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Cinematography — B-chain electro-acoustic response of motion-picture control rooms and indoor theatres — Specifications and measurements

Réponse électro-acoustique de la chaîne B des salles de contrôle et d'exploitation cinématographique — Spécifications et mesurages

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 2969 was prepared by Technical Committee ISO/TC 36, *Cinematography.*

This second edition cancels and replaces the first edition (ISO 2969 : 1977), of which it constitutes a technical revision.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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Cinematography — B-chain electro-acoustic response of motion-picture control rooms and indoor theatres — Specifications and measurements

0 Introduction

This International Standard shall be used in conjunction with the relevant standards which cover that part of the motion picture sound system from the transducer to the input terminals of the main fader.

1 Scope and field of application

This International Standard specifies the characteristics of the B-chain response of motion-picture studio dubbing theatres, review rooms and indoor theatres. It is intended to assist in the standardization of recording monitor and reproduction characteristics of motion-picture sound in rooms with volumes of at least 150 m^3. It does not apply where the recorded sound is intended for reproduction under domestic listening conditions, i.e. radio and television broadcasting, tape or disk.

This International Standard does not cover the electro-acoustic response characteristic of motion-picture surround or effects loudspeakers, or sub-bass loudspeakers (sub-woofers).

2 References

ISO 140, *Acoustics — Measurement of sound insulation in buildings and of building elements.*

ISO 266, *Acoustics — Preferred frequencies for measurements.*

IEC Publication 651, *Sound level meters.*

3 Definitions

For the purpose of this International Standard, the following definitions apply.

3.1 complete sound reproduction system: A system used (see figure 1) in sound dubbing theatres, review rooms and indoor theatres; by convention consists of an A-chain and a B-chain.

3.2 pre-emphasized sound-track: A conventional photographic sound-track, also known as an academy sound-track, which is intended for playback over normally de-emphasized theatre playback systems.

3.3 wide range sound-track: A photographic sound-track which has been pre-emphasized and is intended for playback over a theatre system whose B-chain has been aligned to curve A of this International Standard.

3.4 A-chain (transducer system): The "A" part of a motion-picture sound system as shown in figure 1, which extends from the transducer to the input terminals of the main fader.

NOTE — It is customary for the A-chain to contain the necessary de-emphasis network for the playback of pre-emphasized sound-tracks. In some theatres part of the de-emphasis characteristic may result from aperture loss. Wide range sound tracks do not require use of a de-emphasis network and aperture loss will normally require correction. In addition, wide range sound tracks may require the use of noise reduction decoding circuitry.

3.5 B-chain (final chain): The "B" part of a motion-picture reproduction system (see figure 1), which extends from the input terminals of the main fader to the listening area of the room or auditorium.

NOTE — Two B-chain characteristics are described in this International Standard: a normal curve typical of current practice, and a wide range curve referred to as curve X.

3.6 electro-acoustic response: The electro-acoustic response of the final chain at a given position is the sound pressure level expressed in decibels with respect to an arbitrary reference pressure over a given frequency range.

Determination of the electro-acoustic response for the entire listening area requires multiple measurements and averaging as described in clauses A.4 and A.5 of the annex.

3.7 pink noise: A continuous spectrum noise having constant energy per constant percentage bandwith, with Gaussian probability distribution of instantaneous values.

3.8 wideband pink noise: Pink noise having a bandwidth exceeding the frequency range of interest, typically extending from 31,5 Hz to at least 12,5 kHz.

4 Method of measurement

4.1 The electro-acoustic response shall be measured with the equipment and instruments arranged in accordance with figure 2 (see clauses A.3, A.4 and A.5 of the annex).

4.2 Sound pressure level measurements shall be taken as follows (see 4.4 and 4.5):

a) in dubbing theatres, at each of the principal listening areas;

b) in review rooms and indoor theatres, at a sufficient number of positions to cover the listening area (see 4.5 and 4.6).

4.2.1 Absolute sound pressure levels shall be measured with a sound level meter conforming to IEC Publication 651 and with C scale weighting, using wideband pink noise as the test signal.

4.2.2 The diffuse field frequency response of the microphone shall be flat within ± 1,5 dB in the range 40 to 10 000 Hz. The free-field frequency response of the microphone for the angle of incidence used during the measurements shall be flat within ± 1,5 dB in the range 50 to 10 000 Hz; consequently, the directivity index of the microphone shall be close to 0 dB in the range 50 to 10 000 Hz.

4.3 In multiple loudspeaker auditoria, the electro-acoustic response of each stage loudspeaker shall be measured individually, and each loudspeaker assembly shall be checked for consistent polarity response (see clause A.6 of the annex). With the same electrical input, normally pink noise, each loudspeaker assembly shall give the equivalent sound pressure level in the auditorium to within ± 1 dB.

4.4 At least five methods of measurement are recognized as providing appropriate data for the evaluation of the electro-acoustic response of the B-chain. These methods, described in 4.4.1 to 4.4.5, depend upon the generation of pink noise from 31,5 Hz to 10 kHz or beyond, and the use of a microphone calibrated in accordance with IEC Publication 651.

4.4.1 Generate wide-band pink noise. Measure the acoustic output with a calibrated microphone intended for use in the diffuse field and a sound-frequency spectrum analyser, covering the spectrum in one-third octave bands.

4.4.2 Generate pink noise in one-third octave bands with preferred central frequencies conforming to ISO 266. Measure the signal input and the sound level meter output with an rms voltmeter and sound level meter complying with IEC Publication 651.

4.4.3 Generate wide-band pink noise. Measure the acoustic output with an rms voltmeter and sound level meter complying with IEC Publication 651, reading acoustic output through a series of one-third octave bandpass filters.

4.4.4 Generate pink noise in octave bands altering the centre frequencies in either 1/1- or 1/3-octave steps. Measure the acoustic output with a sound level meter as described in 4.4.2.

This procedure using full octave bands requires that tolerances on the B-chain electro-acoustic response curve be reduced as noted in table 1.

4.4.5 Generate pink noise as described in 4.4.1, 4.4.2 or 4.4.4, then, with a calibrated microphone intended for use in the diffuse field, and a precision tape recorder, record the microphone output for each frequency band, where applicable, and for each measurement position. Reproduce and analyse the results at a subsequent time, in an appropriate laboratory, using one of the methods described above.

4.4.6 The sound pressure level within each one-third octave band should be at least 10 dB above both the background acoustic noise level and the instrumentation noise in that band. If it is not, but has a 4 dB or better signal-to-noise ratio, then the measurement shall be corrected according to the method described in ISO 140. If the signal-to-noise ratio is less than 4 dB, the measurement for this band is invalid.

The pink noise shall not be so loud as to risk loudspeaker damage or to reach power amplifier saturation. A typical single loudspeaker auditorium wideband sound pressure level using pink noise is 85 dB(C).

4.5 microphone position: The microphone shall not be placed closer than 1,5 m from the side or rear walls of the auditorium, and not closer to the screen than 25 % of the distance to the rear wall. It shall be mounted at normal seated head height and at a minimum of 15 cm above the top of the seat back.

To obtain a valid representation of the acoustic response throughout the listening area, it is suggested that at least three positions be averaged when employing whole octave bands and at least five positions when employing one-third octave bands. In balcony houses representative measurements shall also be made in the balcony.

Care should be taken that none of the microphone positions chosen are unusual. Positions should be avoided which are exactly on lateral or transverse theatre centrelines, or under the lip of a balcony.

4.6 averaging: If the variations among the sound pressure levels at the different measuring positions are small, not exceeding 4 dB, the arithmetic mean of the individual sound pressure levels in decibels can be made. If the variations exceed 4 dB, the procedures for averaging described in ISO 140 shall be followed.

5 Characteristics

The electro-acoustic response of the B-chain shall be within the tolerance of curve N given in table 1 and shown in figure 3. This response is satisfactory for record monitoring and playback of conventionally pre-emphasized sound tracks. The curve X and its tolerance, shown in figure 4, is required for recording monitoring and playback of wide-range sound tracks.

NOTE — Care should be taken that deviations from the curve though within the tolerance area, do not cause a tonal imbalance; for example, a situation where bass responses were all positive and treble responses negative should be avoided.

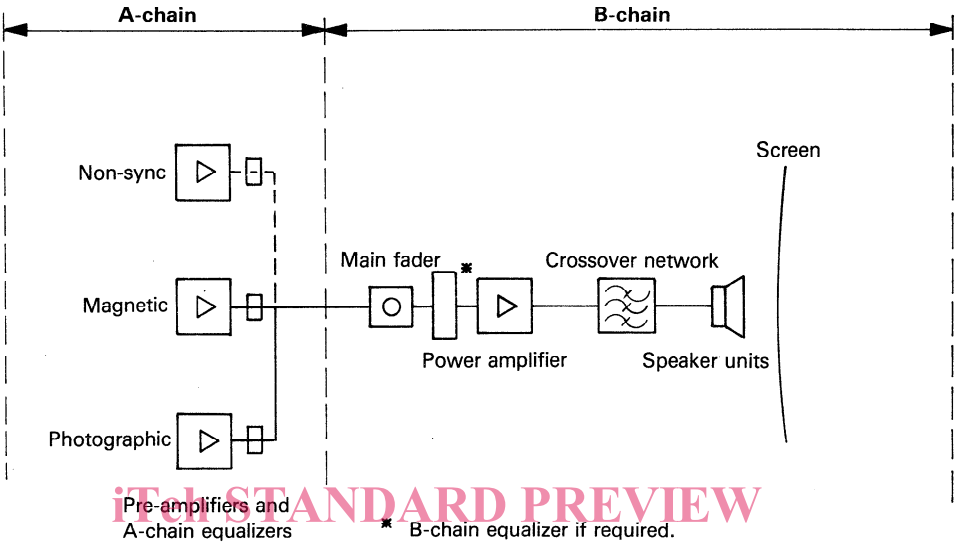

Figure 1 — Complete theatrical sound reproducing system

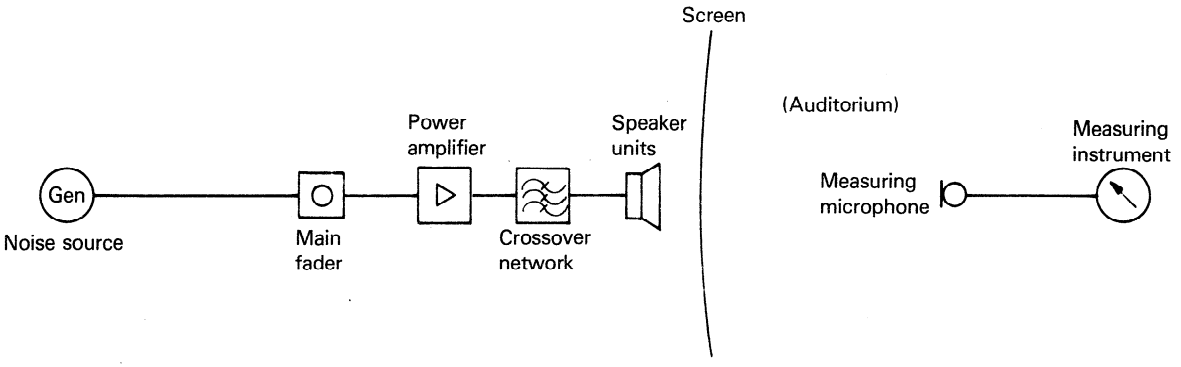

Figure 2 — Method of measurement of B-chain

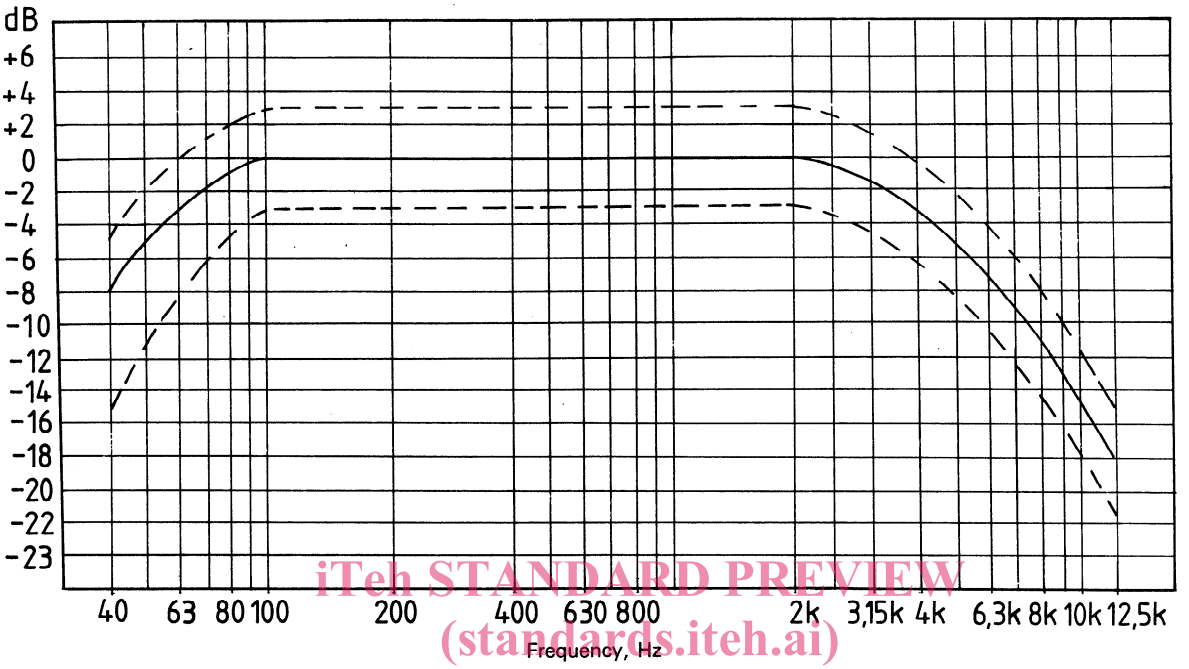

Figure 3 — Curve N of B-chain characteristic

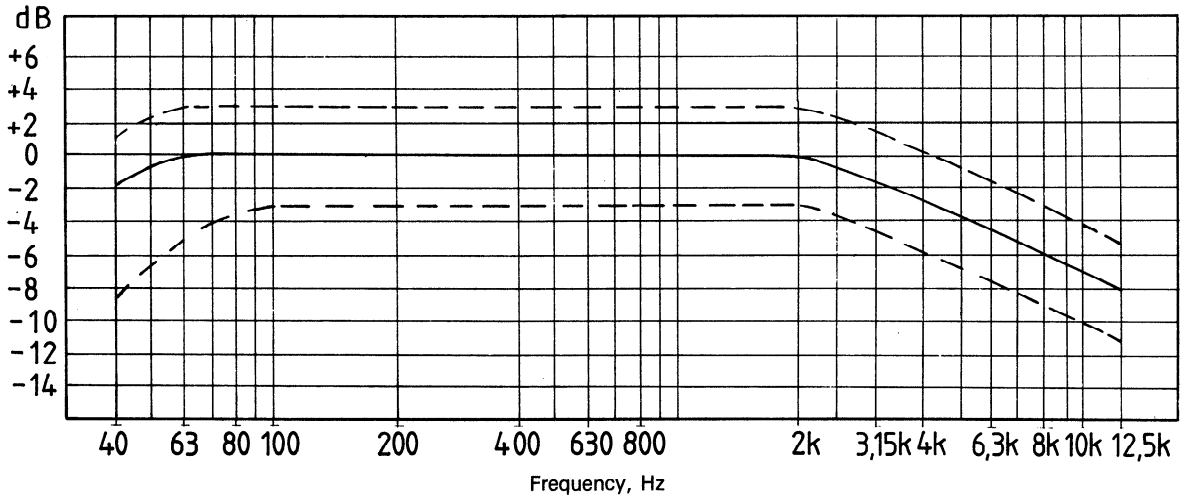

Figure 4 — Curve X of B-chain characteristic

Table 1 — Characteristics of the B-chain

Central frequency of one-third octave band	Characteristics		Tolerances*	
	Curve N	Curve X		
Hz	dB		dB +	dB −
40	−8	−2	3	7
50	−6	−1	3	6
63	−3	0	3	5
80	−1	0	3	4
100	0	0	3	3
125	0	0	3	3
160	0	0	3	3
200	0	0	3	3
250	0	0	3	3
315	0	0	3	3
400	0	0	3	3
500	0	0	3	3
630	0	0	3	3
800	0	0	3	3
1 000	0	0	3	3
1 250	0	0	3	3
1 600	0	0	3	3
2 000	0	0	3	3
2 500	−1	−1	3	3
3 150	−2	−2	3	3
4 000	−3	−3	3	3
5 000	−5	−4	3	3
6 300	−8	−5	3	3
8 000	−11	−6	3	3
10 000	−14	−7	3	3
12 500	−18	−8	3	3

* Tolerances are based on 1/3 octave measurements. If 1/1 octave measurements are used, reduce the tolerance by 1 dB.

6 Bibliography

ISO 1189, *Cinematography — Recorded characteristic for magnetic sound record on* 35 mm *motion-picture film — Specifications.*

ISO 7831, *Cinematography — Photographic sound records on* 35 mm *motion-picture film — Audio reproduction characteristics.*

ISO 8622, *Cinematography — Magnetic sound records on* 35 mm *and* 70 mm *striped prints — A-chain reproduction characteristics.*

Annex

Additional data

(This annex does not form part of this Standard.)

A.1 This International Standard refers to the B-chain (final chain), which embraces the reproduction equipment as shown in figure 1 and the listening area or auditorium.

It is emphasized that in practice, the satisfactory reproduction of sound in a listening room or auditorium is also dependent upon the alignment and performance of the A-chain (see figure 1) of the installation. It is therefore essential that the A-chain be correctly aligned with the tolerances of appropriate standards by the use of the appropriate photographic or magnetic test film and, where applicable, the appropriate de-emphasis applied. When magnetic masters are being mixed for release as pre-emphasized sound tracks, it is necessary to add the relevant A-chain characteristic to the B-chain monitor characteristic.

A.2 It is recommended that preliminary checks are made for gross acoustic errors prior to measuring the electro-acoustic response as described in this International Standard. Typical checks include

— verification that the loudspeaker being measured is close enough to the screen to avoid any behind screen echos;

— there is no interference from masking or curtains;

— a quick verification that the loudspeaker distribution is sufficiently smooth throughout the listening room or auditorium.

This latter test can easily be performed by ear if wide-band pink noise is available as a test signal.

A.3 Minor corrections

A.3.1 The perceived electro-acoustic response resulting from a loudspeaker situated behind a motion-picture screen is affected by various factors before the sound is heard by a listener. These include

a) attenuation of high frequencies caused by the screen. With conventional theatre loudspeakers and screens the attenuation will be approximately 3 dB at 8 kHz. The resultant of this effect has automatically been included in the measurement technique described in this International Standard.

b) a room gain reverberation component added to the direct signal. This component will have a frequency response proportional to the reverberation time versus frequency characteristic. It should be noted that as the reverberation takes a finite time to build up, this component will only be measurable with quasi-steady state signals, such as pink noise, or sustained music chords. The reverberation component builds up too slowly to be added to signals of short duration, such as many speech sounds;

c) HF attenuation in the air, proportional to the signal path length.

To take account of b) and c) above, the measured characteristics to maintain a subjectively identical response will differ slightly according to auditorium size. The measured response should have a slightly attenuated high frequency characteristic in a large theatre when compared with table 1 and figures 3 and 4. In the same way, there should be a slightly elevated high frequency response in a small theatre. Corrections for auditorium size are not normally required below 2 kHz, as a result of a more linear reverberation/frequency at mid-frequencies, and the ear's longer integration time at low frequencies. Determination of the above correction factors for a particular auditorium can be deduced from measurement of the reverberation/frequency characteristic (see table 2).

Table 2 — Approximate correction factors for auditorium size, in decibels

Frequency kHz	Number of seats					
	30	150	500	1 000	1 500	2 000
2,0	0	0	0	0	0	1
4,0	1,0	0,5	0	−0,5	−1,0	−1,5
8,0	2,0	1,5	0	−1,0	−2,0	−3,0

NOTE — Particular care should be taken when measuring or equalizing extremely small rooms, as standing waves may make low and mid-frequency averaging techniques unreliable.

A.3.2 Adjustments for humidity: Wherever possible, the electro-acoustic response should be measured with the auditorium's typical operational humidity. If abnormal humidity conditions are present, then corrections can be applied based on the following data. With respect to 1 kHz, the high frequency loss at 10 kHz per 20 m is approximately 4 dB at 20 % humidity, 3 dB at 45 % humidity and 2 dB at 80 % humidity.

A.4 Non-conformity of electro-acoustic response: With an unequalized loudspeaker, the response should conform to the normal characteristics and tolerances given in table 1 and shown in figure 3.

Radical deviations from the characteristics may be caused by one of the following factors:

a) faulty power amplifier;

b) incorrect or faulty loudspeaker performance;

c) incorrect location, orientation or directivity of the loudspeaker;

d) severe acoustical room defects;

e) incorrect adjustment of the loudspeaker cross-over network (relative level of the bass and treble loudspeaker units), or cross-over wiring phase reversal.

Some highfrequency loudspeaker units exhibit more distortion components than others; this may cause a subjective change in the highfrequency response which will not be identified by the methods of test described in this International Standard.

A.5 Adoption of curve X: Adjustment of the electro-acoustic response curve X for record monitoring and playback of wide-range sound tracks will normally require some electrical equalization, typically one-third octave. The following points should be noted:

a) the cross-over network should be adjusted to the smoothest response before equalization is attempted;

b) equalization above 8 kHz should not be attempted with normal theatre loudspeakers;

c) equalization of room node aberrations below approximately 100 Hz should be avoided; these specific room resonances cannot be corrected with one-third octave filters without attenuation or amplification of other frequencies within the same one-third octave passband.

A.6 Multiple loudspeaker polarity: In multiple loudspeaker auditoria, each stage loudspeaker should be individually checked for electro-acoustic response. After measurement, and if possible, equalization, a full bandwidth pink noise test signal can be sent to combinations of loudspeakers (L and C, L and R, C and R) as a simple verification of consistent loudspeaker polarity.