CSE 331 – COMPUTER ORGANIZATION HOMEWORK 3 REPORT

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REQUESTED

We are askd to design an unsigned number multiplier using Logisim.

EXPLANATIONS ABOUT PROJECT

In this Project, firstly I created a state diagram. After that I wrote the truth table for different states. Using these values, I found the next state pin's booleans expressions. Also I have pins that understand which operations are taking place in which state. These pins are below :

Load Multiplicand &Multipliers : If this pin is 1, the multiplicand and multiplier will be loaded to the register.

Select Product : Select input for the product left(most significant 32bit) and product right(less significant 32 bit).

Load Product : If the load product is 1, then load the values to the register

Select Add : If the zero bit of product is 1, then this pin will be 1 and multiplexer selects adder's result(multiplicand and product's most significant 32 bit) for shifter. Otherwise it selects product's most significant 32 bit for shifter.

Load Result : If the load result is 1, then the results load the registers.

Counter Increment : It increments the counters step.

Counter Reset : It resets the S1 for new calculating.

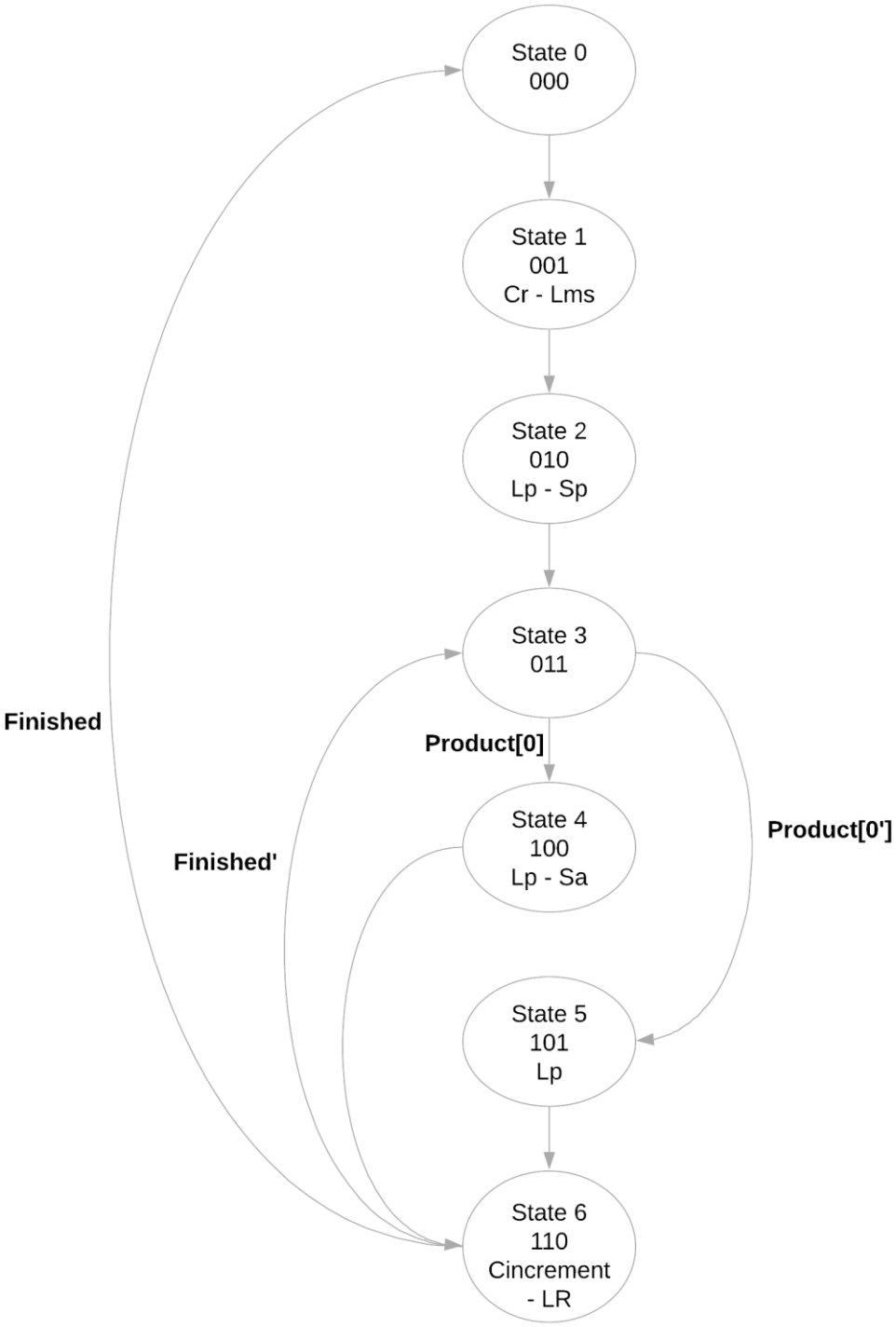
Finished : If the counter equals to 32, then this pin will be 1 and operations will be over.

Product[0] = The less significant bit of product.

Clock : Clock

Summary : The values are entered. Then the counter will be reseted because may be you could do calculating before this time. Also in this step values are loaded to registers. Next step, the values loaded to product registers. For that, select product will be 1. And in the other step, program looks the product[0] bit. If it is 1, then the multiplicand and product left side will sum. Otherwise the product left goes to the shifter directly. And it continues 32 times. Finally counter will be 32 and the program will finish.

NOTE : I made my own 1bit adder, 32bit adder and shifter. It is in datapath.circ Logisim file.


State 0
000
State 1
001
Cr - Lms
State 2
010
Lp - Sp
State 3
011
Product[0]
State 4
100
Lp - Sa
State 5
101
Lp
State 6
110
Cincrement
- LR
Finished
Finished'
Product[0']

Present State			Inputs		Next State		
P2	P1	P0	Product[0]	Finished	N2	N1	N0
0	**0**	**0**	**-**	**-**	**0**	**0**	**1**
0	**0**	**1**	**-**	**-**	**0**	**1**	**0**
0	**1**	**0**	**-**	**-**	**0**	**1**	**1**
0	**1**	**1**	**0**	**-**	**1**	**0**	**1**
0	**1**	**1**	**1**	**-**	**1**	**0**	**0**
1	**0**	**0**	**-**	**-**	**1**	**1**	**0**
1	**0**	**1**	**-**	**-**	**1**	**1**	**0**
1	**1**	**0**	**-**	**0**	**0**	**1**	**1**
1	**1**	**0**	**-**	**1**	**0**	**0**	**0**

Boolean Expressions

N2 = P2' . P1.P0 + P2.P1'

N1 = P2' (P1.P0' + P1'.P0) + P2.P1' + P2.P1.P0'.Finished'

= P2' (P1 XOR P0) + P2.P1' + P2.P1.P0'.Finished'

N0 = P2'.P1'.P0' + P2'.P1.P0' + P2'.P1.P0.Product[0]' + P2.P1.P0'.Finished'

= P2'P0'(P1' + P1) + P2'. P1. P0. Product[0]' + P2. P1. P0'.Finished'

= P2'P0' + P2'. P1. P0. Product[0]' + P2. P1. P0'.Finished'

PS	Load Product	Load Multiplicand &Multipliers	Select Add	Select Product	Counter Increment	Counter Reset	Load Result
S0	**0**	**0**	**0**	**0**	**0**	**0**	**0**
S1	**0**	**1**	**0**	**0**	**0**	**1**	**0**
S2	**1**	**0**	**0**	**1**	**0**	**0**	**0**
S3	**0**	**0**	**0**	**0**	**0**	**0**	**0**
S4	**1**	**0**	**1**	**0**	**0**	**0**	**0**
S5	**1**	**0**	**0**	**0**	**0**	**0**	**0**
S6	**0**	**0**	**0**	**0**	**1**	**0**	**1**

Load Product = S2 + S4 + S5

Load Multiplicand &Multipliers = S1

Select Add = S4

Select Product = S2

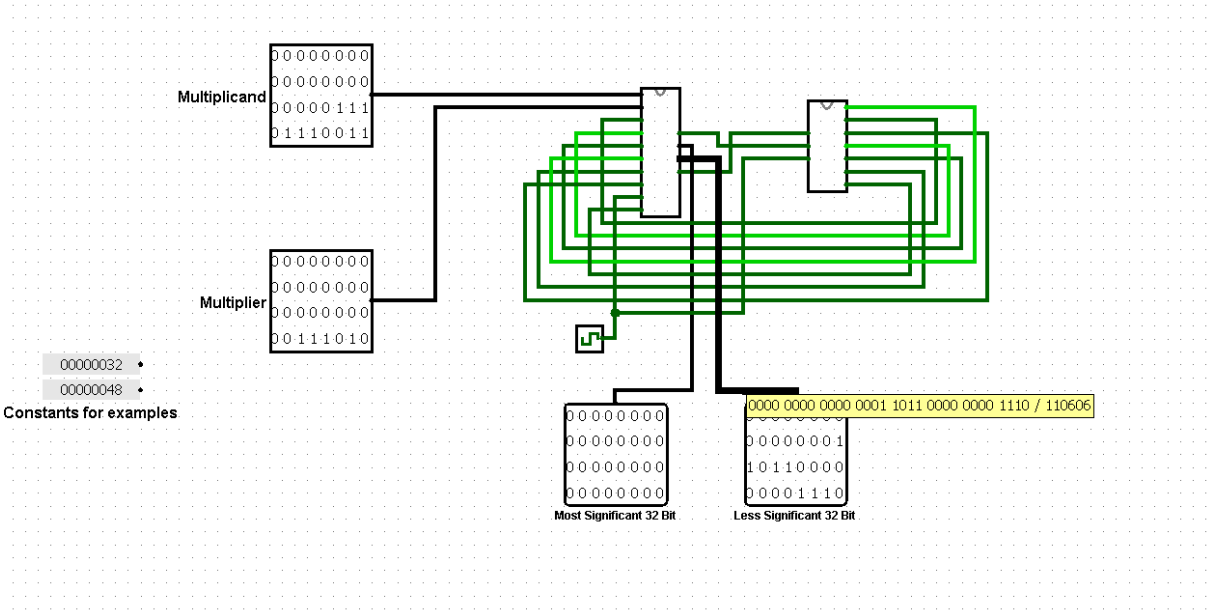
Counter Increment = S6

Counter Reset = S1

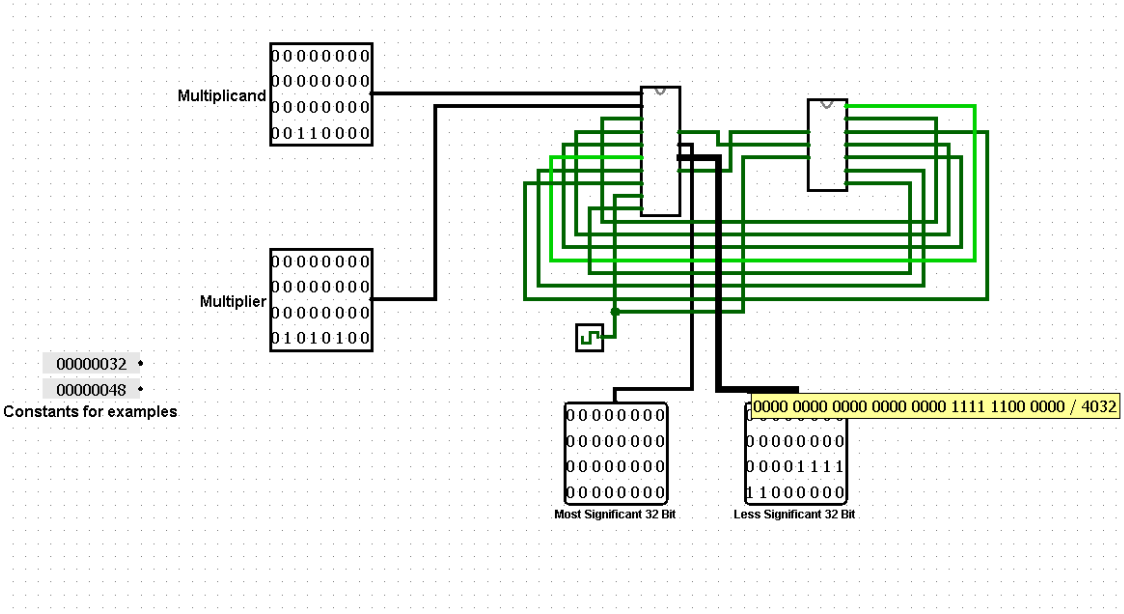
Load Result = S6

TEST CASES

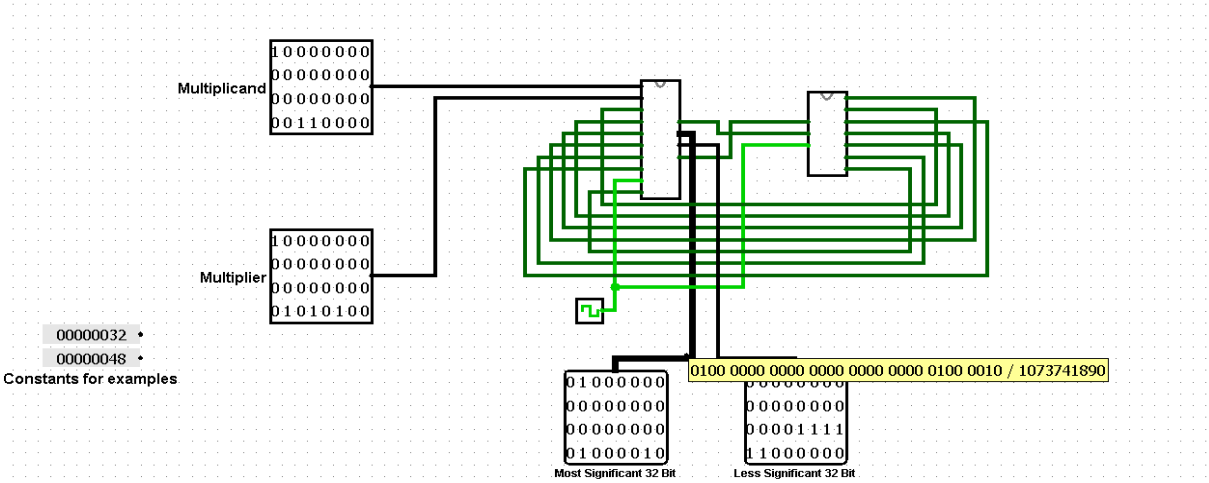
Test 1 : I tried 1907 * 58 = 110.606

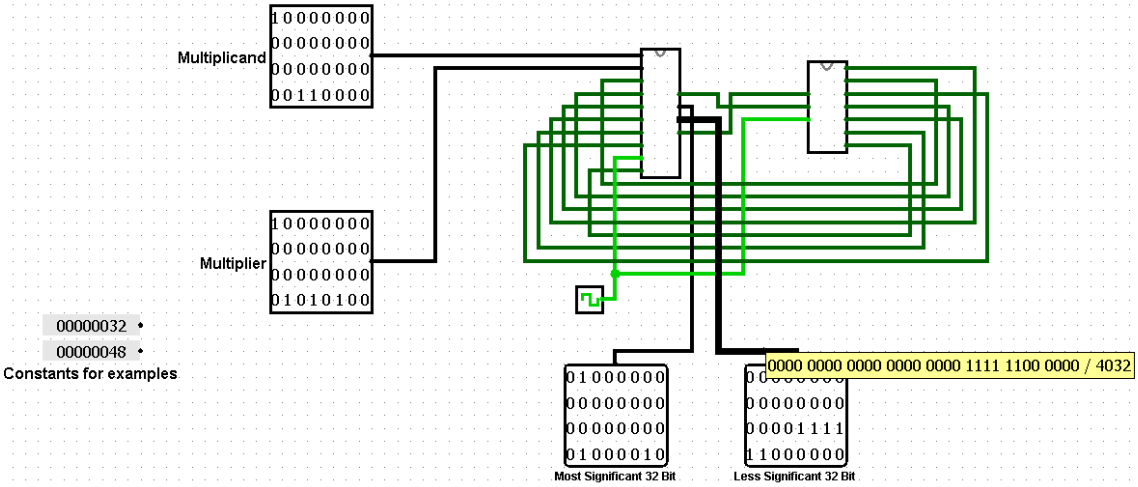


Test 2 : I tried 48 *84 = 4.032



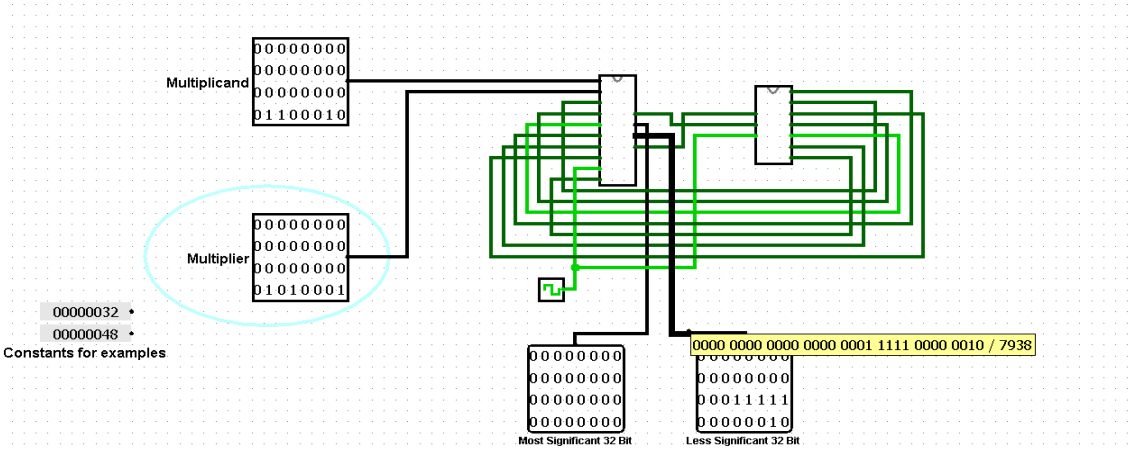
Test 3 : I tried 2,147,483,696 * 2,147,483,732 = 4,611,686,301,895,233,472 (Yes, I calculated :))



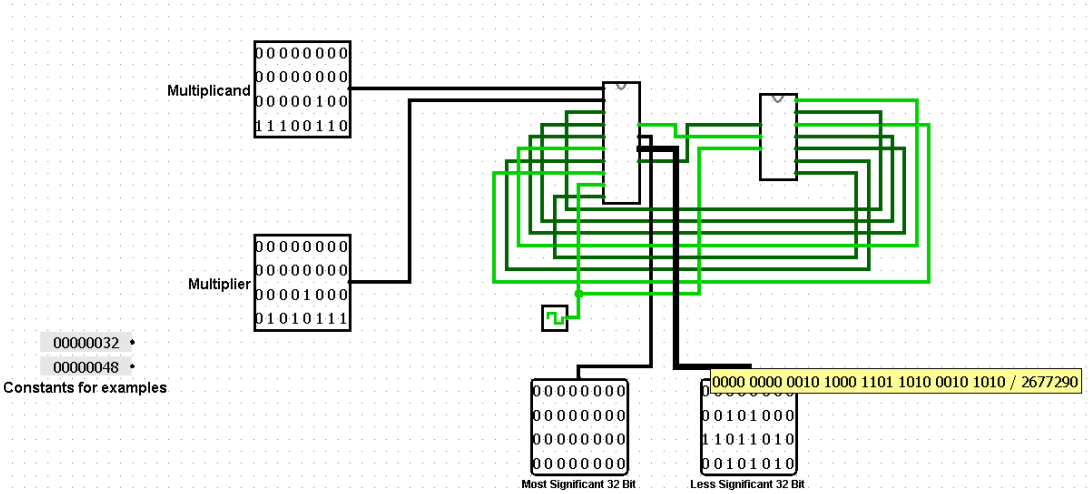


(The most significant 32 bit starts with 2^32 multiply.)

Test 4 : I tried 98 * 81 = 7938



Test 5 : I tried 1254 * 2135 = 2.677.290



Test 6 : I tried 75134* 215 = 16.153.810