

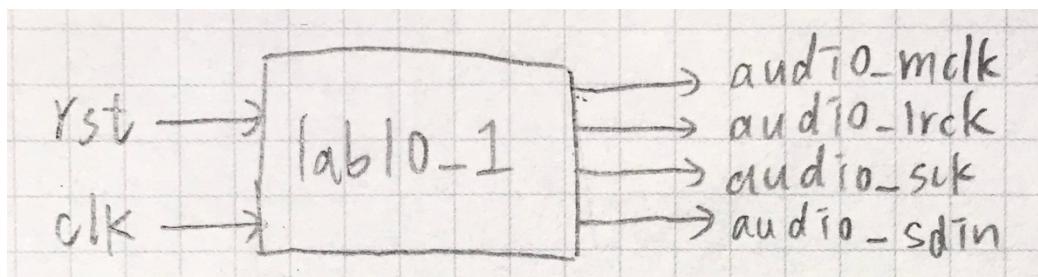
Lab 10: Electronic Organ

- Play the 14 sounds repeatedly based on the sound table. Every sound is played for one second.

Specification:

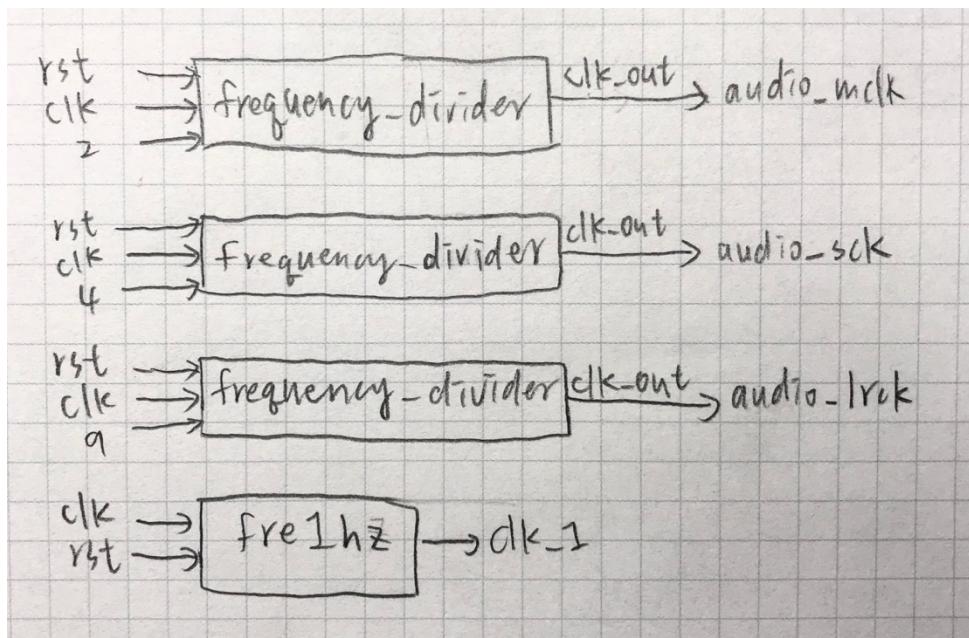
Input: clk, rst

Output: audio_mclk, audio_lrck, audio_sck, audio_sdin



I/O	clk	rst	audio_mclk	audio_lrck	audio_sck	audio_sdin
LOC	W5	V17	A14	A16	B15	B16

Implementation:

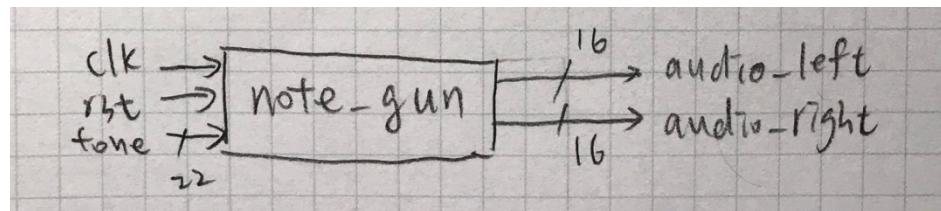


首先做出 25 M, (25/128) M, 6.25 MHz 的 clock，利用 frequency divider 除出相對應的頻率後，再將 clk_out 接給 lab10_1 的 audio_mclk, audio_lrck, audio_sck 這 3 個 outputs，再另外設計一個 1HZ 的 clock clk_1。

設計一個 counter，4-bit a 由 0 開始每秒向上加 1，當 a 為 13 則重新由 0 開始數。

將 a 經由 MUX，選出 22-bit tone 的值，a 從 0 到 13，tone 會每秒變化共有 14 個不同的值。

```
case(a)
  4'd0: tone = 22'd227273;
  4'd1: tone = 22'd204082;
  4'd2: tone = 22'd191571;
  4'd3: tone = 22'd170648;
  4'd4: tone = 22'd151515;
  4'd5: tone = 22'd143266;
  4'd6: tone = 22'd127551;
  4'd7: tone = 22'd113636;
  4'd8: tone = 22'd101215;
  4'd9: tone = 22'd95420;
  4'd10: tone = 22'd85034;
  4'd11: tone = 22'd75758;
  4'd12: tone = 22'd71633;
  default: tone = 22'd63776;
```



把 tone 接到 note_gun module 的 input note_div，產生對應的 output 16-bit audio_left, audio_right，再將 audio_left, audio_right 一個一個 bit 的給 audio_sdin，就完成了。

討論：

這題原本是想說要用 shift 給 tone 不同的值，後來想到用 MUX 會比較簡單些。

2. Electronic Organ

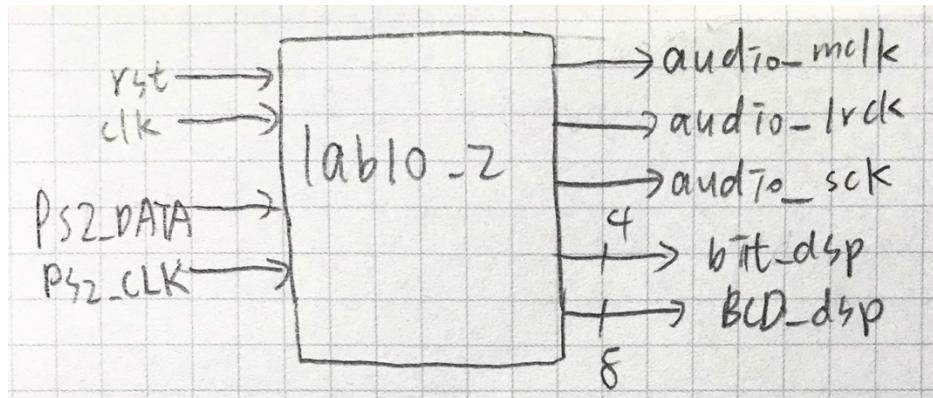
- 2.1 Integrate the keypad as the keyboard of the electronic organ. Keys c, d, e, f, g, a, b, C, D, E, F, G, A, B (two octaves from mid-Do) represent the sounds from low to high frequencies.
- 2.2 Display your playing sound (Do, Re, Mi, Fa, So, La, Si) in the 7-segment LED.

Specification:

Input: clk, rst

Inout: PS2_DATA, PS2_CLK

Output: audio_mclk, audio_lrck, audio_sck, audio_sdin, [3:0]bit_dsp, [7:0]BCD_dsp

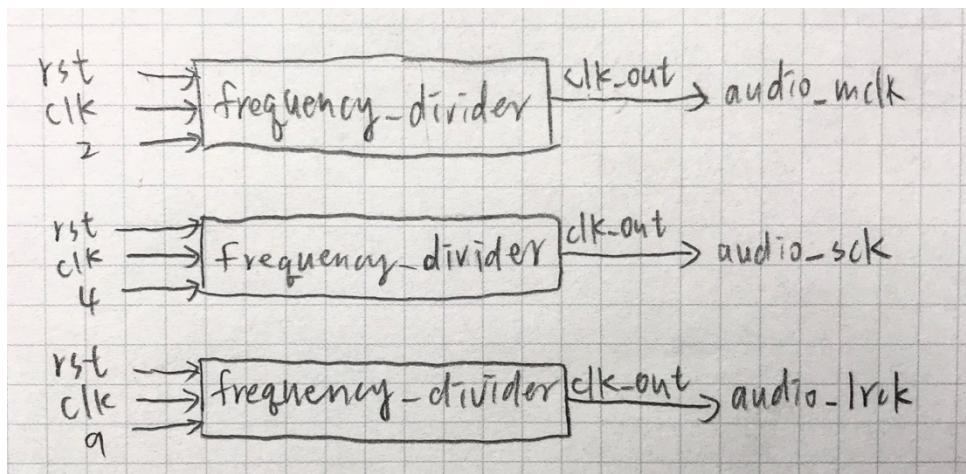


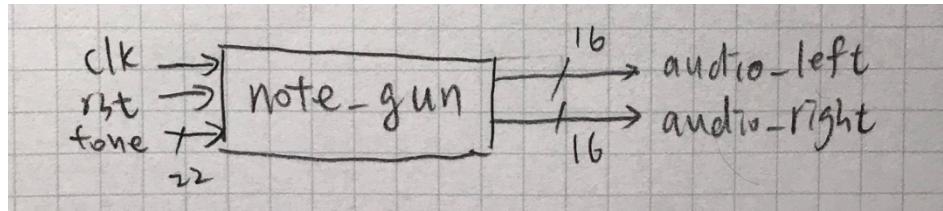
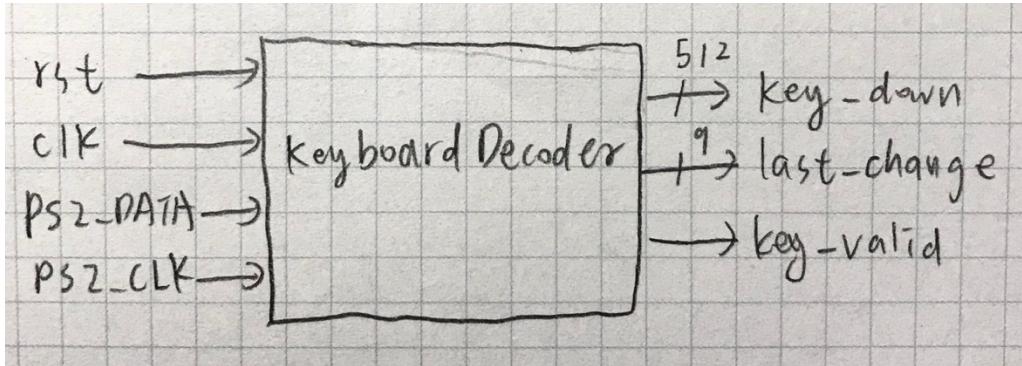
I/O	clk	rst	audio_mclk	audio_lrck	audio_sck	audio_sdin
LOC	W5	V17	A14	A16	B15	B16

PS2_CLK	PS2_DATA	bit_dsp[0]	bit_dsp[1]	bit_dsp[2]	bit_dsp[3]
C17	B17	U2	U4	V4	W4

BCD_dsp [0]	BCD_dsp [1]	BCD_dsp [2]	BCD_dsp [3]	BCD_dsp [4]	BCD_dsp [5]	BCD_dsp [6]	BCD_dsp [7]
V7	U7	V5	U5	V8	U8	W6	W7

Implementation:





這題是結合 lab9 的實驗，按下按鈕 key_down[last_change]會透過 MUX 將 ASCII_ 純 0~6，代表 c,d,e,f,g,a,b，一開始 ASCII_ 為 15，當 caps 為 0 代表設定大寫，就將 ASCII_+7 純 4-bit in，若 caps 為 1 代表為小寫 in 就是 ASCII_，所以當 in 為 15 或是 22 就代表按到其他沒功能的鍵。

將 in 經過 MUX 讓 tone 選擇 22-bit 的數字，in 若非 0~13，tone 為 22'd0，

```

case(in)
  5'd0: tone = 22'd227273;
  5'd1: tone = 22'd204082;
  5'd2: tone = 22'd191571;
  5'd3: tone = 22'd170648;
  5'd4: tone = 22'd151515;
  5'd5: tone = 22'd143266;
  5'd6: tone = 22'd127551;
  5'd7: tone = 22'd113636;
  5'd8: tone = 22'd101215;
  5'd9: tone = 22'd95420;
  5'd10: tone = 22'd85034;
  5'd11: tone = 22'd75758;
  5'd12: tone = 22'd71633;
  5'd13: tone = 22'd6377;
  default: tone = 22'd0;

```

之後就是將 tone 接到 note_gun module 再將 output audio_left, audio_right 一個一個 bit 的給 audio_sdin。

設定 in1 為 in/10，in2 為 in%10，若 in 為 15/22，則 in1 為 0，in2 為 10，把 in1,in2 利用 MUX 給 8-bit S1,S2 不同的值，若 in2 為 10 則 S2 為`SS_F，讓 7-seg 顯示 F，其他則會顯示 0~14。

討論：

這題沒遇到什麼困難，很順利就完成了。

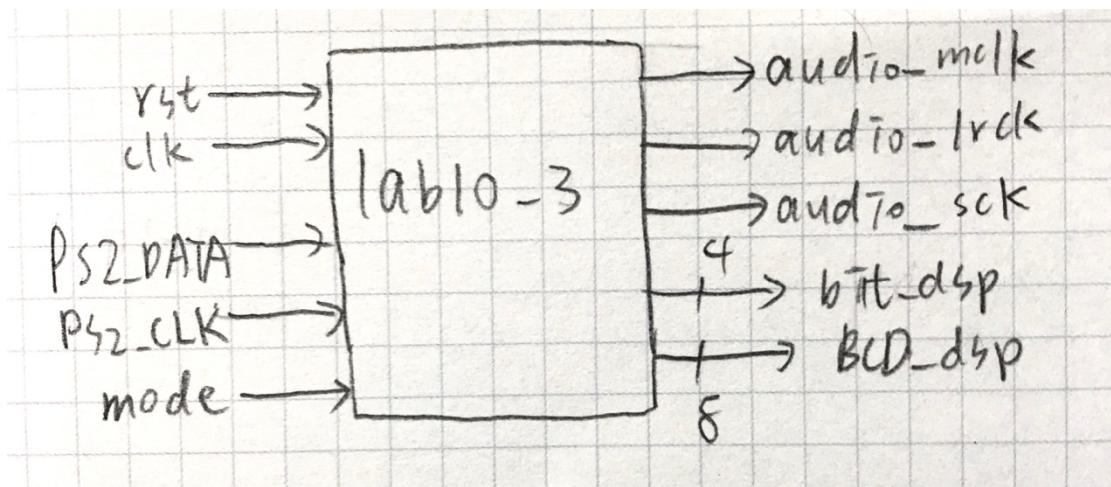
- (Bonus) Playback double tones by separate left and right channels. If you turn one DIP switch off, the electronic organ playback single tone when you press keyboard (as in Prob. 2). If you turn DIP switch on, left (right) channels play Do(Mi), Re(Fa), Mi(So), Fa(La), So(Si) when you press the keyboard.

Specification:

Input: clk, rst, mode

Inout: PS2_DATA, PS2_CLK

Output: audio_mclk, audio_lrck, audio_sck, audio_sdin, [3:0]bit_dsp, [7:0]BCD_dsp

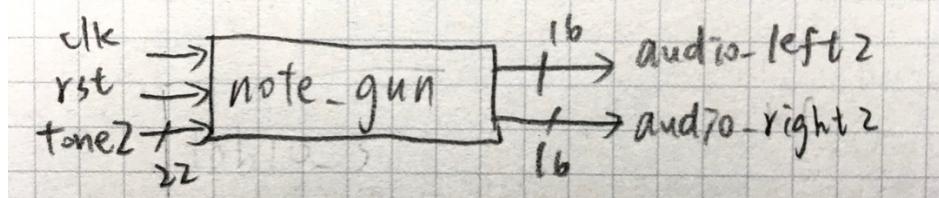
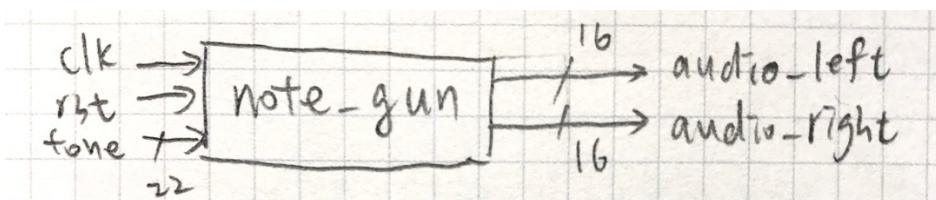
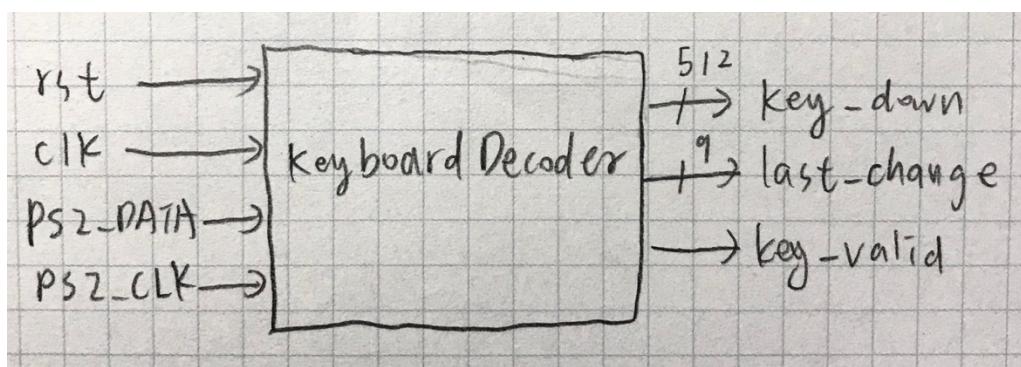
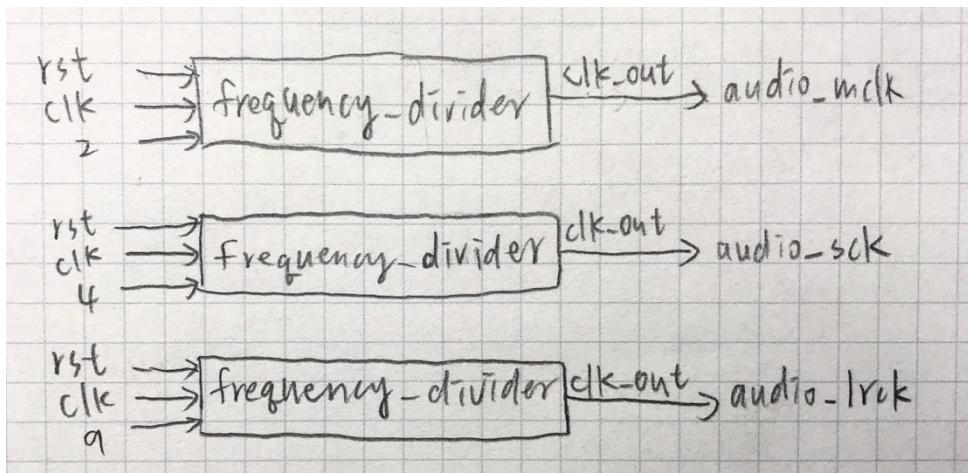


I/O	clk	rst	mode	audio_mclk	audio_lrck	audio_sck	audio_sdin
LOC	W5	V17	R2	A14	A16	B15	B16

PS2_CLK	PS2_DATA	bit_dsp[0]	bit_dsp[1]	bit_dsp[2]	bit_dsp[3]
C17	B17	U2	U4	V4	W4

BCD_dsp [0]	BCD_dsp [1]	BCD_dsp [2]	BCD_dsp [3]	BCD_dsp [4]	BCD_dsp [5]	BCD_dsp [6]	BCD_dsp [7]
V7	U7	V5	U5	V8	U8	W6	W7

Implementation:



這題跟第二題大部分都一樣，增加了 22-bit `tone2`，`last_change` 經過 MUX 給 `tone2` 對應的值，若 `last_change` 非`KEY_a~g`，代表按到無功能按鍵，`tone2` 為 0，

```
case(last_change)
    `KEY_c: tone2 = 22'd191571;
    `KEY_d: tone2 = 22'd170648;
    `KEY_e: tone2 = 22'd151515;
```

```
`KEY_f: tone2 = 22'd143266;  
`KEY_g: tone2 = 22'd143266;  
default: tone2 = 0;
```

將 tone2 設為另一個 note_gun module 的 input，output 為 audio_left2, audio_right2，當 mode 為 0，左右聲道為不同聲音，則將 audio_right2/audio_left 穿插 1 個 1 個 bit 的給 audio_sdin，若 mode 為 1，左右聲道相同，則為正常的 audio_right/audio_left 穿插 1 個 1 個 bit 的給 audio_sdin。

討論：

有稍微想一下要怎麼讓左右聲道不同聲音，原本想說是不是要修改 note_gun 裡面的 code，又來有想到多設一個 note_gun module 就能解決了。

結論：

這次實驗算是簡單，幾乎沒什麼 bug，把之前的實驗結合起來就能完成。