Experiment # 1- Clock and Periodic Signal Generation

Sana SariNavaei
810199435

1.1

1.10 ns

2.2 * N * $Delay_{inv}$ = 19ns

N = 5

2 * N = 10

$Delay_{inv}$ = 1.9ns

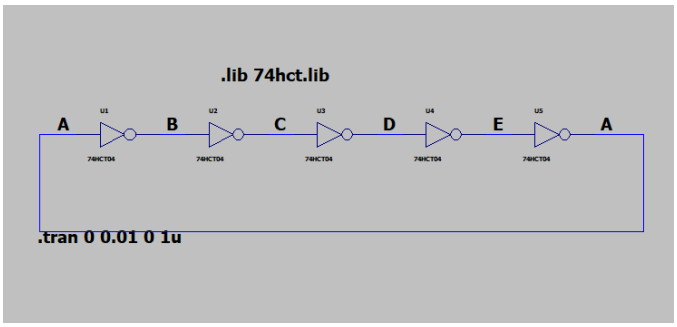

Fig. 1 ring oscillator

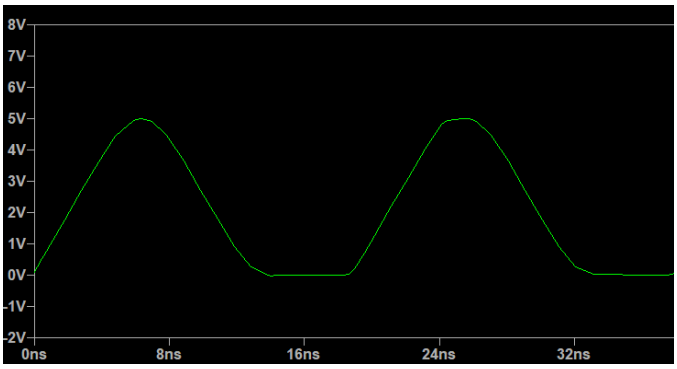

Fig. 2 waveform of the output

1.

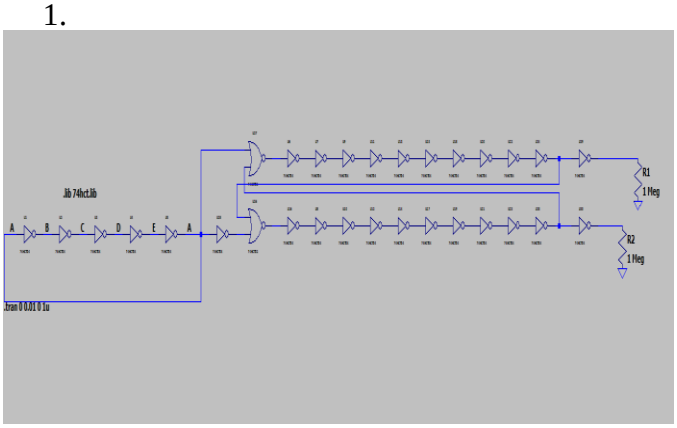

Fig. 3 Two-phase clock generator

2.

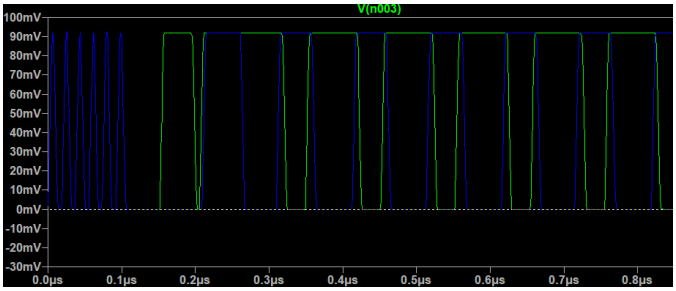

Fig. 4 output phase 1 and phase 2

1.2

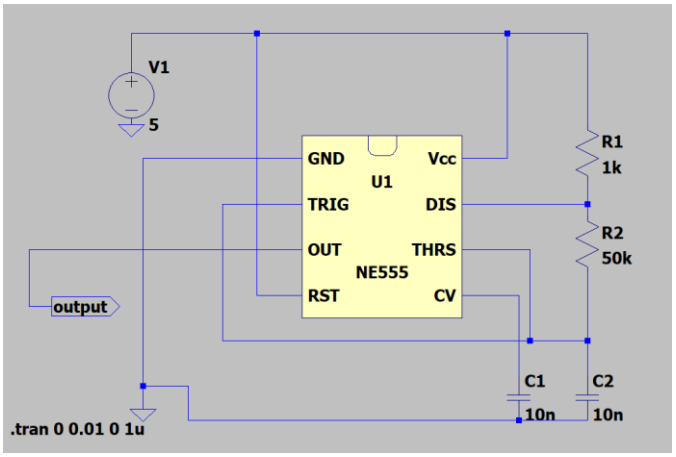

Fig. 5 LM555

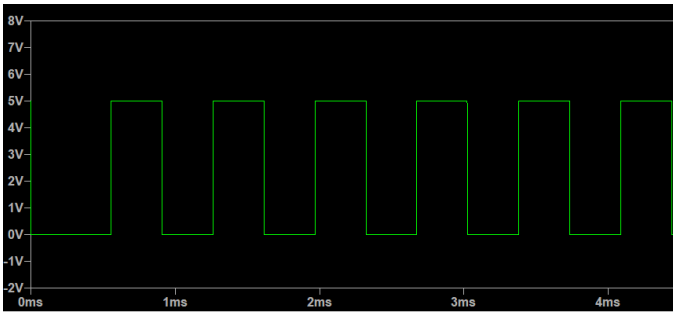

Fig. 6 waveform of the output

1. Clock frequency: 1 / T

$T = T_1 + T_2 = 0.693 * (R_1 + 2R_2) * C$

$= 0.693 * (101000) * 10 * 10^{-9}$

$= 0.699930 * 10^{-3}$ s

Clock frequency: $1 / (0.699930 * 10^{-3})$

= 1428.714

Duty cycle: $(R_1 + R_2) / (R_1 + 2R_2)$
= 51 / 101
= 50.49%

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2. Clock frequency: 1 / T
$T = T_1 + T_2 = 0.693 * (R_1 + 2R_2) * C$
Duty cycle: $(R_1 + R_2) / (R_1 + 2R_2)$
If $R_2 = 1k\Omega$:
$T = 0.693 * (3000) * 10 * 10^{-9}$
$= 0.2079 * 10^{-4}s$
Clock frequency: $1 / (0.2079 * 10^{-4)}$
= 48100.04
Duty cycle: 2 / 3 = 66.67%

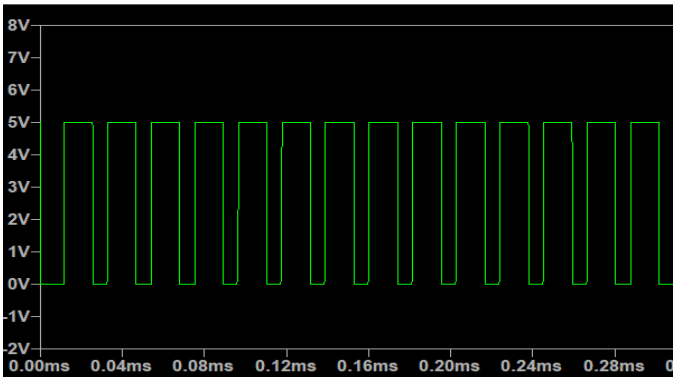

Fig. 7 $R_2 = 1k\Omega$

If $R_2 = 10k\Omega$:
$T = 0.693 * (21000) * 10 * 10^{-9}$
$= 0.14553 * 10^{-3}s$
Clock frequency: $1 / (0.14553 * 10^{-3}s)$
= 6871.435
Duty cycle: 11 / 21 = 52.38%

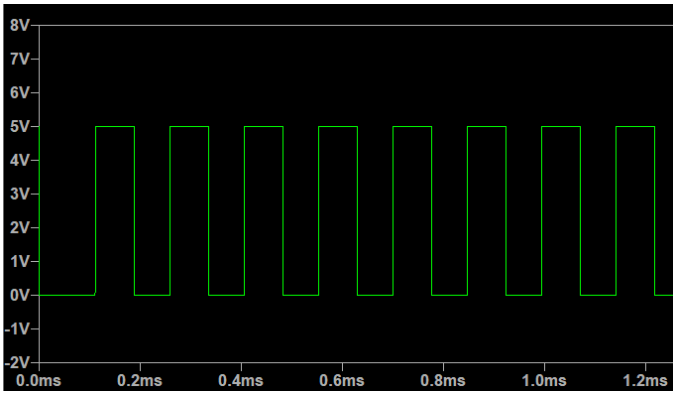

Fig. 8 $R_2 = 10k\Omega$

If $R_2 = 200k\Omega$:
$T = 0.693 * (401000) * 10 * 10^{-9}$
$= 0.277893 * 10^{-2}s$
Clock frequency: $1 / (0.277893 * 10^{-2}s)$
= 359.850
Duty cycle: 201 / 401 = 50.12%

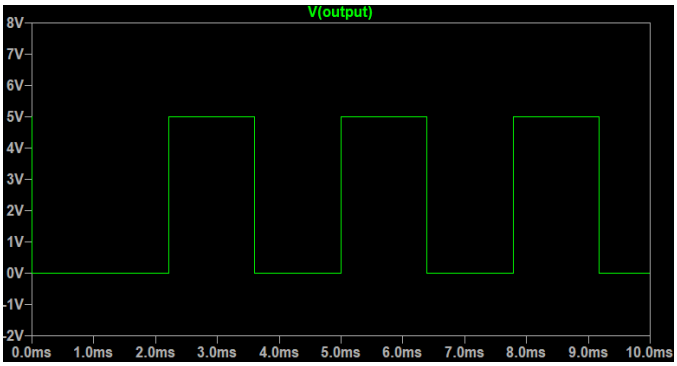

Fig. 9 $R_2 = 200k\Omega$

1.3
1.

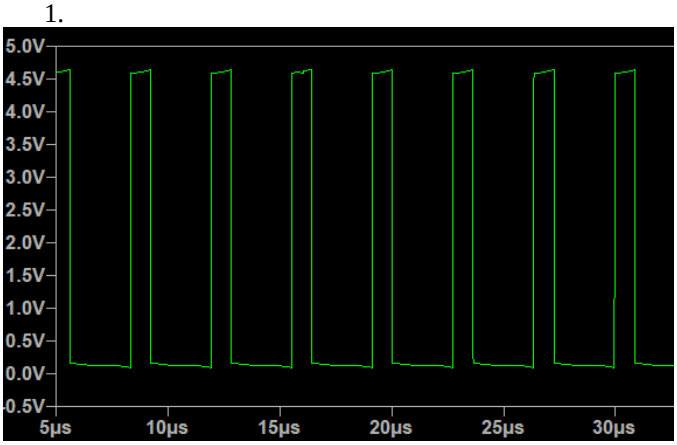

Fig. 10 waveform when R = 470Ω

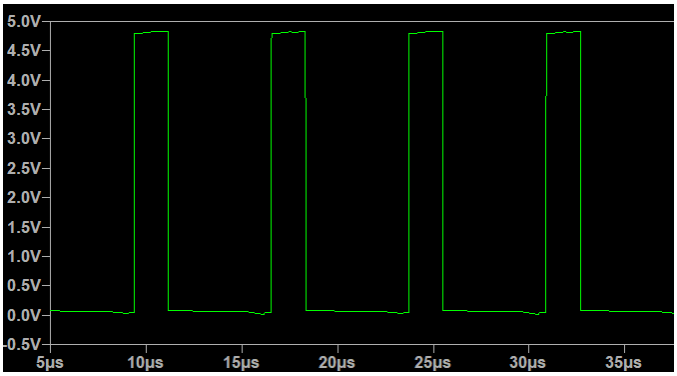

Fig. 11 waveform when R = 1000Ω

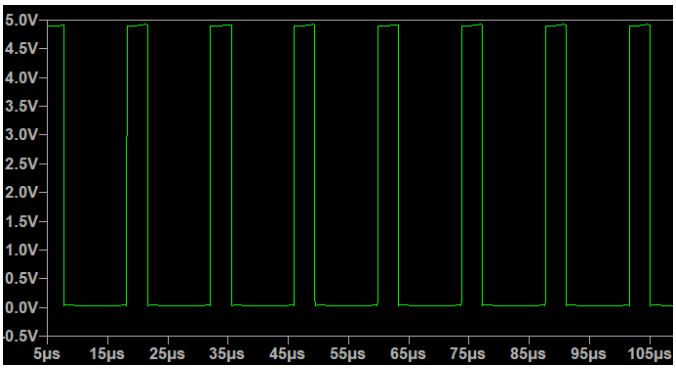

Fig. 12 waveform when R = 2000Ω

2.

When R = 470Ω:

T = 3.6µs

F = 1 / T = 1 / (3.6µs)

a = f * R * C = 1 / (3.6µs) * 470 * 10 * 10^{-9} = 1.305

When R = 1000Ω:

T = 7.2µs

F = 1 / T = 1 / (7.2µs)

a = f * R * C = 1 / (7.2µs) * 1000 * 10 * 10^{-9} = 1.388

When R = 1000Ω:

T = 14µs

F = 1 / T = 1 / (14µs)

a = f * R * C = 1 / (14µs) * 2000 * 10 * 10^{-9} = 1.428

2.1

T = 2 * 5 * $Delay_{inv}$ = 19ns

Ring oscillator frequency = 1 / T

= 1 / (19 * 10^{-9}) = 5.26 * 10^{7}

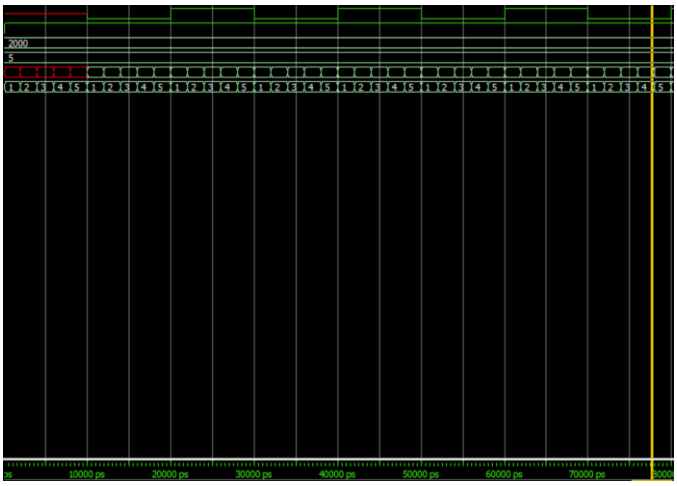

Fig. 13 waveforms of inputs and outputs

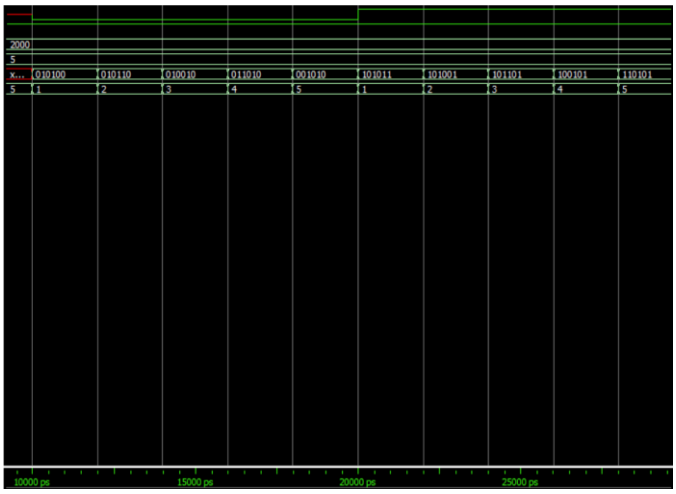

Fig. 14 waveforms of inputs and outputs

2.2

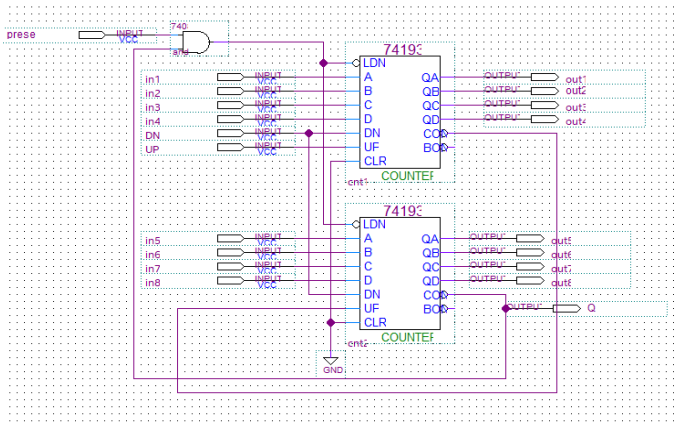

Fig. 15 Frequency divider

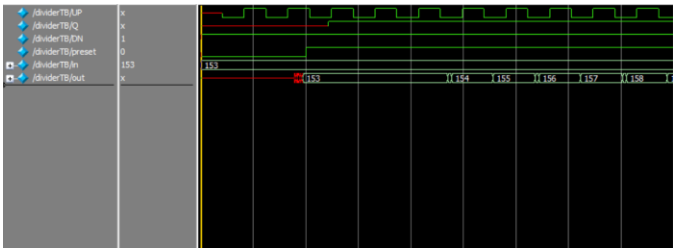

Fig. 16 Counter waveform

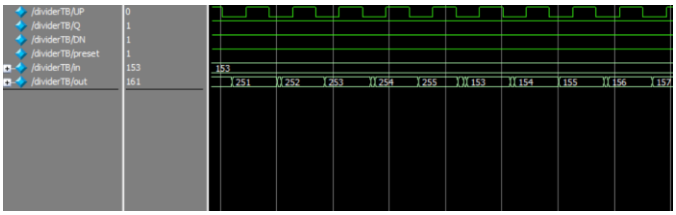

Fig. 17 Counter waveform

$Delay_{inv}$ = 1900ps
T = 2 * N * $Delay_{inv}$ = 19000ps
Frequency of input: = 1 / 19000ps = 0.5263 * 10^8
$T_{counter}$ = 19000 * 103 = 1957000ps
Because every 4150ps => output = output + 1
And total time is 19000 * 103ps
Frequency of counter: 1 / T
= 1 / 1957000ps = 0.5109 * 10^6
Compare frequencies:
Frequency of counter * 103 = Frequency of input

2.3

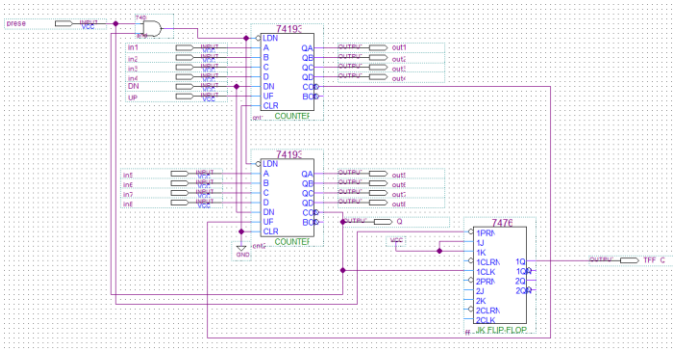

Fig. 18 counter with T Flip-Flop

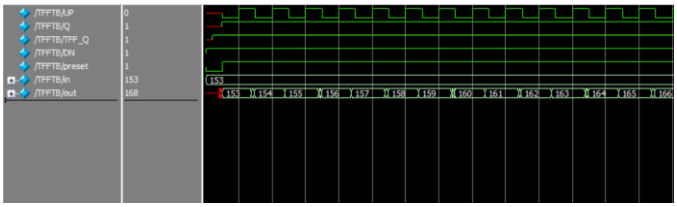

Fig. 19 output waveform T Flip-Flop

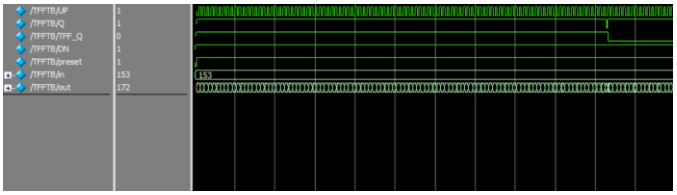

Fig. 20 output waveform T Flip-Flop

3.1

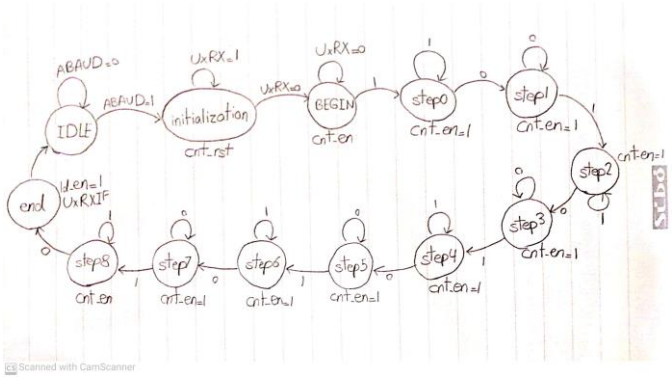

Fig. 21 state diagram of controller

3.4

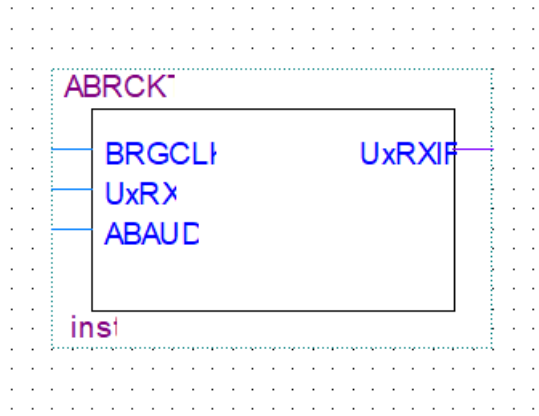

Fig. 22 schematic symbol for ABRCKT

3.6

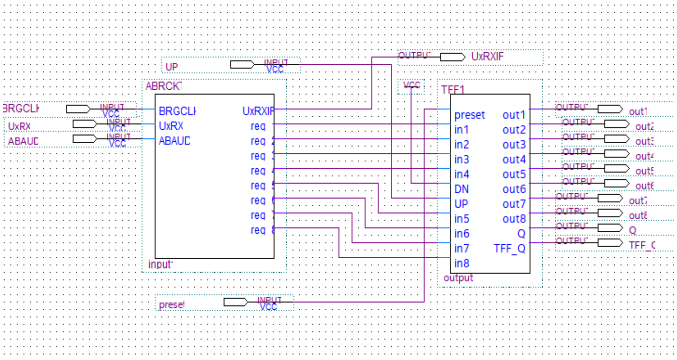

Fig. 23 BRGCLK block diagram