

# Program service for monitoring system of solar drying system

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**Abstract:** *The program service for monitoring systems is important part of technical and software equipment for scientific researches. In this paper it is presented one possibility for using visual programming environment DELPHI for realization service of monitoring system for testing. The real experimental device, which the developed program service supports, is a solar drying-room. The base output information through microcontrollers, sent from this device is values of the 12 thermo sensors and 3 humidity transmitters. The interface for data receiving is COM port of the computer. The program application stores data in files and shows selected and transformed data in table and graphic mode. It supports time diagrams, on/off switchers of data flows and some other settings. After receiving the data are archived in database format. The program supports possibilities of making the reports for different periods and sensors and output in text file and Excel format.*

**Keywords:** *Program service, microcontrollers, transmitting protocol, Delphi components*

## 1. Introduction

The uses of computers in scientific researches to this time have two main directions. First of them is the realization of numerical procedures for mathematical simulation models, processing of experimental data etc. The second one is the using computers for registration and storing of the experimental results. Actually, these two directions have common background. This is the programming process, i.e. program support (service).

This paper discusses how can be built a software package with visual programming environment DELPHI to allow a PC communicates with a nonstandard device. This has been organized with electronic elements on the base of an AVR microprocessor AT90S8535 and using the PC serial port to import needed data. The experimental unit is a solar dryer-room (fig.1) for drying agriculture products. Monitoring system includes humidity and temperature measurement devices, data transferring system, computer registration data base and program processing unit.

## 2. The basic device

The basic device for registration of the temperature and humidity in experimental system was built in South-West University - Blagoevgrad. Atmel's AVR microcontrollers, used in data registration system have a RISC core running single cycle instructions and a well-defined I/O structure that limits the need for external components. Internal oscillators, timers, UART, SPI, pull-up resistors, pulse width modulation, 10 bit ADC, analog comparator and watch dog timers are some of the features in AVR devices. AVR instructions are tuned to decrease the size of the program whether the code is written in C or Assembly. With on-chip in-system programmable Flash and EEPROM, the AVR is a reasonable choice to optimize for cost and get products to the market quickly.

The microprocessor presented in this paper is an AT90S8535, which has 8 KB of flash memory for program storage and 512 B of RAM. All 8 A/D channels are used for the thermocouple amplifier output, LM335Z temperature sensor and for 808H5V6 humidity

sensors. For increasing the number of channels up to 15 it is used an external 8 channel multiplexer. LM335Z is precise, easily-calibrated, integrated circuit temperature sensor. 808H5V6 module humidity transmitter is designed on the base of capacitive humidity sensor. This product utilizes craftwork of SIP and owns extremely small body. That makes it easy to use as component in kinds of humidity measuring and controlling products.



Fig.1. Solar drying-room

Figure 2 shows the controller scheme. Microcontroller and supported elements are mounted on a special plate (fig. 3).

The software for programming of the AT90S8535 was written with the C compiler. Approximately half of the 8 KB of flash memory has been used for driver program. The AT90S8535's flash memory is in-circuit programmed through an Atmel standard ISP header. The software continuously reads the thermocouple temperatures and humidity sensors and sends it to the port of computer.

### 3. The Program service

The temperature and humidity values are registered and sent to the RS-232 port once per second. Special terminal capture program is used for data transferring. The output signal from basic plate is a digital signal proportional to the temperature and humidity. The protocol signal for transmitting from microcontroller to the serial port is RTS=0. RS232 send the number of channel (from 0 to 14) to the microprocessor AT90S8535. After that, AT90S8535 send to RS232 current value of this channel, corresponding with one of the sensors. When the data are received, RS232 sends the different value from 0 (such as 255). Protocol signals RTS=1 and RTS=0 are sent consequently for each of the sensors. The source code serves the communication protocol in application for PC is:

```

for i:=Index to 15 do
begin
ComPort1.SetRTS; //RTS=0
ComPort1.WriteByte(Channel);
a:=ComPort1.ReadWord;
a:=((4*a/1024)*100)-273.15;
ComPort1.WriteByte(255);
ComPort1.ClearRTS; //RTS=1
ComPort1.SetRTS; //RTS=0
end;

```

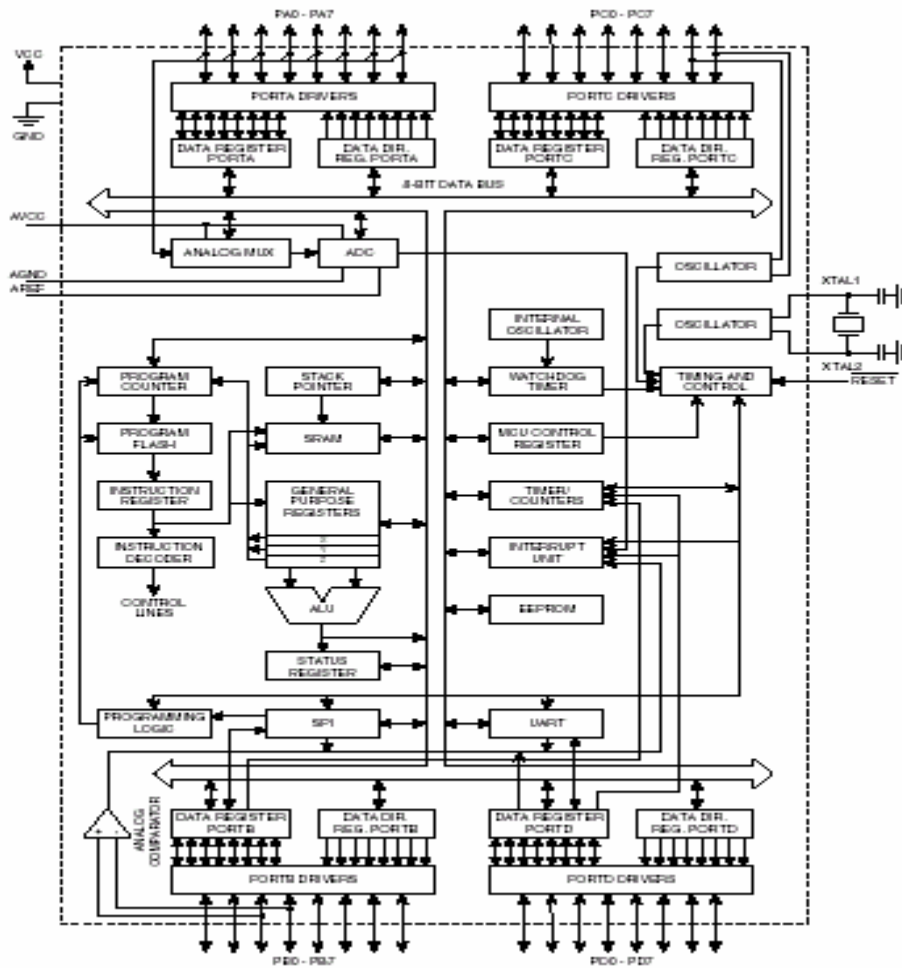


Fig.2. The AT90S8535 block diagram

For realization of the transfer protocol it is used a DELPHI component ComPort. It is external component for visual programming environment DELPHI that means it was installed in addition. This component supports all needed properties for communication with AT90S8535. In source code the name of this component is ComPort1.

The digital signal received on RS232 is directly formed from ADC of microcontroller. After receiving this signal, it must be decoded for receiving voltage value in sensors, which is proportional to the real physical parameter (temperature or humidity). For this purpose there is software processing. First, receiving value is multiplied with value of  $V_{CC}$  (basic voltage in ADC; it is 4V) and after that it must be divided by  $2^{10}$  or 1024 corresponding with the 10 bit ADC:

$$RD = \frac{4 * ADC}{1024}$$

where RD is a real value of received physical parameter.

The temperature conversion is simple: received voltage is corresponding with the value of thermo sensor in Kelvin, so 2,93 V corresponds to 293K. For humidity-received voltage there is a linear dependence between voltage and humidity. Voltage in channel with humidity sensor is in range of 0 to 3V, so 3V corresponds to 100% humidity.

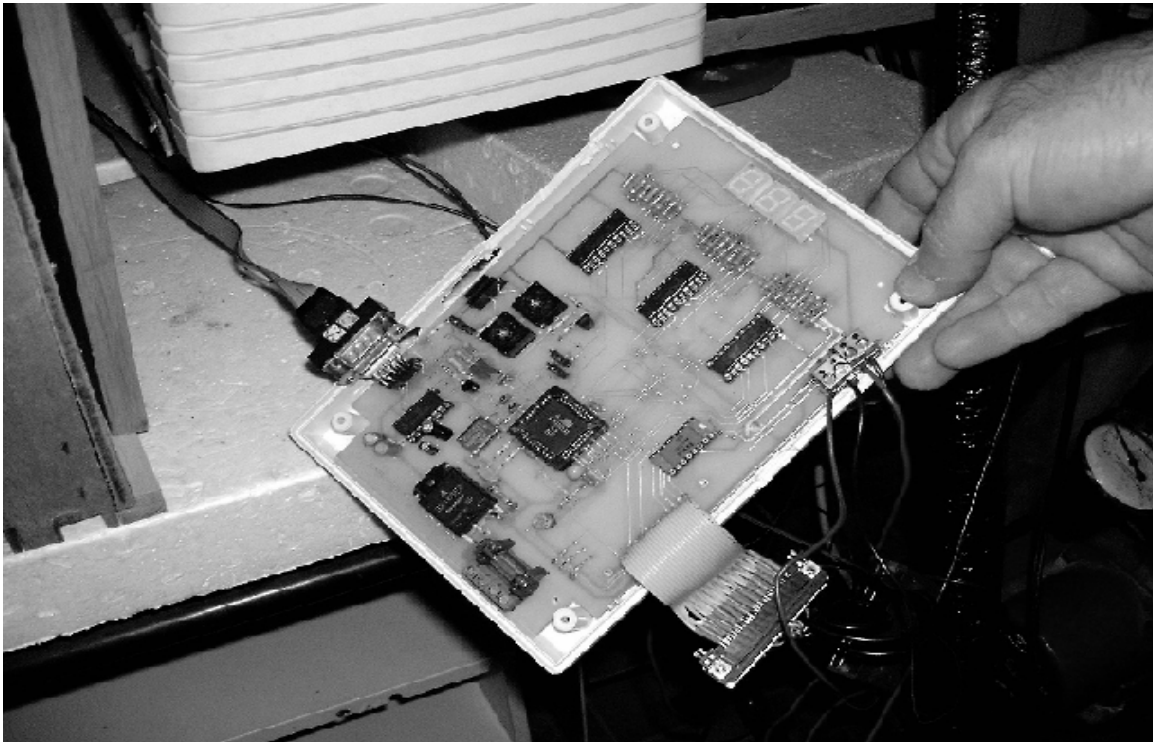


Fig.3. Plate with microcontroller

#### 4. Program structure

When the program is started on the monitor is displayed the screen shown in figure 4. This is the main window of application. The information received on the serial port of computer is shown on the top right part of the screen in table form. This table includes 4 columns (Number of sensor, Value of measurement quantity, Time, Color). The number of rows is corresponding with the number of sensors (15).

The diagram on the screen shows received data in graphic mode as for every one of the sensors was drawn up own line with different color, corresponding with received data. It has possibility to change the color of everyone of the line or hide some of the sensor. In

panel "Control" situated in the bottom part of the screen, the user can start reading ("Start"), stop reading ("Stop"), make print preview of diagram ("Print Preview") or close program ("Close"). In the top of the main form of the application is drag-drop menu. It has four segments "Settings", "Diagram", "Help", "Close".

First item "Settings" includes 2 submenus "Time settings" and "Diagram settings".

- "Time settings" – this item activate a window, where a time parameters can be regulated for refresh of data (at what interval read information on RS232), for save data in database (at what interval system makes record in database) and clear diagram (at what interval the canvas of the diagram be cleared).

When button "OK" is pressed, the time settings are saved in file (configuration file .ini), so that when user goes out of the application and then starts again the settings are ready for use. The application makes this file automatically and carries out for its existence. In case of deleting or damaging them, application recovered them with default values.

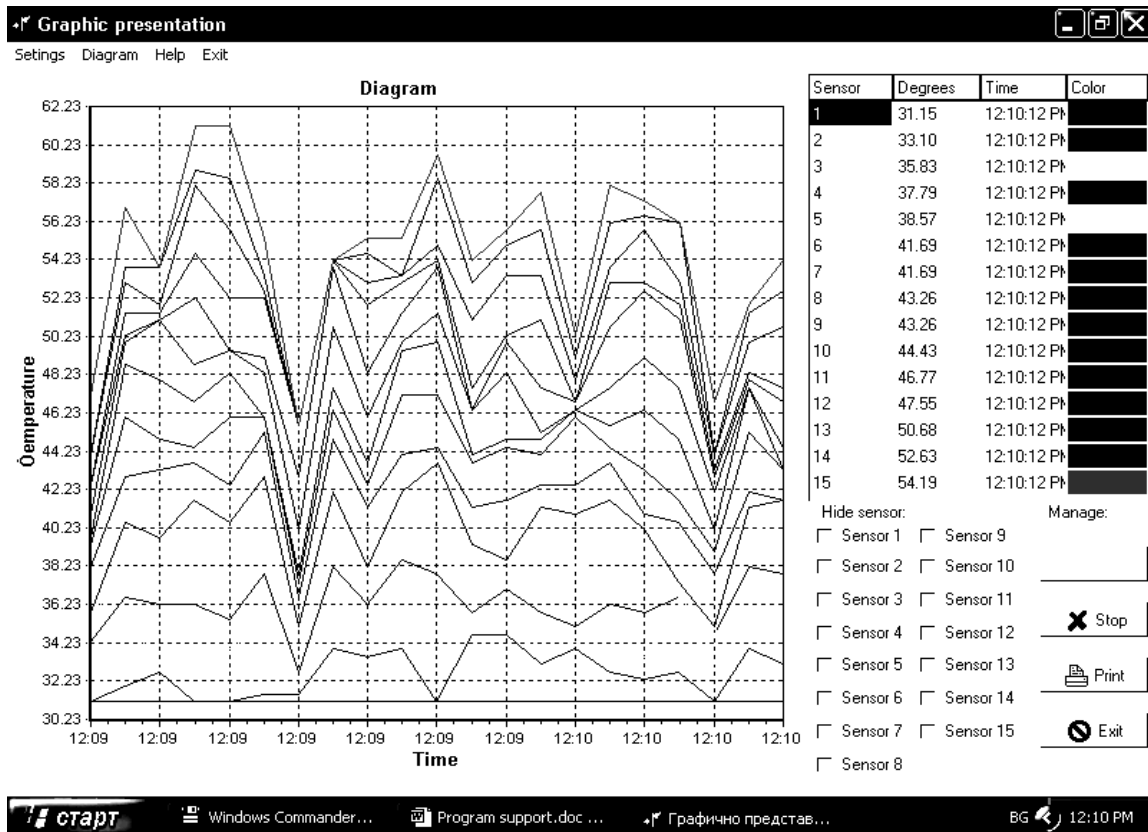


Fig.4. Start screen of application

- "Diagram settings" – this item starts a window with tree pages. There are possibilities for regulating the graphic mode of the diagrams. In first page can be defined colors of lines in diagram for different sensors. Second page regulates scale for data presentation and third page defines the diagram mode – 2D or 3D graphic.

Second item in main menu "Diagram" shows another form. In it is presented current diagram of every one of the sensors (fig.5). Double click at one of the diagram shows print preview of them.

All received experimental data are saved in database form Paradox 7. The package includes another application for reports ensure the possibilities taking from database experimental results, for different periods and for different sensors. The data can be exported in text file or in Excel file.

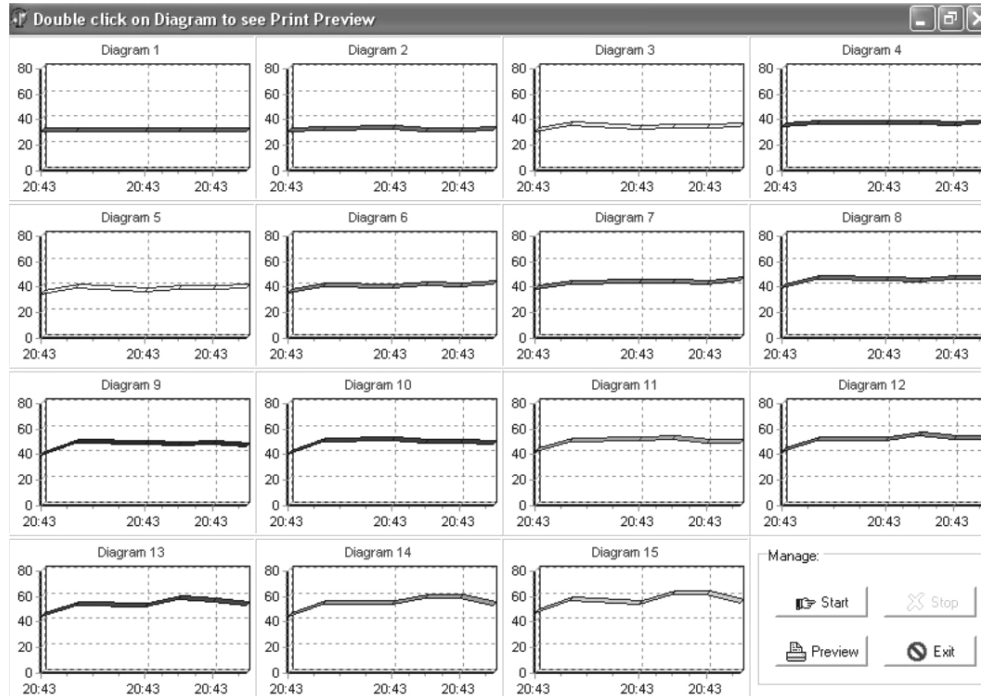


Fig.5. All sensors

#### 4. Conclusions

Monitoring system with AVR microcontroller for registration the physical parameters (temperature and humidity) in special experimental unit was built. The system has been tested and a good reliability and functionality has been registered. This work shows that with on-chip in-system programmable Flash and EEPROM, the AVR is a reasonable choice to optimize for cost and get products to the market quickly.

Software package created with visual programming environment DELPHI allows a PC communicates with a nonstandard device. For realization of the transfer protocol it is used a DELPHI component ComPort. This component supports all needed properties for communication with AT90S8535.

#### References

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