 You have previously submitted this assignment with David Rama Jimeno. Group can only change between different assignments.

This course has already ended.

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/ 12.1 Exercise 09: Synthesizer top level

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Exercise 09: Synthesizer top level


Your task is to make a top level structural description of the synthesizer by connecting the sub-blocks together. The device is guided with four push-buttons. Every button refers to a sound with a specific frequency.

Interface

- Name of the block: synthesizer
- Generic-parameters, all of them are integers and all of them have a default value
 - `clk_freq_g`, 12 288 000 (Hz)
 - `sample_rate_g`, 48 000 (Hz)
 - `data_width_g`, 16 (bit)
 - `n_keys_g`, 4
- Ports
 - `clk`
 - `rst_n`
 - `keys_in` (width `n_keys_g` bits)
 - `aud_bclk_out` (1 bit)
 - `aud_data_out` (1 bit)
 - `aud_lrcclk_out` (1 bit)

Architecture

The structural description instantiates four wave generators, the multiport adder and the audio controller made in the previous exercises. In the block diagram below, the synthesizer is depicted with light orange color. The push buttons are connected to inputs `sync_clear_in` of the generators.

 top-level block diagram (https://plus.tuni.fi/graderA/static/compce240-f2021/project_work_fixed.png)

The wave generators are configured to produce different frequencies by adjusting their parameter. Values 1,2,4 and 8 are quite good. The wave frequency can be approximated this way:

$$f = \frac{s}{2 * 2^{16}} f_{\text{ref}}$$

Verify the block using test bench [tb_synthesizer.vhd](https://plus.tuni.fi/graderA/static/compce240-f2021/E09/tb_synthesizer.vhd) (https://plus.tuni.fi/graderA/static/compce240-f2021/E09/tb_synthesizer.vhd) and the audio codec model (which you did in [exercise 8](#) (https://plus.tuni.fi/comp.ce.240/spring-2024/E08/tb_audio_ctrl/)).

This [Example figure](#) (https://plus.tuni.fi/graderA/static/compce240-f2021/E09/tb_synthesizer_wave_new.png) illustrates how the waveform window should roughly look like. Pushed buttons are shown in the top ('1' = pushed) and the samples received by the audio codec as analog representation are at the bottom. Four buttons have naturally 16 combinations and with 16-bit data the simulation takes a very long time. The figure shows the two slowest triangular waves. First they are played separately and after that together.

Notice that in this example the overflow is **not** corrected. After doing the [bonus exercise 4](#) (<https://plus.tuni.fi/comp.ce.240/spring-2024/bonus/overflow/>) the output looks more sensible (something like [this](#) (https://plus.tuni.fi/graderA/static/compce240-f2021/E09/tb_synthesizer_wave.jpg)). With the overflow, the output both looks and sounds ~~uglier~~ like heavy metal but that is OK too.

Return:

- Put your returned files under E09 folder in your Git repository
 - Return files:
 - `synthesizer.vhd`
 - `wave.png` (a screenshot from the waveform of your simulation)
- Check that the files' header comments are valid, made according to instructions, and you have followed the coding rules
- Push the changes to your repository and submit (with your partner if you have a group!)
 - Use the **ssh variant** of the repository url in the submission. Otherwise the tests will fail 100% even with working design.
 - The url looks like `git@course-gitlab.tuni.fi:compce240-spring2024/<your_group_number>.git`.

Enter your Git repository address for grading

Did you remember git add - git commit - git push?

Submit with David Rama Jimeno



Submit

Earned points

6 / 6

Exercise info**Assignment category**

VHDL exercises

Your submissions

1 / 1000

Points required to pass

6

Deadline

Sunday, 24 March 2024, 23:59

Late submission deadline

Friday, 31 May 2024, 23:59

Group size

1-2

Total number of submitters

58

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