Analog and Digital Systems (UEE505)

Lecture # 15
Combinational Circuits & BCD Adder

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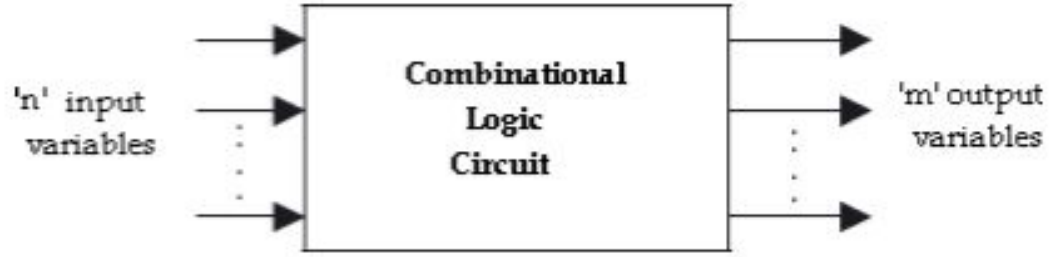
Combinational Circuits : Introduction

Logic circuits without a memory i.e. outputs depend only on the current inputs.



- For n input variables there are 2^n possible combinations of binary input values.
- For each possible input combination, there is one and only one possible output combination.
- The circuit can be describe by m Boolean functions , one for each output variable.
- Each output function expressed in terms of the n input variables.

Design Procedure

1. State the problem.
2. Identify the input and output variables.
3. Assign the input and output variables letter symbols.
4. Construct a truth table to meet input -output requirements.
5. Write Boolean expressions for various output variables in terms of input variables.
6. Simplify Boolean expression using any method of minimization— algebraic method, Karnaugh map method or tabulation method.
7. Make a logic diagram using logic gates for the simplified boolean expression.

Practical Design

A practical design method would have to consider such constrains as:

- Min. no. of gates.
- Min. no. of inputs to gates.
- Min. no. of interconnections.

Combinational Circuits : Applications

- **Arithmetic & Logical Operations:**
  - Adders, Subtractor and Comparator
- **Data Transmission:**
  - Multiplexer, Demultiplexer, Encoders & Decoders
- **Code Converters:**
  - Binary to Gray Code

BCD Adder

- A circuit which adds two BCD numbers and produces a sum also in BCD.

❖ BCD Addition:

BCD Adder

This adder must perform the following:

- Add two 4 bit BCD code groups, using binary addition.
- Check whether the SUM produced is greater than 9 or carry is generated.
- If it is, add 6 to the SUM to get valid BCD result.

BCD Adder

- Those cases in which SUM is greater than 9 are listed as:

$S4$	S_3	S_2	S_1	S_0	
0	1	0	1	0	10
0	1	0	1	1	11
0	1	1	0	0	12
0	1	1	0	1	13
0	1	1	1	0	14
0	1	1	1	1	15
1	0	0	0	0	16
1	0	0	0	1	17
1	0	0	1	0	18

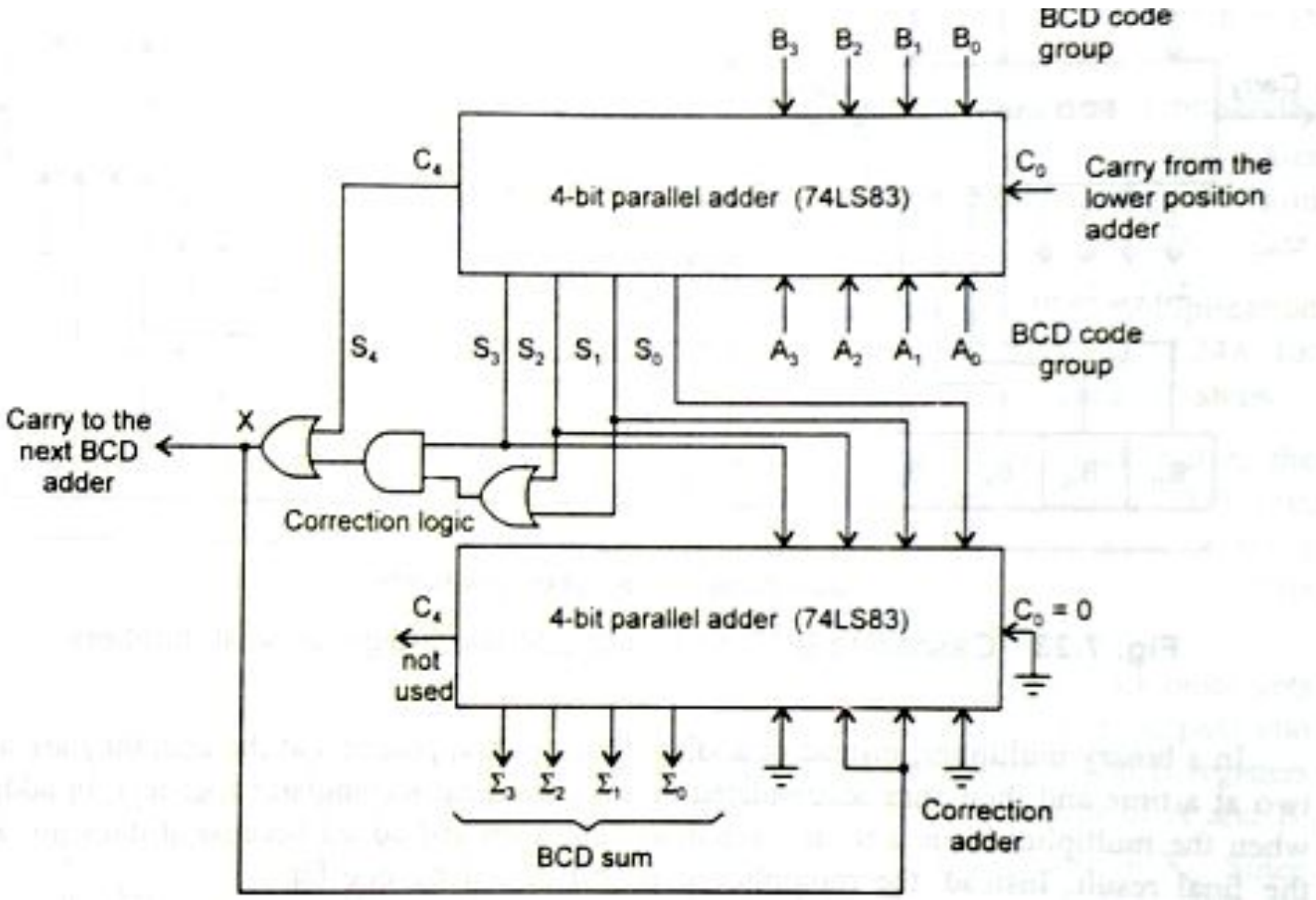
❖ Define logic output X that would be HIGH for either of the following conditions:

- Whenever S_4 = 1 (SUM greater than 15).
- Whenever S_3 = 1 and either S_2 or S_1 or both are 1(sums 10 to 15).

❖ This condition can be expressed as:

$$X = S_4 + S_3 (S_2 + S_1)$$

Logic Diagram of BCD Adder



Design a logic circuit with 4 inputs A,B,C,D that will produce output ‘1’ only whenever two adjacent input variables are 1s. A and D are also treated as adjacent.

References

- *Floyd, T.L. and Jain, R. P., Digital Fundamentals, Pearson Education.*
- *Tocci, R. and Widmer, N., Digital Systems: Principles and Applications, Pearson Education.*
- *Mano, M. M. and Ciletti, M., Digital Design, Pearson Education.*
- *Kumar, A., Fundamentals of Digital Circuits, Prentice Hall.*