Experience of Using EasyEDA to Develop Training Boards on the PIC16f887 Microcontroller

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Abstract. A brief overview of computer-aided design (CAD) systems widely used in Russia is presented, and the main requirements for tracing PCB boards are given. The main features of the actively developing cloud CAD system EasyEDA are shown, and the expediency of its use is justified. The idea of creating low-cost electronic training boards based on the PIC16F887 microcontroller for studying the basics of microprocessor technology is presented. Electronic training boards demonstrate all the capabilities of the microcontroller – the operation of the I/O ports, serial port, analog-to-digital converter (ADC), with a two-line liquid crystal display (LCD), with temperature sensors, with a DC motor, with a stepper motor, etc. The experience of developing a budget electronic training boards based on a PIC microcontroller in EasyEDA, which can be used to study the programming of microcontrollers, is shown. Shown are the possibilities of using the jlcpcb.com service to order PCB boards in the largest PCB prototyping enterprise in China, called JLCPCB.

1. Introduction

Currently, there are dozens of different design systems for the installation of electronic equipment, information about which is presented in various sources [1,2]. However, the leaders in the CAD market for PCB boards (PCBs) are Mentor Graphics (about 40%), then Cadence (both represent the USA), and then Zuken (Japan). In addition, Altium (Australia), Pulsonix (England), Eagle (Germany), Topological Router (Eremex, Russia) should be highlighted, and then there are many small software products such as KiCAD, Dip Trace (Ukraine), etc. ... [3].

One of the basic components of these systems is the routing tools for PCB boards, which must provide such essential functions as:

1. Setting technological parameters and restrictions on the routing of PCB boards (PCB);
2. Placement of components;
3. Tracing of connections on the PCB;
4. Editing the PCB routing topology;
5. Monitoring the implementation of technological violations at the diluted PP;
6. Providing communication with other software for the design of radio electronic equipment at the file exchange level (import and export of the description of PCB boards and its technological parameters), namely:
   • with a schematic editor, with databases of elements with conventional graphic designations (UGO) and seating places;
   • simulation of work and analysis of electronic circuit in various modes;
• modeling and analysis of the design of PCB boards in CAD systems;
• transferring the results of PCB design to systems for its production.

All these functions should be provided with the tools of any PCB design system, but to solve the presented tasks, the programs of the following companies are currently most widely used in Russia: Mentor Graphics - PADS and Expedision, Altium - Altium Designer, NanoBoard, as well as companies Cadence - SPECCTRA (Alegro PCB Router), Eremex - Topological Router (TopoR) [3].

Given the wide variety of available software products, the problem of choosing software that ensures effective PCB design is a rather difficult task, which is primarily determined by the technical capabilities and features of the corresponding product, financial and costs for the purchase of appropriate licenses and personnel training. as well as the technical characteristics of the hardware components of the computer that meet the requirements of the installed application.

2. Cloud-based CAD systems

Recently, cloud-based CAD systems that work in a virtual computing environment, and not on a local computer, have begun to actively develop. These CAD systems are accessed either through a dedicated application or through a regular browser. The indisputable advantage of such systems is the ability to use them on weak computers, since all work takes place in the "cloud".

Cloud-based CAD systems are actively developing, and if several years ago they could be attributed to light CAD systems, now they have firmly established themselves in the category of medium CAD systems [4]. Consider a popular cloud-based CAD system.

EasyEDA is a free, no-install, cloud-based Electronic Computer Aided Design (EDA) system designed to give engineers, educators, engineering students, and radio amateurs a handy tool. It is an easy-to-use schematic editor, circuit simulator and PCB design system that can be run right in a browser [5].

The environment includes the following tools:
• editor of schematic diagrams;
• editor of PCB boards;
• SPICE simulator;
• editor of electronic components;
• generator of files of the GERBER format;
• program for viewing files of the GERBER format;
• project management system;
• ordering system for the manufacture of PCB boards;
• cloud storage of files.

The environment works on the basis of a client-server model. The client part of the application is completely executed in a browser that supports HTML5. Installation of any programs or plugins is not required. The application environment uses the SVG vector graphics engine available in modern browsers. The files are stored on the server. The system is not tied in any way to the user's files on the local computer and allows you to continue working at any time on any computer connected to the Internet.

The system is very stable, reliable and easy to learn. The user interface is very nice and responsive. EasyEDA has a rich library of thousands of electronic components (for both schematic diagrams and PCB boards and SPICE simulations), and tens of thousands of examples of various circuits. It is also possible to import existing designs from Altium, Eagle and KiCad and then edit them in EasyEDA. In addition, another outstanding feature of EasyEDA is that users have access to a huge library of Open Source modules developed by thousands of electronic engineers [5].

EasyEDA provides a wide range of possibilities, for example: scheme editor, PCB editor, PCB autorouting, 3D view of PCB, creation of files for production (Gerber) of PCB, possibility of modeling electrical schemes, export to BOM (custom -shaped specification) and much more.
3. Development experience in easyeda and assembly of layouts

Currently, any communication device, automation, navigation systems, audiovisual equipment, household devices, etc. require the presence of a microcontroller in their composition [6-10]. Because of this, teaching students microprocessor technology is one of the key factors in obtaining high-quality modern education in the field of electronics. In addition, there is a significant number of "old school" development engineers and simply radio amateurs who would like to independently master microcontroller technology and thereby improve their professional level.

To acquire practical skills of programming and debugging of microprocessor devices by students, it is necessary to use laboratory boards based on modern microprocessor devices [11-19]. In connection with the development and widespread use of microcontrollers in modern electronics, it is necessary to provide students with basic knowledge in this area. At the same time, it is necessary to start with the most easy-to-learn universal 8-bit controllers. The study of the currently widely used more complex controllers of 16- and 32-bit series, controllers with digital signal processing (the so-called DSP-controllers) is not always justified due to the relative complexity of their development.

Microchip microcontrollers were selected for the study. This choice is based, on the one hand, on the relative simplicity of the command system of microcontrollers of this company, which greatly facilitates initial training, and in addition, Microchip is well represented by Russian-language documentation for microcontrollers and development tools.

It was decided to develop 2 electronic training boards that will demonstrate the operation of the connected peripheral devices.

Training board №1 is assembled on the basis of the PIC16F887 microcontroller from Microchip with a minimum strapping in the form of the elements most widely used in such devices - a 2-line LCD display of the HD44780 type, buttons, LEDs, a serial port interface, a piezoelectric emitter, trimming resistors for work with ADC. A set of laboratory works in the C language for PIC-controllers was developed for this board. Training board №1 demonstrates the operation of the ADC, timers, I/O ports, interrupts, processing of button presses, operation with a temperature sensor using the 1-Wire protocol, indication on a 2-line LCD display, etc.

Training board №2 based on the same PIC16F887 microcontroller, more focused on studying the possibilities of controlling the actuators most widely used in automation:

- DC motor control - the possibility of reverse, PWM regulation;
- stepper motor control;
- connection of a powerful load using an electromagnetic relay.

The board also allows you to study the programming of information input from the keyboard, from the photo sensor, working out the operation of the interrupt button, connecting devices via the interface of the standard serial port and the I2C interface. The board includes:

- 3x4 keyboard
- 3 seven-segment indicators
- photosensor
- button at the external interrupt output INT
- serial port interface (MAX232)
- PCF8574 port expander microcircuit connected via I2C protocol.
- ULN2003A driver, which allows you to connect a stepper motor with a current up to 500mA and voltage up to 50V.
- the popular L293D driver for controlling low-power DC motors 4.5 V..36 V and current up to 600mA.

For the manufacture of Training board №1 and Training board №2, an electrical scheme was assembled in Easy EDA (Fig. 1), a PCB layouts was designed (Fig. 2), and an order was made at the manufacturing enterprise PCB layouts for their manufacture, took advantage of the integration of Easy EDA with the largest PCB prototyping enterprise in China, called JLCPCB (Fig. 3). As a result, the layout was assembled (Fig. 4).
The layouts were assembled using a soldering iron, which causes significant time delays. The process of assembling a large batch of devices can be improved by using a soldering stencil, a reflow oven \([20]\) and solder paste. The stencil is ordered separately at JLCPBC and costs about $6-8 (Fig. 5). Due to the use of a stencil and a solder reflow oven, a significant simplification of labor intensity occurs in the manufacture of a large batch [18-20].

Figure 1. Schemes of training boards.

Figure 2. Schemes of training boards.
4. Conclusions
Currently, any communication device, automation, navigation systems, audiovisual equipment, household devices, etc. require the presence of a microcontroller in their composition [6-8]. Because of this, teaching students microprocessor technology is one of the key factors in obtaining high-quality modern education in the field of electronics. In addition, there is a significant number of "old school" development engineers and simply radio amateurs who would like to independently master microcontroller technology and thereby improve their professional level.
A brief overview of the most widely used PCB design systems in Russia is carried out. The problem of choosing software that ensures effective design of PCB boards is identified, which is solved primarily by the technical capabilities and features of the corresponding product, financial costs for the purchase of appropriate licenses and personnel training, as well as technical characteristics of the hardware components of the computer that satisfy the requirements requirements presented by the installed application.

This problem can be solved using actively developing "cloud" CAD systems that work in a virtual computing environment, and not on a local computer, which is accessed either through a special application or through a regular browser. The indisputable advantage of such systems is the ability to use them on weak computers, since all work takes place in the "cloud".

As a result of a review of PC design systems, the popular EasyEDA cloud-based computer-aided design system was chosen for the design of the educational wall.

The experience of development in EasyEDA of a budget educational training boards based on a PIC microcontroller is shown, which can be used to study the basics of microprocessor technology both by students and those interested in mastering PIC16 microcontrollers from Microchip.

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