

A Guide to Wadia Technology



ClockLink Jitter-Reduction

Wadia's ClockLink Jitter Reduction

ClockLink is the newest and most effective jitter-reduction method in Wadia's history. ClockLink dramatically reduces the most sonically damaging sources of jitter from compact disc playback systems.

In 1990, Wadia engineers were the first to identify jitter, or clock timing error, as a source of audible degradation in CD players. Since that time, Wadia has developed the best jitter-reduction methods available, including the well-known RockLok circuit in 1990, the Time-Base Corrector in 1992, and now, ClockLink.

Most jitter-reduction techniques attempt to reduce jitter from an already contaminated clock signal. ClockLink is different. It is more effective because it eliminates the opportunities for jitter to contaminate the clock signal before they occur. The performance advantages of ClockLink are immediately apparent when listening to music, with a degree of musical clarity and purity not previously available.

What is Jitter?

Jitter is inconsistency in a clock signal. Specifically, jitter in the clock signal affects the spacing of successive samples in a digital-to-analog conversion system, causing measurable distortion and audible sonic degradation in CD playback systems.

How does jitter affect sound quality of CD Playback?

Imagine an analog waveform produced by a musical instrument; it may look like the drawing at right. During the process of digital encoding, an analog-to-digital converter takes a series of snapshot-like samples measuring the amplitude of the signal at discrete time intervals.

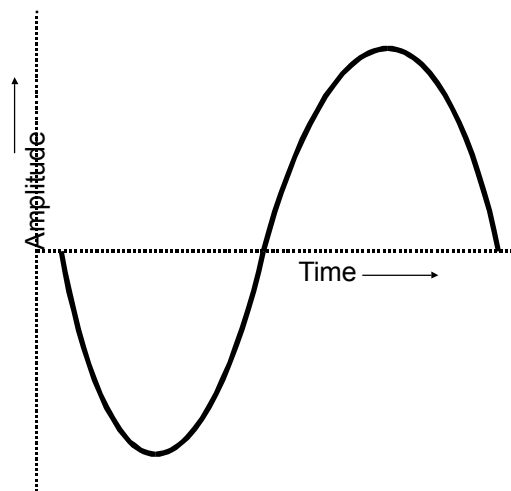


Figure 1. An analog waveform

Figure 2 shows these samples, taken by the analog-to-digital converter. These values, labeled here as S_1 , S_2 , S_3 , are stored numerically on a compact disc. When the CD is played back, the values are decoded back into an analog wave that theoretically looks identical to the original music signal.

The analog-to-digital converter uses a very accurate clock to determine when each successive sample should be taken. Notice that the time interval between samples is consistent.

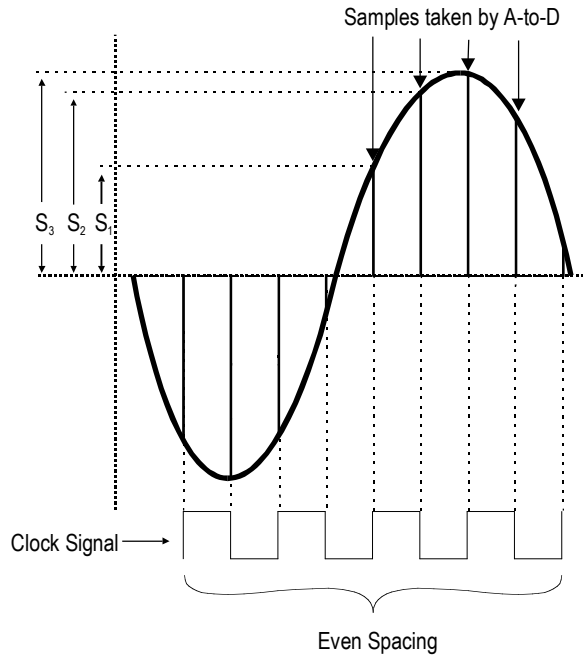


Figure 2. Samples taken by analog-to-digital converter.

Figure 3 shows this same set of samples, but decoded at uneven time intervals. During digital-to-analog conversion process, the time interval between samples is determined by a clock signal that is fed to the DAC chip. If this DAC clock has been contaminated by jitter so that it has uneven intervals between clock pulses, then the time interval between DAC output pulses will be uneven as well.

Notice that even though only the time interval (that is, the horizontal position) between samples has been shifted, the shape of the resulting analog wave is distorted. The degradation is both measurable and clearly audible. The sonic effects of jitter are often described as harsh sound in the high frequencies, and a loss of music's natural harmonic quality.

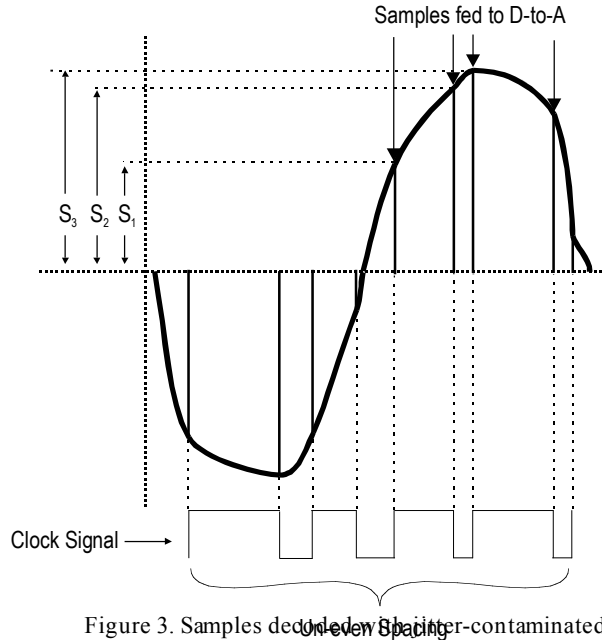


Figure 3. Samples decoded by jitter-contaminated clock.

Where does Jitter come from?

The original designers of the Compact Disc system may not have fully understood the sonic problems associated with jitter; the CD format is ripe with opportunities for jitter to degrade the clock signal. Figure 4 shows the layout of conventional CD playback systems. The master clock, which determines the time interval between samples, is located in the CD transport section.

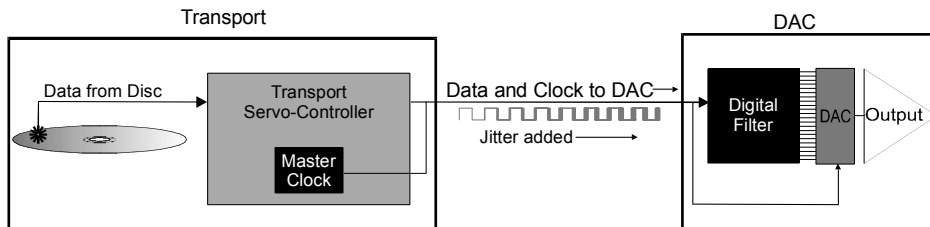


Figure 4. A conventional CD player with Master Clock located in the transport section.

As this clock signal is transmitted to the digital-to-analog converter, there are many sources of noise and distortion that degrade the clock signal and add jitter. Each section of wire, circuit board trace, connector, or electronic circuit is an opportunity for jitter to be added. Each step of the way jitter accumulates so that by the time the clock signal reaches the DAC section it is inevitably contaminated with jitter.

Previous Jitter-Reduction Techniques

Existing jitter-reduction techniques perform some type of processing to the clock signal that attempts to re-equalize the spacing between clock cycles. However, no type of processing can eliminate jitter once it has contaminated a clock signal.

Phase-Locked Loops

Wadia was one of the first companies to use a phase-locked loop to reduce jitter. A phase-locked loop uses a stable oscillator with variable frequency that seeks to lock onto the incoming clock frequency. Because this oscillator has much lower jitter than the incoming clock signal, this type of system can significantly reduce jitter from a noisy clock signal.

In 1991, Wadia has introduced a sophisticated phase-locked loop system called RockLok. The RockLok system uses two cascaded phase-locked loops; the first loop performs a rough lock and the second loop uses an ultra-stable crystal oscillator for more complete jitter-reduction. Phase-lock loop systems, the Wadia RockLok in particular, can be very effective in reducing jitter. However, they are limited. No matter how well designed, some residual jitter passes through every phase-locked loop.

Buffers and Time-Base Correctors

In 1992, Wadia became the first audio manufacturer to use the Time-Base Corrector (TBC), a second generation of jitter-reduction technology. Time-Base Corrector systems use a buffer or “FIFO” (First

In, First Out) memory to store incoming digital data stream and a very stable oscillator to clock the data out of the buffer at even intervals. Time-Base Corrector systems can be even more effective than phase-locked loop systems. Properly implemented, however, they are somewhat expensive.

Outboard Jitter Reduction

Since the introduction of RockLok and the Time Based Corrector, other manufacturers have implemented similar circuits. In fact, several companies have used these technologies to introduce outboard jitter-reduction devices. With these components, the transport data and clock stream is fed into a jitter-reduction box, where the signal is re-clocked using either a phase locked loop or buffer system. The reduced-jitter signal is then output to a digital to analog converter.

These systems have a significant drawback. Once the clock and data signal leaves the output of the jitter-reduction box, it is once again vulnerable the whole host of jitter contamination mechanisms. Even in the hypothetical case of a “perfect” jitter-reduction box that completely eliminates jitter, the signal will be re-contaminated by the time it reaches the DAC.



Figure 5. With an outboard jitter-reduction unit, the Clock signal is re-contaminated by the time it reaches the DAC.

In addition, these systems are needlessly expensive; any given quality of jitter-reduction circuitry can be installed in the digital-to-analog converter or CD player chassis for far lower cost than building the circuit into a separate chassis.

Wadia’s philosophy has always been that any jitter-reduction circuitry will perform its best when it is located as close as possible to the actual DAC chips. This way there are fewer opportunities for jitter to re-contaminate the clock. For this reason Wadia has never manufactured an outboard jitter-reduction box.

Wadia’s ClockLink

ClockLink effectively sidesteps the drawbacks of conventional jitter-reduction techniques by eliminating the opportunity for jitter to contaminate the clock to begin with. With ClockLink, the master clock for the entire CD playback system is located at the DAC section, in close proximity to the actual DAC chips. This allows the signal path between the clock and the DAC chips to be extremely short and to pass through an absolute minimum of circuitry and connections. A second connection carries the master clock signal from the DAC to the transport section to keep the transport synchronized with the DAC.

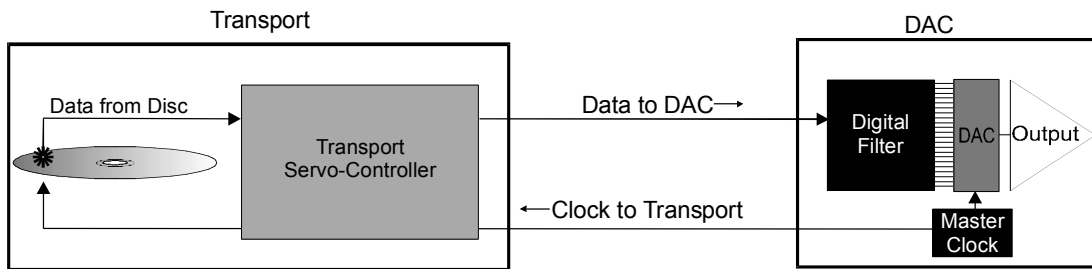


Figure 6. Wadia's ClockLink system, with Master Clock located at the DAC.

The Advantages of ClockLink

The most remarkable feature of ClockLink is that rather than trying to repair a distorted clock signal, it eliminates the opportunity for jitter to degrade the clock signal in the first place. This results in the lowest jitter of any Wadia design to date.

In addition, adding ClockLink technology to a CD player does not require additional expensive circuitry. Implementing ClockLink required re-engineering of the DAC and transport servo-controller that is beyond the means of many digital companies. Once this engineering is completed, the cost of adding ClockLink to a CD player is minimal. As a result, although ClockLink will improve the sound of even the most expensive CD player, it can be applied to modestly priced units as well. In short, it is a perfect example of Wadia's philosophy of using advanced technology to further the art of music reproduction at reasonable prices.

With digital separates, ClockLink does increase the cost since an additional digital transmitter, receiver, and cable are required. However, ClockLink is still far less expensive than other jitter-reduction systems.

The Benefits of ClockLink

Since Wadia's discovery of the sonic affects of jitter, the digital audio industry has focused great attention on the sonic problems associated with jitter. The sonic advantages of low-jitter designs have been described as offering greater purity and clarity, freedom from electronic glaze and grain, and a more natural, musical character. With Wadia ClockLink technology, and the jitter-free clock signal it provides, performance in these areas is brought to a new level, providing unparalleled musical fulfillment and satisfaction.