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Polarity Calibration Tapes

0 Introduction

These tapes contain a full-track recording of a truncated sawtooth wave recorded in accordance with the specification given by Lipshitz and Vanderkooy in "Polarity Calibration Tape (Issue 2)", published in the *Journal of the Audio Engineering Society*, Vol. 29, Nr. 7/8, pp 528, 530 (1981 July/Aug), and reprinted below. This polarity convention has been adopted by the Audio Engineering Society (AES, § 2.1.1 and 2.1.2, below), the International Electrotechnical Commission (IEC, §2.1.3 below), the European Broadcasting Union (EBU, §2.1.4 below), and the Society of Motion Picture and Television Engineers (SMPTE, §2.1.5 below).

This recording may be reproduced at any speed. The frequency will of course be directly proportional to the reproducing speed. When reproduced at 380 mm/s (15 in/s), the period of the wave is 1 ms, corresponding to a frequency of 1000 Hz.

With these calibration tapes, absolute polarity and consistency of polarity can be determined among magnetic tape reproducers, recorders, and recordings.

See "Choosing and Using MRL Calibration Tapes for Audio Tape Recorder Standardization", MRL Publication Choo&U, for more information on choosing and converting between different equalizations and levels, as well as descriptions of other test signals that are available from MRL, and notes on using Calibration Tapes.

1 Commercial Polarity Practices

The professional magnetic recorder interface is usually via an "XL" connector. Early usage of the "XL" connector by Ampex and others in unbalanced electrical signal interfaces was pin 1 ground and pin 3 signal (pin 2 was variously connected). Since "ground" and "negative" are commonly considered to be synonymous, this means that the old Ampex unbalanced usage from 1950, and the IEC Microphone Standard (the first edition was in 1972) are unfortunately inverse. Note that the Ampex usage *never did* specify the polarity on tape!

Surveys of industry usage have shown that professional magnetic recorders had been about half one way, and half the other, but the majority are now according to the standards.

With balanced electrical interfaces on a magnetic recorder, polarity inversion is "only" a matter of reversing the two signal leads on the input, output, or both, connectors. With unbalanced electrical systems (one signal lead common with the system's power supply), inversion usually requires the addition of an inverting amplifier. In any case, polarity inversion in a large system such as a 24-track tape recorder is not a trivial project.

We suggest that you first measure the polarity of all of your tape recorders and reproducers. If the majority use the "XL" connector and follow the AES Standard (pin 2 positive polarity), follow the AES Standard, and modify any equipment that is inversely polarized. If the majority use the "XL" connector in the inverse polarity (pin 3 positive polarity), you will have to weigh the costs of inversion versus the nicety of

MRL Polarity Calibration Tapes

Tape Width and Housing	Tape Speed *	Duration *	Catalog Number	Price
6.3 mm ¼ in Lube Tape, on Reel	380 mm/s 15 in/s	4 min	140-203-480-107	100 $
6.3 mm ¼ in In Broadcast Cartridge	380 mm/s 15 in/s	2 min (4 min @ 7.5 in/s)	140-203-480-408	140 $
6.3 mm ¼ in Open Reel	380 mm/s 15 in/s	4 min	240-203-480-106	100 $
12.5 mm ½ in Open Reel	380 mm/s 15 in/s	4 min	340-203-480-105	145 $
25 mm 1 in Open Reel	380 mm/s 15 in/s	4 min	440-203-480-104	265 $
50 mm 2 in Open Reel	380 mm/s 15 in/s	4 min	540-203-480-103	375 $

* These tapes are recorded at 380 mm/s (15 in/s), but may be reproduced at any speed.
Prices are in US $, and do not include shipping or applicable taxes. Prices may be changed without notice.

standardization with other studios.

2 Polarity Standards

If you are concerned with polarity, you really need to determine the polarity of each element of your complete system containing microphones, connectors, processing equipment, recording and reproducing equipment, and loudspeakers. This Polarity Calibration Tape will help you to determine the polarity of your magnetic tape recorders. It is consistent with the following standards, and they are all consistent with each other.

2.1 Published Polarity Standards

2.1.1 Audio Engineering Society Standard AES26-2001, "AES Recommended Practice for Professional Audio – Conservation of the Polarity of Audio Signals". Complimentary copy available at http://www.aes.org/publications/standards/courtesy.cfm?ID=28 .

This comprehensive standard includes the following topics:

1 Scope

2 Normative references

3 Definitions

4 General requirements (Normal polarity, Polarity inversion),

5 Contacts in connectors for analog signals (XLR connectors and miniature XLR connectors, Concentric connectors, Connectors for loudspeakers and outputs of power amplifiers)

6 Magnetic analog audio tape (Recorded signal, Recording and reproducing equipment)

7 Audio tracks on magnetic videotapes (Longitudinal audio tracks, Frequency-modulated (FM) audio tracks)

8 Sound tracks on film (Optical sound tracks on release film prints, Magnetic tracks)

9 Digital systems (Interconnections, Linearly represented digital audio data, Incremental modulation systems)

10 Electroacoustical transducers (Loudspeakers, Microphones, Headphones)

11 Mechanical disk records (Monophonic records, Stereophonic records)

Annex A Informative references

2.1.2 Audio Engineering Society Standard AES14-1992 (reaffirmed 2002), "AES Standards for Professional Audio Equipment—Application of Connectors, Part 1, XLR-Type Polarity and Gender". Complimentary copy available at http://www.aes.org/publications/standards/courtesy.cfm?ID=19 . Relates only the acoustic and electric signals to the XLconnector.

2.1.3 IEC Standard 60 268 "Sound System Equipment", various parts and dates, available expensively from http://webstore.iec.ch/webstore/webstore.nsf/$$search?openform . It includes the following topics:

Part 4, Microphones, Sec. 6.1.1.

Part 5, Loudspeakers, Sec. 6.1.

Part 12, Circular Connectors for Broadcast and Similar Use.

2.1.4 EBU Technical Recommendation R50-1988, "Conservation of the Polarity of Audio Signals in Radio and Television Production Installations", available for free download from http://www.ebu.ch/CMSimages/en/tec_text_r50-1998_tcm6-4749.pdf

It includes the following topics:

Definition of the polarity of audio signals

Attribution of pins in connectors

Polarity on magnetic analogue audio tapes

Polarity on magnetic television tapes

Digital systems (at base-band)

Loudspeakers mounted in enclosures

Other links in the chain

2.1.5 Society of Motion Picture and Television Engineers SMPTE Recommended Practice RP 134-1986, "Polarity for Analog Audio Magnetic Recording and Reproduction", available for purchase from http://www.smpte.org/smpte_store/standards/index.cfm?stdtype=rp&scope=0

It includes the following topics:

Scope

Microphone Polarity

Audio Chain Polarity

Recording Polarity

Reproduction Polarity

Loudspeaker Polarity

REPORT OF AN AD HOC MEETING ON THE FORMATION OF AN AES COMMITTEE ON AUDIO POLARITY

Date: 1981 May 12

Place: Los Angeles Hilton Hotel, Los Angeles, CA, USA

Present. John G. (Jay') McKnight (Chairman); Peter Butt; Alastair Heaslett; Richard Heyser; Stanley Lipshitz; Edward Long; Lyman Miller; Daniel Queen; Richard Schumeyer; Stephen Temmer; John Vanderkooy; Ron Wickersham.

An ad hoc meeting was held during the 69th Convention in Los Angeles to consider the formation of an AES Technical Committee on Audio Polarity. The attendees expressed concern that audio polarity is an important audio parameter, and they indicated their interest in active participation in such a technical committee. The goals would be:

1) To summarize and report on existing definitions for reference polarities for all audio systems (electroacoustic transducers, electrical signal connectors, audio records and recording and reproducing equipment, and transmission systems using a modulated carrier), and to develop such definitions where they do not already exist.

2) To summarize and report on measurement systems for these polarities, and to develop them where they do not already exist.

3) To summarize and report on current polarity practices, and to develop recommended practices where they do not already exist.

4) If the above items develop the technical basis for a standard on audio polarity, to establish a standards writing group on audio polarity under this technical committee.

The ad hoc meeting concluded that the formation of a Technical Committee on Audio Polarity is appropriate. Dick Heyser is willing to chair this committee, and Ron Wickersham to be the secretary. Jay McKnight will assist in establishing this committee, and a title, scope, and membership will be submitted to the Technical Council for approval.

Stanley Lipshitz and John Vanderkooy expressed interest in chairing a subcommittee on polarity of magnetic recording systems. They have given a paper at this convention, "Polarity and Phase Standards for Analog Tape Recorders," (preprint nr. 1795), and submitted to this group a proposed measurement method, which is reproduced below.

Ed Long expressed interest in chairing a subcommittee on polarity of mechanical recording (phonograph disk) systems, and will be collecting information on the polarity of reproducing cartridges. The committee plans to meet at the 70th Convention in New York, 1981 October.

John G. (Jay) McKnight
Ad Hoc Meeting Chairman

POLARITY CALIBRATION TAPE (ISSUE 2)

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As described in [1], this 6.3-mm (¼-in) tape consists of a half-track - track, 2-channel recording at 380 mm/s (15 in/s) of the 1-kHz half-wave rectified sawtooth waveform $f(t)$ shown in Fig. 1. This signal was recorded on the tape in *unequalized* form, so as not to introduce any visual phase distortions due to equalizer phase effects. The signal was ac coupled to the record head so as to remove the dc component, and was recorded constant-current such that the positive peaks of the waveform are represented on the tape by magnetization **M** pointing in the direction of normal tape motion. This direction of tape magnetization is the one which we have adopted as "positive," and is in agreement with the standard suggested by Stodolsky [2] in 1970, although some later suggestions [3–5] are equivalent to the opposite standard. The good wave-shape of the recording when replayed in the forward direction on a positive-polarity unequalized reproducer is evident in Fig. 2.

When replayed through a reproducer incorporating replay equalization, the wave-shape is somewhat affected depending upon the replay speed (usable from 95 mm/s to 760 mm/s [3.75 in/s to 30 in/s]), replay equalization (NAB, IEC, etc.) and replay direction (forward/ backward). In all cases, the reproduce polarity is unambiguously determinable due to the asymmetry of the waveform of Fig. 1 under *both* polarity [$f(t) \rightarrow -f(t)$] and time [$f(t) \rightarrow f(-t)$] reversals. Playing the tape backward results in both polarity *and* time reversals [$f(t) \rightarrow -f(-t)$], whereas reversing the direction of the motion without interchanging the reels (as it is possible on some machines with a reverse-play facility) leaves the polarity of the playback signal unchanged [$f(t) \rightarrow f(-t)$]. This implies that a machine which can play back in either direction will require the corresponding tracks to be wired with opposite polarities in order to be polarity-consistent. (For example, on a quarter-track stereo machine, a 4-channel playback head would need tracks 2 and 4 wired with reversed polarity in order to correctly play back these tracks of a quarter-track stereo tape in reverse direction.) The four possible replay output wave-forms are shown in Fig. 3, together with their implications with regard to machine replay polarity and tape motion direction. (These traces were obtained at 380 mm/s with NAB replay equalization.) If the machine displays either of traces shown in Fig. 3(a) or (b) at its in-phase output terminal, it has positive replay polarity relative to this standard. Fig. 3(c) or (d) signify negative replay polarity. (It should be noted that pin 2 is now the accepted international in-phase terminal for XLR-3 connectors [6].)

Once the reproduce polarity of the machine has been ascertained, its record polarity is easily determinable by viewing the replay of a recorded asymmetrical signal (e.g., a half-wave rectified sine wave of around 400 Hz). Note that a recorder can be non-inverting in polarity from "line in" to "line out" via tape, and yet record a reversed-polarity signal on the tape. Furthermore, the polarity of' the "source monitor" function does not always agree with that of tape record-replay in all machines. The machine is judged non-inverting if it has positive replay polarity as determined by the polarity tape and is non-inverting overall on both source and tape monitor.

Since positive-polarity tape magnetization **M** produces an external magnetic field **B** which is backward-pointing (Fig. 4(a)), it can be simulated by the magnetic field surrounding a wire induction loop in which *conventional* current is flowing *upward* (electron current flowing downward), (Fig. 4(b)). If one is facing the heads of a normal, horizontally-mounted transport in which the tape moves from left to right, the situation in relation to the head pole-faces is as shown in Fig. 4. A half-wave rectified sine wave of conventional current (opposite to electron flow) flowing *upward* in such a flux loop held adjacent to the playback head gap should produce positive peaks at the in-phase output terminal if the reproduce

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function is non-inverting. (This is opposite to [3...5].) Such a flux loop may form a convenient means of reproduce polarity determination in the absence of suitable polarity calibration tape.

Polarity effects are audible [7, 8], and the time appears to be ripe to standardize the polarity of analog tape recorders.

REFERENCES

[1] J. Vanderkooy and S. P. Lipshitz, "Polarity and Phase Standards for Analog Tape Recorders," presented at the 69th Convention of the Audio Engineering Society, Los Angeles, 1981 May 12–15, preprint nr. 1795.

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[4] P. Butt, "A Fuss About Plus," *Recording Engineer/Producer,* vol. 10 #6, pp. 66–7 1 (1979 Dec.).

[5] P. Butt, "A Proposed Method for Uniform De termination of Polarity Response of Magnetic Reproducers," presented at the 66th Convention of the Audio Engineering Society, Los Angeles, 1980 May 6–9, preprint nr. 1651.

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[7] H. Suzuki, S. Morita, and T. Shindo, "On the Perception of Phase Distortion," *J. Audio Eng. Soc.,* vol 28, pp. 570–574 (1980 Sept.).

[8] S. P. Lipshitz, M. Pocock, and J. Vanderkooy "Preliminary Results on the Audibility of Midrange Phase Distortion in Audio Systems," presented at the 67th Convention of the Audio Engineering Society, New York, 1980 Oct. 31–Nov. 3, preprint nr. 1714.

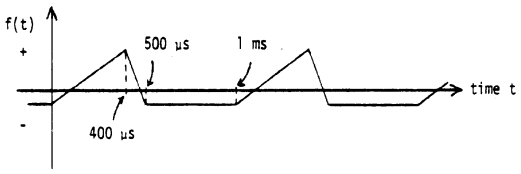


Fig. 1.

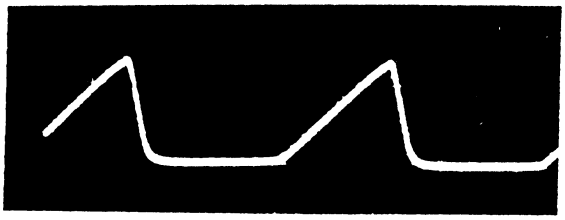
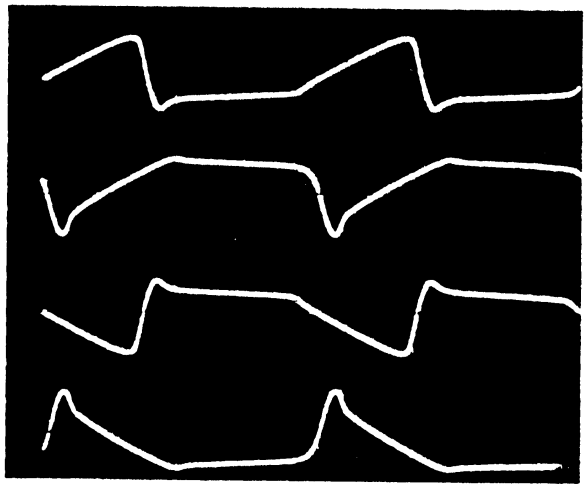
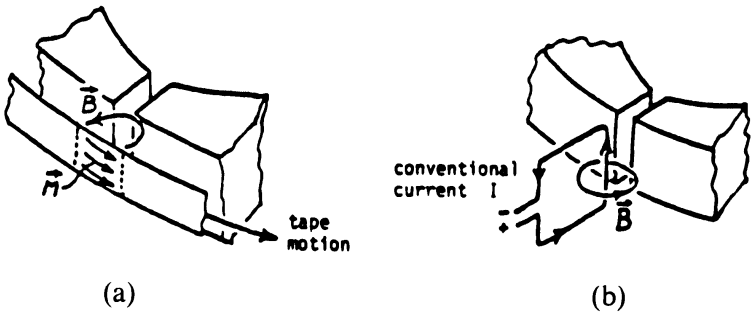


Fig. 2.



	polarity	direction
(a)	positive	forward
(b)	positive	backward
(c)	negative	forward
(d)	negative	backward

Fig. 3.



(a) (b)

Fig. 4.

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