# Sample Champion - Application note # 4

## How detecting distortion in MLS measurements

The MLS based method has the advantage to spread the measured distortion and non-linearities throughout the computed impulse response. Windowing a small portion of the calculated data to perform a FFT, only a small part of the measured distortion will appear in the frequency domain data.

Every MLS sequence has its own characteristic way to spread distortions. Here below some examples of distortion effects are reported. These measurements have been performed using the "loop back" configuration (audio device input directly connected to the output), in order to emphasize this effect, since the "anechoic" impulse is similar to a Dirac impulse. In this test the Sample Champion latency time value has been manually "uncalibrated" to show the impulse starting at a time $t>0$.

The distortion effects in these examples are obtained by setting the input level too high and causing an A/D overload (in Sample Champion the peak meters on the control bar become red).

Figure 1 shows the impulse, measured using a MLS sequence of 16K points, obtained with the shift-register taps 14, 13, 12, 2, with correct input level. The response is perfectly clean and clear.

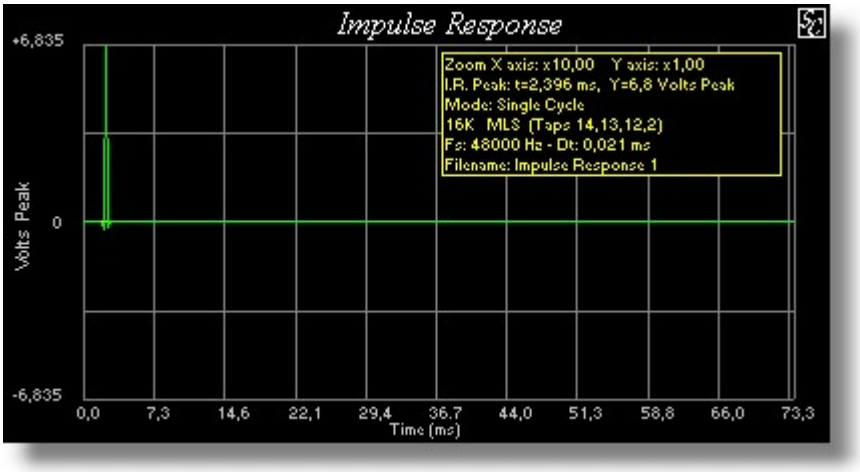


Figure 1

To see the situation in depth, it is useful to zoom the amplitude axis by a factor of 128 (see the yellow text on figure 2).

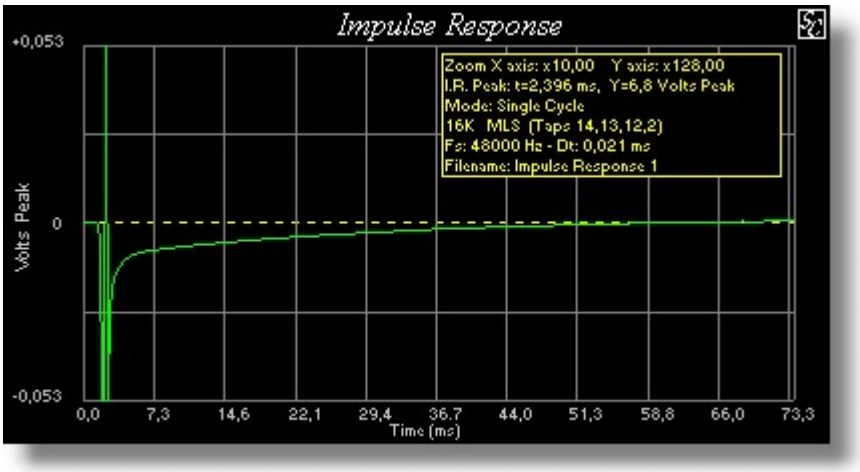


Figure 2

Figure 3 shows the first example of distortion, obtained by increasing the input level in the mixer of the audio device. Note that the peak value is now 10.3 Volts. The A/D converter was severely overloaded. A lot of small peaks now appear.

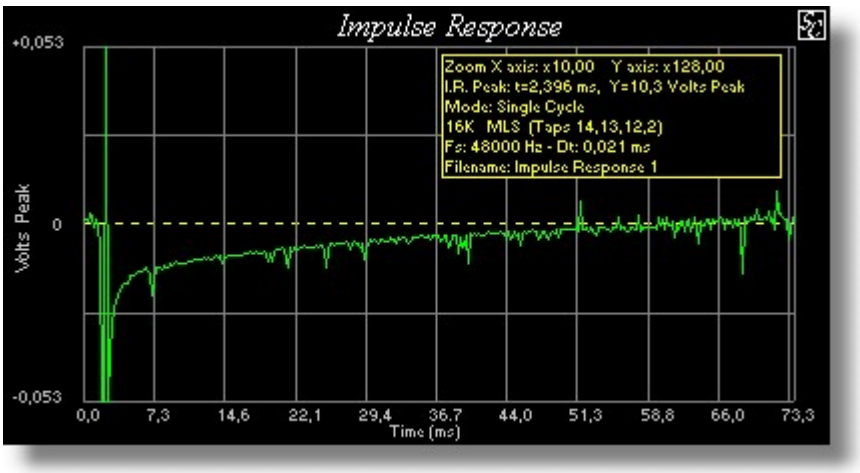


Figure 3

Figure 4 shows a measurement obtained with the same input level as before, but using a different MLS sequence (with the same length, taps 14, 12, 11, 1). Note that the small peaks are located at different time positions.

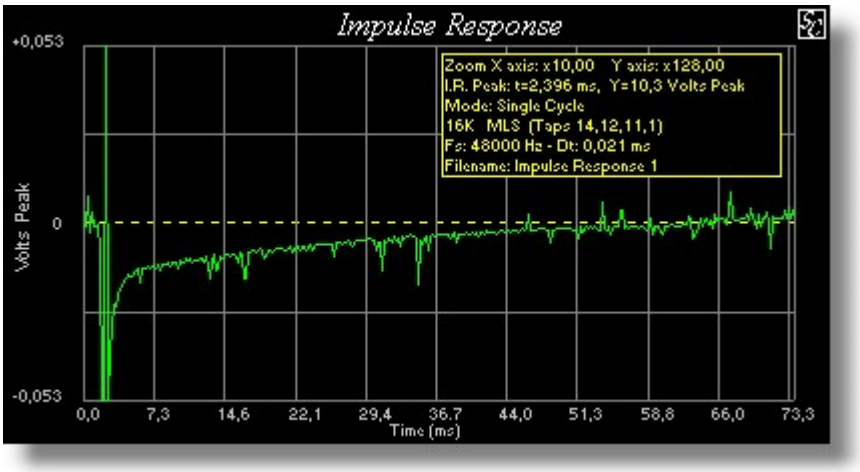


Figure 4

Figure 5 plots another measurement obtained with the same input level as before, using another different MLS sequence (with the same length, taps 14, 12, 10, 9, 7, 5, 3, 1). The small peaks are located at different time positions, compared to previous two measurements. The good news is that these small peaks are not randomly distribuited, but are always at the same locations with the same MLS sequence.

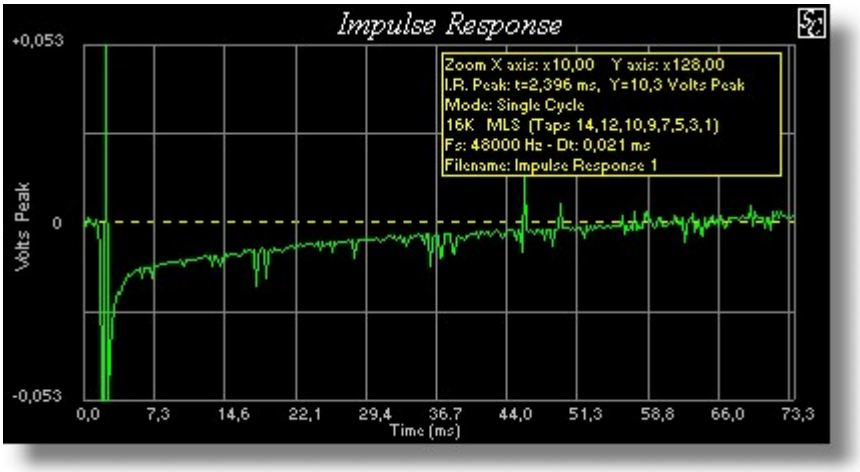


Figure 5

It is useful zooming the Y axis to see these distortions; in fact following figure 6 shows the same impulse of figure 5, but without any Y zoom: apparently there is no distortion at all.

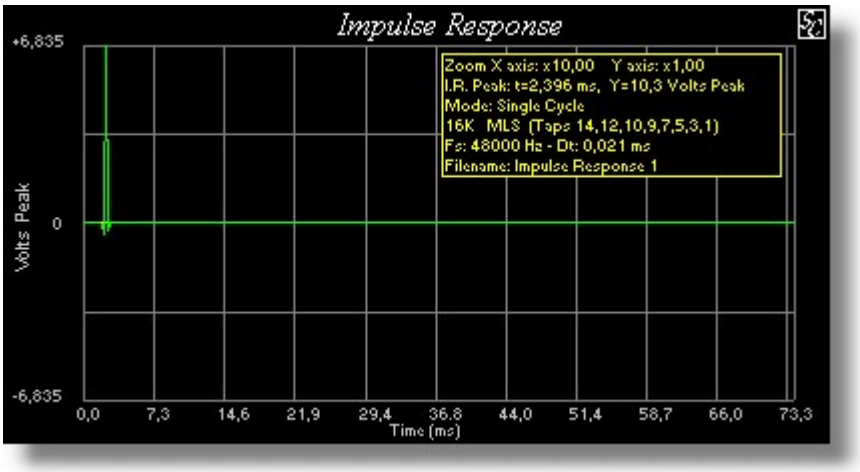


Figure 6

Following figures 7 and 8 show a detail (1:1 time scale) of the time zone around the impulse peak. Figure 7 is a detail of figure 5 (distortion). Figure 8 is a detail of figure 2 (clean).

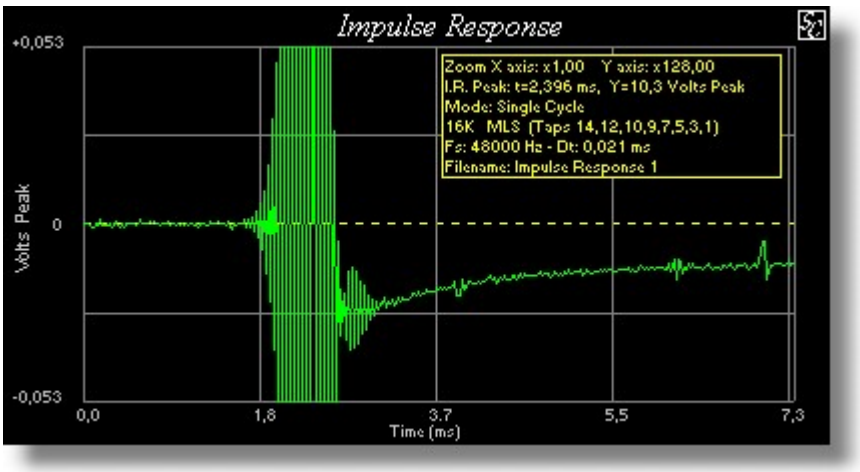


Figure 7

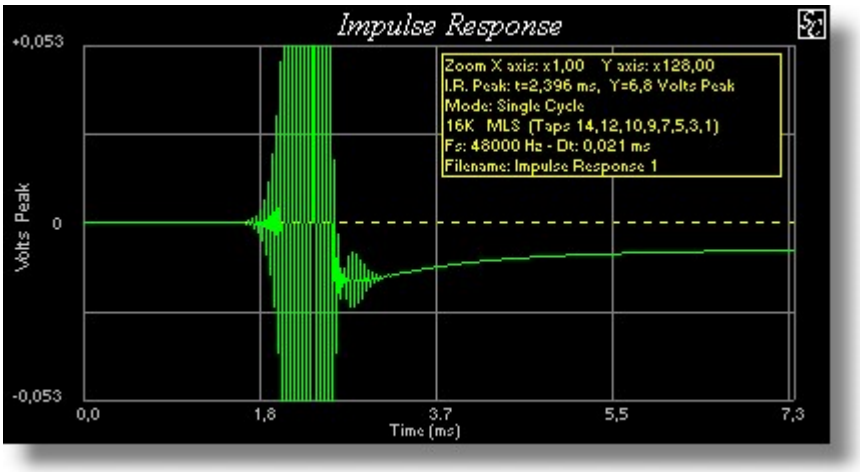


Figure 8

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