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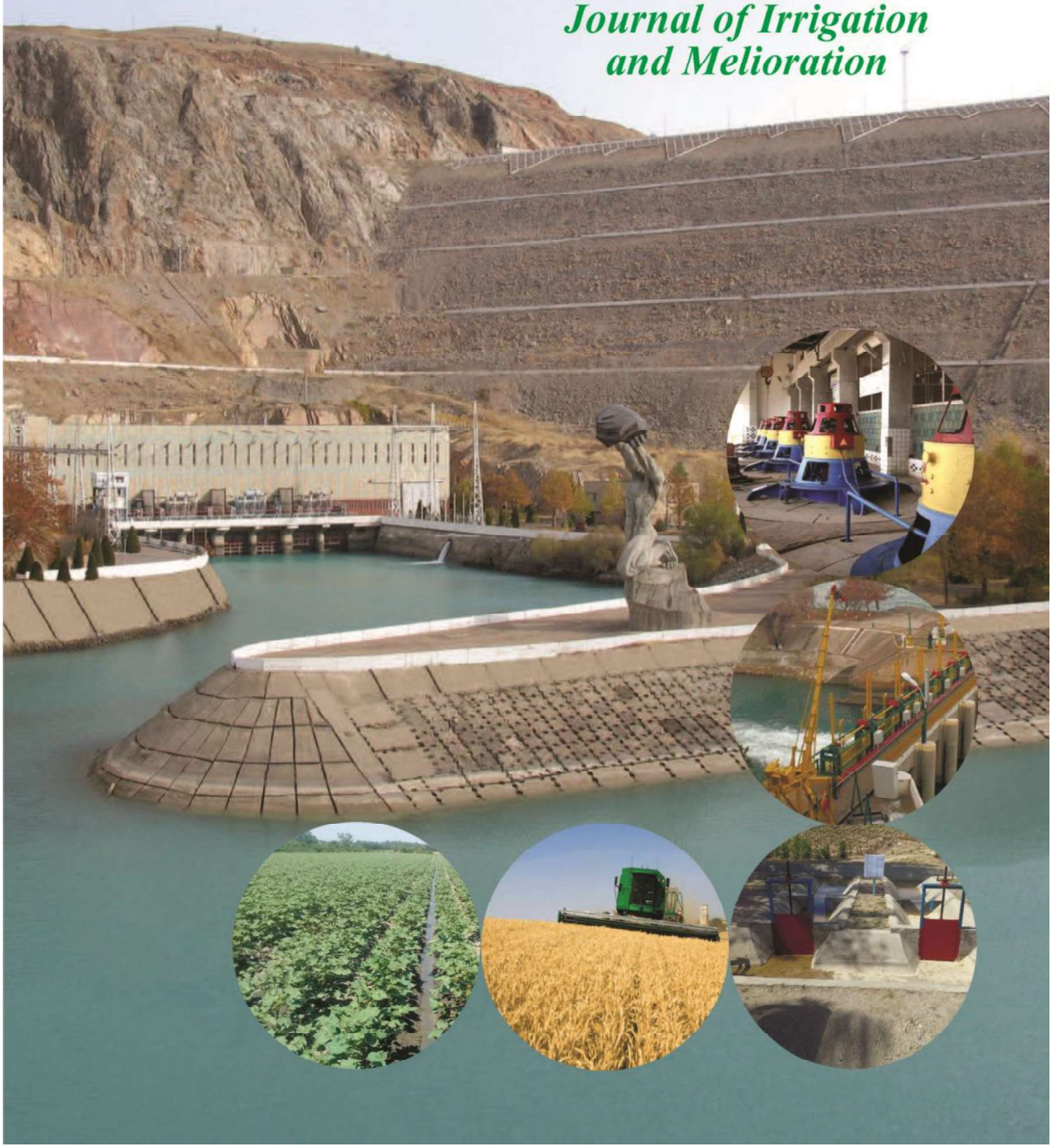

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## ИРРИГАЦИЯ ВА МЕЛИОРАЦИЯ



## ГИДРОТЕХНИКА ИНШООТЛАРИ ВА НАСОС СТАНЦИЯЛАР



## ҚИШЛОҚ ХЎЖАЛИГИНИ МЕХАНИЗАЦИЯЛАШТИРИШ



## ҚИШЛОҚ ВА СУВ ХЎЖАЛИГИНИ ЭЛЕКТРЛАШТИРИШ ВА АВТОМАТЛАШТИРИШ

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# PWB BOARD TOPOLOGY FOR ATMEGA 2560 MICROCONTROLLER IN THE IMPLEMENTATION OF THE AUTOMATIC WATER PURIFICATION SYSTEM FOR IRRIGATION

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**Abstract**

The article discusses the issue of creating a single board for connecting the components of an automatic system for controlling the process of water purification of drainage water for irrigation. The article shows the topology of connecting modules of measuring instruments and control devices in a single package. The article presents a schematic diagram and a 3D model of the control board. The board created according to the technical design features for water purification and the technical justification for the advantage of this topology. Mass-producing circuits with PCBs is cheaper and faster than with other wiring methods, as components are mounted and wired in one operation. Large numbers of PCBs can be fabricated at the same time, and the layout only has to be done once. PCBs can also be made manually in small quantities, with reduced benefits and using of these methods in agriculture give new possibilities to development automation control systems in this sphere.

**Key words:** automation, irrigation, water salinity, water treatment, programming, electronics.

# ТОПОЛОГИЯ PWB ПЛАТЫ ДЛЯ БАЗЫ МИКРОКОНТРОЛЛЕРА ATMEGA 2560 В РЕАЛИЗАЦИИ АВТОМАТИЧЕСКОЙ СИСТЕМЫ ОЧИСТКИ ВОДЫ ДЛЯ ПОЛИВА

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**Аннотация**

В статье рассматривается вопрос создания единой платы соединения компонентов автоматической системы управления процессом водоочистки дренажных вод для орошения. В статье приведена топология соединения модулей измерительных приборов и приборов управления в единую комплектацию. В статье предоставлены принципиальные схемы и 3D модель платы управления процессом водоочистки. Плата создана по техническим особенностям конструкции для очистки воды и приведено техническое обоснование преимущества данной топологии. Серийное производство схем с печатными платами дешевле и быстрее, чем с другими методами подключения, поскольку компоненты монтируются и подключаются за одну операцию. Одновременно можно изготавливать большое количество печатных плат, а компоновку нужно выполнять только один раз. Печатные платы также можно изготавливать вручную в небольших количествах, с меньшими преимуществами, и использование этих методов в сельском хозяйстве открывает новые возможности для разработки систем автоматизации управления.

**Ключевые слова:** автоматика, ирригация, солесодержание воды, водоочистка, программирование, электроника.

# СУҒОРИШ ЖАРАЁНИ УЧУН АВТОМАТИК ТИЗИМИДАГИ ПВБ ПЛАТАНИНГ АТМЕГА 2560 МИКРОКАНТРОЛЕРИ УЧУН ТОПОЛОГИЯСИ

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**Аннотация**

Мақолада суғориш жараёнида дренаж сувини қўллаш учун тозалаш жараёни амалга оширишда қўлланилиши мумкин бўлган автоматик бошқарув тизимининг таркибий қисмларини улаш учун ягона бошқарув платасида жамлаш масаласи кўриб чиқилган. Мақолада ўлчаш воситалари ва бошқариш модуларини ягона тўпламда жамлаш имконини берувчи плата топологияси берилган. Мақолада платанинг 3Д модели ва принципиал схемаси келтирилган бўлиб сув тозалаш ускунасининг тузулиш хусусиятларини инобатга олган ҳолда яратилган. Бу турдаги плата катта миқдорларда ишлаб чиқариш имкониятларини беради. Платага керак бўлган компанентлар бир вақтнинг ўзида уланиши мумкин бу эса ишончлиликни оширади. Бу услубнинг қишлоқ хўжалиги соҳаларига киритилиши, шу соҳадаги ишлаб чиқариш жараёнларининг автоматик бошқарув тизимларини самарасини ошириш учун катта ҳисса қўшиши мумкин.

**Таянч сўзлар:** автоматика, ирригация, сувнинг шўрланганлик даражаси, сув тозалаш, дастурлаш, электроника.

**Introduction.** High water salinity negatively affects soil fertility up to crop loss. In regions with high water salinity, unorthodox methods and devices used to reduce the level of mineralization.

Soil salinization in agriculture is a major process of soil degradation, especially in arid regions. Salinization of soils threatens the natural ecosystem and crops, which are usually sensitive to increased salinity [1].

Soil salinization is widespread: saline and soda soils cover 932.2 million hectares globally, and are one of the main threats to soil degradation worldwide, with ineffective irrigation management affecting 34.19 million hectares or more than 10% from the total area of irrigated land [2].

In Uzbekistan, the economic and demographic pressure on land, especially for agricultural purposes, is increasing from year to year. Of the 17.8 million hectares representing all agricultural land in the republic, only 25% is arable land. Over the past 15 years, the area of agricultural land has decreased by more than 5%, and per capita - by 22% [3]. Over the past 30 years, the area of irrigated land per capita has decreased by about 25%, that is, from 0.23 ha to 0.16 hectares [4].

Considering the above factors, a decrease in the level of water mineralization is very important in the production of agricultural products; in addition, a decrease in the level of soil salinity contributes to an increase in yield. At the moment, the most relevant and developing method of water purification is mechanical or membrane purification, this method is much more effective and much more intensively purifies water than other existing methods [5].

The membrane purification method has its drawbacks - this is the period of operation of the filter, which was indicated in the works of such scientists as I. Khaled "Experimental and numerical optimization of reverse osmosis desalination plant" in which aspects of optimization of the operating period of a reverse osmosis desalination plant are considered [6]. Similar data drawbacks highlighted. Methods in the work of C. Ezedike "Analysis and design of a water purification system for the West African area of operation" [7].

The filter breaks down very quickly, given that, a large volume of water use in agriculture, and the use of this method is economically impractical. To eliminate the above problems, special designs developing taking into account the load and the selective selection of the flow of transferring water for irrigation. A structure of this type could be intensively use with an existing automatic system; without an automatic system, the implementation of this structure is technically impossible. [8].

The control algorithms of the automatic system implementing based on the logic loaded into the controller then receive accounting data about the ongoing technological process using measurement modules and sensors.

The technical side of the implementation of an automatic system based on the integration of modules, sensors, actuators, and a programmable logic controller [9].

The design that use for water treatment has its own specific character and requires an individual approach to the development of an automatic control system. An automatic technical system cannot realized without a printed circuit board and integration connection. In addition, the PWB type printed circuit board increases the signal exchange rate and can be mass-produced [9].

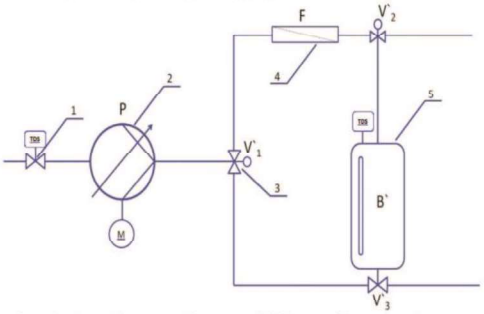
This article discusses the development of a printed circuit board for the process design of selective selection of the volume of water for filtration. Similar issues of creating a topology for printed circuit board technological processes were discussed in the works of such scientists as Senpinar A., K. Arnold, P. Srihari, J. Dilella.

**Research method.** In creating the board topology, the modeling method used taking into account the technical requirements, the connection of the necessary elements of radio electronics, and modules of measuring devices [10].

*Object of research.* The object of research is construction for the selective choice of purification or direct supply of water to the mixing capsule.

The basic principle of operation of the proposed design is to create the required concentration of water with an acceptable salt content inside the tank and then transfer it for irrigation.

The device consists of 5 parts: 1- conduct metric sensor that will be installed in the water source to determine the salt content in the source, 2- centrifugal pump for water transfer, 3-on-off solenoid valves for water distribution, 4-reverse osmosis to lower the salt level in the water, 5- capsules for collecting water (see Figure 1) [11].




*1-conductometric sensor; 2-pump unit; 3-two position valve; 4-reverse osmosis; 5-diffused capsule.*

***Fig. 1. Diffusion mixing design***

The principle of operation of the design is that the electromagnetic control valve V1 distributes water for cleaning using reverse osmosis, valve V2 is use to supply purified water to the capsule, valve V3 is use to supply mixed water for irrigation. The valve operating time and the volume of water flow distribution for cleaning and for direct transfer to the capsule depends on the salinity of the water source. The data that is transmitted from the 1st sensor goes to the controller and then the controller, based on the built-in algorithm, sets the operating time of the on-off valves. The level of reverse osmosis load depends on the salinity of the water source and thus it is possible to extend the level of operation of reverse osmosis by creating an individual regime depending on the degree of salinity of the water [12].

The mixing capsule is equipped with a level sensor and a conductometric sensor to monitor the quality and volume of water inside the capsule.

The technical execution of the liquid circulation of this design is carry out using relays that act on the control valve. The control circuit is carry out using this circuit diagram.

*Algorithm and control method*

Algorithm of work this system based on the equation-1 composition of the source water from the first sensor, and the required final concentration of irrigation water to will obtained. It is required to obtain it by adding pure water from a filter to the initial saltwater containing the required substance. According to the formula below, we can get the amount of pure water needed for the initial part.

$$V_2 = \frac{C_1V_1 - CV_1}{C - C_2} \quad (1)$$

In (1) The concentration of the substance in the first component of the mixture C1, the volume of the first component of the mixture V1, the concentration of the substance in the second component of the mixture C2, the final, the required concentration of the substance C [13].

Switching on and off two-position valves is described based on scheme number two. Confirming the level of the content above or below the specified norm the water components

transfers it for filtration or directly in diffusion, mixing capsules (see figure 2).

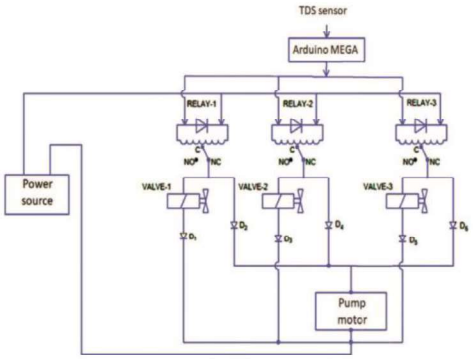



***Fig.2. Schematic diagram of diffusion mixing control***

The algorithm of the technological process, and its automation is carried out in this way, at the beginning of the process, the initial data from the sensors is taken initially, and then they are compared using equation 1, if the water level exceeds this standard for irrigation, which is 3 g per liter, then the water is sent for cleaning. to say that the total volume in the distribution of water is precisely the proportion inside the capsule based on the salt content inside the source. The main logic of the system is to bring the content inside the capsule up to 3 grams, regardless of the volume of salt content inside the source, if the salt content inside the source is high, then the operating time of reverse osmosis increases significantly and the distribution valve mainly operates in the purification mode.

To implement the work of the equation and the block diagram will be using a circuit architecture based on the Arduino line. The logic equation will uploaded to the ATmega 2560 microprocessor because of which the microprocessor solution will transmitted to the executive body in the form of a relay module. Relay modules will transmit voltage to the two-position solenoid valve (see figure 3)[14].

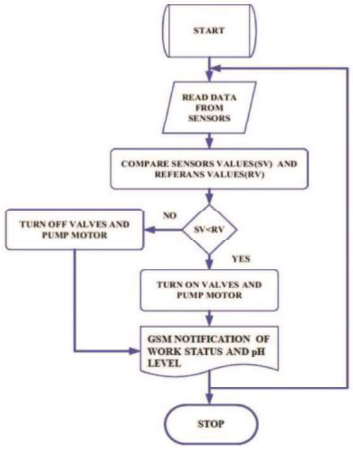



***Fig.3. Block diagram of the control system algorithm***

This microcircuit used to control the automatic system of the experimental stand. The comparison logic program and automatic process control made on the Arduino IDE platform. To control the technological process of using the Arduino Mega microcontroller based on the ATmega 2560 microprocessor.

To measure water quality used a pH sensor with a v 1.1 interface for the Arduino platform with a BNC connector.

For the operation of the on / off valves, four single channel low voltage 5 V relay modules are used. For remote control, the GSM module SIM 800 is used. For local monitoring of the unit operation, a digital display is used (see Figure 4) [15].

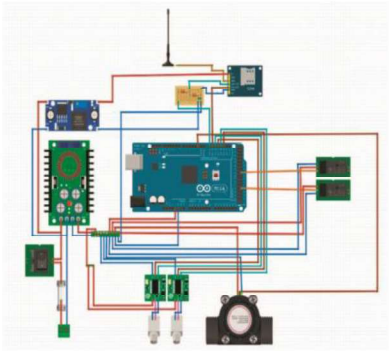


***Fig. 4. Automatic control circuit of the device***

**Results of research.** Based on the above data, a batch-mixing prototype created in Figure-3. The mixing capsule volume is 300 ml. The TDS sensor is use to determine the salt content of the source and mixing capsule. Considering the fact that the water concentration based on the volume and operating time of the valves, an electrode-type water level sensor was installed in the inside of the capsule. (see Figure 5) [16].

The process control panel design according to the architecture shown in Fig. 3. When the device is working, it shows that there are 0.98 grams of salt in the liquid, which is optimal for irrigation [17].

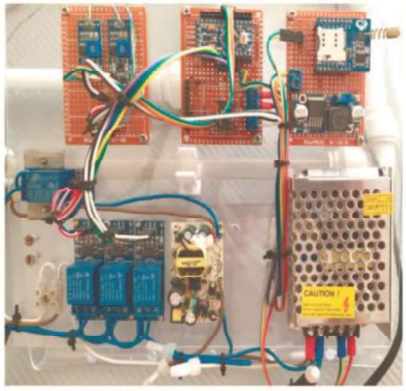


***Fig. 5. The architecture of the control circuit of the experimental bench***

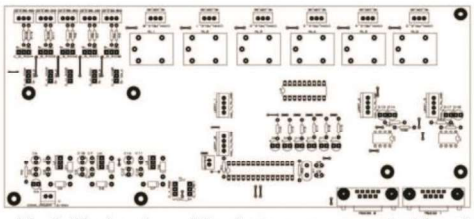


*Fig. 6. The topology of the design process control board*

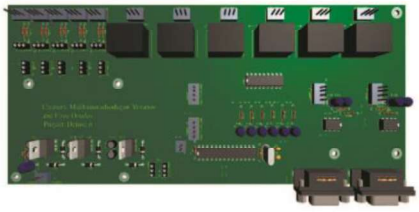


*Fig. 7. 3D topology model of the construction process control board*

Based on the obtained optimal indicators, a full-fledged topography of the technological process control board created.

In contrast to the experimental stand, the topology takes into account the general group of relays for performing the technological process and the microcontroller completely merges with the remaining modules of measuring instruments without external wires [18]. The scheme takes into account the connection of CAM ports for connection and there are no connection wires at all, which increases the reliability of signal exchange [19, 20].

**Conclusion.**

When creating the topology, the following advantages and disadvantages identified;

1.This topology of the printed circuit board makes it possible to use the technological process in a fully integrated form and makes it possible to make a serial production.

2.The control board connects the modules of measuring devices and relays without additional wires, which increases the reliability of the system.

3. Due to the fact that the microcontroller fully integrated with the board, it is more compact in production.

4. Modules of measuring devices and microcontroller processor, directly connected to each other, which increases the signal exchange rate and noise immunity.

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