
MICROCOMPUTER THEORY AND SERVICING

FOURTH EDITION

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Solution

The output waveform X is high whenever inputs A and B are at different logic states. The output waveform Y is the opposite of waveform X .

2.7 SUMMARY OF LOGIC GATES

It is important to understand thoroughly the operation of all the basic logic gates. Figure 2.24 summarizes the Boolean expressions, logic symbols, and truth tables of all the gates presented up to this point. The information in Figure 2.24 should be memorized and completely understood because it is the foundation to all that is to follow.

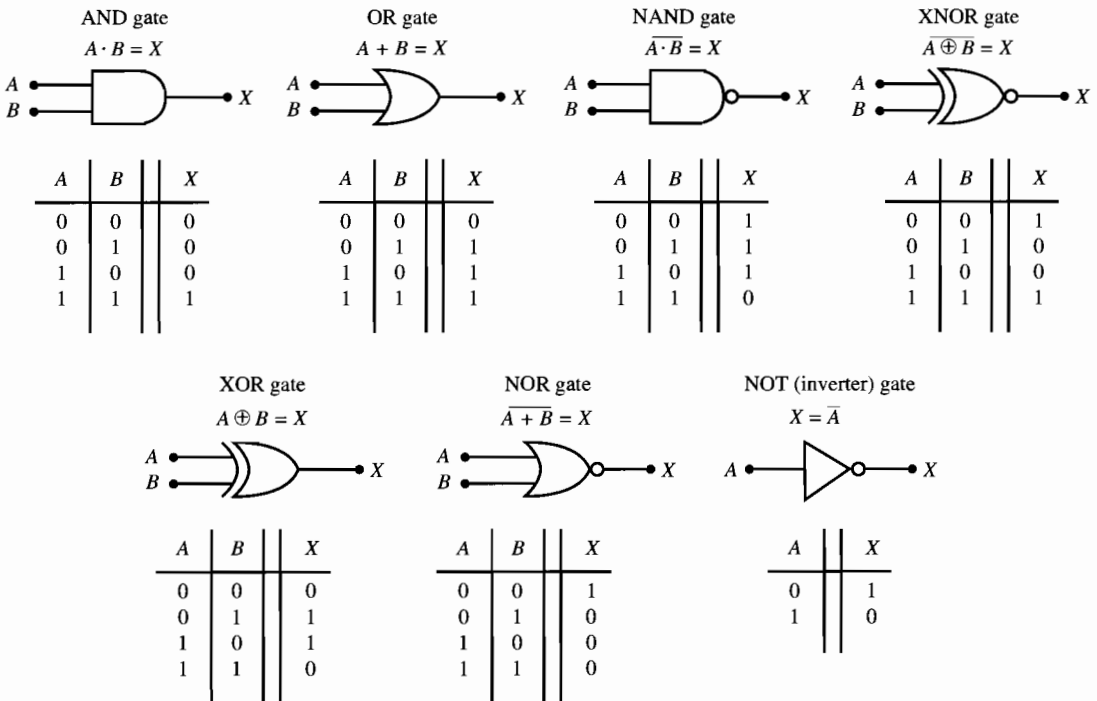


FIGURE 2.24
Summary of logic gates

2.8 TECH TIPS AND TROUBLESHOOTING—T³

The **logic probe** is a tool that you will find extremely useful for troubleshooting digital circuits. Figure 2.25 shows an example of a typical logic probe. The logic probe is a very handy instrument for determining the logic state of a device. Although logic probes may vary in their features and capabilities, they are all quite similar.

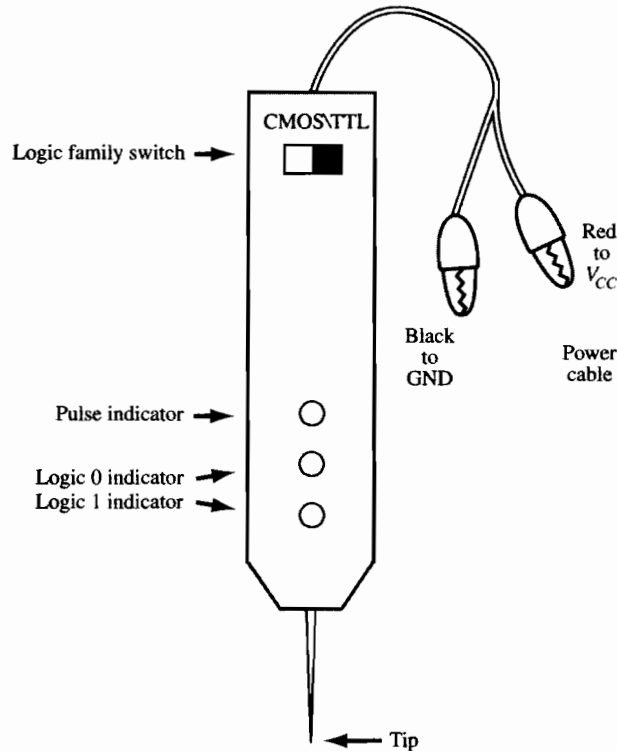


FIGURE 2.25
Logic probe

From our discussion on logic devices, we have seen that there are different types of logic families. Each logic family operates at different voltages and has different input and output characteristics. Because of these differences, logic probes are designed to operate with a particular logic family. Some logic probes have a switch that enables operation with two or more logic families by simply changing the position of the switch.

Most logic probes are powered by the system under test. Power is obtained by connecting a cable from the logic probe to the system power supply (V_{CC}) and ground.

At the bottom of the logic probe is a naillike tip. The tip is used to *probe*, or test, the state of a logic device. When the tip is placed on an IC pin or test point in a circuit, the logic probe indicates the current logic state of that point.

Most probes have visual indicators to signify a logic state. For example, a red light may indicate a logic 1 condition, and a green light may be used to indicate a logic 0 condition. If no light is lit, it usually indicates an open-circuit, or **tristate**, condition. This is sometimes referred to as a **float**. Some logic probes have a third light that pulses to indicate that a constant pulsing is occurring. Others have an internal 1-bit memory built in that is very useful in determining transient pulses.

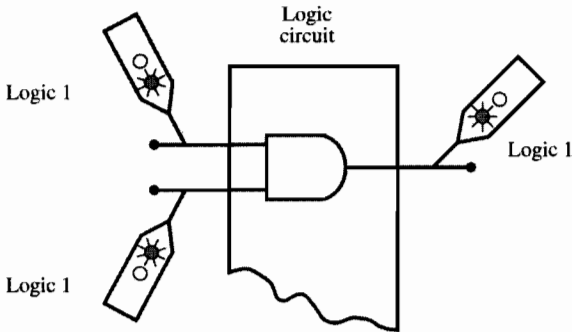


FIGURE 2.26
Use of logic probe

Let's consider the standard AND gate in Figure 2.26 to examine a simple use of the logic probe. Recall that the output of an AND gate is high (1) only when all the inputs are high (1). By probing the inputs we can verify that both inputs are high (1). If both inputs are high (1), we conclude that the output should be high (1). By probing the output, this can be verified. If the output is high (1), we can assume that the gate appears to be operating correctly. To be sure, we would have to test all the possible combinations of input and output conditions dynamically. If the probed output is *not* high (1), we can conclude that either the gate is bad or that something else in the circuit is causing a problem. For example, a short circuit to ground or a second gate that is loading down the output of this gate may be causing the problem.

EXAMPLE
2.8

Identify each logic gate in Figure 2.27 as either good or possibly bad.

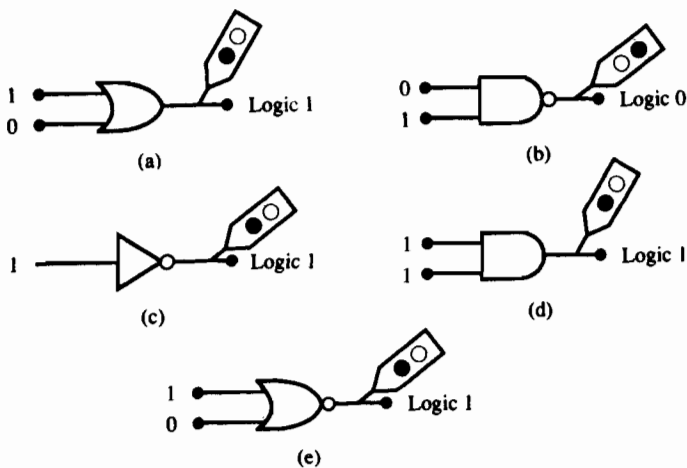


FIGURE 2.27

Solution

- a. Good OR gate.
 - b. Bad NAND gate; output should be high.
 - c. Bad inverter; output should be low.
 - d. Good AND gate.
 - e. Bad NOR gate; output should be low.
-

Logic probes provide useful information when troubleshooting because they allow you to determine quickly the logic state of a signal. When selecting a logic probe, you must consider what features you will need. Usually the more features, the more expensive the logic probe will be. However, having a feature may save you a lot of money in time and effort. As we study and examine more complex digital circuits, you will appreciate this device even more.

EXERCISES

- 2.1 What is a logic gate?
- 2.2 Describe the types of devices that can be used to make a logic gate.
- 2.3 If the greater of two voltages is used to represent a logic 1, this is called _____.
- 2.4 If the greater of two voltages is used to represent a logic 0, this is called _____.
- 2.5 Most systems today use _____ V_{DC} to represent a logic 1 and _____ V_{DC} to represent a logic 0.
- 2.6 Find the frequency of a waveform that has a period of 250 μs .
- 2.7 If the pulse width of a waveform is 75 μs , and its period is 250 μs , calculate its duty cycle.
- 2.8 Explain the difference between a positive-going pulse and a negative-going pulse.
- 2.9 Draw an ideal pulse. Show the leading edge and trailing edge.
- 2.10 Draw a real, or nonideal, pulse showing t_r , t_f , and t_w .
- 2.11 Identify and explain the three basic logic functions.
- 2.12 Boolean algebra was first applied to what type of circuits?
- 2.13 Describe a truth table.
- 2.14 Identify the logic function that can be thought of as a series circuit containing two or more logic switches.
- 2.15 Identify the logic function represented by the Boolean expression $A \cdot B \cdot C = L1$.
- 2.16 Identify the logic function represented by the Boolean expression $A + B + C = L1$.
- 2.17 Identify the logic function that can be thought of as logic switches in parallel.
- 2.18 Calculate the number of logic combinations that are possible from a 5-input logic circuit.
- 2.19 Using logic switches, draw the logic circuits to perform the following functions:
 - a. AND
 - b. OR
 - c. NOT