Digital Circuits Lab Project

Project Report: 4-bit Digital Calculator with Logical and Arithmetic Operations

1. Project Title:

Design and Implementation of a 4-bit Digital Calculator for Logical and Arithmetic Operations

2. Objective:

To design and implement a 4-bit digital calculator that performs the following operations:

- Logical operations: AND, OR, NAND, NOR, XOR, XNOR

- 4-bit binary addition

- 4-bit magnitude comparison

- 4-bit left and right shift

- 4-bit binary multiplication

3. Components Required:

| 1 | Logic Gates (ICs: 7408, 7432, 7400, 7402, 7486) | As needed |

| 2 | 4-bit Adder (IC 7483 or full adder logic) | 1 |

| 3 | 4-bit Comparator (ICs: 7408, 7402, 7404) | 1 |

| 4 | Shift Register (ICs: 7408, 7432, 7400, 7402, 7486) | 1 |

| 5 | 4-bit Multiplier (built using AND gates and adders) | 1 |

| 6 | DIP Switches | 2 sets (4-bit each) |

| 7 | LEDs | As needed |

| 8 | Breadboard or PCB | As needed |

| 9 | Power Supply (5V) | 1 |

| 10 | Connecting Wires | As needed |

4. Theory and Operation:

4.1 Logical Operations:

- AND, OR, NAND, NOR, XOR, XNOR using ICs: 7408, 7432, 7400, 7402, 7486

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4.2 4-bit Addition:

- Binary addition using IC 7483 or full adder logic

4.3 4-bit Comparison:

- Binary comparator logic to compare two 4-bit numbers using basic logic gates.

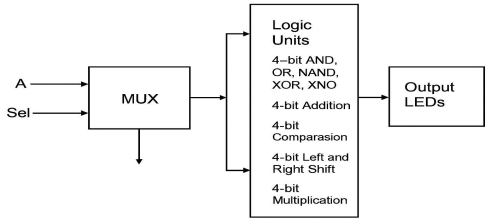
4.4 Left and Right Shift:

- Performed using basic logic gates NOT,AND,OR

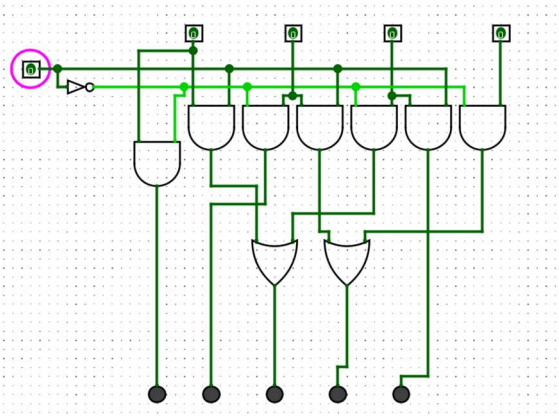
4.5 4-bit Multiplication:

- Multiply two 4-bit numbers using AND gates to create partial products and full adders for summation

5. Block Diagram AND Circuit Diagram:



4 bit right and left shifter



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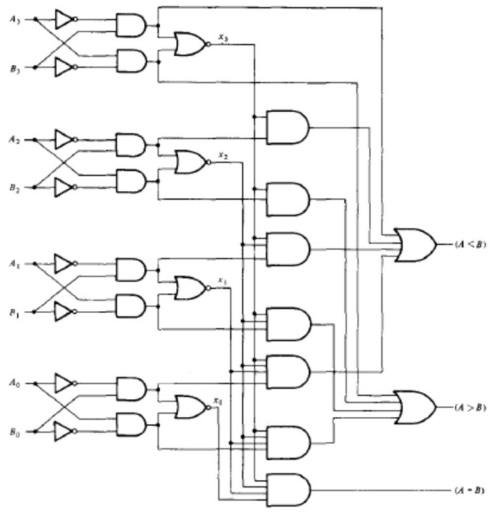
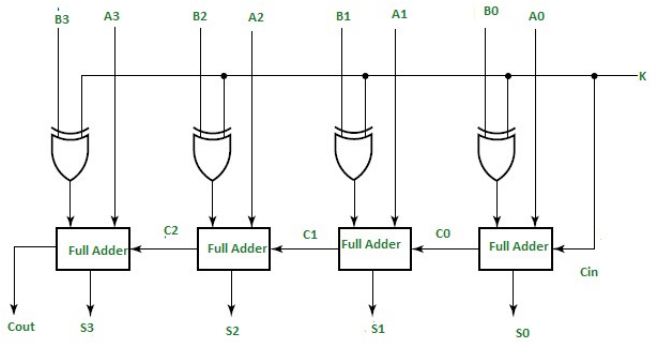
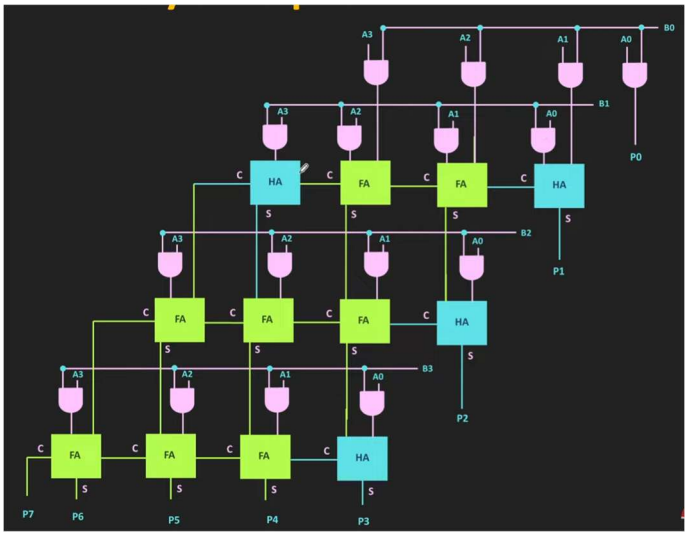
4 bit Comparater



4 bit Adder



4 bit multiplier



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6. Implementation Steps:

1. Connect DIP switches for 4-bit input A and B.

2. Use toggle switches to select desired operation.

3. Design and connect each operation block (logic gates, adder, comparator, shifter, multiplier).

4. Use LEDs to show output result of selected operation.

5. Ensure each module output is isolated and connected to a MUX or selector logic.

7. Truth Tables (Examples):

AND Operation:

| A | B | A AND B |

|---|---|---------|

| 1101 | 1011 | 1001 |

Addition:

| A | B | Sum | Carry |

|---|---|------|--------|

| 0101 | 0011 | 1000 | 0 |

Multiplication Example:

| A | B | Product |

|---|---|---------|

| 0101 | 0011 | 00001111 | (5 * 3 = 15)

8. Result:

The calculator successfully executes:

- 4-bit logical operations: AND, OR, NAND, NOR, XOR, XNOR

- 4-bit addition and carry detection

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- 4-bit comparison: A > B, A = B, A < B

- Bitwise left and right shifts

- 4-bit multiplication producing 8-bit result

9. Applications:

- ALU implementation in processors

- Digital electronics education and simulation

- Embedded systems with binary computation

10. Future Scope:

- Expand to 8-bit or 16-bit operations

- Implement subtraction, division, BCD conversions

- Add LCD or 7-segment display output

- Integrate with microcontroller

11. Conclusion:

This digital calculator project demonstrates understanding of digital logic design. It integrates core arithmetic and logic operations, preparing the foundation for building a complete Arithmetic Logic Unit (ALU).

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