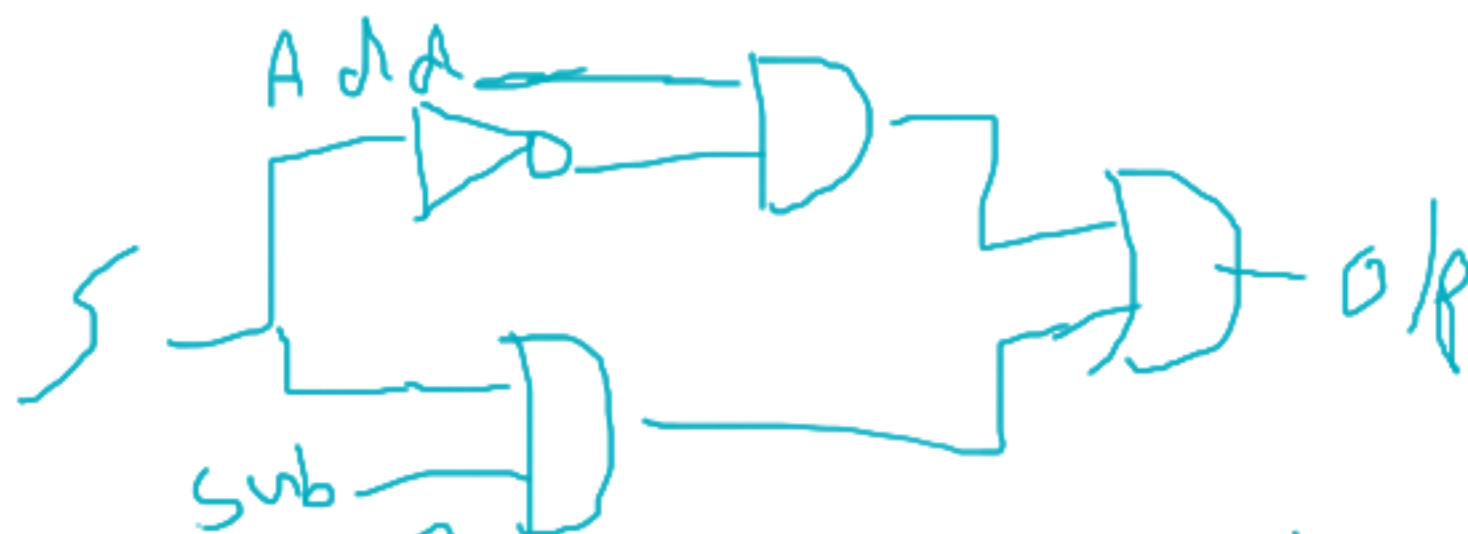


Mux



S	o/p
0	Add
1	sub



S. Add + S. sub



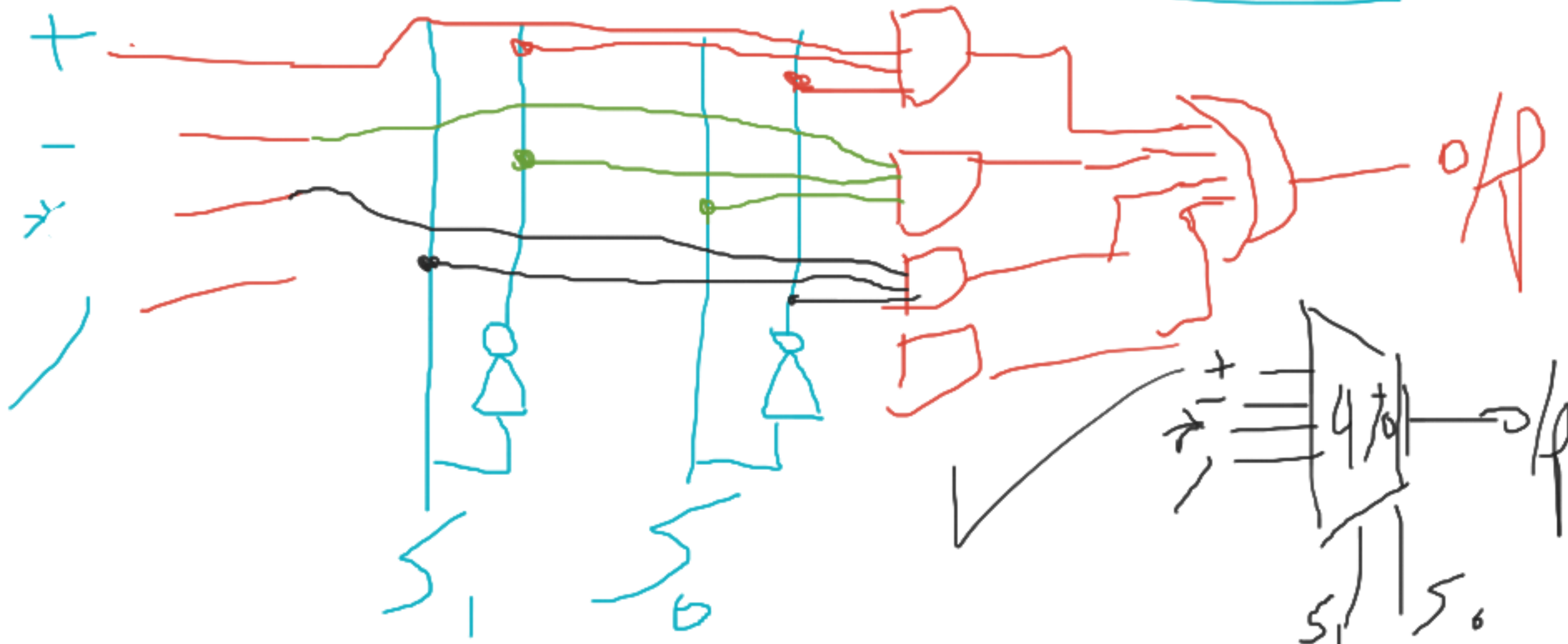
2 to 1

4 to 1

8 to 1

2<sup>n</sup> selectors

S <sub>1</sub>	S <sub>0</sub>	o/p
0	0	+
0	1	-
1	0	*
1	1	/



## BCD

Table

*Four Different Binary Codes for the Decimal Digits*

Decimal Digit	BCD 8421	2421	Excess-3	8, 4, -2, -1
0	0000	0000	0011	0000
1	0001	0001	0100	0111
2	0010	0010	0101	0110
3	0011	0011	0110	0101
4	0100	0100	0111	0100
5	0101	1011	1000	1011
6	0110	1100	1001	1010
7	0111	1101	1010	1001
8	1000	1110	1011	1000
9	1001	1111	1100	1111
Unused bit combinations	1010	0101	0000	0001
	1011	0110	0001	0010
	1100	0111	0010	0011
	1101	1000	1101	1100
	1110	1001	1110	1101
	1111	1010	1111	1110

HEX	Binary <sup>8 7 6 5 4 3 2 1</sup>				Binary Coded Decimal (BCD)					BCD
	b3	b2	b1	b0	p4	p3	p2	p1	p0	
0	0	0	0	0	0	0	0	0	0	00
1	0	0	0	1	0	0	0	0	1	01
2	0	0	1	0	0	0	0	1	0	02
3	0	0	1	1	0	0	0	1	1	03
4	0	1	0	0	0	0	1	0	0	04
5	0	1	0	1	0	0	1	0	1	05
6	0	1	1	0	0	0	1	1	0	06
7	0	1	1	1	0	0	1	1	1	07
8	1	0	0	0	0	1	0	0	0	08
9	1	0	0	1	0	1	0	0	1	09
A	1	0	1	0	1	0	0	0	0	10
B	1	0	1	1	1	0	0	0	1	11
C	1	1	0	0	1	0	0	1	0	12
D	1	1	0	1	1	0	0	1	1	13
E	1	1	1	0	1	0	1	0	0	14
F	1	1	1	1	1	0	1	0	1	15

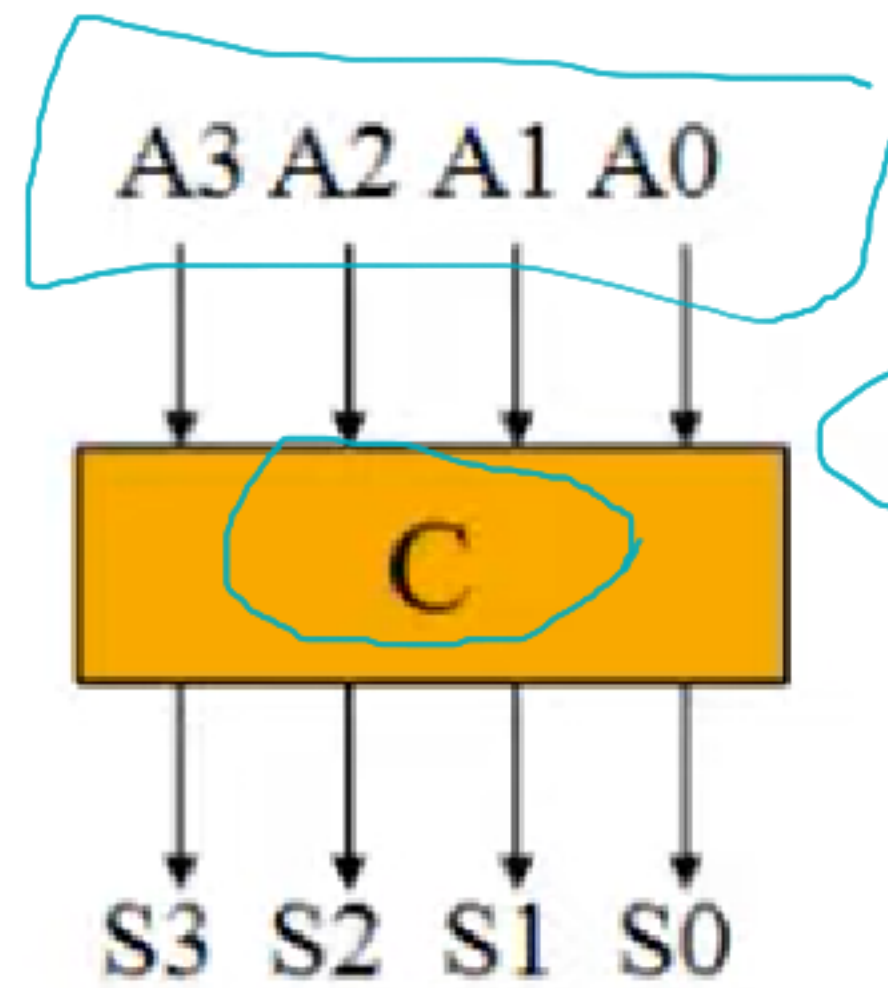


# Shift and Add-3 Algorithm

1. Shift the binary number left one bit.
2. If 8 shifts have taken place, the BCD number is in the *Hundreds, Tens, and Units* column.
3. If the binary value in any of the BCD columns is 5 or greater, add 3 to that value in that BCD column.
4. Go to 1.

unsigned

Operation	Hundreds	Tens	Units	Binary
HEX				F F
Start				1 1 1 1 1 1 1 1
Shift 1			(1)	1 1 1 1 1 1 1
Shift 2			(1 1)	1 1 1 1 1 1
Shift 3			(1 1 1) ✓	1 1 1 1 1
Add 3			(1 0 1 0) ✗	1 1 1 1 1
Shift 4		(1)	(0 1 0 1)	1 1 1 1
Add 3		1	1 0 0 0	1 1 1 1
Shift 5		1 1	0 0 0 1	1 1 1
Shift 6		(1 1 0) ✗	0 0 1 1	1 1
Add 3		(1 0 0 1) ✗	0 0 1 1	1 1
Shift 7	1	0 0 1 0	(0 1 1 1) ✗	1
Add 3	1	0 0 1 0	(1 0 1 0) ✗	1
Shift 8	(1 0)	(0 1 0 1)	(0 1 0 1)	
BCD	2	5	5	



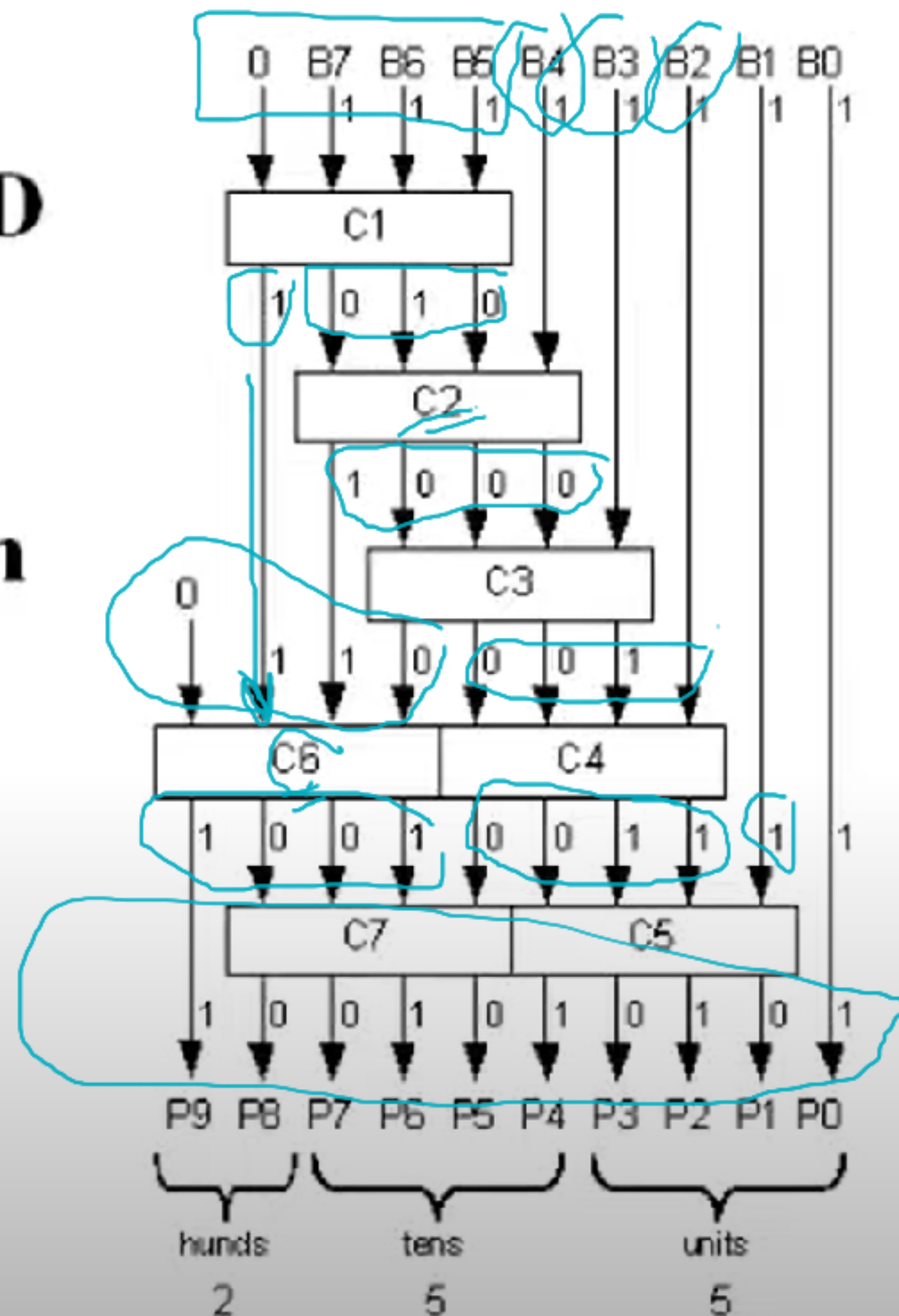
A3	A2	A1	A0	S3	S2	S1	S0
0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1
0	0	1	0	0	0	1	0
0	0	1	1	0	0	1	1
0	1	0	0	0	1	0	0
0	1	0	1	1	0	0	0
0	1	1	0	1	0	0	1
0	1	1	1	1	0	1	0
1	0	0	0	1	0	1	1
1	0	0	1	1	1	0	0
1	0	1	0	X	X	X	X
1	0	1	1	X	X	X	X
1	1	0	0	X	X	X	X
1	1	0	1	X	X	X	X
1	1	1	0	X	X	X	X
1	1	1	1	X	X	X	X

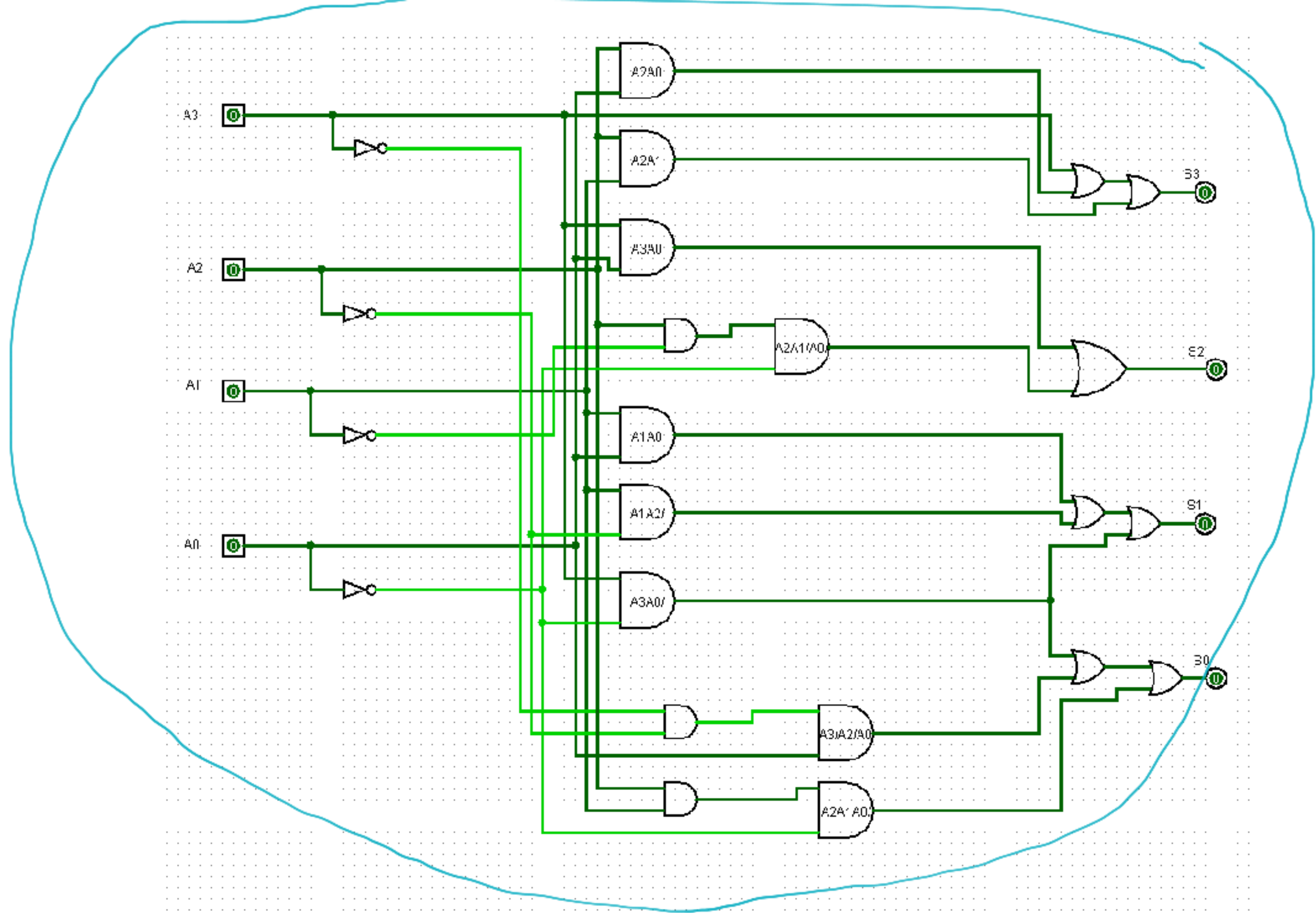
A handwritten truth table for a 4-bit adder, showing the sum of two 4-bit numbers. The inputs are labeled A3, A2, A1, A0 and the outputs are labeled S3, S2, S1, S0. The table is a 4x4 grid with the first two columns representing the inputs and the last two columns representing the outputs. The first row shows the sum of 0000 and 0000 is 0000. The second row shows the sum of 0000 and 0001 is 0001. The third row shows the sum of 0000 and 0010 is 0010. The fourth row shows the sum of 0000 and 0011 is 0011. The rest of the table is empty.



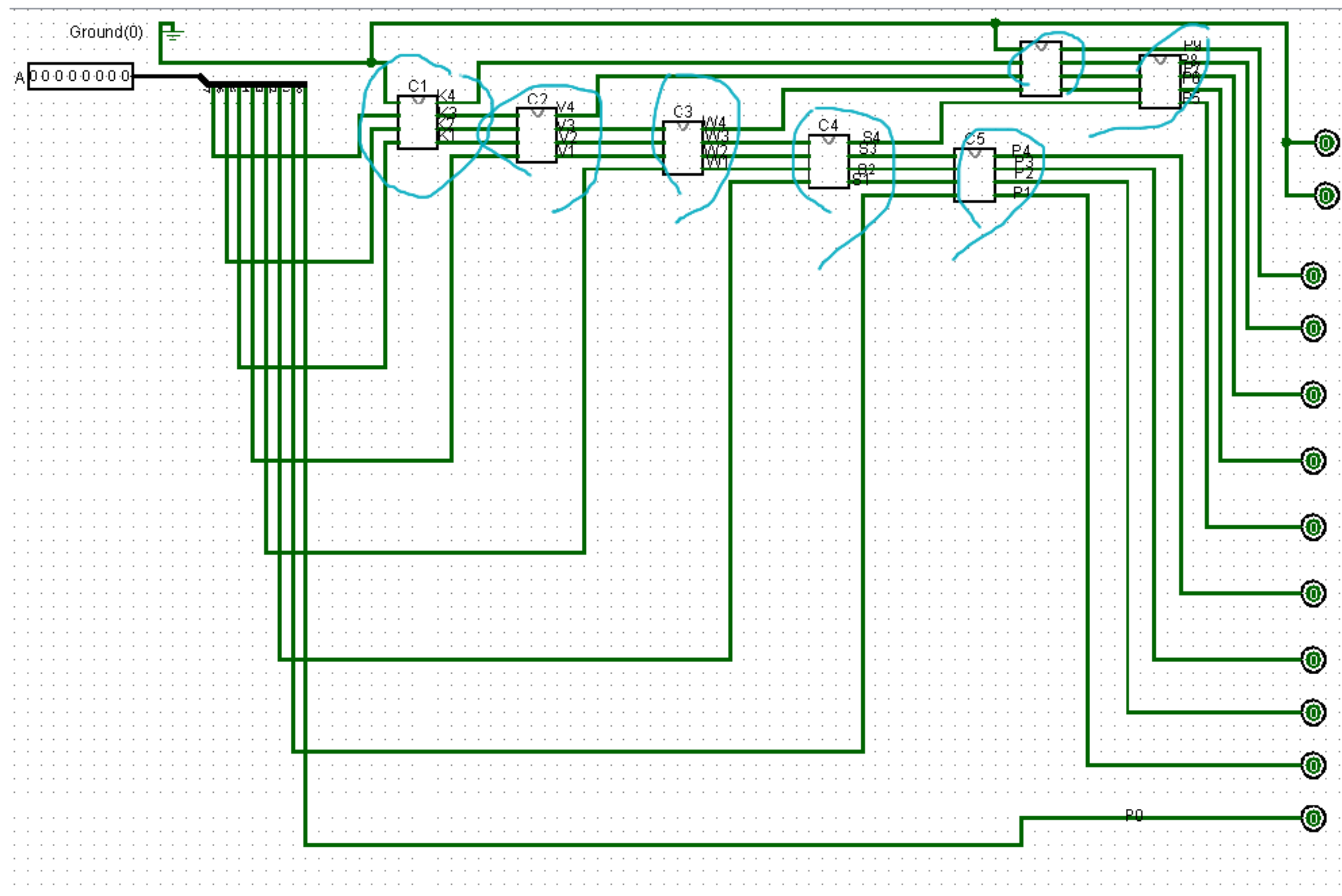
# Binary-to-BCD Converter

## Logic Diagram

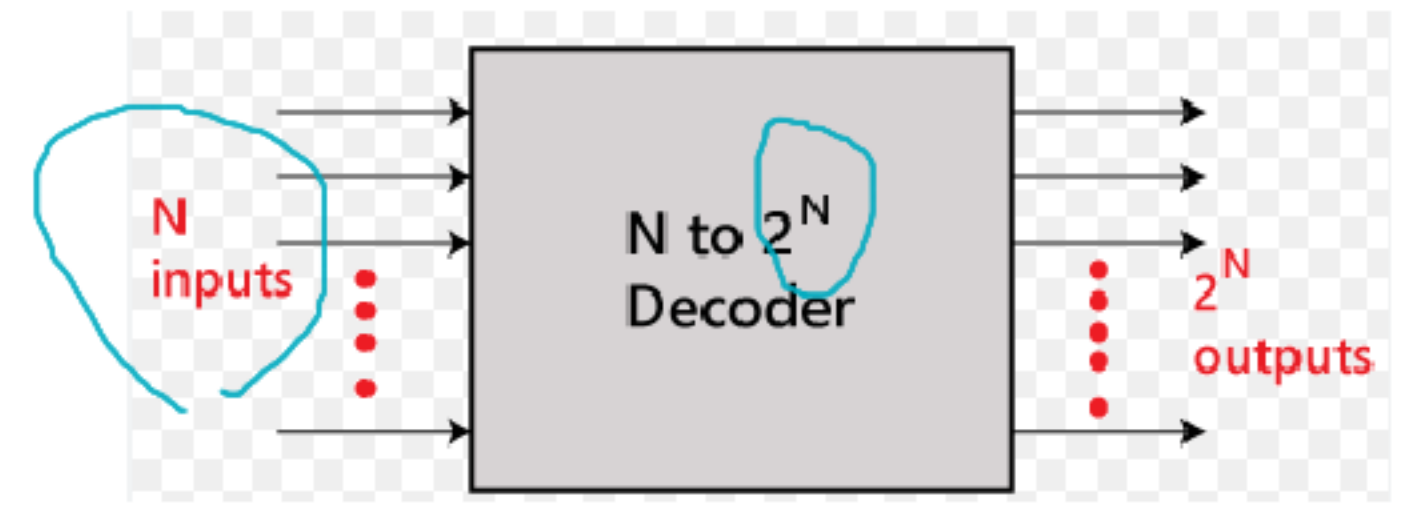
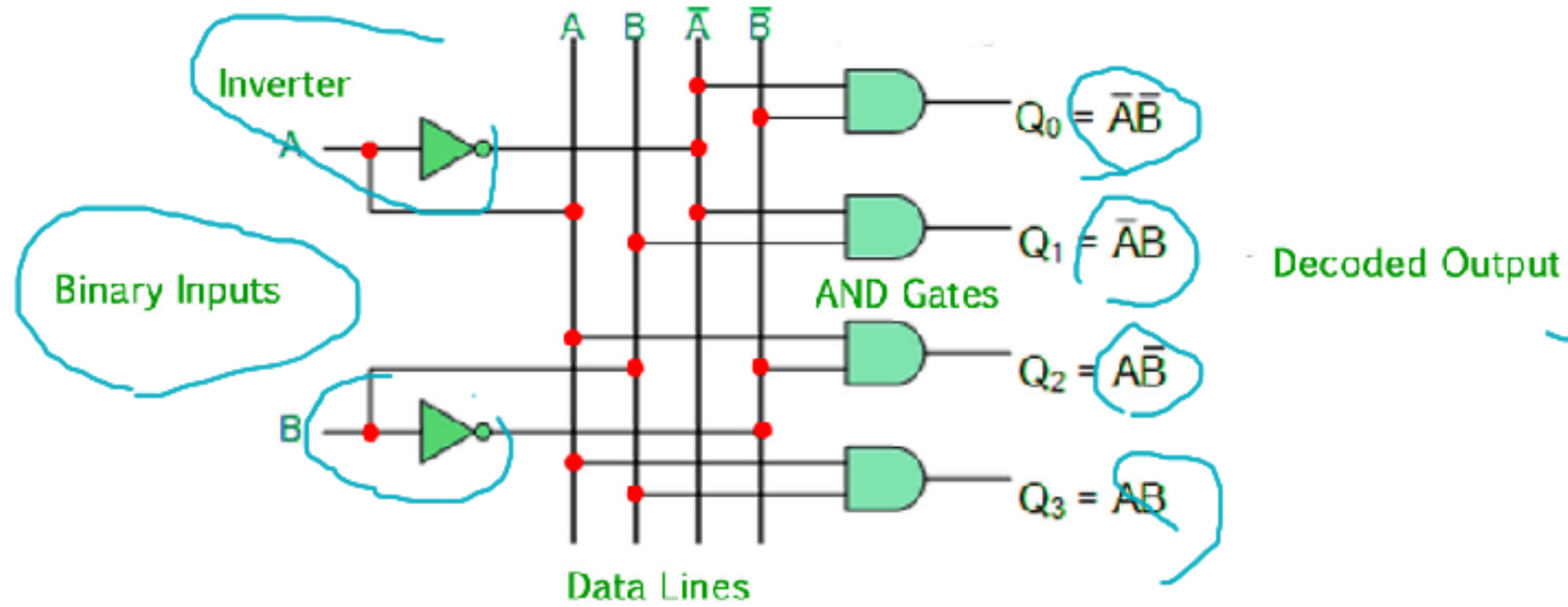








# Decoder

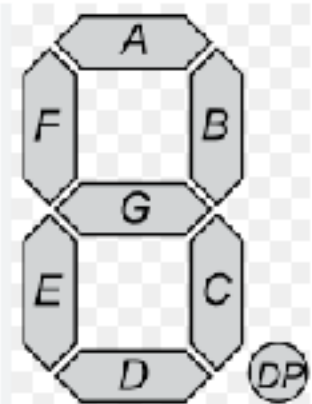


3-8

A	B	o/p
0	0	$\rightarrow \bar{A}\bar{B}$
0	1	$\rightarrow \bar{A}B$
1	0	$\rightarrow A\bar{B}$
1	1	$\rightarrow AB$

Search for Encoder

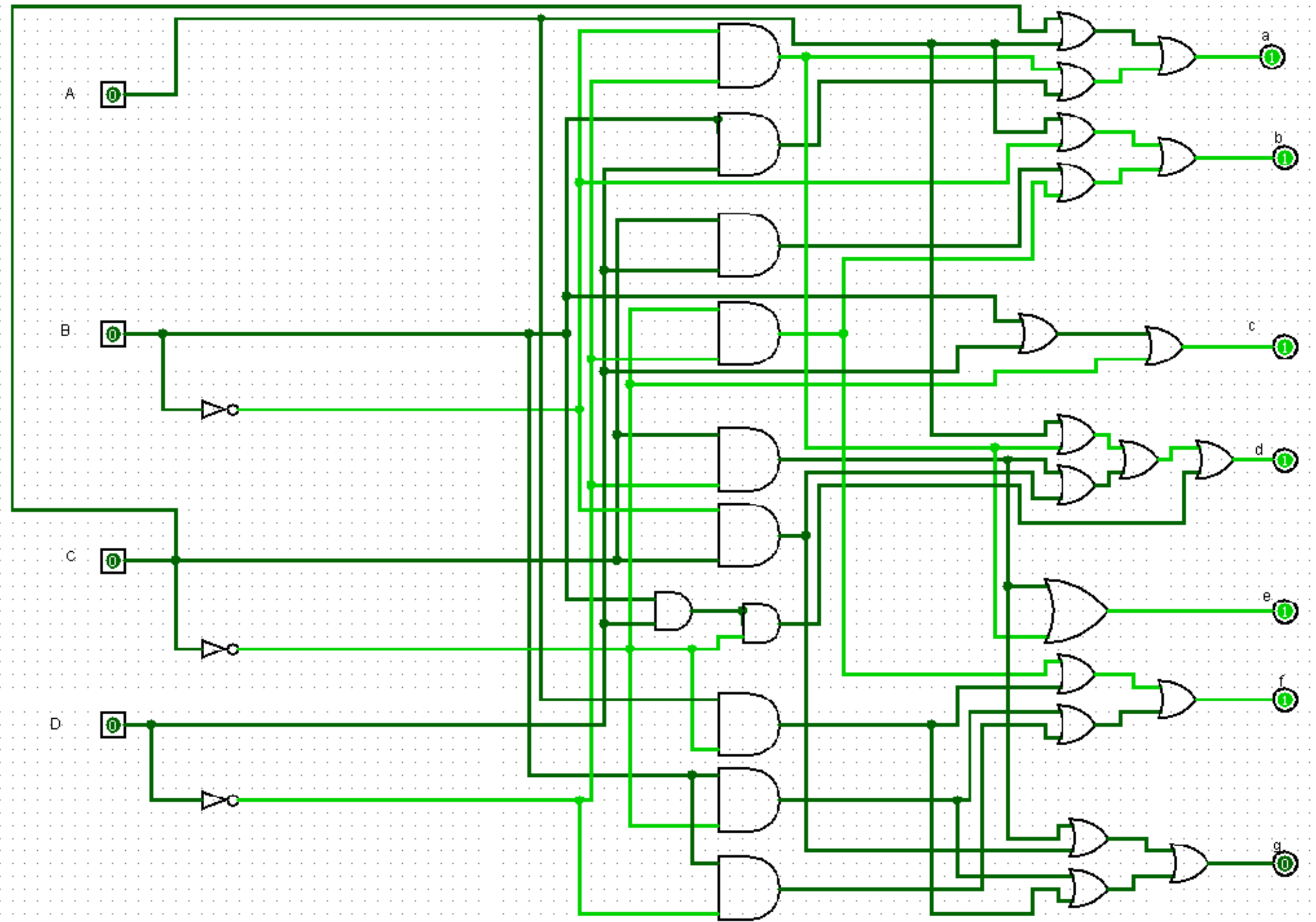
Decimal Digit	Input lines				Output lines							Display pattern
	A	B	C	D	a	b	c	d	e	f	g	
0	0	0	0	0	1	1	1	1	1	1	0	0
1	0	0	0	1	0	1	1	0	0	0	0	1
2	0	0	1	0	1	1	0	1	1	0	1	2
3	0	0	1	1	1	1	1	1	0	0	1	3
4	0	1	0	0	0	1	1	0	0	1	1	4
5	0	1	0	1	1	0	1	1	0	1	1	5
6	0	1	1	0	1	0	1	1	1	1	1	6
7	0	1	1	1	1	1	1	0	0	0	0	7
8	1	0	0	0	1	1	1	1	1	1	1	8
9	1	0	0	1	1	1	1	1	0	1	1	9



$$a = \bar{A}C + \bar{A}BD + \bar{B}\bar{C}\bar{D} + A\bar{B}\bar{C}$$

$$b = \bar{A}\bar{B} + \bar{A}\bar{C}\bar{D} + \bar{A}C\bar{D} + A\bar{B}\bar{C}$$

	A	B	C	D	a	b	c	d	e	f	g
0	0	0	0	0	1	1	1	1	1	1	0
1	0	0	0	1	0	1	1	0	0	0	0
2	0	0	1	0	1	1	0	1	1	0	1
3	0	0	1	1	1	1	1	1	0	0	1
4	0	1	0	0	0	1	1	0	0	1	1
5	0	1	0	1	1	0	1	1	0	1	1
6	0	1	1	0	1	0	1	1	1	1	1
7	0	1	1	1	1	1	1	0	0	0	0
8	1	0	0	0	1	1	1	1	1	1	1
9	1	0	0	1	1	1	1	1	0	1	1
10	1	0	1	0	0	0	0	0	0	0	0
11	1	0	1	1	0	0	0	0	0	0	0
12	1	1	0	0	0	0	0	0	0	0	0
13	1	1	0	1	0	0	0	0	0	0	0
14	1	1	1	0	0	0	0	0	0	0	0
15	1	1	1	1	0	0	0	0	0	0	0





# Main Interface

