PROPOSED SMPTE STANDARD

for Television —

Transmission of AES-EBU Digital Audio Signals Over Coaxial Cable

1 Scope

This standard describes a point-to-point coaxial cable interface for the transmission of AES-EBU digital audio signals throughout television production and broadcast facilities .

The purpose of this standard is to ensure that a level of compatibility exists between signals generated to this standard and analog video equipment, such as nonclamping distribution amplifiers, switchers, cables, and connectors, as normally used in television applications.

Signals conforming to ANSI S4.40 balanced AES-EBU can be interfaced to signals conforming to this standard through the use of matching networks. Examples of the use of matching networks in conjunction with this standard are provided, for information purposes only, in annex A.

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 S4.40-1992, Digital Audio Engineering — Serial Transmission Format for Two-Channel Linearly Represented Digital Audio Data (AES-3)

IEC 169-8 (1978), R.F. Coaxial Connectors with Inner *Diameter of Outer Conductor* of 6.5 *mm* (0.256 in) with Bayonet Lock – Characteristic Impedance of 50 Ohms (Type BNC), and Appendix A (1993)

3 Transmission format

The transmission channel code and source code shall be as described in ANSI S4.40.

4 Generator characteristics

4.1 The output of the generator shall be measured across a 75-ohm resistive load connected directly to the output.

4.1.1 The generator shall have an unbalanced output circuit with a source impedance of 75 ohms and a return loss greater than 25 dB over the frequency band 0.1 MHz to 6.0 MHz.

4.2 The peak-to-peak signal amplitude shall be 1.0 V ± 10%, when measured across a 75-ohm resistive load.

4.3 The dc offset, as defined by the *midamplitude* point of the signal, shall be nominally 0.0 V ± 50 mV.

4.4 The rise and fall times, determined between the 10% and 90% amplitude points and measured across a 75-ohm resistive load, shall lie between 30 ns and 44 ns.

4.5 Data jitter of the output signal shall comply with ANSI S4.40.

5 Receiver characteristics

5.1 The receiver shall present an impedance of 75 ohms with a return loss greater than 25 dB over the frequency band 0.1 MHz to 6.0 MHz.

5.2 The receiver shall correctly interpret the data when connected directly to a line driver working at the upper voltage limit specified in 4.2.

5.3 The receiver shall correctly interpret the data when the transmitted signal is attenuated to an *eye-height* level of 100 mV, due to cable losses. (See annex A for input sensitivity and interfacing considerations to matching networks [conversion between coaxial and balanced twisted-pair transmission formats].)

6 Equalization

Equalization for transmission cable losses is not usually required. When necessary, equalization shall be provided at the link receiver only.

7 Cable

The interconnecting coaxial cable shall have a nominal characteristic impedance of 75 ohms over the frequency range 0.1 MHz to 6.0 MHz.

8 Connector type

The connector shall have mechanical characteristics conforming to BNC as described in IEC 169-8, but may feature an impedance of 75 ohms.

Annex A (informative)
Matching network interface considerations

A.1 This standard is intended primarily for use in specifying systems operating with unbalanced electrical line drivers and receivers optimized for coaxial cable transmission. Due consideration should be applied when applying the standard to systems featuring matching network passive circuits, such as are commercially available or may be constructed for interfacing balanced 110-Ω circuits to unbalanced 75-Ω circuits. For additional information on this topic, the reader's attention is drawn to AES 3ID.

When integrating coaxial and balanced twisted-pair AES-EBU signals in a television system, the following points should be considered:

A.1.1 Conversion between balanced 110 Ω and unbalanced 75 Ω for use according to this standard

ANSI S4.40 (also referred to as AES-3) provides for an output voltage of a balanced line driver in the range 2 V – 10 V p-p. Note, however, that the 1992 version restricts the maximum p-p voltage to 7 V.

A signal conforming to the 1985 version of the standard, when converted for unbalanced coaxial transmission via a matching network, must then be attenuated by a ratio of between 1:2 and 1:10 in order to conform to 5.2 of this standard (V_{max} = 1.0 V p-p ± 10%). (This restriction is specified to ensure that unbalanced coaxial AES-EBU signals can be routed successfully through nonclamping analog video amplifiers.) The particular value of attenuation is decided by the value of the resistive attenuator portion of the matching network.

NOTE – Precision resistors (1%) should be used to maintain the return-loss specification cited in this standard.

A purely resistive matching network Pi attenuator (figures A.1 and A.2) can be applied, but is incapable of providing a signal attenuation ratio of less than 1:2.6 while maintaining the correct load and source impedance. In this case, if the balanced voltage at the input to the matching network is only 2 V p-p, the unbalanced output voltage will be of the order of 770 mV.

An impedance transformer in series with an unbalanced T resistive attenuator (figures A.3 and A.4) can provide an output of 1 V p-p with an input level from 2 V – 10 V, while providing loop current immunity. Note that multiple transformer isolated matching networks used in a transmission circuit may result in the circuit return loss being degraded outside the specification cited in this standard.

A.1.1.1 Examples of balanced to unbalanced matching networks

Figures A.1 – A.4 are examples of resistive and inductive matching networks that can be applied for conformity to this standard.

A 14-dB attenuator (figures A.1 and A.3) will provide good video equipment compatibility for an AES-EBU signal up to 6 V – 7 V p-p (as per AES-3-1992), while an 18-dB attenuator (figures A.2 and A.4) should provide compatibility for any AES-EBU level up to 10 V p-p (as per AES-3-1985).

In all the examples shown in figures A.1 – A.4, a reduction in long distance transmission capability will result from the attenuation. This is described in table A.1, which is based on the cable attenuation properties of standard coaxial cable performance at 6 MHz (normally characterized as 0.78 dB/100 ft @ 10 MHz).

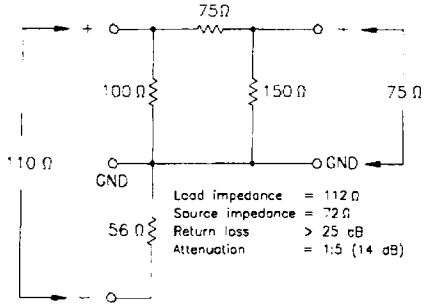

Figure A.1 – 14-dB resistive attenuator

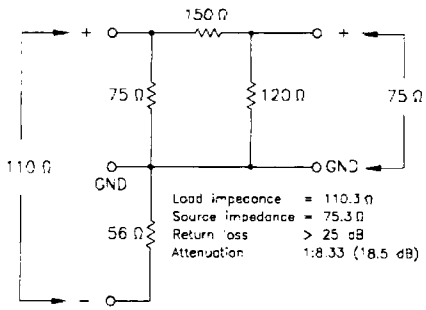

Figure A.2 – 18-dB resistive attenuator

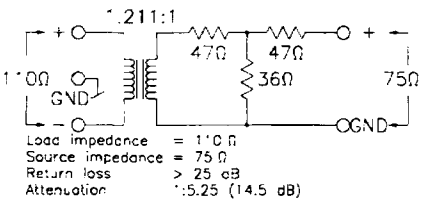

Figure A.3 – 14-dB transformer attenuator

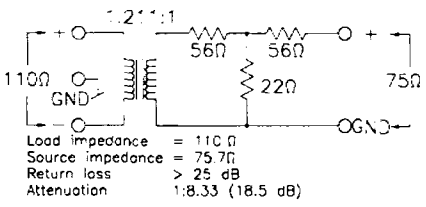

Figure A.4 – 18-dB transformer attenuator

Table A.1 – AES-EBU transmission capabilities of described matching networks

PERFORMANCE (@ 6 MHz)

Eye height	14-dB attenuator		18-dB attenuator	
V_{IN}	VOUT	Dist. (m)[1]	V_{OUT}	Dist. (m)[1]
2.0	0.38	600	0.24	400
5.0	0.95	1000	0.60	750
7.0	1.33	1100	0.84	900
10.0	1.90[2]	1250	1.20	1050

[1] Based on additional (cable) attenuation to a minimum eye height of 100 mV at the input of the coaxial receiver.

[2] *Not compatible with analog video equipment.*

A.1.2 Conversion between unbalanced 75 Ω and balanced *110 Ω for use according to this standard*

The input sensitivity cited in 5.3 of this standard (V_{IN} > 100 mV) is designed to compensate for cable attenuation losses of 20 dB from the nominal output voltage specified in 5.2.

It should be noted, however, that the minimum eye height at the input to an unbalanced to balanced matching network must be higher than this to retain conformity to the minimum eye height of 200 mV at the input of a balanced receiver, as specified in ANSI S4.40.

Using an 'L' resistive matching network (figure A.5), a voltage of 320 mV is required on the 75-Ω input side of the network to render a voltage of 200 mV on the 110-Ω output, in a manner that maintains a sufficient impedance match. As a result, the use of resistive matching networks in circuits designed to feature maximum voltage levels conforming to this standard will result in additional limitations on maximum transmission distances due to cable attenuation.

Using an impedance matching transformer (TR = 1:1.211) (figure A.6) requires a voltage of 165 mV on the 75-Ω input side of the network to render a voltage of 200 mV on the 110-Ω output. This type of circuit then imparts no significant limitation on maximum transmission distances, unlike the resistive network shown in figure A.5.

A.1.2.1 Examples of unbalanced to balanced matching networks

In either of the following cases, a return loss of 25 dB cannot be guaranteed. Note that the resistive matching pad will guarantee a return loss higher than the transformer.

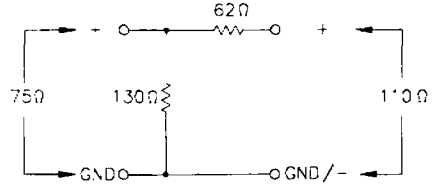

Figure A.5 – Coaxial to balanced resistive matching network

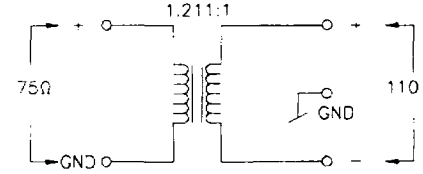

Figure A.6 – Coaxial to balanced transformer matching network

Annex B (informative)
Bibliography

AES 31D. AES Information Document for Digital Audio Engineering — Transmission of AES-3 Formatted Data by Unbalanced Coaxial Cable

PROPOSED SMPTE STANDARD

for Motion-Picture Film — Indoor Theater and Review Room Projection — Screen Luminance and Viewing Conditions

SMPTE 196M
Revision of
ANSI/SMPTE 196M-1993

1 Scope

This standard specifies the screen luminance level, luminance distribution, and spectral distribution (color temperature) of the projection light for theatrical, review-room, and nontheatrical presentation of 16-, 35-, and 70-mm motion-picture prints intended for projection at 24 frames per second. This standard also specifies review-room viewing conditions. It is the purpose of these specifications to achieve the tone scale, contrast, and pictorial quality of the projected print that will be of the quality intended during its production.

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.

SMPTE RP 27.4-1994, Specifications for an Operational Test Pattern for Checking Jitter, Weave and Travel Ghost in Television Projectors

SMPTE RP 95-1994, Installation of Gain Screens

SMPTE RP 98-1990, Measurement of Screen Luminance in Theaters

CIE S002-1986, Colorimetric Observers

3 Projector operating conditions

Measurement of screen luminance shall be made with the projector in normal operation (with shutter running), with its lens set at focus position, but with no film in the aperture. The measurement of spectral distribution (color temperature) of the projection light is best made with the shutter momentarily stopped and held open, and with no film in the aperture.

4 Photometer type

Screen luminance shall be measured with a spot photometer having the spectral luminance response of the standard observer (photopic vision), as defined in CIE S002 (see annex A.4). The acceptance angle of the photometer shall be 2° or less. The photometer response to the alternation of light and dark on the screen shall be to integrate over the range of 24 Hz to 72 Hz and display the arithmetic mean value.

5 Luminance level

5.1 Measurement location

To simulate audience viewing, screen luminance measurements shall be taken from the center of the seating area at a height of approximately 1 m (39 in) above the floor. To ensure reasonable luminance at other seating locations, measurements shall also be taken from the center and each end of the middle row, and shall be within the limits given in 5.3 or 5.4.

5.2 Theater nominal luminance

Theater screen luminance shall be nominally 55 cd/m^2 (16 fL) measured at the screen center. The luminance of the screen sides and corners shall be measured at a distance of 5% of the screen width from the screen edges. The readings shall be taken from each location specified in 5.1.

5.3 Theater luminance limits

Theater screen luminance at the screen center shall be between 41 cd/m^2 (12 fL) and 75 cd/m^2 (22 fL). Luminance at the screen sides shall be 75% to 90% of the screen center luminance, but not less than 34 cd/m^2 (10 fL).

5.4 Review room luminance and limits

Review room screen luminance shall be 55 cd/m^2 ± 7 cd/m^2 (16 fL ± 2 fL) at the screen center. The luminance of the screen sides and corners, measured as described in 5.2, shall be at least 80% of the screen center reading.

6 Luminance distribution

The screen luminance shall be symmetrically distributed about the geometric center of the screen. The luminance of any point on the screen between the center and the edges, as measured from any seat in the middle row, shall not exceed the screen center reading (see annex A.2). For screens with a gain factor of 1.1 or more, the screen shall be curved for light uniformity as described in SMPTE RP 95. A more complete measurement of screen luminance distribution is described in SMPTE RP 98 and is recommended for new or revised installations.

7 Spectral distribution

7.1 For 35- and 70-mm prints, the light reflected from the screen in theaters shall have a spectral distribution approximating that of a blackbody at a color temperature of 5400 K + 600 K – 200K, the use of short-arc xenon light sources being assumed. For review rooms, where color matching is more critical, projectors shall have a chromaticity match, for the same film format, of x = ± 0.002 and y = ± 0.004. For laboratory use in color timing, projectors shall have a chromaticity match of x = ± 0.001 and y = ± 0.002. Typical chromaticity readings would be D_{5500}: x = 0.332 and y = 0.347. Chromaticity measurement requires a precision chromaticity meter, not a color temperature meter.

7.2 16-mm prints are made for projection with either arc or tungsten illuminant. When the intended illuminant cannot be specified uniquely, 16-mm prints should be evaluated at 5400 K.

8 Multiple projector adjustment

8.1 Same format

The resultant luminance from all projectors intended for use in the continuous sequential viewing of material of the same format shall not vary by more than 7 cd/m^2 (2 fL).

8.2 Different formats

The resultant luminance from projectors intended for use in a sequential system of viewing material of different formats shall not vary by more than 14 cd/m^2 (4 fL) (see annex A.5).

8.3 Temperature

The apparent color temperature of the projection light from projectors intended for continuous sequential operation shall be consistent within a total range of 400 K. For 16-mm projection with light sources with a color temperature of less than 3500 K, the range shall be limited to 7% or 200 K.

9 Review room viewing conditions

All observers in a review room shall be located within a standard observing area which shall be:

a) within the limits of a 15° angle on either side of a perpendicular to the center of the screen, in both the horizontal and vertical planes; and

b) at a distance of 3 picture heights ± 1 picture height from the screen.

10 Stray light and contrast

10.1 No stray light or illuminated area with luminance greater than 3.4 cd/m^2 (1.0 fL) shall be visible from the normal observing area of theaters or review rooms.

10.2 Screen luminance due to stray light shall be less than 0.16% (600:1 theater screen contrast ratio) for review rooms and primary theaters. For all other theaters, the luminance due to stray light shall be less than 0.25% (400:1 theater screen contrast ratio).