Digital Logical Circuits Volume II

An Online Continuing Education Course for Engineers

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Digital Logic Circuits
Volume II
Fundamental Logic Circuits

Table of Contents

Section **Page**

Introduction …………………………………………….. 3

Chapter 1, Computer Logic ……………………………… 4

Chapter 2, Basic Logic Circuits …………………………. 10

Chapter 3, Variations of Fundamental Gates ……………. 26

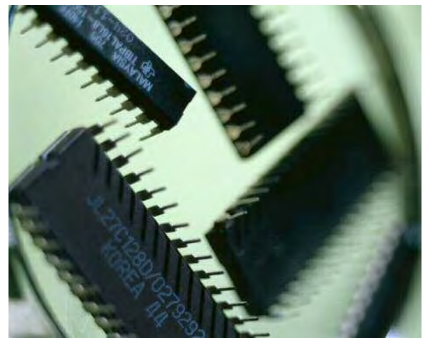
Chapter 4, Logic Gates in Combinations ………………… 31

Chapter 5, Boolean Algebra ……………………………… 36

Summary …………………………………………………. 41

Introduction

In the first course in this series, Digital Logic Circuits, Volume I, Introduction to Logic, we learned that the two digits of the binary number system can be represented by the state or condition of electrical or electronic devices. A binary 1 can be represented by a switch that is closed, a lamp that is lit, or a transistor that is conducting. Conversely, a binary 0 would be represented by the same devices in the opposite state: the switch open, the lamp off, or the transistor in cut-off.



In this, the second course in the series, we will study the four basic logic gates that make up the foundation for digital equipment. We will see the types of logic that are used in equipment to accomplish the desired results.

This course includes an introduction to Boolean algebra, the logic mathematics system used with digital equipment. Certain Boolean expressions are used in explanation of the basic logic gates, and their expressions will be used as each logic gate is introduced.

Chapter 1
Computer Logic

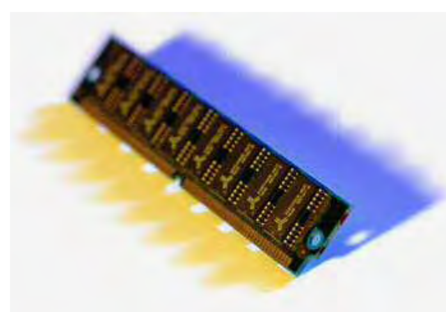
Logic is defined as the science of reasoning. In other words, it is the development of a reasonable or logical conclusion based on known information.

Consider the following example: If it is true that all non-penny, US coins are silver and the Nickel is a coin, then you would reach the logical conclusion that the Nickel is silver. To reach a logical conclusion, you must assume the qualifying statement is a condition of truth. For each statement there is also a corresponding false condition. The statement "A Nickel is a US coin" is true; therefore, the statement "A Nickel is not a US coin" is false. There are no *in-between* conditions.

Computers operate on the principle of logic and use the *TRUE* and *FALSE* logic conditions of a logical statement to make a programmed decision.

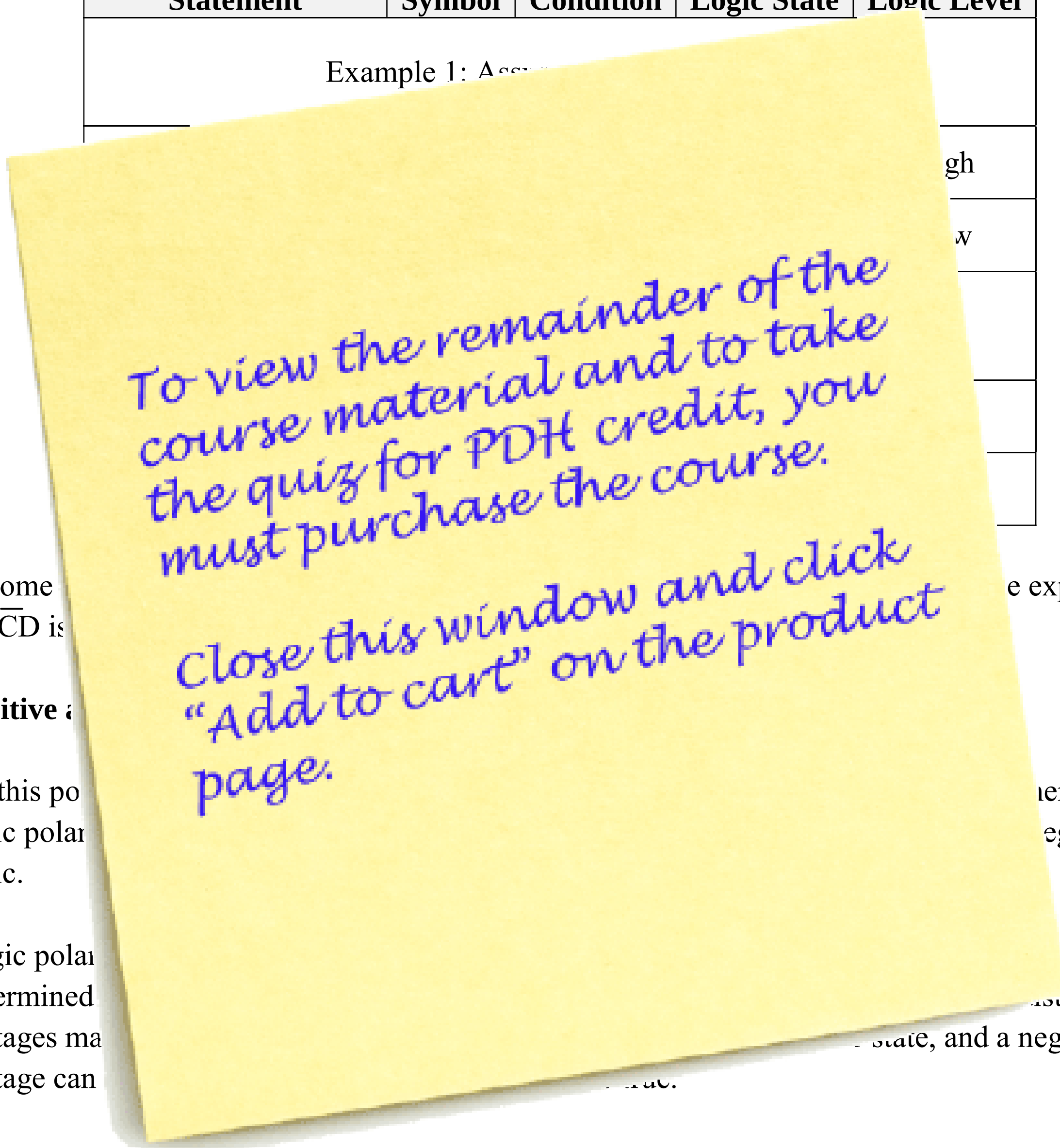
The conditions of a statement can be represented by symbols, called *variables*; for instance, the statement "Today is Tuesday" might be represented by the symbol T. If today actually is Tuesday, then T is TRUE. If today is not Tuesday, then T is FALSE. As we can see, a statement has two conditions. In computers, these two conditions are represented by electronic circuits operating in two *logic states*. These logic states are 0 (*zero*) and 1 (*one*). Respectively, 0 and 1 represent the FALSE and TRUE conditions of a statement.

When the TRUE and FALSE conditions are converted to electrical signals, they are referred to as *logic levels* called *HIGH* and *LOW*. The 1 state might be represented by the presence of an electrical signal (HIGH), while the 0 state might be represented by the absence of an electrical signal (LOW).



If the statement "Today is Tuesday" is FALSE, then the statement "Today is NOT Tuesday" must be TRUE. This is called the *complement* of the original statement. In the case of computer math, complement is defined as the opposite or negative form of the original statement or variable. If today were Tuesday, then the statement "Today is not Tuesday" would be FALSE. The complement is shown by placing a bar, or *vinculum*, over the statement symbol (in this case, $\overline{T}$). This variable is spoken as NOT T. Table 1 shows this concept and the relationship with logic states and logic levels.

Table 1 **Relationship of Digital Logic and Terms**				
Statement	**Symbol**	**Condition**	**Logic State**	**Logic Level**
Example 1: Ass				
				gh
				w



In some … e expression ABC̄D is …

Positive …

To this po … ner define logic polar … egative logic.

Logic polar … have determined … istinct voltages ma … state, and a negative voltage can … rue.

Logic circuits are generally divided into two broad classes according to their polarity - positive logic and negative logic. The voltage levels used and a statement indicating the use of positive or negative logic will usually be specified on logic diagrams supplied by manufacturers.