REAFFIRMED 2012

SMPTE STANDARD

SMPTE 211M-2001
Revision of
ANSI/SMPTE 211M-1996

for Motion-Picture Film — 16- and 35-mm Variable-Area Photographic Audio Records — Signal-to-Noise Ratio

1 Scope

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

2 Definitions

2.1 biased, unmodulated audio record: A variable-area audio record with no input to the photographic audio recorder, but with noise-reduction biasing used in accordance with normal practice for the recorder being used.

2.2 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 annex B).

2.3 system noise: The noise output of the reproducer itself.

2.4 unbiased, unmodulated audio record: A variable-area audio record recorded with no input to the photographic audio recorder, and with no noise-reduction biasing.

2.5 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.

3 Test method

3.1 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.

3.1.1 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.

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

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

3.2 Test measurements

3.2.1 The test track described in 3.1 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.

3.2.2 The test track shall be reproduced, and the output of the reproducer shall be measured with the required test apparatus (see 4.1 through 4.4). The signal level of section 1 (the reference signal) shall be measured without the weighting

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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.

3.2.3 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.

4 Test equipment

4.1 Measuring devices

Two types of measuring devices may be used:

Type ITU/ARM consists of a weighting circuit with unity gain at 2000 Hz and an average response voltmeter. The system is described in 4.2.

Type ITU consists of a weighting network with unity gain at 1000 Hz and a quasi-peak response voltmeter. The system is described in 4.3.

Type ITU 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.

4.2 ITU/ARM measuring apparatus

An acceptable signal-to-noise measuring apparatus is shown in figure 1.

4.2.1 Weighting network

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

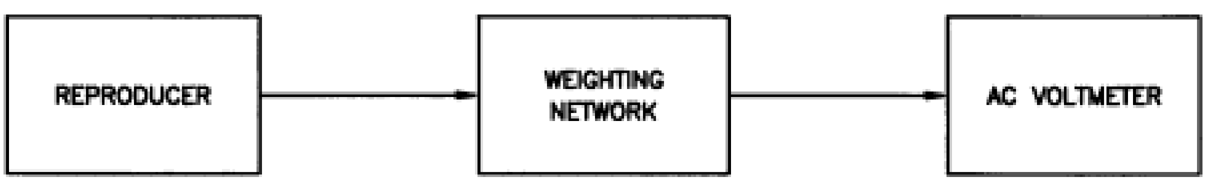

Figure 1 – Measuring apparatus for signal-to-noise ratio

Table 1 – Weighting curve

Frequency (Hz)	ITU/ARM response (dB)	ITU 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	0.0
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.

4.2.1.2 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.

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

4.2.2 Voltmeter

4.2.2.1 The ITU/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.

4.2.2.2 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.

4.3 ITU measuring apparatus

An acceptable signal-to-noise measuring apparatus is shown in figure 1.

4.3.1 Weighting network

4.3.1.1 The nominal response of the ITU weighting network shall vary with frequency in accordance with the numerical values shown in the third column of table 1.

4.3.1.2 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.

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

4.3.2 Voltmeter

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

4.3.2.1 Meter response

The response of the meter to signal 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 fullscale 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.

4.3.2.2 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-ms 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.

4.3.2.3 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-ms 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.

4.3.2.4 Reversibility error

The difference in reading when the polarity of an asymmetric signal is reversed shall not be greater

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

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.

4.3.2.5 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.

4.3.2.6 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 dB and 10 dB below full scale.

4.4 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 ± 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.

Annex A (informative)
Additional data

A.1 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, 3.1.1 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 3.2.2 and 3.2.3. 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 figure A.1, for a bilateral variable-area audio track. The modulation width for a dual-bilateral track is calculated similarly.

A.2 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 A.1.

A.3 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 4.4.

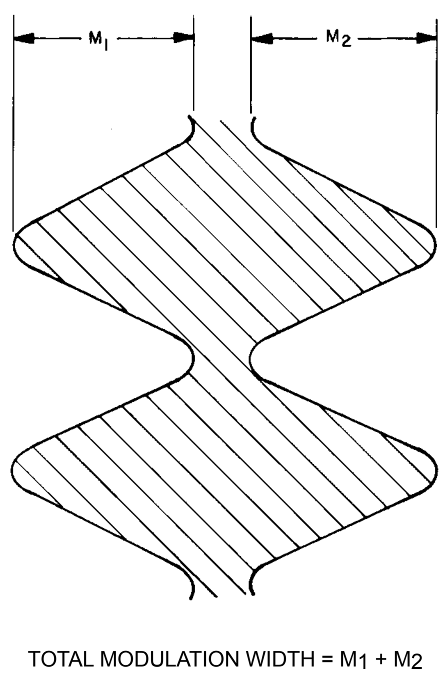

Figure A.1 – Modulation width

A.4 The weighting curve for the ITU/ARM meter, given in column 2 of table 1, is derived from the weighting characteristic specified in ITU-R BS.468. 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 ITU-R BS.468.

A.5 The ITU measuring apparatus described in 4.3 is in agreement with ITU-R BS.468. The ITU measuring device described in 4.3 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.

A.6 The ITU/ARM measuring device described in 4.2 is judged to be effective and useful when the noise signal is uniform and does not contain impulsive components. The ITU/ARM method has the advantage of being implemented with more readily available equipment.

A.7 One possible network for the realization of the weighting characteristic of table 1 is shown in figure A.2. This network is derived from ITU-R BS.468.

A.8 Some voltmeter amplifiers may clip the signal if the noise reading approaches full scale, giving incorrect noise readings. If possible, the noise reading should be made below two-thirds of full scale. Also, in order to increase the accuracy of the measurement, the noise reading should be above one-third of full scale.

A.9 The objective of the measurement in 3.2.3 is to ensure that the noise of the system is at least 10 dB lower than film plus system noise, thus ensuring the integrity of the film signal-to-noise ratio.

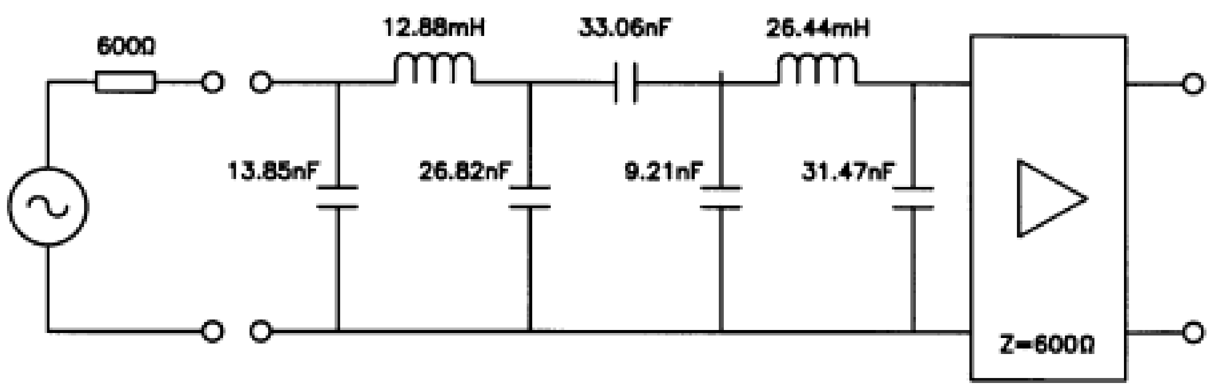

Figure A.2 – Sample weighting network

Annex B (informative)
Bibliography

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SMPTE 41-1999, Motion-Picture Film (16-mm) — Prints — Photographic Audio Records

ITU-R BS.468-4 (07/86), Measurement of Audio-Frequency Noise Voltage Level in Sound Broadcasting