CENG4480 Embedded System Development and Applications

Computer Science and Engineering Department

The Chinese University of Hong Kong

Laboratory 5: Sound Recorder (I)

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Introduction

In this lab session you will prepare the sound recorder board and test it.

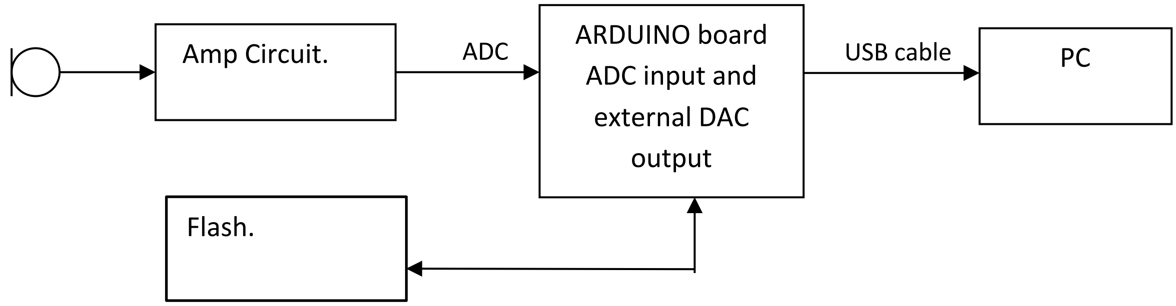
- Read the signal from a signal generator.
- Amplify the signal by an operation amplifier (Op-am).
- Feed the amplified signal to the Analog-to-digital input (ADC) of the ARDUINO microcontroller.
- The ARDUINO performs Analog to Digital conversion.
- The ARDUINO writes the data to flash.
- The ARDUINO reads the stored data from flash and performs Digital to Analog conversion and feed the signal to an oscilloscope.

Objectives

- To learn how to interface an analogue signal to digital systems.
- To learn how to process signals in an embedded system.
- To learn how to write and read data from a flash.

Procedure 1. Hardware Design

The following diagram shows the hardware system.



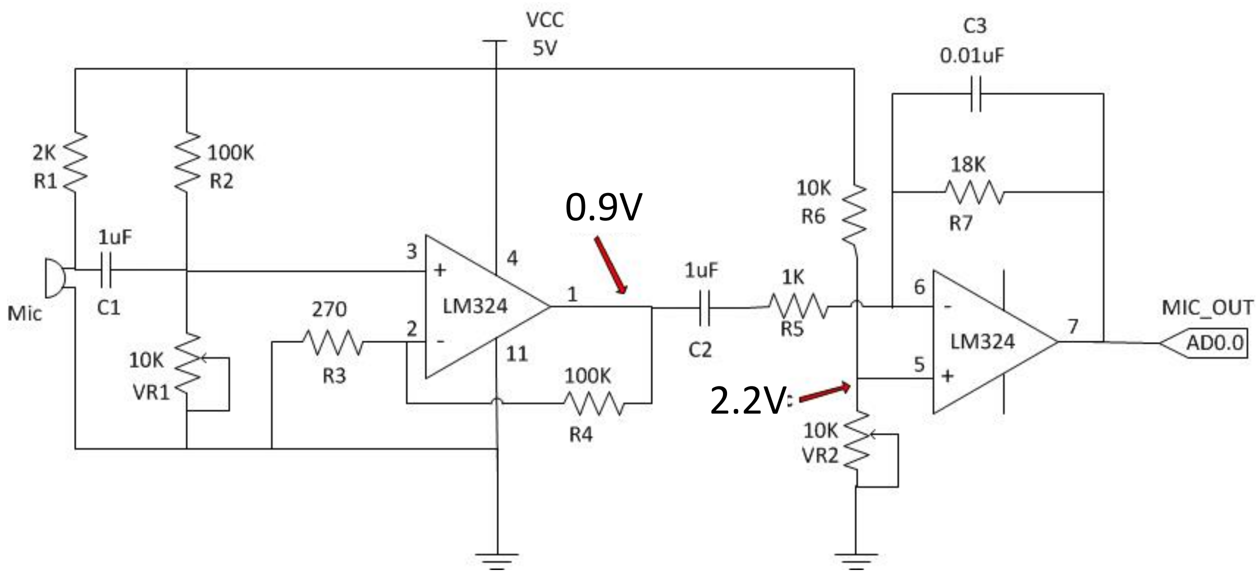


Figure 1. Amplifier Circuit

The signal input from the microphone port is amplified by a Mic. Amp. Then the amplified signal (0 – 5V) is fed to the ADC input of the ARDUINO board (A0). The signal is then sampled and converted into 10-bit digital data and saved in the external flash.

(i). Sampling rate

The sampling rate of the ADC used depends on the maximum frequency $f_{\max}$ of input signal. According to Nyquist sampling theorem, the sampling frequency $f_{sampling}$ should be greater or equal to two times $f_{\max}$.

$$f_{sampling} >= 2 \times f_{\max}$$

In our example, we assume the $f_{\max}$ = 8KHz (e.g. the highest note of a piano is C8=4186Hz) , so we choose the sampling frequency $f_{sampling}$ = 16 KHz.

Procedure 2. Software Design

(i). The offered flash library functions:

We offer these following functions:

a. void FlashStartWrite(uint32_t page); (give the starting address to write data in flash)
b. void FlashStoreByte(uint8_t input); (write data)
c. void FlashEndAction(); (tell flash the current action “read” or “write” is finished)
d. boolean CheckForFinish(); (ensure the flash is ready for another action)
e. void FlashStartRead(uint32_t page); (give the starting address to read data from flash)

f. uint8_t FlashReadByte();(read data, also need to be follwwed by function c)
g. void DeleteAll();(eraser the whole flash)

Procedure 3. Construction of Microphone amp.

On provided prototyping PCB board, connect the components by soldering them on the boards to build the Mic amp. circuit (as shown in Fig. 1). (Refer to Fig. 2 sample board)

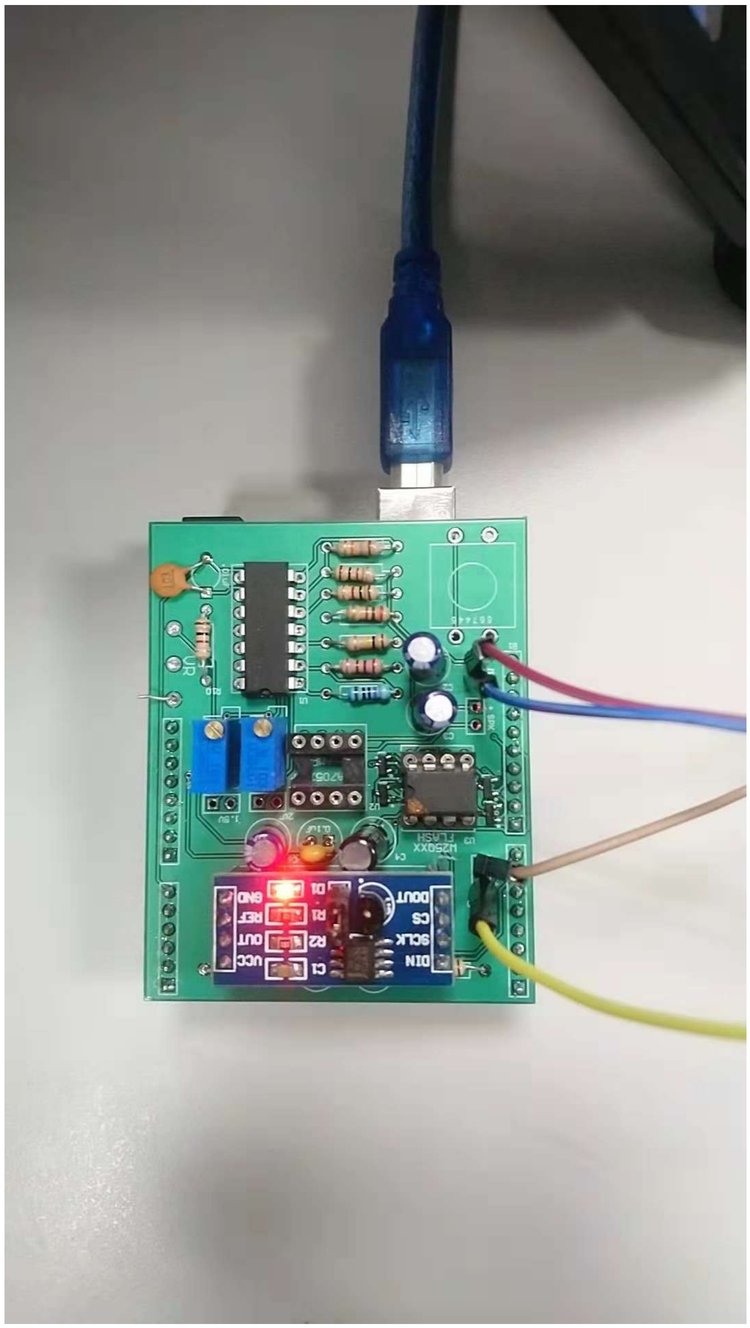


Figure 2. Sample Board

Procedure 4. Adjust the bias voltages of mic amp. and test the mic amp.

Refer to the Figure 1 adjust the bias voltages and use oscilloscope DVM function to measure the voltage:

- Adjust VR1 such that the voltage at LM324 pin1 equal to 0.9V dc
- Adjust VR2 such that the voltage at LM324 pin5 equal to 2.2V dc

Connect the input channel of oscilloscope to the output of mic amp. (LM324 pin 7), you should see the amplified audio signal display on the screen. The audio signal should be swinging between 2.2V dc level, as shown in Figure. 3.

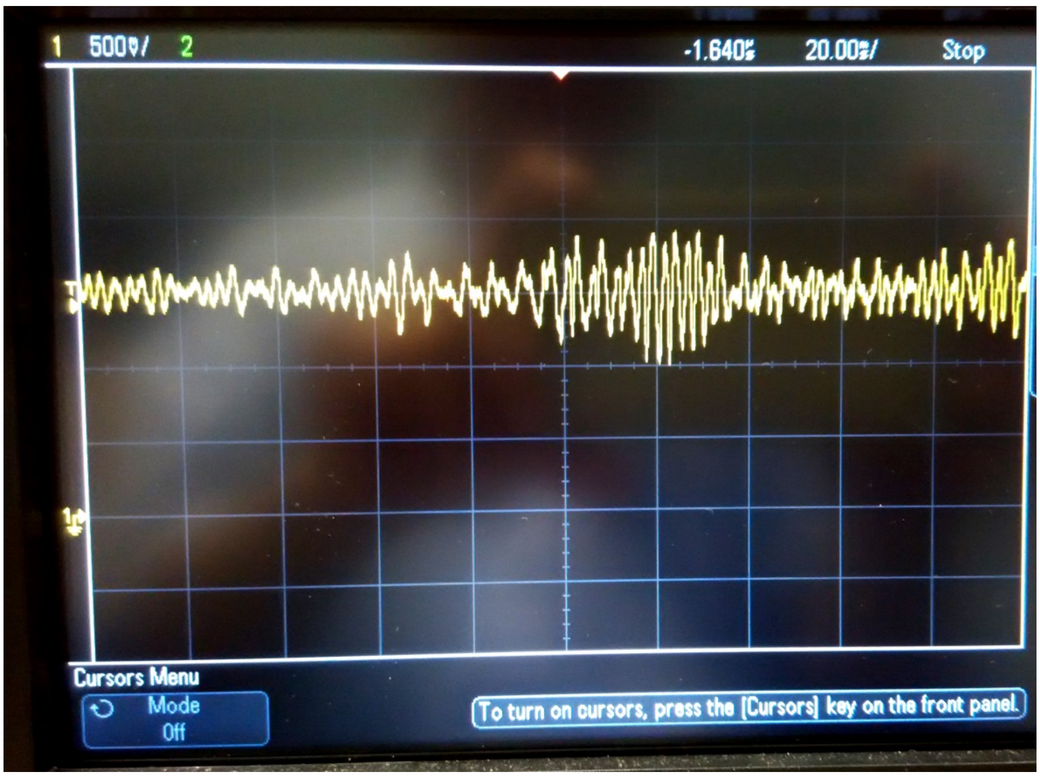


Figure. 3

Procedure 5. Write something to the flash from serial port and read it back to serial port.

(Hint: use the offered flash library functions and serial port functions from last lab.)

Procedure 6. Use a signal from the signal generator as input and observe the output via an oscilloscope.

1. Connect **Wave Gen** output of oscilloscope to the positive of Mic input terminal.

2. Connect the Channel 1 input of oscilloscope to the A0.

3. Connect the Channel 2 input of oscilloscope to the DAC_O.

4. Configure the waveform generator on the oscilloscope with following settings:
   Waveform = Sine
   Frequency = 500Hz
   Amplitude = 20mV p-p
   Offset = 0V

5. Turn on channel 1 and channel 2 displays of oscilloscope. Select channel 2 Coupling to AC. Set appropriate Vertical scales of both channels.

6. Download your program to ARDUINO.

7. Observe the output waveform of DAC.

8. Change the frequency of the signal generator from 0.5kHz to 16kHz. Run the programme again and repeat the step 7. **Record the output waveform at 50Hz, 100Hz, 500Hz, 1kHz, 2kHz, 4kHz, 6kHz, 8kHz in your own report.**

9. **Record the exact frequency** that the output waveform is start to look **different** than the input.

END