

Place value system

Decimal - binary
decimal

$d_n \dots d_2 d_1 d_0$

$$145 = 1 \times 10^2 + 4 \times 10^1 + 5 \times 10^0$$

$$100 + 40 + 5$$

binary

$b_2 b_1 b_0$

$b_n \dots b_2 b_1 b_0$

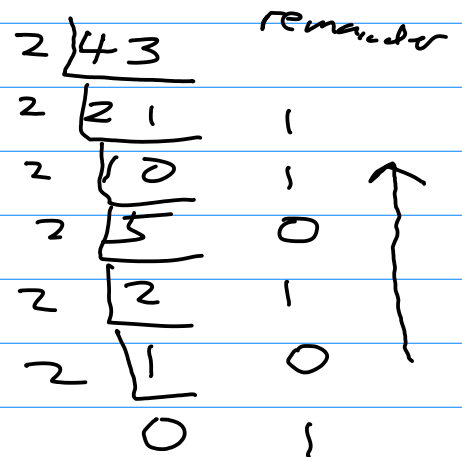
$$101 = 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$$

$$2^2 \quad 2^1 \quad 2^0$$

Convert binary \rightarrow decimal

decimal to binary eg 43

$$43_{10} = 00101011_2$$



Octal = base 8

✓ hexadecimal = base 16

base 2 0010110101
base 16 1 B 5

d	bin	hex
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F

$$\begin{array}{r} 01 \\ 145 \\ \underline{237} \\ 382 \end{array}$$

Addition hex

$$\begin{array}{r} 1011011 \\ \underline{0011001} \\ 0110100 \end{array}$$
 5B
 19
 74

$2 = 10$
 $3 = 11$

$20_{10} = 14_{16}$

Half adder (LSB)

$x_0 y_0$	Carry ₁	Sum ₀
00	0	0
$\bar{x}y$ 01	0	1
$x\bar{y}$ 10	0	1
11	1	0

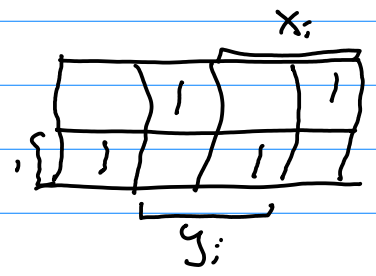
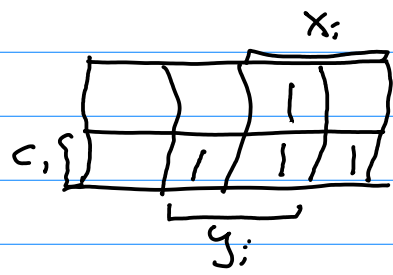
$C = x \cdot y$

$S = \bar{x}y + x\bar{y}$

$S = x \oplus y$

Full adder

C_i	x_i	y_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

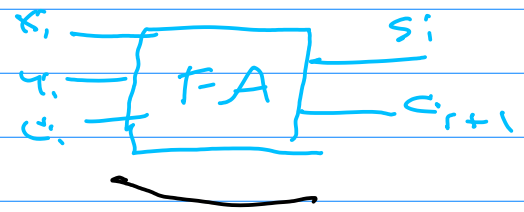
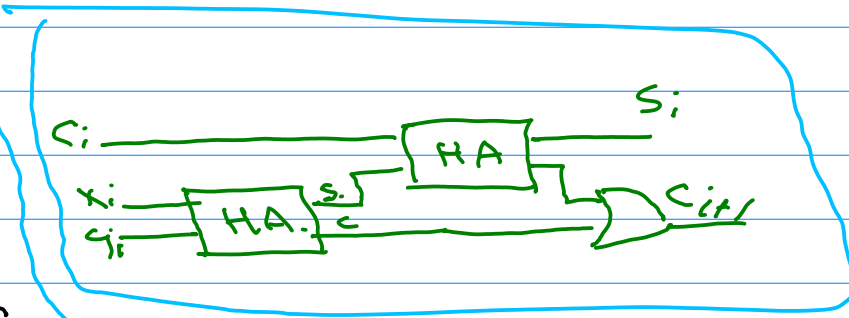
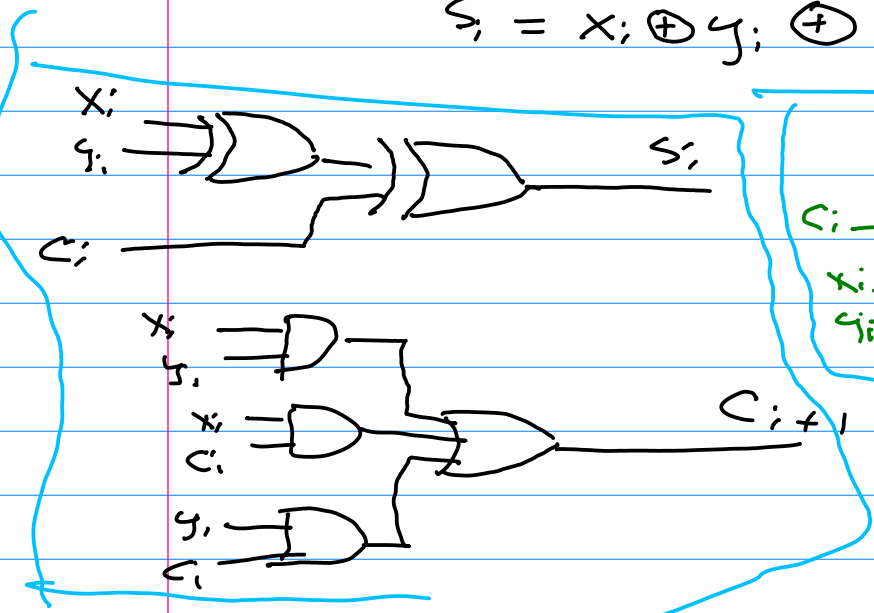


C_{i+1}

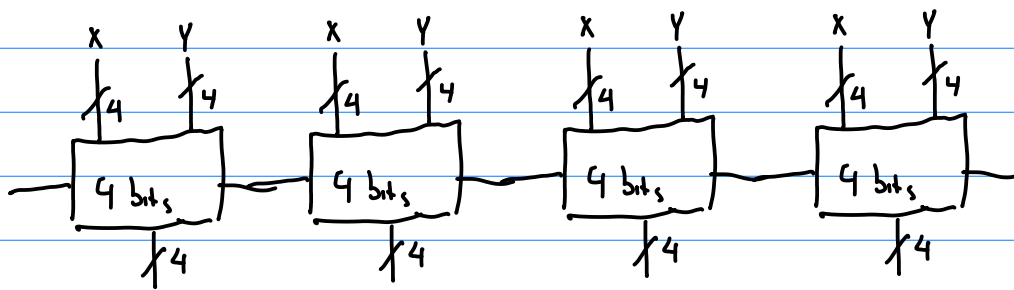
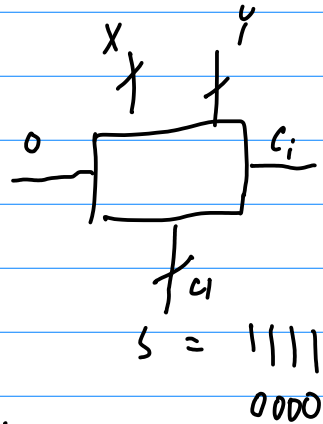
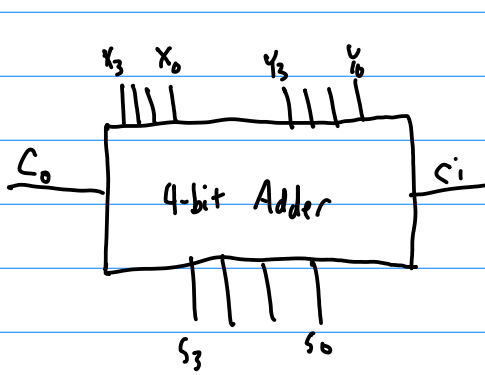
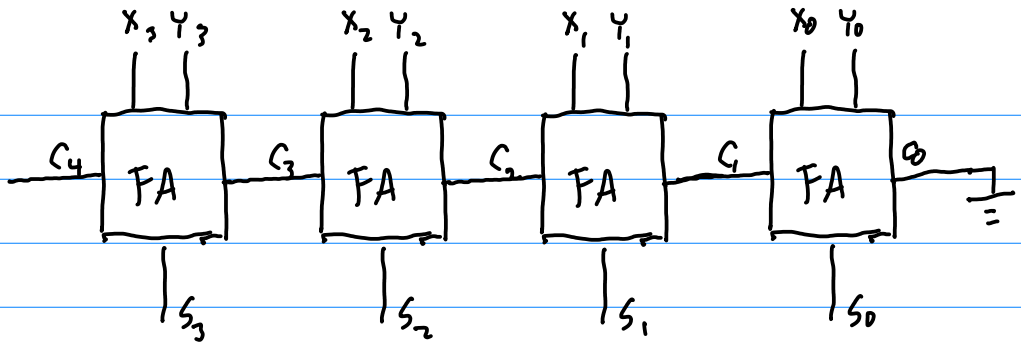
S_i

$C_{i+1} = x_i y_i + x_i C_i + y_i C_i$

$S_i = x_i \oplus y_i \oplus C_i$

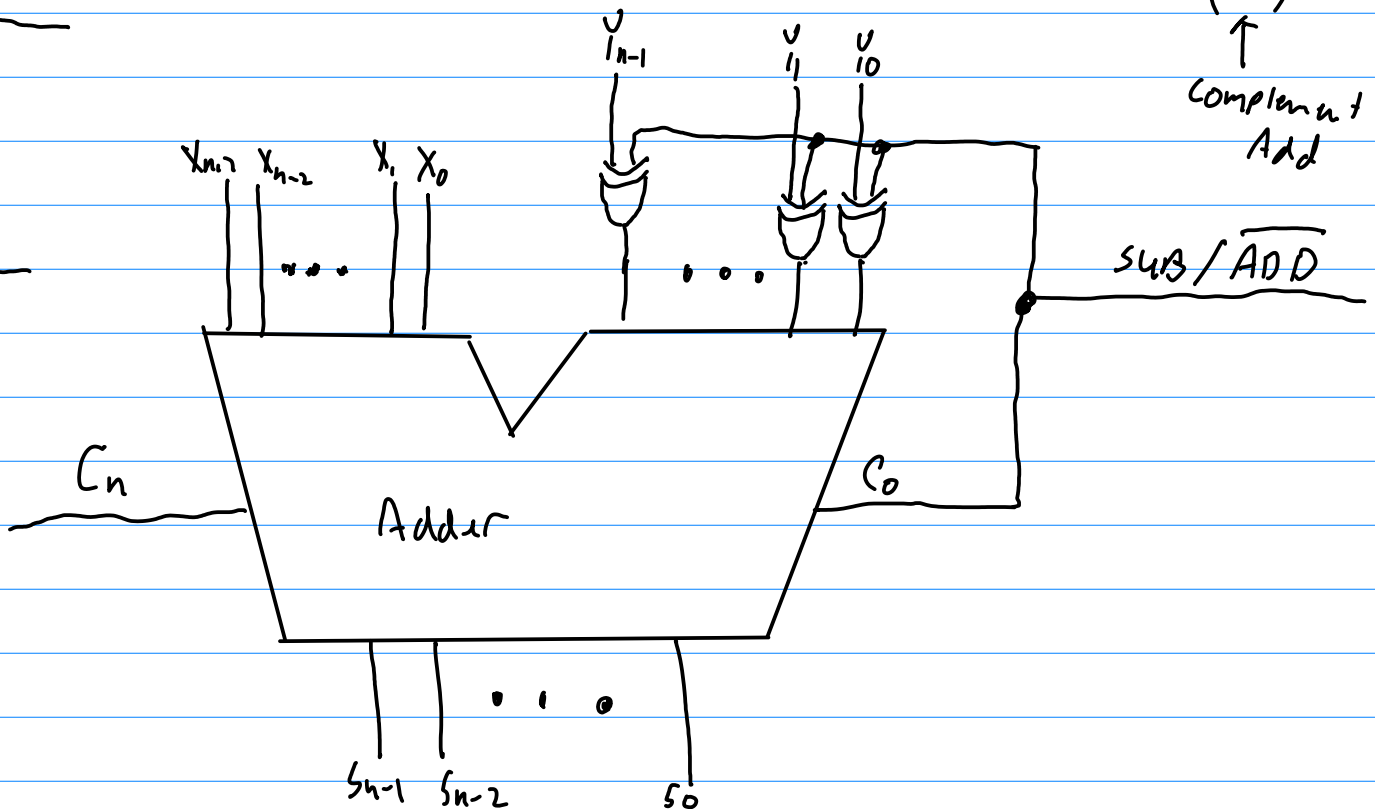
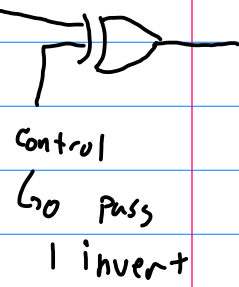
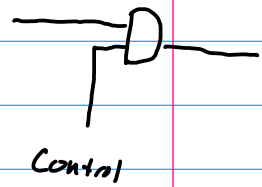


Ripple-Carry
adder

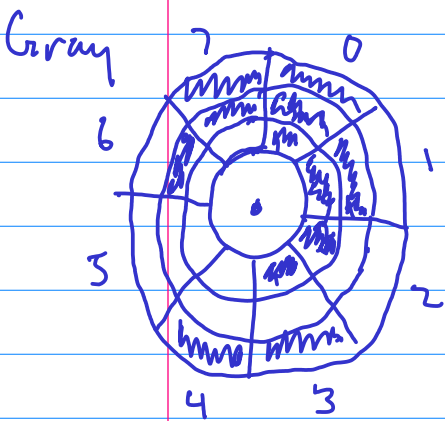
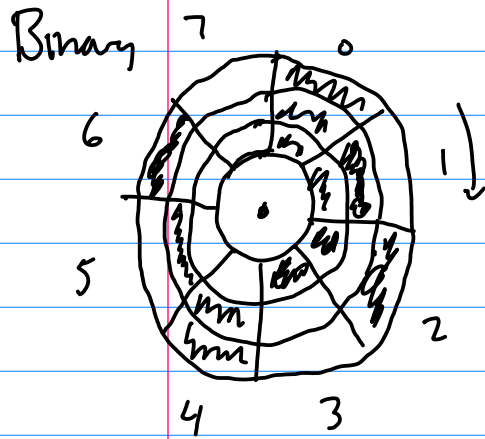


$$A - B = A + (-B)$$

↑
Complement of
Add



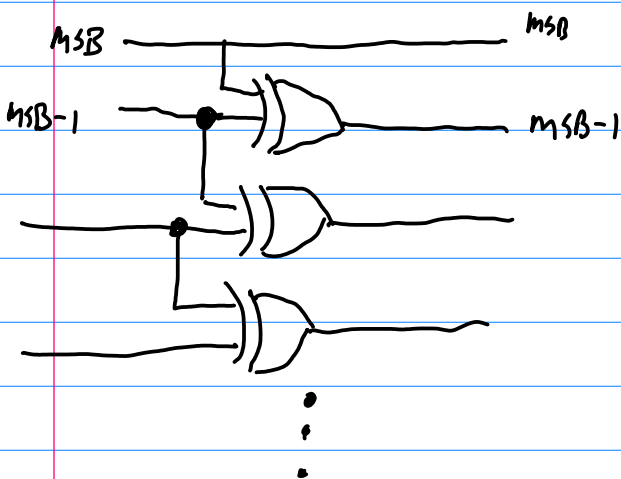
Gray Code



	Binary	Gray
0	0000	0000
1	0001	0001
2	0010	0011
3	0011	0010
4	0100	0110
5	0101	0111
6	0110	0101
7	0111	0100
8	1000	1100
9	1001	1101
10	1010	1111
11	1011	1110
12	1100	1010
13	1101	1011
14	1110	1001
15	1111	1000

reflected
Gray
code

Binary \rightarrow Gray



Gray \rightarrow Binary

