

SMPTE STANDARD

**for Motion-Picture Film (16-mm) —
Perforated 1R and 2R**



1 Scope

This standard specifies the cutting and perforating dimensions for 16-mm motion-picture film with perforations along one or both edges and a perforation pitch of either 0.2994 in or 0.3000 in (7.605 mm or 7.620 mm) for the following two categories:

- a) 16-mm motion-picture films;
- b) manufacturer-designated 16-mm professional motion-picture camera films with tighter tolerances.

2 Normative reference

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

ANSI/SMPTE 223M-1991, Motion-Picture Film — Safety Film

3 Dimensions

3.1 The dimensions and tolerances shall be as given in table 1 and in the accompanying figures 1, 2, and 3.

3.2 The dimensions pertain to a safety film as defined in ANSI/SMPTE 223M.

3.3 The dimensions apply at the time of cutting and perforating for film adjusted to a temperature of 23°C ± 1°C (nominally converted to 73°F ± 1°F) and a relative humidity of (50 ± 2)%. The manufacturer may indicate other nominal temperature and humidity conditions under which the dimensions apply.

NOTE — The title of this standard was established by the application of a nomenclature system developed for all film dimension standards. Each title provides an indication of the film width, a code designation for the perforation shape (BH, KS, DH, or CS), or the number of rows of perforations (1R, 2R, etc.), depending upon which is the significant factor, or the perforation pitch without the decimal point.

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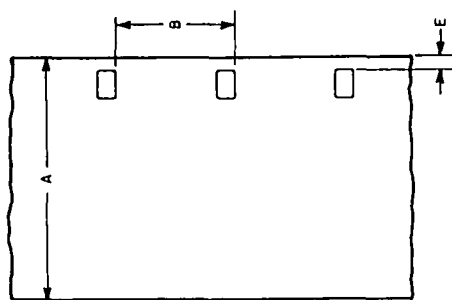


Figure 1 — 16-mm film perforated 1R

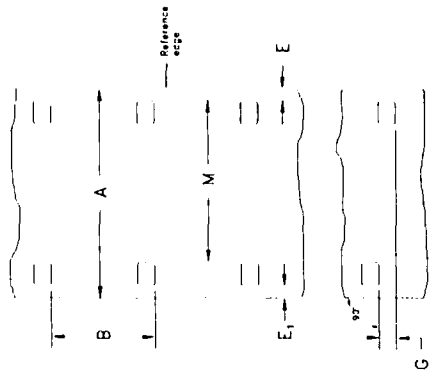


Figure 2 — 16-mm film perforated 2R

Table 1 — Dimensions

| Dimensions | All films | | Notes |
|-------------------|-----------------|---------------------------|--|
| | Inches | Millimeters ¹⁾ | |
| A ²⁾ | 0.628 ± 0.001 | 15.950 ± 0.025 | Designated professional camera films (only dimensions which differ from all films are shown) |
| B ³⁾ | 0.3000 ± 0.0004 | 7.620 ± 0.010 | |
| B ³⁾ | 0.2994 ± 0.0004 | 7.605 ± 0.010 | 5,6 |
| C | 0.0720 ± 0.0004 | 1.830 ± 0.010 | 5 |
| D | 0.0500 ± 0.0004 | 1.270 ± 0.010 | 5 |
| E | 0.0355 ± 0.0020 | 0.900 ± 0.050 | 5,6 |
| E ¹⁾ | 0.0355 ± 0.0020 | 0.900 ± 0.050 | |
| G | 0.001 max | 0.025 max | |
| L ^{3,4)} | 30.00 ± 0.03 | 762.0 ± 0.8 | |
| L ^{3,4)} | 29.94 ± 0.03 | 760.5 ± 0.8 | |
| M | 0.485 ± 0.001 | 12.32 ± 0.03 | |
| R | 0.010 ± 0.001 | 0.25 ± 0.03 | |

NOTES (applicable to all 16-mm films)

- 1 The metric dimensions are chosen to reflect the practice in those countries which use the metric system primarily.
- 2 The metric conversion of dimension A is purposely chosen and shown to three decimal places to prevent the maximum width dimension from exceeding 16 mm.
- 3 Dimensions B and L apply to long perforation pitch; dimensions B' and L' apply to short perforation pitch.
- 4 Dimensions L and L' represent the length of any 100 consecutive perforation intervals.
- 5 The range of values measured in any 50 consecutive perforations shall not exceed 0.0004 in (0.010 mm) for dimensions B, B', C, and D, and 0.0008 in (0.020 mm) for dimension E (see A.3).
- 6 The difference in the dimensional value of B or B' between any consecutive perforation intervals shall not exceed 0.0002 in (0.005 mm). Between consecutive perforations, the difference in the dimensional value of E shall not exceed 0.0004 in (0.010 mm) (see A.3).

SMPTE STANDARD

for Motion-Picture Film —
**35- and 16-mm
Magnetic Audio Records —
Recorded Characteristics**

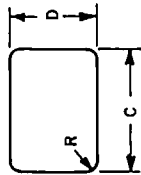


Figure 3 — Perforation for 16-mm film 1R and 2R

**Annex A (informative)
General Information**

A.1 The user is reminded that, as a plastic, film can change dimensions temporarily due to moisture or temperature, or permanently due to solvent loss or strain effect.

A.2 Film for positive use has a longitudinal pitch 0.2% longer than its companion negative. Shrinkage of the negative during processing and aging prior to printing will generally not exceed 0.2%. Thus, the negative stock is expected to be 0.3% ± 0.1% shorter than the positive. This difference will minimize slippage between the two on the 12-in (305-mm) circumference sprocket of the printer, assuming

a film thickness of 0.0055 in to 0.0065 in (0.140 mm to 0.165 mm).

A.3 The uniformity of pitch, hole size, and margin (Dimensions B, C, D, and E) is an important variable affecting steadiness. Variations in these dimensions, from roll to roll, are of little significance compared to variations from one perforation to the next within any small group of consecutive perforations. As an example, the uniformity of the margin is uniquely critical for optical printing.

1 Scope

This standard specifies the recorded characteristics of magnetic records on 35-mm motion-picture film intended for reproduction at 24 frames per second, and on 16-mm motion-picture film intended for reproduction at 24 frames per second. (See notes 1 and 2.)

2 Recorded characteristics

With a constant-amplitude sine-wave signal applied to the input of the recording system, the nominal characteristic of the short circuit magnetic flux versus frequency shall decrease with increasing frequency proportionately to the impedance of a parallel combination of a capacitance and a resistance having the time constant $\tau = 35 \mu\text{s}$ for 35-mm motion-picture film, and the time constant $\tau = 70 \mu\text{s}$ for 16-mm motion-picture film. (See note 3.)

The characteristics defined above are represented by the following equation:

$$L_{\phi} = L_0 - 10 \log_{10} (1 + (2\pi\tau f)^2) \text{ dB}$$

where L_{ϕ} is the recorded relative short circuit magnetic flux level in decibels, f is the frequency in hertz, τ is the time constant described above, and L_0 is a constant calculated to make $L_{\phi} = 0$ at the reference frequency of 1 kHz for 35-mm motion-picture film, and to make $L_{\phi} = 0$ at the reference frequency of 400 Hz for 16-mm motion-picture film:

$$L_0 = \begin{matrix} \text{for 35-mm film} & \text{for 16-mm film} \\ 0.20511 & 0.13238 \end{matrix}$$

Approximate numerical values for each curve are given in table 1.

Table 1 — Recorded characteristics

| Frequency Hz | Relative level, dB | |
|-----------------|--------------------------------|--------------------------------|
| | 35-mm film 35 μs | 16-mm film 70 μs |
| 20 | 0.20 | 0.13 |
| 31.5 | 0.20 | 0.13 |
| 40 | 0.20 | 0.13 |
| 50 | 0.20 | 0.13 |
| 63 | 0.20 | 0.13 |
| 80 | 0.20 | 0.13 |
| 100 | 0.20 | 0.12 |
| 125 | 0.20 | 0.12 |
| 160 | 0.20 | 0.11 |
| 200 | 0.20 | 0.10 |
| 250 | 0.19 | 0.08 |
| 315 | 0.18 | 0.05 |
| 400 | 0.17 | 0.00 |
| 500 | 0.15 | -0.07 |
| 630 | 0.12 | -0.19 |
| 800 | 0.07 | -0.37 |
| 1000 | 0.00 | -0.64 |
| 1250 | -0.11 | -1.01 |
| 1600 | -0.30 | -1.61 |
| 2000 | -0.56 | -2.36 |
| 2500 | -0.94 | -3.31 |
| 3150 | -1.50 | -4.52 |
| 4000 | -2.28 | -5.99 |
| 5000 | -3.24 | -7.53 |
| 6300 | -4.45 | -9.25 |
| 8000 | -5.92 | -11.13 |
| 10000 | -7.46 | -12.95 |
| 12500 | -9.12 | -14.81 |
| 14000 | -10.00 | -15.77 |
| 16000 | -11.06 | -16.90 |
| 20000 | -12.88 | -18.88 |

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3 Tolerances

Magnetic audio records on motion-picture film shall be recorded to the characteristics specified in clause 2 with the tolerances shown in figure 1 for 35-mm magnetic audio records, and with the tolerances shown in figure 2 for 16-mm magnetic audio records.

NOTES

1 The film velocity of 35-mm film is also commonly stated as 18 inches per second or 457 millimeters per second, and historically stated as 90 feet or 27 meters per minute.

2 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.

3 The time constant is only a convenience in defining the desired response curve and is never intended as a recommended electrical circuit.

4 This standard has substantially the same technical content as that of ISO 1188:1984 and ISO 1189:1986.

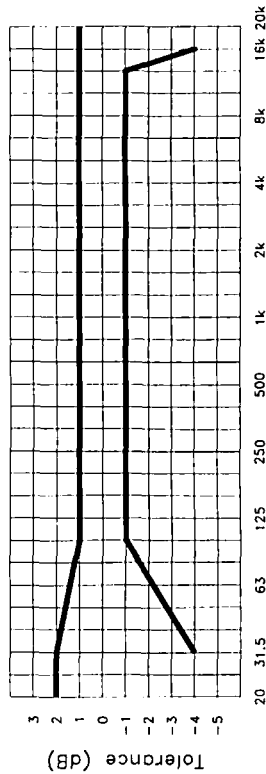


Figure 1 — Tolerance on 35-mm recorded records

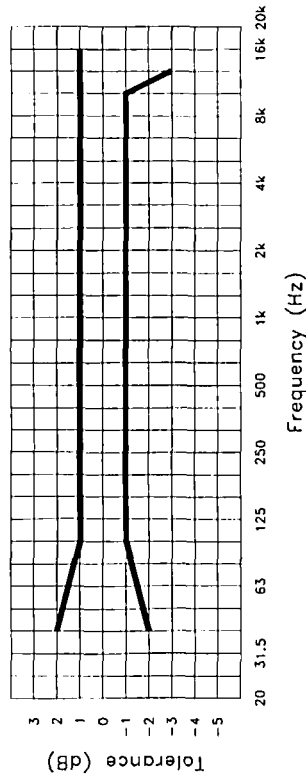


Figure 2 — Tolerance on 16-mm recorded records

**Annex A (informative)
Bibliography**

ISO 1188:1984, Cinematography — Recorded Characteristic for Magnetic Sound on Full-Coat 16 mm Motion-Picture Film — Specifications

ISO 1189:1986, Cinematography — Recorded Characteristic for Magnetic Sound Records on 35 mm Motion-Picture Film Excluding Striped Release Prints — Specifications

SMPTE STANDARD

**for Motion-Picture Film (16-mm) —
Projectable Image Area
and Projector Usage**



3.2 The angle between the horizontal edges of the image area and the reference edge of the film shall be $90^\circ \pm 1/2^\circ$.

4 Relationship to other standards

4.1 This standard may be used as the basis for establishing picture areas from original photography for final viewing because it presents a description of the picture area on the projection print that is usable for the indicated purposes of the print (which is of primary importance because the projection print is the most commonly interchanged item). (See annex A.2.)

2 Normative references

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

ANSI/SMPTE 41-1989, Motion-Picture Film (16-mm) — Photographic Audio Records — Prints

ANSI/SMPTE 112-1989, Motion-Picture Film (16-mm) — 100-Mil Magnetic Audio Record

3 Dimensions

3.1 The dimensions shall be as given in figure 1 and table 1.

5 Emulsion position

For original reversal film, the emulsion side shall be toward the projection lens. For prints, the emulsion position is dependent upon the process of preparation and either emulsion to light source or emulsion to projection lens orientation may be encountered. (See figure 2 and note 5.) The actual emulsion position should be indicated on the leader and the film container by notation or diagram.

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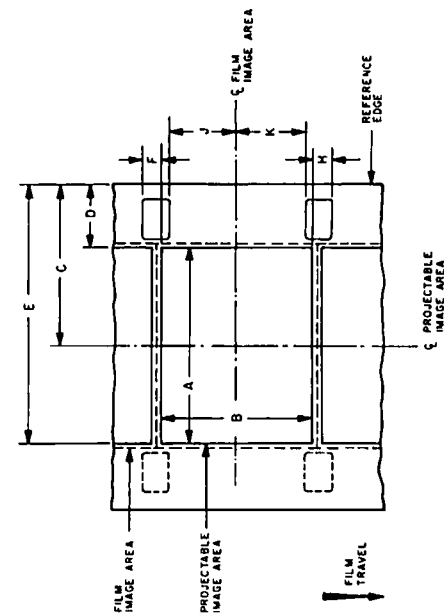


Figure 1 - Projectable image area on film as seen looking through the film toward the lens

Table 1 - Dimensions

| Dimensions | Inches | Millimeters |
|------------|-----------------|-----------------|
| A | 0.380 ref | 9.65 ref |
| B | 0.286 max | 7.26 max |
| C | 0.314 ref | 7.98 ref |
| D | 0.122 min | 3.10 min |
| E | 0.506 max | 12.85 max |
| F = H | within 0.014 | within 0.36 |
| J = K | nominally equal | nominally equal |

6 Projection rate

The standard frame rate for motion-picture projection is 24 frames per second. However, it is recognized that nonstandard frame rates are sometimes used for specific applications. For example: 24, 25, or 30 frames per second may be used for motion pictures intended for television; higher or lower frame rates may be used for special effects and analysis, and nonstandard rates may be used for special motion-picture systems. A rate of 18 frames per second is

often used for amateur silent films. The use of non-standard frame rates requires notification and agreement of all parties concerned with the use of the particular film.

7 Relationship between audio and picture

The projection thread-up for motion-picture films containing an audio record shall place the audio-scanning point ahead (in the direction of film travel) of the center

of the picture being projected. Counting the frame in the projector aperture as zero, the audio-scanning point shall be opposite the center of the 26th frame for photographic audio or the 28th frame for magnetic audio, as specified in ANSI/SMPTE 41 and ANSI/SMPTE 112. If there is a significant distance between the average observer and the loudspeaker when the audio record is reproduced, the distance from the center of the projected aperture to the audio-scanning point may need to be shortened in the projector thread-up to bring the picture and audio into synchronization for the average observer (because of the slower rate of travel of audio compared to that of light). If the average loudspeaker-to-audience distance is greater than 50 ft (15 m), the projector thread-up distance between projected picture and audio scan should be shortened by one frame for each nominal 50 ft of distance from loudspeaker to average audience.

NOTES

1 Camera and printer apertures

The actual image on the film is significantly larger than the maximum area intended for projection, so that in placement of the images throughout the sequence of films, the tolerance is not restrictive of commercial practice. Upper limits have been established through consideration of good practice in avoiding overlap, encroachment upon areas reserved for audio records, flare from perforation edges, etc. Lower limits are similarly related to the avoidance of image effects at a defined edge, tolerances in film positioning, etc.

2 Projector aperture

Dimensions B, D, and E in table 1 define the maximum image area on the film that is available for projection. They do not define the opening in the aperture plate of a projector. The size of this opening may differ from dimensions A and B, for example, because of the physical separation necessary between the aperture plate and the film to avoid scratching the film, or the slant of the marginal rays accepted by the lens.

3 Actual projected area

It is recognized that, in many cases, the actual film image area that is projected may be smaller than the projectable maximum and, in some cases, may be nonrectangular (for example, an irregular four-sided figure bound by either straight or curved lines). Such departures may result from equipment considerations such as slight inconsistencies

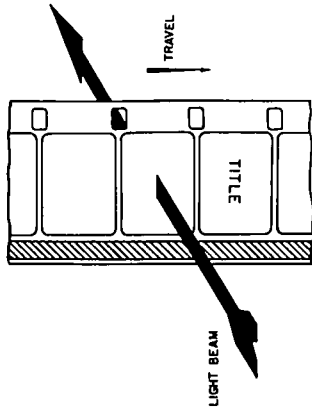


Figure 2 - Film as seen from projector light source looking toward lens

among lenses, screen sizes, etc.; from geometric limitations such as the screen surface being at an angle other than 90° from the projection axis, or being nonplanar, or both; and from aesthetic considerations such as pictorial composition within more restrictive image limits. In the absence of specific instructions to the contrary, it is intended that the actual projected film image area be the largest appropriately-shaped figure that can be inscribed within the specified dimensions.

When the picture outline on the screen is defined by the projector aperture, it is customary to round the corners of the projected film area. A maximum corner radius of 0.020 in (0.51 mm) at the film plane is recommended.

4 Film perforations

Film intended for projection with this image area is normally perforated as specified in SMPTE 109.

5 Contact prints

When a relatively small number of prints is required, contact prints are often made from 16-mm original materials, resulting in the emulsion position toward the light source. The majority of 16-mm release prints are printed by contact from a 16-mm intermediate or by reduction from a 35-mm intermediate in order to protect the originals. The resulting prints generally have the emulsion side toward the projection lens. This permits intercutting of prints and originals without requiring a change of picture or sound focus during projection.