

A Spectulative History of Polarity Standards in Audio

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0 Introduction

Polarity in audio has received some attention recently, but previously it was mostly ignored other than in the AES Standards AES14 and AES26 and the corresponding IEC Standards. Altho the AES Journal has published papers about the audibility of polarity, the engineering community has large ignored it. This paper presents what I can find historically. Practically everything that I say should be preceded by “It appears that...”, since there are very few, if any, authoritative sources. If you are aware of errors, or of standards that I’ve missed, please email me.

When audio devices are connected by a cable (only), with connectors, polarity is trivial – merely connect the corresponding contacts, 1 to 1, 2 to 2, etc. Unfortunately, many other media other than “a cable” are used in practical audio engineering – for instance, magnetic analog audio tape, optical sound tracks on film, digital systems, electroacoustical transducers (microphones and loudspeakers), and mechanical disk records. In each of these cases, the input and output “terminals” must be defined, as well as the meaning of “polarity”, and what constitutes a “positive” signal.

1 History

The earliest common connectors for professional audio were made by Cannon (http://en.wikipedia.org/wiki/ITT_Interconnect_Solutions). The Cannon “P” connector (see Ray Rayburn’s <http://www.soundfirst.com/xlr.html>) was commonly used from perhaps the 1930s, but neither the connector nor its application (contact usage) was formally standardized.

1.1 UA-3 Connector of RETMA TR-118

The earliest standard for polarity that I can find is RETMA (later EIA) Standard “Cable Connectors for Audio Facilities for Radio Broadcasting” TR-118, dated 1949 December. (I have and can email to you all of the standards and papers referenced here.) Altho not mentioned by name, it uses the Cannon UA-3 connectors (see Rayburn), and standardizes its application:

“V. APPLICATION

“A. Program sources such as microphone, reproducing unit, etc., shall be provided with male connectors.

“Explanatory:

Microphone : male connector.

Cable, source end: female connector.

Cable, amplifier end : male connector.

Wall receptacle connected to amplifier: female connector.

Wall receptacle connected to program source: male connector.

“B. The voltage on Contact No. 1 shall be positive with respect to Contact No. 2 for a positive pressure pulse on the microphone diaphragm.

“C When used in an unsymmetrical circuit Contact No. 1 shall be the high side of the unbalanced audio syetem.”

1.2 Loudspeaker Polarity, RS-233

There was also an EIA Standard “Phasing of Receiver Loudspeakers”, RS-233, 1960 Aug.

1.3 Broadcast Microphone Polarity with the UA-3, RS-221

An EIA Standard “Polarization...of Broadcast Microphones”, RS-221, 1959 April, using the connector of TR-118 (the Cannon UA-3). There are definitions of

Microphone,
Polarity,
Inphase and Out-of-Phase terminals of a Microphone Transducer,
Inphase and Out-of-Phase Terminals of a Microphone

and

Marking of Polarity:

| | |
|-----------------------|---|
| Inphase Terminal | 1 |
| Out-of-phase Terminal | 2 |
| Ground Terminal | G |

And there are sections on “Methods of Establishing Polarity” and “Methods of Verifying Polarity”.

1.4 Cannon XLR-3 Connector

Unfortunately, the nicely-standardized connector UA-3 was soon replaced in almost all commercial audio systems by the Cannon “XLR-3” (see Rayburn, above), which is smaller and cheaper. The exact date of introduction is unknown to me, but I know that it was used on the Ampex Model 200A, which was introduced in 1947 or -8, for a balanced (only – no unbalanced) connection . Since, at that time, there was no definition of audio signal polarity of a magnetically recorded signal, and there are now (2014) few if any unmodified Model 200A recorders available to measure, we do not know what the polarity convention was for the Ampex Model 200A.

Unfortunately Cannon only identified the contacts of the XLR-3 by the numbers 1, 2, 3, with no suggested application. Altho unstated by Cannon, pin 1 makes contact first, and so is obviously intended to be “ground”. But which pin to use as “in-polarity” in a balanced connection, and how to make an unbalanced connection, was completely unspecified. And there’s no analogy possible with the Cannon UA-3 connector, since its contacts are G, 1, 2. So polarity was completely unstandardized in the 1940s.

When Ampex introduced the Model 400 around 1950, they again used the Cannon XLR-3 connector for the audio signal connections. The audio input connector could be switched for “microphone” (pins 2 and 3), “balanced bridging” (pins 2 and 3), or “unbalanced bridging” (ground pin 1, signal pin 3)..

Note that altho the Foreword to AES14 says that Ampex used “the pin-2-return, pin-3-positive convention” for balanced bridging, there is *no basis* for saying this. The Ampex 400 Manual only says “pin 1 (ground)” and pin 3 for the signal for unbalanced bridging, and “Connect balanced line to pins 2 and 3 of the input connector.”

The output connection is tied to pins 2 and 3, “floating”, with the comment “If unbalanced output is desired, tie either side of the line to ground.”

2 Device polarity standardization

No polarity convention had been established (or even thought of) for magnetic audio tape recorders in the 1940s, when the XLR-3 was introduced.

So it should be no surprise that, in accordance with Murphey’s Law, the audio industry ended up about half and half, one polarity and the other polarity (however you define polarity).

In the Foreword to AES14, there is an attempt to explain the history of this standardization, as it occurred in the late 1940s. But at that time there was neither a definition nor a measurement for polarity in magnetic recording. So one cannot ascribe any intentional polarity convention to any tape recorder manufacturer – one can only describe what they did, and this requires a measurement of the devices, because schematic diagrams do not give any polarity information.

2.1 Standardization

In 1970, David Stodolsky published a paper [1], and the section “Standarization” proposes definitions for “positive polarity” for several media, including magnetic recording and mechanical disk recording. These definitions have been accepted in modern standards. Another important paper on standardization is that by Vanderkooy and Lipshitz [2], which accepts Stodolsky’s definitions.

REFERENCES

- [1] David Stodolski, “The Standardization of Monaural Phase”, IEEE Trans Audio and Electroacoustics, Vol AU-18, pp 288...299 (1970 Sept).
- [2] John Vanderkooy and Stanley Lipschitz, “Polarity and Phase Standards for Analog Tape Recorders”, AES Preprint 1795, 1981 May.