Polyphonic Digital Synth

Teenage Mixing Ninja Turtles

PURDUE UNIVERSITY®

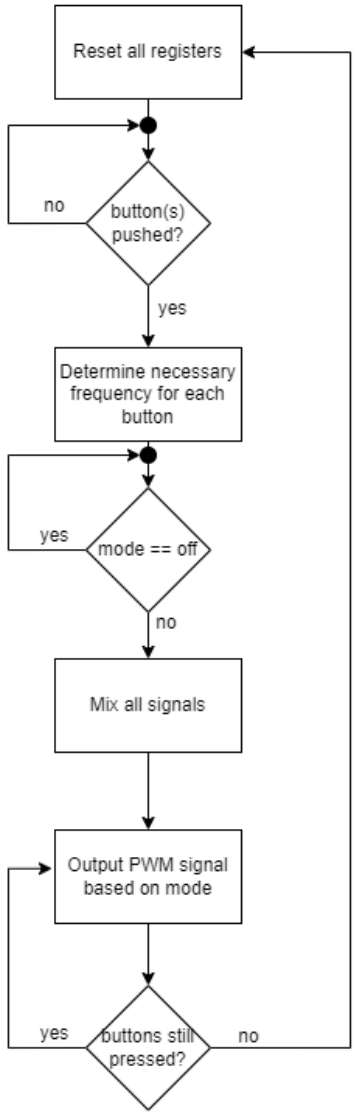
Goal of the Design

- The project aims to replicate a basic synth that has multiple button inputs and can produce unique tones with each button press, while also allowing for polyphonic mixing.
- The team's design will have 12 buttons that can be mixed to represent a full scale.
- The final product will generate a PWM wave that will be played through a speaker with a DAC.

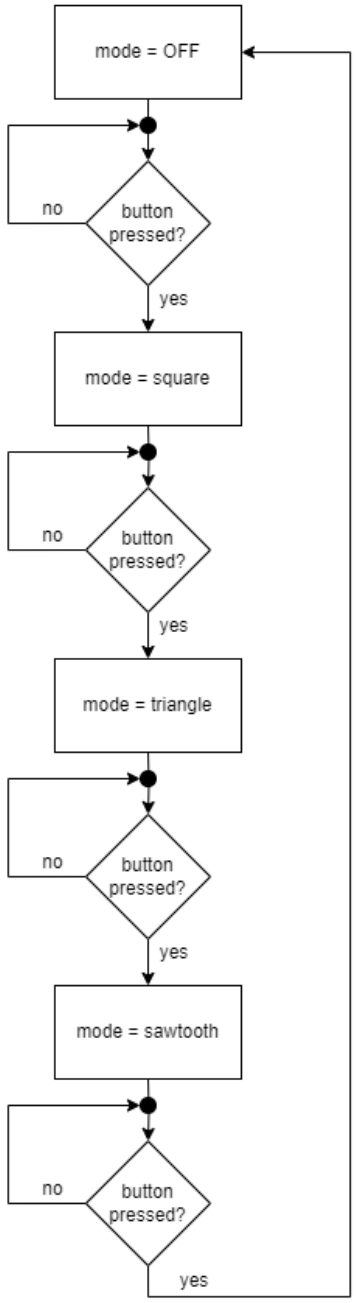

https://cdm.link/app/uploads/2013/04/korg_volca.jpg

Overall User Flow Diagram

Sound Generation Sequence

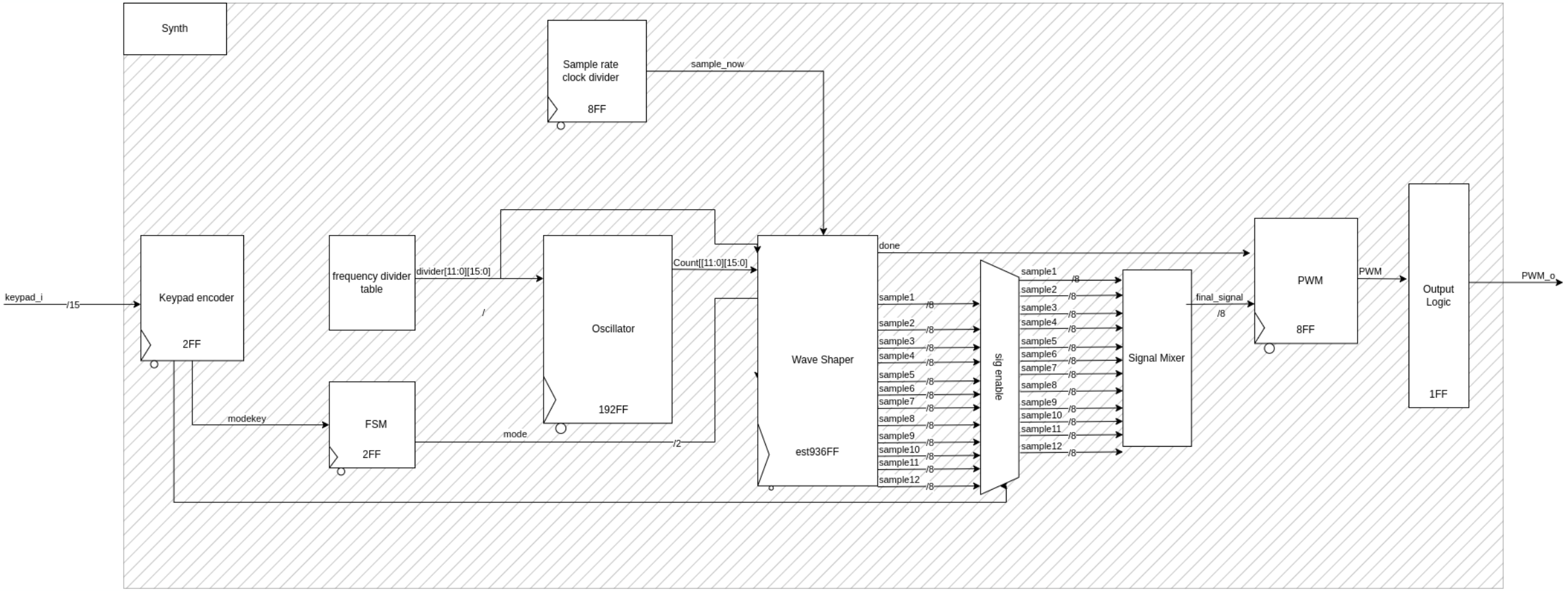


Mode Select



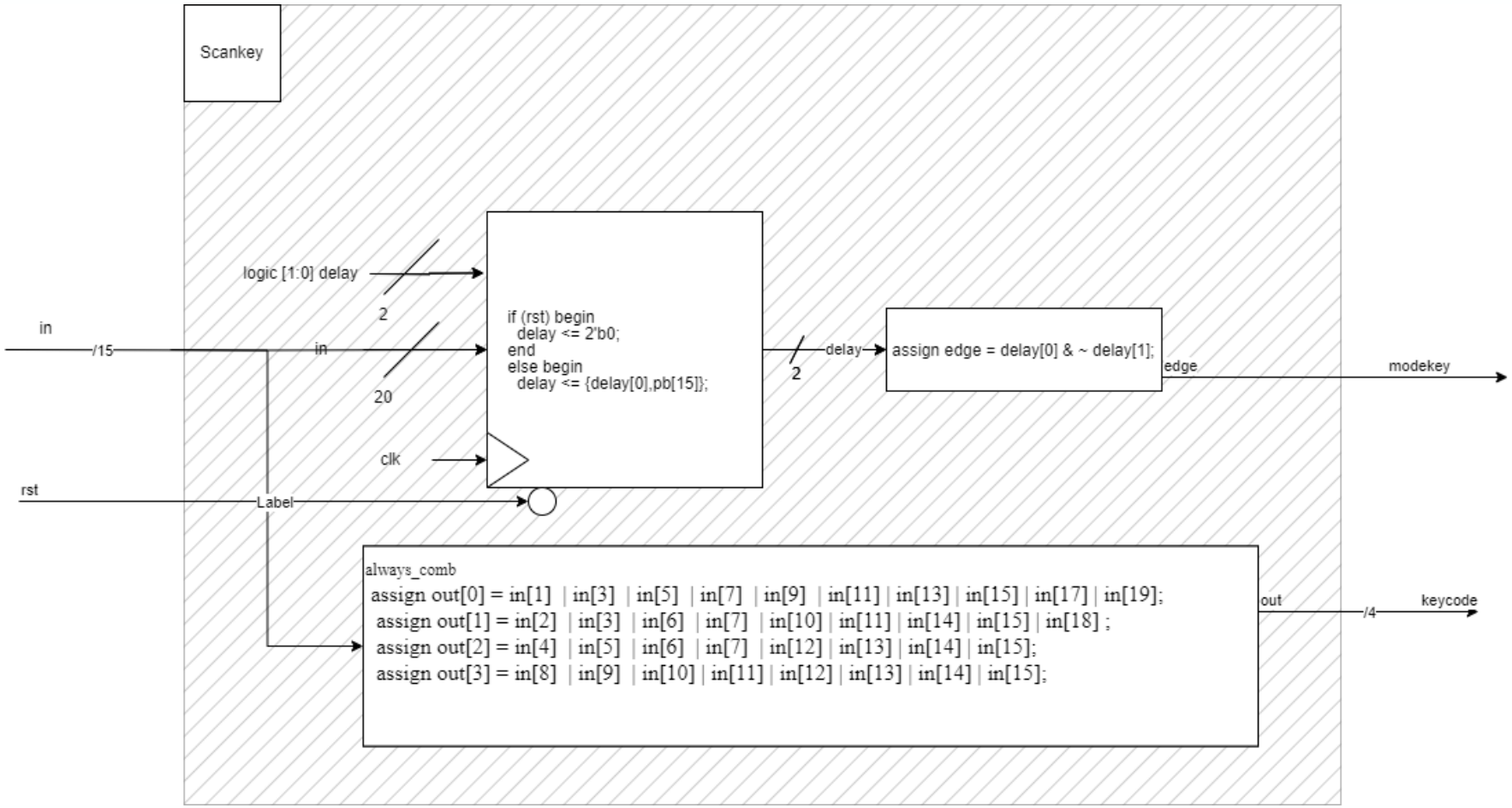
Overview

RTL Diagram



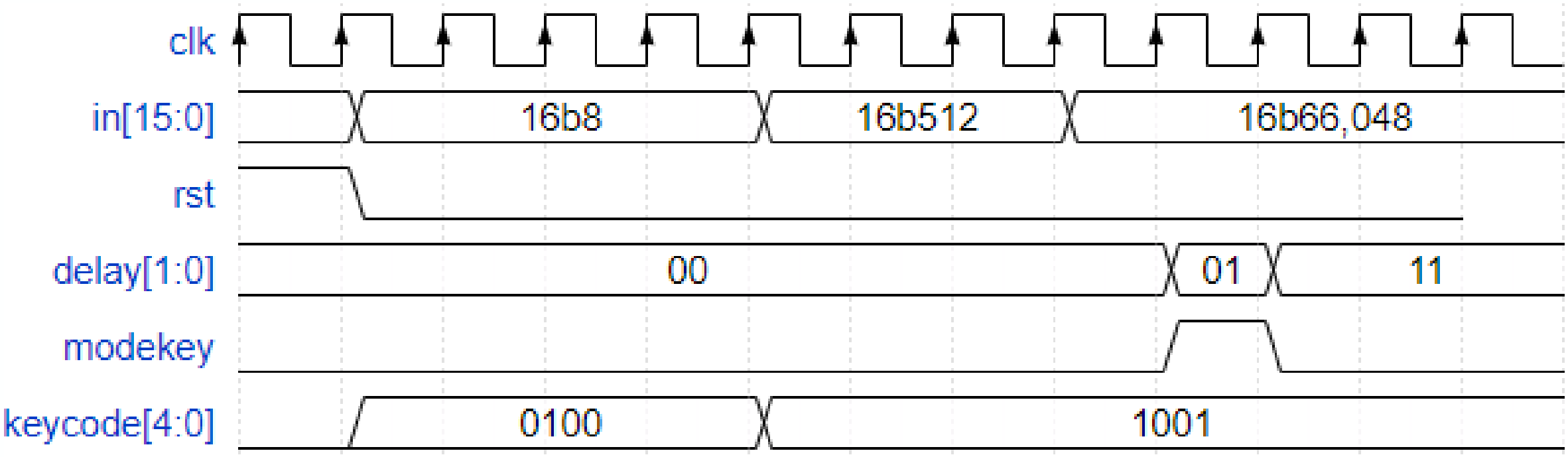
Keypad

RTL


Scankey
logic [1:0] delay
2
if (rst) begin
delay <= 2'b0;
end
else begin
delay <= {delay[0],pb[15]};
in
/15
in
20
clk
rst
Label
2
delay
assign edge = delay[0] & ~ delay[1];
edge
modekey
always_comb
assign out[0] = in[1] | in[3] | in[5] | in[7] | in[9] | in[11] | in[13] | in[15] | in[17] | in[19];
assign out[1] = in[2] | in[3] | in[6] | in[7] | in[10] | in[11] | in[14] | in[15] | in[18] ;
assign out[2] = in[4] | in[5] | in[6] | in[7] | in[12] | in[13] | in[14] | in[15];
assign out[3] = in[8] | in[9] | in[10] | in[11] | in[12] | in[13] | in[14] | in[15];
out
/4
keycode

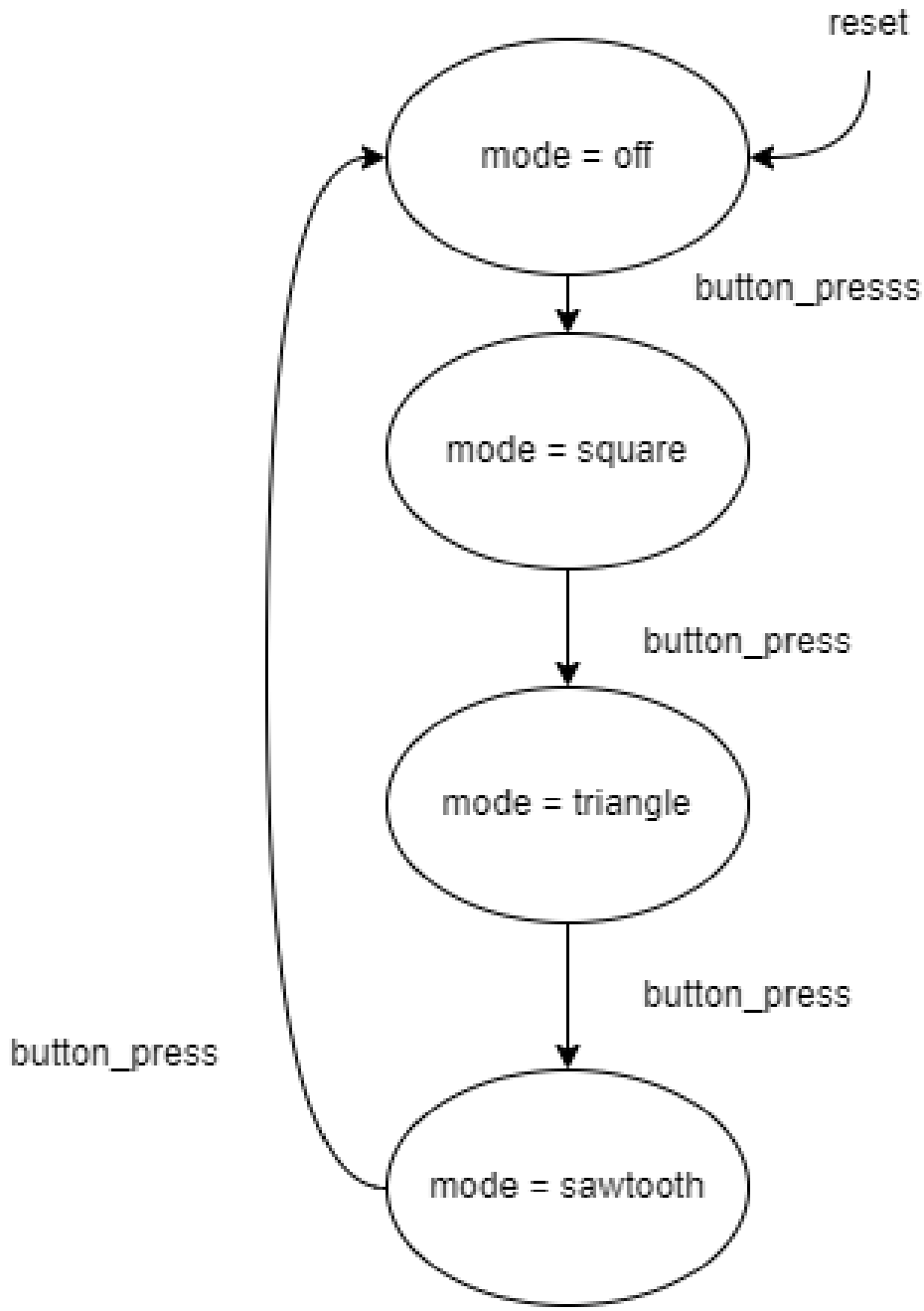
Keypad

Wavedrom



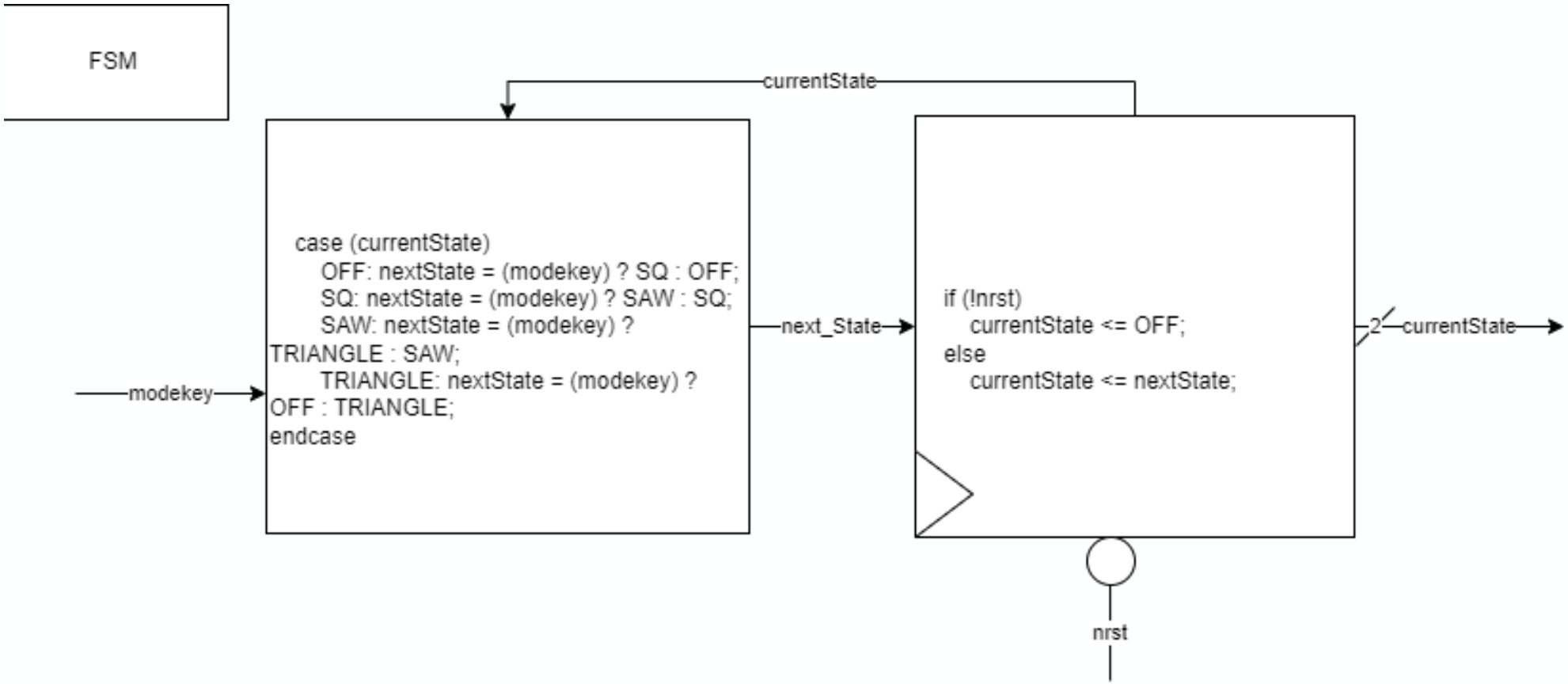
FSM

State Diagram



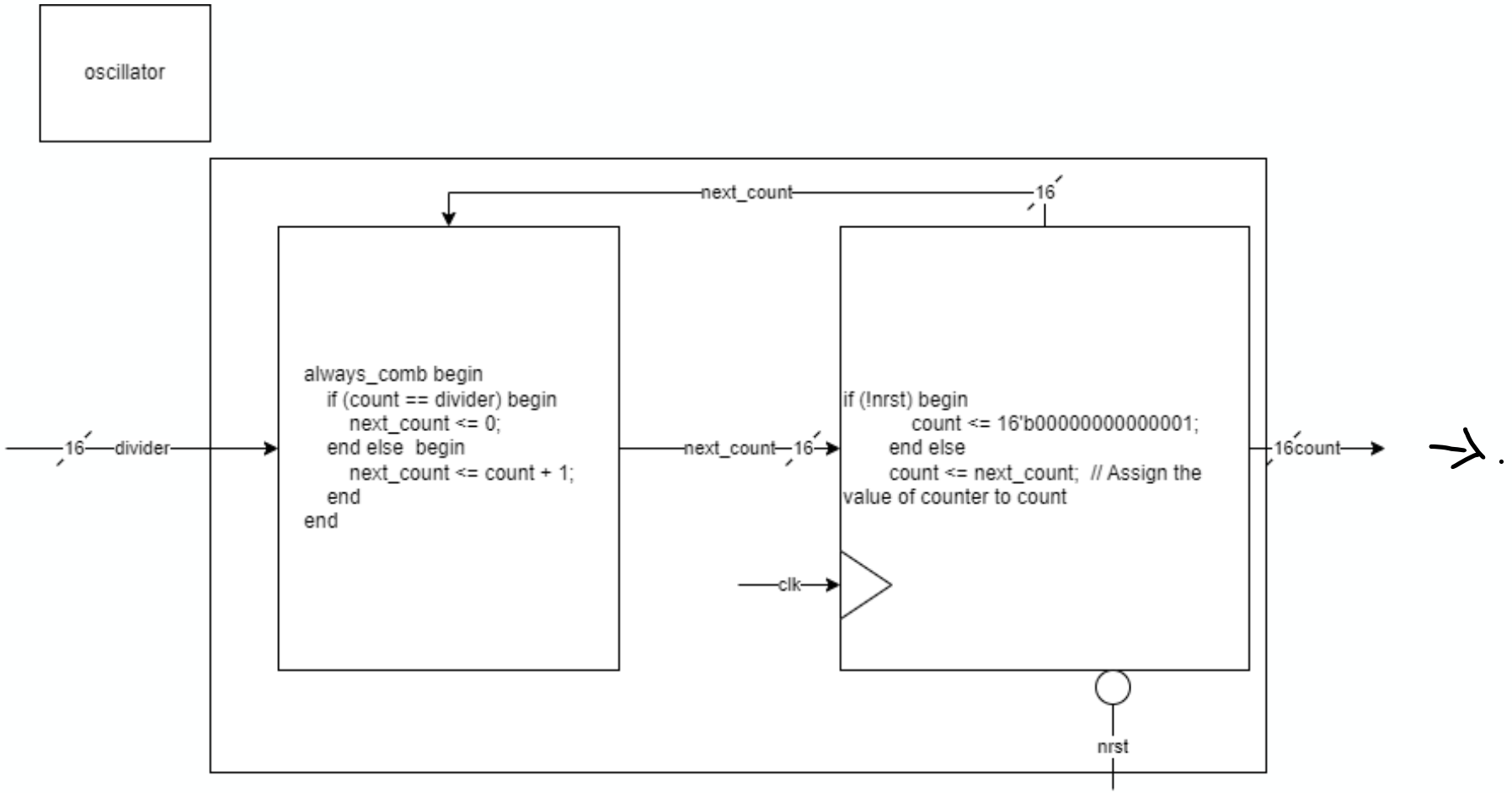
FSM

Register Transfer Level



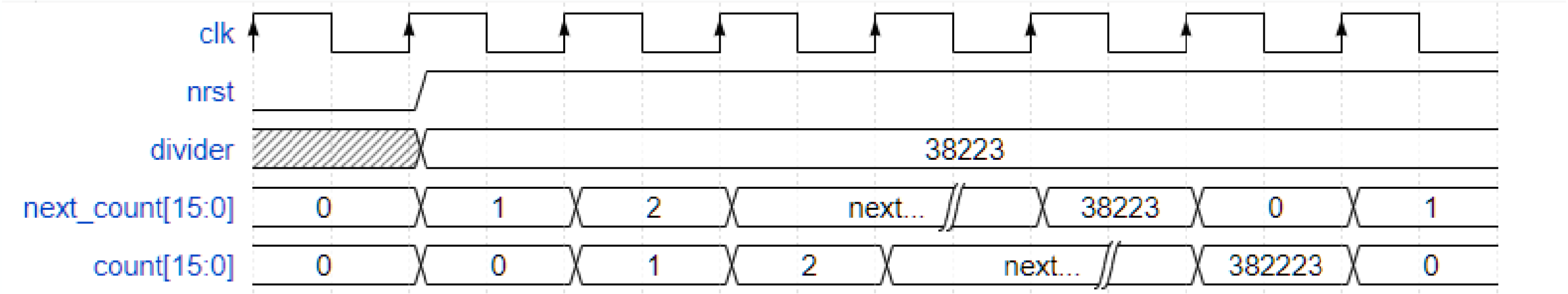
Oscillator

RTL



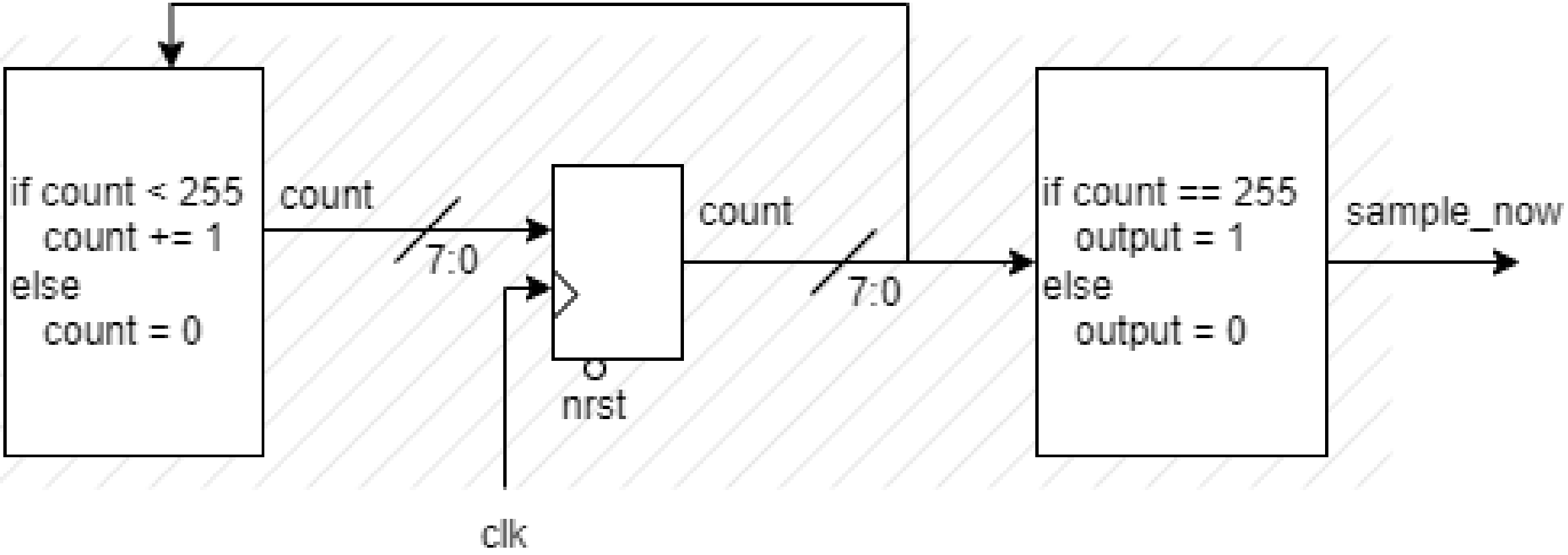
Oscillator

Wavedrom



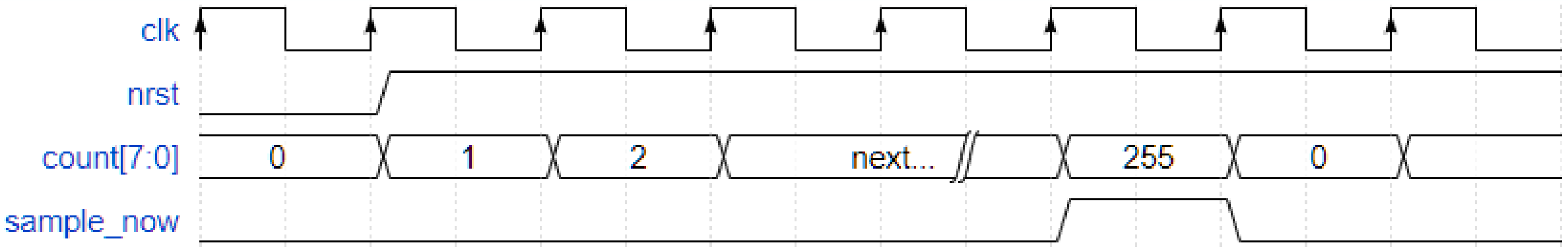
Sample Rate ClkDiv

RTL



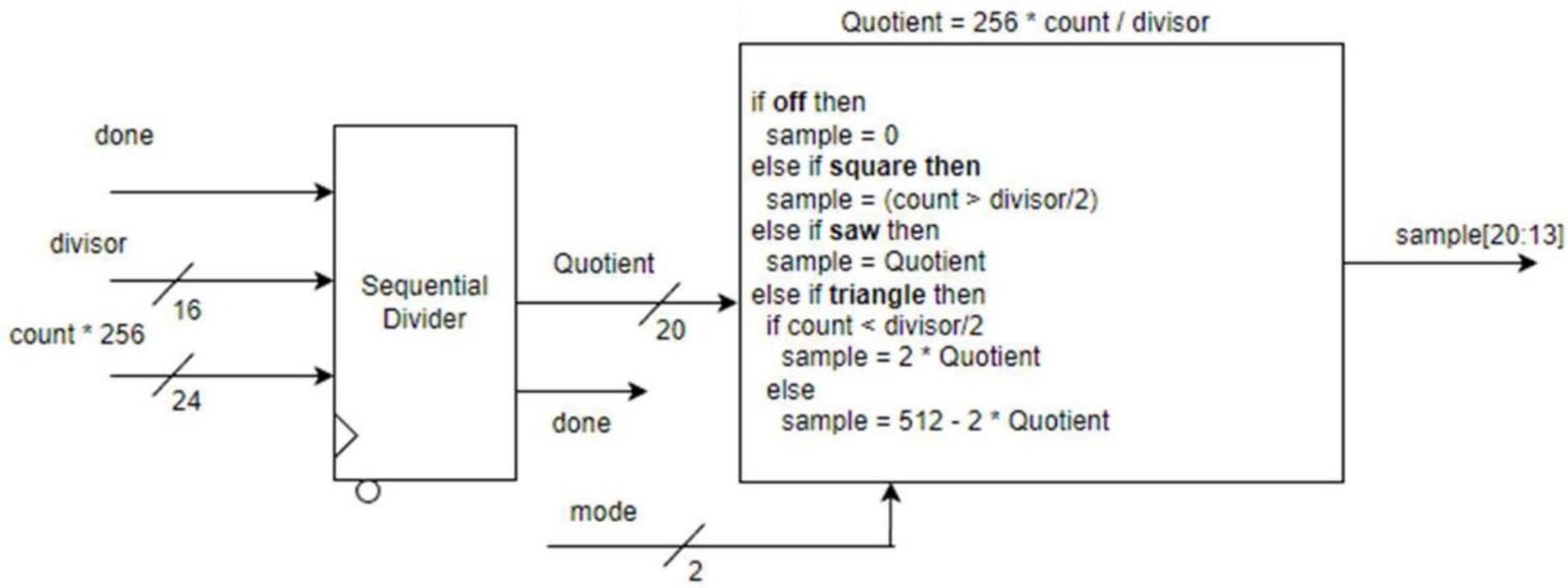
Sample Rate ClkDiv

Wavedrom



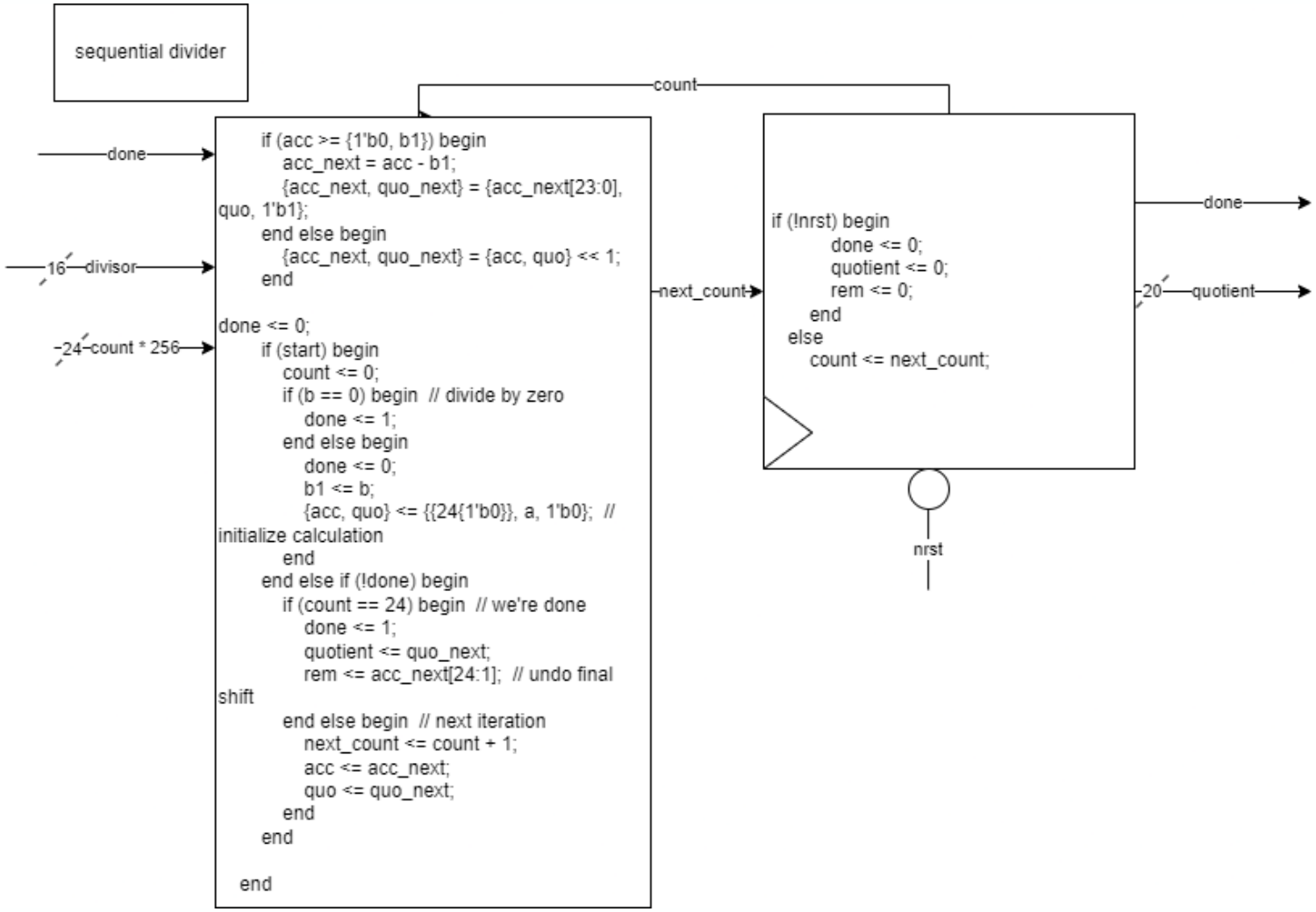
Wave Shaper

RTL

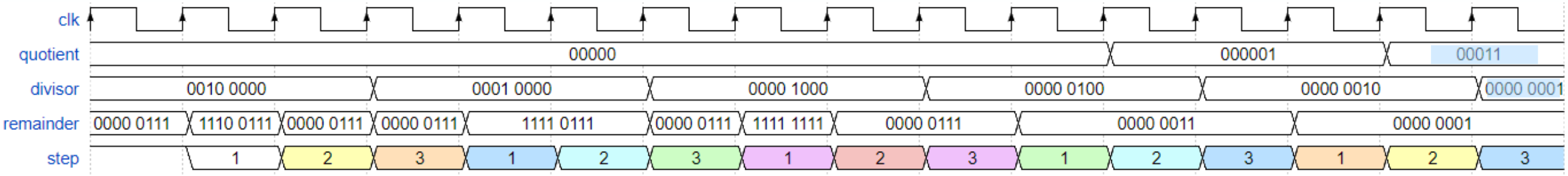


Wave Shaper sub-RTL

Sequential divider



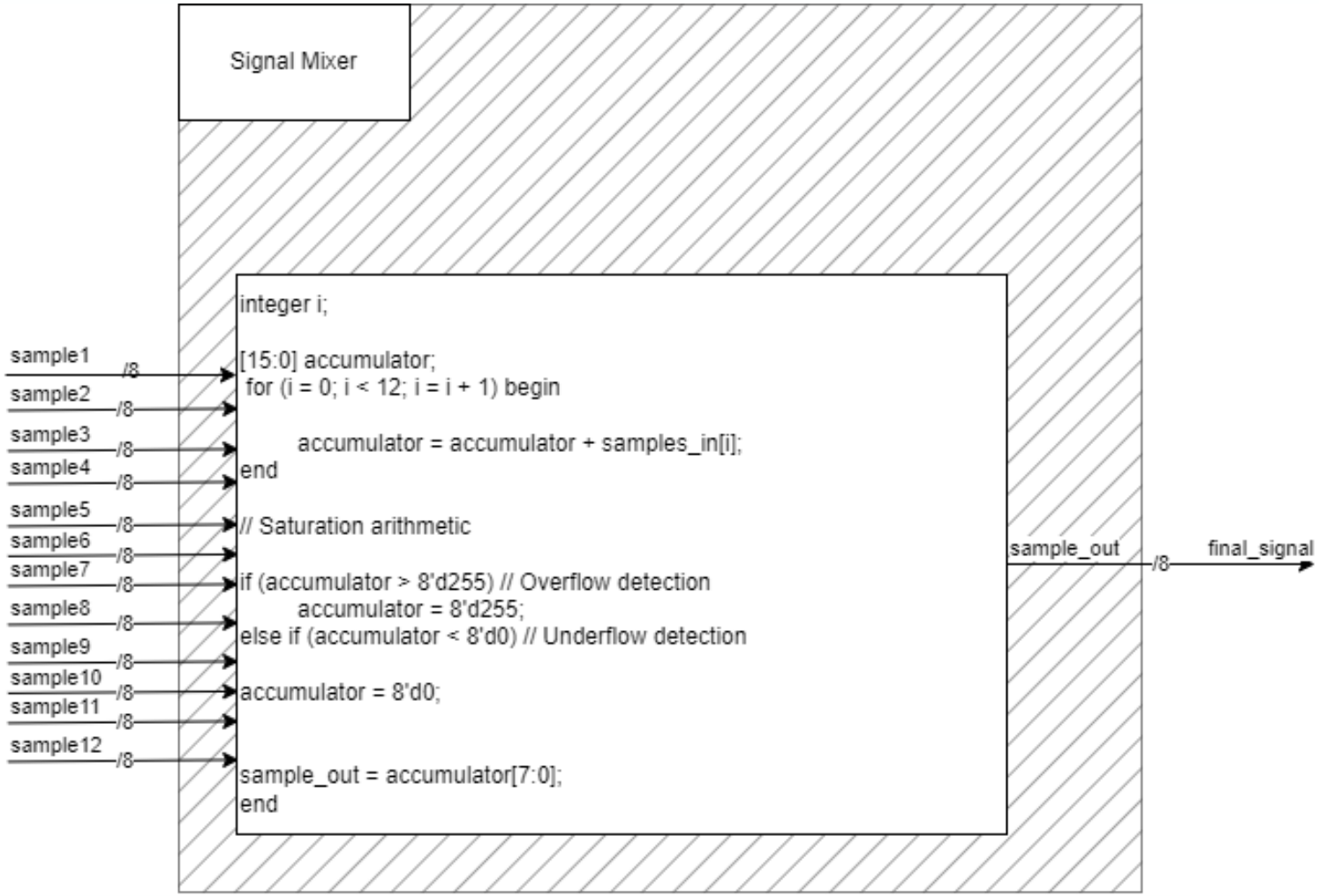
Wavedrom



Wave Shaper

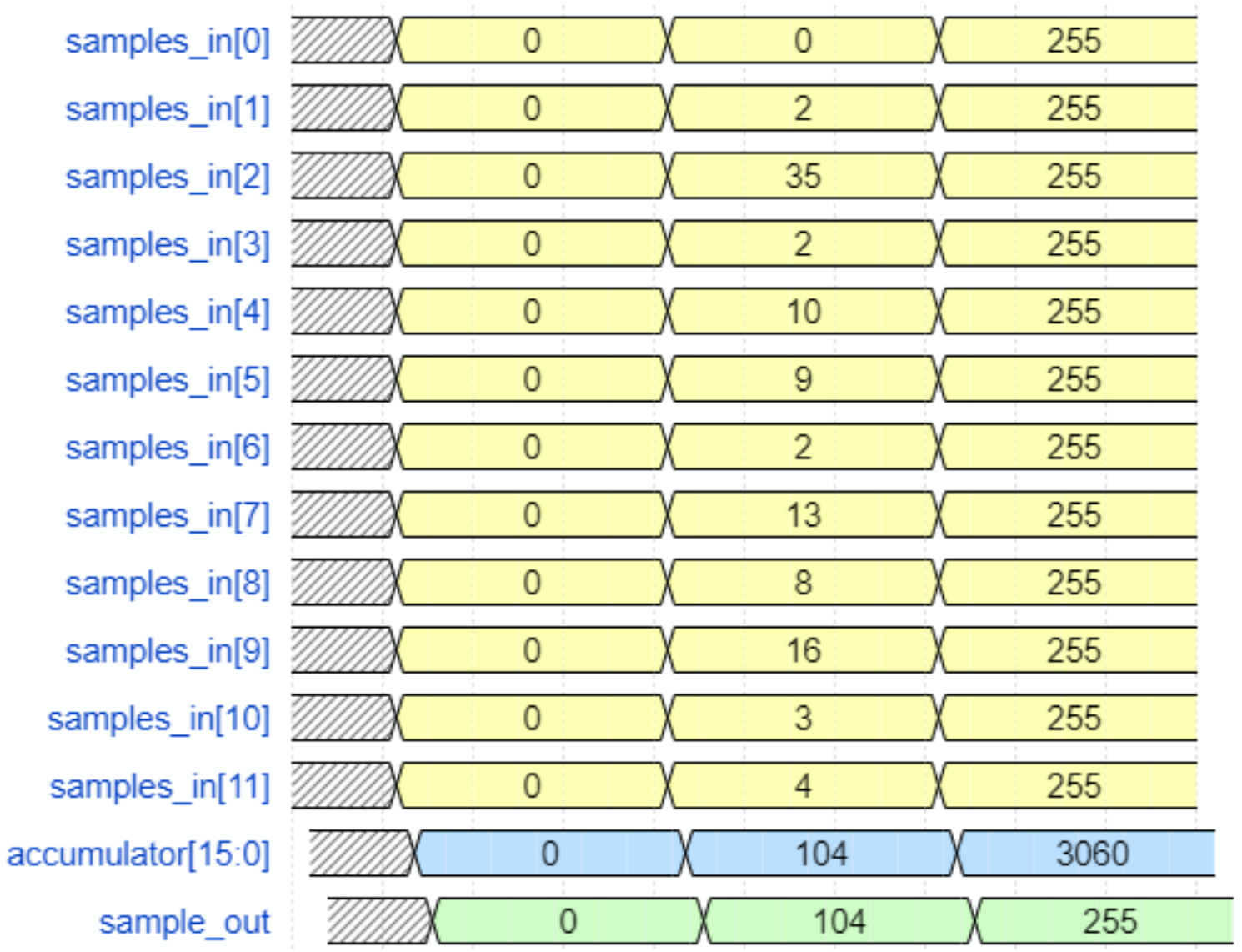
RTL

Signal Mixer



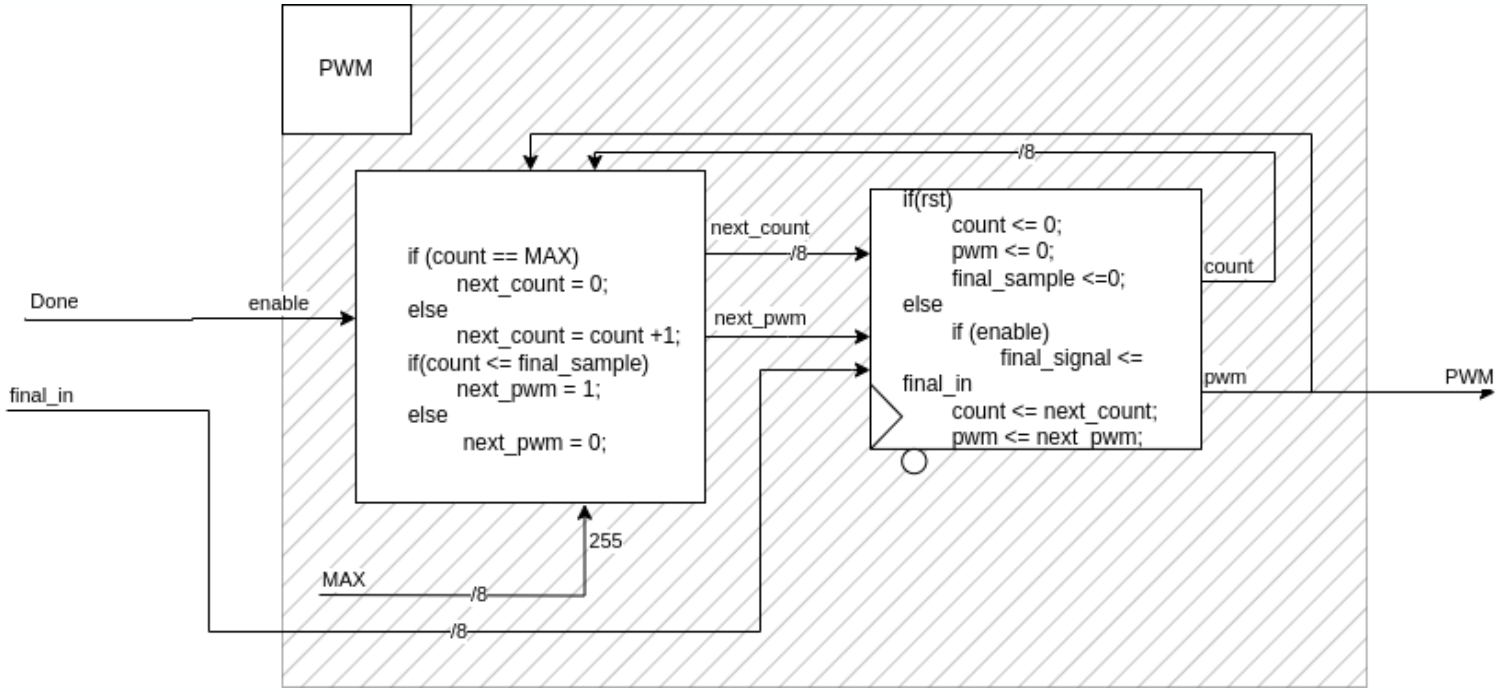
Wavedrom

Signal Mixer



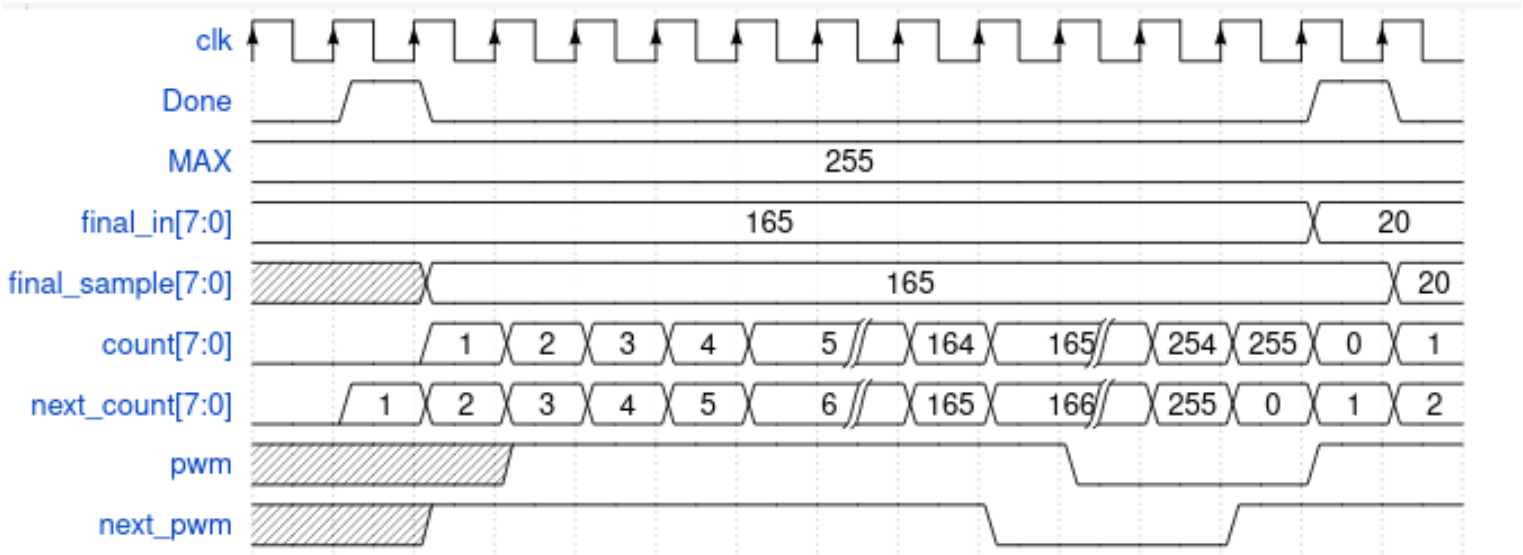
RTL

PWM


PWM
if (count == MAX)
next_count = 0;
else
next_count = count +1;
if(count <= final_sample)
next_pwm = 1;
else
next_pwm = 0;
next_count
/8
next_pwm
if(rst)
count <= 0;
pwm <= 0;
final_sample <=0;
else
if (enable)
final_signal <=
final_in
count <= next_count;
pwm <= next_pwm;
count
pwm
PWM
/8
Done
enable
final_in
MAX
/8
255
/8

Wavedrom

PWM



Number of Flip-Flops

Module	Number of Flip-Flops
Keypad	2
Frequency Divider Table	2
FSM	2
Oscillator	192
Sample ClkDiv	2
Wave Shaper	938
Signal Mixer	0
PWM	8
Logic Out	1
Total	1147

I/O Pins

I/O	Number of pins	Component
Keypad (notes)	12	Push Button
Reset	1	Push Button
Mode	1	Push Button
PWM_out	1	Speaker
Total	15	