Project "Musical Note Generator"

In this project, you shall create a musical note generator. The goal is to generate notes based on a selection using the navigation keys on the board, and then playing them through the board's audio output.

AC-97:

The audio is played using the on-board AC-97 codec. We write an AC-97 controller which sends audio data to the codec as shown in Fig.1. The AC-97 codec module is responsible for the digital-to-analog conversion. Please refer to the AC-97 reference and *genesys_rm.pdf* provided in the documents folder for detailed information. An entity declaration is already provided to you in *ac97_controller.vhd* file.

For the design of the controller you shall have to refer Chapter 4 and Section 5.1.1 in the manual *genesys_rm.pdf*, which corresponds to the AC-link protocol based Audio Output Frame. Since we are not concerned with recording, the Input Frame can be ignored.
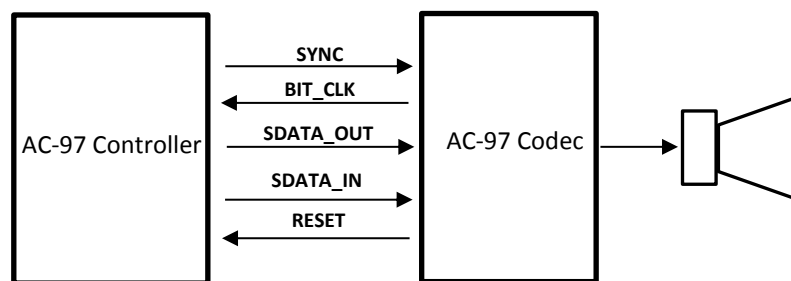

Fig. 1. AC-97

System Architecture:

The system shall consist of the tone generator, tone selector, AC-97 Controller and wishbone bus interface as shown in Fig.2. To help you with the integration of all modules a top-level entity for the system is already provided in *audio.vhd*. This file contains the component instantiations for the AC-97 controller, the wishbone interface and two processes for tone selection and generation. You should be familiar with the design of the wishbone interface by now from your warm-up tasks.

In the *ac97_controller.vhd* the state machine initializes the AC-97 codec and then goes to a "LISTEN" state.
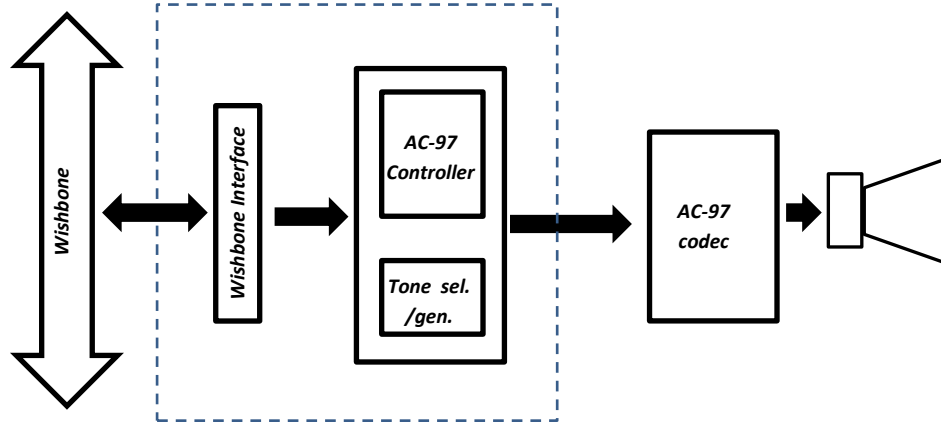
Fig. 2. System Architecture

Tone generation:

Tone generation involves the generation of discreet periodic waveforms. The waveform can be of any shape e.g., square, saw-tooth.

The objective of the project is to be able to generate tones corresponding to piano note frequencies as given in this table.

In order to generate these tones, we need to create periodic waves with the corresponding frequencies. If the frequency that needs to be produced is F and the sampling frequency is Fs (which is $48kHz$), then the number of samples in a period is a round-off to the nearest integer of Fs/F.

For example, to play the tone number 45 on the table which has a frequency $\sim 349\,Hz$ the number of samples in a period has to be $48000/349$ which is ~ 136.

In order to avoid a division operation store the pre-calculated sample sizes in the form of a ROM.

Use the joystick (Nav Switch) up/down to select the desired tone while displaying its corresponding name on the LCD. The selected tone should be played when the joystick is kept pressed, and should stop playing when the joystick is released.

Tasks:

1. Complete the tone selection and generation processes in *audio.vhd* so as to be able to create a digital waveform corresponding to the piano key range 40 to 55.
2. You have to complete the *ac_link.vhd* to implement the AC-97 protocol and send data to the codec. It should take the output from the tone generator and send it to the AC-97 codec module as per the AC-97 protocol. It will you help you to understand well the sections in the "genesys_rm.pdf" manual mentioned above under "AC-97".
3. Integrate the modules as necessary and synthesize. Make sure you provide the proper pin configuration. Refer to *genesys_rm.pdf* for the same.
4. Write a software controller such that the Navigation up/down can be used to scroll notes and pressing it produces the corresponding tone. The scientific name of the scrolled note should be displayed on the LCD screen.