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Software and hardware monitoring subsystem outdoor temperature and humidity of air at energy-efficient climate control in greenhouses

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The expediency of development of software and hardware subsystem monitoring process parameters in the greenhouse : temperature and humidity. The technological requirements of means of this subsystem . Designed schematic diagrams and printed circuit boards , by perceiving calibration elements. Synthesized algorithmically software controls the equipment. Investigated , using oscillograms , the quality of engineering of automation . A check of the production subsystem monitor external temperature and humidity.

Control system , a subsystem monitoring, humidity , temperature, perceiving elements reliability.

As a result of researches diagram of the control process of growing plants in a greenhouse [1-3]. It unit neural network modeling and prediction of time series (BNMPCHR) (Fig. 1) is based on neural networks such as multilayer perceptron temperature time series and for the time series of solar radiation.

Using block optimization using genetic algorithm optimization neural network occurs .

Estimated value of the perturbation is transmitted to the power of decision-making (BDP) in the database which is stored the possible choices for the control and quality

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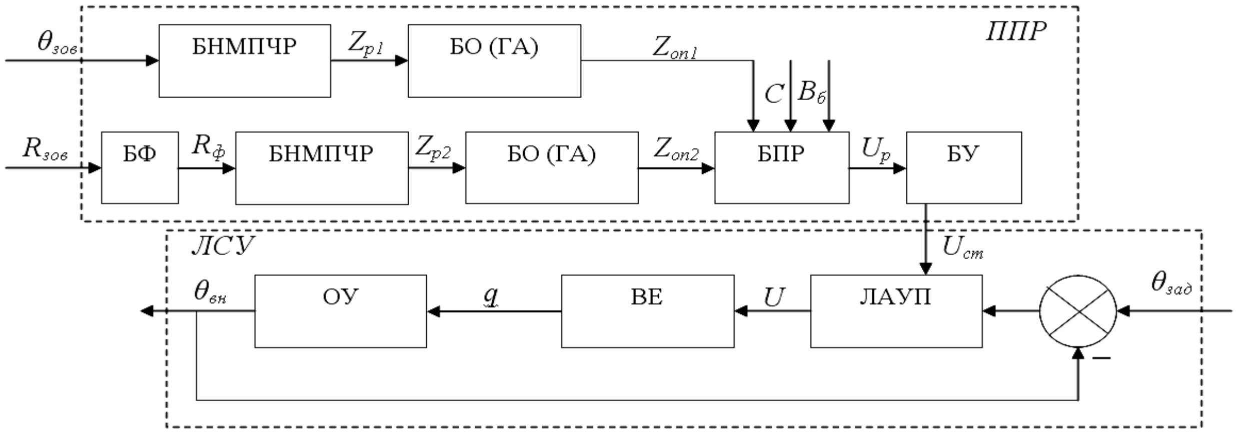
in physical units. In the BDP entered data value component of return C, and then based parameters (K) for every action in performance of production, material and energy costs on the optimization criterion made the choice of the optimal management strategy (Ur). With control unit (BU) is made change the specified action to Uzad , taking into account local automatic humidity control unit (LAUP).



Rice . 1. Block diagram of the control system of the process of growing in a greenhouse : PPR - subsystem decision making CF - block filtering intensity of solar radiation ; BNMPCHR - block neural network modeling and time series prediction , because (GA) - power optimization based on genetic algorithm; BDP - block decisions , SU - power management, LSU - local management system , LAUP - local automatic control device , DE - actuators ; SO - facility management

Additional filtering the blocks for the time series of solar radiation intensity , and power optimization settings neural networks using genetic algorithm.

Obviously, for the effective functioning of the system (see Figure 1.) Prerequisite is the availability of adequate and reliable software and hardware subsystems collection, transformation and transmission of technical data from the object to intelligent control units .

The purpose of research - research and development of software and hardware monitoring subsystem external temperature and humidity.

Materials and methods research. Technological requirements for monitoring subsystem requiring measurement : temperature to within 1 ° C, relative humidity to within 2%. Measurements should be carried out in a greenhouse in the area of the plant at

1 , 2 and 3 m, and outside the greenhouse. Assumed data measurements every 5 minutes to transfer to upper-level computer for storing information in a database and transfer over the Internet.

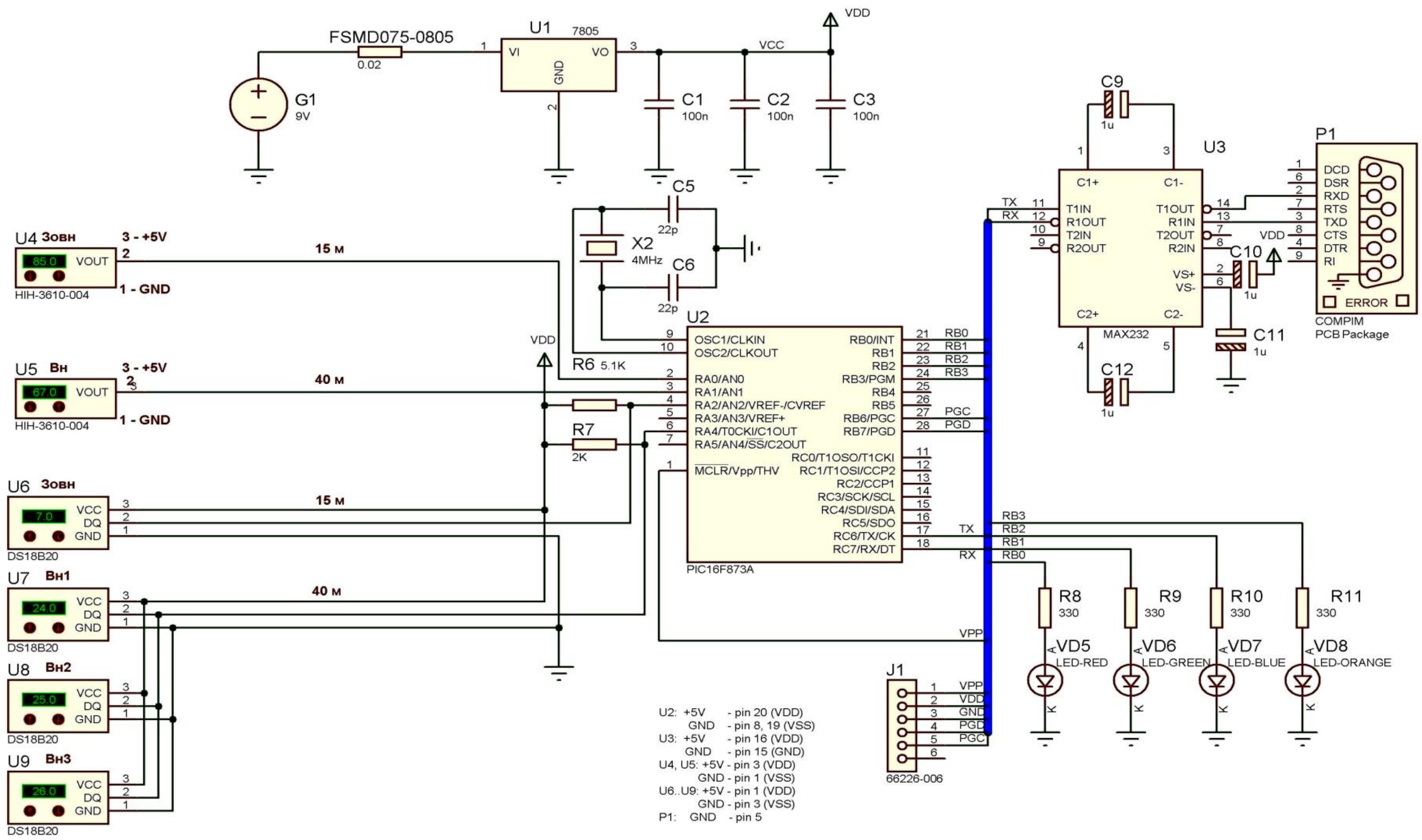
Subsystem monitoring temperature and humidity consists of four digital temperature sensor DS18B20, two relative humidity sensor HIH- 3610 -004 , chip microcontroller PIC16F873A, due to the COM- port MAX232, voltage 5 V 7805 quartz crystal with a frequency of 4 MHz to set the clock frequency of the microcontroller , four LEDs signaling, power supply 9 V , 0.5 A fuse , electrical resistances and condensers.

Results. Electrical schematic diagram (Fig. 2) is powered by a stabilized source G1napruhoyu 9 electronically protected against short circuits. Chip U1 7805 3 stabilizes the output voltage of 5 V, from which the feed circuits and sensors. U4 and U5 sensors respectively external and internal relative humidity make this an option in the electrical voltage that is fed to the inputs of the module analog-to- digital conversion (ADC) of the microcontroller U2. Signals are digital sensors external (U6) and internal (U7. .. U9) temperature single- interface MicroLAN transmitted to the inputs and RA2 RA4 port A of the microcontroller U2. Communication between the microcontroller and the computer top-level is performed every 5 min using chip U3 via COM port (connector P1).

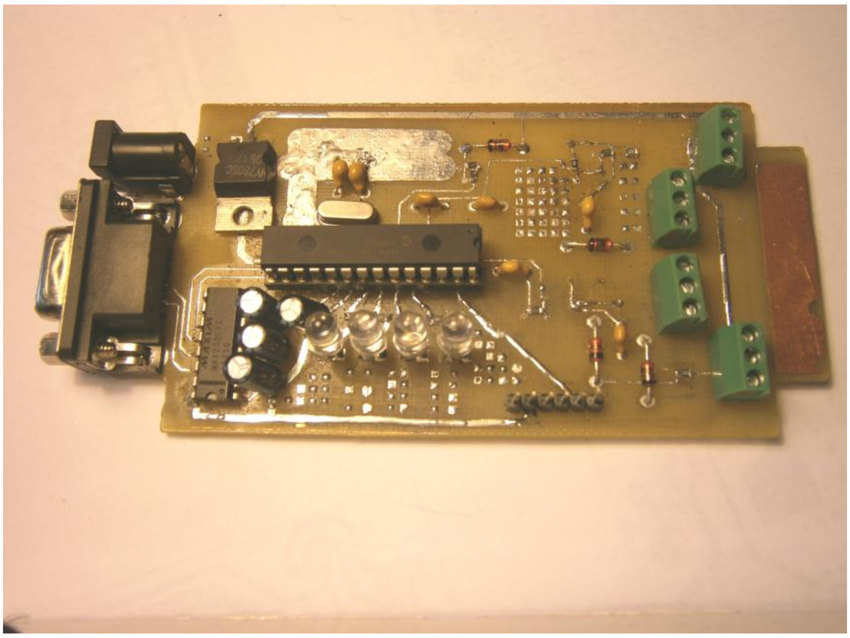
Crystal X2 with capacitors C5, C6 provides a stable clock speed Fhen = 4 MHz oscillator microcontroller. LED VD5 ... VD8 with limiting resistor R8 ... R11 are designed to indicate the initial launch of the microcontroller and possible errors in the process subsystem.

Pidtyahuvalni resistors R6, R7 provide a high voltage level when no transmission and reception " zero" of the line interface MicroLAN. Capacitors C1 ... C3 are mounted next to the chips to reduce interference. Due to connector J1 is made in-circuit programming of the program memory of the microcontroller U2.

Printed circuit board microprocessor monitoring subsystem developed among Sprint Layout (Fig. 3).



Rice. 2. Electrical schematic diagram of the subsystem monitor temperature and humidity in the greenhouse



Rice . 3. PCB microprocessor subsystem monitoring

According to the technical description of the humidity sensors [4] of the voltage dependence of the relative humidity is linear. Converting voltage to the ADC code is also linear. To calibrate each sensor is defined by two point static characteristics of sensors.

The first point is obtained in the laboratory environment , using a model of aspiration psychrometer MV- 4M. The second point is received in environment over a saturated solution of NaCl, where according to the standard ISO 483-88 humidity is 75 % (Table).

From these data , the following calibration dependence:

Humidity sensor number 421 : $\varphi = 0{,}606 \cdot C - 32.67$,

Humidity sensor number 420 : $\varphi = 0{,}606 \cdot C - 39{,}34$,

where φ - humidity , %

C - Code of ADC.

Calibration data relative humidity sensor HIH 3610-004

Sensor relative humidity of outside air № 421		Sensor relative humidity of outside air № 420	
Relative humidity,%	ADC code	Relative humidity,%	ADC code
34,6	111	34,6	122
75,0	178	75,0	189

–

DS18B20 digital temperature sensors calibrated in their manufacture [5]. Conversion result is transferred to the microcontroller in Celsius allowing resolution of 0,0625 ° C. These software are rounded to integers.

The algorithm of the monitoring subsystem consists of two main parts:

- Main program ;
- Interrupt subroutine .

The main program includes the following components .

1. Initialization of external ports , ADC module , timer TMR2, USART serial exchange with the computer interface RS232. Initial setup registers and flags attributes.
2. If the sign of the measurement Fm = 1, go to step 4 , otherwise - Section 3 .
3. If the sign Ftx = 1 transfer to your computer, go to step 5 , otherwise - to point 2.
4. Measurement of relative humidity from two sensors HIH- 3610-004 and temperature of four sensors DS18B20. Fm = 0. Go to item 2.
5. Calculation of mean values of measured parameters for 5 min, unpacking and record them as ASCII codes, checksum calculation , transfer array ASCII codes for the RS232 interface to a PC for storage database. Ftx = 0.

Algorithm interrupt subroutine contains the following blocks.

1. Save context.
2. If you sign TMR2IF = 1, go to step 4 , otherwise - to step 3.
3. If you have accumulated 19 s , install a sign Fm = 1, start vidrahunok first time and go to step 4 , otherwise - go to step 4.
4. If deducted 5 min , Ftx = 1, start vidrahunok first time and go to step 5 , otherwise - go to step 5.
5. Restore context and return from the interrupt subroutine .

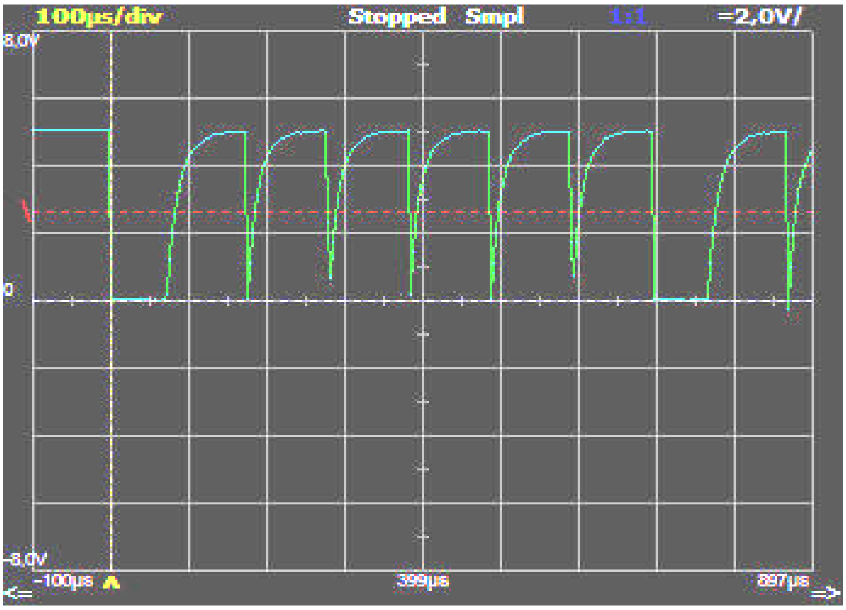
The software was created and established in the environment MPLAB 8.92 using programmer - debugger PICKIT 2. Example forms of signals of sensors DS18B20 shown in Fig. 5.

The program fan control regulates the function of recirculation fans depending on:

time of inclusion and exclusion;

screen position ;

outside temperature.



Rice. 4. Oscillogram fragment signal of temperature sensor

Vidovidnu system was installed and tested on the basis of JSC "Combine" Greenhouse "(Fig. 6). During the operation she showed technologically sound performance and reliability.

Rice . 5. Photofacts implementation monitoring subsystem in the production of JSC "Combine " Greenhouse "

Conclusions

Reasonable designed and tested production software and hardware monitoring subsystem outdoor temperature and humidity of energy-efficient climate control in greenhouses appropriate, in terms of reliability and functional parameters apply to industrial facilities .

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