Lab #8: Function Generator and ROM

Physics 127BL   Winter 2024

Lab report due **Wednesday, March 6, at 11:55 P.M.**

Please read the lab report and homework guidelines handout on the course web page.

Introduction

In this lab, we will implement an 8-bit triangle-wave and sine-wave generator that will produce tones on a speaker. You will learn how to use a *lookup table* stored in read-only memory (ROM) to translate the numerical values from a triangle waveform into the voltage levels of a sine wave.

1. **Triangle-wave generator.** We will first design a triangle-wave generator that drives a speaker connected to the FPGA board. To generate a triangle wave, we would like to feed a series of numbers to the DAC that first increases linearly to a peak, then reverses and decreases linearly at the same rate for the second half of the period. This can be done with an up-down counter, which counts in one direction with its direction input high, and in the other with the direction input low.

   Using an 8-bit up-down counter, a decoder with outputs corresponding to input values 1 and 254, and an S-R flip-flop, create a circuit in Quartus that generates numerical values for a triangle wave. Clock the circuit so that the triangle wave will oscillate at about 1 kHz.

   Connect an 8-bit bus from the counter output to the VGA DAC and send the analog output to headphones or a speaker as you did in the previous lab. Use an oscilloscope to verify that you are getting the correct analog waveform at the expected frequency.

2. **Sine-wave generator.** To generate a sine wave, we will use the numbers generated for the triangle wave as *addresses* of voltage levels stored in a *lookup table* we place in read-only memory (ROM).

   Use the megafunction `ROM:1-PORT`. The sine wave data are in the file `lab8_sinecode.mif` on the course web page. Configure a 2-input 8-bit multiplexer to select either the triangle wave or the sine wave. Use a slide switch to drive the select input on the multiplexer.

   Listen to the analog output on a speaker or headphones, and verify proper operation of the generator with an oscilloscope.