2 Bit and 3 Bit Binary Addition and Subtraction

Binary addition and subtraction for 2-bit and 3-bit numbers follow standard rules (0+0=0, 1+1=10; 1-0=1, 1-1=0) but with carry/borrow propagation, using Half Adders/Subtractors for single bits and Full Adders/Subtractors (with carry-in/borrow-in) for multi-bit operations, often implemented with XOR/AND gates for logic, or using 2's complement for subtraction in digital systems.

Binary Addition Rules

- (Sum: 0, Carry: 0)
- (Sum: 1, Carry: 0)
- (Sum: 1, Carry: 0)
- (Sum: 0, Carry: 1)

Binary Subtraction Rules (with Borrow)

- (Difference: 0, Borrow: 0)
- (Difference: 1, Borrow: 0)
- (Difference: 0, Borrow: 0)
- (Difference: 1, Borrow: 1) - *Borrow from next bit*

2-Bit Examples (A + B)

- **10 (2) + 01 (1) = 11 (3)**
- **11 (3) + 10 (2) = 101 (5)**

3-Bit Examples (A + B)

- **101 (5) + 011 (3) = 1000 (8)**
  - Rightmost: 1+1=10 (0, carry 1)
  - Middle: 0+1+1(carry)=10 (0, carry 1)
  - Leftmost: 1+0+1(carry)=10 (0, carry 1)
  - Final carry: 1

Subtraction Using 2's Complement (for computers)

For $A - B$, you calculate $A + (\text{2's Complement of } B)$.

1. Find 1's complement of B (flip all bits).
2. Add 1 to get 2's complement.
3. Add A and (2's complement of B). Ignore final carry if present.

- **Example: 110 (6) - 010 (2) = 100 (4)**
  - Subtrahend (B) = 010

- 1's Comp: 101
- 2's Comp (101+1): 110
- Add: $110 + 110 = 1100$
- Ignore carry (1), result is **100** (4).

Key Components

- **Half Adder/Subtractor:** Adds/subtracts two single bits (inputs A, B; outputs Sum/Diff & Carry/Borrow).
- **Full Adder/Subtractor:** Adds/subtracts three bits (inputs A, B, and Carry-In/Borrow-In from previous stage).