

Difference between Half Adder and Full Adder

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In this article, we will go through the Difference between the Half adder and Full adder, First, we will briefly describe what is half and full adders with their logical expressions and truth table, and then we will go through their differences between them, At last we will conclude our article with some FAQs.

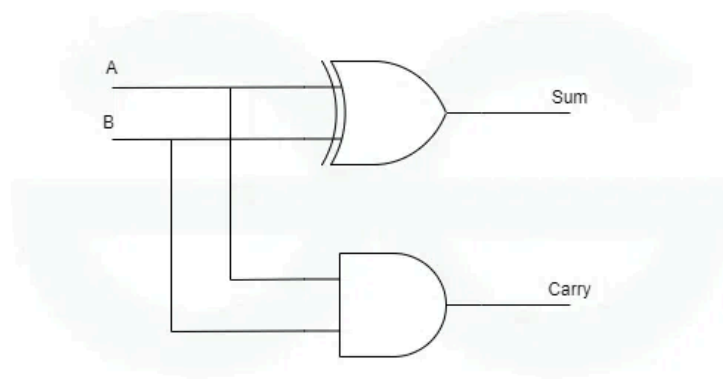
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What is Half Adder?

[Half Adder](#) is a combinational logic circuit that is designed by connecting one [EX-OR gate](#) and one AND gate. The half-adder circuit has two inputs: A and B, which add two input digits and generate a carry and a sum.

Half Adder



Difference between Half adder and full adder



Half Adder

The output obtained from the EX-OR gate is the sum of the two numbers while that obtained by AND gate is the carry. There will be no forwarding of carry addition because there is no logic gate to process that. Thus, this is called the Half Adder circuit.

Logical Expression of Half Adder

The Logical Expression for half added is given as

$$Sum = A \oplus B$$

$$Carry = A \text{ AND } B$$

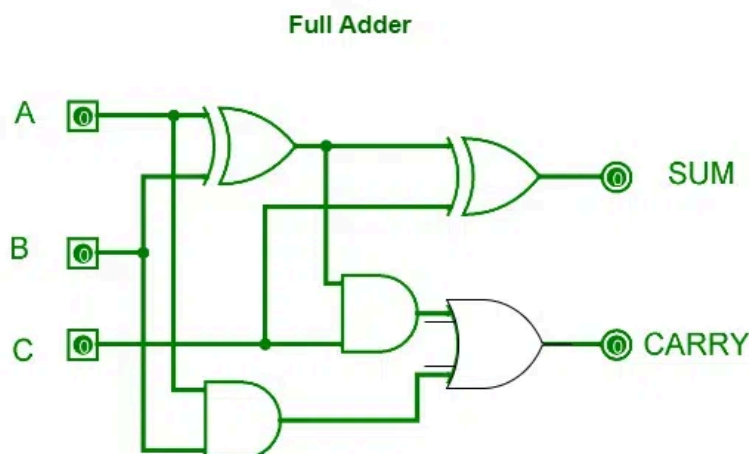
Truth Table of Half Adder

The Truth Table for Half Added is Given as

Truth Table			
Input		Output	
A	B	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

What is Full Adder ?

Full Adder is the circuit that consists of two EX-OR gates, two AND gates, and one OR gate. Full Adder is the adder that adds three inputs and produces two outputs which consist of two EX-OR gates, two AND gates, and one OR gate. The first two inputs are A and B and the third input is an input carry as C-IN. The output carry is designated as C-OUT and the normal output is designated as S which is SUM.



Difference between Half adder and full adder



Full Adder

The equation obtained by the EX-OR gate is the sum of the binary digits. While the output obtained by AND gate is the carry obtained by addition.

Logical Expression of Full Adder

Given Below is the Logical Expression of Full Adder

$$SUM = (A \text{ XOR } B) \text{ XOR } Cin = (A \oplus B) \oplus Cin$$

$$CARRY-OUT = A \text{ AND } B \text{ OR } Cin(A \text{ XOR } B) = A.B + Cin(A \oplus B)$$

Truth Table of Full Adder

Given Below is the truth Table of Full Adder

Input			Output	
A	B	Cin	Sum	Carry
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

Sum and Carry Operation

In both Half Adders and Full Adders, Sum is the output of the addition of the two inputs and Carry is the output which is an overflow of the output position and needs to be shifted to the next higher position while adding successive bit inputs.

- **Sum (S)** : It results from the XOR gate, which is a logic gate that adds two or more bits together in the same way that you add in base 2 with no acknowledgement of carry from the previous bit.
- **Carry (C or Cout)**: It is the output of the AND operation in the case of the Half Adder or both AND and OR Operations in the case of the Full Adder to indicate that a '1' has to be carried over to the next bit position.

Advantages and Disadvantages

Advantages of Half Adder

- Flexible and easy when it comes to design.

- Involves the use of fewer logic gates thus, is cheaper.

Disadvantages of Half Adder

- Fails to process a carry input from the previously added numbers.
- Restricted to the addition of only two bits.

Advantages of Full Adder

- Can add 3 bits, it includes one carry input and a carry output, which can perform more elaborate computations.
- It can be cascaded to produce adders for a number of bit additions which makes it suitable for multi bit arithmetic.

Disadvantages of Full Adder

- Complex and needs more gates, hence making the design more complicate and expensive.
- Yeah man, slightly slower because normally 2 gate process are used instead of 1.

Applications

Applications of Half Adder

- Arithmetic operations like addition, subtraction, and multiplication in low level dynamic circuits.
- Three types of rectifiers: half-wave, full-wave, and full-wave with a center tapped secondary. Used in small integration circuits.

Applications of Full Adder

- Carry-look ahead adders in digital processors that utilize multi-bit binary addition.
- Present in the arithmetic logic units (ALU) and other complicated digital systems.

Difference Between Half Adder and Full Adder

Given Below is the Difference between the Half adder and Full adder

Parameters	Half Adder	Full Adder
Description	Half Adder is a combinational logic circuit that adds two 1-bit digits. The half adder produces a sum of the two inputs.	A full adder is a combinational logic circuit that performs an addition operation on three one-bit binary numbers. The full adder produces a sum of the three inputs and carry value.
Previous carry	The previous carry is not used.	The previous carry is used.
Inputs	In Half adder, there are two input bits (A, B).	In full adder, there are three input bits (A, B, C-in).
Outputs	The generated output is of two bits-Sum and Carry from the input of 2 bits.	The generated output is of two bits-Sum and Carry from the input of 3 bits.
Used as	A half adder circuit cannot be used in the same way as a full adder circuit.	A full adder circuit can be used in place of a half adder circuit.
Feature	It is simple and easy to implement	The design of a full adder is not as simple as a half adder.
Logical Expression	Logical Expression for half adder is : $S=a \oplus b$; $C=a*b$.	Logical Expression for Full adder is : $S=a \oplus b \oplus C_{in}$; $C_{out}=(a*b)+(C_{in}*(a \oplus b))$.

Parameters	Half Adder	Full Adder
Logic gates	It consists of one EX-OR gate and one AND gate.	It consists of two EX-OR, two AND gates, and one OR gate.
Applications	It is used in Calculators, computers, digital measuring devices, etc.	It is used in Multiple bit addition, digital processors, etc.
Alternate name	There is no alternate name for half adder.	Full adder is also known as ripple-carry adder.

Conclusion

In this article we have gone through the half adder and full adder in brief with their logical expression and truth table, we have also seen difference between them in detail.

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