

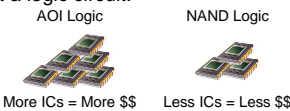


Universal Gate – NAND

Digital Electronics

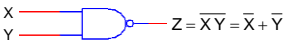
Universal Gate – NAND

- This presentation will demonstrate
- The basic function of the **NAND** gate.
 - How a **NAND** gate can be used to replace an **AND** gate, an **OR** gate, or an **INVERTER** gate.
 - How a logic circuit implemented with **AOI** logic gates can be re-implemented using only **NAND** gates.
 - That using a single gate type, in this case **NAND**, will reduce the number of integrated circuits (IC) required to implement a logic circuit.



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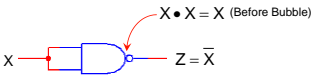
NAND Gate



X	Y	Z
0	0	1
0	1	1
1	0	1
1	1	0

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NAND Gate as an Inverter Gate



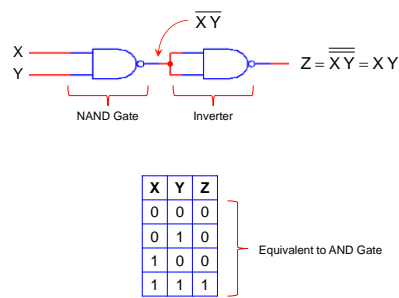
X	Z
0	1
1	0

Equivalent to Inverter

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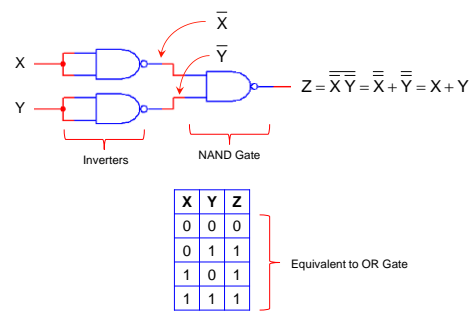


NAND Gate as an AND Gate



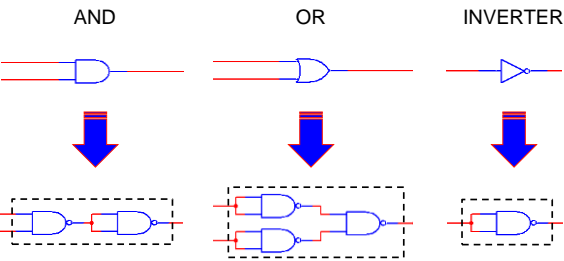
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NAND Gate as an OR Gate



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NAND Gate Equivalent to AOI Gates



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Process for NAND Implementation

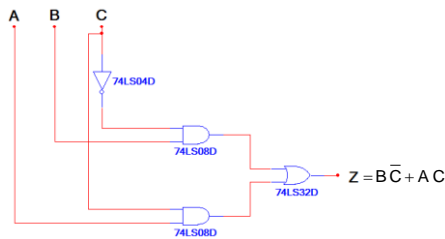
1. If starting from a logic expression, implement the design with AOI logic.
2. In the AOI implementation, identify and replace every AND, OR, and INVERTER gate with its NAND equivalent.
3. Redraw the circuit.
4. Identify and eliminate any double inversions (i.e., back-to-back inverters).
5. Redraw the final circuit.

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NAND Implementation

Example:
Design a NAND Logic Circuit that is equivalent to the AOI circuit shown below.

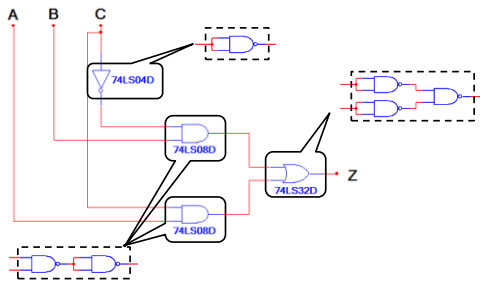


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NAND Implementation

Solution – Step 2

Identify and replace every AND, OR, and INVERTER gate with its NAND equivalent.

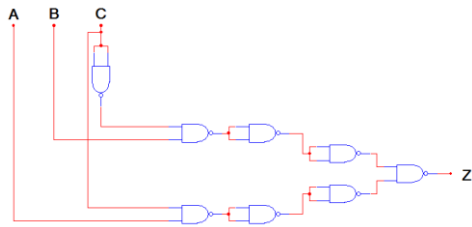


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NAND Implementation

Solution – Step 3

Redraw the circuit.

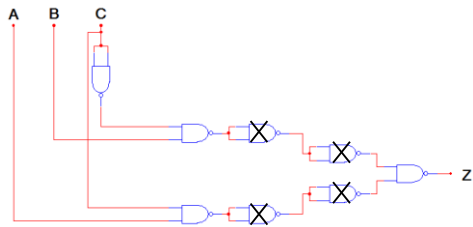


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NAND Implementation

Solution – Step 4

Identify and eliminate any double inversions.



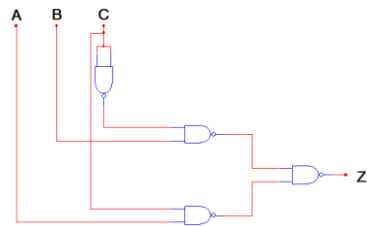
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NAND Implementation

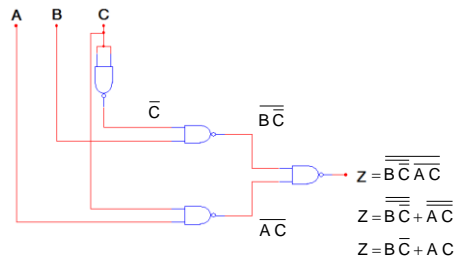
Solution – Step 5

Redraw the circuit.



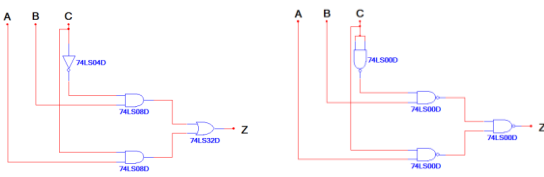
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Proof of Equivalence



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AOI vs. NAND



IC Type	Gates	Gate / IC	# ICs
74LS04	1	6	1
74LS08	2	4	1
74LS32	1	4	1
Total Number of ICs →			3

IC Type	Gates	Gate / IC	# ICs
74LS00	4	4	1
Total Number of ICs →			1

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