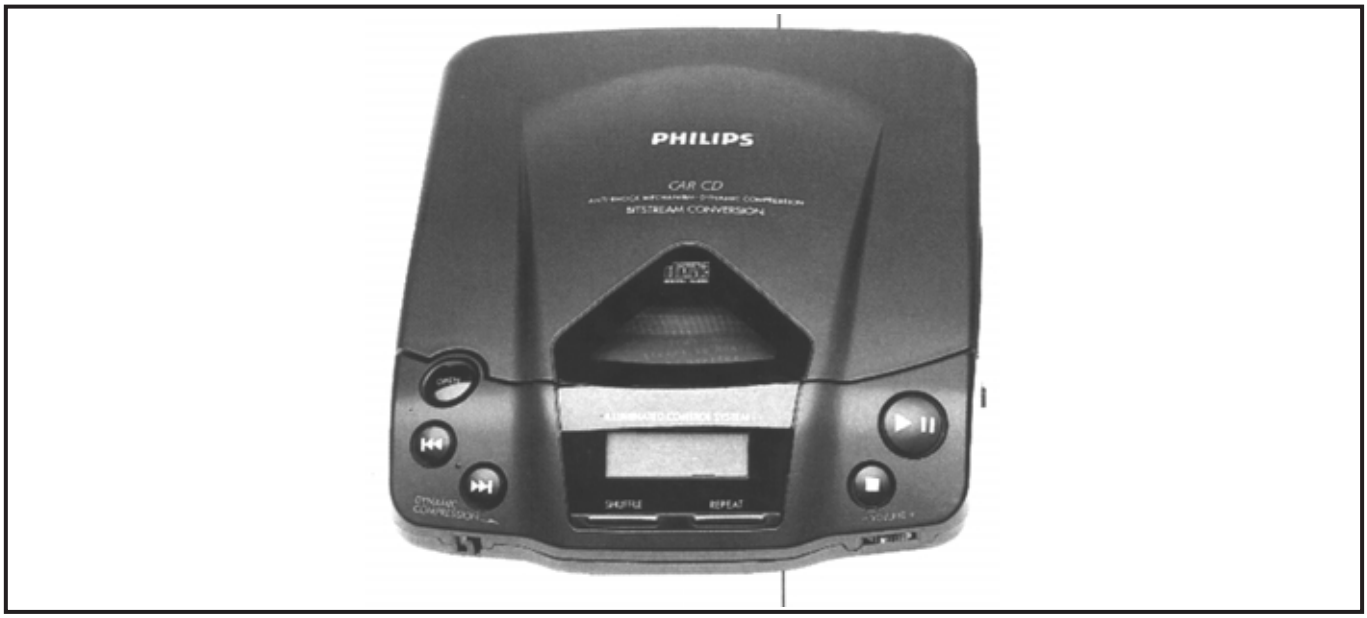
CD-jitter measurements



Background

The Compact Disc (CD) contains digitally stored information of for example audio, video or computer data. The digital signals are physically stored in a spiral track with a length of several km. The data is stored as a pattern of “pits” (cavities) and “lands” (the area between pits) in the CD surface. The length of the pits and lands are detected by an optical pick-up and transformed to electrical “digital symbols”, used to reconstruct the audio signal. The data on the disc is recorded with a very high precision. The width of the cavities (pits) are only about 0.6 μm and the depth is about 0.12 μm.

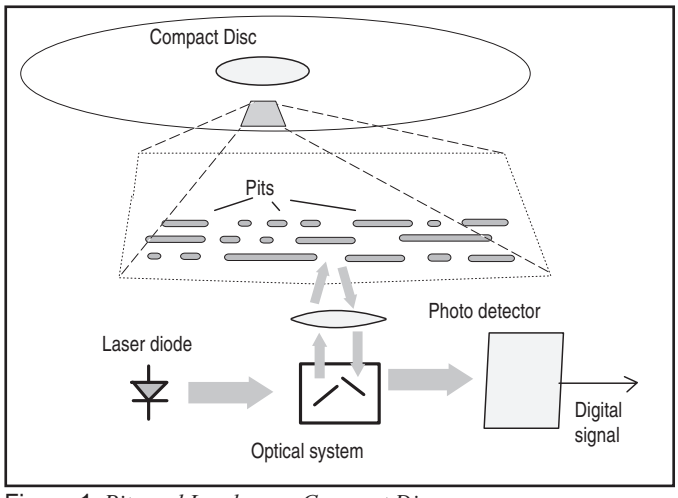


Figure 1 *Pits and Lands on a Compact Disc*

Nine different symbols called T3...T9 are used, both for pits and for lands (see fig. 1). Each symbol is represented by an electrical pulse having a width of 3...11 clock periods.

The importance of low jitter

The overall quality of the CD system is based on, amongst others, the amount of jitter in the system. The jitter could be caused by a bad recording or by the CD-player.

If the jitter is too large, the CD-player can’t separate the various symbols, and the result will be a bad sound or wrong data interpretation in a CD-ROM system.

To maintain system quality, measurement of jitter of a selected symbol width is made at various stages in the production process. It is also important to verify jitter levels after repair of a CD-player.

Measurement of jitter is however not an easy task. For fast high performance measurement and analysis, expensive and complicated measuring systems are normally required.

Normal high resolution timer counters, even though they include statistic functions, can not measure these signals, since the symbol of interest must be extracted from the eight others by some sort of window technique.

Measurement problem

This application describes how a CNT-81 timer/counter/analyzer together with the PC-based TimeView analysis SW is used for quantifying the jitter in a portable CD-player.

Beside jitter analysis of the digital symbols, CNT-81 and TimeView can also be used to analyze the analog output signal from a CD-player. These further analysis include e.g. frequency stability analysis and detection of unwanted mains voltage modulation (50/60 Hz) of the system clock.

Tapping the unprocessed digital CD-signals

For correct measurements on digital signals in a CD player, the signal to be measured must be tapped early in the signal path, where it has not yet been frequency compensated (see fig. 2).

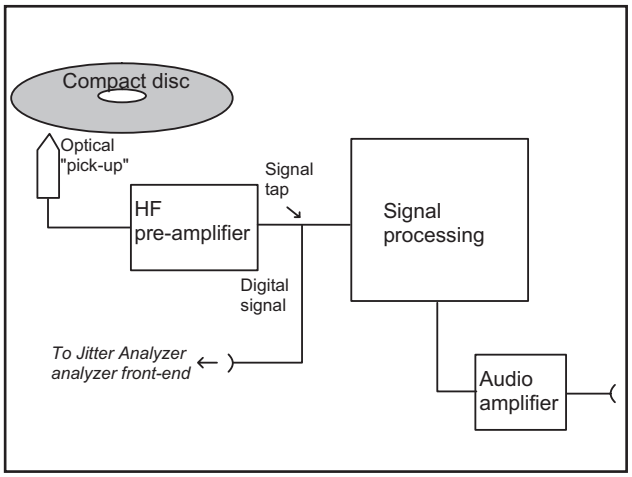


Figure 2 *Blockdiagram of CD-player*

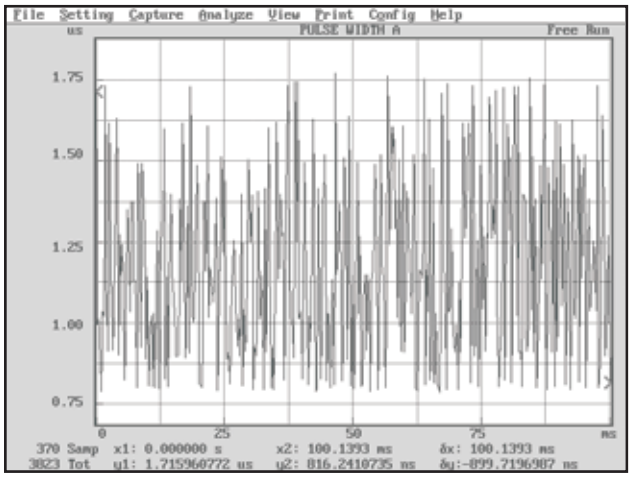


Figure 3 *The pulse widths measured during the first 100 ms shows a random pattern, and is difficult to interpret*

Measurement setup

The following description illustrates jitter measurements on the digital signal in a portable CD-player (Philips AZ 6821).

We rebuilt the player by tapping the signal early in the HF-pre-amplifier, where the output signal is a series of pulses with basically 9 different pulse widths . TimeView will show the amount of jitter present on the pulses. In other words, we will measure the *Pulse Width Jitter*.

In TimeView the measuring function was set to Pos. Pulse Width. Measuring time was set to minimum (80 ns) and SINGLE was ON.

The data capture via TimeView is made by free-run, single-block, capture. The number of samples was set to somewhat less than 4000.

The number of samples in itself is not critical. But notice that for highest TimeView capture speed in pulse width measurements, the sample size should be maximum 4466.

Data capture showing pulse width data vs time

The screen in figure 3 shows how the pulse width varies over time. The data is more or less a random pattern that is very difficult to interpret in a meaningful way.

However, by using the statistical function we can easily analyze the data. The distribution histogram of the pulse widths measured is shown in figure 4.

Statistical analysis quantifies jitter

Figure 4 shows the statistical distribution of the width of the 9 different symbols (T3...T11) on a CD, representing the nine different pit lengths.

In quality control and after repair it is of interest to analyze each of these clusters. In production testing, usually only the first population T3 is analyzed.

Let us zoom in by placing the cursors to the left and right of the first population.

As said, a quality criteria is the jitter data in the cluster. According to CD-standards this jitter must be less than 35 ns for an audio disk or a CD-ROM with single speed. For higher speeds, the demand for low jitter is increased.

Another important value is the effective length of the Pits or Lands, here found in the “text box” on the screen as a “Mean” value of 805 ns (depending on CD and actual trigger level settings). The jitter value (= “Stand Dev” in the text box) is found to be 13.1 ns.

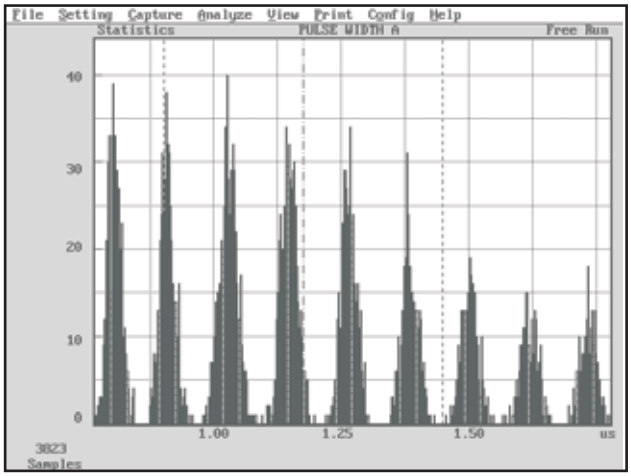


Figure 4 *The distribution of the width of the 9 different CD-symbols (T3...T11)*

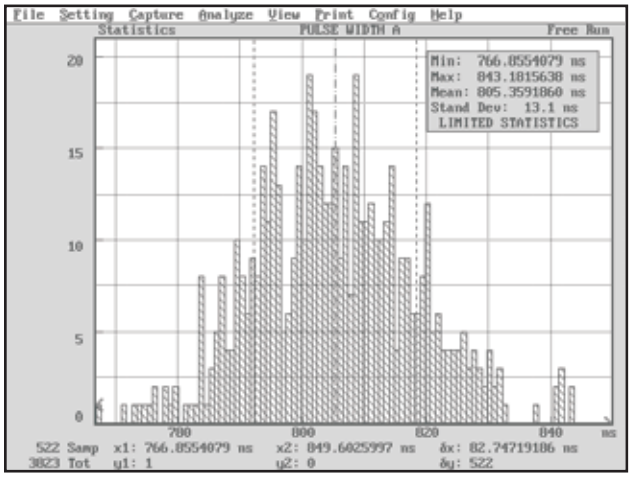


Figure 5 *The distribution of the width of the first symbol (T3)*