

COMP3601 - Design Project A

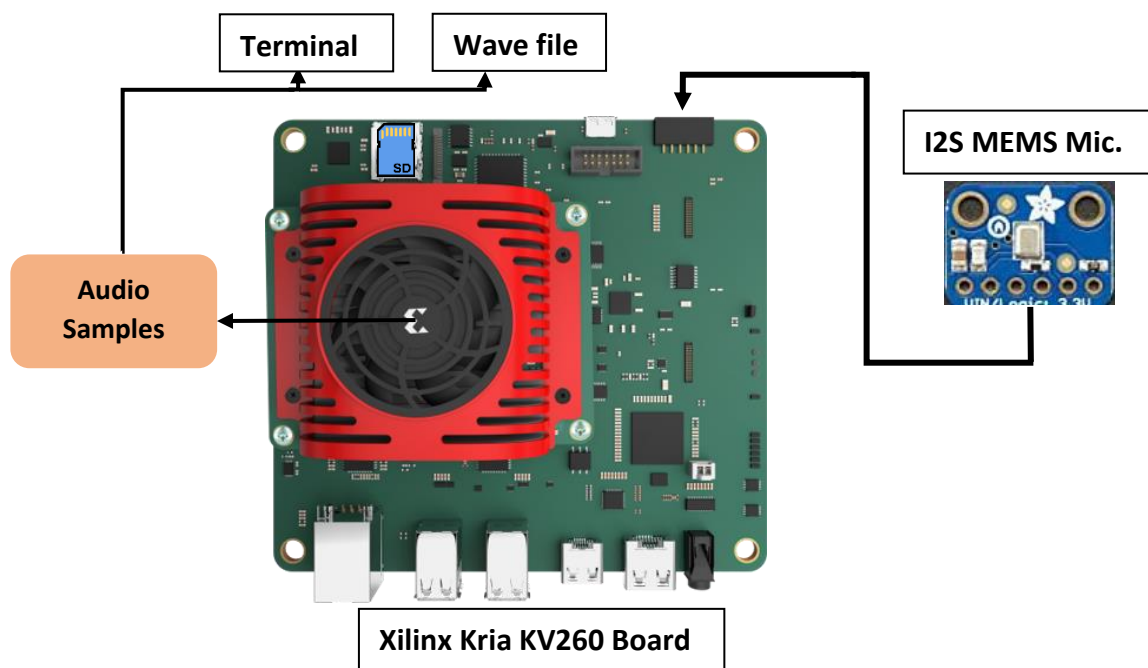
22T3

FPGA-driven Microphone System

In this project, you will be designing a custom microphone system using a multiprocessor system on a chip (an MPSoC) system that has an FPGA and ARM microprocessor (assume you are a start-up company who wants to develop custom audio hardware and applications). Your product involves capturing user audio (as a personal recording device) via a microphone and then processing the audio using the MPSoC.

There are two parts/tasks to the project with the first task being to develop a basic microphone system and the second task extending the basic design based on each team's choice of extension. The basic microphone system will include an I2S MEMS microphone breakout board interfaced with the FPGA. The FPGA module of the system will drive the microphone, collect the audio samples from the microphone, and send the audio samples to the software running on the ARM processor. As an example, the software for the basic system can be a simple audio recorder that records and save the collected audio samples into a wav file that can be played back using a media player or into a csv file that can be opened with an application such as MATLAB to display the waveform or playback.

The second task will be a more open-ended system extension task where teams can decide what features to add to their microphone system. See the deliverables and talk to your tutors for what options can you extend on.



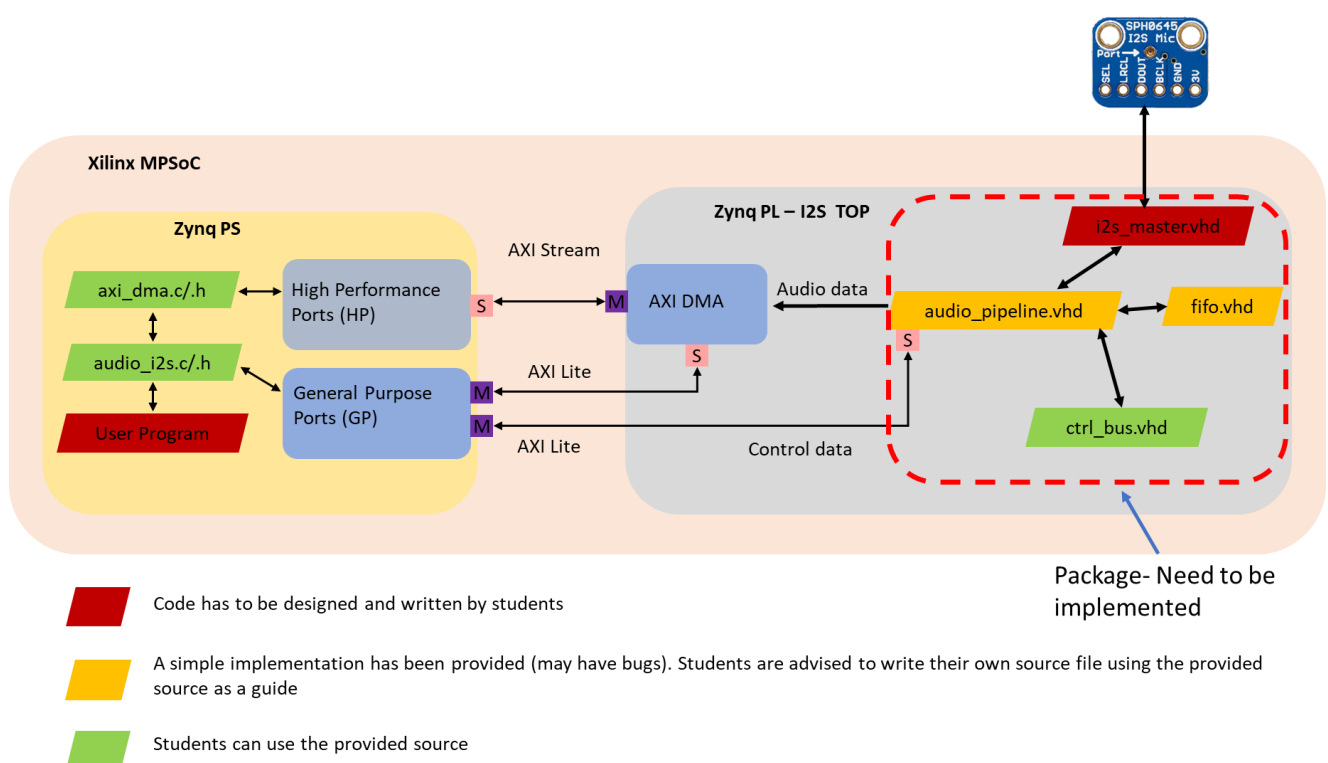
Development Board –

The development board (MPSoC Board) chosen for this course is the Xilinx Kria KV260 Vision AI Starter Kit which is a development kit that includes a Zynq UltraScale+ MPSoC. The MPSoC IC combines a quad-core ARM Cortex A53 hard processor (usually referred as processing system or PS) and an FPGA (referred as programmable logic or PL). PS will run a custom Linux image which referred to as PetaLinux. On the top of PetaLinux, drivers and recorder application (or any other application) can be executed to save audio samples from the microphone (or perform any software operation that you intend).

I2S MEMS Microphone

I2S MEMS Microphone is a small microphone that converts sound to voltage and gives out the sampled audio as a purely digital signal. This microphone is capable of capturing sound waves with frequencies ranging from 50Hz to 15KHz, which is good for all general audio recording/processing applications. The microphone supports I2S (Inter-IC Sound) serial bus interface protocol, which is used for connecting digital audio devices together, and this protocol is being used to transfer the sampled audio data (digital) to the FPGA-based audio processing pipeline in the project.

Source Code Structure



Components Provided

- 1x Kria KV260 Vision AI Starter Kit
- 1x Power Supply
- 2x I2S MEMS Microphone
- Wires

Deliverables

Task1:

Design and develop a basic I2S microphone system using the provided I2S MEMS microphones and the Kria development board. The system should be able to record an audio clip from the microphone that are wired to the PMOD pins connected to the FPGA of the MPSoC.

Task2:

Extend on your basic I2S microphone system. This could be:

- Electronics
 - Supporting microphones of other protocols
 - Adding physical control methods to the audio
 - Others
- FPGA
 - DSP (Volume/Gain control, FIR filter, etc.)
 - Audio monitoring
 - Audio format (sample rate, etc.)
 - Others
- Software application
 - Audio messaging
 - Audio monitoring
 - *Audio networking*
 - Others

Be curious and use your creativity for task 2.

References

- <https://www.xilinx.com/products/som/kria/kv260-vision-starter-kit.html>
- <https://www.xilinx.com/products/silicon-devices/soc/zynq-ultrascale-mpsoc.html>
- <https://www.adafruit.com/product/3421>
- <https://digilent.com/reference/pmod/pmodbb/reference-manual?redirect=1>
- <https://en.wikipedia.org/wiki/I%C2%B2S>