Synopsis: Digital Circuit

Title

Implementation and Simulation of a 4-bit Ripple Carry Adder using CMOS Logic in eSim

Problem Statement

The Ripple Carry Adder (RCA) is a fundamental digital circuit widely used in Arithmetic Logic Units (ALUs), microprocessors, and embedded systems. A 4-bit RCA adds two 4-bit binary numbers by cascading four full adders, where each carry output propagates to the next stage. While the RCA suffers from propagation delay, it remains an essential design for understanding the basics of arithmetic operations in VLSI systems.

Reference Paper

Kumar, V., & Kumar, A. (2019). *Design and Analysis of Low Power 4-bit CMOS Ripple Carry Adder.* International Journal of Recent Technology and Engineering (IJRTE), 8(3), 2277–3878.

Objective of Migration

The aim is to replicate the CMOS-based 4-bit Ripple Carry Adder using **eSim**. The design will be created at the transistor level by implementing XOR, AND, and OR gates using NMOS and PMOS transistors, followed by construction of a full adder. Finally, four full adders will be cascaded to form the complete 4-bit RCA.

Circuit Diagram :

Top level Circuit

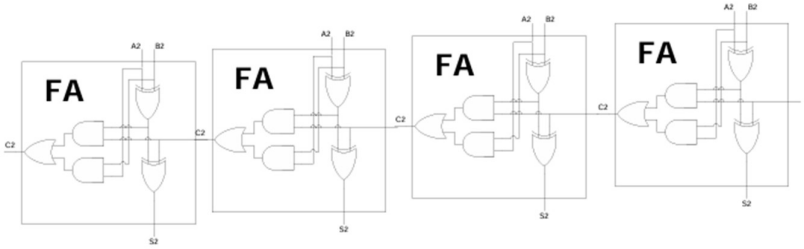

Fig. 5 4-bit Ripple Carry adder

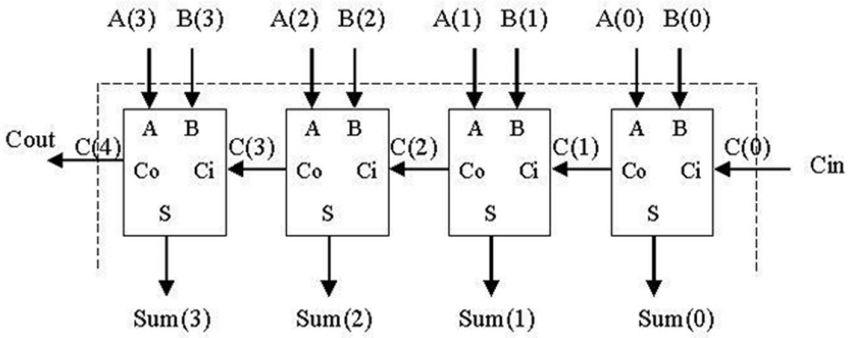

Fig. 1 4_bit adder

Bottom Level

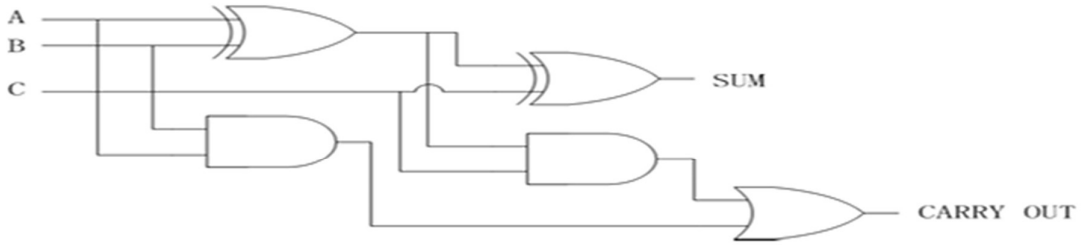

Fig. 3. The Gate level Diagram of Full Adder

Waveform

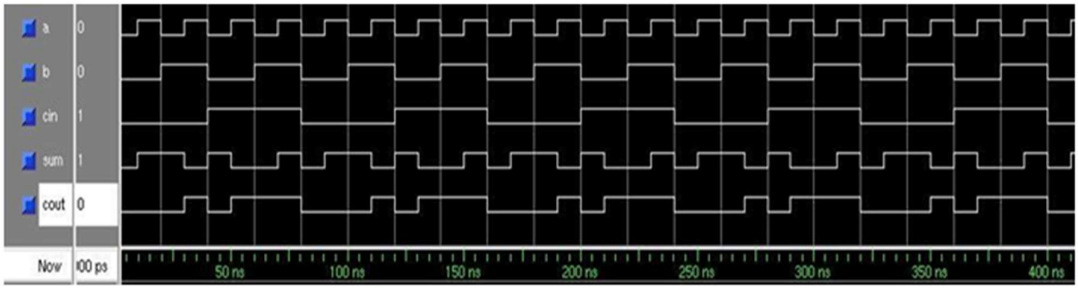

Fig. 4 1 bit full adder simulation results

Circuits Needed for building Full Added

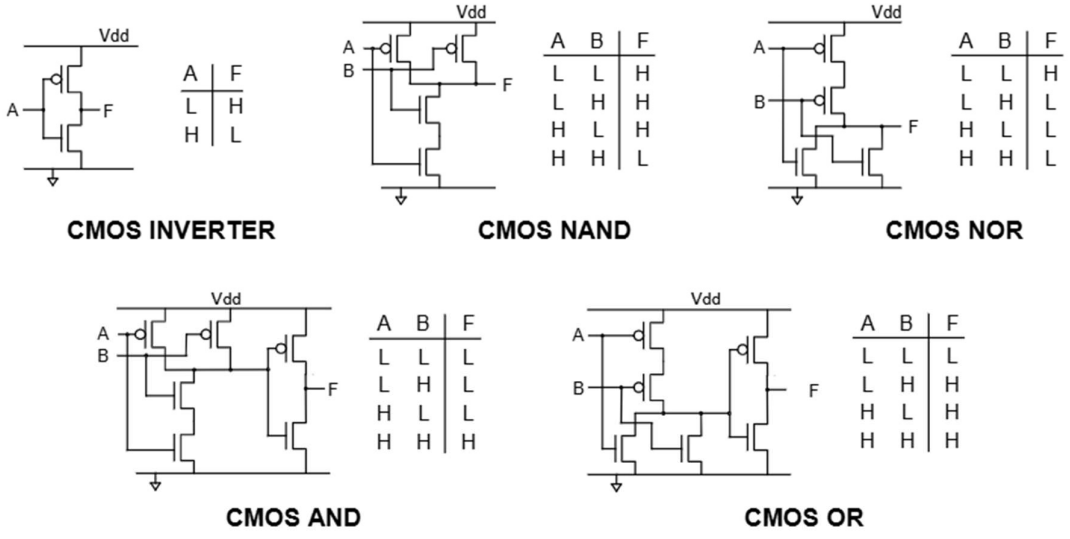

Figure 4. Basic CMOS Gates and Their Truth Tables

Expected Outcome

- Successful transistor-level implementation of the 4-bit RCA in eSim.
- Functional verification of sum and carry outputs for all possible 4-bit inputs.
- Demonstration of carry propagation and timing behavior through simulation waveforms.
- Validation of the migrated design against the reference work.

Significance

This project demonstrates the ability to migrate and simulate digital designs in eSim, strengthening open-source VLSI tool adoption. It provides a foundation for more complex arithmetic circuits and helps students understand transistor-level digital design concepts.