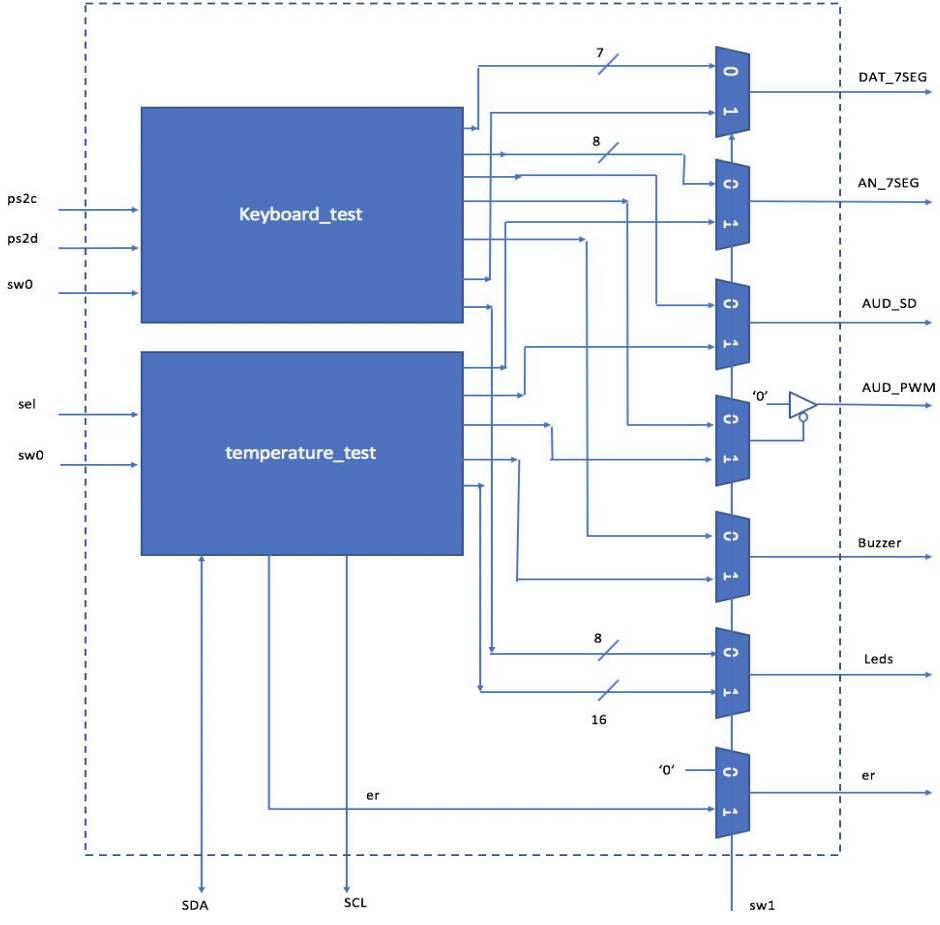
Tones from Keyboard and Temperature Sensor

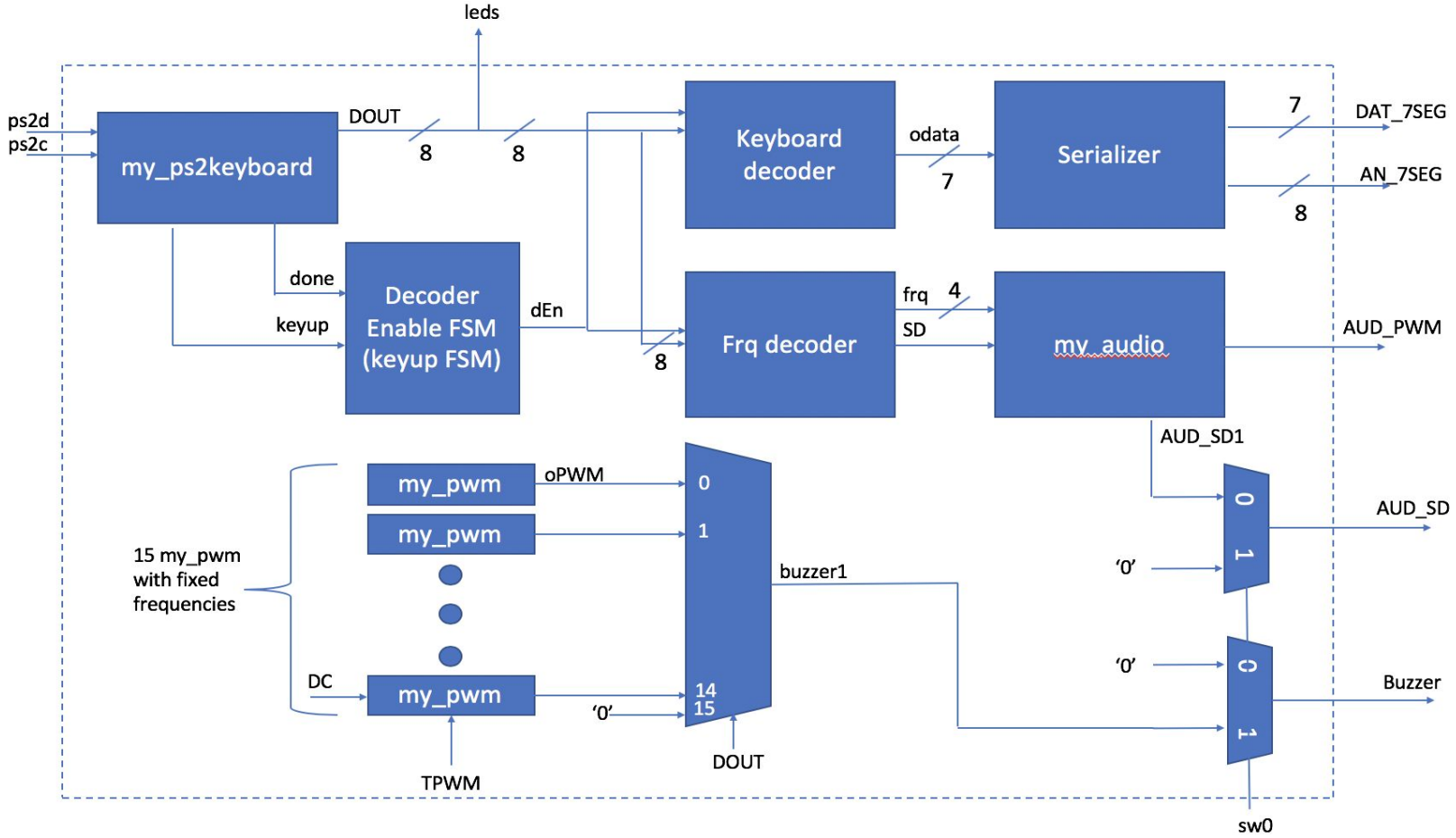
Arsha Ali, Zhenye Li, Stefanie Kozera

Overview



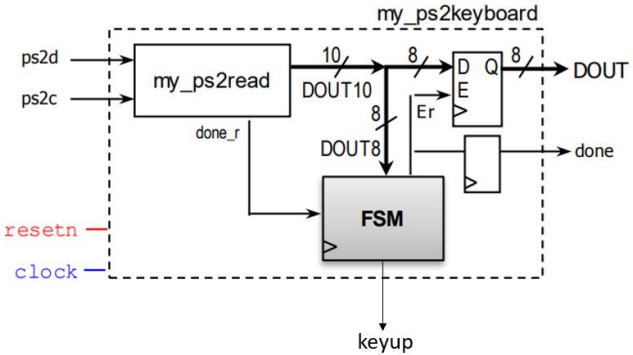
- Outputs
  - Mono Audio Output
  - Buzzer
  - Seven Segment Display
  - LEDs
- Inputs
  - Keyboard or Temp. Sensor
  - Mono Audio or Buzzer
  - Temperature or Status and ID
  - PS/2 signals for keyboard
  - I2C signals for temp. sensor

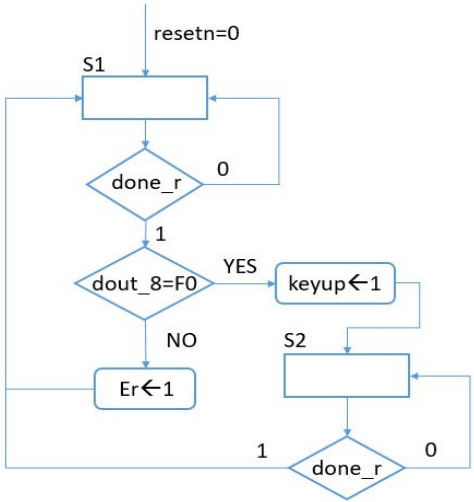
Keyboard


leds
ps2d
ps2c
my_ps2keyboard
DOUT
8
8
Keyboard decoder
odata
7
Serializer
7
DAT_7SEG
AN_7SEG
8
done
keyup
Decoder Enable FSM (keyup FSM)
dEn
8
Frq decoder
frq
4
SD
my_audio
AUD_PWM
AUD_SD1
my_pwm
my_pwm
my_pwm
oPWM
15 my_pwm with fixed frequencies
DC
TPWM
0
1
14
15
'0'
DOUT
buzzer1
0
1
'0'
AUD_SD
0
1
'0'
Buzzer
sw0

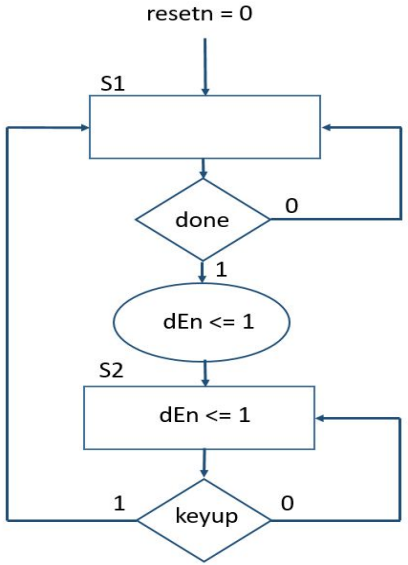
Keyboard

- PS/2 Protocol:
  - Scan code sent every 100ms
  - Key up scan code
  - Repeated scan code
- PIC24FJ128 chip
- Enable other blocks only while a key is being pressed



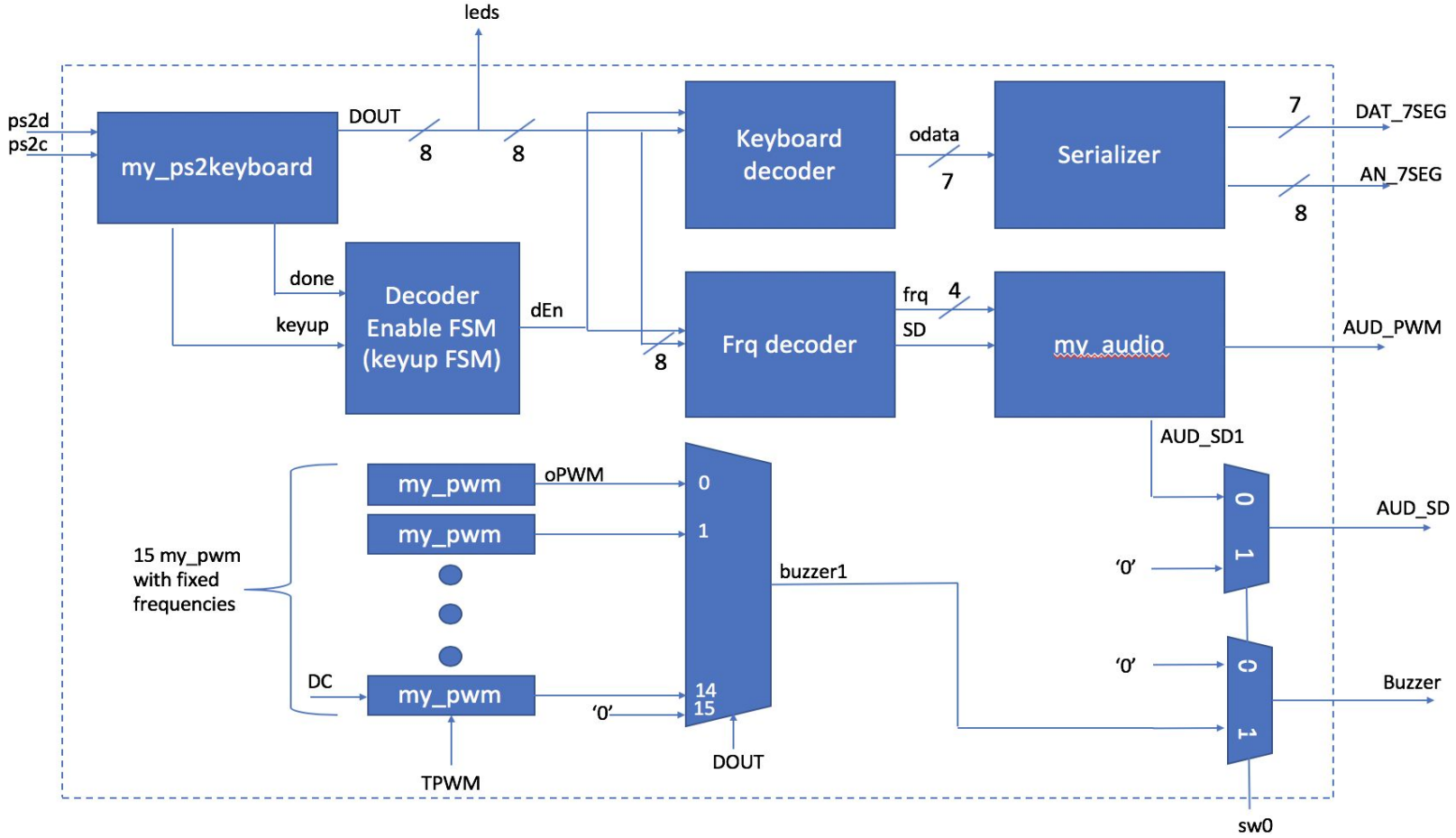


FSM to detect key up scan code



Keyup FSM

Keyboard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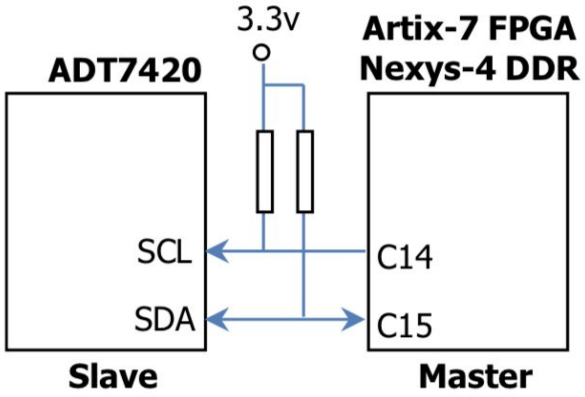
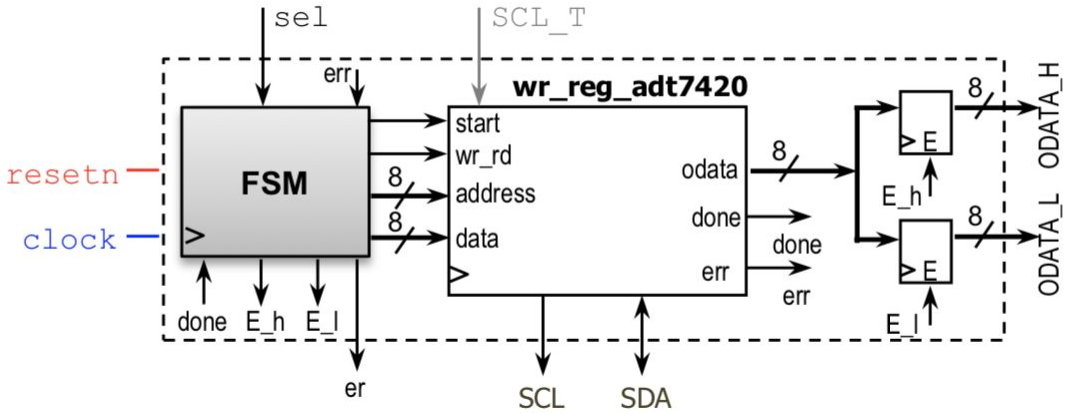
my_audio
AUD_PWM
AUD_SD1
my_pwm
my_pwm
my_pwm
oPWM
15 my_pwm with fixed frequencies
DC
TPWM
0
1
14
15
'0'
DOUT
buzzer1
0
1
'0'
AUD_SD
0
1
'0'
Buzzer
sw0

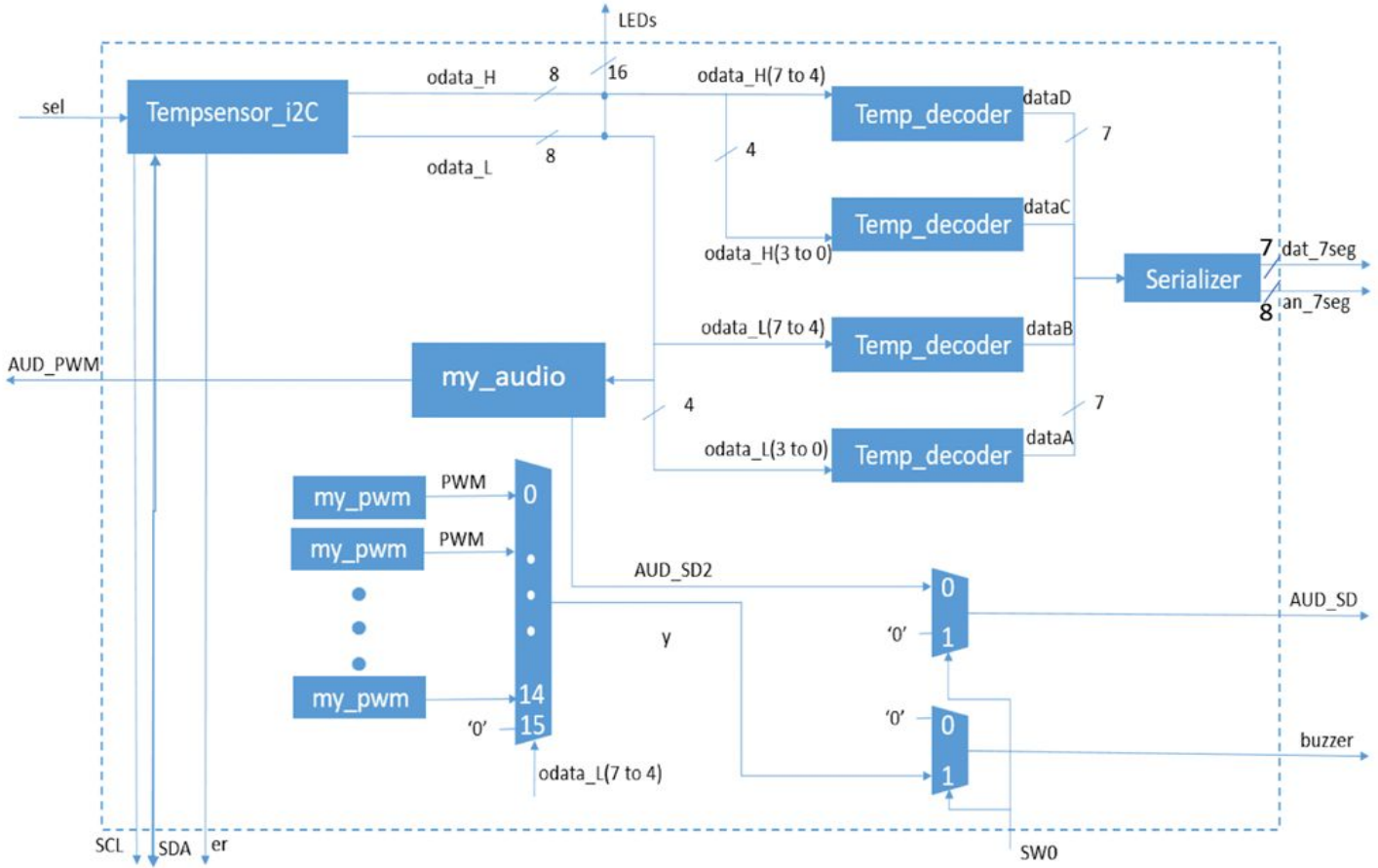
Temperature Sensor

- ADT7420 chip
- 16-bit mode:
  - 0.0078°C resolution
- I²C Interface

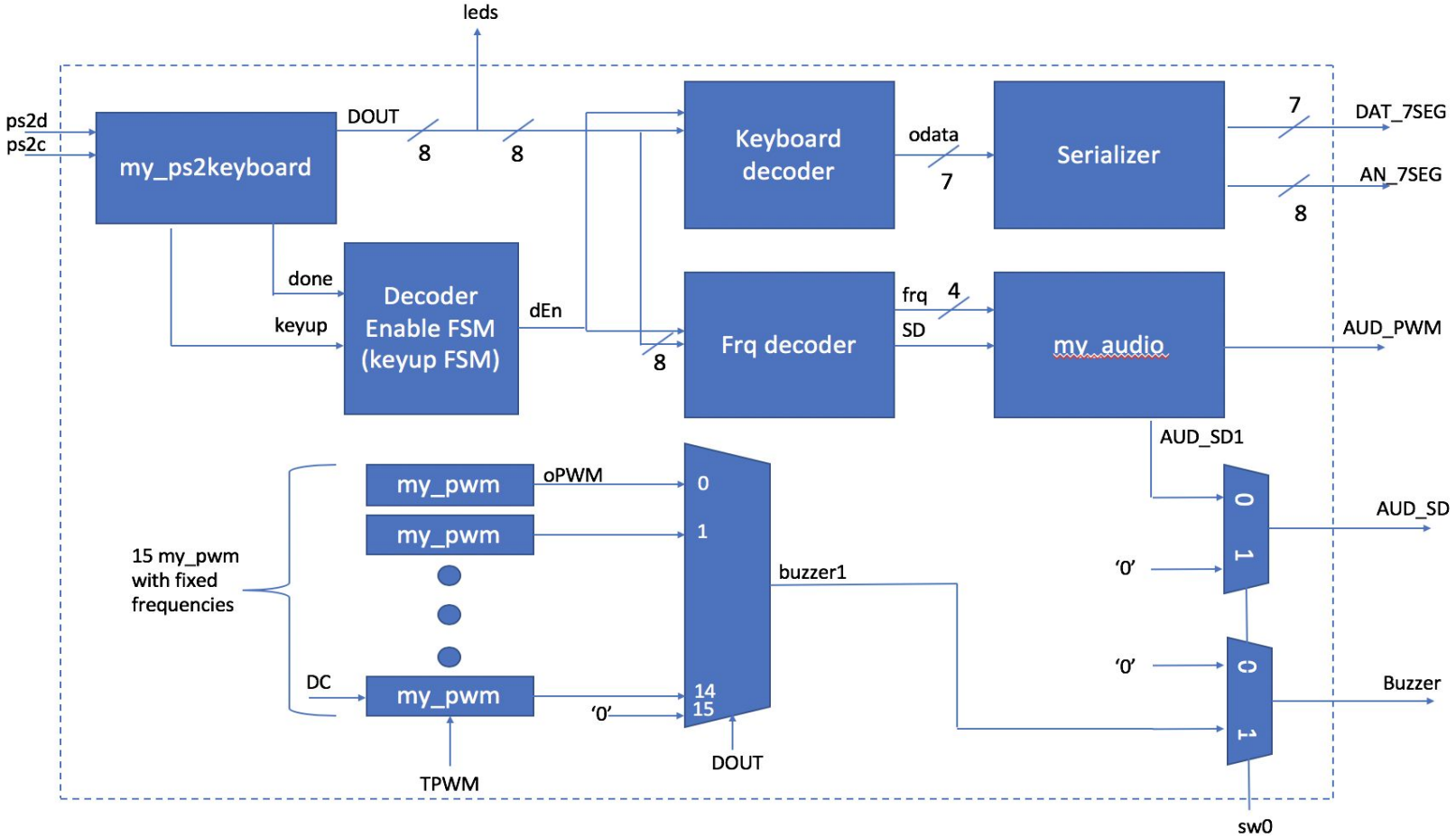




Temperature Sensor

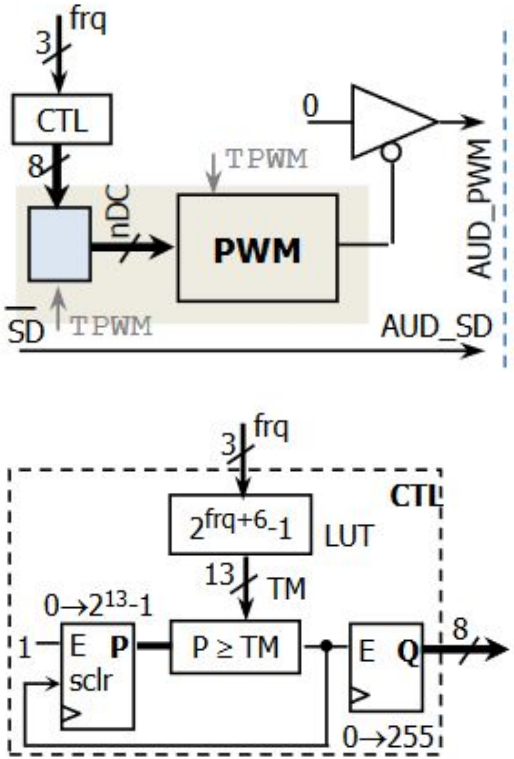


Mono Audio Output

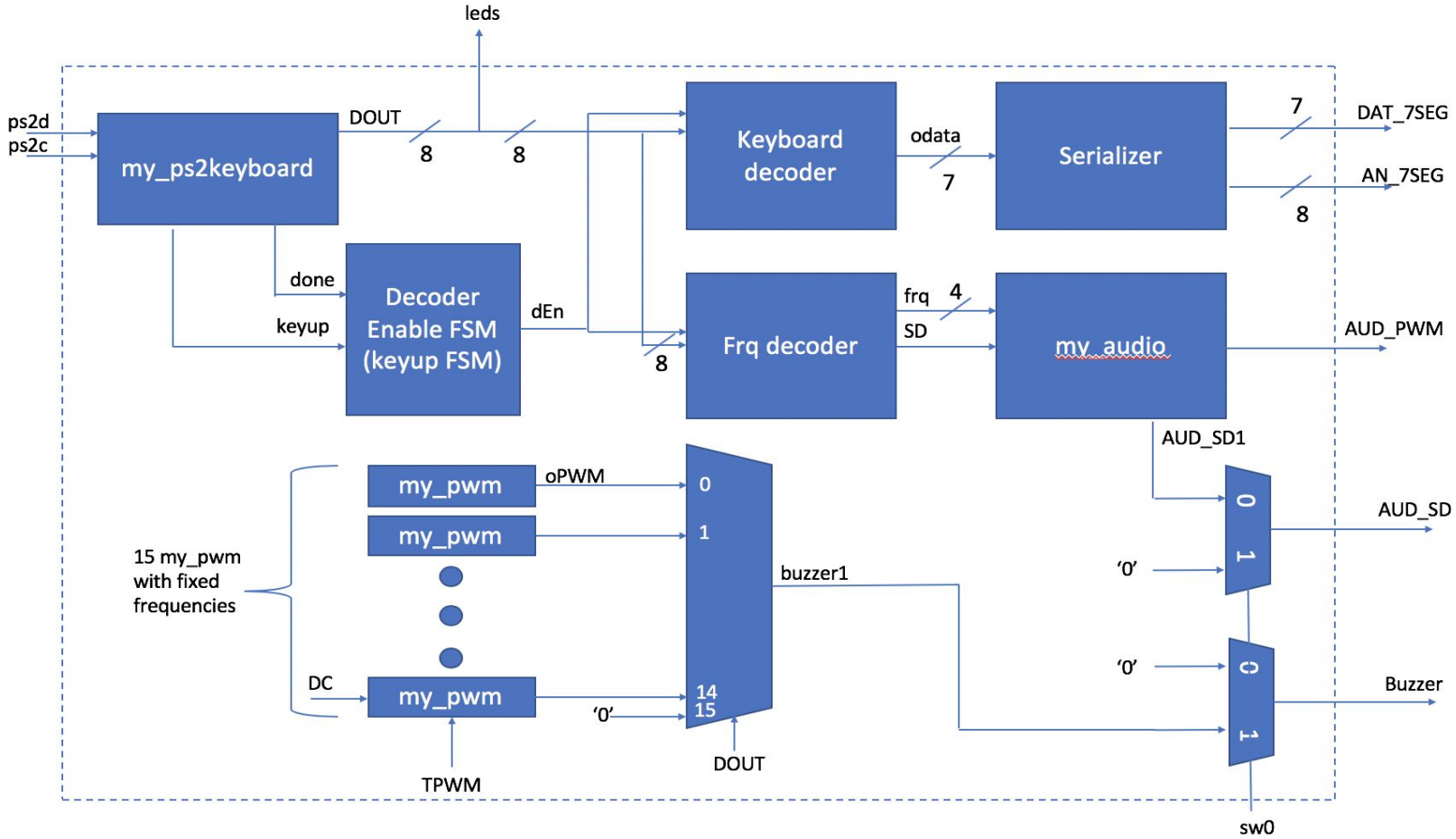


Mono Audio Output - my_audio

- Generates a PWM signal from a 4-bit number
  - Modified from existing code, originally only support for 3-bit number
- The PWM signal with varying duty cycle turned into a sinusoid by a low pass filter on the nexys board

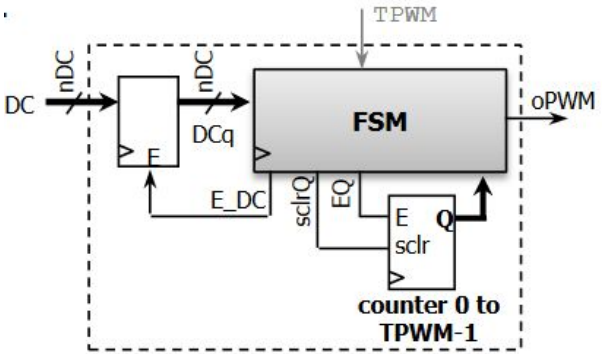


Buzzer


leds
ps2d
ps2c
my_ps2keyboard
DOUT
8
8
Keyboard decoder
odata
7
Serializer
7
DAT_7SEG
AN_7SEG
8
done
keyup
Decoder Enable FSM (keyup FSM)
dEn
8
Frq decoder
frq
4
SD
my_audio
AUD_PWM
AUD_SD1
15 my_pwm with fixed frequencies
my_pwm
oPWM
my_pwm
DC
my_pwm
TPWM
0
1
14
15
'0'
DOUT
buzzer1
0
1
'0'
AUD_SD
'0'
0
1
Buzzer
sw0

Buzzer - mypwm

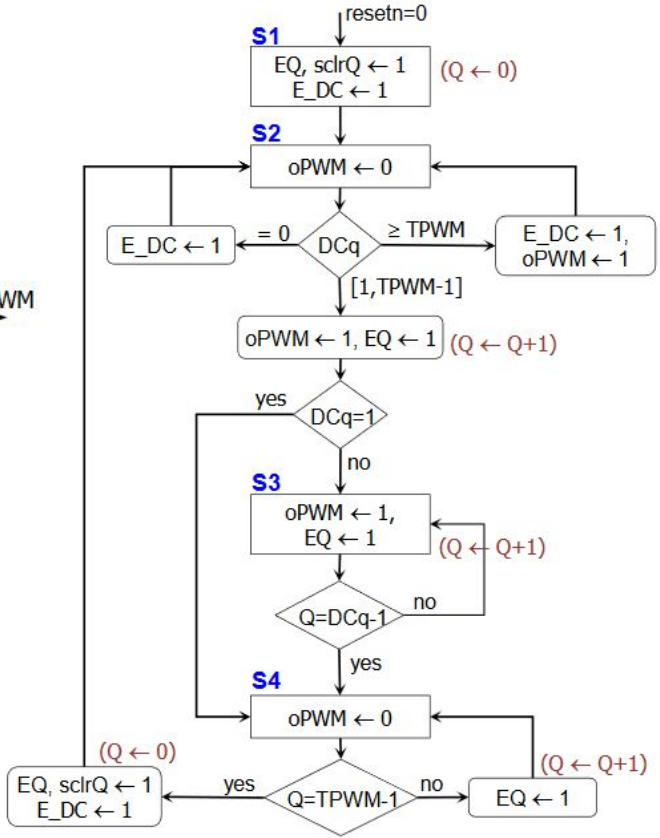
- Generates a PWM signal at a fixed frequency
- Sent through a multiplexor and then output onto a buzzer



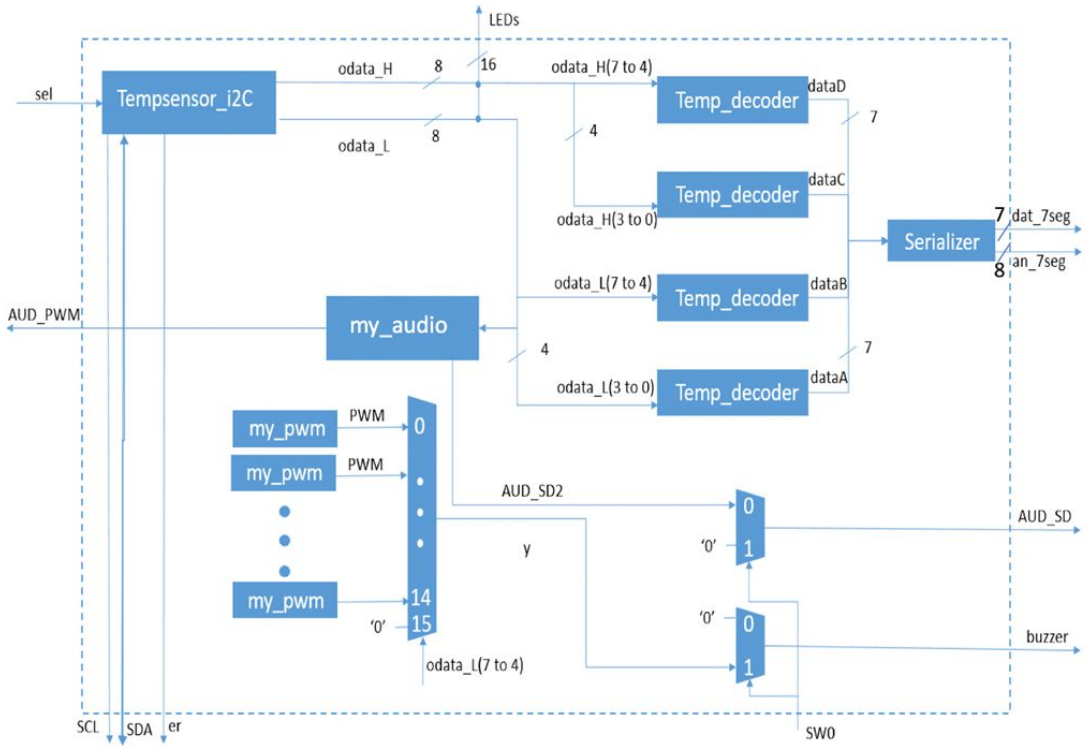
$$nDC = \lceil \log_2(TPWM + 1) \rceil$$

$$If\ DC = 0 \rightarrow oPWM = 0$$

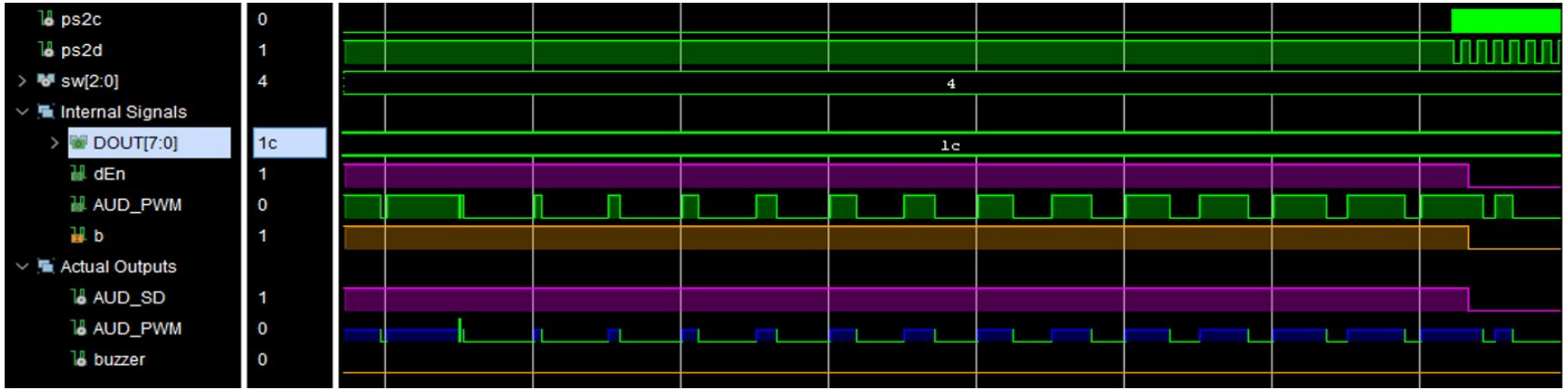
$$If\ DC = TPWM \rightarrow oPWM = 1$$

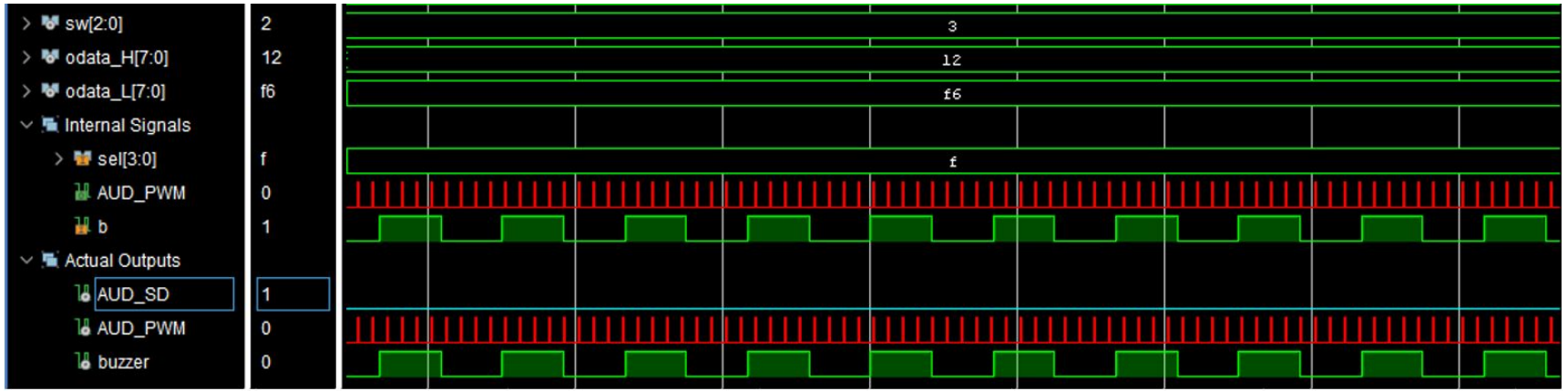


Buzzer and Audio - Temperature Sensor



Demo


ps2c
ps2d
sw[2:0]
Internal Signals
DOUT[7:0]
dEn
AUD_PWM
b
Actual Outputs
AUD_SD
AUD_PWM
buzzer
0
1
4
1c
1
0
1
1
0
0
4
1c


sw[2:0]
odata_H[7:0]
odata_L[7:0]
Internal Signals
sel[3:0]
AUD_PWM
b
Actual Outputs
AUD_SD
AUD_PWM
buzzer
2
12
f6
f
0
1
1
0
0
3
12
f6
f

Conclusions

- Keyboard
- Temperature Sensor
- Mono Audio Output
- Buzzer
- Seven Segment Display
- LEDs

- Communication Protocols
- PWM
- PDM

References

- D. Llamocca, “Unit 3-External Peripherals: Interfacing,” Mar. 2019, pp. 2-3, 7-14., https://moodle.oakland.edu/pluginfile.php/5005747/mod_resource/content/7/Notes%20-%20Unit%203.pdf
- D. Llamocca, “PS/2 Keyboard Controller (XDC included),” http://www.secs.oakland.edu/~llamocca/VHDLforFPGAs.html
- D. Llamocca, “ADT4720 Temp. Sensor (I2C)-Basic Control (XDC included),” http://www.secs.oakland.edu/~llamocca/VHDLforFPGAs.html
- D. Llamocca, “PWM: Tone control. Mono audio output with Low-Pass Filter (XDC included),” http://www.secs.oakland.edu/~llamocca/VHDLforFPGAs.html
- D. Llamocca, “Unit 2: Concurrent Description.” *VHDL Coding for FPGAs,* slides 7-10., http://www.secs.oakland.edu/~llamocca/Tutorials/VHDLFPGA/Unit%202.pdf