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Research Article

SHEFFER AND PEIRCE PERFORM ACTIONS ON OTHER LOGICAL ELEMENTS BASED ON THE LOGICAL ELEMENT

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ABSTRACT

This article presents several solutions for creating block diagrams from logic elements, including AND, NAND, OR, NOR and other logic element block diagrams using the Sheffer element. Also, the article shows how to create logic element block diagrams in the Multisim program.

KEYWORDS

Multisim software, logic element, Sheffer element, 2AND, NAND, 2OR, NOR logic elements.

INTRODUCTION

As we all know, when working with information, working with it in digital form creates a number of conveniences. Logical elements are devices designed to process information in digital form. In other words, a logical element (LE) is an electronic device that performs a specific logical operation on input signals.

Physically logical elements are divided into mechanical, electromechanical, electronic (by diodes and transistors), pneumatic, hydraulic, optical and other types. With the development of electrical engineering, mechanical logic elements were transferred to electromechanical logic elements (electromagnetic relays), then electronic lamps, and then transistors. In 1946, after the confirmation of John von Neumann's theory about the economics of positional number systems, the advantages of binary and ternary systems over the decimal number system became known. Converts from decimal logical elements to binary logical elements. Compared to binary and triple fractions, this process significantly reduces the number of operations and elements. It is possible to count dozens of low-level integrated and high-level integrated microcircuit components, independent digital microcircuits, that is, logic elements.

The basic operations in logical algebra (and the corresponding digital electronic circuits) are AND, OR, and NOT (or invert). In addition, there are five common operations (or digital electronic functions) in logical algebra that are produced by combining the functions of these three basic operations.

Truth tables

The truth table is one of the most useful tools for analyzing problems in logical algebra, and to show the functions of the corresponding digital electronic circuits.

As shown in Fig-1, the truth table consists of one vertical column for each of the logic variables involved in a given problem. The horizontal lines or rows of the truth table are filled with all possible true-false combinations the variables can assume with respect to each other.

For example, two variables can assume four different combinations at any of four different times: that is, both true at the same time; both false at the same time; and one true and one false. There are no other possible combinations. The additional columns contain the output or results produced by the combinations of variables.

Two-variable truth table and a summary of truth tables for logic gates

Table 1.

X_1	X_2	AND	NAND	OR	NOR	EXCLUSIVE OR	EXCLUSIVE NOR
0	0	0	1	0	1	0	1
0	1	0	1	1	0	1	0
1	0	0	1	1	0	1	0
1	1	1	0	1	0	0	1

The functional nodes and units are under design of the digital electronic circuits fulfilling the elementary (basic) logic operations. These circuits are called as basic logical elements or gates. For implementation in digital systems of various logic functions it is enough to have the dial-up of logical elements named minimum element base (or basis).

As minimum element basis can serve:

- A dial-up from two types of the logical elements one of which fulfills operation AND, another - operation NOT;

- A dial-up from two types of the logical elements one of which fulfills operation OR, another - operation NOT;

- A dial-up of logical elements of Peirce, fulfilling operation NOR (NOT-OR);

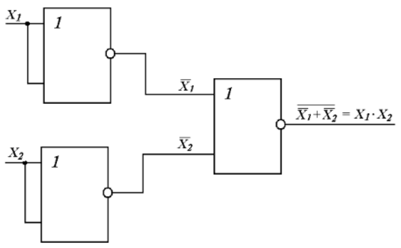
- A dial-up of logical elements Sheffer fulfilling operation NAND.

In practice, for the purpose of abbreviation of the nomenclature of elements and other reasons, use the element basis, fulfilling operation NAND more often, or NOR.

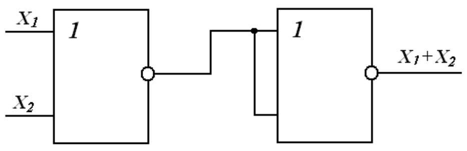
NAND and NOR gates are minimum element base.

The minimum element base is functionally full system of logical elements. It means that set gates of minimum base allows to implementing the logic operations of the arbitrary complexity.

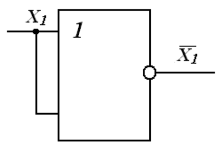
As an example, we consider performance of operations AND, OR and NOT with usage of gates NOR (fig.1) and with usage only gates NAND (fig.2).



1)AND

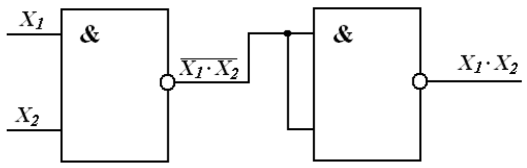


2)OR

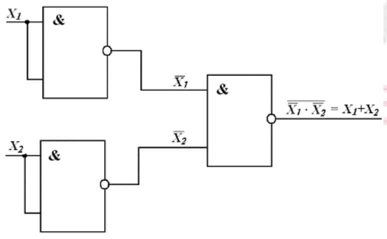


3)NOT

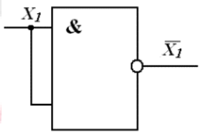
Fig. 1. Implementation of the main logic operations 1)AND, OR, NOT on the basis of gates 2NOR.



1)AND



2)OR



3)NOT

Fig. 2. Implementation of the main logic operations AND, OR, NOT on the basis of gates 2NAND.

We will learn several solutions for creating 2AND, 2NAND, 2OR, 2NOR, and other logic block diagrams using Sheffer logic. Buning uchun De Morgan's theoremalarini bilish talab etiladi.

De Morgan's theorems

$$\bar{\bar{x}} = x \qquad \overline{x_1 + x_2} = \bar{x}_1 \cdot \bar{x}_2 \qquad \overline{x_1 \cdot x_2} = \bar{x}_1 + \bar{x}_2$$

Issue 1. Using gates 2NAND, design the circuit of the 4NAND operation, truth table.

Solution: in this we use the basic axioms and laws of the algebra of logic - that is, from the law of transformation into two,

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$\overline{\overline{\overline{x_1 \cdot x_2} \cdot \overline{x_3 \cdot x_4}}} = x_1 \cdot x_2 \cdot x_3 \cdot x_4$

The block scheme is generated as follows:

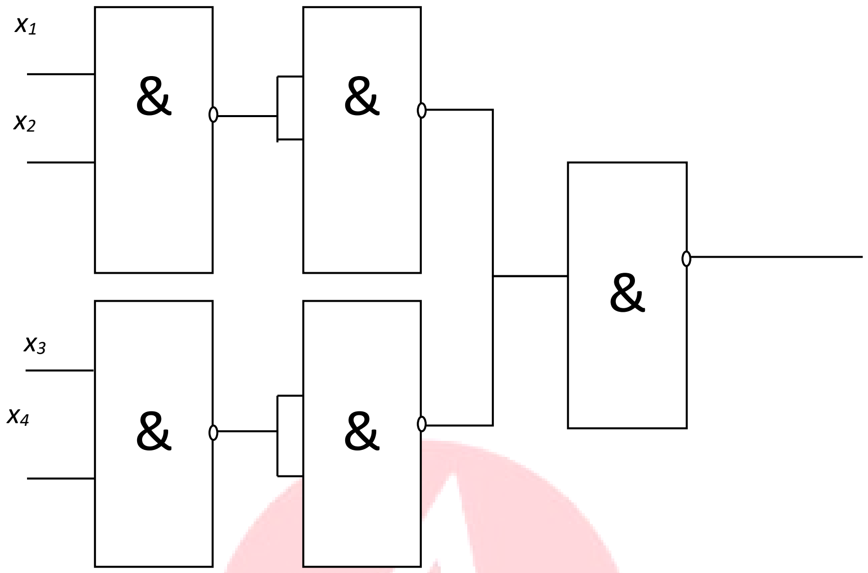

Fig. 3. Implementation of the main logic operation 4NAND the basis of gates 2NAND.

Four-variable truth table and a summary of truth tables for logic gates

Table 2.

X_1	X_2	X_3	X_4	4NAND
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	1
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1

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1	1	0	1	1
1	1	1	0	1
1	1	1	1	0

Base elements perform the necessary tasks for digital integrated circuits. Therefore, it is not for nothing that these base elements are also universal logical elements. In conclusion, it can be said that we can assemble an arbitrary logical element using the elements of the base.

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