the tone under consideration.

tone duration. The time interval during which a tone present condition exists continuously.

tone leak. The occurrence of any address signaling tone during the signal present or signal off intervals when such tone is not intended.

tone off. Any condition where the tone under consideration is below a specified OFF level.

tone present. Any condition where the tone under consideration is equal to or greater than a specified threshold value.

tone rise time. The time interval between the end of the tone off condition and the beginning of the tone present condition at the beginning of the tone under consideration.

twist. In a two-tone signal, during the signal present condition, the level of the higher-frequency tone relative to the level of the lower-frequency tone, expressed in decibels. Twist is negative if the higher-frequency tone level is below the lower-frequency tone level.

3. Measurement Techniques

3.1 Introduction. This section presents requirements that shall be adhered to when mea-

asuring the performance of tone address signaling systems. Specific requirements on ranges, accuracies, and stabilities are established, and where appropriate, methods of testing for the requirements are suggested. Also included are suggested general descriptions of the different classes of measuring instruments.

3.2 Classes of Instruments

3.2.1 High-Performance Instruments. Instruments in this category are designated Class 3 Instruments and are intended primarily for laboratory type application or special diagnostic activities in an operating equipment environment. These instruments offer the highest currently attainable degree of accuracy and stability.

3.2.2 General-Purpose Instruments. Instruments in this category are designated Class 2 Instruments and are intended primarily for preservice, routine maintenance, and diagnostic activities. These instruments, therefore, offer a degree of accuracy and stability consistent with the testing requirements and limits for such activities. Unless otherwise indicated, the requirements of this document refer to the general purpose (Class 2) instruments.

3.2.3 Reduced-Performance Instruments. Instruments in this category are designated Class 1 Instruments and are intended primarily for field application. Therefore, portability, rugged construction, and ease of operation are a major consideration in their design. These instruments offer accuracy acceptable for basic parameter measurement.

3.2.4 Instrument Capabilities. The capabilities provided in any given instrument shall be at the discretion of the manufacturer.

3.2.5 Class Designations. The following designations will be used for test equipment.

- (1) Classes 1, 2, and 3 as defined in 3.2.1 through 3.2.3
- (2) Suffix G for signal, noise source, or generator
- (3) Suffix M for measurement of incoming signals

3.3 Specific Measurements. This section defines the requirements for measurement in tone address signaling systems, including the measurement of tone signal parameters and of extraneous interference. Measurements may be performed at any point in the system, but are most typically made at the output of signaling

senders to evaluate sender performance, and at the input to receivers to evaluate overall sender and transmission facility performance.

3.3.1 Tone Separation. In order to measure signal tone parameters in two-tone signaling systems such as MF and DTMF, it is first necessary to separate the two tones. For DTMF, a pair of filters separating the low-band tones from the high-band tones is sufficient. For MF, a filter is needed for each of the six signaling tone frequencies. In order to limit the response time of the tone separation filters to 5 ms, their bandwidth (± 0.2 dB) should be 200 Hz. To reject the adjacent tones by greater than 40 dB (OFF level), the above filters need to be 8th order elliptic. Finally, all bandwidths should be the same (200 Hz) in order to have similar transient response characteristics. In general, the tone separation filters used in operating-system DTMF and MF receivers are not satisfactory for measurement purposes. Appendix A to this standard describes one example of a pair of digital band-separation filters that meet the requirements for DTMF signal tone measurement purposes. Appendix B describes an example of a set of six digital tone separation filters that meet the requirements for MF signal tone measurement purposes. An alternative to the use of tone separation filters is some form of digital analysis of a tone address signal burst.

3.3.2 Frequency Measurement

3.3.2.1 Sustained Single Tones. Measurement of the frequency of address signal tones is facilitated by sustaining the tones for substantially longer than the operating ON time. Measurement of sustained single-tone frequency can be accomplished with a general-purpose frequency counter. For tone address signal frequencies, single-tone measurement resolution shall be 1 Hz or less and measurement accuracy shall be ± 1 Hz or better.

3.3.2.2 Sustained Two-Tone Signals. Class 2-M and 3-M equipment shall have the capability of measuring the frequencies of both tones of a sustained two-tone signal. Resolution shall be 1 Hz or less and measurement accuracy shall be ± 1 Hz or better.

The measurement requirements of this section shall be met for all tone levels within acceptable limits at the transmission point where measurement is made, and in the presence of noise and extraneous frequency components that are within acceptable limits. See 3.3.3 and 3.3.6.