ECE 271 Microcomputer Architecture and Applications
Lab 11: Music Synthesizing
Instructor: Prof. Yifeng Zhu
Spring 2015

Goals

1. Understand the function of DAC conversion
2. Utilize the system timer to perform accurate delay
3. Develop a digital musical synthesis system

Pre-Lab Requirements

1. Read Chapter 16 DAC conversion
2. Complete the pre-lab report

Lab Requirements

1. Play the song of "Twinkle Twinkle Little Star" (ADSR is not required). (80%)
2. Something cool (10%). The following gives a few examples.
    a. Play your favorite song
    b. Tune the ADSR parameters to emulate an music instrument
    c. Flash a LED on each beat, and control the brightness based on the tone amplitude
    d. Show the frequency and duration on LCD
    e. Automatically translate music letter notes into frequencies
    f. Control the speed of the song (tempo) by using a potentiometer (pot)
    g. Control the volume of the song by using a potentiometer (pot)

Post-Lab Requirements

Lab Note:

Note: **Only PA.5 works since PA.4 was connected to the IDD measurement unit which measures the electrical current the processor take. A capacitor connects PA.4 and the ground.**

```
        AREA myMusic, DATA
        ALIGN

        ; Size, Frequency, Time Duration of Twinkle Twinkle Little Star
STAR_S  DCD  42  ; Number of notes
STAR_F  DCD 262, 262, 392, 392, 440, 440, 392       ; Twinkle twinkle little star
        DCD 349, 349, 330, 330, 294, 294, 262       ; How I wonder what you are
        DCD 392, 392, 349, 349, 330, 330, 294        ; Up above the world so high
        DCD 392, 392, 349, 349, 330, 330, 294        ; Like a diamond in the sky
        DCD 262, 262, 392, 392, 440, 440, 392        ; Twinkle twinke little star
        DCD 349, 349, 330, 330, 294, 294, 262       ; How I wonder what you are!
        ; Set Beats Per Minute (BMP) as 120
STAR_T  DCD 1, 1, 1, 1, 1, 1, 2                     ; Twinkle twinkle little star
        DCD 1, 1, 1, 1, 1, 1, 2                     ; How I wonder what you are
        DCD 1, 1, 1, 1, 1, 1, 2                      ; Up above the world so high
        DCD 1, 1, 1, 1, 1, 1, 2                     ; Like a diamond in the sky
        DCD 1, 1, 1, 1, 1, 1, 2                     ; Twinkle twinke little star
        DCD 1, 1, 1, 1, 1, 1, 2                     ; How I wonder what you are!

        ; Size, Frequency, Time Duration of Happy Birthday
HB_S    DCD  25
HB_F    DCD 392, 392, 440, 392, 523, 494            ; Happy Birthday to You
        DCD 392, 392, 440, 392, 523, 494            ; Happy Birthday to You
        DCD 392, 392, 784, 659, 523, 494, 440       ; Happy Birthday to Dear (name)
        DCD 349, 349, 330, 262, 294, 262            ; Happy Birthday to You
        ; Set Beats Per Minute (BMP) as 240
HB_T    DCD 1, 1, 2, 2, 2, 4                        ; Happy Birthday to You
        DCD 1, 1, 2, 2, 2, 4                        ; Happy Birthday to You
        DCD 1, 1, 2, 2, 2, 2, 6                     ; Happy Birthday to Dear (name)
        DCD 2, 2, 2, 2, 2, 4                        ; Happy Birthday to You

        END
```

ECE 271 Pre-Lab Assignment
Lab 11: Musical Synthesizing

Student Name: _____
TA: _____
Time & Date: _____

1. Suppose the music is recorded as 44,100 samples per second. As you have done in the previous lab, the timer generates 44,100 interrupts per second. How many degrees the angle variable of the sin waveform should increases in each interrupt for a music note with a frequency of *f*?

2. Since we cannot directly store floating numbers directly, how can you reduce the rounding error of the angel variable *x*? Based on the sin wave frequencies we have in the song, what is a reasonable parameter you will choose?

3. The system timer is used to perform some periodic tasks. For example, it can be used as a time delay or periodically updates some parameters. How would you use the system timer in this lab? What is the SysTick Reload Value Register (SysTick_LOAD) ? What is the time interval between two consecutive SysTick interrupts? Note HSI (16MHz) is used in this lab. The music speed is often measured as BPM (Beats per minute). For example, the song "Twinkle Twinkle Little Star" is played at a speed of 120 beats per minutes.

4. List the key tasks of your lab program

main
1. Initialize Clock 2. Initialize Timer 3. Initialize System Timer (SysTick) 4. Initialize DAC

SysTick_Handler

TIM4_IRQHandler

ECE 271 Post-lab
Lab 11: Digital to Analog Conversion (DAC)
Spring 2015

Submit your answer in *readme.md*.

1. Do you have any suggestions for me to improve the course if I teach it again?
2. Overall, how do you think about the course?
3. Overall, how do you think about the labs?
4. Overall, how do you think about the textbook?