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SMPTE RECOMMENDED PRACTICE

RP 90-2004
Revision of RP 90-1999

Specifications for Type U Audio Level and Multifrequency Test Film for 16-mm Audio Reproducers, Magnetic Type

1 Scope

1.1 This practice specifies a type U audio frequency test film to be used for adjusting the mechanical and electrical parameters of 16-mm motion-picture magnetic audio reproducers operating at 24 frames per second.

NOTE – The film velocity of 16-mm film is also commonly stated as 7.2 inches per second or 183 millimeters per second, and historically stated as 36 feet or 11 meters per minute.

1.2 The International Organization for Standardization recognizes two reference levels for test films — type U with a reference level of 185 nWb/m and type E with a reference level of 320 nWb/m — in order to account for differing meter types in common use in the United States and Europe.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this practice. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this practice are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

ANSI S4.3-1982 (R1992), Method for Measurement of Weighted Peak Flutter of Sound Recording and Reproducing Equipment

ANSI S4.6-1982 (R1992), Method of Measuring Recorded Flux of Magnetic Sound Records at Medium Wavelengths

ANSI/IEEE 152-1992, Audio Program Level Measurement

SMPTE 97-1999, Motion-Picture Film (16-mm) — 200-Mil Edge Position — Magnetic Audio Record

SMPTE 109-2003, Motion-Picture Film (16-mm) — Perforated 1R and 2R

SMPTE 223M-2001, Motion-Picture Film — Safety Film

3 Manufacturing

3.1 Film stock

3.1.1 The film stock shall be polyester-base, full-coat, splice-free and in compliance with SMPTE 223M.

3.1.2 Test films shall be made on a base cut and perforated in accordance with SMPTE 109.

3.1.3 The film stock shall be conditioned for 10 days at 20°C ± 3°C (68°F ± 5.4°F) at a relative humidity of (50 ± 10)% prior to recording.

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3.2 Magnetic coating

3.2.1 Full-coat film

The coating shall extend from edge to edge of the film.

3.2.2 Magnetic particle orientation

Because of orientation of the magnetic particles within the coating during manufacture, the film may show a preferred direction for recording. The preferred direction is the direction which shows the greatest high-frequency sensitivity. If there is such a preferred direction, it shall be marked by means of an arrow faced in the preferred direction on the head and tail of the film.

4 Primary characteristics of test film records

4.1 Test film content

This general-purpose, diagnostic, and verification test film consists of the following sections:

1) Reference level
2) Azimuth check
3) Pink noise
4) Frequency response
5) Reference level

4.2 Audio record

4.2.1 Track width

The audio record shall be recorded so that it extends from one edge of the film to the other.

4.2.2 Azimuth

The azimuth of the audio records shall be 90° ± 3' to the reference edge of the film.

4.2.3 Distortion

The total harmonic distortion of the recorded reference level tone (5.1) and the frequency response tones (5.4) shall not exceed 0.5%.

4.2.4 Flutter

The weighted peak flutter of the audio record shall not exceed ± 0.1%. Verification of this section shall be made with the film stock to be used for making these test films, and measured in accordance with ANSI S4.3.

4.2.5 Signal identification

Each test section and segment shall be preceded by voice announcements identifying the content at a level whose peak value does not exceed peak level of the frequency series.

4.2.6 Reference level

A 400-Hz sine-wave tone recorded at the type U reference level of 185 nWb/m is provided at the beginning of the test film, and again at the end, as a check for system linearity and freedom from overload.

4.2.7 Frequency response section

4.2.7.1 Frequencies

The audio record on the film shall be a recording which will reproduce at the frequencies specified in 5.4.2 when the linear speed of the film is 24 perforations per second or approximately 36 ft per minute (7.2 in per second or 18.3 cm per second).

4.2.7.2 Selection of frequencies

For measurements and adjustments of frequency response, it has been observed that the mid-frequencies are seldom a problem, but that careful attention is needed at both the low end and the high end to ensure that specified system response is achieved. Accordingly the test film includes the third-octave preferred frequencies for these two end portions of the spectrum. Through the mid-spectrum the selected frequencies have a wider spacing.

Additional frequencies of 14 000 and 16 000 have been added as a convenience in providing more points to define the high end.

4.2.7.3 Duration

The duration of frequency response test segments shall be approximately 10 seconds, except for the 16-kHz tone which shall be approximately 30 seconds for additional azimuth alignment as well as high-frequency equalization adjustment.

5 Test section specifications

5.1 Reference level

A 400-Hz ± 2% sine-wave tone shall be recorded at a flux level of 185 nWb/m ± 10 nWb/m (± 0.5 dB) for a duration of approximately 30 seconds.

5.2 Azimuth

A sine-wave frequency of 12.5 kHz ± 2% shall be recorded ahead of the pink noise section, having an absolute short-circuit flux level of 10.63 nWb/m, for a duration of approximately 30 seconds.

5.3 Pink noise

Pink noise shall be recorded for a duration of approximately 30 seconds. The pink noise test signal shall be recorded at such a level that upon playback there is a low statistical probability of peaks exceeding the peak-to-peak amplitude of the reference level. This condition can be verified by observing the reproduction of the pink noise signal on an oscilloscope connected to the playback preamplifier, and comparing it with the peak-to-peak signal indicated by the reference level. The pink noise shall be so recorded that the short-circuit flux level vs frequency conforms to 5.4.2, as measured in third-octave bands.

5.4 Frequency response

5.4.1 Objectives

The mathematical expression specifying the short circuit flux as a function of frequency has been chosen to maximize the capabilities of the magnetic recording system and to provide a known input to reproducing systems.

With a constant amplitude vs frequency sine-wave signal applied to the input of the recording system, the recorded flux vs frequency shall decrease with increasing frequency along a curve which describes the impedance of the parallel combination of a capacitance and a resistance having a time constant of 70 μs. The curve is the locus of the following equation:

$$L_\Phi (f) \text{ re } 58.50 \text{ nWb/m} = 0.132 - 10 \log_{10} [1 + (2 \pi \tau)^2 f^2] \text{ dB}$$

where L_Φ is the recorded relative short circuit flux in decibels (referred to the operating level of 58.50 nWb/m), f is the frequency in hertz for which L_Φ is computed, τ is a time constant of 70 μs, and 0.132 is a constant calculated to make $L_\Phi = 0$ at the reference frequency of 400 Hz. (A time constant is a shorthand notation, such as illustrated by a frequency response curve, having a shape which results from a time constant of one or more microseconds. This is a convenient way of defining a response curve and is not intended as a recommended electrical circuit.)

Approximate numerical values for the frequencies employed in the test film are given in table 1.

Table 1 – Flux levels and relative levels vs frequency

Frequency (Hz)	Short circuit flux (nWb/m)	Relative level (dB)
400	58.50	0.00
31.5	59.39	+ 0.13
40	59.39	+ 0.13
50	59.38	+ 0.13
80	59.36	+ 0.13
100	59.34	+ 0.12
160	59.25	+ 0.11
400	58.50	0.00
1000	54.37	– 0.64
2500	39.96	– 3.31
4000	29.35	– 5.99
6300	20.16	– 9.25
8000	16.24	– 11.13
10000	13.17	– 12.95
12500	10.63	– 14.81
14000	9.52	– 15.77
16000	8.36	– 16.90
400	185.00	+ 10.00

5.4. 2 Operating level

The frequency response section is referenced to the operating level (i.e., 10 dB below reference level) to avoid possible saturation of the higher frequency signals.

5.4.3 Frequencies

The 400-Hz sine-wave tones for this section shall be recorded at the operating level of 10 dB below the 185 nWb/m reference level (i.e., at 58.50 nWb/m). The other sine-wave tones in the frequency response sequence shall be recorded at the frequencies and short-circuit flux levels specified in table 1 and defined in 5.4.1.

5.5 Reference level

A 400-Hz ± 2% sine-wave tone shall be recorded at a flux level of 185 nWb/m ± 10 nWb/m (± 0.5 dB) for a duration of approximately 30 seconds.

6 Calibration

6.1 Flux levels

6.1.1 400-Hz reference level

The reference level shall be determined by means of the calibrated short-gap ferromagnetic core reproducer technique described in ANSI S4.6.

6.1.2 Frequency response flux levels

Inasmuch as the calibrated gap method of measuring short-circuit flux can only be applied to the longer wavelengths, the flux levels of other signals in the series are determined by comparing the reproduced outputs from a flat amplifier, on an ac voltmeter certified to be true-rms, or average responding rms-calibrated, and having a frequency response of ± 0.1 dB over a minimum frequency range of 31.5 Hz to 16 kHz.

6.2 Corrections for wide tracks

When a magnetic recording is reproduced by a head that is narrower than the recorded track, the head collects flux in the longer wavelengths, from outside its immediate path. Thus, if in applying 6.1.2 the reproducing head is not full-width, the corrections detailed in ANSI S4.6 must be applied in order not to overestimate the flux levels for the lower frequencies.

6.3 Tolerances

6.3.1 Short circuit flux levels

The flux level at each frequency from 31.5 Hz through 10 kHz shall be within ± 0.50 dB of the value in table 1. The flux level at each frequency from 10 kHz through 16 kHz shall be within ± 1.0 dB of the value in table 1. Measurements shall be made as specified in 6.1.2.

6.3.2 Full-width uniformity of short-circuit flux

The recording shall be monitored and checked for accuracy over a 200-mil area as designated by SMPTE 97.

6.3.3 Tolerances

The frequencies shall be within ± 2% of the values in table 1.

6.3.4 Uniformity within single-frequency test segments

The reproduced level for any test segment shall not vary over the length of that segment by more than ± 0.5 dB, when measured with a standard volume indicator conforming to ANSI/IEEE 152.