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Information technologies in the study of the implementing complex logic functions possibilities

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Abstract. In the article approaches of acquaintance of students of pedagogical high school with the information technologies, allowing to carry out multifactor research of logic elements of modern digital computers are considered. Description of stages and results of research of possibilities of realization of difficult logic functions by means of the basic logic elements executed on integrated circuits with potential representation of the information is resulted. The course of research on the basis of the Electronic Workbench training electronic laboratory software, which allows to perform schematic modeling of digital and analogue radio electronic devices, is presented.

1. Introduction

The text of the article is aimed at expanding the understanding of the organization and conduct of multistage research of the implementation of complex logical functions with the help of basic logical elements, performed on integrated circuits with the potential presentation of information based on the use of information technology. The article contains recommendations allowing to carry out such research for students of non-technical specialties.

The organization and conduct of the proposed research is devoted to familiarization with the theoretical and experimental foundations of modern microelectronics, based on the one hand on the account of the theoretical foundations of microelectronics and the description of the use of integrated circuits based on logical elements, on the other hand, on common technological methods and techniques, the latest trends and trends in modern microelectronics [1, 2, 3, 4].

Preliminary study of the electronic circuit with the use of computer modeling allows to find the optimal parameters for the work of the device under study, without resorting to its practical implementation. Research on the software model allows you to familiarize yourself with the possibilities of checking the correctness of the schemes. To create the schemes considered within the framework of laboratory works on the course "Fundamentals of microelectronics" it is enough to use available typical components.

2. Main headings.

The discipline "Fundamentals of Microelectronics" refers to the variable part of the professional cycle of mathematical and natural science disciplines. To master the discipline "Fundamentals of



Microelectronics", students use knowledge, skills and abilities developed in the process of studying the disciplines "Computer Science", "Computer Architecture", "Software". Mastering the discipline "Fundamentals of microelectronics" is a necessary basis for further study of the disciplines of the variable part of the professional cycle, passing pedagogical practice [5, 6, 7].

Thus, mastering the organization and conducting multistage research of the possibilities of implementing complex logic functions with the help of basic logic elements, performed on integrated circuits with the potential representation of information based on the use of information technologies allows to form:

- knowledge of principles:
 - actions, design and technological features of integral circuits based on semiconductor transistors;
 - designing (creation) the element base of digital computing and communication media;
 - actions, design and technological features of digital devices and ways of their practical use and improvement;
- skills:
 - to take into account various features of students in pedagogical interaction;
 - to design the educational process with the use of modern technologies corresponding to the general and specific laws and peculiarities of the age-related development of a personality;
 - to create a pedagogically appropriate and psychologically safe educational environment;
- mastering skills:
 - construction of electronic devices and microelectronics by means of information technologies;
 - increasing the degree of integration of knowledge of related disciplines on the use of new physical principles in microelectronics.

The multifactor research consists in carrying out of stage-by-stage research of work of the electronic devices realized on the basis of elements of transistor logic. Modeling of the operating scheme is carried out, analytical measurements of the main parameters important for the operation of a digital device are carried out, training in working with various measuring devices is carried out.

At each stage there is a complication of the scheme of the digital device for research. The article gives examples of organization and carrying out of such multifactor research of realization of complex logic functions by means of the basic logic elements executed on integrated circuits with potential representation of the information.

3. Implementation and results of the study.

3.1. Formulation of the assignment for passage a multifactor study

The research is carried out with the use of Electronic Workbench training electronic laboratory software on a PC, developed by Interactive Image Technologies (Canada) for circuit simulation of digital and analogue radio electronic devices [8, 9, 10].

Stage 1. Convert the logic function in sequence (see table 1 for an example of a task) into a truth table, a minimized logic function, and a logic circuit.

Table 1. Example of tasks to carry out a study of complex logic functions with the help of basic logic elements.

№	Logic function	Generator outputs numbers	The time after which the value of "1" is reached.
1	$A'BC'D' + A'BCD + AB'C'D + AB'CD + ABCD$	A – 10, B – 2, C – 4, D – 7	6, 10, 12 sec
2	$A'BCD' + A'BCD + ABCD'$	A – 11, B – 15, C – 2, D – 4	3, 12, 15 sec
3	$A'B'C'D' + A'BCD' + A'BCD + A'BCD + ABCD'$	A – 2, B – 3, C – 10, D – 6	1, 5, 10 sec

Connect the indicator with logic output. Enter a 4-digit hexadecimal number in the number generator so that the logic output is set to "1" for each second (see table).

Stage 2. Investigation of the simplest schemes of asynchronous R-S triggers with the use of logical elements "AND-NOT", "OR-NOT"

Use the 5-volt source and switch to supply the logic "0" and "1" trigger inputs. To control the values at the direct output of the trigger, use the light-indicator. Check the operation of the trigger using the status table. Find and explain the differences in the asynchronous trigger control on the "OR-NOT" elements. Create time diagrams of triggers operation. To analyze the time diagram of this trigger, use the connection of LEDs on the first stage of the trigger and on the trigger output.

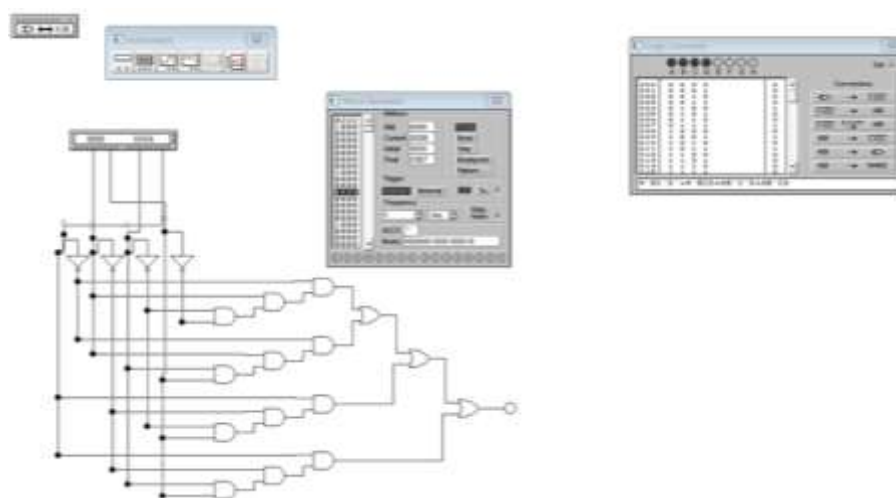
Stage 3. Familiarization with the possibilities of modeling and principles of operation of the schemes of registers of different purposes.

Draw up a three-digit register scheme for entering a word in a parallel code and the possibility of output in forward and reverse codes and control over indicators. Organize control of the shift direction by means of a switch and provide indication of shift operations. Create a time diagram of the parallel entry register operation.

3.2. Procedure for the implementation and results of a multifactor study.

In the course of such a multifactor study, which includes several stages of familiarization with the modeling and design of complex logic functions with the help of basic logic elements, performed on integrated circuits with the potential presentation of information, the student understands the degree of complexity of the scheme. The final digital device applied in construction of real schemes, is projected in process of complication of researched object.

The results of stage 1 you can see at figure 1. Transformation of a complex logic function describing the work of a digital device into a logic circuit and study of its work.

**Figure 1.** Conversion of a logic function into a logic circuit.

Results of stage 2. Creation of the current model of the synchronous R-S trigger circuitry describes the figure 2. Time diagram of the synchronous RS trigger describes the figure 3.

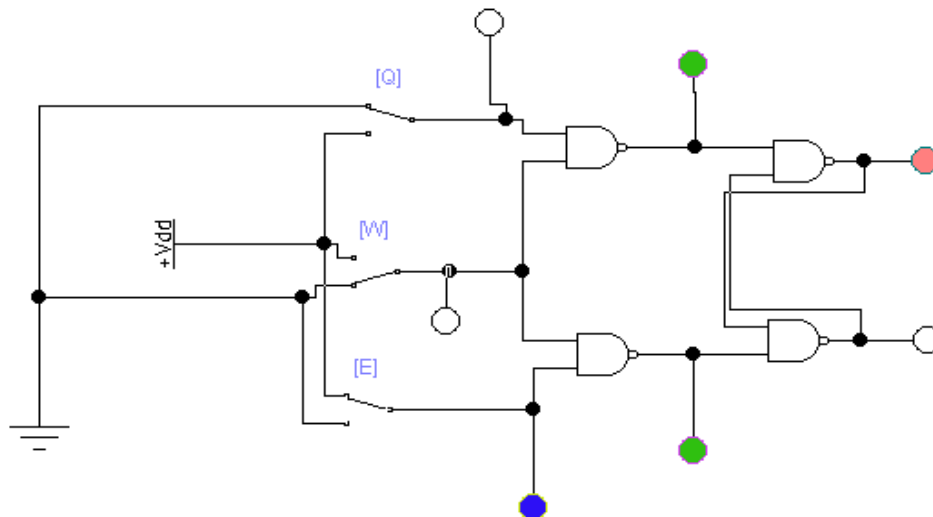


Figure 2. Circuitry of synchronous RS trigger.

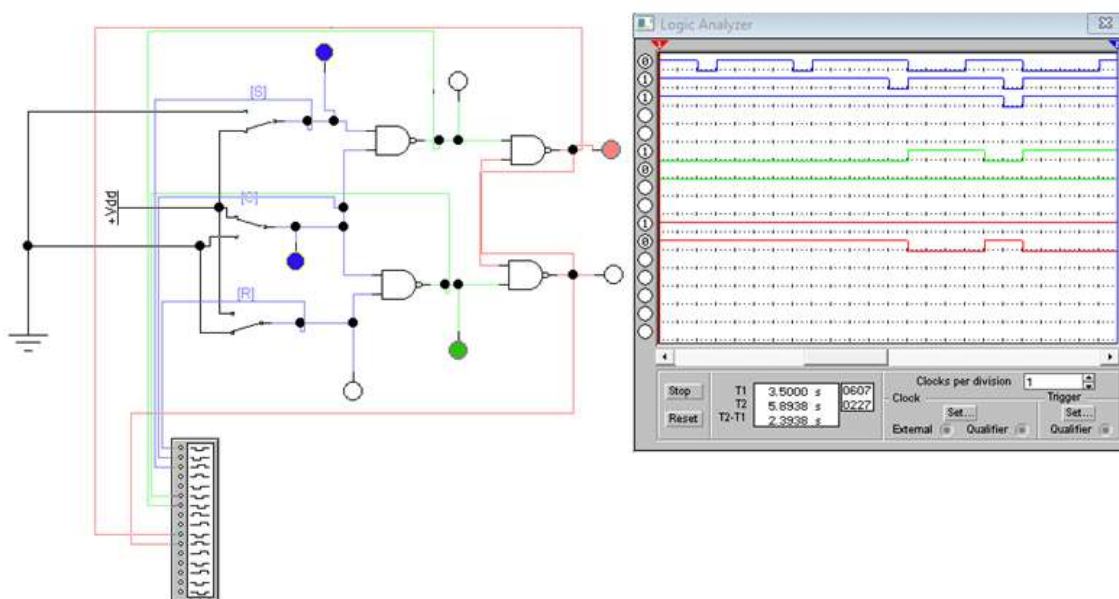


Figure 3. Schematic and timing diagram of the synchronous RS trigger.

A synchronous RS trigger is a JK trigger, so the table of states of a synchronized RS trigger is equivalent to the table of states of a JK trigger (table 2), which has no prohibited states.

Table 2. JK Trigger Status table.

J	K	Q	Q'
0	0	Q	Q'
0	1	1	0
1	0	0	1

1 1 Q' Q

Results of stage 3 are at figure 4. Building a three-digit register scheme for entering a word with a parallel code.

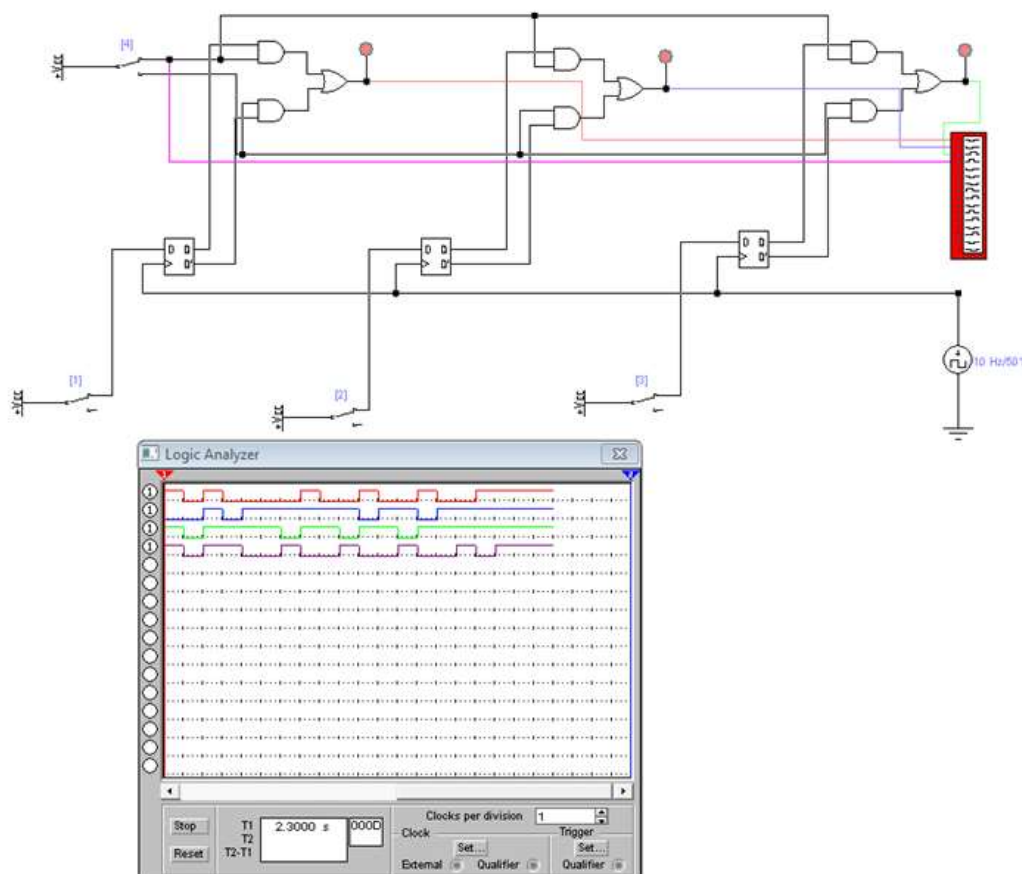


Figure 4. Scheme and time diagram of three-digit register for entering a word by a parallel code.

4. Conclusion

Thus, step-by-step acquaintance with systems of logic elements of modern digital computers is carried out. The carried out research of possibilities of realization of difficult logic functions by means of the basic logic elements executed on the integrated schemes with potential representation of the information, visually shows necessity of mastering the basic aspects of microelectronics: physical, technical and circuit engineering. The multistage of such research allows students of non-technical specialties to master the stages of designing and construction of schemes of false logic functions in comfortable conditions. And carrying out of researches of work of the received schemes is carried out within the limits of realization of an individual trajectory of training, taking into account individual possibilities and personal features.

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