EBU Technical Recommendation R50-1998
Conservation of the polarity of audio signals in radio and television production installations

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1. General

In the early days of broadcasting, it was seldom thought necessary to pay attention to the polarity of audio signals, but since the introduction of multi-channel techniques, and in particular stereophony, this has become essential in order to permit the satisfactory combination of signals from different sources. Conservation of polarity on a local basis is easy to achieve in isolation, but the satisfactory interconnection of equipment obtained from the manufacturers that supply an international market requires international standardization. For this reason, the EBU has prepared this Recommendation, which is concerned only with polarity, and not, for example, with the signal levels, impedances or mechanical characteristics of the connections within audio systems.

In order to ensure that the correct polarity is maintained throughout the audio production chain, it is necessary to standardize the polarity of the signals at the various interface points between different items of equipment, in particular from the electrical and the magnetic aspects. Each item of equipment should comply separately with the polarity requirements for the input and output signals.

As it is possible that much existing equipment does not comply with the following recommendation, broadcasting organizations will have to arrange for all equipment to be examined from the point of view of conservation of audio polarity. Equipment that does not conserve polarity can then be modified, or temporarily labelled as "inverting". Ultimately, no equipment incidentally introducing inversion of polarity should remain; if inversion facilities are required for any reason, however, these should be provided in the form of "inverting units", which perform no other function.

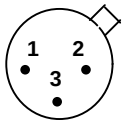
2. Definition of the polarity of audio signals

An audio signal is deemed to be positive when it results from in an increase in the acoustic pressure on the microphone diaphragm, and thus in the displacement of the diaphragm towards the rear. (This corresponds to the definition given in section 10 of IEC Publication 268-2 [1]).

3. Attribution of pins in connectors

Pin number	Attribution
1	Screen*
2	Audio Signal (+)
3	Audio Signal (-)**

Front view of pins



Notes:

* At insertion, this pin makes contact first.

** If the audio signal is unbalanced, pin 3 should be connected to the reference potential.

Fig. 1 – Front view of the male type XLR connector

The attribution of the pins depends on the type of connector.

a) In the case of the type "XLR" connector, which is probably the most widely-used universal type, the attribution of the pins should comply with the arrangement shown in *Fig. 1*, which is in accordance with sections 5 and 6 of IEC Publication 268-12 [2].

A positive audio signal should produce an instantaneous positive voltage on pin 2 with respect to pin 3.

In the case of unbalanced connections, a positive audio signal corresponds to a positive electrical signal with respect to the reference potential (earth).

b) In the case of other types of connector in default of assignments complying with a specific established standard or conventional operating practice, the following rules should be applied in the given order, in the assignment of pins to each pair of conductors intended to carry an AF signal, and the associated screen conductor, if any.

- The pins that is designed to make contact first with the corresponding socket when the two parts of the connector are brought together, or in default of such a pin whichever pin is intended to be used for the screen by the designer of the connector, should be assigned to the screen (if any) enclosing the pair. The pin assigned in this way must not be used for any other purpose. If a screen conductor is required and the foregoing rule is not sufficient to determine which pin should be assigned to it, then the unassigned pin with the lowest number[1] should be assigned to this conductor.
- The lower-numbered pin of a pair intended to carry an AF signal should be assigned to the conductor on which an instantaneous positive voltage with respect to the other conductor of the pair is caused by a positive audio signal as defined in *Section 2* above.
- If a screened pair of conductors is intended to carry an unbalanced AF signal, the conductor that has been assigned the higher pin number should be linked to the screen conductor at the connector.

4. Polarity on magnetic analogue audio tapes

The direction of the magnetisation of the tape corresponding to the presence of an instantaneous positive audio signal should be in the same direction as that of the motion of the tape.

Note: Because it is difficult to apply this specification directly, it is convenient to simulate the presence of such an instantaneous positive audio signal at the playback head by using a wire carrying an asymmetric audio signal at about 1 kHz, temporarily mounted adjacent to the gap as shown in *Fig. 2*.
The specification corresponds to that given in SMPTE Recommended Practice RP134-1986 [3].

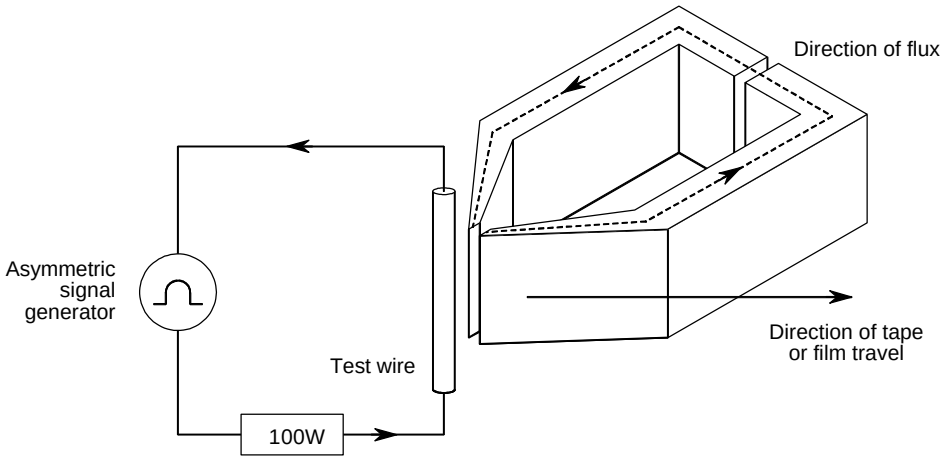


Fig. 2 - Simulation of an instantaneous positive audio signal at the playback head.

1. The expression "lower number" should be understood to mean "letter nearer the beginning of the alphabet" where appropriate. In default of marked numbers or letters, numbers should be assigned to the contacts consecutively from a convenient reference point, such as a notch or a gap in the sequence of contacts, proceeding in a clockwise direction when the plug is viewed from the position of the socket. (This corresponds to the conventional practice in numbering the pins on thermionic valves and integrated circuits.) The contacts in coaxial connectors should be numbered consecutively starting from the outside and those of jack plugs in the following order (so as to ensure compatibility with sections 7 and 8 of IEC Publication 268-12): tip, sleeve (=screen), ring(s) starting with that nearest the tip.

Furthermore, the recording equipment should be designed such that the polarity of AF signals is conserved during their passage through it, from the input connector to all output connectors, both in the operating condition (recording followed by playback, including monitoring) and in the standby condition (the output being fed from the input, possibly through some or all of the signal-processing stages).

Compliance of the playback channel with this convention can be verified most conveniently by means of the playback of a standard test tape recorded with a significantly asymmetric test signal (it is envisaged that further work is required to determine the optimum waveshape for the recorded signal). When the playback channel is known to comply, the recording channel can be verified by means of the application of a similar test AF signal to the recorder input.

5. Polarity of audio tracks on magnetic television tapes

5.1. Longitudinal audio tracks

The polarity specification detailed in *Section 4* above also applies to the audio signals recorded on analogue tracks of television tapes.

Compliance with the specification is especially desirable for stereophonic operation. It is suggested that EBU Members gradually check and align their VTRs to comply, as they become utilised for stereophonic operation.

The EBU Technical Centre is in possession of a few reference tapes, recorded in format B and format C with an asymmetrical sawtooth audio signal of the correct polarity. These tapes can be lent on request to EBU Members wishing to check their in-house polarity test tapes against a common reference.

5.2. FM audio tracks

A positive-going audio base-band signal applied at the input of the recorder should increase the instantaneous FM carrier frequency.

An increase in the instantaneous FM carrier frequency applied to the demodulator should create a positive going audio base-band signal at the output of the recorder.

The polarity of the FM signal at the head/tape interface need not be defined.

6. Sound tracks on film

6.1. Optical sound tracks on release film prints

A positive audio signal shall correspond to increasing optical transmittance of optical sound tracks on release film prints.

Compliance of an optical sound reproducer with this convention can be verified most conveniently by a sudden exposure of the photosensor with light. This shall produce a positive pulse on the audio signal terminal: (+) (e.g. pin 2 with respect to pin 3 in *Section 3a*).

6.2. Magnetic tracks

The polarity specification in *Section 4* above also applies to the audio signals recorded on film magnetic tracks of the COMMAG and SEPMAG types.

Compliance with the specification is especially desirable for stereophonic operation. It is suggested that EBU Members should progressively check and align their telecine and film sound reproduction facilities to comply, when each unit is first used for stereophonic operation.

The EBU Technical Department is in possession of a few perforated magnetic calibration films for 16-mm, 17.5-mm or 35-mm gauges recorded with an asymmetrical sawtooth audio signal of the correct polarity. These films can be lent on request to EBU Members wishing to check their own polarity.

7. Digital systems (at base-band)

A positive audio signal should be represented by a positive number, and a positive-going change in the amplitude of the audio signal should correspond to an increase in the numerical value of the equivalent digital signal. It should be noted that digital systems may be unaffected by the polarity of the interconnections between different items of equipment. However, when the same cables may be used for both analogue and digital connections, the rules for maintaining polarity in analogue cables should be respected.

8. Loudspeakers mounted in enclosures

This definition of polarity refers only to the situation at the connector to the enclosure containing the electroacoustic transducer and the associated electrical circuits, if any. The connectors on enclosures containing loudspeakers should be wired in such a way that the instantaneous presence of a positive AF signal at that connector in accordance with the convention given in *Section 3* above causes an increase in the acoustic pressure at the normal listening position, at frequencies within the pass-band in which the loudspeaker is intended to operate.

It should be noted that the polarity at the connector defined in this way is not necessarily the same as that at the terminals of the electroacoustic transducer itself, which should comply with Section 10 of IEC Publication 268, par 2: "(...) a terminal of a transducer has positive polarity when (...) an instantaneous positive voltage at that terminal produces an outward movement of the diaphragm."

9. Other links in the chain

Arrangements for ensuring the conservation of audio polarity downstream through the distribution network to the transmitter output are under study. It is planned to issue another EBU Recommendation dealing with these arrangements in due course.

Bibliography

[1] IEC Publication 60268: **Sound systems equipment – Part 2** plus Amendment 1**: Explanation of general terms and calculation methods***

[2] IEC Publication 60268: **Sound systems equipment – Part 12** plus Amendments 1 and 2**: Application of connectors for broadcast and similar use***

[3] SMPTE Recommended Practice RP134-1986: **Polarity for analog audio magnetic recording and reproduction**

See also

[4] Stodolsky, DO.S.: **The standardization of monaural phase**
IEEE Transactions on Audio and Electroacoustics, Vol. AU18, September 1970, pp. 288-299.

[5] Vanderkooy, J. and Lipshitz, S.P.: **Polarity and phase standards for analog tape records**
Paper presented at the 69th AES Convention, Los Angeles, 12th to 15th May, 1981 (AES preprint 1795 (D4).

* Note: from 1997 the catalogue numbers of all IEC Publications have been increased by 60 000 to avoid duplication with the numbers of ISO Standards.