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The Use of GreenPAK Dialog Semiconductor as a Laboratory Basis for the Design of FPGA Devices

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***Abstract*—The peculiarities of modern higher technical education in the conditions of the rapid flow of new scientific and technical solutions within the framework of industrial revolutions are considered. It is shown that the cooperation of higher education institutions and leading industry companies allows to provide training of highly qualified specialists in modern conditions. The rationale for the feasibility of using GreenPAK Dialog Semiconductor as a laboratory basis for technical educational components aimed at designing devices on FPGAs is given.**

Keywords—CPLD, FPGA, GreenPAK, Dialog Semiconductor, laboratory base, higher education, device design.

I. INTRODUCTION

Modern higher technical education is based on the rapid development of industrial revolutions and requires higher education institutions (HEIs) to provide appropriate personnel, material and technical, informational and methodical support. At the present time, provision of the appropriate level of material and technical base for the HEI is possible only with the support of production, scientific-production and industrial structures. Such cooperation will allow higher education institutions to train specialists at a high scientific and technical level, and enterprises to obtain qualified personnel with the necessary skills [1-4].

The Department of Microprocessor Technologies and Systems (MTS) of the Kharkiv National University of Radio Electronics (KHNURE) conducts fundamental training of specialists in the field of designing devices on microcontrollers and field programmable gate array integrated circuits (FPGAs) [1-5]. In cooperation with the Dialog Semiconductor company, the MTS department is working on the development of a laboratory workshop based on Dialog Semiconductor's GreenPAK integrated circuits using the GreenPAK Designer software.

Dialog Semiconductor's GreenPAK ICs are a family of configurable mixed-signal integrated circuits (CMICs) that provide miniaturized and customized solutions to common challenges faced by system-level circuit designers. GreenPAK provides means to significantly reduce PCB size, specification cost, and development time. A motivated developer will be able to use GreenPAK in almost most industries. Taking into account the wide range of practical problems solved with the support of GreenPAK, it is advisable to implement this solution in the development of laboratory workshops on the design of devices on programmable logic integrated circuits. The GreenPAK Designer software has a fully graphical design process, requires no programming language or compiler, and has an open distribution license [10].

II. THE MAIN PART

The MTS department teaches the educational component "Design of devices on microcontrollers and programmable logic integrated circuits" module "FPGA" [5-9]. Given the capabilities of Dialog Semiconductor's GreenPAK integrated circuits, the availability of a programmer and the open-license GreenPAK Designer software is a very attractive proposition for use in the educational process for the development of a laboratory base.

GreenPAK™ ICs are a cost-effective programmable non-volatile memory device that enables the integration of many system functions while minimizing component count, board space, and power consumption. Using Dialog's GreenPAK Designer software and the GreenPAK Development Kit, designers can create and program their own circuit in minutes [10-13].

GreenPAK offers the following advantages over a discrete design:

- smaller area on the printed circuit board - plastic cases measuring only 1.0 x 1.2 mm;

- fewer components / lower cost – a typical GreenPAK implementation allows you to save ten to thirty components per instance;
- higher reliability – a smaller number of interconnections on printed circuit boards increases reliability;
- accelerated design - with the help of a full cycle design with GreenPAK Designer;
- reduced power - use of components with low energy consumption and sleep function;
- design security – significantly complicates reverse engineering by disabling reverse reading of the non-volatile memory configuration, which allows you to hide design details;
- tested solutions - each GreenPAK IC is tested, while the discrete circuit is not tested before the final board-level test.

GreenPAK can provide unique subsets of functions [10]:

- GreenPAK dual power supply – a flexible interface of two independent voltage ranges;
- GreenPAK with load switches – GreenPAK configuration with simultaneous control of high current drive power switches;
- GreenPAK with asynchronous state machine - allows you to develop your own state machine designs;
- GreenPAK with regulators with low voltage drop;
- GreenPAK with in-system programming provided;
- high-voltage GreenPAKs – the benefits of combined mixed-signal logic and high-voltage H-bridge functionality;
- automotive GreenPAKs – integration of many system functions in one integrated microcircuit that meets the AEC-Q100 standard;
- analog GreenPAKs – creation of unique analog circuits in combination with customizable GreenPAK logic.

The appearance of the programmer board is shown in Fig. 1. The appearance of integrated circuits is shown in Fig. 2.

Fig. 1. Appearance of the programmer board.

Fig. 2. Appearance of integrated circuits.

The appearance of the programmer board with a representation of the available peripherals is shown in Fig. 3.

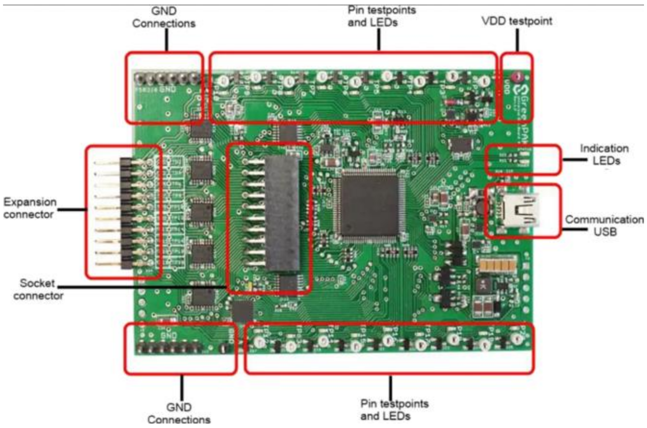

Fig. 3. Programmer's board showing the available peripherals.

Power Supply (Power Supply). The primary power source for the GreenPAK Advanced Development Board is the USB power line. The development board can output voltages from 0 to 5.5 V. To provide this power range, the development board is equipped with a step-up converter. A signal generator with a buffered output controls the power bus of the GreenPAK chip.

USB communication (USB Communication). The board has a USB communication interface that uses a USB mini-B connector. This interface communicates with the control software tool and supplies power to the platform.

GND connections (GND Connections). There are 6 GND pins on the left side, 6 pins and 1 pin on the right side. They can be used as a signal ground the test ground of equipment (oscilloscope, multimeter, etc.) or to connect an external test ground circuit.

Pin Test Points. Each pin of the GreenPAK chip, including VDD, has its own observation reference point. These test points are for observation only. Use the software-controlled expansion jack to connect an external signal source.

Light emitting diodes (LEDs). All pins except pin 2 can be connected to buffered LEDs. This option allows you to visualize the digital levels on the IC pins. There are two selection modes:

- buffered LED (with high input resistance);
- inverted buffered LED (with high input resistance).

Connector (Socket Connector). The optional GreenPAK development board must be used with the removable connector board. Its main purpose is to connect the GreenPAK chip to the programmer board. It is easy to use the programmed chip in external circuits or to measure the current consumption of a realizable project.

Expansion Connector (Expansion Connector). This port was designed to connect the GreenPAK Advanced Development Board to external circuits and supply external power, signal sources and loads. It can be used to apply the GreenPAK chip to your custom design with minimal additional tools.

GreenPAK Designer is a full-featured integrated development environment (IDE) that implements a full cycle of end-to-end design, which includes the stages of: creation of initial project descriptions, synthesis, modeling, placement and tracing on the crystal, crystal configuration and in-crystal hardware setup. It provides direct access to all GreenPAK device features and full control over routing and configuration options. GreenPAK Designer has an integrated programming tool that allows you to program your customized design into your GreenPAK chip. With this tool, you can also read an already programmed chip and export its data to the designer. The designer will generate a project that has the same configuration as the chip. GreenPAK Designer is designed to work in the environment of operating systems (OS): Windows 7/8.1/10, MAC OS X (v10.8 or higher), Ubuntu 18.04 (32, 64-bit), Debian 11 (32, 64-bit) [12].

Digital blocks are the main functional components of any GreenPAK. They include: Look-Up Table (LUT); D Flip-Flop (DFF) / Latch; Counter / Delay (CNT/DLY); I2C (many devices); SPI (select devices); Pattern Generator (PGEN); Pipe Delay; Programmable delay (PDLY); Filter / Edge Detector (Fig. 4) [10-13].

Many components in GreenPAK Designer can be configured as one of several block types. This is indicated by the name of the digital block, for example:

A 2-bit LUT0/DFF/LATCH0 can be, as the name suggests, a LUT, DFF, or Latch. Block type selection is configured using the Type option in the Properties window.

Almost every GreenPAK is equipped with two or more analog comparators [ACMPs], each with two input sources; IN+ and IN-. The input signal source for each is configured in the Properties window.

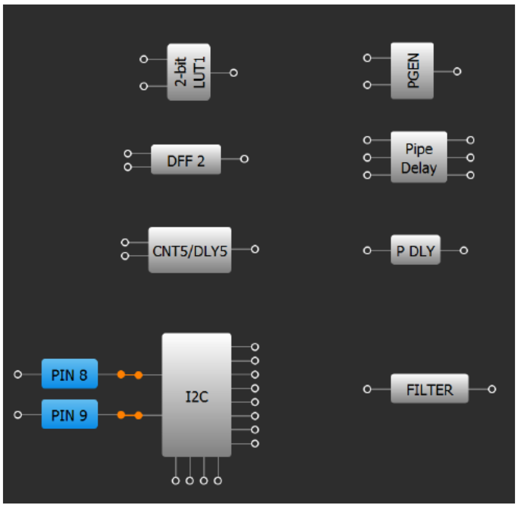

Fig. 4. Digital blocks.

The inputs/outputs in GreenPAK are very flexible. I/O capabilities vary from pin to pin and from part to part, so before choosing a specific GreenPAK you need to match the design with the required pin configuration. The outputs can be configured as push-pull or open-drain in NMOS or PMOS configuration. A scaling factor such as 2x indicates that the output power is doubled. In addition, 10 kΩ, 100 kΩ and 1 MΩ pull-up and pull-down resistor options are available on the output pins.

Several input options are also available, such as: digital input, Schmitt-trigger digital input, low-voltage digital input, and analog input. Analog input is used as ACMP input.

The GreenPAK user interface is shown in Fig. 5.

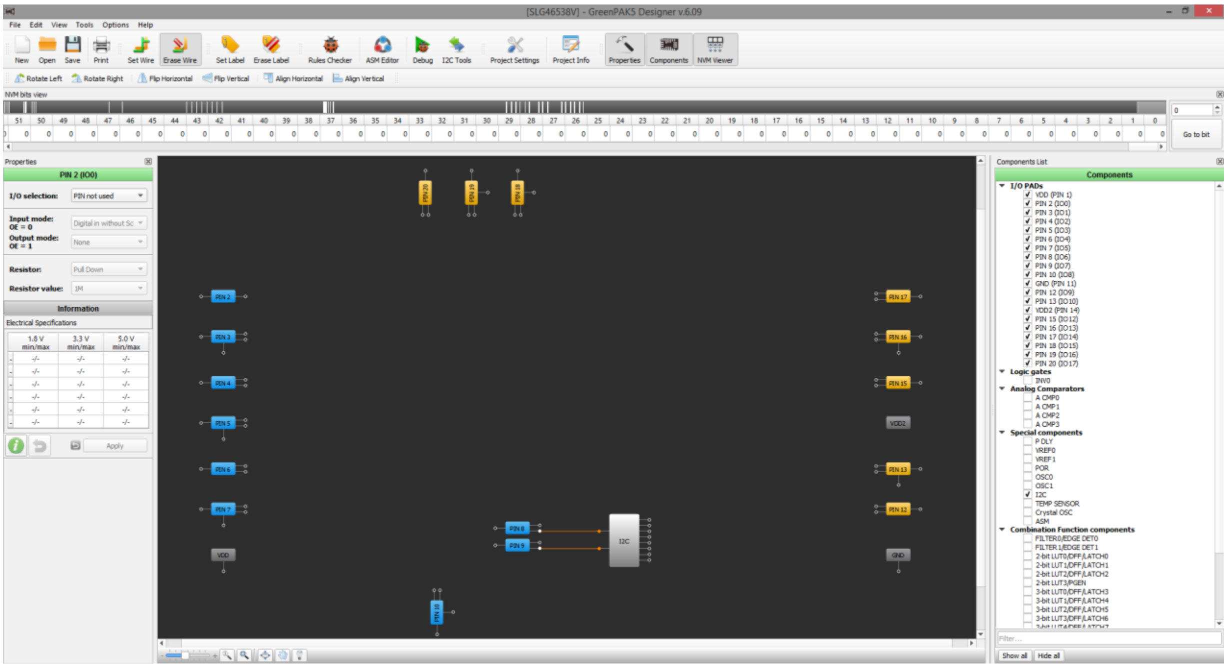

Fig. 5. User Interface in GreenPAK Designer.

The given description of GreenPAK Dialog Semiconductor, GreenPAK Designer and GreenPAK Development Kit demonstrates the full capabilities of the existing at the MTS department laboratory workshop on the educational component "Design of devices on microcontrollers and programmable logic integrated circuits" module "FPGA" [1]. And it will also allow to implement new laboratory work and conduct the work of student groups. GreenPAK Designer will allow students to study fully in remote mode with the support of remote laboratories of the MTS department [6-8].

Conclusions

The use by institutions of higher education in the educational process of higher technical education of modern material and technical, informational, methodical support with an appropriate level of training of scientific and pedagogical workers and educational and support staff allows to ensure the training of a highly qualified specialist in demand on the labor market. Fulfillment of such requirements is possible only with the consolidated cooperation of leading industry enterprises and companies with institutions of higher education.

Dialog Semiconductor is a leading global manufacturer of highly integrated GreenPAK mixed-signal integrated circuits optimized for personal portable, low-power wireless, LED solid-state lighting and automotive applications. Dialog Semiconductor takes an active part in the support and development of higher education in terms of providing high-quality technical education. The expediency of using GreenPAK Dialog Semiconductor as a laboratory basis for technical educational components is demonstrated on the example of laboratory workshops of the Department of Microprocessor Technologies and Systems of the Kharkiv National University of Radio Electronics.

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