Assignment 1: Elementary Adders

Group 20

January 16, 2021

1 Ripple Carry Adder

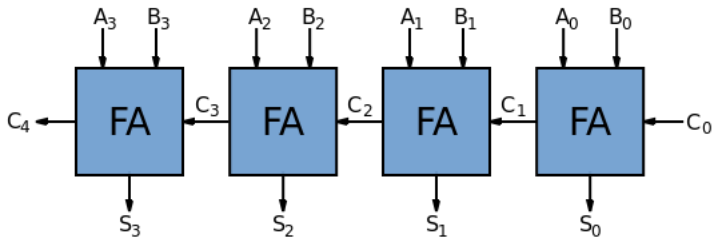

Figure 1: 4 Bit Ripple Carry Adder[1]

For an n bit ripple carry adder and assuming XOR gate has a delay of 3 units

1. From A_0, B_0 and C_0 computing C_1 takes 5 units (XOR + AND + OR) and computing S_0 takes 6 units (XOR + XOR).
2. Each carry forward $C_i \to C_{i+1}$ for $1 \leq i < n$ takes 2 units (AND + OR) of time and this happens $n-1$ times $\therefore$ this contributes $2(n-1)$ time steps.
3. To calculate S_i from A_i, B_i and C_i we need an additional 3 units (XOR) after we get C_i (other calculations would be done by then) $\therefore$ time delay for $S_i = 5 + 2(i-2) + 3$

From this, we can conclude for $n \geq 2$

$$\Delta_{C_n} = 5 + 2(n-1) = 2n + 3$$

$$\Delta_{S_n} = 5 + 2(n-2) + 3 = 2n + 4$$

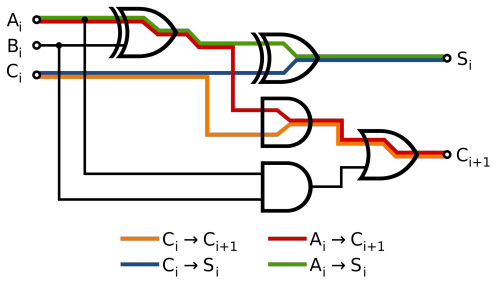

Figure 2: Full Adder [2]

2 Ripple Carry Adder/Subtractor

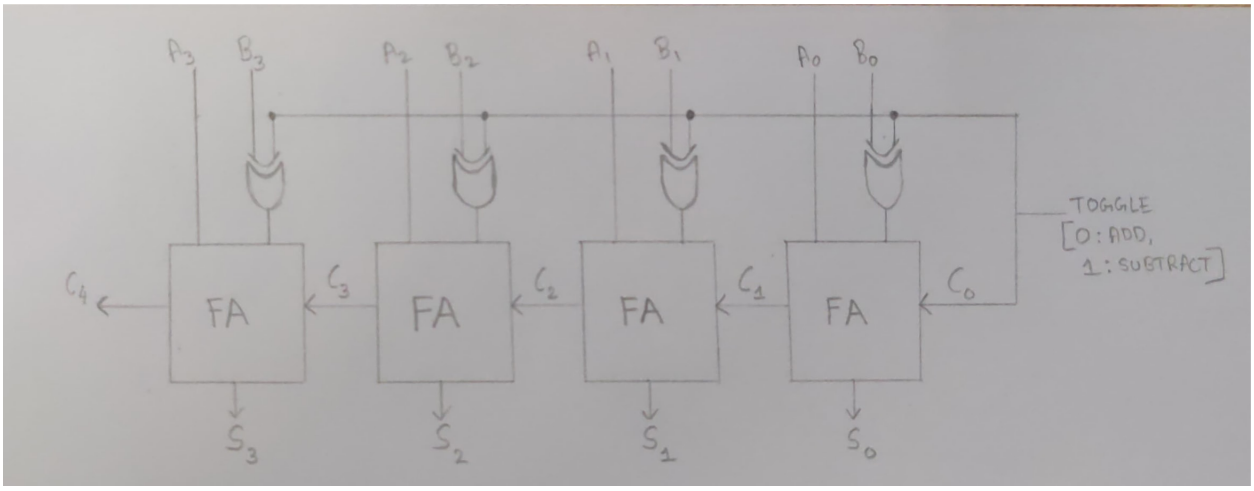

Figure 3: 4 bit RCA/S

The only difference between RCA and RCA/S is the presence of an extra XOR gate, so much of the calculations remain the same as RCA.
$\therefore$ for an n bit RCA/S and assuming XOR gate has a delay of 3 units

1. From A_0, B_0 and C_0 computing C_1 takes 8 units (XOR + XOR + AND + OR) and computing S_0 takes 9 units (XOR + XOR + XOR).

2. Each carry forward $C_i \to C_{i+1}$ for $1 \leq i < n$ takes 2 units (AND + OR) of time and this happens $n-1$ times $\therefore$ this contributes $2(n-1)$ time steps.

3. To calculate S_i from A_i, B_i and C_i we need an additional 3 units (XOR) after we get C_i (other calculations would be done by then) $\therefore$ time delay for $S_i = 8 + 2(i-2) + 3$

From this, we can conclude $n \geq 2$

$$\Delta_{C_n} = 8 + 2(n-1) = 2n + 6$$

$$\Delta_{S_n} = 8 + 2(n-2) + 3 = 2n + 7$$

3 Group Details

1. Kaushal Banthia - 19CS10039
2. Rohit Raj - 19CS10049
3. Animesh Jha - 19CS10070
4. Nisarg Upadhyaya - 19CS30031
5. Pranav Rajput - 19CS30036