GONIOMETER CONTROL

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The control unit for the goniometer has been developed and manufactured. The unit includes four independent programmable stepper motor control channels, three logical channels for analyzing the state of limit switches and a power supply. Powerful field-effect transistors of the company International Rectifier are used as controlled power switches. To generate output signals and communicate with a computer, an ATmega328 microprocessor is used in each control channel. This channel design allows you to control almost any type of stepper motors, you only need to replace the control program. The software is written using the WinAVR package which has a General Public License. Data transfer between the computer and the unit is carried out via the USB interface.
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1. GONIOMETER CONTROL UNIT

Goniometer control unit designed to generate control signals for four stepper motors: SD-4E-У – 2 pcs. and MSR – 2 pcs., movement in azimuth, elevation, up and down movement, rotation around the X axis and processing of logical signals from limit switches. GCU consists of four independent channels, each of which can be configured by software to control a specific type of motor. This construction of the control unit provides its versatility and allows you to control almost any type stepper motors.

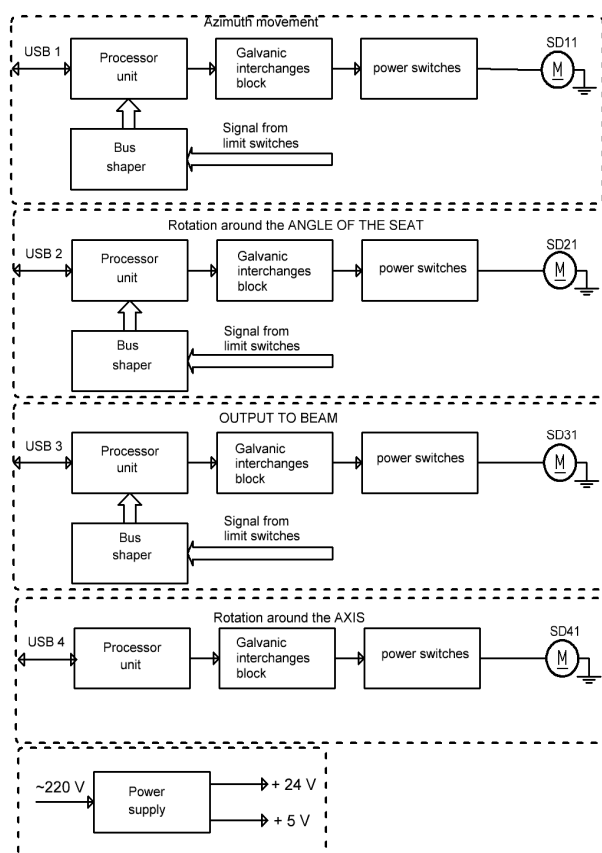The block diagram of the control unit is shown in Fig. 1.

Fig. 1. Block diagram of the control unit

The power switch modules are connected to the processor unit through galvanic isolation. This construction of the control channel increases the reliability of the control unit as a whole, since damage to the power switches will not damage the processor unit.

Input circuits of position sensors are connected via bus drivers to increase noise immunity.

The processor unit is made on the basis of a chip Atmel ATmega328 and converter USB – UART CH340G. Such a construction ensures that the required block speed is obtained at moderate financial costs. The block diagram of the processor unit is shown in Fig. 2.
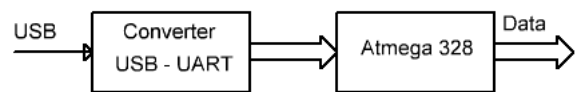

Fig. 2. Block diagram of the processor unit

The initial firmware of the software is done through Serial Peripheral Interface (SPI), further reprogramming is possible both via SPI and via USB interfaces [1].

The software was developed using the WinAVR package. The hardware construction of the processor unit allows you to program it using the Arduino IDE. Both software packages are distributed free of charge under the General Public License (GPL).

The power switch module is made on N-channel field-effect transistors IRFZ44N manufactured using MOSFET technology. The IRFZ44N transistor is ideal for driving high-power loads, because of the low resistance of the n-channel (channel resistance in open state Rsi: 28 mΩ) and dissipation power up to 110 W.

The control unit and the goniometer stepper motors are powered by power supplies LRS-150-24, LRS-100-24, APV-12-12.

Structurally, the control and power supply units are housed in an AT case of 330×180×400.

2. SOFTWARE

The goniometer control software includes two levels:
- programs loaded into the module controllers for direct control of stepper motors;
- programs for controlling the goniometer in a computer, realizing the logic of work and interaction with experimenters.

2.1. CONTROLLER PROGRAMS

The ATmega328 microcontroller is programmed using the C ++ language. Programs in each microcontroller are developed and loaded using a special programming environment. The ATmega328 microcontrollers are connected to a computer via USB ports operating in the COM ports emulation mode. Each ATmega328 microcontroller is connected to its own port.

The program in each microcontroller performs the following functions: receiving commands from the computer via the USB port, analyzing the received command, analyzing the state of the limit switches and the current state of the engine, generating pulses of a given period and duration to control the engine, generating and transmitting the state to the computer.

The corresponding programs for controlling motor microcontrollers must be pre-flashed.

2.2. GONIOMETER CONTROL PROGRAM

When starting the control program on the computer, the presence of connected motor control boards is checked and the initial information is loaded from the configuration file on the disk.

The control program supports the exchange of information and control of microcontrollers on boards, displaying information about the state of motors and limit switches on the computer screen, interacting with the operator, loading and saving information when the program is turned on and off, provides the necessary measurements, processes and stores their results.

The general program has a number of tabs providing various functions and operating modes of the goniometer.
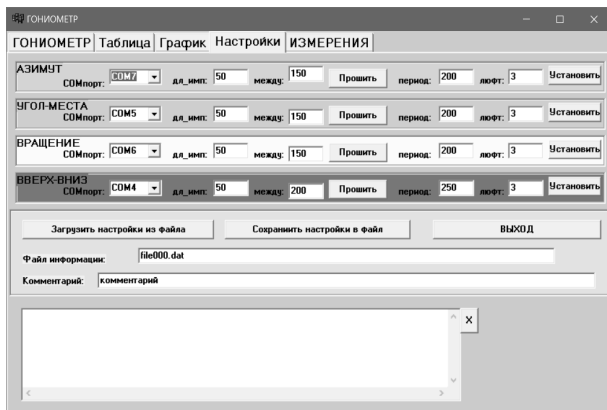

Fig. 3. View of the goniometer control program on the "Settings" tab

On the "Settings" tab (Fig. 3), the operation parameters are set for each direction of movement: the port to which the corresponding control board is connected, the parameters for shaping the impulses of the motor movement in the control board, the period of steps execution, the backlash being worked out. In addition, using the buttons on this tab, the parameters of the goniometer are saved to a configuration file on the disk, the parameters are loaded from the file and installed in the program. On the same tab, a name for the file for recording information during measurements and a comment for this file are set.

The main functions of movement control along the axes is carried out on the "GONIOMETER" tab (Fig. 4) This tab contains control windows for each of the directions: "Rotation along AZIMUTH", "Rotation around the ANGLE OF THE SEAT", "Rotation around the AXIS", "OUTPUT TO BEAM".
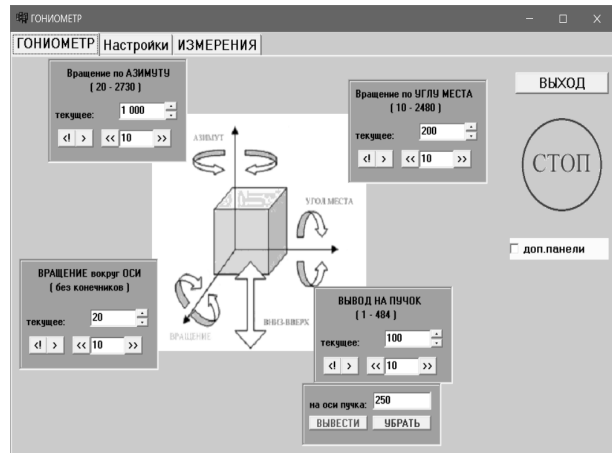

Fig. 4. View of the goniometer control program on the "GONIOMETER" tab in the goniometer control mode

Each of these windows displays information about the permissible range of movement, about pressing the corresponding endpoint when reaching the limits of movement, the current position of the motor. The windows have navigation buttons. Movement control in these directions can be carried out both in single steps mode and in pulse burst mode, the burst size is set in the corresponding field.

For REMOVAL to the beam, the operations of REMOVING directly to the specified vertical position, and REMOVING the return to the lower end are possible.

When moving to the left, the backlash is sampled by performing a specified number of steps and then returning to the same number of steps.

When the tip is reached, further steps in the direction of the pressed tip are blocked. Information about pressing the tip is displayed in the corresponding window.

On the "GONIOMETER" tab, in addition to the engine control mode, the measurement mode is implemented. When you check the "additional panels" checkbox, the corresponding panels for measurements are displayed on the screen (Fig. 5).
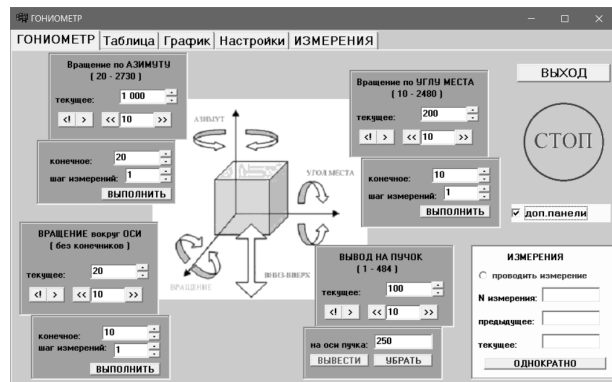

Fig. 5. View of the goniometer control program on the "GONIOMETER" tab in the measurement mode

On the corresponding measurement panel, you set the end position to which the measurement will be made and the step for the measurement positions. By pressing the "EXECUTE" button, a series of measurements and movements are carried out in the corresponding direction. The result of the measurements is displayed on the screen on the "Table" and "Graph" tabs and is written in text form to the information file on the disk.

The measured signal is connected to the inputs of the multifunctional USB module 4704.

The information written to the file is available for further processing by third-party programs.
On the panel "GONIOMETER" there is a STOP button for emergency stop of movement.

To connect USB devices used in the program, the corresponding drivers and libraries are installed.

CONCLUSIONS

The control unit for the goniometer has been developed and manufactured.

The developed software makes it possible to execute the necessary movements and measurements using a goniometric device.

REFERENCES

1. Datasheet on microcontroller ATmega328 https://pdf1.alldatasheet.com/datasheet-pdf/view/313218/ATMEL/ATmega328P.html

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УПРАВЛЕНИЕ ГОНИОМЕТРОМ

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Разработан и изготовлен блок управления гониометром. В состав блока входят четыре независимых программируемых канала управления шаговыми двигателями, три логических канала анализа состояния конечных выключателей и источник электропитания. В качестве управляемых силовых ключей используются мощные полевые транзисторы фирмы International Rectifier. Для формирования выходных сигналов и связи с компьютером в каждом канале управления используется микропроцессор ATmega328. Такое построение канала позволяет управлять практически любым типом шаговых двигателей, требуется только заменить программу управления. Программное обеспечение написано с использованием пакета WinAVR, имеющего General Public License. Передача данных между компьютером и блоком осуществляется по USB-интерфейсу.

УПРАВЛІННЯ ГОНІОМЕТРОМ

Г.П. Васильєв, Г.Д. Коваленко, М.І. Маслов, В.Д. Овчинник, М.Ю. Шуліка, І.М. Шляхов, В.І. Яловенко

Розроблено та виготовлено блок управління гоніометром. До складу блоку входять чотири незалежних програмованих канали керування кроковими двигунами, три логічних канали аналізу стану кінцевих вимикачів та джерело електроживлення. В якості керованих силових ключів використовуються потужні польові транзистори фірми International Rectifier. Для формування вихідних сигналів і зв'язку з комп'ютером у кожному каналі управління використовується мікропроцесор ATmega328. Така побудова каналу дозволяє управляти практично будь-яким типом крокових двигунів, потрібно тільки замінити програму управління. Програмне забезпечення написано з використанням пакета WinAVRб який має General Public License. Передача даних між комп'ютером та блоком здійснюється за допомогою USB-інтерфейсу.