Experiment #3 – Function Generator

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***Abstract*: We can use digital components and gates for generating waveforms. We can generate sin, square, rhomboid, and other different waveforms in this way.**

***Keywords*:** clock divider, frequency regulation, Frequency range specification

I. INTRODUCTION:

The goal of this experiment is to generate different waveforms with digital components. We used many components for this experiment. The main components are waveform generator that is the heart of this experiment, frequency selector that determines the frequency of a wave, and amplitude selector.

II. WAVEFORM GENERATOR

This component is the heart of this experiment. This module generates special waves. Waves include rhomboid, sine, square, reciprocal, saw-tooth, full-wave rectified, and modulated sine wave. This module is created with Verilog code. For generating these waves, we use an 8-bit counter. With the output of this counter, we generate waves. For rhomboid, we use counter [0] bit and use count or minus count. (the count is counter output).

For sine, we use the formula that is given. With any count up, sine is calculated.

For square, the output is high (255) in half time and low (0) at other times.

For reciprocal and saw-tooth, we use count directly.

For full-wave rectified and modulated sine wave, we use sine output and count.

Figures 1, 2 show the results of this part and waveforms.

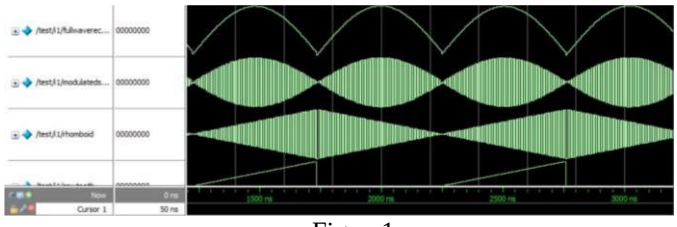

Figure1

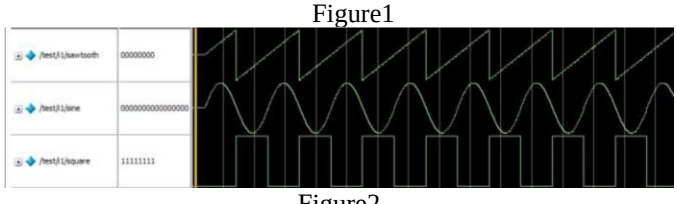

Figure2

Figure3

For arbitrary wave, we use rom and code that is provided for us. Waveform for this input, is shown in figure 4.

Figure4

III. FREQUENCY SELECTOR

In this part, we use a frequency selector to determine the frequency of a wave. For select frequency, we use the results of experiment two and the frequency regulator that was created in the previous experiment. Use "SetPeriod" that is sw[7:0] in this experiment for selecting frequency. So, psi is used for the waveform generator clock. Figure 5 shows how the frequency selector and waveform generator are connected.

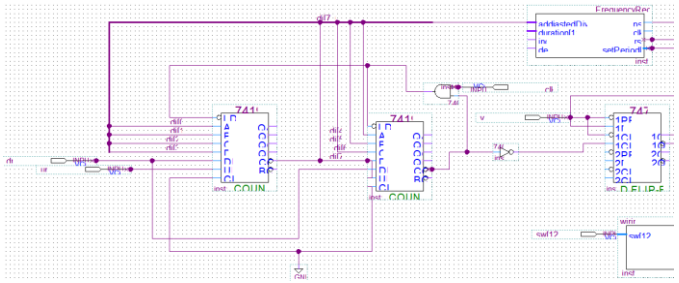

Figure 5

For testing this part, we change "SetPeriod" and observe different results. Wave frequency is changing when "SetPeriod" is changing. Figures 6, 7, and 8 show results for different "SetPeriod".

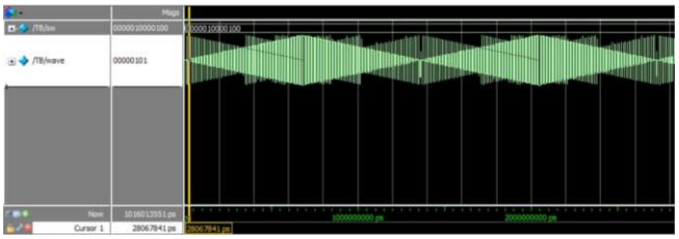

Figure6

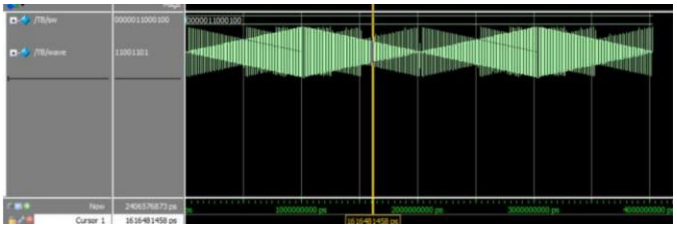

Figure7

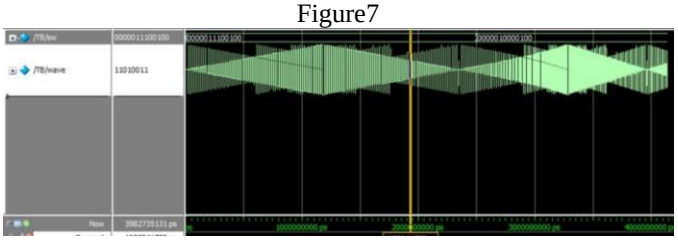

Figure8

Based on the figures that are shown above, with changing sw[7:0], wave frequency will change.
For example, in figure 6, "setPeriod" is 132. So the psi frequency is about 379 kHz. Thus the desired frequency is about 740 Hz. The achieved frequency is near 740 Hz.
In figure 7, "setPeriod" is 196. So, the psi frequency is about 255 kHz. Thus the desired frequency is about 500 Hz. The achieved frequency is near 495 Hz.
Figure 8 shows the result of changing "setPeriod" (sw [7:0]).

IV.AMPLITUDE SELECTOR

This module can scale down waveforms amplitude. The input of this module is the output of the previous part. Sw [12:11] is another input for this module. This module scale down amplitude by dividing the previous part output by numbers. Numbers are 1, 2, 4, and 8 that sw[12:11] specify them. Figures 9 and 10 show changing results by changing sw[12:11].

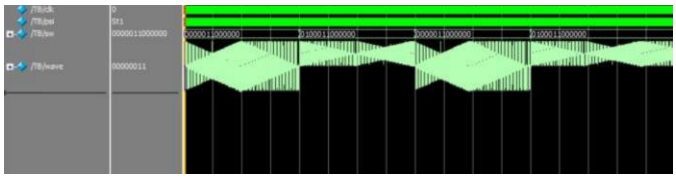

Figure9

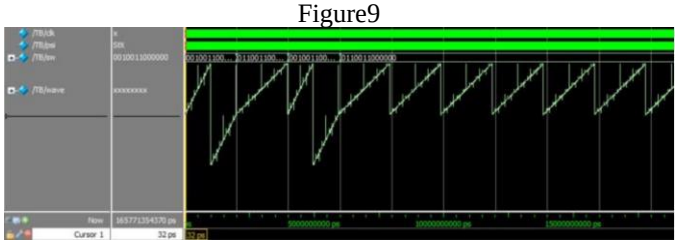

Figure10

V. ADDITIONAL DESCRIPTION

All waves after synthesizing in quartes and testing in ModelSim are shown in Figures 11 and 12.

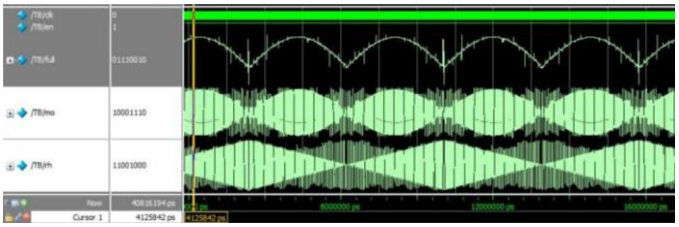

Figure11

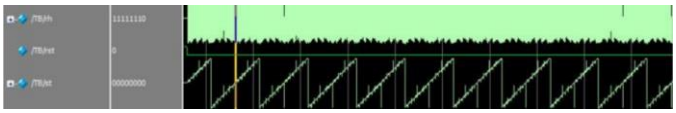

Figure12

Waveforms that are observed after synthesis in quartes and testing in ModelSim are different. Because we observe noise in these waveforms. Figure 13 shows the final block diagram.

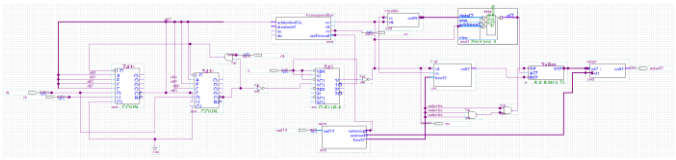

Figure13