

Binary Arithmetic

Let's go back to Elementary School

Counting in Binary

Decimal	Binary		Decimal	Binary		Decimal	Binary		Decimal	Binary
0	000000		16	010000		32	100000		48	110000
1	000001		17	010001		33	100001		49	110001
2	000010		18	010010		34	100010		50	110010
3	000011		19	010011		35	100011		51	110011
4	000100		20	010100		36	100100		52	110100
5	000101		21	010101		37	100101		53	110101
6	000110		22	010110		38	100110		54	110110
7	000111		23	010111		39	100111		55	110111
8	001000		24	011000		40	101000		56	111000
9	001001		25	011001		41	101001		57	111001
10	001010		26	011010		42	101010		58	111010
11	001011		27	011011		43	101011		59	111011
12	001100		28	011100		44	101100		60	111100
13	001101		29	011101		45	101101		61	111101
14	001110		30	011110		46	101110		62	111110
15	001111		31	011111		47	101111		63	111111

Decimal Addition Table

+	0	1	2	3	4	5	6	7	8	9
0	0	1	2	3	4	5	6	7	8	9
1	1	2	3	4	5	6	7	8	9	10
2	2	3	4	5	6	7	8	9	10	11
3	3	4	5	6	7	8	9	10	11	12
4	4	5	6	7	8	9	10	11	12	13
5	5	6	7	8	9	10	11	12	13	14
6	6	7	8	9	10	11	12	13	14	15
7	7	8	9	10	11	12	13	14	15	16
8	8	9	10	11	12	13	14	15	16	17
9	9	10	11	12	13	14	15	16	17	18

Binary Addition Table

+	0	1
0	0	1
1	1	10 Decimal 2

$$0 + 0 = 0$$

$$0 + 1 = 1$$

$$1 + 0 = 1$$

$$1 + 1 = 10$$

Adding two numbers directly in Binary

Subtracting two numbers directly in Binary

Negative Numbers in Binary

Decimal	Binary		Decimal	Binary		Decimal	Binary		Decimal	Binary
-32	100000		-16	110000		0	000000		16	010000
-31	100001		-15	110001		1	000001		17	010001
-30	100010		-14	110010		2	000010		18	010010
-29	100011		-13	110011		3	000011		19	010011
-28	100100		-12	110100		4	000100		20	010100
-27	100101		-11	110101		5	000101		21	010101
-26	100110		-10	110110		6	000110		22	010110
-25	100111		-9	110111		7	000111		23	010111
-24	101000		-8	111000		8	001000		24	011000
-23	101001		-7	111001		9	001001		25	011001
-22	101010		-6	111010		10	001010		26	011010
-21	101011		-5	111011		11	001011		27	011011
-20	101100		-4	111100		12	001100		28	011100
-19	101101		-3	111101		13	001101		29	011101
-18	101110		-2	111110		14	001110		30	011110
-17	101111		-1	111111		15	001111		31	011111

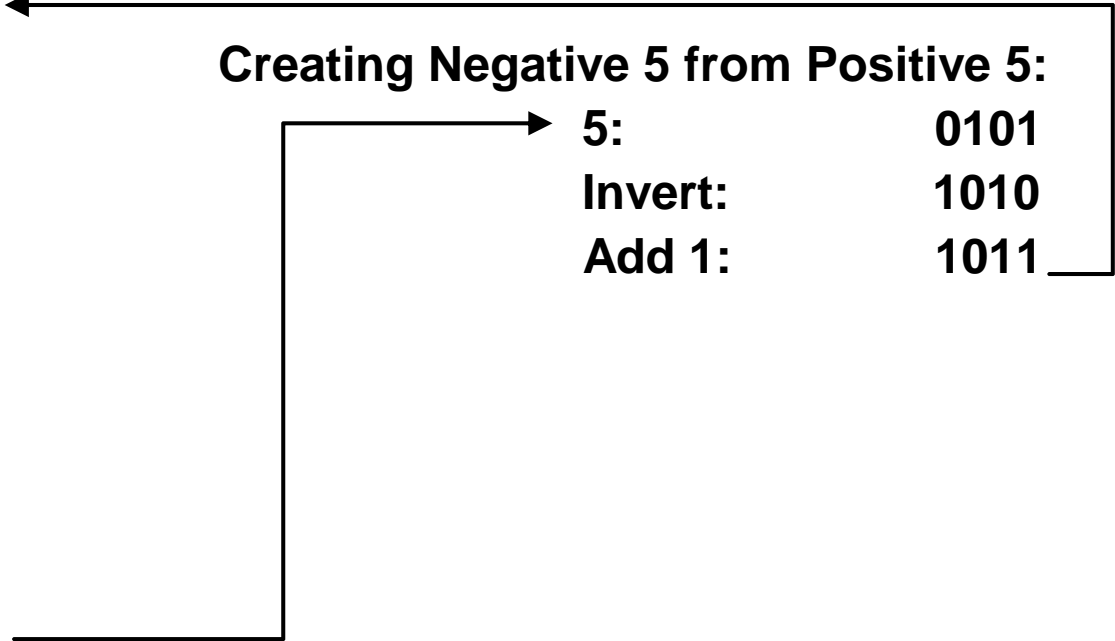
Decimal

Binary

-8	1 0 0 0
-7	1 0 0 1
-6	1 0 1 0
-5	1 0 1 1
-4	1 1 0 0
-3	1 1 0 1
-2	1 1 1 0
-1	1 1 1 1
0	0 0 0 0
1	0 0 0 1
2	0 0 1 0
3	0 0 1 1
4	0 1 0 0
5	0 1 0 1
6	0 1 1 0
7	0 1 1 1

Creating Negative 5 from Positive 5:

5: 0101
Invert: 1010
Add 1: 1011



Subtracting two numbers using Two Complement

Decimal Multiplication Table

x	0	1	2	3	4	5	6	7	8	9
0	0	0	0	0	0	0	0	0	0	0
1	0	1	2	3	4	5	6	7	8	9
2	0	2	4	6	8	10	12	14	16	18
3	0	3	6	9	12	15	18	21	24	27
4	0	4	8	12	16	20	24	28	32	36
5	0	5	10	15	20	25	30	35	40	45
6	0	6	12	18	24	30	36	42	48	54
7	0	7	14	21	28	35	42	49	56	63
8	0	8	16	24	32	40	48	56	64	72
9	0	9	18	27	36	45	54	63	72	81

Binary Multiplication Table

X	0	1
0	0	0
1	0	1

$$0 \times 0 = 0$$

$$0 \times 1 = 0$$

$$1 \times 0 = 0$$

$$1 \times 1 = 1$$

Multiplying two numbers directly in Binary

Multiplying two numbers using
Shift Left and Add

Dividing two numbers directly in Binary

Dividing two numbers using Shift Right and Subtract

End of Presentation