Experiment #4-
Integrated System

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1-Integrated System

1.

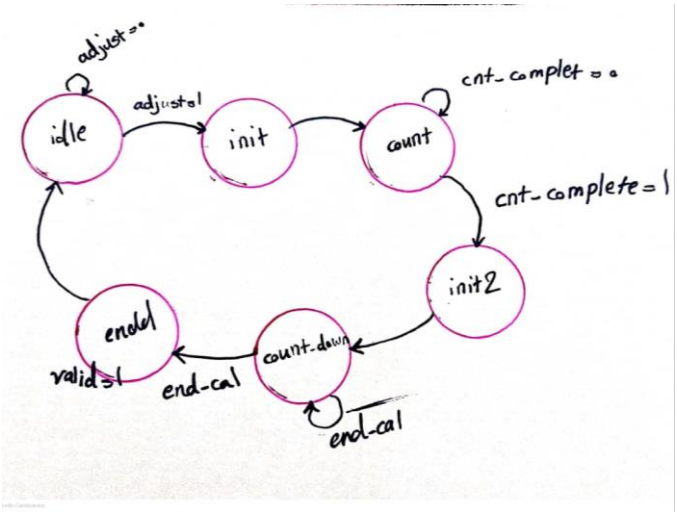


Fig1: state machine

2. testbench result in modelsim simulation software
Input frequency = 100kHz

Fig2: n = 1 and frequency become 200 kHz

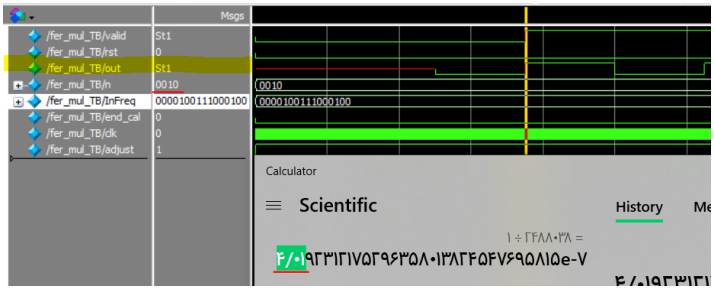


Fig3: n = 2 and frequency become 400 kHz

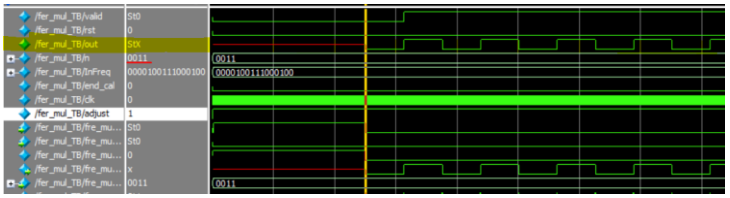
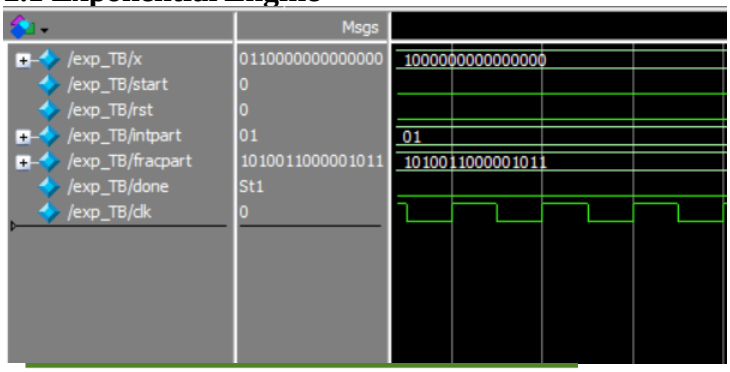


Fig 4: n = 3 and frequency become 800 kHz

2 Exponential Accelerator

2.1 Exponential Engine



$e^{0.5} = 1.6487212707001$

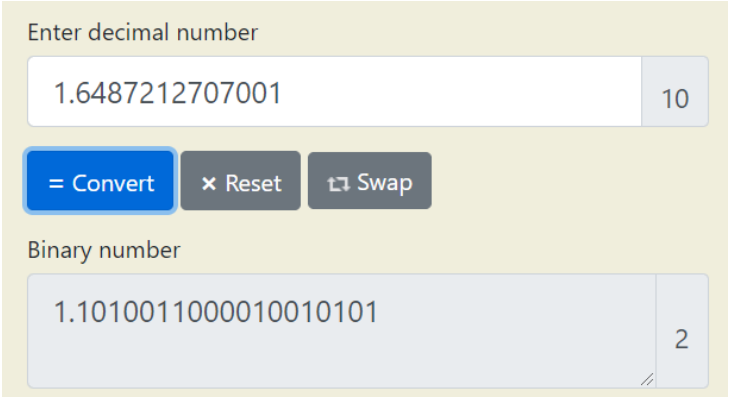
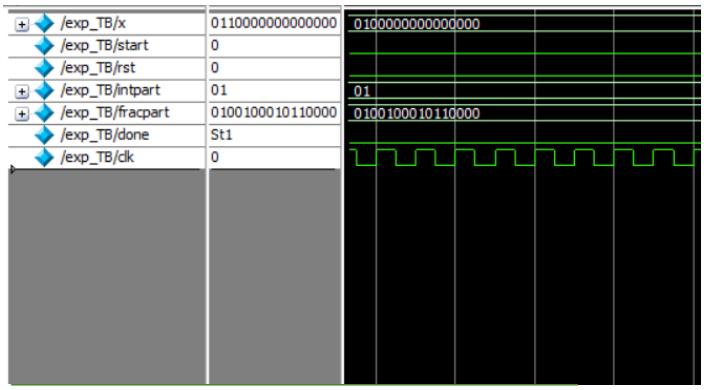


Fig5: input x = 0.5 and output is correct based on calculation



$e^{0.25} = 1.2840254166877$

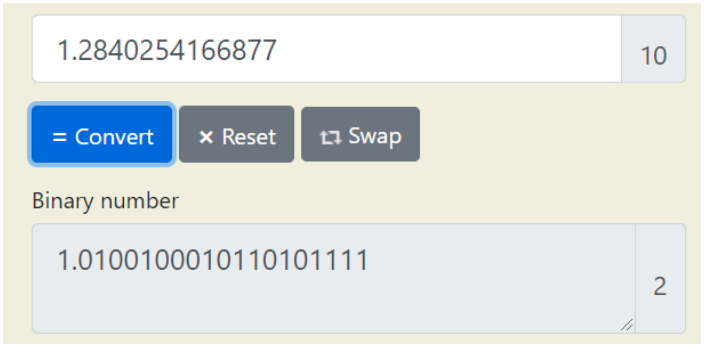


Fig6: input x = 0.25 and output is correct based on calculation

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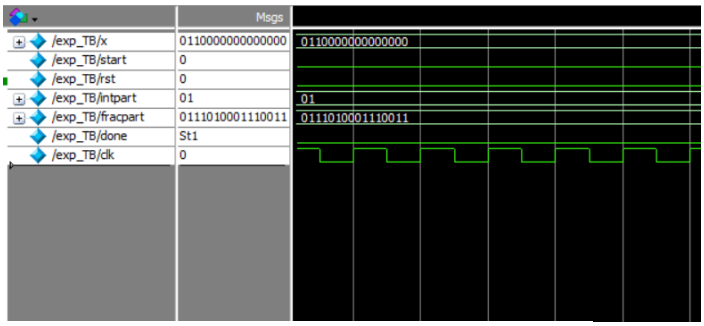


$e^{0.375} = 1.4549914146182$

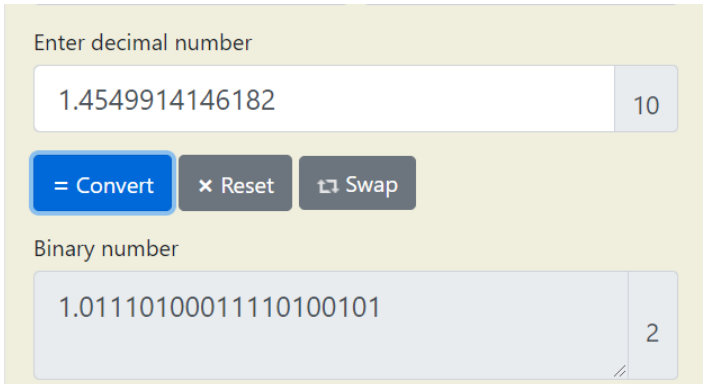


Fig6: input x = 0.375 and output is correct based on calculation

2-

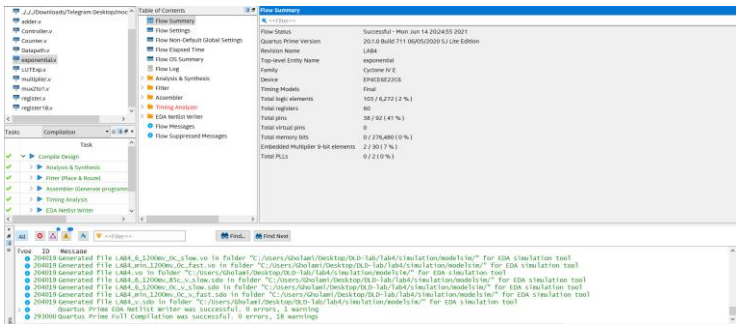


Fig7: synthesis summary

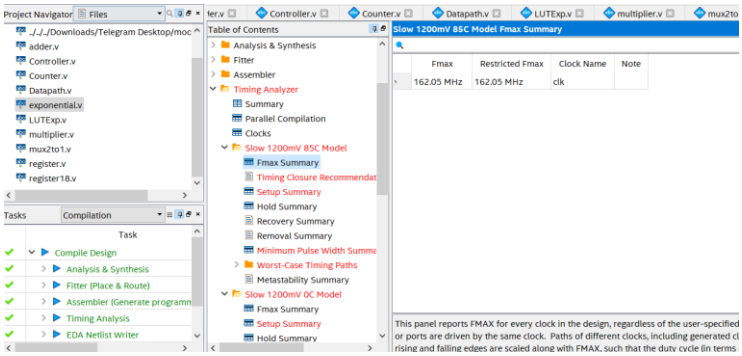


Fig8: maximum frequency of this accelerator is 162.5 MHz

2.2 Exponential Accelerator Wrapper

1-

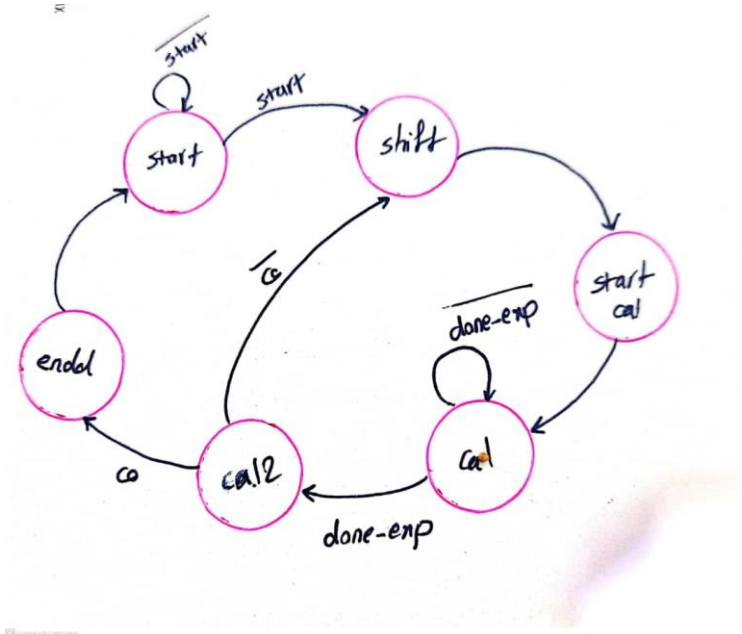
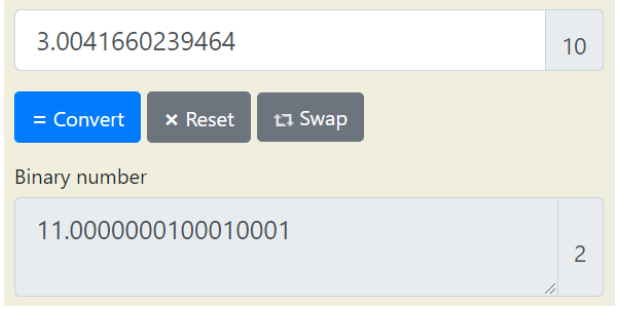


Fig9: state diagram of Wrapper

4- Assume x = 1.1

$e^{1.1} = 3.0041660239464$



$e^{1.2} = 3.3201169227365$

3.3201169227365 | 10

= Convert | × Reset | Swap

Binary number

11.01010001111100110011 | 2

$e^{1.4} = 4.0551999668447$

4.0551999668447 | 10

= Convert | × Reset | Swap

Binary number

100.00001110001000011001 | 2

$e^{1.8} = 6.0496474644129$

6.0496474644129 | 10

= Convert | × Reset | Swap

Binary number

110.00001100101101011011 | 2

Fig11: expected value for n = 4

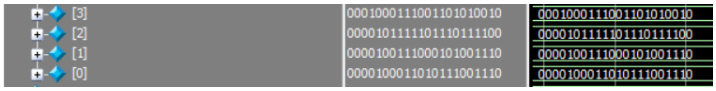


Fig12: achieved results.

n = 0 → answer = 2.2
n = 1 → answer = 2.4
n = 2 → answer = 2.9
n = 3 → answer = 4.22

It has difference with expected value because of approximation

Second example: x = 0.01

$e^{0.08} = 1.083287067675$

Enter binary number

1.0001010101001011 | 2

= Convert | × Reset | Swap

Decimal number

1.0831756591796875 | 10

$e^{0.04} = 1.0408107741924$

Enter binary number

1.0000101001101101 | 2

= Convert | × Reset | Swap

Decimal number

1.0407257080078125 | 10

$e^{0.02} = 1.0202013400268$

Enter binary number

1.0000010100101000 | 2

= Convert | × Reset | Swap

Decimal number

1.0201416015625 | 10

$e^{0.01} = 1.0100501670842$

Enter binary number

1.0000001010000111 | 2

= Convert | × Reset | Swap

Decimal number

1.009979248046875 | 10

Fig13: expected value for n = 4

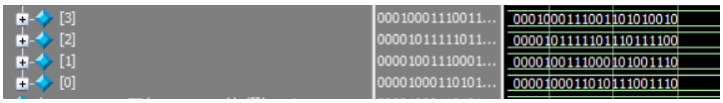


Fig14: achieved results

n = 0 → answer = 1.009
n = 1 → answer = 1.02
n = 2 → answer = 1.04
n = 3 → answer = 1.08

6.

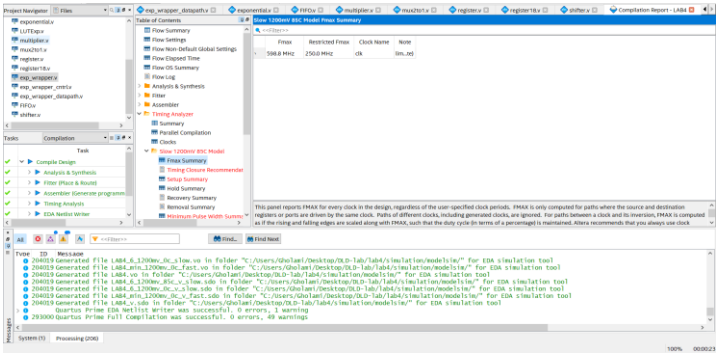


Fig15: Synthesis summary

maximum frequency of this accelerator wrapper is 250MHz

3. Integrated Circuit

2- $162*10^6 / 200*10^3 = 810$ → [log810] = 9 → n needs 4 bit

5-

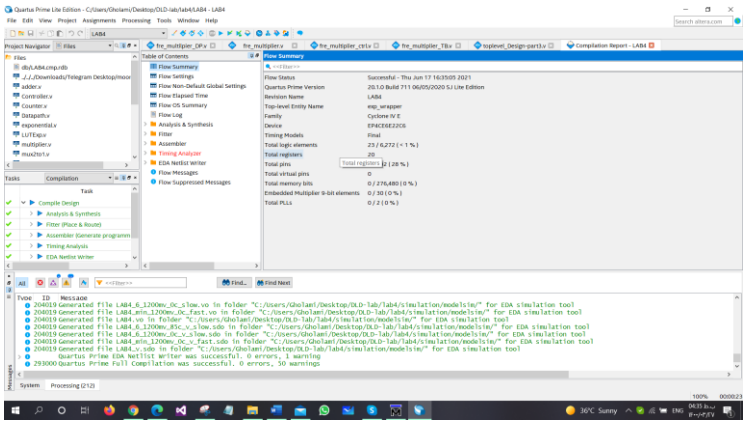


Fig16: Synthesis summary