COMPUTER SIMULATION OF ELECTRONIC CIRCUITS BASED ON MICROCONTROLLER AVR

I. Matveenko, Ph.D.

Belarusian State University of Agricultural Technology, Minsk

Various computer-aided control of production and technological processes in agriculture based on the use of electronic and microprocessor technology, for example, in crop production - for the measurement of temperature and soil moisture; in the meat and poultry industry - for remote monitoring and control of temperature and humidity; the operation of the machine and tractor - to diagnose the technical condition of internal combustion engines, fuel injection control process in diesel cylinder and the moment of ignition of the combustible mixture in the cylinder gasoline engines; in the energy sector - to protect the current collectors from abnormal operating modes, control of electric lighting, electrical safety, etc.

Such automated control system typically includes electronic circuits using various types of microcontrollers. However, the real controllers debugging work is expensive task, as not enough just to write a program in a particular environment, you must use the programming "flash" processor, ie burn it developed a program to connect to the controller output actuators and only if clearly see the result of their work.

The purpose of research - to show the benefits and methods of creating, debugging and operation of virtual circuits by means of computer simulation.

Materials and methods of research. We use AVR microcontrollers company ATMEL, which represent a modern high-performance and cost-effective multi-purpose embedded controllers.

To carry out computer simulations were used integrated development environment AVR Studio 6 and the program Proteus v7.7.

AVR Studio 6 provides the ability to carry out development and debugging software for microcontrollers AVR, supports many programming and debugging.

Programs are written in assembly language (Assembler), also supported by the C programming language.

Proteus (by Labcenter Electronics) - simulation of fundamental electronic circuits, with which you can test the designed circuitry.

The results of research. The technique works with AVR Studio 6 and Proteus v7.7.

Creating a project in AVR Studio 6.

1. After you install and run the program after the launch window in the upper left corner click New Project.

2. Select your language programming AVR Assembler, click the tab at the top of AVR Assembler Project.

Line Name to specify the name of the project, using the Latin alphabet (eg, Primer1).

Line Location - path and file storage.

The project name is entered on line Solution name will be displayed in the menu at startup.

If there is difficulty in creating a project or open a previously created project, you can use the standard way: Panel Menu select File - New or Open - Project.

After clicking OK selection dialog microcontroller (Device Selection) (Figure 1).

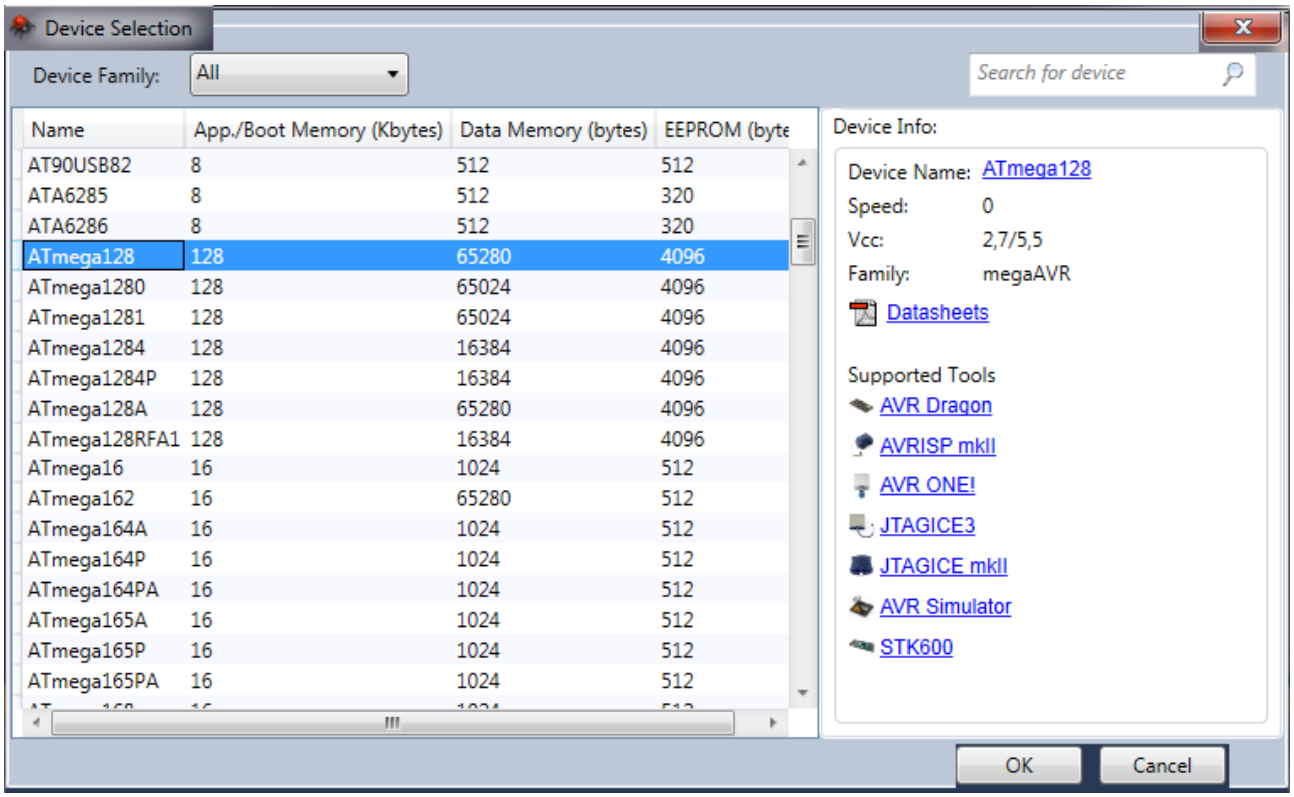

Fig.1. Type selection screen microcontroller

3. Select the type of microcontroller (eg, ATmega128), click OK, and then it asks me to write a program editor for Assembler (Figure 2).

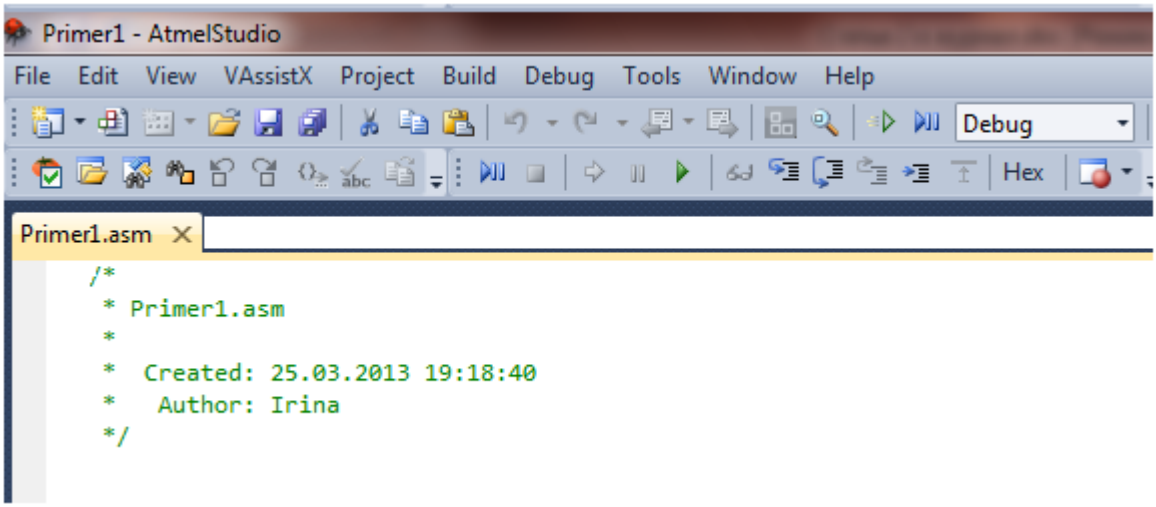

Fig.2. Page editor to write the program in Assembler

4. Write a program. To do this, you must first study the instruction sets and know Assembler statement of the problem, ie, that we want to get the output of the microcontroller. We need to microcontroller received information processed by a given algorithm and outstanding results in an understandable form for us. In the

simplest case, to see the output of the microcontroller to its output ports connected LEDs that should light up according to the algorithm.

Text example program is shown below. In this program through the ports B and D controller ATmega128 installed a set of predetermined signals (11001100), ie, made to include the relevant diodes.

```
/*
 * Primer1.asm
 *
 *  Created: 25.03.2013 19:18:40
 *   Author: Irina
 */
 .def temp=r16; директива
 ;=====================================================
; Начало программы
.cseg; директива
.org 0; начало первой строки программы
rjmp Start; относительный переход к метке Start
; =====================================================
Start:
ser temp; устанавливает все биты регистра temp  в 1
out DDRB,temp; переводит все биты
out DDRD,temp; порта B  и D на вывод
clr temp; обнуляет регистр temp (устанавливает все биты регистра temp в
0)
out PortB,temp; отключает подтягивающие резисторы
out PortD,temp; портов B и D
Cicle:
ldi temp,0b11001100; включает светодиоды
out PortB, temp; порта B
rjmp Cicle; Возвращаемся к метке Cicle, зацикливаемся
```

5. To compile the program by using the Debug - Start Without Debugging (Figure 3). The essence of the compiler is to translate written symbols that are understandable for a person to machine code (a code of zeros and ones) and create a new file with the hex.

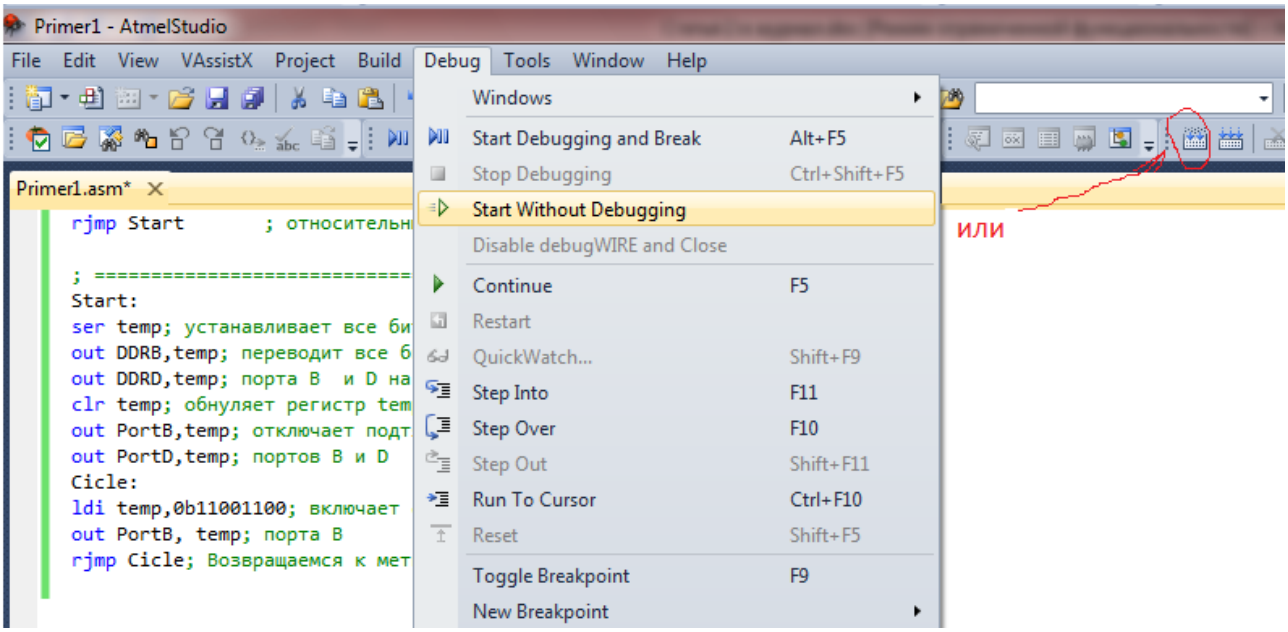

Figure 3. Conducting program is compiled

In the Output window displays information about the compilation carried out at the end should be the inscription Build succeeded, which confirms the successful assembly .hex file.

All files can be viewed, where it was stated in a row Location. In the folder Debug, which is located in the folder specified in the string Location, will be compile the .hex file, which is necessary for real microcontroller or firmware to simulate the operation of the microcontroller in the program Proteus v7.7.

In Proteus along with the editor of electronic circuits (ISIS) enabled editing of printed circuit boards (ARES), ie if necessary, may be diluted PCB in accordance with the developed electronic circuitry and create a real device.

Creating a project in Proteus v7.7.

1. Open the preset program Proteus v7.7.

2. Collect virtual electronic circuit, which in this project include:

 microcontroller ATmega128, the program for which you have created in the AVR Studio 6;

 eight LEDs, with which you can see the output of the microcontroller;

 eight current limiting resistors;

 eight buttons, with the help of which can be controlled manually with the LEDs.

3. Select a virtual electronic circuit elements.

This can be done in two ways.

The first method: press the button on the toolbar to the left, then to the P button to the left of DEVICES. A window opens in which you select the item to us. For example, Microprocessor ICs

 AVR Family

 ATMEGA128, and can napist the desired name in the search bar above.

The second way to select items - through the panel Menu   Library Select the device / symbol.

After pressing Enter, the selected items will appear in the list in the left pane DEVICES (Figure 4).

Similarly selects other circuit elements: the resistor (RES), LED (LED-GREEN) button (BUTTON). LEDs can be selected for various light - green (green), as in our case, red (red) or yellow (yellow).

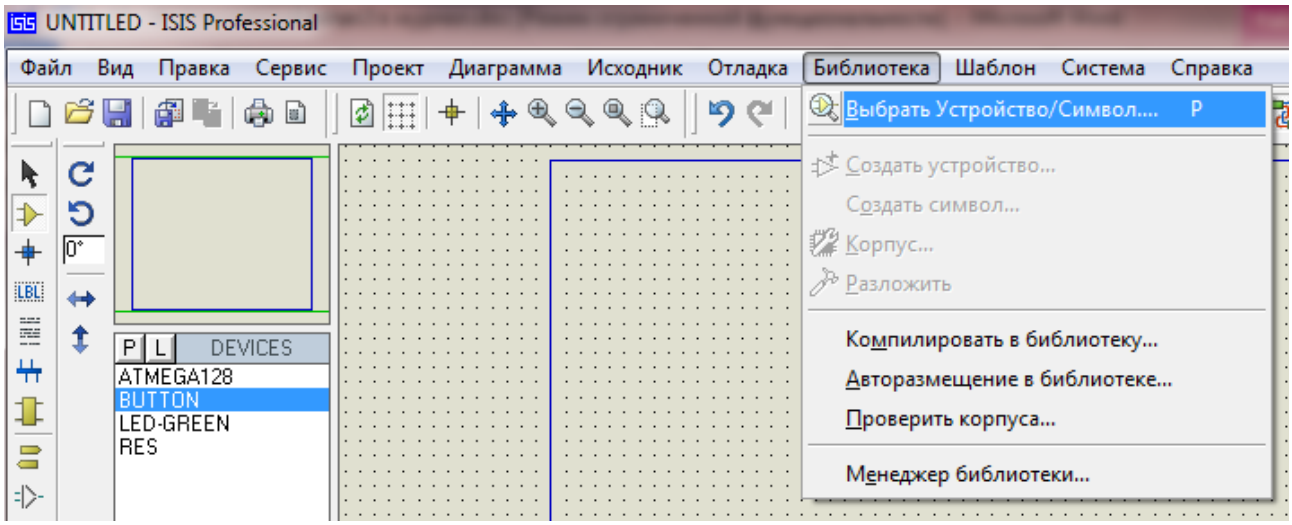

Figure 4. Combine the elements of the scheme.

From the list, select DEVICES microcontroller and put it into the workspace. Then add in the same way 8 LEDs and resistors 8 and 8 buttons. The resistors have a resistance of 10 ohms by default, and we need to 300 ohms. To change the resistance of the resistor schëlknem by double-clicking in the window that opens, find the field «Resistance» and make the number 300 there.

Circuit elements on the mounting box is placed in such a way that on the one hand, to minimize the connection between the elements, and the other - to eliminate

their intersection, ie, in our case, the input buttons are connected to port D of the microcontroller, and the LEDs with current limiting resistor to port B. Compound elements by using the buttons on the left panel.

The cathodes of LEDs need to connect to the ground. To get the output of "Earth" have to click and select from the list «GROUND». The result is a finished project layout.

5. Check the assembled circuit.

In the scheme click on the image controller and enter the path where the .hex file (Figure 5), click OK.

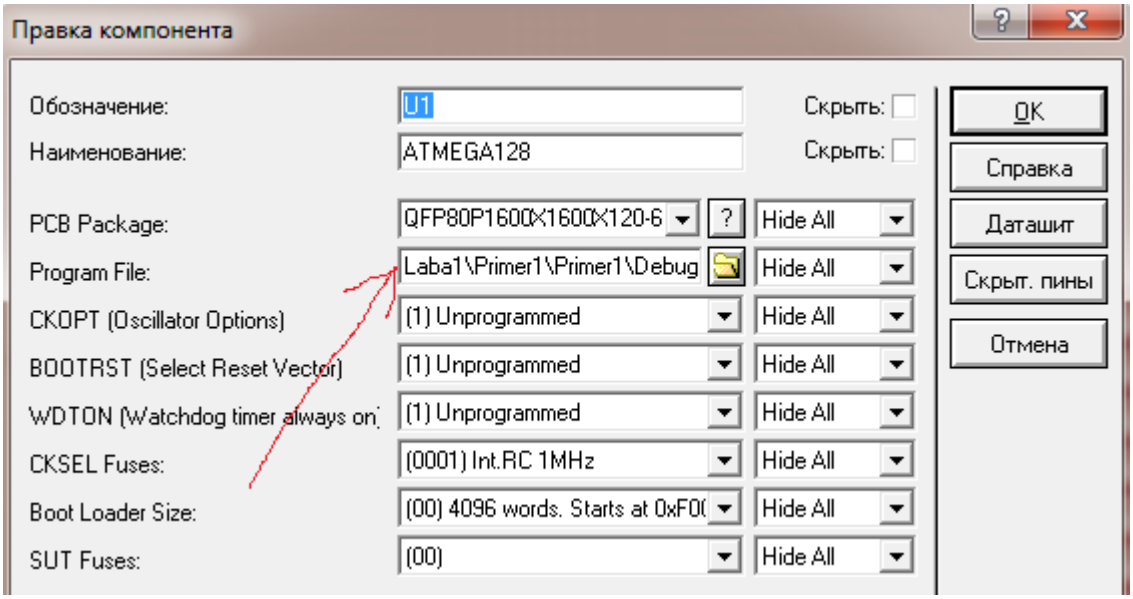

Figure 5. Choosing the path to .hex file microcontroller

Then run the emulation program by clicking on the Start button, and observe operation of the circuit in accordance with the written program for the microcontroller (Figure 6).

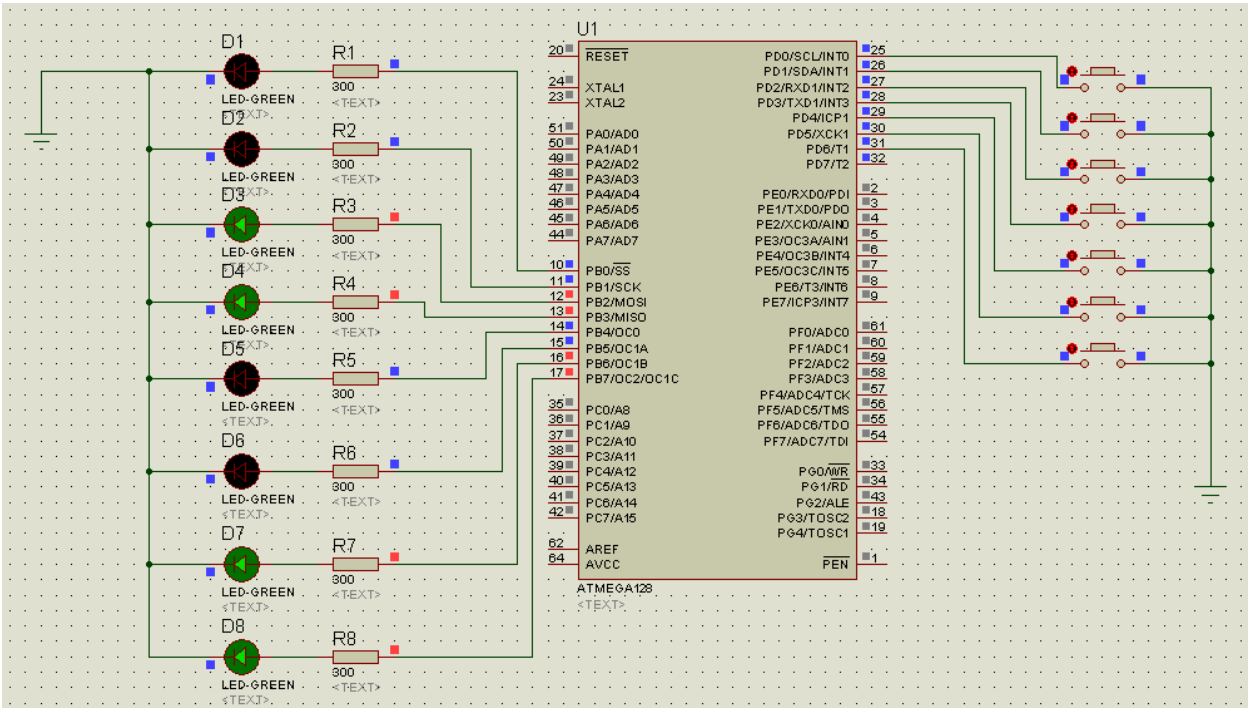

Figure 6. Working prototype project

Conclusions

Thus, by using an integrated development environment AVR Studio 6 and the program Proteus v7.7, it is possible to quite easily, with minimal and time-consuming, electronic circuit design, including any microcontroller AVR, hold her debugging and board layout. And then create a real device.