Ripple Carry Adder:

A **Ripple Carry Adder (RCA)** is a fundamental digital circuit used to perform binary addition. It consists of multiple full adders connected in series, where each full adder is responsible for adding corresponding bits from two binary numbers along with a carry bit from the previous stage. The carry output from each full adder "ripples" to the next, hence the name.

Structure and Operation:

- **Full Adders in Series:** An RCA is constructed by cascading full adders, with the carry output of one feeding into the carry input of the next.
- **Carry Propagation:** The carry signal propagates through each stage, which can introduce a delay proportional to the number of bits being added.

Advantages:

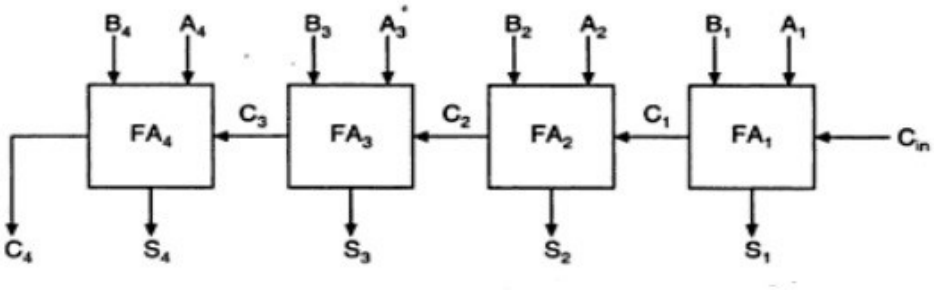
- **Simplicity:** The design is straightforward and easy to implement.
- **Scalability:** It can be extended to add numbers of any bit length by increasing the number of full adders.

Disadvantages:

- **Propagation Delay:** The main drawback is the cumulative delay caused by each carry bit waiting for the previous one, making it slower for large bit-width additions.

4-bit Ripple Carry Adder

- The below diagram represents the 4-bit ripple-carry adder. In this adder, four full adders are connected in cascade. Co is the carry input bit and it is zero always. When this input carry ‘Co’ is applied to the two input sequences A1 A2 A3 A4 and B1 B2 B3 B4 then output represented with S1 S2 S3 S4 and output carry C4.



Simulation Waveforms:

Schematic: