

Experiment 5

Tone Synthesizer

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Overview of the experiment

- The purpose of the experiment is to design a circuit which will generate the seven major notes in the Indian classical music named Sa, Re, Ga, Ma, Pa, Dha, Ni and Sa (upper octave) on the speaker.
- I used the 50MHz Master Clock (Krypton's On-board clock) to calculate the count value for each note by using the formula $\frac{50MHz}{2*f}$ where 'f' is the required frequency and using the if-else loops I implemented my logic.
- The report contains a handmade diagram which describes my approach, some important extracts of VHDL code, the output waveforms, Krypton Board Observations and Circuit Images.

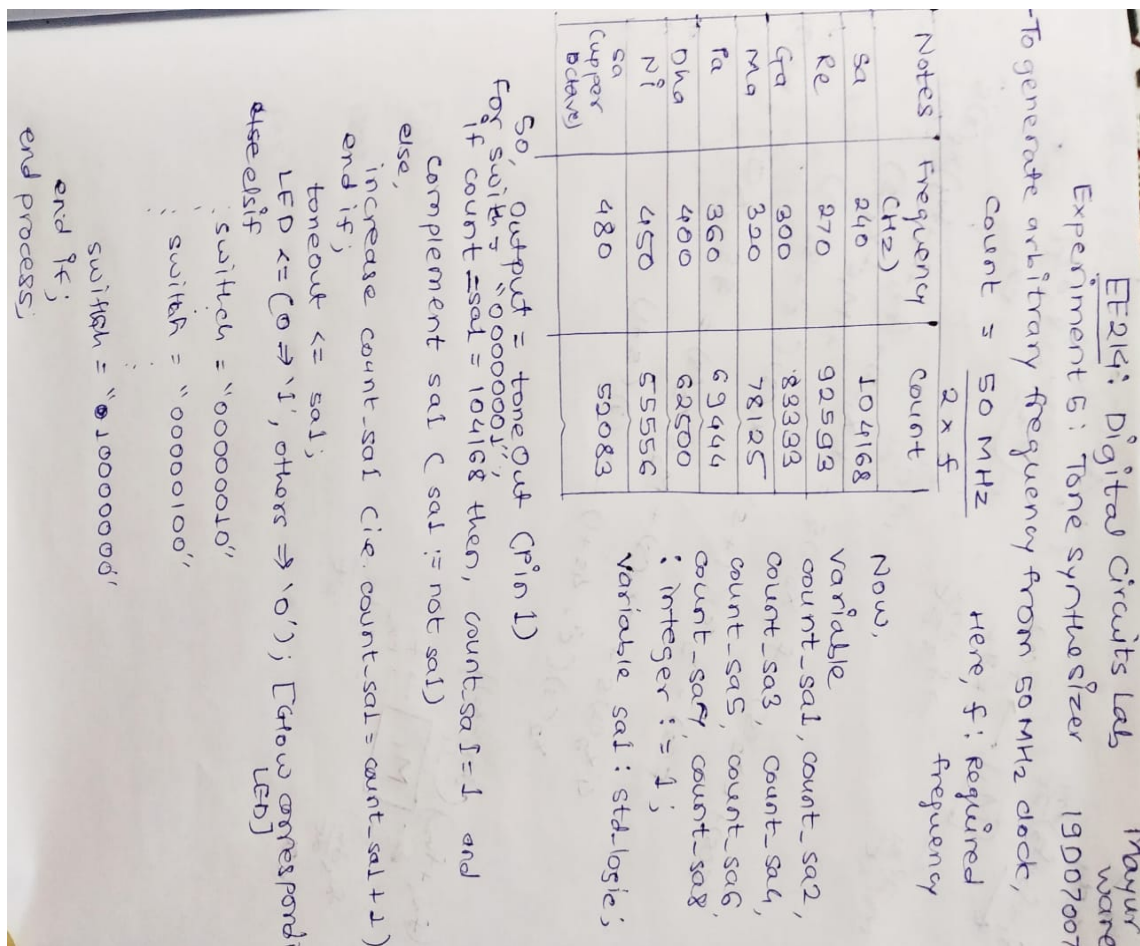
Approach to the experiment

First, I calculated the counts for each Note using the formula given above.

The counts for each Note are given in this table:

Note	Frequency (Hz)	Count Value
Sa	240	104168
Re	270	92593
Ga	300	83333
Ma	320	78125
Pa	360	69444
Dha	400	62500
Ni	450	55556
Sa (Upper Octave)	480	52083

Then, using if-else, if-elsif loops and these count values, I implemented the logic.



Design document and VHDL code if relevant

Main Entity :

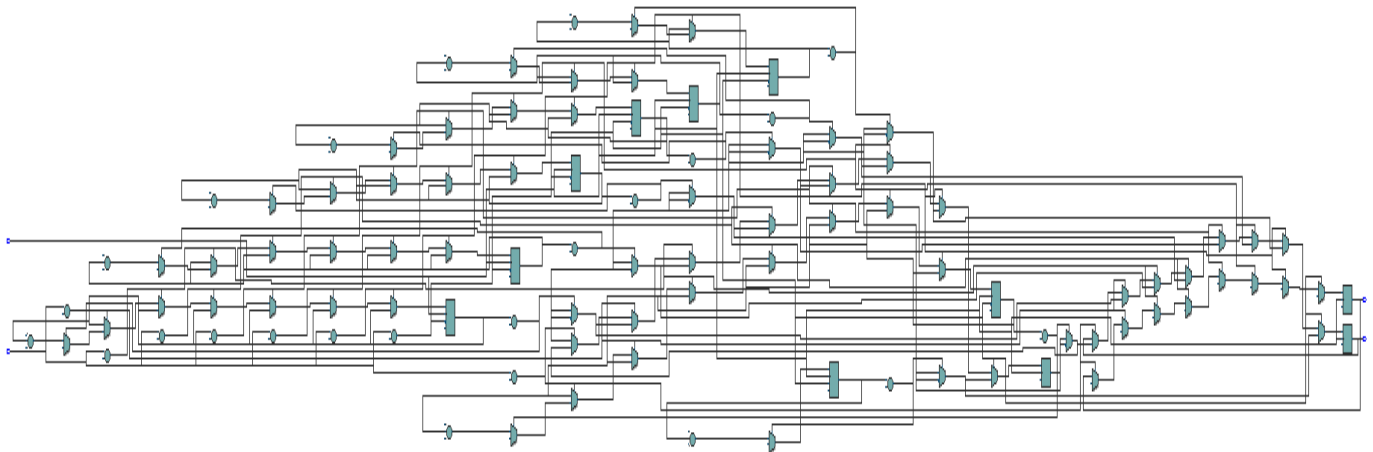
```
entity toneGenerator is
port (toneOut : out std_logic;           --this pin will give your notes output
      clk : in std_logic;
      LED : out std_logic_vector(7 downto 0);
      switch : in std_logic_vector(7 downto 0));
end entity toneGenerator;
```

BCD Adder :

```
if (count_sa1 = 104168) then           --240Hz for "Sa"
count_sa1 := 1;
sa1 := not sa1;
else
count_sa1 := count_sa1 + 1;
end if;
toneOut <= sa1;
LED <= (0 => '1', others => '0');
```

```
elsif switch= "00000010" then
if (count_sa2 = 92593) then           --270Hz for "Re"
count_sa2 := 1;
sa1 := not sa1;
else
count_sa2 := count_sa2 + 1;
end if;
toneOut <= sa1;
LED <= (1 => '1', others => '0');
Similar for 'Ga', 'Ma', 'Pa', 'Dha', 'Ni' and 'Sa (Upper Octave)'
```

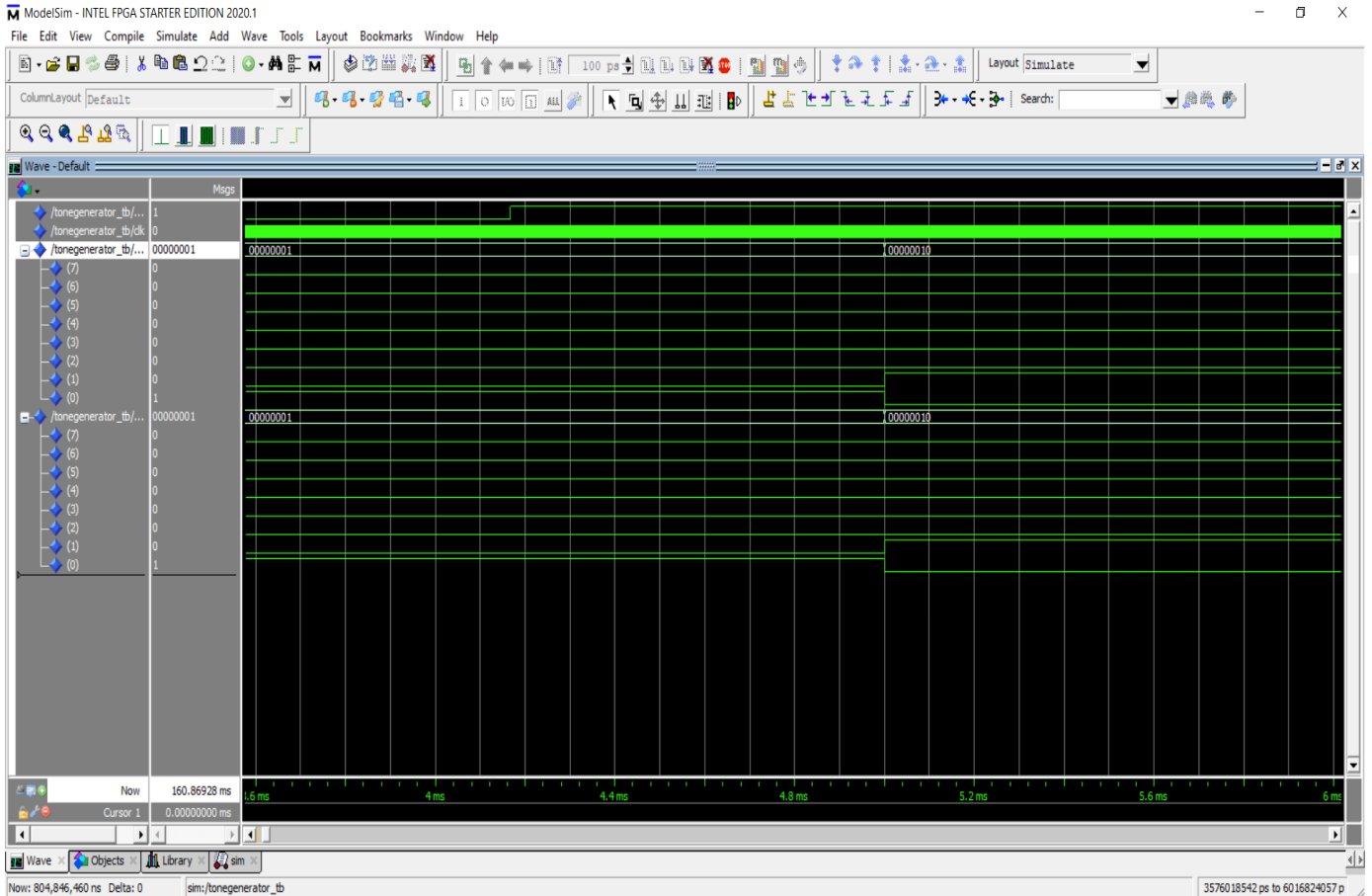
RTL View



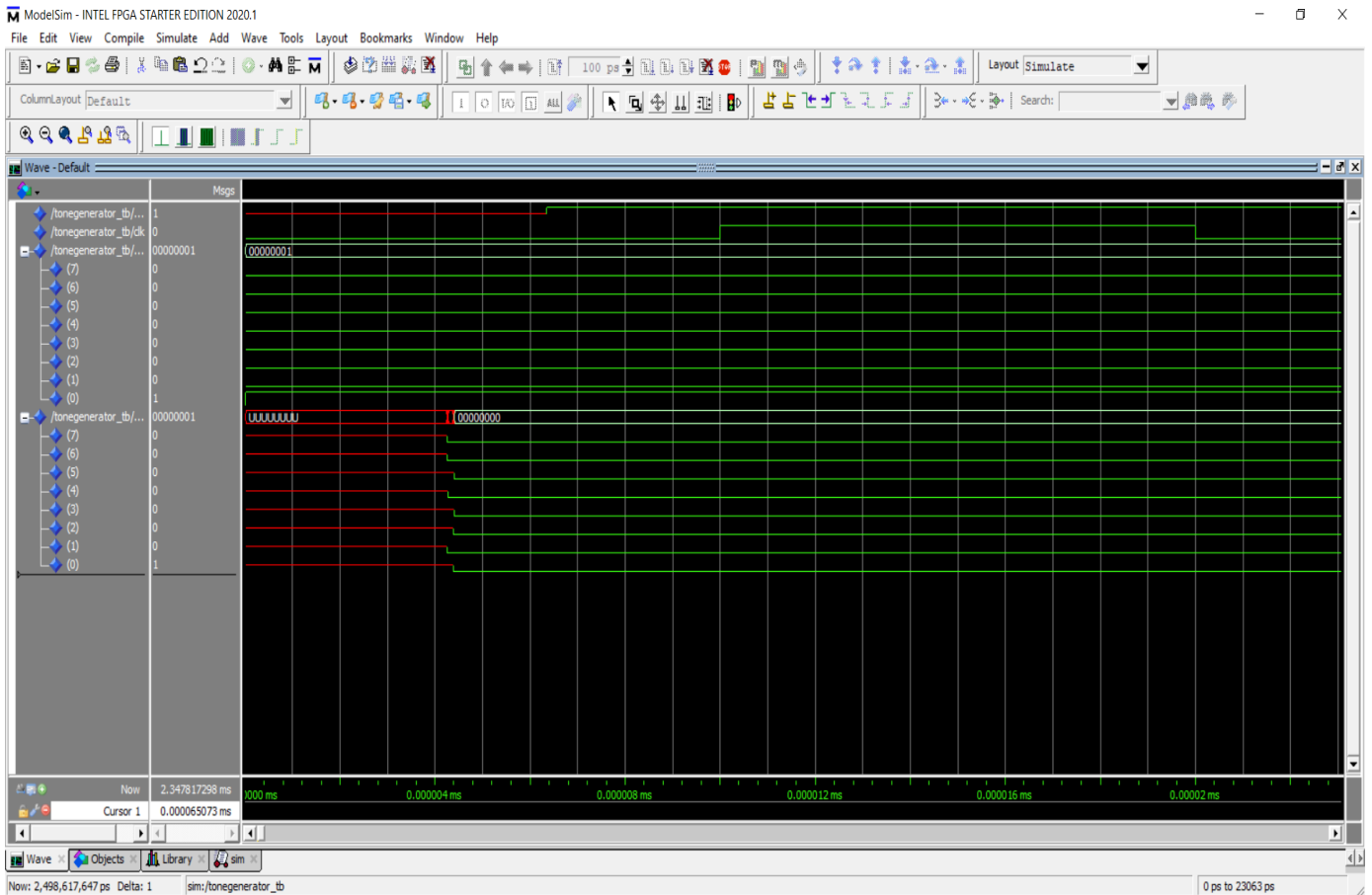
DUT Input/Output Format

```
toneOut : out std_logic;
clk : in std_logic;
LED : out std_logic_vector(7 downto 0);
switch : in std_logic_vector(7 downto 0);
```

RTL Simulation



Gate-level Simulation



Krypton board

Pin Planner - E:/4. SPRING 2021/EE214/EXP 5/Exp5 - DUT

File Edit View Processing Tools Window Help

Report not available

Groups Report

Tasks

- Early Pin Planning
 - Early Pin Planning...
 - Run I/O Assignment
 - Export Pin Assignment
- Pin Finder...
- Highlight Pins

Top View Wire Bond

MAX V

5M1270ZT144C5

Pin Legend

Symbol Pin Type

- User I/O
- User assign...
- Fitter assign...
- Unbonded...
- Reserved pin
- DEV_OE
- DEV_CLR
- DIFF_n outp...
- DIFF_p outp...
- CLK_n
- TDI
- TCK
- TMS
- TDO
- VCCINT
- VCCIO

Filter: Pins: all

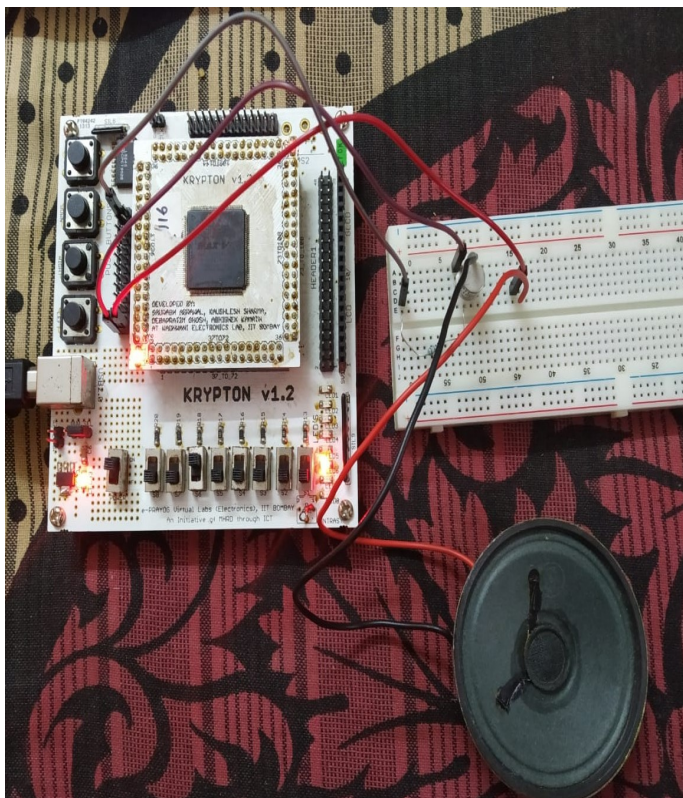
Node Name	Direction	Location	I/O Bank	Fitter Location	I/O Standard	Reserved	Current Strength	Differential Pair	IOCT Preservat
clk	Input	PIN_89	3	PIN_89	3.3-V LVTTTL		16mA ..aut		
LED[7]	Output	PIN_49	4	PIN_49	3.3-V LVTTTL		16mA ..aut		
LED[6]	Output	PIN_50	4	PIN_50	3.3-V LVTTTL		16mA ..aut		
LED[5]	Output	PIN_51	4	PIN_51	3.3-V LVTTTL		16mA ..aut		
LED[4]	Output	PIN_52	4	PIN_52	3.3-V LVTTTL		16mA ..aut		
LED[3]	Output	PIN_53	4	PIN_53	3.3-V LVTTTL		16mA ..aut		
LED[2]	Output	PIN_55	4	PIN_55	3.3-V LVTTTL		16mA ..aut		
LED[1]	Output	PIN_57	4	PIN_57	3.3-V LVTTTL		16mA ..aut		
LED[0]	Output	PIN_58	4	PIN_58	3.3-V LVTTTL		16mA ..aut		
switch[7]	Input	PIN_39	4	PIN_39	3.3-V LVTTTL		16mA ..aut		
switch[6]	Input	PIN_40	4	PIN_40	3.3-V LVTTTL		16mA ..aut		
switch[5]	Input	PIN_41	4	PIN_41	3.3-V LVTTTL		16mA ..aut		
switch[4]	Input	PIN_42	4	PIN_42	3.3-V LVTTTL		16mA ..aut		
switch[3]	Input	PIN_43	4	PIN_43	3.3-V LVTTTL		16mA ..aut		
switch[2]	Input	PIN_44	4	PIN_44	3.3-V LVTTTL		16mA ..aut		
switch[1]	Input	PIN_45	4	PIN_45	3.3-V LVTTTL		16mA ..aut		
switch[0]	Input	PIN_48	4	PIN_48	3.3-V LVTTTL		16mA ..aut		
toneOut	Output	PIN_1	1	PIN_1	3.3-V LVTTTL		16mA ..aut		
<<new node>>									

0% 00:00

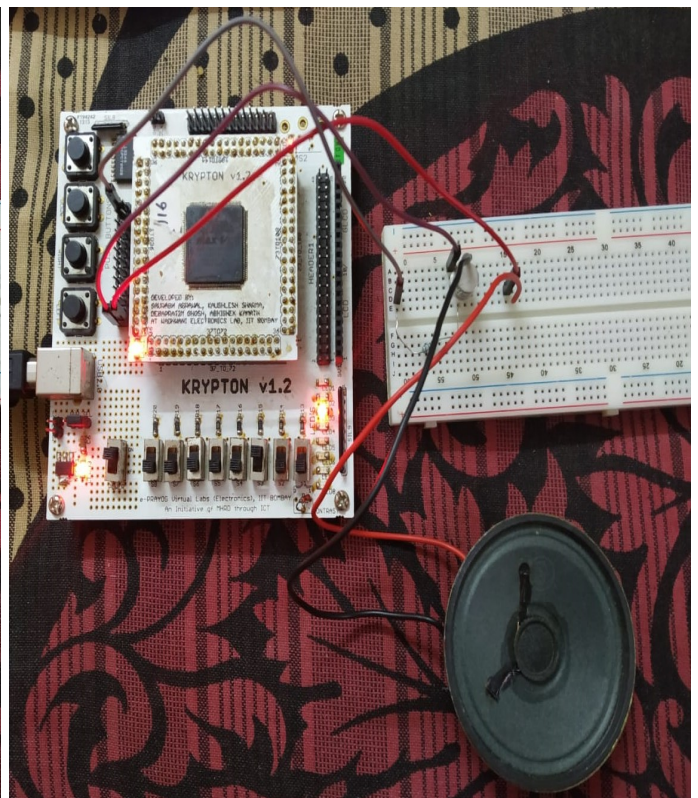
Pin Planner

Observations

Some of the observations were :



Observation 1



Observation 2

Observation 1 : Switch 6 was ON. LED 6 was glowing and Musical Note 'Dha' was audible.

Observation 2 : Switch 3 was ON. LED 3 was glowing and Musical Note 'Ga' was audible.

References

Clock Divider Tutorial by Teaching Assistant Mr. Sandesh Goyal

Quartus 20.1 Lite Software

EE214.Tone.Synthesizer.pdf for code snippets