Week11-Circuit Report

Youwei Li

S1923864

Introduction :

The designed circuit will take the input as a slight signal ,which carries sound information, from microphone and output amplified input. Output will be represented as number **0-4095** which is regarded as sound information. Then STM32 board will sample the circuit-output data and output all sampled data as all **0-4095** numbers. Hence, designed circuit implements recording.

Circuit design :

Designed circuit is shown in appendix **Figure 1**. In this report, **R1** and **C0** are set to **2.2kΩ** and **1uF** respectively because the data sheet for microphone measurement circuit, which is shown in appendix **Figure 2**, has chosen specific value for resistor and capacitor(**2.2kΩ**, **1uF**). From appendix **Figure 1**, it can be seen that AC input voltage is **6.6mv**(3uA*2.2kΩ = 6.6mv). In order to achieve a **1.1v** or higher peak-to-peak voltage, AC input should be amplified **100** times. Because the effect of capacitor for amplification is very slight, only **R1** and **R2** affect amplification. **R2** should be **220kΩ** to get a **100** times amplification because the gain for inverter amplifier is -R2/R1(-220kΩ/2.2kΩ=**-100**).

C0 and **C1** are used to cut off the voltage with frequency that is not in range of **300Hz - 3000Hz**. C0-R1 is a **high-pass** filter and **C0** is set to **1uF** in the data sheet for microphone measurement circuit, which can be seen in appendix **Figure 2**. C1-R2 is a **low-pass** filter that removes voltage with frequency higher than 3000Hz. C1 should be **220pF** to get a **cut-off** frequency of **3288.325Hz**(1/(2*π*220kΩ*220pF)=3288.325Hz). **R3** and **R4** are **potential divider** and **2.2kΩ** will be a good option for both **R3** and **R4**.

Other than that, there are some changes made to circuit after week 7. To reduce noise arising from digital circuits on STM32 Nucleo board, decoupling capacitors **C2** and **C3** are connected in parallel between positive electrode and negative electrode of power supply. Power Indicator Circuit is also added to designed circuit to allows the LED diode to glow showing **3.3V** is indeed connected. Power Indicator Circuit is consist of a **LED** diode in series with a **4.7kΩ** resistor **R6**.

Circuit Testing:

The first step is to check **DC** levels. Disconnecting the microphone from designed circuit ,connecting a 1MΩ resistor to the output of STM32 and checking the **DC** levels on the inputs/output of the op-amp by connecting in the **ADC** input. Then compare the STM32 result with simulated LT spice test circuit. Simulated LT spice test circuit, the output of simulated LT spice test circuit and STM32 output are shown in appendix **Figure 3**, **Figure 4** and **Figure 5** respectively. It can be observed from **Figure 5** that output is in range of **1933-2085**. It can be deduced that the STM32 output voltage is in range of **1.558v**(3.3v*1933/4095) - **1.680v**(3.3v*2085/4095). Comparing STM32 output with the simulated result(**1.651v**) in **Figure 4**, it can be seen that the **DC** part of STM32 output is slightly different from simulated result(**1.651v**, **1.558v** to **1.680v**). Because STM32 output is in a real case not in a simulated case, there may be noise which slightly change the output voltage. Hence, the **DC** part of STM32 output works well.

The next step is to check STM32 **AC** part combined with **DC** part output. Removing the **1MΩ** resistor **R5** in appendix **Figure 3**, connecting microphone to the circuit and connecting op-amp output directly to the **ADC input** to digitalize output. Run the STM32 circuit ,record data and converting the output data in the range **-1** to **1**. The STM32 speech recordings output in this report is the recordings of an exciting music. The output is plotted in appendix **Figure 6** and STM32 speech recordings circuit is shown in appendix **Figure 7**. The quality of recording is superior and it is almost the original sound.

Conclusion:

Speech recording has been carried out in some different cases and key findings are shown below:

- The output will change rapidly, if the **tone** change quickly.
- The higher **sample rate** it is, the higher quality recording has.
- If output data hasn't convert to **-1**-**1**, many recording information will be **clipped** by audiowrite method in matlab.
- Output data won't be continuous recording if the execution while-loops in main.c is more than once. That is because the code won't start to next loop to record sound until it finishing printing all output data.

Appendix:

Reference:

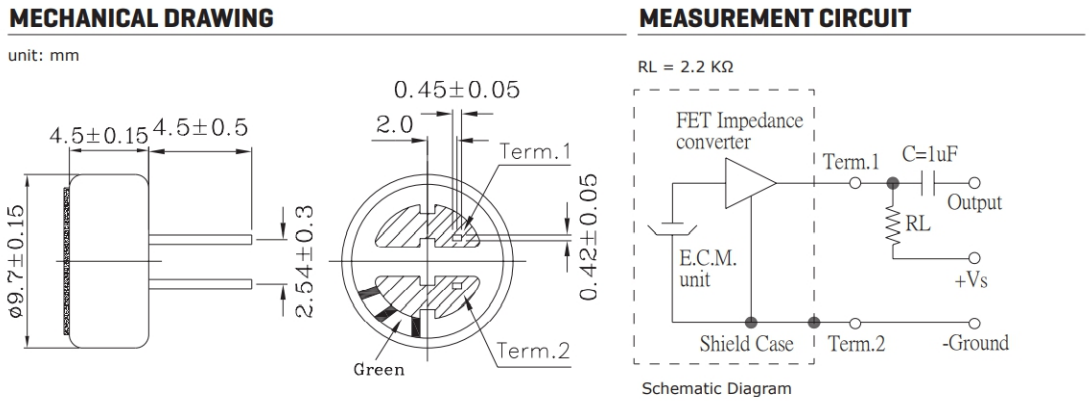

Figure 2

Reference from Learn - material - Lab 9: Speech Sampling - Datasheets for the Amplifier/Microphone plus Identifying Resistors/Capacitors.

LT Spice Circuit Diagram:

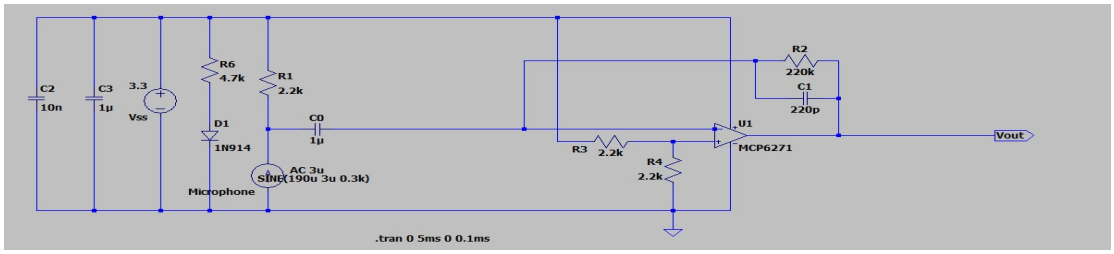

Figure 1

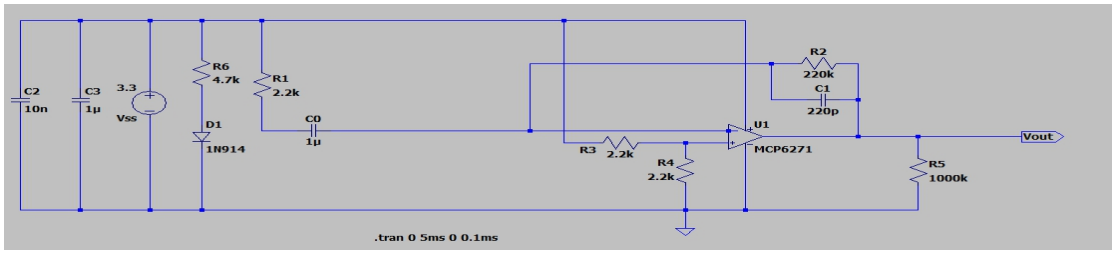

Figure 3

Figure 4

Breadboard Photo:

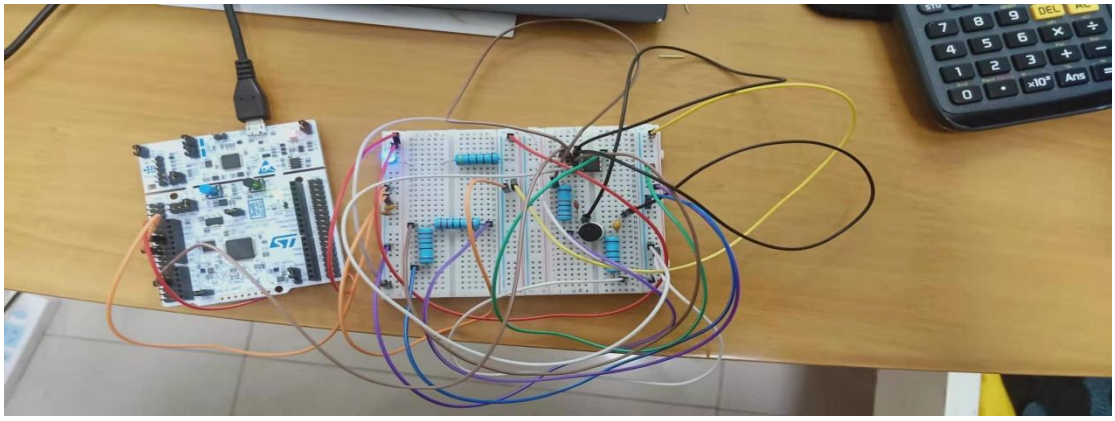

Figure 7

Figure 5

MATLAB Audio Plot:

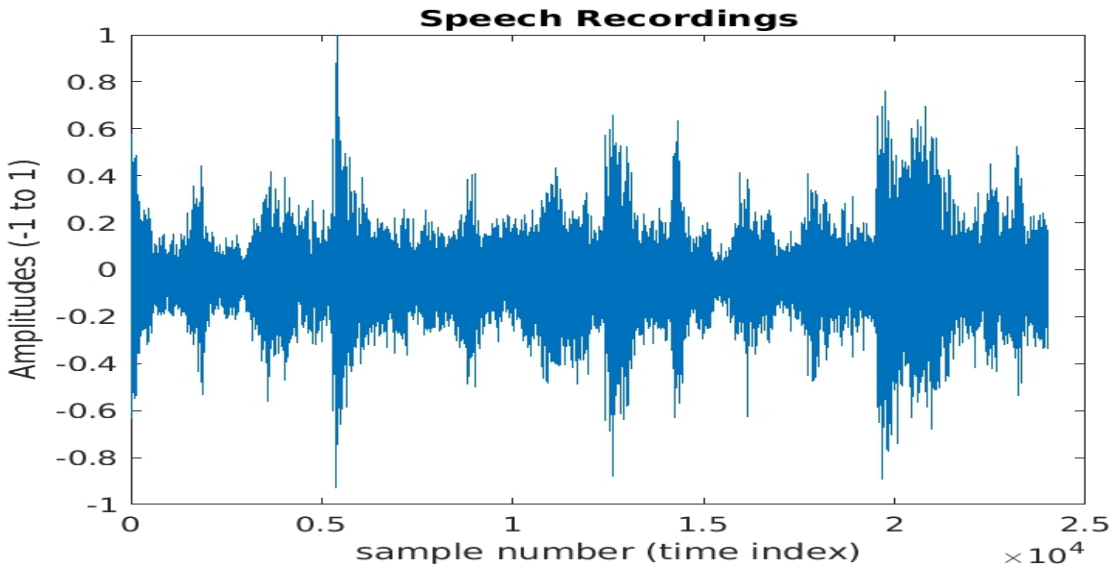

Figure 6