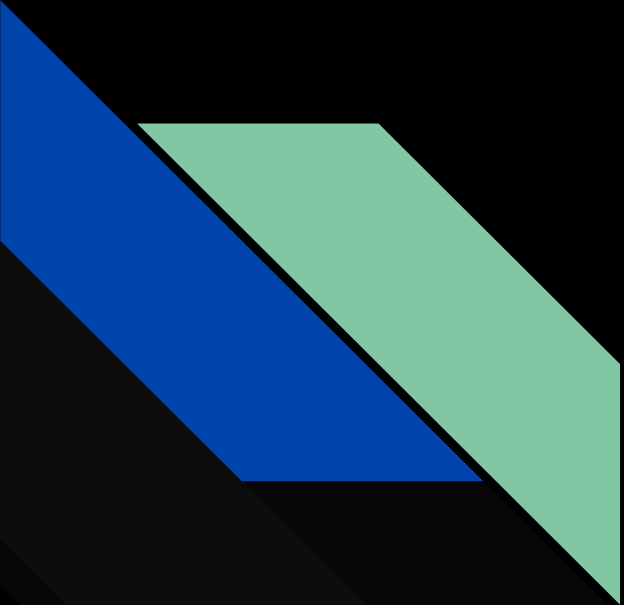
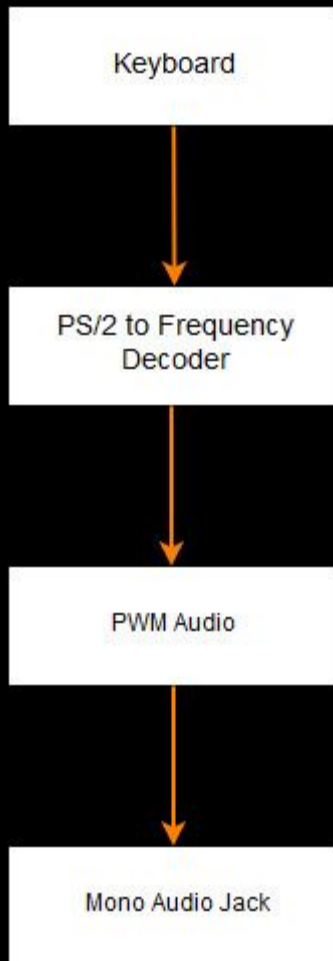


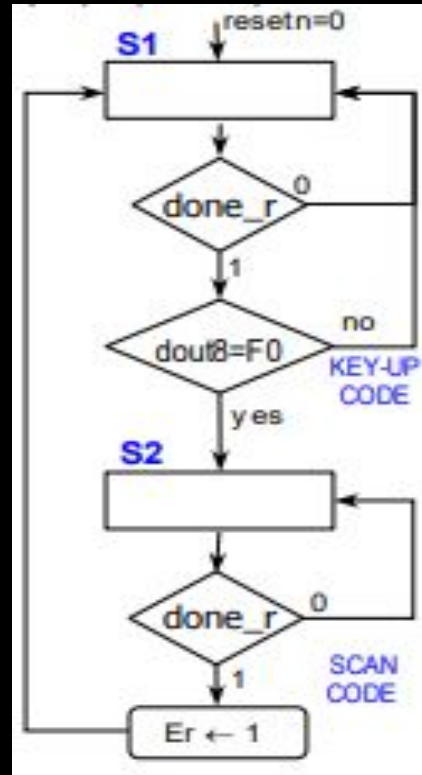
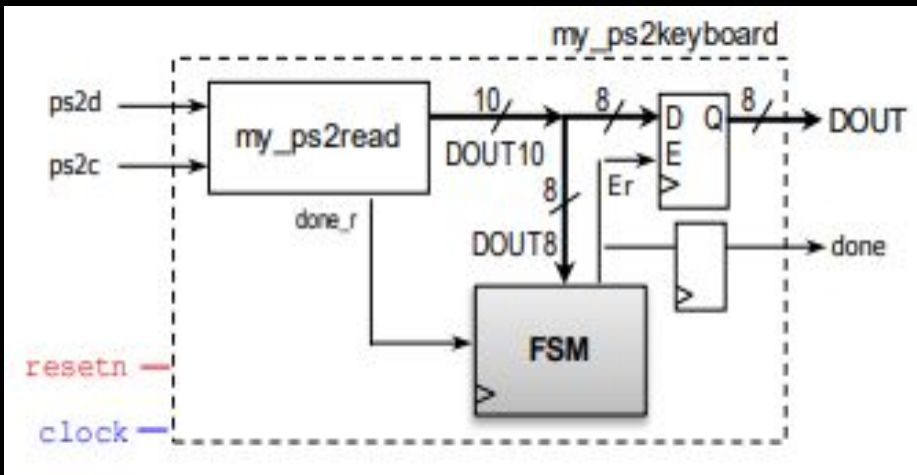


Music Time

By: Chris Viray, David Lewis, Kulin Damani

Design System



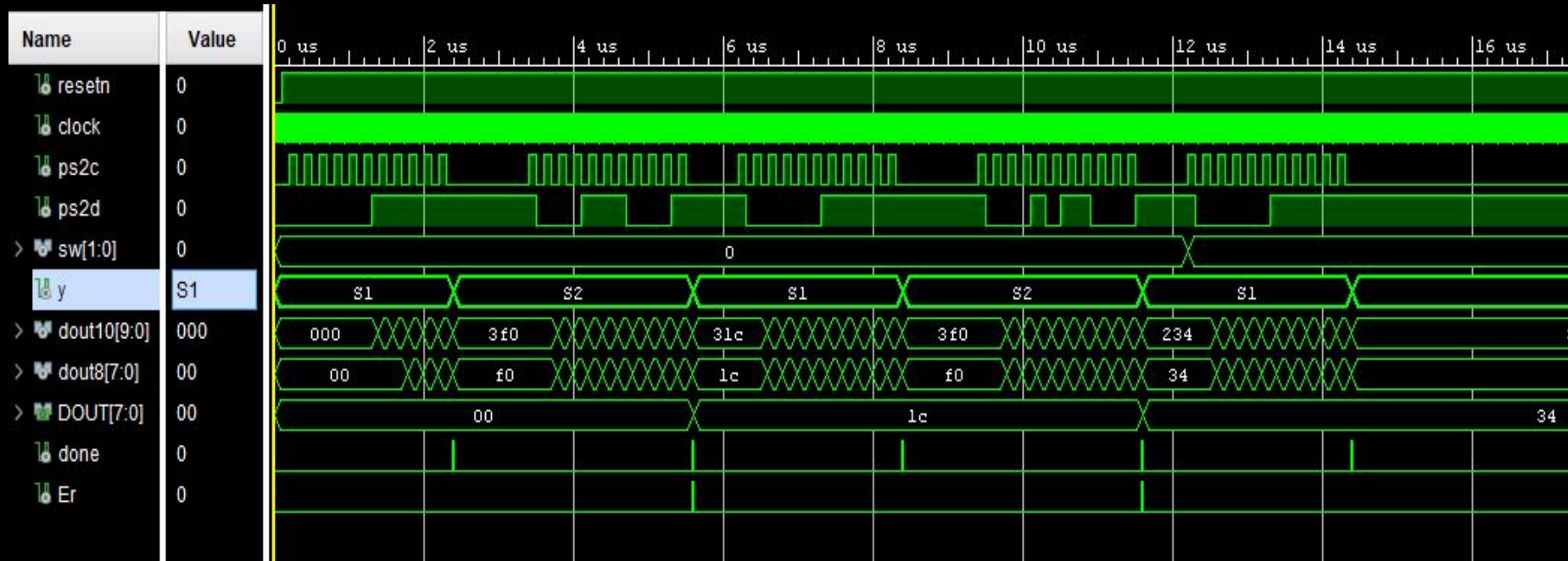


Keyboard

ESC 76	F1 05	F2 06	F3 04	F4 0C	F5 03	F6 0B	F7 83	F8 0A	F9 01	F10 09	F11 78	F12 07	
~ 0E	1! 16	2@ 1E	3# 26	4\$ 25	5% 2E	6^ 36	7 & 3D	8* 3E	9(46	0) 45	-_ 4E	=+ 55	BackSpace ← 66
TAB 0D	Q 15	W 1D	E 24	R 2D	T 2C	Y 35	U 3C	I 43	O 44	P 4D	[{ 54	]} 5B	\ 5D
Caps Lock 58	A 1C	S 1B	D 23	F 2B	G 34	H 33	J 3B	K 42	L 4B	:: 4C	"" 52	Enter ↵ 5A	
Shift 12	Z 1Z	X 22	C 21	V 2A	B 32	N 31	M 3A	,< 41	>. 49	/? 4A	↑ 59	Shift	
Ctrl 14	Alt 11	Space 29						Alt E0 11	Ctrl E0 14				

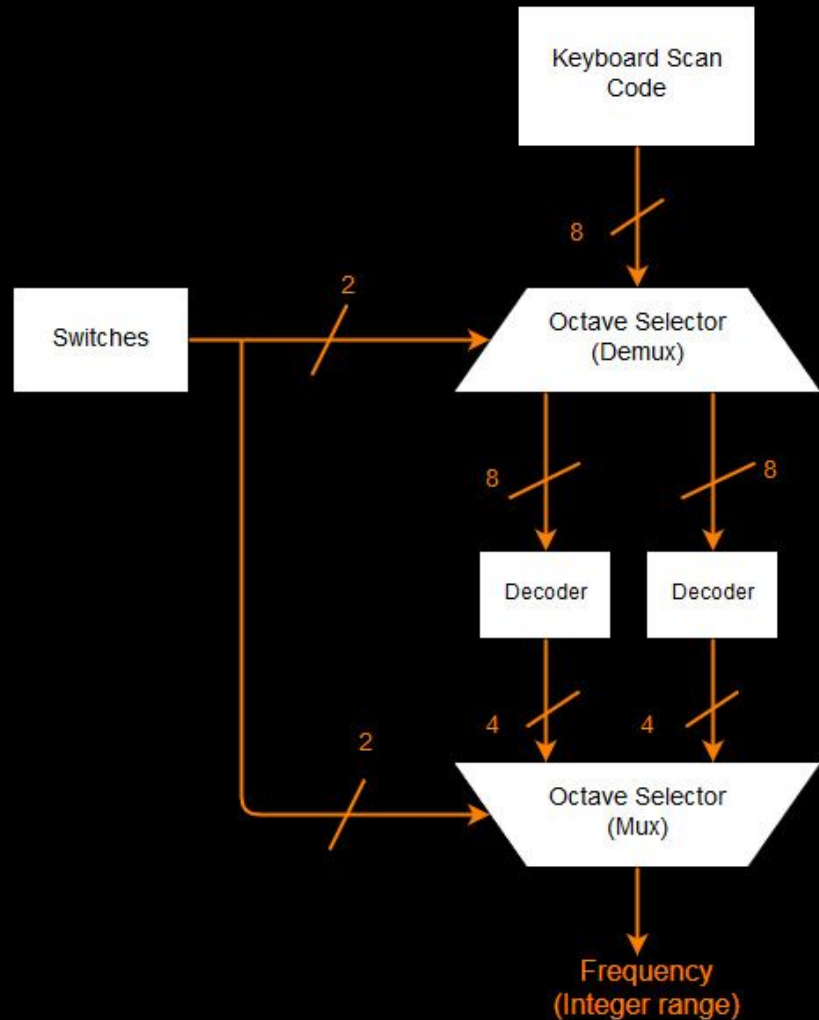
Figure 9. Keyboard scan codes.

Keyboard Simulation



Keyboard Decoder

```
if SW = "01" then
case key is
  when "00110010" => frq <= 65;--b
  when "00011100" => frq <= 73;--a
  when "00110100" => frq <= 82;--g
  when "00101011" => frq <= 86;--f
  when "00100100" => frq <= 97;--e
  when "00100011" => frq <= 109;--d
  when "00100001" => frq <= 123;--c
```



Example I/O



- If Sel = "00"
 - Scan Code = "00110100" (Letter 'A')
 - Freq = 65 (integer)
 - Scan Code = "00100011" (Letter 'E')
 - Freq = 97 (integer)
- If Sel = "01"
 - Scan Code = "00110100" (Letter 'A')
 - Freq = 247 (integer)

PWM Audio

Issues:

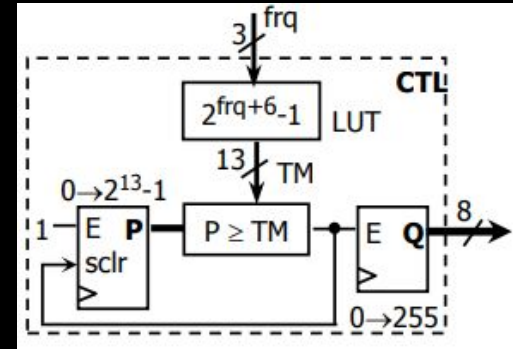
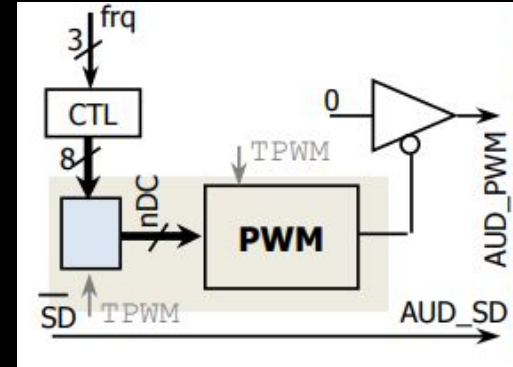
Duty Cycle was backwards.

As $freq$ increased the duty cycle decreased.

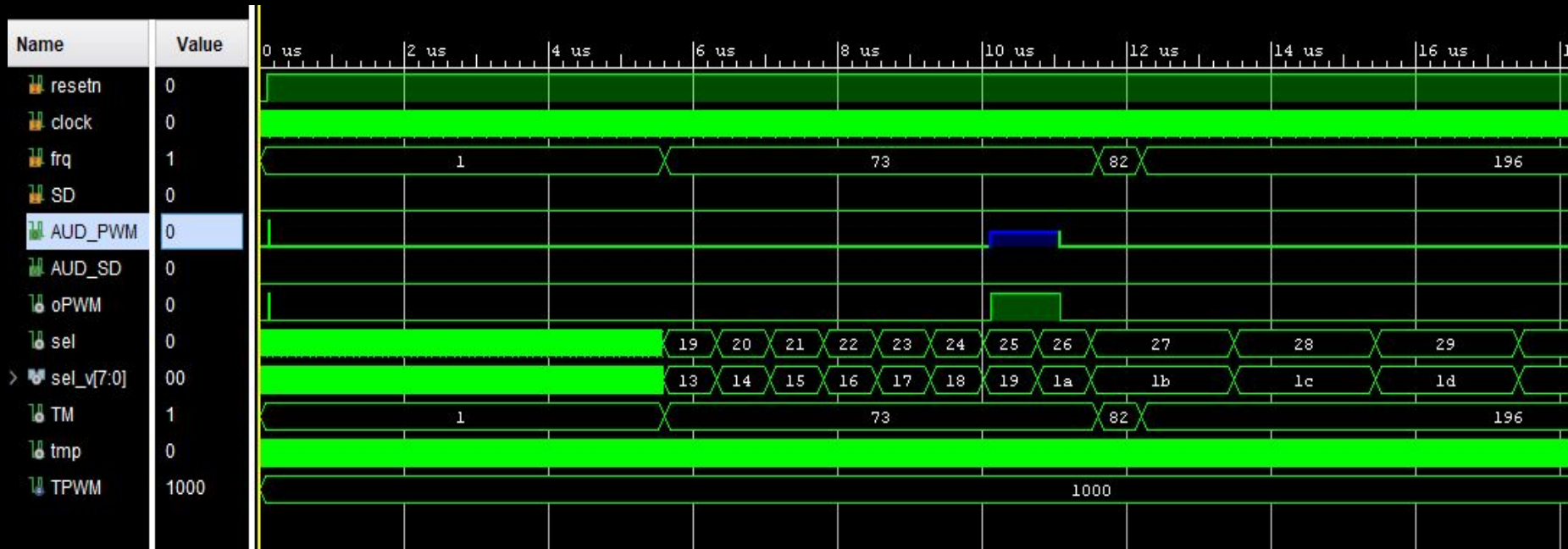
Frequency became mirrored.

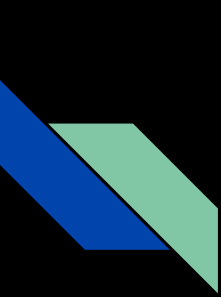
Solution:

Map the key press to the corresponding $freq$ based on its duty cycle



PWM Audio Simulation





References

- <https://reference.digilentinc.com/detail/reference/programmable-logic/nexys-4-ddr/n4k.png?id=reference%3Aprogrammable-logic%3Anexys-4-ddr%3Areference-manual>
- https://moodle.oakland.edu/pluginfile.php/5005747/mod_resource/content/7/Notes%20-%20Unit%203.pdf
- <http://www.secs.oakland.edu/~llamocca/VHDLforFPGAs.html>
- http://www.ece.iastate.edu/~alexs/classes/2016_Spring_575/HW/HW5/files/piano-key-freq-wikipedia.pdf

Questions?

