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), Part 8: R.F. Coaxial Connectors with Inner Diameter of Outer Conductor 6.5 mm (0.256 in) with Bayonet Lock – Characteristic Impedance 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.

American National Standard

Approved
December 1, 1995

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).

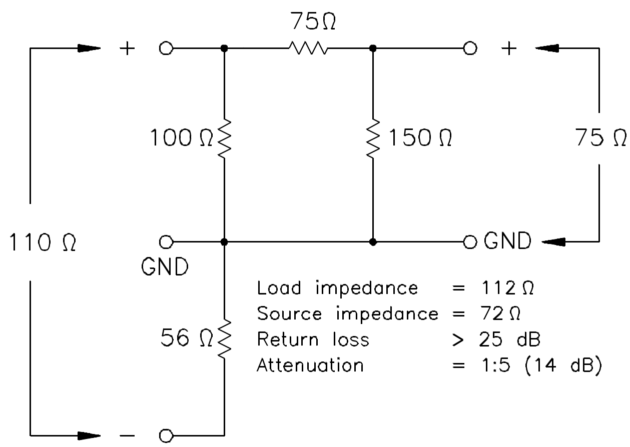

Figure A.1 – 14-dB resistive attenuator

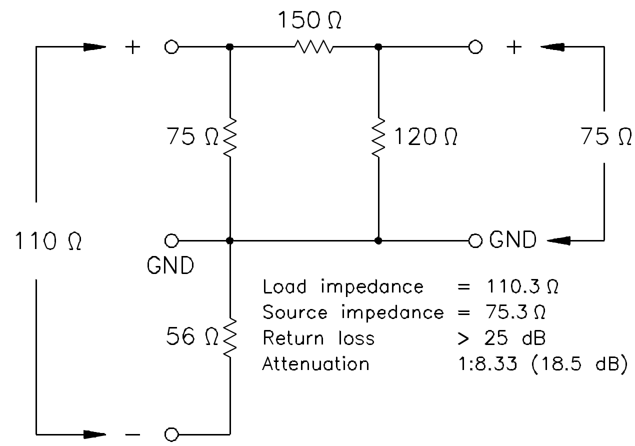

Figure A.2 – 18-dB resistive attenuator

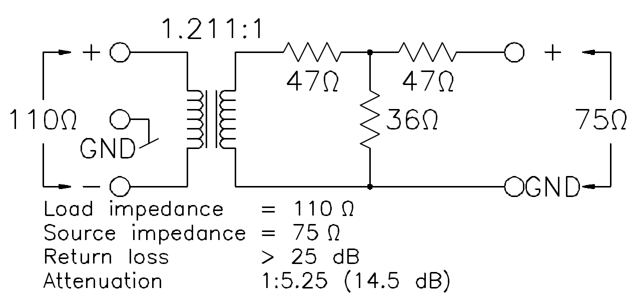

Figure A.3 – 14-dB transformer attenuator

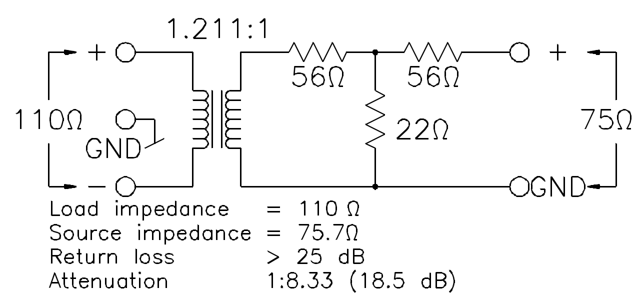

Figure A.4 – 18-dB transformer attenuator

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.

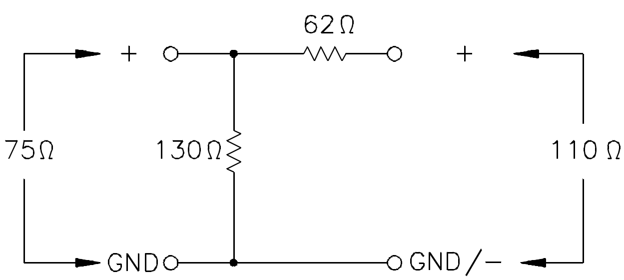

Figure A.5 – Coaxial to balanced resistive matching network

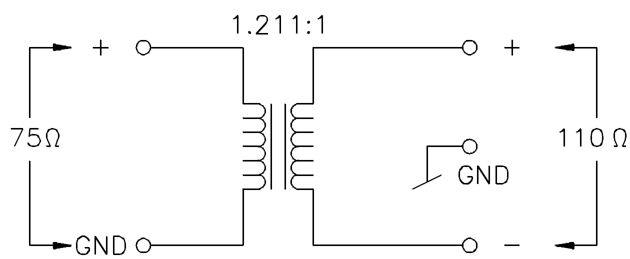

Figure A.6 – Coaxial to balanced transformer matching network

Annex B (informative)
Bibliography

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