

Design of Full adder

Carry Propagate Adder (CPA)

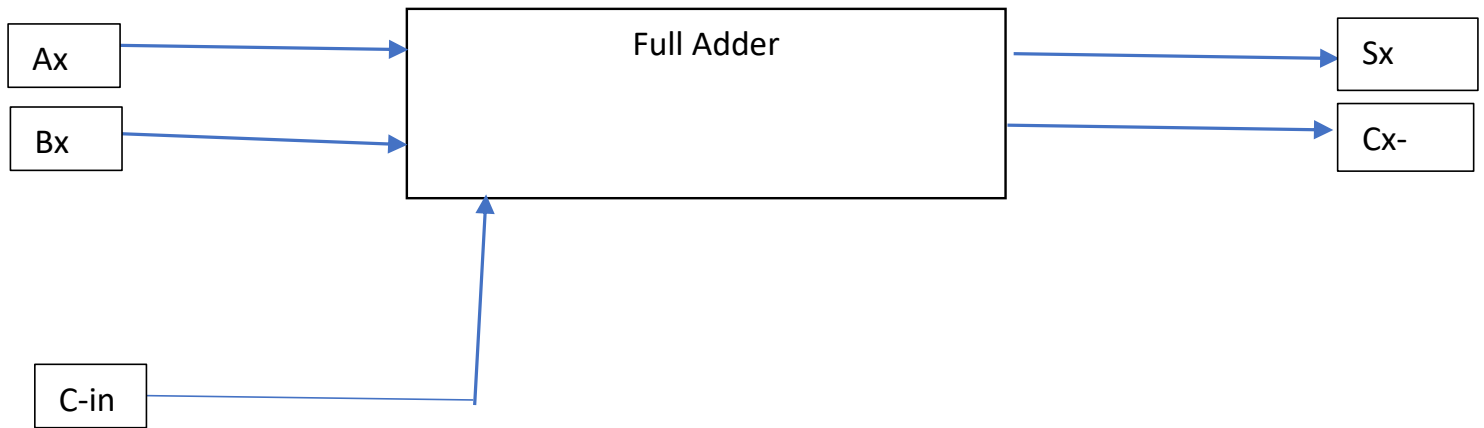
- Full adder is an arithmetic logic unit or circuit to add two single digit numbers with Carry-in.
- It is still combinational circuit with inputs Ax and Bx.
- **S = Sum (1bit); C-in = Carry in; C-out = Carry Out.**
- Adder is also called Ripple Carry Adder (RCA)
- Simplest circuit for an adder and has longest propagation delay that is proportional to the number of the carry bits
- Equation to estimate the propagation delay of an n-bit CPA. ΔF_{AC} and ΔF_{AS} stand for delta time for carry bit and delta time for sum signal propagation delay of a Full Adder (FA)

$$\Delta CPA(n) = [(n-1) * \Delta F_{AC}] + \Delta F_{AS} \quad \text{Eq(2.8)}$$

- Using AND/OR/EOR gate, Δ for AND/OR gate is = 0.1 ns and Δ for EOR = 0.3ns, $\Delta F_{AC} = 0.2\text{ns}$ and $\Delta F_{AS} = 0.3\text{ns}$, as per Eq(2.8)
 - For 8 bit CPA (n=8), the equation to calculate propagation delay is as follows:

$$\Delta CPA(n) = (n - 1)(0.2\text{ns}) + 0.3\text{ns}$$

Block Diagram of Full adder

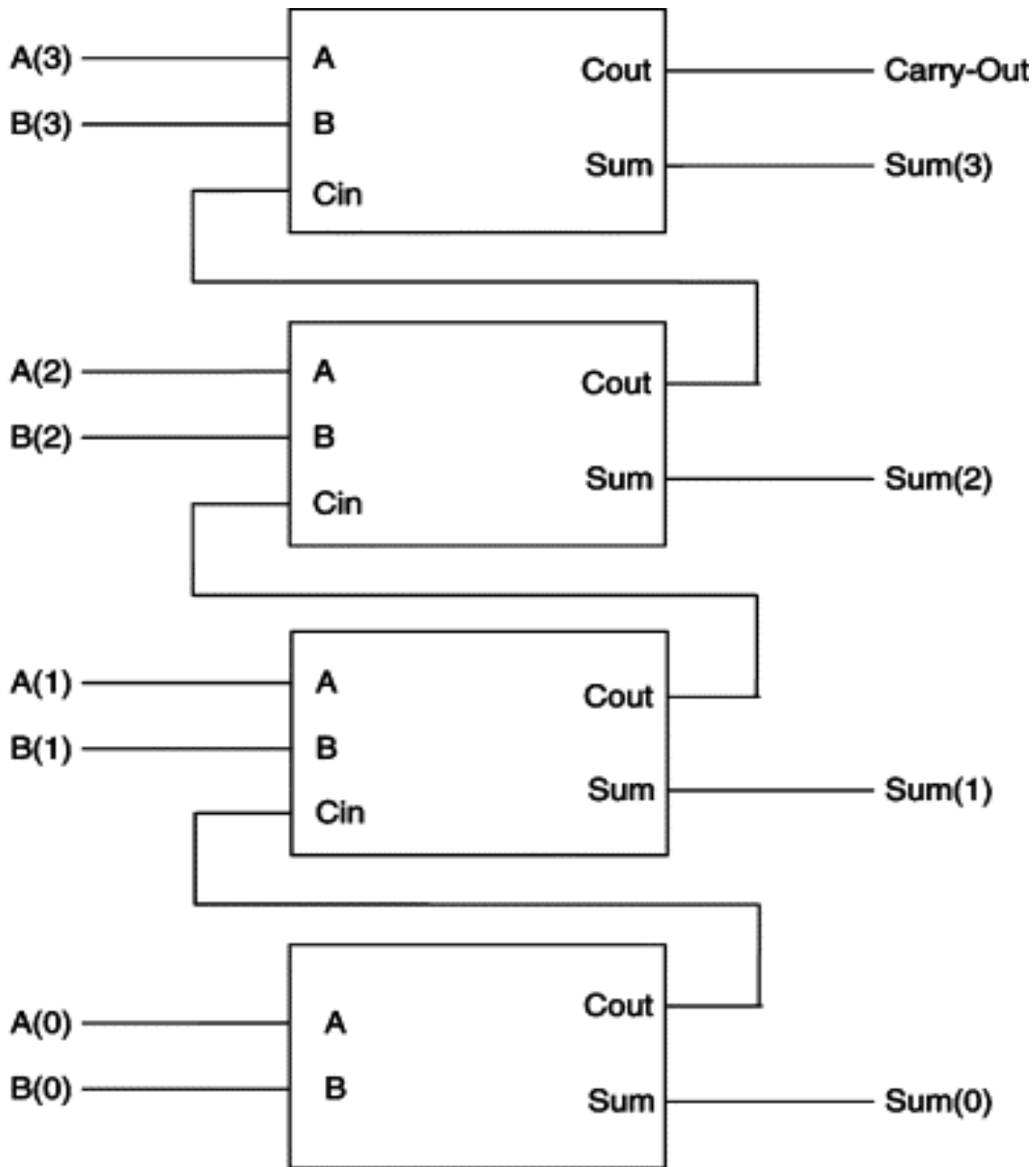


Design of Full Adder

- With three inputs and 2 outputs
- **Full adder Truth Table**

Inputs			Outputs	
A	B	C – IN	Sum	C - Out
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Schematic of a 4 bit Carry Propagate Adder (CPA)



4-bit binary addition

	A (3)	A (2)	A (1)	A (0)	
	B (3)	B (2)	B (1)	B (0)	+
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Carry-Out	Sum (3)	Sum (2)	Sum (1)	Sum (0)	
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4-bit binary addition

	A (3)	A (2)	A (1)	A (0)	
	B (3)	B (2)	B (1)	B (0)	+
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Carry-Out	Sum (3)	Sum (2)	Sum (1)	Sum (0)	
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Binary Addition review:

$0 + 0 = 0$; $0 + 1 = 1$; $1 + 0 = 1$;
 $1 + 1 = 10$

A	B	S	Cout
0	0	0	
0	1	1	
1	0	1	
1	1	0	1

A = 0111

B = 1111

Inputs			Output	
A[i]	B[i]	C-in	S	C out
1	1	0	0	1
1	1	1	1	1
1	1	1	1	1
0	1	1	0	1

Multiplexer

- Selecting of data or information is a critical function in a digital systems and computers
- A Multiplexer (Mux for short) is a digital switch; Mux is a circuit used to select and route any of the several inputs to a output signal
- Mux is a combinational circuit. it has the following:
 - 2^n inputs
 - n control inputs
 - one set of output
 - In summary, has the following 2^n input signals, n control inputs (selector signals), and a single set of output – Output signal.
- For a multiplexer, the value of the control inputs (selector signals) determines the data input that is selected
- Multiplexer means many into one. a simple example of a non-electronic circuit of a mux is a single pole multi-position switch. Multi-position switches are widely used in many electronics circuit, however, circuits that operate at high speed require the multiplexer to be automatically selected. A mechanical switch cannot perform this task satisfactorily. Therefore, mux is used to perform high speed switching and are constructed for digital circuits
- Example:
 - X and Y are inputs
 - S is the selector signal
 - r is the output

Design of a 1 bit, 2 to 1 mux

1. Block diagram of 1 bit, 2 to 1 mux

