DIGITAL LOGIC CIRCUITS

Digital logic circuits ➡ electronic circuits that handle information encoded in binary form (deal with signals that have only two values, **0** and **1**)

◆ *Digital* .... computers, watches, controllers, telephones, cameras, ...

★ BINARY NUMBER SYSTEM

Number ....in whatever base	Decimal value of the given number

Decimal: **1,998** $= 1 \times 10^3 + 9 \times 10^2 + 9 \times 10^1 + 8 \times 10^0 = 1,000 + 900 + 90 + 8 =$ **1,998**

Binary:
11111001110 $= 1 \times 2^{10} + 1 \times 2^9 + 1 \times 2^8 + 1 \times 2^7 + 1 \times 2^6 + 1 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 =$
$1,024 + 512 + 258 + 128 + 64 + 8 + 4 + 2 =$ **1,998**

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Powers of 2

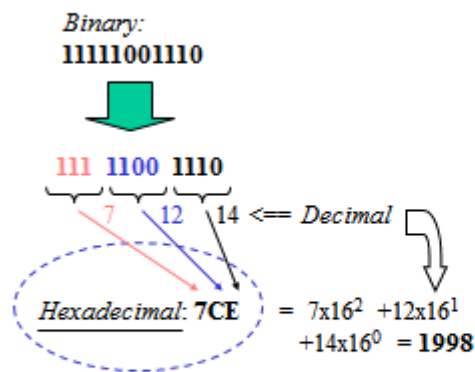| N	2^N	Comments
0	1	
1	2	
2	4	
3	8	
4	16	
5	32	
6	64	
7	128	
8	256	
9	512	
10	1,024	"Kilo" as 2^{10} is the closest power of 2 to 1,000 (decimal)
11	2,048	
15	32,768	2^{15} Hz often used as clock crystal frequency in digital watches
20	1,048,576	"Mega" as 2^{20} is the closest power of 2 to 1,000,000 (decimal)
30	1,073,741,824	"Giga" as 2^{30} is the closest power of 2 to 1,000,000,000 (decimal)

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Negative Powers of 2

$N < 0$	2^N
-1	$2^{-1} = 0.5$
-2	$2^{-2} = 0.25$
-3	$2^{-3} = 0.125$
-4	$2^{-4} = 0.0625$
-5	$2^{-5} = 0.03125$
-6	$2^{-6} = 0.015625$
-7	$2^{-7} = 0.0078125$
-8	$2^{-8} = 0.00390625$
-9	$2^{-9} = 0.001953125$
-10	$2^{-10} = 0.0009765625$
...	

◆ **Binary numbers less than 1**

Binary	*Decimal value*

$$0.101101 = 1 \times 2^{-1} + 1 \times 2^{-3} + 1 \times 2^{-4} + 1 \times 2^{-6} = 0.703125$$

◆ **HEXADECIMAL**

Binary:
11111001110

⬇

111 1100 1110

7   12   14 ⟸ *Decimal*

Hexadecimal: **7CE** $= 7 \times 16^2 + 12 \times 16^1 + 14 \times 16^0 = \textbf{1998}$

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