The use of RS-485 and CAN interfaces for connecting sensors in climate control systems of greenhouse complexes

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Abstract. Purpose of this article is to demonstrate the features of the use of existing connection interfaces for the functioning of climate control systems of agricultural complexes. The article contains the author's classification of the characteristics of the connection interfaces. The two most suitable interfaces are considered. The article compares RS-485 and CAN protocols. Key differences between CAN and RS-485 for use in agricultural complexes are shown. A test sample of a system containing 3 sensors was presented.

1 Introduction

According to statistics, 4 billion people in the world (56%) live in cities [1]. A person consumes 1.5 kg of food per day. The total daily food intake reaches 6 million tons. Greenhouse complexes are being built near major cities to compensate for food losses and reduce the cost of supplies.

Year-round greenhouses create the ability to supply daily crops to consumer and silage grass to livestock farms. Plants need an optimal range of climatic conditions to maximize their yield. Yield conditions are temperatures above 14 C and illumination of at least 8 hours a day for most light-loving plants [2]. The optimum temperature for plants is maintained by a climate control system that includes a heating system, humidifiers, lamps and air condition sensors. All elements of the climate control system are connected to each other via an interface.

Modern agricultural complexes can cover an area of up to 30 hectares. This poses a challenge for the interface used, as the signal strength decreases with increasing cable length.

The problems of climate formation in greenhouses have been raised more than once. A.N. Zadeev in his article describes the calculation of the thermal regime of the greenhouse [3]. This article is necessary when setting up the interface of the heating system of a greenhouse complex. The main factors are the ambient air temperature and indoor

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insolation. The amount of heat transmitted by sunlight throughout the year on the territory of Kazakhstan is shown in Figure 1.

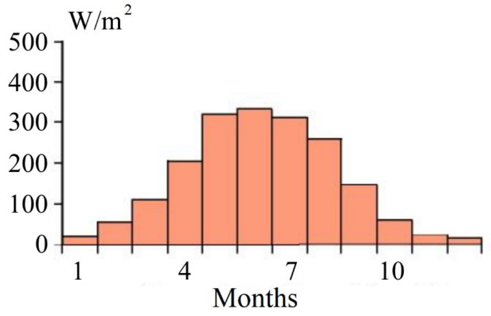

Fig. 1. Change of insolation during the year.

Agarkova A.M. and Iveshko G.G. raises the issue of rational consumption of energy resources when heating greenhouse premises. [4]. When operating a greenhouse complex in winter, it is necessary to take into account 2 important factors:

- Do not allow the temperature to drop below optimal.
- Avoid excessive consumption of fuel for space heating. This can lead to excessive evaporation and increased humidity in greenhouses.

The trend towards urbanization dictates the need to provide food for more and more people all year round. Efficient use of land in the suburban zone is possible with the competent organization of greenhouse complexes.

The purpose of this article is to demonstrate the features of the use of existing connection interfaces for the functioning of climate control systems of agricultural complexes.

2 Matherials and methods

Connection interfaces have not clear classification system yet. Each of them still has a set of characteristics that reveal different aspects such as:

- Data transfer rate;
- Coverage of the network;
- Simplicity of the transfer protocol;
- Energy saving;
- Safety;
- Reliability and performance;
- Market prevalence.

The specifics of working with greenhouse complexes involves changes in the microclimate of greenhouses within hours of time at considerable distances (up to 30 hectares). The transmitted data has no significant commercial value. A systematic failure in data transmission will be difficult to notice until it leads to crop losses.

All listed factors put forward the requirements for network coverage (distance and number of sensors), and neglect factors such as data transfer speed and network security. The personnel of the agricultural complex does not always have the quick network repair experience. Therefore, simplicity of the protocol and market availability are also desirable, but not paramount.

The interface used in most enterprises and ICS devices is RS-485. This interface has the ability to organize two-way data exchange with just one twisted pair of wires. It provides a communication length up to 1200 meters and assumes connection up to 32 devices (sensors) [5, 6].

The soil is saturated with fertilizers and moisture, which provoke cable corrosion. Therefore, the cable is laid above the ground. But the cable can be damaged by vehicles in this case. It is recommended to run the cable along the walls of the greenhouse complex. The pairing of RS-485 and power circuits should be avoided, especially in a common braid. The overhead cable can be replaced or repaired easily.

RS-485 interface has code combinations prohibited for transmission, which complicates its inner architecture. The RS-422 interface is devoid of this drawback. Its simplicity in comparison with RS-485 can be seen in Figure 2. However, it assumes the connection of only 10 devices (sensors). Its application for large greenhouse complexes will not be considered. An example of RS-485 connection is shown in Figure 2.

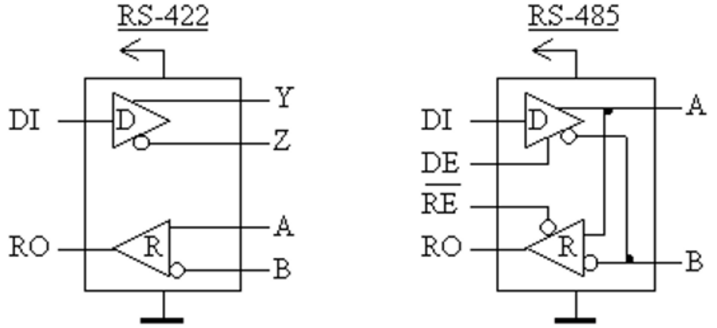

Fig. 2. Connection diagrams RS-422 and RS-485.

The CAN (Controller Area Network) interface can be a full-fledged analogue of RS-485 interface [7]. The CAN format is common in many areas. It was originally developed for the automotive industry. The CAN interface allows data transmission over 1000 m and up to 64 devices. The protocol provides for special methods of error detection, error signaling and self-monitoring to achieve maximum reliability of the transmitted data.

The following measures are used to detect errors:

- The transmitter compares each bit on the bus with the transmitted bit to confirm correct transmission at the bit level;
- Cyclic Redundancy Check (CRC) is performed;
- Bit stuffing is used;
- Check of each transmitted frame is used.

This increases the size of the overhead in the package and the complexity of the internal architecture, which complicates the repair. The authors find these security measures redundant for transmitting data on the state of the greenhouse complex.

3 Results and discussion

As a test sample, the authors assembled a temperature control system based on a greenhouse facility in Rudny, Kazakhstan. The RS-485 protocol was used (Figure 3).

Three sensors are installed: the first is at ground level, the second is at the ceiling level, the third is on the street. It is possible to monitor online what is the temperature in the greenhouse at a given time and change the temperature and humidity indicators.

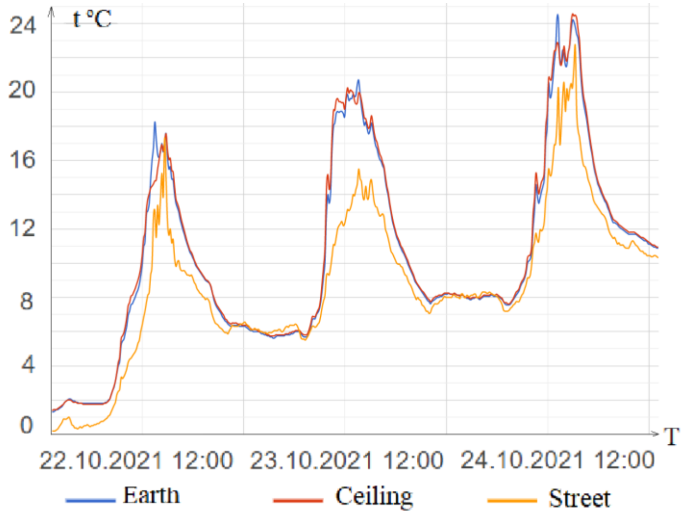

Fig. 3. Temperature control system performance.

Modernization of greenhouses, introduction of a climate control system and efficient use of resources allows increasing the yield of the agricultural complex by 20 percent [8].

Outside air temperature significantly affects the greenhouse yield due to large heat losses through the greenhouse fences. The light of the sun is biologically important for plants. However, insolation does not have a significant effect on the indoor temperature in the winter period.

Analysis shows that a large number of devices cannot be connected to a network with a simple architecture. This limits the choice of technical solutions to advanced interfaces. For large greenhouse complexes, for those who grow similar agrocultures, the RS-485 interface is suitable. It allows enough sensors to be placed within a 1200 meter radius around the main controller. For a dense accumulation of greenhouses for growing various crops, the CAN interface is suitable. It allows you to cover a circle with an area of 30% less, however the placement of sensors in the accessible area will be up to 3 times denser.

In multi-node systems at speeds above 1 Mbit/s, under harsh conditions, the advantage remains with CAN. The CAN interface has a wide temperature range. It is well suited for automotive and transportation applications. This is not required to transfer data from a greenhouse agricultural complex. The transfer of temperature and humidity parameters for greenhouses is better handled by the RS-485 interface. Excessive CAN productivity in this situation is not applicable [9, 10].

4 Conslusion

The article provides a detailed comparison of the RS-485 and CAN interface protocols. Key differences between CAN and RS-485 for use in agricultural complexes is shown. CAN interface provides 30% closer sensor coverage. It is designed for larger industries such as automotive and aerospace. RS-485 provides just enough sensor coverage and has a technological reserve of the recognition level. It also has 30% more coverage.

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