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AES Information Document for digital audio measurements - Jitter performance specifications

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Abstract

The question of sample-clock quality is a perennial one for digital audio equipment designers, yet most chip makers provide very little information about the jitter performance of their products. Consequently, equipment designers are sometimes caught out by jitter issues. The increasing use of packet-based communications and class-D amplification is throwing these matters into sharper relief. This information document reviews various ways of characterizing and quantifying jitter, and refines several of them for audio purposes. It also attempts to present a common, unambiguous terminology. Its focus includes wideband jitter, baseband jitter, jitter spectra, period jitter, long-term jitter and jitter signatures. Comments are made on jitter transfer through phase-locked loops and on the jitter susceptibility of audio converters.

Audio Engineering Society Inc. 551 Fifth Avenue, New York, NY 10176, US.
www.aes.org/standards standards@aes.org

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Foreword

[This foreword is not part of AES-12id-2006, *AES Information Document for digital audio measurements - Jitter performance specifications*.]

Clock jitter is known to affect the performance of audio electronics. This AES information document specifies appropriate jitter measurement techniques and allows jitter specifications to be compared. Much of the material is based on the AES 117th Convention paper "Specifying the Jitter Performance of Audio Components", authored by Chris Travis of Sonopsis and Paul Lesso of Wolfson Microelectronics. The work described in the paper was supported by Peter Frith of Wolfson Microelectronics, with helpful technical contributions from Anthony Magrath, Bruno Putzeys and Steven Harris. I would like to thank Chris Travis for his work in preparing AES-12id. I would also like to acknowledge all the SC-02-01 committee members who submitted valuable comments.

Steven Harris, Chair, SC-02-01
2006-10-07

Corrigendum: Captions in Figure 10 were editorially amended in the 2007-05-07 printing.

Note on normative language

NOTE: In AES standards documents, sentences containing the word “shall” are requirements for compliance with the document. Sentences containing the verb “should” are strong suggestions (recommendations). Sentences giving permission use the verb “may”. Sentences expressing a possibility use the verb “can”.

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1 Introduction

Clocks tick at the heart of every digital audio product. Jitter on clocks that are applied to audio converters (analog-to-digital and digital-to-analog) can degrade audio performance. To make sense of this situation, designers need a framework for thinking about jitter. To make progress, the industry needs some good ways of characterizing and quantifying jitter performance. It also needs a common and unambiguous terminology. This information document aims to contribute in all of these areas.

2 Overview

The emphasis in this document is on sample clocks and on the clocking chains from which they are derived. It is not on interface-specific aspects of jitter.

We have chosen to focus at this stage on components (for example, semiconductor chips) rather than equipment (for example, mixing desks). Progress with the former will hopefully spawn progress with the latter in due course.

There is much disagreement in the industry on how low jitter must be for its effects to be inaudible [1, 2, 3]. Some of this may be due to the inappropriate use of period jitter as a measure of sample clock quality (3.5.1). Further research is needed in this area. The authors hope that the present document is entirely complementary to work on the audibility of jitter.

Currently, there is little in place that helps equipment designers predict jitter-related performance degradation. This is a problem. For example, the use of conventional phase-locked-loop techniques to lock to timestamps in packet-based audio interfaces can easily produce clocks that are too jittery for use in professional products [4]. Technologies are available that solve the problem, but unless designers know early on that they must use them, redesign may be required. One aim of this document is to help designers avoid such uncertainty and expense.

The core of this document is section 3, which looks at ways of characterizing and quantifying jitter. It refines the wideband and long-term jitter measures for audio use, and introduces a new measure called baseband jitter. It sets out some guidelines for plotting jitter spectra, and unifies the frequency-domain and time-domain views through plots that the authors refer to as jitter signatures. Some numeric examples are included to keep things concrete. Section 4 covers clocking chains and jitter transfer. Section 5 presents a unified qualitative treatment of the jitter susceptibility of audio converters, discussing four distinct aspects. Section 6 re-iterates the key points. Annex A contains a list of technical references. Annex B explores reasons for preferring jitter spectra (s/rtHz) to phase noise spectra (dBc/rtHz), and illustrates the effect of clock division.