CSE 331-Computer Organization HW3

32-bit Multiplicator

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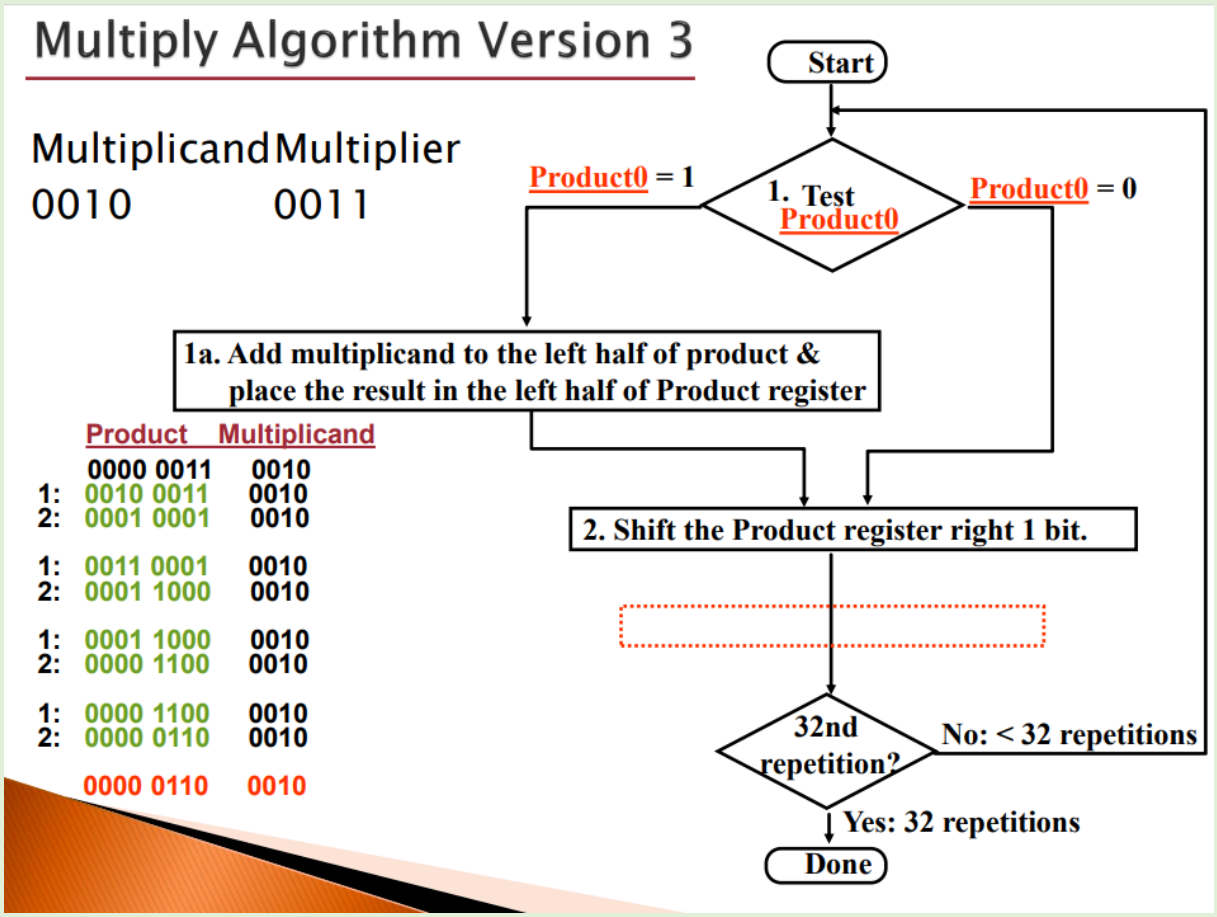
(all the required circuits are in the mult32.circ file)

Following circiuts are implemented to the project;

- 1 Arithmetic-Logic Unit(Datapath)
- 1 Control Unit
- 1 Signal Generator
- 1 Synchroniser for Buttons
- 1 one-bit Shifter
- 1 one-bit Adder
- 1 32-bit Adder
- 1 Main circuit named as Multiplier_(main)

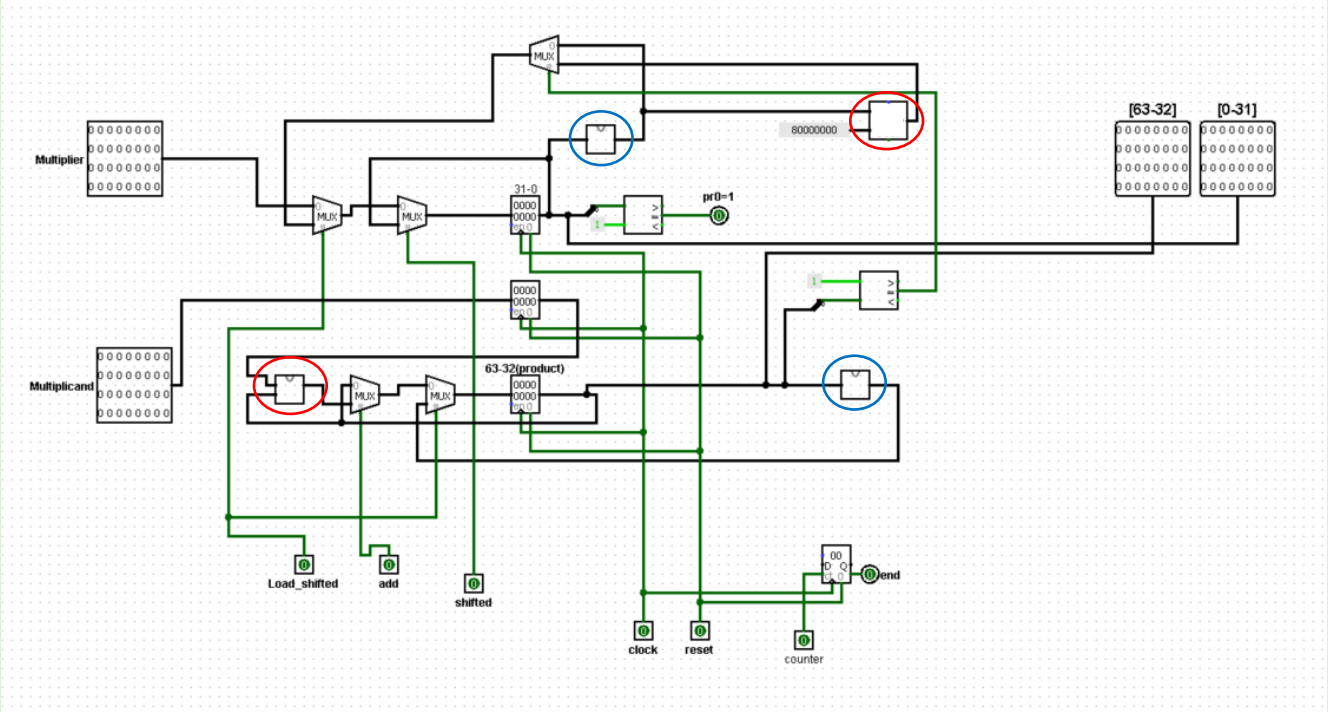
The Algorithm:

The algorithm, which is seen in lecture 5, is used.



Datapath(ALU):

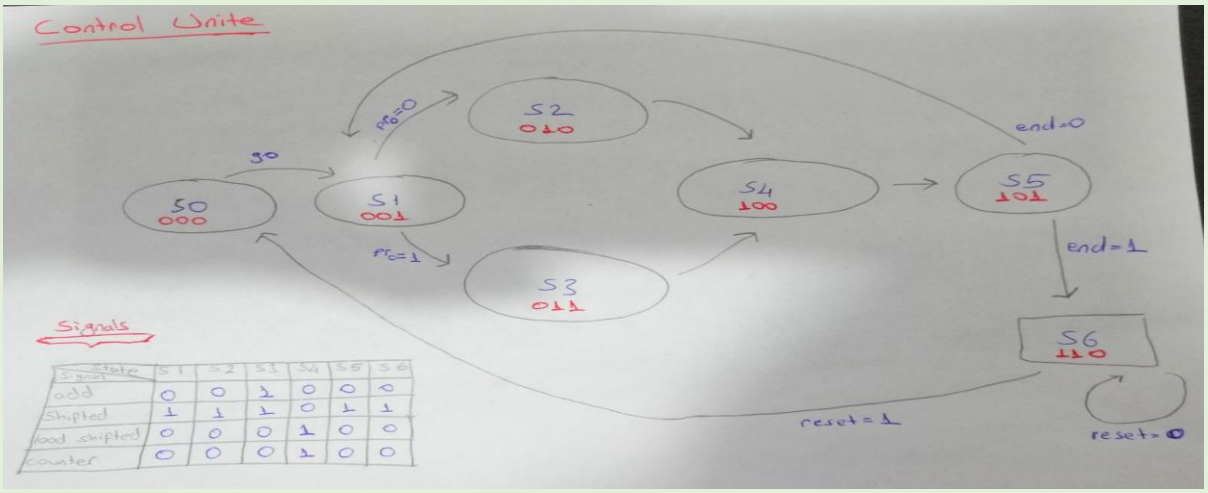
Datapath is the circuit which provides to make required calculations and generate signals for any algorithm.

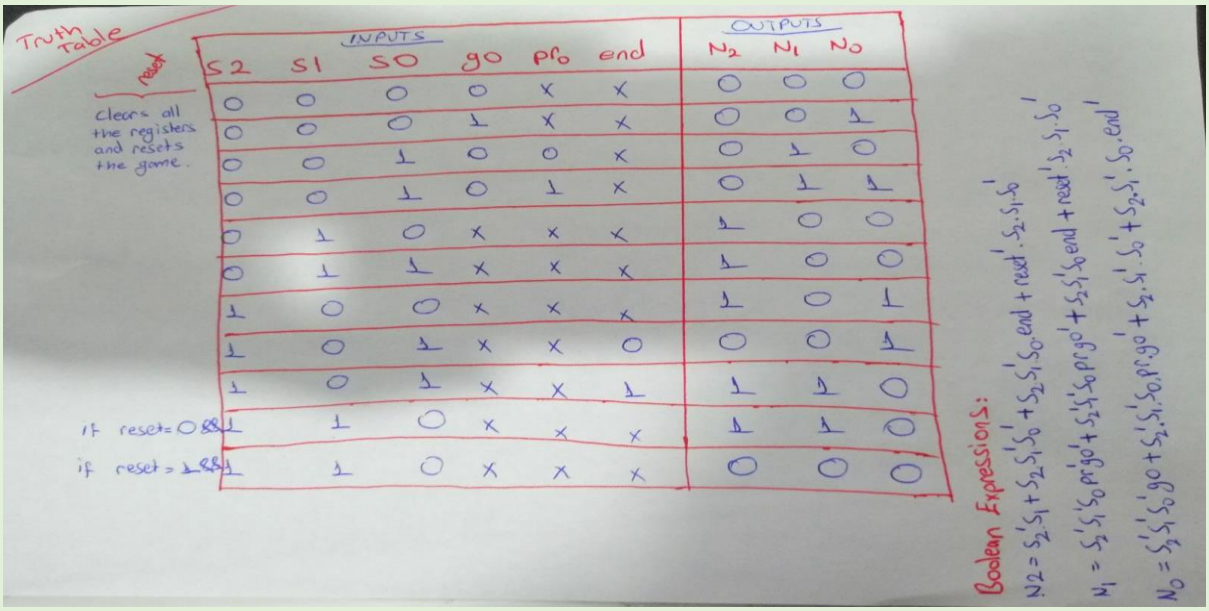


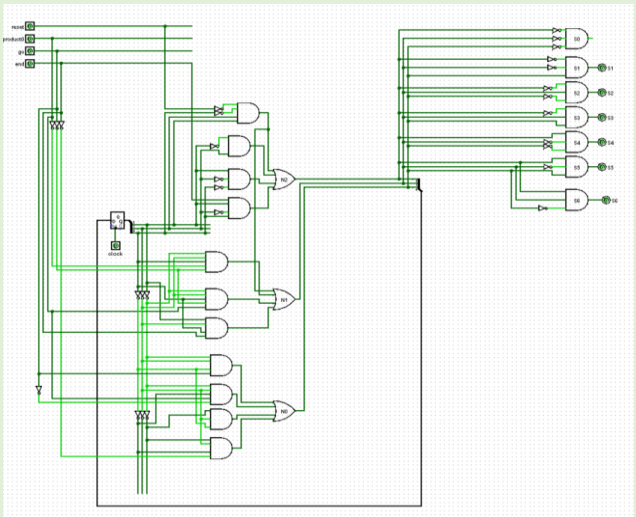
- Red circle shows the designed 32-bit adder. (as bonus)
- Blue circles show the designed 1-bit shifter. (as bonus)
- All the inputs (except clock) are taken from the control unit.
- All the outputs (“Pr0” and “end”) are received to the control unit for controling the state transitions.
- If pr0=1 adding operation will be performed for 64 bit product. Then it will be shifted.
- If pr0=0 adding operation will NOT be performed. Only the 64 bit product will be shifted.
- Since Logisim does not support 64 bit components, 2x32 bit outputs are used. If 32th bit of the product is 1, [31-0] of the product will be added by 0x80000000 (10000000000000000000000000000000) to make the MSB of first part of the product 1.

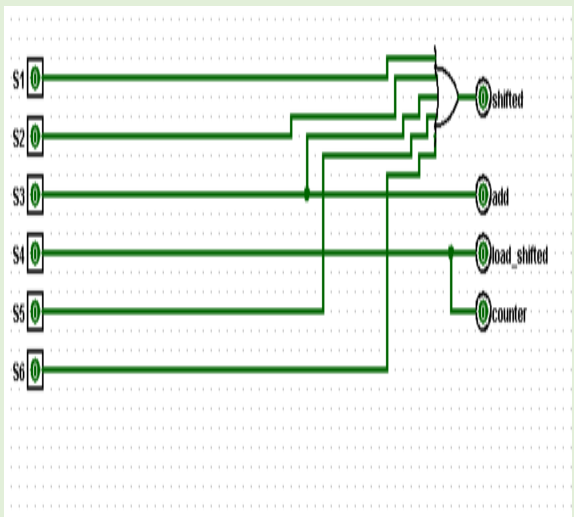
Control Unit(FSM):

- The state diagram,truth table,boolean equations and designed circuits are shown below.



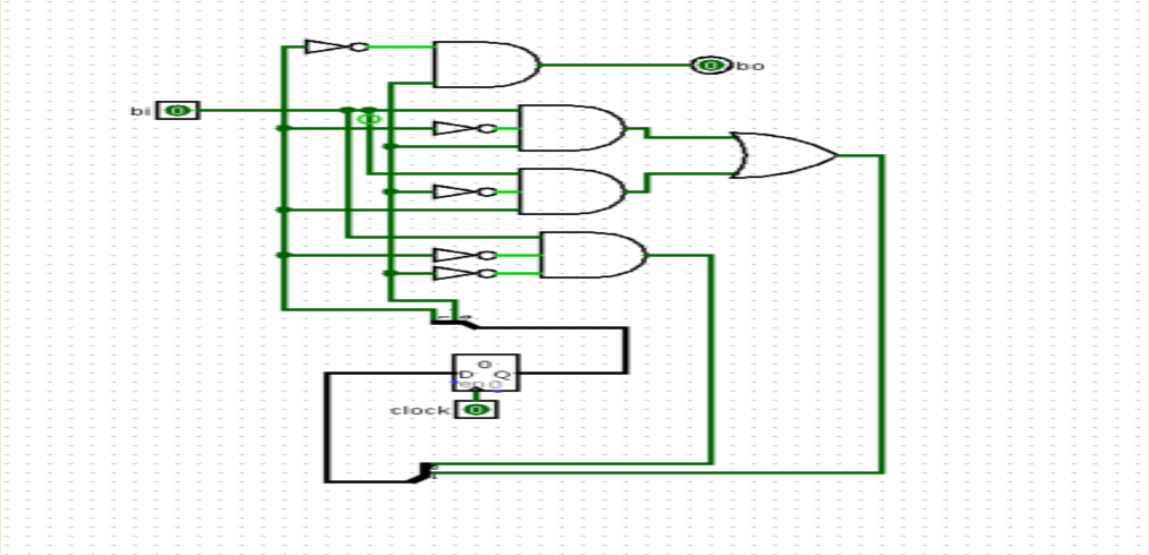






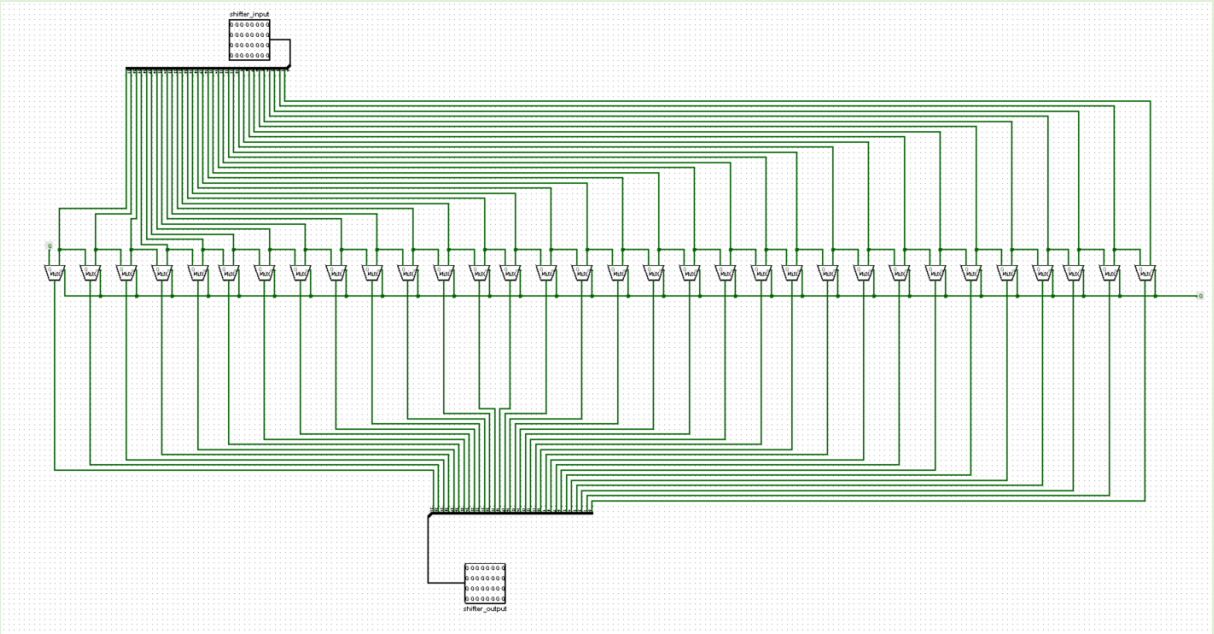
Synchroniser:

- Synchroniser provides to push button for once even it is keeped pushed. The synchroniser is already design by me in the Logic Circuits assignments.



1-bit Shifter:

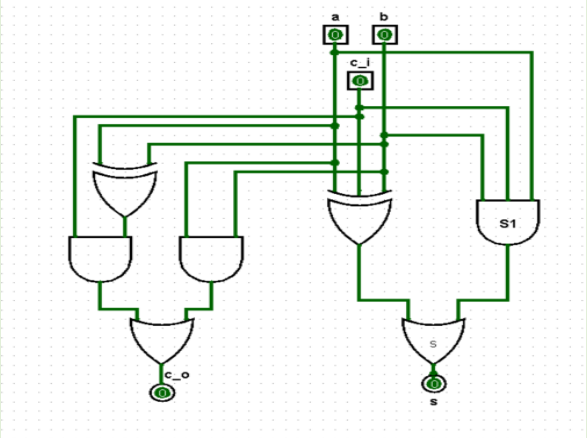
- The designed shifter provides to shift the input number for 1 bit. The constant 0 is for choosing the correct input of mulitiplexer's. It can be changed as an input but if it is changed, the multiplexers inputs must be switched.



1-bit Adder:

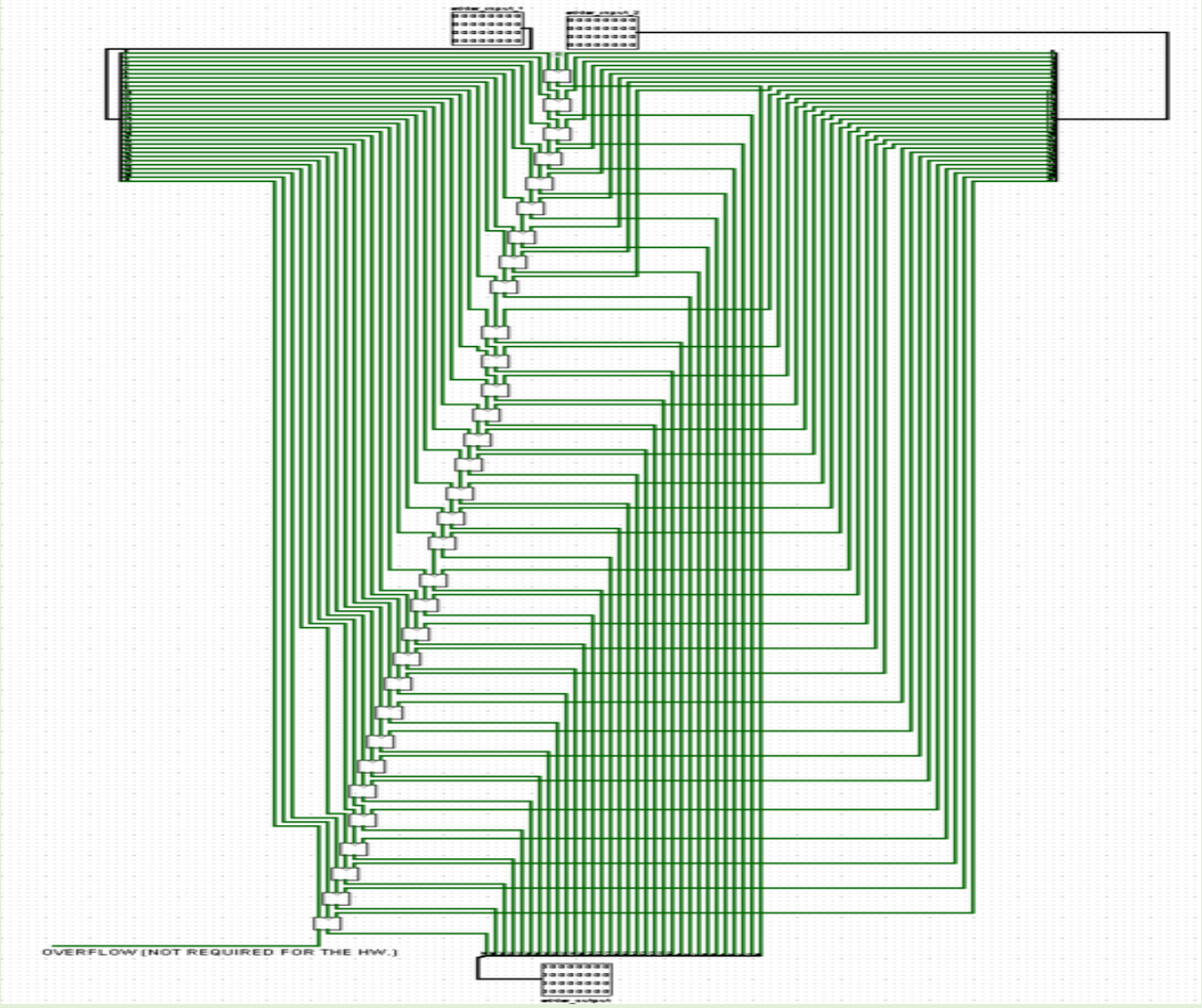
- The truth table, which is seen in lecture 4, is used with some modifications.

a_i	b_i	c_i	c_{i+1}	s_i
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1



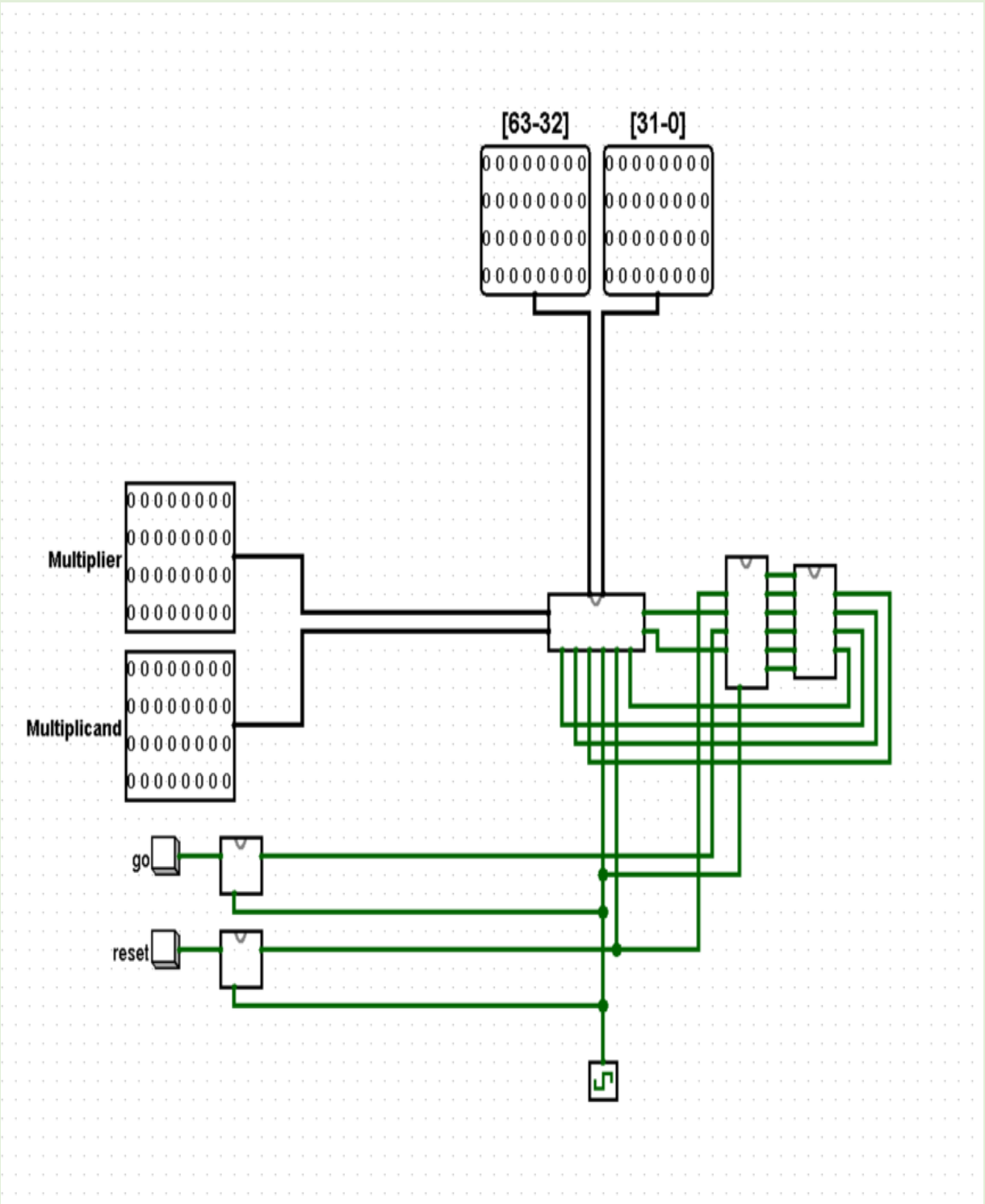
32-bit Adder:

- 32 bit adder is composed of 32x1-bit adder.Adder's carry in values and carry out values are connected to each other. The MSB's carry out bit can show the overflow but it is not required to show it for this project. The template is shown in the circuit below.

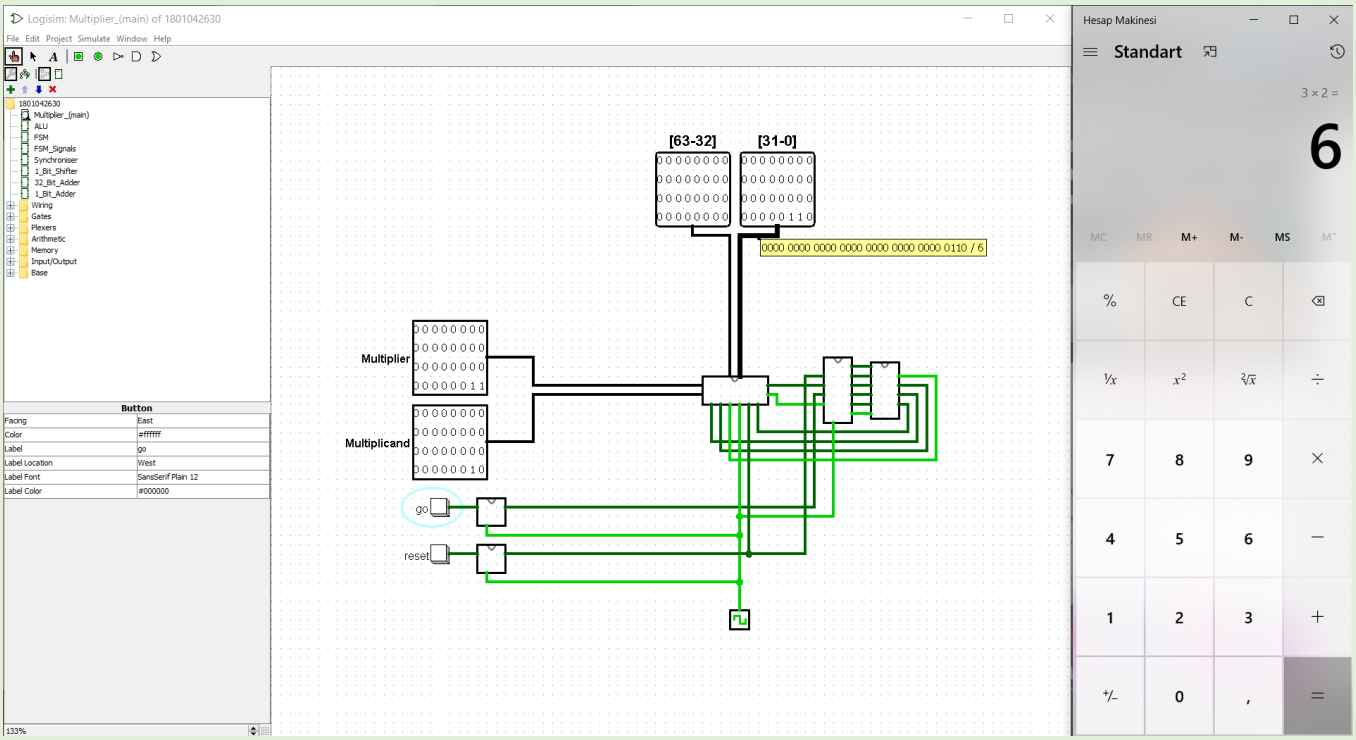


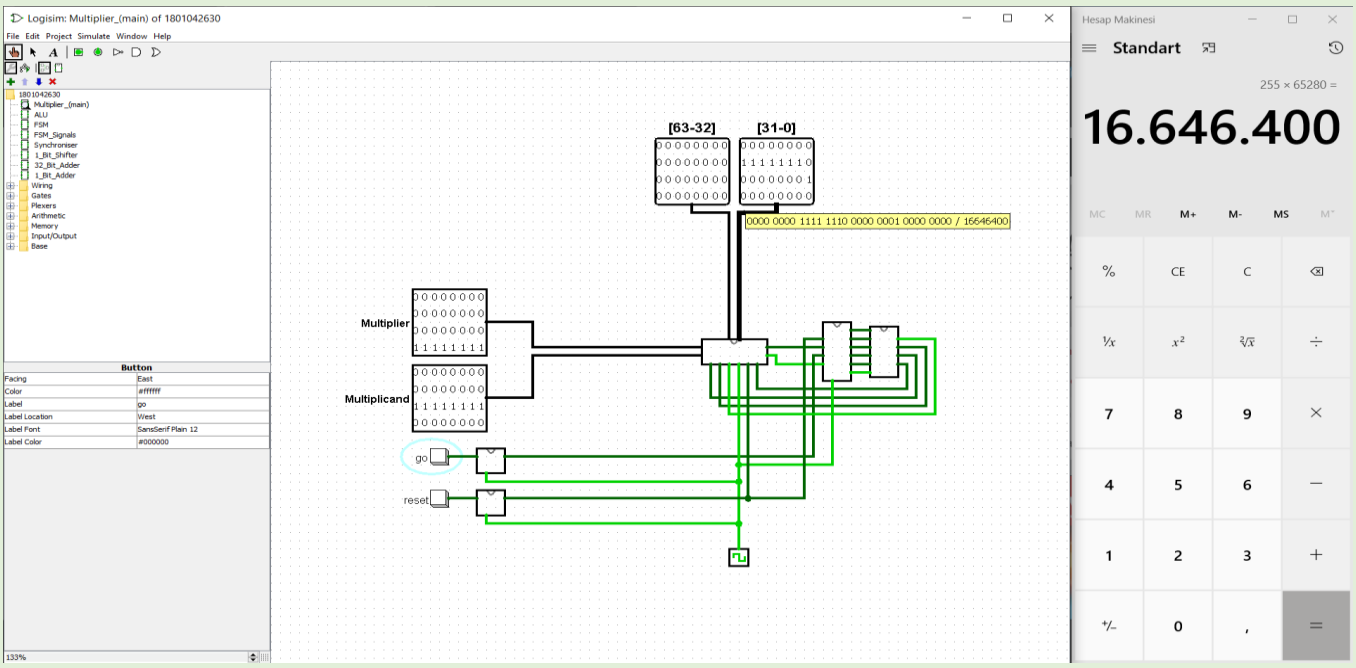
The Main:

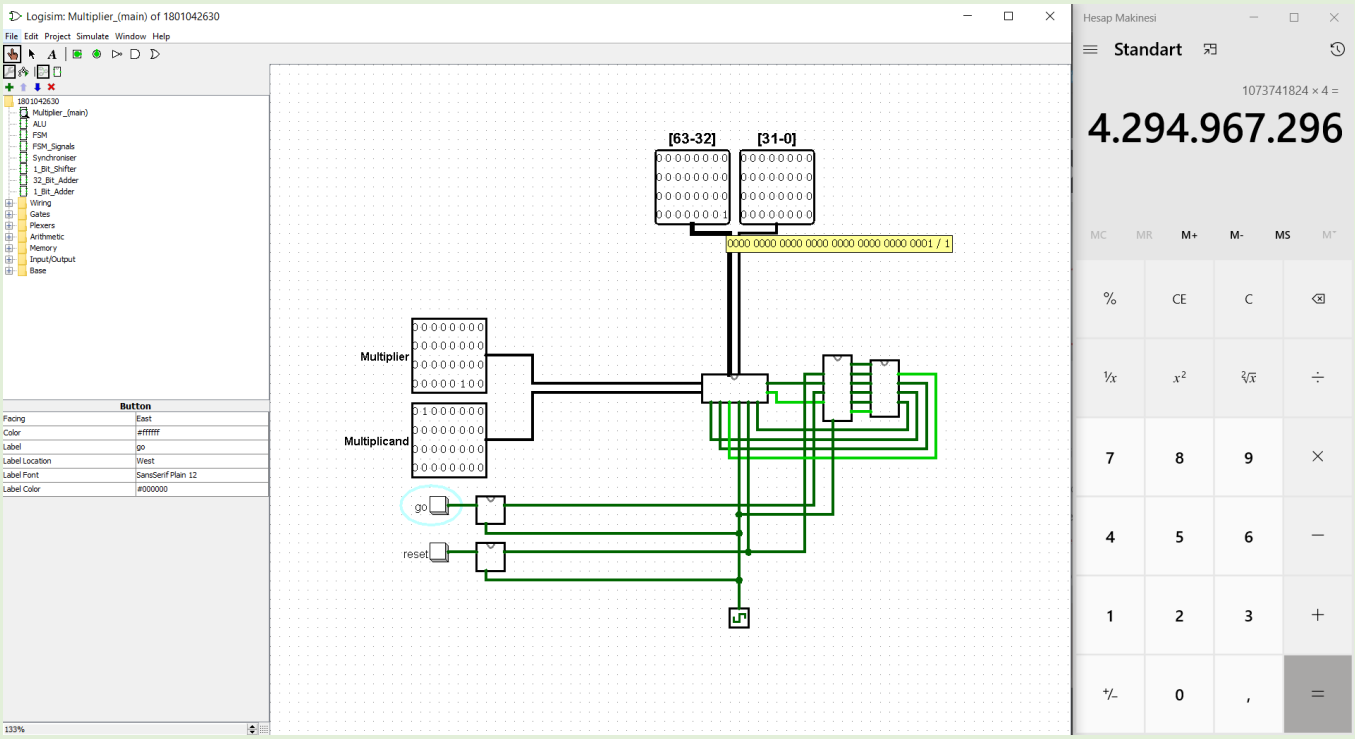
- Here is an indigenous and national multiplier :))

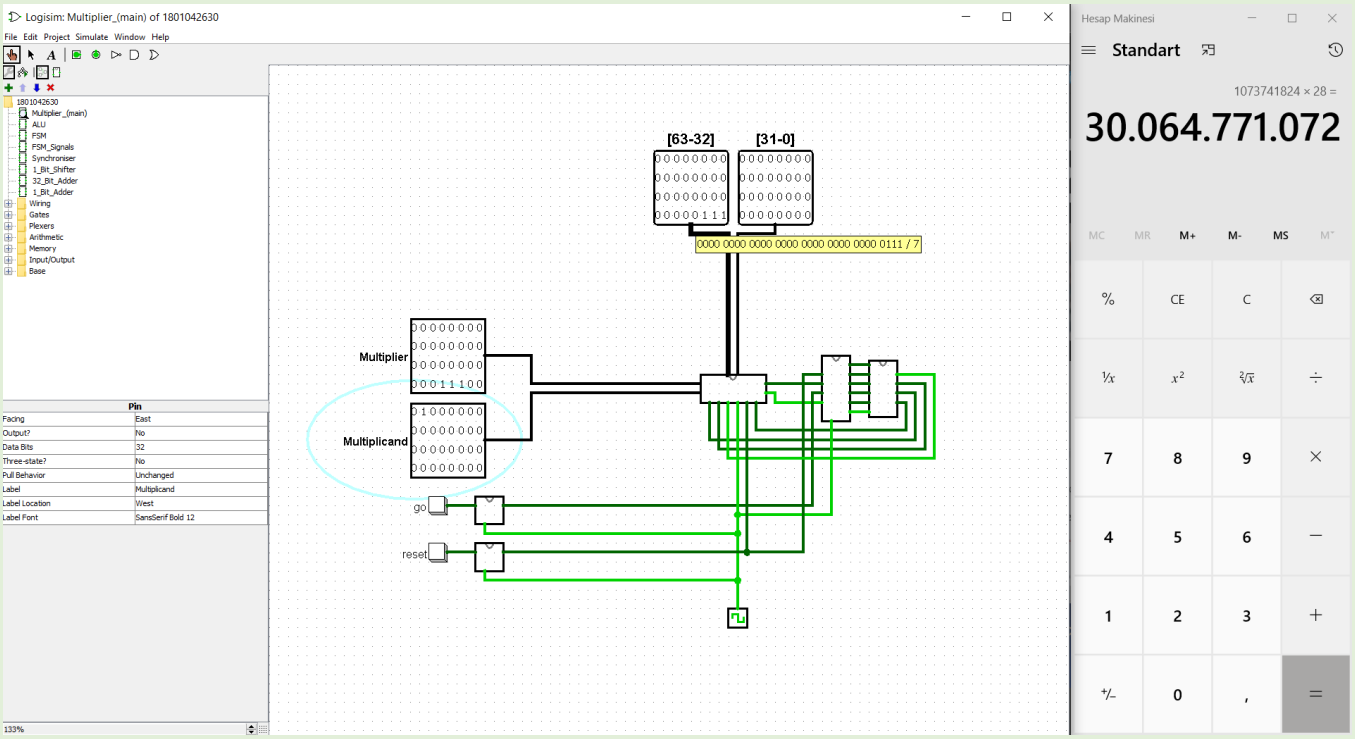


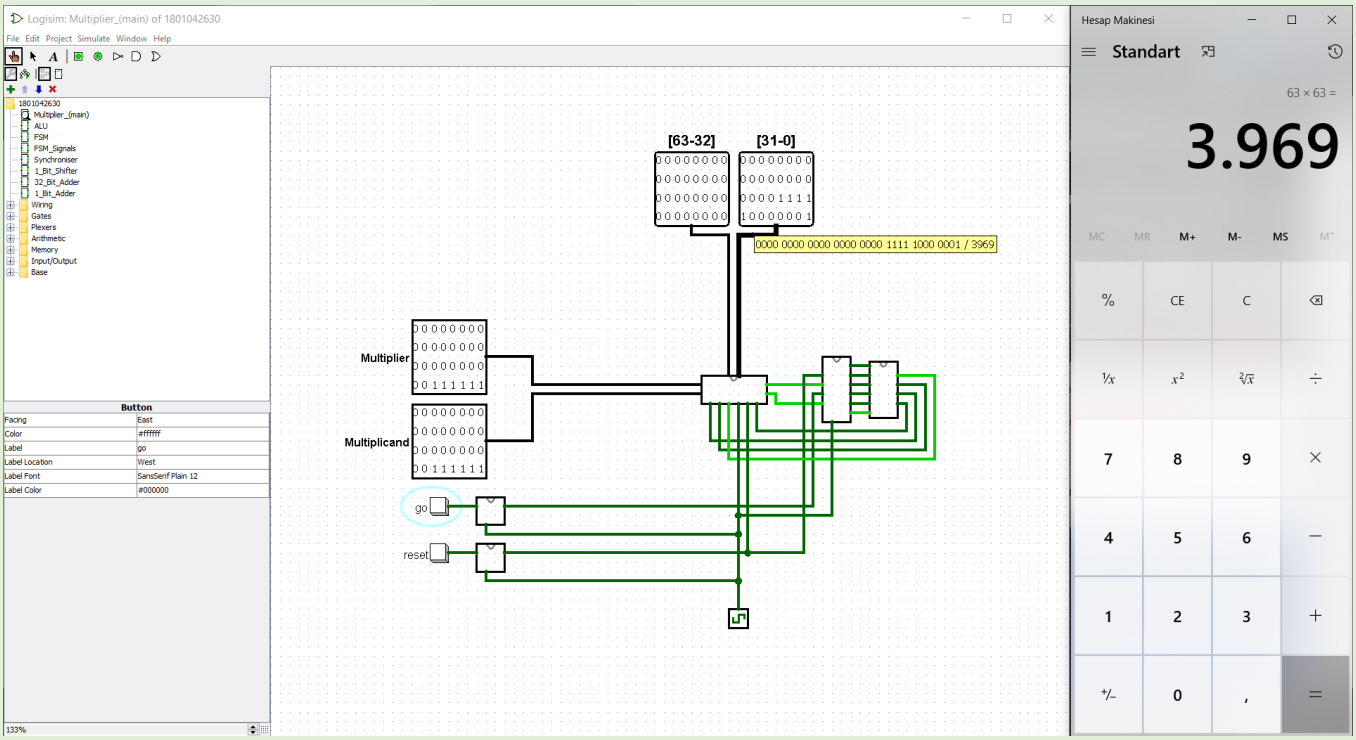
Test Cases:

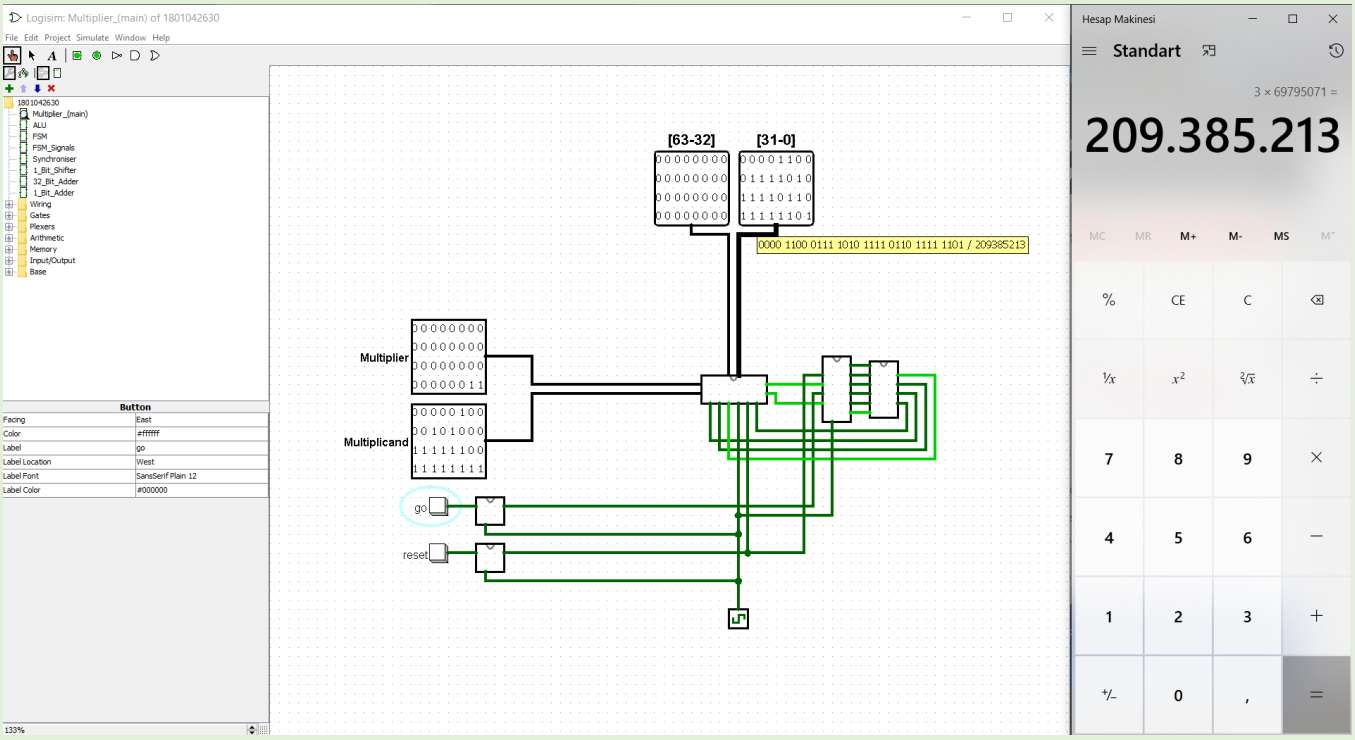

Logisim: Multiplier_(main) of 1801042630
[63-32]
[31-0]
0000 0000 0000 0000 0000 0000 0110 / 6
Multiplier
Multiplicand
go
reset
Hesap Makinesi
Standart
3 × 2 =
6


Logisim: Multiplier_(main) of 1801042630
[63-32]
[31-0]
0000 0000 1111 1110 0000 0001 0000 0000 / 16646400
Multiplier
Multiplicand
go
reset
Hesap Makinesi
Standart
255 × 65280 =
16.646.400


Logisim: Multiplier_(main) of 1801042630
File Edit Project Simulate Window Help
1801042630
Multiplier_(main)
ALU
FSM
FSM_Signals
Synchroniser
1_Bit_Shifter
32_Bit_Adder
1_Bit_Adder
Wiring
Gates
Plexers
Arithmetic
Memory
Input/Output
Base
Button
Facing East
Color #ffffff
Label go
Label Location West
Label Font SansSerif Plain 12
Label Color #000000
133%
[63-32]
[31-0]
0000 0000 0000 0000 0000 0000 0000 0001 / 1
Multiplier
Multiplicand
go
reset
Hesap Makinesi
Standart
1073741824 × 4 =
4.294.967.296
MC MR M+ M- MS M˅
% CE C
1/x x² ²√x ÷
7 8 9 ×
4 5 6 −
1 2 3 +
+/- 0 , =


Logisim: Multiplier_(main) of 1801042630
File Edit Project Simulate Window Help
1801042630
Multiplier_(main)
ALU
FSM
FSM_Signals
Synchroniser
1_Bit_Shifter
32_Bit_Adder
1_Bit_Adder
Wiring
Gates
Plexers
Arithmetic
Memory
Input/Output
Base
Pin
Facing East
Output? No
Data Bits 32
Three-state? No
Pull Behavior Unchanged
Label Multiplicand
Label Location West
Label Font SansSerif Bold 12
133%
[63-32]
[31-0]
0000 0000 0000 0000 0000 0000 0000 0111 / 7
Multiplier
Multiplicand
go
reset
Hesap Makinesi
Standart
1073741824 × 28 =
30.064.771.072
MC MR M+ M- MS M˅
% CE C
1/x x² ²√x ÷
7 8 9 ×
4 5 6 −
1 2 3 +
+/- 0 , =


Logisim: Multiplier_(main) of 1801042630
[63-32]
[31-0]
0000 0000 0000 0000 0000 1111 1000 0001 / 3969
Multiplier
Multiplicand
go
reset
Hesap Makinesi
Standart
63 × 63 =
3.969


Logisim: Multiplier_(main) of 1801042630
[63-32]
[31-0]
0000 1100 0111 1010 1111 0110 1111 1101 / 209385213
Multiplier
Multiplicand
go
reset
Hesap Makinesi
Standart
3 × 69795071 =
209.385.213