American National Standard
for motion-picture film (16-mm)— recording head gaps for two magnetic audio records

Approved February 8, 1984 Secretariat: Society of Motion Picture and Television Engineers

1. Scope

1.1 This standard specifies the lateral positions and width dimensions of the recording heads for two 3.81-mm (0.150-in) magnetic audio records and a control track on 16-mm single-perforated magnetic recording film.

1.2 This standard also specifies the reproducing velocity of the film travel.

2. Reference Documents

The following documents are intended to be used in conjunction with this standard:

ANSI PH22.109-1980, Dimensions for 16-mm Motion-Picture Film Perforated 1R

SMPTE RP 25-1968 (R1978), Sound and Picture Synchronization of Motion-Picture Film Relative to the Universal Leader for Magnetic and Photographic Tracks

3. Audio Record

3.1 The lateral location and width of each magnetic audio record shall be as specified in the figure and table.

3.2 *The recording shall be made so that the* azimuth of each record is at an angle of 90° ± 5′ to the reference edge of the film.

3.3 With the direction of travel as shown in the figure, the magnetic coating shall be on the surface toward the observer.

4. Reproducing Speed

The recording shall be made so that the audio records will reproduce properly at 24 perforations per second (approximately 11m [36 ft] per minute or 183 mm [7.2 in] per second), which is 24 frames per second.

5. Track Usage

5.1 For recording single records, the center track position shall be used. However, for international exchange, interchangeability is facilitated by placing identical information on both tracks.

5.2 *For recording stereo programs, the center* track position shall be used for the left-hand channel.

5.3 For recording two languages, the center track shall be used for the primary language and the edge track position shall be used for the secondary language.

5.4 The control track shall be used for recording other information and for address systems in analog or digital form.

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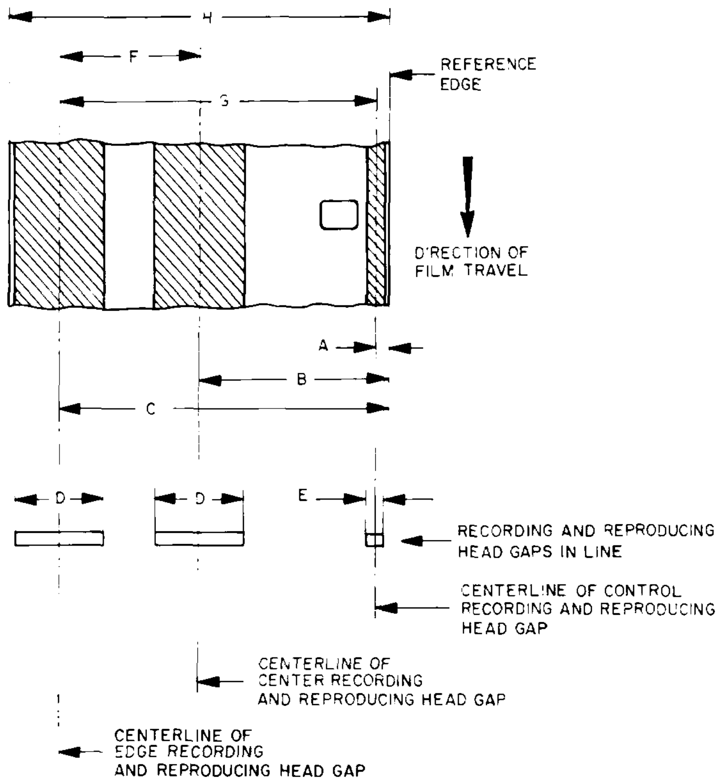

Dimensions	Millimeters	Inches
A	0.46 ± 0.05	0.018 ± 0.002
B	7.95 ± 0.05	0.313 ± 0.002
C	13.89 ± 0.05	0.547 ± 0.002
D	3.81 +0 −0.10	0.150 +0 −0.004
E	0.71 +0 −0.10	0.028 +0 −0.004
F	5.95 nom	0.234 nom
G*	13.45 nom	0.529 nom
H	15.95 ref	0.628 ref

*Dimension G deviates from standard conversion procedures to reflect *the practice in countries using the English system.*

Appendix

(The Appendix is not a part of this American National Standard, but is included for information purposes only.)

A1. Record Width

The width of the recorded area must be measured with great care, as it enters directly into the calculation of flux per unit track width.

When the recording head gap is narrower than the width of the coating or stripe, as is normal for all motion-picture test films, there is a measurement complication involving the uncertainties both in seeing the track and in determining the recording fringing.

If the recording head is available, the track width is best measured indirectly by measuring the gap width and adding to this dimension twice the thickness of the test record magnetic coating. This correction will usually be 0.0003 to 0.0006 in (8 to 15 μm).

If the recording head is unavailable, the recorded record may be made visible by the use of a carbonyl iron suspension. Care should be taken to apply the minimum quantity that makes the recording visible, so that the developed image is not wider than the actual recorded area.

A2. Reproducing Head Gap Width

If precision measurements or calibrations are to be made on magnetic audio records made in accordance with this standard, reproducing head gaps of the same width dimension or wider than the recorded track must be used to prevent edge effects or fringing.

A3. Erase Heads

Erasing head gaps used to erase the records covered in this standard should be substantially wider than the records.

A4. Picture-Sound Synchronization

The film is used for records only. Any accompanying picture is on a separate photographic film. When audio records are intended to be used in synchronization with pictorial material found on a separate film, the picture-sound relationship should be in accordance with SMPTE RP 25-1968.

A5. Magnetic Coating

The dimensions of the magnetic coating are not specified, but it is assumed that the coating is wide enough to permit the placement of the audio records in accordance with this standard.

American National Standard for motion-picture film— 16- and 35-mm variable-area photographic audio records— signal-to-noise ratio

Approved February 8, 1984 | Secretariat: Society of Motion Picture and Television Engineers

1. Scope

This standard specifies a method for measuring the signal-to-noise ratio of 16-mm and 35-mm variable-area photographic audio records.

2. Reference Standards

The following American National Standards are intended to be used in conjunction with this standard:

ANSI PH22.40-1984, Motion-Picture Film (35-mm)—Photographic Audio Records—Release Prints

ANSI PH22.41-1983, Motion-Picture Film (16-mm)—Prints—Photographic Sound Records

3. Definitions

Biased, Unmodulated Audio Record. A variable-area audio record recorded with no input to the photographic audio recorder, but with noise-reduction biasing used in accordance with normal practice for the recorder being used.

Fully-Modulated Audio Record. A variable-area audio record which has an amplitude equal to the maximum amplitude permitted by the applicable standard defining the dimensions of the photographic audio records. (See Sec. 2.)

System Noise. The noise output of the reproducer itself.

Unbiased, Unmodulated Audio Record. A variable-area audio record recorded with no input to the photographic audio recorder, and with no noise-reduction biasing.

Weighting Network. A circuit which alters the frequency response of the measuring apparatus by a prescribed amount to provide agreement between the measured signal-to-noise ratio and the subjective impression of noisiness.

4. Test Method

4.1 Test Track. The test track shall consist of three sections, recorded in sequence at the same lamp-current setting and printed at the same light step.

4.1.1 Section 1 shall consist of an audio record of 1000 Hz recorded at 80% of full modulation and shall serve as the reference signal. The length of this section shall provide about 10 seconds of running time. When reproduced, this section shall have less than 5% harmonic distortion.

4.1.2 Section 2 shall be recorded with an unbiased, unmodulated audio record. The length of this section shall provide about 15 seconds of running time.

4.1.3 Section 3 shall be recorded with a biased, unmodulated audio record. The length of this section shall provide about 15 seconds of running time.

4.2 Test Measurements

4.2.1 The test track described in 4.1 shall be recorded and developed under standard conditions for the system being checked. There shall be sufficient unspliced film ahead of the test track to permit stabilization of printer speed.

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4.2.2 The test track shall be reproduced, and the output of the reproducer shall be measured with the required test apparatus. (See 5.1 through 5.4.) The signal level of Section 1 (the reference signal) shall be measured without the weighting network, and the signal level of Sections 2 and 3 shall be measured with the weighting network. The unbiased, unmodulated signal-to-noise ratio (A), in decibels, shall be calculated as follows:

$$A = 20 \log \frac{V_{s1}}{V_{s2}} - 2 \text{ dB}$$

where V_{s1} is the signal level of Section 1 in volts and V_{s2} is the signal level of Section 2 in volts.

The biased, unmodulated signal-to-noise ratio (B), in decibels, shall be calculated as follows:

$$B = 20 \log \frac{V_{s1}}{V_{s3}} + 2 \text{ dB}$$

where V_{s1} is the signal level of Section 1 in volts and V_{s3} is the signal level of Section 3 in volts.

4.2.3 Following the above measurements, the system noise shall be measured with the required test apparatus with the exciter lamp on, all driving and take-up motors on, and a 0.4 neutral-density filter placed at or near the film plane. The signal-to-system-noise ratio (C), in decibels, shall be calculated as follows:

$$C = 20 \log \frac{V_{s1}}{V_n} + 2 \text{ dB}$$

where V_{s1} is the signal level of Section 1 in volts and V_n is the signal level of system noise in volts.

If the signal-to-system-noise ratio is not at least 10 dB greater than the unbiased, unmodulated signal-to-noise ratio or the biased, unmodulated signal-to-noise ratio, whichever is greater, the system signal-to-noise ratio measurement shall be reported with the audio track signal-to-noise ratios.

5. Test Equipment

5.1 Measuring Devices. Two types of measuring devices may be used:

Type CCIR/ARM consists of a weighting circuit with unity gain at 2000 Hz and an average response voltmeter. The system is described in 5.2.

Type CCIR consists of a weighting network with unity gain at 1000 Hz and a quasi-peak response voltmeter. The system is described in 5.3.

Type CCIR measurements should be made when the system to be measured contains significant amounts of impulse noise. The readings made on the two measuring systems are generally different and cannot be compared. The type of measurement used shall be stated when giving the result.

5.2 CCIR/ARM Measuring Apparatus. An acceptable signal-to-noise measuring apparatus is shown in Fig. 1.

5.2.1 Weighting Network

5.2.1.1 The nominal response of the weighting network shall vary with frequency in accordance with the numerical values shown in the second column of Table 1.

5.2.1.2 The permissible differences between the response curve of the measuring network and the nominal response of the weighting network shall be as shown in the last column of Table 1.

5.2.1.3 The weighting network shall be provided with a means of bypassing or defeating itself.

5.2.2 Voltmeter

5.2.2.1 The CCIR/ARM voltmeter shall provide a voltage indication proportional to the average value of the rectified signal. It shall have sufficient sensitivity so that the noise signals will cause a meter deflection of at least one-third of full scale.

Fig. 1
Measuring Apparatus for Signal-to-Noise Ratio

Table 1
Weighting Curve

Frequency (Hz)	CCIR/ARM Response (dB)	CCIR Response (dB)	Tolerance (dB)
31.5	−35.5	−29.9	±2.00
63.0	−29.5	−23.9	±1.40*
100.0	−25.4	−19.8	±1.00
200.0	−19.4	−13.8	±0.85*
400.0	−13.4	−7.8	±0.70*
800.0	−7.5	−1.9	±0.55*
1000.0	−5.6	0.0	±0.50
2000.0	0.0	+5.6	±0.50*
3150.0	+3.4	+9.0	±0.50*
4000.0	−4.9	+10.5	±0.50*
5000.0	+6.1	+11.7	±0.50
6300.0	+6.6	+12.2	0.00
7100.0	+6.4	+12.0	±0.20*
8000.0	+5.8	+11.4	±0.40*
9000.0	+4.5	+10.1	±0.60*
10 000.0	+2.5	+8.1	±0.80*
12 500.0	−5.6	0.0	±1.20*
14 000.0	−10.9	−5.3	±1.40*
16 000.0	−17.3	−11.7	±1.65*
20 000.0	−27.8	−22.2	±2.00
31 500.0	−48.3	−42.7	−2.80* / −∞

*This tolerance is obtained by linear interpolation on a logarithmic graph on the basis of values specified for the frequencies used to define the mask, i.e., 31.5, 100, 1000, 5000, 6300, and 20 000 Hz.

5.2.2.2 The voltmeter shall be free from excessive overswing, determined as follows: When a 1000-Hz signal is suddenly applied to the input at an amplitude which would give a steady reading of approximately two-thirds of full scale, there shall be less than 0.3 dB momentary excess reading.

5.3 CCIR Measuring Apparatus. An acceptable signal-to-noise measuring apparatus is shown in Fig. 1.

5.3.1 Weighting Network

5.3.1.1 The nominal response of the CCIR weighting network shall vary with frequency in accordance with the numerical values shown in the third column of Table 1.

5.3.1.2 The permissible differences between the response curve of the measuring networks and the nominal response of the weighting network shall be as shown in the last column of Table 1.

5.3.1.3 The weighting network shall be provided with a means of bypassing or defeating itself.

5.3.2 Voltmeter

5.3.2.1 The CCIR voltmeter shall provide a voltage indication proportional to the quasi-peak value of the signal, as follows:

5.3.2.2 The response of the meter to single tone bursts shall be as shown in Table 2. The method of measurement shall be as follows: Single bursts of 5-kHz tone are applied to the input of an amplitude such that the steady signal would give a reading of 80% of full scale. The limits of reading corresponding to each duration of tone burst are given in Table 2.

The tests shall be performed both without adjustment of the attenuators with the readings being observed directly from the instrument scale, and also with the attenuators adjusted for each burst duration to maintain the reading as nearly constant at 80% of full scale as the attenuator steps permit.

Table 2
Single Tone Burst Response

Burst Duration (ms)*	1	2	5	10	20	50	100	200
Amplitude Reference Steady Signal Reading								
(%)	17.0	26.6	40	48	52	59	68	80
(dB)	−15.4	−11.5	−8.0	−6.4	−5.7	−4.6	−3.3	−1.9
Limiting Values								
Lower (%)	13.5	22.4	34	41	44	50	58	68
Limit (dB)	−17.4	−13.0	−9.3	−7.7	−7.1	−6.0	−4.7	−3.3
Upper (%)	21.4	31.6	46	55	60	68	78	92
Limit (dB)	−13.4	−10.0	−6.6	−5.2	−4.4	−3.3	−2.2	−0.7

*The rise- and fall-time of the burst envelope shall be less than 5 µs.

5.3.2.3 Response to Repetitive Tone Bursts. The meter shall respond to repetitive tone bursts as shown in Table 3. The method of measurement is as follows: A series of 5-millisecond bursts of a 5-kHz tone shall be applied to the input at an amplitude such that the steady signal would give a reading of 80% of full scale.

The limits of the reading corresponding to each repetition frequency are given in Table 3. The tests shall be performed without adjustment of the attenuators but the characteristic shall be within tolerance on all ranges.

5.3.2.4 Overload Characteristics. The overload capacity of the measuring set should be more than 20 dB with respect to the maximum indication of the scale at all settings of the attenuators. The term "overload capacity" refers both to the absence of clipping in linear stages and to retention of the law of any logarithmic or similar stage which may be incorporated. Overload capacity shall be measured as follows: Isolated 5-kHz tone bursts of 0.5-millisecond duration are applied to the input at an amplitude giving full-scale reading using the most sensitive range of the instrument. The amplitude of the tone bursts is decreased in steps by a total of 20 dB while the readings are observed to check that they decrease by corresponding steps within an overall tolerance of ± 1 dB. The test is repeated for each range.

5.3.2.5 Reversibility Error. The difference in reading when the polarity of an asymmetric signal is reversed shall not be greater than 0.5 dB, measured as follows: Isolated 1-ms rectangular pulses are applied to the input in the unweighting mode, at an amplitude giving an indication of 80% of full scale. The polarity of the input signal is reversed and the difference in indication is noted.

5.3.2.6 Overswing. The reading device shall be free from excessive overswing, measured as follows: When a 1-kHz tone is suddenly applied to the input at an amplitude which would give a steady reading of 0.775 V or 0 dB, there shall be less than 0.3 dB momentary excess reading.

5.3.2.7 Calibration. The instrument shall be calibrated so that a steady input signal of 1-kHz sine wave at 0.775 V rms, having less than 1% total harmonic distortion, shall give a reading of 0.775 V or 0 dB. The scale should have a calibrated range of at least 20 dB with the indication corresponding to 0.775 V (or 0 dB) between 2 and 10 dB below full scale.

5.4 Test Reproducer. The area of the film scanned by the test reproducer shall be as described in the applicable standard defining the dimensions of the photographic audio records. The test reproducer shall be capable of reproducing all frequencies of a multifrequency test film, as described by the applicable standard, at a uniform level plus or minus 2 dB. If the test reproducer does not meet this criterion, the frequency response of the test reproducer shall be reported along with the signal-to-noise ratios. The meter used for measuring the frequency response of the reproducer shall have no weighting network and shall have either an average response or a true rms meter response.

Table 3
Repetitive Tone-Burst Response

Burst Repetition Frequency	(Hz)	2	10	100
Amplitude Reference Steady Signal Reading	(%)	48	77	97
	(dB)	— 6.4	— 2.3	— 0.25
Limiting Values				
Lower Limit	(%)	43	72	94
	(dB)	— 7.3	— 2.9	— 0.5
Upper Limit	(%)	53	82	100
	(dB)	— 5.5	— 1.7	— 0.0

Appendix

(The Appendix is not a part of this American National Standard, but is included for information purposes only.)

A1. The effective reference signal level used in this standard is a fully-modulated audio record. However, in order to avoid the production of unwanted harmonic distortion and the possibility of uncorrectable overmodulation, 4.1.1 requires that the reference signal be recorded at 80% of full modulation. To bring the effective reference signal level to that of a fully-modulated audio track, 2 dB are then added to the measured signal-to-noise ratio in each of the equations in 4.2.2 and 4.2.3. If the reference signal is recorded at other than 80% of full modulation, a correction factor, computed as follows, should be added to the measured signal-to-noise ratio:

$$C = 20 \log \frac{0.8 \times W_a}{W_r}$$

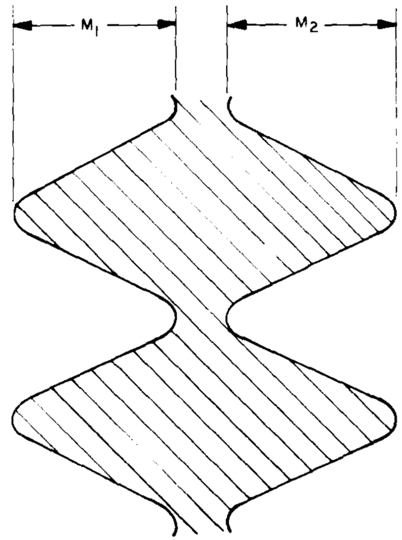
where C is the correction factor in decibels, W_a is the width of the fully-modulated audio record, and W_r is the total modulation width of the reference signal.

The total modulation width of the reference signal is the sum of the modulation amplitudes, as illustrated in Fig. 2, for a bilateral variable-area audio track. The modulation width for a dual-bilateral track is calculated similarly.

A2. It may be desirable sometimes to make a measurement of the system signal-to-noise ratio of a projector or other reproducer without making it in conjunction with a measurement of the signal-to-noise ratio of a particular audio record. In such a case, an appropriate reference signal would be that contained on the applicable signal level test film. If the reference signal is not 80% modulated, a correction factor should be applied as described in A1.

A3. The basic measuring method described in this standard is also applicable to 8-mm Type S photographic audio tracks. However, no standards now exist describing an 8-mm Type S multifrequency or signal level test film; therefore, it is not possible to measure the frequency response as required in 5.4.

A4. The weighting curve for the CCIR/ARM meter, given in column 3 of Table 1, is derived from the weighting characteristic specified in CCIR Recommendation 468-2-1978, Measurement of Audio-Frequency Noise in Sound Broadcasting, in Sound-Recording Systems and on Sound Programme Circuits. It has been modified to have unity gain at 2000 Hz when 5.6 dB are subtracted from the response at each frequency specified in CCIR Recommendation 468-2-1978.



TOTAL MODULATION WIDTH = $M_1 + M_2$

Fig. 2
Modulation Width

A5. The CCIR measuring apparatus described in 5.3 is in agreement with CCIR Recommendation 468-2-1978. The CCIR measuring device described in 5.3 is judged to be the best method for measuring signal-to-noise ratios of photographic audio tracks under all conditions, especially when the noise contains impulsive components.

A6. The CCIR/ARM measuring device described in 5.2 is judged to be effective and useful when the noise signal is uniform and does not contain impulsive components. The CCIR/ARM method has the advantage of being implemented with more readily available equipment.