1.2 BOOLEAN ARITHMETIC

Binary Addition

Rules of Binary Addition

- ✓ **Binary Addition**

- ✓ **Rules of Binary Addition**
- $0 + 0 = 0$
- $0 + 1 = 1$
- $1 + 0 = 1$
- $1 + 1 = 0$, and carry 1 to the next more significant bit

✓ Example

00011010 + 00001100 = 00100110

```
      1  1
   0  0  0  1  1  0  1  0
+  0  0  0  0  1  1  0  0
-------------------------
   0  0  1  0  0  1  1  0
```

Note: The rules of binary addition (without carries) are the same as the truths of the XOR gate.

Binary Subtraction

Rules of Binary Subtraction

0 - 0 = 0

0 - 1 = 1, and borrow 1 from the next more significant bit

1 - 0 = 1

1 - 1 = 0

Example

00100101 - 00010001= 00010100

```
  0 0 1 0 0 1 0 1
+ 0 0 0 1 0 0 0 1
-----------------
  0 0 0 1 0 1 0 0
```

Binary Multiplication

Rules of Binary Multiplication

0 x 0 = 0

0 x 1 = 0

1 x 0 = 0

1 x 1 = 1, and no carry or borrow bits

Example

00101001 × 00000110 = 11110110

```
    0 0 1 0 1 0 0 1
  × 0 0 0 0 0 1 1 0
-----------------------
    0 0 0 0 0 0 0 0
  0 0 1 0 1 0 0 1
  0 1 0 1 0 0 1
-----------------------
  0 1 1 1 1 0 1 1 0
```

Note: The rules of binary multiplication are the same as the truths of the AND gate.

Binary Division

Binary division is the repeated process of subtraction, just as in decimal division.

Example 1: 00101010 ÷ 00000110 = 00000111

00101010÷00000110 = 00000111

1 1 1 = 7(base 10)

1 1 0 0 0 1 1 0 1 0 = 42(base 10)
- 1 1 0 = 6(base 10)

1 *borrows*

1 0 1 1
- 1 1 0

1 1 0
- 1 1 0

0

Example 2: 10000111 ÷ 00000101 = 00011011 1.3 1.4 1.5

10000111÷00000101
=00011011

1 1 0 1 1 = 27(base 10)

1 0 1 1 0 0 1 1 1 = 135(base 10)
- 1 0 1 = 5(base 10)

1 1 1 0
- 1 0 1

1 1
- 0

1 1 1
- 1 0 1

1 0 1
- 1 0 1

0