

**AUTOMATION OF MICROCLIMATE CONTROL FOR LONG STORAGE OF
VEGETABLES AND FRUIT**

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***Abstract:** The issues of the possible implementation in the agricultural industry of an automated alarm system for measuring moisture during storage of crops and microclimate control in the premises of vegetable stores are described in the article.*

***Keywords:** agricultural products, moisture, electrode, sensor, multivibrator, microcircuit, resistor, low-frequency pulse.*

At the present stage of development of all mankind, one of the main strategic tasks is to solve the food supply of the population. In order to continuously provide people with vegetables and fruits, it is necessary to extend their storage in vegetable storage facilities. This strategic task is solved in several stages. These include preserving the integrity of fruits, limiting the physiological activity of stored vegetables and microorganisms, increasing the physiological stability of vegetables, ensuring the fulfillment of the evolutionary purpose of the organism at the time needed by the consumer. The strategic task of storage is to limit the physiological activity of two antagonistic populations: plant host organisms and pathogenic microorganisms, causative agents of their spoilage. In this regard, at present, the possibilities of storage methods based on reducing the physiological activity of vegetables and microorganisms are limited.

For this purpose, at the current stage of development, automated microclimate control systems are used with the use of moisture-sensitive alarm sensors.

We offer a sensor configuration with a built-in base microcircuit designed to measure the moisture content in solid and volatile substances.

Two electrode capacitors are used as alarm sensors. Depending on the humidity of the measured environment, the resistance between the electrodes changes in connection with the resistance value, that is, when the humidity increases, the resistance between the electrodes decreases, the current passing through the circuit increases, and sensor signals are received [4].

The main element of the circuit is the integrated circuit CD4002A or SD4002V. These integrated circuits consist of four logical elements "I-NE". The elements of the circuit are powered by a 3-5V uninterruptible power supply. Elements DD1.1 and DD1.2 are the first multivibrator, DD1.3 and DD1.4 are the second multivibrators. The microcircuit has 14 external connecting ends (outputs) of the circuit (Fig. 1).

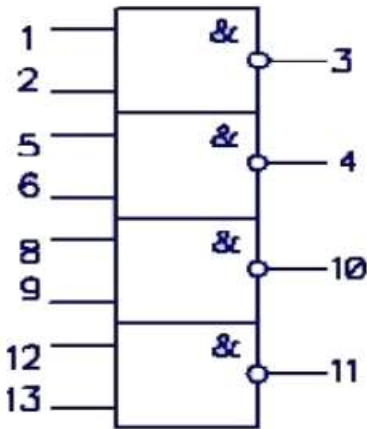


Figure 1. Microcircuit.

End of chains 1,2,5,6,8,9,12,13 is the input, 3,4,10,11 are the ends, end 7 is the common (mass) end, end 14 is the connecting end. Figure 2 shows the basic circuit diagram of the alarm. The output of the sensitive element (electrode) is connected to end 1 of the chain. The pulse is transmitted to end 1 of the microcircuit through sensitive elements installed in the environment with the measured humidity. Capacitor S1 with a capacity of 33 pF is charged by the signal received by sensors F1 and F2 of external humidity, and holds the logical signal 1 at the input of the CD4002A microcircuit until it is completely discharged through resistor R1 with a 22 MOhm resistor. If the environment is dry, the signal at the end of the microcircuit is logically equal to 0.

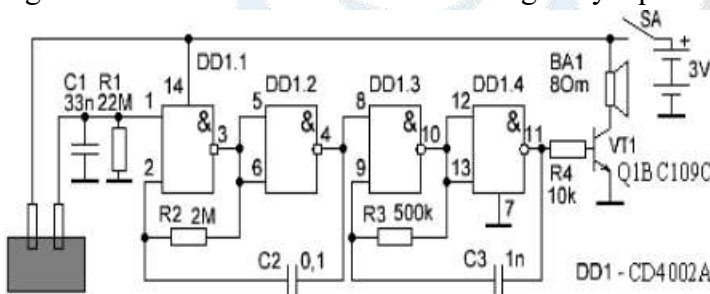


Figure 2. Schematic diagram of the signaling system.

The other two I-NE elements are interconnected as indicated above. The resistance of the resistor R3 used in the second part of the circuit is 500 kOhm, the capacitor S3, the capacitor 1 pF.

The first elements of the multivibrator DD1.1 and DD1.2 generate a low-frequency pulse, the second elements of the multivibrator DD1.3 and DD1.4 produce a sound pulse.

The microcircuit is controlled through DD1.1. If the measured medium is not wet, the source voltage cannot charge the capacitor C1 due to the high resistance between the electrodes. The signal at the input end of element 1 of DD1.1 is logically 0. The first multivibrator will not work, and the output signal will be logically 0. This logical 0 is transmitted in time to one of the elements DD1.3 of the second multivibrator, and the logical 0 signal blocks the second multivibrator. As a result, there is no signal at the output of the second multivibrator (end 11 of the mixer).

When the moisture evaporates, the DD1.1 element inputs a signal through the electrodes. This signal also charges the capacitor S1.

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The first multivibrator is triggered. Depending on this, the second multivibrator will also be triggered, which will generate a pulse at the output of 11 circuits. This pulse enters the base of the transmitter through the resistor R4, and with the effect of a logical signal of 1, the transmitter opens and produces a dynamic sound signal connected to the output of the circuit.

The energy accumulated in the capacitor S1 is discharged by the resistor R1. Until the capacitor S1 is completely discharged, the logical signal level at the 1st end of the DD1.1 element is 1.

The sensor model we have developed can sense moisture at a distance. To do this, you just need to narrow the distance between the electrodes. In this case, our sensor will sense moisture released from the surface of the stored product, for example, in vegetable storage facilities.



These sensors operate both in immersion and free space. Their operating principle is based on the operation of contacts between electrodes, which, when the interelectrode distance approaches a minimum, are triggered at fairly low moisture concentrations in the space above the stored products, thereby ensuring constant microclimate control. Only for certain crops, such as potatoes, onions, ripening fruits and fruit vegetables, a step-by-step mode with constantly decreasing temperatures was recommended. In this case, automatic control of the room microclimate is set in accordance with the sequence of the storage mode for a certain period. An example is the recommended storage mode for potatoes for different periods: during the treatment period 13-18 ° C, during the main period - 3-5 ° C with a gradual decrease in temperature by 0.5 ° C per day, in the spring period - 1-2 ° C.

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