

# Number Systems

## Unsigned Binary

Last updated 8/20/20

# Number Systems – unsigned binary

- Unsigned Binary (Binary)
  - All  $n$  bits used to represent the magnitude of the value
  - No negative values
  - Often used as absolute memory addresses, counts, ...

4      →      00000100

32     →      00100000

16     →      00010000

50            →      ?

10010110<sub>b</sub>    →      ?

0.625        →      ?

# Number Systems – unsigned binary

- Unsigned Binary (Binary)

convert 50 decimal to 8 bit unsigned binary

8 bits  $\rightarrow$  bit values of 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1

greatest bit value  $\leq 50 = 32$   
 $50 - 32 = 18$

0 0 1

greatest bit value  $\leq 18 = 16$   
 $18 - 16 = 2$

0 0 1 1

greatest bit value  $\leq 2 = 2$   
 $2 - 2 = 0$

0 0 1 1 0 0 1

no more left

0 0 1 1 0 0 1 0

# Number Systems – unsigned binary

- Unsigned Binary (Binary)

convert 10010110 unsigned binary to decimal

8 bits  $\rightarrow$  bit values of 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1

$$1*128 + 0*64 + 0*32 + 1*16 + 0*8 + 1*4 + 1*2 + 0*1$$

$$128 + 16 + 4 + 2 = 150$$

$$10010110_b \rightarrow 150$$

# Number Systems – unsigned binary

- Unsigned Binary (Binary)

convert 0.625 decimal to unsigned binary

first few fractional bits → bit values of  $1/2$  |  $1/4$  |  $1/8$  |  $1/16$   
0.5      0.25      0.125      0.0625

greatest bit value  $\leq 0.625 = 1/2$       . 1  
 $0.625 - 0.5 = 0.125$

greatest bit value  $\leq 0.125 = 1/8$       . 1 0 1  
 $0.125 - 0.125 = 0$

no more left      . 1 0 1 0 or 0.101

# Number Systems – unsigned binary

- Unsigned Binary (Binary)
  - Maximum values: (non fractional)
    - 4 bits (1111) = 15
    - 8 bits (1111 1111) = 255
    - 16 bits (1111 1111 1111 1111) = 65,535
    - 32 bits (1111 1111 1111 1111 1111 1111 1111 1111) = 4,294,967,295
  - **Wait!** 4 bits  $\rightarrow 2^4 = 16$ , why is the maximum value 15
  - 8 bits  $\rightarrow 2^8 = 256$ , why is the maximum value 255
  - ...

# Number Systems – unsigned binary

- Unsigned Binary (Binary)
  - **Wait!** 4 bits  $\rightarrow 2^4 = 16$ , why is the maximum value 15
  - 8 bits  $\rightarrow 2^8 = 256$ , why is the maximum value 255
  - ...
  - Zero is one of our values, that only leaves 15 more ...

decimal

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

unsigned binary