电子技术
Introduction to Electronics

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Chapter 5 Combinational Logic

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Objective

- Gate circuits
- Basic Combinational logic circuits
  - AND-OR
  - AND-OR-Inverter
  - NAND/NOR
- Analyze and design of combinational logic circuits

Reading assignment

- P233-P255

Logic circuit

- **Combinational Logic circuit** 组合逻辑电路（无记忆功能）
- **Sequential Logic circuit** 时序电路（带存储元件，有记忆）

Basic Combinational Circuits

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- AND-OR
- AND-OR-Invert
- XOR
- XNOR
- NAND
- NOR

1 AND-OR Logic

$X=AB+CD$

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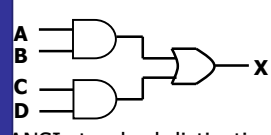
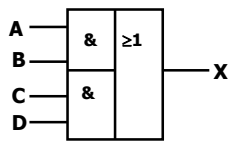
An AND-OR circuit directly implements *SOP* expression, assuming the complements of the variables are available.



ANSI standard distinctive shape symbols



ANSI standard rectangular outline symbols

Example chip: 74HC58

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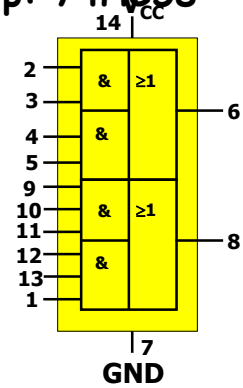
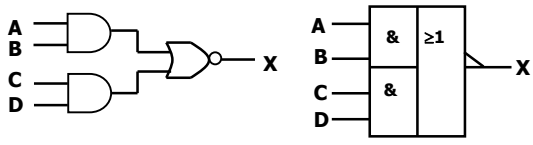
- 74HC58 (CMOS): dual AND-OR
  - 1 two inputs AND-OR.
  - 1 three inputs AND-OR



2 AND-OR-Invert Logic

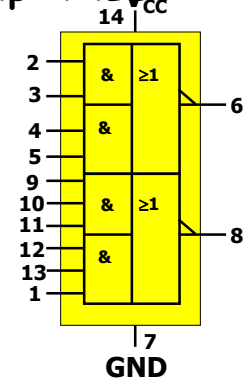
$X = \overline{AB + CD} = (\overline{A} + \overline{B})(\overline{C} + \overline{D})$

An AND-OR-Invert can be used to implement ***POS*** expression.



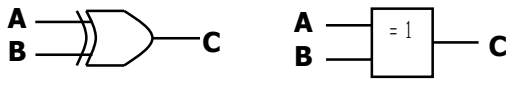
Example chip: 74LS51

- **74LS51** : dual 2-wide AND-OR-Invert
  - 1 two inputs AND-OR-Invert.
  - 1 three inputs AND-OR-Invert



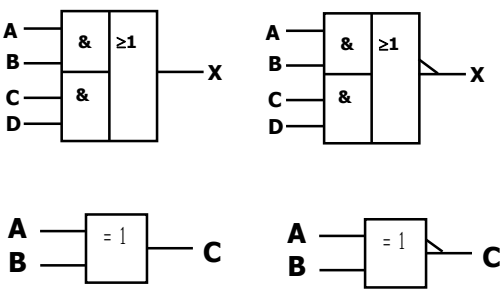
3 Exclusive-OR (XOR)

$X = \overline{A}B + A\overline{B}$



4 Exclusive-NOR (XNOR)

$X = AB + \overline{A}\,\overline{B}$



5 Combinational Logic Using NAND and NOR Gates

- NAND $\overline{AB} = \overline{A} + \overline{B}$ ⇒ Negative-OR
- NOR $\overline{A + B} = \overline{A}\,\overline{B}$ ⇒ Negative-AND

The NAND Gate as a Universal Logic Element

- The NAND gate can be used to produce the NOT, AND, OR, and NOR operations.

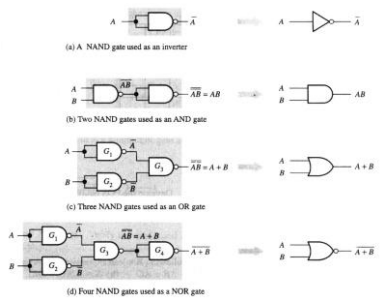


FIGURE 5–18
Universal application of NAND gates.

The NOR Gate as a Universal Logic Element

- The NOR gate can be used to produce the NOT, AND, OR, and NAND operations.

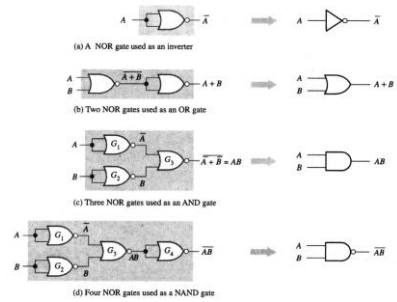


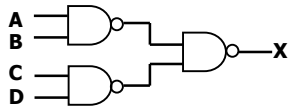
FIGURE 5–19
Universal application of NOR gates.

Example: Implenting the following expression using NAND gates:

$$X = AB + CD$$

Solution: $X = AB + CD$

$$= \overline{\overline{AB + CD}} = \overline{\overline{AB} \cdot \overline{CD}}$$



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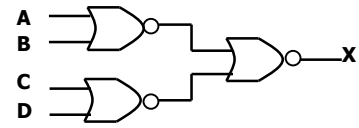
Example: Implementing the following expression using NOR gates:

$$X = (A + B)(C + D)$$

Solution: $X = (A + B)(C + D)$

$$= \overline{\overline{(A + B)(C + D)}} = \overline{\overline{A + B} + \overline{C + D}}$$



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Summary

- Basic combinational logic circuits
- Design of logic functions using basic logic circuits

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Problems chapter 5:

2, 6(d), 12(c),

24(e), 26(g), 29.

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