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USING INNOVATIVE TECHNOLOGIES IN TEACHING THE DISCIPLINE "PROGRAMMABLE DIGITAL DEVICES"

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Abstract: FPGA technology, known for its versatility, enables rapid digital device design using automated design systems (ALT/SAPR). These systems simplify development through modular approaches and structured workflows. FPGA programming relies on hardware description languages (HDLs) such as Verilog and VHDL, which define hardware models as interacting modules. Modern ALT systems support various design methods, including text-based, schematic, and graphical representations. VHDL stands out for its flexibility in describing both structure and functionality, making it essential for FPGA-based digital system development.

Keywords: VHDL programming language, digital devices, DMIS (FPGA), integrated circuits, macrocell, module interface, logic elements, diagrams, converters.

Interest in the field of programming is steadily increasing in the Republic of Uzbekistan. The adoption of various decisions and laws, as well as initiatives such as the "One Million Programmers" project, contribute to the growing number of programmers. The programming field consists of several branches, one of which is logic device programming. Software developed for automated processing devices, industrial robots, and smart buildings falls within this category.

For this reason, the President has issued a series of decrees on information technologies, emphasizing the development of this sector within the country and ensuring Uzbek software secures a respectable position in the global market.

Currently, programmable logic integrated circuits (DMIS (FPGA)) are widely used in the development of digital devices. The key advantage of FPGAs is their versatility and their ability to be rapidly programmed to perform the functions of almost any digital device. An FPGA is a semi-finished product that enables developers with a personal computer to design a digital device in record time. This process is supported by specialized software called an automated design system (ALT (SAPR)), which provides a simple and relatively inexpensive development environment.

This system initially presents only a general overview of the designed system with minimal detail, which expands in later stages, where the system is broken down into separate blocks rather than a single entity. Such an approach allows for the structured formation and resolution of complex problems while making the design process easier to understand for students and enhancing their ability to utilize design tools effectively.

Figure 1. Accelerated FPGA Computing Processor.

FPGA programming is carried out using hardware description languages (HDLs) such as Verilog and VHDL. At a high level, these languages are quite similar-hardware models are described as interacting blocks (modules), with defined interfaces and implementations for each. Module interfaces describe input, output, and bidirectional ports, which allow modules to exchange data and control signals. The implementation specifies the elements of the internal state, the procedure for calculating output interface values based on the internal state and input port values, and the rules for updating the internal state.

The general workflow for designing digital devices based on FPGA is carried out using specialized ALT (SAPR) systems. Traditionally, modeling is divided into the following stages: system-level, structural, algorithmic, technological, and functional.

Modern ALT systems support several methods for describing a device: Hardware description (VHDL, Verilog, AHDL, etc.) using a specialized text editor. Schematic method using visual modeling software, allowing developers to place functional blocks in the workspace and connect them. At the end of the visual modeling process, the schematic is converted into a language-based description. Graphical representation of digital machines in specialized editors that convert graphical images into language descriptions. Combinational logic description using truth tables, Karnaugh maps, and Boolean algebra functions. The compiler performs a specialized analysis and generates a netlist, which is a list of all elements in the diagram and their interconnections. In addition to Verilog primitives, the Quartus II IDE provides a library of numerous macro functions and library modules optimized for specific tasks.

A programmable logic integrated circuit is an electronic component used to create digital integrated circuits. Unlike traditional digital chips, the logic of an FPGA is configured through programming by developers and specialized software.

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Among various hardware description languages, VHDL (Hardware Description Language) stands out due to its versatility, as it allows not only the description of a simple logic element's structure but also its operation.

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