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DEVELOPMENT OF LABORATORY BENCH – THERMOMETER WITH AUTOMATIC TEMPERATURE CONTROL

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Nowadays measurement, control and regulation of temperature are a very important problem. To solve it various sensors and digital temperature controllers with microprocessor technology are used.

The function of the thermometer is to maintain temperature in a specified range of values. The range of temperatures indicated when the operator builds a microprocessor program and the data on the current temperature are shown on the display.

In the process of designing microcontroller ATMEGA8 and digital sensor DALLAS 18B20 were chosen.

Characteristics of the microcontroller:

1) RISC (restricted (reduced) instruction set computer) architecture – the performance is increased by simplifying the instructions for the microprocessor.
2) Energy independent memory of programs and data – 8 kilobytes of Flash memory, 512 byes of EEPROM (Electrically Erasable Programmable Read-Only Memory) memory, 1 kilobyte of built-in SRAM (Static Random Access Memory) memory.
3) Built-in peripherals – 4 timers/counters, 3 PWM channels, 2 analog to digital (ADC) converters.
4) Operating voltage: 4.5-5.5 V
5) Operating frequency: 0 - 16 MHz

Characteristics of the temperature sensor:

1) Measurement range: - 10…+ 85 ^{o}C
2) Accuracy : ± 0.5 %
3) Operating voltage: 3.0-5.5 V
4) Conversion time: 750 nS

The advantages of chosen equipment are as follows:

- wide range of measuring temperatures;
- no need to install additional ADC;
- 8 sensors can be installed to 1 microcontroller;
- availability of energy-saving mode.

The principal scheme of the thermometer presented is shown in the Fig.1. The scheme was developed and simulated in the MicroCup software.

The program for the microcontroller was produced in AVR Studio software.

When starting, the system configures the peripheral of the microcontroller and reads the data from EEPROM. If any incorrect data appear in EEPROM, the default parameters and values are being chosen. After reading the EEPROM, the system is set into tracking for the temperature mode, and waits for events, associated with the excess of limits for the temperature. At this stage, the current temperature and the system status are shown on the display.

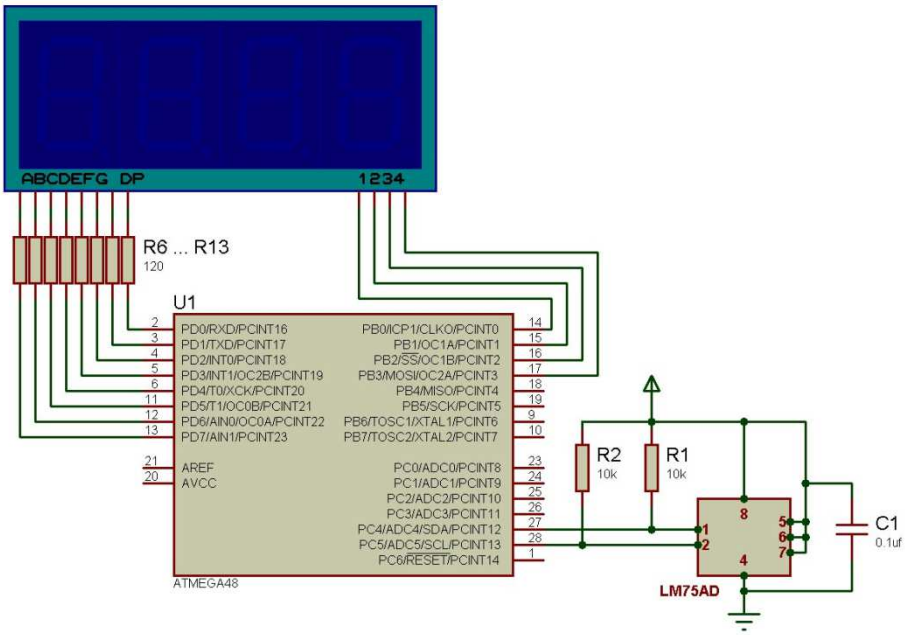

Fig1. – The principal scheme of the thermometer.

There are two phases of configuring parameters by a user:

- setting the higher temperature value and
- setting the lower temperature value.

To work with the thermometer, the user can operate with 9 commands:

1) Read temp (AAh): reading the register values, which contain the results of the last measurement.
2) Start conversion T (EEh): starting the process of the temperature measuring. No data are transmitted.
3) Stop convert T (22h): stopping the process of measuring. No data are transmitted.
4) Write TH (01h): recording of a higher limit of the temperature – 9 data bits.
5) Write TL (01h): recording of a lower limit of the temperature – 9 data bits.
6) Read TH (A1h): reading the higher limit of the temperature – 9 data bits.
7) Read TL (A2h): reading the lower limit of the temperature – 9 data bits.
8) Write configuration (0Ch): recording the configuration data in the register of the configuration – 8 data bits.
9) Read configuration (ACh): reading the configuration data in the register of the configuration – 8 data bits.

The scheme of the program operation is shown in the Fig2. The program is waiting for the response from the sensor. If the response is detected, the data from the sensor are getting up. The data are being converted by the microcontroller. In case of any necessity, the control signal for the heating element is generated.

To reduce the number of signals to operate the heating element, the hysteresis is made on the program for the microcontroller. The signal for switching on the heating elements is generated not for any specific temperature, but for the range of temperatures.

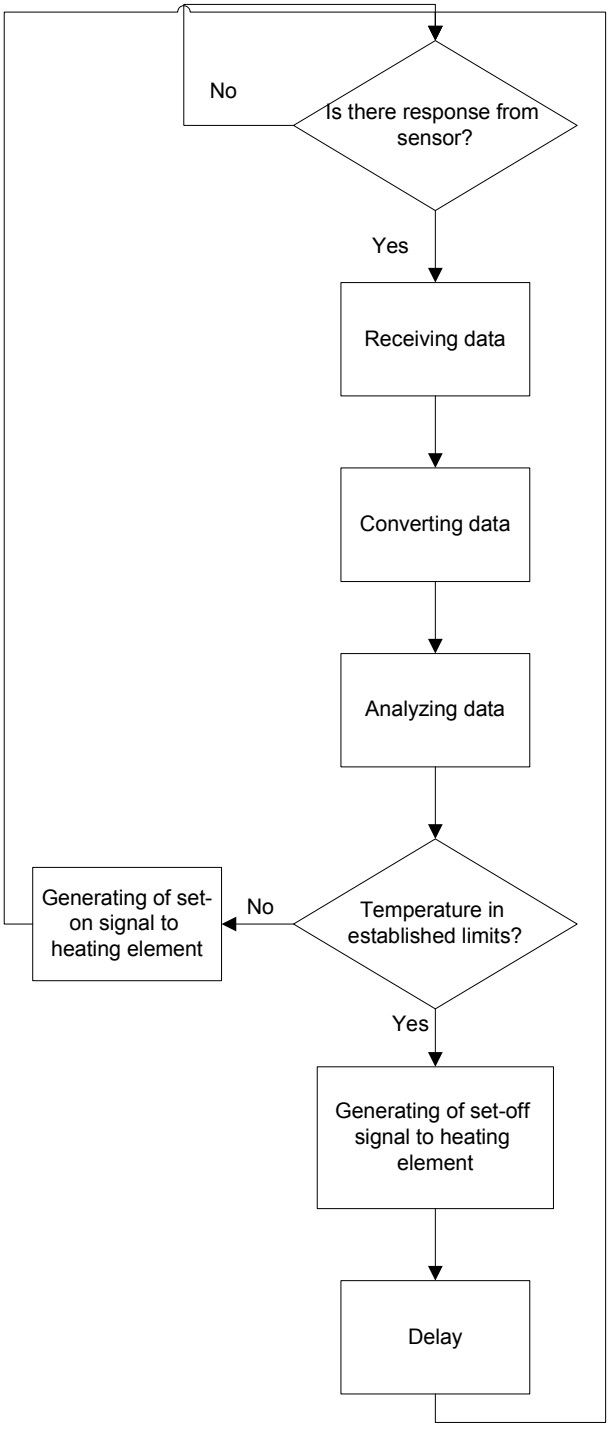

Fig2.– The principle of the program operation.

The thermometer developed is used as a laboratory bench for the students studying such disciplines as Metrology and Information Devices and Systems in Robotics.