RP 200-2002
Revision of RP 200-1999

SMPTE RECOMMENDED PRACTICE

Relative and Absolute Sound Pressure Levels for Motion-Picture Multichannel Sound Systems — Applicable for Analog Photographic Film Audio, Digital Photographic Film Audio and D-Cinema

1 Scope

This practice specifies the measurement methods and wide-band sound pressure levels for motion-picture dubbing theatres, review rooms, and indoor theatres. Together with SMPTE 202M, it is intended to assist in standardization of reproduction of motion-picture sound in such rooms.

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.

SMPTE 202M-1998, Dubbing Theatres, Review Rooms and Indoor Theaters — B-Chain Electroacoustic Response

IEC 60268-17 (1990-10), Sound System Equipment — Part 17: Standard Volume Indicators

3 Definitions

3.1 absolute sound pressure level: The spatially averaged sound pressure level of a single channel of a theatrical sound system measured with broadband pink noise at the *reference electrical level* as a stimulus. The reference level for sound pressure is 20μN/m^2.

3.2 average responding meter: A meter which provides a voltage indication proportional to the average value of the rectified signal, with ballistics as described in IEC 60268-17.

3.3 bass extension: The technique of taking low-frequency information from a film sound-track, processing it, and sending it to a subwoofer, as opposed to an *LFE* channel (see annex A.3).

3.4 B-chain (final chain): That part of a motion-picture sound reproduction system, as shown in figure 1 for a typical film system, commencing at the input terminals of the main fader and terminating in the listening area defined in figure 2 in which sound pressure measurements are taken (see annex A.7).

Approved November 7, 2002

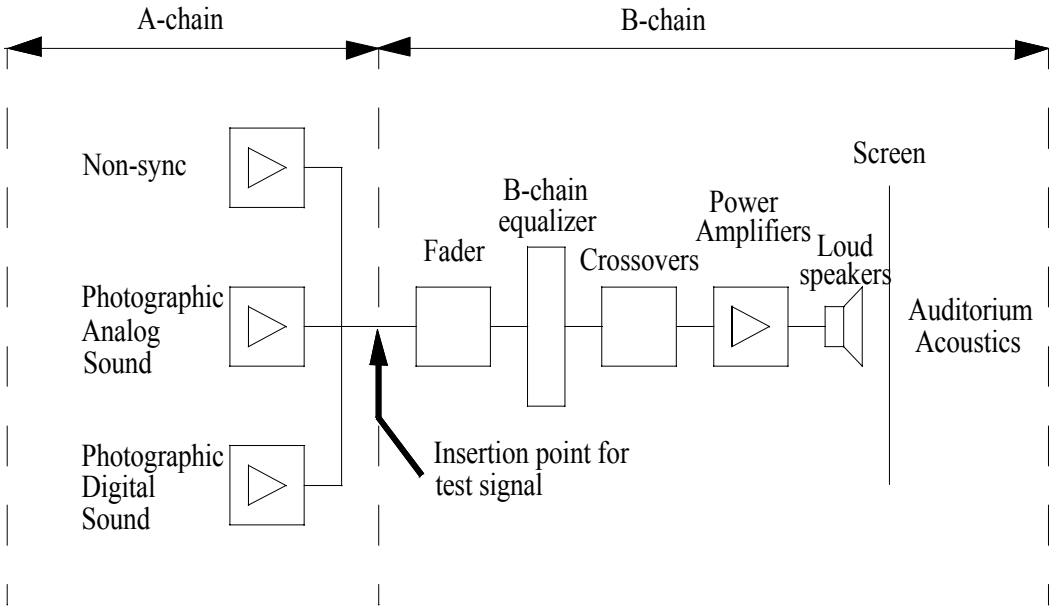

Figure 1 – Complete theatrical sound reproduction system (typical film system – see annex A.7)

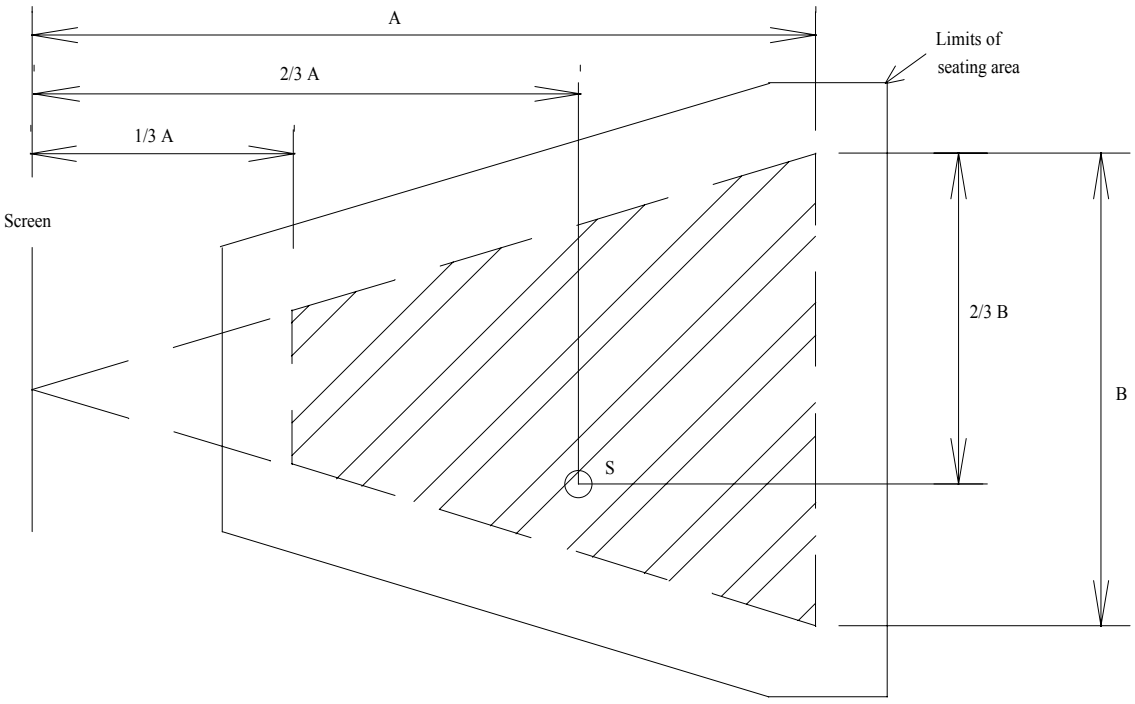

Figure 2 – Plan view of theater auditorium

3.5 electroacoustic response: The electroacoustic response of the B-chain is the spatially averaged frequency response measured in 1/3 octave bands expressed in decibels, as described in SMPTE 202M.

3.6 LFE channel: A discrete low-frequency effects channel, normally having an upper bandwidth between 80 Hz and 125 Hz.

3.7 pink noise: A stochastic signal having a continuous spectrum with equal energy per equal logarithmic interval of frequency, and with a gaussian probability distribution of instantaneous amplitude.

3.8 reference electrical level: The voltage measured by an average responding voltmeter of *wide-band pink noise* using a measurement bandpass filter of 22-Hz to 22-kHz bandwidth when the test signal is at *reference recorded level*, and when the fader is at its normal setting (see annexes A.5 and A.7).

3.9 reference recorded level: The level of pink noise equivalent to 50% modulation on an analog photographic soundtrack, or the equivalent level on a digital photographic soundtrack or a digital cinema (D-Cinema) sound-track (typically in each case 20 dB below 100% modulation).

3.10 relative sound pressure level: In this context, the sound pressure level of one channel when compared with another during reproduction of the wide-band test signal of 3.1, as opposed to the sound pressure level in one frequency range when compared with another.

3.11 wide-band pink noise: Pink noise having a bandwidth exceeding the normal acoustic frequency range. A suitable test signal should have a frequency response flat to within $\pm$ 0.5 dB when measured in 1/3-octave bands with center frequencies from 25 Hz to 20 kHz with an integrating averaging technique.

4 Method of measurement

4.1 Electroacoustic response

The electroacoustic response of each channel should be measured and confirmed to conform to SMPTE 202M before measurement of relative and absolute sound pressure levels.

4.2 Measuring equipment

The sound pressure level of screen and surround channels should be made using a wideband sound level meter set to C-weighting and slow response. The sound pressure level of the subwoofer channel should be made using a third-octave real-time analyzer, or a sound-level meter with a third-octave filter set.

4.3 Test signal

The test signal should be wide-band pink noise, fed into the sound system one channel at a time. The pink noise should be inserted into the system prior to the main fader, or at an equivalent point. The fader should be set to its normal setting (see annexes A.5 and A.7)

4.4 Sound pressure level

The sound pressure level should be measured in at least one position for each screen and surround channel and the measurements for each channel then spatially averaged. If a single location only is selected, it should be position S as shown in figure 2. All measurement locations should be within the normal seating area as shown in the hatched area in figure 2. The subwoofer sound pressure level should be measured in at least four positions and averaged over time intervals of not less than 30 seconds.

4.5 Screen channels

The relative sound pressure level of each screen channel should be within ± 0.5dB of the absolute sound pressure level.

4.6 Surround channel(s)

If there is one single surround channel, then the sound pressure level when playing the test signal should equal that of the absolute sound pressure level. If there are two independent surround channels, left and right, then each should display a sound pressure level such that when they are simultaneously fed the same in-phase test signal the sum should equal the absolute sound pressure level. For two surround channel systems, the individual sound pressure level for each channel will usually be 3dB below the absolute sound pressure level (see annex A.8). This procedure will ensure compatibility for theatres with fewer surround playback channels where the surround information is combined. With three or more surround channels, the individual channel reproduction levels should be set up to be equal to one channel of a two surround channel system.

4.7 Subwoofer LFE channel, playback of discrete digital photographic soundtrack or D-Cinema soundtrack

The subwoofer channel, when compared with a wide-band screen channel, should show 10 dB of in-band gain when viewed on a real-time analyzer; i.e., the same level in its pass band as the level in the pass band of the screen channel (see figure 3 and annex A.1).

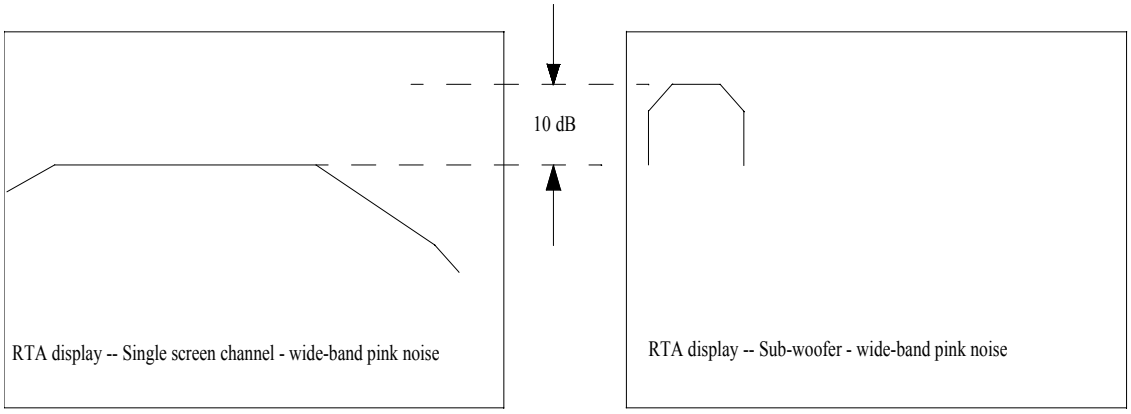

Figure 3 – Measurement of subwoofer sound-pressure level, digital LFE sound-track, using real-time analyzer

4.8 Subwoofer channel, for playback of matrix-encoded analog photographic soundtrack with bass extension playback processing

The bass extension subwoofer channel, when compared with a wide-band screen channel, should show the same level; i.e., should show no in-band gain when viewed on a real-time analyzer (see figure 4 and annexes A.2 and A.3). If the test signal is applied to both the center screen channel and the subwoofer channel simultaneously, the analyzer should show 3 dB of in-band gain in the frequency area common to both transducers.

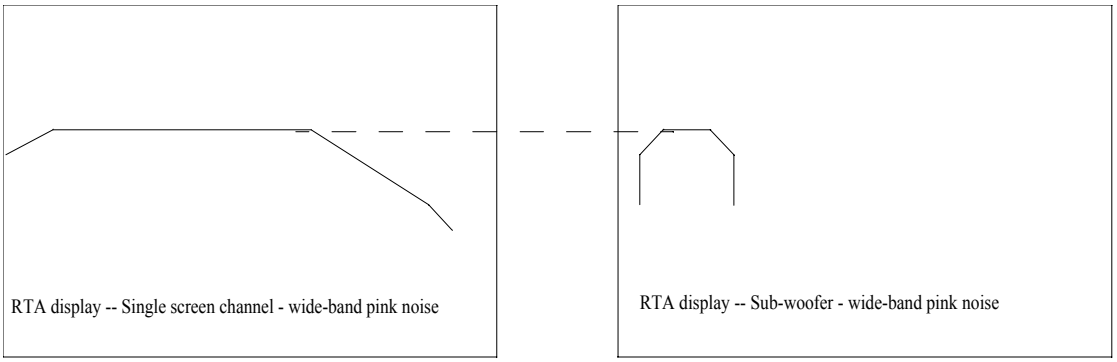

Figure 4 – Measurement of subwoofer sound-pressure level, analog photographic soundtrack with bass extension playback processing, using real-time analyzer

5 Reference level

The recommended reference level, as defined in 3.1 and measured as specified in this practice, should be 85 dBC for normal theatrical operation.

Annex (informative)
General Information

A.1 Subwoofers and sound level meters

While a wideband sound-level meter is suitable for measuring sound pressure levels of screen and surround channels, it is not suitable for measurement of subwoofer levels. The first reason for this is the differing low-pass cut-off of different subwoofers. For example, if pink noise and a sound-level meter were used to set equal levels between one loudspeaker extending to 125 Hz and another extending to 250 Hz, the sound pressure levels in the pass band of each loudspeaker would be significantly different, as shown in figure A.1.

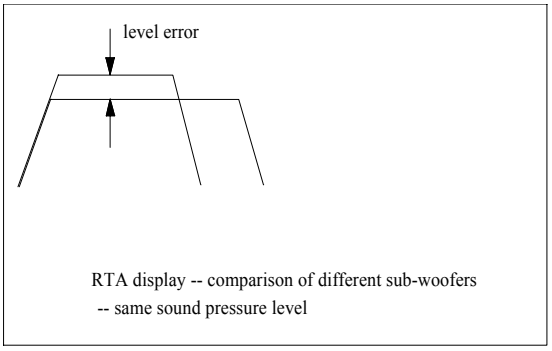

Figure A.1 – Setting sound-pressure levels of subwoofers with sound-level meters can create level ambiguity

A second reason to avoid use of wideband sound-level meters for subwoofer measurement is the loose tolerance at low-frequencies associated with the inexpensive meters typically used.

A sound level meter incorporating a third-octave filter set may provide acceptable results.

A.2 In-band gain

Using a real-time analyzer is the only accurate method of measuring band-limited signal levels. In-band gain is the relative level within the bandpass of interest, as seen on a real-time analyzer display.

A.3 Bass extension

With analog photographic sound-tracks, unwanted noises can occur at very low frequencies, below approximately 50 Hz. Two main causes of these noises are ground noise reduction timing errors causing thumping, and low frequency streaking noise caused by bad print washing. For this reason, some analog processors strip out low-frequency information, and process it to remove low-level unwanted components. This processed output is then sent to a dedicated subwoofer.

A.4 Subwoofer polarity

It is frequently very difficult to determine the best polarity of a subwoofer by conventional methods of checking the speaker cone polarity. The effective phase may change with frequency, especially with a discrete digital subwoofer channel where filter slopes may cause changing phase with frequency. For this reason, it is recommended that subwoofer polarity is evaluated with pink noise sent to center and subwoofer channels simultaneously. The best result should be selected of the two polarities by looking at the resultant combination signal measured with a real-time analyzer. In some cases there may be no apparent signal level change regardless of selected polarity of subwoofer with respect to center front with discrete signals, and in this case optimum polarity should be selected from evaluation of a composite signal through the analog photographic B-chain.

A.5 Fader setting

The vast majority of theatre B-chains have a calibrated fader, which allows the operator to return to a known mark. In many cases, there is a scale ranging from 0 to 10, and fader point 7 is the calibrated setting. This 70% of full-scale allows for a fade to silence, and has some gain in hand for the playback of unusual modulation level program. In a some theatre equipment fader setting “0” is the calibrated setting, with permissible variations to both plus and minus. For all normal film program, the playback level should be at the calibration point, which in turn should result in the reference level as described in clause 5.

A.6 Historical note

Previous versions of this recommended practice were technically correct in describing the test signal level as being equivalent to 60% modulation on an analog photographic soundtrack, and 18 dB below 100% modulation on a digital soundtrack, when measured with a true rms meter. However, field experience shows that practically all users employ average responding meters for measuring level of noise in day-to-day work, including VU meters to IEC 60268-17. This recommended practice recognizes the widely used conventional practice rather than the more technically accurate use of rms derived metering, due to the readily availability of VU and other average meters. These changes represent an effective level difference of approximately 0.6 dB — motion picture theatres set up according to older versions of this recommended practice will play 0.6 dB quieter than theatres set-up according to procedures described in this practice.

A.7 Noise insertion point

While figure 1 shows a typical film system playback layout, in some cases the fader will follow the B-chain equalizer. With a D-Cinema playback, the pink noise should be inserted at an equivalent position prior to the B-chain equalizer, and any non-linear signal processing or decryption after the noise insertion point should be disabled. The fader should always be set at its normal setting (see annex A.5).

A.8 Sum of multiple surround arrays

Theoretically two surround channels carrying the same in-phase signal each at -3 dB below reference level, will generate a sum equal to reference level. In rare cases, however, the required individual levels may be only 2 dB or even 1 dB below reference, or occasionally 4 dB below reference, depending on the number of speakers in each array, the geometry and spacing of the array, and the reverberation time of the theatre.

A.9 Surround level during playback of matrix encoded sound-tracks

Crosstalk in the optical pick-up assembly may reduce the subjective amplitude of surround signals with phase encoded material. For this reason, a subjective test film is sometimes used to make slight subjective adjustments to the analog surround output, after initial alignment according to the procedures described in this practice.