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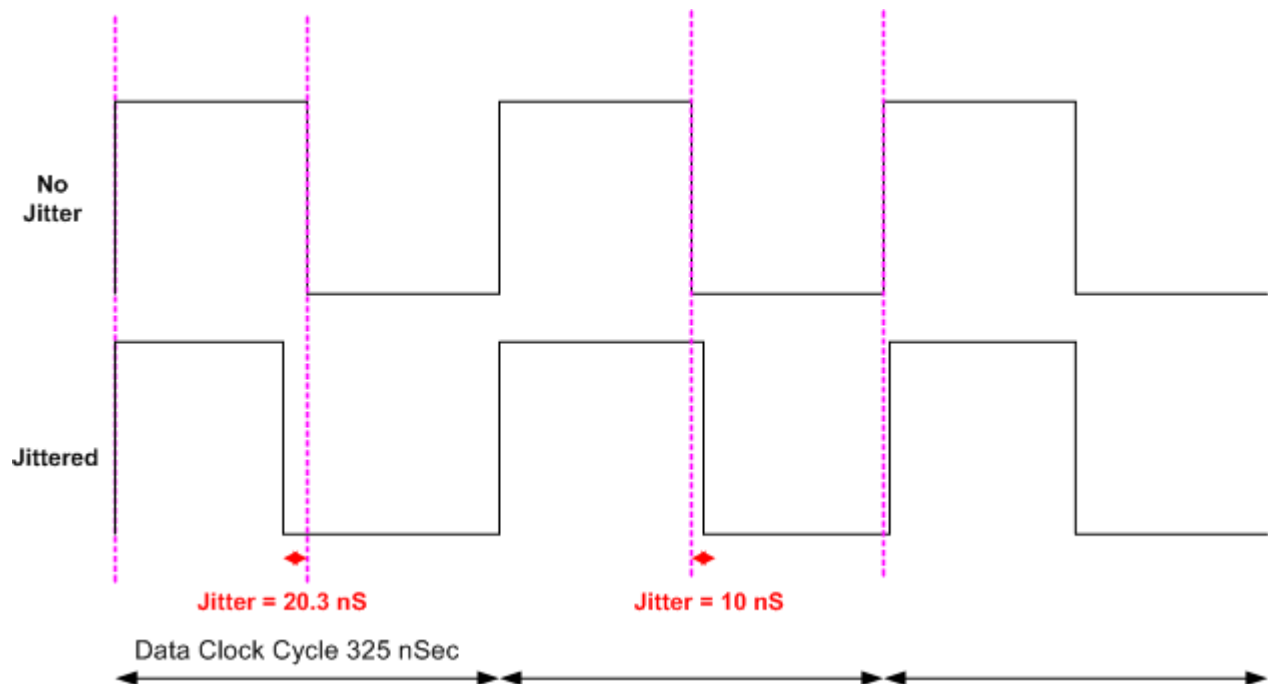
## *Analyzing Digital Audio Jitter*

Digital audio changes the way we must think about audio testing and troubleshooting. The ole trusty tone generator and oscilloscope offers little help in diagnosing digital audio problems. But, transitioning from analog to digital audio troubleshooting is not as hard as you may think. Sure, it will take some study and familiarization with new analyzing tests and instrumentation. This article introduces you to a common digital audio performance issue, jitter, and shows how it can be measured with the Sencore Digital Audio Analyzer DA795.

### **What is Jitter?**

Every digital audio system has a clock, typically a crystal oscillator or voltage controlled crystal oscillator circuit. The oscillator output determines the resulting audio sample rate and audio data rate. A perfect clock would be exactly the desired frequency and each cycle of the clock waveform would be identical in duration or time.

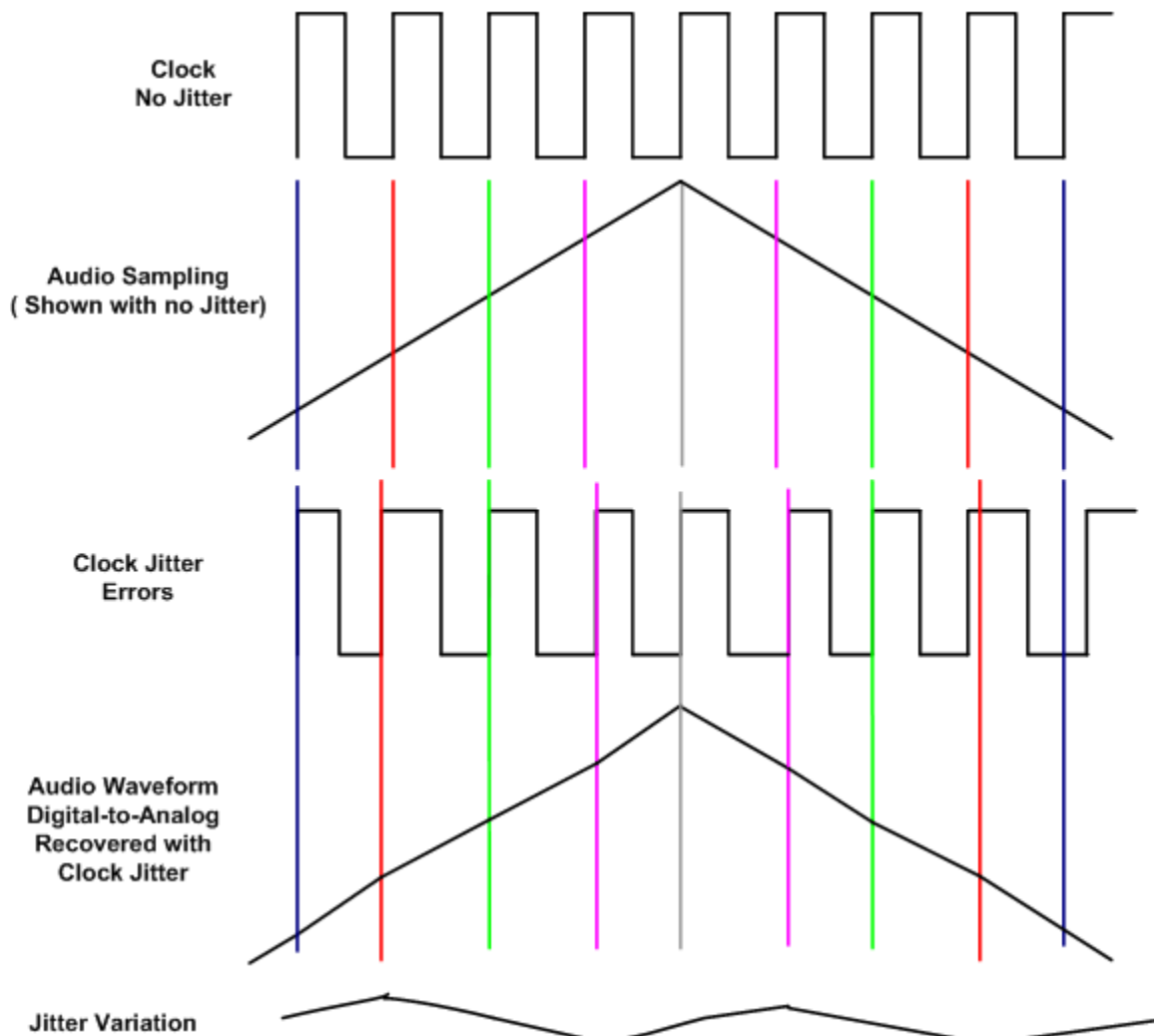
The clock (oscillator) is not perfect. Clock cycles may fluctuate in time with cycles being slightly shorter or longer than previous cycles. Clock positive and negative times may be slightly longer or shorter causing transitions to occur at slightly different intervals in time. These variations are called "jitter."



*Figure 1. Jitter is variations in the transition times of the clock waveform.*

## How Jitter Effects Audio Quality

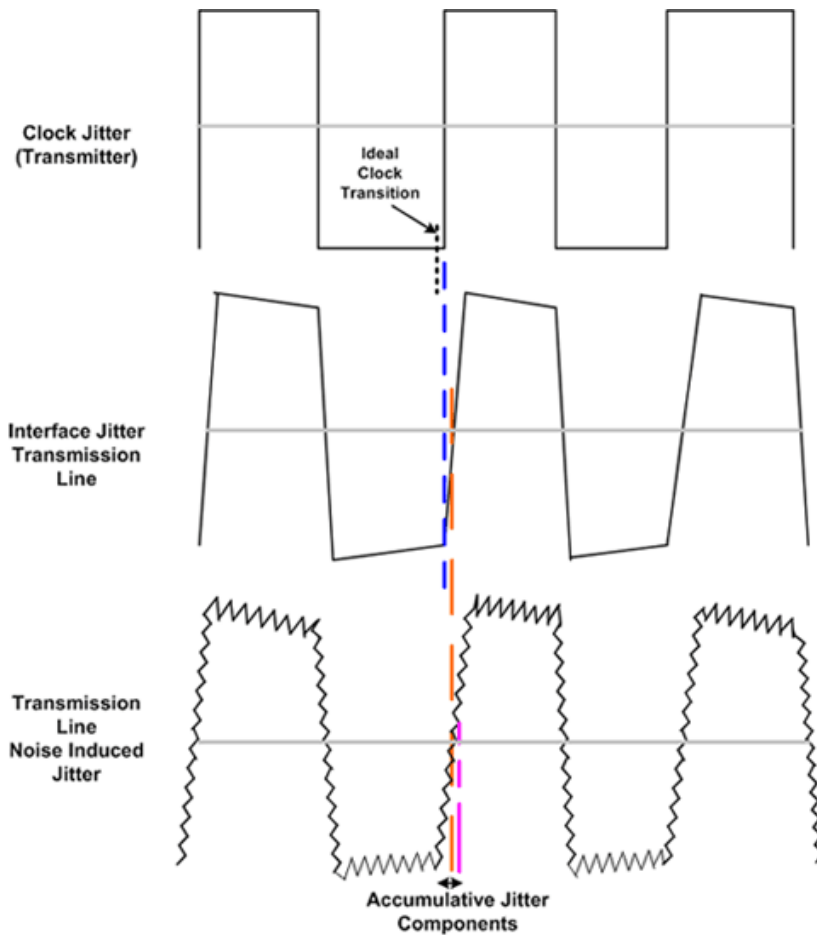
Consider how these seemingly innocent timing variations can cause audio signal degradation. Imagine a perfect jitter free clock digitally sampling a linear rising waveform during the analog to digital conversion as shown in Figure 2. If the waveform is reconstructed by a digital-to-analog converter containing some clock jitter, the linear rising voltage is no longer linear. The digital values correctly indicate the audio level as it was sampled, but since the levels are incorrectly placed in time, the resulting waveform is distorted by the jitter component.



*Figure 2. Jitter causes timing errors when the audio signal is reconstructed by the receiver. The receiver locks and regenerates a clock from the incoming digital audio signal.*

## Where does Jitter Come From?

Jitter occurs in a digital audio system at the transmitter from the non-perfect clock or crystal oscillator circuit. This is commonly called transmitter or sampling jitter. The digital audio signal is also adversely affected on the interface transmission line which contributes to jitter. This is commonly called interface jitter. These jitter elements are cumulative as the digital audio is transmitted and moves through a transmission line to a receiver.



*Figure 3. Receiver generated clock jitter is related to transmitter (sampling) jitter, interface transition variations, and transmission line noise. These effects can be cumulative.*

Digital audio embeds the clock signal and sync transitions within the serial digital audio data stream. It is up to the receiver to regenerate an oscillator locked to the incoming digital audio. As in any digital system, the data transitions from high to low have crossover points. These transition points are used to lock and correct the oscillator frequency in the receiver. Influences on these transition points contribute to jitter within the receiver's clock. Any timing difference between the receiver's recovered clock transitions as compared to the transitions of the original sampling clock is jitter.

A common cause or contributor of jitter is the data transmission line, better known as the connecting cable(s). The cable's capacity and frequency response characteristics can cause waveform shaping and slight DC balance shifts to the digital audio waveform. This causes slight delays or advances of the transition points along the digital waveform input to the receiver. This is interpreted at the receiver as jitter. Noise can also be induced into the transmission line, which further can shift the crossover points. (See figure 3.)

## Analyzing Digital Audio Signal Jitter

Jitter is measured with an AES digital audio analyzer such as the Sencore DA795. Jitter measurements are displayed as very small time errors and are expressed in nano or pico seconds. Jitter errors are commonly expressed as an average RMS value to reduce the measurement effects of randomly occurring peak jitter errors. The AES/EBU standard specifies that jitter be less than  $\pm 20$  nS. However, it is desirable to minimize jitter to much lower levels to optimize digital sound reproduction.

Figure 4 shows an active jitter measurement on the DA795. The digital audio signal is input to the INPUT 2 jack of the analyzer, either the AES/EBU Balance input or SPDIF input. With the proper input selected, the analyzer measures the jitter through comparison to a stable internal reference clock (Int 48kHz as shown in figure 4). The jitter is shown on a scale from 10ps to 100 ns and readout as a jitter RMS value. The jitter meter also tests super clock (256 x Fs) signals for jitter when input to the Word Clock In jack and selected for analysis.



**Figure 4.** Jitter measurement of an AES Digital Audio Input taken with a Sencore DA795 Digital Audio Analyzer.

The DA795's jitter measuring capability provides additional testing features. The jitter analyzer can be used to analyze the quality of digital audio cables. The DA795's Digital Cable Tester outputs a special digital signal sequence (Julian Dunn J-test waveform) into the cable being tested which excites interface jitter on the cable. The cable is connected to the jitter meter input (Input 2). The analyzer quantifies the amount of jitter produced by the cable. Higher quality cables exhibit less jitter effects for improved digital audio performance.

For more information on analyzing digital audio signals with the DA795 DigiPro, call 1-800 Sencore (736-2673) or visit [www.sencore.com](http://www.sencore.com).