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Engineering – 303

Lab 9

5/5/2017

Introduction/Description

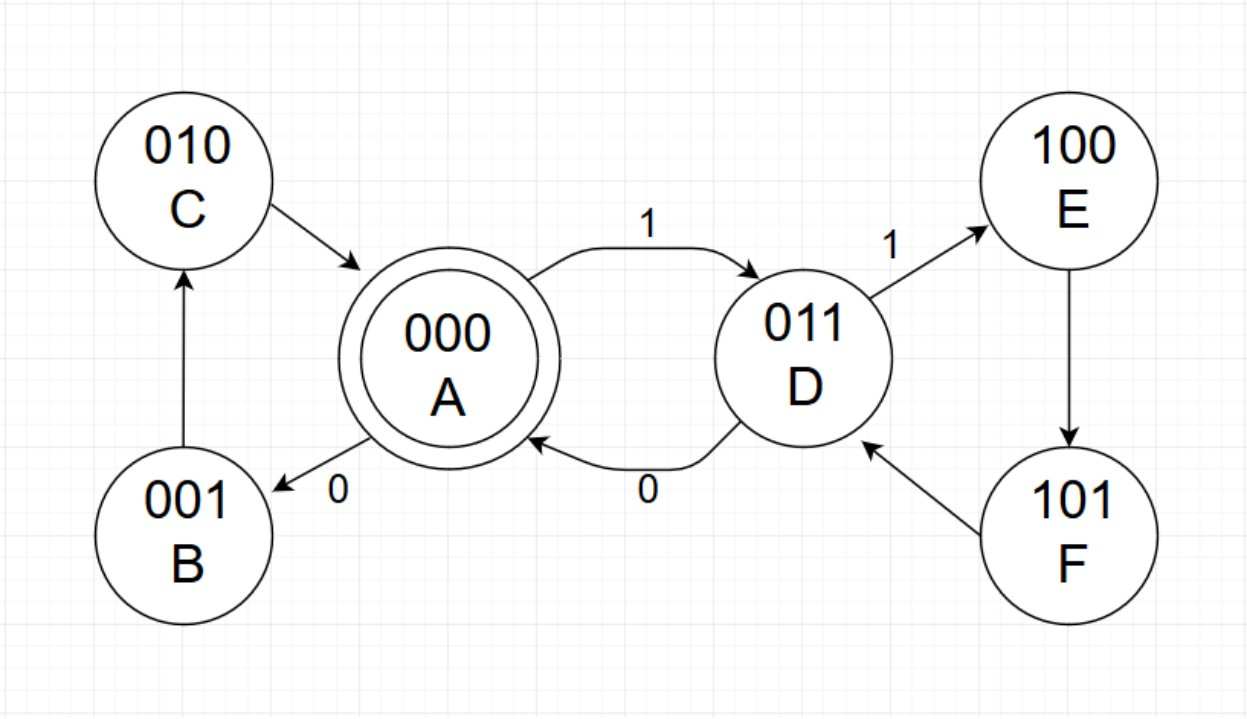
The goal of this lab was to learn further how to build and implement state machines. This lab allowed me to further my understanding of the workings of a state machine. In this lab, I created two circuits one was called Freaky State Machine and the other Vendomatic. Please note, this lab was done for extra credit.

Design

Part 0 – Freaky State Machine

The first circuit that I had to create in this lab was called a freaky state machine. This state machine is different from the previous state machines that I have created because this thing has states where both a binary zero and one will lead to the same result. This gives this machine the ability to get stuck in loops.

Here is the State Diagram for the circuit.



Here is the Truth Table for the circuit.

Inputs				Outputs						
State			X	Next State			Moore Outs			
A	B	C		DA	DB	DC	Z3	Z2	Z1	Z0
0	0	0	0	0	0	1	1	0	1	0
0	0	0	1	0	1	1	1	0	1	0
0	0	1	0	0	1	0	1	0	1	1
0	0	1	1	0	1	0	1	0	1	1
0	1	0	0	0	0	0	1	1	0	0
0	1	0	1	0	0	0	1	1	0	0
0	1	1	0	0	0	0	1	1	0	1
0	1	1	1	1	0	0	1	1	0	1
1	0	0	0	1	0	1	1	1	1	0
1	0	0	1	1	0	1	1	1	1	0
1	0	1	0	0	1	1	1	1	1	1
1	0	1	1	0	1	1	1	1	1	1
1	1	0	0	DC	DC	DC	DC	DC	DC	DC
1	1	0	1	DC	DC	DC	DC	DC	DC	DC
1	1	1	0	DC	DC	DC	DC	DC	DC	DC
1	1	1	1	DC	DC	DC	DC	DC	DC	DC

Here is the MinTerm chart for the circuit.

MinTerms						
mDA	mDB	mDC	mZ3	mZ2	mZ1	mZ0
		A'B'C'X'	A'B'C'X'		A'B'C'X'	
	A'B'C'X	A'B'C'X	A'B'C'X		A'B'C'X	
	A'B'CX'		A'B'CX'		A'B'CX'	A'B'CX'
	A'B'CX		A'B'CX		A'B'CX	A'B'CX
			A'BC'X'	A'BC'X'		
			A'BC'X	A'BC'X		
			A'BCX'	A'BCX'		A'BCX'
A'BCX			A'BCX	A'BCX		A'BCX
AB'C'X'		AB'C'X'	AB'C'X'	AB'C'X'	AB'C'X'	
AB'C'X		AB'C'X	AB'C'X	AB'C'X	AB'C'X	
	AB'CX'	AB'CX'	AB'CX'	AB'CX'	AB'CX'	AB'CX'
	AB'CX	AB'CX	AB'CX	AB'CX	AB'CX	AB'CX
ABC'X'						
ABC'X						
ABCX'						

ABCX

Here are the Kmaps used to design the circuit.

Kmap DA	CX	C'X	C'X'	CX'
AB	DC	DC	DC	DC
A'B	1			
A'B'				
AB'		1	1	
DA = BCX + AB'C'				

Kmap DB	CX	C'X	C'X'	CX'
AB	DC	DC	DC	DC
A'B				
A'B'	1	1		1
AB'	1			1
DB = B'C + A'B'X				

Kmap DC	CX	C'X	C'X'	CX'
AB	DC	DC	DC	DC
A'B				
A'B'		1	1	
AB'	1	1	1	1
DC = AB' + B'C'				

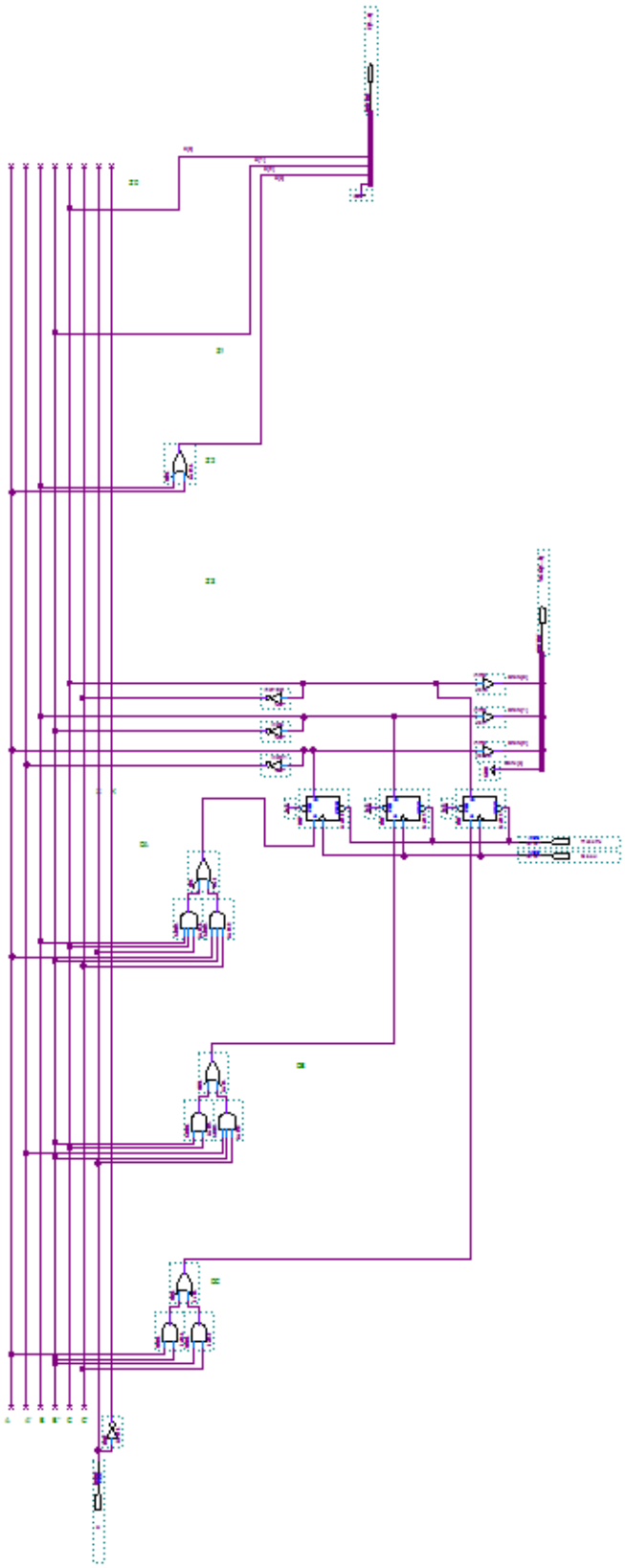
Kmap Z0	CX	C'X	C'X'	CX'
AB	DC	DC	DC	DC
A'B	1			1
A'B'	1			1
AB'	1			1
Z0 = C				

Kmap Z1	CX	C'X	C'X'	CX'
AB	DC	DC	DC	DC
A'B				
A'B'	1	1	1	1
AB'	1	1	1	1
Z1 = B'				

Kmap Z2	CX	C'X	C'X'	CX'
AB	DC	DC	DC	DC
A'B	1	1	1	1
A'B'				
AB'	1	1	1	1
Z2 = B + A				

Kmap Z3	CX	C'X	C'X'	CX'
AB	DC	DC	DC	DC
A'B	1	1	1	1
A'B'	1	1	1	1
AB'	1	1	1	1
Z3 = Always High				

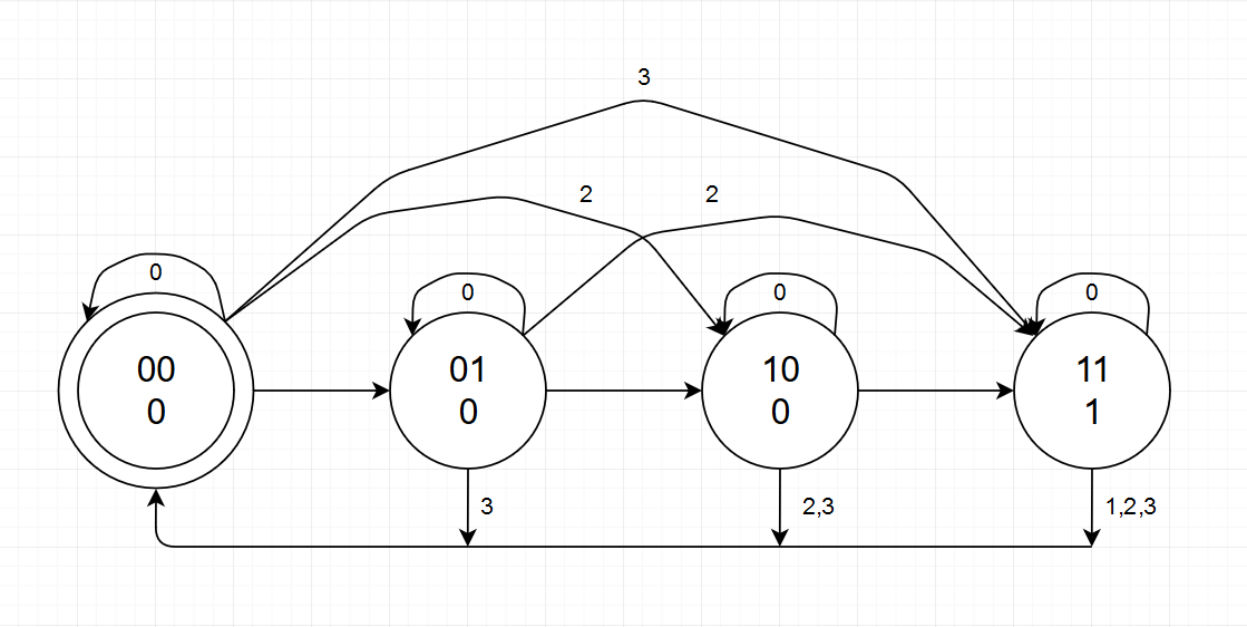
Here is the Block-Diagram for the circuit



Part 1 – Vendomatic

This circuit was another unique state machine. Unlike any other state machine, I had made before this machine accepted two user defined inputs instead of one. This state machine was designed to mimic the operation of a vending machine. For instance, this machine waits until a certain amount has been entered it then will output one once it has reached that amount. However, if this machine goes over the amount it will reset itself.

Here is the State Diagram for the circuit.



Here is the Truth Table for the circuit.

Inputs				Outputs			MinTerms		
State		X1	X2	Next State		Z	mDA	mDB	mZ
A	B			DA	DB				
0	0	0	0	0	0	0			
0	0	0	1	0	1	0		A'B'X1'X2	
0	0	1	0	1	0	0	A'B'X1X2'		
0	0	1	1	1	1	0	A'B'X1X2	A'B'X1X2	
0	1	0	0	0	1	0		A'BX1'X2'	
0	1	0	1	1	0	0	A'BX1'X2		
0	1	1	0	1	1	0	A'BX1X2'	A'BX1X2'	
0	1	1	1	0	0	0			
1	0	0	0	1	0	0	AB'X1'X2'		
1	0	0	1	1	1	0	AB'X1'X2	AB'X1'X2	
1	0	1	0	0	0	0			
1	0	1	1	0	0	0			
1	1	0	0	1	1	1	ABX1'X2'	ABX1'X2'	ABX1'X2'
1	1	0	1	0	0	1			ABX1'X2
1	1	1	0	0	0	1			ABX1X2'
1	1	1	1	0	0	1			ABX1X2

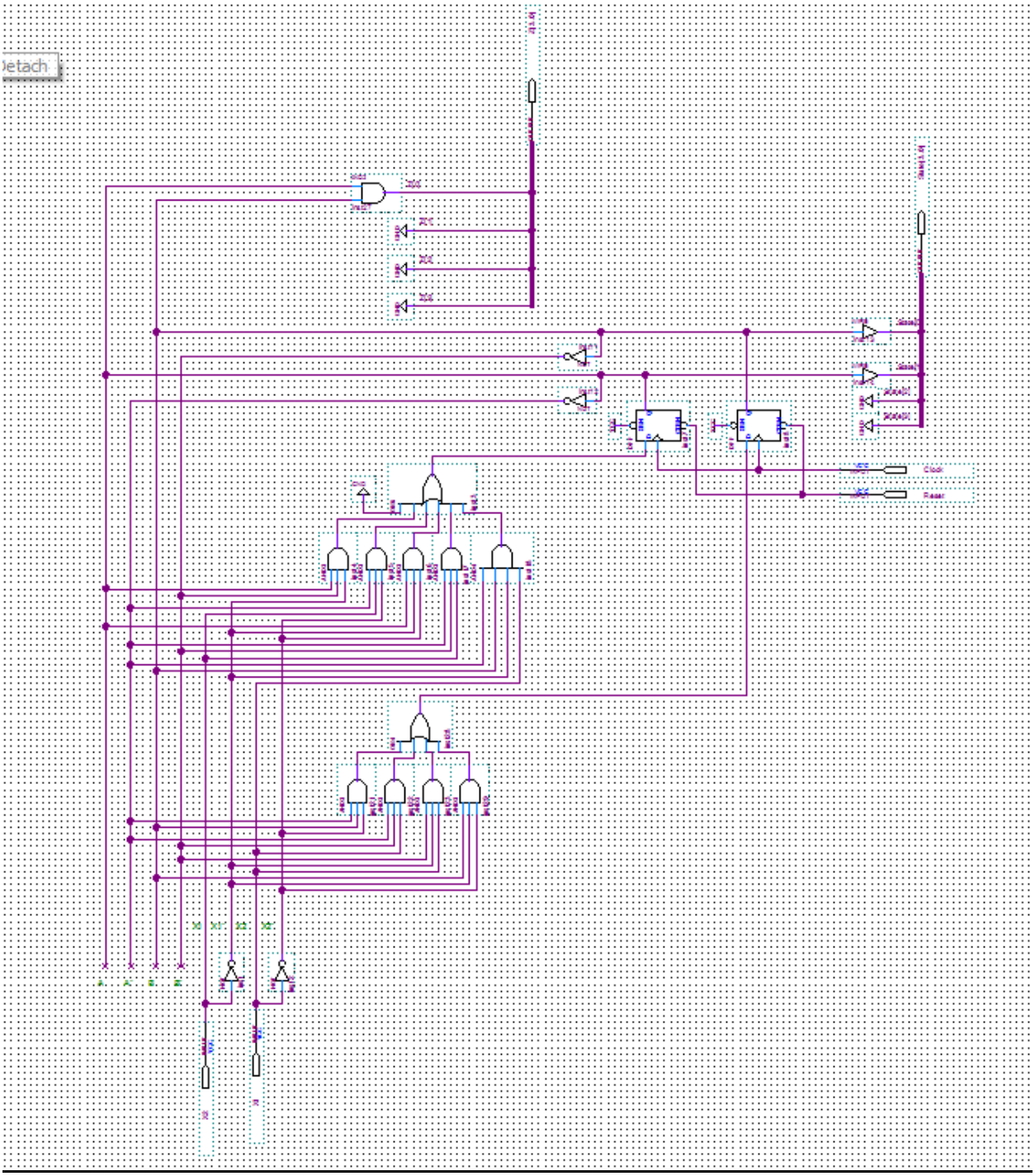
Here are the Kmaps used to design the circuit.

Kmap DA	x1x2	x1'x2	x1'x2'	x1x2'
AB			1	
A'B		1		1
A'B'	1			1
AB'		1	1	
DA = AB'X1' + A'X1X2' + AX1'X2' + A'B'X1 + A'BX1'X2				

Kmap DB	x1x2	x1'x2	x1'x2'	x1x2'
AB			1	
A'B			1	1
A'B'	1	1		
AB'		1		
DB = A'BX2' + A'B'X2 + B'X1'X2 + BX1'X2'				

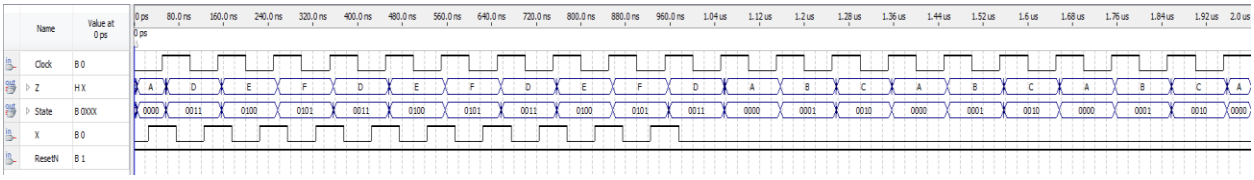
Kmap Z	x1x2	x1'x2	x1'x2'	x1x2'
AB	1	1	1	1
A'B				
A'B'				
AB'				
Z = AB				

Here is the Block-Diagram for the circuit.

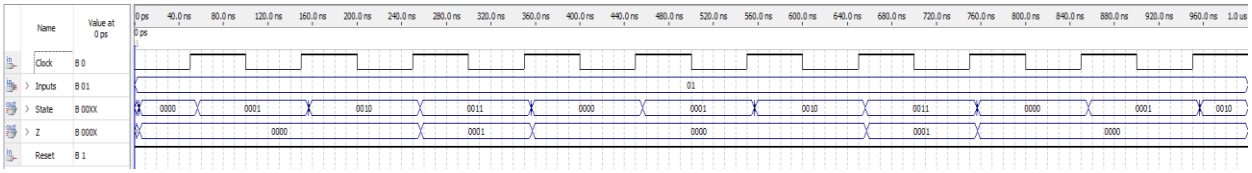


Testing

When testing the Freaky State Machine I encountered no problems and it performed as expected for every single input combination.



When testing the Vendomatic I encountered no problems and it performed as expected for every single input combination.



Conclusion

In this lab, I learned that state machines have many uses in our lives. Be it simulating certain situations or making sure that a vending machine only gives you a soda once you have inserted enough cash. The state machines that I created in this lab proved to be enjoyable to make. I really like being able to create a circuit that completes a certain task that is completely of my own design.